Software for Opto-Mechanical Modeling

TracePro Trial Version
Get Started / Examples Guide
Release 4.0

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The user of this Trial Version of TracePro is granted a license to use this product subject to the following restrictions and limitations.

The user may not engage in, or permit third parties to engage in, any of the following:

- Providing use of the software in a computer service business or network
- Making alterations or excerpts of any kind in the software
- Attempting to disassemble, decompile, or reverse engineer the software in any way
- Attempting to defeat the software protection

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Introduction

What is TracePro?

TracePro is a comprehensive, versatile software tool for modeling the propagation of light in imaging and non-imaging opto-mechanical systems. Models are created by importing from a lens design program or a CAD program or by directly creating the solid geometry in TracePro. Sources propagate through the model with portions of the flux of each traced ray allocated for absorption, specular reflection and transmission, fluorescence and scattering. From the model, analyze:

- Light distributions in illumination and imaging systems
- Stray light, scattered light and aperture diffraction
- Throughput, loss, or system transmittance
- Flux or power absorbed by surfaces and bulk media
- Flux or power scattered by surfaces and bulk media
- Luminance and radiance maps
- Candela distributions
- Polarization effects
- Fluorescence effects
- Birefringence effects

TracePro has a simple, intuitive interface and short learning curve. It is compatible with commercially available CAD programs such as SolidWorks®, AutoCAD®, Pro/E® and CATIA®. It can share solid modeling data with all other software based on ACIS, and exchange data with most other CAD programs and analysis programs via IGES and STEP files. It can also import data from commercially available lens design programs including (OSLO, ACCOS V, Code V, Sigma, and ZEMAX). TracePro runs on Windows based PCs.

What Is the Trial Version?

This Trial Version of TracePro is a working copy of the software with certain key features disabled. Core functionary including geometry creation, ray tracing and analysis is enabled. Material and surface property data may be viewed but not edited. Example models are provided that illustrate a sample of the addressable applications.

The Trial Version disables the following functionality:

- Saving models to disk
- Printing
- Applying optical properties to objects and surfaces
- Importing or exporting CAD files
- Macro processing

System Requirements

TracePro requires a PC running Windows XP or Windows 2000. A minimum of 512MB of RAM is required. 1024 MB is the recommended minimum. Additional physical memory the more rays you can trace without TracePro using virtual memory. Using virtual memory significantly decreases the speed of a TracePro raytrace. Many TracePro users use 512MB or more of physical RAM. TracePro requires at least 128 MB of disk space for installation. **A minimum allocation of 512MB of Virtual Memory is required**. This is controlled in Windows 2000/XP by selecting Start→Settings→Control Panel, double-clicking on the System icon, and specifying in the Performance tab.

Installing the TracePro Trial Version

The installation procedure for TracePro is as follows:

- Insert the TracePro CD-ROM into the drive.
- Select Install TracePro from the TracePro Setup Utility which automatically launches when the CD is inserted [OR… Run setup.exe using Windows Explorer or by selecting *Start→Settings→Control Panel* and running the Add/Remove Programs]

The installation program will create a TracePro item on the Programs menu. A detailed description of all installation options is provided in the TracePro Installation Guide.

Running TracePro

To start TracePro, select *Start→Programs→TracePro*.

FIRST TIME NOTE:

TracePro needs to know the location of the TRACEPRO.MDB file. This file contains the material and surface property data. If TracePro cannot locate the file, it will prompt you to specify the location of the file, then present you with an *Open File* dialog box. Using this dialog box, locate the TRACEPRO.MDB file (it is probably in the TracePro directory) and press OK. The new path will be stored in the TracePro.INI file so that the next time you start TracePro you can skip this step.

Next, TracePro will display the following dialog box offering to let you run TracePro in demonstration mode. Other options are available for licensed versions or more extensive Trials and evaluations.

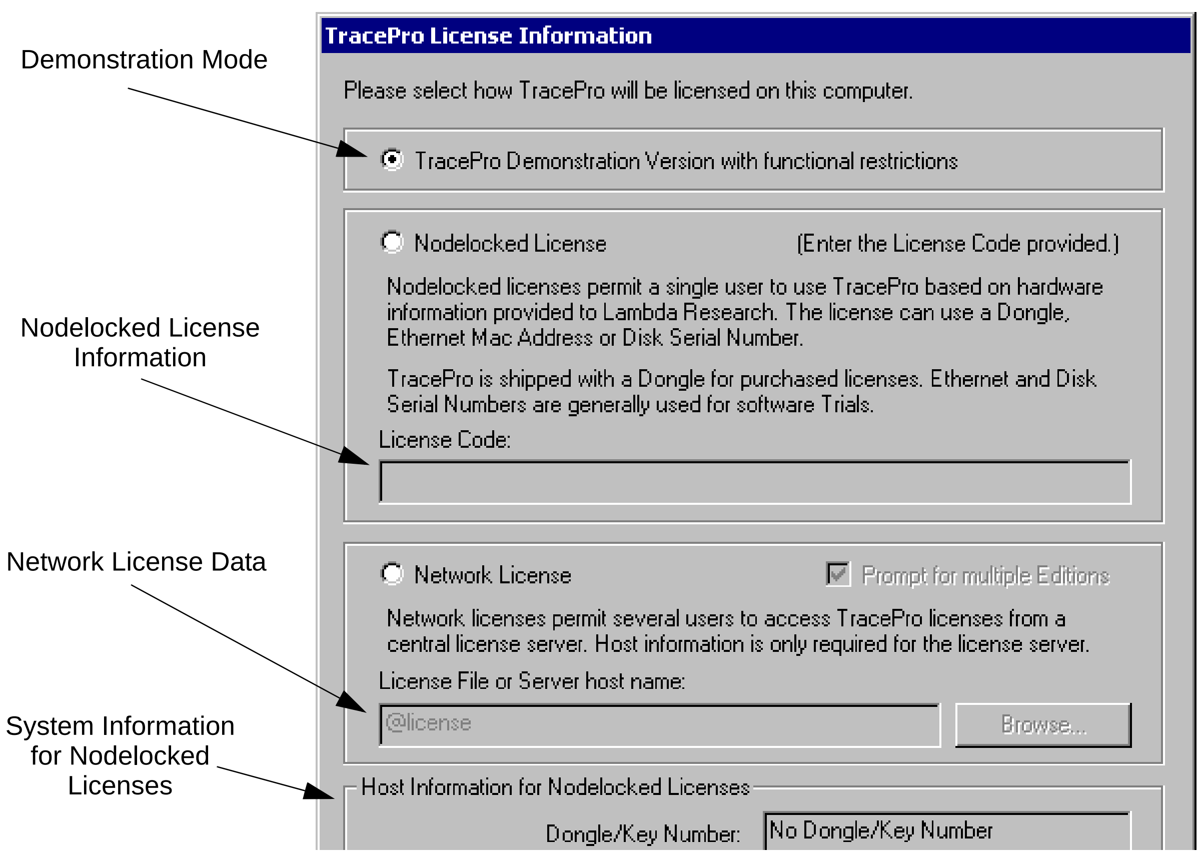


FIGURE 1 - TracePro License Information

Select **TracePro Demonstration Version with functional restrictions** and click OK.

The TracePro Demonstration dialog box will appear as shown below. Select Run Demo and TracePro will start.

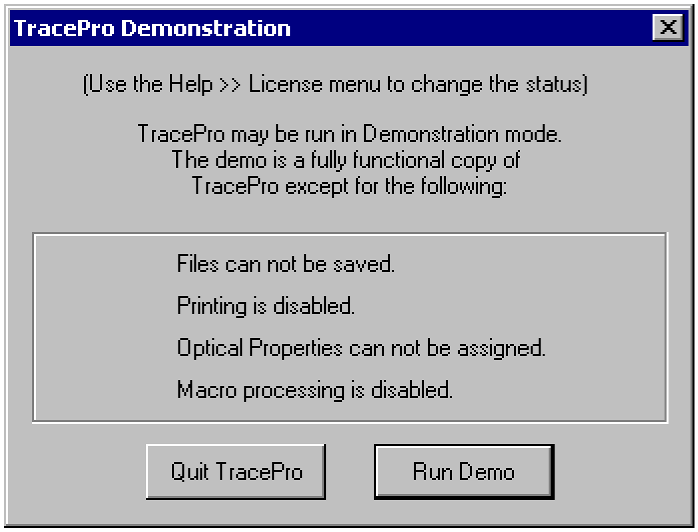


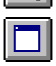
FIGURE 2 - TracePro Demonstration Dialog

Get Started

You can start by opening one of the prepared examples as described below. Many of the viewing functions (*Zoom Window, Orbit View, Rotate View*) are performed interactively using the mouse. For example, after opening any of the files, you can rotate the view using the *Rotate View* option. Press the *Orbit Rotate View* button on the toolbar (or select `View|Rotate|Orbit` from the menu), then move the mouse cursor inside the geometry window. Press and hold the mouse button down, move the mouse around, and watch the view change in real time as you move the mouse.



The *Zoom Window* command operates the same way as in a CAD program. Press the *Zoom Window* button, press and hold the mouse button down at one corner of the region you would like to zoom to, drag the mouse to the opposite corner of the region, and release the button. You can also zoom in or out using the *Zoom In* and *Zoom Out* buttons.



TracePro features multiple views and multiple documents. Using the `Window|New` menu item (or the *New Window* toolbar button), you can open as many views as you like of the current model. You can also have as many models open at one time as you wish, with as many views of each as you wish as well. There are practical limits to this, of course, imposed by your computer's memory and screen area. You can choose from silhouette view (the default), rendered view, hidden line, or wireframe view using the *View* menu.

You can access context-sensitive help anytime by pressing F1 or by using the Help button on the toolbar in TracePro.

Example Files

When TracePro is installed several example models are transferred onto your computer. The files are placed under the **Examples** folder in the TracePro folder in **Demos**. The TracePro folder is installed on your computer in "**C:\Program Files\Lambda Research Corporation\TracePro**" by default. If you changed the location or are starting Windows on an alternative disk drive, the full path may be different.

Example - Stray Light in a Photolithography Lens

This model domesticates a simple stray light analysis - via., analyzing ghost images in a refractive lens system. The model contains a multi-element lens system including lens barrels, retaining rings, and other mount design details. The lenses are made of Schott glasses. With the exception of the third lens element that is uncoated, all lenses surfaces are modeled with anti-reflection coatings and surface scattering. The non-optical surfaces are coated with diffuse black paint.

From the **`File`** menu select **`Open`**. Navigate to the **Demos** folder and open the **Lens Demo** folder. See “Example Files” on page 6. Pick *lensdemo.oml* and press Open. After the file is opened, a side view of the lens will be displayed in the Model Window, as shown below.

