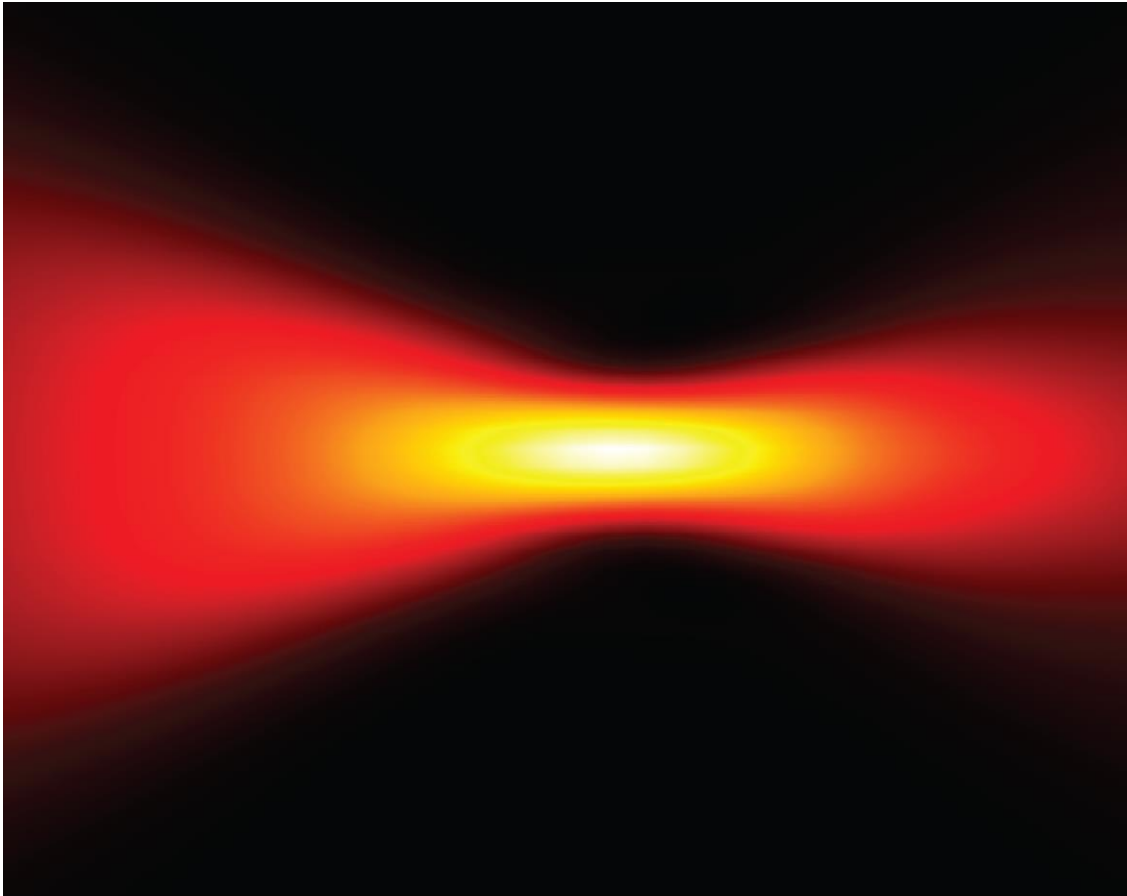


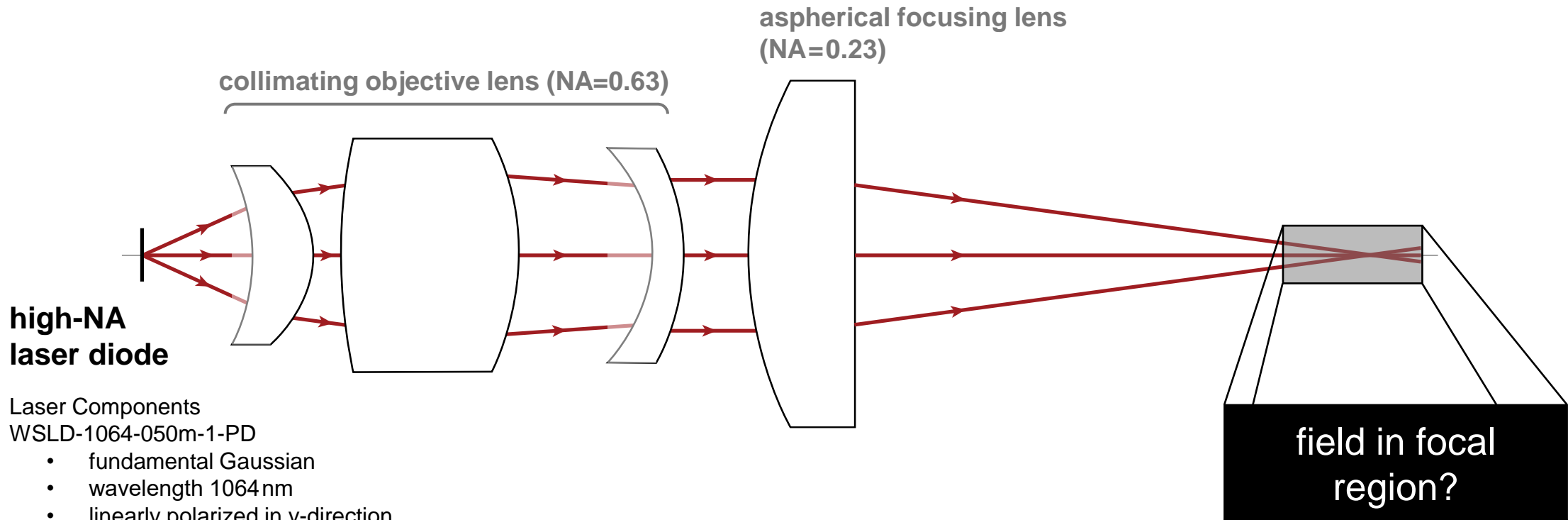
# Focus Investigation behind Aspherical Lens

