kSEMAWc software

Spectrophotometric (SP), Ellipsometric (ELI) and photothermal deflection spectroscopy (PDS) Measurements Analysis Workbench

k stands for the use of Qt libraries
c stands for full C++ language

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Summary

Part I - what is kSEMAWc intended for?

Part II - some software details:

- Language and libraries
- Where to find it?
- Installation

Part III – How to use it?

Part I : what is it for?

kSEMAWc deals with optical devices

- composed by layers (from 1 to 9) of
- homogeneous or not (EMA, graded index, ect.) materials
- thin ($d \leq \frac{\lambda^2}{\Delta\lambda}$) or thick,
- with plane and parallel interfaces,
- eventually, with moderate roughness ($\sigma \ll \lambda$)

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kSEMAWc can:

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3) **Evaluate** mean value of Transmittance / Reflectance weighted on a given international or customized spectrum (D65, ASTM-G173, etc.)

Part I : what can do?

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kSEMAWc can:

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2) **Calculate** complex refractive index (n – i k) and thickness of a given thin layer, when the surrounding layers are known

3) **Evaluate** mean value of Transmittance / Reflectance weighted on a given international or customized spectrum (D65, ASTM-G173, etc.)

4) **Predict** Transmittance / Reflectance once a realistic or an equivalent model of the optical device has been set

Part II : some details

Language: full C++ (since v1.0.0)

Graphical User Interface: based on Qt library

Plots: based on Qwt library

Non linear least square: C/C++ MINPACK library, for Levenberg-Marquardt algorithm

Distribution: free open source under GNU v3 license

Downloadable from

https://github.com/mmonty1960/ksemaw

mmonty1960 / ksemaw

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gsl-2.7.zip	ksemawc-v2.1	7 months ago
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manuale_ksemawc_V2.5.pdf	v2.5	2 months ago

README | GPL-3.0 license

ksemaw_v2.6

About

kSEMAW: a workspace for the analysis of Spectrophotometric (SP), Ellipsometric (ELI) and Photothermal Deflection Spectroscopy (PDS) measurements

Readme
GPL-3.0 license
Activity
2 stars
1 watching
0 forks

Releases 11

v2.6 Latest
yesterday

+ 10 releases

Packages

Part II : the Workspace

Please note: users are asked to download the whole

Workspace

folder, containing:

- source files
- configuration files
- exemplary data files
- MS Windows executable

and

- MS launcher
- user-manual
- ORE paper with some use cases

Part II : installation

Option #1: compilation of source files

- OS: Linux, MS Windows, Mac (not tested)
- For MS Windows, preliminary installation of MinGW
- Libreries: Qt, Qwt, C/C++MINPACK
- Qt Creator (IDE): load `ksemawc.pro` and compile

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Option #2: only in MS Windows

