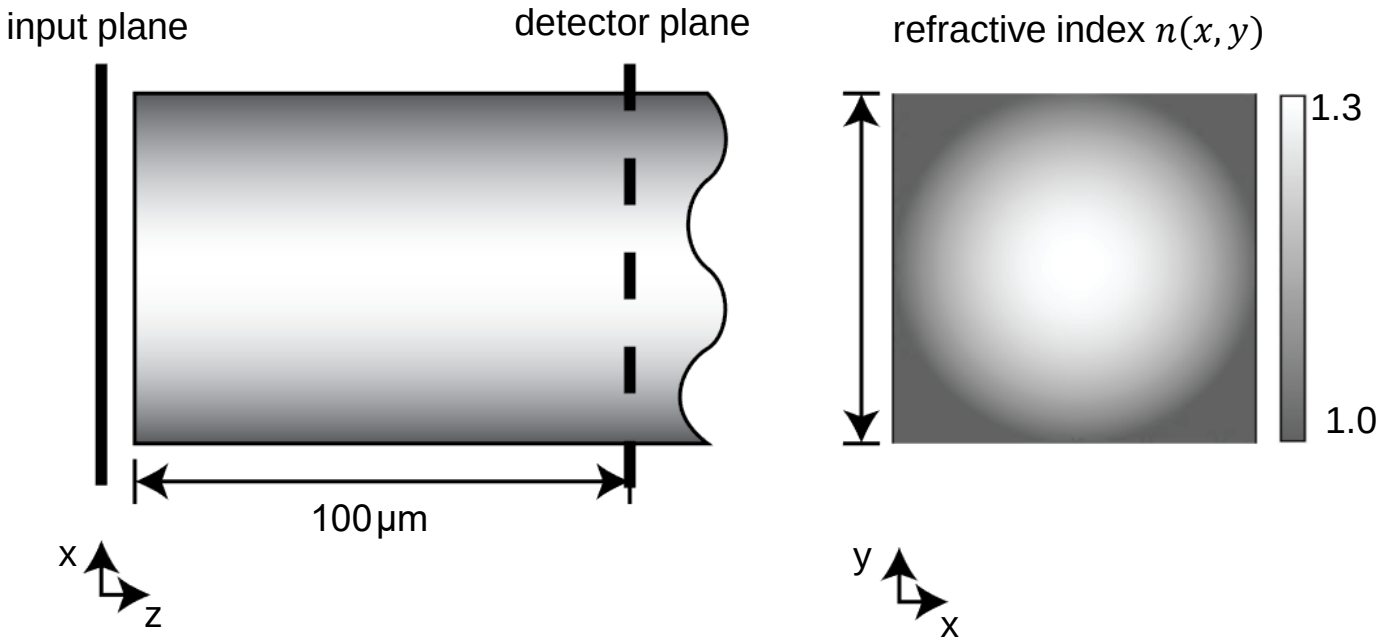
Laser Systems > Beam Delivery System

Modeling of Graded-Index (GRIN) Multimode Fiber

Task/System Illustration

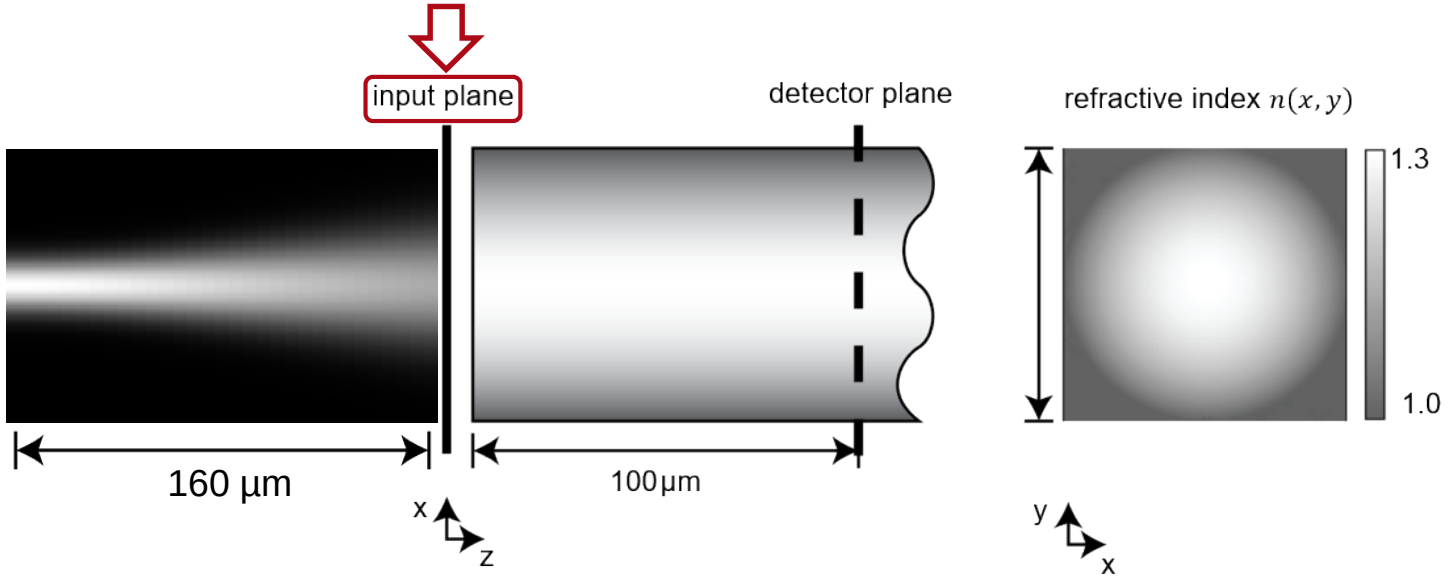


- ray propagation through a GRIN fiber
- electromagnetic field propagation through a GRIN fiber by
  - a rigorous Maxwell solver, the Fourier Modal Method (FMM) with Perfectly Matched Layers (PMLs)
  - our newly developed very fast approximated Maxwell solver

Highlights

- arbitrarily customizable refractive index profile
