

# The New Surface Property Generator in TracePro

A Lambda Research Corporation Webinar

March 22, 2018

# Presenter

- **Presenter**

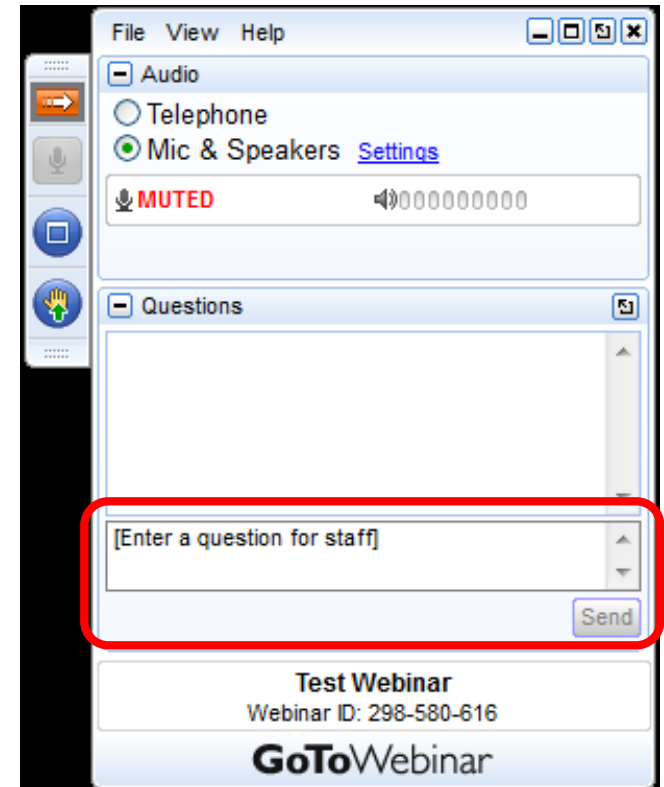
Dave Jacobsen

Sr. Application Engineer

Lambda Research Corporation

# Format

- A 25-30 minute presentation followed by a question and answer session
- Please submit your questions anytime using Question box in the GoToWebinar control panel



# Additional Resources

- Past TracePro Webinars
  - <https://www.lambdares.com/su/tracepro-webinars/>
- TracePro Tutorial Videos
  - <https://www.lambdares.com/su/tracepro-videos/>
- TracePro Tutorials
  - <https://www.lambdares.com/su/tracepro-tutorials/>
- Information on upcoming TracePro Training Classes
  - <https://www.lambdares.com/training/>

# Upcoming TracePro Training

- **Littleton, MA**
  - Introduction to TracePro – April 10-11, 2018
  - Optimization with TracePro – April 12-13, 2018
  
- **Please ask us about custom onsite training**

# Latest TracePro and RayViz Release

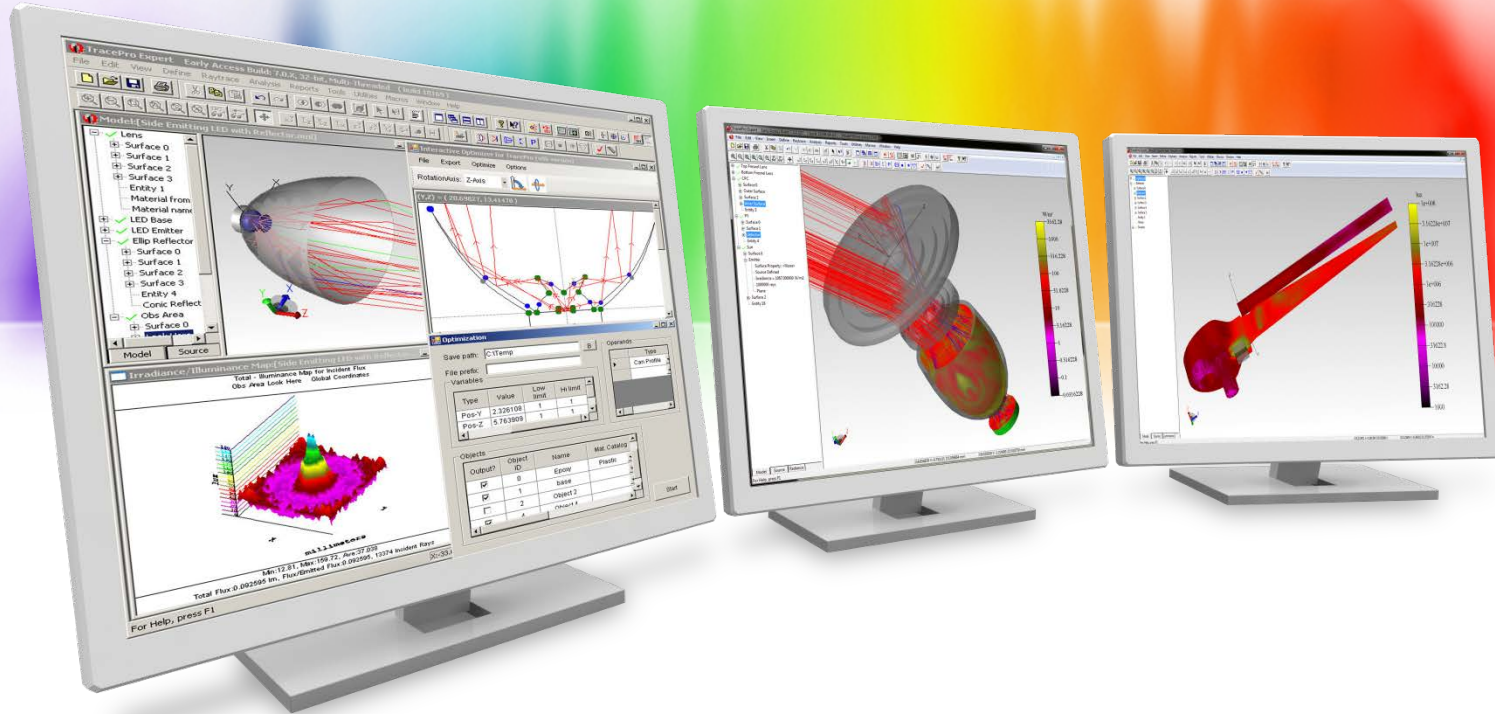
**TracePro 2018 18.1** - Released February 12, 2018

**TracePro 2018 18.1.3 Early Visibility** - Now available

**RayViz 2018 18.1** - Released February 12, 2018

Customers with current maintenance and support agreements can download this new release at:

<http://www.lambdare.com/CustomersupportCenter/index.php/trace-pro/current-release>



# The New Surface Property Generator in TracePro

A Lambda Research Corporation Webinar

March 22, 2018

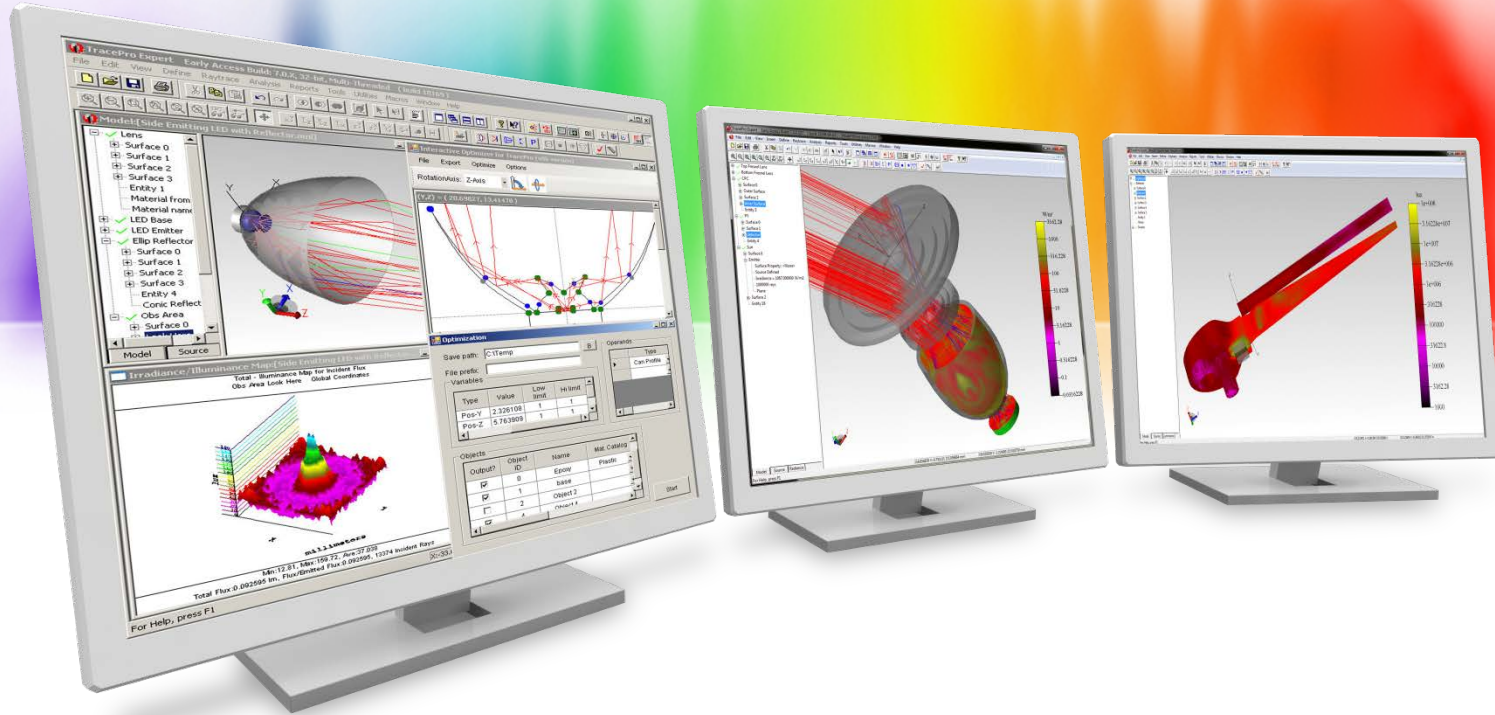
# Agenda

- Features of the new Surface Property Generator in TracePro
- Using the new Surface Property Generator to make Surface Properties in TracePro
- How the Surface Property Generator can be used to read measured BSDF data and make new Surface Properties for TracePro based on the scattering measurements
- An example of making a new Surface Property for TracePro



# Agenda

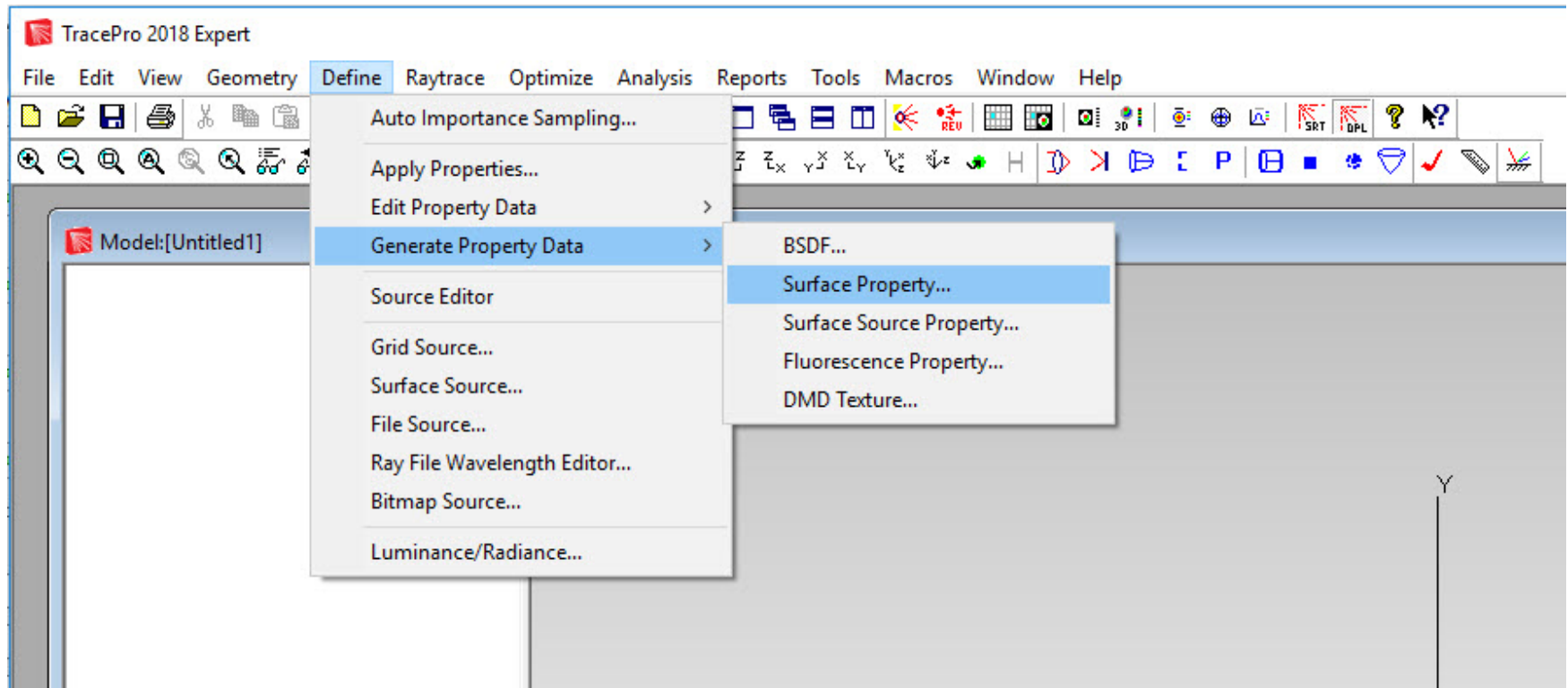
- Demonstrate a method for using the new Surface Property Generator to make a Surface Property for materials with large scattering features, such as Alanod Miro 9
- Questions and Answers



