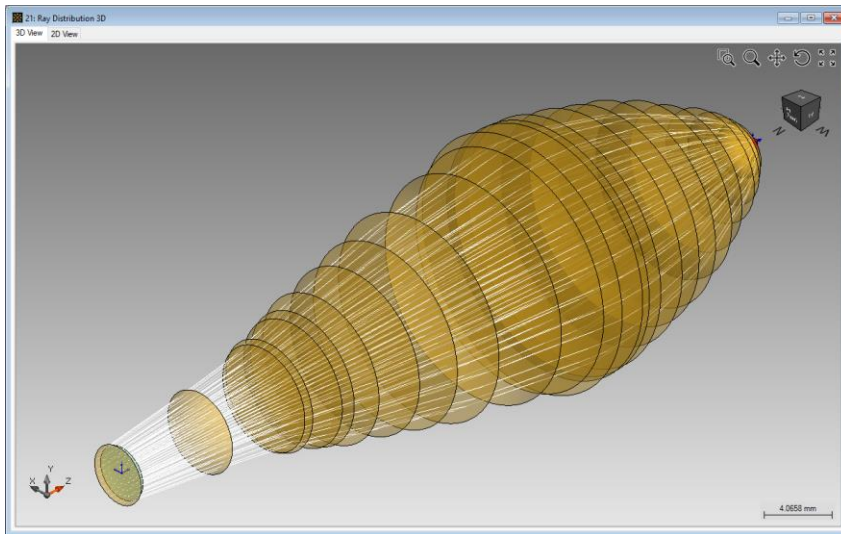


# **Analyzing High-NA Objective Lens Focusing**

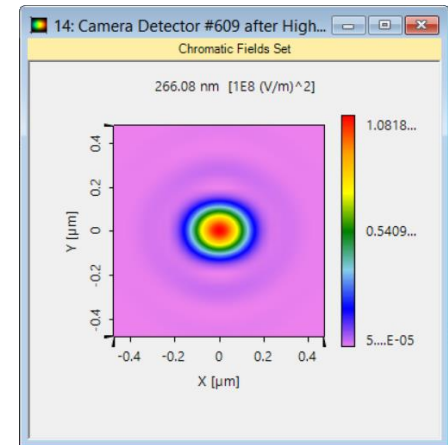
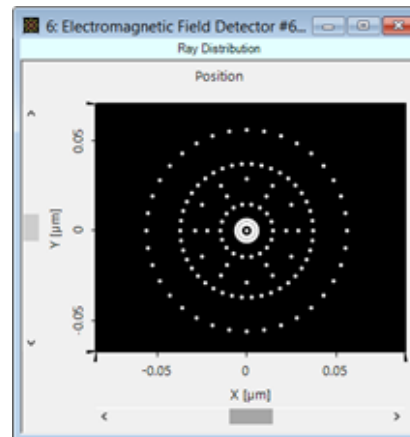
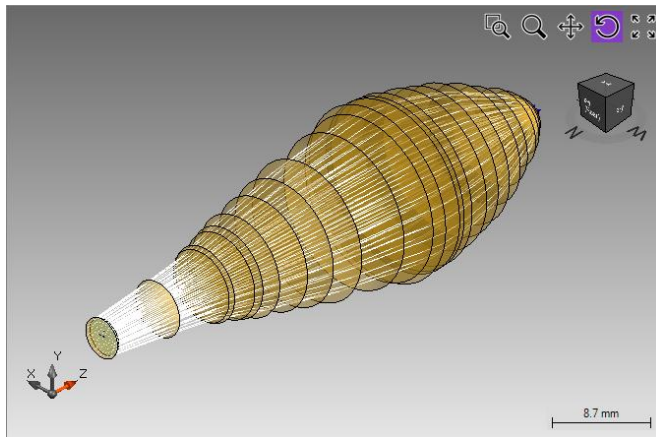
# Abstract



High-NA objective lenses are widely used in optical lithography, microscopy, etc. Consideration of the vectorial nature of light in the simulation of the focusing is therefore fundamental. VirtualLab supports switching the ray and field tracing with great ease. The focal spot is shown, demonstrating the well-known asymmetry which stems from the vectorial effects. The evaluation of the energy density in the focal plane is realized by the camera detector. The camera detector allows the user select which vectorial component shall be included for the detector evaluation.

