An Introduction to Radiometry and Photometry in TracePro

Presented by :
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Format

- A 25-30 minute presentation followed by a 10-15 minute question and answer session

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

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In this webinar you will:

- Learn about Radiometry and Photometry and what the difference is between the two

- Gain an understanding of the basic terms in Radiometry and Photometry

- Discover the tools in TracePro that you can use to verify the radiometric and photometric performance of your model

In this webinar you will:

•See how changes to the TracePro analysis settings can affect your radiometric and photometric results, and why

•Find out about the color capabilities in TracePro, including Correlated Color Temperature or CCT and CIE Color Coordinates

•Have your questions answered in the Question and Answer session

Current TracePro Release

- TracePro 7.0.8

- Can be downloaded by anyone with a current Maintenance and Support Agreement

- www.lambdares.com

TracePro Early Access Release

- TracePro 7.1 Early Access
- Can be downloaded by anyone with a current Maintenance and Support Agreement
- www.lambdares.com
- Please see our August 2011 Webinar showing the new features in TracePro 7.1
- http://www.lambdares.com/webinars/

An Introduction to Radiometry and Photometry in TracePro

What do all those terms mean, and how to use them.

Radiometry vs. Photometry

What is the difference between the two?

Radiometry is the measurement of electromagnetic radiation

•In the most general sense this includes everything from x-rays to microwaves and radio waves. Wavelengths range from less than a billionth of a meter for x-rays to greater than a meter for radio waves.

•For optical systems we could limit this to light from Ultraviolet to Infrared with wavelengths from 0.1um for Ultraviolet to greater than 10um for Infrared.

•Silicon detectors such as CCD's and photodiodes are sensitive to light in the 0.2-1.1um range.

•Standard unit of radiometric, or radiant, flux is the **watt (W)**.

Photometry is the measurement of light as it is perceived by the human eye

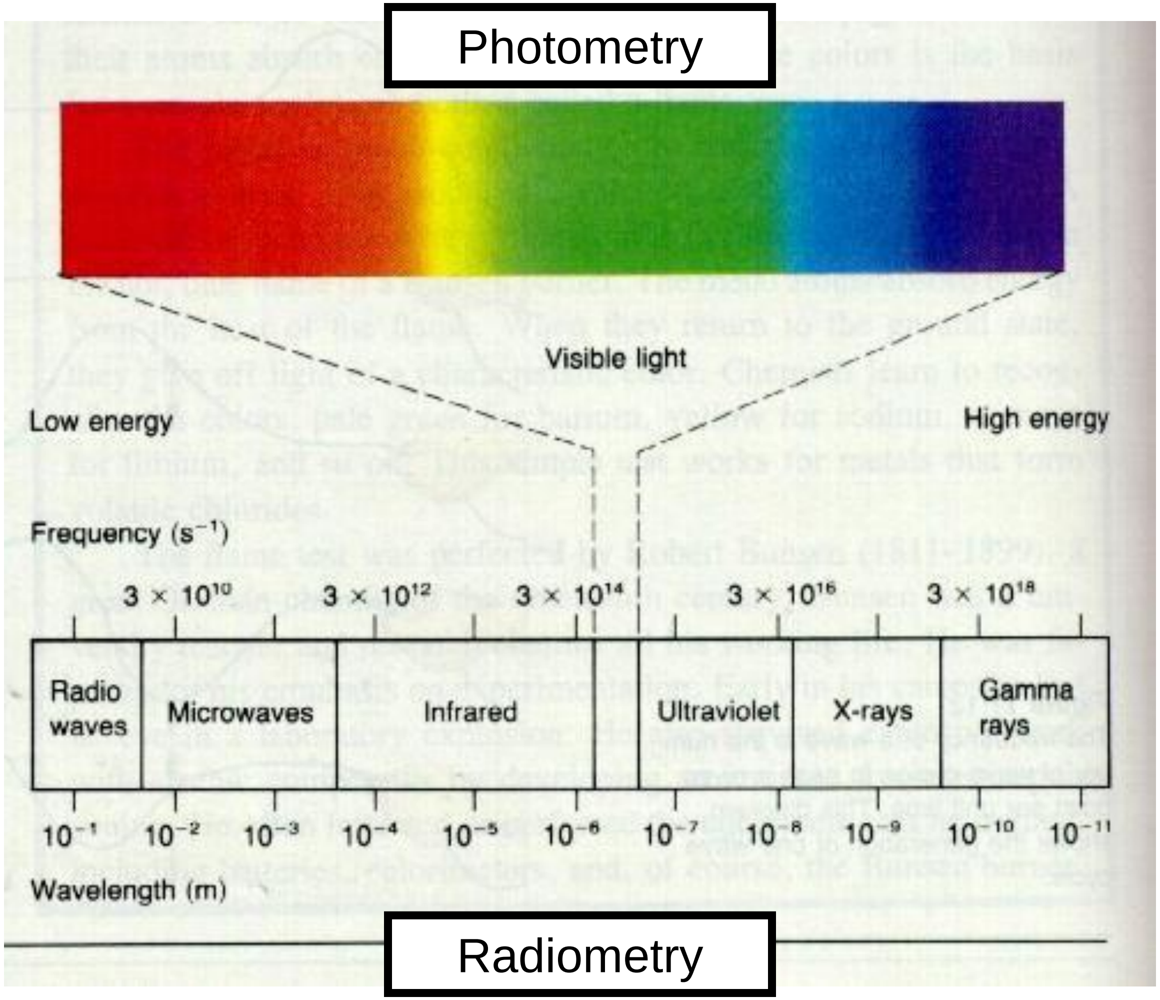
- The human eye is sensitive to light from about 0.4 – 0.75um, 400-750nm. This is known as visible light.

- The human eye is not equally sensitive to all wavelengths in this range.

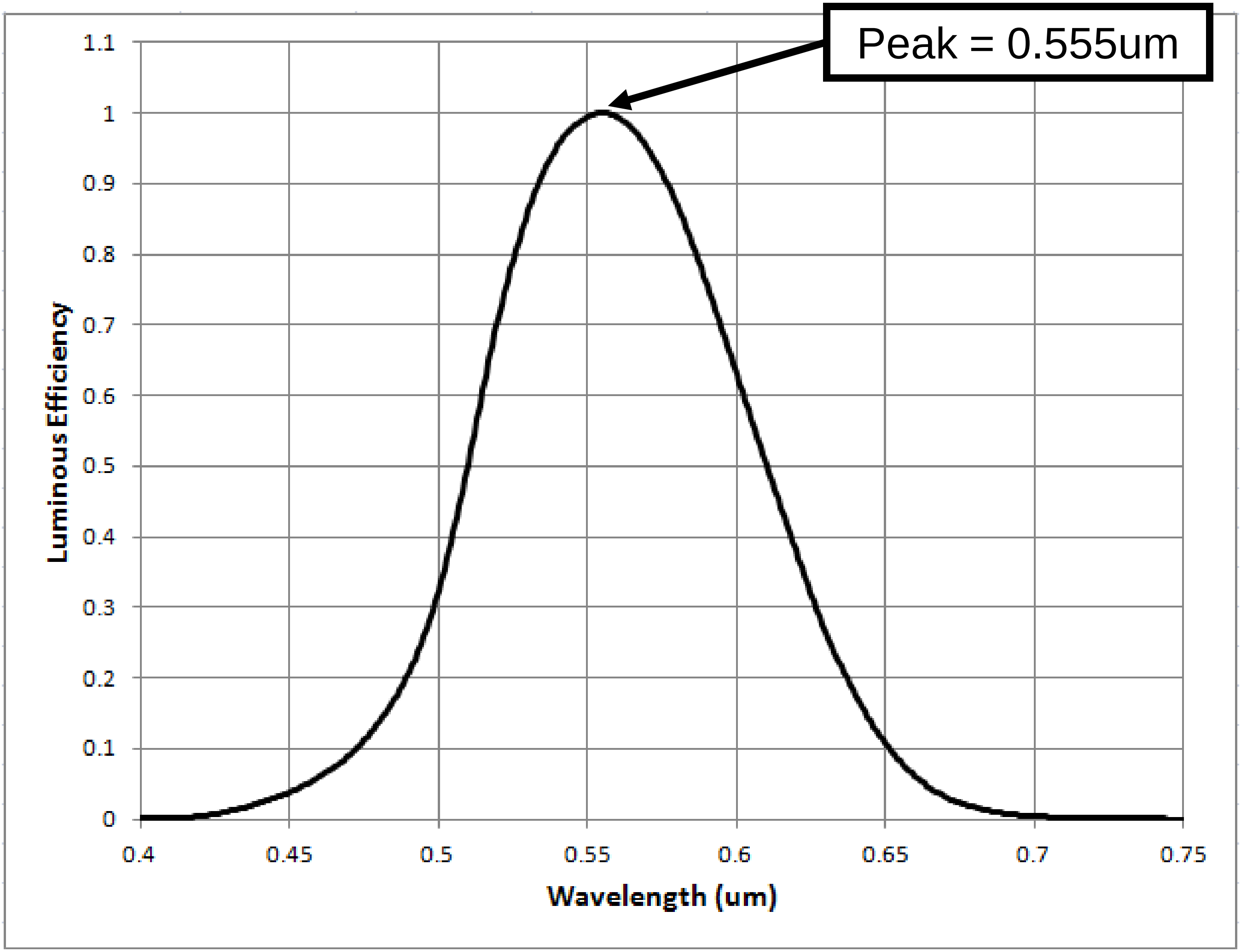
- Peak sensitivity for a light adapted eye is at ≈ 0.555um.

- Standard unit of visible, or luminous, flux is the **lumen (lm)**.