# Abstract



High-power laser diodes often show asymmetric divergence and astigmatism. As an example, a laser diode is first collimated by an objective, then focused by an aspherical lens, and the evolution of the field in the focal region is investigated in VirtualLab Fusion. The influence of the astigmatism on the field in its focal region is clearly presented, compared against the case without astigmatism.

# Modeling Task



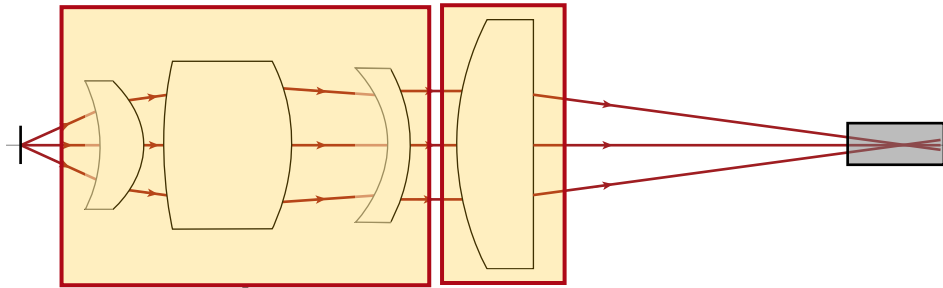
## Laser Components

WSLD-1064-050m-1-PD

- fundamental Gaussian
- wavelength 1064 nm
- linearly polarized in  $y$ -direction
- divergence (FWHM)  $20^\circ \times 10^\circ$
- astigmatism  $11.6 \mu\text{m}$  between  $x$ - and  $y$ -plane

What is the field in focal region behind an aspherical lens? Especially, the astigmatism of the laser diode must be taken into account.

# Aspherical Lens & Collimating Objective Lens



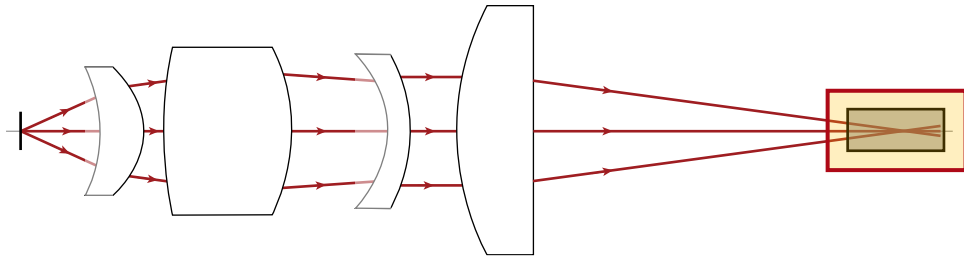
The screenshot shows the 'Edit Lens System Component' dialog box. It features a table with the following data:

Index	Distance	Position	Type	Homogeneous Medium	Comment
1	0 mm	0 mm	Conical Interface	N-SF6_Schott_2014 in H	Zemax Interface
2	7012983 r	2.0070129	Conical Interface	Standard Air in Homoge	Zemax Interface
3	74607918	2.9744737	Conical Interface	N-BK7_Schott_2014 in H	Zemax Interface
4	10461477 r	8.9749352	Conical Interface	Standard Air in Homoge	Zemax Interface
5	39159599 r	13.464094	Conical Interface	N-BK7_Schott_2014 in H	Zemax Interface
6	31386059 r	14.545480	Conical Interface	Standard Air in Homoge	Zemax Interface

The dialog box also includes a sidebar with icons for Coordinate Systems, Position / Orientation, Structure, Solver, Channel Configuration, and Fourier Transforms. At the bottom, there are buttons for Add, Insert, Delete, OK, Cancel, and Help, along with a validity indicator.

The *Lens System Component* allows for the easy definition of a component consisting of an alternating sequence of smooth surfaces and homogeneous, isotropic media. In terms of both the interfaces and the materials, it is possible to choose ready-made entries from the in-built catalogs or to customize your own for maximum flexibility.

