

Package ‘Luminescence’

September 18, 2026

Type Package

Title Comprehensive Luminescence Dating Data Analysis

Version 1.3.1

Date 2026-09-18

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Description A collection of various R functions for the purpose of Luminescence dating data analysis. This includes, amongst others, data import, export, application of age models, curve deconvolution, sequence analysis and plotting of equivalent dose distributions.

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URL <https://r-lum.github.io/Luminescence/>

BugReports <https://github.com/R-Lum/Luminescence/issues>

Depends R (>= 4.4)

LinkingTo Rcpp (>= 1.1.2)

Imports bbmle (>= 1.0.25.1), data.table (>= 1.18.4), DEoptim (>= 2.2-8), httr (>= 1.4.8), interp (>= 1.1-6), lamW (>= 2.2.7), matrixStats (>= 1.5.0), methods, minpack.lm (>= 1.2-4), mclust (>= 6.1.3), Rcpp (>= 1.1.2), shape (>= 1.4.6), stats, parallel, utils, XML (>= 3.99-0.23),

Suggests spelling (>= 2.3.2), plotly (>= 4.12.1), rmarkdown (>= 2.31), rstudioapi (>= 0.19.0), rjags (>= 4-17), coda (>= 0.19-4), knitr, pander (>= 0.6.6), testthat (>= 3.3.2), vdiffr (>= 1.0.9), tiff (>= 0.1-12), devtools (>= 2.5.2), R.rsp (>= 0.46.0)

VignetteBuilder R.rsp, knitr

Encoding UTF-8

Language en-US

Config/testthat/edition 3

Config/testthat/parallel TRUE

Config/roxygen2/version 8.1.0

NeedsCompilation yes

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Repository CRAN

Date/Publication 2026-09-18 06:41:01 UTC

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Luminescence-package *Comprehensive Luminescence Dating Data Analysis*

Description

A collection of various R functions for the purpose of luminescence dating data analysis. This includes, amongst others, data import, export, application of age models, curve deconvolution, sequence analysis and plotting of equivalent dose distributions.

Details

Supervisor of the initial version in 2012

Markus Fuchs, Justus-Liebig-University Giessen, Germany

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- <developers@r-luminescence.org>
- <https://github.com/R-Lum/Luminescence/discussions>

Bug reporting

- <developers@r-luminescence.org> or
- <https://github.com/R-Lum/Luminescence/issues>

Project website

- <https://r-luminescence.org>

Project source code repository

- <https://github.com/R-Lum/Luminescence>

Related package projects

- <https://cran.r-project.org/package=RLumShiny>
- <https://cran.r-project.org/package=RLumModel>
- <https://cran.r-project.org/package=RLumCarlo>
- <https://cran.r-project.org/package=RCarb>

Funding

- 2011-2013: The initial version of the package was developed, while Sebastian Kreutzer was funded through the DFG programme "Rekonstruktion der Umweltbedingungen des Spätpleistozäns in Mittelsachsen anhand von Löss-Paläobodensequenzen" (DFG id: 46526743)
- 2014-2018: Cooperation and personal exchange between the developers is gratefully funded by the DFG (SCHM 3051/3-1) in the framework of the program "Scientific Networks". Project title: "RLum.Network: Ein Wissenschaftsnetzwerk zur Analyse von Lumineszenzdaten mit R" (2014-2018)
- 05/2014-12/2019: The work of Sebastian Kreutzer as maintainer of the package was supported by LabEx LaScArBx (ANR - n. ANR-10-LABX-52).
- 01/2020-04/2022: Sebastian Kreutzer as maintainer of the package has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 844457 (CREDit), and could continue maintaining the package.
- since 03/2023: Sebastian Kreutzer as maintainer of the package receives funding from the DFG Heisenberg programme No 505822867.
- since 08/2024: The future and sustainable development of 'Luminescence' towards better reproducibility and usability is supported through the DFG programme "REPLAY: REProducible Luminescence Data AnalYses" No 528704761, led by Dr Sebastian Kreutzer (PI at LIAG - Institute for Applied Geophysics, Hannover, DE) and Dr Thomas Kolb (PI at Justus-Liebig-University Giessen, DE).
- All other authors gratefully received additional funding from various public funding bodies.

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References

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- Mercier, N., Galharret, J.-M., Tribolo, C., Kreutzer, S., Philippe, A., 2022. Luminescence age calculation through Bayesian convolution of equivalent dose and dose-rate distributions: the De_Dr model. *Geochronology* 4, 297–310. [doi:10.5194/gchron42972022](#)
- Smedley, R.K., 2015. A new R function for the Internal External Uncertainty (IEU) model. *Ancient TL* 33 (1), 16-21.
- King, E.G., Burow, C., Roberts, H., Pearce, N.J.G., 2018. Age determination using feldspar: evaluating fading-correction model performance. *Radiation Measurements* 119, 58-73. [doi:10.1016/j.radmeas.2018.07.013](#)

See Also

Useful links:

- <https://r-lum.github.io/Luminescence/>
- Report bugs at <https://github.com/R-Lum/Luminescence/issues>

add_metadata<-	<i>Safe manipulation of object metadata</i>
----------------	---

Description

Generic functions for manipulation of metadata in [Risoe.BINfileData](#), [RLum.Analysis](#) and [RLum.Data](#) objects.

Usage

```
add_metadata(object, ...) <- value

rename_metadata(object, ...) <- value

replace_metadata(object, ...) <- value

## S4 replacement method for signature 'RLum.Analysis'
add_metadata(object, info_element) <- value

## S4 replacement method for signature 'RLum.Analysis'
rename_metadata(object, info_element) <- value

## S4 replacement method for signature 'RLum.Analysis'
replace_metadata(object, info_element, subset = NULL) <- value

## S4 replacement method for signature 'RLum.Data'
add_metadata(object, info_element) <- value

## S4 replacement method for signature 'RLum.Data'
rename_metadata(object, info_element) <- value

## S4 replacement method for signature 'RLum.Data'
replace_metadata(object, info_element, subset = NULL, verbose = TRUE) <- value

## S4 replacement method for signature 'Risoe.BINfileData'
add_metadata(object, info_element) <- value

## S4 replacement method for signature 'Risoe.BINfileData'
rename_metadata(object, info_element) <- value

## S4 replacement method for signature 'Risoe.BINfileData'
replace_metadata(object, info_element, subset = NULL) <- value
```

Arguments

object [RLum.Analysis](#), [Risoe.BINfileData](#) (**required**): object of class [RLum.Analysis](#) or [Risoe.BINfileData](#) to manipulate.

...	further arguments passed to the specific class method
value	(required) : value to be assigned to the selected metadata entry. A NULL value is acceptable only for replace_metadata, in which case the elements named in info_element will be removed.
info_element	character (required) : name of the metadata entry to manipulate.
subset	expression (optional) : logical expression to limit the substitution only to the selected subset of elements.
verbose	logical (with default) : enable/disable output to the terminal.

Functions

- add_metadata(RLum.Analysis) <- value: Adds metadata to [RLum.Analysis](#) objects.
- rename_metadata(RLum.Analysis) <- value: Renames a metadata entry of [RLum.Analysis](#) objects.
- replace_metadata(RLum.Analysis) <- value: Replaces or removes metadata of [RLum.Analysis](#) objects.
- add_metadata(RLum.Data) <- value: Add metadata entries to [RLum.Data](#) objects.
- rename_metadata(RLum.Data) <- value: Rename a metadata entry of [RLum.Data](#) objects.
- replace_metadata(RLum.Data) <- value: Replaces or removes metadata of [RLum.Data](#) objects.
- add_metadata(Risoe.BINfileData) <- value: Adds metadata to [Risoe.BINfileData](#) objects.
- rename_metadata(Risoe.BINfileData) <- value: Renames a metadata entry of [Risoe.BINfileData](#) objects.
- replace_metadata(Risoe.BINfileData) <- value: Replaces or removes metadata of [Risoe.BINfileData](#) objects.

How to cite

Colombo, M., 2026. add_metadata<-(): Safe manipulation of object metadata. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Marco Colombo, Institute of Geography, Heidelberg University (Germany) , RLum Developer Team

See Also

[RLum.Data](#), [RLum.Analysis](#), [Risoe.BINfileData](#)

Examples

```
## load example data
data(ExampleData.BINfileData, envir = environment())

## show data
CWOSL.SAR.Data

## add a new field
add_metadata(CWOSL.SAR.Data,
             info_element = "INSTITUTE") <- "Heidelberg University"

## rename a field
rename_metadata(CWOSL.SAR.Data,
               info_element = "INSTITUTE") <- "INSTITUTION"

## replace all LTYPE to RSL
## but only for the first position
replace_metadata(
  object = CWOSL.SAR.Data,
  info_element = "LTYPE",
  subset = (POSITION == 1)) <- "RSL"

## replacing a field with NULL allows to remove that field
replace_metadata(CWOSL.SAR.Data,
               info_element = "PREVIOUS") <- NULL

## show the modified data
CWOSL.SAR.Data
```

analyse_Al2O3C_CrossTalk

Al2O3:C Reader Cross-Talk Analysis

Description

The function provides the analysis of cross-talk measurements on a FI lexsyg SMART reader using Al2O3:C chips.

Usage

```
analyse_Al2O3C_CrossTalk(
  object,
  signal_integral = NULL,
  integral_input = c("channel", "measurement"),
  dose_points = c(0, 4),
  recordType = "OSL (UVVIS)",
  irradiation_time_correction = NULL,
  method_control = NULL,
```

```

    plot = TRUE,
    ...
  )

```

Arguments

object [RLum.Analysis](#) or **list** (**required**): measurement input

signal_integral [numeric](#) (*optional*): signal integral, used for the signal and the background. If nothing is provided, the full range is used.

integral_input [character](#) (*with default*): input type for signal_integral, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.

dose_points [numeric](#) (*with default*): vector with dose points, if dose points are repeated, only the general pattern needs to be provided. Default values follow the suggestions made by Kreutzer et al., 2018.

recordType [character](#) (*with default*): input curve selection, which is passed to [get_RLum](#). To deactivate the automatic selection set the argument to NULL.

irradiation_time_correction [numeric](#) or [RLum.Results](#) (*optional*): information on the used irradiation time correction obtained by another experiment.

method_control [list](#) (*optional*): optional parameters to control the calculation. See details for further explanations.

plot [logical](#) (*with default*): enable/disable the plot output.

... further arguments and graphical parameters to control the plot output. Supported are: main, mtext, and pt.cex (point size).

Value

Function returns results numerically and graphically:

```
[ NUMERICAL OUTPUT ]
```

RLum.Results-object

slot: @data

Element	Type	Description
\$data	data.frame	summed apparent dose table
\$data_full	data.frame	full apparent dose table
\$fit	lm	the linear model obtained from fitting
\$col.seq	numeric	the used colour vector

slot: @info

The original function call

[PLOT OUTPUT]

- An overview of the obtained apparent dose values

Function version

0.1.5

How to cite

Kreutzer, S., 2026. analyse_Al2O3C_CrossTalk(): Al2O3:C Reader Cross-Talk Analysis. Function version 0.1.5. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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References

Kreutzer, S., Martin, L., Guérin, G., Tribolo, C., Selva, P., Mercier, N., 2018. Environmental Dose Rate Determination Using a Passive Dosimeter: Techniques and Workflow for alpha-Al2O3:C Chips. *Geochronometria* 45, 56-67. doi: 10.1515/geochr-2015-0086

See Also

[analyse_Al2O3C_ITC](#)

Examples

```
##load data
data(ExampleData.Al2O3C, envir = environment())

##run analysis
analyse_Al2O3C_CrossTalk(data_CrossTalk)
```

analyse_Al2O3C_ITC *Al2O3 Irradiation Time Correction Analysis*

Description

The function provides a very particular analysis to correct the irradiation time while irradiating Al2O3:C chips in a luminescence reader.

Usage

```
analyse_Al2O3C_ITC(
  object,
  signal_integral = NULL,
  integral_input = c("channel", "measurement"),
  dose_points = c(2, 4, 8, 12, 16),
  recordType = "OSL (UVVIS)",
  method_control = NULL,
  verbose = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

object	RLum.Analysis or list (required) : results obtained from the measurement. Alternatively a list of RLum.Analysis objects can be provided to allow an automatic analysis
signal_integral	numeric (<i>optional</i>): signal integral, used for the signal and the background. If nothing is provided the full range is used. Argument can be provided as list .
integral_input	character (<i>with default</i>): input type for signal_integral, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.
dose_points	numeric (<i>with default</i>): vector with dose points, if dose points are repeated, only the general pattern needs to be provided. Default values follow the suggestions made by Kreutzer et al., 2018. Argument can be provided as list .
recordType	character (<i>with default</i>): input curve selection, which is passed to function get_RLum . To deactivate the automatic selection set the argument to NULL
method_control	list (<i>optional</i>): optional parameters to control the calculation. See details for further explanations
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further arguments and graphical parameters to control the plot output. Supported are: xlab, ylab, main, xlim, ylim, pt.cex (point size), legend.pos, legend.text, and mtext.

Details

Background: Due to their high dose sensitivity Al₂O₃:C chips are usually irradiated for only a very short duration or under the closed beta-source within a luminescence reader. However, due to its high dose sensitivity, during the movement towards the beta-source, the pellet already receives and non-negligible dose. Based on measurements following a protocol suggested by Kreutzer et al., 2018, a dose response curve is constructed and the intersection (absolute value) with the time axis is taken as real irradiation time.

method_control

To keep the generic argument list as clear as possible, arguments to allow a deeper control of the method are all preset with meaningful default parameters and can be handled using the argument method_control only, e.g., method_control = list(fit.method = "LIN"). Supported arguments are:

ARGUMENT	FUNCTION	DESCRIPTION
mode	fit_DoseResponseCurve	sets the mode used for fitting
fit.method	fit_DoseResponseCurve	sets the function applied for fitting

Value

Function returns results numerically and graphically:

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$data	data.frame	correction value and error
\$table	data.frame	table used for plotting
\$table_mean	data.frame	table used for fitting
\$fit	lm or nls	the fitting as returned by the function fit_DoseResponseCurve

slot: @info

The original function call

[PLOT OUTPUT]

- A dose response curve with the marked correction values

Function version

0.1.3

How to cite

Kreutzer, S., 2026. analyse_Al2O3C_ITC(): Al2O3 Irradiation Time Correction Analysis. Function version 0.1.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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References

Kreutzer, S., Martin, L., Guérin, G., Tribolo, C., Selva, P., Mercier, N., 2018. Environmental Dose Rate Determination Using a Passive Dosimeter: Techniques and Workflow for alpha-Al2O3:C Chips. *Geochronometria* 45, 56-67. doi: 10.1515/geochr-2015-0086

See Also

[fit_DoseResponseCurve](#)

Examples

```
##load data
data(ExampleData.Al2O3C, envir = environment())

##run analysis
analyse_Al2O3C_ITC(data_ITC)
```

analyse_Al2O3C_Measurement

Al2O3:C Passive Dosimeter Measurement Analysis

Description

The function provides the analysis routines for measurements on a FI lexsyg SMART reader using Al2O3:C chips according to Kreutzer et al., 2018

Usage

```
analyse_Al2O3C_Measurement(
  object,
  signal_integral = NULL,
  integral_input = c("channel", "measurement"),
  dose_points = c(0, 4),
  recordType = c("OSL (UVVIS)", "TL (UVVIS)"),
```

```

    calculate_TL_dose = FALSE,
    irradiation_time_correction = NULL,
    cross_talk_correction = NULL,
    travel_dosimeter = NULL,
    test_parameters = NULL,
    verbose = TRUE,
    plot = TRUE,
    ...
)

```

Arguments

object [RLum.Analysis](#) (**required**): measurement input

signal_integral [numeric](#) (*optional*): signal integral, used for the signal and the background. Example: `c(1:10)` for the first 10 channels. If nothing is provided the full range is used

integral_input [character](#) (*with default*): input type for `signal_integral`, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.

dose_points [numeric](#) (*with default*): vector with dose points, if dose points are repeated, only the general pattern needs to be provided. Default values follow the suggestions made by Kreutzer et al., 2018

recordType [character](#) (*with default*): input curve selection, which is passed to function [get_RLum](#). To deactivate the automatic selection set the argument to NULL

calculate_TL_dose [logical](#) (*with default*): enables/disable experimental dose estimation based on the TL curves. It is computed as the ratio of the peak sums of each curves +/- 5 channels.

irradiation_time_correction [numeric](#) or [RLum.Results](#) (*optional*): information on the used irradiation time correction obtained by another experiments. If a numeric is provided it has to be of length two: mean, standard error

cross_talk_correction [numeric](#) or [RLum.Results](#) (*optional*): information on the used irradiation time correction obtained by another experiments. If a numeric vector is provided it has to be of length three: mean, 2.5 % quantile, 97.5 % quantile.

travel_dosimeter [numeric](#) (*optional*): specify the position of the travel dosimeter (so far measured at the same time). The dose of travel dosimeter will be subtracted from all other values.

test_parameters [list](#) (*with default*): set test parameters. Supported parameters are: `TL_peak_shift`. All input: [numeric](#) values, NA and NULL (see details).

verbose [logical](#) (*with default*): enable/disable output to the terminal.

plot [logical](#) (*with default*): enable/disable the plot output. If object is of type [list](#), a numeric vector can be provided to limit the plot output to certain aliquots.

... further arguments that can be passed to the plot output, supported are norm, main, mtext, title (for self-call mode to specify, e.g., sample names)

Details

Working with a travel dosimeter

The function allows to define particular position numbers as travel dosimeters. For example: `travel_dosimeter = c(1,3,5)` sets positions 1, 3 and 5 as travel dosimeters. These dose values #' of this dosimeters are combined and automatically subtracted from the obtained dose values of the other dosimeters.

Calculate TL dose

The argument `calculate_TL_dose` provides the possibility to experimentally calculate a TL-dose, i.e. an apparent dose value derived from the TL curve ratio. However, it should be noted that this value is only a fall back in case something went wrong during the measurement of the optical stimulation. The TL derived dose value is corrected for cross-talk and for the irradiation time, but not considered if a travel dosimeter is defined.

Calculating the palaeodose is possible without **any** TL curve in the sequence!

Test parameters

`TL_peak_shift` [numeric](#) (default: 15):

Checks whether the TL peak shift is bigger > 15 K, indicating a problem with the thermal contact of the chip.

`stimulation_power` [numeric](#) (default: 0.05):

So far available, information on the delivered optical stimulation are compared. Compared are the information from the first curves with all others. If the ratio differs more from unity than the defined by the threshold, a warning is returned.

Value

Function returns results numerically and graphically:

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$data	data.frame	the estimated equivalent dose
\$data_table	data.frame	full dose and signal table
test_parameters	data.frame	results with test parameters
data_TDcorrected	data.frame	travel dosimeter corrected results (only if TD was provided)

Note: If correction the irradiation time and the cross-talk correction method is used, the De values in the table data table are already corrected, i.e. if you want to get an uncorrected value, you can use the column CT_CORRECTION remove the correction.

slot: @info

The original function call

[PLOT OUTPUT]

- OSL and TL curves, combined on two plots.

Function version

0.2.7

How to cite

Kreutzer, S., 2026. analyse_Al2O3C_Measurement(): Al2O3:C Passive Dosimeter Measurement Analysis. Function version 0.2.7. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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References

Kreutzer, S., Martin, L., Guérin, G., Tribolo, C., Selva, P., Mercier, N., 2018. Environmental Dose Rate Determination Using a Passive Dosimeter: Techniques and Workflow for alpha-Al2O3:C Chips. *Geochronometria* 45, 56-67.

See Also

[analyse_Al2O3C_ITC](#)

Examples

```
##load data
data(ExampleData.Al2O3C, envir = environment())

##run analysis
analyse_Al2O3C_Measurement(data_CrossTalk)
```

analyse_baSAR

*Bayesian models (baSAR) applied on luminescence data***Description**

This function allows the application of Bayesian models on luminescence data measured with the single-aliquot regenerative-dose (SAR, Murray and Wintle, 2000) protocol. In particular, it follows the idea proposed by Combès et al., 2015 of using an hierarchical model for estimating a central equivalent dose from a set of luminescence measurements. This function (I) implements this approach for the R environment and (II) provides an extension and a technical refinement of the published code.

Usage

```
analyse_baSAR(
  object,
  CSV_file = NULL,
  aliquot_range = NULL,
  source_doserate = NULL,
  signal_integral = NULL,
  background_integral = NULL,
  signal_integral_Tx = NULL,
  background_integral_Tx = NULL,
  irradiation_times = NULL,
  sigmab = 0,
  sig0 = 0.025,
  distribution = "cauchy",
  baSAR_model = NULL,
  n.MCMC = 1e+05,
  fit.method = c("SSE", "SSE+LIN", "LIN"),
  fit.force_through_origin = TRUE,
  fit.includingRepeatedRegPoints = TRUE,
  method_control = list(),
  digits = 3L,
  distribution_plot = c("kde", "abanico"),
  plot = TRUE,
  plot_reduced = TRUE,
  plot_singlePanels = FALSE,
  verbose = TRUE,
  ...
)
```

Arguments

object [Risoe.BINfileData](#), [RLum.Results](#), [list](#) of [RLum.Analysis](#), [character](#) or [list](#) (**required**): input object used for the Bayesian analysis. If a character is provided

the function assumes a file connection and tries to import a BIN/BINX-file using the provided path. If a list is provided the list can only contain either `Risoe.BINfileData` objects or characters providing a file connection. Mixing of both types is not allowed. If an `RLum.Results` is provided the function directly starts with the Bayesian Analysis (see details)

CSV_file	character or data.frame (<i>optional</i>): if a character, it must be the path to a CSV file with data for the analysis. Either way, data should contain 3 columns: the name of the file, the disc position and the grain position (the last being 0 for multi-grain measurements).
aliquot_range	numeric (<i>optional</i>): allows to limit the range of the aliquots used for the analysis. This argument has only an effect if the argument <code>CSV_file</code> is used or object is a previous output (i.e. is <code>RLum.Results</code>). In this case, the new selection will add the aliquots to the removed aliquots table.
source_doserate	numeric (required): source dose rate of beta-source used for the measurement and its uncertainty in Gy/s, e.g., <code>source_doserate = c(0.12, 0.04)</code> . Parameter can be provided as a list, for the case that more than one BIN-file is provided, e.g., <code>source_doserate = list(c(0.04, 0.004), c(0.05, 0.004))</code> .
signal_integral	vector (required): vector with the limits for the signal integral used for the calculation, e.g., <code>signal_integral = 1:5</code> . It is ignored if object is an <code>RLum.Results</code> object. The parameter can be provided as a list, see <code>source_doserate</code> .
background_integral	vector (required): vector with the limits for the background integral. It is ignored if object is an <code>RLum.Results</code> object. The parameter can be provided as a list, see <code>source_doserate</code> .
signal_integral_Tx	vector (<i>optional</i>): vector with the limits for the signal integral for the Tx curve. If nothing is provided, the value from <code>signal_integral</code> is used. It is ignored if object is an <code>RLum.Results</code> object. The parameter can be provided as a list, see <code>source_doserate</code> .
background_integral_Tx	vector (<i>optional</i>): vector with the limits for the background integral for the Tx curve. If nothing is provided, the value from <code>background_integral</code> is used. It is ignored if object is an <code>RLum.Results</code> object. The parameter can be provided as a list, see <code>source_doserate</code> .
irradiation_times	numeric (<i>optional</i>): if set this vector replaces all irradiation times for one aliquot and one cycle (Lx and Tx curves) and recycles it for all others cycles and aliquots. Please note that if this argument is used, for every(!) single curve in the dataset an irradiation time needs to be set.
sigmab	numeric (<i>with default</i>): option to set a manual value for the overdispersion (for LnTx and TnTx), used for the Lx/Tx error calculation. The value should be provided as absolute squared count values, cf. <code>calc_OSLLxTxRatio</code> . The parameter can be provided as list, see <code>source_doserate</code> .
sig0	numeric (<i>with default</i>): allow adding an extra component of error to the final Lx/Tx error value (e.g., instrumental error, see details is <code>calc_OSLLxTxRatio</code>). The parameter can be provided as list, see <code>source_doserate</code> .

distribution	character (<i>with default</i>): type of distribution used during Bayesian calculations to determine the Central dose and overdispersion values (one of "cauchy", "normal", "log_normal" and "user_defined"). If set to "user_defined", argument baSAR_model must be provided.
baSAR_model	character (<i>optional</i>): option to provide an own modified or new model for the Bayesian calculation (see details). If provided, argument distribution is automatically set to "user_defined".
n.MCMC	integer (<i>with default</i>): number of iterations for the Markov chain Monte Carlo (MCMC) simulations
fit.method	character (<i>with default</i>): equation used both for the fitting of the dose-response curve using function <code>fit_DoseResponseCurve</code> and then for the Bayesian modelling. Supported methods: SSE, SSE+LIN and LIN.
fit.force_through_origin	logical (<i>with default</i>): force fitting through origin
fit.includingRepeatedRegPoints	logical (<i>with default</i>): includes the recycling point (assumed to be measured during the last cycle)
method_control	list (<i>optional</i>): named list of control parameters that can be directly passed to the Bayesian analysis, e.g., <code>method_control = list(n.chains = 4)</code> . See details for further information
digits	integer (<i>with default</i>): round output to the number of given digits
distribution_plot	character (<i>with default</i>): sets the final distribution plot that shows equivalent doses obtained using the frequentist approach and sets in the central dose as comparison obtained using baSAR. Allowed input is 'abanico' or 'kde'. If set to NULL nothing is plotted.
plot	logical (<i>with default</i>): enable/disable the plot output.
plot_reduced	logical (<i>with default</i>): enable/disable the advanced plot output.
plot_singlePanels	logical (<i>with default</i>): enable/disable single plots or plots arranged by analyse_baSAR.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	parameters that can be passed to the function <code>calc_OSLLxTxRatio</code> (almost full support), <code>data.table::fread</code> (skip), <code>read_BIN2R</code> (n.records, position, duplicated.rm), see details.

Details

Internally the function consists of two parts: (I) a Bayesian core that performs the hierarchical modelling and calculations, and (II) a data pre-processing stage. The Bayesian core can be run independently if sufficient input data are provided (see below). The data pre-processing stage exists to simplify the user workflow by preparing all required inputs; in principle it is enough to provide a BIN/BINX-file with the SAR measurement data. For the Bayesian analysis for each aliquot the following information are needed from the SAR analysis: LxTx, the LxTx error and the dose values for all regeneration points.

How is the systematic error contribution calculated?

Standard errors (so far) provided with the source dose rate are considered as systematic uncertainties and added to final central dose by:

$$systematic.error = 1/n \sum SE(source.doserate)$$

$$SE(central.dose.final) = \sqrt{SE(central.dose)^2 + systematic.error^2}$$

Please note that this approach is rather rough and can only be valid if the source dose rate errors, in case different readers had been used, are similar. In cases where more than one source dose rate is provided a warning is given.

Input / output scenarios

Various inputs are allowed for this function. Unfortunately this makes the function handling rather complex, but at the same time very powerful. Available scenarios:

(1) - object is BIN-file or link to a BIN-file

It does not matter how the information of the BIN/BINX file are provided. The function supports **(a)** either a path to a file or directory or a list of file names or paths or **(b)** a [Risoe.BINfileData](#) object or a list of these objects. The latter one can be produced by using function [read_BIN2R](#), but this function is called automatically if only a file name and/or a path is provided. In both cases it will become the data that can be used for the analysis.

[CSV_file = NULL]

If no CSV file (or data frame with the same format) is provided, the function runs an automatic process that consists of the following steps:

1. Select all valid aliquots using the function [verify_SingleGrainData](#)
2. Calculate Lx/Tx values using the function [calc_OSLLxTxRatio](#)
3. Calculate De values using the function [fit_DoseResponseCurve](#)

These proceeded data are subsequently used in for the Bayesian analysis

[CSV_file != NULL]

If a CSV file is provided (or a data.frame containing similar information) the pre-processing phase consists of the following steps:

1. Calculate Lx/Tx values using the function [calc_OSLLxTxRatio](#)
2. Calculate De values using the function [fit_DoseResponseCurve](#)

The CSV file should contain the BIN-file names and the aliquots selected for the further analysis. This allows a manual selection of input data, as the automatic selection by [verify_SingleGrainData](#) might not be sufficient.

(2) - object RLum.Results object

If an [RLum.Results](#) object is provided as input and(!) this object was previously created by the function [analyse_baSAR\(\)](#) itself, the pre-processing part is skipped and the function starts directly with the Bayesian analysis. This option is very powerful as it allows to change parameters for the Bayesian analysis without the need to repeat the data pre-processing. If furthermore the argument `aliquot_range` is set, aliquots can be manually excluded based on previous runs.

`method_control`

These are arguments that can be passed directly to the Bayesian calculation core, supported arguments are:

Parameter	Type	Description
lower_centralD	numeric	sets the lower bound for the expected De range. Change it only if you know what you are doing
upper_centralD	numeric	sets the upper bound for the expected De range. Change it only if you know what you are doing
n.chains	integer	sets number of parallel chains for the model (default = 3) (cf. rjags::jags.model)
inits	list	option to set initialisation values (cf. rjags::jags.model)
thin	numeric	thinning interval for monitoring the Bayesian process (cf. rjags::jags.model)
variable.names	character	set the variables to be monitored during the MCMC run, default: 'central_D', 'sigma_D', '...

User defined models

The function provides the option to modify and to define own models that can be used for the Bayesian calculation. In the case the user wants to modify a model, a new model can be piped into the function via the argument `baSAR_model` as character. The model has to be provided in the JAGS dialect of the BUGS language (cf. [rjags::jags.model](#)) and parameter names given with the pre-defined names have to be respected, otherwise the function will break.

FAQ

Q: How can I set the seed for the random number generator (RNG)?

A: Use the argument `method_control`, e.g., for three MCMC chains (as it is the default):

```
method_control = list(
  inits = list(
    list(.RNG.name = "base::Wichmann-Hill", .RNG.seed = 1),
    list(.RNG.name = "base::Wichmann-Hill", .RNG.seed = 2),
    list(.RNG.name = "base::Wichmann-Hill", .RNG.seed = 3)
  )
)
```

This sets a reproducible set for every chain separately.

Q: How can I modify the output plots?

A: You can't, but you can use the function output to create own, modified plots.

Q: Can I change the boundaries for the central_D?

A: Yes, we made it possible, but we DO NOT recommend it, except you know what you are doing!

Example: `method_control = list(lower_centralD = 10)`

Q: The lines in the baSAR-model appear to be in a wrong logical order?

A: This is correct and allowed (cf. JAGS manual)

Additional arguments support via the ... argument

This list summarizes the additional arguments that can be passed to the internally used functions.

Supported argument	Corresponding function	Default	Short description
threshold	verify_SingleGrainData	30	change rejection

skip	data.table::fread	0	number of rows
n.records	read_BIN2R	NULL	limit records dur
duplicated.rm	read_BIN2R	TRUE	remove duplicat
pattern	read_BIN2R	TRUE	select BIN-file b
position	read_BIN2R	NULL	limit import to a
background.count.distribution	calc_OSLLxTxRatio	"non-poisson"	set assumed cou
fit.weights	fit_DoseResponseCurve	NULL	enable/disable fi
fit.bounds	fit_DoseResponseCurve	TRUE	enable/disable fi
n.MC	fit_DoseResponseCurve	100	number of MC r
plot_drc	plot_DoseResponseCurve	TRUE	enable/disable d
plot_extended	plot_DoseResponseCurve	TRUE	enable/disable e
recordType	get_RLum	c(OSL (UVVIS), irradiation (NA)	helps for the cur

Value

Function returns results numerically and graphically:

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$summary	data.frame	statistical summary, including the central dose
\$mcmc	mcmc	coda::mcmc.list object including raw output
\$models	character	implemented models used in the baSAR-model core
\$input_object	data.frame	summarising table (same format as the XLS-file) including, e.g., Lx/Tx values
\$removed_aliquots	data.frame	table with removed aliquots (e.g., NaN, or Inf Lx/Tx values). If nothing was removed N

slot: @info

The original function call

[PLOT OUTPUT]

- (A) Ln/Tn curves with set integration limits,
- (B) trace plots are returned by the baSAR-model, showing the convergence of the parameters (trace) and the resulting kernel density plots. If plot_reduced = FALSE for every(!) dose a trace and a density plot is returned (this may take a long time),
- (C) dose plots showing the dose for every aliquot as boxplots and the marked HPD in within. If boxes are coloured 'orange' or 'red' the aliquot itself should be checked,
- (D) the dose response curve resulting from the monitoring of the Bayesian modelling are provided along with the Lx/Tx values and the HPD. Note: The amount for curves displayed is limited to 1000 (random choice) for performance reasons,

- (E) the final plot is the De distribution as calculated using the conventional (frequentist) approach and the central dose with the HPDs marked within. This figure is only provided for a comparison, no further statistical conclusion should be drawn from it.

Please note: If distribution was set to `log_normal` the central dose is given as geometric mean!

Function version

0.1.41

How to cite

Mercier, N., Kreutzer, S., 2026. analyse_baSAR(): Bayesian models (baSAR) applied on luminescence data. Function version 0.1.41. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

If you provide more than one BIN-file, it is **strongly** recommended to provide a list with the same number of elements for the following parameters:

source_doserate, signal_integral, signal_integral_Tx, background_integral, background_integral_Tx, sigmab, sig0.

Example for two BIN-files: `source_doserate = list(c(0.04, 0.006), c(0.05, 0.006))`

The function is currently limited to work with standard Risoe BIN-files only!

Author(s)

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 Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 The underlying Bayesian model based on a contribution by Combès et al., 2015. , RLum Developer Team

References

Combès, B., Philippe, A., Lanos, P., Mercier, N., Tribolo, C., Guérin, G., Guibert, P., Lahaye, C., 2015. A Bayesian central equivalent dose model for optically stimulated luminescence dating. *Quaternary Geochronology* 28, 62-70. doi:10.1016/j.quageo.2015.04.001

Mercier, N., Kreutzer, S., Christophe, C., Guérin, G., Guibert, P., Lahaye, C., Lanos, P., Philippe, A., Tribolo, C., 2016. Bayesian statistics in luminescence dating: The 'baSAR'-model and its implementation in the R package 'Luminescence'. *Ancient TL* 34, 14-21.

Further reading

Gelman, A., Carlin, J.B., Stern, H.S., Dunson, D.B., Vehtari, A., Rubin, D.B., 2013. Bayesian Data Analysis, Third Edition. CRC Press.

Murray, A.S., Wintle, A.G., 2000. Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol. *Radiation Measurements* 32, 57-73. doi:10.1016/S1350-4487(99)00253-X

Plummer, M., 2017. JAGS Version 4.3.0 user manual. <https://sourceforge.net/projects/mcmc-jags/files/Manuals>

See Also

[read_BIN2R](#), [calc_OSLxTxRatio](#), [fit_DoseResponseCurve](#), [plot_DoseResponseCurve](#), [data.table::fread](#), [verify_SingleGrainData](#), [rjags::jags.model](#), [rjags::coda.samples](#), [boxplot.default](#)

Examples

```
##(1) load package test data set
data(ExampleData.BINfileData, envir = environment())

##(2) selecting relevant curves, and limit dataset
CWOSL.SAR.Data <- subset(
  CWOSL.SAR.Data,
  subset = POSITION%in%c(1:3) & LTYPE == "OSL")

## Not run:
##(3) run analysis
## please note that the parameters used here are
## chosen for performance, not for reliability
results <- analyse_baSAR(
  object = CWOSL.SAR.Data,
  source_doserate = c(0.04, 0.001),
  signal_integral = 1:2,
  background_integral = 80:100,
  fit.method = "LIN",
  plot = FALSE,
  n.MCMC = 200
)

print(results)

##CSV_file template
##copy and paste this the code below in the terminal
##you can further use the function write.csv() to export the example

CSV_file <-
structure(
  list(
    BIN_FILE = NA_character_,
    DISC = NA_real_,
    GRAIN = NA_real_,
    .Names = c("BIN_FILE", "DISC", "GRAIN"),
    class = "data.frame",
    row.names = 1L)
)

## End(Not run)
```

analyse_FadingMeasurement

Analyse fading measurements and returns the fading rate per decade (g-value)

Description

The function analyses fading measurements and returns a fading rate including an error estimation. The function is not limited to standard fading measurements, as can be seen, e.g., Huntley and Lamothe (2001). Additionally, the density of recombination centres (ρ) is estimated after Kars et al. (2008).

Usage

```
analyse_FadingMeasurement(
  object,
  structure = c("Lx", "Tx"),
  signal_integral = NULL,
  background_integral = NULL,
  integral_input = c("channel", "measurement"),
  t_star = c("half", "half_complex", "end"),
  n.MC = 100,
  verbose = TRUE,
  plot = TRUE,
  plot_singlePanels = FALSE,
  ...
)
```

Arguments

- | | |
|-----------|---|
| object | <p>RLum.Analysis, data.frame or list (required): input object with the measurement data. Alternatively, a list containing RLum.Analysis objects or a data.frame with three columns ($x = LxTx$, $y = LxTx$ error, $z =$ time since irradiation) can be provided. Can also be a wide table, i.e. a data.frame with a number of columns divisible by 3 and where each triplet has the before mentioned column structure.</p> <p>Note: The input object should solely consists of the curve needed for the data analysis, i.e. only IRSL curves representing Lx (and Tx). If the object originated from an XSYG file, also the irradiation steps must be preserved in the input object.</p> <p>If data from multiple aliquots are provided, please see the details below with regard to Lx/Tx normalisation. Note: The function assumes that all your measurements are related to one (comparable) sample. If you have to treat independent samples, you have use this function in a loop.</p> |
| structure | <p>character (with default): the structure of the measurement data, one of 'Lx' or c('Lx', 'Tx').</p> |

signal_integral	vector (required) : vector with channels for the signal integral (e.g., 1:10). It is not required if a <code>data.frame</code> with <code>LxTx</code> values is provided.
background_integral	vector (required) : vector with channels for the background integral (e.g., 90:100). It is not required if a <code>data.frame</code> with <code>LxTx</code> values is provided.
integral_input	character (with default) : input type for <code>signal_integral</code> , one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.
t_star	character, function (with default) : method for calculating the time elapsed since irradiation if input is not a <code>data.frame</code> . Options are: 'half' (the default), 'half_complex', which uses the long equation in Auclair et al. 2003, and 'end', which takes the time between irradiation and the measurement step. Alternatively, <code>t_star</code> can be a function with one parameter which works on <code>t1</code> . For more information see details. <i>t_star has no effect if the input is a <code>data.frame</code>, because this input comes without irradiation times.</i>
n.MC	integer (with default) : number for Monte Carlo runs for the error estimation.
verbose	logical (with default) : enable/disable output to the terminal.
plot	logical (with default) : enable/disable the plot output.
plot_singlePanels	logical or numeric (with default) : enable/disable single plot mode, i.e. one plot window per plot. Alternatively a vector specifying the plot to be drawn, e.g., <code>plot_singlePanels = c(3,4)</code> draws only the last two plots in separate windows.
...	further arguments and graphical parameters to control the plot output. Supported are: <code>xlab</code> , <code>log</code> , <code>mtext</code> , <code>pt.cex</code> (point size), <code>plot.trend</code> (enable/disable the trend blue line), <code>xlim</code> (for the two first curve plots), and <code>ylim</code> (for the fading curve plot). For further plot customization please use the numerical output of the functions for own plots.

Details

All provided output corresponds to the t_c value obtained by this analysis. Additionally, the g-value normalised to 2-days is provided in the output object. The output of this function can be passed to the function `calc_FadingCorr`.

Fitting and error estimation

For the fitting the function `stats::lm` is used without applying weights. For the error estimation all input values, except t_c , as the precision can be considered as sufficiently high enough with regard to the underlying problem, are sampled assuming a normal distribution for each value with the value as the mean and the provided uncertainty as standard deviation.

The options for `t_star`

- `t_star = "half"` (the default) The calculation follows the simplified version in Auclair et al. (2003), which reads

$$t_{star} := t_1 + (t_2 - t_1)/2$$

- `t_star = "half_complex"` This option applies the complex function shown in Auclair et al. (2003), which is derived from Aitken (1985) appendix F, equations 9 and 11. It reads

$$t_{star} = t_0 * 10^{[(t_2 \log(t_2/t_0) - t_1 \log(t_1/t_0) - 0.43(t_2 - t_1))/(t_2 - t_1)]}$$

where $0.43 = 1/\ln(10)$. t_0 , which is an arbitrary constant, is set to 1. Please note that the equation in Auclair et al. (2003) is incorrect insofar that it reads $10 \exp(\dots)$, where the base should be 10 and not the Euler's number. Here we use the correct version (base 10).

- `t_star = "end"` This option uses the simplest possible form for `t_star` which is the time since irradiation without taking into account any addition parameter and it equals `t1` in Auclair et al. (2003)
- `t_star = <function>` This last option allows you to provide an R function object that works on `t1` and gives you all possible freedom. For instance, you may want to define the following function `fun <- function(x) {x^2}`, this would square all values of `t1`, because internally it calls `fun(t1)`. The name of the function does not matter.

Density of recombination centres

The density of recombination centres, expressed by the dimensionless variable ρ' , is estimated by fitting equation 5 in Kars et al. (2008) to the data. For the fitting the function `stats::nls` is used without applying weights. For the error estimation the same procedure as for the g-value is applied (see above).

Multiple aliquots & Lx/Tx normalisation

Be aware that this function will always normalise all $\frac{L_x}{T_x}$ values by the $\frac{L_x}{T_x}$ value of the prompt measurement of the first aliquot. This implicitly assumes that there are no systematic inter-aliquot variations in the $\frac{L_x}{T_x}$ values. If deemed necessary to normalise the $\frac{L_x}{T_x}$ values of each aliquot by its individual prompt measurement please do so **before** running `analyse_FadingMeasurement` and provide the already normalised values for object instead.

Shine-down curve plots Please note that the shine-down curve plots are for information only. As such a maximum of five pause steps are plotted to avoid graphically overloaded plots. However, *all* pause times are taken into consideration for the analysis.

Value

An `RLum.Results` object is returned:

Slot: **@data**

OBJECT	TYPE	COMMENT
<code>fading_results</code>	<code>data.frame</code>	results of the fading measurement in a table
<code>fit</code>	<code>lm</code>	object returned by the used linear fitting function <code>stats::lm</code>
<code>rho_prime</code>	<code>data.frame</code>	results of ρ' estimation after Kars et al. (2008)
<code>LxTx_table</code>	<code>data.frame</code>	Lx/Tx table, if curve data had been provided
<code>irr.times</code>	<code>integer</code>	vector with the irradiation times in seconds

Slot: **@info**

OBJECT	TYPE	COMMENT
--------	------	---------

call call the original function call

Function version

0.1.28

How to cite

Kreutzer, S., Burow, C., 2026. analyse_FadingMeasurement(): Analyse fading measurements and returns the fading rate per decade (g-value). Function version 0.1.28. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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Christoph Burow, University of Cologne (Germany) , RLum Developer Team

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See Also

[calc_OSLLxTxRatio](#), [read_BIN2R](#), [read_XSYG2R](#), [extract_IrradiationTimes](#), [calc_FadingCorr](#)

Examples

```
## load example data (sample UNIL/NB123, see ?ExampleData.Fading)
data("ExampleData.Fading", envir = environment())

##(1) get fading measurement data (here a three column data.frame)
fading_data <- ExampleData.Fading$fading.data$IR50

##(2) run analysis
g_value <- analyse_FadingMeasurement(
```

```
fading_data,
plot = TRUE,
verbose = TRUE,
n.MC = 10)

##(3) this can be further used in the function
## to correct the age according to Huntley & Lamothe, 2001
results <- calc_FadingCorr(
age.faded = c(100,2),
g_value = g_value,
n.MC = 10)
```

analyse_IRSAR.RF

Analyse IRSAR RF measurements

Description

The function analyses IRSAR RF measurements on K-feldspar samples performed using the protocol according to Erfurt et al. (2003) and beyond.

Usage

```
analyse_IRSAR.RF(
  object,
  sequence_structure = c("NATURAL", "REGENERATED"),
  RF_nat.lim = NULL,
  RF_reg.lim = NULL,
  method = c("FIT", "SLIDE", "VSLIDE", "NONE"),
  method_control = NULL,
  test_parameters = NULL,
  n.MC = 10,
  txtProgressBar = TRUE,
  plot = TRUE,
  plot_reduced = FALSE,
  cores = 1,
  ...
)
```

Arguments

object	RLum.Analysis or a list of such objects (required): input object containing data for protocol analysis. The function expects to find at least two curves in the RLum.Analysis object: (1) RF_nat, (2) RF_reg. If a list is provided as input, all other parameters can be provided as list as well to gain full control.
sequence_structure	vector character (<i>with default</i>): specifies the general sequence structure. Allowed steps are NATURAL and REGENERATED, and at least one of each must appear. In addition, any other character is allowed in the sequence structure; such

	curves will be ignored during the analysis. If <code>sequence_structure</code> is shorter than the number of curves in object, it is recycled. If multiple NATURAL and REGENERATED steps are specified, the corresponding measurements are stacked.
<code>RF_nat.lim</code>	vector (<i>with default</i>): minimum and maximum channel range for natural signal fitting and sliding. If only one value is provided, this will be treated as minimum value and the maximum limit will be added automatically.
<code>RF_reg.lim</code>	vector (<i>with default</i>): minimum and maximum channel range for regenerated signal fitting and sliding. If only one value is provided, this will be treated as minimum value and the maximum limit will be added automatically.
<code>method</code>	character (<i>with default</i>): method to obtain the D_e , one of "FIT", "SLIDE", "VSLIDE" (see details); "NONE" can be used to disable the analysis and plot the natural points at their original position.
<code>method_control</code>	list (<i>optional</i>): parameters to control the behaviour of the chosen method (see details).
<code>test_parameters</code>	list (<i>with default</i>): set test parameters. Supported parameters are: <code>curves_ratio</code> , <code>residuals_slope</code> (only for <code>method = "SLIDE"</code> and <code>"VSLIDE"</code>), <code>curves_bounds</code> , <code>dynamic_ratio</code> , <code>lambda</code> , <code>beta</code> and <code>delta.phi</code> . All input: numeric values, NA and NULL (see Details for further information).
<code>n.MC</code>	numeric (<i>with default</i>): number of Monte Carlo runs for the estimation of the start parameter (<code>method = "FIT"</code>) or of the error (<code>method = "SLIDE"</code> and <code>"VSLIDE"</code>). This value can be set to NULL to skip the MC runs. Note: Large values will significantly increase the computation time.
<code>txtProgressBar</code>	logical (<i>with default</i>): enable/disable the progress bar during MC runs.
<code>plot</code>	logical (<i>with default</i>): enable/disable the plot output.
<code>plot_reduced</code>	logical (<i>optional</i>): provides a reduced plot output if enabled to allow common R plot combinations, e.g., <code>par(mfrow(...))</code> . If TRUE no residual plot is returned; it has no effect if <code>plot = FALSE</code>
<code>cores</code>	integer, numeric (<i>with default</i>): number of cores allocated for parallel processing of the Monte-Carlo runs. The default value corresponds to single-threaded computation; the recommended values is NULL, which assigns all but two of the available logical CPU cores.
<code>...</code>	further arguments and graphical parameters to control the plot output. Supported are: <code>main</code> , <code>mtext</code> , <code>xlab</code> , <code>ylab</code> , <code>xlim</code> , <code>ylim</code> , <code>cex</code> , <code>pt.cex</code> (point size), <code>log</code> , <code>legend</code> (TRUE/FALSE), <code>legend.pos</code> , <code>legend.text</code> (passes argument to <code>x</code> , <code>y</code> in <code>graphics::legend</code>), <code>col_nat</code> (colour of natural points), <code>col_reg</code> (colour of regenerated points), <code>yaxis_scientific</code> (TRUE/FALSE), <code>xaxt</code> , and <code>verbose</code> (TRUE/FALSE).

Details

The function performs an IRSAR analysis described for K-feldspar samples by Erfurt et al. (2003) assuming a negligible sensitivity change of the RF signal.

General Sequence Structure (according to Erfurt et al., 2003)

1. Measure IR-RF intensity of the natural dose for a few seconds (RF_{nat})

2. Bleach the samples under solar conditions for at least 30 min without changing the geometry
3. Wait for at least one hour
4. Regeneration of the IR-RF signal to at least the natural level (measuring (RF_{reg}))
5. Fit the data with a stretched exponential function
6. Calculate the palaeodose D_e using the parameters from the fitting

Three methods are supported to obtain the D_e : `method = "FIT"`, `method = "SLIDE"` and `method = "VSLIDE"`:

`method = "FIT"`

The principle is described above and follows the original suggestions by Erfurt et al., 2003. For the fitting, the mean count value of the `RF_nat` curve is used.

Function used for the fitting (according to Erfurt et al. (2003)):

$$\phi(D) = \phi_0 - \Delta\phi(1 - \exp(-\lambda D))^\beta$$

with $\phi(D)$ the dose dependent IR-RF flux, ϕ_0 the initial IR-RF flux, $\Delta\phi$ the dose dependent change of the IR-RF flux, λ the exponential parameter, D the dose and β the dispersive factor.

To obtain the palaeodose D_e the function is changed to:

$$D_e = \ln(-(\phi(D) - \phi_0)/(-\lambda\phi)^{1/\beta} + 1) / -\lambda$$

The fitting is done using the `port` algorithm of the `nls` function.

`method = "SLIDE"`

For this method, the natural curve is slid along the x-axis until congruence with the regenerated curve is reached. Unlike fitting, this allows for working with the original data without the need for any physical model. This approach was introduced for RF curves by Buylaert et al., 2012 and Lapp et al., 2012.

Here the sliding is done by searching for the minimum of the sum of squared residuals. For the mathematical details of the implementation see Frouin et al., 2017

`method = "VSLIDE"`

Same as "SLIDE" but searching also vertically for the best match (i.e. in xy-direction.) See Kreutzer et al. (2017) and Murari et al. (2021). By default, the vertical sliding range is set automatically, but can be set manually by changing the `vslide_range` parameter (see `method_control`).

`method_control`

To keep the generic argument list as clear as possible, parameters to control the methods for D_e estimation are preset with meaningful default values, which can however be modified using the `method_control` argument, e.g., `method_control = list(trace = TRUE)`. Supported parameters are:

For FIT

- `trace` ([logical](#), default: FALSE): as in [nls](#); shows sum of squared residuals.
- `maxiter` ([integer](#), default: 500): as in [nls](#).
- `warnOnly` ([logical](#), default: FALSE): as in [nls](#).

- minFactor (**numeric**, default: 1 / 4096): as in [nls](#).

For *SLIDE* or *VSLIDE*

- trace (**logical**, default: FALSE): as in [nls](#); shows sum of squared residuals.
- trace_vslide (**logical**, default: FALSE): enable/disable the tracing of the vertical sliding.
- correct_onset (**logical**, default: TRUE): whether the curves should be shifted along the x-axis by the first channel, as light is expected in the first channel.
- show_density (**logical**, default: TRUE): enable/disable KDE plots for MC run results. Nothing is shown if the distribution is too narrow.
- show_fit (**logical**, default: FALSE): enable/disable the plot of the fitted curve routinely obtained during the evaluation.
- n.MC (**integer**, default: 1000): number of Monte Carlo runs within the sliding (assessing the possible minimum values). **Note:** This parameter is not the same as the function argument n.MC.
- vslide_range (**numeric** or **character**, default: "auto"): boundaries for the vertical curve sliding. The argument expects a vector with absolute minimum and maximum (e.g., c(-1000, 1000)). The default "auto" mode detects the reasonable vertical sliding range (*recommended*). NULL disables the vertical sliding.
- num_slide_windows (**integer**, default: 3): number of differently-sized windows tested when sliding: the higher the value (up to a maximum of 10), the more time is spent in searching the global optimum. The default setting attempts to strike a balance between quality of the fit and computation speed.

Error estimation

For method = "FIT", the D_e error range is obtained by using the 2.5 % (lower) and the 97.5 % (upper) quantiles of the RF_{nat} curve.

For method = "SLIDE" and method = "VSLIDE", the error is obtained by bootstrapping the residuals of the slid curve to construct new natural curves for a Monte Carlo simulation. The error is returned in two ways: (a) the standard deviation of the D_e obtained from the MC runs and (b) the confidence interval using the 2.5 % (lower) and the 97.5 % (upper) quantiles. The results of the MC runs are returned with the function output.

Test parameters

The argument test_parameters allows to pass thresholds for several test parameters, which will be evaluated during the function run. If a threshold is set and it is exceeded, the test parameter status will be set to "FAILED". This argument is intentionally not termed 'rejection criteria' as not all test parameters are evaluated for both methods and some parameters are calculated but not evaluated by default.

NA and NULL are the allowed values for all parameters. If the parameter is set to NA, the value is calculated but the result will not be evaluated, therefore it will have no effect on the status ("OK" or "FAILED") of the parameter. Setting the parameter to NULL disables the parameter entirely and the parameter will also be removed from the function output. This might be useful in cases where a particular parameter requires a long computation time. Currently supported parameters are:

- curves_ratio (**numeric**, default: 1.001): the ratio of RF_{nat} to RF_{reg} is calculated over the range spanned by RF_{nat} , and should not exceed the threshold value.

- `intersection_ratio` ([numeric](#), default: NA): calculated as absolute difference from 1 of the ratio of the integral of the normalised RF-curves. This value indicates intersection of the RF-curves and should be close to 0 if the curves have a similar shape. For this calculation first the corresponding time-count pair value on the RF_reg curve is obtained using the maximum count value of the RF_nat curve and only this segment (fitting to the RF_nat curve) on the RF_reg curve is taken for further calculating this ratio. If nothing is found at all, Inf is returned.
- `residuals_slope` ([numeric](#), default: NA; only for method = "SLIDE" and "VSLIDE"): a linear function is fitted on the residuals after sliding. The corresponding slope can be used to discard values as a high (positive, negative) slope may indicate that both curves are fundamentally different and the method cannot be applied at all. By default, the value of this parameter is calculated but not evaluated.
- `curves_bounds` ([numeric](#), default: $\max(RF_{reg_counts})$): this measure uses the maximum time (x) value of the regenerated curve. The maximum time (x) value of the natural curve cannot be larger than this value. However, although this is not recommended the value can be changed or disabled.
- `dynamic_ratio` ([numeric](#), default: NA): the dynamic ratio of the regenerated curve is calculated as ratio of the minimum and maximum count values.
- `lambda`, `beta` and `delta.phi` ([numeric](#) (default: NA): the stretched exponential function suggested by Erfurt et al. (2003) describing the decay of the RF signal, comprises several parameters that might be useful to evaluate the shape of the curves. For method = "FIT", this parameter is obtained during the fitting; for method = "SLIDE" a rather rough estimation is made using the function `minpack.lm::nlsLM` and the equation given above. **Note:** As this procedure requests more computation time, it is performed only if all three parameters are set.

Value

The function returns numerical output and an (*optional*) plot.

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

[.. \$data : data.frame]

Column	Type	Description
DE	numeric	the obtained equivalent dose
DE.ERROR	numeric	(only method = "SLIDE") standard deviation obtained from MC runs
DE.LOWER	numeric	2.5% quantile for De values obtained by MC runs
DE.UPPER	numeric	97.5% quantile for De values obtained by MC runs
DE.STATUS	character	test parameter status
RF_NAT.LIM	character	used RF_nat curve limits
RF_REG.LIM	character	used RF_reg curve limits
POSITION	integer	(<i>optional</i>) position of the curves
DATE	character	(<i>optional</i>) measurement date

SEQUENCE_NAME character (*optional*) sequence name
UID character unique data set ID

[.. \$De.MC : numeric]
A numeric vector with all the De values obtained by the MC runs.
[.. \$test_parameters : data.frame]

Column	Type	Description
POSITION	numeric	aliquot position
PARAMETER	character	test parameter name
THRESHOLD	numeric	set test parameter threshold value
VALUE	numeric	the calculated test parameter value (to be compared with the threshold)
STATUS	character	test parameter status either "OK" or "FAILED"
SEQUENCE_NAME	character	name of the sequence, so far available
UID	character	unique data set ID

[.. \$fit : data.frame]
An [nls](#) object produced by the fitting.
[.. \$slide : list]
A [list](#) with data produced during the sliding. Some elements are previously reported with the summary object data. List elements are:

Element	Type	Description
De	numeric	the final De obtained with the sliding approach
De.MC	numeric	all De values obtained by the MC runs
residuals	numeric	the obtained residuals for each channel of the curve
trend.fit	lm	fitting results produced by the fitting of the residuals
RF_nat.slid	matrix	the slid RF_nat curve
t_n.id	numeric	the index of the t_n offset
I_n	numeric	the vertical intensity offset if a vertical slide was applied
algorithm_error	numeric	the vertical sliding suffers from a systematic effect induced by the used algorithm. The returned value is 0 if no error was detected.
vslide_range	numeric	the range used for the vertical sliding
num_slide_windows	integer	the number of windows used for the vertical sliding
squared_residuals	numeric	the squared residuals (horizontal sliding)

slot: @info
The original function call
The output (data) should be accessed using the function [get_RLum](#).

[PLOT OUTPUT]

The slid IR-RF curves with the finally obtained De

Function version

0.7.14

How to cite

Kreutzer, S., 2026. analyse_IRSAR.RF(): Analyse IRSAR RF measurements. Function version 0.7.14. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function assumes that there is no sensitivity change during the measurements (natural vs. regenerated signal), which is in contrast to the findings by Buylaert et al. (2012).

Author(s)

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** Further reading**

Murari, M.K., Kreutzer, S., King, G.E., Frouin, M., Tsukamoto, S., Schmidt, C., Lauer, T., Klasen, N., Richter, D., Friedrich, J., Mercier, N., Fuchs, M., 2021. Infrared radiofluorescence (IR-RF) dating: A review. *Quaternary Geochronology* 64, 101155. doi:10.1016/j.quageo.2021.101155

See Also

[RLum.Analysis](#), [RLum.Results](#), [get_RLum](#), [nls](#), [minpack.lm::nlsLM](#), [parallel::mclapply](#), [Example-Data.RF70Curves](#)

Examples

```
##load data
data(ExampleData.RLum.Analysis, envir = environment())

##(1) perform analysis using the method 'FIT'
results <- analyse_IRSAR.RF(object = IRSAR.RF.Data)

##show De results and test parameter results
get_RLum(results, data.object = "data")
get_RLum(results, data.object = "test_parameters")

##(2) perform analysis using the method 'SLIDE'
data(ExampleData.RF70Curves, envir = environment())
results <- analyse_IRSAR.RF(
  object = RF70Curves,
  method = "SLIDE",
  n.MC = 1)

## Not run:
##(3) perform analysis using the method 'VSLIDE' and method control option
## 'trace'
results <- analyse_IRSAR.RF(
  object = RF70Curves,
  method = "VSLIDE",
  method_control = list(trace = TRUE))
```

```
## End(Not run)
```

analyse_pIRIRSequence *Analyse post-IR IRSL measurement sequences*

Description

The function performs an analysis of post-IR IRSL sequences including curve fitting on [RLum.Analysis](#) objects.

Usage

```
analyse_pIRIRSequence(
  object,
  signal_integral,
  background_integral,
  integral_input = c("channel", "measurement"),
  dose.points = NULL,
  sequence.structure = c("TL", "IR50", "pIRIR225"),
  plot = TRUE,
  plot_singlePanels = FALSE,
  ...
)
```

Arguments

object	RLum.Analysis or list of RLum.Analysis objects (required): input object containing data for analysis. If a list is provided the function tries to iterate over each element in the list.
signal_integral	integer (required): vector of channels for the signal integral. Provide this value as a list for different integration limits for the different IRSL curves.
background_integral	integer (required): vector of channels for the background integral. Provide this value as a list for different integration limits for the different IRSL curves.
integral_input	character (<i>with default</i>): input type for signal_integral, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.
dose.points	numeric (<i>optional</i>): a numeric vector containing the dose point values. Using this argument overwrites dose point values in the signal curves.
sequence.structure	vector character (<i>with default</i>): specifies the general sequence structure. Allowed values are "TL" and any "IR" combination (e.g., "IR50", "pIRIR225"). Additionally a parameter "EXCLUDE" is allowed to exclude curves from the analysis (Note: If a preheat without PMT measurement is used, i.e. preheat as none TL, remove the TL step.)

plot [logical](#) (*with default*): enable/disable the plot output.
plot_singlePanels [logical](#) (*with default*): enable/disable plotting of the results in a single window for each plot. Ignored if `plot = FALSE`.
... further arguments that will be passed to [analyse_SAR.CWOSL](#) and [plot_DoseResponseCurve](#). Furthermore, the arguments `main` (headers), `log` (IRSL curves), `cex` (control the size) and `mtext.outer` (additional text on the plot area) can be passed to influence the plotting. If the input is a list, `main` can be passed as [vector](#) or [list](#).

Details

To allow post-IR IRSL protocol (Thomsen et al., 2008) measurement analyses, this function has been written as an extended wrapper for [analyse_SAR.CWOSL](#), thus facilitating an entire sequence analysis in one run. With this, its functionality is strictly limited by the functionality provided by [analyse_SAR.CWOSL](#).

Defining the sequence structure

The argument `sequence.structure` expects a shortened pattern of your sequence structure and was mainly introduced to ease the use of the function. For example: If your measurement data contains the following curves: TL, IRSL, IRSL, TL, IRSL, IRSL, the pattern in `sequence.structure` becomes `c('TL', 'IRSL', 'IRSL')`. The second part of your sequence for one cycle should be similar and can be discarded. If this is not the case (e.g., additional hotbleach) such curves must be removed before using the function.

If the input is a list

If the input is a list of [RLum.Analysis](#) objects, every argument can be provided as list to allow for different sets of parameters for every single input element. For further information see [analyse_SAR.CWOSL](#).

Value

Plots (*optional*) and an [RLum.Results](#) object is returned containing the following elements:

DATA.OBJECT	TYPE	DESCRIPTION
<code>..\$data :</code>	<code>data.frame</code>	Table with De values
<code>..\$LnLxTnTx.table :</code>	<code>data.frame</code>	with the LnLxTnTx values
<code>..\$rejection.criteria :</code>	data.frame	rejection criteria
<code>..\$Formula :</code>	list	Function used for fitting of the dose response curve
<code>..\$call :</code>	call	the original function call

The output should be accessed using the function [get_RLum](#).

Function version

0.2.8


```

object <- sapply(1:length(sequence.structure), function(x){
  object[[sequence.structure[x]]]
})

object <- set_RLum(class = "RLum.Analysis", records = object, protocol = "pIRIR")

##(2) Perform pIRIR analysis (for this example with quartz OSL data!)
## Note: output as single plots to avoid problems with this example
results <- analyse_pIRIRSequence(object,
  signal_integral = 1:2,
  background_integral = 900:1000,
  fit.method = "SSE",
  sequence.structure = c("TL", "pseudoIRSL1", "pseudoIRSL2"),
  main = "Pseudo pIRIR data set based on quartz OSL",
  plot_singlePanels = TRUE)

##(3) Perform pIRIR analysis (for this example with quartz OSL data!)
## Alternative for PDF output, uncomment and complete for usage
## Not run:
tempfile <- tempfile(fileext = ".pdf")
pdf(file = tempfile, height = 18, width = 18)
results <- analyse_pIRIRSequence(object,
  signal_integral = 1:2,
  background_integral = 900:1000,
  fit.method = "SSE",
  main = "Pseudo pIRIR data set based on quartz OSL")

dev.off()

## End(Not run)

```

analyse_portableOSL *Analyse portable CW-OSL measurements*

Description

The function analyses CW-OSL curve data produced by a SUERC portable OSL reader and produces a combined plot of OSL/IRSL signal intensities, OSL/IRSL depletion ratios and the IRSL/OSL ratio.

Usage

```

analyse_portableOSL(
  object,
  signal_integral = NULL,
  integral_input = c("channel", "measurement"),
  invert = FALSE,
  normalise = FALSE,

```

```

mode = c("profile", "surface"),
coord = NULL,
plot = TRUE,
...
)

```

Arguments

object	RLum.Analysis (required) : object produced by read_PSL2R . The input can be a list of such objects, in which case each input is treated as a separate sample and the results are merged.
signal_integral	numeric (required) : vector specifying the range of channels used to calculate the OSL/IRSL signal. It can be provided as a vector of length 2 such as <code>c(1, 5)</code> , or as a sequence such as <code>1:5</code> , in which case the lowest and highest values define the range.
integral_input	character (with default) : input type for <code>signal_integral</code> , one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.
invert	logical (with default) : whether the data should be plotted in reverse order (FALSE by default).
normalise	logical (with default) : whether the OSL/IRSL signals should be normalised to the <i>mean</i> of all corresponding data curves.
mode	character (with default) : analysis mode, one of "profile" (the default) or "surface" for surface interpolation.
coord	list matrix (optional) : a list or a 2-column matrix with the <i>x</i> and <i>y</i> coordinates for the sampling positions in meters (m), of the same length as the number of samples measured. For example, the coordinates for one sample could be <code>coord = list(samp1 = c(0.1, 0.2))</code> . If the <i>x</i> coordinates were not measured, <i>x</i> should be set to 0. Note that, in such case, a surface plot cannot be produced.
plot	logical (with default) : enable/disable the plot output.
...	other parameters to be passed to modify the plot output. Supported are run to provide the run name (if the input is a list, this is set automatically). Further plot parameters accepted are <code>main</code> , <code>col</code> , <code>xlim</code> (a named list for profile mode), <code>ylim</code> , <code>ylab</code> , <code>xlab</code> . Additional parameters for <code>mode = "profile"</code> are <code>type</code> , <code>pch</code> , <code>grid</code> (TRUE/FALSE), <code>bg_img</code> (a raster object for the background image, usually a profile photo), <code>bg_img_positions</code> (a vector with the four corner positions, see graphics::rasterImage), <code>zlab</code> (here x-axis labelling). Additional parameters for <code>mode = "surface"</code> are <code>surface_value</code> (character with names of the surfaces to plot), <code>col_ramp</code> , <code>legend</code> (TRUE/FALSE), <code>contour</code> (TRUE/FALSE), <code>contour_nlevels</code> , <code>contour_col</code> , <code>nx</code> and <code>ny</code> (size of the interpolation grid), <code>labcex</code> (scaling of the contour labels), <code>zlim</code> .

Details

This function only works with **RLum.Analysis** objects produced by [read_PSL2R](#). It further assumes (or rather requires) an equal amount of OSL and IRSL curves that are pairwise combined for calculating the IRSL/OSL ratio. For calculating the depletion ratios, the cumulative signal of the last

n channels (same number of channels as specified by `signal_integral`) is divided by cumulative signal of the first n channels (`signal_integral`).

Note: The function assumes the following sequence pattern: DARK COUNT, IRSL, DARK COUNT, BSL, DARK COUNT. Therefore, the total number of curves in the input object must be a multiple of 5, and there must be 3 DARK_COUNT records for each IRSL/BSL pair. If a different sequence was used, the function will produce an error.

Signal processing The function processes the signals as follows: BSL and IRSL signals are extracted using the chosen signal integral, dark counts are taken in full.

Working with coordinates Usually samples are taken from a profile with a certain stratigraphy. In the past, the function calculated an index. Currently, you have two ways of passing on xy-coordinates to the function:

- (1) Add coordinates to the sample name during measurement. The form is rather strict and has to follow the scheme `_x:<number>|y:<number>`. Example: `sample_x:0.2|y:0.4`.
- (2) Alternatively, you can provide a [list](#) or [matrix](#) with the (x , y) coordinates of each sample in meters (m) using the `coord` argument: Example: `coord = list(c(0.2, 1), c(0.3, 1.2))`

If in your profile the x-coordinates were not measured, x should be set to 0. Note that, in such case, a surface plot cannot be produced.

Value

Returns an S4 [RLum.Results](#) object with the following elements:

`$data`

.. `$summary`: [data.frame](#) with the results

.. `$data`: [list](#) with the [RLum.Analysis](#) objects

.. `$args`: [list](#) the input arguments

Function version

0.1.5

How to cite

Burow, C., Kreutzer, S., Colombo, M., 2026. `analyse_portableOSL()`: Analyse portable CW-OSL measurements. Function version 0.1.5. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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See Also

[RLum.Analysis](#), [RLum.Data.Curve](#), [read_PSL2R](#)

Examples

```
## example profile plot
# (1) load example data set
data("ExampleData.portableOSL", envir = environment())

# (2) merge and plot all RLum.Analysis objects
merged <- merge_RLum(ExampleData.portableOSL)
plot_RLum(
  object = merged,
  combine = TRUE,
  records_max = 5,
  legend.pos = "outside")
merged

# (3) analyse and plot
results <- analyse_portableOSL(
  merged,
  signal_integral = 1:5,
  invert = FALSE,
  normalise = TRUE)
get_RLum(results)
```

analyse_SAR.CWOSL

Analyse SAR CW-OSL Measurements

Description

The function performs a SAR CW-OSL analysis on an [RLum.Analysis](#) object, including growth curve fitting.

Usage

```
analyse_SAR.CWOSL(
  object,
  signal_integral = NULL,
  background_integral = NULL,
  signal_integral_Tx = NULL,
  background_integral_Tx = NULL,
  integral_input = c("channel", "measurement"),
  OSL.component = NULL,
  rejection.criteria = list(),
  dose.points = NULL,
  dose.points.test = NULL,
```

