How to Model Light Sources in TracePro

Presented by:

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July 28, 2010

How to Model Light Sources in TracePro

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Format

- 20-30 minute presentation followed by a 10-15 minute question and answer session

- Please submit questions using the Question box in the GoToWebinar control panel

In this webinar you will:

- Learn about the light source modeling tools in TracePro, including Grid, File, Surface, and Bitmap Source

- Gain insight on how to choose the best method for modeling a given light source

- Learn how combinations of sources can be used to model complex light sources such as arc lamps or diffuse sky models

- See a comparison of modeled versus measured data for a light source

In this webinar you will:

- Discover the helpful TracePro utilities for source modeling including the Surface Source Property Generator Utility, the IES Import Utility, and the Bitmap Source Utility

- Have your source modeling questions answered in the Questions and Answer session

How to Model Light Sources in TracePro

Question:

What types of light sources can you model in TracePro?

Answer:

Pretty much anything.

Examples

- LEDs
- OLEDs
- Arc lamps
- Filament lamps
- Lasers
- Fluorescent lamps
- HID lamps
- Sun
- Sky
- Fire
- Fluorescence

Types of Light Sources in TracePro

- Grid Sources

- File Sources

- Surface Sources

- Bitmap Sources

Grid Sources

Best for:
- Planar sources that have a well defined boundary
- Sources that emit in a Lambertian or uniform manner
- Monochromatic and polychromatic sources

Considerations:
- Not the best option for a 3-dimensional source
- May not be able to model more complex angular distributions

Examples:
- Fiber optics
- Laser diodes

Grid Source - Laser Diode Example

Grid Source - Laser Diode Example

File Sources

Best for:
• Planar and 3-dimensional sources
• Sources that emit in complex angular distribution patterns
• Sources that can be modeled monochromatically
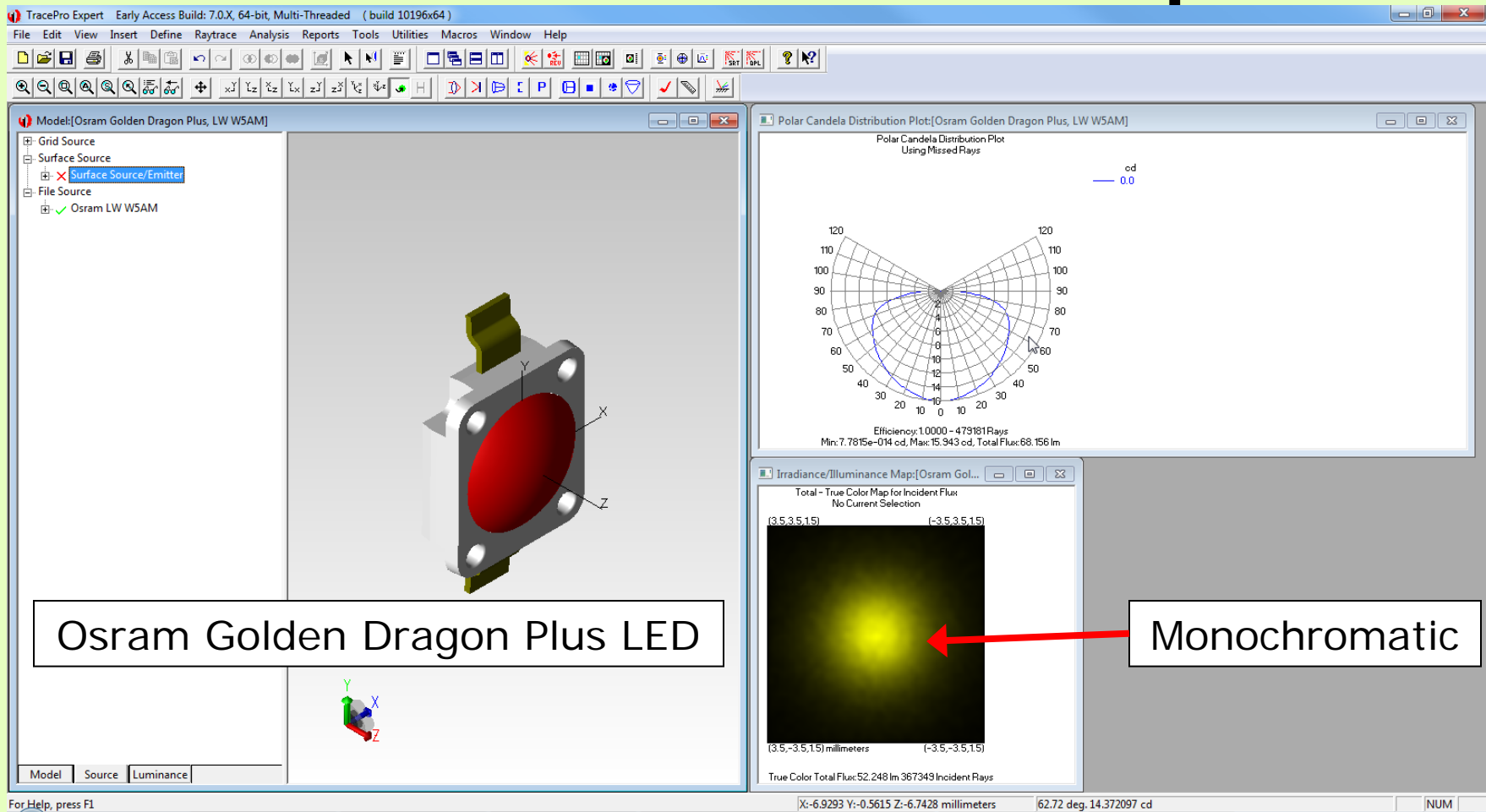• Sources that have lenses and structural elements

Considerations:
• Defined monochromatically
• Not a good choice if emitted light will interact with source

Examples:
• LEDs
• Luminaires

File Source – LED Example

Osram Golden Dragon Plus LED

Monochromatic

Example of File Source or Ray File Data

```
!! Source file:

TracePro Release: 6 0 2 |
Data for Block 1 Surface 1
Linear Units in mm
Data generated at 15:51:06 January 20, 2010
X Pos.                   Y Pos.                   Z Pos.                  X Vec.                   Y Vec.                   Z Vec.                   Inc Flux
 0.000000000000000e+000   0.000000000000000e+000   4.900000000000000e+001   0.000000000000000e+000   0.000000000000000e+000   1.000000000000000e+000   9.164210624726462e-001
 3.241904746004420e-002   0.000000000000000e+000   4.900000000000000e+001  -1.943468304810075e-002   0.000000000000000e+000   9.998111287112282e-001   9.164242320047675e-001
 1.620952373002205e-002   2.807571866689163e-002   4.900000000000000e+001  -9.717341524050380e-003  -1.683092923415404e-002   9.998111287112282e-001   9.164242320047675e-001
-1.620952373002205e-002   2.807571866689163e-002   4.900000000000000e+001   9.717341524050373e-003  -1.683092923415404e-002   9.998111287112282e-001   9.164242320047675e-001
-3.241904746004420e-002   1.158548475946197e-016   4.900000000000000e+001   1.943468304810075e-002   0.000000000000000e+000   9.998111287112282e-001   9.164242320047675e-001
-1.620952373002205e-002  -2.807571866689174e-002   4.900000000000000e+001   9.717341524050387e-003   1.683092923415403e-002   9.998111287112282e-001   9.164242320047675e-001
 1.620952373002205e-002  -2.807571866689163e-002   4.900000000000000e+001  -9.717341524050380e-003   1.683092923415404e-002   9.998111287112282e-001   9.164242320047675e-001
 5.712924240950290e-002   0.000000000000000e+000   4.900000000000000e+001  -3.569226746605052e-002   0.000000000000000e+000   9.993628280275048e-001   9.164314560568593e-001
 4.947537522558876e-002   2.856462120475134e-002   4.900000000000000e+001  -3.091041034426859e-002  -1.784613373302526e-002   9.993628280275048e-001   9.164314560568593e-001
 2.856462120475156e-002   4.947537522558876e-002   4.900000000000000e+001  -1.784613373302526e-002  -3.091041034426859e-002   9.993628280275048e-001   9.164314560568593e-001
 1.062959457824578e-016   5.712924240950290e-002   4.900000000000000e+001   0.000000000000000e+000  -3.569226746605052e-002   9.993628280275048e-001   9.164314560568593e-001
-2.856462120475145e-002   4.947537522558876e-002   4.900000000000000e+001   1.784613373302525e-002  -3.091041034426859e-002   9.993628280275048e-001   9.164314560568593e-001
-4.947537522558876e-002   2.856462120475134e-002   4.900000000000000e+001   3.091041034426859e-002  -1.784613373302526e-002   9.993628280275048e-001   9.164314560568593e-001
-5.712924240950290e-002   2.125918915649157e-016   4.900000000000000e+001   3.569226746605052e-002   0.000000000000000e+000   9.993628280275048e-001   9.164314560568593e-001
-4.947537522558876e-002  -2.856462120475134e-002   4.900000000000000e+001   3.091041034426859e-002   1.784613373302525e-002   9.993628280275048e-001   9.164314560568593e-001
-2.856462120475134e-002  -4.947537522558876e-002   4.900000000000000e+001   1.784613373302528e-002   3.091041034426858e-002   9.993628280275048e-001   9.164314560568593e-001
-3.188878373473735e-016  -5.712924240950290e-002   4.900000000000000e+001   0.000000000000000e+000   3.569226746605052e-002   9.993628280275048e-001   9.164314560568593e-001
 2.856462120475156e-002  -4.947537522558876e-002   4.900000000000000e+001  -1.784613373302526e-002   3.091041034426859e-002   9.993628280275048e-001   9.164314560568593e-001
 4.947537522558876e-002  -2.856462120475134e-002   4.900000000000000e+001  -3.091041034426858e-002   1.784613373302528e-002   9.993628280275048e-001   9.164314560568593e-001
 7.840016396490235e-002   0.000000000000000e+000   4.900000000000000e+001  -5.271353434212828e-002   0.000000000000000e+000   9.986096751469817e-001   9.164426412964354e-001
 7.367205554622380e-002   2.681443531603167e-002   4.900000000000000e+001  -4.953451923684252e-002  -1.802909057089728e-002   9.986096751469817e-001   9.164426412964354e-001
 6.005800994492994e-002   5.039465399403187e-002   4.900000000000000e+001  -4.038091005994879e-002  -3.388360673790594e-002   9.986096751469817e-001   9.164426412964354e-001
 3.920008198245095e-002   6.789653365447013e-002   4.900000000000000e+001  -2.635676717106415e-002  -4.565125986354653e-002   9.986096751469817e-001   9.164426412964354e-001
 1.361404560129381e-002   7.720908931006365e-002   4.900000000000000e+001  -9.153609176893731e-003  -5.191269730880322e-002   9.986096751469817e-001   9.164426412964354e-001
-1.361404560129376e-002   7.720908931006365e-002   4.900000000000000e+001   9.153609176893725e-003  -5.191269730880322e-002   9.986096751469817e-001   9.164426412964354e-001
-3.920008198245095e-002   6.789653365447013e-002   4.900000000000000e+001   2.635676717106413e-002  -4.565125986354653e-002   9.986096751469817e-001   9.164426412964354e-001
```

