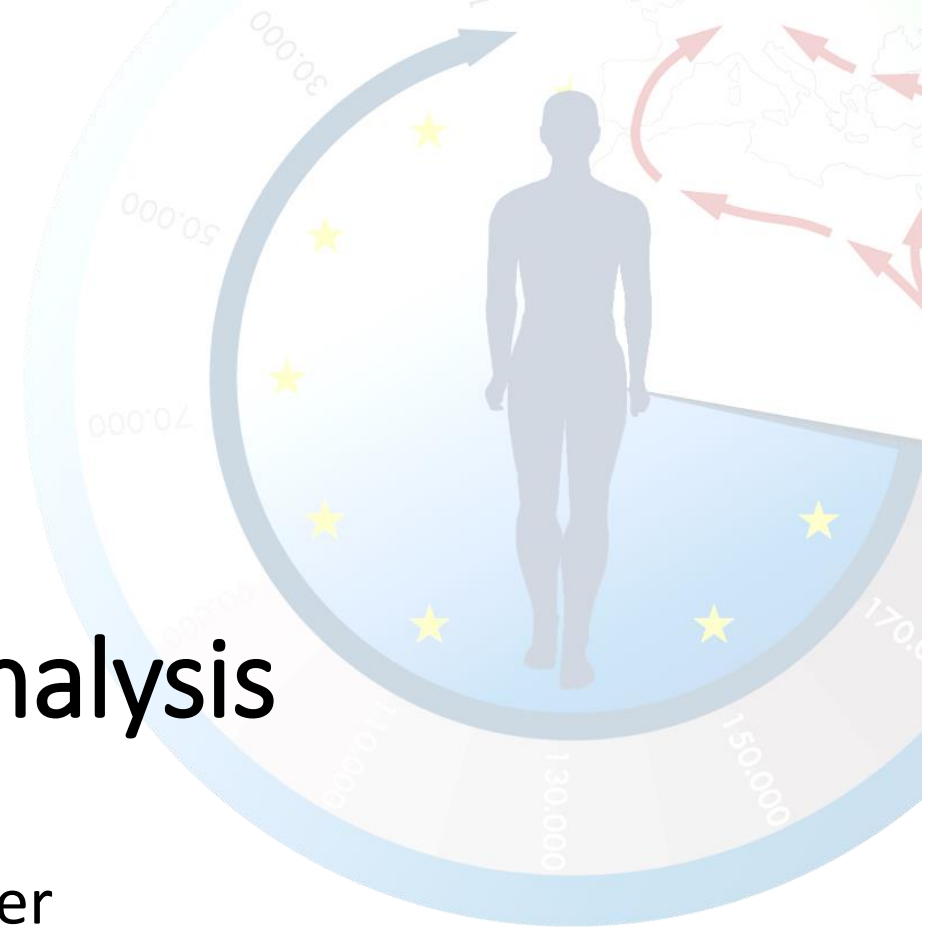
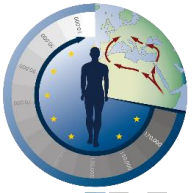


# ‘Shiny’ new apps for luminescence: data documentation and analysis

David Strebler, Dominik Brill, Helmut Brückner

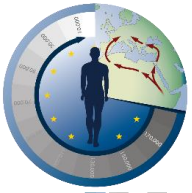
*Institute of Geography – University of Cologne, Cologne, Germany*





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  - What is shiny?
- ***ShinyDRAC***
  - Graphical interface for  $\hat{D}$  estimation
- ***ShinyLumReader***
  - Simulating a luminescence experiment
- ***ShinyTLdating***
  - An app 'all inclusive'
- **Conclusion & outlook**
- Acknowledgment
- Bibliography



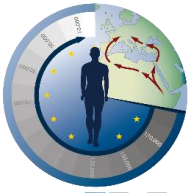
# Introduction

## What is shiny?

- **R** package that allows to ‘turn your analyses into interactive web applications’.
  - Rstudio → GUI for **R**.
  - shiny → GUI for your scripts.
- ‘Pure’ **R** (no html, css, JS *required*).

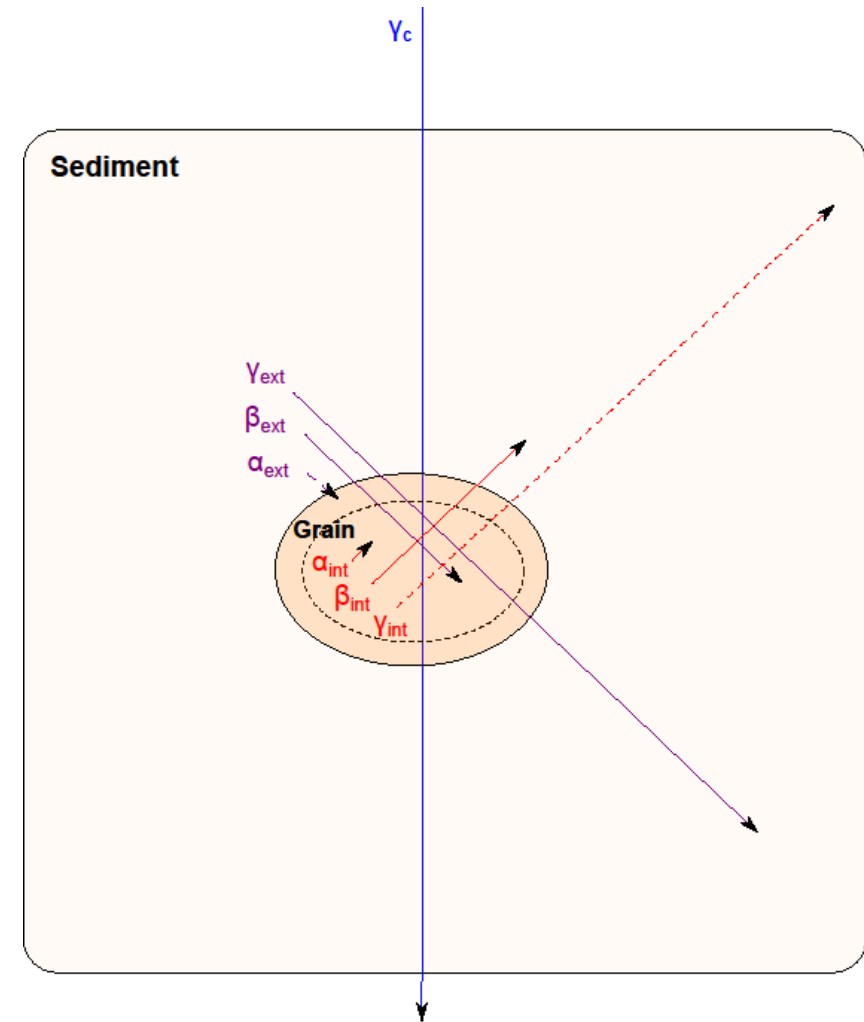
## Why making apps?

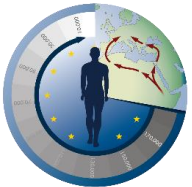
- More user friendly
  - We are used to graphical user interfaces (GUI) rather than command line interfaces (CLI).
  - Interactive
  - No knowledge in **R** required.
- BUT
  - Less flexible
    - Only do what it is designed for.



