DESIGNING A SIMPLE OPTICAL SYSTEM IN LIGHTTOOLS

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WHAT IS LIGHTTOOLS

LightTools is a 3D optical design software that supports virtual prototyping, simulation, optimization, and photorealistic renderings of illumination applications. This is a non-sequential software that allows to create and modify illumination system designs and allows for further optimization [1].

Free for Op-Sci students!!!!

LightTools®

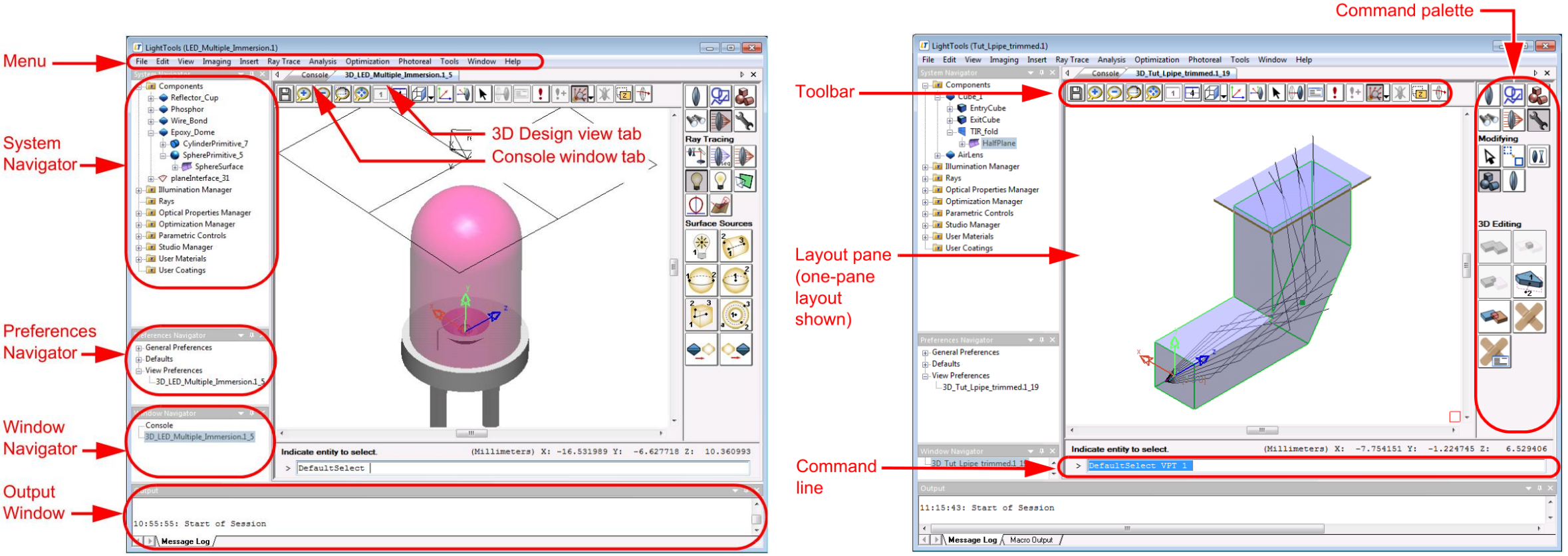
LightTools(64) 8.3
Copyright (c) 1994-2015 Synopsys, Inc.
Build: 2015.06.29.2246.580928 [x64]

SEQUENTIAL VS NON-SEQUENTIAL RAYTRACING

Key differences between these modes [2] are:

- Sequential raytracing
  - Mainly used for designing imaging and afocal systems
  - Rays only intersect each surface once and they follow specified sequential order
  - Each surface has its own local coordinate system
- Non-sequential raytracing
  - Primarily used for non-imaging applications
  - A ray can intersect the same object more than once and in multiple order
  - Each object is referenced to a global coordinate
  - Partially reflected rays can be generated and traced from a refractive interface, in addition to tracing the refracted ray

