

Introduction to software

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SOPRALAB

II - WINSE SOFTWARE



II - WINELLI II SOFTWARE



III - SOPRA R&D SOFTWARE



WINSE SOFTWARE



- Full measurements
- Basic analysis
- Recipe buiding

Two working modes :

- Engineer Mode
 - Buiding recipe
 - Measuement testing
 - Basic analysis testing
- Operator Mode
 - Loading recipe
 - Fully automatic measurement and analysis

Starting Screen



10/3/2008 5:49:22 PM

MASTER

SYSTEM AWAITING PROCESS

Log Off

Logged In : maintenance Maintenance SOPRA Visible

Product : Unknown Job : default

Calibration Sopra TMI

Start

Abort

Lot Information

Lot ID Time Start End

Sample N* Samples 0

Sample Measurement

Time Points

AUTOMATIC GONIO

Angle	69.26	°
Critical Angle	78.00	°

SAMPLE POSITION

X	0.00	mm
Y	0.00	mm
Z	0.00	μm

Automatic Recipe Manual Result Setup Tools Data Log Users Alarms

Recipe loading

Start Measure and Analysis

MASTER

10/3/2008 5:47:24 PM

SOPRA

Log Off

Logged In :

maintenance

Maintenance SOPRA

Visible

NEED INITIALIZATION

Product : Unknown

Job : default

Automatic Display Switch

Initialization

Start

Abort

Status

Focus Signal

Measurement Graph

Results

Graphics

Lot Informations

Lot ID

Time

Start

End

Sample N°

Samples

0

Sample Measurement

Start

Time

Points

AUTOMATIC GONIO

Angle

-0.00

°

Critical Angle

78.00

°

SAMPLE POSITION

X

0.00

mm

Y

0.00

mm

Z

0.00

µm

Automatic

Recipe

Manual

Result

Setup

Tools

Data Log

Users

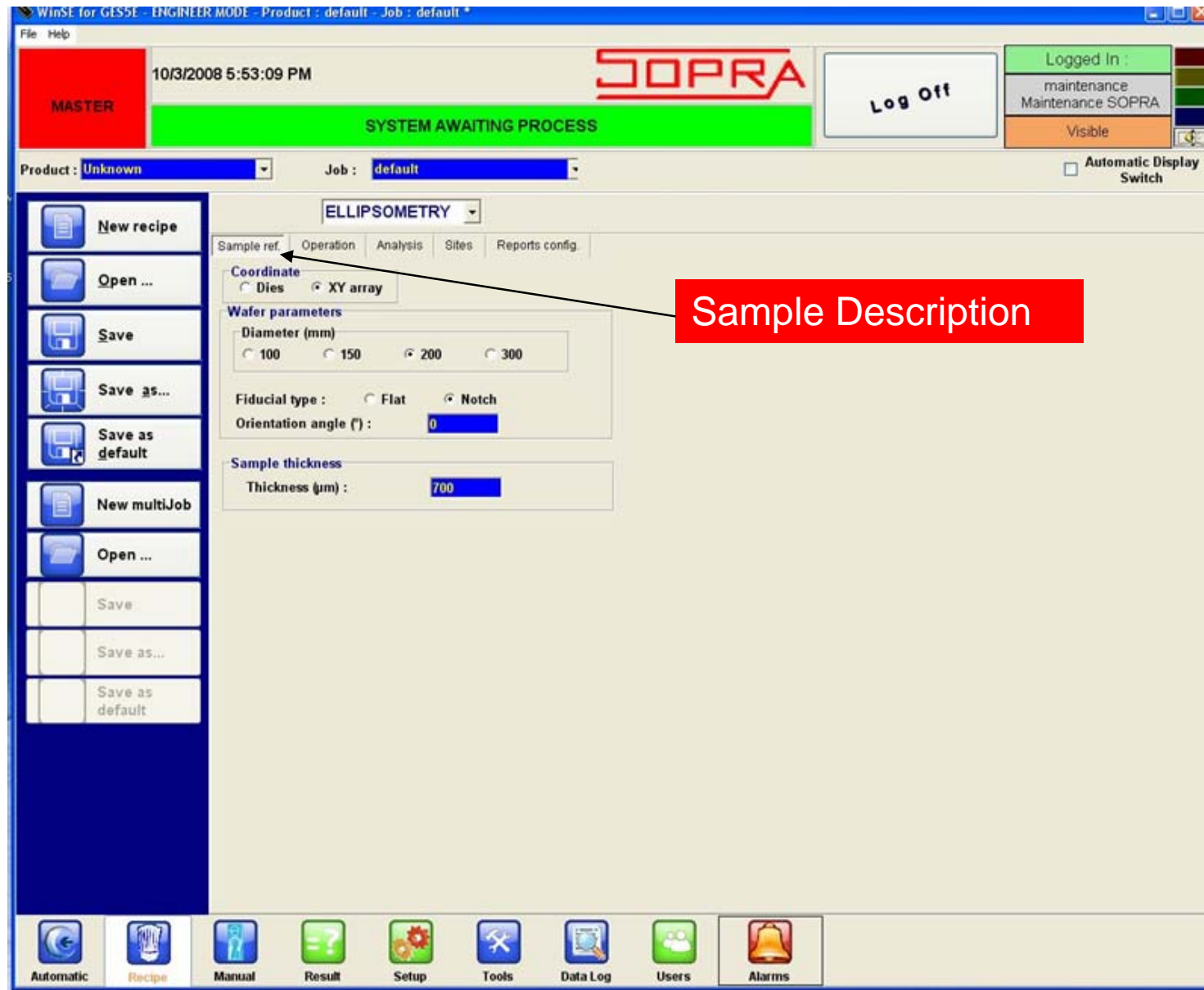
Alarms

First : Initialisation

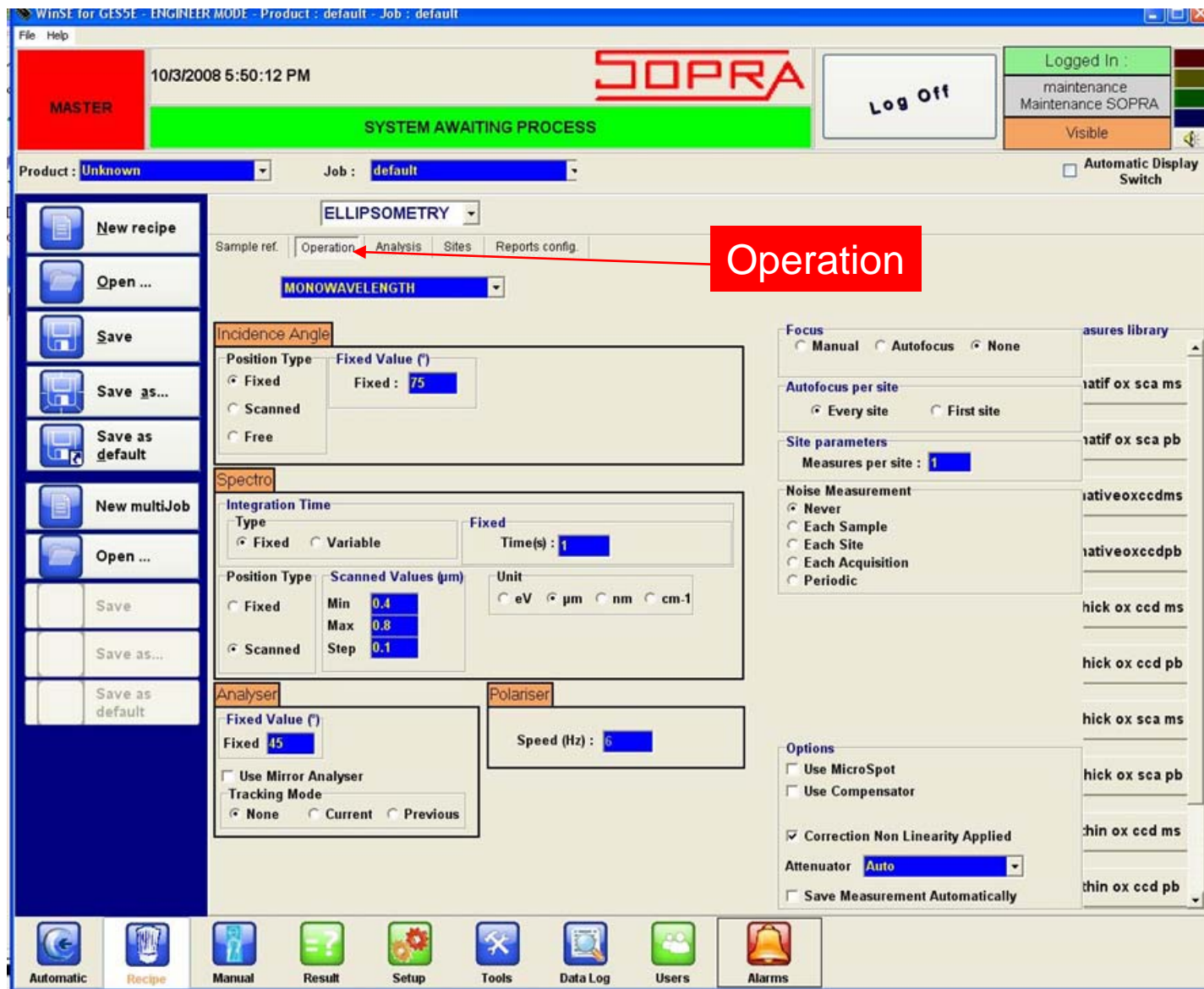
Define recipe

step by step measurement and analysis

How to define a recipe



How to define a recipe



How to define a recipe

WinSE for GESSE - ENGINEER MODE - Product : default - Job : default

File Help

10/3/2008 5:51:03 PM

MASTER

SYSTEM AWAITING PROCESS

Log Off

Logged In : maintenance Maintenance SOPRA Visible

Product : Unknown Job : default

ELLIPSOmetry

Sample ref. Operation Analysis Sites Reports config.

Layers Regression

Number of layers : 1

Layer	Component	Component	Concentration (%)			Thickness (Å)		
			Value	Min	Max	Value	Min	Max
1	Cauchy (n,k)	PARAMETER	0			5000	0	0

Sub SICRIR

Add new layer Delete bottom layer

Offsets...

Regression Type

None Winse Winelli

Film Stacks library

reference-68

Automatic Recipe Manual Result Setup Tools Data Log Users Alarms

