

UseCase.0081 (1.0)

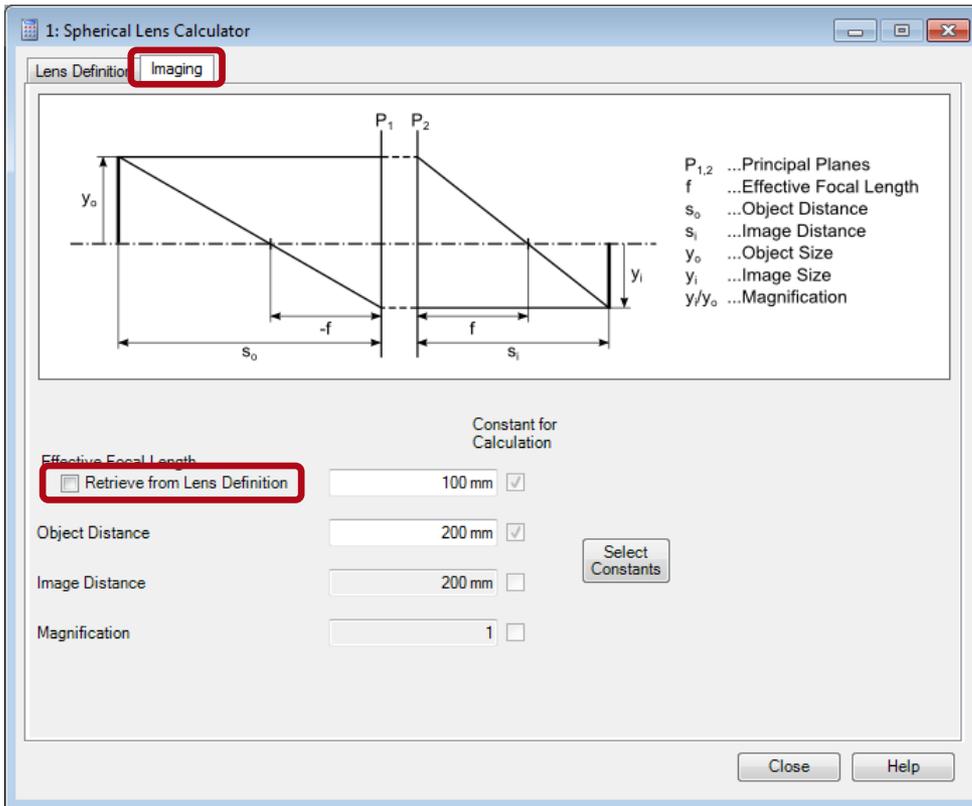
Spherical Lens Calculator

Keywords: spherical lens, paraxial, lens maker's equation, imaging equation, focal length, principal planes, curvature radius, design wavelength

Description

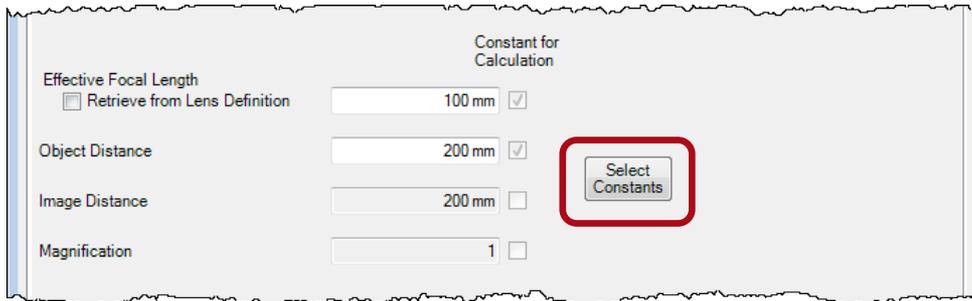
- This use case demonstrates how to use the calculator for spherical lenses.
- Especially, the workflow of using the calculator with the spherical lens component is shown.

Determining the Focal Length I



- The “Imaging” page of the Spherical Lens Calculator shows the relations of focal length, object distance, image distance, and magnification.
- At first, we don’t want to retrieve the focal length from the “Lens Definition” page, so this checkbox has to be unchecked.