LIGHTTOOLS INTERFACE ELEMENTS



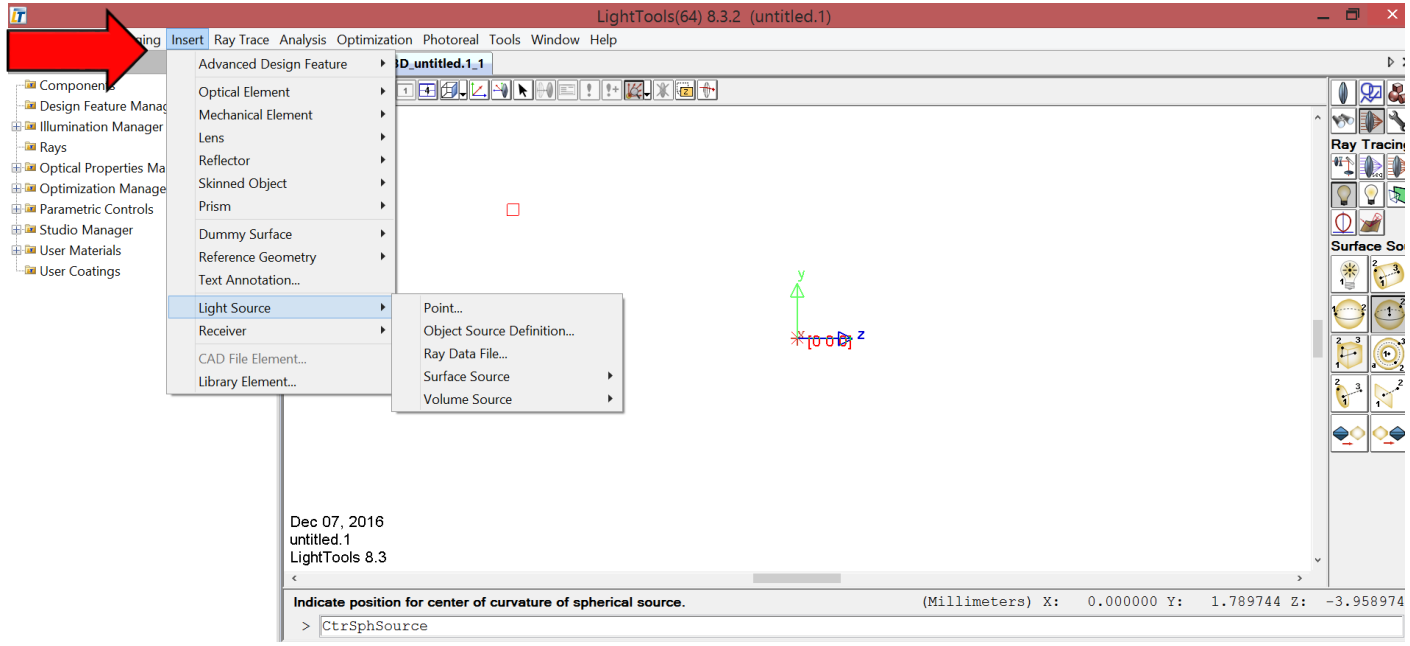
Menus and tabs in LightTools, image taken from LightTools tutorial documentation [3]

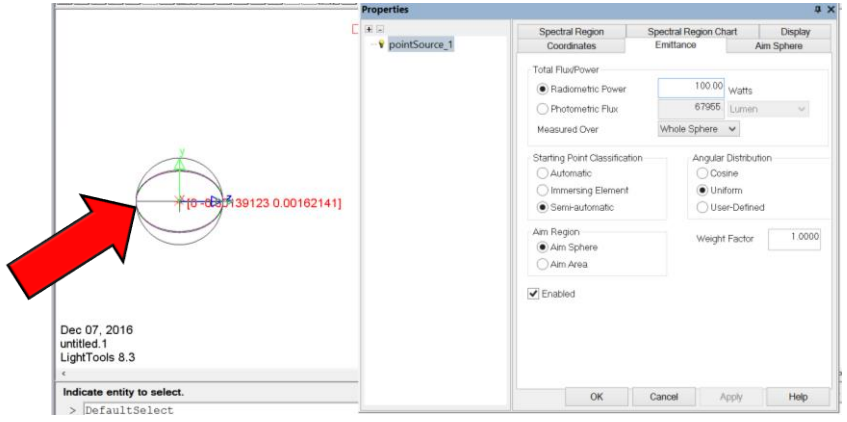
BASIC OPTICAL SETUP

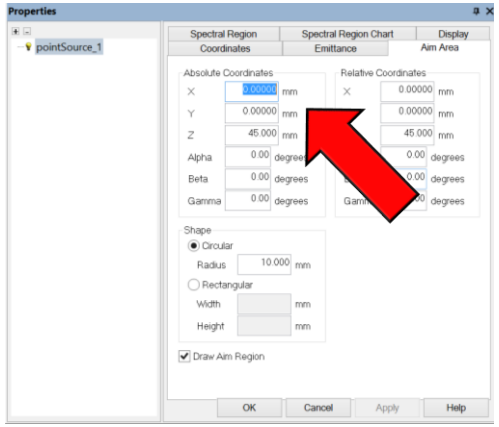
In order to ray trace in LightTools you need to have at the very least a source and a receiver. The optical elements (lenses, prisms, mirrors, etc) can be placed anywhere regardless of the detector and source direction and position.