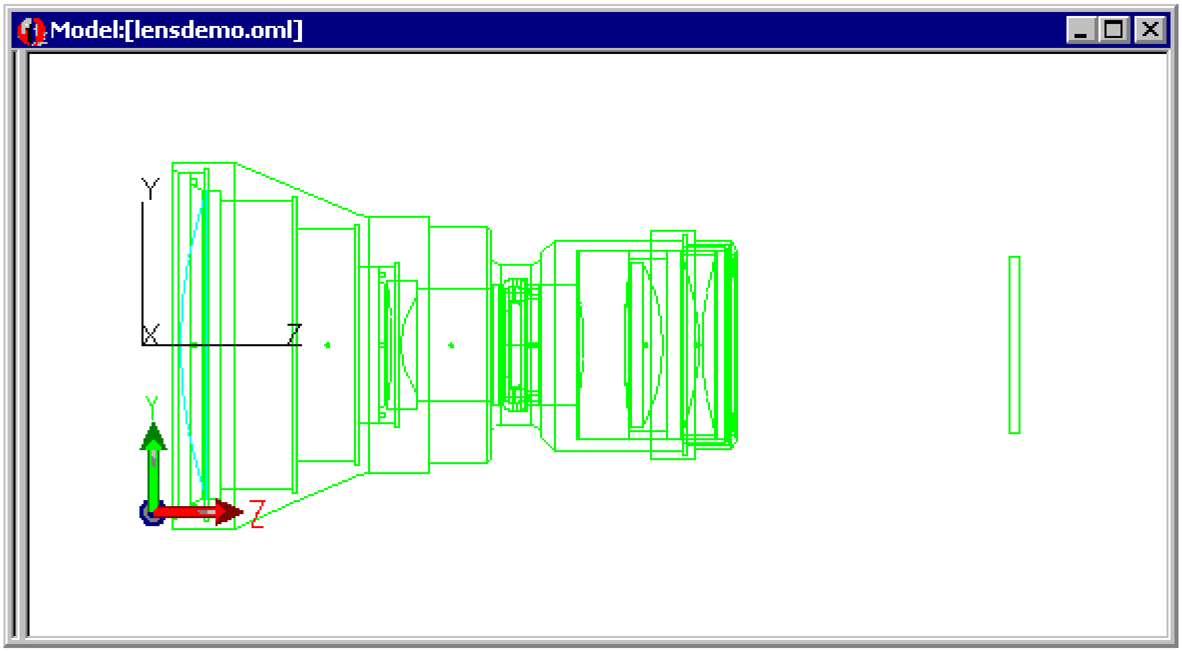
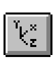
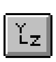


FIGURE 3 - Photolithography Lens Model





Now select **`View|Profiles|Iso 1`** to see an isometric view of the lens system. You can also see a rendered view of the lens by selecting **`View|Render`**. It will take a few seconds for TracePro to calculate the rendered view. Return to the y-z silhouette view by first selecting **`View|Silhouettes`**, then selecting **`View|Profiles|YZ`**. Now we are ready to ray-trace the model.

Select **`Define|Grid Source`** from the menu to open the *Grid Setup* dialog box as shown below.

The settings specify a line of rays lying in the y-z (vertical) plane, and directed horizontally along the +z axis.

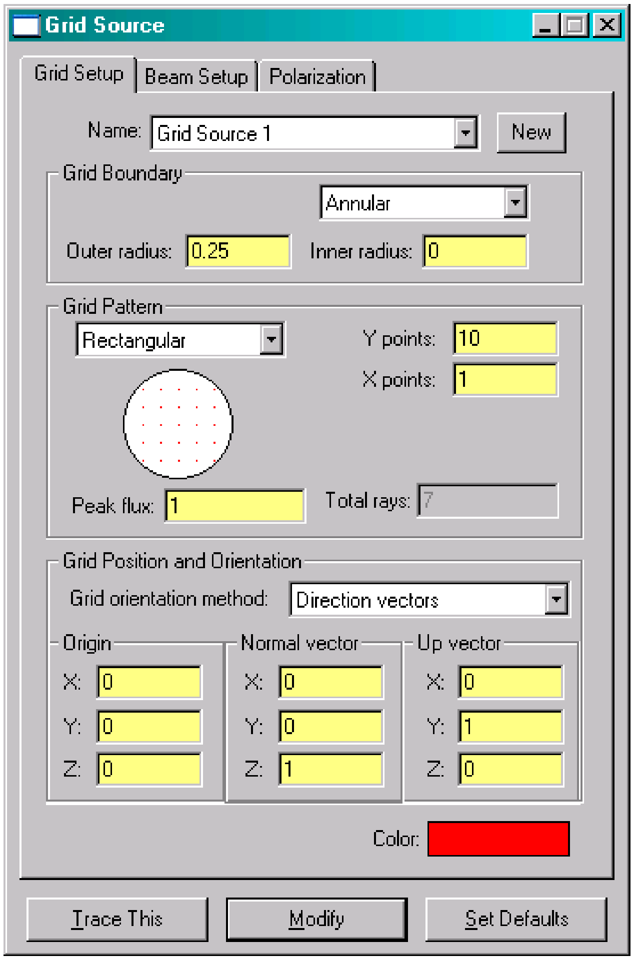


FIGURE 4 - Grid Raytrace Dialog

Ray Tracing

Ray Tracing is the means by which TracePro simulates the distribution of flux throughout a model. How rays interact with the model is determined by the model itself (the geometry of created objects and their applied properties), and how you control the rays being launched into the model. There are three basic methods of defining rays: *Grid Sources*, *File Sources* and *Surface Sources*.

The next step in this example is ray tracing. From the menu, select `Analysis|Trace Rays`. Select *Trace Source using discrete wavelengths.* Select *All* for *Grid*; select *None* for *Surface*; select *None* for *File*. Press the *Apply* button. Press the *Trace Rays* button.

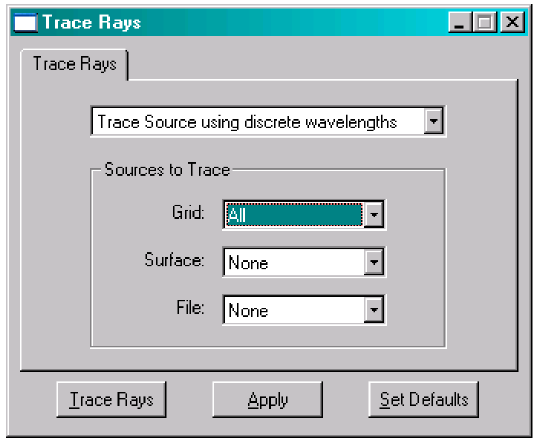


FIGURE 5 - Trace Rays Dialog

First, TracePro will perform an Audit of the model to ensure that all surface and material properties are in the database and to preprocess the geometry in the model for faster ray tracing. After the ray-trace is finished, the rays will be displayed in the Model window as shown below.

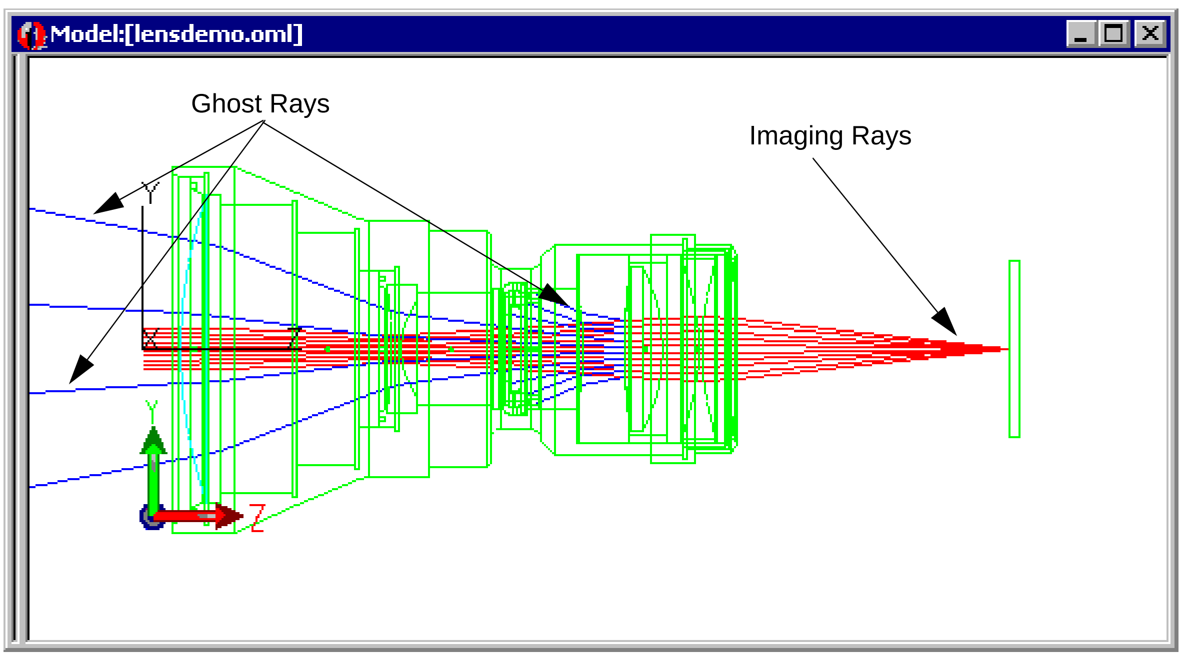


FIGURE 6 - Ray Trace of Photolithography Lens Model

This ray-trace shows image-forming rays and some ghost rays caused by reflections from the uncoated element. The image-forming rays converge to a point at the image plane. The ghost rays are the ones reflected from lens element #3. They are terminated when their flux falls below the flux threshold, or go back out the front of the lens system.

Flux Threshold

The flux threshold is used to control the ray-trace. As rays are traced in the model, they are split into two or more components. For example, at the surfaces of lens element #3 in this model, the incident ray is split into two new rays, one transmitted and one reflected. The flux or power carried by these split rays is proportional to the transmittance and reflectance of the surface. This splitting process occurs at each ray-surface intercept, with the flux of each ray segment decreasing at each ray-surface intercept. When the flux of the ray drops below the Flux Threshold, the ray is terminated. The flux threshold is controlled using the **`Analysis|Raytrace Options`** dialog. Select the **`Thresholds`** tab and change the **`Flux Threshold`** from 0.05 to 0.0002. Rerun the ray-trace. This will produce many more rays (and the ray-trace will take longer to finish). Some ghost rays will reach the image plane, causing stray light.

