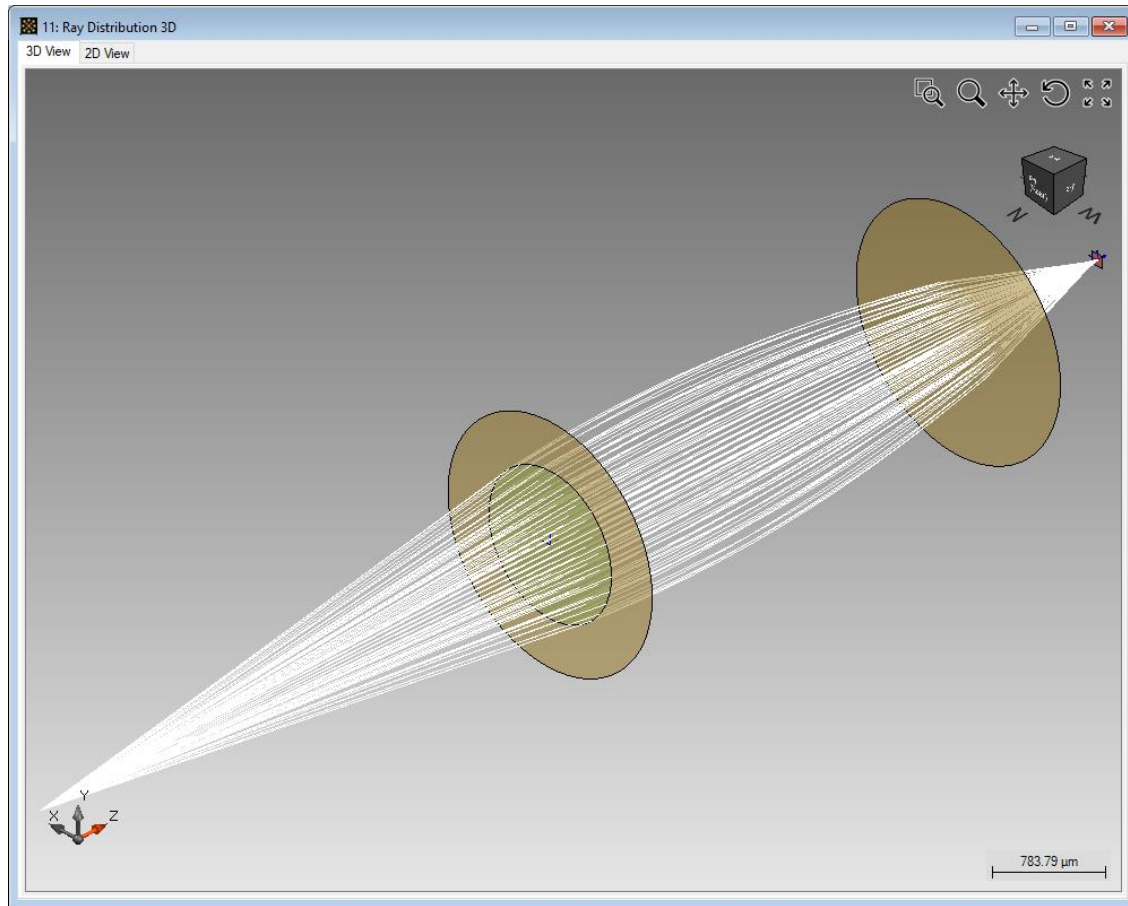# Construction and Modeling of a Graded-Index Lens