I will demonstrate how to use a plano-convex lens to collimate light from a point source and learn how to analyze the collimation with a detector.

INSERTING THE SOURCE

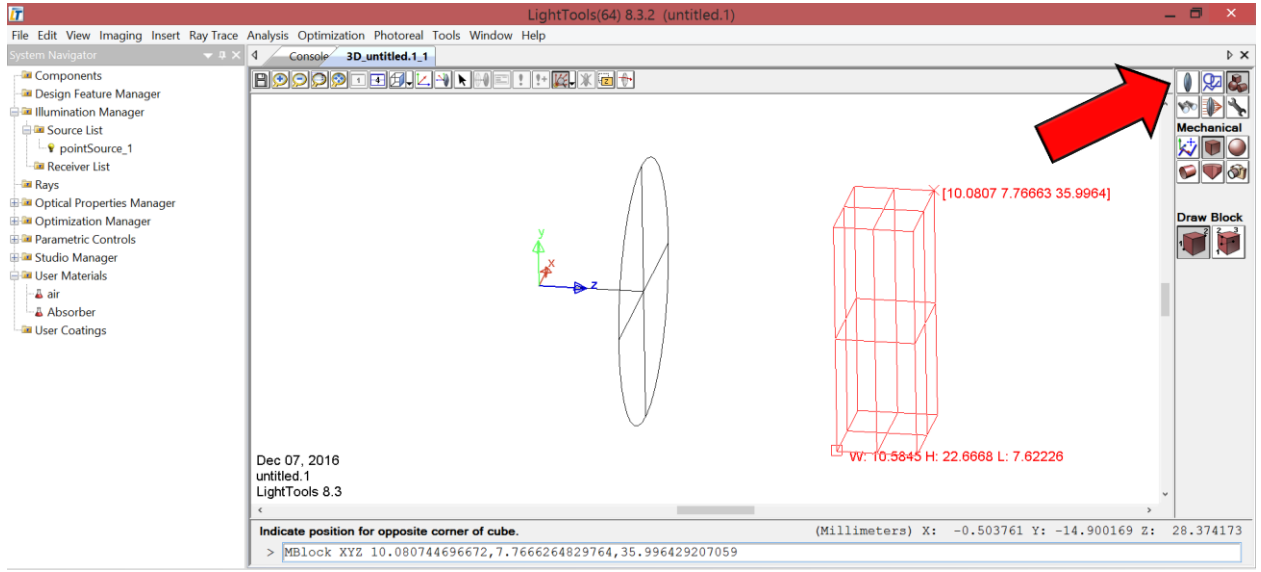


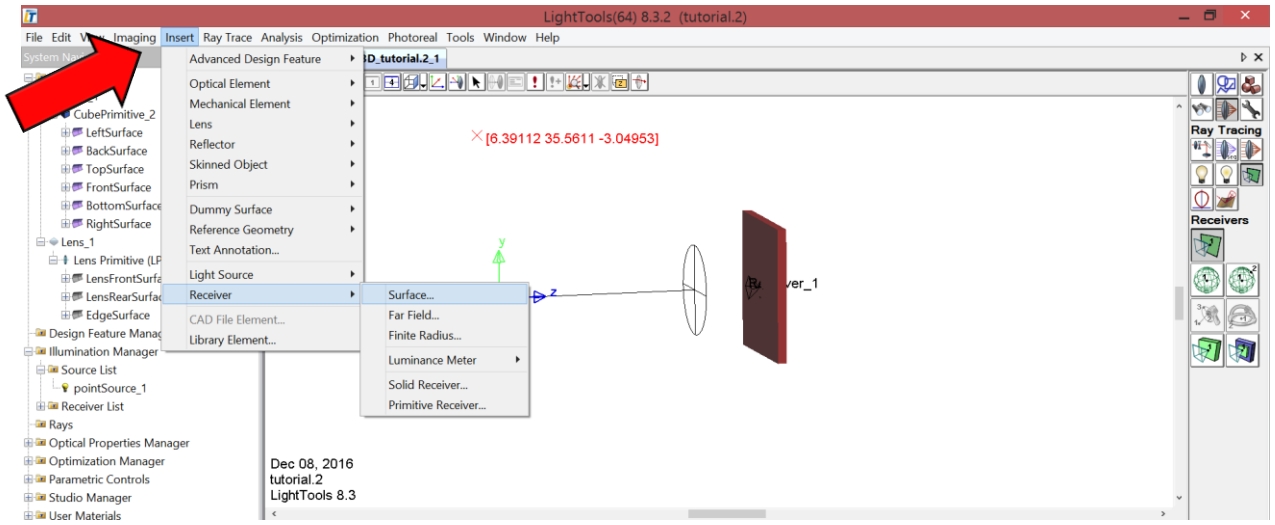




- The easiest way to create a source is to use the *insert* tab and click in *Light Source* from the main top menu. This will open another tab which contains several options to create a source, depending in your needs.