Determining the Focal Length II



Constant for Calculation

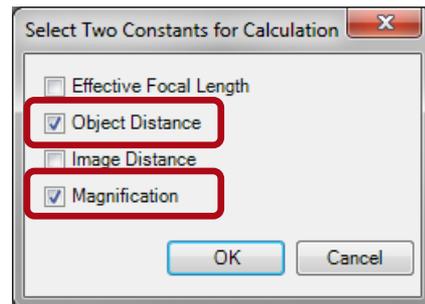
Effective Focal Length
 Retrieve from Lens Definition 100 mm

Object Distance 200 mm

Image Distance 200 mm

Magnification 1

Select Constants



Select Two Constants for Calculation

Effective Focal Length

Object Distance

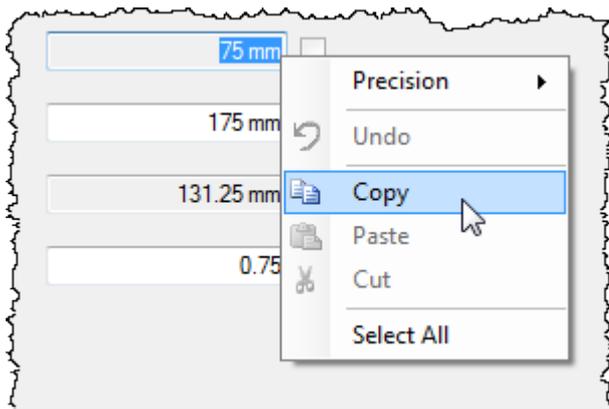
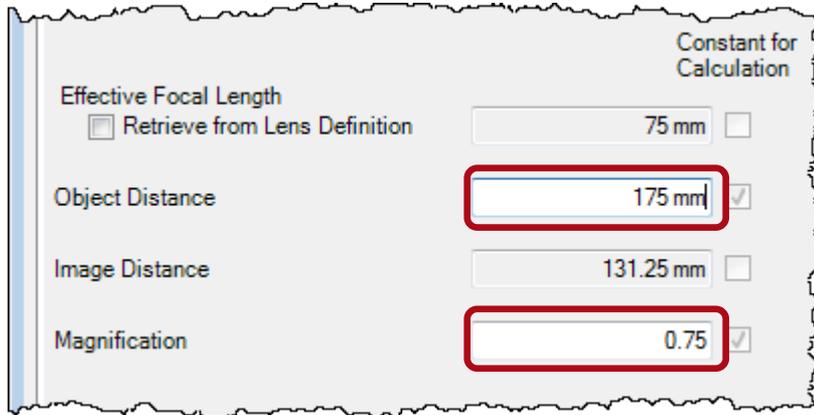
Image Distance

Magnification

OK Cancel

- Pressing “Select Constants” allows the user to determine the constants and the variables in the equations.
- We choose “Object Distance” as well as “Magnification” in the dialog.

Determining the Focal Length III



- When an *object distance* of 175mm and a *magnification* of 0.75 have been entered, the resulting values for the effective focal length and the image distance are shown immediately.
- We copy the new value for the focal length to the clipboard.

Determining the Curvature Radius I

- The “Lens Definition” page allows the user to apply the lens maker’s equation practically.
- The lower part of the page gives the values for several characteristic distances of the lens for a certain “Design Wavelength”.

