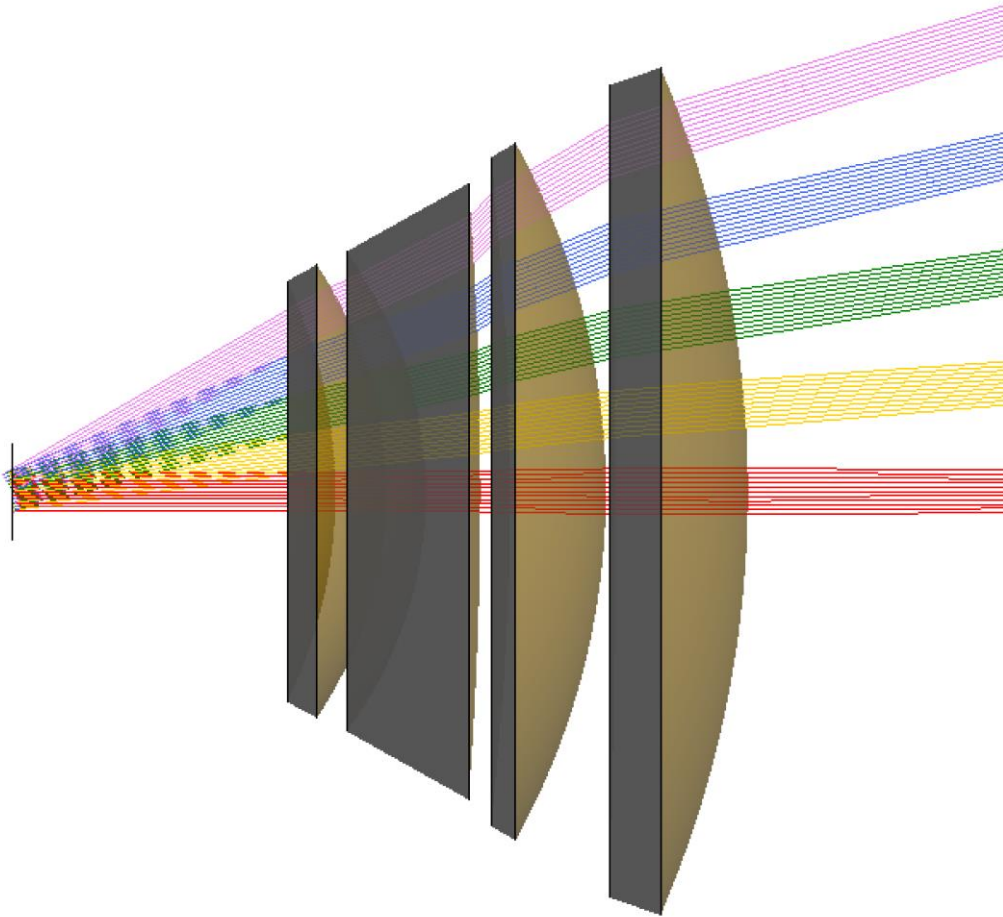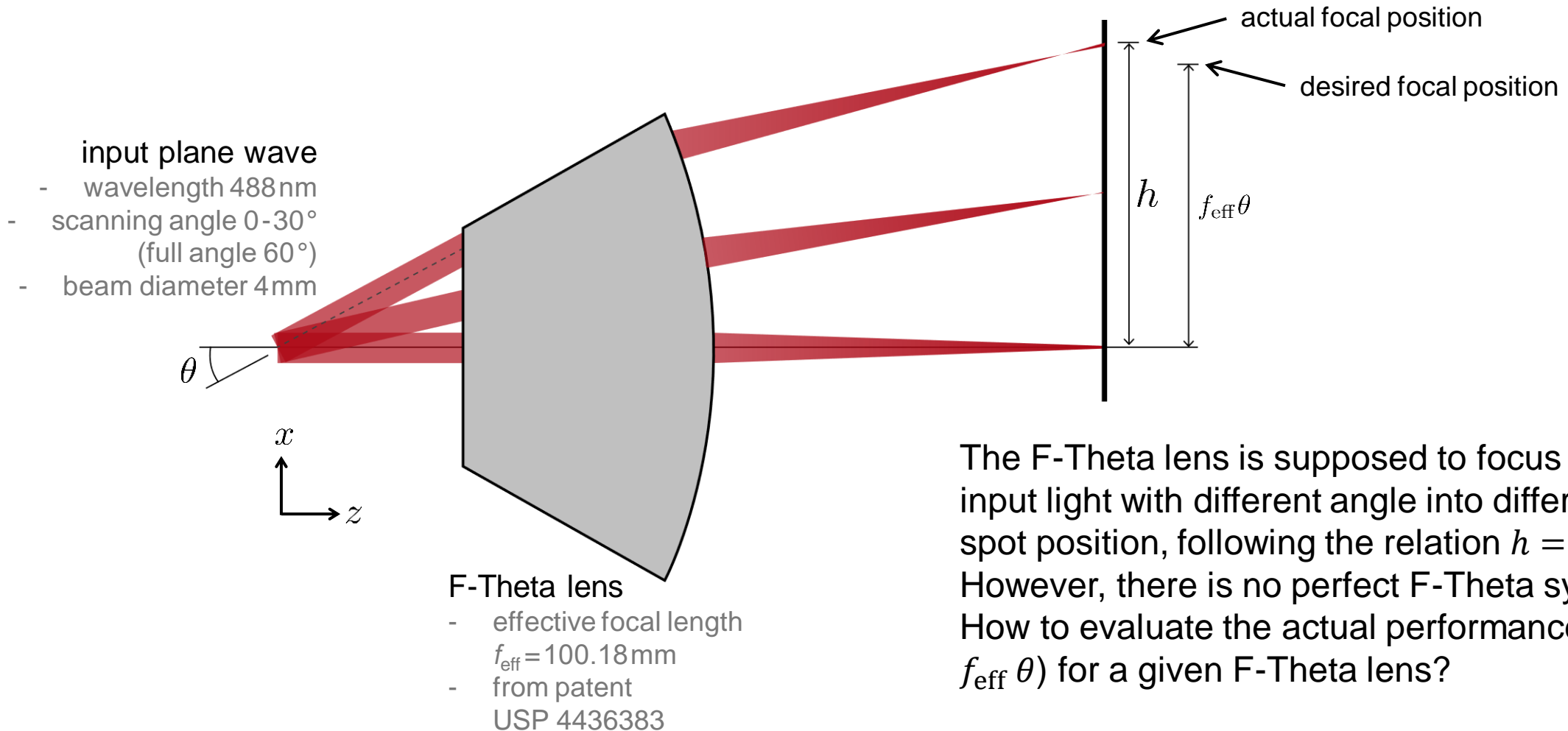