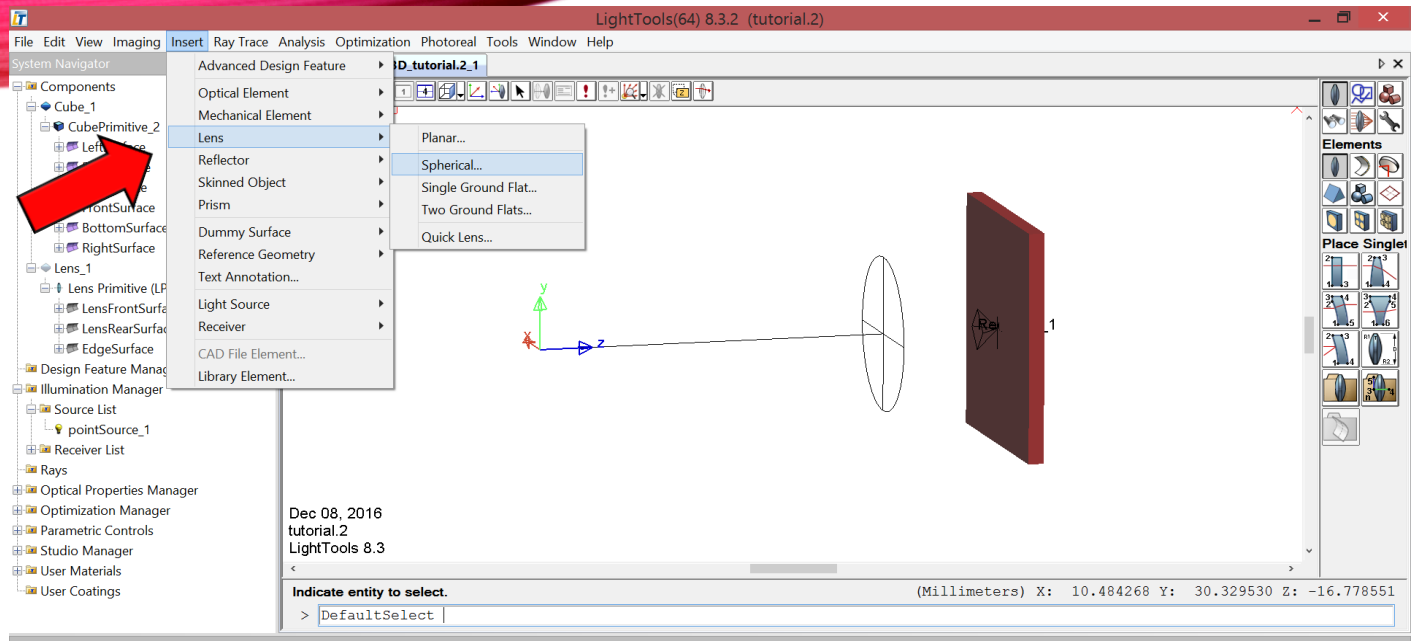
INSERTING THE RECEIVER

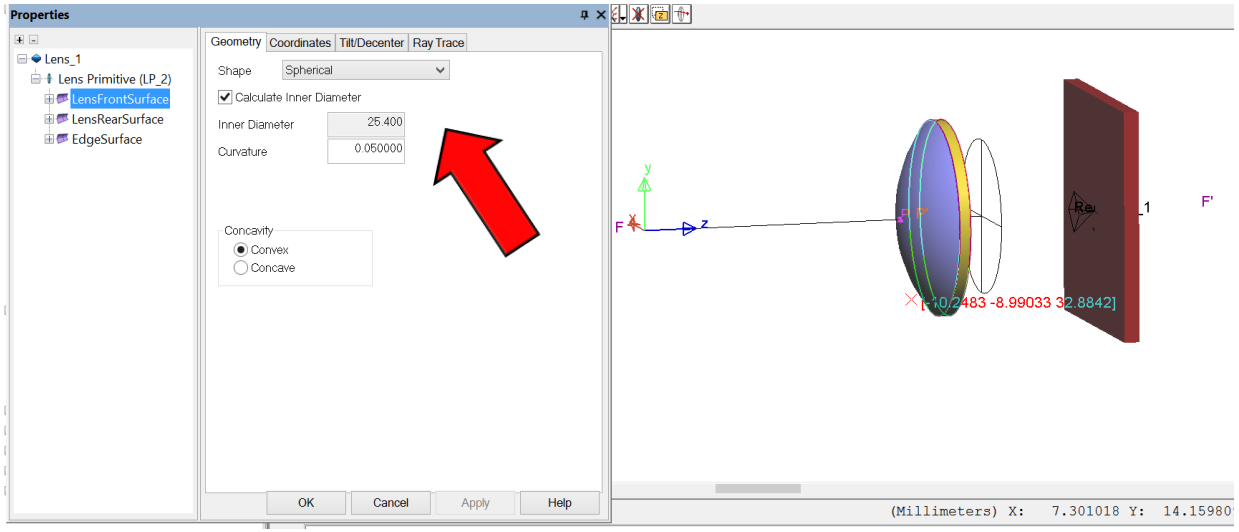




- There are multiple ways to create a detector. A common way is to create a solid object and then add a detector on one of its surfaces.