- easy switching between ray and field tracing
- high accuracy of new propagation method for multimode GRIN fibers
- consideration of polarization crosstalk

Specifications: Light Source



Parameter	Description / Value
coherence/mode	single Hermite Gaussian (0,0) mode
wavelength	532 nm
polarization	linear in y-direction (90°)
distance between beam waist and input plane	160 µm

Specifications: GRIN fiber

- refractive index $n(x, y)$

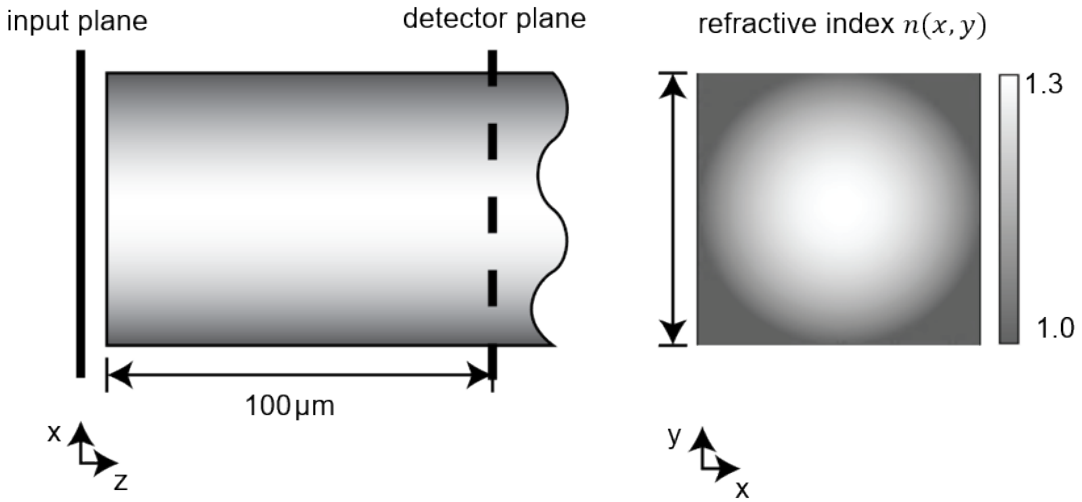
$$n(x,y) = n_0 \sqrt{1 - 2 \cdot \Delta \cdot \frac{r^2}{r_0^2}}$$

