

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

Grid Setup | Beam Setup | Polarization | Wavelengths

Name: Grid Source 1

Grid Boundary: Rectangular

Y half-height: 0.0001 X half-width: 0.05

Grid Pattern: Rectangular

Y points: 1000 X points: 1000

Units: Radiometric Rays/wave: 1000000

Flux per ray: 1 Watts

Grid Position and Orientation

Grid orientation method: Direction Vectors

Origin	Normal vector	Up vector
X: 0	X: 0	X: 0
Y: 0	Y: 0	Y: 1
Z: 0	Z: 1	Z: 0

Color: ■

Insert Modify Set Defaults

Grid Source

Grid Setup | Beam Setup | Polarization | Wavelengths

Spatial profile: Gaussian

Spatial weighting: uniform flux/weighted position

Beam waist X: 0.05 Beam waist Y: 0.0001
(Beam waist is the 1/e² point)

Angular profile: Gaussian (degrees)

Angular weighting: uniform flux/weighted angle

Half angle X: 17.5 Half angle Y: 7.5000000

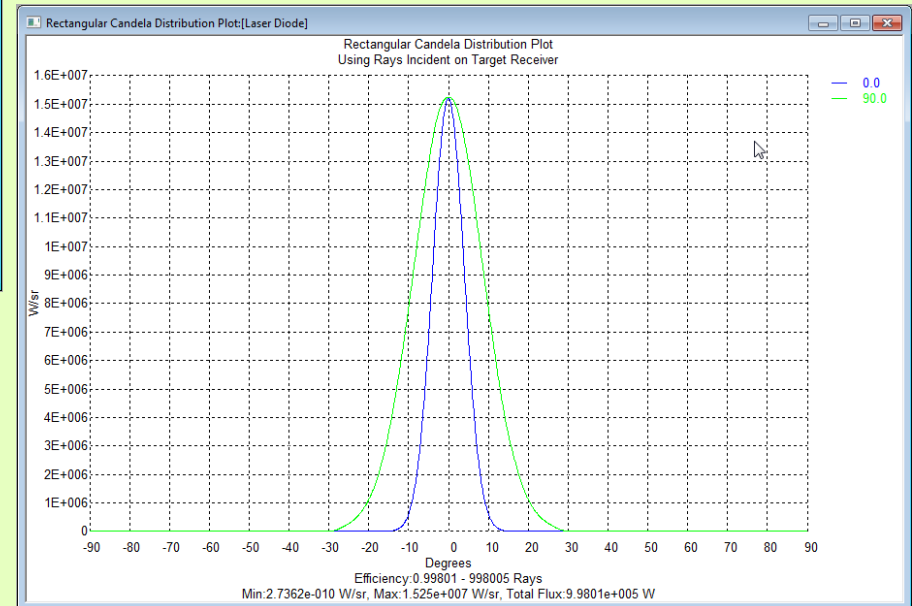
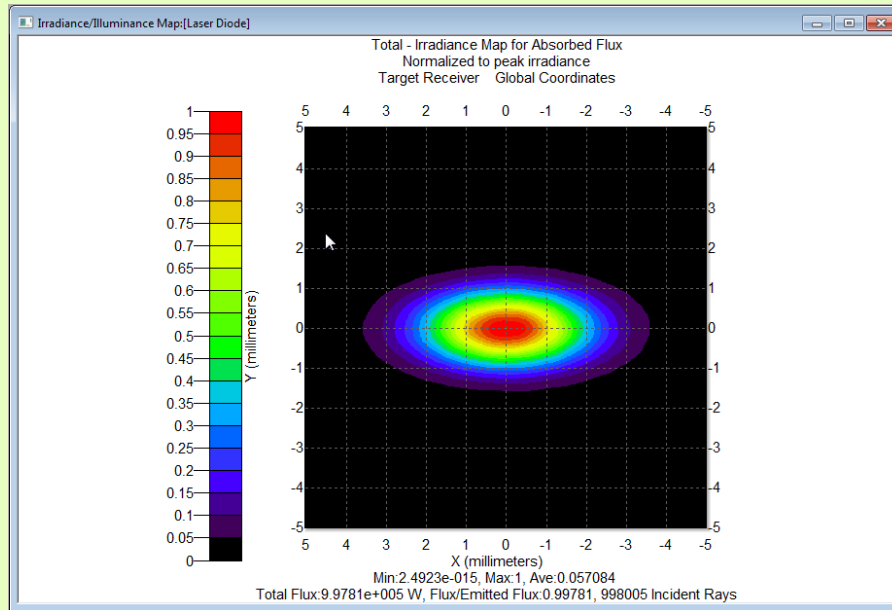
Beam Orientation

Beam orientation method: Perpendicular to grid

Normal vector	Up vector
X: 0	X: 0
Y: 0	Y: 1
Z: 1	Z: 0

Insert Modify Set Defaults

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

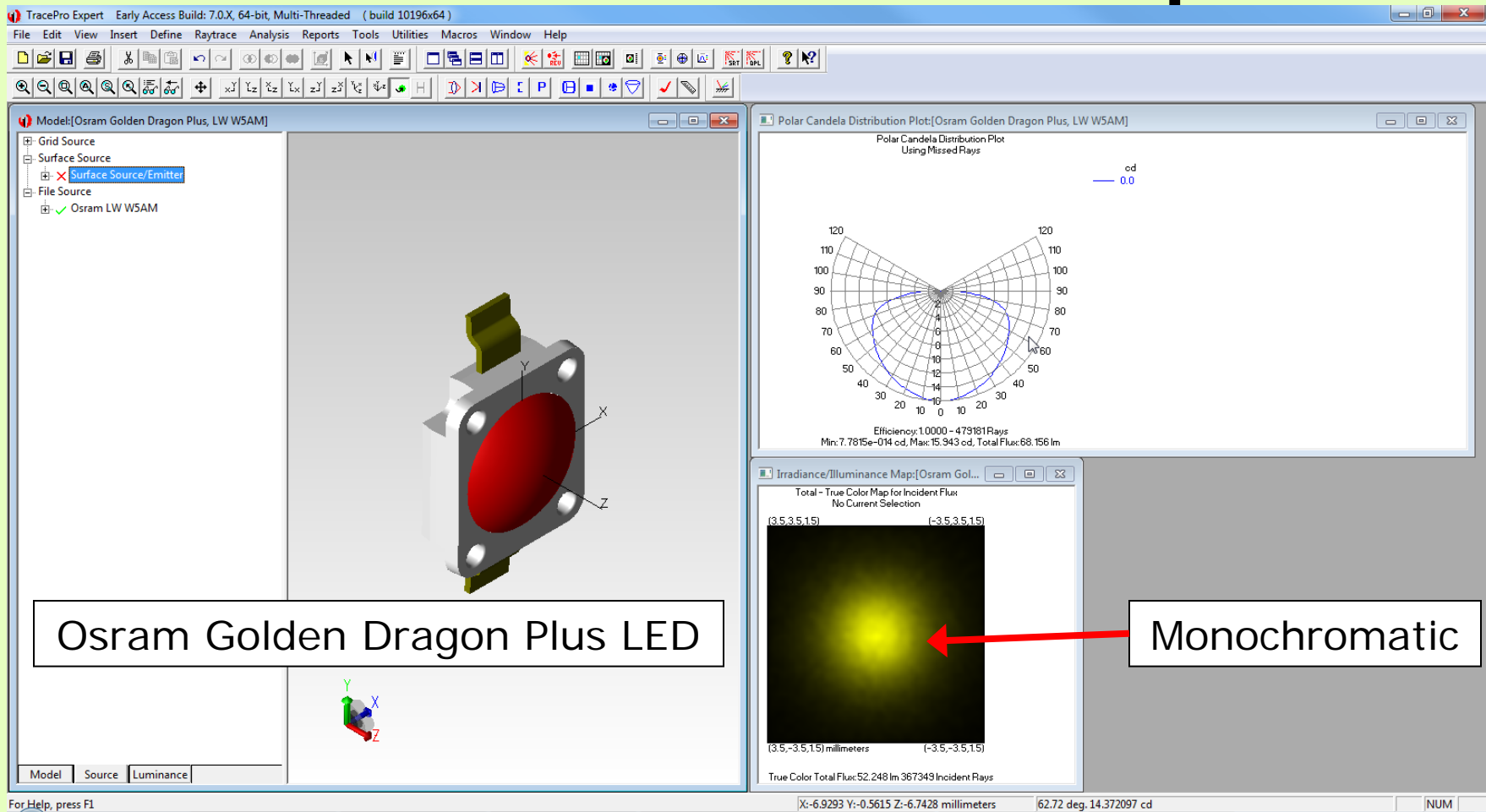
Considerations:

- Defined monochromatically
- Not a good choice if emitted light will interact with source

Examples:

- LEDs
- Luminaires

File Source – LED Example



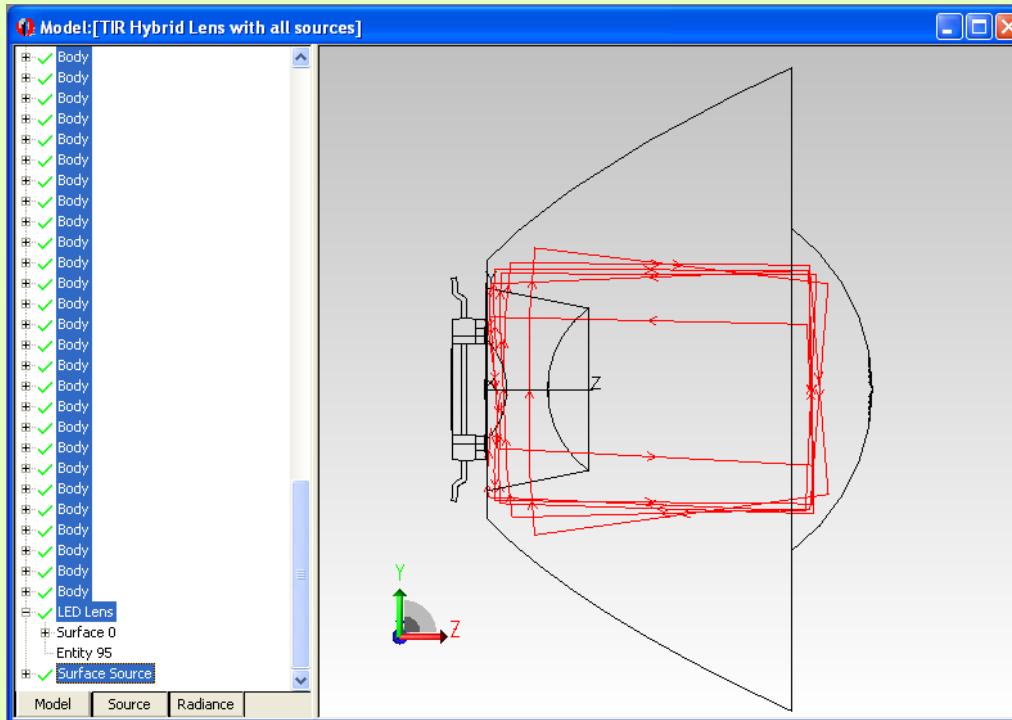
Example of File Source or Ray File Data

```
!! 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 9.717341524050380e-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 -1.8029090577089728e-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



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

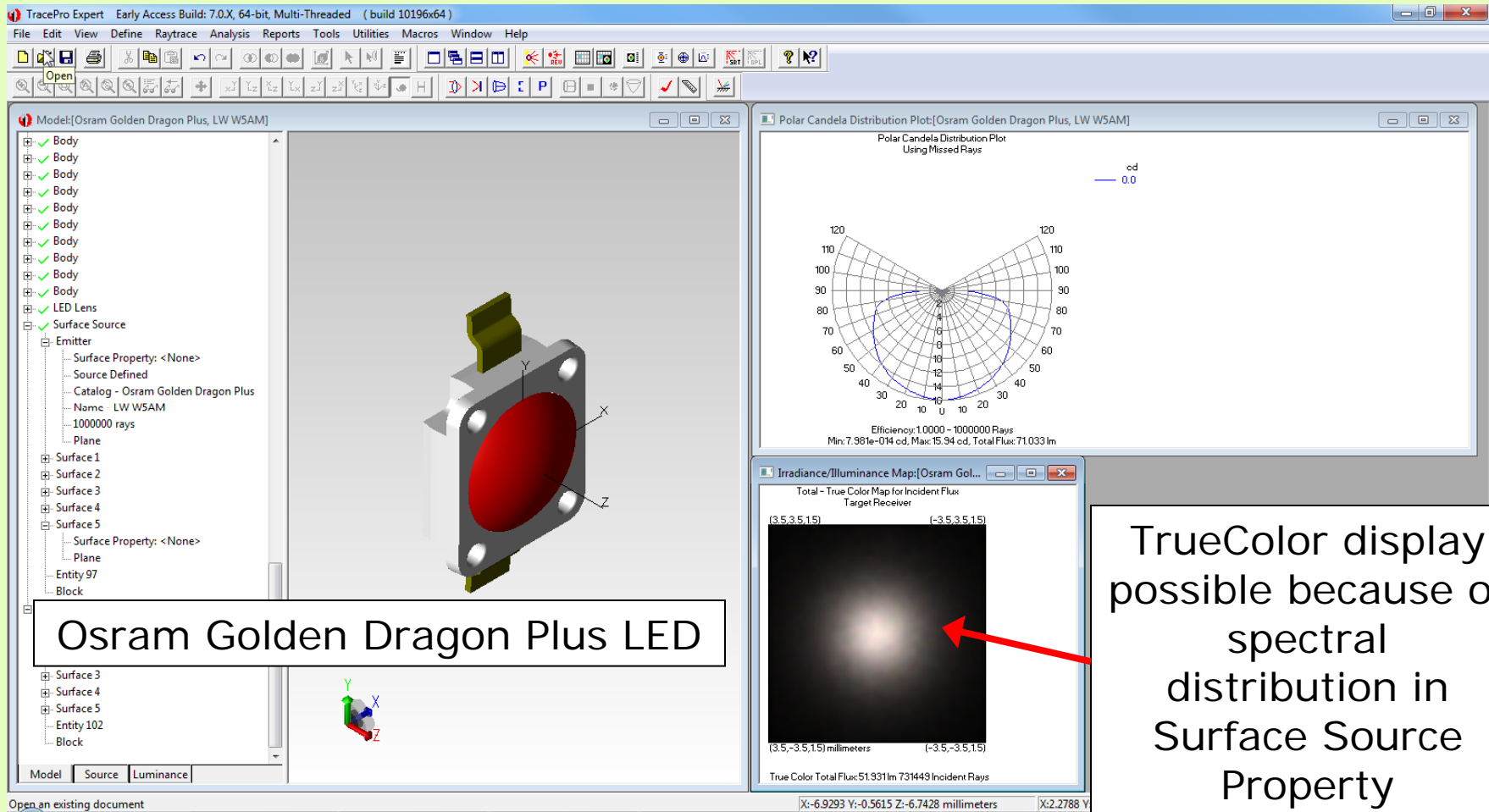
Note:
Units should be consistent.
If spectrum is defined in
radiometric units then
emission should be as well.

```
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



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:

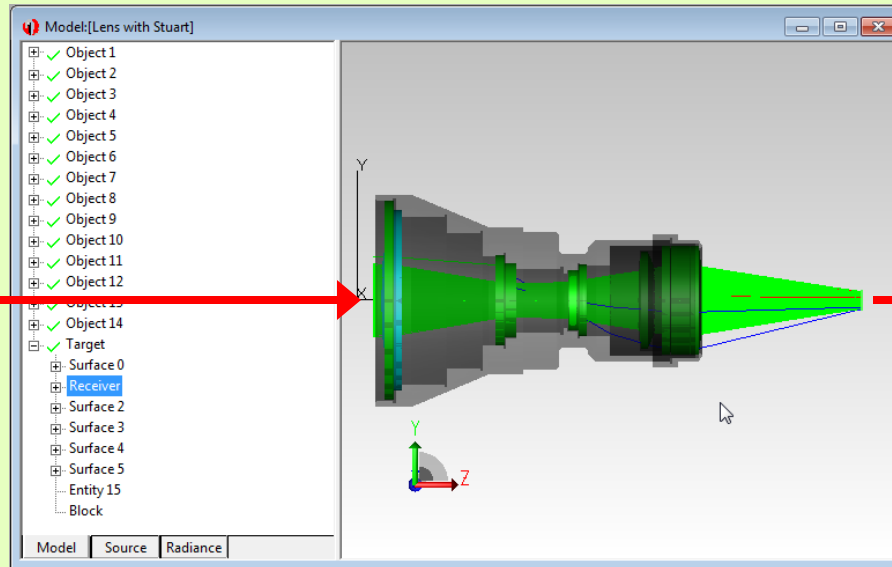
- Tracing images through systems in TracePro

