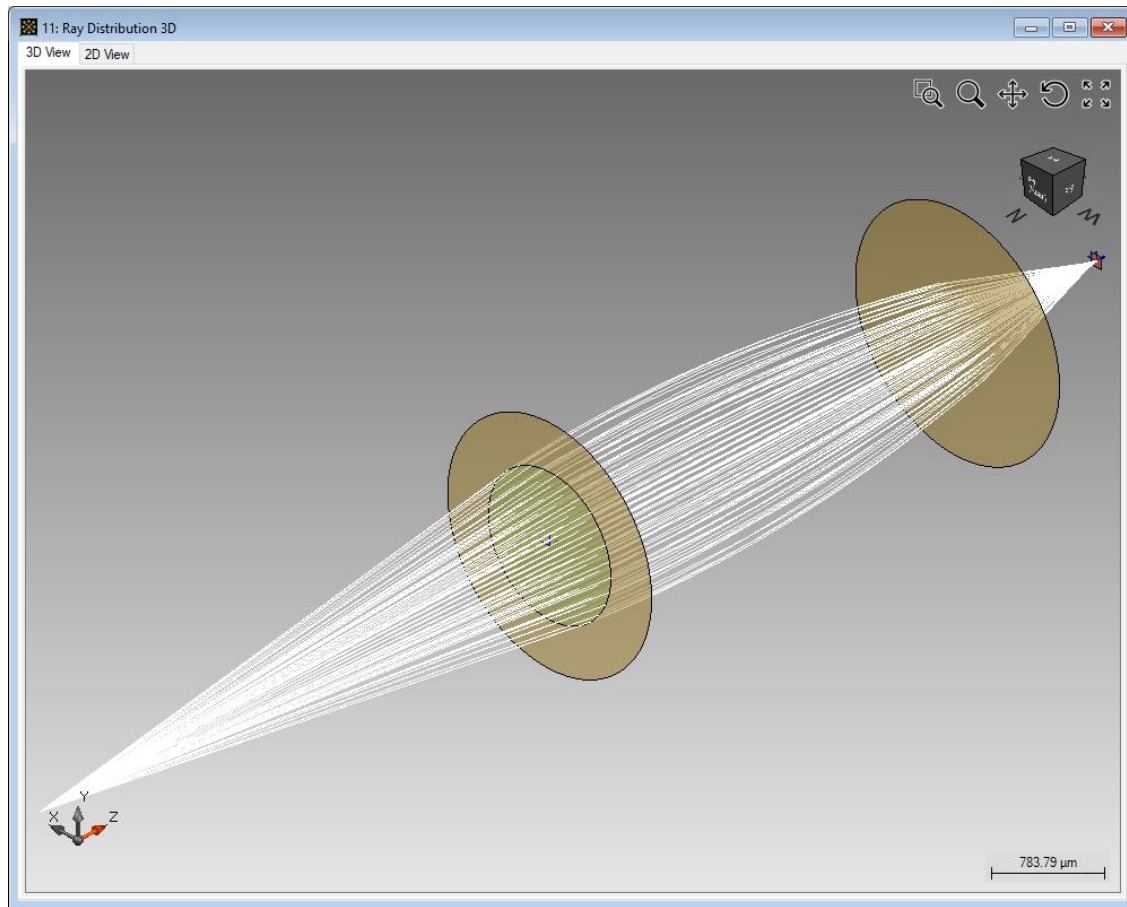


# Construction and Modeling of a Graded-Index Lens

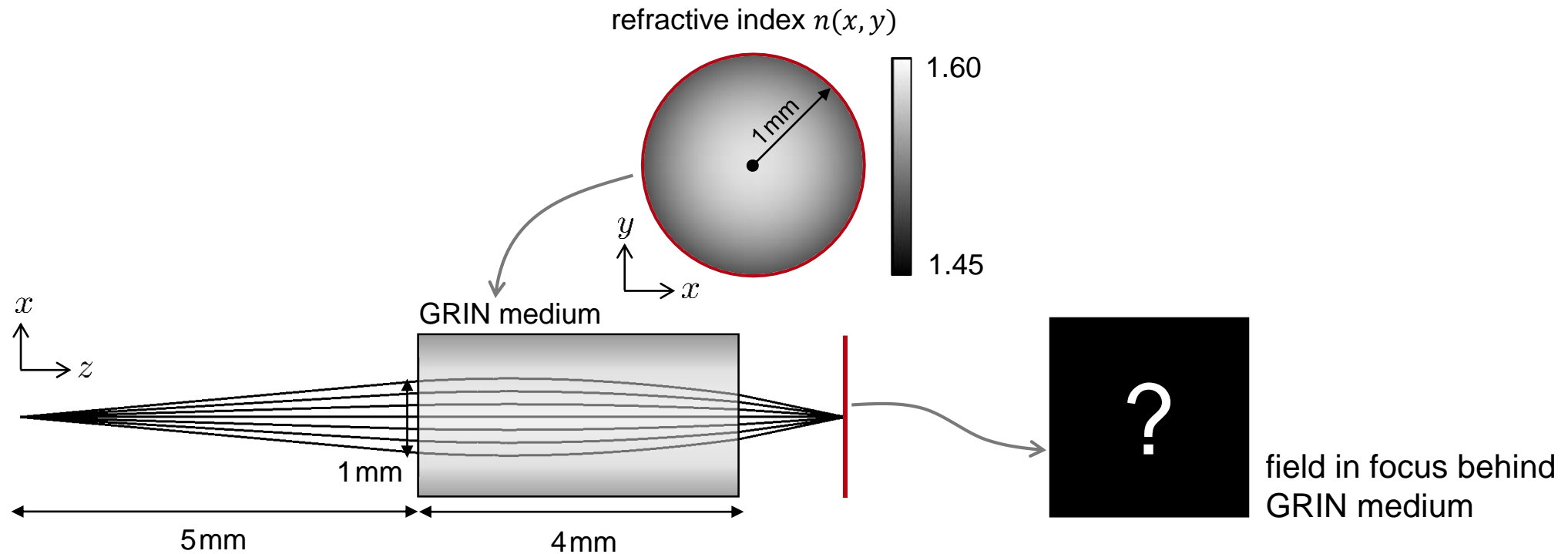
# Abstract



VirtualLab allows the specification of a graded-index lens in a very user friendly way. In addition such index modulated lenses can be analyzed by ray tracing as well as field tracing. Within this use case we will show how easy it is to configure a graded-index lens in VirtualLab and show