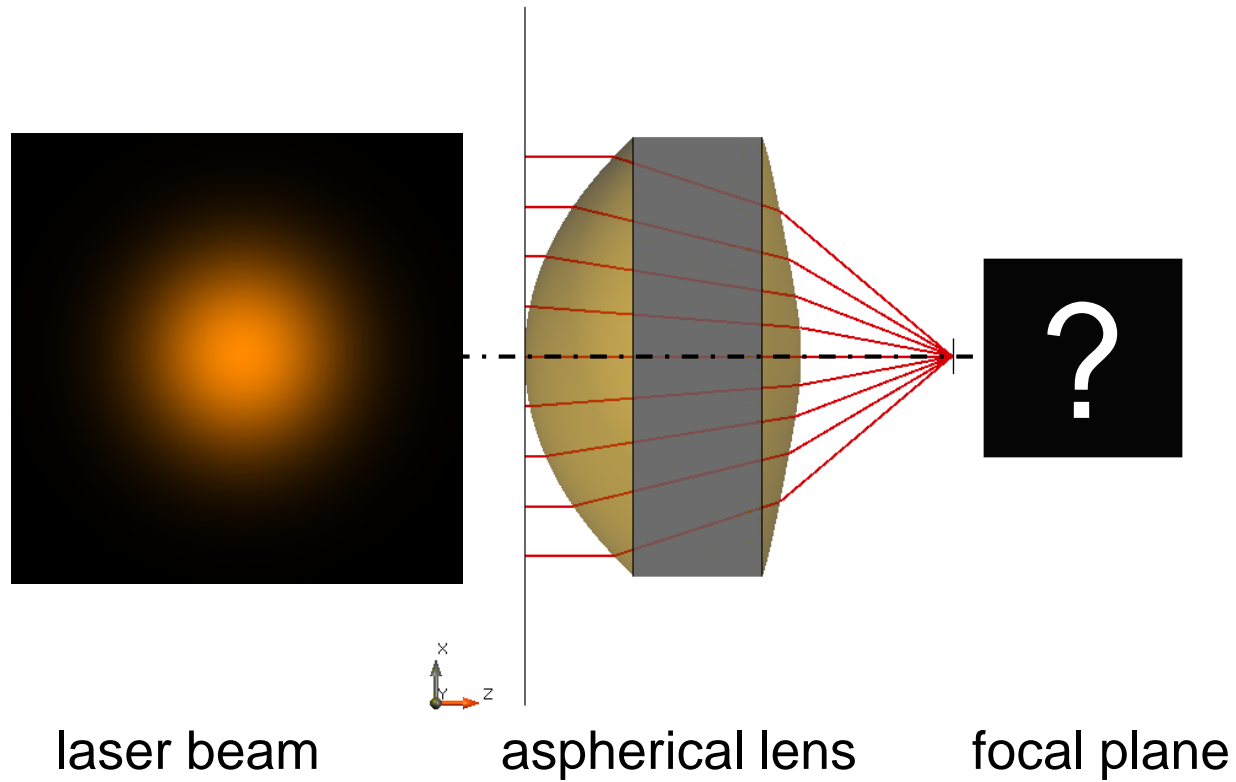Laser Systems > Beam Delivery
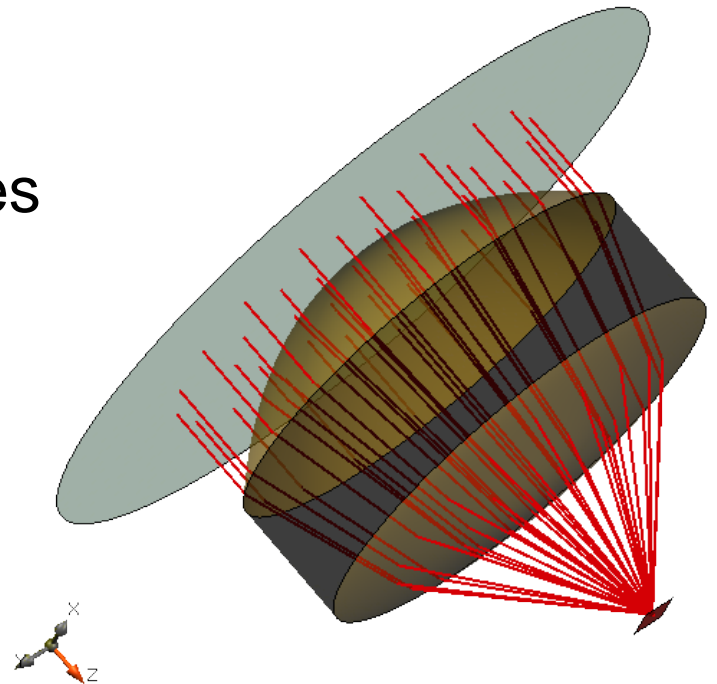
Simulation of Laser Beam in Focal Region of High-NA Asphere