```

    dose_rate_source = NULL,
    trim_channels = FALSE,
    mtext.outer = "",
    plot = TRUE,
    plot_onePage = FALSE,
    plot_singlePanels = FALSE,
    onlyLxTxTable = FALSE,
    method_control = list(),
    ...
)

```

Arguments

- object** [RLum.Analysis](#) (**required**): input object containing data for analysis, alternatively a [list](#) of [RLum.Analysis](#) objects can be provided. The object should **only** contain curves considered part of the SAR protocol (see Details). When `OSL.component` is set, the input object must have been processed by `OSLdecomposition::RLum.OSL_decomposition`.
- signal_integral** [integer](#) (**required**): vector of channels for the signal integral. It can be a [list](#) of integers, if object is a list. If set to `NULL` (default) or `NA`, no integrals are taken into account and their settings are ignored.
- background_integral** [integer](#) (**required**): vector of channels for the background integral. It can be a [list](#) of integers, if object is a list. If set to `NULL` (default), no integrals are taken into account and their settings are ignored. If set to `NA`, no background integral is subtracted.
- signal_integral_Tx** [integer](#) (*optional*): vector of channels for the signal integral for the Tx curve. It can be a [list](#) of integers, if object is a list. If `NULL`, the `signal_integral` vector is used also for the Tx curve.
- background_integral_Tx** [integer](#) (*optional*): vector of channels for the background integral for the Tx curve. It can be a [list](#) of integers, if object is a list. If `NULL`, the `background_integral` vector is used. If set to `NA`, no background integral for the Tx curve is subtracted.
- integral_input** [character](#) (*with default*): input type for `signal_integral`, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.
- OSL.component** [character](#) or [integer](#) (*optional*): single index or a [character](#) defining the signal component to be evaluated. It requires that the object was processed by `OSLdecomposition::RLum.OSL_decomposition`. This argument can either be the name of the OSL component assigned by `OSLdecomposition::RLum.OSL_global_fitting` or the index in descending order of decay rates. Then "1" selects the fastest decaying component, "2" the second fastest and so on. Can be a [list](#) of [integers](#) or strings (or mixed) If object is a [list](#) and this parameter is provided as [list](#) it alternates over the elements (aliquots) of the object list, e.g., `list(1,2)` processes the first aliquot with component 1 and the second aliquot with component 2. `NULL` does not process any component.

rejection.criteria

list (*with default*): provide a *named* list and set rejection criteria in **percentage**. It can be a nested **list**, if object is of type **list**. Note: *unnamed* list elements are ignored.

Allowed options:

- `recycling.ratio` **numeric** (default: 10)
- `recuperation.rate` **numeric** (default: 10)
- `palaeodose.error` **numeric** (default: 10)
- `testdose.error` **numeric** (default: 10)
- `sn.ratio` **numeric** (default: NA)
- `exceed.max.regpoint` **logical** (default: FALSE)
- `consider.uncertainties` **logical** (default: FALSE)
- `recuperation_reference` **character** (default: "Natural"; set to, e.g., "R1" for another point; use "Rmax" to select the point with highest dose as reference)
- `sn_reference` **character** (default: "Natural").

Example: `rejection.criteria = list(recycling.ratio = 10)`.

All numerical criteria can be set to NA, in which case values are calculated, but they are not considered, and their corresponding RC.Status is always "OK". In the "Checks" plot, they are shown with a grey circle and only their value is reported (without showing `<= NA` or `>= NA`).

If `onlyLxTxTable = TRUE`, the `palaeodose.error` and `exceed.max.regpoint` criteria are not computed.

dose.points **numeric** (*optional*): a numeric vector containing the dose point values. Using this argument overwrites dose point values extracted from other data. Can be a **list** of **numeric** vectors, if object is of type **list**.

dose.points.test **numeric** (*optional*): a numeric vector containing the test dose in the same units as `dose.points`. If length = 1, the values will be recycled. It has only an effect for `fit.method = 'OTORX'`.

dose_rate_source **numeric** (*optional*): numerical value for the source dose rate, typically in Gy/s. If set, the x-axis default for the dose-response curve changes to Dose [Gy].

trim_channels **logical** (*with default*): trim channels per record category to the lowest number of channels in the category by using `trim_RLum.Data`. Applies only to OSL and IRSL curves. For a more granular control use `trim_RLum.Data` before calling this function.

mtext.outer **character** (*optional*): option to provide an outer margin mtext. Can be a **list** of **characters**, if object is of type **list**

plot **logical** (*with default*): enable/disable the plot output.

plot_onePage **logical** (*with default*): enable/disable plotting all subplots on one page.

plot_singlePanels **logical** (*with default*) or **numeric** (*optional*): control the plotting of subplots in single windows (one subplot per page). Using a **numeric** vector allows to select

- the subplots individually; setting it to TRUE corresponds to `plot_singlePanels = 1:8`. For example, `plot_singlePanels = c(1,2,3,4)` will plot the TL and Lx, Tx curves; `plot_singlePanels = c(5,6,7,8)` will plot the legend (5), the dose-response curve (6), the rejection criteria (7), and either the IRSL curve or the single grain (8). It is ignored if `plot = FALSE` or `plot_onePage = TRUE`.
- `onlyLxTxTable` **logical** (*with default*): If TRUE the dose response curve fitting and plotting is skipped, and the `palaeodose.error` and `exceed.max.regpoint` criteria are not computed. This allows to get hands on the Lx/Tx table for large datasets without the need for a curve fitting.
- `method_control` **list** (*optional*): options to control the function behaviour. Currently only the 'auto_curve_removal' (logical) option is supported, which controls whether curves with `recordType` starting with `_` should be automatically removed (TRUE by default).
- ... further arguments that will be passed to [fit_DoseResponseCurve](#), [plot_DoseResponseCurve](#) or [calc_OSLLxTxRatio](#) (the latter only supports `background.count.distribution`, `sigmab`, `sig0`, `od_rates`). Additionally, supported are `legend.cex` and `legend.pch` to modify the legend symbols. **Note:** If you consider using the early light subtraction method, `sigmab` should be provided.
- Note:** `od_rates` can be used to treat uncertainties in Lx/Tx according to Bluszcz et al. (2015) instead of the standard approach of Galbraith (2002, 2014). See [calc_OSLLxTxRatio](#) for details.

Details

The function performs an analysis for standard SAR protocol measurements introduced by Murray and Wintle (2000) with CW-OSL curves. For the calculation of the Lx/Tx value the function [calc_OSLLxTxRatio](#) is used. To **change the way the Lx/Tx error is calculated** use arguments `background.count.distribution` and `sigmab`, which will be passed to [calc_OSLLxTxRatio](#).

What is part of a SAR sequence?

The function is rather picky when it comes to accepted curve input (OSL, IRSL,...) and structure. A SAR sequence is basically a set of L_x/T_x curves. Hence, every second curve is considered a shine-down curve related to the test dose. It also means that the number of curves for L_x has to be equal to the number of T_x curves, and that hot-bleach curves **do not** belong in a SAR sequence; at least not for the analysis. Other curves allowed and processed are preheat curves, or preheat curves measured as TL, and irradiation curves. The latter indicates the duration of the irradiation, the dose and test dose points, e.g., as part of XSYG files.

Argument object is of type list

If the argument object is of type **list** containing **only** [RLum.Analysis](#) objects, the function re-calls itself on each element in the list. This is useful for analysing an entire measurement without writing separate for-loops. To gain full control of the parameters (e.g., `dose.points`) for every aliquot (corresponding to one [RLum.Analysis](#) object in the list), in this case the arguments can be provided as **list**. This list should be of similar length as the list provided with the argument object, otherwise the function will create an own list of the requested length. Function output will be just one single [RLum.Results](#) object.

Please be careful when using this option. While it may allow for a fast and efficient data analysis, the function may break with an unclear error message if the input data is misspecified.

Working with IRSL data

The function was originally designed to work just for 'OSL' curves, following the principles of the SAR protocol. An IRSL measurement protocol may follow this procedure, e.g., post-IR IRSL protocol (Thomsen et al., 2008). Therefore this function has been enhanced to work with IRSL data, however, the function is only capable of analysing curves that follow the SAR protocol structure, i.e., to analyse a post-IR IRSL protocol, curve data have to be pre-selected by the user to fit the standards of the SAR protocol, i.e., Lx,Tx,Lx,Tx and so on.

Example: Imagine the measurement contains pIRIR50 and pIRIR225 IRSL curves. Only one curve type can be analysed at the same time: either the pIRIR50 curves or the pIRIR225 curves.

Supported rejection criteria

[recycling.ratio]: calculated for every repeated regeneration dose point.

[recuperation.rate]: recuperation rate calculated by comparing the Lx/Tx values of the zero regeneration point with the Ln/Tn value (the Lx/Tx ratio of the natural signal). For methodological background see Aitken and Smith (1988). As a variant, recuperation_reference can be specified to select another dose point as reference instead of Ln/Tn (e.g. "R1"; "Rmax" selects the point with highest dose as reference).

[testdose.error]: set the allowed error for the test dose, which by default should not exceed 10%. The test dose error is calculated as $T_{x_net}.error/T_{x_net}$. The calculation of the T_n error is detailed in [calc_OSLLxTxRatio](#).

[palaeodose.error]: set the allowed error for the De value, which by default should not exceed 10%.

[sn.ratio]: set the allowed signal/noise ratio, which by default should be at least 50. By default it uses the value from the natural curve, but this can be changed by specifying the sn_reference option.

By default, the computed values are compared directly to the corresponding thresholds to establish their result status ("OK" or "FAILED"). By setting the option consider_uncertainties = TRUE in the rejection.criteria list, quantified uncertainties are considered in the computation of the test value before comparing it to the threshold (currently supported only for recycling.ratio, recuperation.rate and exceed.max.regpoint). This reduces tests being marked as "FAILED" when the deviation from the threshold is smaller than the uncertainty margin.

Irradiation times

The function makes two attempts to extract irradiation data (dose points) automatically from the input object, if the argument dose.points is not set (aka set to NULL).

1. It searches in every curve for an info object called IRR_TIME. If this is found, any value set there is taken as dose point.
2. If the object contains curves of type irradiation, the function tries to use this information to assign these values to the curves. However, the function does **not** overwrite values preset in IRR_TIME.

Value

A plot (*optional*) and an [RLum.Results](#) object is returned containing the following elements:

data [data.frame](#) containing De-values, De-error and further parameters

LnLxTnTx.values

[data.frame](#) of all calculated Lx/Tx values including signal, background counts and the dose points

rejection.criteria

[data.frame](#) with values that might be used as rejection criteria. NA is produced if no R0 dose point exists.

Formula [formula](#) formula that have been used for the growth curve fitting

.plot.data List used internally for plotting.

The output should be accessed using the function [get_RLum](#).

The function currently supports only 'OSL', 'IRSL' and 'POSL' data!

Function version

1.0.1

How to cite

Kreutzer, S., Colombo, M., 2026. analyse_SAR.CWOSL(): Analyse SAR CW-OSL Measurements. Function version 1.0.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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See Also

[calc_OSLLxTxRatio](#), [fit_DoseResponseCurve](#), [plot_DoseResponseCurve](#), [RLum.Analysis](#), [RLum.Results](#)

Examples

```

##load data
##ExampleData.BINfileData contains two BINfileData objects
##CWOSL.SAR.Data and TL.SAR.Data
data(ExampleData.BINfileData, envir = environment())

##transform the values from the first position in a RLum.Analysis object
object <- Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos=1)

##perform SAR analysis and set rejection criteria
results <- analyse_SAR.CWOSL(
  object = object,
  signal_integral = 1:2,
  background_integral = 900:1000,
  log = "x",
  fit.method = "SSE",
  plot_onePage = TRUE,
  rejection.criteria = list(
    recycling.ratio = 10,
    recuperation.rate = 10,
    testdose.error = 10,
    palaeodose.error = 10,
    recuperation_reference = "Natural",
    sn.ratio = 50,
    sn_reference = "Natural",
    exceed.max.regpoint = TRUE)
)

##show De results
get_RLum(results)

##show LnTnLxTx table
get_RLum(results, data.object = "LnLxTnTx.table")

## Run example with special case for
## the OTORX fit
## Not run:
results <- analyse_SAR.CWOSL(
  object = object,
  signal_integral = 1:2,
  background_integral = 900:1000,
  dose.points.test = 15,
  n.MC = 10,
  fit.method = "OTORX")

## End(Not run)

```

Description

The function computes the natural sensitivity correction factor (NCF) for the assessment of single aliquot regeneration based palaeodoses. This allows to produce D_e values that account for sensitivity changes that may occur during the preheat and readout of the natural OSL.

Usage

```
analyse_SAR.NCF(object, TL_peak_range = 15, method_control = NULL, ...)
```

Arguments

object	RLum.Analysis or list of RLum.Analysis objects (required): input object containing data for analysis. If a list is provided the functions tries to iterate over each element in the list.
TL_peak_range	numeric (with default): size of the integration window in deg. C on each side of the identified peak.
method_control	list (<i>optional</i>): parameters to control the peak-finding step (see Details).
...	further arguments that will be passed to fit_DoseResponseCurve , plot_DoseResponseCurve or calc_OSLLxTxRatio (the latter only supports <code>background.count.distribution</code> , <code>sigmab</code> , <code>sig0</code> , <code>od_rates</code>). Additionally, supported are <code>legend.cex</code> and <code>legend.pch</code> to modify the legend symbols. Note: If you consider using the early light subtraction method, <code>sigmab</code> should be provided. Note: <code>od_rates</code> can be used to treat uncertainties in Lx/Tx according to Bluszcz et al. (2015) instead of the standard approach of Galbraith (2002, 2014). See calc_OSLLxTxRatio for details.

Details

This function is a wrapper around [analyse_SAR.CWOSL](#): it works in a similar way, but corrects the natural OSL signal according to Singhvi et al. (2011) and by implementing the MatLab code reported in Kaushal et al. (2022).

The NCF procedure:

The NCF protocol modifies the standard SAR protocol by adding a small dose before the readout of the natural signal; the corresponding 110 deg. C TL peak in quartz is monitored and compared to the TL peak recorded during the typical cutheat measurement. The additional dose used for the NCF TL curves is subtracted automatically. The published NCF sequence structure must be followed, otherwise the correction will not work.

The natural sensitivity correction factor (NCF) is measured as the ratio of the 110 deg. C TL peaks before and after the measurement of natural OSL, accounting for an integration range around the peak, typically 15 deg. C or the full width at half maximum (FWHM).

TL peak finding:

The TL peaks are found automatically by finding the position with highest counts below 160 deg. C (after some smoothing has been applied to the counts data) for each of the two TL curves.

The peak search parameters can be controlled via the `method_control` argument. If used, this must be a list with one or more of the following named arguments (e.g. `method_control = list(search.threshold.degrees = 130)`):

- `peak.temperature`: this can be used to set the temperature of the TL peak manually; if set to NULL (default), the peak is found automatically
- `search.threshold.degrees`: threshold in deg. C below which the peak is searched (160 by default); this is ignored if `peak.temperature` is not NULL

The identified TL curves and the chosen signal integral are shown in the graphical output.

Value

Plots (*optional*) and an [RLum.Results](#) object is returned containing the following elements:

DATA.OBJECT	TYPE	DESCRIPTION
<code>..\$data :</code>	<code>data.frame</code>	Table with corrected D_e values
<code>..\$LnLxTnTx.table :</code>	<code>data.frame</code>	Corrected LnLxTnTx values
<code>..\$rejection.criteria :</code>	<code>data.frame</code>	Rejection criteria
<code>..\$Formula :</code>	<code>list</code>	Function used for fitting of the dose response curve
<code>..\$data_uncor :</code>	<code>data.frame</code>	Table with the uncorrected data
<code>..\$LnLxTnTx.table_uncor :</code>	<code>data.frame</code>	Uncorrected LnLxTnTx values
<code>..\$NCF_settings :</code>	<code>list</code>	Setting used for TL peak finding

This output is similar to the output of [analyse_SAR.CWOSL](#) extended by a few more elements.

Function version

0.1.1

How to cite

Colombo, M., Kreutzer, S., 2026. `analyse_SAR.NCF()`: Compute SAR palaeodoses using natural sensitivity correction (NCF). Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function is a beta version.

Author(s)

Marco Colombo, Institute of Geography, Heidelberg University (Germany)
Sebastian Kreutzer, LIAG Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Kaushal, R.K., Chauhan, N., Singhvi, A.K., 2022. Luminescence dating of quartz: A MATLAB-based program for computation of SAR palaeodoses using natural sensitivity correction (NCF). *Ancient TL*, 40 (2), 1-7. doi:10.26034/la.atl.2022.561

Singhvi, A.K., Stokes, S.C., Chauhan, N., Nagar, Y.C., Jaiwal, M.K., 2011. Changes in natural OSL sensitivity during single aliquot regeneration procedure and their implications for equivalent dose determination. *Geochronometria*, 38 (3), 231-241. doi:10.2478/s1338601100283

See Also

[analyse_SAR.CWOSL](#), [fit_DoseResponseCurve](#)

Examples

```
## Load example data
file <- system.file("extdata/NCF.binx", package = "Luminescence")
ncf <- read_BIN2R(file, fastForward = TRUE)

results <- analyse_SAR.NCF(
  object = ncf,
  signal_integral = 1:2,
  background_integral = 100:250,
  dose_rate_source = 0.1)
```

analyse_SAR.TL	<i>Analyse SAR TL measurements</i>
----------------	------------------------------------

Description

The function performs a SAR TL analysis on a [RLum.Analysis](#) object including growth curve fitting.

Usage

```
analyse_SAR.TL(
  object,
  object.background,
  signal_integral,
  integral_input = "channel",
  sequence.structure = c("PREHEAT", "SIGNAL", "BACKGROUND"),
  rejection.criteria = list(recycling.ratio = 10, recuperation.rate = 10),
  dose.points = NULL,
  log = "",
  ...
)
```

Arguments

object	RLum.Analysis or a list of such objects (required) : input object containing data for analysis
--------	---

object.background	currently not used
signal_integral	integer (required) : vector of inputs (as defined by integral_input) for the signal integral.
integral_input	character (with default) : input type for signal_integral, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given temperature range are selected.
sequence.structure	vector character (with default) : specifies the general sequence structure. Three steps are allowed ("PREHEAT", "SIGNAL", "BACKGROUND"), in addition a parameter "EXCLUDE". This allows excluding TL curves which are not relevant for the protocol analysis. (Note: No TL are removed by default)
rejection.criteria	list (with default) : list containing rejection criteria in percentage for the calculation.
dose.points	numeric (optional) : option set dose points manually
log	character (with default) : a character string which contains "x" if the x-axis is to be logarithmic, "y" if the y axis is to be logarithmic and "xy" or "yx" if both axes are to be logarithmic. See plot.default).
...	further arguments that will be passed to the function fit_DoseResponseCurve

Details

This function performs a SAR TL analysis on a set of curves. The SAR procedure in general is given by Murray and Wintle (2000). For the calculation of the Lx/Tx value the function [calc_TLLxTxRatio](#) is used.

Provided rejection criteria

[recycling.ratio]: calculated for every repeated regeneration dose point.

[recuperation.rate]: recuperation rate calculated by comparing the Lx/Tx values of the zero regeneration point with the Ln/Tn value (the Lx/Tx ratio of the natural signal). For methodological background see Aitken and Smith (1988)

Value

A plot (*optional*) and an [RLum.Results](#) object is returned containing the following elements:

De.values	data.frame containing De-values and further parameters
LnLxTnTx.values	data.frame of all calculated Lx/Tx values including signal, background counts and the dose points.
rejection.criteria	data.frame with values that might be used as rejection criteria. NA is produced if no R0 dose point exists.

The output should be accessed using the function [get_RLum](#).

Function version

0.3.5

How to cite

Kreutzer, S., 2026. analyse_SAR.TL(): Analyse SAR TL measurements. Function version 0.3.5. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note**THIS IS A BETA VERSION**

No TL curves will be removed from the input object without further warning.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

- Aitken, M.J. and Smith, B.W., 1988. Optical dating: recuperation after bleaching. Quaternary Science Reviews 7, 387-393.
- Murray, A.S. and Wintle, A.G., 2000. Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol. Radiation Measurements 32, 57-73.

See Also

[calc_TLLxTxRatio](#), [fit_DoseResponseCurve](#), [RLum.Analysis](#), [RLum.Results](#), [get_RLum](#)

Examples

```
##load data
data(ExampleData.BINfileData, envir = environment())

##transform the values from the first position in a RLum.Analysis object
object <- Risoe.BINfileData2RLum.Analysis(TL.SAR.Data, pos=3)

##perform analysis
analyse_SAR.TL(
  object = object,
  signal_integral = 210:220,
  fit.method = "SSE OR LIN",
  sequence.structure = c("SIGNAL", "BACKGROUND"))
```

 apply_CosmicRayRemoval

*Cosmic-ray removal and spectrum smoothing for
RLum.Data.Spectrum objects*

Description

The function provides several methods for cosmic-ray removal and spectrum smoothing for [RLum.Data.Spectrum](#) objects, and those embedded in [list](#) or [RLum.Analysis](#) objects.

Usage

```
apply_CosmicRayRemoval(
  object,
  method = c("smooth", "smooth.spline", "smooth_RLum", "Pych"),
  method.Pych.smoothing = 2,
  method.Pych.threshold_factor = 3,
  MARGIN = 2,
  verbose = FALSE,
  plot = FALSE,
  ...
)
```

Arguments

- | | |
|------------------------------|---|
| object | RLum.Data.Spectrum or RLum.Analysis (required): input object to be treated, which can be also provided as list . If an RLum.Analysis object is provided, only its RLum.Data.Spectrum objects are treated. Please note: this mixing of objects does not work for a list of RLum.Data objects. |
| method | character (<i>with default</i>): Defines method that is applied for cosmic ray removal. Allowed methods are smooth, the default, (stats::smooth), smooth.spline (stats::smooth.spline), smooth_RLum (smooth_RLum) and Pych . See details for further information. |
| method.Pych.smoothing | integer (<i>with default</i>): Smoothing parameter for cosmic ray removal according to Pych (2003) . The value defines how many neighbouring values in each frame are used for smoothing (e.g., 2 means that the two previous and two following values are used). |
| method.Pych.threshold_factor | numeric (<i>with default</i>): Threshold for zero-bins in the histogram. Small values mean that more peaks are removed, but signal might be also affected by this removal. |
| MARGIN | integer (<i>with default</i>): on which part the function cosmic ray removal should be applied on: <ul style="list-style-type: none"> • 1 = along the time axis (line by line), • 2 = along the wavelength axis (column by column). |

Note: This argument only affects methods `smooth`, `smooth.spline` and `smooth_RLum`.

`verbose` [logical](#) (*with default*): enable/disable output to the terminal.

`plot` [logical](#) (*with default*): If TRUE the histograms used for the cosmic-ray removal are returned as plot including the used threshold. Note: A separate plot is returned for each frame! Currently only for `method = "Pych"` a graphical output is provided.

`...` further arguments and graphical parameters that will be passed to the [stats::smooth](#), [stats::smooth.spline](#) or [smooth_RLum](#). See details for more information.

Details

`method = "Pych"`

This method applies the cosmic-ray removal algorithm described by Pych (2003). There are some differences with respect to the publication:

- For interpolation between neighbouring values, the median is used instead of the mean.
- The number of breaks in the histogram is set to half the number of the input values.

For further details see references below.

Other methods Arguments supported through ...

METHOD	ARGUMENT	TYPE	REMARKS
"smooth"	kind	character	see stats::smooth
	twiceit	logical	see stats::smooth
"smooth.spline"	spar	numeric	see stats::smooth.spline
"smooth_RLum"	k	numeric	see smooth_RLum
	fill	numeric	see smooth_RLum
	align	character	see smooth_RLum
	method_smooth_RLum	character	see smooth_RLum

Best practice

There is no single silver-bullet strategy for cosmic-ray removal, as it depends on the characteristic of the detector and the chosen settings. For instance, high values for pixel binning will improve the light output, but also cause multiple pixels to be affected by a single cosmic ray. The same is valid for longer integration times. The best strategy is to combine methods and ensure that the spectrum is not distorted on a case-to-case basis.

How to combine methods?

Different methods can be combined by applying the method repeatedly to the dataset (see example).

Value

Returns same object as input.

Function version

0.4.1

How to cite

Kreutzer, S., 2026. `apply_CosmicRayRemoval()`: Cosmic-ray removal and spectrum smoothing for `RLum.Data.Spectrum` objects. Function version 0.4.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. *Luminescence: Comprehensive Luminescence Dating Data Analysis*. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , `RLum` Developer Team

References

Pych, W., 2004. A Fast Algorithm for Cosmic-Ray Removal from Single Images. *The Astronomical Society of the Pacific* 116 (816), 148-153. doi:[10.1086/381786](https://doi.org/10.1086/381786)

See Also

[RLum.Data.Spectrum](#), [RLum.Analysis](#), [stats::smooth](#), [stats::smooth.spline](#), [smooth_RLum](#)

Examples

```
##(1) - use with your own data and combine (uncomment for usage)
## run two times the default method and smooth with another method
## your.spectrum <- apply_CosmicRayRemoval(your.spectrum, method = "Pych")
## your.spectrum <- apply_CosmicRayRemoval(your.spectrum, method = "Pych")
## your.spectrum <- apply_CosmicRayRemoval(your.spectrum, method = "smooth")
```

`apply_Crosstalk`

Apply crosstalk

Description

Add crosstalk, evenly spread in rook (top-right-bottom-left) directions, to all grain whole locations on one measurement discs (=on position on a measurement wheel in a reader). An added crosstalk value of as example 0.2 means that 0.2 of the value of the central grain is added to each grain in the rook directions. This is an additive action: the central grain itself is not affected by this operation (but will on its turn increase because of crosstalk from its neighbours). This function is used for simulations: can this added crosstalk be detected?

Usage

```
apply_Crosstalk(object, n_crosstalk = 0.2)
```

Arguments

- object** **RLum.Results** or **numeric (required)**: a numerical vector of length 100, representing one or more measurement discs ("positions") in a reader. Each element in the vector represents one grain hole location on a disc.
- n_crosstalk** **numeric (with default)**: A single number quantifying the added crosstalk. Defaults for testing purposes to 0.2. Can be any number, even negative, but for realistic simulations we suggest something between 0 and 0.25.

Details

If an element in object is NA, it is internally set to 0, so it will not be added.

Value

A vector of size 100, with the value at each grain hole location including simulated crosstalk.

How to cite

de Boer, A., Steinbuch, L., 2026. apply_Crosstalk(): Apply crosstalk. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Anna-Maartje de Boer, Wageningen University & Research (The Netherlands)
 Luc Steinbuch, Wageningen University & Research (The Netherlands)
 , RLum Developer Team

References

de Boer, A-M., Steinbuch, L., Heuvelink, G.B.M., Wallinga, J., 2025. A novel method to assess crosstalk in single-grain luminescence detection. Radiation Measurements 186, 107459. doi:10.1016/j.radmeas.2025.107459

Examples

```
## Create artificial disc observation
observations <- set_RLum(class = "RLum.Results",
                        data = list(vn_values = rep(x = c(1,2), each = 50))
                        )
hist(get_RLum(object = observations))

## Add crosstalk (with default set to 0.2), and visualize the difference
## in the resulting histogram.
observations_with_simulated_crosstalk <- apply_Crosstalk(observations)
hist(observations_with_simulated_crosstalk)
```

`apply_EfficiencyCorrection`*Apply spectral efficiency correction to `RLum.Data.Spectrum` objects*

Description

The function applies spectral efficiency correction to `RLum.Data.Spectrum` objects.

Usage

```
apply_EfficiencyCorrection(object, spectral.efficiency)
```

Arguments

`object` `RLum.Data.Spectrum` or `RLum.Analysis` (**required**): object of class `RLum.Data.Spectrum`, `RLum.Analysis` or a [list](#) of such objects. Other objects in the list are skipped.

`spectral.efficiency` [data.frame](#) or [character](#) (**required**): either a data frame with 2 columns containing wavelengths and relative spectral response values (values between 0 and 1); or a character string specifying the path to a CSV file (with a header row), which the function will attempt to import via [utils::read.csv](#). When object is a [list](#), the provided data will be used to correct all spectra.

Details

The efficiency correction is based on a spectral response dataset provided by the user. Usually the data set for the quantum efficiency is of lower resolution and values are interpolated for the required spectral resolution using function [stats::approx](#).

If the energy calibration differs for both data set NA values are produced that will be removed from the matrix.

Value

Returns same object as provided as input

Function version

0.3.0

How to cite

Kreutzer, S., Friedrich, J., 2026. `apply_EfficiencyCorrection()`: Apply spectral efficiency correction to `RLum.Data.Spectrum` objects. Function version 0.3.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Please note that the spectral efficiency data from the camera alone may not sufficiently correct for spectral efficiency of the entire optical system (e.g., spectrometer, camera ...).

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Johannes Friedrich, University of Bayreuth (Germany) , RLum Developer Team

See Also

[RLum.Data.Spectrum](#), [RLum.Analysis](#)

Examples

```
##(1) - use with your own data (uncomment for usage)
## spectral.efficiency <- read.csv("your data")
##
## your.spectrum <- apply_EfficiencyCorrection(your.spectrum, )
```

as

as() - *RLum-object coercion*

Description

```
for [RLum.Analysis-class]
for [RLum.Data.Curve-class]
for [RLum.Data.Image-class]
for [RLum.Data.Spectrum-class]
for [RLum.Results-class]
```

Usage

```
## S4 method for signature 'list,RLum.Analysis'
coerce(from, to = "RLum.Analysis", strict = TRUE)

## S4 method for signature 'list,RLum.Data.Curve'
coerce(from, to = "RLum.Data.Curve", strict = TRUE)

## S4 method for signature 'data.frame,RLum.Data.Image'
coerce(from, to = "RLum.Data.Image", strict = TRUE)

## S4 method for signature 'data.frame,RLum.Data.Spectrum'
coerce(from, to = "RLum.Data.Spectrum", strict = TRUE)
```

```
## S4 method for signature 'list,RLum.Results'  
coerce(from, to = "RLum.Results", strict = TRUE)
```

Arguments

- from [RLum](#), [list](#), [data.frame](#), [matrix](#) (**required**): object to be coerced from
- to [character](#) (**required**): class name to be coerced to
- strict Unused.

Details

[RLum.Analysis](#)

from	to
list	list

Given that the [list](#) consists of [RLum.Analysis](#) objects.

[RLum.Data.Curve](#)

from	to
list	list
data.frame	data.frame
matrix	matrix

[RLum.Data.Image](#)

from	to
data.frame	data.frame
matrix	matrix

[RLum.Data.Spectrum](#)

from	to
data.frame	data.frame
matrix	matrix
list	list

[RLum.Results](#)

from	to
list	list

Given that the [list](#) consists of [RLum.Results](#) objects.

Note

Due to the complex structure of the RLum objects itself a coercing to standard R data structures will be always loosely!

See Also

[methods::as](#)

BaseDataSet

Base datasets

Description

Collection of datasets with published and unpublished data used within the package.

BaseData.ConversionFactors Collection of published dose-rate conversion factors to convert concentrations of radioactive isotopes to dose rate values

BaseData.GrainSizeAttenuation Grain size attenuation data by Guérin et al. (2012)

BaseData.FractionalGammaDose Collection of (un-)published fractional gamma dose-rate values to scale the gamma-dose rate considering layer-to-layer variations in soil radioactivity

Format**Dose-rate conversion factors**

A [list](#) with three elements with dose-rate conversion factors sorted by article and radiation type (alpha, beta, gamma):

AdamiecAitken1998:	Conversion factors from Tables 5 and 6
Cresswelletal2018:	Conversion factors from Tables 5 and 6
Guerinetal2011:	Conversion factors from Tables 1, 2 and 3
Liritzisetetal2013:	Conversion factors from Tables 1, 2 and 3

Grain size attenuation data

A [data.frame](#) seven columns and sixteen rows. Column headers are GrainSize, Q_K, FS_K, Q_Th, FS_Th, Q_U, FS_U. Grain sizes are quoted in μm (e.g., 20, 40, 60 etc.)

Fractional gamma dose-rate values

A [list](#) with fractional gamma dose-rate values sorted by article:

Aitken1985:	Fractional gamma-dose values from table H.1
-------------	---

Version

0.2.0

Source

Dose-rate conversion factors

All gamma conversion factors were carefully read from the tables given in:

Adamiec, G., Aitken, M.J., 1998. Dose-rate conversion factors: update. *Ancient TL* 16, 37-46.

Cresswell, A.J., Carter, J., Sanderson, D.C.W., 2018. Dose rate conversion parameters: Assessment of nuclear data. *Radiation Measurements* 120, 195-201.

Guérin, G., Mercier, N., Adamiec, G., 2011. Dose-rate conversion factors: update. *Ancient TL* 29, 5-8.

Liritzis, I., Stamoulis, K., Papachristodoulou, C., Ioannides, K., 2013. A re-evaluation of radiation dose-rate conversion factors. *Mediterranean Archaeology and Archaeometry* 13, 1-15.

Grain size attenuation data

Guérin, G., Mercier, N., Nathan, R., Adamiec, G., Lefrais, Y., 2012. On the use of the infinite matrix assumption and associated concepts: A critical review. *Radiation Measurements* 47, 778-785.

Fractional gamma dose-rate values

Fractional gamma dose values were carefully read from the tables given in:

Aitken, M.J., 1985. *Thermoluminescence Dating*. Academic Press, London.

Examples

```
## conversion factors
data("BaseDataSet.ConversionFactors", envir = environment())

## grain size attenuation
data("BaseDataSet.GrainSizeAttenuation", envir = environment())

## fractional gamma dose
data("BaseDataSet.FractionalGammaDose", envir = environment())
```

bin_RLum.Data

Channel binning for RLum.Data-class objects

Description

The function provides a generalised access point for specific [RLum.Data](#) objects. Depending on the input object, the corresponding function will be selected.

Usage

```
bin_RLum.Data(object, ...)

## S4 method for signature 'RLum.Data.Curve'
bin_RLum.Data(object, bin_size = 2)

## S4 method for signature 'RLum.Data.Spectrum'
bin_RLum.Data(object, bin_size.col = 1, bin_size.row = 1)
```

Arguments

object	RLum.Data (required): S4 object of class <code>RLum.Data</code>
...	further arguments passed to the specific class method
bin_size	integer (<i>with default</i>): number of channels used for each bin, e.g. <code>bin_size = 2</code> means that two channels are binned.
bin_size.col	integer (<i>with default</i>): number of channels used for each bin, e.g. <code>bin_size.col = 2</code> means that two channels are binned. Note: The function does not check the input, very large values mean a full column binning (a single sum)
bin_size.row	integer (<i>with default</i>): number of channels used for each bin, e.g. <code>bin_size.row = 2</code> means that two channels are binned. Note: The function does not check the input, very large values mean a full row binning (a single sum)

Value

An object of the same type as the input provided after binning is applied.

Methods (by class)

- `bin_RLum.Data(RLum.Data.Curve)`: Allows binning of `RLum.Data.Curve` data.
- `bin_RLum.Data(RLum.Data.Spectrum)`: Allows binning of `RLum.Data.Spectrum` data. Count values and values on the x-axis are summed up; for wavelength/energy values, the mean is calculated.

Function version

0.2.0

How to cite

Kreutzer, S., 2026. `bin_RLum.Data()`: Channel binning for `RLum.Data`-class objects. Function version 0.2.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Currently only `RLum.Data` objects of class [RLum.Data.Curve](#) and [RLum.Data.Spectrum](#) are supported.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , `RLum` Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Data.Spectrum](#)

Examples

```
## load example data
data(ExampleData.CW_OSL_Curve, envir = environment())

## create RLum.Data.Curve object from this example
curve <-
  set_RLum(
    class = "RLum.Data.Curve",
    recordType = "OSL",
    data = as.matrix(ExampleData.CW_OSL_Curve)
  )

## plot data without and with 2 and 4 channel binning
plot_RLum(curve)
plot_RLum(bin_RLum.Data(curve, bin_size = 2))
plot_RLum(bin_RLum.Data(curve, bin_size = 4))
```

calc_AliquotSize

Estimate the amount of grains on an aliquot

Description

This function can be used to either estimate the number of grains on an aliquot or to compute the packing density, depending on the arguments provided.

The following formula is used to estimate the number of grains n :

$$n = (\pi * x^2) / (\pi * y^2) * d$$

where x is the radius of the aliquot size (microns), y is the mean radius of the mineral grains (mm), and d is the packing density (a value between 0 and 1).

Packing density

The default value for `packing.density` is 0.65, which is the mean of empirical values determined by Heer et al. (2012) and unpublished data from the Cologne luminescence laboratory. If `packing.density = Inf`, a maximum density of $\pi/\sqrt{12} \approx 0.9069$ is used. However, note that this value is not appropriate as the standard preparation procedure of aliquots resembles a PECC (*Packing Equal Circles in a Circle*) problem, where the maximum packing density is asymptotic to about 0.87.

Monte Carlo simulation

The number of grains on an aliquot can be estimated by Monte Carlo simulation when setting `MC = TRUE`. All parameters necessary to calculate n (x , y , d) are assumed to be normally distributed with means μ_x, μ_y, μ_d and standard deviations $\sigma_x, \sigma_y, \sigma_d$.

For the mean grain size, random samples are taken first from $N(\mu_y, \sigma_y)$, where $\mu_y = \text{mean.grain.size}$ and $\sigma_y = (\text{max.grain.size} - \text{min.grain.size})/4$, so that 95% of all grains are within the provided the grain size range. This effectively takes into account that after sieving the sample there is still a

small chance of having grains smaller or larger than the used mesh sizes. For each random sample the mean grain size is calculated, from which random subsamples are drawn for the Monte Carlo simulation.

The packing density is assumed to be normally distributed with an empirically determined $\mu = 0.65$ (or provided value) and $\sigma = 0.18$. The normal distribution is truncated at $d = 0.87$ as this is approximately the maximum packing density that can be achieved in a PECC problem.

The sample diameter has $\mu = \text{sample.diameter}$ and $\sigma = 0.2$ to take into account variations in sample disc preparation (i.e. applying silicon spray to the disc). A lower truncation point at $x = 0.5$ is used, which assumes that aliquots with sample diameter smaller than 0.5 mm are discarded. Likewise, the normal distribution is truncated at the diameter of the sample carrier (9.8 mm by default, but controllable via the `sample_carrier.diameter` argument).

For each random sample drawn from the normal distribution, the amount of grains on the aliquot is calculated. By default, 10^4 iterations are used, but the can be controlled with option `MC.iter` (see ...). Results are visualised in a bar- and boxplot together with a statistical summary.

Usage

```
calc_AliquotSize(
  grain.size,
  sample.diameter,
  packing.density = 0.65,
  MC = TRUE,
  grains.counted = NULL,
  sample_carrier.diameter = 9.8,
  plot = TRUE,
  ...
)
```

Arguments

- `grain.size` **numeric (required)**: mean grain size (microns) or a range of grain sizes from which the mean grain size is computed (e.g. `c(100, 200)`).
- `sample.diameter` **numeric (required)**: diameter (mm) of the targeted area on the sample carrier.
- `packing.density` **numeric (with default)**: empirical value for the mean packing density. If `packing.density = Inf`, a hexagonal structure on an infinite plane with a packing density of $\pi/\sqrt{12} \approx 0.9069$ is assumed.
- `MC` **logical (optional)**: if `TRUE` the function performs a Monte Carlo simulation for estimating the amount of grains on the sample carrier and assumes random errors in grain size distribution and packing density. Requires `grain.size` to be specified as a 2-element vector with the range (min and max) of grain sizes. For more information see details.
- `grains.counted` **numeric (optional)**: grains counted on a sample carrier. If a non-zero positive integer is provided, this function will calculate the packing density of the aliquot. If more than one value is provided, the mean packing density and its standard deviation are calculated. Note that this overrides `packing.density`.

sample_carrier.diameter **numeric** (*with default*): diameter (mm) of the sample carrier.

plot **logical** (*with default*): enable/disable the plot output.

... further arguments and graphical parameters to be passed. In particular, MC.iter to control the number of Monte Carlo iterations, main, xlab, col, line_col, line_lwd, cex, rug (TRUE/FALSE), boxplot (TRUE/FALSE), summary (TRUE/FALSE), legend (TRUE/FALSE).

Value

Returns a terminal output. In addition an **RLum.Results** object is returned containing the following element:

.\$summary **data.frame** summary of all relevant calculation results.

.\$args **list** used arguments

.\$call **call** the function call

.\$MC **list** results of the Monte Carlo simulation

The output should be accessed using the function **get_RLum**.

Function version

0.33

How to cite

Burow, C., Colombo, M., 2026. calc_AliquotSize(): Estimate the amount of grains on an aliquot. Function version 0.33. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Christoph Burow, University of Cologne (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany) , RLum Developer Team

References

Duller, G.A.T., 2008. Single-grain optical dating of Quaternary sediments: why aliquot size matters in luminescence dating. *Boreas* 37, 589-612.

Heer, A.J., Adamiec, G., Moska, P., 2012. How many grains are there on a single aliquot?. *Ancient TL* 30, 9-16.

Further reading

Chang, H.-C., Wang, L.-C., 2010. A simple proof of Thue's Theorem on Circle Packing. <https://arxiv.org/pdf/1009.4322v1>, 2013-09-13.

Graham, R.L., Lubachevsky, B.D., Nurmela, K.J., Oestergard, P.R.J., 1998. Dense packings of congruent circles in a circle. *Discrete Mathematics* 181, 139-154.

Huang, W., Ye, T., 2011. Global optimization method for finding dense packings of equal circles in a circle. *European Journal of Operational Research* 210, 474-481.

Examples

```
## Estimate the amount of grains on a small aliquot
calc_AliquotSize(grain.size = c(100,150), sample.diameter = 1, MC.iter = 100)

## Calculate the mean packing density of large aliquots
calc_AliquotSize(grain.size = c(100,200), sample.diameter = 8,
                 grains.counted = c(2525,2312,2880), MC.iter = 100)
```

calc_AverageDose	<i>Calculate the Average Dose and the dose rate dispersion</i>
------------------	--

Description

This functions calculates the Average Dose and its extrinsic dispersion, estimating the standard errors by bootstrapping based on the Average Dose Model by Guérin et al., 2017.

sigma_m

The program requires the input of a known value of sigma_m, which corresponds to the intrinsic overdispersion, as determined by a dose recovery experiment. Then the dispersion in doses (sigma_d) will be that over and above sigma_m (and individual uncertainties sigma_wi).

Usage

```
calc_AverageDose(
  data,
  sigma_m,
  Nb_BE = 500,
  na.rm = TRUE,
  plot = TRUE,
  verbose = TRUE,
  ...
)
```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with De (data[,1]) and De error (values[,2])
sigma_m	numeric (required): the overdispersion resulting from a dose recovery experiment, i.e. when all grains have received the same dose. Indeed in such a case, any overdispersion (i.e. dispersion on top of analytical uncertainties) is, by definition, an unrecognised measurement uncertainty.

Nb_BE	integer (<i>with default</i>): sample size used for the bootstrapping
na.rm	logical (<i>with default</i>): exclude NA values from the data set prior to any further operation.
plot	logical (<i>with default</i>): enable/disable the plot output.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	further arguments that can be passed to graphics::hist . As three plots are returned all arguments need to be provided as list , e.g., <code>main = list("Plot 1", "Plot 2", "Plot 3")</code> . Note: not all arguments of <code>hist</code> are supported, but the output of <code>hist</code> is returned and can be used of own plots.

Further supported arguments: `mtext` ([character](#)), `rug` (TRUE/FALSE).

Value

The function produces numerical output and an optional plot. In addition, an [RLum.Results](#) object containing the following elements is returned:

<code>\$summary</code>	data.frame summary of all relevant model results.
<code>\$data</code>	data.frame with original input data.
<code>\$dstar</code>	matrix with bootstrap values.
<code>\$hist</code>	list object as produced by the hist function.

The `$summary` `data.frame` contains the following columns:

Column	Type	Description
AVERAGE_DOSE	numeric	the obtained average dose
AVERAGE_DOSE.SE	numeric	the average dose error
SIGMA_D	numeric	sigma
SIGMA_D.SE	numeric	standard error of the sigma
IC_AVERAGE_DOSE.LEVEL	character	confidence level average dose
IC_AVERAGE_DOSE.LOWER	character	lower quantile of average dose
IC_AVERAGE_DOSE.UPPER	character	upper quantile of average dose
IC_SIGMA_D.LEVEL	integer	confidence level sigma
IC_SIGMA_D.LOWER	character	lower sigma quantile
IC_SIGMA_D.UPPER	character	upper sigma quantile
L_MAX	character	maximum likelihood value
de	numeric	same as AVERAGE_DOSE (internal use)
de_err	numeric	same as AVERAGE_DOSE . SE (internal use)

The function returns two different plot panels.

- (1) An abanico plot with the dose values
- (2) A histogram panel comprising 3 histograms with the equivalent dose and the bootstrapped average dose and the sigma values.

Function version

0.1.7

How to cite

Christophe, C., Philippe, A., Guérin, G., Kreutzer, S., 2026. calc_AverageDose(): Calculate the Average Dose and the dose rate dispersion. Function version 0.1.7. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function has beta status!

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Guillaume Guérin, IRAMAT-CRP2A, Université Bordeaux Montaigne, (France)
Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Guérin, G., Christophe, C., Philippe, A., Murray, A.S., Thomsen, K.J., Tribolo, C., Urbanova, P., Jain, M., Guibert, P., Mercier, N., Kreutzer, S., Lahaye, C., 2017. Absorbed dose, equivalent dose, measured dose rates, and implications for OSL age estimates: Introducing the Average Dose Model. Quaternary Geochronology 1-32. doi:10.1016/j.quageo.2017.04.002

Further reading

Efron, B., Tibshirani, R., 1986. Bootstrap Methods for Standard Errors, Confidence Intervals, and Other Measures of Statistical Accuracy. Statistical Science 1, 54-75.

See Also

[graphics::hist](#)

Examples

```
## load example data
data(ExampleData.DeValues, envir = environment())

## calculate Average dose (using only the first 56 values here)
AD <- calc_AverageDose(ExampleData.DeValues$CA1[1:56, ], sigma_m = 0.1)

## plot De and set Average dose as central value
plot_AbanicoPlot(AD, z.0 = AD$summary$de)
```

calc_CentralDose	<i>Apply the central age model (CAM) after Galbraith et al. (1999) to a given De distribution</i>
------------------	---

Description

This function calculates the central dose and dispersion of the De distribution, their standard errors and the profile log likelihood function for sigma.

This function uses the equations of Galbraith & Roberts (2012). The parameters delta and sigma are estimated by numerically solving eq. 15 and 16. Their standard errors are approximated using eq. 17. In addition, the profile log-likelihood function for sigma is calculated using eq. 18 and presented as a plot. Numerical values of the maximum likelihood approach are **only** presented in the plot and **not** in the console. A detailed explanation on maximum likelihood estimation can be found in the appendix of Galbraith & Laslett (1993, 468-470) and Galbraith & Roberts (2012, 15)

Usage

```
calc_CentralDose(data, sigmab = 0, log = TRUE, plot = TRUE, ...)
```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with De (data[,1]) and De error (data[,2]). Records containing missing values will be removed.
sigmab	numeric (<i>with default</i>): additional spread in De values, representing the expected overdispersion in the data should the sample be well-bleached (Cunningham & Wallinga 2012, p. 100). Note: For the logged model (log = TRUE) this value must be a fraction, e.g. 0.2 (= 20 %). If the un-logged model is used (log = FALSE), sigmab must be provided in the same absolute units of the De values (seconds or Gray).
log	logical (<i>with default</i>): fit the (un-)logged central age model to De data. Log transformation is allowed only if the De values are positive.
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further arguments (trace, verbose).

Value

Returns a plot (*optional*) and terminal output. In addition an [RLum.Results](#) object is returned containing the following elements:

.\$summary	data.frame summary of all relevant model results.
.\$data	data.frame original input data
.\$args	list used arguments
.\$call	call the function call
.\$profile	data.frame the log likelihood profile for sigma

The output should be accessed using the function [get_RLum](#).

Function version

1.6

How to cite

Burow, C., 2026. calc_CentralDose(): Apply the central age model (CAM) after Galbraith et al. (1999) to a given De distribution. Function version 1.6. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Christoph Burow, University of Cologne (Germany)
Based on a rewritten S script of Rex Galbraith, 2010 , RLum Developer Team

References

Galbraith, R.F. & Laslett, G.M., 1993. Statistical models for mixed fission track ages. Nuclear Tracks Radiation Measurements 4, 459-470.

Galbraith, R.F., Roberts, R.G., Laslett, G.M., Yoshida, H. & Olley, J.M., 1999. Optical dating of single grains of quartz from Jinmium rock shelter, northern Australia. Part I: experimental design and statistical models. Archaeometry 41, 339-364.

Galbraith, R.F. & Roberts, R.G., 2012. Statistical aspects of equivalent dose and error calculation and display in OSL dating: An overview and some recommendations. Quaternary Geochronology 11, 1-27.

Further reading

Arnold, L.J. & Roberts, R.G., 2009. Stochastic modelling of multi-grain equivalent dose (De) distributions: Implications for OSL dating of sediment mixtures. Quaternary Geochronology 4, 204-230.

Bailey, R.M. & Arnold, L.J., 2006. Statistical modelling of single grain quartz De distributions and an assessment of procedures for estimating burial dose. Quaternary Science Reviews 25, 2475-2502.

Cunningham, A.C. & Wallinga, J., 2012. Realizing the potential of fluvial archives using robust OSL chronologies. Quaternary Geochronology 12, 98-106.

Rodnight, H., Duller, G.A.T., Wintle, A.G. & Tooth, S., 2006. Assessing the reproducibility and accuracy of optical dating of fluvial deposits. Quaternary Geochronology 1 109-120.

Rodnight, H., 2008. How many equivalent dose values are needed to obtain a reproducible distribution?. Ancient TL 26, 3-10.

See Also

[plot](#), [calc_CommonDose](#), [calc_FiniteMixture](#), [calc_FuchsLang2001](#), [calc_MinDose](#)

Examples

```
##load example data
data(ExampleData.DeValues, envir = environment())

##apply the central dose model
calc_CentralDose(ExampleData.DeValues$CA1)
```

calc_CobbleDoseRate	<i>Calculate dose rate of slices in a spherical cobble</i>
---------------------	--

Description

Calculates the dose rate profile through the cobble based on Riedesel and Autzen (2020).
Corrects the beta dose rate in the cobble for the grain size following results of Gu  rin et al. (2012).
Sediment beta and gamma dose rates are corrected for the water content of the sediment using the
correction factors of Aitken (1985). Water content in the cobble is assumed to be 0.

Usage

```
calc_CobbleDoseRate(object, conversion = "Guerinetal2011", ...)
```

Arguments

object	data.frame (required): A data frame containing all relevant information for each individual layer. For the table layout see details.
conversion	character (with default): dose rate conversion factors to use, see BaseDataSet.ConversionFactors for the accepted values.
...	currently not used.

Details

The input table layout

COLUMN	DATA TYPE	DESCRIPTION
Distance	numeric	distance from the surface of the cobble to the top of each rock slice in mm. The distance
DistanceError	numeric	Error on the distance in mm
Thickness	numeric	Thickness of each slice in mm
ThicknessError	numeric	uncertainty of the thickness in mm.
Mineral	character	'FS' for feldspar, 'Q' for quartz, depending which mineral in the cobble is used for dati
Cobble_K	numeric	K nuclide content in % of the bulk cobble
Cobble_K_SE	numeric	error on K nuclide content in % of the bulk cobble
Cobble_Th	numeric	Th nuclide content in ppm of the bulk cobble
Cobble_Th_SE	numeric	error on Th nuclide content in ppm of the bulk cobble
Cobble_U	numeric	U nuclide content in ppm of the bulk cobble
Cobble_U_SE	numeric	error on U nuclide content in ppm of the bulk cobble

GrainSize	numeric	average grain size in μm of the grains used for dating
Density	numeric	Density of the cobble. Default is 2.7 g cm^{-3}
CobbleDiameter	numeric	Diameter of the cobble in cm.
Sed_K	numeric	K nuclide content in % of the sediment matrix
Sed_K_SE	numeric	error on K nuclide content in % of the sediment matrix
Sed_Th	numeric	Th nuclide content in ppm of the sediment matrix
Sed_Th_SE	numeric	error on Th nuclide content in ppm of the sediment matrix
Sed_U	numeric	U nuclide content in ppm of the sediment matrix
Sed_U_SE	numeric	error on U nuclide content in ppm of the sediment matrix
GrainSize_Sed	numeric	average grain size of the sediment matrix
Density_Sed	numeric	average density of the sediment matrix
WaterContent	numeric	mean water content of the sediment matrix in %
WaterContent_SE	numeric	relative error on water content

Water content The water content provided by the user should be calculated according to:

$$(Wet_weight - Dry_weight) / Dry_weight * 100$$

Value

The function returns an **RLum.Results** object for which the first element is a **matrix** (**DataIndividual**) that gives the dose rate results for each slice for each decay chain individually, for both, the cobble dose rate and the sediment dose rate. The second element is also a **matrix** (**DataComponent**) that gives the total beta and gamma-dose rates for the cobble and the adjacent sediment for each slice of the cobble.

Function version

0.1.1

How to cite

Riedesel, S., Autzen, M., 2026. calc_CobbleDoseRate(): Calculate dose rate of slices in a spherical cobble. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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Martin Autzen, DTU NUTECH Center for Nuclear Technologies (Denmark) , RLum Developer Team

References

Riedesel, S., Autzen, M., 2020. Beta and gamma dose rate attenuation in rocks and sediment. Radiation Measurements 133, 106295.

See Also

[convert_Concentration2DoseRate](#)

Examples

```
## load example data
data("ExampleData.CobbleData", envir = environment())

## run function
calc_CobbleDoseRate(ExampleData.CobbleData)
```

calc_CommonDose	<i>Apply the (un-)logged common age model after Galbraith et al. (1999) to a given De distribution</i>
-----------------	--

Description

Function to calculate the common dose of a De distribution.

Usage

```
calc_CommonDose(data, sigmab = 0, log = TRUE, ...)
```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with De (data[,1]) and De error (data[,2])
sigmab	numeric (<i>with default</i>): additional spread in De values, representing the expected overdispersion in the data should the sample be well-bleached (Cunningham & Wallinga 2012, p. 100). Note: For the logged model (log = TRUE) this value must be a fraction, e.g. 0.2 (= 20%). If the un-logged model is used (log = FALSE), sigmab must be provided in the same absolute units of the De values (seconds or Gray).
log	logical (<i>with default</i>): fit the (un-)logged central age model to De data
...	currently not used.

Details**(Un-)logged model**

When log = TRUE this function calculates the weighted mean of logarithmic De values. Each of the estimates is weighted by the inverse square of its relative standard error. The weighted mean is then transformed back to the dose scale (Galbraith & Roberts 2012, p. 14).

The log transformation is not applicable if the De estimates are close to zero or negative. In this case the un-logged model can be applied instead (log = FALSE). The weighted mean is then calculated using the un-logged estimates of De and their absolute standard error (Galbraith & Roberts 2012, p. 14).

Value

Returns a terminal output. In addition an [RLum.Results](#) object is returned containing the following element:

\$summary	data.frame summary of all relevant model results.
\$data	data.frame original input data
\$args	list used arguments
\$call	call the function call

The output should be accessed using the function [get_RLum](#).

Function version

0.1.1

How to cite

Burow, C., 2026. calc_CommonDose(): Apply the (un-)logged common age model after Galbraith et al. (1999) to a given De distribution. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Christoph Burow, University of Cologne (Germany) , RLum Developer Team

References

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- Galbraith, R.F., Roberts, R.G., Laslett, G.M., Yoshida, H. & Olley, J.M., 1999. Optical dating of single grains of quartz from Jinmium rock shelter, northern Australia. Part I: experimental design and statistical models. Archaeometry 41, 339-364.
- Galbraith, R.F. & Roberts, R.G., 2012. Statistical aspects of equivalent dose and error calculation and display in OSL dating: An overview and some recommendations. Quaternary Geochronology 11, 1-27.
- Further reading**
- Arnold, L.J. & Roberts, R.G., 2009. Stochastic modelling of multi-grain equivalent dose (De) distributions: Implications for OSL dating of sediment mixtures. Quaternary Geochronology 4, 204-230.
- Bailey, R.M. & Arnold, L.J., 2006. Statistical modelling of single grain quartz De distributions and an assessment of procedures for estimating burial dose. Quaternary Science Reviews 25, 2475-2502.
- Cunningham, A.C. & Wallinga, J., 2012. Realizing the potential of fluvial archives using robust OSL chronologies. Quaternary Geochronology 12, 98-106.

Rodnight, H., Duller, G.A.T., Wintle, A.G. & Tooth, S., 2006. Assessing the reproducibility and accuracy of optical dating of fluvial deposits. *Quaternary Geochronology* 1 109-120.

Rodnight, H., 2008. How many equivalent dose values are needed to obtain a reproducible distribution?. *Ancient TL* 26, 3-10.

See Also

[calc_CentralDose](#), [calc_FiniteMixture](#), [calc_FuchsLang2001](#), [calc_MinDose](#)

Examples

```
## load example data
data(ExampleData.DeValues, envir = environment())

## apply the common dose model
calc_CommonDose(ExampleData.DeValues$CA1)
```

calc_CosmicDoseRate	<i>Calculate the cosmic dose rate</i>
---------------------	---------------------------------------

Description

This function calculates the cosmic dose rate taking into account the soft- and hard-component of the cosmic ray flux and allows corrections for geomagnetic latitude, altitude above sea-level and geomagnetic field changes.

This function calculates the total cosmic dose rate considering both the soft- and hard-component of the cosmic ray flux.

Internal calculation steps

(1) Calculate total depth of all absorber in hg/cm² (1 hg/cm² = 100 g/cm²)

$$absorber = depth_1 * density_1 + depth_2 * density_2 + ... + depth_n * density_n$$

(2) If half.depth = TRUE

$$absorber = absorber / 2$$

(3) Calculate cosmic dose rate at sea-level and 55 deg. latitude

a) If absorber is > 167 g/cm² (only hard-component; Allkofer et al. 1975): apply equation given by Prescott & Hutton (1994) (c.f. Barbouti & Rastin 1983)

$$D0 = C / (((absorber + d)^\alpha + a) * (absorber + H)) * \exp(-B * absorber)$$

b) If absorber is < 167 g/cm² (soft- and hard-component): derive D0 from Fig. 1 in Prescott & Hutton (1988).

- (4) Calculate geomagnetic latitude (Prescott & Stephan 1982, Prescott & Hutton 1994)

$$\lambda = \arcsin(0.203 \cos(latitude) \cos(longitude - 291) + 0.979 \sin(latitude))$$

- (5) Apply correction for geomagnetic latitude and altitude above sea-level. Values for F, J and H were read from Fig. 3 shown in Prescott & Stephan (1982) and fitted with 3-degree polynomials for $\lambda < 35$ degree and a linear fit for $\lambda > 35$ degree.

$$Dc = D0 * (F + J \exp((altitude/1000)/H))$$

- (6) Optional: Apply correction for geomagnetic field changes in the last 0-80 ka (Prescott & Hutton 1994). Correction and altitude factors are given in Table 1 and Fig. 1 in Prescott & Hutton (1994). Values for altitude factor were fitted with a 2-degree polynomial. The altitude factor is operated on the decimal part of the correction factor.

$$Dc' = Dc * correctionFactor$$

Usage of depth and density

- (1) If only one value for depth and density is provided, the cosmic dose rate is calculated for exactly one sample and one absorber as overburden (i.e. depth*density).
- (2) In some cases it might be useful to calculate the cosmic dose rate for a sample that is overlain by more than one absorber, e.g. in a profile with soil layers of different thickness and a distinct difference in density. This can be calculated by providing a matching number of values for depth and density (e.g. depth = c(1, 2), density = c(1.7, 2.4))
- (3) Another possibility is to calculate the cosmic dose rate for more than one sample of the same profile. This is done by providing more than one values for depth and only one for density. For example, depth = c(1, 2, 3) and density = 1.7 will calculate the cosmic dose rate for three samples in 1, 2 and 3 m depth in a sediment of density 1.7 g/cm³.

Usage

```
calc_CosmicDoseRate(
  depth,
  density,
  latitude,
  longitude,
  altitude,
  corr.fieldChanges = FALSE,
  est.age = NA,
  half.depth = FALSE,
  error = 10,
  ...
)
```

Arguments

depth	numeric (required) : depth of overburden (m). For more than one absorber use <code>c(depth_1, depth_2, ..., depth_n)</code>
density	numeric (required) : average overburden density (g/cm ³). For more than one absorber use <code>c(density_1, density_2, ..., density_n)</code>
latitude	numeric (required) : latitude (decimal degree), N positive
longitude	numeric (required) : longitude (decimal degree), E positive
altitude	numeric (required) : altitude (m above sea-level)
corr.fieldChanges	logical (with default) : correct for geomagnetic field changes after Prescott & Hutton (1994). Apply only when justified by the data.
est.age	numeric (with default) : estimated age range (ka) for geomagnetic field change correction (0-80 ka allowed)
half.depth	logical (with default) : How to overcome with varying overburden thickness. If TRUE only half the depth is used for calculation. Apply only when justified, i.e. when a constant sedimentation rate can safely be assumed.
error	numeric (with default) : general error (percentage) to be implemented on corrected cosmic dose rate estimate
...	further arguments (verbose to disable/enable output to the terminal).

Value

Returns a terminal output. In addition an **RLum.Results** object is returned containing the following element:

summary	data.frame summary of all relevant calculation results.
args	list used arguments
call	call the function call

The output should be accessed using the function `get_RLum`.

Function version

0.5.3

How to cite

Burow, C., 2026. `calc_CosmicDoseRate()`: Calculate the cosmic dose rate. Function version 0.5.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Despite its universal use, the equation to calculate the cosmic dose rate provided by Prescott & Hutton (1994) is falsely stated to be valid from the surface to 10^4 hg/cm² of standard rock. The original expression by Barbouti & Rastin (1983) only considers the muon flux (i.e. hard-component) and is, by their own definition, only valid for depths between 10- 10^4 hg/cm².

Thus, for near-surface samples (i.e. for depths < 167 g/cm²) the equation of Prescott & Hutton (1994) underestimates the total cosmic dose rate, as it neglects the influence of the soft-component of the cosmic ray flux. For samples at zero depth and at sea-level the underestimation can be as large as ~0.1 Gy/ka. In a previous article, Prescott & Hutton (1988) give another approximation of Barbouti & Rastin's equation in the form of

$$D = 0.21 * \exp(-0.070 * absorber + 0.0005 * absorber^2)$$

which is valid for depths between 150-5000 g/cm². For shallower depths (< 150 g/cm²) they provided a graph (Fig. 1) from which the dose rate can be read.

As a result, this function employs the equation of Prescott & Hutton (1994) only for depths > 167 g/cm², i.e. only for the hard-component of the cosmic ray flux. Cosmic dose rate values for depths < 167 g/cm² were obtained from the "AGE" program (Gruen 2009) and fitted with a 6-degree polynomial curve (and hence reproduces the graph shown in Prescott & Hutton 1988). However, these values assume an average overburden density of 2 g/cm³.

It is currently not possible to obtain more precise cosmic dose rate values for near-surface samples as there is no equation known to the author of this function at the time of writing.

Author(s)

Christoph Burow, University of Cologne (Germany) , RLum Developer Team

References

- Allkofer, O.C., Carstensen, K., Dau, W.D., Jokisch, H., 1975. Letter to the editor. The absolute cosmic ray flux at sea level. *Journal of Physics G: Nuclear and Particle Physics* 1, L51-L52.
- Barbouti, A.I., Rastin, B.C., 1983. A study of the absolute intensity of muons at sea level and under various thicknesses of absorber. *Journal of Physics G: Nuclear and Particle Physics* 9, 1577-1595.
- Crookes, J.N., Rastin, B.C., 1972. An investigation of the absolute intensity of muons at sea-level. *Nuclear Physics B* 39, 493-508.
- Gruen, R., 2009. The "AGE" program for the calculation of luminescence age estimates. *Ancient TL* 27, 45-46.
- Prescott, J.R., Hutton, J.T., 1988. Cosmic ray and gamma ray dosimetry for TL and ESR. *Nuclear Tracks and Radiation Measurements* 14, 223-227.
- Prescott, J.R., Hutton, J.T., 1994. Cosmic ray contributions to dose rates for luminescence and ESR dating: large depths and long-term time variations. *Radiation Measurements* 23, 497-500.
- Prescott, J.R., Stephan, L.G., 1982. The contribution of cosmic radiation to the environmental dose for thermoluminescence dating. Latitude, altitude and depth dependences. *PACT* 6, 17-25.

See Also

[BaseDataSet.CosmicDoseRate](#)

Examples

```
##(1) calculate cosmic dose rate (one absorber)
calc_CosmicDoseRate(depth = 2.78, density = 1.7,
                    latitude = 38.06451, longitude = 1.49646,
                    altitude = 364, error = 10)

##(2a) calculate cosmic dose rate (two absorber)
calc_CosmicDoseRate(depth = c(5.0, 2.78), density = c(2.65, 1.7),
                    latitude = 38.06451, longitude = 1.49646,
                    altitude = 364, error = 10)

##(2b) calculate cosmic dose rate (two absorber) and
##correct for geomagnetic field changes
calc_CosmicDoseRate(depth = c(5.0, 2.78), density = c(2.65, 1.7),
                    latitude = 12.04332, longitude = 4.43243,
                    altitude = 364, corr.fieldChanges = TRUE,
                    est.age = 67, error = 15)

##(3) calculate cosmic dose rate and export results to .csv file
#calculate cosmic dose rate and save to variable
results<- calc_CosmicDoseRate(depth = 2.78, density = 1.7,
                             latitude = 38.06451, longitude = 1.49646,
                             altitude = 364, error = 10)

# the results can be accessed by
get_RLum(results, "summary")

#export results to .csv file - uncomment for usage
#write.csv(results, file = "c:/users/public/results.csv")

##(4) calculate cosmic dose rate for 6 samples from the same profile
## and save to .csv file
#calculate cosmic dose rate and save to variable
results<- calc_CosmicDoseRate(depth = c(0.1, 0.5 , 2.1, 2.7, 4.2, 6.3),
                             density = 1.7, latitude = 38.06451,
                             longitude = 1.49646, altitude = 364,
                             error = 10)

#export results to .csv file - uncomment for usage
#write.csv(results, file = "c:/users/public/results_profile.csv")
```

Description

Modelling incomplete and heterogeneous bleaching of mobile grains partially exposed to the light, an implementation of the EED model proposed by Guibert et al. (2019).

Usage

```
calc_EED_Model(
  data,
  D0 = 120L,
  expected_dose = NULL,
  MinIndivDose = NULL,
  MaxIndivDose = NULL,
  kappa = NULL,
  sigma_distr = NULL,
  n.simul = 5000L,
  n.minSimExp = 50L,
  sample_name = "",
  method_control = list(),
  verbose = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

data	data.frame (required) : input data consisting of two columns, the De and the SE(De). Values are expected in Gy
D0	integer (with default) : D0 value (in Gy), defining the characterisation behaviour of the quartz.
expected_dose	numeric (required) : expected equivalent dose.
MinIndivDose	numeric (with default) : value specifying the minimum dose taken into account for the plateau. NULL applies all values.
MaxIndivDose	numeric (with default) : value specifying the maximum dose taken into account for the plateau. NULL applies all values.
kappa	numeric (optional) : positive dimensionless exposure parameter characterising the bleaching state of the grains. Low values (< 10) indicate poor bleaching
sigma_distr	numeric (optional) : positive dose rate parameter, representing the dose variability to which the grains were exposed ##TODO perhaps it should be renamed
n.simul	integer (with default) : number of simulations
n.minSimExp	integer (with default) : number of MC runs for calculating the uncertainty contribution from the sampling
sample_name	character (with default) : name of the sample
method_control	list (with default) : additional deep control parameters, parameters need to be provided as named list, see details
verbose	logical (with default) : enable/disable output to the terminal.

plot [logical](#) (*with default*): enable/disable the plot output.

... further parameters that can be passed to better control the plot output. Support arguments are xlab, xlim.

Details

The function is an implementation and enhancement of the scripts used in Guibert et al. (2019). The implementation supports a semi-automated estimation of the parameters kappa and sigma_distr. If set to NULL, a surface interpolation is used to estimated those values.

Method control parameters

ARGUMENT	FUNCTION	DEFAULT	DESCRIPTION
lower	-	c(0.1, 0, 0)	set lower bounds for kappa, sigma, and the expected De in auto mode
upper	-	c(1000, 2)	set upper bounds for kappa, sigma, and the expected De in auto mode
iter_max	-	1000	maximum number for iterations for used to find kappa and sigma
trace	-	FALSE	enable/disable terminal trace mode; overwritten by global argument verbose
trace_plot	-	FALSE	enable/disable additional trace plot output; overwritten by global argument v

Function version

0.1.1

How to cite

Guibert, P., Kreutzer, S., 2026. calc_EED_Model(): Modelling Exponential Exposure Distribution. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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, RLum Developer Team

References

Guibert, P., Christophe, C., Urbanova, P., Guérin, G., Blain, S., 2017. Modelling incomplete and heterogeneous bleaching of mobile grains partially exposed to the light - Towards a new tool for single grain OSL dating of poorly bleached mortars. Radiation Measurements 107, 48–57. [doi:10.1016/j.radmeas.2017.10.003](https://doi.org/10.1016/j.radmeas.2017.10.003)

See Also

[RLum.Results](#), [calc_MinDose](#), [calc_FuchsLang2001](#), [calc_IEU](#), [calc_FiniteMixture](#)

Examples

```

data(ExampleData.MortarData, envir = environment())
calc_EED_Model(
  data = MortarData,
  kappa = 14,
  sigma_distr = 0.37,
  expected_dose = 11.7)

## automated estimation of
## sigma_distribution and
## kappa
## Not run:
calc_EED_Model(
  data = MortarData,
  kappa = NULL,
  sigma_distr = NULL,
  expected_dose = 11.7)

## End(Not run)

```

calc_FadingCorr

Fading Correction after Huntley & Lamothe (2001)

Description

Apply a fading correction according to Huntley & Lamothe (2001) for a given g -value and a given t_c

Usage

```

calc_FadingCorr(
  age.faded,
  g_value,
  tc,
  tc.g_value = tc,
  n.MC = 10000,
  seed = NULL,
  interval = c(0.01, 500),
  txtProgressBar = TRUE,
  verbose = TRUE
)

```

Arguments

`age.faded` **numeric vector (required)**: vector of length 2 containing the uncorrected age and the error in k_a (see example).

g_value	vector or RLum.Results (required): either a vector of length 2 containing the g-value and error obtained from separate fading measurements (see example), or an RLum.Results object produced by analyse_FadingMeasurement . If the latter, the tc argument is set automatically.
tc	numeric (required): time in seconds between irradiation and the prompt measurement (cf. Huntley & Lamothe 2001). The argument is ignored when g_value is an RLum.Results object.
tc.g_value	numeric (<i>with default</i>): time in seconds between irradiation and the prompt measurement used in the estimation of the g-value. If the g-value was normalised, the normalisation time (in seconds) should be given, e.g., for a g-value normalised to 2 days, the value 172800 should be used. If nothing is provided the time is set to tc, which is usual case for g-values obtained using the SAR method and g-values that have been not normalised to 2 days.
n.MC	integer (<i>with default</i>): number of Monte Carlo simulation runs for error estimation. If n.MC = 'auto' is used the function tries to find a 'stable' error for the age. See details for further information. Note: This may take a while!
seed	integer (<i>optional</i>): sets the seed for the random number generator in R using set.seed
interval	numeric (<i>with default</i>): a vector containing the end-points (age interval) of the interval to be searched for the root in 'ka'. This argument is passed to the function stats::uniroot used for solving the equation.
txtProgressBar	logical (<i>with default</i>): enable/disable the progress bar.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.

Details

This function solves the equation used for correcting the fading affected age including the error for a given g -value according to Huntley & Lamothe (2001):

$$\frac{A_f}{A} = 1 - \kappa * \left[\ln\left(\frac{A}{t_c}\right) - 1 \right]$$

with κ defined as

$$\kappa = \frac{\frac{g_value}{\ln(10)}}{100}$$

A and A_f are given in ka. t_c is given in s, however, it is internally recalculated to ka.

As the g -value slightly depends on the time t_c between irradiation and the prompt measurement, a value for tc must always be provided. If the g -value was normalised to a distinct time or evaluated with a different tc value (e.g., external irradiation), also the t_c value for the g -value needs to be provided (argument tc.g_value and then the g -value is recalculated to t_c of the measurement used for estimating the age applying the following equation:

$$\kappa_{tc} = \kappa_{tc.g} / (1 - \kappa_{tc.g} * \ln(tc/tc.g))$$

where

$$\kappa_{tc.g} = g/100/\ln(10)$$

The error of the fading-corrected age is determined using a Monte Carlo simulation approach. Solving of the equation is performed using [uniroot](#). Large values for `n.MC` will significantly increase the computation time.

`n.MC = 'auto'`

The error estimation based on a stochastic process, i.e. for a small number of MC runs the calculated error varies considerably every time the function is called, even with the same input values. The argument option `n.MC = 'auto'` tries to find a stable value for the standard error, i.e. the standard deviation of values calculated during the MC runs (`age.corr.MC`), within a given precision (2 digits) by increasing the number of MC runs stepwise and calculating the corresponding error.

If the determined error does not differ from the 9 values calculated previously within a precision of (here) 3 digits the calculation is stopped as it is assumed that the error is stable. Please note that (a) the duration depends on the input values as well as on the provided computation resources and it may take a while, (b) the length (size) of the output vector `age.corr.MC`, where all the single values produced during the MC runs are stored, equals the number of MC runs (here termed observations).

To avoid an endless loop the calculation is stopped if the number of observations exceeds 10^7 . This limitation can be overwritten by setting the number of MC runs manually, e.g. `n.MC = 10000001`. Note: For this case the function is not checking whether the calculated error is stable.

`seed`

This option allows to recreate previously calculated results by setting the seed for the R random number generator (see [set.seed](#) for details). This option should not be mixed up with the option `n.MC = 'auto'`. The results may appear similar, but they are not comparable!

FAQ

Q: Which t_c value is expected?

A: t_c is the time in seconds between irradiation and the prompt measurement applied during your D_e measurement. However, this t_c might differ from the t_c used for estimating the g -value. In the case of an SAR measurement t_c should be similar, however, if it differs, you have to provide this t_c value (the one used for estimating the g -value) using the argument `tc.g_value`.

Q: The function could not find a solution, what should I do?

A: This usually happens for model parameters exceeding the boundaries of the fading correction model (e.g., very high g -value). Please check whether another fading correction model might be more appropriate.

Value

Returns an S4 object of type [RLum.Results](#).

Slot: @data

Object	Type	Comment
age.corr	data.frame	Corrected age
age.corr.MC	numeric	MC simulation results with all possible ages from that simulation

Slot: @info

Object	Type	Comment
info	character	the original function call

Function version

0.4.4

How to cite

Kreutzer, S., 2026. calc_FadingCorr(): Fading Correction after Huntley & Lamothe (2001). Function version 0.4.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Special thanks to Sébastien Huot for his support and clarification via e-mail.

Author(s)

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References

Huntley, D.J., Lamothe, M., 2001. Ubiquity of anomalous fading in K-feldspars and the measurement and correction for it in optical dating. Canadian Journal of Earth Sciences, 38, 1093-1106.

See Also

[RLum.Results](#), [analyse_FadingMeasurement](#), [get_RLum](#), [uniroot](#)

Examples

```
##run the examples given in the appendix of Huntley and Lamothe, 2001

##(1) faded age: 100 a
results <- calc_FadingCorr(
  age.faded = c(0.1,0),
  g_value = c(5.0, 1.0),
  tc = 2592000,
  tc.g_value = 172800,
  n.MC = 100)

##(2) faded age: 1 ka
results <- calc_FadingCorr(
  age.faded = c(1,0),
  g_value = c(5.0, 1.0),
  tc = 2592000,
  tc.g_value = 172800,
  n.MC = 100)

##(3) faded age: 10.0 ka
results <- calc_FadingCorr(
  age.faded = c(10,0),
  g_value = c(5.0, 1.0),
  tc = 2592000,
  tc.g_value = 172800,
  n.MC = 100)

##access the last output
get_RLum(results)
```

calc_FastRatio

Calculate the Fast Ratio for CW-OSL curves

Description

Function to calculate the fast ratio of quartz CW-OSL single grain or single aliquot curves after Durcan & Duller (2011).

This function follows the equations of Durcan & Duller (2011). The energy required to reduce the fast and medium quartz OSL components to x and x2 % respectively using eq. 3 to determine channels L2 and L3 (start and end). The fast ratio is then calculated from: $(L1 - L3)/(L2 - L3)$.