Bitmap Sources

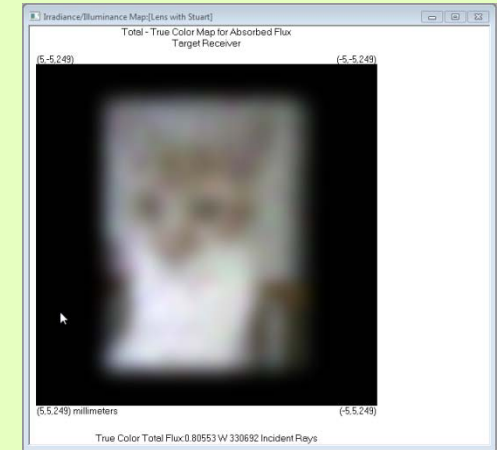
Object



Lens system in TracePro



Image

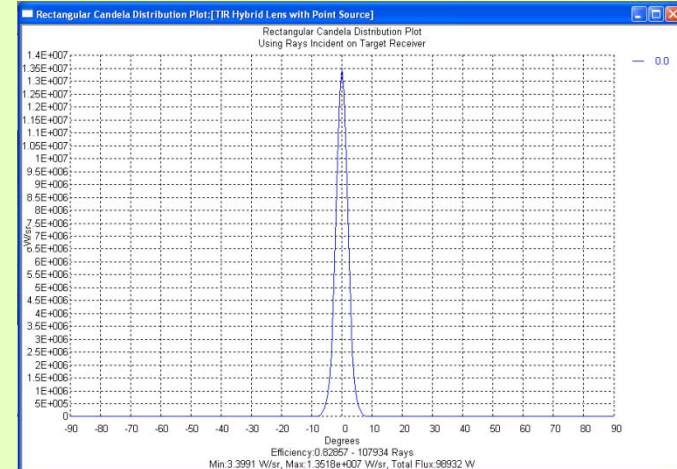
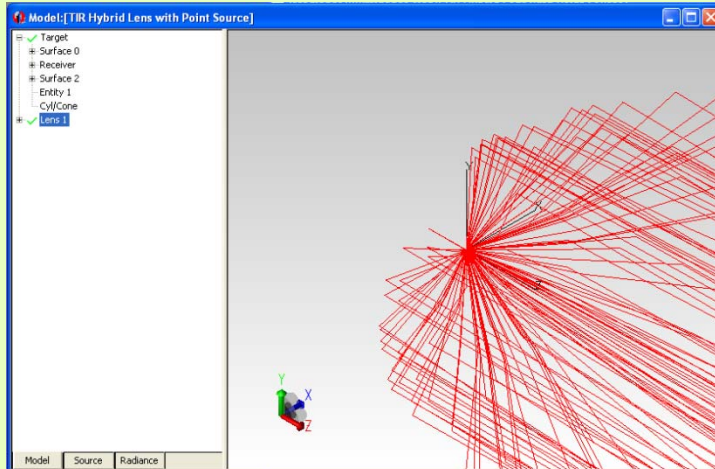
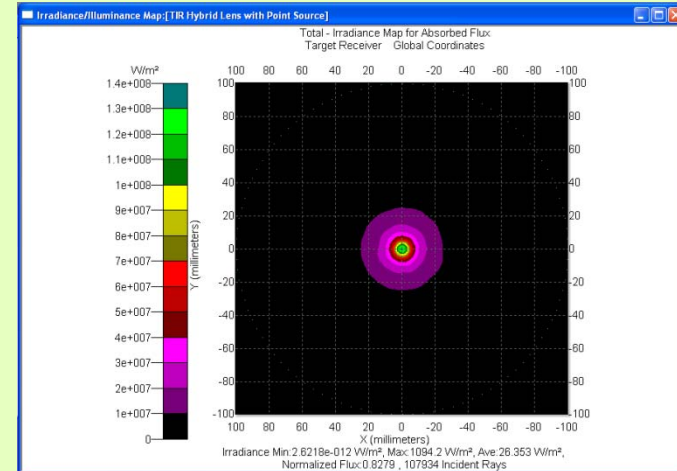
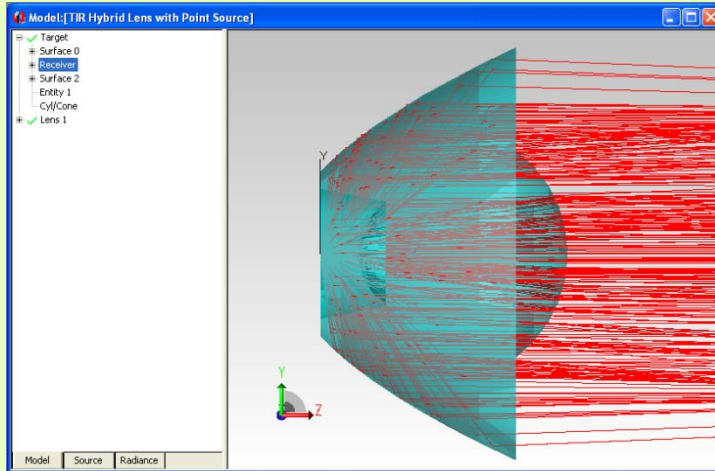


Bitmap image and Bitmap Source Utility is used to create a File Source for TracePro

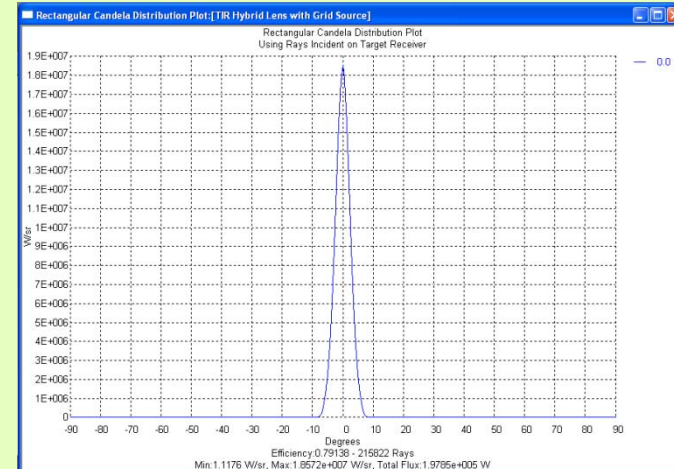
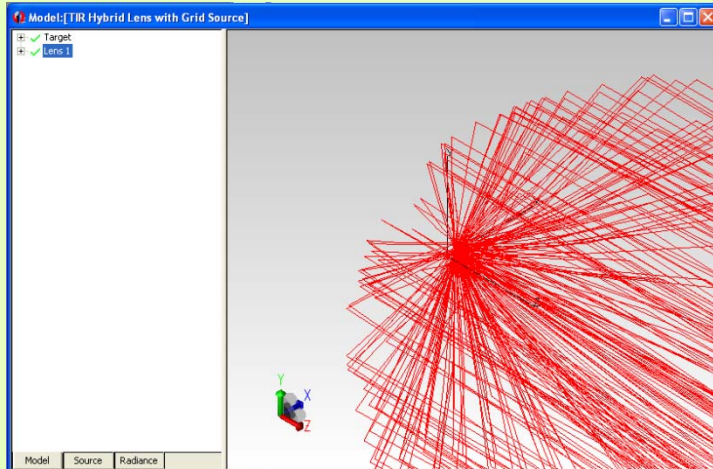
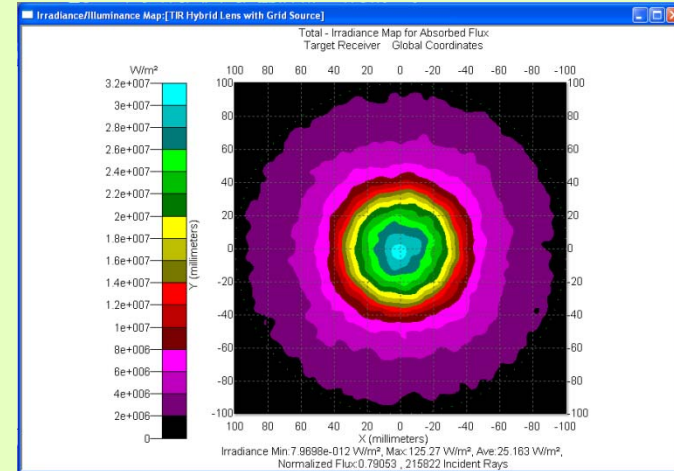
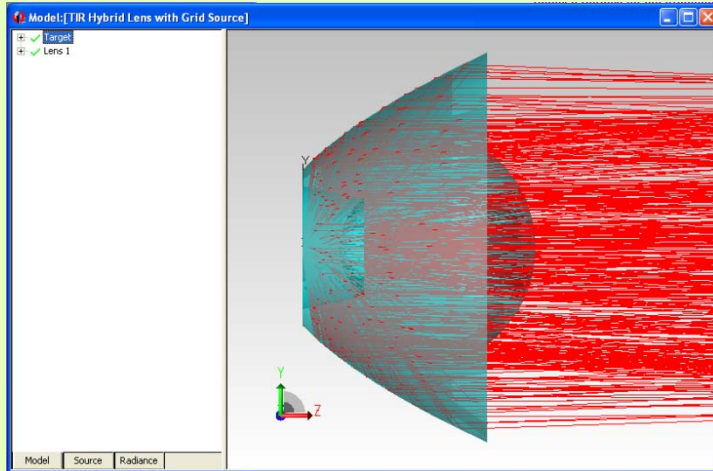
4 Sources, 1 Model



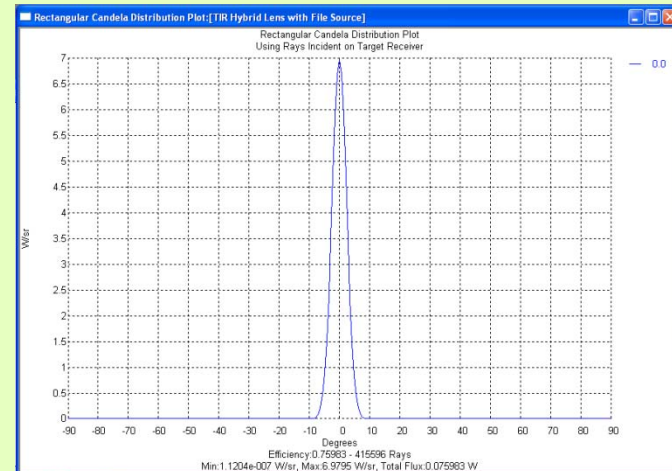
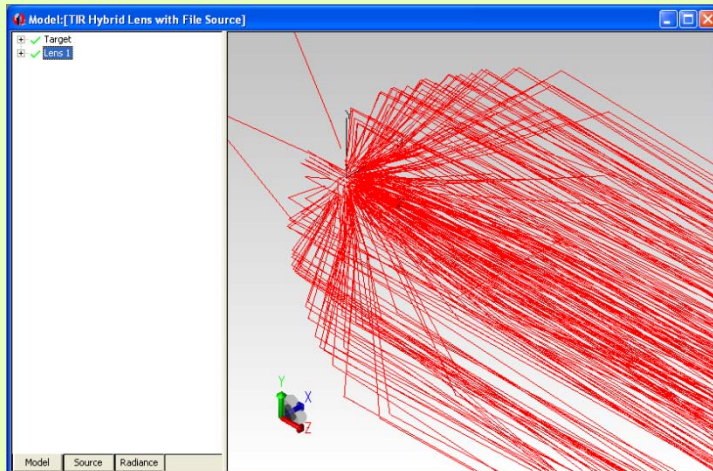
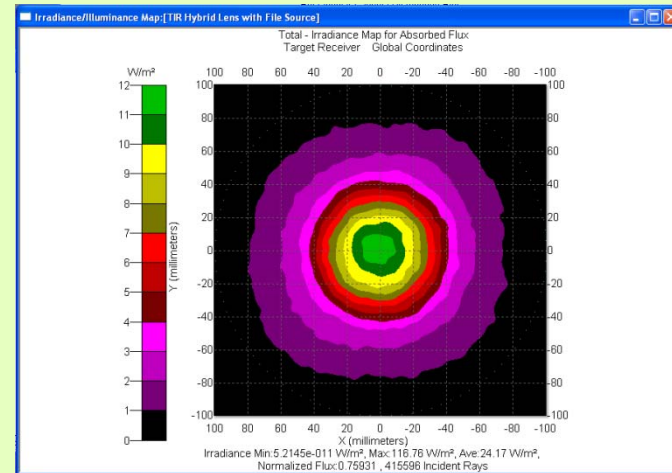
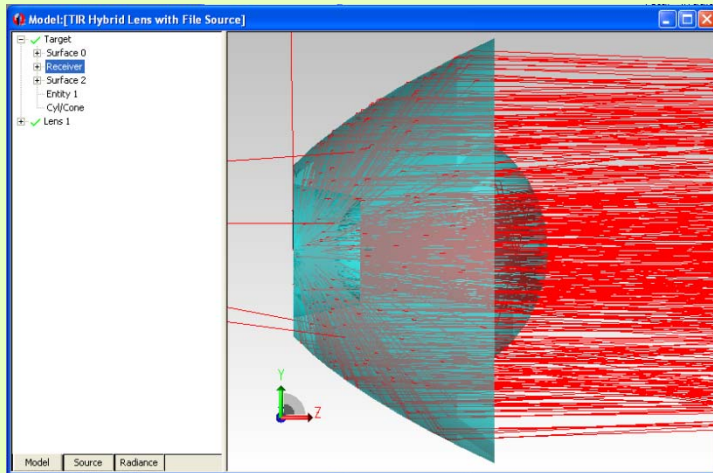
TIR Hybrid Lens with Point Source



