

$L_n, L_x$  curves

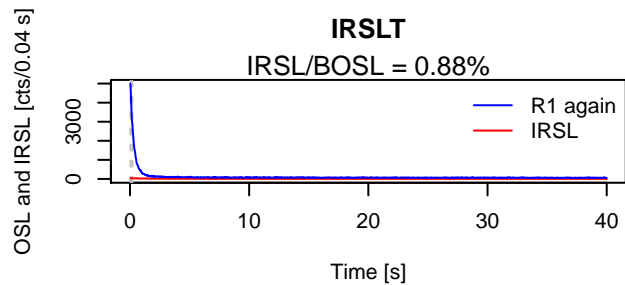
ALQ Pos. 1

$T_n, T_x$  curves

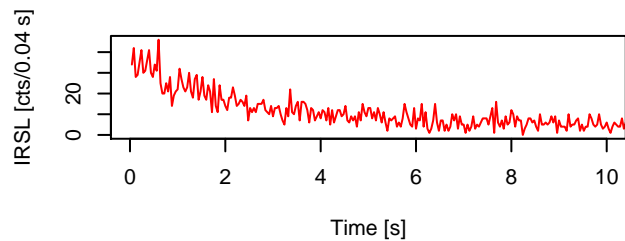


Cutheat – TL curves

IRSLT



IRSL curve (10 s)



help("Analyse\_SAR\_OSLdata")

unkown measurement





**Fig. 4 – Bos & Wallinga (2012)**





`help("CW2pLM")`



**Fig. 4 – Bos & Wallinga (2012)**







**Fig. 4 – Bos & Wallinga (2012)**





# Histogram



# Histogram





`help("ExampleData.FittingLM")`



`help("ExampleData.LxTxData")`



`help("ExampleData.LxTxOSLData")`



`help("ExampleData.LxTxOSLData")`



**RF**

**#1**



**RF**

**#2**



[help\("ExampleData.RLum.Analysis"\)](#)

# RLum.Data.Image



# OSL (UVVIS)



help("ExampleData.XSYG")

RLum.Data.Spectrum



help("ExampleData.XSYG")

# IR-RF

$D_e = 623.25$  [600.63 ; 635.8]



TL previous  $L_n, L_x$  curvesTL previous  $T_n, T_x$  curves $L_n, L_x$  curves $T_n, T_x$  curves

●  
Natural  
(0)

●  
R1  
(450)

●  
R2  
(1050)

●  
R3  
(2000)

●  
R4  
(2550)

●  
R5  
(450)

●  
R0  
(0)

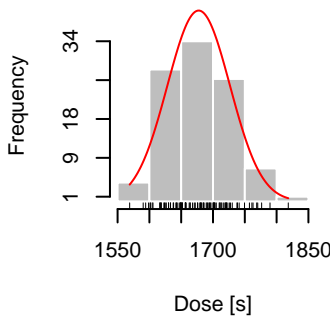
Growth curve

$D_e = 1668.25 \pm 49.22$  | fit: EXP

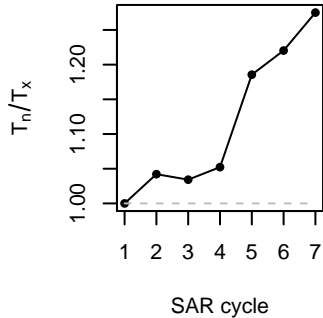


$D_e$  from MC simulation

$D_{eMC} = 1677.48 \pm 49.22$  | quality = 99.4 %



Test dose response



## Rejection criteria



- 0.2      + 0.2

## IRSL



[help\("analyse\\_SAR.CWOSL"\)](#)



$L_n, L_x$  curves



$T_n, T_x$  curves



Plateau test  $L_n, L_x$  curves



plateau Test  $T_n, T_x$  curves



Natural  
(0)

Natural  
(136)

Natural  
(317)

Natural  
(544)

Natural  
(815)

Natural  
(0)

Natural  
(317)

# Growth curve

$D_e = 406.61 \pm 48.44$  | fit: EXP



## $D_e$ from MC simulation

$D_{eMC} = 408.74 \pm 48.44$  | quality = 99.5 %



## Test dose response



## Pseudo pIRIR data set based on quartz OSL

TL  
pseudolRSL1  
pseudolRSL2

help("analyse\_pIRIRSequence")

# Pseudo pIRIR data set based on quartz OSL



# Pseudo pIRIR data set based on quartz OSL



# Pseudo pIRIR data set based on quartz OSL

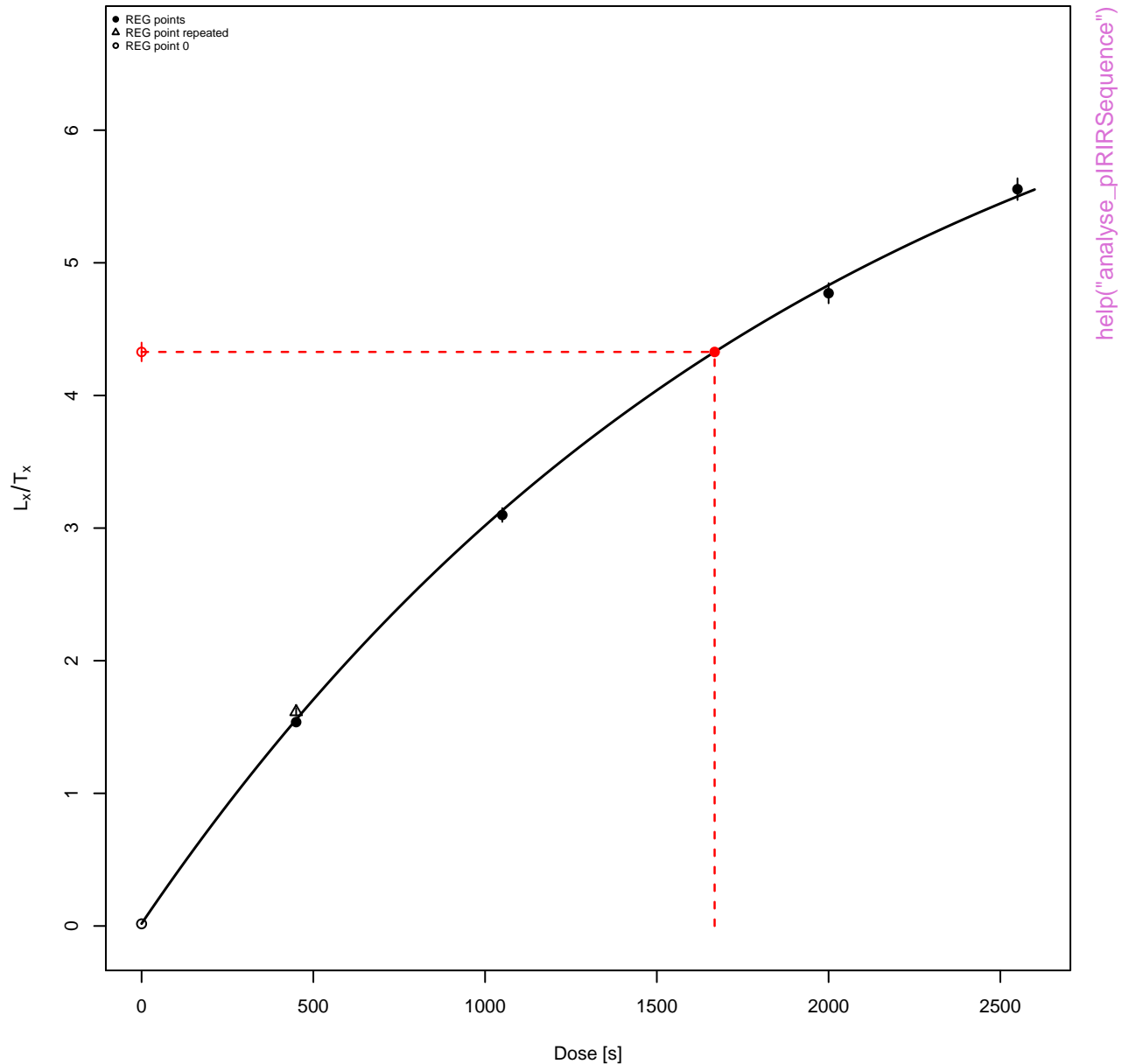


# Pseudo pIRIR data set based on quartz OSL



# Pseudo pIRIR data set based on quartz OSL

$D_e = 1668.25 \pm 41.38$  | fit: EXP





# D<sub>e</sub> from MC simulation

D<sub>eMC</sub> = 1666.57 ± 41.38 | quality = 99.9 %



help("analyse\_pIRIRSequence")

Test dose response



# Pseudo pIRIR data set based on quartz OSL



# Pseudo pIRIR data set based on quartz OSL





Pseudo pIRIR data set based on quartz OSL

$D_e = 1668.25 \pm 47.59$  | fit: EXP



help("analyse\_pIRIRSequence")

# D<sub>e</sub> from MC simulation

D<sub>e,MC</sub> = 1669.37 ± 47.59 | quality = 99.9 %



Dose [s]

n = 100 , valid fits = 100

help("analyse\_pIRSequence")

# Test dose response





# Summarised Dose Response Curves



help("analyse\_pIRSequence")

# Sensitivity change

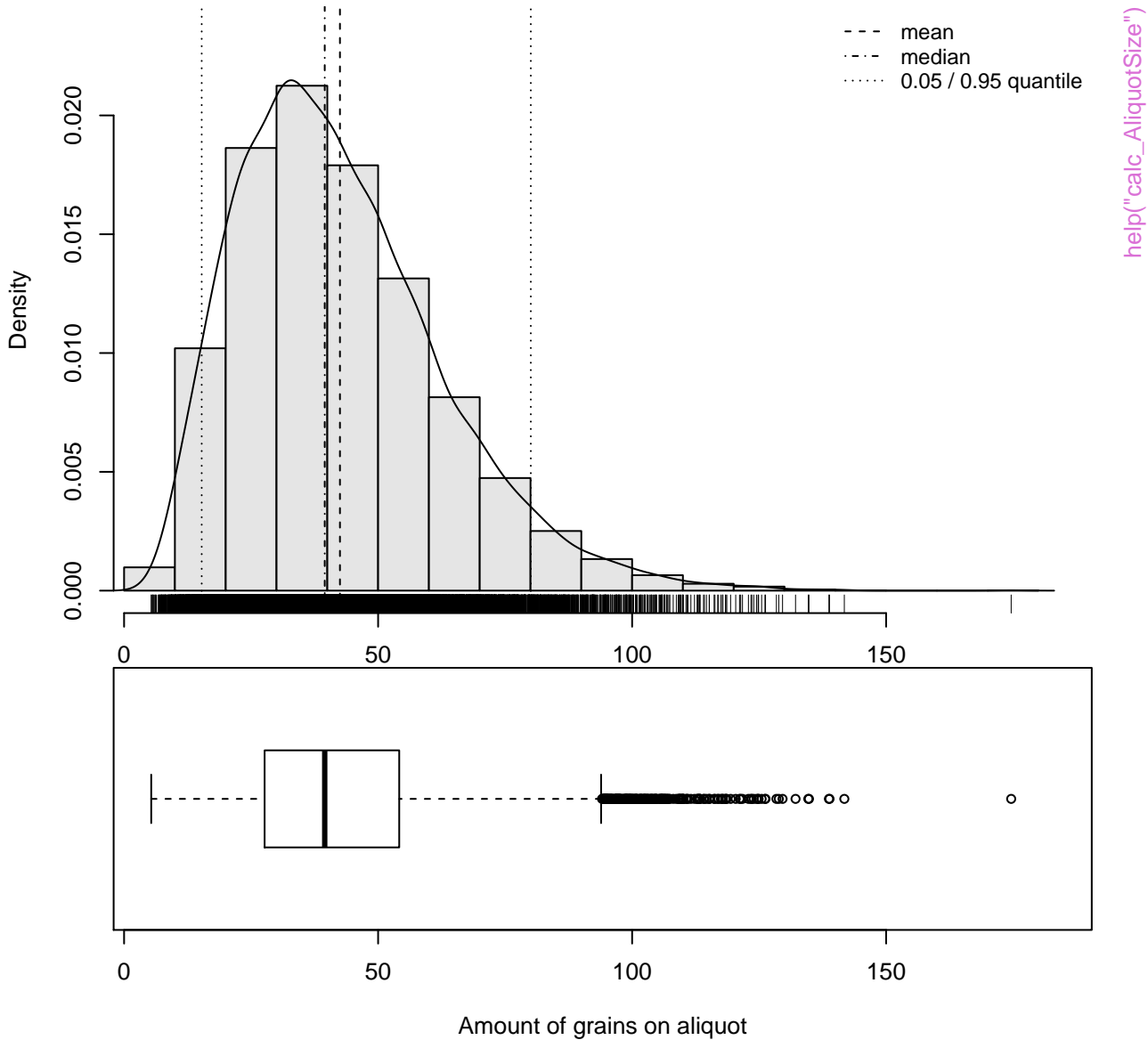


## Rejection criteria



# Monte Carlo Simulation

$n = 10000 \mid \hat{\mu} = 42 \mid \hat{\sigma} = 20 \mid \frac{\hat{\sigma}}{\sqrt{n}} = 0 \mid v = 0.89$



Profile log likelihood for  $\sigma_{OD}$



# Finite Mixture Model

$\sigma_b = 0.2 \mid n = 62$

## Normal distributions



## Proportion of components



## Statistical criteria



help("calc\_FiniteMixture")

# Fuchs & Lang (2001)









help("calc\_I EU")

**Likelihood profile: gamma**



**Likelihood profile: sigma**



help("calc\_MaxDose")

**Likelihood profile: p0**



**Likelihood profile: gamma**



**Likelihood profile: sigma**



help("calc\_MinDose")

**Likelihood profile: p0**



**Likelihood profile: gamma**



**Likelihood profile: sigma**



help("calc\_MinDose")

**Likelihood profile: p0**



# 3-parameter Minimum Age Model

Parameters:  $\sigma_b = 0.1$  ,  $\gamma = 3.5$  ,  $\sigma = 0.7$  ,  $\rho = 0.01$

n = 62

mean = 66.01

weighted mean = 62.16

median = 71.07

Standardised estimate



0

5

Precision

10

15

Density (bw 0.1)

0 0.106

$D_e$  (Gy)

help("calc\_MinDose")

120

100

80

60

40

20

$34.3 \pm 2.6$  Gy

# Source Dose Rate Prediction

source type: Sr-90 | half-life: 28.9 a



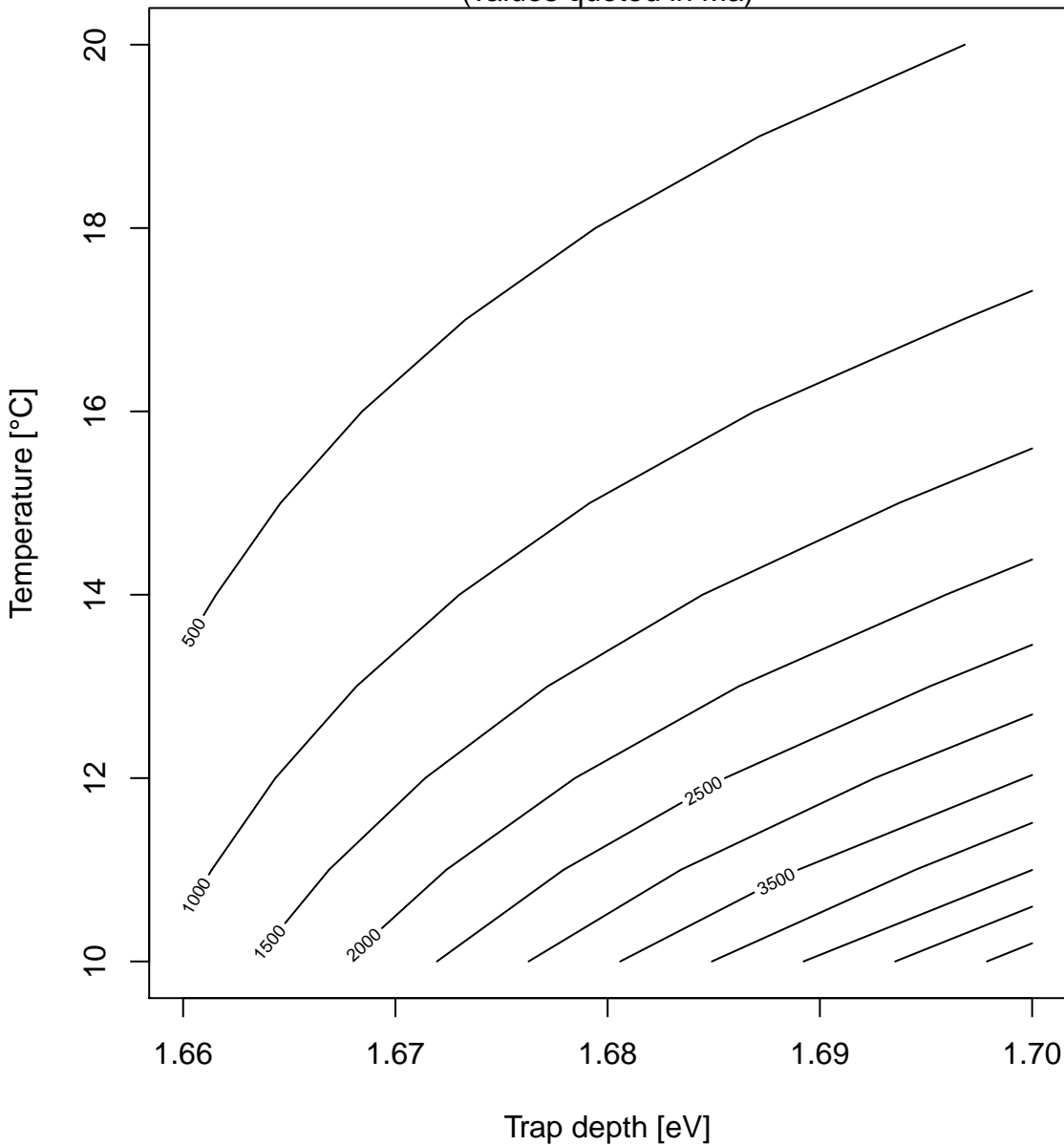
help("calc\_SourceDoseRate")

**D<sub>e</sub> distribution**



# Thermal Lifetime Contour Plot

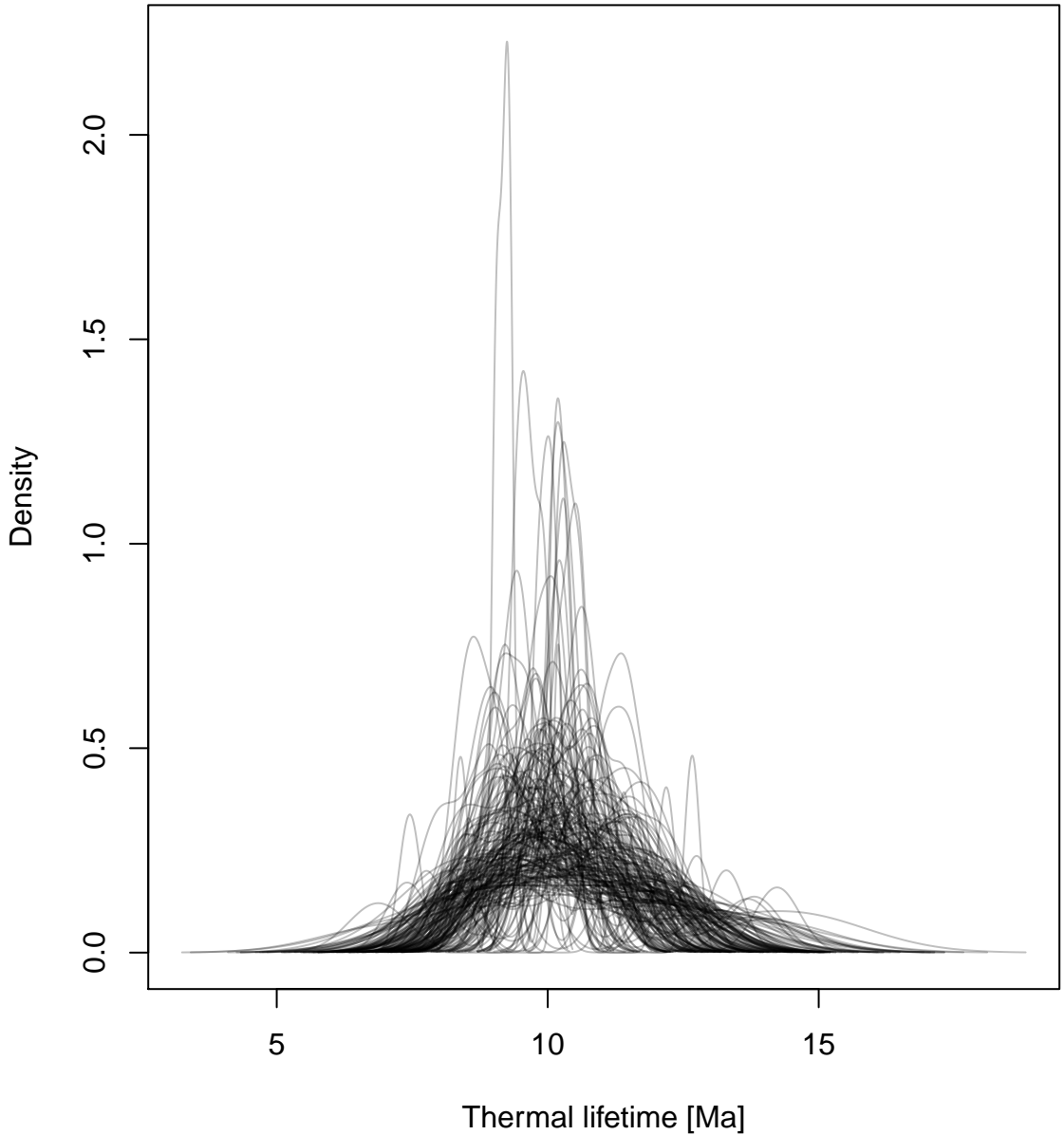
(values quoted in Ma)



help("calc\_ThermalLifetime")

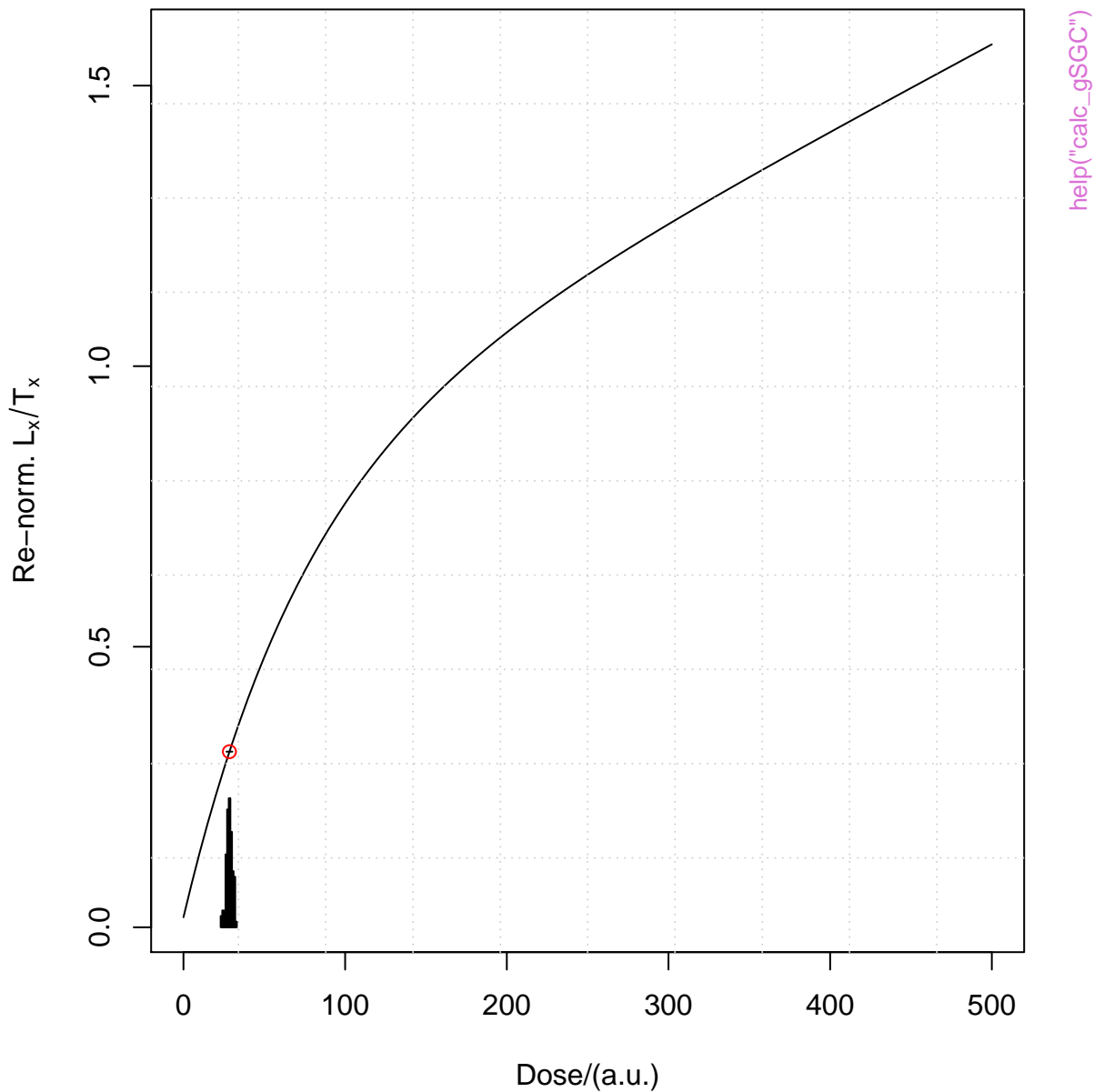


# Thermal Lifetime Density Plot



`help("calc_ThermalLifetime")`

# gSGC and resulting De



# CW Curve Fit

Default



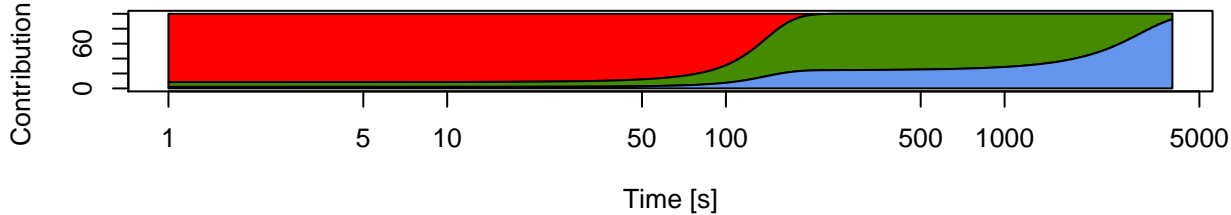
## Component contribution to sum curve



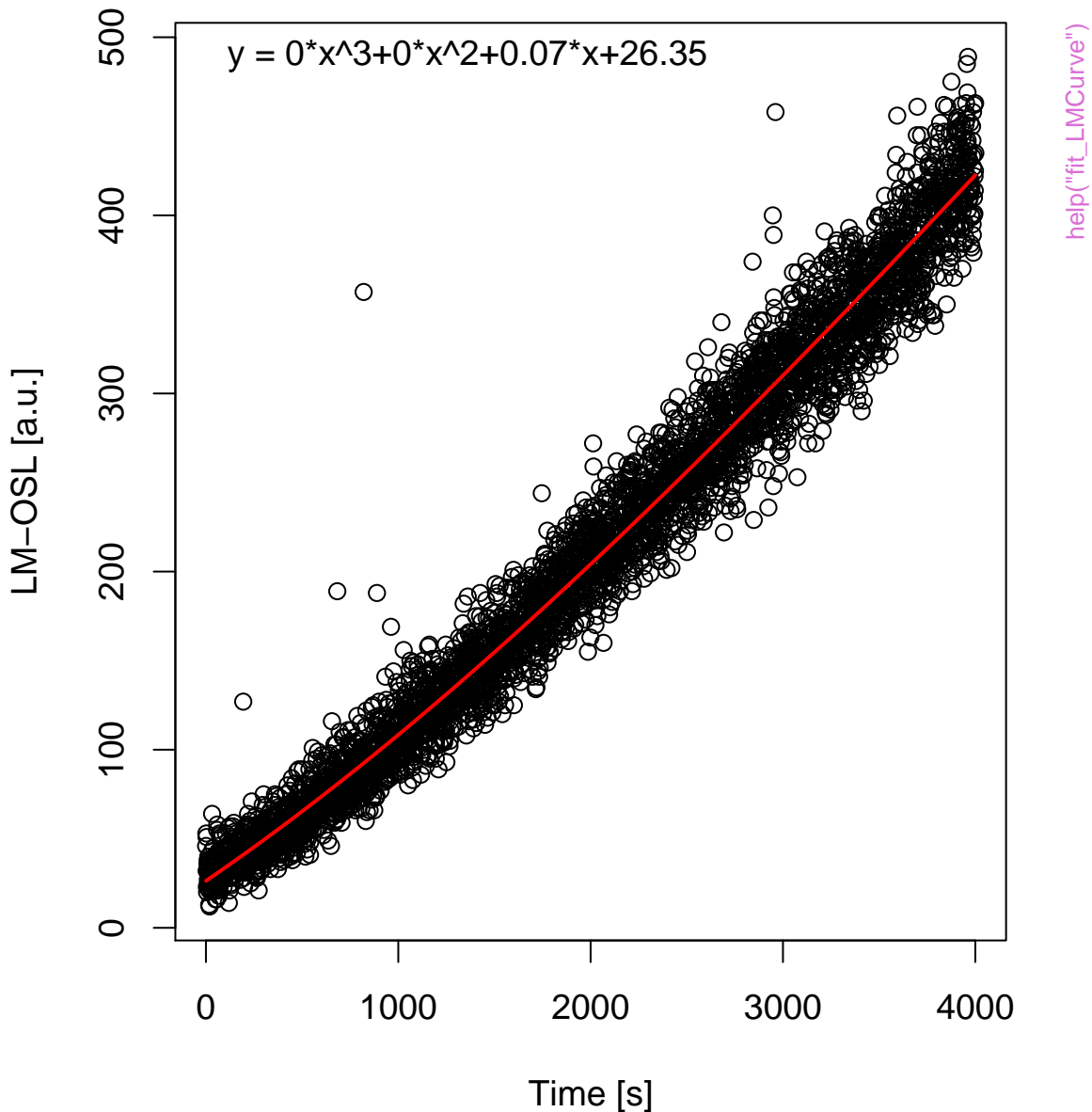
## Default



## Component contribution to sum curve



# Background



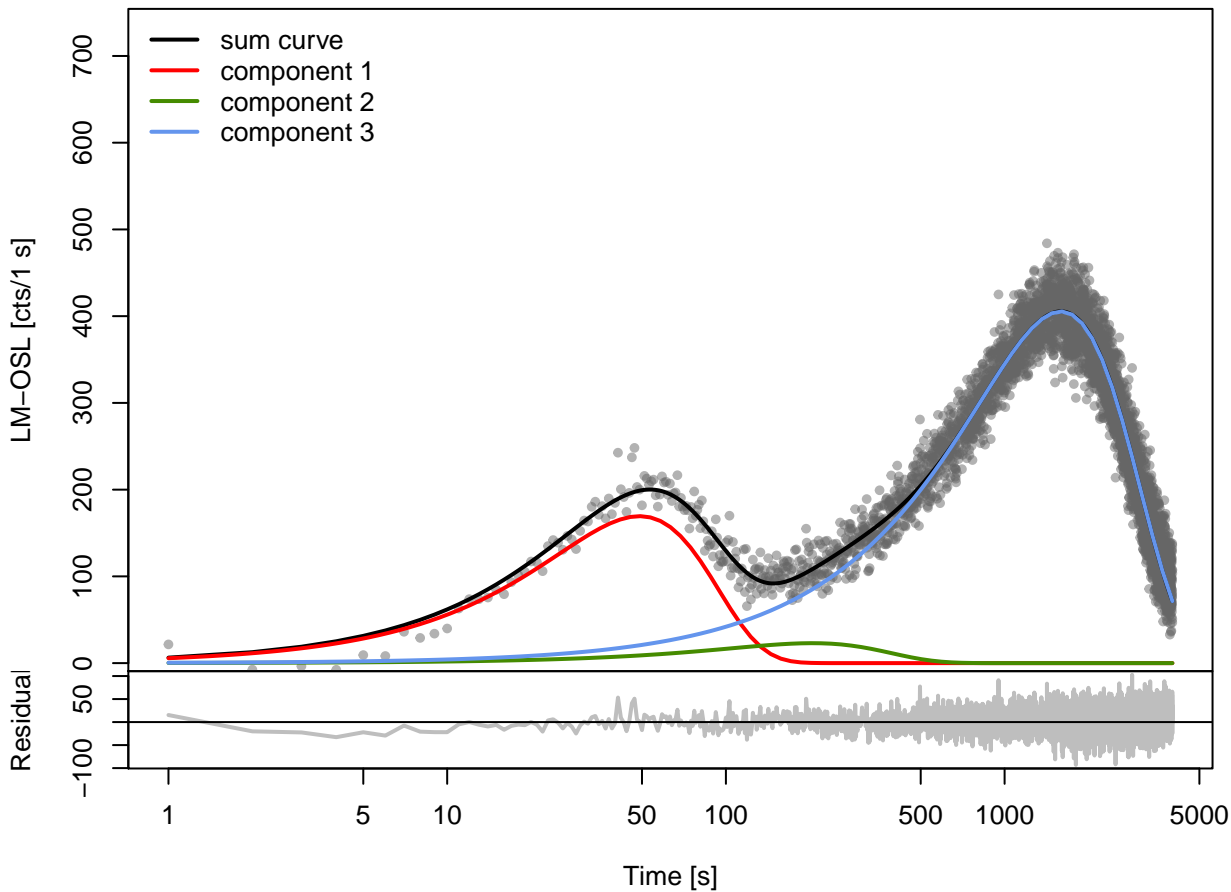
## Default



## Component contribution to sum curve



## Default



## Component contribution to sum curve

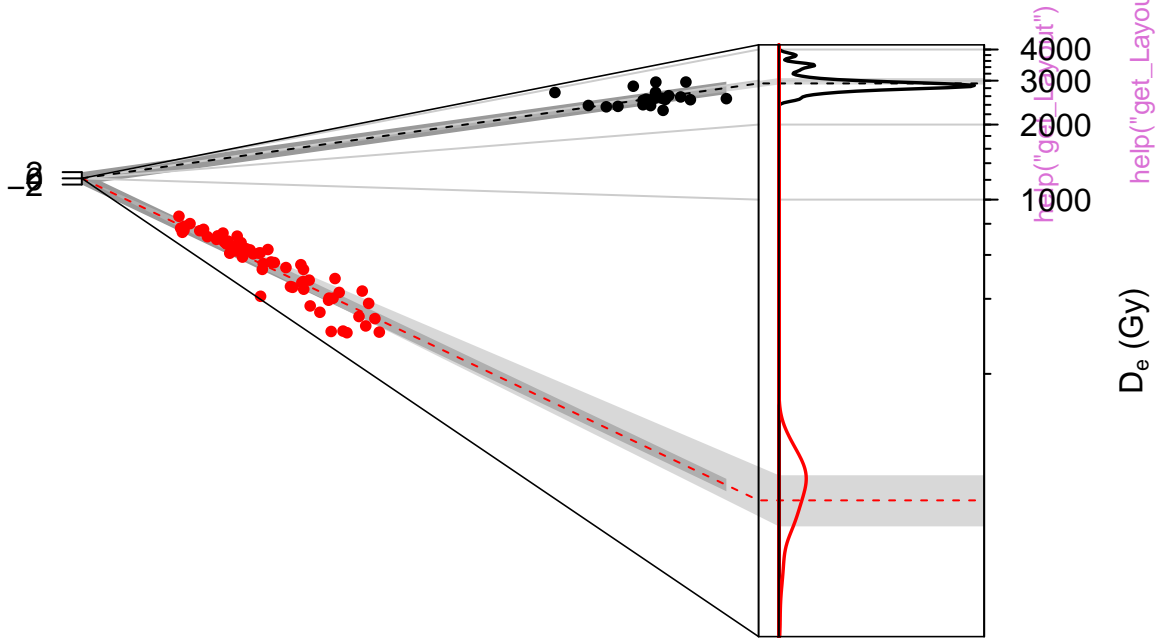


# D<sub>e</sub> distribution

n = 25

n = 62

Standardised estimate



Relative standard error (%)

10

5

3.3

0

10

20

30

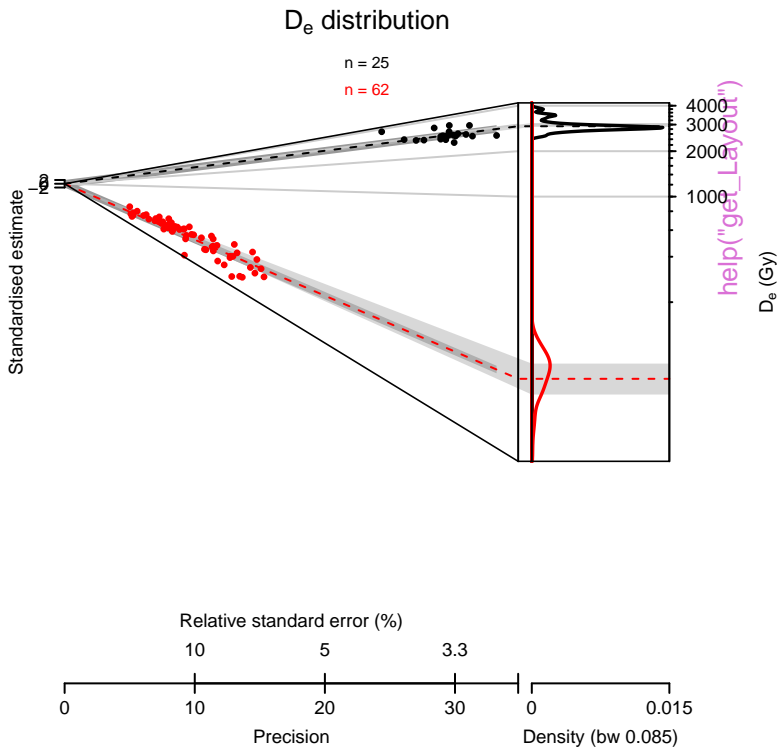
0

0.015

Precision

Density (bw 0.085)



