LCD Back Lighting Tutorial

This is a tutorial for users of TracePro Expert.

LCD Back Lighting Tutorial

This tutorial illustrates how to use TracePro for the analysis of LCD Back Lights. The steps include

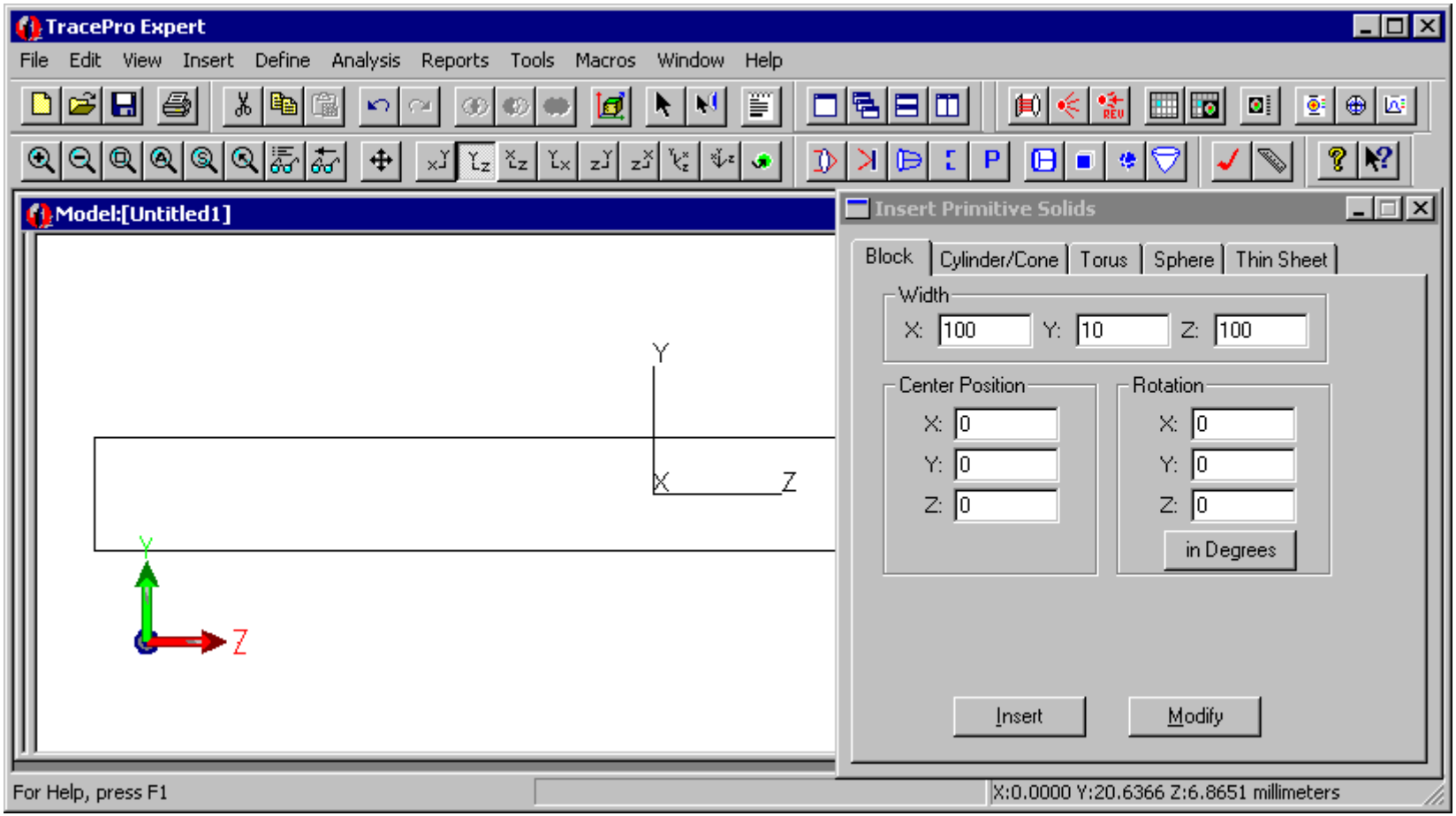
- generating a solid model
- applying material properties
- applying surface properties
- creating and applying RepTile properties
- creating surface sources
- tracing rays
- viewing irradiance

The tutorial also provides an expanded description of the irradiance options included in TracePro.

Create an LCD Panel

The first step will be to create the LCD Panel

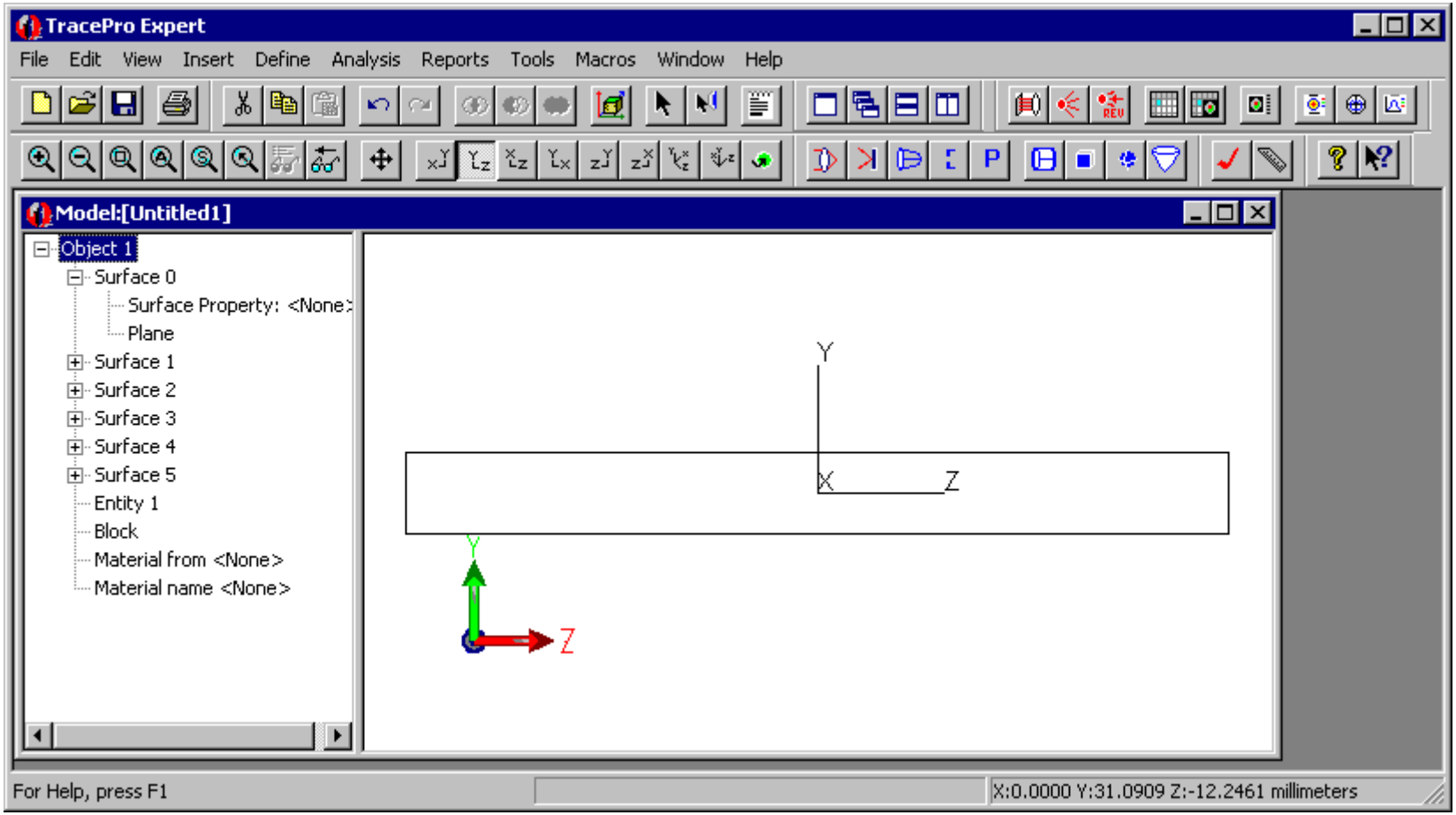
1. Start TracePro.
2. From the **`Insert`** Menu, select **`Primitive Solid`**.
3. Select the **`Block`** Tab and enter the Width values 100 for X, 10 for Y and 100 for Z.
4. Click the **`Insert`** button to create the block.
5. Press the Zoom All button or select the **`View|Zoom|All`** menu to see the new object



Opening the System Tree

The TracePro System Tree provides an expandible list of data showing model object and surfaces along with their properties.

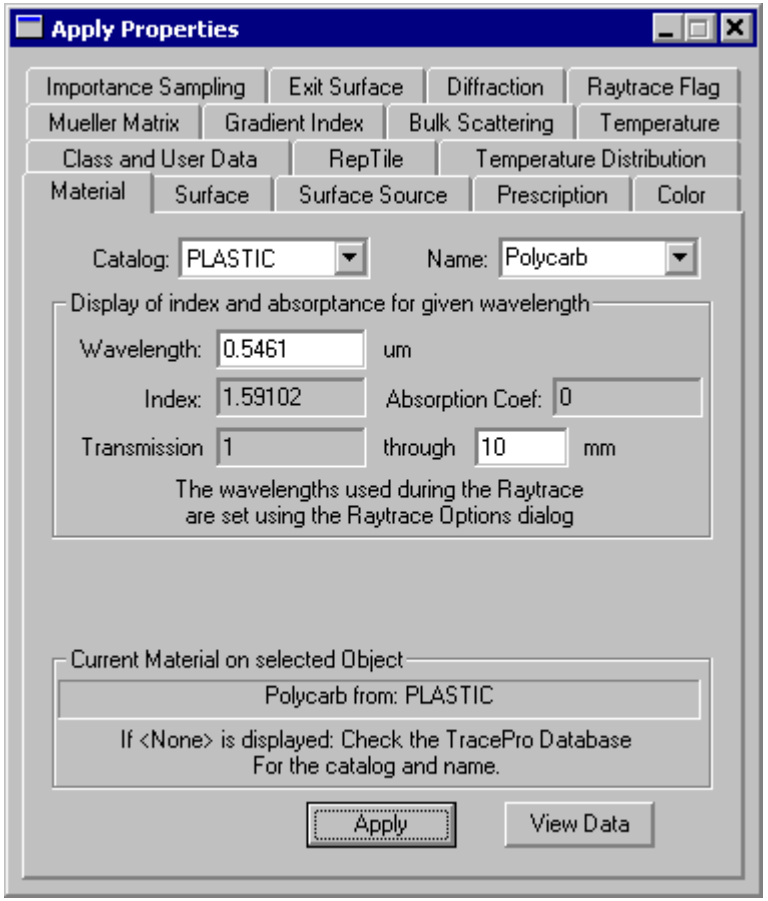
1. To open the System Tree go to the **`Window`** Menu and select the **`Split`** option. This option moves the mouse cursor over the splitter bar at the left of the window. You can do the same by moving the mouse there yourself.
2. Drag the splitter bar to separate the window into two separate and distinct areas, one showing the System Tree and the second the 3D viewing area.
3. Left mouse clicking on any + sign in the System Tree opens the object or surface to display more information.



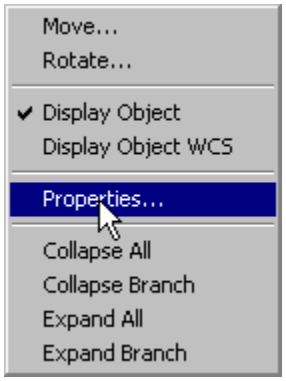
Adding Material Properties to the LCD Panel

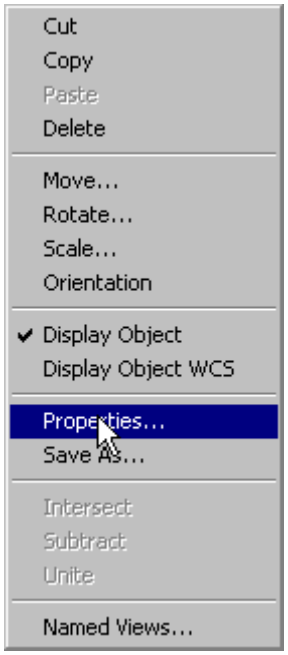
TracePro attaches properties to the model objects and surfaces in order to create an “optical model”. The LCD Panel needs to be made optical by the application of a Material Proeprty.