Analysis

Definition of the model

How to define a recipe

The screenshot displays the WinSE for GESSE - ENGINEER MODE interface. At the top, a status bar shows the date and time (10/3/2008 5:51:36 PM) and the system status (SYSTEM AWAITING PROCESS). The main window is divided into several sections:

- Left Panel:** Contains a vertical toolbar with buttons for 'New recipe', 'Open ...', 'Save', 'Save as...', 'Save as default', 'New multiJob', and 'Open ...'. Below these are 'Save', 'Save as...', and 'Save as default' buttons.
- Top Bar:** Includes a 'Log Off' button and a 'Logged In' status indicator showing 'maintenance Maintenance SOPRA' and 'Visible'.
- Main Area:**
 - Product:** Unknown
 - Job:** default
 - Analysis Tab:** The 'Analysis' tab is selected, showing the 'ELLIPSOMETRY' analysis type. The 'Regression' sub-tab is active, displaying the 'Definition of the fitted parameters'.
 - Regression Settings:**
 - Total pass number:** 1
 - Number:** 1 / 1
 - Regression on:** Alpha Beta (selected), Tan(psi) Cos(delta), Pseudo Dielectric
 - Incidence angle:** Angle (°): 75 (Default)
 - Spectral range:** Start limit (eV): 0.14, End limit (eV): 0.6, Nb points: 100, Filter: OFF
 - Regression Limit Parameter:** Max. iteration: 20, Max. value: 0.00001, Delta: 0.0001
 - Deactivate aperture correction:** Alarm Gof: 0.1
 - Component Table:**

Layer	1	2	Concent.	Thick.
Cauchy La			0	5000
Sub	SICRIR			
- Bottom Panel:** Contains a row of icons for 'Automatic', 'Recipe', 'Manual', 'Result', 'Setup', 'Tools', 'Data Log', 'Users', and 'Alarms'.

How to define a recipe

MASTER 10/3/2008 5:52:34 PM **SOPRA** Log Off

SYSTEM AWAITING PROCESS

Product: Unknown Job: default

ELLIPSONOMETRY

Sample ref. Operation Analysis **Sites** Reports config.

Sample informations (mm)
Diameter (mm): 200
X origin 0.00 X inversion ☒
Y origin 0.00 Y inversion ☒
Sites number: 25

Mapping parameters
☒ Square
Vertical lines: 10
Horizontal lines: 8
☐ Radial
Sites number: 1

Edge Exclusion (mm)
Edge: 0 Flat: 0

Mapping informations

Mappings library
25pts-10mm

	X	Y
1	10	10
2	10	380
3	10	750
4	10	1120
5	10	1490
6	467.5	10
7	467.5	380
8	467.5	750
9	467.5	1120
10	467.5	1490
11	925	10
12	925	380
13	925	750
14	925	1120
15	925	1490
16	1382.5	10
17	1382.5	380
18	1382.5	750
19	1382.5	1120
20	1382.5	1490
21	1840	10
22	1840	380
23	1840	750
24	1840	1120
25	1840	1490

