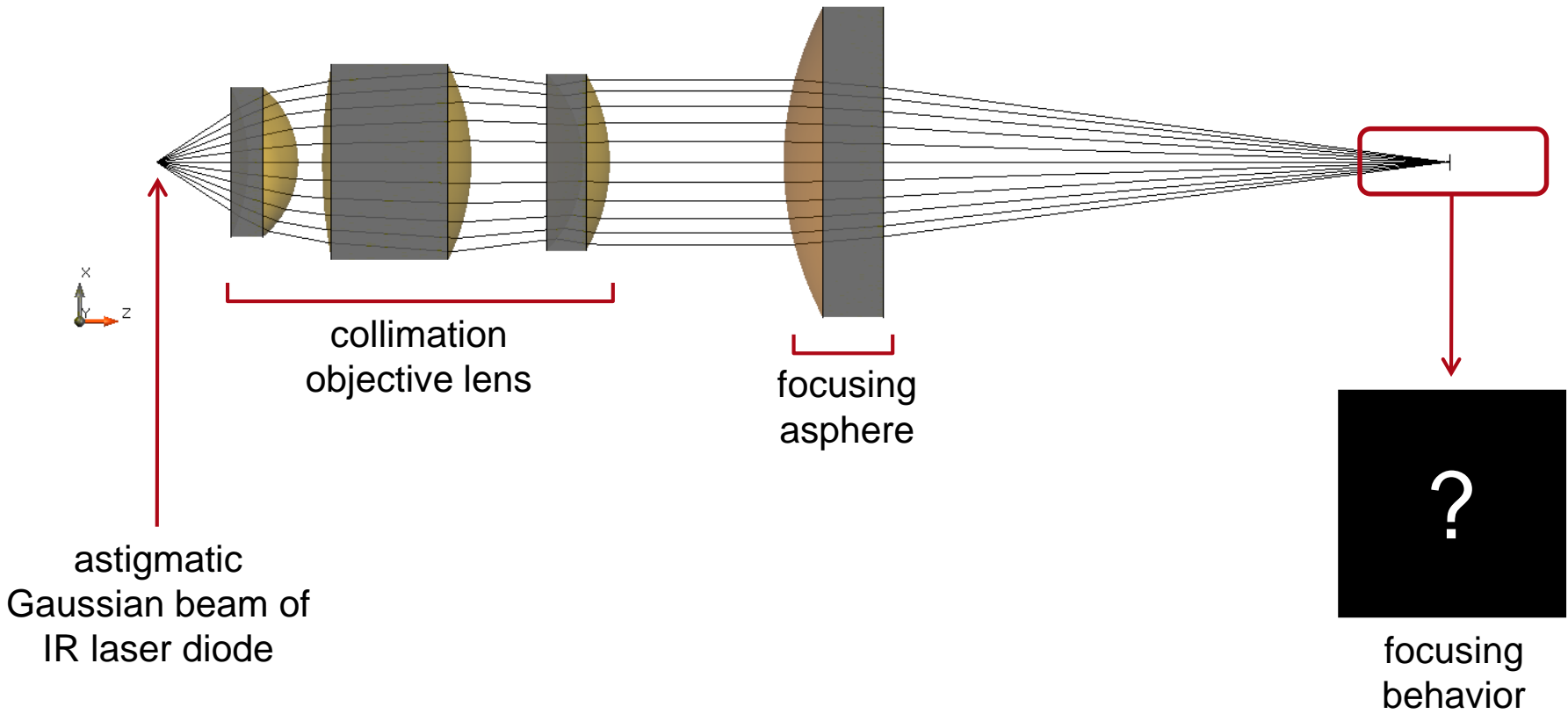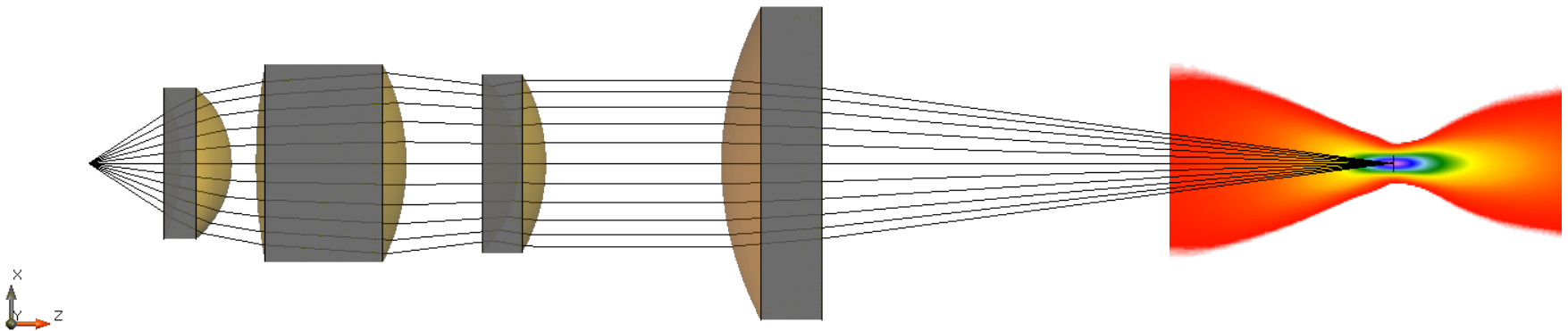Laser Systems > Beam Delivery