Task/System Illustration
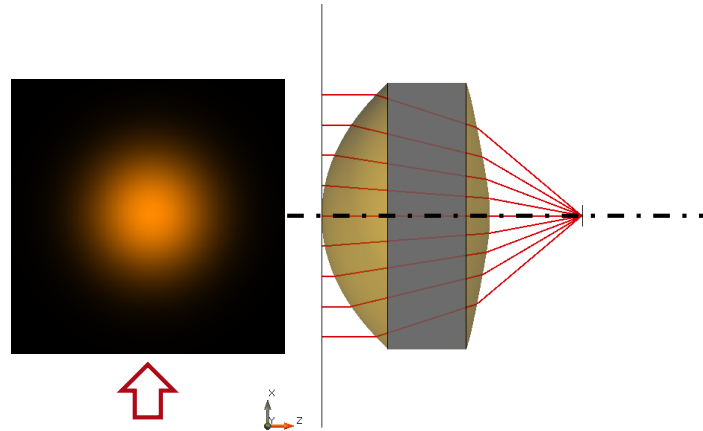

laser beam　　　aspherical lens　　　focal plane

Highlights

- propagation & evaluation
  of fully vectorial electromagnetic field of light
  → allows to evaluate polarization effects

- accurate consideration
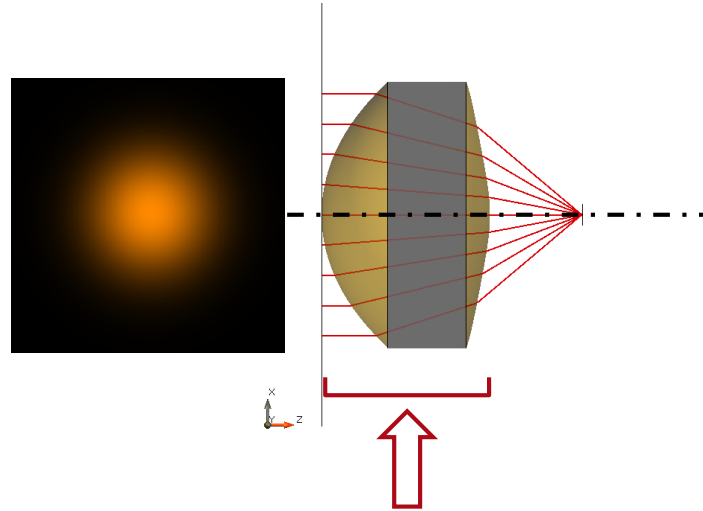 of Fresnel losses at lens surfaces

Specification: Light Source

Parameter	Description / Value & Unit
coherence/mode	single Hermite Gaussian (0,0) mode
wavelength	600 nm
polarization	linear in x-direction (0°)
$1/e^2$ diameter	2.5 mm
initial M^2 in x- and y-direction	1.00 × 1.00

Specification: Focusing Asphere

| Parameter	Value & Unit
name/type	convex-convex aspherical lens
numerical aperture	0.59
material	C0550 from Corning