1: Spherical Lens Calculator

Lens Definition Imaging

$V_{1,2}$...Vertices of the surfaces
 $P_{1,2}$...Principal Points
 $F_{1,2}$...Focal Points
 t_c ...Center Thickness
 f ...Effective Focal Length
 $f_{v1,v2}$...Front/Back Focal Length
 e ...Distance: Principal Points to Each Other
 V_1P_1 ...Distance: Front Vertex to Front Principal Point
 V_2P_2 ...Distance: Back Vertex to Back Principal Point

Refractive Indices Geometry

Surrounding Medium
Standard Air in Homogeneous Medium
Refractive Index of Surrounding Medium
1.000273447

Lens Medium
N-BK7 in Homogeneous Medium
Refractive Index of Lens Medium
1.519896139

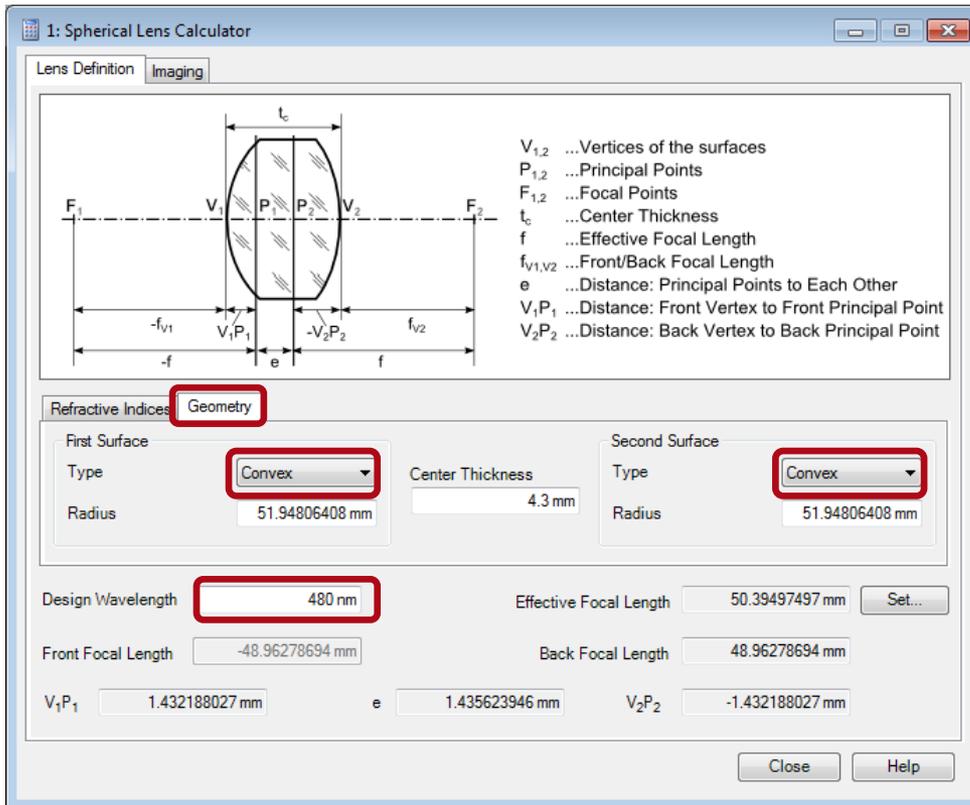
Design Wavelength 532 nm Effective Focal Length 100 mm Set...

