

Raytrace and Analysis

Requirements

Models: EllipticalReflector.oml

Properties: None

Editions: TracePro LC, Standard or Expert

Introduction

This tutorial uses an example TracePro model to illustrate opening and viewing model data, tracing rays, and displaying analysis output. The steps described are common to most TracePro analysis.

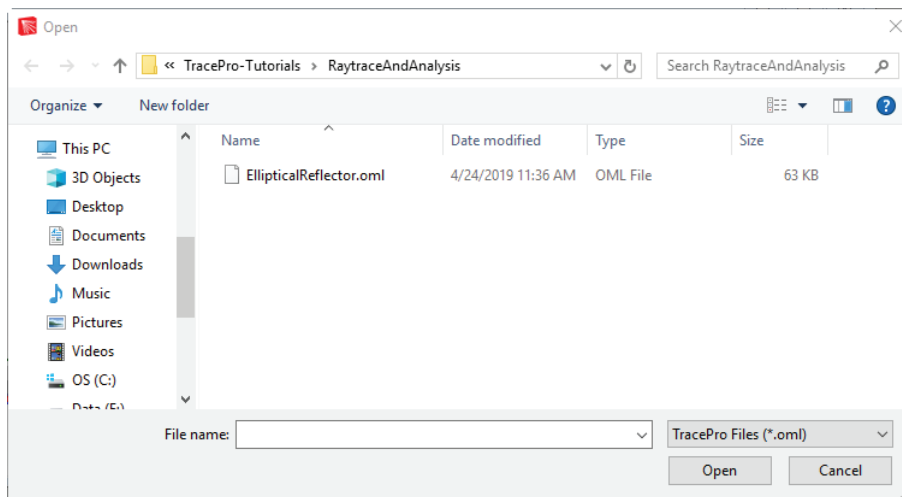


Figure 1. Open TracePro file EllipticalReflector.oml

Download the Elliptical Reflector model from www.lambdares.com and open it in TracePro.

The Model Window

The elliptical reflector and metal halide bulb will appear as shown in the model window. The global origin is indicated by the black XYZ axes. All measurements are relative to this location. The model window is split into two panes showing the geometry and the system tree.

1. To resize the system tree, drag the splitter bar using the mouse.
2. You can also use the **Window | Split** menu to position the splitter bar.
3. When you first open the model, it may not fit in the window. To zoom it to fill the window, click on the Zoom All icon (or select **View | Zoom > All**).

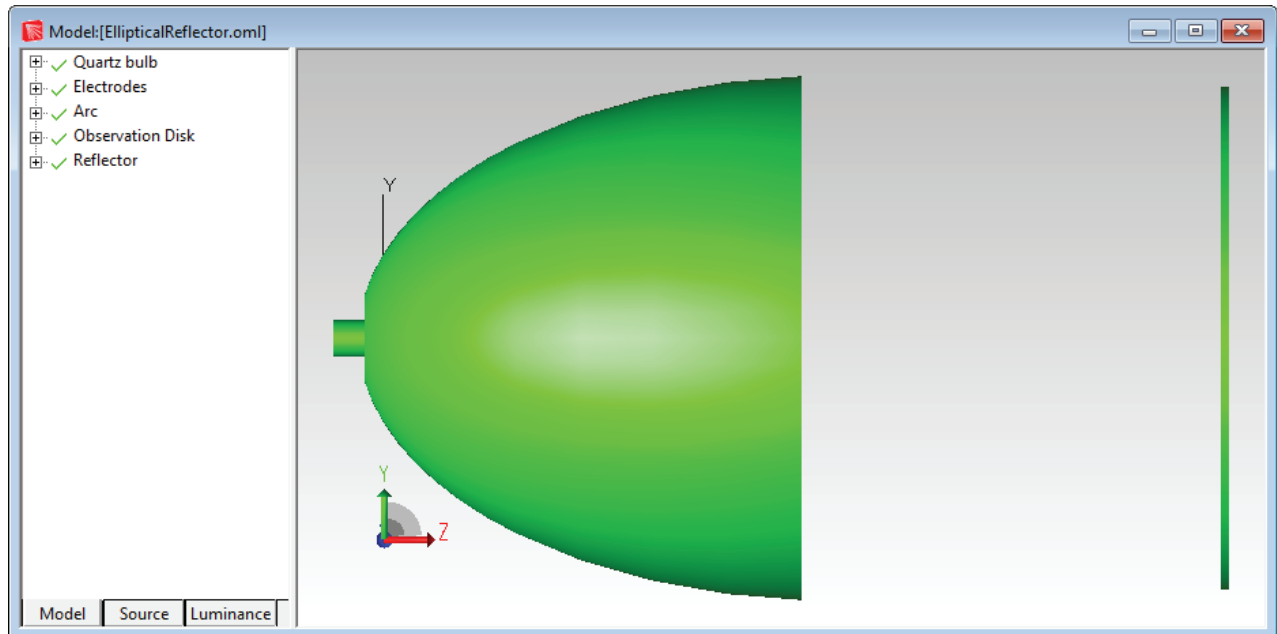


Figure 2. TracePro Elliptical Reflector model

Change from the default **Render** view to **Silhouette** view by selecting **View | Silhouettes**. This viewing mode makes it much easier to select surfaces and objects when setting up the model.