- Can be 1 million+ lines long
- Monochromatic only

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TracePro

Example of Emitted Light Interacting with Source
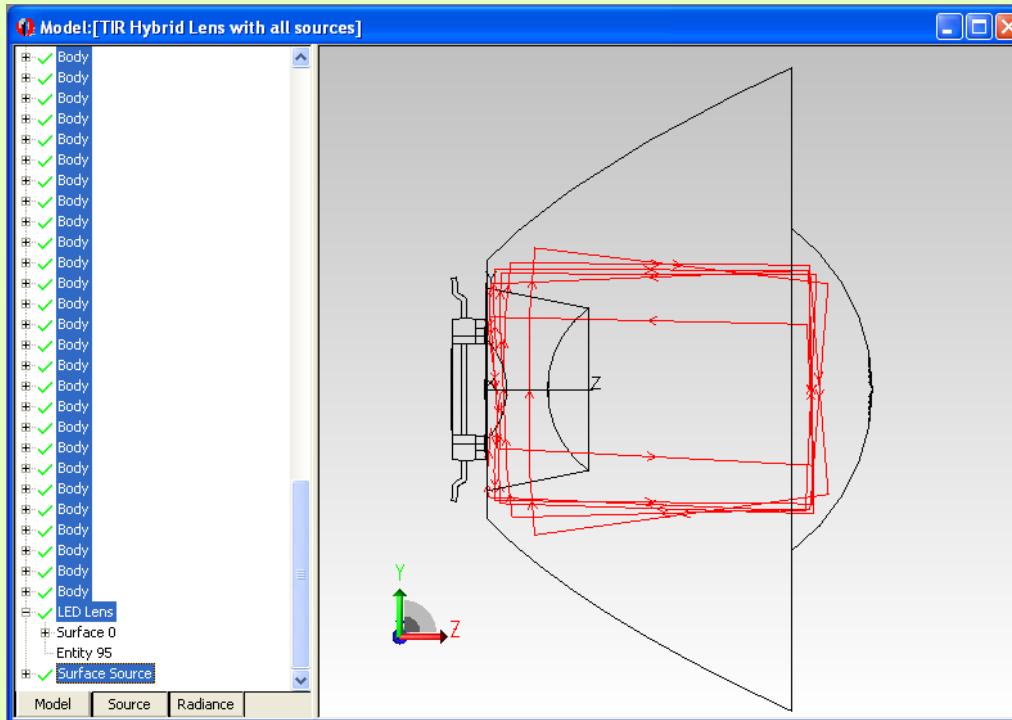
Small percentage of rays shown

- Some of the light emitted by the LED is totally internally reflected by the lens

- Ray sorting feature in TracePro® is used to show rays that are hitting the LED's lens dome

- Approximately 0.1% of initial flux is impinging back on the source

Surface Sources

Best for:
- Detailed source models
- Sources that emit in complex angular and spectral distribution patterns
- Where modeling the interaction of light with the source structure is important

Considerations:
- Models can be more complex to make
- Need accurate material and surface properties

Examples:
- LEDs
- Lamps such as arc and filament
- Complete optical systems

Example of Surface Source Property Data

Emission can vary as a function of:
- **Temperature**
- **Wavelength**
- **Polar Angle**
- **Azimuth Angle**

Note:
Units should be consistent.
If spectrum is defined in radiometric units then emission should be as well.

```
TracePro Surface Source Property Data
File Name      C:\Documents and Settings\
TracePro Release: 6 0 2
Database Version: 4 1 0
Data generated at 17:08:48 January 22, 2010

Name    PKI FX-1150
Catalog Flashlamps
Description
User_Data       1
Spectral Type   3
Angular Type    4
Units    0
Quantity        1
Emission        1
Wavelength1     0
Wavelength2     0
Angle1   90
Angle2   10

Temperature    Wavelength    PolarAngle    AzimuthAngle    Emissivity
300            0.204         0             0               0.1621716
300            0.204         0             20              0.1621716
300            0.204         0             40              0.1621716
300            0.204         0             60              0.1621716
300            0.204         0             80              0.1621716
300            0.204         0             100             0.1621716
300            0.204         0             120             0.1621716
300            0.204         0             140             0.1621716
300            0.204         0             160             0.1621716
300            0.204         0             180             0.1621716
300            0.204         0             200             0.1621716
300            0.204         0             220             0.1621716
300            0.204         0             240             0.1621716
300            0.204         0             260             0.1621716
300            0.204         0             280             0.1621716
300            0.204         0             300             0.1621716
300            0.204         0             320             0.1621716
300            0.204         0             340             0.1621716
300            0.204         2.045         0               0.161919
300            0.204         2.045         20              0.1619135
300            0.204         2.045         40              0.161946
300            0.204         2.045         60              0.1620167
300            0.204         2.045         80              0.162176
```

Surface Source – LED Example

Osram Golden Dragon Plus LED

TrueColor display possible because of spectral distribution in Surface Source Property
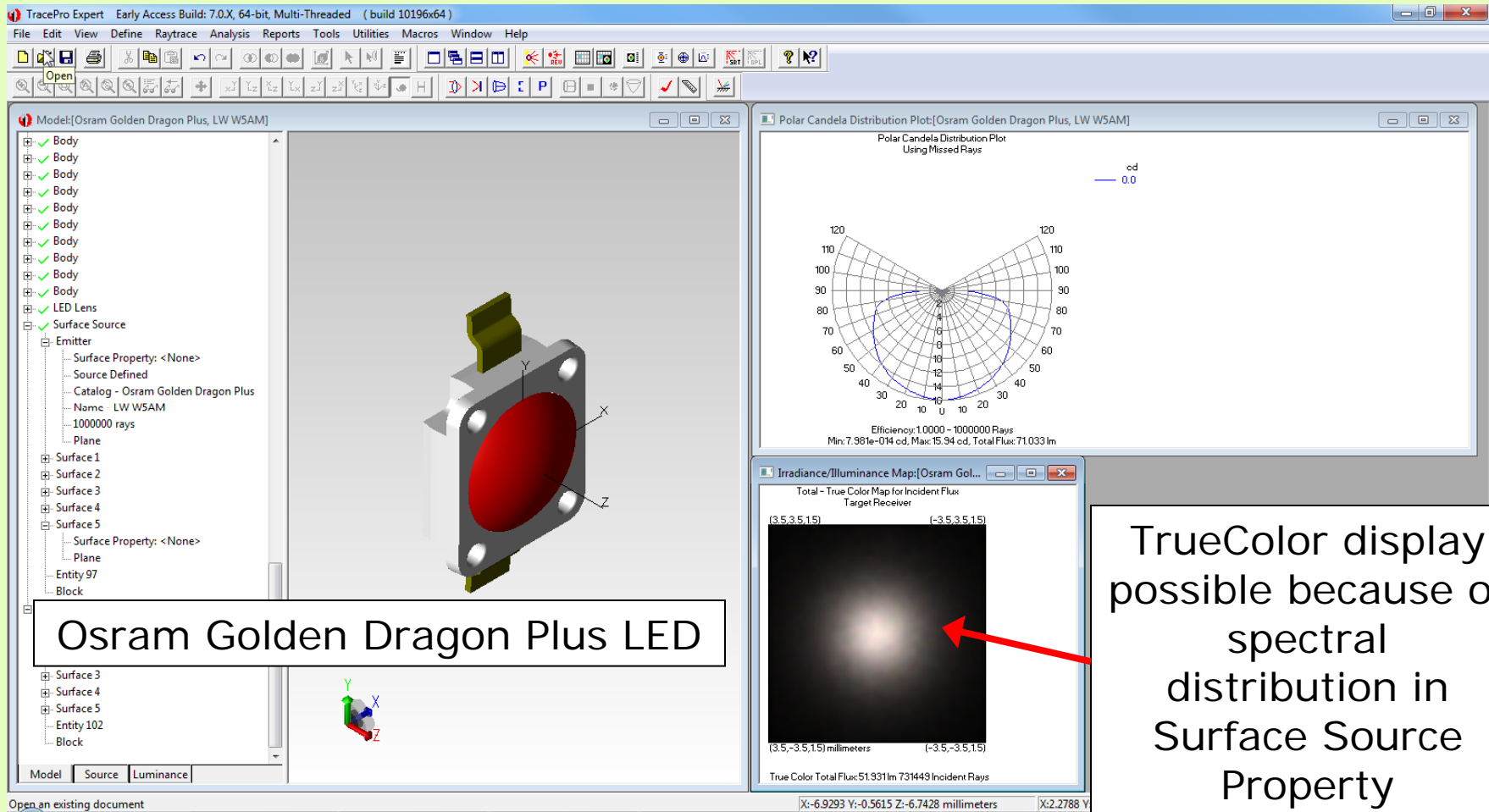
Bitmap Sources

