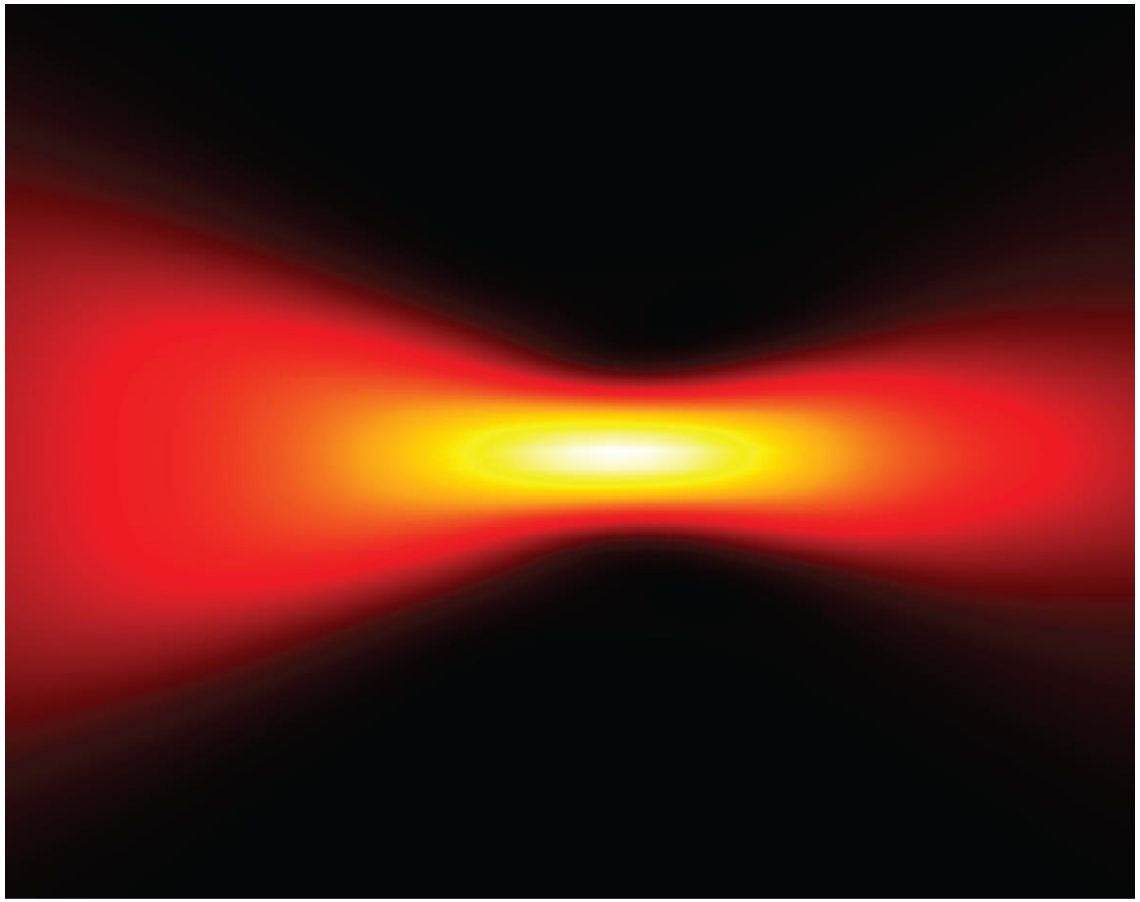
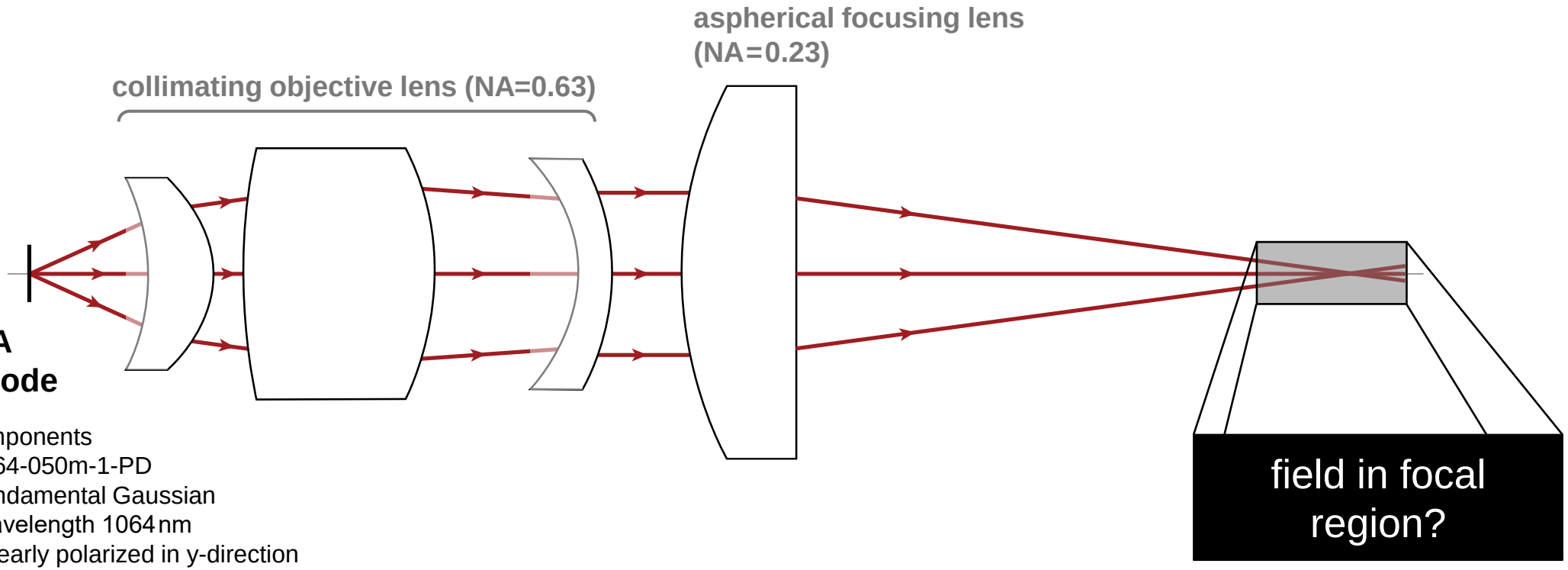
Focus Investigation behind Aspherical Lens