## Surface Property Generator Features

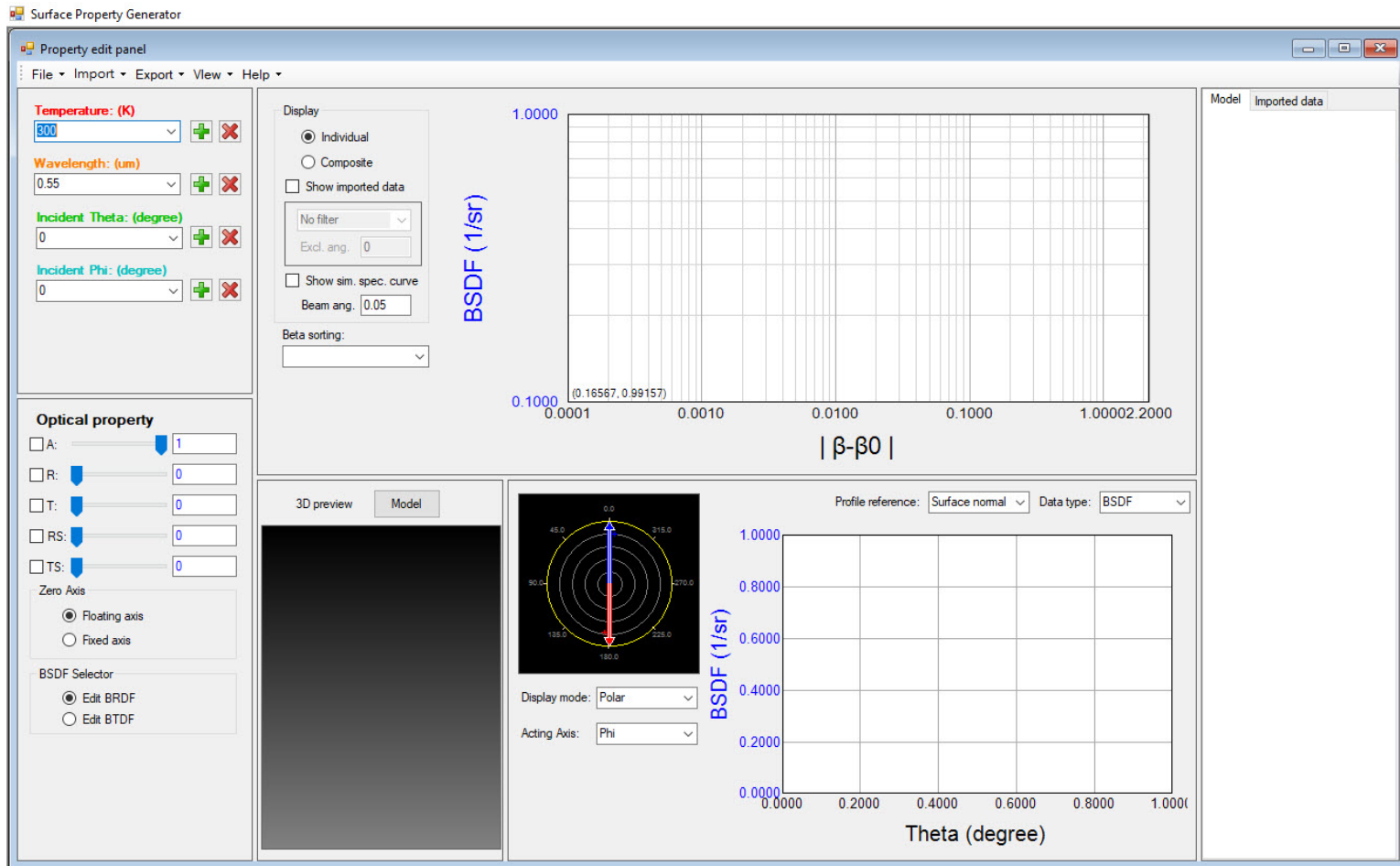
# Surface Property Generator Features

Available in all versions of TracePro



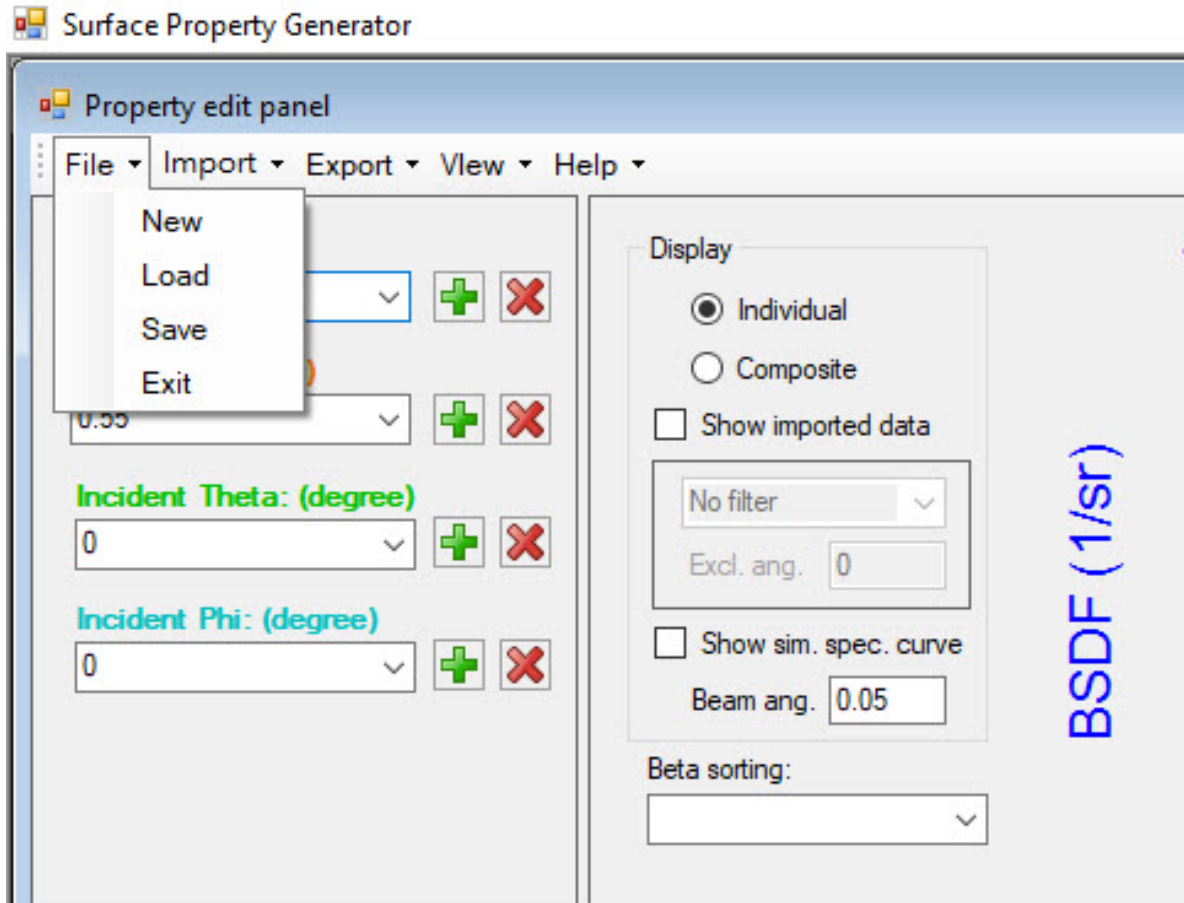
# Surface Property Generator Features

## Surface Property Generator



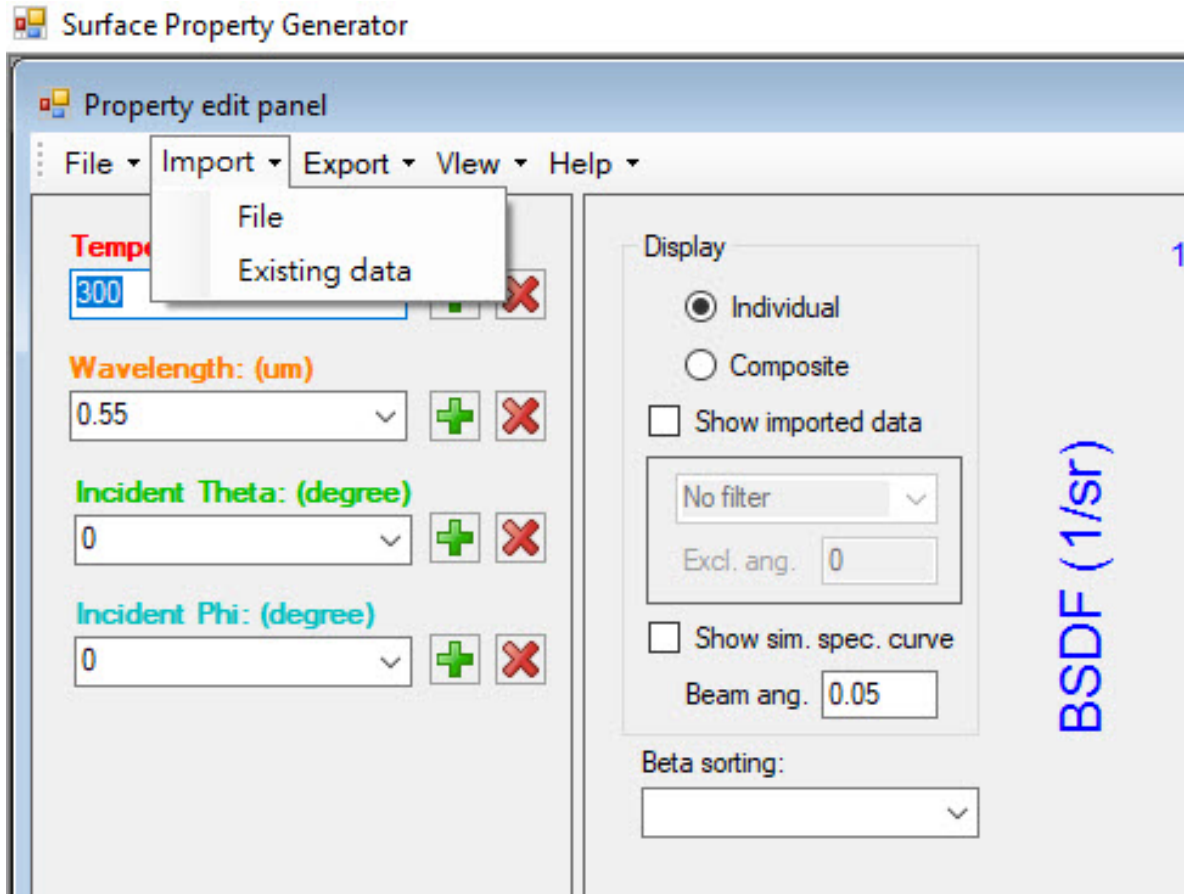
# Surface Property Generator Features

## Surface Property Generator – File menu



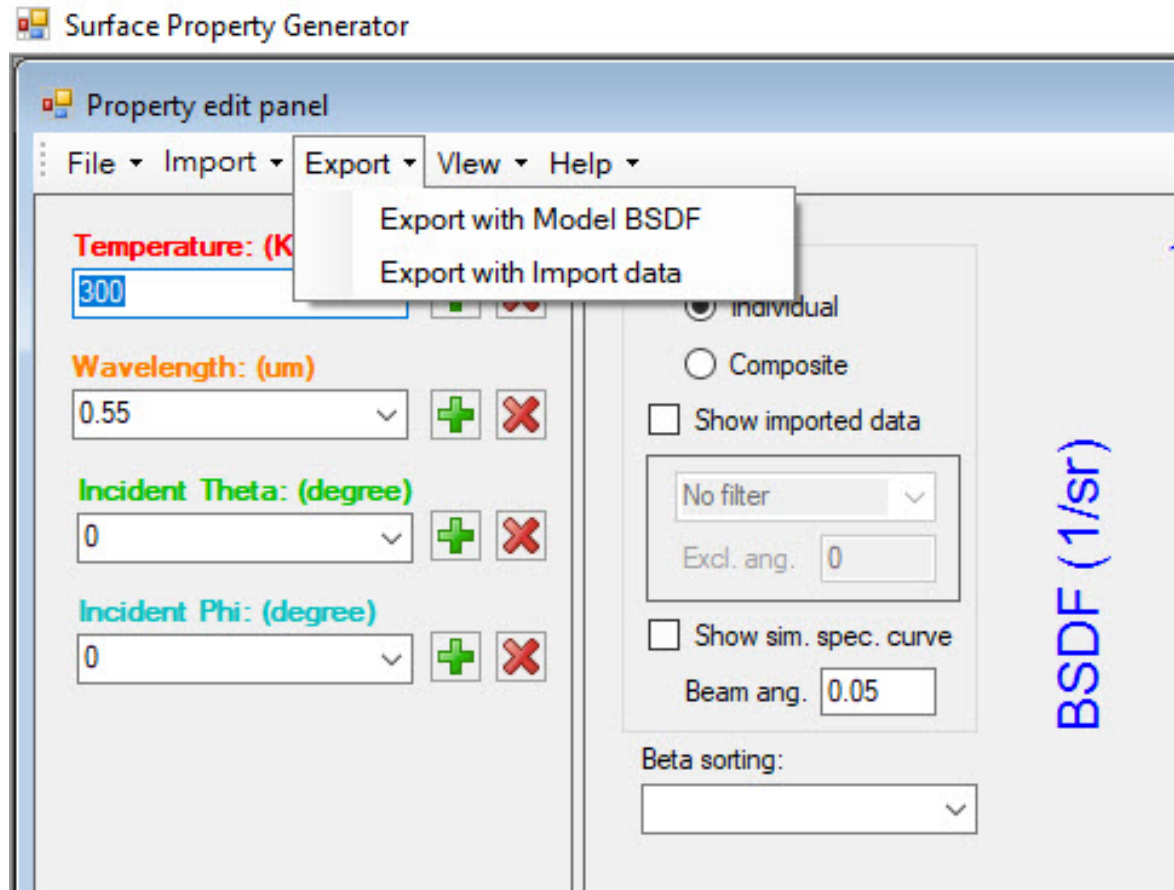
# Surface Property Generator Features

## Surface Property Generator – Import menu



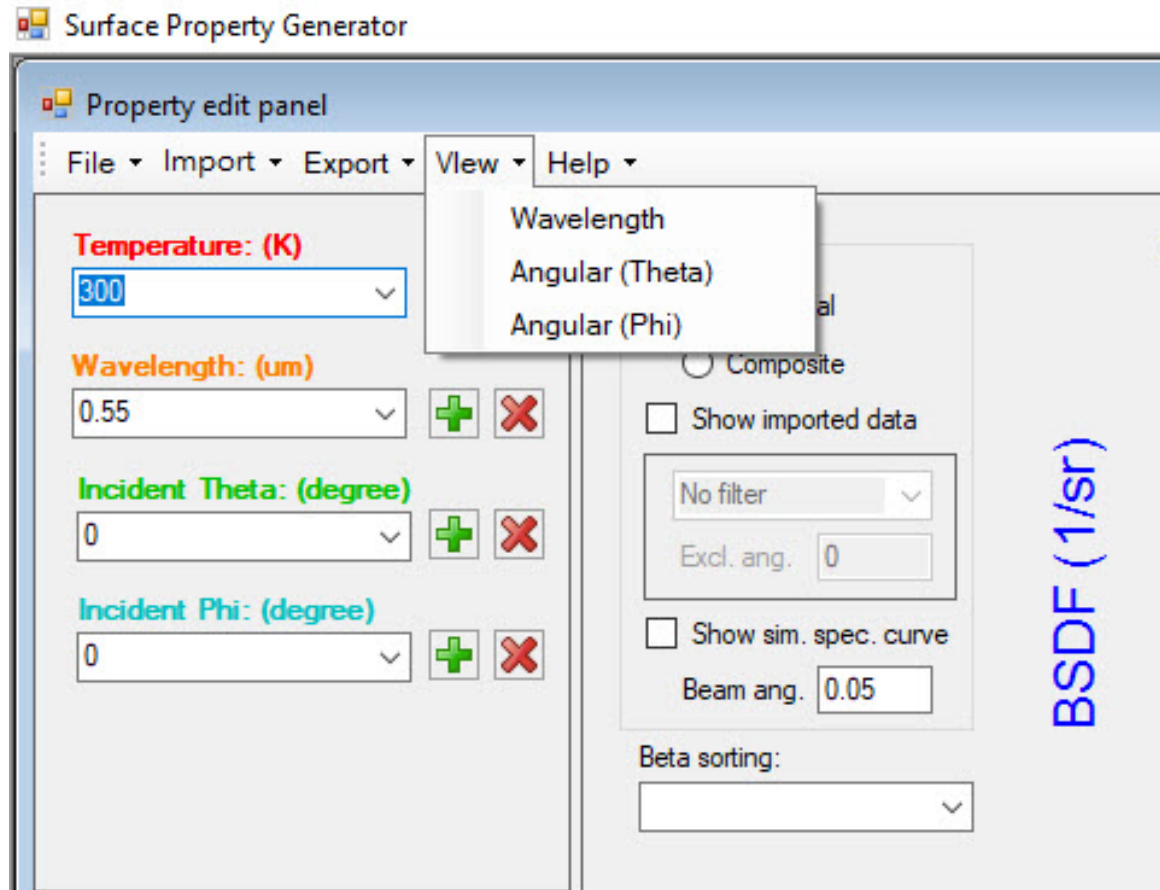
# Surface Property Generator Features

## Surface Property Generator – Export menu



# Surface Property Generator Features

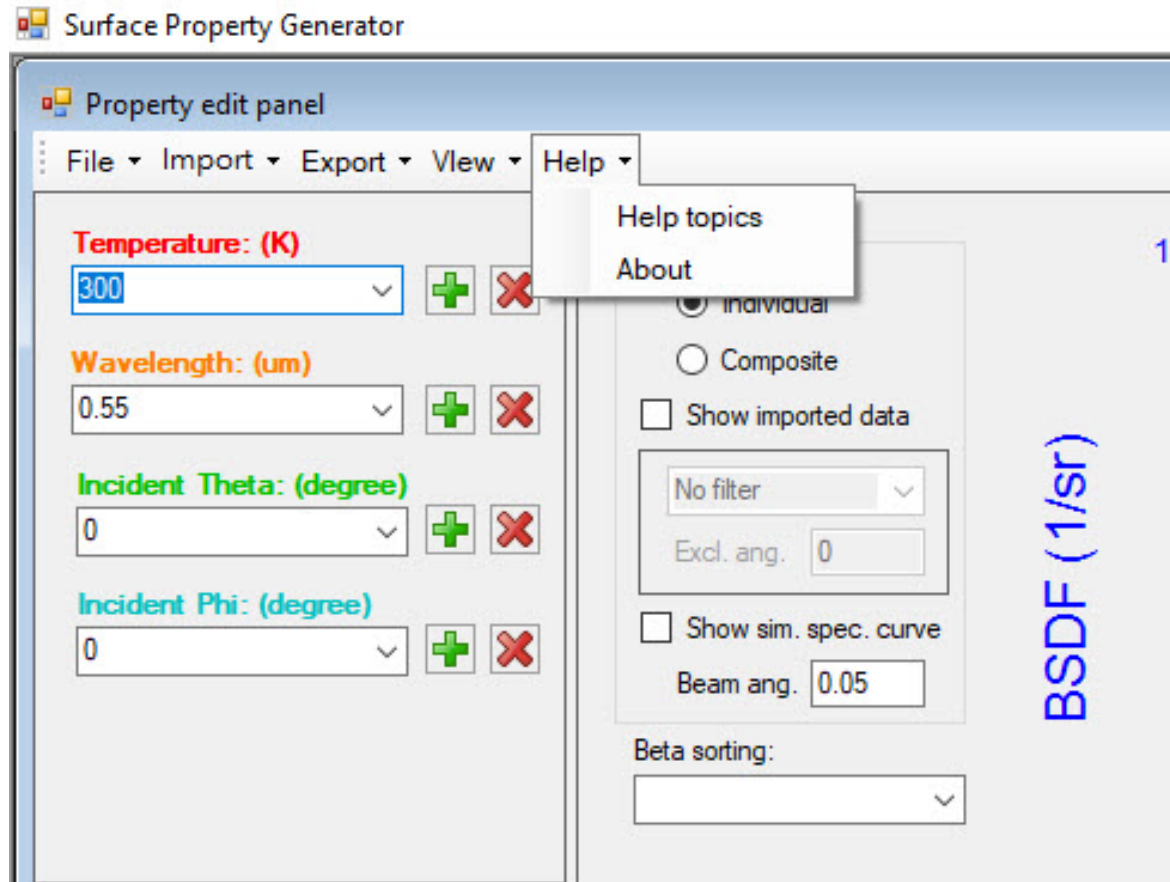
## Surface Property Generator – View menu





# Surface Property Generator Features

## Surface Property Generator – Help menu



# Surface Property Generator Features

Surface Property Generator – Enter values for Temperature, Wavelength, Incident Theta, and Incident Phi

The screenshot displays the 'Surface Property Generator' software interface. The 'Property edit panel' is the central focus, containing several input fields and control options:

- Temperature: (K)**: Set to 300 (highlighted with a red circle).
- Wavelength: (um)**: Set to 0.55.
- Incident Theta: (degree)**: Set to 0.
- Incident Phi: (degree)**: Set to 0.

Additional controls include 'Display' options (Individual, Composite), 'Show imported data', 'No filter', 'Excl. ang.', 'Show sim. spec. curve', 'Beam ang.', and 'Beta sorting'.

The interface features two main plots:

- Top Plot:** A log-log plot of BSDF (1/sr) versus  $|\beta - \beta_0|$ . The y-axis ranges from 0.1000 to 1.0000, and the x-axis ranges from 0.0001 to 1.00002.0000. A data point is labeled at (0.16567, 0.99157).
- Bottom Plot:** A plot of BSDF (1/sr) versus Theta (degree). The y-axis ranges from 0.0000 to 1.0000, and the x-axis ranges from 0.0000 to 1.0000. The plot is currently empty.

Other interface elements include an 'Optical property' section with sliders for A, R, T, RS, and TS; a '3D preview' window; a 'Model' window showing 'Imported data'; and a 'Polar' plot showing a circular distribution with angles from 0.0 to 315.0 degrees.

# Surface Property Generator Features

Surface Property Generator – Enter values for Absorption, Specular Reflection, Specular Transmission, Reflected Scatter, and Transmitted Scatter

The screenshot displays the 'Surface Property Generator' software interface. The main window is titled 'Property edit panel' and contains several sections:

- Input Parameters:** Temperature (K) set to 300, Wavelength (um) set to 0.55, Incident Theta (degree) set to 0, and Incident Phi (degree) set to 0.
- Display Options:** Includes radio buttons for 'Individual' (selected) and 'Composite', a 'Show imported data' checkbox, a 'No filter' dropdown, an 'Excl. ang.' field set to 0, a 'Show sim. spec. curve' checkbox, and a 'Beam ang.' field set to 0.05.
- Optical property (highlighted in red):** Contains checkboxes and sliders for:
  - A: Absorption (value 1)
  - R: Reflection (value 0)
  - T: Transmission (value 0)
  - RS: Reflected Scatter (value 0)
  - TS: Transmitted Scatter (value 0)
- Axis Selection:** Radio buttons for 'Floating axis' (selected) and 'Fixed axis'.
- BxDF Selector:** Radio buttons for 'Edit BRDF' (selected) and 'Edit BTDF'.
- 3D preview:** A dark area with a 'Model' button.
- Plots:**
  - Polar Plot:** Shows BxDF (1/sr) vs  $|\beta - \beta_0|$  on a logarithmic scale. The y-axis ranges from 0.1000 to 1.0000, and the x-axis ranges from 0.0001 to 1.00002.0000. A data point is labeled (0.16567, 0.99157).
  - Theta Plot:** Shows BxDF (1/sr) vs Theta (degree). The y-axis ranges from 0.0000 to 1.0000, and the x-axis ranges from 0.0000 to 1.0000. The plot is currently empty.
- Profile reference:** Set to 'Surface normal'.
- Data type:** Set to 'BxDF'.

# Surface Property Generator Features

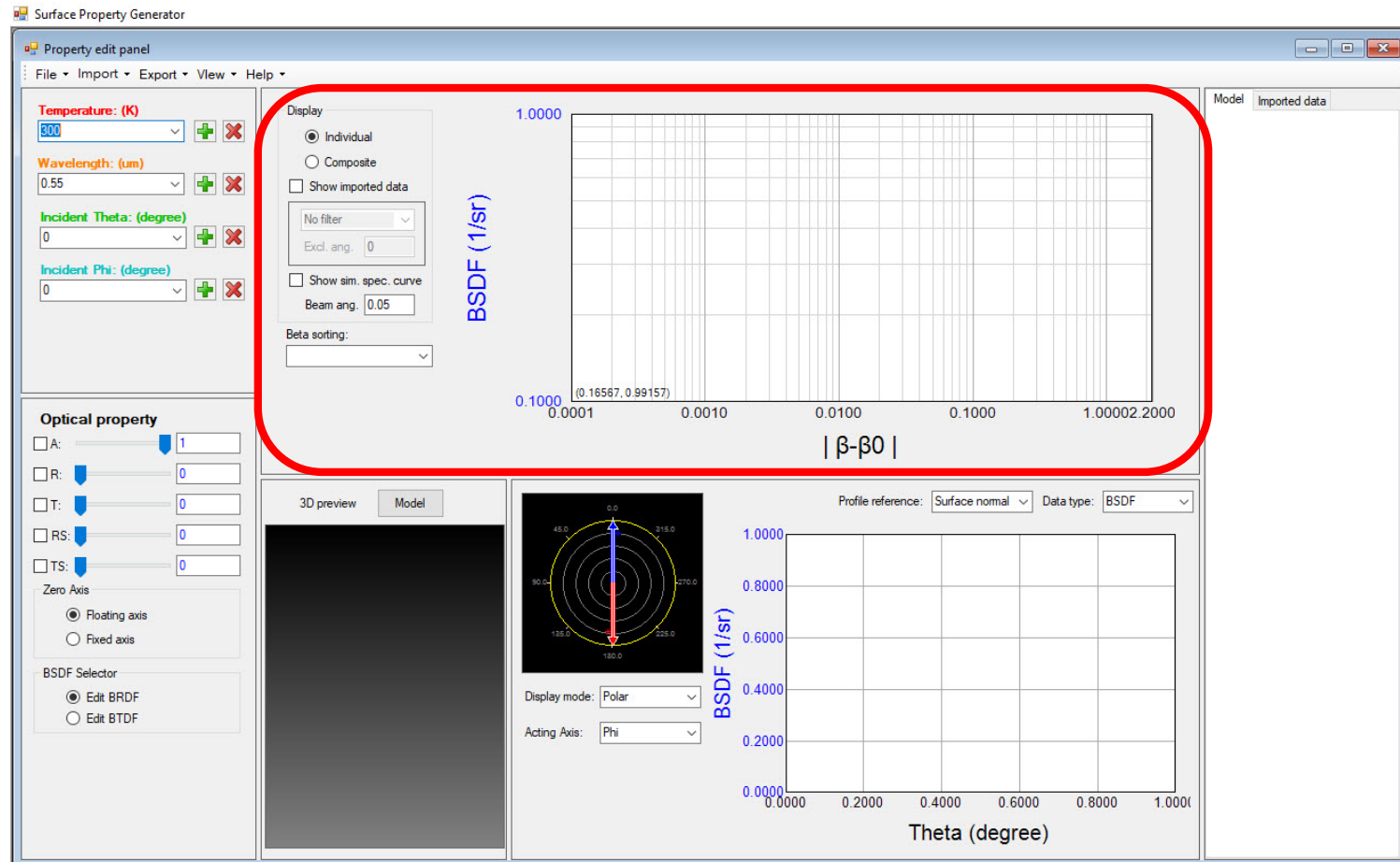
## Surface Property Generator – Zero Axis and BRDF or BTDF

The screenshot displays the 'Surface Property Generator' software interface. The main window is titled 'Property edit panel' and includes a menu bar with 'File', 'Import', 'Export', 'View', and 'Help'. The interface is divided into several sections:

- Input Parameters:** Temperature (K) set to 300, Wavelength (um) set to 0.55, Incident Theta (degree) set to 0, and Incident Phi (degree) set to 0. Each parameter has a dropdown menu and +/- buttons.
- Display Options:** Includes radio buttons for 'Individual' (selected) and 'Composite', a checkbox for 'Show imported data', a 'No filter' dropdown, 'Excl. ang.' set to 0, a checkbox for 'Show sim. spec. curve', and 'Beam ang.' set to 0.05. A 'Beta sorting' dropdown is also present.
- Optical Property:** A section with checkboxes for 'A', 'R', 'T', 'RS', and 'TS', each with a corresponding slider. Below this, the 'Zero Axis' section has radio buttons for 'Floating axis' (selected) and 'Fixed axis'. The 'BSDF Selector' has radio buttons for 'Edit BRDF' (selected) and 'Edit BTDF'. This entire section is highlighted with a red circle.
- 3D Preview:** A '3D preview' window showing a dark surface with a 'Model' button.
- Plots:** Two plots are visible. The top plot shows BSDF (1/sr) vs.  $|\beta - \beta_0|$  on a log-log scale. The bottom plot shows BSDF (1/sr) vs. Theta (degree) on a linear scale, with a 'Polar' display mode and 'Phi' acting axis.
- Model:** A 'Model' window on the right showing 'Imported data'.

