

# Ray and Path Sorting in TracePro

A Lambda Research Corporation Webinar

December 15, 2016

# Presenter

- **Presenter**

Dave Jacobsen

Sr. Application Engineer

Lambda Research Corporation

- **Moderator**

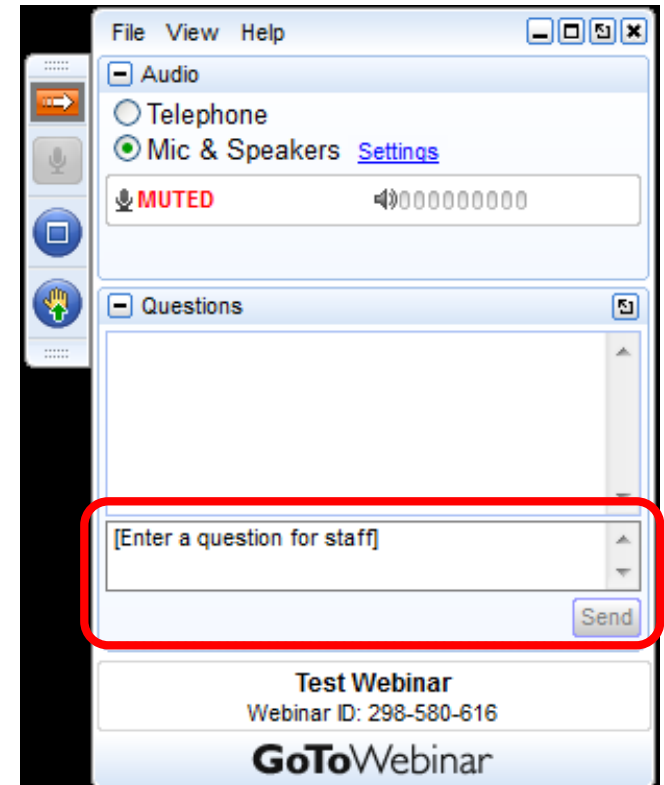
Mike Gauvin

Vice President of Sales and Marketing

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
  - <http://www.lambdares.com/webinars>
- TracePro Tutorial Videos
  - <http://www.lambdares.com/videos>
- TracePro Tutorials
  - <http://www.lambdares.com/features/tracepro-tutorials>
- Information on upcoming TracePro Training Classes
  - <http://www.lambdares.com/training/software-training>



# Upcoming TracePro Training

- **Jena, Germany**

- Introduction to TracePro – March 6-7, 2017
- Optimization with TracePro – March 8-9, 2017
- Stray Light Analysis using TracePro – March 10, 2017

- **Littleton, MA USA**

- Introduction to TracePro – April 11-12, 2017
- Optimization with TracePro – April 13-14, 2017

- **Please ask us about custom onsite training**

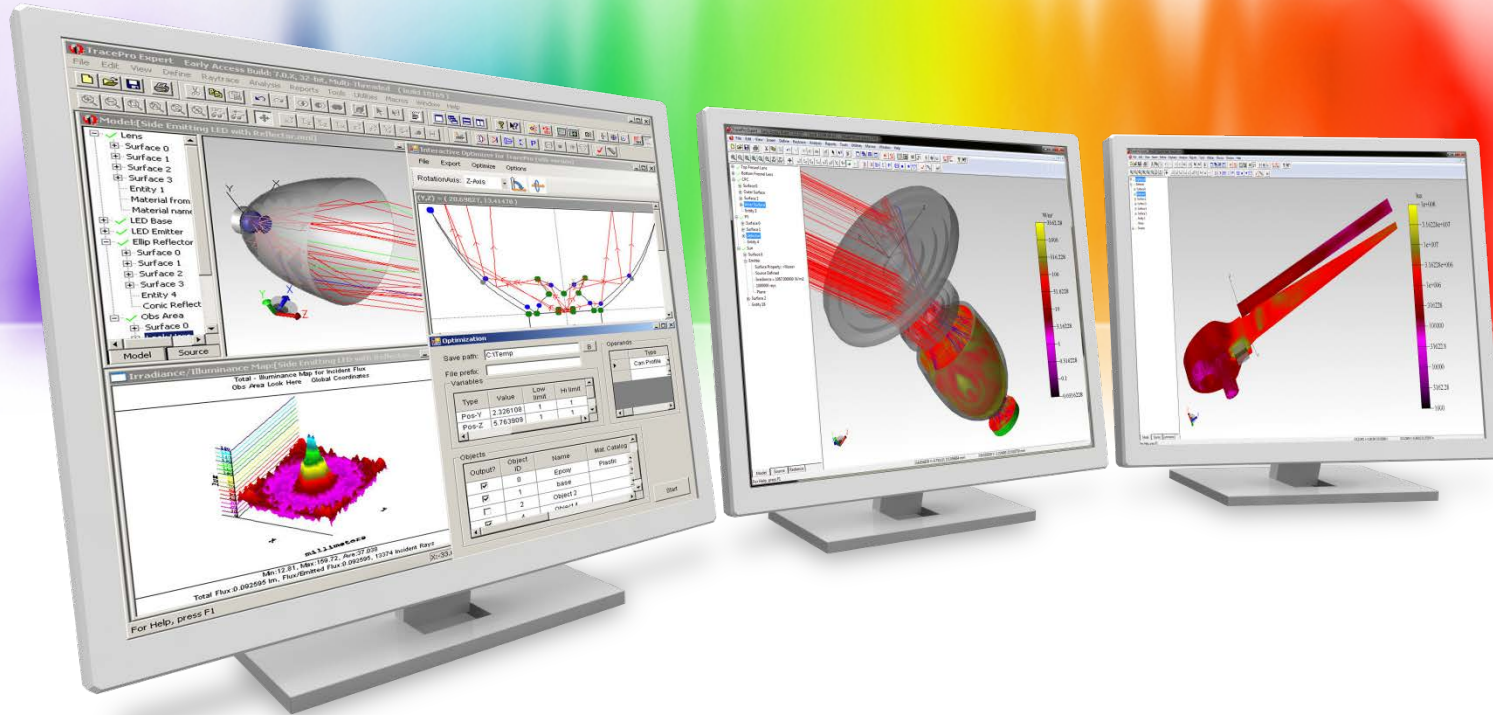
# Latest TracePro and RayViz Release

**TracePro 7.8.0** - Released October 1, 2016

**RayViz 7.8.0** - Released October 1, 2016

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

<http://www.lambdares.com/CustomerSupportCenter/index.php/trace-pro/current-release>



# Ray and Path Sorting in TracePro

A Lambda Research Corporation Webinar

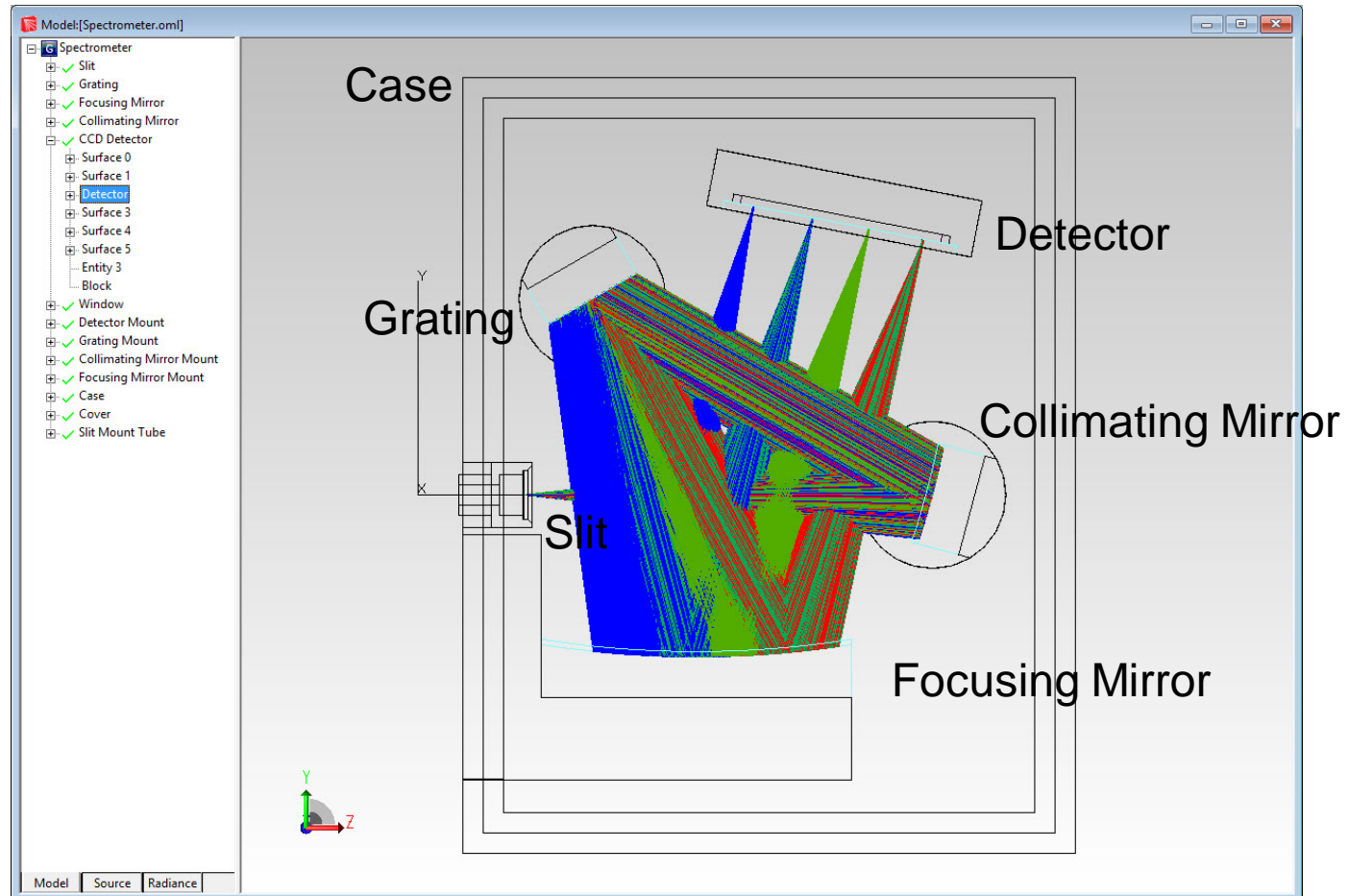
December 15, 2016

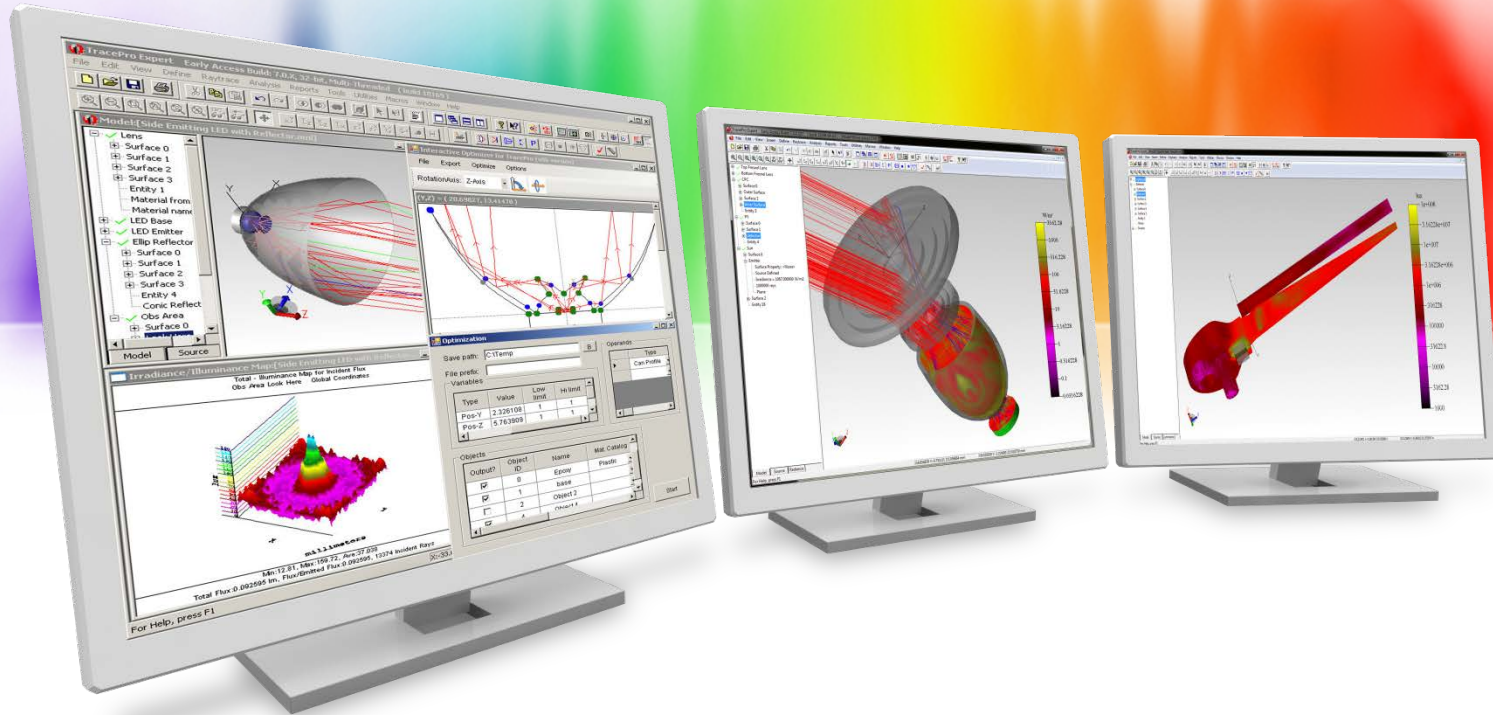
# Agenda

- What is Ray Sorting and Path Sorting and how are they different
- Ray Sorting options in TracePro
- The Path Sort Table
- Defining Path Sort Filters
- Ray and Path Sorting uses, including stray light analysis
- Questions and Answers

# Example TracePro Model

## Crossed Czerny-Turner spectrometer





## What is Ray and Path Sorting?

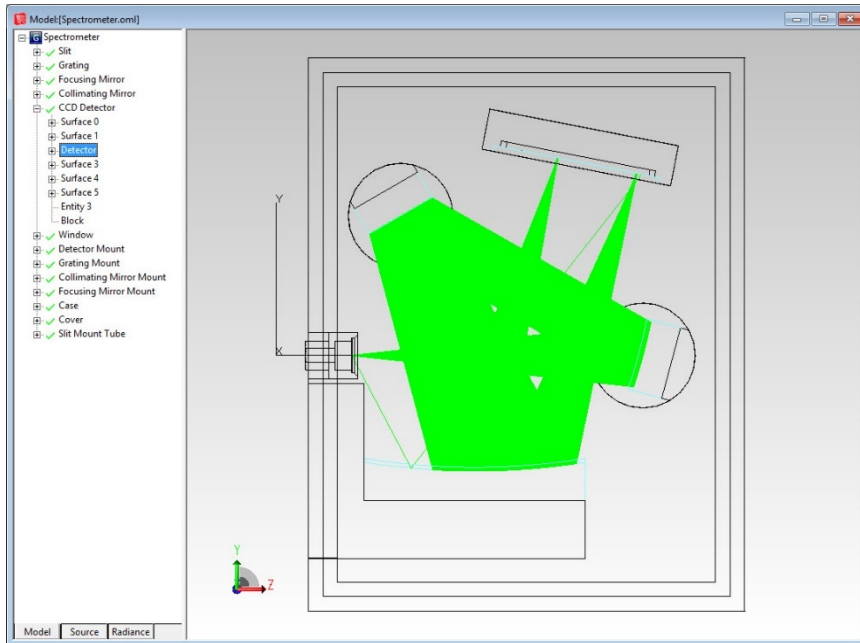
# Ray and Path Sorting - Differences

- The Ray and Path Sorting tools are located in the Analysis menu in TracePro
- Can be used to display a subset of the complete raytrace results
- Ray Sorting shows all rays that meet a specified criteria
- Path Sorting shows rays that follow a discrete path to a selected surface
- The Ray and Path Sorting tools are available in all versions of TracePro
- Ray Sorting for Single and Multiple Bulk Scatter and Diffraction requires TracePro Standard or Expert
- Ray and Path Sorting can also be applied to the Irradiance/Illuminance Map



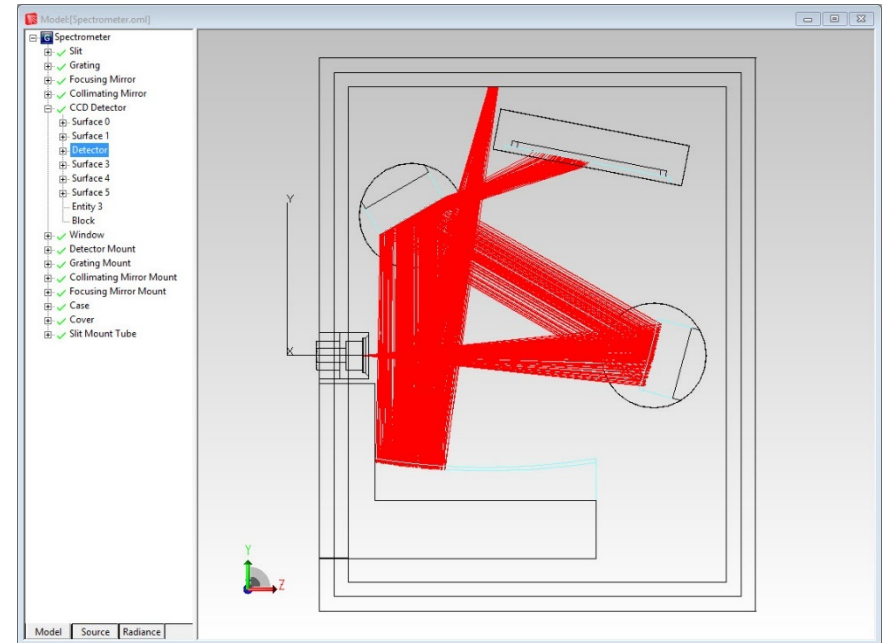
# Ray and Path Sorting - Differences

## Ray Sorting



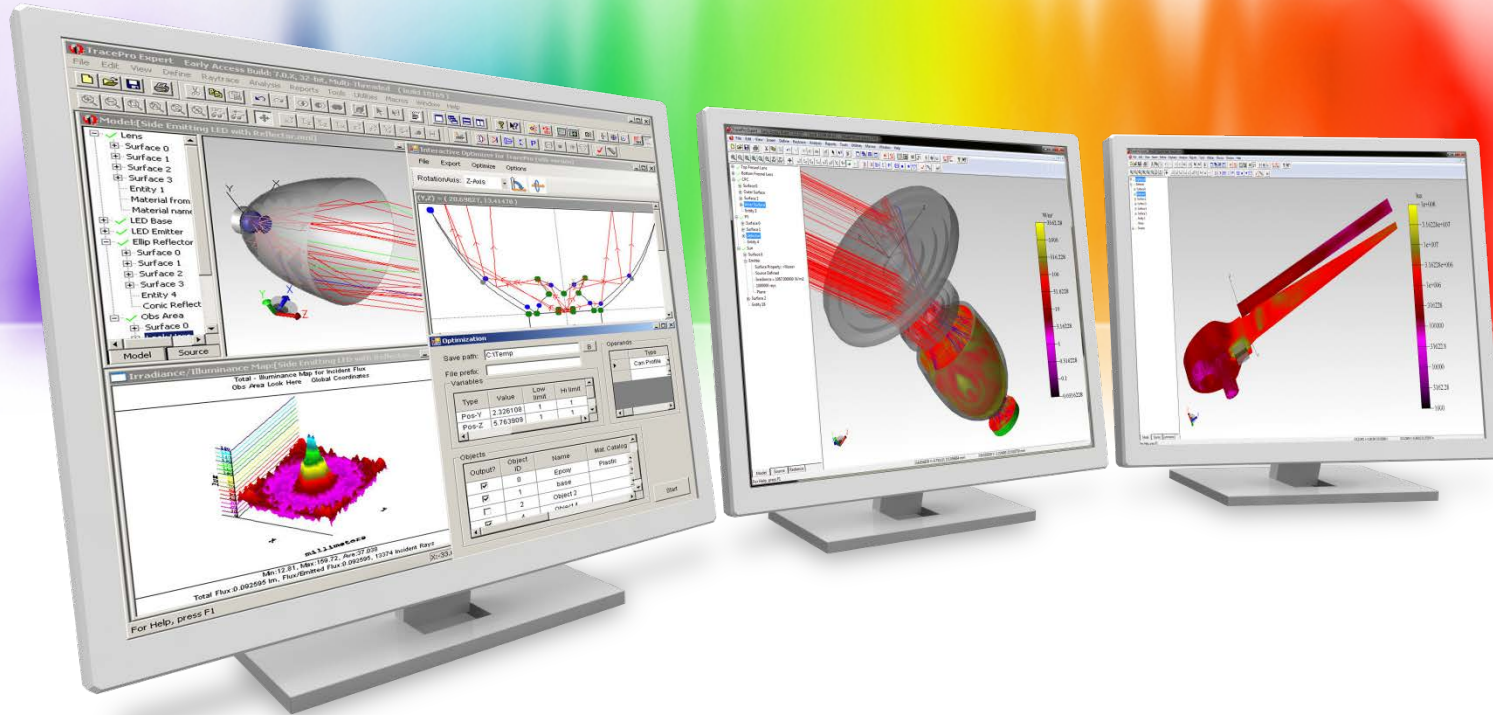
Ray Sorting shows all rays that meet a specified criteria, such as hitting a selected surface, wavelength, or surface interaction type

## Path Sorting



Path Sorting shows all rays that follow a discrete path to reach a selected surface



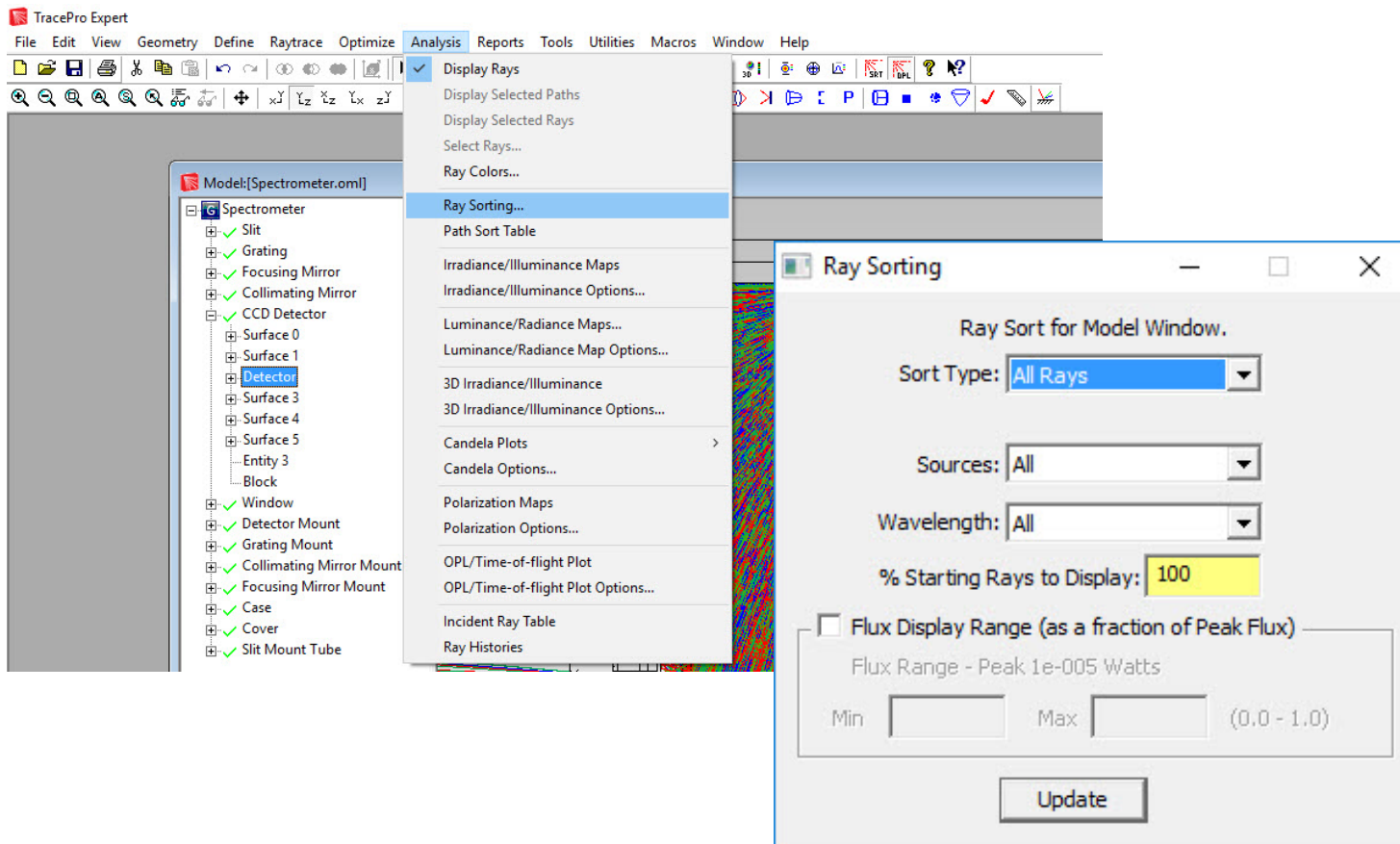


## Ray Sorting Options

# Ray Sorting Options

Ray Sorting allows for sorting rays based on a specified criteria

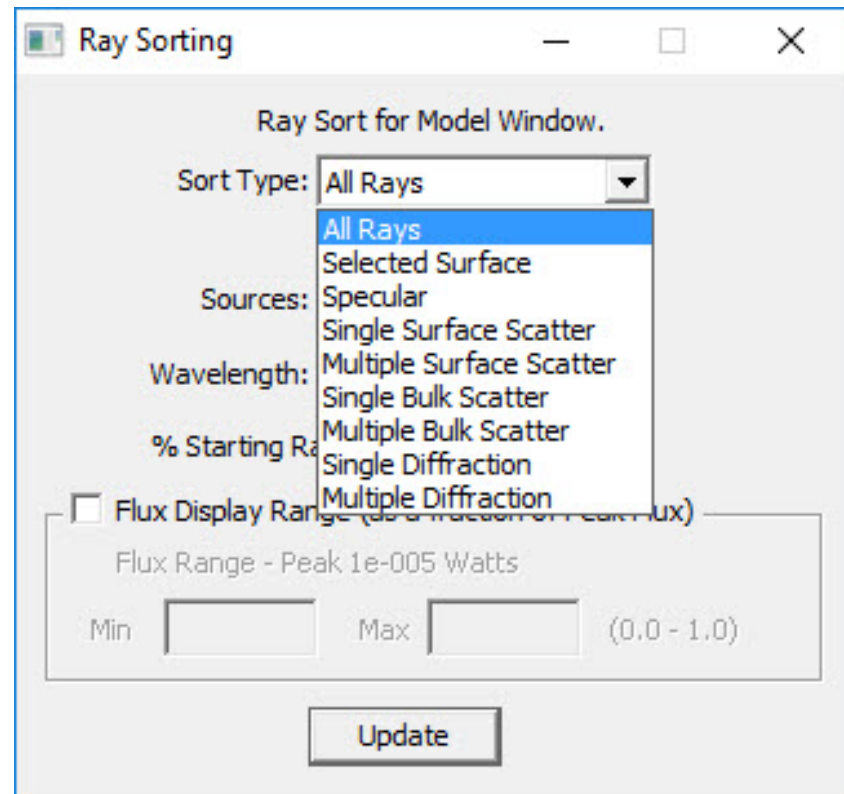
- Analysis->Ray Sorting



# Ray Sorting Options

## Sort Type Options

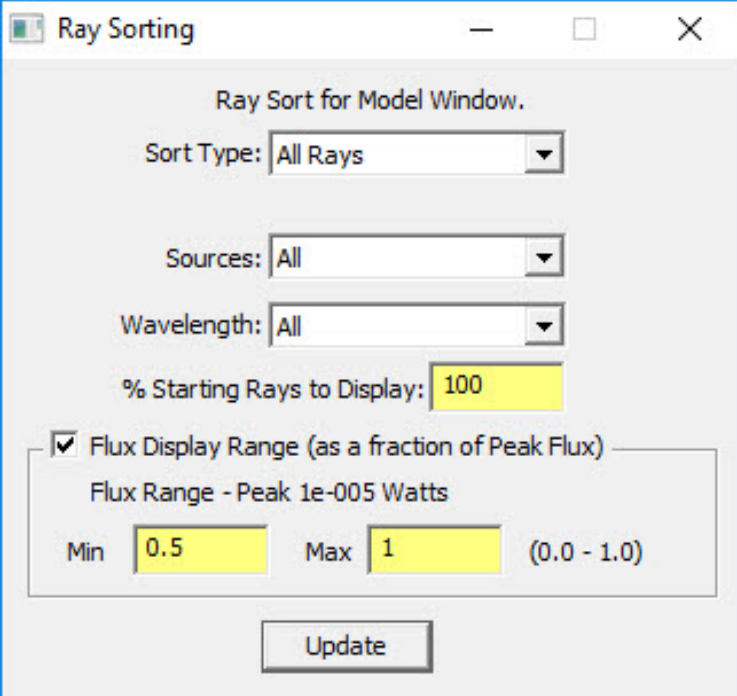
- Selected Surface
- Specular
- Single Surface Scatter
- Multiple Surface Scatter
- Single Bulk Scatter
- Multiple Bulk Scatter
- Single Diffraction
- Multiple Diffraction