Specification: Detectors
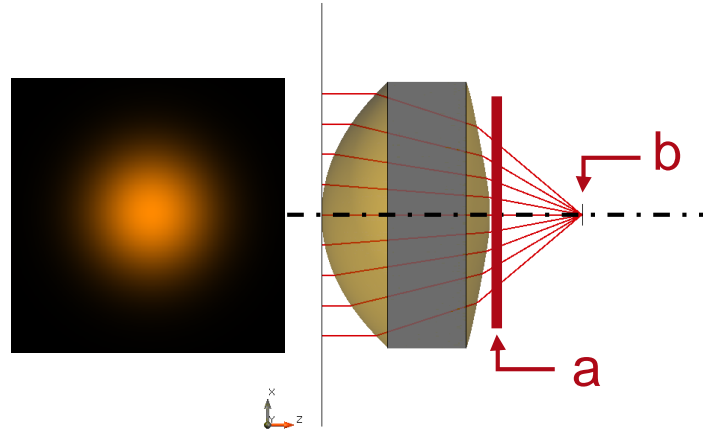
Position	Modeling Technique	Detector/Analyzer
full system	3D system ray tracing	general overview of light behavior in system
a	ray tracing	residual phase aberrations
b	ray tracing	dot diagram & focal beam size (x ✕ y)
b	field tracing	intensity distribution, focal beam size, M^2 value (x ✕ y)
b	field tracing	vectorial **E** field (E_x, E_y, E_z)*

the intensity is proportional to $|E_x|^2 + |E_x|^2 + |E_x|^2$
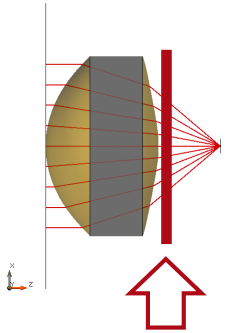
Result: 3D System Ray Tracing
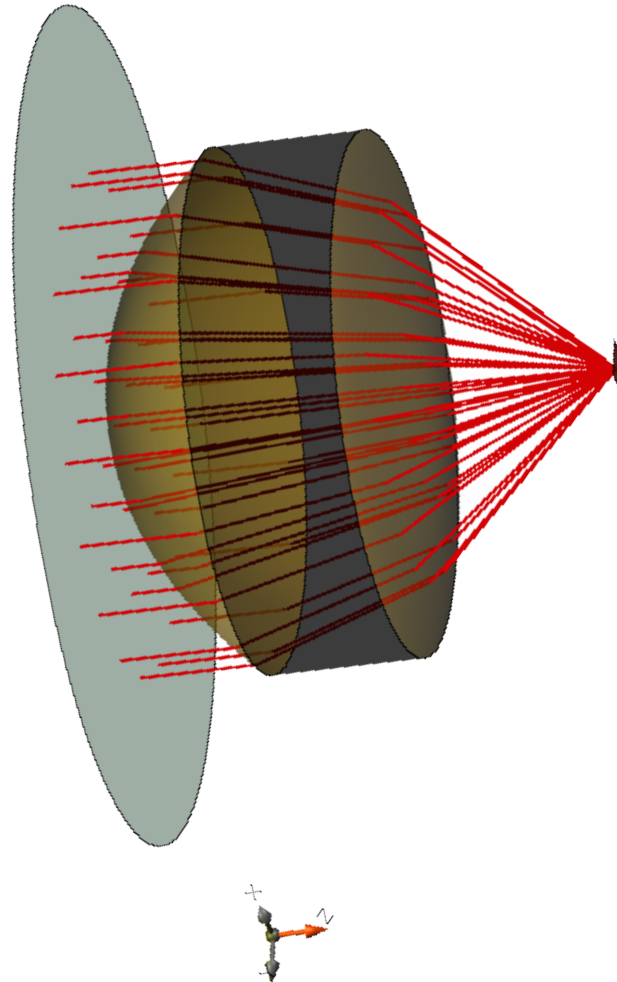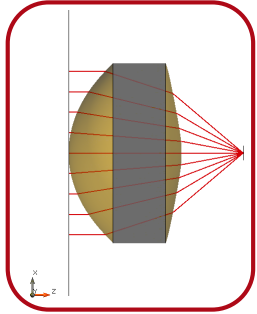
Results: Residual Phase Aberrations
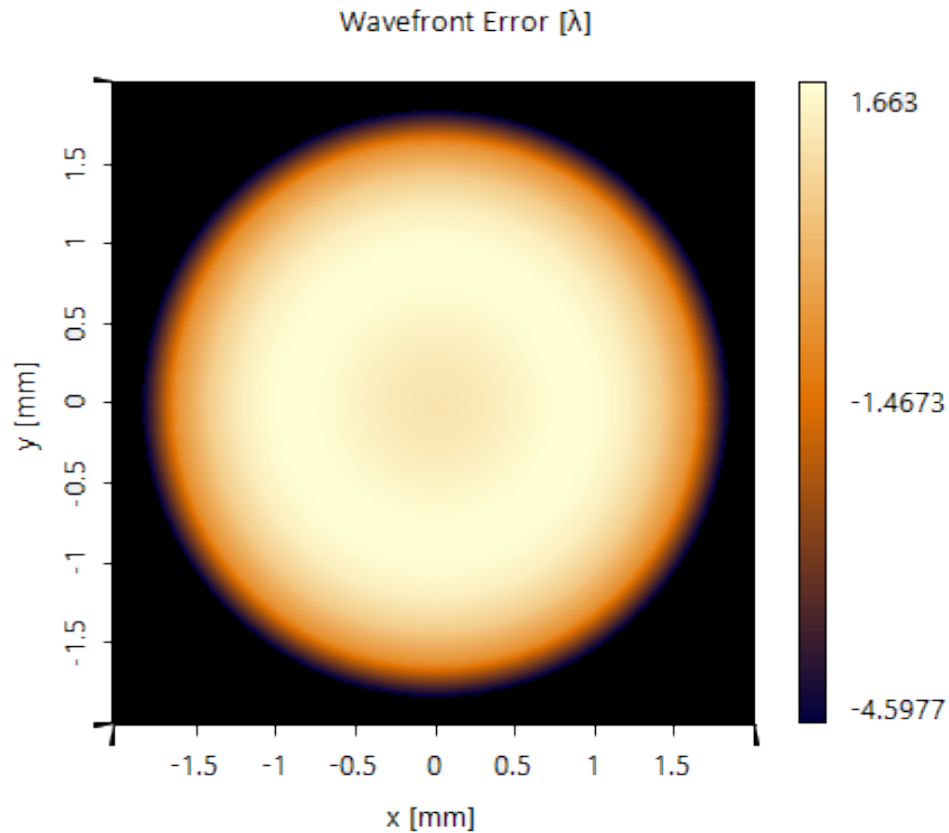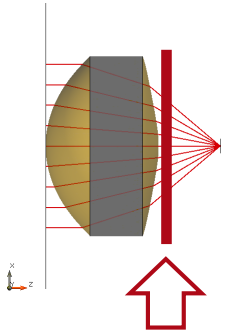
RMS of wavefront error $= 2.00\lambda$
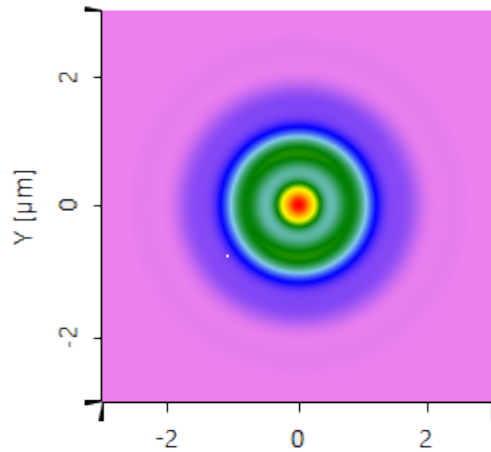
Results: Consideration of E_x, E_y, E_z