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

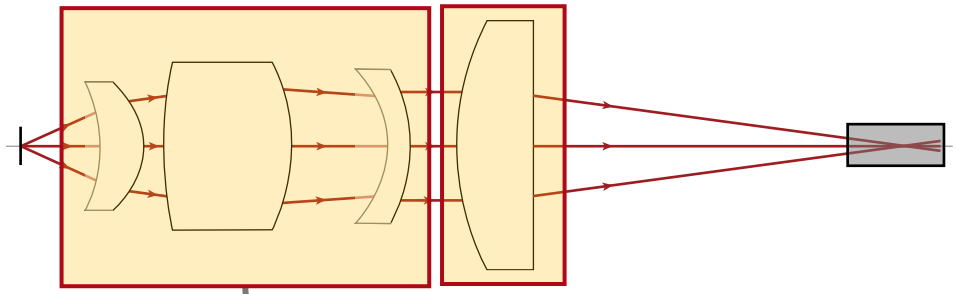


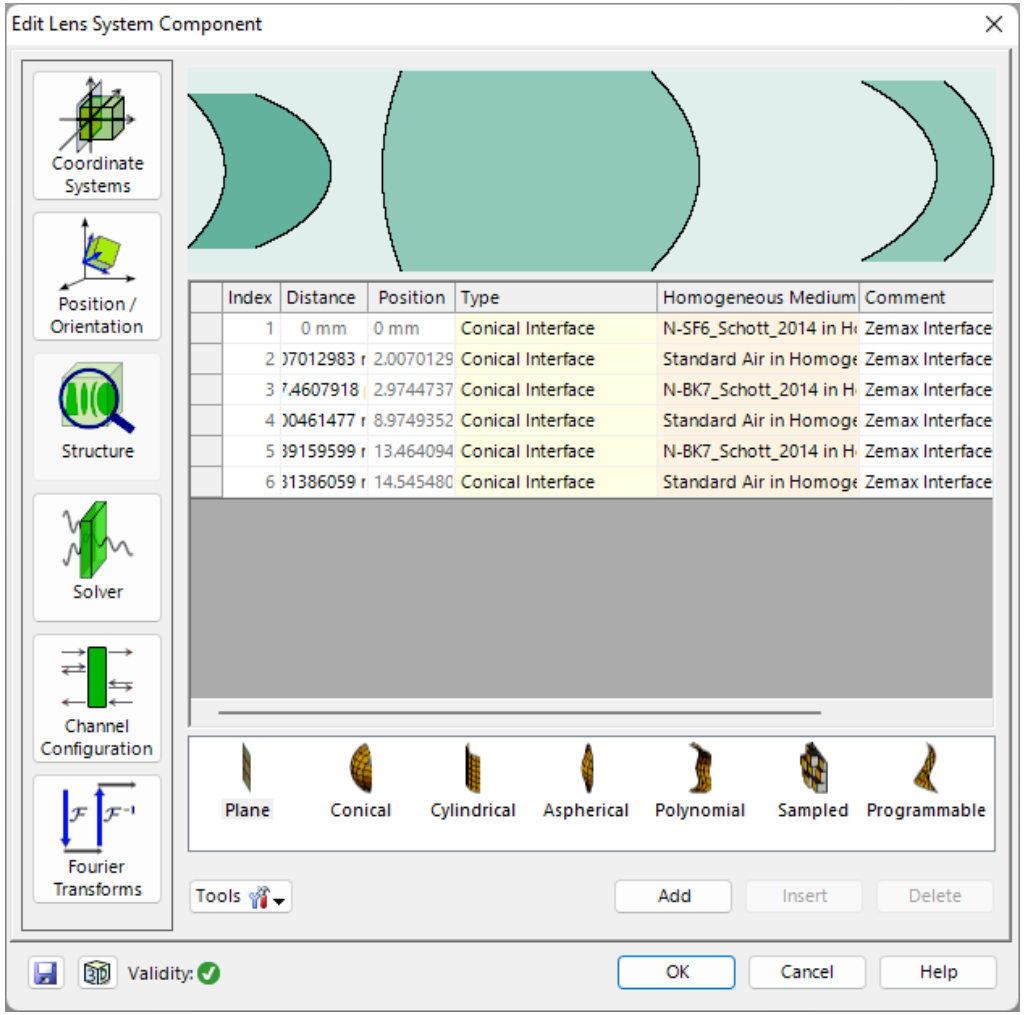
Laser Components
WSLD-1064-050m-1-PD

- fundamental Gaussian
- wavelength 1064 nm
- linearly polarized in y-direction
- divergence (FWHM) 20° x 10°
- astigmatism 11.6 µm 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.

