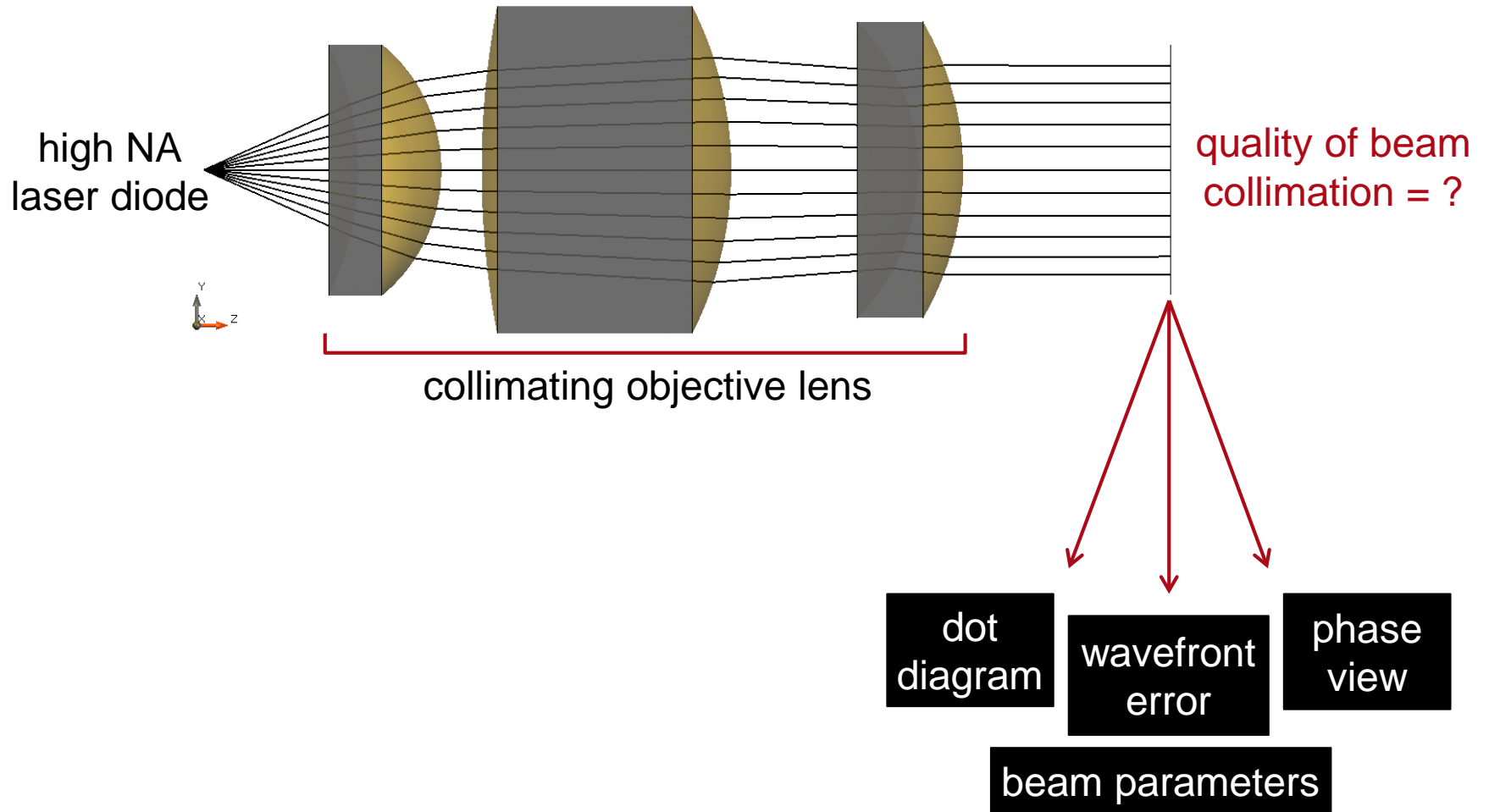Laser Systems > Beam Delivery

Analysis of Collimation of Astigmatic Diode Laser Beam by Objective Lens

Task/System Illustration

high NA laser diode

collimating objective lens

quality of beam collimation = ?