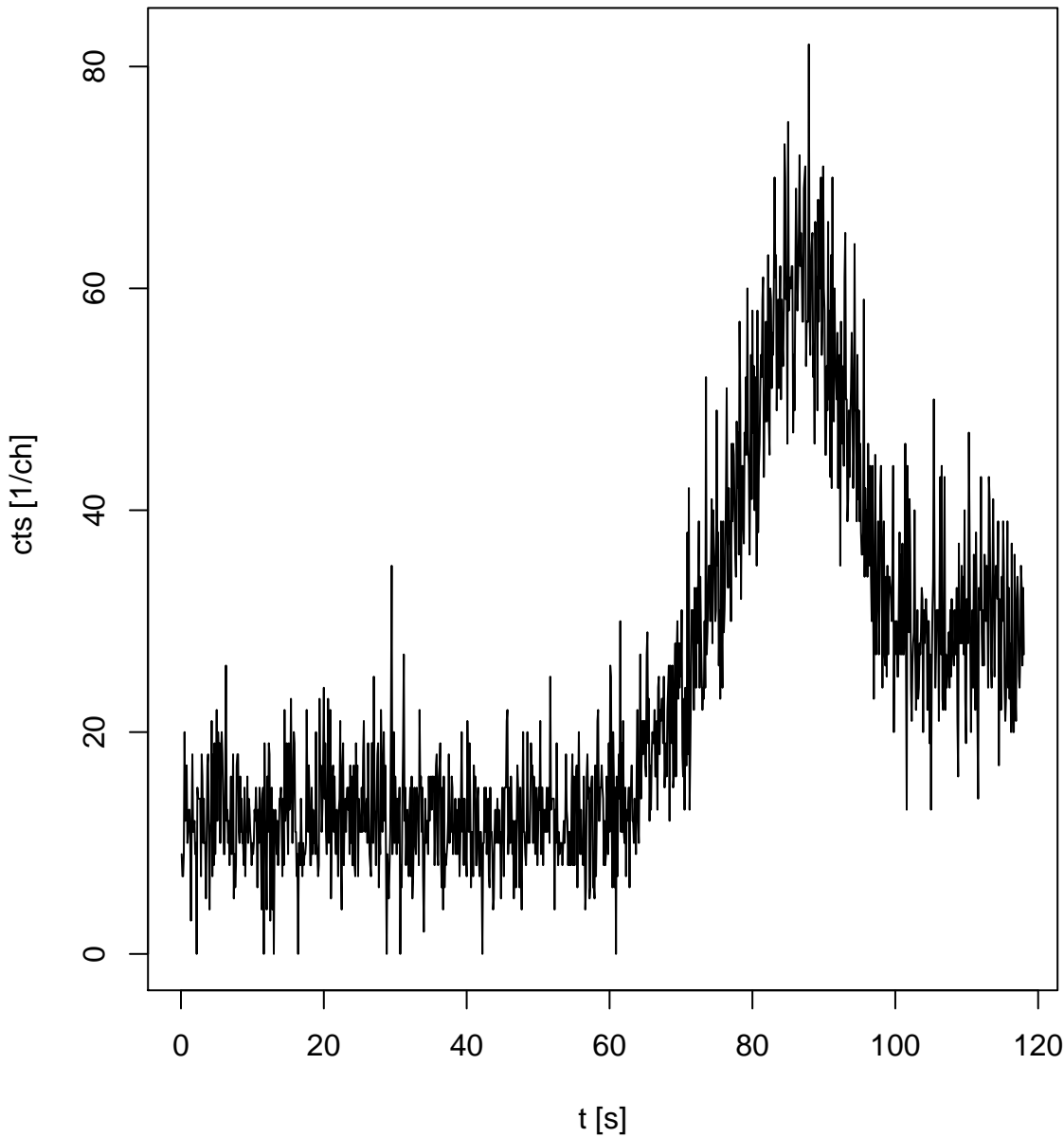


help("get\_Layout")

Profile log likelihood for  $\sigma_{OD}$

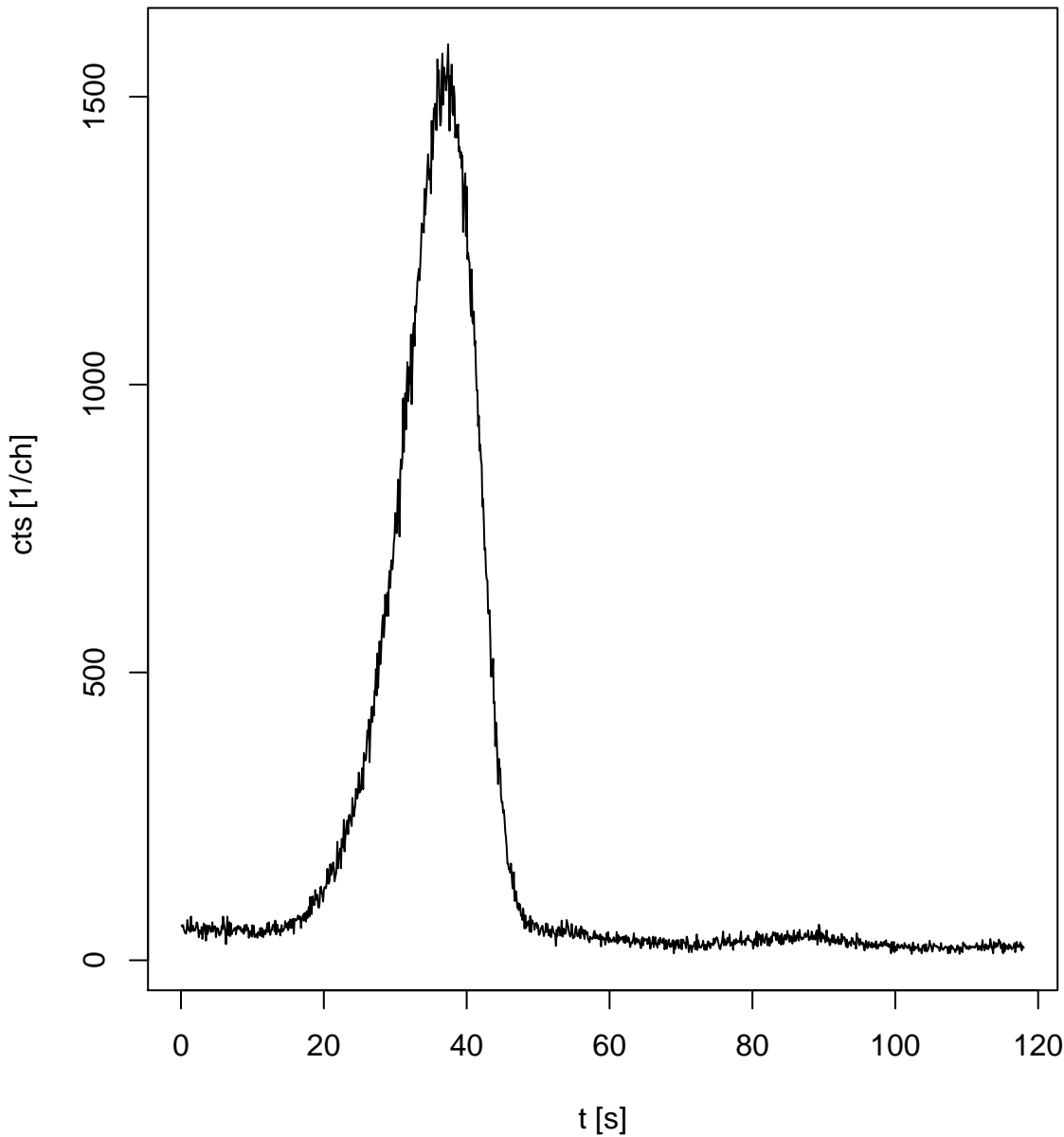


# TL (UVVIS)



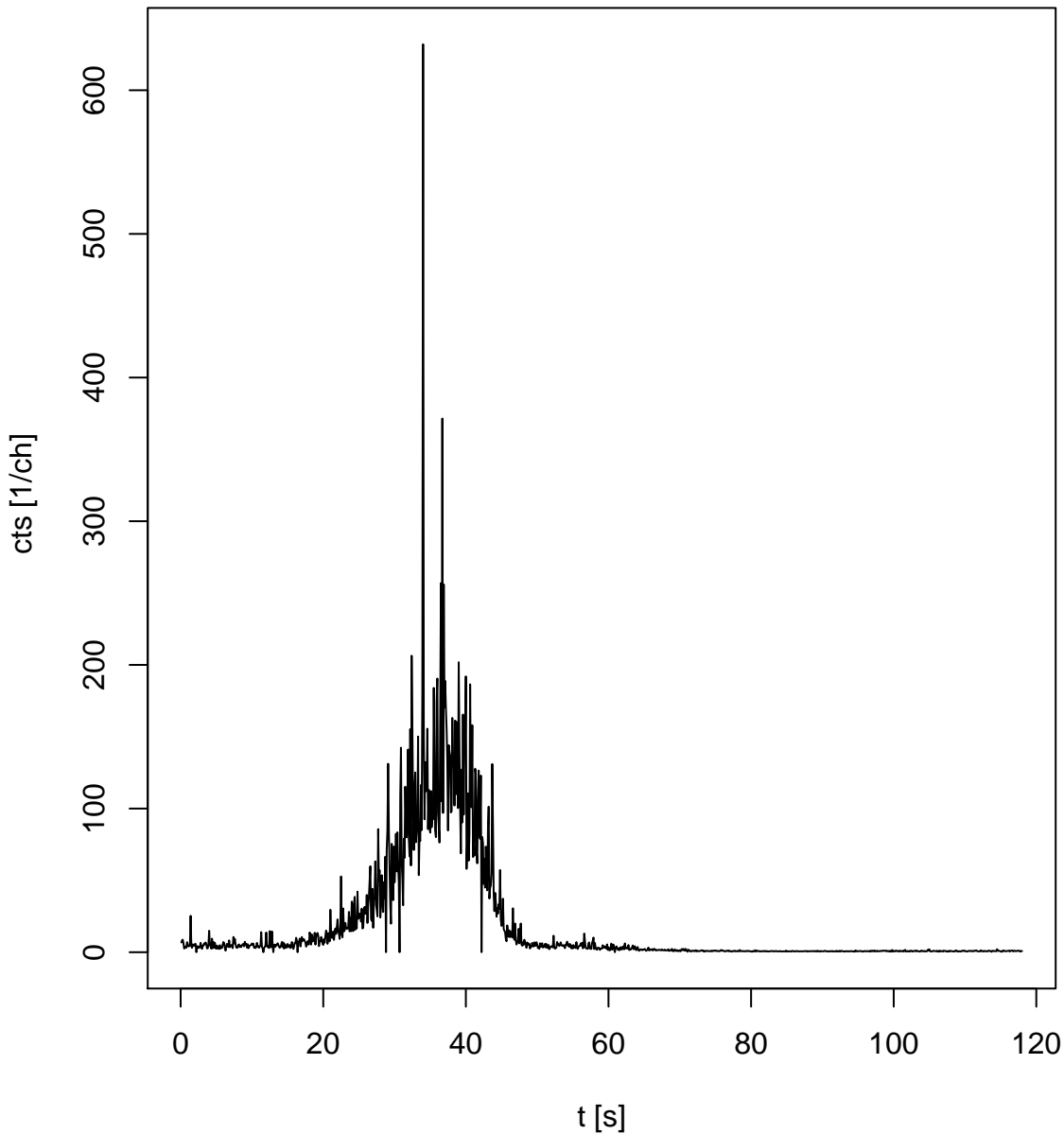
help("merge\_RLum.Data.Curve")

# TL (UVVIS)



help("merge\_RLum.Data.Curve")

# TL (UVVIS)



help("merge\_RLum.Data.Curve")

Profile log likelihood for  $\sigma_{OD}$



Profile log likelihood for  $\sigma_{OD}$



# $D_e$ distribution

n = 62

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

10

15

0.016

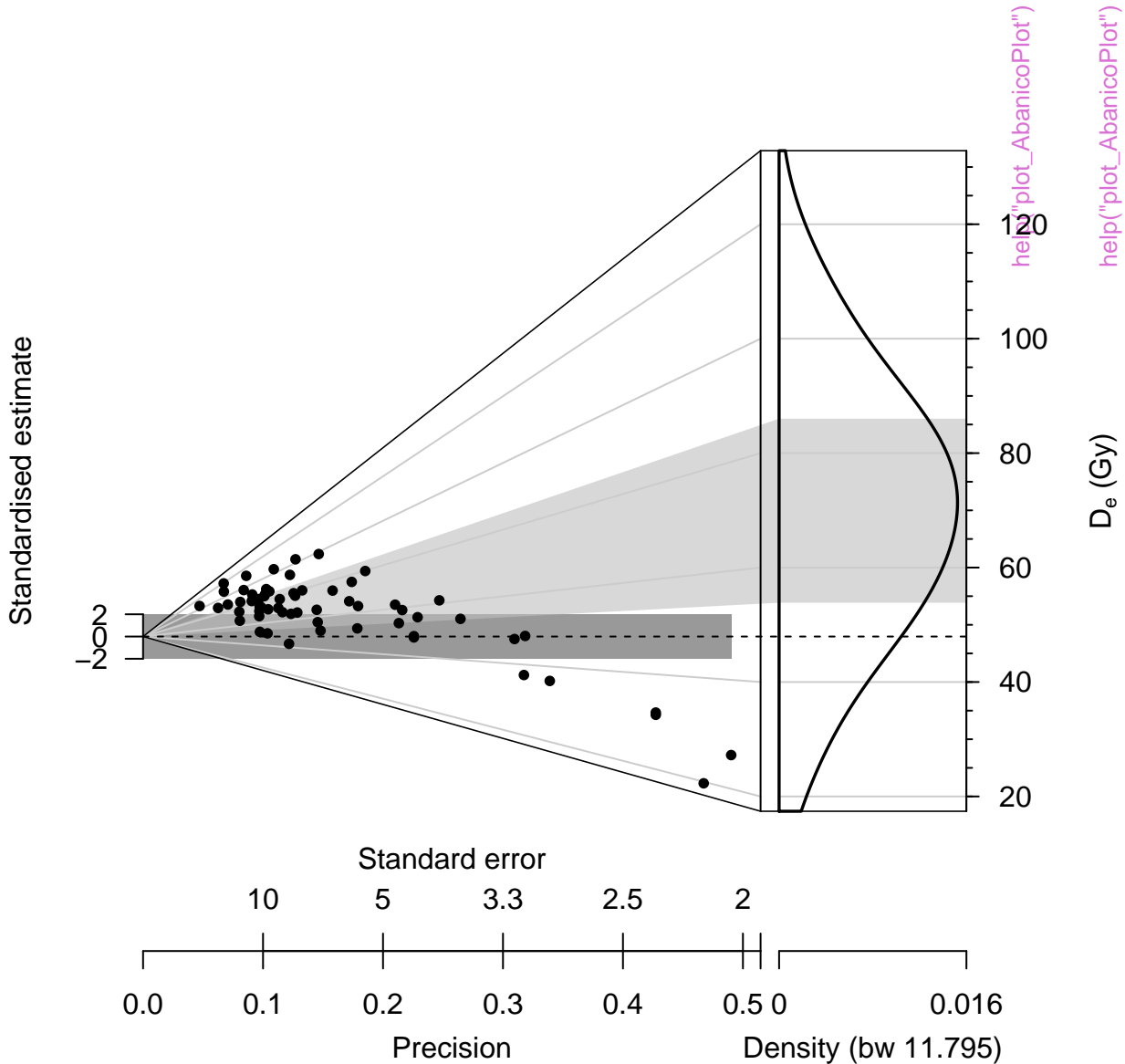
Precision

Density (bw 0.15)



# D<sub>e</sub> distribution

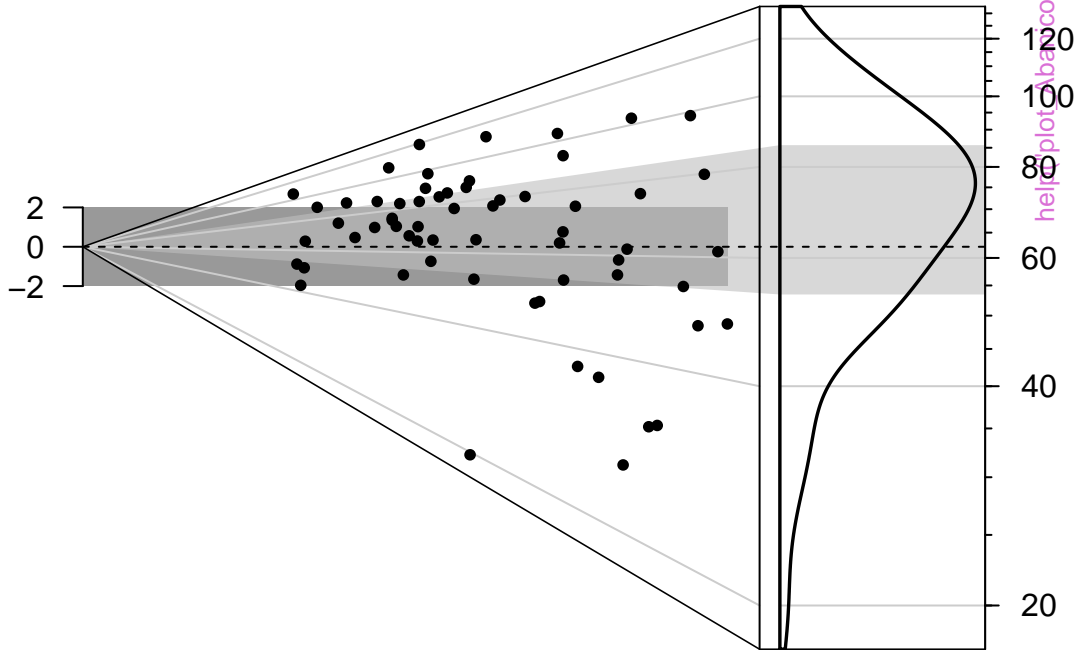
n = 62



# $D_e$ distribution

n = 62

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

10

15

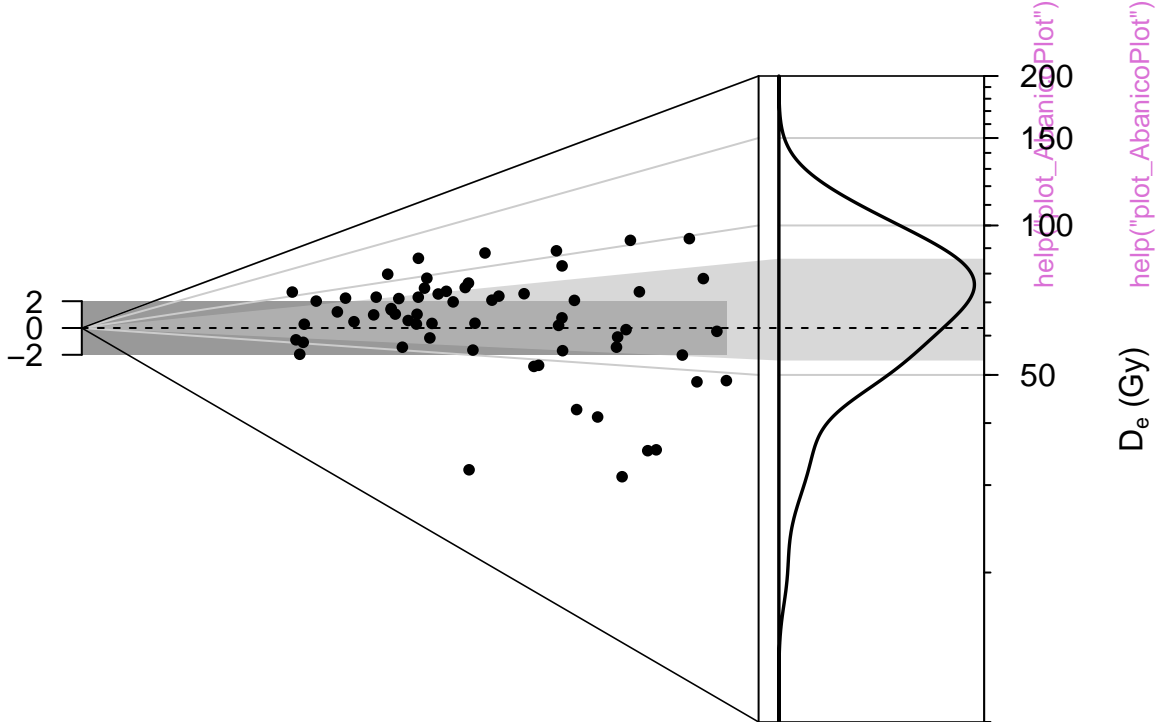
0.016

Precision

Density (bw 0.15)

## $D_e$ distribution

n = 62



Relative standard error (%)

20

10

## 6.7

0

5

10

15

0.016

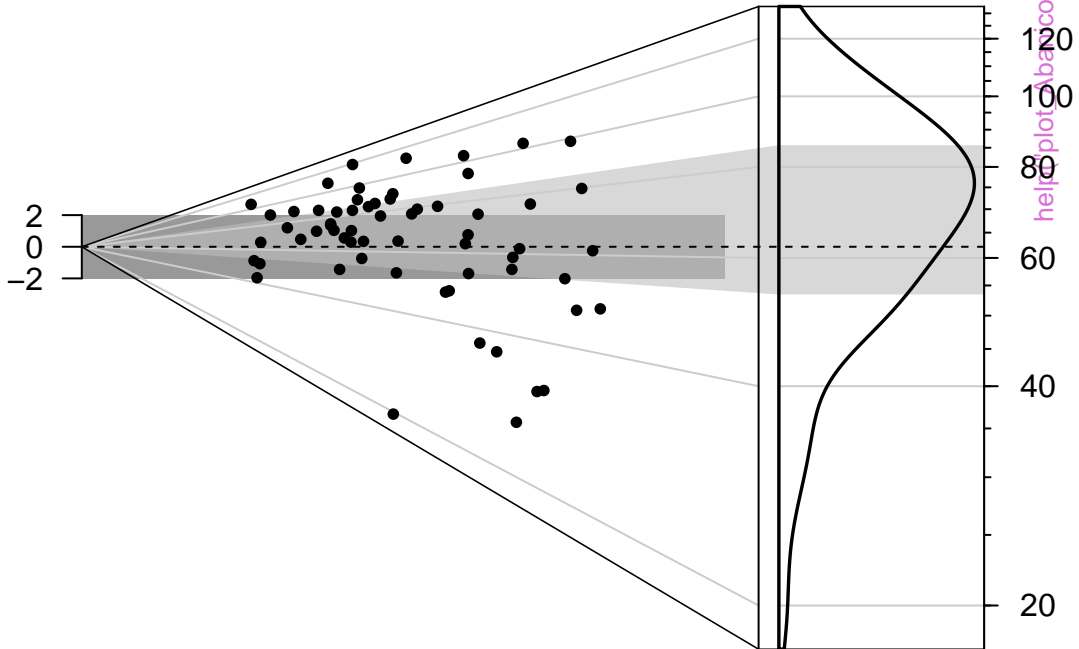
## Precision

Density (bw 0.15)

# $D_e$ distribution

n = 62

Standardised estimate



Relative standard error (%)

20

10

6.7

5

0

5

10

15

200

0.016

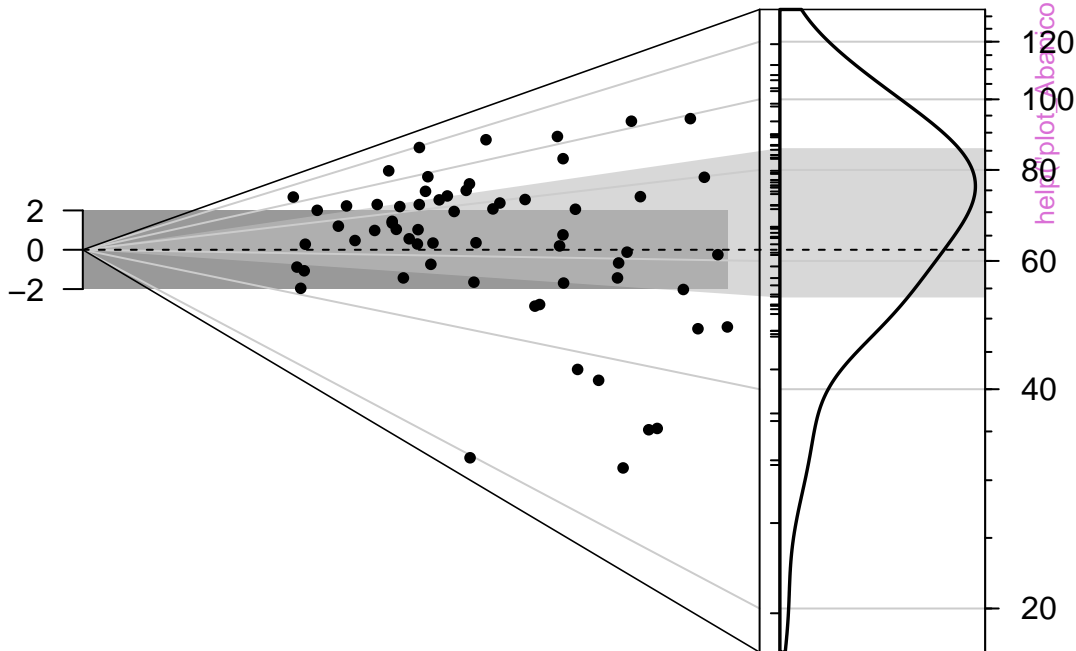
Precision

Density (bw 0.15)

# $D_e$ distribution

n = 62

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

Precision

10

15

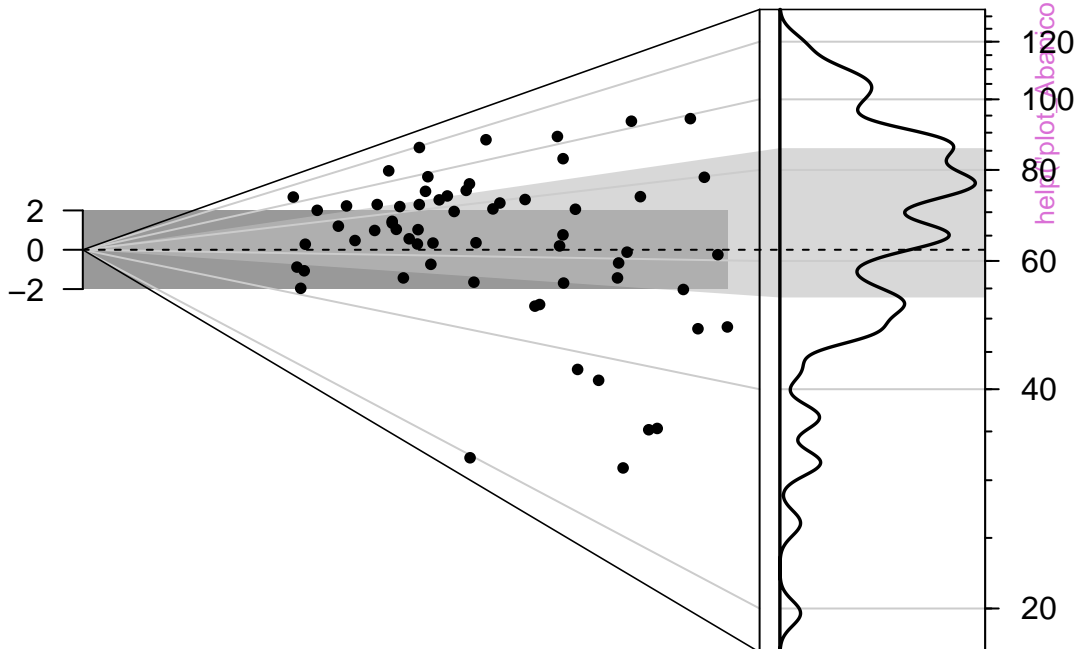
Density (bw 0.15)

0.016

# D<sub>e</sub> distribution

n = 62

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

10

15

0

0.264

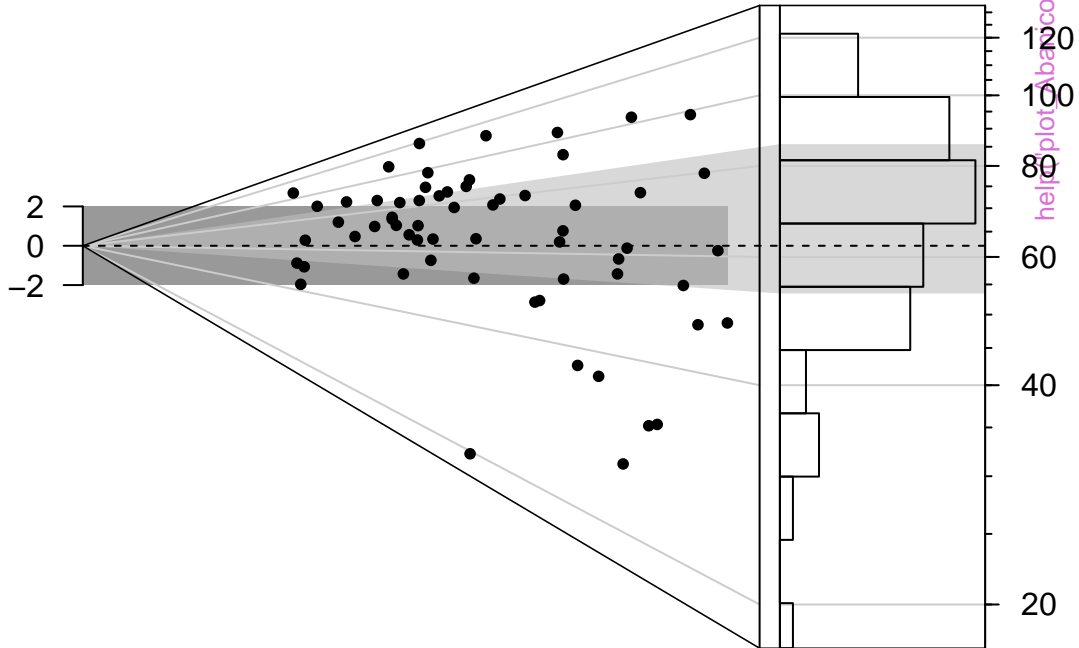
Precision

Density (bw 0.04)

# D<sub>e</sub> distribution

n = 62

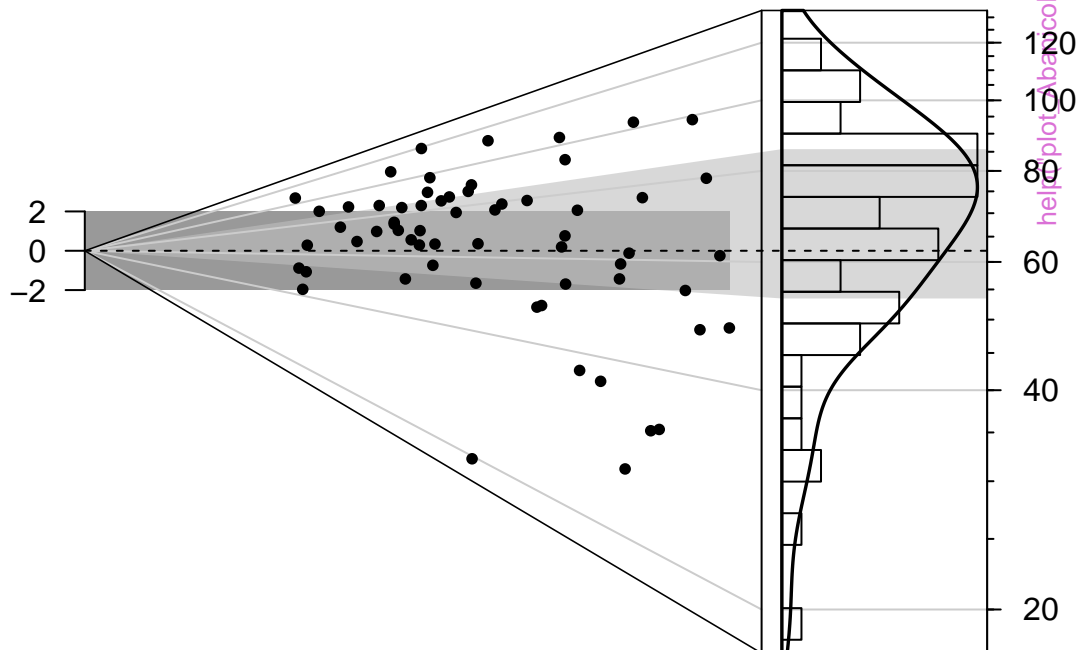
Standardised estimate



# D<sub>e</sub> distribution

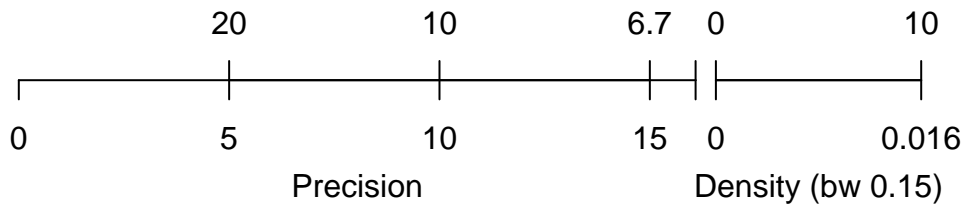
n = 62

Standardised estimate



Relative standard error (%)