# shinyDRAC

- **DRAC**
  - Dose Rate and Age Calculator
  - open access, web-based program
    - Aberystwyth university
  - Input/output
    - .csv file
- **Luminescence R package**
  - *template\_DRAC*
  - *use\_DRAC*
  - *calc\_CosmicDoseRate*





# shinyDRAC:

## A graphical interface for $\dot{D}$ estimation

ShinyDRAC   Sample information   **Input**   Output   help

**Equivalent dose**

$D_e$  [Gy]    $\delta D_e$

20   0,2

**General parameters**

**Context**

sediment

**Mineral**

Q

**Conversion factor**

Guerinetal2011

**Alpha size attenuation factor**

Brennanetal1991

**Beta size attenuation factor**

Guerinetal2012-Q

**Beta etch attenuation factor**

Bell1979

Age estimation

Waiting for age calculation

**Grain information**

$\dot{D}$  based on:

radioelement concentration

direct measurement

**Grain size [ $\mu\text{m}$ ]**

min   max

90   125

**Etch depth [ $\mu\text{m}$ ]**

min   max

8   10

**a-value**

a    $\delta a$

0   0

**Sediment information**

$\dot{D}$  based on:

radioelement concentration

direct measurement

**U [ppm]**    $\delta U$

3.4   0.51

**Th [ppm]**    $\delta Th$

14.47   1.69

**K [%]**    $\delta K$

1.2   0.14

Rb from K

**Rb [ppm]**    $\delta Rb$

0   0

**Density [mg/mm<sup>3</sup>]**

$\rho$     $\delta \rho$

1.8   0.1

**Water content  $m = (W-D)/D$  [%]**

m    $\delta m$

5   2

**Dc information**

$\dot{D}$  based on:

geographical position

in-situ measurement

**Latitude**   **Longitude**

30   70

**Altitude [m]**

150

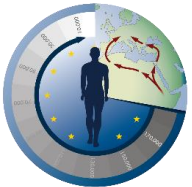
field change correction

Scale for shallow depth

**Depth [m]**

$\tau$     $\delta \tau$

2.22   0.05



# shinyDRAC:

## A graphical interface for $\dot{D}$ estimation

ShinyDRAC   Sample information   Input   **Output**   help

### Input table

Site	Sample	Depth [m]	Grain				Sediment			
			U [ppm]	Th [ppm]	K [%]	a	U [ppm]	Th [ppm]	K [%]	W [%]
DRAC-example	Quartz	2.22 ± 0.05	NA ± NA	NA ± NA	NA ± NA	0 ± 0	3.4 ± 0.51	14.47 ± 1.69	1.2 ± 0.14	5 ± 2

LaTeX source

### Result table

Site	Sample	Depth [m]	$\dot{D}$ [Gy/ka]					$D_e$ [Gy]	Age [ka]
			$\alpha$ [Gy/ka]	$\beta$ [Gy/ka]	$\gamma$ [Gy/ka]	cosmic [Gy/ka]	Tot. [Gy/ka]		
DRAC-example	Quartz	2.22 ± 0.05	0 ± 0	1.56 ± 0.129	1.298 ± 0.103	0.154 ± 0.015	3.012 ± 0.166	20 ± 0.2	6.642 ± 0.371

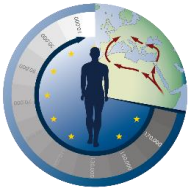
LaTeX source

```

\usepackage{multirow}
\usepackage{pdflscape}

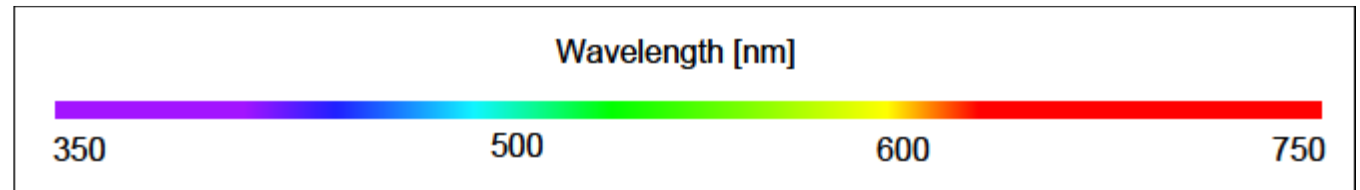
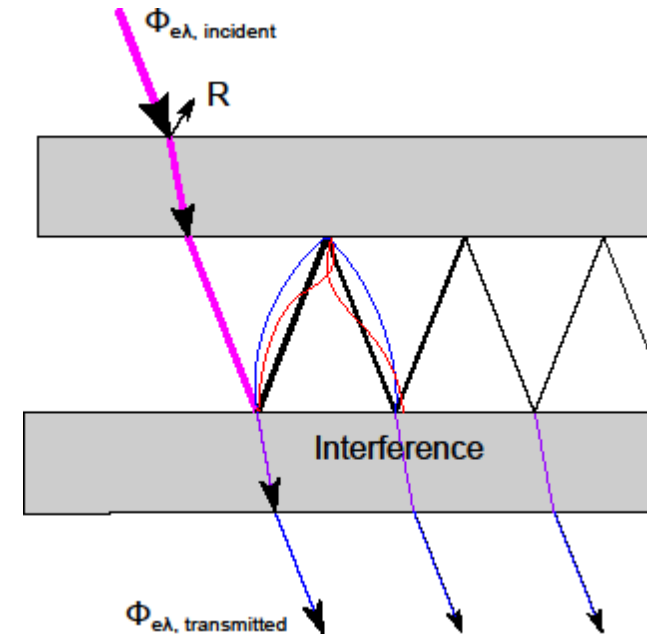
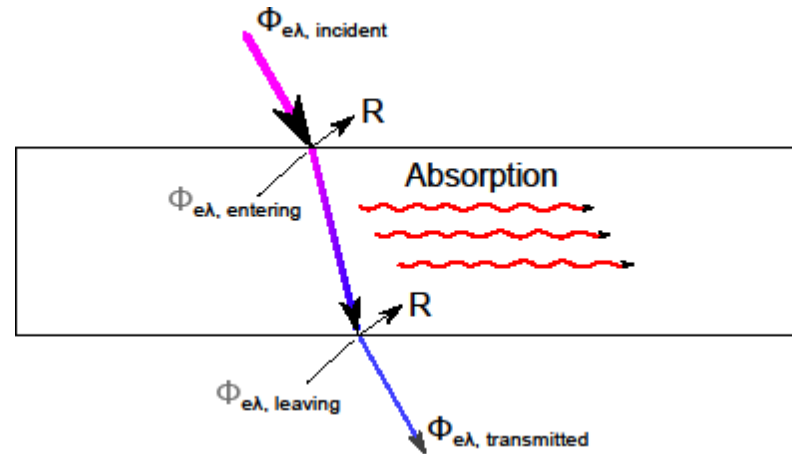
\begin{landscape}
\begin{table}
\renewcommand{\arraystretch}{1.5}
\centering
\begin{tabular}{|c|c|c|c|c|c|c|c|c|c|}
\hline
\multirow{2}{*}{Site} & \multirow{2}{*}{Sample} & \multirow{2}{*}{Depth} & \multicolumn{5}{c}{{\dot{D}} [Gy/ka]} & \multirow{2}{*}{De [Gy]} & \multirow{2}{*}{Age [ka]} \\
\cline{4-8}
& & & \alpha [Gy/ka] & \beta [Gy/ka] & \gamma [Gy/ka] & Dc [Gy/ka] & Tot. [Gy/ka] & & \\
\hline
DRAC-example & Quartz & 2.22 ± 0.05 & 0 ± 0 & 1.56 ± 0.129 & 1.298 ± 0.103 & 0.154 ± 0.015 & 3.012 ± 0.166 & 20 ± 0.2 & 6.642 ± 0.371 \\
\hline
\end{tabular}
\end{table}
\end{landscape}

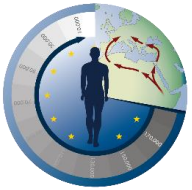
```