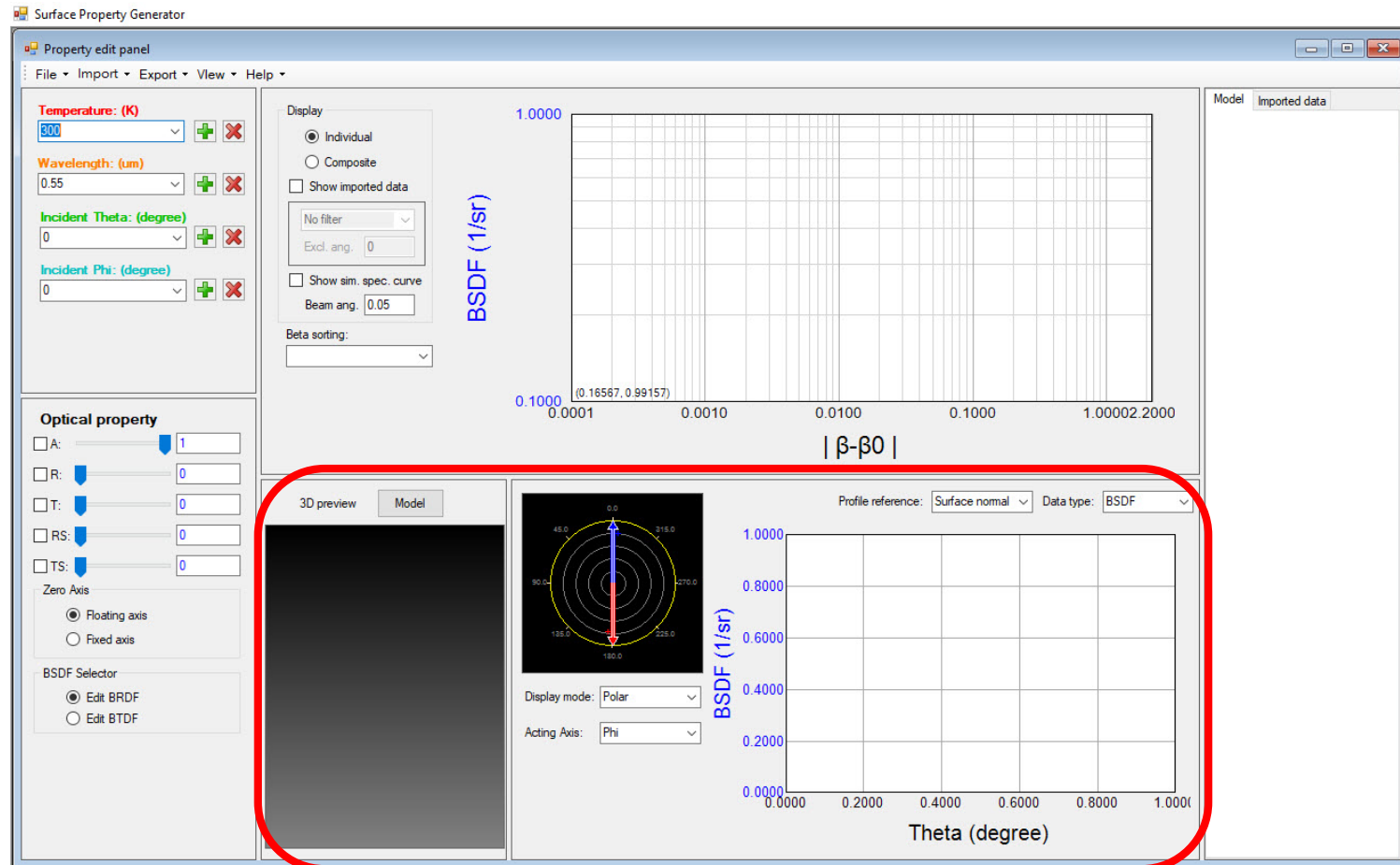
# Surface Property Generator Features

## Surface Property Generator – BSDF Plot – Imported Data



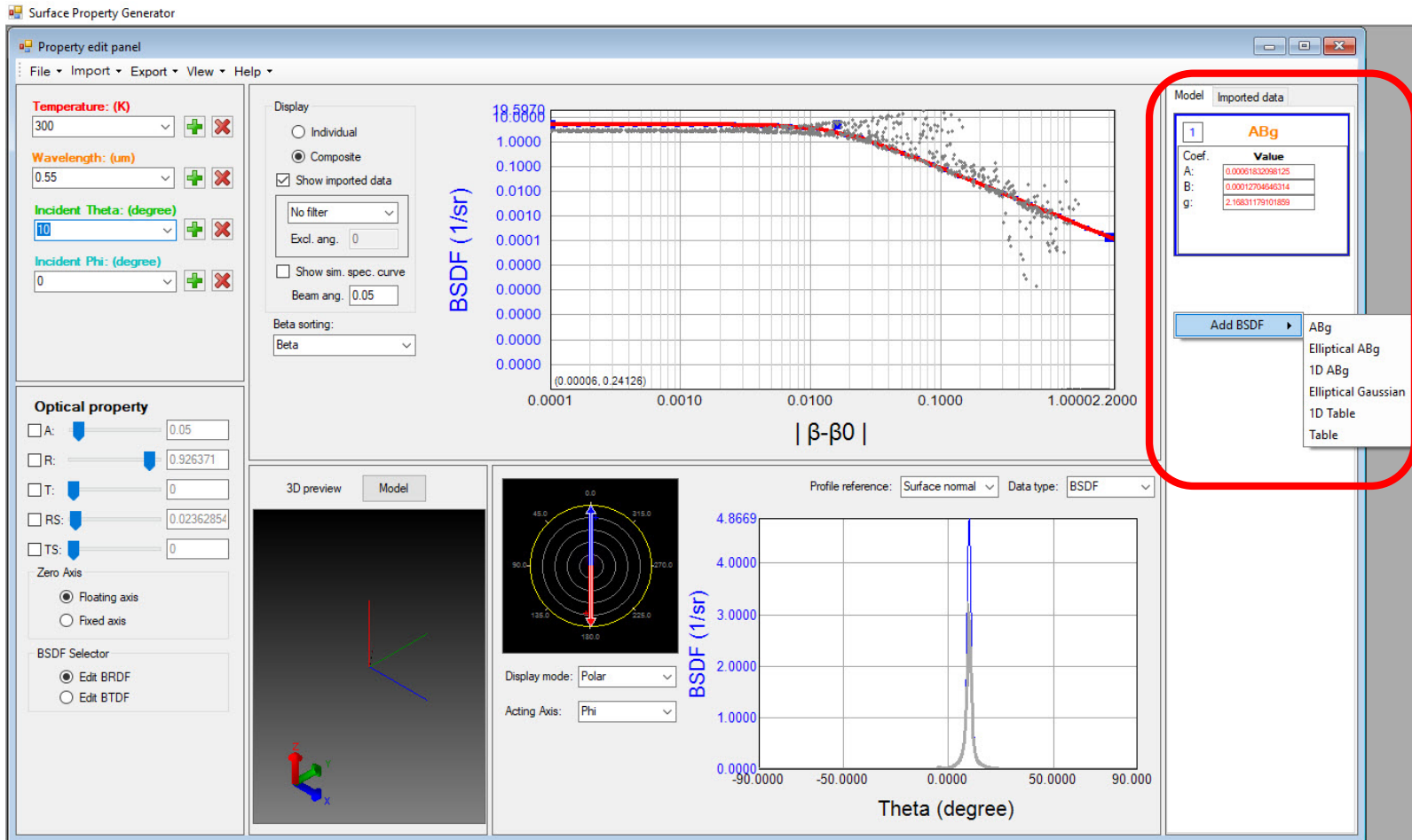
# Surface Property Generator Features

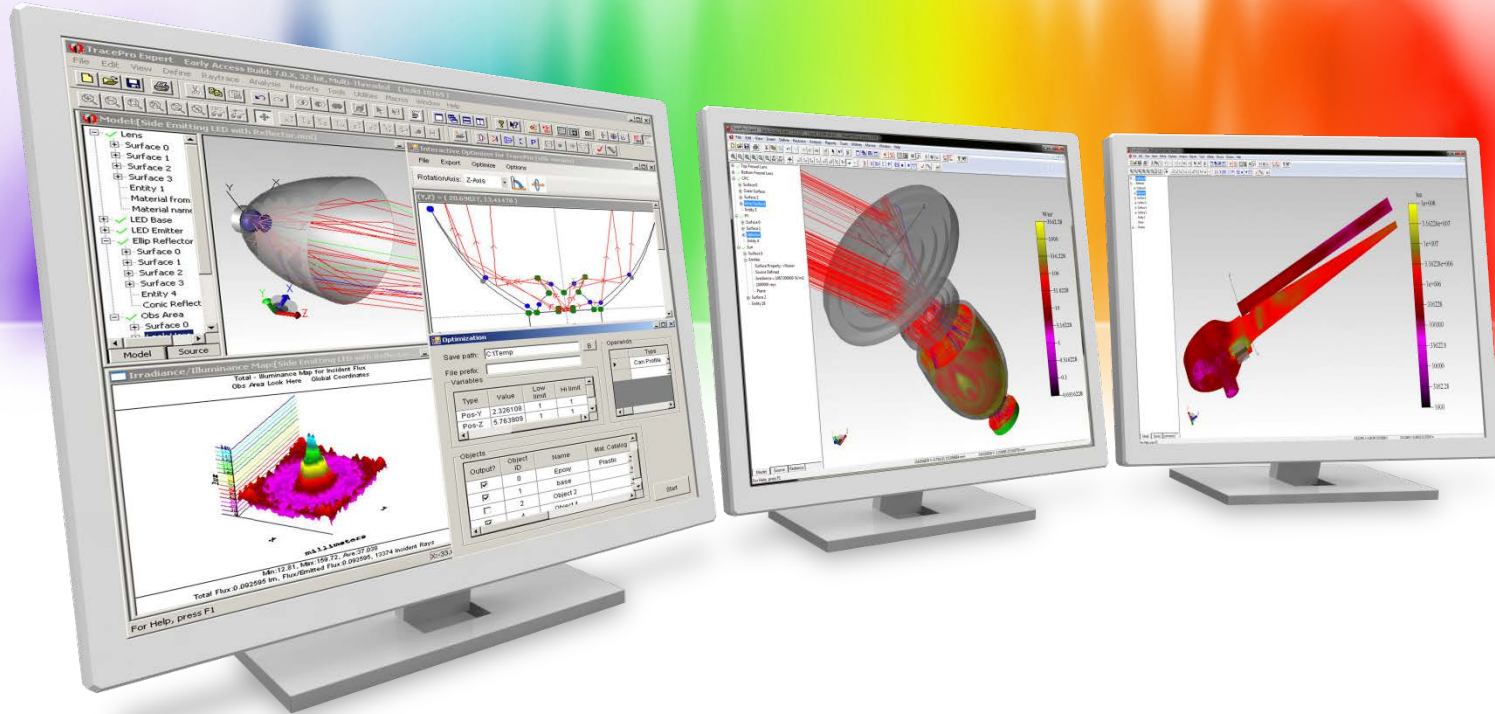
## Surface Property Generator – BSDF Plot – Fitted BSDF Data



# Surface Property Generator Features

## Surface Property Generator – BSDF Plot – Available Scatter Models





## Making a Surface Property – No Scattering



# Making a new Surface Property – No Scattering

Open the Surface Property Generator

The screenshot displays the 'Surface Property Generator' software interface. The main window is titled 'Property edit panel' and contains several sections:

- Input Parameters:** Temperature (K) set to 300, Wavelength (um) set to 0.55, Incident Theta (degree) set to 0, and Incident Phi (degree) set to 0. Each parameter has a dropdown menu and +/- buttons.
- Optical property:** A section with checkboxes for A, R, T, RS, and TS, each with a slider and a numerical value (A: 1, R: 0, T: 0, RS: 0, TS: 0). Below this are 'Zero Axis' options (Floating axis selected, Fixed axis) and a 'BSDF Selector' (Edit BRDF selected, Edit BTDF).
- Display Controls:** Radio buttons for 'Individual' (selected) and 'Composite', a 'Show imported data' checkbox, a 'No filter' dropdown, 'Excl. ang.' set to 0, a 'Show sim. spec. curve' checkbox, and 'Beam ang.' set to 0.05. A 'Beta sorting' dropdown is also present.
- 3D preview:** A '3D preview' section with a 'Model' button and a dark 3D view area.
- Plots:**
  - Top Plot:** A log-log plot of BSDF (1/sr) vs  $|\beta - \beta_0|$ . The y-axis ranges from 0.1000 to 1.0000, and the x-axis ranges from 0.0001 to 2.0000. A data point is labeled at (0.16567, 0.99157).
  - Bottom Plot:** A plot of BSDF (1/sr) vs Theta (degree). The y-axis ranges from 0.0000 to 1.0000, and the x-axis ranges from 0.0000 to 1.0000. The plot is currently empty.
  - Polar Plot:** A polar plot showing angular distribution with concentric circles and radial lines. The acting axis is set to Phi.
- Profile reference:** A dropdown menu set to 'Surface normal' and 'Data type' set to 'BSDF'.
- Model Imported data:** A panel on the right side of the window.

# Making a new Surface Property – No Scattering

Enter values for Temperature, Wavelength, Incident Theta, and Incident Phi

The screenshot displays the TracePro software interface. On the left, the 'Property edit panel' is visible, containing input fields for 'Temperature: (K)' (300), 'Wavelength: (um)' (0.5461), 'Incident Theta: (degree)' (0), and 'Incident Phi: (degree)' (0). These fields are highlighted with a red box. A red arrow points from this box to a floating dialog box in the center of the screen. The dialog box contains the same four input fields: 'Temperature: (K)' (300), 'Wavelength: (um)' (0.5461), 'Incident Theta: (degree)' (0), and 'Incident Phi: (degree)' (0). The background shows a 3D preview window with a coordinate system and a plot of BSDF (1/sr) versus Theta (degree). The plot shows a sharp peak at 0 degrees with a value of 18.5878. The x-axis ranges from -90.0000 to 90.0000, and the y-axis ranges from 0.0000 to 1.0000. The plot is labeled 'BSDF (1/sr)' and 'Theta (degree)'. The '3D preview' window shows a model of a surface with a coordinate system (X, Y, Z) and a 'Zero Axis' section with options for 'Floating axis' and 'Fixed axis'. The 'BxDF Selector' section has options for 'Edit BRDF' and 'Edit BTDF'. The 'Optical property' section has checkboxes for 'A', 'R', 'T', 'RS', and 'TS', each with a corresponding value field. The 'Display' section has options for 'Individual' and 'Composite', and a 'Show imported data' checkbox. The 'Beta sorting' section has a 'Beta' dropdown menu. The 'Model' section shows 'Imported data'.

# Making a new Surface Property – No Scattering

Enter values for Absorption, Reflection, and Transmission

The screenshot shows the 'Property edit panel' in TracePro. The 'Optical property' section is highlighted with a red box. It contains the following settings:

- A: 0.1
- R: 0.6
- T: 0.3
- RS: 0
- TS: 0

The 'Zero Axis' section has 'Fixed axis' selected. The 'BSDF Selector' has 'Edit BRDF' selected. The 'BSDF' plot shows a single peak at 0 degrees with a value of 18.5878 1/sr. The 'Theta (degree)' axis ranges from -90.0000 to 90.0000. The 'Y-axis' is labeled 'BSDF (1/sr)' and ranges from 0.0000 to 18.5878.

Values can be set using the sliders or by entering the values directly.  
Check the box next to the parameter you want to Solve For.

# Making a new Surface Property – No Scattering

Repeat the process for additional Temperature, Wavelength, Incident Theta, and/or Incident Phi

The screenshot displays the TracePro software interface, specifically the Property edit panel and the Optical property settings. A red box highlights the Temperature, Wavelength, Incident Theta, and Incident Phi input fields in the Property edit panel. A red arrow points from this box to the Optical property panel, which shows the BSRDF (Bidirectional Scattering Reflectance Distribution Function) settings. The BSRDF panel includes sliders for A, R, T, RS, and TS, and radio buttons for Zero Axis (Floating axis or Fixed axis) and BSRDF Selector (Edit BRDF or Edit BTDF). The main window shows a 3D preview of a model and a graph of BSRDF (1/sr) versus Theta (degree).

**Property edit panel:**

- Temperature: (K) 300
- Wavelength: (um) 0.75
- Incident Theta: (degree) 0
- Incident Phi: (degree) 0

**Optical property:**

- A: 0.1
- R: 0.5
- T: 0.4
- RS: 0
- TS: 0
- Zero Axis:  Floating axis,  Fixed axis
- BSRDF Selector:  Edit BRDF,  Edit BTDF

**Graph:** BSRDF (1/sr) vs Theta (degree). The y-axis ranges from 0.0000 to 18.5878. The x-axis ranges from 0.0000 to 90.0000. A single data point is visible at Theta = 0.0000, BSRDF = 18.5878.

# Making a new Surface Property – No Scattering

Export the property to TracePro – Export->Export with Model BSRF

The screenshot displays the TracePro Property Editor window. The 'Export' menu is open, and the 'Export with Model BSRF' option is highlighted with a red box. The interface includes several panels:

- Temperature (K):** 300
- Wavelength: (um):** 0.75
- Incident Theta: (degree):** 0
- Incident Phi: (degree):** 0
- Optical property:** A: 0.1, R: 0.5, T: 0.4, RS: 0, TS: 0. Zero Axis: Fixed axis. BSRF Selector: Edit BRDF.
- Graphs:** A large graph shows BSRF (1/sr) vs  $|\beta - \beta_0|$  on a log-log scale. A smaller graph shows BSRF (1/sr) vs Theta (degree) on a linear scale.
- 3D preview:** A 3D model of the surface property is shown.

# Making a new Surface Property – No Scattering

Enter a Catalog and Property Name. Click Export->Export to TracePro in the Export Property with Model BSDF window

The screenshot shows the TracePro software interface. The main window is titled 'Property edit panel' and contains several input fields for defining a surface property:

- Temperature: (K) 300
- Wavelength: (um) 0.75
- Incident Theta: (degree) 0
- Incident Phi: (degree) 0

Below these are 'Optical property' settings with sliders for A (0.1), R (0.5), and T (0.4), and checkboxes for RS and TS. There are also options for 'Zero Axis' (Floating or Fixed) and 'BSDF Selector' (Edit BRDF or Edit BTDF).

The 'Export Property with Model BSDF' dialog box is open, showing the following information:

- Catalog: Webinar
- Property name: Webinar Property, 1
- Solve for: BRDF

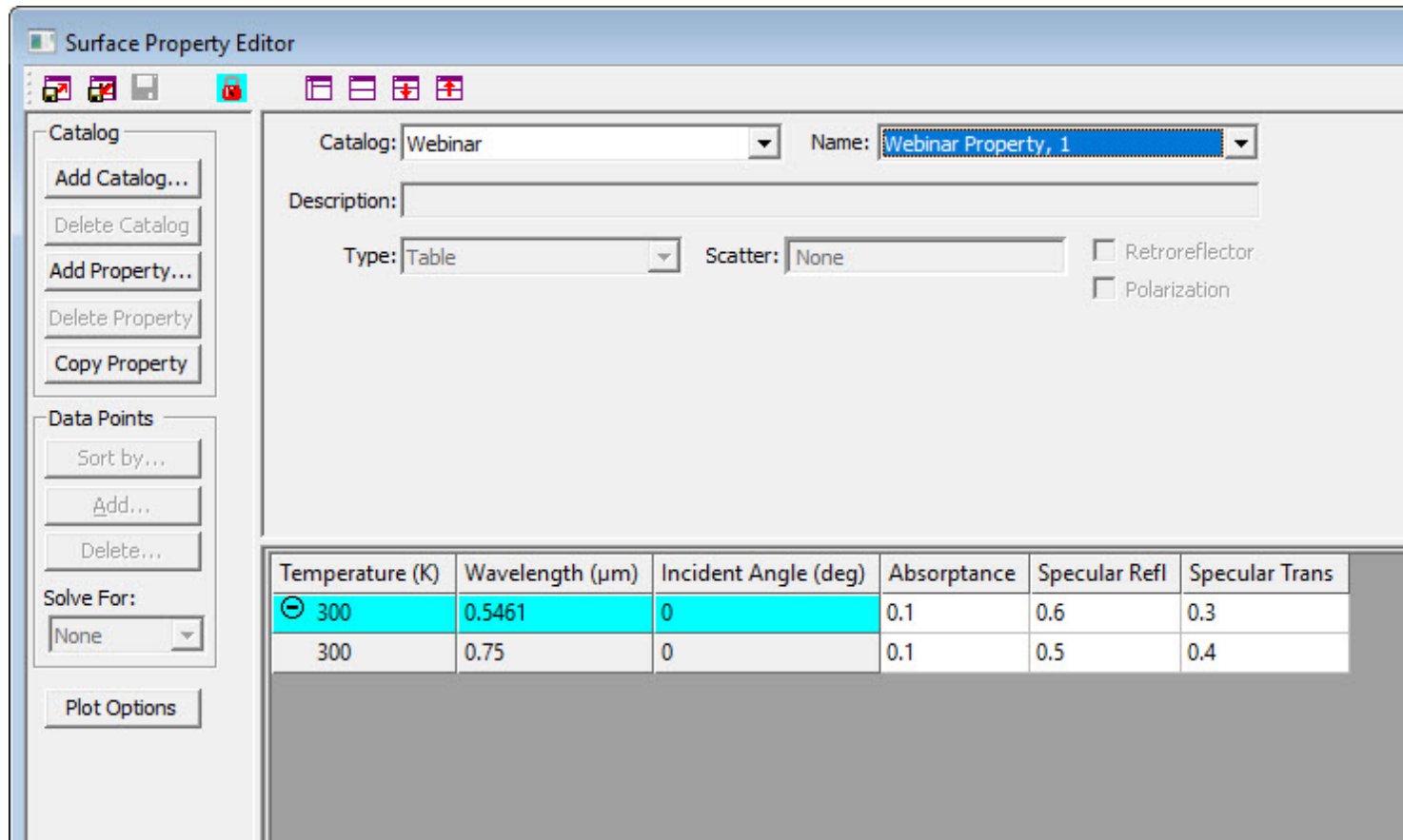
The 'Property overview' table is as follows:

Temperature	Wavelength	Incident angle	Azimuth angle	Absorptance	Reflectance	Transmittance	BRDF	BRDF model	BTDF	BTDF model
300.0	0.5461	0.0	0.0	0.1	0.6	0.3	0.0		0.0	
300.0	0.75	0.0	0.0	0.1	0.5	0.4	0.0		0.0	

The 'Export' button in the dialog box is highlighted with a red circle, and a context menu is open over it, with 'Export to TracePro' selected.