also simulation results for analysis by different propagation engines. For the illustration of this technology a simple setup is used, which includes a spherical wave, a graded-index lens component and a detector to show the electromagnetic field component in the focus and directly after the lens.

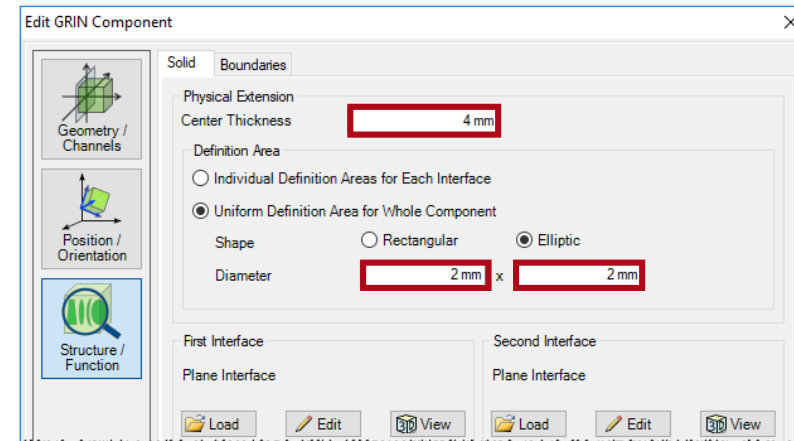
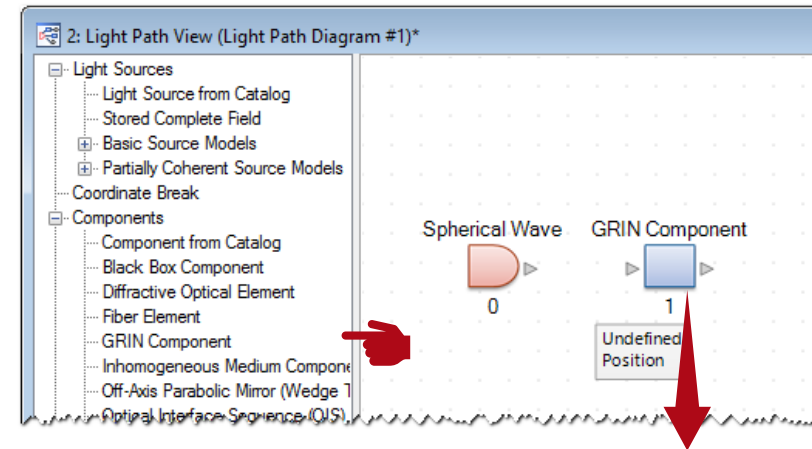
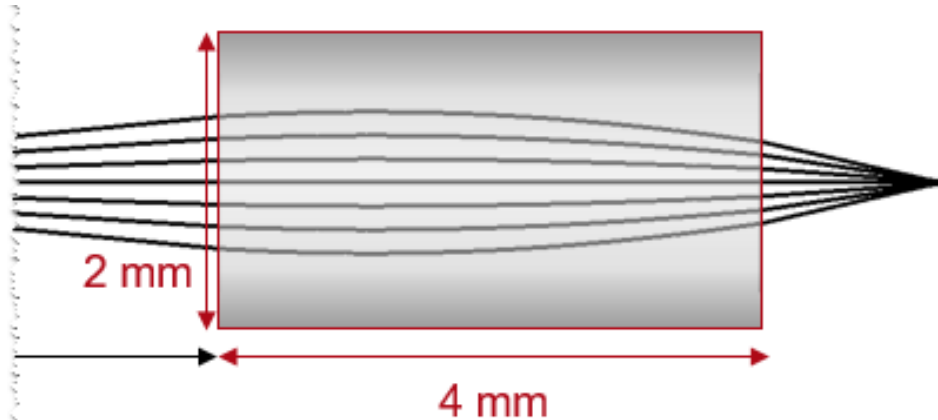
# Modeling Task