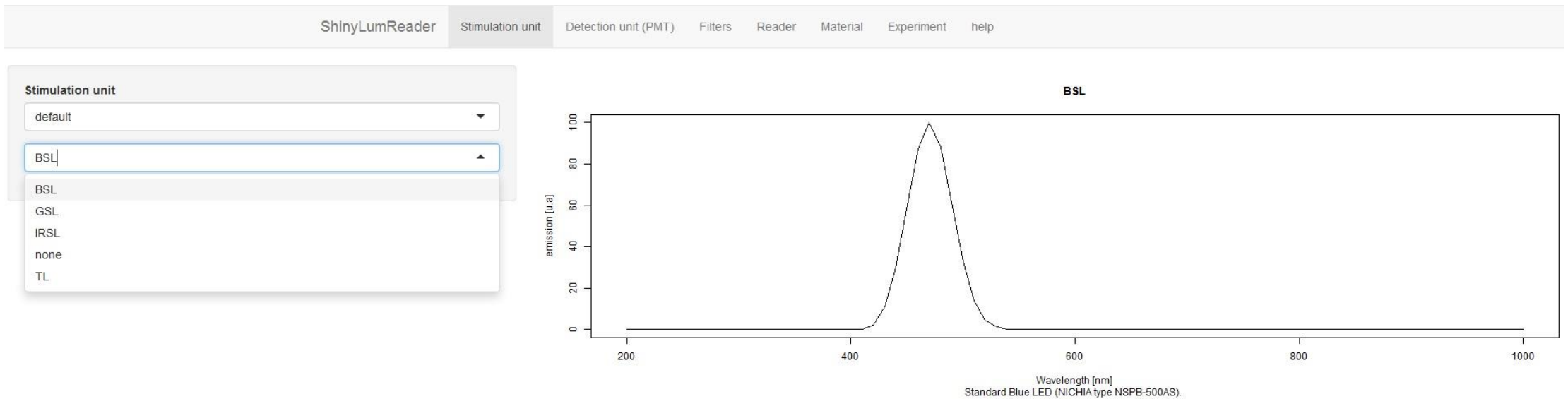
# *shinyLumReader*: The *LumReader* package

- Reader
  - Stimulation unit
    - TL vs. OSL
  - Detection unit
    - PMT
  - Filters
    - Absorption filter
    - Interference filter
- Experiment
  - Reader + Material
- Material
  - TL properties
  - OSL properties

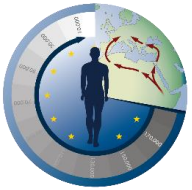




# *shinyLumReader:* Simulating a luminescence experiment

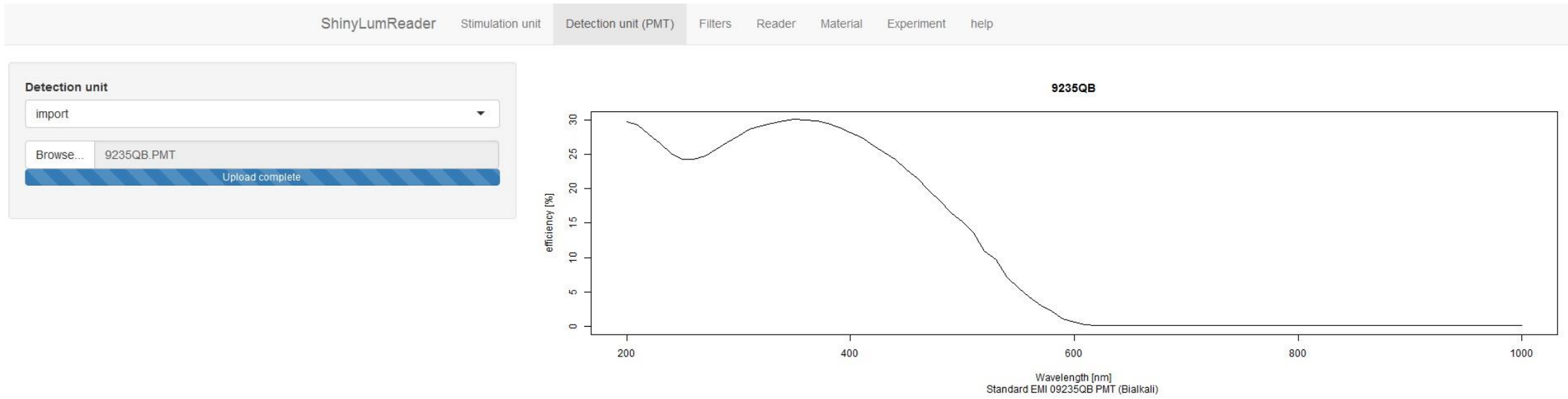


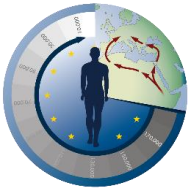




# shinyLumReader:

## Simulating a luminescence experiment





# shinyLumReader: Simulating a luminescence experiment



ShinyLumReader   Stimulation unit   Detection unit (PMT)   **Filters**   Reader   Material   Experiment   help

**Name**  
BSL

**Description**  
BSL filters

**Number of filters (max. 4)**  
2

**1st filter**  
shiny  
U340   4.3 [mm]

**2nd filter**  
shiny  
none   1 [mm]

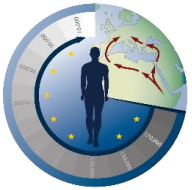
- BG18
- BG3
- BG39
- GG400
- GG420
- HA3
- none

**U340**

Transmission [%]  
Wavelength [nm]  
U - 340 (Daybreak)