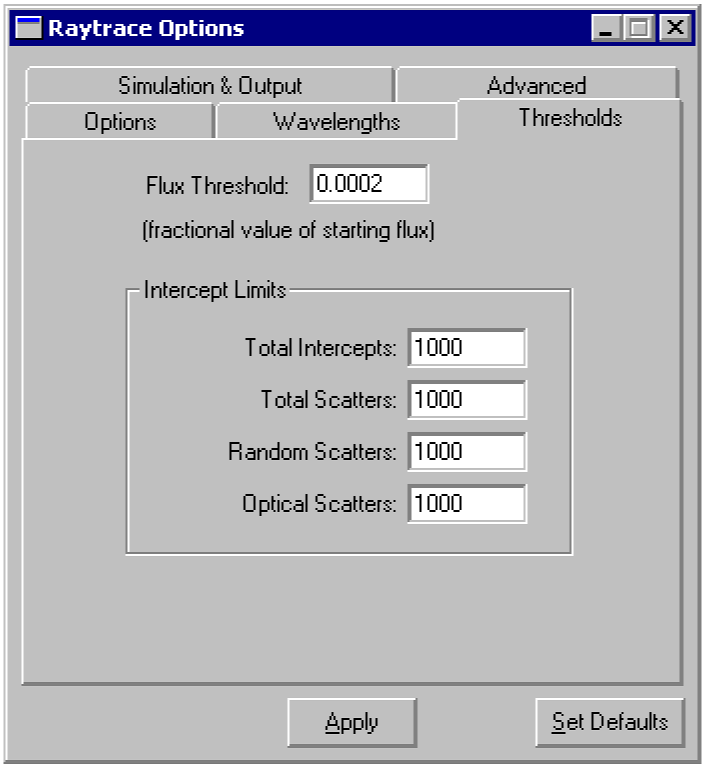


FIGURE 7 - Threshold Tab in Raytrace Options Dialog

This example illustrates how TracePro can be used for stray light analysis. With its modeling of scattering and its importance sampling feature, TracePro can predict stray light in telescopes and other optical systems that have high attenuation of stray light. By examining ray paths using the Ray Sort feature, design alternatives to improve stray light performance are identified.

Example - Metal Halide Lamp with Elliptical Reflector

This example contains a simplified model of a metal halide lamp with an elliptical reflector, electrodes with a plasma arc and quartz enclosure, and an output plane. The arc is simulated as a cylinder that radiates in a Lambertian pattern from its cylindrical surface.

From the **File** menu select **Open**. Navigate to the **Demos** folder and open the **Elliptical Reflector** folder. See “Example Files” on page 6. Select *eliprefl.oml* and press Open. After the file is opened, a side view of the lens will be displayed in the Model Window, as shown below.

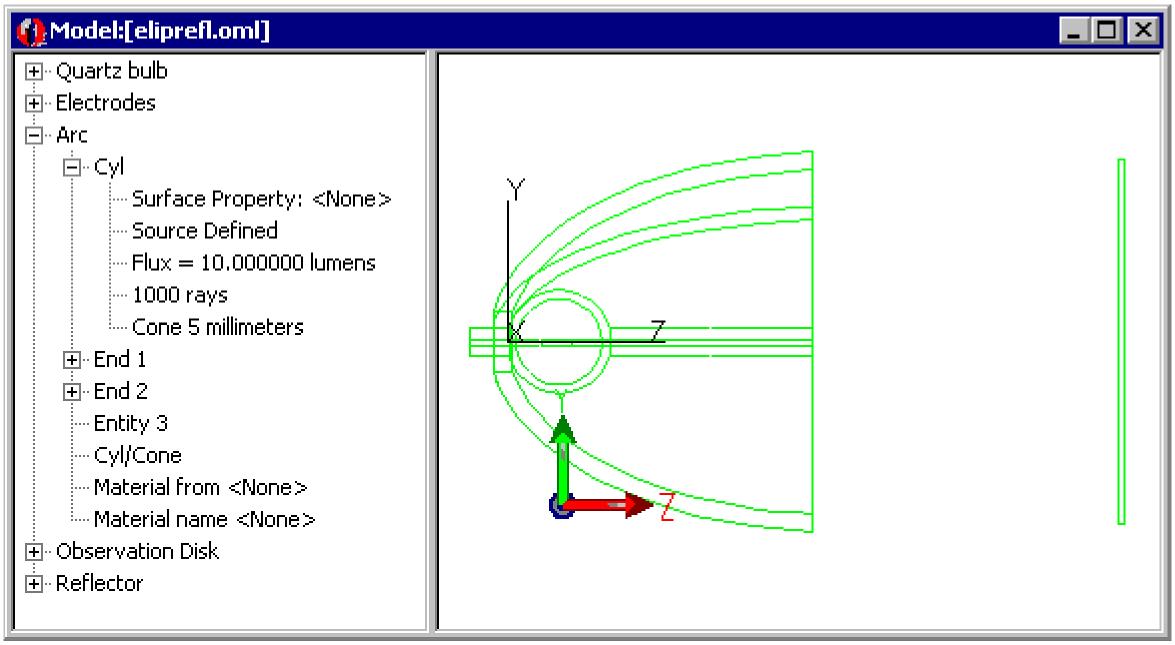


FIGURE 8 - Elliptical Reflector Model

The Model window will be displayed after you open the file. To see the display shown above, you must open the *System Tree*. Just inside the left border of the model window is a vertical splitter bar. Place your mouse cursor on this splitter bar and you will see a special splitter cursor. Press and hold down the mouse button and drag the splitter bar to the right to expose the *System Tree*. Items with a + in the System Tree can be expanded by a single mouse click on the +. Once expanded, the + changes to a -. You can collapse an expanded item by clicking on the -.

TracePro describes models as collections of Objects, each of which are bounded by one or more Surfaces. For example, a sphere object has one bounding surface, and a cube object has six bounding surfaces. Objects have Material Properties specified by name, like Glass or Aluminum, and Surfaces have Surface Properties, like Mirror, Lens, or Black Paint. Objects have main branches on the system tree, and surfaces have sub-branches.

Defining Rays with Source Types

Sources are defined as *Grid*, *Surface* and *File*. Grid Source are defined as virtual windows to a distant source with rays emanating from the window. Surface Sources are applied as a property to an object’s surface. File Sources are comprised of external ray data read by TracePro during the ray trace. Each of the source types can be defined from the **Define** menu or by Right-Clicking in the Source Pane of the System tree.

The Source Pane in the System Tree is a central repository for all sources contained in the model. Each source is displayed as a node in a Source Tree. Expanding a node displays the various sources of each type and further displays the relevant data for each source. Each source node is preceded by a Green Check or Red X. Clicking on this flag will add or remove the source from the list of sources to trace.

Any surface in a TracePro model can be made a source of light by making it a Surface Source. The cylindrical source in the eliprefl.oml example has a Surface Source property assigned to it. The total flux that will be emitted by the surface is 10 lumens and the emission will be simulated using 1000 rays. The characteristics are shown above in the Model Pane of the System Tree and below in the Source Pane of the System Tree where a Green Check is set indicating it us enabled for raytracing.

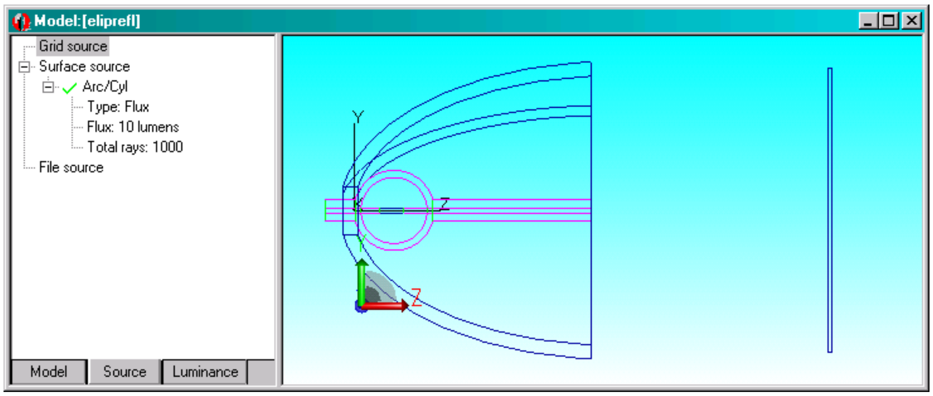
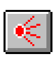


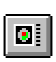
FIGURE 9 - Source Pane in System Tree



The next step in this example is ray tracing. From the menu, select **`Analysis|Trace Rays`**. Select *Trace Source using discrete wavelengths.* In *Sources to Trace*, select *None* for *Grid*; select *Checked Only* for *Source*; select *None* for *File*. Press the *Trace Rays* button. You can also start this type of ray-trace by pressing the *Source Trace* button on the Analysis toolbar after selecting defined *Surface source in the Source Pane of the System Tree*

The progress of the ray-trace is displayed in the progress dialog and the ray-trace can be interrupted at any time by pressing *Cancel*.

After the raytrace is finished, rays will be displayed in the Model window as shown in the figure below. One focus of the ellipse is at the center of the cylindrical source, and the Front surface of the Observation Disk object is at the other focus. You can see the irradiance map for this surface, but first you must select it for viewing. To do this, expand the Observation Disk in the System Tree so that it looks like the figure below, and click on Front to select it.



Below is an Irradiance Map of the output. Select **`Analysis|Irradiance Maps`** (or press the *Irradiance Maps* button) to see this irradiance map.