Usage

```
calc_FastRatio(
  object,
  stimulation.power = 30.6,
  wavelength = 470,
  sigmaF = 2.6e-17,
```

```

sigmaM = 4.28e-18,
Ch_L1 = 1,
Ch_L2 = NULL,
Ch_L3 = NULL,
x = 1,
x2 = 0.1,
dead.channels = c(0, 0),
fitCW.sigma = FALSE,
fitCW.curve = FALSE,
plot = TRUE,
...
)

```

Arguments

object	RLum.Analysis , RLum.Data.Curve or data.frame (required): x, y data of measured values (time and counts).
stimulation.power	numeric (<i>with default</i>): Stimulation power in mW/cm ²
wavelength	numeric (<i>with default</i>): Stimulation wavelength in nm
sigmaF	numeric (<i>with default</i>): Photoionisation cross-section (cm ²) of the fast component. Default value after Durcan & Duller (2011).
sigmaM	numeric (<i>with default</i>): Photoionisation cross-section (cm ²) of the medium component. Default value after Durcan & Duller (2011).
Ch_L1	numeric (<i>with default</i>): An integer specifying the channel for L1.
Ch_L2	numeric (<i>optional</i>): An integer specifying the channel for L2.
Ch_L3	numeric (<i>optional</i>): A vector of length 2 with integer values specifying the start and end channels for L3 (e.g., c(40, 50)), with the second component greater than or equal to the first.
x	numeric (<i>with default</i>): Percentage of signal remaining from the fast component. Used to define the location of L2 and L3 (start).
x2	numeric (<i>with default</i>): Percentage of signal remaining from the medium component. Used to define the location of L3 (end).
dead.channels	numeric (<i>with default</i>): Vector of length 2 in the form of c(x, y). Channels that do not contain OSL data, i.e. at the start or end of measurement.
fitCW.sigma	logical (<i>optional</i>): fit CW-OSL curve using fit_CWCurve to calculate sigmaF and sigmaM (experimental).
fitCW.curve	logical (<i>optional</i>): fit CW-OSL curve using fit_CWCurve and derive the counts of L2 and L3 from the fitted OSL curve (experimental).
plot	logical (<i>with default</i>): enable/disable the plot output.
...	available options: verbose (logical). Further arguments passed to fit_CWCurve .

Value

Returns a plot (*optional*) and an S4 object of type [RLum.Results](#). The slot data contains a [list](#) with the following elements:

summary	data.frame summary of all relevant results
data	the original input data
fit	RLum.Results object if either fitCW.sigma or fitCW.curve is TRUE
args	list of used arguments
call	call the function call

Function version

0.1.2

How to cite

King, G.E., Durcan, J., Burow, C., Colombo, M., 2026. calc_FastRatio(): Calculate the Fast Ratio for CW-OSL curves. Function version 0.1.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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References

Durcan, J.A. & Duller, G.A.T., 2011. The fast ratio: A rapid measure for testing the dominance of the fast component in the initial OSL signal from quartz. Radiation Measurements 46, 1065-1072.

Madsen, A.T., Duller, G.A.T., Donnelly, J.P., Roberts, H.M. & Wintle, A.G., 2009. A chronology of hurricane landfalls at Little Sippewissett Marsh, Massachusetts, USA, using optical dating. Geomorphology 109, 36-45.

Further reading

Steffen, D., Preusser, F. & Schlunegger, 2009. OSL quartz age underestimation due to unstable signal components. Quaternary Geochronology 4, 353-362.

See Also

[fit_CWCurve](#), [get_RLum](#), [RLum.Analysis](#), [RLum.Results](#), [RLum.Data.Curve](#)

Examples

```
# load example CW-OSL curve
data("ExampleData.CW_OSL_Curve")

# calculate the fast ratio w/o further adjustments
res <- calc_FastRatio(ExampleData.CW_OSL_Curve)

# show the summary table
get_RLum(res)
```

calc_FiniteMixture	<i>Apply the finite mixture model (FMM) after Galbraith (2005) to a given De distribution</i>
--------------------	---

Description

This function fits a k-component mixture to a De distribution with differing known standard errors. Parameters (doses and mixing proportions) are estimated by maximum likelihood assuming that the log dose estimates come from a mixture of normal distributions.

Usage

```
calc_FiniteMixture(
  data,
  sigmab,
  n.components,
  grain.probability = FALSE,
  pdf.weight = TRUE,
  pdf.sigma = c("sigmab", "se"),
  pdf.colors = c("gray", "colors", "none"),
  plot.proportions = TRUE,
  plot.criteria = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with De (data[,1]) and De error (values[,2])
sigmab	numeric (required): spread in De values (given as a fraction, e.g. 0.2), representing the expected overdispersion in the data should the sample be well-bleached (Cunningham & Wallinga 2012, p. 100).
n.components	numeric (required): number of components to be fitted. If a vector is provided (e.g. c(2:8)) the finite mixtures for 2, 3 ... 8 components are calculated and a plot and a statistical evaluation of the model performance (BIC score and maximum log-likelihood) is provided.

grain.probability	logical (<i>with default</i>): prints the estimated probabilities of which component each grain is in
pdf.weight	logical (<i>with default</i>): weight the probability density functions by the components proportion. Ignored if n.components has length 1.
pdf.sigma	character (<i>with default</i>): if "sigmab" the components normal distributions are plotted with a common standard deviation (i.e. sigmab) as assumed by the FFM. Alternatively, "se" takes the standard error of each component for the sigma parameter of the normal distribution
pdf.colors	character (<i>with default</i>): colour coding of the components in the plot. Possible options are "gray", "colors" and "none".
plot.proportions	logical (<i>with default</i>): plot a graphics::barplot showing the proportions of components. Ignored if n.components has length 1.
plot.criteria	logical (<i>with default</i>): plot the statistical criteria (BIC and log-likelihood). Ignored if n.components has length 1.
plot	logical (<i>with default</i>): enable/disable the plot output. This is ignored and no plot is produced if n.components has length 1.
...	other parameters to control the plot output. Supported are cex, main, main.densities, main.proportions, main.criteria, pdf.scale, dose.scale.

Details

This model uses the maximum likelihood and Bayesian Information Criterion (BIC) approaches.

Indications of overfitting are:

- increasing BIC
- repeated dose estimates
- covariance matrix not positive definite
- covariance matrix produces NaN
- convergence problems

Plot

If n.components is a vector (c(k.min:k.max)), a plot is generated showing the k components equivalent doses as normal distributions. By default pdf.weight is set to TRUE, so that the probability density functions are weighted by the components proportion for each iteration of k components, so the sum of areas of each component equals 1. If pdf.weight is set to FALSE, the area under each normal distribution is always 1. While the density values are on the same scale when no weights are used, the y-axis are individually scaled if the probability density are weighted by the components proportion.

The standard deviation (sigma) of the normal distributions is by default determined by a common sigmab (see pdf.sigma). For pdf.sigma = "se" the standard error of each component is taken instead.

The stacked [graphics::barplot](#) shows the proportion of each component (in per cent) calculated by the FMM. The last plot shows the achieved BIC scores and maximum log-likelihood estimates for each value of k .

Value

Returns a plot (*optional*) and terminal output. In addition an [RLum.Results](#) object is returned containing the following elements:

<code>.\$summary</code>	data.frame summary of all relevant model results.
<code>.\$data</code>	data.frame original input data
<code>.\$args</code>	list used arguments
<code>.\$call</code>	call the function call
<code>.\$mle</code>	covariance matrices of the log likelihoods
<code>.\$BIC</code>	BIC score
<code>.\$llik</code>	maximum log likelihood
<code>.\$grain.probability</code>	probabilities of a grain belonging to a component
<code>.\$components</code>	matrix estimates of the de, de error and proportion for each component
<code>.\$single.comp</code>	data.frame single component FFM estimate

If a vector for `n.components` is provided (e.g. `c(2:8)`), `mle` and `grain.probability` are lists containing matrices of the results for each iteration of the model.

The output should be accessed using the function [get_RLum](#).

Function version

0.4.4

How to cite

Burow, C., Colombo, M., 2026. `calc_FiniteMixture()`: Apply the finite mixture model (FMM) after Galbraith (2005) to a given De distribution. Function version 0.4.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Christoph Burow, University of Cologne (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany)
 Based on a rewritten S script of Rex Galbraith, 2006. , RLum Developer Team

References

Galbraith, R.F. & Green, P.F., 1990. Estimating the component ages in a finite mixture. Nuclear Tracks and Radiation Measurements 17, 197-206.
 Galbraith, R.F. & Laslett, G.M., 1993. Statistical models for mixed fission track ages. Nuclear Tracks Radiation Measurements 4, 459-470.

Galbraith, R.F. & Roberts, R.G., 2012. Statistical aspects of equivalent dose and error calculation and display in OSL dating: An overview and some recommendations. *Quaternary Geochronology* 11, 1-27.

Roberts, R.G., Galbraith, R.F., Yoshida, H., Laslett, G.M. & Olley, J.M., 2000. Distinguishing dose populations in sediment mixtures: a test of single-grain optical dating procedures using mixtures of laboratory-dosed quartz. *Radiation Measurements* 32, 459-465.

Galbraith, R.F., 2005. *Statistics for Fission Track Analysis*, Chapman & Hall/CRC, Boca Raton.

Further reading

Arnold, L.J. & Roberts, R.G., 2009. Stochastic modelling of multi-grain equivalent dose (De) distributions: Implications for OSL dating of sediment mixtures. *Quaternary Geochronology* 4, 204-230.

Cunningham, A.C. & Wallinga, J., 2012. Realizing the potential of fluvial archives using robust OSL chronologies. *Quaternary Geochronology* 12, 98-106.

Rodnight, H., Duller, G.A.T., Wintle, A.G. & Tooth, S., 2006. Assessing the reproducibility and accuracy of optical dating of fluvial deposits. *Quaternary Geochronology* 1, 109-120.

Rodnight, H. 2008. How many equivalent dose values are needed to obtain a reproducible distribution?. *Ancient TL* 26, 3-10.

See Also

[calc_CentralDose](#), [calc_CommonDose](#), [calc_FuchsLang2001](#), [calc_MinDose](#)

Examples

```
## load example data
data(ExampleData.DeValues, envir = environment())

## (1) apply the finite mixture model
## NOTE: the data set is not suitable for the finite mixture model,
## which is why a very small sigmab is necessary
calc_FiniteMixture(ExampleData.DeValues$CA1,
                    sigmab = 0.2, n.components = 2,
                    grain.probability = TRUE)

## (2) repeat the finite mixture model for 2, 3 and 4 maximum number of fitted
## components and save results
## NOTE: The following example is computationally intensive. Please un-comment
## the following lines to make the example work.
FMM<- calc_FiniteMixture(ExampleData.DeValues$CA1,
                        sigmab = 0.2, n.components = c(2:4),
                        pdf.weight = TRUE)

## show structure of the results
FMM

## show the results on equivalent dose, standard error and proportion of
## fitted components
get_RLum(object = FMM, data.object = "components")
```

calc_FuchsLang2001	<i>Apply the model after Fuchs & Lang (2001) to a given De distribution</i>
--------------------	---

Description

This function applies the method according to Fuchs & Lang (2001) for heterogeneously bleached samples with a given coefficient of variation threshold.

Usage

```
calc_FuchsLang2001(data, cvThreshold = 5, startDeValue = 1, plot = TRUE, ...)
```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with De (data[,1]) and De error (values[,2])
cvThreshold	numeric (<i>with default</i>): coefficient of variation in percent, as threshold for the method, e.g. cvThreshold = 3. See details .
startDeValue	numeric (<i>with default</i>): number of the first aliquot that is used for the calculations
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further arguments and graphical parameters passed to plot

Details

Used values

If the coefficient of variation ($c[v]$) of the first two values is larger than the threshold $c[v_threshold]$, the first value is skipped. Use the `startDeValue` argument to define a start value for calculation (e.g. 2nd or 3rd value).

Basic steps of the approach

1. Estimate natural relative variation of the sample using a dose recovery test
2. Sort the input values in ascending order
3. Calculate a running mean, starting with the lowermost two values and add values iteratively.
4. Stop if the calculated $c[v]$ exceeds the specified `cvThreshold`

Value

Returns a plot (*optional*) and terminal output. In addition an [RLum.Results](#) object is returned containing the following elements:

summary	data.frame summary of all relevant model results.
data	data.frame original input data
args	list used arguments
call	call the function call
usedDeValues	data.frame containing the used values for the calculation

Function version

0.4.1

How to cite

Kreutzer, S., Burow, C., 2026. calc_FuchsLang2001(): Apply the model after Fuchs & Lang (2001) to a given De distribution. Function version 0.4.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Please consider the requirements and the constraints of this method (see Fuchs & Lang, 2001)

Author(s)

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Christoph Burow, University of Cologne (Germany) , RLum Developer Team

References

Fuchs, M. & Lang, A., 2001. OSL dating of coarse-grain fluvial quartz using single-aliquot protocols on sediments from NE Peloponnese, Greece. In: Quaternary Science Reviews 20, 783-787.

Fuchs, M. & Wagner, G.A., 2003. Recognition of insufficient bleaching by small aliquots of quartz for reconstructing soil erosion in Greece. Quaternary Science Reviews 22, 1161-1167.

See Also

[plot](#), [calc_MinDose](#), [calc_FiniteMixture](#), [calc_CentralDose](#), [calc_CommonDose](#), [RLum.Results](#)

Examples

```
## load example data
data(ExampleData.DeValues, envir = environment())

## calculate De according to Fuchs & Lang (2001)
temp<- calc_FuchsLang2001(ExampleData.DeValues$BT998, cvThreshold = 5)
```

calc_gSGC

*Calculate De value based on the gSGC by Li et al., 2015***Description**

The function computes De value and De value error using the global standardised growth curve (gSGC) assumption proposed by Li et al., 2015 for OSL dating of sedimentary quartz.

Usage

```
calc_gSGC(
  data,
  gSGC.type = c("0-250", "0-450"),
  gSGC.parameters = NULL,
  n.MC = 100,
  verbose = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

data	data.frame (required): input data the following columns five columns in the given order: LnTn, LnTn.error, Lr1Tr1, Lr1Tr1.error, Dr1. Column names are not required.
gSGC.type	character (with default): function parameters to use for the iteration procedure, either "0-450" or "0-250", as presented in Li et al., 2015 (Table 2). This is ignored if gSGC.parameters is set.
gSGC.parameters	list (optional): option to provide own function parameters used for fitting as named list. Nomenclature follows Li et al., 2015, i.e. list(A, A.error, D0, D0.error, c, c.error, Y0, Y0.error, range), where range is defines the interval where the function is considered as valid, e.g. range = c(0, 250). If set, option gSGC.type will be ignored.
n.MC	integer (with default): number of Monte Carlo simulation runs for error estimation, see details.
verbose	logical (with default): enable/disable output to the terminal.
plot	logical (with default): enable/disable the plot output.
...	parameters will be passed to the plot output

Details

The error of the De value is determined using a Monte Carlo simulation approach. Solving of the equation is realised using **uniroot**. Large values for n.MC will significantly increase the computation time.

Value

Returns an S4 object of type `RLum.Results`.

```
@data
$ De.value (data.frame)
.. $ De
.. $ De.error
.. $ Eta
$ De.MC (list) contains the matrices from the error estimation.
$ uniroot (list) contains the uniroot outputs of the De estimations

@info
'$ call' (call) the original function call
```

Function version

0.1.3

How to cite

Kreutzer, S., 2026. `calc_gSGC()`: Calculate De value based on the gSGC by Li et al., 2015. Function version 0.1.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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References

Li, B., Roberts, R.G., Jacobs, Z., Li, S.-H., 2015. Potential of establishing a 'global standardised growth curve' (gSGC) for optical dating of quartz from sediments. *Quaternary Geochronology* 27, 94-104. doi:10.1016/j.quageo.2015.02.011

See Also

`RLum.Results`, `get_RLum`, `uniroot`

Examples

```
results <- calc_gSGC(data = data.frame(
  LnTn = 2.361, LnTn.error = 0.087,
  Lr1Tr1 = 2.744, Lr1Tr1.error = 0.091,
  Dr1 = 34.4))

get_RLum(results, data.object = "De")
```

calc_gSGC_feldspar	<i>Calculate Global Standardised Growth Curve (gSGC) for Feldspar MET-pIRIR</i>
--------------------	---

Description

Implementation of the gSGC approach for feldspar MET-pIRIR by Li et al. (2015)

Usage

```
calc_gSGC_feldspar(
  data,
  gSGC.type = "50LxTx",
  gSGC.parameters = NULL,
  n.MC = 100,
  plot = FALSE
)
```

Arguments

data	data.frame (required) : data frame with five columns per sample c("LnTn", "LnTn.error", "Lr1Tr1", "Lr1Tr1.error", "Dr1")
gSGC.type	character (with default) : growth curve type to be selected according to Table 3 in Li et al. (2015). Allowed options are "50LxTx", "50Lx", "50Tx", "100LxTx", "100Lx", "100Tx", "150LxTx", "150Lx", "150Tx", "200LxTx", "200Lx", "200Tx", "250LxTx", "250Lx", "250Tx"
gSGC.parameters	data.frame (optional) : an own parameter set for the gSGC with the following columns y1, y1_err, D1 D1_err, y2, y2_err, y0, y0_err.
n.MC	numeric (with default) : number of Monte-Carlo runs for the error calculation
plot	logical (with default) : enable/disable the plot output.

Details

##TODO

Value

Returns an S4 object of type [RLum.Results](#).

@data

\$ df ([data.frame](#))

.. \$DE the calculated equivalent dose

.. \$DE.ERROR error on the equivalent dose, which is the standard deviation of the MC runs

.. \$HPD95_LOWER lower boundary of the highest probability density (95%)

.. \$HPD95_UPPER upper boundary of the highest probability density (95%)

\$ m.MC ([list](#)) numeric vector with results from the MC runs.

```
@info
'$ call' (call) the original function call
```

Function version

0.1.1

How to cite

Gray, H.J., Kreutzer, S., 2026. calc_gSGC_feldspar(): Calculate Global Standardised Growth Curve (gSGC) for Feldspar MET-pIRIR. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Harrison Gray, USGS (United States), Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Li, B., Roberts, R.G., Jacobs, Z., Li, S.-H., Guo, Y.-J., 2015. Construction of a “global standardised growth curve” (gSGC) for infrared stimulated luminescence dating of K-feldspar 27, 119–130. [doi:10.1016/j.quageo.2015.02.010](https://doi.org/10.1016/j.quageo.2015.02.010)

See Also

[RLum.Results](#), [get_RLum](#), [uniroot](#), [calc_gSGC](#)

Examples

```
##test on a generated random sample
n_samples <- 10
data <- data.frame(
  LnTn = rnorm(n=n_samples, mean=1.0, sd=0.02),
  LnTn.error = rnorm(n=n_samples, mean=0.05, sd=0.002),
  Lr1Tr1 = rnorm(n=n_samples, mean=1.0, sd=0.02),
  Lr1Tr1.error = rnorm(n=n_samples, mean=0.05, sd=0.002),
  Dr1 = rep(100,n_samples))

results <- calc_gSGC_feldspar(
  data = data, gSGC.type = "50LxTx",
  plot = FALSE)

plot_AbanicoPlot(results)
```

calc_HomogeneityTest *Apply a simple homogeneity test after Galbraith (2003)*

Description

A simple homogeneity test for De estimates. For details see Galbraith (2003).

Usage

```
calc_HomogeneityTest(data, log = TRUE, ...)
```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with De (data[,1]) and De error (values[,2])
log	logical (<i>with default</i>): perform the homogeneity test with (un-)logged data
...	further arguments (verbose).

Value

Returns a terminal output. In addition an [RLum.Results](#)-object is returned containing the following elements:

summary	data.frame summary of all relevant model results.
data	data.frame original input data
args	list used arguments
call	call the function call

The output should be accessed using the function [get_RLum](#).

Function version

0.3.0

How to cite

Burow, C., Kreutzer, S., 2026. calc_HomogeneityTest(): Apply a simple homogeneity test after Galbraith (2003). Function version 0.3.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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Geophysics (Germany)
, RLum Developer Team

References

Galbraith, R.F., 2003. A simple homogeneity test for estimates of dose obtained using OSL. Ancient TL 21, 75-77.

See Also

[stats::pchisq](#)

Examples

```
## load example data
data(ExampleData.DeValues, envir = environment())

## apply the homogeneity test
calc_HomogeneityTest(ExampleData.DeValues$BT998)

## using the data presented by Galbraith (2003)
df <-
  data.frame(
    x = c(30.1, 53.8, 54.3, 29.0, 47.6, 44.2, 43.1),
    y = c(4.8, 7.1, 6.8, 4.3, 5.2, 5.9, 3.0))

calc_HomogeneityTest(df)
```

calc_Huntley2006

Apply the Huntley (2006) model

Description

The function calculates the expected sample specific fraction of saturation based on the model of Huntley (2006), using the approach as implemented in Kars et al. (2008) or Guralnik et al. (2015).

Usage

```
calc_Huntley2006(
  data,
  LnTn = NULL,
  rhop = NULL,
  ddot = NULL,
```

```

readerDdot = NULL,
normalise = TRUE,
fit.method = c("SSE", "GOK"),
lower.bounds = c(-Inf, -Inf, -Inf, -Inf),
cores = 1,
summary = TRUE,
plot = TRUE,
...
)

```

Arguments

data

data.frame (required): A data.frame with one of the following structures:

- **three columns** with numeric values for dose (s), LxTx and LxTx error, in this order.
- **two columns** with numeric values for dose (s) and LxTx, in this order. This assumes that errors on LxTx are missing, and a third column will be automatically attached with an arbitrary 5 % error on the provided LxTx values.
- **wide table**, i.e. a **data.frame** with a number of columns divisible by 3 and where each triplet has the aforementioned column structure.

		(optional)		
	dose (s)	LxTx	LxTx error	
	[,1]	[,2]	[,3]	
	-----	-----	-----	
[1,]	0	LnTn	LnTn error	(optional, see arg 'LnTn')
[2,]	R1	L1T1	L1T1 error	
...	...	...	...	
[x,]	Rx	LxTx	LxTx error	

Note: The function assumes the first row of the data to be the Ln/Tn-value. If you want to provide more than one Ln/Tn-values, consider using argument LnTn.

LnTn

data.frame (optional): A two column data frame with the following structure:

	LnTn	LnTn error
	[,1]	[,2]
	-----	-----
[1,]	LnTn_1	LnTn_1 error
[2,]	LnTn_2	LnTn_2 error
...	...	...
[x,]	LnTn_x	LnTn_x error

The function will calculate a **mean** Ln/Tn-value and uses either the standard deviation or the highest individual error, whichever is larger. If another mean value (e.g. a weighted mean or median) or error is preferred, this value must be calculated beforehand and used in the first row in the data frame for argument data.

Note: This argument should **only** be used to provide more than one Ln/Tn-value. If you provide LnTn-values with this argument, the data frame for the data-argument **must not** contain any LnTn-values.

rhop	numeric (required): A vector of length 2 for the density of recombination centres (ρ') and its error (see Huntley 2006). Note that ρ' must not be provided as the common logarithm. Example: <code>rhop = c(2.92e-06, 4.93e-07)</code> .
ddot	numeric (required): A vector of length 2 for the environmental dose rate and its error. Expected unit: Gy/ka. Example: <code>ddot = c(3.7, 0.4)</code> .
readerDdot	numeric (required): A vector of length 2 for the dose rate of the irradiation source of the OSL reader and its error. Expected unit: Gy/s. Example: <code>readerDdot = c(0.08, 0.01)</code> .
normalise	logical (with default): If TRUE (the default) all measured and computed $\frac{L_x}{T_x}$ values are normalised by the pre-exponential factor A (see details).
fit.method	character (with default): Fit function of the dose response curve. Can either be "SSE" (default) or "GOK". Note that "SSE" (single saturating exponential) is the original function the model after Huntley (2006) and Kars et al. (2008) was designed to use. The use of a general-order kinetics function ("GOK") is an experimental adaptation of the model and should be used with great care.
lower.bounds	numeric (with default): A vector of length 4 for the values of the lower bounds to be applied when fitting the models with <code>minpack.lm::nlsLM</code> . In most cases, the default values (<code>c(-Inf, -Inf, -Inf, -Inf)</code>) are appropriate for finding a best fit, but sometimes it may be useful to restrict the lower bounds to e.g. <code>c(0, 0, 0, 0)</code> . The values of the vectors are, respectively, for parameters a, D0, c and d in that order (parameter d is ignored when <code>fit.method = "SSE"</code>). More details can be found in fit_DoseResponseCurve .
cores	integer, numeric (with default): number of cores allocated for parallel processing of the Monte-Carlo runs. The default value corresponds to single-threaded computation; the recommended values is NULL, which assigns all but two of the available logical CPU cores.
summary	logical (with default): If TRUE (the default) various parameters provided by the user and calculated by the model are added as text on the right-hand side of the plot.
plot	logical (with default): enable/disable the plot output.
...	Further parameters:

- verbose **logical:** Enable/disable output to the terminal (default = TRUE)
- n.MC **numeric:** Number of Monte Carlo iterations (default = 10000)
- cex **numeric:** Scaling of the plot (default = 1)
- maxiter **numeric:** Number of iteration limits for nls fitting
- trace **logical:** Enable/disable value tracing the terminal during fitting **Note:** it is generally advised to have a large number of Monte Carlo iterations for the results to converge. Decreasing the number of iterations will often result in unstable estimates.

All other arguments are passed to `plot` and `fit_DoseResponseCurve` (in particular mode for the De calculation mode, `fit.force_through_origin`, and `fit.bounds`).

Details

This function applies the approach described in Kars et al. (2008) or Guralnik et al. (2015), which are both developed from the model of Huntley (2006), to calculate the expected sample specific fraction of saturation of a feldspar and also to calculate fading corrected age using this model. ρ' (rhop), the density of recombination centres, is a crucial parameter of this model and must be determined separately from a fading measurement. The function [analyse_FadingMeasurement](#) can be used to calculate the sample specific ρ' value.

Kars et al. (2008) – Single saturating exponential

To apply the approach after Kars et al. (2008), use `fit.method = "SSE"`.

Firstly, the unfaded D_0 value is determined through applying equation 5 of Kars et al. (2008) to the measured $\frac{L_x}{T_x}$ data as a function of irradiation time, and fitting the data with a single saturating exponential of the form:

$$\frac{L_x}{T_x}(t^*) = A\phi(t^*)\{1 - \exp(-\frac{t^*}{D_0})\}$$

where

$$\phi(t^*) = \exp(-\rho' \ln(1.8\tilde{s}t^*)^3)$$

after King et al. (2016) where A is a pre-exponential factor, t^* (s) is the irradiation time, starting at the mid-point of irradiation (Auclair et al. 2003) and $\tilde{s}$ ($3 \times 10^{15} \text{ s}^{-1}$) is the athermal frequency factor after Huntley (2006).

Using fit parameters A and D_0 , the function then computes a natural dose response curve using the environmental dose rate, $\dot{D}$ (Gy/s) and equations [1] and [2]. Computed $\frac{L_x}{T_x}$ values are then fitted using the [fit_DoseResponseCurve](#) function and the laboratory measured LnTn can then be interpolated onto this curve to determine the fading corrected D_e value, from which the fading corrected age is calculated.

Guralnik et al. (2015) – General-order kinetics

To apply the approach after Guralnik et al. (2015) use `fit.method = "GOK"`.

The approach of Guralnik et al. (2015) is very similar to that of Kars et al. (2008) but, instead of using a single saturating exponential, the model fits a general-order kinetics function of the form:

$$\frac{L_x}{T_x}(t^*) = A\phi(t^*)(1 - (1 + (\frac{1}{D_0})t^*c)^{-1/c})$$

where A , ϕ , t^* and D_0 are the same as above and c is a dimensionless kinetic order modifier (cf. equation 10 in Guralnik et al., 2015).

Level of saturation

The [calc_Huntley2006](#) function also calculates the level of saturation ($\frac{n}{N}$) and the field saturation (i.e. athermal steady state, (n/N)_SS) value for the sample under investigation using the sample specific ρ' , unfaded D_0 and $\dot{D}$ values, following the approach of Kars et al. (2008).

The computation is done using 1000 equally-spaced points in the interval [0.01, 3]. This can be controlled by setting option `rprime`, such as in `rprime = seq(0.01, 3, length.out = 1000)` (the default).

Uncertainties

Uncertainties are reported at 1σ and are assumed to be normally distributed and are estimated using Monte-Carlo re-sampling ($n.MC = 10000$ by default) of ρ' and $\frac{L_n}{T_n}$ during dose response curve fitting, and of $\rho' \#'$ in the derivation of (n/N) and $(n/N)_{SS}$.

Age calculated from 2D0 of the simulated natural DRC

In addition to the age calculated from the equivalent dose derived from $\frac{L_n}{T_n}$ projected on the simulated natural dose response curve (DRC), this function also calculates an age from twice the characteristic saturation dose ($D0$) of the simulated natural DRC. This can be a useful information for (over)saturated samples (i.e., no intersect of $\frac{L_n}{T_n}$ on the natural DRC) to obtain at least a "minimum age" estimate of the sample. In the console output this value is denoted by "Age @2D0 (ka):".

Value

An [RLum.Results](#) object is returned:

Slot: @data

OBJECT	TYPE	COMMENT
results	data.frame	results of the of Kars et al. 2008 model
data	data.frame	original input data
Ln	numeric	Ln and its error
LxTx_tables	list	A list of data.frames containing data on dose, LxTx and LxTx error for each of the dose resp
fits	list	A list of nls objects produced by minpack.lm::nlsLM when fitting the dose response curves

Slot: @info

OBJECT	TYPE	COMMENT
call	call	the original function call
args	list	arguments of the original function call

Function version

0.4.8

How to cite

King, G.E., Burow, C., Kreutzer, S., Colombo, M., 2026. calc_Huntley2006(): Apply the Huntley (2006) model. Function version 0.4.8. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function has BETA status, in particular for the GOK implementation. Please verify your results carefully.

Author(s)

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 Christoph Burow, University of Cologne (Germany)
 Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany) , RLum Developer Team

References

Kars, R.H., Wallinga, J., Cohen, K.M., 2008. A new approach towards anomalous fading correction for feldspar IRSL dating-tests on samples in field saturation. *Radiation Measurements* 43, 786-790. doi:10.1016/j.radmeas.2008.01.021

Guralnik, B., Li, B., Jain, M., Chen, R., Paris, R.B., Murray, A.S., Li, S.-H., Pagonis, P., Herman, F., 2015. Radiation-induced growth and isothermal decay of infrared-stimulated luminescence from feldspar. *Radiation Measurements* 81, 224-231.

Huntley, D.J., 2006. An explanation of the power-law decay of luminescence. *Journal of Physics: Condensed Matter* 18, 1359-1365. doi:10.1088/0953-8984/18/4/020

King, G.E., Herman, F., Lambert, R., Valla, P.G., Guralnik, B., 2016. Multi-OSL-thermochronometry of feldspar. *Quaternary Geochronology* 33, 76-87. doi:10.1016/j.quageo.2016.01.004

Further reading

Morthekai, P., Jain, M., Cunha, P.P., Azevedo, J.M., Singhvi, A.K., 2011. An attempt to correct for the fading in million year old basaltic rocks. *Geochronometria* 38(3), 223-230.

Examples

```
## Load example data (sample UNIL/NB123, see ?ExampleData.Fading)
data("ExampleData.Fading", envir = environment())

## (1) Set all relevant parameters
# a. fading measurement data (IR50)
fading_data <- ExampleData.Fading$fading.data$IR50

# b. Dose response curve data
data <- ExampleData.Fading$equivalentDose.data$IR50

## (2) Define required function parameters
ddot <- c(7.00, 0.004)
readerDdot <- c(0.134, 0.0067)

# Analyse fading measurement and get an estimate of rho'.
# Note that the RLum.Results object can be directly used for further processing.
# The number of MC runs is reduced for this example
```

```

rhop <- analyse_FadingMeasurement(fading_data, plot = TRUE, verbose = FALSE, n.MC = 10)

## (3) Apply the Kars et al. (2008) model to the data
kars <- calc_Huntley2006(
  data = data,
  rhop = rhop,
  ddot = ddot,
  readerDdot = readerDdot,
  n.MC = 25)

## Not run:
# You can also provide LnTn values separately via the 'LnTn' argument.
# Note, however, that the data frame for 'data' must then NOT contain
# a LnTn value. See argument descriptions!
LnTn <- data.frame(
  LnTn = c(1.84833, 2.24833),
  nTn.error = c(0.17, 0.22))

LxTx <- data[2:nrow(data), ]

kars <- calc_Huntley2006(
  data = LxTx,
  LnTn = LnTn,
  rhop = rhop,
  ddot = ddot,
  readerDdot = readerDdot,
  n.MC = 25)

## End(Not run)

```

calc_IEU

Apply the internal-external-uncertainty (IEU) model after Thomsen et al. (2007) to a given De distribution

Description

Function to calculate the IEU De for a De data set.

Usage

```
calc_IEU(data, a, b, interval, decimal.point = 2, plot = TRUE, ...)
```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with De (data[,1]) and De error (values[,2])
a	numeric (required): slope
b	numeric (required): intercept

interval	numeric (required) : fixed interval (e.g. 5 Gy) used for iteration of Dbar, from the mean to Lowest.De used to create Graph.IEU [Dbar.Fixed vs Z]
decimal.point	integer (with default) : number of decimal points for rounding calculations (e.g. 2)
plot	logical (with default) : enable/disable the plot output.
...	further arguments (trace, verbose).

Details

This function uses the equations of Thomsen et al. (2007). The parameters a and b are estimated from dose-recovery experiments.

Value

Returns a plot (*optional*) and terminal output. In addition an **RLum.Results** object is returned containing the following elements:

.\$summary	data.frame summary of all relevant model results.
.\$data	data.frame original input data
.\$args	list used arguments
.\$call	call the function call
.\$tables	list a list of data frames containing all calculation tables

The output should be accessed using the function **get_RLum**.

Function version

0.1.3

How to cite

Smedley, R.K., Colombo, M., 2026. calc_IEU(): Apply the internal-external-uncertainty (IEU) model after Thomsen et al. (2007) to a given De distribution. Function version 0.1.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Rachel Smedley, Geography & Earth Sciences, Aberystwyth University (United Kingdom)
Based on an excel spreadsheet and accompanying macro written by Kristina Thomsen.
Marco Colombo, Institute of Geography, Heidelberg University (Germany) , RLum Developer Team

References

Smedley, R.K., 2015. A new R function for the Internal External Uncertainty (IEU) model. *Ancient TL* 33, 16-21.

Thomsen, K.J., Murray, A.S., Boetter-Jensen, L. & Kinahan, J., 2007. Determination of burial dose in incompletely bleached fluvial samples using single grains of quartz. *Radiation Measurements* 42, 370-379.

See Also

[plot](#), [calc_CommonDose](#), [calc_CentralDose](#), [calc_FiniteMixture](#), [calc_FuchsLang2001](#), [calc_MinDose](#)

Examples

```
## load data
data(ExampleData.DeValues, envir = environment())

## apply the IEU model
ieu <- calc_IEU(ExampleData.DeValues$CA1, a = 0.2, b = 1.9, interval = 1)
```

calc_Lamothe2003

Apply fading correction after Lamothe et al., 2003

Description

This function applies the fading correction for the prediction of long-term fading as suggested by Lamothe et al., 2003. The function basically adjusts the L_n/T_n values and fits a new dose-response curve using function [fit_DoseResponseCurve](#).

Usage

```
calc_Lamothe2003(
  object,
  dose_rate.envir,
  dose_rate.source,
  g_value,
  tc = NULL,
  tc.g_value = tc,
  verbose = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

object	RLum.Results data.frame (required): Input data for applying the fading correction, can be (1) a data.frame with three columns (dose, LxTx, LxTx error; see details), or (2) an RLum.Results object created by analyse_SAR.CWOSL or analyse_pIRIRSequence .
dose_rate.envir	numeric vector of length 2 (required): Environmental dose rate in mGy/a.
dose_rate.source	numeric vector of length 2 (required): Irradiation source dose rate in Gy/s, which is, according to Lamothe et al. (2003) De/t.
g_value	numeric vector of length 2 (required): g_value in %/decade <i>recalculated at the moment</i> the equivalent dose was calculated, i.e. tc is either similar for the g-value measurement and the De measurement or needs be to recalculated (cf. calc_FadingCorr). Inserting a normalised g-value, e.g., normalised to 2-days , will lead to wrong results.
tc	numeric (<i>optional</i>): time in seconds between the end of the irradiation and the prompt measurement used in the equivalent dose estimation (cf. Huntley & Lamothe 2001). If set to NULL, it is assumed that tc is similar for the equivalent dose estimation and the g-value estimation.
tc.g_value	numeric (<i>with default</i>): time in seconds between irradiation and the prompt measurement estimating the g-value. If the g-value was normalised to, e.g., 2 days, this time in seconds (i.e., 172800) should be entered here along with the time used for the equivalent dose estimation. If nothing is provided the time is set to tc, which is the usual case for g-values obtained using the SAR method and g-values that had been not normalised to 2 days. Note: If this value is not NULL the functions expects a numeric value for tc.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further arguments passed to plot_DoseResponseCurve .

Details

Format of object if data.frame

If object is a [data.frame](#), all input values must be of type [numeric](#). Dose values are expected in seconds (s) not Gray (Gy). No NA values are allowed and the value for the natural dose (first row) should be 0. Example for three dose points (column names are arbitrary):

```
object <- data.frame(
  dose = c(0,25,50),
  LxTx = c(4.2, 2.5, 5.0),
  LxTx_error = c(0.2, 0.1, 0.2))
```

Note on the g-value and tc

Users new to R and fading measurements are often confused about what to enter for tc and why it may differ from tc.g_value. By convention (Huntley & Lamothe 2001), the tc value is the

time elapsed between the end of the irradiation and the prompt measurement. Usually there is no reason for having a *tc* value different for the equivalent dose measurement and the *g*-value measurement, except if different equipment was used. However, if, for instance, the *g*-value measurement sequence was analysed with the *Analyst* (Duller 2015) and Luminescence is used to correct for fading, there is a high chance that the value returned by the *Analyst* comes normalised to 2-days, even if the *tc* values of the measurement were identical. In such cases, the fading correction cannot be correct until the *tc.g_value* is manually set to 2-days (172800 s) because the function will internally recalculate values to an identical *tc* value.

Value

The function returns an [RLum.Results](#) object and the graphical output produced by [plot_DoseResponseCurve](#).

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$data	data.frame	the fading corrected values
\$fit	nls	the object returned by the dose response curve fitting

'slot: @info

The original function call

Function version

0.1.1

How to cite

Kreutzer, S., Mercier, N., 2026. calc_Lamothe2003(): Apply fading correction after Lamothe et al., 2003. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)

Norbert Mercier, IRAMAT-CRP2A, Université Bordeaux Montaigne (France) , RLum Developer Team

References

- Huntley, D.J., Lamothe, M., 2001. Ubiquity of anomalous fading in K-feldspars and the measurement and correction for it in optical dating. *Canadian Journal of Earth Sciences* 38, 1093-1106.
- Duller, G.A.T., 2015. The Analyst software package for luminescence data: overview and recent improvements. *Ancient TL* 33, 35–42.
- Lamothe, M., Auclair, M., Hamzaoui, C., Huot, S., 2003. Towards a prediction of long-term anomalous fading of feldspar IRSL. *Radiation Measurements* 37, 493-498.

See Also

[fit_DoseResponseCurve](#), [plot_DoseResponseCurve](#), [calc_FadingCorr](#), [analyse_SAR.CWOSL](#), [analyse_pIRIRSequence](#)

Examples

```
##load data
##ExampleData.BINfileData contains two BINfileData objects
##CWOSL.SAR.Data and TL.SAR.Data
data(ExampleData.BINfileData, envir = environment())

##transform the values from the first position in a RLum.Analysis object
object <- Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos=1)

##perform SAR analysis and set rejection criteria
results <- analyse_SAR.CWOSL(
  object = object,
  signal_integral = 1:2,
  background_integral = 900:900,
  verbose = FALSE,
  plot = FALSE,
  onlyLxTxTable = TRUE
)

##run fading correction
results_corr <- calc_Lamothe2003(
  object = results,
  dose_rate.envir = c(1.676 , 0.180),
  dose_rate.source = c(0.184, 0.003),
  g_value = c(2.36, 0.6),
  plot = TRUE,
  fit.method = "SSE")
```

Description

Function to fit the (un-)logged three or four parameter minimum dose model (MAM-3/4) and maximum dose model to De data after Galbraith et al. (1999) and Olley et al. (2006).

Parameters

This model has four parameters:

gamma: minimum dose on the log scale
 mu: mean of the non-truncated normal distribution
 sigma: spread in ages above the minimum
 p0: proportion of grains at gamma

If par=3 (default) the 3-parameter model is applied, where gamma=mu. For par=4 the 4-parameter model is applied instead.

(Un-)logged model

In the original version of the minimum dose model, which is applied if log = TRUE (default), the basic data are the natural logarithms of the De estimates and relative standard errors of the De estimates.

If log=FALSE, the modified un-logged model will be applied instead. This has essentially the same form as the original version, but gamma and sigma are in Gy and gamma becomes the minimum true dose in the population.

In either case, the value for sigmab must be provided as a ratio (e.g, 0.2 for 20 %).

While the original (logged) version of the minimum dose model may be appropriate for most samples (i.e. De distributions), the modified (un-logged) version is specially designed for modern-age and young samples containing negative, zero or near-zero De estimates (Arnold et al. 2009, p. 323).

Maximum dose model

To estimate the maximum dose population and its standard error, the minimum age model of Galbraith et al. (1999) is adapted. The measured De values are transformed as follows:

1. convert De values to natural logs
2. multiply the logged data by -1 to create a mirror image of the De distribution
3. shift De values along x-axis by the smallest x-value found to obtain only positive values
4. combine in quadrature the measurement error associated with each De value with a relative error specified by sigmab
5. apply the MAM to these data

When all calculations are done the results are then converted back as follows:

1. subtract the x-offset
2. multiply the natural logs by -1
3. take the exponent to obtain the maximum dose estimate in Gy

Only a logged maximum dose model is supported.

Initial values and boundaries

The log-likelihood calculations use the `nlminb` function for box-constrained optimisation using PORT routines. By default, initial values for the four parameters are estimated from the input data. If the final estimates of *gamma*, *mu*, *sigma* and *p0* are totally off target, consider providing custom starting values via `init.values`.

The boundaries for individual model parameters need not be specified explicitly. To override the default boundary values, provide arguments `gamma.lower`, `gamma.upper`, `sigma.lower`, `sigma.upper`, `p0.lower`, `p0.upper`, `mu.lower` and `mu.upper`.

Bootstrap

When `bootstrap = TRUE` the function applies the bootstrapping method as described in Cunningham & Wallinga (2012). The minimum age model produces `bs.M` first-level bootstrap replicates (1000 by default) and `bs.N` second-level replicates ($3 * \text{bs.M}$ by default), with an uncertainty `sigma.sd` on the overdispersion parameter (0.04 by default). These values can be changed by using arguments `bs.M`, `bs.N` and `sigmab.sd`, respectively. The bandwidth of the kernel density estimate can be specified with `bs.h`. By default, this is calculated as:

$$h = 2\sigma_{DE}/\sqrt{n}$$

Note: Setting `bs.N` to 0 corresponds to a classic bootstrap, which bypasses some of the computations required for the full approach by Cunningham & Wallinga (2012), such as polynomial smoothing. This may be sufficient when no subsequent Bayesian analysis is required.

Multicore support

Parallel processing can be enabled by setting the `cores` argument to a value greater than 1 (or to `NULL` to use all but two of the available logical CPU cores). Multicore processing is supported only when `bootstrap = TRUE`, and spawns one R process per core to compute MAM estimates for each of the $N * M$ bootstrap replicates. Performance gains grow with the number of bootstrap replicates, but each additional core (R process) increases memory usage. When memory is insufficient, overall performance can degrade severely.

Likelihood profiles

The likelihood profiles are generated and plotted by the `bbmle` package. The profile likelihood plots look different to ordinary profile likelihood as

"[...] the plot method for likelihood profiles displays the square root of the deviance difference (twice the difference in negative log-likelihood from the best fit), so it will be V-shaped for cases where the quadratic approximation works well [...]" (Bolker 2016).

For more details on the profile likelihood calculations and plots please see the vignettes of the `bbmle` package (also available at <https://CRAN.R-project.org/package=bbmle>).

Usage

```
calc_MinDose(
  data,
  sigmab,
  log = TRUE,
  par = 3,
```

```

    bootstrap = FALSE,
    init.values = NULL,
    level = 0.95,
    log.output = FALSE,
    plot = TRUE,
    cores = 1,
    ...
)

calc_MaxDose(data, sigmab, plot = TRUE, ...)

```

Arguments

data	RLum.Results or data.frame (required): for data.frame : two columns with (data[, 1]) and De error (data[, 2]).
sigmab	numeric (required): additional spread in De values, representing the expected overdispersion in the data should the sample be well-bleached (Cunningham & Wallinga 2012, p. 100). This value must be expressed as a ratio, e.g. 0.2 (for 20 %), independently of the log argument. Note: Up to v1.2.1, it was required that the unlogged model specified sigmab in the same absolute units of the De values (seconds or Gray). This is no longer the case, and an error will be thrown if values of sigmab greater than 1 are assigned.
log	logical (<i>with default</i>): whether the logged minimum dose model should be fit to De data (TRUE by default).
par	numeric (<i>with default</i>): number of parameters in the model, either 3 (default) or 4.
bootstrap	logical (<i>with default</i>): apply the recycled bootstrap approach of Cunningham & Wallinga 2012. See details for default values and options to modify them.
init.values	numeric (<i>optional</i>): a named list with starting positive values for gamma, sigma, p0 and mu (e.g. list(gamma=100, sigma=1.5, p0=0.1, mu=100)). If set to NULL (default), reasonable values will be estimated from the data. Note: the initial values must always be given in the absolute units. If a logged model is applied (log = TRUE), the provided init.values are automatically log-transformed.
level	logical (<i>with default</i>): the confidence level required (defaults to 0.95).
log.output	logical (<i>with default</i>): if TRUE and log = TRUE, the console output will also show the logged values of the final parameter estimates and confidence intervals.
plot	logical (<i>with default</i>): enable/disable the plot output.
cores	integer , numeric (<i>with default</i>): number of cores allocated for parallel processing of the bootstrap step (only considered if bootstrap = TRUE). The default value corresponds to single-threaded computation; the recommended value is NULL, which assigns all but two of the available logical CPU cores.
...	Further arguments: • bs.M, bs.N, bs.h, sigmab.sd: arguments for bootstrapping, see details for their usage. • verbose: enable/disable output to the terminal.

- debug: enable/disable extended console output.
- all named argument of [calc_MinDose](#) can be passed to [calc_MaxDose](#).

Value

Returns a plot (*optional*) and terminal output. In addition an [RLum.Results](#) object is returned containing the following elements:

\$summary	data.frame summary of all relevant model results.
\$data	data.frame original input data
\$args	list used arguments
\$call	call the function call
\$mle	bbmle::mle2 object containing the maximum log likelihood functions for all parameters
\$BIC	numeric BIC score from the non-bootstrapped model
\$confint	data.frame confidence intervals for all parameters
\$profile	stats::profile the log likelihood profiles
\$bootstrap	list bootstrap results

The output should be accessed using the function [get_RLum](#).

Function version

0.6.2

How to cite

Burow, C., Colombo, M., 2026. calc_MinDose(): Apply the minimum (maximum) age model to a given De distribution. Function version 0.6.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The default starting values for *gamma*, *mu*, *sigma* and *p0* may only be appropriate for some De data sets and may need to be changed for other data. This is especially true when the un-logged version is applied.

Also note that all R warning messages are suppressed when running this function. If the results seem odd consider re-running the model with debug=TRUE which provides extended console output and forwards all internal warning messages.

Author(s)

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Marco Colombo, Institute of Geography, Heidelberg University (Germany)

Based on a rewritten S script of Rex Galbraith, 2010

The bootstrap approach is based on a MATLAB script by Alastair Cunningham, who helped with implementation and cross-checking. , RLum Developer Team

References

Arnold, L.J., Roberts, R.G., Galbraith, R.F. & DeLong, S.B., 2009. A revised burial dose estimation procedure for optical dating of young and modern-age sediments. *Quaternary Geochronology* 4, 306-325.

Galbraith, R.F. & Laslett, G.M., 1993. Statistical models for mixed fission track ages. *Nuclear Tracks Radiation Measurements* 4, 459-470.

Galbraith, R.F., Roberts, R.G., Laslett, G.M., Yoshida, H. & Olley, J.M., 1999. Optical dating of single grains of quartz from Jinmium rock shelter, northern Australia. Part I: experimental design and statistical models. *Archaeometry* 41, 339-364.

Galbraith, R.F., 2005. *Statistics for Fission Track Analysis*, Chapman & Hall/CRC, Boca Raton.

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Olley, J.M., Roberts, R.G., Yoshida, H., Bowler, J.M., 2006. Single-grain optical dating of grave-infill associated with human burials at Lake Mungo, Australia. *Quaternary Science Reviews* 25, 2469-2474.

Further reading

Arnold, L.J. & Roberts, R.G., 2009. Stochastic modelling of multi-grain equivalent dose (De) distributions: Implications for OSL dating of sediment mixtures. *Quaternary Geochronology* 4, 204-230.

Bolker, B., 2016. Maximum likelihood estimation analysis with the bbmle package. In: Bolker, B., R Development Core Team, 2016. *bbmle: Tools for General Maximum Likelihood Estimation*. R package version 1.0.18. <https://CRAN.R-project.org/package=bbmle>

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Cunningham, A.C. & Wallinga, J., 2012. Realizing the potential of fluvial archives using robust OSL chronologies. *Quaternary Geochronology* 12, 98-106.

Rodnight, H., Duller, G.A.T., Wintle, A.G. & Tooth, S., 2006. Assessing the reproducibility and accuracy of optical dating of fluvial deposits. *Quaternary Geochronology* 1, 109-120.

Rodnight, H., 2008. How many equivalent dose values are needed to obtain a reproducible distribution?. *Ancient TL* 26, 3-10.

See Also

[calc_CentralDose](#), [calc_CommonDose](#), [calc_FiniteMixture](#), [calc_FuchsLang2001](#)

Examples

```
## Load example data
data(ExampleData.DeValues, envir = environment())

# (1) Apply the minimum age model with minimum required parameters.
# By default, this will apply the un-logged 3-parameter MAM.
calc_MinDose(data = ExampleData.DeValues$CA1, sigmab = 0.1)

## Not run:
# (2) Re-run the model, but save results to a variable and turn
# plotting of the log-likelihood profiles off.
mam <- calc_MinDose(
  data = ExampleData.DeValues$CA1,
  sigmab = 0.1,
  plot = FALSE)

# Show structure of the RLum.Results object
mam

# Show summary table that contains the most relevant results
res <- get_RLum(mam, "summary")
res

# Plot the log likelihood profiles retroactively, because before
# we set plot = FALSE
plot_RLum(mam)

# Plot the dose distribution in an abanico plot and draw a line
# at the minimum dose estimate
plot_AbanicoPlot(data = mam,
  main = "3-parameter Minimum Age Model",
  polygon.col = "none",
  hist = TRUE,
  rug = TRUE,
  summary = c("n", "mean", "mean.weighted", "median", "in.ci"),
  centrality = res$de,
  grid.col = "none",
  line.col = "red",
  line.label = paste0(round(res$de, 1), "\u00B1",
    round(res$de_err, 1), " Gy"),
  bw = 0.1,
  ylim = c(-25, 18),
  summary.pos = "topleft",
  mtext = bquote("Parameters: " ~
    sigma[b] == .(get_RLum(mam, "args")$sigmab) ~ ", " ~
    gamma == .(round(log(res$de), 1)) ~ ", " ~
    sigma == .(round(res$sig, 1)) ~ ", " ~
    rho == .(round(res$p0, 2))))

# (3) Run the minimum age model with bootstrap
# NOTE: Bootstrapping is computationally intensive
# (3.1) run the minimum age model with default values for bootstrapping
```

```

calc_MinDose(data = ExampleData.DeValues$CA1,
             sigmab = 0.15,
             bootstrap = TRUE)

# (3.2) Bootstrap control parameters
mam <- calc_MinDose(data = ExampleData.DeValues$CA1,
                  sigmab = 0.15,
                  bootstrap = TRUE,
                  bs.M = 300,
                  bs.N = 500,
                  bs.h = 4,
                  sigmab.sd = 0.06,
                  plot = FALSE)

# Plot the results
plot_RLum(mam)

# save bootstrap results in a separate variable
bs <- get_RLum(mam, "bootstrap")

# show structure of the bootstrap results
str(bs, max.level = 2, give.attr = FALSE)

# print summary of minimum dose and likelihood pairs
summary(bs$pairs$gamma)

# Show polynomial fits of the bootstrap pairs
bs$poly.fits$poly.three

# Plot various statistics of the fit using the generic plot() function
par(mfcol=c(2,2))
plot(bs$poly.fits$poly.three, ask = FALSE)

# Show the fitted values of the polynomials
summary(bs$poly.fits$poly.three$fitted.values)

# apply the maximum dose model
calc_MaxDose(ExampleData.DeValues$CA1, sigmab = 0.2, par = 3)

## End(Not run)

```

calc_MoransI

Calculate Moran's I

Description

Calculate Moran's I

Usage

```
calc_MoransI(
  object,
  df_neighbours = NULL,
  spatial_autocorrelation = TRUE,
  compute_pseudo_p = FALSE,
  tested_moransI = NULL,
  n_permutations = 999,
  ignore_borders = FALSE,
  return_intermediate_values = FALSE
)
```

Arguments

- object** [RLum.Results](#) or [numeric](#) (**required**): values of the grains of one disc. Should have length 100; can contain NA values.
- df_neighbours** [data.frame](#) (*with default*): a data frame with 3 columns (location, neighbour and weight, respectively), with each row indicating the index of one location and one of its neighbours (note that the concept of "location" versus "neighbour" is symmetric, so each neighbouring pair needs to be specified only once), alongside their relative weight (generally set to 1). If NULL (default), this is constructed automatically by the internal function `.get_Neighbours`.
- spatial_autocorrelation** [logical](#) (*with default*): whether spatial autocorrelation should be considered in the computation of Moran's I (TRUE by default). If FALSE, the function computes Moran's I expected value in case of no autocorrelation (H_0). See details for further information.
- compute_pseudo_p** [logical](#) (*with default*): whether a pseudo p-value should be computed (FALSE by default).
- tested_moransI** [numeric](#) (*with default*): The value of Moran's I to be tested against when computing the pseudo p-value. If NULL (default), the value calculated by the function will be used. Ignored if `compute_pseudo_p` is FALSE.
- n_permutations** [integer](#) (*with default*): number of random permutations tested to calculate the fraction which is the pseudo p (defaults to 999). Influences the calculation speed, which will have impact in case of large scale simulation loops. Ignored if `compute_pseudo_p` is FALSE.
- ignore_borders** [logical](#) (*with default*): whether only grain locations that do not lie on the border of the disc should be considered (FALSE by default). Thus if TRUE, only the inner 8x8 grain locations rather than the full 10x10 are considered. Ignored if `df_neighbours` is not NULL or if `spatial_autocorrelation` = FALSE.
- return_intermediate_values** [logical](#) (*with default*): whether the function should return a list with several intermediate calculation results (defaults to FALSE). Ignored if `spatial_autocorrelation` is FALSE.

Details

Case of no spatial autocorrelation

Perhaps a bit counter-intuitive, the expected value of Moran's I under the null hypothesis of no spatial correlation is a value slightly smaller than zero. When setting `spatial_autocorrelation = FALSE`, this function calculates the expected value based on the number of observations or the length of the observation vector (while taking out NA values). Note that the expected value only depends on the number of observed separate grain values. This can be useful for plotting.

The expected Moran's I for the null hypothesis of no spatial correlation corresponds to $-1 / (n - 1)$, with n being the number of non-missing observations.

Value

By default one numerical value, roughly between -1 and 1, where close to zero means no spatial correlation, and value close to 1 a positive spatial correlation given the pattern we interested in (by default all rook neighbours). A value closer to -1 has no meaning within the context of luminescence crosstalk. If `compute_pseudo_p = TRUE`, then the computed pseudo p-value is returned. If `return_intermediate_values` is set to `TRUE`, a list with several values used for calculation is returned instead of a single outcome.

How to cite

de Boer, A., Steinbuch, L., 2026. `calc_MoransI()`: Calculate Moran's I. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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Luc Steinbuch, Wageningen University & Research (The Netherlands)
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References

de Boer, A-M., Steinbuch, L., Heuvelink, G.B.M., Wallinga, J., 2025. A novel method to assess crosstalk in single-grain luminescence detection. *Radiation Measurements* 186, 107459. doi:10.1016/j.radmeas.2025.107459

Examples

```
## Test a fictional sample with spatial correlation
calc_MoransI(object = c(1:100))

## Test some fictional samples without spatial correlation;
## note the randomness with each repetition
calc_MoransI(object = rnorm(n = 100))
calc_MoransI(object = rnorm(n = 100))
calc_MoransI(object = rnorm(n = 100))
```

 calc_OSLLxTxDecomposed

Calculate Lx/Tx ratio for decomposed CW-OSL signal components

Description

Calculate Lx/Tx ratios from a given set of decomposed CW-OSL curves decomposed by `OSLdecomposition::RLum.OSL_decomposition`

Usage

```
calc_OSLLxTxDecomposed(
  Lx.data,
  Tx.data = NULL,
  OSL.component = 1L,
  sig0 = 0,
  digits = NULL
)
```

Arguments

- | | |
|---------------|--|
| Lx.data | data.frame (required) : Component table created by <code>OSLdecomposition::RLum.OSL_decomposition</code> and per default located at <code>object@records[[...]]@info\$COMPONENTS</code> . The value of <code>\$n[OSL.component]</code> is set as <code>LnLx</code> . The value of <code>\$n.error[OSL.component]</code> is set as <code>LnLx.error</code> |
| Tx.data | data.frame (optional) : Component table created by <code>OSLdecomposition::RLum.OSL_decomposition</code> and per default located at <code>object@records[[...]]@info\$COMPONENTS</code> . The value of <code>\$n[OSL.component]</code> is set as <code>TnTx</code> . The value of <code>\$n.error[OSL.component]</code> is set as <code>TnTx.error</code> |
| OSL.component | integer or character (optional) : a single index or a name describing which OSL signal component shall be evaluated. This argument can either be the name of the OSL component assigned by <code>OSLdecomposition::RLum.OSL_global_fitting</code> or the index of component. Then '1' selects the fastest decaying component, '2' the second fastest and so on. If not defined, the fastest decaying component is selected. |
| sig0 | numeric (with default) : allows adding an extra error component to the final Lx/Tx error value (e.g., instrumental error). |
| digits | integer (with default) : round numbers to the specified digits. If digits is set to NULL nothing is rounded. |

Value

Returns an S4 object of type `RLum.Results`.

Slot data contains a [list](#) with the following structure:

@data

```
$LxTx.table (data.frame)
.. $ Net_LnLx
.. $ Net_LnLx.Error
.. $ Net_TnTx
.. $ Net_TnTx.Error
.. $ SN_RATIO_LnLx = NA,
.. $ SN_RATIO_TnTx = NA
.. $ LxTx
.. $ LxTx.Error
```

Function version

0.1.1

How to cite

Mittelstrass, D., 2026. calc_OSLLxTxDecomposed(): Calculate Lx/Tx ratio for decomposed CW-OSL signal components. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Dirk Mittelstrass , RLum Developer Team

References

Mittelstrass D., Schmidt C., Beyer J., Straessner A., 2019. Automated identification and separation of quartz CW-OSL signal components with R. talk presented at DLED 2019, Bingen, Germany http://luminescence.de/OSLdecomp_talk.pdf

See Also

[RLum.Data.Curve](#), [fit_DoseResponseCurve](#), [analyse_SAR.CWOSL](#)

calc_OSLLxTxRatio

Calculate Lx/Tx ratio for CW-OSL curves

Description

Calculate Lx/Tx ratios from a given set of CW-OSL curves assuming late light background subtraction.

Usage

```
calc_OSLLxTxRatio(
  Lx.data,
  Tx.data = NULL,
  signal_integral = NULL,
  background_integral = NULL,
  signal_integral_Tx = NULL,
  background_integral_Tx = NULL,
  integral_input = c("channel", "measurement"),
  background.count.distribution = c("non-poisson", "poisson"),
  use_previousBG = FALSE,
  sigmab = NULL,
  od_rates = NULL,
  sig0 = 0,
  digits = NULL,
  ...
)
```

Arguments

- Lx.data** [RLum.Data.Curve](#), [data.frame](#), [list](#) (**required**): requires a CW-OSL shine down curve (x = time, y = counts). Data can also be provided as a list.
- Tx.data** [RLum.Data.Curve](#) or [data.frame](#) (*optional*): requires a CW-OSL shine down curve (x = time, y = counts). If no input is given the Tx.data will be treated as NA and no Lx/Tx ratio is calculated. When Lx.data is a list, it must be provided as a list of the same length.
- signal_integral** [integer](#) (**required**): vector of channels for the signal integral. If set to NA (alternate mode), no integrals are taken into account and their settings are ignored.
- background_integral** [integer](#) (**required**): vector of channels for the background integral. If set to NA, no background integral is subtracted; in this case, `sigmab.LnLx` (unless manually set) and the signal-to-noise ratio for `Ln/Lx` will be NA.
- signal_integral_Tx** [integer](#) (*optional*): vector of channels for the signal integral for the Tx curve. If NULL, the `signal_integral` vector is used.
- background_integral_Tx** [integer](#) (*optional*): vector of channels for the background integral for the Tx curve. If NULL, the `background_integral` vector is used. If set to NA, no background integral for the Tx curve is subtracted; in this case, `sigmab.TxTx` (unless manually set) and the signal-to-noise ratio for `Tn/Tx` will be NA.
- integral_input** [character](#) (*with default*): input type for `signal_integral`, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time/temperature range are selected.
- background.count.distribution** [character](#) (*with default*): sets the count distribution assumed for the error calculation. Possible arguments are "poisson" or "non-poisson" (default). See

	details for further information. It is ignored if od_rates is provided.
use_previousBG	logical (<i>with default</i>): If set to TRUE the background of the Lx-signal is subtracted also from the Tx-signal. Please note that in this case separate signal integral limits for the Tx-signal are not allowed and will be reset.
sigmab	numeric (<i>optional</i>): option to set a manual value for the overdispersion (for LnTx and TnTx), used for the Lx/Tx error calculation. The value should be provided as absolute squared count values, e.g. sigmab = c(300, 300). Despite its name it is an additional variance (above Poisson variance), not a dispersion. Note: If only one value is provided this value is taken for both (LnTx and TnTx) signals.
od_rates	numeric (<i>optional</i>): a vector of three elements: the dark count rate (or background count rate), the background count overdispersion, and the photon count overdispersion. If set, an alternative way of computing the overdispersion will be used (see details). It is ignored (with a warning) if sigmab is provided.
sig0	numeric (<i>with default</i>): allow adding an extra component of error to the final Lx/Tx error value (e.g., instrumental error, see details).
digits	integer (<i>with default</i>): round numbers to the specified digits. If set to NULL no rounding occurs.
...	currently not used.

Details

The function checks the integrity of the values chosen for the signal and background integrals; the signal integral limits have to be lower than the background integral limits. If a **vector** is given as input instead of a **data.frame**, an artificial **data.frame** is produced.

The error calculation is done according to Galbraith (2002, 2014) or to Bluszcz et al. (2015) depending on the presence of od_rates argument.

Please note: In cases where the calculation results in NaN values (for example due to zero-signal, and therefore a division of 0 by 0), these NaN values are replaced by 0.

background.count.distribution

This argument allows selecting the distribution assumption that is used for the error calculation. According to Galbraith (2002, 2014) the background counts may be overdispersed (i.e. not follow a Poisson distribution, which is assumed for the photomultiplier counts). In that case (might be the normal case) the overdispersion has to be accounted for by estimating σ_B^2 (i.e. the overdispersion value). Therefore the relative standard error is calculated as:

- poisson

$$rse(\mu_S) \approx \sqrt{(Y_0 + Y_1/k^2)/(Y_0 - Y_1/k)}$$

- non-poisson

$$rse(\mu_S) \approx \sqrt{(Y_0 + Y_1/k^2 + \sigma_B^2(1 + 1/k))/(Y_0 - Y_1/k)}$$

If background_integral = NA, then in both cases the relative standard error simplifies to:

$$rse(\mu_S) \approx \sqrt{Y_0/Y_0}$$

sigmab

The default value of sigmab (σ_B^2) is calculated assuming the background is constant and **would not** be applicable when the background varies, e.g., as observed for the early light subtraction method.

Note: When using the early background subtraction method in combination with the 'non-poisson' distribution argument, the corresponding Lx/Tx error may considerably increase due to a high sigmab value. Please check whether this is valid for your data set; if necessary, consider providing a custom value using the sigmab argument.

od_rates

Setting the od_rates argument activates the error calculation according to Bluszcz et al. (2015). The argument expects a 3-element vector:

- B_DC is the PMT-specific dark count rate as pulses per second (not per channel)
- k_DC is the PMT-specific dispersion excess factor for dark counts
- k_ph is the PMT-specific dispersion excess factor for photon counts

The dark count rate and the dispersion excess factors have to be known in advance, and can be obtained by direct experiments performed in laboratory conditions, essentially the same as the routine measurement conditions (for examples see: Bluszcz et al. (2015), Carter et al. (2018)). The photon count overdispersion k_{ph} needs a photon source with a constant photon emission rate and independent photon emissions (so the number of photons emitted in a fixed time is a Poisson variable). Note that B_{DC} must be non-negative, while k_{DC} and k_{ph} must be positive (for readers with no pulse divider, they should be greater or equal to 1).

Under the assumption of statistically independent background (N_{DC}) and photon counts (N_{ph}), the total number of counts (say, a certain integral N of the OSL curve over time t) is:

$$N = N_{ph} + N_{DC}$$

and has the following variance:

$$s^2(N) = k_{ph}^2 N_{ph} + K_{DC}^2 N_{DC} = k_{ph}^2 (N - B_{DC}t) + k_{DC}^2 B_{DC}t = k_{ph}^2 N + (k_{DC}^2 - k_{ph}^2) B_{DC}t$$

The LnLx.Error and TnTx.Error are computed as $\sqrt{s^2(N)}$.

sig0

This argument allows adding an extra component of error to the final Lx/Tx error value. The input will be treated as a factor that is multiplied by the already calculated LxTx and the result is added according to:

$$se(LxTx) = \sqrt{se(LxTx)^2 + (LxTx * sig0)^2}$$

SN_RATIO_LnLx **and** SN_RATIO_TnTx

For convenience, the function returns the signal-to-noise ratio (SN_RATIO) for the LnLx and the TnTx curves. This is simply the signal divided by the background signal counts normalised to the k value (see below).

Value

Returns an S4 object of type [RLum.Results](#).

Slot data contains a [list](#) with the following structure:

@data

```
$LxTx.table (data.frame)
.. $ LnLx
.. $ LnLx.BG
.. $ TnTx
.. $ TnTx.BG
.. $ Net_LnLx
.. $ Net_LnLx.Error
.. $ Net_TnTx
.. $ Net_TnTx.Error
.. $ SN_RATIO_LnLx,
.. $ SN_RATIO_TnTx,
.. $ LxTx
.. $ LxTx.Error
$calc.parameters (list)
.. $ sigmab.LnTx
.. $ sigmab.TnTx
.. $ k
.. $ od_rates
```

@info

```
$ call (original function call)
```

Function version

0.9.8

How to cite

Kreutzer, S., Colombo, M., Bluszcz, A., 2026. calc_OSLLxTxRatio(): Calculate Lx/Tx ratio for CW-OSL curves. Function version 0.9.8. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The results of this function have been cross-checked with the Analyst (version 3.24b).

Caution: If you are using early light subtraction (EBG), please either provide your own sigmab value or use `background.count.distribution = "poisson"`.

Author(s)

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 , RLum Developer Team

References

- Duller, G., 2018. Analyst v4.57 - User Manual. <https://users.aber.ac.uk/ggd>
- Galbraith, R.F., 2002. A note on the variance of a background-corrected OSL count. *Ancient TL*, 20 (2), 49-51. doi:10.26034/la.atl.2002.348
- Galbraith, R.F., 2014. A further note on the variance of a background-corrected OSL count. *Ancient TL*, 31 (2), 1-3. doi:10.26034/la.atl.2014.477
- Bluszcz, A., Adamiec, G., Herr, A., 2015. Estimation of equivalent dose and its uncertainty in the OSL SAR protocol when count numbers do not follow a Poisson distribution. *Radiation Measurements* 81, 46-54. doi:10.1016/j.radmeas.2015.01.004
- Carter, J., Cresswell, A.J., Kinnaird, T.C., Carmichael, L.A., Murphy, S., Sanderson, D.C.W., 2018. Non-Poisson variations in photomultipliers and implications for luminescence dating. *Radiation Measurements* 120, 267-273. doi:10.1016/j.radmeas.2018.05.010

See Also

[RLum.Data.Curve](#), [fit_DoseResponseCurve](#), [analyse_SAR.CWOSL](#)

Examples

```
##load data
data(ExampleData.LxTxOSLData, envir = environment())

##calculate Lx/Tx ratio
results <- calc_OSLLxTxRatio(
  Lx.data = Lx.data,
  Tx.data = Tx.data,
  signal_integral = 1:2,
  background_integral = 85:100)

##get results object
get_RLum(results)
```

calc_SourceDoseRate *Calculation of the source dose rate via the date of measurement*

Description

Calculating the dose rate of the irradiation source via the date of measurement based on: source calibration date, source dose rate, dose rate error. The function returns a data.frame that provides the input argument dose_rate for the function [convert_Second2Gray](#).

Calculation of the source dose rate based on the time elapsed since the last calibration of the irradiation source. Decay parameters assume a Sr-90 beta source.

$$dose.rate = D0 \exp\left(-\frac{\log(2)}{T.1/2} t\right)$$

where $D0$ is the calibration dose rate, $T.1/2$ is the half-life of the source nuclide (in days), t is the time since source calibration (in days), and $\log(2)/T.1/2$ equals the decay constant λ .

Information on the date of measurements may be taken from the data's original .BIN file (using e.g., `BINfile <- Luminescence::read_BIN2R()` and the slot `BINfile@METADATA$DATE`).

Allowed source types and related values

#	Source type	T.1/2	Reference
[1]	Sr-90	28.90 y	NNDC, Brookhaven National Laboratory
[2]	Am-241	432.6 y	NNDC, Brookhaven National Laboratory
[3]	Co-60	5.274 y	NNDC, Brookhaven National Laboratory
[4]	Cs-137	30.08 y	NNDC, Brookhaven National Laboratory

Usage

```
calc_SourceDoseRate(
  measurement.date,
  calib.date,
  calib.dose.rate,
  calib.error,
  source.type = c("Sr-90", "Am-241", "Co-60", "Cs-137"),
  dose.rate.unit = c("Gy/s", "Gy/min"),
  predict = NULL
)
```

Arguments

`measurement.date` [character](#) or [Date](#) (*with default*): Date of measurement in "YYYY-MM-DD" format. If no value is provided, the date will be set to today. The argument can be provided as vector.

`calib.date` [character](#) or [Date](#) (**required**): date of source calibration in "YYYY-MM-DD" format.

calib.dose.rate	numeric (required) : dose rate at date of calibration in Gy/s or Gy/min.
calib.error	numeric (required) : error of dose rate at date of calibration Gy/s or Gy/min.
source.type	character (with default) : specify irradiation source (Sr-90, Co-60, Cs-137, Am-241), see details for further information.
dose.rate.unit	character (with default) : dose rate unit for input (one of Gy/min or Gy/s). The output is given in Gy/s as valid for the function convert_Second2Gray .
predict	integer (with default) : option allowing to predict the dose rate of the source over time in days set by the provided value. Starting date is the value set with <code>measurement.date</code> , e.g., <code>calc_SourceDoseRate(..., predict = 100)</code> calculates the source dose rate for the next 100 days. If <code>predict</code> is of length two, this will be used to calculate the value per days backwards and forward. For instance: <code>predict = c(-100, 100)</code> will calculate 100 days backwards and 100 days forward.

Value

Returns an S4 object of type [RLum.Results](#). Slot data contains a [list](#) with the following structure:

```
$ dose.rate (data.frame)
.. $ dose.rate
.. $ dose.rate.error
.. $ date (corresponding measurement date)
$ parameters (list)
.. $ source.type
.. $ halflife
.. $ dose.rate.unit
$ call (the original function call)
```

The output should be accessed using the function [get_RLum](#). A plot method of the output is provided via [plot_RLum](#).

Function version

0.3.6

How to cite

Fuchs, M.C., Kreutzer, S., 2026. `calc_SourceDoseRate()`: Calculation of the source dose rate via the date of measurement. Function version 0.3.6. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Please be careful when using the option `predict`, especially when a multiple set for `measurement.date` and `calib.date` is provided. For the source dose rate prediction, the function takes the last `measurement.date` and `calib.date` values and predicts from that the source dose rate for the number of days requested, that is: the (multiple) original input will be replaced.

Author(s)

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Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

NNDC, Brookhaven National Laboratory <https://www.nndc.bnl.gov/>

See Also

[convert_Second2Gray](#), [get_RLum](#), [plot_RLum](#)

Examples

```
##(1) Simple function usage
##Basic calculation of the dose rate for a specific date
dose.rate <- calc_SourceDoseRate(
  measurement.date = "2012-01-27",
  calib.date = "2014-12-19",
  calib.dose.rate = 0.0438,
  calib.error = 0.0019)

##show results
get_RLum(dose.rate)

##(2) Usage in combination with another function (e.g., convert_Second2Gray() )
## load example data
data(ExampleData.DeValues, envir = environment())

## use the calculated variable dose.rate as input argument
## to convert De(s) to De(Gy)
convert_Second2Gray(ExampleData.DeValues$BT998, dose.rate)

##(3) source rate prediction and plotting
dose.rate <- calc_SourceDoseRate(
  measurement.date = "2012-01-27",
  calib.date = "2014-12-19",
  calib.dose.rate = 0.0438,
  calib.error = 0.0019,
  predict = c(-1000,1000))
plot(dose.rate, type = "l")