# Ray Sorting Options

## Additional Sort Options

- Sort by Source
- Sort by Wavelength
- Display a percentage of the starting rays
- Sort by a range of flux values, as a fraction of the peak value



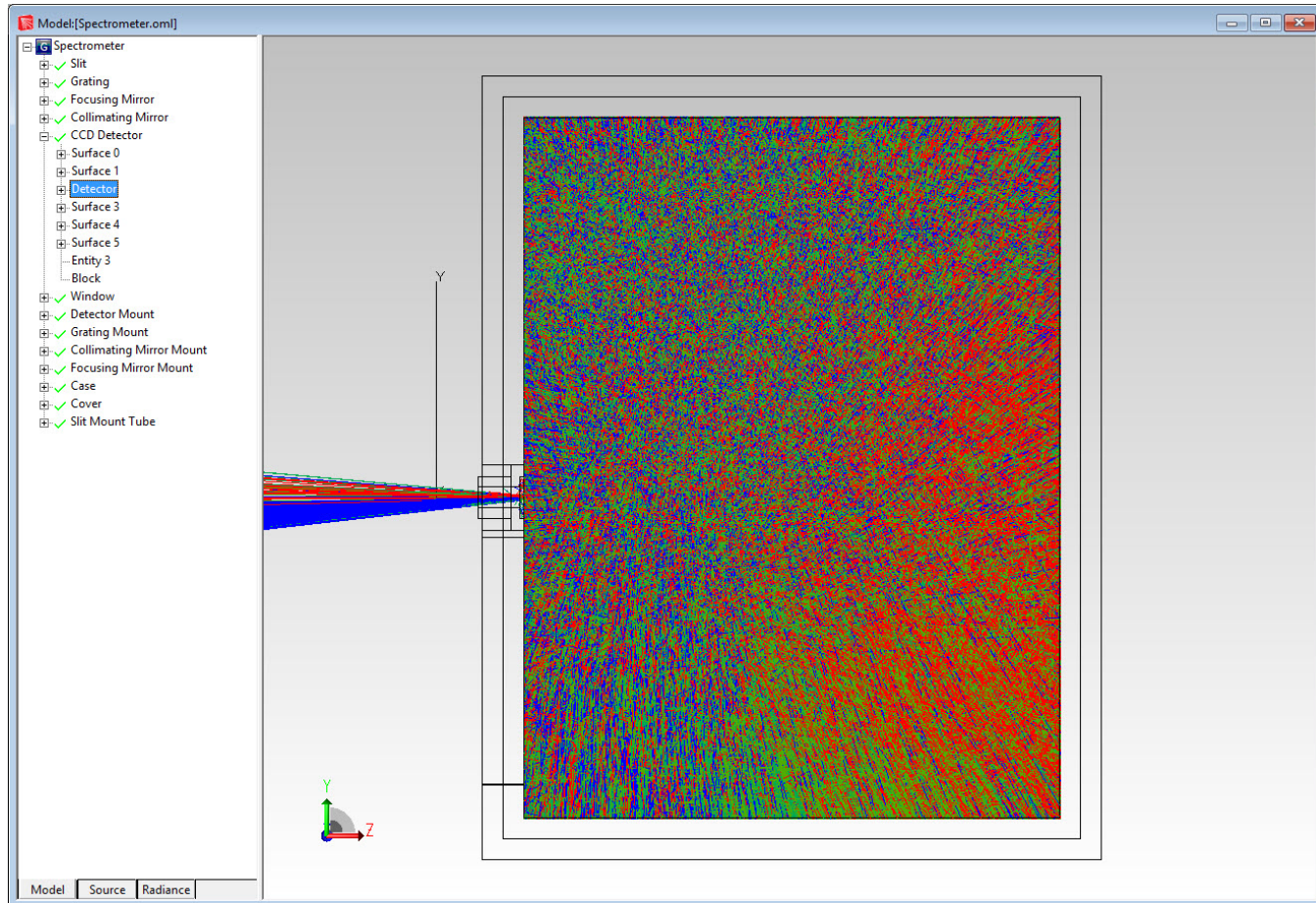
The screenshot shows a 'Ray Sorting' dialog box with the following settings:

- Sort Type: All Rays
- Sources: All
- Wavelength: All
- % Starting Rays to Display: 100
- ☒ Flux Display Range (as a fraction of Peak Flux)
  - Flux Range - Peak 1e-005 Watts
  - Min: 0.5
  - Max: 1
  - (0.0 - 1.0)
- Update button



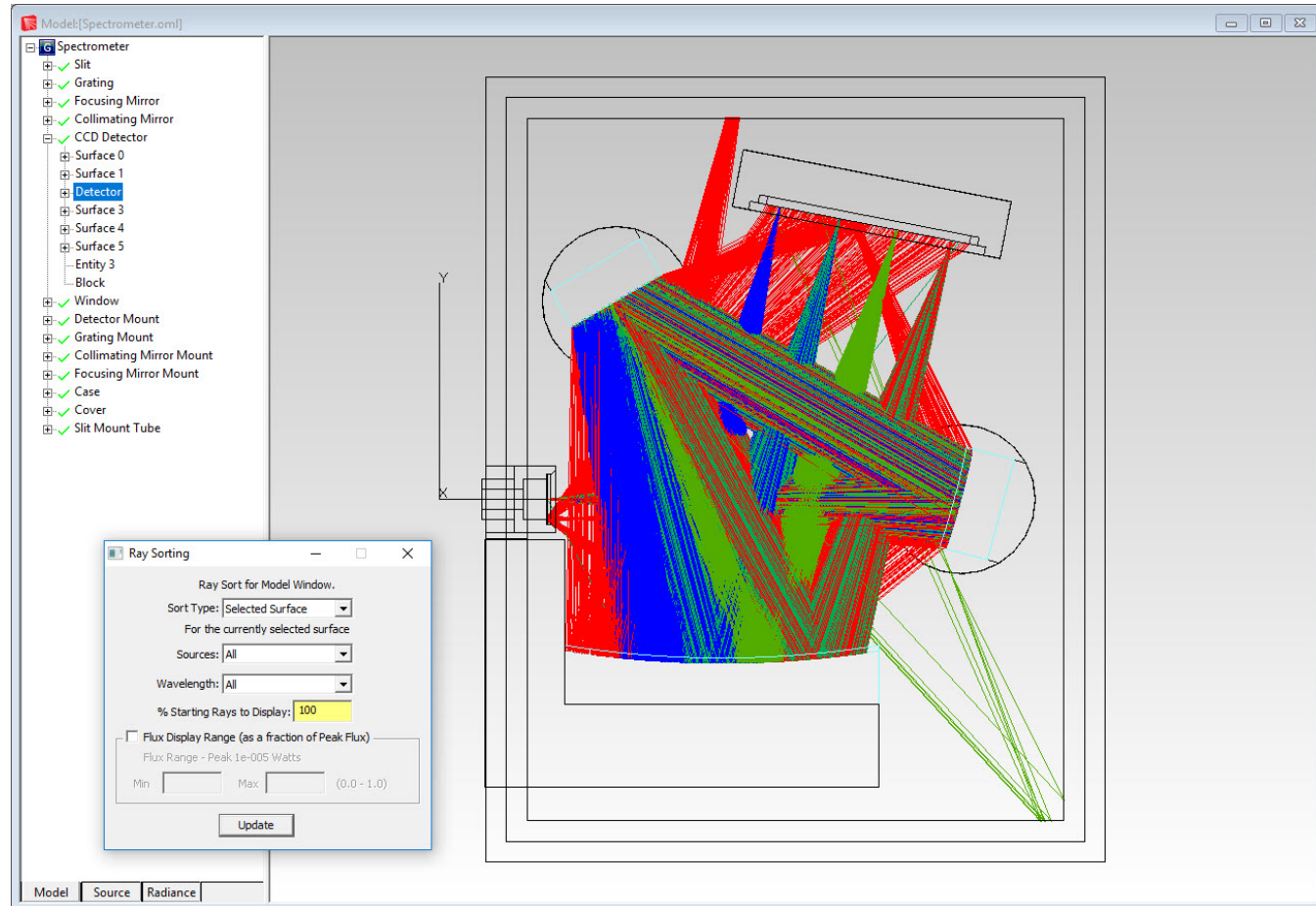
# Ray Sorting Examples

Initial raytrace results – not useable for analysis



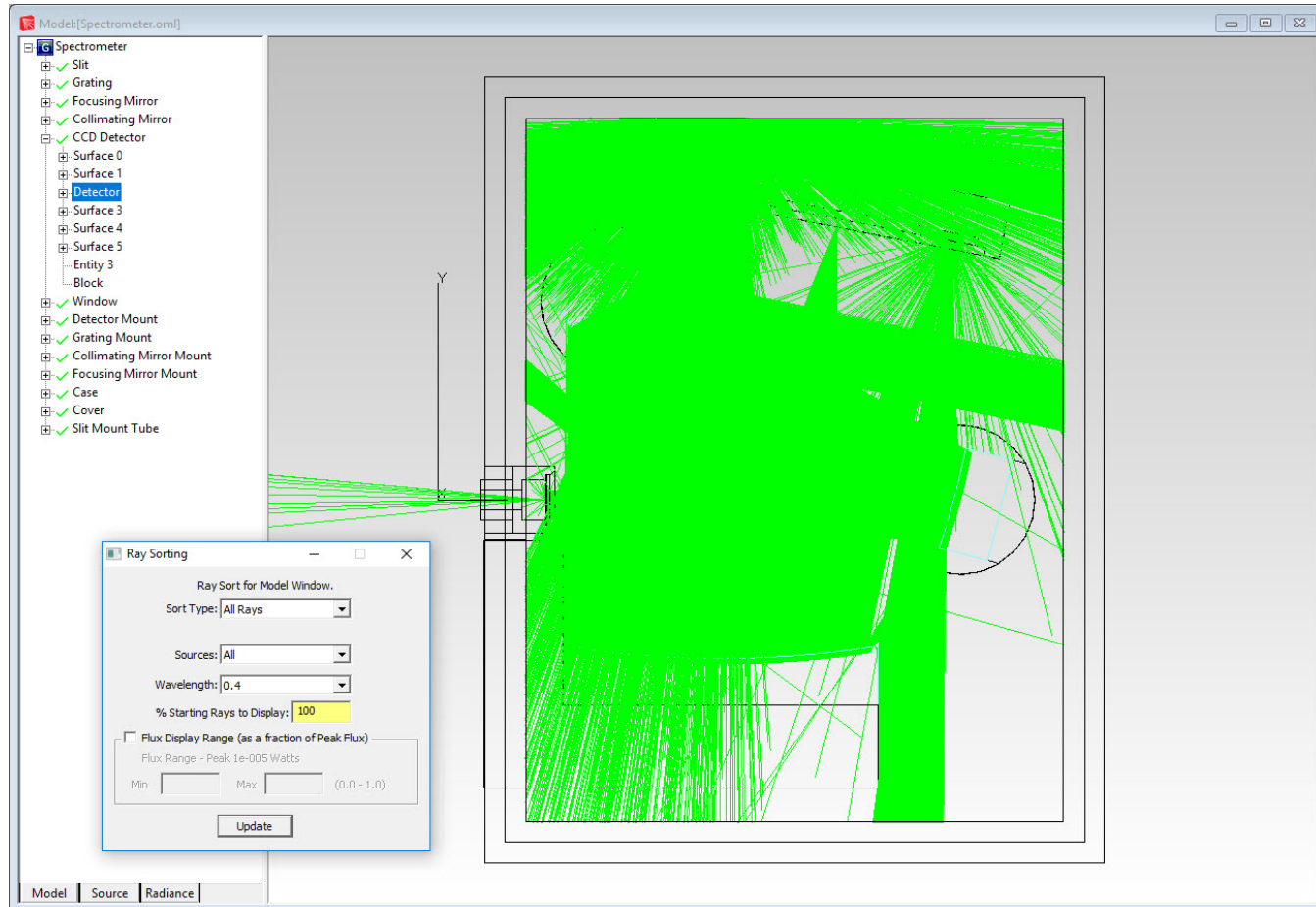
# Ray Sorting Examples

## Sort Type – Selected Surface



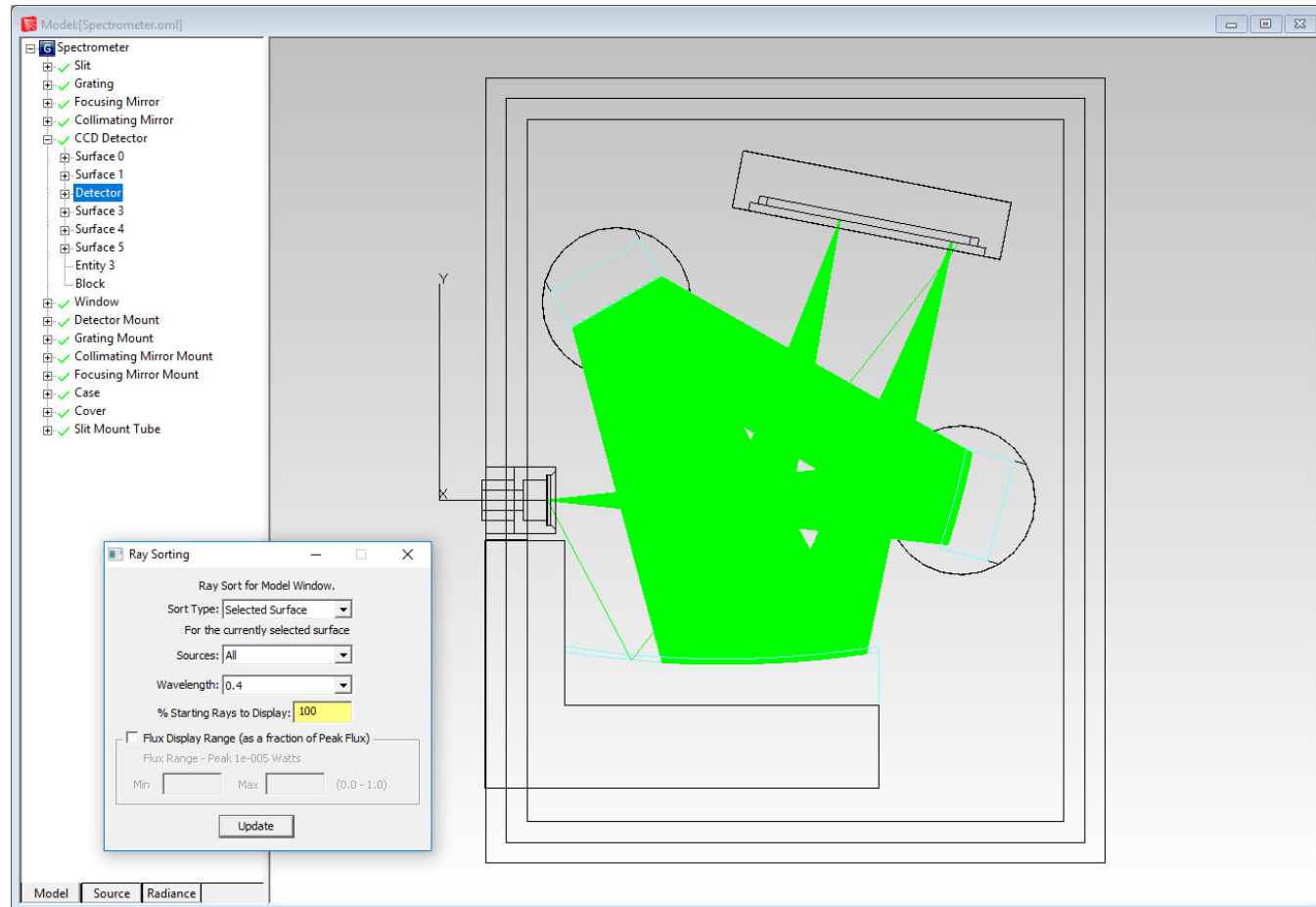
# Ray Sorting Examples

## Sort Type – Wavelength



# Ray Sorting Examples

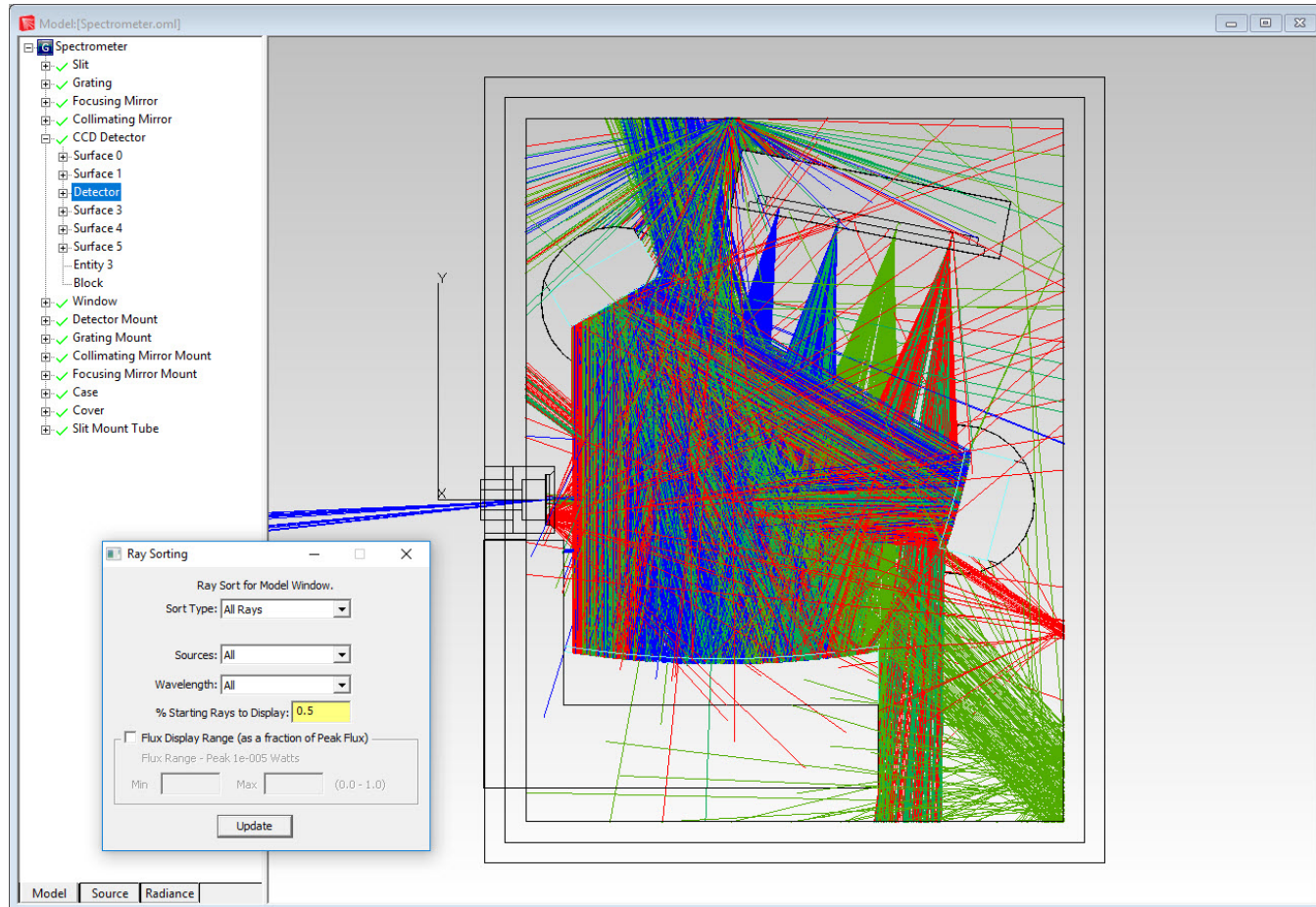
Sort Type – Selected Surface and Wavelength – note second order rays