# Z-Scan in Focal Region



To achieve a z-scan of the focal region a *Parameter Run* can be performed. With this tool the user can easily vary an individual parameter or a set of parameters.

21: D:\LightTrans...\Focus Investigation behind Asphere\_03\_with Astigmatism.run

**Parameter Specification**  
Set up the parameter(s) to be varied.

You can select one or more parameters which shall be varied as well as the resulting number of iterations. Several [modes](#) are available specifying how the parameters are varied per iteration.

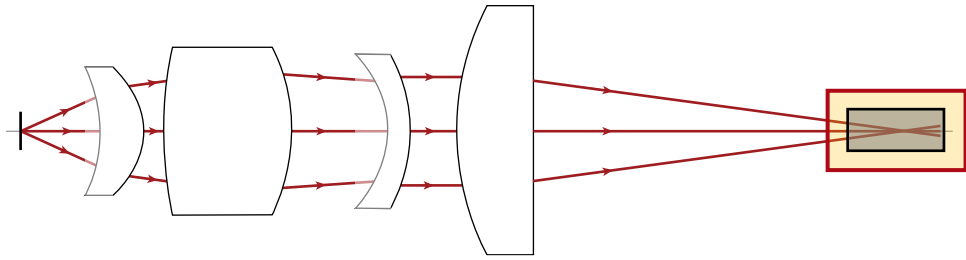
Usage Mode: Standard

Filter by...  Show Only Varied Parameters

1	2	*	Object	Category	Parameter	Vary	From	To	Steps	Step Size	Original Value	
			"Aspherica l Lens (from Aspherico n: A12- 25LPX)" (# 2)	Surface #2 (Plane Interface)	Definition...	<input type="checkbox"/>	1 $\mu$ m	1E+303 mm	1	1E+303 mm	12.5 mm	
					Scaling x-...	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	1	1
					Scaling y-...	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	1	1
					Scaling z-...	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	1	1
					Alpha	<input type="checkbox"/>	-180°	180°	1	360°	1	0°
					Beta	<input type="checkbox"/>	-180°	180°	1	360°	1	0°
					Distance	<input type="checkbox"/>	0 mm	1E+303 mm	1	1E+303 mm	4 mm	
			"Focal Plane" (#3 )	Basal Positioning (Relative)	Distance...	<input checked="" type="checkbox"/>	22.25 mm	22.85 mm	61	10 $\mu$ m	22.548 mm	
					Lateral Sh...	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	1	0 mm
					Lateral Sh...	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	1	0 mm
					Spherical...	<input type="checkbox"/>	-360°	360°	1	720°	1	0°
					Spherical...	<input type="checkbox"/>	-360°	360°	1	720°	1	0°
					Angle Zeta	<input type="checkbox"/>	-360°	360°	1	720°	1	0°
				Basal Positionin...	X	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	0 mm	
			Y		<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	1	0 mm	