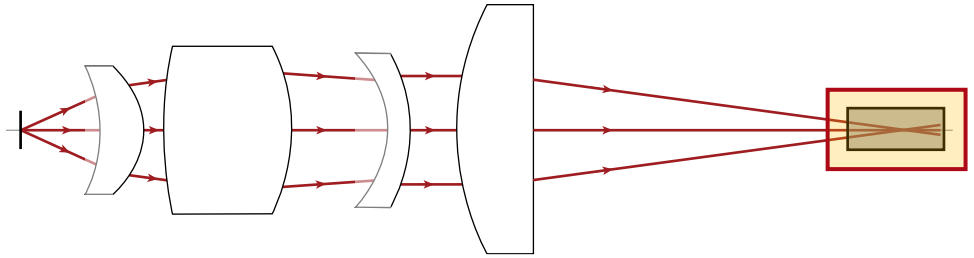
Aspherical Lens & Collimating Objective Lens



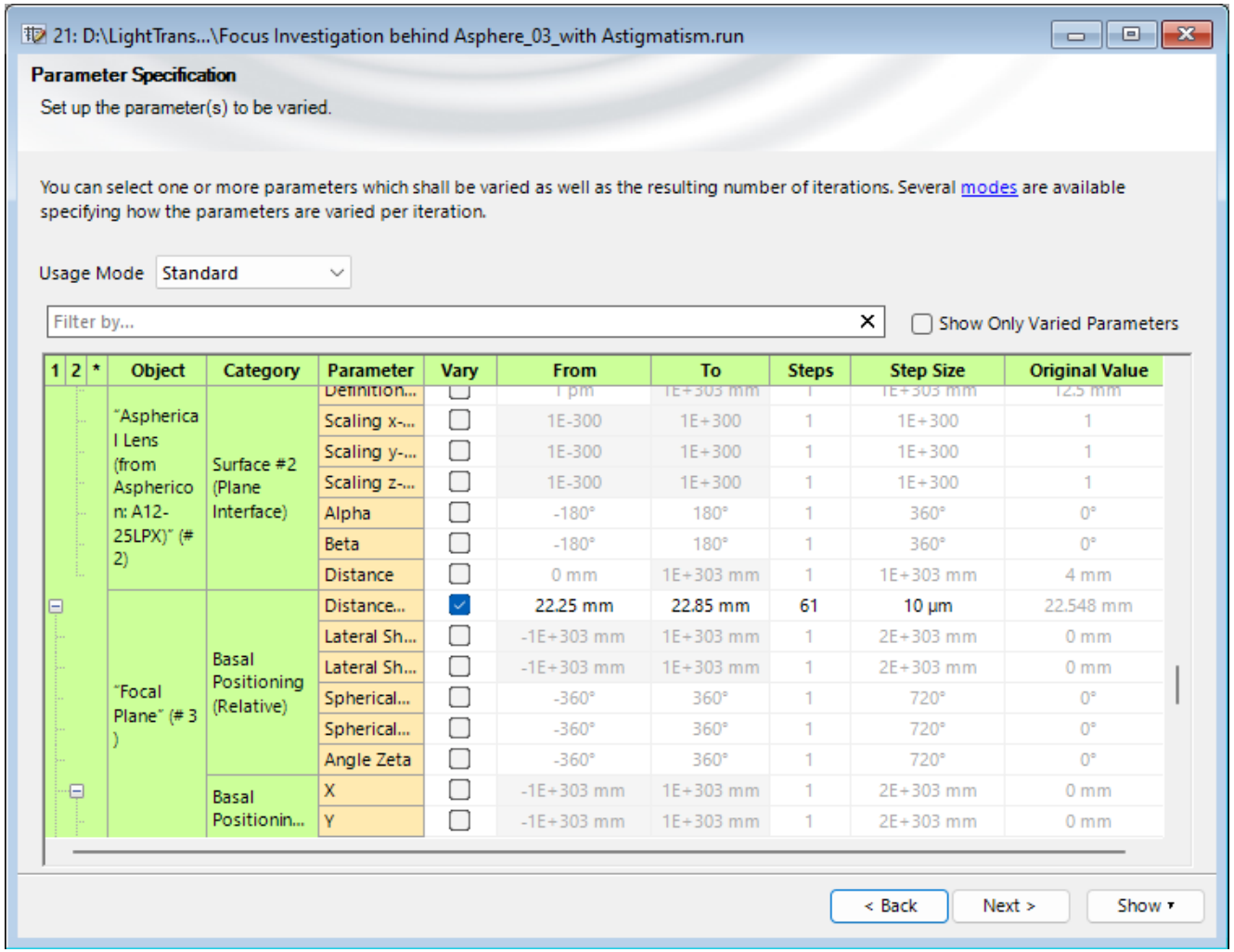


The *Lens System Component* allows for the easy definition of a component consisting of an alternating sequence of smooth surfaces and homogeneous, isotropic media. In terms of both the interfaces and the materials, it is possible to choose ready-made entries from the in-built catalogs or to customize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