Focus Investigation behind Aspherical Lens

Task/System Illustration

collimation
objective lens

focusing
asphere

astigmatic
Gaussian beam of
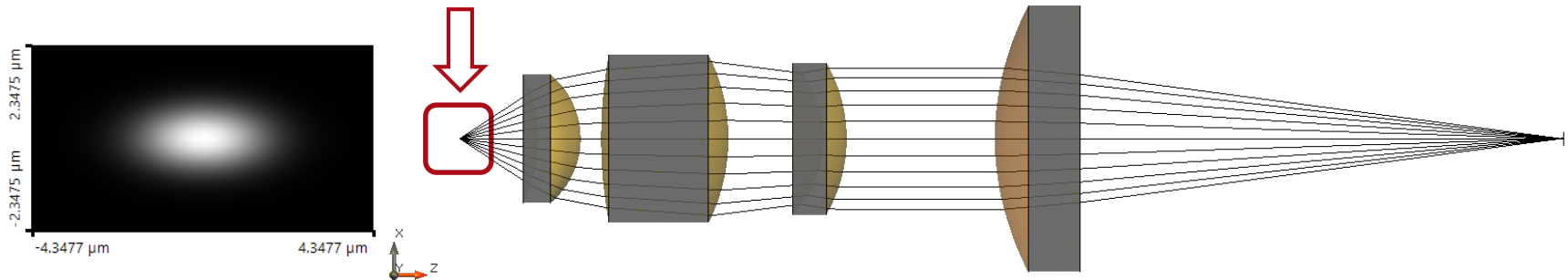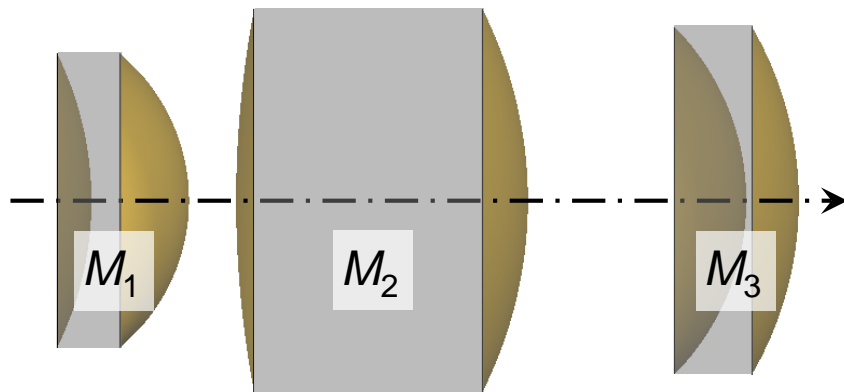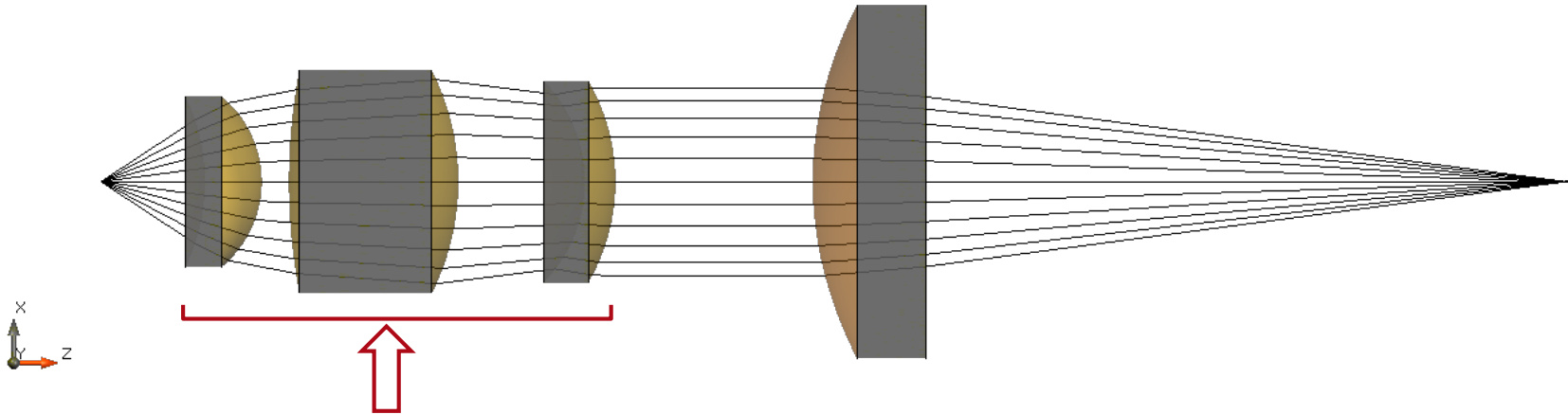IR laser diode