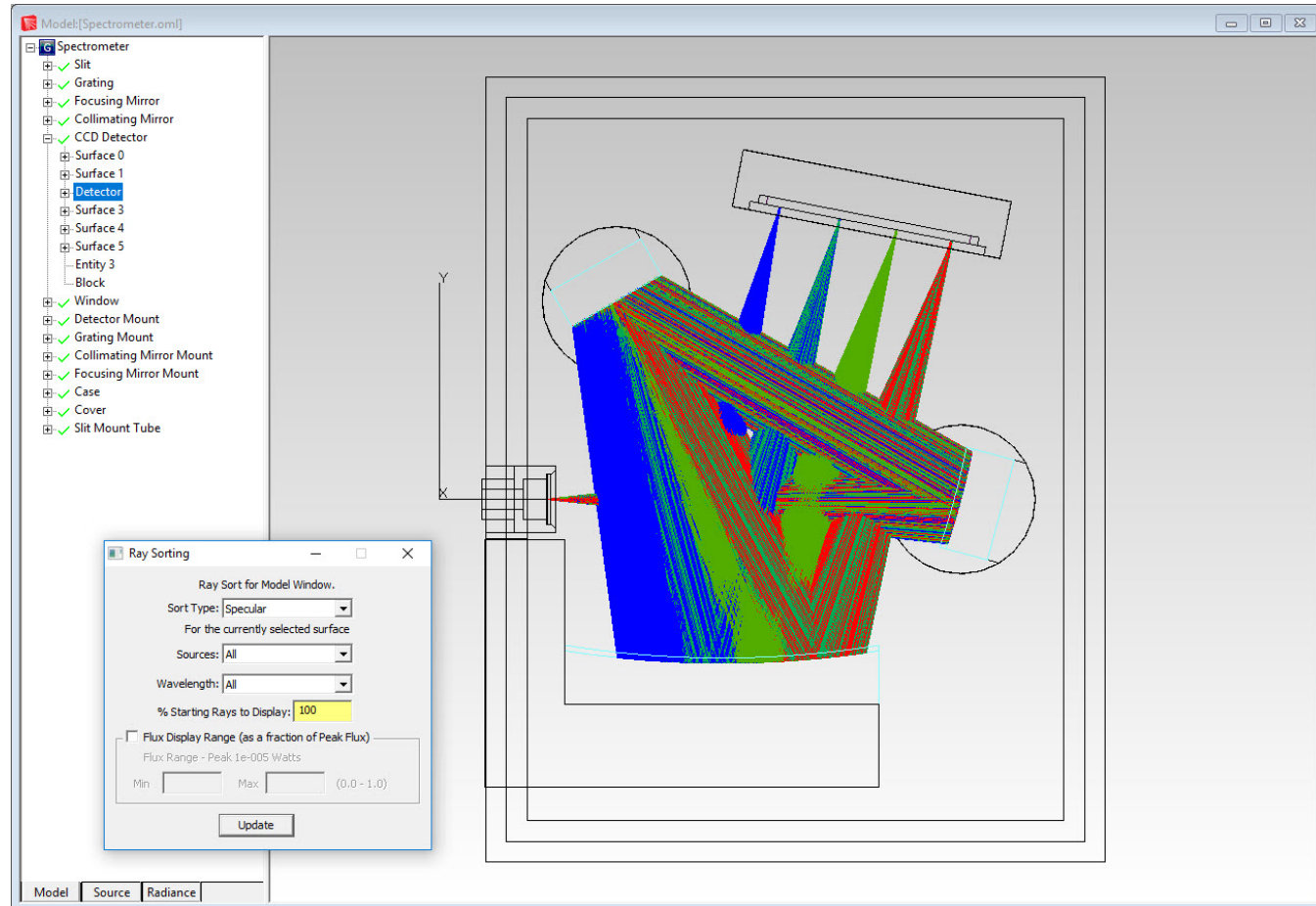
# Ray Sorting Examples

## Sort Type – Percentage of Starting Rays



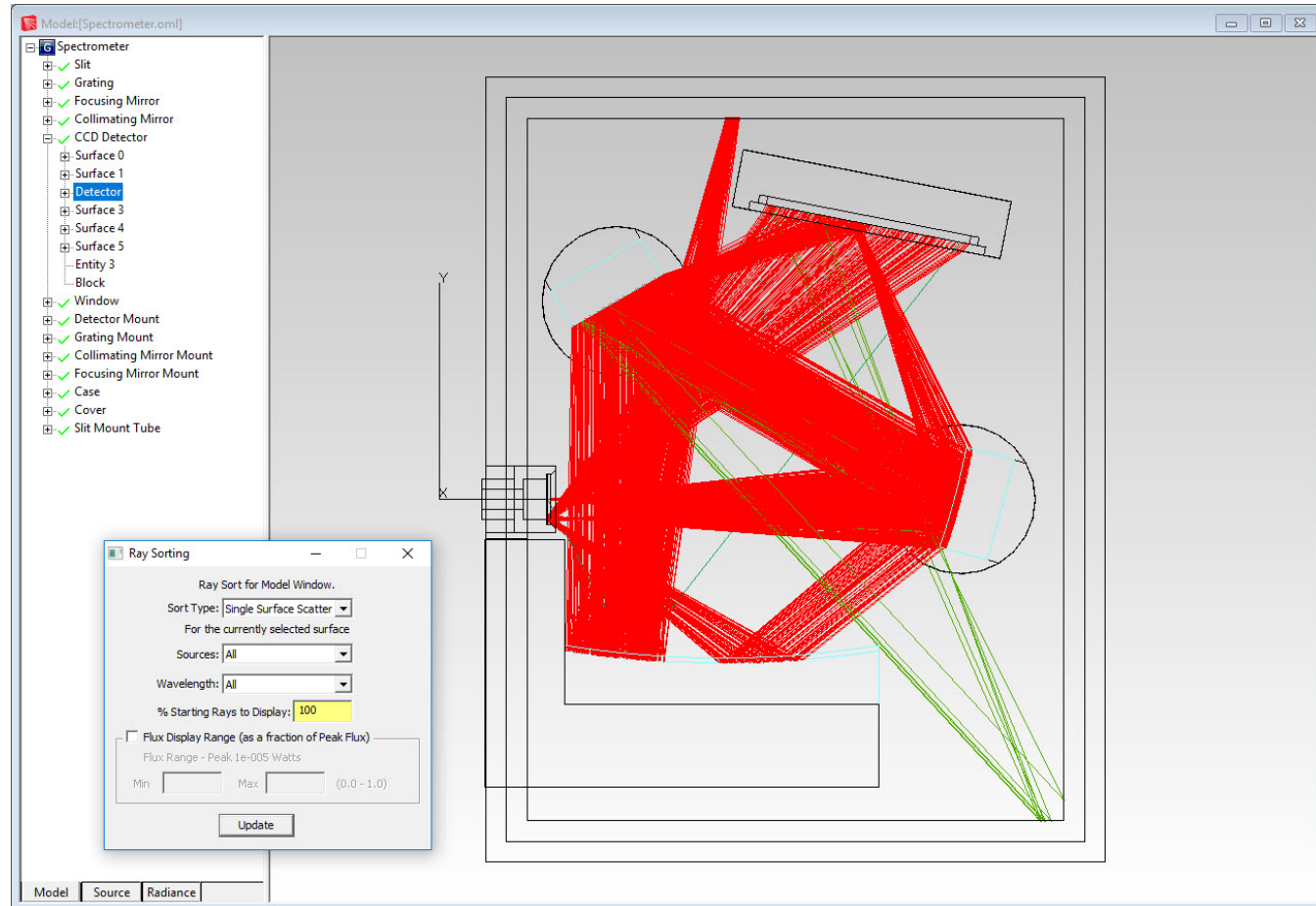
# Ray Sorting Examples

## Sort Type – Specular Rays



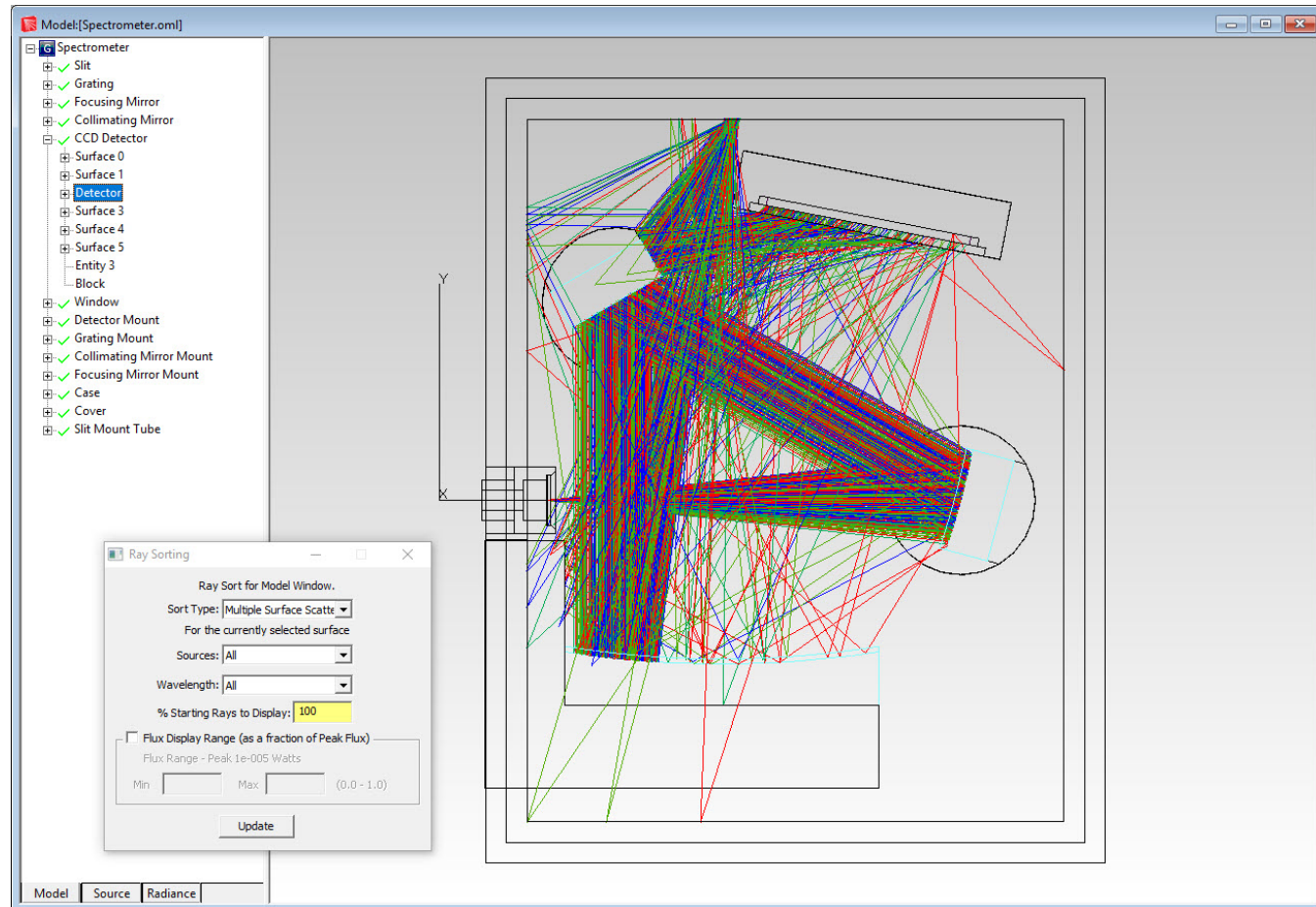
# Ray Sorting Examples

## Sort Type – Single Surface Scatter Rays



# Ray Sorting Examples

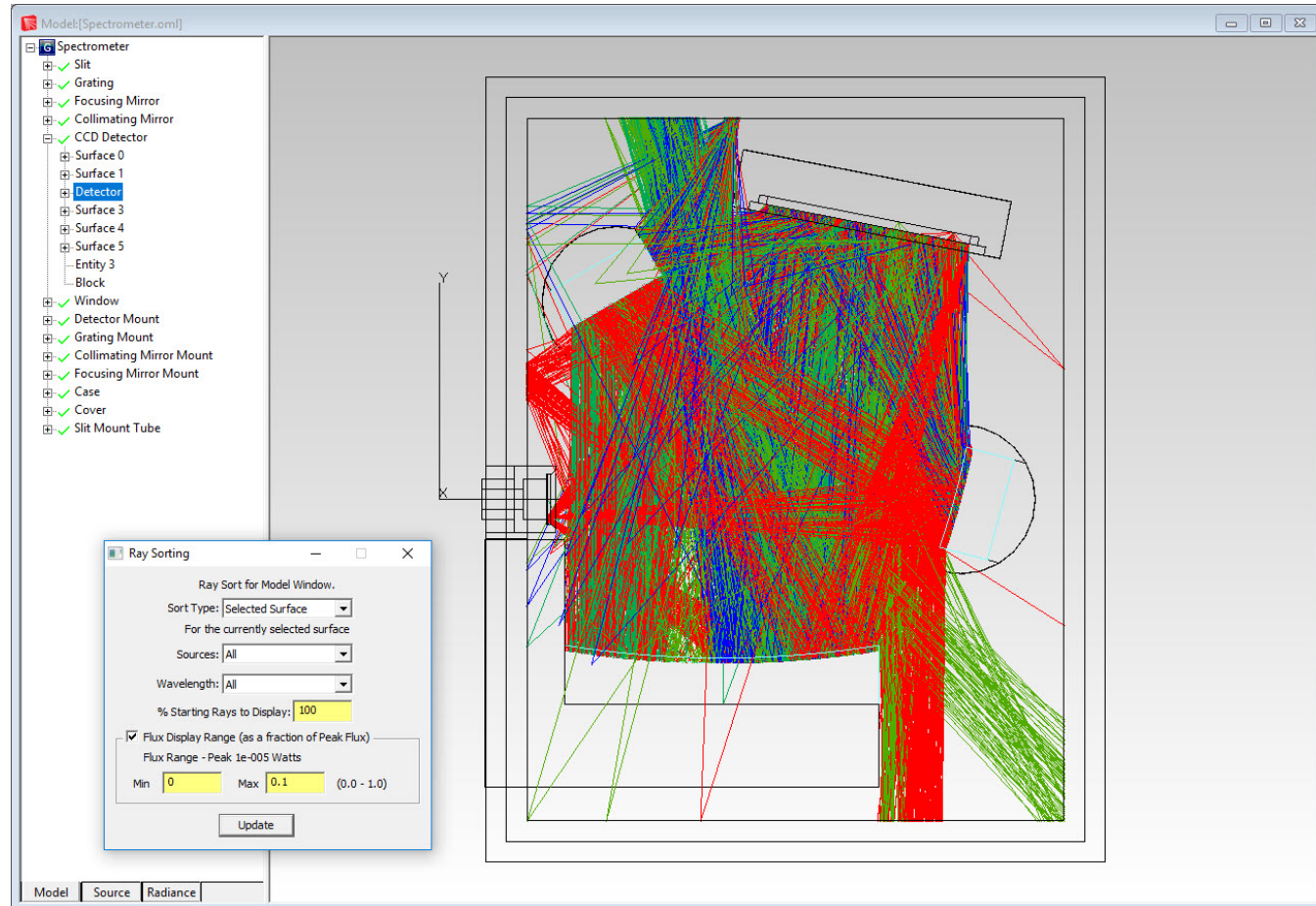
Sort Type – Multiple Surface Scatter Rays – may require lower flux threshold

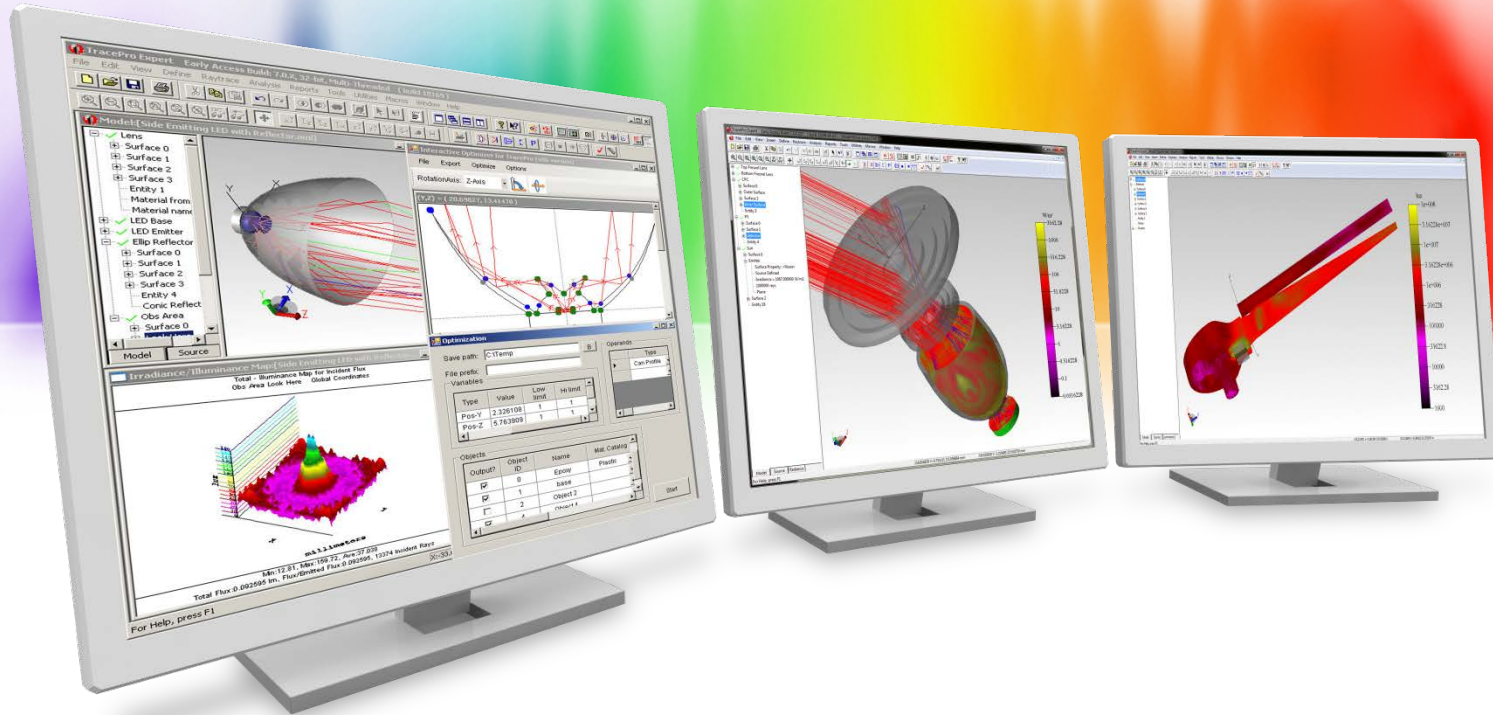




# Ray Sorting Examples

## Sort Type – Range of Flux Values





## The Path Sort Table

# Path Sort Table

Path Sorting allows for sorting rays by the discrete paths they take to a selected surface

- Analysis->Path Sort Table

TracePro Expert

File Edit View Geometry Define Raytrace Optimize Analysis Reports Tools Utilities Macros Window Help

Display Rays  
Display Selected Paths  
Display Selected Rays  
Select Rays...  
Ray Colors...  
Ray Sorting...  
**Path Sort Table**  
Irradiance/Illuminance Maps  
Irradiance/Illuminance Options...  
Luminance/Radiance Maps...  
Luminance/Radiance Map Options...  
3D Irradiance/Illuminance  
3D Irradiance/Illuminance Options...  
Candela Plots  
Candela Options...  
Polarization Maps  
Polarization Options...  
OPL/Time-of-flight Plot  
OPL/Time-of-flight Plot Options...  
Incident Ray Table  
Ray Histories

Model[Spectrometer.oml]

Spectrometer

- ✓ Slit
- ✓ Grating
- ✓ Focusing Mirror
- ✓ Collimating Mirror
- ✓ CCD Detector
- Surface 0
  - Surface 1
  - Detector**
  - Surface 3
  - Surface 4
  - Surface 5
- Entity 3
- Block
- ✓ Window
- ✓ Detector Mount
- ✓ Grating Mount
- ✓ Collimating Mirror Mount
- ✓ Focusing Mirror Mount
- ✓ Case
- ✓ Cover
- ✓ Slit Mount Tube

Path Sort Table [Spectrometer.oml]

Sources: [1] No. of intercepts: [ ] Filter Editor [ ] Apply [ ]

Wavelengths: All % of rays to display: 100 Select filters: [None]

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	% of Total	Path Type	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.4	49392	0.129005549779135	30.10	0.129005549779135	30.10	Specular	7				
2	Slit Grid Source	0.2	49934	0.128553687790855	30.00	0.128553687790855	30.00	Specular	7				
3	Slit Grid Source	0.6	24809	0.0862091766888437	20.12	0.0862091766888437	20.12	Specular	7				
4	Slit Grid Source	0.8	24379	0.0847656197332225	19.78	0.0847656197332225	19.78	Specular	7				
5	Slit Grid Source	0.8	200	1.73135192951191e-005	0.00	1.73135192951191e-005	0.00	Single Surf Scat	8				
6	Slit Grid Source	0.8	124	9.71566949611267e-006	0.00	9.71566949611267e-006	0.00	Single Surf Scat	10				
7	Slit Grid Source	0.8	87	6.7911730791225e-006	0.00	6.7911730791225e-006	0.00	Single Surf Scat	10				
8	Slit Grid Source	0.6	5	4.56796072838936e-007	0.00	4.56796072838936e-007	0.00	Single Surf Scat	7				
9	Slit Grid Source	0.4	1	4.56699408674095e-007	0.00	4.56699408674095e-007	0.00	Single Surf Scat	6				
10	Slit Grid Source	0.8	2	1.72581642881935e-007	0.00	1.72581642881935e-007	0.00	Single Surf Scat	8				
11	Slit Grid Source	0.8	2	1.72505932439079e-007	0.00	1.72505932439079e-007	0.00	Single Surf Scat	8				
12	Slit Grid Source	0.6	1	9.11860556920241e-008	0.00	9.11860556920241e-008	0.00	Single Surf Scat	7				



# Path Sort Table

Path Sort Table – Lists all the paths rays take to a selected surface

Path Sort Table [Spectrometer.omi]

Sources:  No. of intercepts:  Filter Editor

Wavelengths:  % of rays to display:  Select filters: ☒ None

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	% of Total	Path Type	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.4	49392	0.129005549779135	30.10	0.129005549779135	30.10	Specular	7				
2	Slit Grid Source	0.2	49934	0.128553687790855	29.99	0.128553687790855	29.99	Specular	7				
3	Slit Grid Source	0.6	24809	0.0862091766888437	20.11	0.0862091766888437	20.11	Specular	7				
4	Slit Grid Source	0.8	24379	0.0847656197332225	19.78	0.0847656197332225	19.78	Specular	7				
5	Slit Grid Source	0.8	180	1.55801147274786e-005	0.00	1.55801147274786e-005	0.00	Single Surf Scat	8				
6	Slit Grid Source	0.8	124	9.71566949611267e-006	0.00	9.71566949611267e-006	0.00	Single Surf Scat	10				
7	Slit Grid Source	0.8	102	7.96361472605634e-006	0.00	7.96361472605634e-006	0.00	Single Surf Scat	10				
8	Slit Grid Source	0.8	163	5.10063775120543e-006	0.00	5.10063775120543e-006	0.00	Single Surf Scat	11				
9	Slit Grid Source	0.4	315	4.00133385772469e-006	0.00	4.00133385772469e-006	0.00	Single Surf Scat	5				
10	Slit Grid Source	0.8	305	3.88442867923526e-006	0.00	3.88442867923526e-006	0.00	Single Surf Scat	5				
11	Slit Grid Source	0.4	122	3.8115217689709e-006	0.00	3.8115217689709e-006	0.00	Single Surf Scat	10				
12	Slit Grid Source	0.6	276	3.51296523740237e-006	0.00	3.51296523740237e-006	0.00	Single Surf Scat	5				
13	Slit Grid Source	0.2	260	3.26619363480386e-006	0.00	3.26619363480386e-006	0.00	Single Surf Scat	5				
14	Slit Grid Source	0.6	62	2.15445074118627e-006	0.00	2.15445074118627e-006	0.00	Single Surf Scat	9				
15	Slit Grid Source	0.4	134	7.57887500631242e-007	0.00	7.57887500631242e-007	0.00	Single Surf Scat	11				
16	Slit Grid Source	0.2	103	7.40613806332179e-007	0.00	7.40613806332179e-007	0.00	Single Surf Scat	11				
17	Slit Grid Source	0.6	8	7.30425540752795e-007	0.00	7.30425540752795e-007	0.00	Single Surf Scat	7				
18	Slit Grid Source	0.6	19	6.60232345427624e-007	0.00	6.60232345427624e-007	0.00	Single Surf Scat	9				
19	Slit Grid Source	0.6	106	5.75610515892231e-007	0.00	5.75610515892231e-007	0.00	Single Surf Scat	11				
20	Slit Grid Source	0.8	93	5.52073729286869e-007	0.00	5.52073729286869e-007	0.00	Single Surf Scat	9				
21	Slit Grid Source	0.4	1	4.56699408674095e-007	0.00	4.56699408674095e-007	0.00	Single Surf Scat	6				
22	Slit Grid Source	0.8	40	3.14059945287995e-007	0.00	3.14059945287995e-007	0.00	Multiple Surf Scat	9				
23	Slit Grid Source	0.6	3	2.7358280821207e-007	0.00	2.7358280821207e-007	0.00	Single Surf Scat	7				
24	Slit Grid Source	0.6	35	2.70511238773133e-007	0.00	2.70511238773133e-007	0.00	Multiple Surf Scat	9				
25	Slit Grid Source	0.8	49	2.55459299919144e-007	0.00	2.55459299919144e-007	0.00	Single Surf Scat	11				
26	Slit Grid Source	0.2	32	2.46357710548204e-007	0.00	2.46357710548204e-007	0.00	Multiple Surf Scat	9				
27	Slit Grid Source	0.4	22	1.71522988717445e-007	0.00	1.71522988717445e-007	0.00	Multiple Surf Scat	9				
28	Slit Grid Source	0.8	3	1.63383115334241e-007	0.00	1.63383115334241e-007	0.00	Single Surf Scat	15				
29	Slit Grid Source	0.6	20	1.2073626454074e-007	0.00	1.2073626454074e-007	0.00	Single Surf Scat	9				



# Path Sort Table

Path Sort Table – Shows Source, Wavelength, No. of Rays, Absorbed Flux, % of Total, Path Type, and No. of Intercepts for each path. Columns can be sorted in ascending or descending order.

Path Sort Table [Spectrometer.oml]

Sources:  No. of intercepts:  Filter Editor

Wavelengths:  % of rays to display:  Select filters: ☒ None

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	% of Total	Path Type	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.4	49392	0.129005549779135	30.10	0.129005549779135	30.10	Specular	7				
2	Slit Grid Source	0.2	49934	0.128553687790855	29.99	0.128553687790855	29.99	Specular	7				
3	Slit Grid Source	0.6	24809	0.0862091766888437	20.11	0.0862091766888437	20.11	Specular	7				
4	Slit Grid Source	0.8	24379	0.0847656197332225	19.78	0.0847656197332225	19.78	Specular	7				
5	Slit Grid Source	0.8	180	1.55801147274786e-005	0.00	1.55801147274786e-005	0.00	Single Surf Scat	8				
6	Slit Grid Source	0.8	124	9.71566949611267e-006	0.00	9.71566949611267e-006	0.00	Single Surf Scat	10				
7	Slit Grid Source	0.8	102	7.96361472605634e-006	0.00	7.96361472605634e-006	0.00	Single Surf Scat	10				
8	Slit Grid Source	0.8	163	5.10063775120543e-006	0.00	5.10063775120543e-006	0.00	Single Surf Scat	11				
9	Slit Grid Source	0.4	315	4.00133385772469e-006	0.00	4.00133385772469e-006	0.00	Single Surf Scat	5				
10	Slit Grid Source	0.8	305	3.88442867923526e-006	0.00	3.88442867923526e-006	0.00	Single Surf Scat	5				
11	Slit Grid Source	0.4	122	3.8115217689709e-006	0.00	3.8115217689709e-006	0.00	Single Surf Scat	10				
12	Slit Grid Source	0.6	276	3.51296523740237e-006	0.00	3.51296523740237e-006	0.00	Single Surf Scat	5				
13	Slit Grid Source	0.2	260	3.26619363480386e-006	0.00	3.26619363480386e-006	0.00	Single Surf Scat	5				
14	Slit Grid Source	0.6	62	2.15445074118627e-006	0.00	2.15445074118627e-006	0.00	Single Surf Scat	9				
15	Slit Grid Source	0.4	134	7.57887500631242e-007	0.00	7.57887500631242e-007	0.00	Single Surf Scat	11				
16	Slit Grid Source	0.2	103	7.40613806332179e-007	0.00	7.40613806332179e-007	0.00	Single Surf Scat	11				
17	Slit Grid Source	0.6	8	7.30425540752795e-007	0.00	7.30425540752795e-007	0.00	Single Surf Scat	7				
18	Slit Grid Source	0.6	19	6.60232345427624e-007	0.00	6.60232345427624e-007	0.00	Single Surf Scat	9				
19	Slit Grid Source	0.6	106	5.75610515892231e-007	0.00	5.75610515892231e-007	0.00	Single Surf Scat	11				
20	Slit Grid Source	0.8	93	5.52073729286869e-007	0.00	5.52073729286869e-007	0.00	Single Surf Scat	9				
21	Slit Grid Source	0.4	1	4.56699408674095e-007	0.00	4.56699408674095e-007	0.00	Single Surf Scat	6				
22	Slit Grid Source	0.8	40	3.14059945287995e-007	0.00	3.14059945287995e-007	0.00	Multiple Surf Scat	9				
23	Slit Grid Source	0.6	3	2.7358280821207e-007	0.00	2.7358280821207e-007	0.00	Single Surf Scat	7				
24	Slit Grid Source	0.6	35	2.70511238773133e-007	0.00	2.70511238773133e-007	0.00	Multiple Surf Scat	9				
25	Slit Grid Source	0.8	49	2.55459299919144e-007	0.00	2.55459299919144e-007	0.00	Single Surf Scat	11				
26	Slit Grid Source	0.2	32	2.46357710548204e-007	0.00	2.46357710548204e-007	0.00	Multiple Surf Scat	9				
27	Slit Grid Source	0.4	22	1.71522988717445e-007	0.00	1.71522988717445e-007	0.00	Multiple Surf Scat	9				
28	Slit Grid Source	0.8	3	1.63383115334241e-007	0.00	1.63383115334241e-007	0.00	Single Surf Scat	15				
29	Slit Grid Source	0.6	20	1.2073626454074e-007	0.00	1.2073626454074e-007	0.00	Single Surf Scat	9				

# Path Sort Table

Path Sort Table – Expand the path by double clicking on the “+” next to the path number to show the surface interactions for that path

Path Sort Table [Spectrometer.omi]

Sources: All No. of intercepts: Filter Editor Apply

Wavelengths: All % of rays to display: 100 Select filters: ☒ None

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	% of Total	Path Type	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.4	49392	0.129005549779135	30.10	0.129005549779135	30.10	Specular	7	1	Emitted		
										2	SpecRefl	Collimating Mirror	Mirror Surface
										3	SpecRefl	Grating	Grating Surface
										4	SpecRefl	Focusing Mirror	Mirror Surface
										5	SpecTran	Window	Surface 2
										6	SpecTran	Window	Surface 2
										7	At Surface	CCD Detector	Detector
2	Slit Grid Source	0.2	49934	0.128553687790855	29.99	0.128553687790855	29.99	Specular	7				
3	Slit Grid Source	0.6	24809	0.0862091766888437	20.11	0.0862091766888437	20.11	Specular	7				
4	Slit Grid Source	0.8	24379	0.0847656197332225	19.78	0.0847656197332225	19.78	Specular	7				
5	Slit Grid Source	0.8	180	1.55801147274786e-005	0.00	1.55801147274786e-005	0.00	Single Surf Scat	8				
6	Slit Grid Source	0.8	124	9.71566949611267e-006	0.00	9.71566949611267e-006	0.00	Single Surf Scat	10				
7	Slit Grid Source	0.8	102	7.96361472605634e-006	0.00	7.96361472605634e-006	0.00	Single Surf Scat	10				
8	Slit Grid Source	0.8	163	5.10063775120543e-006	0.00	5.10063775120543e-006	0.00	Single Surf Scat	11				
9	Slit Grid Source	0.4	315	4.00133385772469e-006	0.00	4.00133385772469e-006	0.00	Single Surf Scat	5				
10	Slit Grid Source	0.8	305	3.88442867923526e-006	0.00	3.88442867923526e-006	0.00	Single Surf Scat	5				
11	Slit Grid Source	0.4	122	3.8115217689709e-006	0.00	3.8115217689709e-006	0.00	Single Surf Scat	10				
12	Slit Grid Source	0.6	276	3.51296523740237e-006	0.00	3.51296523740237e-006	0.00	Single Surf Scat	5				
13	Slit Grid Source	0.2	260	3.26619363480386e-006	0.00	3.26619363480386e-006	0.00	Single Surf Scat	5				
14	Slit Grid Source	0.6	62	2.15445074118627e-006	0.00	2.15445074118627e-006	0.00	Single Surf Scat	9				
15	Slit Grid Source	0.4	134	7.57887500631242e-007	0.00	7.57887500631242e-007	0.00	Single Surf Scat	11				
16	Slit Grid Source	0.2	103	7.40613806332179e-007	0.00	7.40613806332179e-007	0.00	Single Surf Scat	11				
17	Slit Grid Source	0.6	8	7.30425540752795e-007	0.00	7.30425540752795e-007	0.00	Single Surf Scat	7				
18	Slit Grid Source	0.6	19	6.60232345427624e-007	0.00	6.60232345427624e-007	0.00	Single Surf Scat	9				
19	Slit Grid Source	0.6	106	5.75610515892231e-007	0.00	5.75610515892231e-007	0.00	Single Surf Scat	11				
20	Slit Grid Source	0.8	93	5.52073729286869e-007	0.00	5.52073729286869e-007	0.00	Single Surf Scat	9				
21	Slit Grid Source	0.4	1	4.56699408674095e-007	0.00	4.56699408674095e-007	0.00	Single Surf Scat	6				
22	Slit Grid Source	0.8	40	3.14059945287995e-007	0.00	3.14059945287995e-007	0.00	Multiple Surf Scat	9				

# Path Sort Table

Path Sort Table – Expand the path by clicking on the “+” next to the path number to show the surface interactions for that path

Path Sort Table [Spectrometer.aml]

Sources: All Wavelengths: All No. of intercepts: % of rays to display: 100 Filter Editor Apply Select filters: ☒ None

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	% of Total	Path Type	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.4	49392	0.129005549779135	30.10	0.129005549779135	30.10	Specular	7				
2	Slit Grid Source	0.2	49934	0.128553687790855	29.99	0.128553687790855	29.99	Specular	7				
3	Slit Grid Source	0.6	24809	0.0862091766888437	20.11	0.0862091766888437	20.11	Specular	7				
4	Slit Grid Source	0.8	34370	0.0847656107333335	19.78	0.0847656107333335	19.78	Specular	7				
5	Slit Grid Source	0.8	180	1.55801147274786e-005	0.00	1.55801147274786e-005	0.00	Single Surf Scat	8				
										1	Emitted		
										2	SpecRefl	Collimating Mirror	Mirror Surface
										3	SpecRefl	Grating	Grating Surface
										4	SpecRefl	Collimating Mirror	Mirror Surface
										5	RandRefl	Slit	Surface 2
										6	SpecTran	Window	Surface 2
										7	SpecTran	Window	Surface 2
										8	At Surface	CCD Detector	Detector
6	Slit Grid Source	0.8	124	9.71586949611267e-006	0.00	9.71586949611267e-006	0.00	Single Surf Scat	10				
7	Slit Grid Source	0.8	102	7.96361472605634e-006	0.00	7.96361472605634e-006	0.00	Single Surf Scat	10				
8	Slit Grid Source	0.8	163	5.10063775120543e-006	0.00	5.10063775120543e-006	0.00	Single Surf Scat	11				
9	Slit Grid Source	0.4	315	4.00133385772469e-006	0.00	4.00133385772469e-006	0.00	Single Surf Scat	5				
10	Slit Grid Source	0.8	305	3.88442867923526e-006	0.00	3.88442867923526e-006	0.00	Single Surf Scat	5				
11	Slit Grid Source	0.4	122	3.8115217689709e-006	0.00	3.8115217689709e-006	0.00	Single Surf Scat	10				
12	Slit Grid Source	0.6	276	3.51296523740237e-006	0.00	3.51296523740237e-006	0.00	Single Surf Scat	5				
13	Slit Grid Source	0.2	260	3.26619363480386e-006	0.00	3.26619363480386e-006	0.00	Single Surf Scat	5				
14	Slit Grid Source	0.6	62	2.15445074118627e-006	0.00	2.15445074118627e-006	0.00	Single Surf Scat	9				
15	Slit Grid Source	0.4	134	7.57887500631242e-007	0.00	7.57887500631242e-007	0.00	Single Surf Scat	11				
16	Slit Grid Source	0.2	103	7.40613806332179e-007	0.00	7.40613806332179e-007	0.00	Single Surf Scat	11				
17	Slit Grid Source	0.6	8	7.30425540752795e-007	0.00	7.30425540752795e-007	0.00	Single Surf Scat	7				
18	Slit Grid Source	0.6	19	6.60232345427624e-007	0.00	6.60232345427624e-007	0.00	Single Surf Scat	9				
19	Slit Grid Source	0.6	106	5.75610515892231e-007	0.00	5.75610515892231e-007	0.00	Single Surf Scat	11				
20	Slit Grid Source	0.8	93	5.52073729286869e-007	0.00	5.52073729286869e-007	0.00	Single Surf Scat	9				
21	Slit Grid Source	0.4	1	4.56699408674095e-007	0.00	4.56699408674095e-007	0.00	Single Surf Scat	6				

# Path Sort Table

Path Sort Table – Expand the path by clicking on the “+” next to the path number to show the surface interactions for that path

Sources: All

Wavelengths: All

No. of intercepts:

% of rays to display: 100

Filter Editor

Apply

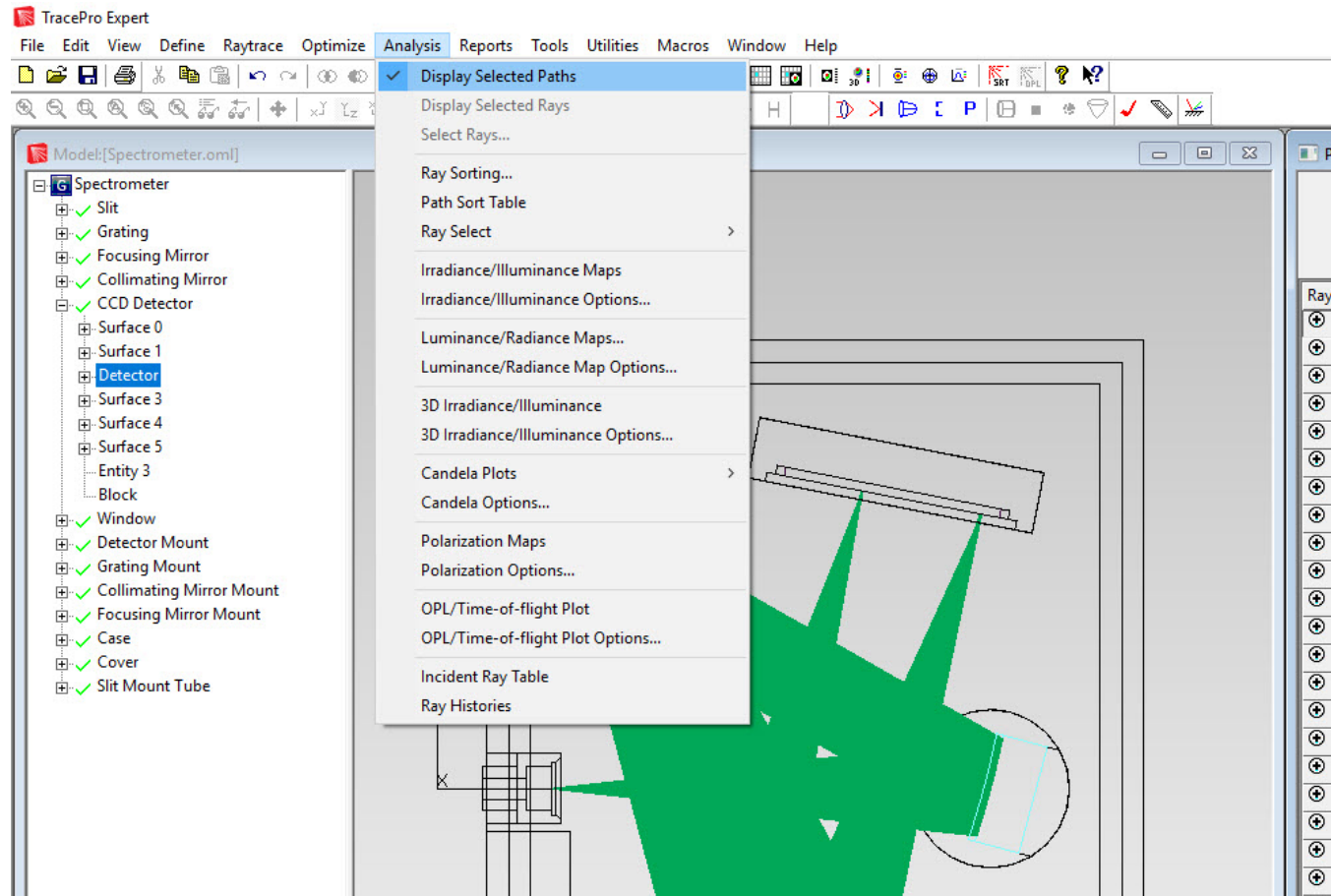
Select filters: ☒ None

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	% of Total	Path Type	No. Intercepts	No.	Intercept Type	Object	Surface
7	Slit Grid Source	0.8	102	7.96361472605634e-006	0.00	7.96361472605634e-006	0.00	Single Surf Scat	10				
8	Slit Grid Source	0.8	163	5.10063775120543e-006	0.00	5.10063775120543e-006	0.00	Single Surf Scat	11				
9	Slit Grid Source	0.4	315	4.00133385772469e-006	0.00	4.00133385772469e-006	0.00	Single Surf Scat	5				
10	Slit Grid Source	0.8	305	3.88442867923526e-006	0.00	3.88442867923526e-006	0.00	Single Surf Scat	5				
11	Slit Grid Source	0.4	122	3.8115217689709e-006	0.00	3.8115217689709e-006	0.00	Single Surf Scat	10				
12	Slit Grid Source	0.6	276	3.51296523740237e-006	0.00	3.51296523740237e-006	0.00	Single Surf Scat	5				
13	Slit Grid Source	0.2	260	3.26619363480386e-006	0.00	3.26619363480386e-006	0.00	Single Surf Scat	5				
14	Slit Grid Source	0.6	62	2.15445074118627e-006	0.00	2.15445074118627e-006	0.00	Single Surf Scat	9				
15	Slit Grid Source	0.4	134	7.57887500631242e-007	0.00	7.57887500631242e-007	0.00	Single Surf Scat	11				
16	Slit Grid Source	0.2	103	7.40613806332179e-007	0.00	7.40613806332179e-007	0.00	Single Surf Scat	11				
17	Slit Grid Source	0.6	8	7.30425540752795e-007	0.00	7.30425540752795e-007	0.00	Single Surf Scat	7				
18	Slit Grid Source	0.6	19	6.60232345427624e-007	0.00	6.60232345427624e-007	0.00	Single Surf Scat	9				
19	Slit Grid Source	0.6	106	5.75610515892231e-007	0.00	5.75610515892231e-007	0.00	Single Surf Scat	11				
20	Slit Grid Source	0.8	93	5.52073729286869e-007	0.00	5.52073729286869e-007	0.00	Single Surf Scat	9				
21	Slit Grid Source	0.4	1	4.56699408674095e-007	0.00	4.56699408674095e-007	0.00	Single Surf Scat	6				
22	Slit Grid Source	0.8	40	3.14059945287995e-007	0.00	3.14059945287995e-007	0.00	Multiple Surf Scat	9				
23	Slit Grid Source	0.6	3	3.7350308031307e-007	0.00	3.7350308031307e-007	0.00	Single Surf Scat	7				
24	Slit Grid Source	0.6	35	2.70511238773133e-007	0.00	2.70511238773133e-007	0.00	Multiple Surf Scat	9				
										1	Emitted		
										2	SpecRefl	Collimating Mirror	Mirror Surface
										3	SpecRefl	Grating	Grating Surface
										4	SpecRefl	Focusing Mirror	Mirror Surface
										5	RandRefl	Case	Surface 6
										6	RandRefl	Grating	Surface 4
										7	SpecTran	Window	Surface 2
										8	SpecTran	Window	Surface 2
										9	At Surface	CCD Detector	Detector
25	Slit Grid Source	0.8	49	2.55459299919144e-007	0.00	2.55459299919144e-007	0.00	Single Surf Scat	11				
26	Slit Grid Source	0.2	32	2.46357710548204e-007	0.00	2.46357710548204e-007	0.00	Multiple Surf Scat	9				



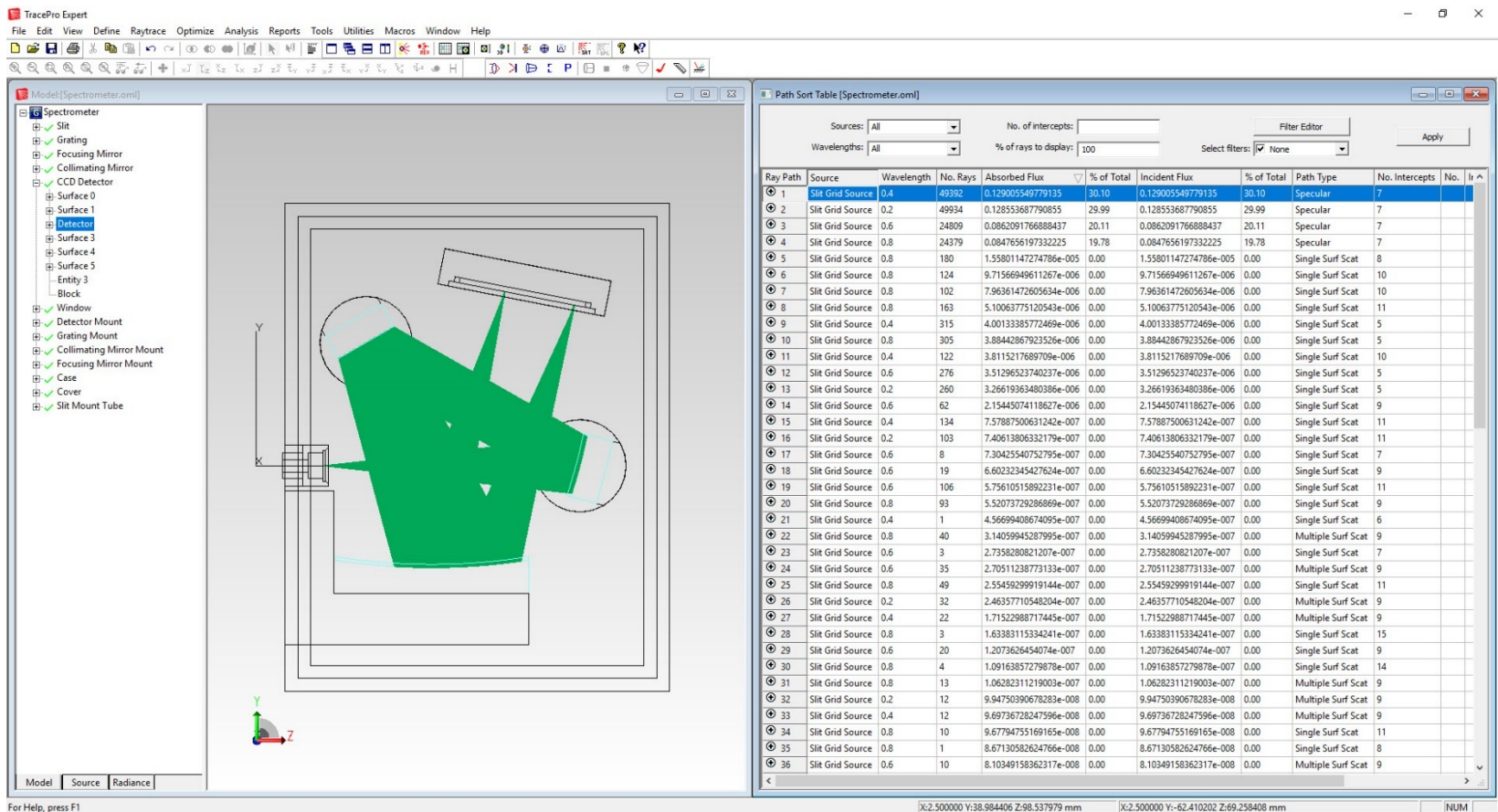
# Path Sort Table

Analysis -> Display Selected Paths – Shows the selected path graphically



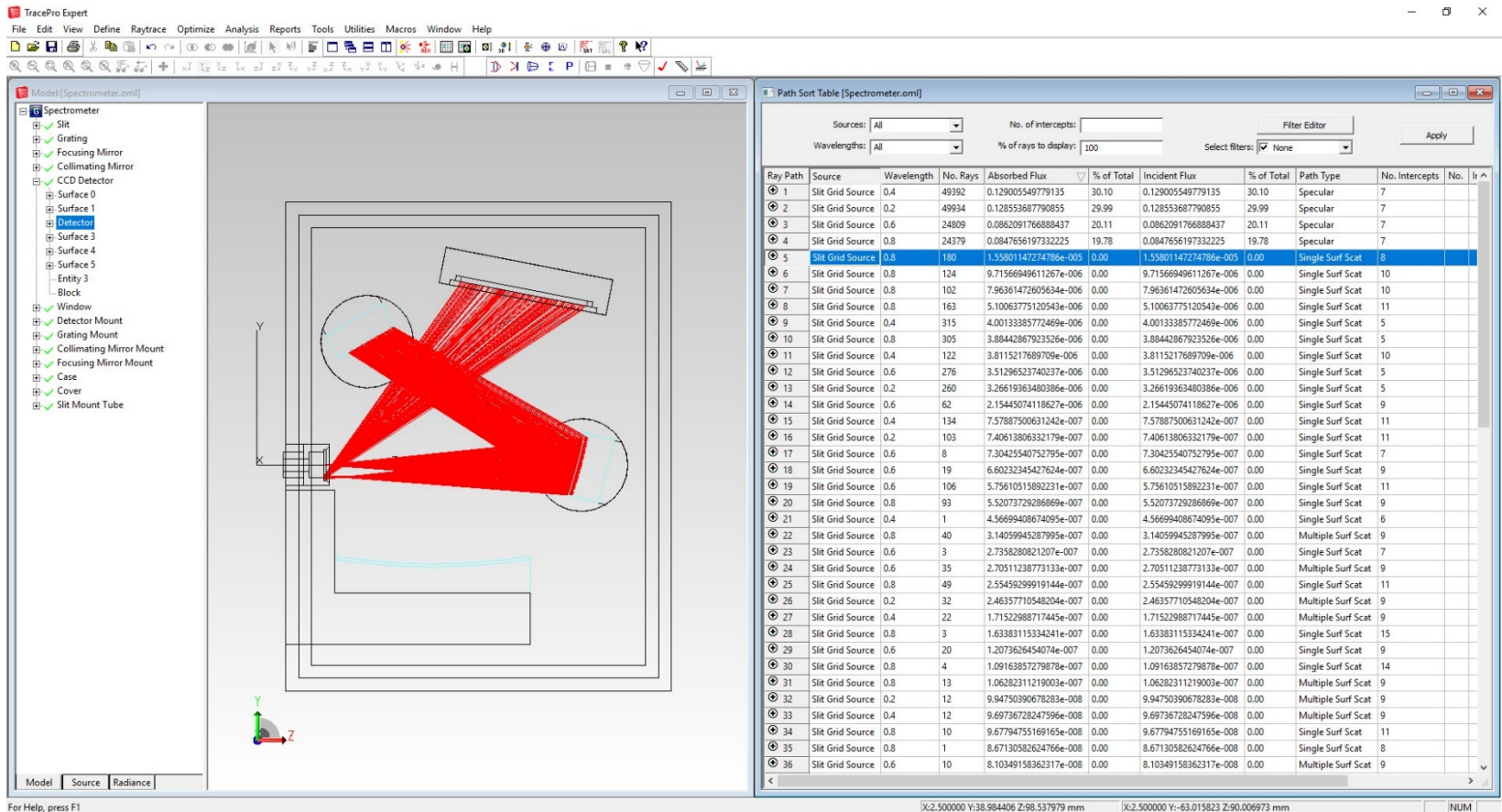
# Path Sort Table

Analysis -> Display Selected Paths – Shows the selected path graphically



# Path Sort Table

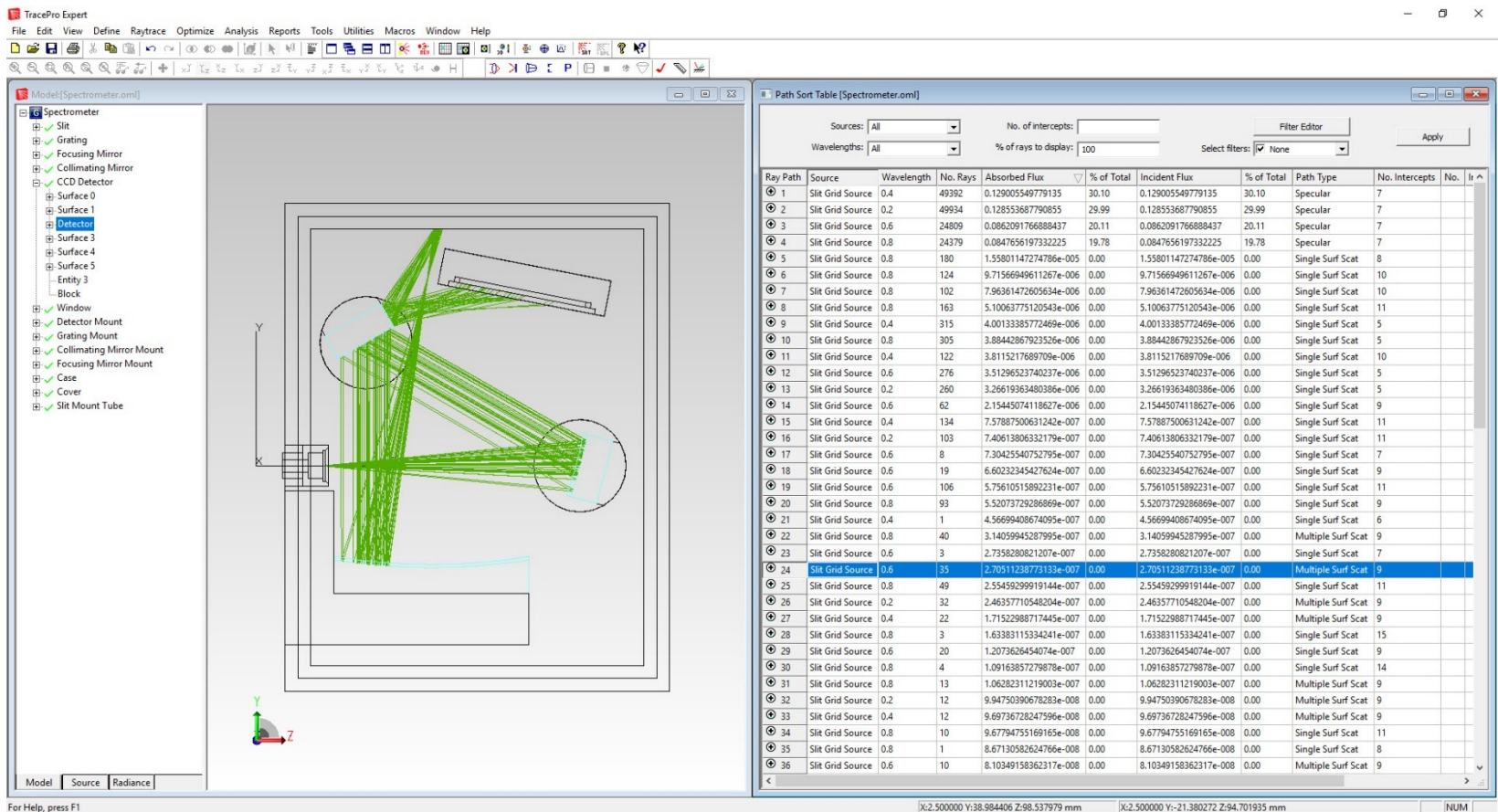
Analysis -> Display Selected Paths – Shows the selected path graphically



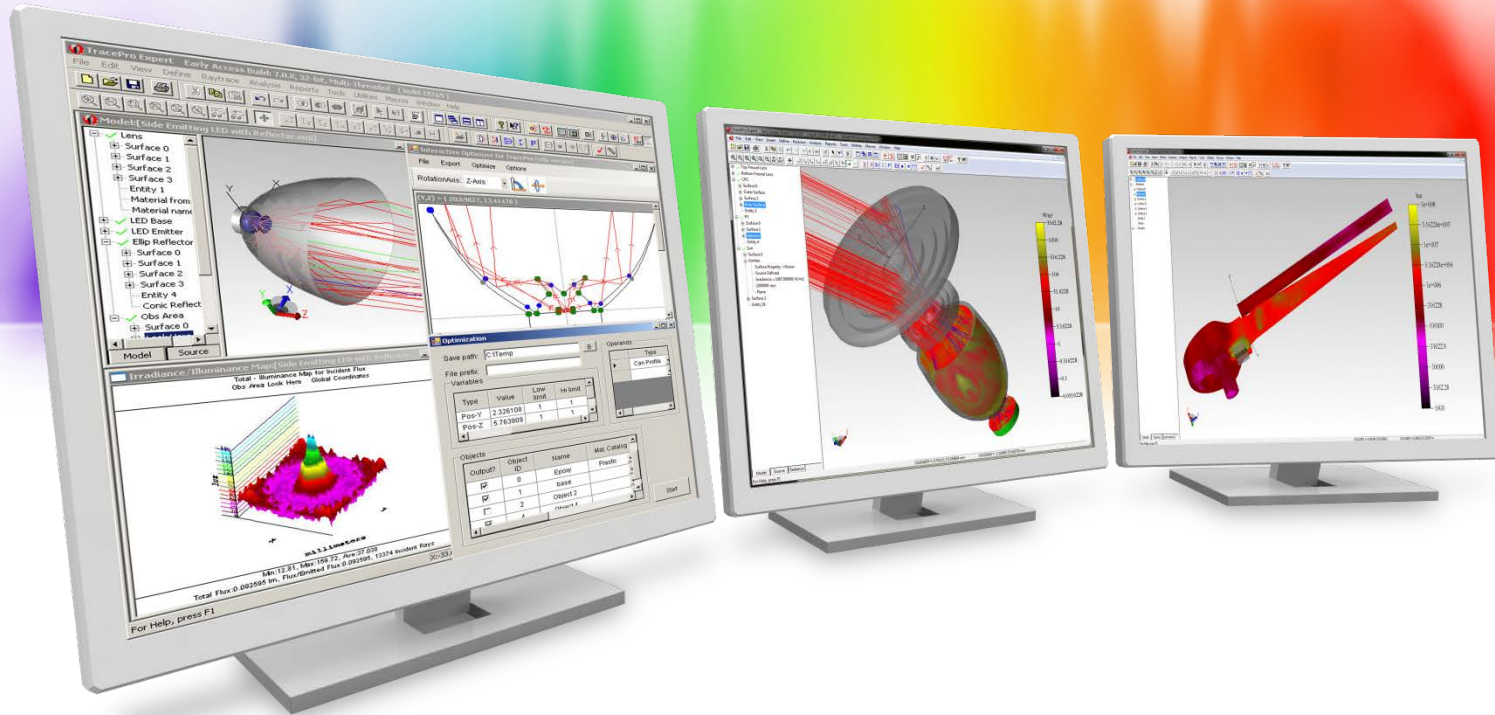


# Path Sort Table

Analysis -> Display Selected Paths – Shows the selected path graphically







## Path Sort Filters

# Path Sort Filters

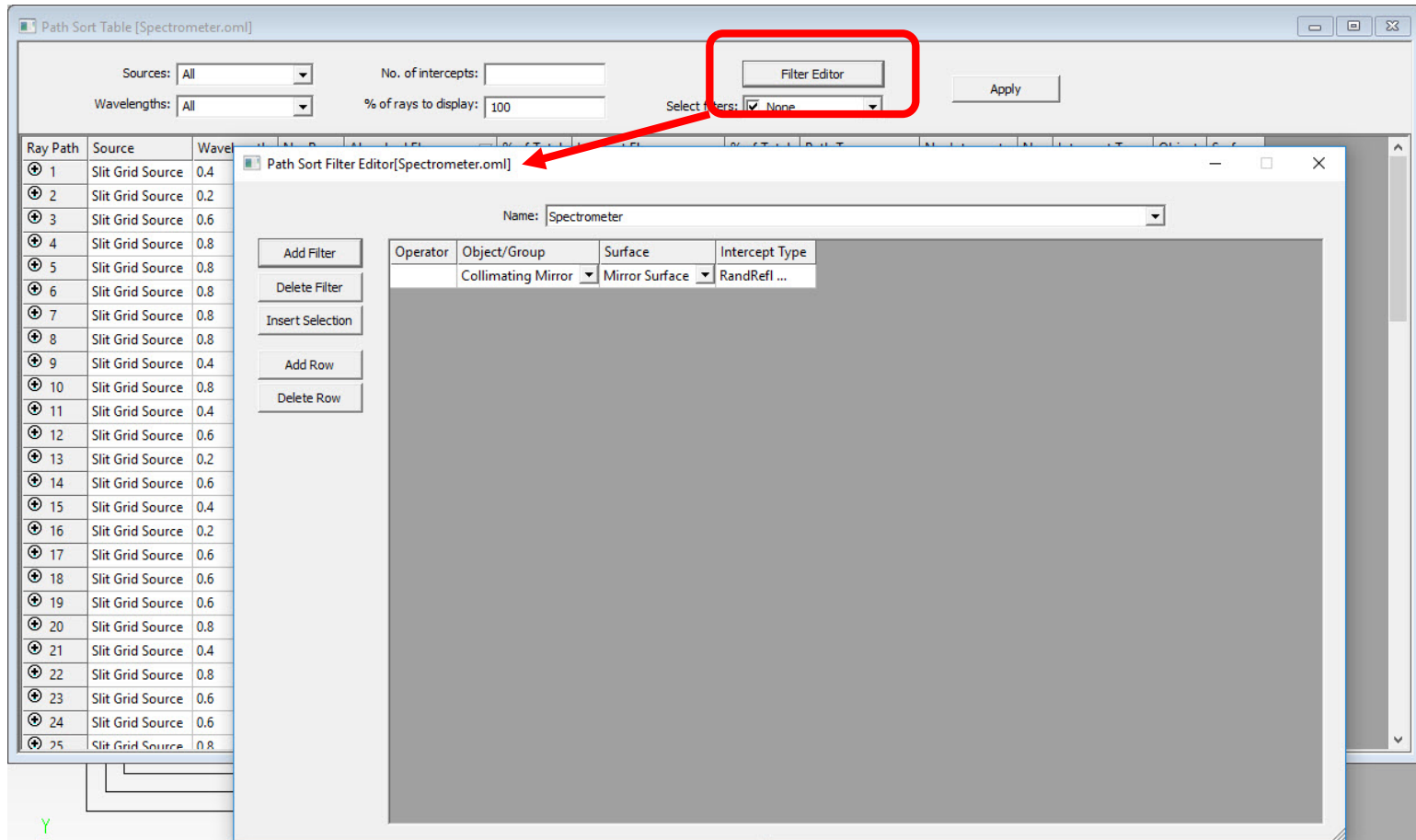
TracePro 7.8 adds the ability to apply filters to the Path Sort table to look for specific path types

The screenshot displays the 'Path Sort Table [Spectrometer.oml]' window in TracePro 7.8. The table lists ray paths with columns for Ray Path, Source, Wavelength, No. Rays, Absorbed Flux, % of Total, Incident Flux, % of Total, Path Type, No. Intercepts, No., Intercept Type, Object, and Surface. The first three rows show paths from 'Slit Grid Source' at wavelengths 0.4, 0.2, and 0.6. A 'Path Sort Filter Editor [Spectrometer.oml]' dialog is open, showing a filter rule: 'Collimating Mirror' (Object/Group) 'Mirror Surface' (Surface) 'RandRefl ...' (Intercept Type). The dialog also includes buttons for 'Add Filter', 'Delete Filter', 'Insert Selection', 'Add Row', and 'Delete Row'. A small 3D coordinate system (X, Y, Z) is visible in the bottom left corner of the main window.