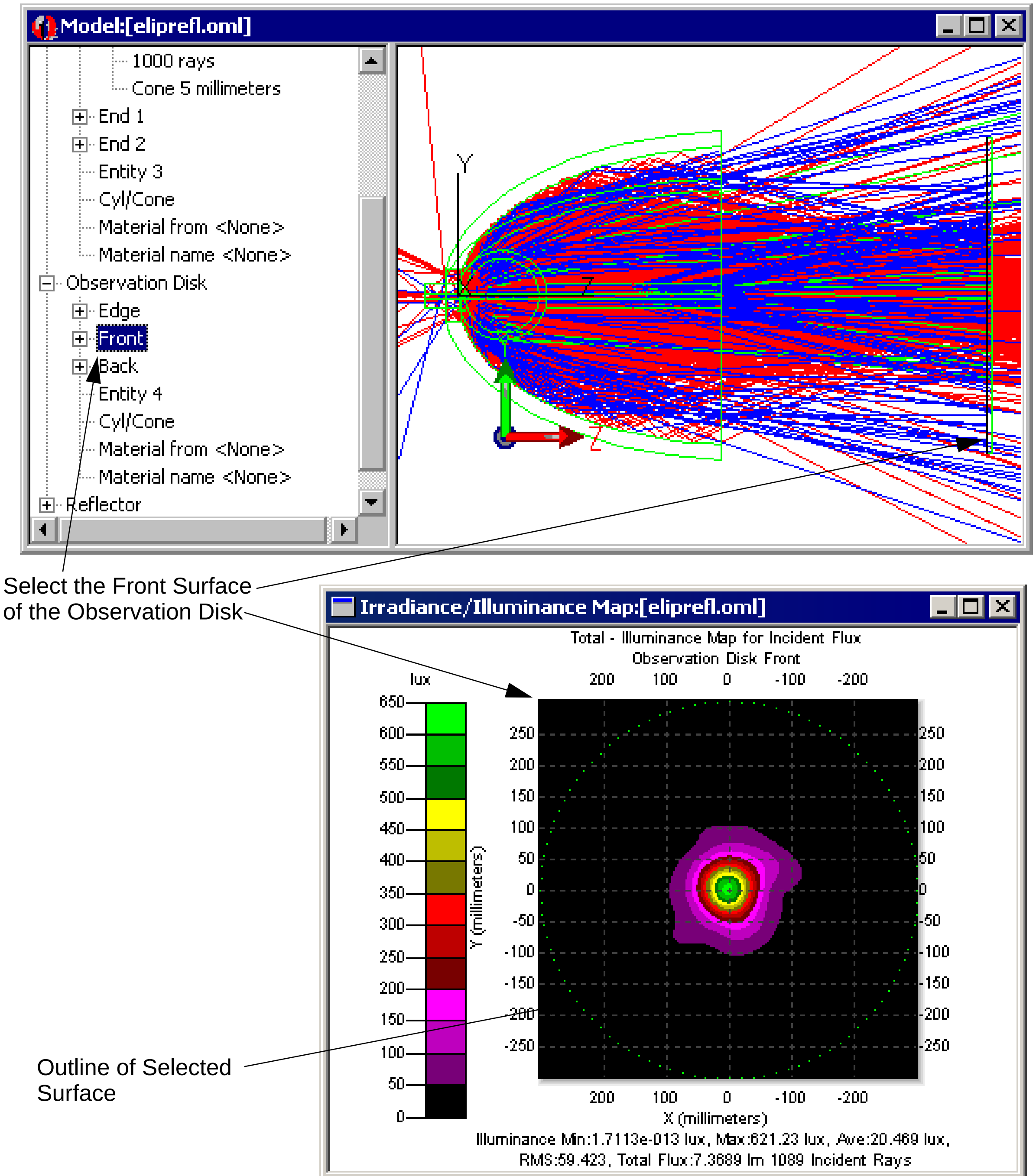


FIGURE 10 - Ray Trace and Illuminance Map of Elliptical Reflector Model

You can also create a candela plot to see the angular distribution of light coming out of the lamp. Select `Analysis|Candela Plots|Polar Iso-Candela` to get the plot shown below. This is a polar plot of candela versus angle, and shows the intensity per unit solid angle, or lumens/steradian.

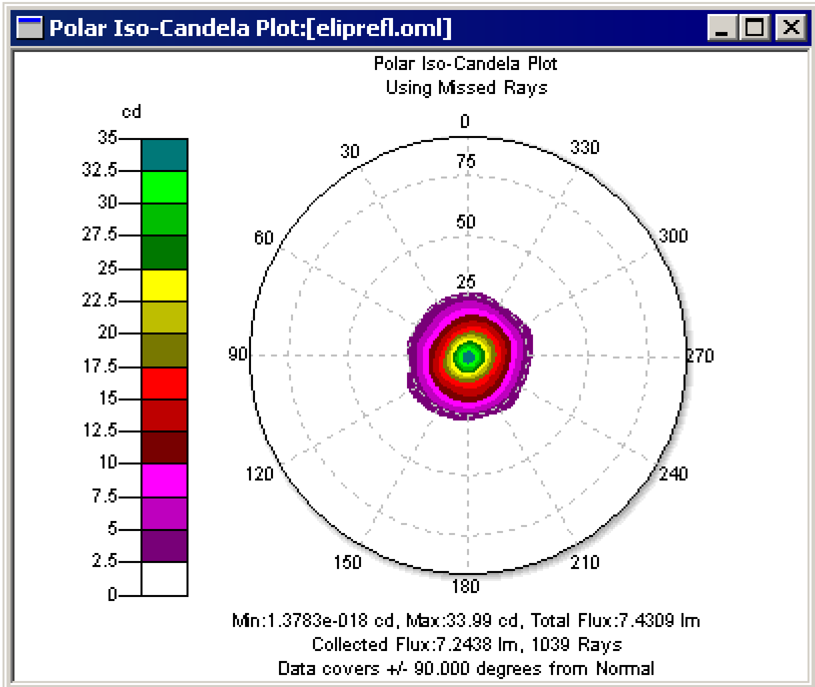


FIGURE 11 - Polar Iso-Candela Plot of Elliptical Reflector

To create a candela plot, select **Analysis|Candela Options** to open the dialog box shown below. Set the Ray Selection to “*Use incident rays from selected surface*” and click **Apply** button.

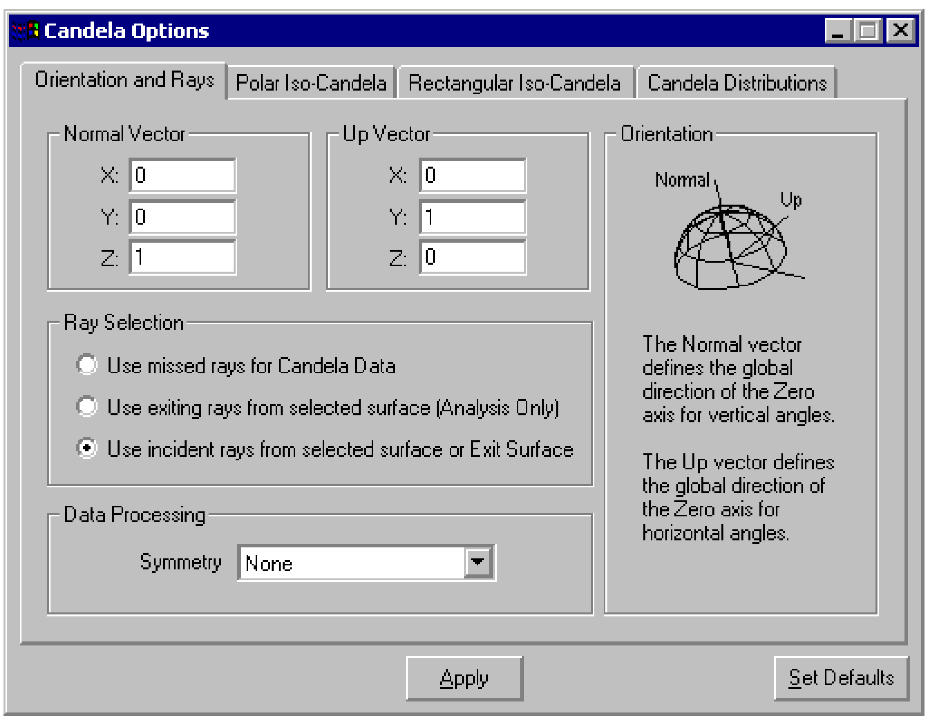


FIGURE 12 - Candela Options Dialog

In the above Candela plot, if you move the mouse cursor over on the candela plot, the status bar at the bottom of the TracePro window shows the angular coordinates and the candela value at the location of the mouse cursor. You can also display slices through this plot or a smaller square region within this polar plot.

Example - Integrating Sphere

This model simulates an integrating sphere to illustrate tracing of scattered rays and importance sampling. An integrating sphere is a hollow sphere with a highly reflecting, diffuse coating on the inside. Often an integrating sphere has an entrance port to let light in, and an exit port to let the (integrated) light escape. In this model, however, the sphere has only an exit port, and rays are emitted from a virtual source inside the sphere. This integrating sphere has a diffuse coating with 99% reflectance on the inside.

From the `File` menu select `Open`. Navigate to the **Demos** folder and open the **Integrating Sphere** folder. See “Example Files” on page 6. Pick *intspher.oml* and press Open.

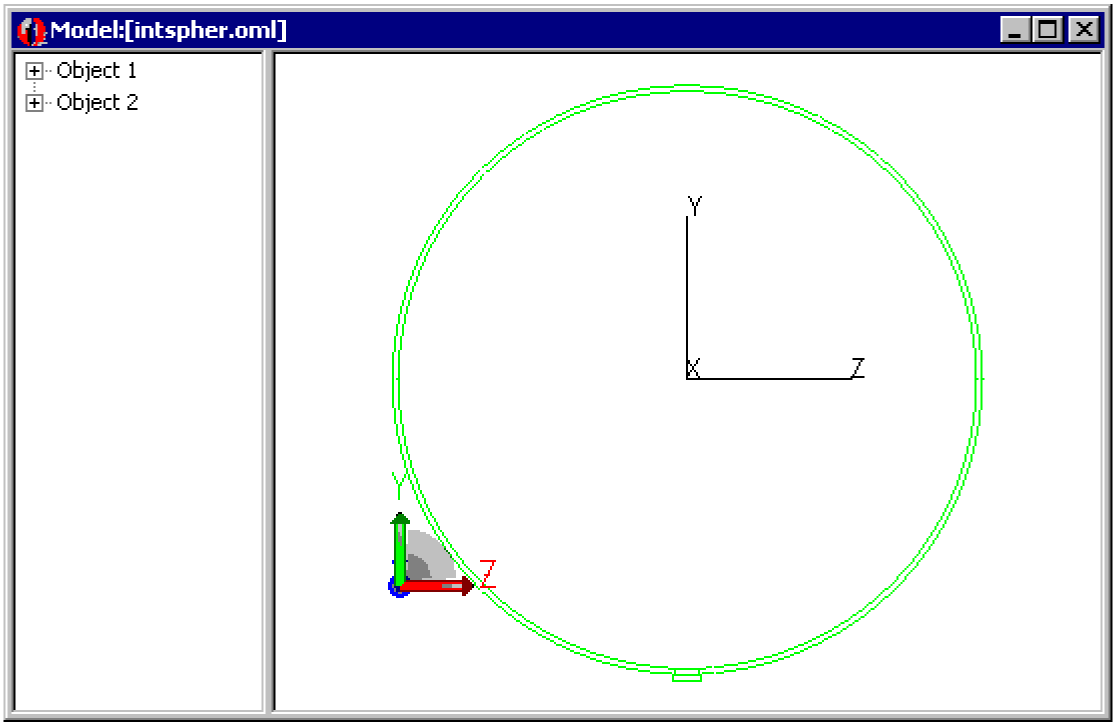


FIGURE 13 - Integrating Sphere Model

This model has the flux threshold set to $5x10^{-5}$. This allows rays to scatter many times within the sphere before being terminated. To see how to set this threshold, select **`Analysis|Raytrace Options`** to open the dialog box shown below right, and select the **`Thresholds`** tab.