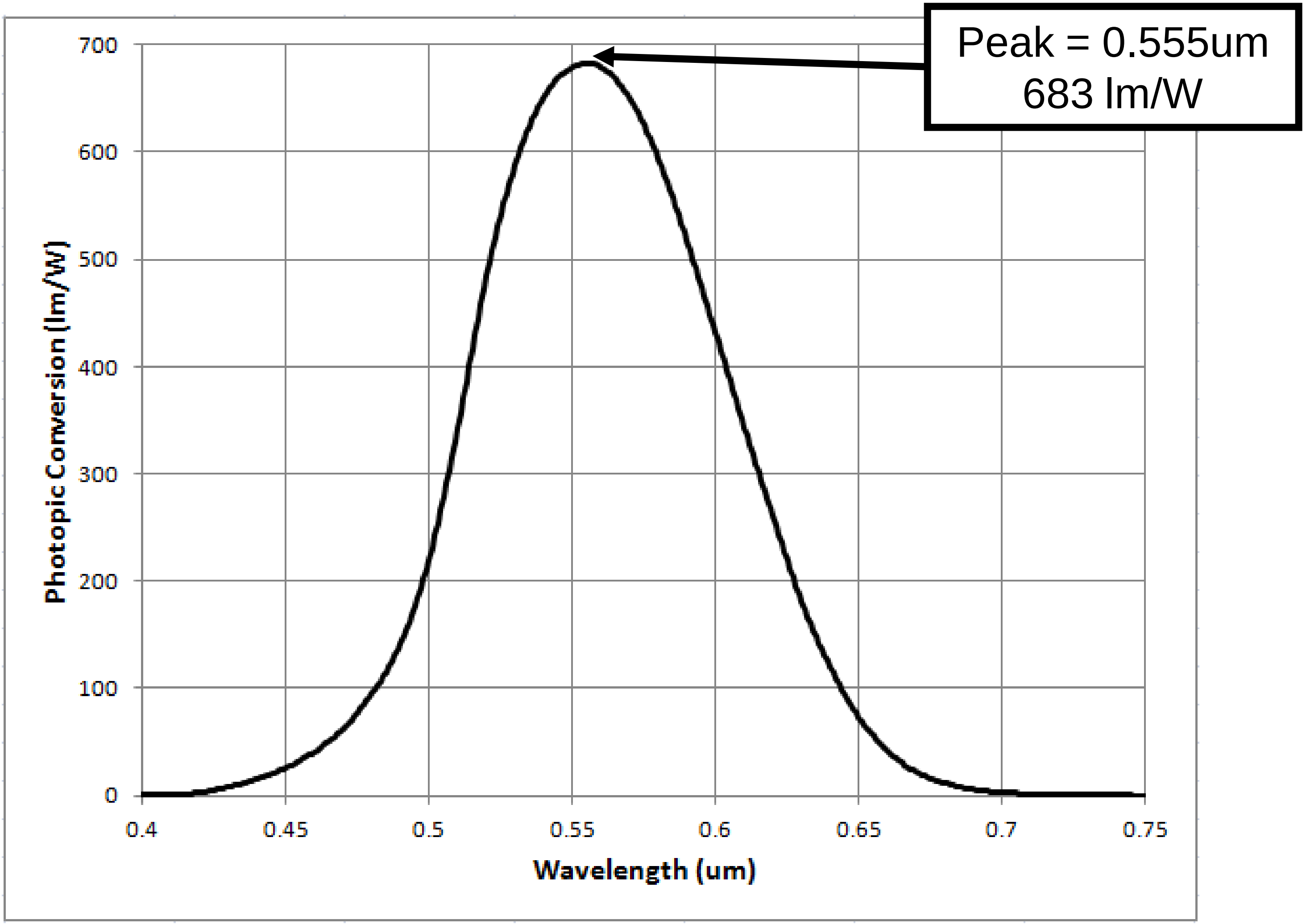
Visible Light Spectrum



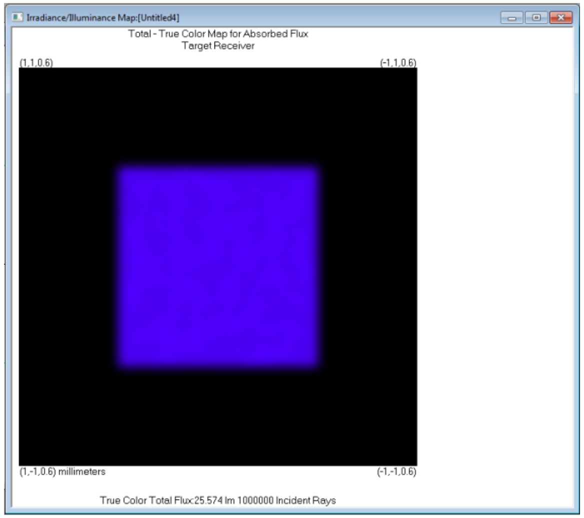
Photopic Curve – Human Eye Response

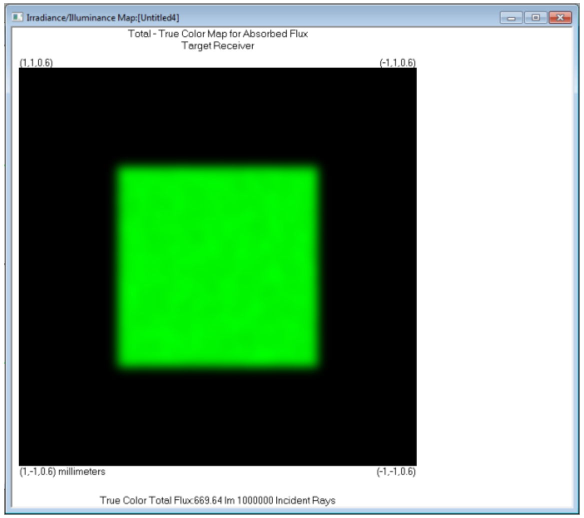


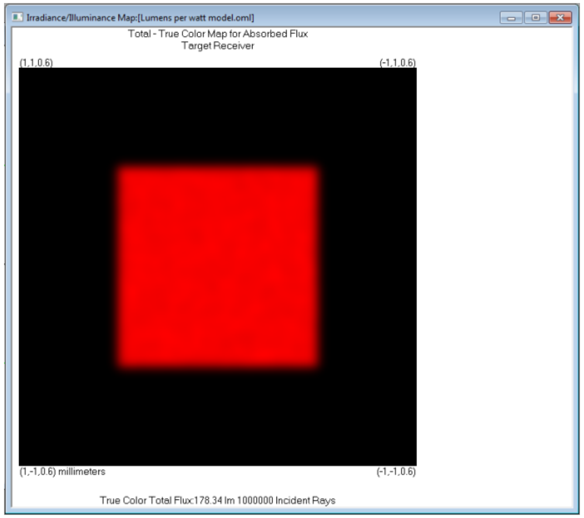
Photopic Curve – Human Eye Response



Lumens/watt Conversion







λ= 0.45um
1 watt ≈ 25.5 lumens

λ= 0.55um
1 watt ≈ 670 lumens

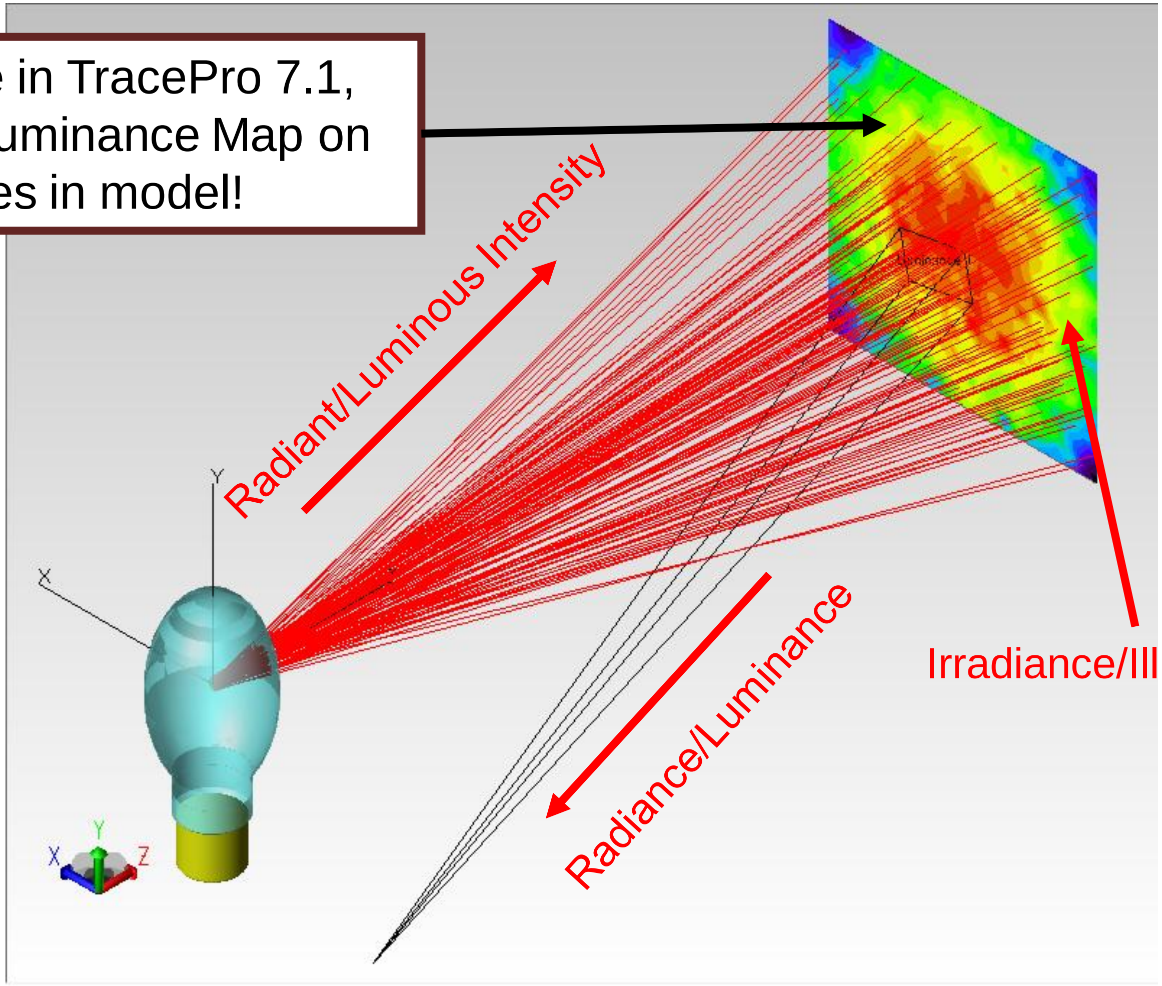
λ= 0.63um
1 watt ≈ 178 lumens

3 Common Types of Radiometric/Photometric Measurements

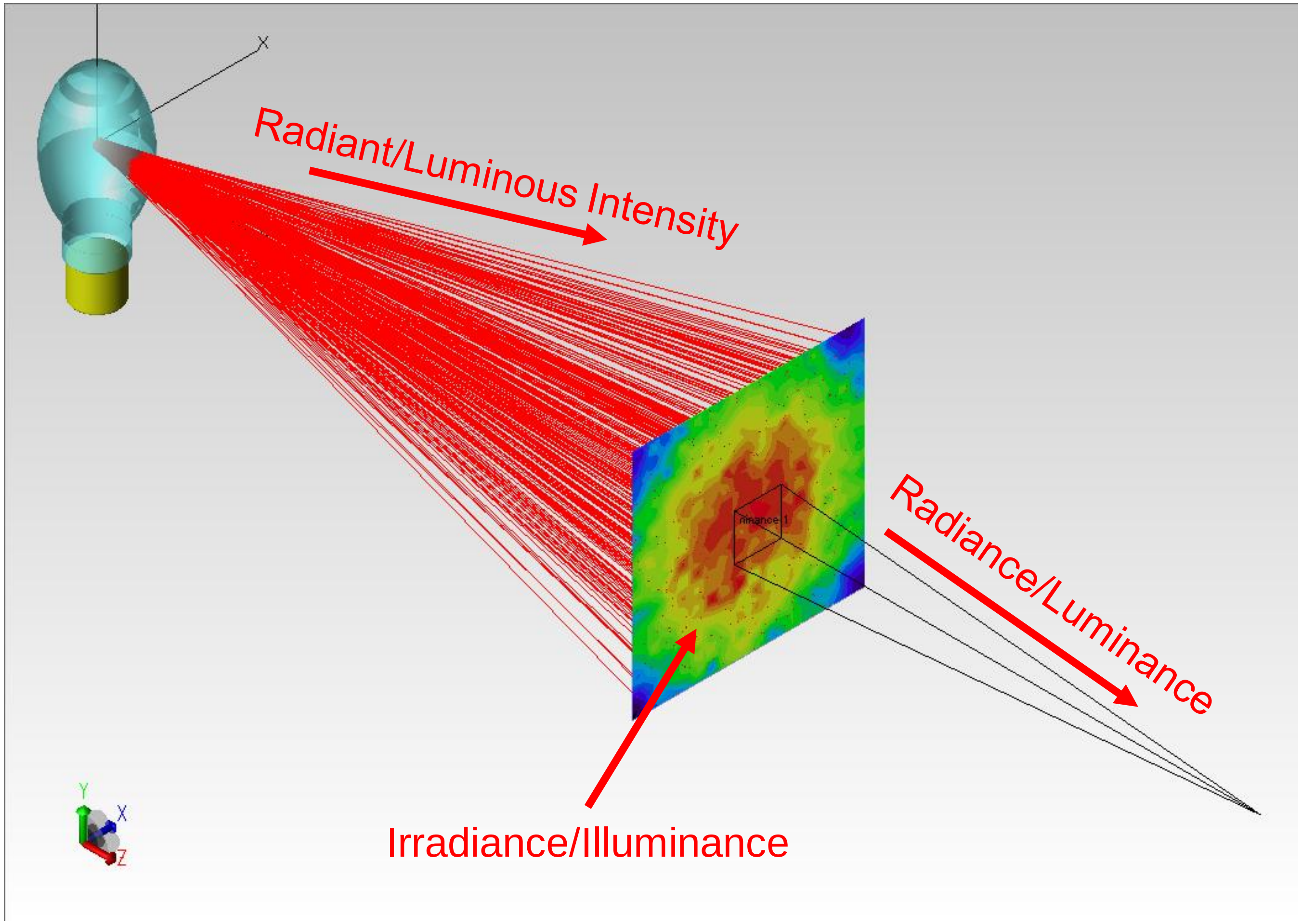
- **Radiant/Luminous Intensity** - flux per solid angle
- **Irradiance/Illuminance** – flux per unit area
- **Radiance/Luminance** – flux per solid angle per unit projected area

3 Common Types of Radiometric/Photometric Measurements

New feature in TracePro 7.1, Irradiance/Illuminance Map on surfaces in model!



3 Common Types of Radiometric/Photometric Measurements



Solid Angle (Ω)

- Units of Solid Angle are the steradian. Steradians are dimensionless.

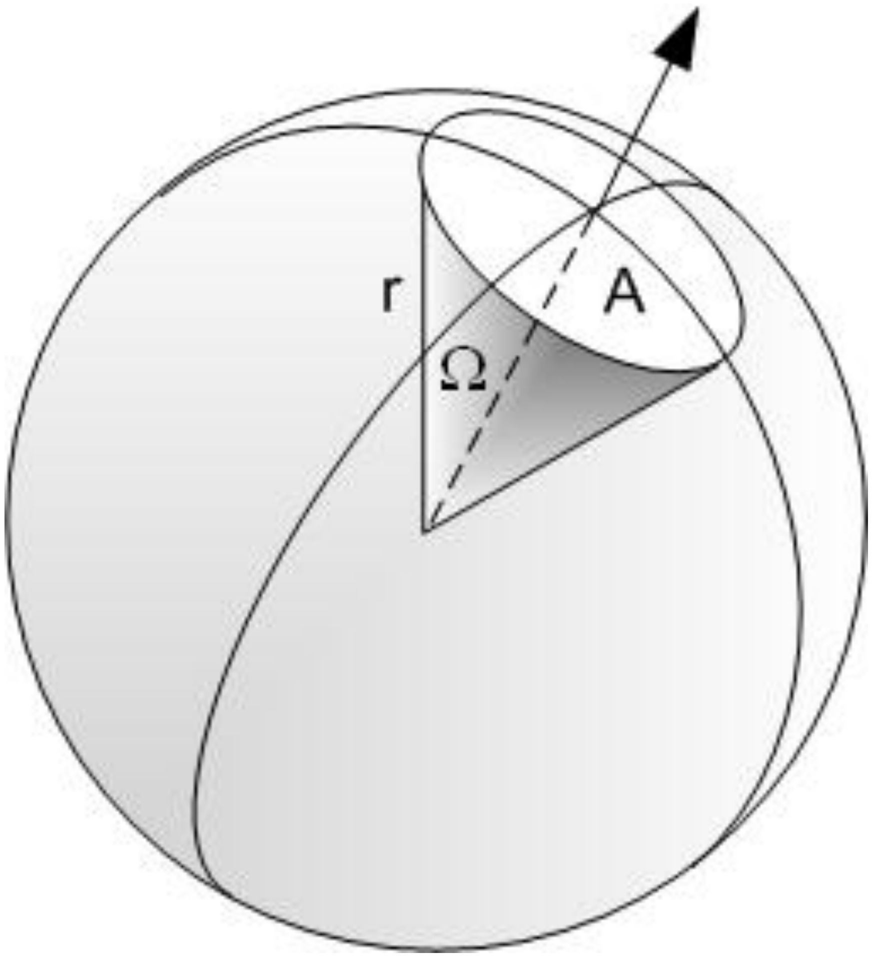
- A sphere contains 4π steradians.

- A steradian equals the solid angle that has its vertex at the center of a sphere and subtends a spherical surface area equal to the square of the radius of the sphere.