Click on

`ksemawc_WinExecLauncher.bat`

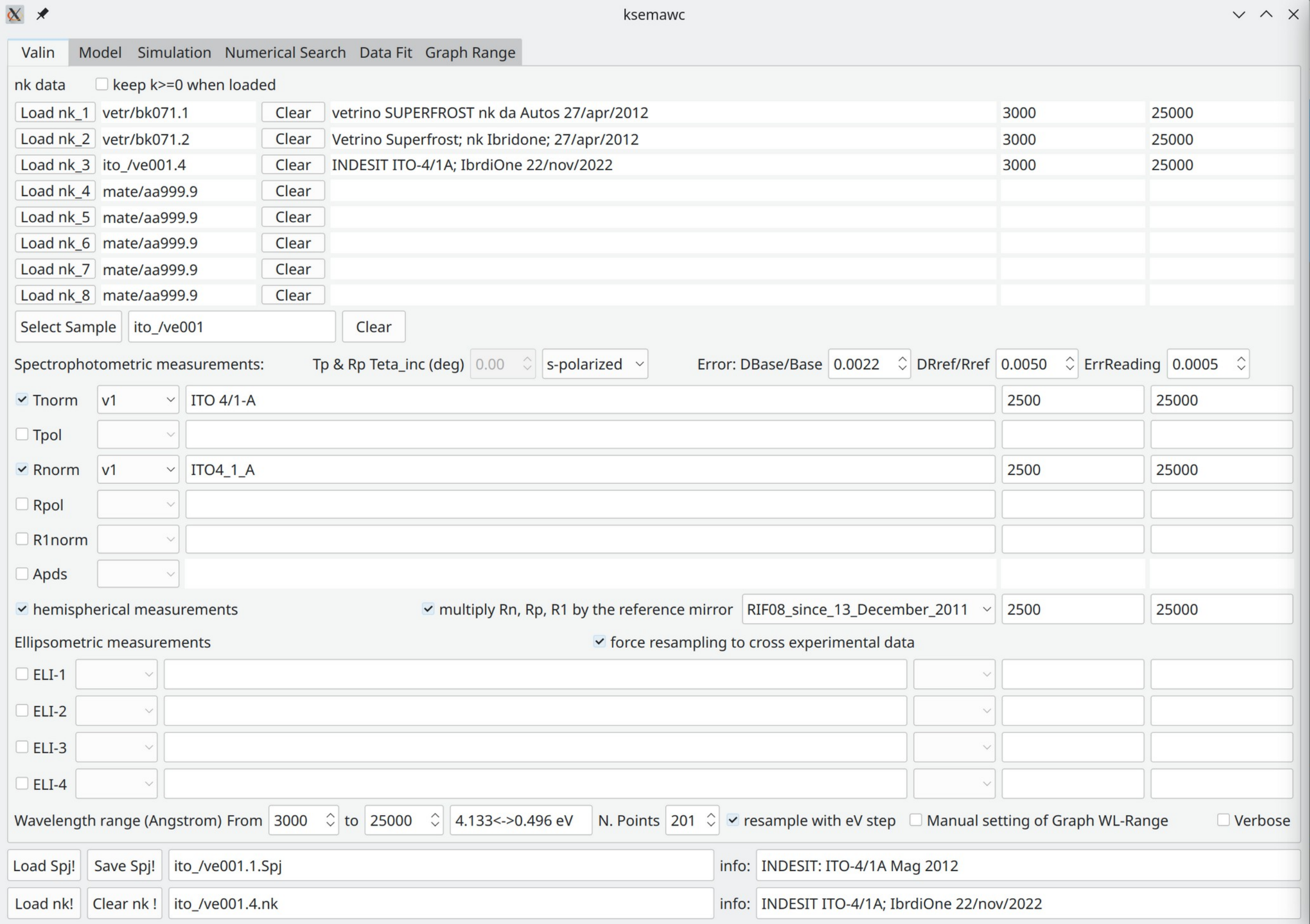
Part III : please note

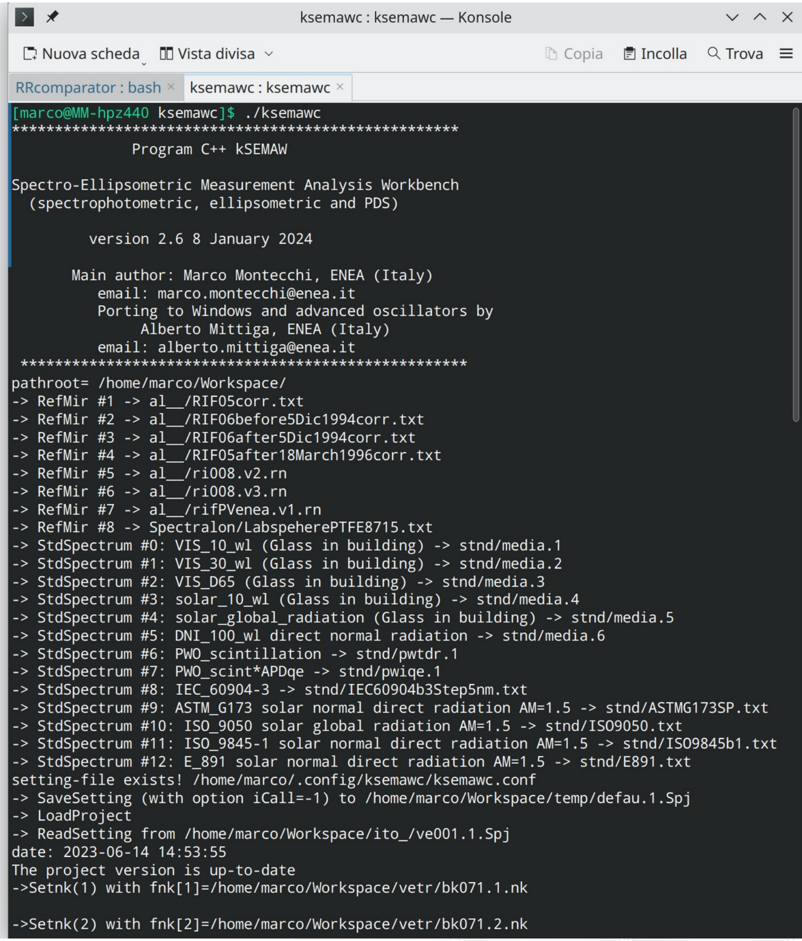
Important points:

- kSEMAWc works embedded in the Workspace folder
- All data files concerning a given optical device should be named with a unique code, adding suitable extensions (see the manual)
- Since version 1.0.0, kSEMAWc offers 3 different approaches for evaluating the unknown complex refractive index:

1) **Exhaustive Numerical search** in λ-n space
2) **Standard Fit** method
3) **IbridOne** method (best-fit of R / Ψ with *n* modeled by oscillators, and k computed to reproduce T spectrum)

Part III : GUI and terminal



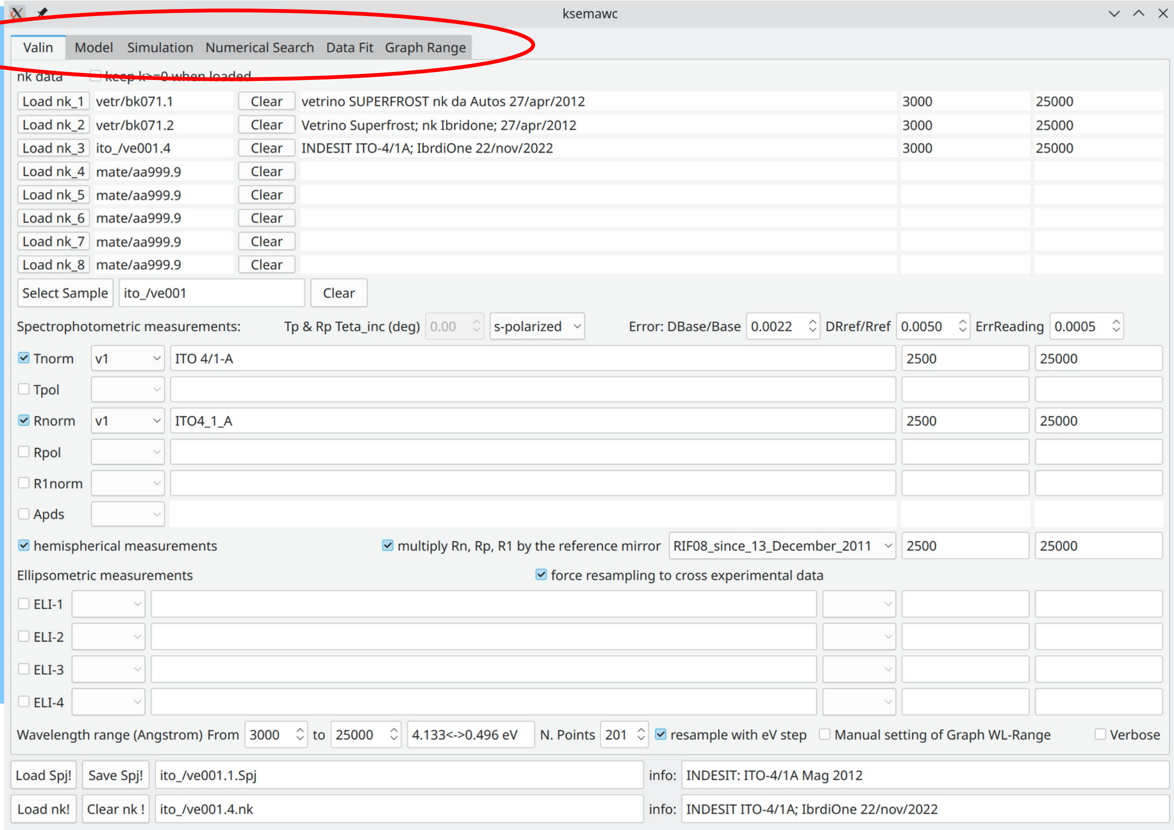


Part III : initial GUI -Valin tab

GUI organized in 6 tabs

<u>ordered according to the workflow</u>:

1) **Valin**: load known *nk*-files and experimental spectra, re-sampled on 201 points (default)
2) **Model**: set the model of the optical device
3) **Simulation**: set and draw simulations
4) **Numerical Search**: search in **n-k space @ λ** or exhaustive solution search in λ-*n* space
5) **Data Fit**: standard best fit or IbridOne
6) **Graph range:** plot and GUI grahic managment



Part III : Model tab

Layered model
(max 9 layers)

Type of layer:

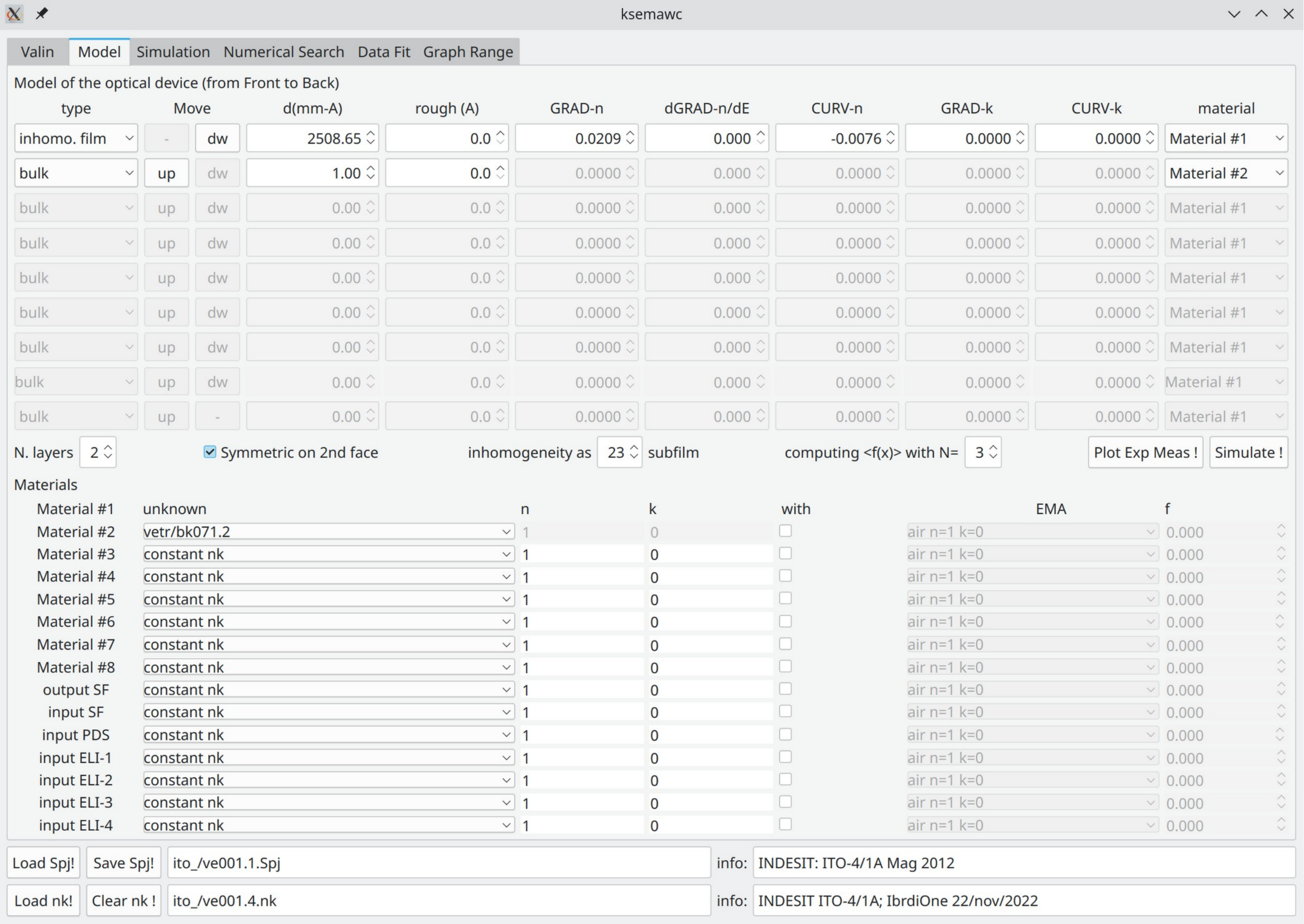
1) bulk = thick = incoherent interfaces

2) homo. film = thin film

3) inhomo. film = graded-index thin film

Materials (up to 8):
are set in Material#J
(<u>#1 is the unknown !</u>)