Front Focal Length -97.1700857 mm Back Focal Length 100 mm

V_1P_1 2.829914304 mm e 1.470085696 mm V_2P_2 0 m

Close Help

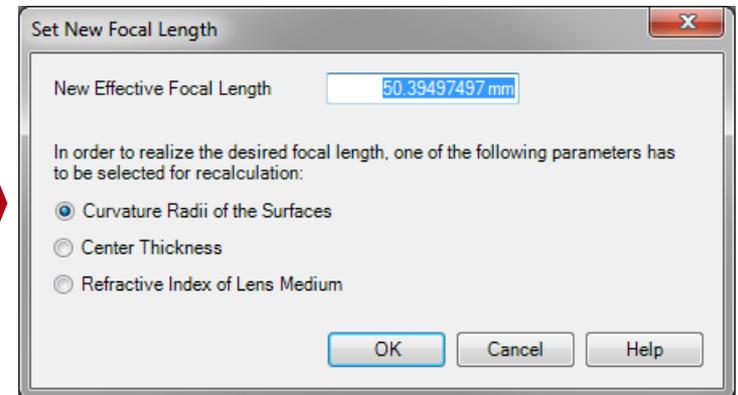
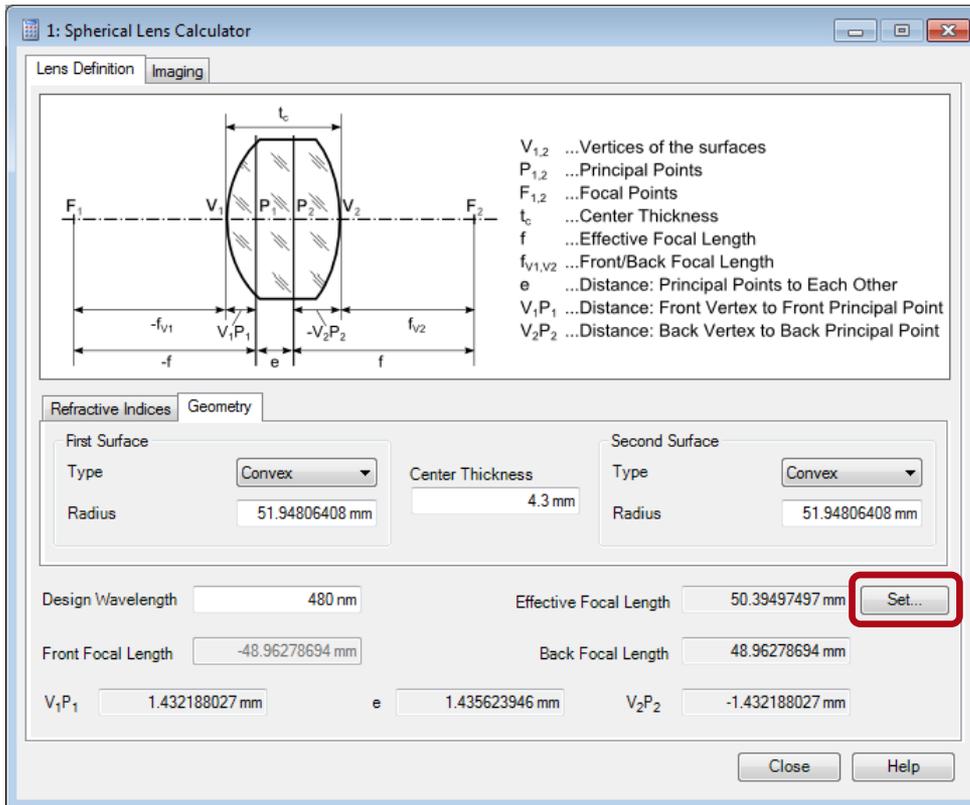
Determining the Curvature Radius II



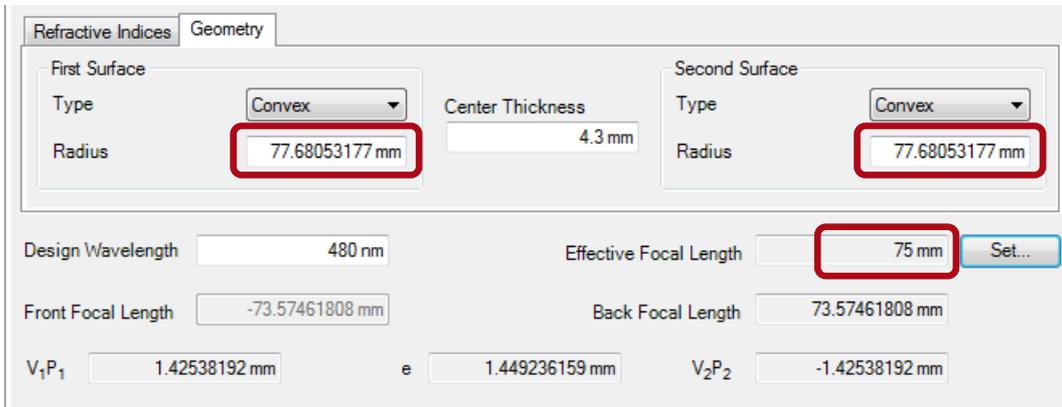
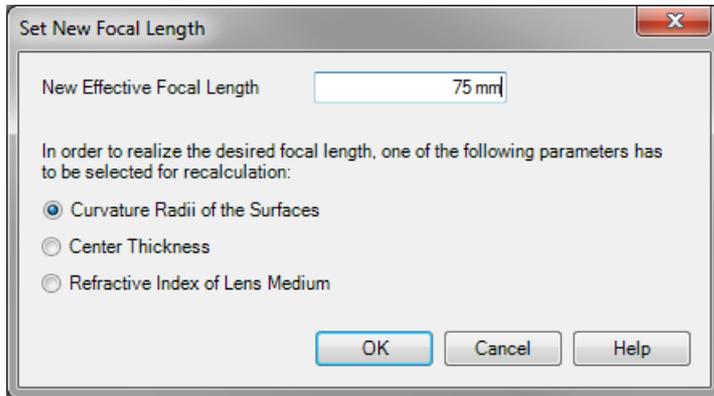
- Now we want to calculate the curvature radii of a biconvex lens which realizes the magnification for a given object distance as calculated before.
- For that purpose, we switch to the “Geometry” panel, set both surface types to “convex” and enter a new design wavelength of 480nm.