Abstract

VirtualLab Fusion 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 Fusion 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.
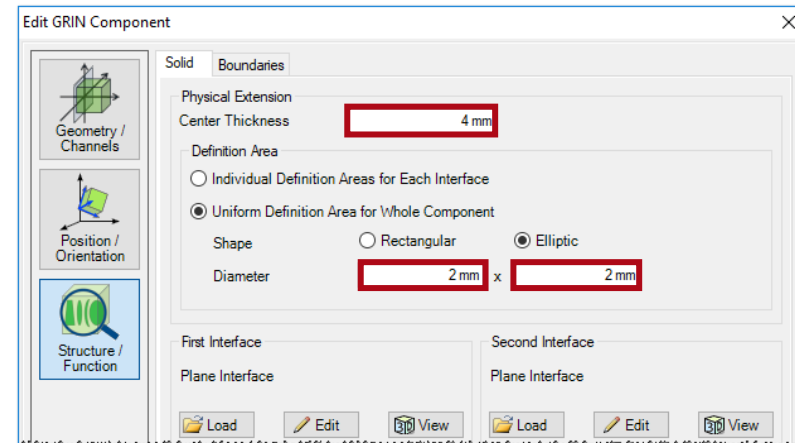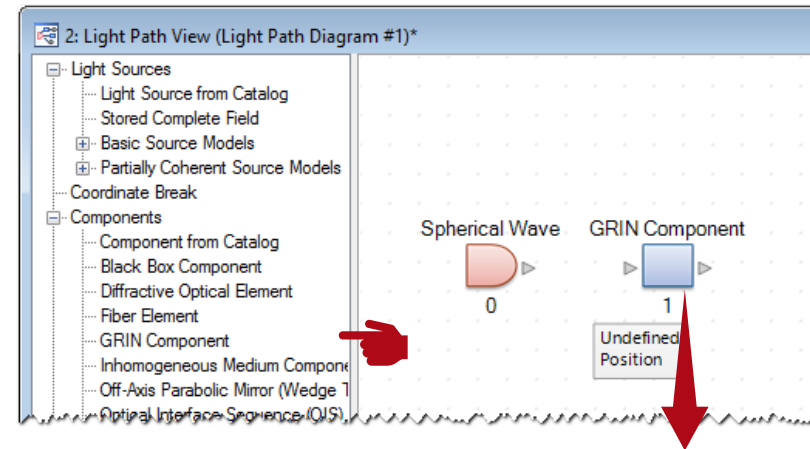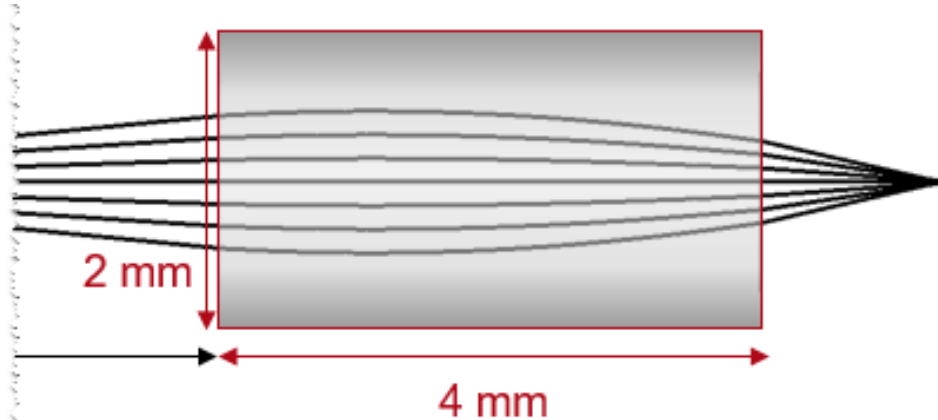
