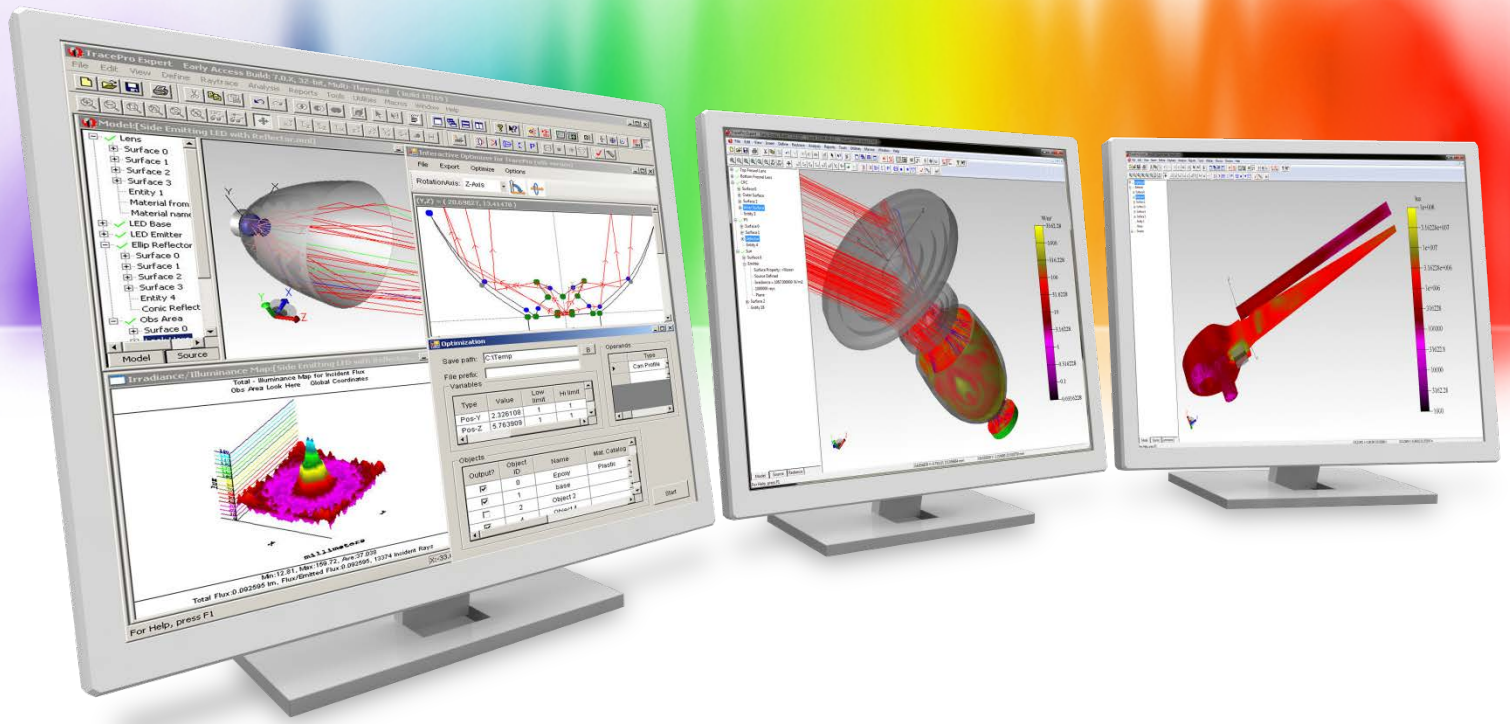
TracePro



Luminance, Radiance, and Photorealistic Rendering in TracePro

Lambda Research Corporation Webinar

July 1, 2020

LAMBDA RESEARCH CORPORATION

Presenter

- **Presenter**

  Dave Jacobsen

  Sr. Application Engineer

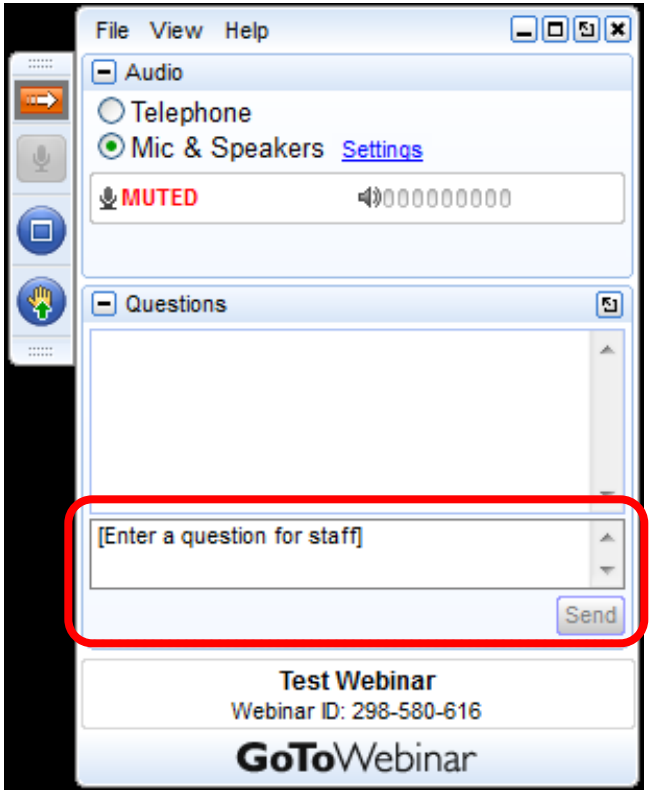
  Lambda Research Corporation

TracePro

Format

- A 30-40 minute presentation followed by a question and answer session

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

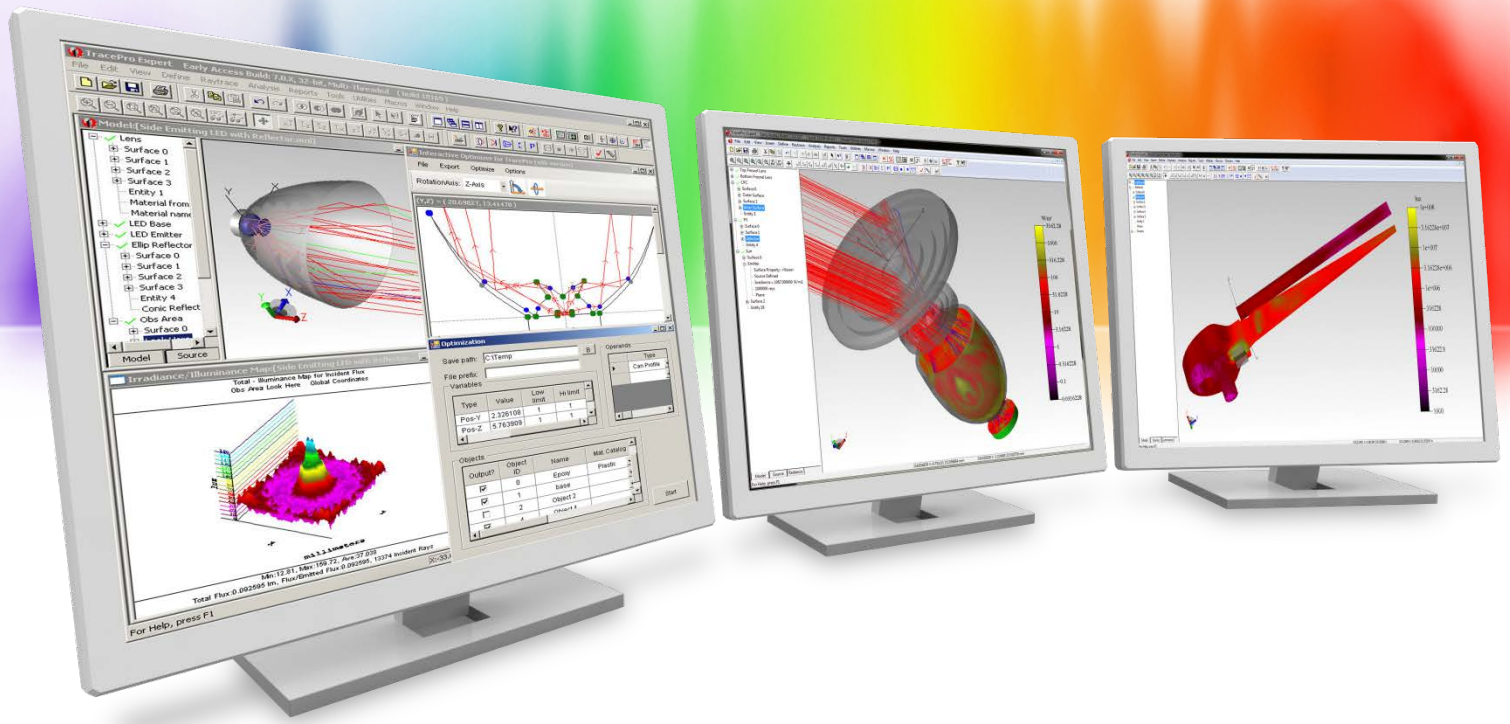


TracePro

Additional Resources

- Webinars and Tutorial Videos
  - https://www.lambdares.com/su/tracepro-videos/
  - https://www.lambdares.com/su/oslo-videos/
- Tutorials
  - https://www.lambdares.com/su/tracepro-tutorials/
  - https://www.lambdares.com/su/oslo-tutorials/
- Information on upcoming training classes
  - https://www.lambdares.com/training/

TracePro



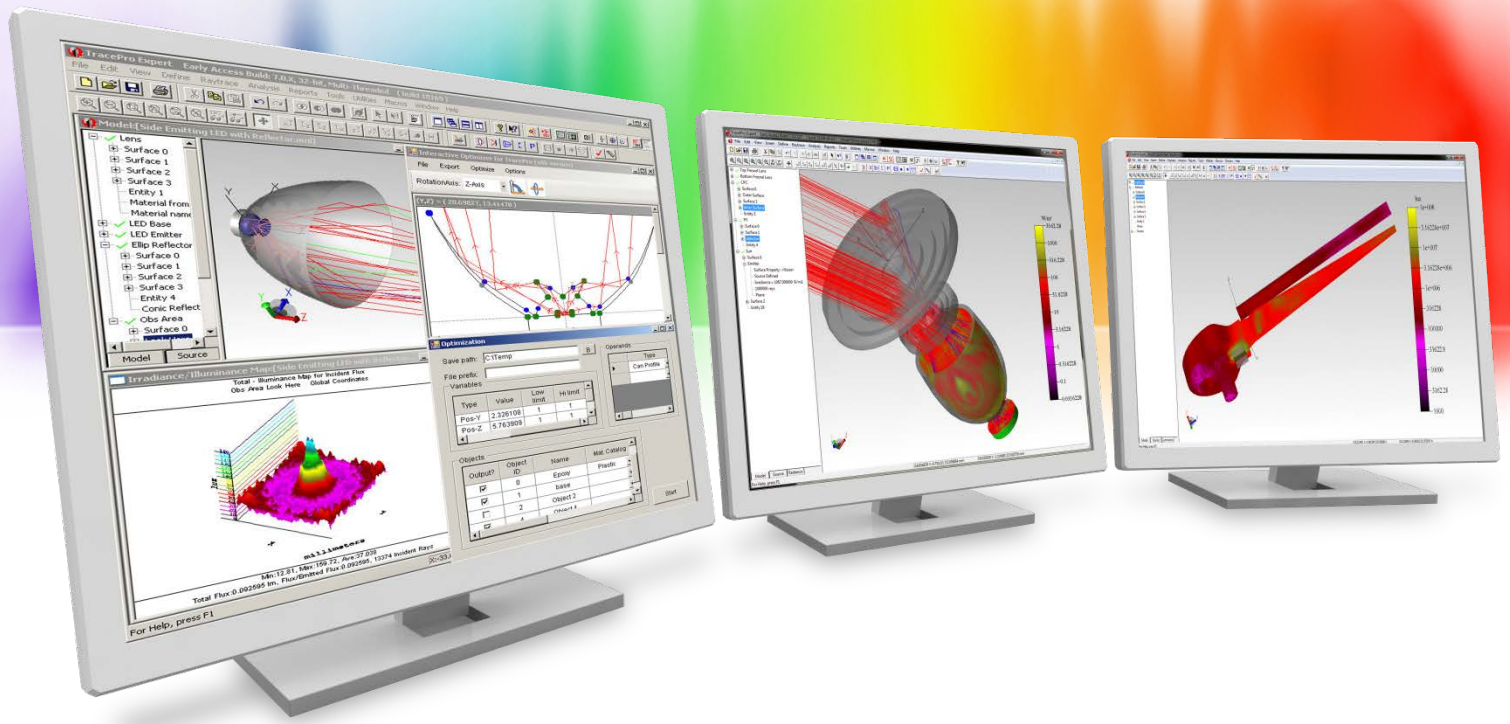
Introduction

LAMBDA RESEARCH CORPORATION

Topics

- Introduction and review of radiometry and photometry
- The need for luminance, radiance, and photorealistic rendering
- Setting up luminance and radiance raytraces in TracePro
- Setting up photorealistic rendering in TracePro
- Luminance, radiance, and photorealistic rendering options
- Examples
- Live Demo
- Question and Answer session

TracePro



Radiometry and Photometry

LAMBDA RESEARCH CORPORATION

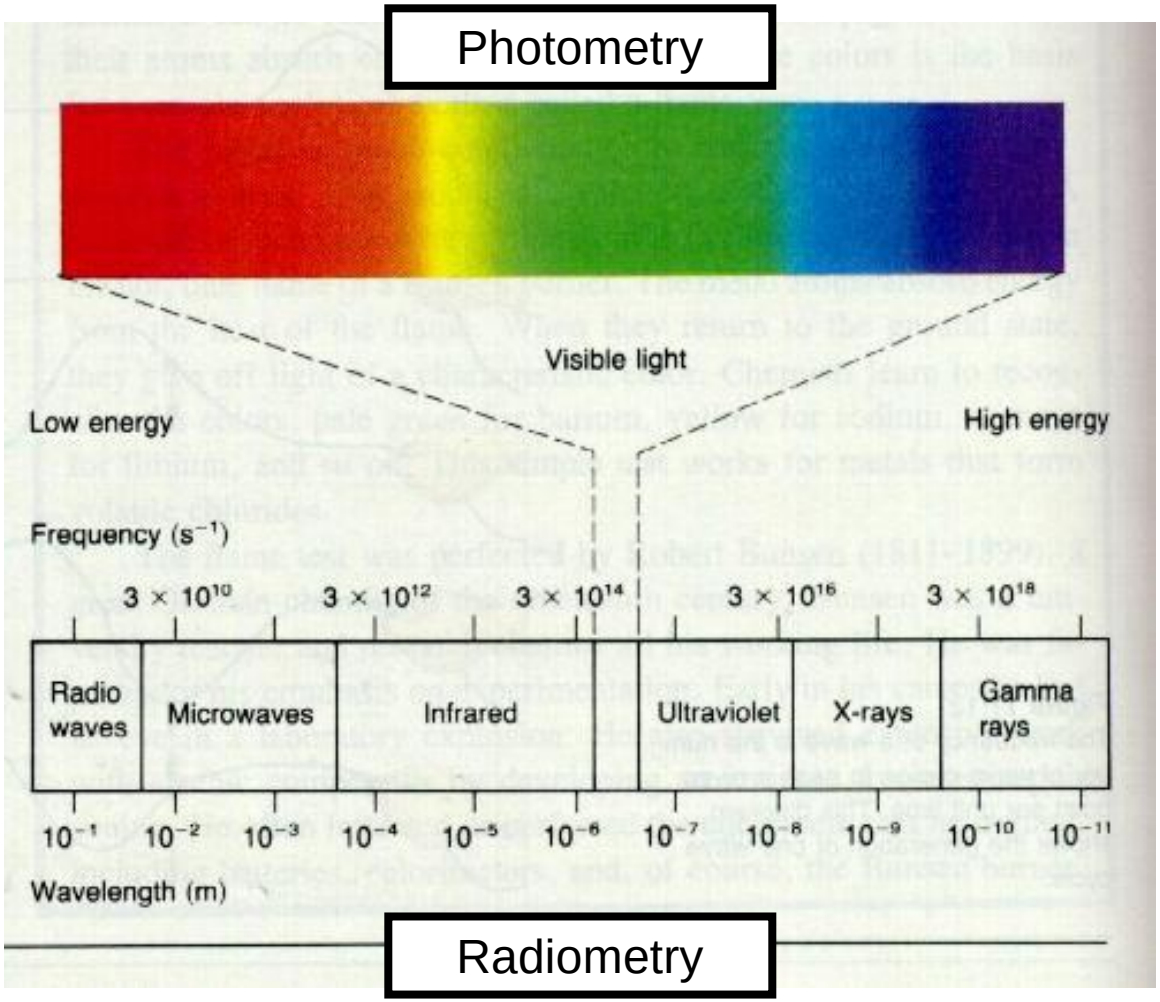
Radiometry

- 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)**.