# This Use Case Shows...

- 3D ray tracing of the objective lens focusing.
- the dot diagram at the focal plane.
- field intensity and field amplitude at the focal plane.



# Overview: System Parameters

- Input plane wave

Parameter	Description / Value & Unit
wavelength	266.08 nm
polarization	linear in x-direction ( $0^\circ$ )
diameter	3 mm

- Objective Lens

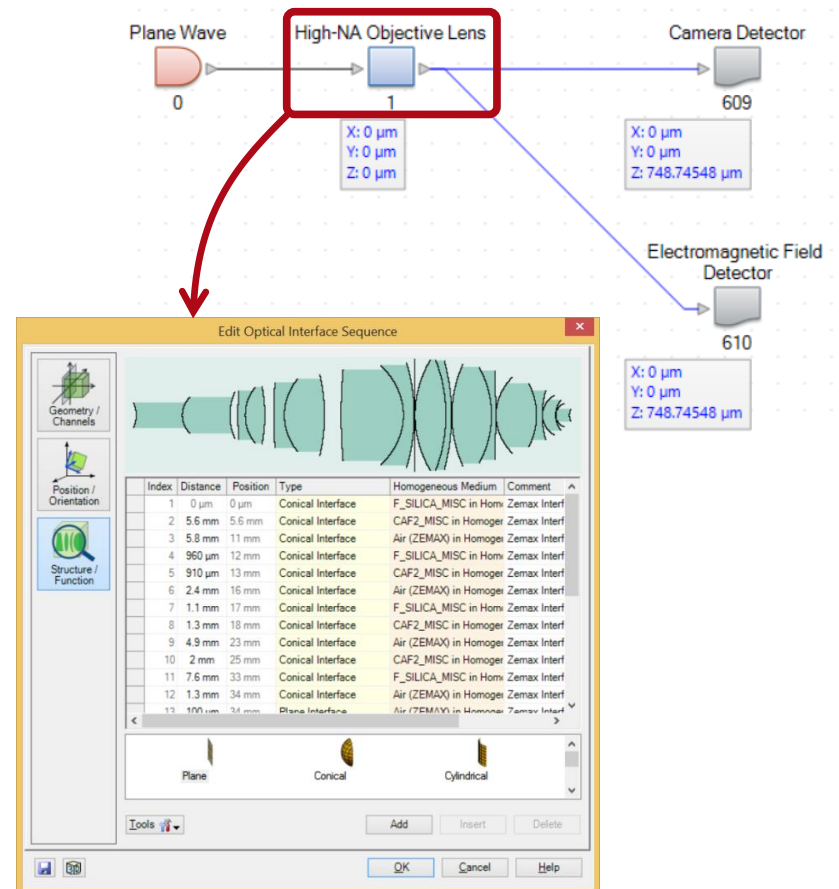
Parameter	Description / Value & Unit
NA of condenser lens	0.85
number of interfaces	26

- Detector

Parameter	Description / Value & Unit
window size	$1\ \mu\text{m} \times 1\ \mu\text{m}$