1. Click on the block in the System Tree to highlight it in the tree and the viewing area.
2. Right-click either on the viewing side or the tree side of the screen to open a pop-up menu. Select Properties to open the Apply Properties dialog box. (You can also do this by selecting **`Define|Apply Properties`** from the TracePro menu.)
3. On the **`Apply Properties`** dialog box, select the **`Material`** Tab.
4. Select the Plastic Catalog and the Polycarb name using the drop-down lists.
5. Click the **Apply** button to apply the property.
6. The System Tree should show the Plastic Polycarb as the material applied to the block.



Popup in System Tree



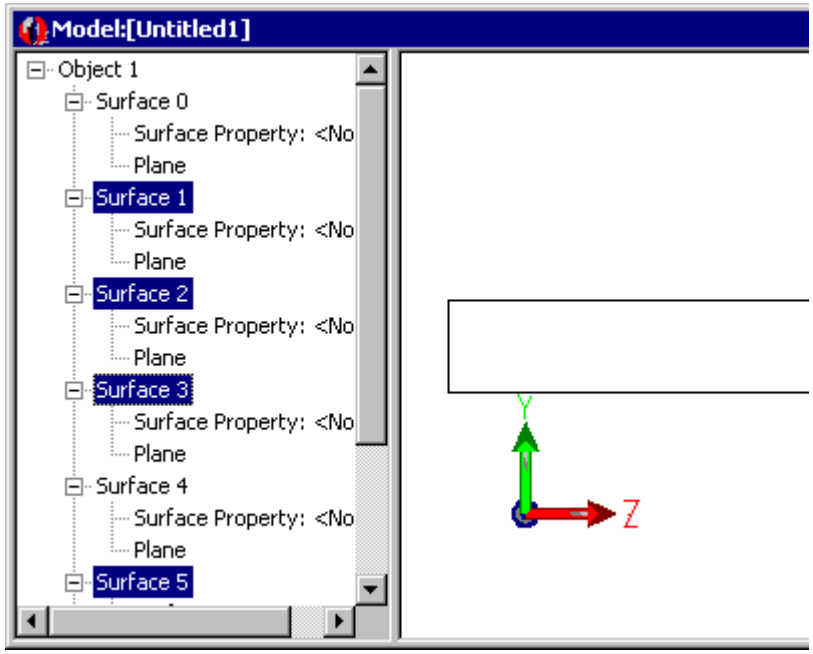


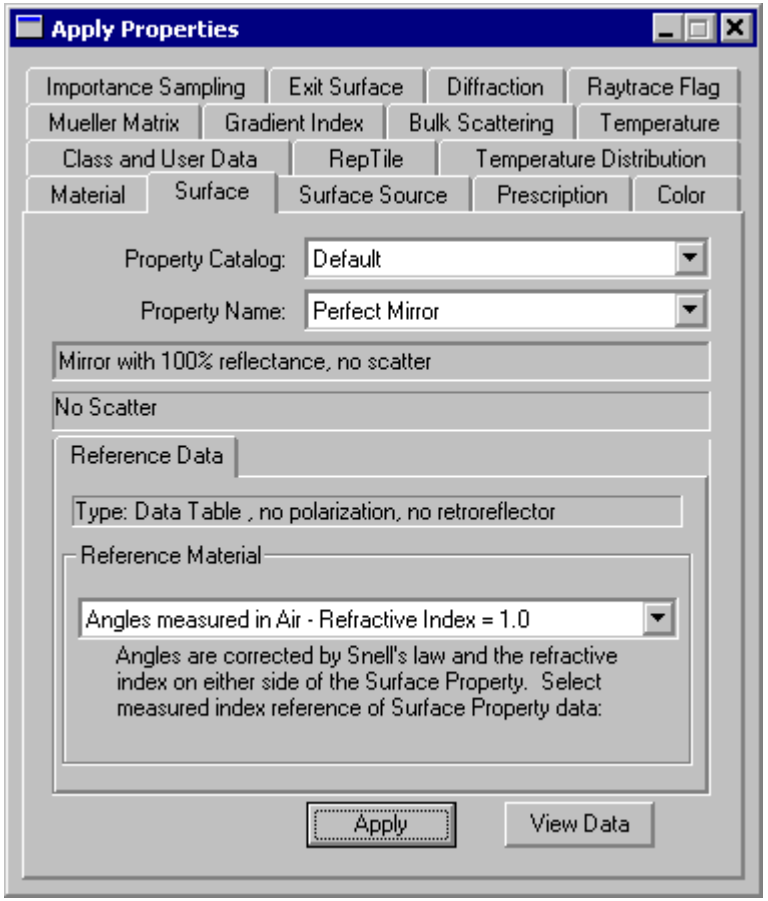
Popup in Model View

Adding Surface Properties to the LCD Panel

Add a mirrored surface to the bottom and three sides of the panel you need to select surfaces 1, 2, 3 and 5.

1. First expand the block object by clicking on the + sign next to the object.
2. Click on Surface 1 to highlight the surface in the System Tree and the viewing area.
3. Hold the Ctrl key down and click on surfaces 2, 3, and 5 to add them to the selection.
4. In the Apply Properties dialog box, select the Surface tab.
5. Using the drop-down list, select the Perfect Mirror property.
6. Click the Apply button to apply this property to all the selected surfaces.
7. Look in the System Tree to verify that the surface property has been applied to the correct surfaces

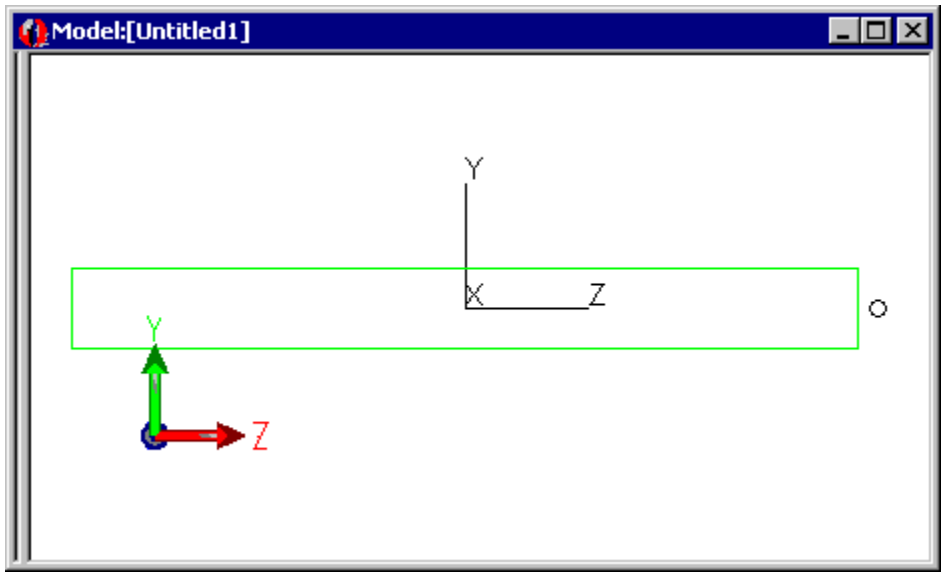


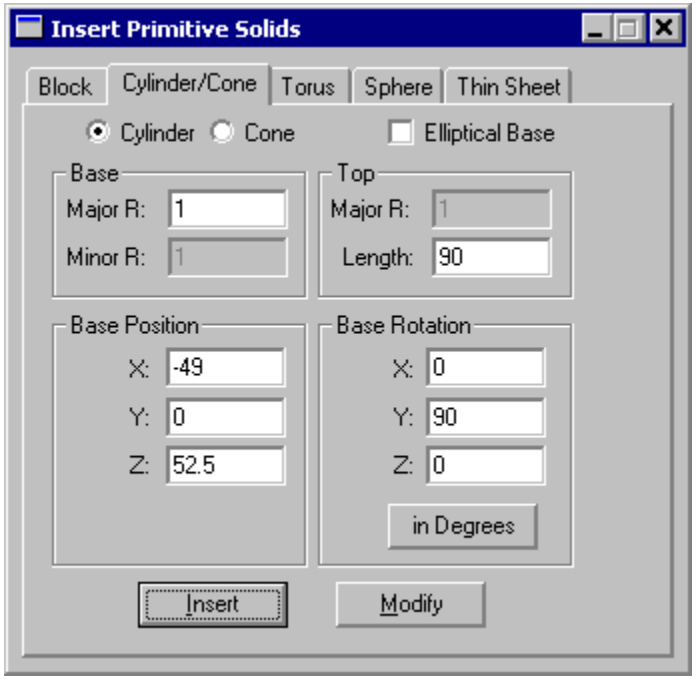


Creating the Fluorescent Tube

The panel will be illuminated from the side by a fluorescent tube. The next several steps will create the tube.

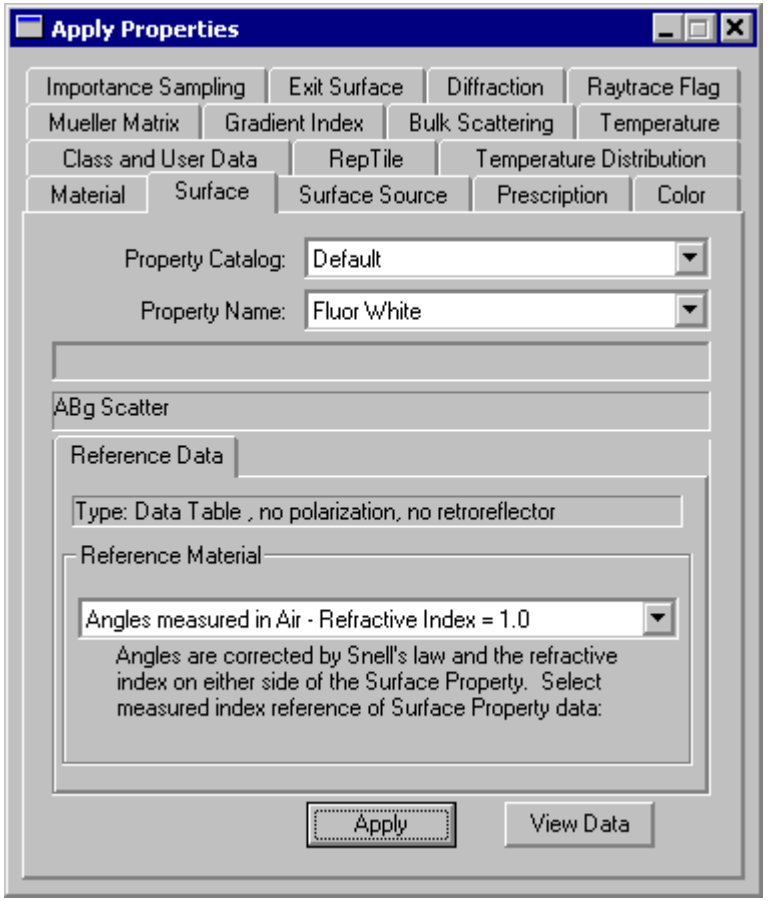
1. To create the fluorescent tube, from the **`Insert`** Menu select **`Primitive Solid`**, then select the **`Cylinder/Cone`** tab.
2. Enter the radius, length, base position, and rotation as shown in the dialog box at right.
3. Click the Insert button to create the cylinder.

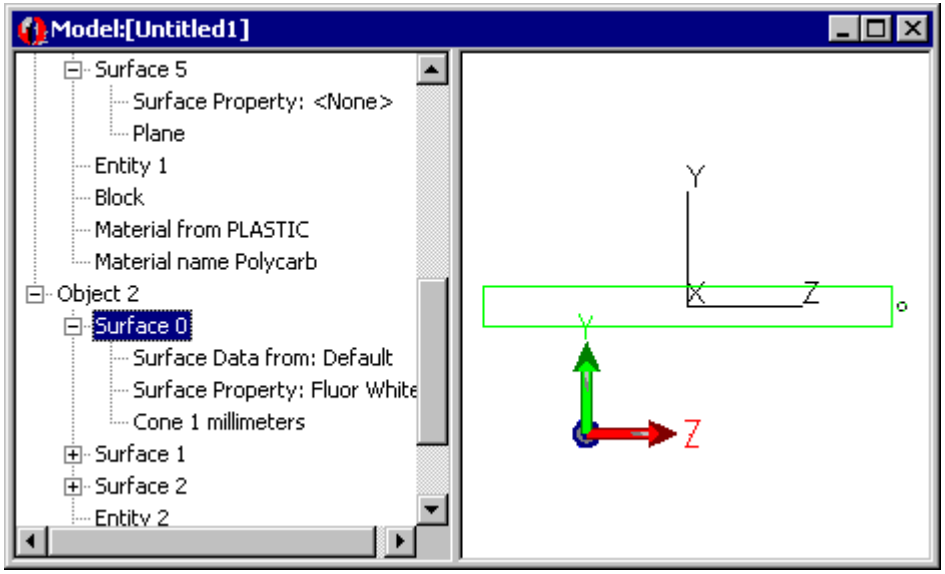




Adding a Surface Property to the Bulb

1. Click on the + sign of the object that was just created to expand the tree and display the three surfaces that make the cylinder: the two plane ends and the cone between the ends.
2. Click on Surface 0 to highlight the surface in the System Tree and the viewing screen.
3. Click on the + sign of Surface 0.Right-click on the viewing area to open the pop-up menu.
4. Select Properties.
5. Select the Surface tab.
6. Using the drop-down list, select the Fluor White property.
7. Click the **Apply** button at the bottom of the Apply Properties dialog box to apply the property.
8. Surface 0 should now display the Surface Property Fluor White as shown in the figure.