with $r = \sqrt{x^2 + y^2}$ and $\Delta = \frac{n_1^2 - n_2^2}{2n_1^2}$

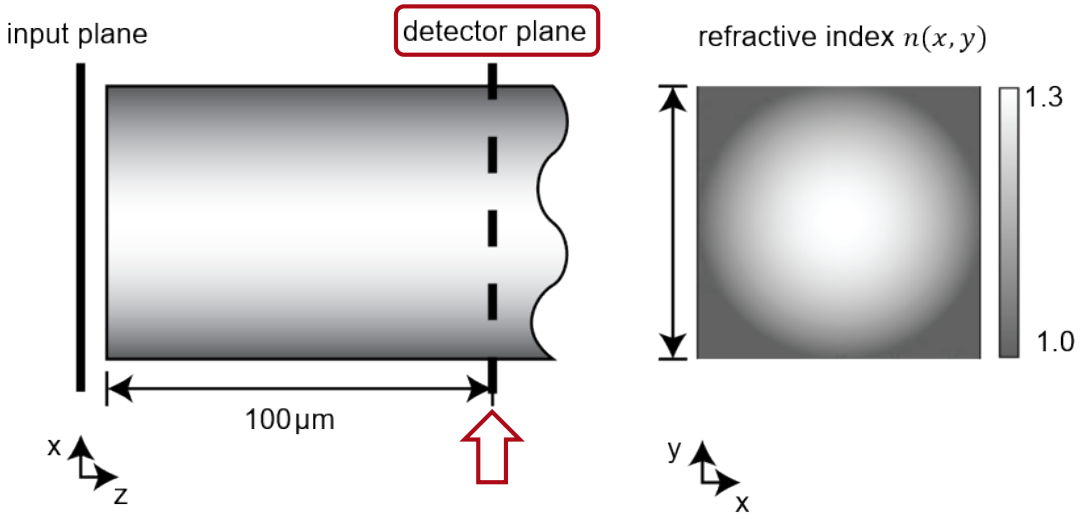
- in this case, $n_1 = 1.3,\ n_2 = 1.0, r_0 = 50\,\mu m$