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	% of Total	Path Type	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.4	49392	0.129005549779135	30.10	0.129005549779135	30.10	Specular	7				
2	Slit Grid Source	0.2	49934	0.128553687790855	29.99	0.128553687790855	29.99	Specular	7				
3	Slit Grid Source	0.6	24800	0.0862001766888437	20.11	0.0862001766888437	20.11	Specular	7				
4	Slit Grid Source	0.8											
5	Slit Grid Source	0.8											
6	Slit Grid Source	0.8											
7	Slit Grid Source	0.8											
8	Slit Grid Source	0.8											
9	Slit Grid Source	0.4											
10	Slit Grid Source	0.8											
11	Slit Grid Source	0.4											
12	Slit Grid Source	0.6											
13	Slit Grid Source	0.2											
14	Slit Grid Source	0.6											
15	Slit Grid Source	0.4											
16	Slit Grid Source	0.2											
17	Slit Grid Source	0.6											
18	Slit Grid Source	0.6											
19	Slit Grid Source	0.6											
20	Slit Grid Source	0.8											
21	Slit Grid Source	0.4											
22	Slit Grid Source	0.8											
23	Slit Grid Source	0.6											
24	Slit Grid Source	0.6											
25	Slit Grid Source	0.8											

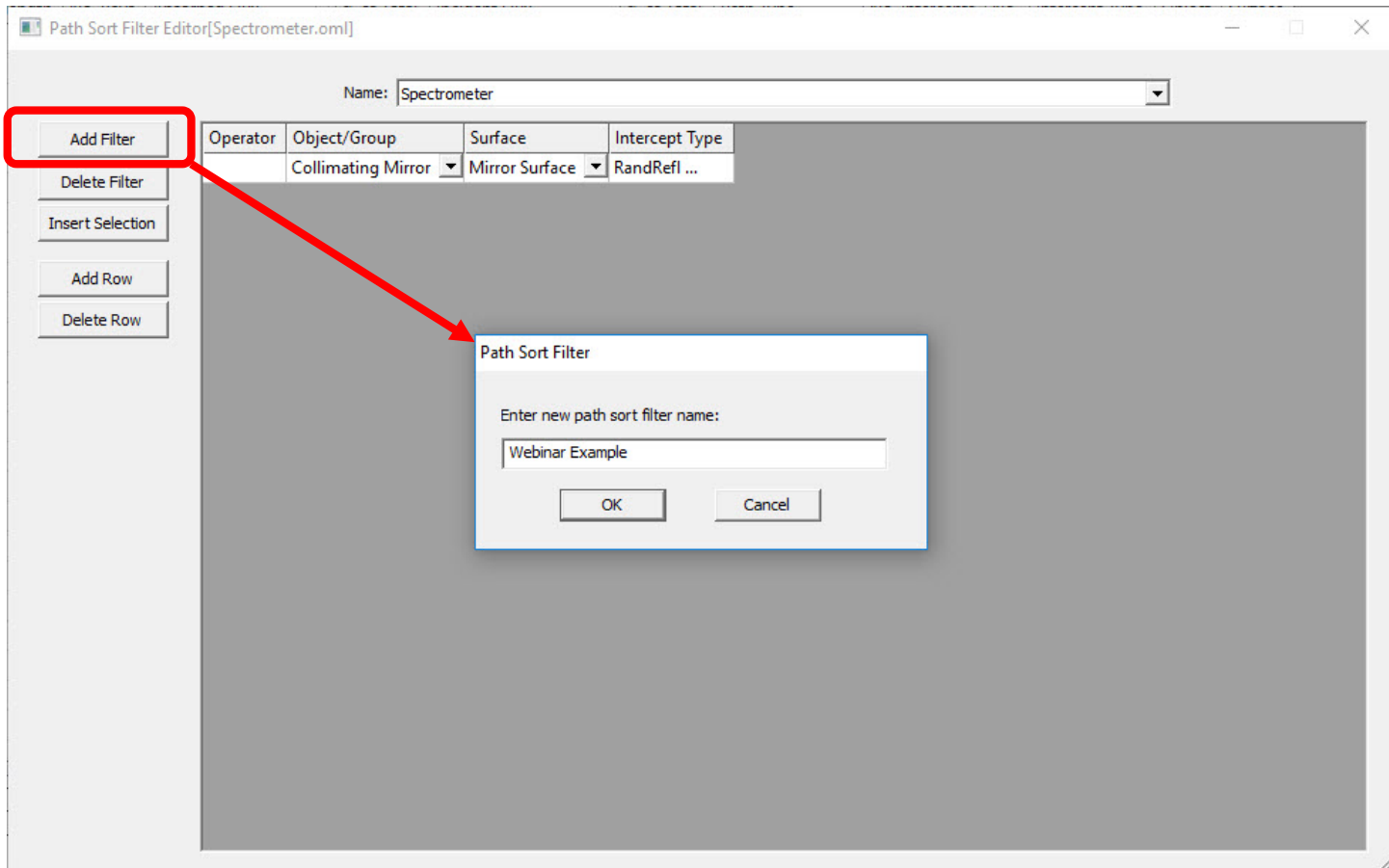
# Path Sort Filters

Click Filter Editor in the Path Sort Table to open the Path Sort Filter Editor



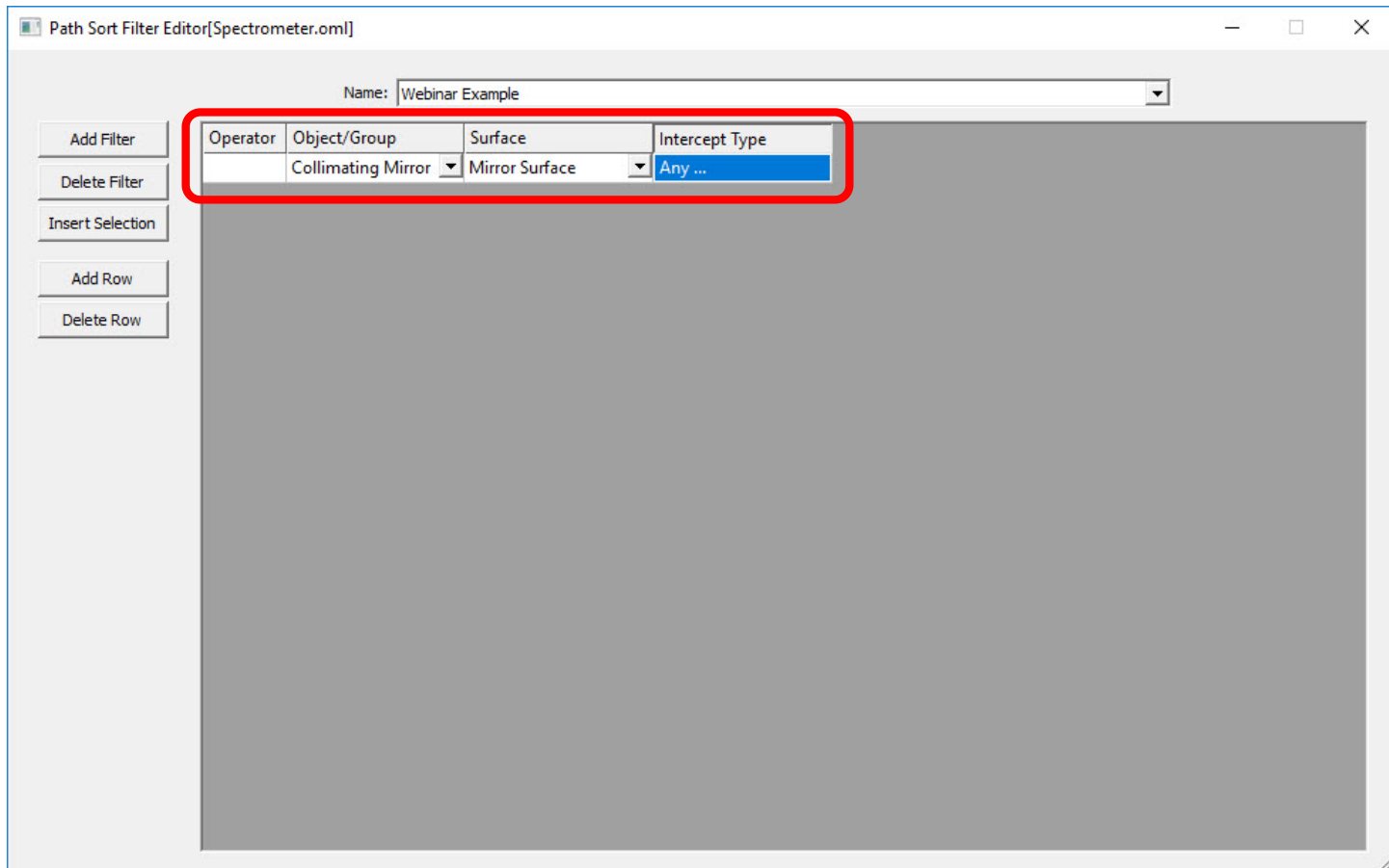
# Path Sort Filters

To define a new Path Sort Filter, click Add Filter, enter a name for the Filter, and then click OK.



# Path Sort Filters

The Path Sort Filter Editor allows you to define the objects, surfaces, surface intercept types, and an operator for the filter



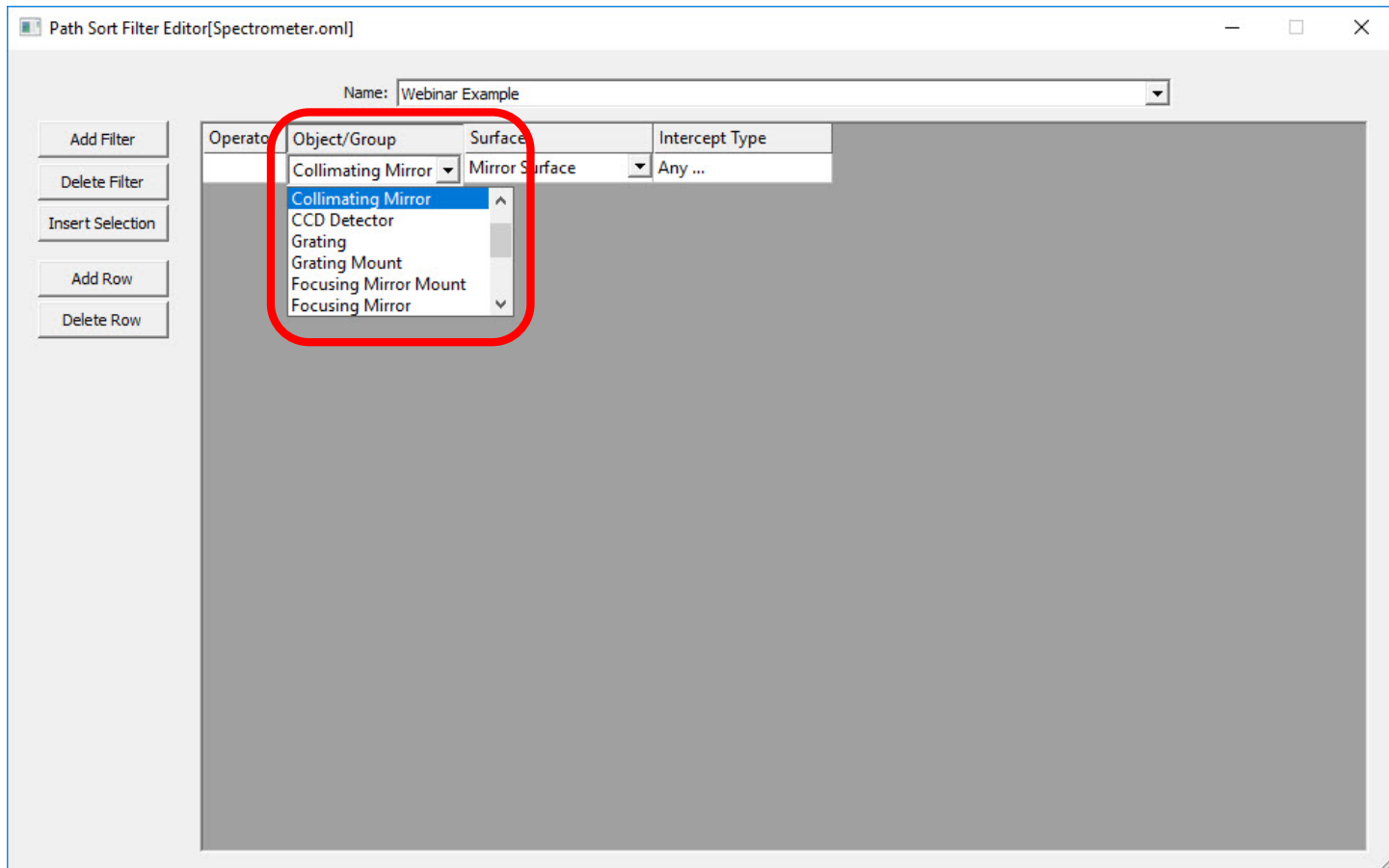
The screenshot shows the 'Path Sort Filter Editor[Spectrometer.oml]' window. At the top, there is a 'Name:' field with the value 'Webinar Example'. Below this is a table with four columns: 'Operator', 'Object/Group', 'Surface', and 'Intercept Type'. The first row of the table is highlighted with a red border and contains the values: an empty 'Operator' field, 'Collimating Mirror' in the 'Object/Group' dropdown, 'Mirror Surface' in the 'Surface' dropdown, and 'Any ...' in the 'Intercept Type' dropdown. To the left of the table are five buttons: 'Add Filter', 'Delete Filter', 'Insert Selection', 'Add Row', and 'Delete Row'. The main area of the window is a large grey rectangle.

Operator	Object/Group	Surface	Intercept Type
	Collimating Mirror	Mirror Surface	Any ...



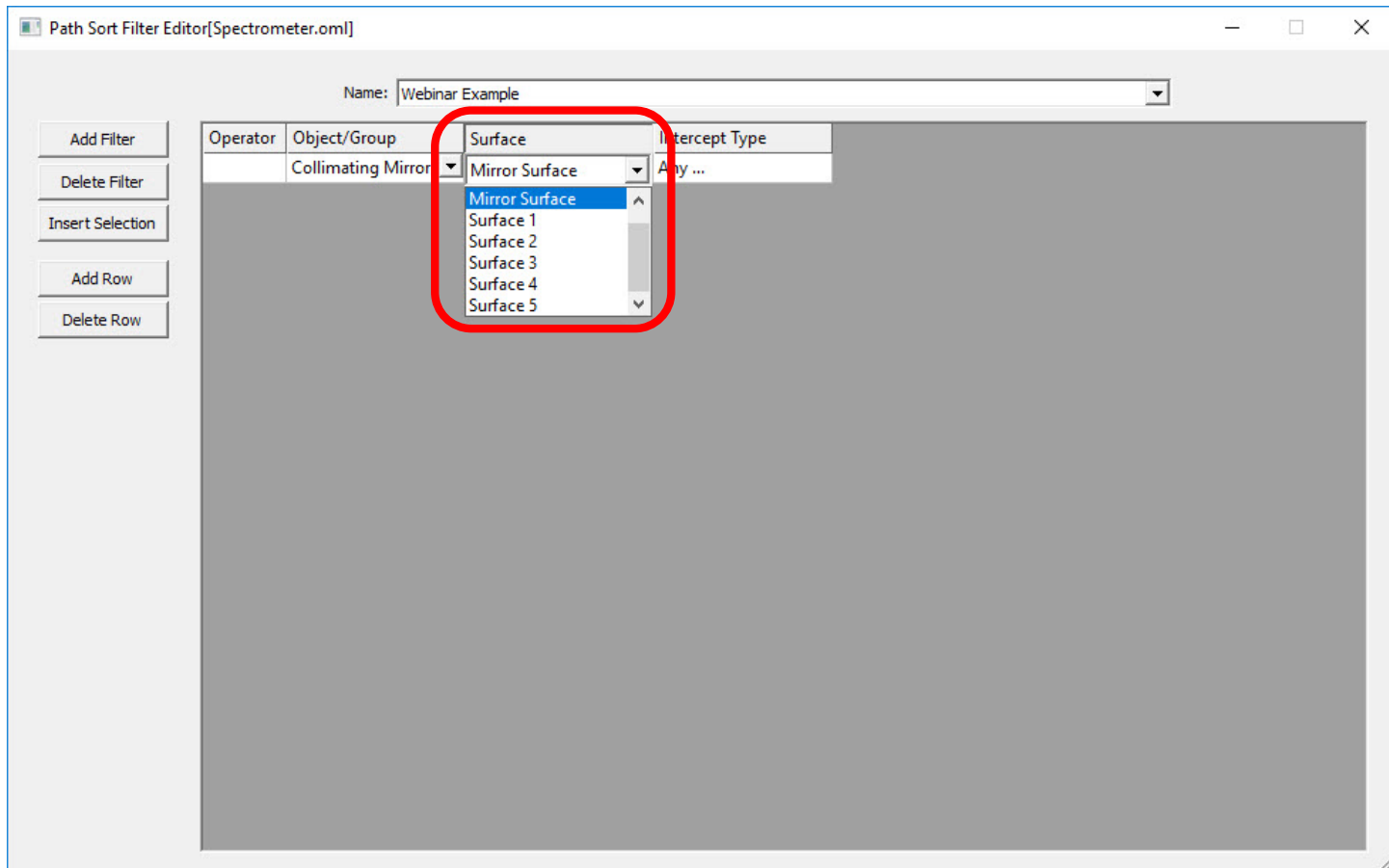
# Path Sort Filters

The Object/Group dropdown menu lists the objects and groups in the current TracePro model



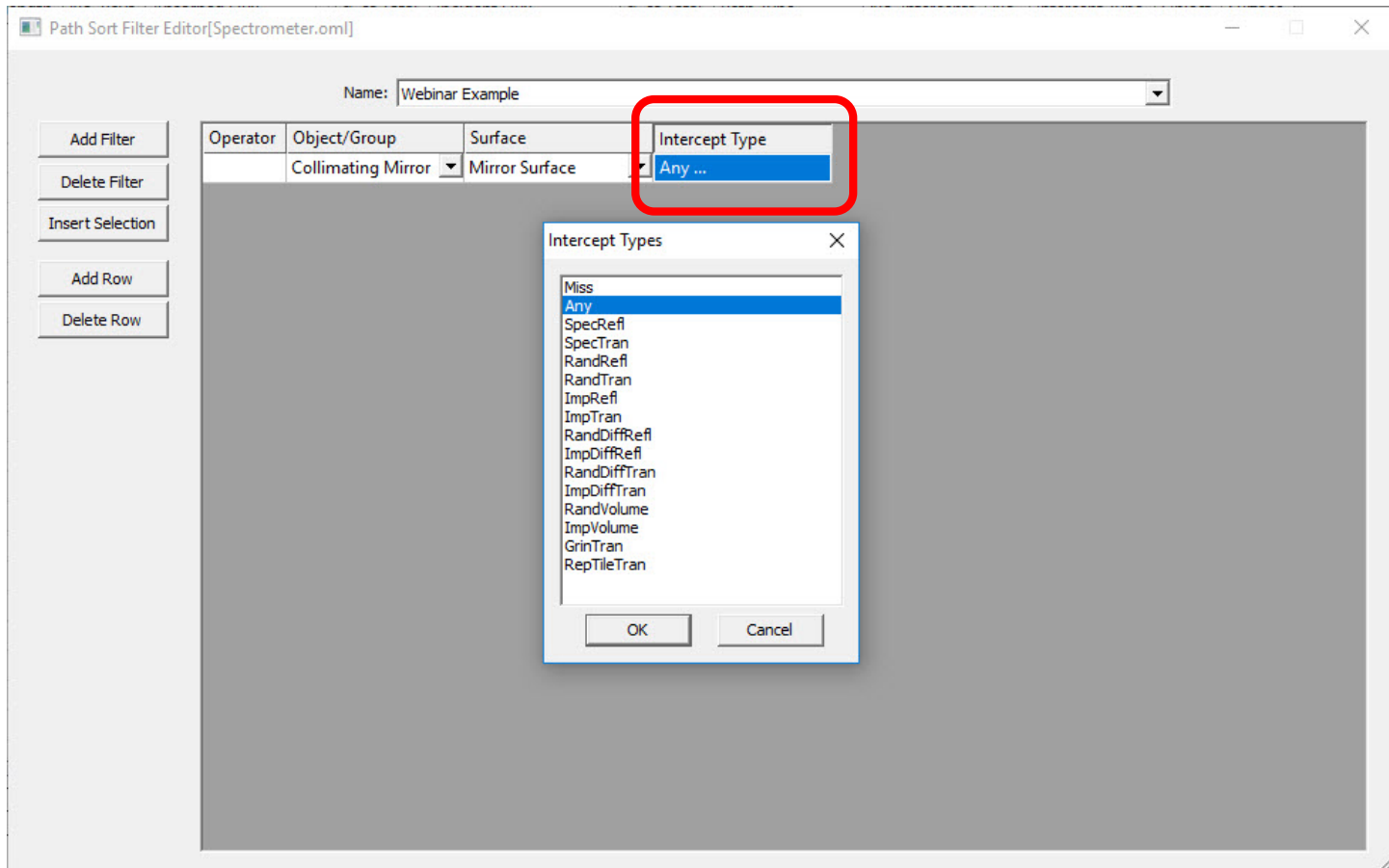
# Path Sort Filters

The Surface dropdown menu lists the surfaces for the selected Object/Group



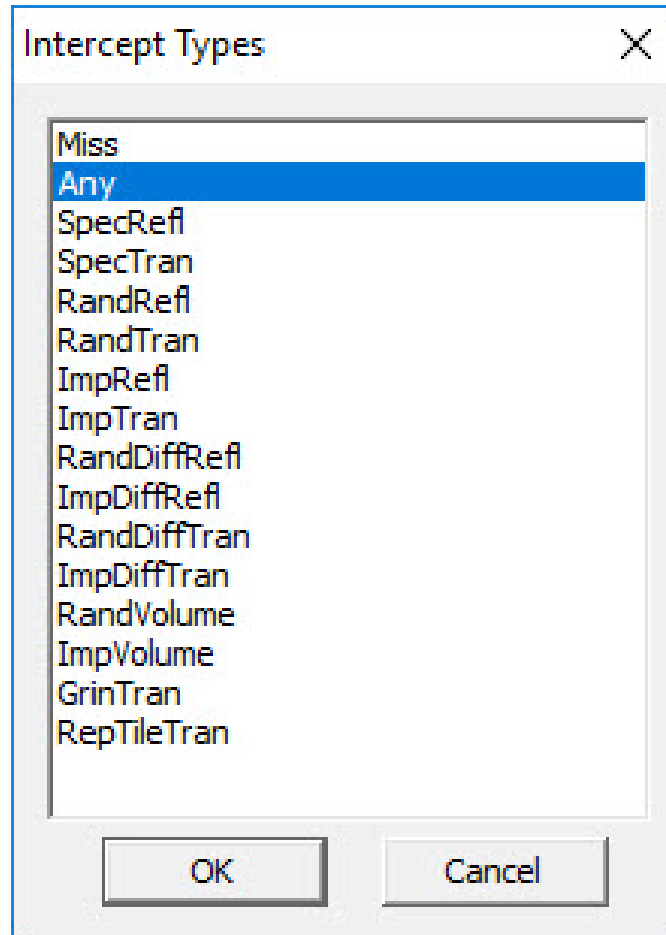
# Path Sort Filters

The Intercept dropdown menu lists the options for the surface intercept/interactions



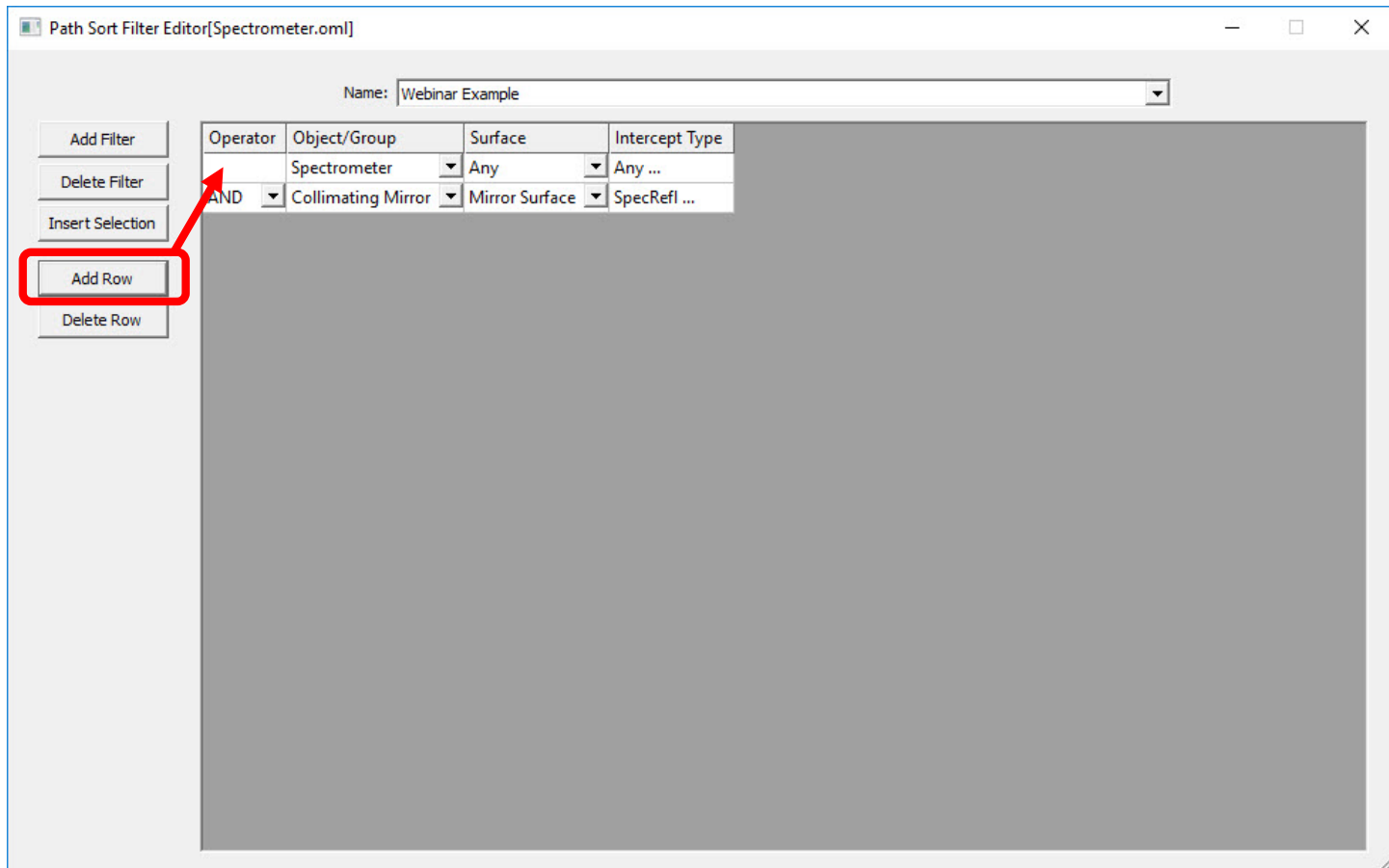
# Path Sort Filters

## Available Intercept Types



# Path Sort Filters

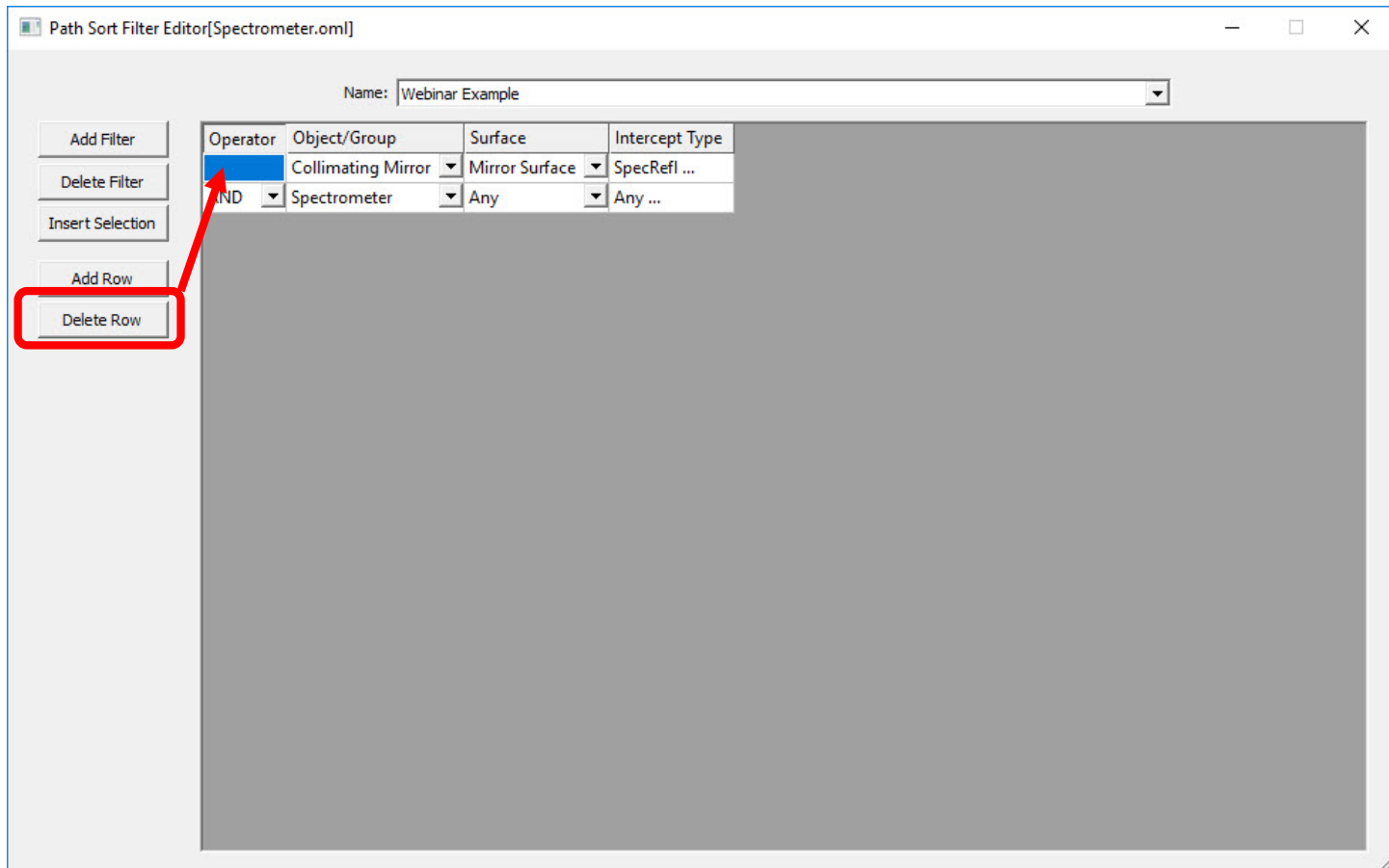
Click Add Row to add a new row to the Filter table