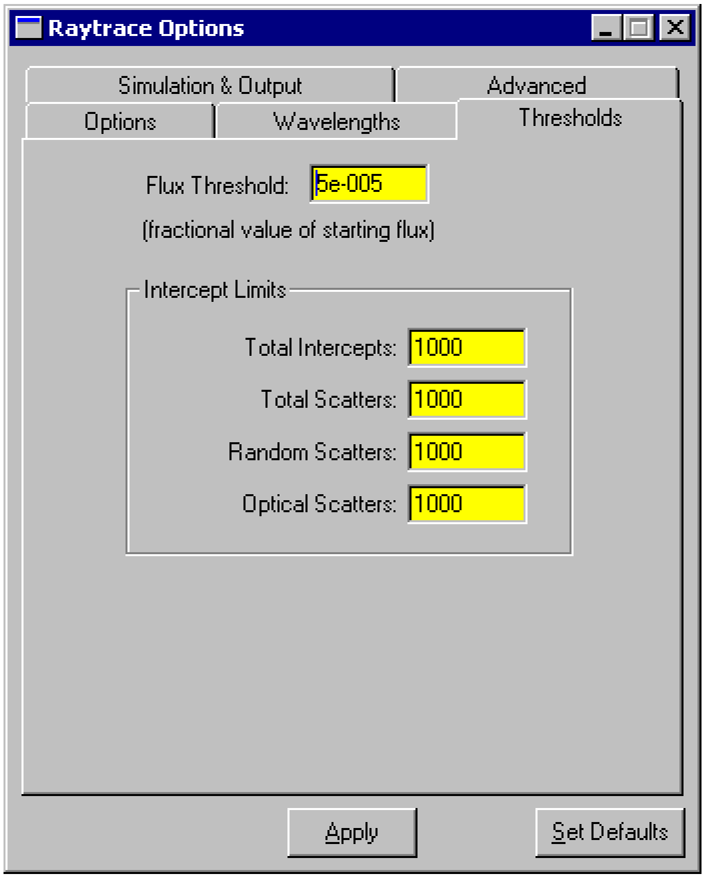
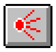


FIGURE 14 - Raytrace Options Dialog



Now open *Source Pane* in *System Tree* and notice that the number of rays for Grid Source 1 is set to one. Press the *Source Trace* button on the Analysis toolbar.

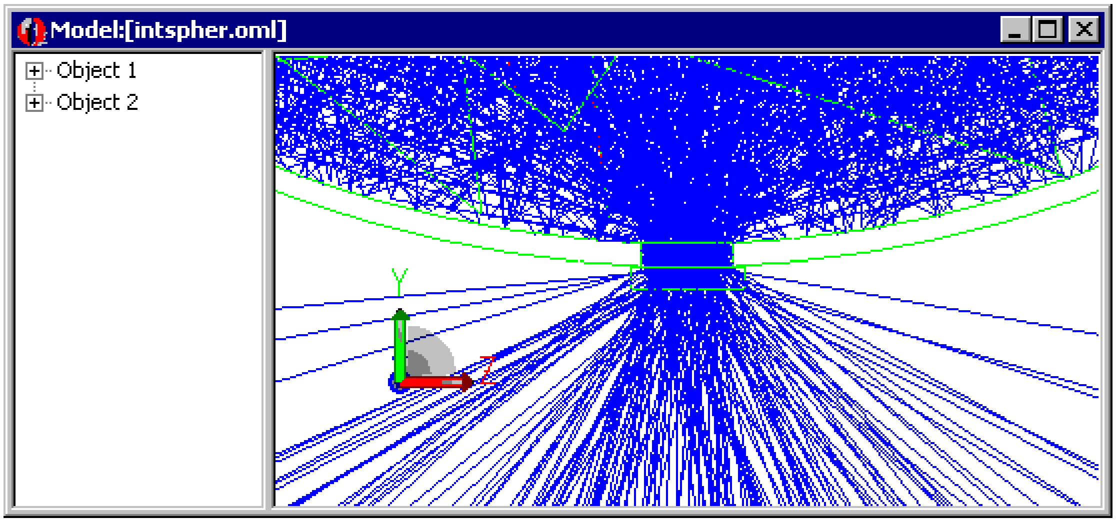


FIGURE 15 - Ray Trace of Integrating Sphere Model

The previous figure shows a close-up view of the integrating sphere output port for a single starting ray.

Select **`View|Zoom|Window`** (or press the *Zoom Window* button) then zoom in on the exit port at the bottom of the sphere to get the view shown on the previous page. Zooming to a window is described in the *"Get Started"*.

As you can see, one starting ray produces many ray components as the ray scatters many times inside the sphere. Each time a ray segment strikes the inside surface of the sphere, one importance sampling ray is directed toward the exit port of the sphere. This process of importance sampling greatly increases the sampling (i.e. number of ray components) at the exit port and thus improves the efficiency of the ray-trace.

Importance Sampling

Importance sampling is a technique for improving the sampling in the Monte Carlo method. It is essential for studies like stray light analyses, wherein only a tiny fraction of the incident light reaches the image surface. In a well-baffled telescope, 10^{-10}, 10^{-15}, or even less of the flux from the source may reach the image surface. In a "brute force" Monte Carlo raytrace in which rays find their way to the image surface by random scattering only (without importance sampling), an enormous number of rays must be traced to get only a few rays through the system. For example, if 10^{-10} of the incident flux reaches the image surface, you must start 10^{10} rays to produce one ray at the image surface, on average.

In TracePro, importance sampling is a technique in which scattered rays are sent in specified directions in the optical system, such as toward the exit port of this integrating sphere. The probability of these rays reaching the exit port is thereby increased to one by this process, so the flux carried by them is reduced by the probability of them randomly reaching the exit surface. This calculation is easily done by TracePro during the ray-trace and it assures that energy is conserved, i.e., that no "double dipping" takes place.

Creating Geometry

You can create the integrating sphere model geometry yourself, although the Trial Version does not allow you to apply the surface properties needed to do the ray-trace shown above. To create the hollow sphere needed for the integrating sphere, you define two concentric solid spheres and subtract the smaller one from the larger to create a spherical shell. To accomplish this, do the following steps:

1. Select **`File|New`** or press the **`New`** button to open a new model window.
2. Select **`Insert|Primitive Solid`** and select the **`Sphere`** tab.
3. Enter 50 for the *Radius* and press the *Insert* button. A sphere will be drawn in the window.
4. Change the *Radius* to 51 and press the *Insert* button. A second sphere will be drawn.
5. Select **`Edit|Select|Object`** (or press the *Select Object* button on the toolbar) to enable Object Selection. Click on the Outer Sphere and, press and hold down the Ctrl key, then click on the Inner Sphere. Zooming in on the edge of the spheres makes it easier to pick the right one. You can also select items from the System Tree.
6. Select **`Edit|Boolean|Subtract`** (or press the *Subtract* button on the toolbar). Once you complete this, the inner sphere has been subtracted from the outer sphere to produce a spherical shell. (If you make a mistake, press the *Undo* button and try again.)
7. Select the **`Cylinder/Cone`** tab on the **`Insert|Primitive Solids`** dialog box to prepare to make a cylinder. The cylinder will be used to make a hole in the bottom of the spherical shell.
8. For the cylinder set the *Base Major R* = ***2***, *Top Length* = 20, .
9. Set the *Base Position Y* = -49, *Base Rotation X* = 90, and press the *Insert* button. A cylinder will be drawn at the bottom of the spherical shell. If you had previously zoomed in as suggested in 5. above, do **`Zoom All`** to see the cylinder.

10. Select the spherical shell and then the cylinder as shown in step 5. Select **`Edit|Boolean|Subtract`** (or press the *Subtract* button on the toolbar). You have used the cylinder as a drill bit to drill a hole in the shell.

11. In the **`Cylinder/Cone`** tab of the **`Insert|Primitive Solids`** dialog box, set the cylinder *Top Length* = 1, and *Base Major R* to 2.5. Set the *Base Position Y* = -51 and the *Base Rotation X* = 90. Press the Insert button.

The geometry you have created in these 11 steps is identical to the integrating sphere model.

Example - Luminaire

This model simulates a fluorescent light fixture with louvers. The lamp is represented as a surface source and the typical output is these applications is a Polar Candela distribution.

From the **File** menu select **Open**. Navigate to the **Demos** folder and open the **Luminaire** folder. See “Example Files” on page 6. Pick *louver.oml* and press Open. The model will look like the following.

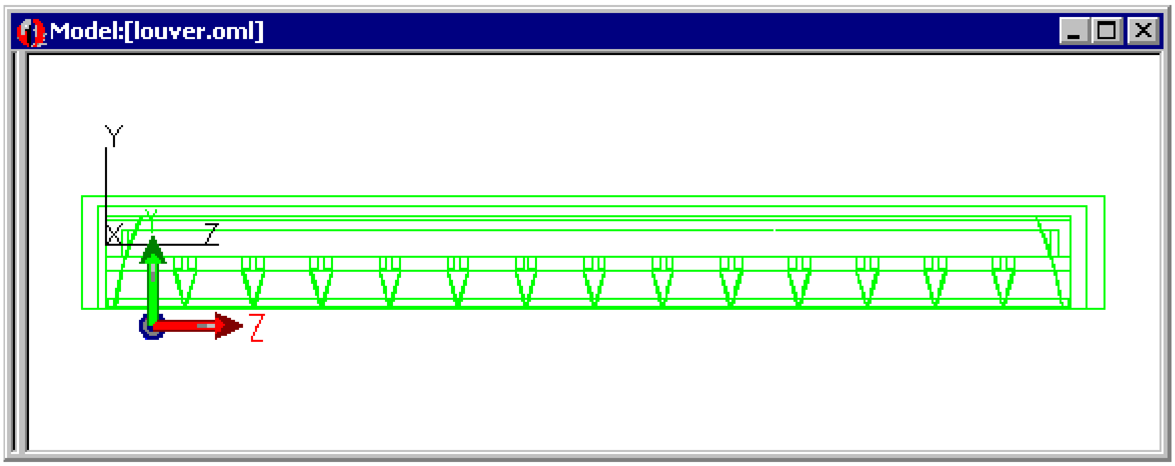
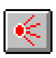


FIGURE 16 - Luminaire with Louvers Model



From the menu select **Analysis|Source Raytrace** and press the *Trace Rays* button. You can also start this type of ray-trace by pressing the *Source Trace* button on the Analysis toolbar. This model is set to trace 10,000 rays. Once the raytrace is complete select **Analysis|Candela Plots|Polar Candela Distribution** to get the plot shown below.