Then, “material” has to be assigned for each layer

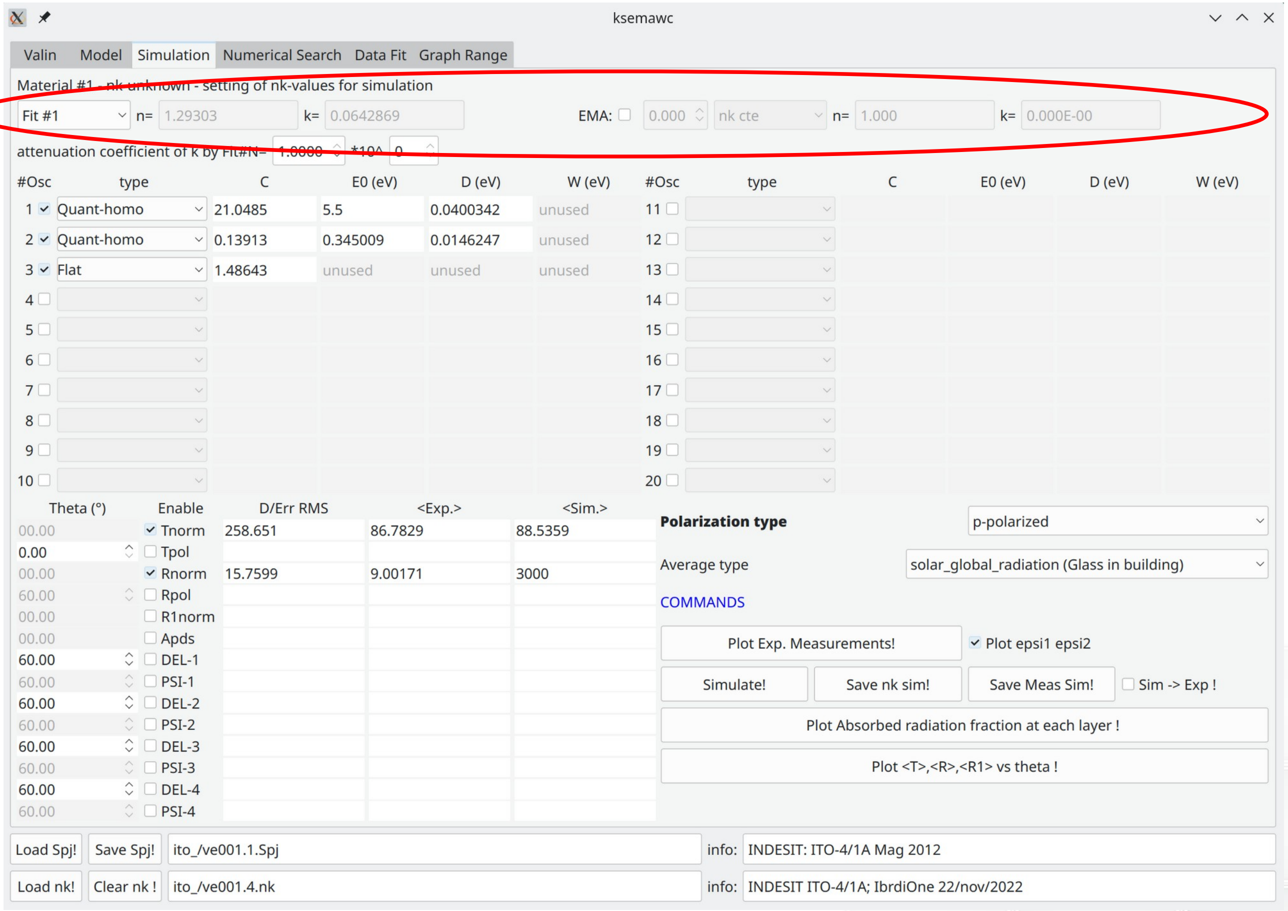


Part III : Simulation tab

To compare simulated with experimental
nk-unknown has to be set among:

- Constant nk
- Fit #M   1≤M≤7
- *Nk*-file #M   1≤M≤8
- Nk-DataFit from the last computation

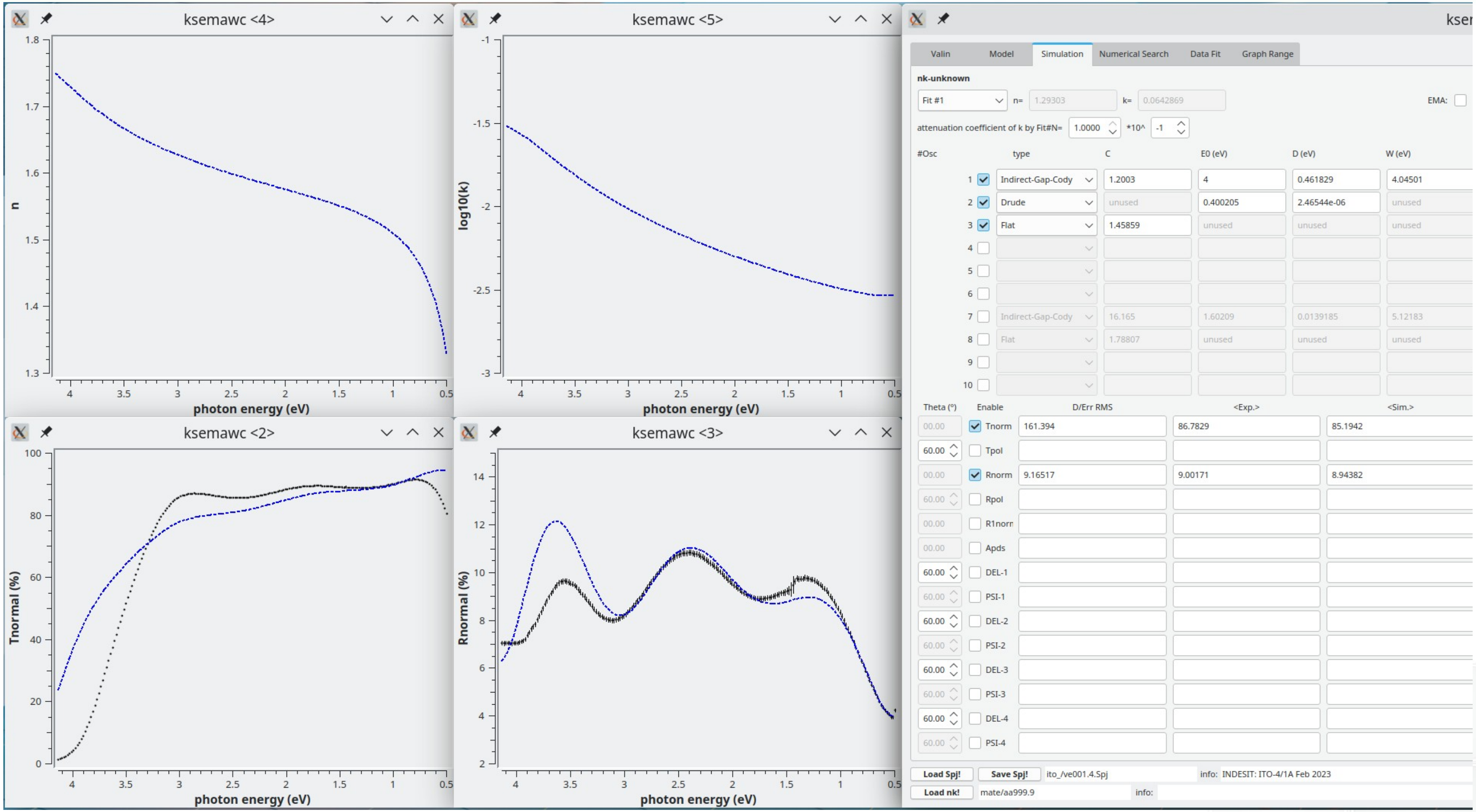
Two different materials can be combined according to the Effective Medium Approximation