Best for:
•Making TracePro File Sources from image file formats such as BMP, GIF, JPG, PNG, and MOV

Considerations:
•Resulting File Sources can be very large

Examples:
•Tracing images through systems in TracePro

Bitmap Sources

Object

Image

Lens system in TracePro
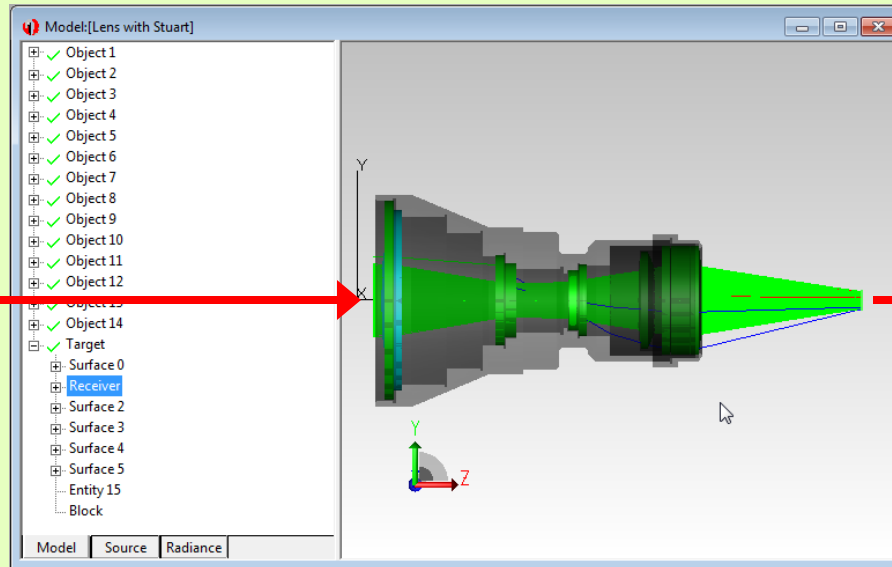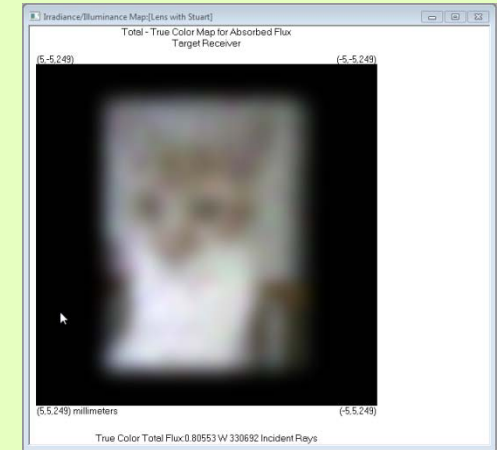
Bitmap image and Bitmap Source Utility is used to create a File Source for TracePro