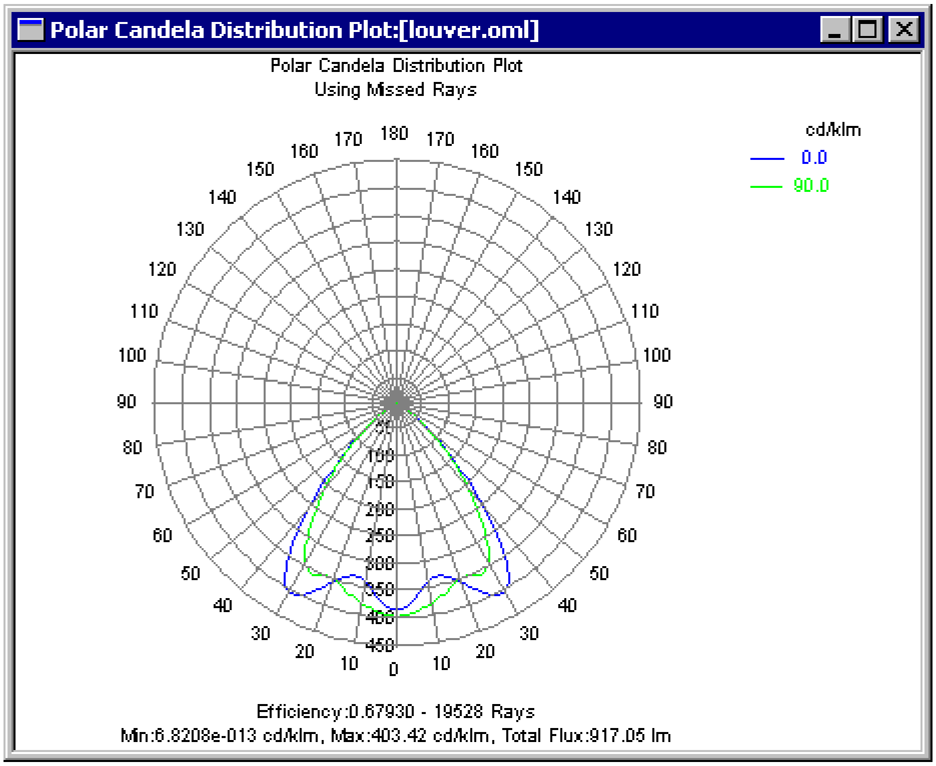
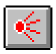


FIGURE 17 - Polar Candela Distribution Plot

Example - Eye Model

This model simulates light entering the eye. TracePro uses property information to describe how light interacts with surfaces and objects (or volumes). The model with traced rays is shown below, along with a TracePro Flux Report.



From the **`File`** menu select **`Open`**. Navigate to the **Demos** folder and open the **Eye Model** folder. See “Example Files” on page 6. Pick *Eye_Model_CGBF.oml* and press Open. Open the *Source Pane* in the *System Tree* and notice that Grid Source 1 is green checked for inclusion in the ray trace. Press the *Source Trace* button on the Analysis toolbar to trace the currently defined grid. The model with rays is shown below.

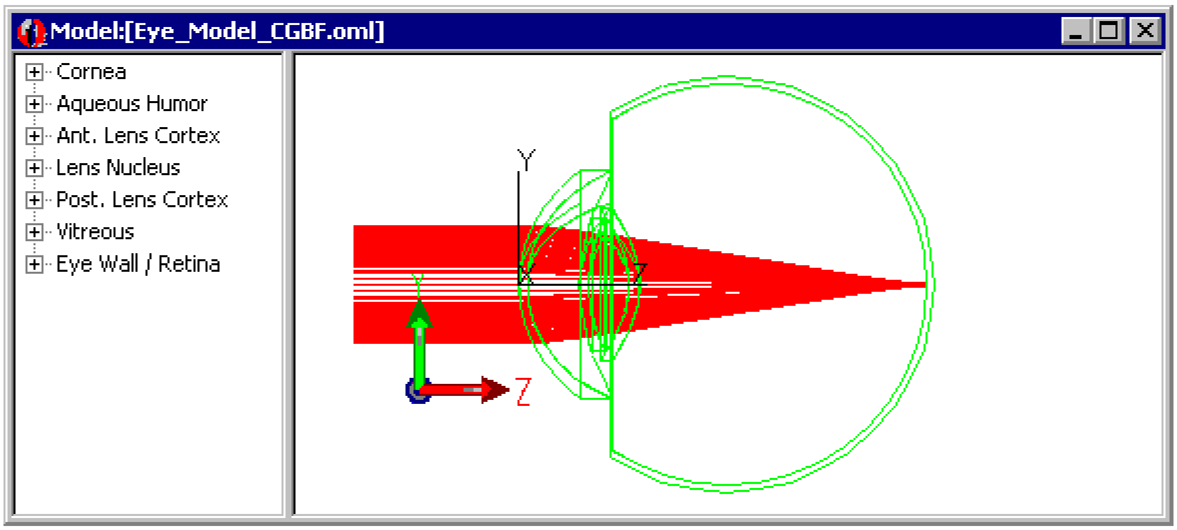
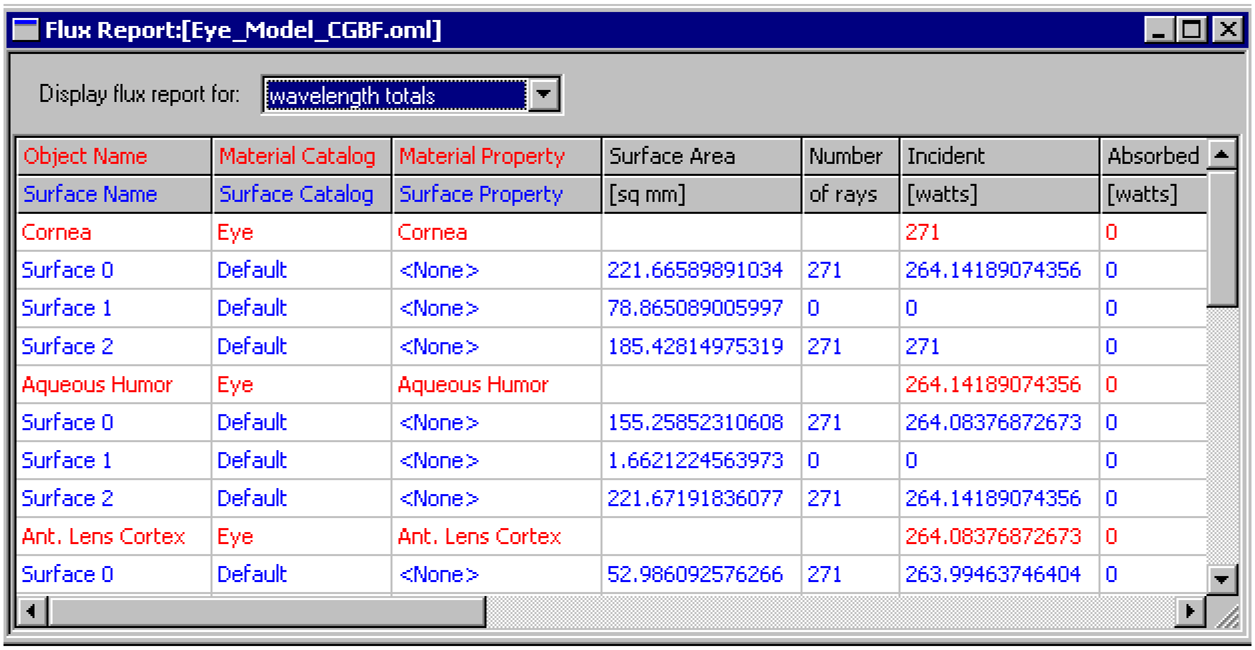


FIGURE 18 - Eye Model

A Flux Report provides a table of flux distributions throughout the mode. Each surface and object is shown with the number of incident rays, incident and absorbed flux, and other data. The report is shown below. The Flux Report is displayed using the **`Reports|Flux`** menu.



Flux Report:[Eye_Model_CGBF.oml]

Display flux report for: wavelength totals

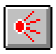
Object Name / Surface Name	Material Catalog / Surface Catalog	Material Property / Surface Property	Surface Area [sq mm]	Number of rays	Incident [watts]	Absorbed [watts]
Cornea	Eye	Cornea			271	0
Surface 0	Default	<None>	221.66589891034	271	264.14189074356	0
Surface 1	Default	<None>	78.865089005997	0	0	0
Surface 2	Default	<None>	185.42814975319	271	271	0
Aqueous Humor	Eye	Aqueous Humor			264.14189074356	0
Surface 0	Default	<None>	155.25852310608	271	264.08376872673	0
Surface 1	Default	<None>	1.6621224563973	0	0	0
Surface 2	Default	<None>	221.67191836077	271	264.14189074356	0
Ant. Lens Cortex	Eye	Ant. Lens Cortex			264.08376872673	0
Surface 0	Default	<None>	52.986092576266	271	263.99463746404	0

FIGURE 19 - Flux Report Table

Example - Importing Models

This example illustrates how to import model data from CAD and Lens Design programs. Applying property data is not enabled in the Trial Version. The first example will open a Lens file which will include the optical properties. The second will open a similar ACIS SAT file without property data.

From the **File** menu select **Open**. Navigate to the **Demos** folder and open the **OSLO** folder. See “Example Files” on page 6. Change the **Files of type:** selection to read *OSLO Files (*.len;*.osl)*. Pick *DEMOTRIP.LEN* and press Open.



Open the *Source Pane* in the *System Tree,* right mouse click on Grid Source 1and select *Define Source*. Change the *Outer radius* to 5 and the Rings to 3. Check Grid Source 1 for inclusion in the ray trace. Press the *Source Trace* button on the Analysis toolbar to trace the currently defined grid. The model with rays is shown below.

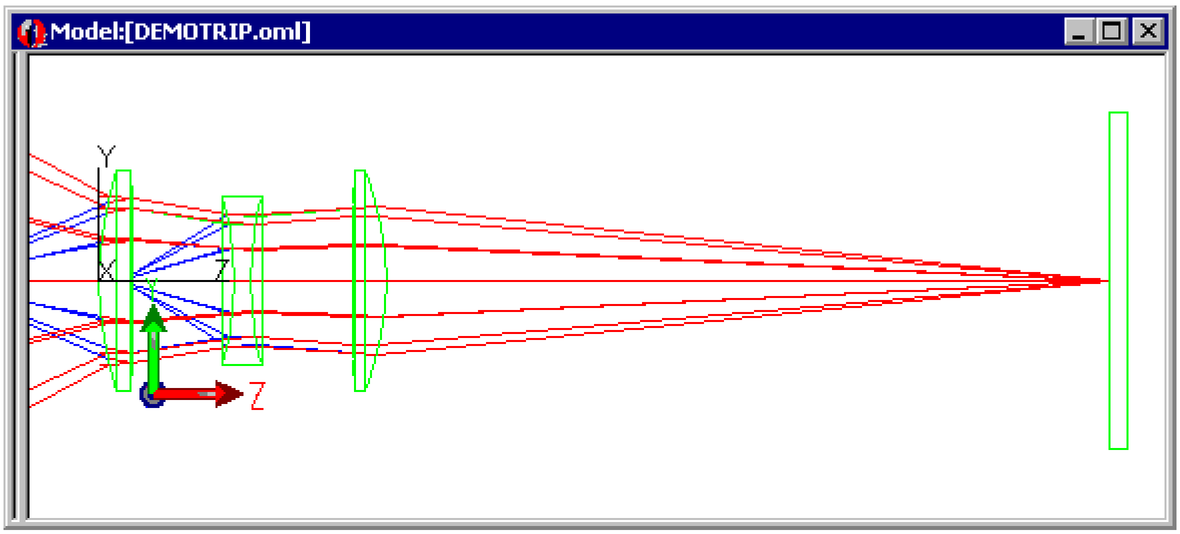
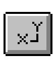


FIGURE 20 - OSLO Triplet Lens File opened in TracePro

From the **File** menu select **Open**. Navigate to the **Demos** folder and open the **ACIS** folder. See “Example Files” on page 6. Change the **Files of type:** selection to read *ACIS Files (*.sat*. Pick *TESSAR.SAT* and press Open. The model is in a standard CAD orientation so select the **View|Profiles|XY** menu or press the *XY View* button to rotate the view to see the lens elements in a lens barrel. The model is shown below.