# Making a new Surface Property – No Scattering

## Resulting Surface Property in TracePro



Surface Property Editor

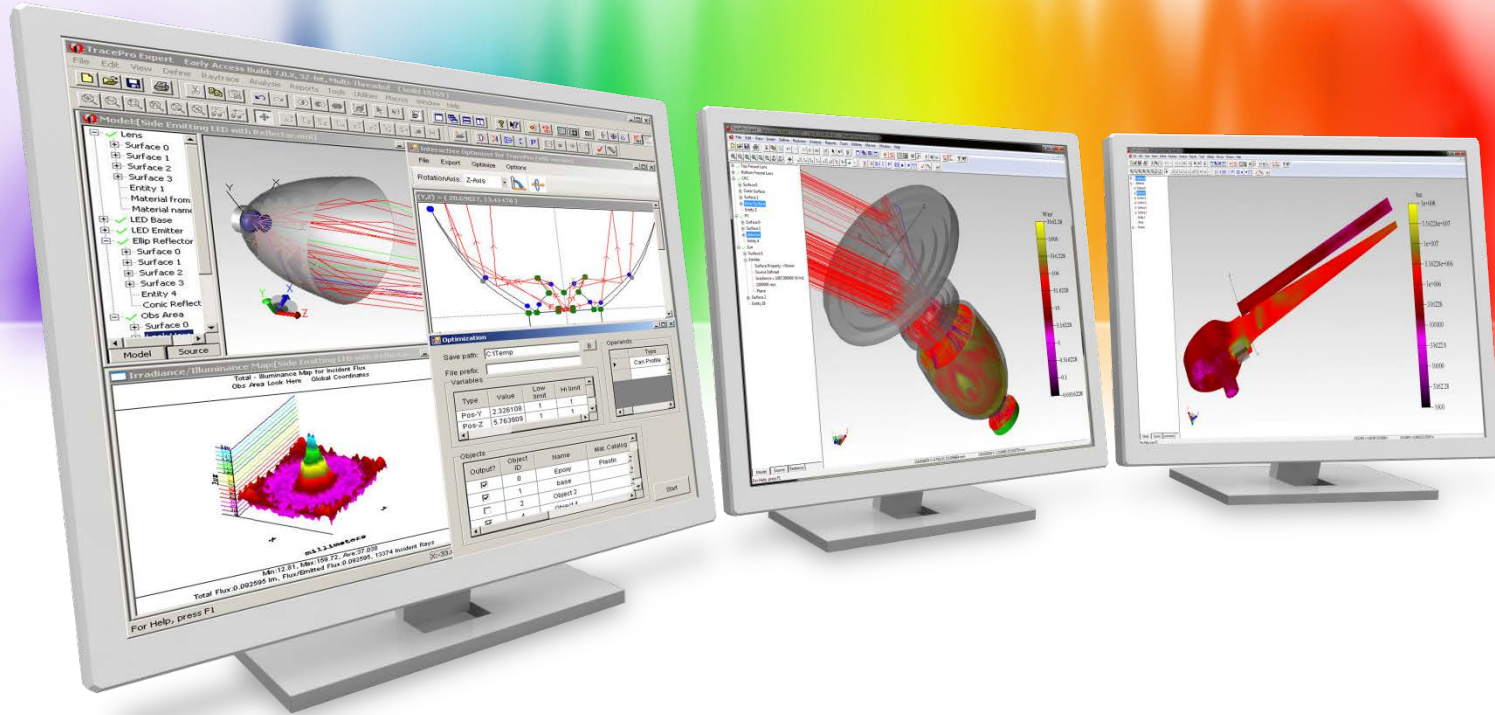
Catalog: Webinar Name: Webinar Property, 1

Description:

Type: Table Scatter: None  Retroreflector  Polarization

Data Points

Temperature (K)	Wavelength (μm)	Incident Angle (deg)	Absorptance	Specular Refl	Specular Trans
300	0.5461	0	0.1	0.6	0.3
300	0.75	0	0.1	0.5	0.4



## Making a Surface Property – With Scattering



# Making a new Surface Property – With Scattering

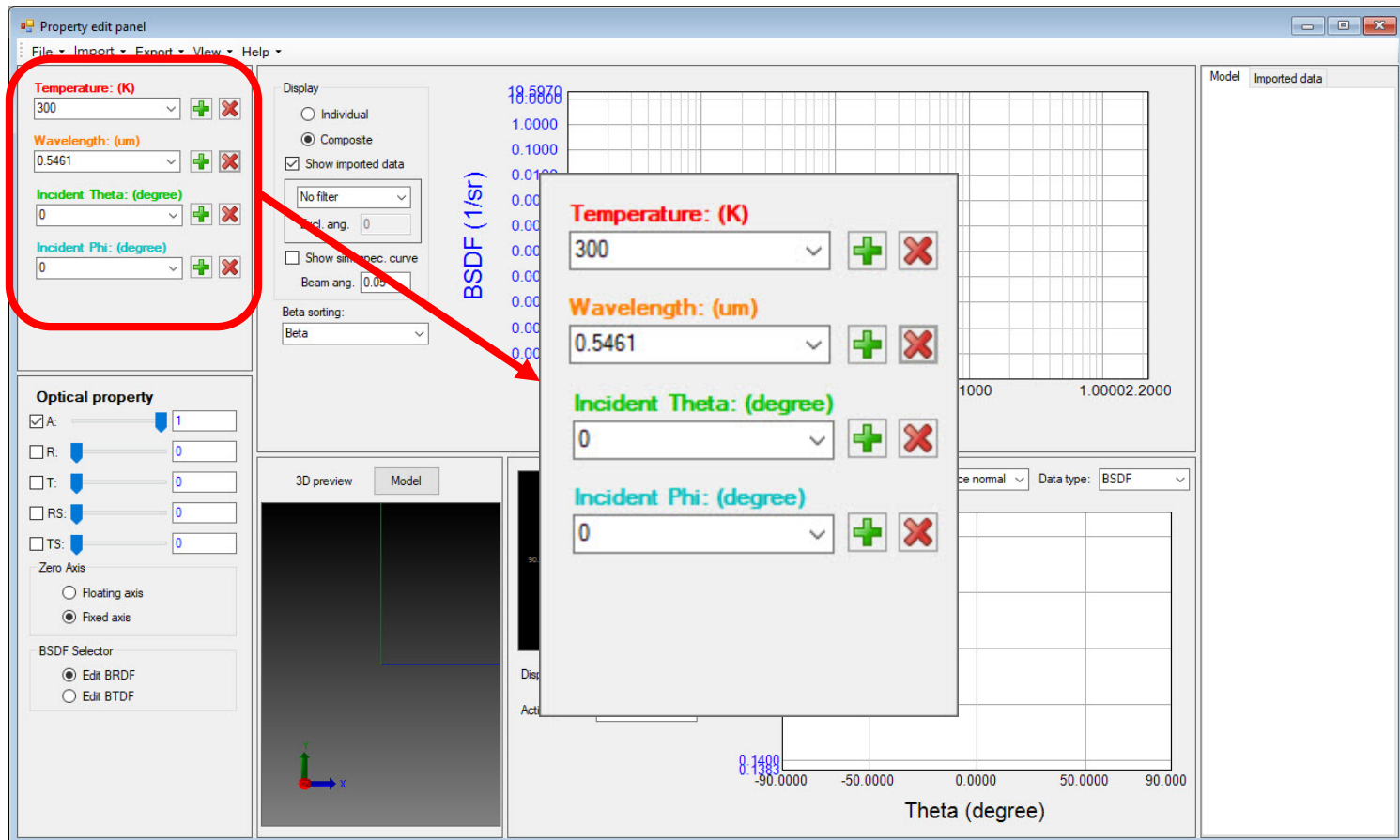
Open the Surface Property Generator

The screenshot displays the 'Surface Property Generator' software interface. The main window is titled 'Property edit panel' and contains several sections:

- Input Parameters:** Temperature (K) set to 300, Wavelength (um) set to 0.55, Incident Theta (degree) set to 0, and Incident Phi (degree) set to 0. Each parameter has a dropdown menu and +/- buttons.
- Optical property:** A section with checkboxes for A, R, T, RS, and TS, each with a slider and numerical value. Below this are 'Zero Axis' options (Floating axis selected, Fixed axis) and 'BSDF Selector' options (Edit BRDF selected, Edit BTDF).
- Display Controls:** Radio buttons for 'Individual' (selected) and 'Composite', a 'Show imported data' checkbox, a 'No filter' dropdown, 'Excl. ang.' set to 0, a 'Show sim. spec. curve' checkbox, and 'Beam ang.' set to 0.05. A 'Beta sorting' dropdown is also present.
- 3D preview:** A '3D preview' window showing a dark model, and a 'Model' window showing a polar plot of the surface property with concentric circles and radial lines. The plot is labeled with angles: 0.0, 45.0, 90.0, 135.0, 180.0, 225.0, 270.0, and 315.0. The 'Display mode' is set to 'Polar' and the 'Acting Axis' is 'Phi'.
- Plots:** Two plots showing BSRDF (1/sr) vs.  $|\beta - \beta_0|$  and BSRDF (1/sr) vs. Theta (degree). The top plot has a logarithmic x-axis from 0.0001 to 2.000 and a linear y-axis from 0.1000 to 1.0000. The bottom plot has a linear x-axis from 0.0000 to 1.0000 and a linear y-axis from 0.0000 to 1.0000. Both plots show a sharp peak at the origin.

# Making a new Surface Property – No Scattering

Enter values for Temperature, Wavelength, Incident Theta, and Incident Phi as before. Multiple values can be used for each parameter.



# Making a new Surface Property – With Scattering

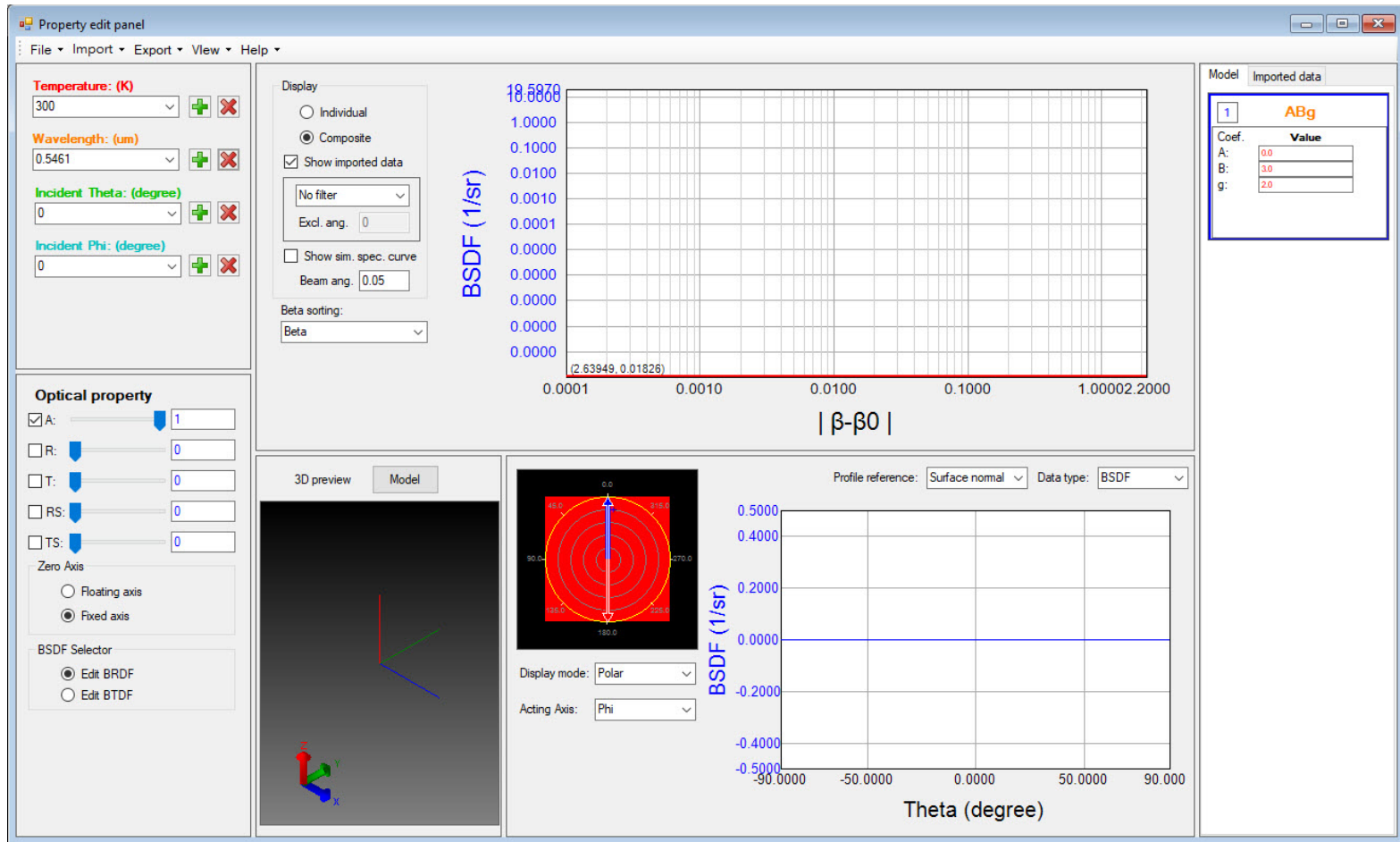
Right click on the right side of the window, select Add BSDF, and then select the BSDF model to use

The screenshot displays the 'Property edit panel' in TracePro. The interface is divided into several sections:

- Temperature (K):** 300
- Wavelength: (um):** 0.5461
- Incident Theta: (degree):** 0
- Incident Phi: (degree):** 0
- Optical property:** A: 1, R: 0, T: 0, RS: 0, TS: 0. Zero Axis: Fixed axis. BSDF Selector: Edit BRDF.
- Display:** Composite, Show imported data, No filter, Excl. ang. 0, Beam ang. 0.05, Beta sorting: Beta.
- Main Plot:** A log-log plot of BSDF (1/sr) vs  $|\beta - \beta_0|$ . The y-axis ranges from 0.0000 to 18.6868, and the x-axis ranges from 0.0001 to 1.0000. A data point is marked at (2.63949, 0.01828).
- 3D preview:** A 3D coordinate system showing the surface normal.
- Profile reference:** Surface normal, Data type: BSDF.
- Secondary Plot:** A plot of BSDF (1/sr) vs Theta (degree). The y-axis ranges from -0.5000 to 0.5000, and the x-axis ranges from -90.0000 to 90.0000. The plot shows a polar coordinate system with concentric circles and radial lines.
- Model:** Imported data.
- Context Menu:** A right-click context menu is open over the 'Model' area, showing the following options: Add BSDF, ABg, Elliptical ABg, 1D ABg, Elliptical Gaussian, 1D Table, and Table.

# Making a new Surface Property – With Scattering

ABg scatter model used in this example



# Making a new Surface Property – With Scattering

Enter values for Absorption, Reflection, and Transmission, Reflected Scatter, and Transmitted Scatter

The screenshot displays the 'Property edit panel' for an optical property. The 'Optical property' section is highlighted with a red box. The parameters are as follows:

Parameter	Value
A (Absorption)	0.1
R (Reflection)	0.05
T (Transmission)	0
RS (Reflected Scatter)	0.85
TS (Transmitted Scatter)	0

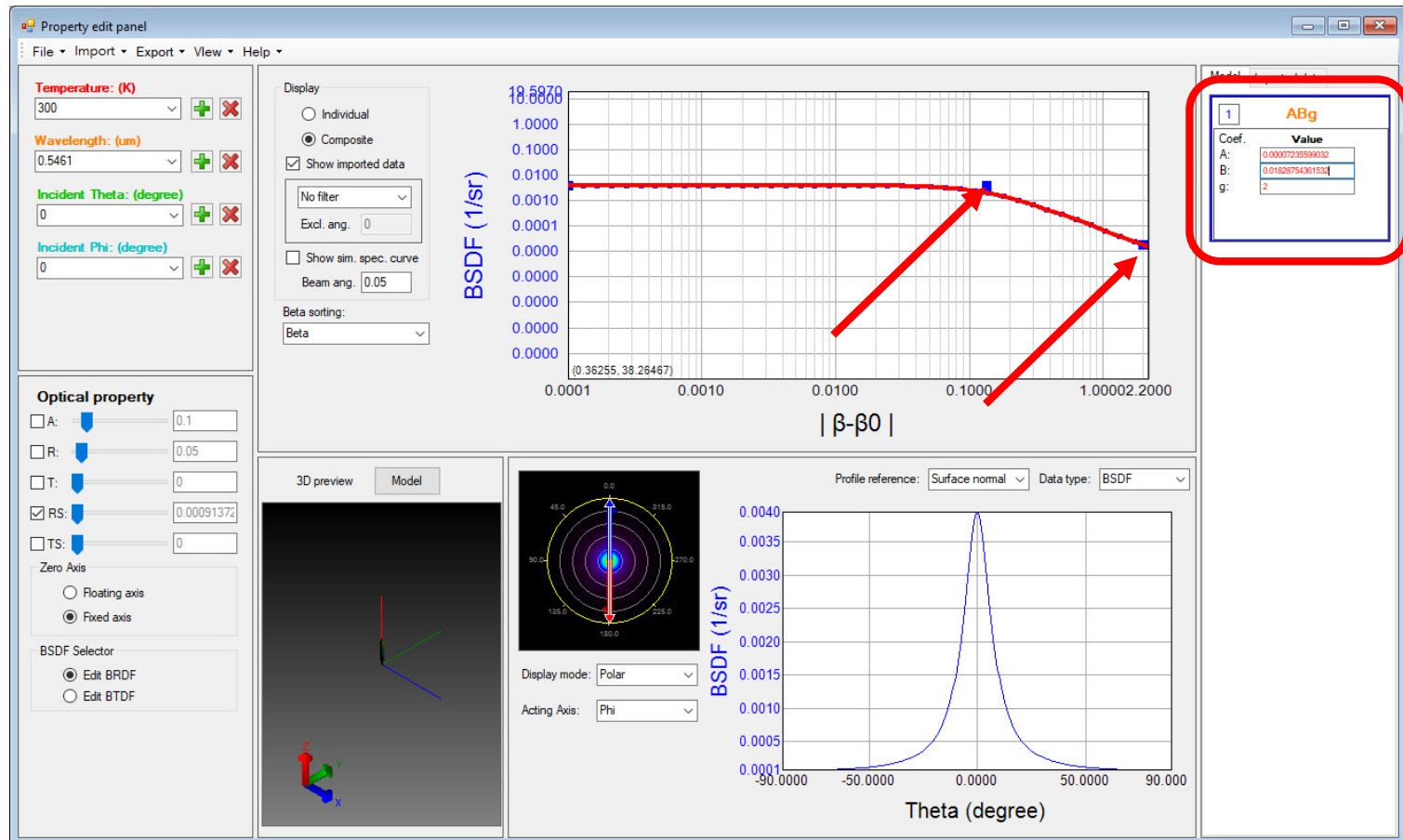
The 'Zero Axis' section has 'Fixed axis' selected. The 'BxDF Selector' section has 'Edit BRDF' selected. The graph shows a bell-shaped curve for BxDF (1/sr) vs Theta (degree), peaking at 0.3135 at 0 degrees. The table on the right shows the Coef. values for A, B, and g.

Coef.	Value
A	0.9409448737051
B	3.0
g	2.0

Values can be set using the sliders or by entering the values directly.  
Check the box next to the parameter you want to Solve For.