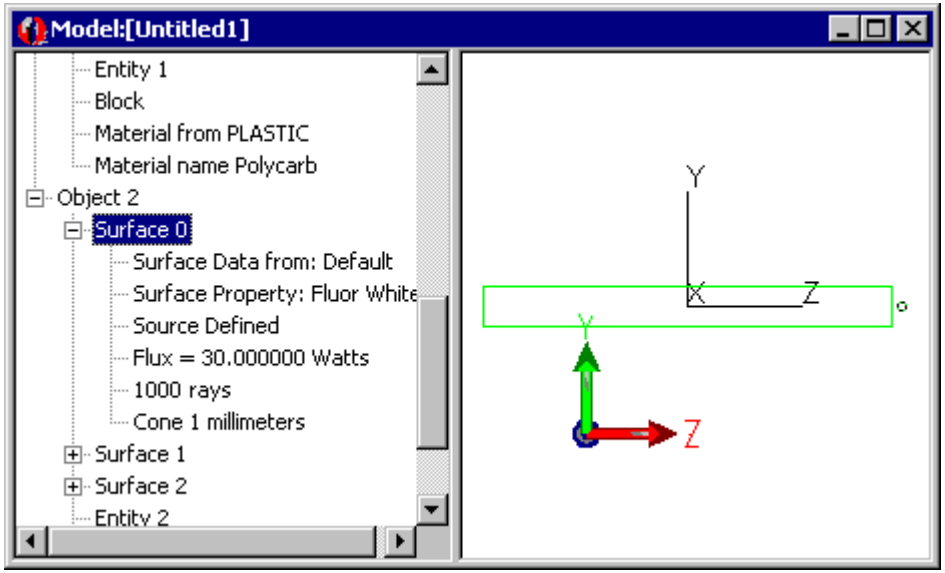


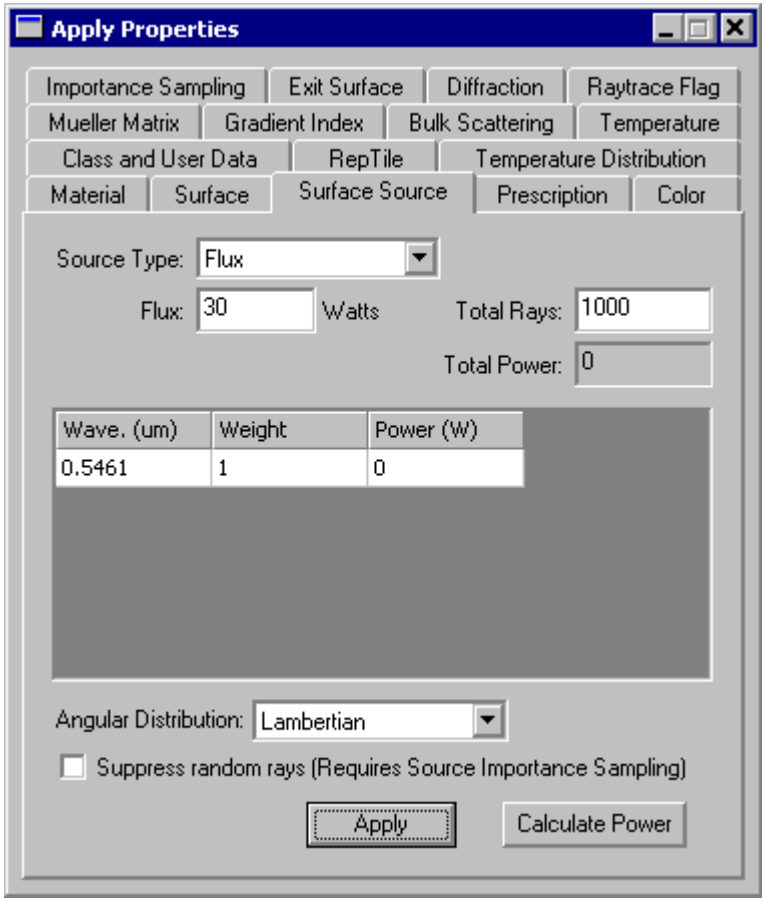


Adding a Surface Source Property to the Bulb

The next step with the tube is to add a Source Property to the tube's cylindrical surface. Surface Sources define emitting surfaces in Tracepro.

1. On the **`Apply Properties`** dialog box, select the **`Surface Source`** tab.
2. For the **Source Type** select **Flux**, enter **Flux** of **30** Watts, set the **Number of Rays** to **1000**, and set the **Angular Distribution** to **Lambertian**.
3. Click **Apply** to apply this source property to surface 0.

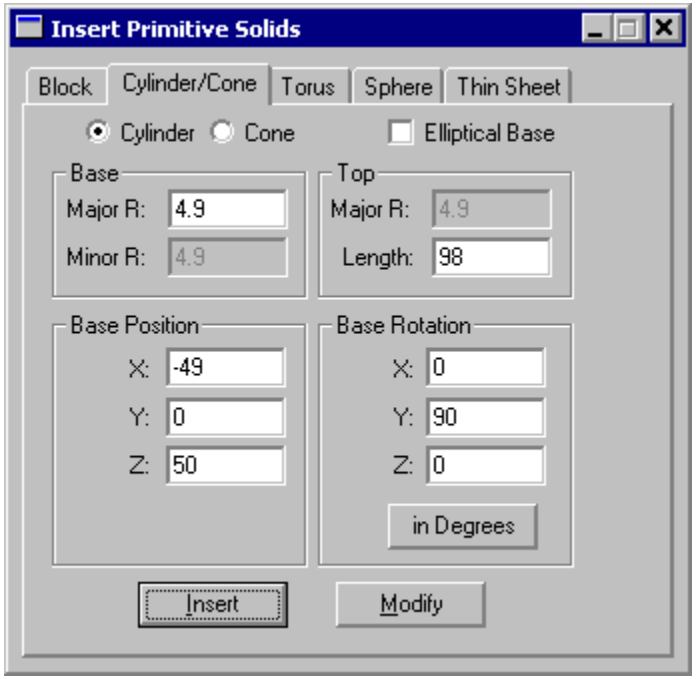




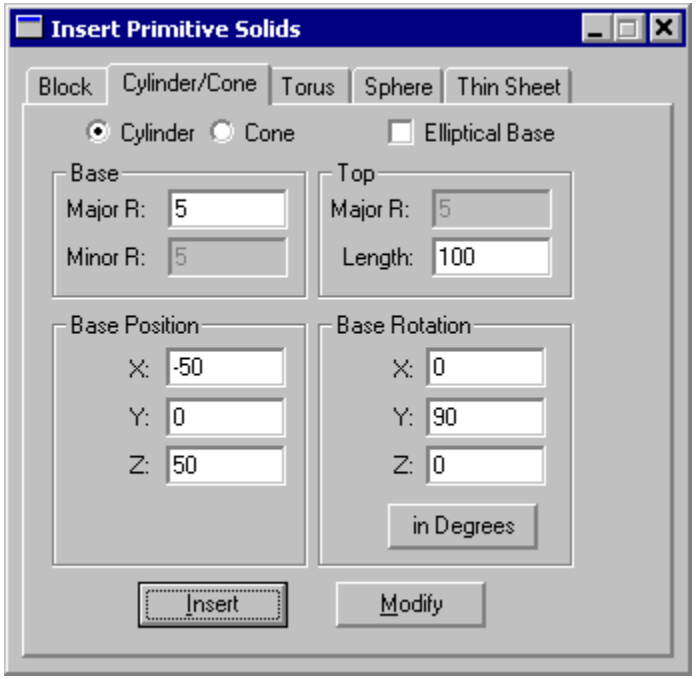
Creating the Reflector around the Source

A reflecting surface will be added to collect the light from the source which is emitted away from the panel and redirect the light into the panel.

1. Select **`Insert|Primitive Solid`** to open the Insert Primitive Solids dialog box.
2. Select the **`Cylinder/Cone`** tab and insert a cylinder with the dimensions as shown in the dialog box at right.
3. Make a second cylinder slightly shorter and smaller in radius than the first. This will define the inside of a cylindrical shell.
4. After inserting a cylinder with the dimensions as in the dialog box below, you will have two cylinders that are positioned around the bulb.



Inside Reflector Dimensions



Outside Reflector Dimensions

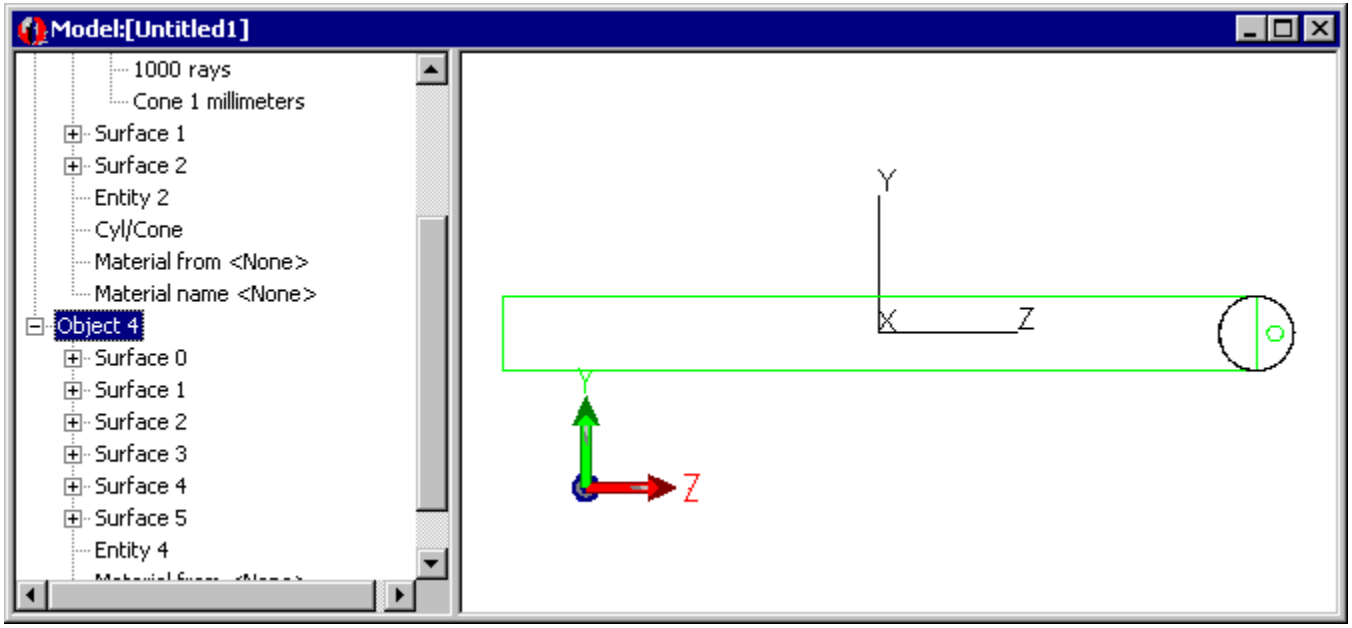
Creating the Reflector

The reflector shell will be made by subtracting the inner cylinder from the outer cylinder using a Boolean Subtraction operation.

1. Select the outer (larger) cylinder in the System Tree.
2. Select the inner (smaller) cylinder in the System tree while pressing the Ctrl key. This is call a Ctrl+Click and extends the selection tow include both objects.