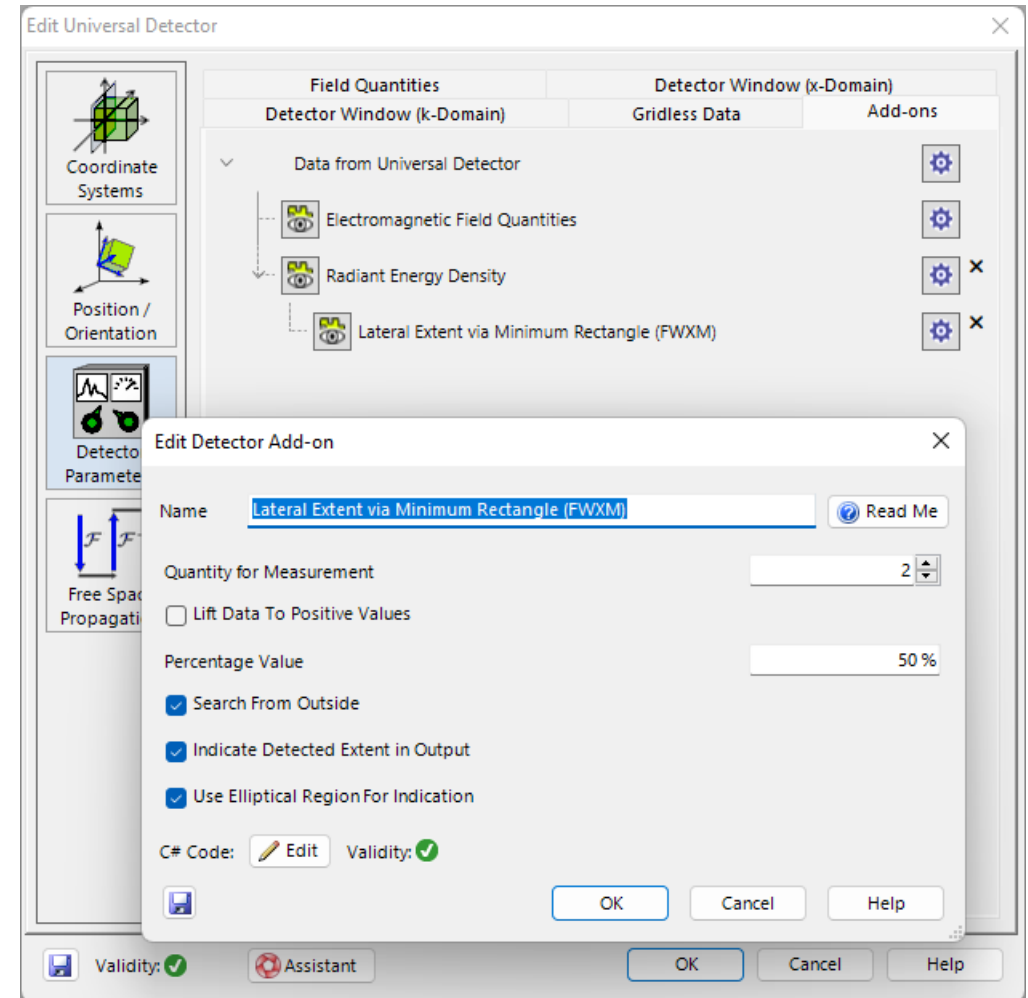
< Back    Next >    Show ▾

# Universal Detector & Detector Add-ons

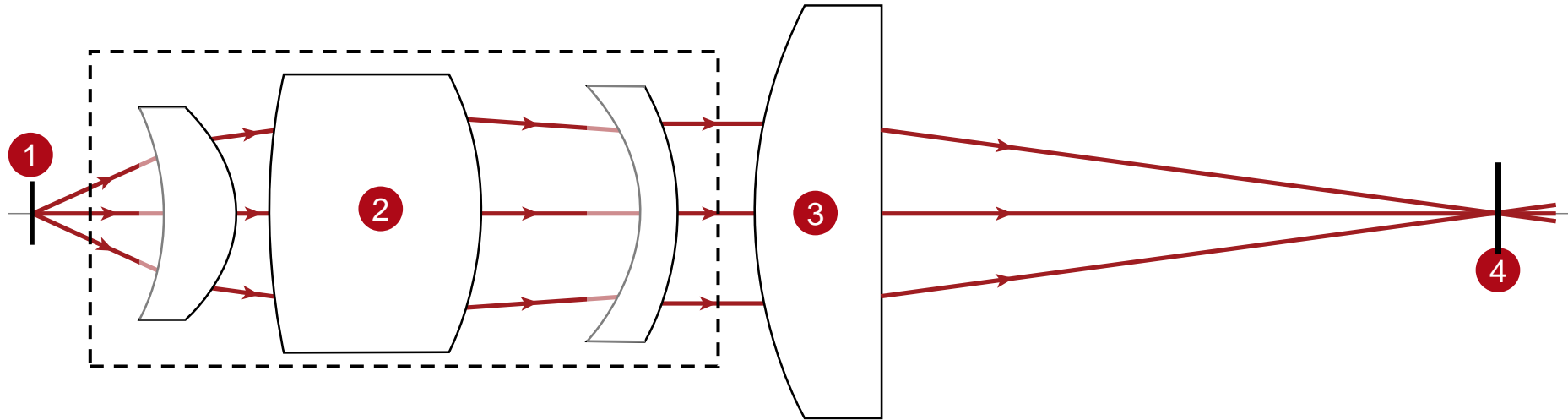


The *Universal Detector* allows the user to evaluate the impinging field and to calculate various physical quantities by using so-called *Add-ons*. The add-ons can provide each other with information (i.e., they can be nested); in our example we use the field data to calculate the radiant energy density and then use another add-on on this data to obtain the field size (FWHM). More information under:

[Universal Detector](#)