dot diagram

wavefront error
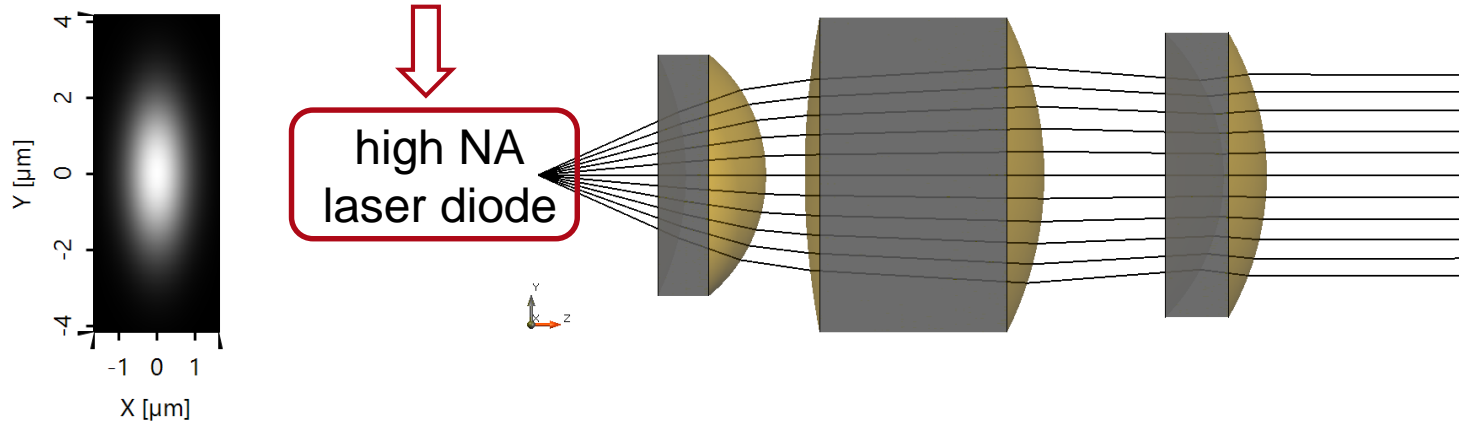
phase view

beam parameters

Highlights

- laser diode modeling including astigmatism

- various options for evaluation of beam collimation
  → influence of astigmatism

- quality analysis of beam truncated by lens aperture
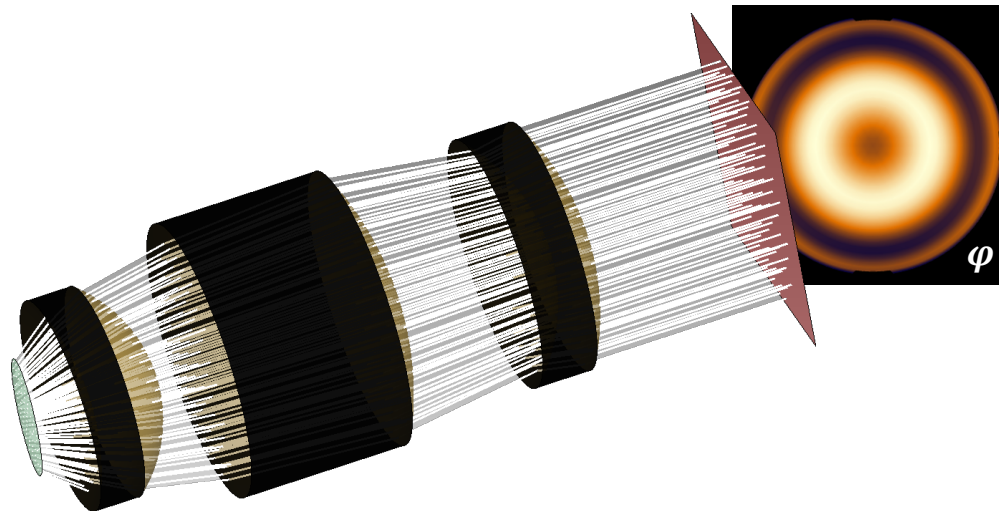
Specification: Light Source