# Making a new Surface Property – With Scattering

BSDF curve can be changed by entering A, B, and g values in the ABg dialog box, or by moving the blue control points on the ABg BSDF curve.



# Making a new Surface Property – With Scattering

Export the property to TracePro – Export->Export with Model BSGDF

The screenshot shows the TracePro Property Editor window. The 'Export' menu is open, and 'Export with Model BSGDF' is highlighted. The main area displays a graph of BSGDF (1/sr) versus  $|\beta - \beta_0|$ . The y-axis ranges from 0.0000 to 1.0000, and the x-axis ranges from 0.0001 to 1.00002. A red curve shows the BSGDF value, which is constant at approximately 0.000723599032 for  $|\beta - \beta_0|$  up to about 0.1, then decreases. A blue square marker is visible on the curve at  $|\beta - \beta_0| \approx 0.1$ . Below the graph is a 3D preview of the surface property, a polar plot showing the BSGDF distribution, and a graph of BSGDF (1/sr) versus Theta (degree). The y-axis ranges from 0.0001 to 0.0040, and the x-axis ranges from -90.0000 to 90.0000. A blue curve shows a sharp peak at Theta = 0.0000. The right side of the window shows the 'Model Imported data' table.

Coef.	Value
A:	0.0000723599032
B:	0.01826754361532
g:	2.0

# Making a new Surface Property – No Scattering

Enter a Catalog and Property Name. Click Export->Export to TracePro in the Export Property with Model BSDF window

The screenshot shows the 'Property edit panel' in the background with the following settings:

- Temperature: (K) 300
- Wavelength: (um) 0.5461
- Incident Theta: (degree) 0
- Incident Phi: (degree) 0

The 'Export Property with Model BSDF' dialog box is open, showing the following fields:

- Catalog: Webinar
- Property name: Webinar Property, 2
- Solve for: BRDF

The 'Property overview' table is as follows:

Temperature	Wavelength	Incident angle	Azimuth angle	Absorptance	Reflectance	Transmittance	BRDF	BRDF model	BTDF	BTDF model
300.0	0.5461	0.0	0.0	0.1	0.05	0.0	0.000913720...	Model 0	0.0	Model 0

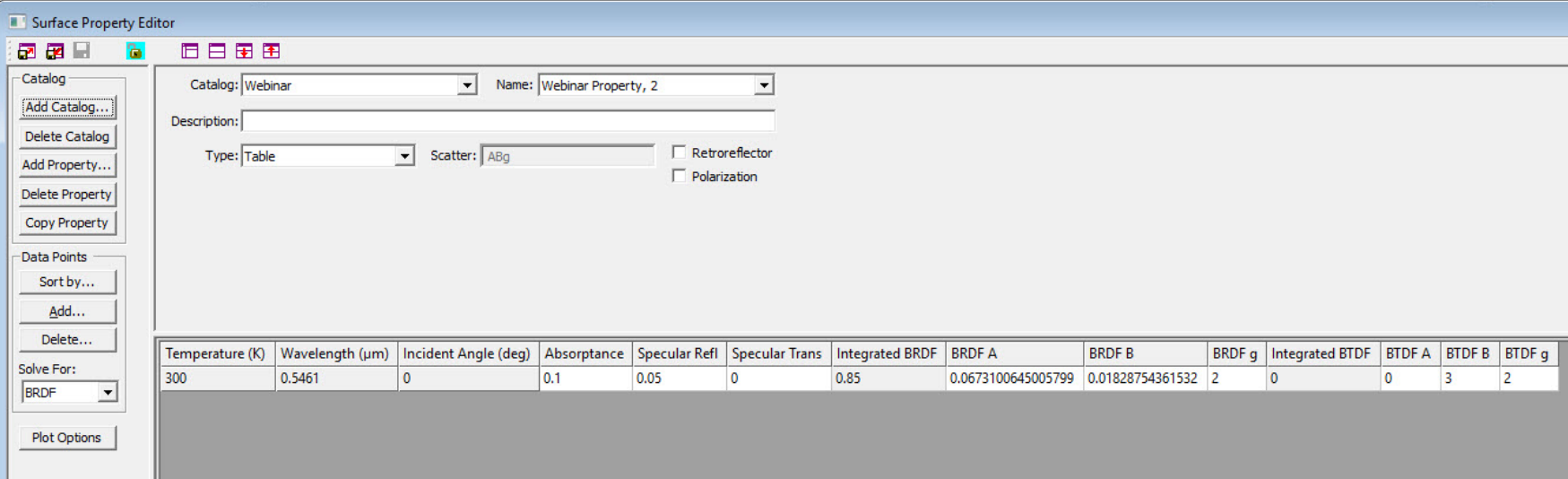
The 'Model property view' section is currently empty.

The background graph shows DF (1/sr) on the y-axis (0.0000 to 18.5870) and Theta (degree) on the x-axis (-90.0000 to 90.0000). A red curve is plotted, starting at approximately 0.001 and decreasing as Theta increases.



# Making a new Surface Property – No Scattering

## Resulting Surface Property in TracePro



Surface Property Editor

Catalog: Webinar Name: Webinar Property, 2

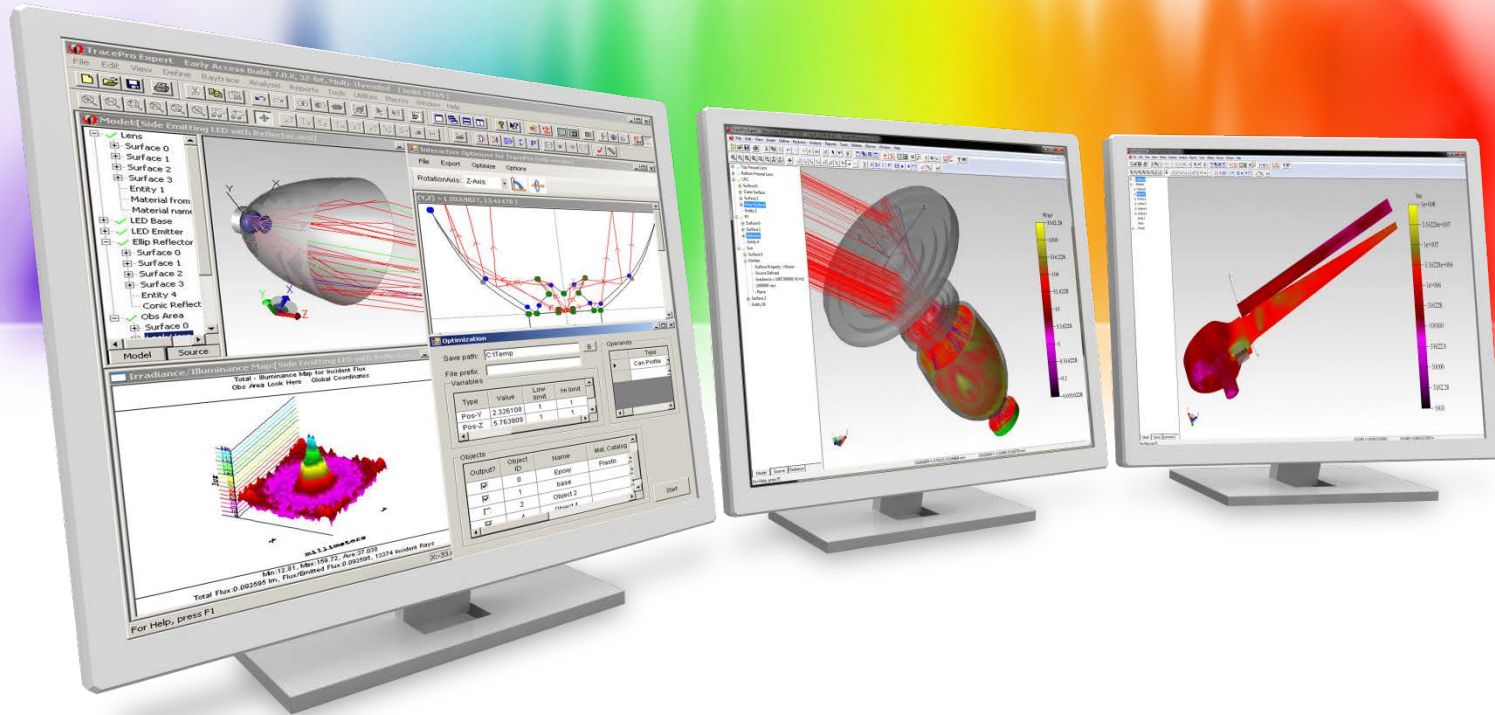
Description:

Type: Table Scatter: ABg  Retroreflector  Polarization

Temperature (K)	Wavelength (μm)	Incident Angle (deg)	Absorptance	Specular Refl	Specular Trans	Integrated BRDF	BRDF A	BRDF B	BRDF g	Integrated BTDF	BTDF A	BTDF B	BTDF g
300	0.5461	0	0.1	0.05	0	0.85	0.0673100645005799	0.01828754361532	2	0	0	3	2

Solve For: BRDF

Plot Options



## Making a Surface Property – Using Measured Scatter Data

# Making a new Surface Property – Measured Scatter Data

Open the Surface Property Generator

The screenshot displays the 'Surface Property Generator' software interface. The main window is titled 'Property edit panel' and contains several sections:

- Input Parameters:** Temperature (K) set to 300, Wavelength (um) set to 0.55, Incident Theta (degree) set to 0, and Incident Phi (degree) set to 0. Each parameter has a dropdown menu and +/- buttons.
- Optical property:** A section with sliders for A, R, T, RS, and TS, all set to 0. It also includes options for 'Zero Axis' (Floating axis selected) and 'BSDF Selector' (Edit BRDF selected).
- Display Controls:** Radio buttons for 'Individual' (selected) and 'Composite', a 'Show imported data' checkbox, a 'No filter' dropdown, 'Excl. ang.' set to 0, a 'Show sim. spec. curve' checkbox, and 'Beam ang.' set to 0.05. A 'Beta sorting' dropdown is also present.
- 3D preview:** A '3D preview' window showing a dark model, and a 'Model' window showing a polar plot of the surface property with concentric circles and radial lines.
- Plots:** Two plots are visible. The top plot shows BSDF (1/sr) vs  $|\beta - \beta_0|$  on a log-log scale. The bottom plot shows BSDF (1/sr) vs Theta (degree) on a linear scale. Both plots have a y-axis from 0.1000 to 1.0000. The bottom plot also has an x-axis from 0.0000 to 1.0000.
- Profile reference:** A dropdown menu set to 'Surface normal' and a 'Data type' dropdown set to 'BSDF'.

# Making a new Surface Property – Measured Scatter Data

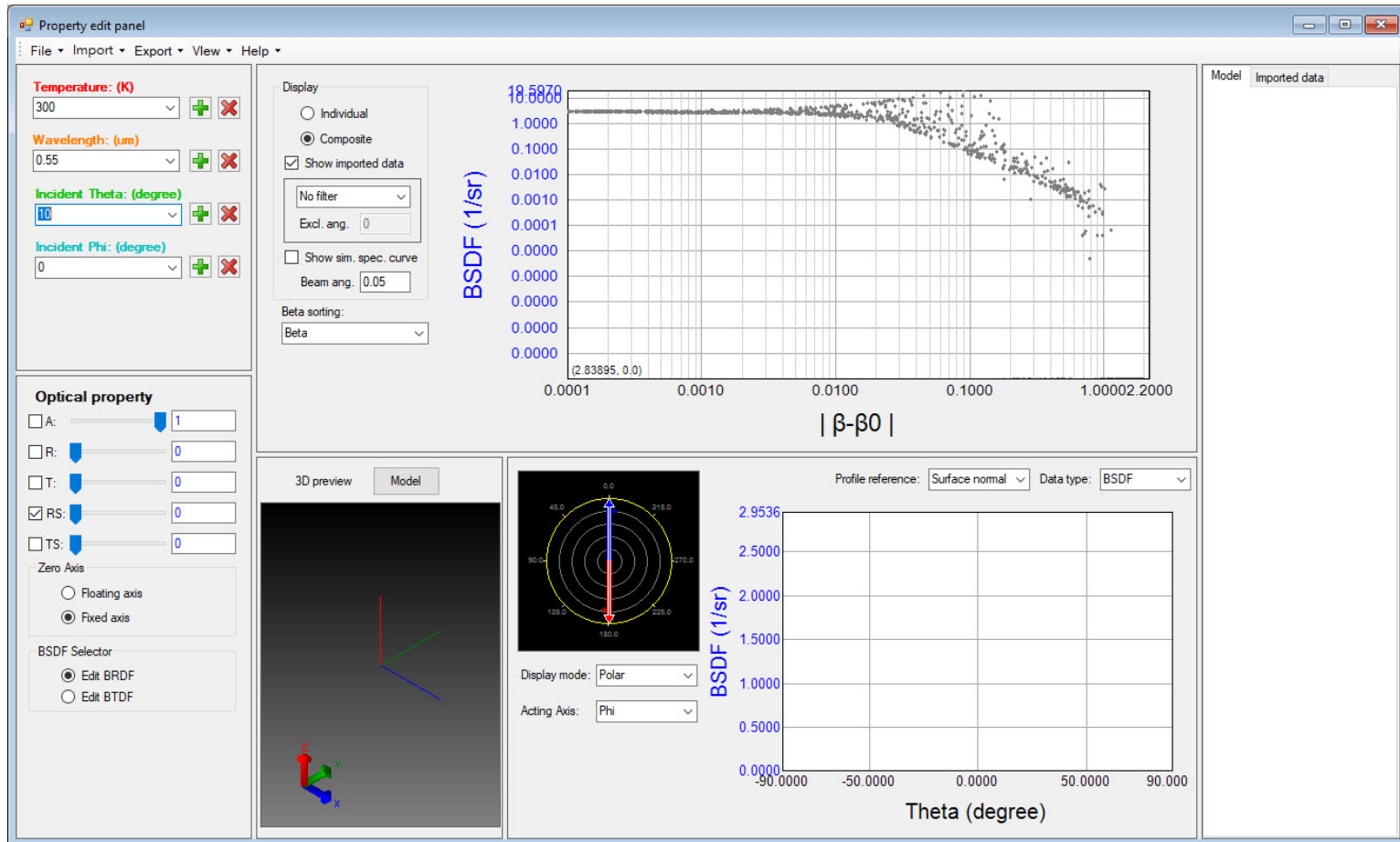
Load the measured scatter data file – Import->File

The screenshot displays the TracePro software interface for defining a surface property. The 'Import' menu is open, with 'File' and 'Existing data' options visible. The main window is divided into several sections:

- Left Panel:** Contains input fields for 'Wavelength: (um)' (0.55), 'Incident Theta: (degree)' (0), and 'Incident Phi: (degree)' (0). Below these are 'Optical property' settings (A, R, T, RS, TS) and 'BxDF Selector' (Edit BRDF, Edit BTDF).
- Top Right Panel:** 'Display' options including 'Individual' and 'Composite' (selected), 'Show imported data' (checked), and 'Beta sorting' (Beta).
- Top Center Plot:** A log-log plot of BxDF (1/sr) versus  $|\beta - \beta_0|$ . The y-axis ranges from 0.0000 to 18.6870, and the x-axis ranges from 0.0001 to 2.0000.
- Bottom Left:** A 3D preview window showing a coordinate system with X, Y, and Z axes.
- Bottom Center:** A polar plot showing angular distribution with 'Display mode: Polar' and 'Acting Axis: Phi'. The plot includes concentric circles and radial lines.
- Bottom Right Plot:** A linear plot of BxDF (1/sr) versus Theta (degree). The y-axis ranges from 0.0001 to 0.0040, and the x-axis ranges from -90.0000 to 90.0000.

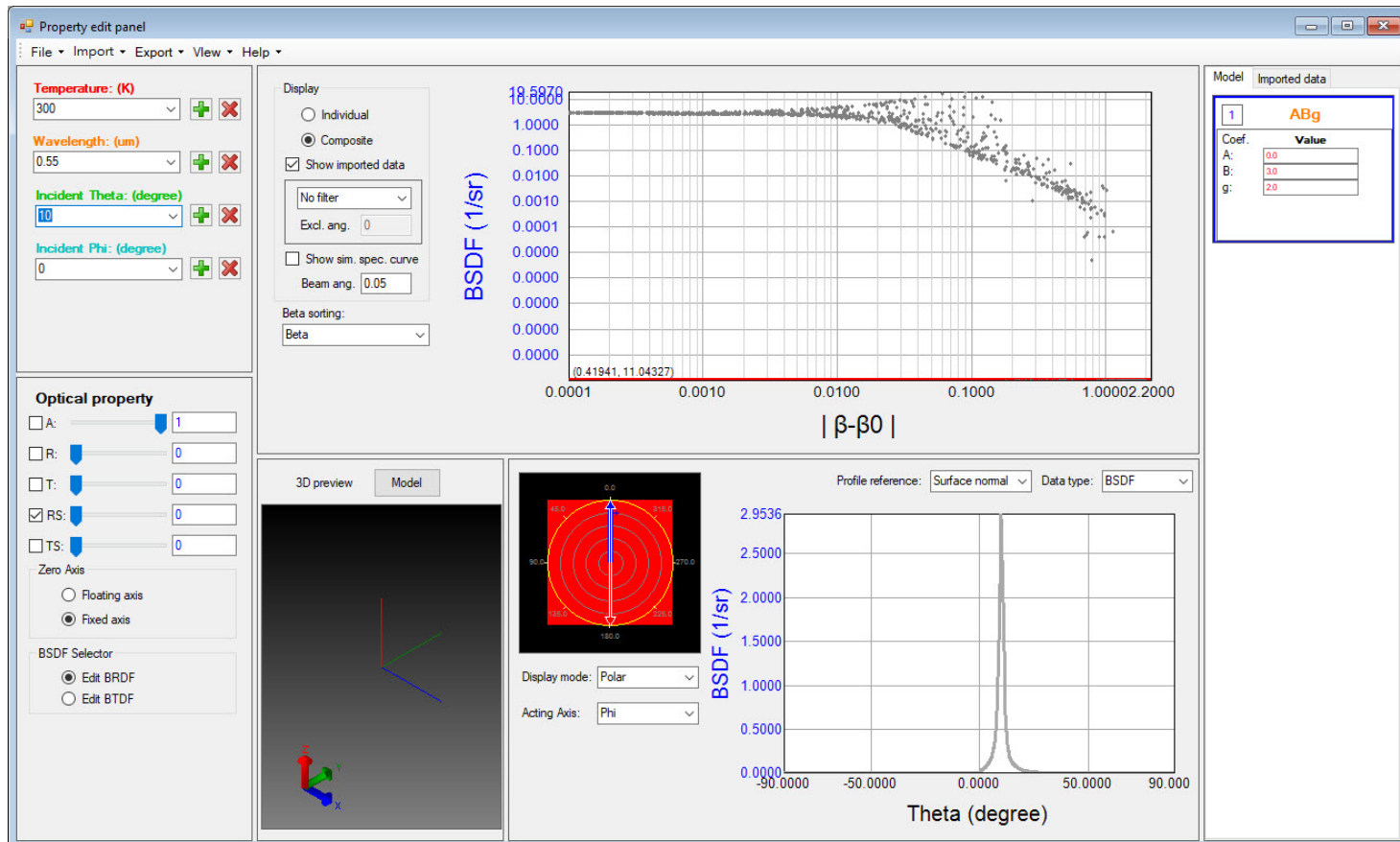
# Making a new Surface Property – Measured Scatter Data

Load the measured scatter data file – Import->File



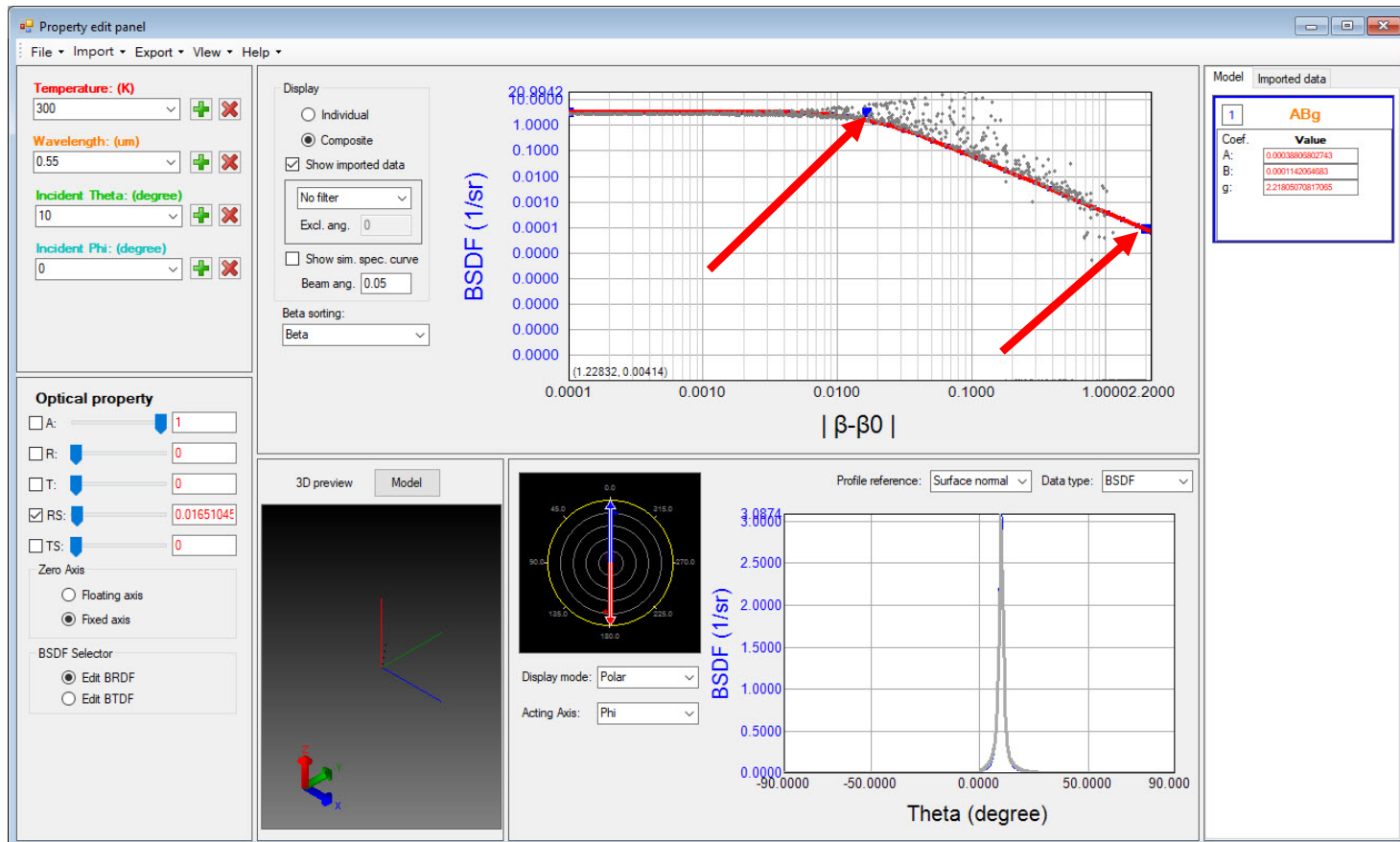
# Making a new Surface Property – Measured Scatter Data

Right click on the right side of the window, select Add BSDF, and then select the BSDF model to use. ABg selected for this example.