3. Select the Boolean Subtract icon, or use the **`Edit|Boolean|Subtract`** menu to perform the Boolean operation.
4. then click on the Object number that is the larger cylinder in the System Tree, then click on the smaller cylinder in the tree. The result will be one object with 6 surfaces.

5. If you make a mistake, click on the Undo Icon or select **`Edit|Undo`** to reverse the subtraction operation and try again.

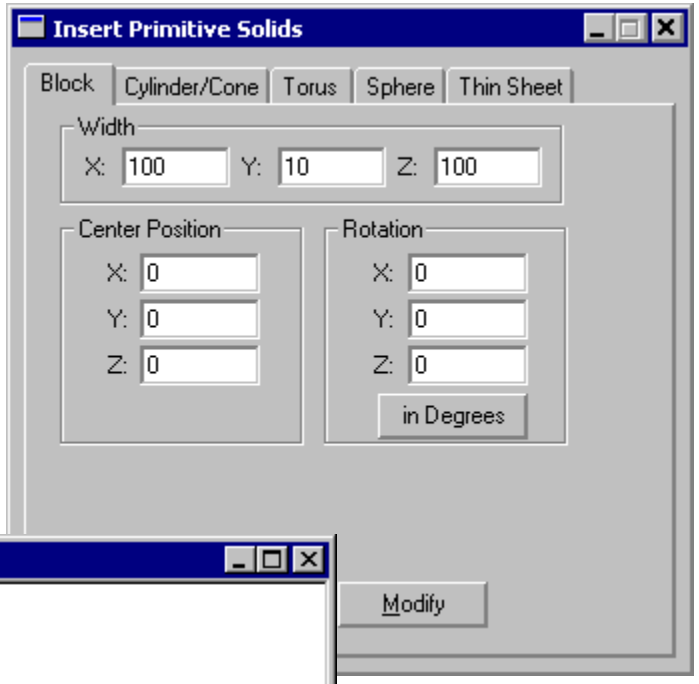


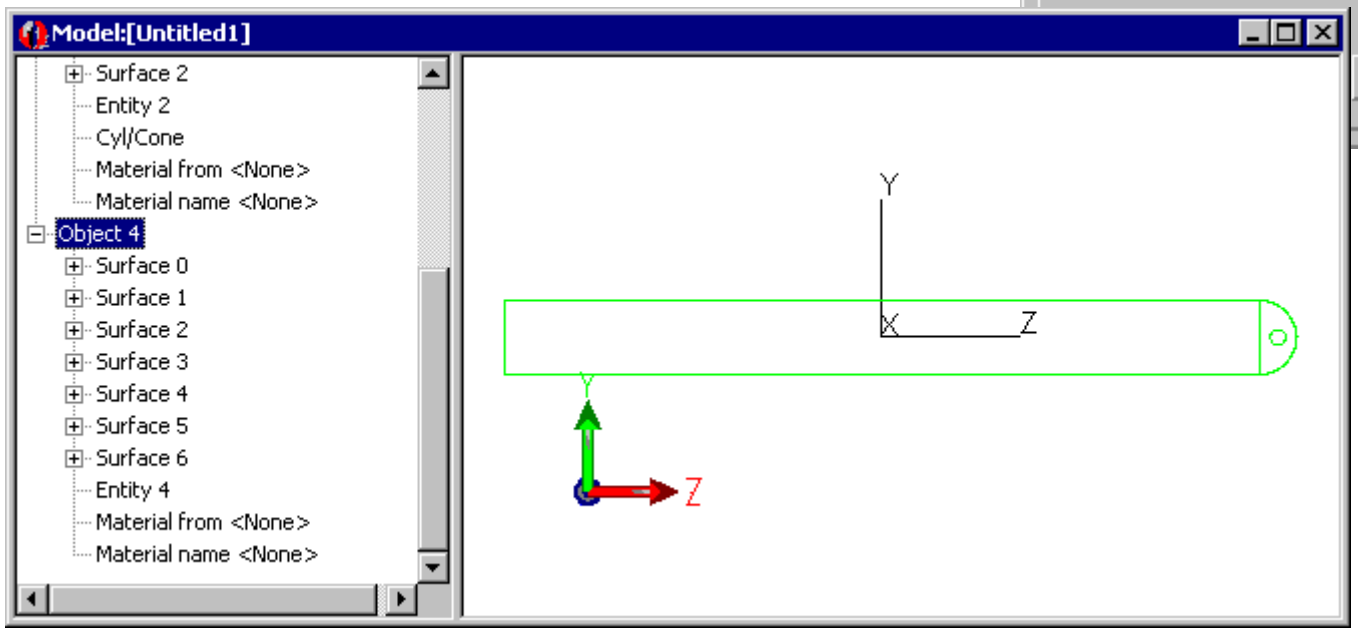
Creating the Reflector

You only need the right half of the reflector shell. Another Boolean Subtract is used to complete the creation of the reflector geometry. Start by inserting a second block and use it to cut off half the reflector.

1. Open the Insert Primitive Solids dialog box and make a block with the dimensions shown at right.
2. Select the reflector shell
3. Ctrl+Click select the block.
4. Click the Boolean Subtract icon.

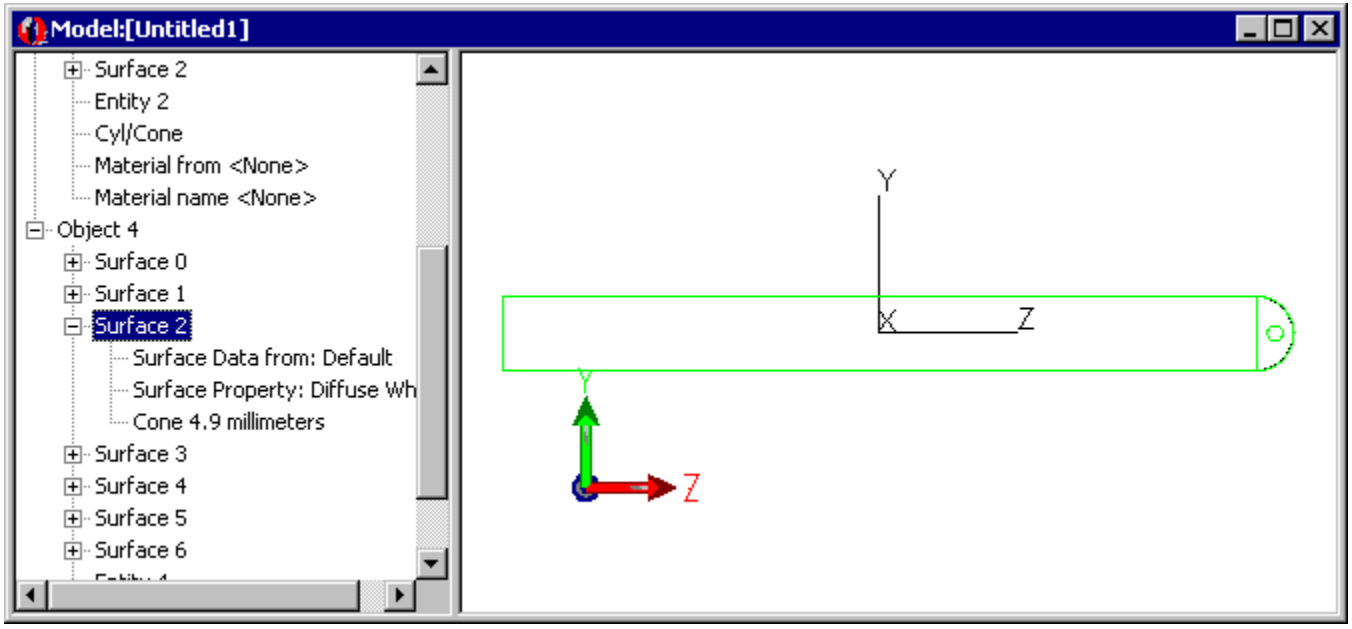
5. This should create the half-cylinder reflector that you need.





Applying a Surface Property to the Reflector

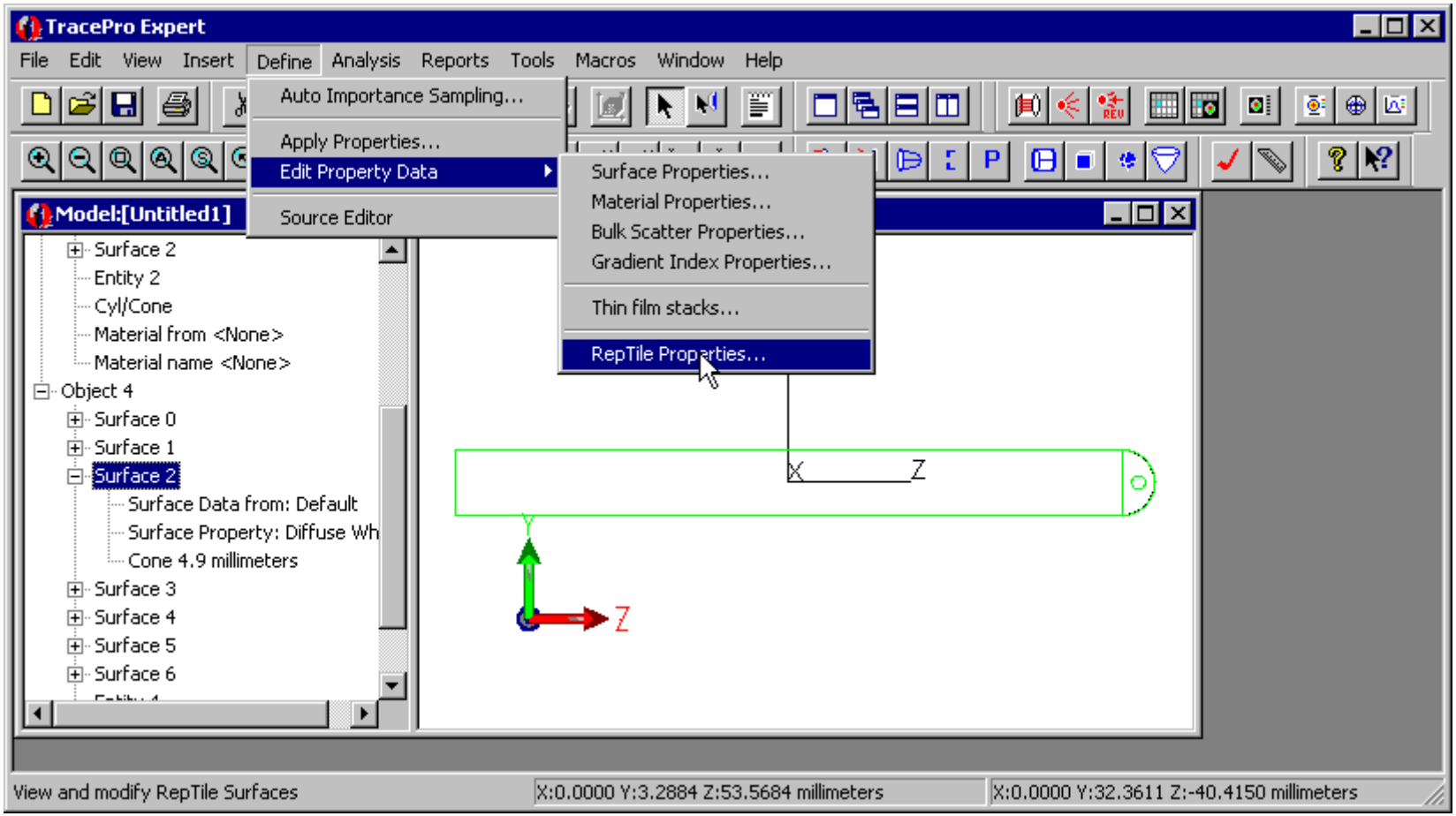
1. Using the System Tree, click on the reflector object, expand it and click on the surface tagged “Cone 4.9 millimeters” This is the inside cylindrical surface of the reflector.
2. In the Apply Properties dialog box, Surface tab, select the Diffuse White surface property.
3. Click **Apply** to apply it to the reflector surface.
4. An expanded view of the object is shown in the System Tree.



Creating a dot pattern using RepTile™

Now you will create a dot pattern using the RepTile™ feature in TracePro Expert Edition.