| 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 y-direction (90°)
FWHM of beam divergence with astigmatism	20° × 10° (i.e. 16.97° × 8.49° referring to the $1/e^2$ waist radius), astigmatic shift set to 11.6 μm
initial M^2 in x- and y-direction	1.00 × 1.00

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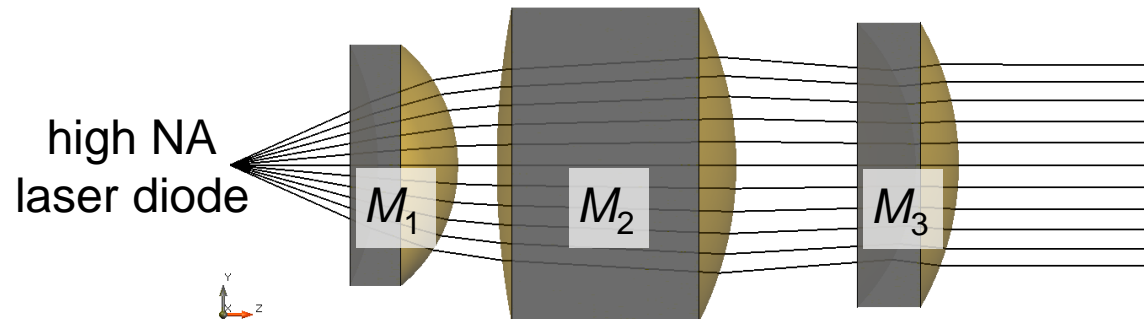
| Parameter	Value & Unit
types of lens surfaces	3 lenses with 6 spherical surfaces
numerical aperture (NA)	0.63
materials	M_1: N-SF6* M_2, M_3: N-BK7*

from catalog "Schott_2014"

Specification: Detectors
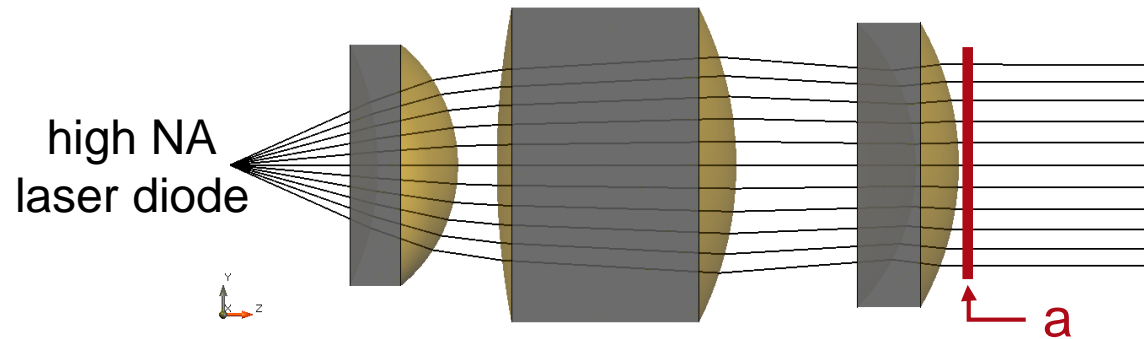
| Position	Modeling Technique	Detector/Analyzer
full system	3D system ray tracing	general overview of light behavior in system
a	ray tracing	phase aberrations (RMS of wavefront error)
a	ray tracing	ray directions from dot diagram
a	field tracing	intensity distribution
a	field tracing	beam parameters (for x × y): • full $1/e^2$ angle divergence • M^2 value