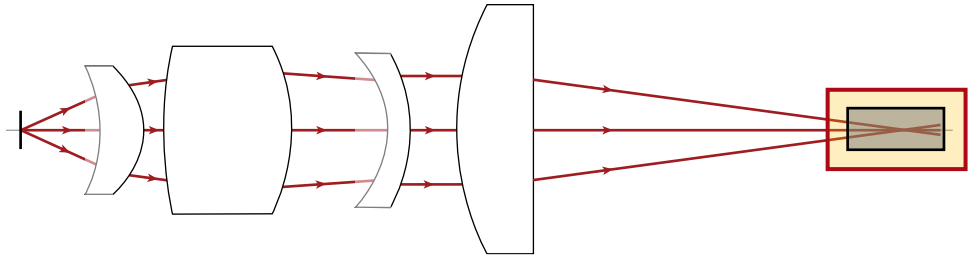
Z-Scan in Focal Region



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.

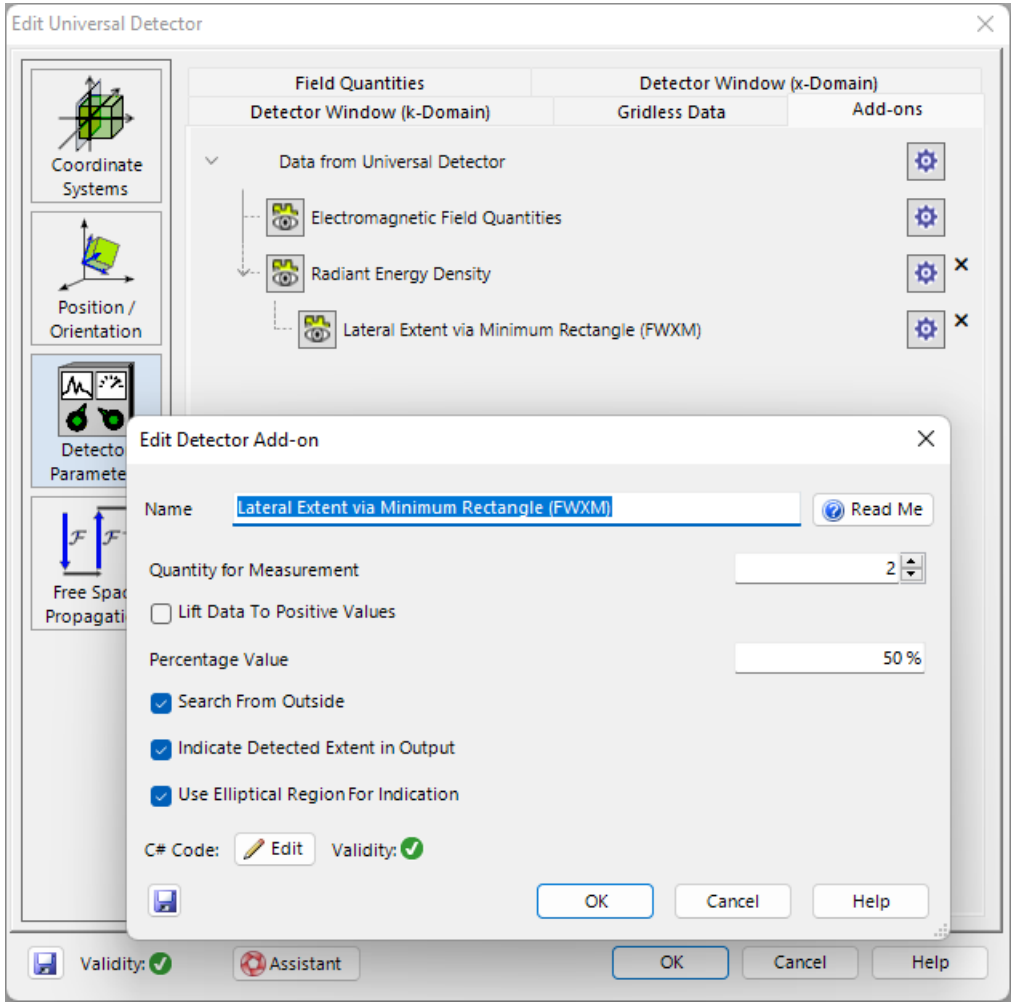


Universal Detector & Detector Add-ons

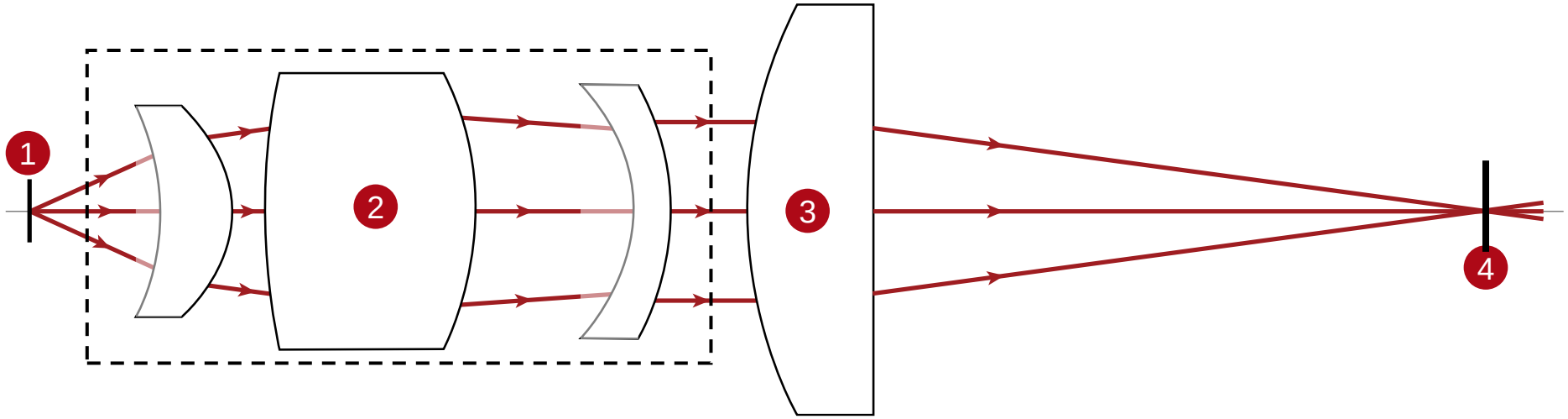


The *Universal Detector* allows the user to evaluate the impinging field and to calculate various physical quantities by