- how to construct a GRIN lens.
- how to perform both ray and field tracing analysis of it.



# Construction of a GRIN Lens

- Specifications of the GRIN lens
  - Components →  
*GRIN Component* is used to model the GRIN lens.



# GRIN Lens: GRIN Medium

- Refractive index  $n(x, y)$

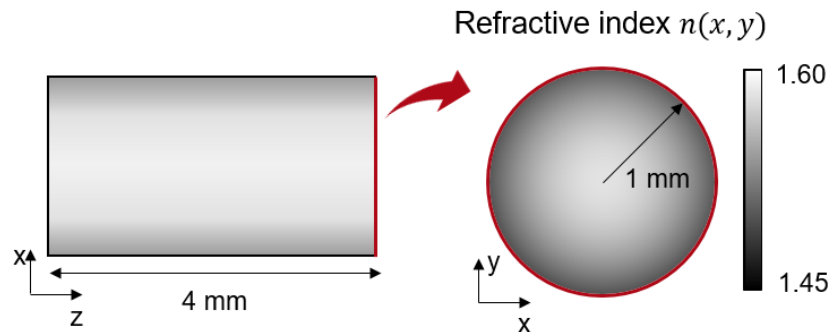
$$n(x, y) = n_0 \left( 1 - \frac{g^2}{2} \cdot r^2 \right)$$

with  $r = \sqrt{x^2 + y^2}$ .

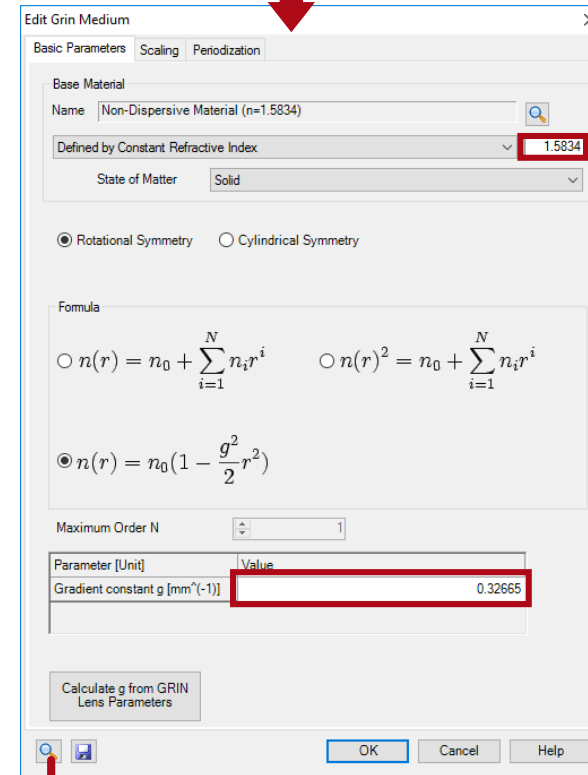
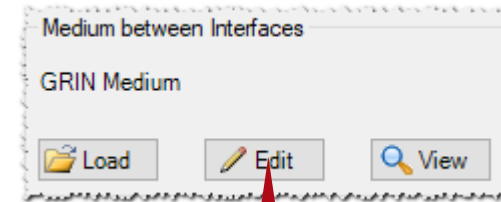
- In this case [1]:

$$n_0 = 1.5834$$

$$g = 0.32665 \text{ mm}^{-1}$$



[1] Riedl, M.J., *Optical Design Fundamentals*, SPIE Press (2001)