**BSL**

Transmission [%]  
Wavelength [nm]  
BSL filters



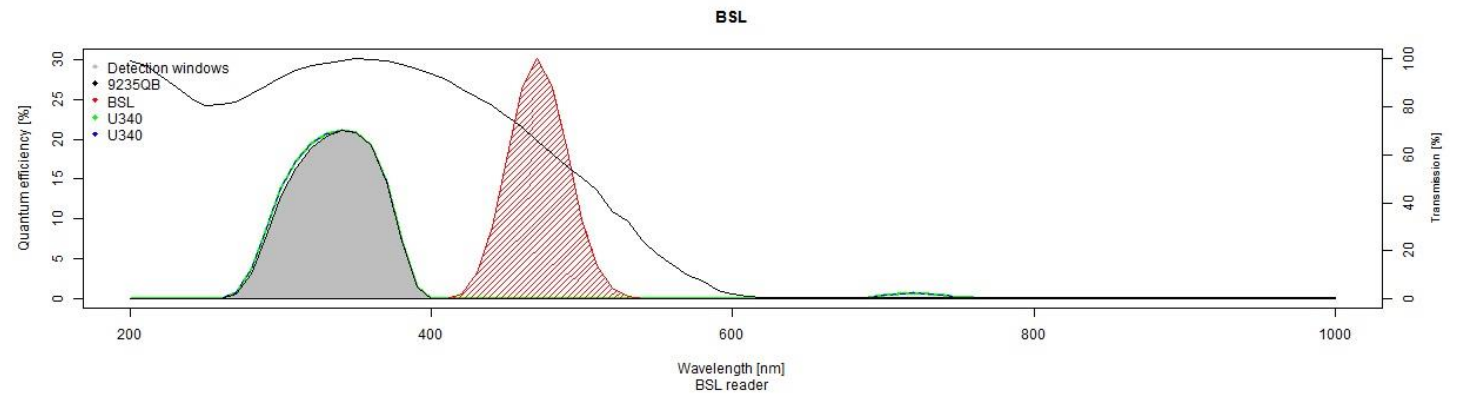
# *shinyLumReader:* Simulating a luminescence experiment

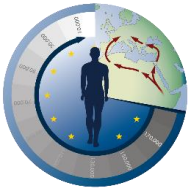


ShinyLumReader Stimulation unit Detection unit (PMT) Filters **Reader** Material Experiment help

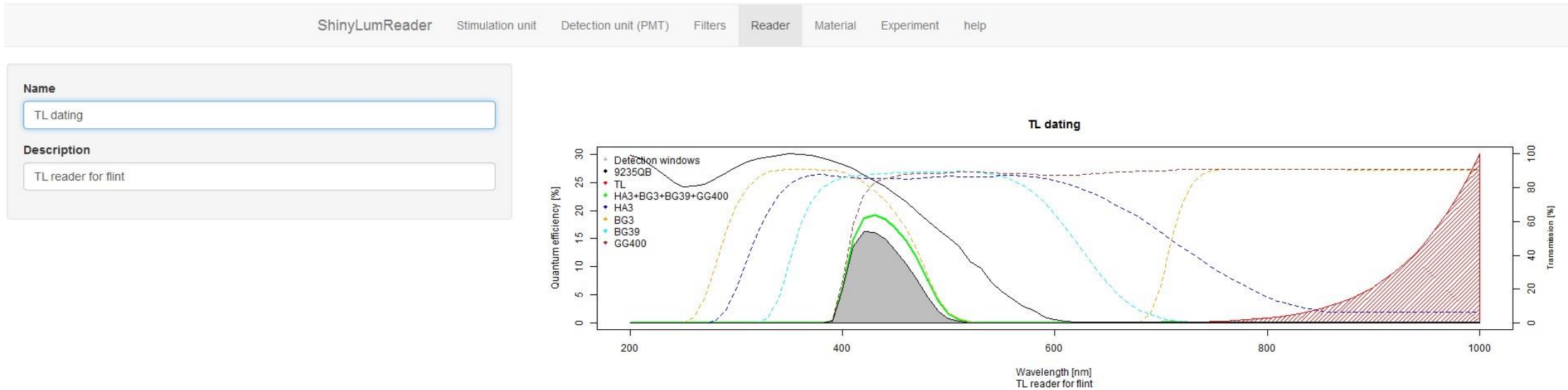
**Name**

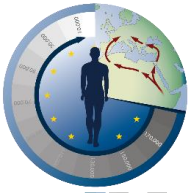
**Description**





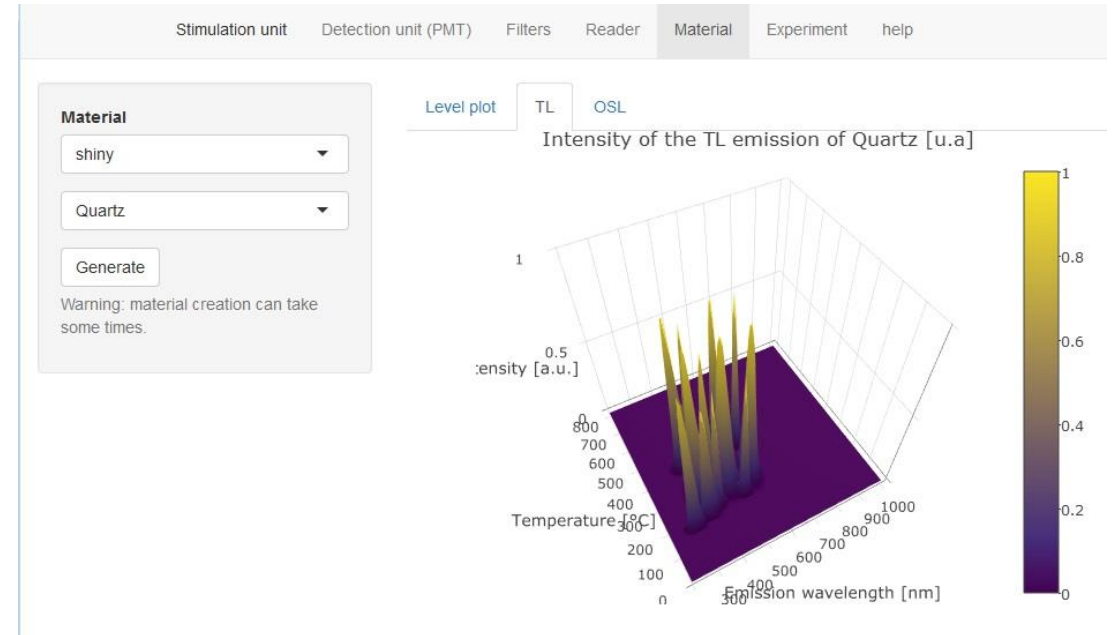
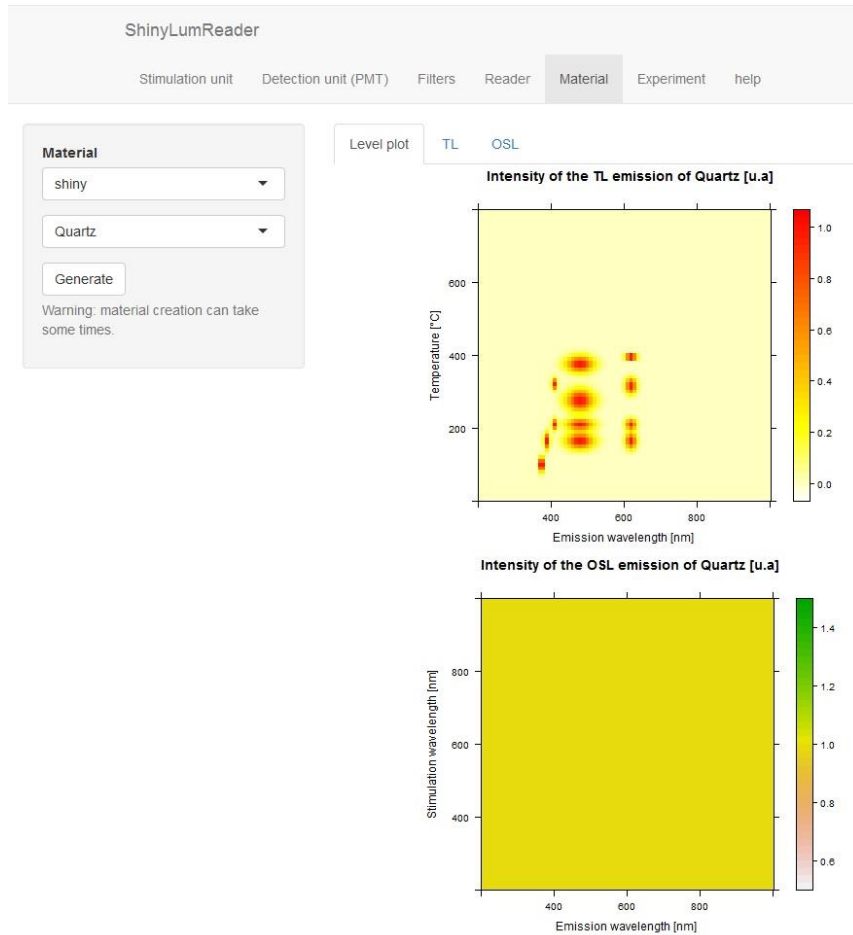
# shinyLumReader: Simulating a luminescence experiment