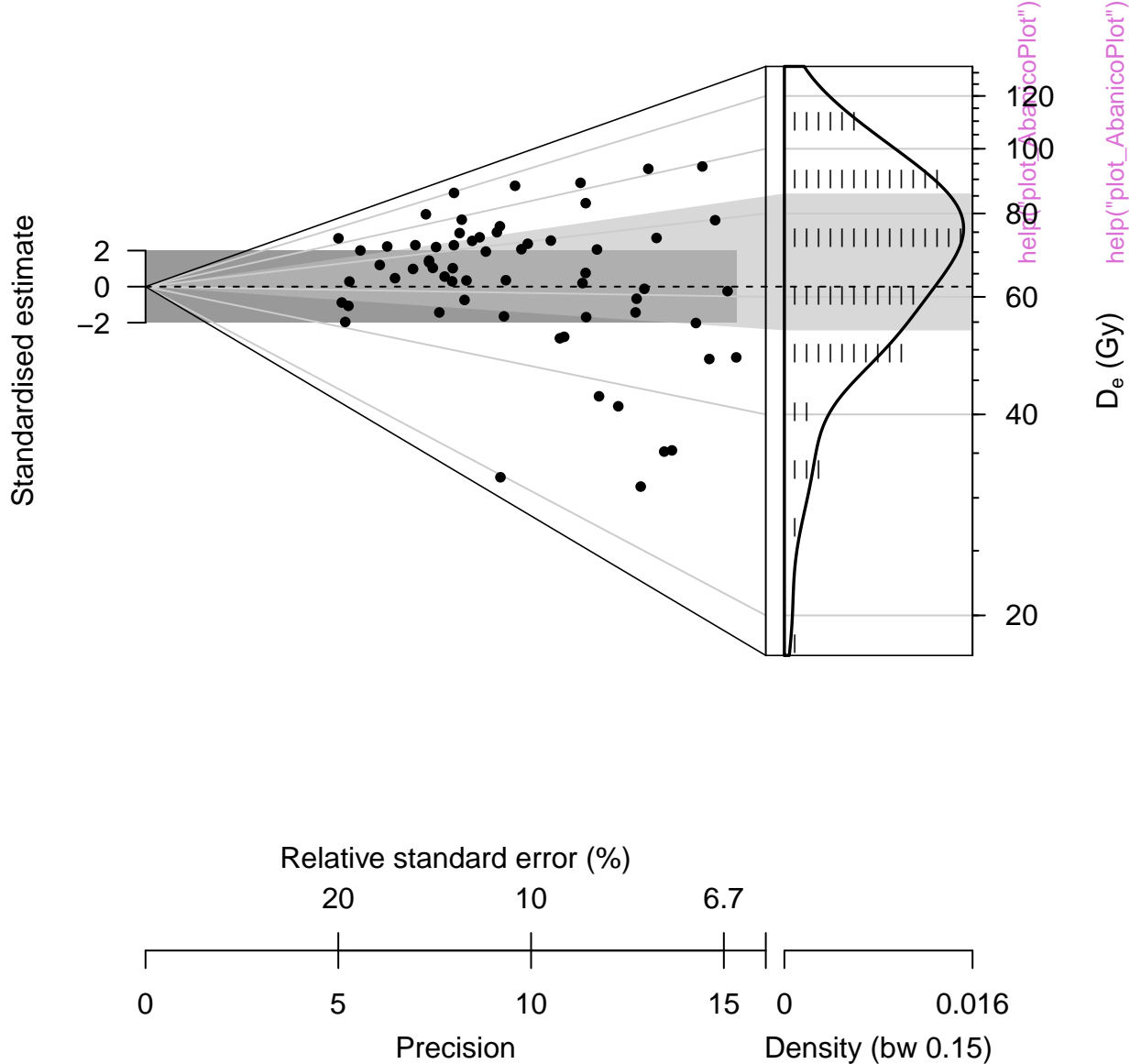
n





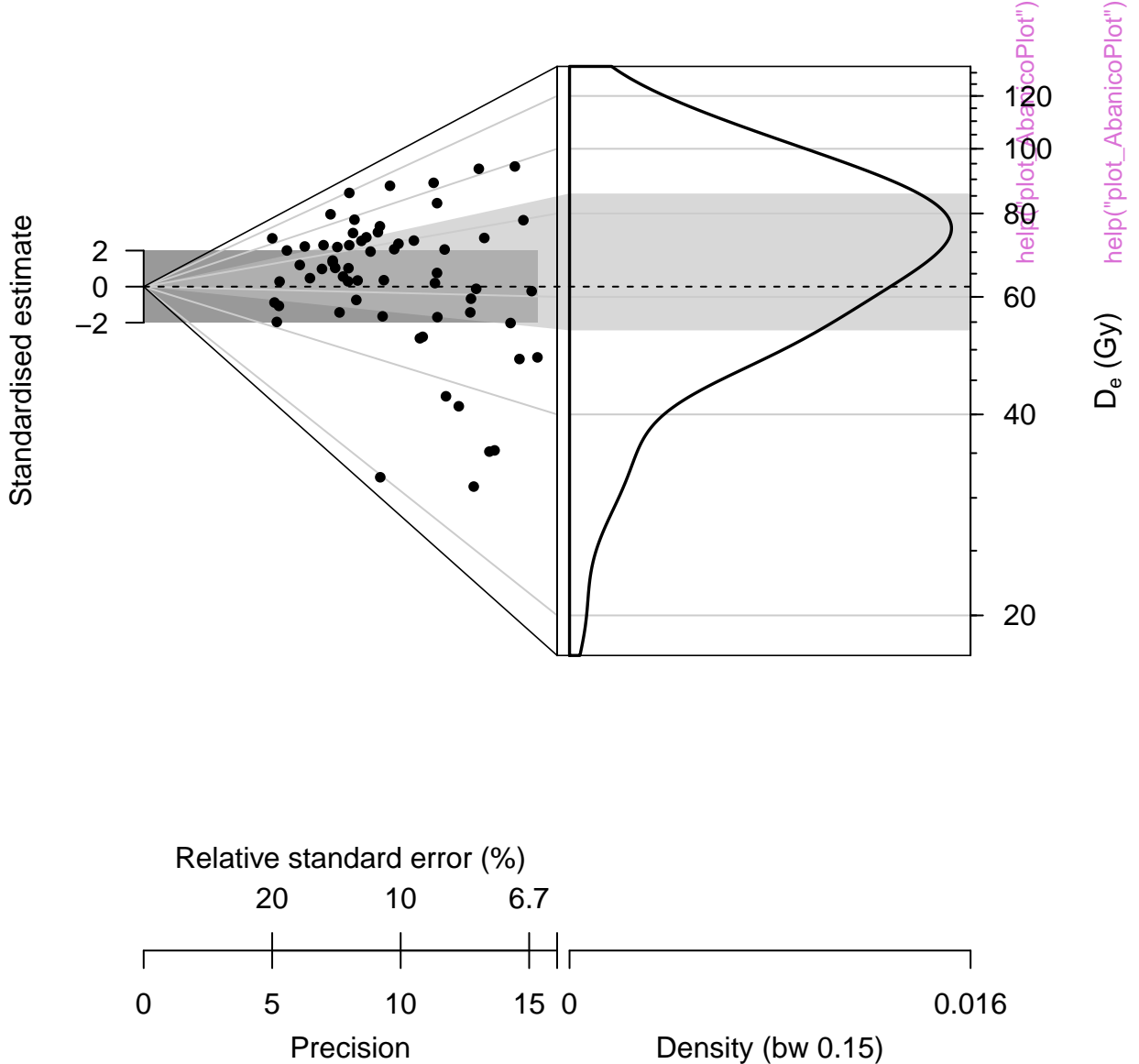
# D<sub>e</sub> distribution

n = 62



# D<sub>e</sub> distribution

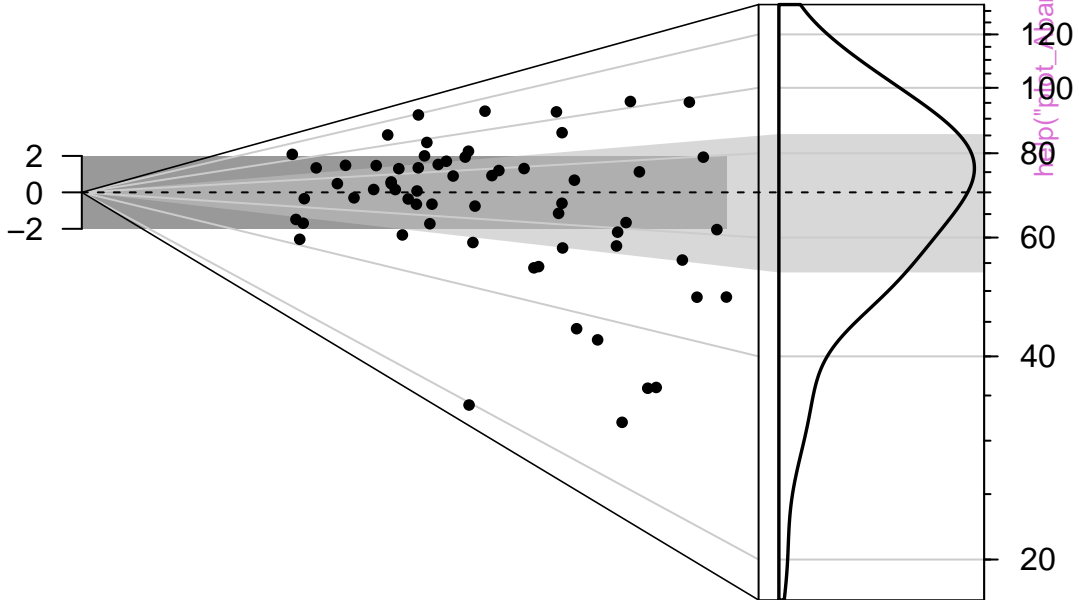
n = 62



# $D_e$ distribution

n = 62

Standardised estimate



$D_e$  (Gy)

Relative standard error (%)

20

10

6.7

0

5

Precision

10

15

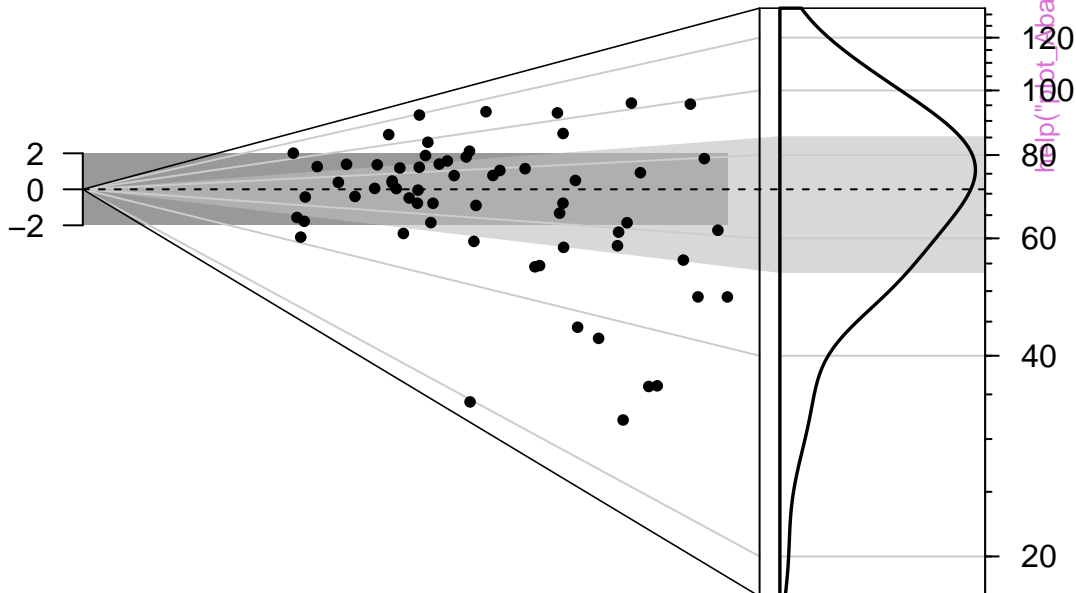
Density (bw 0.15)

0.016

# $D_e$ distribution

n = 62

Standardised estimate



$D_e$  (Gy)

Relative standard error (%)

20

10

6.7

0

5

10

15

0.016

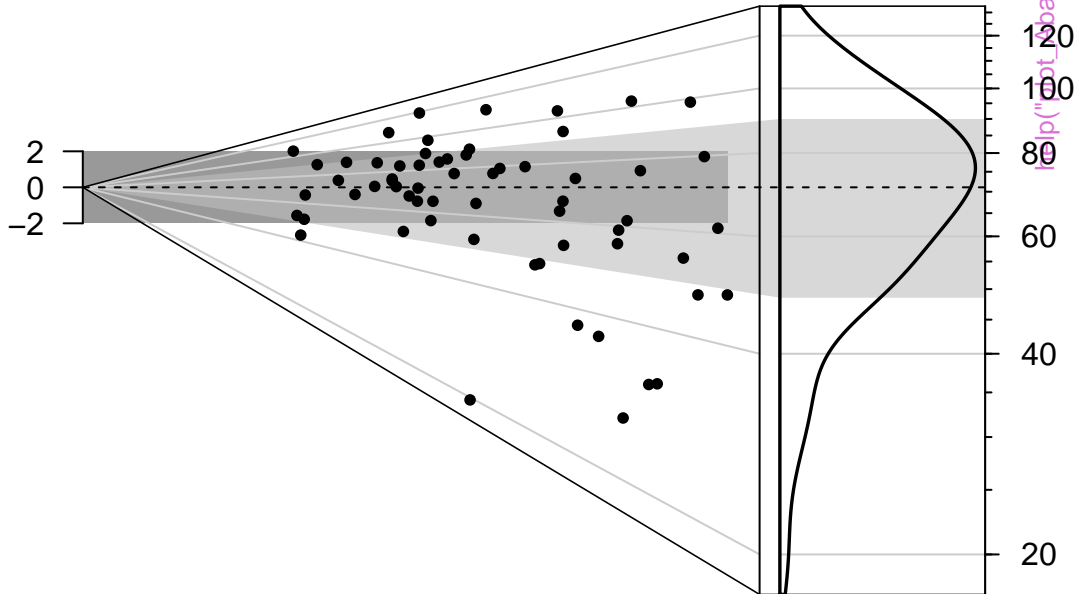
Precision

Density (bw 0.15)

# $D_e$ distribution

n = 62

Standardised estimate



$D_e$  (Gy)

Relative standard error (%)

20

10

6.7

0

5

10

15

0.016

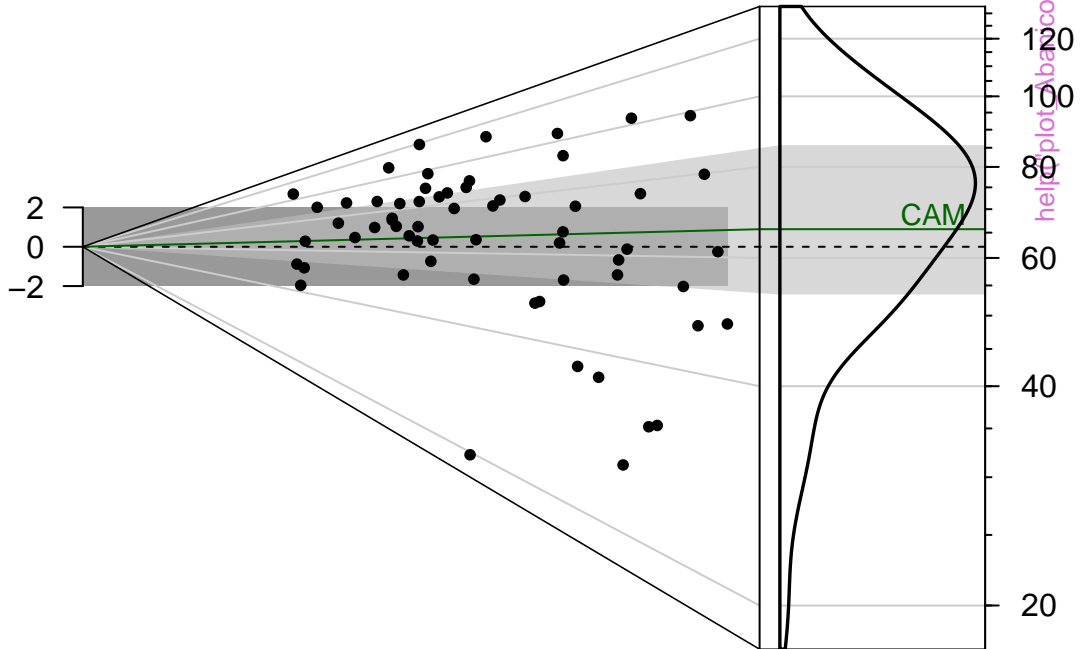
Precision

Density (bw 0.15)

# D<sub>e</sub> distribution

n = 62

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

10

15

0.016

Precision

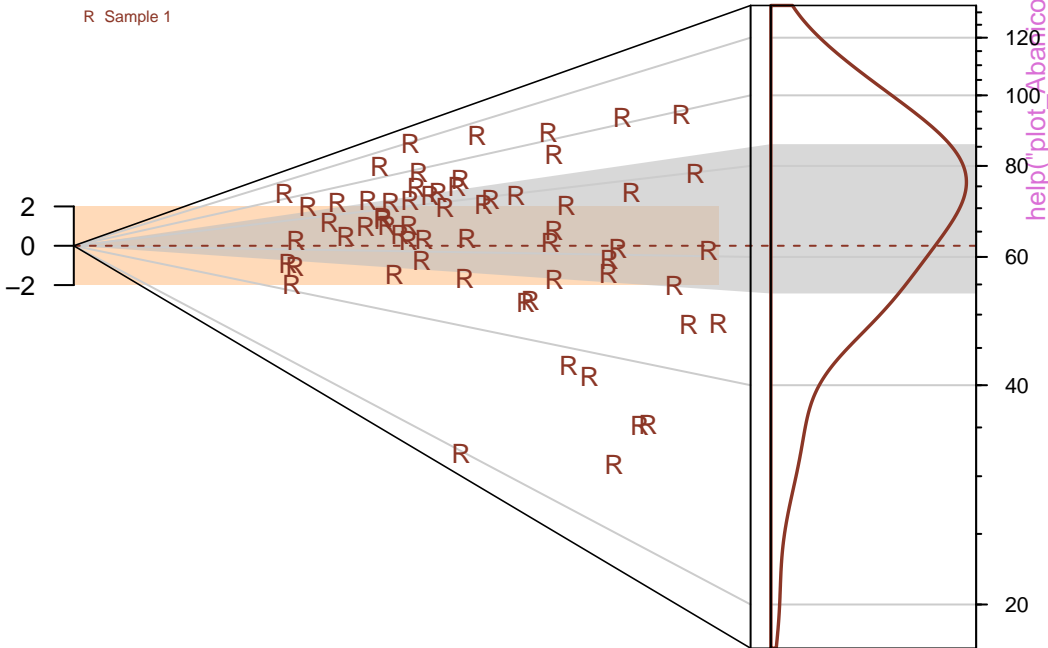
Density (bw 0.15)

# D<sub>e</sub> distribution

n = 62

R Sample 1

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

10

15

0.016

Precision

Density (bw 0.15)

# $D_e$ distribution

n = 62

Standardised estimate

0

help("plot\_AbanicoPlot")

help("plot\_AbanicoPlot")

$D_e$  (Gy)

120  
100  
80  
60  
40  
20

Relative standard error (%)

20

10

6.7

0

5

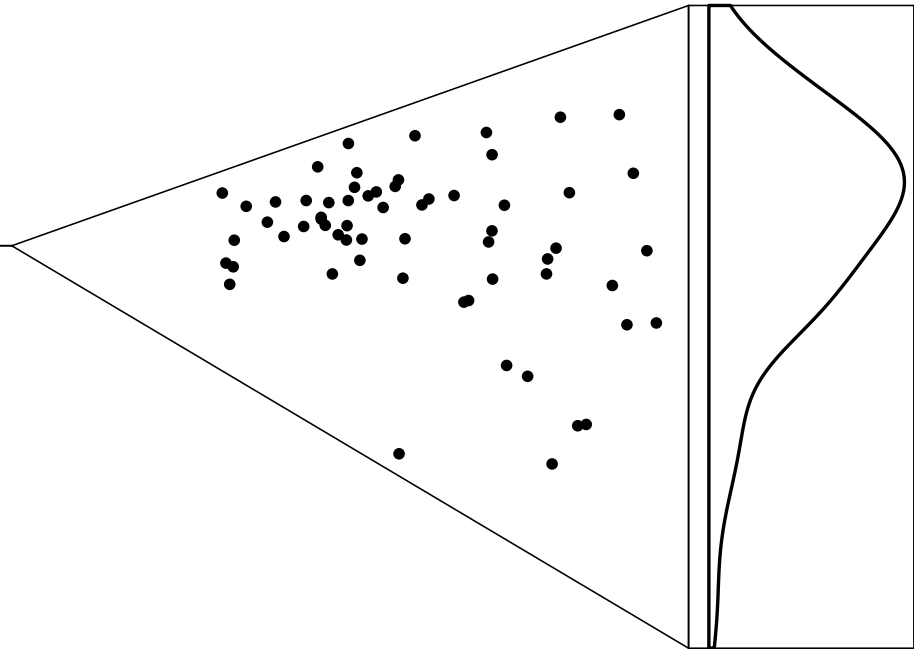
Precision

10

15

Density (bw 0.15)

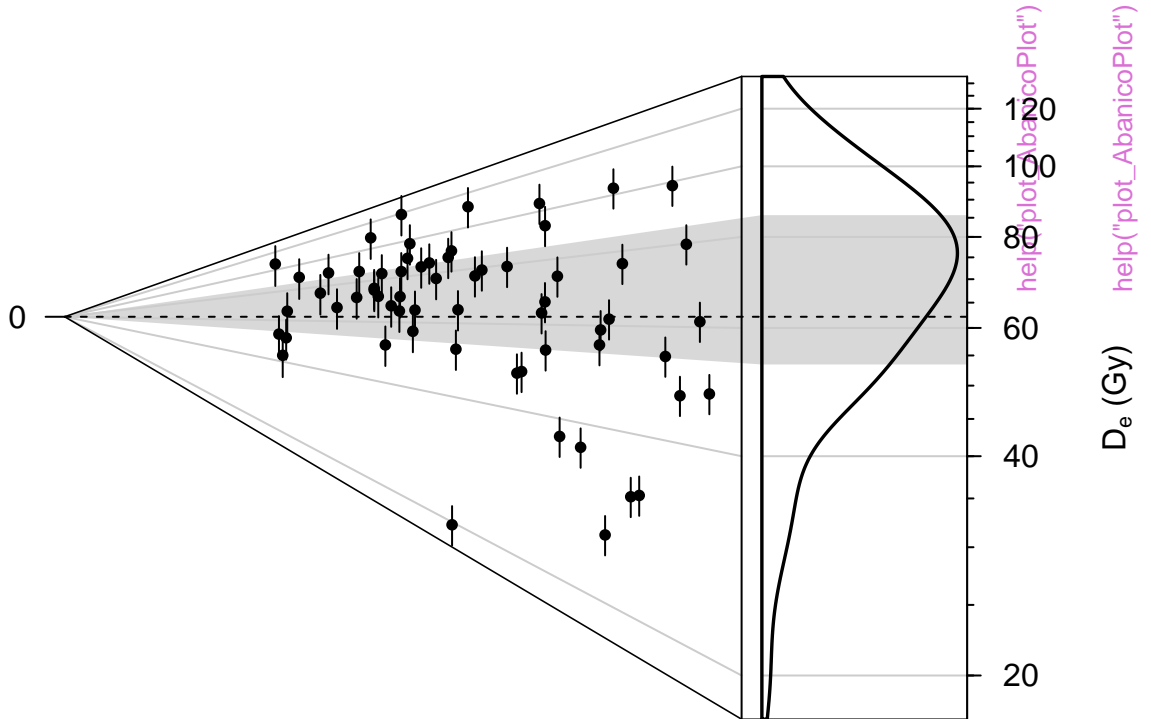
0.016





# D<sub>e</sub> distribution

n = 62

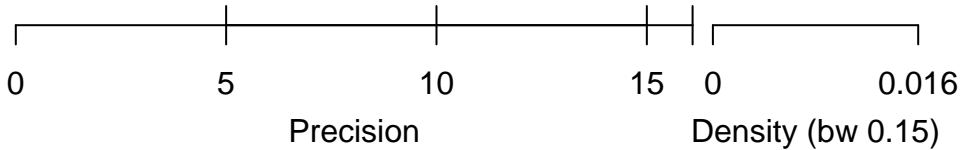


Relative standard error (%)

20

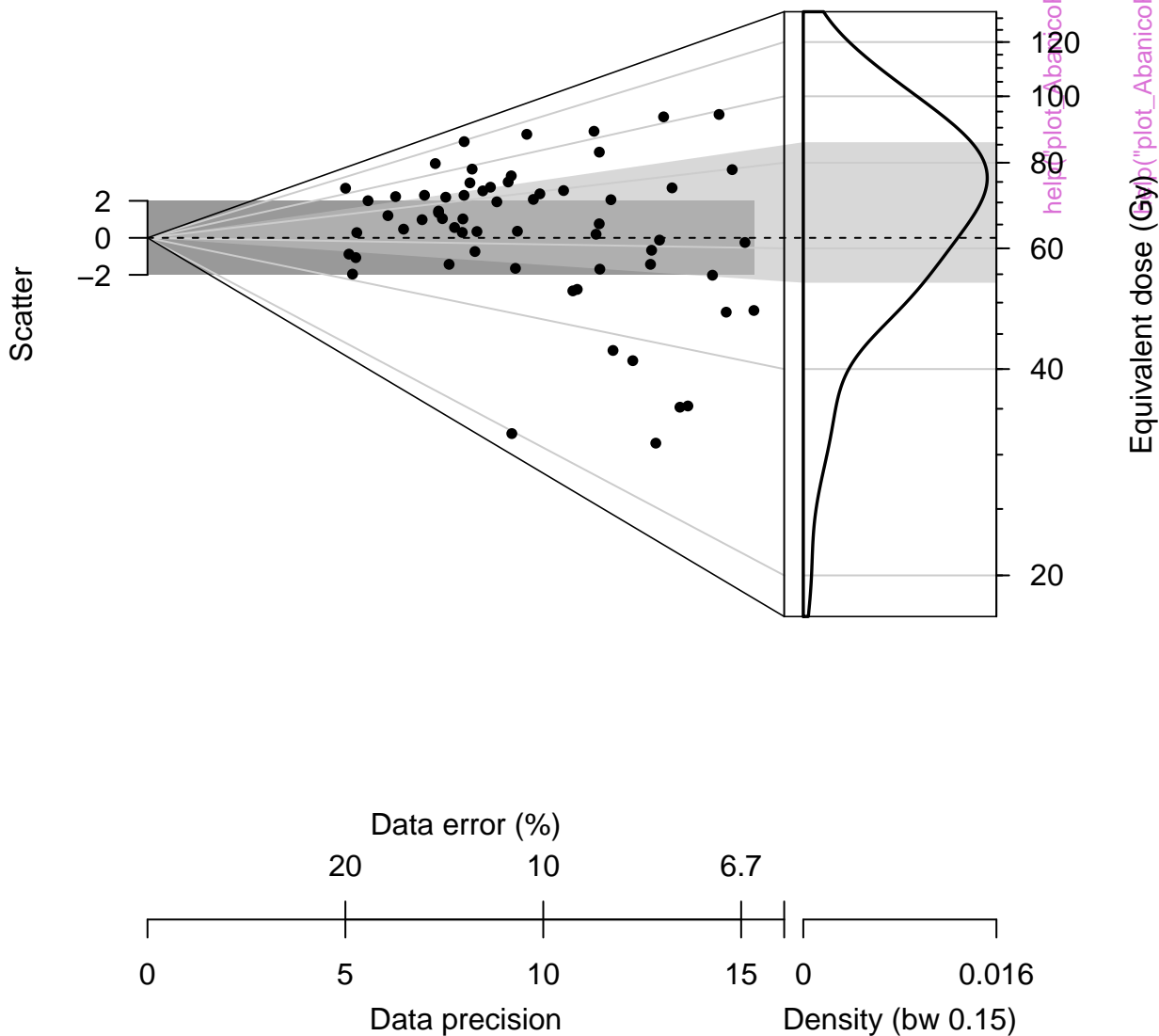
10

6.7



# $D_e$ distribution

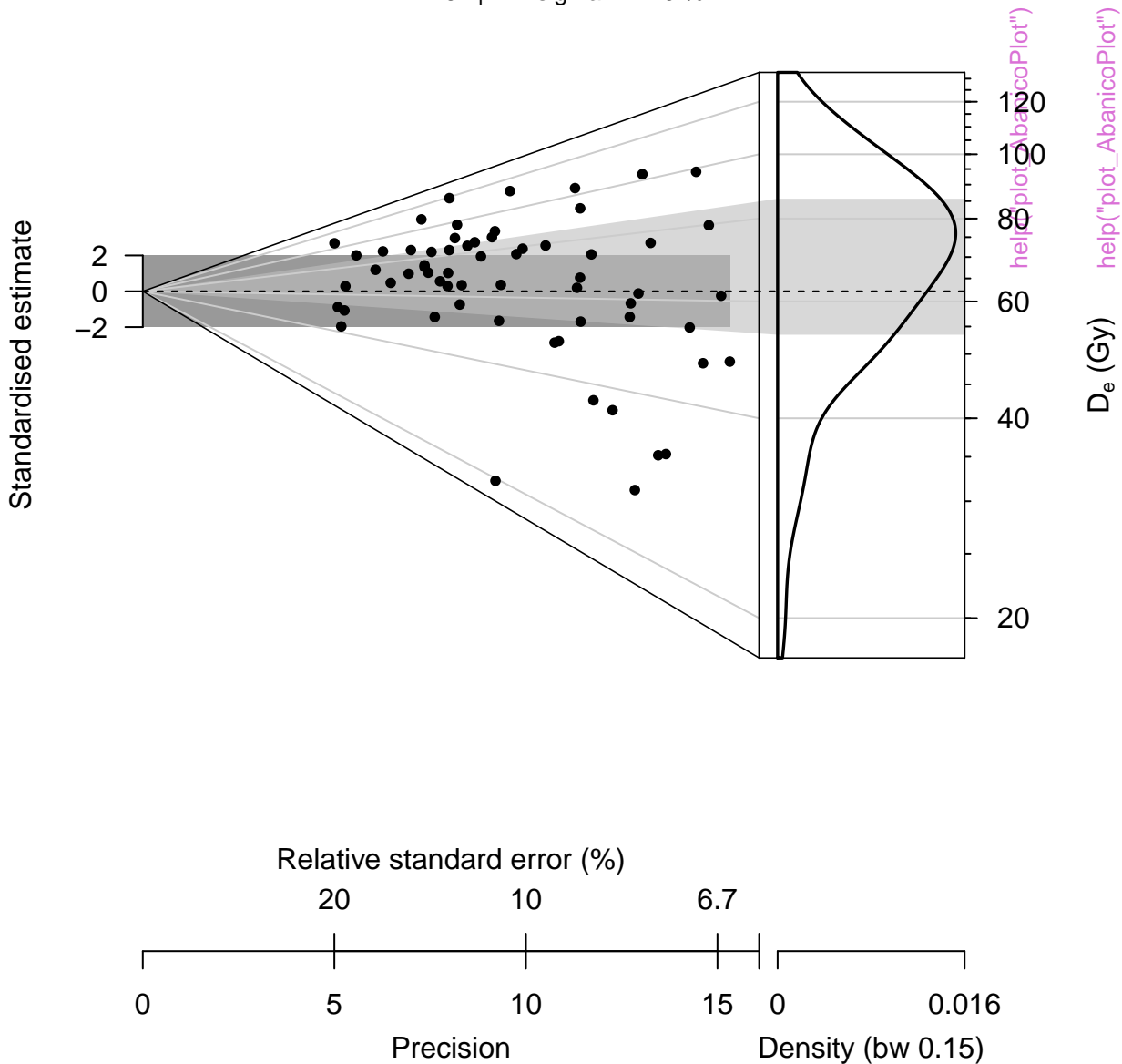
n = 62





# D<sub>e</sub> distribution

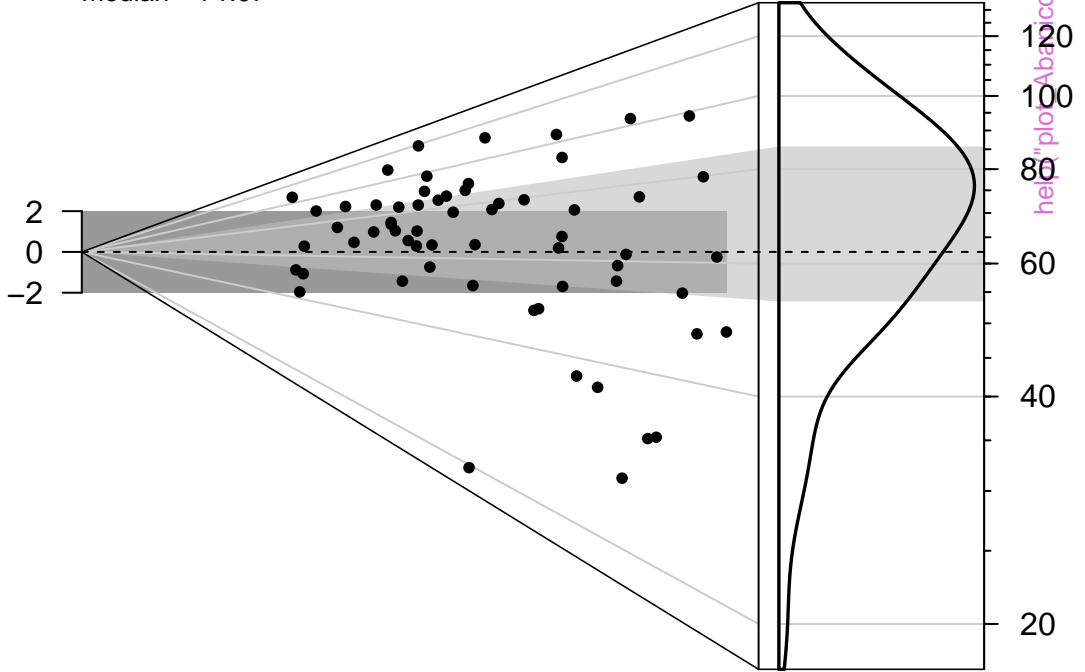
n = 62 | in 2 sigma = 41.9 %



# D<sub>e</sub> distribution

weighted mean = 62.16  
median = 71.07

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

Precision

10

15

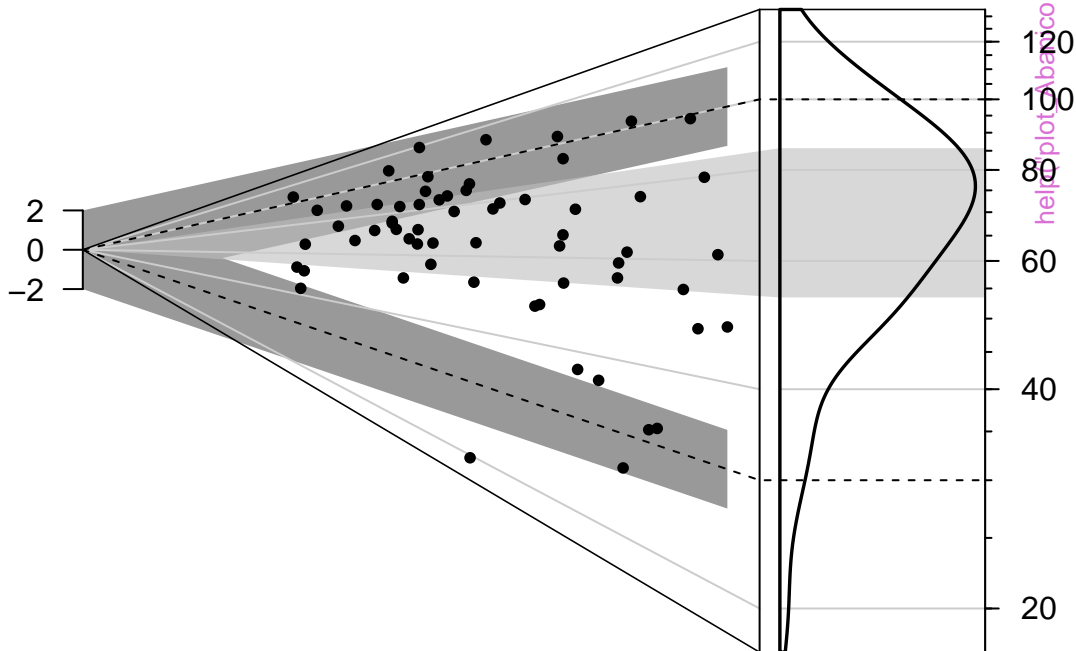
Density (bw 0.15)

0.016

# $D_e$ distribution

n = 62

Standardised estimate



Relative standard error (%)

20

10

6.7

0

5

Precision

10

15

Density (bw 0.15)

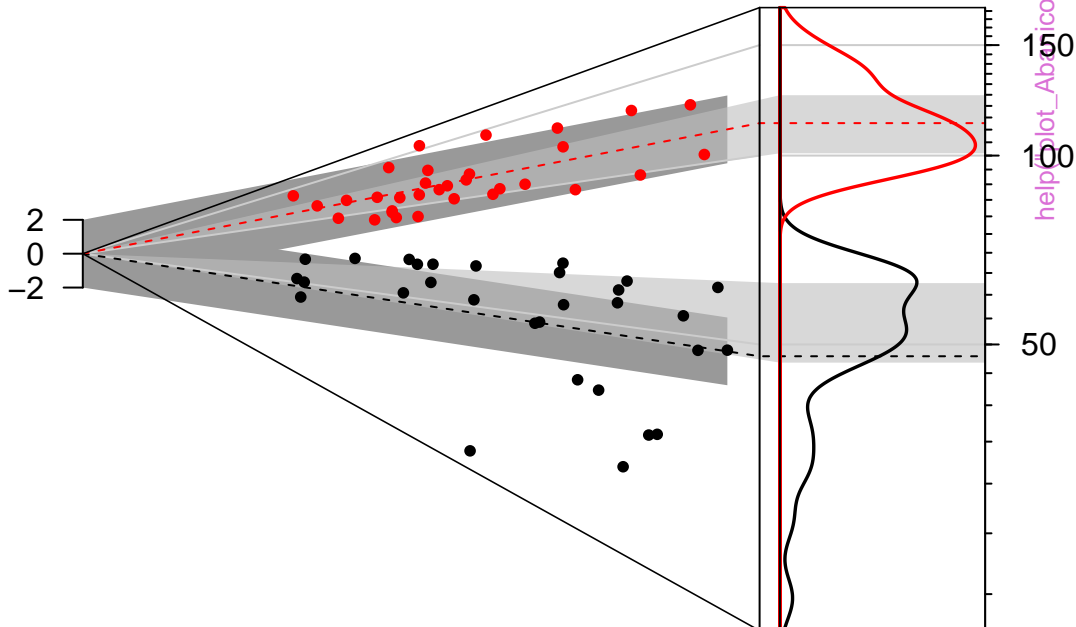
0.016

# D<sub>e</sub> distribution

n = 30

n = 32

Standardised estimate



D<sub>e</sub> (Gy)

help("plot\_AbanicoPlot")

Relative standard error (%)

20

10

6.7

0

5

10

15

Density (bw 0.074)