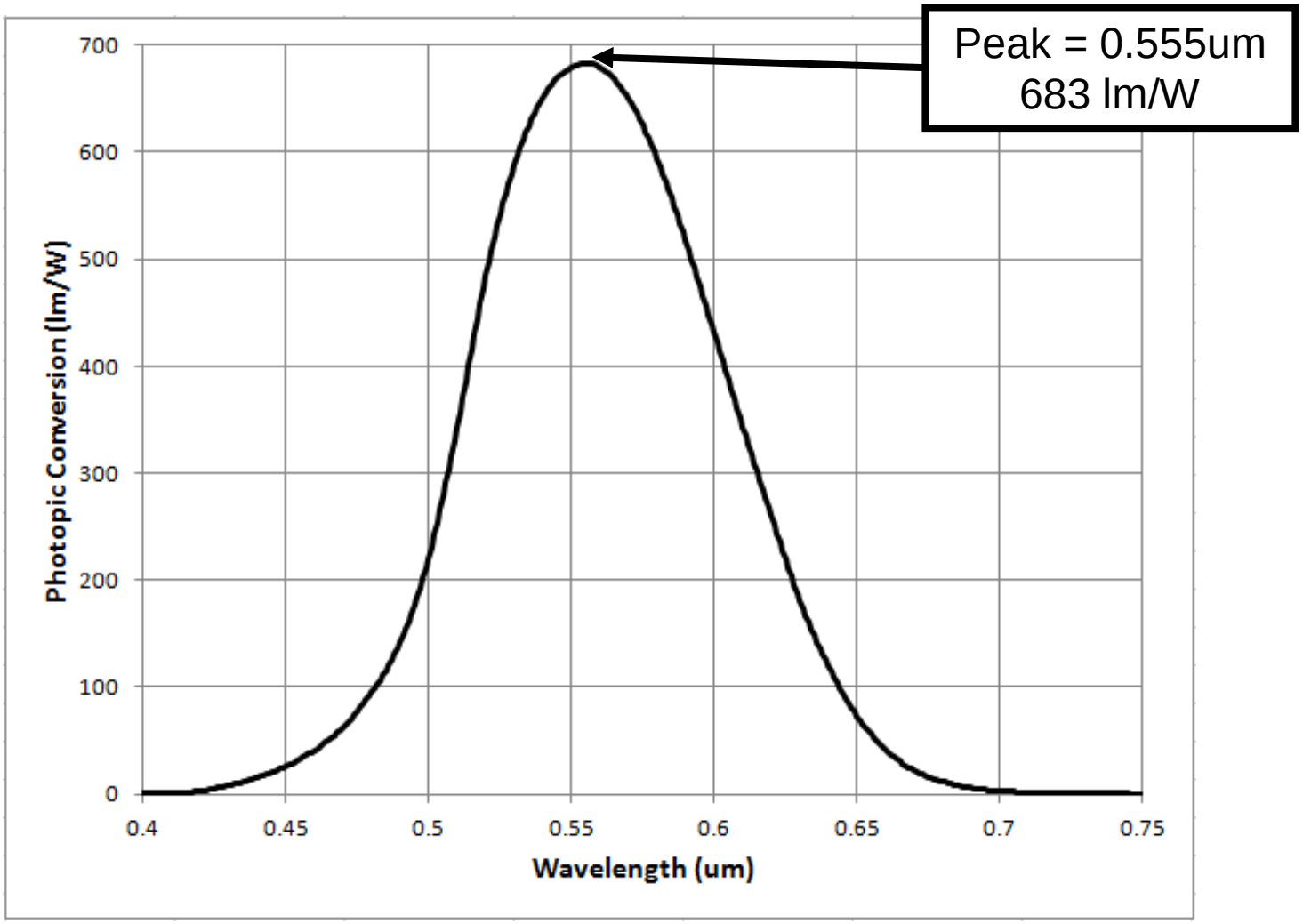
Photometry

- 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)**

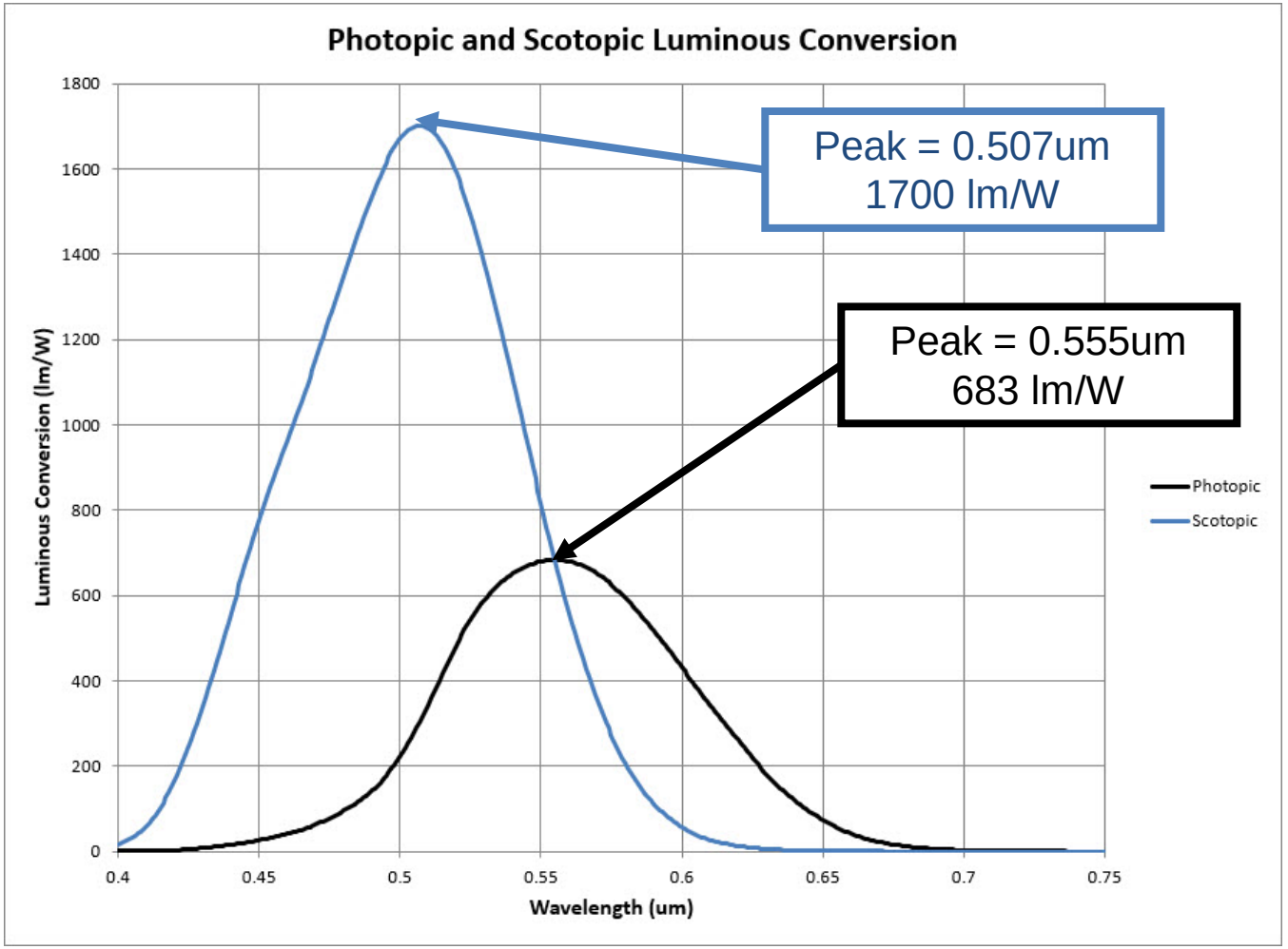
Visible Light Spectrum



Photopic Curve – Human Eye Response



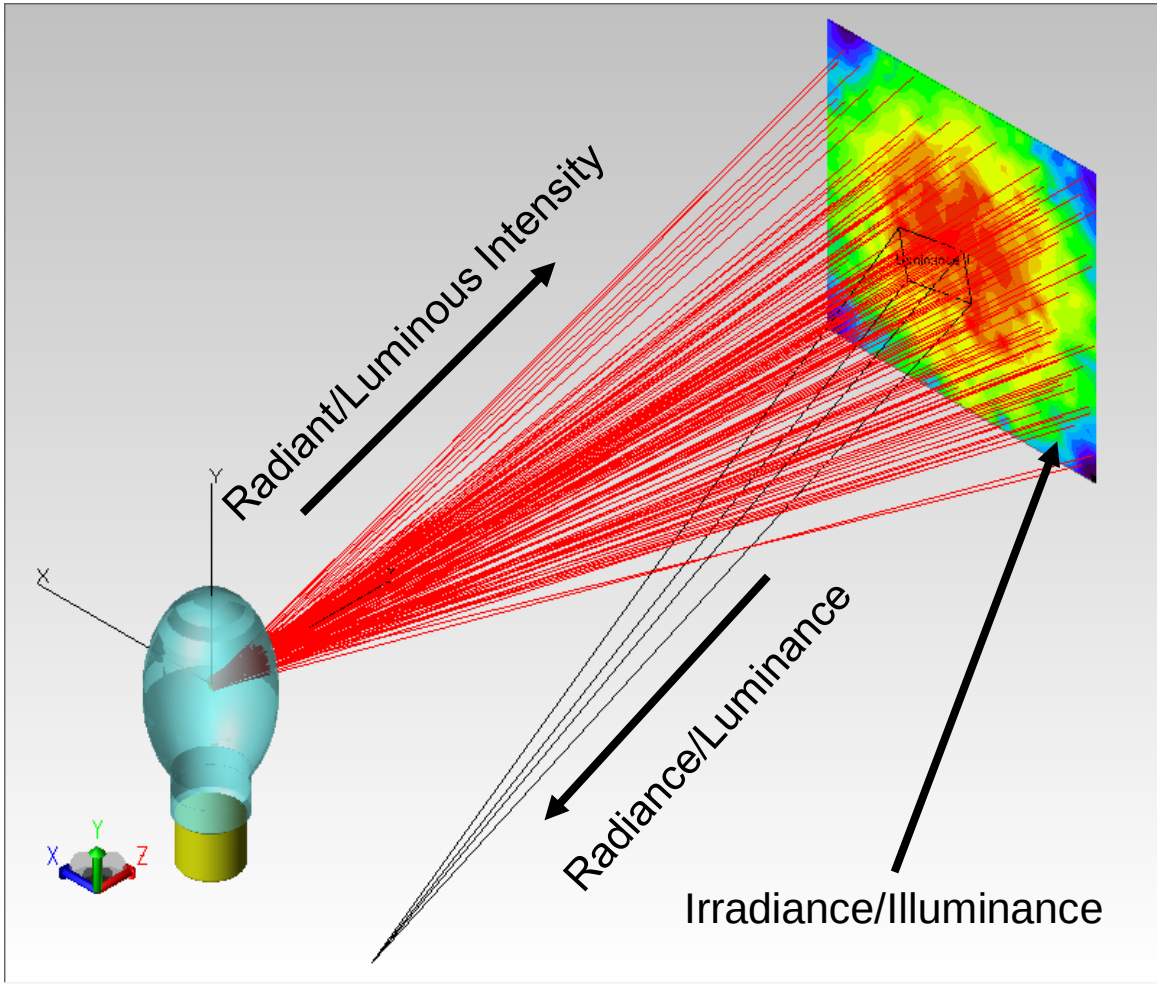
Photopic vs Scotopic Curve



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



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
- Radiance and Luminance are distance invariant as long as the solid angle remains smaller than the source
- Photorealistic Rendering is a lit appearance display of an object as it would appear to a viewer

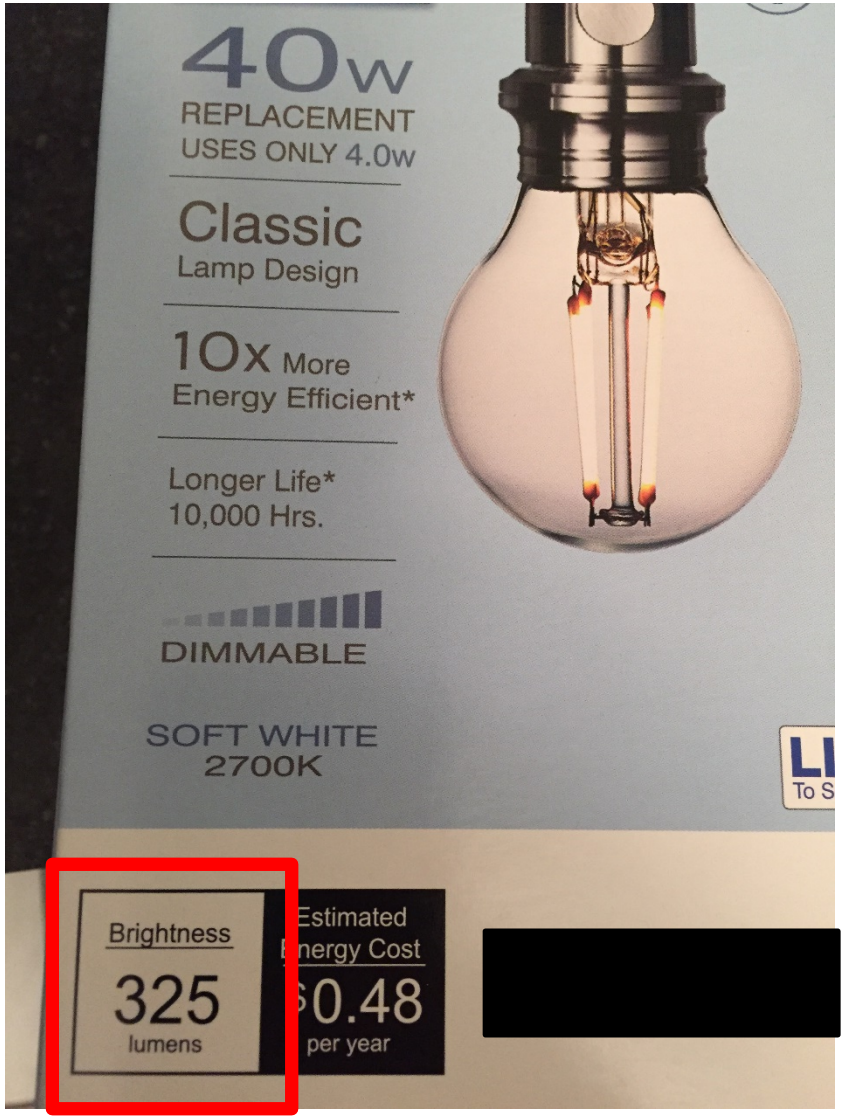
What about Brightness?

Brightness is an attribute of visual perception in which a source appears to be radiating or reflecting light. In other words, brightness is the perception elicited by the luminance of a visual target. It is not necessarily proportional to luminance. This is a subjective attribute/property of an object being observed and one of the color appearance parameters of color appearance models.

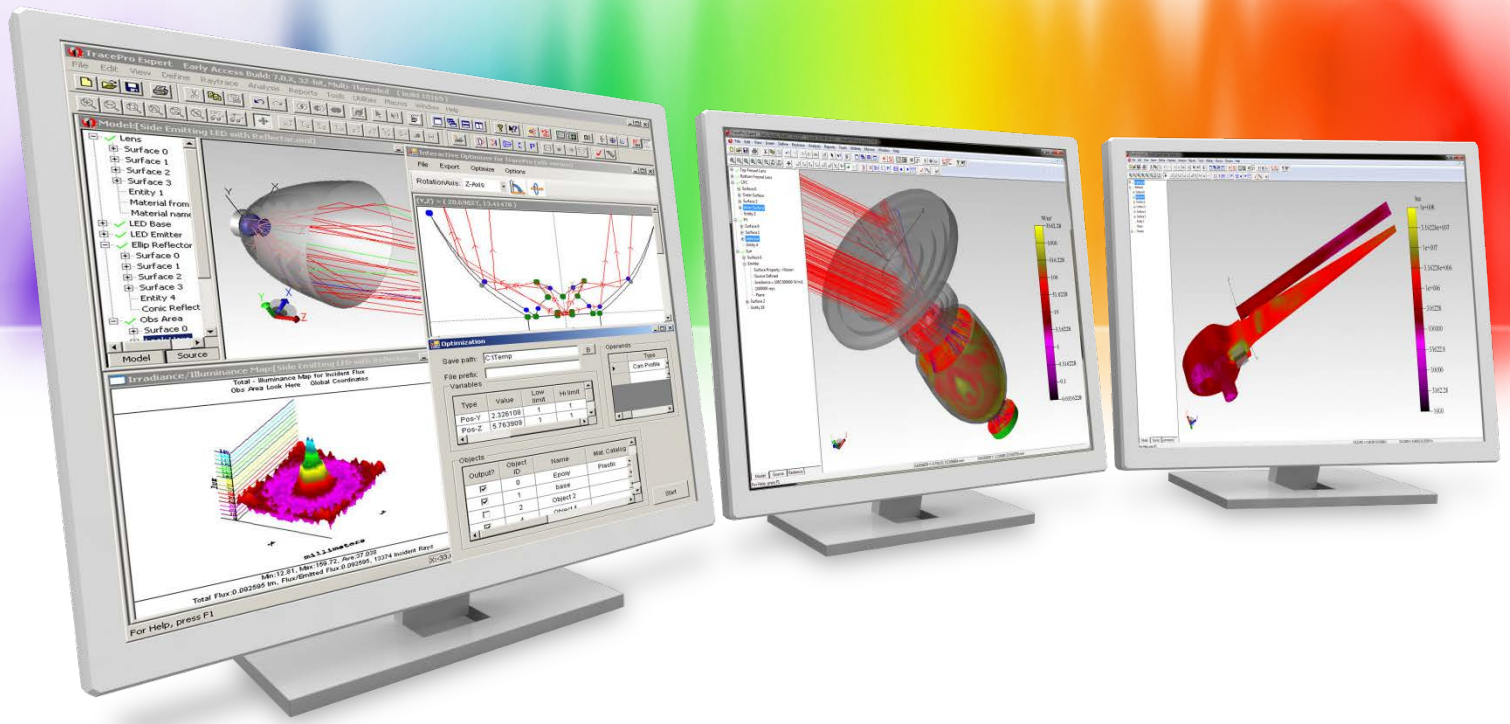
"Brightness" was formerly used as a synonym for the photometric term *luminance* and (incorrectly) for the radiometric term *radiance*. As defined by the US *Federal Glossary of Telecommunication Terms* (FS-1037C), "brightness" should now be used only for non-quantitative references to physiological sensations and perceptions of light.

Source: Wikipedia

What about Brightness?