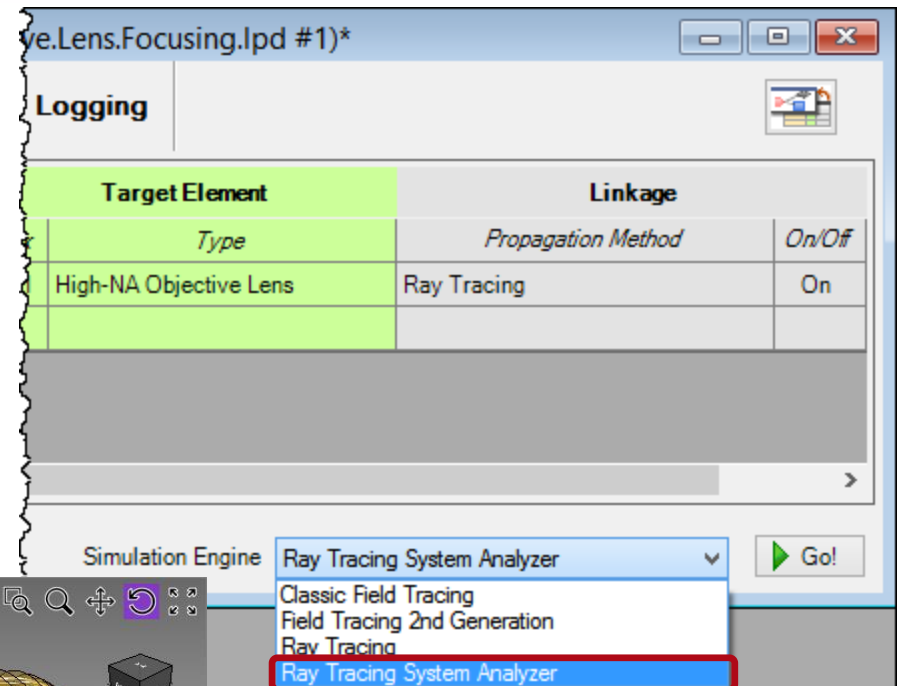
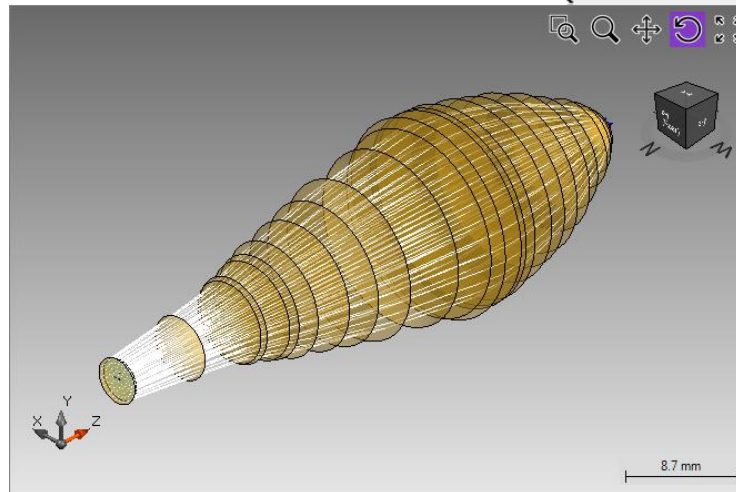
# Overview

- The sample system is preset with the complicated objective lens included.
- Next, we demonstrate how to perform simulation on the sample system following the recommended workflow in VirtualLab.