# Performance Evaluation of an F-Theta Scanning Lens
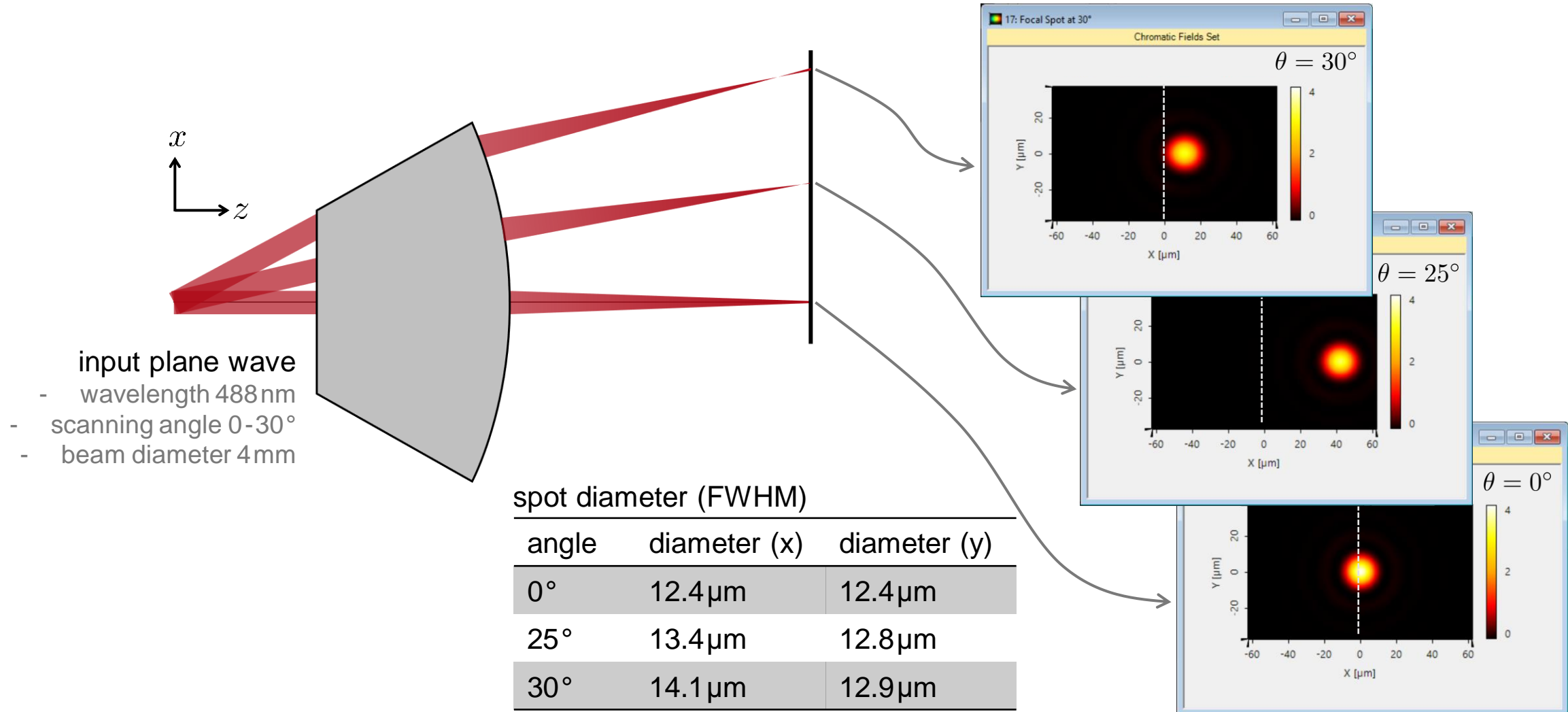
Abstract