Determining the Curvature Radius III

Pressing the “Set...” button near to the focal length textbox will open a dialog.

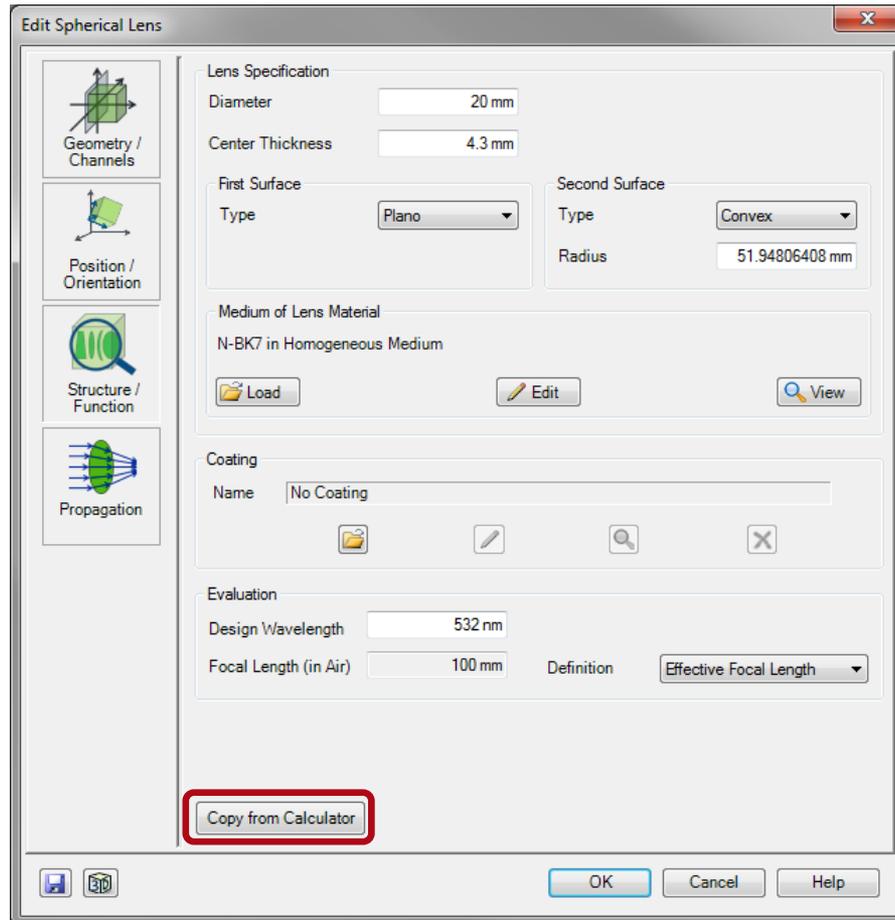


Determining the Curvature Radius IV

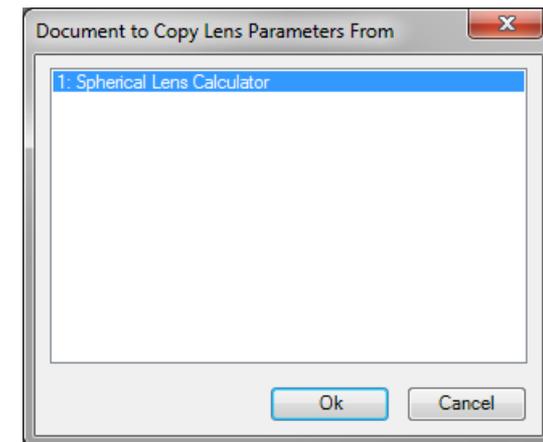


- We paste the previously calculated effective focal length and keep the selection “Curvature Radii of the Surfaces”.
- After closing the dialog via “OK”, the new curvature radii are calculated, resulting in the desired focal length.

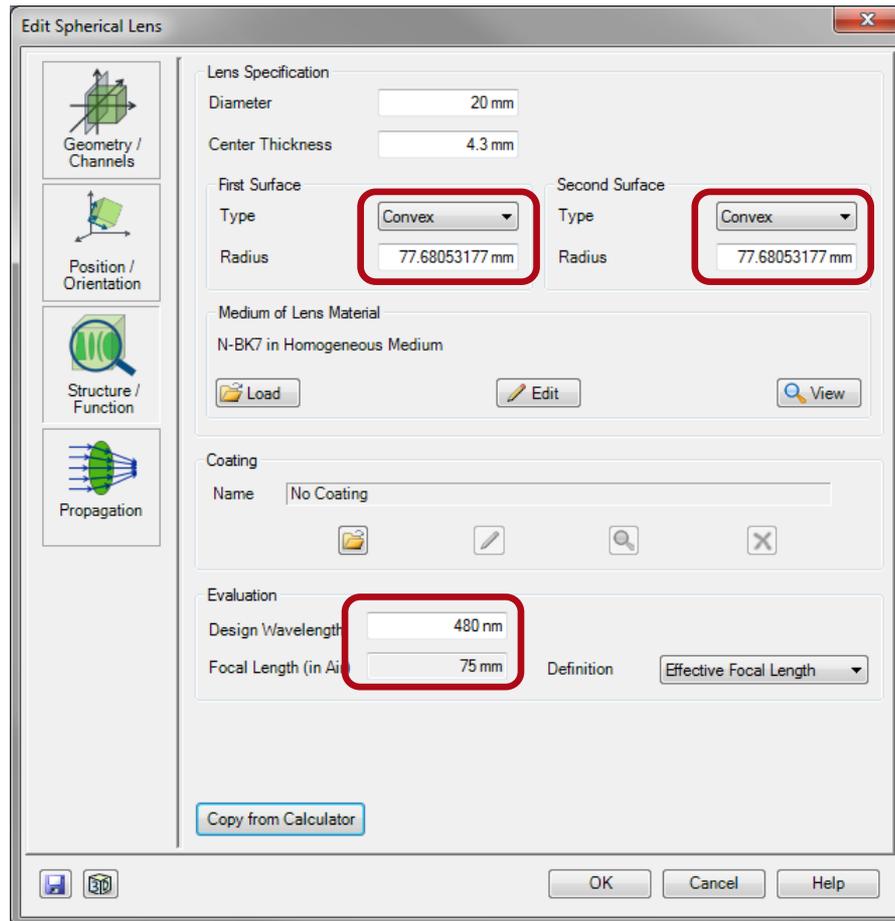
Using the Calculator Results I



- The calculator results can be used in the edit dialog for spherical lens components in the light path.
- Pressing “Copy from Calculator” will open a selection dialog.



Using the Calculator Results II



- After choosing the calculator...
- ...the surface types as well as the curvature radii will be copied from the calculator into the dialog.
- The effective focal length for the new design wavelength is identical to that of the calculator too.