- $\Omega = A/r^2$

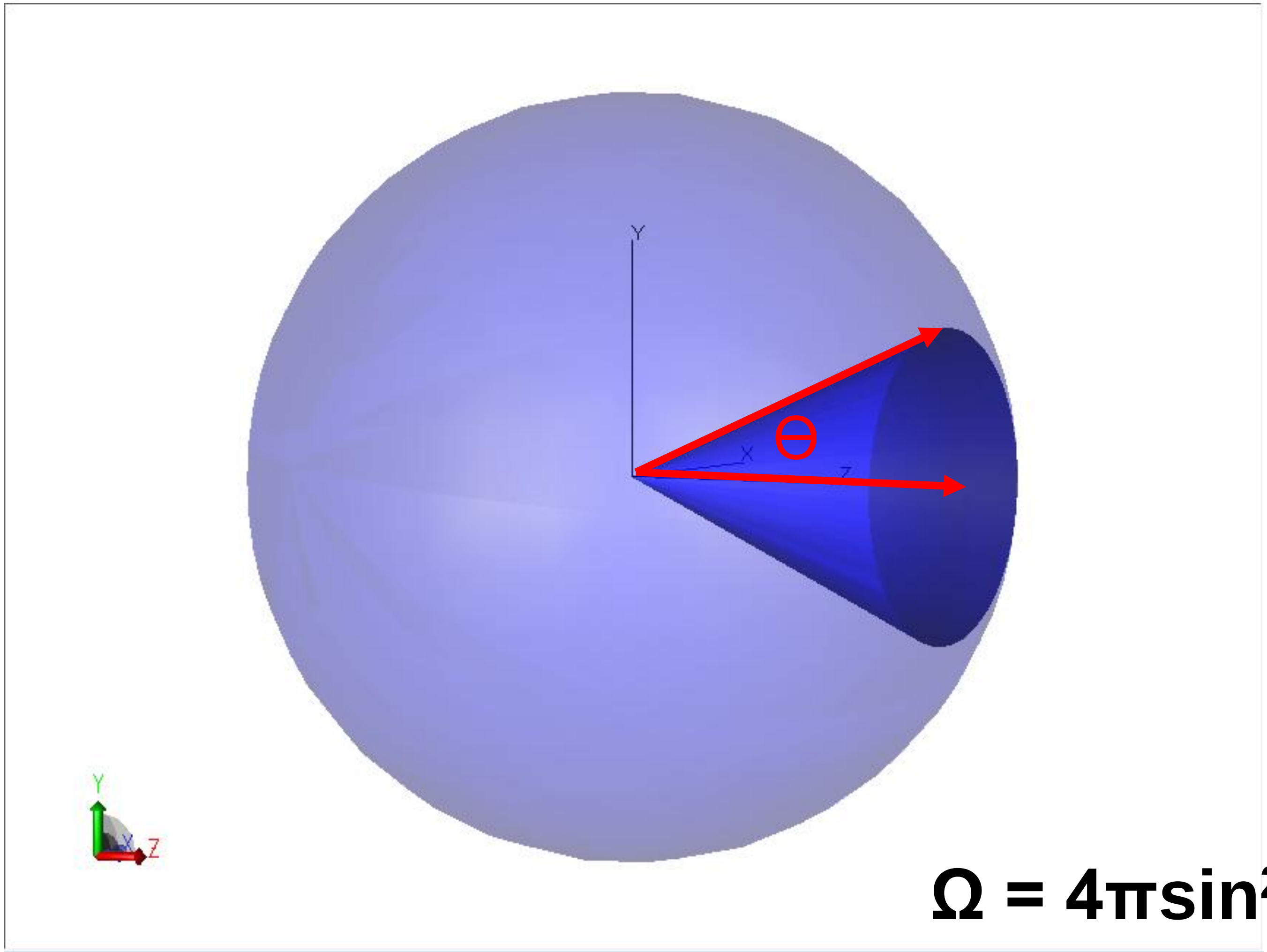
- $\Omega = 4\pi\sin^2(\Theta/2)$

Solid Angle (Ω)



$$\Omega = A/r^2$$

Solid Angle (Ω)



$$\Omega = 4\pi \sin^2(\Theta/2)$$

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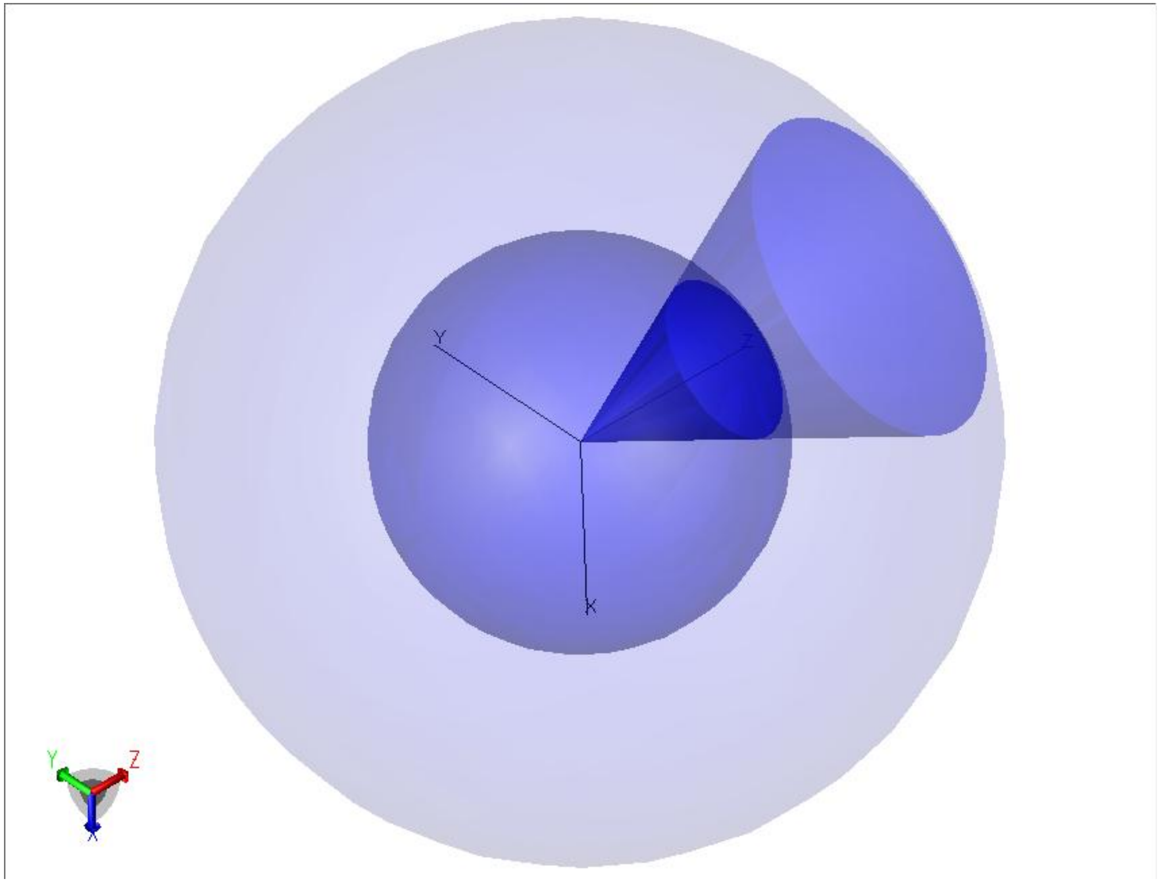
Solid Angle (Ω)



As distance from the center of the sphere increases, the subtended surface area increases, but the solid angle remains constant.

Radiant and Luminous Intensity

- Flux per solid angle in either radiometric or photometric units
- Measure of the angular distribution of light
- Units for radiant intensity are typically watts per steradian ($W \cdot sr^{-1}$)
- Units for photometric intensity are typically candela
- Candela = lumens per steradian ($lm \cdot sr^{-1}$)
- 1 lumen = light into 1 steradian by a 1 candela point source
- 1 candela = 1/683 watts/steradian at 0.555um
- Candela measurement is distance invariant

Radiant and Luminous Intensity in TracePro

•Candela Plots (Analysis -> Candela Plots)

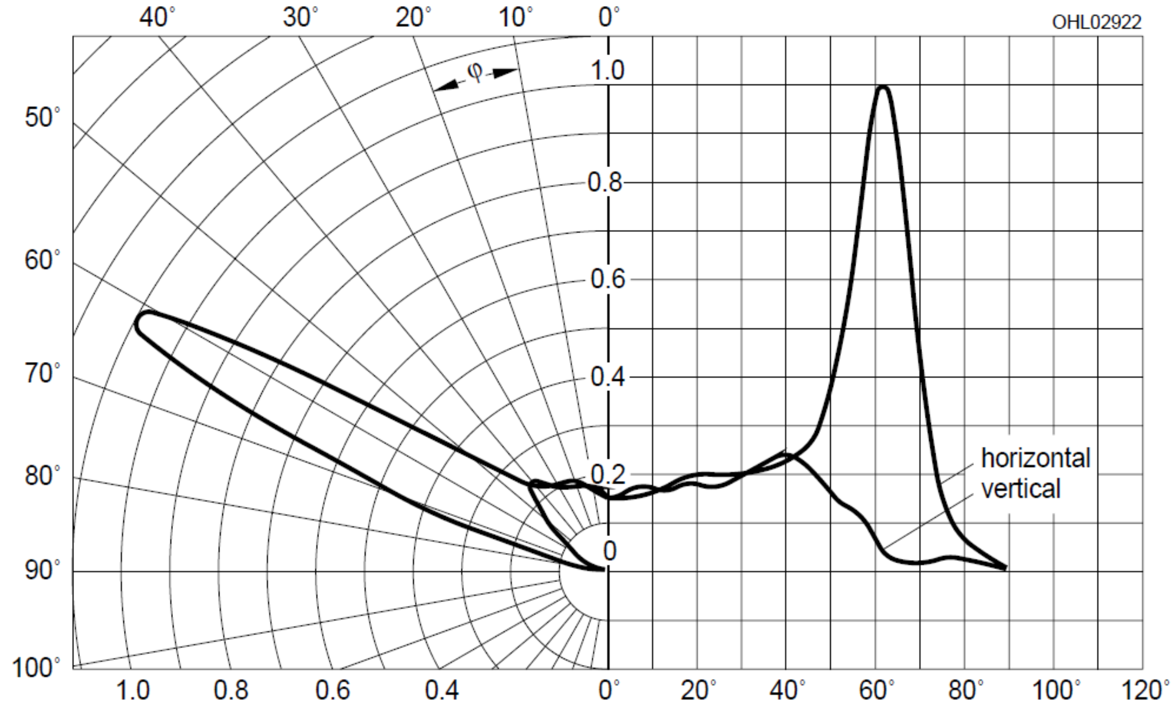
•Options
- •Polar Iso-Candela
- •Rectangular Iso-Candela
- •Polar Candela Distribution
- •Rectangular Candela Distribution

•Analysis Units can be either Radiometric (W/sr) or Photometric (cd or cd/klm)

•To change units in TracePro, go to :
Raytrace->Raytrace Options->Options

TracePro Candela Plots

Abstrahlcharakteristik[2)] *Seite 14*
Radiation Characteristic[2)] *page 14*
$I_{rel} = f(\varphi)$; T_A=25°C



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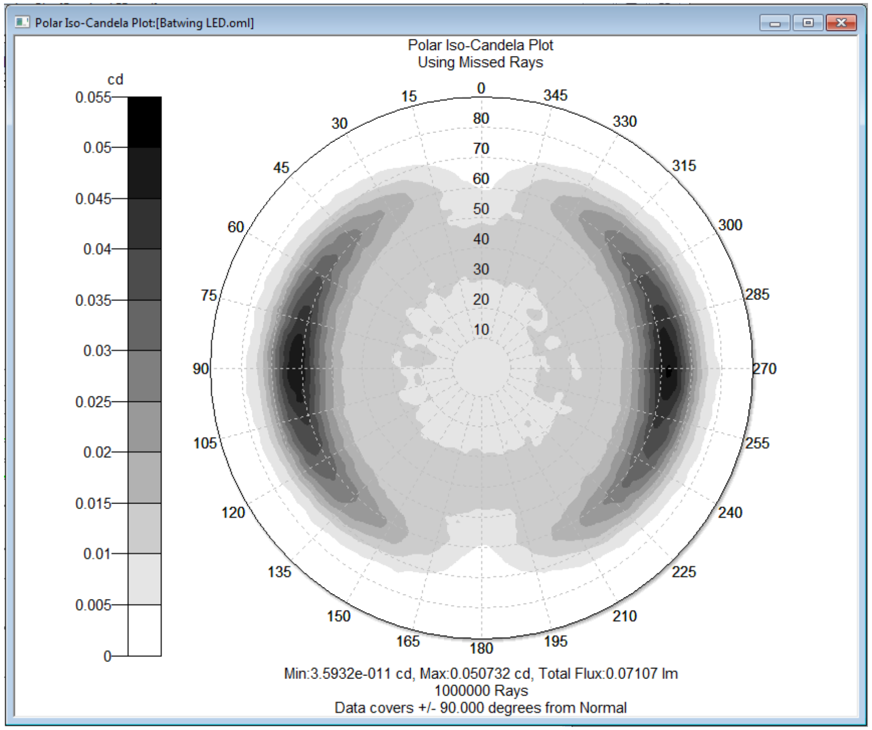
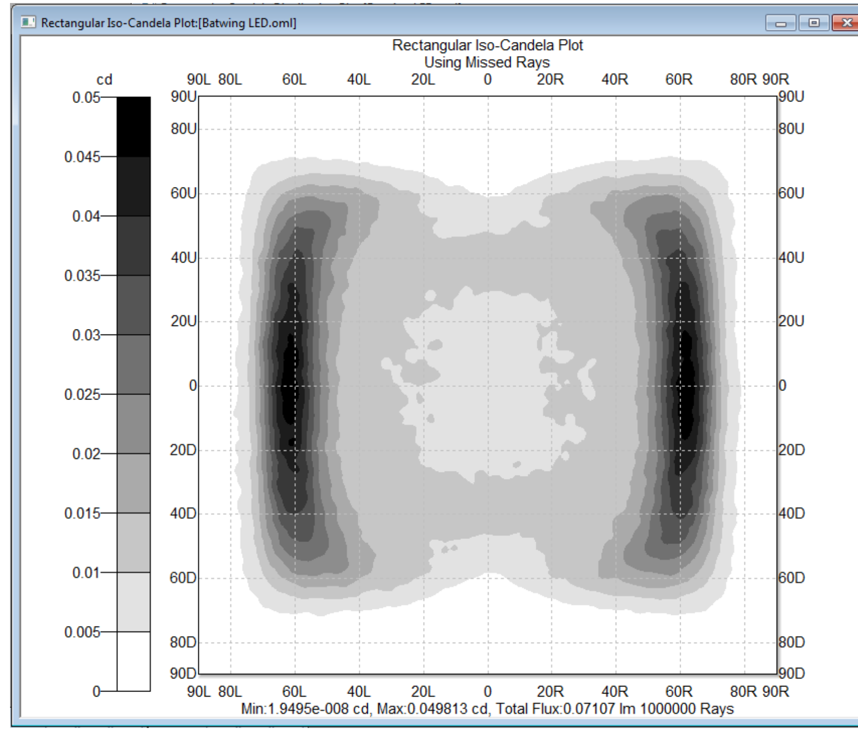
Osram LY W5JM Golden Dragon Lensed LED : Angular Distribution