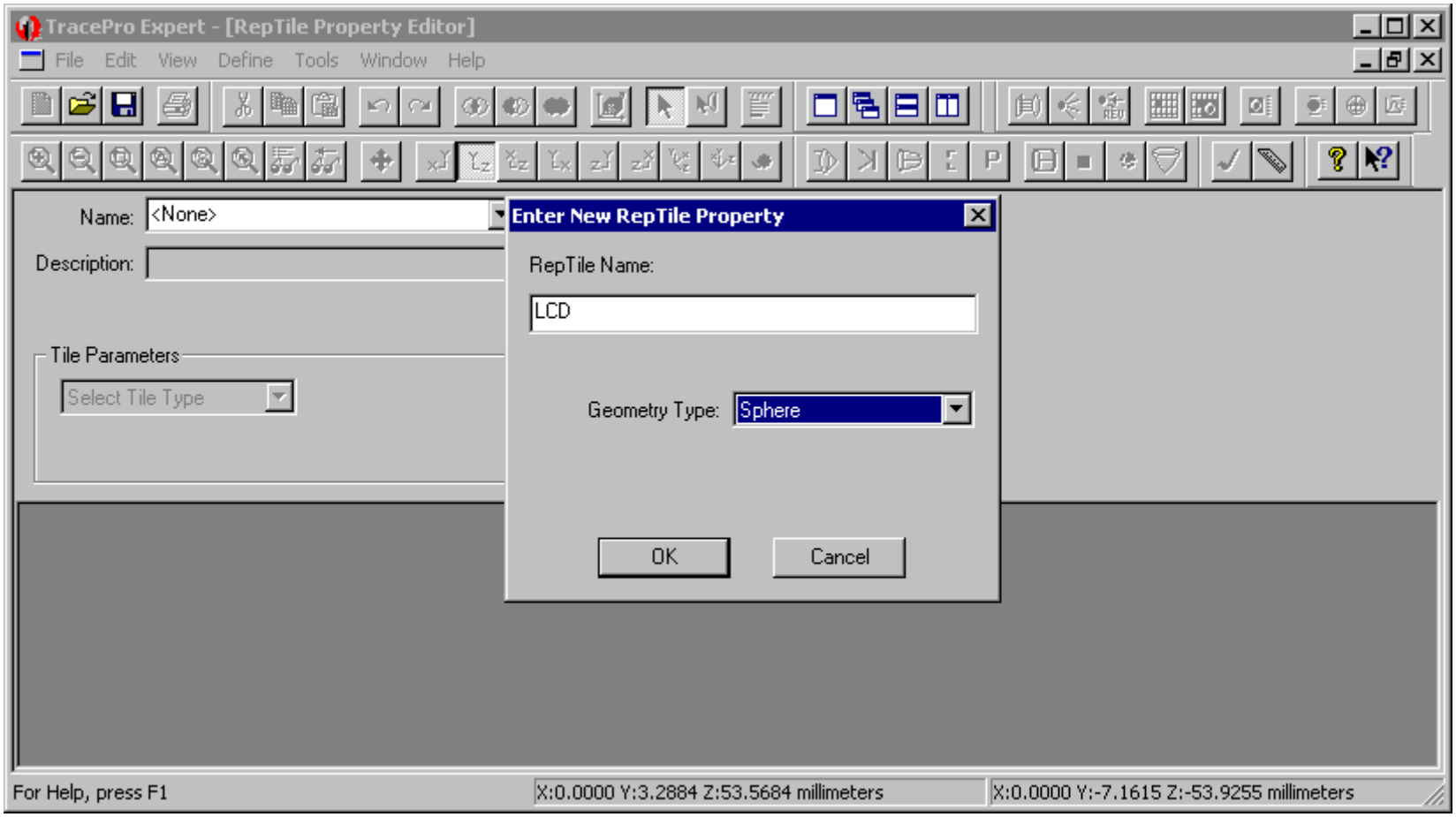
1. Select **`Define|Edit Property Data|RepTile Properties`** to open the RepTile Property Editor



Creating a dot pattern using RepTile

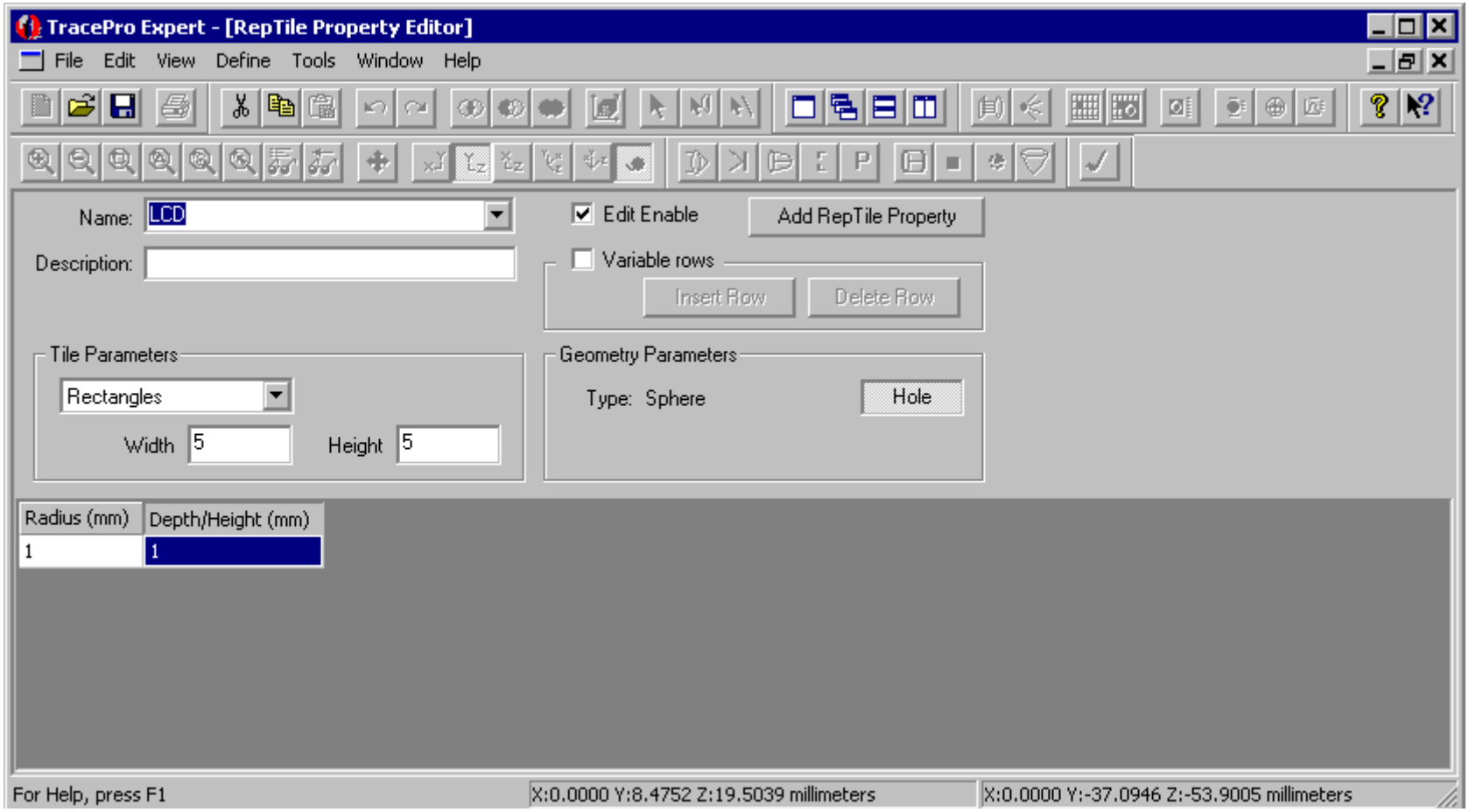
You can add and edit property data with the Tracepro Property editors. The next step is to add a RepTile property for the LCD panel.

1. In the RepTile Property Editor, click Add Reptile Property.
2. Type in **LCD** panel dot pattern for the name, and select **Geometry Type** = **Sphere**.
3. Click OK to create the property.



Creating a dot pattern using RepTile

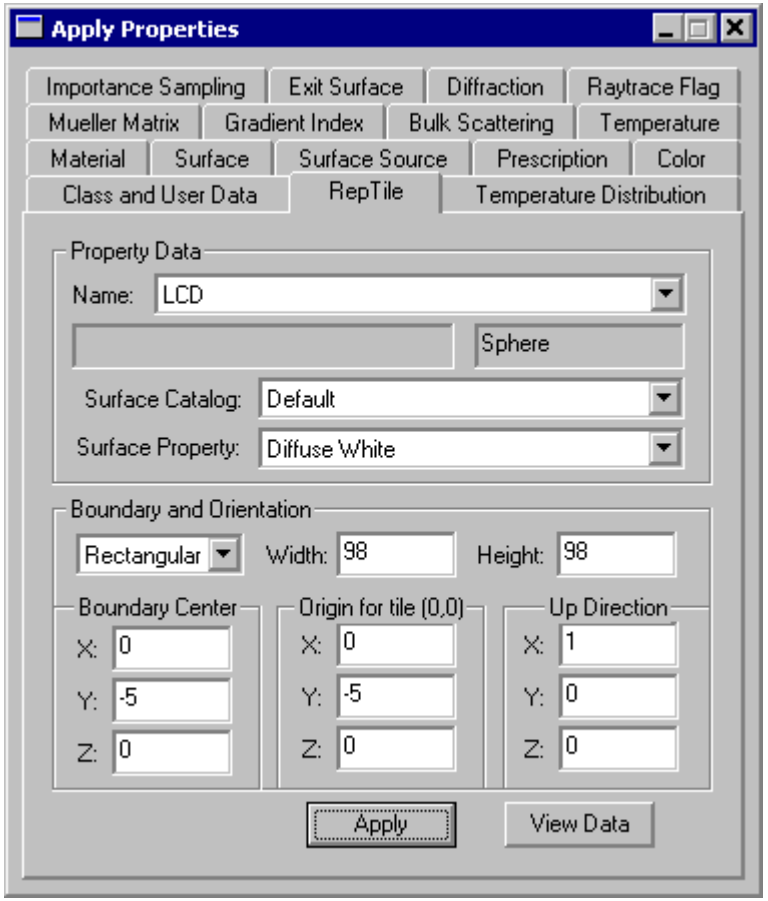
1. Select Tile Parameters Rectangles from the drop-down list.
2. Enter 5 for both the Width and Height.
3. In the spreadsheet part of the editor, enter 1 for the radius and 1 for the height.
4. Finally, click the Bump button to change it from Bump to Hole.
5. The completed property should appear as shown.
6. Click the Save icon to save the property in the database (or select **`File|Save`**) and close the Editor.



Creating a dot pattern using RepTile

The RepTile property will be used on the bottom of the LCD panel to improve the uniformity of the reflected light.

1. Select the bottom surface of the LCD in preparation for applying the RepTile property. It's also a good idea to label the objects and surfaces for easy reference. Surface and object names are modified by clicking in the Stem Tree label and typing the new name.
2. Open the **`Define|Apply Properties`** dialog box and select the **`RepTile`** tab.
3. Select the LCD panel dot pattern property and Diffuse White surface property
4. Enter the values shown for boundary dimensions, center, (0,0) tile, and Up Vector.
5. Press **Apply** to update the surface.