Check with Imaging System I

The screenshot displays two windows from a ray tracing software. The top window, titled "31: Light Path View", shows a diagram of a light path. It starts with a "Stored Field" element (index 0), followed by a "Spherical Lens" element (index 1), and then a "Virtual Screen" element (index 600). A second "Virtual Screen" element (index 601) is also shown. A "Ray Tracing System Analyzer" element (index 800) is positioned below the lens. The lens and the first virtual screen have coordinate boxes indicating their positions: X: 0 m, Y: 0 m, Z: 175 mm for the lens, and X: 0 m, Y: 0 m, Z: 131.25 mm for the first virtual screen. The bottom window, titled "30: Light Path Editor", shows a table with the following data:

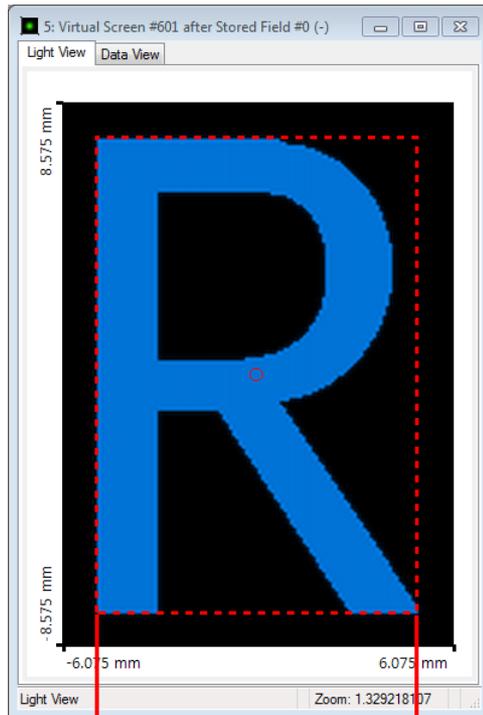
Start Element				Target Element	
Index	Type	Channel	Medium	Index	Type
0	Stored Field	-	Vacuum in Homogeneous...	1	Spherical Lens
1	Spherical Lens	T	Standard Air in Homogene...		

The editor window also includes tabs for "Path", "Detectors", "Analyzers", and "Logging", a "Simulation Engine" dropdown set to "Classic Field Tracing", and a "Go!" button.

- The sample LPD can be used to check the lens calculation.
- The distances between the elements correspond to those used in the “Imaging” page of the calculator. (Important: the measurement has to be done from and to the lens’ principal planes!)

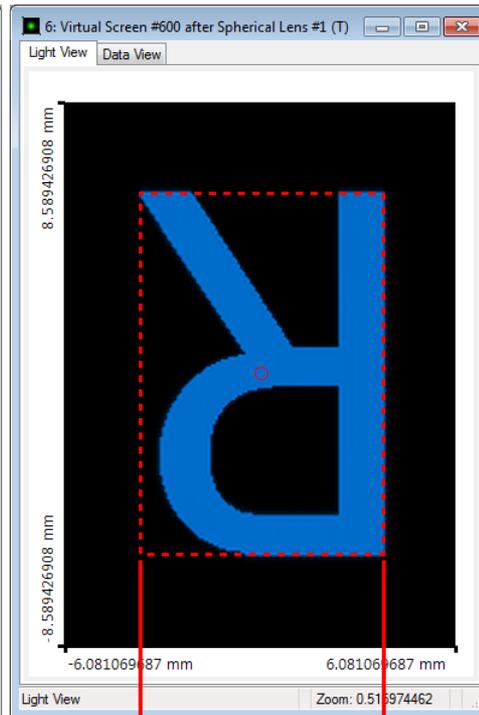
Check with Imaging System II

Object



y_o

Image



y_i

- Doing “Classical Field Tracing” through this system will show the object as well as the image.
- A comparison of both shows that the desired magnification of $y_i / y_o = 0.75$ has effectively been achieved for the given object distance of 175mm.