using so-called *Add-ons*. The add-ons can provide each other with information (i.e., they can be nested); in our example we use the field data to calculate the radiant energy density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

Universal Detector

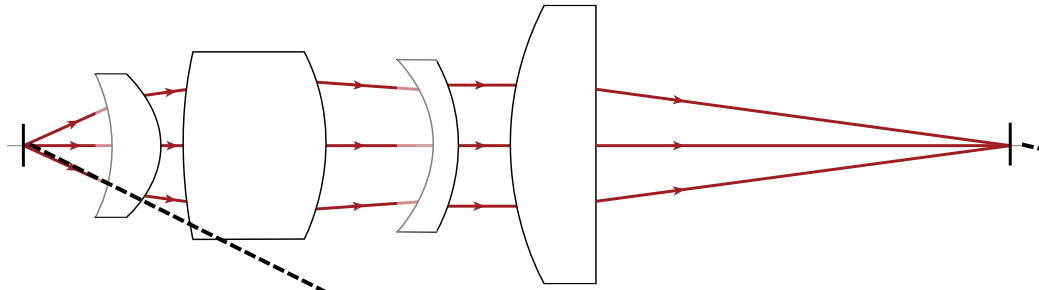


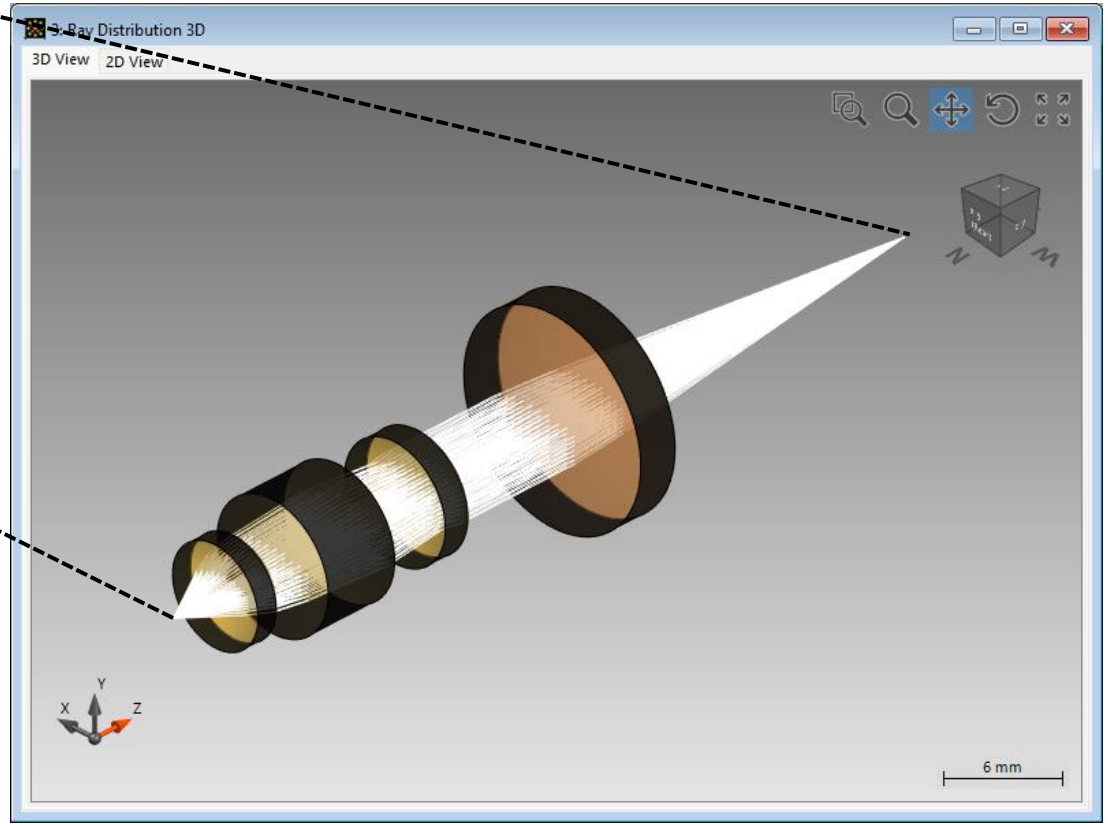
Summary – Components...