?

focusing
behavior

Highlights

- laser diode modeling inclusive astigmatism
  → impact on size, shape & position of focus spot

- diffraction at lens apertures

- advanced focal region analysis

Specification: Light Source

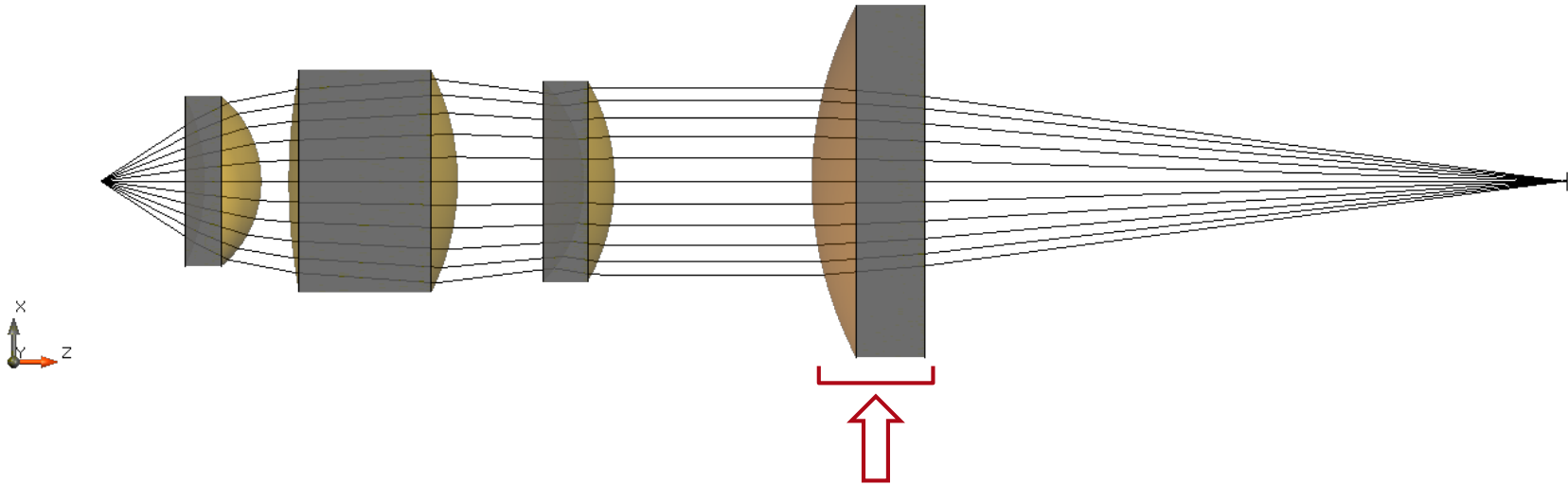| Parameter	Description / Value & Unit
type/number	single mode IR diode laser from Laser Components: WSLD-1064-050m-1-PD
coherence/mode	single Hermite Gaussian (0,0) mode
wavelength	1064 nm
polarization	linear in x-direction (0°)
FWHM of beam divergence with astigmatism	10° × 20° (i.e. 8.49° × 16.97° referring to the $1/e^2$ waist radius), astigmatic shift: -11.6 µm
initial M^2 in x- and y-direction	1.00 × 1.00

Specification: Collimating Lens

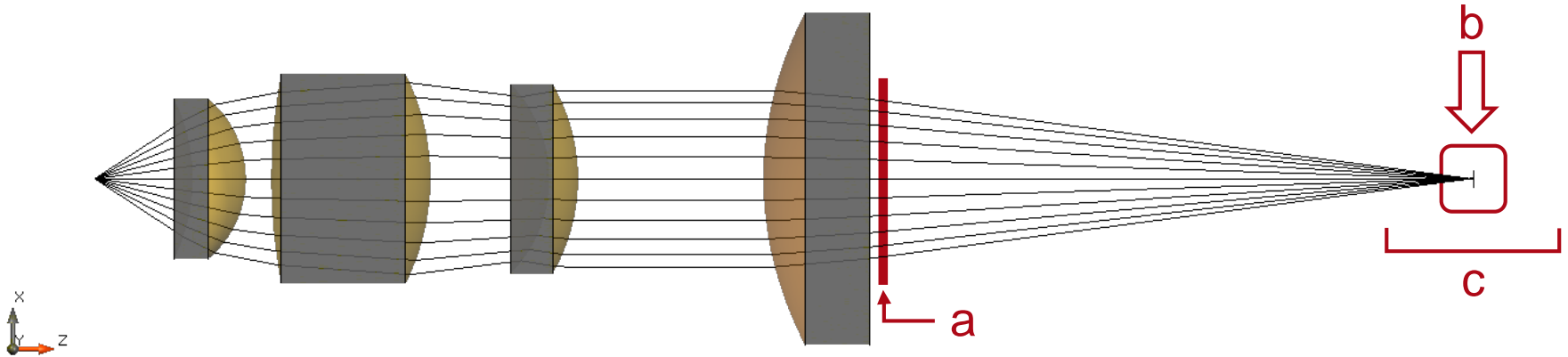| Parameter	Value & Unit
types of lens surfaces	3 lenses with 6 spherical surfaces
numerical aperture (NA)	0.63
materials	M_1: N-SF6* M_2, M_3: N-BK7*