F-Theta lenses are typically designed to provide high performance in laser scanning systems. With such lenses, the focused spot displacement on the target plane is proportional to the produce of focal length and scan angle. That makes them standard lenses for Galvo-scanner-based laser material processing systems. With the help of the scanning source in VirtualLab Fusion, we analyze the performance of a given F-Theta lens, by measuring the deviation between actual spot position and desired value and the spot size for different angles.
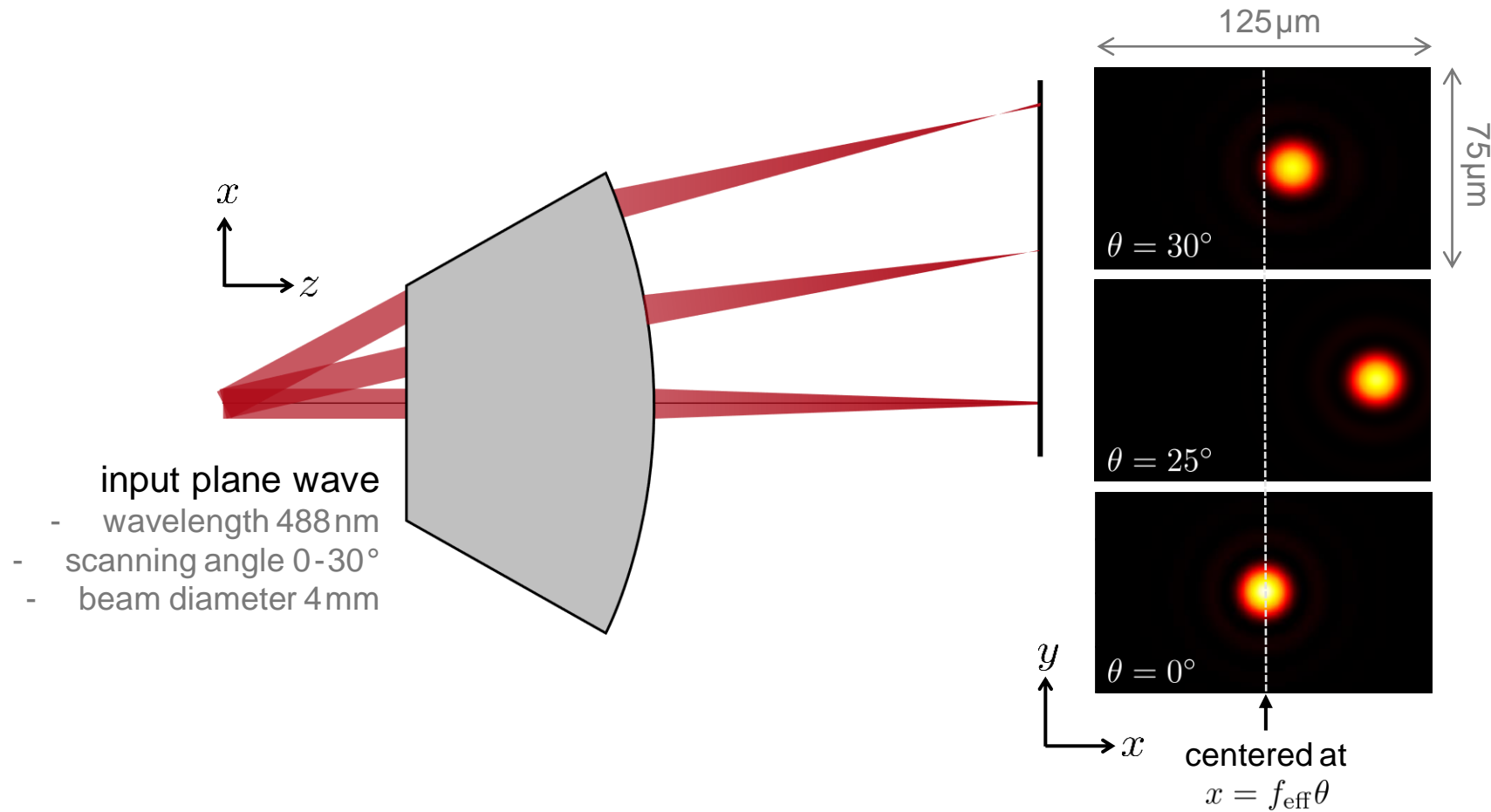
Modeling Task