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

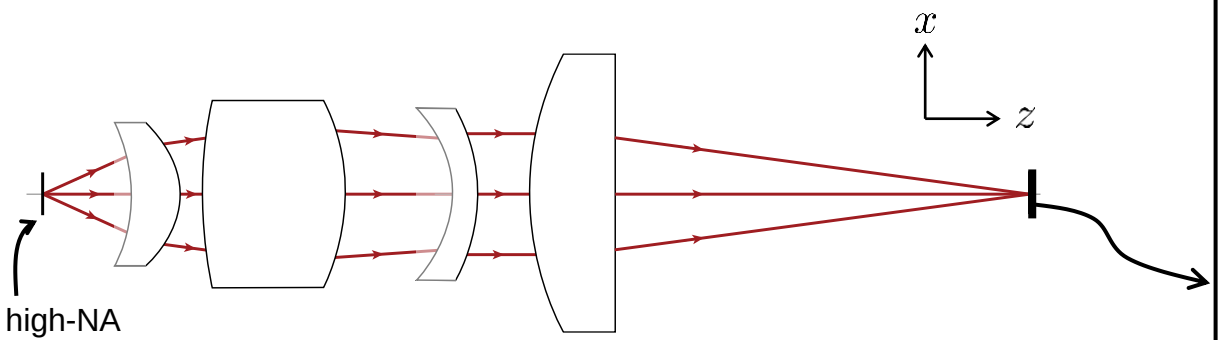
System Analysis with Ray Tracing





Ray-tracing analysis provides a fast overview of the system in space.

Investigation in Focal Plane



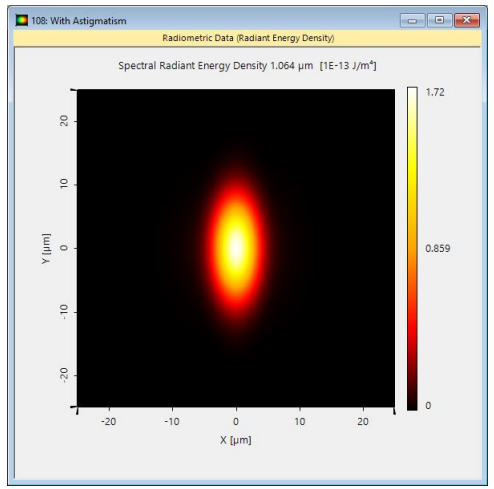
high-NA
laser diode
with or w/o
astigmatism

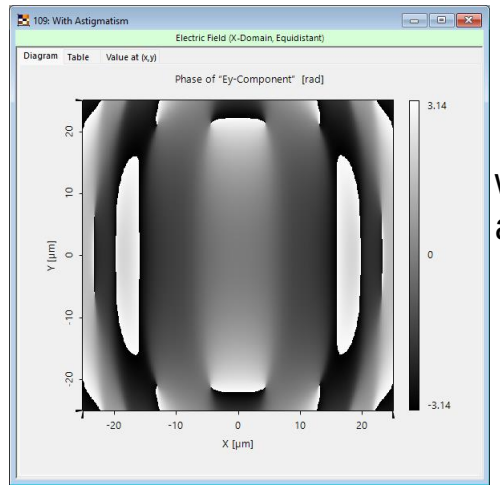
FWHM of focal spots

FWHM	without astigmatism	with astigmatism
x-direction	5.6 µm	5.7 µm
y-direction	10.8 µm	12.7 µm