TracePro Candela Plots

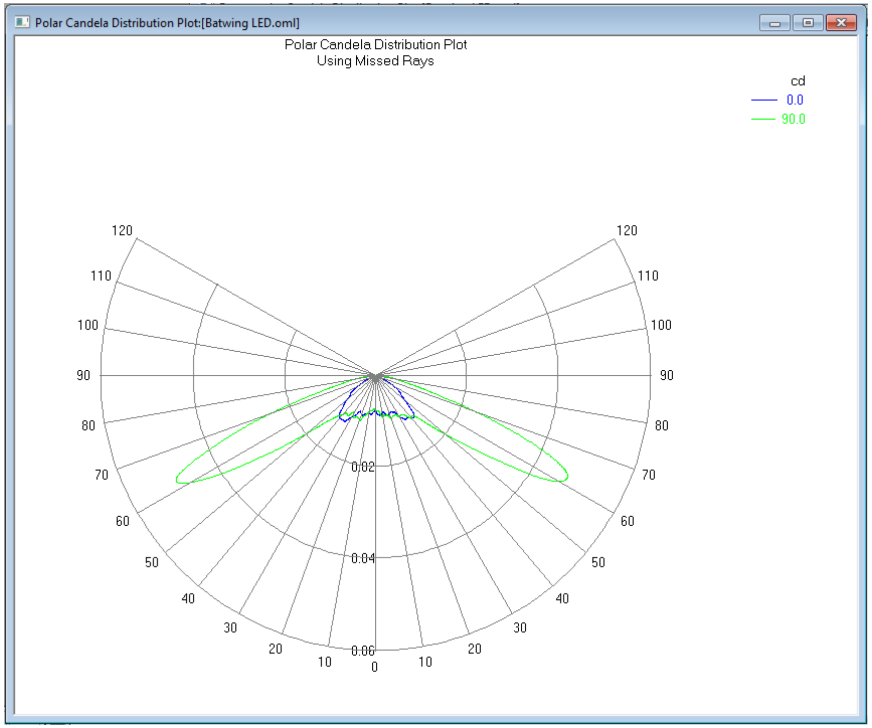


Polar Iso-Candela Plot

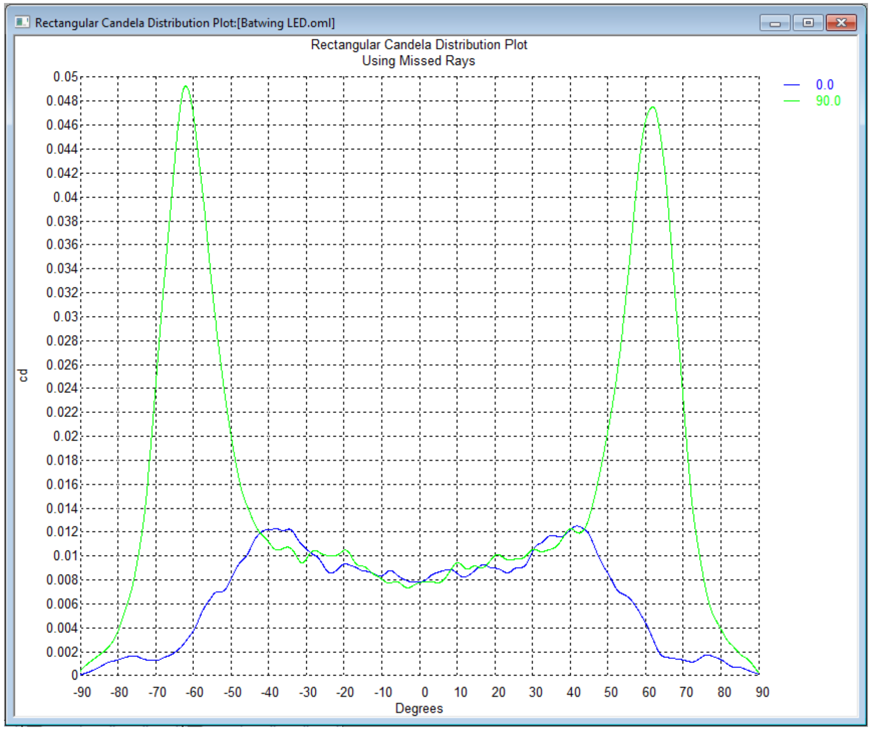


Rectangular Iso-Candela Plot

TracePro Candela Plots



Polar Candela Distribution Plot



Rectangular Candela Distribution Plot

Irradiance and Illuminance

- Flux per unit area in either radiometric or photometric units

- Measure of the spatial distribution of light on a surface

- Units for Irradiance are typically watts per square meter ($W \cdot m^{-2}$)

- Units for Illuminance are typically lux ($lm \cdot m^{-2}$) or foot-candles ($lumens \cdot ft^{-2}$)

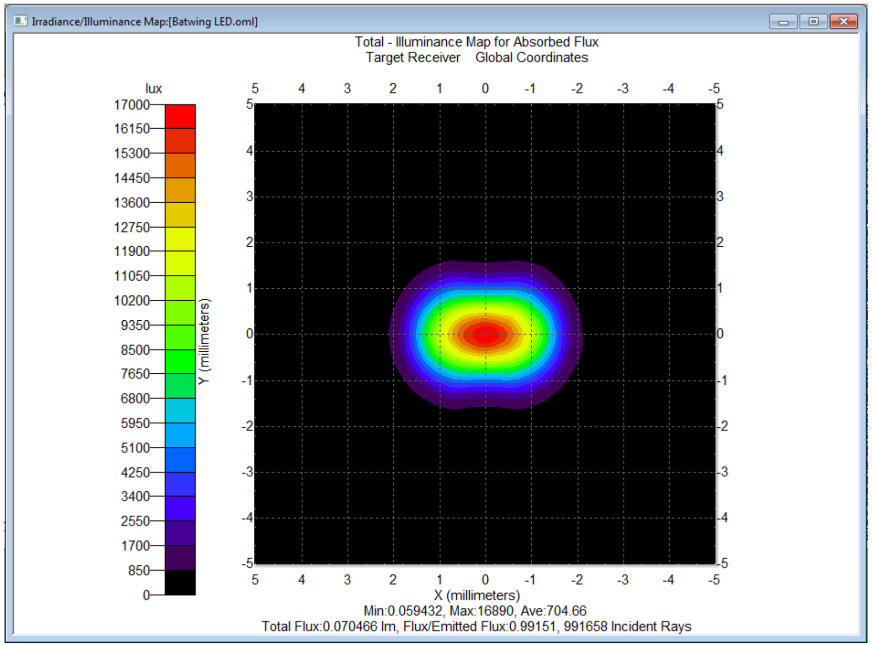
- To convert lux to foot-candles, divide lux value by 10.76, the number of square feet in a square meter

- For “point” sources, or at distances greater than 5-10x the largest source dimension, irradiance and illuminance values will obey the Inverse Square Law. The irradiance or illuminance will be reduced by the inverse of the distance squared as you move away from the source. For example, double the distance = ¼ the irradiance or illuminance.

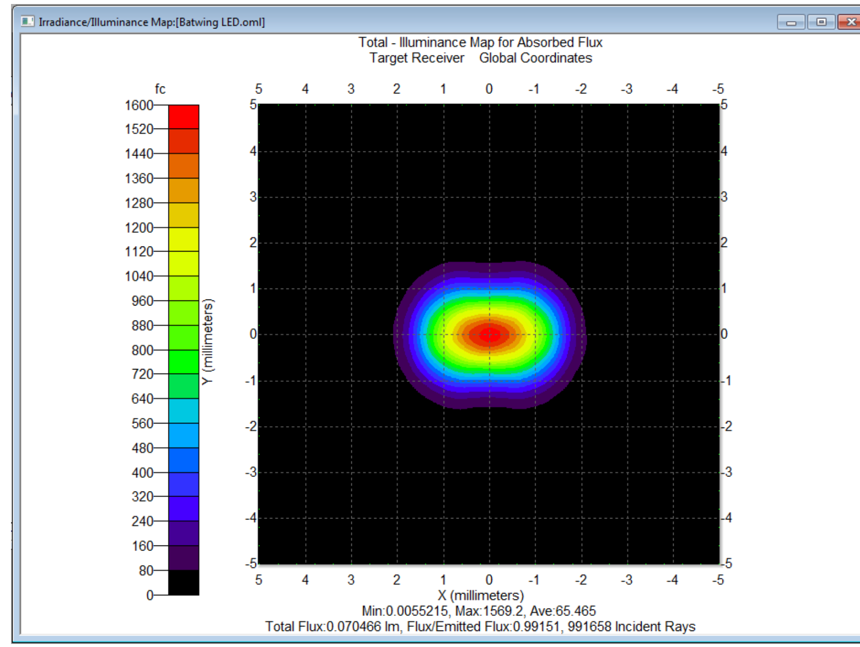
Irradiance and Illuminance in TracePro

- Irradiance/Illuminance Maps (Analysis -> Irradiance/Illuminance Maps)
- 3D Irradiance Maps (Analysis->3D Irradiance/Illuminance)
- Analysis Units can be either Radiometric (W/m^2) or Photometric (lux or foot-candles)
- To change units in TracePro, go to :
  Raytrace->Raytrace Options->Options
- Photometric units can be changed to foot-candles at:
  Analysis->Irradiance/Illuminance Options

Irradiance and Illuminance in TracePro

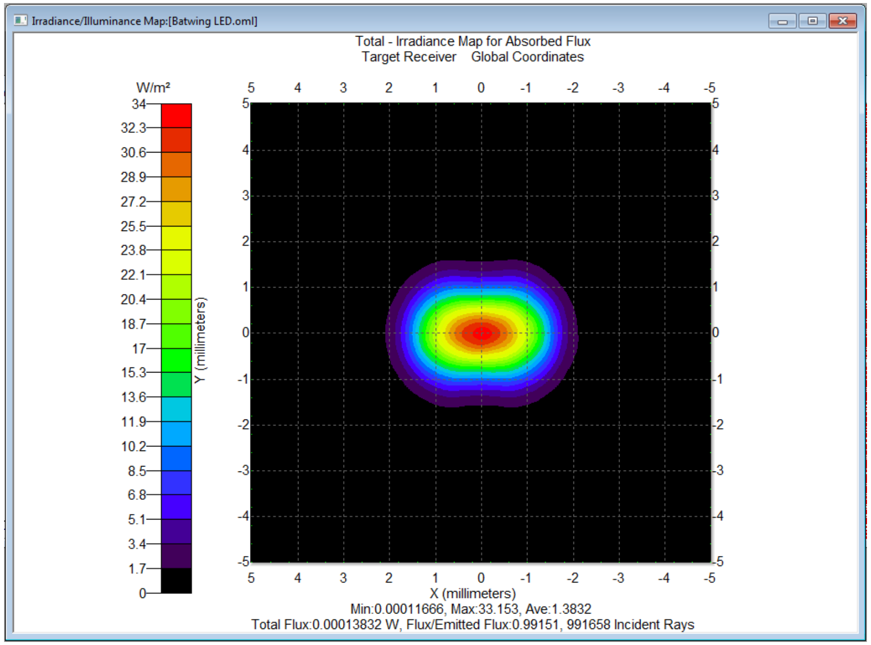


Illuminance - lux

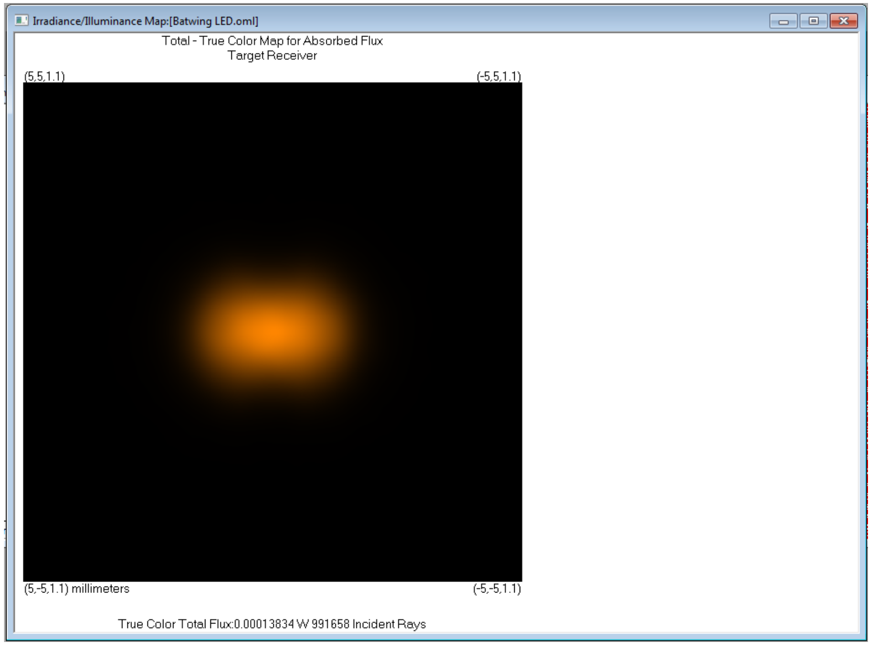


Illuminance – foot-candles

Irradiance and Illuminance in TracePro



Irradiance – W/m^2



Irradiance - TrueColor

Radiance and Luminance

•Flux per solid angle per projected unit area in either radiometric or photometric units