input plane wave
- wavelength 488 nm
- scanning angle 0-30°
  (full angle 60°)
- beam diameter 4 mm

F-Theta lens
- effective focal length
  $f_{\mathrm{eff}} = 100.18$ mm
- from patent
  USP 4436383

actual focal position

desired focal position

h

$f_{\mathrm{eff}}\theta$

θ

x

z

The F-Theta lens is supposed to focus the input light with different angle into different spot position, following the relation $h = f_{\mathrm{eff}}\,\theta$. However, there is no perfect F-Theta system. How to evaluate the actual performance ($h - f_{\mathrm{eff}}\,\theta$) for a given F-Theta lens?
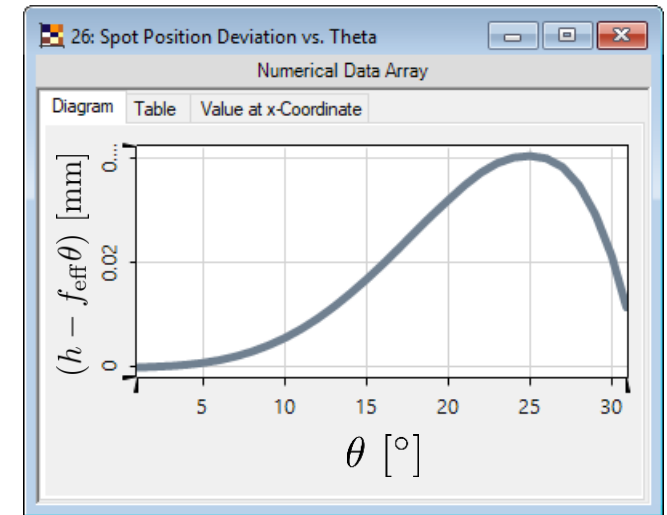
Performance Evaluation – Spot Diameter Measurement

input plane wave
- wavelength 488 nm
- scanning angle 0-30°
- beam diameter 4 mm

spot diameter (FWHM)

angle	diameter (x)	diameter (y)
0°	12.4 µm	12.4 µm
25°	13.4 µm	12.8 µm
30°	14.1 µm	12.9 µm

Performance Evaluation – Spot Position Deviation

125 µm

75 µm

$\theta = 30°$

$\theta = 25°$

$\theta = 0°$

x
z

input plane wave
- wavelength 488 nm
- scanning angle 0‑30°
- beam diameter 4 mm

y
x

centered at
$x = f_{\mathrm{eff}}\theta$
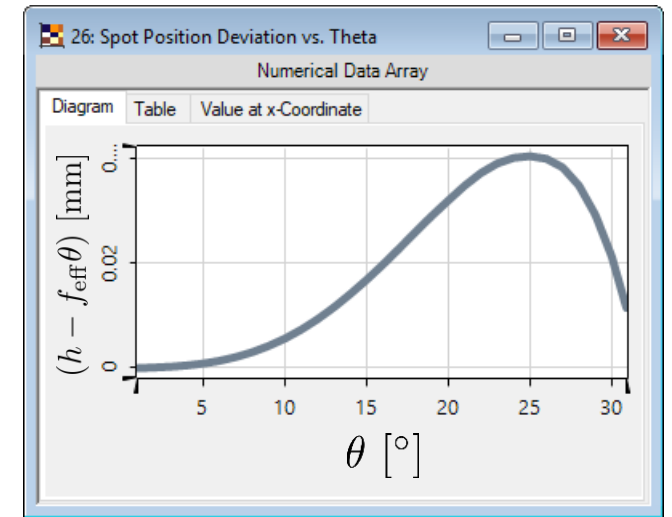
Deviation between actual and the desired focal spot position indicates the performance of the F-Theta lens.

26: Spot Position Deviation vs. Theta
Numerical Data Array
Diagram   Table   Value at x-Coordinate

$(h - f_{\mathrm{eff}}\theta)$ [mm]

0.02
0

5   10   15   20   25   30

θ [°]