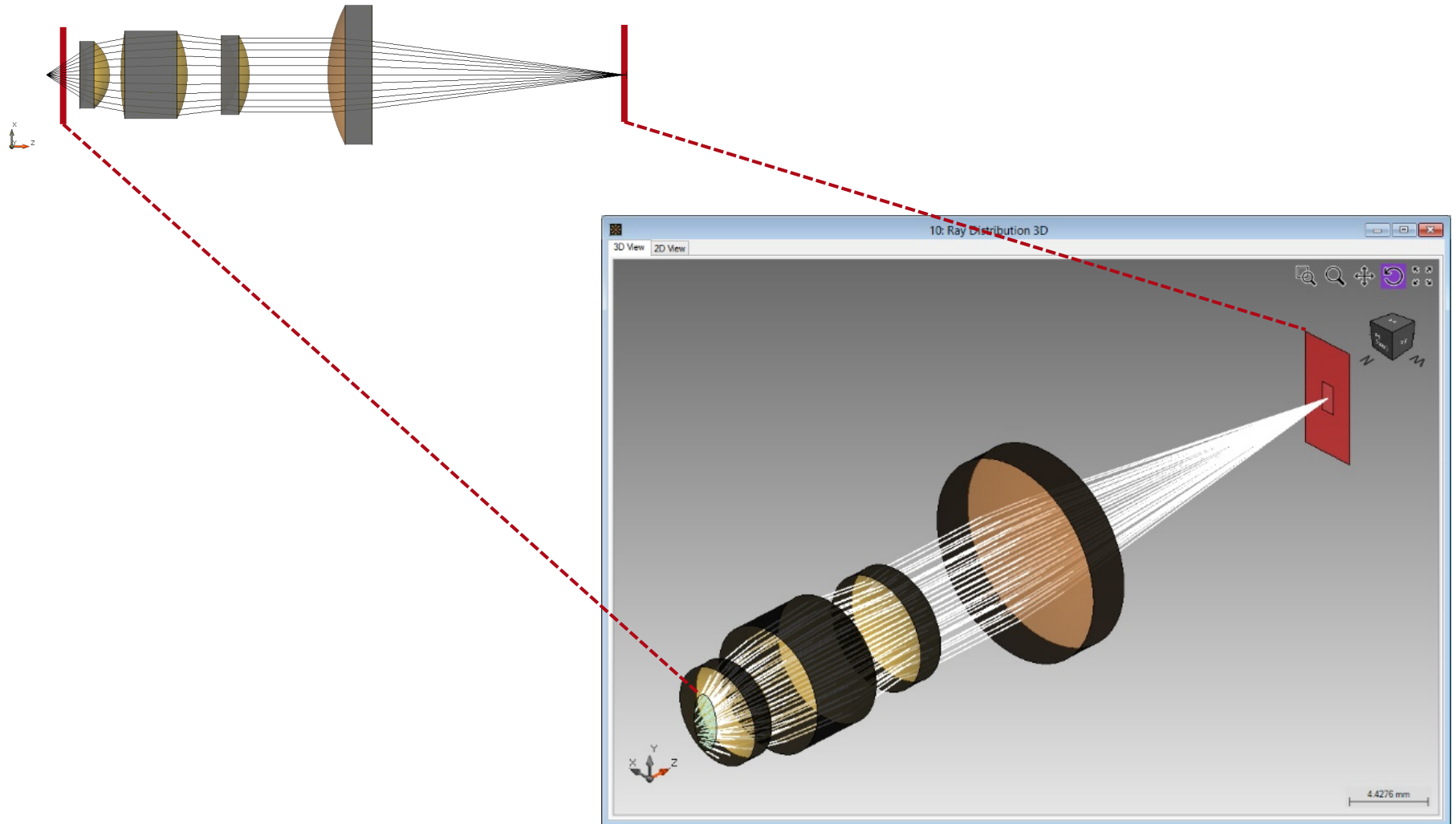*from catalog "Schott_2014"*

Specification: Focusing Asphere

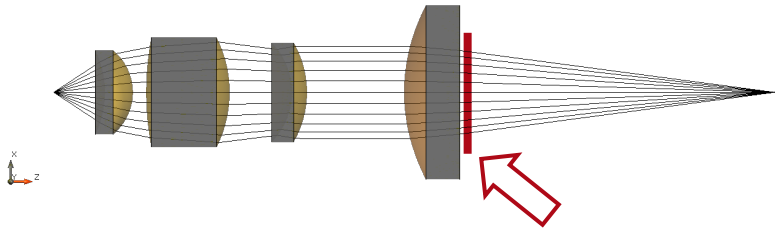| Parameter	Value & Unit
name/type	convex-plano aspherical lens from Asphericon: ALL12-25-S-U (A12-25LPX)
numerical aperture	0.23
material (M)	N-BK7