Highlight

arbitrarily customizable refractive index profile

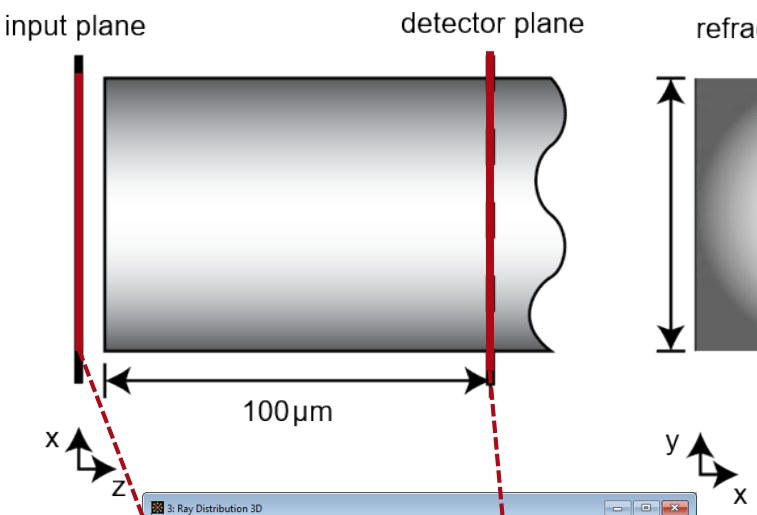


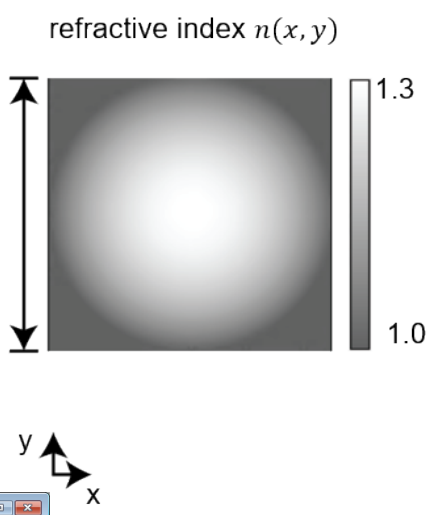
Specifications: Detector

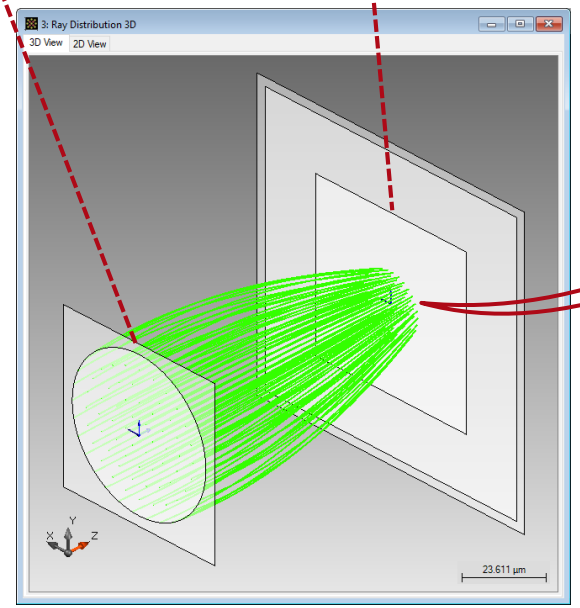


Position	Modeling Technique	Detector/Analyzer
full system	3D system ray tracing	general overview of light behavior in system
detector plane	ray tracing	dot diagram
detector plane	field tracing	amplitude of E_x, E_y, E_z calculated by FMM
detector plane	field tracing	amplitude of E_x, E_y, E_z calculated by fast approach
detector plane	field tracing	deviation between results calculated by the two approaches