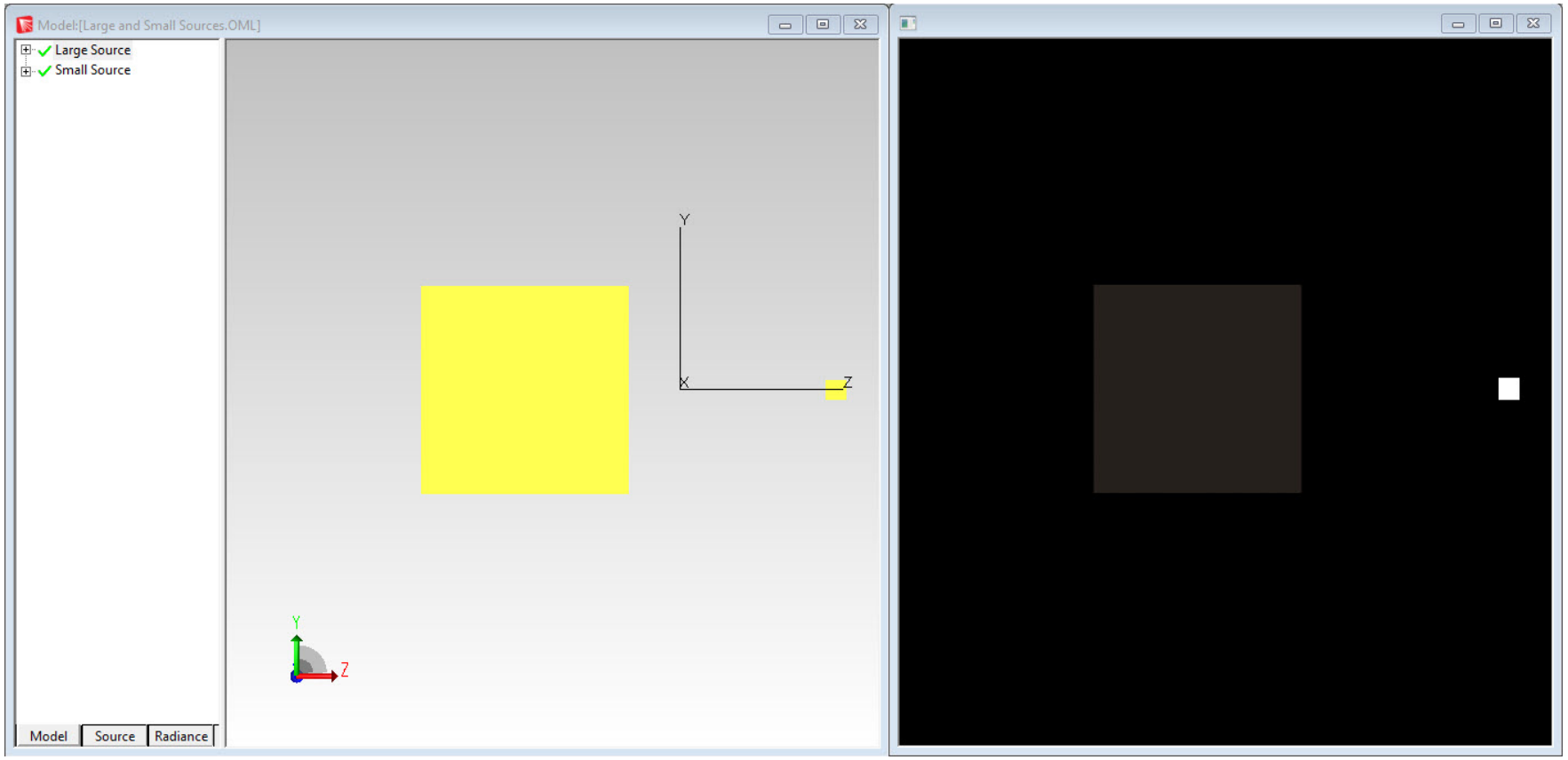
TracePro



Luminance, Radiance, and Photorealistic Rendering

LAMBDA RESEARCH CORPORATION

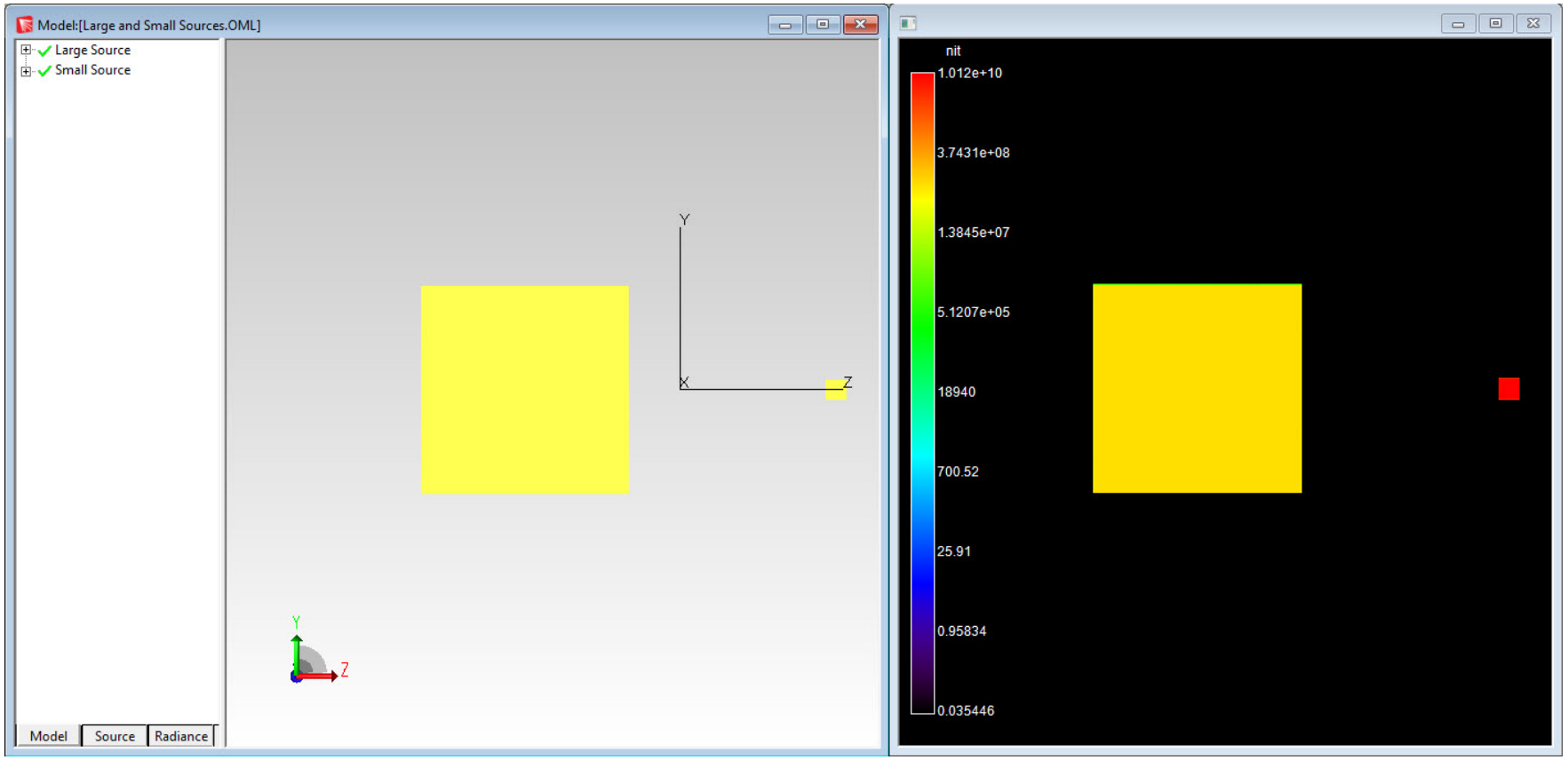
100 lumen sources – Photorealistic Rendering



100mm^2 vs. 1mm^2 sources, both with 100 lumens

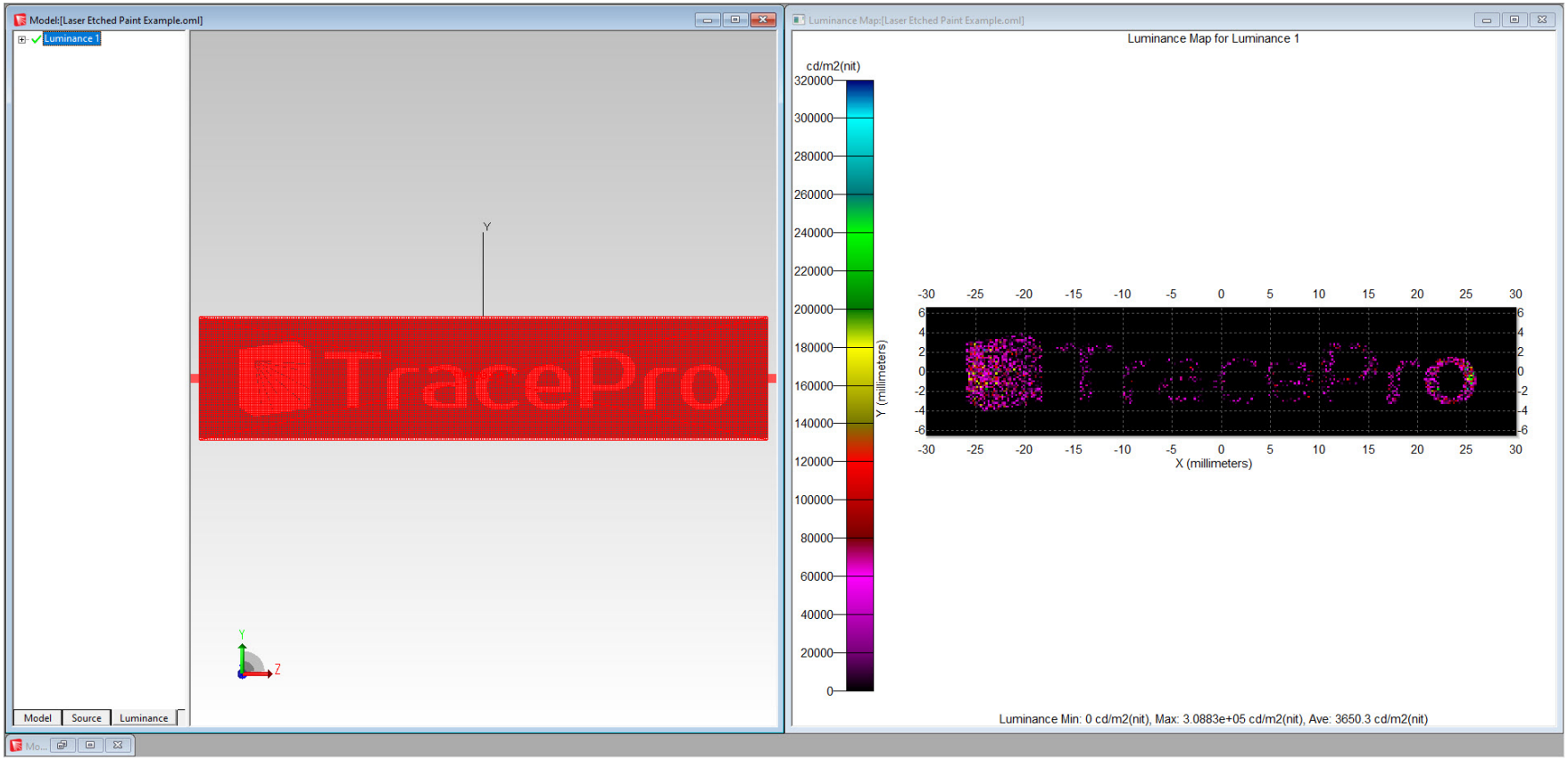
TracePro

100 lumen sources – Luminance

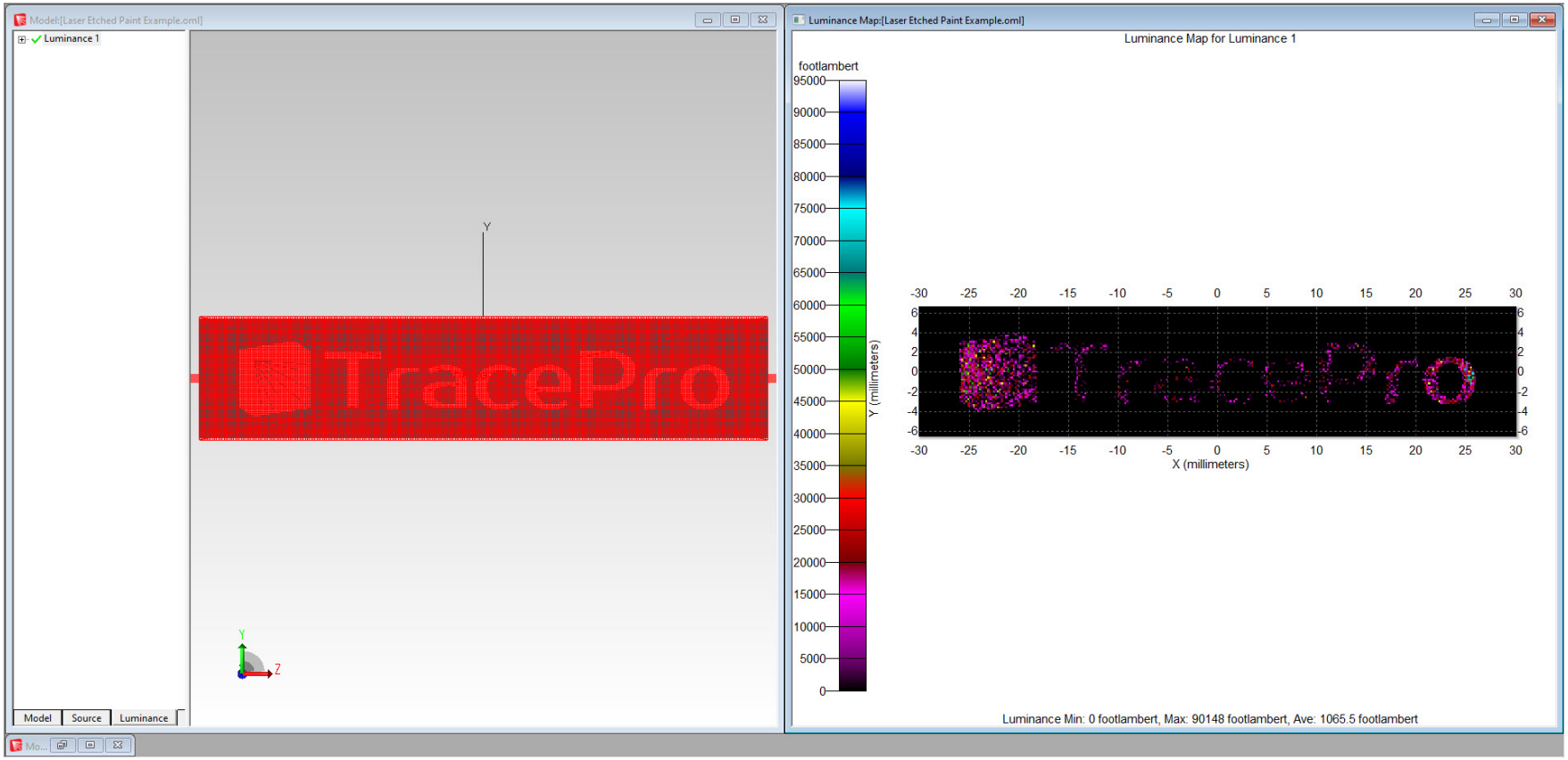


100mm^2 vs. 1mm^2 sources, both with 100 lumens

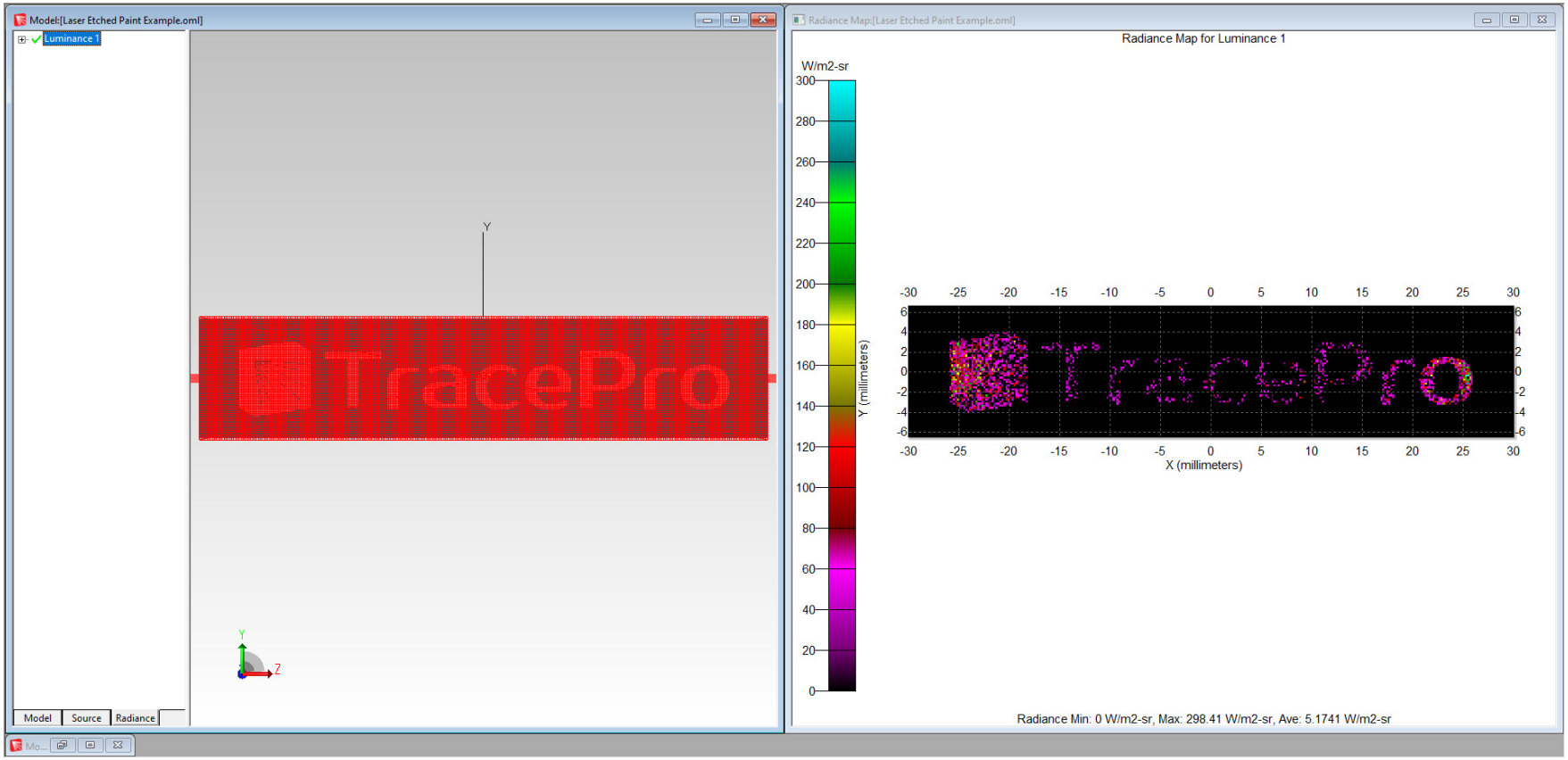
Luminance example – cd/m2(nits)