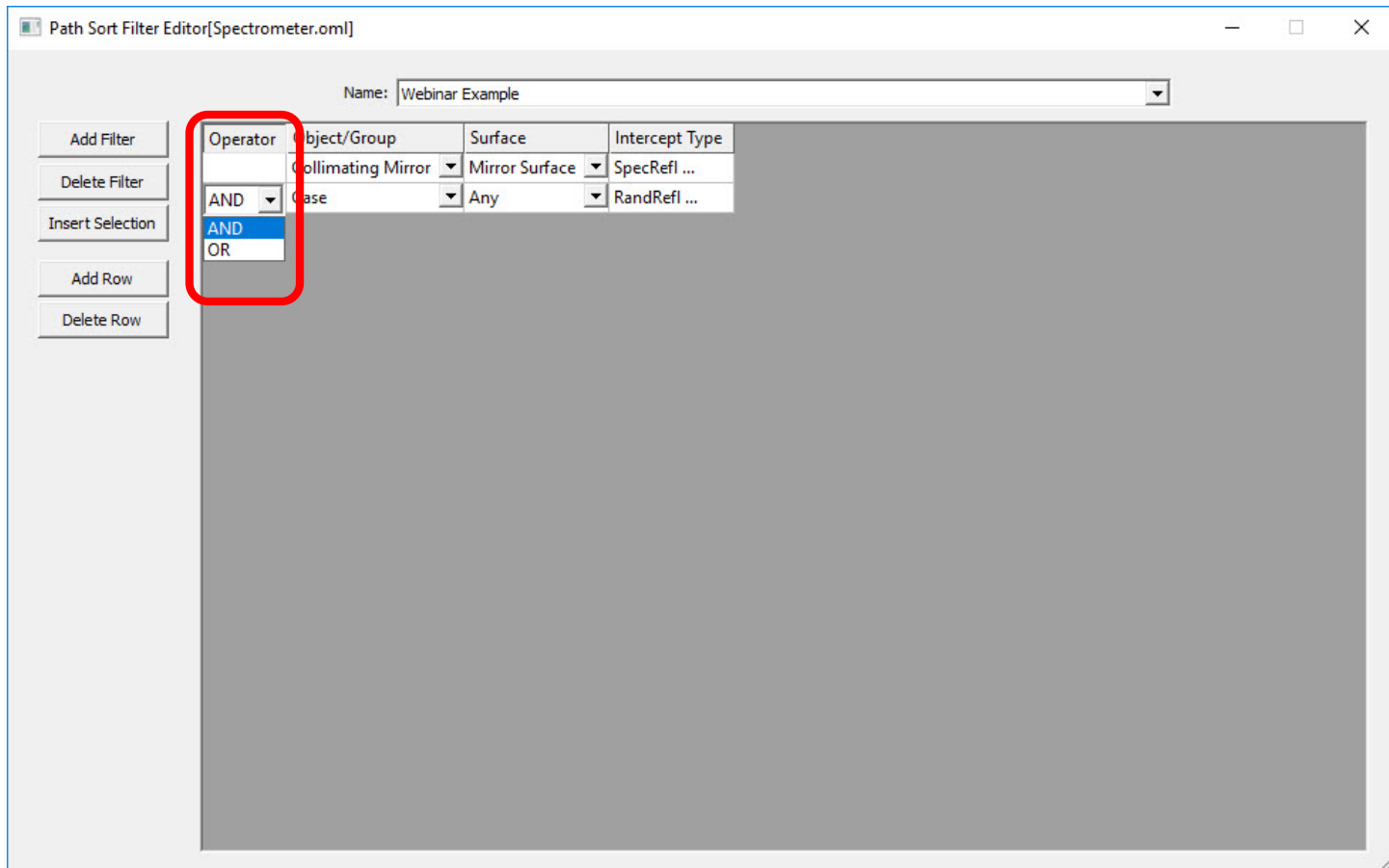
# Path Sort Filters

To delete a row, select the row and then click Delete Row



# Path Sort Filters

The available Operators are AND and OR



# Path Sort Filters

The following filter example will show the ray paths that have a Specular Reflection from the Mirror Surface of the Collimating Mirror and a Random Reflection from any surface of the Case

Path Sort Filter Editor[Spectrometer.oml]

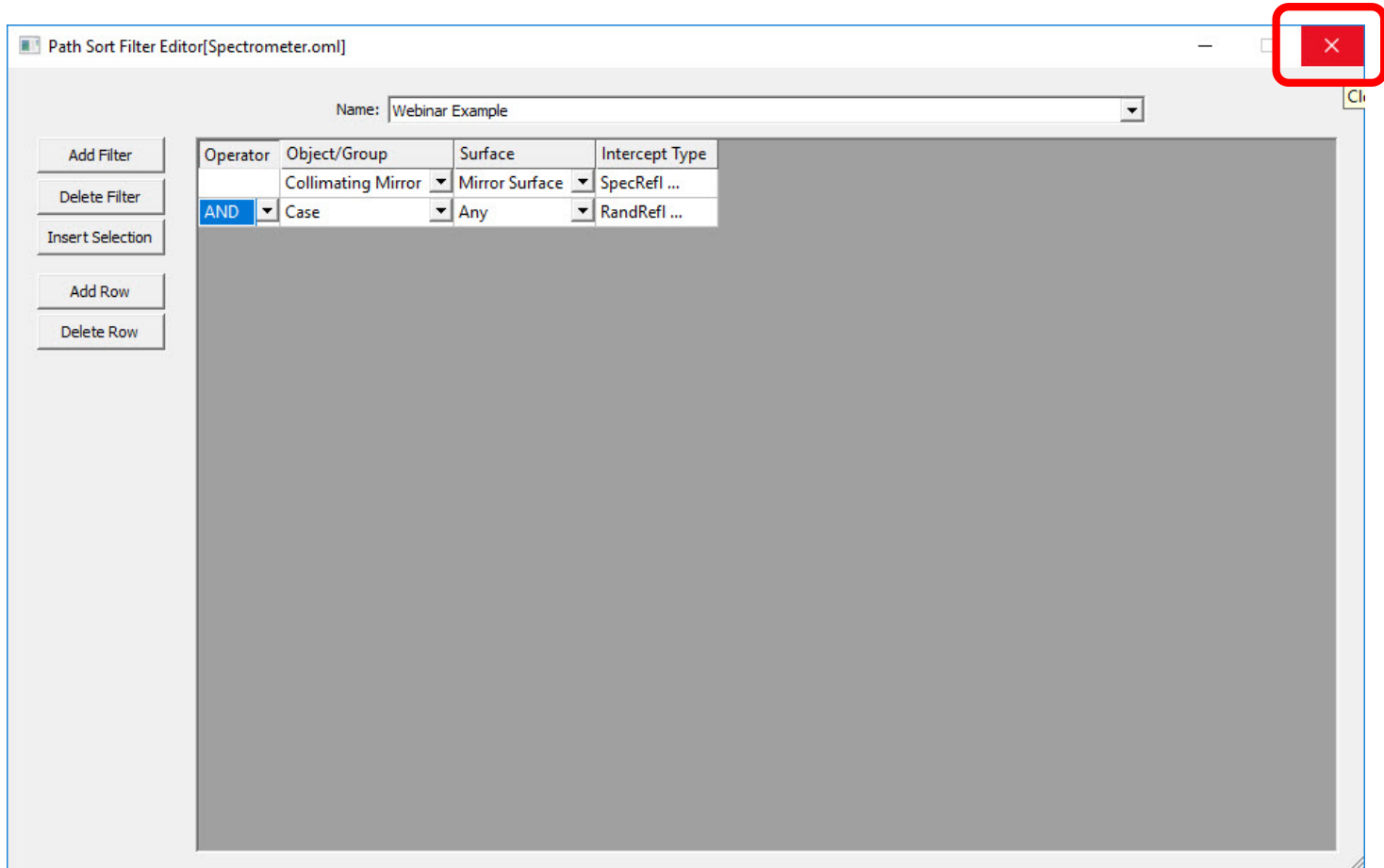
Name: Webinar Example

Operator	Object/Group	Surface	Intercept Type
	Collimating Mirror	Mirror Surface	SpecRefl ...
AND	Case	Any	RandRefl ...

Buttons: Add Filter, Delete Filter, Insert Selection, Add Row, Delete Row

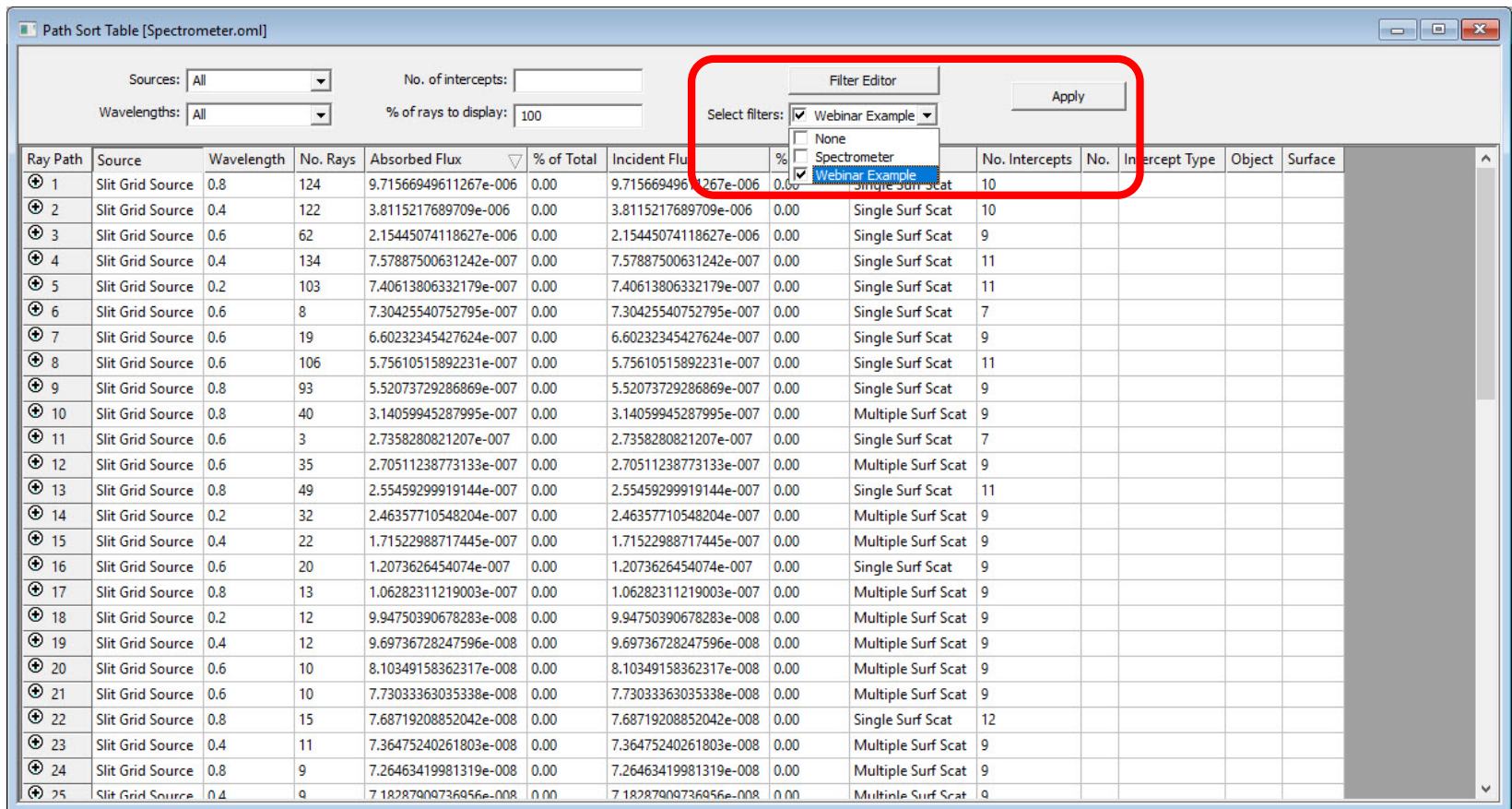
# Path Sort Filters

Click the X in the upper right corner to save the filter and close the Path Sort Filter Editor



# Path Sort Filters

Path Sort Filters are saved with the TracePro model



Path Sort Table [Spectrometer.omt]

Sources: All No. of intercepts: Wavelengths: All % of rays to display: 100

Filter Editor

Select filters: ☒ Webinar Example ☐ None ☐ Spectrometer ☒ Webinar Example

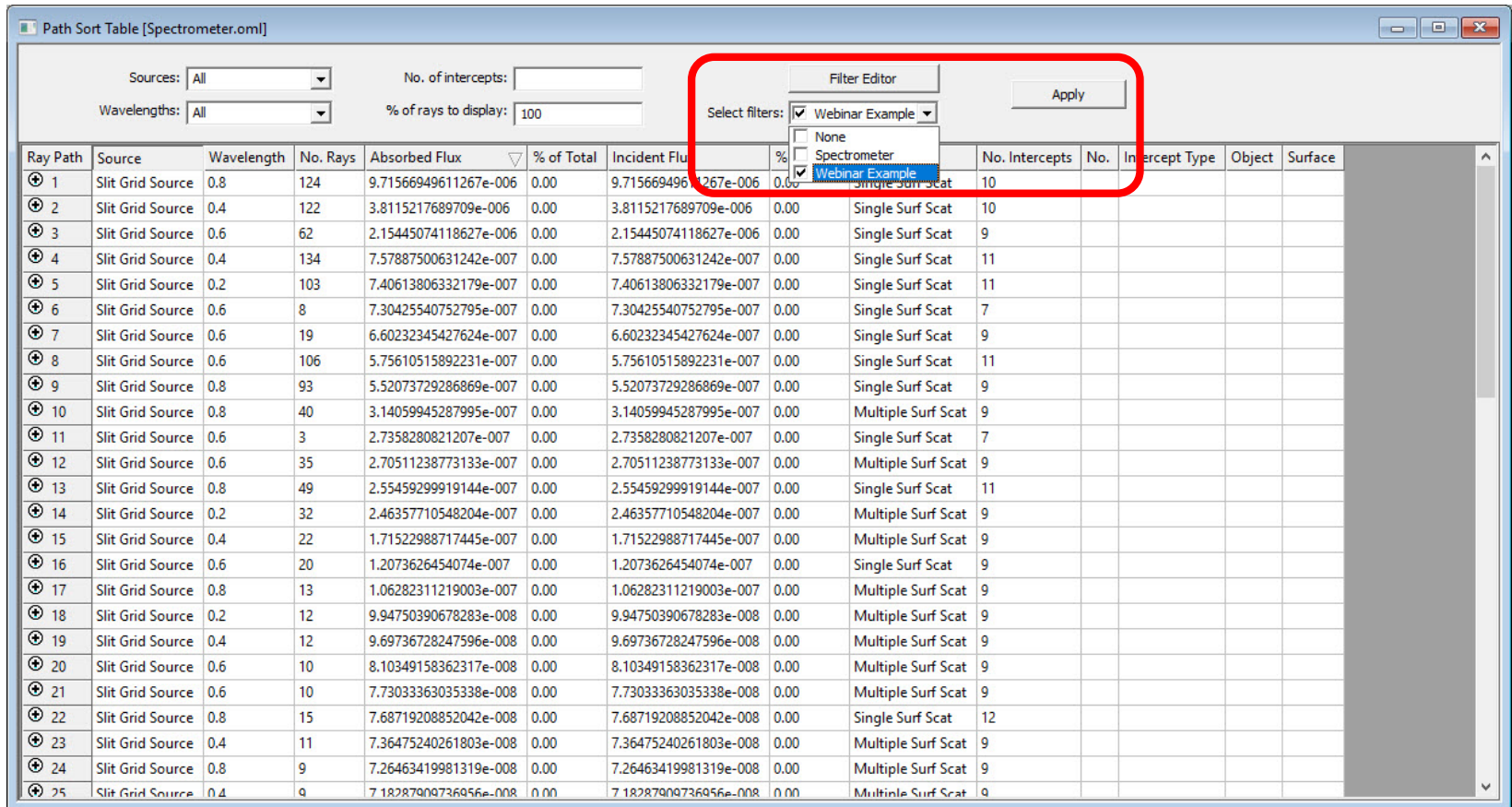
Apply

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	%	Intercept Type	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.8	124	9.71566949611267e-006	0.00	9.71566949611267e-006	0.00	Single Surf Scat	10				
2	Slit Grid Source	0.4	122	3.8115217689709e-006	0.00	3.8115217689709e-006	0.00	Single Surf Scat	9				
3	Slit Grid Source	0.6	62	2.15445074118627e-006	0.00	2.15445074118627e-006	0.00	Single Surf Scat	9				
4	Slit Grid Source	0.4	134	7.57887500631242e-007	0.00	7.57887500631242e-007	0.00	Single Surf Scat	11				
5	Slit Grid Source	0.2	103	7.40613806332179e-007	0.00	7.40613806332179e-007	0.00	Single Surf Scat	11				
6	Slit Grid Source	0.6	8	7.30425540752795e-007	0.00	7.30425540752795e-007	0.00	Single Surf Scat	7				
7	Slit Grid Source	0.6	19	6.60232345427624e-007	0.00	6.60232345427624e-007	0.00	Single Surf Scat	9				
8	Slit Grid Source	0.6	106	5.75610515892231e-007	0.00	5.75610515892231e-007	0.00	Single Surf Scat	11				
9	Slit Grid Source	0.8	93	5.52073729286869e-007	0.00	5.52073729286869e-007	0.00	Single Surf Scat	9				
10	Slit Grid Source	0.8	40	3.14059945287995e-007	0.00	3.14059945287995e-007	0.00	Multiple Surf Scat	9				
11	Slit Grid Source	0.6	3	2.7358280821207e-007	0.00	2.7358280821207e-007	0.00	Single Surf Scat	7				
12	Slit Grid Source	0.6	35	2.70511238773133e-007	0.00	2.70511238773133e-007	0.00	Multiple Surf Scat	9				
13	Slit Grid Source	0.8	49	2.55459299919144e-007	0.00	2.55459299919144e-007	0.00	Single Surf Scat	11				
14	Slit Grid Source	0.2	32	2.46357710548204e-007	0.00	2.46357710548204e-007	0.00	Multiple Surf Scat	9				
15	Slit Grid Source	0.4	22	1.71522988717445e-007	0.00	1.71522988717445e-007	0.00	Multiple Surf Scat	9				
16	Slit Grid Source	0.6	20	1.2073626454074e-007	0.00	1.2073626454074e-007	0.00	Single Surf Scat	9				
17	Slit Grid Source	0.8	13	1.06282311219003e-007	0.00	1.06282311219003e-007	0.00	Multiple Surf Scat	9				
18	Slit Grid Source	0.2	12	9.94750390678283e-008	0.00	9.94750390678283e-008	0.00	Multiple Surf Scat	9				
19	Slit Grid Source	0.4	12	9.69736728247596e-008	0.00	9.69736728247596e-008	0.00	Multiple Surf Scat	9				
20	Slit Grid Source	0.6	10	8.10349158362317e-008	0.00	8.10349158362317e-008	0.00	Multiple Surf Scat	9				
21	Slit Grid Source	0.6	10	7.73033363035338e-008	0.00	7.73033363035338e-008	0.00	Multiple Surf Scat	9				
22	Slit Grid Source	0.8	15	7.68719208852042e-008	0.00	7.68719208852042e-008	0.00	Single Surf Scat	12				
23	Slit Grid Source	0.4	11	7.36475240261803e-008	0.00	7.36475240261803e-008	0.00	Multiple Surf Scat	9				
24	Slit Grid Source	0.8	9	7.26463419981319e-008	0.00	7.26463419981319e-008	0.00	Multiple Surf Scat	9				
25	Slit Grid Source	0.4	9	7.18287909736956e-008	0.00	7.18287909736956e-008	0.00	Multiple Surf Scat	9				



# Path Sort Filters

Select the new Filter in the Select Filters dropdown menu and then click Apply to apply the filter to the Path Sort Table



Path Sort Table [Spectrometer.oml]

Sources: All No. of intercepts: Wavelengths: All % of rays to display: 100

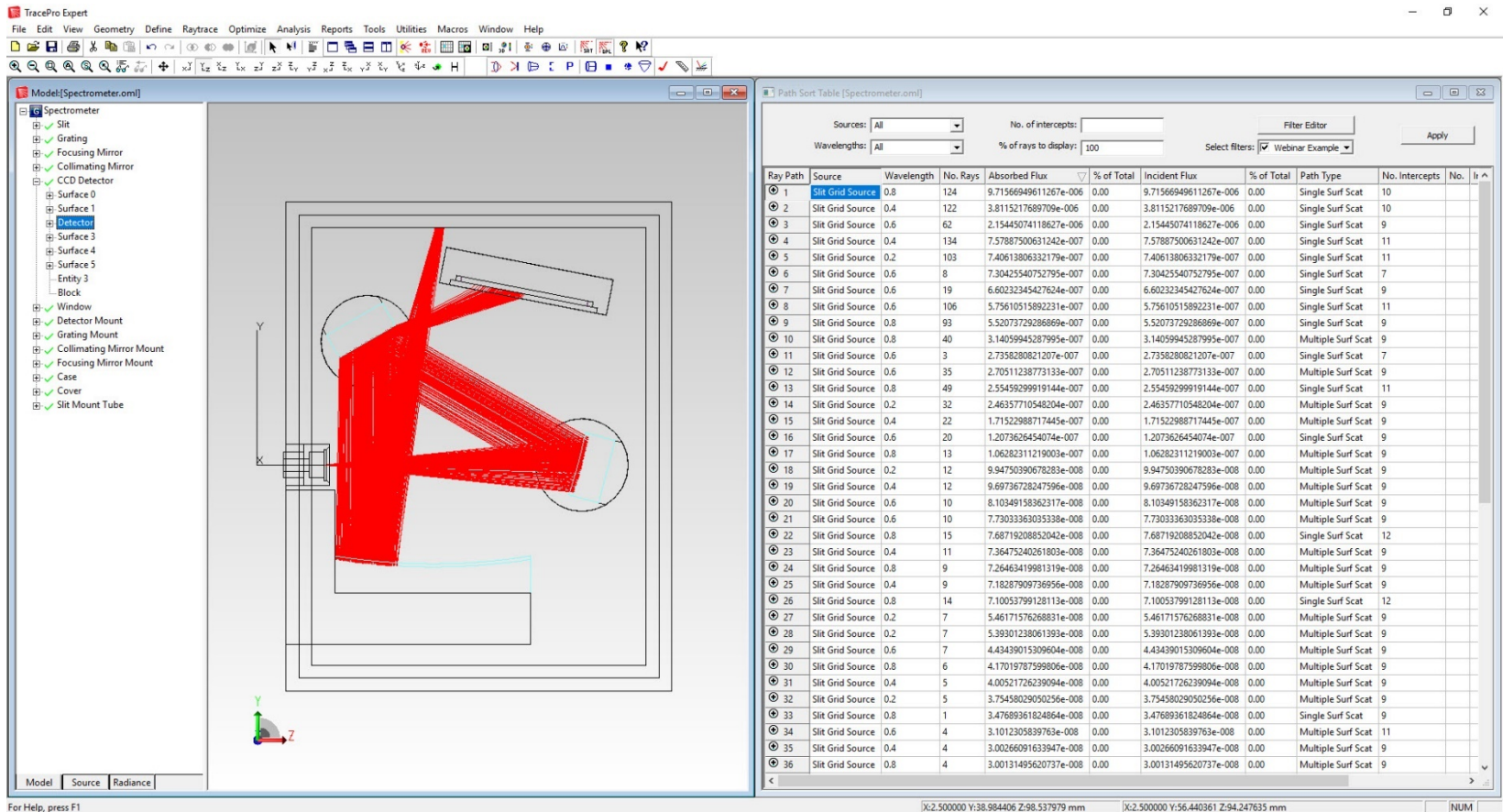
Select filters: ☒ Webinar Example ☐ None ☐ Spectrometer ☒ Webinar Example

Filter Editor Apply

Ray Path	Source	Wavelength	No. Rays	Absorbed Flux	% of Total	Incident Flux	%	No. Intercepts	No.	Intercept Type	Object	Surface
1	Slit Grid Source	0.8	124	9.71566949611267e-006	0.00	9.71566949611267e-006	0.00	10				
2	Slit Grid Source	0.4	122	3.8115217689709e-006	0.00	3.8115217689709e-006	0.00	10				
3	Slit Grid Source	0.6	62	2.15445074118627e-006	0.00	2.15445074118627e-006	0.00	9				
4	Slit Grid Source	0.4	134	7.57887500631242e-007	0.00	7.57887500631242e-007	0.00	11				
5	Slit Grid Source	0.2	103	7.40613806332179e-007	0.00	7.40613806332179e-007	0.00	11				
6	Slit Grid Source	0.6	8	7.30425540752795e-007	0.00	7.30425540752795e-007	0.00	7				
7	Slit Grid Source	0.6	19	6.60232345427624e-007	0.00	6.60232345427624e-007	0.00	9				
8	Slit Grid Source	0.6	106	5.75610515892231e-007	0.00	5.75610515892231e-007	0.00	11				
9	Slit Grid Source	0.8	93	5.52073729286869e-007	0.00	5.52073729286869e-007	0.00	9				
10	Slit Grid Source	0.8	40	3.14059945287995e-007	0.00	3.14059945287995e-007	0.00	9				
11	Slit Grid Source	0.6	3	2.7358280821207e-007	0.00	2.7358280821207e-007	0.00	7				
12	Slit Grid Source	0.6	35	2.70511238773133e-007	0.00	2.70511238773133e-007	0.00	9				
13	Slit Grid Source	0.8	49	2.55459299919144e-007	0.00	2.55459299919144e-007	0.00	11				
14	Slit Grid Source	0.2	32	2.46357710548204e-007	0.00	2.46357710548204e-007	0.00	9				
15	Slit Grid Source	0.4	22	1.71522988717445e-007	0.00	1.71522988717445e-007	0.00	9				
16	Slit Grid Source	0.6	20	1.2073626454074e-007	0.00	1.2073626454074e-007	0.00	9				
17	Slit Grid Source	0.8	13	1.06282311219003e-007	0.00	1.06282311219003e-007	0.00	9				
18	Slit Grid Source	0.2	12	9.94750390678283e-008	0.00	9.94750390678283e-008	0.00	9				
19	Slit Grid Source	0.4	12	9.69736728247596e-008	0.00	9.69736728247596e-008	0.00	9				
20	Slit Grid Source	0.6	10	8.10349158362317e-008	0.00	8.10349158362317e-008	0.00	9				
21	Slit Grid Source	0.6	10	7.73033363035338e-008	0.00	7.73033363035338e-008	0.00	9				
22	Slit Grid Source	0.8	15	7.68719208852042e-008	0.00	7.68719208852042e-008	0.00	12				
23	Slit Grid Source	0.4	11	7.36475240261803e-008	0.00	7.36475240261803e-008	0.00	9				
24	Slit Grid Source	0.8	9	7.26463419981319e-008	0.00	7.26463419981319e-008	0.00	9				
25	Slit Grid Source	0.4	9	7.18287909736956e-008	0.00	7.18287909736956e-008	0.00	9				