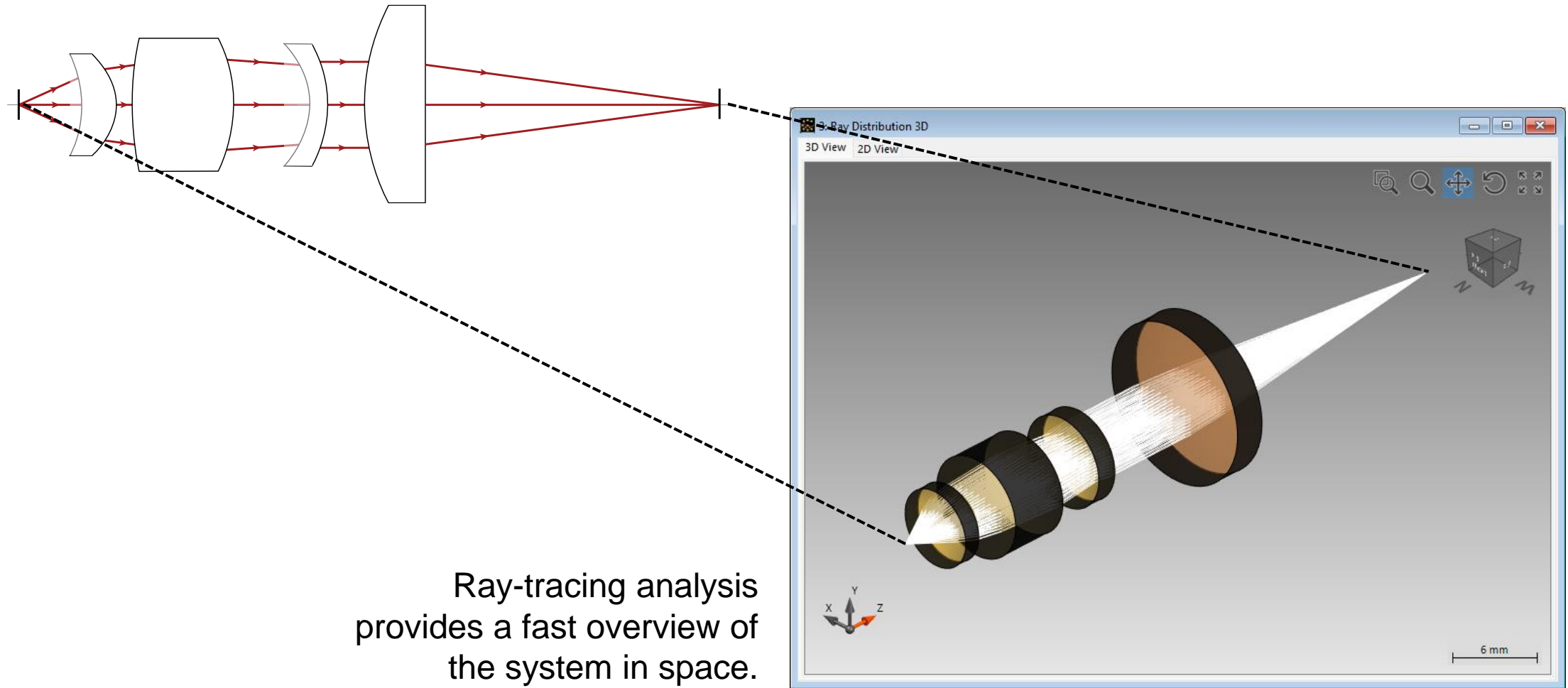


# Summary – Components...



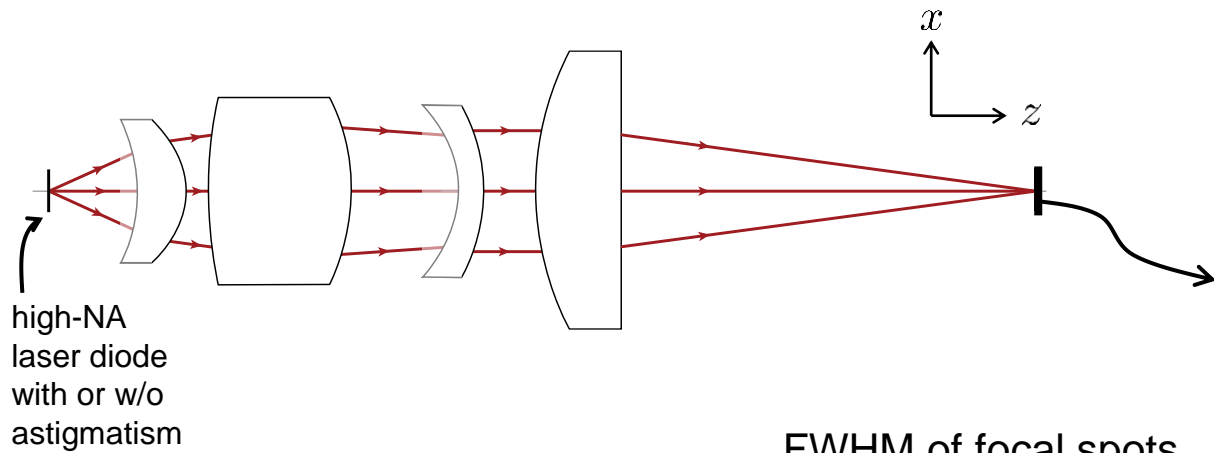
... of Optical System	... in VirtualLab Fusion	Model/Solver/Detected Magnitude
1. laser diode	<i>Gaussian Wave</i>	spatial Gaussian function
2. collimating objective lens	<i>Lens System Component</i>	Linear Plane Interface Approximation (LPIA)
3. aspherical lens	<i>Lens System Component</i>	Linear Plane Interface Approximation (LPIA)
4. detector	<i>Universal Detector with Radiant Energy Density &amp; Lateral Extent Add-on</i>	radiant energy density & full width at half maximum (FWHM) evaluation