For paraxial system the E_z component of the light field can be neglected.
For this high NA system not...

Highlights

- propagation & evaluation of fully vectorial **E** field of light → allows to evaluate polarization effects

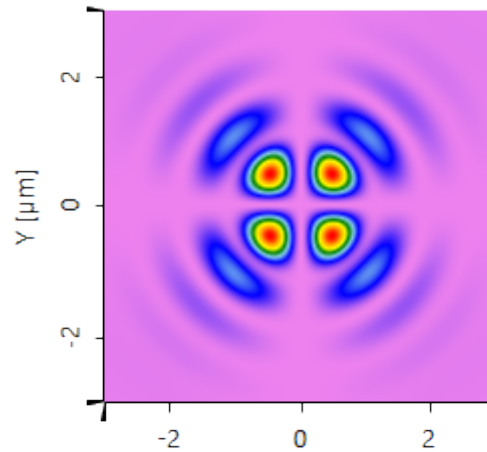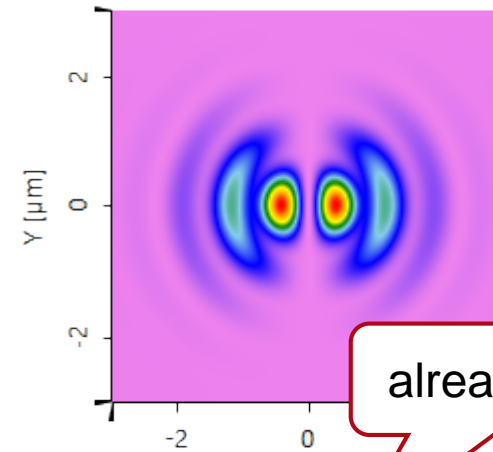- accurate consideration of Fresnel losses at lens surfaces