•Measure of the light from an area that falls in a given solid angle

•Units for Radiance are typically watts per square meter per steradian ($W \cdot m^{-2} \cdot sr^{-1}$)

•Units for Luminance are typically candela per square meter ($cd \cdot m^{-2}$), also called nits, or foot-lamberts

•1 foot-lambert = $1/\pi$ candela$\cdot ft^{-2}$

•Radiance and Luminance are distance invariant as long as the solid angle remains smaller than the source

Radiance and Luminance in TracePro

- Luminance/Radiance Map (Analysis -> Luminance/Radiance Maps)

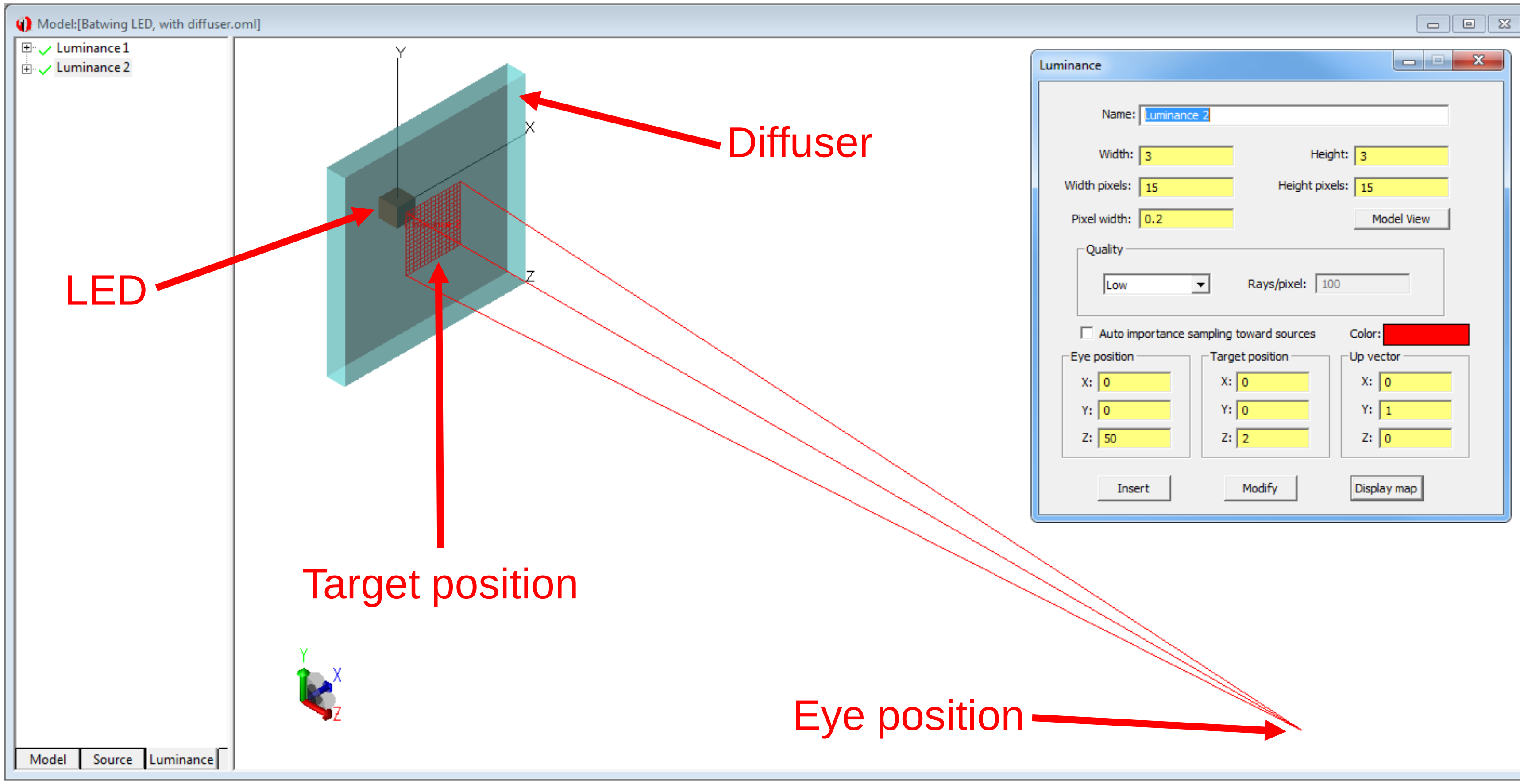
- To set-up a Luminance/Radiance target:
  Define->Luminance/Radiance

- Analysis Units can be either Radiometric ($W \cdot m^{-2} \cdot sr^{-1}$) or Photometric (nits, foot-lamberts, or millilamberts)

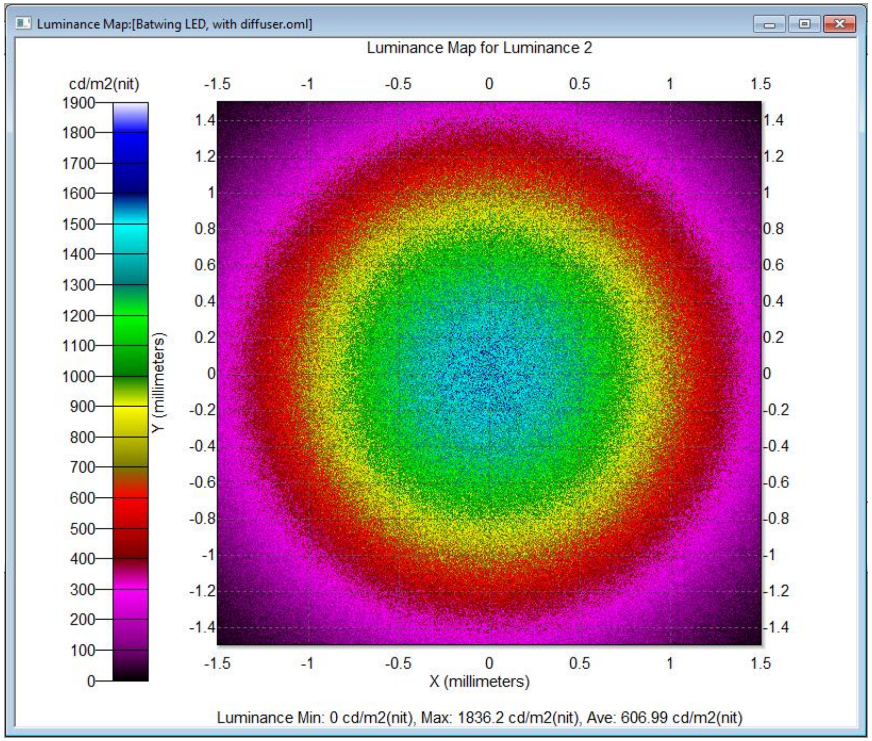
- To change units in TracePro, go to :
  Raytrace->Raytrace Options->Options

- Photometric units can be changed at:
  Analysis->Luminance/Radiance Map Options