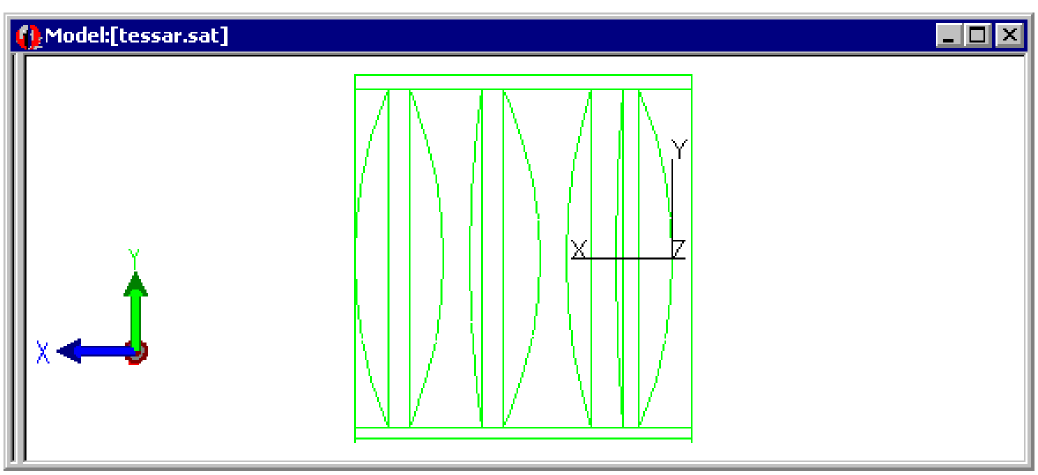
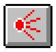


FIGURE 21 - ACIS Tessar Lens File opened in TracePro

Example - Gradient Index

TracePro can evaluate many types of optical materials including Gradient Index (Not available in TracePro LC or TracePro RC). This example will demonstrate raytracing for gradient index and illustrate the methods for importing property data and adding user data.



From the `File` menu select `Open`. Navigate to the **Demos** folder and open the **Gradient Index** folder. Pick *LuneburgLens.OML* and press Open. Open the *Source Pane* in the *System Tree* and notice that Grid Source 1 is green checked for inclusion in the ray trace. Press the *Source Trace* button on the Analysis toolbar to trace the currently defined grid. Some errors will be displayed indicating missing property data.

Select the `Tools|Database|Import` menu or press the `F11` key. The `File Dialog` should be open to the **Demos\Gradient Index** folder and display the file *Grin Props.txt*. Select the file and press Open. Trace rays again to see the effect of the Gradient Index as shown.

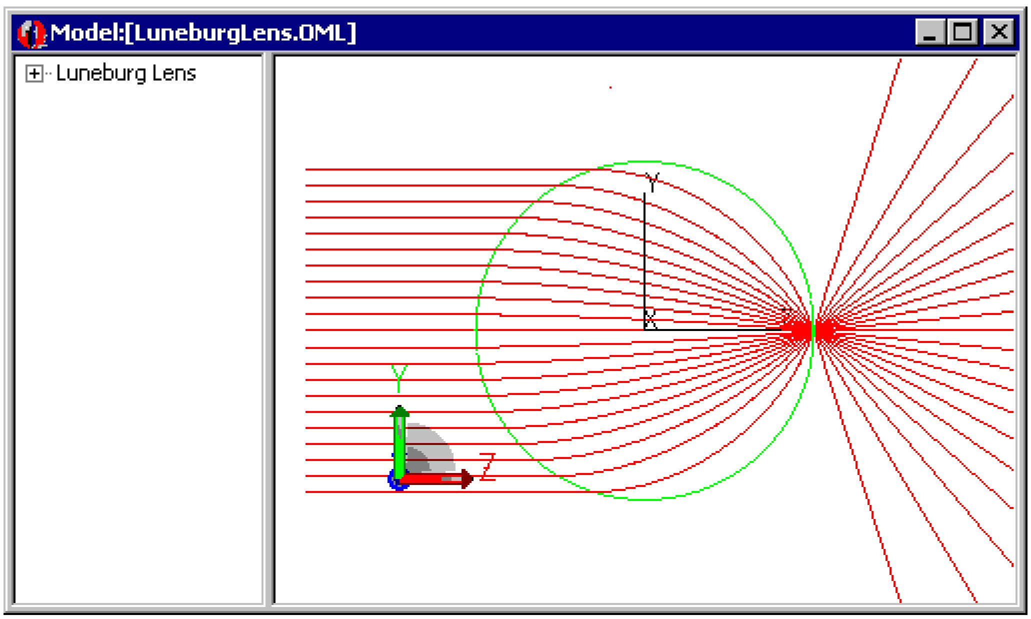
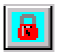
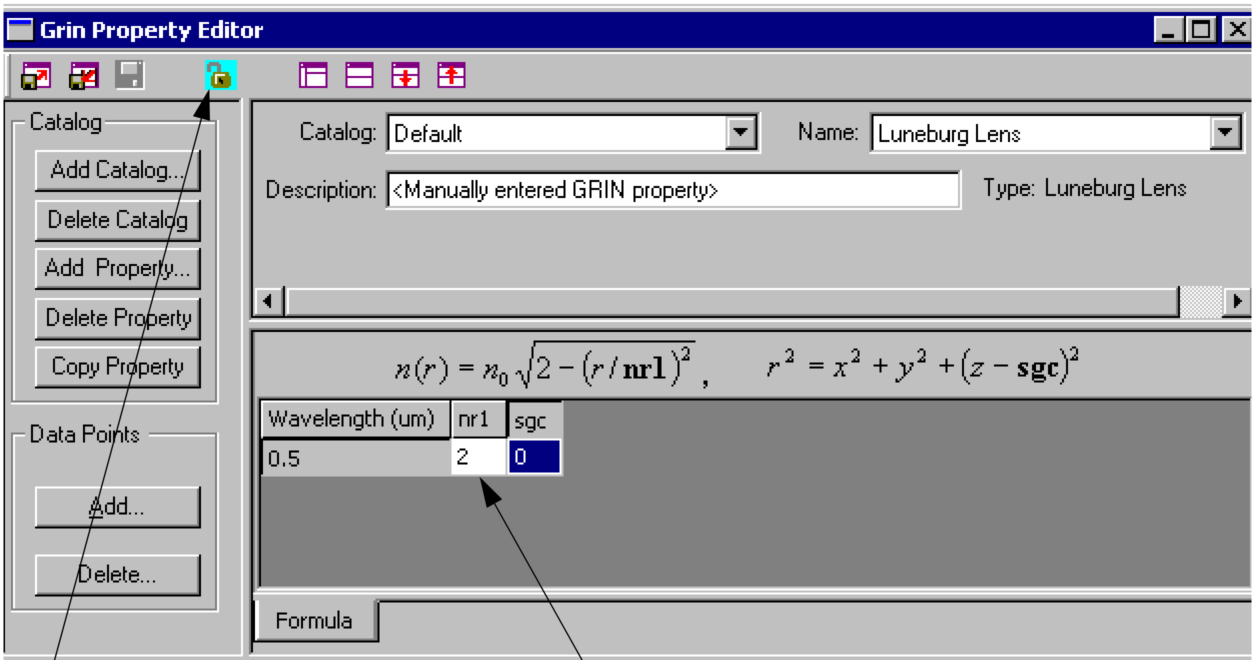


FIGURE 22 - Ray Trace of Gradient Index Luneberg Lens Model



Next, you can modify the property by opening the Gradient Index editor using the **`Define|Edit Property Data|Gradient Index Properties`** menu, select **Luneburg Lens** from the drop down list, and press **`Edit|Unlock Property`**.



Lock/Unlock Icon

Change the value of nr1 from 1 to 2

FIGURE 23 - Grin Property Editor Dialog

Change the nr1 coefficient to 2. Select **`File|Save`** to update the database and trace a Grid Raytrace as above. TracePro automatically updates the model to use the new data. The updated raytrace is shown below. Notice the shift in the focal point.

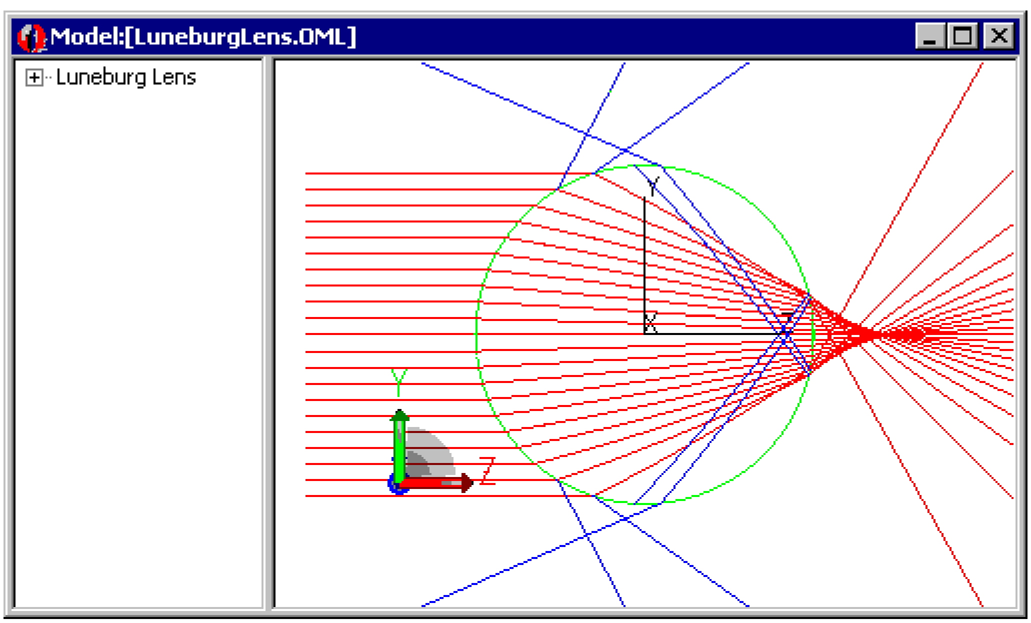
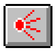


FIGURE 24 - Updated Ray Trace of Gradient Index Luneberg Lens Model

Example - Prisms

The Prism examples illustrate polychromatic properties of optical materials. This example will demonstrate raytracing through two prisms shows the rainbow spectrum as the light is dispersed by the prisms.