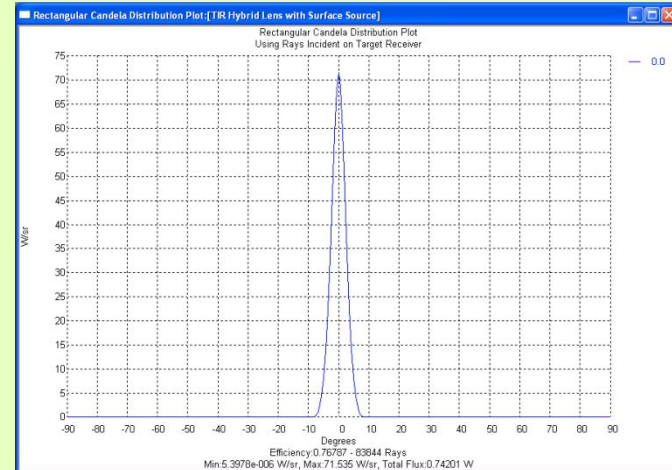
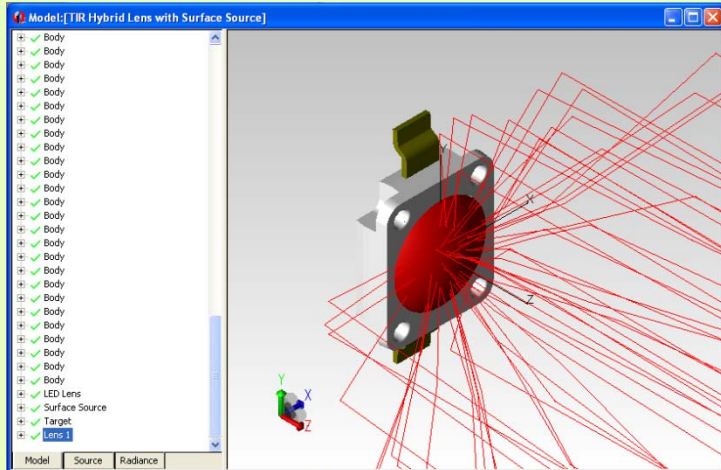
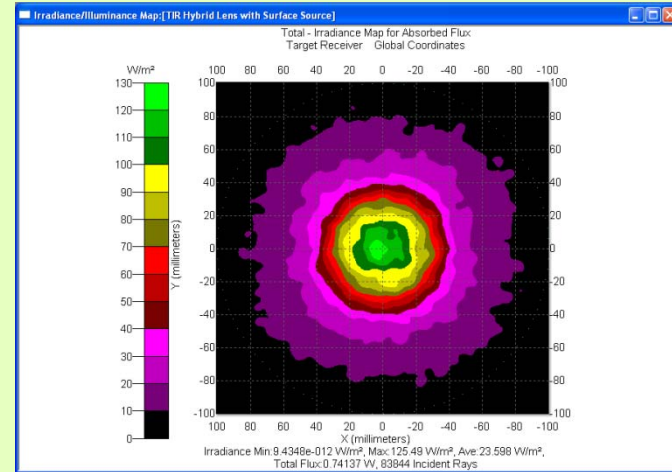
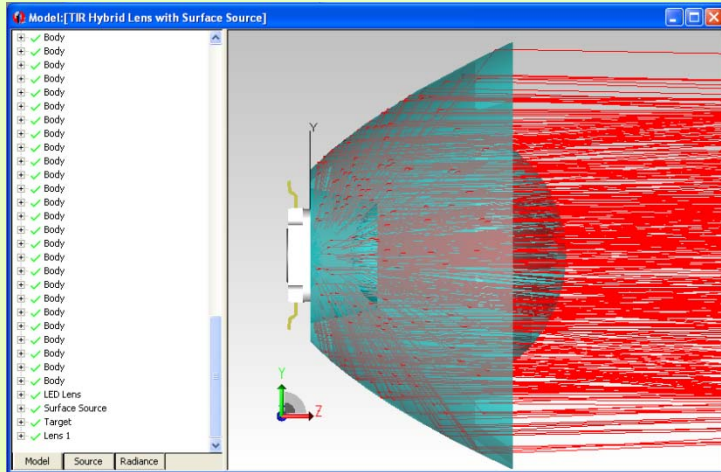
TIR Hybrid Lens with 1mm x 1mm Grid Source



TIR Hybrid Lens with Ray File Source



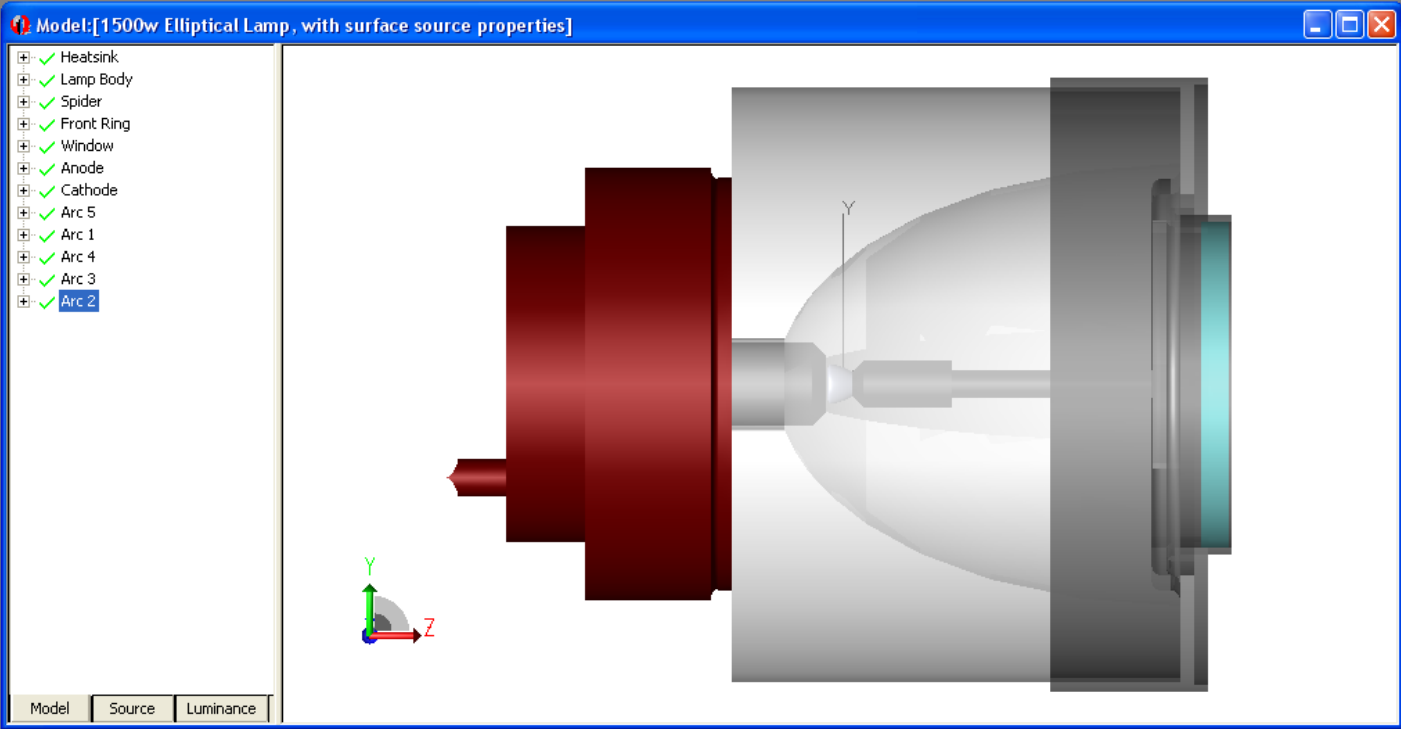
TIR Hybrid Lens with Surface Source Property