Peek in VirtualLab Fusion

scanning source configuration

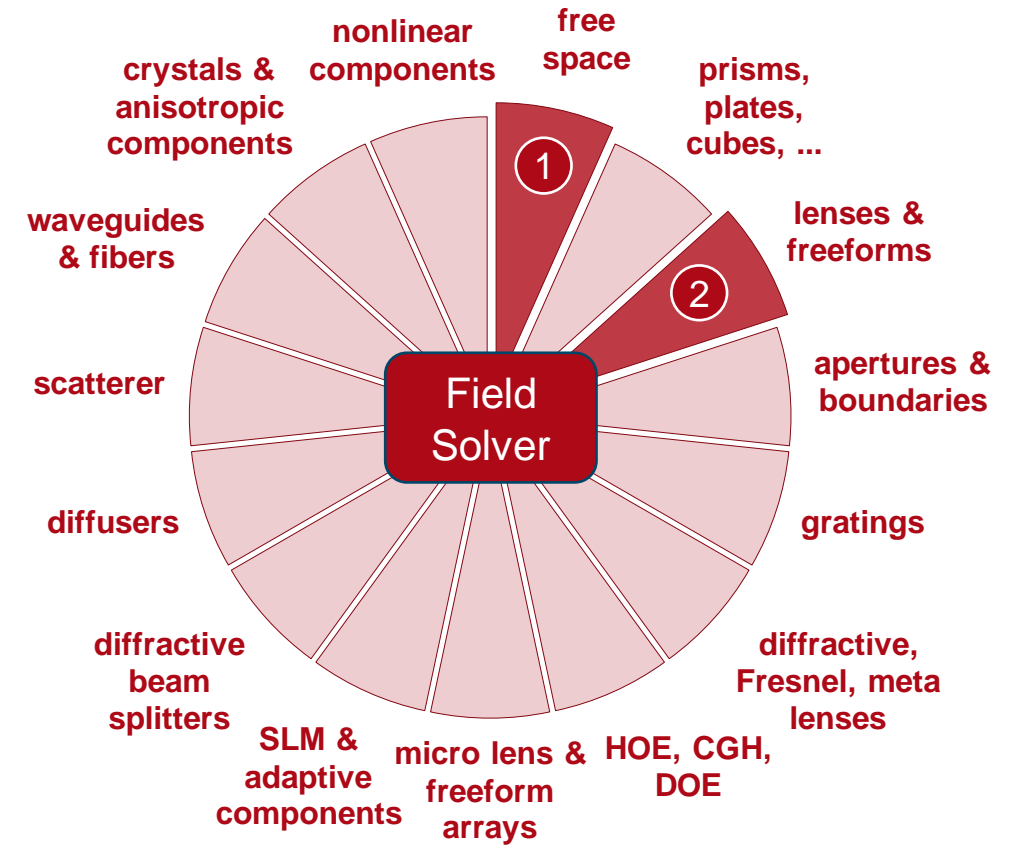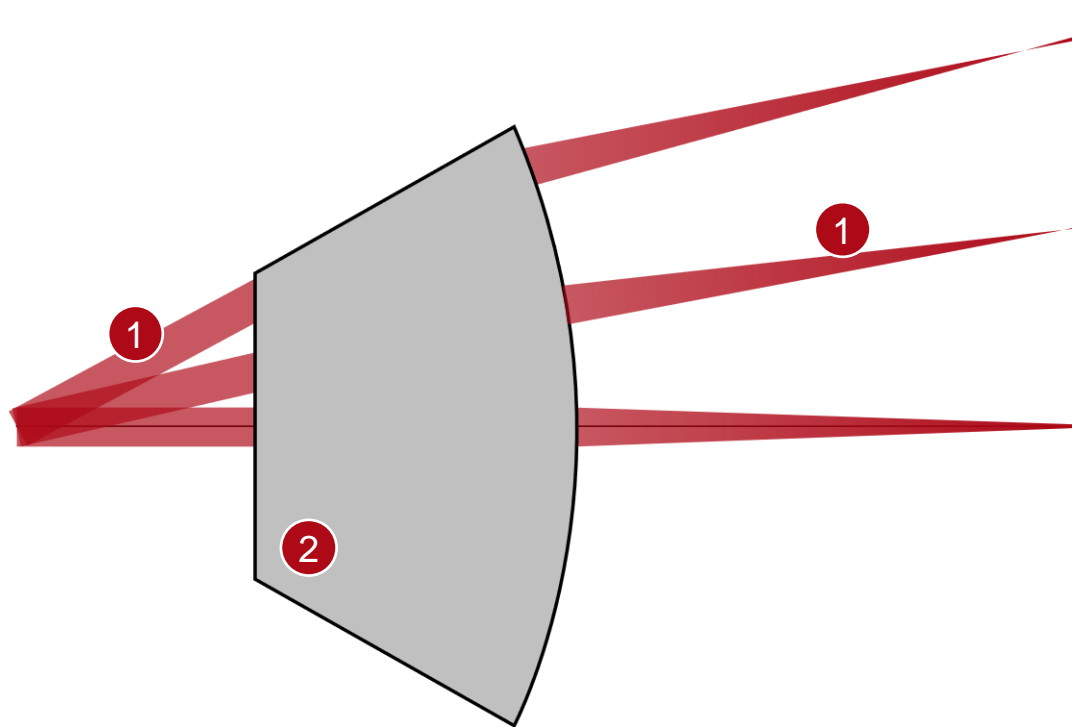lens system construction