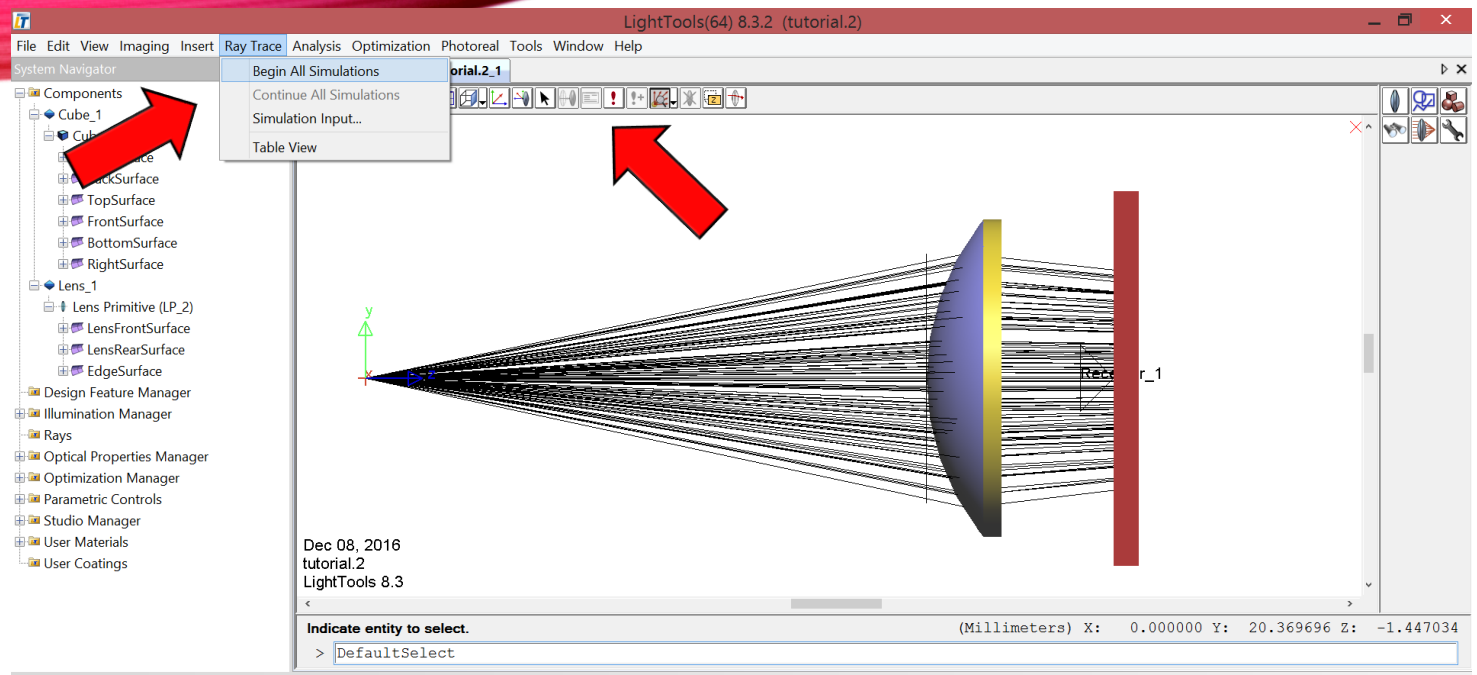
CREATING A LENS

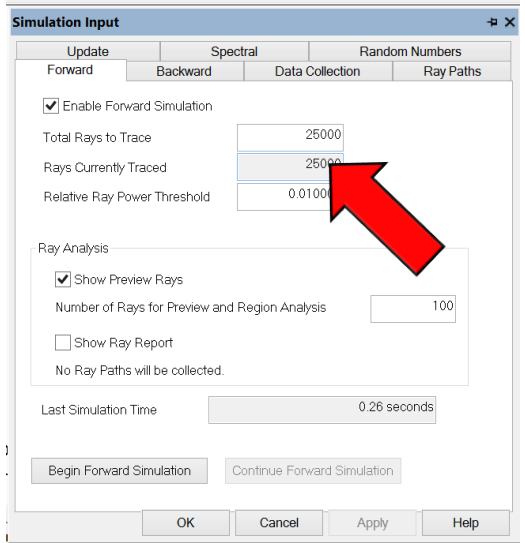




- Select the *Lens* option from the *Insert* tab to create an ideal plano-convex lens.
- By default, the lens material is NBK7 and can be changed in the *Material* tab.
- By changing the curvature, diameter, and thickness, the focal length and principal planes will be calculated automatically.

RAYTRACING