Available actions:

1) Plot **experimental** spectra
2) Plot **simulated** spectra
3) **Set the weights** for computing mean values
4) Plot **mean values** versus **incidence angle**
5) Plot **Absorptance at each layer**

Part III : Simulation tab

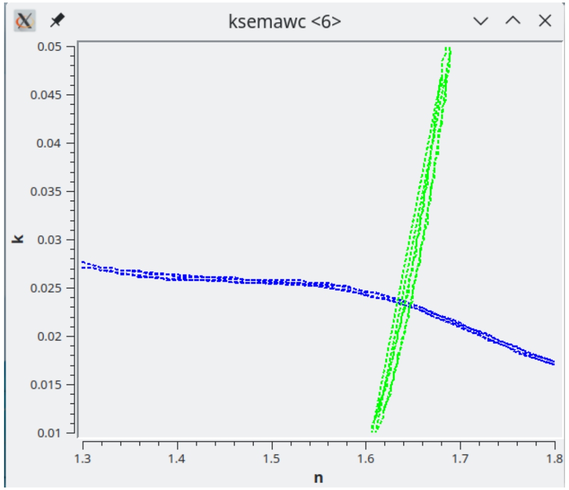


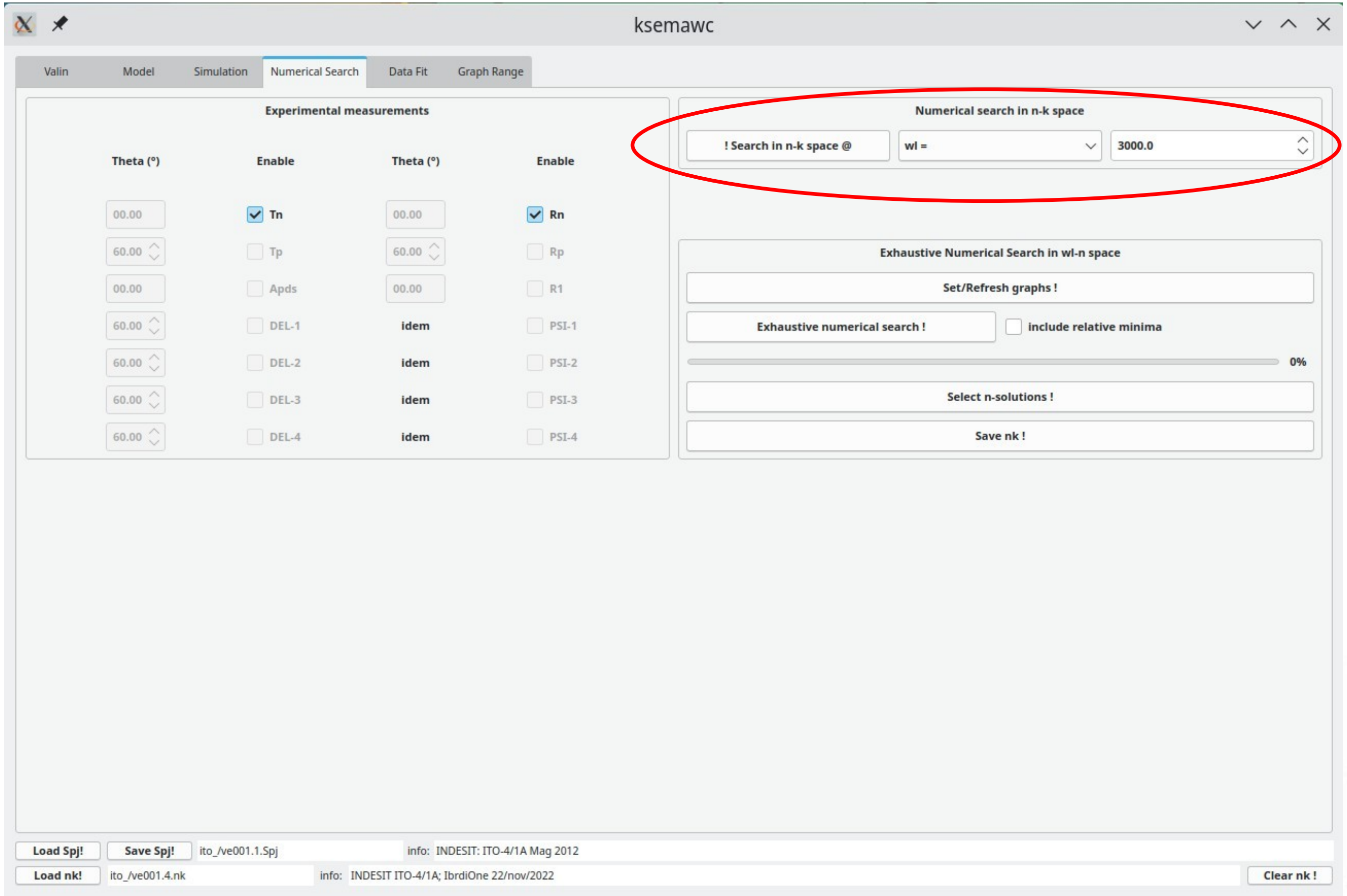
Part III : Numerical Search

Numerical search of solution *n-k*

Available methods:

1) Search in **n-k space @** λ



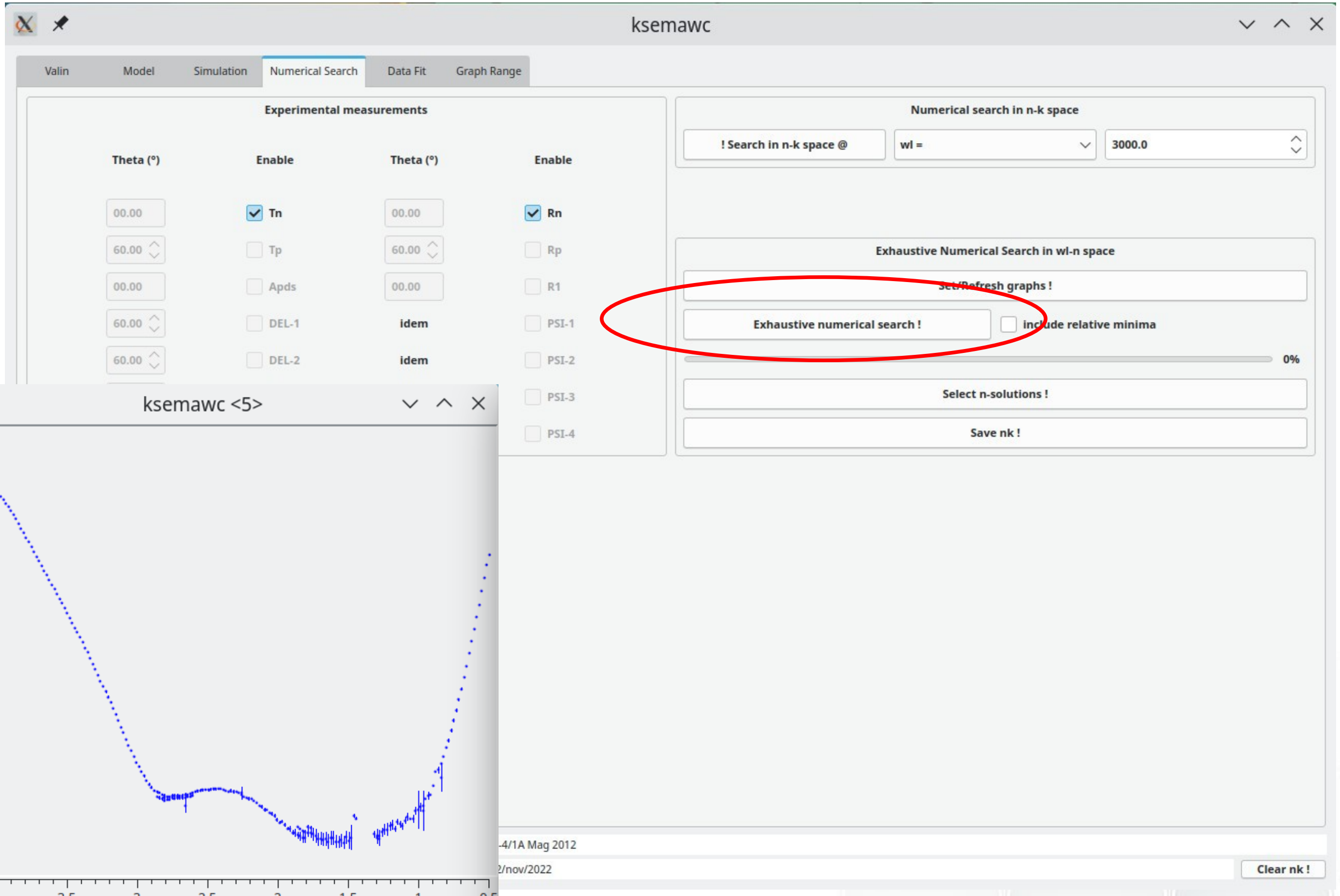


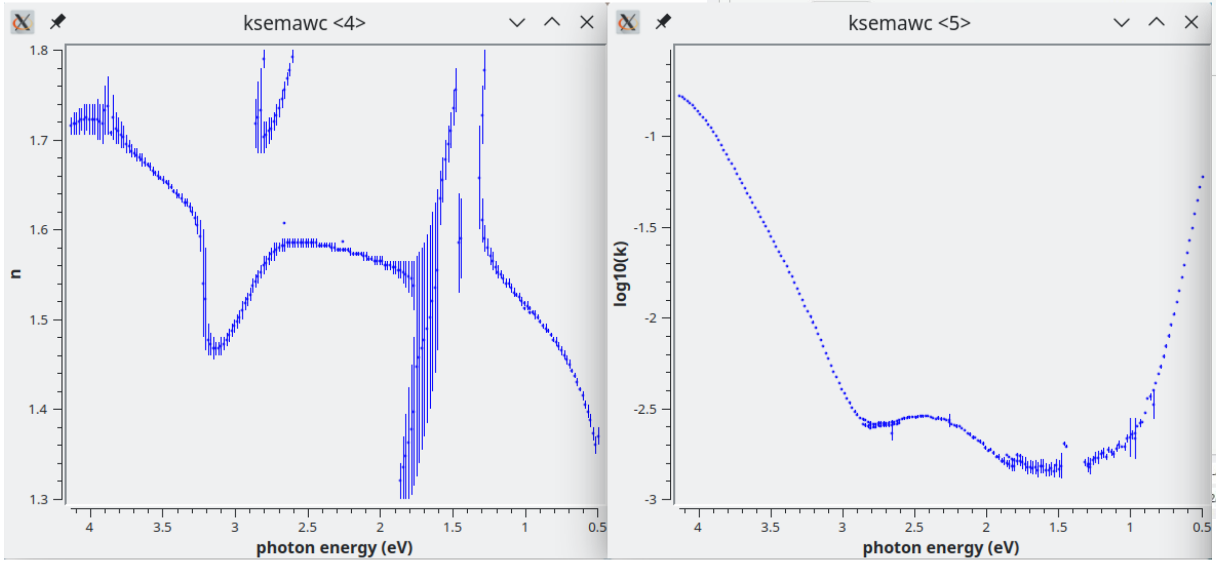
Part III : Numerical Search

Numerical search of solution *n-k*

Available methods:

1) Search in **n-k space @ λ**
2) Exhaustive numerical search in **λ-n** space





Part III : Data Fit tab

Available actions:

1) Fit of ***n*** data

2) Fit of ***n*** and ***k*** data

3) Fit of ε_1 and ε_2 data

4) Fit of experimental spectra

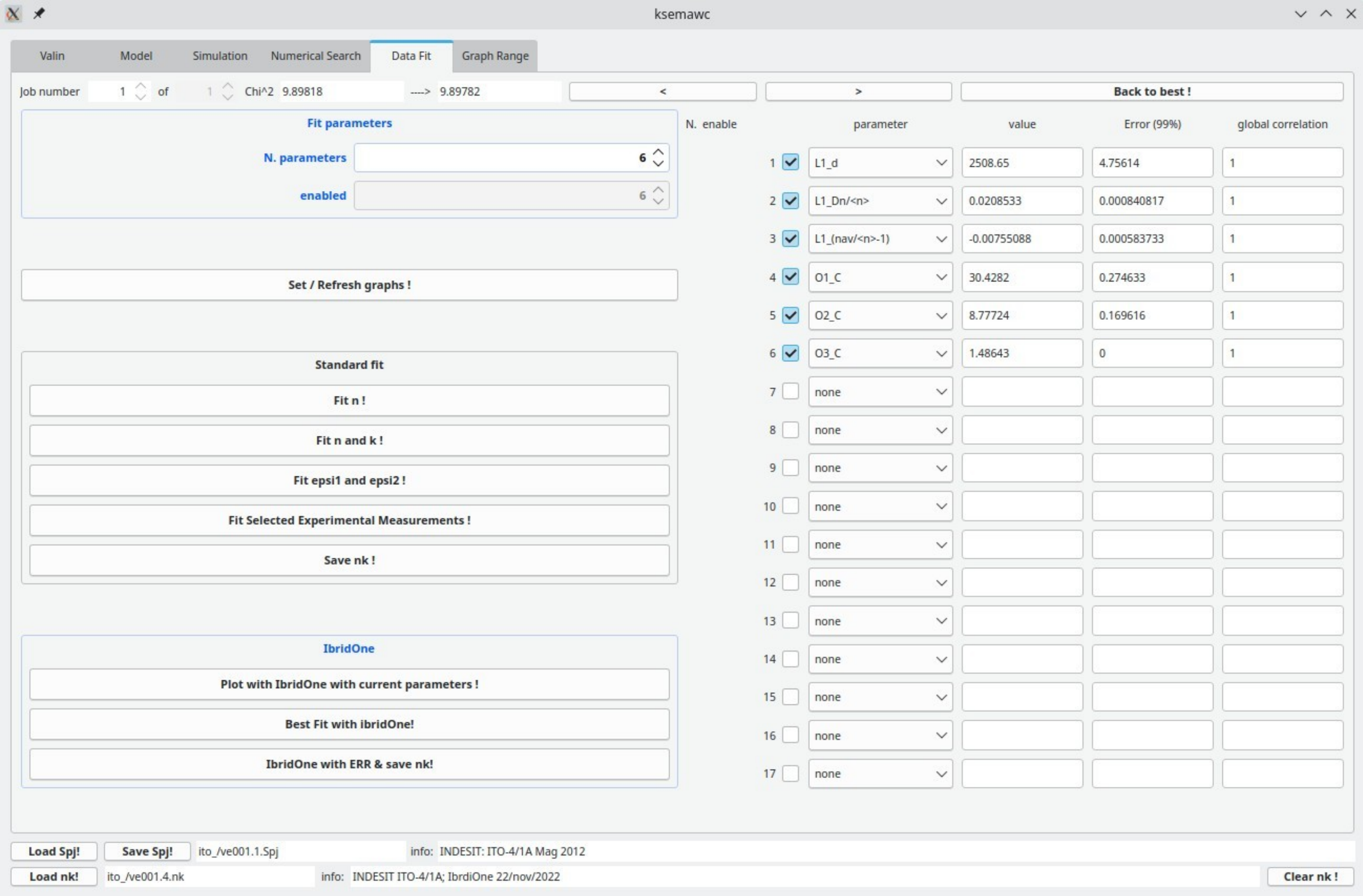
5) IbridOne:

Step-1: fit $R(\lambda)$ with

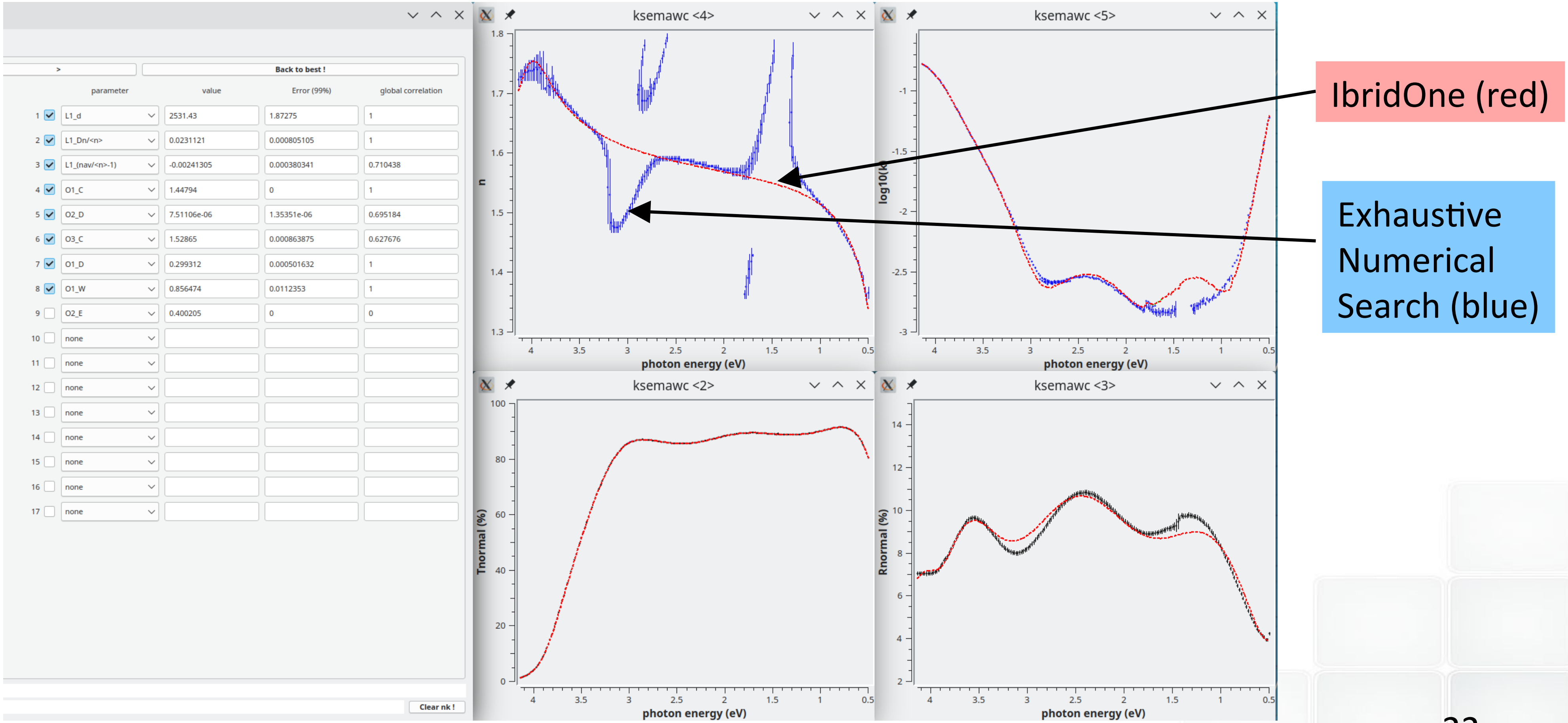
$$n = n(\lambda, p_1, p_2, .., p_M)$$

Step-2: compute $k(\lambda)$ from $T(\lambda)$ given $n(\lambda)$

Called by Levenberg-Marquardt



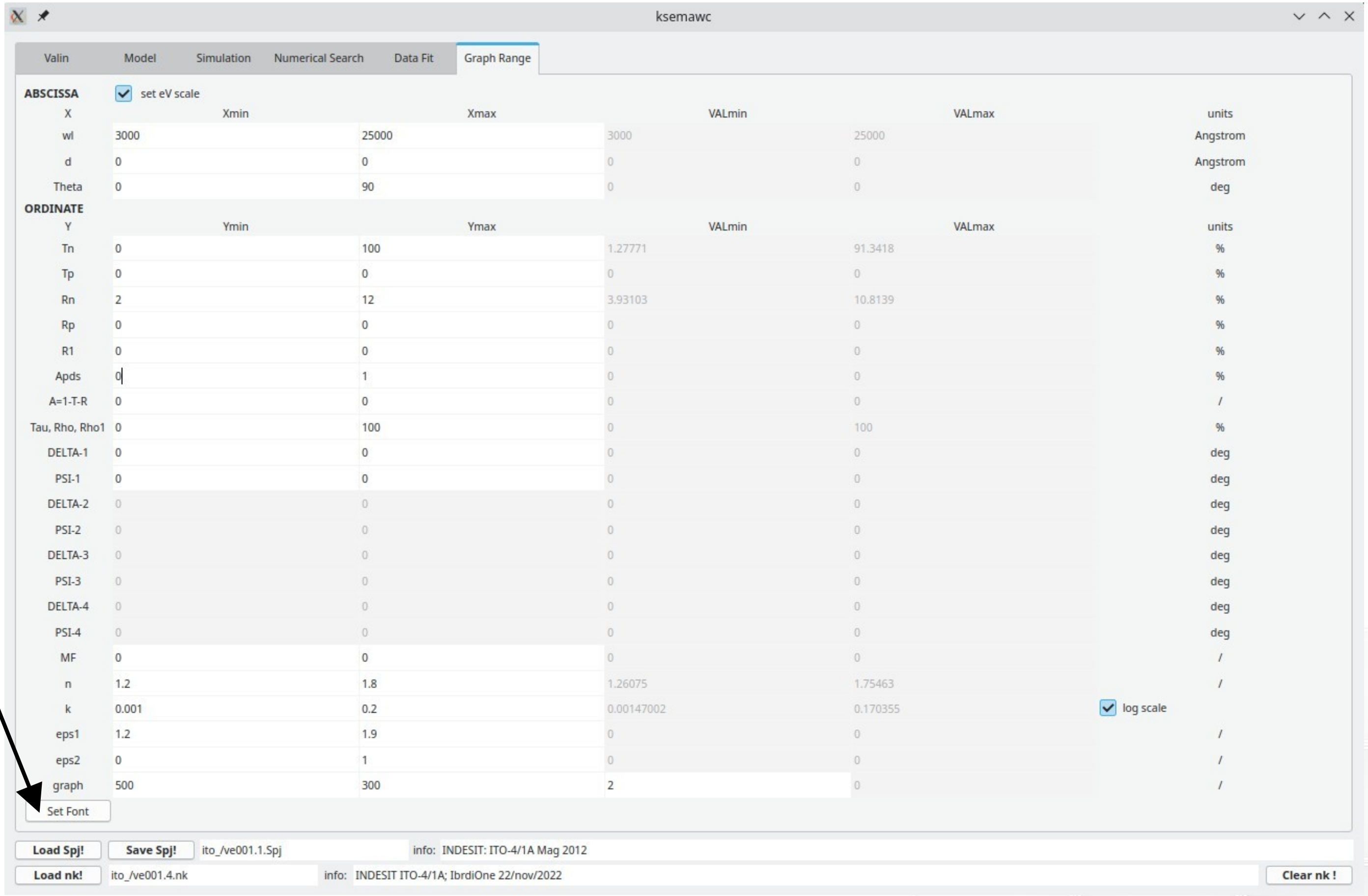
Part III : Data Fit tab



Part III : Graph Range tab

Option management of

- Plots (X-Y range, Energy/Wavelength abscissa, log scale for *k*)
- GUI (font type and size)



How can you help?

BETA-TESTER:

1) **Testing kSEMAWc and reporting bugs**

2) **Proposing improvements to make GUI and usage clearer**

3) **Asking for new features (of general relevance)**

4) ...

Anyone interested in participating at any level is welcome!

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Computer experts:

- **Testing installation from source**
- **Improving the code structure**
- ...

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Contributors

Alberto Mittiga, for his factual collaboration in improving optical constant models about electronic transitions in materials with continuous state density, in the Windows porting as well as in the drafting of the manual

Enrico Nichelatti, for the wise search for analytical solutions of the integrals on the density of the states, as well as for the transfer in LaTex of this manual

Claudia Malerba and Francesca Menchini, for their constant goad to test and improve kSEMAWc to characterize semiconductor materials

Francesco Biccari, for his useful suggestions for simplifying the software distribution

Luca Serenelli, for his support in outlining the Linux installation procedure

What’s next?

Alberto Mittiga, will present an overview of the oscillators used for modeling the dielectric constant

You can ask for further webinars on specific topis, for instance

- Substrate characterization
- Dielectric thin film characterization
- Semiconductor thin film characterization
- ….