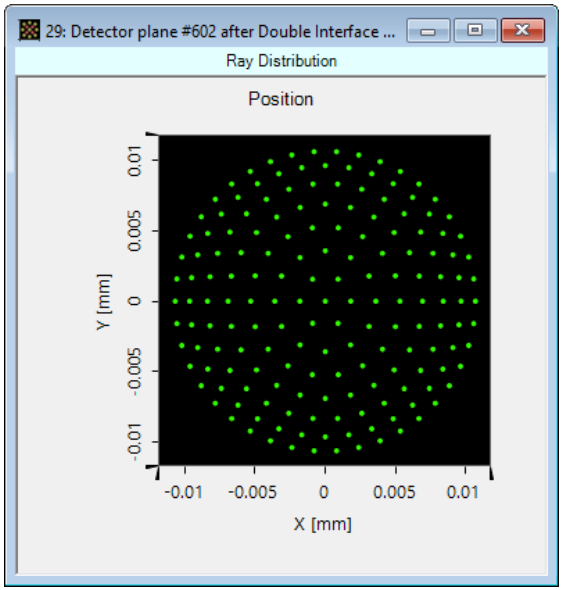
Results: 3D System Ray Tracing



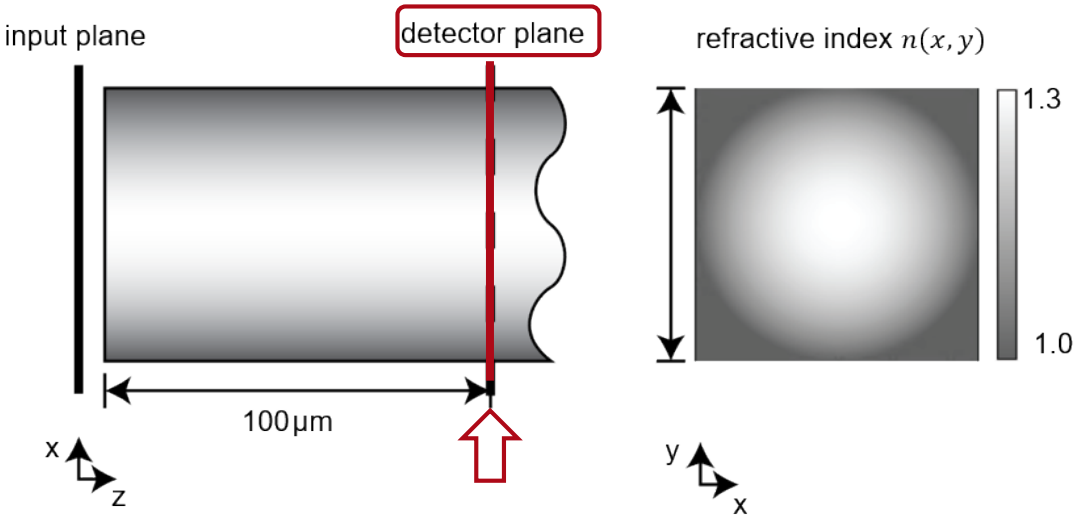




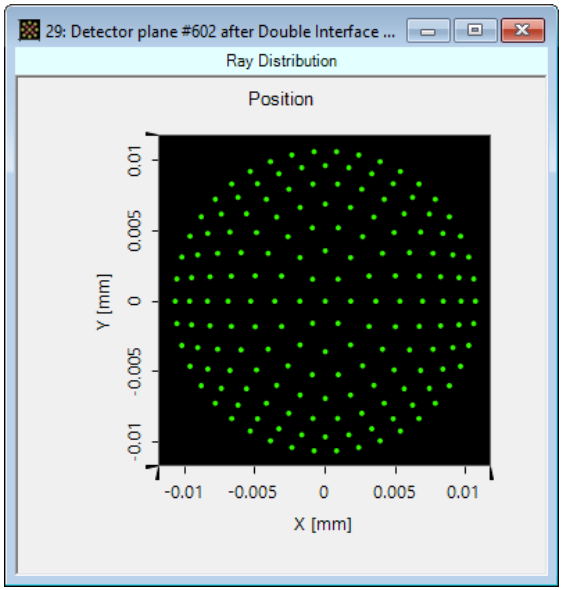
dot diagram