##(4) export output to a LaTeX table (example using the package 'xtable')
```

```
## Not run:
xtable::xtable(get_RLum(dose.rate))

## End(Not run)
```

calc_Statistics

Function to calculate statistic measures

Description

This function calculates a number of descriptive statistics for estimates with a given standard error (SE), most fundamentally using error-weighted approaches.

Usage

```
calc_Statistics(
  data,
  weight.calc = c("inverse_var", "inverse_std"),
  digits = NULL,
  n.MCM = NULL,
  na.rm = TRUE
)
```

Arguments

data	data.frame or RLum.Results object (required): for data.frame two columns: De (data[, 1]) and De error (data[, 2]).
weight.calc	character (<i>with default</i>): type of weight calculation, either "inverse_var" (weight is 1/error^2, default) or "inverse_std" (weight is 1/error).
digits	integer (<i>with default</i>): number of decimal places to be used when rounding numbers. If set to NULL (default), no rounding occurs.
n.MCM	numeric (<i>with default</i>): number of samples drawn for Monte Carlo-based statistics. NULL (the default) disables MC runs.
na.rm	logical (<i>with default</i>): indicating whether NA values should be stripped before the computation proceeds.

Details

If the error column of data is missing or only contains 0, the weighted statistics will match the unweighted ones. If only some errors are 0, then the weighted statistics will contain NA values.

The option to use Monte Carlo Methods (n.MCM) allows calculating all descriptive statistics based on random values. The distribution of these random values is based on the Normal distribution with De values as means and De_error values as one standard deviation. Increasing the number of MCM-samples linearly increases computation time. On a Lenovo X230 machine evaluation of 25 Aliquots with n.MCM = 1000 takes 0.01 s, with n = 100000, ca. 1.65 s. It might be useful to work with logarithms of these values. See Dietze et al. (2016) and [plot_AbanicoPlot](#) for details.

Value

Returns a list with weighted and unweighted statistic measures.

Function version

0.1.9

How to cite

Dietze, M., 2026. calc_Statistics(): Function to calculate statistic measures. Function version 0.1.9. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Michael Dietze, GFZ Potsdam (Germany) , RLum Developer Team

References

Dietze, M., Kreutzer, S., Burow, C., Fuchs, M.C., Fischer, M., Schmidt, C., 2016. The abanico plot: visualising chronometric data with individual standard errors. Quaternary Geochronology 31, 1-7. [doi:10.1016/j.quageo.2015.09.003](https://doi.org/10.1016/j.quageo.2015.09.003)

Examples

```
## load example data
data(ExampleData.DeValues, envir = environment())

## show a rough plot of the data to illustrate the non-normal distribution
plot_KDE(ExampleData.DeValues$BT998)

## calculate statistics and show output
str(calc_Statistics(ExampleData.DeValues$BT998))

## Not run:
## now the same for 10000 normal distributed random numbers with equal errors
x <- as.data.frame(cbind(rnorm(n = 10^5, mean = 0, sd = 1),
                          rep(0.001, 10^5)))

## note the congruent results for weighted and unweighted measures
str(calc_Statistics(x))

## End(Not run)
```

calc_ThermalLifetime *Calculates the Thermal Lifetime using the Arrhenius equation*

Description

The function calculates the thermal lifetime of charges for given E (in eV), s (in 1/s) and T (in deg. C.) parameters. The function can be used in two operational modes:

Usage

```
calc_ThermalLifetime(
    E,
    s,
    T = 20,
    output_unit = "Ma",
    profiling = FALSE,
    profiling_config = list(),
    verbose = TRUE,
    plot = TRUE,
    ...
)
```

Arguments

- | | |
|------------------|---|
| E | numeric (required) : vector of trap depths in eV, if profiling = TRUE only the first two elements are considered |
| s | numeric (required) : vector of frequency factor in 1/s, if profiling = TRUE only the first two elements are considered |
| T | numeric (with default) : temperature in deg. C for which the lifetime(s) will be calculated. A vector can be provided. |
| output_unit | character (with default) : output unit of the calculated lifetimes, accepted entries are: "Ma", "ka", "a", "d", "h", "min", "s" |
| profiling | logical (with default) : this option allows to estimate uncertainties based on given E and s parameters and their corresponding standard error (cf. details and examples section) |
| profiling_config | list (optional) : allows to set configuration parameters used for the profiling (and only have an effect here). Supported parameters are: <ul style="list-style-type: none"> • n (number of MC runs), • E.distribution (distribution used for the re-sampling for E) and • s.distribution (distribution used for the re-sampling for s). Currently only the normal distribution is supported (e.g., profiling_config = list(E.distribution = "norm")) |
| verbose | logical (with default) : enable/disable output to the terminal. |

`plot` [logical](#) (*with default*): enable/disable the plot output, currently only in combination with `profiling = TRUE`.

`...` further arguments that can be passed in combination with the plot output. Standard plot parameters are supported ([plot.default](#))

Details

Mode 1 (`profiling = FALSE`)

An arbitrary set of input parameters (E , s , T) can be provided and the function calculates the thermal lifetimes using the Arrhenius equation for all possible combinations of these input parameters. An array with 3-dimensions is returned that can be used for further analyses or graphical output (see example 1)

Mode 2 (`profiling = TRUE`)

This mode tries to profile the variation of the thermal lifetime for a chosen temperature by accounting for the provided E and s parameters and their corresponding standard errors, e.g., $E = c(1.600, 0.001)$. The calculation is based on a Monte Carlo simulation, where values are sampled from a normal distribution (for E and s).

Used equation (Arrhenius equation)

$$\tau = \frac{1}{s} \exp(E/kT)$$

where: τ in s as the mean time an electron spends in the trap for a given T , E trap depth in eV, s the frequency factor in 1/s, T the temperature in K and k the Boltzmann constant in eV/K (cf. Furetta, 2010).

Value

A [RLum.Results](#) object is returned along with a plot (for `profiling = TRUE`). The output object contains the following slots:

`@data`

Object	Type	Description
<code>lifetimes</code>	array or numeric	calculated lifetimes
<code>profiling_matrix</code>	matrix	profiling matrix used for the MC runs

`@info`

Object	Type	Description
<code>call</code>	<code>call</code>	the original function call

Function version

0.1.0

How to cite

Kreutzer, S., 2026. calc_ThermalLifetime(): Calculates the Thermal Lifetime using the Arrhenius equation. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The profiling is currently based on re-sampling from a normal distribution, this distribution assumption might be, however, not valid for given E and s parameters.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Furetta, C., 2010. Handbook of Thermoluminescence, Second Edition. World Scientific.

See Also

[graphics::matplot](#), [stats::rnorm](#), [get_RLum](#)

Examples

```
##EXAMPLE 1
##calculation for two trap-depths with similar frequency factor for different temperatures
E <- c(1.66, 1.70)
s <- 1e+13
T <- 10:20
temp <- calc_ThermalLifetime(
  E = E,
  s = s,
  T = T,
  output_unit = "Ma"
)
graphics::contour(x = E, y = T, z = temp$lifetimes[1,,],
  ylab = "Temperature [\u00B0C]",
  xlab = "Trap depth [eV]",
  main = "Thermal Lifetime Contour Plot"
)
mtext(side = 3, "(values quoted in Ma)")

##EXAMPLE 2
##profiling of thermal life time for E and s and their standard error
E <- c(1.600, 0.003)
s <- c(1e+13, 1e+011)
T <- 20
```

```

calc_ThermalLifetime(
  E = E,
  s = s,
  T = T,
  profiling = TRUE,
  output_unit = "Ma"
)

```

calc_TLLxTxRatio

Calculate the Lx/Tx ratio for a given set of TL curves -beta version-

Description

Calculate Lx/Tx ratio for a given set of TL curves.

Usage

```

calc_TLLxTxRatio(
  Lx.data.signal,
  Lx.data.background = NULL,
  Tx.data.signal = NULL,
  Tx.data.background = NULL,
  signal_integral = NULL,
  integral_input = c("channel", "measurement"),
  ...
)

```

Arguments

Lx.data.signal [RLum.Data.Curve](#) or [data.frame](#) (**required**): TL data (x = temperature, y = counts) (TL signal).

Lx.data.background [RLum.Data.Curve](#) or [data.frame](#) (*optional*): TL data (x = temperature, y = counts). If no data are provided no background subtraction is performed.

Tx.data.signal [RLum.Data.Curve](#) or [data.frame](#) (**required**): TL data (x = temperature, y = counts) (TL test signal).

Tx.data.background [RLum.Data.Curve](#) or [data.frame](#) (*optional*): TL data (x = temperature, y = counts). If no data are provided no background subtraction is performed.

signal_integral [integer](#) (**required**): vector of channels for the signal integral.

integral_input [character](#) (*with default*): input type for signal_integral, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given temperature range are selected.

... currently not used.

Details

Uncertainty estimation

The standard errors are calculated using the following generalised equation:

$$SE_{signal} = abs(Signal_{net} * BG_f / BG_{signal})$$

where BG_f is a term estimated by calculating the standard deviation of the sum of the L_x background counts and the sum of the T_x background counts. However, if both signals are similar the error becomes zero.

Value

Returns an S4 object of type `RLum.Results`. Slot data contains a [list](#) with the following structure:

```
$ LxTx.table
.. $ LnLx
.. $ LnLx.BG
.. $ TnTx
.. $ TnTx.BG
.. $ Net_LnLx
.. $ Net_LnLx.Error
.. $ SN_RATIO_LnLx
.. $ SN_RATIO_TnTx
.. $ LxTx
.. $ LxTx.Error
```

Function version

0.3.7

How to cite

Kreutzer, S., Schmidt, C., 2026. calc_TLLxTxRatio(): Calculate the Lx/Tx ratio for a given set of TL curves -beta version-. Function version 0.3.7. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function has still BETA status! Please further note that a similar background for both curves results in a zero error and is therefore set to NA.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Christoph Schmidt, University of Bayreuth (Germany) , RLum Developer Team

See Also

[RLum.Results](#), [analyse_SAR.TL](#)

Examples

```
##load package example data
data(ExampleData.BINfileData, envir = environment())

##convert Risoe.BINfileData into a curve object
temp <- Risoe.BINfileData2RLum.Analysis(TL.SAR.Data, pos = 3)

Lx.data.signal <- get_RLum(temp, record.id=1)
Lx.data.background <- get_RLum(temp, record.id=2)
Tx.data.signal <- get_RLum(temp, record.id=3)
Tx.data.background <- get_RLum(temp, record.id=4)
signal_integral <- 210:230

output <- calc_TLLxTxRatio(
  Lx.data.signal,
  Lx.data.background,
  Tx.data.signal,
  Tx.data.background,
  signal_integral)
get_RLum(output)
```

calc_WodaFuchs2008	<i>Obtain the equivalent dose using the approach by Woda and Fuchs 2008</i>
--------------------	---

Description

The function generates a histogram-like reorganisation of the data, to assess counts per bin. The log-transformed counts per bin are used to calculate the second derivative of the data (i.e., the curvature of the curve) and to find the central value of the bin hosting the distribution maximum. A normal distribution model is fitted to the counts per bin data to estimate the dose distribution parameters. The uncertainty of the model is estimated based on all input equivalent doses smaller than that of the modelled central value.

Usage

```
calc_WodaFuchs2008(data, breaks = NULL, plot = TRUE, ...)
```

Arguments

data [data.frame](#) vector, or [RLum.Results](#) object (**required**): for [data.frame](#): either two columns: De (values[,1]) and De error (values[,2]), or one: De (values[,1]). If a numeric vector or a single-column data frame is provided, De error is set to NA. For plotting multiple data sets, these must be provided as list (e.g. list(dataset1, dataset2)).

breaks **numeric**: Either number or locations of breaks. See [hist] for details. If missing, the number of breaks will be estimated based on the bin width (as function of median error).

plot **logical** (*with default*): enable/disable the plot output.

... Further plot arguments passed to the function.

Function version

0.2.0

How to cite

Kreutzer, S., Dietze, M., 2026. calc_WodaFuchs2008(): Obtain the equivalent dose using the approach by Woda and Fuchs 2008. Function version 0.2.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Michael Dietze, GFZ Potsdam (Germany) , RLum Developer Team

References

Woda, C., Fuchs, M., 2008. On the applicability of the leading edge method to obtain equivalent doses in OSL dating and dosimetry. Radiation Measurements 43, 26-37.

See Also

[calc_FuchsLang2001](#), [calc_CentralDose](#)

Examples

```
## read example data set
data(ExampleData.DeValues, envir = environment())

results <- calc_WodaFuchs2008(
  data = ExampleData.DeValues$CA1,
  xlab = expression(paste(D[e], " [Gy]"))
)
```

combine_De_Dr

*Combine Dose Rate and Equivalent Dose Distribution***Description**

A Bayesian statistical analysis of OSL age requiring dose rate sample. Estimation contains a preliminary step for detecting outliers in the equivalent dose sample.

Usage

```
combine_De_Dr(
  De,
  s,
  Dr,
  int_OD,
  Age_range = c(1, 300),
  outlier_threshold = 0.05,
  outlier_method = "default",
  outlier_analysis_plot = FALSE,
  method_control = list(),
  par_local = TRUE,
  verbose = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

De	numeric (required) : an equivalent dose sample.
s	numeric (required) : a vector of measurement errors on the equivalent dose
Dr	numeric (required) : a dose rate sample
int_OD	numeric (required) : the intrinsic overdispersion, typically the standard deviation characterizing a dose-recovery test distribution
Age_range	numeric (with default) : age range to be investigated by the algorithm. The larger the value, the more iterations are needed and the longer it takes. It should not be set too narrow to cut the algorithm some slack.
outlier_threshold	numeric (with default) : the required significance level used for the outlier detection. If set to 1, no outliers are removed. If outlier_method = "RousseeuwCroux1993", the median distance is used as outlier threshold. Please see details for further information.
outlier_method	character (with default) : outlier detection method, either "default" or "RousseeuwCroux1993". See details.
outlier_analysis_plot	logical (with default) : enable/disable the outlier analysis plot. Note: the outlier analysis will happen independently of the plot output.

`method_control` **list** (*with default*): named **list** of parameters to control `rjags::jags.model`. This can be used to set the random seed for the MCMC chains (four by default):

```
method_control = list(inits = list(
  list(.RNG.name = "base::Wichmann-Hill", .RNG.seed = 1),
  list(.RNG.name = "base::Wichmann-Hill", .RNG.seed = 2),
  list(.RNG.name = "base::Wichmann-Hill", .RNG.seed = 3),
  list(.RNG.name = "base::Wichmann-Hill", .RNG.seed = 4))
)
```

`par_local` **logical** (*with default*): if set to TRUE the function uses its own `graphics::par` settings (which will end in two plots next to each other)

`verbose` **logical** (*with default*): enable/disable output to the terminal.

`plot` **logical** (*with default*): enable/disable the plot output.

... a few further arguments to fine-tune the plot output such as `cdf_ADr_quantiles` (TRUE/FALSE), `legend.pos`, `legend` (TRUE/FALSE)

Details

Outlier detection

Two different outlier detection methods are implemented (full details are given in the cited literature).

1. The *default* and *recommend* method, uses quantiles to compare prior and posterior distributions of the individual variances of the equivalent doses. If the corresponding quantile in the corresponding posterior distribution is larger than the quantile in the prior distribution, the value is marked as outlier (cf. Galharret et al., preprint)
2. The alternative method employs the method suggested by Rousseeuw and Croux (1993) using the absolute median distance.

Parameters available for `method_control`

The parameters listed below are used to granular control Bayesian modelling using `rjags::rjags`. Internally the functions `.calc_IndividualAgeModel()` and `.calc_BayesianCentralAgeModel()`. The parameter settings affect both models. Note: `method_control` expects a **named** list of parameters

PARAMETER	TYPE	DEFAULT	REMARKS
<code>variable.names_IAM</code>	character	<code>c('A', 'a', 'sig_a')</code>	variables names to be monitored in the modelling process using <code>variable.names_IAM</code>
<code>variable.names_BCAM</code>	character	<code>c('A', 'D_e')</code>	variables names to be monitored in the modelling process using <code>variable.names_BCAM</code>
<code>n.chains</code>	integer	4	number of MCMC chains
<code>n.adapt</code>	integer	1000	number of iterations for the adaptation
<code>n.iter</code>	integer	5000	number of iterations to monitor cf. <code>rjags::coda.samples</code>
<code>thin</code>	numeric	1	thinning interval for the monitoring cf. <code>rjags::coda.samples</code>
<code>diag</code>	logical	FALSE	additional terminal convergence diagnostic. FALSE if <code>verbose = TRUE</code>
<code>progress.bar</code>	logical	FALSE	enable/disable progress bar. FALSE if <code>verbose = FALSE</code>
<code>quiet</code>	logical	TRUE	silence terminal output. Set to TRUE if <code>verbose = FALSE</code>
<code>return_mcmc</code>	logical	FALSE	return additional MCMC diagnostic information

Value

The function returns a plot if `plot = TRUE` and an **RLum.Results** object with the following slots:

@data

```
.. $Ages: a numeric vector with the modelled ages to be further analysed or visualised
.. $Ages_stats: a data.frame with sum HPD, CI 68% and CI 95% for the ages
.. $outliers_index: the index with the detected outliers
.. $cdf_ADr_mean : empirical cumulative density distribution A * Dr (mean)
.. $cdf_ADr_quantiles : empirical cumulative density distribution A * Dr (quantiles .025,.975)
.. $cdf_De_no_outlier : empirical cumulative density distribution of the De with no outliers
.. $cdf_De_initial : empirical cumulative density distribution of the initial De
.. $mcmc_IAM: the MCMC list of the Individual Age Model, only of method_control = list(return_mcmc = TRUE) otherwise NULL
.. $mcmc_BCAM: the MCMC list of the Bayesian Central Age Model, only of method_control = list(return_mcmc = TRUE) otherwise NULL
```

@info

```
.. $call: the original function call
.. $model_IAM: the BUGS model used to derive the individual age
.. $model_BCAM: the BUGS model used to calculate the Bayesian Central Age
```

Function version

0.1.0

How to cite

Philippe, A., Galharret, J., Mercier, N., Kreutzer, S., 2026. combine_De_Dr(): Combine Dose Rate and Equivalent Dose Distribution. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Anne Philippe, Université de Nantes (France), Jean-Michel Galharret, Université de Nantes (France), Norbert Mercier, IRAMAT-CRP2A, Université Bordeaux Montaigne (France), Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Mercier, N., Galharret, J.-M., Tribolo, C., Kreutzer, S., Philippe, A., (2022). Luminescence age calculation through Bayesian convolution of equivalent dose and dose-rate distributions: the De_Dr model. *Geochronology* 4, 297-310. doi:10.5194/gchron42972022

Galharret, J.-M., Philippe, A., Mercier, N. (2021). Detection of outliers with a Bayesian hierarchical model: application to the single-grain luminescence dating method. *Electronic Journal of Applied Statistics* 14 (2), 318-338. doi:10.1285/i20705948v14n2p318

Further reading

Rousseeuw, P.J., Croux, C., 1993. Alternatives to the median absolute deviation. *Journal of the American Statistical Association* 88, 1273–1283. doi:10.2307/2291267

Rousseeuw, P.J., Debruyne, M., Engelen, S., Hubert, M., 2006. Robustness and outlier detection in chemometrics. *Critical Reviews in Analytical Chemistry* 36, 221–242. doi:10.1080/10408340600969403

See Also

[plot_OSLAgeSummary](#), [rjags::rjags](#), [mclust::mclust-package](#)

Examples

```
## set parameters
Dr <- stats::rlnorm(1000, 0, 0.3)
De <- 50*sample(Dr, 50, replace = TRUE)
s <- stats::rnorm(50, 10, 2)

## run modelling
## note: modify parameters for more realistic results
## Not run:
results <- combine_De_Dr(
  Dr = Dr,
  int_OD = 0.1,
  De,
  s,
  Age_range = c(0,100),
  method_control = list(
    n.iter = 100,
    n.chains = 1))

## show models used
writeLines(results@info$model_IAM)
writeLines(results@info$model_BCAM)

## End(Not run)
```

convert_Activity2Concentration

Convert Nuclide Activities to Abundance and Vice Versa

Description

The function performs the conversion of the specific activities into mass abundance and vice versa for the radioelements U, Th, and K to harmonise the measurement unit with the required data input unit of potential analytical tools for, e.g. dose rate calculation or related functions such as [use_DRAC](#).

Usage

```
convert_Activity2Concentration(
  data,
  input_unit = c("activity", "abundance"),
  verbose = TRUE
)
```

Arguments

data	data.frame (required): provide dose rate data (activity or concentration) in three columns. The first column indicates the nuclide, the 2nd column measured value and in the 3rd column its error value. Allowed nuclide data are 'U-238', 'Th-232' and 'K-40'. See examples for an example.
input_unit	character (with default): specify unit of input data given in the dose rate data frame, one of "activity" (considered as given Bq/kg, the default) and "abundance" (considered as given in mug/g or mass. %).
verbose	logical (with default): enable/disable output to the terminal.

Details

The conversion from nuclide activity of a sample to nuclide concentration is performed using conversion factors that are based on the mass-related specific activity of the respective nuclide.

Constants used in this function were obtained from <https://physics.nist.gov/cuu/Constants/> all atomic weights and composition values from <https://www.nist.gov/pml/atomic-weights-and-isotopic-composit> and the nuclide data from <https://www.iaea.org/resources/databases/livechart-of-nuclides-advanced-version>

The factors can be calculated using the equation:

$$A = N_A \frac{N_{abund}}{N_{mol.mass}} \ln(2)/N.half.life$$

to convert in µg/g we further use:

$$f = A/10^6$$

where:

- N_A - Avogadro constant in 1/mol
- A - specific activity of the nuclide in Bq/kg
- $N.abund$ - relative natural abundance of the isotope
- $N.mol.mass$ molar mass in kg/mol
- $N.half.life$ half-life of the nuclide in s

example for calculating the activity of the radionuclide U-238:

- $N_A = 6.02214076 \times 10^{23}$ (1/mol)
- $T_{0.5} = 1.41 \times 10^{17}$ (s)
- $m_{U-238} = 0.23802891$ (kg/mol)
- $U.abund = 0.992745$ (unitless)

$$A_U = N_A * U_{abund} / m_{U238} * \ln(2) / T_{1/2} = 2347046$$

(Bq/kg)

$$f.U = A_U / 10^6$$

Value

Returns an `RLum.Results` object with a `data.frame` containing input and newly calculated values. Please note that in the column header $\mu\text{g/g}$ is written as `mug/g` due to the R requirement to maintain packages portable using ASCII characters only.

Function version

0.1.2

How to cite

Fuchs, M.C., 2026. `convert_Activity2Concentration()`: Convert Nuclide Activities to Abundance and Vice Versa. Function version 0.1.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Although written otherwise for historical reasons. Input values must be element values. For instance, if a value is provided for U-238 the function assumes that this value represents the sum (activity or abundance) of U-238, U-235 and U-234. In other words, 1 $\mu\text{g/g}$ of U means that this is the composition of 0.992 parts of U-238, 0.000054 parts of U-234, and 0.00072 parts of U-235.

Author(s)

Margret C. Fuchs, Helmholtz-Institute Freiberg for Resource Technology (Germany) , RLum Developer Team

References

- Debertin, K., Helmer, R.G., 1988. Gamma- and X-ray Spectrometry with Semiconductor Detectors, Elsevier Science Publishers, p.283
- Wiechen, A., Ruehle, H., Vogl, K., 2013. Bestimmung der massebezogenen Aktivitaet von Radionukliden. AEQUIVAL/MASSAKT, ISSN 1865-8725, https://www.bundesumweltministerium.de/fileadmin/Daten_BMU/Download_PDF/Strahlenschutz/aequival-massakt_v2013-07_bf.pdf

Examples

```
##construct data.frame
data <- data.frame(
  NUCLIDES = c("U-238", "Th-232", "K-40"),
  VALUE = c(40,80,100),
  VALUE_ERROR = c(4,8,10),
  stringsAsFactors = FALSE)

##perform analysis
convert_Activity2Concentration(data)
```

convert_BIN2CSV	<i>Export Risoe BIN-file(s) to CSV-files</i>
-----------------	--

Description

This function is a wrapper function around the functions [read_BIN2R](#) and [write_RLum2CSV](#) and it imports a Risoe BIN-file and directly exports its content to CSV-files. If nothing is set for the argument path ([write_RLum2CSV](#)) the input folder will become the output folder.

Usage

```
convert_BIN2CSV(file, ...)
```

Arguments

file	character (required): name of the BIN-file to be converted to CSV-files
...	further arguments that will be passed to the function read_BIN2R and write_RLum2CSV

Value

The function returns either a CSV-file (or many of them) or for the option `export == FALSE` a list comprising objects of type [data.frame](#) and [matrix](#)

Function version

0.1.0

How to cite

Kreutzer, S., 2026. `convert_BIN2CSV()`: Export Risoe BIN-file(s) to CSV-files. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data](#), [RLum.Results](#), [utils::write.table](#), [write_RLum2CSV](#), [read_BIN2R](#)

Examples

```
##transform Risoe.BINfileData values to a list
data(ExampleData.BINfileData, envir = environment())
convert_BIN2CSV(subset(CWOSL.SAR.Data, POSITION == 1), export = FALSE)

## Not run:
##select your BIN-file
file <- file.choose()

##convert
convert_BIN2CSV(file)

## End(Not run)
```

```
convert_Concentration2DoseRate
```

Dose-rate conversion function

Description

This function converts radionuclide concentrations (K in %, Th and U in ppm) into dose rates (Gy/ka). Beta-dose rates are also attenuated for the grain size. Beta and gamma-dose rates are corrected for the water content. This function converts concentrations into dose rates (Gy/ka) and corrects for grain size attenuation and water content.

Dose rate conversion factors can be chosen from Adamiec and Aitken (1998), Guérin et al. (2011), Liritzis et al. (201) and Cresswell et al. (2018). Default is Guérin et al. (2011).

Grain size correction for beta dose rates is achieved using the correction factors published by Guérin et al. (2012).

Water content correction is based on factors provided by Aitken (1985), with the factor for beta dose rate being 1.25 and for gamma 1.14.

Usage

```
convert_Concentration2DoseRate(object, conversion = "Guerinetal2011", ...)
```

Arguments

object	data.frame (<i>optional</i>): a data frame containing all relevant information for each individual layer. If nothing is provided, the function returns a template data frame, the values of which should be filled in by the user. Please note that only one dataset per input is supported.
conversion	character (<i>with default</i>): dose rate conversion factors to use, by default those by Guérin et al. (2011). For accepted values see BaseDataSet.ConversionFactors .
...	currently not used.

Details

The input data

COLUMN	DATA TYPE	DESCRIPTION
Mineral	character	'FS' for feldspar, 'Q' for quartz
K	numeric	K nuclide content in %
K_SE	numeric	error on K nuclide content in %
Th	numeric	Th nuclide content in ppm
Th_SE	numeric	error on Th nuclide content in ppm
U	numeric	U nuclide content in ppm
U_SE	numeric	error on U nuclide content in ppm
GrainSize	numeric	average grain size in μm
WaterContent	numeric	mean water content in %
WaterContent_SE	numeric	relative error on water content

Water content The water content provided by the user should be calculated according to:

$$(Wet_{weight} - Dry_{weight}) / Dry_{weight} * 100$$

The unit for the weight is gram (g).

Value

The function returns an [RLum.Results](#) object for which the first element is a [matrix](#) with the converted values. If no input is provided, the function returns a template [data.frame](#) that can be used as input.

Function version

0.1.1

How to cite

Riedesel, S., Autzen, M., 2026. convert_Concentration2DoseRate(): Dose-rate conversion function. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Svenja Riedesel, Aberystwyth University (United Kingdom)
 Martin Autzen, DTU NUTECH Center for Nuclear Technologies (Denmark) , RLum Developer Team

References

Adamiec, G., Aitken, M.J., 1998. Dose-rate conversion factors: update. *Ancient TL* 16, 37-46.

Cresswell., A.J., Carter, J., Sanderson, D.C.W., 2018. Dose rate conversion parameters: Assessment of nuclear data. *Radiation Measurements* 120, 195-201.

Guérin, G., Mercier, N., Adamiec, G., 2011. Dose-rate conversion factors: update. *Ancient TL* 29, 5-8.

Guérin, G., Mercier, N., Nathan, R., Adamiec, G., Lefrais, Y., 2012. On the use of the infinite matrix assumption and associated concepts: A critical review. *Radiation Measurements* 47, 778-785.

Liritzis, I., Stamoulis, K., Papachristodoulou, C., Ioannides, K., 2013. A re-evaluation of radiation dose-rate conversion factors. *Mediterranean Archaeology and Archaeometry* 13, 1-15.

Examples

```
## create input template
input <- convert_Concentration2DoseRate()

## fill input
input$Mineral <- "FS"
input$K <- 2.13
input$K_SE <- 0.07
input$Th <- 9.76
input$Th_SE <- 0.32
input$U <- 2.24
input$U_SE <- 0.12
input$GrainSize <- 200
input$WaterContent <- 30
input$WaterContent_SE <- 5

## convert
convert_Concentration2DoseRate(input)
```

convert_CW2pHMi	<i>Transform a CW-OSL curve into a pHM-OSL curve via interpolation under hyperbolic modulation conditions</i>
-----------------	---

Description

This function transforms a conventionally measured continuous-wave (CW) OSL-curve to a pseudo hyperbolic modulated (pHM) curve under hyperbolic modulation conditions using the interpolation procedure described by Bos & Wallinga (2012).

Usage

```
convert_CW2pHMi(object, delta = NULL, ...)
```

Arguments

object	RLum.Data.Curve or data.frame (required): RLum.Data.Curve object or a <code>data.frame</code> with measured curve data of type stimulation time (t) (<code>object[, 1]</code>) and measured counts (cts) (<code>object[, 2]</code>).
delta	vector (<i>optional</i>): stimulation rate parameter, if no value is given, the optimal value is estimated automatically (see details). Smaller values of delta produce more points in the rising tail of the curve.
...	currently not used.

Details

The complete procedure of the transformation is described in Bos & Wallinga (2012). The input `data.frame` consists of two columns: time (t) and count values (CW(t))

Internal transformation steps

- (1) log(CW-OSL) values
- (2) Calculate t' which is the transformed time:

$$t' = t - (1/\delta) * \log(1 + \delta t)$$

- (3) Interpolate CW(t'), i.e. use the log(CW(t)) to obtain the count values for the transformed time (t'). Values beyond min(t) and max(t) produce NA values.
- (4) Select all values for t' < min(t), i.e. values beyond the time resolution of t. Select the first two values of the transformed data set which contain no NA values and use these values for a linear fit using [lm](#).
- (5) Extrapolate values for t' < min(t) based on the previously obtained fit parameters.
- (6) Transform values using

$$pHM(t) = (\delta t / (1 + \delta t)) * c * CW(t')$$

$$c = (1 + \delta P) / \delta * P$$

$$P = \text{length}(\text{stimulation period})$$

- (7) Combine all values and truncate all values for t' > max(t)

Note: The number of values for t' < min(t) depends on the stimulation rate parameter delta. To avoid the production of too many artificial data at the raising tail of the determined pHM curve, it is recommended to use the automatic estimation routine for delta, i.e. provide no value for delta.

Value

The function returns the same data type as the input data type with the transformed curve values.

RLum.Data.Curve

`$CW2pHMi.x.t` : transformed time values
`$CW2pHMi.method` : used method for the production of the new data points

data.frame

`$x` : time
`$y.t` : transformed count values
`$x.t` : transformed time values
`$method` : used method for the production of the new data points

Function version

0.2.7

How to cite

Kreutzer, S., Colombo, M., 2026. convert_CW2pHMi(): Transform a CW-OSL curve into a pHM-OSL curve via interpolation under hyperbolic modulation conditions. Function version 0.2.7. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

According to Bos & Wallinga (2012), the number of extrapolated points should be limited to avoid artificial intensity data. If `delta` is provided manually and more than two points are extrapolated, a warning message is returned.

The function [approx](#) may produce some Inf and NaN data, in which case the function tries to interpolate these values by calculating the mean of the adjacent channels. If two invalid values are succeeding, the values are removed and no further interpolation is attempted. In every case a warning message is shown.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)

Marco Colombo, Institute of Geography, Heidelberg University (Germany)

Based on comments and suggestions from: Adrie J.J. Bos, Delft University of Technology, The Netherlands , RLum Developer Team

References

Bos, A.J.J. & Wallinga, J., 2012. How to visualize quartz OSL signal components. *Radiation Measurements* 47, 752-758.

Further Reading

Bulur, E., 1996. An Alternative Technique For Optically Stimulated Luminescence (OSL) Experiment. *Radiation Measurements* 26, 701-709.

Bulur, E., 2000. A simple transformation for converting CW-OSL curves to LM-OSL curves. *Radiation Measurements* 32, 141-145.

See Also

[convert_CW2pLM](#), [convert_CW2pLMi](#), [convert_CW2pPMi](#), [fit_LMCurve](#), [lm](#), [RLum.Data.Curve](#)

Examples

```
##(1) - simple transformation

##load CW-OSL curve data
data(ExampleData.CW_OSL_Curve, envir = environment())

##transform values
values.transformed <- convert_CW2pHMi(ExampleData.CW_OSL_Curve)

##plot
plot(values.transformed$x, values.transformed$y.t, log = "x")

##(2) - load CW-OSL curve from BIN-file and plot transformed values

##load BINfile
#BINfileData<-readBIN2R("[path to BIN-file]")
data(ExampleData.BINfileData, envir = environment())

##grep first CW-OSL curve from ALQ 1
curve.ID<-CWOSL.SAR.Data@METADATA[CWOSL.SAR.Data@METADATA[, "LTYPE"]=="OSL" &
                                   CWOSL.SAR.Data@METADATA[, "POSITION"]==1
                                   , "ID"]

curve.HIGH<-CWOSL.SAR.Data@METADATA[CWOSL.SAR.Data@METADATA[, "ID"]==curve.ID[1]
                                   , "HIGH"]

curve.NPOINTS<-CWOSL.SAR.Data@METADATA[CWOSL.SAR.Data@METADATA[, "ID"]==curve.ID[1]
                                   , "NPOINTS"]

##combine curve to data set
curve<-data.frame(x = seq(curve.HIGH/curve.NPOINTS, curve.HIGH,
                          by = curve.HIGH/curve.NPOINTS),
                  y=unlist(CWOSL.SAR.Data@DATA[curve.ID[1]]))

##transform values
```

```

curve.transformed <- convert_CW2pHMi(curve)

##plot curve
plot(curve.transformed$x, curve.transformed$y.t, log = "x")

##(3) - produce Fig. 4 from Bos & Wallinga (2012)

##load data
data(ExampleData.CW_OSL_Curve, envir = environment())
values <- CW_Curve.BosWallinga2012

##open plot area
plot(NA, NA,
     xlim=c(0.001,10),
     ylim=c(0,8000),
     ylab="pseudo OSL (cts/0.01 s)",
     xlab="t [s]",
     log="x",
     main="Fig. 4 - Bos & Wallinga (2012)")

values.t <- convert_CW2pLMi(values, P = 1/20)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col="red", lwd=1.3)
text(0.03,4500,"LM", col="red", cex=.8)

values.t <- convert_CW2pHMi(values, delta = 40)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col="black", lwd=1.3)
text(0.005,3000,"HM", cex=.8)

values.t <- convert_CW2pPMi(values, P = 1/10)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col="blue", lwd=1.3)
text(0.5,6500,"PM", col="blue", cex=.8)

```

convert_CW2pLM

Transform a CW-OSL curve into a pLM-OSL curve

Description

Transforms a conventionally measured continuous-wave (CW) curve into a pseudo linearly modulated (pLM) curve using the equations given in Bulur (2000).

Usage

```
convert_CW2pLM(object, ...)
```

Arguments

object **RLum.Data.Curve** or **data.frame** (**required**): **RLum.Data.Curve** object or a **data.frame** with measured curve data of type stimulation time (t) (`object[, 1]`) and measured counts (cts) (`object[, 2]`).

... currently not used.

Details

According to Bulur (2000) the curve data are transformed by introducing two new parameters P (stimulation period) and u (transformed time):

$$P = 2 \max(t)$$

$$u = \sqrt{(2t * P)}$$

The new count values are then calculated by

$$cts_{NEW} = cts(u/P)$$

and the returned **data.frame** is produced by: `data.frame(u, ctsNEW)`

The output of the function can be further used for LM-OSL fitting.

Value

The function returns the same data type as the input data type with the transformed curve values (**data.frame** or **RLum.Data.Curve**).

Function version

0.4.4

How to cite

Kreutzer, S., Colombo, M., 2026. `convert_CW2pLM()`: Transform a CW-OSL curve into a pLM-OSL curve. Function version 0.4.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The transformation is recommended for curves recorded with a channel resolution of at least 0.05 s/channel.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany)
 , RLum Developer Team

References

Bulur, E., 2000. A simple transformation for converting CW-OSL curves to LM-OSL curves. *Radiation Measurements* 32, 141-145.

Further Reading

Bulur, E., 1996. An Alternative Technique For Optically Stimulated Luminescence (OSL) Experiment. *Radiation Measurements* 26, 701-709.

See Also

[convert_CW2pHMi](#), [convert_CW2pLMi](#), [convert_CW2pPMi](#), [fit_LMCurve](#), [lm](#), [RLum.Data.Curve](#)

Examples

```
##read curve from CWOSL.SAR.Data transform curve and plot values
data(ExampleData.BINfileData, envir = environment())

##read id for the 1st OSL curve
id.OSL <- CWOSL.SAR.Data@METADATA[CWOSL.SAR.Data@METADATA[, "LTYPE"] == "OSL", "ID"]

##produce x and y (time and count data for the data set)
x<-seq(CWOSL.SAR.Data@METADATA[id.OSL[1], "HIGH"]/CWOSL.SAR.Data@METADATA[id.OSL[1], "NPOINTS"],
       CWOSL.SAR.Data@METADATA[id.OSL[1], "HIGH"],
       by = CWOSL.SAR.Data@METADATA[id.OSL[1], "HIGH"]/CWOSL.SAR.Data@METADATA[id.OSL[1], "NPOINTS"])
y <- unlist(CWOSL.SAR.Data@DATA[id.OSL[1]])
values <- data.frame(x,y)

##transform values
values.transformed <- convert_CW2pLM(values)

##plot
plot(values.transformed)
```

convert_CW2pLMi	<i>Transform a CW-OSL curve into a pLM-OSL curve via interpolation under linear modulation conditions</i>
-----------------	---

Description

Transforms a conventionally measured continuous-wave (CW) OSL-curve into a pseudo linearly modulated (pLM) curve under linear modulation conditions using the interpolation procedure described by Bos & Wallinga (2012).

Usage

```
convert_CW2pLMi(object, P = NULL, ...)
```

Arguments

object	RLum.Data.Curve or data.frame (required): RLum.Data.Curve object or a <code>data.frame</code> with measured curve data of type stimulation time (t) (<code>object[, 1]</code>) and measured counts (cts) (<code>object[, 2]</code>).
P	numeric (<i>optional</i>): stimulation time in seconds. If set to NULL, the optimal value is estimated automatically (see details). Greater values of P produce more points in the rising tail of the curve.
...	currently not used.

Details

The complete procedure of the transformation is given in Bos & Wallinga (2012). The input `data.frame` consists of two columns: time (t) and count values (CW(t))

Nomenclature

- P = stimulation time (s)
- 1/P = stimulation rate (1/s)

Internal transformation steps

(1) log(CW-OSL) values

(2) Calculate t' which is the transformed time:

$$t' = 1/2 * 1/P * t^2$$

(3) Interpolate CW(t'), i.e. use the log(CW(t)) to obtain the count values for the transformed time (t'). Values beyond min(t) and max(t) produce NA values.

(4) Select all values for t' < min(t), i.e. values beyond the time resolution of t. Select the first two values of the transformed data set which contain no NA values and use these values for a linear fit using [lm](#).

(5) Extrapolate values for t' < min(t) based on the previously obtained fit parameters.

(6) Transform values using

$$pLM(t) = t/P * CW(t')$$

(7) Combine values and truncate all values for t' > max(t)

Note: The number of values for t' < min(t) depends on the stimulation period (P) and therefore on the stimulation rate 1/P. To avoid the production of too many artificial data at the raising tail of the determined pLM curves it is recommended to use the automatic estimation routine for P, i.e. provide no own value for P.

Value

The function returns the same data type as the input data type with the transformed curve values.

`RLum.Data.Curve`

- `$CW2pLMi.x.t` : transformed time values
- `$CW2pLMi.method` : used method for the production of the new data points

Function version

0.3.5

How to cite

Kreutzer, S., Colombo, M., 2026. convert_CW2pLMi(): Transform a CW-OSL curve into a pLM-OSL curve via interpolation under linear modulation conditions. Function version 0.3.5. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

According to Bos & Wallinga (2012) the number of extrapolated points should be limited to avoid artificial intensity data. If P is provided manually and more than two points are extrapolated, a warning message is returned.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)

Marco Colombo, Institute of Geography, Heidelberg University (Germany)

Based on comments and suggestions from: Adrie J.J. Bos, Delft University of Technology, The Netherlands , RLum Developer Team

References

Bos, A.J.J. & Wallinga, J., 2012. How to visualize quartz OSL signal components. Radiation Measurements 47, 752-758.

Further Reading

Bulur, E., 1996. An Alternative Technique For Optically Stimulated Luminescence (OSL) Experiment. Radiation Measurements 26, 701-709.

Bulur, E., 2000. A simple transformation for converting CW-OSL curves to LM-OSL curves. Radiation Measurements 32, 141-145.

See Also

[convert_CW2pLM](#), [convert_CW2pHMi](#), [convert_CW2pPMi](#), [fit_LMCurve](#), [RLum.Data.Curve](#)

Examples

```
##(1)
##load CW-OSL curve data
data(ExampleData.CW_OSL_Curve, envir = environment())

##transform values
values.transformed <- convert_CW2pLMi(ExampleData.CW_OSL_Curve)
```

```
##plot
plot(values.transformed$x, values.transformed$y.t, log = "x")

##(2) - produce Fig. 4 from Bos & Wallinga (2012)
##load data
data(ExampleData.CW_OSL_Curve, envir = environment())
values <- CW_Curve.BosWallinga2012

##open plot area
plot(NA, NA,
     xlim = c(0.001,10),
     ylim = c(0,8000),
     ylab = "pseudo OSL (cts/0.01 s)",
     xlab = "t [s]",
     log = "x",
     main = "Fig. 4 - Bos & Wallinga (2012)")

values.t <- convert_CW2pLMi(values, P = 1/20)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col = "red", lwd = 1.3)
text(0.03,4500,"LM", col = "red", cex = .8)

values.t <- convert_CW2pHMi(values, delta = 40)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col = "black", lwd = 1.3)
text(0.005,3000,"HM", cex =.8)

values.t <- convert_CW2pPMi(values, P = 1/10)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col = "blue", lwd = 1.3)
text(0.5,6500,"PM", col = "blue", cex = .8)
```

convert_CW2pPMi	<i>Transform a CW-OSL curve into a pPM-OSL curve via interpolation under parabolic modulation conditions</i>
-----------------	--

Description

Transforms a conventionally measured continuous-wave (CW) OSL-curve into a pseudo parabolic modulated (pPM) curve under parabolic modulation conditions using the interpolation procedure described by Bos & Wallinga (2012).

Usage

```
convert_CW2pPMi(object, P = NULL, ...)
```

Arguments

object	RLum.Data.Curve or data.frame (required): RLum.Data.Curve object or a <code>data.frame</code> with measured curve data of type stimulation time (t) (<code>object[, 1]</code>) and measured counts (cts) (<code>object[, 2]</code>).
P	numeric (<i>optional</i>): stimulation time in seconds. If set to NULL, the optimal value is estimated automatically (see details). Greater values of P produce more points in the rising tail of the curve.
...	currently not used.

Details

The complete procedure of the transformation is given in Bos & Wallinga (2012). The input `data.frame` consists of two columns: time (t) and count values (CW(t))

Nomenclature

- P = stimulation time (s)
- 1/P = stimulation rate (1/s)

Internal transformation steps

(1) log(CW-OSL) values

(2) Calculate t' which is the transformed time:

$$t' = (1/3) * (1/P^2)t^3$$

(3) Interpolate CW(t'), i.e. use the log(CW(t)) to obtain the count values for the transformed time (t'). Values beyond min(t) and max(t) produce NA values.

(4) Select all values for t' < min(t), i.e. values beyond the time resolution of t. Select the first two values of the transformed data set which contain no NA values and use these values for a linear fit using [lm](#).

(5) Extrapolate values for t' < min(t) based on the previously obtained fit parameters. The extrapolation is limited to two values. Other values at the beginning of the transformed curve are set to 0.

(6) Transform values using

$$pLM(t) = t^2/P^2 * CW(t')$$

(7) Combine all values and truncate all values for t' > max(t)

Note: The number of values for t' < min(t) depends on the stimulation period P. To avoid the production of too many artificial data at the raising tail of the determined pPM curve, it is recommended to use the automatic estimation routine for P, i.e. provide no value for P.

Value

The function returns the same data type as the input data type with the transformed curve values.

`RLum.Data.Curve`

`$CW2pPMi.x.t` : transformed time values
`$CW2pPMi.method` : used method for the production of the new data points

`data.frame`

`$x` : time
`$y.t` : transformed count values
`$x.t` : transformed time values
`$method` : used method for the production of the new data points

Function version

0.2.5

How to cite

Kreutzer, S., Colombo, M., 2026. convert_CW2pPMi(): Transform a CW-OSL curve into a pPM-OSL curve via interpolation under parabolic modulation conditions. Function version 0.2.5. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

According to Bos & Wallinga (2012), the number of extrapolated points should be limited to avoid artificial intensity data. If P is provided manually, not more than two points are extrapolated.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany)
 Based on comments and suggestions from: Adrie J.J. Bos, Delft University of Technology, The Netherlands , RLum Developer Team

References

Bos, A.J.J. & Wallinga, J., 2012. How to visualize quartz OSL signal components. Radiation Measurements 47, 752-758.

Further Reading

Bulur, E., 1996. An Alternative Technique For Optically Stimulated Luminescence (OSL) Experiment. Radiation Measurements 26, 701-709.

Bulur, E., 2000. A simple transformation for converting CW-OSL curves to LM-OSL curves. Radiation Measurements 32, 141-145.

See Also

[convert_CW2pLM](#), [convert_CW2pLMi](#), [convert_CW2pHMi](#), [fit_LMCurve](#), [RLum.Data.Curve](#)

Examples

```
##(1)
##load CW-OSL curve data
data(ExampleData.CW_OSL_Curve, envir = environment())

##transform values
values.transformed <- convert_CW2pPMi(ExampleData.CW_OSL_Curve)

##plot
plot(values.transformed$x, values.transformed$y.t, log = "x")

##(2) - produce Fig. 4 from Bos & Wallinga (2012)

##load data
data(ExampleData.CW_OSL_Curve, envir = environment())
values <- CW_Curve.BosWallinga2012

##open plot area
plot(NA, NA,
     xlim = c(0.001, 10),
     ylim = c(0, 8000),
     ylab = "pseudo OSL (cts/0.01 s)",
     xlab = "t [s]",
     log = "x",
     main = "Fig. 4 - Bos & Wallinga (2012)")

values.t <- convert_CW2pLMi(values, P = 1/20)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col = "red", lwd = 1.3)
text(0.03, 4500, "LM", col = "red", cex = .8)

values.t <- convert_CW2pHMi(values, delta = 40)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col = "black", lwd = 1.3)
text(0.005, 3000, "HM", cex = .8)

values.t <- convert_CW2pPMi(values, P = 1/10)
lines(values[1:length(values.t[, 1]), 1], values.t[, 2],
      col = "blue", lwd = 1.3)
text(0.5, 6500, "PM", col = "blue", cex = .8)
```

convert_Daybreak2CSV *Export measurement data produced by a Daybreak luminescence reader to CSV-files*

Description

This function is a wrapper function around the functions [read_Daybreak2R](#) and [write_RLum2CSV](#) and it imports a Daybreak-file (TXT-file, DAT-file) and directly exports its content to CSV-files. If

nothing is set for the argument path ([write_RLum2CSV](#)) the input folder will become the output folder.

Usage

```
convert_Daybreak2CSV(file, ...)
```

Arguments

file	character (required): name of the Daybreak-file (TXT-file, DAT-file) to be converted to CSV-files
...	further arguments that will be passed to the function read_Daybreak2R and write_RLum2CSV

Value

The function returns either a CSV-file (or many of them) or for the option `export = FALSE` a list comprising objects of type [data.frame](#) and [matrix](#)

Function version

0.1.1

How to cite

Kreutzer, S., 2026. `convert_Daybreak2CSV()`: Export measurement data produced by a Daybreak luminescence reader to CSV-files. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data](#), [RLum.Results](#), [utils::write.table](#), [write_RLum2CSV](#), [read_Daybreak2R](#)

Examples

```
## Not run:
##select your BIN-file
file <- file.choose()

##convert
convert_Daybreak2CSV(file)

## End(Not run)
```

convert_PSL2CSV	<i>Export PSL-file(s) to CSV-files</i>
-----------------	--

Description

This function is a wrapper function around the functions [read_PSL2R](#) and [write_RLum2CSV](#) and it imports an PSL-file (SUERC portable OSL reader file format) and directly exports its content to CSV-files. If nothing is set for the argument path ([write_RLum2CSV](#)) the input folder will become the output folder.

Usage

```
convert_PSL2CSV(file, extract_raw_data = FALSE, single_table = FALSE, ...)
```

Arguments

file	character (required) : name of the PSL-file to be converted to CSV-files
extract_raw_data	logical (<i>with default</i>): enable/disable raw data extraction. The PSL files imported into R contain an element <code>\$raw_data</code> , which provides a few more information (e.g., count errors), sometimes it makes sense to use this data of the more compact standard values created by read_PSL2R
single_table	logical (<i>with default</i>): enable/disable the creation of single table with n rows and n columns, instead of separate data.frame objects. Each curve will be represented by two columns for time and counts
...	further arguments that will be passed to the function read_PSL2R and write_RLum2CSV

Value

The function returns either a CSV-file (or many of them) or, when `export = FALSE`, a list of [data.frame](#) and [matrix](#) objects.

Function version

0.1.2

How to cite

Kreutzer, S., 2026. `convert_PSL2CSV()`: Export PSL-file(s) to CSV-files. Function version 0.1.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data](#), [RLum.Results](#), [utils::write.table](#), [write_RLum2CSV](#), [read_PSL2R](#)

Examples

```
## export into single data.frame
file <- system.file("extdata/DorNie_0016.psl", package="Luminescence")
convert_PSL2CSV(file, export = FALSE, single_table = TRUE)

## Not run:
##select your BIN-file
file <- file.choose()

##convert
convert_PSL2CSV(file)

## End(Not run)
```

```
convert_PSL2Risoe.BINfileData
```

Convert portable OSL data to a Risoe.BINfileData object

Description

Converts an [RLum.Analysis](#) object produced by the function [read_PSL2R](#) to a [Risoe.BINfileData](#) object (**BETA**).

This function converts an [RLum.Analysis](#) object that was produced by the [read_PSL2R](#) function to a [Risoe.BINfileData](#). The [Risoe.BINfileData](#) can be used to write a Risø BIN file via [write_R2BIN](#).

Usage

```
convert_PSL2Risoe.BINfileData(object, ...)
```

Arguments

object	RLum.Analysis (required): RLum.Analysis object produced by read_PSL2R
...	currently not used.

Value

Returns an S4 [Risoe.BINfileData](#) object that can be used to write a BIN file using [write_R2BIN](#).

Function version

0.0.1

How to cite

Burow, C., 2026. convert_PSL2Risoe.BINfileData(): Convert portable OSL data to a Risoe.BINfileData object. Function version 0.0.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Christoph Burow, University of Cologne (Germany) , RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data.Curve](#), [Risoe.BINfileData](#)

Examples

```
# (1) load and plot example data set
data("ExampleData.portableOSL", envir = environment())
plot_RLum(ExampleData.portableOSL)

# (2) merge all RLum.Analysis objects into one
merged <- merge_RLum(ExampleData.portableOSL)
merged

# (3) convert to RisoeBINfile object
bin <- convert_PSL2Risoe.BINfileData(merged)
bin

# (4) write Risoe BIN file
## Not run:
write_R2BIN(bin, "~/portableOSL.binx")

## End(Not run)
```

convert_RLum2Risoe.BINfileData

*Converts RLum.Analysis and RLum.Data.Curve objects to
RLum2Risoe.BINfileData objects*

Description

The functions converts [RLum.Analysis](#) and [RLum.Data.Curve](#) objects (or a [list](#) of such objects) to [Risoe.BINfileData](#) objects. The function intends to provide a minimum of compatibility between both formats. The created [RLum.Analysis](#) object can be later exported to a BIN-file using function [write_R2BIN](#).

Usage

```
convert_RLum2Risoe.BINfileData(object, keep.position.number = FALSE)
```

Arguments

object [RLum.Analysis](#) or [RLum.Data.Curve](#) (**required**): input object to be converted
keep.position.number [logical](#) (*with default*): keeps the original position number or re-calculate the numbers to avoid doubling

Value

The function returns a [Risoe.BINfileData](#) object.

Function version

0.1.4

How to cite

Kreutzer, S., 2026. convert_RLum2Risoe.BINfileData(): Converts RLum.Analysis and RLum.Data.Curve objects to RLum2Risoe.BINfileData objects. Function version 0.1.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The conversion can be never perfect. The RLum objects may contain information which are not part of the [Risoe.BINfileData](#) definition.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data.Curve](#), [write_R2BIN](#)

Examples

```
##simple conversion using the example dataset
data(ExampleData.RLum.Analysis, envir = environment())
convert_RLum2Riso.BINfileData(IRSAR.RF.Data)
```

convert_Second2Gray	<i>Converting equivalent dose values from seconds (s) to Gray (Gy)</i>
---------------------	--

Description

Conversion of absorbed radiation dose in seconds (s) to the SI unit Gray (Gy) including error propagation. Normally used for equivalent dose data.

Calculation of De values from seconds (s) to Gray (Gy)

$$De[Gy] = De[s] * DoseRate[Gy/s]$$

Provided calculation error propagation methods for error calculation (with 'se' as the standard error and 'DR' of the dose rate of the beta-source):

(1) omit (default)

$$se(De)[Gy] = se(De)[s] * DR[Gy/s]$$

In this case the standard error of the dose rate of the beta-source is treated as systematic (i.e. non-random), and error propagation is omitted. However, the error must be considered during calculation of the final age (cf. Aitken, 1985, pp. 242). This approach can be seen as method (2) (gaussian) for the case the (random) standard error of the beta-source calibration is 0. Which particular method is requested depends on the situation and cannot be prescriptive.

(2) gaussian error propagation

$$se(De)[Gy] = \sqrt{(DR[Gy/s] * se(De)[s])^2 + (De[s] * se(DR)[Gy/s])^2}$$

Applicable under the assumption that errors of De and se are uncorrelated.

(3) absolute error propagation

$$se(De)[Gy] = abs(DR[Gy/s] * se(De)[s]) + abs(De[s] * se(DR)[Gy/s])$$

Applicable under the assumption that errors of De and se are correlated.

Usage

```
convert_Second2Gray(
  data,
  dose.rate,
  error.propagation = c("omit", "gaussian", "absolute")
)
```

Arguments

- `data` [data.frame](#) (**required**): input values, structure: `data (values[, 1])` and data error (`values[, 2]`) are required.
- `dose.rate` [RLum.Results](#), [data.frame](#) or [numeric](#) (**required**): for [RLum.Results](#), it needs to be originated from [calc_SourceDoseRate](#); for vector, dose rate and dose rate error (in Gy/s).
- `error.propagation` [character](#) (*with default*): error propagation method used for error calculation (`omit`, `gaussian` or `absolute`), see details for further information.

Value

Returns a [data.frame](#) with converted values.

Function version

0.6.0

How to cite

Kreutzer, S., Dietze, M., Fuchs, M.C., 2026. `convert_Second2Gray()`: Converting equivalent dose values from seconds (s) to Gray (Gy). Function version 0.6.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

If no or a wrong error propagation method is given, the execution of the function is stopped. Furthermore, if a `data.frame` is provided for the dose rate values it has to be of the same length as the data frame provided with the argument `data`

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Michael Dietze, GFZ Potsdam (Germany)
Margret C. Fuchs, HZDR, Helmholtz-Institute Freiberg for Resource Technology (Germany) ,
RLum Developer Team

References

Aitken, M.J., 1985. Thermoluminescence dating. Academic Press.

See Also

[calc_SourceDoseRate](#)

Examples

```
## load De data from the example data help file
data(ExampleData.DeValues, envir = environment())

##(A) for known source dose rate at date of measurement
## - convert De(s) to De(Gy)
convert_Second2Gray(ExampleData.DeValues$BT998, c(0.0438, 0.0019))

##(B) for source dose rate calibration data
## - calculate source dose rate first
dose.rate <- calc_SourceDoseRate(measurement.date = "2012-01-27",
                                calib.date = "2014-12-19",
                                calib.dose.rate = 0.0438,
                                calib.error = 0.0019)

# read example data
data(ExampleData.DeValues, envir = environment())

# apply dose.rate to convert De(s) to De(Gy)
convert_Second2Gray(ExampleData.DeValues$BT998, dose.rate)
```

convert_SG2MG

Converts Single-Grain Data to Multiple-Grain Data

Description

Conversion of single-grain data to multiple-grain data by adding signals from grains belonging to one disc (unique pairs of position, set and run).

Usage

```
convert_SG2MG(object, write_file = FALSE, ...)
```

Arguments

object	Risoe.BINfileData , character (required) : Risoe.BINfileData object or BIN/BINX-file name.
write_file	logical (<i>with default</i>): whether the output should be written to a file (only considered if object is of type character). The multiple grain file will be written to a file of named after the original one with -SG appended to it.
...	further arguments passed down to read_BIN2R and write_R2BIN if object is a path to a file.

Value

A [Risoe.BINfileData](#) object. If write_file = TRUE an the input was a file path, a file is also written out to origin folder.

Function version

0.1.1

How to cite

Kreutzer, S., Mercier, N., 2026. convert_SG2MG(): Converts Single-Grain Data to Multiple-Grain Data. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Norbert Mercier, IRAMAT-CRP2A, UMR 5060, CNRS-Université Bordeaux Montaigne (France) ,
RLum Developer Team

See Also

[Risoe.BINfileData](#), [read_BIN2R](#), [write_R2BIN](#)

Examples

```
## simple run
## (please not that the example is not using SG data)
data(ExampleData.BINfileData, envir = environment())
convert_SG2MG(CWOSL.SAR.Data)
```

convert_Wavelength2Energy

Emission Spectra Conversion from Wavelength to Energy Scales (Jacobian Conversion)

Description

The function provides a convenient and fast way to convert emission spectra wavelength to energy scales. The function works on [RLum.Data.Spectrum](#), [data.frame](#) and [matrix](#) and a [list](#) of such objects. The function was written to smooth the workflow while analysing emission spectra data. This is in particular useful if you want to further treat your data and apply, e.g., a signal deconvolution.

Usage

```
convert_Wavelength2Energy(object, digits = 3L, order = FALSE)
```

Arguments

object	<code>RLum.Data.Spectrum</code> , <code>data.frame</code> , <code>matrix</code> (required): input object to be converted. If the input is not an <code>RLum.Data.Spectrum</code> object, the first column is always treated as the wavelength column. The function supports a list of allowed input objects.
digits	<code>integer</code> (<i>with default</i>): number of digits on the returned energy axis.
order	<code>logical</code> (<i>with default</i>): enable/disable sorting of the values in ascending energy order. After the conversion, the longest wavelength has the lowest energy value and the shortest wavelength the highest. While this is correct, some R functions expect increasing x-values.

Details

The intensity of the spectrum is re-calculated using the following approach to recalculate wavelength and corresponding intensity values (e.g., Appendix 4 in Blasse and Grabmaier, 1994; Mooney and Kambhampati, 2013):

$$\phi_E = \phi_\lambda * \lambda^2 / (hc)$$

with ϕ_E the intensity per interval of energy E (1/eV), ϕ_λ the intensity per interval of wavelength λ (1/nm) and h (eV * s) the Planck constant and c (nm/s) the velocity of light.

For transforming the wavelength axis (x-values) the equation as follow is used

$$E = hc/\lambda$$

Value

The same object class as provided as input is returned.

Function version

0.1.1

How to cite

Kreutzer, S., 2026. convert_Wavelength2Energy(): Emission Spectra Conversion from Wavelength to Energy Scales (Jacobian Conversion). Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This conversion works solely for emission spectra. In case of absorption spectra only the x-axis has to be converted.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Blasse, G., Grabmaier, B.C., 1994. Luminescent Materials. Springer.

Mooney, J., Kambhampati, P., 2013. Get the Basics Right: Jacobian Conversion of Wavelength and Energy Scales for Quantitative Analysis of Emission Spectra. J. Phys. Chem. Lett. 4, 3316–3318. doi:10.1021/jz401508t

Mooney, J., Kambhampati, P., 2013. Correction to “Get the Basics Right: Jacobian Conversion of Wavelength and Energy Scales for Quantitative Analysis of Emission Spectra.” J. Phys. Chem. Lett. 4, 3316–3318. doi:10.1021/jz401508t

Further reading

Angulo, G., Grampp, G., Rosspeintner, A., 2006. Recalling the appropriate representation of electronic spectra. Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 65, 727–731. doi:10.1016/j.saa.2006.01.007

Wang, Y., Townsend, P.D., 2013. Potential problems in collection and data processing of luminescence signals. Journal of Luminescence 142, 202–211. doi:10.1016/j.jlumin.2013.03.052

See Also

[RLum.Data.Spectrum](#), [plot_RLum](#)

Examples

```
#####
##(1) Literature example after Mooney et al. (2013)
##(1.1) create matrix
m <- matrix(
  data = c(seq(400, 800, 50), rep(1, 9)), ncol = 2)

##(1.2) set plot function to reproduce the literature figure
p <- function(m) {
  plot(x = m[, 1], y = m[, 2])
  polygon(
    x = c(m[, 1], rev(m[, 1])),
    y = c(m[, 2], rep(0, nrow(m))))
  for (i in 1:nrow(m)) {
    lines(x = rep(m[i, 1], 2), y = c(0, m[i, 2]))
  }
}

##(1.3) plot curves
par(mfrow = c(1,2))
p(m)
p(convert_Wavelength2Energy(m))

#####
```

```
##(2) Another example using density curves
##create dataset
xy <- density(
  c(rnorm(n = 100, mean = 500, sd = 20),
    rnorm(n = 100, mean = 800, sd = 20)))
xy <- data.frame(xy$x, xy$y)

##plot
par(mfrow = c(1,2))
plot(
  xy,
  type = "l",
  xlim = c(150, 1000),
  xlab = "Wavelength [nm]",
  ylab = "Luminescence [a.u.]"
)
plot(
  convert_Wavelength2Energy(xy),
  xy$y,
  type = "l",
  xlim = c(1.23, 8.3),
  xlab = "Energy [eV]",
  ylab = "Luminescence [a.u.]"
)
```

convert_XSYG2CSV

Export XSYG-file(s) to CSV-files

Description

This function is a wrapper function around the functions [read_XSYG2R](#) and [write_RLum2CSV](#) and it imports an XSYG-file and directly exports its content to CSV-files. If nothing is set for the argument path ([write_RLum2CSV](#)) the input folder will become the output folder.

Usage

```
convert_XSYG2CSV(file, ...)
```

Arguments

file	character (required): name of the XSYG-file to be converted to CSV-files
...	further arguments that will be passed to the function read_XSYG2R and write_RLum2CSV

Value

The function returns either a CSV-file (or many of them) or for the option `export = FALSE` a list comprising objects of type [data.frame](#) and [matrix](#)

Function version

0.1.1

How to cite

Kreutzer, S., 2026. convert_XSYG2CSV(): Export XSYG-file(s) to CSV-files. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data](#), [RLum.Results](#), [utils::write.table](#), [write_RLum2CSV](#), [read_XSYG2R](#)

Examples

```
##transform XSYG-file values to a list
data(ExampleData.XSYG, envir = environment())
convert_XSYG2CSV(OSL.SARMeasurement$Sequence.Object[1:10], export = FALSE)

## Not run:
##select your BIN-file
file <- file.choose()

##convert
convert_XSYG2CSV(file)

## End(Not run)
```

correct_PMTLinearity *Dead-time (linearity) Correction for Photomultiplier tubes (PMT)*

Description

Correct dead-time (also linearity) of PMT counts to avoid saturation effects, depending on pulse-pair-resolution of individual PMTs.

Usage

```
correct_PMTLinearity(object, PMT_pulse_pair_resolution = NULL)
```

Arguments

- object** [RLum.Analysis](#) [RLum.Data.Curve](#) (**required**): object with records to correct; can be a [list](#) of such objects
- PMT_pulse_pair_resolution** [numeric](#) (*with default*): pulse-pair resolution in ns. Values can be found on the PMT datasheets. If NULL nothing is done.

Details

We correct for count linearity using a well-known formula that can be found for example in the Hamamatsu Photomultiplier handbook (Hamamatsu Photonics K.K., 2017):

$$N = \frac{M}{1 - Mt}$$

where N (in s^{-1}) is the true count rate, M (in s^{-1}) the measured count rate, and t (in s) the pulse pair resolution.

Value

Returns the same type of object type as object.

Function version

0.1.1

How to cite

Kreutzer, S., Mittelstrass, D., 2026. correct_PMTLinearity(): Dead-time (linearity) Correction for Photomultiplier tubes (PMT). Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function is an adaptation of core from the R package 'OSLdecomposition'.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Dirk Mittelstrass, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Hamamatsu Photonics K.K., 2017. Photomultiplier Tubes: Basics and Applications, 4th edition. ed. Hamamatsu.

Mittelstraß, D., Kreutzer, S., Schmidt, C., 2022. OSLdecomposition: Signal component analysis for optically stimulated luminescence. [doi:10.32614/CRAN.package.OSLdecomposition](https://doi.org/10.32614/CRAN.package.OSLdecomposition)

Examples

```
o <- set_RLum("RLum.Data.Curve")
correct_PMTLinearity(o, PMT_pulse_pair_resolution = 10)
```

ExampleData	<i>All examples</i>
-------------	---------------------

Description

These examples are fully documented:

- [ExampleData.CobbleData](#)
- [ExampleData.DeValues](#)
- [ExampleData.Fading](#)
- [ExampleData.portableOSL](#)
- [ExampleData.RLum.Data.Image](#)
- [ExampleData.ScaleGammaDose](#)
- [ExampleData.SurfaceExposure](#)
- [ExampleData.TR_OSL](#)

The following ones are also available, but are visible only via the internal documentation, as they correspond to unpublished or synthetic data:

- [ExampleData.Al2O3C](#)
- [ExampleData.BINfileData](#)
- [ExampleData.CW_OSL_Curve](#)
- [ExampleData.FittingLM](#)
- [ExampleData.LxTxData](#)
- [ExampleData.LxTxOSLData](#)
- [ExampleData.MortarData](#)
- [ExampleData.RF70Curves](#)
- [ExampleData.RLum.Analysis](#)
- [ExampleData.XSYG](#)

ExampleData.CobbleData

Example data for calc_CobbleDoseRate()

Description

An example data set for the function [calc_CobbleDoseRate](#) containing layer specific information for the cobble to be used in the function.

Format

A [data.frame](#). Please see [calc_CobbleDoseRate](#) for detailed information on the structure of the [data.frame](#).

Version

0.1.0

Examples

```
## Load data
data("ExampleData.CobbleData", envir = environment())
```

ExampleData.DeValues *Example De data sets for the package Luminescence*

Description

Equivalent dose (De) values measured for a fine grain quartz sample from a loess section in Rottewitz (Saxony/Germany) and for a coarse grain quartz sample from a fluvial deposit in the rock shelter of Cueva Anton (Murcia/Spain).

Format

A [list](#) with two elements, each containing a two column [data.frame](#):

- \$BT998: De and De error values for a fine grain quartz sample from a loess section in Rottewitz.
- \$CA1: Single grain De and De error values for a coarse grain quartz sample from a fluvial deposit in the rock shelter of Cueva Anton

References

BT998

Unpublished data

CA1

Burow, C., Kehl, M., Hilgers, A., Weniger, G.-C., Angelucci, D., Villaverde, V., Zapata, J. and Zilhao, J. (2015). Luminescence dating of fluvial deposits in the rock shelter of Cueva Anton, Spain. *Geochronometria* 52, 107-125.

BT998

Lab: Luminescence Laboratory Bayreuth
 Lab-Code: BT998
 Location: Rottewitz (Saxony/Germany)
 Material: Fine grain quartz measured on aluminium discs on a Risø TL/OSL DA-15 reader
 Units: Values are given in seconds
 Dose Rate: Dose rate of the beta-source at measurement ca. 0.0438 Gy/s +/- 0.0019 Gy/s
 Measurement Date: 2012-01-27

CA1

Lab: Cologne Luminescence Laboratory (CLL)
 Lab-Code: C-L2941
 Location: Cueva Anton (Murcia/Spain)
 Material: Coarse grain quartz (200-250 microns) measured on single grain discs on a Risoe TL/OSL DA-20 reader
 Units: Values are given in Gray
 Measurement Date: 2012

Examples

```
##(1) plot values as histogram
data(ExampleData.DeValues, envir = environment())
plot_Histogram(ExampleData.DeValues$BT998, xlab = "De [s]")

##(2) plot values as histogram (with second to gray conversion)
data(ExampleData.DeValues, envir = environment())

De.values <- convert_Second2Gray(ExampleData.DeValues$BT998,
                                dose.rate = c(0.0438, 0.0019))

plot_Histogram(De.values, xlab = "De [Gy]")
```

ExampleData.Fading *Example data for feldspar fading measurements*

Description

Example data set for fading measurements of the IR50, IR100, IR150 and IR225 feldspar signals of sample UNIL/NB123. It further contains regular equivalent dose measurement data of the same sample, which can be used to apply a fading correction to.

Format

A [list](#) with two elements, each containing a further [list](#) of [data.frames](#) containing the data on the fading and equivalent dose measurements:

```
$fading.data: A named list of data.frames, each having three named columns (LxTx, LxTx.error, timeSinceIrrad)
.. $IR50: Fading data of the IR50 signal.
.. $IR100: Fading data of the IR100 signal.
.. $IR150: Fading data of the IR150 signal.
.. $IR225: Fading data of the IR225 signal.
```

```
$equivalentDose.data: A named list of data.frames, each having three named columns (dose, LxTx, LxTx.error).
.. $IR50: Equivalent dose measurement data of the IR50 signal.
.. $IR100: Equivalent dose measurement data of the IR100 signal.
.. $IR150: Equivalent dose measurement data of the IR150 signal.
.. $IR225: Equivalent dose measurement data of the IR225 signal.
```

Source

These data were kindly provided by Georgina E. King. Detailed information on the sample UNIL/NB123 can be found in the reference given below. The raw data can be found in the accompanying supplementary information.

References

King, G.E., Herman, F., Lambert, R., Valla, P.G., Guralnik, B., 2016. Multi-OSL-thermochronometry of feldspar. *Quaternary Geochronology* 33, 76-87. doi:10.1016/j.quageo.2016.01.004

Details

Lab:	University of Lausanne
Lab-Code:	UNIL/NB123
Location:	Namche Barwa (eastern Himalayas)
Material:	Coarse grained (180-212 microns) potassium feldspar
Units:	Values are given in seconds
Lab Dose Rate:	Dose rate of the beta-source at measurement ca. 0.1335 +/- 0.004 Gy/s
Environmental Dose Rate:	7.00 +/- 0.92 Gy/ka (includes internal dose rate)

Examples

```
## Load example data
data("ExampleData.Fading", envir = environment())

## Get fading measurement data of the IR50 signal
IR50_fading <- ExampleData.Fading$fading.data$IR50
head(IR50_fading)

## Determine g-value and rho' for the IR50 signal
IR50_fading.res <- analyse_FadingMeasurement(IR50_fading)

## Show g-value and rho' results
gval <- get_RLum(IR50_fading.res)
rhop <- get_RLum(IR50_fading.res, "rho_prime")

gval
rhop

## Get LxTx values of the IR50 DE measurement
IR50_De.LxTx <- ExampleData.Fading$equivalentDose.data$IR50

## Calculate the De of the IR50 signal
IR50_De <- fit_DoseResponseCurve(IR50_De.LxTx,
                                mode = "interpolation",
                                fit.method = "SSE")

## Extract the calculated De and its error
IR50_De.res <- get_RLum(IR50_De)
De <- c(IR50_De.res$De, IR50_De.res$De.Error)

## Apply fading correction (age conversion greatly simplified)
IR50_Age <- De / 7.00
IR50_Age.corr <- calc_FadingCorr(IR50_Age, g_value = IR50_fading.res)
```

ExampleData.portableOSL

Example portable OSL curve data for the package Luminescence

Description

A list of [RLum.Analysis](#) objects, each containing the same number of [RLum.Data.Curve](#) objects representing individual OSL, IRSL and dark count measurements of a sample.

Source

ExampleData.portableOSL

Lab: Cologne Luminescence Laboratory

Lab-Code: none
 Location: Nievenheim/Germany
 Material: Fine grain quartz
 Reference: unpublished data

Examples

```
data(ExampleData.portableOSL, envir = environment())
plot_RLum(ExampleData.portableOSL)
```

ExampleData.RLum.Data.Image

Example data as [RLum.Data.Image](#) objects

Description

Measurement of Princeton Instruments camera imported with the function [read_SPE2R](#) to R to produce an [RLum.Data.Image](#) object.