Luminance example – footlamberts

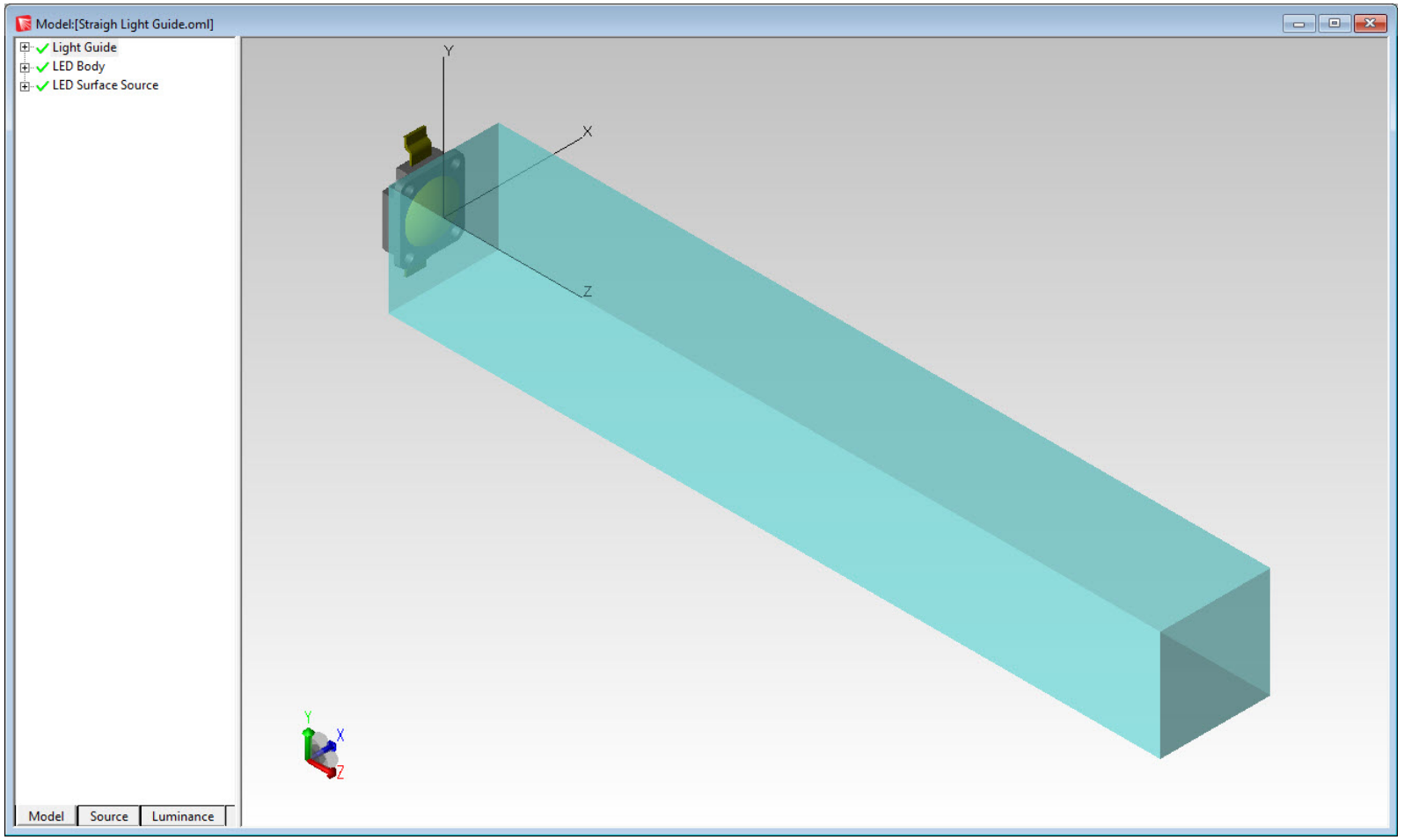


Radiance example – W/m2-sr



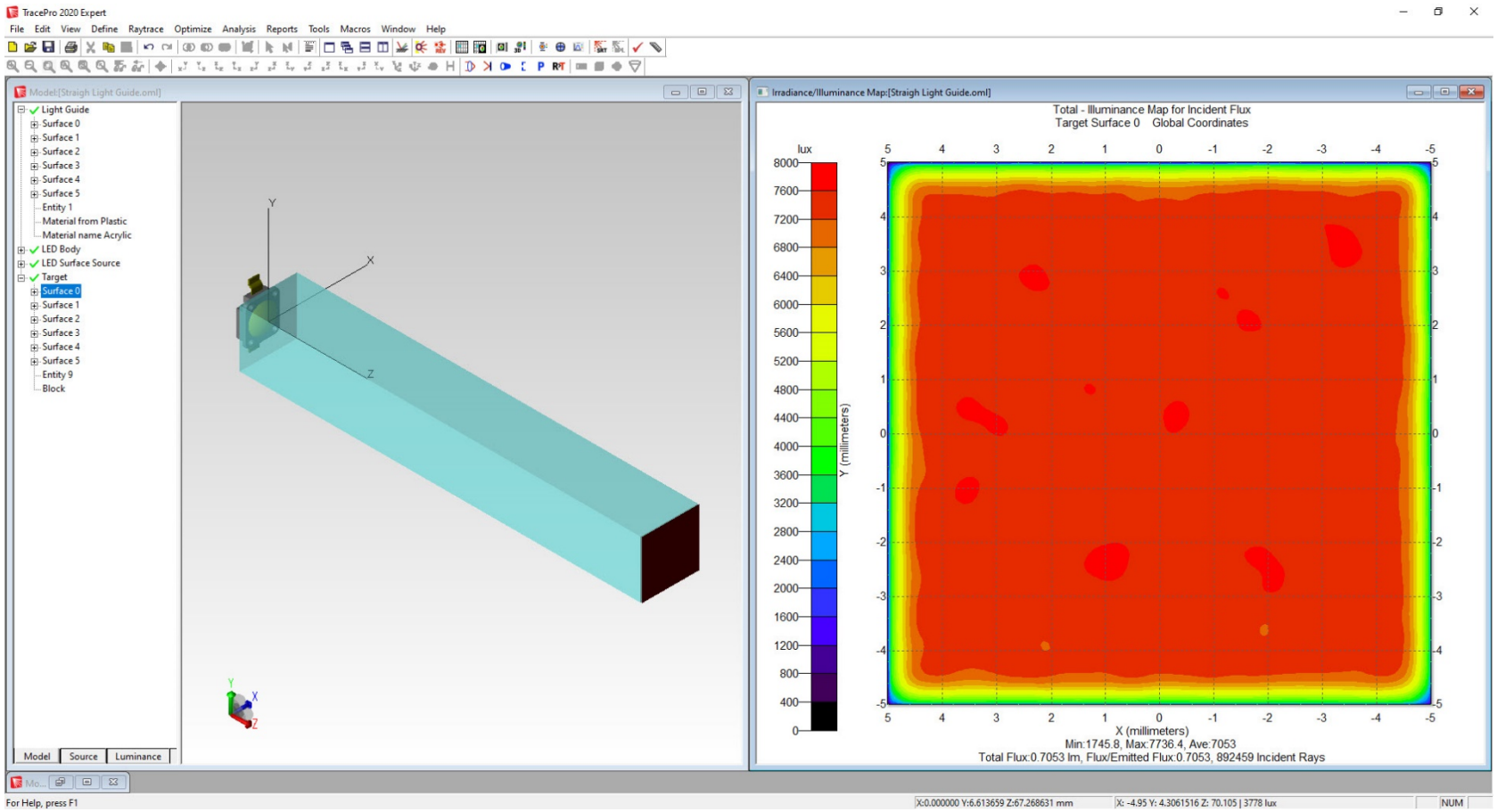
Why look at luminance or radiance?

- Simple light guide design



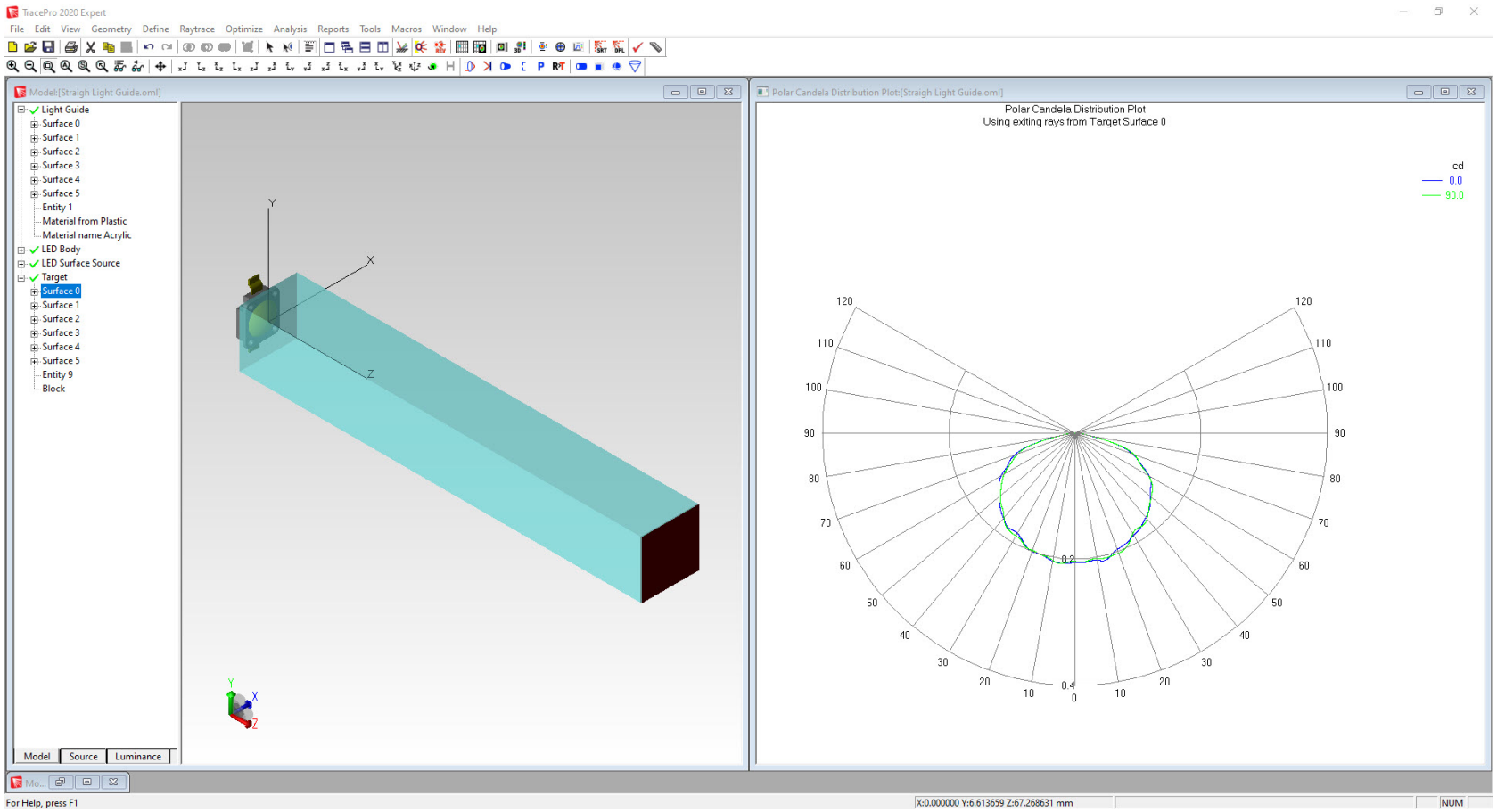
Why look at luminance or radiance?

- Illuminance Map looks good



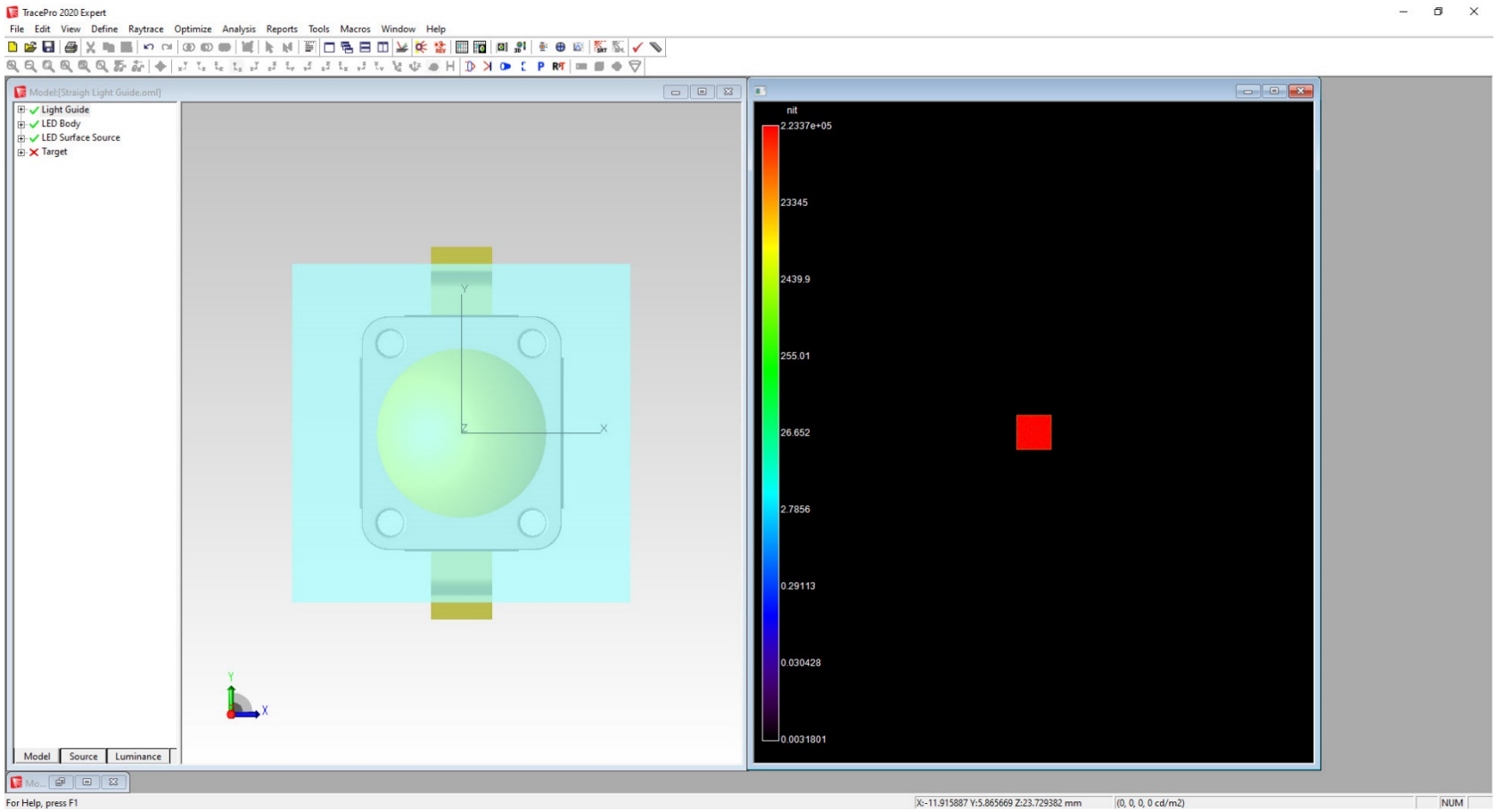
Why look at luminance or radiance?

- Candela Plot looks good



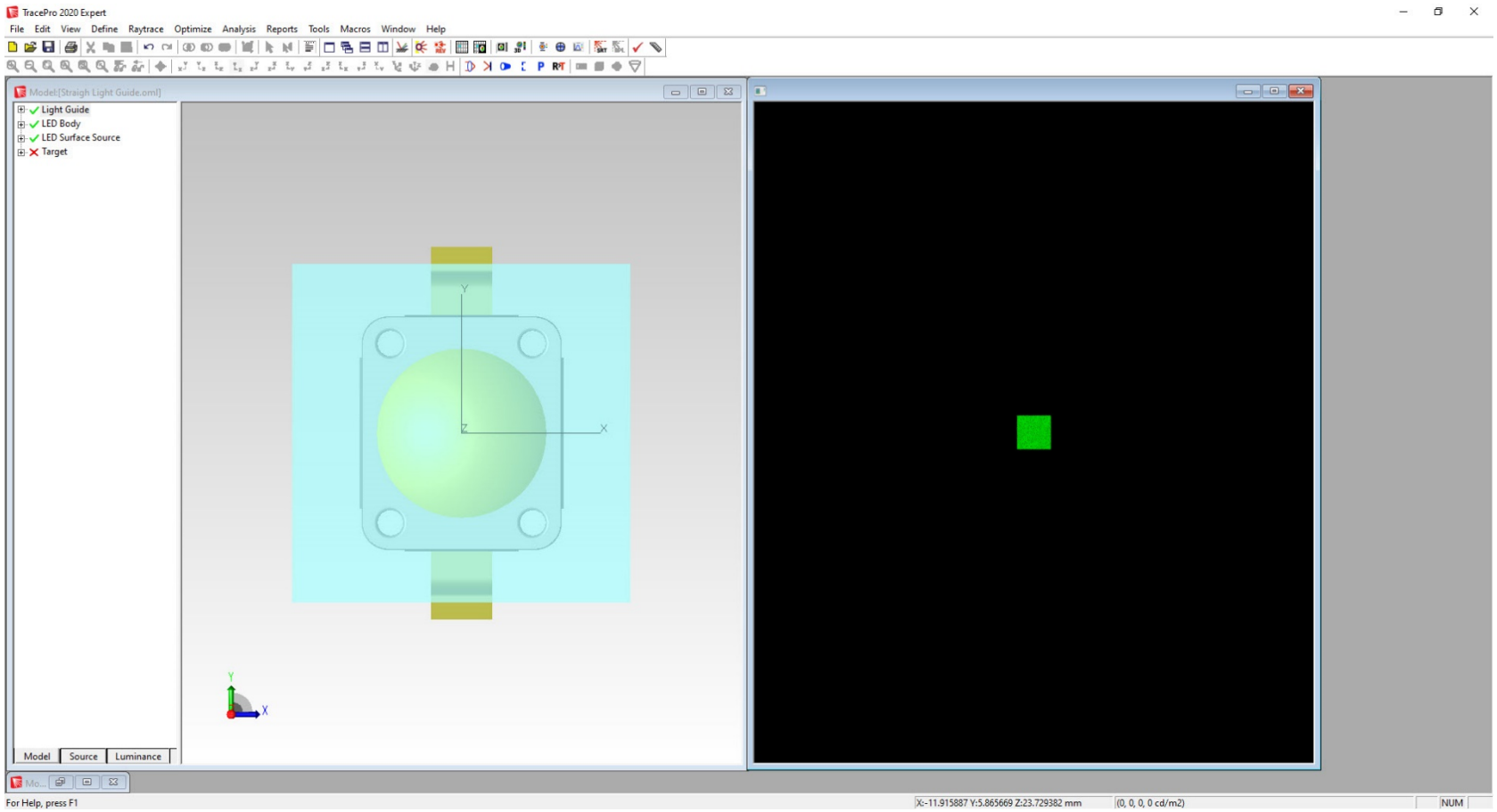
Why look at luminance or radiance?

- What about the luminance?