Results: 3D System Ray Tracing

high NA
laser diode
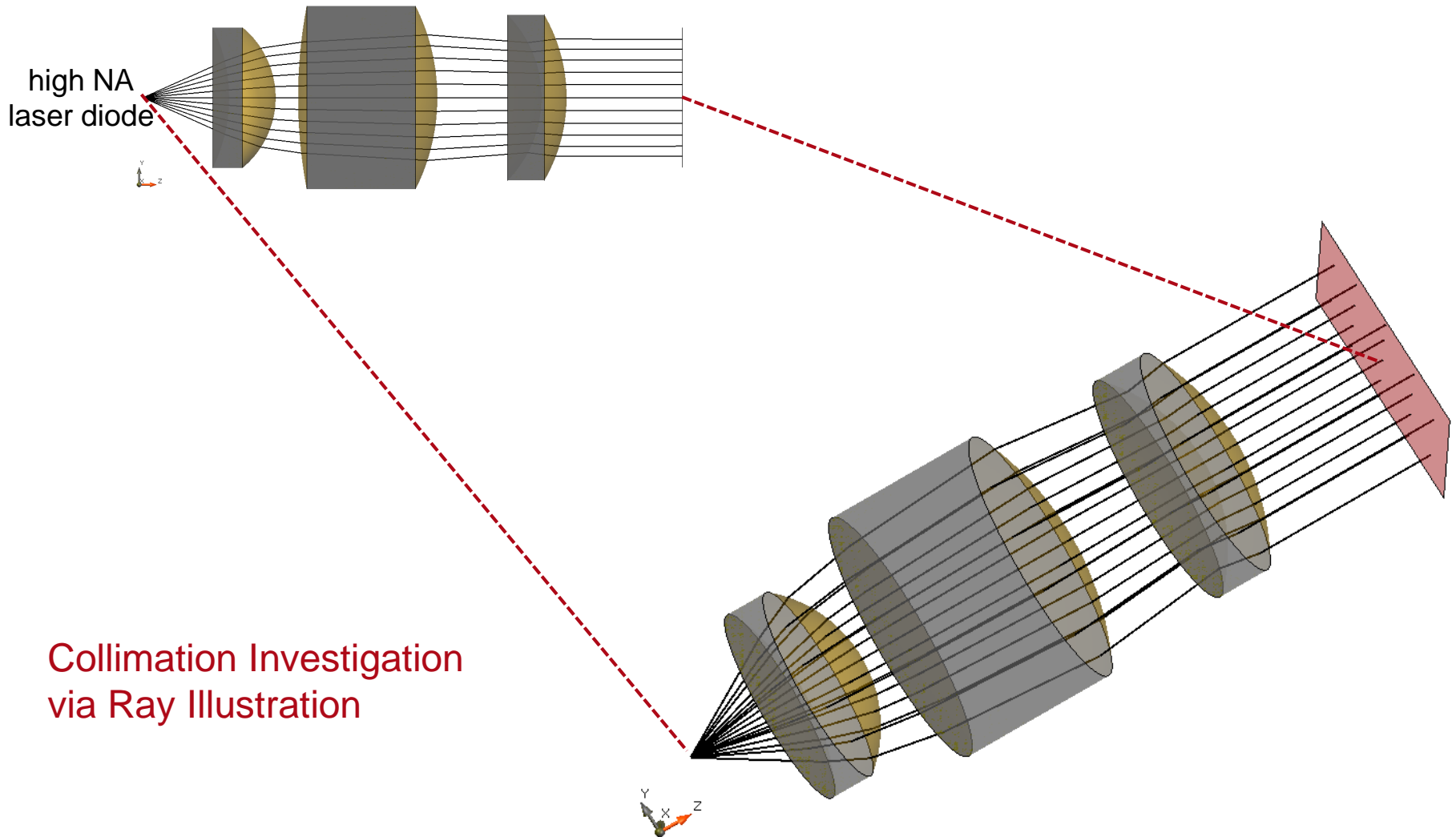
Collimation Investigation
via Ray Illustration