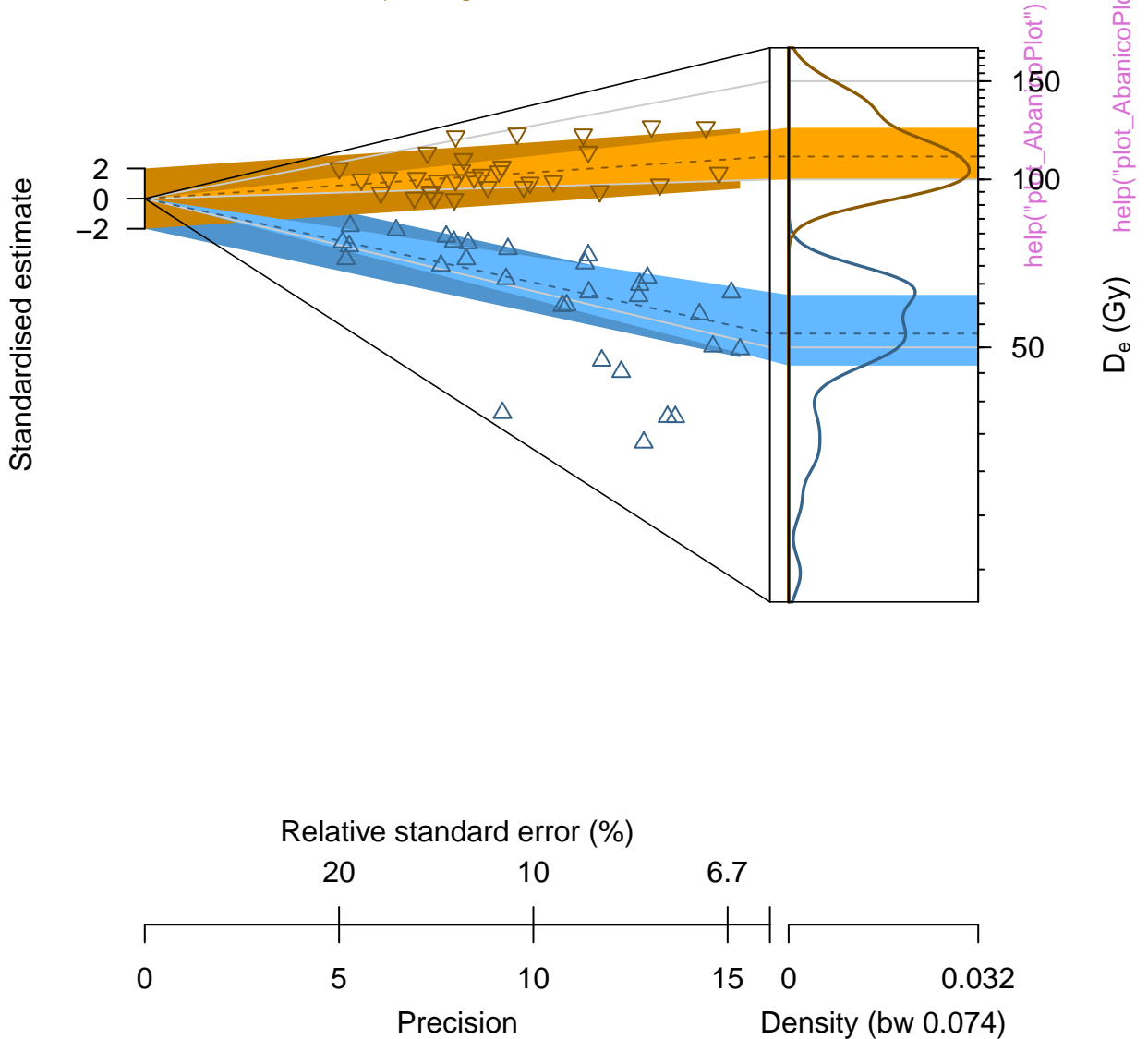
Precision

0.032

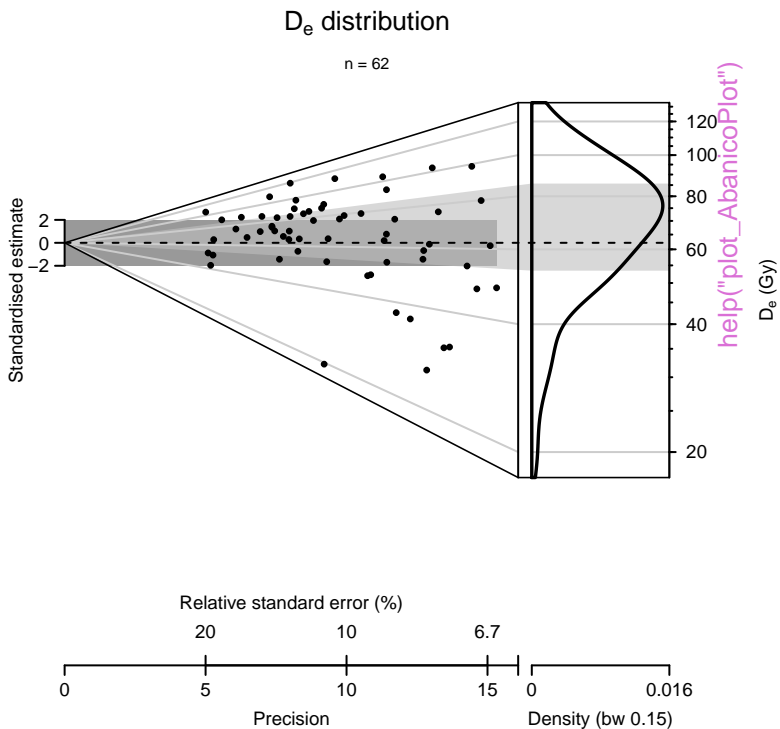
# D<sub>e</sub> distribution

n = 30 | in 2 sigma = 70 % median = 52.94

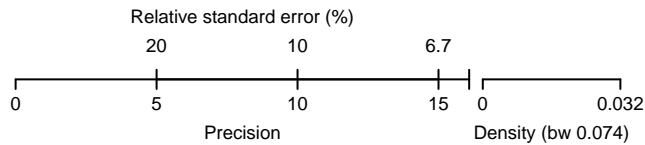
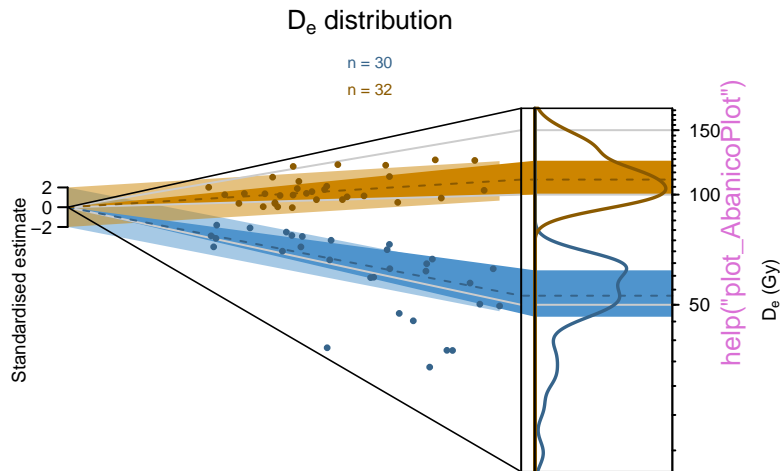
n = 32 | in 2 sigma = 84.4 % median = 109.93







`help("plot_AbanicoPlot")`



`help("plot_AbanicoPlot")`

# Dose recovery test

Example data



# Dose recovery test



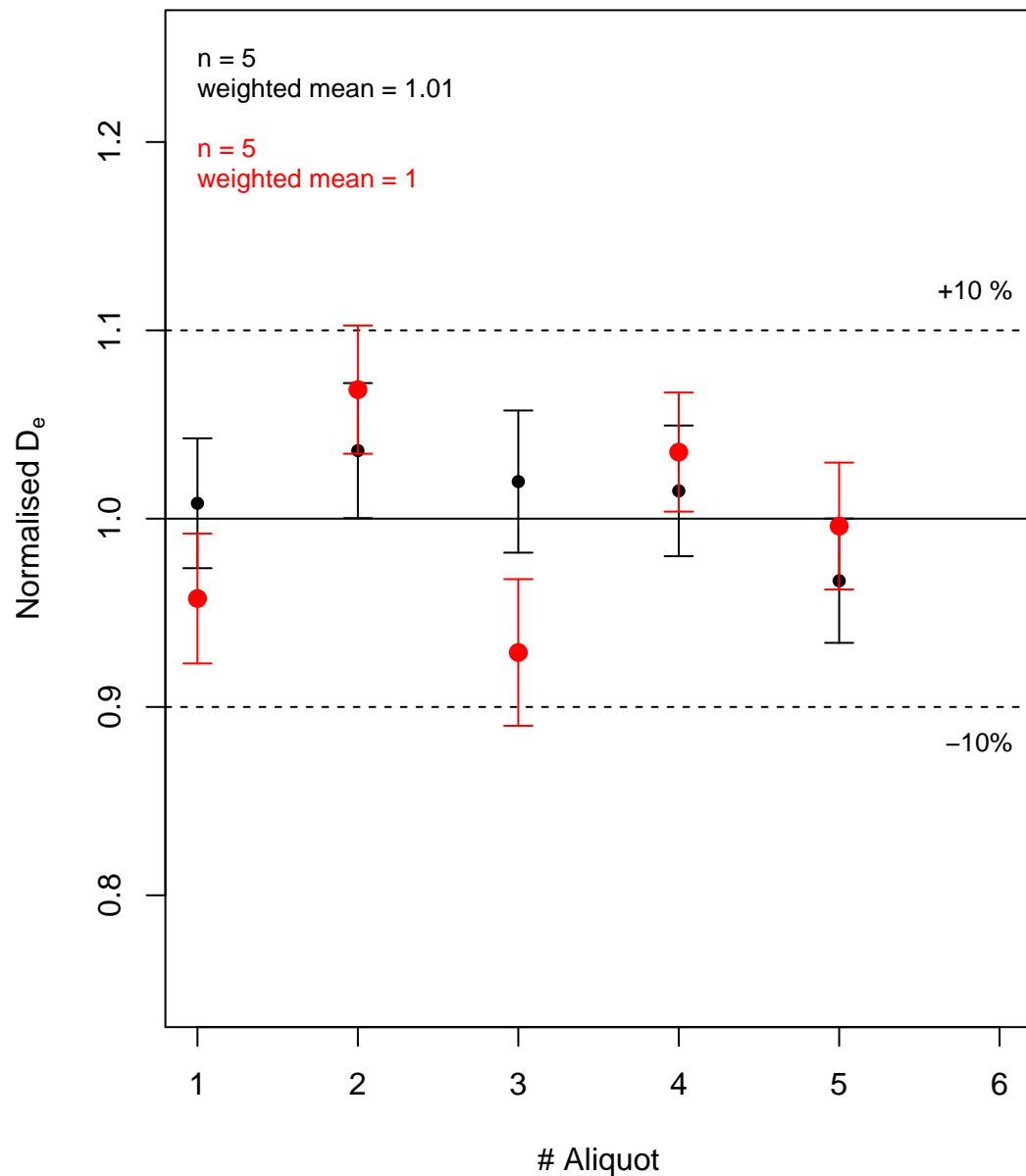
# Dose recovery test



# Dose recovery test



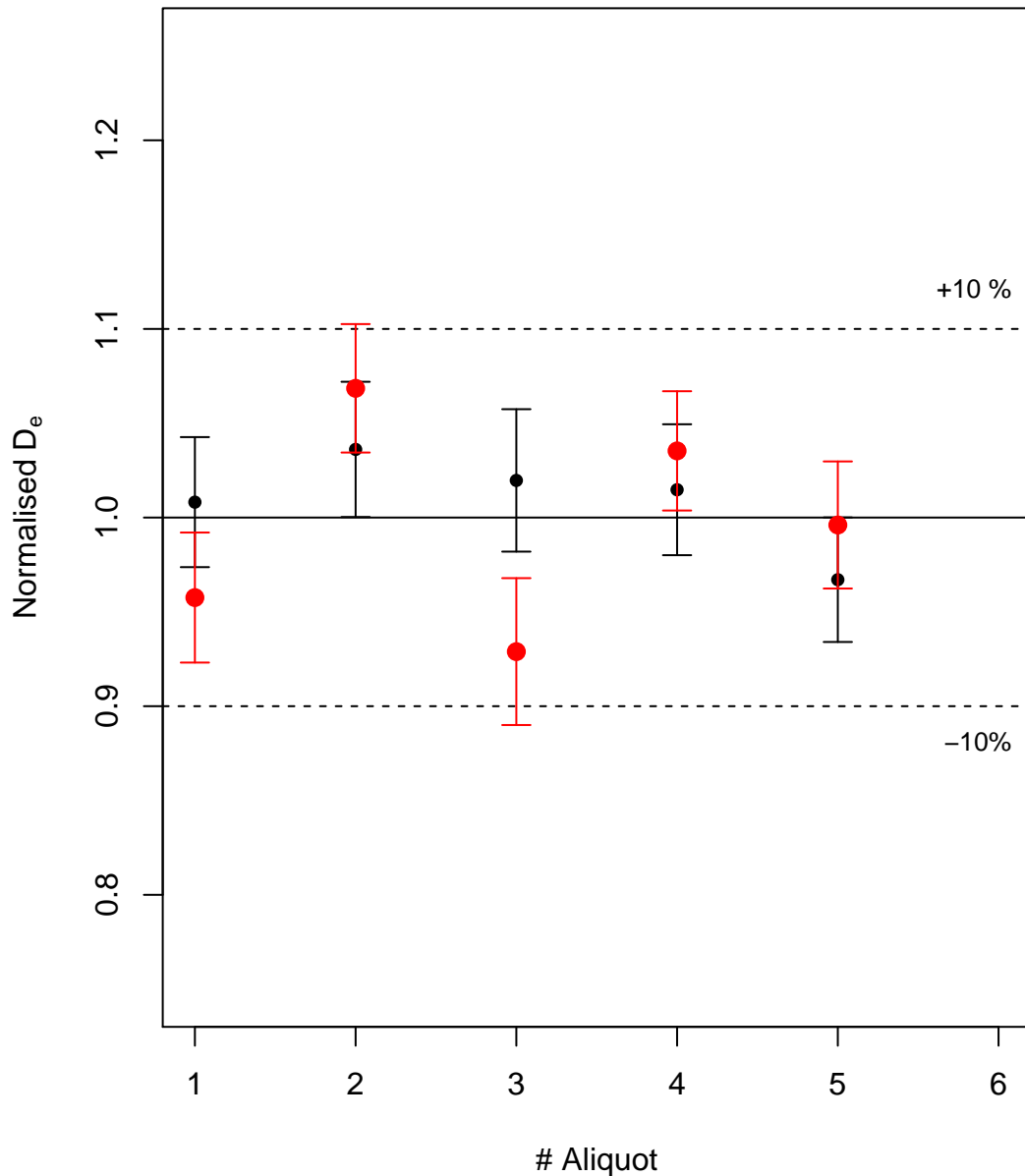
# Dose recovery test



# Dose recovery test

| n = 5 | weighted mean = 1.01 |

| n = 5 | weighted mean = 1 |





# Dose recovery test



# Dose recovery test

Example data



# Dose recovery test

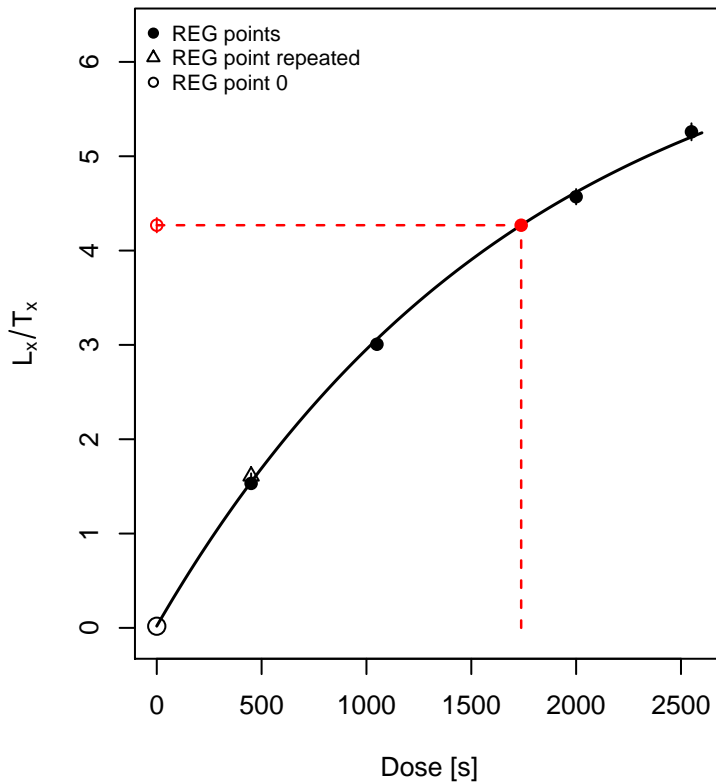


# Dose recovery test



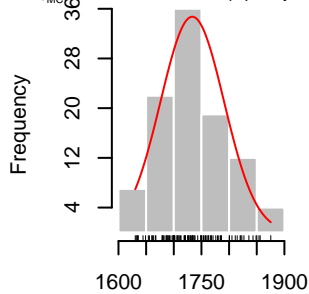
# Growth curve

$D_e = 1737.88 \pm 57.45$  | fit: EXP

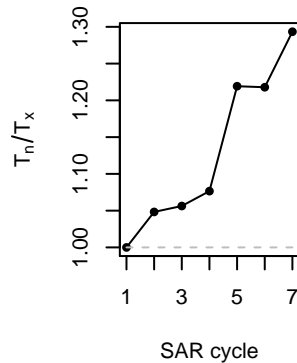


$D_e$  from MC simulation

$D_{eMC} = 1733.43 \pm 57.45$  | quality = 99.7 %

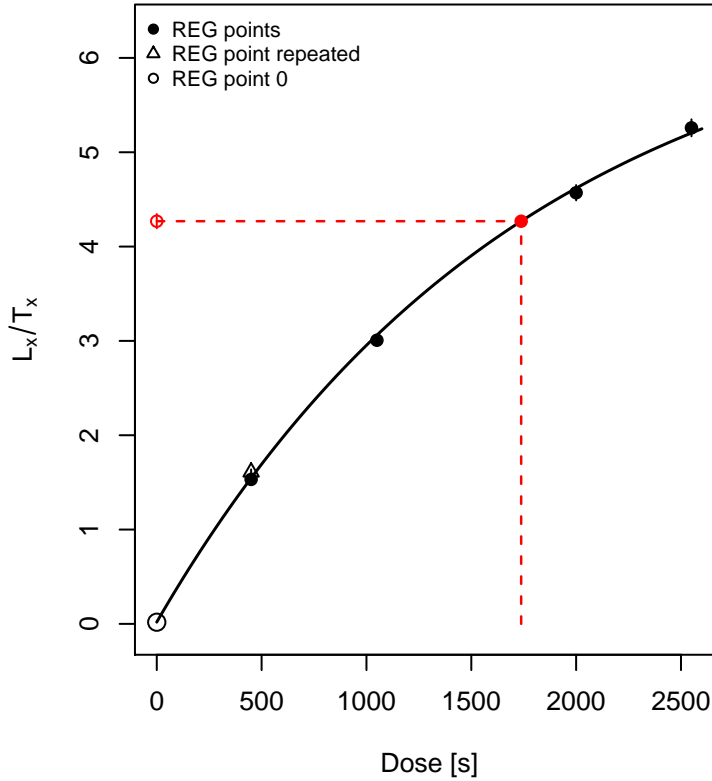


Test dose response



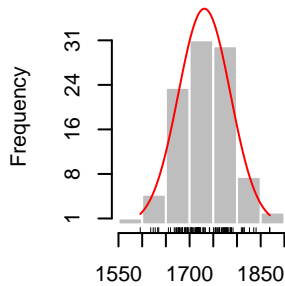
# Growth curve

$D_e = 1737.88 \pm 54.9$  | fit: EXP

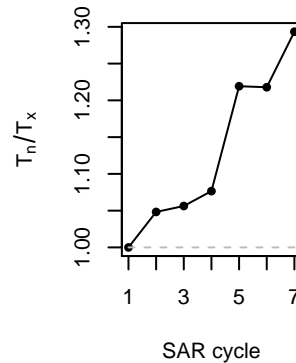


$D_e$  from MC simulation

$D_{eMC} = 1731.23 \pm 54.9$  | quality = 99.6 %

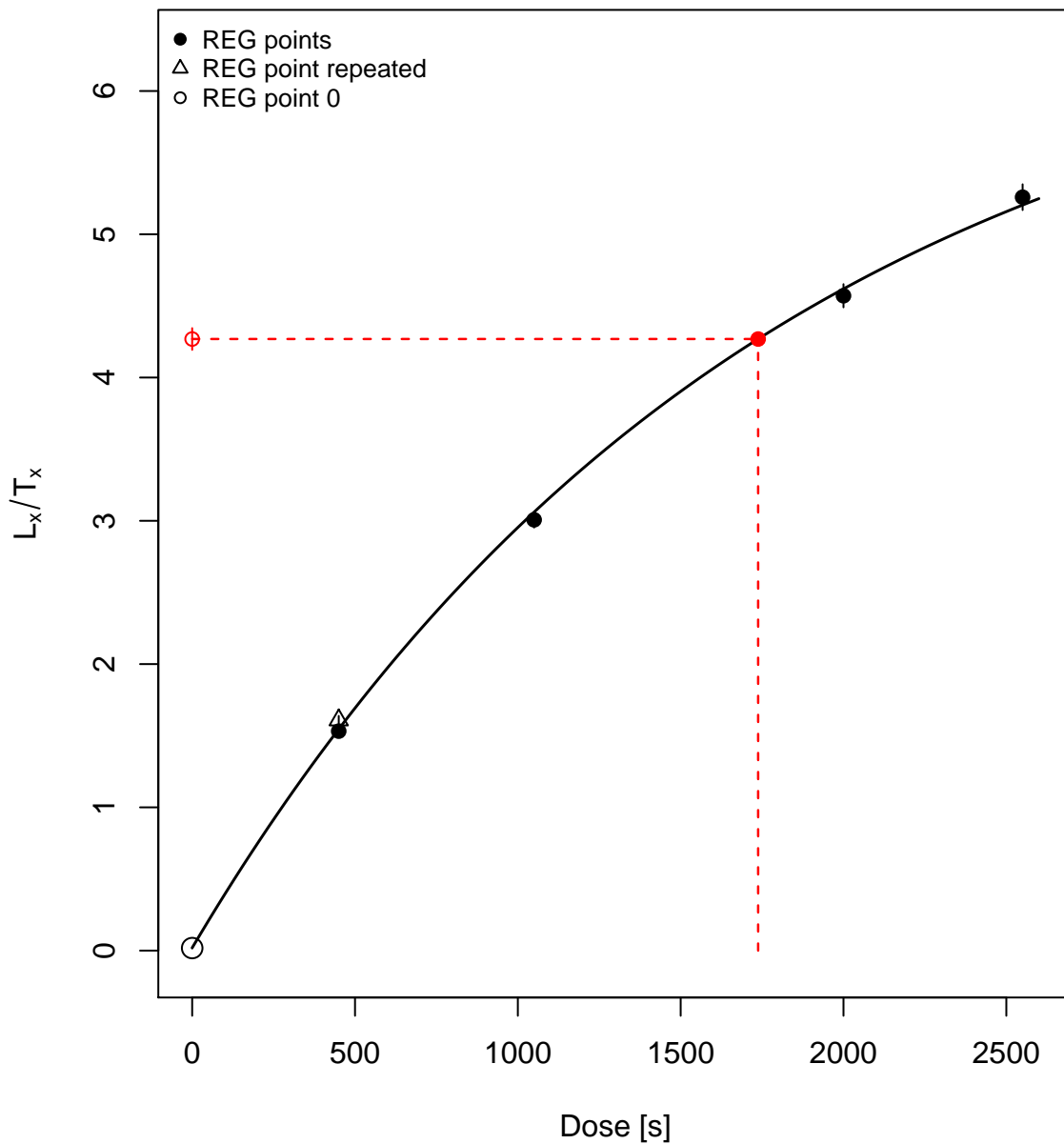


Test dose response



# Growth curve

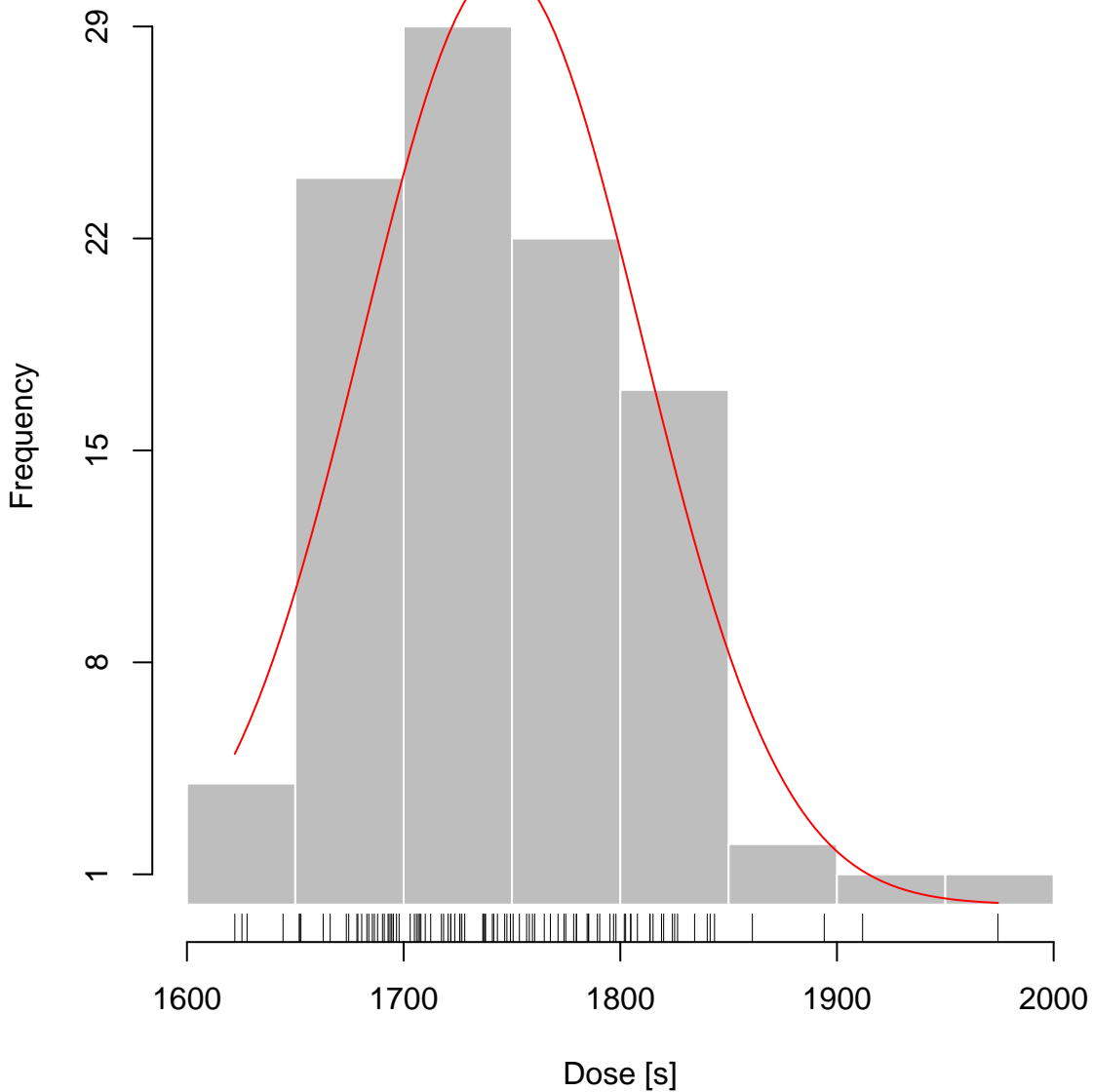
$D_e = 1737.88 \pm 64.53$  | fit: EXP



[help\("plot\\_GrowthCurve"\)](#)

# D<sub>e</sub> from MC simulation

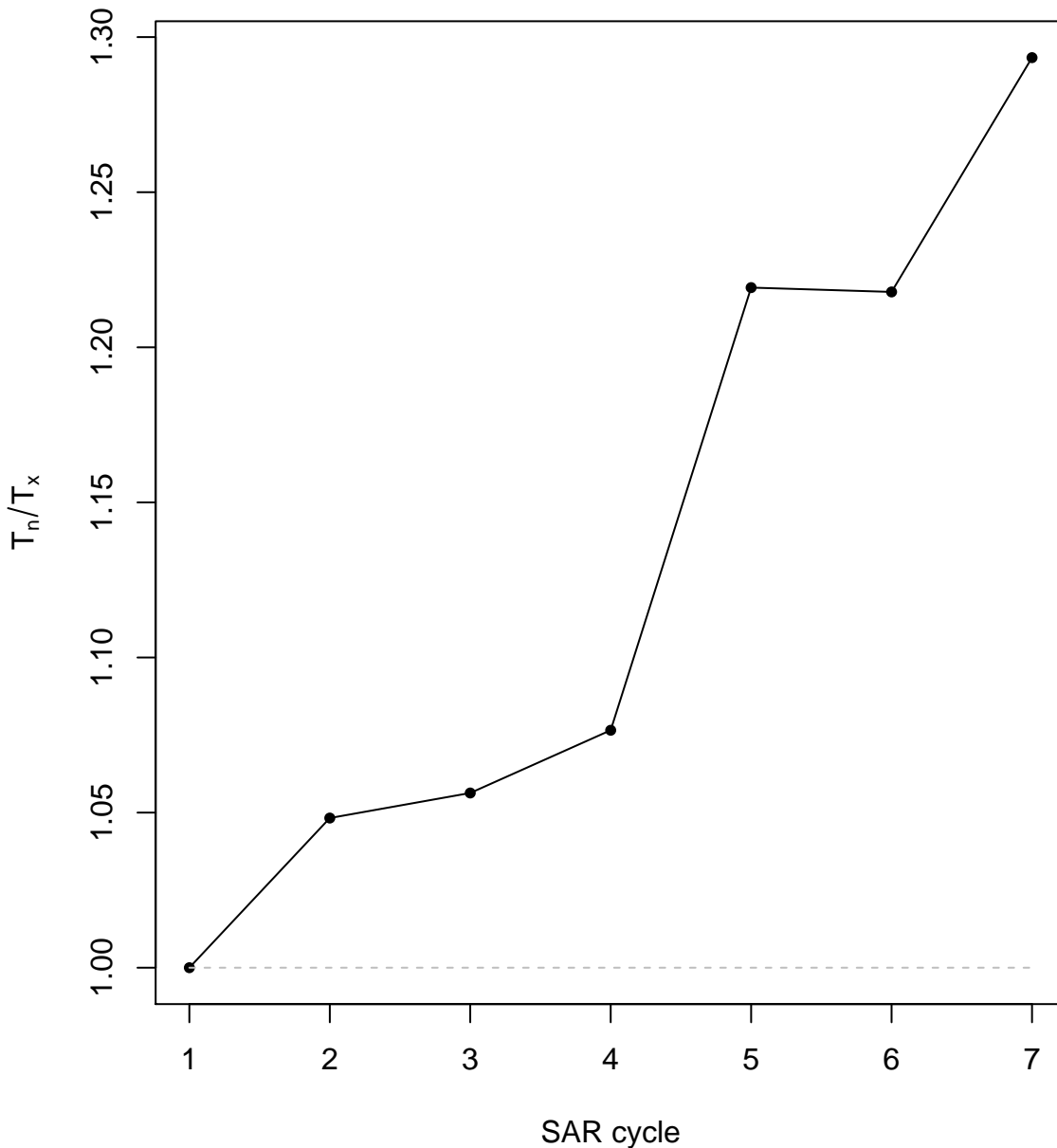
D<sub>eMC</sub> = 1745.42 ± 64.53 | quality = 99.6 %



help("plot\_GrowthCurve")

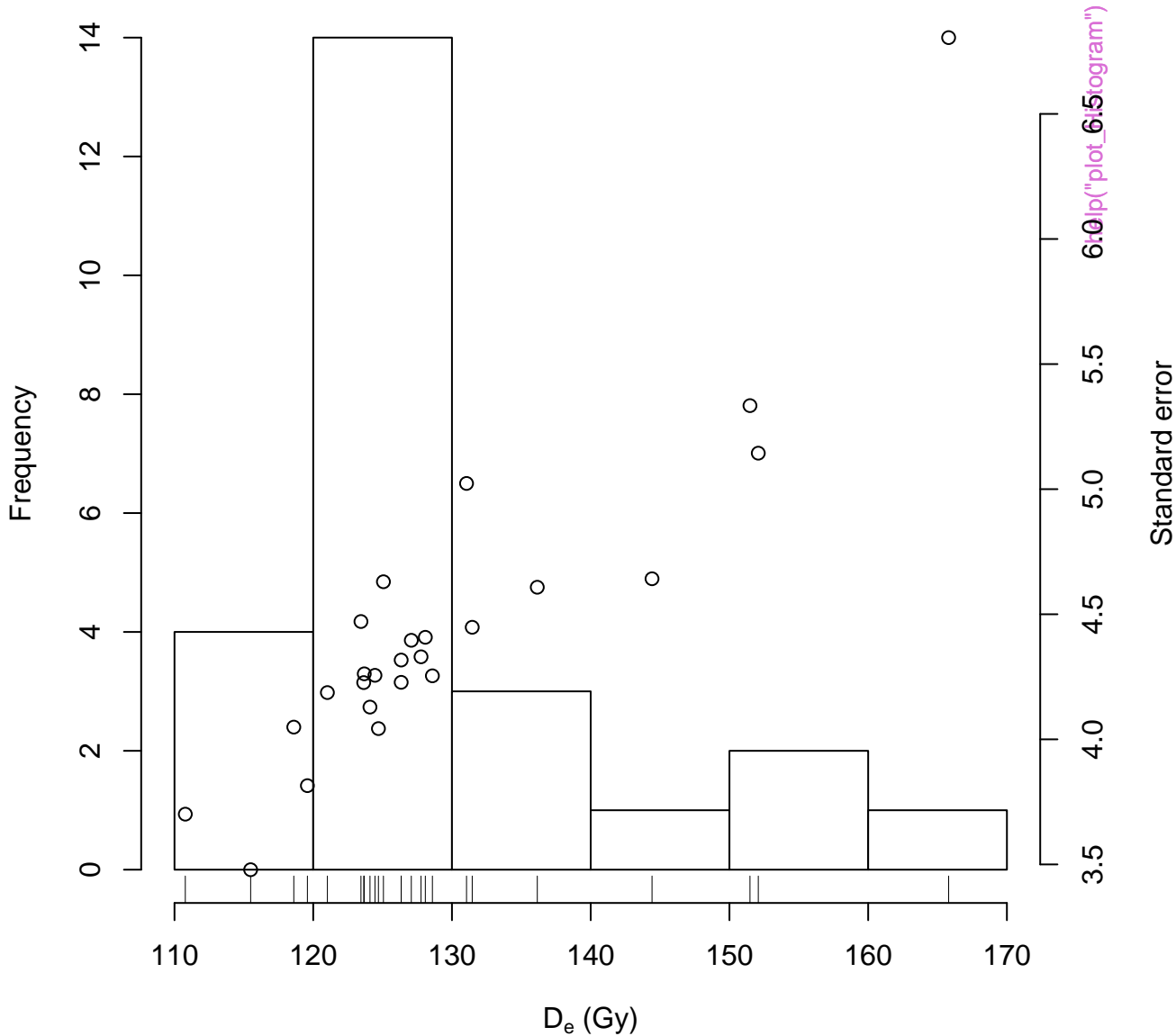


Test dose response



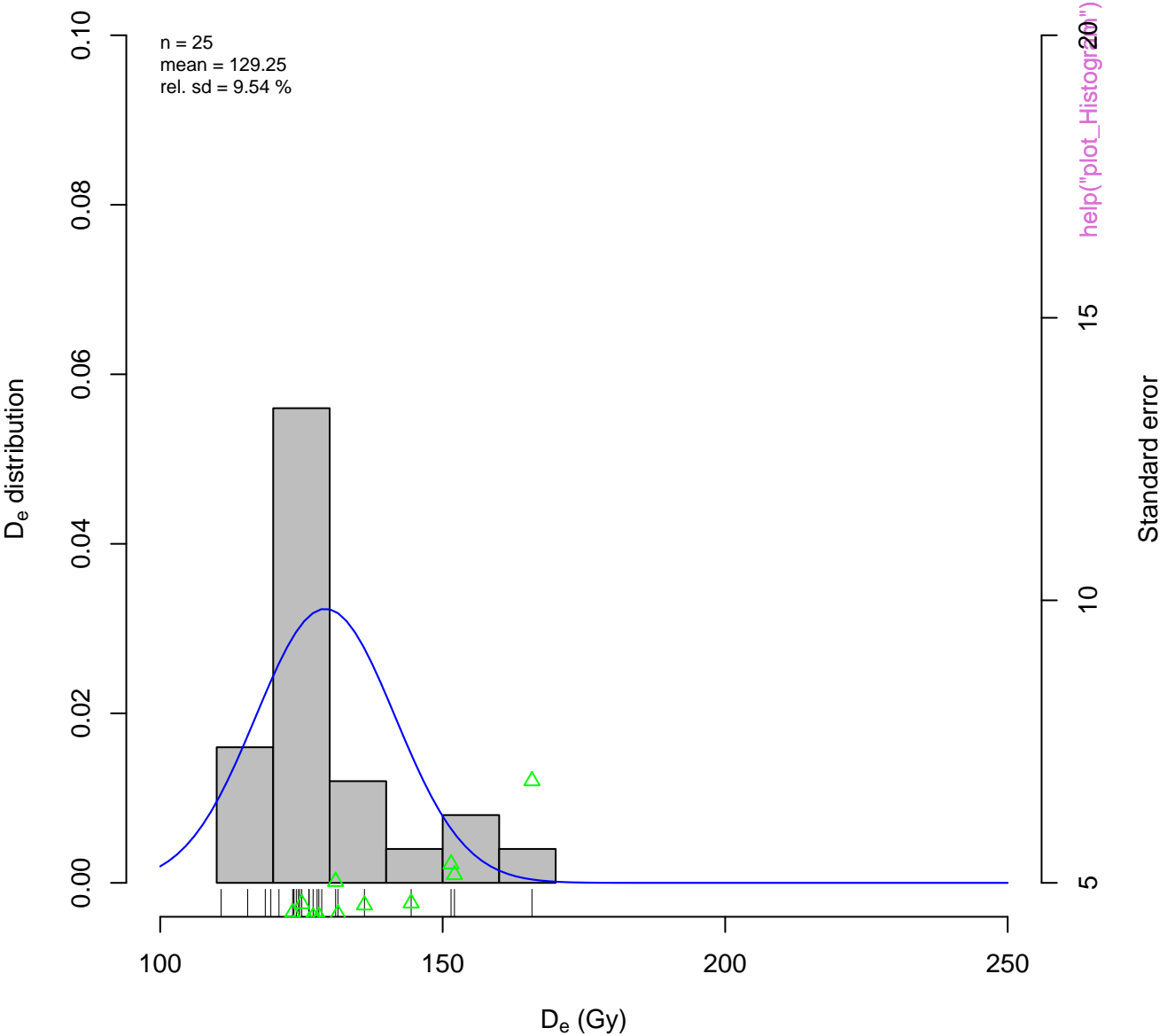
help("plot\_GrowthCurve")