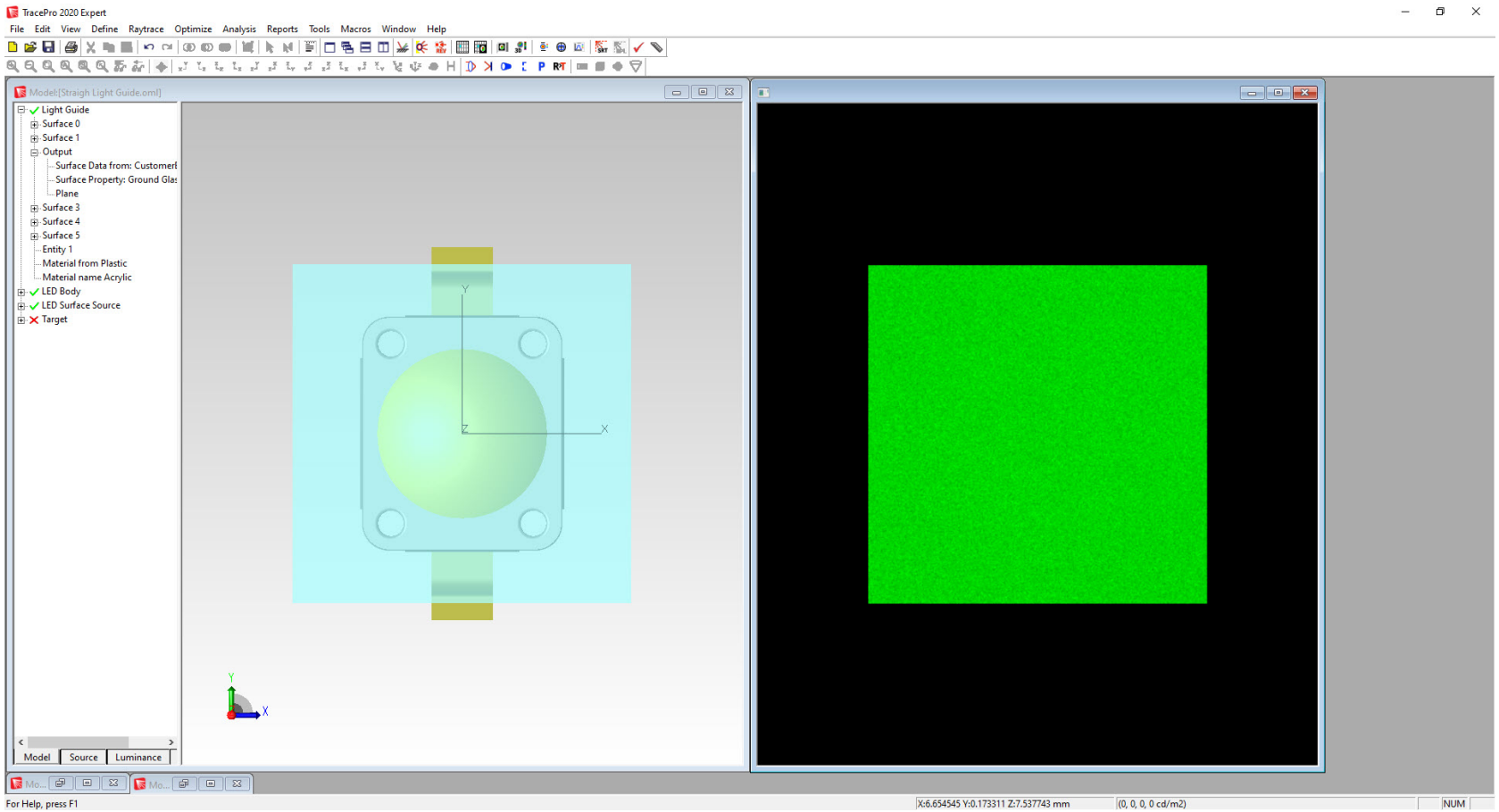
Why look at luminance or radiance?

- Or photorealistic rendering?



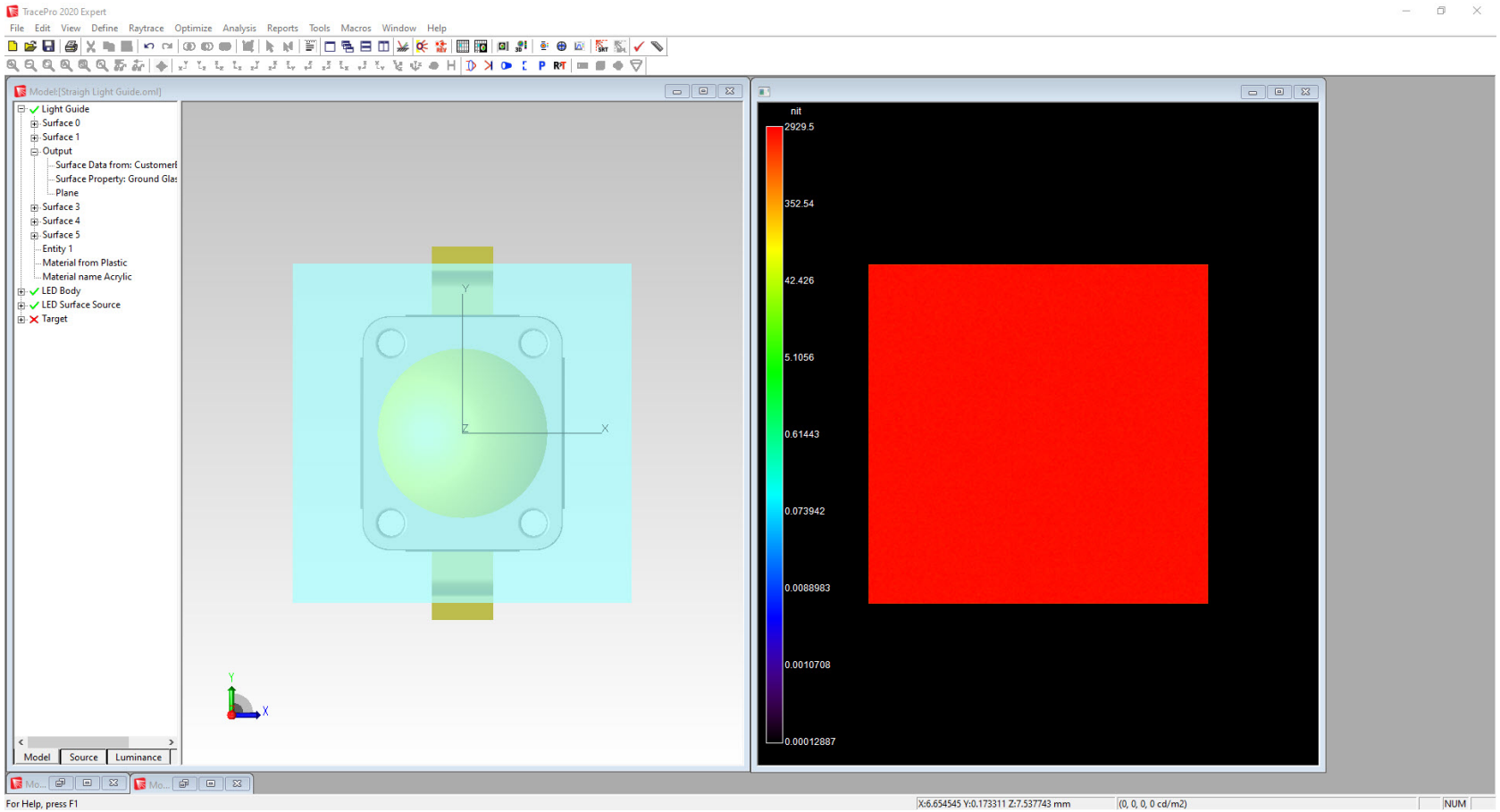
Why look at luminance or radiance?

- Add a texture to the output surface of the light guide – much better results



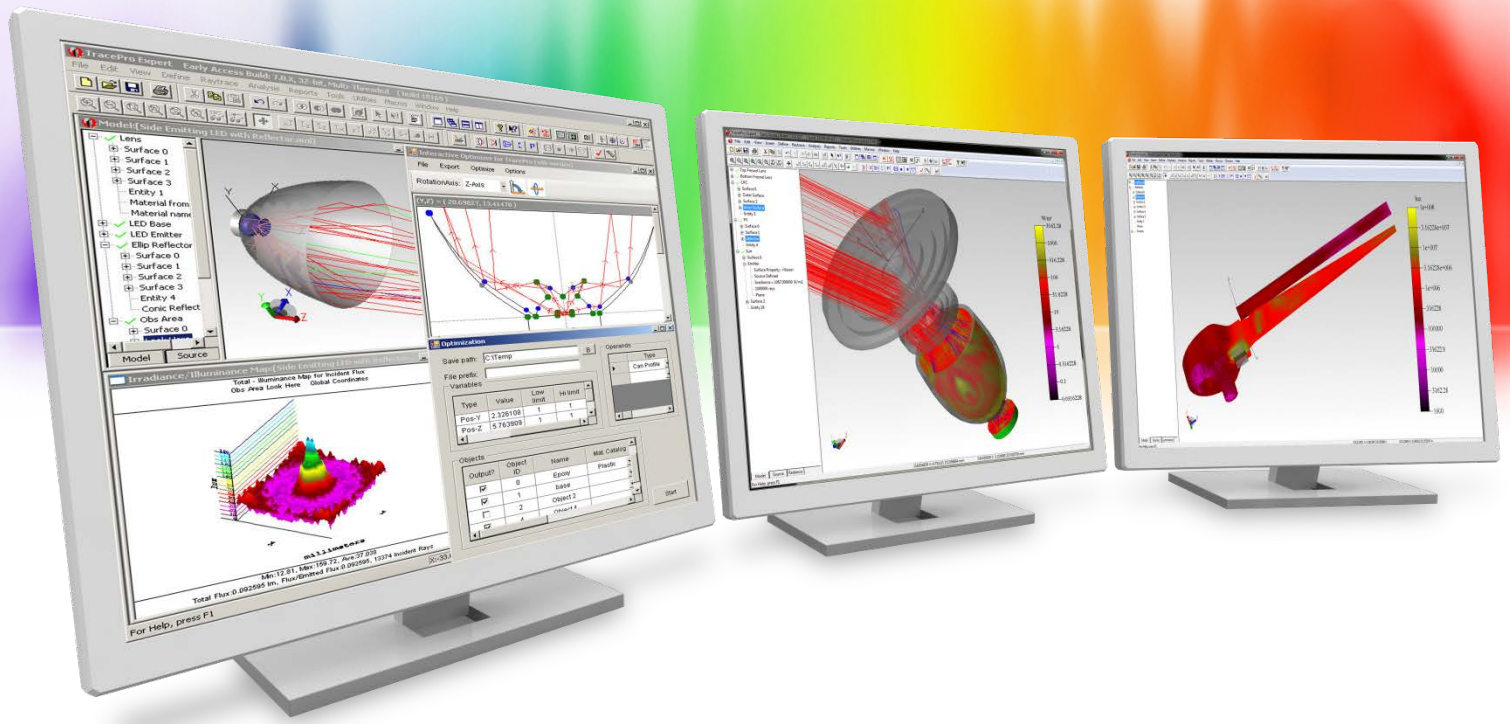
Why look at luminance or radiance?

- Add a texture to the output surface of the light guide – much better results



TracePro

TracePro



Setting up luminance, radiance, and photorealistic rendering in TracePro

LAMBDA RESEARCH CORPORATION

Luminance and photorealistic rendering methods

- There are 2 ways to run luminance and photorealistic rendering raytraces in TracePro

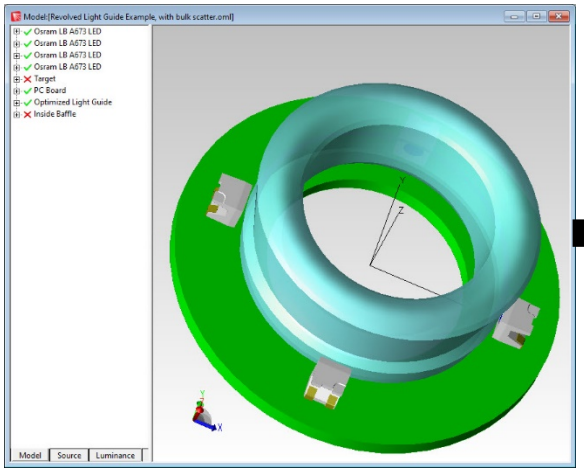
    1. View->Photorealistic Rendering

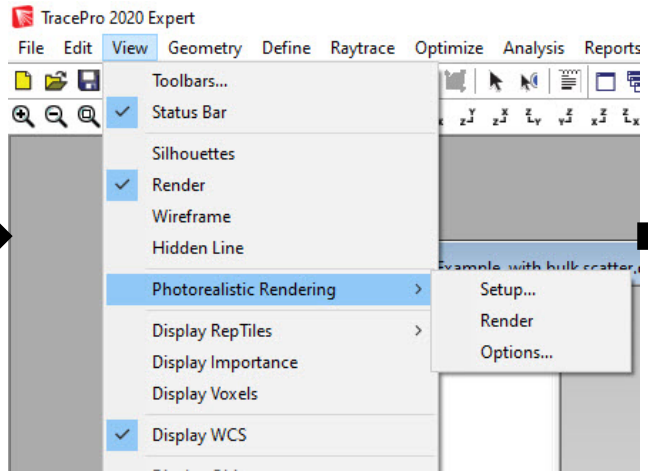
    2. Define->Luminance/Radiance

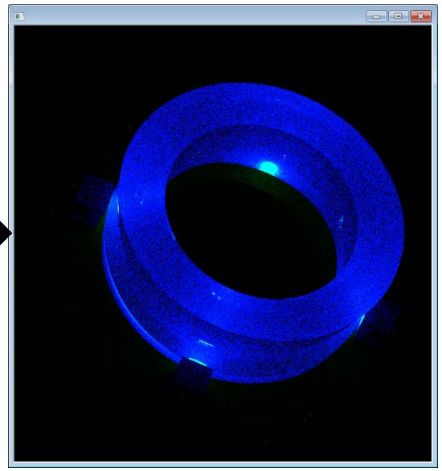
- Radiance raytraces can be run using Define->Luminance/Radiance

View->Photorealistic Rendering

- Orient the model to have the view that you want to use – use small window size initially
- Go to View->Photorealistic Rendering->Setup to set the parameters for the rendering
- Go to View->Photorealistic Rendering->Render to run the rendering

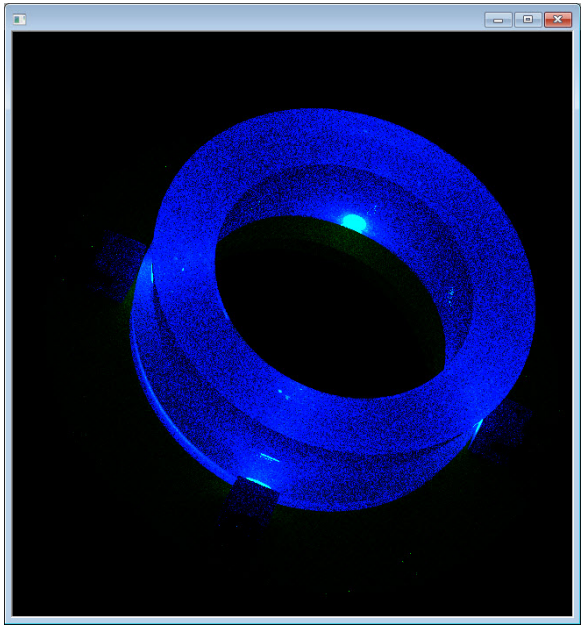


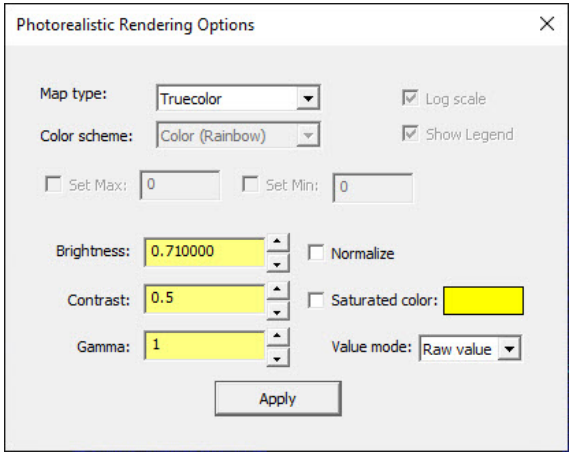


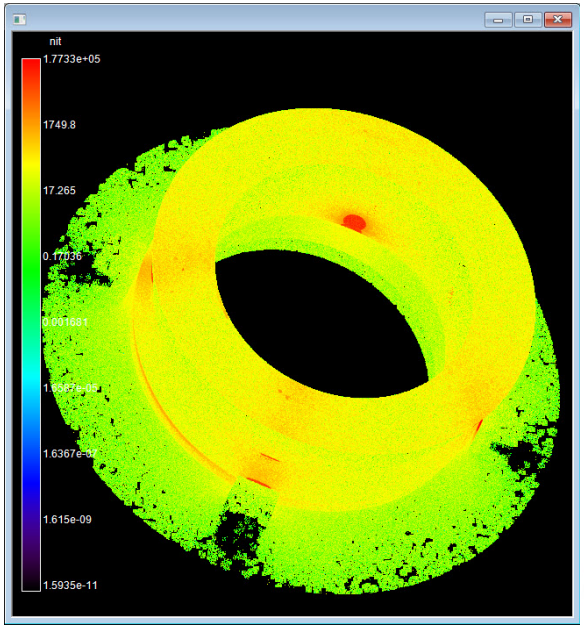


View->Photorealistic Rendering->Options

- Sets the options for the rendering
- Can also be accessed by right clicking in the display window and selecting Photorealistic Rendering Options
- Allows the switch to luminance values