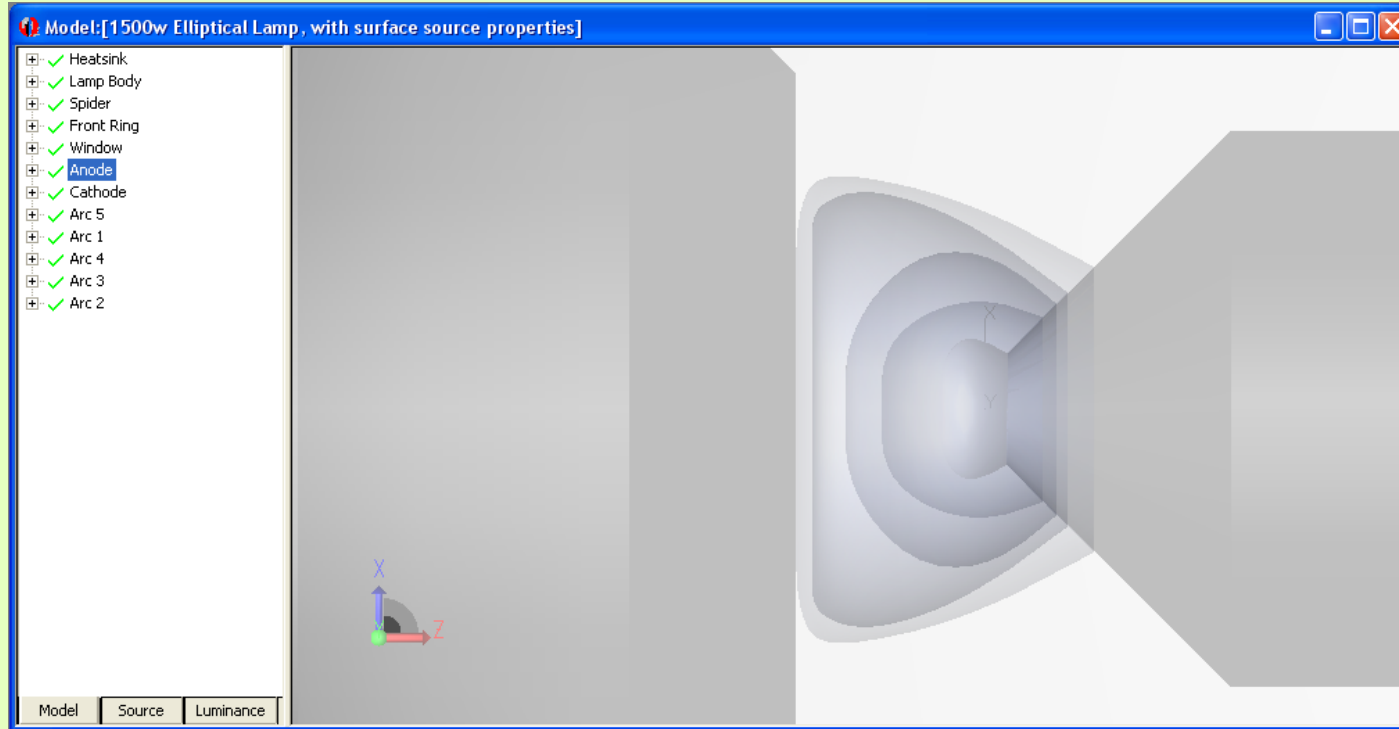
Increasing the Complexity



1500-watt Xenon Lamp with Surface Source Properties



1500-watt Xenon Lamp with Surface Source Properties

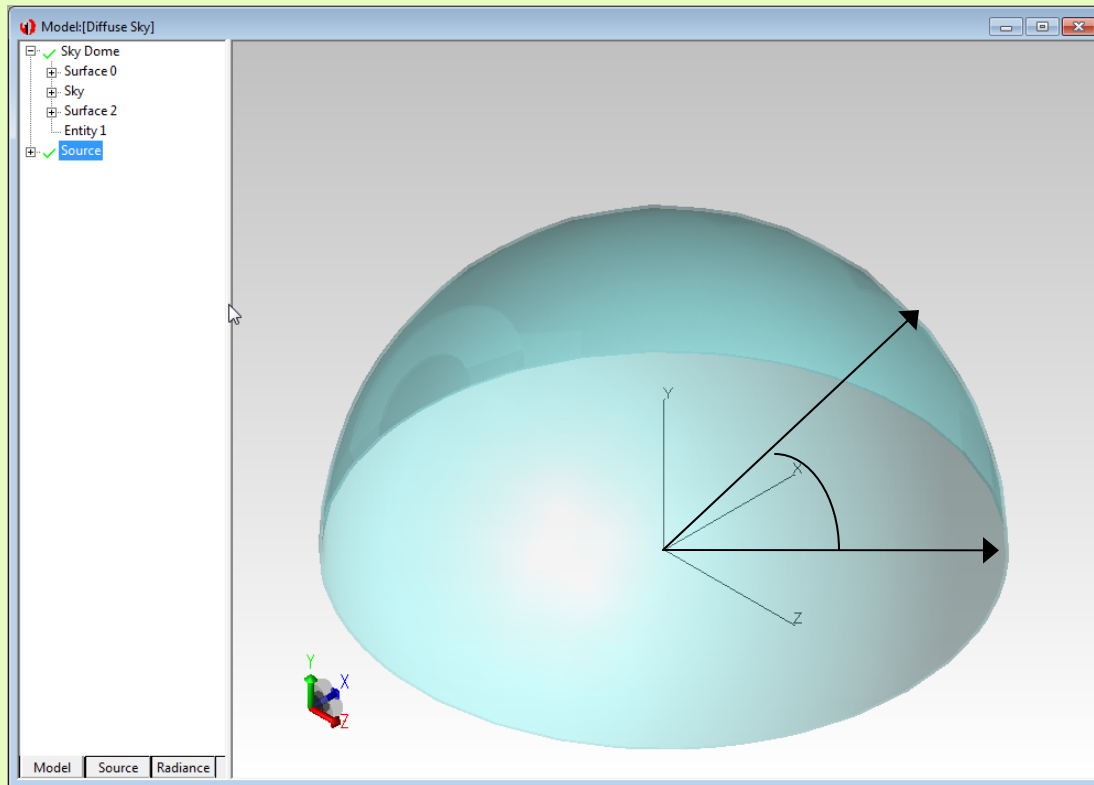


Arc model showing luminous intensity distribution

Modeling an Overcast Sky

A Spatially Varying Source

Modeling an Overcast Sky

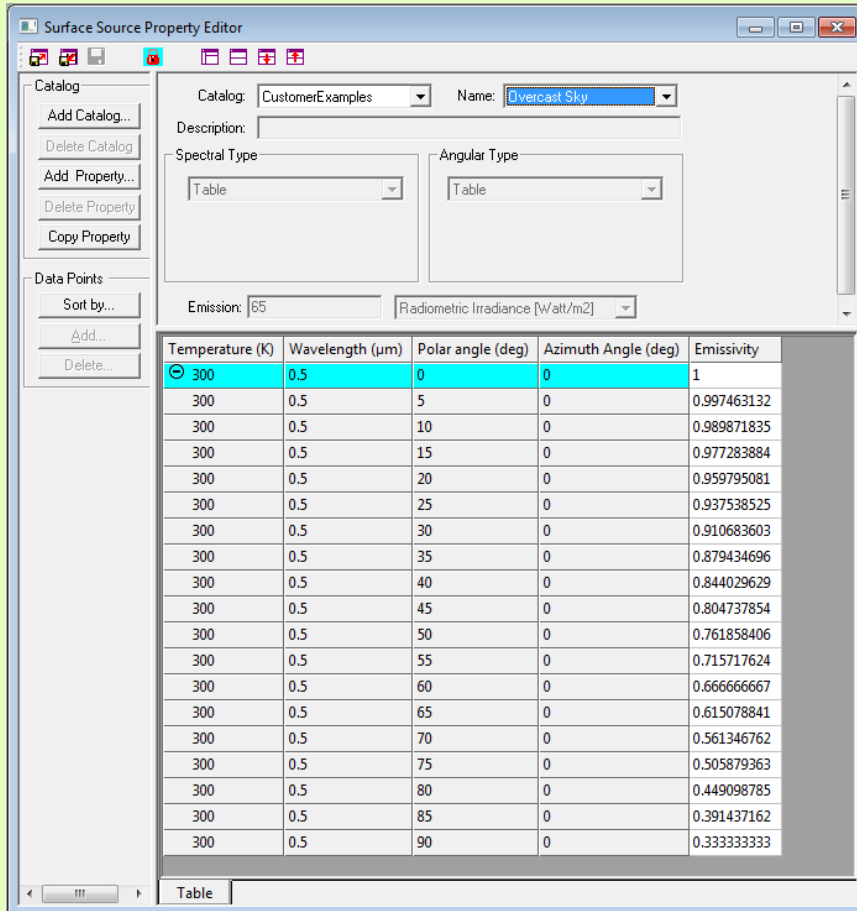


Luminance varies as a function of angle above horizon:

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

CIE DS 011.2/E: 2002

Modeling an Overcast Sky



Temperature (K)	Wavelength (µm)	Polar angle (deg)	Azimuth Angle (deg)	Emissivity
300	0.5	0	0	1
300	0.5	5	0	0.997463132
300	0.5	10	0	0.989871835
300	0.5	15	0	0.977283884
300	0.5	20	0	0.959795081
300	0.5	25	0	0.937538525
300	0.5	30	0	0.910683603
300	0.5	35	0	0.879434696
300	0.5	40	0	0.844029629
300	0.5	45	0	0.804737854
300	0.5	50	0	0.761858406
300	0.5	55	0	0.715717624
300	0.5	60	0	0.666666667
300	0.5	65	0	0.615078841
300	0.5	70	0	0.561346762
300	0.5	75	0	0.505879363
300	0.5	80	0	0.449098785
300	0.5	85	0	0.391437162
300	0.5	90	0	0.333333333

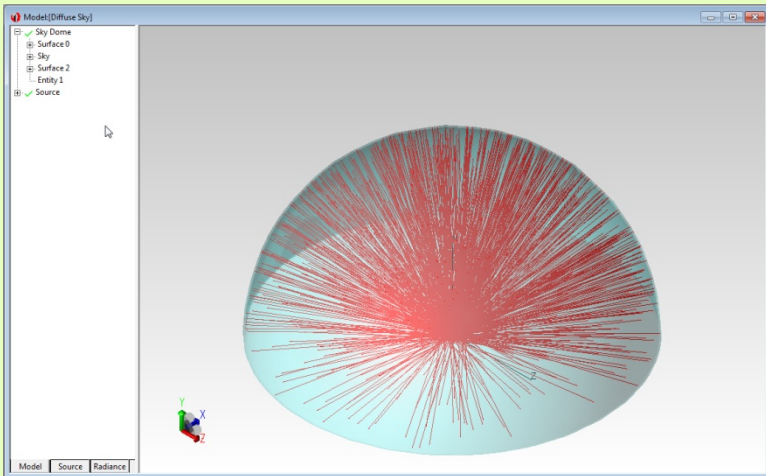
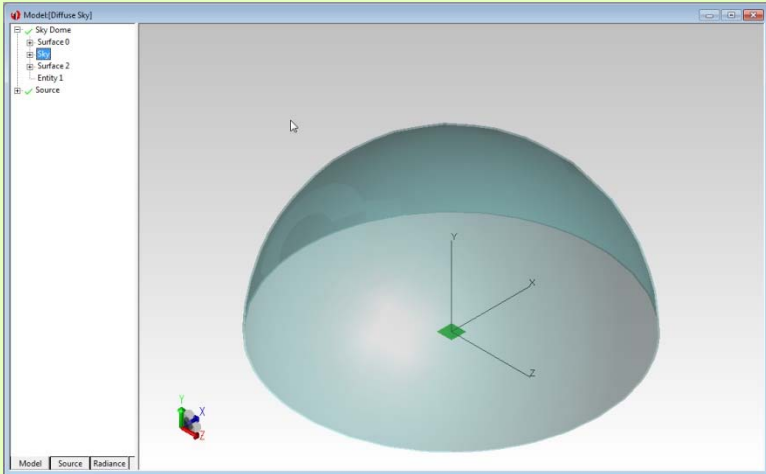
Use:

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

to make a Surface Source Property in TracePro

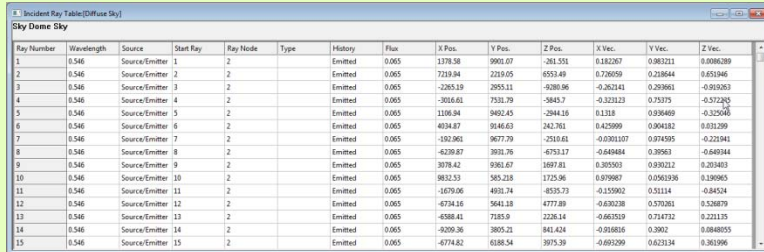
Note that the zenith in TracePro is 0-degrees

Modeling an Overcast Sky



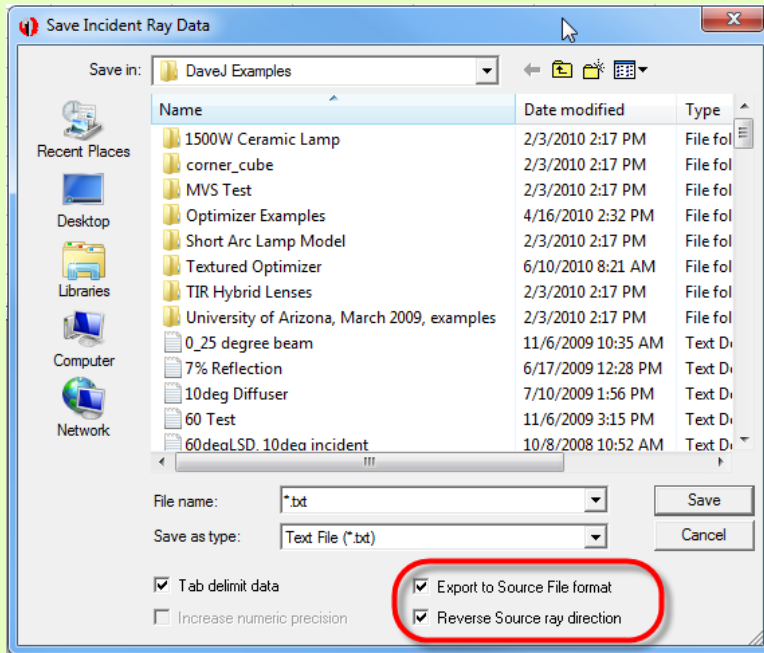
- Use a hemisphere to represent the sky
- Apply the Surface Source Property to the surface of object at the center of the hemisphere
- Trace rays to the inside surface of the hemisphere

Modeling an Overcast Sky



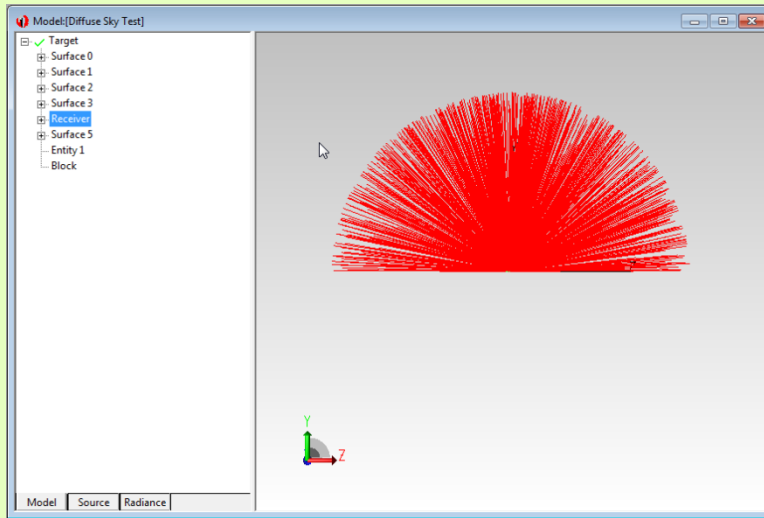
Ray Number	Wavelength	Source	Start Ray	Ray Mode	Type	History	Flux	X Pos.	Y Pos.	Z Pos.	X Vec.	Y Vec.	Z Vec.
1	0.546	Source/Emitter 1	2		Emitted	0.005	1378.58	9901.07	-261.551	0.182267	0.983211	0.0086289	
2	0.546	Source/Emitter 2	2		Emitted	0.005	7239.84	2219.05	6553.49	0.726959	0.238644	0.651346	
3	0.546	Source/Emitter 3	2		Emitted	0.005	-2855.19	2955.11	-9280.96	-0.262141	0.292961	-0.910263	
4	0.546	Source/Emitter 4	2		Emitted	0.005	-2016.61	7128.79	-9843.7	-0.321823	0.752375	-0.572261	
5	0.546	Source/Emitter 5	2		Emitted	0.005	1106.34	9462.45	-2944.16	0.1318	0.928469	-0.325265	
6	0.546	Source/Emitter 6	2		Emitted	0.005	4034.87	9146.63	242.761	0.425999	0.904382	0.331299	
7	0.546	Source/Emitter 7	2		Emitted	0.005	-192.961	9677.79	-2510.61	-0.0301107	0.974395	-0.221941	
8	0.546	Source/Emitter 8	2		Emitted	0.005	-6239.87	3931.76	-6753.17	-0.648484	0.39963	-0.649344	
9	0.546	Source/Emitter 9	2		Emitted	0.005	3976.42	9361.67	1497.81	0.305503	0.939212	0.202403	
10	0.546	Source/Emitter 10	2		Emitted	0.005	9812.53	345.235	1735.96	0.979987	0.0263396	0.126905	
11	0.546	Source/Emitter 11	2		Emitted	0.005	1679.06	4931.74	-8335.73	-0.155902	0.51114	-0.84524	
12	0.546	Source/Emitter 12	2		Emitted	0.005	4734.16	5641.18	4777.89	-0.630238	0.570261	0.526879	
13	0.546	Source/Emitter 13	2		Emitted	0.005	4588.41	7181.9	2226.14	-0.663519	0.714732	0.221125	
14	0.546	Source/Emitter 14	2		Emitted	0.005	-6295.36	3893.21	841.424	-0.914816	0.3962	0.884895	
15	0.546	Source/Emitter 15	2		Emitted	0.005	-6774.82	6388.54	3973.39	-0.693299	0.623134	0.301996	