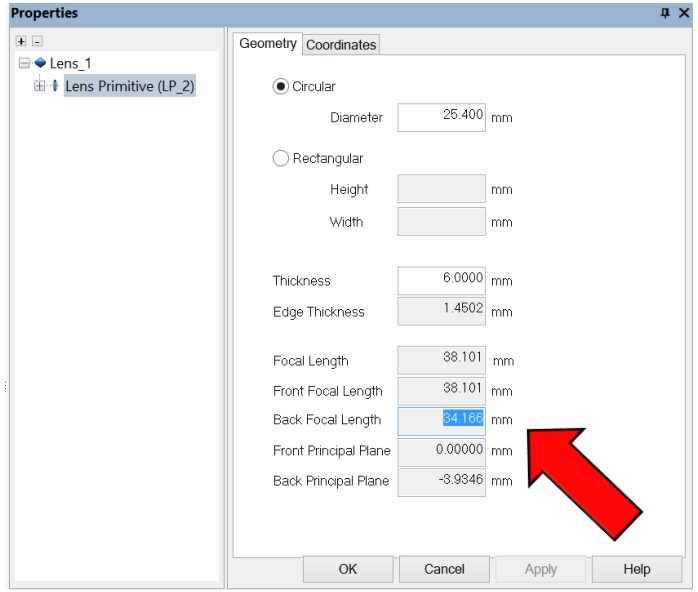


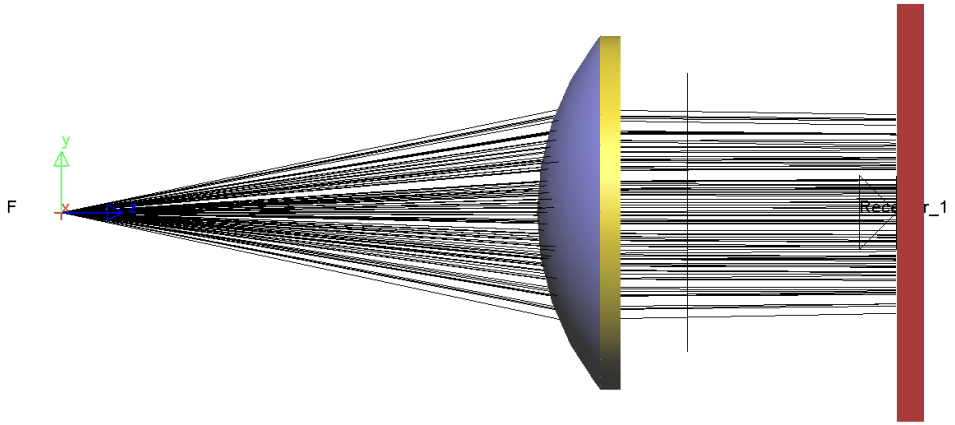


- Select *Ray Trace* tab and select *Begin All Simulations*. This will show your point source generating rays towards your square detector.
- If you need to increase the number of rays trace/shown, click on *Simulation Input* instead and modify the forward simulation as needed. When you finish, click on Begin Forward Simulation to start ray trace.