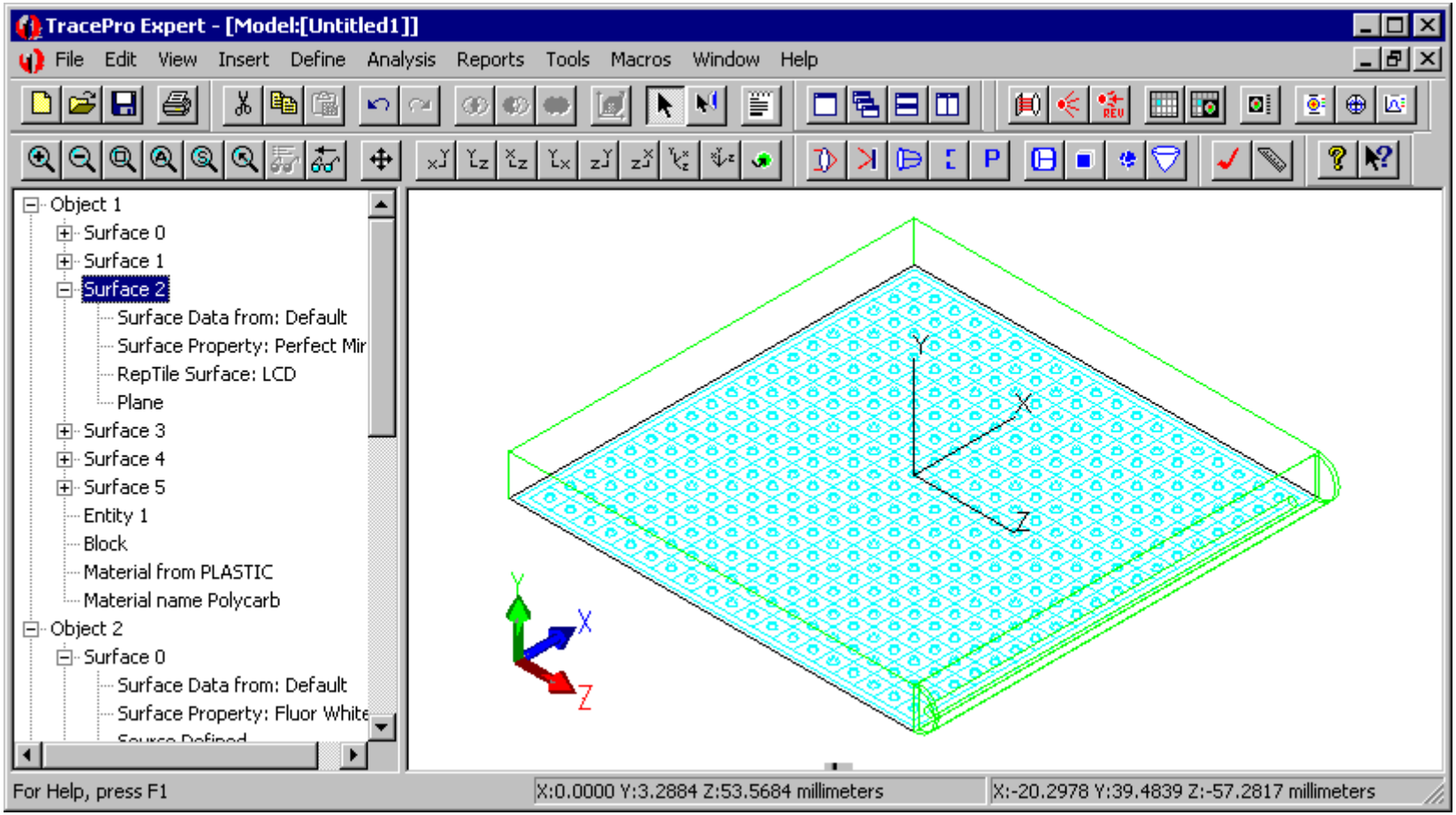
The patterned surface is now complete.

- You have created a 98x98 mm rectangular region on the bottom surface filled with spherical holes (as seen from the outside of the solid).
- The surface property on the substrate is Perfect Mirror, and the property on the holes is Diffuse White.
- The holes are spaced 5 mm apart and are 1 mm in radius.

Display the RepTile Surface

RepTile surfaces do not have geometry like other objects and surfaces in TracePro but can be displayed.

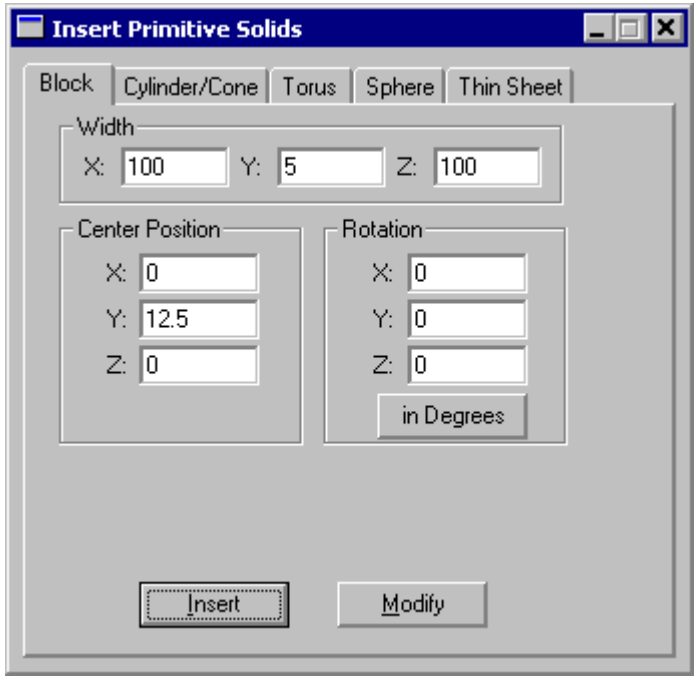
1. Select the **`View|Display RepTile`** menu.
2. Select the **`View|Profile|Iso 1`** menu.

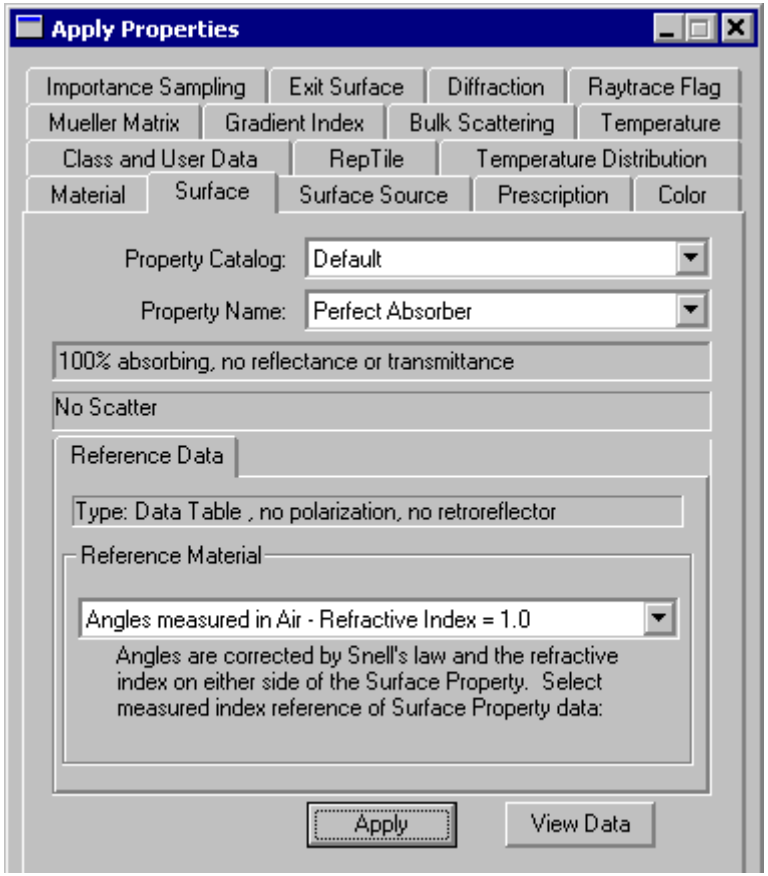


Adding an observation screen

An observation screen defines the output of the LCD panel and can be located anywhere in space. The object will allow you to examine the irradiance distribution from your light guide.

1. To add an observation screen to the system, select **`Insert|Primitive Solid`** and select the **`Block`** tab.
2. Enter the width and position for the block as shown.
3. Label the object Observation Screen.
4. Apply the Perfect Absorber surface property to the object. This operation will apply the surface property to all member surfaces of the object.
5. Label the bottom surface Screen.