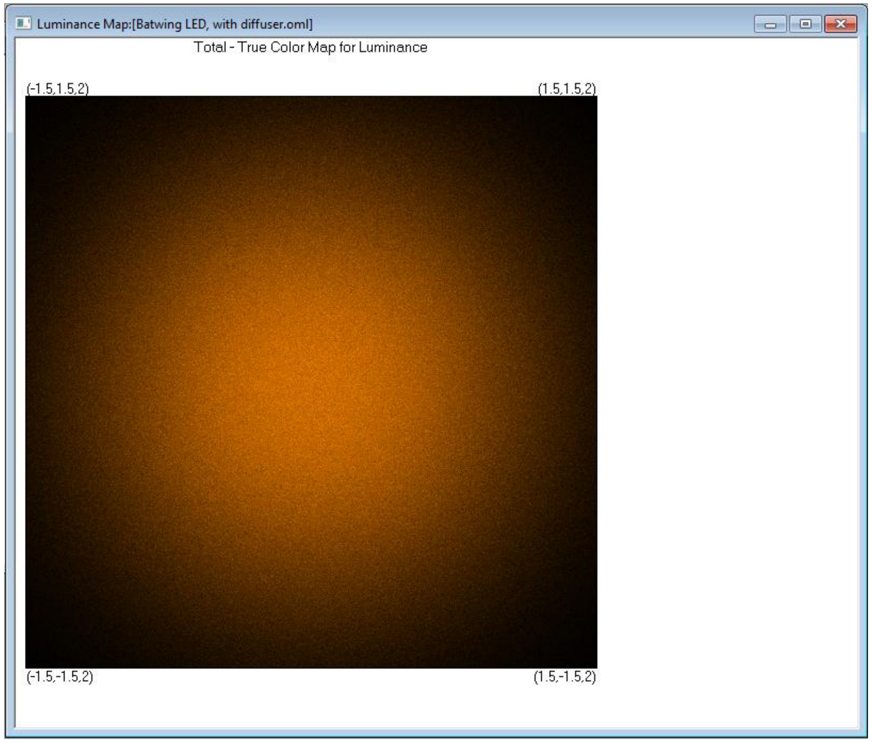
Radiance and Luminance in TracePro



Radiance and Luminance in TracePro

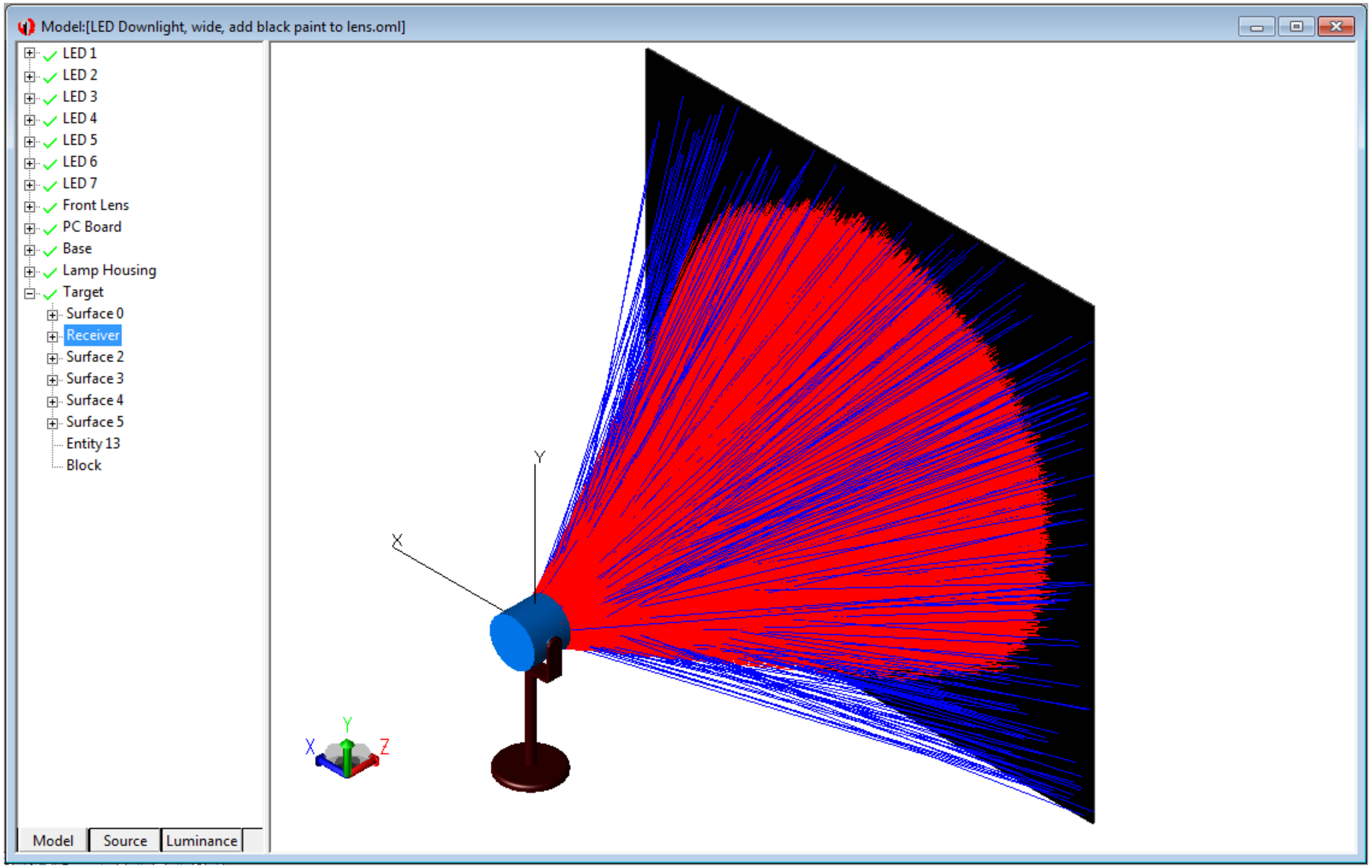


Luminance Map – cd·m^{-2}

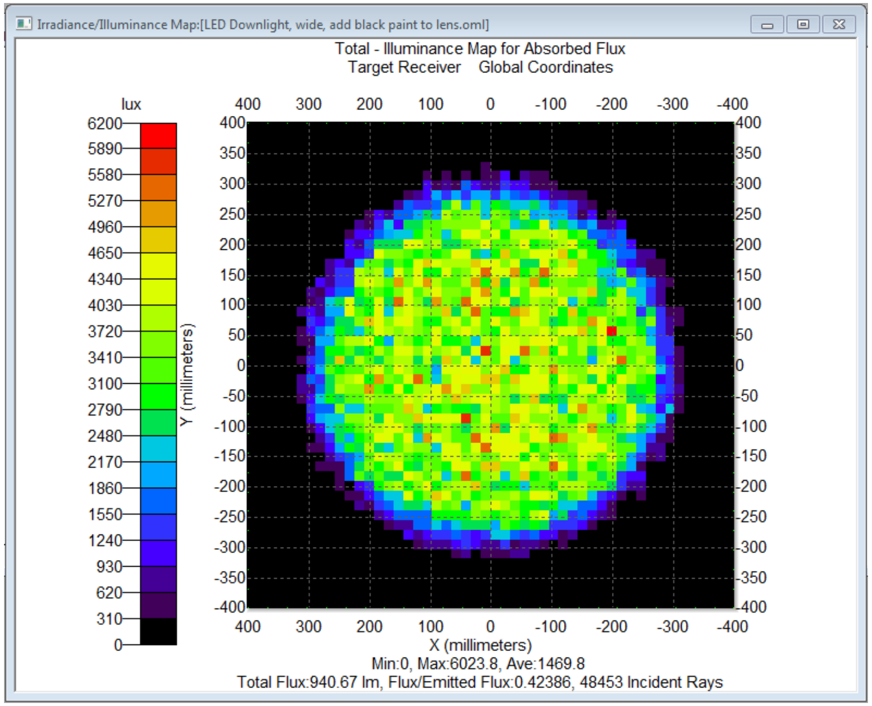


Luminance Map – TrueColor

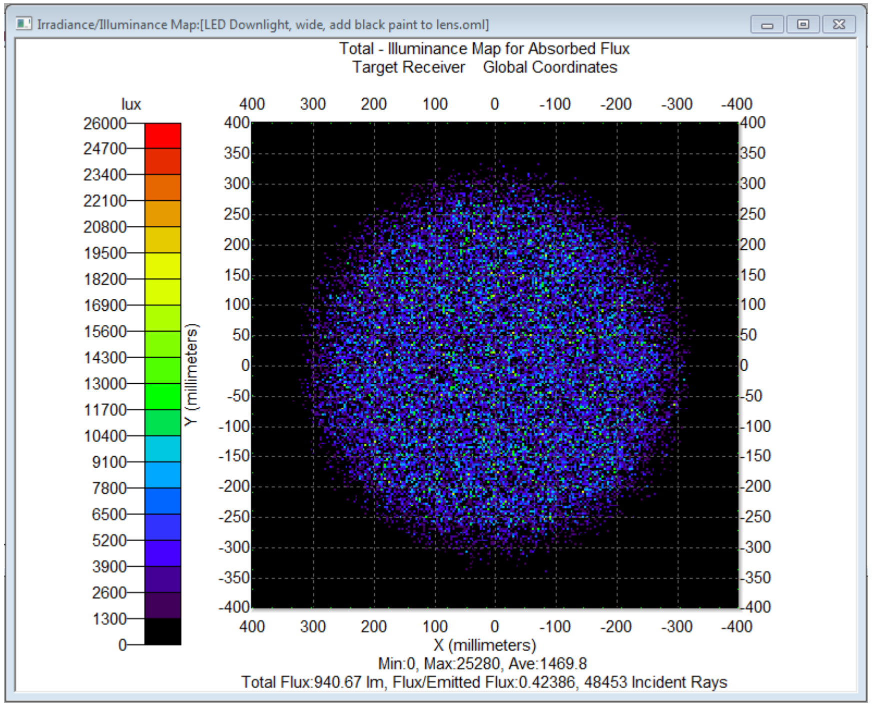
TracePro Settings and
Effects on Radiometric and Photometric Values