$|E_x|^2$ $|E_y|^2$ $|E_z|^2$

already >5%

maximum values $[(V/m)^2]$

| 0.9E+06 (100%) | 1.1E+2 (0.0012% ~ 0%) | 5.7E4 (6.3%) |

Results: with & without E_z Component
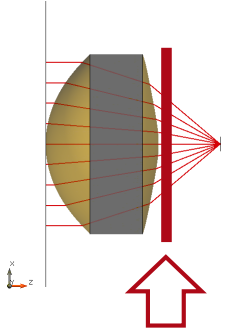
1D cross section in x direction
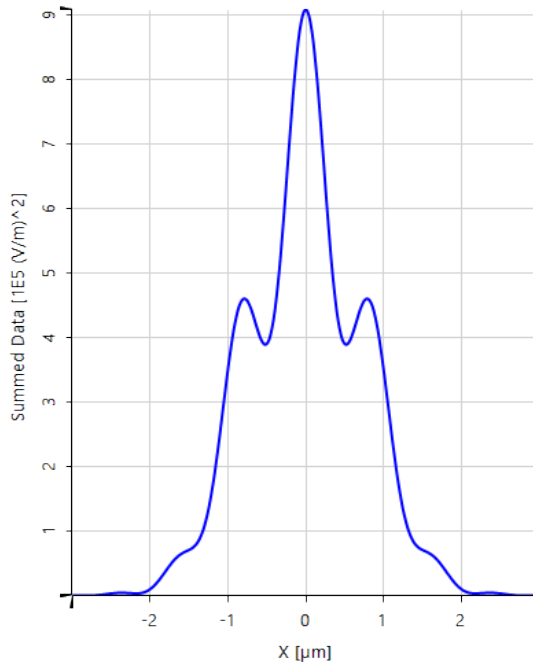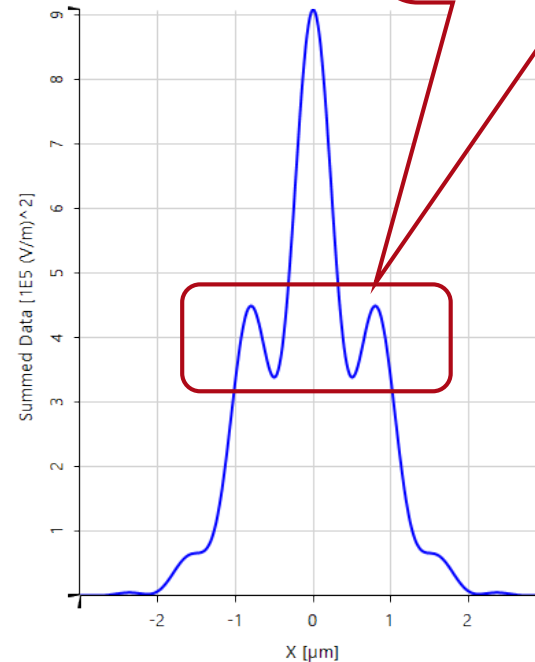
accurate intensity calculation → requires all field components

$|E_x|^2$

$|E_x|^2 + |E_y|^2 + |E_z|^2$

Document & Technical Info

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category	Laser Systems > Beam Delivery (BD)
author	Hartwig Crailsheim (LightTrans)
used VL version	7.0.0.29

Specifications of PC Used for Simulation	
Processor	i7-4910MQ (4 CPU cores)
RAM	32 GB
Operating System	Windows 10