4 Sources, 1 Model

TIR Hybrid Lens with Point Source
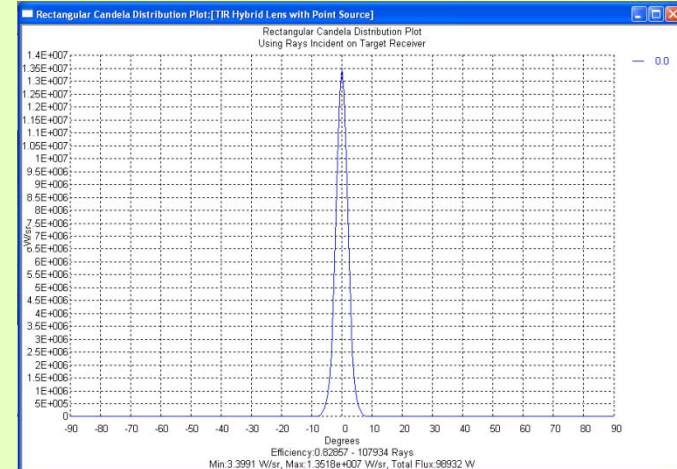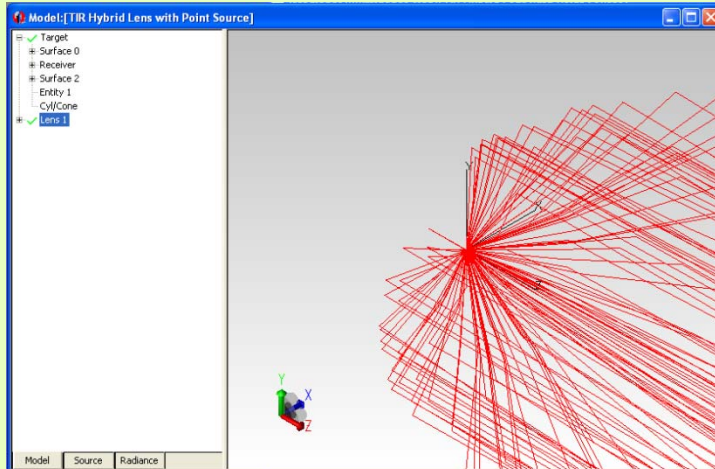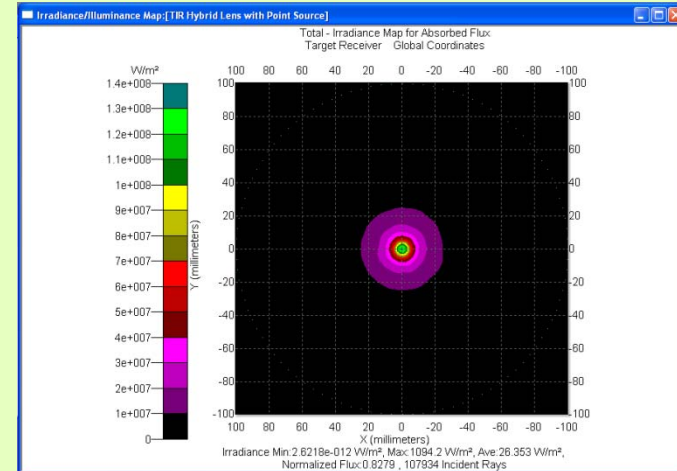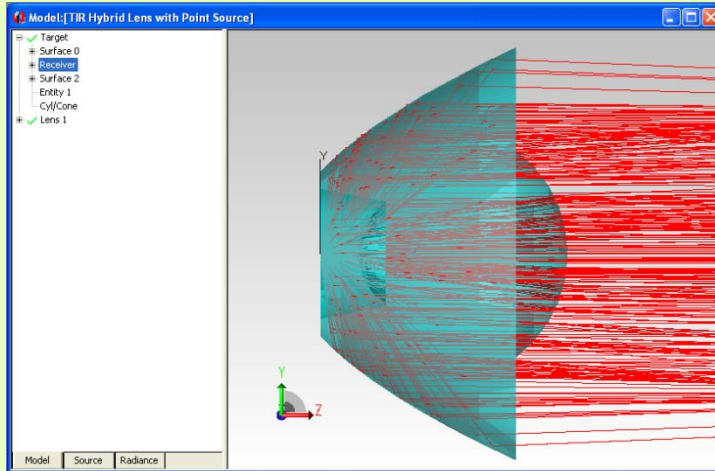
TIR Hybrid Lens with 1mm x 1mm Grid Source
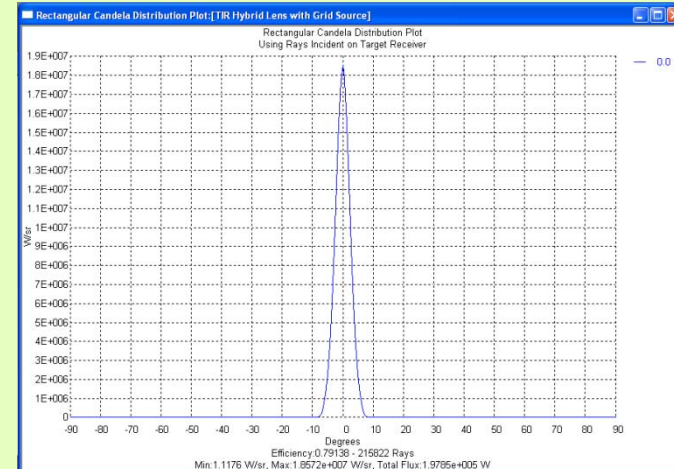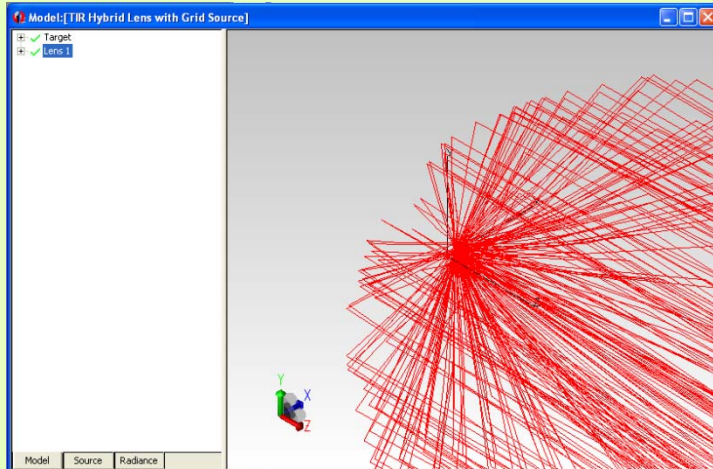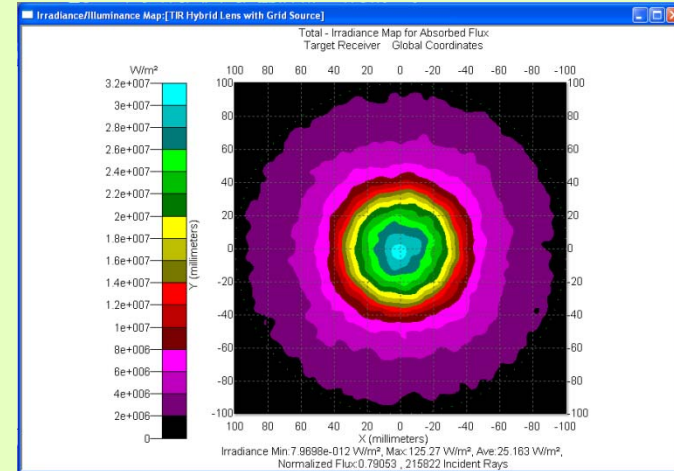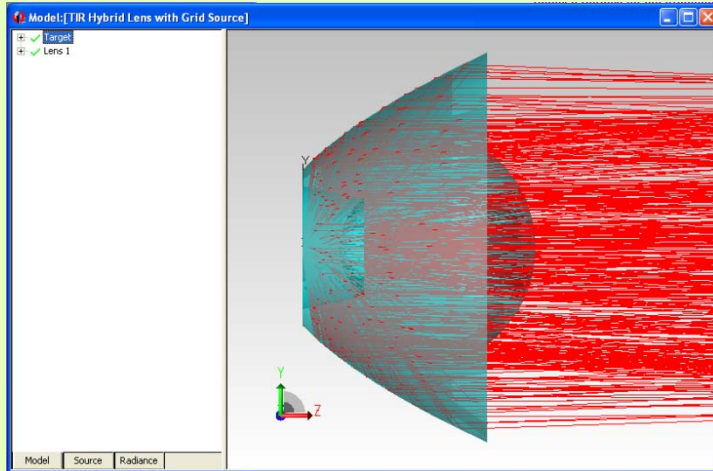
TIR Hybrid Lens with Ray File Source
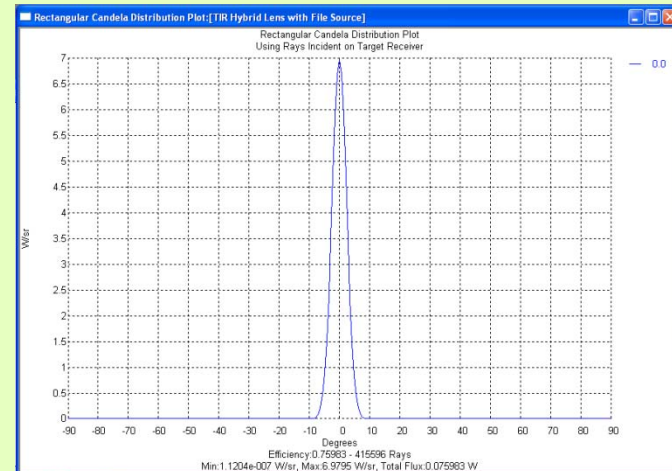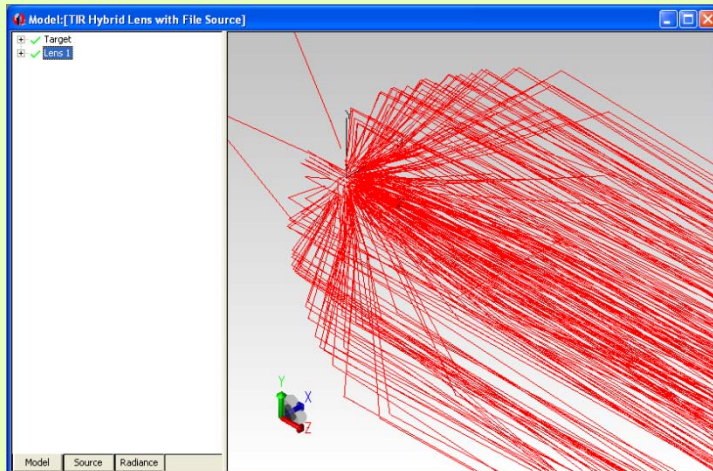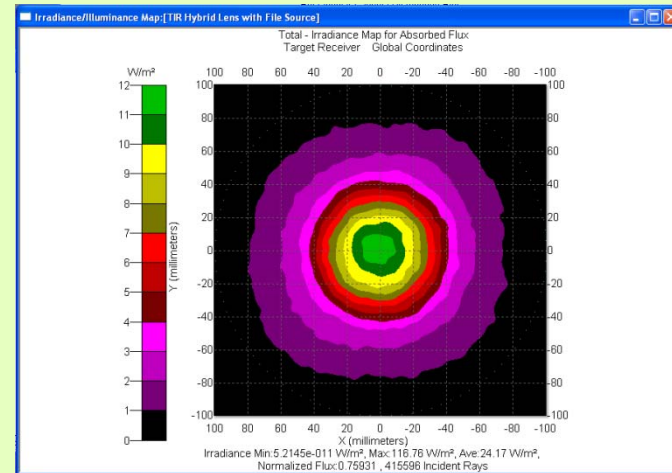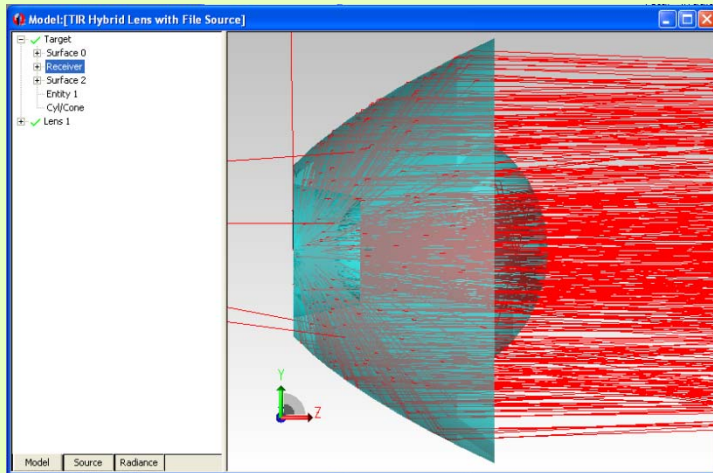
TIR Hybrid Lens with Surface Source Property
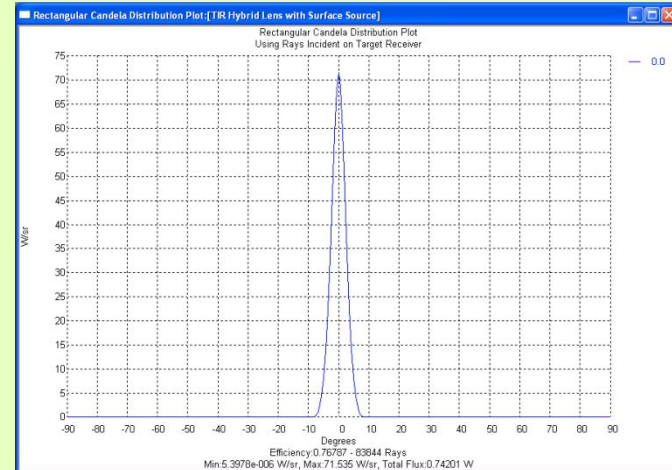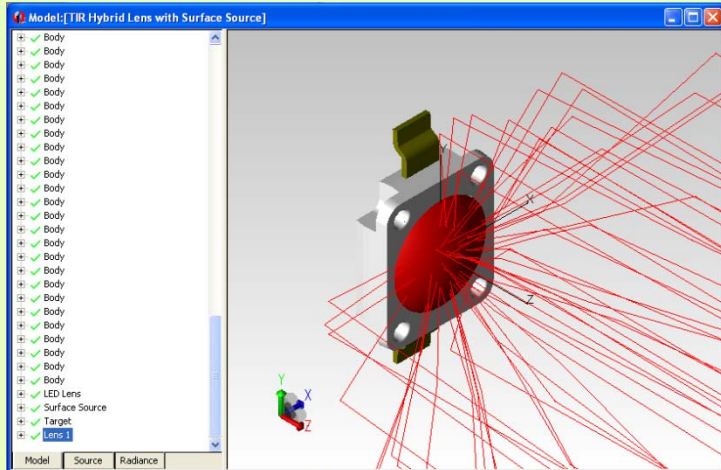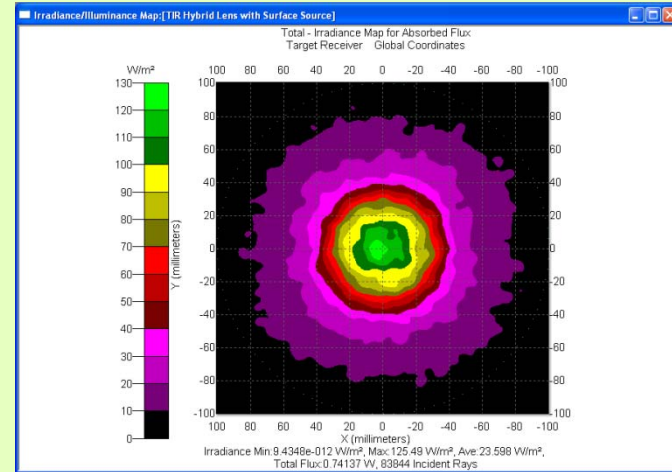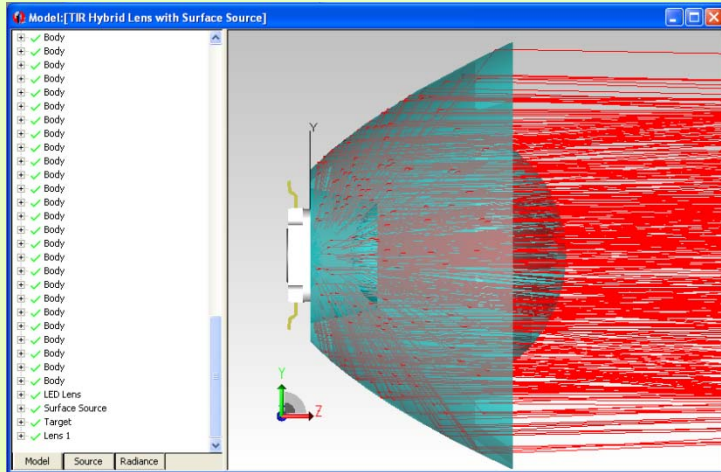
Increasing the Complexity

