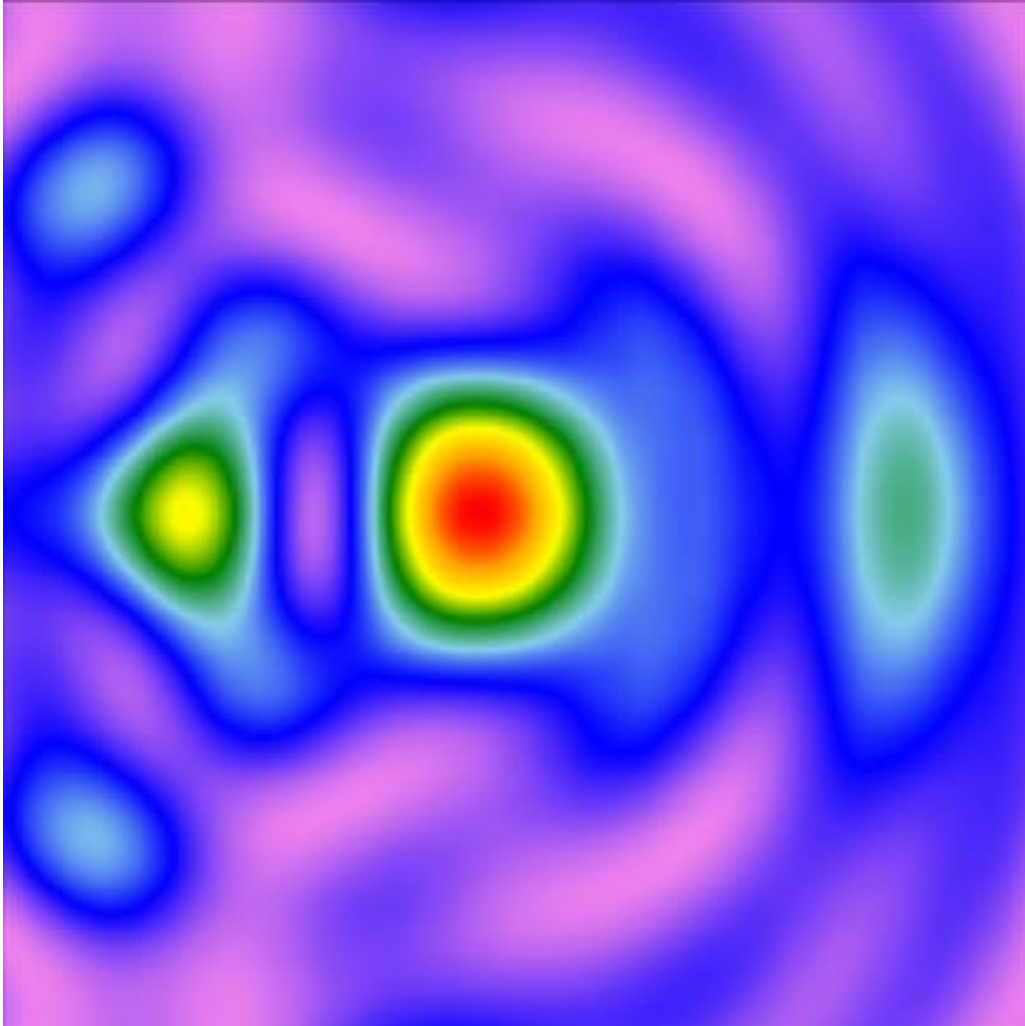


Influence of the Position of the Stop in a Lens System on Point Spread Function (PSF)

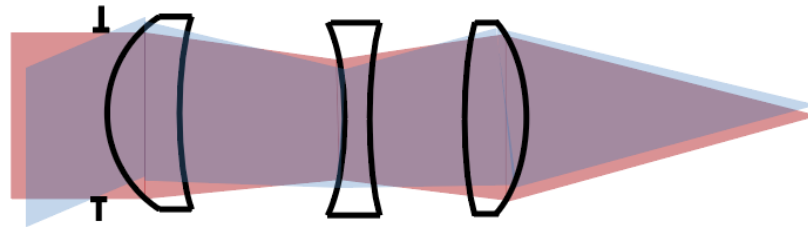
Abstract



Stop in a lens system is important because it directly determines the light interaction with the edge of the aperture of the lens surface, which existed physically in the manufactured lens system. Therefore, different positions of the stop might have an influence on the Point Spread Function (PSF). VirtualLab Fusion provides an ease way to investigate this influence by considering the diffraction, if necessary, from the edge of each surface, especially with inclined illumination.