Format

Object of class [RLum.Data.Image](#)

Version

0.1

Source

ExampleData.RLum.Data.Image

These data were kindly provided by Regina DeWitt.

Lab.: Department of Physics, East-Carolina University, NC, USA
 Lab-Code: -
 Location: -
 Material: -
 Reference: -

Image data is a measurement of fluorescent ceiling lights with a cooled Princeton Instruments (TM) camera fitted on Risø DA-20 TL/OSL reader.

Examples

```
##load data
data(ExampleData.RLum.Data.Image, envir = environment())

##plot data
plot_RLum(ExampleData.RLum.Data.Image)
```

ExampleData.ScaleGammaDose

Example data for scale_GammaDose()

Description

An example data set for the function `scale_GammaDose()` containing layer specific information to scale the gamma dose rate considering variations in soil radioactivity.

Format

A [data.frame](#). Please see `?scale_GammaDose()` for a detailed description of its structure.

Version

0.1

Examples

```
## Load data
data("ExampleData.ScaleGammaDose", envir = environment())
```

ExampleData.SurfaceExposure

Example OSL surface exposure dating data

Description

A set of synthetic OSL surface exposure dating data to demonstrate the [fit_SurfaceExposure](#) functionality. See examples to reproduce the data interactively.

Format

A [list](#) with 4 elements:

Element	Content
\$sample_1	A data.frame with 3 columns (depth, intensity, error)
\$sample_2	A data.frame with 3 columns (depth, intensity, error)
\$set_1	A list of 4 data.frames , each representing a sample with different ages
\$set_2	A list of 5 data.frames , each representing a sample with different ages

Details

\$sample_1

mu	sigmaphi	age
0.9	5e-10	10000

\$sample_2

mu	sigmaphi	age	Dose rate	D0
0.9	5e-10	10000	2.5	40

\$set_1

mu	sigmaphi	ages
0.9	5e-10	1e3, 1e4, 1e5, 1e6

\$set_2

mu	sigmaphi	ages	Dose rate	D0
0.9	5e-10	1e2, 1e3, 1e4, 1e5, 1e6	1.0	40

Source

See examples for the code used to create the data sets.

References

Unpublished synthetic data

[illegible]

```

## VALIDATE set_1
fit_SurfaceExposure(synth_3, age = age, sigmaphi = sigmaphi)

## ExampleData.SurfaceExposure$set_2
sigmaphi <- 5e-10
mu <- 0.9
x <- seq(0, 15, 0.2)
age <- c(1e2, 1e3, 1e4, 1e5, 1e6)
Ddot <- 1.0 / 1000 / 365.25 / 24 / 60 / 60 # 2.0 Gy/ka in Seconds
D0 <- 40
set.seed(666)

synth_4 <- vector("list", length = length(age))

for (i in 1:length(age)) {
  fun <- (sigmaphi * exp(-mu * x) *
    exp(-(age[i] * 365.25*24*3600) *
      (sigmaphi * exp(-mu * x) + Ddot/D0)) + Ddot/D0) /
    (sigmaphi * exp(-mu * x) + Ddot/D0)

  synth_4[[i]] <- data.frame(depth = x,
    intensity = jitter(fun, 1, 0.05))
}

## VALIDATE set_2
fit_SurfaceExposure(synth_4, age = age, sigmaphi = sigmaphi, D0 = D0, Ddot = 1.0)

## Not run:
ExampleData.SurfaceExposure <- list(
  sample_1 = synth_1,
  sample_2 = synth_2,
  set_1 = synth_3,
  set_2 = synth_4
)

## End(Not run)

```

ExampleData.TR_OSL *Example TR-OSL data*

Description

Single TR-OSL curve obtained by Schmidt et al. (2019) for quartz sample BT729 (origin: Trebgast Valley, Germany, quartz, 90-200 μm , unpublished data).

Format

One [RLum.Data.Curve](#) dataset imported using the function [read_XSYG2R](#)

ExampleData.TR_OSL: A single [RLum.Data.Curve](#) object with the TR-OSL data

References

Schmidt, C., Simmank, O., Kreutzer, S., 2019. Time-Resolved Optically Stimulated Luminescence of Quartz in the Nanosecond Time Domain. *Journal of Luminescence* 213, 376-387.

See Also

[fit_OSLLifeTimes](#)

Examples

```
##(1) curves
data(ExampleData.TR_OSL, envir = environment())
plot_RLum(ExampleData.TR_OSL)
```

extdata

Collection of External Data

Description

Description and listing of data provided in the folder data/extdata

Details

The **R** package Luminescence includes a number of raw data files, which are mostly used in the example sections of appropriate functions. They are also used internally for testing corresponding functions using the testthat package (see files in tests/testthat/) to ensure their operational reliability.

Accessibility

If the **R** package Luminescence is installed correctly the preferred way to access and use these data from within **R** is as follows:

```
system.file("extdata/<FILENAME>", package = "Luminescence")
```

Individual file descriptions

»Daybreak_TestFile.DAT.txt«

Type: raw measurement data

Device: Daybreak OSL/TL reader

Measurement date: unknown

Location: unknown

Provided by: unknown

Related R function(s): read_Daybreak2R()

Reference: unknown

»DorNie_0016.psl«

Type: raw measurement data

Device: SUERC portable OSL reader

Measurement date: 19/05/2016

Location: Dormagen-Nievenheim, Germany

Provided by: Christoph Burow (University of Cologne)

Related R function(s): read_PSL2R()

Reference: unpublished

Additional information: Sample measured at an archaeological site near Dormagen-Nievenheim (Germany) during a practical course on Luminescence dating in 2016.

»QNL84_2_bleached.txt, QNL84_2_unbleached.txt«

Type: Test data for exponential fits

Reference: Berger, G.W., Huntley, D.J., 1989. Test data for exponential fits. Ancient TL 7, 43-46.
doi:10.26034/la.atl.1989.150

»STRB87_1_bleached.txt, STRB87_1_unbleached.txt«

Type: Test data for exponential fits

Reference: Berger, G.W., Huntley, D.J., 1989. Test data for exponential fits. Ancient TL 7, 43-46.
doi:10.26034/la.atl.1989.150

»XSYG_file.xsyg

Type: XSYG-file stump

Info: XSYG-file with some basic curves to test functions

Reference: no reference available

extract_IrradiationTimes

Extract Irradiation Times from an XSYG-file or RLum. Analysis object

Description

Extracts irradiation times, dose and times since last irradiation, from a Freiberg Instruments XSYG-file. These information can be further used to update an existing BINX-file.

Usage

```
extract_IrradiationTimes(
  object,
  file.BINX,
  recordType = c("irradiation (NA)", "IRSL (UVVIS)", "OSL (UVVIS)", "TL (UVVIS)"),
  return_same_as_input = FALSE,
  compatibility.mode = TRUE,
  txtProgressBar = TRUE
)
```

Arguments

object	character, RLum.Analysis or list (required): path and file name of the XSYG file or an RLum.Analysis produced by the function read_XSYG2R; alternatively, a list of RLum.Analysis can be provided. Note: If an RLum.Analysis is used, any input for the arguments <code>file.BINX</code> and <code>recordType</code> will be ignored!
file.BINX	character (<i>optional</i>): path and file name of an existing BINX-file. If a file name is provided the file will be updated with the information from the XSYG file in the same folder as the original BINX-file. Note: The XSYG and the BINX-file must originate from the same measurement!
recordType	character (<i>with default</i>): select relevant curves types from the XSYG file or RLum.Analysis object. As the XSYG-file format comprises much more information than usually needed for routine data analysis and allowed in the BINX-file format, only the relevant curves are selected by using the function get_RLum. The argument <code>recordType</code> works as described for this function. Note: A wrong selection will causes a function error. Please change this argument only if you have reasons to do so.
return_same_as_input	logical (<i>with default</i>): if set to TRUE, an updated RLum.Analysis object (or a list of it) is returned, with each record having gained two new info element fields: <code>IRR_TIME</code> and <code>TIMESCINCEIRR</code>. This makes the RLum.Analysis object compatible with external functions that search explicitly for <code>IRR_TIME</code> and <code>TIMESCINCEIRR</code>.
compatibility.mode	logical (<i>with default</i>): whether all position values should be reset to a maximum value of 48 (see write_R2BIN). Only used if <code>file.BINX</code> is specified.
txtProgressBar	logical (<i>with default</i>): enable/disable the progress bar during import and export.

Details

The function was written to compensate missing information in the BINX-file output of Freiberg Instruments lexsys readers. As all information are available within the XSYG-file anyway, these information can be extracted and used for further analysis or/and to stored in a new BINX-file, which can be further used by other software, e.g., *Analyst* (Geoff Duller).

Typical application example: *g*-value estimation from fading measurements using the *Analyst* or any other self-written script.

Beside some simple data transformation steps, the function relies on **read_XSYG2R**, **read_BIN2R**, **write_R2BIN** for data import and export.

Calculation details

- The value `DURATION.STEP` is calculated as `START` + the end of the time axis for all curves except for TL, where the function tries to extract meta information about the duration.
- The value `END` is calculated as `START` + `DURATION.STEP`
- All curves for which no prior irradiation was detected receive an -1 (*Analyst* convention)
- Irradiation steps have always `IRR_TIME` = 0

Value

An [RLum.Results](#) object is returned with the following structure:

```
.. $irr.times (data.frame)
```

If `return_same_as_input = TRUE` an [RLum.Analysis](#) or a [list](#) of it, but we updated info elements including irradiation times.

If a BINX-file path and name is set, the output will be additionally transferred into a new BINX-file (with the function name as suffix) located in the folder of the input BINX-file. Note that this will not work if the input object is a file path to an XSYG-file, instead of a link to only one file. In this case the argument `input` for `file.BINX` is ignored.

In the self call mode (`input` is a list of [RLum.Analysis](#) objects) a list of [RLum.Results](#) is returned.

Function version

0.4.0

How to cite

Kreutzer, S., 2026. `extract_IrradiationTimes()`: Extract Irradiation Times from an XSYG-file or [RLum.Analysis](#) object. Function version 0.4.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The function can be also used to extract irradiation times from [RLum.Analysis](#) objects imported via [read_BIN2R](#) with option `fastForward = TRUE`, or in combination with [Riso.BINfileData2RLum.Analysis](#). Unfortunately the timestamp might not be very precise (or even invalid), but it allows to essentially treat different formats in a similar manner.

The produced output object contains still the irradiation steps to keep the output transparent. However, for the BINX-file export this steps are removed as the BINX-file format description does not allow irradiations as separate sequences steps.

BINX-file 'Time Since Irradiation' value differs from the table output?

The way the value 'Time Since Irradiation' is defined differs. In the BINX-file the 'Time Since Irradiation' is calculated as the 'Time Since Irradiation' plus the 'Irradiation Time'. The table output returns only the real 'Time Since Irradiation', i.e. time between the end of the irradiation and the next step.

Negative values for TIMESINCELAST.STEP?

Yes, this is possible and not a bug, as in the XSYG-file multiple curves are stored for one step. Example: TL step may comprise three curves:

- (a) counts vs. time,
- (b) measured temperature vs. time and

- (c) predefined temperature vs. time.

Three curves, but they are all belonging to one TL measurement step, but with regard to the time stamps this could produce negative values as the important function ([read_XSYG2R](#)) do not change the order of entries for one step towards a correct time order.

TIMESINCELAST.STEP is odd if TL curves are involved?

Yes, this is possible! The end time is calculated as start + duration, and the duration is deduced from the time values of each step. A typical TL curve, however, does not have a time but a temperature axis. Hence, the function tries to extract the information from metadata. If that information is missing, the x-values are presumed time values, which might still be wrong.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Duller, G.A.T., 2015. The Analyst software package for luminescence data: overview and recent improvements. *Ancient TL* 33, 35-42. doi:10.26034/la.atl.2015.489

See Also

[RLum.Analysis](#), [RLum.Results](#), [Risoe.BINfileData](#), [read_XSYG2R](#), [read_BIN2R](#), [write_R2BIN](#)

Examples

```
## take system file
xsysg <- system.file("extdata/XSYG_file.xsysg", package="Luminescence")

## the import is automatically
## but you can import it before
irr_times <- extract_IrradiationTimes(xsysg)
irr_times$irr.times

## Not run:
# (1) - example for your own data

# set files and run function
file.XSYG <- file.choose()
file.BINX <- file.choose()

extract_IrradiationTimes(file.XSYG = file.XSYG, file.BINX = file.BINX)

# export results additionally to a CSV-file in the same directory as the XSYG-file
write.table(x = get_RLum(output),
  file = paste0(file.BINX, "_extract_IrradiationTimes.csv"),
  sep = ";",
  row.names = FALSE)

## End(Not run)
```

extract_ROI	<i>Extract Pixel Values through Circular Region-of-Interests (ROI) from an Image</i>
-------------	--

Description

Light-weighted function to extract pixel values from pre-defined regions-of-interest (ROI) from [RLum.Data.Image](#), [array](#) or [matrix](#) objects and provide simple image processing capacity. The function is limited to circular ROIs.

Usage

```
extract_ROI(
  object,
  roi,
  roi_summary = c("mean", "median", "sd", "sum"),
  plot = FALSE
)
```

Arguments

object	RLum.Data.Image , array or matrix (required): input image data
roi	matrix (required): matrix with three columns containing the centre coordinates of the ROI (first two columns) and the diameter of the circular ROI. All numbers must be of type integer and will forcefully be coerced into such numbers using <code>as.integer()</code> regardless.
roi_summary	(<i>with default</i>): defines what is returned in the <code>roi_summary</code> element; it can be "mean" (default), "median", "sd" or "sum". Pixel values are conveniently summarised using the above defined keyword.
plot	logical (<i>optional</i>): enable/disable the plot output. Only the first image frame is shown.

Details

The function uses a cheap approach to decide whether a pixel lies within a circle or not. It assumes that pixel coordinates are integer values and that a pixel centring within the circle is satisfied by:

$$x^2 + y^2 \leq (d/2)^2$$

where x and y are integer pixel coordinates and d is the integer diameter of the circle in pixel.

Value

RLum.Results object with the following elements: `..$roi_signals`: a named [list](#) with all ROI values and their coordinates `..$roi_summary`: a [matrix](#) where rows are frames from the image, and columns are different ROI The element has two attributes: `summary` (the method used to summarise pixels) and `area` (the pixel area) `..$roi_coord`: a [matrix](#) that can be passed to [plot_ROI](#)

If `plot = TRUE` a control plot is returned.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. `extract_ROI()`: Extract Pixel Values through Circular Region-of-Interests (ROI) from an Image. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Image](#)

Examples

```
m <- matrix(runif(100,0,255), ncol = 10, nrow = 10)
roi <- matrix(c(2.,4,2,5,6,7,3,1,1), ncol = 3)
extract_ROI(object = m, roi = roi, plot = TRUE)
```

fit_CWCurve

Non-linear Least Squares Fit for CW-OSL curves -beta version-

Description

The function determines the weighted least-squares estimates of the component parameters of a CW-OSL signal for a given maximum number of components and returns various component parameters.

Fitting function

The function for the CW-OSL fitting has the general form:

$$y = I0_1 \lambda_1 \exp(-\lambda_1 x) + \dots + I0_i \lambda_i \exp(-\lambda_i x)$$

where $0 < i < 8$, λ is the decay constant, and $I0$ the initial number of trapped electrons.

(for the used equation cf. Boetter-Jensen et al., 2003, Eq. 2.31)

Start values

Start values are estimated automatically by fitting a linear function to the logarithmized input data set. Currently, there is no option to manually provide start parameters.

Goodness of fit

The goodness of the fit is given as $\text{pseudo}R^2$ value (pseudo coefficient of determination). According to Lave (1970), the value is calculated as:

$$\text{pseudo}R^2 = 1 - \text{RSS}/\text{TSS}$$

where RSS is the Residual Sum of Squares, and TSS is the Total Sum of Squares.

Error of fitted component parameters

The 1-sigma error for the components is calculated using the function `stats::confint`. Due to considerable calculation time, this option is deactivated by default. In addition, the error for the components can be estimated by using internal R functions like `summary`. See the `nls` help page for more information.

For details on the nonlinear regression in R, see Ritz & Streibig (2008).

Usage

```
fit_CWCurve(
  object,
  n.components.max = 7,
  fit.failure_threshold = 5,
  fit.method = c("port", "LM"),
  fit.trace = FALSE,
  fit.calcError = FALSE,
  LED.power = 36,
  LED.wavelength = 470,
  cex.global = 0.6,
  sample_code = "Default",
  verbose = TRUE,
  output.terminalAdvanced = TRUE,
  plot = TRUE,
  method_control = list(),
  ...
)
```

Arguments

`object` `RLum.Data.Curve` or `data.frame` (**required**): x, y data of measured values (time and counts).

n.components.max	vector (<i>optional</i>): maximum number of components that are to be used for fitting. The upper limit is 7.
fit.failure_threshold	integer (<i>with default</i>): limits the failed fitting attempts.
fit.method	character (<i>with default</i>): select the fit method, either "port" to use the 'port' routine from function nls , or "LM" to use the Levenberg-Marquardt algorithm as implemented in function minpack.lm::nlsLM .
fit.trace	logical (<i>with default</i>): traces the fitting process on the terminal.
fit.calcError	logical (<i>with default</i>): calculate 1-sigma error range of components using stats::confint
LED.power	numeric (<i>with default</i>): LED power (max.) used for intensity ramping in mW/cm ² . Note: The value is used for the calculation of the absolute photoionisation cross section.
LED.wavelength	numeric (<i>with default</i>): LED wavelength used for stimulation in nm. Note: The value is used for the calculation of the absolute photoionisation cross section.
cex.global	numeric (<i>with default</i>): global scaling factor.
sample_code	character (<i>optional</i>): sample code used for the plot and the optional output table (mtext).
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
output.terminalAdvanced	logical (<i>with default</i>): enhanced terminal output. Only valid if verbose = TRUE.
plot	logical (<i>with default</i>): enable/disable the plot output.
method_control	list (<i>optional</i>): options to control the output produced. Currently only the 'export.comp.contrib.matrix' (logical) option is supported, to enable/disable export of the component contribution matrix.
...	further arguments and graphical parameters passed to plot .

Value

plot (*optional*)

the fitted CW-OSL curves are returned as plot.

RLum.Results object

Beside the plot and table output options, an [RLum.Results](#) object is returned.

fit: an [nls](#) object (`$fit`) for which generic R functions are provided, e.g. [summary](#), [stats::confint](#), [profile](#). For more details, see [nls](#).

output.table: a [data.frame](#) containing the summarised parameters including the error

component.contribution.matrix: [matrix](#) containing the values for the component to sum contribution plot (`$component.contribution.matrix`). Produced only if `method_control$export.comp.contrib.matrix = TRUE`).

Matrix structure:

Column 1 and 2: time and `rev(time)` values

Additional columns are used for the components, two for each component, containing `I0` and `n0`. The last columns `cont.` provide information on the relative component contribution for each time interval including the row sum for this values.

Function version

0.5.6

How to cite

Kreutzer, S., 2026. fit_CWCurve(): Non-linear Least Squares Fit for CW-OSL curves -beta version-. Function version 0.5.6. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Beta version - This function has not been properly tested yet and should therefore not be used for publication purposes!

The pseudo- R^2 may not be the best parameter to describe the goodness of the fit. The trade off between the n.components and the pseudo- R^2 value is currently not considered.

The function **does not** ensure that the fitting procedure has reached a global minimum rather than a local minimum!

Author(s)

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References

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See Also

[fit_LMCurve](#), [plot,nls](#), [RLum.Data.Curve](#), [RLum.Results](#), [get_RLum](#), [minpack.lm::nlsLM](#)

Examples

```
##load data
data(ExampleData.CW_OSL_Curve, envir = environment())

##fit data
fit <- fit_CWCurve(ExampleData.CW_OSL_Curve,
  main = "CW Curve Fit",
  n.components.max = 4,
  log = "x")
```

fit_DoseResponseCurve *Fit a dose-response curve for luminescence data (Lx/Tx against dose)*

Description

A dose-response curve is produced for luminescence measurements using a regenerative or additive protocol. The function supports interpolation and extrapolation to calculate the equivalent dose.

Usage

```
fit_DoseResponseCurve(
  object,
  mode = c("interpolation", "extrapolation", "alternate"),
  fit.method = c("SSE", "LIN", "QDR", "SSE OR LIN", "SSE+LIN", "DSE", "GOK", "OTOR",
    "OTORX"),
  fit.force_through_origin = FALSE,
  fit.weights = c("inverse_var", "inverse_std", "norm_inverse_std"),
  fit.includingRepeatedRegPoints = TRUE,
  fit.NumberRegPoints = NULL,
  fit.NumberRegPointsReal = NULL,
  fit.bounds = TRUE,
  n.MC = 100,
  txtProgressBar = TRUE,
  verbose = TRUE,
  ...
)
```

Arguments

object [data.frame](#) or a [list](#) of such objects (**required**): data frame with columns for Dose, LxTx, LxTx.Error and TnTx (optional). If these column names are used, then they can be passed in whatever order; otherwise columns are taken by position.

If object is a list, the function is called on each of its elements.

If fit.method = "OTORX" you have to provide the test dose in the same unit as the dose in a column called Test_Dose. The function searches explicitly for this column name. Only the first value will be used assuming a constant test dose over the measurement cycle.

mode [character](#) (*with default*): selects calculation mode of the function.

- "interpolation" (default) calculates the De by interpolation,
- "extrapolation" calculates the equivalent dose by extrapolation (useful for MAAD measurements) and
- "alternate" calculates no equivalent dose and just fits the data points.

	Please note that for option "interpolation" the first point is considered as natural dose.
fit.method	character (with default): function used for fitting. Possible options are: LIN, QDR, SSE, SSE OR LIN, SSE+LIN, DSE (not defined for extrapolation), GOK, OTOR and OTORX. See details.
fit.force_through_origin	logical (with default) allow to force the fitted function through the origin. For method = "DSE" the function will be fixed through the origin in either case, so this option will have no effect.
fit.weights	character numeric (with default): weighting approach to be used for the fitting. Options are inverse_var (default), inverse_std, norm_inverse_std, a numeric vector, or NULL (no weighting). If the input is a numeric vector, it must have length equal to the number of data points to fit (usually the LxTx values). See details.
fit.includingRepeatedRegPoints	logical (with default): includes repeated points for fitting (TRUE/FALSE).
fit.NumberRegPoints	integer (optional): set number of regeneration points manually. By default the number of all (!) regeneration points is used automatically.
fit.NumberRegPointsReal	integer (optional): if the number of regeneration points is provided manually, the value of the real, regeneration points = all points (repeated points) including reg 0, has to be inserted.
fit.bounds	logical (with default): set lower fit bounds for all fitting parameters to 0. Limited to use with the fit methods SSE, SSE+LIN, SSE OR LIN, GOK, OTOR, OTORX Argument to be inserted for experimental application only!
n.MC	integer (with default): number of Monte Carlo simulations for error estimation.
txtProgressBar	logical (with default): enable/disable the progress bar. If verbose = FALSE also no txtProgressBar is shown.
verbose	logical (with default): enable/disable output to the terminal.
...	Further arguments to be passed (currently ignored).

Details

Implemented fitting methods:

For all options (except for the LIN, QDR and the SSE OR LIN), the `minpack.lm::nlsLM` function with the LM (Levenberg-Marquardt algorithm) algorithm is used. Note: For historical reasons for the Monte Carlo simulations partly the function `nls` using the `port` algorithm.

The solution is found by transforming the function or using `stats::uniroot`.

Keyword: LIN

Fits a linear function to the data using `lm`:

$$y = mx + D_i$$

Keyword: QDR

Fits a linear function with a quadratic term to the data using [lm](#):

$$y = a + bx + cx^2$$

Keyword: SSE (formerly EXP)

Fits a single saturating exponential function of the form

$$y = N(1 - \exp(-\frac{x + D_i}{D_0}))$$

Parameters D_0 and D_i are approximated by a linear fit using [lm](#).

Keyword: SSE OR LIN (formerly EXP OR LIN)

Works for some cases where an SSE fit fails. If the SSE fit fails, a LIN fit is done instead, which always works.

Keyword: SSE+LIN (formerly EXP+LIN)

Tries to fit an exponential plus linear function of the form:

$$y = N(1 - \exp(-\frac{x + D_i}{D_0})) + gx$$

The D_e is calculated by iteration.

Note: In the context of luminescence dating, this function has no physical meaning. Therefore, no D_0 value is returned.

Keyword: DSE (formerly EXP+EXP)

Tries to fit a double exponential function of the form

$$y = N_1(1 - \exp(-\frac{x + D_i}{D_{01}})) + N_2(1 - \exp(-\frac{x + D_i}{D_{02}}))$$

This fitting procedure is not really robust against wrong start parameters.

Keyword: GOK

Tries to fit the general-order kinetics function following Guralnik et al. (2015) of the form

$$y = a(d - (1 + \frac{1}{D_0}xc)^{-1/c})$$

where $c > 0$ is a kinetic order modifier.

Keyword: OTOR (formerly LambertW)

This tries to fit a dose-response curve based on the Lambert W function and the one trap one recombination centre (OTOR) model according to Pagonis et al. (2020). The function has the form:

$$y = (1 + (W((R - 1) * \exp(R - 1 - (x + D_i)/D_c)))/(1 - R))) * N$$

with W the Lambert-W function (calculated using [lamW::lamertW0](#)), R the dimensionless re-trapping ratio, N the total concentration of trappings states in cm^{-3} , $D_c = N/R$ a constant, and D_i is the offset on the x-axis (not part of the original formula in Pagonis et al. 2020). Note that R and D_c have a valid physical interpretation only when saturation is reached. Please note that finding the root in mode = "extrapolation" is a non-easy task due to the shape of the function and the results might be unexpected.

Keyword: OTORX

This adapts extended OTOR (therefore: OTORX) model proposed by Lawless and Timar-Gabor (2024) accounting for retrapping (the equation implemented here is written slightly differently than in the original manuscript):

$$F_{OTORX} = 1 + \left[\mathcal{W} \left(-Q * \exp \left(-Q - \left(1 - Q \left(1 - \frac{1}{\exp(1)} \right) \right) \frac{D + D_i}{D_{63}} \right) \right) \right] / Q$$

with

$$Q = \frac{A_m - A_n}{A_m} \frac{N}{N + N_D}$$

where A_m and A_n are rate constants for the recombination and the trapping of electrons (N), respectively. D_{63} corresponds to the value at which the trap occupation corresponds to 63% of the saturation value. D_i is an offset: if set to zero, the curve will be forced through the origin as in the original publication.

For the implementation the calculation reads further

$$y = \frac{F_{OTORX}(((D + D_i)/D_{63}), Q)}{F_{OTORX}((D_{test} + D_i)/D_{63}, Q)}$$

with D_{test} being the test dose in the same unit (usually s or Gy) as the regeneration dose points. This value is essential and needs to be provided along with the usual dose and $\frac{L_x}{T_x}$ values (see object parameter input and the example section). For more details see Lawless and Timar-Gabor (2024). The fit also returns the parameter R known from OTOR, which is derived as $R = 1 - Q$.

Note: The offset adder D_i is not part of the formula in Timar-Gabor (2024) and can be set to zero with the option `fit.force_through_origin = TRUE`

Fit weighting

- "inverse_var" (inverse variance weighting - current default)

$$w_i = \frac{1}{\sigma_i^2}$$

- "inverse_std" (inverse standard error)

$$w_i = \frac{1}{\sigma_i}$$

- "norm_inverse_std" (normalised inverse standard error weighting - default up to v1.2.1)

$$w_i = \frac{\frac{1}{\sigma_i}}{\sum \frac{1}{\sigma_i}}$$

Although used until Luminescence v1.2.1, this method is no longer recommended, as it does not align with the mathematical approach used in common nls fitting methods.

If the option `fit.weights = NULL` all weights are set to 1, which disables weighting altogether. If `fit.weights` is a [numeric](#) vector of correct length (same number of rows as the input $L \times T$), then those fit weights are used. This may be helpful to compare different fitting algorithms that have implemented fit weights differently.

Error estimation using Monte Carlo simulation

Error estimation is done using a parametric bootstrap. A set of $\frac{L_d}{T_x}$ values is constructed by randomly drawing curve data from normal distributions defined by the input values (mean = value, sd = value.error). A dose-response curve is then fitted for each sampled dataset using the chosen fitting method, producing a distribution of single De values. The standard deviation of this distribution is taken as the error of the De. With more iterations (n.MC) the error estimate stabilizes. However, naturally the error will not decrease with more MC runs.

Alternatively, the function returns highest probability density interval estimates as output, users may find more useful under certain circumstances.

Note: It may take some calculation time with increasing MC runs, especially for the composed functions (SSE+LIN and DSE).

Value

An [RLum.Results](#) object is returned containing the slot data with the following elements:

Overview elements

DATA.OBJECT	TYPE	DESCRIPTION
..\$De :	data.frame	Table with De values
..\$De.MC :	numeric	Table with De values from MC runs
..\$Fit :	nls or lm	object from the fitting for SSE, SSE+LIN and DSE. In case of a resulting linear fit when using
..Fit.Args :	list	Arguments to the function
..\$Formula :	expression	Fitting formula as R expression

The @info slot contains the following elements:

DATA.OBJECT	TYPE	DESCRIPTION
..\$fit_message:	character	The fit message reported
..\$call :	call	The original function call

If object is a list, then the function returns a list of [RLum.Results](#) objects as defined above.

Details - DATA.OBJECT\$De This object is a [data.frame](#) with the following columns

De	numeric	equivalent dose
De.Error	numeric	standard error the equivalent dose
D01	numeric	D_0 value, curvature parameter of the exponential
D01.ERROR	numeric	standard error of the D_0 value
D02	numeric	2nd D_0 value, only for DSE
D02.ERROR	numeric	standard error for 2nd D_0 ; only for DSE
R	numeric	the material specific parameter R (only for OTOR and DSE)
R.LOWER	numeric	lower 25% quantile of R
R.UPPER	numeric	upper 75% quantile of R
Dc	numeric	value indicating saturation level; only for OTOR and DSE
Dc.LOWER	numeric	lower 25% quantile for Dc; only for OTOR and DSE
Dc.UPPER	numeric	upper 75% quantile for Dc; only for OTOR and DSE

D63	numeric	the specific saturation level; only for OTOR, OTORX
D63.LOWER \ tab	numeric	lower 25% quantile of D63; only for OTOR, OTORX
D63.UPPER \ tab	numeric	upper 75% quantile of D63; only for OTOR, OTORX
D80	numeric	the specific saturation level; only for SSE, OTOR
D80.LOWER \ tab	numeric	lower 25% quantile of D80; only for OTOR, OTORX
D80.UPPER \ tab	numeric	upper 75% quantile of D80; only for OTOR, OTORX
n_N	numeric	saturation level of dose-response curve derived
De.MC	numeric	equivalent dose derived by Monte-Carlo simul
Fit	character	applied fit function
Mode	character	mode used in fitting
HPDI68_L	numeric	highest probability density of the approximate
HPDI68_U	numeric	same as HPDI68_L for the upper bound
HPDI95_L	numeric	same as HPDI68_L but for 95% probability
HPDI95_U	numeric	same as HPDI95_L but for the upper bound
.De.plot	numeric	equivalent dose used internally for plotting
.De.raw	numeric	equivalent dose reported 'as is', that is, contain

Function version

1.7

How to cite

Kreutzer, S., Dietze, M., Colombo, M., 2026. fit_DoseResponseCurve(): Fit a dose-response curve for luminescence data (Lx/Tx against dose). Function version 1.7. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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References

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- Guralnik, B., Li, B., Jain, M., Chen, R., Paris, R.B., Murray, A.S., Li, S.-H., Pagonis, P., Herman, F., 2015. Radiation-induced growth and isothermal decay of infrared-stimulated luminescence from feldspar. *Radiation Measurements* 81, 224-231. doi:10.1016/j.radmeas.2015.02.011
- Lawless, J.L., Timar-Gabor, A., 2024. A new analytical model to fit both fine and coarse grained quartz luminescence dose response curves. *Radiation Measurements* 170, 107045. doi:10.1016/j.radmeas.2023.107045

Pagonis, V., Kitis, G., Chen, R., 2020. A new analytical equation for the dose response of dosimetric materials, based on the Lambert W function. Journal of Luminescence 225, 117333. doi:[10.1016/j.jlumin.2020.117333](https://doi.org/10.1016/j.jlumin.2020.117333)

See Also

[plot_DoseResponseCurve](#), [nls](#), [RLum.Results](#), [get_RLum](#), [minpack.lm::nlsLM](#), [lm](#), [uniroot](#), [lamW::lambertW0](#)

Examples

```
##(1) fit growth curve for a dummy data.set and show De value
data(ExampleData.LxTxData, envir = environment())
temp <- fit_DoseResponseCurve(LxTxData)
get_RLum(temp)

##(1b) to access the fitting value try
get_RLum(temp, data.object = "Fit")

##(2) fit using the 'extrapolation' mode
LxTxData[1,2:3] <- c(0.5, 0.001)
print(fit_DoseResponseCurve(LxTxData, mode = "extrapolation"))

##(3) fit using the 'alternate' mode
LxTxData[1,2:3] <- c(0.5, 0.001)
print(fit_DoseResponseCurve(LxTxData, mode = "alternate"))

##(4) import and fit test data set by Berger & Huntley 1989
QNL84_2_unbleached <-
read.table(system.file("extdata/QNL84_2_unbleached.txt", package = "Luminescence"))

results <- fit_DoseResponseCurve(
  QNL84_2_unbleached,
  mode = "extrapolation",
  verbose = FALSE)

#calculate confidence interval for the parameters
#as alternative error estimation
confint(results$Fit, level = 0.68)

## Not run:
##(5) special case the OTORX model with test dose column
df <- cbind(LxTxData, Test_Dose = 15)
fit_DoseResponseCurve(object = df, fit.method = "OTORX", n.MC = 10) |>
  plot_DoseResponseCurve()

QNL84_2_bleached <-
read.table(system.file("extdata/QNL84_2_bleached.txt", package = "Luminescence"))
STRB87_1_unbleached <-
read.table(system.file("extdata/STRB87_1_unbleached.txt", package = "Luminescence"))
STRB87_1_bleached <-
read.table(system.file("extdata/STRB87_1_bleached.txt", package = "Luminescence"))
```

```
print(
  fit_DoseResponseCurve(
    QNL84_2_bleached,
    mode = "alternate",
    verbose = FALSE)$Fit)

print(
  fit_DoseResponseCurve(
    STRB87_1_unbleached,
    mode = "alternate",
    verbose = FALSE)$Fit)

print(
  fit_DoseResponseCurve(
    STRB87_1_bleached,
    mode = "alternate",
    verbose = FALSE)$Fit)

## End(Not run)
```

fit_EmissionSpectra	<i>Luminescence Emission Spectra Deconvolution</i>
---------------------	--

Description

This function performs a luminescence spectra deconvolution on [RLum.Data.Spectrum](#) and [matrix](#) objects on an **energy scale**. The function is optimised for emission spectra typically obtained in the context of TL, OSL and RF measurements detected between 200 and 1000 nm. The function is not designed to deconvolve TL curves (counts against temperature; no wavelength scale). If you are interested in such analysis, please check, e.g., package 'tgcd'.

Usage

```
fit_EmissionSpectra(
  object,
  frame = NULL,
  n_components = NULL,
  start_parameters = NULL,
  sub_negative = 0,
  input_scale = NULL,
  method_control = list(),
  verbose = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

object	RLum.Data.Spectrum , matrix (required): input object. Please note that an energy spectrum is expected
frame	integer (<i>optional</i>): number of the frame to be analysed. If NULL, all available frames are analysed.
n_components	integer (<i>optional</i>): maximum number of components desired: the number of component actually fitted may be smaller than this. Can be combined with other parameters.
start_parameters	numeric (<i>optional</i>): allows to provide own start parameters for a semi-automated procedure. Parameters need to be provided in eV. Every value provided replaces a value from the automated peak finding algorithm (in ascending order).
sub_negative	numeric (<i>with default</i>): substitute negative values in the input object by the number provided here (default: 0). Can be set to NULL, i.e. negative values are kept.
input_scale	character (<i>optional</i>): defines whether your x-values are expressed as wavelength or energy values. Allowed values are "wavelength", "energy" or NULL, in which case the function tries to guess the input automatically.
method_control	list (<i>optional</i>): options to control the fit method and the output produced, see details.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further arguments to be passed to control the plot output (supported: main, xlab, ylab, xlim, ylim, log, mtext, legend (TRUE or FALSE), legend.text, legend.pos)

Details**Used equation**

The emission spectra (on an energy scale) can be best described as the sum of multiple Gaussian components:

$$y = \sum_i \frac{C_i}{\sigma_i \sqrt{2\pi}} \exp(-1/2((x - \mu_i)/\sigma_i)^2)$$

with the parameters σ (peak width) and μ (peak centre) and C (scaling factor).

Start parameter estimation and fitting algorithm

The spectrum deconvolution consists of the following steps:

1. Peak finding
2. Start parameter estimation
3. Fitting via [minpack.lm::nls.lm](#)

The peak finding is based on an approach (re-)suggested by Petr Pikal in November 2005 in the R-help mailing list (<https://stat.ethz.ch/pipermail/r-help/2005-November/thread.html>). This goes back to even earlier discussion in 2001 based on Prof Brian Ripley's idea. It smartly uses the functions `stats::embed` and `max.col` to identify peaks positions. For the use in this context, the algorithm has been further modified to scale on the input data resolution (cf. source code).

The start parameter estimation uses random sampling from a range of meaningful parameters and repeats the fitting until 1000 successful fits have been produced or the set `max.runs` value is exceeded.

Currently the best fit is the one with the lowest number for squared residuals, but other parameters are returned as well. If a series of curves needs to be analysed, it is recommended to make few trial runs, then fix the number of components and run at least 10,000 iterations (parameter `method_control = list(max.runs = 10000)`).

Supported method_control settings

Parameter	Type	Default	Description
<code>max.runs</code>	integer	10000	maximum allowed search iterations, if exceed the searching stops
<code>graining</code>	numeric	15	control over how coarse or fine the spectrum is split into search intervals for the p
<code>norm</code>	logical	TRUE	normalise data to the highest count value before fitting
<code>export.plot.data</code>	logical	FALSE	enable/disable export of the values of all curves in the plot for each frame analyse
<code>trace</code>	logical	FALSE	enable/disable the tracing of the minimisation routine

Value

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
<code>\$data</code>	matrix	the final fit matrix
<code>\$fit</code>	nls	the fit object returned by <code>minpack.lm::nls.lm</code>
<code>\$fit_info</code>	list	a few additional parameters that can be used to assess the quality of the fit
<code>\$df_plot</code>	list	values of all curves in the plot for each frame analysed (only if <code>method_control\$export.plot.data</code>

slot: @info

The original function call

[TERMINAL OUTPUT]

The terminal output provides brief information on the deconvolution process and the obtained results. Terminal output is only shown when `verbose = TRUE`.

[PLOT OUTPUT]

The function returns a plot showing the raw signal with the detected components. If the fitting failed, a basic plot is returned showing the raw data and indicating the peaks detected for the start parameter estimation. The grey band in the residual plot indicates the 10% deviation from 0 (means no residual).

Function version

0.1.3

How to cite

Kreutzer, S., Colombo, M., 2026. fit_EmissionSpectra(): Luminescence Emission Spectra Deconvolution. Function version 0.1.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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See Also

[RLum.Data.Spectrum](#), [RLum.Results](#), [plot_RLum](#), [convert_Wavelength2Energy](#), [minpack.lm::nls.lm](#)

Examples

```
##load example data
data(ExampleData.XSYG, envir = environment())

##subtract background
TL.Spectrum@data <- TL.Spectrum@data[] - TL.Spectrum@data[,15]

results <- fit_EmissionSpectra(
  object = TL.Spectrum,
  frame = 5,
  method_control = list(max.runs = 10)
)

##deconvolution of a TL spectrum
## Not run:

##load example data
```

```
##replace 0 values
results <- fit_EmissionSpectra(
  object = TL.Spectrum,
  frame = 5, main = "TL spectrum"
)

## End(Not run)
```

fit_LMCurve

Non-linear Least Squares Fit for LM-OSL curves

Description

The function determines weighted non-linear least-squares estimates of the component parameters of an LM-OSL curve (Bulur 1996) for a given number of components and returns various component parameters. The fitting procedure uses the Levenberg-Marquardt algorithm as implemented in function `nlsLM` from package `minpack.lm`.

Usage

```
fit_LMCurve(
  object,
  object.bg,
  n.components = 3,
  start_values = NULL,
  input.dataType = c("LM", "pLM"),
  sample_code = "",
  sample_ID = "",
  LED.power = 36,
  LED.wavelength = 470,
  fit.trace = FALSE,
  fit.calcError = FALSE,
  bg.subtraction = c("polynomial", "linear", "channel", "none"),
  verbose = TRUE,
  plot = TRUE,
  plot.BG = FALSE,
  plot.residuals = TRUE,
  plot.contribution = TRUE,
  legend = TRUE,
  legend.pos = "topright",
  method_control = list(),
  ...
)
```

Arguments

object	RLum.Data.Curve or data.frame (required): x,y data of measured values (time and counts).
object.bg	RLum.Data.Curve or data.frame (<i>optional</i>): x,y data of measured values (time and counts) for background subtraction.
n.components	integer (<i>with default</i>): fixed number of components that are to be recognised during fitting (min = 1, max = 7).
start_values	data.frame (<i>optional</i>): starting values for I_m and x_m parameters in the fit. If set to NULL, an automatic start value estimation is attempted (see details).
input.dataType	character (<i>with default</i>): alter the plot output depending on the input data: "LM" or "pLM" (pseudo-LM). See: convert_CW2pLM
sample_code	character (<i>optional</i>): sample code used for the plot and the optional output table (mtext).
sample_ID	character (<i>optional</i>): additional identifier used as column header for the table output.
LED.power	numeric (<i>with default</i>): LED power (max.) used for intensity ramping in mW/cm ² . Note: This value is used for the calculation of the absolute photoionisation cross section.
LED.wavelength	numeric (<i>with default</i>): LED wavelength in nm used for stimulation. Note: This value is used for the calculation of the absolute photoionisation cross section.
fit.trace	logical (<i>with default</i>): traces the fitting process on the terminal.
fit.calcError	logical (<i>with default</i>): calculate 1-sigma error range of components using stats::confint .
bg.subtraction	character (<i>with default</i>): specifies method for background subtraction (one of "polynomial", "linear", "channel", or "none", see Details). Only considered if object.bg is specified.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
plot	logical (<i>with default</i>): enable/disable the plot output.
plot.BG	logical (<i>with default</i>): enable/disable a plot of the background values with the fit used for the background subtraction.
plot.residuals	logical (<i>with default</i>): enable/disable the plot of the residuals.
plot.contribution	logical (<i>with default</i>): enable/disable the plot of the component contribution.
legend	logical (<i>with default</i>): enable/disable the plot legend.
legend.pos	character (<i>with default</i>): keyword specifying the position of the legend.
method_control	list (<i>optional</i>): options to control the output produced. Currently only the 'export.comp.contrib.matrix' (logical) option is supported, to enable/disable export of the component contribution matrix.
...	Further arguments that may be passed to the plot output, e.g. main, xlab, ylab, xlim, ylim, cex, log.

Details

Fitting function

The function for the fitting has the general form:

$$y = (\exp(0.5)*Im_1*x/xm_1)*\exp(-x^2/(2*xm_1^2)) + \dots + \exp(0.5)*Im_i*x/xm_i*\exp(-x^2/(2*xm_i^2))$$

where $1 < i < 8$

This function and the equations for the conversion to b (detrapping probability) and $n0$ (proportional to initially trapped charge) have been taken from Kitis et al. (2008):

$$xm_i = \sqrt{\max(t)/b_i}$$

$$Im_i = \exp(-0.5)n0/xm_i$$

Background subtraction

When a background signal is provided with the `object.bg` argument, the user can choose among three methods for background subtraction by setting the `bg.subtraction` argument to one of these:

- "polynomial" (default): a polynomial function is fitted using `glm` and the resulting function is used for background subtraction:

$$y = ax^4 + bx^3 + cx^2 + dx + e$$

- "linear": a linear function is fitted using `glm` and the resulting function is used for background subtraction:

$$y = ax + b$$

- "channel": the measured background signal is subtracted channel-wise from the measured signal.
- "none": this disables background subtraction even if `object.bg` is provided.

Start values

The choice of the initial parameters for the nls-fitting is a crucial point and the fitting procedure may mainly fail due to ill chosen start parameters. Here, three options are provided:

(a) If `start_values` is not provided by the user, a cheap guess is made by using the detrapping values found by Jain et al. (2003) for quartz for a maximum of 7 components. Based on these values, the pseudo start parameters xm and Im are recalculated for the given data set. In all cases, fitting starts with the ultra-fast component and (depending on `n.components`) steps through the following values. If no fit could be achieved, an error plot (for `plot = TRUE`) with the pseudo curve (based on the pseudo start parameters) is provided. This may give the opportunity to identify appropriate start parameters visually.

(b) If start values are provided, the function works like a simple `nls` fitting approach.

Goodness of fit

The goodness of the fit is given by a pseudo- R^2 value (pseudo coefficient of determination). According to Lave (1970), the value is calculated as:

$$pseudoR^2 = 1 - RSS/TSS$$

where RSS is the Residual Sum of Squares, and TSS is the Total Sum of Squares.

Error of fitted component parameters

The 1-sigma error for the components is calculated using the function `stats::confint`. Due to considerable calculation time, this option is disabled by default. In addition, the error for the components can be estimated by using internal R functions like `summary`. See the `nls` help page for more information.

For more details on the nonlinear regression in R, see Ritz & Streibig (2008).

Value

Various types of plots are returned. For details see above. Furthermore an `RLum.Results` object is returned with the following structure:

@data:

```
.. $data : data.frame with fitting results
.. $fit : nls (nls object)
.. $component_matrix : matrix with numerical xy-values of the single fitted components with the
resolution of the input data .. $component.contribution.matrix : list component distribution
matrix (produced only if method_control$export.comp.contrib.matrix = TRUE)
```

info:

```
.. $call : call the original function call
```

Matrix structure for the distribution matrix:

Column 1 and 2: time and rev(time) values

Additional columns are used for the components, two for each component, containing `I0` and `n0`. The last columns `cont.` provide information on the relative component contribution for each time interval including the row sum for this values.

Function version

0.3.8

How to cite

Kreutzer, S., 2026. `fit_LMCurve()`: Non-linear Least Squares Fit for LM-OSL curves. Function version 0.3.8. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The pseudo- R^2 may not be the best parameter to describe the goodness of the fit. The trade off between the `n.components` and the pseudo- R^2 value currently remains unconsidered.

The function **does not** ensure that the fitting procedure has reached a global minimum rather than a local minimum! In any case of doubt, the use of manual start values is highly recommended.

Author(s)

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References

- Bulur, E., 1996. An Alternative Technique For Optically Stimulated Luminescence (OSL) Experiment. *Radiation Measurements* 26, 5, 701-709.
- Jain, M., Murray, A.S., Boetter-Jensen, L., 2003. Characterisation of blue-light stimulated luminescence components in different quartz samples: implications for dose measurement. *Radiation Measurements* 37 (4-5), 441-449.
- Kitis, G. & Pagonis, V., 2008. Computerized curve deconvolution analysis for LM-OSL. *Radiation Measurements* 43, 737-741.
- Lave, C.A.T., 1970. The Demand for Urban Mass Transportation. *The Review of Economics and Statistics* 52 (3), 320-323.
- Ritz, C. & Streibig, J.C., 2008. Nonlinear Regression with R. R. Gentleman, K. Hornik, & G. Parmigiani, eds., Springer, p. 150.

See Also

[fit_CWCurve](#), [plot](#), [nls](#), [minpack.lm::nlsLM](#), [get_RLum](#)

Examples

```
##(1) fit LM data without background subtraction
data(ExampleData.FittingLM, envir = environment())
fit_LMCurve(values.curve, n.components = 3, log = "x")

##(2) fit LM data with background subtraction and export as JPEG
## -alter file path for your preferred system
##jpeg(file = "~/Desktop/Fit_Output\\%03d.jpg", quality = 100,
## height = 3000, width = 3000, res = 300)
data(ExampleData.FittingLM, envir = environment())
fit_LMCurve(values.curve, object.bg = values.curveBG,
            n.components = 2, log = "x", plot.BG = TRUE)
##dev.off()

##(3) fit LM data with manual start parameters
data(ExampleData.FittingLM, envir = environment())
fit_LMCurve(values.curve,
            object.bg = values.curveBG,
            n.components = 3,
            log = "x",
            start_values = data.frame(Im = c(170,25,400), xm = c(56,200,1500)))
```

Description

Fitting and Deconvolution of OSL Lifetime Components

Usage

```
fit_OSLLifeTimes(
  object,
  tp = 0,
  signal_range = NULL,
  n.components = NULL,
  method_control = list(),
  plot = TRUE,
  plot_simple = FALSE,
  verbose = TRUE,
  ...
)
```

Arguments

- | | |
|----------------|---|
| object | RLum.Data.Curve , RLum.Analysis , data.frame or matrix (required): Input object containing the data to be analysed. All objects can be provided also as list for an automated processing. Please note: NA values are automatically removed and the dataset should comprise at least 5 data points (possibly more if n.components is set to a value greater than 1) |
| tp | numeric (<i>with default</i>): option to account for the stimulation pulse width. For off-time measurements the default value is 0. tp has the same unit as the measurement data, e.g., μs . Please set this parameter carefully, if it all, otherwise you may heavily bias your fit results. |
| signal_range | numeric (<i>optional</i>): set a channel range, either by specifying both extremes, e.g. <code>signal_range = c(2, 100)</code> considers only channels 2 to 100, or only the start of the range, e.g. <code>signal_range = 2</code> considers only channels from channel 2 onwards. If NULL (default) all channels are used. |
| n.components | numeric (<i>optional</i>): Fix the number of components. If set the algorithm will try to fit the number of predefined components. If nothing is set, the algorithm will try to find the best number of components. |
| method_control | list (<i>optional</i>): Named to allow a more fine control of the fitting process. See details for allowed options. |
| plot | logical (<i>with default</i>): Enable/disable the plot output. |
| plot_simple | logical (<i>with default</i>): Enable/disable the reduced plot output. If TRUE, no residual plot is shown, however, plot output can be combined using the standard R layout options, such as <code>par(mfrow = c(2,2))</code> . |

verbose [logical](#) (with default): Enable/disable output to the terminal.
... parameters passed to [plot.default](#) to control the plot output, supported are: main, xlab, ylab, log, xlim, ylim, col, lty, legend.pos, legend.text. If the input object is of type [RLum.Analysis](#) this arguments can be provided as a [list](#).

Details

The function intends to provide an easy access to pulsed optically stimulated luminescence (OSL) data, in order determine signal lifetimes. The fitting is currently optimised to work with the off-time flank of OSL measurements only. For the signal deconvolution, a differential evolution optimisation is combined with nonlinear least-square fitting following the approach by Bluszcz & Adamiec (2006).

Component deconvolution algorithm

The component deconvolution consists of two steps:

(1) Adaptation phase

In the adaptation phase the function tries to figure out the optimal and statistically justified number of signal components following roughly the approach suggested by Bluszcz & Adamiec (2006). In contrast to their work, for the optimisation by differential evolution here the package 'DEoptim' is used.

The function to be optimized has the form:

$$\chi^2 = \sum (w * (n_i/c - \sum (A_i * \exp(-x/(tau_i + t_p))))^2)$$

with $w = 1$ for unweighted regression analysis (`method_control = list(weights = FALSE)`) or $w = c^2/n_i$ for weighted regression analysis. The default values is TRUE.

$$F = (\Delta\chi^2/2)/(\chi^2/(N - 2 * m - 2))$$

(2) Final fitting

method_control

Parameter	Type	Description
p	numeric	controls the probability for the F statistic reference values. For a significance level of 5 % a value of 0.05 is used.
seed	numeric	set the seed for the random number generator, provide a value here to get reproducible results
DEoptim.trace	logical	enable/disable the tracing of the differential evolution (cf. DEoptim::DEoptim.control)
DEoptim.itermax	logical	control the number of the allowed generations (cf. DEoptim::DEoptim.control)
weights	logical	enable/disable the weighting for the start parameter estimation and fitting (see equations above)
nlsLM.trace	logical	enable/disable trace mode for the nls fitting (minpack.lm::nlsLM), can be used to identify convergence
nlsLM.upper	logical	enable/disable upper parameter boundary, default is TRUE
nlsLM.lower	logical	enable/disable lower parameter boundary, default is TRUE

Value

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$data	matrix	the final fit matrix
\$start_matrix	matrix	the start matrix used for the fitting
\$total_counts	integer	Photon count sum
\$fit	nls	the fit object returned by minpack.lm::nls.lm

slot: @info

The original function call

[TERMINAL OUTPUT]

Terminal output is only shown if the argument `verbose = TRUE`.

(1) Start parameter and component adaption

Trace of the parameter adaptation process

(2) Fitting results (sorted by ascending tau)

The fitting results sorted by ascending tau value. Please note that if you access the nls fitting object, the values are not sorted.

(3) Further information

- The photon count sum
- Durbin-Watson residual statistic to assess whether the residuals are correlated, ideally the residuals should be not correlated at all. Rough measures are:
 D = 0: the residuals are systematically correlated
 D = 2: the residuals are randomly distributed
 D = 4: the residuals are systematically anti-correlated

You should be suspicious if D differs largely from 2.

[PLOT OUTPUT]

A plot showing the original data and the fit so far possible. The lower plot shows the residuals of the fit.

Function version

0.1.7

How to cite

Kreutzer, S., Schmidt, C., 2026. fit_OSLLifeTimes(): Fitting and Deconvolution of OSL Lifetime Components. Function version 0.1.7. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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References

Bluszcz, A., Adamiec, G., 2006. Application of differential evolution to fitting OSL decay curves. Radiation Measurements 41, 886-891. doi:10.1016/j.radmeas.2006.05.016

Durbin, J., Watson, G.S., 1950. Testing for Serial Correlation in Least Squares Regression: I. Biometrika 37, 409-21. doi:10.2307/2332391

Further reading

Hughes, I., Hase, T., 2010. Measurements and Their Uncertainties. Oxford University Press.

Storn, R., Price, K., 1997. Differential Evolution – A Simple and Efficient Heuristic for Global Optimization over Continuous Spaces. Journal of Global Optimization 11, 341–359.

See Also

[minpack.lm::nls.lm](#), [DEoptim::DEoptim](#)

Examples

```
##load example data
data(ExampleData.TR_OSL, envir = environment())

##fit lifetimes (short run)
fit_OSLLifeTimes(
  object = ExampleData.TR_OSL,
  n.components = 1)

##long example
## Not run:
fit_OSLLifeTimes(
  object = ExampleData.TR_OSL)

## End(Not run)
```

fit_SurfaceExposure	<i>Nonlinear Least Squares Fit for OSL surface exposure data</i>
---------------------	--

Description

This function determines the (weighted) least-squares estimates of the parameters of either equation 1 in *Sohbati et al. (2012a)* or equation 12 in *Sohbati et al. (2012b)* for a given OSL surface exposure data set (**BETA**).

Usage

```
fit_SurfaceExposure(  
  data,  
  sigmaphi = NULL,  
  mu = NULL,  
  age = NULL,  
  Ddot = NULL,  
  D0 = NULL,  
  weights = FALSE,  
  plot = TRUE,  
  legend = TRUE,  
  errorBars = TRUE,  
  coord_flip = FALSE,  
  ...  
)
```

Arguments

data [data.frame](#) or [list](#) (**required**): Measured OSL surface exposure data with the following structure:

		(optional)		
	depth (a.u.)	intensity	error	
	[,1]	[,2]	[,3]	
	-----	-----	-----	
[1,]	~~~~	~~~~	~~~~	
[2,]	~~~~	~~~~	~~~~	
...	...	...	...	
[x,]	~~~~	~~~~	~~~~	

Alternatively, a [list](#) of `data.frame`s can be provided, where each `data.frame` has the same structure as shown above, with the exception that they must **not** include the optional error column. Providing a [list](#) as input automatically activates the global fitting procedure (see details).

sigmaphi [numeric](#) (*optional*): A numeric value for sigmaphi, i.e. the charge detrapping rate. Example: sigmaphi = 5e-10

mu	numeric (<i>optional</i>): A numeric value for mu, i.e. the light attenuation coefficient. If data is a list of n samples, then mu must be a vector of length 1 or n . Example: mu = 0.9, or mu = c(0.9, 0.8, 0.9).
age	numeric (<i>optional</i>): The age (a) of the sample, if known. If data is a list of n samples, then age must be a numeric vector of length n . Example: age = 10000, or age = c(1e4, 1e5, 1e6).
Ddot	numeric (<i>optional</i>): A numeric value for the environmental dose rate (Gy/ka). For this argument to be considered a value for D0 must also be provided; otherwise it will be ignored.
D0	numeric (<i>optional</i>): A numeric value for the characteristic saturation dose (Gy). For this argument to be considered a value for Ddot must also be provided; otherwise it will be ignored.
weights	logical (<i>with default</i>): If TRUE the fit will be weighted by the inverse square of the error. Requires data to be a data.frame with three columns.
plot	logical (<i>with default</i>): enable/disable the plot output.
legend	logical (<i>with default</i>): Show or hide the equation inside the plot.
errorBars	logical (<i>with default</i>): Show or hide error bars (only applies if errors were provided).
coord_flip	logical (<i>with default</i>): Flip the coordinate system.
...	Further parameters passed to plot . Custom parameters include: • verbose (logical): enable/disable output to the terminal • line_col: Colour of the fitted line • line_lty: Type of the fitted line (see lty in ?par) • line_lwd: Line width of the fitted line (see lwd in ?par)

Details

Weighted fitting

If weights = TRUE the function will use the inverse square of the error ($1/\sigma^2$) as weights during fitting using **minpack.lm::nlsLM**. Naturally, for this to take effect individual errors must be provided in the third column of the **data.frame** for data. Weighted fitting is **not** supported if data is a list of multiple **data.frames**, i.e., it is not available for global fitting.

Dose rate If any of the arguments Ddot or D0 is at its default value (NULL), this function will fit equation 1 in Sohbaty et al. (2012a) to the data. If the effect of dose rate (i.e., signal saturation) needs to be considered, numeric values for the dose rate (Ddot) (in Gy/ka) and the characteristic saturation dose (D0) (in Gy) must be provided. The function will then fit equation 12 in Sohbaty et al. (2012b) to the data.

Note: Currently, this function does **not** consider the variability of the dose rate with sample depth (x)! In the original equation the dose rate D is an arbitrary function of x (term D(x)), but here D is assumed constant.

Global fitting If data is **list** of multiple **data.frames**, each representing a separate sample, the function automatically performs a global fit to the data. This may be useful to better constrain the parameters sigmaphi or mu and **requires** that a known age for each sample (e.g., age = c(100, 1000) if data is a list with two samples).

Value

Function returns results numerically and graphically:

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$summary	data.frame	summary of the fitting results
\$data	data.frame	the original input data
\$fit	nls	the fitting object produced by minpack.lm::nlsLM
\$args	character	arguments of the call
\$call	call	the original function call

slot: @info

Currently unused.

[PLOT OUTPUT]

A scatter plot of the provided depth-intensity OSL surface exposure data with the fitted model.

Function version

0.1.0

How to cite

Burow, C., 2026. fit_SurfaceExposure(): Nonlinear Least Squares Fit for OSL surface exposure data. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function has BETA status. If possible, results should be cross-checked.

Author(s)

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References

Sohbati, R., Murray, A.S., Chapot, M.S., Jain, M., Pederson, J., 2012a. Optically stimulated luminescence (OSL) as a chronometer for surface exposure dating. *Journal of Geophysical Research* 117, B09202. doi: [doi:10.1029/2012JB009383](https://doi.org/10.1029/2012JB009383)

Sohbati, R., Jain, M., Murray, A.S., 2012b. Surface exposure dating of non-terrestrial bodies using optically stimulated luminescence: A new method. *Icarus* 221, 160-166.

See Also

[ExampleData.SurfaceExposure](#), [minpack.lm::nlsLM](#)

Examples

```
## Load example data
data("ExampleData.SurfaceExposure")

## Example 1 - Single sample
# Known parameters: 10000 a, mu = 0.9, sigmaphi = 5e-10
sample_1 <- ExampleData.SurfaceExposure$sample_1
head(sample_1)
results <- fit_SurfaceExposure(
  data = sample_1,
  mu = 0.9,
  sigmaphi = 5e-10)
get_RLum(results)

## Example 2 - Single sample and considering dose rate
# Known parameters: 10000 a, mu = 0.9, sigmaphi = 5e-10,
# dose rate = 2.5 Gy/ka, D0 = 40 Gy
sample_2 <- ExampleData.SurfaceExposure$sample_2
head(sample_2)
results <- fit_SurfaceExposure(
  data = sample_2,
  mu = 0.9,
  sigmaphi = 5e-10,
  Ddot = 2.5,
  D0 = 40)
get_RLum(results)

## Example 3 - Multiple samples (global fit) to better constrain 'mu'
# Known parameters: ages = 1e3, 1e4, 1e5, 1e6 a, mu = 0.9, sigmaphi = 5e-10
set_1 <- ExampleData.SurfaceExposure$set_1
str(set_1, max.level = 2)
results <- fit_SurfaceExposure(
  data = set_1,
  age = c(1e3, 1e4, 1e5, 1e6),
  sigmaphi = 5e-10)
get_RLum(results)

## Example 4 - Multiple samples (global fit) and considering dose rate
# Known parameters: ages = 1e2, 1e3, 1e4, 1e5, 1e6 a, mu = 0.9, sigmaphi = 5e-10,
```

```
# dose rate = 1.0 Ga/ka, D0 = 40 Gy
set_2 <- ExampleData.SurfaceExposure$set_2
str(set_2, max.level = 2)
results <- fit_SurfaceExposure(
  data = set_2,
  age = c(1e2, 1e3, 1e4, 1e5, 1e6),
  sigmaphi = 5e-10,
  Ddot = 1,
  D0 = 40)
get_RLum(results)
```

fit_ThermalQuenching *Fitting Thermal Quenching Data*

Description

Applying a nls-fitting to thermal quenching data.

Usage

```
fit_ThermalQuenching(
  data,
  start_param = list(),
  method_control = list(),
  n.MC = 100,
  verbose = TRUE,
  plot = TRUE,
  ...
)
```

Arguments

data	data.frame (required) : input data with three columns, the first column contains temperature values in deg. C, columns 2 and 3 the dependent values with its error
start_param	list (optional) : option to provide the start parameters for the fitting, see details
method_control	list (optional) : further options to fine tune the fitting, see details for further information
n.MC	integer (with default) : number of Monte Carlo runs for the error estimation. If n.MC is NULL or 1, the error estimation is skipped.
verbose	logical (with default) : enable/disable output to the terminal.
plot	logical (with default) : enable/disable the plot output.
...	further arguments that can be passed to control the plotting, support are main, pch, col_fit, col_points, lty, lwd, xlab, ylab, xlim, ylim, xaxt

Details

Used equation

The equation used for the fitting is

$$y = A/(1 + C * \exp(-W/(k_B x))) + c$$

W is the energy depth in eV, C is a dimensionless constant, A and c are used to adjust the curve for the given signal, k_B is the Boltzmann constant in eV/K and x is the absolute temperature in K.

Error estimation

The error estimation is done by varying the input parameters using the given uncertainties in a Monte Carlo simulation. Errors are assumed to follow a normal distribution.

start_param

The function allows the injection of starting values for the parameters to be optimised via the start_param argument. The parameters must be provided as a named list. Examples: start_param = list(A = 1, C = 1e+5, W = 0.5, c = 0)

method_control

The following arguments can be provided via method_control. Please note that arguments provided via method_control are not further tested, i.e., if the function crashes your input was probably wrong.

ARGUMENT	TYPE	DESCRIPTION
upper	named vector	sets upper fitting boundaries, if provided boundaries for all arguments are required, e.g., c(A
lower	names vector	set lower fitting boundaries (see upper for details)
trace	logical	enable/disable progression trace for minpack.lm::nlsLM
weights	numeric	option to provide own weights for the fitting, the length of this vector needs to be equal to the

Value

The function returns numerical output and an (*optional*) plot.

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

[.. \$data : data.frame]

A table with all fitting parameters and the number of Monte Carlo runs used for the error estimation (this may be smaller than n.MC).

[.. \$fit : nls object]

The nls `stats::nls` object returned by the function `minpack.lm::nlsLM`. This object can be further passed to other functions supporting an nls object (cf. details section in `stats::nls`)

```
slot: @info
[. $call : call]
```

The original function call.

[GRAPHICAL OUTPUT]

Plotted are temperature against the signal and their uncertainties. The fit is shown as dashed-line (can be modified). Please note that for the fitting the absolute temperature values are used but are re-calculated to deg. C for the plot.

Function version

0.2

How to cite

Kreutzer, S., Colombo, M., 2026. `fit_ThermalQuenching()`: Fitting Thermal Quenching Data. Function version 0.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Marco Colombo, Institute of Geography, Heidelberg University (Germany) , RLum Developer Team

References

Wintle, A.G., 1975. Thermal Quenching of Thermoluminescence in Quartz. *Geophys. J. R. astr. Soc.* 41, 107–113.

See Also

[minpack.lm::nlsLM](#)

Examples

```
##create short example dataset
data <- data.frame(
  T = c(25, 40, 50, 60, 70, 80, 90, 100, 110),
  V = c(0.06, 0.058, 0.052, 0.051, 0.041, 0.034, 0.035, 0.033, 0.032),
  V_X = c(0.012, 0.009, 0.008, 0.008, 0.007, 0.006, 0.005, 0.005, 0.004))
```

```
##fit
fit_ThermalQuenching(
  data = data,
  n.MC = NULL)
```

get_Layout

Collection of layout definitions

Description

This helper function returns a list with layout definitions for homogeneous plotting.

The easiest way to create a user-specific layout definition is perhaps to create either an empty or a default layout object and fill/modify the definitions (`user.layout <- get_Layout(data = "empty")`).

Usage

```
get_Layout(layout)
```

Arguments

`layout` **character** or **list** object (**required**): name of the layout definition to be returned. If name is provided the respective definition is returned. One of the following supported layout definitions is possible: "default", "journal.1", "small", "empty".

User-specific layout definitions must be provided as a list object of predefined structure, see details.

Value

A list object with layout definitions for plot functions.

Function version

0.1

How to cite

Dietze, M., 2026. `get_Layout()`: Collection of layout definitions. Function version 0.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Michael Dietze, GFZ Potsdam (Germany) , RLum Developer Team

Examples

```
## read example data set
data(ExampleData.DeValues, envir = environment())

## show structure of the default layout definition
layout.default <- get_Layout(layout = "default")
str(layout.default)

## show colour definitions for Abanico plot, only
layout.default$abanico$colour

## set Abanico plot title colour to orange
layout.default$abanico$colour$main <- "orange"

## create Abanico plot with modified layout definition
plot_AbanicoPlot(data = ExampleData.DeValues,
                 layout = layout.default)

## create Abanico plot with predefined layout "journal"
plot_AbanicoPlot(data = ExampleData.DeValues,
                 layout = "journal")
```

get_rightAnswer	<i>Function to get the right answer</i>
-----------------	---

Description

This function returns just the right answer

Usage

```
get_rightAnswer(...)
```

Arguments

... you can pass an infinite number of further arguments

Value

Returns the right answer

Function version

0.1.0

How to cite

NA, NA, , , 2026. get_rightAnswer(): Function to get the right answer. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

inspired by R.G. , RLum Developer Team

Examples

```
## you really want to know?
get_rightAnswer()
```

get_RLum

General accessor function for RLum-class objects

Description

The function provides a generalised access point for specific **RLum** objects. Depending on the input object, the corresponding function will be selected.

Usage

```
get_RLum(object, ...)

## S4 method for signature 'list'
get_RLum(object, class = NULL, null.rm = FALSE, ...)

## S4 method for signature 'NULL'
get_RLum(object, ...)

## S4 method for signature 'RLum.Analysis'
get_RLum(
  object,
  record.id = NULL,
  recordType = NULL,
  curveType = NULL,
  RLum.type = NULL,
  protocol = "UNKNOWN",
  get.index = FALSE,
  drop = TRUE,
  recursive = TRUE,
  info.object = NULL,
```

```

    subset = NULL,
    env = parent.frame(2),
    verbose = TRUE
)

## S4 method for signature 'RLum.Data.Curve'
get_RLum(object, info.object = NULL)

## S4 method for signature 'RLum.Data.Image'
get_RLum(object, info.object = NULL)

## S4 method for signature 'RLum.Data.Spectrum'
get_RLum(object, info.object = NULL)

## S4 method for signature 'RLum.Results'
get_RLum(object, data.object, info.object = NULL, drop = TRUE)

```

Arguments

object	RLum (required) : S4 object of class RLum or an object of type list containing only objects of type RLum
...	further arguments passed to the specific class method.
class	character (<i>optional</i>): define which class gets selected if applied to a list, e.g., if a list consists of different type of RLum objects, this arguments allows to make a selection. If nothing is provided, all RLum objects are treated.
null.rm	logical (<i>with default</i>): whether empty and NULL objects should be removed.
record.id	numeric or logical (<i>optional</i>): IDs of specific records. If of type logical the entire id range is assumed and TRUE and FALSE indicates the selection.
recordType	character (<i>optional</i>): record type (e.g., "OSL"). Can be also a vector, for multiple matching, e.g., recordType = c("OSL", "IRSL")
curveType	character (<i>optional</i>): curve type (e.g. "predefined" or "measured")
RLum.type	character (<i>optional</i>): RLum object type. Defaults to "RLum.Data.Curve" and "RLum.Data.Spectrum".
protocol	character (<i>optional</i>): currently ignored.
get.index	logical (<i>optional</i>): return a numeric vector with the index of each element in the RLum.Analysis object (FALSE by default).
drop	logical (<i>with default</i>): coerce to the next possible layer (which are RLum.Data objects if object is an RLum.Analysis object). If drop = FALSE, an object of the same type as the input is returned.
recursive	logical (<i>with default</i>): if TRUE (default) when the result of the get_RLum() request is a single object, the object itself will be returned directly, rather than being wrapped in a list. Mostly this makes things easier, but this might be undesired if this method is used within a loop.
info.object	character (<i>optional</i>): name of the wanted info element.

subset	expression (<i>optional</i>): logical or character masking a logical expression indicating elements or rows to keep: missing values are taken as false. This argument takes precedence over all other arguments, meaning they are not considered when subsetting the object. subset works slots and info elements.
env	environment (<i>with default</i>): An environment passed to eval as the enclosure. This argument is only relevant when subsetting the object and should not be used manually.
verbose	logical (<i>with default</i>): Enable/disable output to the terminal.
data.object	character or numeric : name or index of the data slot to be returned.

Value

An object of the same type as the input object provided.

Methods (by class)

- `get_RLum(list)`: Returns a list of [RLum](#) objects that had been passed to [get_RLum](#)
- `get_RLum(~NULL~)`: Returns NULL.
- `get_RLum(RLum.Analysis)`: Accessor method for [RLum.Analysis](#) objects. The optional arguments `record.id`, `recordType`, `curveType` and `RLum.type` allow to limit records by their id (list index number), their record type (e.g. `recordType = "OSL"`), their curve type (e.g. `curveType = "predefined"` or `curveType = "measured"`), or object type.
The selection of a specific `RLum.type` object superimposes the default selection. Currently supported objects are: [RLum.Data.Curve](#) and [RLum.Data.Spectrum](#)
Returns:
 1. list of [RLum.Data](#) objects or
 2. Single [RLum.Data](#) object, if only one object is contained and `recursive = FALSE` or
 3. [RLum.Analysis](#) objects for `drop = FALSE`
- `get_RLum(RLum.Data.Curve)`: Accessor method for [RLum.Data.Curve](#) object. The argument `info.object` is optional to directly access the info elements. If no info element name is provided, the raw curve data (matrix) will be returned.
- `get_RLum(RLum.Data.Image)`: Accessor method for [RLum.Data.Image](#) objects. The argument `info.object` is optional to directly access the info elements. If no info element name is provided, the raw image data (array) will be returned.
- `get_RLum(RLum.Data.Spectrum)`: Accessor method for [RLum.Data.Spectrum](#) objects. The argument `info.object` is optional to directly access the info elements. If no info element name is provided, the raw curve data (matrix) will be returned.
- `get_RLum(RLum.Results)`: Accessor method for [RLum.Results](#) object. The argument `data.object` allows to access directly objects stored within the slot data. The default return object depends on the object originator (e.g., `fit_LMCurve`). If nothing is specified always the first `data.object` will be returned.

Note: Detailed specification should be made in combination with the originator slot in the receiving function if results are piped.

Returns:

1. Data object from the specified slot

2. [list](#) of data objects from the slots if 'data.object' is vector or
3. an [RLum.Results](#) for drop = FALSE.

Function version

0.3.3

How to cite

Kreutzer, S., 2026. `get_RLum()`: General accessor function for RLum-class objects. Function version 0.3.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Data.Image](#), [RLum.Data.Spectrum](#), [RLum.Analysis](#), [RLum.Results](#)

Examples

```
## Example based using data and from the calc_CentralDose() function

## load example data
data(ExampleData.DeValues, envir = environment())

## apply the central dose model 1st time
temp1 <- calc_CentralDose(ExampleData.DeValues$CA1)

## get results and store them in a new object
temp.get <- get_RLum(object = temp1)
```

import_Data

Import Luminescence Data into R

Description

Convenience wrapper function to provide a quicker and more standardised way of reading data into R by looping through all in the package available data import functions starting with `read_`. Import data types can be mixed.

Usage

```
import_Data(file, ..., fastForward = TRUE, verbose = FALSE)
```

Arguments

file	character (required) : file to be imported, can be a list or a character vector
...	arguments to be further passed down to supported functions (please check the functions to determine the correct arguments)
fastForward	logical (with default) : option to create RLum objects during import or a list of such objects
verbose	logical (with default) : enable/disable output to the terminal.

Value

Always returns a [list](#); empty or filled with [RLum.Analysis](#) objects

Function version

0.1.6

How to cite

Kreutzer, S., 2026. import_Data(): Import Luminescence Data into R. Function version 0.1.6. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[read_BIN2R](#), [read_BINXLOG2R](#), [read_Daybreak2R](#), [read_HeliosOSL2R](#), [read_PSL2R](#), [read_RF2R](#), [read_SPE2R](#), [read_TIFF2R](#), [read_XSYG2R](#)

Examples

```
## import BINX/BIN
file <- system.file("extdata/BINfile_V8.binx", package = "Luminescence")
temp <- import_Data(file)

## RF data
file <- system.file("extdata", "RF_file.rf", package = "Luminescence")
temp <- import_Data(file)
```

length_RLum	<i>Length retrieval function for RLum-class objects</i>
-------------	---

Description

The function provides a generalised access point for specific [RLum](#) objects. Depending on the input object, the corresponding function will be selected.

Usage

```
length_RLum(object)

## S4 method for signature 'RLum.Analysis'
length_RLum(object)

## S4 method for signature 'RLum.Data.Curve'
length_RLum(object)

## S4 method for signature 'RLum.Results'
length_RLum(object)
```

Arguments

object [RLum](#) (**required**): S4 object of class [RLum](#)

Value

An [integer](#) indicating the length of the object.

Methods (by class)

- `length_RLum(RLum.Analysis)`: Returns the number of records stored in the object.
- `length_RLum(RLum.Data.Curve)`: Returns the length of the curve object, which is the maximum of the value time/temperature of the curve (corresponding to the stimulation length).
- `length_RLum(RLum.Results)`: Returns the number of stored data elements.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. `length_RLum()`: Length retrieval function for [RLum](#)-class objects. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Data.Image](#), [RLum.Data.Spectrum](#), [RLum.Analysis](#), [RLum.Results](#)

melt_RLum

Melt RLum-class objects into a flat data.frame

Description

Melt RLum-class objects into a flat data.frame

Usage

```
melt_RLum(object, ...)