1500-watt Xenon Lamp with Surface Source Properties
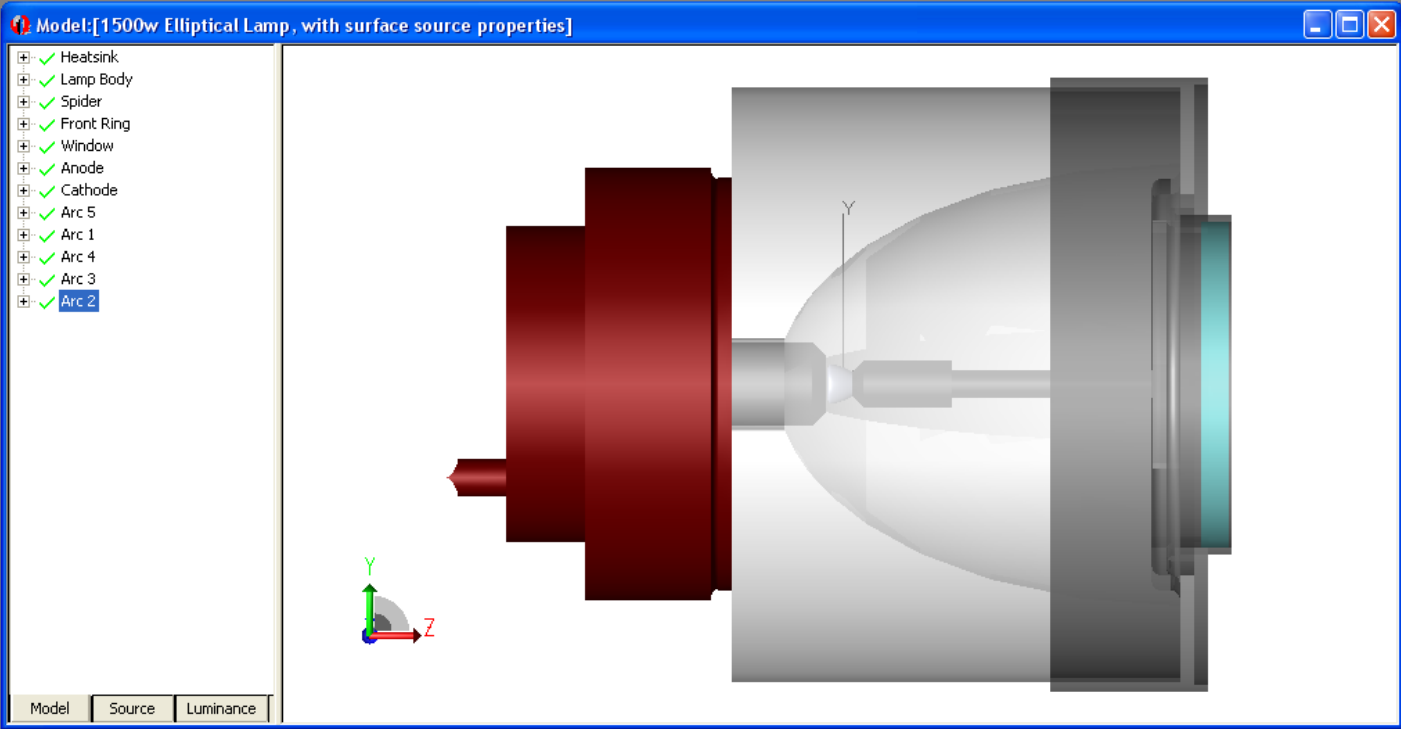
1500-watt Xenon Lamp with Surface Source Properties
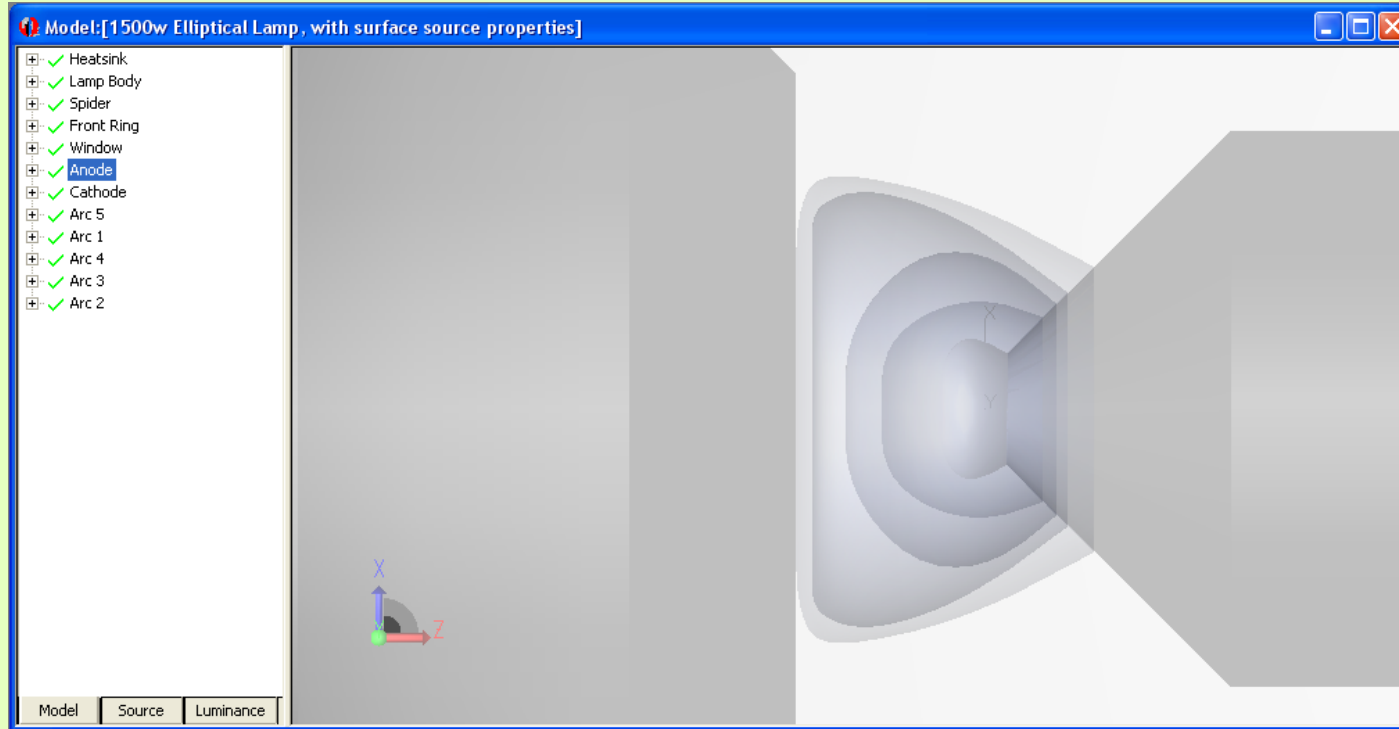
Arc model showing luminous intensity distribution