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
b	field tracing	focal beam size, M^2 value (x ✕ y)
c	field tracing	focal region analysis by multiple 1D cross sections in x- & y-direction

Results: 3D System Ray Tracing
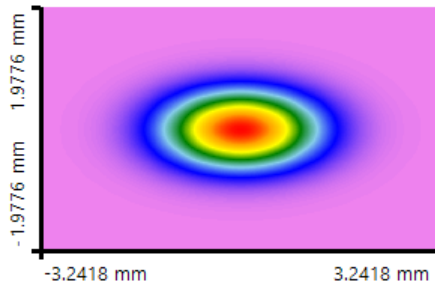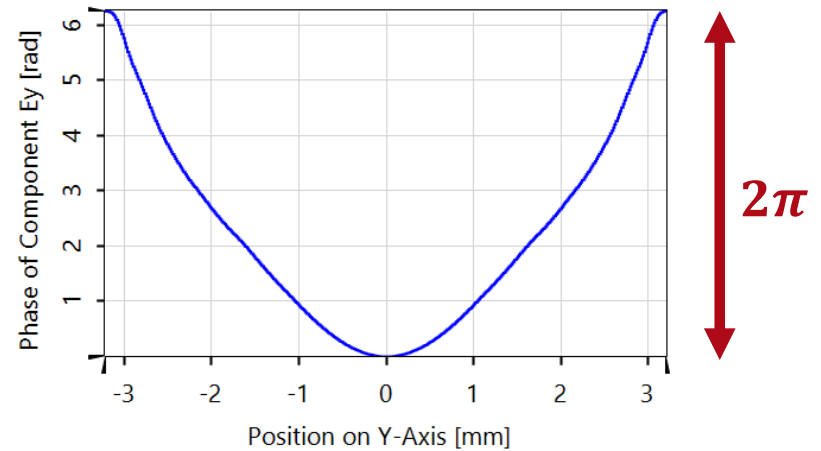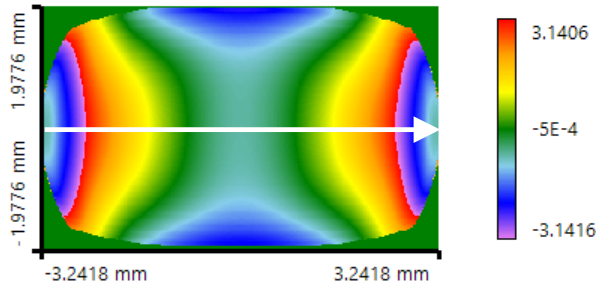
Results: Field behind Asphere

- laser diode modeling inclusive astigmatism
- diffraction at lens apertures
- advanced focal region analysis

intensity

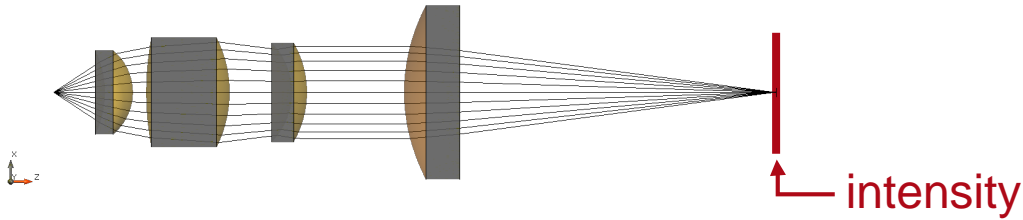**residual phase**

Simulation Time ~2s

2π

1D cross section of remaining phase
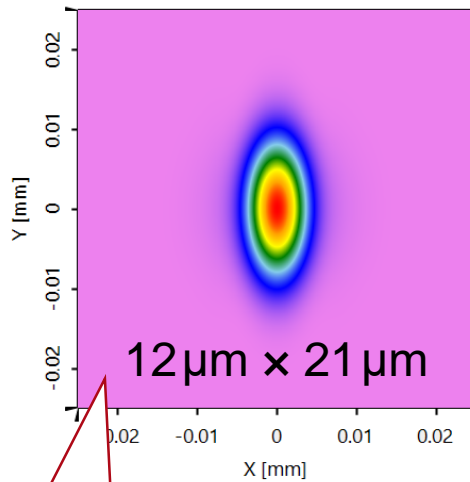
Results: Comparison with/without Astigmatisms

intensity

- laser diode modeling inclusive astigmatism
- diffraction at lens apertures
- advanced focal region analysis