# System Analysis with Ray Tracing





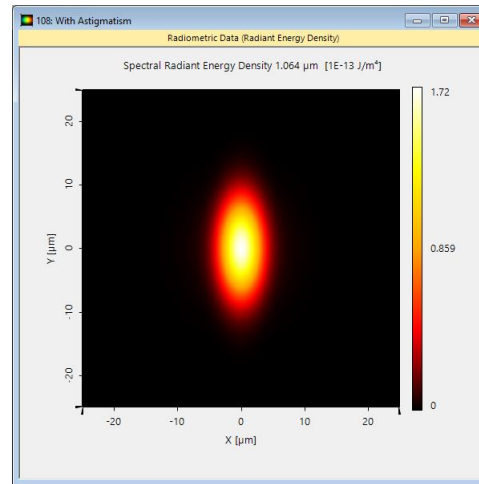
# Investigation in Focal Plane



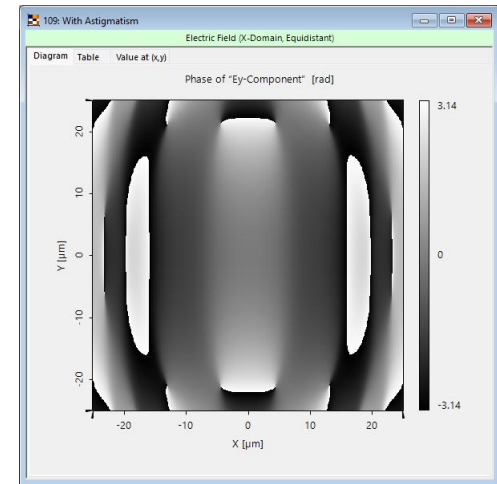
FWHM of focal spots

FWHM	without astigmatism	with astigmatism
x-direction	5.6 $\mu\text{m}$	5.7 $\mu\text{m}$
y-direction	10.8 $\mu\text{m}$	12.7 $\mu\text{m}$

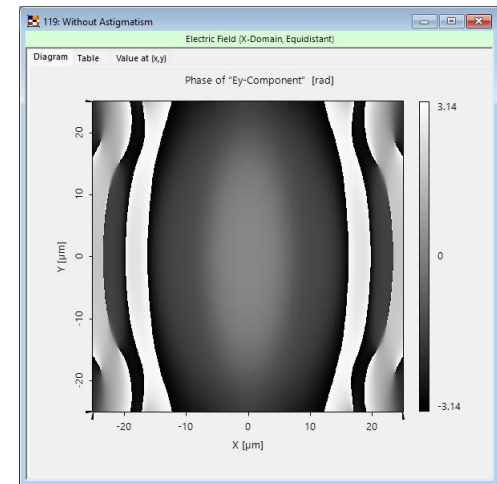
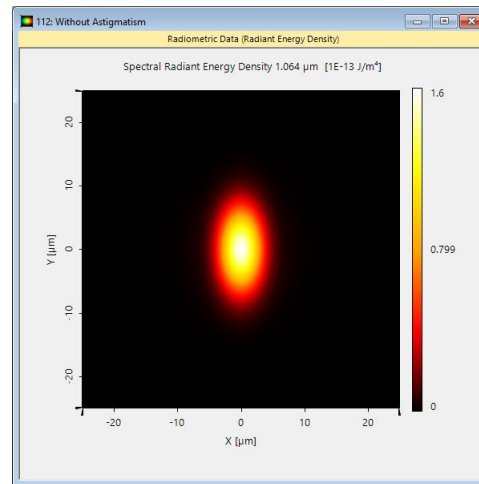
focal spot