# Making a new Surface Property – Measured Scatter Data

Use the blue control points to adjust the fitted ABg curve to match the imported data. Results can be checked in the lower plot.



# Making a new Surface Property – Measured Scatter Data

Enter a value for Absorption. RS (reflected scatter) comes from the BSDF curve. Solve for R (reflection).

**Property edit panel**

Temperature: (K) 300  
Wavelength: (um) 0.55  
Incident Theta: (degree) 10  
Incident Phi: (degree) 0

**Optical property**

A: 0.05  
 R: 0.93348954  
 T: 0  
 RS: 0.0165104E  
 TS: 0

**Zero Axis**

Floating axis  
 Fixed axis

**BSDF Selector**

Edit BRDF  
 Edit BTDF

**Model Imported data**

Coef.	Value
A:	0.00038809802743
B:	0.0001142064683
g:	2.21805070817005

**Scatter Plot**

Y-axis:  $|\beta - \beta_0|$   
X-axis: Theta (degree)

Profile reference: Surface normal  
Data type: BSDF



# Making a new Surface Property – Measured Scatter Data

Repeat the process for other incident angles.

The screenshot shows the 'Property edit panel' in TracePro. The 'Incident Theta: (degree)' dropdown menu is highlighted with a red box, and a red arrow points to the '10' value. The 'Wavelength: (um)' is set to 0.55 and 'Temperature: (K)' is set to 300. The 'Display' section is set to 'Composite' and 'Show imported data' is checked. The 'BDF Selector' is set to 'Edit BRDF'. The right side of the panel shows a scatter plot of data points and a table of coefficients for the ABg model.

Coef.	Value
A:	0.000389302743
B:	0.0001142064983
g:	2.21905070817095

# Making a new Surface Property – Measured Scatter Data

Export the property to TracePro – Export->Export with Model BSDF

The screenshot displays the 'Property edit panel' in TracePro. The 'Export Property with Model BSDF' dialog is open, showing the following details:

- Catalog: Webinar
- Property name: Webinar Property, 3
- Solve for: BRDF
- Export button

**Property overview table:**

Temperature	Wavelength	Incident angle	Azimuth angle	Absorptance	Reflectance	Transmittance	BRDF	BRDF model	BTDF	BTDF model
300.0	0.55	10.0	0.0	0.05	0.933489544...	0.0	0.016510455...	Model 0	0.0	Model 0
300.0	0.55	45.0	0.0	0.05	0.926112047...	0.0	0.023887952...	Model 0	0.0	Model 0
300.0	0.55	75.0	0.0	0.05	0.893580965...	0.0	0.056419034...	Model 0	0.0	Model 0

**Optical property section:**

- A: 0.05
- R: 0.933
- T: 0
- RS: 0.016
- TS: 0

**Model property view:** (Empty)

**Model imported data table:**

Coef.	Value
A:	0.0003880802743
B:	0.0001142064683
g:	2.21805070817065

# Making a new Surface Property – Measured Scatter Data

## Resulting Surface Property in TracePro

Surface Property Editor

Catalog: Webinar Name: Webinar Property, 3

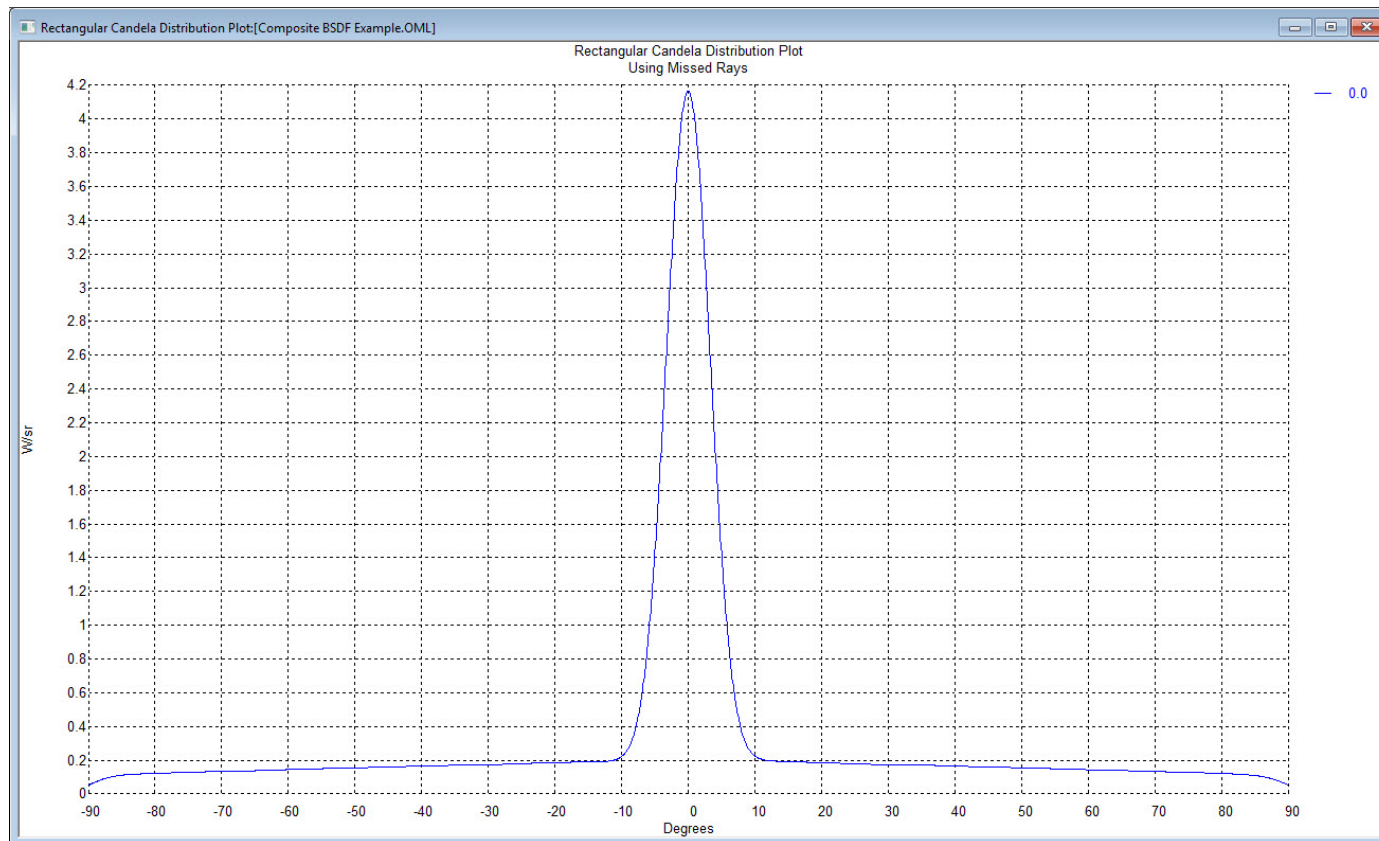
Description:

Type: Table Scatter: ABg  Retroreflector  Polarization

Temperature (K)	Wavelength (µm)	Incident Angle (deg)	Absorbance	Specular Refl	Specular Trans	Integrated BRDF	BRDF A	BRDF B	BRDF g	Integrated BTDF	BTDF A	BTDF B	BTDF g
300	0.55	10	0.05	0.93348954477799	0	0.01651045522201	0.000388068027427378	0.0001142064683	2.21805070817065	0	0	3	2
300	0.55	45	0.05	0.9261120471366	0	0.0238879528634	0.00104852272050251	7.081551947e-005	1.90293858113183	0	0	3	2
300	0.55	75	0.05	0.89358096505646	0	0.0564190349435399	0.000226520149165233	4.66737178e-006	2.78837471906763	0	0	3	2

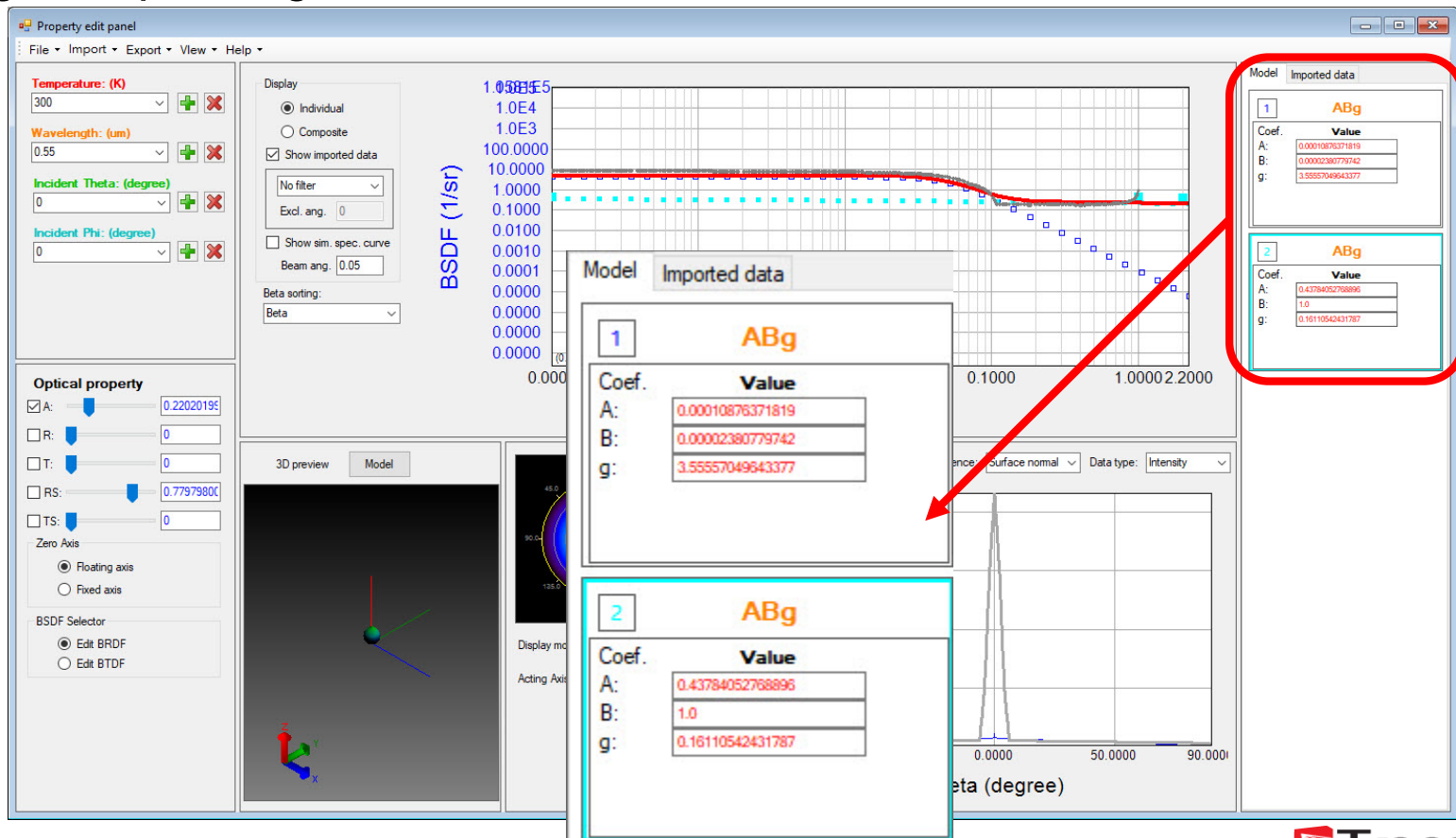
# Making a new Surface Property – Measured Scatter Data

Some scatter profiles are not well modeled with a standard ABg model. The new Surface Property Generator allows for composite BSDF profiles using multiple ABg models.



# Making a new Surface Property – Measured Scatter Data

Some scatter profiles are not well modeled with a standard ABg model. The new Surface Property Generator allows for composite BSDF profiles using multiple ABg models.



# Making a new Surface Property – Measured Scatter Data

Some scatter profiles are not well modeled with a standard ABg model. The new Surface Property Generator allows for composite BSDF profiles using multiple ABg models.

The screenshot displays the 'Property edit panel' in TracePro, showing various input parameters and a graph of the surface property. The 'Export Property with Model BSDF' dialog box is open, showing the 'Property overview' table.

Temperature	Wavelength	Incident angle	Azimuth angle	Absorptance	Reflectance	Transmittance	BRDF	BRDF model	BTDF	BTDF model
300.0	0.55	0.0	0.0	0.220201997...	0.0	0.0	0.779798002...		0.0	
							0.064428043...	Model 0	0.0	Model 0
							0.715369958...	Model 1	0.0	Model 1

# Making a new Surface Property – Measured Scatter Data

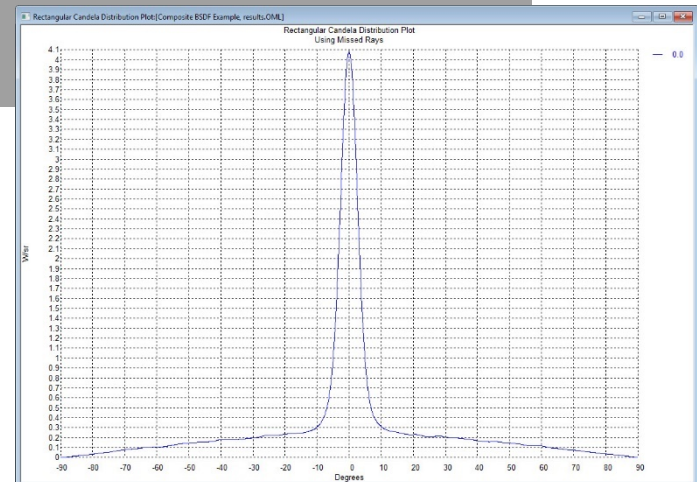
Resulting Surface Property in TracePro and raytrace results

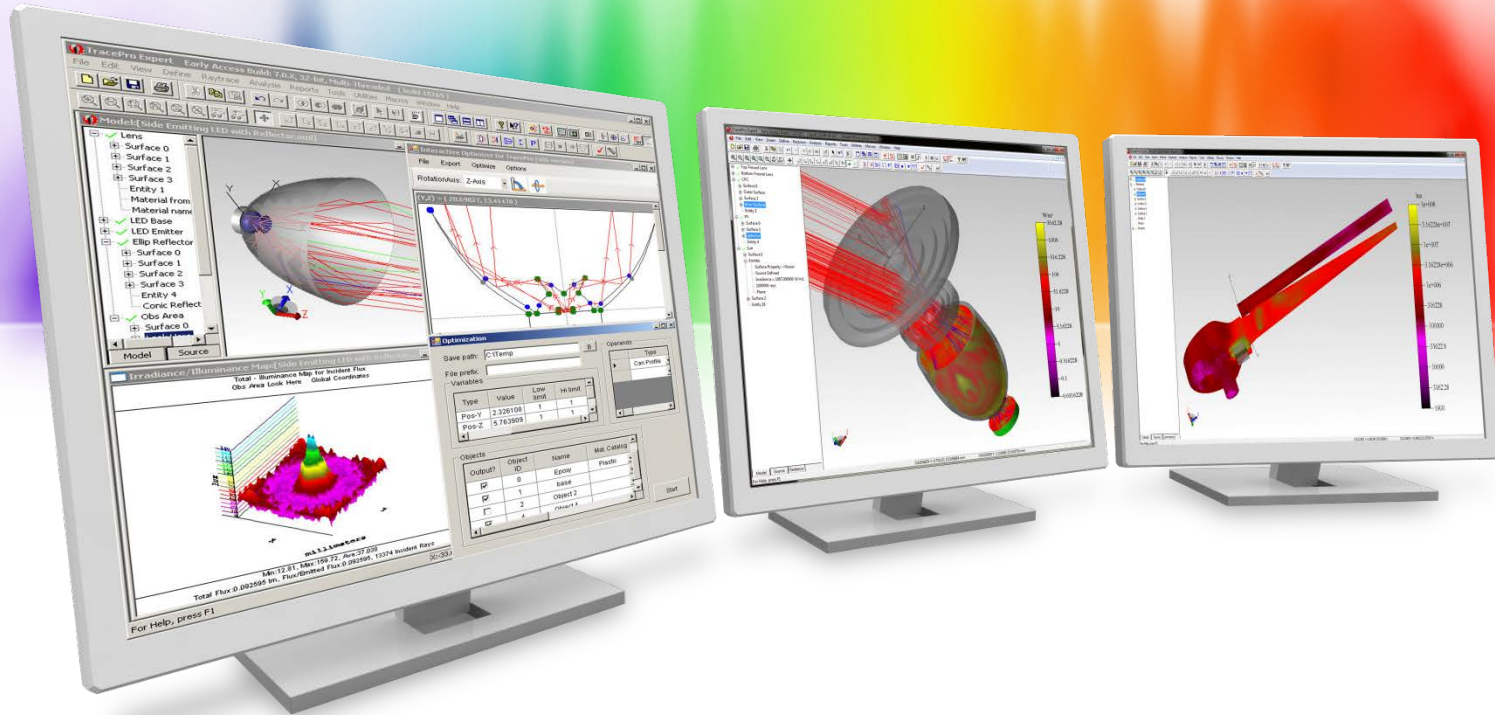
The screenshot shows the 'Surface Property Editor' window. The 'Catalog' is set to 'Webinar' and the 'Name' is 'Webinar Property, 4'. The 'Type' is 'Table' and 'Scatter' is 'Use BSDF Properties'. There are checkboxes for 'Retroreflector' and 'Polarization', both of which are unchecked. Below the configuration fields is a table with the following data:

Temperature (K)	Wavelength (μm)	Incident Angle (deg)	Absorptance	Specular Refl	Specular Trans	Integrated BRDF	Integrated BTDF
300	0.55	0	0.22020199784423	0	0	0.779798002157282	0

This screenshot shows the 'Surface Property Editor' window with a list of properties. The 'Catalog' is 'Webinar' and the 'Name' is 'Webinar Property, 4'. The 'Type' is 'Table' and 'Scatter' is 'Use BSDF Properties'. The 'Retroreflector' and 'Polarization' checkboxes are unchecked. Below the configuration fields is a table with the following data:

Catalog	Name
Surf prop composite lib	Webinar_0_Webinar Property, 4
Surf prop composite lib	Webinar_1_Webinar Property, 4





## Making a Surface Property – Surface with large scattering features



# Making a new Surface Property – Large Scattering Features

- When using materials and surfaces with large scattering features such as Alanod Miro 9, ACA 475/900OC, or ANOFOL Medium Hammertone 1216, the traditional method of measuring BSDF and then using the data to make a scatter property may not work properly.
- One potential problem is that the laser or other light source used to illuminate the sample may be smaller than the texture features on the surface. The surface finish on the material may actually be highly specular, but the texture features work to scatter and diffuse the light. If the illumination source in the scatterometer does not adequately sample a large enough area, the resulting BSDF model may be more specular overall than the actual surface is.

