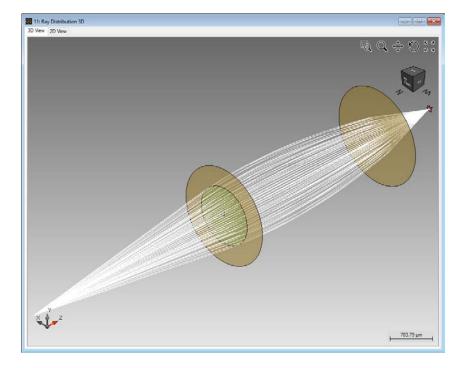


#### Construction and Modeling of a Graded-Index Lens

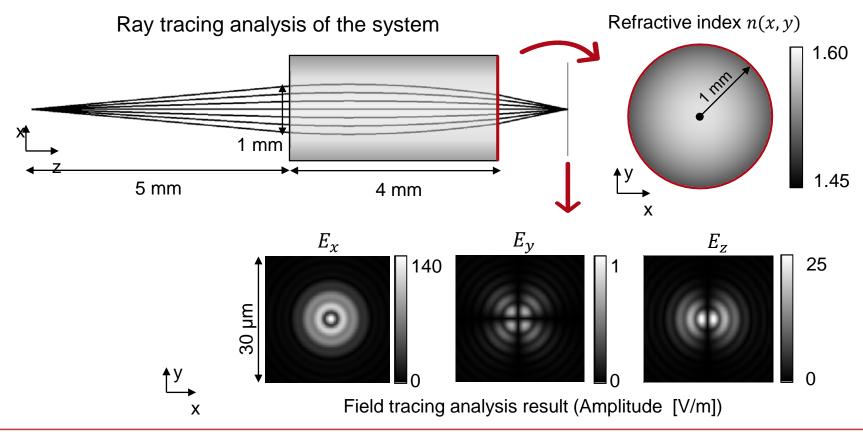
#### Abstract



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.

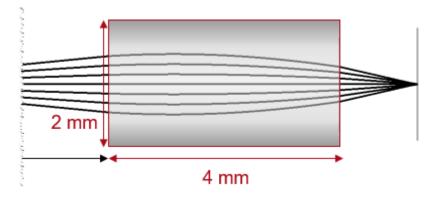
## **Modeling Task**

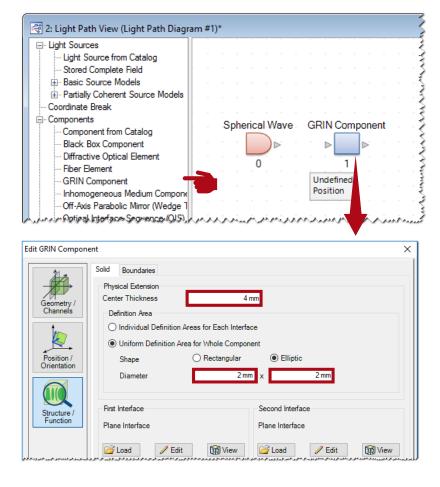
- how to construct a GRIN lens.
- how to perform both ray and field tracing analysis of it.



## **Construction of a GRIN Lens**

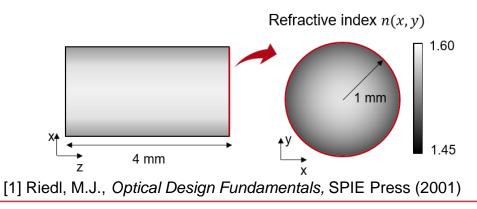
- Specifications of the GRIN lens
  - Components →
    GRIN Component is used to model the GRIN lens.





## **GRIN Lens: GRIN Medium**

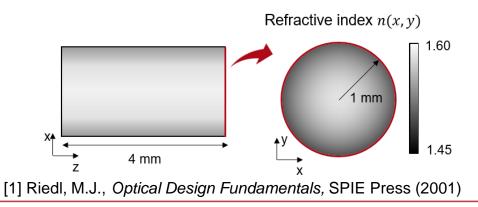
- Refractive index n(x, y)  $n(x, y) = n_0 \left(1 - \frac{g^2}{2} \cdot r^2\right)$ with  $r = \sqrt{x^2 + y^2}$ .
- In this case [1]:  $n_0 = 1.5834$  $g = 0.32665 \,\mathrm{mm^{-1}}$

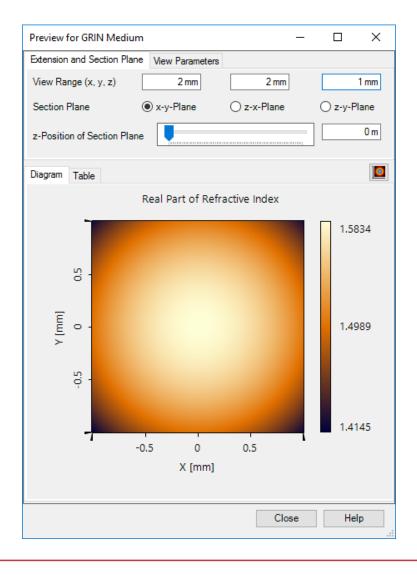


Medium between Interfaces
GRIN Medium
Load City Ciew
Edit Grin Medium X
Basic Parameters Scaling Periodization
Base Material
Name Non-Dispersive Material (n=1.5834)
Defined by Constant Refractive Index v 1.5834
State of Matter Solid V
• $n(r) = n_0(1 - \frac{g^2}{2}r^2)$
Maximum Order N 🚖 1
Parameter [Unit] Value
Gradient constant g [mm^(-1)] 0.32665
Calculate g from GRIN Lens Parameters
OK Cancel Help
•