Modeling Task

- how to construct a GRIN lens.

- how to perform both ray and field tracing analysis of it.

refractive index $n(x, y)$

GRIN medium

field in focus behind GRIN medium
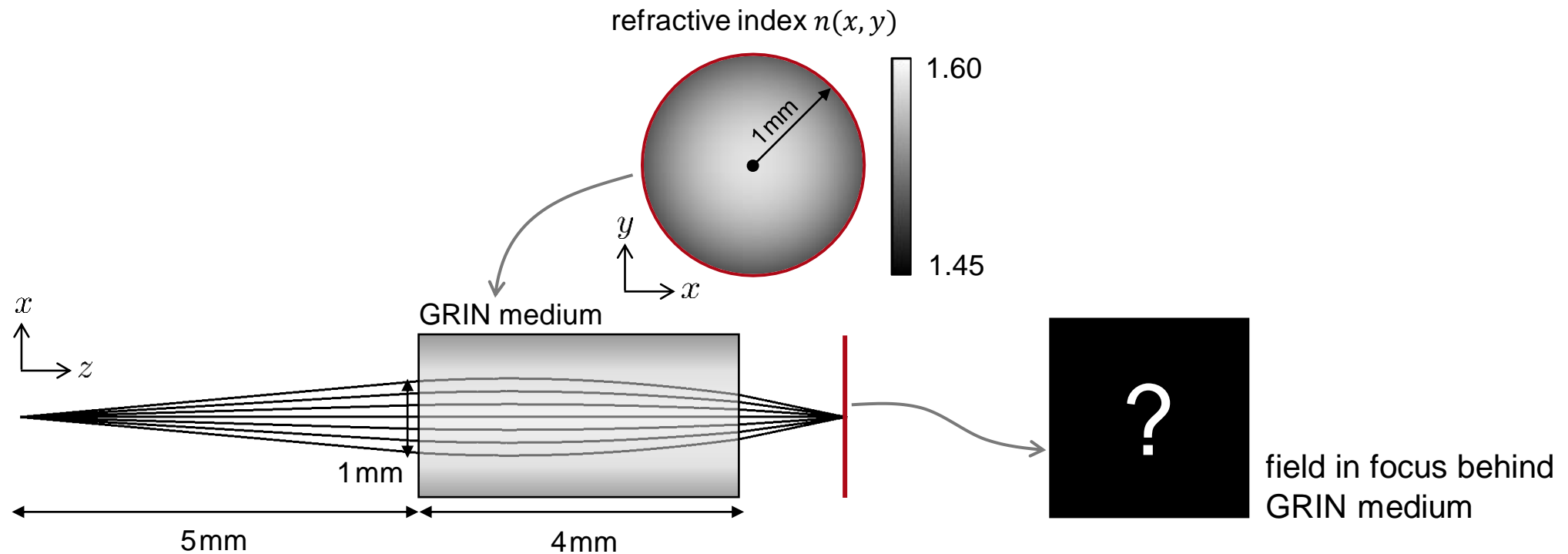
Construction of a GRIN Lens