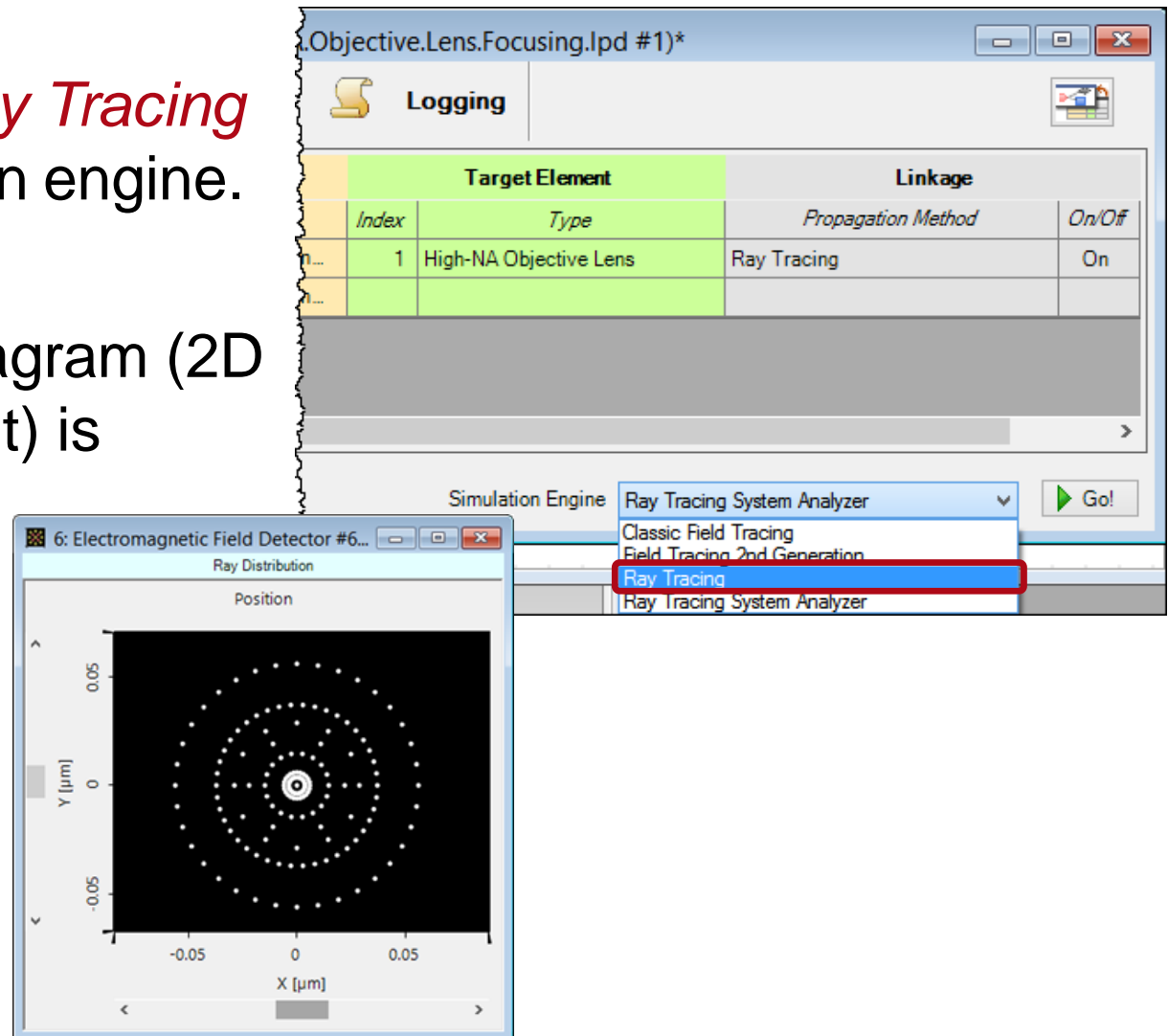
# Ray Tracing Simulation

- Choose *Ray Tracing System Analyzer* as the simulation engine at first.
- Click on *Go!*
- The 3D ray tracing result is obtained.



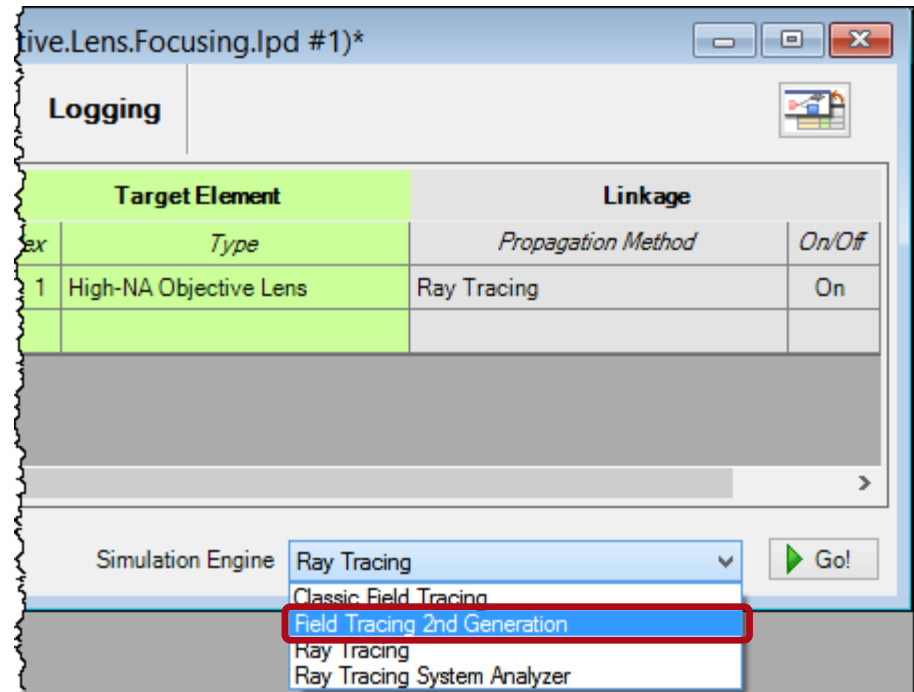
# Ray Tracing Simulation

- Then, select *Ray Tracing* as the simulation engine.
- Click *Go!*
- Then the dot diagram (2D ray tracing result) is obtained.