- Get the Incident Ray Table for the inside surface of the hemisphere

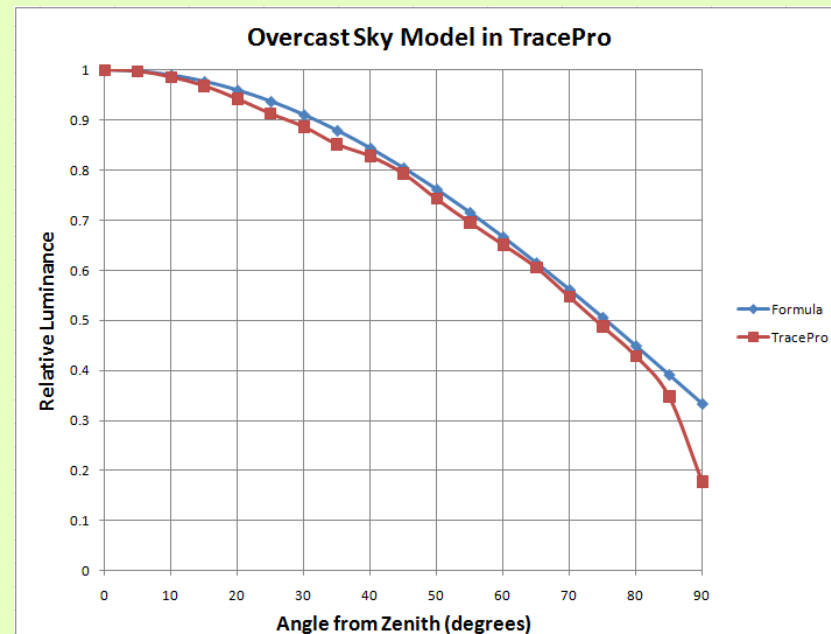


- Use Save Incident Ray Data with “Export to Source File format” and “Reverse Source ray direction” options to create a new File Source from the Incident Ray Table data

Modeling an Overcast Sky



- Insert the new File Source in your model and run the raytrace

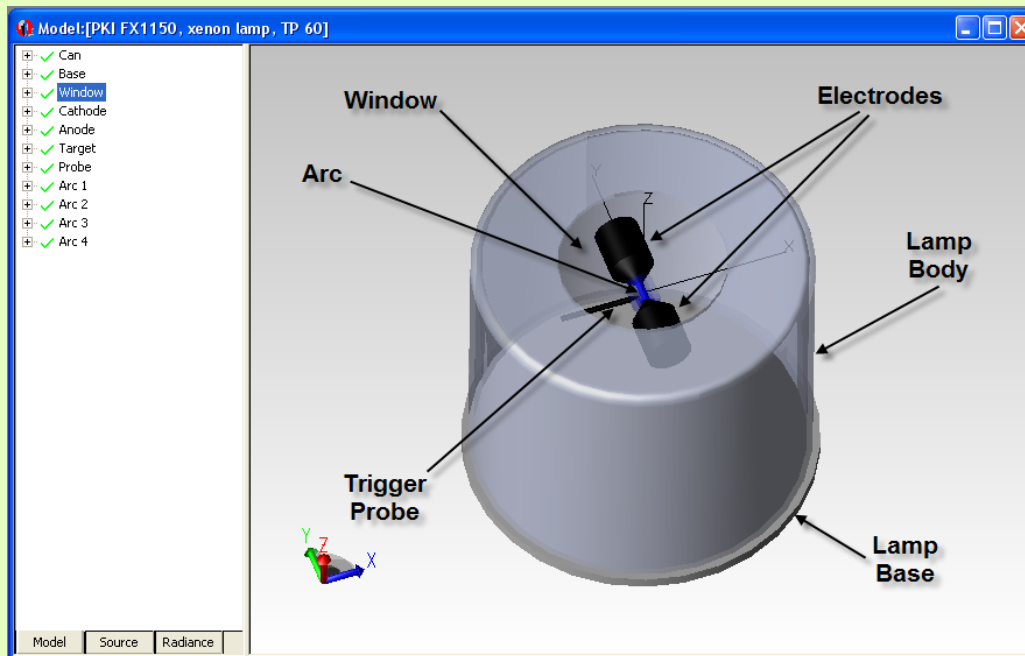


Measured Data vs. Simulation Data: An Example

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

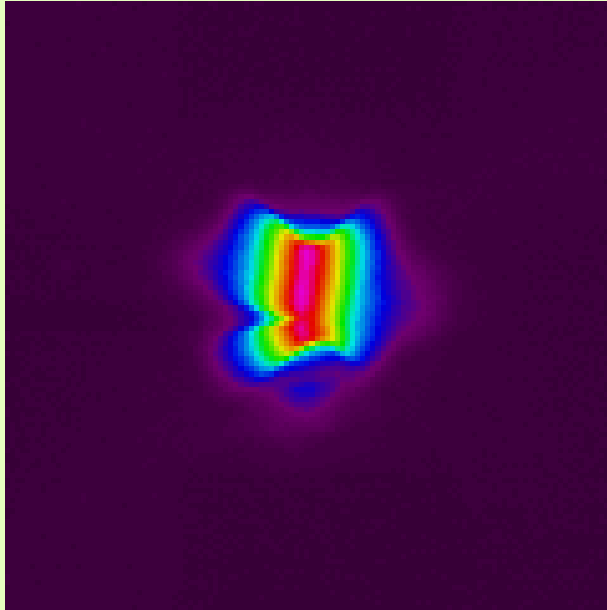
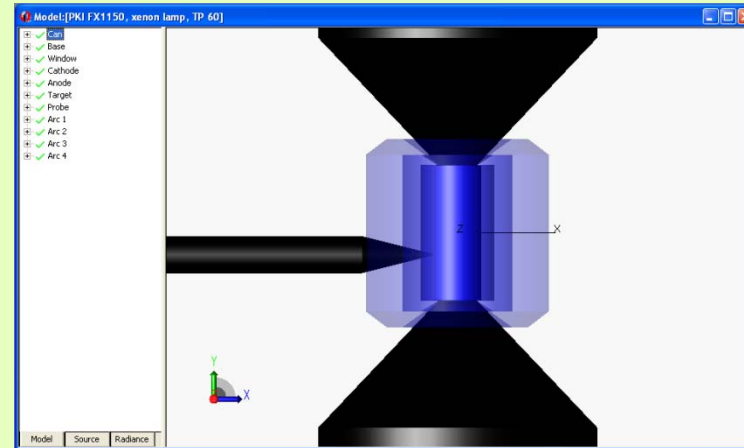
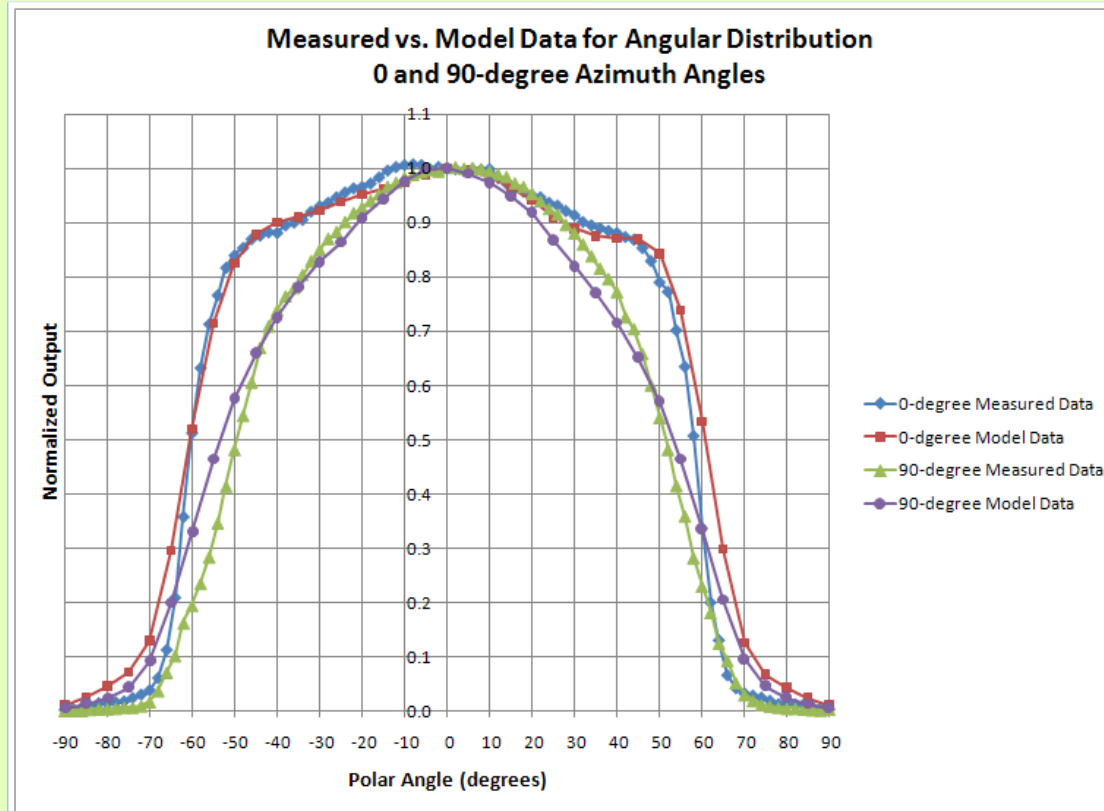