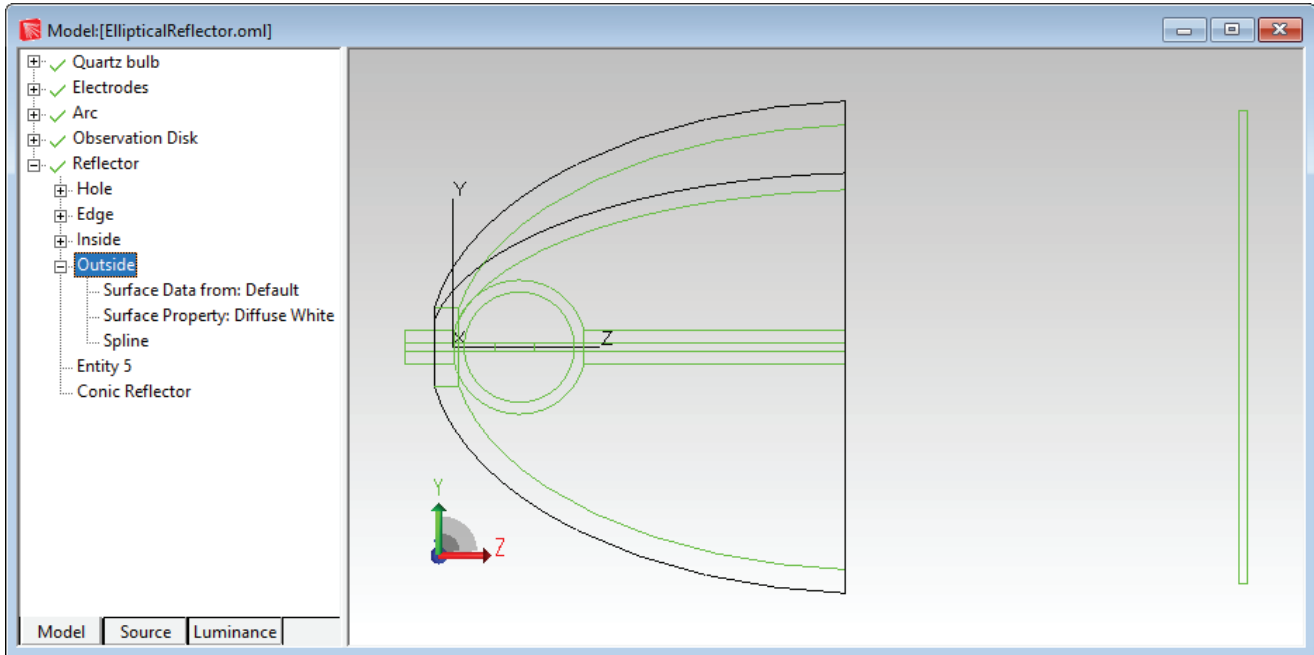


Figure 3. Switch to silhouette view by selecting **View | Silhouettes**.

Using the System Tree

The system tree contains information about the objects and surfaces in the model.

1. Clicking the plus sign next to an object or surface expands the item in the system tree, and shows information on that object or surface.
2. Clicking the minus sign collapses this information.

This information consists of the surface properties, type of surface, and material properties of an object. Further information may show if it is a source, an exit surface or if other properties are applied.