Results: Wavefront Error without Astigmatism

high NA
laser diode
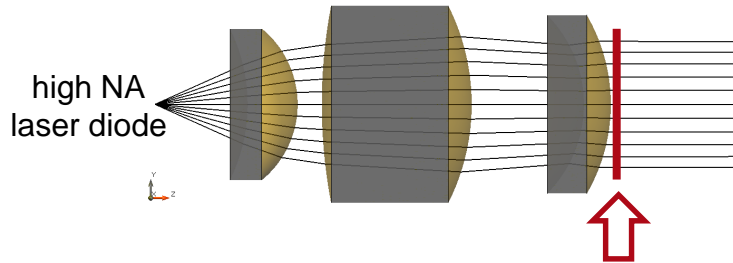
Collimation Investigation
via Wavefront Error
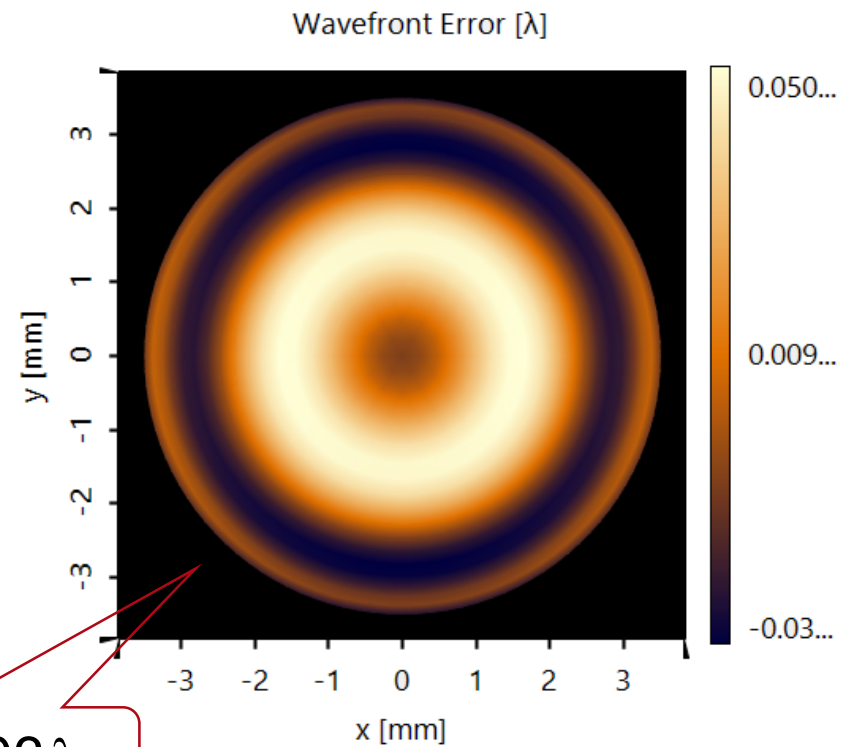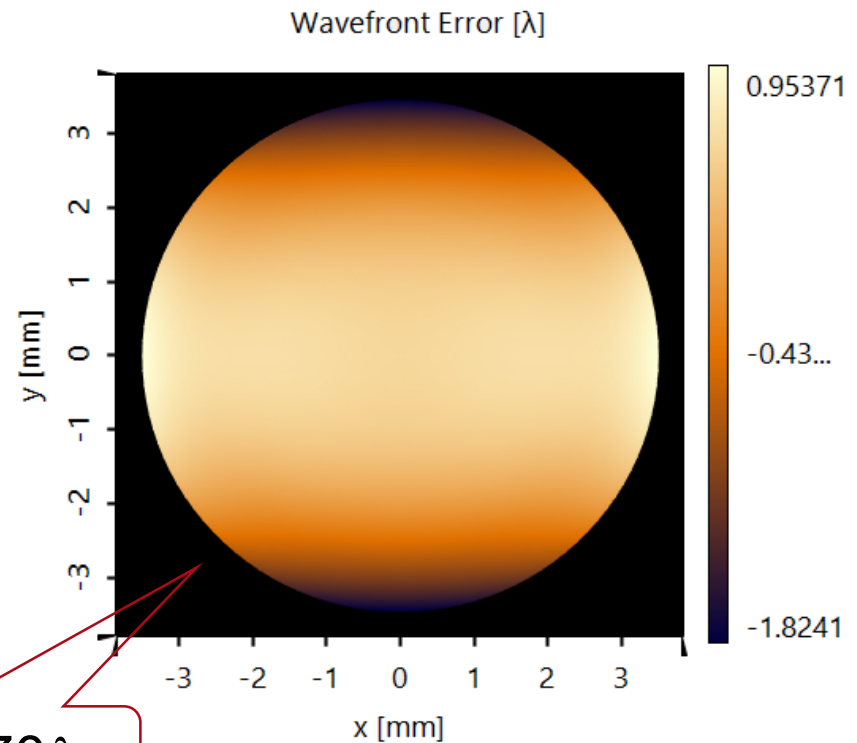
Wavefront Error [λ]