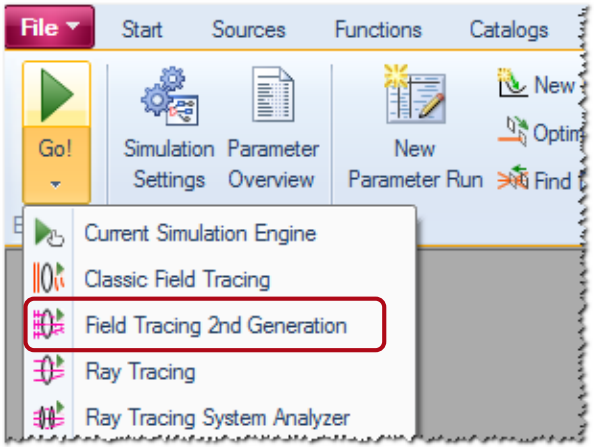
Results: Switching to Our Fast Approach



dot diagram



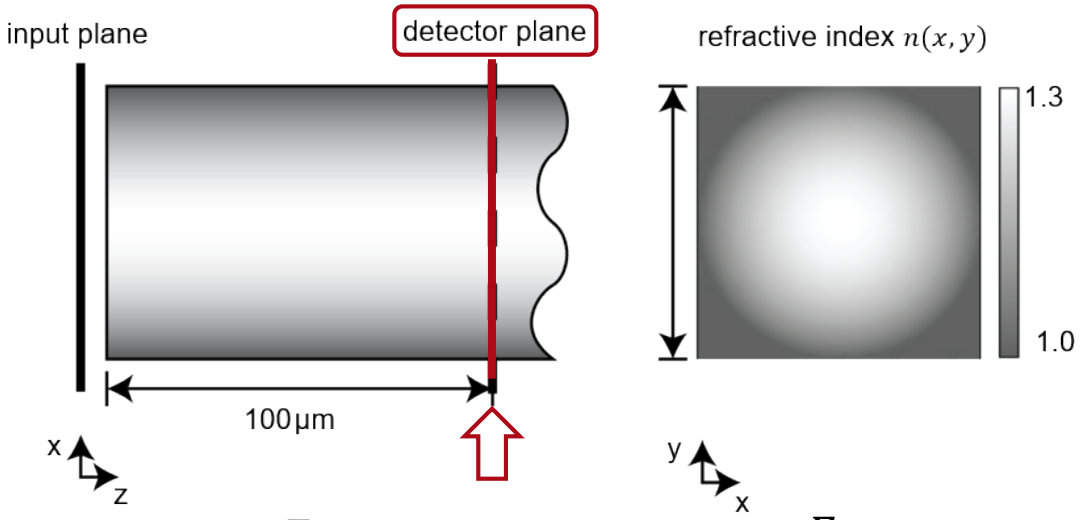
switching from ray tracing to field tracing by just one click