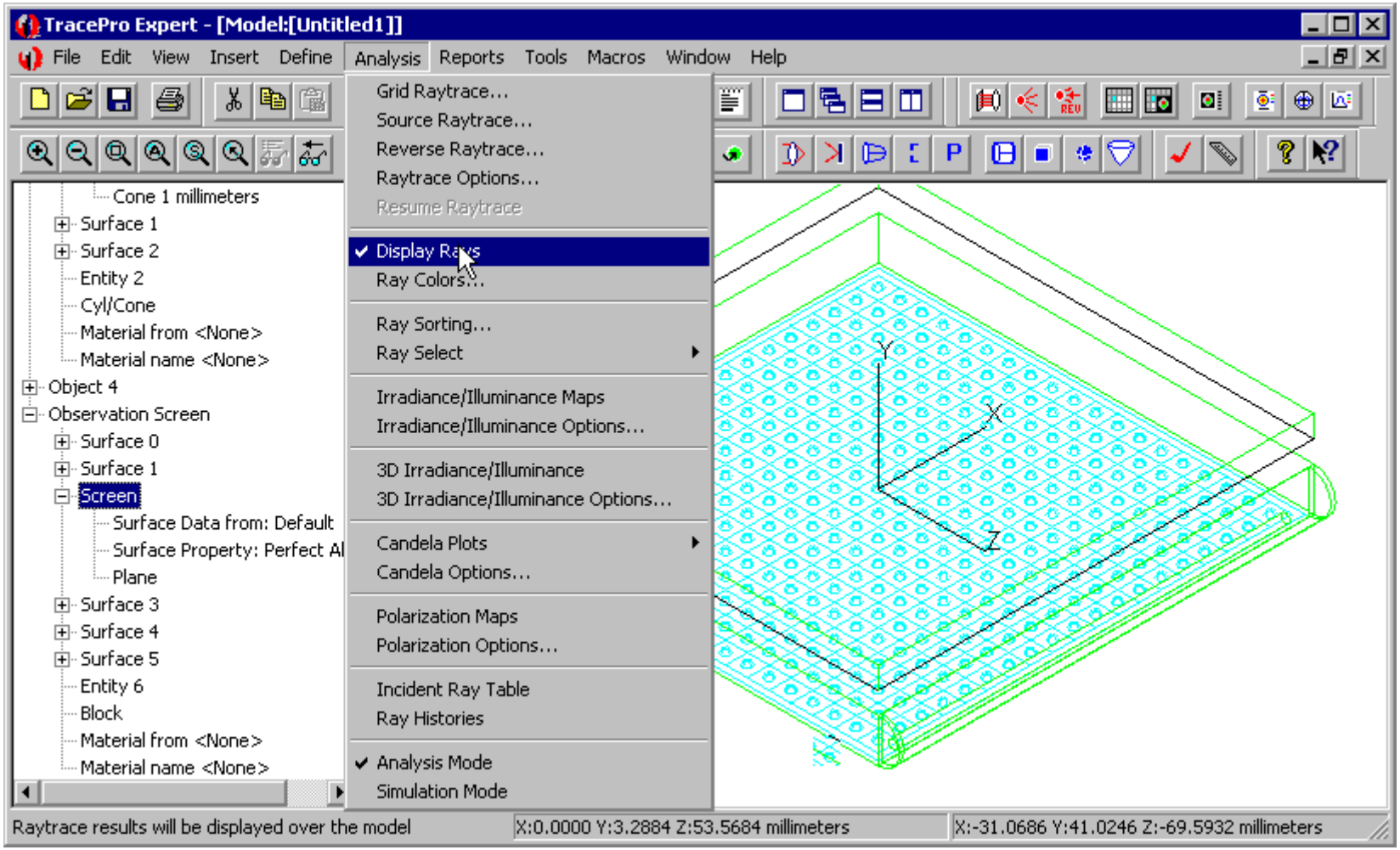




Turning the Display of Rays off

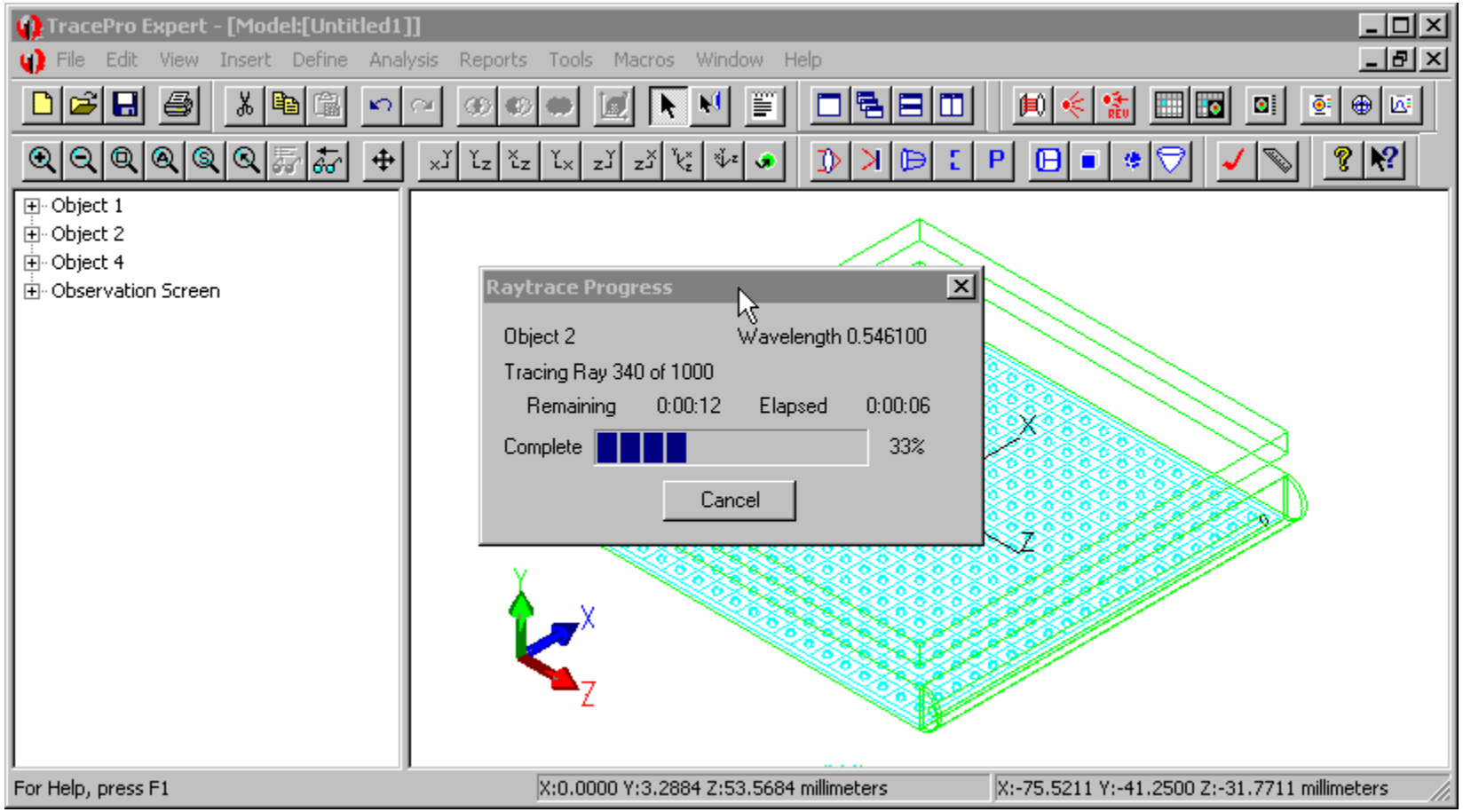
Since you are tracing 1,000 rays and having them scatter into 1000s of more rays it is a good idea to turn off the display of rays off before the ray-trace, so the screen doesn't become too cluttered with rays.

1. To do this go to the **`Analysis`** menu and left mouse click on the **`Display Rays`** option.
2. The check mark in front of the Display Rays option should disappear.



Running a source trace simulation

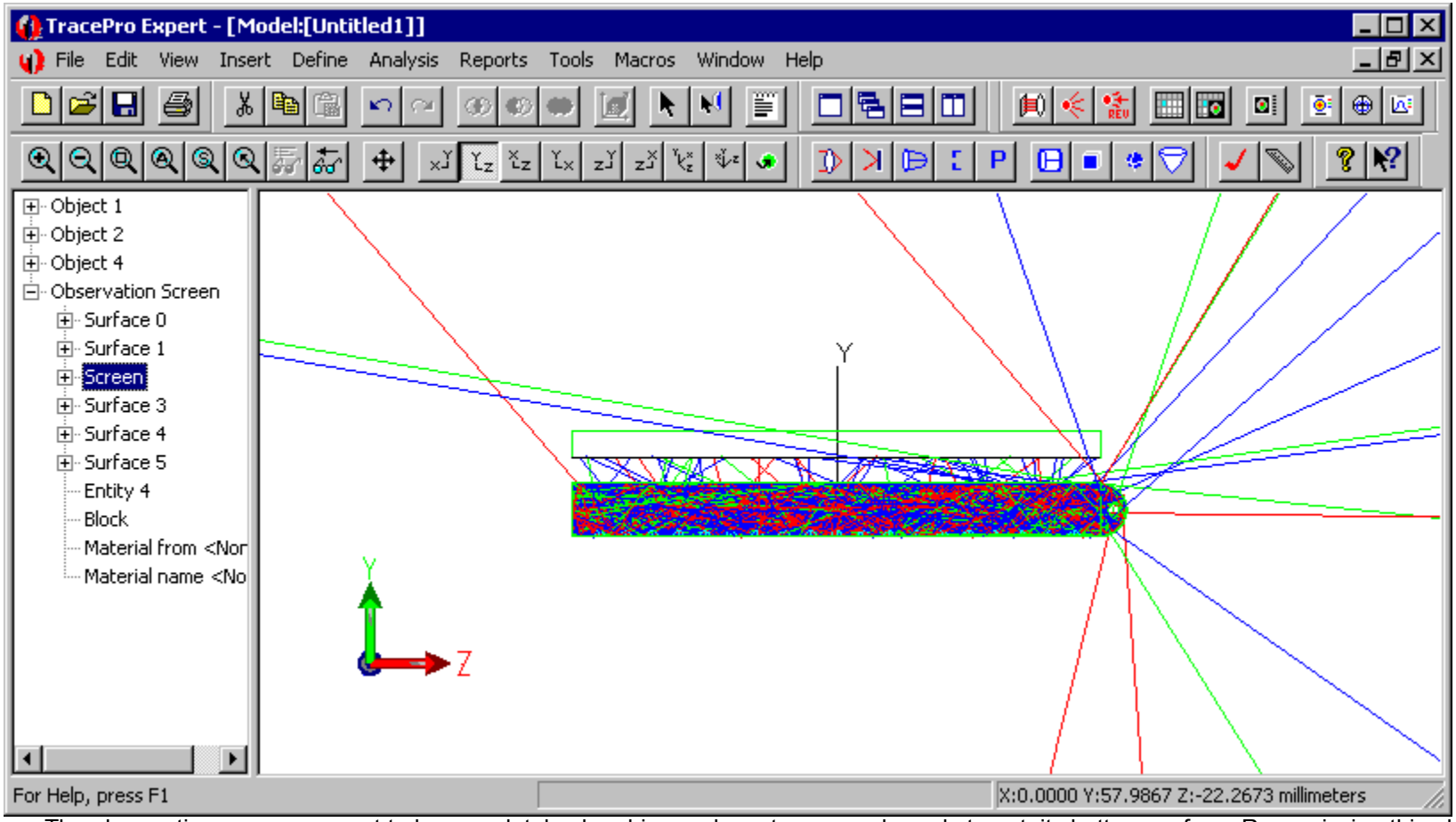
1. Now click on the Source Trace icon to begin the Surface Source ray-trace.
2. Before the ray-trace begins, TracePro will Audit the system. All properties will be preprocessed, and the object space will be partitioned for faster ray-tracing.
3. When the ray-trace begins, a dialog box will appear showing how long the ray trace will take and what ray is currently being traced. The time it takes will depend on your computer, but expect it to take a few minutes.
4. After the audit is finished, TracePro will start ray tracing 1,000 rays.



Display Ray Trace

With large numbers of rays the ray display sheds little light on what is happening in the model. The Ray Sorting options in Tracepro provide a way to reduce number and select the type of rays to display.

1. Select **`Analysis|Ray Sorting`**.
2. Change 100 to 5 in the **% Starting Rays** to Display and click **Update**. This will reduce the number of rays shown to 5 out of every 100.
3. Turn the Display Rays option back on by selecting **`Analysis|Display Rays`**. Rays will be displayed.



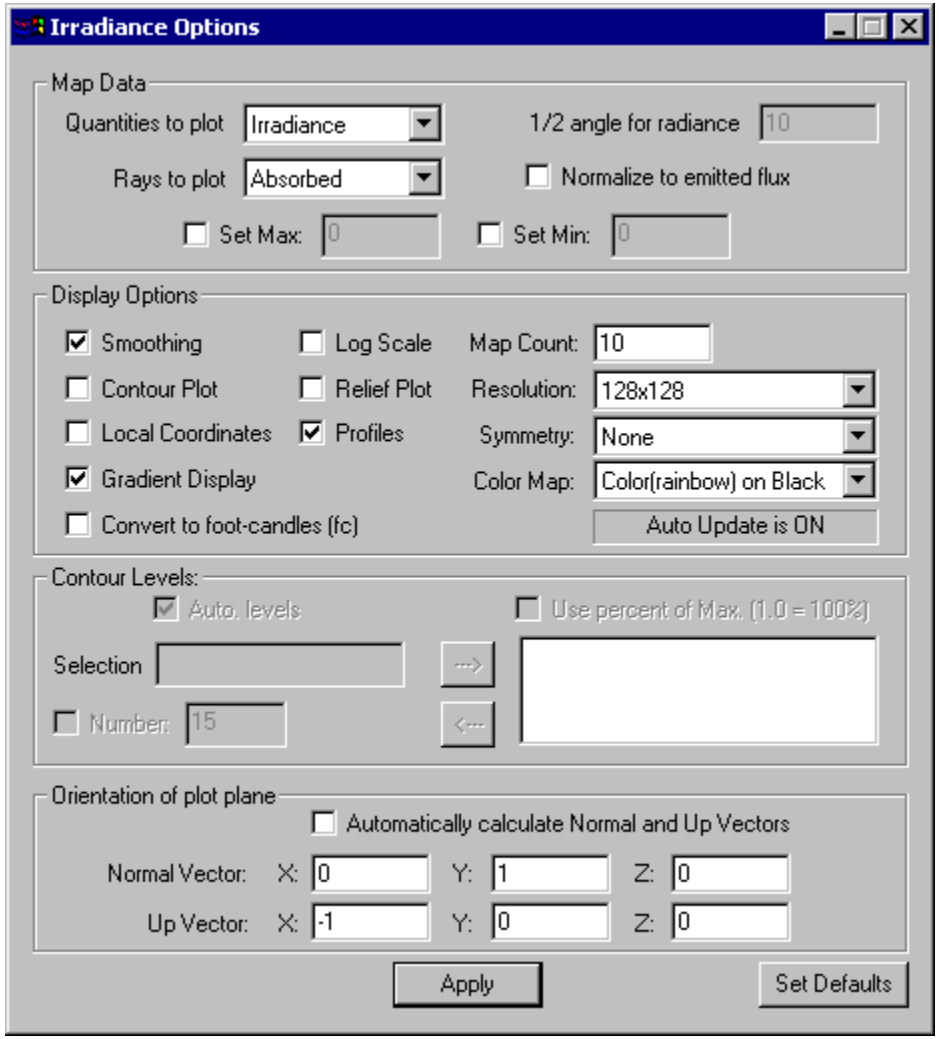
The observation screen was set to be completely absorbing and most rays reach, and stop at, its bottom surface. Rays missing this object are shown bypassing it. The color of each ray indicates its flux. Red rays have flux from 100 to 66 percent of their beginning ray flux. Green rays are between 66 and 33 percent and blue rays are between 33 and 0 percent.

Displaying an Irradiance Map

There are two modes to trace rays in TracePro, Analysis and Simulation mode. Analysis mode lets the user look at Irradiance/Illuminance maps and Candela/ Intensity plots on any surface. Simulation mode lets the user look at only one surface that must be defined before a ray trace takes place. Simulation mode has less flexibility, but uses much less memory.

By default Analysis mode is on.