RMS = 0.03λ
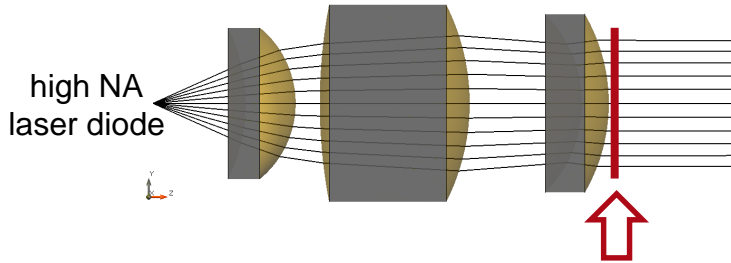
Results: Wavefront Error with Astigmatism

high NA
laser diode
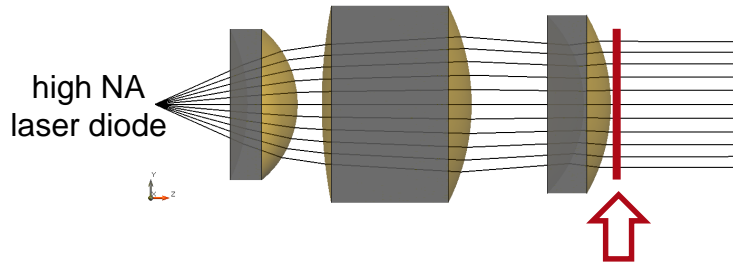
Collimation Investigation
via Wavefront Error

→ Astigmatism of source causes
asymmetric & stronger
wavefront error.

RMS = 0.70λ

Wavefront Error [λ]

0.95371

-0.43...

-1.8241

y [mm]

x [mm]