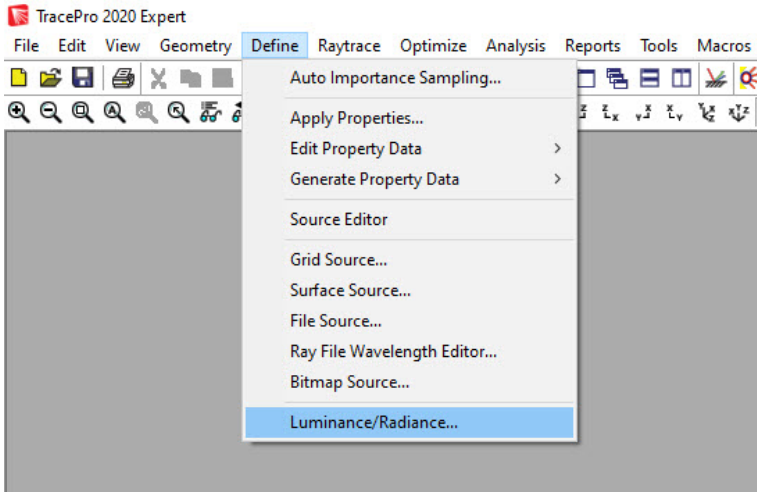


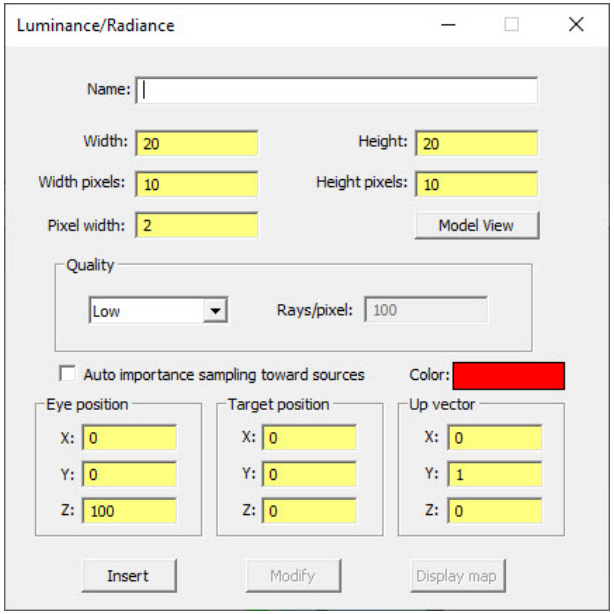




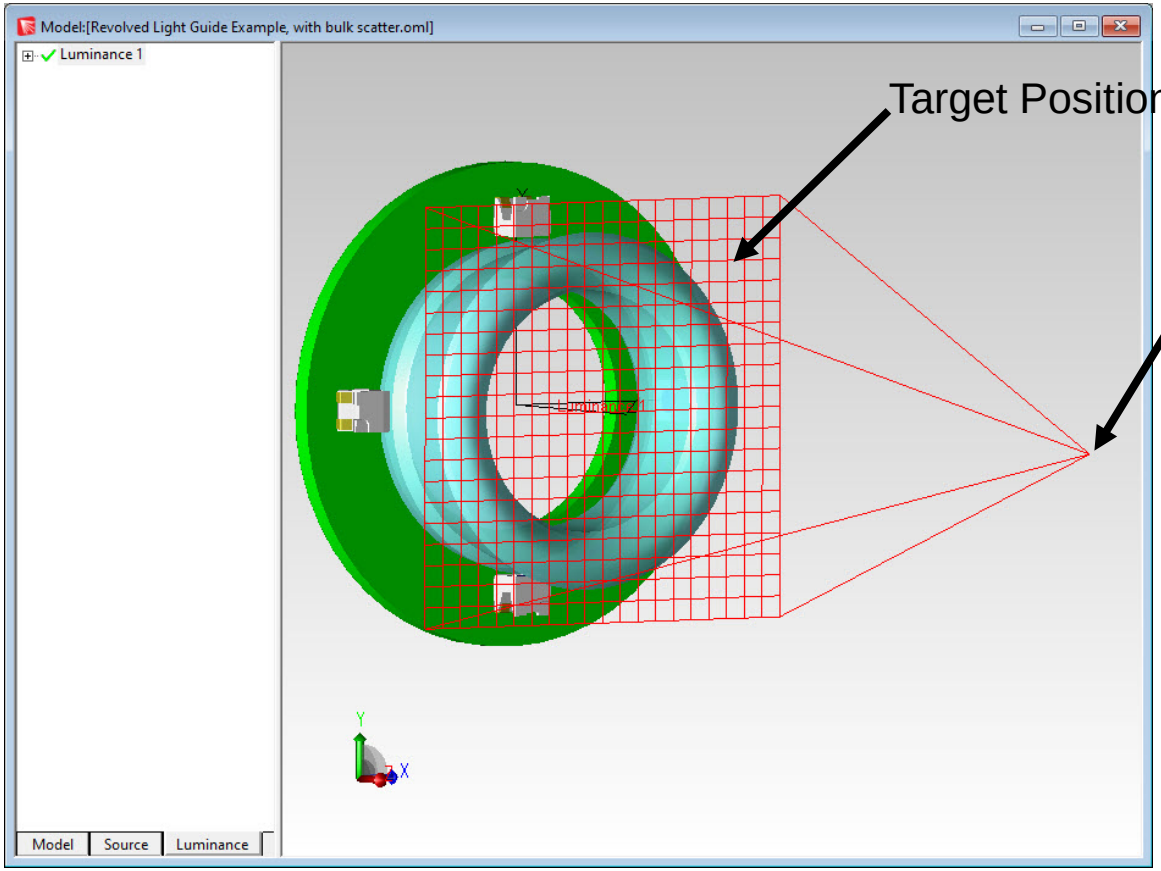
Define->Luminance/Radiance

- Go to Define->Luminance/Radiance to set the parameters for the raytrace
- These settings will determine the eye and target positions and the target size for the raytrace
- The Analysis Units setting will determine of it is luminance or radiance



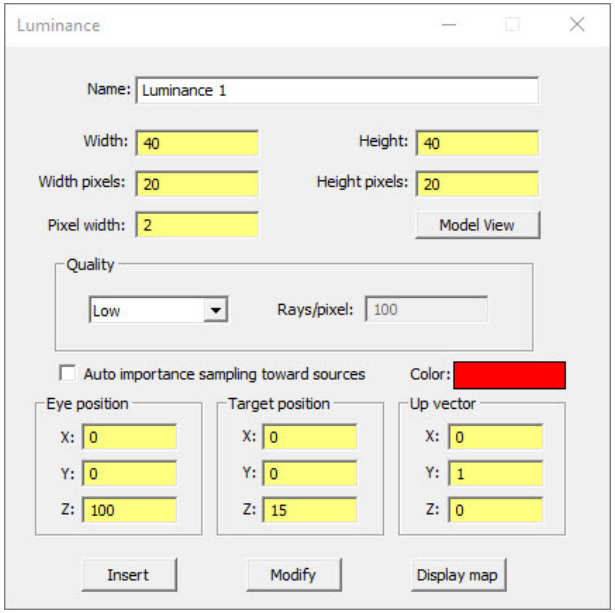


Define->Luminance/Radiance



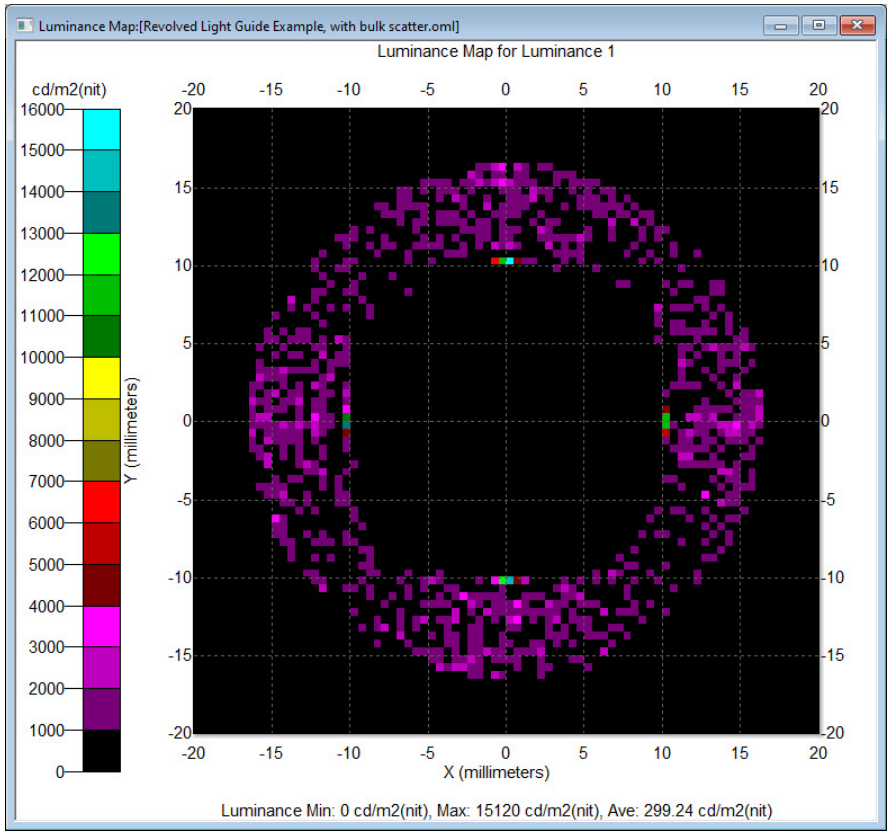
Target Position and size

Eye Position



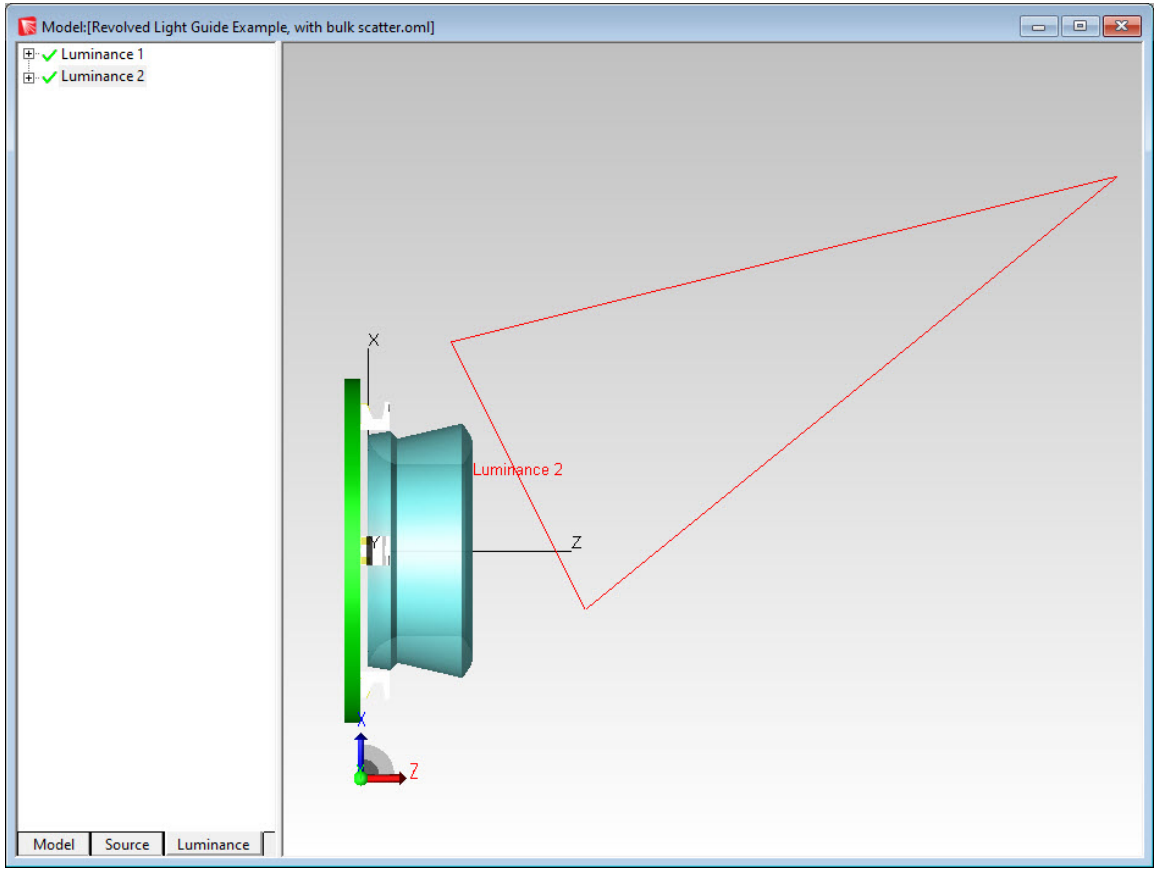
Define->Luminance/Radiance

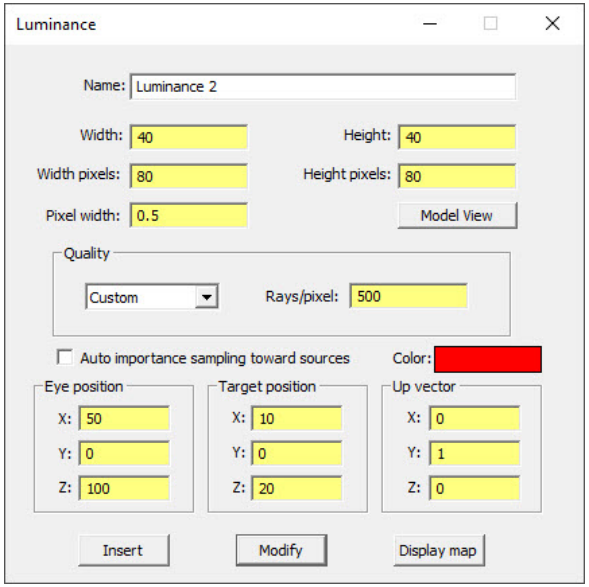
- Raytrace->Luminance/Radiance
- Analysis->Luminance/Radiance Map to see the results after the raytrace



Define->Luminance/Radiance

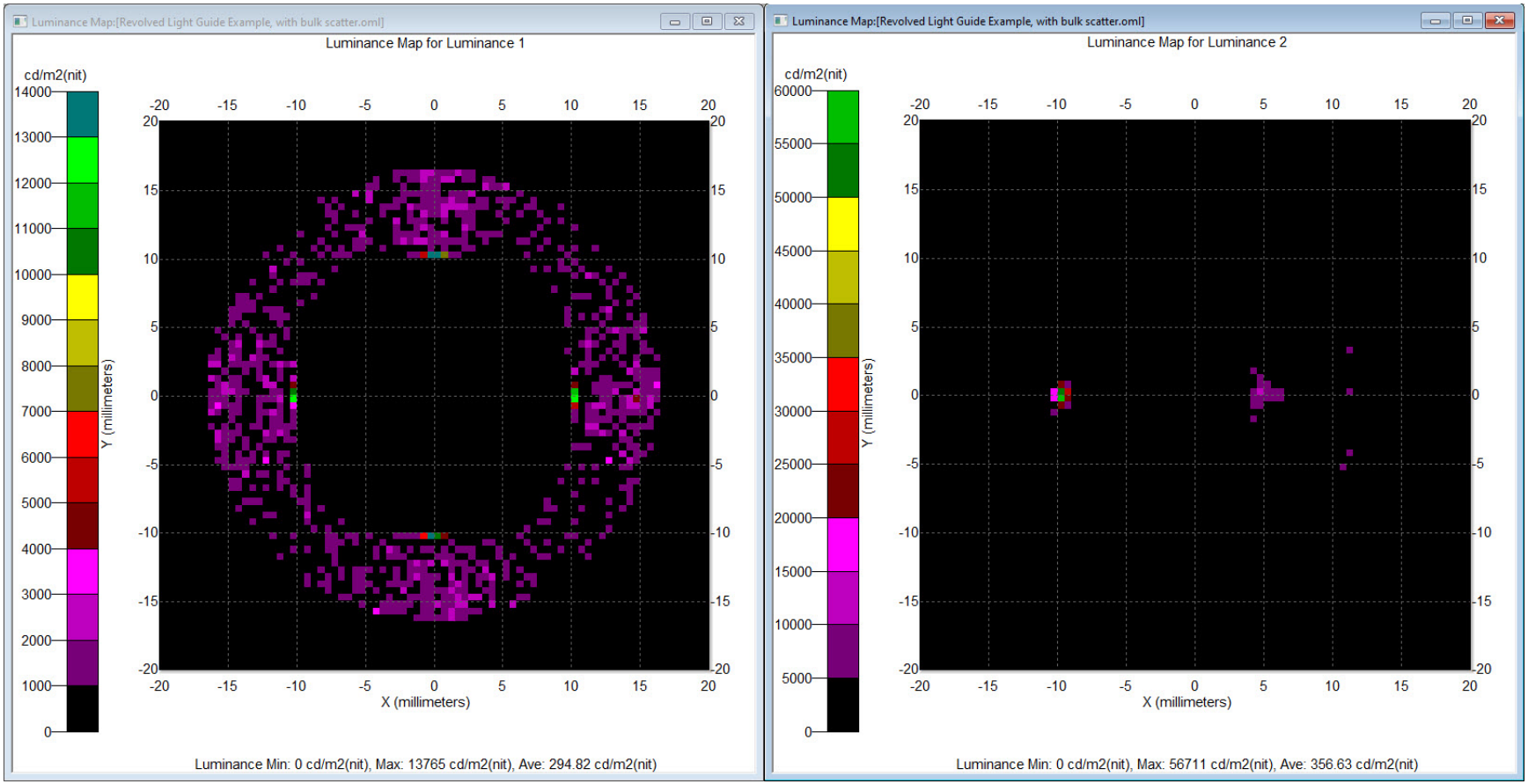
- Multiple luminance and radiance targets can be defined and then raytraced sequentially





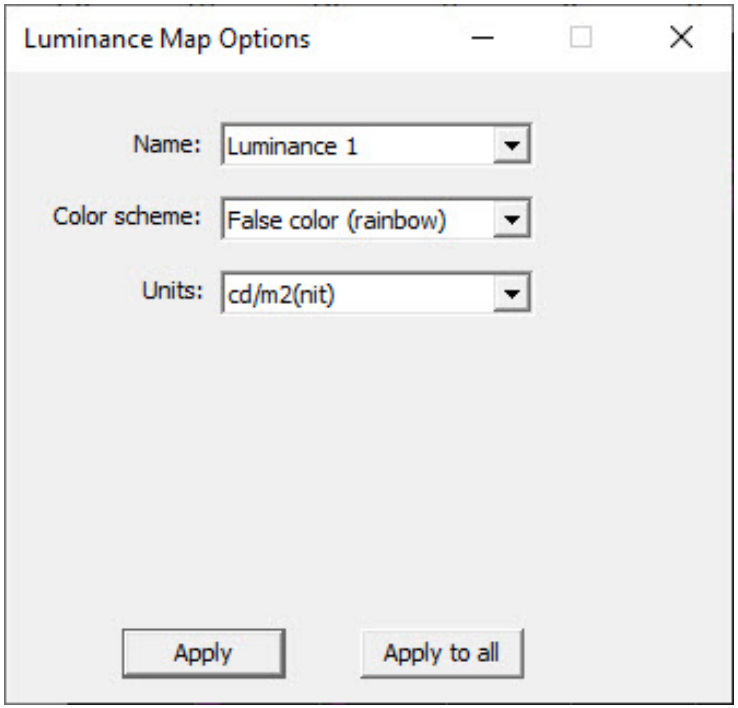
Define->Luminance/Radiance

- Multiple luminance and radiance targets can be defined and then raytraced sequentially