Modeling an Overcast Sky

A Spatially Varying Source

Modeling an Overcast Sky
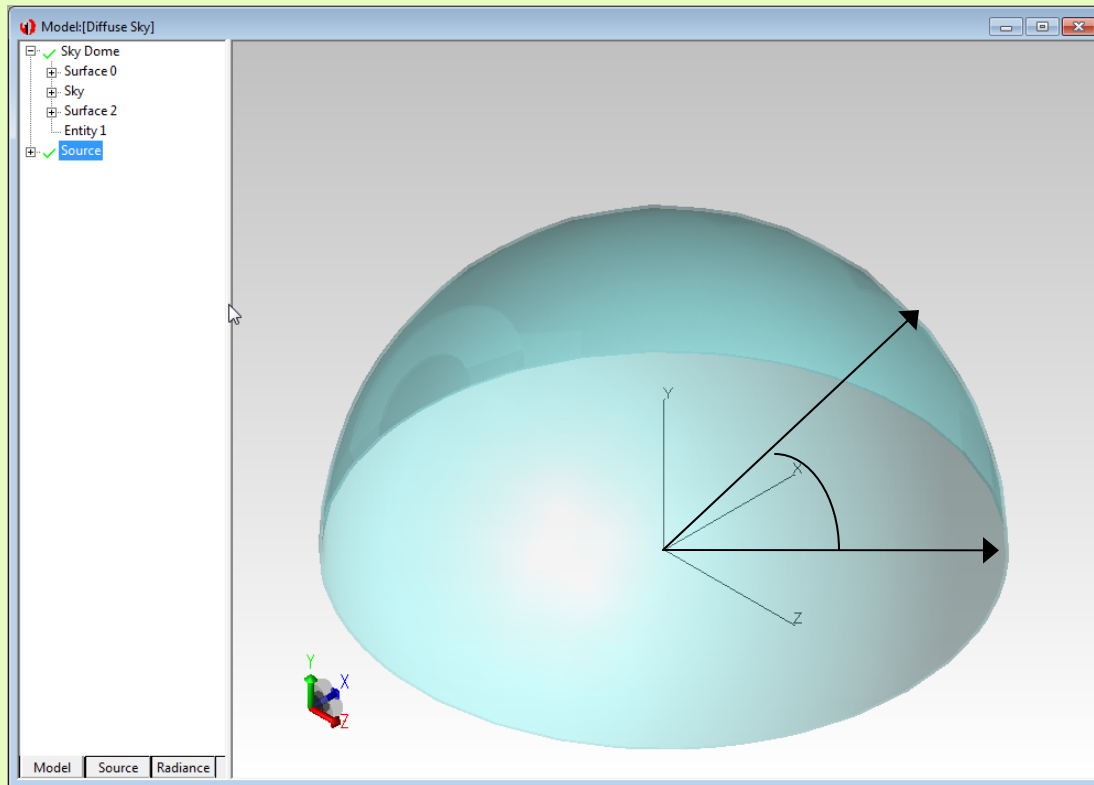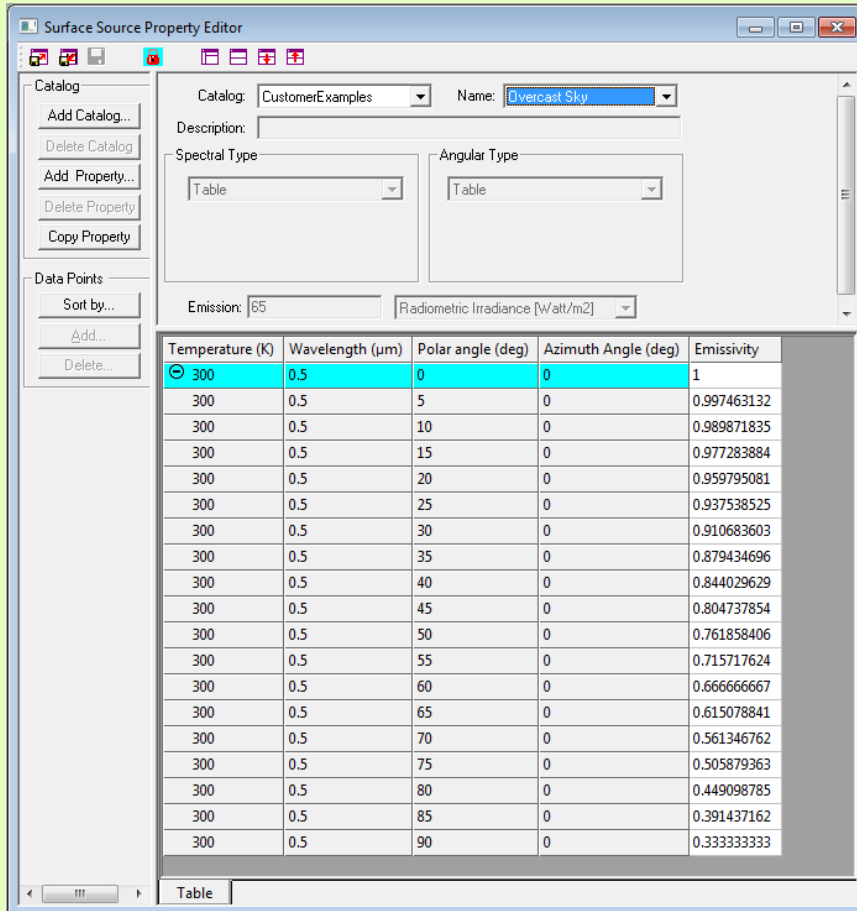
Luminance varies as a function of angle above horizon:

$$\frac{L_{oc}(\theta)}{L_{zoc}} = \frac{1 + 2 * sin(\theta)}{3}$$

CIE DS 011.2/E: 2002

Modeling an Overcast Sky

Use:

$$\frac{L_{oc}(\theta)}{L_{zoc}} = \frac{1 + 2 * sin(\theta)}{3}$$

to make a Surface Source Property in TracePro
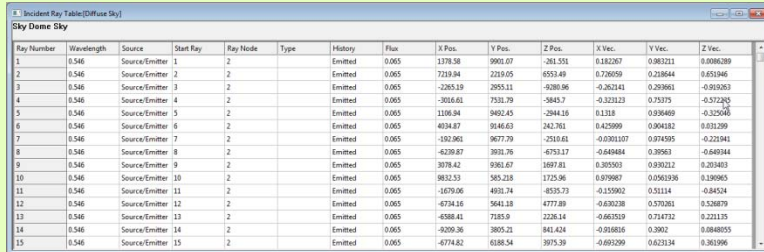
Note that the zenith in TracePro is 0-degrees

Modeling an Overcast Sky
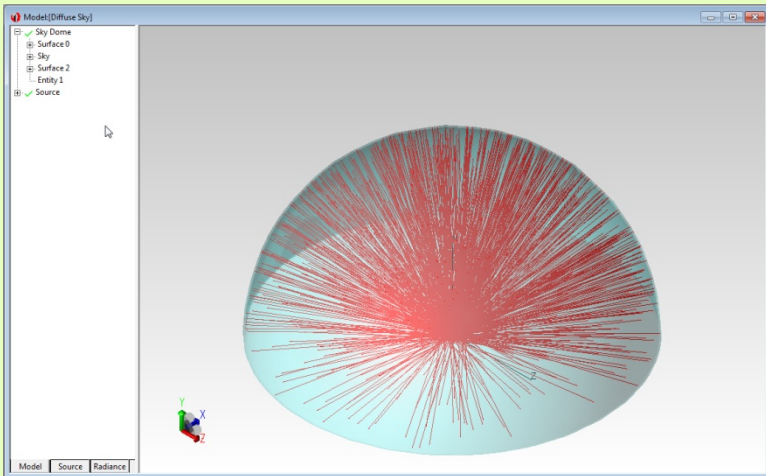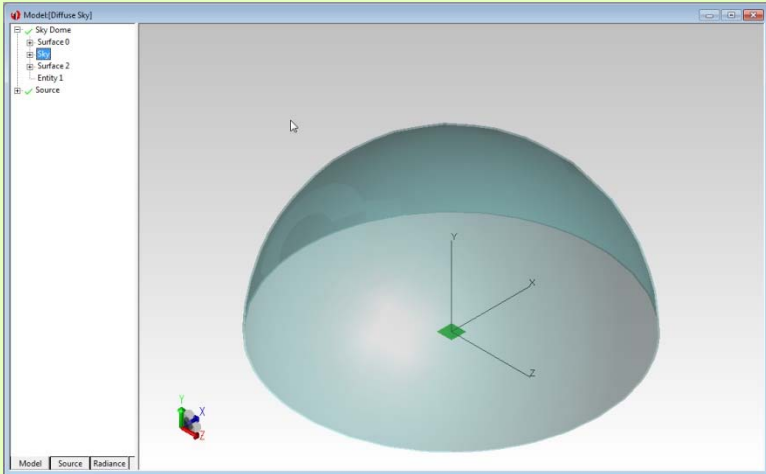
- •Use a hemisphere to represent the sky

- •Apply the Surface Source Property to the surface of object at the center of the hemisphere