# Histogram



# Histogram of De-values

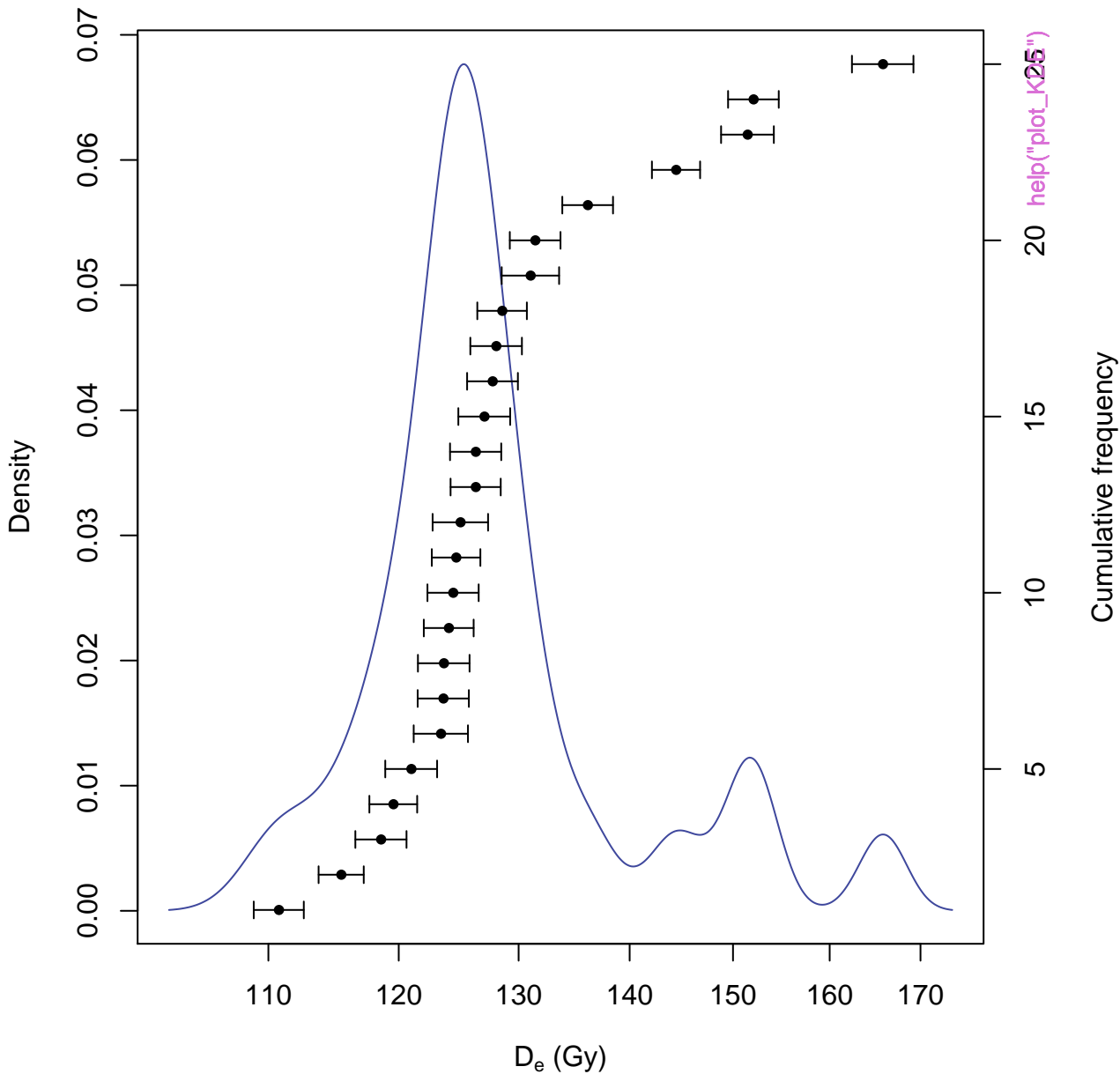
Example data set



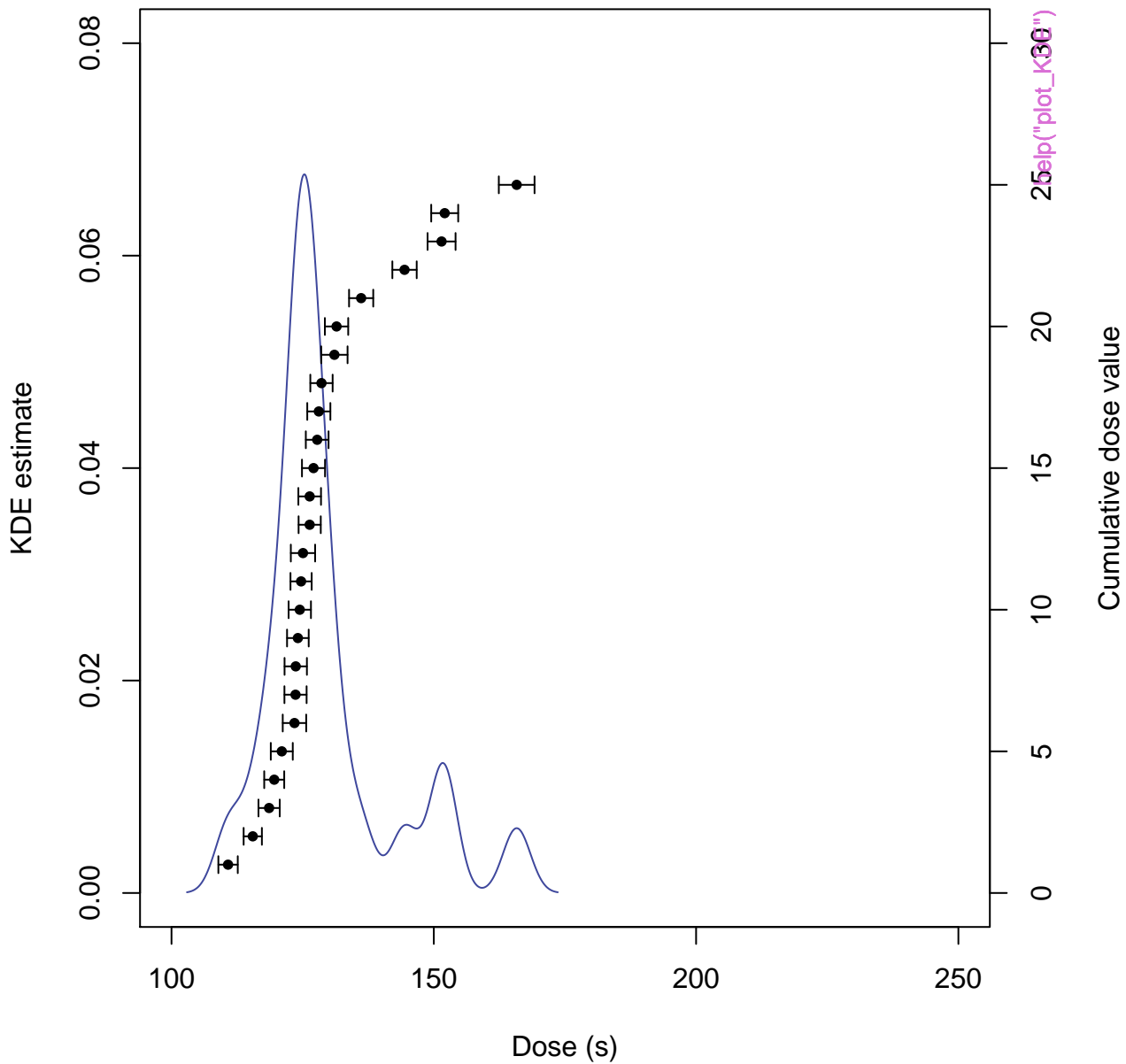
# D<sub>e</sub> distribution



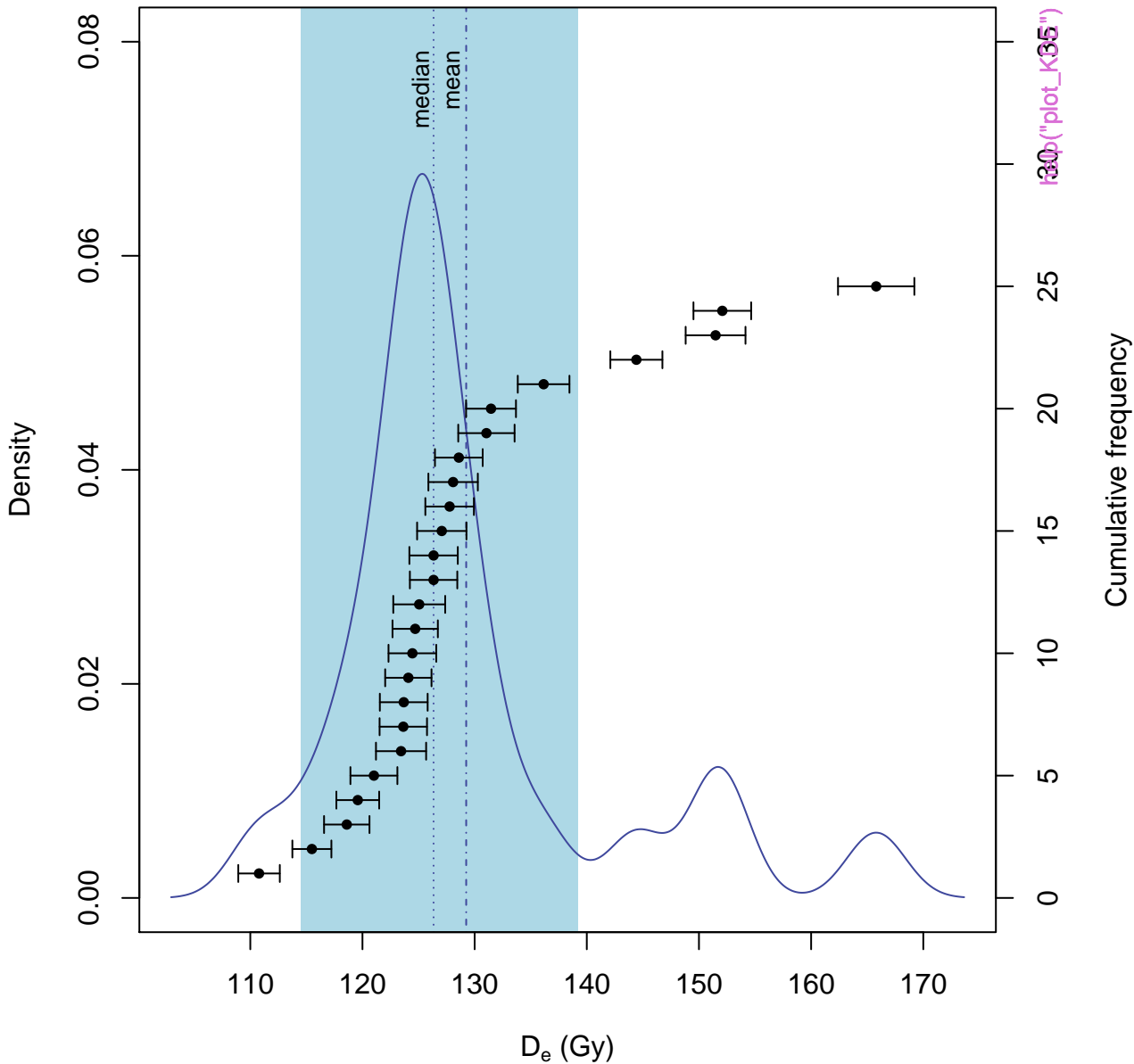
# D<sub>e</sub> distribution



# Dose distribution

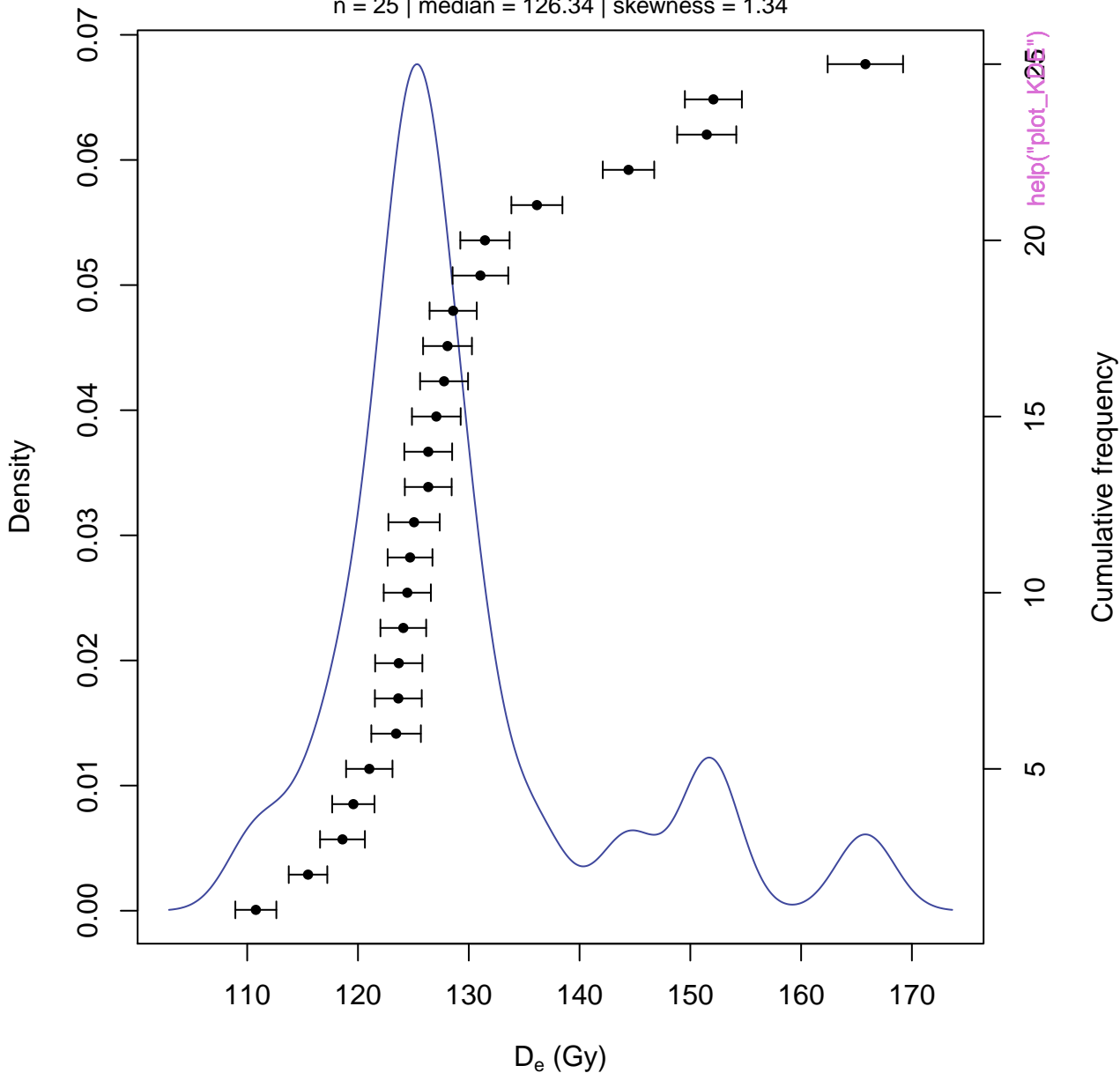


**D<sub>e</sub> distribution**



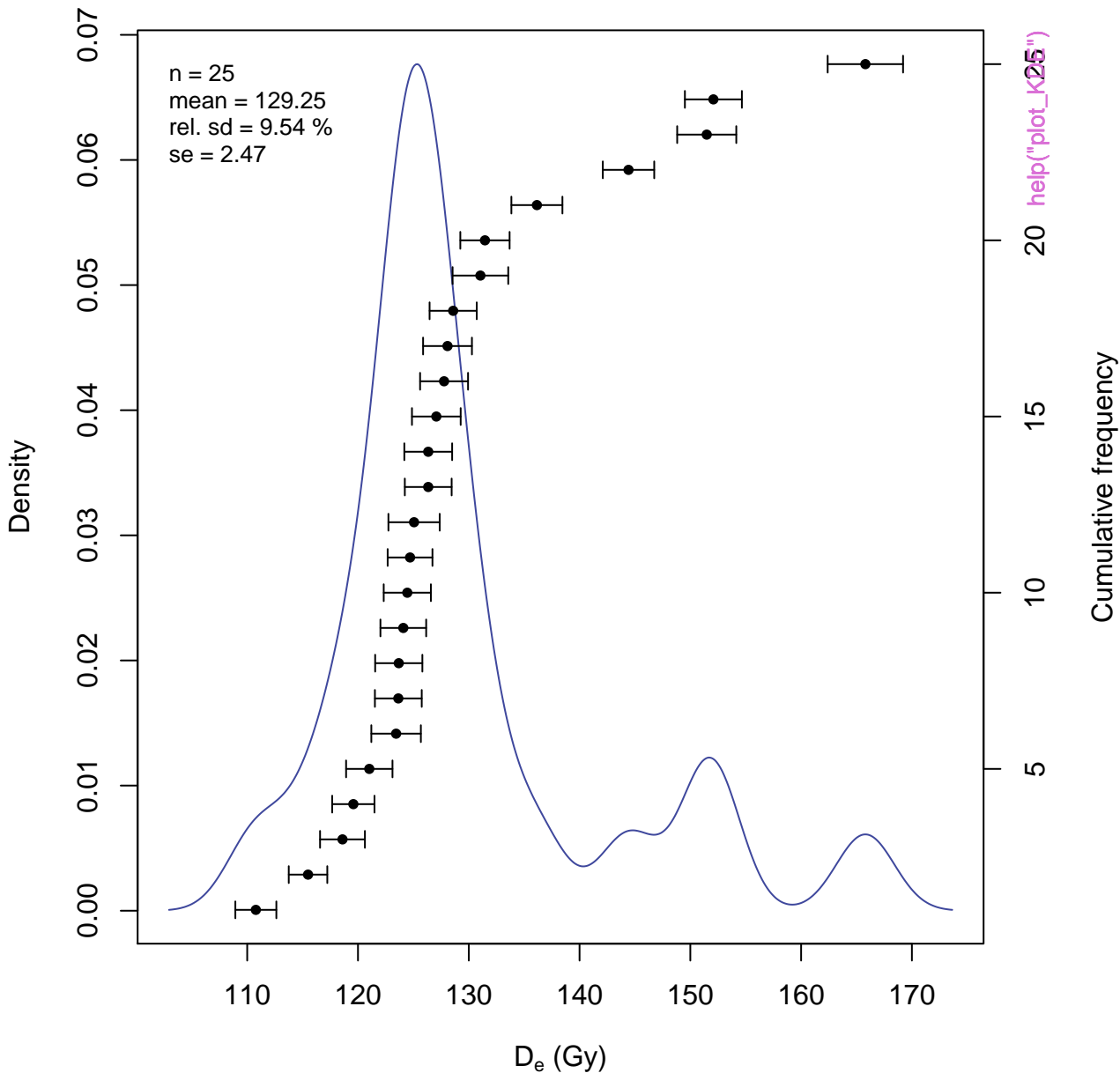
# D<sub>e</sub> distribution

n = 25 | median = 126.34 | skewness = 1.34

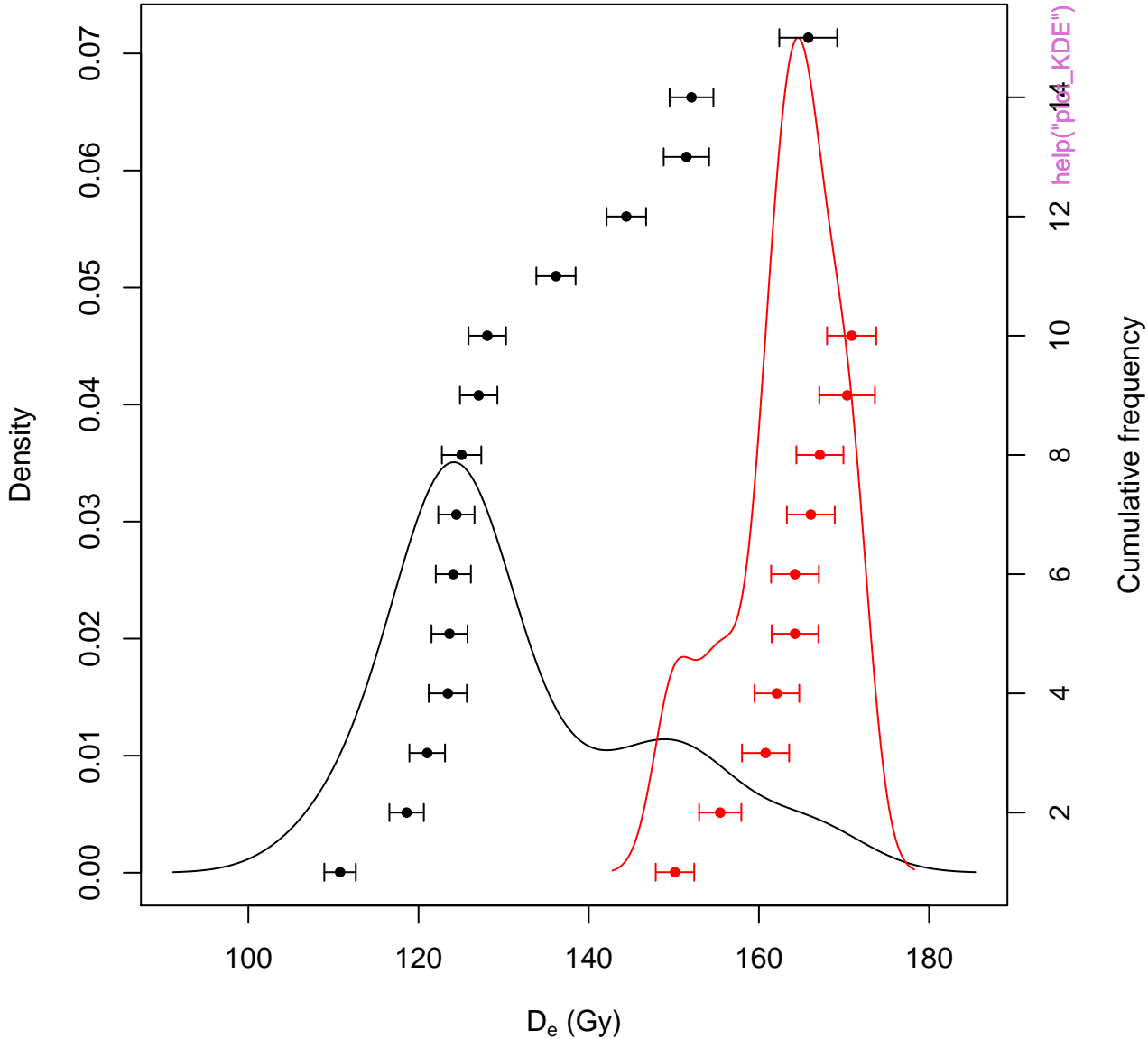




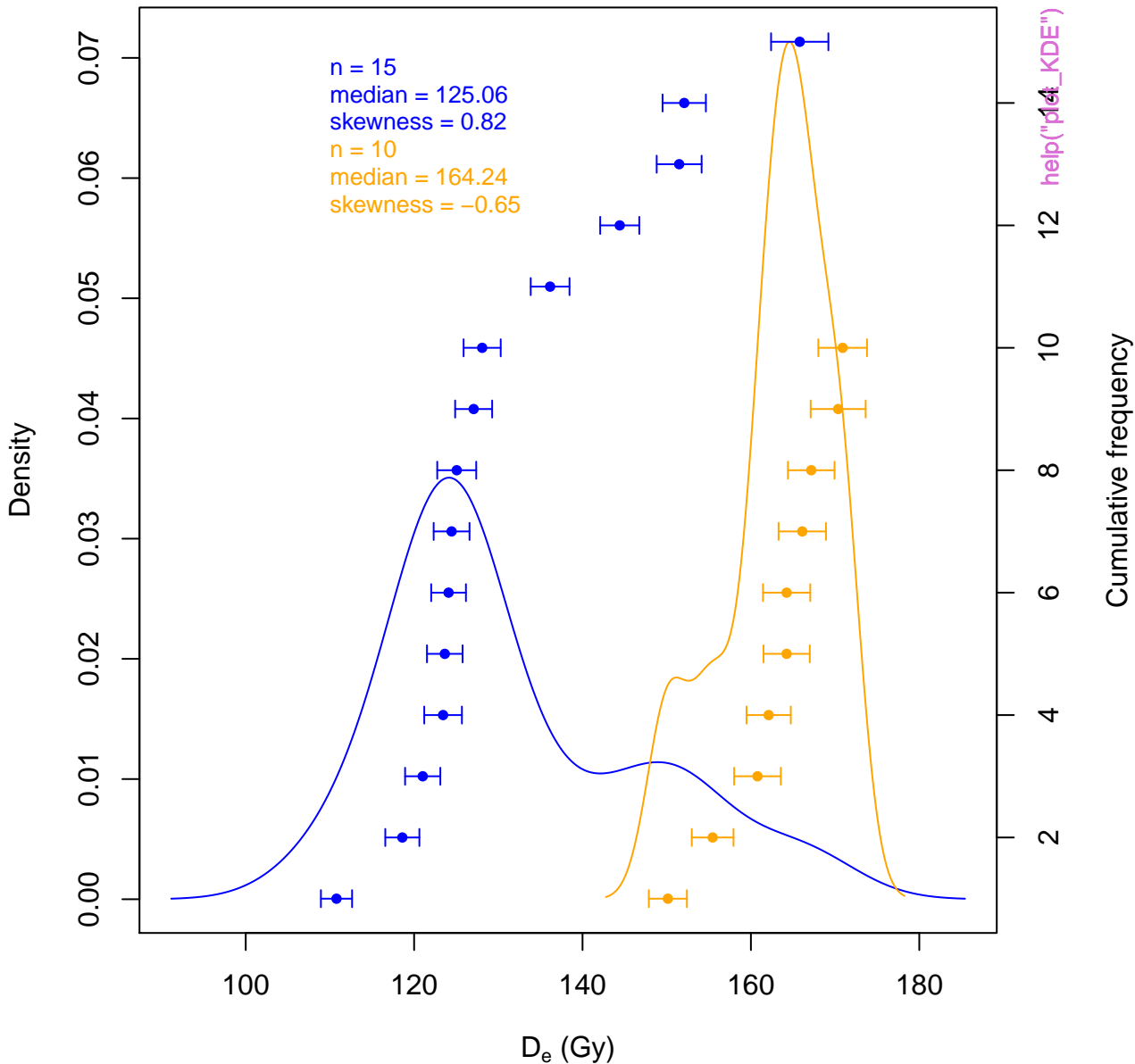
# D<sub>e</sub> distribution



**D<sub>e</sub> distribution**



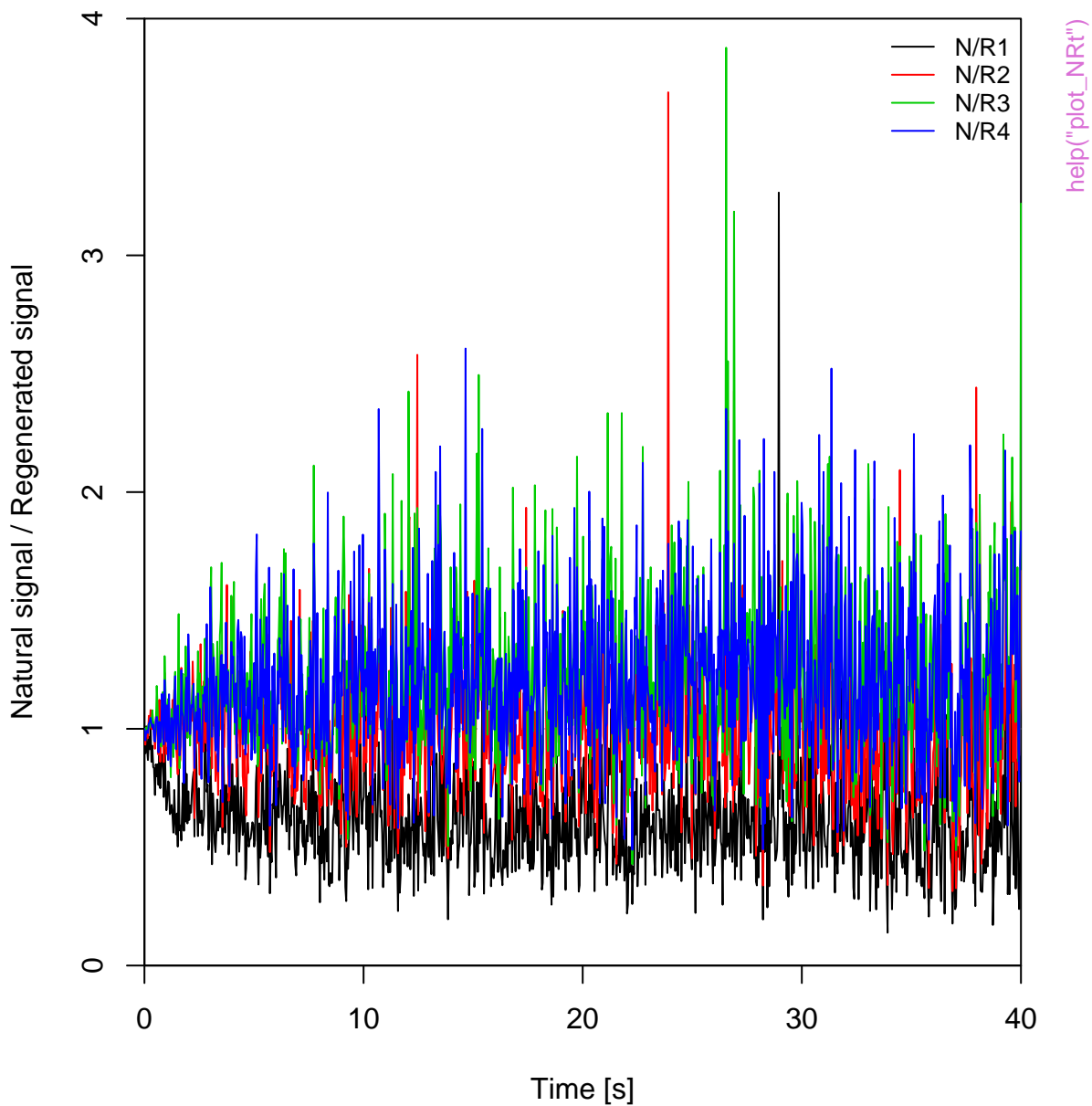
# D<sub>e</sub> distribution



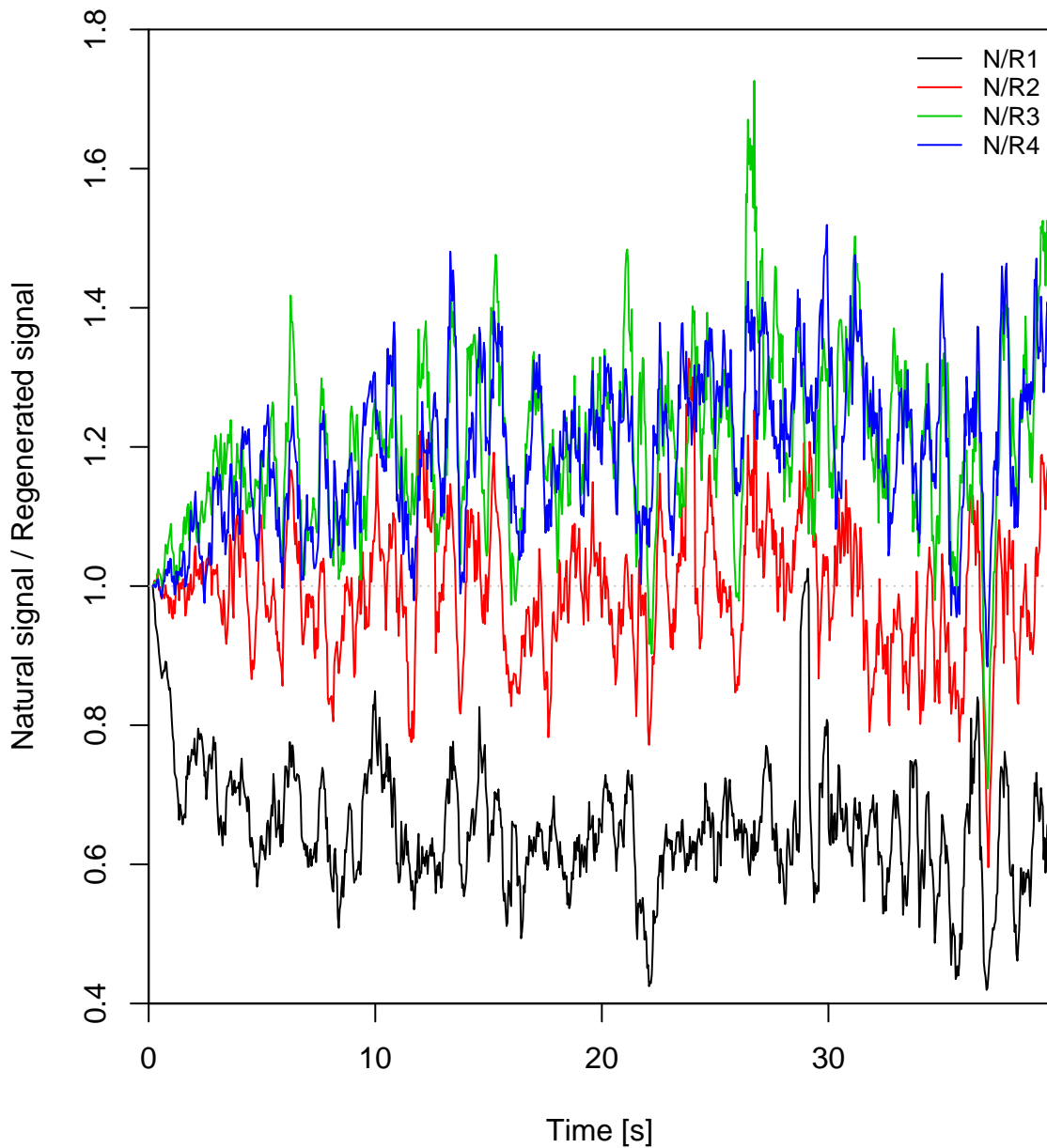
# $D_e$ distribution



NR(t) Plot

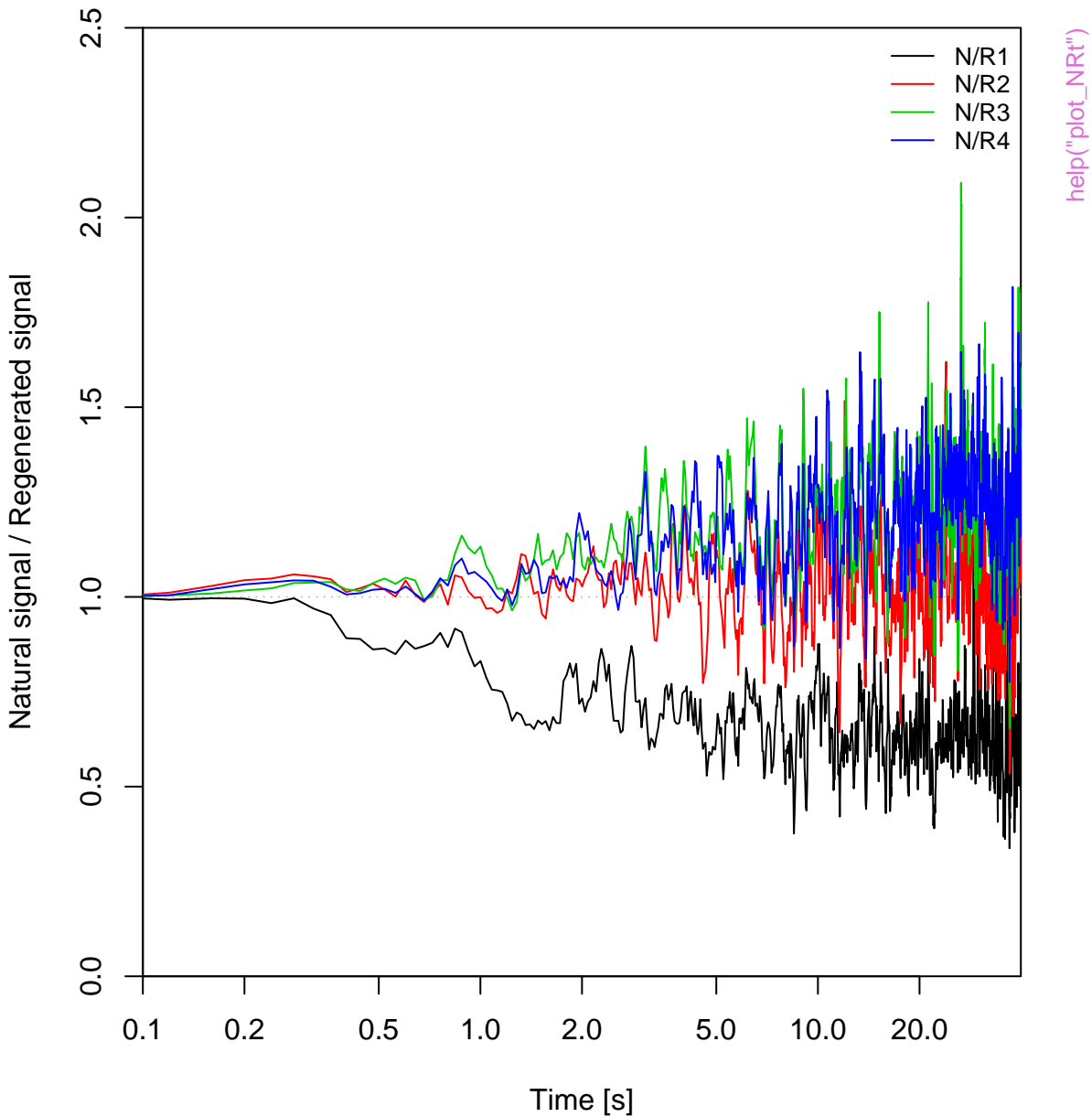


NR(t) Plot

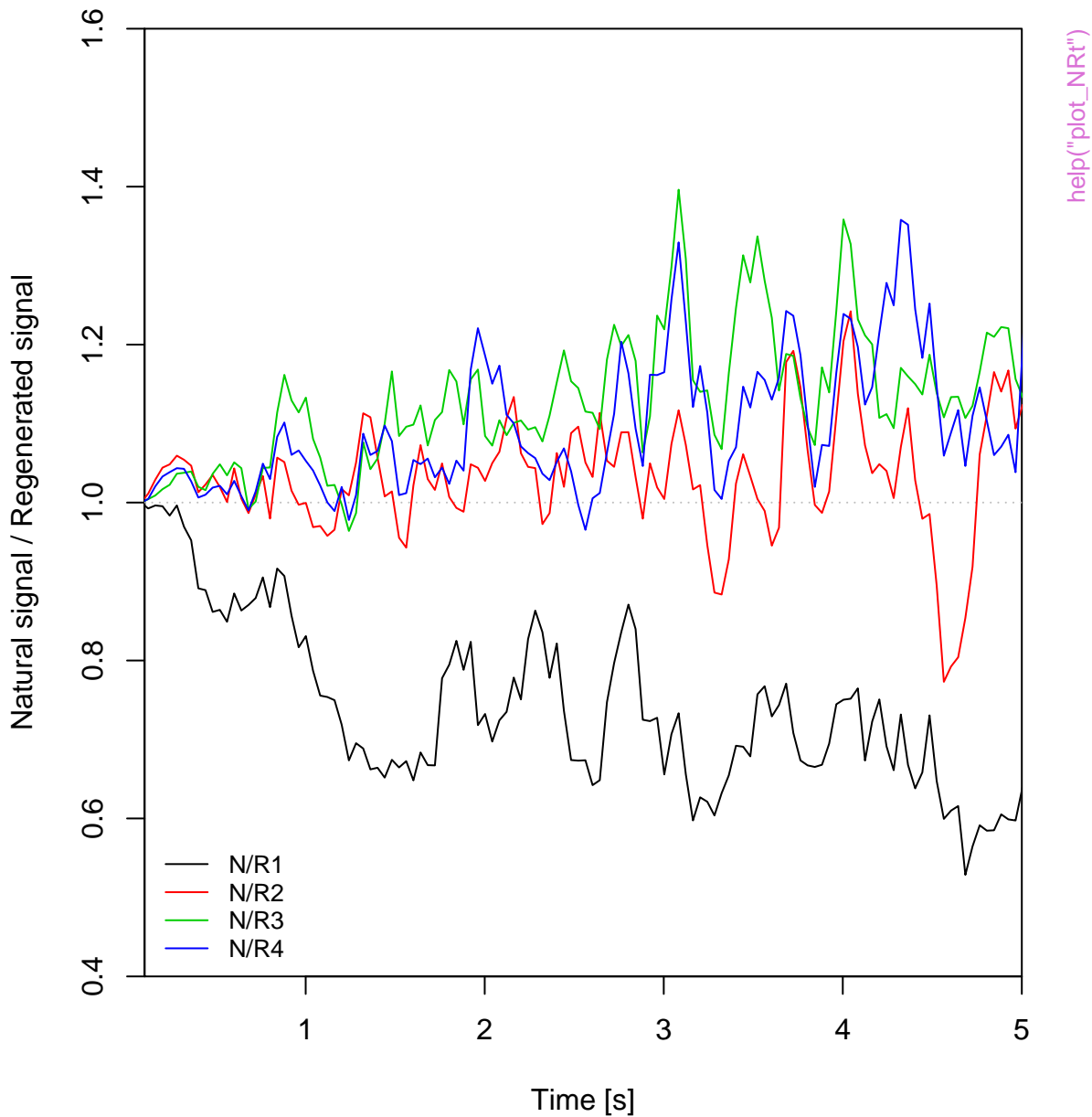


help("plot\_NRt")