## S4 method for signature 'list'
melt_RLum(object, ...)

## S4 method for signature 'RLum.Analysis'
melt_RLum(object)

## S4 method for signature 'RLum.Data.Curve'
melt_RLum(object)
```

Arguments

object **RLum (required)**: S4 object of class RLum
 ... further arguments passed to the specific class method

Value

A flat [data.frame](#).

Methods (by class)

- melt_RLum(list): Returns a list of melted [RLum](#) objects; non-RLum objects are silently removed.
- melt_RLum(RLum.Analysis): Melts [RLum.Analysis](#) objects into a flat data.frame with columns X, Y, TYPE, UID, to be used in combination with other packages such as ggplot2.
- melt_RLum(RLum.Data.Curve): Melts [RLum.Data.Curve](#) objects into a flat data.frame with columns X, Y, TYPE, UID, to be used in combination with other packages such as ggplot2.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. melt_RLum(): Melt RLum-class objects into a flat data.frame. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Analysis](#)

Examples

```
data(ExampleData.XSYG, envir = environment())
melt_RLum(OSL.SARMeasurement[[2]][[1]])
```

merge_Risoe.BINfileData

Merge Risoe.BINfileData objects or Risoe BIN-files

Description

The function allows merging Risoe BIN/BINX files or [Risoe.BINfileData](#) objects.

Usage

```
merge_Risoe.BINfileData(
  object,
  output.file,
  keep.position.number = FALSE,
  position.number.append.gap = 0,
  verbose = TRUE,
  ...
)
```

Arguments

object	character or Risoe.BINfileData (required): Character vector with path and files names with ".bin" or ".binx" extension (e.g. <code>object = c("path/file1.bin", "path/file2.bin")</code>) or a list of Risoe.BINfileData objects (e.g. <code>object = c(object1, object2)</code>).
output.file	character (<i>optional</i>): File output path and name. If no value is given, a Risoe.BINfileData object returned instead of a file.
keep.position.number	logical (<i>with default</i>): Allows keeping the original position numbers of the input objects. Otherwise the position numbers are recalculated.
position.number.append.gap	integer (<i>with default</i>): Set the position number gap between merged BIN-file sets, if the option <code>keep.position.number = FALSE</code> is used. See details for further information.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	currently not used.

Details

The function allows merging different measurements to one file or one object. The record IDs are recalculated for the new object. Other values are kept for each object. The number of input objects is not limited.

position.number.append.gap option

If the option `keep.position.number = FALSE` is used, the position numbers of the new data set are recalculated by adding the highest position number of the previous data set to the each position number of the next data set. For example: The highest position number is 48, then this number will be added to all other position numbers of the next data set (e.g. $1 + 48 = 49$)

However, there might be cases where an additional addend (summand) is needed before the next position starts. Example:

- Position number set (A): 1, 3, 5, 7
- Position number set (B): 1, 3, 5, 7

With no additional summand the new position numbers would be: 1, 3, 5, 7, 8, 9, 10, 11. That might be unwanted. Using the argument `position.number.append.gap = 1` it will become: 1, 3, 5, 7, 9, 11, 13, 15, 17.

Value

Returns a [Risoe.BINfileData](#) object or writes to the BIN-file specified by `output.file`.

Function version

0.2.11

How to cite

Kreutzer, S., 2026. merge_Risoe.BINfileData(): Merge Risoe.BINfileData objects or Risoe BIN-files. Function version 0.2.11. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The validity of the output objects is not further checked.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Duller, G.A.T., 2007. Analyst (Version 3.24) (manual). Aberystwyth University, Aberystwyth.

See Also

[Risoe.BINfileData](#), [read_BIN2R](#), [write_R2BIN](#)

Examples

```
##merge two objects
data(ExampleData.BINfileData, envir = environment())

object1 <- CWOSL.SAR.Data
object2 <- CWOSL.SAR.Data

object.new <- merge_Risoe.BINfileData(c(object1, object2))
```

merge_RLum	<i>General merge function for RLum-class objects</i>
------------	--

Description

The function provides a generalised access point for merging specific [RLum](#) objects. Depending on the input object, the corresponding merge function will be selected. Allowed arguments can be found in the documentation of each merge function. Empty list elements (NULL) are automatically removed from the input list.

object		corresponding merge function
RLum.Data.Curve	->	merge_RLum.Data.Curve

```

RLum.Data.Spectrum -> merge_RLum.Data.Spectrum
RLum.Analysis      -> merge_RLum.Analysis
RLum.Results       -> merge_RLum.Results

```

Usage

```
merge_RLum(object, ...)
```

Arguments

object [list of RLum \(required\)](#): list of S4 object of class RLum.
... further arguments that one might want to pass to the specific merge function

Value

Returns an [RLum.Analysis](#) object of class if any of the inputs is of that class. Otherwise, it returns an object of the same type as the input.

Function version

0.1.4

How to cite

Kreutzer, S., 2026. merge_RLum(): General merge function for RLum-class objects. Function version 0.1.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

So far merging of [RLum.Data.Image](#) objects is not supported.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Data.Spectrum](#), [RLum.Analysis](#), [RLum.Results](#)

Examples

```

##Example based using data and from the calc_CentralDose() function

##load example data
data(ExampleData.DeValues, envir = environment())

```

```
##apply the central dose model 1st time
temp1 <- calc_CentralDose(ExampleData.DeValues$CA1)

##apply the central dose model 2nd time
temp2 <- calc_CentralDose(ExampleData.DeValues$CA1)

##merge the results and store them in a new object
temp.merged <- get_RLum(merge_RLum(object = list(temp1, temp2)))
```

names_RLum	<i>Name retrieval function for RLum-class objects</i>
------------	---

Description

The function provides a generalised access point for specific [RLum](#) objects. Depending on the input object, the corresponding function will be selected.

Usage

```
names_RLum(object)

## S4 method for signature 'list'
names_RLum(object)

## S4 method for signature 'RLum.Analysis'
names_RLum(object)

## S4 method for signature 'RLum.Data.Curve'
names_RLum(object)

## S4 method for signature 'RLum.Data.Image'
names_RLum(object)

## S4 method for signature 'RLum.Data.Spectrum'
names_RLum(object)

## S4 method for signature 'RLum.Results'
names_RLum(object)
```

Arguments

object [RLum](#) (**required**): S4 object of class [RLum](#)

Value

A [character](#) vector.

Methods (by class)

- `names_RLum(list)`: Returns a list of names of the [RLum](#) objects that had been passed to it.
- `names_RLum(RLum.Analysis)`: Returns the names of the [RLum.Data](#) objects stored in the object.
- `names_RLum(RLum.Data.Curve)`: Returns the names info elements stored in the object.
- `names_RLum(RLum.Data.Image)`: Returns the names of the info elements stored in the object.
- `names_RLum(RLum.Data.Spectrum)`: Returns the names of the info elements stored in the object.
- `names_RLum(RLum.Results)`: Returns the names of the data field stored in the object.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. `names_RLum()`: Name retrieval function for `RLum`-class objects. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , `RLum` Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Data.Image](#), [RLum.Data.Spectrum](#), [RLum.Analysis](#), [RLum.Results](#)

normalise_RLum

Normalisation of RLum-class objects

Description

The function provides a generalised access point for specific [RLum](#) objects. Depending on the input object, the corresponding function will be selected. The normalisation is performed in the internal function `.normalise_curve()`.

Usage

```

normalise_RLum(object, norm = TRUE, ...)

## S4 method for signature 'list'
normalise_RLum(object, norm = TRUE, ...)

## S4 method for signature 'RLum.Analysis'
normalise_RLum(object, norm = TRUE, ...)

## S4 method for signature 'RLum.Data.Curve'
normalise_RLum(object, norm)

## S4 method for signature 'RLum.Data.Image'
normalise_RLum(object, norm = TRUE, global = TRUE)

## S4 method for signature 'RLum.Data.Spectrum'
normalise_RLum(object, norm = TRUE)

```

Arguments

object	RLum (required) : S4 object of class RLum
norm	logical character (required) : if logical, whether curve normalisation should occur; alternatively, one of "max" (used with TRUE), "min", "first", "last", "huot", "intensity" or a positive number (e.g., 2.2).
...	further arguments passed to the specific class method
global	logical (*with default): this defines whether the normalisation is applied globally (same to all) or locally, in which case each frame has its own normalisation. If global = TRUE the arguments for norm = 'first' and norm = 'last' work as expected and consider either the first or the last frame for the normalisation. Normalise RLum.Data.Image objects to value set via the argument norm

Details

The norm argument normalises all count values. The following options are supported:

norm = TRUE or norm = "max": Curve values are normalised to the highest count value in the curve

norm = "min": Curve values are normalised to the smallest count value in the curve

norm = "first": Curve values are normalised to the first count value.

norm = "last": Curve values are normalised to the last count value (this can be useful in particular for radiofluorescence curves)

norm = "huot": Curve values are normalised as suggested by Sébastien Huot via GitHub:

$$y = (observed - median(background)) / (max(observed) - median(background))$$

The background of the curve is defined as the last 20% of the count values of a curve.

norm = "intensity": Curve values are normalised to the channel length.

norm = 2.2: Curve values are normalised to a positive number (e.g., 2.2).

Value

An object of the same type as the input object provided.

Functions

- `normalise_RLum(list)`: Returns a list of [RLum.Data](#) objects that had been passed to [normalise_RLum](#)
- `normalise_RLum(RLum.Analysis)`: Normalisation of `RLum.Data` records contained in the input object.
- `normalise_RLum(RLum.Data.Curve)`: Normalise [RLum.Data.Curve](#) objects to value set via the argument `norm`
- `normalise_RLum(RLum.Data.Image)`: Normalise [RLum.Data.Image](#) objects to value set via the argument `norm`.
- `normalise_RLum(RLum.Data.Spectrum)`: Normalise [RLum.Data.Spectrum](#) objects to value set via the argument `norm`

Function version

0.1.3

How to cite

Kreutzer, S., 2026. `normalise_RLum()`: Normalisation of `RLum`-class objects. Function version 0.1.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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See Also

[RLum.Data.Curve](#), [RLum.Analysis](#), [RLum.Data.Spectrum](#), [RLum.Data.Image](#)

Examples

```
## load example data
data(ExampleData.CW_OSL_Curve, envir = environment())

## create RLum.Data.Curve object from this example
curve <-
  set_RLum(
    class = "RLum.Data.Curve",
    recordType = "OSL",
    data = as.matrix(ExampleData.CW_OSL_Curve)
  )
```

```
## plot data without and with smoothing
plot_RLum(curve)
plot_RLum(normalise_RLum(curve))
```

plot_AbanicoPlot	<i>Function to create an abanico plot</i>
------------------	---

Description

The abanico plot provides a comprehensive presentation of data precision and its dispersion around a central value, and can also display a kernel density estimate, histogram and/or dot plot of the dose values.

Usage

```
plot_AbanicoPlot(
  data,
  log.z = TRUE,
  z.0 = c("mean.weighted", "mean", "median"),
  dispersion = c("qr", "sd", "2sd"),
  plot.ratio = 0.75,
  rotate = FALSE,
  mtext = "",
  summary = c("n", "in.2s"),
  summary.pos = "sub",
  summary.method = c("MCM", "weighted", "unweighted"),
  legend = NULL,
  legend.pos = "topleft",
  stats = NULL,
  rug = FALSE,
  kde = TRUE,
  hist = FALSE,
  dots = FALSE,
  boxplot = FALSE,
  y.axis = TRUE,
  error.bars = FALSE,
  bar = NULL,
  bar.col = NULL,
  polygon.col = NULL,
  line = NULL,
  line.col = NULL,
  line.lty = NULL,
  line.label = NULL,
  grid.col = NULL,
  frame = 1,
```

```

    interactive = FALSE,
    ...
)

```

Arguments

data	data.frame or RLum.Results object (required): for <code>data.frame</code> two columns: De (<code>data[,1]</code>) and De error (<code>data[,2]</code>). To plot several data sets in one plot the data sets must be provided as <code>list</code>, e.g. <code>list(data.1, data.2)</code>. Rows with NA values will be removed prior to plotting. For some RLum.Results objects, one or more lines (and corresponding labels) are drawn automatically: • calc_AverageDose (ADM) • calc_CentralDose (CDM) • calc_MaxDose (MDM) • calc_MinDose (MAM) • calc_FiniteMixture Alternative labels can be set via the <code>line.label</code> option. This behaviour can be suppressed altogether by setting <code>line = NA</code>.
log.z	logical (<i>with default</i>): display the z-axis in logarithmic scale (TRUE by default). The setting is automatically reset to FALSE if any zero values appear in the De column.
z.0	character or numeric (<i>with default</i>): User-defined central value used for centring of data. One of "mean.weighted" (default), "mean" and "median", or a single numeric value (not its logarithm).
dispersion	character (<i>with default</i>): measure of dispersion used to draw the scatter polygon. Can be one of the following: • "qr" (quartile range, default) • "sd" (standard deviation) • "2sd" (2 standard deviations) • "pNN" (symmetric percentile range, with NN being the lower percentile, e.g. "p05" indicates the range between 5 and 95 %, or "p10" indicates the range between 10 and 90 %) The default is "qr". Note that "sd" and "2sd" are only meaningful in combination with "<code>z.0 = 'mean'</code>" because the unweighted mean is used to centre the polygon.
plot.ratio	numeric (<i>with default</i>): Relative space, given to the radial versus the cartesian plot part, default is 0.75.
rotate	logical (<i>with default</i>): Option to turn the plot by 90 degrees.
mtext	character (<i>with default</i>): additional text below the plot title.
summary	character (<i>with default</i>): add statistic measures of centrality and dispersion to the plot. Can be one or more of several keywords. See details for available keywords. Results differ depending on the log-option for the z-scale (see details).
summary.pos	numeric or character (<i>with default</i>): optional position coordinates or keyword (e.g. "topright") for the statistical summary. Alternatively, the keyword "sub" may be specified to place the summary below the plot header. However, this latter option is only possible if <code>mtext</code> is not used.

summary.method	character (<i>with default</i>): keyword indicating the method used to calculate the statistic summary. One of "MCM" (default), "weighted" or "unweighted". See calc_Statistics for details.
legend	character vector (<i>optional</i>): legend content to be added to the plot.
legend.pos	numeric or character (<i>with default</i>): optional position coordinates or keyword (e.g. "topright") for the legend to be plotted.
stats	character : additional labels of statistically important values in the plot. Can be one or more of the following: • "min" • "max" • "median"
rug	logical (<i>with default</i>): Option to add a rug to the KDE part, to indicate the location of individual values.
kde	logical (<i>with default</i>): Option to add a KDE plot to the dispersion part (TRUE by default). The smoothing bandwidth can be controlled by setting the bw argument ("SJ" by default; see stats::density for details).
hist	logical (<i>with default</i>): Option to add a histogram to the dispersion part. Only meaningful when only one data set is plotted. The number of cells in the histogram can be controlled by setting the breaks argument (see graphics::hist for details).
dots	logical (<i>with default</i>): Option to add a dot plot to the dispersion part. If number of dots exceeds space in the dispersion part, a square indicates this.
boxplot	logical (<i>with default</i>): Option to add a boxplot to the dispersion part, default is FALSE.
y.axis	logical (<i>with default</i>): option to hide standard y-axis labels and show 0 only, useful for data with small scatter. To suppress the y-axis entirely, use yaxt == 'n' (the standard graphics::par setting) instead.
error.bars	logical (<i>with default</i>): Option to show De-errors as error bars on De-points. Useful in combination with y.axis = FALSE, bar = FALSE.
bar	numeric or logical (<i>with default</i>): option to add one or more dispersion bars (i.e., bar showing the 2-sigma range) centred at the defined values. By default a bar is drawn according to "z.0". To omit the bar set "bar = FALSE".
bar.col	character or numeric (<i>with default</i>): colour of the dispersion bar. Default is "grey60".
polygon.col	character or numeric (<i>with default</i>): colour of the polygon showing the data scatter. Sometimes this polygon may be omitted for clarity. To disable it use FALSE or polygon = FALSE. Default is "grey80".
line	numeric or RLum.Results : numeric values of the additional lines to be added. This can be set to NA to suppress the line added automatically by some RLum.Results objects.
line.col	character or numeric : colour of the additional lines.
line.lty	integer : line type of additional lines.
line.label	character : labels for the additional lines.

grid.col	character or numeric (with default): colour of the grid lines (originating at $[0, 0]$ and stretching to the z-scale). To disable grid lines use FALSE. Default is "grey".
frame	numeric (with default): the plot frame type, one of the following: • 0: no frame • 1: frame originates at 0,0 and runs along min/max isochrons (default) • 2: frame embraces the 2-sigma bar • 3: frame embraces the entire plot as a rectangle
interactive	logical (with default): create an interactive abanico plot (requires the 'plotly' package).
...	further arguments and graphical parameters to control the plot output. Supported are: main, sub, ylab, xlab, zlab, xlim, ylim, zlim, cex, pt.cex (point size), lty, lwd, pch, col, at, bw, and breaks. xlab must be a vector of length two, specifying the upper and lower x-axis labels. Please note that in the interactive mode, if you are using an expression, the zlab must use HTML tags, such as $D_{e</sub>e</sub>}$ for $D[e]$.

Details

The abanico plot is a combination of the classic radial plot [plot_RadialPlot](#) and a kernel density estimate plot (e.g. [plot_KDE](#)). It allows straightforward visualisation of data precision, error scatter around a user-defined central value and the combined distribution of the values, on the actual scale of the measured data (e.g. seconds, equivalent dose, years). The principle of the plot is shown in Galbraith & Green (1990). The function authors are thankful for the thought-provoking figure in this article.

The semi circle (z-axis) of the classic radial plot is bent to a straight line here, which actually is the basis for combining this polar (radial) part of the plot with any other Cartesian visualisation method (KDE, histogram, PDF and so on). Note that the plot allows displaying two measures of distribution. One is the 2-sigma bar, which illustrates the spread in value errors, and the other is the polygon, which stretches over both parts of the abanico plot (polar and Cartesian) and illustrates the actual spread in the values themselves.

Since the 2-sigma-bar is a polygon, it can be (and is) filled with shaded lines. To change density (lines per inch, default is 15) and angle (default is 45 degrees) of the shading lines, specify these parameters. See [graphics::polygon](#) for further help.

The proportion of the polar part and the cartesian part of the abanico plot can be modified for display reasons (`plot.ratio = 0.75`). By default, the polar part spreads over 75 % and leaves 25 % for the part that shows the KDE graph.

The abanico plot supports other than the weighted mean as measure of centrality. When it is obvious that the data is not (log-)normally distributed, the mean (weighted or not) cannot be a valid measure of centrality and hence central dose. Accordingly, the median and the weighted median can be chosen as well to represent a proper measure of centrality (e.g. `centrality = "median.weighted"`). Also user-defined numeric values (e.g. from the central age model) can be used if this appears appropriate.

Statistics summary:

A statistic summary, i.e. a collection of statistic measures of centrality and dispersion (and further measures) can be added by specifying one or more of the following keywords in the summary argument:

- "n" (number of samples)
- "mean" (mean De value)
- "median" (median of the De values)
- "sd.abs" (absolute standard deviation)
- "sd.rel" (relative standard deviation in percent)
- "se.abs" (absolute standard error)
- "se.rel" (relative standard error)
- "in.2s" (percent of samples in 2-sigma range)
- "q.25" (25% percentile)
- "q.75" (75% percentile)
- "skewness" (skewness)
- "kurtosis" (kurtosis)

Note: the input data for the statistic summary is sent to the function [calc_Statistics](#) depending on the log-option for the z-scale. If "log.z = TRUE", the summary is based on the logarithms of the input data. If "log.z = FALSE" the linearly scaled data is used.

Note: [calc_Statistics](#) calculates these statistic measures in three different ways: unweighted, weighted and MCM-based (i.e., based on Monte Carlo Methods). By default, the MCM-based version is used. If you wish to use another method, indicate this with the appropriate keyword using the argument `summary.method`.

Other arguments:

The optional parameter `layout` allows more sophisticated ways to modify the entire plot. Each element of the plot can be addressed and its properties can be defined. This includes font type, size and decoration, colours and sizes of all plot items. To infer the definition of a specific layout style cf. [get_Layout](#) or type, e.g. for the layout type "journal". A layout type can be modified by the user by assigning new values to the list object.

It is possible for the z-scale to specify where ticks are to be drawn by using the parameter `at`, e.g. `at = seq(80, 200, 20)`, cf. function documentation of `axis`. Specifying tick positions manually overrides a `zlim`-definition.

Value

Returns a plot object and, optionally, a list with plot calculus data.

Function version

0.1.25

How to cite

Dietze, M., Kreutzer, S., Colombo, M., 2026. `plot_AbanicoPlot()`: Function to create an abanico plot. Function version 0.1.25. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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 Marco Colombo, Institute of Geography, Heidelberg University (Germany)
 Inspired by a plot introduced by Galbraith & Green (1990) , RLum Developer Team

References

Galbraith, R. & Green, P., 1990. Estimating the component ages in a finite mixture. International Journal of Radiation Applications and Instrumentation. Part D. Nuclear Tracks and Radiation Measurements 17 (3), 197-206.

Dietze, M., Kreutzer, S., Burow, C., Fuchs, M.C., Fischer, M., Schmidt, C., 2015. The abanico plot: visualising chronometric data with individual standard errors. Quaternary Geochronology. doi:10.1016/j.quageo.2015.09.003

See Also

[plot_RadialPlot](#), [plot_KDE](#), [plot_Histogram](#), [plot_ViolinPlot](#)

Examples

```
## load example data and recalculate to Gray
data(ExampleData.DeValues, envir = environment())
ExampleData.DeValues <- ExampleData.DeValues$CA1

## plot the example data straightforward
plot_AbanicoPlot(data = ExampleData.DeValues)

## now with linear z-scale
plot_AbanicoPlot(data = ExampleData.DeValues,
                  log.z = FALSE)

## now with output of the plot parameters
plot1 <- plot_AbanicoPlot(data = ExampleData.DeValues)
str(plot1)
plot1$zlim

## now with adjusted z-scale limits
plot_AbanicoPlot(data = ExampleData.DeValues,
                  zlim = c(10, 200))

## now with adjusted x-scale limits
plot_AbanicoPlot(data = ExampleData.DeValues,
                  xlim = c(0, 20))

## now with rug to indicate individual values in KDE part
plot_AbanicoPlot(data = ExampleData.DeValues,
                  rug = TRUE)

## now with a smaller bandwidth for the KDE plot
```

```

plot_AbanicoPlot(data = ExampleData.DeValues,
                 bw = 0.04)

## now with a histogram instead of the KDE plot
plot_AbanicoPlot(data = ExampleData.DeValues,
                 hist = TRUE,
                 kde = FALSE)

## now with a KDE plot and histogram with manual number of bins
plot_AbanicoPlot(data = ExampleData.DeValues,
                 hist = TRUE,
                 breaks = 20)

## now with a KDE plot and a dot plot
plot_AbanicoPlot(data = ExampleData.DeValues,
                 dots = TRUE)

## now with user-defined plot ratio
plot_AbanicoPlot(data = ExampleData.DeValues,
                 plot.ratio = 0.5)
## now with user-defined central value
plot_AbanicoPlot(data = ExampleData.DeValues,
                 z.0 = 70)

## now with median as central value
plot_AbanicoPlot(data = ExampleData.DeValues,
                 z.0 = "median")

## now with the 17-83 percentile range as definition of scatter
plot_AbanicoPlot(data = ExampleData.DeValues,
                 z.0 = "median",
                 dispersion = "p17")

## now with user-defined green line for minimum age model
CAM <- calc_CentralDose(ExampleData.DeValues,
                      plot = FALSE)
plot_AbanicoPlot(data = CAM,
                 line.col = "darkseagreen")

## now create plot with legend, colour, different points and smaller scale
plot_AbanicoPlot(data = ExampleData.DeValues,
                 legend = "Sample 1",
                 col = "tomato4",
                 bar.col = "peachpuff",
                 pch = "R",
                 cex = 0.8)

## now without 2-sigma bar, polygon, grid lines and central value line
plot_AbanicoPlot(data = ExampleData.DeValues,
                 bar.col = FALSE,
                 polygon.col = FALSE,
                 grid.col = FALSE,
                 y.axis = FALSE,

```



```

## create Abanico plot with predefined layout definition
plot_AbanicoPlot(data = ExampleData.DeValues,
                 layout = "journal")

## now with predefined layout definition and further modifications
plot_AbanicoPlot(
  data = data.3,
  z.0 = "median",
  layout = "journal",
  col = c("steelblue4", "orange4"),
  bar.col = adjustcolor(c("steelblue3", "orange3"),
                        alpha.f = 0.5),
  polygon.col = c("steelblue3", "orange3"))

## for further information on layout definitions see documentation
## of function get_Layout()

## now with manually added plot content
## create empty plot with numeric output
AP <- plot_AbanicoPlot(data = ExampleData.DeValues,
                      pch = NA)

## identify data in 2 sigma range
in_2sigma <- AP$data[[1]]$data.in.2s

## restore function-internal plot parameters
par(AP$par)

## add points inside 2-sigma range
points(x = AP$data[[1]]$precision[in_2sigma],
       y = AP$data[[1]]$std.estimate.plot[in_2sigma],
       pch = 16)

## add points outside 2-sigma range
points(x = AP$data[[1]]$precision[!in_2sigma],
       y = AP$data[[1]]$std.estimate.plot[!in_2sigma],
       pch = 1)

```

plot_DetPlot

Create $De(t)$ plot

Description

Plots the equivalent dose (D_e) in dependency of the chosen signal integral (cf. Bailey et al., 2003). The function is simply passing several arguments to the function `plot` and the used analysis functions and runs it in a loop. Example: `legend.pos` for legend position, `legend` for legend text.

Usage

```

plot_DetPlot(
  object,
  signal_integral,
  background_integral,
  method = "shift",
  signal_integral.seq = NULL,
  integral_input = c("channel", "measurement"),
  analyse_function = c("analyse_SAR.CWOSL", "analyse_pIRIRSequence"),
  analyse_function.control = list(),
  n.channels = NULL,
  show_ShineDownCurve = TRUE,
  respect_RC.Status = FALSE,
  cores = NULL,
  verbose = TRUE,
  plot = TRUE,
  ...
)

```

Arguments

- object** [RLum.Analysis](#) (**required**): input object containing data for analysis. Can be provided as a [list](#) of such objects.
- signal_integral** [integer](#) (**required**): vector of channels for the signal integral.
- background_integral** [integer](#) (**required**): vector of channels for the background integral.
- method** [character](#) (*with default*): method applied for constructing the De(t) plot.
- *shift (the default)*: the chosen signal integral is shifted the shine down curve,
 - *expansion*: the chosen signal integral is expanded each time by its length
- signal_integral.seq** [numeric](#) (*optional*): argument to provide an own signal integral sequence for constructing the De(t) plot
- integral_input** [character](#) (*with default*): input type for signal_integral, one of "channel" (default) or "measurement". If set to "measurement", the best matching channels corresponding to the given time range (in seconds) are selected.
- analyse_function** [character](#) (*with default*): name of the analyse function to be called. Supported functions are: [analyse_SAR.CWOSL](#), [analyse_pIRIRSequence](#)
- analyse_function.control** [list](#) (*optional*): selected arguments to be passed to the supported analyse functions ([analyse_SAR.CWOSL](#), [analyse_pIRIRSequence](#)). The arguments must be provided as named [list](#), e.g., `list(dose.points = c(0, 10, 20, 30, 0, 10))` will set the regeneration dose points.

n.channels	integer (<i>optional</i>): number of channels used for the De(t) plot. If nothing is provided all De-values are calculated and plotted until the start of the background integral.
show_ShineDownCurve	logical (<i>with default</i>): enable/disable shine down curve in the plot output.
respect_RC.Status	logical (<i>with default</i>): remove De values with 'FAILED' RC.Status from the plot (cf. analyse_SAR.CWOSL and analyse_pIRIRSequence).
cores	integer, numeric (<i>with default</i>): number of cores allocated for parallel processing when object is a list of objects. The default value (NULL) assigns all but two of the available logical CPU cores.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
plot	logical (<i>with default</i>): enable/disable the plot output. Disabling the plot is useful in cases where the output need to be processed differently.
...	further arguments and graphical parameters passed to plot.default , analyse_SAR.CWOSL and analyse_pIRIRSequence (see details for further information). Plot control parameters are: ylim, xlim, ylab, xlab, main, pch, mtext, cex, legend, legend.text, legend.pos

Details

The original method presented by Bailey et al. (2003) shifts the signal integrals and slightly extends them to account for changes in counting statistics, producing sequences such as `c(1:3, 3:5, 5:7)`. Here we provide an additional method that expands the signal integral consecutively by its chosen length, producing sequences like `c(1:3, 1:5, 1:7)` instead.

Note that in both cases the integral limits overlap. The finally applied limits are part of the function output.

analyse_function.control

The argument `analyse_function.control` currently supports the following arguments: `sequence.structure`, `dose.points`, `dose_rate_source`, `mtext.outer`, `fit.method`, `fit.force_through_origin`, `trim.channels`, `plot` and `plot_singlePanels`.

Value

A plot and an [RLum.Results](#) object with the produced D_e values
@data:

Object	Type	Description
De.values	<code>data.frame</code>	table with De values
signal_integral.seq	<code>numeric</code>	integral sequence used for the calculation

@info:

Object	Type	Description
call	<code>call</code>	the original function call

Function version

0.1.12

How to cite

Kreutzer, S., 2026. plot_DetPlot(): Create De(t) plot. Function version 0.1.12. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The entire analysis relies on the functions [analyse_SAR.CWOSL](#) and [analyse_pIRIRSequence](#). However, the integrity checks here are less rigorous than in those functions: therefore, every sequence should be checked carefully before running long calculations over hundreds of channels.

Author(s)

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References

Bailey, R.M., Singarayer, J.S., Ward, S., Stokes, S., 2003. Identification of partial resetting using De as a function of illumination time. Radiation Measurements 37, 511-518. doi:10.1016/S1350-4487(03)00063-5

See Also

[plot](#), [analyse_SAR.CWOSL](#), [analyse_pIRIRSequence](#)

Examples

```
## Not run:
##load data
##ExampleData.BINfileData contains two BINfileData objects
##CWOSL.SAR.Data and TL.SAR.Data
data(ExampleData.BINfileData, envir = environment())

##transform the values from the first position in a RLum.Analysis object
object <- Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos=1)

plot_DetPlot(
  object,
  signal_integral = 1:3,
  background_integral = 900:1000,
  n.channels = 5)

## End(Not run)
```

plot_DoseResponseCurve

Plot a dose-response curve for luminescence data (Lx/Tx against dose)

Description

A dose-response curve is produced for luminescence measurements using a regenerative or additive protocol as implemented in [fit_DoseResponseCurve](#).

Usage

```
plot_DoseResponseCurve(
  object,
  plot_extended = TRUE,
  plot_singlePanels = FALSE,
  verbose = TRUE,
  ...
)
```

Arguments

object	RLum.Results (required): An object produced by fit_DoseResponseCurve .
plot_extended	logical (<i>with default</i>): If TRUE (default), 3 plots on one plot area are provided: 1. the dose-response curve, 2. a histogram from Monte Carlo error simulation and 3. a test dose response plot. If FALSE, just the growth curve will be plotted.
plot_singlePanels	logical (<i>with default</i>): single plot output (TRUE/FALSE) to allow for plotting the results in single plot windows. Ignored if plot_extended = FALSE.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	further arguments and graphical parameters to control the plot output. Supported are: main, mtext, xlim, ylim, xlab, ylab, cex, pt.cex (point size), mar, mgp, tcl, log (not valid for objects fitted with mode = "extrapolation"), legend (TRUE/FALSE), legend.pos, reg_points_pch, density_polygon (TRUE/FALSE), density_polygon_col, density_rug (TRUE/FALSE), lwd_drc, col_drc, lty_drc, and box (TRUE/FALSE).

Value

A plot (or a series of plots) is produced.

Function version

1.0.12

How to cite

Kreutzer, S., Dietze, M., Colombo, M., 2026. `plot_DoseResponseCurve()`: Plot a dose-response curve for luminescence data (Lx/Tx against dose). Function version 1.0.12. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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References

Berger, G.W., Huntley, D.J., 1989. Test data for exponential fits. *Ancient TL* 7, 43-46.
 Guralnik, B., Li, B., Jain, M., Chen, R., Paris, R.B., Murray, A.S., Li, S.-H., Pagonis, P., Herman, F., 2015. Radiation-induced growth and isothermal decay of infrared-stimulated luminescence from feldspar. *Radiation Measurements* 81, 224-231.
 Pagonis, V., Kitis, G., Chen, R., 2020. A new analytical equation for the dose response of dosimetric materials, based on the Lambert W function. *Journal of Luminescence* 225, 117333. doi:10.1016/j.jlumin.2020.117333

See Also

[fit_DoseResponseCurve](#)

Examples

```
##(1) plot dose-response curve for a dummy dataset
data(ExampleData.LxTxData, envir = environment())
fit <- fit_DoseResponseCurve(LxTxData)
plot_DoseResponseCurve(fit)

##(1b) horizontal plot arrangement
layout(mat = matrix(c(1,1,2,3), ncol = 2))
plot_DoseResponseCurve(fit, plot_singlePanels = TRUE)

##(2) plot the dose-response curve with pdf output - uncomment to use
##pdf(file = "~/Dose_Response_Curve_Dummy.pdf", paper = "special")
plot_DoseResponseCurve(fit)
##dev.off()

##(3) plot the growth curve with pdf output - uncomment to use, single output
##pdf(file = "~/Dose_Response_Curve_Dummy.pdf", paper = "special")
plot_DoseResponseCurve(fit, plot_singlePanels = TRUE)
##dev.off()
```

```
##(4) plot resulting function for given interval x
x <- seq(1,10000, by = 100)
plot(
  x = x,
  y = eval(fit$Formula),
  type = "l"
)
```

plot_DRCSummary

Create a Dose-Response Curve Summary Plot

Description

While analysing OSL SAR or pIRIR-data the view on the data is usually limited to one dose-response curve (DRC) at the time for one aliquot. This function overcomes this limitation by plotting all DRCs from an [RLum.Results](#) object created by [analyse_SAR.CWOSL](#) in one single plot.

If you want plot your DRC on an energy scale (dose in Gy), you can either use option `source_dose_rate` or perform your SAR analysis with the dose points in Gy (better axis scaling).

Usage

```
plot_DRCSummary(
  object,
  source_dose_rate = NULL,
  sel_curves = NULL,
  show_dose_points = FALSE,
  show_natural = FALSE,
  n = 51L,
  ...
)
```

Arguments

object	RLum.Results (required): input object created by analyse_SAR.CWOSL . The input object can be provided as list .
source_dose_rate	numeric (<i>optional</i>): allows to modify the axis and show values in Gy, instead seconds. Only a single numerical value is allowed.
sel_curves	numeric (<i>optional</i>): id of the curves to be plotted in its occurring order. A sequence can be provided for selecting, e.g., only every 2nd curve from the input object.
show_dose_points	logical (<i>with default</i>): enable/disable plotting of dose points in the graph.
show_natural	logical (<i>with default</i>): enable/disable the plot of the natural Lx/Tx values.

`n` [integer](#) (*with default*): number of x-values used to evaluate one curve object. Large numbers slow down the plotting process and are usually not needed.

`...` further arguments and graphical parameters to control the plot output. Supported are: `main`, `xlab`, `ylab`, `xlim`, `ylim`, `lty`, `lwd`, `pch`, `col.pch`, `col.lty`, `mtext`, and `pt.cex` (point size).

Value

An [RLum.Results](#) object is returned:

Slot: **@data**

OBJECT	TYPE	COMMENT
results	data.frame	with dose and LxTx values
data	RLum.Results	original input data

Slot: **@info**

OBJECT	TYPE	COMMENT
call	call	the original function call
args	list	arguments of the original function call

Note: If the input object is a [list](#) a list of [RLum.Results](#) objects is returned.

Function version

0.2.5

How to cite

Kreutzer, S., Burow, C., 2026. `plot_DRCSummary()`: Create a Dose-Response Curve Summary Plot. Function version 0.2.5. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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Christoph Burow, University of Cologne (Germany) , RLum Developer Team

See Also

[RLum.Results](#), [analyse_SAR.CWOSL](#)

Examples

```
#load data example data
data(ExampleData.BINfileData, envir = environment())

#transform the values from the first position in a RLum.Analysis object
object <- Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos=1)

## perform SAR analysis
results <- analyse_SAR.CWOSL(
  object,
  signal_integral = 1:2,
  background_integral = 900:1000,
  plot = FALSE
)

##plot only DRC
plot_DRCSummary(results)
```

plot_DTRResults

Visualise dose recovery test results

Description

The function provides a standardised plot output for dose recovery test measurements.

Usage

```
plot_DTRResults(
  object,
  given.dose = NULL,
  error.range = 10,
  preheat = NULL,
  boxplot = FALSE,
  mtext = "",
  summary = "",
  summary.pos = "topleft",
  legend = NULL,
  legend.pos = "topright",
  par.local = TRUE,
  na.rm = FALSE,
  ...
)
```

Arguments

object [RLum.Results](#) or [data.frame](#) (**required**): input values containing at least De and De error. To plot more than one data set in one figure, a list of the individual data sets must be provided (e.g. `list(dataset.1, dataset.2)`).

given.dose	numeric (<i>optional</i>): given dose used for the dose recovery test to normalise data. If only one given dose is provided, this given dose is valid for all input data sets (i.e., object is a list). Otherwise, a given dose for each input data set has to be provided (e.g., <code>given.dose = c(100, 200)</code>). If <code>given.dose</code> is <code>NULL</code> or <code>0</code> , the values are plotted without normalisation (might be useful for preheat plateau tests). Note: Unit has to be the same as from the input values (e.g., Seconds or Gray).
error.range	numeric (<i>with default</i>): symmetric error range in percent will be shown as dashed lines in the plot. It can be set to <code>0</code> to remove the error ranges.
preheat	numeric (<i>optional</i>): optional vector of preheat temperatures to be used for grouping the De values. If specified, the temperatures are assigned to the x-axis.
boxplot	logical (<i>with default</i>): plot values that are grouped by preheat temperature as boxplots. Only possible when <code>preheat</code> vector is specified.
mtext	character (<i>with default</i>): additional text below the plot title.
summary	character (<i>optional</i>): adds numerical output to the plot. Can be one or more out of: • "n" (number of samples), • "mean" (mean De value), • "mean.weighted" (error-weighted mean), • "median" (median of the De values), • "median.weighted" (error-weighted median), • "sd.rel" (relative standard deviation in percent), • "sd.abs" (absolute standard deviation), • "se.rel" (relative standard error in percent) and • "se.abs" (absolute standard error) and all other measures returned by the function <code>calc_Statistics</code> .
summary.pos	numeric or character (<i>with default</i>): optional position coordinates or keyword (e.g. "topright") for the statistical summary. Alternatively, the keyword "sub" may be specified to place the summary below the plot header. However, this latter option is only possible if <code>mtext</code> is not used.
legend	character vector (<i>optional</i>): legend content to be added to the plot.
legend.pos	numeric or character (<i>with default</i>): optional position coordinates or keyword (e.g. "topright") for the legend to be plotted.
par.local	logical (<i>with default</i>): use local graphical parameters for plotting, e.g. the plot is shown in one column and one row. If <code>par.local = FALSE</code> , global parameters are inherited, i.e. parameters provided via <code>par()</code> work.
na.rm	logical (<i>with default</i>): whether NA values should be removed from the input data before plotting.
...	further arguments and graphical parameters to control the plot output (see plot). Supported are: <code>xlab</code> , <code>ylab</code> , <code>xlim</code> , <code>ylim</code> , <code>main</code> , <code>cex</code> , <code>pt.cex</code> (point size), <code>las</code> , and <code>pch</code> .

Details

The procedure tests the accuracy of a measurement protocol to reliably determine the dose of a specific sample. Here, the natural signal is erased and a known laboratory dose administered, which is treated as unknown. Then the De measurement is carried out and the degree of congruence between administered and recovered dose is a measure of the protocol's accuracy for this sample. In the plot the normalised De is shown on the y-axis, i.e. obtained De/Given Dose.

Value

A plot is returned.

Function version

0.1.18

How to cite

Kreutzer, S., Dietze, M., 2026. plot_DRTRResults(): Visualise dose recovery test results. Function version 0.1.18. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Further data and plot arguments can be added by using the appropriate R commands.

Author(s)

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Michael Dietze, GFZ Potsdam (Germany) , RLum Developer Team

References

Wintle, A.G., Murray, A.S., 2006. A review of quartz optically stimulated luminescence characteristics and their relevance in single-aliquot regeneration dating protocols. *Radiation Measurements* 41, 369-391.

See Also

[plot](#)

Examples

```
## read example data set and misapply them for this plot type
data(ExampleData.DeValues, envir = environment())

## plot values
plot_DRTRResults(
```

```

    ExampleData.DeValues$BT998[7:11,],
    given.dose = 2800,
    mtext = "Example data")

## plot values with legend
plot_DRTResults(
  ExampleData.DeValues$BT998[7:11,],
  given.dose = 2800,
  legend = "Test data set")

## create and plot two subsets with randomised values
x.1 <- ExampleData.DeValues$BT998[7:11,]
x.2 <- ExampleData.DeValues$BT998[7:11,] * c(runif(5, 0.9, 1.1), 1)

plot_DRTResults(
  list(x.1, x.2),
  given.dose = 2800)

## some more user-defined plot parameters
plot_DRTResults(
  list(x.1, x.2),
  given.dose = 2800,
  pch = c(2, 5),
  col = c("orange", "blue"),
  xlim = c(0, 8),
  ylim = c(0.85, 1.15),
  xlab = "Sample aliquot")

## plot the data with user-defined statistical measures as legend
plot_DRTResults(
  list(x.1, x.2),
  given.dose = 2800,
  summary = c("n", "mean.weighted", "sd.abs"))

## plot the data with user-defined statistical measures as sub-header
plot_DRTResults(
  list(x.1, x.2),
  given.dose = 2800,
  summary = c("n", "mean.weighted", "sd.abs"),
  summary.pos = "sub")

## plot the data grouped by preheat temperatures
plot_DRTResults(
  ExampleData.DeValues$BT998[7:11,],
  given.dose = 2800,
  preheat = c(200, 200, 200, 240, 240))

## read example data set and misapply them for this plot type
data(ExampleData.DeValues, envir = environment())

## plot values
plot_DRTResults(
  ExampleData.DeValues$BT998[7:11,],

```

```

    given.dose = 2800,
    mtext = "Example data")

## plot two data sets grouped by preheat temperatures
plot_DRTResults(
  list(x.1, x.2),
  given.dose = 2800,
  preheat = c(200, 200, 200, 240, 240))

## plot the data grouped by preheat temperatures as boxplots
plot_DRTResults(
  ExampleData.DeValues$BT998[7:11,],
  given.dose = 2800,
  preheat = c(200, 200, 200, 240, 240),
  boxplot = TRUE)

```

plot_FilterCombinations

Plot filter combinations along with the (optional) net transmission window

Description

The function allows to plot transmission windows for different filters. Missing data for specific wavelengths are automatically interpolated for the given filter data using function [approx](#). With that, a standardised output is reached and a net transmission window can be shown.

Calculations

Net transmission window

The net transmission window of two filters is approximated by

$$T_{final} = T_1 * T_2$$

Optical density

$$OD = -\log_{10}(T)$$

Total optical density

$$OD_{total} = OD_1 + OD_2$$

Please consider using your own calculations for more precise values.

How to provide input data?

CASE 1

The function expects that all filter values are either of type `matrix` or `data.frame` with two columns. The first columns contains the wavelength, the second the relative transmission (but not in percentage, i.e. the maximum transmission can be only become 1).

In this case only the transmission window is show as provided. Changes in filter thickness and reflection factor are not considered.

CASE 2

The filter data itself are provided as list element containing a `matrix` or `data.frame` and additional information on the thickness of the filter, e.g., `list(filter1 = list(filter_matrix, d = 2))`. The given filter data are always considered as standard input and the filter thickness value is taken into account by

$$Transmission = Transmission^d$$

with `d` given in the same dimension as the original filter data.

CASE 3

Same as CASE 2 but additionally a reflection factor `P` is provided, e.g., `list(filter1 = list(filter_matrix, d = 2, P = 0.9))`. The final transmission becomes:

$$Transmission = Transmission^d * P$$

Advanced plotting parameters

The following further non-common plotting parameters can be passed to the function:

Argument	Datatype	Description
<code>legend</code>	logical	enable/disable legend
<code>legend.pos</code>	character	change legend position (graphics::legend)
<code>legend.text</code>	character	same as the argument <code>legend</code> in (graphics::legend)
<code>net_transmission.col</code>	col	colour of net transmission window polygon
<code>net_transmission.col_lines</code>	col	colour of net transmission window polygon lines
<code>net_transmission.density</code>	numeric	specify line density in the transmission polygon
<code>grid</code>	list	full list of arguments that can be passed to the function graphics::grid

For further modifications standard additional R plot functions are recommend, e.g., the legend can be fully customised by disabling the standard legend and using the function [graphics::legend](#) instead.

Usage

```
plot_FilterCombinations(
  filters,
  wavelength_range = 200:1000,
  show_net_transmission = TRUE,
  interactive = FALSE,
  plot = TRUE,
  ...
)
```

Arguments

filters	list (required) : a named list of filter data for each filter to be shown. The filter data itself should be either provided as data.frame or matrix (see details for more options).
wavelength_range	numeric (<i>with default</i>): wavelength range used for the interpolation
show_net_transmission	logical (<i>with default</i>): show net transmission window as polygon.
interactive	logical (<i>with default</i>): enable/disable interactive plots.
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further arguments that can be passed to control the plot output. Supported are main, xlab, ylab, xlim, ylim, type, lty, lwd. For non-common plotting parameters, see the details section.

Value

Returns an S4 object of type [RLum.Results](#).

@data

Object	Type	Description
net_transmission_window	matrix	the resulting net transmission window
OD_total	matrix	the total optical density
filter_matrix	matrix	the filter matrix used for plotting

@info

Object	Type	Description
call	call	the original function call

Function version

0.3.3

How to cite

Kreutzer, S., 2026. plot_FilterCombinations(): Plot filter combinations along with the (optional) net transmission window. Function version 0.3.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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See Also

[RLum.Results](#), [approx](#)

Examples

```
## (For legal reasons no real filter data are provided)

## Create filter sets
filter1 <- density(rnorm(100, mean = 450, sd = 20))
filter1 <- matrix(c(filter1$x, filter1$y/max(filter1$y)), ncol = 2)
filter2 <- matrix(c(200:799,rep(c(0,0.8,0),each = 200)), ncol = 2)

## Example 1 (standard)
plot_FilterCombinations(filters = list(filter1, filter2))

## Example 2 (with d and P value and name for filter 2)
results <- plot_FilterCombinations(
  filters = list(filter_1 = filter1, Rectangle = list(filter2, d = 2, P = 0.6)))
results

## Example 3 show optical density
plot(results$OD_total)

## Not run:
##Example 4
##show the filters using the interactive mode
plot_FilterCombinations(filters = list(filter1, filter2), interactive = TRUE)

## End(Not run)
```

plot_GrowthCurve

Fit and plot a dose-response curve for luminescence data (Lx/Tx against dose)

Description

A dose-response curve is produced for luminescence measurements using a regenerative or additive protocol. This is a wrapper around [fit_DoseResponseCurve](#) and [plot_DoseResponseCurve](#).

Usage

```
plot_GrowthCurve(
  object,
  mode = "interpolation",
  fit.method = "SSE",
  output.plot = TRUE,
  output.plotExtended = TRUE,
  plot_singlePanels = FALSE,
```

```

    verbose = TRUE,
    n.MC = 100,
    ...
)

```

Arguments

object	data.frame or a list of such objects (required): data frame with columns for Dose, LxTx, LxTx.Error and TnTx (optional). If these column names are used, then they can be passed in whatever order; otherwise columns are taken by position. If object is a list, the function is called on each of its elements. If <code>fit.method = "OTORX"</code> you have to provide the test dose in the same unit as the dose in a column called Test_Dose. The function searches explicitly for this column name. Only the first value will be used assuming a constant test dose over the measurement cycle.
mode	character (<i>with default</i>): selects calculation mode of the function. • "interpolation" (default) calculates the De by interpolation, • "extrapolation" calculates the equivalent dose by extrapolation (useful for MAAD measurements) and • "alternate" calculates no equivalent dose and just fits the data points. Please note that for option "interpolation" the first point is considered as natural dose.
fit.method	character (<i>with default</i>): function used for fitting. Possible options are: LIN, QDR, SSE, SSE OR LIN, SSE+LIN, DSE (not defined for extrapolation), GOK, OTOR and OTORX. See details.
output.plot	logical (<i>with default</i>): enable/disable the plot output.
output.plotExtended	logical (<i>with default</i>): If TRUE (default), 3 plots on one plot area are provided: 1. the dose-response curve, 2. a histogram from Monte Carlo error simulation and 3. a test dose response plot. If FALSE, just the growth curve will be plotted.
plot_singlePanels	logical (<i>with default</i>): single plot output (TRUE/FALSE) to allow for plotting the results in single plot windows. Requires <code>output.plotExtended = TRUE</code>.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
n.MC	integer (<i>with default</i>): number of Monte Carlo simulations for error estimation.
...	Further arguments to fit_DoseResponseCurve (<code>fit.force_through_origin</code>, <code>fit_weights</code>, <code>fit.includingRepeatedRegPoints</code>, <code>fit.NumberRegPoints</code>, <code>fit.NumberRegPointsRe</code>, <code>fit_bounds</code>, <code>txtProgressBar</code>) and to plot_DoseResponseCurve (<code>xlim</code>, <code>ylim</code>, <code>main</code>, <code>mtext</code>, <code>xlab</code>, <code>ylab</code>, <code>log</code>, <code>legend</code> (TRUE/FALSE), <code>legend.pos</code>, <code>reg_points_pch</code>, <code>density_polygon</code> (TRUE/FALSE), <code>density_polygon_col</code>, <code>density_rug</code> (TRUE/FALSE), <code>lwd_drc</code>, <code>col_drc</code>, <code>lty_drc</code>, <code>box</code> (TRUE/FALSE)).

Value

Along with a plot (if wanted) the [RLum.Results](#) object produced by [fit_DoseResponseCurve](#) is returned invisibly.

Function version

1.2.3

How to cite

Kreutzer, S., Dietze, M., Colombo, M., 2026. plot_GrowthCurve(): Fit and plot a dose-response curve for luminescence data (Lx/Tx against dose). Function version 1.2.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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References

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Guralnik, B., Li, B., Jain, M., Chen, R., Paris, R.B., Murray, A.S., Li, S.-H., Pagonis, P., Herman, F., 2015. Radiation-induced growth and isothermal decay of infrared-stimulated luminescence from feldspar. *Radiation Measurements* 81, 224-231.

Pagonis, V., Kitis, G., Chen, R., 2020. A new analytical equation for the dose response of dosimetric materials, based on the Lambert W function. *Journal of Luminescence* 225, 117333. [doi:10.1016/j.jlumin.2020.117333](https://doi.org/10.1016/j.jlumin.2020.117333)

See Also

[fit_DoseResponseCurve](#), [plot_DoseResponseCurve](#)

Examples

```
##(1) plot growth curve for a dummy dataset
data(ExampleData.LxTxData, envir = environment())
plot_GrowthCurve(LxTxData)

##(1b) horizontal plot arrangement
layout(mat = matrix(c(1,1,2,3), ncol = 2))
plot_GrowthCurve(LxTxData, plot_singlePanels = TRUE)
```

```

##(2) plot the growth curve with pdf output - uncomment to use
##pdf(file = "~/Desktop/Growth_Curve_Dummy.pdf", paper = "special")
plot_GrowthCurve(LxTxData)
##dev.off()

##(3) plot the growth curve with pdf output - uncomment to use, single output
##pdf(file = "~/Desktop/Growth_Curve_Dummy.pdf", paper = "special")
temp <- plot_GrowthCurve(LxTxData, plot_singlePanels = TRUE)
##dev.off()

##(4) plot resulting function for given interval x
x <- seq(1,10000, by = 100)
plot(
  x = x,
  y = eval(temp$Formula),
  type = "l"
)

##(5) plot using the 'extrapolation' mode
LxTxData[1,2:3] <- c(0.5, 0.001)
print(plot_GrowthCurve(LxTxData, mode = "extrapolation"))

##(6) plot using the 'alternate' mode
LxTxData[1,2:3] <- c(0.5, 0.001)
print(plot_GrowthCurve(LxTxData, mode = "alternate"))

```

plot_Histogram

Plot a histogram with separate error plot

Description

Function plots a predefined histogram with an accompanying error plot as suggested by Rex Galbraith at the UK LED in Oxford 2010.

If the normal curve is added, the y-axis in the histogram will show the probability density.

A statistic summary, i.e. a collection of statistic measures of centrality and dispersion (and further measures) can be added by specifying one or more of the following keywords:

- "n" (number of samples),
- "mean" (mean De value),
- "mean.weighted" (error-weighted mean),
- "median" (median of the De values),
- "median.weighted" (error-weighted median),
- "sd.rel" (relative standard deviation in percent),
- "sd.rel.weighted" (error-weighted relative standard deviation in percent),
- "sd.abs" (absolute standard deviation),

- "sd.abs.weighted" (error-weighted absolute standard deviation),
- "se.rel" (relative standard error in percent),
- "se.rel.weighted" (error-weighted relative standard error in percent),
- "se.abs" (absolute standard error),
- "se.abs.weighted" (error-weighted absolute standard error),
- "kurtosis" (kurtosis) and
- "skewness" (skewness).

Usage

```
plot_Histogram(
  data,
  mtext = "",
  cex.global = 1,
  se = TRUE,
  rug = TRUE,
  normal_curve = FALSE,
  summary = "",
  summary.pos = "sub",
  colour = c("white", "black", "red", "black"),
  interactive = FALSE,
  ...
)
```

Arguments

data	data.frame or RLum.Results object (required): for <code>data.frame</code> : two columns: De (<code>data[,1]</code>) and De error (<code>data[,2]</code>). If the error column is missing or only contains NA values, then <code>se</code> is set to <code>FALSE</code> , and the weighted statistics will match the unweighted ones. In any other case, rows with NA values will be removed prior to plotting.
mtext	character (<i>optional</i>): further sample information (mtext).
cex.global	numeric (<i>with default</i>): global scaling factor.
se	logical (<i>with default</i>): plots standard error points over the histogram, default is <code>TRUE</code> . It is silently reset to <code>FALSE</code> if the error column in data is missing or only contains NA values.
rug	logical (<i>with default</i>): adds rugs to the histogram, default is <code>TRUE</code> .
normal_curve	logical (<i>with default</i>): adds a normal curve to the histogram. Mean and standard deviation are calculated from the input data. If <code>TRUE</code> , the y-axis in the histogram will show the probability density.
summary	character (<i>with default</i>): add statistic measures of centrality and dispersion to the plot. Can be one or more of several keywords. See details for available keywords.

summary.pos	numeric or character (<i>with default</i>): optional position coordinates or keyword (e.g. "topright") for the statistical summary. Alternatively, the keyword "sub" may be specified to place the summary below the plot header. However, this latter option is only possible if mtext is not used. In case of coordinate specification, y-coordinate refers to the right y-axis.
colour	numeric or character (<i>with default</i>): optional vector of length 4 which specifies the colours of the following plot items in exactly this order: histogram bars, rug lines and summary text, normal distribution curve, standard error points (e.g., c("grey", "black", "red", "grey")).
interactive	logical (<i>with default</i>): create an interactive histogram plot (requires the 'plotly' package)
...	further arguments and graphical parameters to control the plot output (see plot and hist). Supported are: main, xlab, ylab, xlim, ylim, breaks, pch, pt.cex (point size), and fun. If y-axis labels are provided, these must be specified as a vector of length 2 since the plot features two axes (e.g. ylab = c("axis label 1", "axis label 2")). Y-axes limits (ylim) must be provided as vector of length four, with the first two elements specifying the left axes limits and the latter two elements giving the right axis limits.

Function version

0.4.6

How to cite

Dietze, M., Kreutzer, S., 2026. plot_Histogram(): Plot a histogram with separate error plot. Function version 0.4.6. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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See Also

[hist](#), [plot](#)

Examples

```
## load data
data(ExampleData.DeValues, envir = environment())
ExampleData.DeValues <- convert_Second2Gray(ExampleData.DeValues$BT998,
                                             dose.rate = c(0.0438,0.0019))

## plot histogram the easiest way
```

```

plot_Histogram(ExampleData.DeValues)

## plot histogram with some more modifications
plot_Histogram(ExampleData.DeValues,
               rug = TRUE,
               normal_curve = TRUE,
               cex.global = 0.9,
               pch = 2,
               colour = c("grey", "black", "blue", "green"),
               summary = c("n", "mean", "sd.rel"),
               summary.pos = "topleft",
               main = "Histogram of De-values",
               mtext = "Example data set",
               ylab = c(expression(paste(D[e], " distribution")),
                       "Standard error"),
               xlim = c(100, 250),
               ylim = c(0, 0.1, 5, 20))

```

plot_KDE

Plot kernel density estimate with statistics

Description

Plot a kernel density estimate of measurement values in combination with the actual values and associated error bars in ascending order. If enabled, the boxplot will show the usual distribution parameters (median as bold line, box delimited by the first and third quartile, whiskers defined by the extremes and outliers shown as points) and also the mean and standard deviation as pale bold line and pale polygon, respectively.

The function allows passing several plot arguments, such as `main`, `xlab`, `cex`. However, as the figure is an overlay of two separate plots, `ylim` must be specified in the order: `c(ymin_axis1, ymax_axis1, ymin_axis2, ymax_axis2)` when using the cumulative values plot option. See examples for some further explanations. For details on the calculation of the bin-width (parameter `bw`) see [density](#).

A statistic summary, i.e. a collection of statistic measures of centrality and dispersion (and further measures) can be added by specifying one or more of the following keywords:

- "n" (number of samples)
- "mean" (mean De value)
- "median" (median of the De values)
- "sd.rel" (relative standard deviation in percent)
- "sd.abs" (absolute standard deviation)
- "se.rel" (relative standard error in percent)
- "se.abs" (absolute standard error)
- "in.2s" (percent of samples in 2-sigma range)
- "kurtosis" (kurtosis)

- "skewness" (skewness)

Note: the input data for the statistic summary is sent to function `calc_Statistics` depending on the log-option for the z-scale. If "log.z = TRUE", the summary is based on the logarithms of the input data. If "log.z = FALSE" the linearly-scaled data is used.

Note: `calc_Statistics` calculates these statistic measures in three different ways: unweighted, weighted and MCM-based (i.e., based on Monte Carlo Methods). By default, the MCM-based version is used. This can be controlled via the `summary.method` argument.

Usage

```
plot_KDE(
  data,
  values.cumulative = TRUE,
  order = TRUE,
  boxplot = TRUE,
  rug = TRUE,
  summary = "",
  summary.pos = "sub",
  summary.method = c("MCM", "weighted", "unweighted"),
  bw = "nrd0",
  ...
)
```

Arguments

data	data.frame , vector or RLum.Results object (required): for <code>data.frame</code> : either two columns: De (<code>values[,1]</code>) and De error (<code>values[,2]</code>), or one: De (<code>values[,1]</code>). If a numeric vector or a single-column data frame is provided, De error is assumed to be 10^{-9} for all measurements and error bars are not drawn. Rows with NA values will be removed prior to plotting. For plotting multiple data sets, these must be provided as list (e.g. <code>list(dataset1, dataset2)</code>).
values.cumulative	logical (<i>with default</i>): show cumulative individual data.
order	logical (<i>with default</i>): Order data in ascending order.
boxplot	logical (<i>with default</i>): optionally show a boxplot (depicting median as thick central line, first and third quartile as box limits, whiskers denoting +/- 1.5 interquartile ranges and dots further outliers).
rug	logical (<i>with default</i>): optionally add rug.
summary	character (<i>with default</i>): add statistic measures of centrality and dispersion to the plot. Can be one or more of several keywords. See details for available keywords.
summary.pos	numeric or character (<i>with default</i>): optional position coordinates or keyword (e.g. "topright") for the statistical summary. Alternatively, the keyword "sub" may be specified to place the summary below the plot header. However, this latter option is only possible if <code>mtext</code> is not used. In case of coordinate specification, y-coordinate refers to the right y-axis.

summary.method **character** (*with default*): keyword indicating the method used to calculate the statistic summary. One of "MCM" (default), "weighted" or "unweighted". See [calc_Statistics](#) for details.

bw **character, numeric** (*with default*): bin-width, chose a numeric value for manual setting.

... further arguments and graphical parameters to control the plot output (see [plot](#)). Supported are: main, sub, mtext, layout, xlab, ylab, xlim, ylim, log, cex, pt.cex (point size), lty, lwd, col, and fun.

Function version

3.6.2

How to cite

Dietze, M., Kreutzer, S., 2026. plot_KDE(): Plot kernel density estimate with statistics. Function version 3.6.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The plot output is no 'probability density' plot (cf. the discussion of Berger and Galbraith in Ancient TL; see references)!

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See Also

[density](#), [plot](#)

Examples

```
## read example data set
data(ExampleData.DeValues, envir = environment())
ExampleData.DeValues <-
  convert_Second2Gray(ExampleData.DeValues$BT998, c(0.0438,0.0019))

## create plot straightforward
plot_KDE(data = ExampleData.DeValues)

## create plot with logarithmic x-axis
plot_KDE(data = ExampleData.DeValues,
          log = "x")
```

```

## create plot with user-defined labels and axes limits
plot_KDE(data = ExampleData.DeValues,
  main = "Dose distribution",
  xlab = "Dose (s)",
  ylab = c("KDE estimate", "Cumulative dose value"),
  xlim = c(100, 250),
  ylim = c(0, 0.08, 0, 30))

## create plot with boxplot option
plot_KDE(data = ExampleData.DeValues,
  boxplot = TRUE)

## create plot with statistical summary below header
plot_KDE(data = ExampleData.DeValues,
  summary = c("n", "median", "skewness", "in.2s"))

## create plot with statistical summary as legend
plot_KDE(data = ExampleData.DeValues,
  summary = c("n", "mean", "sd.rel", "se.abs"),
  summary.pos = "topleft")

## split data set into sub-groups, one is manipulated, and merge again
data.1 <- ExampleData.DeValues[1:15,]
data.2 <- ExampleData.DeValues[16:25,] * 1.3
data.3 <- list(data.1, data.2)

## create plot with two subsets straightforward
plot_KDE(data = data.3)

## create plot with two subsets and summary legend at user coordinates
plot_KDE(data = data.3,
  summary = c("n", "median", "skewness"),
  summary.pos = c(110, 0.07),
  col = c("blue", "orange"))

## example of how to use the numerical output of the function
## return plot output to draw a thicker KDE line
KDE_out <- plot_KDE(data = ExampleData.DeValues)

```

plot_MoranScatterplot *Moran Scatter Plot: Visualizing Spatial Dependency*

Description

The function produces a scatter plot, with on the x axis the original grain signal and on the y axis the weighted mean of the neighbour grain signals. The plot area is divided into four quadrants, and also a least square line (which slopes indicates, but not exactly represents, Moran's I) and an 1:1 line (which indicates a Moran's I of around 1).

Usage

```
plot_MoranScatterplot(
  object,
  df_neighbours = NULL,
  str_y_def = c("mean_neighbours", "weighted_sum"),
  ...
)
```

Arguments

- | | |
|---------------|---|
| object | RLum.Results or numeric (required) : containing a numerical vector of length 100, representing one or more measurement discs ("positions") in a reader. Each element in the vector represents one grain hole location on a disc. |
| df_neighbours | data.frame (<i>with default</i>): Data frame indicating which borders to consider, and their respective weights (see the description provided for calc_MoransI). If NULL (default), this is constructed automatically by the internal function <code>.get_Neighbours</code> . |
| str_y_def | character (<i>with default</i>): Calculation of y position. Defaults to "mean_neighbours" which is the plain mean of all neighbour values and the most illustrative. The other option is "weighted_sum", which means the sum of the border weights times the neighbour values, which is actually closer to the way Moran's I is by default calculated in this package. |
| ... | Other parameters to be forwarded to the base R plot functions. <code>legend</code> (TRUE/FALSE) to enable/disable the legend. Note that <code>xlab</code> (x axis label), <code>ylab</code> (y axis label) and <code>cex</code> (scaling value) are given default values. Because of sometimes large value differences, <code>log = "x"</code> , <code>log = "y"</code> and <code>log = "xy"</code> are supported. In case of negative values and logarithmic plotting, values are increased so the smallest value to plot is 1. Summary elements such as means, least square line etc. will still be based on the linear case. <code>pch</code> accepts options "show_location_ids" (plots grain location id's), "show_n_neighbours" (indicates numbers of neighbours) and the normal base plot pch options. |

Details

Note that this function plots on the y-axis the mean of the neighbours, while the function [calc_MoransI](#) by default will for its global calculation weight every border the same. So, grain locations with 1, 2 or 3 neighbours will appear higher on the y-axis than their influence on Moran's I justify – apart from scaling, this explains a part of the differences of Moran's scatter plots between different packages. Also note that island' grain locations (=those not bordering other grains) are left out of these plots but might still influence Moran's I calculations.

Value

Returns (invisibly) a data frame with plotting coordinates and grain location id's, for creating user-defined plots.

How to cite

de Boer, A., Steinbuch, L., 2026. plot_MoranScatterplot(): Moran Scatter Plot: Visualizing Spatial Dependency. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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 Luc Steinbuch, Wageningen University & Research (The Netherlands)
 , RLum Developer Team

References

de Boer, A-M., Steinbuch, L., Heuvelink, G.B.M., Wallinga, J., 2025. A novel method to assess crosstalk in single-grain luminescence detection. Radiation Measurements 186, 107459. doi:10.1016/j.radmeas.2025.107459

Examples

```
plot_MoranScatterplot(1:100)
```

plot_NRt

Visualise natural/regenerated signal ratios

Description

This function creates a Natural/Regenerated signal vs. time (NR(t)) plot as shown in Steffen et al. 2009.

This function accepts the individual curve data in many different formats. If data is a list, each element of the list must contain a two column data.frame or matrix containing the XY data of the curves (time and counts). Alternatively, the elements can be objects of class [RLum.Data.Curve](#).

Input values can also be provided as a data.frame or matrix where the first column contains the time values and each following column contains the counts of each curve.

Usage

```
plot_NRt(
  data,
  log = "",
  smooth = c("none", "spline", "rmean"),
  k = 3,
  legend = TRUE,
  legend.pos = "topright",
  ...
)
```

Arguments

data	list , data.frame , matrix or RLum.Analysis (required): X,Y data of measured values (time and counts). See details on individual data structure.
log	character (<i>with default</i>): logarithmic axes ("x", "y", "xy") or "" (default) for linear axes.
smooth	character (<i>with default</i>): apply data smoothing. If "none" (default), no data smoothing is applied. Use "rmean" to calculate the rolling mean, where k determines the width of the rolling window (see data.table::frollmean). "spline" applies a smoothing spline to each curve (see stats::smooth.spline)
k	integer (<i>with default</i>): integer width of the rolling window.
legend	logical (<i>with default</i>): enable/disable the plot legend.
legend.pos	character (<i>with default</i>): keyword specifying the position of the legend (see legend).
...	further parameters passed to plot (also see par).

Value

Returns a plot and [RLum.Analysis](#) object.

How to cite

Burow, C., 2026. plot_NRt(): Visualise natural/regenerated signal ratios. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Christoph Burow, University of Cologne (Germany) , RLum Developer Team

References

Steffen, D., Preusser, F., Schlunegger, F., 2009. OSL quartz underestimation due to unstable signal components. *Quaternary Geochronology*, 4, 353-362.

See Also

[plot](#)

Examples

```
## load example data
data("ExampleData.BINfileData", envir = environment())

## EXAMPLE 1

## convert Risoe.BINfileData object to RLum.Analysis object
```

```

data <- Risoe.BINfileData2RLum.Analysis(object = CWOSL.SAR.Data, pos = 8, ltype = "OSL")

## extract all OSL curves
allCurves <- get_RLum(data)

## keep only the natural and regenerated signal curves
pos <- seq(1, 9, 2)
curves <- allCurves[pos]

## plot a standard NR(t) plot
plot_NRt(curves)

## re-plot with rolling mean data smoothing
plot_NRt(curves, smooth = "rmean", k = 10)

## re-plot with a logarithmic x-axis
plot_NRt(curves, log = "x", smooth = "rmean", k = 5)

## re-plot with custom axes ranges
plot_NRt(curves, smooth = "rmean", k = 5,
          xlim = c(0.1, 5), ylim = c(0.4, 1.6),
          legend.pos = "bottomleft")

## re-plot with smoothing spline on log scale
plot_NRt(curves, smooth = "spline", log = "x",
          legend.pos = "top")

## EXAMPLE 2

# you may also use this function to check whether all
# TD curves follow the same shape (making it a TnTx(t) plot).
posTD <- seq(2, 14, 2)
curves <- allCurves[posTD]

plot_NRt(curves, main = "TnTx(t) Plot",
          smooth = "rmean", k = 20,
          ylab = "TD natural / TD regenerated",
          xlim = c(0, 20), legend = FALSE)

## EXAMPLE 3

# extract data from all positions
data <- lapply(1:24, FUN = function(pos) {
  Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos = pos, ltype = "OSL")
})

# get individual curve data from each aliquot
aliquot <- lapply(data, get_RLum)

# set graphical parameters
par(mfrow = c(2, 2))

# create NR(t) plots for all aliquots

```

```

for (i in 1:length(aliquot)) {
  plot_NRt(aliquot[[i]][pos],
    main = paste0("Aliquot #", i),
    smooth = "rmean", k = 20,
    xlim = c(0, 10),
    cex = 0.6, legend.pos = "bottomleft")
}

# reset graphical parameters
par(mfrow = c(1, 1))

```

plot_OSLAgeSummary	<i>Plot Posterior OSL-Age Summary</i>
--------------------	---------------------------------------

Description

The function produces a graphical summary of the statistical inference of an OSL age.

Usage

```
plot_OSLAgeSummary(object, level = 0.95, digits = 1L, verbose = TRUE, ...)
```

Arguments

object	RLum.Results , numeric (required) : an object produced by combine_De_Dr . Alternatively, a numeric vector of a parameter from an MCMC process.
level	numeric (<i>with default</i>): probability of shown credible interval.
digits	integer (<i>with default</i>): number of digits considered for the calculation.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	further arguments to modify the plot, supported: <code>xlim</code> , <code>ylim</code> , <code>xlab</code> , <code>ylab</code> , <code>main</code> , <code>lwd</code> , <code>lty</code> , <code>col</code> , <code>rug</code> , <code>polygon_col</code> , <code>polygon_density</code> .

Details

The function is called automatically by [combine_De_Dr](#).

Value

A posterior distribution plot and an [RLum.Results](#) object with the credible interval.

Function version

0.1.0

How to cite

Philippe, A., Galharret, J., Mercier, N., Kreutzer, S., 2026. plot_OSLAgeSummary(): Plot Posterior OSL-Age Summary. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

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See Also

[combine_De_Dr](#), [plot.default](#), [rjags::rjags](#)

Examples