Unselect All

Add Insert
Delete Sort

Automatic Recipe Manual Result Setup Tools Data Log Users Alarms



WINELLI II SOFTWARE



Research analysis software

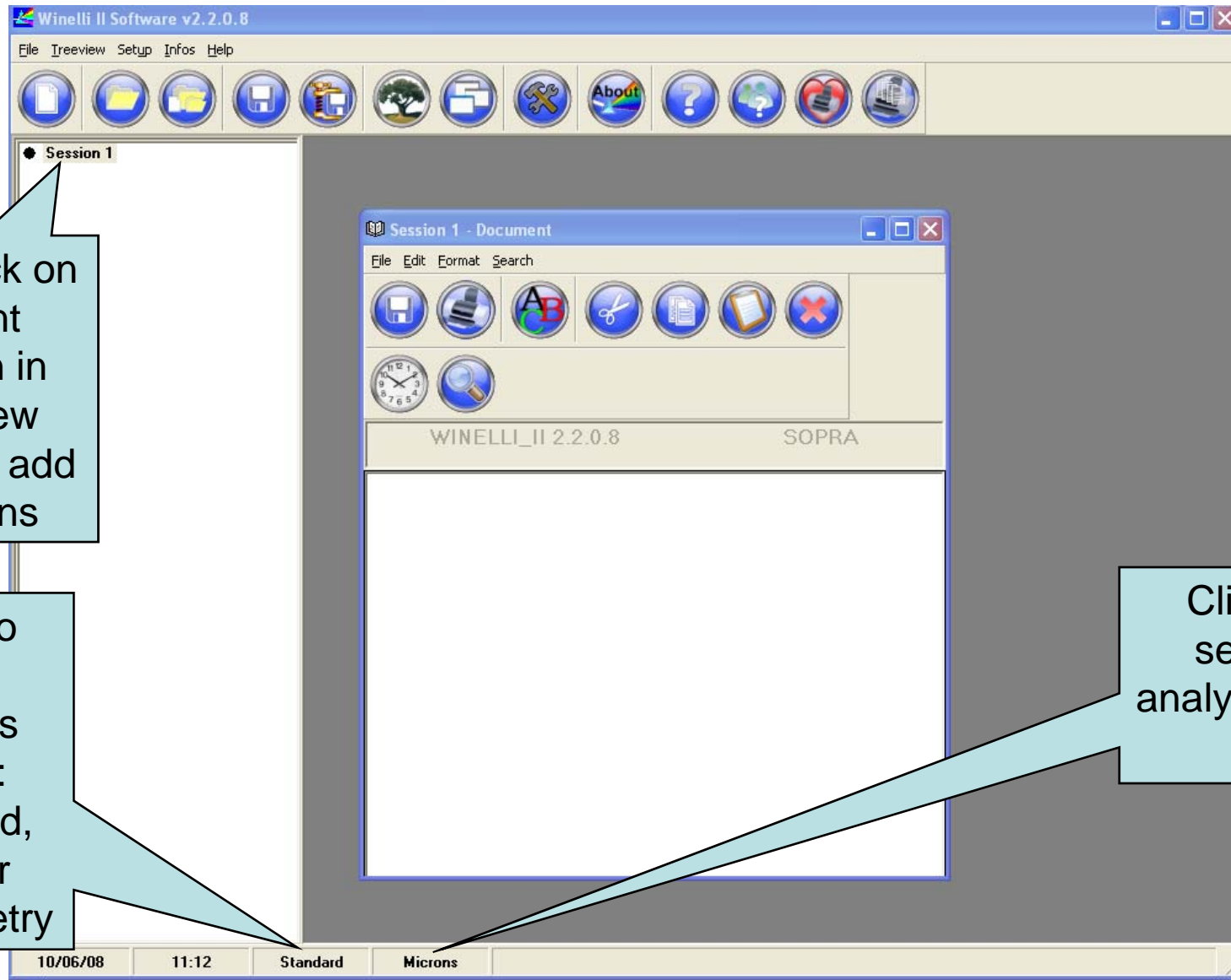
For Simulation : $\tan(\Psi)$, $\cos(\Delta)$, T_p , T_s , R_p , R_s
For fitting using Levenberg Marquard approach

On Ellipsometric data: $\tan(\Psi)$ and $\cos(\Delta)$ spectra
On photometric data : T_p , T_s , R_p , R_s spectra

Using :

- Effective Medium approximation
- Polynomial law
- Harmonic oscillator function
- Drude Model
- Rough layer
- Anisotropic layer

Starting Screen



Right click on current session in tree view allows to add functions

Click to select analysis mode : Standard, Xray or Porosimetry

Click to select analysis unit

How to load a measurement

Click with right button

Click to open one or several data file(s) in current session

Session 1 - Document

Session 1 - Spreadsheet_1

Data list:

Sample 1-2

Selected data type: Ellipsometry Dimension: 2D

Comment:

Number of points: 171 Spectral unit: eV

Range: 0.7500 to 5.000

Micro Spot: ☐

Measurement parameters for ellipsometry

Analyser Mode: Current tracking

Integration time Mode: Fixed at: 5(s)

Background Mode: Meas by scan

Non linearity correction: Hadamard correction

Others: Nothing

Parameters:

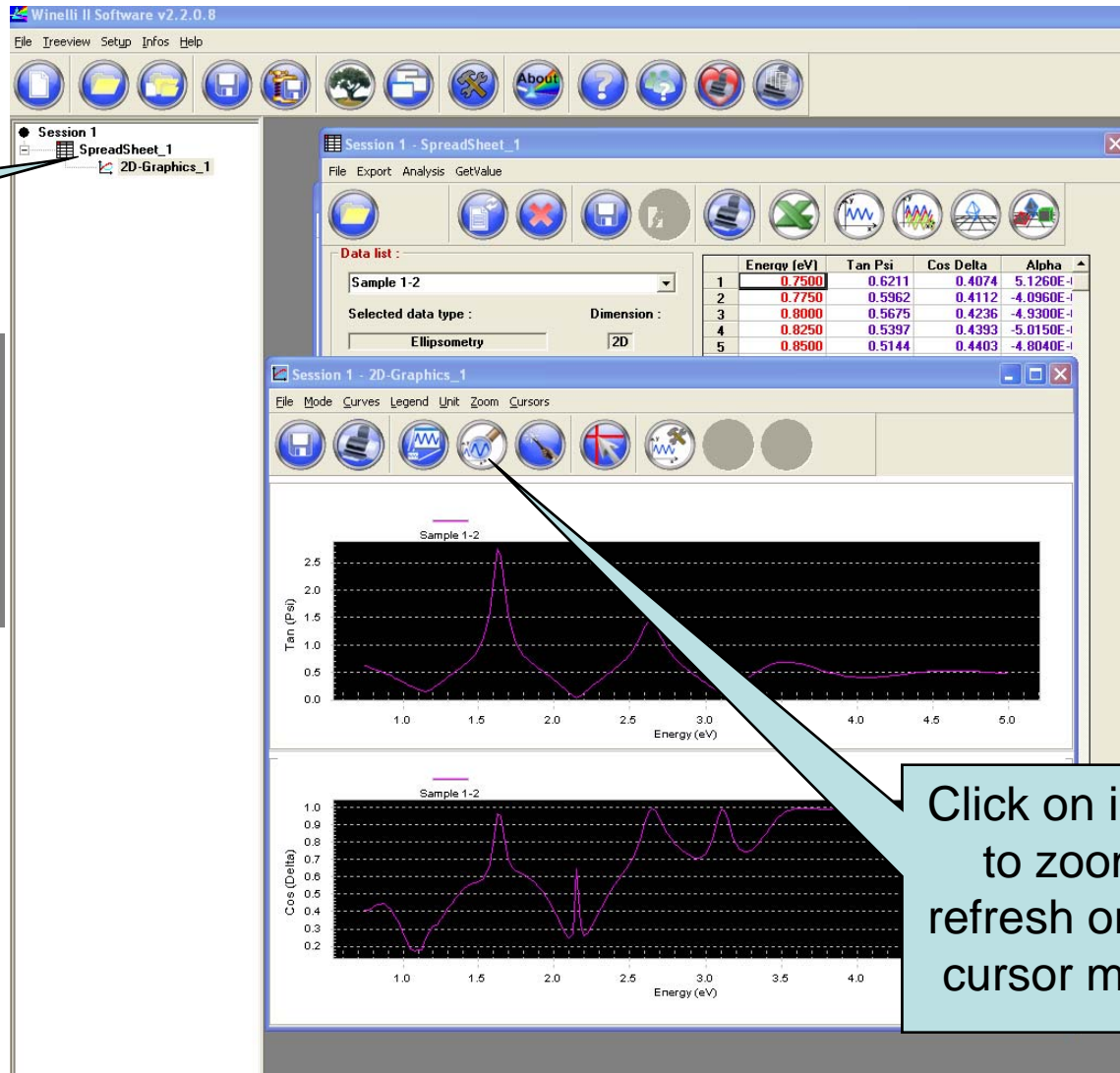
Angle of incidence: 75.00

	Energy [eV]	Tan Psi	Cos Delta	Alpha
1	0.7500	0.6211	0.4074	5.1260E-1
2	0.7750	0.5962	0.4112	-4.0960E-1
3	0.8000	0.5675	0.4236	-4.9300E-1
4	0.8250	0.5397	0.4393	-5.0150E-1
5	0.8500	0.5144	0.4403	-4.8040E-1
6	0.8750	0.4883	0.4434	-5.1930E-1
7	0.9000	0.4689	0.4301	-4.0510E-1
8	0.9250	0.4356	0.4073	-7.3620E-1
9	0.9500	0.3941	0.3690	-9.9690E-1
10	0.9750	0.3611	0.3360	-8.7340E-1
11	1.0000	0.3261	0.2827	-0.10
12	1.025	0.2862	0.2353	-0.12
13	1.050	0.2530	0.1853	-0.12
14	1.075	0.2225	0.1730	-0.12
15	1.100	0.1961	0.1773	-0.12
16	1.125	0.1697	0.1811	-0.14
17	1.150	0.1520	0.2429	-0.10
18	1.175	0.1624	0.2834	6.6320E-1
19	1.200	0.2075	0.3184	0.23
20	1.225	0.2593	0.3190	0.21
21	1.250	0.3123	0.3524	0.18
22	1.275	0.3640	0.3839	0.15
23	1.300	0.4171	0.4187	0.13
24	1.325	0.4642	0.4434	0.10
25	1.350	0.5140	0.4783	0.10
26	1.375	0.5632	0.5014	9.1150E-1
27	1.400	0.6199	0.5294	9.5620E-1
28	1.425	0.6732	0.5426	8.2300E-1
29	1.450	0.7360	0.5548	8.8870E-1
30	1.475	0.8184	0.5630	0.10
31	1.500	0.9220	0.5731	0.11
32	1.525	1.067	0.5852	0.14
33	1.550	1.278	0.6114	0.17
34	1.575	1.601	0.6685	0.22
35	1.600	2.145	0.7970	0.28
36	1.625	2.744	0.9591	0.24

How to display the measurement graph

Click with right button

- Structure standard
- Add Density Calculation
- Add Pseudo Fourier Transform
- Add Graph 2D
- Add Graph 3D
- Delete Spreadsheet



How to display a default structure

Click on icons to add or remove layers

Click with right button

For each layer enter thickness, optical index model and gradient profile (for homogeneous/inhomogeneous layers)

Structure parameters for file : New Structure

Layer	Description	Thickness (μm)	Optical index	Gradient Profile	Multilayers ("n")
Ambient	Void		nk file	None	
1	Dispersion law	30.00	Dispersion law	None	
Substrat	sio2		nk file	None	

Layer : Ambient

Optical index type : n,k file

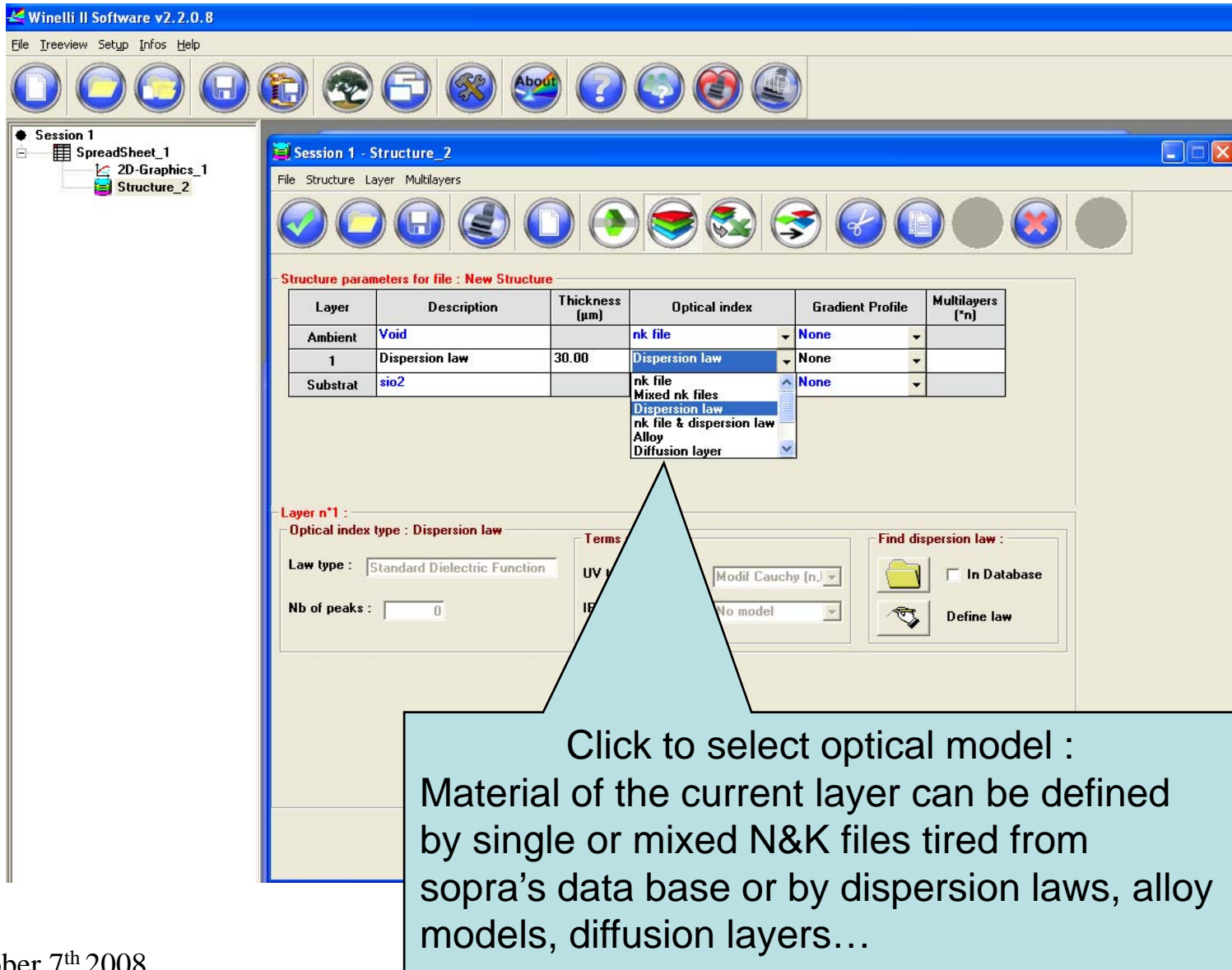
Filename : Void.nk

Show n,k

Find n,k file :

☐ In Database

How to define a model for each layer



Winelli II Software v2.2.0.8

File Treeview Setup Infos Help

Session 1

- SpreadSheet_1
- 2D-Graphics_1
- Structure_2

Session 1 - Structure_2

File Structure Layer Multilayers

Structure parameters for file : New Structure

Layer	Description	Thickness (μm)	Optical index	Gradient Profile	Multilayers (*n)
Ambient	Void		nk file	None	
1	Dispersion law	30.00	Dispersion law	None	
Substrat	sio2		nk file	None	

Optical index type : Dispersion law

Law type : Standard Dielectric Function

Nb of peaks : 0

Find dispersion law :

Modif Cauchy (n, k)

No model

In Database

Define law

Click to select optical model :
Material of the current layer can be defined by single or mixed N&K files tired from sopra's data base or by dispersion laws, alloy models, diffusion layers...