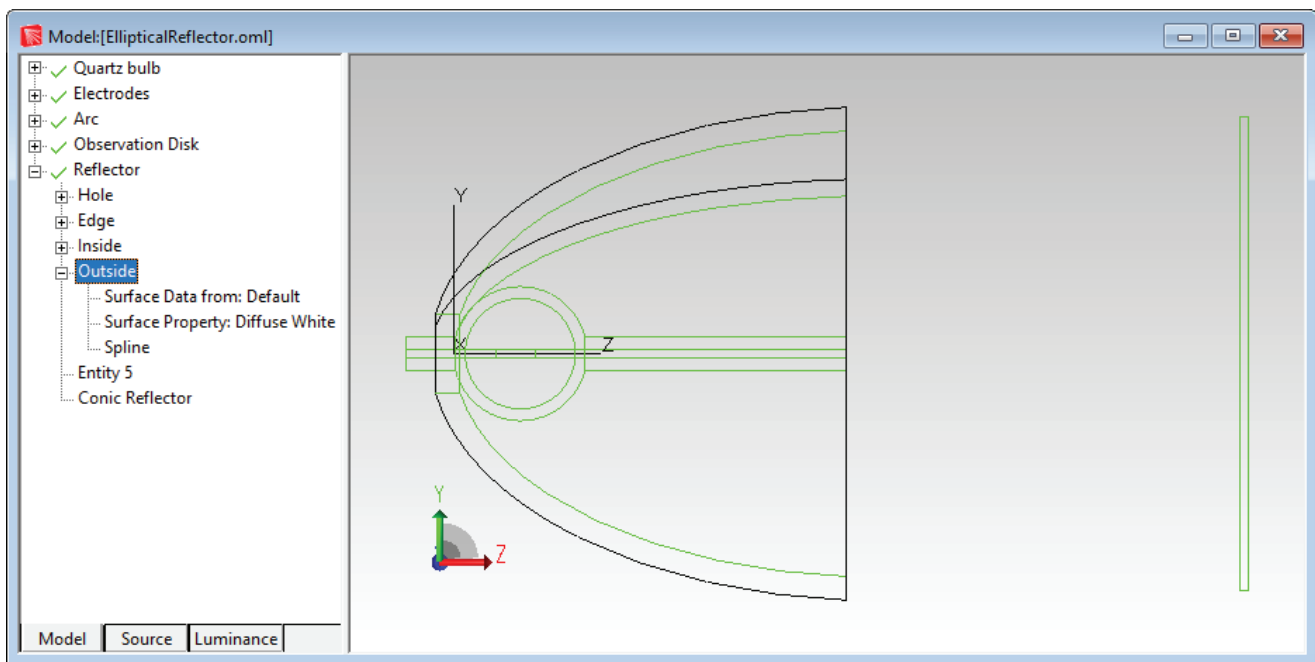


Figure 4. System tree showing the Reflector object expanded, and the Outside surface of the Reflector also expanded.

Selecting Surfaces and Objects

There are two methods for selecting an object or surface in TracePro. You can use either the model window or the system tree.

1. To use the model window:

- Click on the Select Object button to start the selection of objects (or use **Edit | Select > Object**).
- Click on the Select Surface button to start the selection of surfaces (or use **Edit | Select > Surface**).
- If the buttons are grayed out, first click on the model window to activate these buttons.
- You can now select objects or surfaces by clicking on them or dragging a rectangle around them. You can also select multiple surfaces and objects using Ctrl-click.

2. To use the system tree:

- Select an object or surface by clicking on it in the system tree.
- The object or surface will be highlighted in black on the model window and highlighted in the system tree.

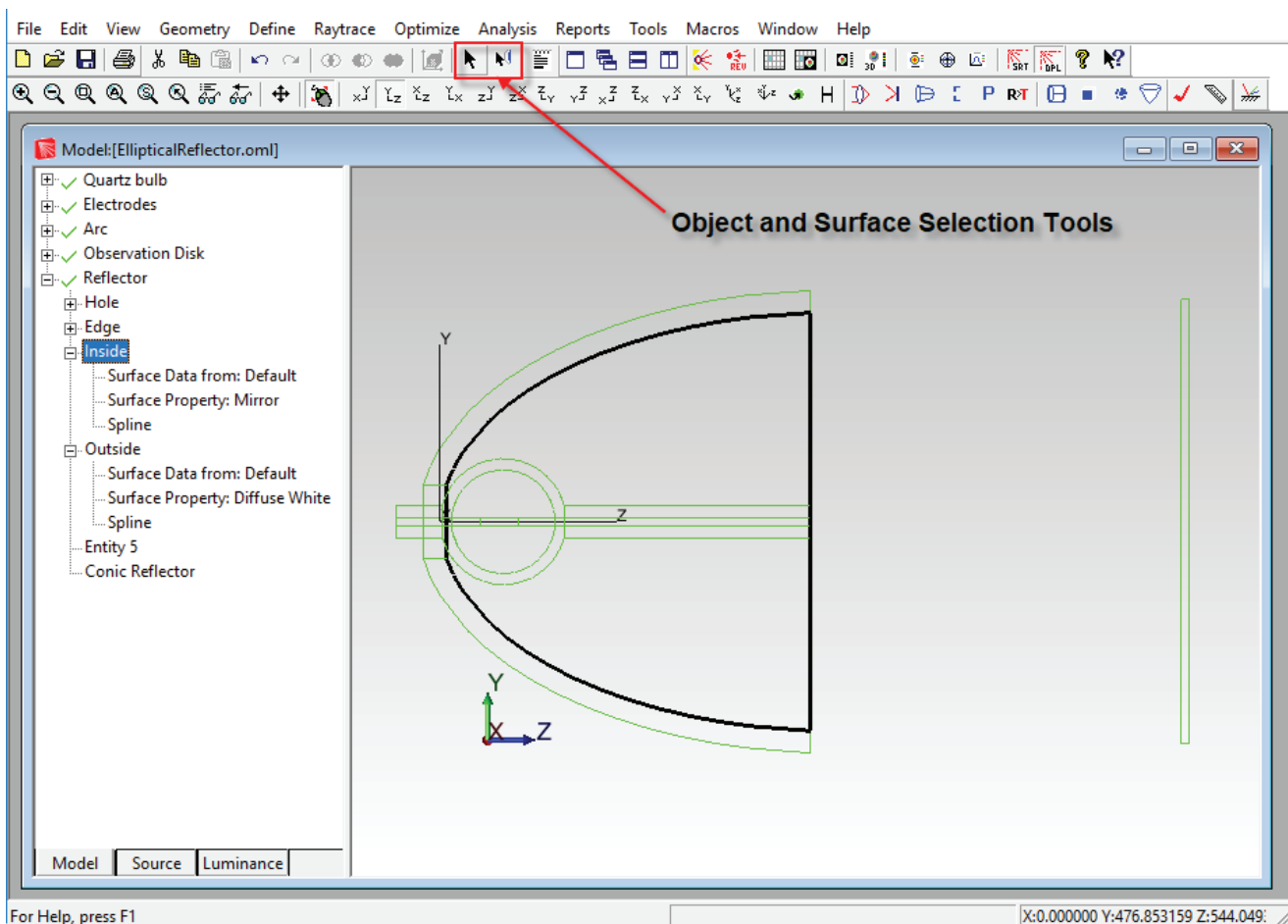


Figure 5. Selecting objects and surfaces for applying properties.