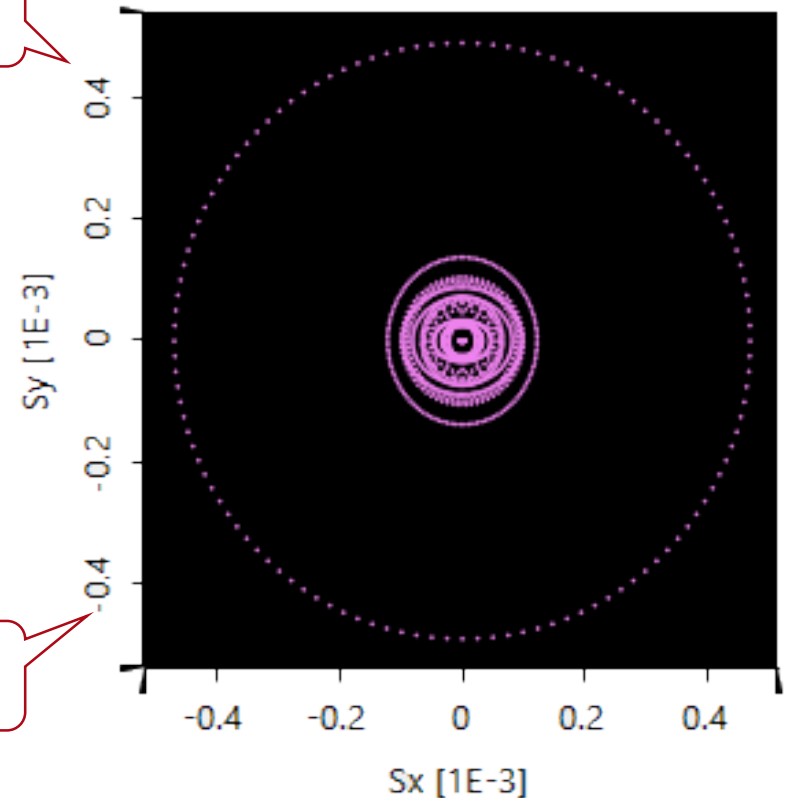# Results: Ray Directions without Astigmatism

high NA
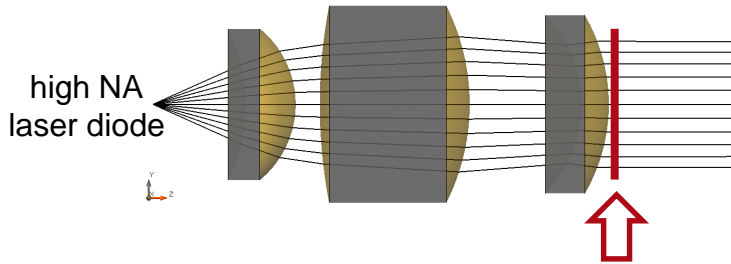laser diode

0.0004

0.0004

Collimation Investigation
via Ray Directions

→ The x- and y-component
of the direction vector
of every ray are almost
zero.

Results: Ray Directions with Astigmatism
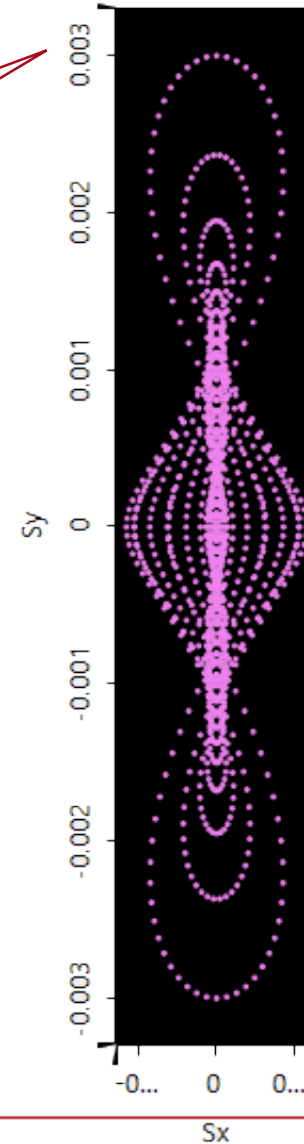