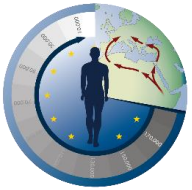




# shinyLumReader:

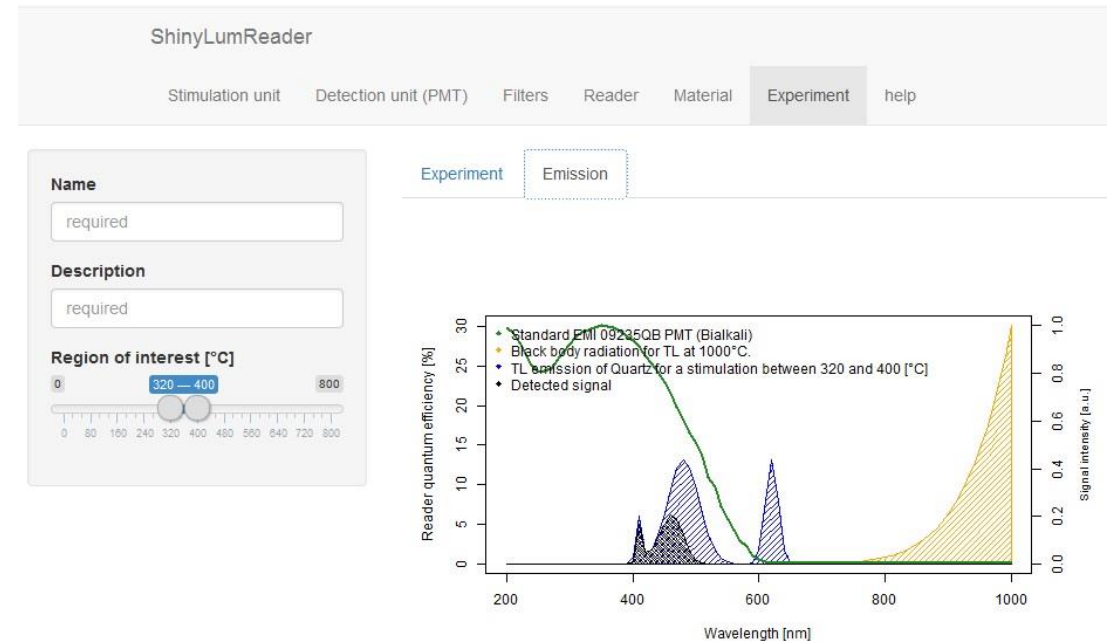
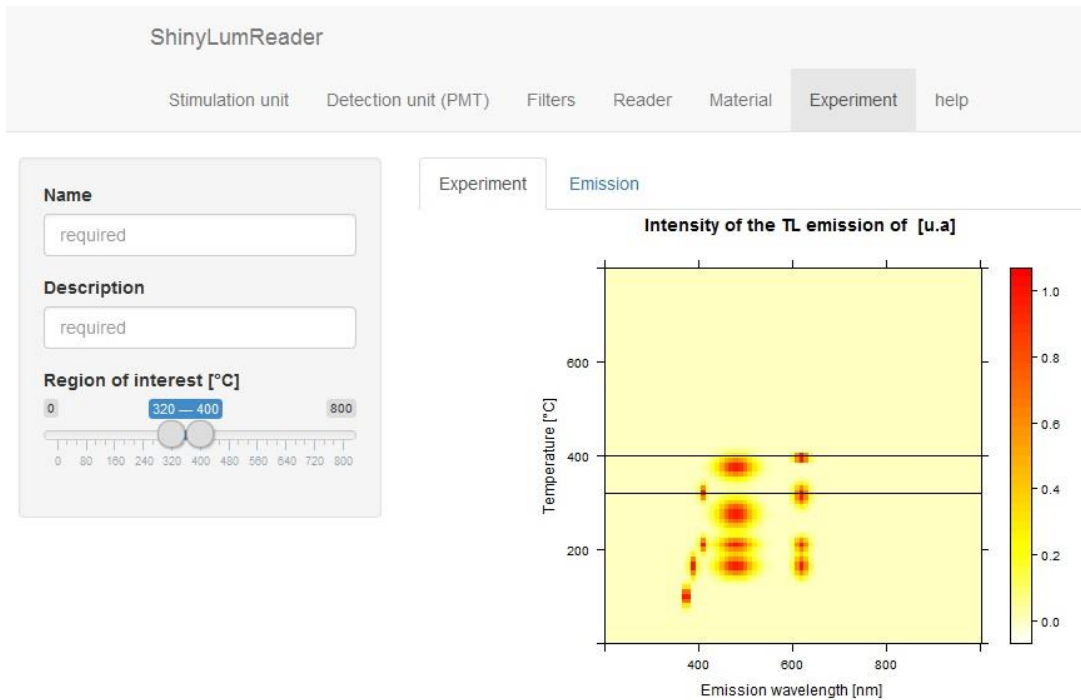
## Simulating a luminescence experiment

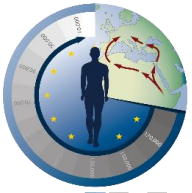




# shinyLumReader:

## Simulating a luminescence experiment





# ShinyTLdating

- Luminescence

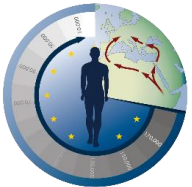
- Import files → BINX
- OSL  $D_e$  → SAR
- Stats & plots for SAR results
  - Abanico plot,...