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

GRIN Lens: GRIN Medium

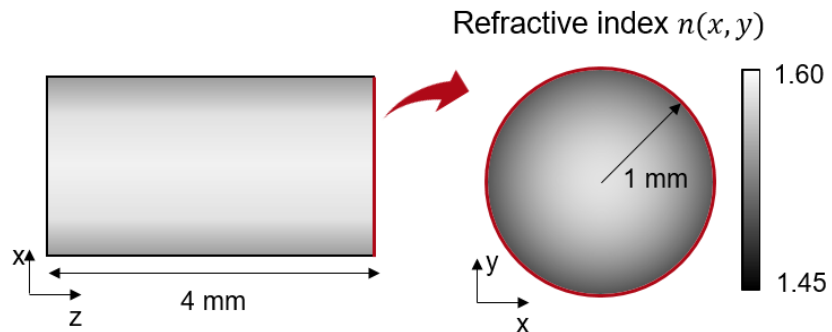- Refractive index $n(x, y)$

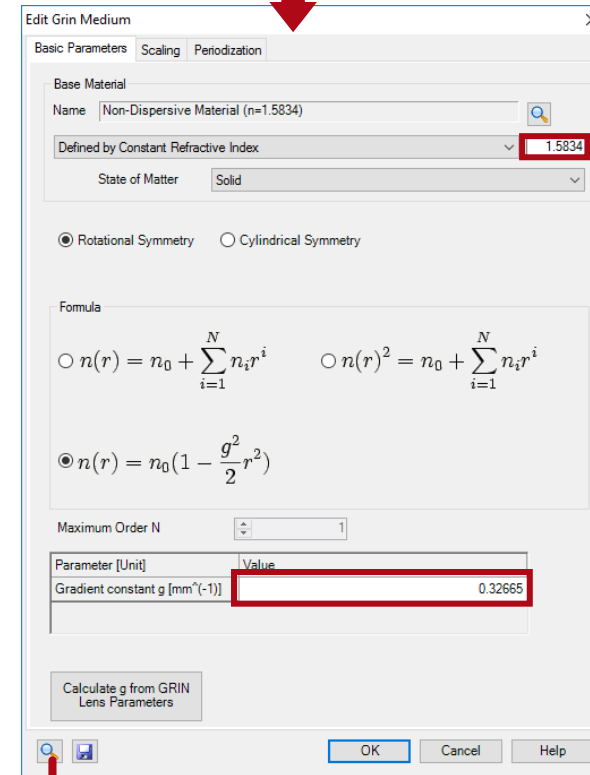$$n(x, y) = n_0 \left(1 - \frac{g^2}{2} \cdot r^2 \right)$$
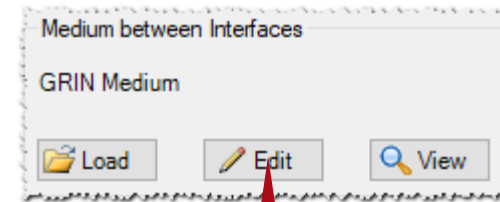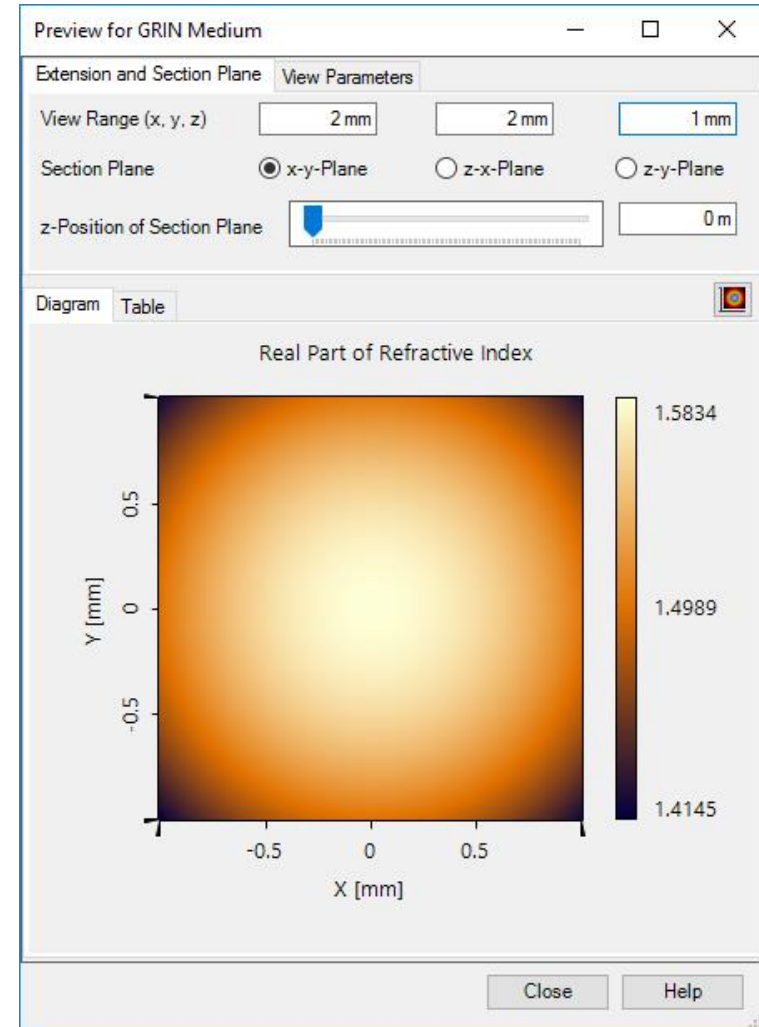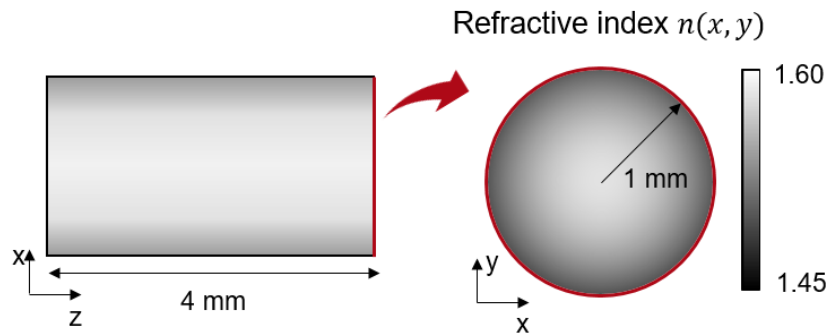
with $r = \sqrt{x^2 + y^2}$.

- In this case [1]:

$$n_0 = 1.5834$$
$$g = 0.32665\,\text{mm}^{-1}$$

Refractive index $n(x, y)$

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

GRIN Lens: GRIN Medium

- Refractive index $n(x, y)$

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

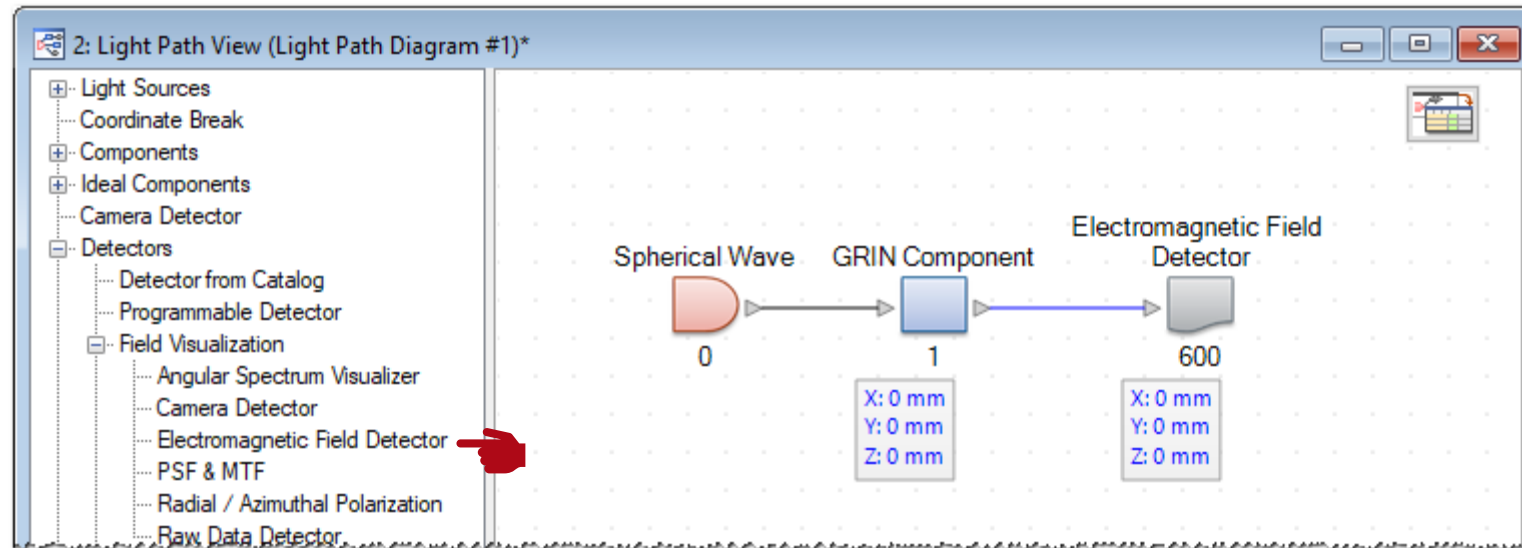with $r = \sqrt{x^2 + y^2}$.

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Refractive index $n(x, y)$

[1] Riedl, M.J., *Optical Design Fundamentals,* SPIE Press (2001)
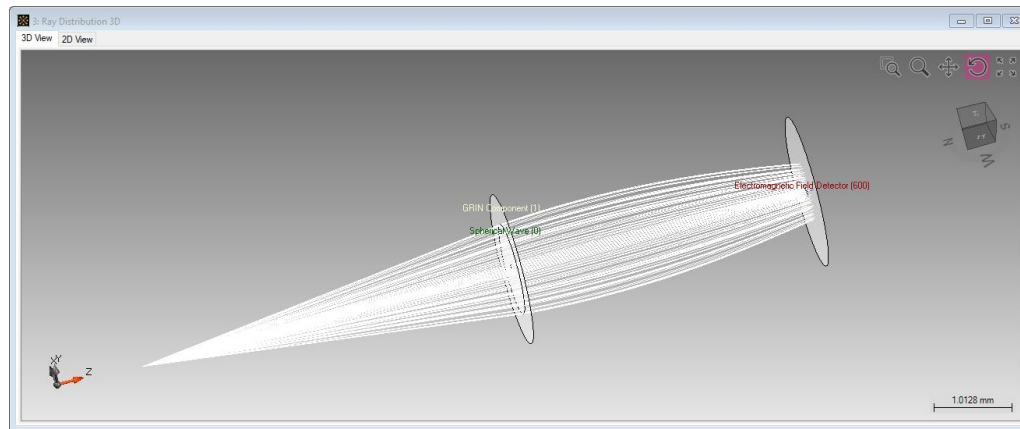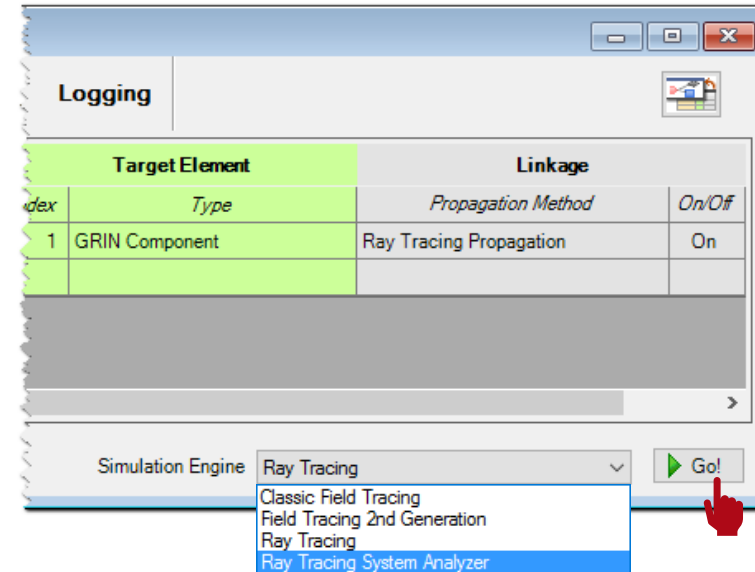
System Setup: Detector and Linkage