```
##generate random data
set.seed(1234)
object <- rnorm(1000, 100, 10)
plot_OSLAgeSummary(object)
```

plot_RadialPlot

Function to create a Radial Plot

Description

A Galbraith's radial plot is produced on a logarithmic or a linear scale.

Usage

```
plot_RadialPlot(
  data,
  log.z = TRUE,
  central.value = NULL,
  centrality = c("mean.weighted", "mean.weighted", "median", "median.weighted"),
  mtext = "",
  summary = c("n", "in.2s"),
  summary.pos = "sub",
  legend = NULL,
```

```

legend.pos = "topright",
stats = "none",
rug = FALSE,
plot.ratio = NULL,
bar.col = NULL,
y.ticks = TRUE,
grid.col = NULL,
line = NULL,
line.col = NULL,
line.label = NULL,
...
)

```

Arguments

data	data.frame or RLum.Results object (required): for data.frame: either two columns: De (data[,1]) and De error (data[,2]), or one: De (values[,1]). If a single-column data frame is provided, De error is assumed to be 10^{-9} for all measurements, and y.ticks is silently reset to FALSE. Rows with NA values will be removed prior to plotting. To plot several data sets in one plot, the data sets must be provided as list, e.g. list(data.1, data.2).
log.z	logical (<i>with default</i>): Option to display the z-axis in logarithmic scale. Default is TRUE.
central.value	numeric (<i>optional</i>): User-defined central value, primarily used for horizontal centring of the z-axis.
centrality	character or numeric (<i>with default</i>): measure of centrality, used for automatically centring the plot and drawing the central line. Can either be one out of • "mean", • "median", • "mean.weighted" and • "median.weighted", or a • numeric value used for the standardisation of the same length as the number of input data sets (it is ignored otherwise).
mtext	character (<i>with default</i>): additional text below the plot title.
summary	character (<i>with default</i>): add statistic measures of centrality and dispersion to the plot. Can be one or more of several keywords. See details for available keywords.
summary.pos	numeric or character (<i>with default</i>): optional position coordinates or keyword (e.g. "topright") for the statistical summary. Alternatively, the keyword "sub" may be specified to place the summary below the plot header. However, this latter option is only possible if mtext is not used.
legend	character vector (<i>optional</i>): legend content to be added to the plot.
legend.pos	numeric or character (<i>with default</i>): optional legend position coordinates or keyword (e.g. "topright").

stats	character (<i>optional</i>): additional labels of statistically important values in the plot. It can be one or more of "min", "max" and "median"; any other values will be ignored.
rug	logical : Option to add a rug to the z-scale, to indicate the location of individual values
plot.ratio	numeric : User-defined plot area ratio (i.e. curvature of the z-axis). If omitted, the default value (4.5/5.5) is used and modified automatically to optimise the z-axis curvature. The parameter should be decreased when data points are plotted outside the z-axis or when the z-axis gets too elliptic.
bar.col	character or numeric (<i>with default</i>): colour of the bar showing the 2-sigma range around the central value. To disable the bar, use "none". Default is "grey80".
y.ticks	logical : Option to hide y-axis labels. Useful for data with small scatter.
grid.col	character or numeric (<i>with default</i>): colour of the grid lines (originating at [0, 0] and stretching to the z-scale). To disable grid lines, use "none". Default is "grey70".
line	numeric : numeric values of the additional lines to be added.
line.col	character or numeric : colour of the additional lines.
line.label	character : labels for the additional lines.
...	further arguments and graphical parameters to control the plot output. Supported are: main, sub, xlab, ylab, zlab, xlim, ylim, zlim, cex, pt.cex (point size), lty, lwd, pch, col, tcl, show, and fun. xlab must be a vector of length 2, specifying the upper and lower x-axes labels.

Details

Details and the theoretical background of the radial plot are given in the cited literature. This function is based on an S script of Rex Galbraith. To reduce the manual adjustments, the function has been rewritten. Thanks to Rex Galbraith for useful comments on this function.

Plotting can be disabled by adding the argument `plot = "FALSE"`, e.g. to return only numeric plot output.

Earlier versions of the Radial Plot in this package had the 2-sigma-bar drawn onto the z-axis. However, this might have caused misunderstanding in that the 2-sigma range may also refer to the z-scale, which it does not! Rather it applies only to the x-y-coordinate system (standardised error vs. precision). A spread in doses or ages must be drawn as lines originating at zero precision (x0) and zero standardised estimate (y0). Such a range may be drawn by adding lines to the radial plot (`line`, `line.col`, `line.label`, cf. examples).

A statistic summary, i.e. a collection of statistic measures of centrality and dispersion (and further measures) can be added by specifying one or more of the following keywords:

- "n" (number of samples),
- "mean" (mean De value),
- "mean.weighted" (error-weighted mean),
- "median" (median of the De values),
- "median.weighted" (error-weighted median),

- "sd.rel" (relative standard deviation in percent),
- "sd.rel.weighted" (error-weighted relative standard deviation in percent),
- "sd.abs" (absolute standard deviation),
- "sd.abs.weighted" (error-weighted absolute standard deviation),
- "se.rel" (relative standard error in percent),
- "se.rel.weighted" (error-weighted relative standard error in percent),
- "se.abs" (absolute standard error),
- "se.abs.weighted" (error-weighted absolute standard error),
- "in.2s" (percent of samples in 2-sigma range),
- "kurtosis" (kurtosis) and
- "skewness" (skewness).

Value

Returns a plot object.

Function version

0.5.12

How to cite

Dietze, M., Kreutzer, S., 2026. plot_RadialPlot(): Function to create a Radial Plot. Function version 0.5.12. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Michael Dietze, GFZ Potsdam (Germany)
 Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Based on a rewritten S script of Rex Galbraith, 2010 , RLum Developer Team

References

- Galbraith, R.F., 1988. Graphical Display of Estimates Having Differing Standard Errors. *Technometrics* 30 (3), 271-281.
- Galbraith, R.F., 1990. The radial plot: Graphical assessment of spread in ages. *International Journal of Radiation Applications and Instrumentation. Part D. Nuclear Tracks and Radiation Measurements* 17 (3), 207-214.
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Galbraith, R.F. & Laslett, G.M., 1993. Statistical models for mixed fission track ages. Nuclear Tracks And Radiation Measurements 21 (4), 459-470.

Galbraith, R.F., 1994. Some Applications of Radial Plots. Journal of the American Statistical Association 89 (428), 1232-1242.

Galbraith, R.F., 2010. On plotting OSL equivalent doses. Ancient TL 28 (1), 1-10.

Galbraith, R.F. & Roberts, R.G., 2012. Statistical aspects of equivalent dose and error calculation and display in OSL dating: An overview and some recommendations. Quaternary Geochronology 11, 1-27.

See Also

[plot](#), [plot_KDE](#), [plot_Histogram](#), [plot_AbanicoPlot](#)

Examples

```
## load example data
data(ExampleData.DeValues, envir = environment())
ExampleData.DeValues <- convert_Second2Gray(
  ExampleData.DeValues$BT998, c(0.0438, 0.0019))

## plot the example data straightforward
plot_RadialPlot(data = ExampleData.DeValues)

## now with linear z-scale
plot_RadialPlot(
  data = ExampleData.DeValues,
  log.z = FALSE)

## store the plot parameters
plot1 <- plot_RadialPlot(
  data = ExampleData.DeValues,
  log.z = FALSE)
plot1
plot1$zlim

## now with adjusted z-scale limits
plot_RadialPlot(
  data = ExampleData.DeValues,
  log.z = FALSE,
  xlim = c(0, 5),
  zlim = c(100, 200))

## now the two plots with serious but seasonally changing fun
#plot_RadialPlot(data = data.3, fun = TRUE)

## now with user-defined central value, in log-scale again
plot_RadialPlot(
  data = ExampleData.DeValues,
  central.value = 150)

## now with a rug, indicating individual De values at the z-scale
```

```

plot_RadialPlot(
  data = ExampleData.DeValues,
  rug = TRUE)

## now with legend, colour, different points and smaller scale
plot_RadialPlot(
  data = ExampleData.DeValues,
  legend = "Sample 1",
  col = "tomato4",
  bar.col = "peachpuff",
  pch = "R",
  cex = 0.8)

## now without 2-sigma bar, y-axis, grid lines and central value line
plot_RadialPlot(
  data = ExampleData.DeValues,
  bar.col = "none",
  grid.col = "none",
  y.ticks = FALSE,
  lwd = 0)

## now with user-defined axes labels
plot_RadialPlot(
  data = ExampleData.DeValues,
  xlab = c("Data error (%)", "Data precision"),
  ylab = "Scatter",
  zlab = "Equivalent dose [Gy]")

## now with minimum, maximum and median value indicated
plot_RadialPlot(
  data = ExampleData.DeValues,
  central.value = 150,
  stats = c("min", "max", "median"))

## now with a brief statistical summary
plot_RadialPlot(
  data = ExampleData.DeValues,
  summary = c("n", "in.2s"))

## now with another statistical summary as subheader
plot_RadialPlot(
  data = ExampleData.DeValues,
  summary = c("mean.weighted", "median"),
  summary.pos = "sub")

## now the data set is split into sub-groups, one is manipulated
data.1 <- ExampleData.DeValues[1:15,]
data.2 <- ExampleData.DeValues[16:25,] * 1.3

## now a common dataset is created from the two subgroups
data.3 <- list(data.1, data.2)

## now the two data sets are plotted in one plot

```

```

plot_RadialPlot(data = data.3)

## now with some graphical modification
plot_RadialPlot(
  data = data.3,
  col = c("darkblue", "darkgreen"),
  bar.col = c("lightblue", "lightgreen"),
  pch = c(2, 6),
  summary = c("n", "in.2s"),
  summary.pos = "sub",
  legend = c("Sample 1", "Sample 2"))

```

plot_Risoe.BINfileData

Plot Single Luminescence Curves from a Risoe.BINfileData-class object

Description

Plots single luminescence curves from a [Risoe.BINfileData](#) object produced by [read_BIN2R](#).

Usage

```

plot_Risoe.BINfileData(
  data,
  position = NULL,
  run = NULL,
  set = NULL,
  sorter = c("POSITION", "RUN", "SET"),
  ltype = c("IRSL", "OSL", "TL", "RIR", "RBR", "RL"),
  curve.transformation = "None",
  dose_rate = NULL,
  temp.lab = "°C",
  cex.global = 1,
  ...
)

```

Arguments

data	Risoe.BINfileData (required): an S4 object generated by the read_BIN2R function.
position	vector (<i>optional</i>): option to limit the plotted curves by position (e.g. position = 1, position = c(1,3,5)).
run	vector (<i>optional</i>): option to limit the plotted curves by run (e.g., run = 1, run = c(1,3,5)).

set	vector (<i>optional</i>): option to limit the plotted curves by set (e.g., set = 1, set = c(1, 3, 5)).
sorter	character (<i>with default</i>): ordering used in plotting the curves, one of "POSITION", "SET" or "RUN". POSITION, SET and RUN are options defined in the Risoe Sequence Editor.
ltype	character (<i>with default</i>): option to limit the plotted curves by the type of luminescence stimulation. Allowed values: "IRSL", "OSL", "TL", "RIR", "RBR" (corresponds to LM-OSL), "RL". All type of curves are plotted by default.
curve.transformation	character (<i>optional</i>): allows transforming CW-OSL and CW-IRSL curves to pseudo-LM curves via transformation functions. Allowed values are: CW2pLM, CW2pLMi, CW2pHMi and CW2pPMi, see details. If set to None (default), no transformation is applied.
dose_rate	numeric (<i>optional</i>): dose rate of the irradiation source at the measurement date. If set, the given irradiation dose will be shown in Gy. See details.
temp.lab	character (<i>with default</i>): the temperature unit to display in the plot labels, by default deg C.
cex.global	numeric (<i>with default</i>): global scaling factor.
...	further undocumented plot arguments.

Details

Nomenclature

See [Risoe.BINfileData](#)

curve.transformation

This argument allows transforming continuous wave (CW) curves to pseudo (linear) modulated curves. For the transformation, the functions of the package are used. Currently, it is not possible to pass further arguments to the transformation functions. The argument works only for ltype OSL and IRSL.

Irradiation time

Plotting the irradiation time (s) or the given dose (Gy) requires that the variable IRR_TIME has been set within the BIN-file. This is normally done by using the 'Run Info' option within the Sequence Editor or by editing in R.

Value

Returns a plot.

Function version

0.4.3

How to cite

Kreutzer, S., Dietze, M., Colombo, M., 2026. plot_Risoe.BINfileData(): Plot Single Luminescence Curves from a Risoe.BINfileData-class object. Function version 0.4.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The function has been successfully tested for the Sequence Editor file output version 3 and 4.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Michael Dietze, GFZ Potsdam (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany) , RLum Developer Team

References

Duller, G., 2007. Analyst. pp. 1-45.

See Also

[Risoe.BINfileData](#), [read_BIN2R](#), [convert_CW2pLM](#), [convert_CW2pLMi](#), [convert_CW2pPMi](#), [convert_CW2pHMi](#)

Examples

```
##load data
data(ExampleData.BINfileData, envir = environment())

##plot all curves from the first position to the desktop
#pdf(file = "~/Desktop/CurveOutput.pdf", paper = "a4", height = 11, onefile = TRUE)

##example - load from *.bin file
#BINfile<- file.choose()
#BINfileData<-read_BIN2R(BINfile)

#par(mfrow = c(4,3), oma = c(0.5,1,0.5,1))
#plot_Risoe.BINfileData(CWOSL.SAR.Data,position = 1)
#mtext(side = 4, BINfile, outer = TRUE, col = "blue", cex = .7)
#dev.off()
```

plot_RLum	<i>General plot function for RLum S4 class objects</i>
-----------	--

Description

The function calls object specific plot functions for RLum S4 class objects.

Usage

```
plot_RLum(object, ...)
```

Arguments

- | | |
|--------|---|
| object | RLum (required): object of class RLum or a list of such objects. If a list is provided, the function tries to plot every object in the list according to its RLum class, after removing non-RLum objects. |
| ... | further arguments and graphical parameters to pass to the specific plot functions. The only arguments that are supported directly are main (plot title) and mtext (subtitle). They may be lists, in which case each element is dispatched to the plots (with recycling)if object is also a list. |

Details

The function provides a generalised access point for plotting various [RLum](#) objects. Depending on the input object, the corresponding plot function will be selected. Allowed arguments can be found in the documentations of each plot function.

object	corresponding plot function
RLum.Data.Curve	plot_RLum.Data.Curve
RLum.Data.Spectrum	plot_RLum.Data.Spectrum
RLum.Data.Image	plot_RLum.Data.Image
RLum.Analysis	plot_RLum.Analysis
RLum.Results	plot_RLum.Results

Value

Produces a plot depending on the input object.

Function version

0.6

How to cite

Kreutzer, S., Colombo, M., 2026. plot_RLum(): General plot function for RLum S4 class objects. Function version 0.6. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany)
 , RLum Developer Team

See Also

[plot_RLum.Analysis](#), [plot_RLum.Data.Curve](#), [plot_RLum.Data.Spectrum](#), [plot_RLum.Data.Image](#), [plot_RLum.Results](#)

Examples

```
#load Example data
data(ExampleData.CW_OSL_Curve, envir = environment())

#transform data.frame to RLum.Data.Curve object
temp <- as(ExampleData.CW_OSL_Curve, "RLum.Data.Curve")

#plot RLum object
plot_RLum(temp)
```

plot_RLum.Analysis	<i>Plot function for an RLum.Analysis S4 class object</i>
--------------------	---

Description

The function provides a standardised plot output for curve data of an [RLum.Analysis](#) object.

The function produces a multiple plot output. A file output is recommended (e.g., [pdf](#)).

curve.transformation

This argument allows transforming continuous wave (CW) curves to pseudo (linear) modulated curves. For the transformation, the functions of the package are used. Currently, it is not possible to pass further arguments to the transformation functions. The argument works only for 1 type OSL and IRSL.

Please note: The curve transformation within this functions works roughly, i.e. every IRSL or OSL curve is transformed, without considering whether it is measured with the PMT or not! However, for a fast look it might be helpful.

Usage

```
plot_RLum.Analysis(
  object,
  subset = NULL,
  nrows = NULL,
  ncols = NULL,
  abline = NULL,
  combine = FALSE,
  records_max = NULL,
  curve.transformation = "None",
  plot_singlePanels = FALSE,
  ...
)
```

Arguments

object	RLum.Analysis (required): S4 object of class RLum.Analysis
subset	named list (<i>optional</i>): subsets elements for plotting. The arguments in the named list will be directly passed to the function get_RLum (e.g., subset = list(curveType = "measured"))
nrows	integer (<i>optional</i>): number of rows in the plot output. If set to NULL the function tries to find a reasonable value.
ncols	integer (<i>optional</i>): number of columns in the plot output. If set to NULL the function tries to find a reasonable value.
abline	list (<i>optional</i>): allows to add ab-lines to the plot. Argument are provided in a list and will be forward to the function abline , e.g., list(v = c(10, 100)) adds two vertical lines add 10 and 100 to all plots. In contrast list(v = c(10), v = c(100)) adds a vertical at 10 to the first and a vertical line at 100 to the 2nd plot.
combine	logical (<i>with default</i>): allows to combine all RLum.Data.Curve objects in one single plot.
records_max	integer (<i>optional</i>): limits number of records shown when combine = TRUE is used. The first and last curves are always shown, the other curves shown are distributed evenly; this may result in fewer curves plotted than specified. This argument must be at least 2 to have an effect.
curve.transformation	character (<i>with default</i>): allows transforming CW-OSL and CW-IRSL curves to pseudo-LM curves via transformation functions. Allowed values are: CW2pLM, CW2pLMi, CW2pHMi and CW2pPMi, see details. If set to None (default), no transformation is applied.
plot_singlePanels	logical (<i>with default</i>): global par settings are considered, normally this should end in one plot per page
...	further arguments and graphical parameters will be passed to the plot function. Supported arguments: main, mtext, log, lwd, lty type, pch, col, norm (see plot_RLum.Data.Curve), xlim, ylim, xlab, ylab, ...

and for `combine = TRUE` also: `sub_title`, `legend`, `legend.text`, `legend.pos` (typical plus 'outside'), `legend.col`, `smooth`.

All arguments can be provided as vector or list to gain in full control of all plot settings.

Value

Returns multiple plots.

Function version

0.3.16

How to cite

Kreutzer, S., 2026. `plot_RLum.Analysis()`: Plot function for an `RLum.Analysis` S4 class object. Function version 0.3.16. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Not all arguments available for `plot` will be passed and they partly do not behave in the way you might expect them to work. This function was designed to serve as an overview plot, if you want to have more control, extract the objects and plot them individually.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

`plot`, `plot_RLum`, `plot_RLum.Data.Curve`

Examples

```
##load data
data(ExampleData.BINfileData, envir = environment())

##convert values for position 1
temp <- Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos=1)

##(1) plot (combine) TL curves in one plot
plot_RLum.Analysis(
  temp,
  subset = list(recordType = "TL"),
  combine = TRUE,
  norm = TRUE,
```

```

abline = list(v = c(110))
)

##(2) same as example (1) but using
## the argument smooth = TRUE
plot_RLum.Analysis(
  temp,
  subset = list(recordType = "TL"),
  combine = TRUE,
  norm = TRUE,
  smooth = TRUE,
  abline = list(v = c(110))
)

```

plot_RLum.Data.Curve *Plot function for an RLum.Data.Curve S4 class object*

Description

The function provides a standardised plot output for curve data of an [RLum.Data.Curve](#) S4-class object.

Usage

```

plot_RLum.Data.Curve(
  object,
  par.local = TRUE,
  norm = FALSE,
  smooth = FALSE,
  auto_scale = FALSE,
  interactive = FALSE,
  ...
)

```

Arguments

object	RLum.Data.Curve (required): S4 object of class RLum.Data.Curve
par.local	logical (<i>with default</i>): use local graphical parameters for plotting, e.g. the plot is shown in one column and one row. If <code>par.local = FALSE</code> , global parameters are inherited.
norm	logical character (<i>with default</i>): whether curve normalisation should occur (FALSE by default). Alternatively, the function offers modes "max" (used with TRUE), "last" and "huot", see details.
smooth	logical (<i>with default</i>): provides automatic curve smoothing based on the internal function <code>.smoothing</code>

auto_scale	logical (<i>with default</i>): if activated, auto scales xlim or ylim to the extent of the other. If both are set, the auto-scaling is skipped.
interactive	logical (<i>with default</i>): enables/disables interactive plotting mode using <code>plotly::plot_ly</code>
...	further arguments and graphical parameters that will be passed to <code>graphics::plot.default</code> and <code>graphics::par</code>

Details

Only single curve data can be plotted with this function. Arguments according to [plot](#).

Curve normalisation

The argument `norm` normalises all count values. To date the following options are supported:

`norm = TRUE` or `norm = "max"`: Curve values are normalised to the highest count value in the curve

`norm = "min"`: Curve values are normalised to the smallest count value in the curve

`norm = "first"`: Curve values are normalised to the very first count value

`norm = "last"`: Curve values are normalised to the last count value (this can be useful in particular for radiofluorescence curves)

`norm = "huot"`: Curve values are normalised as suggested by Sébastien Huot via GitHub:

$$y = (observed - median(background)) / (\max(observed) - median(background))$$

The background of the curve is defined as the last 20% of the count values of a curve.

`norm = "intensity"`: Curve values are normalised to the channel length.

`norm = 2.2`: Curve values are normalised to a positive number (e.g., 2.2).

Value

Returns a plot.

Function version

0.4.0

How to cite

Kreutzer, S., 2026. `plot_RLum.Data.Curve()`: Plot function for an `RLum.Data.Curve` S4 class object. Function version 0.4.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Not all arguments of [plot](#) will be passed!

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[plot](#), [plot_RLum](#)

Examples

```
##plot curve data

#load Example data
data(ExampleData.CW_OSL_Curve, envir = environment())

#transform data.frame to RLum.Data.Curve object
temp <- as(ExampleData.CW_OSL_Curve, "RLum.Data.Curve")

#plot RLum.Data.Curve object
plot_RLum.Data.Curve(temp)
```

`plot_RLum.Data.Image` *Plot function for an RLum.Data.Image S4 class object*

Description

The function provides very basic plot functionality for image data of an [RLum.Data.Image](#) object. For more sophisticated plotting it is recommended to use other very powerful packages for image processing.

Details on the plot functions

Supported plot types:

`plot.type = "plot.raster"`

Uses the standard plot function of R [graphics::image](#). If wanted, the image is enhanced, using the argument `stretch`. Possible values are `hist`, `lin`, and `NULL`. The latter does nothing. The argument `useRaster = TRUE` is used by default, but can be set to `FALSE`.

`plot.type = "contour"`

This uses the function [graphics::contour](#)

Usage

```
plot_RLum.Data.Image(
  object,
  frames = NULL,
  par.local = TRUE,
  plot.type = c("plot.raster", "contour"),
  ...
)
```

Arguments

object	RLum.Data.Image (required): S4 object of class RLum.Data.Image
frames	numeric (<i>optional</i>): sets the frames to be set, by default all frames are plotted. Can be sequence of numbers, as long as the frame number is valid.
par.local	logical (<i>with default</i>): use local graphical parameters for plotting, e.g. the plot is shown in one column and one row. If <code>par.local = FALSE</code> global parameters are inherited.
plot.type	character (<i>with default</i>): plot types. Supported types are <code>plot.raster</code> , <code>contour</code>
...	further arguments and graphical parameters that will be passed to the specific plot functions. Standard supported parameters are <code>xlim</code> , <code>ylim</code> , <code>zlim</code> , <code>xlab</code> , <code>ylab</code> , <code>main</code> , <code>mtext</code> , <code>legend</code> (TRUE or FALSE), <code>col</code> , <code>cex</code> , <code>axes</code> (TRUE or FALSE), <code>zlim_image</code> (adjust the z-scale over different images), <code>stretch</code> , <code>digits</code> , <code>scientific</code> (TRUE or FALSE).

Value

Returns a plot

Function version

0.2.2

How to cite

Kreutzer, S., 2026. `plot_RLum.Data.Image()`: Plot function for an `RLum.Data.Image` S4 class object. Function version 0.2.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The axes limitations (`xlim`, `ylim`, `zlim`) work directly on the object, so that regardless of the chosen limits the image parameters can be adjusted for best visibility. However, in particular for z-scale limitations this is not always wanted, please use `zlim_image` to maintain a particular value range over a series of images.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Image](#), [plot](#), [plot_RLum](#), [graphics::image](#), [graphics::contour](#)

Examples

```
##load data
data(ExampleData.RLum.Data.Image, envir = environment())

##plot data
plot_RLum.Data.Image(ExampleData.RLum.Data.Image)
```

plot_RLum.Data.Spectrum

Plot function for an RLum.Data.Spectrum S4 class object

Description

The function provides a standardised plot output for spectrum data of an [RLum.Data.Spectrum](#) class object. The purpose of this function is to provide easy and straightforward spectra plotting, not a fully customised access to all plot parameters. If this is wanted, standard R plot functionality should be used instead.

Matrix structure

(cf. [RLum.Data.Spectrum](#))

- rows (x-values): wavelengths/channels (xlim, xlab)
- columns (y-values): time/temperature (ylim, ylab)
- cells (z-values): count values (zlim, zlab)

Note: This nomenclature is valid for all plot types of this function!

Nomenclature for value limiting

- xlim: Limits values along the wavelength axis
- ylim: Limits values along the time/temperature axis
- zlim: Limits values along the count value axis

Details on the plot functions

Spectrum is visualised as 3D or 2D plot. Both plot types are based on internal R plot functions.

plot.type = "persp"

Arguments that will be passed to [graphics::persp](#):

- shade: default is 0.4
- phi: default is 15
- theta: default is -30
- lphi: default is 15
- ltheta: default is -30
- expand: default is 1
- axes: default is TRUE

- box: default is TRUE; accepts "alternate" for a custom plot design
- ticktype: default is detailed, r: default is 10

Note: Further parameters can be adjusted via `par`. For example to set the background transparent and reduce the thickness of the lines use: `par(bg = NA, lwd = 0.7)` before the function call.

`plot.type = "single"`

Per frame a single curve is returned. Frames are time or temperature steps.

-frames: pick the frames to be plotted (depends on the binning!). Check without this setting before plotting.

`plot.type = "multiple.lines"`

All frames plotted in one frame.

-frames: pick the frames to be plotted (depends on the binning!). Check without this setting before plotting.

`plot.type = "image" or plot.type = "contour"`

These plot types use the R functions `graphics::image` or `graphics::contour`. The advantage is that many plots can be arranged conveniently using standard R plot functionality. If `plot.type = "image"` a contour is added by default, which can be disabled using the argument `contour = FALSE` to add own contour lines of choice.

`plot.type = "transect"`

Depending on the selected wavelength/channel range a transect over the time/temperature (y-axis) will be plotted along the wavelength/channels (x-axis). If the range contains more than one channel, values (z-values) are summed up. To select a transect use the `xlim` argument, e.g. `xlim = c(300, 310)` plot along the summed up count values of channel 300 to 310.

- add: default is FALSE: adds the plot to an existing plot
- smooth: default is FALSE: performs a simple curve smoothing
- transect_mode: default is sum: sets the integration mode for the transect along the wavelength axis. Other allowed values are mean, mean, min, max

Further arguments that will be passed (depending on the plot type)

`xlab, ylab, zlab, xlim, ylim, zlim, main, mtext, box, pch, type ("single", "multiple.lines", "interactive"), col, border, lwd, bty, showscale ("interactive", "image") contour, contour.col ("image"), labcex ("image", "contour"), n_breaks ("image"), legend (TRUE/FALSE), legend.text ("multiple.lines"), legend.pos ("image"), legend.horiz (TRUE/FALSE | "image")`

Usage

```
plot_RLum.Data.Spectrum(
  object,
  par.local = TRUE,
  plot.type = c("contour", "persp", "single", "multiple.lines", "image", "transect",
    "interactive"),
  optical.wavelength.colours = TRUE,
  bg.spectrum = NULL,
  bg.channels = NULL,
```

```

    bin.rows = 1,
    bin.cols = 1,
    norm = FALSE,
    rug = TRUE,
    limit_counts = NULL,
    xaxis.energy = FALSE,
    plot = TRUE,
    ...
)

```

Arguments

- | | |
|----------------------------|--|
| object | RLum.Data.Spectrum or matrix (required): S4 object of class RLum.Data.Spectrum or a matrix containing count values of the spectrum.
Please note that in case of a matrix row names and col names are set automatically if not provided. |
| par.local | logical (<i>with default</i>): use local graphical parameters for plotting, e.g. the plot is shown in one column and one row. If <code>par.local = FALSE</code> global parameters are inherited. |
| plot.type | character (<i>with default</i>): for a 3D-plot use "persp" or "interactive"; for a 2D-plot you can use "image", "contour", "single" or "multiple.lines" (along the time or temperature axis) or "transect" (along the wavelength axis). |
| optical.wavelength.colours | logical (<i>with default</i>): use optical wavelength colour palette. Note: For this, the spectrum range is limited: <code>c(350,750)</code> . Own colours can be set with the argument <code>col</code> . If you provide already binned spectra, the colour assignment is likely to be wrong, since the colour gradients are calculated using the bin number. |
| bg.spectrum | RLum.Data.Spectrum or matrix (<i>optional</i>): spectrum used for the background subtraction. The background spectrum should be measured using the same setting as the signal spectrum. The argument <code>bg.channels</code> controls how the subtraction is performed: if <code>bg.channels</code> is not specified or the number of channels is identical between the signal and background spectra, a channel-wise subtraction is performed; otherwise, the <i>arithmetic mean</i> is calculated and subtracted from the signal. |
| bg.channels | vector (<i>optional</i>): channels used for background subtraction. If the number of channels is identical between the signal and background spectra, a channel-wise subtraction is performed; otherwise this number is used to select channels for calculating the <i>arithmetic mean</i> . If a spectrum is provided via <code>bg.spectrum</code> , this argument only works on the background spectrum.
Note: Background subtraction is applied prior to channel binning! |
| bin.rows | integer (<i>with default</i>): allow summing-up wavelength channels (horizontal binning), e.g. <code>bin.rows = 2</code> two channels are summed up. Binning is applied after the background subtraction. |
| bin.cols | integer (<i>with default</i>): allow summing-up channel counts (vertical binning) for plotting, e.g. <code>bin.cols = 2</code> two channels are summed up. Binning is applied after the background subtraction. |

norm	logical, character (<i>optional</i>): if logical, whether curve normalisation should occur (FALSE by default); alternatively, one of the values detailed in plot_RLum.Data.Curve . The normalisation is applied after binning.
rug	logical (<i>with default</i>): enable/disable colour rug. Currently only implemented for plot type <code>multiple.lines</code> and <code>single</code> .
limit_counts	numeric (<i>optional</i>): value to limit all count values to this value, i.e. all count values above this threshold will be replaced by this threshold. This is helpful especially in case of TL-spectra.
xaxis.energy	logical (<i>with default</i>): enable/disable using energy instead of wavelength on the x-axis. Function convert_Wavelength2Energy is used to perform the conversion. Note: Besides being used in setting the axis, with this option the the spectrum is recalculated in terms of intensity, see details.
plot	logical (<i>with default</i>): enable/disable the plot output. If the plot output is disabled, the matrix used for the plotting and the calculated colour values (as attributes) are returned. This way, the (binned, transformed etc.) output can be used in other functions and packages, such as plotting with the package 'plot3D'.
...	further arguments and graphical parameters that will be passed to the plot function.

Value

Returns a plot and the transformed matrix used for plotting with some useful attributes such as colour and pmat (the transpose matrix from [graphics::persp](#)).

Function version

0.6.18

How to cite

Kreutzer, S., 2026. `plot_RLum.Data.Spectrum()`: Plot function for an `RLum.Data.Spectrum` S4 class object. Function version 0.6.18. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Not all additional arguments (...) will be passed similarly!

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Spectrum](#), [convert_Wavelength2Energy](#), [plot_RLum](#), [graphics::persp](#), [plotly::plot_ly](#), [graphics::contour](#), [graphics::image](#)

Examples

```
##load example data
data(ExampleData.XSYG, envir = environment())

##(1)plot simple spectrum (2D) - image
plot_RLum.Data.Spectrum(
  TL.Spectrum,
  plot.type="image",
  xlim = c(310,750),
  ylim = c(0,300),
  bin.rows=10,
  bin.cols = 1)

##(2) plot spectrum (3D)
plot_RLum.Data.Spectrum(
  TL.Spectrum,
  plot.type="persp",
  xlim = c(310,750),
  ylim = c(0,100),
  bin.rows=10,
  bin.cols = 1)

##(3) plot spectrum on energy axis
##please note the background subtraction
plot_RLum.Data.Spectrum(TL.Spectrum,
  plot.type="persp",
  ylim = c(0,200),
  bin.rows=10,
  bg.channels = 10,
  bin.cols = 1,
  xaxis.energy = TRUE)

##(4) plot multiple lines (2D) - multiple.lines (with ylim)
plot_RLum.Data.Spectrum(
  TL.Spectrum,
  plot.type="multiple.lines",
  xlim = c(310,750),
  ylim = c(0,100),
  bin.rows=10,
  bin.cols = 1)

## Not run:
##(4) interactive plot using the package plotly ("surface")
plot_RLum.Data.Spectrum(TL.Spectrum, plot.type="interactive",
  xlim = c(310,750), ylim = c(0,300), bin.rows=10,
  bin.cols = 1)
```

```
##(5) interactive plot using the package plotly ("contour")
plot_RLum.Data.Spectrum(TL.Spectrum, plot.type="interactive",
xlim = c(310,750), ylim = c(0,300), bin.rows=10,
bin.cols = 1,
type = "contour",
showscale = TRUE)

##(6) interactive plot using the package plotly ("heatmap")
plot_RLum.Data.Spectrum(TL.Spectrum, plot.type="interactive",
xlim = c(310,750), ylim = c(0,300), bin.rows=10,
bin.cols = 1,
type = "heatmap",
showscale = TRUE)

## End(Not run)
```

plot_RLum.Results	<i>Plot function for an RLum.Results S4 class object</i>
-------------------	--

Description

The function provides a standardised plot output for data of an RLum.Results S4 class object, redirecting to specialised functions if necessary.

Usage

```
plot_RLum.Results(object, single = TRUE, ...)
```

Arguments

object	RLum.Results (required): S4 object of class RLum.Results.
single	logical (<i>with default</i>): single plot output (TRUE/FALSE) to allow for plotting the results in as few plot windows as possible.
...	further arguments and graphical parameters will be passed to the plot function.

Details

The function may produce multiple plots, in which case a file output is recommended (e.g., [pdf](#)).

Value

Returns multiple plots.

Function version

0.2.2

How to cite

Burow, C., Kreutzer, S., 2026. plot_RLum.Results(): Plot function for an RLum.Results S4 class object. Function version 0.2.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Not all arguments available for `plot` will be passed! Only plotting of `RLum.Results` objects are supported.

Author(s)

Christoph Burow, University of Cologne (Germany)
Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[plot](#), [plot_RLum](#)

Examples

```
###load data
data(ExampleData.DeValues, envir = environment())

# apply the un-logged minimum age model
mam <- calc_MinDose(data = ExampleData.DeValues$CA1, sigmab = 0.2, log = TRUE, plot = FALSE)

##plot
plot_RLum.Results(mam)

# estimate the number of grains on an aliquot
grains<- calc_AliquotSize(grain.size = c(100,150), sample.diameter = 1, plot = FALSE, MC.iter = 100)

##plot
plot_RLum.Results(grains)
```

plot_ROI

Create Regions of Interest (ROI) Graphic

Description

The function creates ROI graphic with data extracted from the data imported via [read_RF2R](#). This function might be of use to work with reduced data from spatially resolved measurements. The plot dimensions mimic the original image dimensions.

Usage

```
plot_ROI(
  object,
  exclude_ROI = 1,
  dist_thre = -Inf,
  dim.CCD = NULL,
  bg_image = NULL,
  plot = TRUE,
  ...
)
```

Arguments

object	RLum.Analysis , RLum.Results or a list of such objects (required): input data created either by read_RF2R or extract_ROI .
exclude_ROI	numeric (<i>with default</i>): option to remove particular ROIs from the analysis. Those ROIs are plotted but not coloured and not taken into account in distance analysis. NULL excludes nothing.
dist_thre	numeric (<i>optional</i>): euclidean distance threshold in pixel distance. All ROI for which the euclidean distance is smaller are marked. This helps to identify ROIs that might be affected by signal cross-talk. Note: the distance is calculated from the centre of an ROI, e.g., the threshold should include consider the ROIs or grain radius.
dim.CCD	numeric (<i>optional</i>): metric x and y for the recorded (chip) surface in μm . For instance c(8192, 8192), if set additional x and y-axes are shown.
bg_image	RLum.Data.Image (<i>optional</i>): background image object (please note that dimensions are not checked).
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further parameters to manipulate the plot. Besides the standard arguments of graphics::plot.default , the following arguments are supported: <code>lwd.ROI</code> , <code>lty.ROI</code> , <code>col.ROI</code> , <code>col.pixel</code> , <code>text.labels</code> , <code>text.offset</code> , <code>grid</code> (TRUE/FALSE), <code>legend</code> (TRUE/FALSE), <code>legend.text</code> , <code>legend.pos</code>

Value

An ROI plot and an [RLum.Results](#) object with a matrix containing the extracted ROI data and a object produced by [stats::dist](#) containing the euclidean distance between the ROIs.

Function version

0.2.0

How to cite

Kreutzer, S., 2026. plot_ROI(): Create Regions of Interest (ROI) Graphic. Function version 0.2.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J.,

Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[read_RF2R](#), [extract_ROI](#)

Examples

```
## simple example
file <- system.file("extdata", "RF_file.rf", package = "Luminescence")
temp <- read_RF2R(file)
plot_ROI(temp)

## in combination with extract_ROI()
m <- matrix(runif(100,0,255), ncol = 10, nrow = 10)
roi <- matrix(c(2.,4,2,5,6,7,3,1,1), ncol = 3)
t <- extract_ROI(object = m, roi = roi)
plot_ROI(t, bg_image = m)
```

plot_SingleGrainDisc *Plot a disc with its values*

Description

Shows a schematic representation of the physical appearance of one disc (one position in the reader) and illustrates the measured or calculated values per grain location.

Usage

```
plot_SingleGrainDisc(
  object,
  show_coordinates = FALSE,
  show_location_ids = FALSE,
  show_neighbours = FALSE,
  show_positioning_holes = TRUE,
  df_neighbours = NULL,
  ignore_borders = FALSE,
  str_transform = c("sqrt", "lin", "log"),
  ...
)
```

Arguments

object	RLum.Results or numeric (required): the values to show, should have length 100.
show_coordinates	logical (<i>with default</i>): Show coordinates (1..10) in x and in y direction. Defaults to FALSE.
show_location_ids	logical (<i>with default</i>): Show id with every grain location (1..100). Defaults to FALSE.
show_neighbours	logical (<i>with default</i>): Show which neighbour connections are taken into account if calculating Moran's I. This makes sense when there are NA observations, or when a non-standard neighbour setting is defined.
show_positioning_holes	logical (<i>with default</i>): Show the 3 positioning holes for orientation. Defaults to TRUE.
df_neighbours	data.frame (<i>with default</i>): only relevant if show_neighbours is TRUE. Data frame indicating which borders to consider, and their respective weights (see the description provided for calc_MoransI). If NULL (default), this is constructed automatically by the internal function <code>.get_Neighbours</code> .
ignore_borders	logical (<i>with default</i>): whether only grain locations that do not lie on the border of the disc should be considered (FALSE by default). Thus if TRUE, only the inner 8x8 grain locations rather than the full 10x10 are considered. Ignored if df_neighbours is not NULL or if show_neighbours = FALSE.
str_transform	character (<i>with default</i>): The observed value of each individual grain is reflected in the size of a triangle (or other dot-like element). To account for large value differences, the transformation from value to triangle size can be "lin" (linear), "log" (logarithmic) and "sqrt" (square root). Defaults to "sqrt", so that the surface is linear to the value. Note that the log and sqrt transformations can come with an addition to avoid negative values. When the legend is shown, the actual lower, middle and upper values are printed.
...	other arguments to be given to the base R plot function, such as main, col and pch. legend can be used to enable/disable the legend (FALSE by default).

Details

Depending of the available plotting space, some optional elements might have not enough room to be displayed. As this function is wrapped around the base plot function, one can also choose to add elements manually.

How to cite

de Boer, A., Steinbuch, L., 2026. plot_SingleGrainDisc(): Plot a disc with its values. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Anna-Maartje de Boer, Wageningen University & Research (The Netherlands)
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References

de Boer, A-M., Steinbuch, L., Heuvelink, G.B.M., Wallinga, J., 2025. A novel method to assess crosstalk in single-grain luminescence detection. Radiation Measurements 186, 107459. doi:[10.1016/j.radmeas.2025.107459](https://doi.org/10.1016/j.radmeas.2025.107459)

Examples

```
plot_SingleGrainDisc(1:100)
```

plot_ViolinPlot	Create a violin plot
-----------------	----------------------

Description

Draws a kernel density plot in combination with a boxplot in its middle. The shape of the violin is constructed using a mirrored density curve. This plot is especially designed for cases where the individual errors are zero or too small to be visualised. The idea for this plot is based on the 'violin plot' in the ggplot2 package by Hadley Wickham and Winston Chang. The general idea for the violin plot seems to have been introduced by Hintze and Nelson (1998).

Usage

```
plot_ViolinPlot(
  data,
  boxplot = TRUE,
  rug = TRUE,
  summary = c("n", "median"),
  summary.pos = "sub",
  ...
)
```

Arguments

data	numeric or RLum.Results (required): input data for plotting. Alternatively a data.frame or a matrix can be provided, but only the first column will be considered by the function. Rows with NA values will be removed prior to plotting.
boxplot	logical (<i>with default</i>): enable/disable the boxplot.
rug	logical (<i>with default</i>): enable/disable the rug.

summary	character (<i>with default</i>): add statistic measures of centrality and dispersion to the plot. Can be one or more of several keywords. See details for available keywords.
summary.pos	numeric or character (<i>with default</i>): optional position keywords (cf. legend) for the statistical summary. Alternatively, the keyword "sub" may be specified to place the summary below the plot header. However, this latter option is only possible if <code>mtext</code> is not used.
...	further arguments and graphical parameters passed to plot.default , stats::density and boxplot . See details for further information.

Details

The function is passing several arguments to the functions [plot](#), [stats::density](#), [graphics::boxplot](#):

Supported arguments are: `xlim`, `main`, `xlab`, `ylab`, `col.violin`, `col.boxplot`, `mtext`, `cex`, `mtext`

Valid summary keywords

'n', 'mean', 'median', 'sd.abs', 'sd.rel', 'se.abs', 'se.rel', 'skewness', 'kurtosis'

Function version

0.1.4

How to cite

Kreutzer, S., 2026. `plot_ViolinPlot()`: Create a violin plot. Function version 0.1.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Although the code for this function was developed independently and just the idea for the plot was based on the 'ggplot2' plot type 'violin', it should be mentioned that, beyond this, at least another R package produces this kind of plot, namely 'vioplot' (see references for details).

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

- Daniel Adler (2025). `vioplot`: violin plot. R package version 0.5.1 <http://CRAN.R-project.org/package=vioplot>
- Hintze, J.L., Nelson, R.D. (1998). A Box Plot-Density Trace Synergism. *The American Statistician* 52, 181-184.
- Wickham, H (2009). `ggplot2`: elegant graphics for data analysis. Springer New York.

See Also

[stats::density](#), [plot](#), [boxplot](#), [rug](#), [calc_Statistics](#)

Examples

```
## read example data set
data(ExampleData.DeValues, envir = environment())
ExampleData.DeValues <- convert_Second2Gray(ExampleData.DeValues$BT998,
                                             c(0.0438, 0.0019))

## create plot straightforward
plot_ViolinPlot(data = ExampleData.DeValues)
```

read_BIN2R

Import Risø BIN/BINX-files into R

Description

Import a *.bin or a *.binx file produced by a Risø DA15 and DA20 TL/OSL reader into R.

Usage

```
read_BIN2R(
  file,
  show.raw.values = FALSE,
  position = NULL,
  n.records = NULL,
  zero_data.rm = TRUE,
  duplicated.rm = FALSE,
  fastForward = FALSE,
  show.record.number = FALSE,
  txtProgressBar = TRUE,
  forced.VersionNumber = NULL,
  ignore.RECTYPE = FALSE,
  pattern = NULL,
  verbose = TRUE,
  ...
)
```

Arguments

file [character](#) or [list](#) (**required**): name of one or multiple BIN/BINX files (URLs are supported); it can be the path to a directory, in which case the function tries to detect and import all BIN/BINX files found recursively from the given directory.

show.raw.values	logical (<i>with default</i>): shows raw values from BIN-file for LTYPE, DTYPE and LIGHTSOURCE without translation in characters. Can be provided as list if file is a list.
position	numeric (<i>optional</i>): imports only the selected position. Note: the import performance will not benefit by any selection made here. Can be provided as list if file is a list.
n.records	numeric (<i>optional</i>): limits the number of imported records to the provided record id (e.g., n.records = 1:10 imports the first ten records, while n.records = 3 imports only record number 3. Can be used in combination with show.record.number for debugging purposes, e.g. corrupt BIN-files. Can be provided as list if file is a list.
zero_data.rm	logical (<i>with default</i>): remove erroneous data with no count values. As such data are usually not needed for the subsequent data analysis they will be removed by default. Can be provided as list if file is a list.
duplicated.rm	logical (<i>with default</i>): remove duplicated entries if TRUE. This may happen due to an erroneous produced BIN/BINX-file. This option compares only predecessor and successor. Can be provided as list if file is a list.
fastForward	logical (<i>with default</i>): if TRUE for a more efficient data processing only a list of RLum.Analysis objects is returned instead of a Risoe.BINfileData object. Can be provided as list if file is a list.
show.record.number	logical (<i>with default</i>): shows record number of the imported record, for debugging usage only. Can be provided as list if file is a list. Ignored if verbose = FALSE.
txtProgressBar	logical (<i>with default</i>): enable/disable the progress bar. Ignored if verbose = FALSE.
forced.VersionNumber	integer (<i>optional</i>): allows to cheat the version number check in the function by own values for cases where the BIN-file version is not supported. Can be provided as list if file is a list. Note: The usage is at own risk, only supported BIN-file versions have been tested.
ignore.RECTYPE	logical or numeric (<i>with default</i>): this argument allows to ignore values in the byte 'RECTYPE' (BIN-file version 08), in case there are not documented or faulty set. In this case the corrupted records are skipped. If the setting is numeric (e.g., ignore.RECTYPE = 128), records of those type are ignored for import.
pattern	character (<i>optional</i>): regular expression pattern passed to list.files to construct a list of files to read (used only when file specifies a path).
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	further arguments that will be passed to the function Risoe.BINfileData2RLum.Analysis . Please note that any matching argument automatically sets fastForward = TRUE

Details

The binary data file is parsed byte by byte following the data structure published in the Appendices of the Analyst manual p. 42.

For the general BIN/BINX-file structure, the reader is referred to the Risø website: <https://www.fysik.dtu.dk>

Value

Returns an S4 `Risoe.BINfileData` object containing two slots:

METADATA	A data.frame containing all variables stored in the BIN-file.
DATA	A list containing a numeric vector of the measured data. The ID corresponds to the record ID in METADATA.

If `fastForward = TRUE` an `RLum.Analysis` object is returned (coerced by `Risoe.BINfileData2RLum.Analysis`).

Results are returned as a list when multiple files are processed or `file` is a list.

Function version

0.19

How to cite

Kreutzer, S., Fuchs, M.C., Colombo, M., 2026. `read_BIN2R()`: Import Risø BIN/BINX-files into R. Function version 0.19. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The function works for BIN/BINX-format versions 03, 04, 05, 06, 07 and 08. The version number depends on the used Sequence Editor.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Margret C. Fuchs, HZDR Freiberg, (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany)
 based on information provided by Torben Lapp and Karsten Bracht Nielsen (Risø DTU, Denmark)
 , RLum Developer Team

References

DTU Nutech, 2016. The Sequence Editor, Users Manual, February, 2016. <https://www.fysik.dtu.dk>

See Also

[write_R2BIN](#), [Risoe.BINfileData](#), [base::readBin](#), [merge_Risoe.BINfileData](#), [RLum.Analysis](#) [utils::txtProgressBar](#), [list.files](#)

Examples

```
file <- system.file("extdata/BINfile_V8.binx", package = "Luminescence")
temp <- read_BIN2R(file)
temp
```

read_BINXLOG2R

*Import Risø BINX-data from the BINX Log File***Description**

The function attempts to extract meaningful measurement data from the log file (.txt) stored along with a BINX file if this option was chosen. This is particularly helpful if the BINX file is broken and the data would be lost otherwise.

Usage

```
read_BINXLOG2R(file, verbose = TRUE, ...)
```

Arguments

file	character (required) : name of one or multiple ASCII log files to read; it can be a path to a directory, in which case the function tries to read all files it finds (there is no file extension check, so it may fail ungracefully on binary files).
verbose	logical (with default) : enable/disable output to the terminal.
...	further arguments that will be passed to the function (currently not used)

Details

This function is basically a hack trying to make the most out of a broken file in case at least the log file is salvageable. Please do not expect black magic; the extract is very basic, and the function was written to work for TL, OSL, IRSL curves only. If it breaks, it breaks.

TL curve extraction Since the BIN/BINX do not contain x-values, they also cannot be created magically here. To avoid problems with the conversion, we assume always BIN-file version 3 for the conversion. This should be okay in most cases, however, it may become problematic if you have data for dedicated curve analysis.

Value

Returns an S4 [RLum.Analysis](#) object. Results are returned as a list when multiple files are processed or file is a list.

Function version

0.1.1

How to cite

Kreutzer, S., 2026. read_BINXLOG2R(): Import Risø BINX-data from the BINX Log File. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function tries to extract data from a log file produced for debugging purposes. There is no guarantee regarding the format stability, and the function is meant as a last resort if your BIN/BINX files are unusable.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[read_BIN2R](#), [write_R2BIN](#), [Risoe.BINfileData](#), [base::readLines](#), [RLum.Analysis](#), [list.files](#)

Examples

```
## read log file (RLum.Analysis)
file <- system.file("extdata/BINX_IRSL_LOG.TXT", package = "Luminescence")
object <- read_BINXLOG2R(file = file)

## convert to RisoeBINFile-class object
object <- convert_RLum2Risoe.BINfileData(object)

## export as BINX
## Not run:
write_R2BIN(t, file = tempfile(), version = "04")

## End(Not run)
```

read_Daybreak2R	<i>Import measurement data produced by a Daybreak TL/OSL reader into R</i>
-----------------	--

Description

Import a TXT-file (ASCII file) or a DAT-file (binary file) produced by a Daybreak reader into R. The import of the DAT-files is limited to the file format described for the software TLAPLLIC v.3.2 used for Daybreak models 1100 and 1150, and for FLConsole (any release) for Daybreak models 11xx and 2200.

Usage

```
read_Daybreak2R(file, raw = FALSE, verbose = TRUE, txtProgressBar = TRUE, ...)
```

Arguments

file	character or list (required): name of one or multiple .DAT or .txt files (URLs are supported); it can be the path to a directory, in which case the function tries to detect and import all files with .txt extension.
raw	logical (<i>with default</i>): if the input is a DAT-file (binary) a data.table::data.table instead of the RLum.Analysis object can be returned for debugging purposes.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
txtProgressBar	logical (<i>with default</i>): enable/disable txtProgressBar .
...	not in use, for compatibility reasons only

Value

A list of [RLum.Analysis](#) objects (each per position) is returned.

Function version

0.4.1

How to cite

Kreutzer, S., Bluszcz, A., Zink, A., 2026. read_Daybreak2R(): Import measurement data produced by a Daybreak TL/OSL reader into R. Function version 0.4.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

[BETA VERSION] This function still needs to be tested properly. In particular the function has underwent only very rough tests using a few files.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)

Andrzej Bluszcz, Silesian University of Technology, Gliwice (Poland)

Antoine Zink, C2RMF, Palais du Louvre, Paris (France)

The ASCII-file import is based on a suggestion by William Amidon and Andrew Louis Gorin. ,
RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data.Curve](#), [data.table::data.table](#)

Examples

```
## Not run:
file <- system.file("extdata/Daybreak_TestFile.txt", package = "Luminescence")
temp <- read_Daybreak2R(file)

## End(Not run)
```

read_HeliosOSL2R

Import Luminescence Data from Helios Luminescence Reader

Description

Import of files with .osl extension produced by the zero rad Helios luminescence reader and conversion to [RLum.Analysis](#) objects.

Usage

```
read_HeliosOSL2R(file, verbose = TRUE, ...)
```

Arguments

file	character , list (required): name of one or multiple .osl files (URLs are supported); it can be the path to a directory, in which case the function tries to detect and import all .osl files found in the directory.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	not in use, for compatibility reasons only

Value

A [RLum.Analysis](#) object. Results are returned as a list when multiple files are processed or file is a list.

Function version

0.1.1

How to cite

Kreutzer, S., 2026. read_HeliosOSL2R(): Import Luminescence Data from Helios Luminescence Reader. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Thanks to Krzysztof Maternicki for providing example data.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Analysis](#)

Examples

```
file <- system.file("extdata/HeliosOSL_Example.osl", package = "Luminescence")
read_HeliosOSL2R(file)
```

read_PSL2R

Import SUERC portable OSL Reader PSL files into R

Description

This function provides an import routine for the SUERC portable OSL Reader PSL format (measurement data and sequence). PSL files are just plain text and can be viewed with any text editor. Due to the formatting of PSL files, this import function relies heavily on regular expression to find and extract all relevant information. See **note**.

Usage

```
read_PSL2R(
  file,
  drop_bg = FALSE,
  as_decay_curve = TRUE,
  smooth = FALSE,
  merge = FALSE,
  pattern = "\\psl$",
  verbose = TRUE,
  ...
)
```

Arguments

file	character (required) : name of one or multiple PSL files (URLs are supported); it can be the path to a directory, in which case the function tries to detect and import all PSL files found in the directory.
drop_bg	logical (with default) : TRUE to automatically remove all non-OSL/IRSL curves.

as_decay_curve	logical (<i>with default</i>): Portable OSL Reader curves are often given as cumulative light sum curves. Use TRUE (default) to convert the curves to the more usual decay form.
smooth	logical (<i>with default</i>): TRUE to apply Tukey's Running Median Smoothing for OSL and IRSI decay curves. Smoothing is encouraged if you see random signal drops within the decay curves related to hardware errors.
merge	logical (<i>with default</i>): TRUE to merge all RLum.Analysis objects. Only applicable if multiple files are imported.
pattern	character (<i>with default</i>): regular expression pattern passed to list.files to construct a list of files to read (used only when a path is provided).
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	currently not used.

Value

Returns an S4 **RLum.Analysis** object containing **RLum.Data.Curve** objects for each curve. Results are returned as a list when multiple files are processed or `file` is a list.

Function version

0.1.2

How to cite

Burow, C., Kreutzer, S., 2026. `read_PSL2R()`: Import SUERC portable OSL Reader PSL files into R. Function version 0.1.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Because this function relies heavily on regular expressions to parse PSL files it is currently only in beta status. If the routine fails to import a specific PSL file please report to `<christoph.burow@gmx.net>` so the function can be updated.

Author(s)

Christoph Burow, University of Cologne (Germany)
 Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 , RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data.Curve](#), [RLum.Data.Curve](#)

Examples

```
# (1) Import PSL file to R

file <- system.file("extdata", "DorNie_0016.psl", package = "Luminescence")
psl <- read_PSL2R(file, drop_bg = FALSE, as_decay_curve = TRUE, smooth = TRUE, merge = FALSE)
print(str(psl, max.level = 3))
plot(psl, combine = TRUE)
```

read_RF2R

Import RF-files to R

Description

Import files produced by the IR-RF 'ImageJ' macro (SR-RF.ijm; Mittelstraß and Kreutzer, 2021) into R and create a list of [RLum.Analysis](#) objects.

Usage

```
read_RF2R(file, verbose = TRUE, ...)
```

Arguments

file	character (required): name of one or multiple RF files (URLs are supported); it can be the path to a directory, in which case the function tries to detect and import all RF files found in the directory.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
...	not used, only for compatible reasons

Details

The results of spatially resolved IR-RF data are summarised in so-called RF-files (Mittelstraß and Kreutzer, 2021). The output of the function can be passed to function [analyse_IRSAR.RF](#).

Value

Returns an S4 [RLum.Analysis](#) object containing [RLum.Data.Curve](#) objects for each curve. Results are returned as a list when multiple files are processed or file is a list. The header may contain key = "value" pairs, which will be stored in the info slot; incomplete pairs are silently dropped.

Function version

0.1.4

How to cite

Kreutzer, S., Colombo, M., 2026. read_RF2R(): Import RF-files to R. Function version 0.1.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 Marco Colombo, Institute of Geography, Heidelberg University (Germany)
 , RLum Developer Team

References

Mittelstraß, D., Kreutzer, S., 2021. Spatially resolved infrared radiofluorescence: single-grain K-feldspar dating using CCD imaging. *Geochronology* 3, 299–319. doi:10.5194/gchron32992021

See Also

[RLum.Analysis](#), [RLum.Data.Curve](#), [analyse_IRSAR.RF](#)

Examples

```
file <- system.file("extdata", "RF_file.rf", package = "Luminescence")
object <- read_RF2R(file)
```

read_SPE2R

Import Princeton Instruments (TM) SPE-file into R

Description

The function imports Princeton Instruments (TM) SPE-files into R and provides [RLum.Data.Image](#) objects as output. The import functionality is based on the file format description provided by Princeton Instruments and a MatLab script written by Carl Hall (see references).

Usage

```
read_SPE2R(
  file,
  output.object = c("RLum.Data.Image", "RLum.Data.Spectrum", "matrix"),
  frame.range = NULL,
  txtProgressBar = TRUE,
  verbose = TRUE,
  ...
)
```

Arguments

<code>file</code>	character (required) : name of the SPE file to read (URLs are supported).
<code>output.object</code>	character (with default) : set the output object type. Allowed types are RLum.Data.Spectrum , RLum.Data.Image or "matrix".
<code>frame.range</code>	vector, integer (optional) : range of frames to read. For example, <code>frame.range = c(1, 10)</code> selects only the first 10 frames. If not specified, all available frames (up to a maximum of 100 if <code>output.object = "RLum.Data.Image"</code>) are read.
<code>txtProgressBar</code>	logical (with default) : enable/disable the progress bar. Ignored if <code>verbose = FALSE</code> .
<code>verbose</code>	logical (with default) : enable/disable output to the terminal.
<code>...</code>	not used, for compatibility reasons only.

Value

Depending on the chosen option the functions returns three different type of objects:

`output.object`

[RLum.Data.Spectrum](#)

An object of type [RLum.Data.Spectrum](#) is returned. Row sums are used to integrate all counts over one channel.

[RLum.Data.Image](#)

An object of type [RLum.Data.Image](#) is returned. Due to performance reasons the import is aborted for files containing more than 100 frames. This limitation can be overwritten manually by using the argument `frame.range`.

matrix

Returns a matrix of the form: Rows = Channels, columns = Frames. For the transformation the function [get_RLum](#) is used, meaning that the same results can be obtained by using the function [get_RLum](#) on an [RLum.Data.Spectrum](#) or [RLum.Data.Image](#) object.

Function version

0.1.6

How to cite

Kreutzer, S., 2026. `read_SPE2R()`: Import Princeton Instruments (TM) SPE-file into R. Function version 0.1.6. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The function does not test whether the input data are spectra or pictures for spatial resolved analysis!

The function has been successfully tested for SPE format versions 2.x.

Currently not all information provided by the SPE format are supported.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

Princeton Instruments, 2014. Princeton Instruments SPE 3.0 File Format Specification, Version 1.A (for document URL please use an internet search machine)

Hall, C., 2012: readSPE.m. <https://www.mathworks.com/matlabcentral/fileexchange/35940-readspe>

See Also

[readBin](#), [RLum.Data.Spectrum](#)

Examples

```
## to run examples uncomment lines and run the code

##(1) Import data as RLum.Data.Spectrum object
#file <- file.choose()
#temp <- read_SPE2R(file)
#temp

##(2) Import data as RLum.Data.Image object
#file <- file.choose()
#temp <- read_SPE2R(file, output.object = "RLum.Data.Image")
#temp

##(3) Import data as matrix object
#file <- file.choose()
#temp <- read_SPE2R(file, output.object = "matrix")
#temp

##(4) Export raw data to csv, if temp is a RLum.Data.Spectrum object
# write.table(x = get_RLum(temp),
#             file = "[your path and filename]",
#             sep = ";", row.names = FALSE)
```

read_TIFF2R

Import TIFF Image Data into R

Description

Simple wrapper around [tiff::readTIFF](#) to import TIFF images and TIFF image stacks to be further processed within the 'Luminescence' package.

Usage

```
read_TIFF2R(file, merge2stack = FALSE, verbose = TRUE, ...)
```

Arguments

file	character (required) : name of the TIFF file to read (URLs are supported).
merge2stack	logical (with default) : if file is a list it merges the individual images into one image stack. Please note that the smallest image dimension determines pixel dimension of the output stack.
verbose	logical (with default) : enable/disable output to the terminal.
...	not in use, for compatibility reasons only

Value

Returns an [RLum.Data.Image](#) object. Results are returned as a list when multiple files are processed or file is a list.

Function version

0.2.1

How to cite

Kreutzer, S., 2026. read_TIFF2R(): Import TIFF Image Data into R. Function version 0.2.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[tiff::readTIFF](#), [RLum.Data.Image](#)

Examples

```
## use system file
file <- system.file("extdata", "TIFFfile.tif", package = "Luminescence")

## import image
image <- read_TIFF2R(file)
```

read_XSYG2R	<i>Import XSYG files into R</i>
-------------	---------------------------------

Description

Imports XSYG-files produced by a Freiberg Instruments lexsyg reader into R.

Usage

```
read_XSYG2R(
  file,
  recalculate.TL.curves = TRUE,
  n_records = NULL,
  fastForward = FALSE,
  import = TRUE,
  pattern = "\\\\.xsysg",
  auto_linearity_correction = FALSE,
  verbose = TRUE,
  txtProgressBar = TRUE
)
```

Arguments

file	character or list (required): name of one or multiple XSYG files (URLs are supported); it can be the path to a directory, in which case the function tries to detect and import all XSYG files found recursively from the given directory.
recalculate.TL.curves	logical (<i>with default</i>): if set to TRUE, TL curves are returned as temperature against count values (see details for more information) Note: The option overwrites the time vs. count TL curve. Select FALSE to import the raw data delivered by the lexsyg. Works for TL curves and spectra.
n_records	numeric (<i>with default</i>): number of records to be imported; by default the function attempts to import all records.
fastForward	logical (<i>with default</i>): if TRUE for a more efficient data processing only a list of RLum.Analysis objects is returned.
import	logical (<i>with default</i>): if set to FALSE, only the XSYG file structure is shown.
pattern	character (<i>with default</i>): regular expression pattern passed to list.files to construct a list of files to read (used only when a path is provided).
auto_linearity_correction	logical (<i>with default</i>): enable/disable automatic count linearity correction. Because the information on the detectors are not consistent and are not consistently stored, this option should be used with caution.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
txtProgressBar	logical (<i>with default</i>): enable/disable the progress bar during import. Ignored if verbose = FALSE.

Details

How does the import function work?

The function uses the 'XML' package to parse the file structure. Each sequence is subsequently translated into an [RLum.Analysis](#) object.

General structure XSYG format

```
<?xml?>
<Sample>
  <Sequence>
    <Record>
      <Curve name="first curve" />
      <Curve name="curve with data">x0 , y0 ; x1 , y1 ; x2 , y2 ; x3 , y3</Curve>
    </Record>
  </Sequence>
</Sample>
```

So far, each XSYG file can only contain one <Sample></Sample>, but multiple sequences.

Each record may comprise several curves.

TL curve recalculation

On the FI lexsyg device TL curves are recorded as time against count values. Temperature values are monitored on the heating plate and stored in a separate curve (time vs. temperature). If the option `recalculate.TL.curves = TRUE` is chosen, the time values for each TL curve are replaced by temperature values.

Practically, this means combining two matrices (Time vs. Counts and Time vs. Temperature) with different row numbers by their time values. Three cases are considered:

1. HE: Heating element
2. PMT: Photomultiplier tube
3. Interpolation is done using the function [approx](#)

CASE (1): `nrow(matrix(PMT)) > nrow(matrix(HE))`

Missing temperature values from the heating element are calculated using time values from the PMT measurement.

CASE (2): `nrow(matrix(PMT)) < nrow(matrix(HE))`

Missing count values from the PMT are calculated using time values from the heating element measurement.

CASE (3): `nrow(matrix(PMT)) == nrow(matrix(HE))`

A new matrix is produced using temperature values from the heating element and count values from the PMT.

Note: Please note that due to the recalculation of the temperature values based on values delivered by the heating element, it may happen that multiple count values exists for each temperature value and temperature values may also decrease during heating, not only increase.

Count linearity correction

If the argument `auto_linearity_correction = TRUE`, the function offers a, theoretically, automated linearity correction of the PMT signal using the internal function `correct_PMTLinearity`. The critical parameter is the count-pair resolution, which is provided to the function automatically depending on the detector. Currently, the following settings are used:

DETECTOR	COUNT-PAIR-RESOLUTION
UVVIS	18 ns
NIR50	70 ns
NIR40	70 ns
ETPMT	25 ns

Unfortunately, not all XSYG files provide correct information on the used detector, depending on software version. Hence, in case of doubt, please verify the settings and conduct a manual correction if required.

Advanced file import

To allow for a more efficient usage of the function, instead of single path to a file just a directory can be passed as input. In this particular case the function tries to extract all XSYG-files found in the directory and import them all. Using this option internally the function constructs as list of the XSYG-files found in the directory. Please note no recursive detection is supported as this may lead to endless loops.

Value

Using the option `import = FALSE`

A list consisting of two elements is shown:

- `data.frame` with information on file.
- `data.frame` with information on the sequences stored in the XSYG file.

Using the option `import = TRUE (default)`

A list is provided, the list elements contain:

`Sequence.Header`

`data.frame` with information on the sequence.

`Sequence.Object`

`RLum.Analysis` containing the curves.

Function version

0.8.3

How to cite

Kreutzer, S., Colombo, M., 2026. `read_XSYG2R()`: Import XSYG files into R. Function version 0.8.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function is a beta version as the XSYG file format is not yet fully specified. Thus, further file operations (merge, export, write) should be done using the functions provided with the package 'XML'.

So far, no image data import is provided!

Corresponding values in the XSXG file are skipped.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)

Marco Colombo, Institute of Geography, Heidelberg University (Germany) , RLum Developer Team

References

Grehl, S., Kreutzer, S., Hoehne, M., 2013. Documentation of the XSYG file format. Unpublished Technical Note. Freiberg, Germany

Further reading

XML: <https://en.wikipedia.org/wiki/XML>

See Also

'XML', [RLum.Analysis](#), [RLum.Data.Curve](#), [approx](#), [correct_PMTLinearity](#)

Examples

```
##(1) import XSYG file to R (uncomment for usage)

#FILE <- file.choose()
#temp <- read_XSYG2R(FILE)

##(2) additional examples for pure XML import using the package XML
##      (uncomment for usage)

##import entire XML file
#FILE <- file.choose()
#temp <- XML::xmlRoot(XML::xmlTreeParse(FILE))

##search for specific subnodes with curves containing 'OSL'
#getNodeSet(temp, "//Sample/Sequence/Record[@recordType = 'OSL']/Curve")

##(2) How to extract single curves ... after import
data(ExampleData.XSYG, envir = environment())

##grep one OSL curves and plot the first curve
OSLcurve <- get_RLum(OSL.SARMeasurement$Sequence.Object, recordType="OSL")[[1]]

##(3) How to see the structure of an object?
structure_RLum(OSL.SARMeasurement$Sequence.Object)
```

remove_RLum

*Strips records from RLum-class objects***Description**

Remove records from an RLum-class object in a convenient way using [get_RLum](#) for the selection.

Usage

```
remove_RLum(object, ...)