- TLdating

- Pretreatment
  - Remove PH, subtract BG, align peaks
- TL  $D_e$ 
  - SAR || MAAD
  - Growth curve || dose plateau
- drac4flint & drac4ceramic

- ShinyTLdating

- 'All inclusive'
  - $D_e$  estimation
    - SAR || MAAD
  - a-value estimation
    - SAR || MAAD
  - $\dot{D}$  estimation
    - DRAC
  - Age calculation
- Graphical user interface
  - No script or function to write
  - Easy to modify input parameters
  - Interactive



# ShinyTLdating:

## An app 'all inclusive'



shinyTLdating **Sample information** Equivalent dose a-value Annual dose rate Age help

Welcome in ShinyTLdating

**General information**

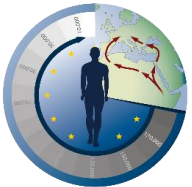
**Project**

**Site**

**Sampling year**

**Sample name**





# ShinyTLdating:

## An app 'all inclusive'



shinyTLdating

Sample information   **Equivalent dose**   a-value   Annual dose rate   Age   help

File   Pretreatment   Analyse    $D_e$

**Protocol**  
MAAD

**File extension**  
.binx

**Import file**  
Browse... TAI\_1\_Q\_CG\_TL\_MAA  
Upload complete

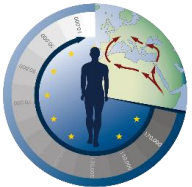
**Parameter for the uncertainties (k)**  
1

Generate data  
Data generated

**TL signal**

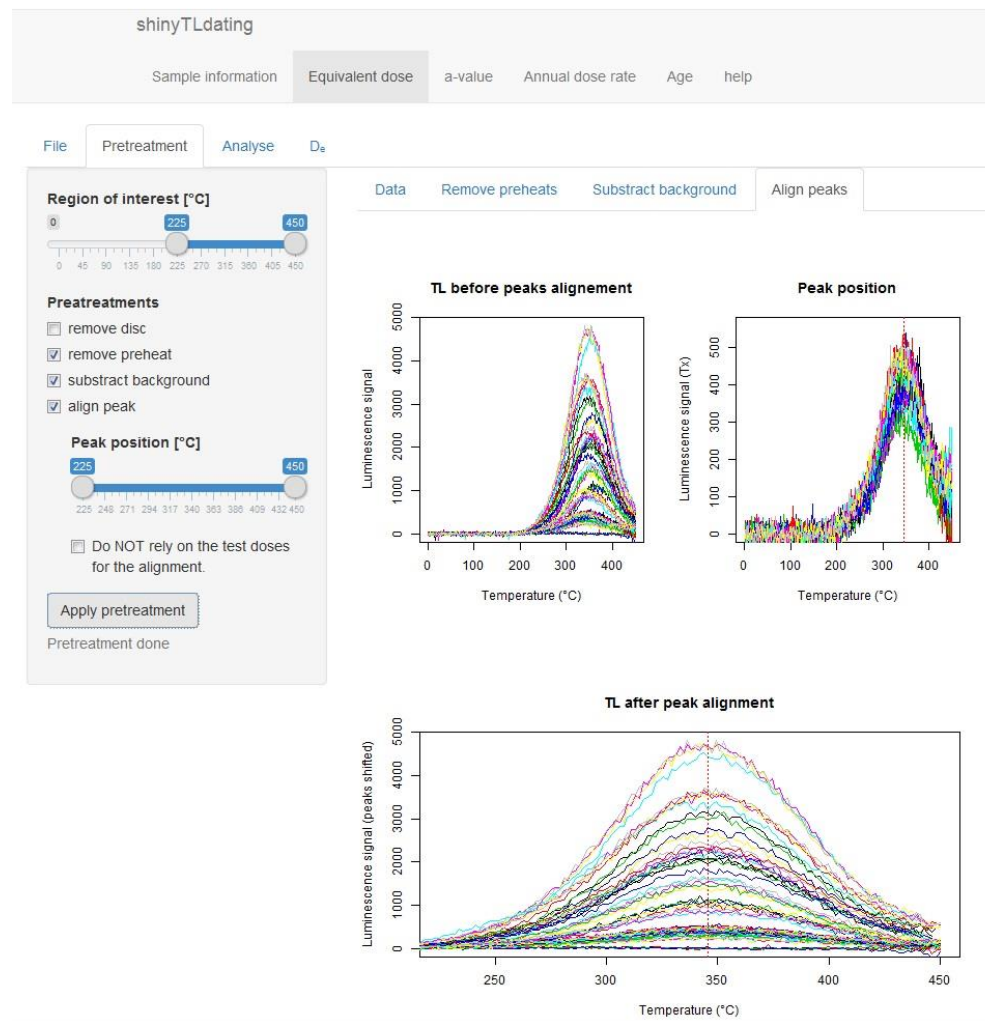
Luminescence signal

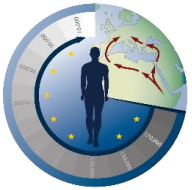
Temperature (°C)



# ShinyTLdating:

## An app 'all inclusive'





# ShinyTLdating:

## An app 'all inclusive'



shinyTLdating   Sample information   **Equivalent dose**   a-value   Annual dose rate   Age   help

File   Pretreatment   **Analyse**   D<sub>e</sub>

**MAAD**

Integration interval [°C]

225 320 370 450

225 248 271 294 317 340 363 386 409 432 450

**Fitting parameters**

**Fitting method**

LIN

Weight fitting

Reuse Q slope for I

**Additive dose interval [s]**

0 600

0 60 120 180 240 300 360 420 480 540 600

**Regenerative dose interval [s]**

0 600

0 60 120 180 240 300 360 420 480 540 600

**Rejection criteria**

Maximum palaeodose error [%]

10

Maximum testdose error [%]

10

Start De estimation

Analyse done

data   Additive doses   Regenerative doses   **Results**

**D<sub>e</sub> plateau - Palaeodose (Q)**

Dose (s)

Temperature (°C)

Q = 211.6 ± 2.39 (1.13%)

**D<sub>e</sub> plateau - supralinearity corr. (I)**

Dose (s)

Temperature (°C)

I = 10.6 ± 1.21 (11.46%)

**D<sub>e</sub> growth curves**

Signal (nT/m)

Dose (s)

Q (GC) = 213.33 ± 4.89 (2.29%) | I (GC) = 12.4 ± 1.61 (13%)

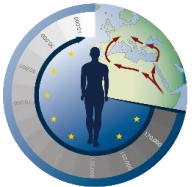
**Rejection criteria**

Q: Lx error (max): 3.5%  
Tx error (max): 7.15%

I: Lx error (max): 3.88%  
Tx error (max): 7.07%

**Curve fitting (GC): Linear (weighted)**  
y = a + bx

a (Q) = 2.56e+00 ± 3.18e-02  
b (Q) = 1.2e-02 ± 1.55e-04



# ShinyTLdating:

## An app 'all inclusive'



shinyTLdating   Sample information   **Equivalent dose**   a-value   Annual dose rate   Age   help