# GRIN Lens: GRIN Medium

- Refractive index  $n(x, y)$

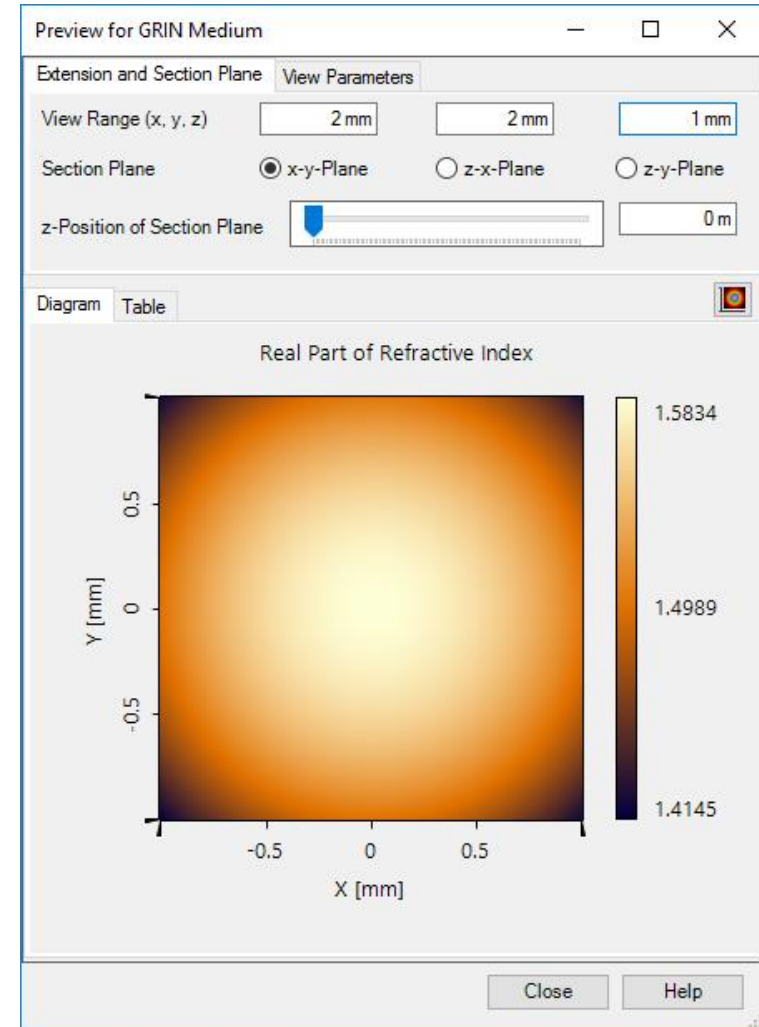
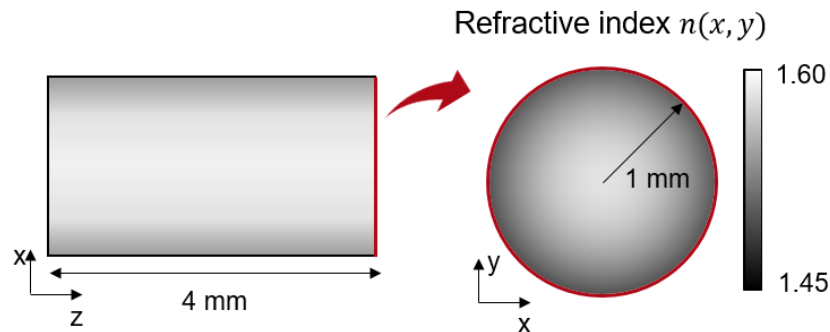
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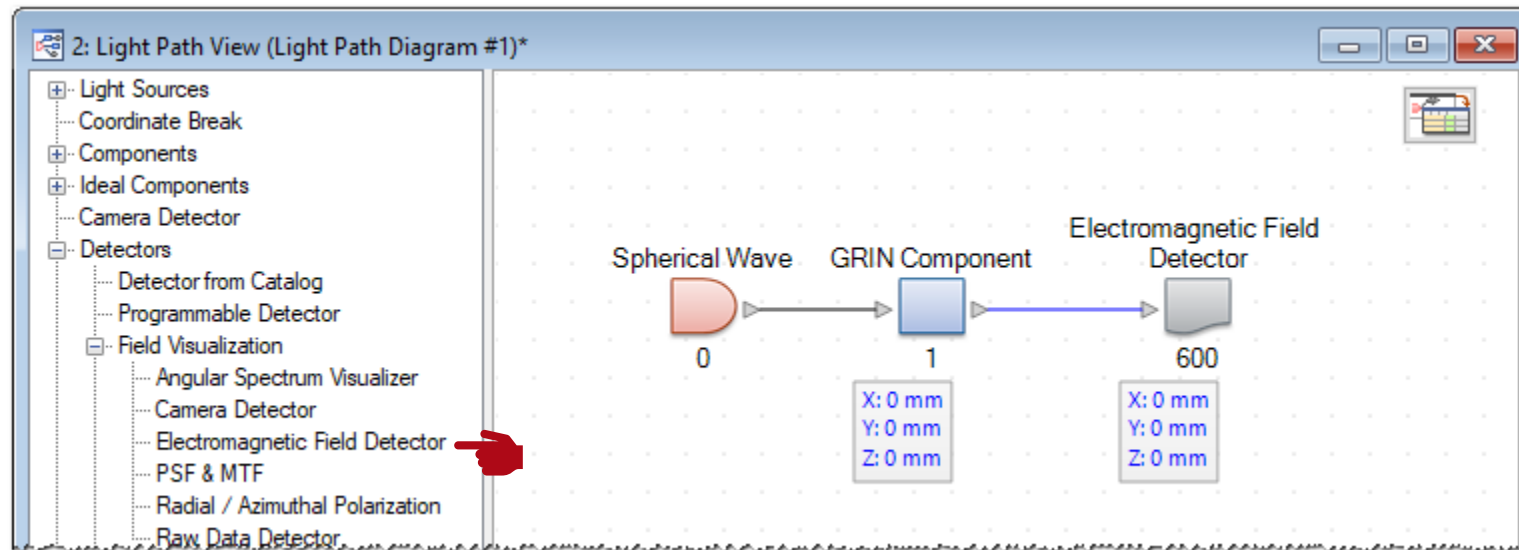
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[1] Riedl, M.J., *Optical Design Fundamentals*, SPIE Press (2001)