## **GRIN Lens: GRIN Medium**

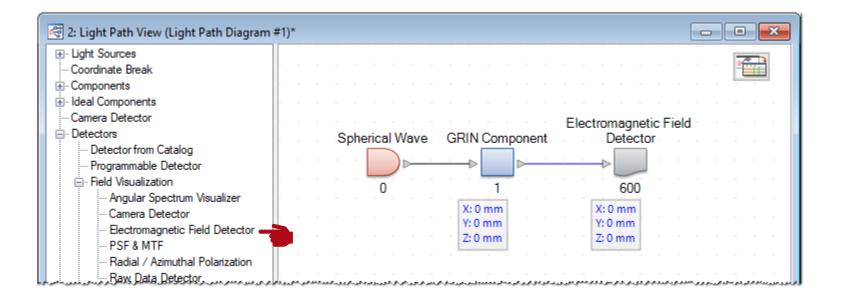
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- In this case [1]:  $n_0 = 1.5834$  $g = 0.32665 \,\mathrm{mm^{-1}}$





### **System Setup: Detector and Linkage**

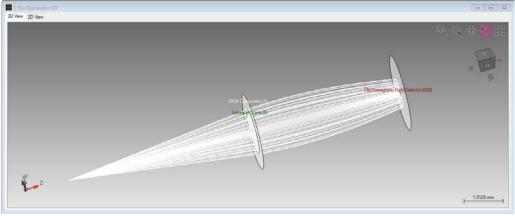
- Specifications of detector:
  - *Electromagnetic Field Detector* is used to detect the image.



## **Simulation Results: Ray Tracing Analysis**

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

L	ogging							
Target Element Linkage								
dex		Туре		Propagation Method	On/Off			
1	GRIN Comp	mponent		Ray Tracing Propagation	On			
	Simulatio	n Engine	Ray Tracing		> Go!			
Classic Field Tracing Field Tracing 2nd Generation Ray Tracing Ray Tracing System Analyzer								
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mm -		Spot diagram						

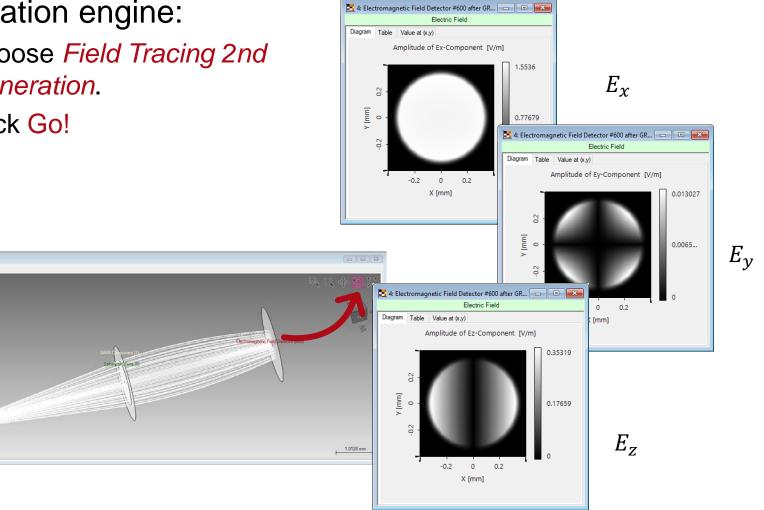


Ray bundle in the imaging system

## **Simulation Results: Field Tracing Analysis**

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

#### Amplitude of the field [V/m]



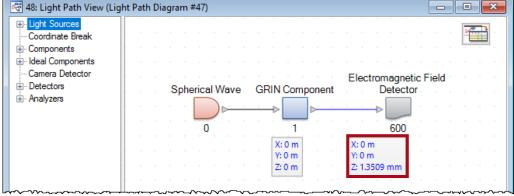
2

2 Ray Distribu 3D View 2D View

## **System Setup: Find the Image Plane**

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

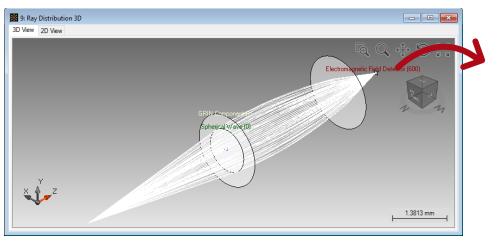
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Go! Simulation Parameter Settings Overview Execution Parameters	New Parameter I	Deti	v Parametric Op mize Detector F I Focus Position Paramete	Positions Use Parag
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		ize Radial ize X Only		ot Size Y Only
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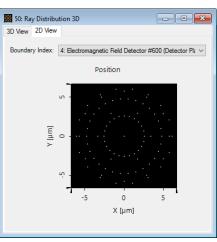


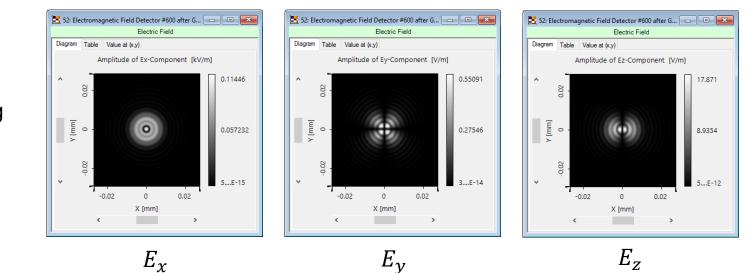
## **Simulation Results: Ray and Field Tracing**

#### Ray bundle in the imaging system

#### Spot diagram







# Field Tracing Results:

### **Document Information**

title	Construction and Modeling of a Graded-Index Lens
version	1.0
VL version used for simulations	7.0.3.4
category	Feature Use Case