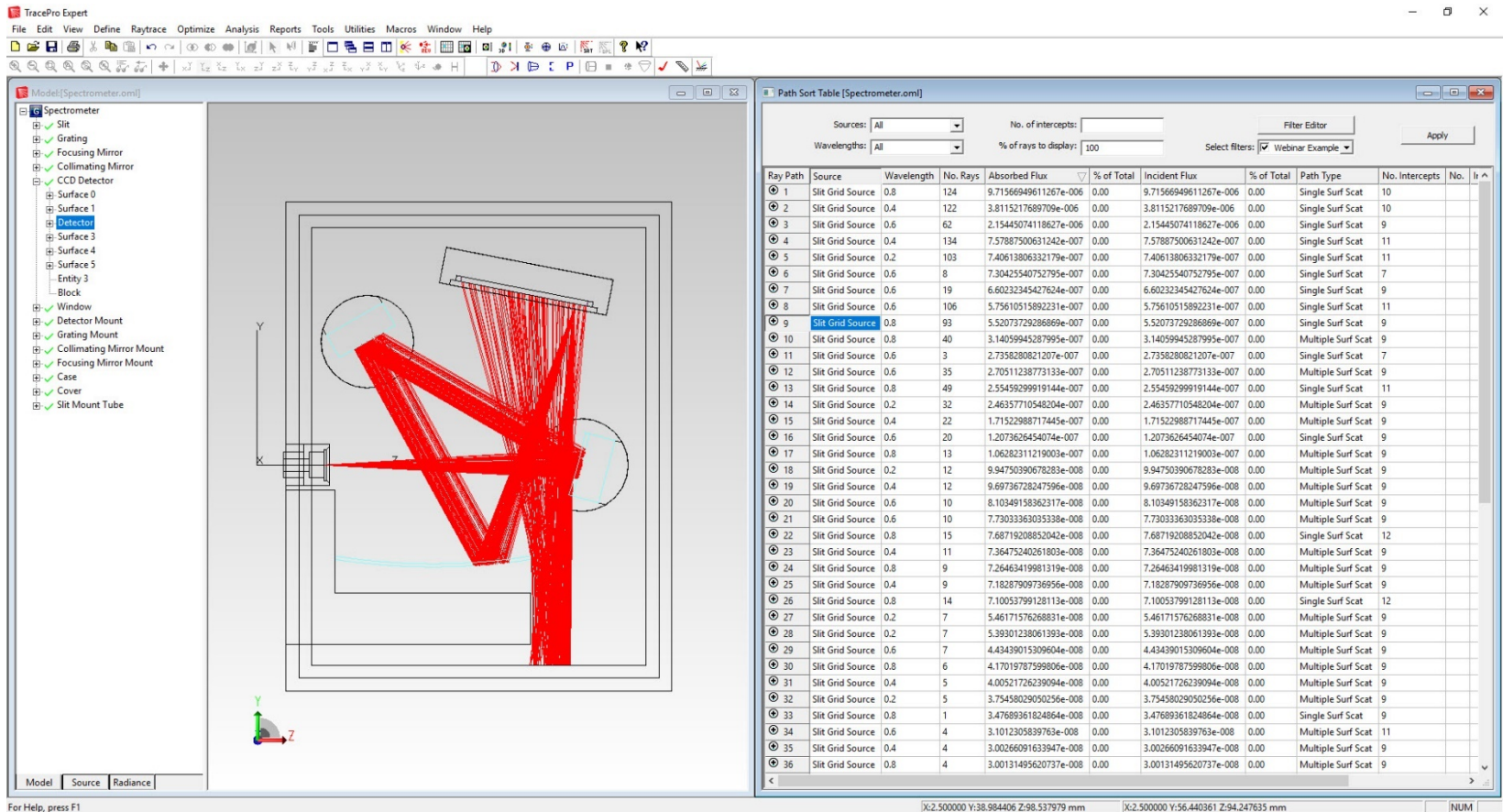
# Path Sort Filters

## Example paths from the filtered Path Sort Table



# Path Sort Filters

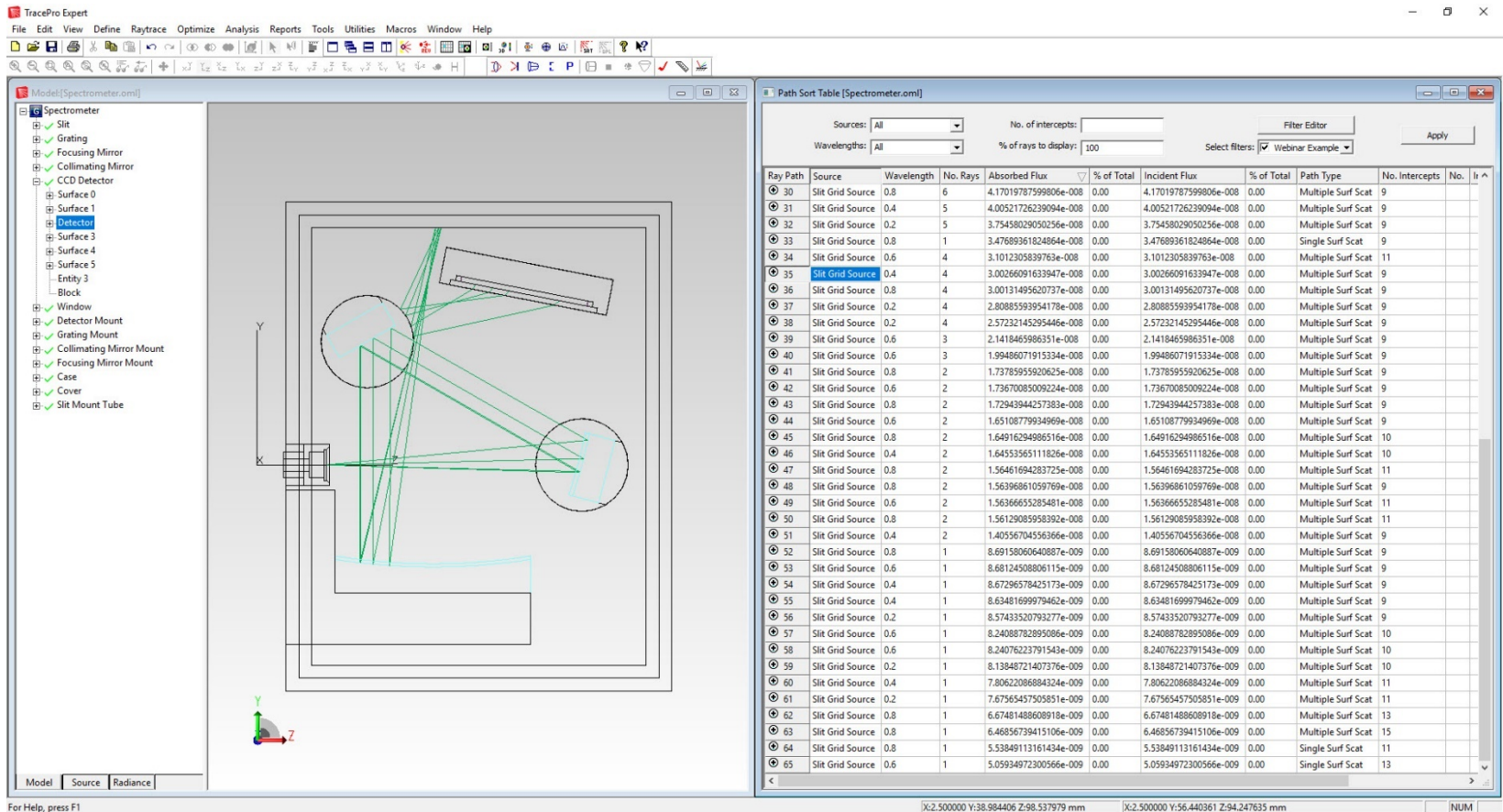
## Example paths from the filtered Path Sort Table





# Path Sort Filters

## Example paths from the filtered Path Sort Table



# Path Sort Filters

More complex path filters can be defined – the following filter shows ray paths that have a Specular Reflection from the Collimating Mirror, Grating, Focusing Mirror, and any type of reflection from the Slit.

Path Sort Filter Editor[Spectrometer.oml]

Name: Webinar Example 2

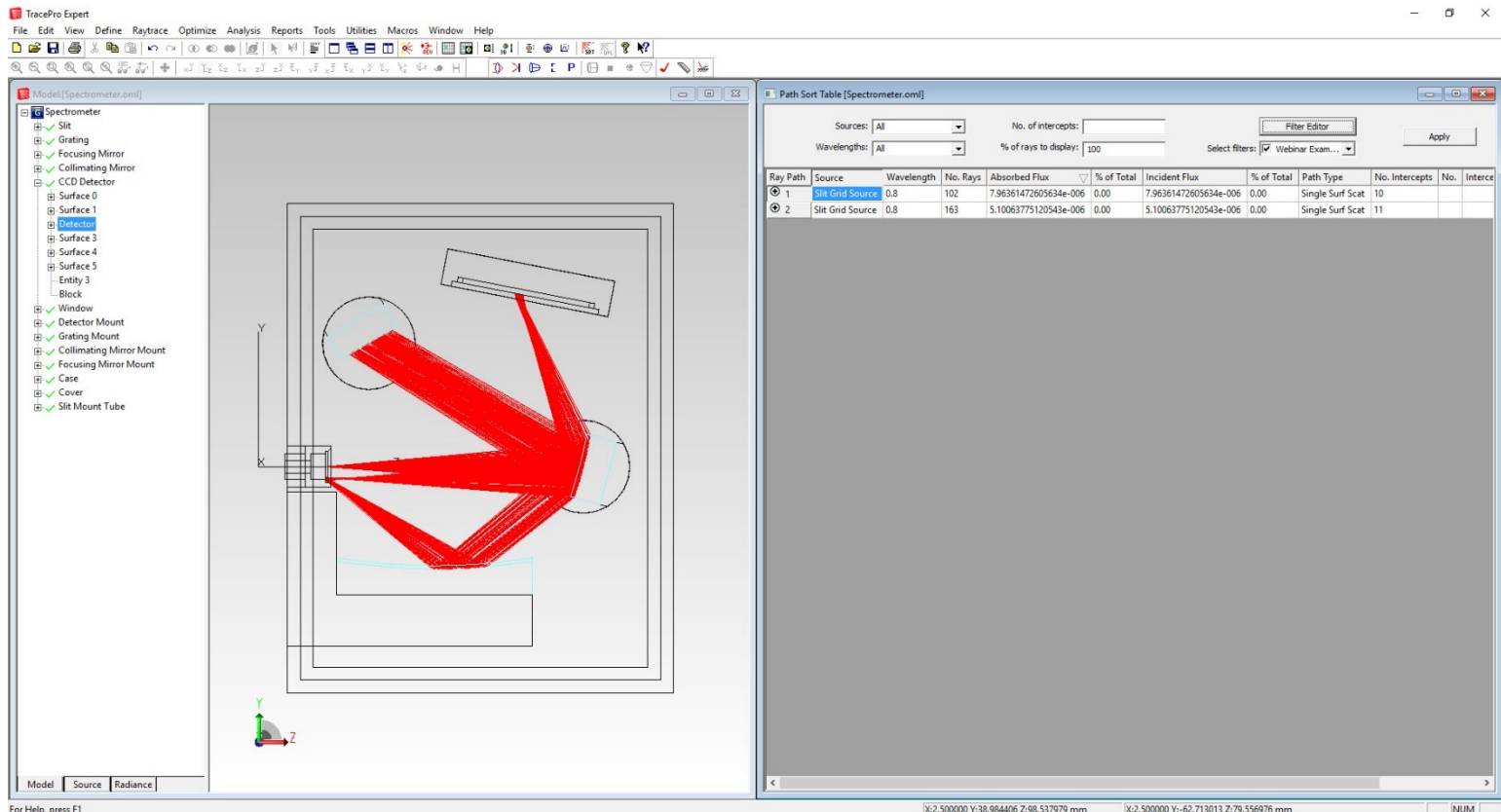
Operator	Object/Group	Surface	Intercept Type
	Collimating Mirror	Mirror Surface	SpecRefl ...
AND	Grating	Grating Surface	SpecRefl ...
AND	Focusing Mirror	Mirror Surface	SpecRefl ...
AND	Slit	Any	Any ...

Buttons: Add Filter, Delete Filter, Insert Selection, Add Row, Delete Row



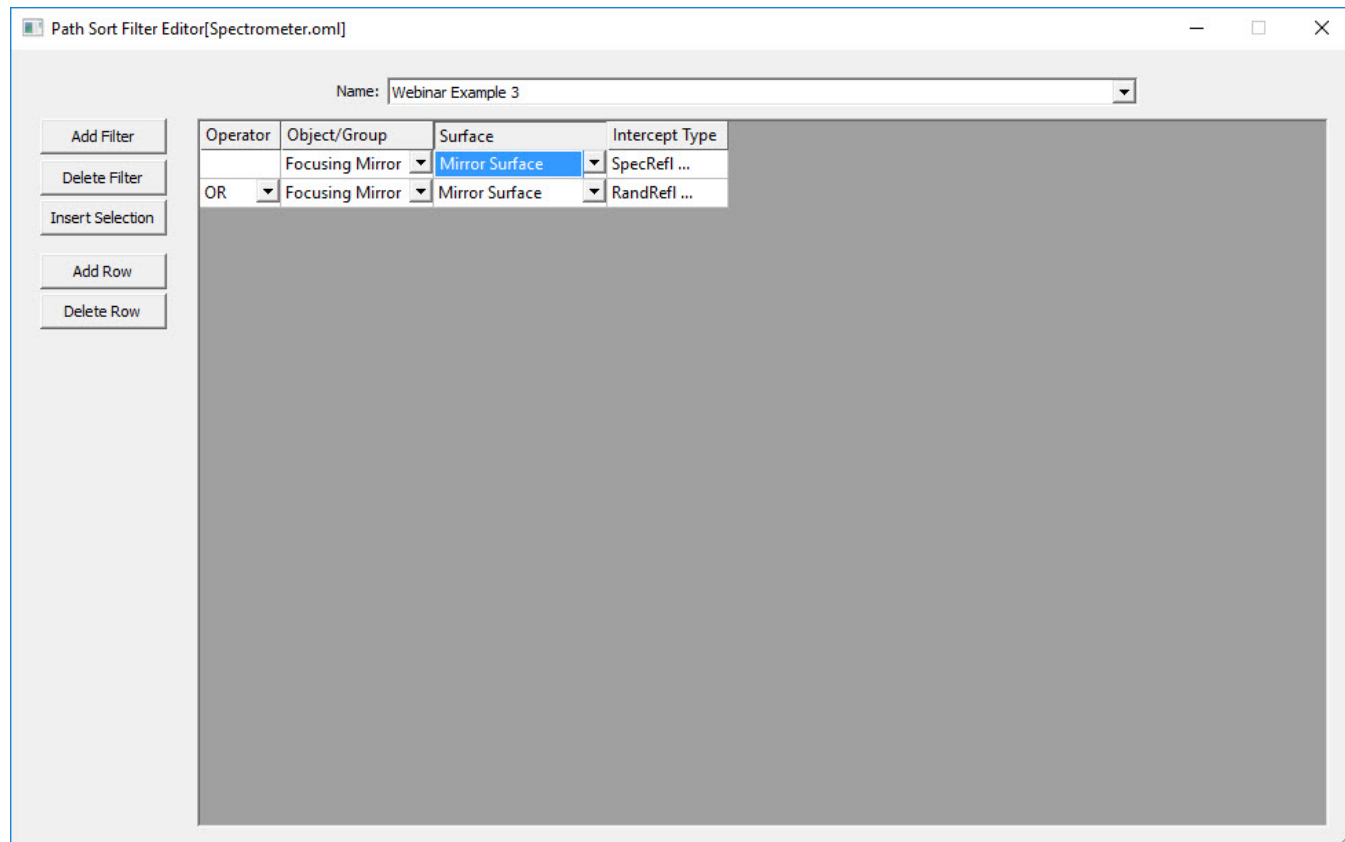
# Path Sort Filters

More complex path filters can be defined – the following filter shows ray paths that have a Specular Reflection from the Collimating Mirror, Grating, Focusing Mirror, and any type of reflection from the Slit.



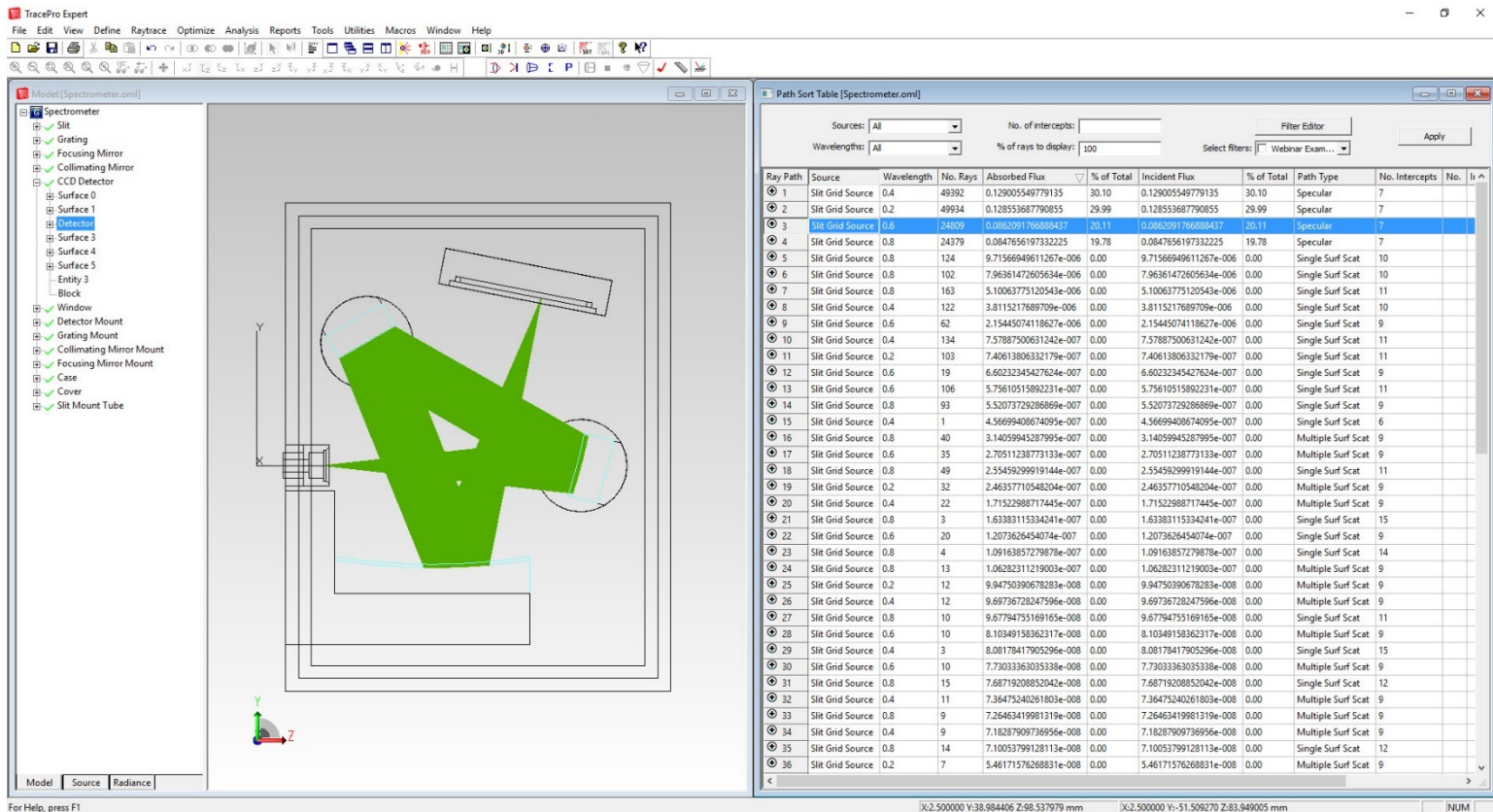
# Path Sort Filters

The following filter shows ray paths that have either a Specular or Random Reflection from the Focusing Mirror



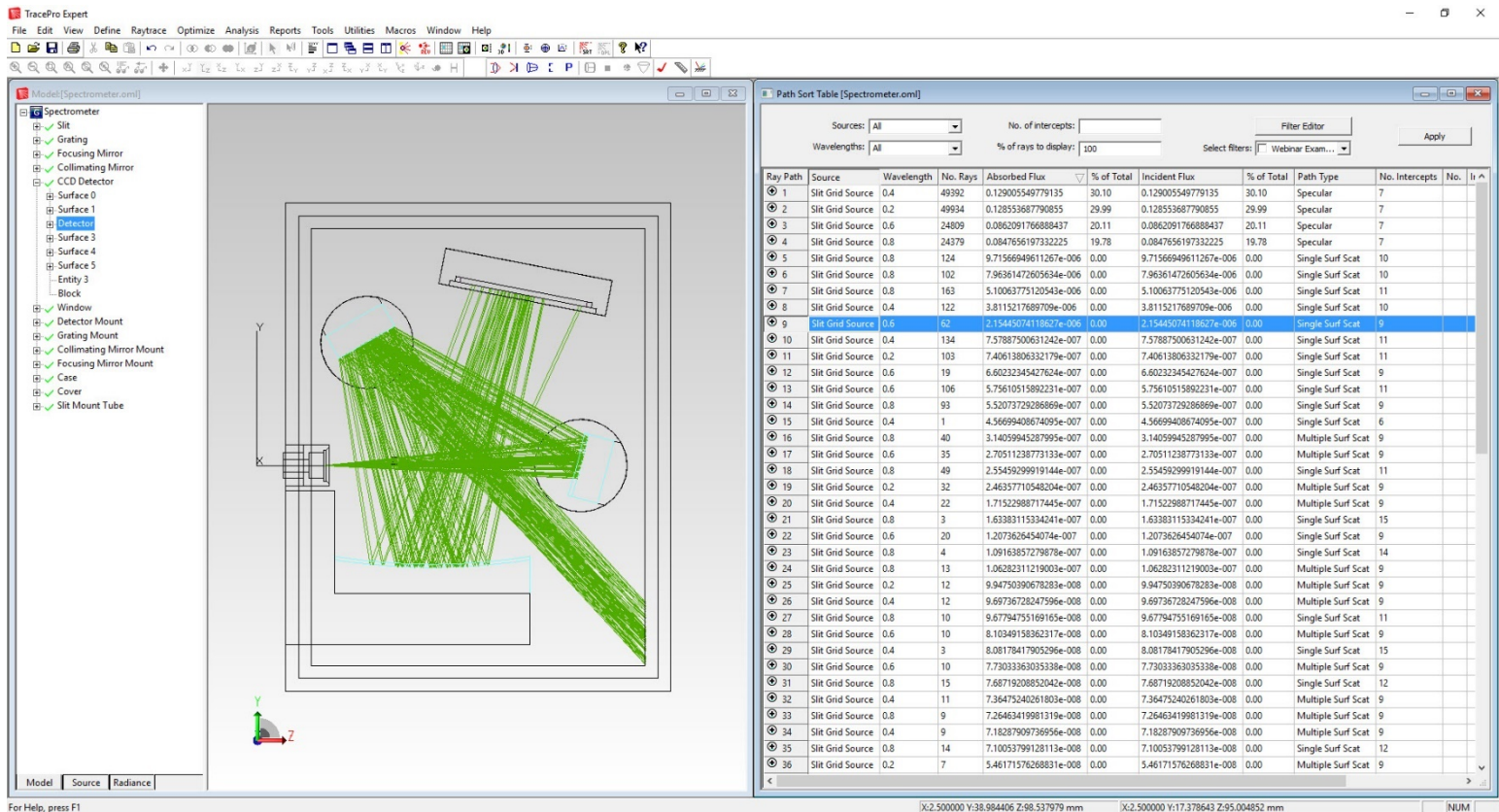
# Path Sort Filters

The following filter shows ray paths that have either a Specular or Random Reflection from the Focusing Mirror

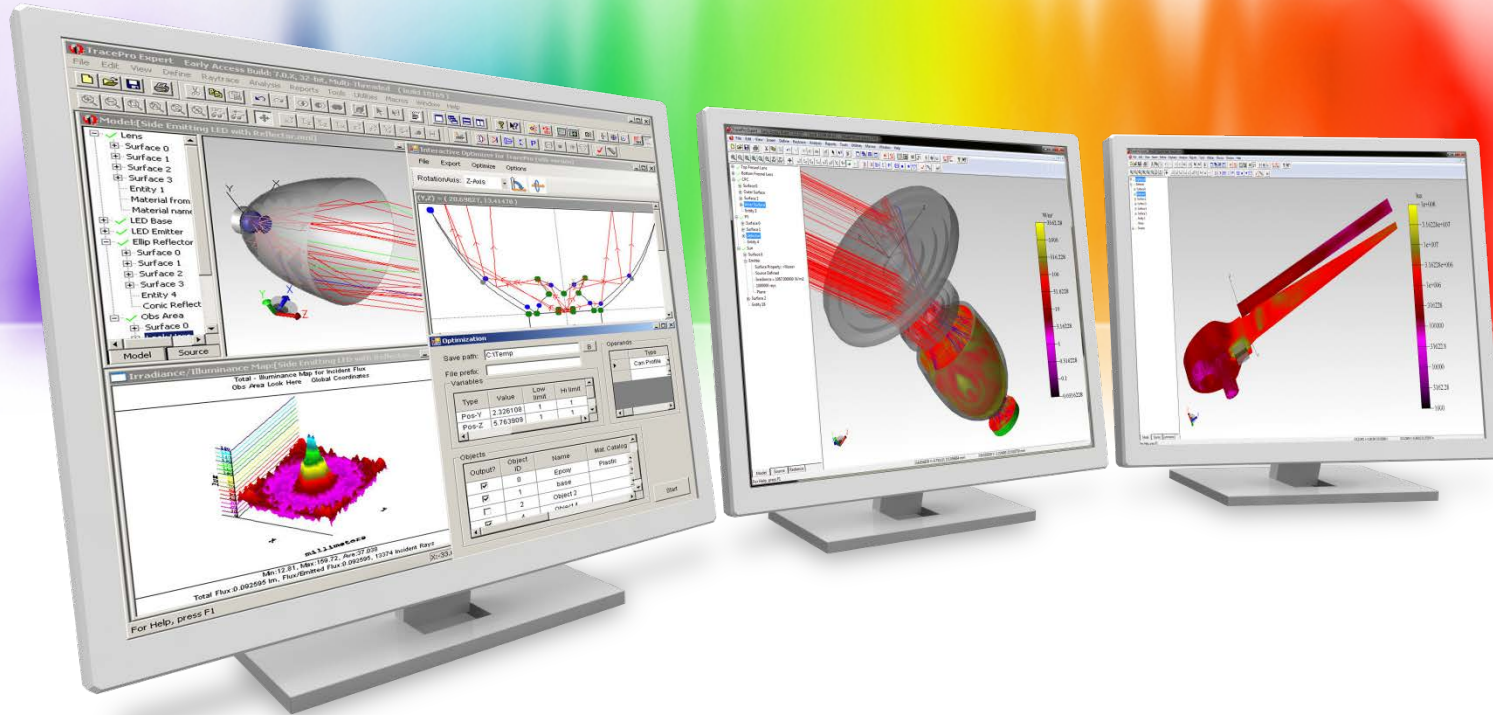


# Path Sort Filters

The following filter shows ray paths that have either a Specular or Random Reflection from the Focusing Mirror







## Ray and Path Sorting Uses

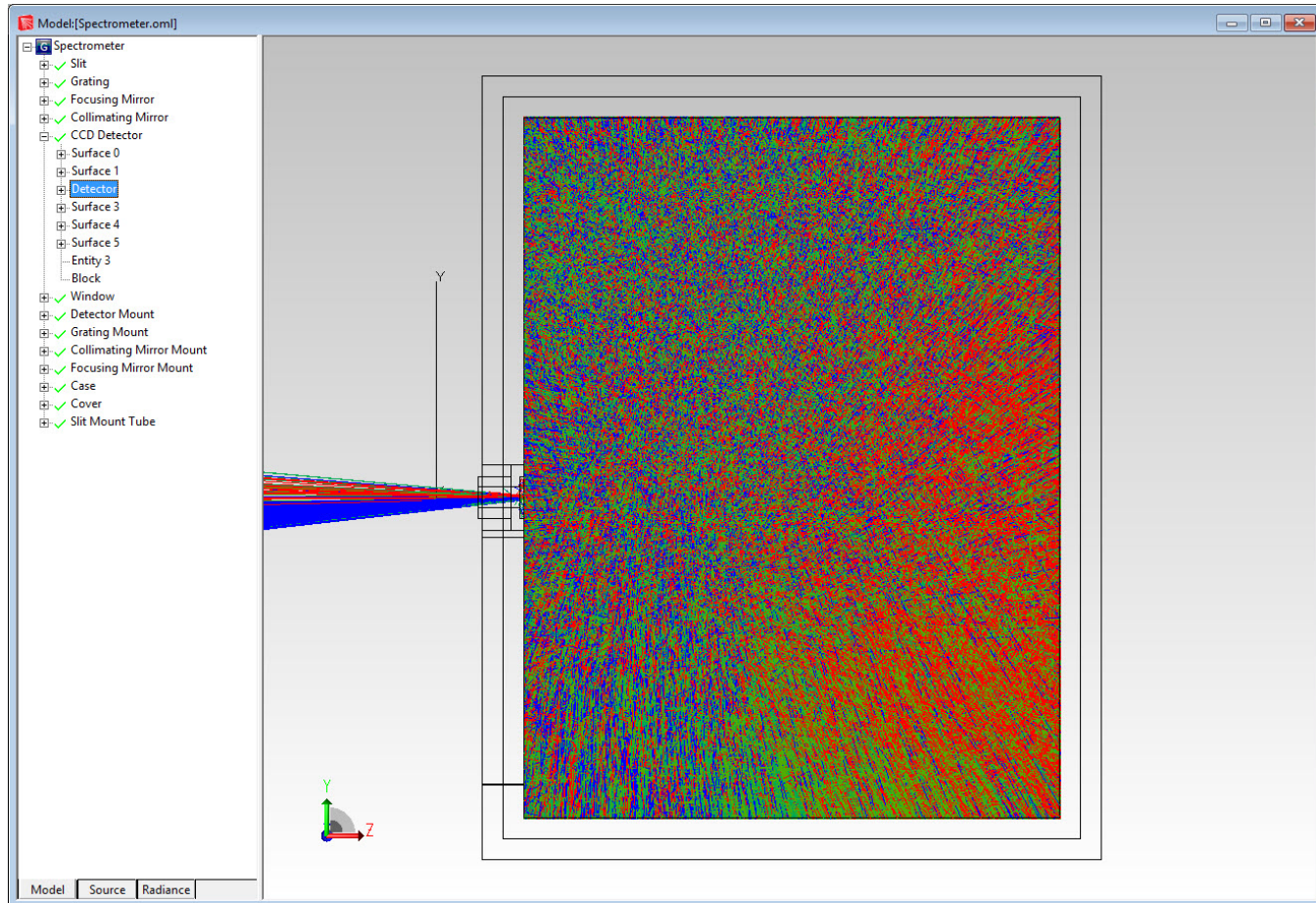


# Ray and Path Sorting Uses

- Simplifying raytrace results
- Reducing number of rays shown on screen
- Identifying anomalous ray paths
- Stray light analysis
- Ray and Path Sorting can also be used with the Irradiance/Illuminance Maps in TracePro