NR(t) Plot

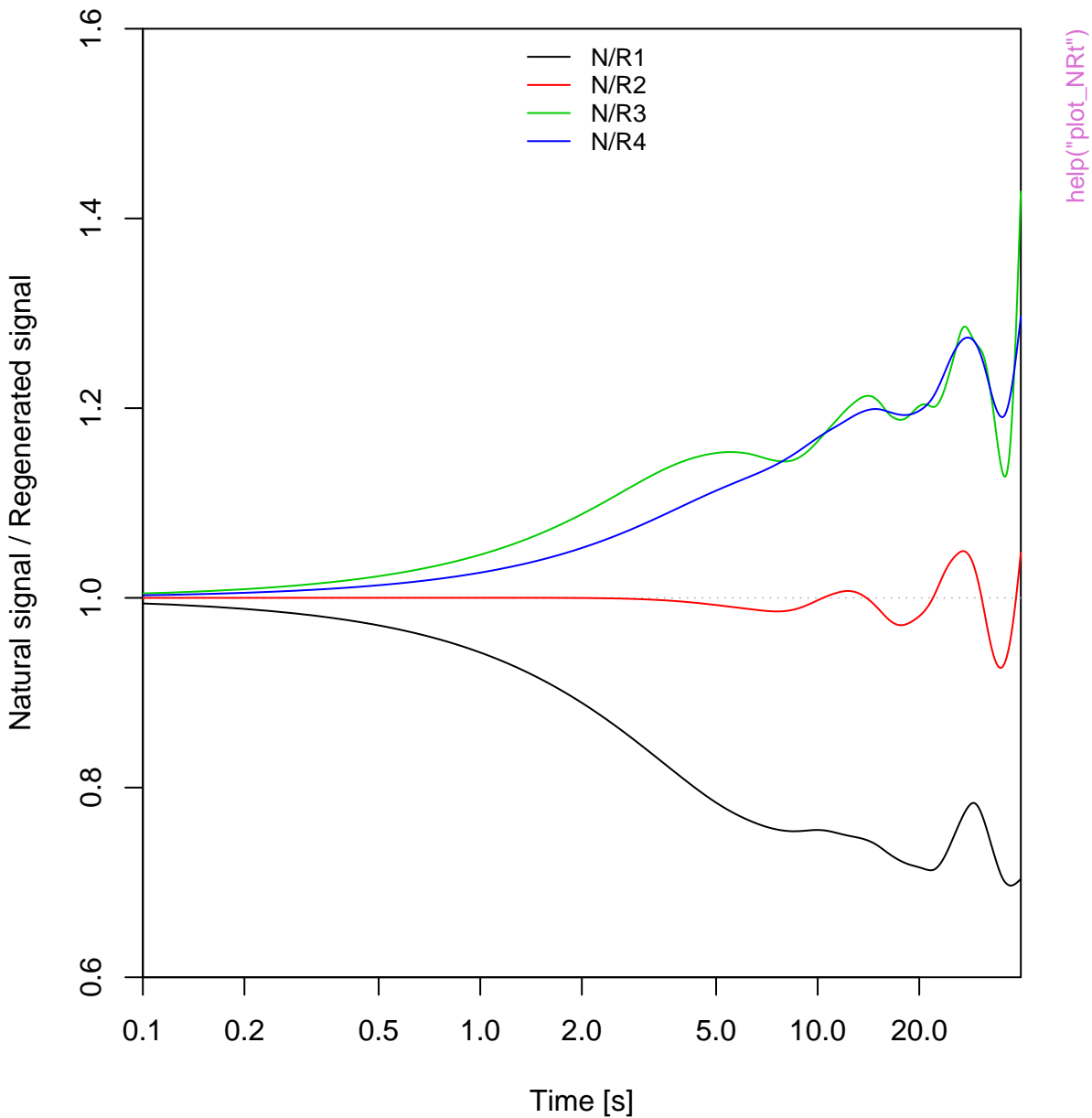


NR(t) Plot

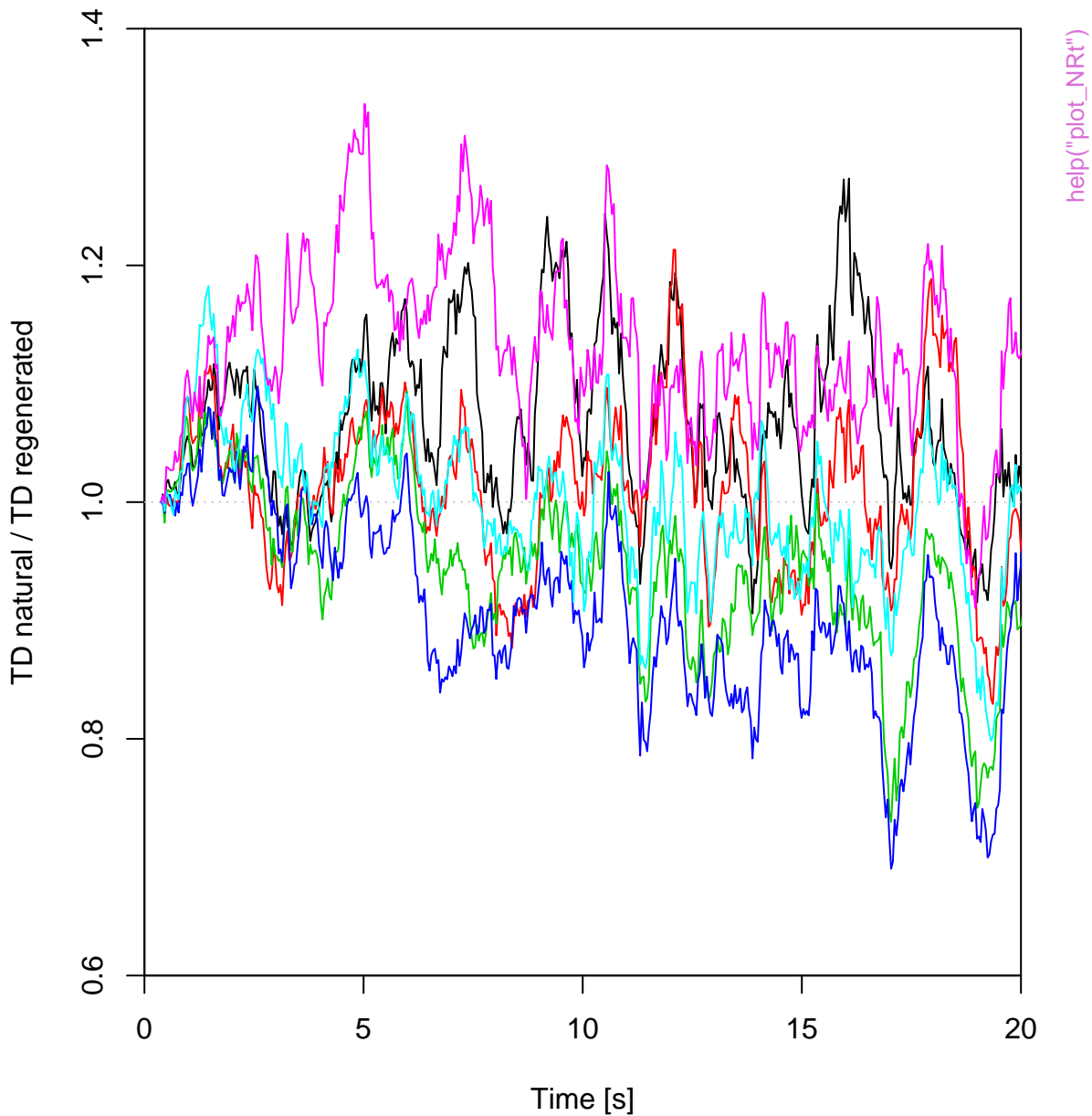


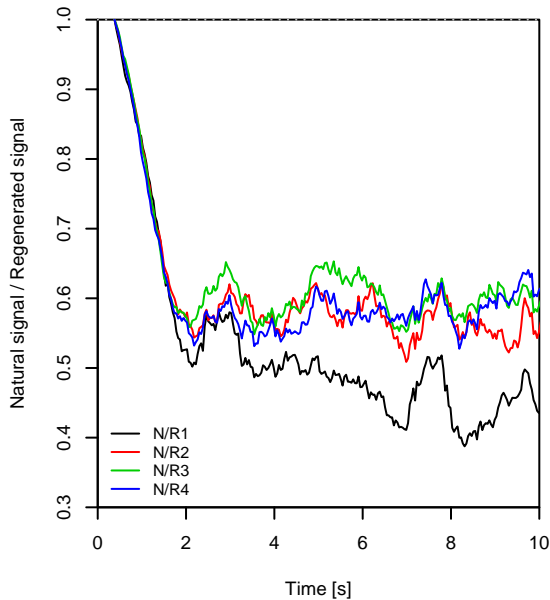
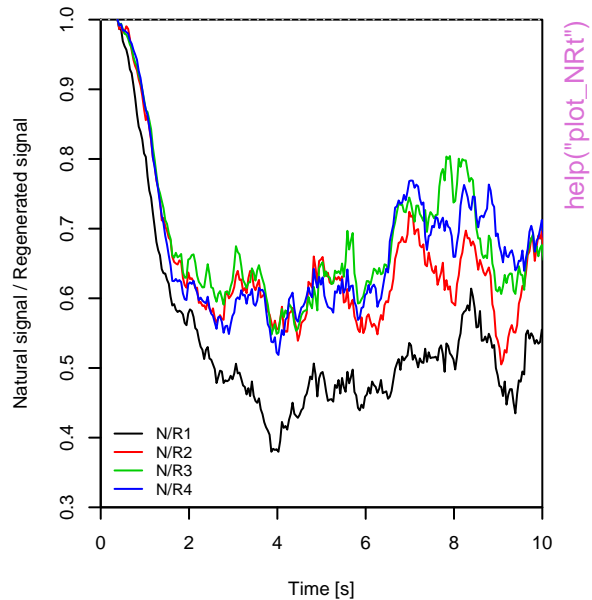


# NR(t) Plot

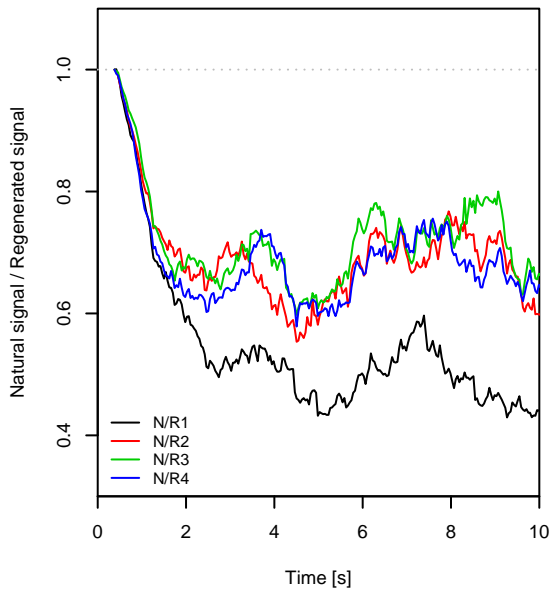
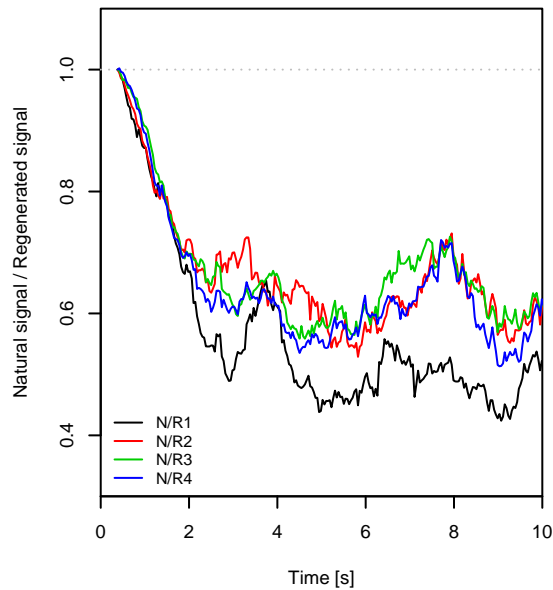


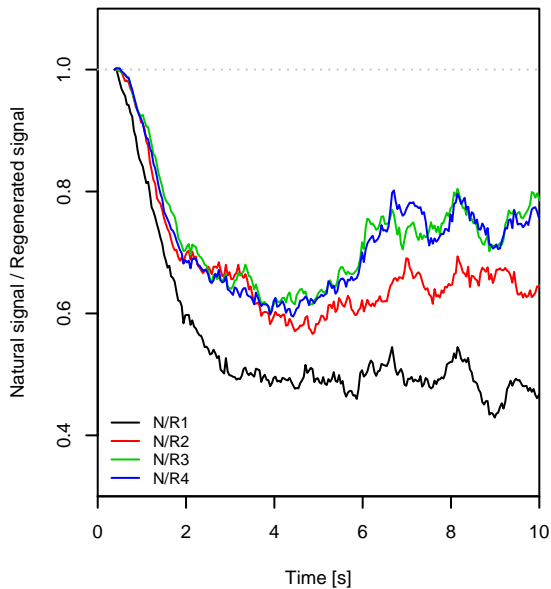
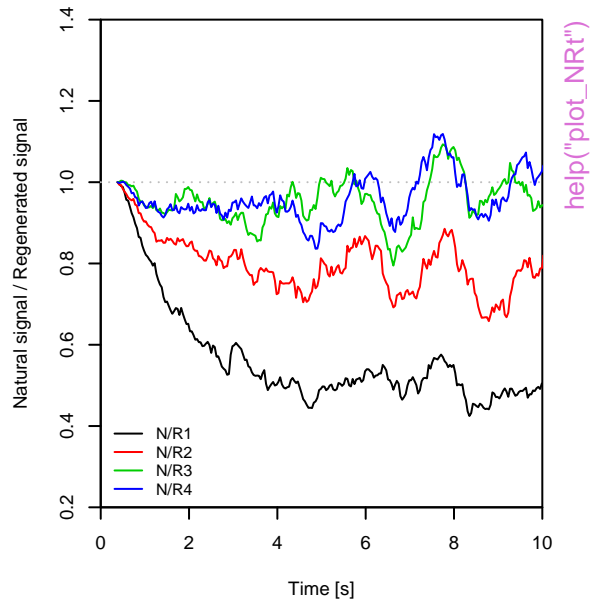
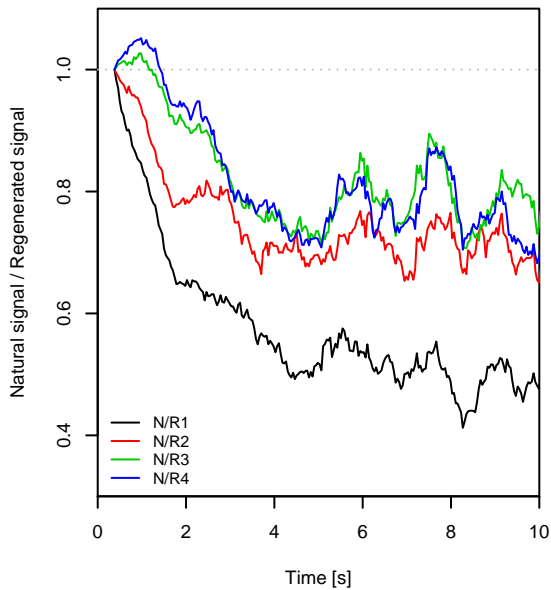
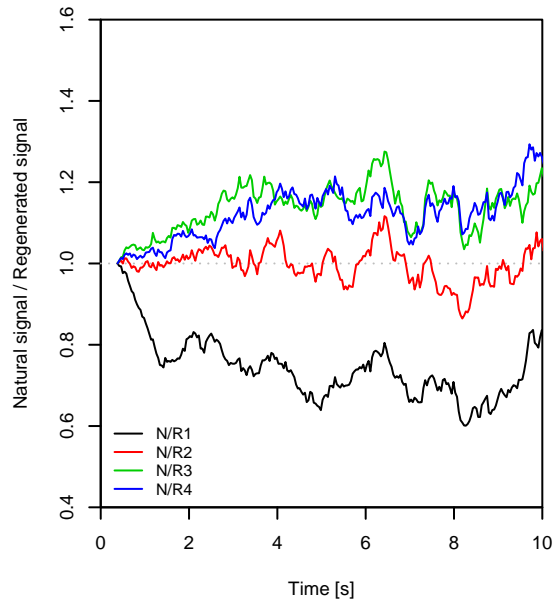
**TnTx(t) Plot**

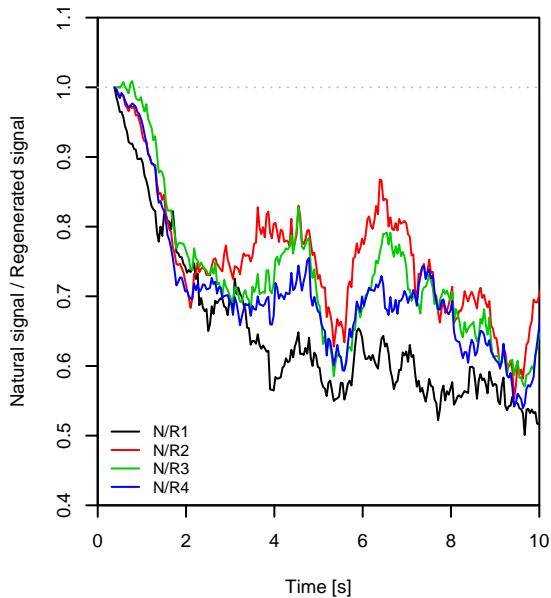
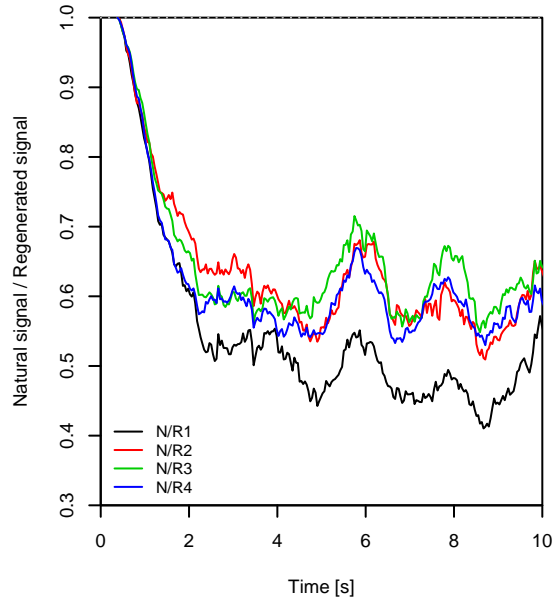


**Aliquot #1****Aliquot #2**

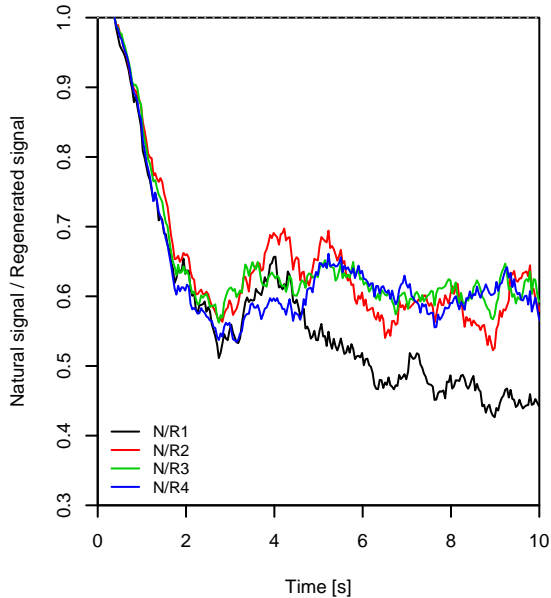
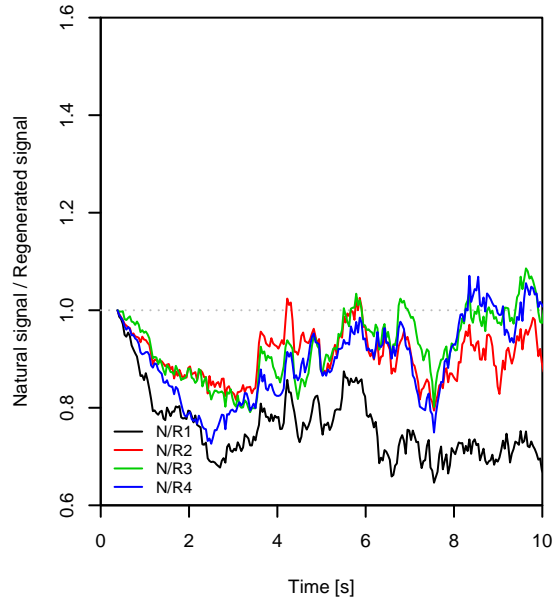
help("plot\_NRt")

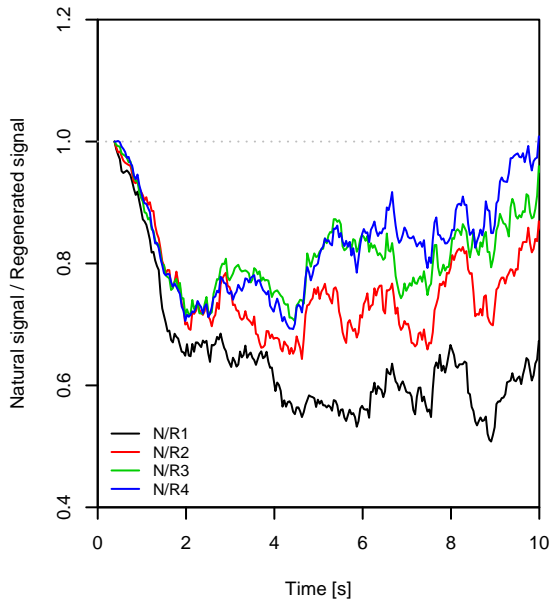
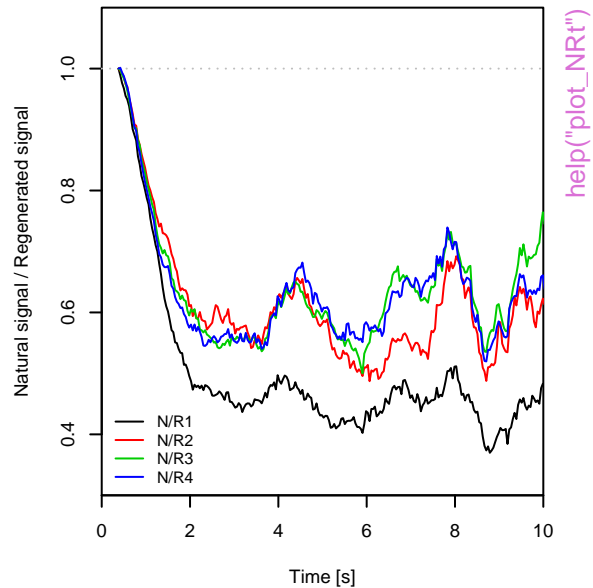
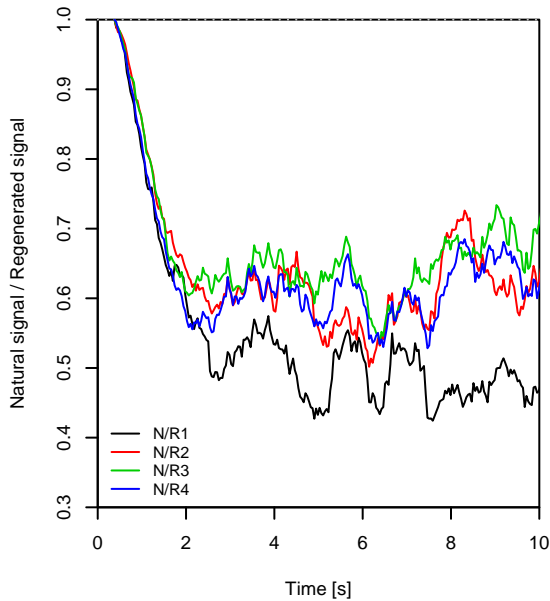
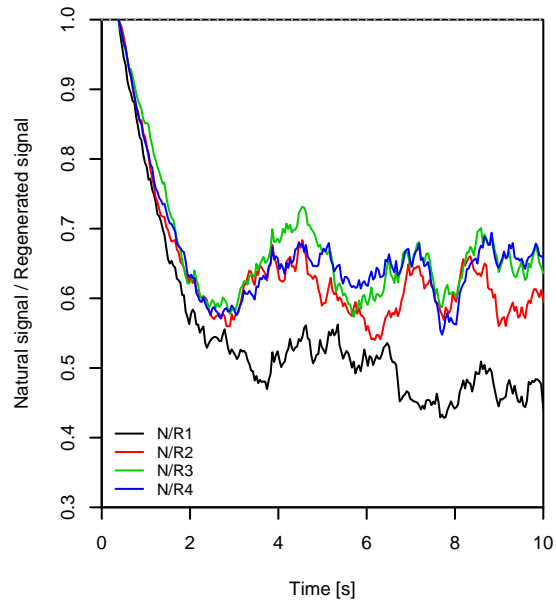
**Aliquot #3****Aliquot #4**

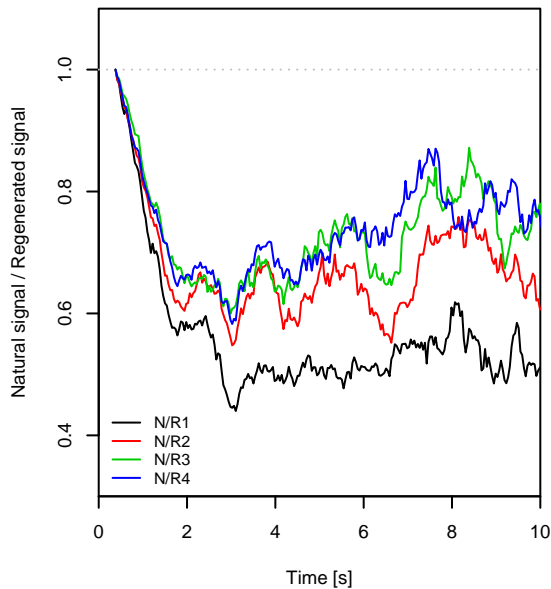
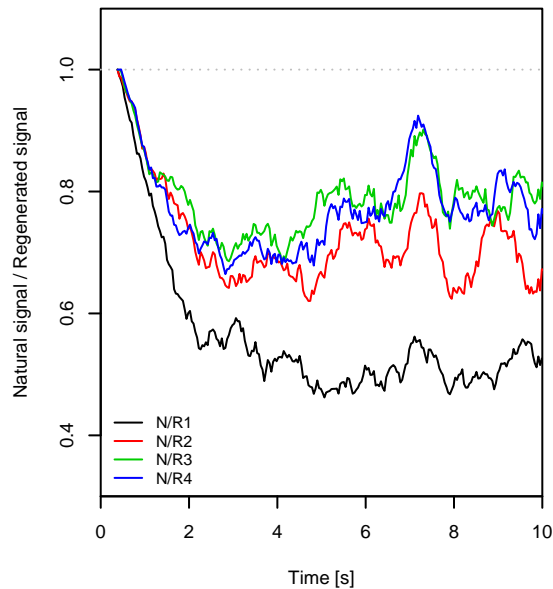
**Aliquot #5****Aliquot #6****Aliquot #7****Aliquot #8**

**Aliquot #9****Aliquot #10**

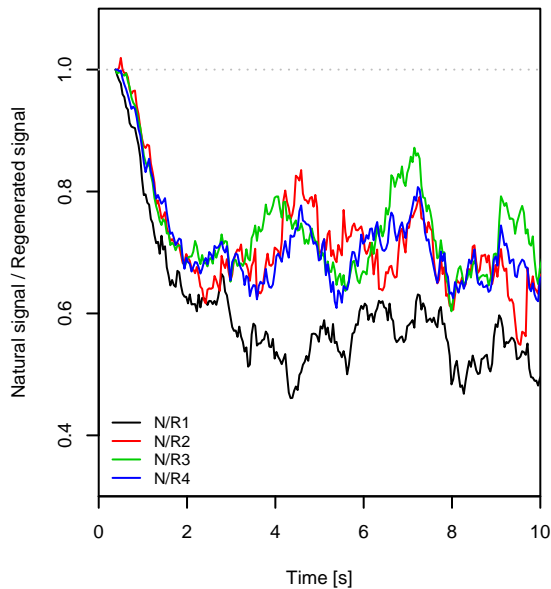
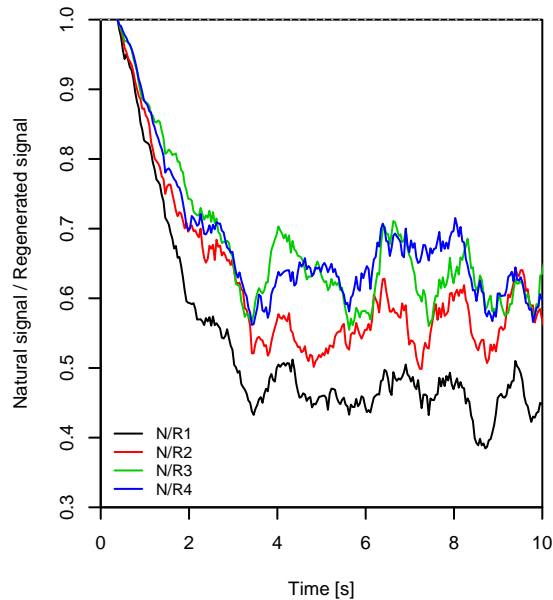
help("plot\_NRt")

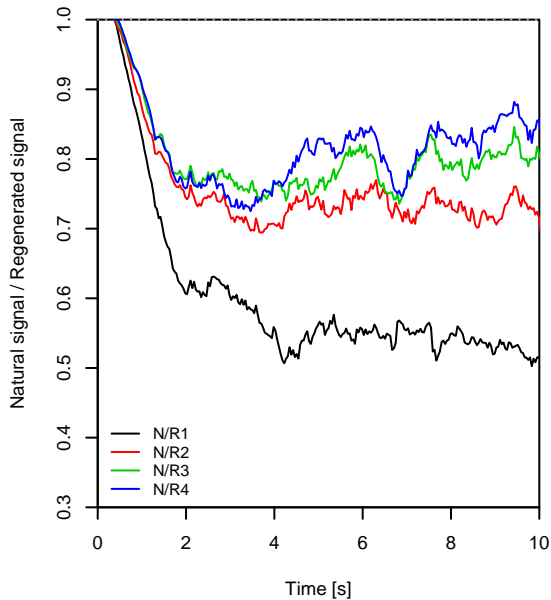
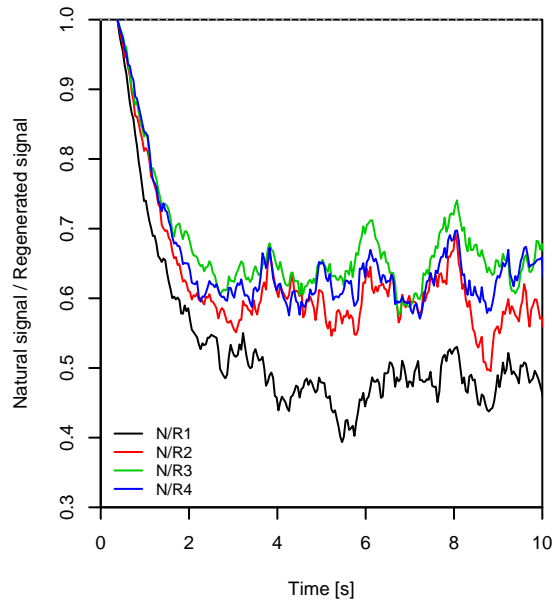
**Aliquot #11****Aliquot #12**

**Aliquot #13****Aliquot #14****Aliquot #15****Aliquot #16**

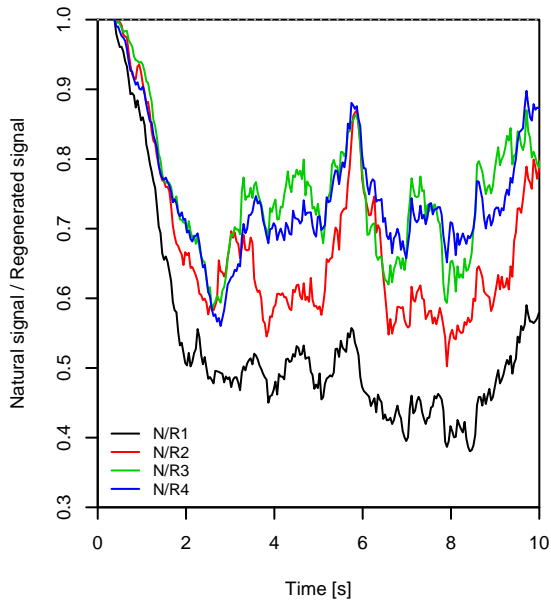
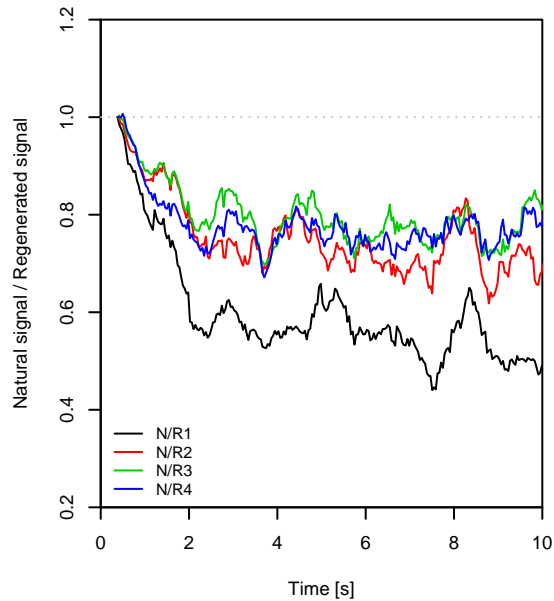
**Aliquot #17****Aliquot #18**

help("plot\_NRt")