# Field Tracing Simulation

- Switch to field tracing and select *Field Tracing 2<sup>nd</sup> Generation* as the simulation engine.
- Click *Go!*

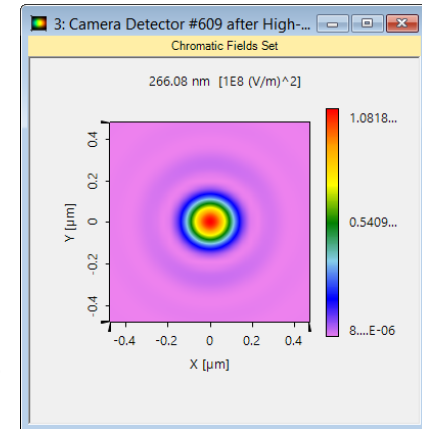




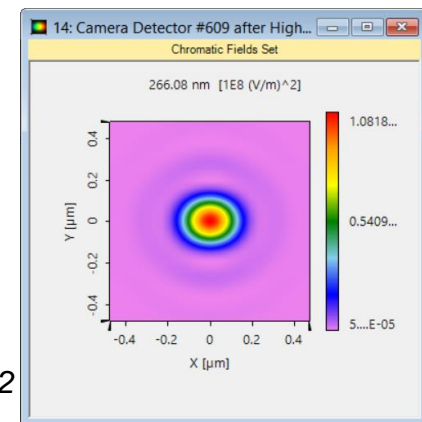
# Field Tracing Results (Camera Detector)

- The top figure shows the field intensity by integrating  $E_x$  and  $E_y$  components only.
- The bottom figure shows the field intensity by integrating  $E_x$ ,  $E_y$  and  $E_z$  components: an obvious asymmetry is seen due to the relatively large  $E_z$  component in high-NA situation.