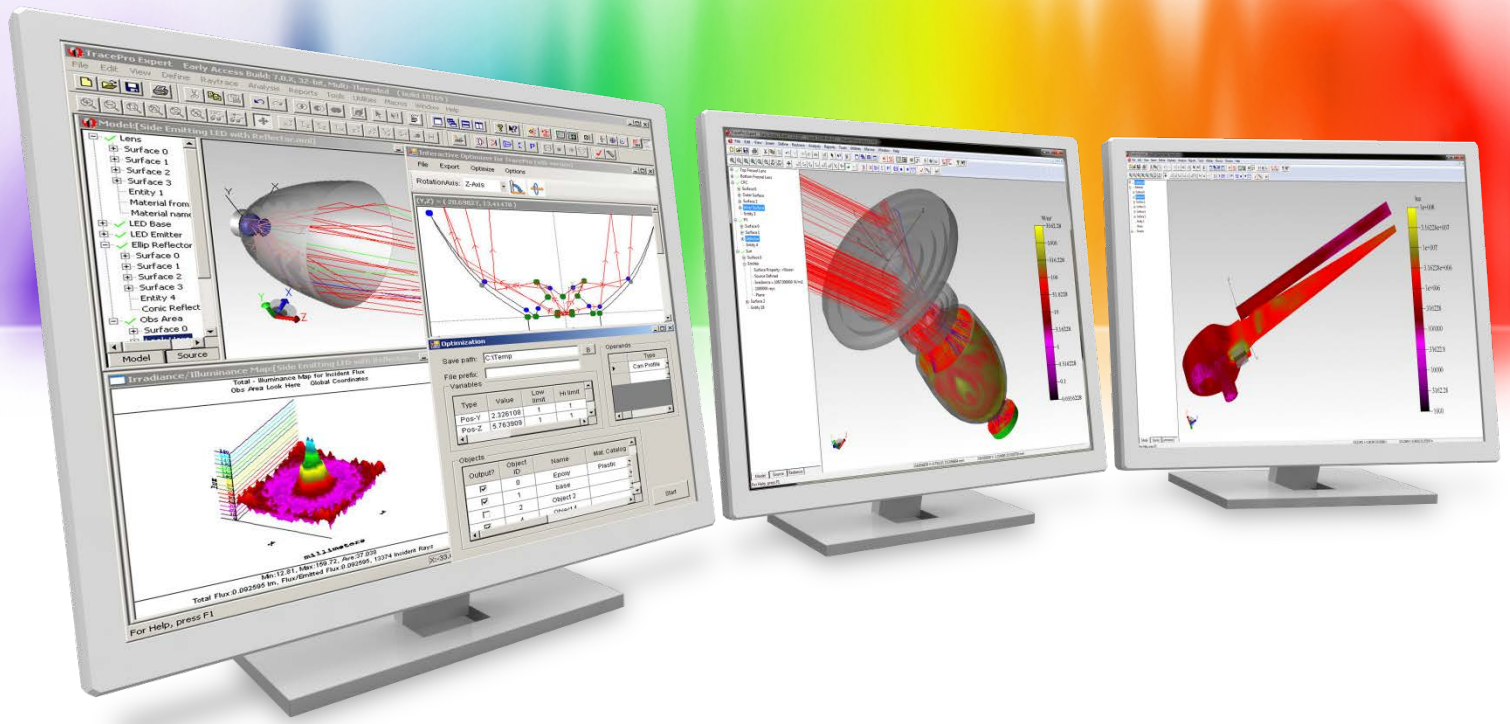


Analysis->Luminance/Radiance Map Options

- Sets the options for the Luminance/Radiance Map
- Can also be accessed by right clicking in the display window and selecting Luminance Map Options or Radiance Map Options