Dispersion Law builder

Winelli II Software v2.2.0.8

File Treeview Setup Infos Help

Session 1

- SpreadSheet_1
- 2D-Graphics_1
- Structure_2

Session 1 - Structure_2

File Structure Layer Multilayers

Dispersion Law Builder

File

Dispersion law informations :

Law type : Standard dielectric function

Filename : picssel_IRSE_3.sdf

Date : 10/03/08

Comment :

Dispersion law terms :

UV term : Modif Cauchy (n,k)

IR term :

Number of peaks : 0

Add Del

Display all Peaks

Parameters :

n°	Parameter	Value	Unit
1	A	1.450	
2	B	1.0000E-02	μm
3	C	0.0	μm^2
4	D	1.0000E-02	μm
5	E	1.0000E-02	μm
6	F	0.0	μm^2

Display : ☒ (n, k) ☐ (Er, Ei)

Display unit : ☐ eV ☐ nm ☒ μm ☐ cm^{-1}

Display Range : Min 0.248 Max 1.653

Nb Points : 171

Refractive index n

Wavelength (μm)

Extinction coefficient k

Wavelength (μm)

Click ok to accept

How to add a Lorentz harmonic oscillator

Winelli II Software v2.2.0.8

File Treeview Setup Infos Help

Session 1

- SpreadSheet_1
- 2D-Graphics_1
- Structure_2

Session 1 - Structure_2

File Structure Layer Multilayers

Dispersion Law Builder

File

Dispersion law informations :

Law type : Standard dielectric function

Filename : picssel_IRSE_3.sdf

Date : 10/03/08

Comment :

Dispersion law terms :

UV term : Modif Cauchy (n,k)

IR term : No model

Number of peaks : 1

Add Del

Model

Display all Peaks

Parameters :

n*	Parameter	Value	Unit
1	A	1.0000	
2	Lambda0	0.5000	μm
3	Gamma	5.0000E-02	μm

Display : (n, k) (Er, Ei)

Display unit : eV nm μm cm^{-1}

Display Range : Min 0.75 Max 5

Nb Points : 171

Refractive index n

Energy [eV]

Extinction coefficient k

Energy [eV]

How to define a Drude Law

Winelli II Software v2.2.0.8

File Treeview Setup Infos Help

Session 1

- SpreadSheet_1
- 2D-Graphics_1
- Structure_2

Session 1 : Structure_2

File Structure Layer Multilayers

Dispersion Law Builder

File

Dispersion law informations :

Law type : Standard dielectric function

Filename : picssel_IRSE_3.sdf

Date : 10/03/08

Comment :

Dispersion law terms :

UV term : Modif Cauchy (n,k)

IR term : Drude

Number of peaks : 0

Add Del

Model

Display all Peaks

Parameters :

n*	Parameter	Value	Unit
1	P	10.000	
2	1/tau	1.0000	μm^{-1}
3	1/E0 (eV-1)	1.0000	eV^{-1}

Display : (n, k) (Er, Ei)

Display unit : eV nm μm cm^{-1}

Display Range : Min 0.248 Max 1.653

Nb Points : 171

Refractive index n

Wavelength (μm)

Extinction coefficient k

Wavelength (μm)

How to enter in the regression parameters window

Click with right button

Session 1 - Regression_1

Analysis Selection Parameters Options Results Pass Definition

Analysis

☐ Simultaneous regression

Files selection

	Data Files	Files
1	Sample 1-2	<input checked="" type="checkbox"/>

Incident angle for current file

Fixed

Fixed value :

Integration time

Fixed value

Open the text

How to define the fitting parameters

The screenshot shows the Winelli II Software v2.2.0.8 interface. The left sidebar shows a tree view with 'Session 1' containing 'SpreadSheet_1', '2D-Graphics_1', 'Structure_2', and 'Regression_1'. The main window is titled 'Session 1 - Regression_1' and has tabs for 'Analysis Selection', 'Parameters', 'Options', 'Results', and 'Pass Definition'. The 'Parameters' tab is active, showing a table of fitting parameters. Callouts point to specific elements: 'Click to start regression' points to a green person icon; 'Select regression function' points to the 'Function Type' dropdown; 'Select the spectral range of the regression' points to the 'Spectral Range' section; and 'Check boxes if you need to fit it on' points to the 'Fit 1' column checkboxes.