File   Pretreatment   Analyse   **D<sub>e</sub>**

**Display parameters**

**Uncertainty**  
absolute

**D<sub>e</sub> selection**

**Approach**  
growth curve

**Equivalent dose**  
D<sub>e</sub>

**Conversion factor [Gy/s]**

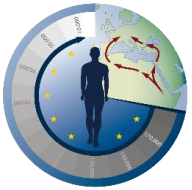
$\dot{D}_\beta$     $\delta D_\beta$   
0.1058   0

Convert D<sub>e</sub>  
D<sub>e</sub> defined

Approach	Q	I	D <sub>e</sub>
DP	211.6 ± 2.39	10.6 ± 1.21	222.2 ± 2.68
GC	213.33 ± 4.89	12.4 ± 1.61	225.73 ± 5.15

Sample	Aliquots	D <sub>e</sub> [Gy]
TAI 1	24	23.883 ± 0.545



# ShinyTLdating:

## An app 'all inclusive'



shinyTLdating   Sample information   Equivalent dose   **a-value**   Annual dose rate   Age   help

File   Pretreatment   Analyse   **a-value**

Display parameters

Uncertainty: absolute

Plot: abanico

$D_e$  selection

Approach: growth curve

Method selection: weighted

Average Selection: mean

Uncertainty Selection: sd

Equivalent dose conversion

$\dot{D}\beta$  [Gy/s]: 0.1003    $\delta\dot{D}\beta$ : 0

**$\alpha$  dose**

$\alpha$  [s]: 720    $\delta\alpha$ : 0

$\dot{D}\alpha$  [Gy/s]: 0.197    $\delta\dot{D}\alpha$ : 0

Calculate a

a calculated

Abanico Plot

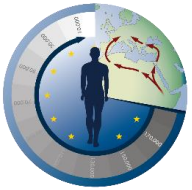
Dose plateau approach

$D_e$  distribution  
n = 12 | mean = 248.33 | abs. sd = 22.31

Growth curve approach

$D_e$  distribution  
n = 12 | mean = 252.2 | abs. sd = 22.19

Sample	Alliquots	$\alpha$ [Gy]	$\beta$ [Gy]	a-Value
TAI 1	12	141.84 ± 0	25.295 ± 2.226	0.178 ± 0.016



# ShinyTLdating:

## An app 'all inclusive'



shinyTLdating

Sample information   Equivalent dose   a-value   Annual dose rate   Age   help

Data    $\hat{D}$

**General parameters**

**Context**  
flint

**Mineral**  
Q

**Conversion factor**  
Lirtzisetal2013

**Alpha size attenuation factor**  
Brennanetal1991

**Beta size attenuation factor**  
Guerinetal2012-Q

**Beta etch attenuation factor**  
Brennan2003

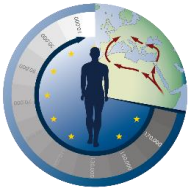
$\hat{D}$  estimation  
 $\hat{D}$  calculated

**Flint information**  
 $\hat{D}$  based on:  
 radioelement concentration  
 direct measurement

**Sediment information**  
 $\hat{D}$  based on:  
 radioelement concentration  
 direct measurement

**Dc information**  
 $\hat{D}$  based on:  
 geographical position  
 in-situ measurement

<b>U [ppm]</b> 1.21	<b><math>\delta U</math></b> 0.01	<b>U [ppm]</b> 0.7	<b><math>\delta U</math></b> 0.05	<b>Latitude</b> 32	<b>Longitude</b> 35
<b>Th [ppm]</b> 0.02	<b><math>\delta Th</math></b> 0.01	<b>Th [ppm]</b> 2.83	<b><math>\delta Th</math></b> 0.18	<b>Altitude [m]</b> 700	
<b>K [%]</b> 0.21	<b><math>\delta K</math></b> 0.01	<b>K [%]</b> 0.16	<b><math>\delta K</math></b> 0.01	<input checked="" type="checkbox"/> field change correction <input checked="" type="checkbox"/> Scale for shallow depth	
<input checked="" type="checkbox"/> Rb from K		<input checked="" type="checkbox"/> Rb from K		<b>Depth [m]</b> $\bar{z}$ 3 $\delta z$ 1	
<b>Grain size [<math>\mu m</math>]</b> min 100   max 200		<b>Density [mg/mm<sup>3</sup>]</b> $\rho$ 1.8 $\delta \rho$ 0.1			
<b>Etch depth [<math>\mu m</math>]</b> min 0   max 0		<b>Water content <math>m = (W-D)/D</math> [%]</b> $m$ 5 $\delta m$ 2			
<b>a-value</b> $a$ 0.178 $\delta a$ 0.016					
<b>density</b> $\rho$ 2.65 $\delta \rho$ 0.2					



# ShinyTLdating:

## An app 'all inclusive'

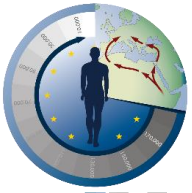


shinyTLdating

Sample information   Equivalent dose   a-value   Annual dose rate   **Age**   help

<b><math>D_e</math></b>	<b><math>\delta D_e</math></b>
23.883	0.545
<b><math>\dot{D}</math></b>	<b><math>\delta \dot{D}</math></b>
1.338	0.321

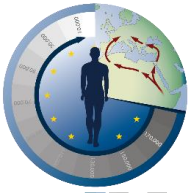
Project	Site	Year	Sample	$D_e$ [Gy]	$\dot{D}$ [Gy/ka]	Age [ka]
CRC 806	Taibeh	2010	TAI 1	23.883 ± 0.545	1.338 ± 0.321	17.85 ± 4.302



# Conclusion & outlook

- 3 new apps
  - *ShinyDRAC* → <https://dstreble.shinyapps.io/shinyDRAC/>
  - *ShinyLumReader* → <https://dstreble.shinyapps.io/shinyLumReader/>
  - *ShinyTLdating* → <https://dstreble.shinyapps.io/shinyTLdating/>
- Work in progress
  - *Database for ShinyLumReader*
  - *More geometries for ShinyDRAC*
  - *More fitting methods for ShinyTLdating*
  - *Multiple samples*
- Just the beginning
  - *ShinyOSLdating*
  - *ShinyESRdating*
- *Complete toolbox for luminescence dating.*

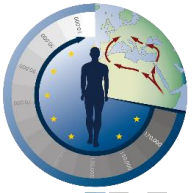




# Acknowledgment

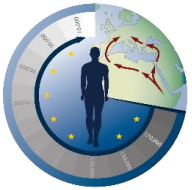
- This project was realized in the context of the CRC 806 “Our way to Europe” funded by the German Research Foundation (DFG).