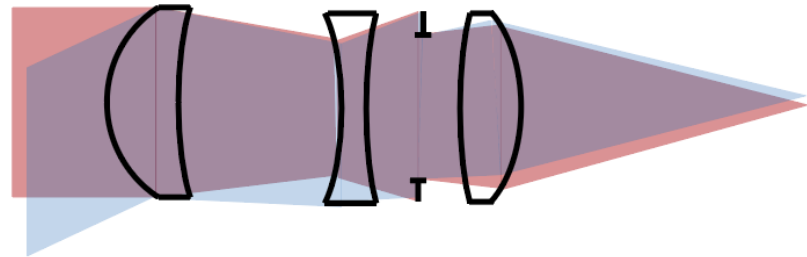
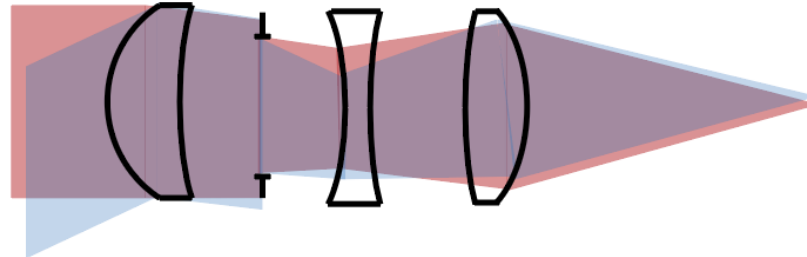
Scenario

retrofocus lens
- US4950055



plane wave

- normal or inclined incidence with 8°
- circularly polarized
- wavelength 587.7 nm



PSF $|E_x|^2 + |E_y|^2 + |E_z|^2$

How is the PSF influenced by the different positions of the stop in the cases of normal and inclined incidence?

Building the System in VirtualLab Fusion

System Building Blocks

The diagram illustrates the building blocks of an optical system. A plane wave enters from the left, passes through three lenses, and is detected by a camera. The system is modeled in three software windows:

- Edit Plane Wave**: Configures the input wave's spectral parameters.
- Edit Lens System Component**: Defines the optical components (lenses) in the system.
- Edit Camera Detector**: Configures the detector's resolution and integration parameters.

Edit Plane Wave Window Details:

- Power Spectrum Type: Single Wavelength
- Spectral Values: Wavelength = 1.064 μm , Weight = 1
- Preview: [Black box]