Image of FX-1150 arc



TracePro model of FX-1150 arc

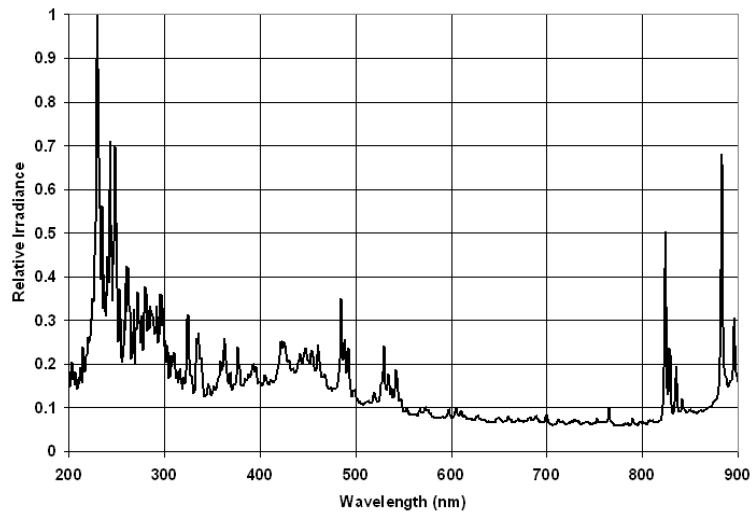
PerkinElmer FX-1150 Short-arc Xenon Flashlamp Example



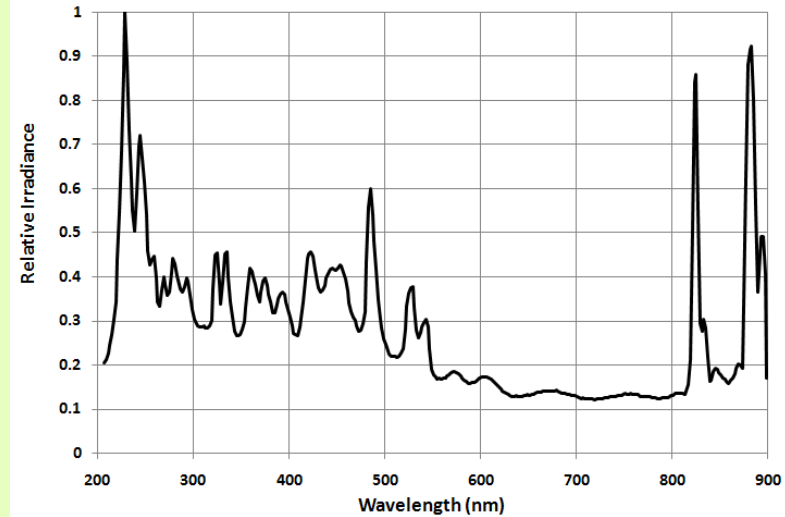
Angular Distribution: Measured vs. Modeled

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

Surface Source Property Generator

File Export Help

Beam shape profile editor (0.00 deg)

Symmetric input

M

Coordinate System

Type: Polar

Note: Origin point, ref. point1, and ref. point2 cannot share a common value or angle

Set	Angle	Value
Set Origin		0
Set Ref 1	0.0	1
Set Ref 2	90	0.869571

Wavelengths editor

Spectrum type: Table

Spectrum data:

Wavelength	Weight
0.3603773	0
0.3693492	0
0.3783211	0.000105618
0.387293	0.004271692
0.3962649	0.005802438
0.4052368	0.003530277
0.4142087	0.03234672
0.4231806	0.1258685
0.4321525	0.3471071
0.4411243	0.824369
0.4500962	0.9274579

Wavelength: 0.547 Add

Weight: 1 Del

Unit: Radiometric

Spectrum input helper

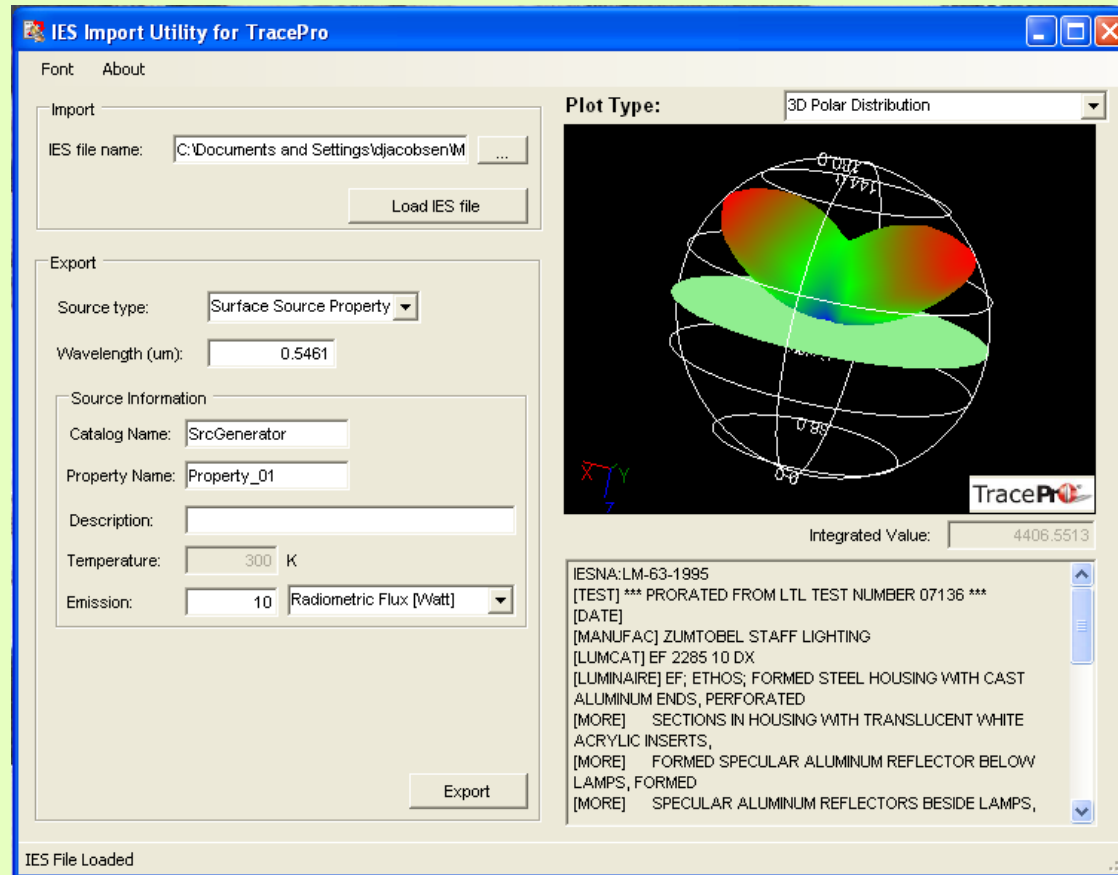
Wavelength Intensity Auto Sample

Set Ref 1	.35	0.0	50
Set Ref 2	0.8	1.0	Sample

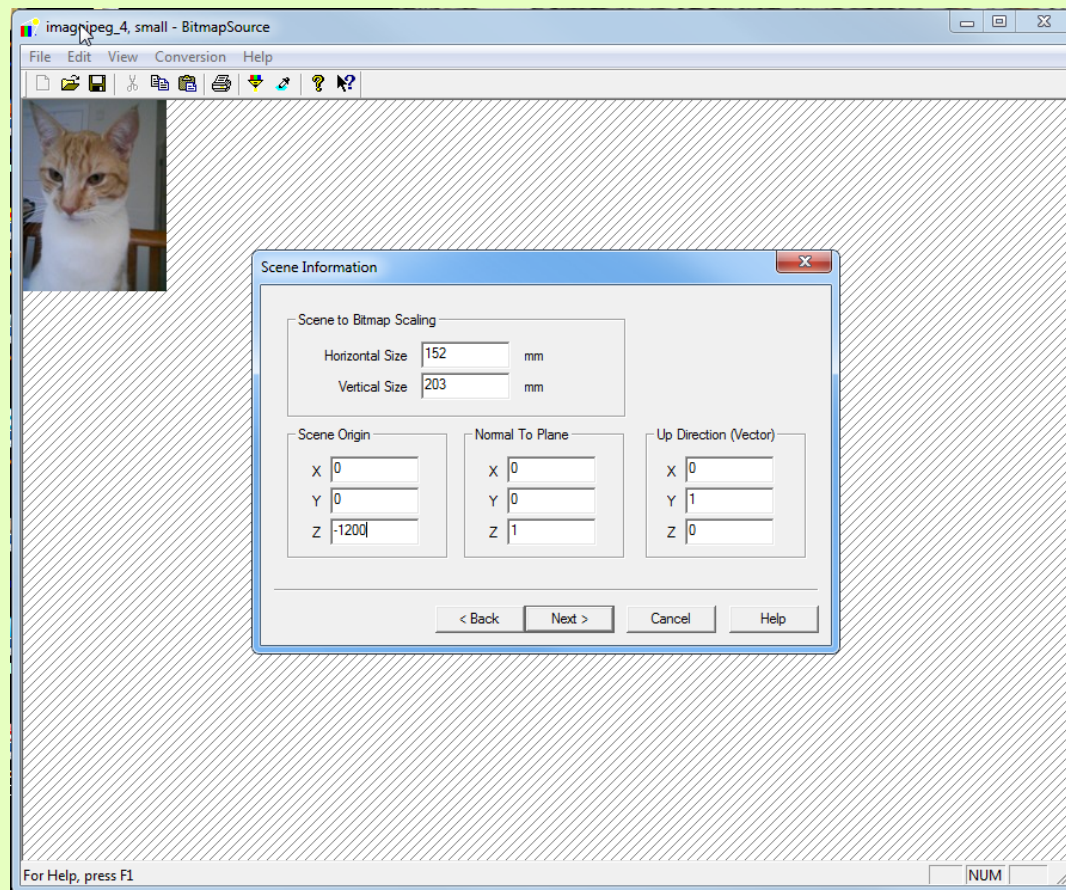
Luxeon Rebel LED

TracePro

IES Import Utility



Bitmap Source Utility



Thank You!



Questions and Answers



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