From the **File** menu select **Open**. Navigate to the **Demos** folder and open the **Color** folder. See “Example Files” on page 6. Pick *2prisms.OML* and press Open. Open the *Source Pane* in the *System Tree* and notice that Grid Source 1 is green checked for inclusion in the ray trace. Press the *Source Trace* button on the Analysis toolbar to trace the currently defined grid.

The figure displayed below shows three TracePro windows, two Model Windows with their System Trees and an Irradiance Plot in CIE model. The Model Windows are in Render Mode.

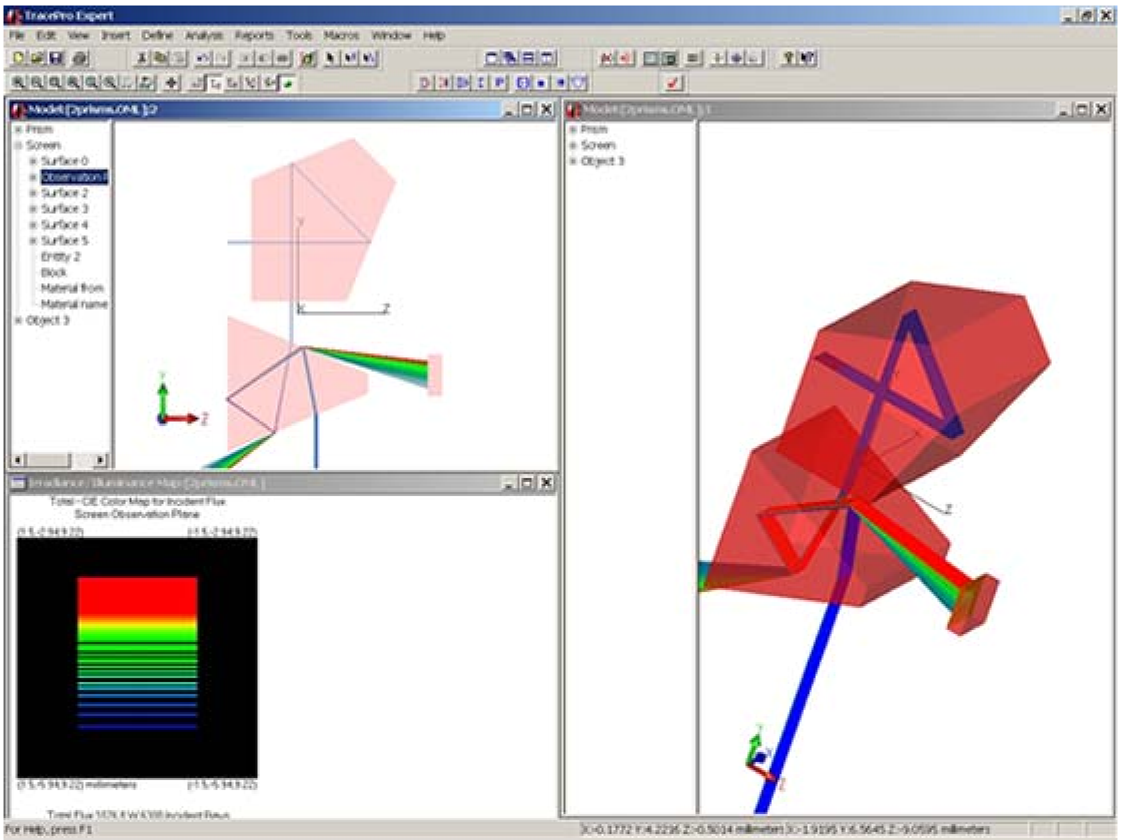
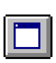


FIGURE 25 - Ray Trace and Irradiance Plot of Prism Model

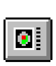
To see a similar output, perform the following operations:

- After the raytrace, Select **View|Render** to change the mode of the Model Window.



- Select **Window|New Window** to open (or press the *New WIndow* button) a second Model Window. Set the View mode to render.

- You can change the viewing orientation by using the **View|Rotate|Orbit** menu or pressing the *Orbit Rotate View* button.
- In the System Tree, select the surface named *Observation Plane* from the object named *Screen.*



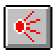
- Select **Analysis|Irradiance Maps** (or press the *Irradiance Maps* button) to see this irradiance map.
- Resize the windows or use **Window|Tile** commands to arrange the windows in a visible layout.

Example - LCD Projector

This example shows the optics for a LCD projector. The light source is split into three channels, red, green and blue. The three channel are recombined to form the output image.

From the **File** menu select **Open**. Navigate to the **Demos** folder and open the **LCD Projector** folder. See "Example Files" on page 6. Pick *Projector.OML* and press Open.

Select the **Tools|Database|Import** menu or press the **F11** key. The **File Dialog** should be open to the **Demos\LCD Projector** folder and display the file *LCD Projector properties.txt*. Select the file and press Open.



From the menu select **Analysis|Source Raytrace** and press the *Trace Rays* button. You can also start this type of ray-trace by pressing the *Source Trace* button on the Analysis toolbar.

The figure is shown in Render Mode with the rays leaving the source, split into three channels and recombined as they exit the projector housing.

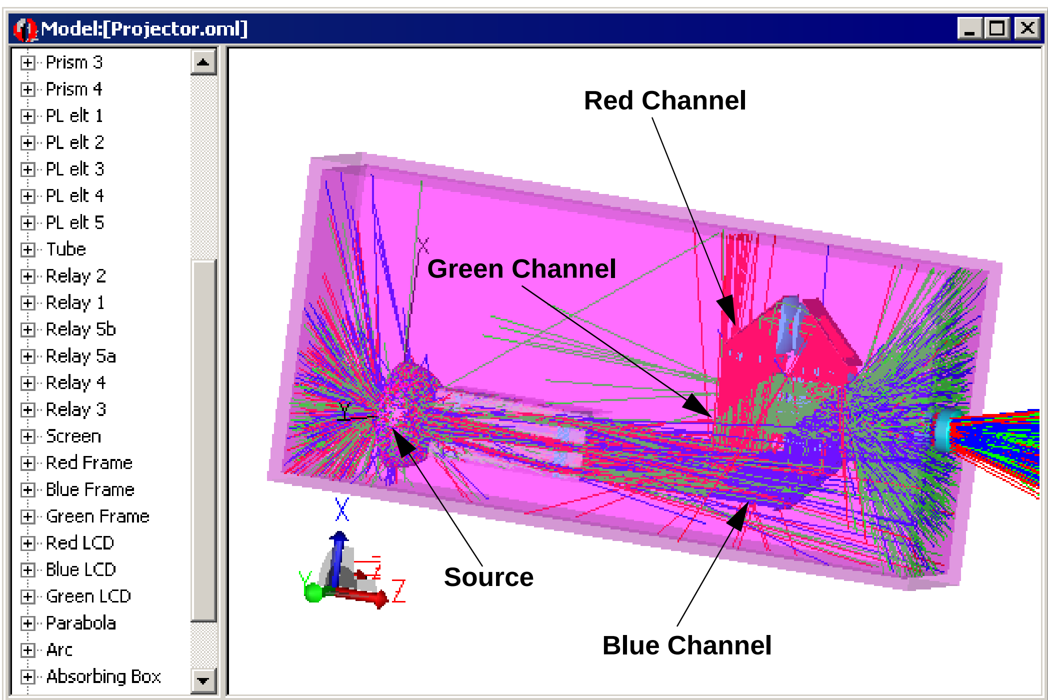


FIGURE 26 - Ray Trace of LCD Projector Model

Models

The **Examples\Demos** folder contains model and property files. Follow the procedure described in the Examples Chapter to open the model file (oml) and load property data (txt) using the F11 key.

File	Description
ACIS\tessar.sat	ACIS file of lenses in a barrel
Billboard\billboard.oml	Illuminated billboard with base lamps
Color\2prisms.oml Color\SF6Prism.oml	Prism examples with polychromatic raytraces
Elliptical Reflector\eliprefl.oml	Metal halide lamp in elliptical reflector
Exit Sign\Multiple LED Exit Sign.oml Exit Sign\Exit Properties.txt	Exit sign with lamps and additional property data
Eye Model\Eye_Model_CGBF.oml Eye Model\Ant. Lens Cortex.txt Eye Model\Aqueous Humor.txt Eye Model\Cornea.txt Eye Model\Lens Nucleus.txt Eye Model\Post. Lens Cortex.txt Eye Model\Vitreous Body.txt	Eye model with additional property data
Front Light\frontlight.oml	Side illuminated light pipe
Gradient Index\LuneburgLens.oml Gradient Index\Grin Props.txt	Gradient index ball lens with additional property data
Integrating Sphere\intspher.oml	Integrating sphere model
Laser Pumping\Pumping example.oml Laser Pumping\pumping.txt	Diode pumped laser rod for Volume Flux demonstrations with additional property data
LCD Projector\Projector.oml LCD Projector\LCD Projector properties.txt	LCD projector model with additional property data
Lens Demo\DBLGAUSS.oml Lens Demo\lensdemo.oml	Optical imaging and stray light models
Luminaire\louver.oml	Fluorescent fixture with louvers

File	Description
Medical Tissue Tutorial\ Medical tissue tutorial file with importance sampling.oml Medical Tissue Tutorial\ Medical tissue tutorial file.oml Medical Tissue Tutorial\ Medical Bulk Scatter.txt	Model for tissue tutorial with additional property data
OSLO\DEMOTRIP.len OSLO\PETZVAL.len	OSLO lens file for lens import
Polarization\BrewsterAngle.oml Polarization\FresnelRhomb.oml Polarization\PolarizingComponents.oml	Models showing polarization effects
Radio Lightpipe\radio lpiron.oml	Lightpipe for dash illumination
RGB LEDs\3 LED RGB.oml RGB LEDs\led 20 blue.txt RGB LEDs\led 20 green.txt RGB LEDs\led 20 red.txt	Three color LEDs combined to show color components of white light
Street Light\street lighting.oml	Street light illuminating a road
Tail Lamp\reverse taillamp.oml	Automotive tail lamp model
Tunnel\Tunnel.oml Tunnel\Holophane Flood.txt	Illuminated tunnel using Holophane flood lamps with additional property data
FluorescenceTutorial\Fluorometer.oml	2 channel fluorometer
LuminanceMapTutorial\glass sphere on checkerboard.oml LuminanceMapTutorial\glass sphere on red-white checkerboard.oml LuminanceMapTutorial\paint, flat1.txt LuminanceMapTutorial\GlassSphereOnCheckerboardProperties.txt	Glass sphere on checkerboard

File	Description
3DTexturesRepTilesTutorial\MicrolensArray.oml 3DTexturesRepTilesTutorial\MicrolensArray3DTextures.txt	Spherical microlens array (Brightness Enhanced Film) with RepTile property data

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