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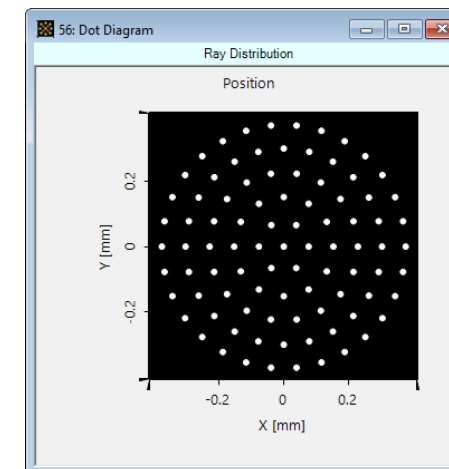 - Electromagnetic Field Detector is used to detect the image.

Simulation Results: Ray Tracing Analysis

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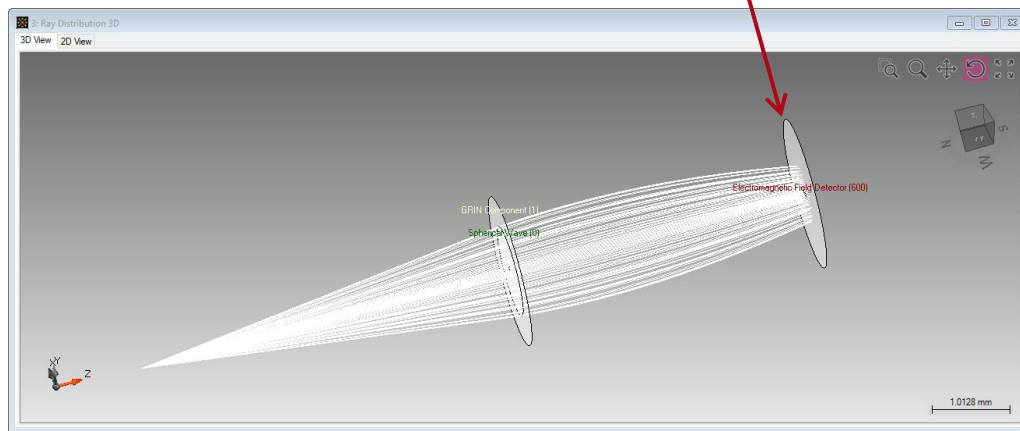 - Choose Ray Tracing System Analyzer
  - Click Go!

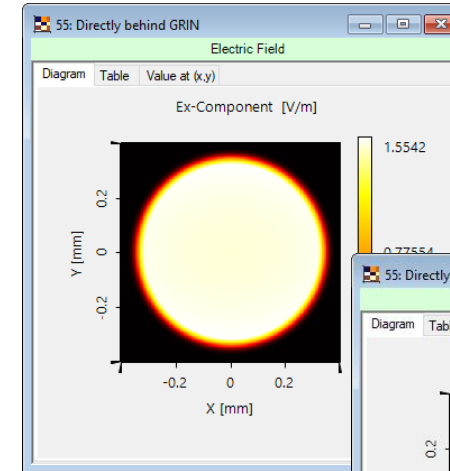ray tracing analysis of the imaging system