Modifying Surface Sources

This model uses a surface source. This source is defined on one of the surfaces of the Arc object. Expand the Arc object in the system tree, then expand the Cyl surface. Finally, select the Cyl surface by clicking on it. The surface should be highlighted in the model window and in the system tree as shown in Figure 6.

1. You can now modify the Surface Source applied to the Cyl surface. To do this, right-click inside the main viewing window and select *Properties*. Select the Surface Source item on the left side of the dialog box to open the Surface Source parameters page. Another quick method of bringing up the *Apply Properties* dialog box to the desired set of information is by using the system tree. Double-click on any item of surface property information in the system tree. For example, double-clicking on the Flux= 1000 lumens item in the system tree brings up the *Apply Properties* dialog box, with the Surface Source page already selected.
2. Change the number of Total Rays from 100000 to 7500 and click the *Apply* button. The information for the source definition will change to 7500 rays in the System Tree. Now, reset the number of rays back to 100000.

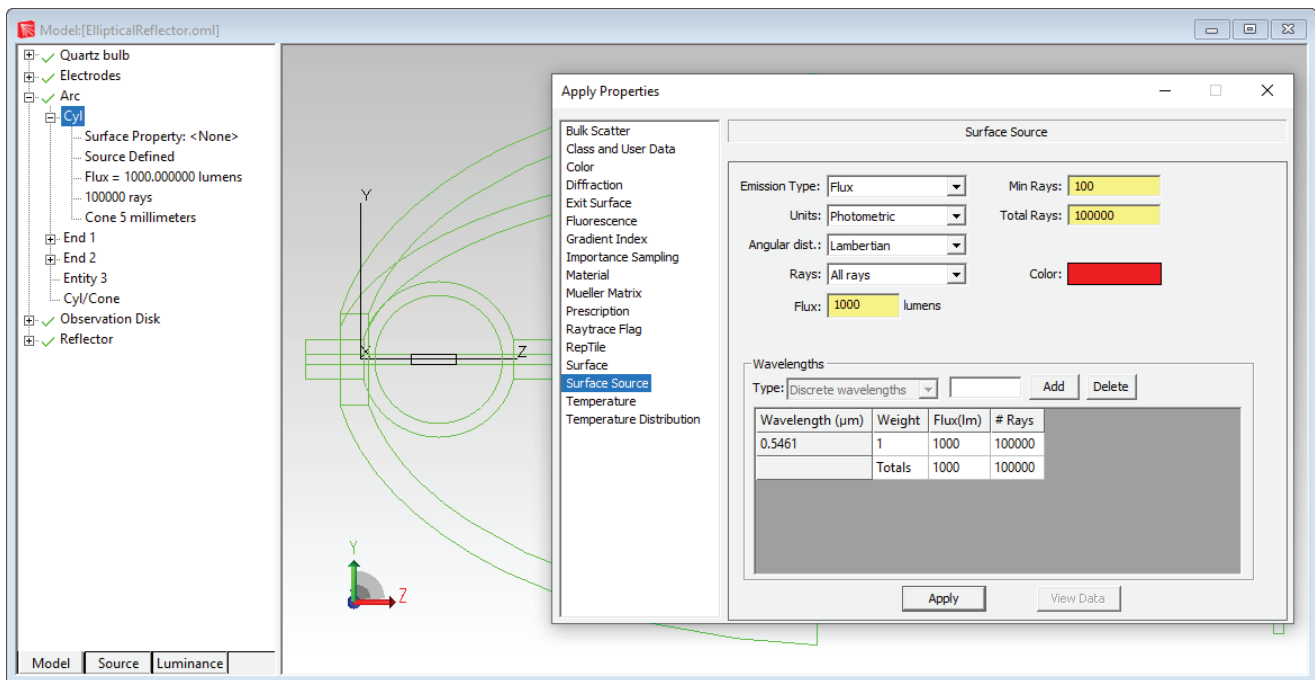


Figure 6. Apply Properties dialog box, Surface Source page.

Tracing Rays

To trace rays from the Cyl Surface Source, click the **Trace Rays** button or select **Raytrace | Trace Rays**.