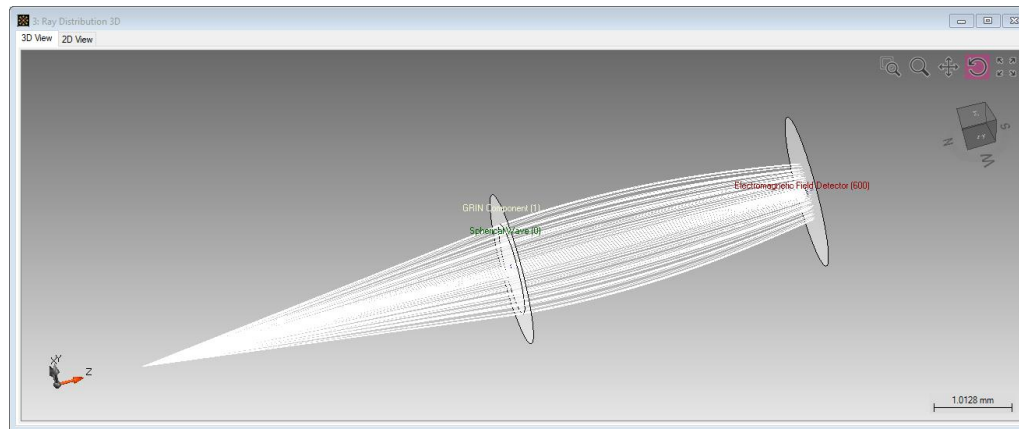
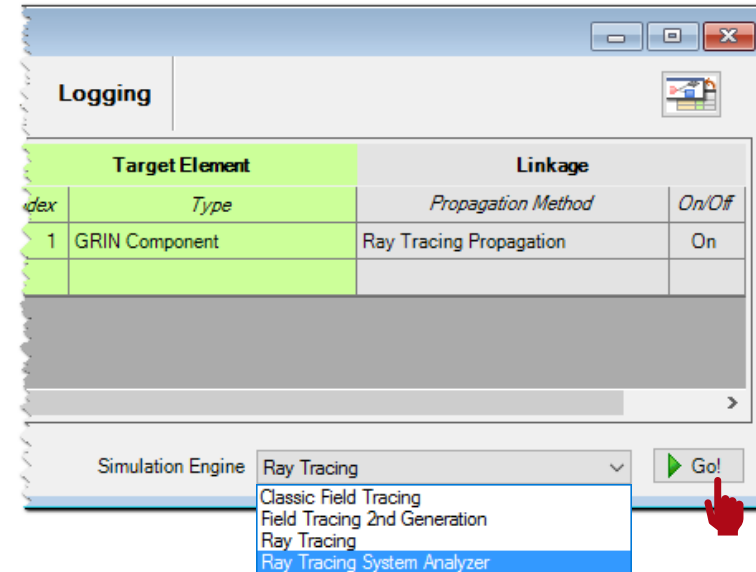
# System Setup: Detector and Linkage

- Specifications of detector:
  - *Electromagnetic Field Detector* is used to detect the image.