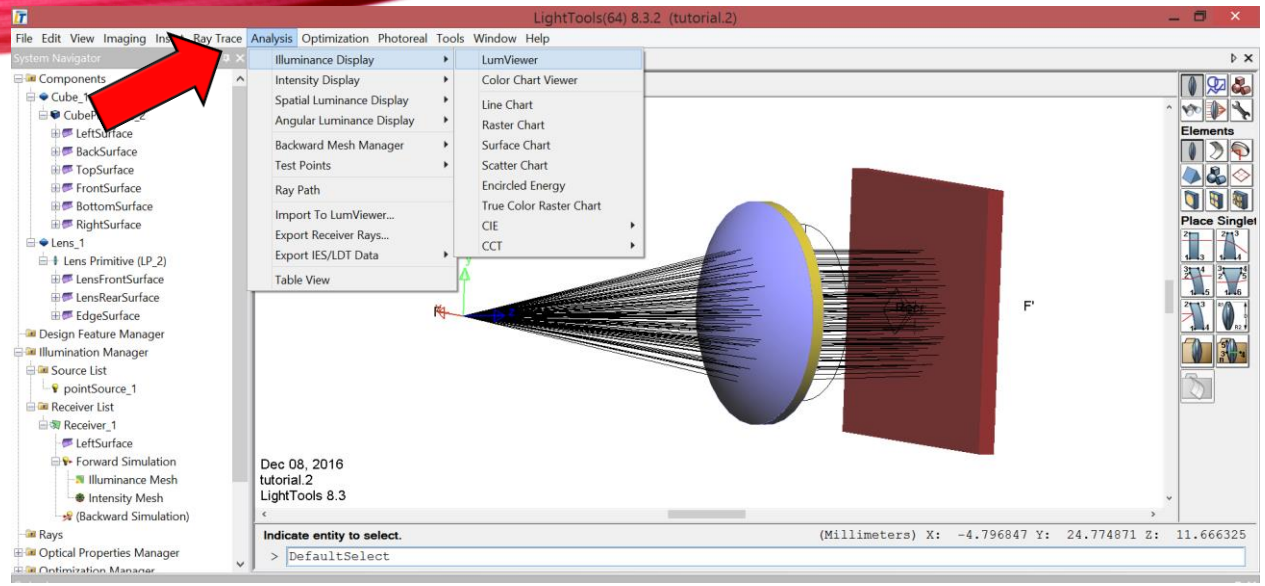
COLLIMATING THE LIGHT SOURCE

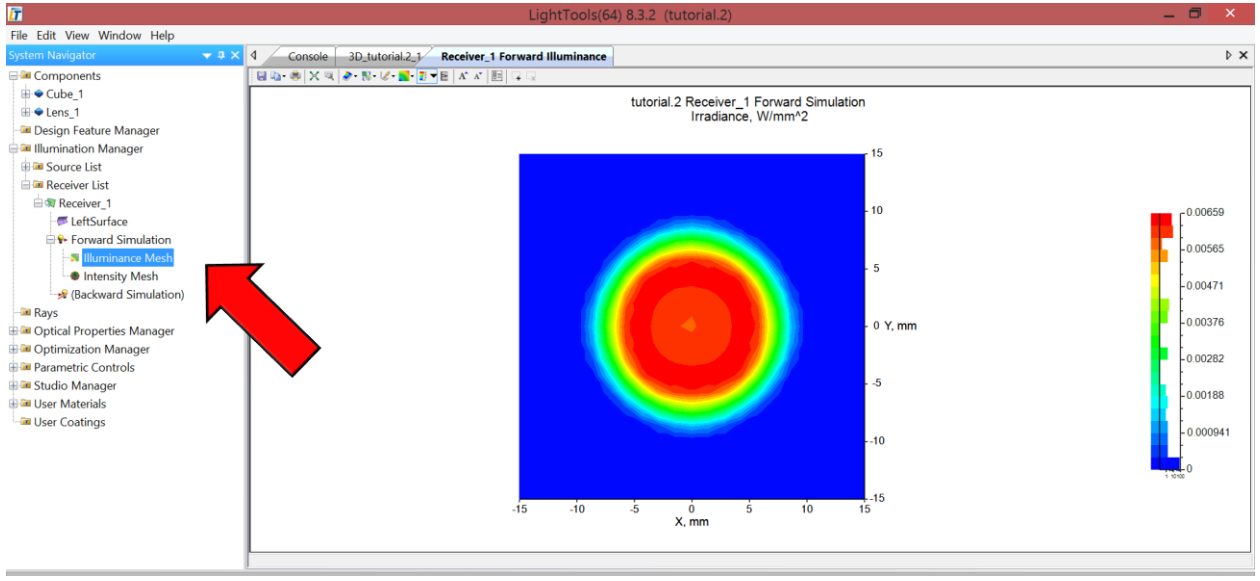
- In the Simulation Window you will see that light is not fully collimated. This occur because the light source is not placed in the back focal length (BFL) of the lens. In order to improve collimation you can copy the BFL from the lens property windows and change the z-axis position of the lens to match this number.