12 µm × 21 µm

11 µm × 19 µm

with astigmatism (11.6 µm)

without astigmatism

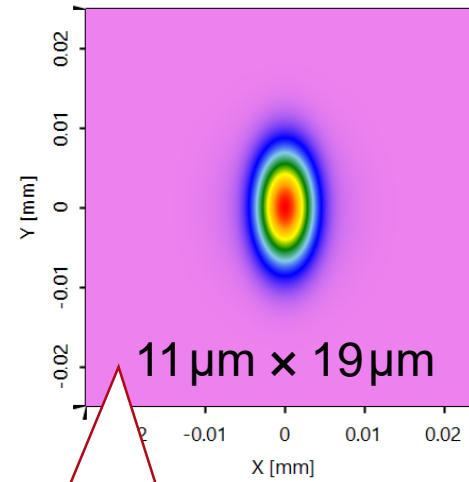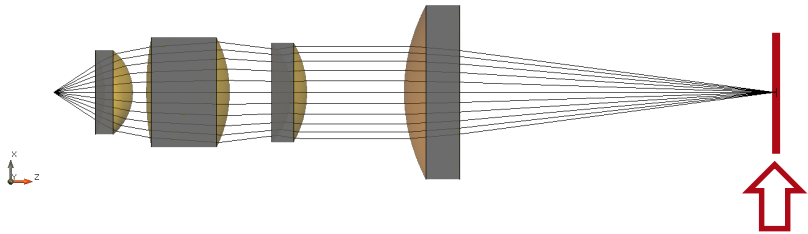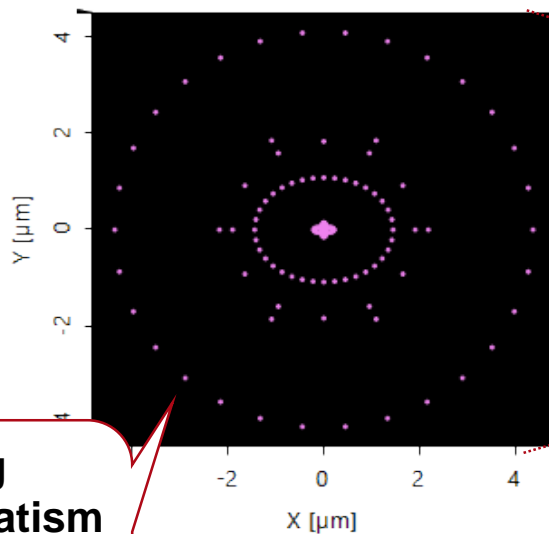# Results: Focus Spot (PSF) & Parameters
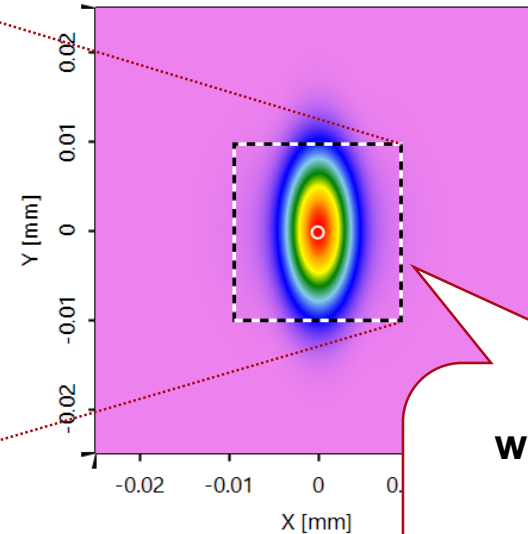
Highlights

- laser diode modeling inclusive astigmatism
- diffraction at lens apertures
- advanced focal region analysis