- •Trace rays to the inside surface of the hemisphere

Modeling an Overcast Sky

- Get the Incident Ray Table for the inside surface of the hemisphere
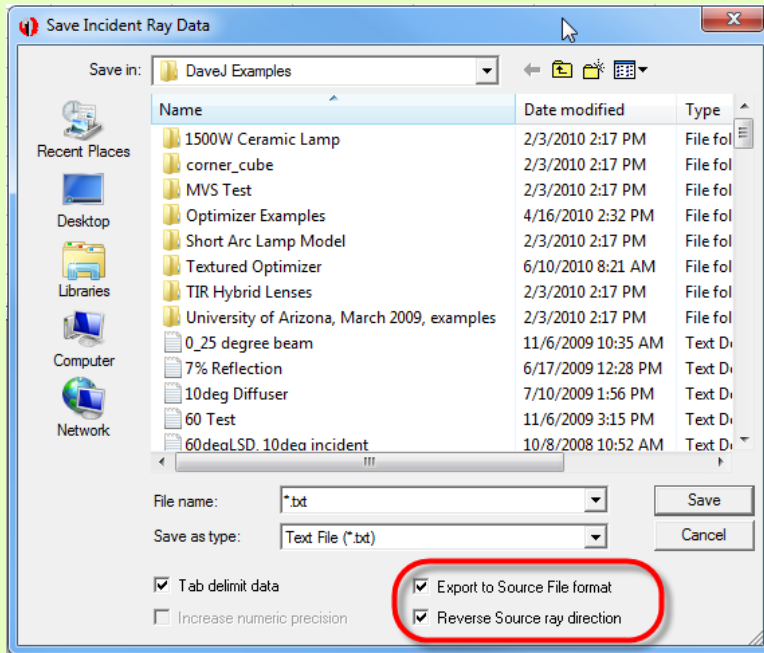
- Use Save Incident Ray Data with "Export to Source File format" and "Reverse Source ray direction" options to create a new File Source from the Incident Ray Table data

Modeling an Overcast Sky
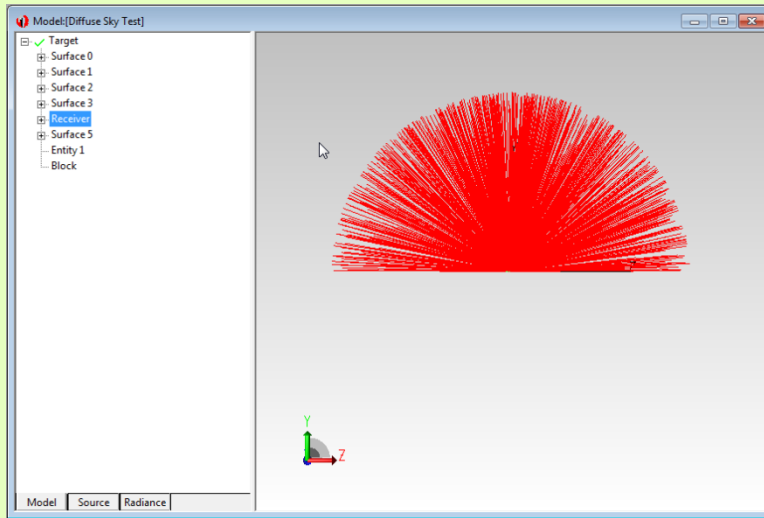
•Insert the new File Source in your model and run the raytrace
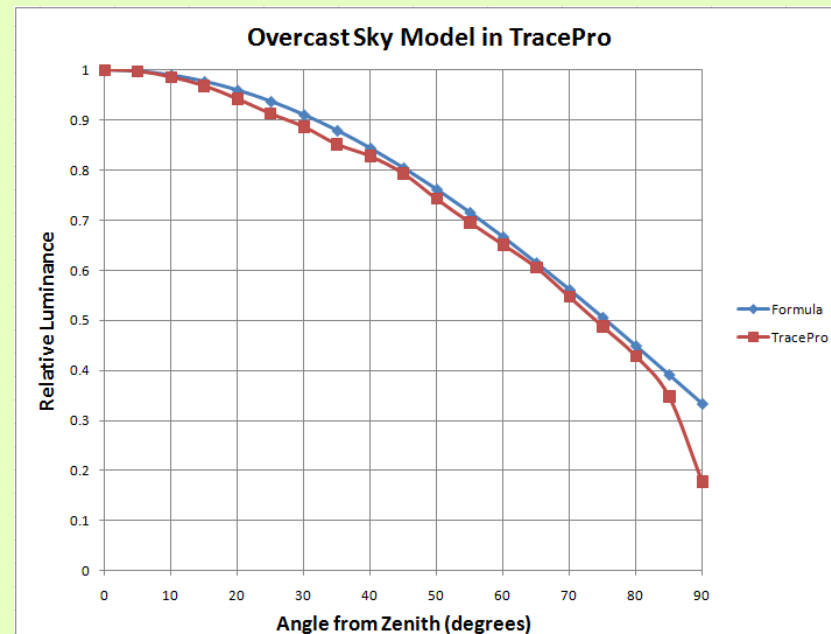
Measured Data vs. Simulation Data: An Example

PerkinElmer FX-1150 Short-arc Xenon Flashlamp Example

Photograph courtesy of PerkinElmer
Optoelectronics, Salem, MA
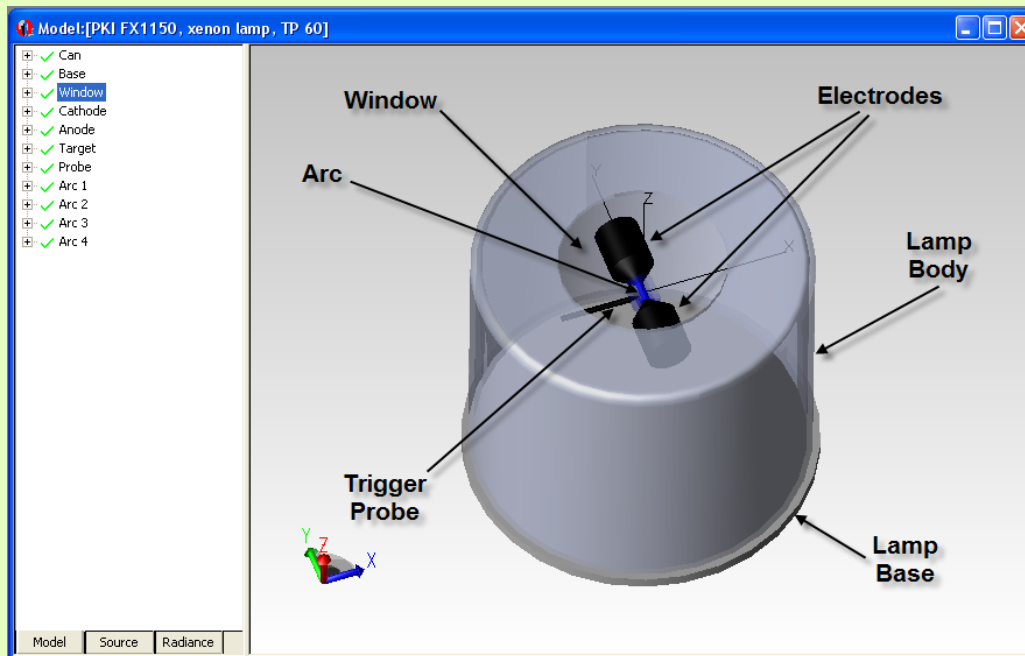
TracePro model of FX-1150

PerkinElmer FX-1150 Short-arc Xenon Flashlamp Example
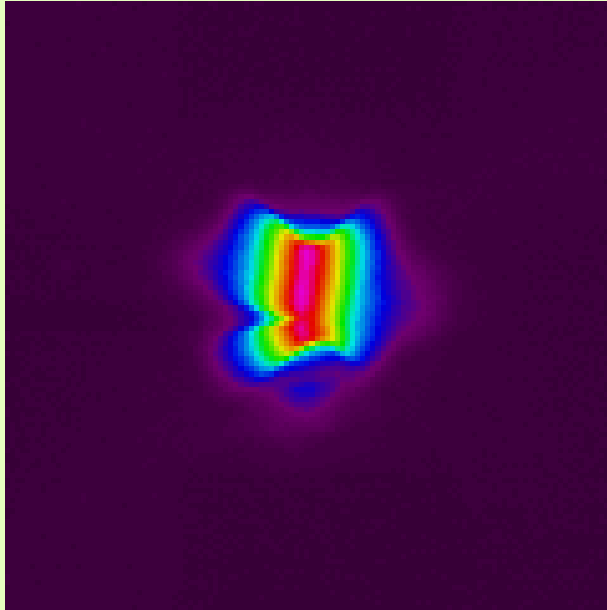
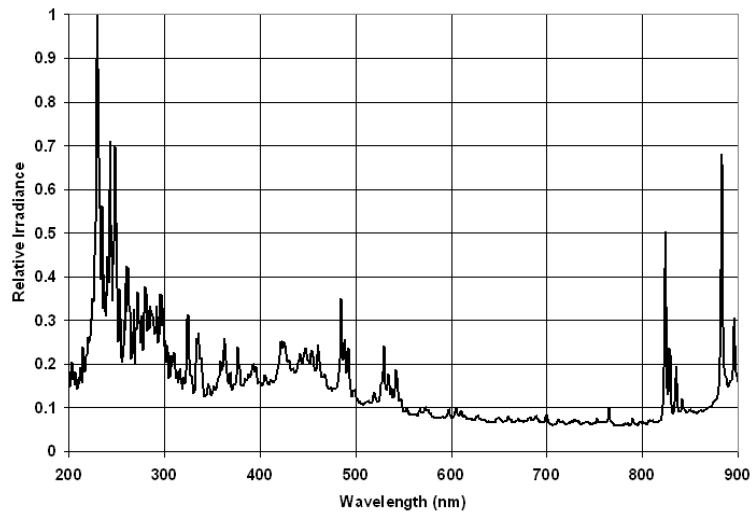
Image of FX-1150 arc
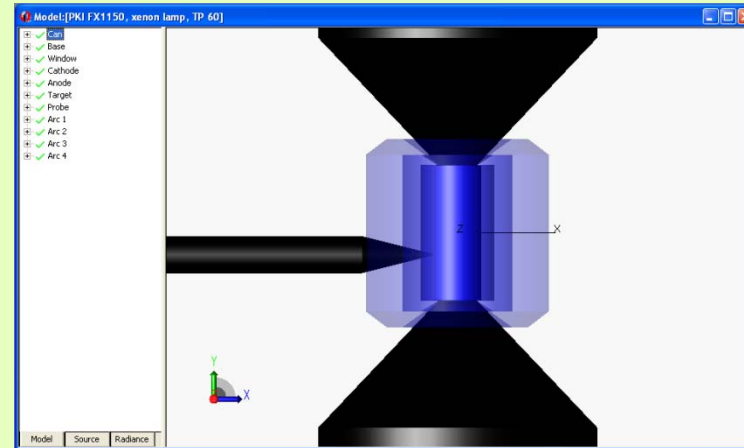
TracePro model of FX-1150 arc