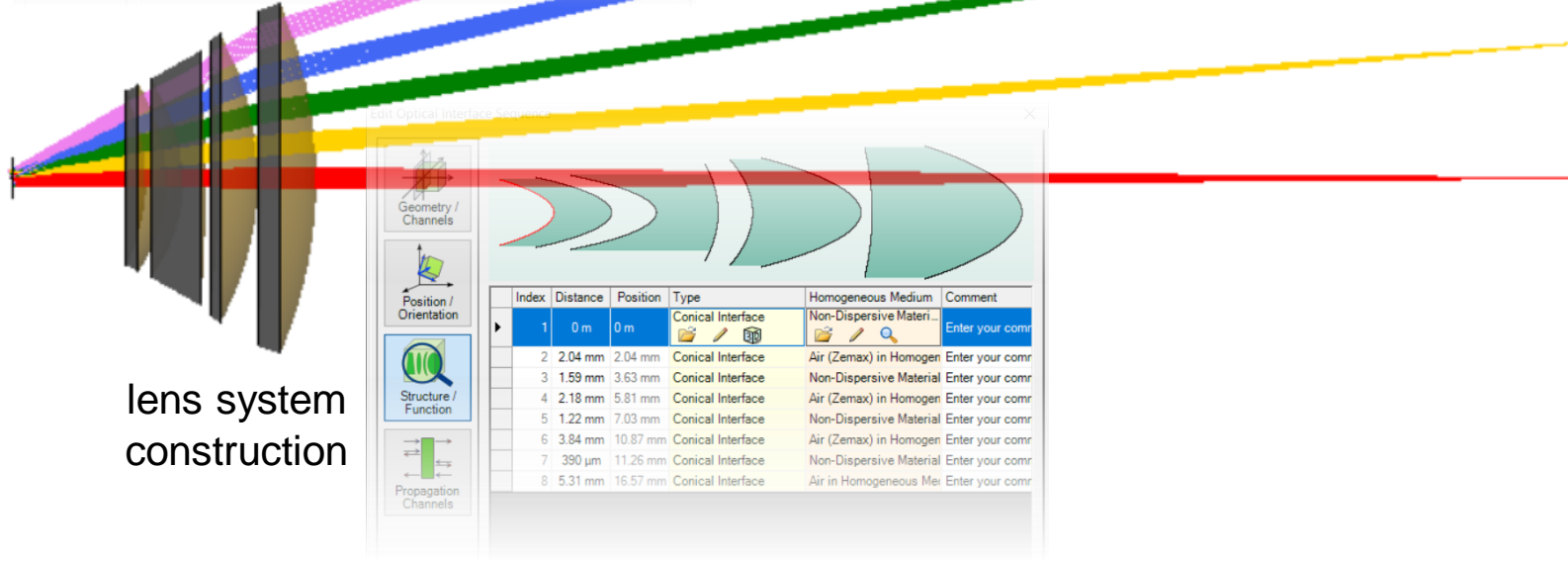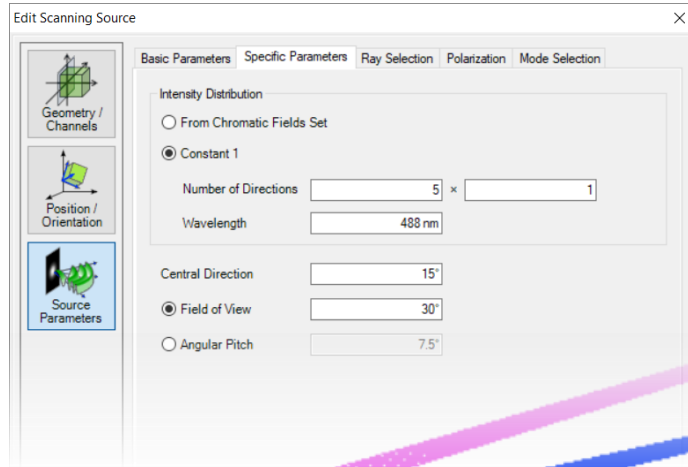
analysis of deviation between actual and the desired focal spot position