**ray tracing
without astigmatism**

RMS diameter
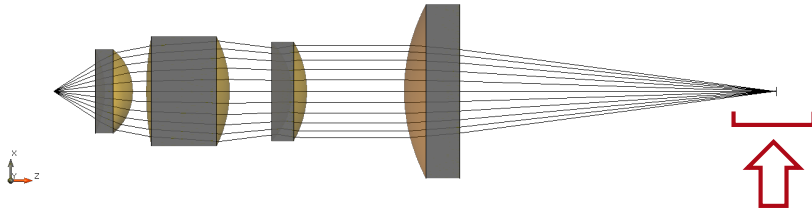(x × y) = 6 µm × 6 µm

**dot diagram
of ray positions**

intensity

**field tracing
with astigmatism**

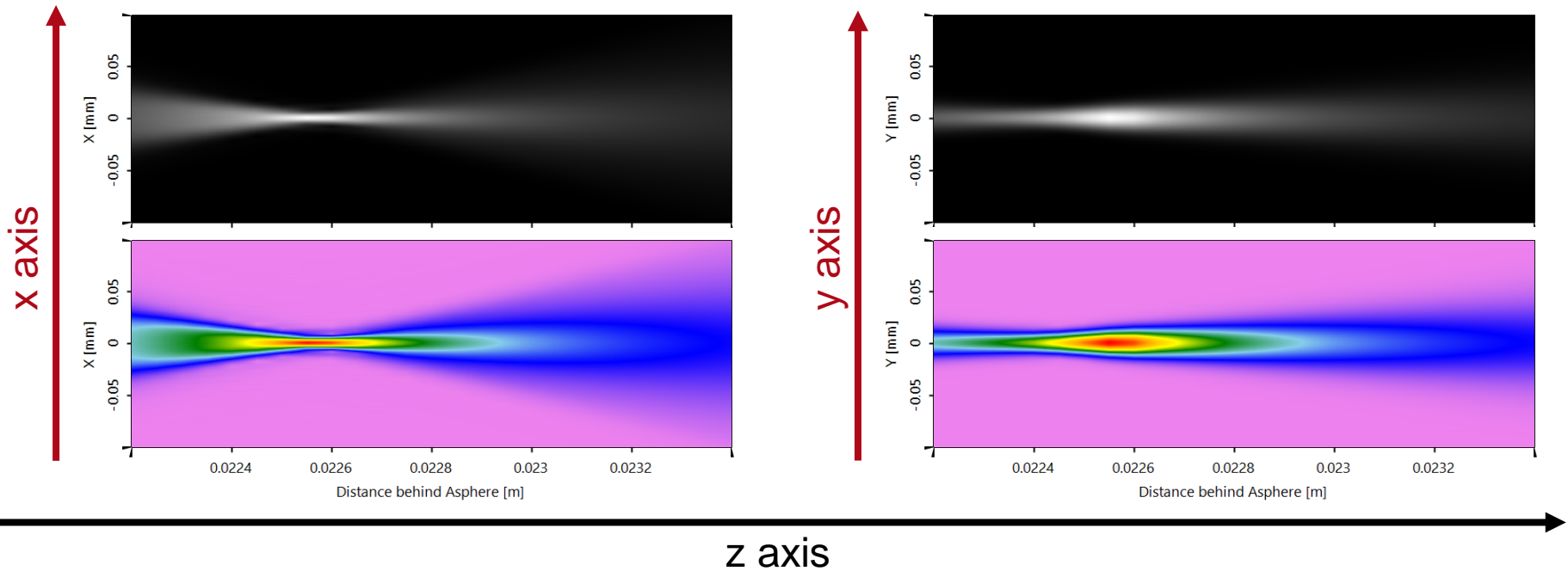$1/e^2$ diameter
(x × y) = 11 µm × 19 µm

beam quality
M2 = 1.07 × 1.01

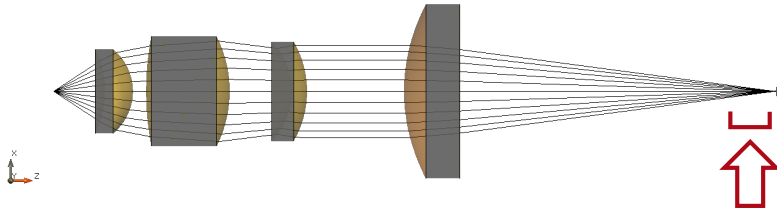# Results: Field Analysis in Focal Region 1D

Highlights

- laser diode modeling inclusive astigmatism
- diffraction at lens apertures
- advanced focal region analysis