1. A dialog box will ask you to choose Analysis Mode or Simulation Mode. Choose Analysis Mode.

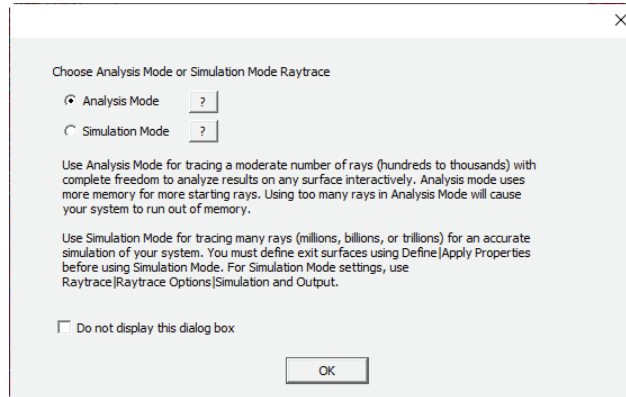


Figure 7. Trace Rays dialog box

2. TracePro will first perform an *Audit and Compute Voxels* function. The Audit function tests the system geometry for defective objects, and then applies the properties and materials to each object and surface. Voxelization is a method of subdividing the model to improve ray-trace speed. Increasing the number of voxels improves raytrace speed at the expense of Audit speed. The number of voxels can be set in the **Raytrace | Raytrace Options | Advanced** dialog box.

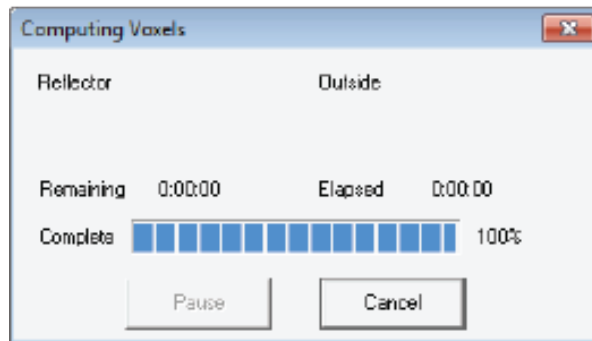


Figure 8. Performing Audit dialog box

3. After the Audit function is complete, the program will trace all 100000 rays. A *Raytrace Progress* progress bar is displayed. The Raytrace Progress displays the number of rays traced so far and an estimate of how much more time the ray trace will take to complete. It will also show you the wavelength(s) for each source.

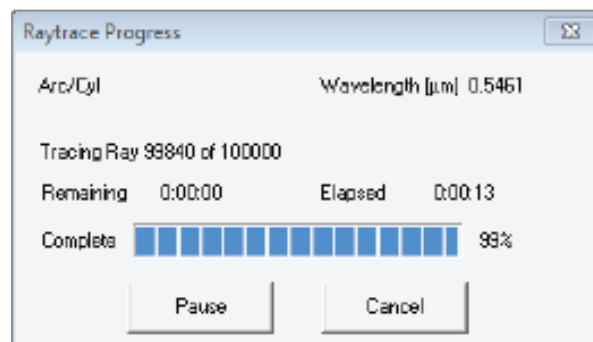


Figure 9. Raytrace Progress dialog box

Viewing the Raytrace

On completion of the ray trace, rays are displayed on the model window. If this does not occur, be sure the **Display Rays** option in the **Analysis Menu** is checked.

By default, the color of each ray traced indicates the flux of the ray. Red rays have flux from 100 to 66 percent of their beginning ray flux. Green rays have flux between 66 and 33 percent and Blue rays are between 33 and 0 percent. Ray colors can be customized using **Analysis | Ray Colors**.