phase of  $E_y$  component

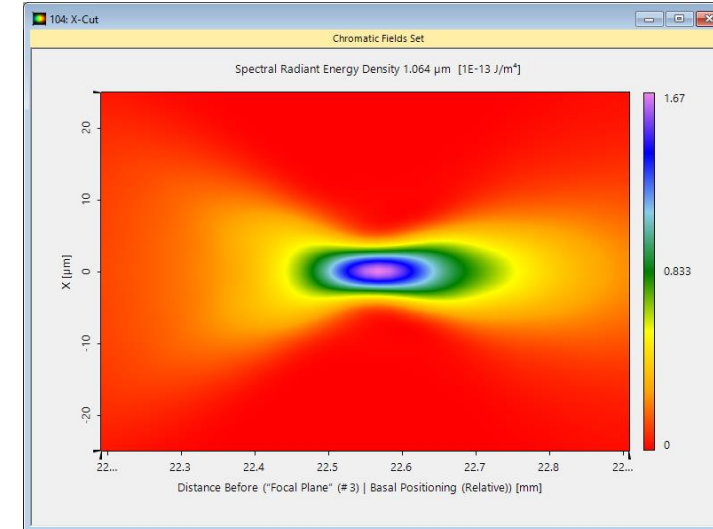
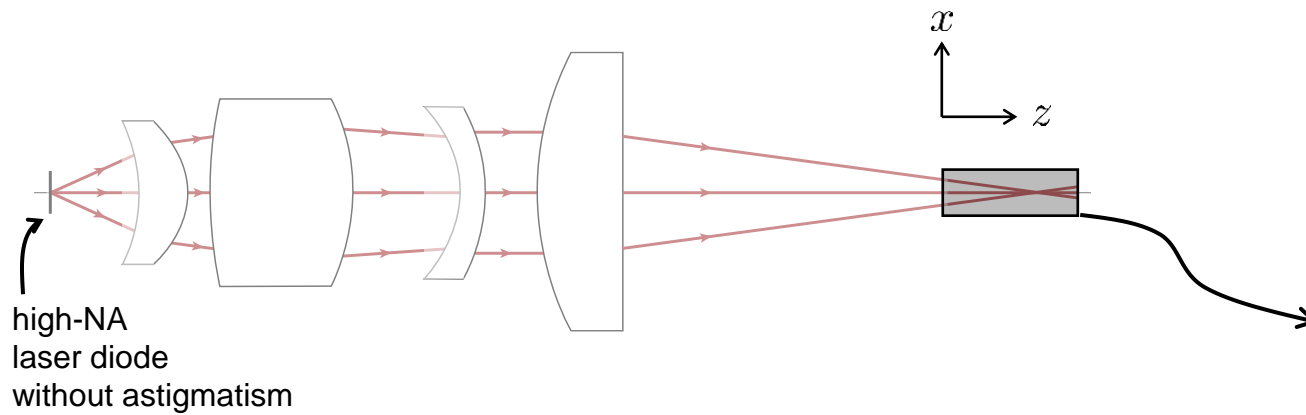