x axis

y axis

z axis

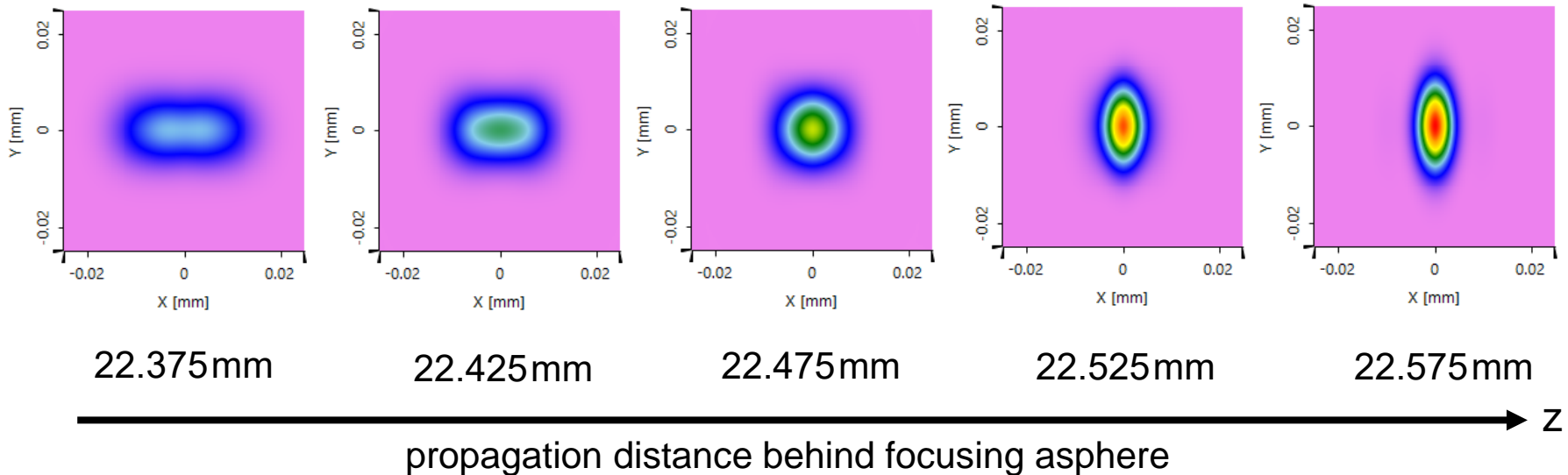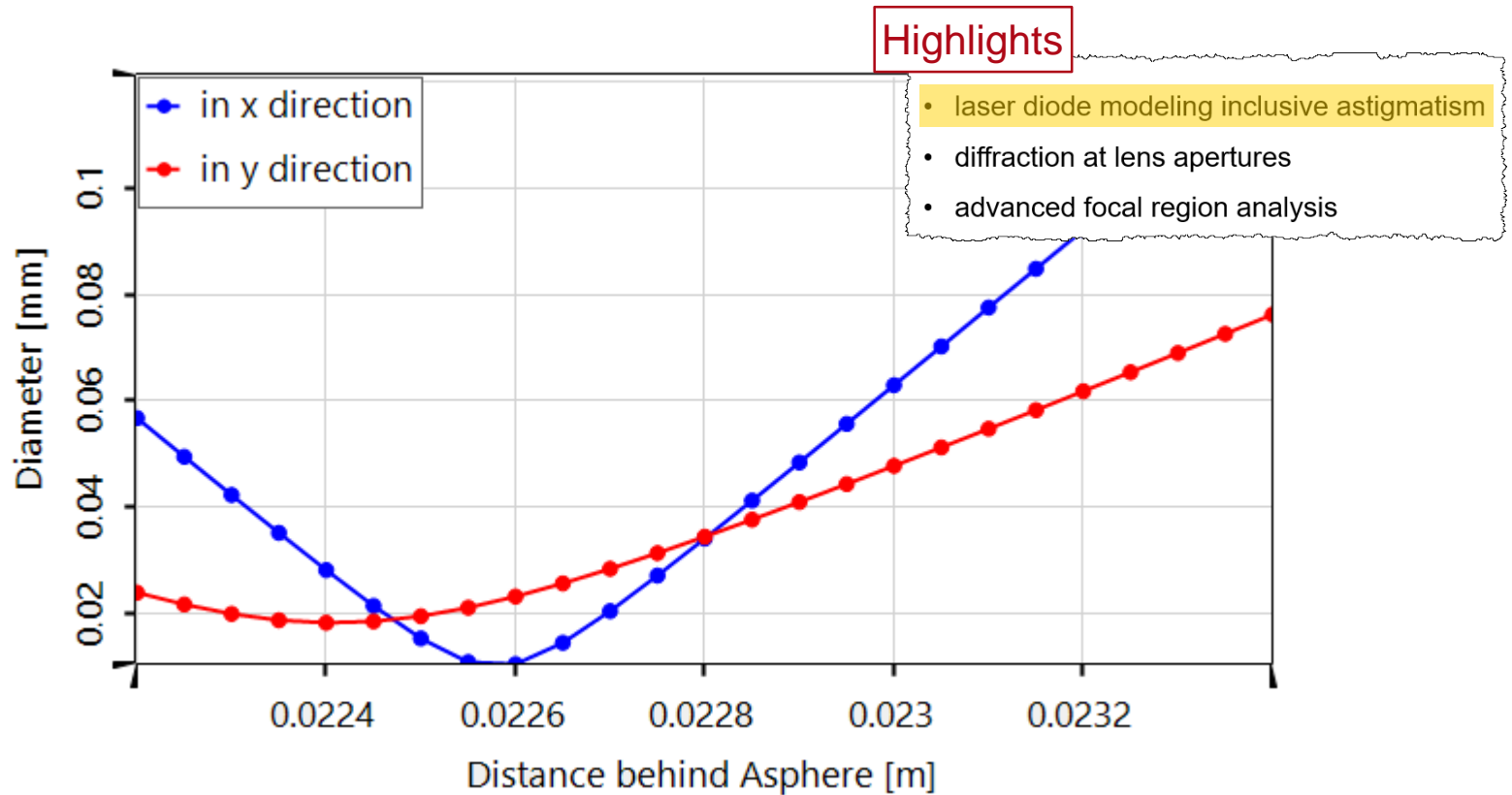*(amplitudes in grey and inverse rainbow colors)*

Results: Field Development in front of Focus 2D

principal axis of beam ellipse changes from y- to x-direction.

| 22.375mm | 22.425mm | 22.475mm | 22.525mm | 22.575mm |

propagation distance behind focusing asphere

Results: Focus Position in X vs Y Direction

z-position of smallest spot diameter
is different for x- and y-direction

Document & Technical Info

code	BD.0002
version of document	1.0
title	Focus Investigation behind Aspherical Lens
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