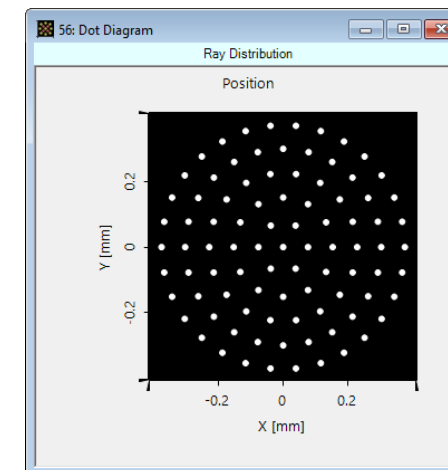


# Simulation Results: Ray Tracing Analysis

- Simulation engine:
  - Choose *Ray Tracing System Analyzer*
  - Click **Go!**



ray tracing analysis of the imaging system

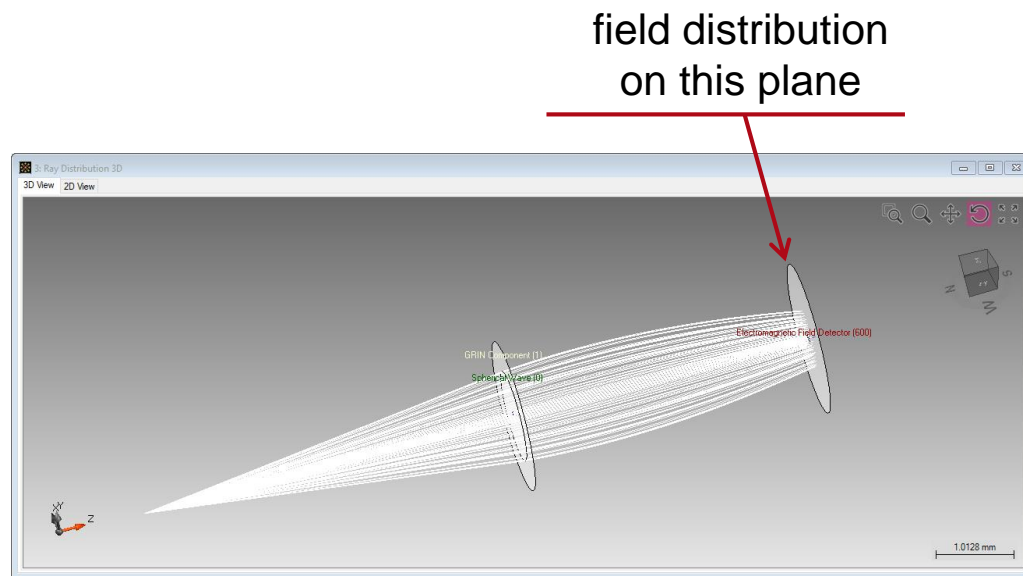


dot diagram