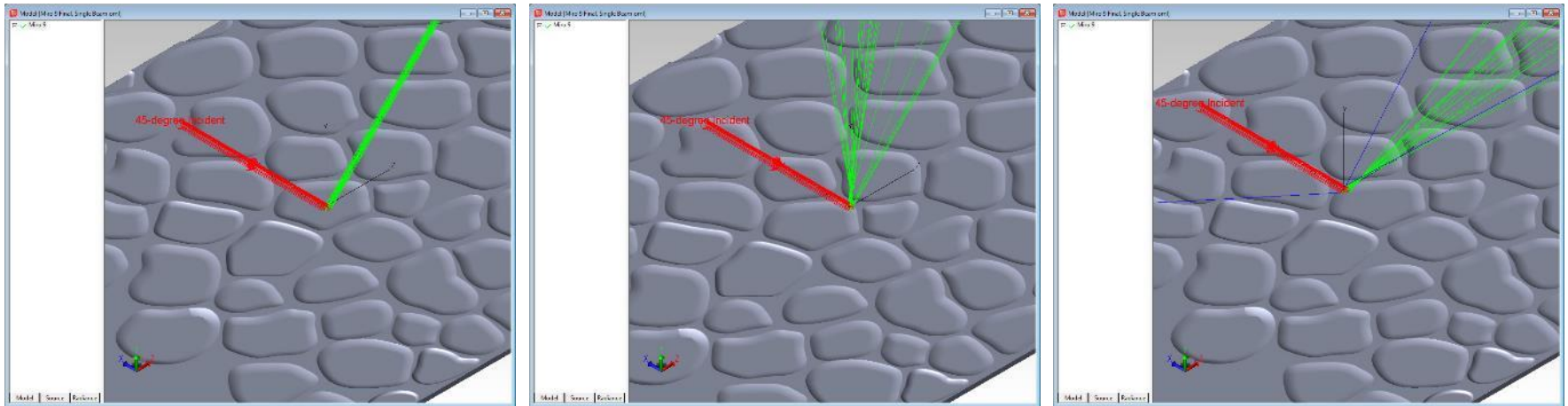
# Making a new Surface Property – Large Scattering Features

Alanod Miro 9 Example



# Making a new Surface Property – Large Scattering Features

If the illuminating beam is small, scattering is dependent on the location of the beam

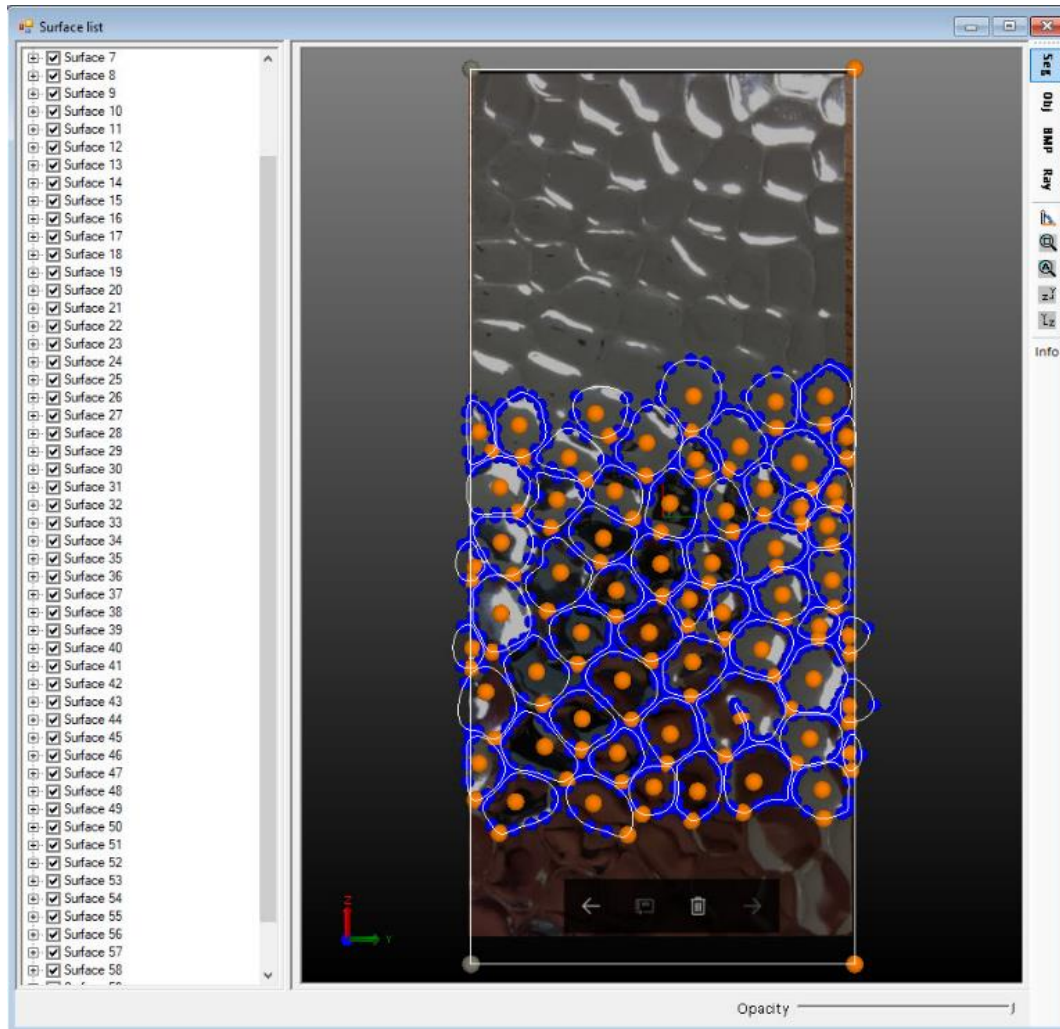


# Making a new Surface Property – Large Scattering Features

- A possible solution to this problem is to make a CAD model of a representative area of the surface, apply a surface property to model the scattering of an equivalent flat surface, and then run a raytrace of the model in an optical design and analysis program. The results of this raytrace can then be used to make an equivalent scatter property of the surface. This scatter property can then be applied like any other surface property to surfaces in the optical model and used to model the effects of the large textured surfaces.

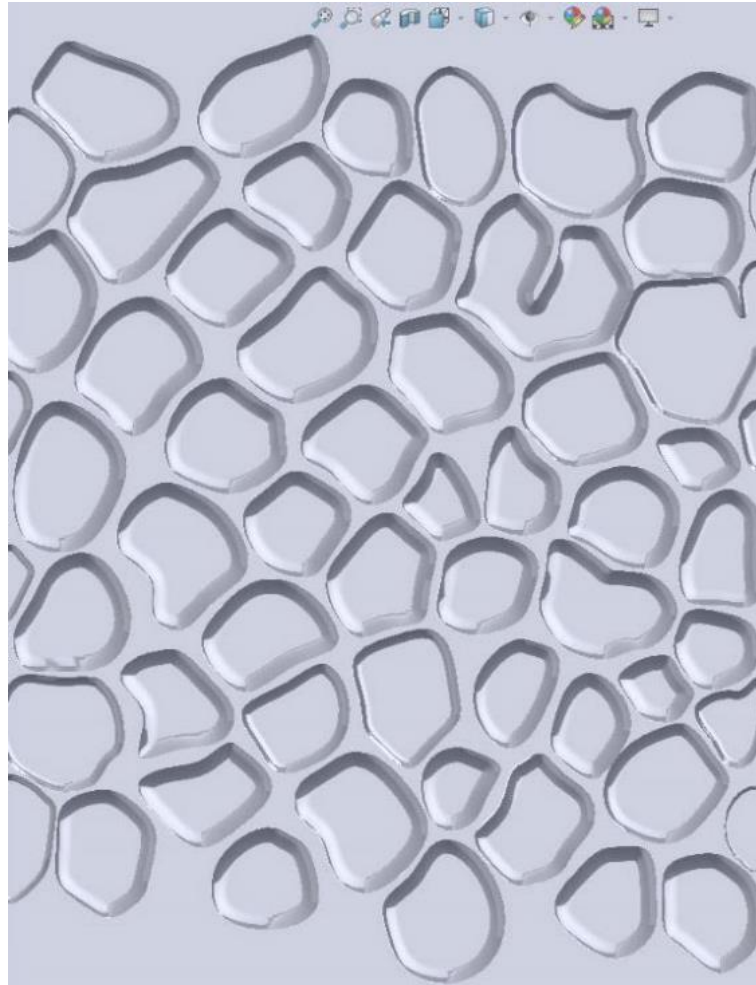
# Making a new Surface Property – Large Scattering Features

Bitmap of Miro 9 in the TracePro 3D Optimizer



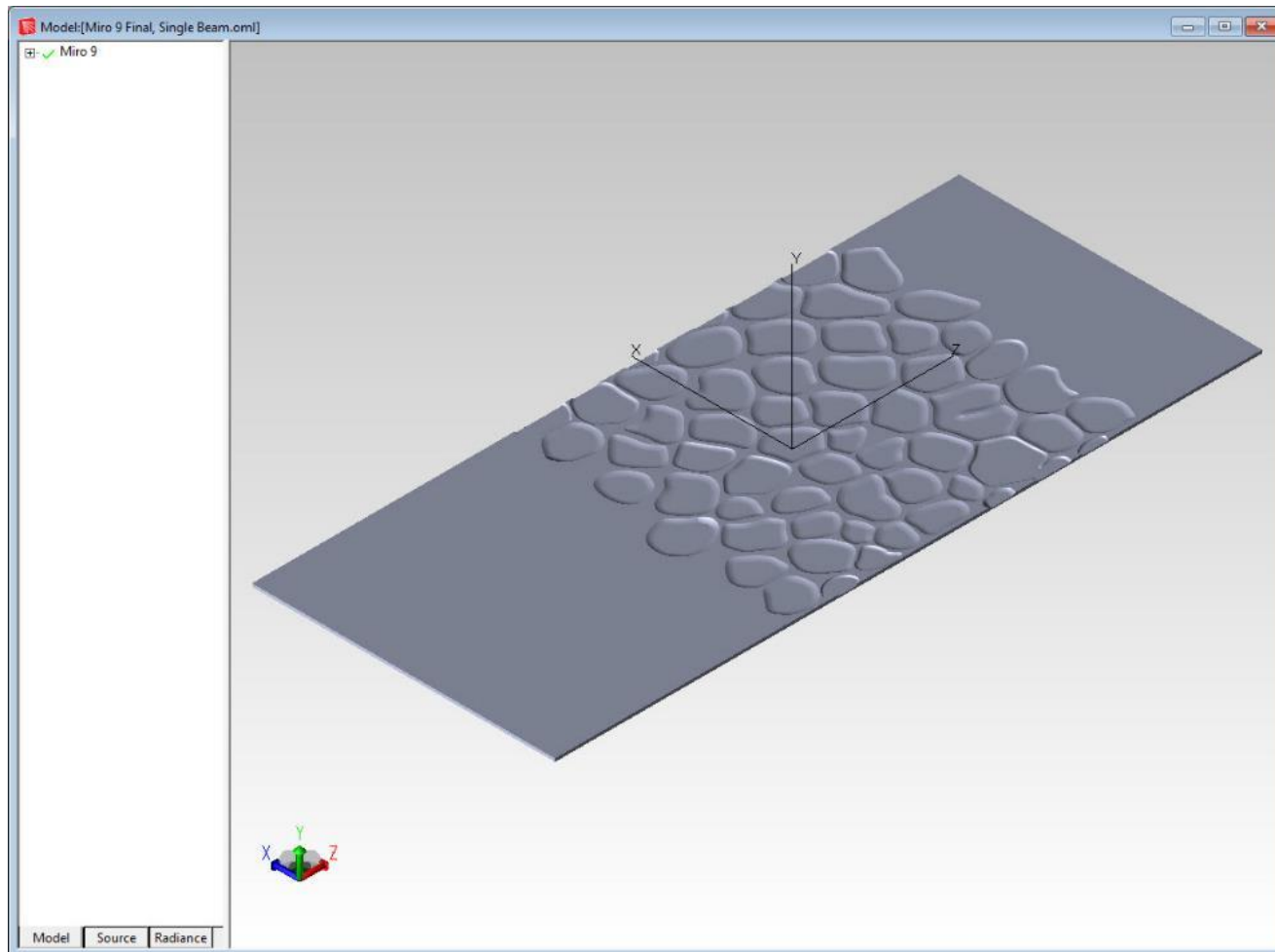
# Making a new Surface Property – Large Scattering Features

Alanod Miro 9 SolidWorks CAD model



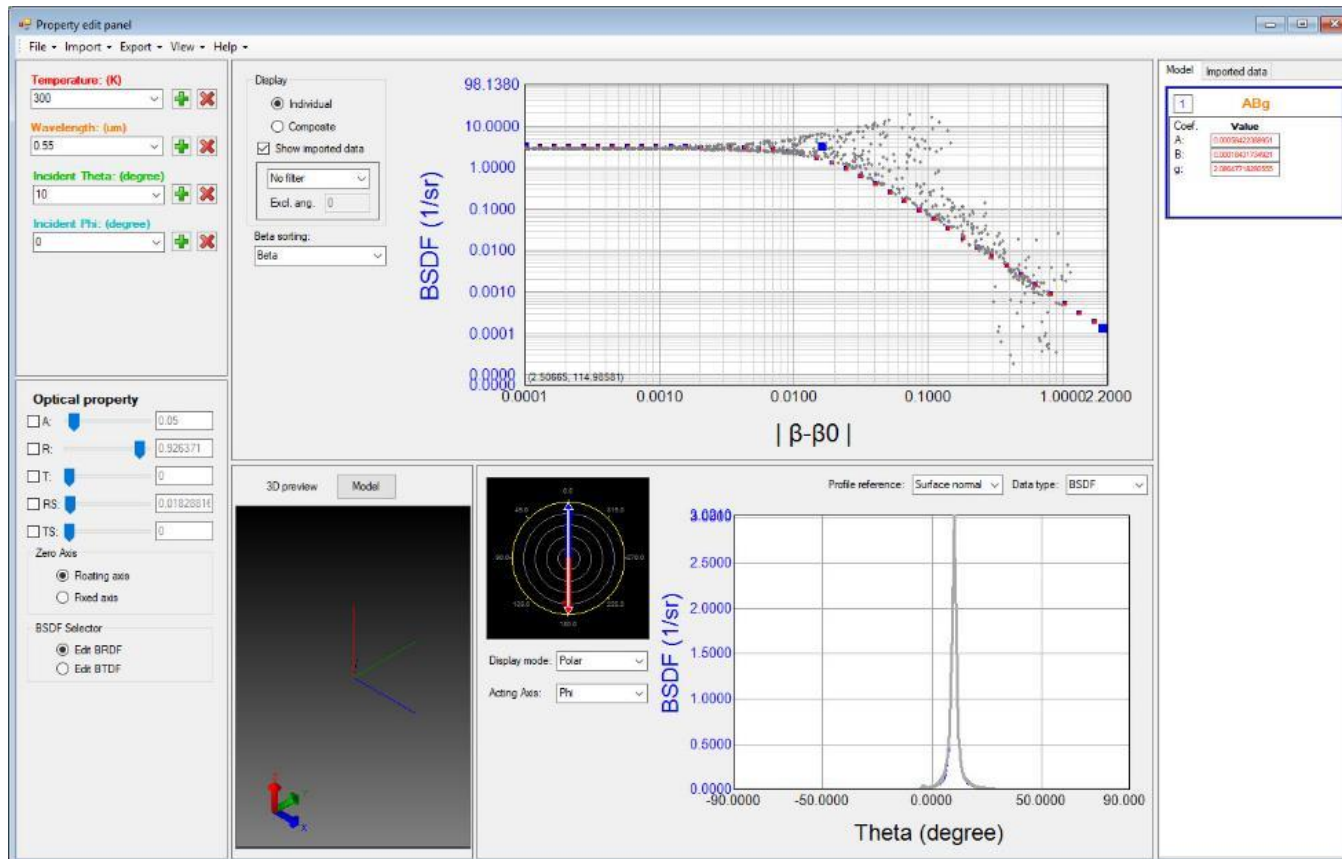
# Making a new Surface Property – Large Scattering Features

Alanod Miro 9 model in TracePro



# Making a new Surface Property – Large Scattering Features

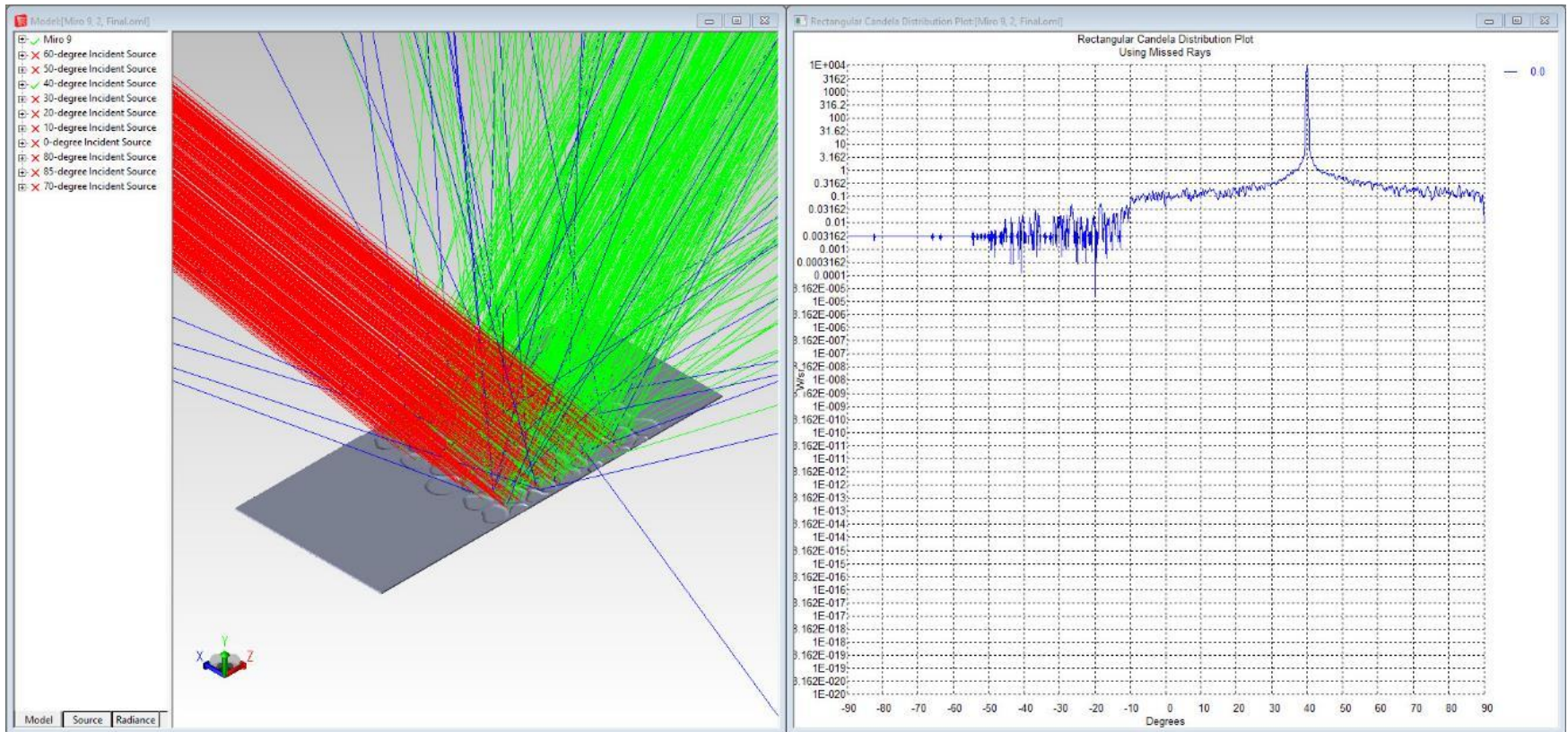
A scatter measurement was made on a flat area of the Miro 9 sample. This data was used to make a Surface Property to apply to the CAD model.