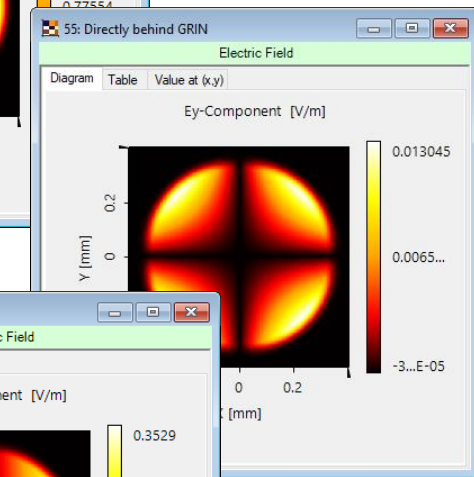dot diagram

Simulation Results: Field Tracing Analysis

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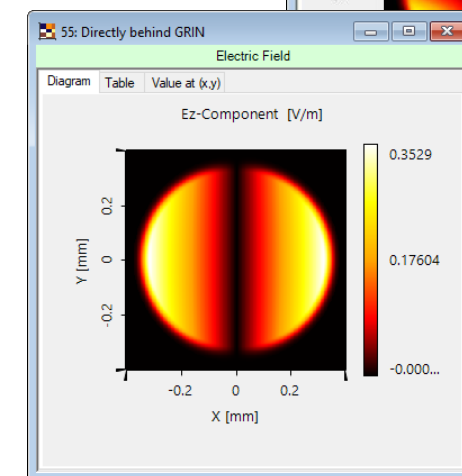 - – Choose Field Tracing 2nd Generation.
  - – Click Go!

field distribution
on this plane

amplitude of fields

E_x

E_y

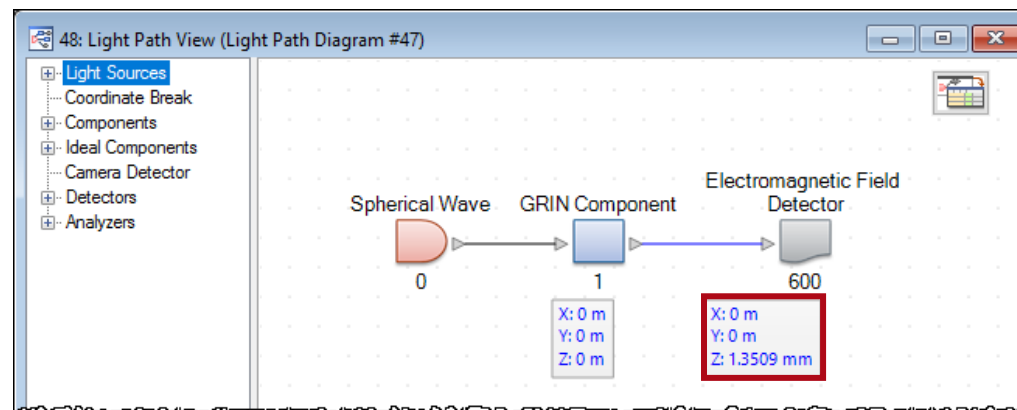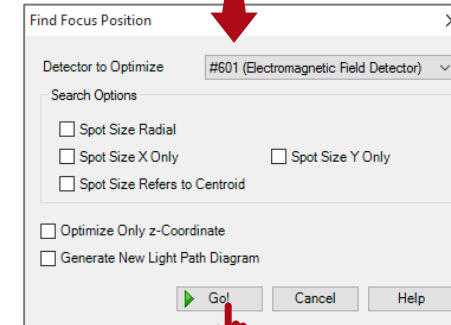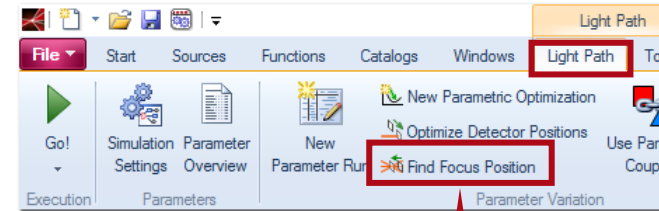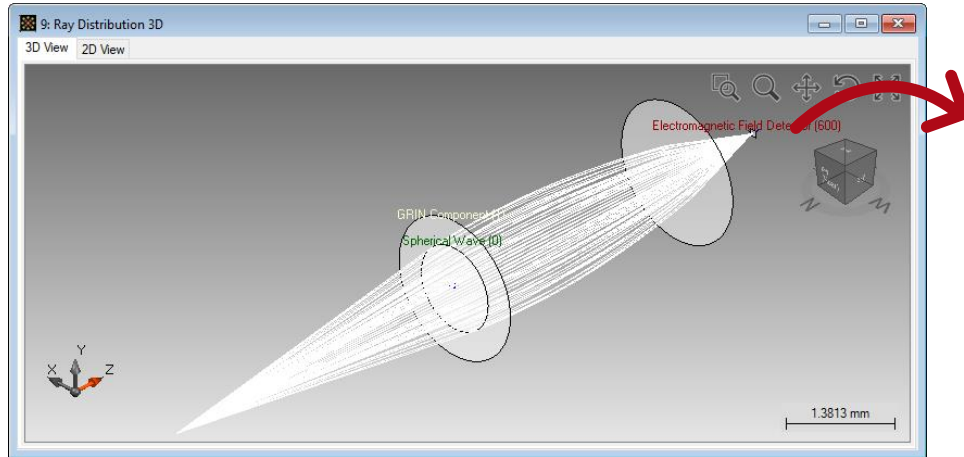E_z