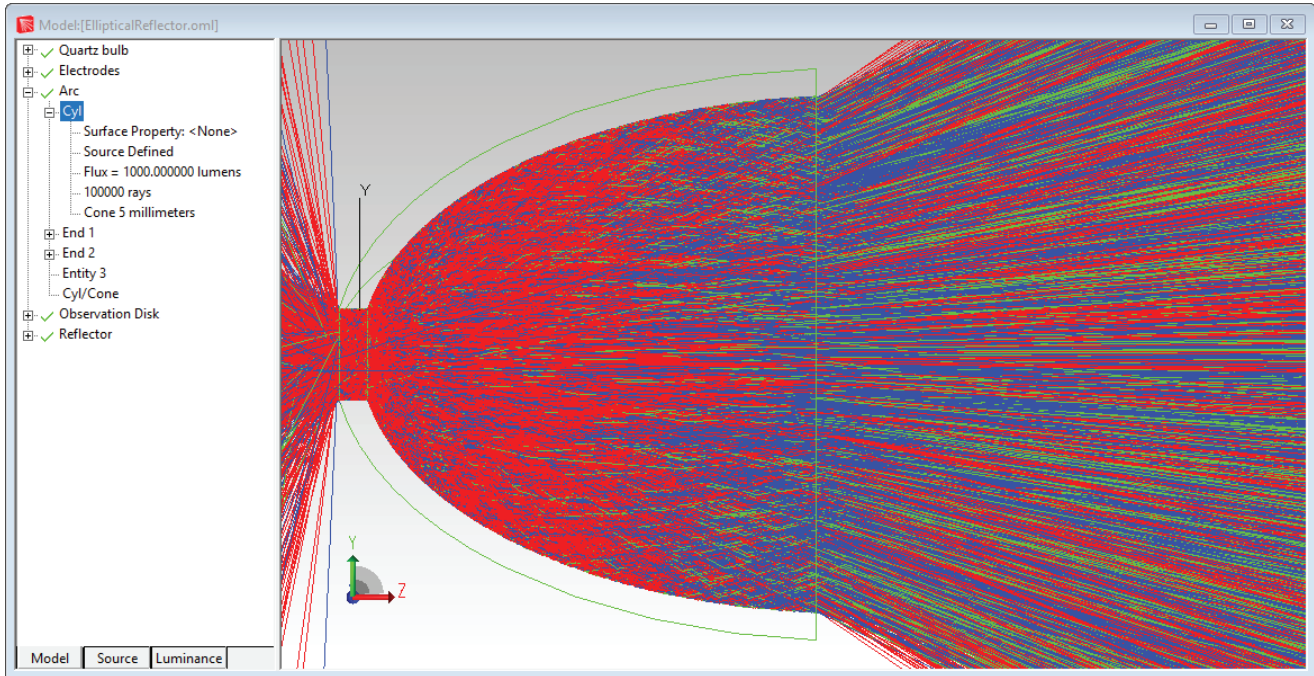


Figure 10. Raytrace of 100,000 rays

Raytrace Mode and Irradiance Plots

There are two modes available for ray tracing and analyzing systems in TracePro, *Analysis* and *Simulation* mode. *Analysis* mode lets you look at *Irradiance/Illuminance Maps* and *Candela plots* on any surface interactively. *Simulation* mode lets you look at only exit surfaces, and you must define exit surfaces before you begin the ray trace. *Simulation* mode uses much less memory due to the smaller amount of information saved.

You have done an *Analysis* mode raytrace. Start by looking at an *Irradiance/Illuminance Map*.

1. First, select the Front surface of the Observation Disk object.
2. Next select **Analysis | Irradiance/Illuminance Maps** to see the plot shown at the left side of Figure 11.
3. Click on the **Tile Windows Vertical** icon to split the screen to show both the model window and Irradiance Map at the same time as shown in the figure below.

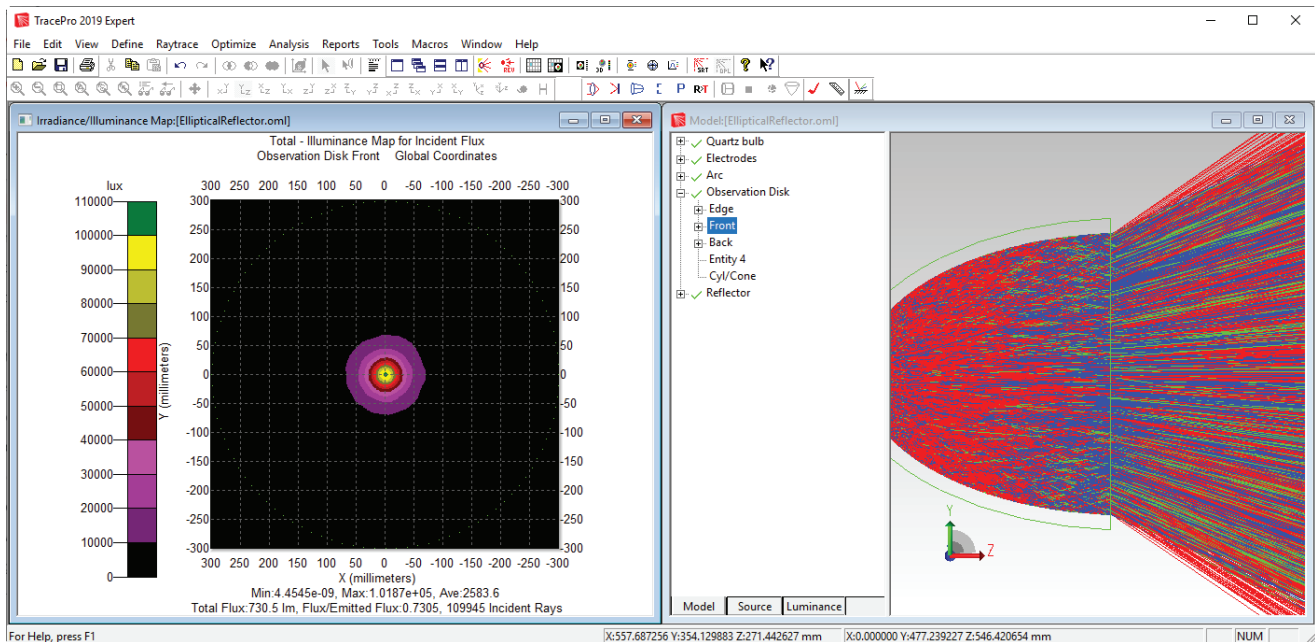


Figure 11. Illuminance map of rays traced with the front of the observation disk selected in the system tree.

Understanding the Irradiance Options

The **Irradiance/Illuminance Options** dialog box is shown below. This dialog box is available from the **Analysis Menu** or by right-clicking on the **Irradiance/Illuminance Map**, and is used to set all the parameters for the map.