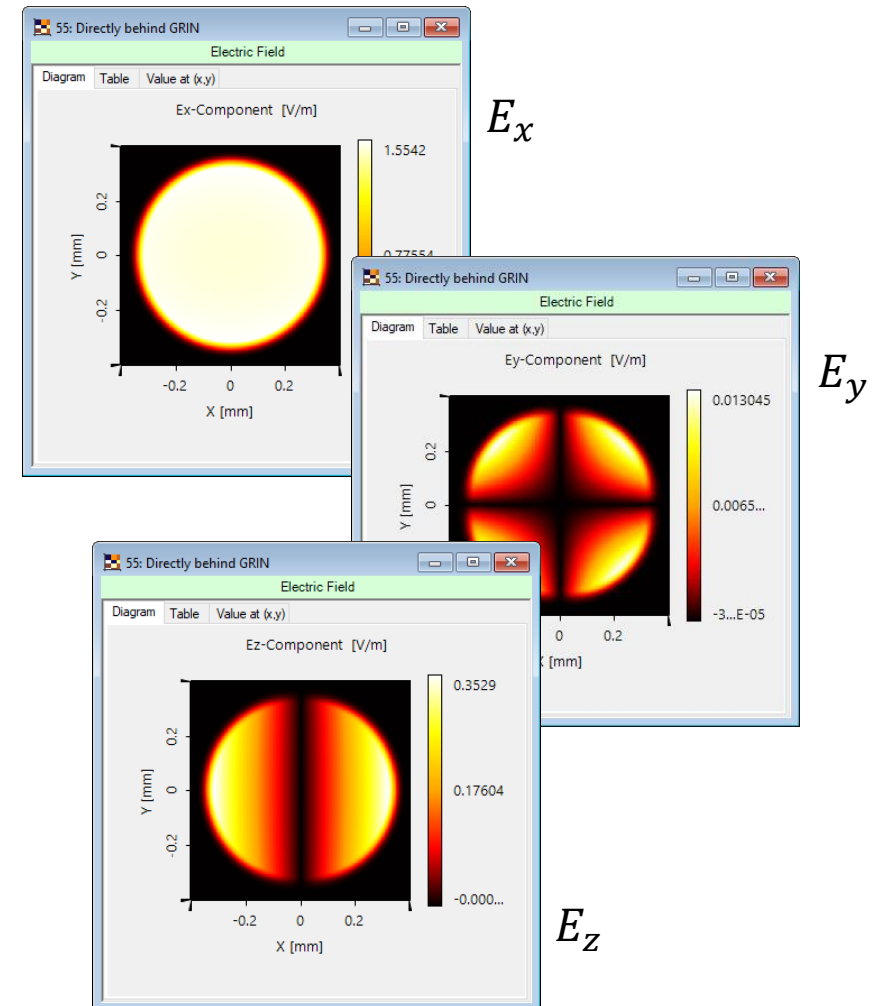


# Simulation Results: Field Tracing Analysis

- Simulation engine:
  - Choose *Field Tracing 2nd Generation*.
  - Click **Go!**

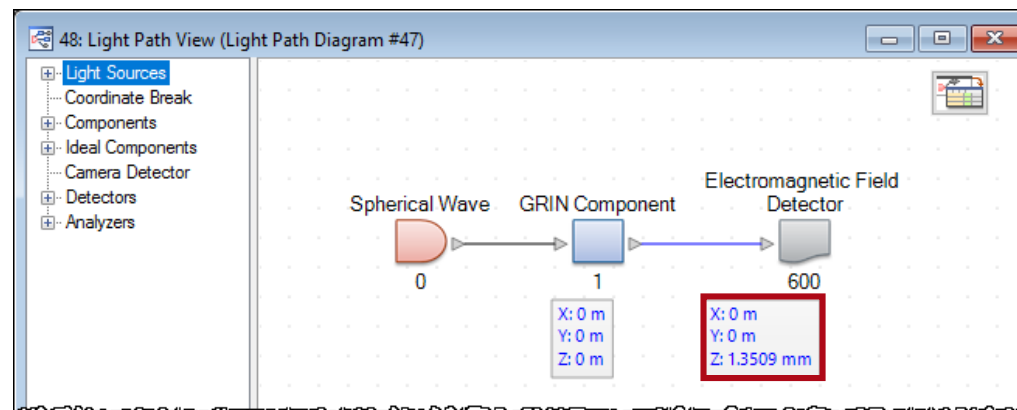
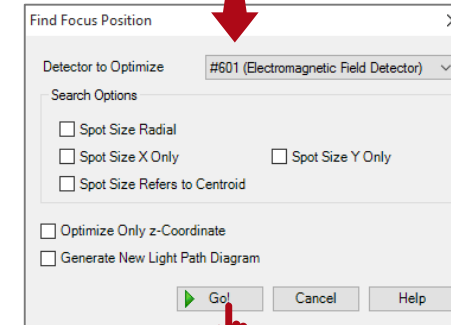
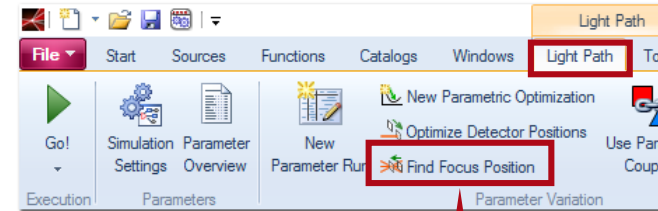