Workflow in VirtualLab Fusion

- Import lens systems from Zemax OpticStudio$^{®}$
  - Import Optical Systems from Zemax [Use Case]

- Analyze imaging performance of real lens system
  - Analyzing High-NA Objective Lens Focusing [Use Case]

- Check influence from different parameters with Parameter Run
  - Usage of the Parameter Run Document [Use Case]
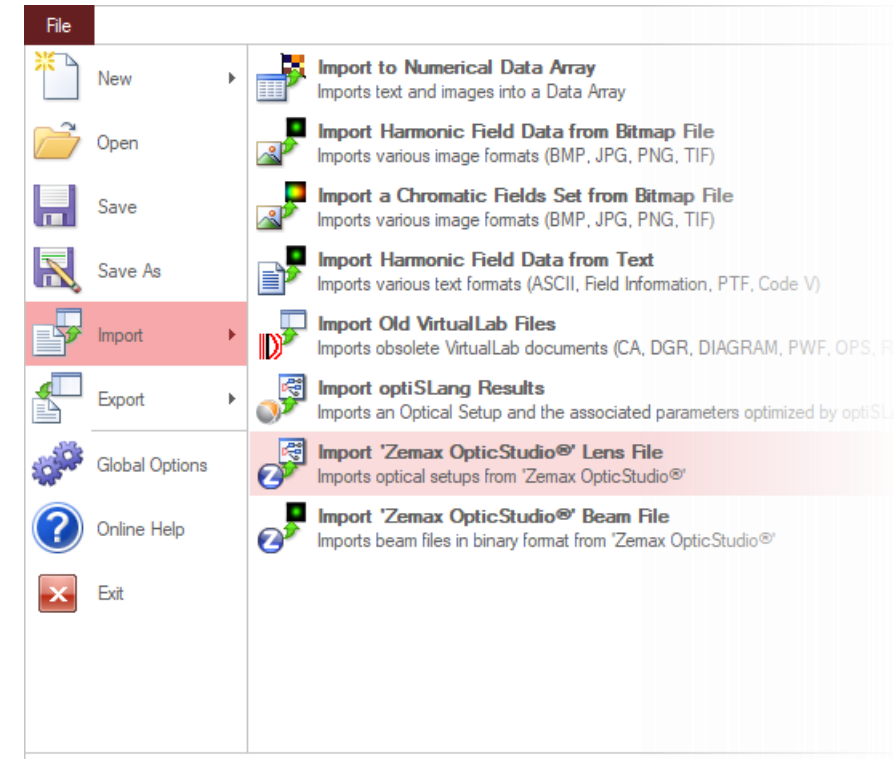
VirtualLab Fusion Technologies

Document Information

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VL version used for simulations	VirtualLab Fusion Summer Release 2019 (7.6.1.18)
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further reading	- Performance Analysis of Laser Scanning System - How to Set Up a Scanning Source