Irradiance Maps
Changing the Number of Pixels

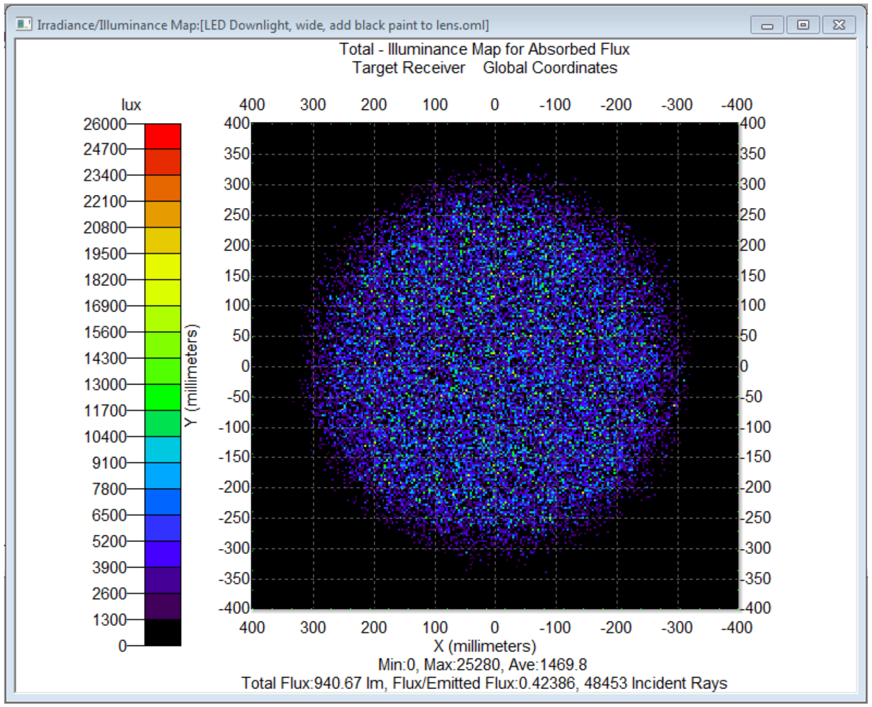


100k Rays
Number of Pixels = 50

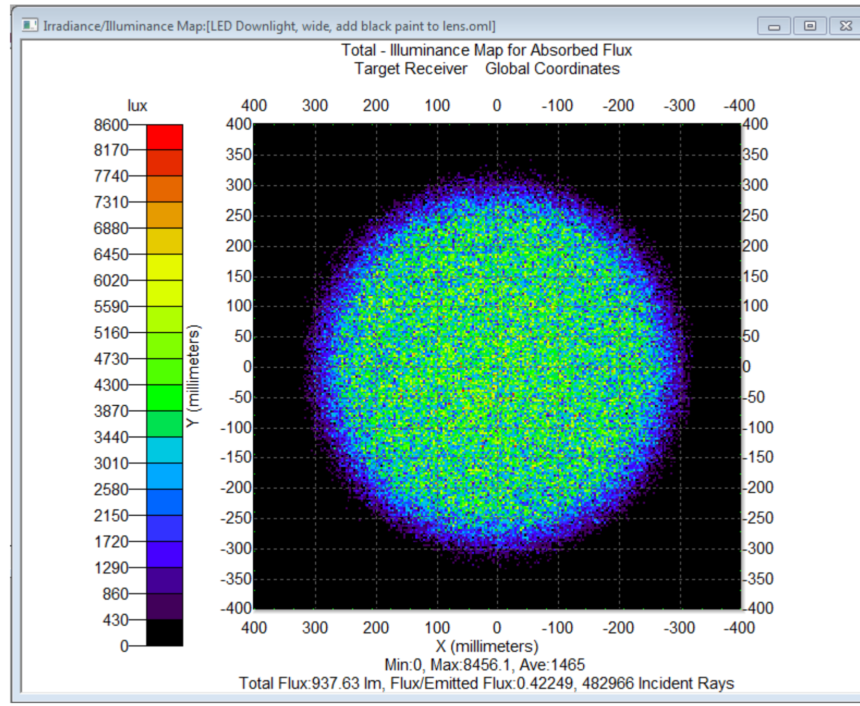


100k Rays
Number of Pixels = 250

Irradiance Maps
Increasing the Number of Rays Traced

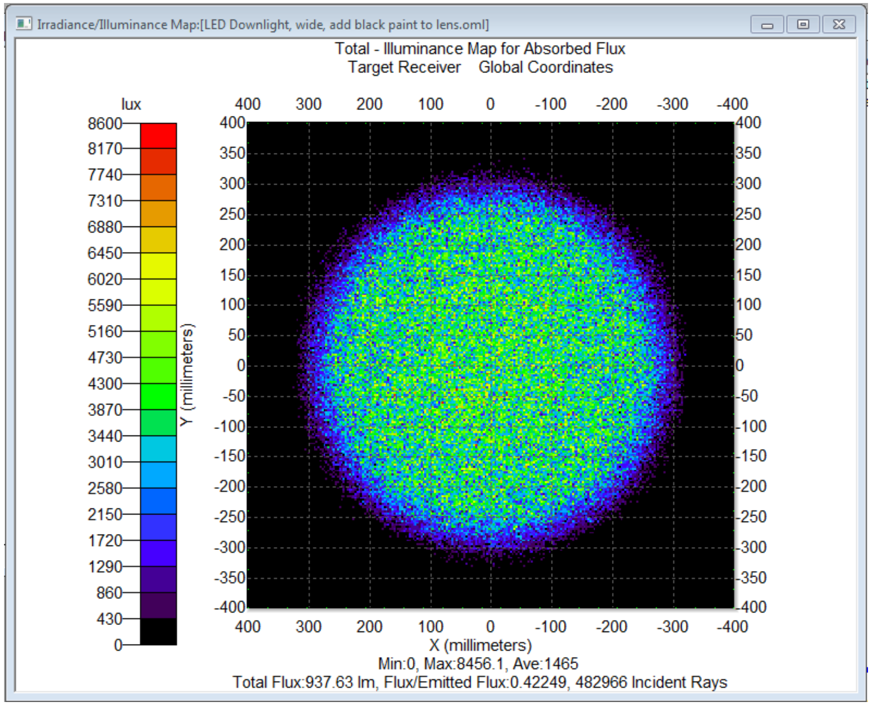


100k Rays
Number of Pixels = 250

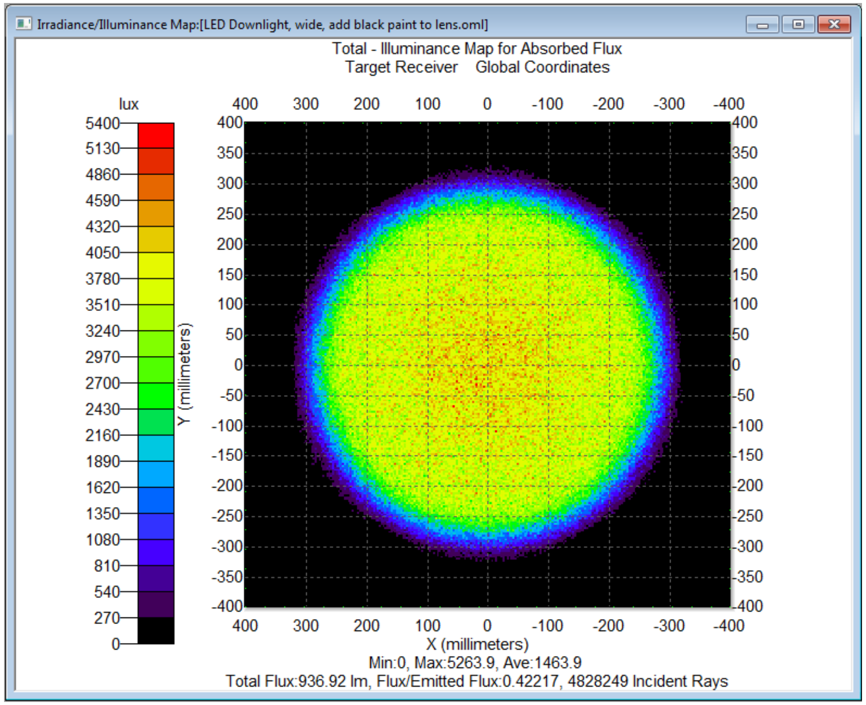


1M Rays
Number of Pixels = 250

Irradiance Maps
Increasing the Number of Rays Traced

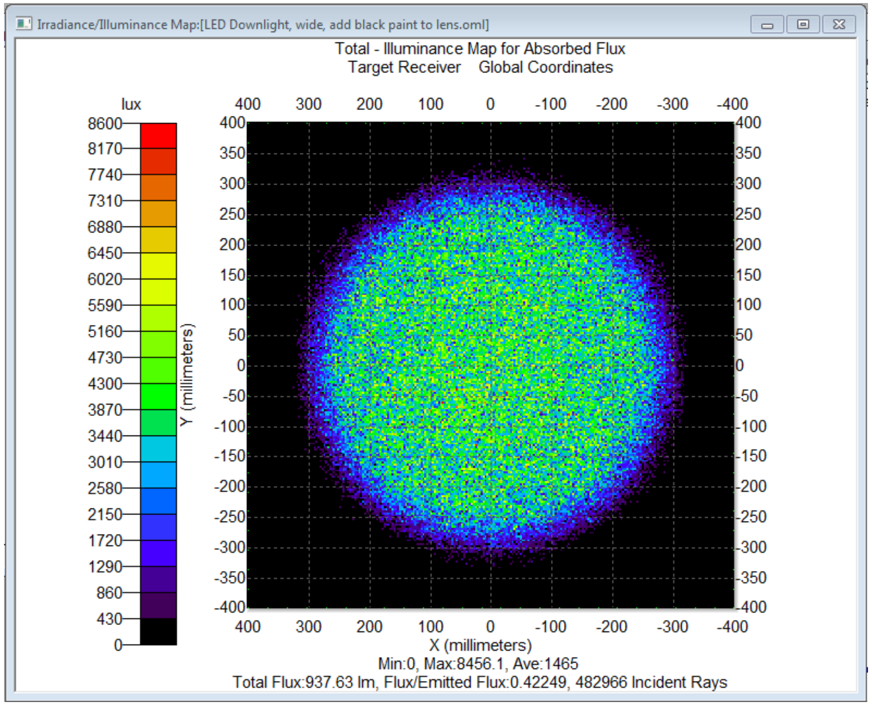


1M Rays
Number of Pixels = 250

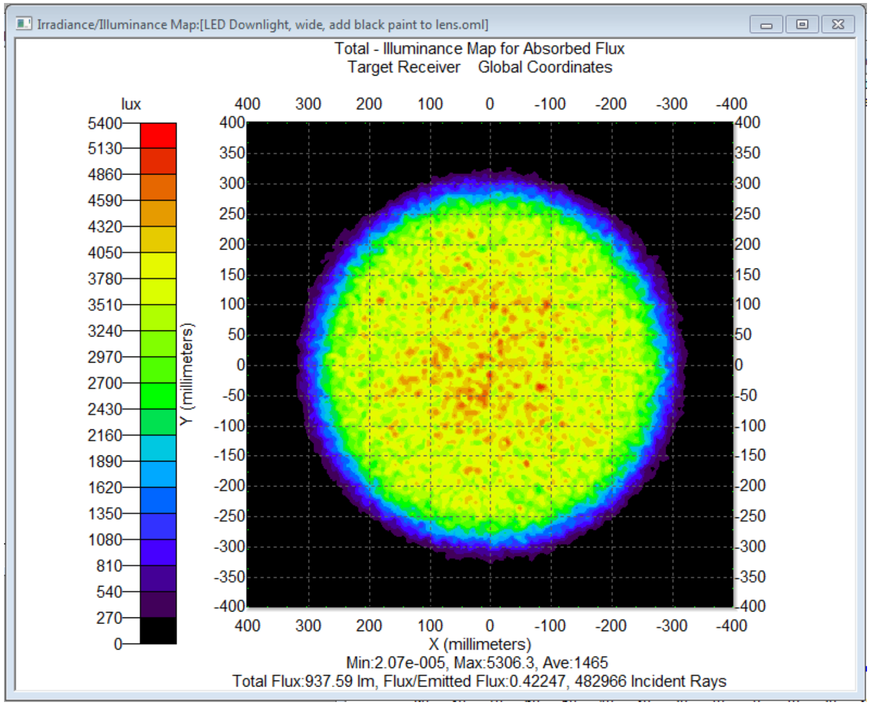


10M Rays
Number of Pixels = 250

Irradiance Maps
Smoothing Off and On



1M Rays
Number of Pixels = 250
Smoothing = Off



1M Rays
Number of Pixels = 250
Smoothing = On

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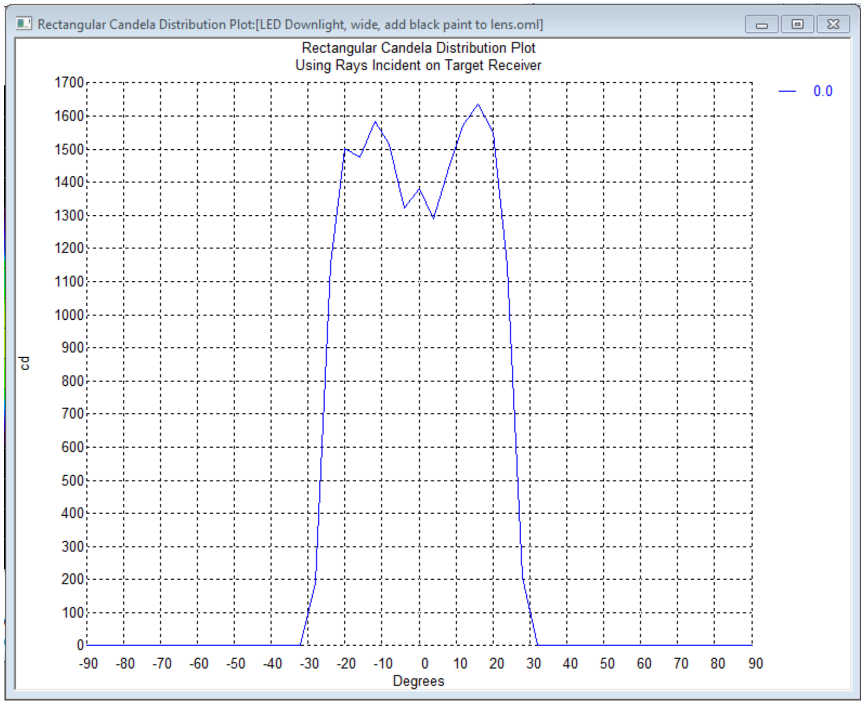
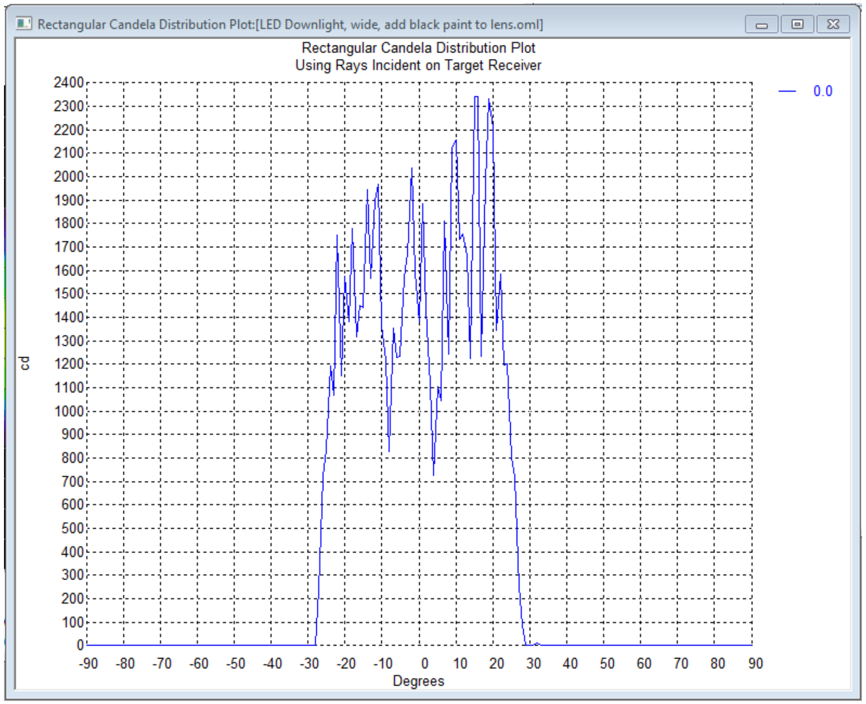
Candela Plots
Changing the Number of Plot Points