DETECTOR ANALYSIS

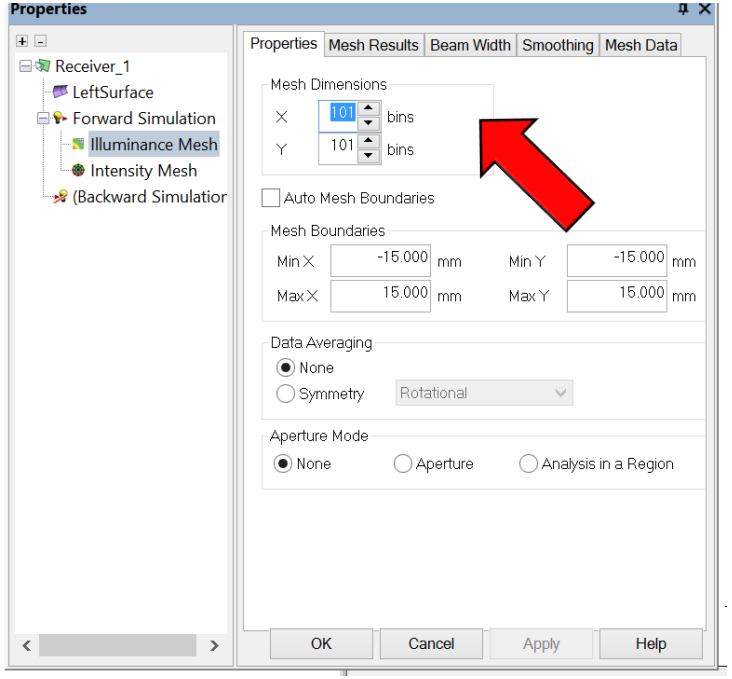


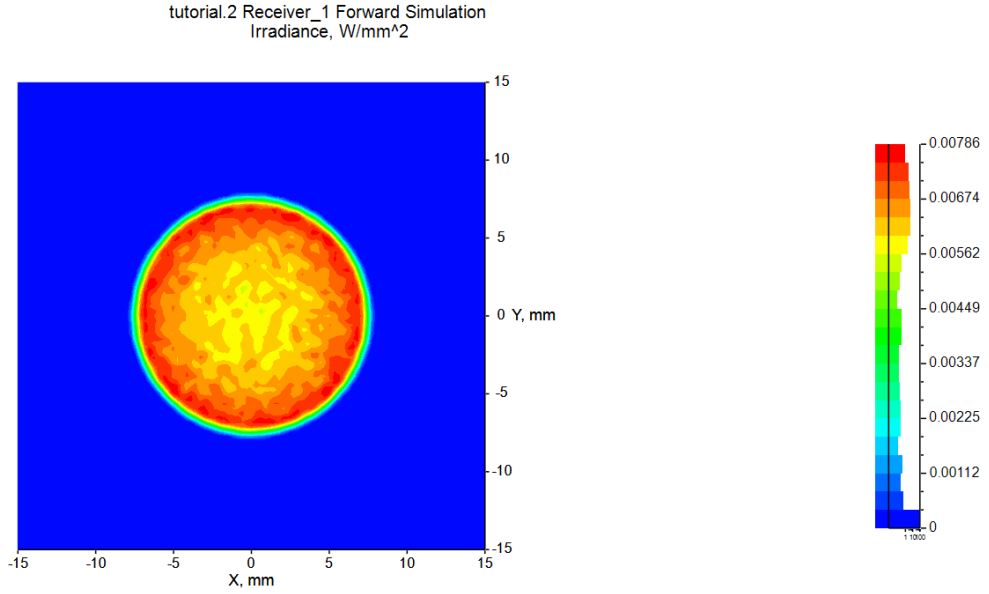


- Click on the Analysis tab and select the Illuminance Display, then select the LumViewer.
- Since there is only one receiver in your optical design the LumViewer will automatically display the measured irradiance from the receiver that you designed.

INCREASING RESOLUTION

- You can improve the resolution by increasing the number of bins. This will allow you to observe more features. Notice that a large number of bins requires a higher number of traced rays as noise starts being more noticeable.





QUESTIONS???

References

[1] LightTools Features https://optics.synopsys.com/lighttools/lighttools-feature-details.html

[2] Exploring Non-Sequential Mode in OpticStudio
https://www.zemax.com/os/resources/learn/knowledgebase/exploring-non-sequential-mode-in-zemax

[3] LightTools Introductory Tutorial - Version 8.3 June 2015