amplitude of fields



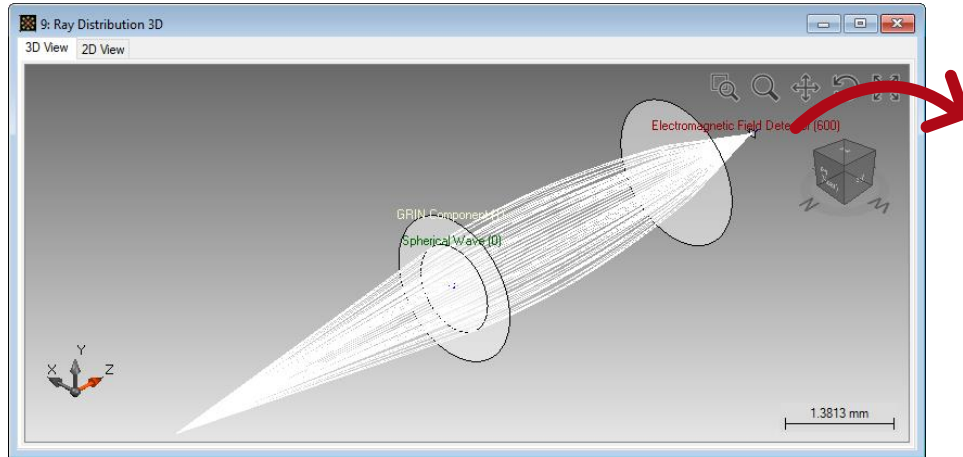
# System Setup: Find the Image Plane

- Find the position of image plane
  - *Light Path* → *Find Focus Position*.

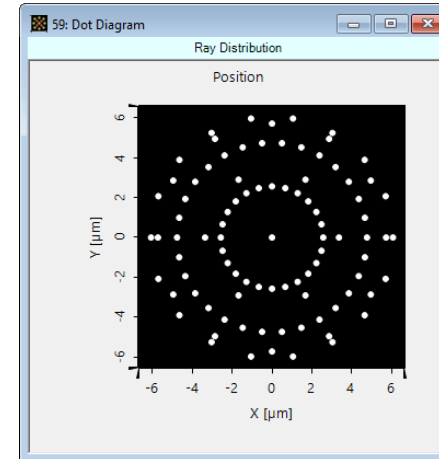


# Simulation Results: Ray and Field Tracing

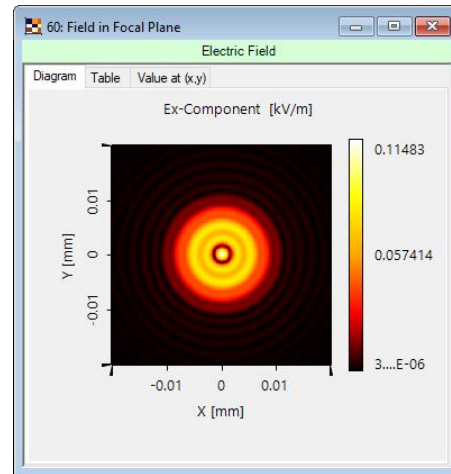
ray tracing analysis of the imaging system



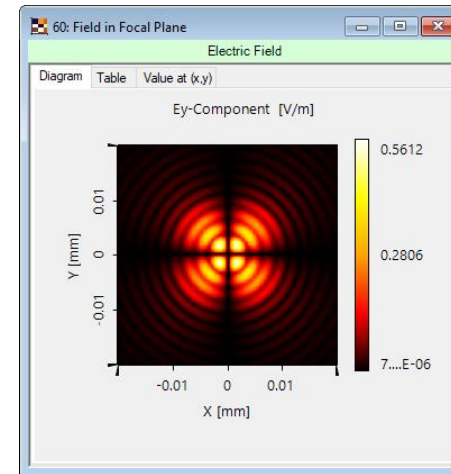
dot diagram



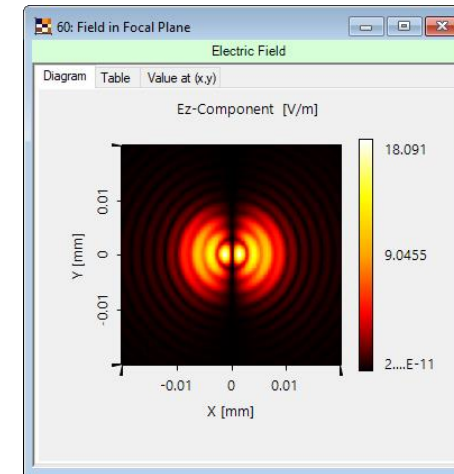
field tracing results  
in focal plane



$E_x$



$E_y$



$E_z$

# Document Information

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title	Construction and Modeling of a Graded-Index Lens
version	2.0
toolbox(es)	Starter Toolbox
VL version used for simulations	7.4.0.49
category	Feature Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#">Modeling of Graded-Index (GRIN) Multimode Fiber</a></li><li>- <a href="#">Gaussian Beam Focused by a Thermal Lens</a></li></ul>

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