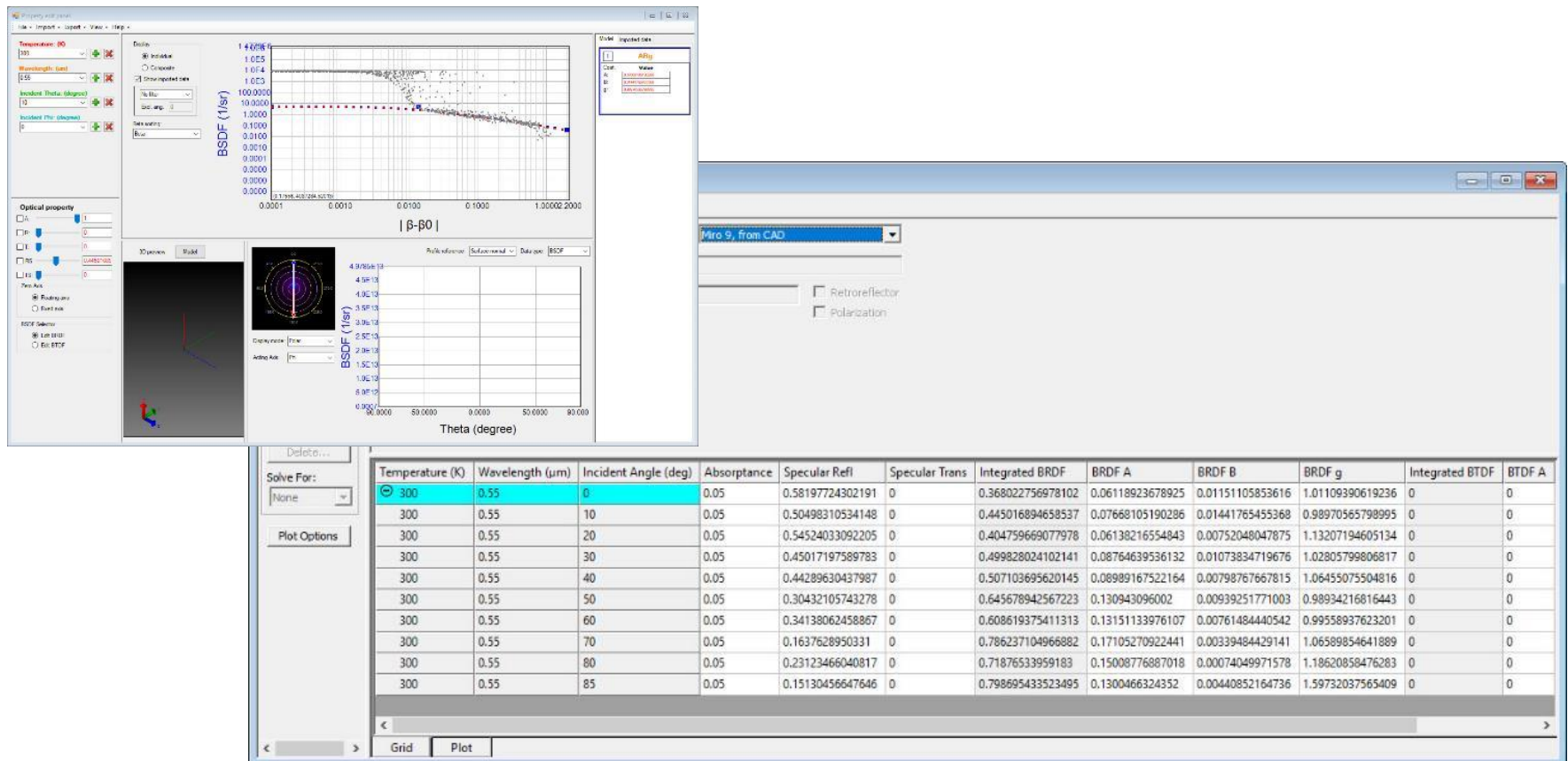
# Making a new Surface Property – Large Scattering Features

A large area of the model was illuminated and the resulting angular distribution for multiple incident angles was saved as Candela Plots.



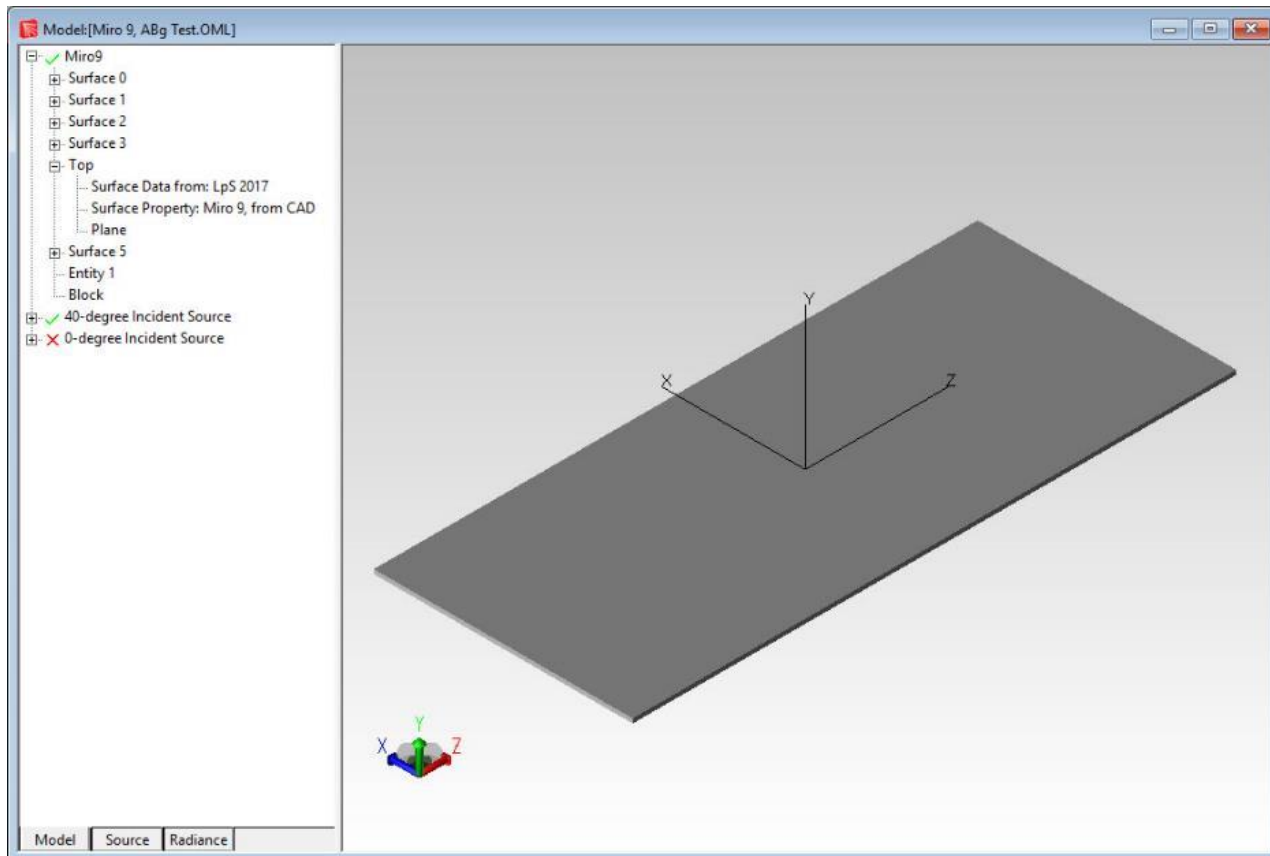
# Making a new Surface Property – Large Scattering Features

A new BSDF ABg surface property was made using the raytrace results from the CAD model. The Surface Property Generator can read TracePro Candela files.



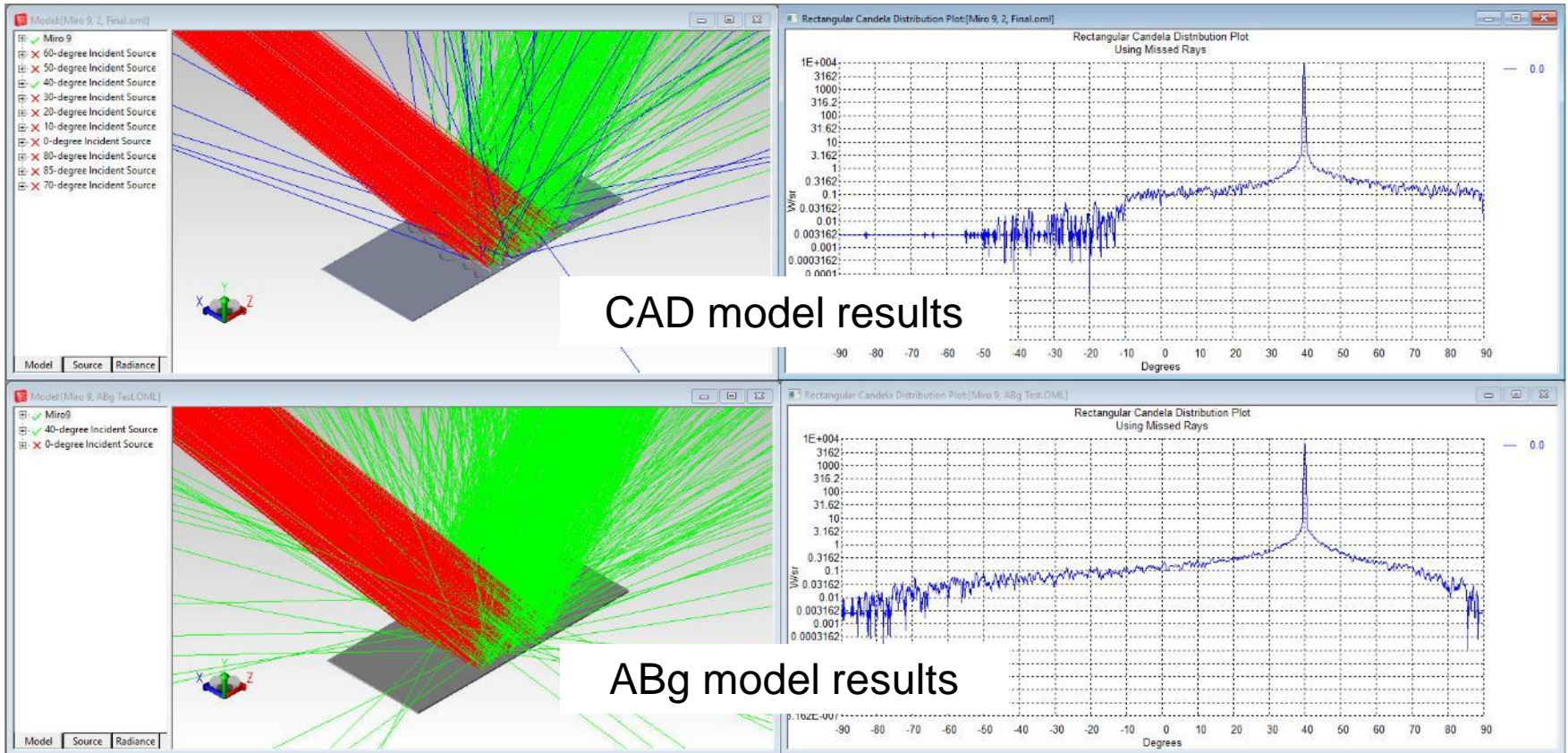
# Making a new Surface Property – Large Scattering Features

The new surface/scatter property was then applied to a surface in the model. The scatter property will model the effect of the large texture features.



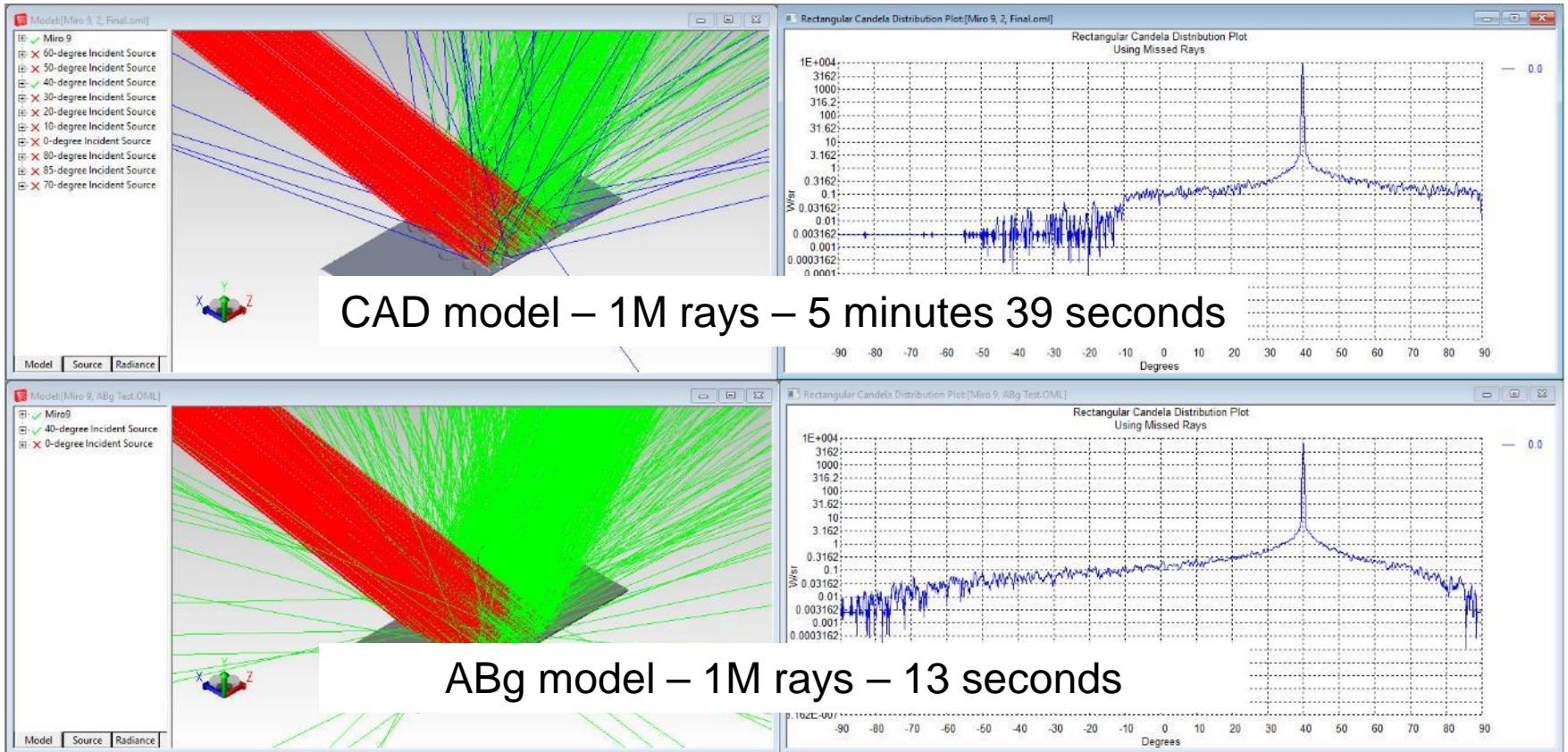
# Making a new Surface Property – Large Scattering Features

## Comparison of CAD model and BSDF ABg model for Alanod Miro 9



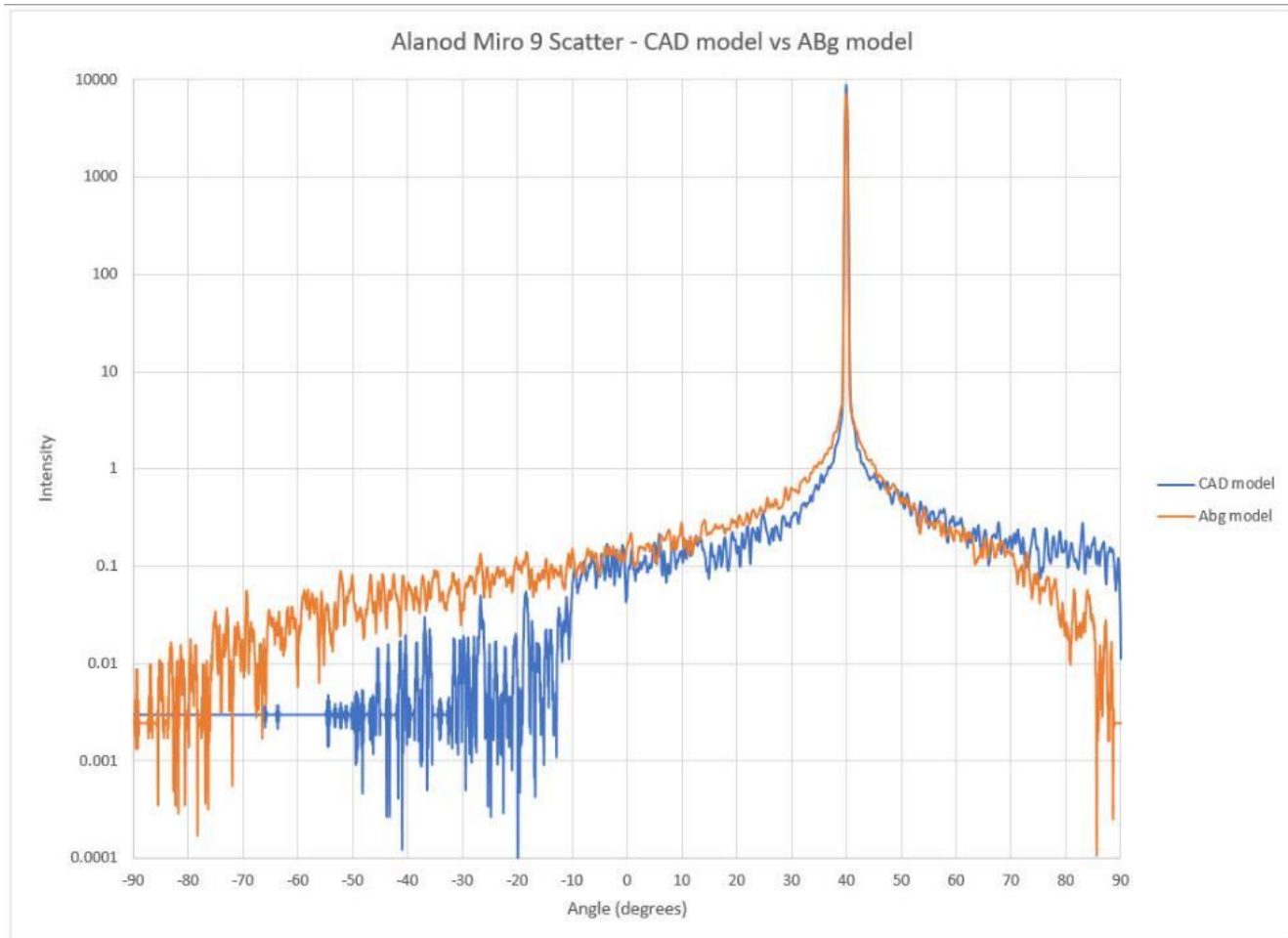
# Making a new Surface Property – Large Scattering Features

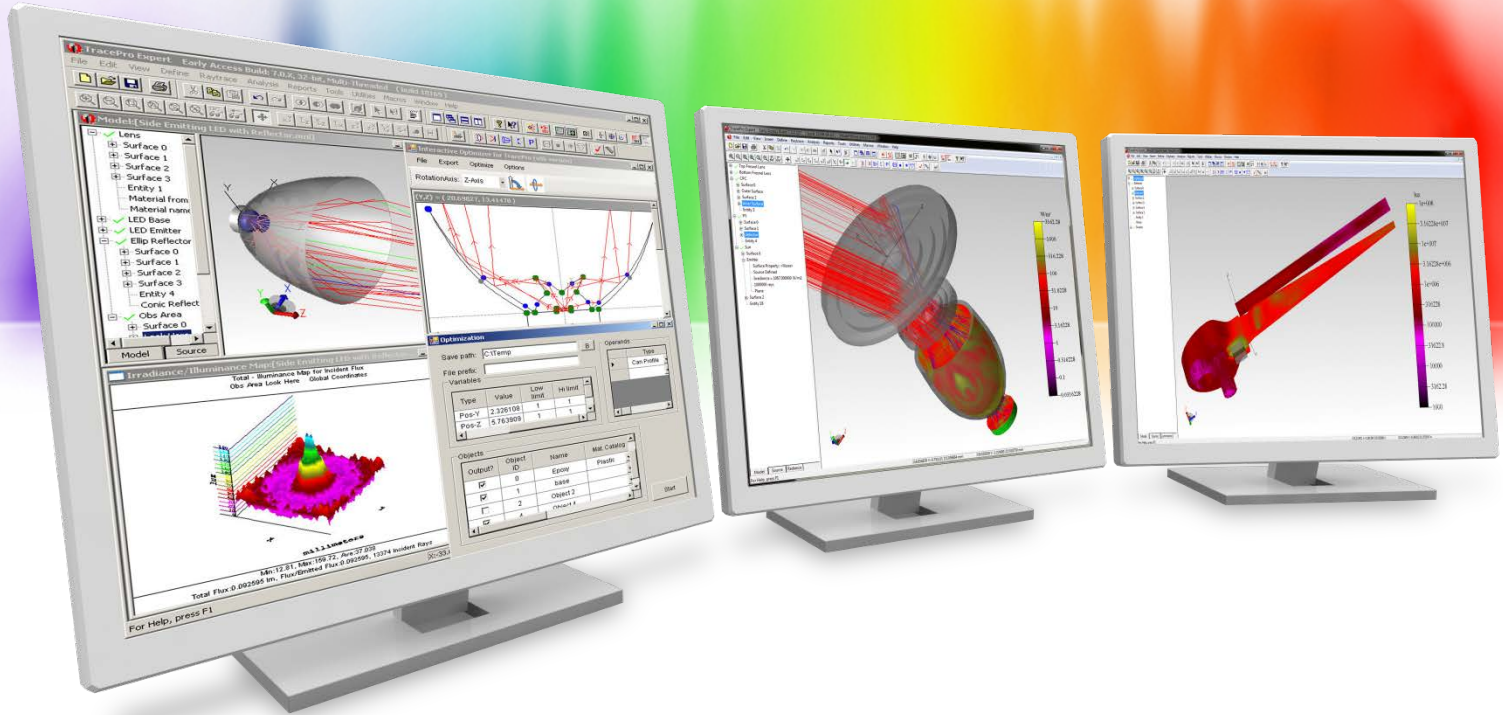
## Comparison of CAD model and BSDF ABg model for Alanod Miro 9



# Making a new Surface Property – Large Scattering Features

## Intensity Plot - CAD model versus ABg model





## Summary and Questions

# Summary and Questions

TracePro features a new Surface Property Generator:

- ✓ New surface properties, both with and without scattering, can be easily made and exported to TracePro from the Surface Property Generator
- ✓ Measured scatter data can be imported into the Surface Property Generator and new TracePro Surface Properties can be made
- ✓ The new Surface Property Generator can be used along with a CAD model to model the scattering of materials with large scattering features. This can lead to easier modeling with these types of materials and faster raytraces.

For more information or to sign up for our free 30-day trial please visit us at:

[www.lambdares.com](http://www.lambdares.com)

Phone: +1 978-486-0766

E-mail: [sales@lambdares.com](mailto:sales@lambdares.com)