**Aliquot #19****Aliquot #20**

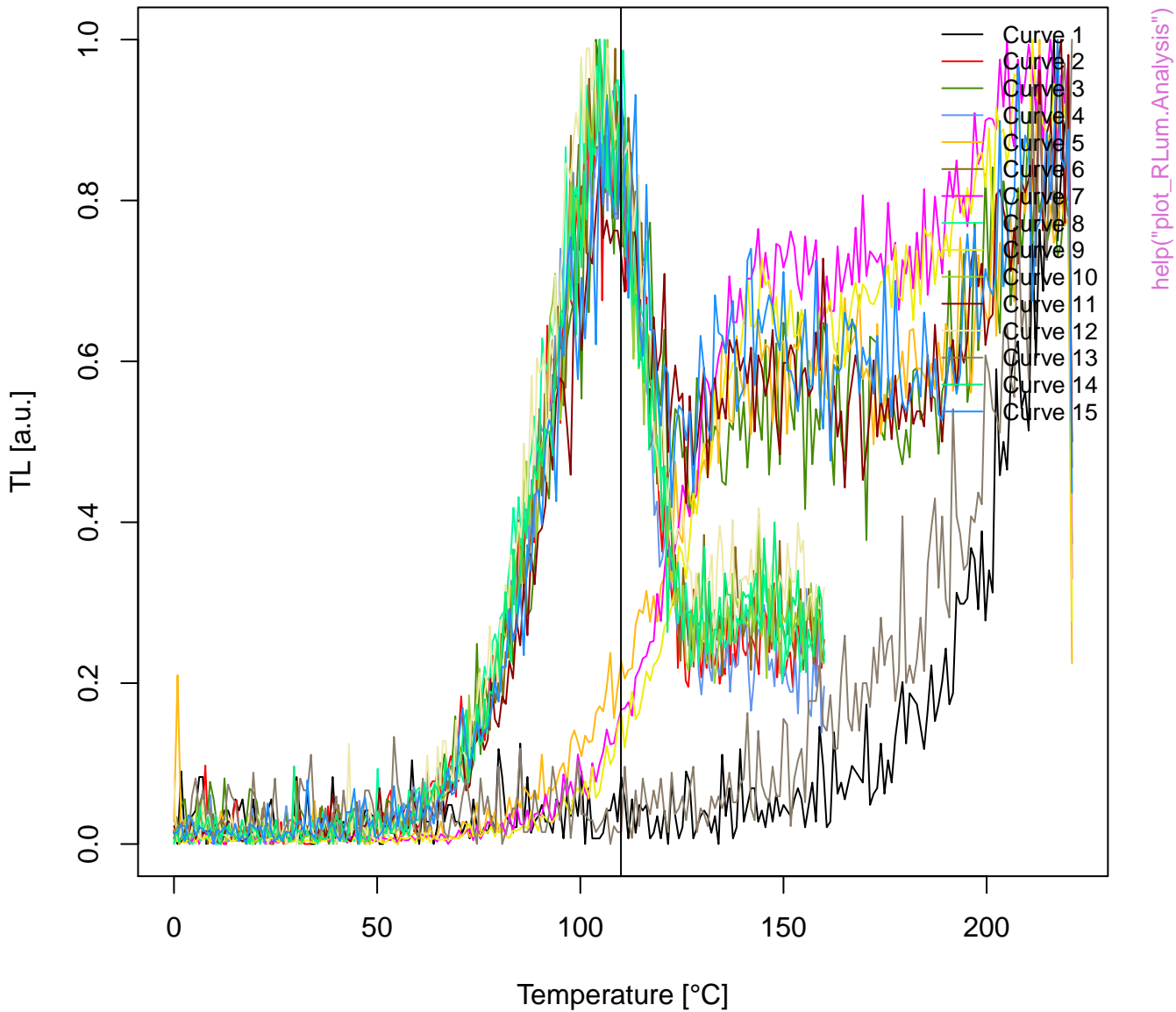
**Aliquot #21****Aliquot #22**

help("plot\_NRt")

**Aliquot #23****Aliquot #24**



# TL combined



## unkown curve type



# RLum.Data.Image

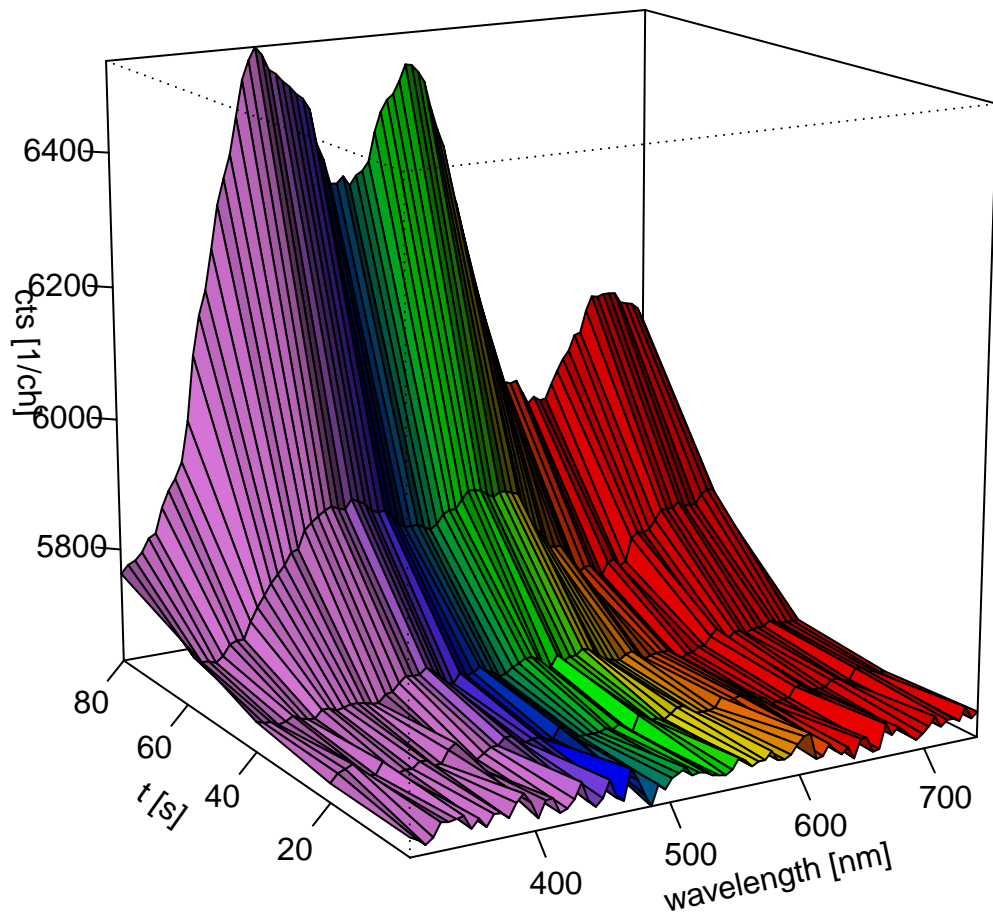


RLum.Data.Spectrum



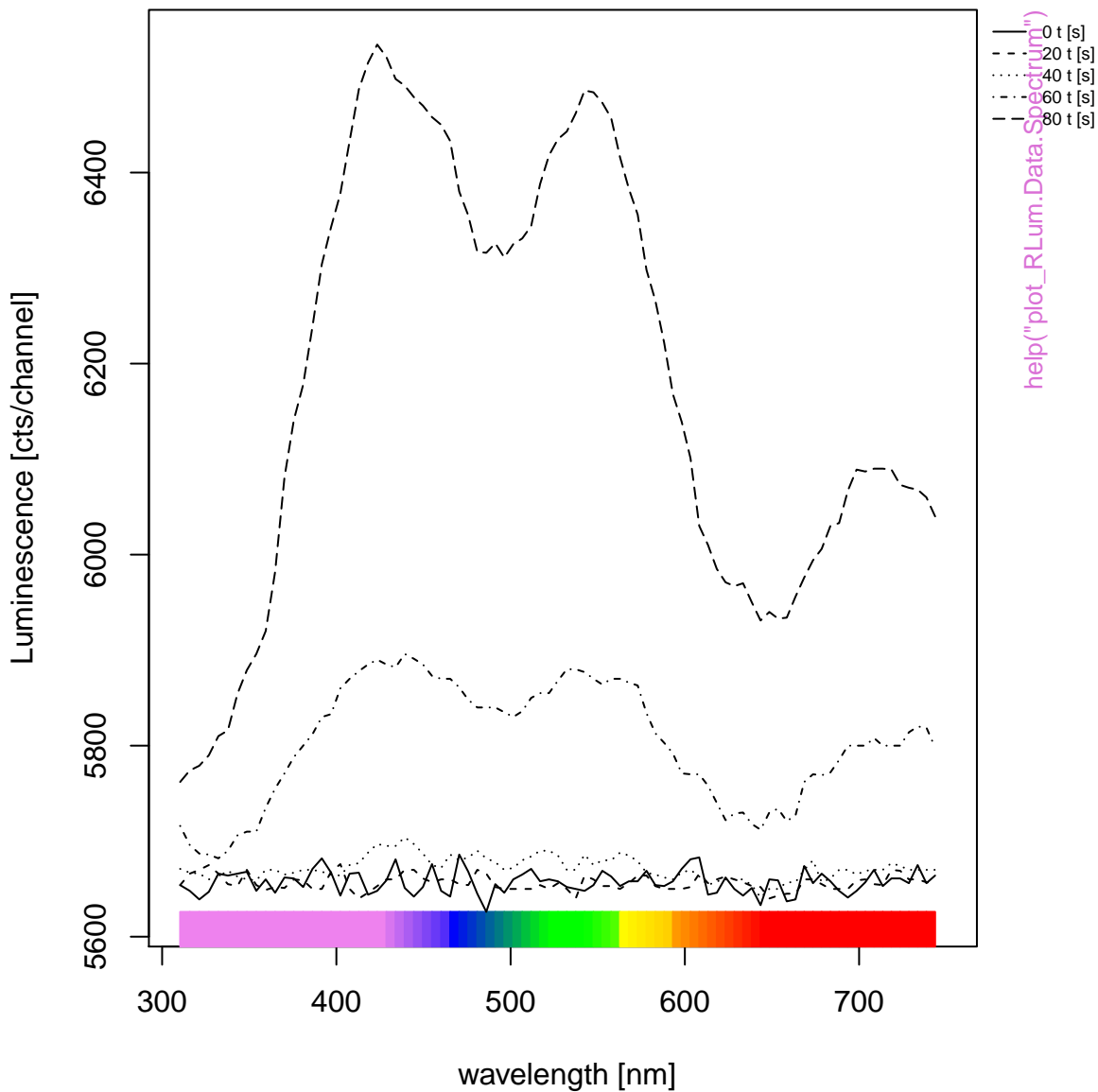
[help\("plot\\_RLum.Data.Spectrum"\)](#)

# RLum.Data.Spectrum



[help\("plot\\_RLum.Data.Spectrum"\)](#)

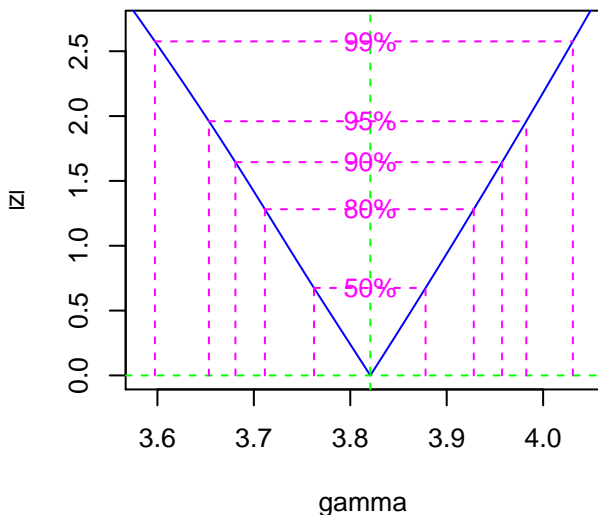
# RLum.Data.Spectrum



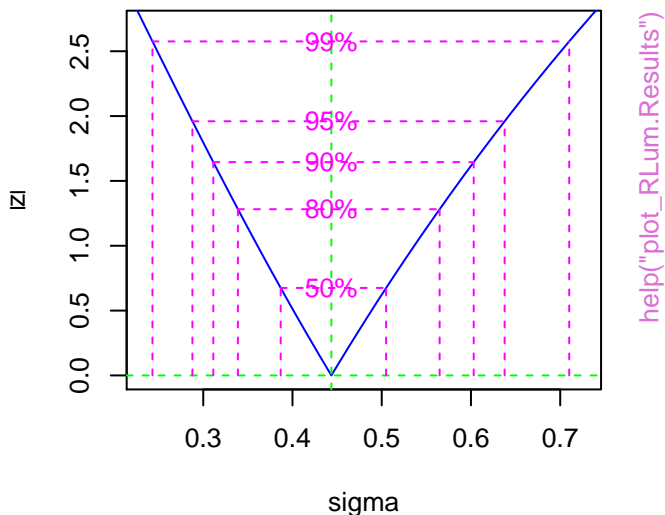
# unkown curve type



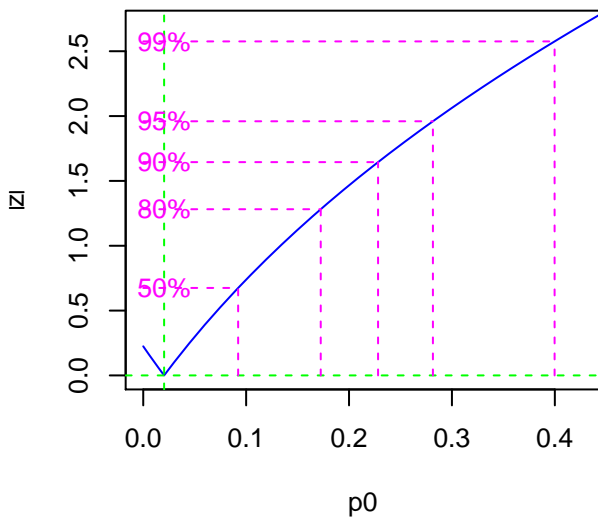
**Likelihood profile: gamma**



**Likelihood profile: sigma**



**Likelihood profile: p0**

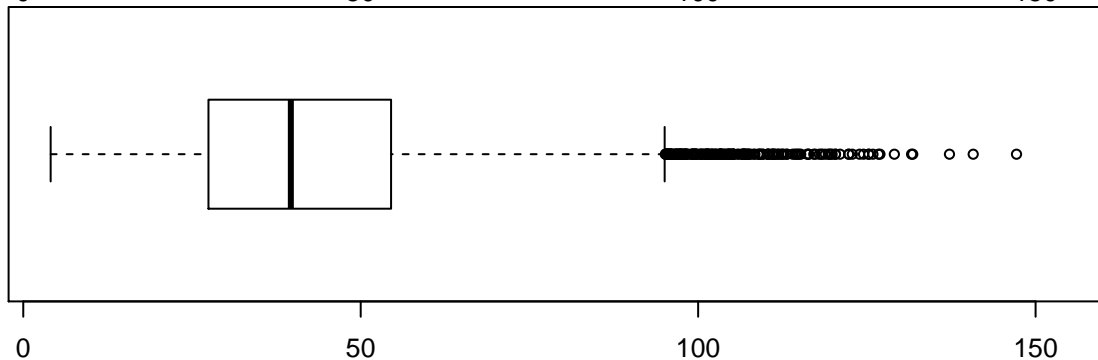
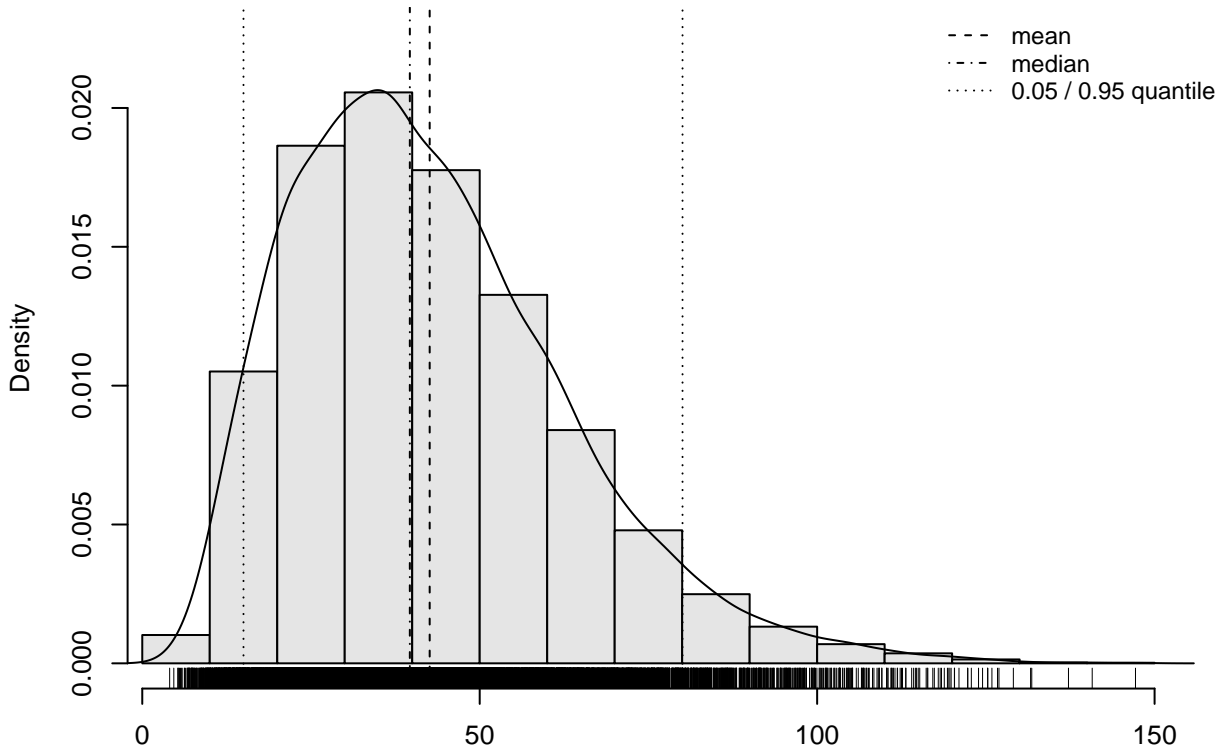


help("plot\_RLum.Results")



# Monte Carlo Simulation

$n = 10000 \mid \hat{\mu} = 43 \mid \hat{\sigma} = 20 \mid \frac{\hat{\sigma}}{\sqrt{n}} = 0 \mid v = 0.84$

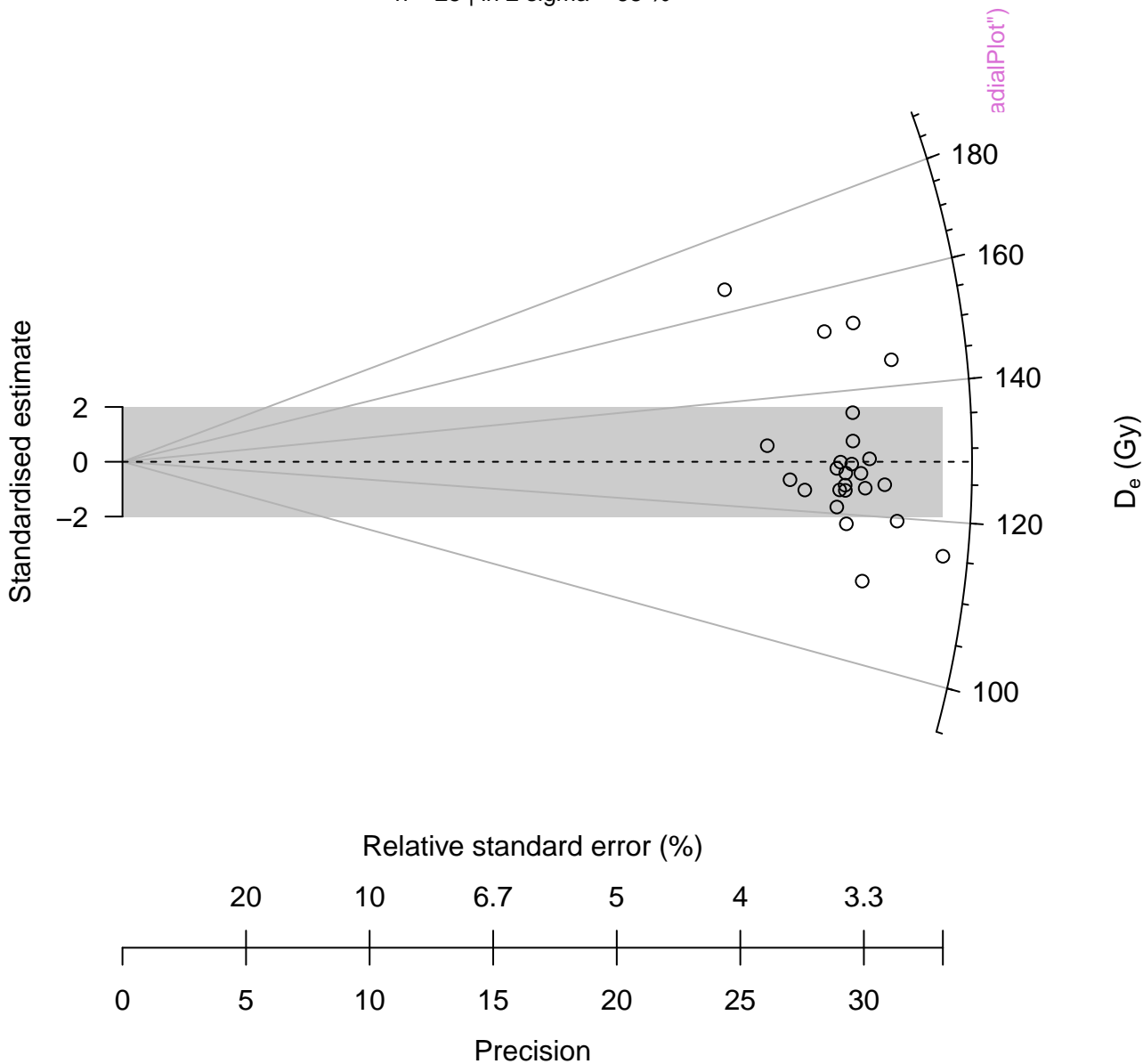


Amount of grains on aliquot

help("plot\_RLum.Results")

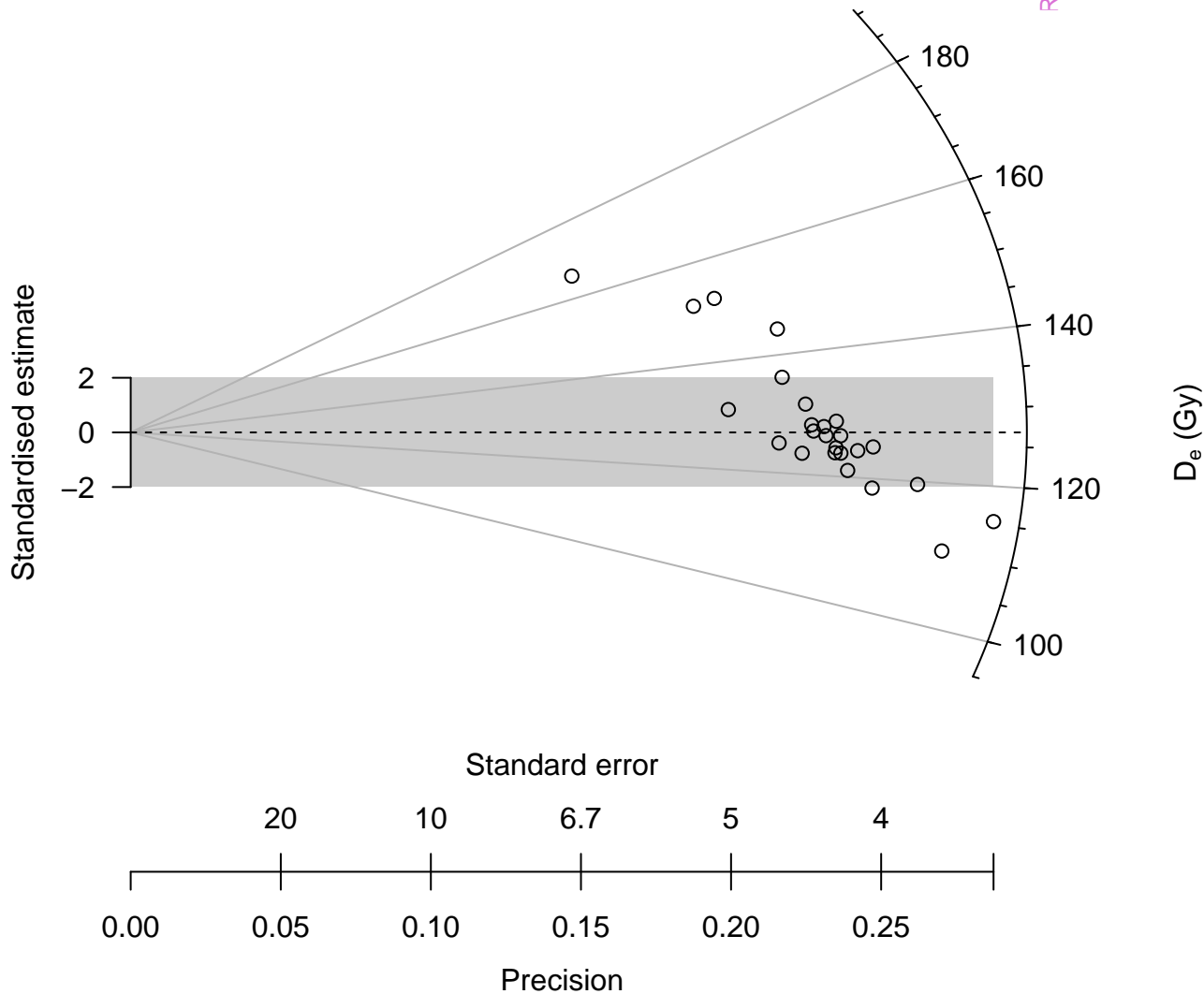
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



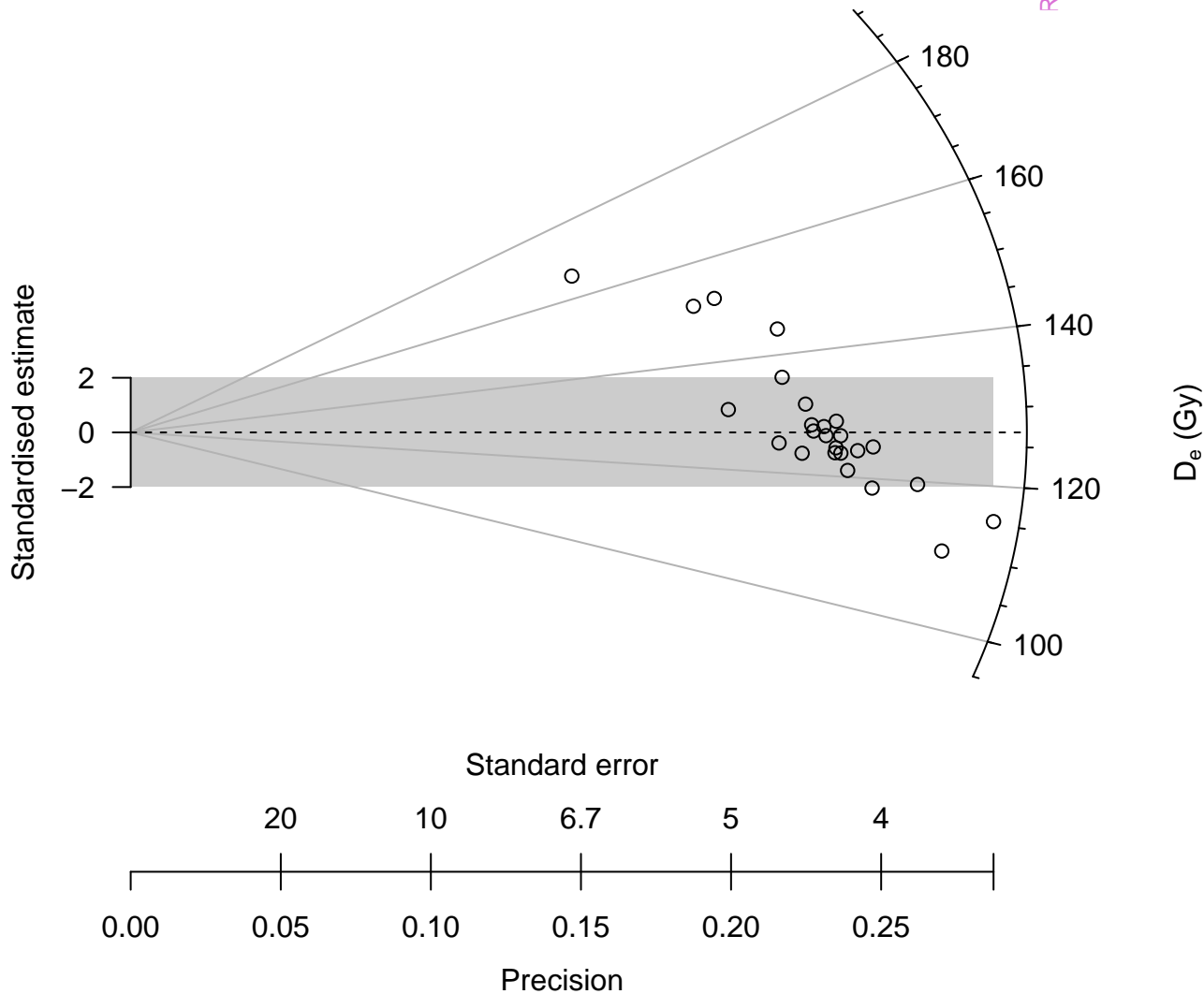
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



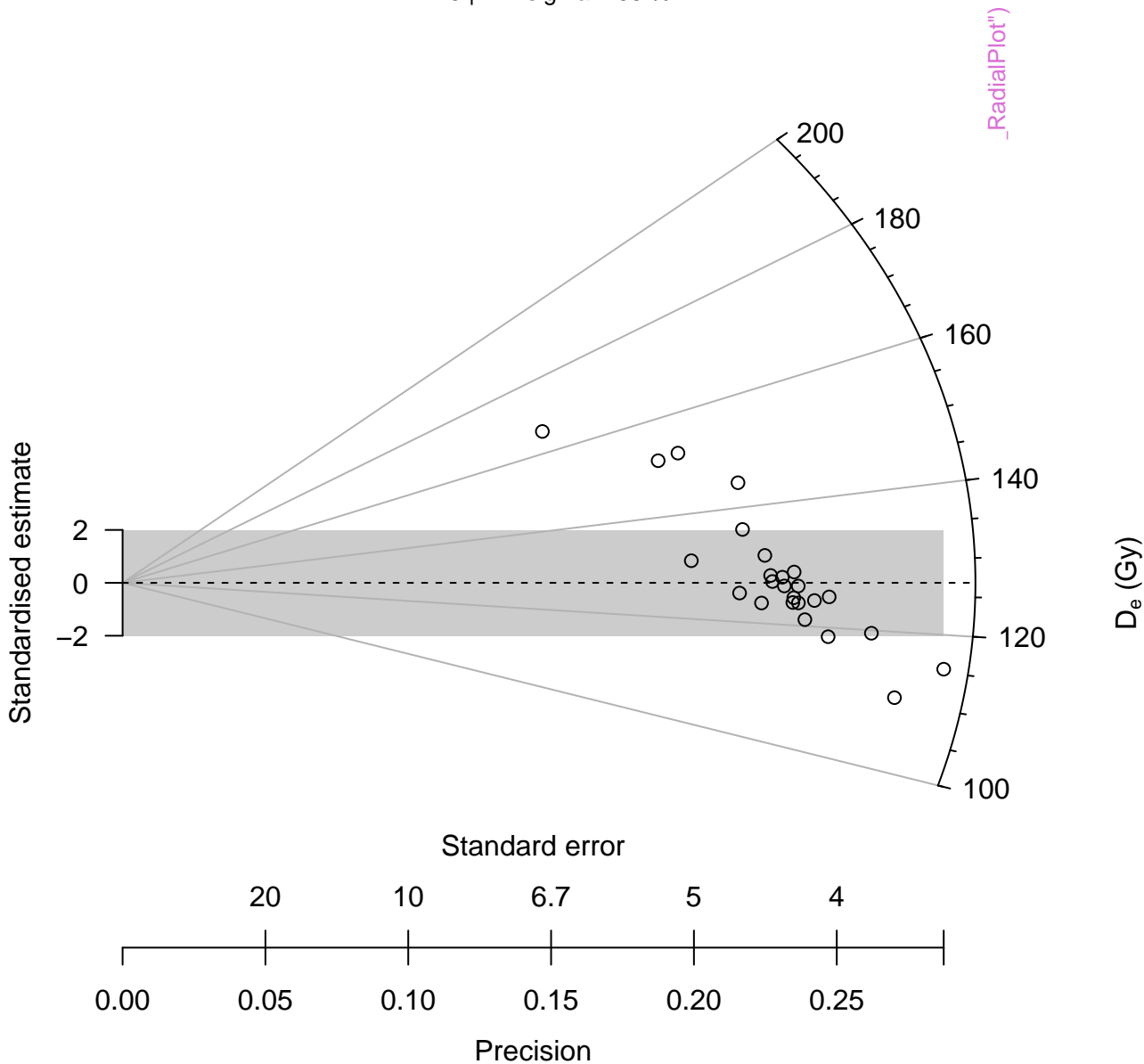
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



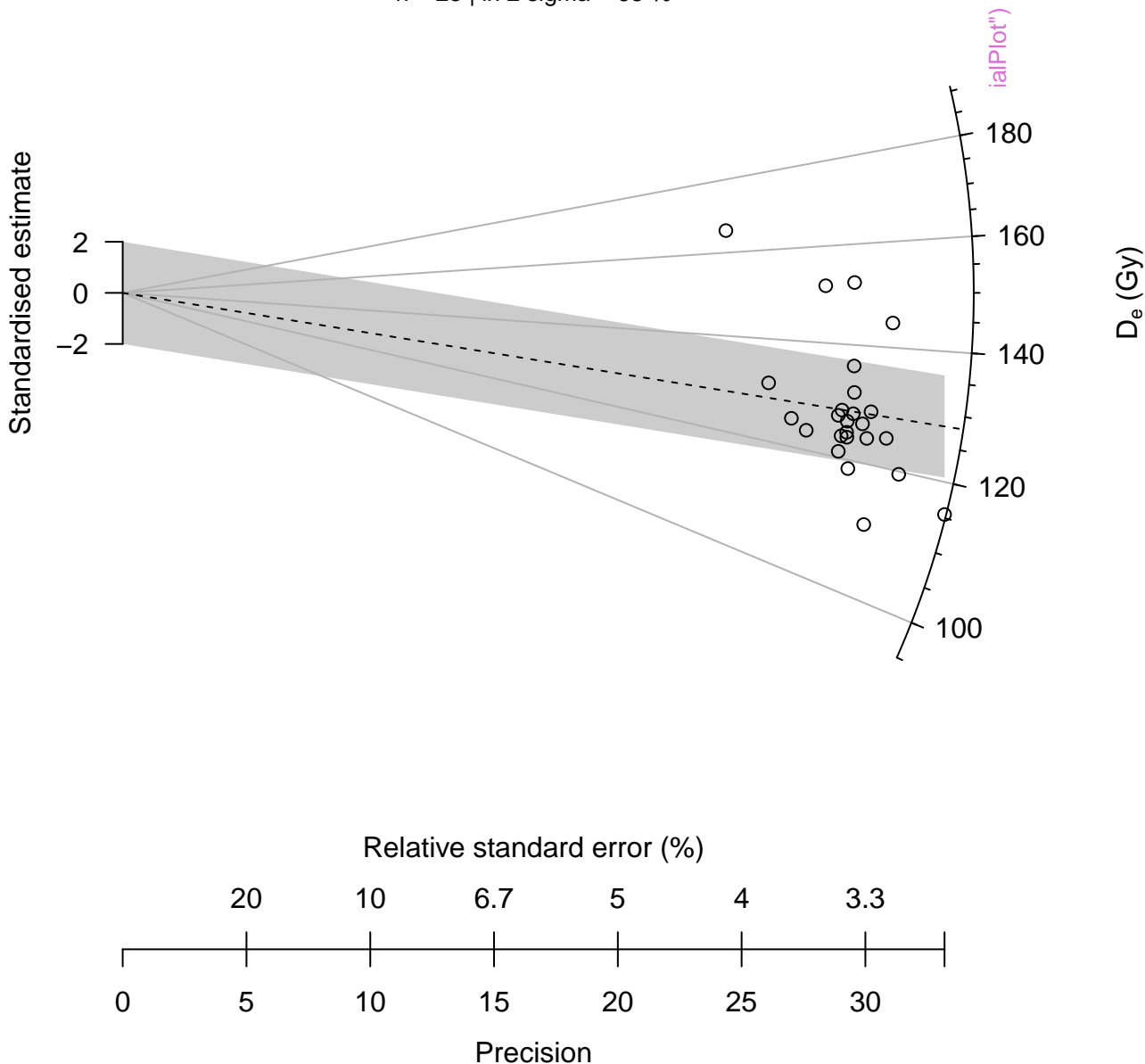
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



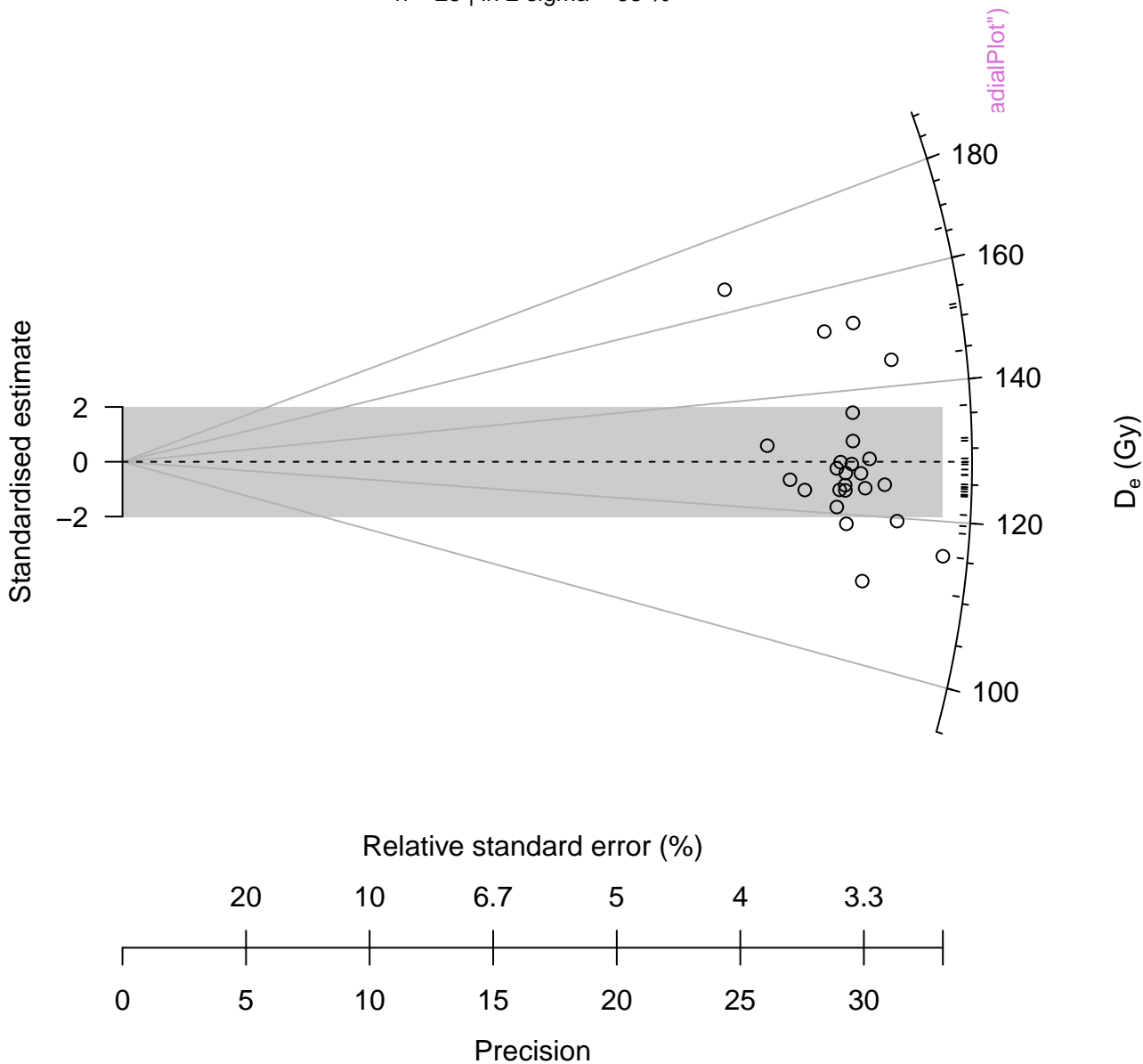
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %

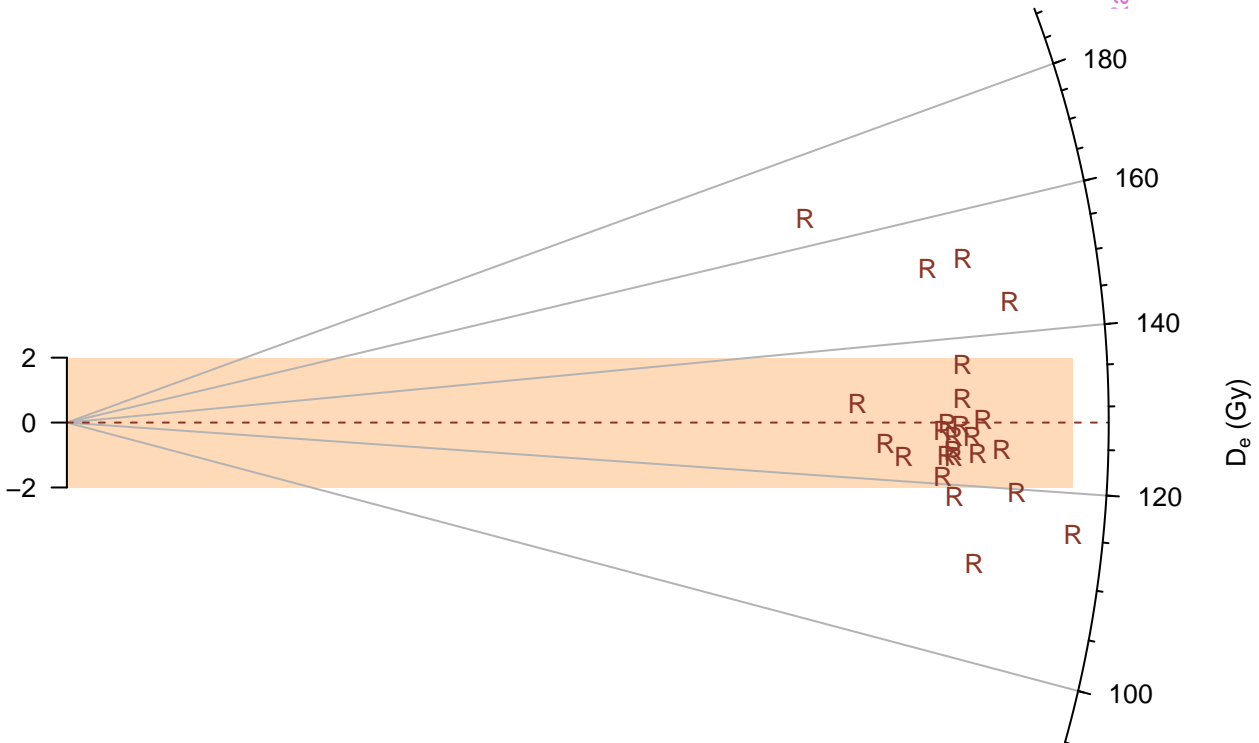


# D<sub>e</sub> distribution

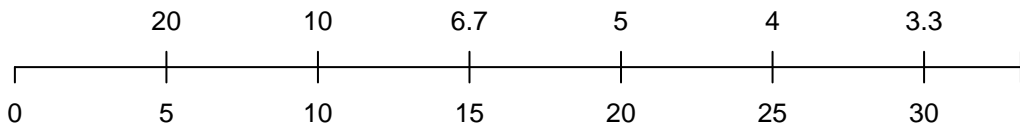
n = 25 | in 2 sigma = 68 %

radialPlot()

Standardised estimate



Relative standard error (%)



Precision



# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %

Standardised estimate

0

0

20

5

10

10

6.7

15

5

20

4

25

3.3

30

Precision

Relative standard error (%)

adialPlot")

180

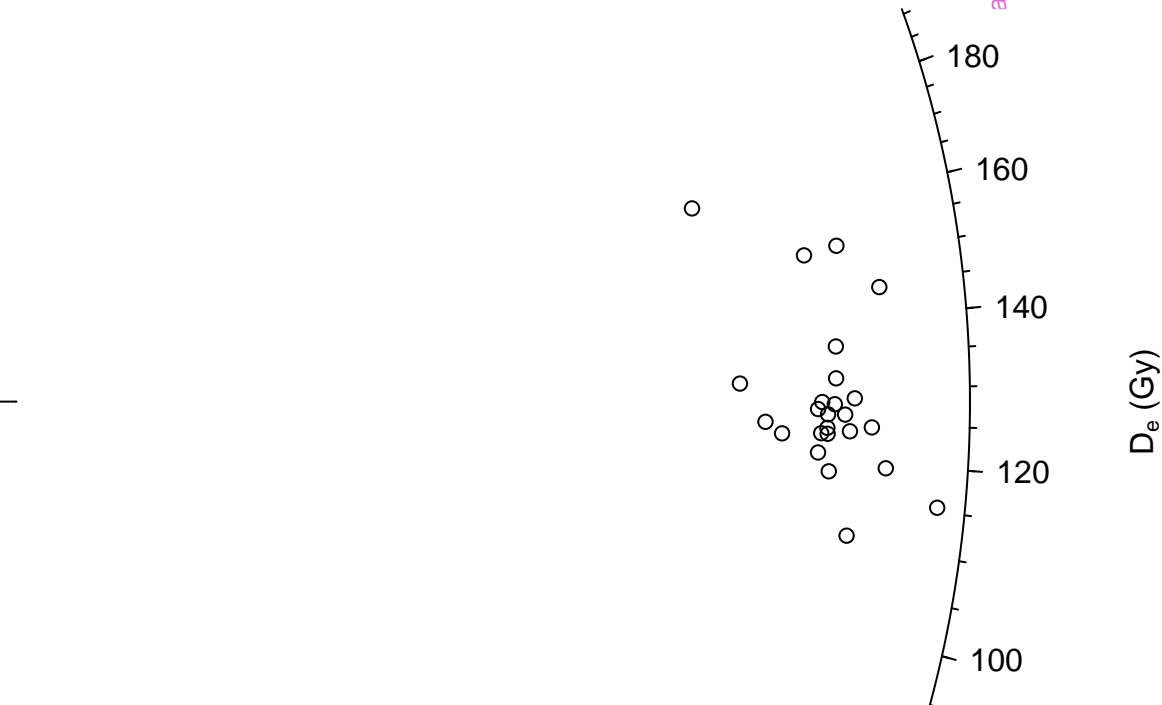
160

140

120

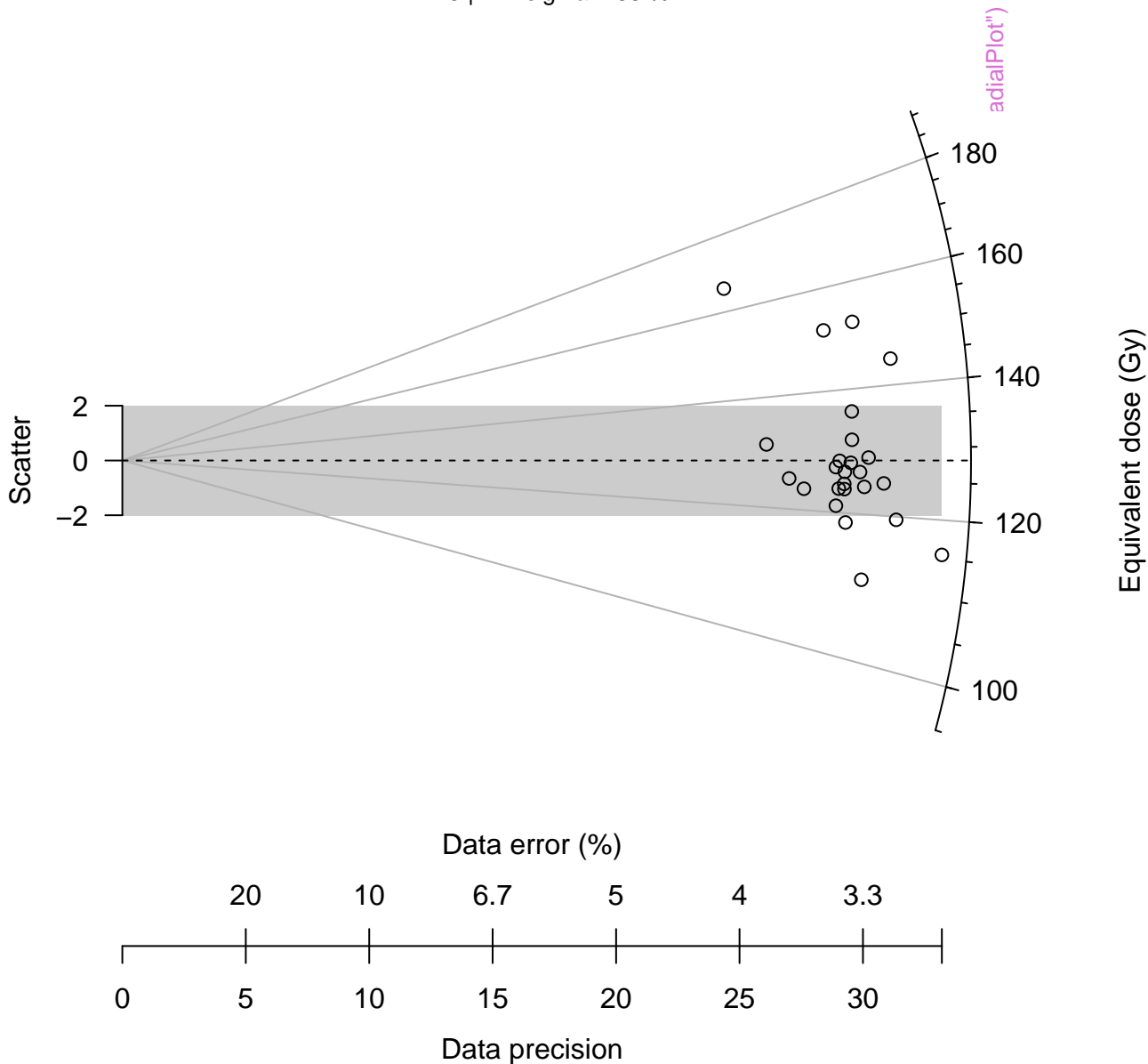
100

D<sub>e</sub> (Gy)



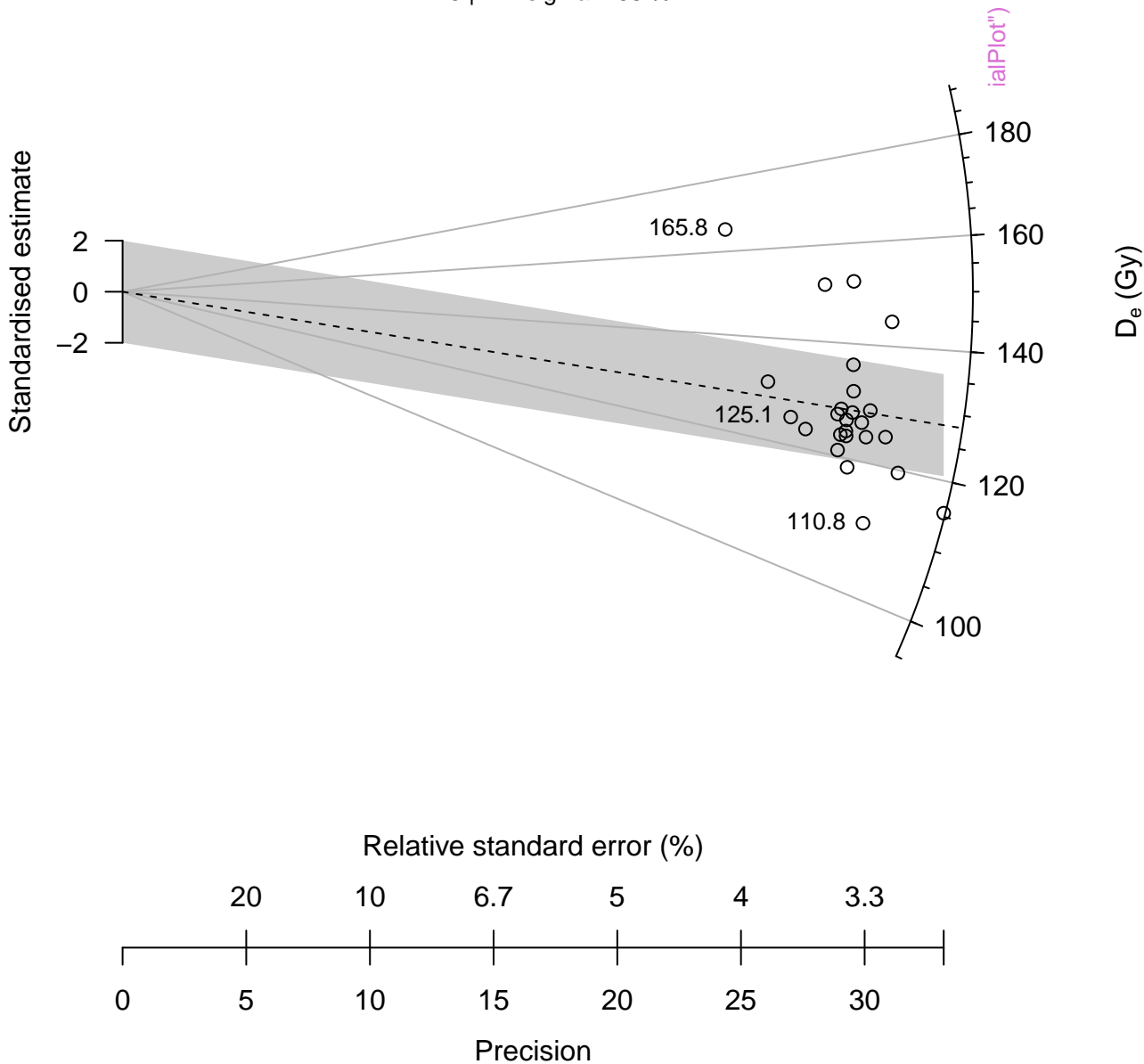
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



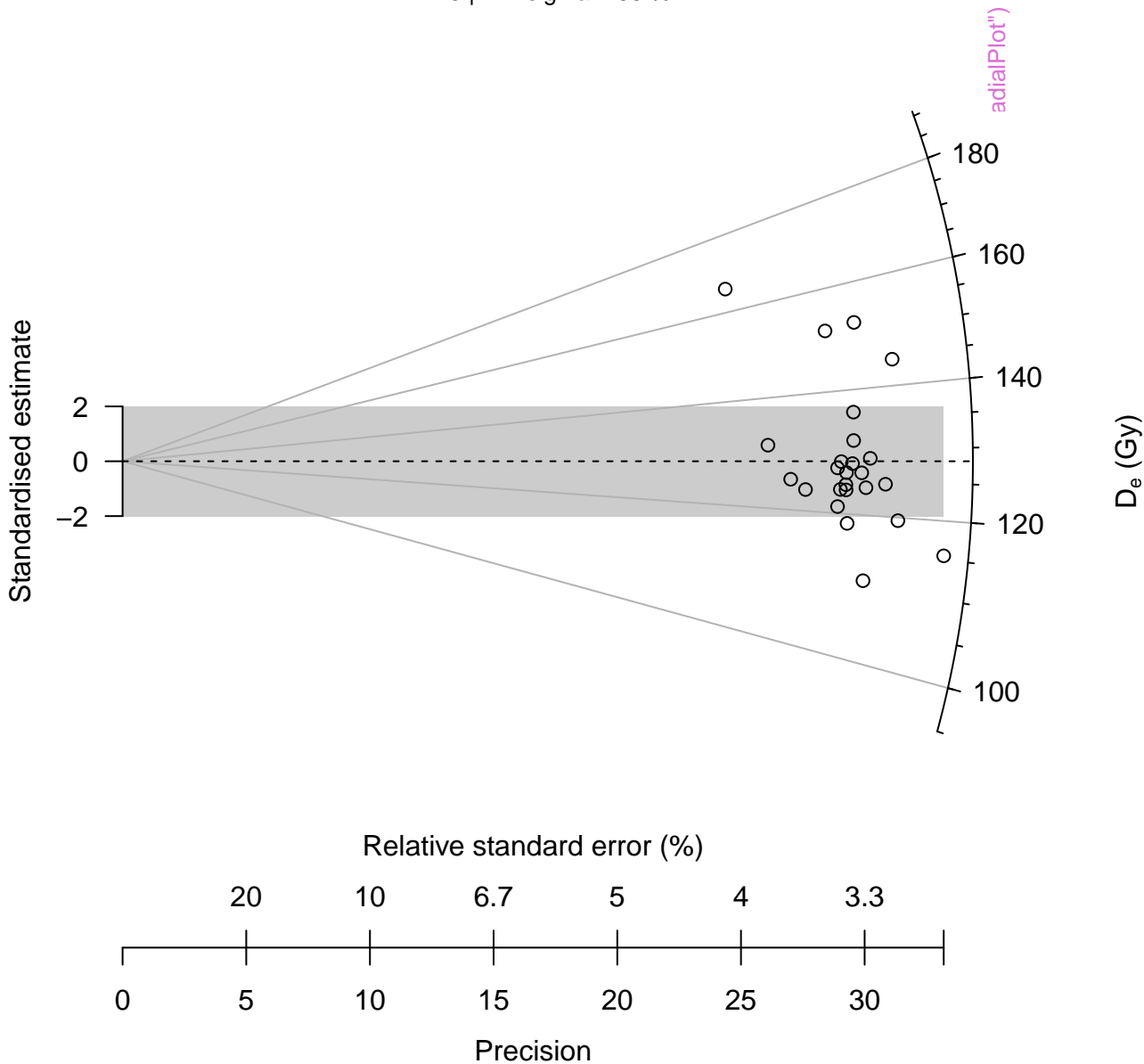
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



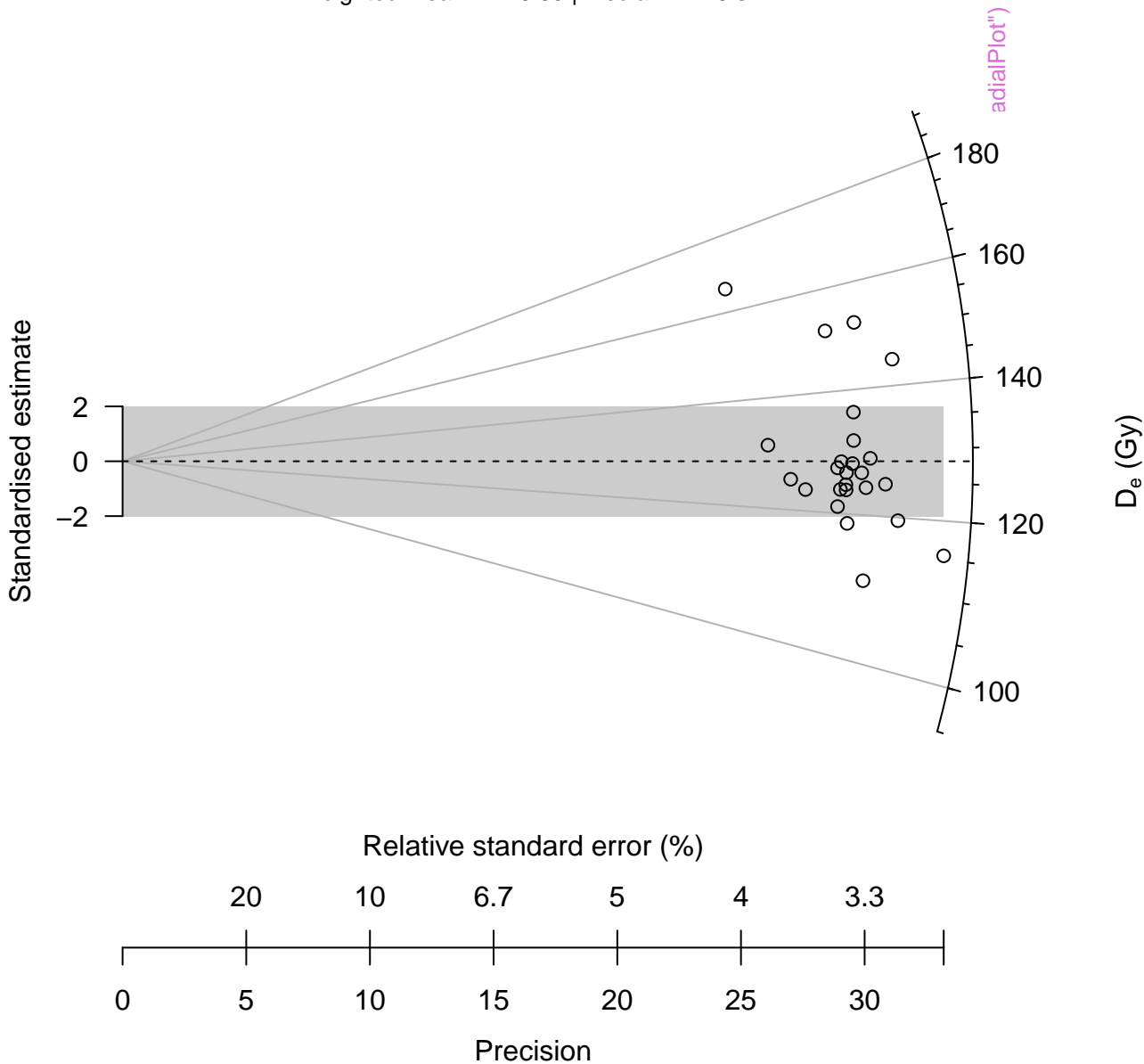
# D<sub>e</sub> distribution

n = 25 | in 2 sigma = 68 %



# D<sub>e</sub> distribution

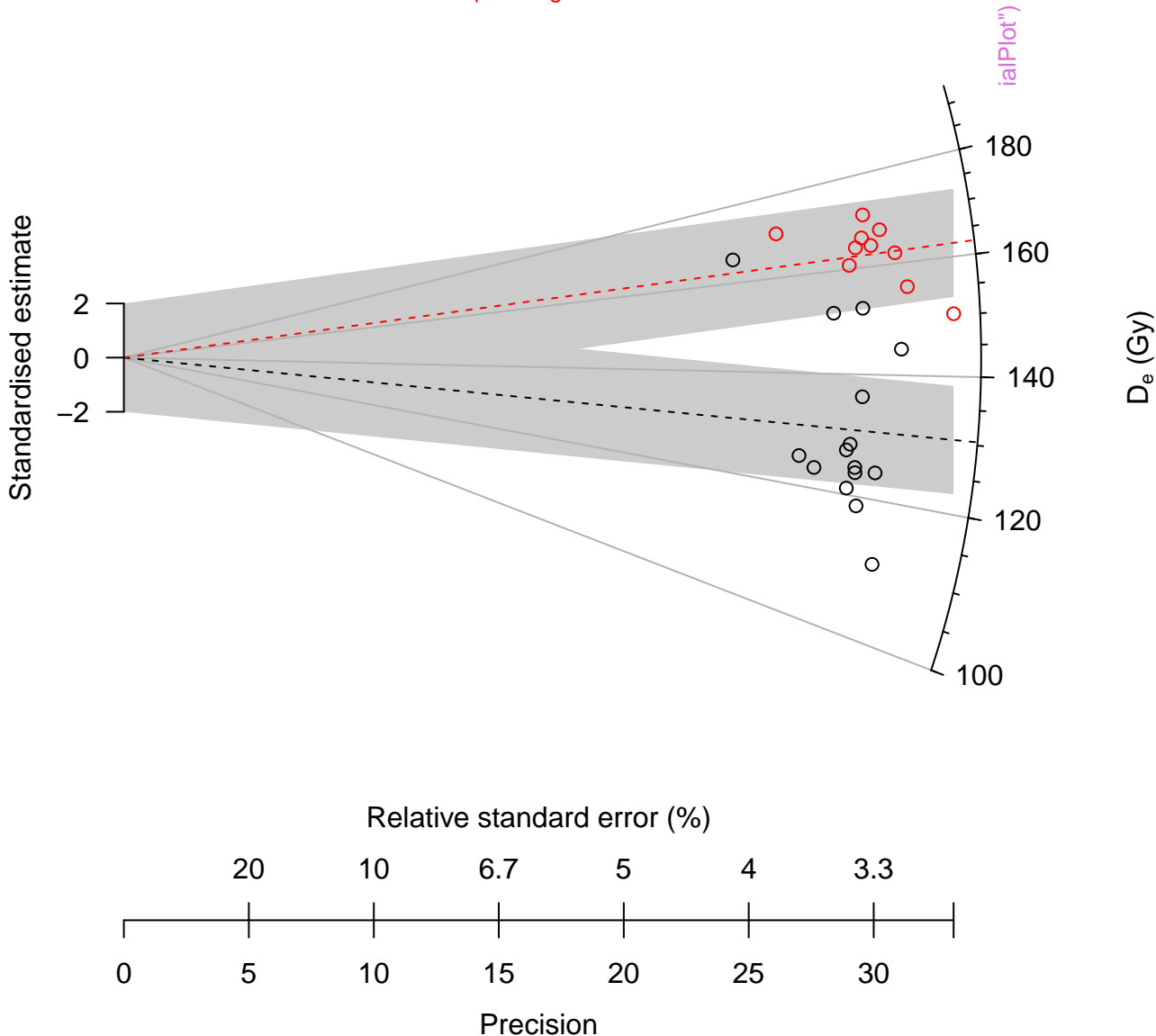
weighted mean = 126.85 | median = 126.34



# D<sub>e</sub> distribution

n = 15 | in 2 sigma = 53.3 %

n = 10 | in 2 sigma = 90 %



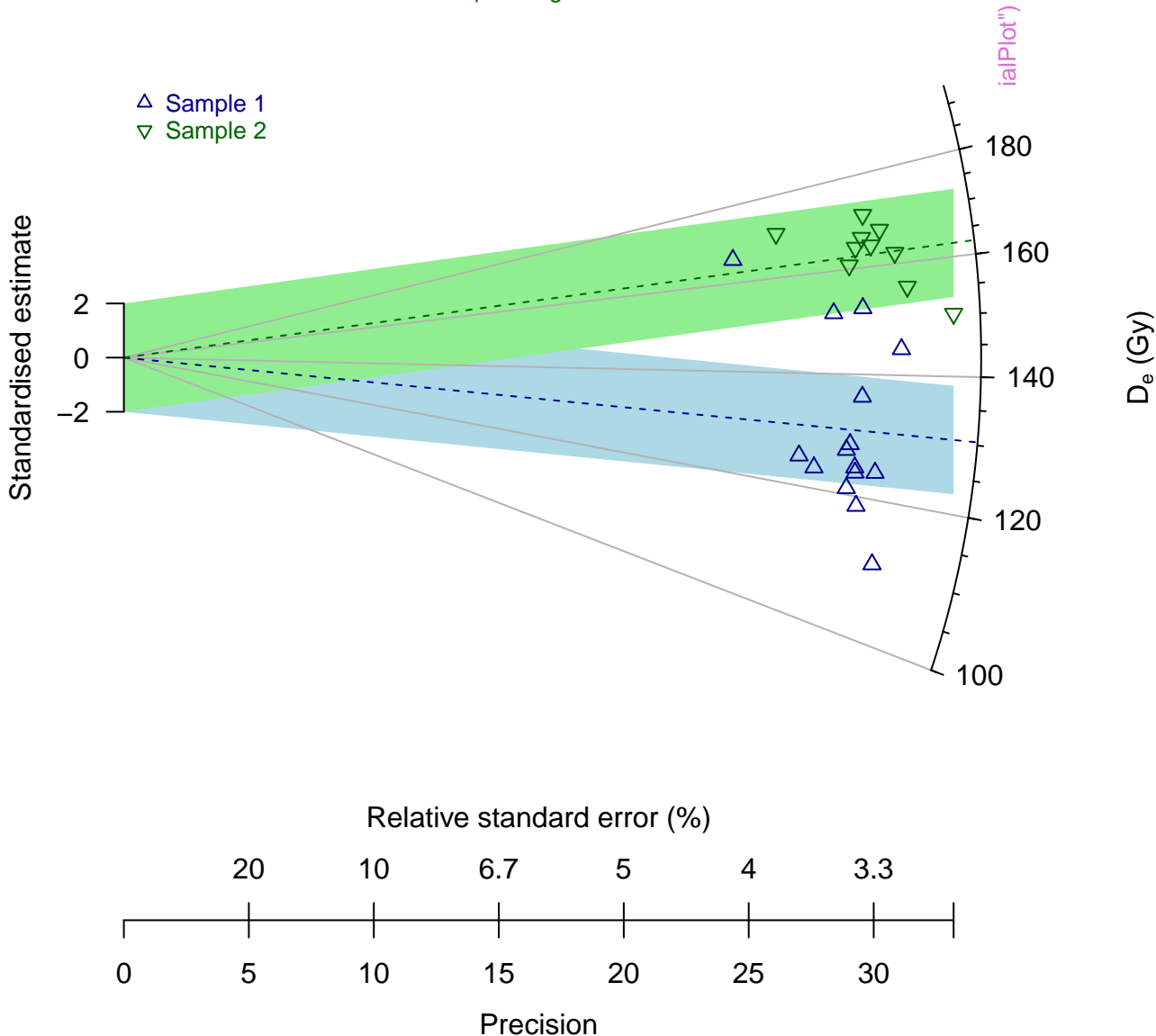
# D<sub>e</sub> distribution

n = 15 | in 2 sigma = 53.3 %

n = 10 | in 2 sigma = 90 %

△ Sample 1

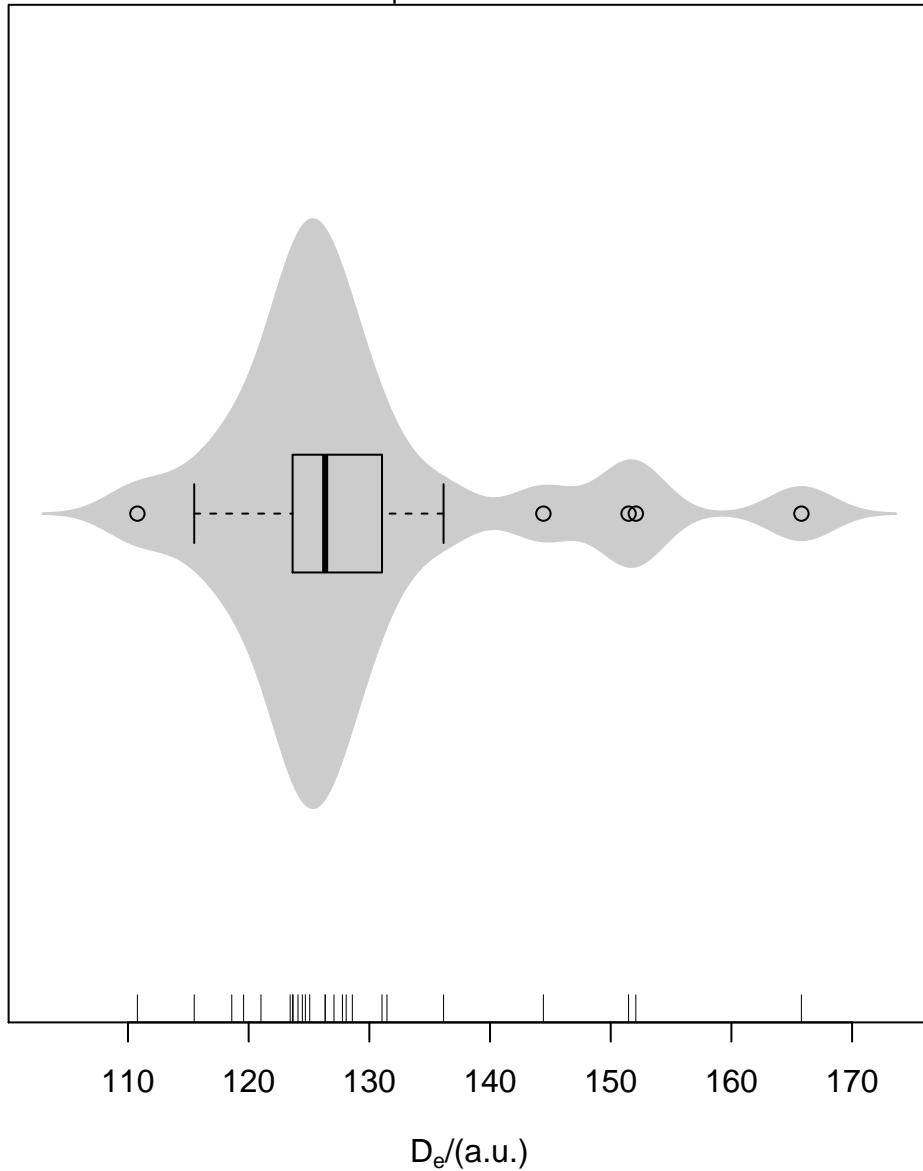
▽ Sample 2



# Violin Plot

n = 25 | median = 126.34

Density



[help\("plot\\_ViolinPlot"\)](#)

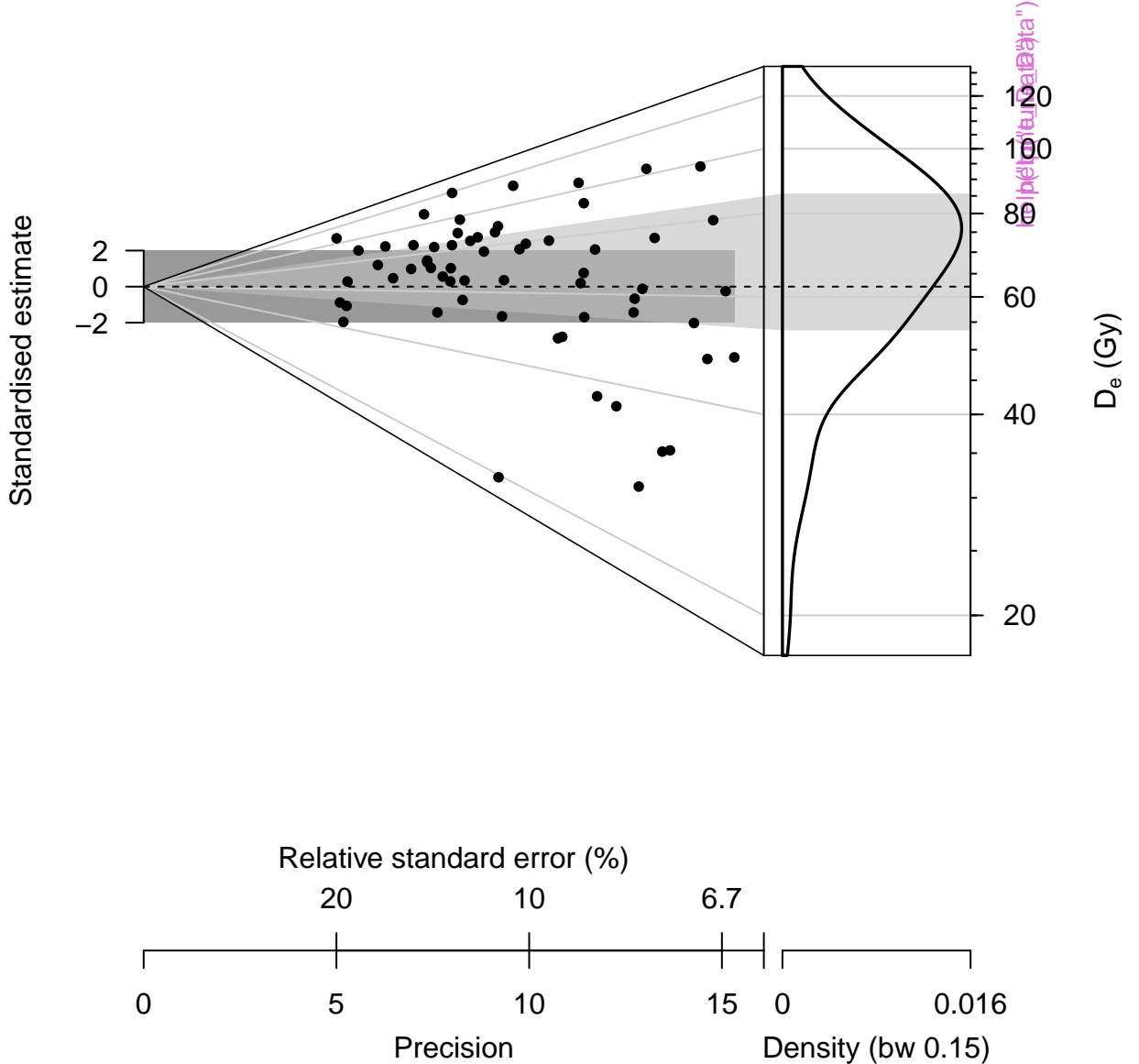


# OSL



# D<sub>e</sub> distribution

n = 62 | mean = 66.01



# D<sub>e</sub> distribution

n = 62 | mean = 66.01