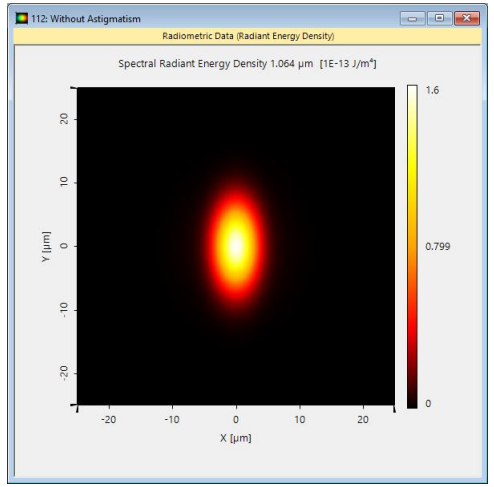
focal spot

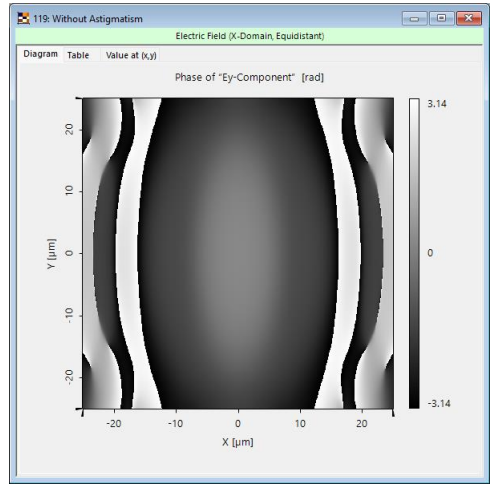
phase of E_y component





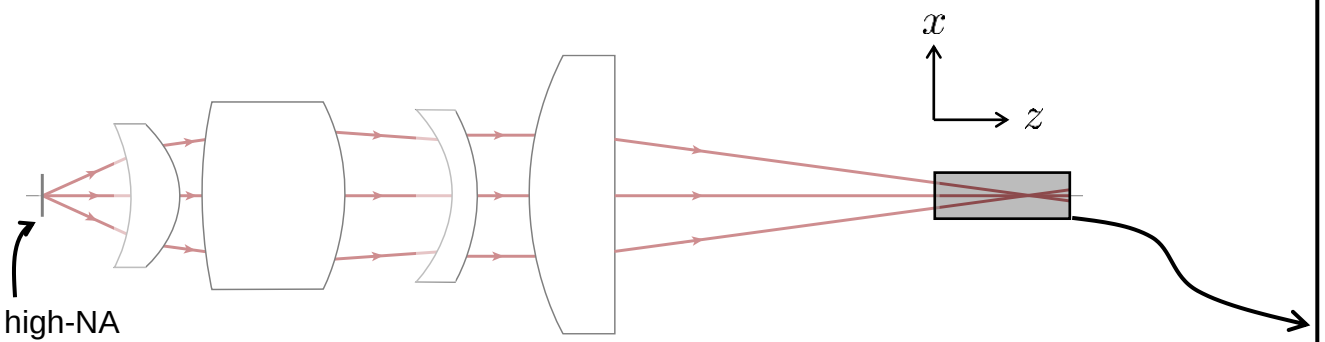
with astigmatism



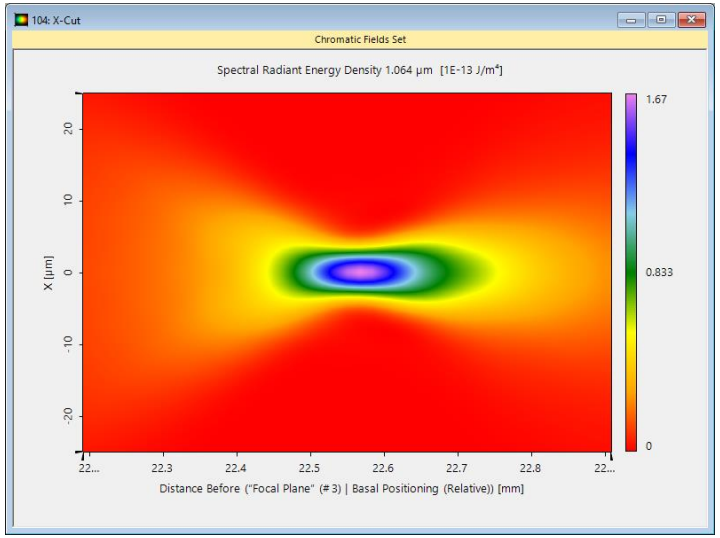


without astigmatism

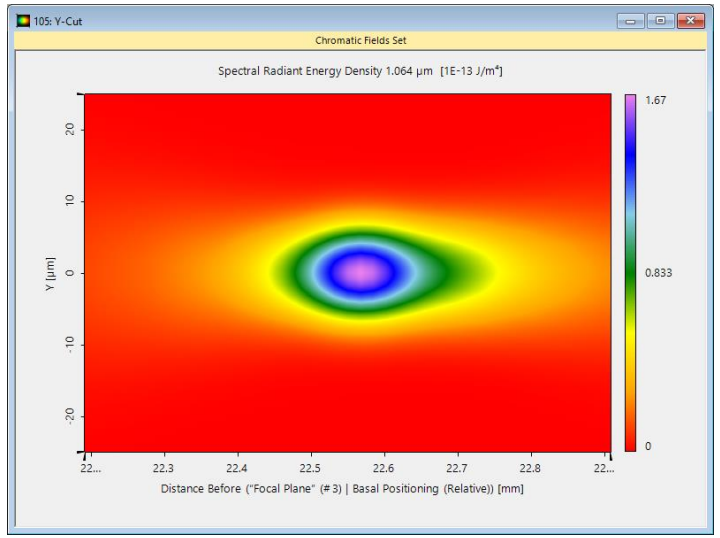
Focal Region Investigation (without Astigmatism)