with astigmatism

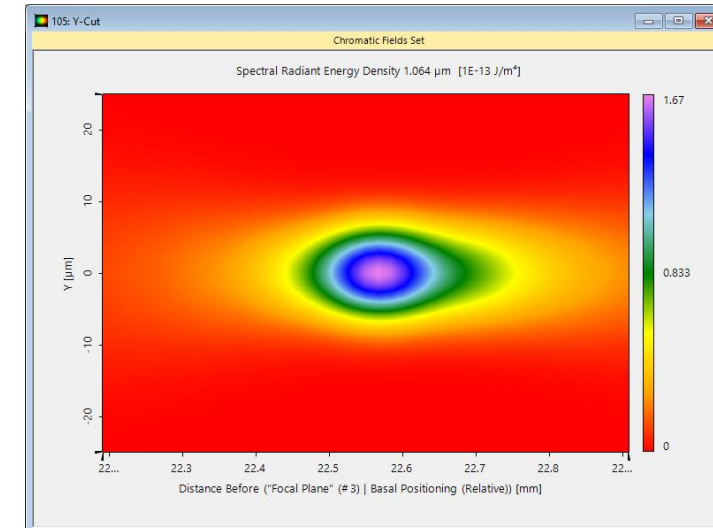


without astigmatism

# Focal Region Investigation (without Astigmatism)

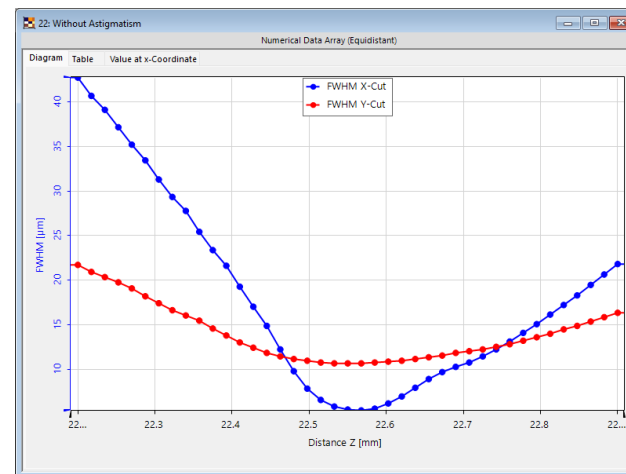


field evolution in z-x cross section

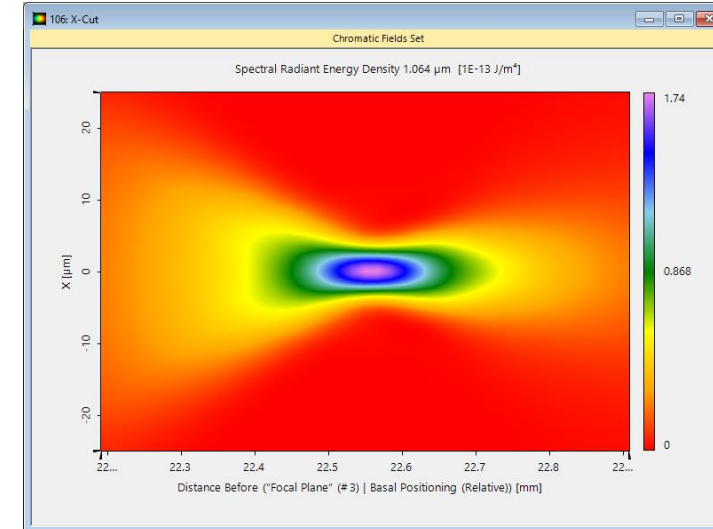
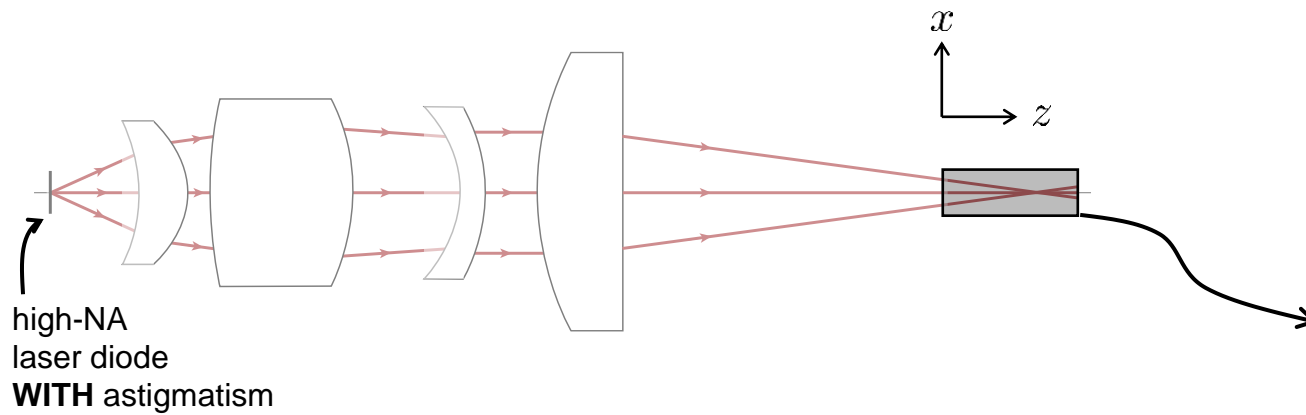


field evolution in z-y cross section

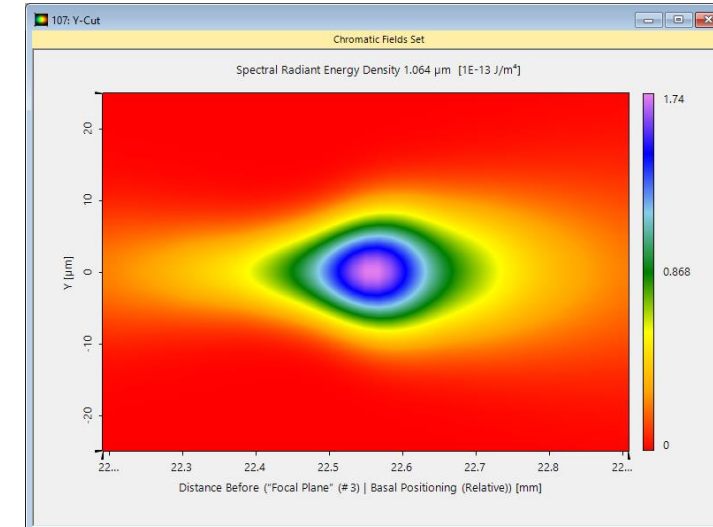
changes of spot diameters along both x and y-directions



# Focal Region Investigation (with Astigmatism)

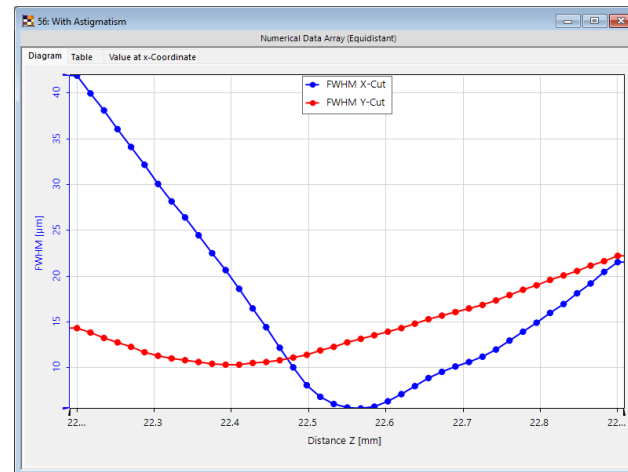


field evolution in z-x cross section



field evolution in z-y cross section

Minimum beam diameters appear at different positions along x and y directions, due to astigmatism.



# Document Information

title	Focus Investigation behind Aspherical Lens
document code	MISC.0030
document version	2.3
software edition	VirtualLab Fusion Basic
software version	2023.1 (Build 1.556)
category	Application Use Case
further reading	<ul style="list-style-type: none"><li>• <a href="#"><u>Collimation of Astigmatic Diode Laser Beam by Objective Lens</u></a></li><li>• <a href="#"><u>Simulation of Laser Beam in Focal Region of High-NA Asphere</u></a></li><li>• <a href="#"><u>Universal Detector</u></a></li></ul>