Click to start regression

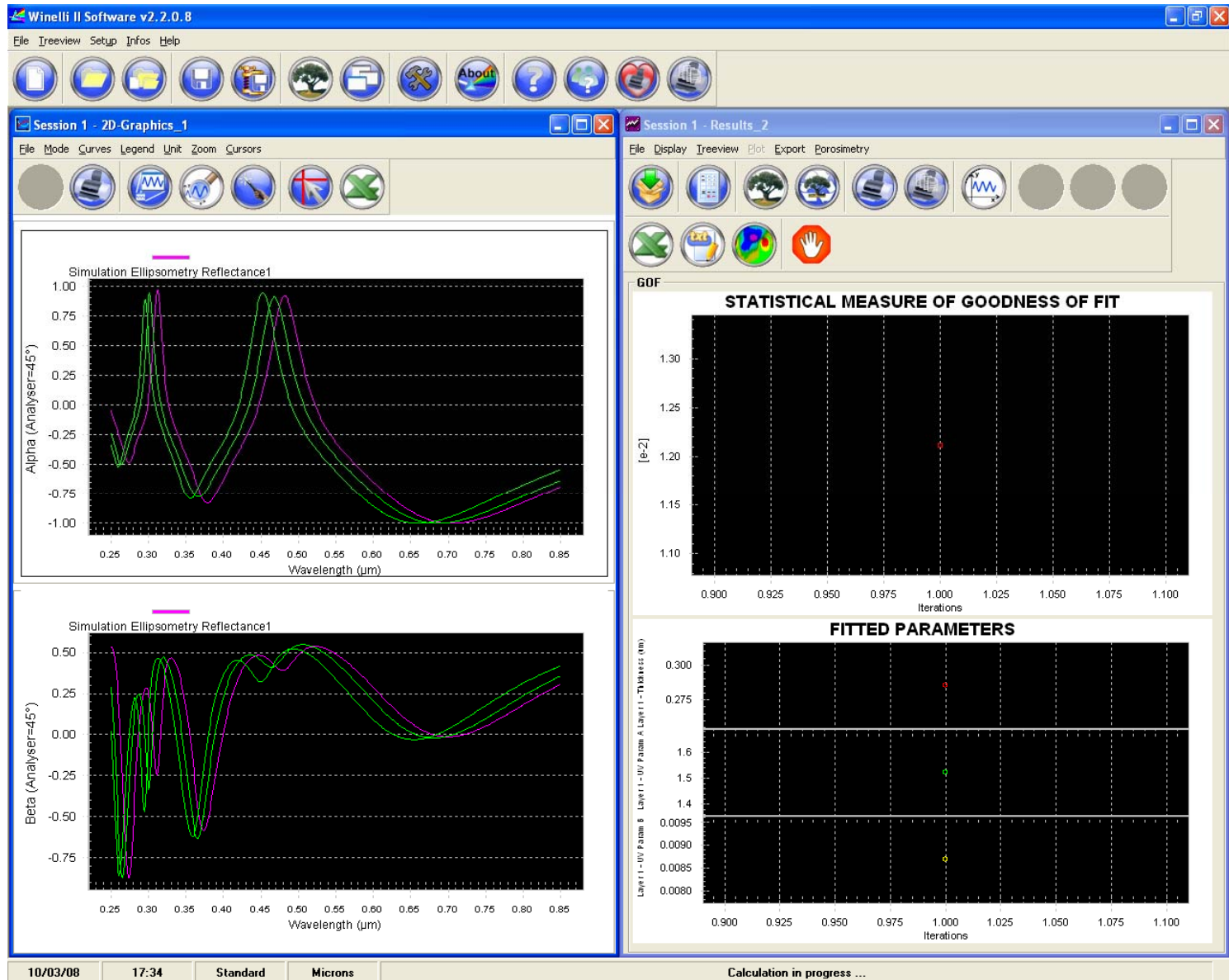
Select regression function

Select the spectral range of the regression

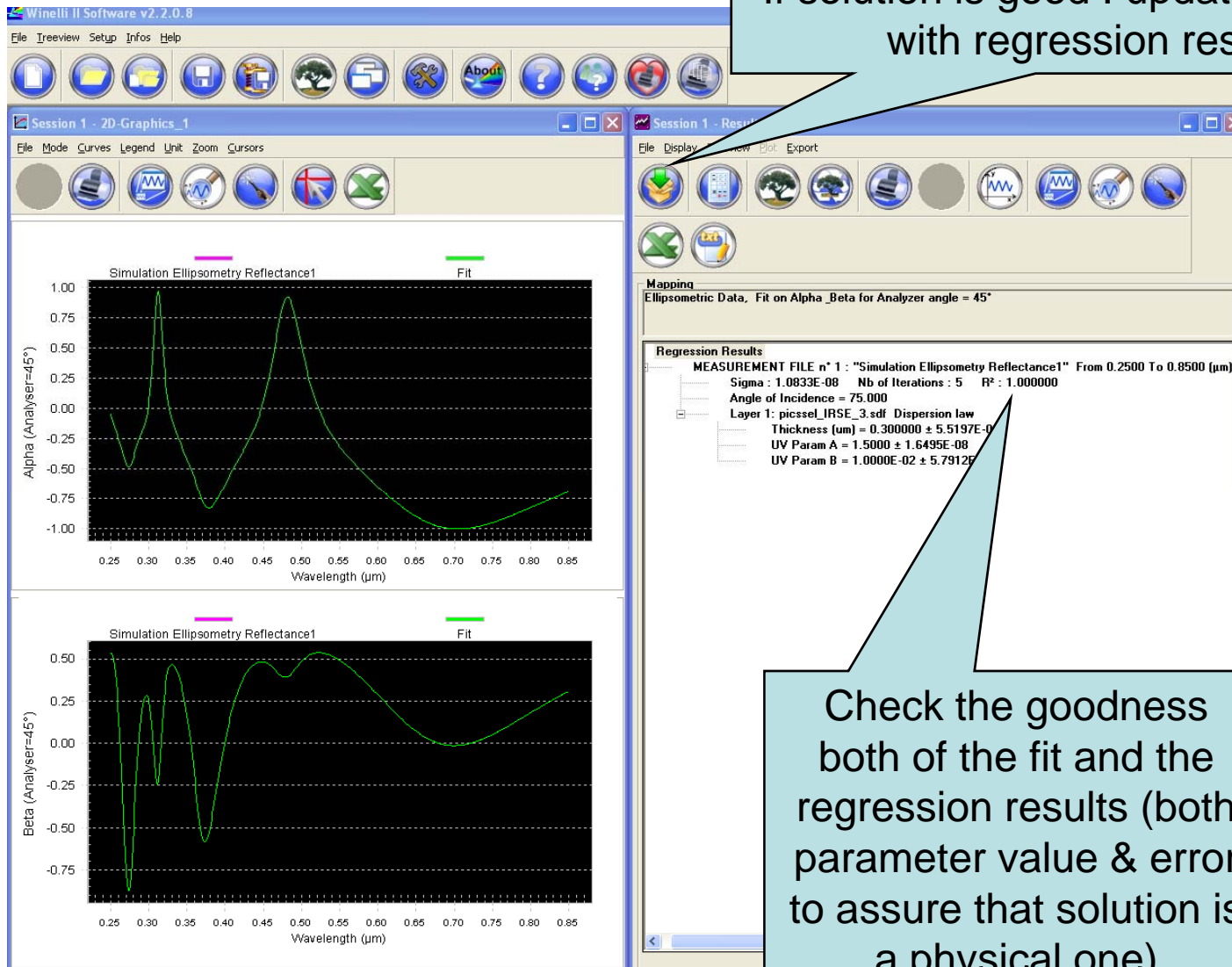
Check boxes if you need to fit it on

Description	Value	Fit 1
Spectral and Parameters Infos:		
Spectral Range:		
From [eV]:		0.7500
To [eV]:		1.241
Function Type:		
Function Type:		Alpha, Beta fit
Incident Angle:		
Fit on:		<input type="checkbox"/>
Ambient		
Layer 1		
Thickness (um)		
Thickness (um)	0.3000	<input checked="" type="checkbox"/>
Modif Cauchy (n,k)		
UV Param A	1.500	<input checked="" type="checkbox"/>
UV Param B	1.0000E-02	<input checked="" type="checkbox"/>
UV Param C	0.0	<input type="checkbox"/>
UV Param D	0.0	<input type="checkbox"/>
UV Param E	0.0	<input type="checkbox"/>
UV Param F	0.0	<input type="checkbox"/>
Drude		
Check All		
IR Drude-Param P	10.000	<input checked="" type="checkbox"/>
IR Drude-Param 1/E0	1.0000	<input checked="" type="checkbox"/>
IR Drude-Param 1/Tau	1.0000	<input checked="" type="checkbox"/>
Substrat		

Fitting procedure



Result of the fitting procedure



If solution is good : update structure with regression results

Check the goodness both of the fit and the regression results (both parameter value & error to assure that solution is a physical one)

How to optimise measurements



Select the spectral range
Select the spectral résolution
Select the appropriate Angle Of Incidence



➤ Using Winelli 2, the n&k database
and the simulation function

How to optimise analysis

- Start with the simplest model
- Select the appropriate model for the optical index determination:

Bruggeman : Poly silicon, Roughness, Porous Materials

Dispersion law : need appropriate started values

SDF-UV term and Lorentz peaks for dielectrics
(most of the time)

SDF-Drude and Lorentz peaks for metals

Forouhi Model (FIM) for amorphous as SiON_x

Model Dielectric Function (MDF) for Alloy
materials (SiGe, Si...)

Bulk calculation : for substrate or fully absorbing layers.

Point by point : need a well defined model (included T knowledge
and interfaces if necessary)

How to optimise analysis

- Select the appropriate model for the regression
 - Tan Psi&Cos Delta for « ultra thin layers »
 - Alpha&Beta for « thin and thick layers »
 - Pseudo Dielectric Functions: ϵ_r and ϵ_i useful for alloy material for instance.

- Optimise the analysis
 - Adjust the spectral range
 - Add interface (rough layers) or/and gradient (inhomogeneous layers).
 - Use special option (Aperture for microspot measurements...)