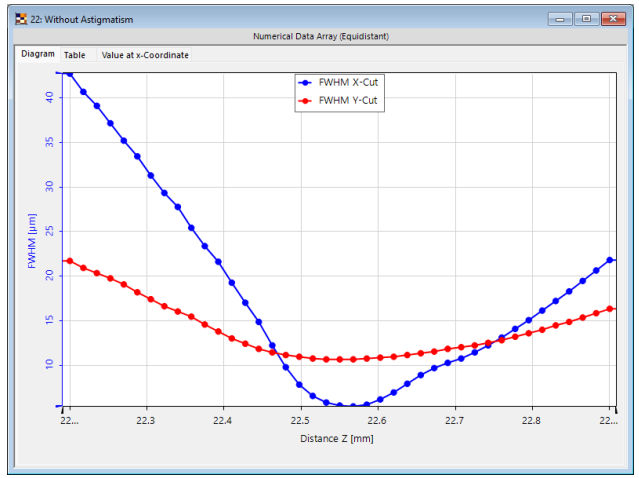
high-NA
laser diode
without astigmatism



field evolution in *z*-x
cross section

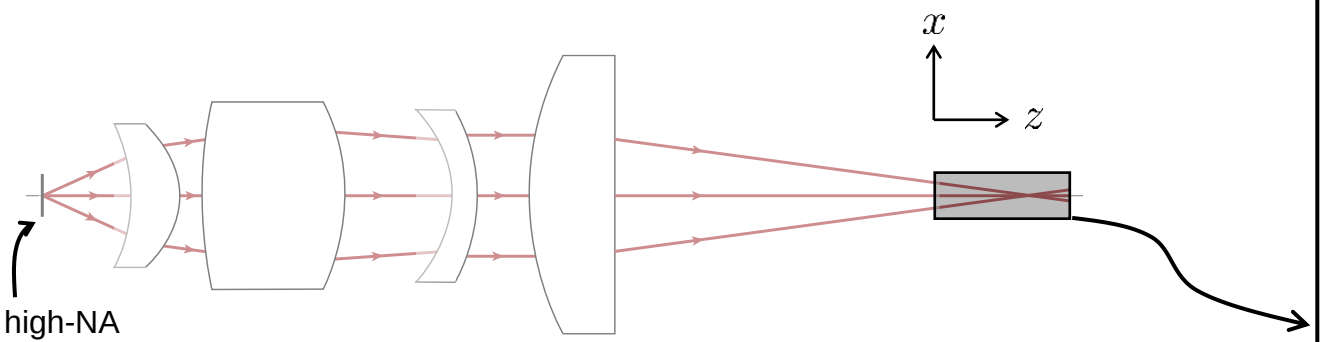


field evolution in *z*-y
cross section

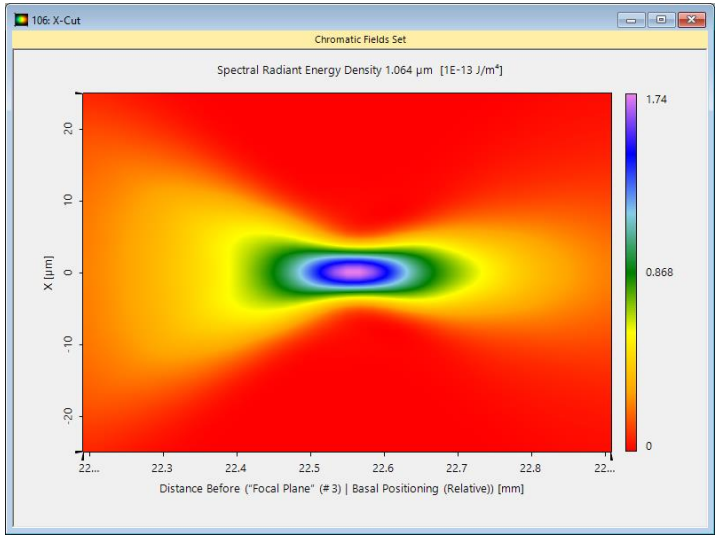


changes of spot diameters
along both *x* and *y*-directions

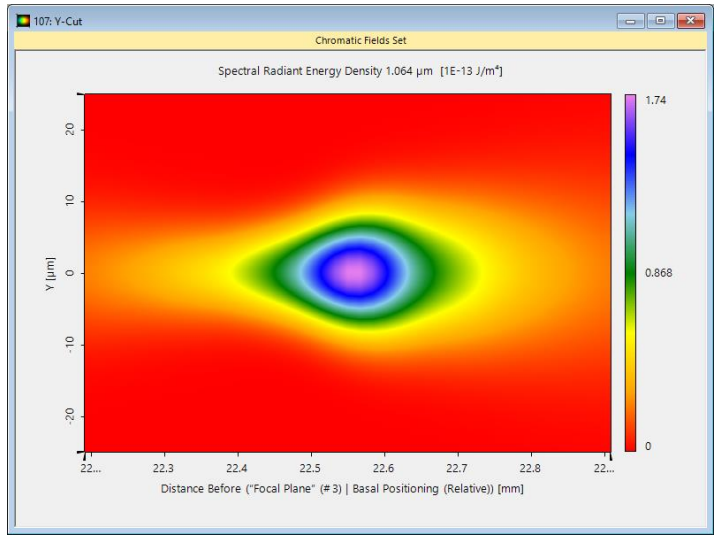
Focal Region Investigation (with Astigmatism)



high-NA
laser diode
WITH astigmatism

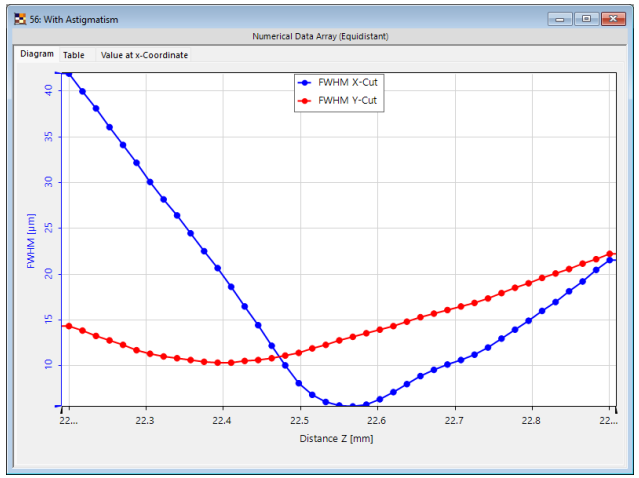


field evolution in *z*-x cross section



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
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category	Application Use Case
further reading	• Collimation of Astigmatic Diode Laser Beam by Objective Lens • Simulation of Laser Beam in Focal Region of High-NA Asphere • Universal Detector