System Setup: Find the Image Plane

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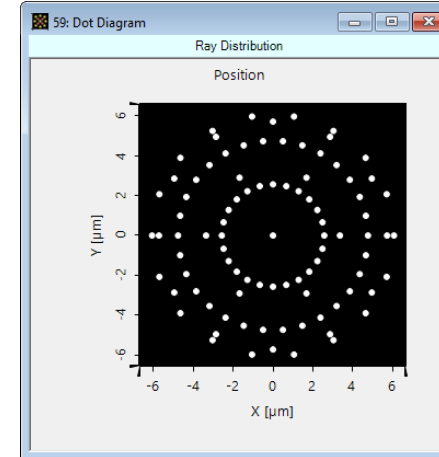 - Light Path ➔ Find Focus Position.

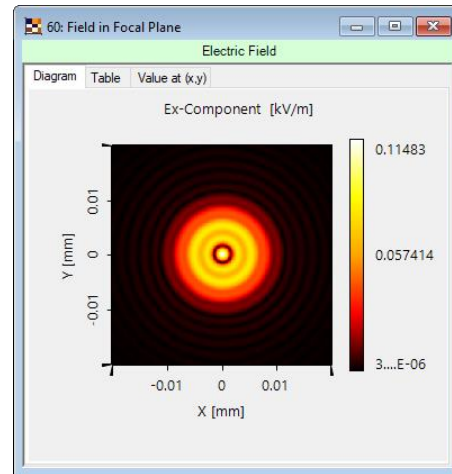# Simulation Results: Ray and Field Tracing
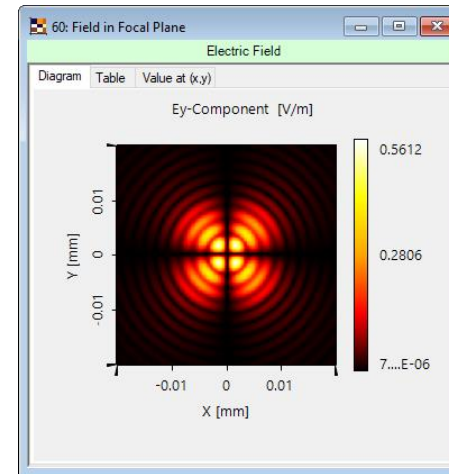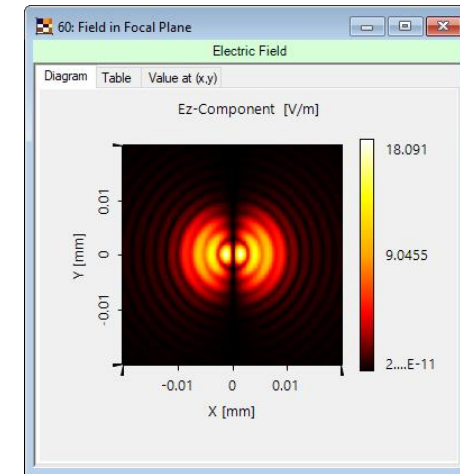
ray tracing analysis of the imaging system

dot diagram

field tracing results
in focal plane

E_x

E_y

E_z

Document Information

title	Construction and Modeling of a Graded-Index Lens
document code	GRIN.0001
version	2.0
toolbox(es)	Starter Toolbox
VL version used for simulations	VirtualLab Fusion Spring Release 2019 (7.4.0.49)
category	Feature Use Case
further reading	- Modeling of Graded-Index (GRIN) Multimode Fiber - Gaussian Beam Focused by a Thermal Lens