PerkinElmer FX-1150 Short-arc Xenon Flashlamp Example
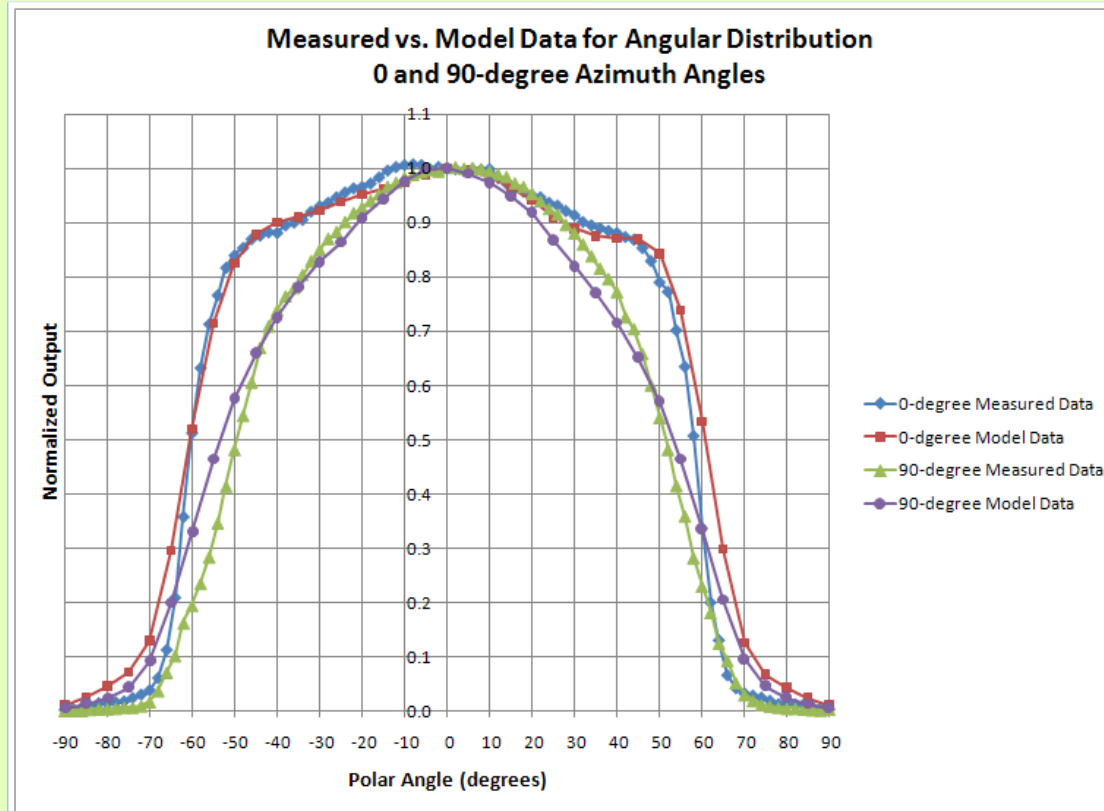
Angular Distribution: Measured vs. Modeled

PerkinElmer FX-1150 Short-arc Xenon Flashlamp Example

Spectral Distribution

Measured
(0.7nm sampling interval)
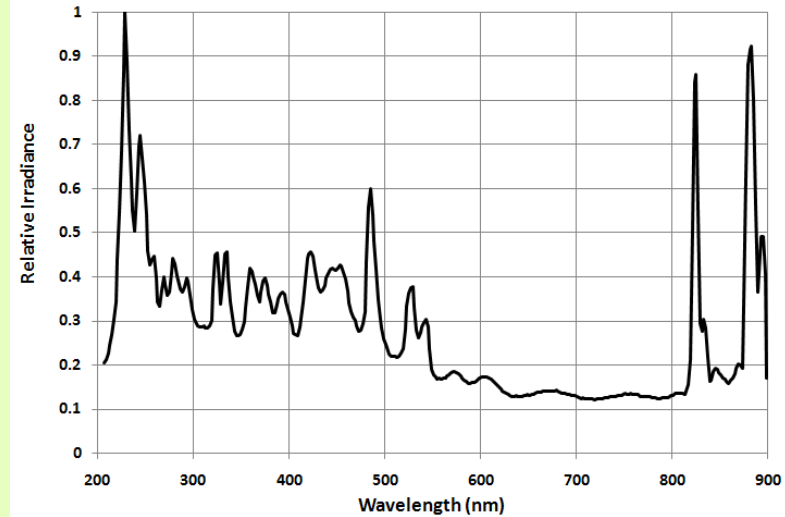
Modeled
(2nm sampling interval)

TracePro Utilities
for Light Source Modeling
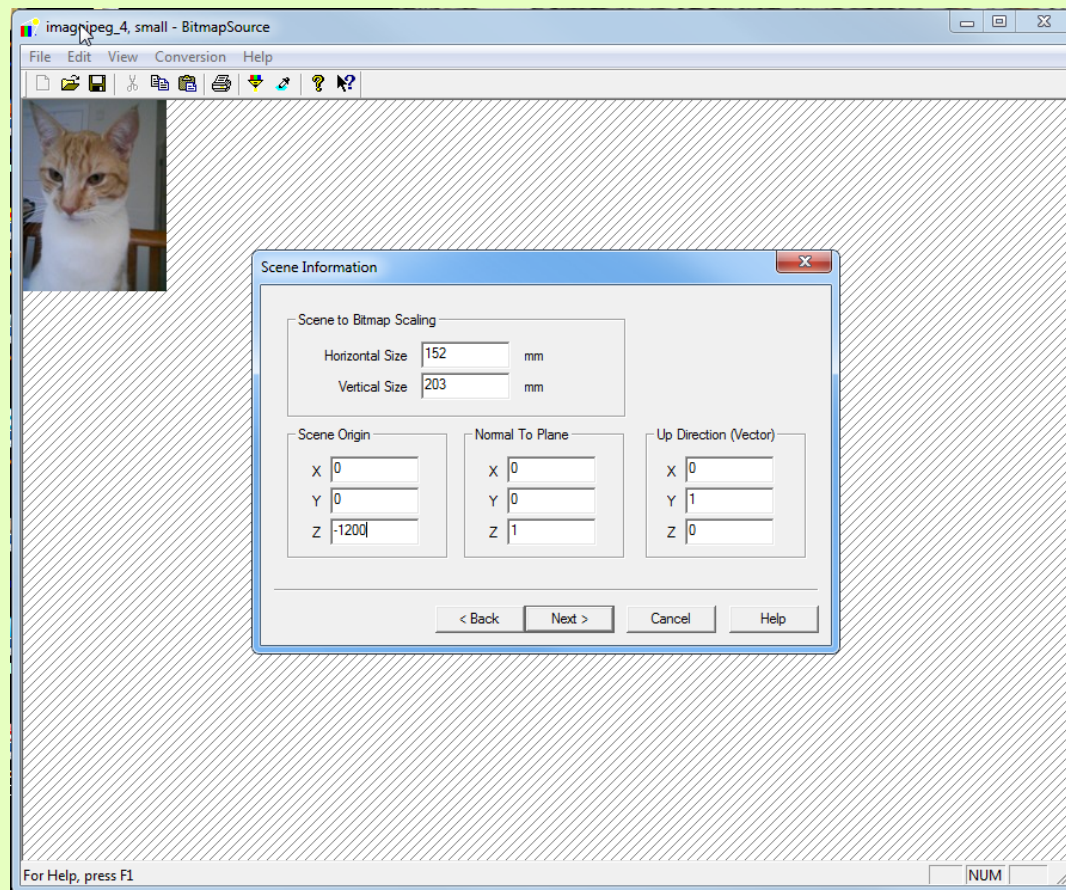
Surface Source Property Generator Utility

Luxeon Rebel LED

IES Import Utility

Bitmap Source Utility

Thank You!

Questions and Answers

For Additional Information Please Contact:

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Littleton, MA
978-486-0766
www.lambdares.com