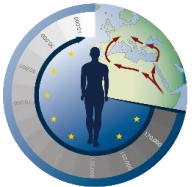
# Bibliography

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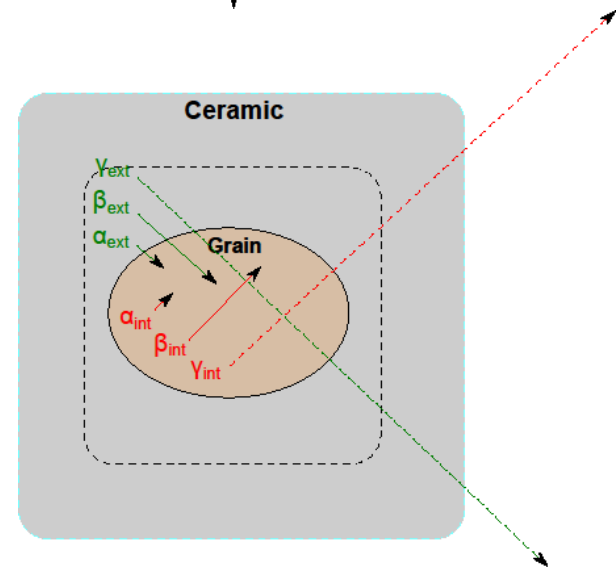
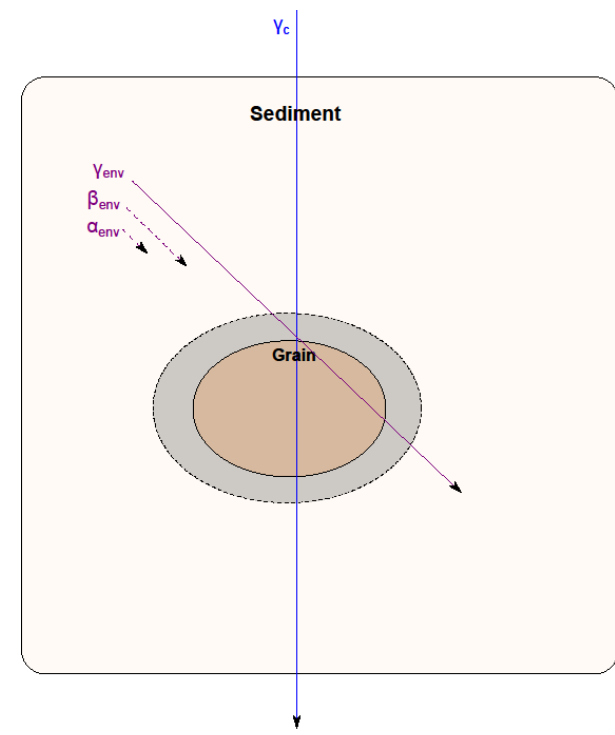
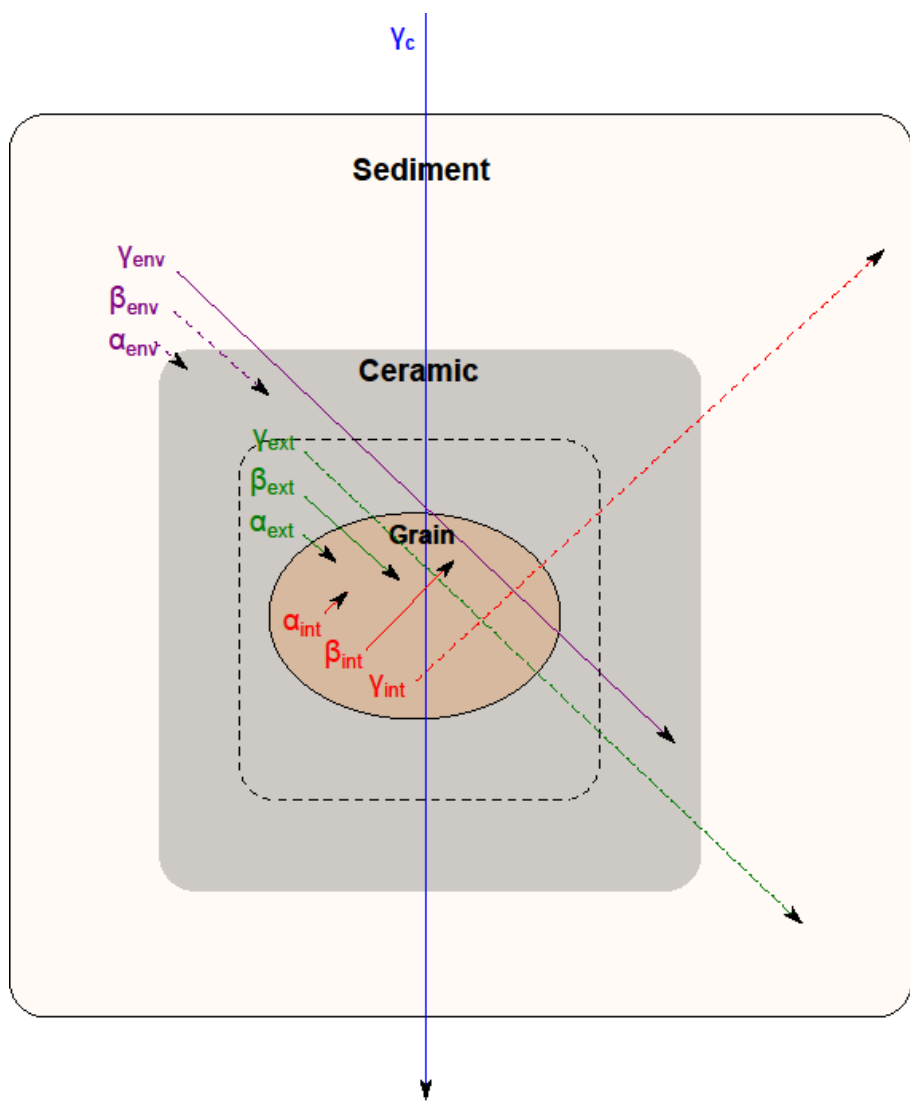


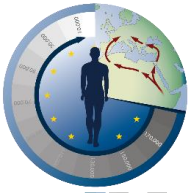
# Complementary material





# shinyDRAC: *drac4ceramic* & *drac4flint*





- Web links
  - Shiny
    - *ShinyLumReader*
      - <https://dstreble.shinyapps.io/shinyLumReader/>
    - *ShinyDRAC*
      - <https://dstreble.shinyapps.io/shinyDRAC/>
      - Github: [https://github.com/dstreble/shiny\\_DRAC](https://github.com/dstreble/shiny_DRAC)
    - *ShinyTLdating*
      - <https://dstreble.shinyapps.io/shinyTLdating/>
      - Github: [https://github.com/dstreble/shiny\\_TLdating](https://github.com/dstreble/shiny_TLdating)
  - R Package
    - *LumReader*
      - Github: <https://github.com/dstreble/LumReader>
    - *TLdating*
      - CRAN: <https://CRAN.R-project.org/package=TLdating>
      - Github: <https://github.com/dstreble/TLdating>
    - Luminescence
      - CRAN: <https://CRAN.R-project.org/package=Luminescence>
      - Github: <https://github.com/R-Lum/Luminescence>
  - DRAC
    - <https://www.aber.ac.uk/en/iges/research-groups/quaternary/luminescence-research-laboratory/dose-rate-calculator/>
    - Github: <https://github.com/DRAC-calculator/DRAC-calculator>