The default Rays to Plot setting is Absorbed rays. If you do not see any Irradiance/Illuminance in the plot, change this option to *Incident* and data should appear in the map. This model is set to *Photometric* units so that all output is shown in lumens and lux.

To change radiometric units to *Radiometric*, select **Raytrace | Raytrace Options | Options** and change the *Analysis Units* setting to Radiometric. This will automatically update your irradiance plot to radiometric units, if it is displayed.

The foreground and background colors of the map are set using the *Color Map* option.

The *No. of Pixels* option determines the number of pixels used by the map to collect rays. A value of 50 divides the surface into a 50x50 grid of pixels, counts the rays striking each section of the grid and then totals the energy of these rays together. Larger counts show more detail and provide a more accurate view of what is happening on the map. Smaller counts let you trace fewer rays and get a quick, approximate idea of what the system looks like.

The *Smoothing* option applies a Gaussian smoothing across the pixels to smooth out noisy data. Use this to trace fewer rays while debugging your system, or while in early design stages and let the Gaussian smoothing function fill in the missing data. For accurate analysis, turn off smoothing and trace more rays.

Figure 12. Irradiance/Illuminance Map Options.

Understanding the Irradiance/Illuminance Options

The *Profiles* option creates cross sectional plots of the map. Clicking anywhere on the map will show a cross-section with both horizontal and vertical cuts through the map. The Profiles intersect at the point you clicked. You can also drag the intersection point to dynamically change it, or move it using the arrow keys on your keyboard.

The *Normal* and *Up Vector* selection sets the projection plane that all rays will be projected on. The default selection is for TracePro to automatically calculate the *Normal* and *Up Vector* for you. This is controlled by the *Automatically calculate Normal and Up Vectors* checkbox. If you would like to enter a different set of Normal and Up Vectors (for example for a curved surface or a rotated plane), simply uncheck the checkbox, enter the desired vectors, and click *Apply*.

- The *Normal Vector* is the vector that is perpendicular to the projection plane.
- The *Up Vector* is parallel to the vertical side of the plane.

If the *Normal* and *Up Vector* are defined with the wrong values, the map may look incorrect. This incorrect map may look like a slice if the selected plane is perpendicular to the correct plane or may show no results at all.

Figure 13. Irradiance/Illuminance Map Options (same as used in figure 12)

Incorrect Normal and Up Vectors

Figure 14 below is an example of an irradiance map of the observation plane with inappropriate *Normal* and *Up* Vectors. The plot is no longer displayed correctly in the plane of the observation surface.

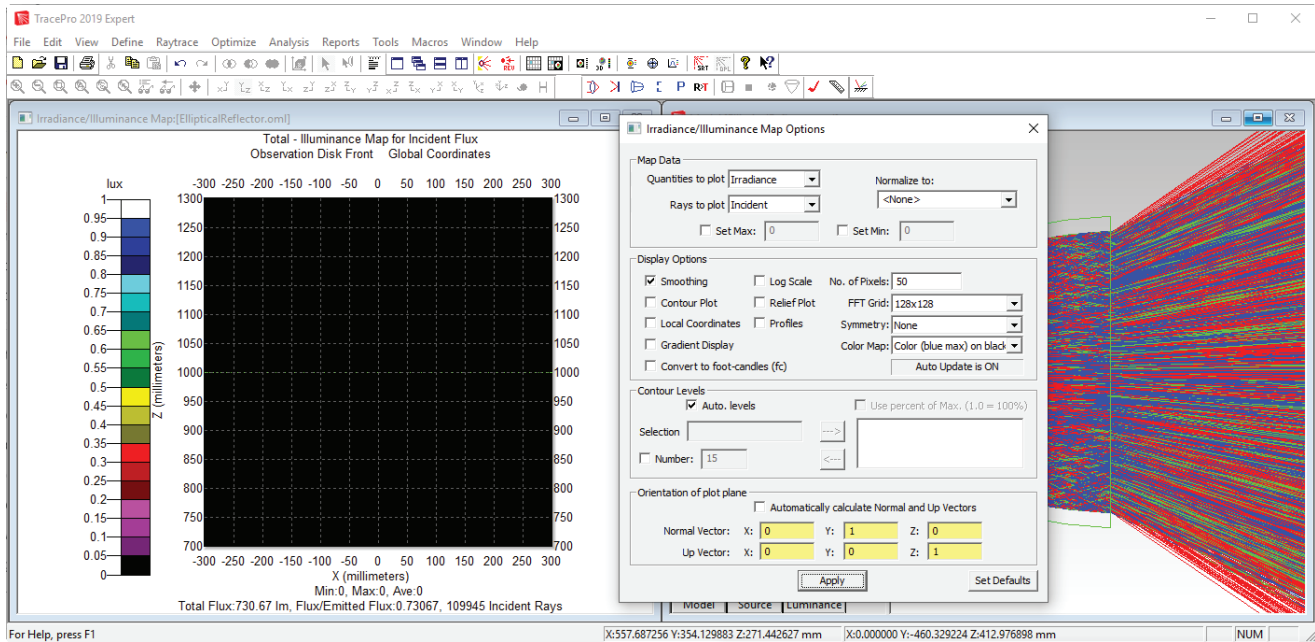


Figure 14. Irradiance/Illuminance Map with options changed to incorrect Normal and Up Vectors.