high NA
laser diode
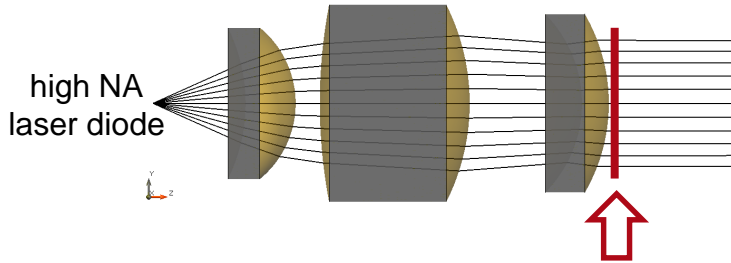
0.003

Collimation Investigation
via Ray Directions

→ The x- and y-component
of the direction vector
of every ray are still negligible.
→ Astigmatism of source causes
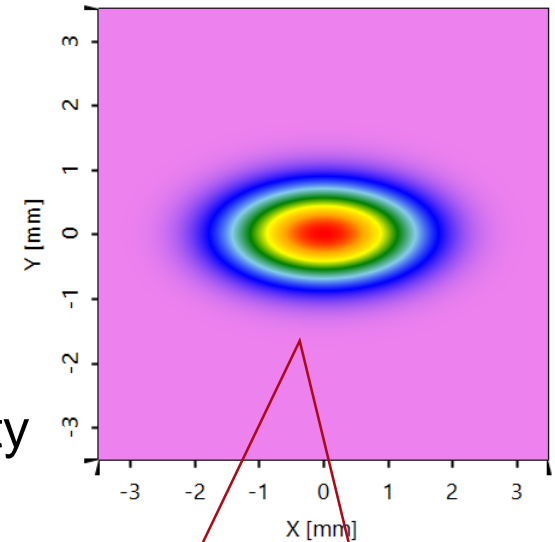asymmetric distribution of
directions.

0.0005

Result: Field Evaluation without Astigmatism

high NA
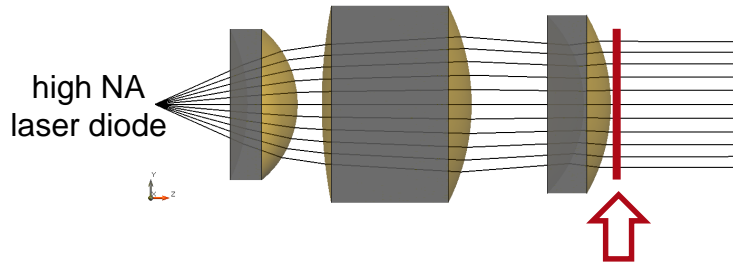laser diode

Collimation Investigation
via Beam Parameters

intensity

Simulation Time ~4s

Parameter	Value & Unit
full $1/e^2$ divergence angle	0.02° × 0.04°
M^2 value	1.09 × 1.01

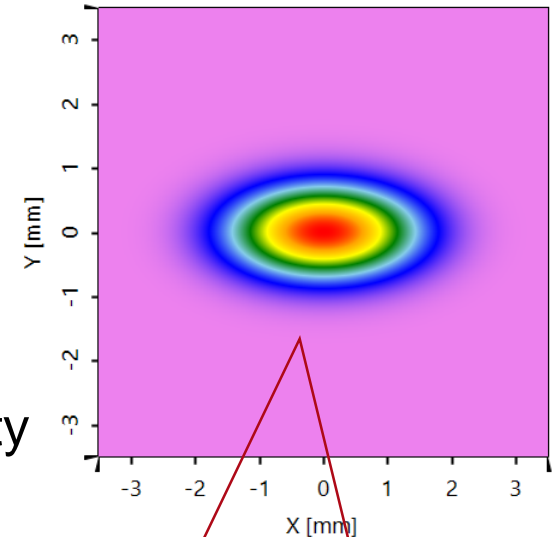# Result: Field Evaluation with Astigmatism

high NA
laser diode

Collimation Investigation via Beam Parameters

→ Astigmatism of source causes changes of
- divergence angle
- beam quality

Simulation Time ~4s

intensity

Parameter	Value & Unit
full $1/e^2$ divergence angle	0.02° × 0.05°
M^2 value	1.06 × 1.01

Document & Technical Info

code	BD.0001
version of document	1.0
title	Analysis of Collimation of Astigmatic Diode Laser Beam by Objective 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