## S4 method for signature 'list'
remove_RLum(object, ...)

## S4 method for signature 'RLum.Analysis'
remove_RLum(object, ...)
```

Arguments

object [RLum \(required\)](#): object with records to be removed.

... parameters to be passed to [get_RLum](#). Only the following named arguments are supported: `record.id`, `recordType`, `curveType`, `RLum.type`, `protocol`, `info.object` and `subset`. Arguments `get.index` and `drop` are preset to `TRUE` and `FALSE`, respectively, and cannot be overridden. Other named arguments are ignored, while unnamed arguments are not supported.

Value

An object of the same type as the input provided with records removed; it can result in an empty object.

Methods (by class)

- `remove_RLum(list)`: Returns a list of [RLum](#) objects where the selected records are stripped
- `remove_RLum(RLum.Analysis)`: Method to remove records from an [RLum.Analysis](#) object.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. `remove_RLum()`: Strips records from RLum-class objects. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Analysis](#)

Examples

```
## load example data
data(ExampleData.XSYG, envir = environment())
sar <- OSL.SARMeasurement$Sequence.Object[1:9]

## strop only OSL curves
sar <- remove_RLum(sar, recordType = "OSL")
sar
```

remove_SignalBackground

Remove Signal Background from RLum.Data.Curve Objects

Description

Convenient (background) of luminescence curves using [merge_RLum](#)

Usage

```
remove_SignalBackground(
  object,
  object_bg = NULL,
  recordType = NULL,
  clean_up = TRUE
)
```

Arguments

object	RLum.Analysis (required): A non-empty RLum.Analysis object with, e.g., OSL/IRSL/TL curves or a list of such object. If a list is provided non-conform list elements are silently removed from the list
object_bg	RLum.Data.Curve , a list of such objects, a matrix or numeric (<i>optional</i>): Sets the background as a curve that is subtracted from the record types set with recordType. If you provide a matrix or numeric internally, everything is coerced to a RLum.Data.Curve object. If you desire full freedom, you can construct a list of RLum.Data.Curve objects.

recordType	character (<i>optional</i>): provide the recordType subject to the background subtraction. Subsequent curve selection uses get_RLum . If set to NULL the record type of highest occurrence will be used. Example: recordType = "TL (UVVIS)"
clean_up	logical (<i>with default</i>): enable/disable background curve removal after background subtraction. If object_bg is set, nothing is removed from the input object as the background is already stored separately.

Details

The function aims to simplify a frequently encountered task: subtracting curves or backgrounds from luminescence curves, such as OSL, TL, or RF. The function presumes that if curves are presented in pairs, for instance, TL - TL, the second curve represents a background signal that needs to be removed from the first curve. Following the removal, the background curve is discarded from the dataset. Alternatively, custom background curves can be provided, which are then utilised for the subtraction. In essence, the function utilises the [merge_RLum](#) function but simplifies the selection of pairs and curves.

Value

Returns an [RLum.Analysis](#) object or a [list](#) of such objects.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. remove_SignalBackground(): Remove Signal Background from RLum.Data.Curve Objects. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[get_RLum](#), [merge_RLum](#), [RLum.Analysis](#), [RLum.Data.Curve](#)

Examples

```
## load example dataset
xsysg <- read_XSYG2R(
  system.file("extdata/XSYG_file.xsysg", package = "Luminescence"),
  fastForward = TRUE,
  verbose = FALSE)
```

```
## remove constant background from OSL curves
remove_SignalBackground(
  object = xsyg,
  object_bg = 100,
  recordType = "OSL (UVVIS)")

## use a more elaborate examples
## with two TL curves (2nd is background)
xsysg_v1 <- set_RLum("RLum.Analysis", records = c(
  rep(xsyg[[1]]@records[[1]], 2),
  xsyg[[1]]@records[[4]],
  xsyg[[1]]@records[[4]],
  rep(xsyg[[1]]@records[[10]], 2),
  xsyg[[1]]@records[[4]],
  xsyg[[1]]@records[[4]]))

## remove background and strip background
## curves from the object
o <- remove_SignalBackground(
  object = xsysg_v1,
  recordType = "TL (UVVIS)")
```

replicate_RLum

*General replication function for RLum-class objects***Description**

The function replicates [RLum](#) objects and returns a list of such objects.

Usage

```
replicate_RLum(object, times = 1)

## S4 method for signature 'RLum'
replicate_RLum(object, times = 1)
```

Arguments

object	RLum (required): an RLum object
times	integer (<i>optional</i>): number for times each element should be repeated.

Value

A [list](#) with the object repeated.

Methods (by class)

- replicate_RLum(RLum): Replication method for [RLum](#) objects.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. replicate_RLum(): General replication function for RLum-class objects. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

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See Also[RLum](#)

report_RLum*Create a HTML-report for (RLum) objects*

Description

Create a HTML-report for (RLum) objects

Usage

```
report_RLum(  
  object,  
  file = tempfile(),  
  title = "RLum.Report",  
  compact = TRUE,  
  timestamp = TRUE,  
  show_report = TRUE,  
  launch.browser = FALSE,  
  css.file = NULL,  
  quiet = TRUE,  
  clean = TRUE,  
  ...  
)
```

Arguments

object	(required): The object to be reported on, preferably of any RLum-class.
file	character (<i>with default</i>): A character string naming the output file. If no filename is provided a temporary file is created.
title	character (<i>with default</i>): A character string specifying the title of the document.
compact	logical (<i>with default</i>): When TRUE the following report components are hidden: @.pid, @.uid, 'Object structure', 'Session Info' and only the first and last 5 rows of long matrices and data frames are shown. See details.
timestamp	logical (<i>with default</i>): TRUE to add a timestamp to the filename (suffix).
show_report	logical (<i>with default</i>): If set to TRUE the function tries to display the report output in the local viewer, e.g., within <i>RStudio</i> after rendering.
launch.browser	logical (<i>with default</i>): TRUE to open the HTML file in the system's default web browser after it has been rendered.
css.file	character (<i>optional</i>): Path to a CSS file to change the default styling of the HTML document.
quiet	logical (<i>with default</i>): TRUE to suppress printing of the pandoc command line.
clean	logical (<i>with default</i>): TRUE to clean intermediate files created during rendering.
...	further arguments passed to or from other methods and to control the document's structure (see details).

Details

This function creates a HTML-report for a given object, listing its complete structure and content. The object itself is saved as a serialised .Rds file. The report file serves both as a convenient way of browsing through objects with complex data structures as well as a mean of properly documenting and saving objects.

The HTML report is created with [rmarkdown::render](#) and has the following structure:

Section	Description
Header	A summary of general characteristics of the object
Object content	A comprehensive list of the complete structure and content of the provided object.
Object structure	Summary of the objects structure given as a table
File	Information on the saved RDS file
Session Info	Captured output from <code>sessionInfo()</code>
Plots	(<i>optional</i>) For RLum-class objects a variable number of plots

The structure of the report can be controlled individually by providing one or more of the following arguments (all logical):

Argument	Description
header	Hide or show general information on the object
main	Hide or show the object's content
structure	Hide or show object's structure

Author(s)

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Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
, RLum Developer Team

See Also

[rmarkdown::render](#), [pander::pander_return](#), [pander::openFileInOS](#), [rstudioapi::viewer](#), [browseURL](#)

Examples

```
## Not run:
## Example: RLum.Results ----

# load example data
data("ExampleData.DeValues")

# apply the MAM-3 age model and save results
mam <- calc_MinDose(ExampleData.DeValues$CA1, sigmab = 0.2)

# create the HTML report
report_RLum(object = mam, file = "~/CA1_MAM.Rmd",
            timestamp = FALSE,
            title = "MAM-3 for sample CA1")

# when creating a report the input file is automatically saved to a
# .Rds file (see saveRDS()).
mam_report <- readRDS("~/CA1_MAM.Rds")
all.equal(mam, mam_report)

## Example: Temporary file & Viewer/Browser ----

# (a)
# Specifying a filename is not necessarily required. If no filename is provided,
# the report is rendered in a temporary file. If you use the RStudio IDE, the
# temporary report is shown in the interactive Viewer pane.
report_RLum(object = mam)

# (b)
# Additionally, you can view the HTML report in your system's default web browser.
report_RLum(object = mam, launch.browser = TRUE)

## Example: RLum.Analysis ----

data("ExampleData.RLum.Analysis")

# create the HTML report (note that specifying a file
# extension is not necessary)
report_RLum(object = IRSAR.RF.Data, file = "~/IRSAR_RF")
```

```
## Example: RLum.Data.Curve ----

data.curve <- get_RLum(IRSAR.RF.Data)[[1]]

# create the HTML report
report_RLum(object = data.curve, file = "~/Data_Curve")

## Example: Any other object ----
x <- list(x = 1:10,
          y = runif(10, -5, 5),
          z = data.frame(a = LETTERS[1:20], b = dnorm(0:9)),
          NA)

report_RLum(object = x, file = "~/arbitray_list")

## End(Not run)
```

Risoe.BINfileData-class

Class "Risoe.BINfileData"

Description

S4 class object for luminescence data in R. The object is produced as output of the function [read_BIN2R](#).

Usage

```
## S4 method for signature 'ANY'
set_Risoe.BINfileData(
  METADATA = data.frame(),
  DATA = list(),
  .RESERVED = list()
)
```

Arguments

METADATA	Object of class "data.frame" containing the meta information for each curve.
DATA	Object of class "list" containing numeric vector with count data.
.RESERVED	Object of class "list" containing list of undocumented raw values for internal use only.

Methods (by generic)

- `set_Risoe.BINfileData(ANY)`: A [Risoe.BINfileData](#) object is normally produced as output of the function [read_BIN2R](#). This construction method is intended for internal usage only.

Slots

METADATA Object of class "data.frame" containing the meta information for each curve.

DATA Object of class "list" containing numeric vector with count data.

.RESERVED Object of class "list" containing list of undocumented raw values for internal use only.

Objects from the Class

Objects can be created by calls of the form `new("Risoe.BINfileData", ...)`.

Function version

0.4.1

How to cite

Kreutzer, S., 2026. Risoe.BINfileData-class(): Class 'Risoe.BINfileData'. Function version 0.4.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note**Internal METADATA - object structure**

This structure is compatible with BIN/BINX-files version 03-08, however, it does not follow (in its sequential arrangement) the manual provided by the manufacturer, but an own structure accounting for the different versions.

#	Name	Data Type	V	Description
[,1]	ID	numeric	RLum	Unique record ID (same ID as in slot DATA)
[,2]	SEL	logic	RLum	Record selection, not part official BIN-format, triggered by TAG
[,3]	VERSION	raw	03-08	BIN-file version number
[,4]	LENGTH	integer	03-08	Length of this record
[,5]	PREVIOUS	integer	03-08	Length of previous record
[,6]	NPOINTS	integer	03-08	Number of data points in the record
[,7]	RECTYPE	integer	08	Record type
[,8]	RUN	integer	03-08	Run number
[,9]	SET	integer	03-08	Set number
[,10]	POSITION	integer	03-08	Position number
[,11]	GRAIN	integer	03-04	Grain number
[,12]	GRAINNUMBER	integer	05-08	Grain number
[,13]	CURVENO	integer	05-08	Curve number
[,14]	XCOORD	integer	03-08	X position of a single grain
[,15]	YCOORD	integer	03-08	Y position of a single grain
[,16]	SAMPLE	factor	03-08	Sample name
[,17]	COMMENT	factor	03-08	Comment name
[,18]	SYSTEMID	integer	03-08	Risø system id
[,19]	FNAME	factor	05-08	File name (.bin/.binx)

[,20]	USER	factor	03-08	User name
[,21]	TIME	character	03-08	Data collection time (hh-mm-ss)
[,22]	DATE	factor	03-08	Data collection date (ddmmyy)
[,23]	DTYPE	character	03-08	Data type
[,24]	BL_TIME	numeric	03-08	Bleaching time
[,25]	BL_UNIT	integer	03-08	Bleaching unit (mJ, J, s, min, h)
[,26]	NORM1	numeric	03-08	Normalisation factor (1)
[,27]	NORM2	numeric	03-08	Normalisation factor (2)
[,28]	NORM3	numeric	03-08	Normalisation factor (3)
[,29]	BG	numeric	03-08	Background level
[,30]	SHIFT	integer	03-08	Number of channels to shift data
[,31]	TAG	integer	03-08	Tag, triggers SEL
[,32]	LTYPE	character	03-08	Luminescence type
[,33]	LIGHTSOURCE	character	03-08	Light source
[,34]	LPOWER	numeric	03-08	Optical stimulation power
[,35]	LIGHTPOWER	numeric	05-08	Optical stimulation power
[,36]	LOW	numeric	03-08	Low (temperature, time, wavelength)
[,37]	HIGH	numeric	03-08	High (temperature, time, wavelength)
[,38]	RATE	numeric	03-08	Rate (heating rate, scan rate)
[,39]	TEMPERATURE	integer	03-08	Sample temperature
[,40]	MEASTEMP	integer	05-08	Measured temperature
[,41]	AN_TEMP	numeric	03-08	Annealing temperature
[,42]	AN_TIME	numeric	03-08	Annealing time
[,43]	TOLDELAY	integer	03-08	TOL 'delay' channels
[,44]	TOLON	integer	03-08	TOL 'on' channels
[,45]	TOLOFF	integer	03-08	TOL 'off' channels
[,46]	IRR_TIME	numeric	03-08	Irradiation time
[,47]	IRR_TYPE	integer	03-08	Irradiation type (alpha, beta or gamma)
[,48]	IRR_UNIT	integer	03-04	Irradiation unit (Gy, rad, s, min, h)
[,49]	IRR_DOSE RATE	numeric	05-08	Irradiation dose rate (Gy/s)
[,50]	IRR_DOSE RATE ERR	numeric	06-08	Irradiation dose rate error (Gy/s)
[,51]	TIMESINCEIRR	integer	05-08	Time since irradiation (s)
[,52]	TIMETICK	numeric	05-08	Time tick for pulsing (s)
[,53]	ONTIME	integer	05-08	On-time for pulsing (in time ticks)
[,54]	OFFTIME	integer	03	Off-time for pulsed stimulation (in s)
[,55]	STIMPERIOD	integer	05-08	Stimulation period (on+off in time ticks)
[,56]	GATE_ENABLED	raw	05-08	PMT signal gating enabled
[,57]	ENABLE_FLAGS	raw	05-08	PMT signal gating enabled
[,58]	GATE_START	integer	05-08	Start gating (in time ticks)
[,59]	GATE_STOP	integer	05-08	Stop gating (in time ticks), 'Gateend' for version 04, here only GATE_
[,60]	PTENABLED	raw	05-08	Photon time enabled
[,61]	DTENABLED	raw	05-08	PMT dead time correction enabled
[,62]	DEADTIME	numeric	05-08	PMT dead time (s)
[,63]	MAXLPOWER	numeric	05-08	Stimulation power to 100 percent (mW/cm^2)
[,64]	XRF_ACQTIME	numeric	05-08	XRF acquisition time (s)
[,65]	XRF_HV	numeric	05-08	XRF X-ray high voltage (V)
[,66]	XRF_CURR	integer	05-08	XRF X-ray current (µA)
[,67]	XRF_DEADTIMEF	numeric	05-08	XRF dead time fraction

[,68]	DETECTOR_ID	raw	07-08	Detector ID
[,69]	LOWERFILTER_ID	integer	07-08	Lower filter ID in reader
[,70]	UPPERFILTER_ID	integer	07-08	Upper filter ID in reader
[,71]	ENOISEFACTOR	numeric	07-08	Excess noise filter, usage unknown
[,72]	MARKPOS_X1	numeric	08	Coordinates marker position 1
[,73]	MARKPOS_Y1	numeric	08	Coordinates marker position 1
[,74]	MARKPOS_X2	numeric	08	Coordinates marker position 2
[,75]	MARKPOS_Y2	numeric	08	Coordinates marker position 2
[,76]	MARKPOS_X3	numeric	08	Coordinates marker position 3
[,77]	MARKPOS_Y3	numeric	08	Coordinates marker position 3
[,78]	EXTR_START	numeric	08	usage unknown
[,79]	EXTR_END	numeric	08	usage unknown
[,80]	SEQUENCE	character	03-04	Sequence name

V = BIN-file version (RLum means that it does not depend on a specific BIN-file version)

Note that the Risoe.BINfileData object combines all values from different versions from the BIN/BINX-file, reserved bits are skipped, however, the function [write_R2BIN](#) reset arbitrary reserved bits. Invalid values for a specific version are set to NA. Furthermore, the internal R data types do not necessarily match the required data types for the BIN-file data import! Data types are converted during data import.

LTYPE values

VALUE	TYPE	DESCRIPTION
[0]	TL	: Thermoluminescence
[1]	OSL	: Optically stimulated luminescence
[2]	IRSL	: Infrared stimulated luminescence
[3]	M-IR	: Infrared monochromator scan
[4]	M-VIS	: Visible monochromator scan
[5]	TOL	: Thermo-optical luminescence
[6]	TRPOSL	: Time Resolved Pulsed OSL
[7]	RIR	: Ramped IRSL
[8]	RBR	: Ramped (Blue) LEDs
[9]	USER	: User defined
[10]	POSL	: Pulsed OSL
[11]	SGOSL	: Single Grain OSL
[12]	RL	: Radio Luminescence
[13]	XRF	: X-ray Fluorescence

DTYPE values

VALUE	DESCRIPTION
[0]	Natural
[1]	N+dose
[2]	Bleach
[3]	Bleach+dose
[4]	Natural (Bleach)

- [5] N+dose (Bleach)
- [6] Dose
- [7] Background

LIGHTSOURCE values

VALUE	DESCRIPTION
[0]	None
[1]	Lamp
[2]	IR diodes/IR Laser
[3]	Calibration LED
[4]	Blue Diodes
[5]	White light
[6]	Green laser (single grain)
[7]	IR laser (single grain)

Internal DATA - object structure

With version 8 of the BIN/BINX file format, slot @DATA (byte array DPOINTS) can contain two different values:

1. DPOINTS (standard for RECTYPE := (0,1)): is a vector with the length defined through NPOINTS. This is the standard for xy-curves since version 03. However, recorded are only y-values and x-values are calculated during import using information from, amongst others, LOW and HIGH. For instance, a simple TL curve would store LOW = 0 and HIGH = 400. This is then becomes the range for the temperature values. All values in between are interpolated with a length matching the number of corresponding values stored in DPOINTS.

Note: The Sequence Editor uses 0 deg. C as the lowest temperature, although this temperature is usually not available in a laboratory. This, however, does not mean that the calculated TL curves are invalid, as the heater would only start the temperature ramp if the ambient temperature is lower than the target temperature.

1. DPOINTS (RECTYPE := 128) is contains no count values but information about the definition of the regions of interest (ROI). Each definition is 504 bytes long. The number of definitions is defined by NPOINTS in @METADATA. The record describes basically the geometric features of the regions of interest. The representation in R is a nested [list](#).

#	Name	Data Type	V	Description
[,1]	NOFPOINTS	numeric	08	number of points in the definition (e.g., if the ROI is a rectangle: 4)
[,2]	USEDFOR	logical	08	samples for which the ROI is used for; a maximum of 48 samples are allowed.
[,3]	SHOWNFOR	logical	08	samples for which the ROI is shown for; a maximum of 48 samples are allowed.
[,4]	COLOR	numeric	08	The colour values of the ROI.
[,5]	X	numeric	08	The x coordinates used to draw the ROI geometry (up to 50 points are allowed).
[,6]	Y	numeric	08	The y coordinates used to draw the ROI geometry (up to 50 points are allowed).

(information on the BIN/BINX file format are kindly provided by Risø, DTU Nutech)

Author(s)

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based on information provided by Torben Lapp and Karsten Bracht Nielsen (Risø DTU, Denmark)
, RLum Developer Team

References

Risø DTU, 2013. The Sequence Editor User Manual - Feb 2013 and Risø DTU, 2016.
The Sequence Editor User Manual - February 2016
<https://www.fysik.dtu.dk>

See Also

[plot_Risoe.BINfileData](#), [read_BIN2R](#), [write_R2BIN](#), [merge_Risoe.BINfileData](#), [Risoe.BINfileData2RLum.Analysis](#)

Examples

```
showClass("Risoe.BINfileData")
```

Risoe.BINfileData2RLum.Analysis

Convert Risoe.BINfileData object to an RLum.Analysis object

Description

Converts values from one specific position of a [Risoe.BINfileData](#) object to an [RLum.Analysis](#) object.

The [RLum.Analysis](#) object requires a set of curves for specific further protocol analyses. However, the [Risoe.BINfileData](#) usually contains a set of curves for different aliquots and different protocol types that may be mixed up. Therefore, a conversion is needed.

Usage

```
Risoe.BINfileData2RLum.Analysis(  
  object,  
  pos = NULL,  
  grain = NULL,  
  run = NULL,  
  set = NULL,  
  ltype = NULL,  
  dtype = NULL,  
  protocol = "unknown",  
  keep.empty = TRUE,  
  txtProgressBar = FALSE  
)
```

Arguments

object	Risoe.BINfileData (required) : object to convert.
pos	numeric (optional) : position number of the <code>Risoe.BINfileData</code> object for which the curves are converted into an <code>RLum.Analysis</code> object. If <code>length(pos) > 1</code> , a list of <code>RLum.Analysis</code> objects is returned. If nothing is provided every position will be converted. If the position is not valid <code>NULL</code> is returned.
grain	vector, numeric (optional) : grain number from the measurement to limit the converted data set (e.g., <code>grain = 1:48</code>). Please be aware that this option may lead to unwanted effects, as the output is strictly limited to the chosen grain number for all position numbers. Invalid grain numbers are skipped with a warning. Records with <code>NA</code> as grain are always included, as some readers report <code>NA</code> instead of a grain number.
run	vector, numeric (optional) : run number from the measurement to limit the converted data set (e.g., <code>run = 1:48</code>).
set	vector, numeric (optional) : set number from the measurement to limit the converted data set (e.g., <code>set = 1:48</code>).
ltype	vector, character (optional) : curve type to limit the converted data. Commonly allowed values are: "IRSL", "OSL", "TL", "RIR", "RBR" and "USER" (see also <code>Risoe.BINfileData</code>).
dtype	vector, character (optional) : data type to limit the converted data. Commonly allowed values are listed in <code>Risoe.BINfileData</code> .
protocol	character (optional) : protocol type to be set in the analysis object. This value may be used by subsequent analysis functions.
keep.empty	logical (with default) : If <code>TRUE</code> (default) an <code>RLum.Analysis</code> object is returned even if it does not contain any records. Set to <code>FALSE</code> to discard all empty objects.
txtProgressBar	logical (with default) : enable/disable the progress bar. The progress bar is disabled automatically if fewer than two positions are converted.

Value

Returns an `RLum.Analysis` object if exactly one position and one grain number were converted, and a list of `RLum.Analysis` objects (one per position/grain combination) otherwise. Returns `NULL` if no valid position is provided or if all objects are discarded by `keep.empty = FALSE`.

Function version

0.4.3

How to cite

Kreutzer, S., 2026. `Risoe.BINfileData2RLum.Analysis()`: Convert `Risoe.BINfileData` object to an `RLum.Analysis` object. Function version 0.4.3. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. *Luminescence: Comprehensive Luminescence Dating Data Analysis*. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The protocol argument of the [RLum.Analysis](#) object is set to 'unknown' if not stated otherwise.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[Risoe.BINfileData](#), [RLum.Analysis](#), [read_BIN2R](#)

Examples

```
##load data
data(ExampleData.BINfileData, envir = environment())

##convert values for position 1
Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos = 1)
```

RLum-class

Class "RLum"

Description

Abstract class for data in the package Luminescence Subclasses are:

Details**RLum-class**

```
|
|— RLum.Data
|—|— RLum.Data.Curve
|—|— RLum.Data.Spectrum
|—|— RLum.Data.Image
|— RLum.Analysis
|— RLum.Results
```

Slots

originator Object of class [character](#) containing the name of the producing function for the object.
Set automatically by using the function [set_RLum](#).

info Object of class [list](#) for additional information on the object itself

.uid Object of class [character](#) for a unique object identifier. This id is usually calculated using the internal function `create_UID` if the function [set_RLum](#) is called.

.pid Object of class [character](#) for a parent id. This allows nesting RLum-objects at will. The parent id can be the uid of another object.

Objects from the Class

A virtual Class: No objects can be created from it.

Class version

0.4.0

Note

RLum is a virtual class.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data](#), [RLum.Data.Curve](#), [RLum.Data.Spectrum](#), [RLum.Data.Image](#), [RLum.Analysis](#), [RLum.Results](#), [methods_RLum](#)

Examples

```
showClass("RLum")
```

RLum.Analysis-class	Class "RLum.Analysis"
---------------------	-----------------------

Description

Object class to represent analysis data for protocol analysis, i.e. all curves, spectra etc. from one measurements. Objects from this class are produced, by e.g. [read_XSYG2R](#), [read_Daybreak2R](#)

Slots

protocol Object of class [character](#) describing the applied measurement protocol
 records Object of class [list](#) containing objects of class [RLum.Data](#)

Objects from the Class

Objects can be created by calls of the form `set_RLum("RLum.Analysis", ...)`.

Class version

0.4.19

Note

The method [structure_RLum](#) is currently just available for objects containing [RLum.Data.Curve](#).

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[Risoe.BINfileData2RLum.Analysis](#), [Risoe.BINfileData](#), [RLum](#)

Examples

```
## show method
showClass("RLum.Analysis")

##set an empty object
set_RLum(class = "RLum.Analysis")

## use example data
##load data
data(ExampleData.RLum.Analysis, envir = environment())

##show curves in object
get_RLum(IRSAR.RF.Data)

##show only the first object, but by keeping the object
get_RLum(IRSAR.RF.Data, record.id = 1, drop = FALSE)

## subsetting with SAR sample data
data(ExampleData.BINfileData, envir = environment())
sar <- object <- Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data)

## get
get_RLum(sar, subset = "NPOINTS == 250")

## remove
remove_RLum(sar, subset = "NPOINTS == 250")
```

RLum.Data.Curve-class *Class* "RLum.Data.Curve"

Description

Class for representing luminescence curve data.

Slots

recordType Object of class "character" containing the type of the curve (e.g. "TL" or "OSL").

curveType Object of class "character" containing curve type, allowed values are "measured" or "predefined".

data Object of class [matrix](#) containing curve x and y data. 'data' can also be of type `RLum.Data.Curve` to change object values without de-constructing the object. For example:

```
set_RLum(class = 'RLum.Data.Curve',
         data = Your.RLum.Data.Curve,
         recordType = 'never seen before')
```

would just change the **recordType**. Missing arguments the value is taken from the input object in 'data' (which is already an `RLum.Data.Curve` object in this example).

Create objects from this Class

Objects can be created by calls of the form `set_RLum(class = "RLum.Data.Curve", ...)`.

Class version

0.5.2

Note

The class should only contain data for a single curve. For additional elements the slot `info` can be used (e.g. providing additional heating ramp curve). Objects from the class `RLum.Data.Curve` are produced by other functions (partly within [RLum.Analysis](#) objects), namely: [Riso.BINfileData2RLum.Analysis](#), [read_XSYG2R](#)

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum](#), [RLum.Data](#), [plot_RLum](#), [merge_RLum](#)

Examples

```
showClass("RLum.Data.Curve")

##set empty curve object
set_RLum(class = "RLum.Data.Curve")
```

RLum.Data.Image-class *Class* "RLum.Data.Image"

Description

Class for representing luminescence image data (TL/OSL/RF). Such data are for example produced by function [read_SPE2R](#).

Slots

recordType Object of class [character](#) containing the type of the curve (e.g. "OSL image", "TL image").

curveType Object of class [character](#) containing curve type, allowed values are measured or predefined

data Object of class [array](#) containing image data.

info Object of class [list](#) containing further meta information objects

Objects from the class

Objects can be created by calls of the form `set_RLum("RLum.Data.Image", ...)`.

Class version

0.5.1

Note

The class should only contain data for a set of images. For additional elements the slot `info` can be used.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum](#), [RLum.Data](#), [plot_RLum](#), [read_SPE2R](#), [read_TIFF2R](#)

Examples

```
showClass("RLum.Data.Image")

##create empty RLum.Data.Image object
set_RLum(class = "RLum.Data.Image")
```

RLum.Data.Spectrum-class

Class "RLum.Data.Spectrum"

Description

Class for representing luminescence spectra data (TL/OSL/RF).

Slots

recordType Object of class [character](#) containing the type of the curve (e.g. "TL" or "OSL")

curveType Object of class [character](#) containing curve type, allowed values are "measured" or "pre-defined"

data Object of class [matrix](#) containing spectrum (count) values. Row labels indicate wavelength/pixel values, column labels are temperature or time values.

info Object of class [list](#) containing further meta information objects

Objects from the Class

Objects can be created by calls of the form `set_RLum("RLum.Data.Spectrum", ...)`.

Class version

0.5.2

Note

The class should only contain data for a single spectra data set. For additional elements the slot `info` can be used. Objects from this class are automatically created by, e.g., [read_XSYG2R](#)

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum](#), [RLum.Data](#), [plot_RLum](#)

Examples

```
showClass("RLum.Data.Spectrum")

##show example data
data(ExampleData.XSYG, envir = environment())
TL.Spectrum

##show data matrix
```

```
get_RLum(TL.Spectrum)

##plot spectrum
## Not run:
plot_RLum(TL.Spectrum)

## End(Not run)
```

RLum.Results-class	Class "RLum.Results"
--------------------	----------------------

Description

Object class contains results data from functions (e.g., [analyse_SAR.CWOSL](#)).

Slots

data Object of class [list](#) containing output data

Objects from the Class

Objects can be created by calls of the form `new("RLum.Results", ...)`.

Class version

0.5.2

Note

The class is intended to store results from functions to be used by other functions. The data in the object should always be accessed by the method [get_RLum](#).

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum](#), [plot_RLum](#), [merge_RLum](#)

Examples

```
showClass("RLum.Results")

##create an empty object from this class
set_RLum(class = "RLum.Results")

##use another function to show how it works

##Basic calculation of the dose rate for a specific date
dose.rate <- calc_SourceDoseRate(
  measurement.date = "2012-01-27",
  calib.date = "2014-12-19",
  calib.dose.rate = 0.0438,
  calib.error = 0.0019)

##show object
dose.rate

##get results
get_RLum(dose.rate)

## get parameters used for the calculation from the same object
get_RLum(dose.rate, data.object = "parameters")

##alternatively objects can be accessed using S3 generics, such as
dose.rate$parameters
```

scale_GammaDose	<i>Calculate the gamma dose deposited within a sample accounting for layer-to-layer variations in radioactivity</i>
-----------------	---

Description

This function calculates the gamma dose deposited in a luminescence sample taking into account layer-to-layer variations in sediment radioactivity according to Aitken, 1985. The function scales user inputs of uranium, thorium and potassium based on input parameters for sediment density, water content and given layer thicknesses and distances to the sample.

User Input

To calculate the gamma dose deposited in a sample, the user needs to provide sediment information that may influence the luminescence sample. As a rule of thumb, all sediment layers within at least a 30 cm radius from the luminescence sample should be taken into account when calculating the gamma dose rate. However, the actual range of gamma radiation might be different, depending on the emitting radioelements, the water content and the sediment density of each layer (Aitken, 1985). Therefore, the user is advised to provide as much detail as possible that is physically sensible.

The function requires a [data.frame](#) with the samples listed in rows. In order, the columns should contain:

- Column 1 contains information on the layer/sample ID.
- Column 2 gives the thickness (in cm) of each layer.
- Column 3: for the layer from which the OSL/TL sample was taken, the distance (in cm) measured from the middle of the sample to the **bottom** of the layer of interest must be provided. If the whole layer was sampled, insert 0. All layers that are not sampled for OSL/TL should be set to NA.
- Columns 4 to 9 contain radionuclide concentrations and their standard errors for potassium (in %), thorium (in ppm) and uranium (in ppm).
- Columns 10 and 11 give information on the water content and its standard error in %.
- Column 12 contains the layer density (in g/cm³).

No cell should be left blank. Please ensure that the column names match those given in the example dataset, see `data('ExampleData.ScaleGammaDose')`.

The user can decide which dose rate conversion factors should be used to calculate the gamma dose rates. The options are:

- "Cresswelletal2018" (Cresswell et al., 2018)
- "Liritzisetal2013" (Liritzis et al., 2013)
- "Guerinetal2011" (Guérin et al., 2011)
- "AdamiecAitken1998" (Adamiec and Aitken, 1998)

Water content

The water content provided by the user should be calculated according to:

$$\frac{\text{Wet weight[g]} - \text{Dry weight[g]}}{\text{Dry weight[g]}} * 100$$

Calculations

After converting the radionuclide concentrations into dose rates, the function will scale the dose rates based on the thickness of the layers, the distances to the sample, the water content and the density of the sediment. The calculations are based on Aitken (1985, Appendix H). As an example (equivalent to Aitken, 1985), assuming three layers of sediment, where **L** is inert and positioned in between the infinite thick and equally active layers **A** and **B**, the dose in **L** and **B** due to **A** is given by

$$1 - f(x)D_A$$

Where x is the distance into the inert medium, so $f(x)$ is the weighted average fractional dose at x and D_A denotes that the dose is delivered by **A**. $f(x)$ is derived from table H1 (Aitken, 1985), when setting $z = x$. Consequently, the dose in **A** and **L** due to **B** is given by

$$1 - f(t - x)D_B$$

Here t is the thickness of **L** and the other parameters are denoted as above, just for the dose being delivered by **B**. $f(t - x)$ is derived from table H1 (Aitken, 1985), when setting z equal to $t - x$. Following this, the dose in **L** delivered by **A** and **B** is given by

$$2 - f(x) - f(t - x)D_{AB}$$

Since **A** and **B** are equally active $D_{\{AB\}} = D_A = D_B$.

The function uses the value of the fractional dose rate at the layer boundary to start the calculation for the next layer. This way, the function is able to scale the gamma dose rate accurately for distant layers when the density and water content is not constant for the entire section.

Usage

```
scale_GammaDose(
  data,
  conversion_factors = c("Cresswelletal2018", "Guerinetal2011", "AdamiecAitken1998",
    "Liritzisetetal2013"),
  fractional_gamma_dose = "Aitken1985",
  verbose = TRUE,
  plot = TRUE,
  plot_singlePanels = FALSE,
  ...
)
```

Arguments

- data** [data.frame](#) (**required**): A table containing all relevant information for each individual layer. The table must have the following named columns:
- **id** ([character](#)): an arbitrary id or name of each layer
 - **thickness** ([numeric](#)): vertical extent of each layer in cm
 - **sample_offset** ([logical](#)): distance of the sample in cm, **measured from the bottom of the target layer**. Except for the target layer all values must be NA.
 - **K** ([numeric](#)): K nuclide content in %
 - **K_se** ([numeric](#)): error on the K content
 - **Th** ([numeric](#)): Th nuclide content in ppm
 - **Th_se** ([numeric](#)): error on the Th content
 - **U** ([numeric](#)): U nuclide content in ppm
 - **U_se** ([numeric](#)): error on the U content
 - **water_content** ([numeric](#)): water content of each layer in %
 - **water_content_se** ([numeric](#)): error on the water content
 - **density** ([numeric](#)): bulk density of each layer in g/cm⁻³
- conversion_factors** [character](#) (*optional*): The conversion factors used to calculate the dose rate from sediment nuclide contents. Valid options are:
- "Cresswelletal2018" (default)
 - "Liritzisetetal2013"
 - "Guerinetal2011"
 - "AdamiecAitken1998"

fractional_gamma_dose
character (optional): Factors to scale gamma dose rate values. Valid options are:

- "Aitken1985" (default): Table H1 in the appendix

verbose
logical (with default): enable/disable output to the terminal.

plot
logical (with default): enable/disable the plot output.

plot_singlePanels
logical (with default): enable/disable single plot mode, i.e. one plot window per plot.

...
Further parameters passed to [barplot](#).

Value

After performing the calculations the user is provided with different outputs.

1. The total gamma dose rate received by the sample (+/- uncertainties) as a print in the console.
2. A plot showing the sediment sequence, the user input sample information and the contribution to total gamma dose rate.
3. RLum Results. If the user wishes to save these results, writing a script to run the function and to save the results would look like this:

```
mydata <- read.table("c:/path/to/input/file.txt")
results <- scale_GammaDose(mydata)
table <- get_RLum(results)
write.csv(table, "c:/path/to/results.csv")
```

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$summary	data.frame	summary of the model results
\$data	data.frame	the original input data
\$dose_rates	list	two data.frames for the scaled and infinite matrix dose rates
\$tables	list	several data.frames containing intermediate results
\$args	character	arguments of the call
\$call	call	the original function call

slot: @info

Currently unused.

[PLOT OUTPUT]

Three plots are produced:

- A visualisation of the provided sediment layer structure to quickly assess whether the data was provided and interpreted correctly.
- A scatter plot of the nuclide contents per layer (K, Th, U) as well as the water content. This may help to correlate the dose rate contribution of specific layers to the layer of interest.
- A barplot visualising the contribution of each layer to the total dose rate received by the sample in the target layer.

Function version

0.1.4

Acknowledgements

We thank Dr Ian Bailiff for the provision of an excel spreadsheet, which has been very helpful when writing this function.

How to cite

Riedesel, S., Autzen, M., Burow, C., 2026. scale_GammaDose(): Calculate the gamma dose deposited within a sample accounting for layer-to-layer variations in radioactivity. Function version 0.1.4. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function has **BETA** status. If possible, results should be cross-checked.

Author(s)

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 Martin Autzen, DTU NUTECH Center for Nuclear Technologies (Denmark)
 Christoph Burow, University of Cologne (Germany)
 Based on an excel spreadsheet and accompanying macro written by Ian Bailiff. , RLum Developer Team

References

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- Adamiec, G., Aitken, M.J., 1998. Dose-rate conversion factors: update. Ancient TL 16, 37-46. [doi:10.26034/la.atl.1998.292](https://doi.org/10.26034/la.atl.1998.292)
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Guérin, G., Mercier, N., Adamiec, G., 2011. Dose-rate conversion factors: update. Ancient TL 29, 5-8. doi:10.26034/la.atl.2011.443

Liritzis, I., Stamoulis, K., Papachristodoulou, C., Ioannides, K., 2013. A re-evaluation of radiation dose-rate conversion factors. Mediterranean Archaeology and Archaeometry 13, 1-15.

See Also

[ExampleData.ScaleGammaDose](#), [BaseDataSet.ConversionFactors](#), [approx](#), [barplot](#)

Examples

```
# Load example data
data("ExampleData.ScaleGammaDose", envir = environment())

# Scale gamma dose rate
results <- scale_GammaDose(data = ExampleData.ScaleGammaDose,
                           conversion_factors = "Cresswelletal2018",
                           fractional_gamma_dose = "Aitken1985",
                           verbose = TRUE,
                           plot = TRUE)

get_RLum(results)
```

set_Risoe.BINfileData *General setter function for Risoe.BINfileData objects*

Description

The function provides a generalised access point for specific [Risoe.BINfileData](#) objects. Depending on the input object, the corresponding function will be selected. Allowed arguments can be found in the documentations of the corresponding [Risoe.BINfileData](#) class.

Usage

```
set_Risoe.BINfileData(
  METADATA = data.frame(),
  DATA = list(),
  .RESERVED = list()
)
```

Arguments

METADATA	x
DATA	x
.RESERVED	x

Value

A [Risoe.BINfileData](#) object.

Function version

0.1

How to cite

Kreutzer, S., 2026. set_Risoe.BINfileData(): General setter function for Risoe.BINfileData objects. Function version 0.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[Risoe.BINfileData](#)

set_RLum

General setter function for RLum-class objects

Description

The function provides a generalised access point for specific [RLum](#) objects. Depending on the given class, the corresponding method to create an object from this class will be selected.

Usage

```
set_RLum(class, originator, .uid = create_UID(), .pid = NA_character_, ...)

## S4 method for signature 'RLum.Analysis'
set_RLum(
  class,
  originator,
  .uid,
  .pid,
  protocol = NA_character_,
  records = list(),
  info = list()
)
```

```

## S4 method for signature 'RLum.Data.Curve'
set_RLum(
  class,
  originator,
  .uid,
  .pid,
  recordType = NA_character_,
  curveType = NA_character_,
  data = matrix(0, ncol = 2),
  info = list()
)

## S4 method for signature 'RLum.Data.Image'
set_RLum(
  class,
  originator,
  .uid,
  .pid,
  recordType = "Image",
  curveType = NA_character_,
  data = array(),
  info = list()
)

## S4 method for signature 'RLum.Data.Spectrum'
set_RLum(
  class,
  originator,
  .uid,
  .pid,
  recordType = "Spectrum",
  curveType = NA_character_,
  data = matrix(),
  info = list()
)

## S4 method for signature 'RLum.Results'
set_RLum(class, originator, .uid, .pid, data = list(), info = list())

```

Arguments

class	character (required) : name of the S4 class to create, must correspond to one of the <code>RLum</code> classes.
originator	character (automatic) : contains the name of the calling function (the function that produces this object); can be set manually.
.uid	character (automatic) : unique ID for this object, by default set using the internal C++ function <code>create_UID</code> .

.pid	character (<i>with default</i>): option to provide a parent id for nesting at will.
...	further arguments passed to the specific class method
protocol	character (<i>optional</i>): sets protocol type for analysis object. Value may be used by subsequent analysis functions.
records	list (<i>optional</i>): list of RLum.Analysis objects
info	list (<i>optional</i>): a list containing additional info data for the object.
recordType	character (<i>optional</i>): record type (e.g., "OSL")
curveType	character (<i>optional</i>): curve type (e.g., "predefined" or "measured")
data	matrix or list (<i>with default</i>): a matrix containing raw curve data or a list containing the data to be stored in the object (for RLum.Results objects) . If data itself is a RLum.Data.Curve -object this can be used to re-construct the object, i.e. modified parameters except .uid, .pid and originator. The rest will be subject to copy and paste unless provided.

Value

An object of the specified **RLum** class.

Functions

- **set_RLum(RLum.Analysis)**: Construction method for **RLum.Analysis** objects.
- **set_RLum(RLum.Data.Curve)**: Construction method for **RLum.Data.Curve** objects.
- **set_RLum(RLum.Data.Image)**: Construction method for **RLum.Data.Image** objects.
- **set_RLum(RLum.Data.Spectrum)**: Construction method for **RLum.Data.Spectrum** objects.
- **set_RLum(RLum.Results)**: Construction method for **RLum.Results** objects.

Function version

0.3.0

How to cite

Kreutzer, S., 2026. **set_RLum()**: General setter function for **RLum**-class objects. Function version 0.3.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. *Luminescence: Comprehensive Luminescence Dating Data Analysis*. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , **RLum** Developer Team

See Also

RLum.Data.Curve, **RLum.Data.Image**, **RLum.Data.Spectrum**, **RLum.Analysis**, **RLum.Results**

Examples

```
## produce empty objects from each class
set_RLum(class = "RLum.Data.Curve")
set_RLum(class = "RLum.Data.Spectrum")
set_RLum(class = "RLum.Data.Spectrum")
set_RLum(class = "RLum.Analysis")
set_RLum(class = "RLum.Results")

## produce a curve object with arbitrary curve values
object <- set_RLum(
  class = "RLum.Data.Curve",
  curveType = "arbitrary",
  recordType = "OSL",
  data = matrix(c(1:100, exp(-c(1:100))), ncol = 2))

## plot this curve object
plot_RLum(object)
```

show

Show the structure of RLum-class and Risoe.BINfileData-class objects

Description

Show the structure of RLum-class and Risoe.BINfileData-class objects

Usage

```
## S4 method for signature 'RLum.Analysis'
show(object)

## S4 method for signature 'RLum.Data.Curve'
show(object)

## S4 method for signature 'RLum.Data.Image'
show(object)

## S4 method for signature 'RLum.Data.Spectrum'
show(object)

## S4 method for signature 'RLum.Results'
show(object)

## S4 method for signature 'Risoe.BINfileData'
show(object)
```

Arguments

object [RLum](#), [Risoe.BINfileData](#) (**required**): object of class RLum or Risoe.BINfileData.

Methods (by class)

- show(RLum.Analysis): Show the structure of RLum.Analysis objects.
- show(RLum.Data.Curve): Show the structure of RLum.Data.Curve objects.
- show(RLum.Data.Image): Show the structure of RLum.Data.Image objects.
- show(RLum.Data.Spectrum): Show the structure of RLum.Data.Spectrum objects.
- show(RLum.Results): Show the structure of RLum.Results objects.
- show(Risoe.BINfileData): Show the structure of Risoe.BINfileData objects.

smooth_RLum

*Smoothing of data for RLum-class objects***Description**

The function provides a generalised access point for specific [RLum](#) objects. Depending on the input object, the corresponding function will be selected. The smoothing is performed in the internal function `.smoothing()`.

Usage

```
smooth_RLum(object, ...)

## S4 method for signature 'list'
smooth_RLum(object, ...)

## S4 method for signature 'RLum.Analysis'
smooth_RLum(object, ...)

## S4 method for signature 'RLum.Data.Curve'
smooth_RLum(
  object,
  k = NULL,
  fill = NA,
  align = "right",
  method = "mean",
  p_acceptance = 1e-07
)
```

Arguments

object	RLum (required): S4 object of class RLum
...	further arguments passed to the specific class method
k	smooth_RLum ; integer (<i>with default</i>): window for the rolling mean or median. If NULL, this set automatically (ignored if method = "Carter_etal_2018").

fill	smooth_RLum ; numeric (with default): value used to pad the result so to have the same length as the input.
align	smooth_RLum ; character (with default): one of "right", "center" or "left", specifying whether the index of the result should be right-aligned (default), centred, or left-aligned compared to the rolling window of observations (ignored if method = "Carter_etal_2018").
method	smooth_RLum ; character (with default): smoothing method to be applied: one of "mean", "median" or "Carter_etal_2018".
p_acceptance	smooth_RLum ; numeric (with default): probability threshold of accepting a value to be a sample from a Poisson distribution (only used for method = "Carter_etal_2018"). Values that have a Poisson probability below the threshold are replaced by the average over the four neighbouring values.

Value

An object of the same type as the input object provided.

Methods (by class)

- `smooth_RLum(list)`: Returns a list of [RLum](#) objects that had been passed to [smooth_RLum](#)
- `smooth_RLum(RLum.Analysis)`: Smoothing of `RLum.Data` records contained in the input object.
- `smooth_RLum(RLum.Data.Curve)`: Smoothing of [RLum.Data.Curve](#) objects using a rolling mean or median. For methods "mean" and "median", smoothing is performed by rolling mean and rolling median with window of size k. Method "Carter_etal_2018" implements a Poisson smoother for dark-background signals measured by a photomultiplier tube.

Function version

0.1.0

How to cite

Kreutzer, S., 2026. `smooth_RLum()`: Smoothing of data for `RLum`-class objects. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

Currently only `RLum` objects of class `RLum.Data.Curve` and `RLum.Analysis` (with curve data) are supported.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , `RLum` Developer Team

References

Carter, J., Cresswell, A.J., Kinnaird, T.C., Carmichael, L.A., Murphy, S. & Sanderson, D.C.W., 2018. Non-Poisson variations in photomultipliers and implications for luminescence dating. *Radiation Measurements* 120, 267-273. doi:10.1016/j.radmeas.2018.05.010

See Also

[RLum.Data.Curve](#), [RLum.Analysis](#)

Examples

```
## load example data
data(ExampleData.CW_OSL_Curve, envir = environment())

## create RLum.Data.Curve object from this example
curve <-
  set_RLum(
    class = "RLum.Data.Curve",
    recordType = "OSL",
    data = as.matrix(ExampleData.CW_OSL_Curve)
  )

## plot data without and with smoothing
plot_RLum(curve)
plot_RLum(smooth_RLum(curve))
```

sort_RLum

Sort data for RLum-class and Risoe.BINfileData-class objects

Description

The function provides a generalised access point for specific [RLum](#) and [Risoe.BINfileData](#) objects. Depending on the input object, the corresponding function will be selected.

Usage

```
sort_RLum(object, ...)

## S4 method for signature 'list'
sort_RLum(object, ...)

## S4 method for signature 'RLum.Analysis'
sort_RLum(object, slot = NULL, info_element = NULL, decreasing = FALSE, ...)

## S4 method for signature 'Risoe.BINfileData'
sort_RLum(object, info_element, decreasing = FALSE, ...)
```

Arguments

object	RLum or Riso.BINfileData (required): S4 object of class <code>RLum.Analysis</code> or <code>Riso.BINfileData</code> .
...	further arguments passed to the specific class method
slot	character (<i>optional</i>): slot name to use in sorting.
info_element	character (<i>optional</i>): names of the info field to use in sorting. The order of the names sets the sorting priority. Regardless of available info elements, the following elements always exist because they are calculated from the record <code>XY_LENGTH</code> , <code>NCOL</code> , <code>X_MIN</code> , <code>X_MAX</code> , <code>Y_MIN</code> , <code>Y_MAX</code> .
decreasing	logical (<i>with default</i>): whether the sort order should be decreasing (<code>FALSE</code> by default). It can be provided as a vector to control the ordering sequence for each sorting element.

Value

An object of the same type as the input object provided.

Methods (by class)

- `sort_RLum(list)`: Returns a list of sorted [RLum](#) objects.
- `sort_RLum(RLum.Analysis)`: Sorting of `RLum.Data` objects contained in this `RLum.Analysis` object. At least one of `slot` and `info_element` must be provided. If both are given, ordering by `slot` always takes priority over `info_element`. Only the first element in each slot and each `info_element` is used for sorting. Example: `.pid` can contain multiple values, however, only the first is taken. Please note that the `show()` method does some structuring, which may lead to the impression that the sorting did not work.
- `sort_RLum(Riso.BINfileData)`: Sort method for [Riso.BINfileData](#) objects.

Function version

0.1.0

How to cite

Colombo, M., 2026. `sort_RLum()`: Sort data for `RLum`-class and `Riso.BINfileData`-class objects. Function version 0.1.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Marco Colombo, Institute of Geography, Heidelberg University (Germany) , `RLum` Developer Team

See Also

[RLum.Analysis](#), [Risoe.BINfileData](#)

Examples

```
## load example data
data(ExampleData.XSYG, envir = environment())
obj <- OSL.SARMeasurement$Sequence.Object[1:9]

sort_RLum(obj, slot = "recordType")
sort_RLum(obj, info_element = "curveDescriptor")

data(ExampleData.XSYG, envir = environment())
sar <- OSL.SARMeasurement$Sequence.Object[1:5]
sort_RLum(sar, slot = "recordType", info_element = c("startDate"))
```

sTeve

sTeve - sophisticated tool for efficient data validation and evaluation

Description

This function provides a sophisticated routine for comprehensive luminescence dating data analysis.

Usage

```
sTeve(n_frames = 10, t_animation = 2, n.tree = 7, type = NULL)
```

Arguments

n_frames	integer (<i>with default</i>): n frames
t_animation	integer (<i>with default</i>): t animation
n.tree	integer (<i>with default</i>): how many trees do you want to cut?
type	integer (<i>optional</i>): Make a decision: 1, 2 or 3

Details

This amazing sophisticated function validates your data seriously.

Value

Validates your data.

How to cite

NA, NA, , 2026. sTeve(): sTeve - sophisticated tool for efficient data validation and evaluation. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function should not be taken too seriously.

Author(s)

R Luminescence Team, 2012-2046 , RLum Developer Team

See Also

[plot_KDE](#)

Examples

```
##no example available
```

structure_RLum

General structure function for RLum-class objects

Description

The function provides a generalised access point for specific [RLum](#) objects. Depending on the input object, the corresponding function will be selected.

Usage

```
structure_RLum(object, ...)

## S4 method for signature 'list'
structure_RLum(object, ...)

## S4 method for signature 'RLum.Analysis'
structure_RLum(object, fullExtent = FALSE)
```

Arguments

object	RLum (required): S4 object of class RLum
...	further arguments passed to the specific class method
fullExtent	logical (<i>with default</i>): extends the returned data.frame to its full extent, i.e. all info elements are part of the return as well. The default value is FALSE as the data frame might become rather big.

Value

Returns a [data.frame](#) with structure of the object.

Methods (by class)

- `structure_RLum(list)`: Returns a list of data frames containing the structure of each [RLum](#) object in the input list.
- `structure_RLum(RLum.Analysis)`: Returns the structure of an [RLum.Analysis](#) object.

Function version

0.2.0

How to cite

Kreutzer, S., 2026. `structure_RLum()`: General structure function for `RLum`-class objects. Function version 0.2.0. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , `RLum` Developer Team

See Also

[RLum.Data.Curve](#), [RLum.Data.Image](#), [RLum.Data.Spectrum](#), [RLum.Analysis](#), [RLum.Results](#)

Examples

```
## load example data
data(ExampleData.XSYG, envir = environment())

## show structure
structure_RLum(OSL.SARMeasurement$Sequence.Object)
```

subset_SingleGrainData

Simple Subsetting of Single Grain Data from Risø BIN/BINX files

Description

Most measured single grains do not exhibit light and it usually makes sense to subset single grain datasets using a table of position and grain pairs.

Usage

```
subset_SingleGrainData(object, selection)
```

Arguments

object [Risoe.BINfileData](#) (**required**): input object with the data to subset.

selection [data.frame](#), [matrix](#) (**required**): selection table with two columns for position and grain, respectively.

Value

A subset [Risoe.BINfileData](#) object

Function version

0.1.1

How to cite

Kreutzer, S., 2026. subset_SingleGrainData(): Simple Subsetting of Single Grain Data from Risø BIN/BINX files. Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[Risoe.BINfileData](#), [read_BIN2R](#), [verify_SingleGrainData](#)

Examples

```
## load example data
data(ExampleData.BINfileData, envir = environment())

## set POSITION/GRAIN pair dataset
selection <- data.frame(POSITION = c(1,5,7), GRAIN = c(0,0,0))

##subset
subset_SingleGrainData(object = CWOSL.SAR.Data, selection = selection)
```

template_DRAC	Create a DRAC input data template (v1.2)
---------------	--

Description

This function returns a DRAC input template (v1.2) to be used in conjunction with the [use_DRAC](#) function

Usage

```
template_DRAC(nrow = 1L, preset = NULL, file_input = NULL, notification = TRUE)
```

Arguments

- | | |
|--------------|--|
| nrow | integer (<i>with default</i>): specifies the number of rows of the template (i.e., the number of data sets you want to submit). |
| preset | <p>character (<i>optional</i>): By default, all values of the template are set to NA, which means that the user needs to fill in all data first before submitting to DRAC using use_DRAC. To reduce the number of values that need to be provided, preset can be used to create a template with at least a minimum of reasonable preset values.</p> <p>preset can be one of the following:</p> <ul style="list-style-type: none"> • quartz_coarse • quartz_fine • feldspar_coarse • polymineral_fine • DRAC-example_quartz • DRAC-example_feldspar • DRAC-example_polymineral <p>Note that the last three options can be used to produce a template with values directly taken from the official DRAC input .csv file.</p> |
| file_input | character (<i>optional</i>): file connection to a DRAC .csv file. The file will be imported and translated to a template usable by use_DRAC . Please note that there is no check on the validity of the .csv file. |
| notification | logical (<i>with default</i>): show or hide the notification. |

Value

A list of class `DRAC.list`.

Function version

0.1.1

How to cite

Burow, C., Kreutzer, S., 2026. template_DRAC(): Create a DRAC input data template (v1.2). Function version 0.1.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Christoph Burow, University of Cologne (Germany)
 Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
 , RLum Developer Team

References

Durcan, J.A., King, G.E., Duller, G.A.T., 2015. DRAC: Dose Rate and Age Calculator for trapped charge dating. *Quaternary Geochronology* 28, 54-61. doi:10.1016/j.quageo.2015.03.012

See Also

[as.data.frame, list](#)

Examples

```
# create a new DRAC input input
input <- template_DRAC(preset = "DRAC-example_quartz")

# show content of the input
print(input)
print(input$`Project ID`)
print(input[[4]])

## Example: DRAC Quartz example
# note that you only have to assign new values where they
# are different to the default values
input$`Project ID` <- "DRAC-Example"
input$`Sample ID` <- "Quartz"
input$`Conversion factors` <- "AdamiecAitken1998"
input$`External U (ppm)` <- 3.4
input$`errExternal U (ppm)` <- 0.51
input$`External Th (ppm)` <- 14.47
input$`errExternal Th (ppm)` <- 1.69
input$`External K (%)` <- 1.2
input$`errExternal K (%)` <- 0.14
input$`Calculate external Rb from K conc?` <- "N"
input$`Calculate internal Rb from K conc?` <- "N"
input$`Scale gammadoserate at shallow depths?` <- "N"
input$`Grain size min (microns)` <- 90
input$`Grain size max (microns)` <- 125
```

```

input$`Water content ((wet weight - dry weight)/dry weight)` <- 5
input$`errWater content` <- 2
input$`Depth (m)` <- 2.2
input$`errDepth (m)` <- 0.22
input$`Overburden density (g cm-3)` <- 1.8
input$`errOverburden density (g cm-3)` <- 0.1
input$`Latitude (decimal degrees)` <- 30.0000
input$`Longitude (decimal degrees)` <- 70.0000
input$`Altitude (m)` <- 150
input$`De (Gy)` <- 20
input$`errDe (Gy)` <- 0.2

# use DRAC
## Not run:
output <- use_DRAC(input)

## End(Not run)

```

trim_RLum.Data

Trim Channels of RLum.Data-class Objects

Description

Trim off the number of channels of [RLum.Data](#) objects of similar record type on the time domain. This function is useful in cases where objects have different lengths (short/longer measurement time) but should be analysed jointly by other functions.

Usage

```
trim_RLum.Data(object, recordType = NULL, trim_range = NULL)
```

Arguments

object	RLum.Data RLum.Analysis (required): input object, can be a list of objects. Please note that in the latter case the function works only isolated on each element of the list .
recordType	character (<i>optional</i>): type of the record where the trim should be applied. If not set, the types are determined automatically and applied for each record type classes. Can be provided as list .
trim_range	numeric (<i>optional</i>): sets the range of indices to keep. If only one value is given, this is taken to be the minimum; if two values are given, then the range is defined between the two values (inclusive). Any value beyond the second is silently ignored. If nothing is set (default), then all curves are trimmed to the same maximum length.

Details

The function has two modes of operation:

1. Single [RLum.Data](#) objects or a [list](#) of such objects: the function is applied separately over each object.
2. Multiple curves via [RLum.Analysis](#) or a [list](#) of such objects: in this mode, the function first determines the minimum number of channels for each category of records and then jointly processes them. For instance, if the object contains one TL curve with 100 channels and two OSL curves with 100 and 99 channels, respectively, then the minimum would be set to 100 channels for the TL curve and to 99 for the OSL curves. If no further parameters are applied, the function will shorten all OSL curves to 99 channels, but leave the TL curve untouched.

Value

A trimmed object or [list](#) of such objects similar to the input objects

Function version

0.2

How to cite

Kreutzer, S., 2026. trim_RLum.Data(): Trim Channels of RLum.Data-class Objects. Function version 0.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[RLum.Data](#), [RLum.Analysis](#)

Examples

```
## trim all TL curves in the object to channels 10 to 20
data(ExampleData.BINfileData, envir = environment())
temp <- Risoe.BINfileData2RLum.Analysis(CWOSL.SAR.Data, pos = 1)

c <- trim_RLum.Data(
  object = temp,
  recordType = "TL",
  trim_range = c(10,20))

plot_RLum.Analysis(
  object = c,
```

```

combine = TRUE,
subset = list(recordType = "TL"))

## simulate a situation where one OSL curve
## in the dataset has only 999 channels instead of 1000
## all curves should be limited to 999
temp@records[[2]]@data <- temp@records[[2]]@data[-nrow(temp[[2]]@data),]

c <- trim_RLum.Data(object = temp)
nrow(c@records[[4]]@data)

```

tune_Data

Tune data for experimental purpose

Description

The error can be reduced and sample size increased for specific purpose.

Usage

```
tune_Data(data, decrease.error = 0, increase.data = 0)
```

Arguments

data [data.frame](#) (**required**): input values, structure: values (data[, 1]) and error (data[, 2]) are required.

decrease.error [numeric](#): factor by which the error is decreased, ranges between 0 and 1.

increase.data [numeric](#): factor by which the error is decreased, ranges between 0 and 1000.

Value

Returns a 2-column [data.frame](#) with tuned values.

Function version

0.5.1

How to cite

Dietze, M., 2026. tune_Data(): Tune data for experimental purpose. Function version 0.5.1. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

You should not use this function to improve your poor data set!

Author(s)

Michael Dietze, GFZ Potsdam (Germany) , RLum Developer Team

Examples

```
## load example data set
data(ExampleData.DeValues, envir = environment())
x <- ExampleData.DeValues$CA1

## plot original data
plot_AbanicoPlot(data = x,
                 summary = c("n", "mean"))

## decrease error by 10 %
plot_AbanicoPlot(data = tune_Data(x, decrease.error = 0.1),
                 summary = c("n", "mean"))

## increase sample size by 200 %
#plot_AbanicoPlot(data = tune_Data(x, increase.data = 2),
#                 summary = c("n", "mean"))
```

use_DRAC

Use DRAC to calculate dose rate data

Description

The function provides an interface from R to DRAC. An R-object or a CSV file is passed to the DRAC website and results are re-imported into R.

Usage

```
use_DRAC(
  file,
  name = NULL,
  print_references = TRUE,
  citation_style = "text",
  ...
)
```

Arguments

file	character (required) : name of a CSV file (formatted according to the DRAC v1.3 CSV template) to be sent to the DRAC website for calculation. It can also be a DRAC template object obtained from <code>template_DRAC()</code> , which supports also import from CSV-files.
name	character (with default) : Optional user name submitted to DRAC. If NULL, a random name will be generated.
print_references	(with default) : Print all references used in the input data table to the console.
citation_style	(with default) : If print_references = TRUE this argument determines the output style of the used references. Valid options are "Bibtex", "citation", "html", "latex" or "R". Default is "text".
...	further arguments: • url character: provide an alternative URL to DRAC • ignore_version logical: ignores the version check, this might come in handy if the version has changed, but not the column order • user character: option to provide username for secured site • password character: password for secured site, only works jointly with user • verbose logical: enable/disable output to the terminal

Value

Returns an `RLum.Results` object containing the following elements:

DRAC	list : a named list containing the following elements in slot @data:
\$highlights	data.frame summary of 25 most important input/output fields
\$header	character HTTP header from the DRAC server response
\$labels	data.frame descriptive headers of all input/output fields
\$content	data.frame complete DRAC input/output table
\$input	data.frame DRAC input table
\$output	data.frame DRAC output table
references	list A list of bib entries of used references
data	character or list path to the input spreadsheet or a DRAC template
call	call the function call
args	list used arguments

The output should be accessed using the function `get_RLum`.

Function version

0.18

How to cite

Kreutzer, S., Dietze, M., Burow, C., 2026. use_DRAC(): Use DRAC to calculate dose rate data. Function version 0.18. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany)
Michael Dietze, GFZ Potsdam (Germany)
Christoph Burow, University of Cologne (Germany) , RLum Developer Team

References

Durcan, J.A., King, G.E., Duller, G.A.T., 2015. DRAC: Dose Rate and Age Calculator for trapped charge dating. Quaternary Geochronology 28, 54-61. doi:10.1016/j.quageo.2015.03.012

See Also

[template_DRAC](#), [.as.latex.table](#)

Examples

```
## (1) Method using the DRAC spreadsheet

file <-  "/PATH/TO/DRAC_Input_Template.csv"

# send the actual IO template spreadsheet to DRAC
## Not run:
use_DRAC(file = file)

## End(Not run)

## (2) Method using an R template object
# Create a template
input <- template_DRAC(preset = "DRAC-example_quartz")

# Fill the template with values
input$`Project ID` <- "DRAC-Example"
input$`Sample ID` <- "Quartz"
input$`Conversion factors` <- "AdamiecAitken1998"
input$`External U (ppm)` <- 3.4
input$`errExternal U (ppm)` <- 0.51
input$`External Th (ppm)` <- 14.47
input$`errExternal Th (ppm)` <- 1.69
input$`External K (%)` <- 1.2
input$`errExternal K (%)` <- 0.14
input$`Calculate external Rb from K conc?` <- "N"
input$`Calculate internal Rb from K conc?` <- "N"
```

```

input$`Scale gammadoserate at shallow depths?` <- "N"
input$`Grain size min (microns)` <- 90
input$`Grain size max (microns)` <- 125
input$`Water content ((wet weight - dry weight)/dry weight) %` <- 5
input$`errWater content %` <- 2
input$`Depth (m)` <- 2.2
input$`errDepth (m)` <- 0.22
input$`Overburden density (g cm-3)` <- 1.8
input$`errOverburden density (g cm-3)` <- 0.1
input$`Latitude (decimal degrees)` <- 30.0000
input$`Longitude (decimal degrees)` <- 70.0000
input$`Altitude (m)` <- 150
input$`De (Gy)` <- 20
input$`errDe (Gy)` <- 0.2

# use DRAC
## Not run:
output <- use_DRAC(input)

## export as LaTeX table
.as.latex.table(output)

## End(Not run)

```

```
verify_SingleGrainData
```

Verify single grain data sets and check for invalid grains, i.e. zero-light level grains

Description

This function tries to identify automatically zero-light level curves (grains) from single grain data measurements.

Usage

```

verify_SingleGrainData(
  object,
  threshold = 10,
  use_fft = FALSE,
  cleanup = FALSE,
  cleanup_level = c("aliquot", "curve"),
  verbose = TRUE,
  plot = FALSE,
  ...
)

```

Arguments

object	Risoe.BINfileData or RLum.Analysis (required): input object. The function also accepts a list with objects of allowed type.
threshold	numeric (<i>with default</i>): numeric threshold value for the allowed difference between the mean and the var of the count values (see details).
use_fft	logical (<i>with default</i>): applies an additional approach based on stats::fft . The threshold is fixed and cannot be changed.
cleanup	logical (<i>with default</i>): if set to TRUE, curves/aliquots identified as zero light level curves/aliquots are automatically removed. Output is an object as same type as the input, i.e. either Risoe.BINfileData or RLum.Analysis
cleanup_level	character (<i>with default</i>): selects the level for the clean-up of the input data sets. Two options are allowed: "curve" or "aliquot": • If "curve" is selected, every single curve marked as invalid is removed. • If "aliquot" is selected, curves of one aliquot (grain or disc) can be marked as invalid, but will not be removed. An aliquot will be only removed if all curves of this aliquot are marked as invalid.
verbose	logical (<i>with default</i>): enable/disables output to the terminal.
plot	logical (<i>with default</i>): enable/disable the plot output.
...	further parameters to control the plot output; if selected. Supported arguments <code>main</code> , <code>ylim</code>

Details

How does the method work?

The function compares the expected values ($E(X)$) and the variance ($Var(X)$) of the count values for each curve. Assuming that the background roughly follows a Poisson distribution, the absolute difference of both values should be zero or at least around zero as

$$E(x) = Var(x) = \lambda$$

Thus the function checks for:

$$abs(E(x) - Var(x)) \geq \Theta$$

With Θ an arbitrary, user defined, threshold. Values above the threshold indicate curves comprising a signal.

Note: the absolute difference of $E(X)$ and $Var(x)$ instead of the ratio was chosen as both terms can become 0 which would result in 0 or Inf, if the ratio is calculated.

Value

The function returns

[NUMERICAL OUTPUT]

RLum.Results-object

slot: @data

Element	Type	Description
\$unique_pairs	data.frame	the unique position and grain pairs
\$selection_id	numeric	the selection as record ID
\$selection_full	data.frame	implemented models used in the baSAR-model core

slot: @info

The original function call

Output variation

For `cleanup = TRUE` the same object as the input is returned, but cleaned up (invalid curves were removed). This means: Either a [Risoe.BINfileData](#) or an [RLum.Analysis](#) object is returned in such cases. A [Risoe.BINfileData](#) object can be exported to a BINX-file by using the function [write_R2BIN](#).

Function version

0.2.7

How to cite

Kreutzer, S., 2026. `verify_SingleGrainData()`: Verify single grain data sets and check for invalid grains, i.e. zero-light level grains. Function version 0.2.7. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

This function can work with [Risoe.BINfileData](#) objects or [RLum.Analysis](#) objects (or a list of it). However, the function is highly optimised for [Risoe.BINfileData](#) objects as it make sense to remove identify invalid grains before the conversion to an [RLum.Analysis](#) object.

The function checking for invalid curves works rather robust and it is likely that Reg0 curves within a SAR cycle are removed as well. Therefore it is strongly recommended to use the argument `cleanup = TRUE` carefully if the cleanup works only on curves.

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[Risoe.BINfileData](#), [RLum.Analysis](#), [write_R2BIN](#), [read_BIN2R](#)

Examples

```
##01 - basic example I
##just show how to apply the function
data(ExampleData.XSYG, envir = environment())

##verify and get data.frame out of it
verify_SingleGrainData(OSL.SARMeasurement$Sequence.Object)$selection_full

##02 - basic example II
data(ExampleData.BINfileData, envir = environment())
id <- verify_SingleGrainData(object = CWOSL.SAR.Data,
cleanup_level = "aliquot")$selection_id

## Not run:
##03 - advanced example I
##importing and exporting a BIN-file

##select and import file
file <- file.choose()
object <- read_BIN2R(file)

##remove invalid aliquots(!)
object <- verify_SingleGrainData(object, cleanup = TRUE)

##export to new BIN-file
write_R2BIN(object, paste0(dirname(file),"/", basename(file), "_CLEANED.BIN"))

## End(Not run)
```

view

Convenience data visualisation function

Description

Invokes the [utils::View](#) function tailored to objects in the package. If started from RStudio, it uses the RStudio viewer.

Usage

```
view(object, ...)

## S4 method for signature 'RLum.Analysis'
view(object, ...)
```

```
## S4 method for signature 'RLum.Data'
view(object, ...)

## S4 method for signature 'RLum.Results'
view(object, element = 1, ...)

## S4 method for signature 'Risoe.BINfileData'
view(object, ...)
```

Arguments

object	(required) object to view
...	further arguments passed to the specific class method
element	integer (<i>with default</i>): index of the element to display.

Value

NULL and opens the data viewer.

Methods (by class)

- `view(RLum.Analysis)`: View method for [RLum.Analysis](#) objects.
- `view(RLum.Data)`: View method for [RLum.Data](#) objects.
- `view(RLum.Results)`: View method for [RLum.Results](#) objects.
- `view(Risoe.BINfileData)`: View method for [Risoe.BINfileData](#) objects.

How to cite

Kreutzer, S., 2026. `view()`: Convenience data visualisation function. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[utils::View\(\)](#)

write_R2BIN

*Export Risoe.BINfileData into Risø BIN/BINX-file***Description**

Exports a [Risoe.BINfileData](#) object in a *.bin or *.binx file that can be opened by the Analyst software or other Risø software.

Usage

```
write_R2BIN(
  object,
  file,
  version,
  compatibility.mode = FALSE,
  verbose = TRUE,
  txtProgressBar = TRUE
)
```

Arguments

object	Risoe.BINfileData (required): input object to be stored in a bin file.
file	character (required): file name and path of the output file • [WIN]: write_R2BIN(object, "C:/Desktop/test.bin") • [MAC/LINUX]: write_R2BIN("/User/test/Desktop/test.bin")
version	character (<i>optional</i>): version number for the output file. If no value is provided, the highest version number from the Risoe.BINfileData is taken automatically. Note: This argument can be used to convert BIN-file versions.
compatibility.mode	logical (<i>with default</i>): this option recalculates the position values if necessary and set the max. value to 48. The old position number is appended as comment (e.g., 'OP: 70). This option accounts for potential compatibility problems with the Analyst software. It further limits the maximum number of points per curve to 9,999. If a curve contains more data the curve data get binned using the smallest possible bin width.
verbose	logical (<i>with default</i>): enable/disable output to the terminal.
txtProgressBar	logical (<i>with default</i>): enable/disable the progress bar. Ignored if verbose = FALSE.

Details

The structure of the exported binary data follows the data structure published in the Appendices of the *Analyst* manual p. 42.

If LTYPE, DTYPE and LIGHTSOURCE are not of type [character](#), no transformation into numeric values is done.

Value

Write a binary file and returns the name and path of the file as [character](#).

Function version

0.5.5

How to cite

Kreutzer, S., 2026. write_R2BIN(): Export Risoe.BINfileData into Risø BIN/BINX-file. Function version 0.5.5. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Note

The function just roughly checks the data structures. The validity of the output data depends on the user.

The validity of the file path is not further checked. BIN-file conversions using the argument `version` may be a lossy conversion, depending on the chosen input and output data (e.g., conversion from version 08 to 07 to 06 to 05 to 04 or 03).

Warning

Although the coding was done carefully, it seems that the BIN/BINX-files produced by Risø DA 15/20 TL/OSL readers slightly differ on the byte level. No obvious differences are observed in the METADATA, however, the BIN/BINX-file may not fully compatible, at least not similar to the ones directly produced by the Risø readers!

ROI definitions (introduced in BIN-file version 8) are not supported! There are furthermore ignored by the function [read_BIN2R](#).

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

References

DTU Nutech, 2016. The Sequence Editor, Users Manual, February, 2016. <https://www.fysik.dtu.dk>

See Also

[read_BIN2R](#), [Risoe.BINfileData](#), [writeBin](#)

Examples

```
##load example dataset
file <- system.file("extdata/BINfile_V8.bin", package = "Luminescence")
temp <- read_BIN2R(file)

##create temporary file path
##(for usage replace by own path)
temp_file <- tempfile(pattern = "output", fileext = ".bin")

##export to temporary file path
write_R2BIN(temp, file = temp_file)
```

write_R2TIFF	<i>Export <code>RLum.Data.Image</code> and <code>RLum.Data.Spectrum</code> objects to TIFF Images</i>
--------------	---

Description

Simple wrapper around [tiff::writeTIFF](#) to export suitable [RLum](#) objects to TIFF images. Per default 16-bit TIFF files are exported.

Usage

```
write_R2TIFF(object, file = tempfile(), norm = 65535, ...)
```

Arguments

object	RLum.Data.Image or RLum.Data.Spectrum object (required): input object, can be a list of such objects.
file	character (required): name of the output file.
norm	numeric (<i>with default</i>): normalisation value. Usually, in imaging applications the pixel values are integer count values, but values in TIFF files must be in the 0-1 range. Normalising to the to the highest 16-bit integer values - 1 ensures that the numerical values are retained in the exported image. If 1 nothing is normalised.
...	further arguments to be passed to tiff::writeTIFF .

Value

A TIFF file

Function version

0.1.2

How to cite

Kreutzer, S., 2026. write_R2TIFF(): Export RLum.Data.Image and RLum.Data.Spectrum objects to TIFF Images. Function version 0.1.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, F2.1 Geophysical Parametrisation/Regionalisation, LIAG - Institute for Applied Geophysics (Germany) , RLum Developer Team

See Also

[tiff::writeTIFF](#), [RLum.Data.Image](#), [RLum.Data.Spectrum](#)

Examples

```
data(ExampleData.RLum.Data.Image, envir = environment())
write_R2TIFF(ExampleData.RLum.Data.Image, file = tempfile(fileext = ".tiff"))
```

write_RLum2CSV

Export RLum-objects to CSV

Description

This function exports [RLum](#)-objects to CSV-files using the R function [utils::write.table](#). All [RLum](#)-objects are supported, but the export is lossy, i.e. the pure numerical values are exported only. Information that cannot be coerced to a [data.frame](#) or a [matrix](#) are discarded as well as metadata.

Usage

```
write_RLum2CSV(
  object,
  path = NULL,
  prefix = "",
  export = TRUE,
  compact = TRUE,
  ...
)
```

Arguments

object	RLum or a list of RLum objects (required): objects to be written. Can be a data.frame if needed internally.
path	character (<i>optional</i>): character string naming folder for the output to be written. If nothing is provided path will be set to the working directory. Note: this argument is ignored when <code>export = FALSE</code> .
prefix	character (<i>with default</i>): optional prefix to name the files. This prefix is valid for all written files
export	logical (<i>with default</i>): enable/disable the file export. If set to <code>FALSE</code> nothing is written to the file connection, but a list comprising objects of type data.frame and matrix is returned instead.
compact	logical (<i>with default</i>): if <code>TRUE</code> (default) the output will be simpler but less comprehensive, that is not all elements in the objects will be fully broken down. This is in particular useful for writing RLum.Results objects to CSV files, as such objects can be rather complex and not all information are needed in a CSV file or can be meaningfully translated to CSV format.
...	further arguments that will be passed to the function utils::write.table . All arguments except the argument <code>file</code> are supported

Details

However, in combination with the implemented import functions, nearly every supported import data format can be exported to CSV-files, this gives a great deal of freedom in terms of compatibility with other tools.

Input is a list of objects

If the input is a [list](#) of objects all explicit function arguments can be provided as [list](#).

Value

The function returns either a CSV-file (or many of them) or for the option `export == FALSE` a list comprising objects of type [data.frame](#) and [matrix](#)

Function version

0.2.2

How to cite

Kreutzer, S., 2026. write_RLum2CSV(): Export RLum-objects to CSV. Function version 0.2.2. In: Kreutzer, S., Burow, C., Dietze, M., Fuchs, M.C., Schmidt, C., Fischer, M., Friedrich, J., Mercier, N., Philippe, A., Riedesel, S., Autzen, M., Mittelstrass, D., Gray, H.J., Galharret, J., Colombo, M., Steinbuch, L., de Boer, A., Bluszcz, A., 2026. Luminescence: Comprehensive Luminescence Dating Data Analysis. R package version 1.3.1. <https://r-lum.github.io/Luminescence/>

Author(s)

Sebastian Kreutzer, Geography & Earth Science, Aberystwyth University (United Kingdom) ,
RLum Developer Team

See Also

[RLum.Analysis](#), [RLum.Data](#), [RLum.Results](#), [utils::write.table](#)

Examples

```
## transform values to a list (and do not write)
data(ExampleData.BINfileData, envir = environment())
object <- Riso.BINfileData2RLum.Analysis(CWOSL.SAR.Data)[[1]]
write_RLum2CSV(object, export = FALSE)

## Not run:
## write to a temporary file
temp_file <- tempfile(pattern = "output", fileext = ".csv")
write_RLum2CSV(object, temp_file)

## write to the working directory
write_RLum2CSV(object)

## End(Not run)
```

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