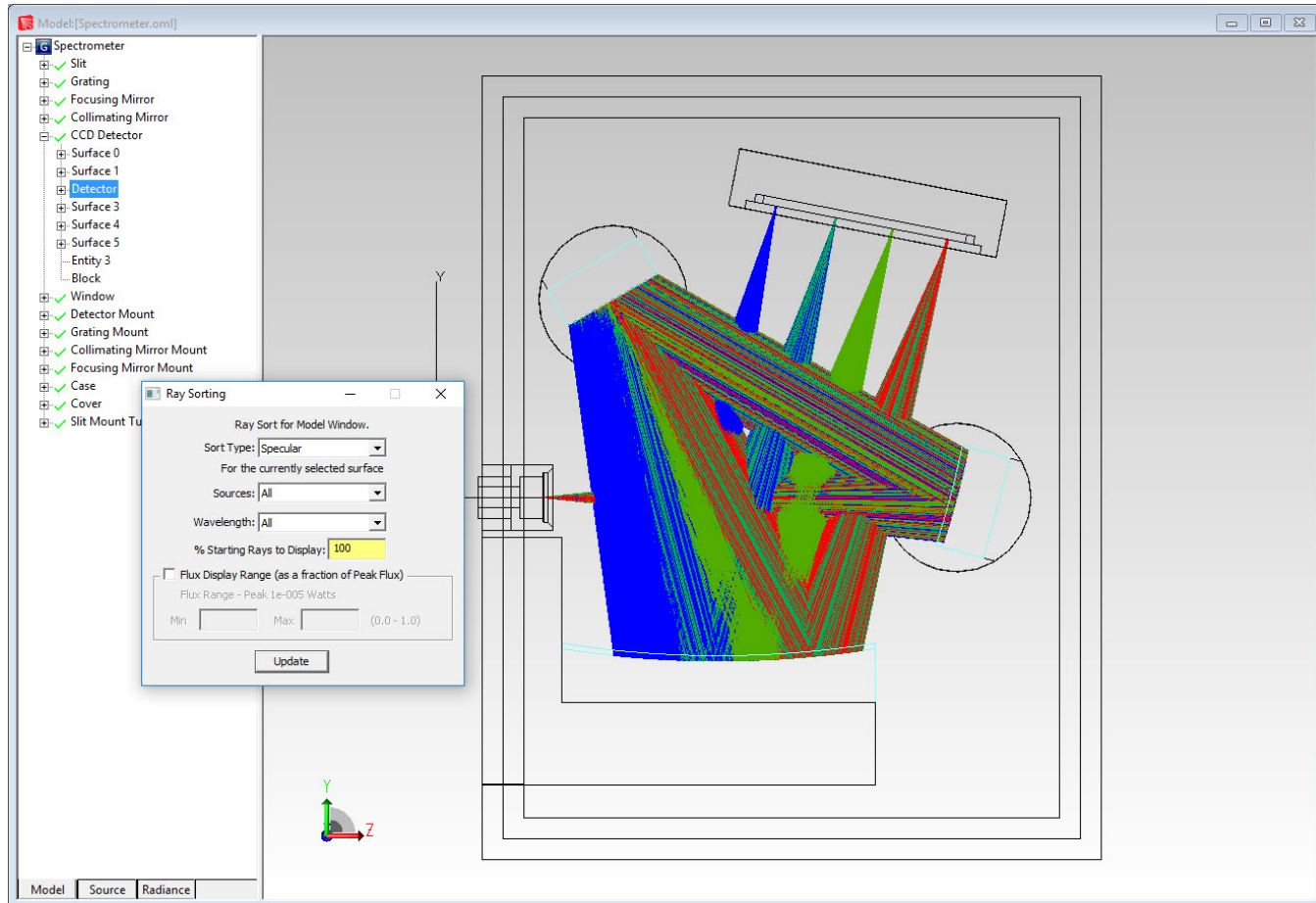
# Ray and Path Sorting Uses

Initial raytrace results – not useable for analysis



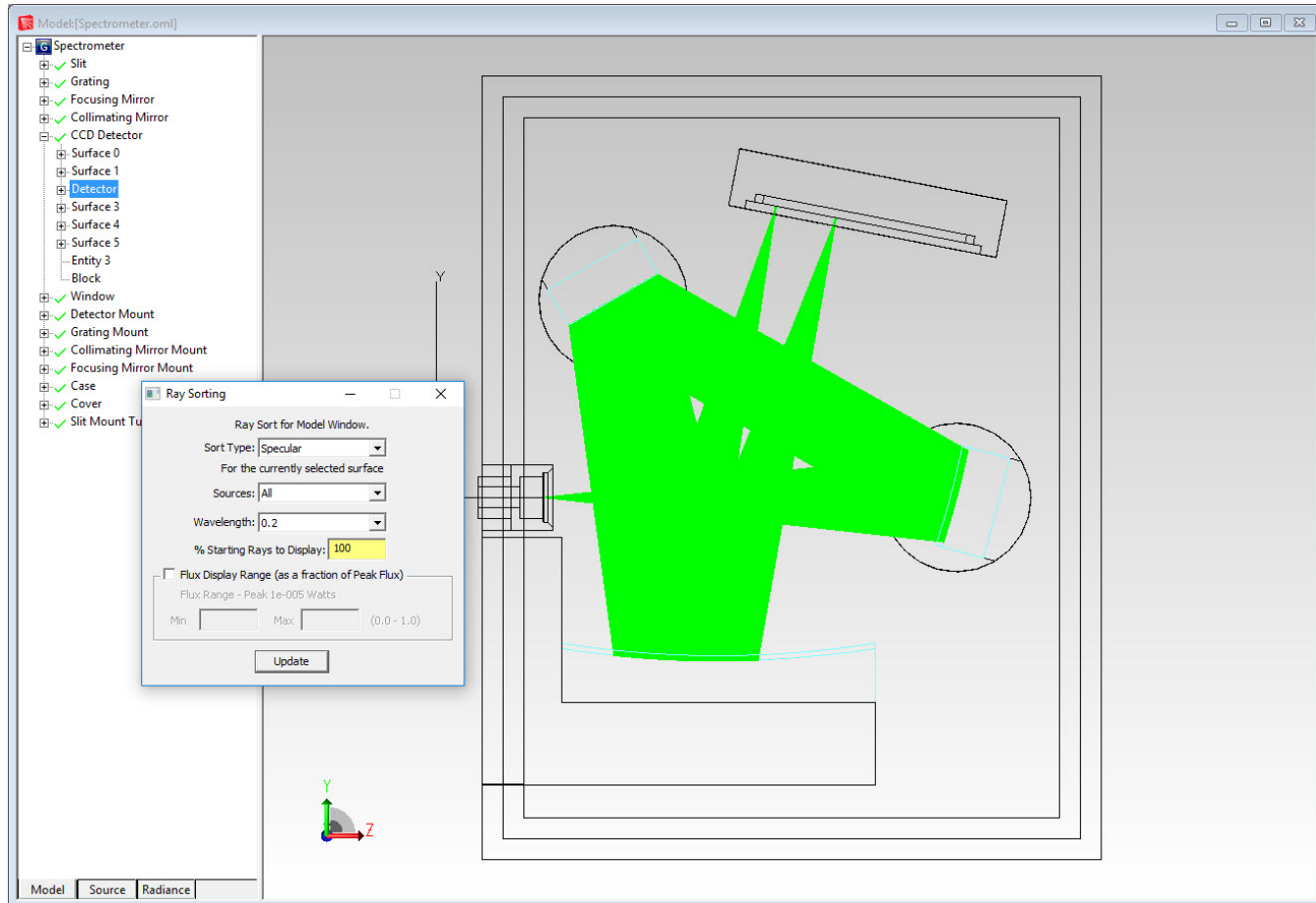
# Ray and Path Sorting Uses

Specular rays shown



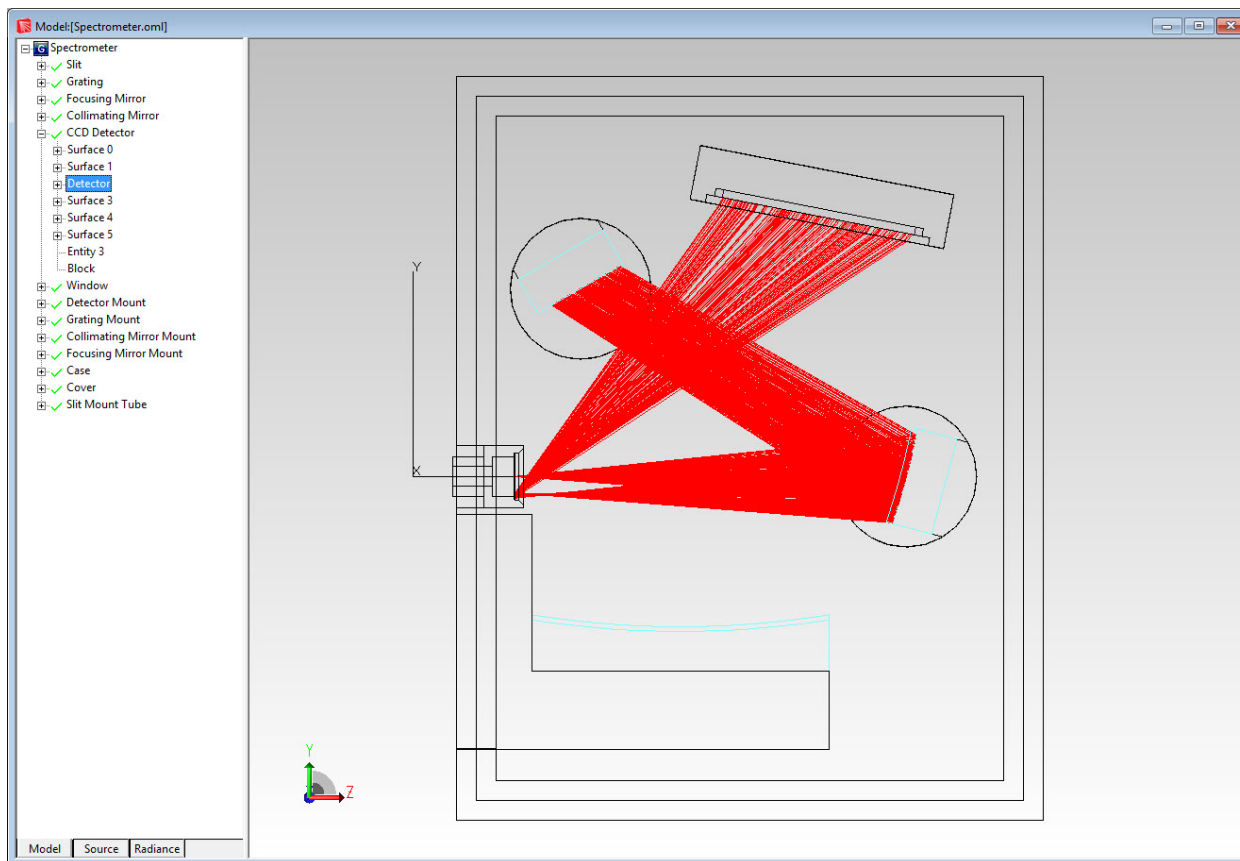
# Ray and Path Sorting Uses

Specular rays with 0.2um wavelength shown



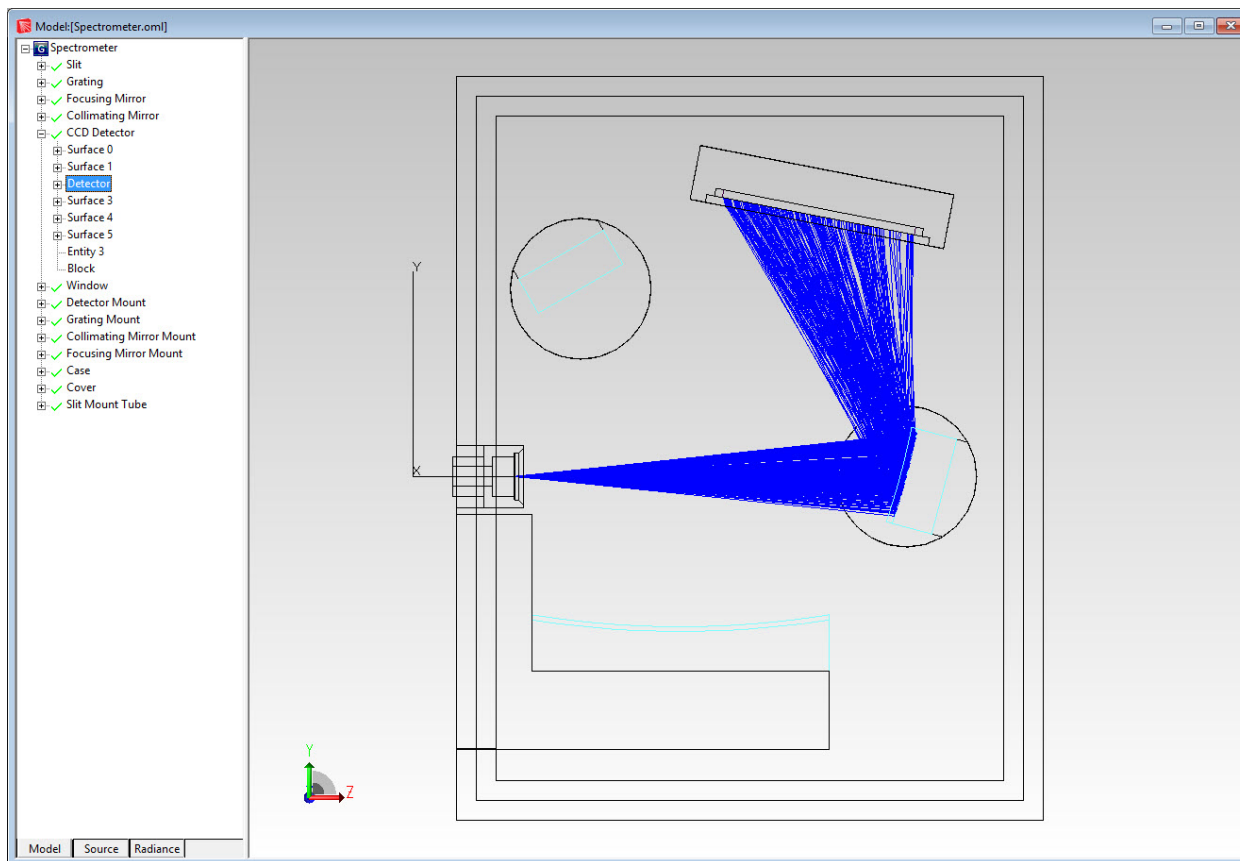
# Ray and Path Sorting Uses

Path Sorting can show anomalous ray paths that may need to be mitigated. This example shows unwanted reflections from the slit.



# Ray and Path Sorting Uses

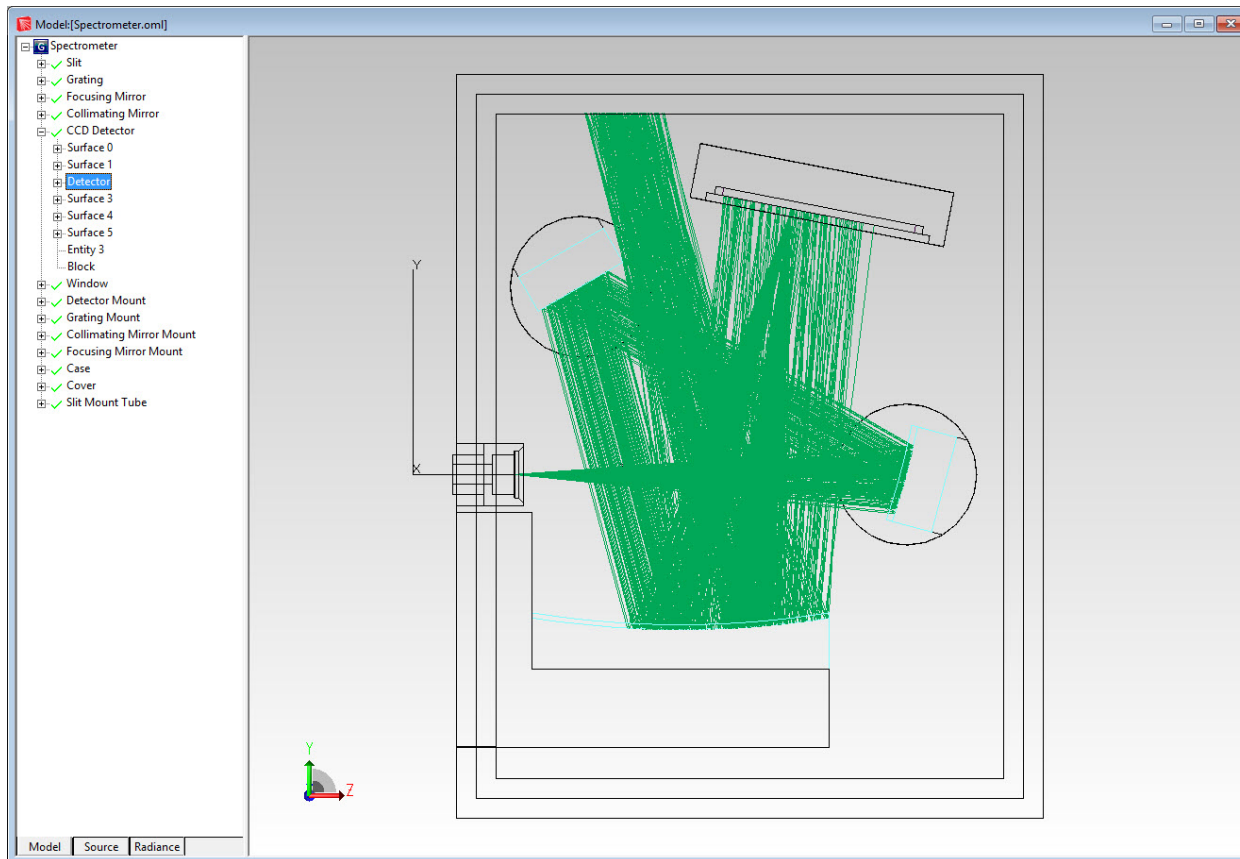
Stray light can be analyzed and evaluated using Path Sorting. The example below shows light scattered to the detector from the collimating mirror.





# Ray and Path Sorting Uses

Stray light can be analyzed and evaluated using Path Sorting. The example below shows light scattered to the detector from the spectrometer case.



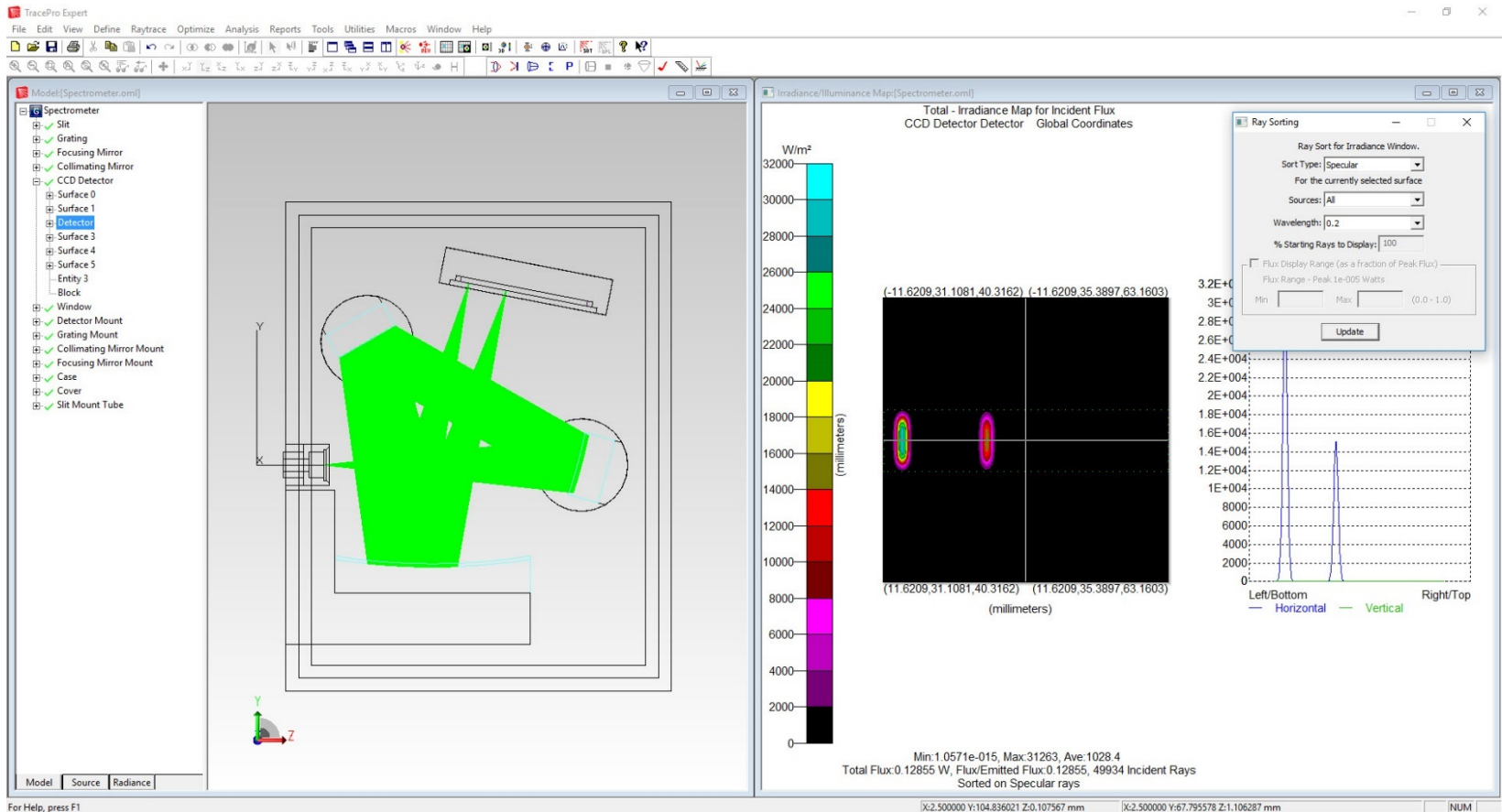
# Ray and Path Sorting Uses

The Ray and Path Sorting tables can also be used in conjunction with the Irradiance/Illuminance Maps.

- To use Ray Sorting, open the Irradiance/Illuminance Map, and then go to Analysis->Ray Sorting
- The Ray Sorting selections can then applied in the same manner as for graphical ray sorting
- To use Path Sorting, open the Path Sort Table, select a path, go to Analysis->Display Selected Paths, and then open the Irradiance/Illuminance Map
- Selecting a different path in the Path Sort Table will update the Irradiance/Illuminance Map

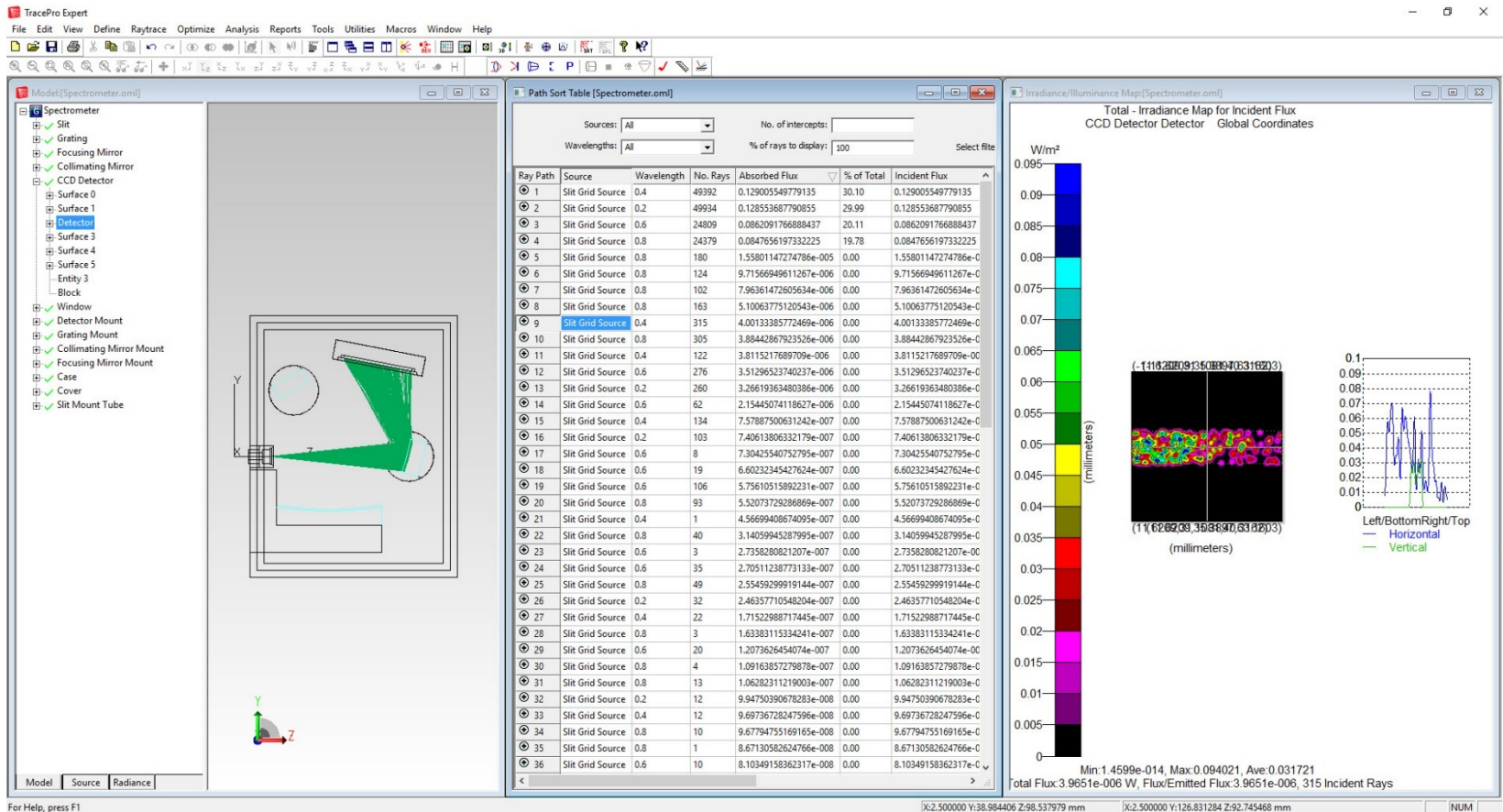
# Ray and Path Sorting Uses

Ray Sorting in Irradiance/Illuminance Map to show 0.2um rays



# Ray and Path Sorting Uses

## Irradiance/Illuminance Map results for a selected path

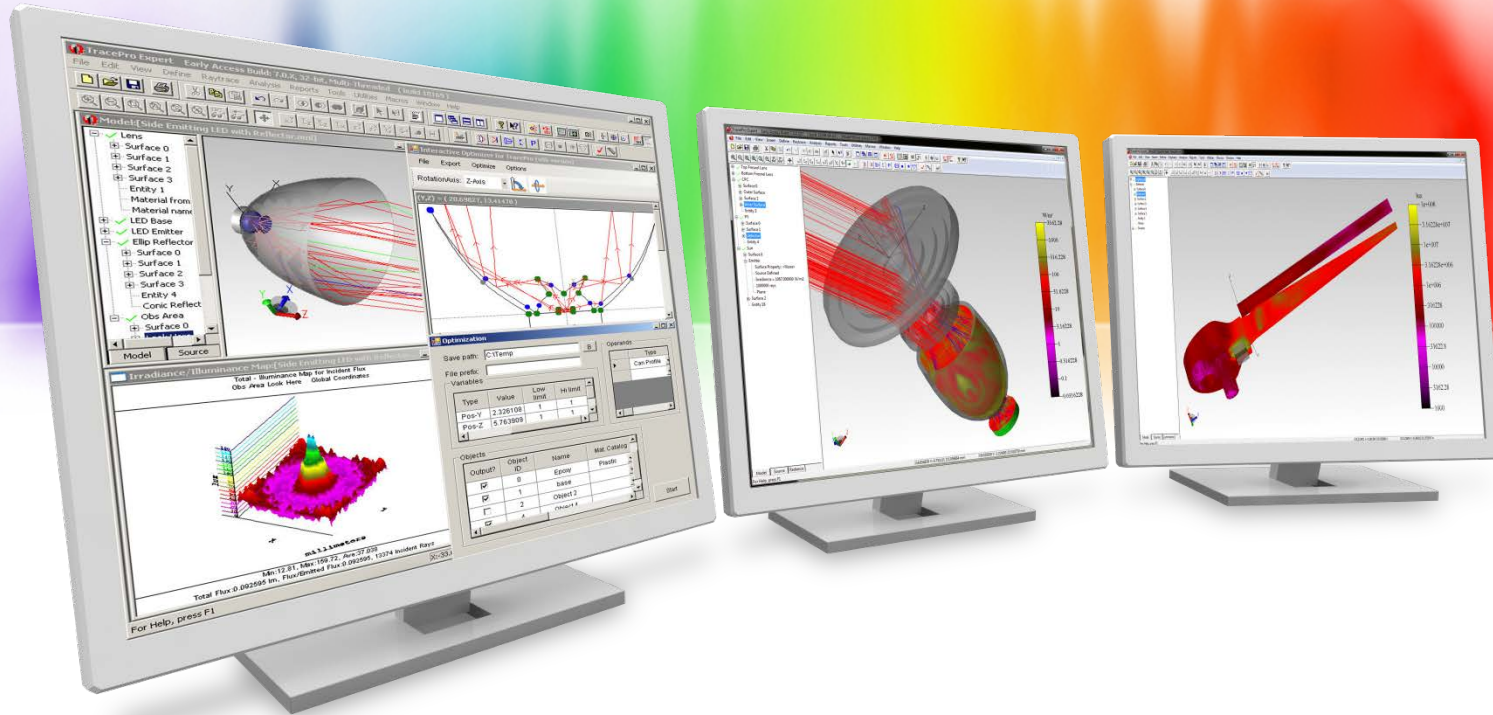


For Help, press F1

X:2.500000 Y:38.984406 Z:98.537979 mm

X:2.500000 Y:126.831284 Z:92.745468 mm

NUM



## Summary and Questions



# Summary and Questions

The TracePro features powerful and easy to use Ray and Path Sorting tools:

- ✓ The ray display can be simplified for better clarity and understanding
- ✓ Sort rays based on criteria such as surface interaction type, wavelength, percentage of starting rays, etc...
- ✓ Sort rays based on the path they take to get to a selected surface
- ✓ Sorted results can also be displayed in the Irradiance/Illuminance Map
- ✓ Excellent tools for stray light analysis

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

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