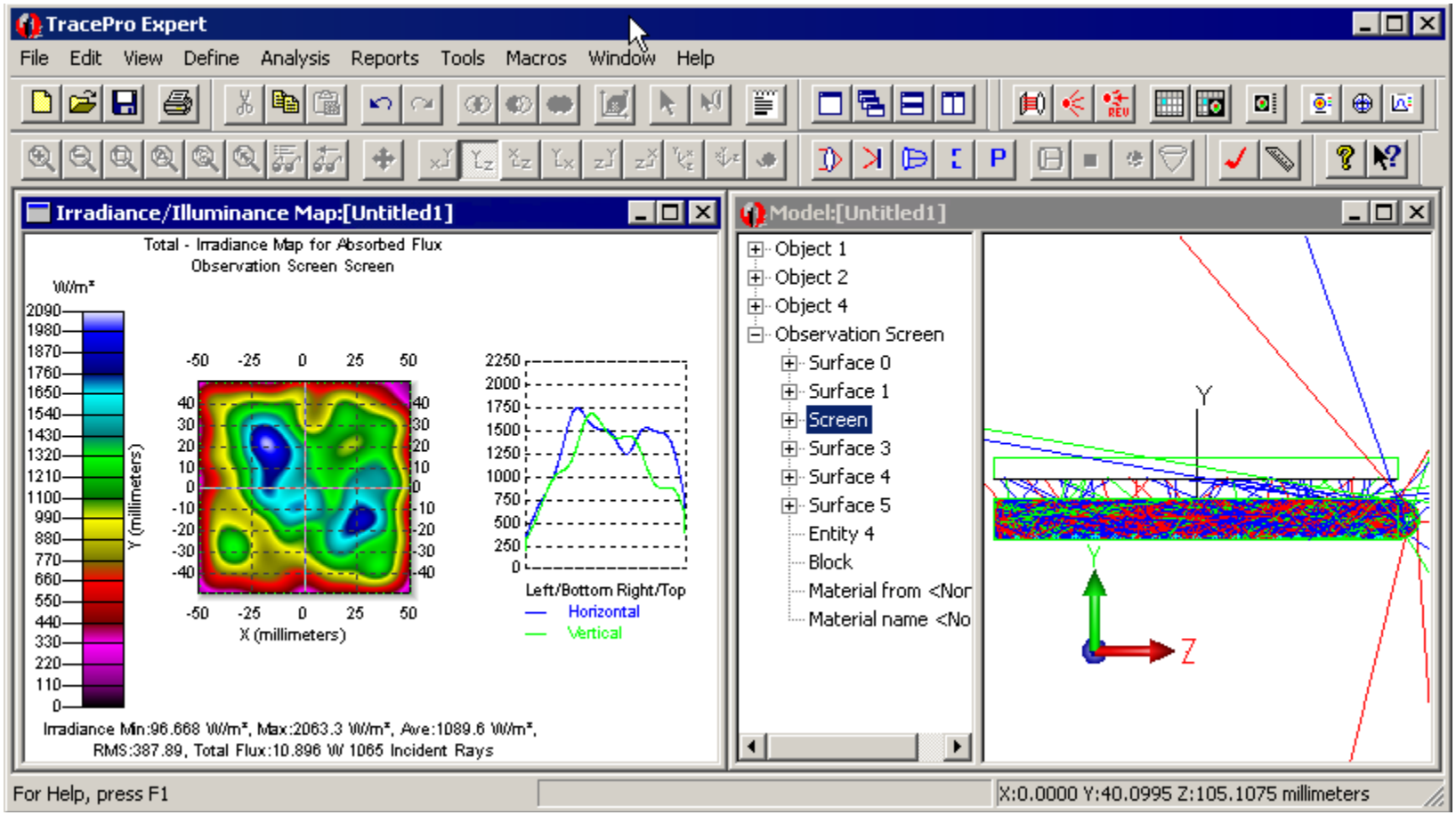
1. Select **`Analysis|Irradiance Options`**.
2. Update the Irradiance Options as shown to correctly display an Irradiance Map.
3. Click **Apply** to make the new settings take effect.



Irradiance map

When showing an Irradiance map, a surface needs to be selected to define the map's data set.

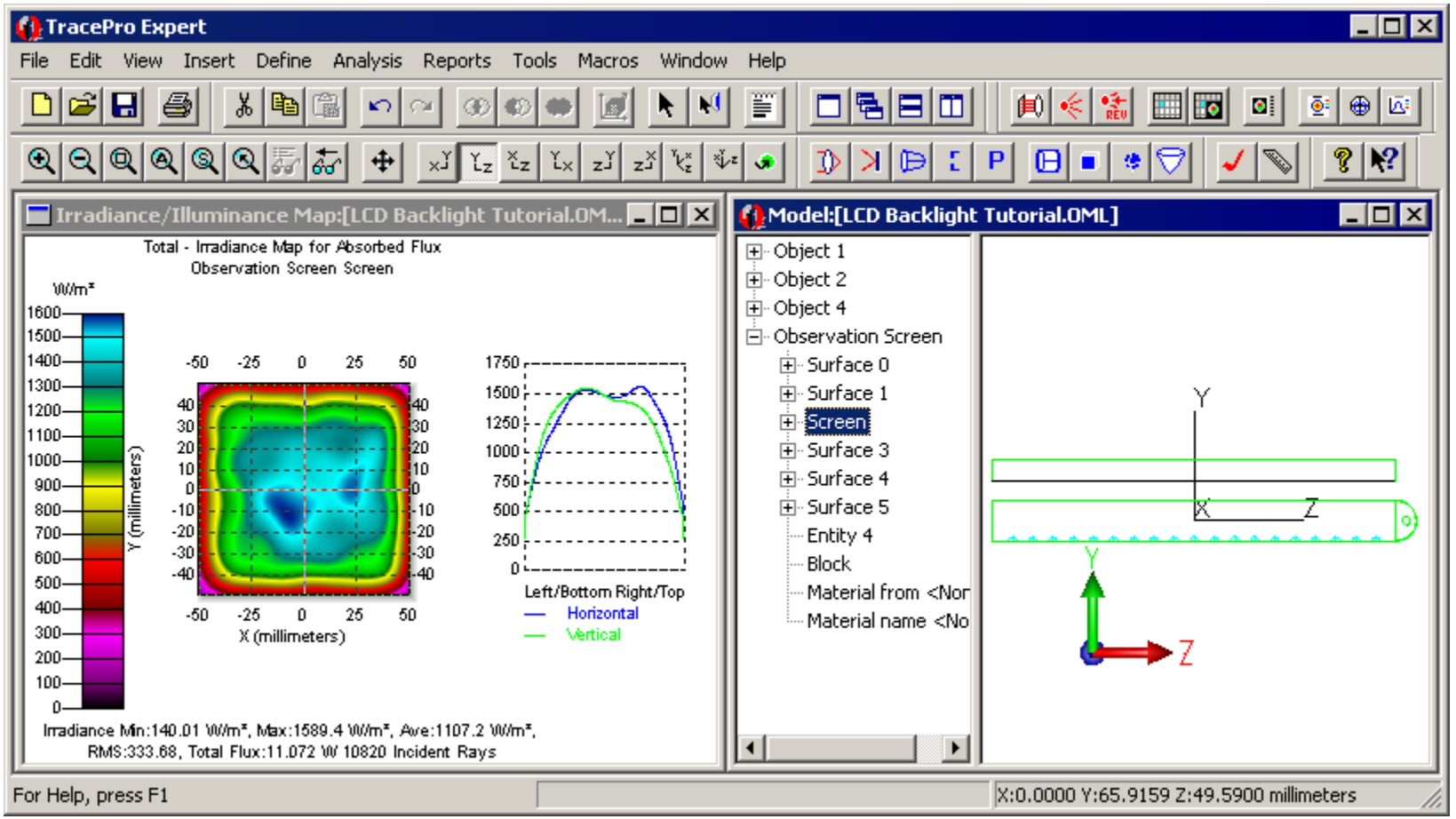
1. Select the Screen surface of Observation Screen object.
2. Click on the Irradiance Map icon (or select **`Analysis|Irradiance/ Illuminance Map`**) to see the plot shown at right.
3. Click in the center of the irradiance map to get the profiles to appear. The two profiles will pass through whatever point you click.
4. The irradiance map shown should pop-up on the screen.
5. To see the windows side by side as shown, select **`Window|Tile Vertical`** or click the Tile Vertical toolbar button.



Improve Irradiance Sampling

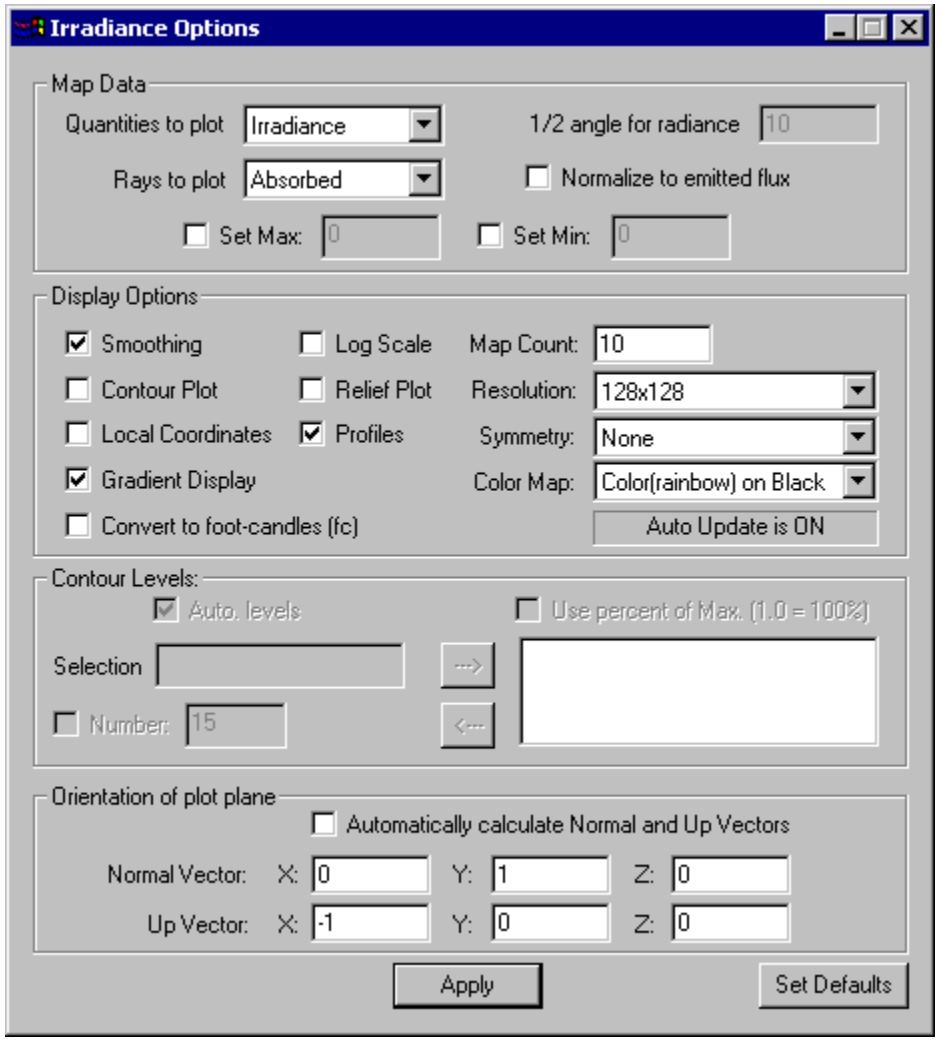
The Irradiance plot displayed with 1000 rays is greatly under sampled. This can be improved by increasing the rays traced and displaying the plot.

1. Start by turning off the ray display from the **`Analysis`** menu and left mouse click on the **`Display Rays`** option.
2. Select the source surface and update the number of rays from 1,000 to 10,000. See “Adding a Surface Source Property to the Bulb”.
3. Perform a source raytrace and view the Irradiance Map.



Understanding the Irradiance Options

The Irradiance/Illuminance Options dialog box is shown at right. This dialog box is available from the Analysis Menu and is used to set all the parameters for the Irradiance/Illuminance Map.



The default Rays to Plot setting is Absorbed rays. If you do not see any irradiance/illuminance on a surface, change this option to incident and an Irradiance/ Illuminance Map should appear. This system is set to Radiometric units so that all output units are shown in Watts and Watts per meter squared.

To change radiometric units to Photometric, select **`Analysis|Raytrace Options`** and change the Radiometric Units setting.

If the Normalize to emitted flux box is checked the flux of each ray is divided by the total emitted flux from the source(s) before being added to the irradiance map. Us this to calculate the efficiency of a light pipe when you have many sources.

The foreground and background colors of the map are set using the Color Map option. Black&White and grayscale maps are good for sending maps over faxes or Black and White printers. Color is best for pseudo-color display.

The Count option determines the number of pixels used by the map to collect rays. A count set to 20 divides the detector into a 20x20 grid of pixels and counts the rays striking each section of the grid and then totals the energy of these rays together. Larger counts show more rays and provide a more accurate view of what is happening on the map if small detail is needed. 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 detector pixels to smooth out choppy or non-contiguous 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.

Understanding the Irradiance Options

The **Profiles** option creates the cross sectional plots of the map**.** Clicking anywhere on the map will show a cross section in both profiles of a horizontal and vertical cut through the map. The profiles intersect at the point you click.

The Normal and Up Vector selection sets the projection plane that all rays will be collected on. If you have a doubt what the collection plane is, the program can automatically calculate the Normal and Up vector for you. Just click on the **Automatically calculate Normal and Up Vector** box. Remember you must click **Apply** before any option is applied to the map.

- The normal vector is the vector that is perpendicular to the collection plane.
- The Up vector is parallel to the vertical side of the plane.

If the Normal and Up vector box is entered with the wrong vectors 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.