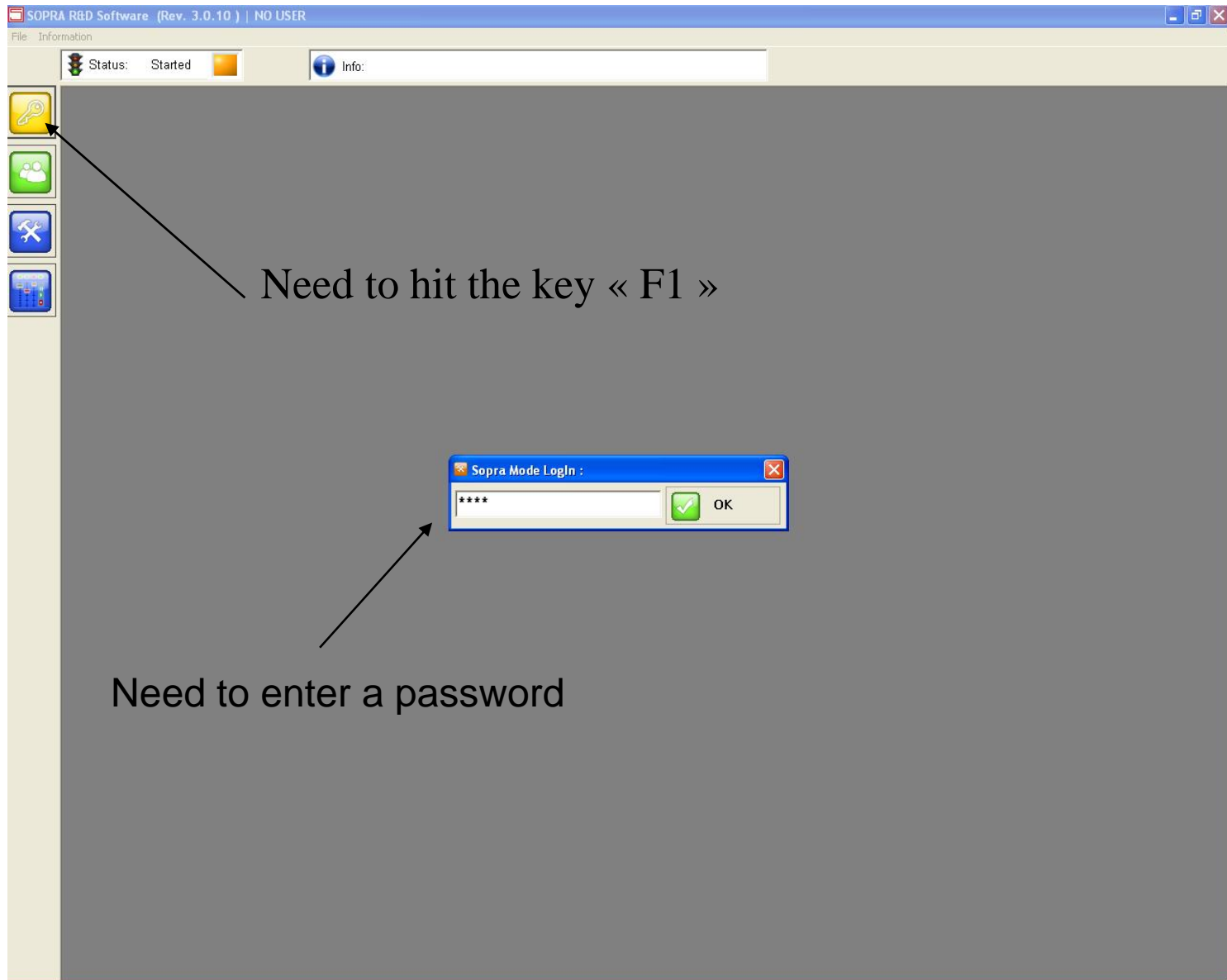
SOPRA R&D SOFTWARE



- Basic displacements of the different motor axis
- Basic acquisition of the signal : Show mode
- Basic measurements
- Calibration of the system
 - Spectrometer
 - Spectrograph
 - Non lineary of the detectors
 - Polariser and analyzer axis versus the plane of incidence : A0 and P0
- Hardware Setting

Starting Screen





Basic Displacements of each axis

The screenshot displays the SOPRA R&D Software (Rev. 3.0.10) Administrator window. The main interface is divided into several sections:

- Status Bar:** Shows "Status: Initialized" with a green light icon and "Info: End of measurement" with an information icon.
- Axis Tools Panel:** Located on the left, it contains a list of components:
 - Analyser:** Includes buttons for "Init", "Send to", and "Cont Rotation".
 - Polariser**
 - Spectrometer**
 - Goniometer**
 - Polariser Arm**
 - Analyser Arm**
 - Mapping**
 - Spectrometer 68°**
 - Spectrometer 76°**
 - Tilt**
 - Retarder 1 (Mueller Matrix)**
 - Retarder 2 (Mueller Matrix)**
- IO Tools Panel:** Located on the right, it contains a list of input/output devices with checkboxes:
 - ☒ Shutter
 - ☐ Attenuator 1
 - ☐ Attenuator 2
 - ☐ Inactinic Filter
 - ☒ Visible Retarder
 - ☐ Microspots
 - ☐ Fiber Changer
 - ☒ FTIR Retarder

An arrow points from the "Init" button in the Axis Tools panel to the "IO Tools" panel, indicating a sequence of operations.

SOPRA R&D Software (Rev. 3.0.10) | Administrator - [Show Window]

File Measurement Calibration Maintenance Information

Status: ■ Initialized i Info: End of measurement

Left Sidebar (Control Panel):

- Sensor:** ☒ Mono ☐ Multi ☐ FT-IR ☐ X-Ray
- Measurement type:** ☒ Ellipsometry ☐ Photometry
- General options:**
 - ☐ Intrinsic Filter
 - ☐ MicroSpots
 - ☒ Retarder
 - ☐ Shutter
 - Attenuators:** Auto Attenuator 1 Attenuator 2
- Retarder options:** ☒ With & Without ☐ With
- Correction:**
- Analyser tracking:** ☒ None ☐ Previous
- Correction:** ☐ None ☒ Apply
- Special features:**
 - ☐ Four sums
 - ☒ Eight sums
 - ☐ Single shot
 - ☒ Background (cts.s-1)
 - Integration time (s): 0.167
 - Polariser Frequency: 6
 - ☐ Log data
- Spectrometer:** ☐ Scan ☐ Trigg out Unit: µm Set WaveLength: 0.45

Main Display Area:

- Top Tab:** Sums Intensity Tan(Psi)/Cos(Delta) Alpha/Beta Options
- Top Right Table:**

Item #	Intensity (cts/s)	Symetry (%)	Residual
- Plots:**
 - Hadamard Sums:** Intensity [Cts] vs Acquisition number (0 to 10)
 - Residual:** Residual vs Acquisition number (0 to 10)
 - Symetry (%):** Symetry (%) vs Acquisition number (0 to 10)

Bottom Panel:

- Optical bench | Mueller Matrix:**
 - Optical bench:** Move Analyser (°) 45 Move Polariser (°) 0
 - Goniometer:** ☐ Arms uncoupled Move Incidence 90.000
- Mapping | Tilt:**
 - Axis Positions: X 0 Y 0 Z 0 Axis 4 0
 - Buttons: Move X, Move Y, Move Z, Move Axis4, Move XY, Move XYZ, Move XYZ Theta, User Position, Save user position, Loading Position
 - Z Axis:** ▲ ▲ ▲ ▲ ▼ ▼ ▼ ▼
 - Joystick:** Joystick

Hit this button
To enter in the show mode

Measurements Parameters Window

SOPRA R&D Software (Rev. 3.0.10) | Administrator - [Measure]

File Measurement Calibration Maintenance Information

Status: Initialized

Info: Select measurement parameters

File: Current.Param
Date: 10/3/2008 3:53:30 PM
Comment: Last Parameters

Sensor
☒ Mono ☒ Multi ☐ FT-IR ☐ X-Ray
 DMA_NIR ☐ Extended measurement mode

Measurement type
☒ Ellipsometry ☐ Photometry

General options
☐ Mirror Analyser Background measurement: Once
☐ Symetry Post measurement correction(s): Yes
 Photometry mode: Polarization mode: ☒ Reference 90° Focus: ☒ None ☐ Manual ☐ Auto

Special features
☒ Four Sums ☐ Eight Sums Averaging: 1
 Polariser rotation frequency (Hz): 6