$$E_x^2 + E_y^2$$

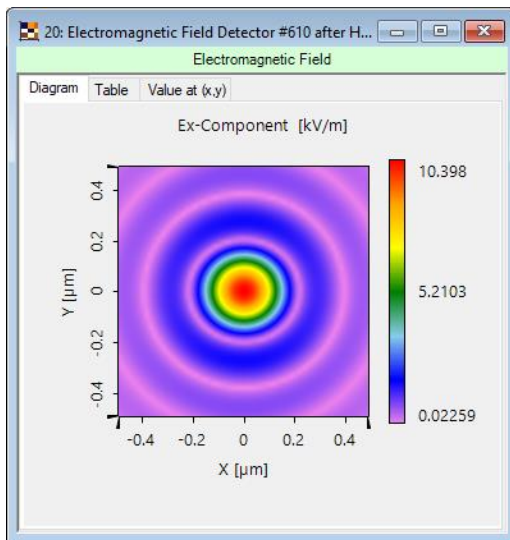


$$E_x^2 + E_y^2 + E_z^2$$

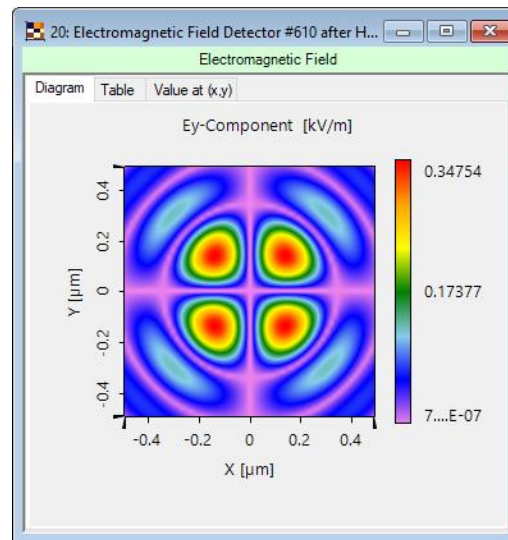


# Field Tracing Results (EM Field Detector)

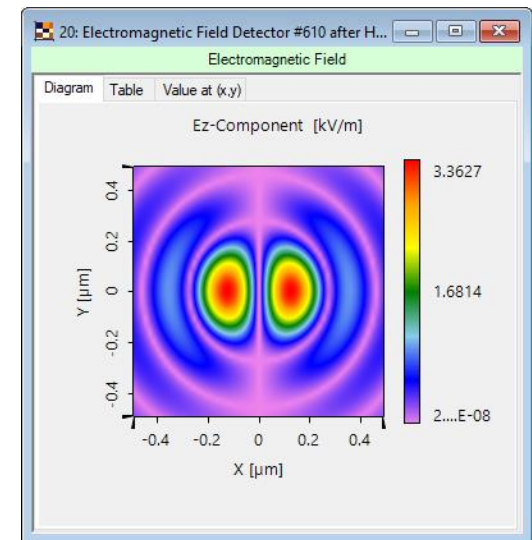
- All electromagnetic field components are obtained by using the Electromagnetic Field Detector.



Amplitude of  $E_x$



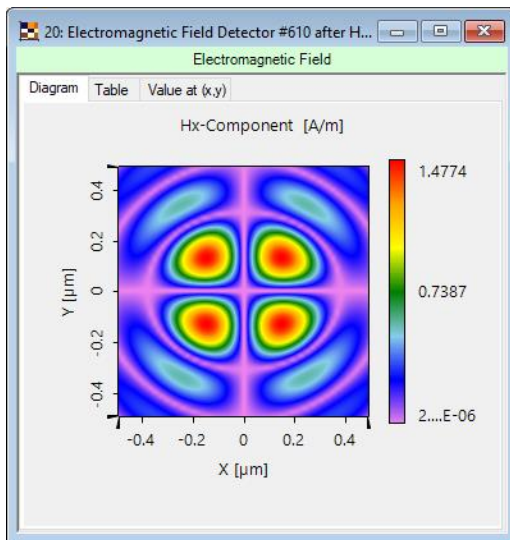
Amplitude of  $E_y$



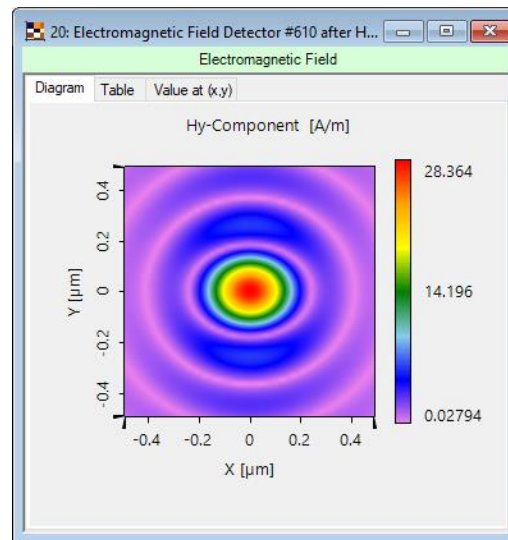
Amplitude of  $E_z$

# Field Tracing Results (EM Field Detector)

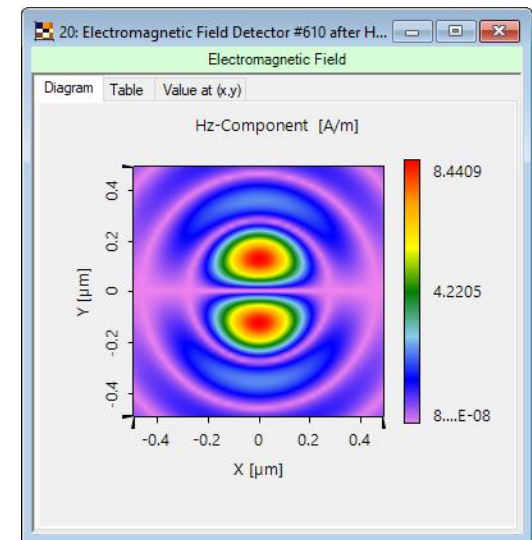
- All electromagnetic field components are obtained by using the Electromagnetic Field Detector.



Amplitude of  $H_x$



Amplitude of  $H_y$



Amplitude of  $H_z$

# Document Information

---

title	Analyzing High-NA Objective Lens Focusing
version	1.0
VL version used for simulations	7.0.3.4
category	Feature Use Case

---