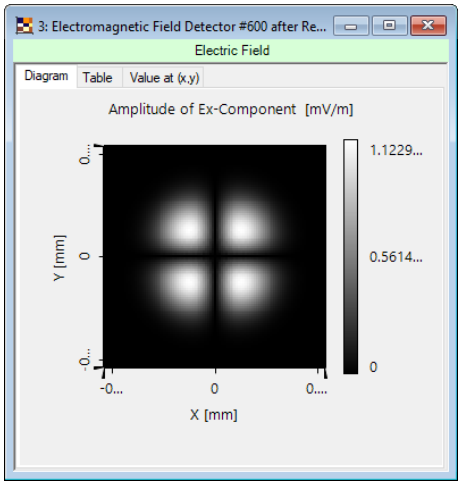
Highlights

easy switching between ray and field tracing

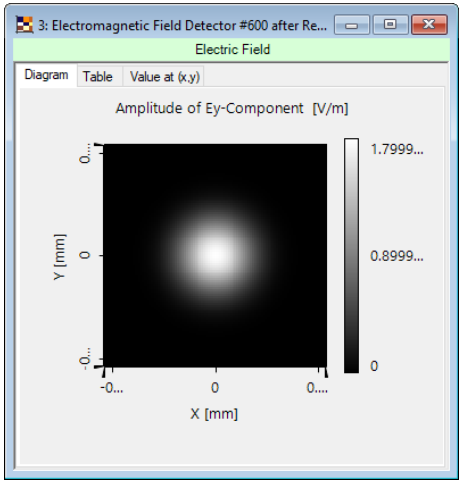
Results: Our Fast Approach



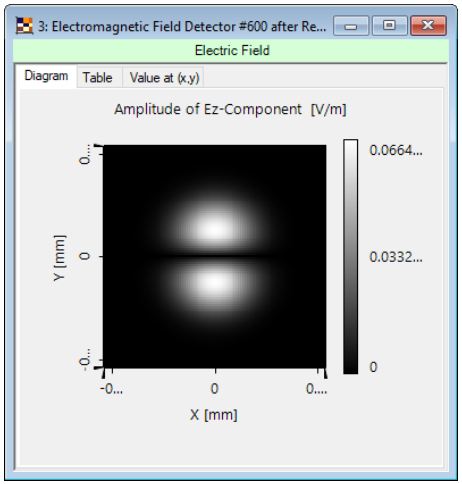
E_x



E_y

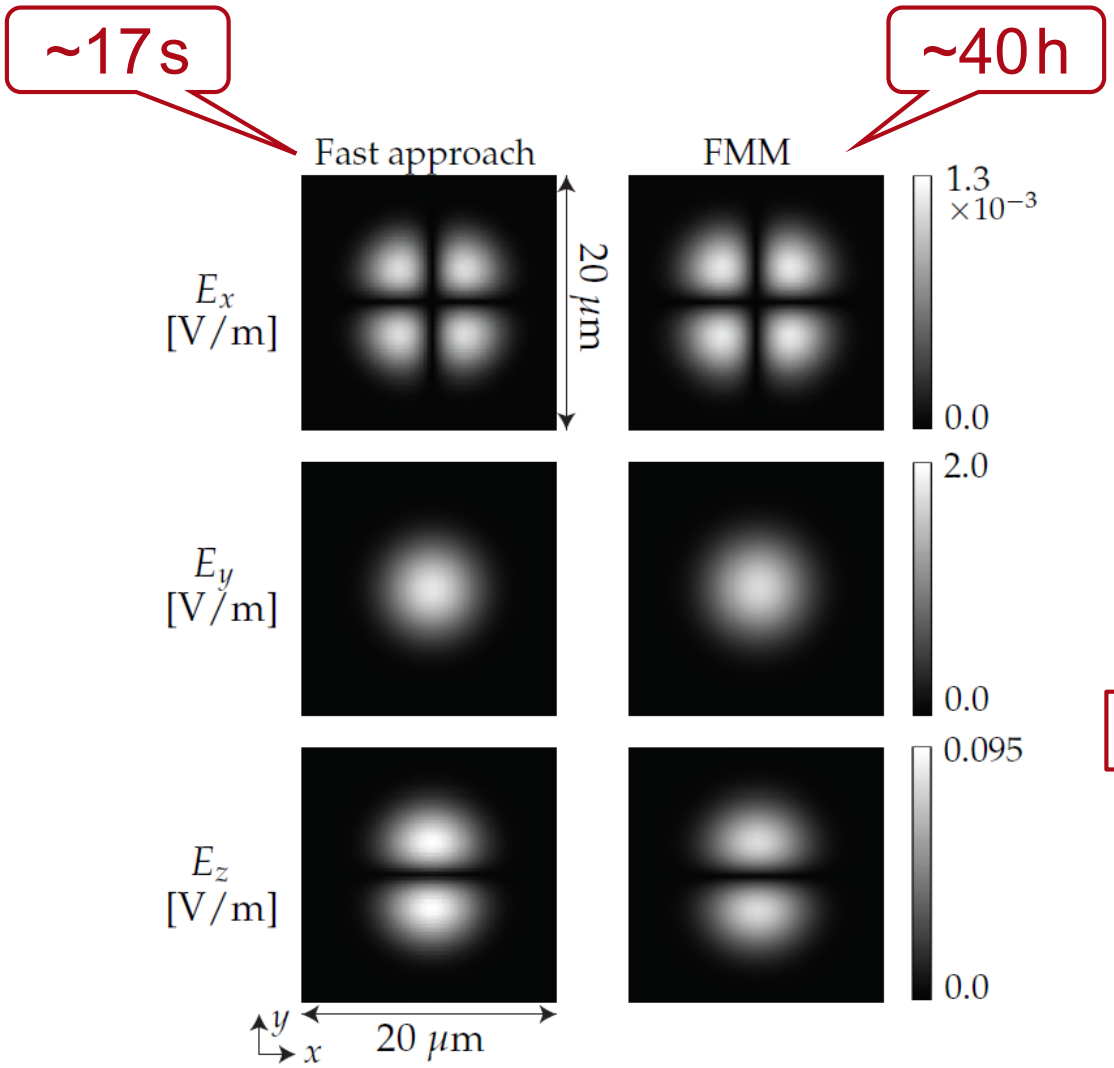


E_z



Amplitude [V/m]

Results: Our Fast Approach vs FMM



Deviation between results of both approaches is < 1%

Highlights

- high accuracy of new propagation method for multimode GRIN fibers
- consideration of polarization crosstalk

Document & Technical Info

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category	Laser Systems > Beam Delivery Systems (BD)
author	Huiying Zhong (LightTrans)
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Specifications of PC Used for Simulation	
Processor	i7-5600U (2 CPU cores)
RAM	12 GB
Operating System	Windows 10