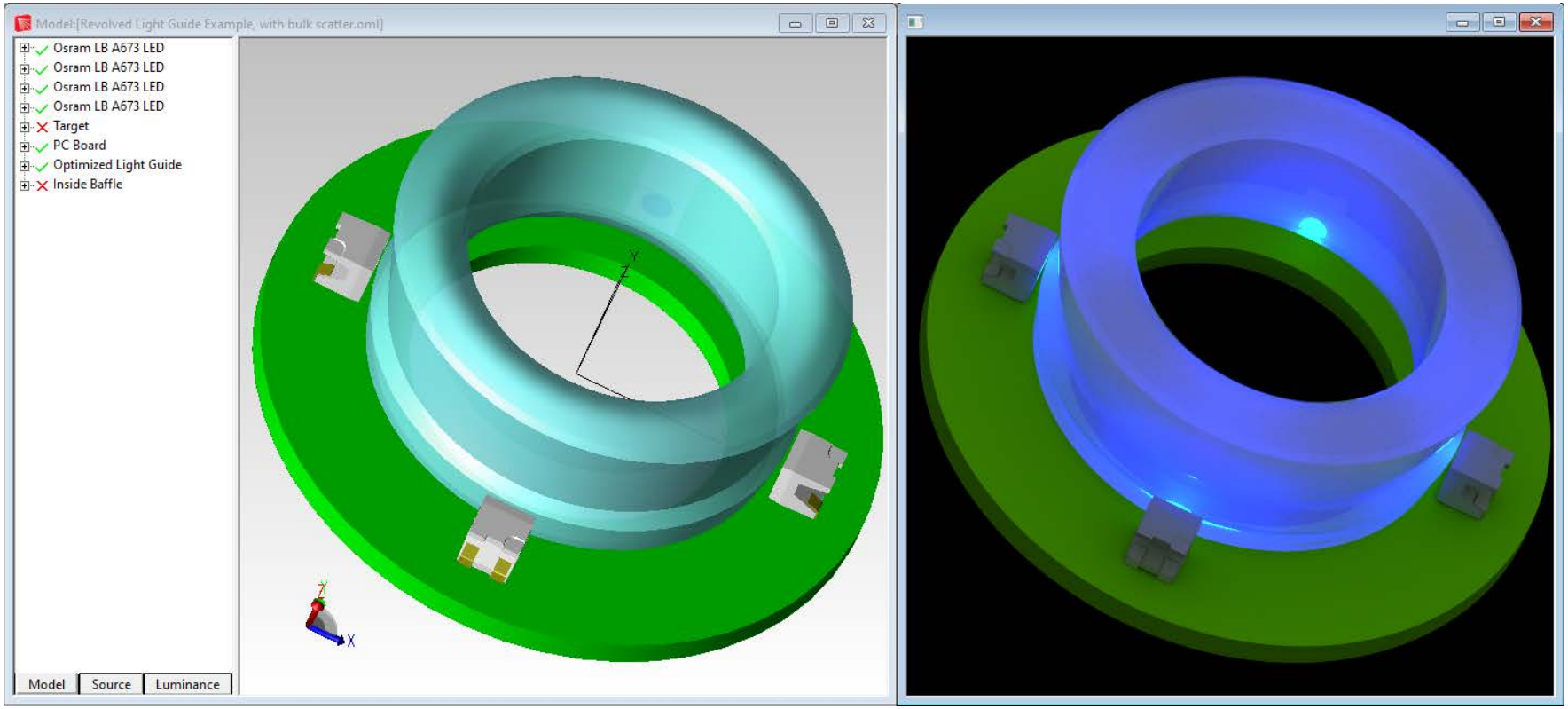
TracePro



Examples

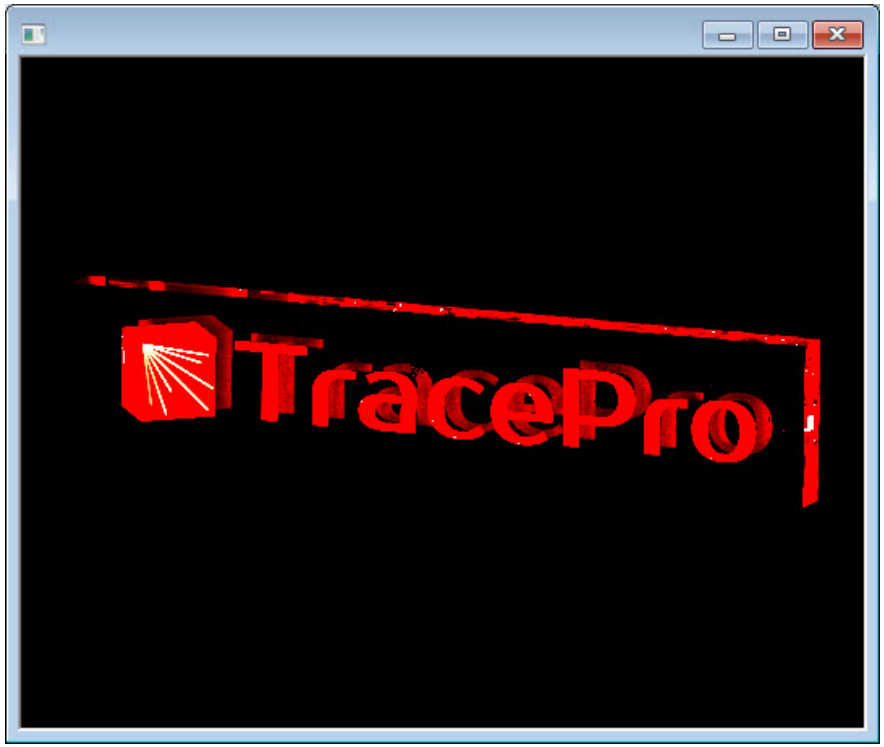
LAMBDA RESEARCH CORPORATION

Light Guide with bulk scatter property

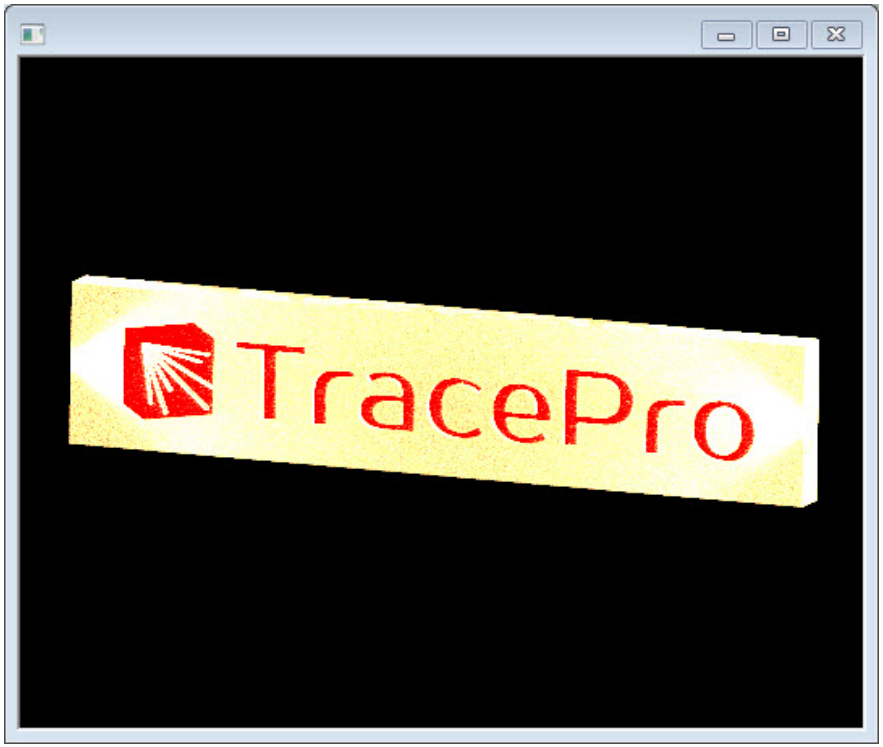


Speedometer example

Light Guide with and without bulk scatter property

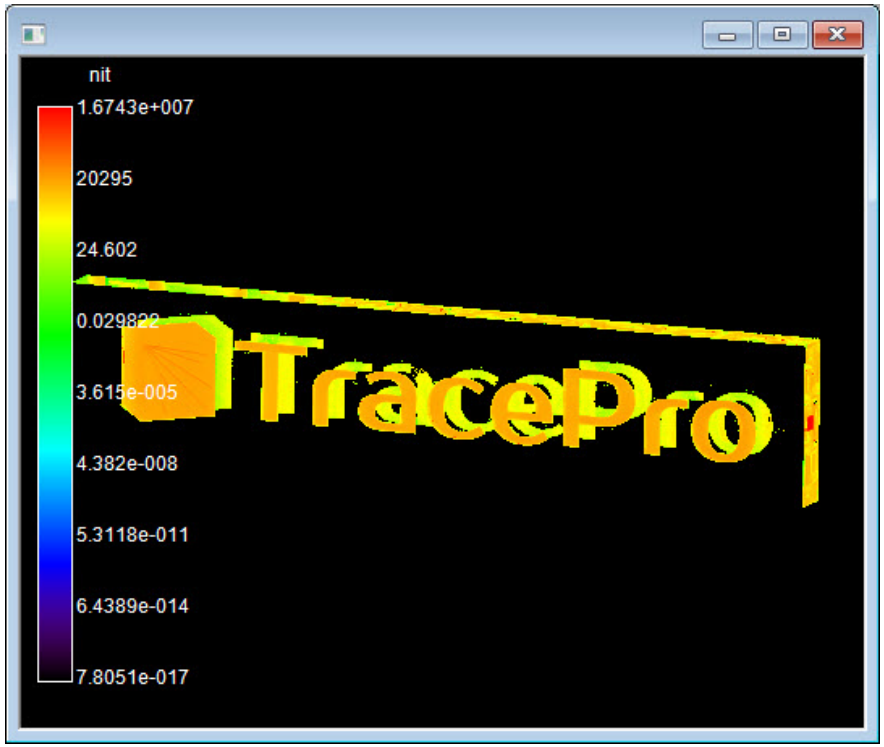


No bulk scatter property

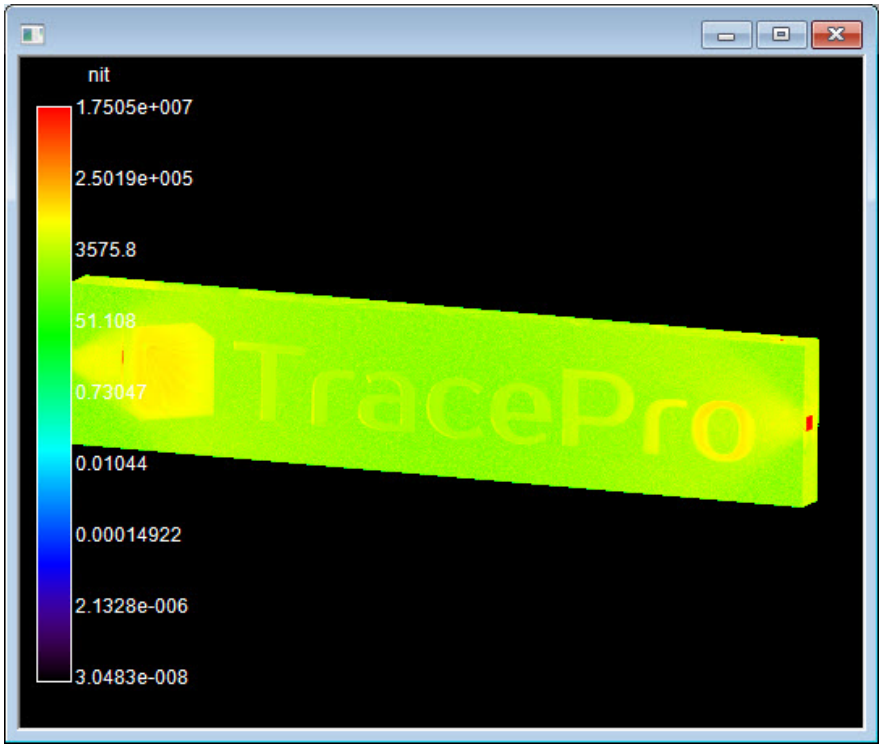


With bulk scatter property

Light Guide with and without bulk scatter property

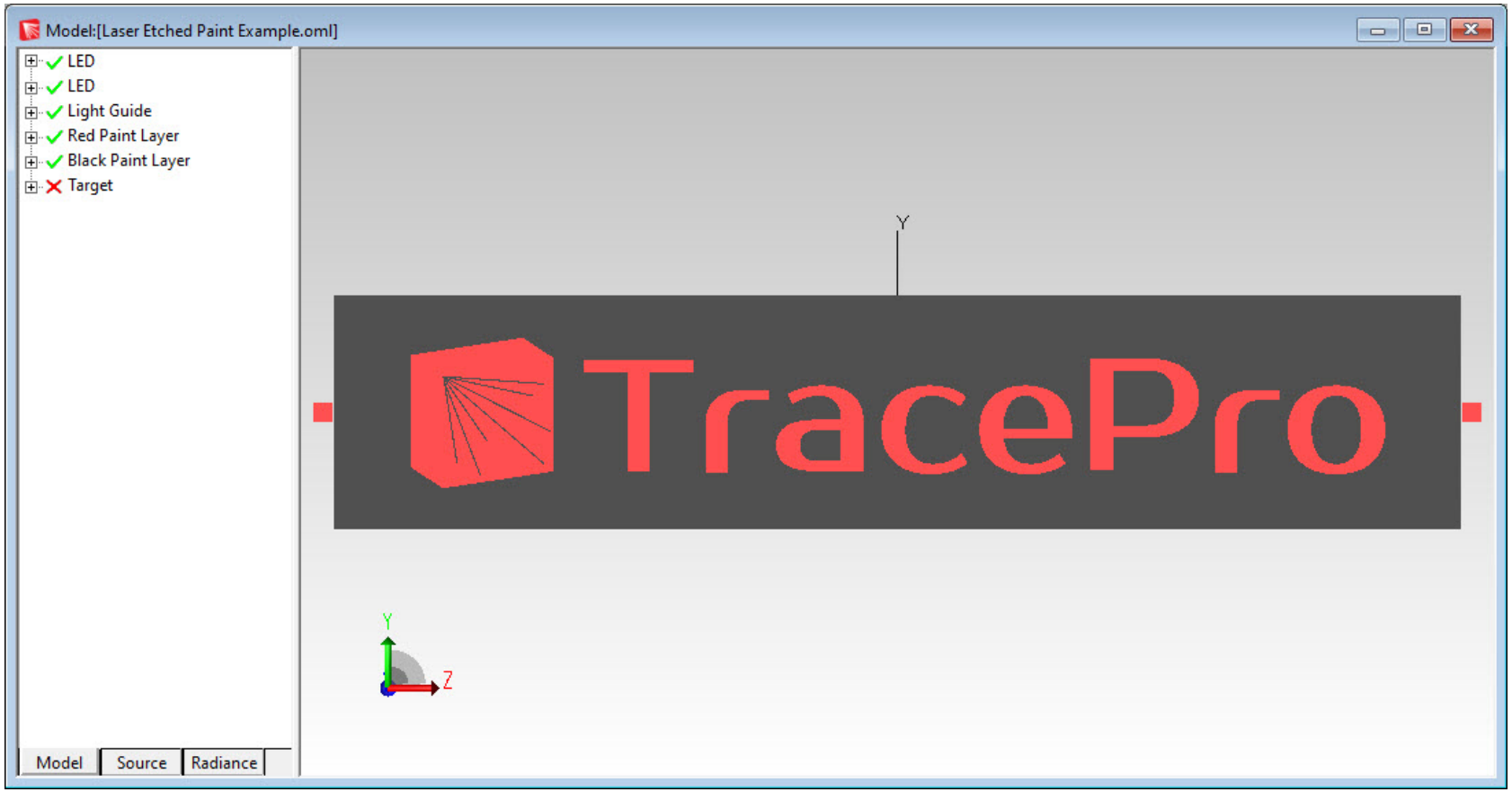


No bulk scatter property



With bulk scatter property

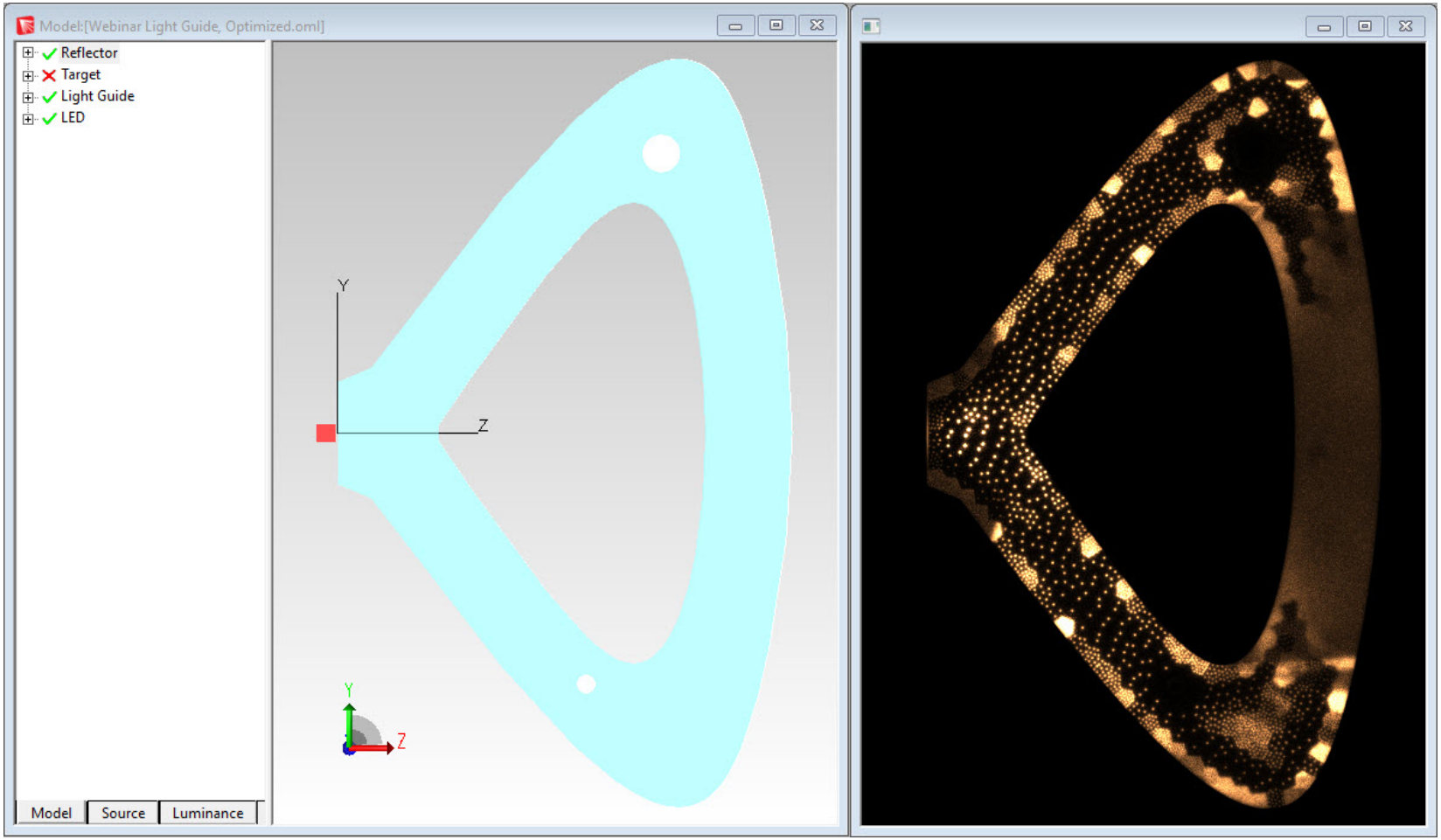
Laser etched paint example



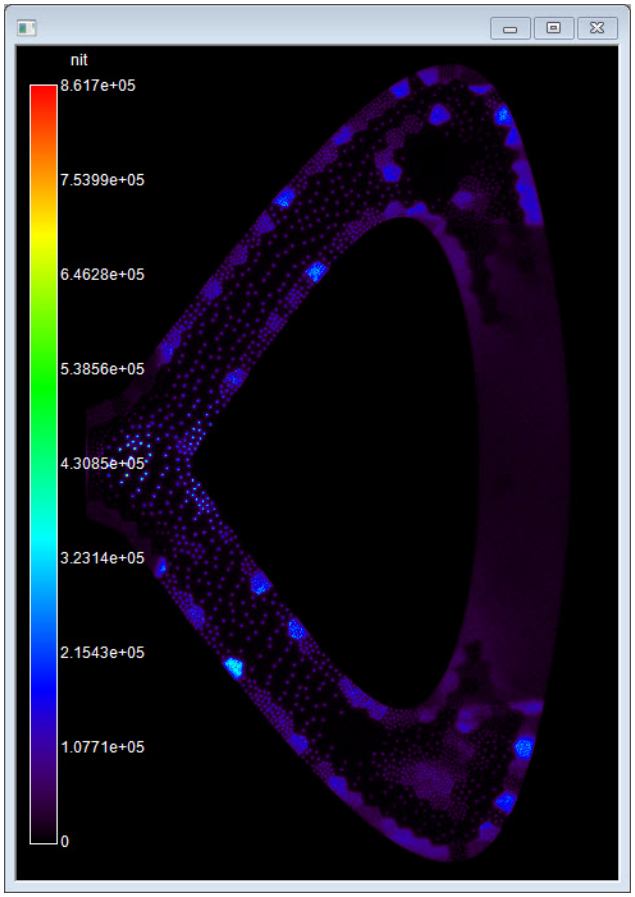
Laser etched paint example

Laser etched paint example

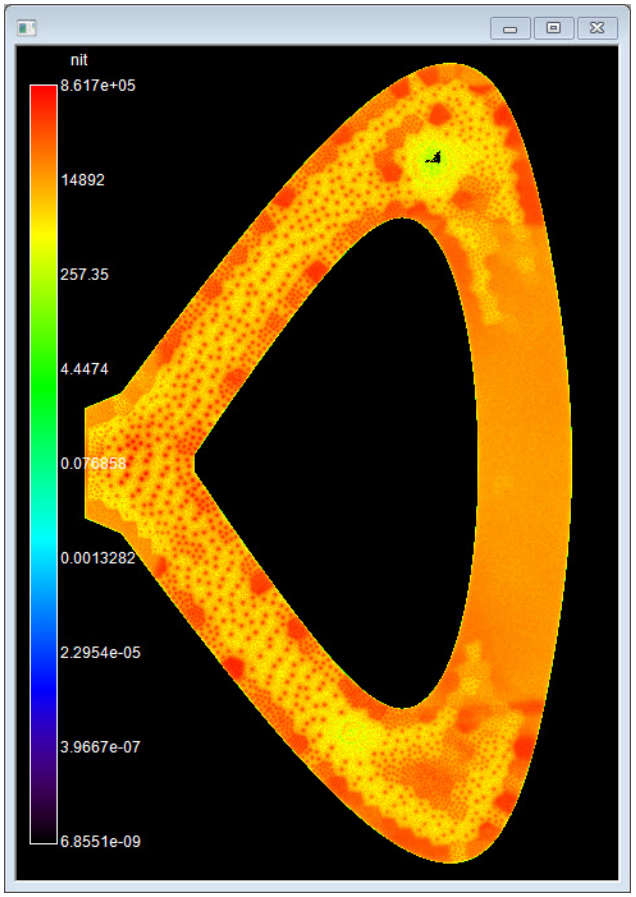
Backlight example



Backlight example

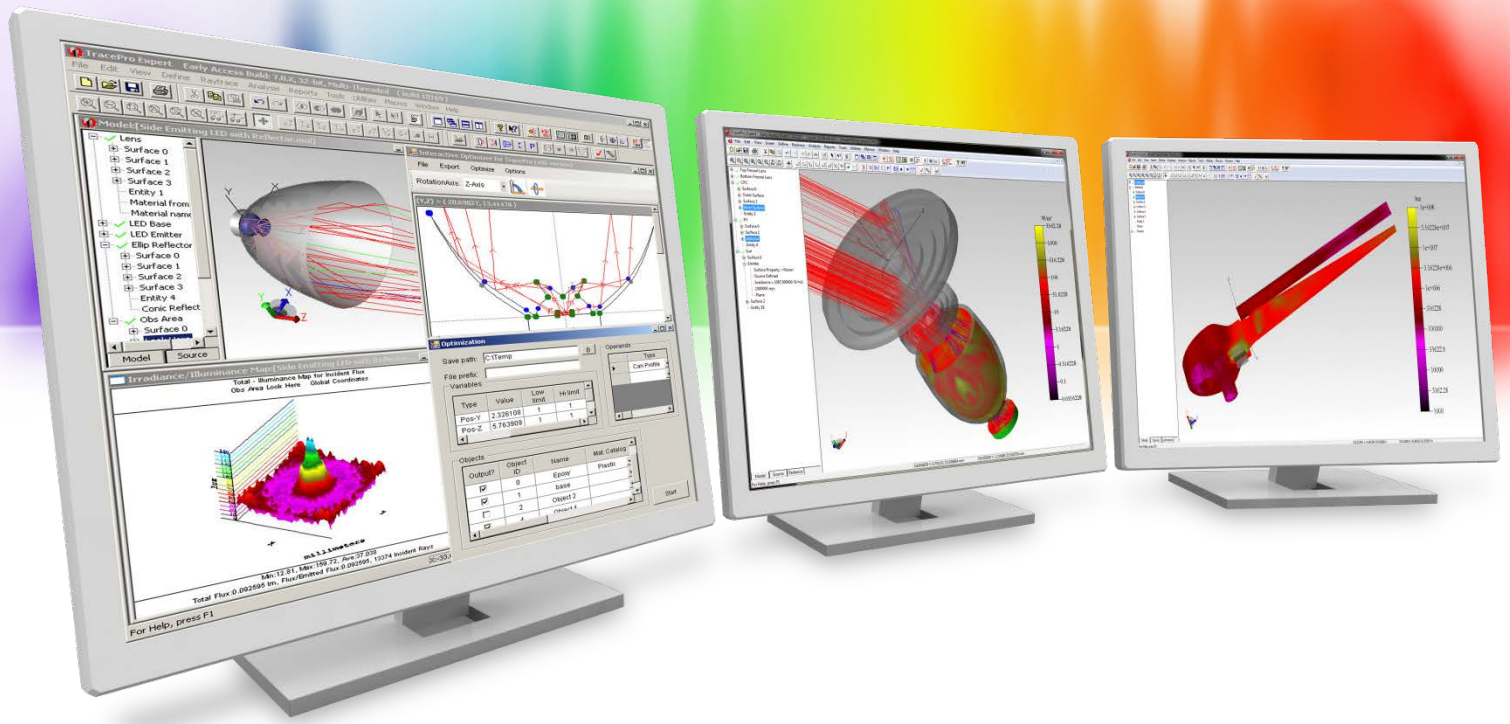


Luminance – linear scale



Luminance – log scale

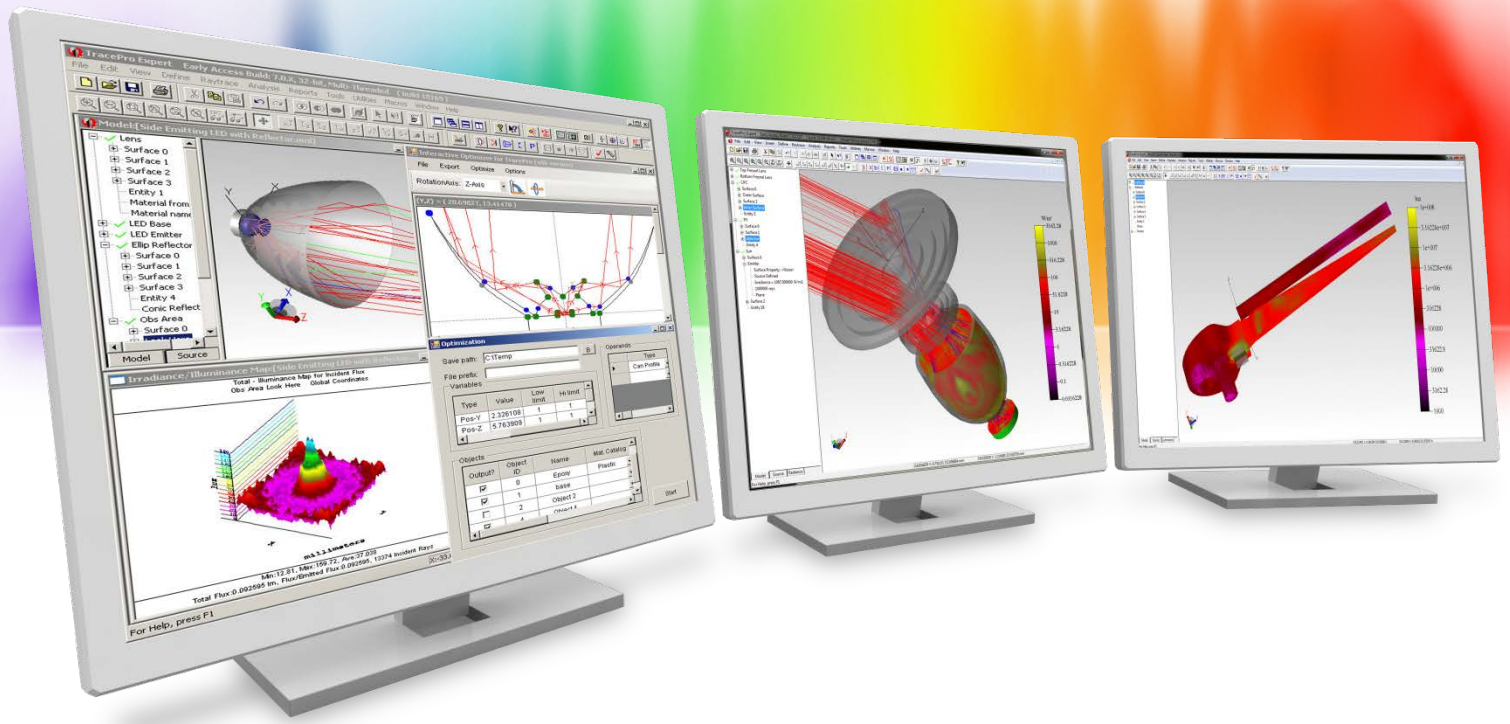
TracePro



Live Demo

LAMBDA RESEARCH CORPORATION

TracePro



Summary and Questions

LAMBDA RESEARCH CORPORATION

Precautions

- Don’t leave a Perfect Absorber between the eye position and the target!
- Start with a small window size or large pixels and a low number of rays/photons to make sure all settings are correct
- Once the initial results look good, increase the window size and number of rays and decrease the pixel size for better resolution
- Watch out for luminance/radiance values that may exceed the dynamic range of the Luminance/Radiance Map
- Turn off Windows Update if you are running a really long rendering, luminance, or radiance
- Don’t leave a Perfect Absorber between the eye position and the target!

Summary and Questions

- ✓ Luminance, radiance, and photorealistic rendering simulations are an important part of many types of designs including light guides, backlights, and displays
- ✓ TracePro has several tools for luminance, radiance, and photorealistic rendering raytracing
- ✓ These tools are easy to set-up and use

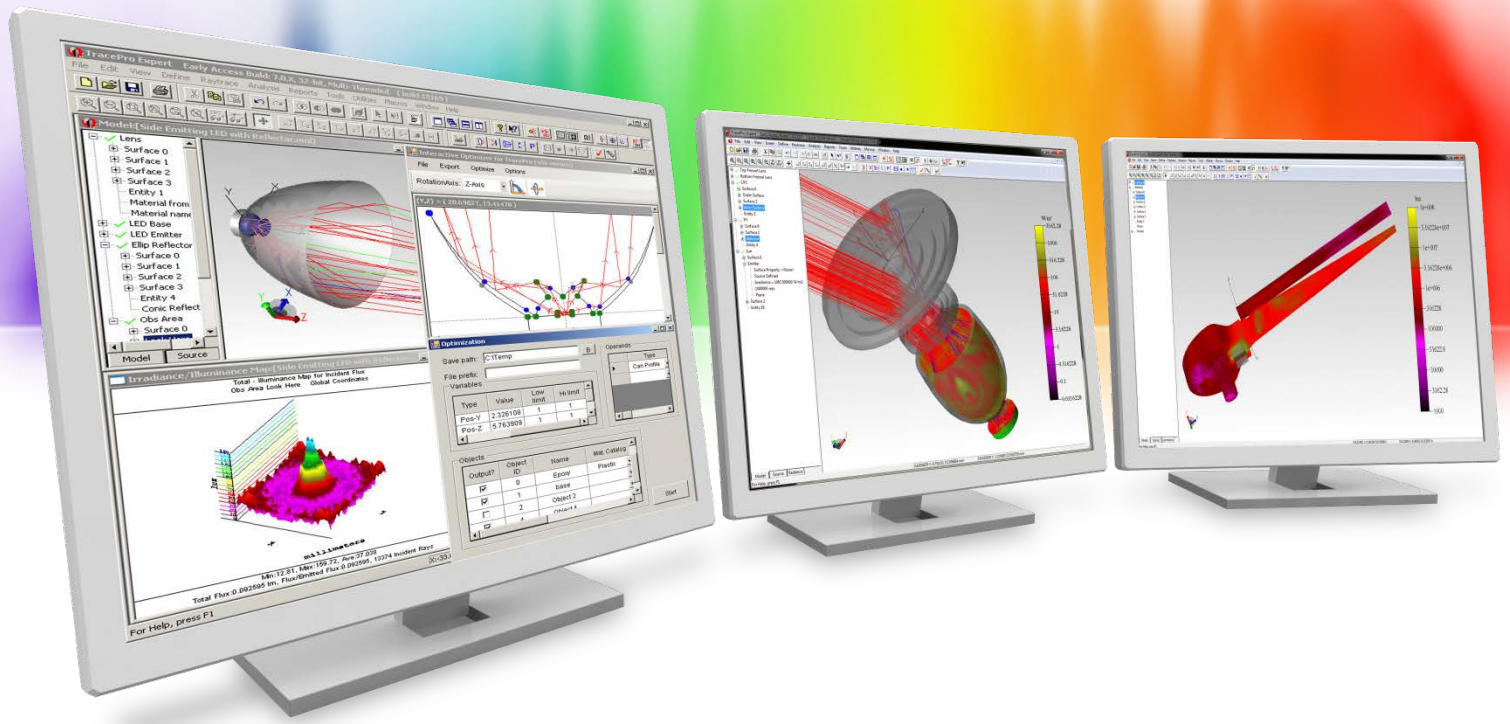
For more information or for a free 14-day trial for qualified users, please contact us at:

www.lambdares.com

Phone: +1 978-486-0766
E-mail: sales@lambdares.com

TracePro

TracePro



Thank You!

LAMBDA RESEARCH CORPORATION