3D Irradiance/Illuminance Map

To display a **3D Irradiance/Illuminance Map** on all of the surfaces and objects selected in the system tree, use the **Analysis | 3D Irradiance/Illuminance** selection. To create a **3D Irradiance/Illuminance Map** of the Elliptical Reflector model that we have been working on, follow these steps:

1. Turn the ray display off by de-selecting **Analysis | Display Rays**, or by clicking the Display Rays button .
2. Select the Observation Disk | Front surface and Reflector | Inside surface in the system tree as shown in Figure 16 use Ctrl-click to select the two surfaces.
3. Change to an oblique view by orbiting with the mouse or selecting **View | Profiles > Iso 2**.
4. Select **Analysis | 3D Irradiance/Illuminance Options** and adjust the setting as shown in Figure 15.
5. To show the 3D map select **Analysis | 3D Irradiance/Illuminance** or click the toolbar button.

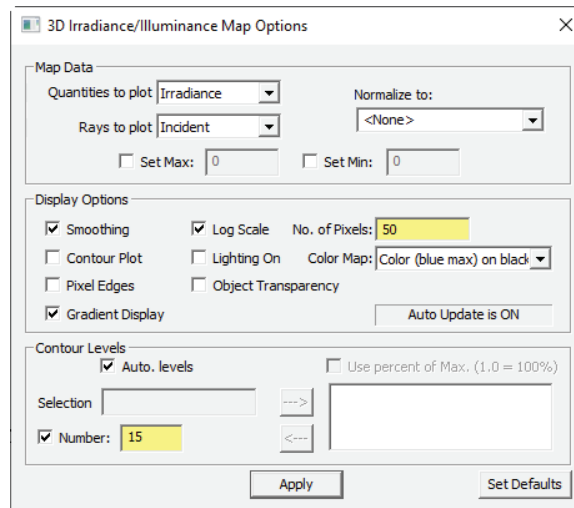


Figure 15. 3D Irradiance/Illuminance Map with options set

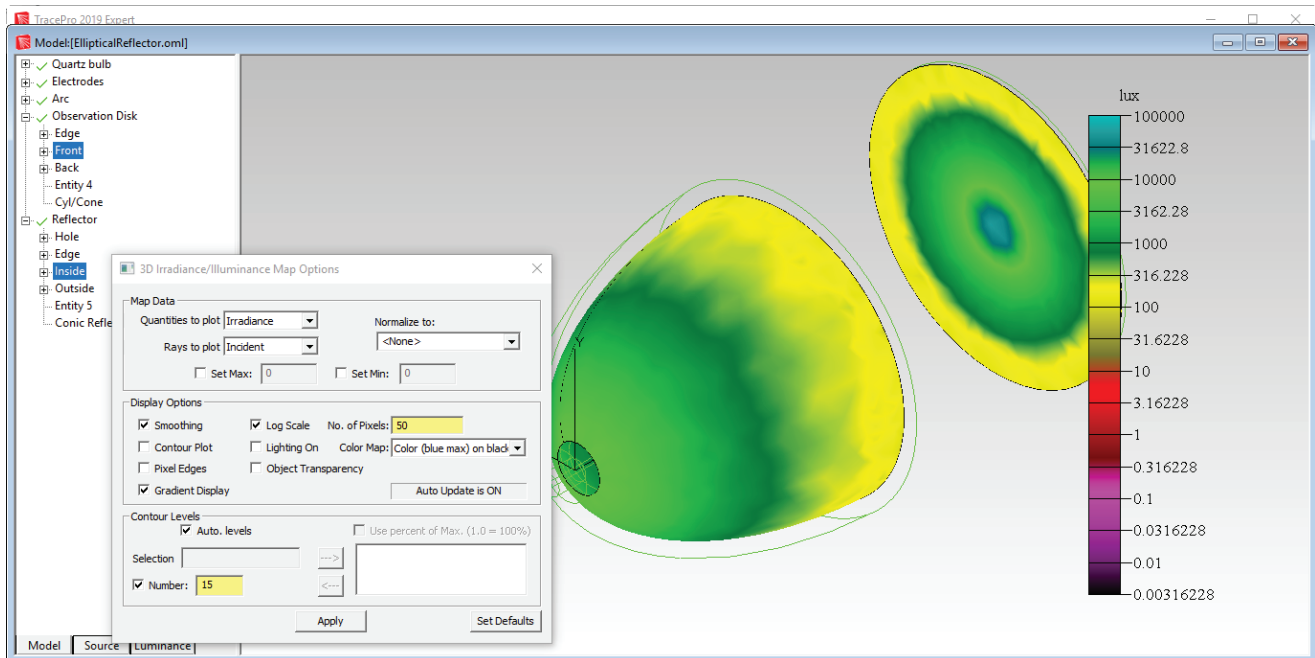


Figure 16. 3D Irradiance/Illuminance Map of the Elliptical Reflector model.