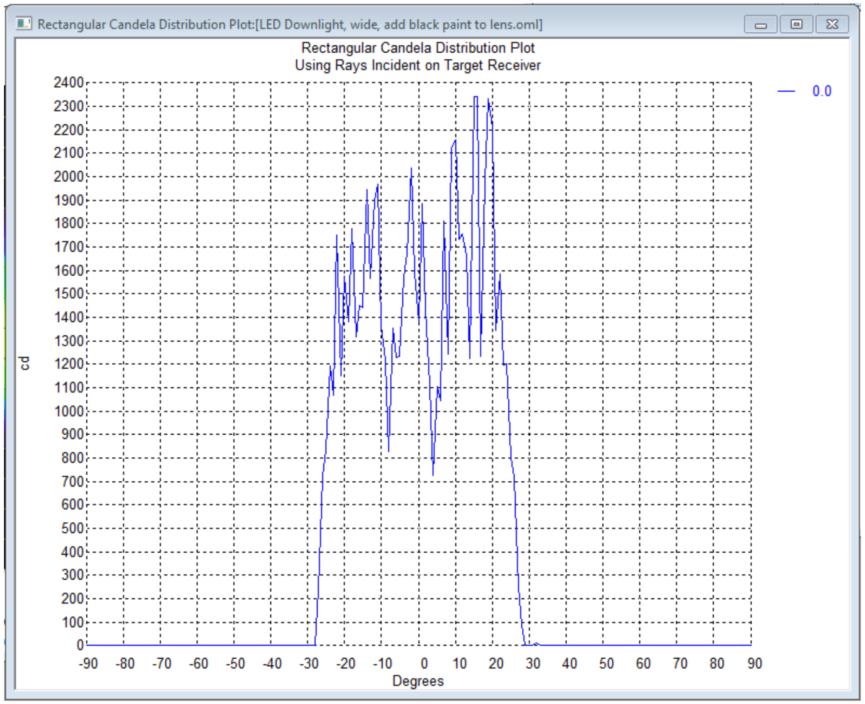
100k Rays
Number of Plot Points = 90



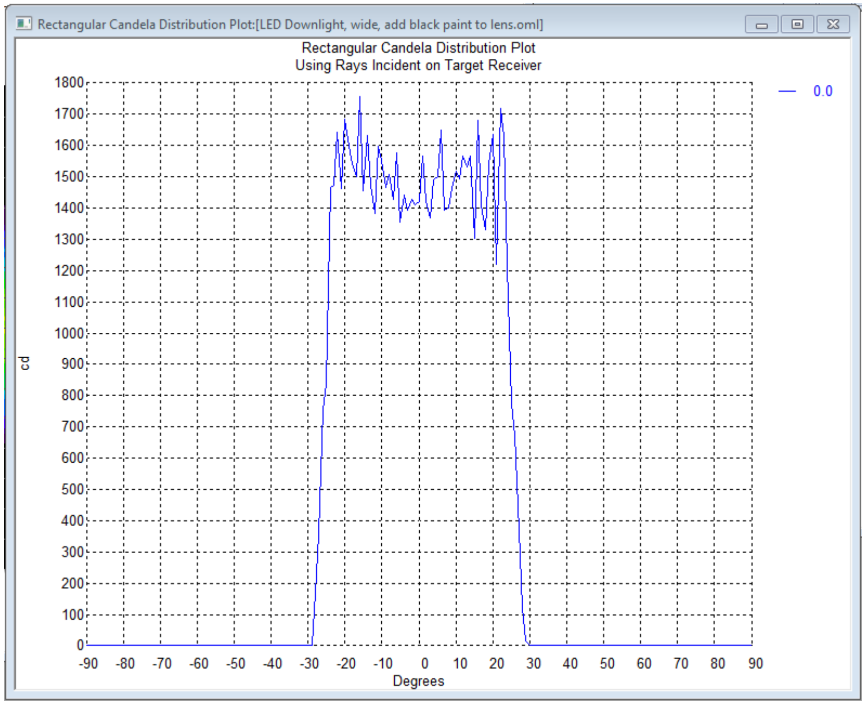
100k Rays
Number of Plot Points = 360

Candela Plots

Increasing the Number of Rays Traced

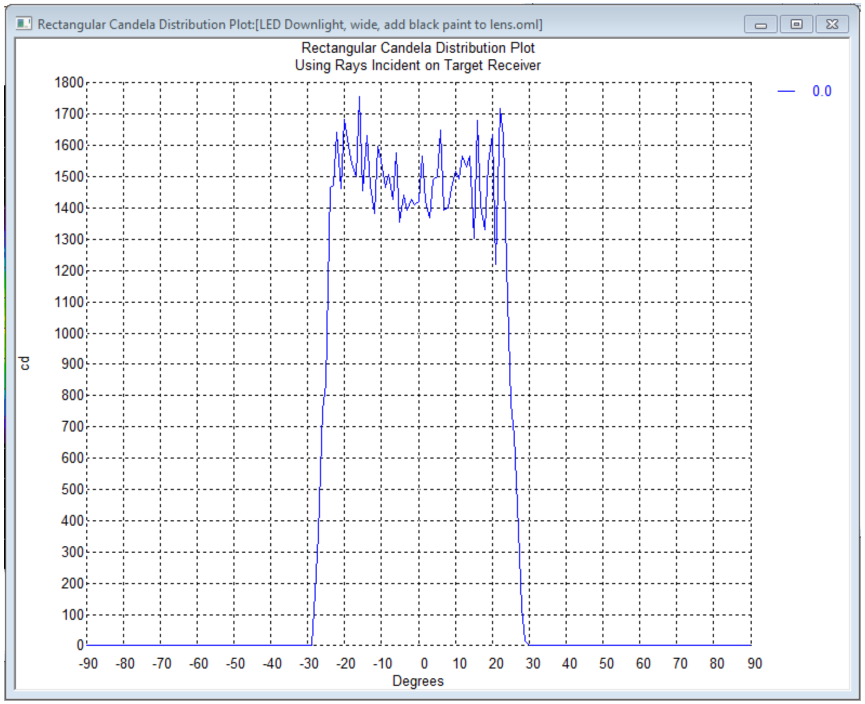


100k Rays
Number of Plot Points = 360

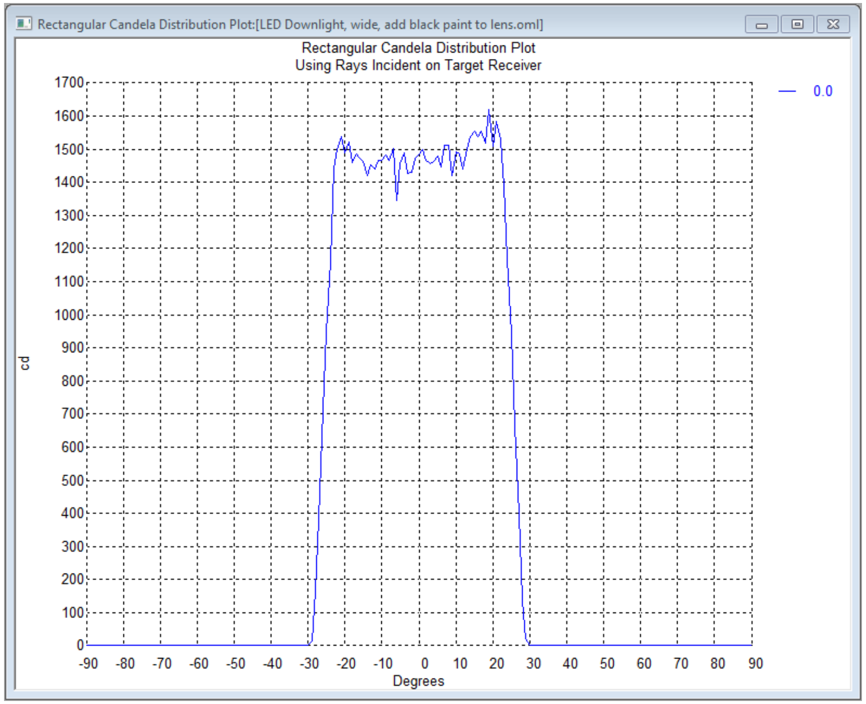


1M Rays
Number of Plot Points = 360

Candela Plots
Increasing the Number of Rays Traced

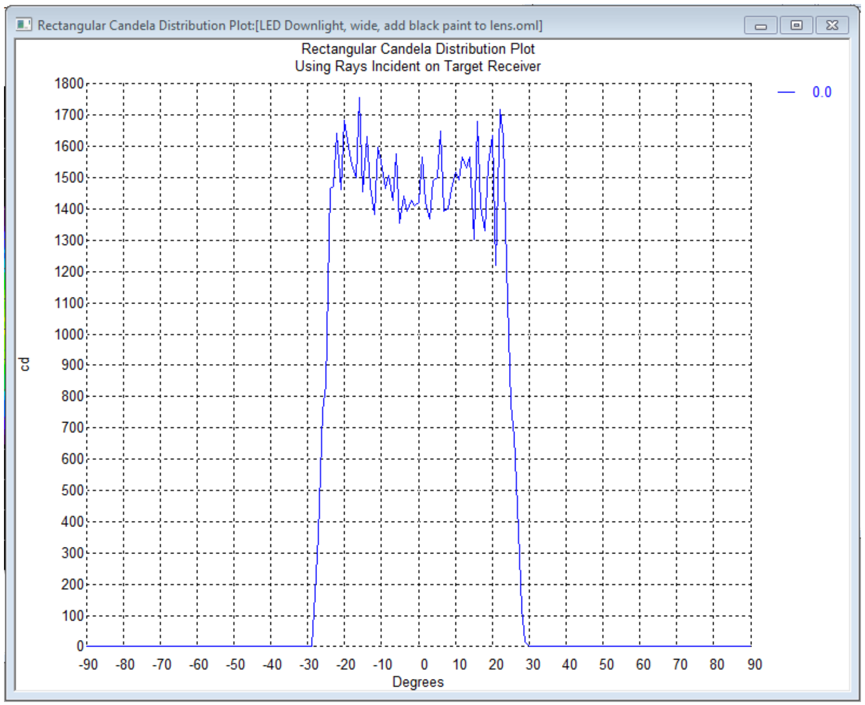


1M Rays
Number of Plot Points = 360

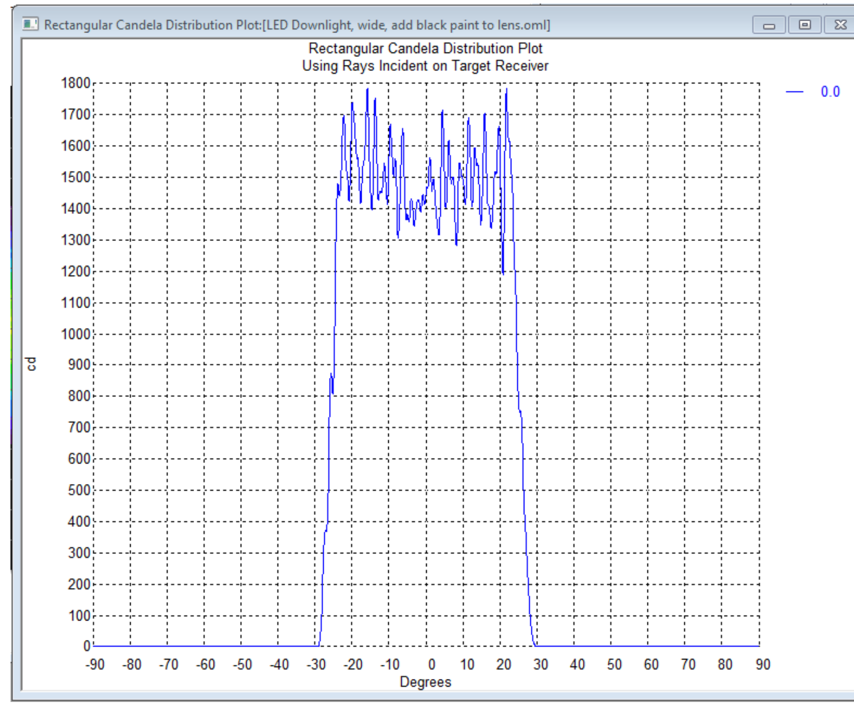


10M Rays
Number of Plot Points = 360

Candela Plots
Smoothing Off and On



1M Rays
Number of Plot Points = 360
Smoothing = Off



1M Rays
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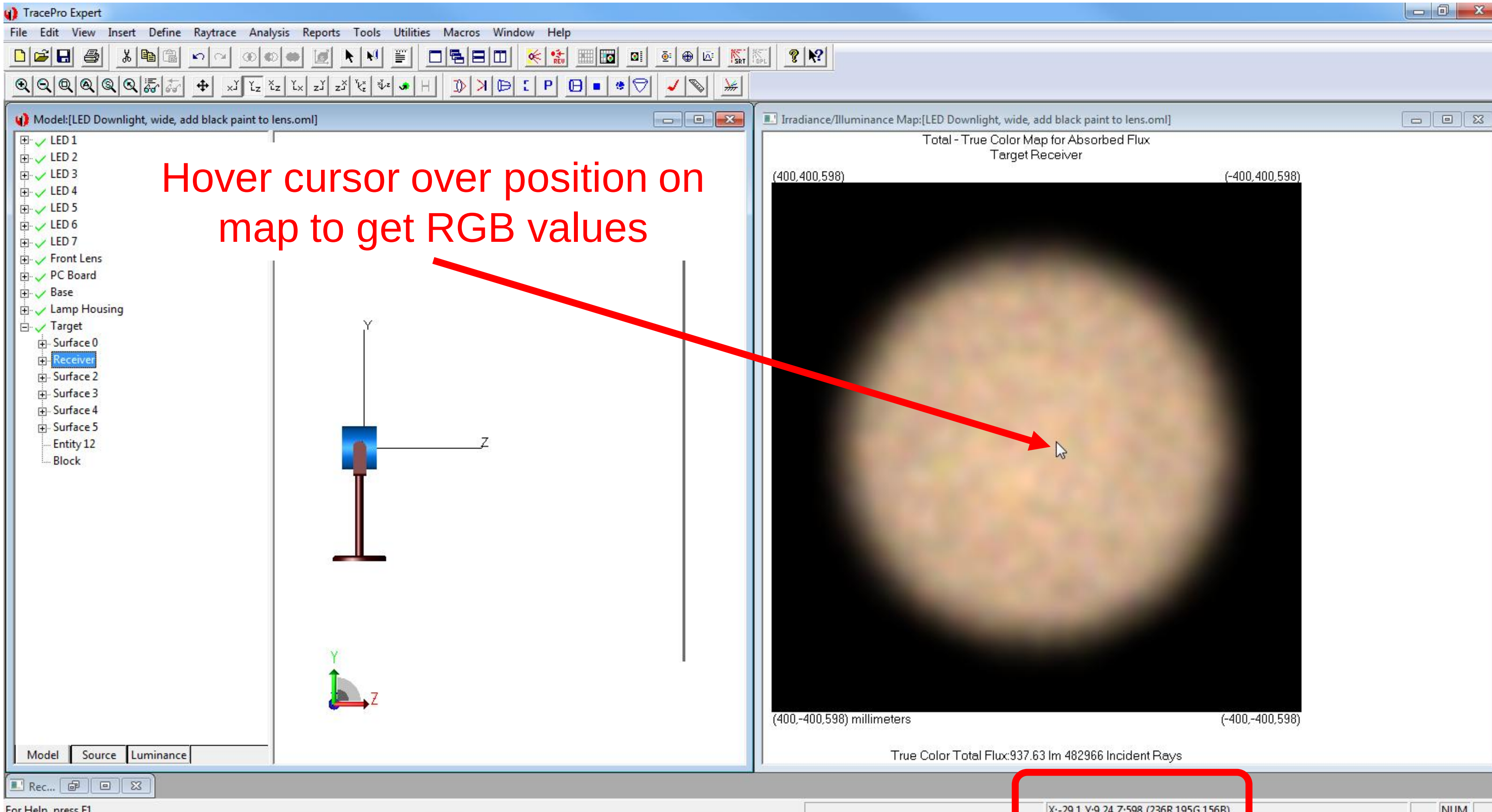
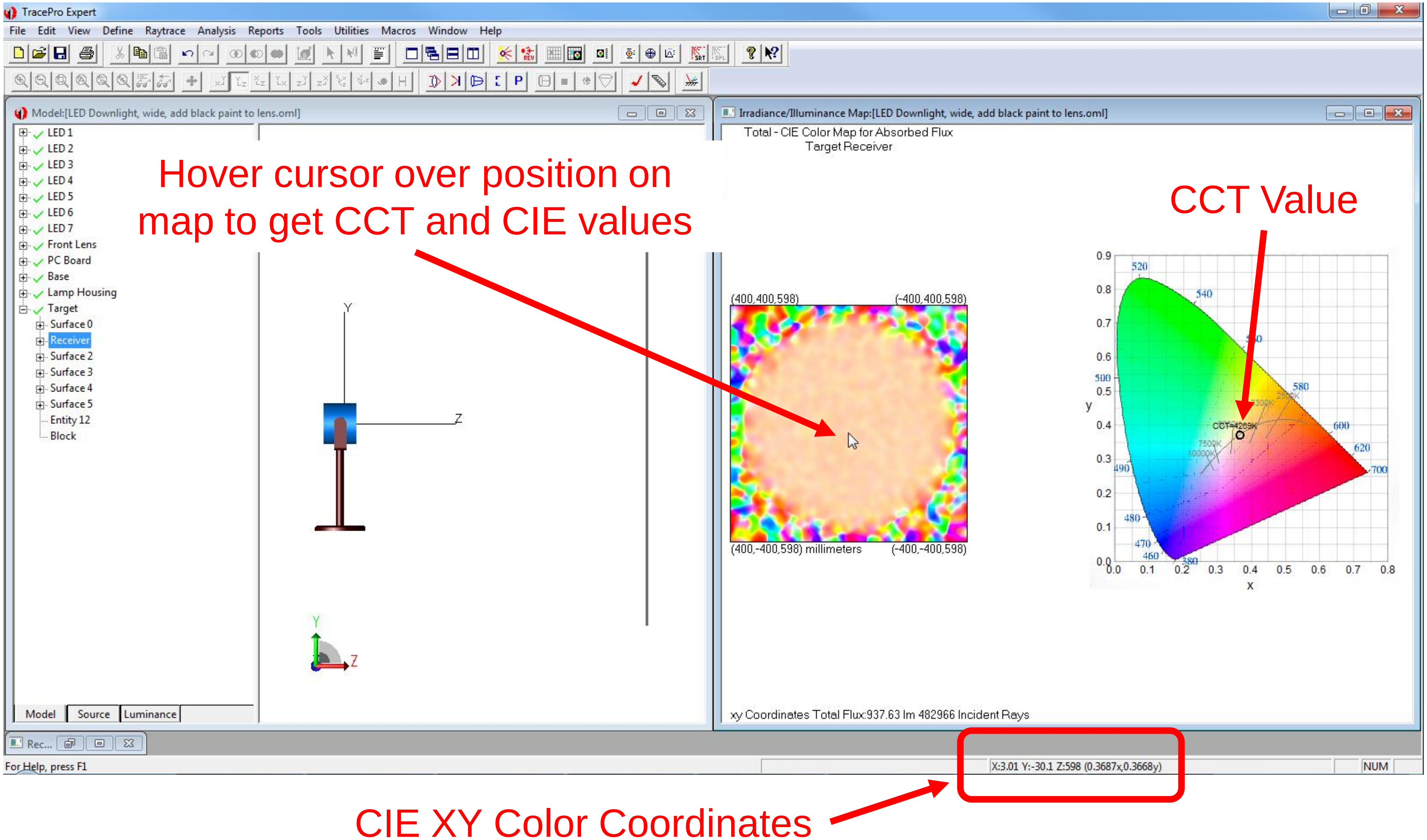
Smoothing = On

Color Measurements in TracePro



RGB Color Values

Color Measurements in TracePro



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Thank You

ScatterScope3D Special Offer

10% off all ScatterScope3D orders placed before November 30, 2011

There are now 3 versions of the ScatterScope to meet your needs contact techsales@lambdares.com for a quote.

- Reflective and transmissive version
- Transmissive only version
- Reflective only version

Questions and Answers

For Additional Information Please Contact:

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