Analysers
☒ Fixed ☐ Scan ☐ Free Angle: 45
☒ Fixed ☐ Scan ☐ Free Angle: 0

Analysers tracking
☒ Fixed ☐ Previous

Integration time
☒ Fixed ☐ Variable Time (s): 1

Retarder options
☐ With & without ☒ With only

Timing
☒ No ☐ Step in time ☐ Continuous ☐ Ext. trig

Component(s) to scan
 Retarder

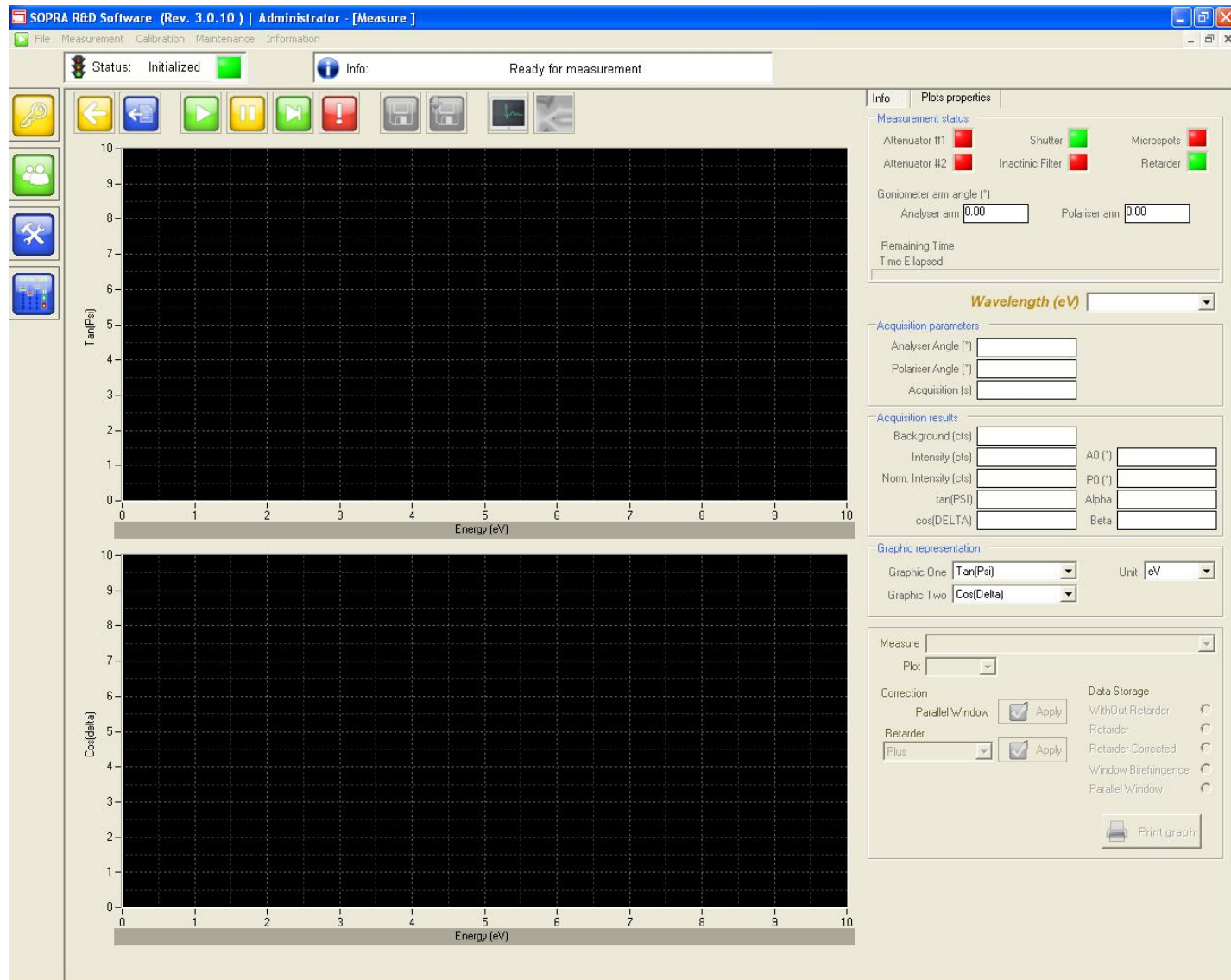
Estimated measurement time calculator
 [Estimated time: 00:00:04 (1 Unitary acquisition)]

IO
☐ Use Inactive Filter Attenuator: Auto
☐ Use MicroSpots

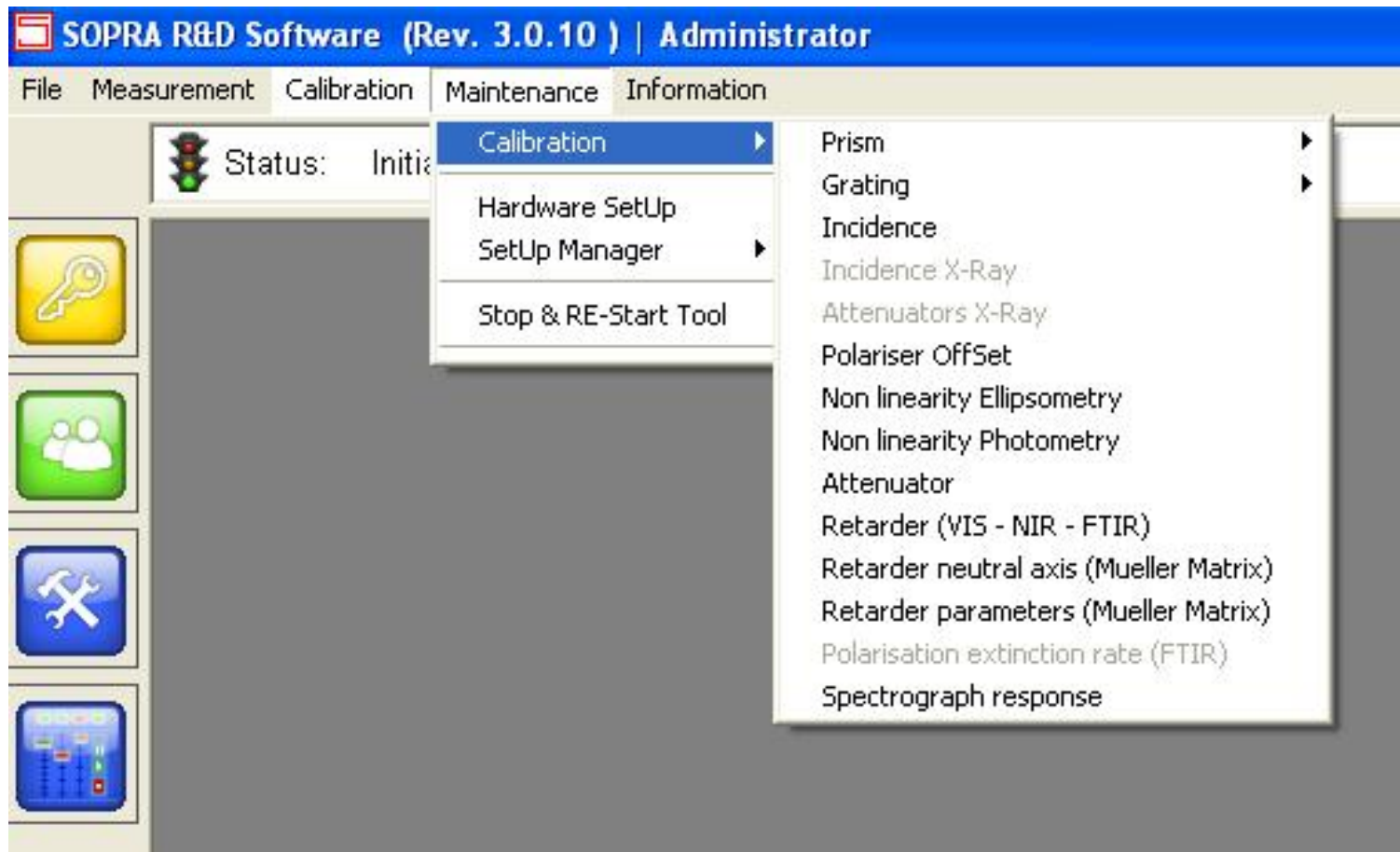
Spectrograph
 Unit: eV
 Begin: 0.72986 End: 1.47508

Goniometer
☒ Arms coupled ☐ Arms Uncoupled
☒ Fixed ☐ Scan ☐ Free Incidence Angle: 90

During Acquisition ...



General Calibration menu



Polariser and Analyser offset calibration