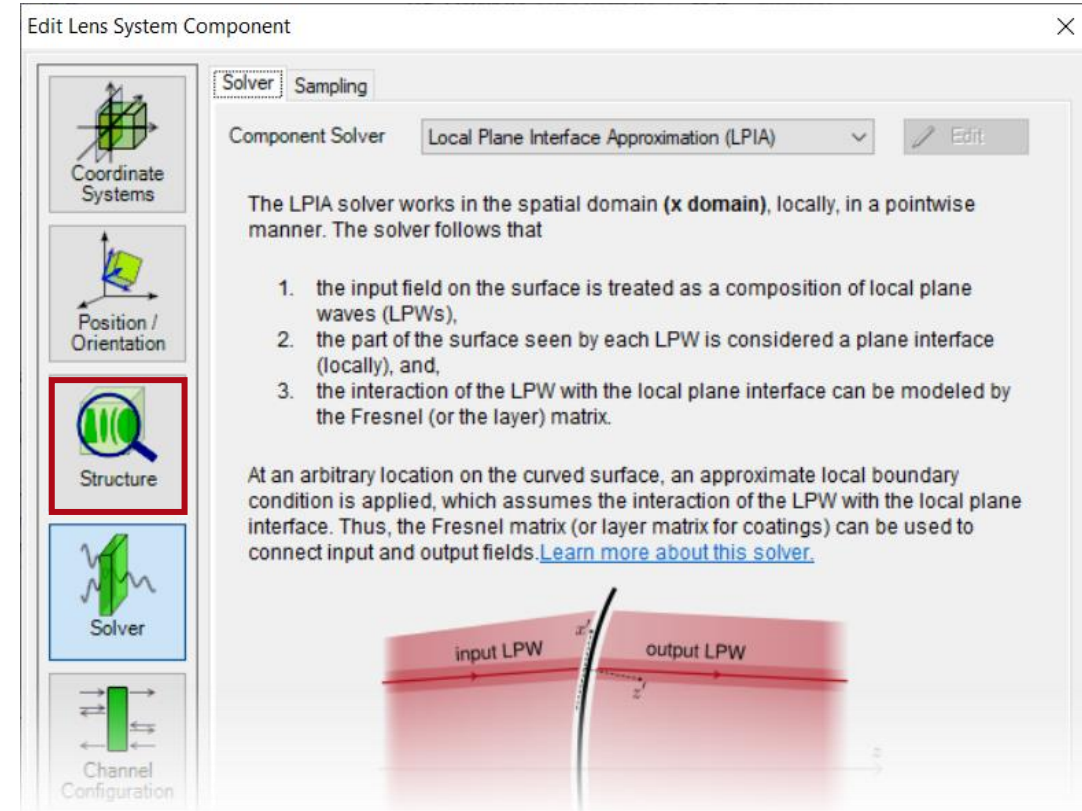
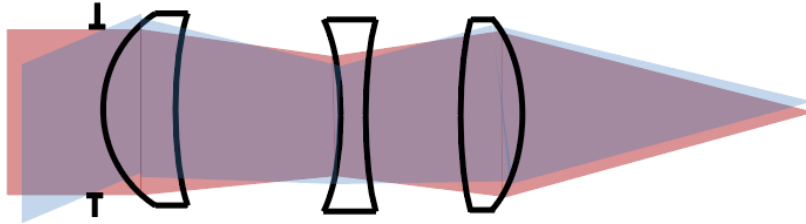
Edit Lens System Component Window Details:

Index	Distance	Position	Type	Homogeneous Medium	Comment
1	0 mm	0 mm	Conical Surface	Index_d_1.81_Abbe_25	Enter your comr
2	17961203 r	5.2796120	Conical Surface	Air (Zemax OS) in Homc	Enter your comr
3	0955104 r	11.389163	Conical Surface	Index_d_1.75_Abbe_52	Enter your comr
4	1091836 r	22.498346	Conical Surface	Air (Zemax OS) in Homc	Enter your comr
5	9.979426 r	22.778326	Conical Surface	Index_d_1.71_Abbe_53	Enter your comr
6	19926521 r	32.777591	Conical Surface	Air (Zemax OS) in Homc	Enter your comr

Edit Camera Detector Window Details:

- Detector Window and Resolution: [Tab]
- Coherence Parameters: Summation Type = Coherent Summation
- Components to Integrate: ☒ Ex-Component, ☒ Ey-Component, ☒ Ez-Component
- View Settings of Result: ☐ Real Color, ☒ False Color, ☐ Reverse Rainbow

Solvers for Components



Components

Solvers

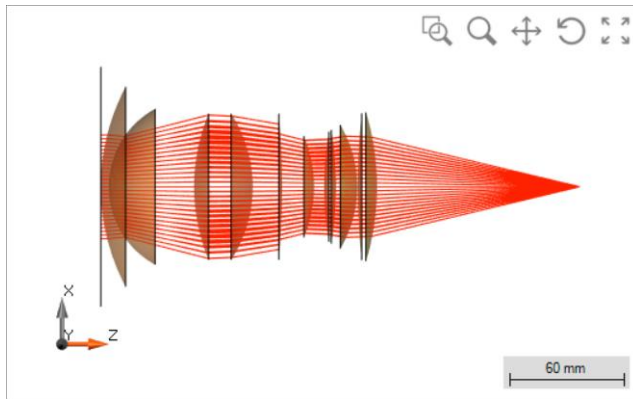
Lens system

Local Plane Interface Approximation (LPIA)

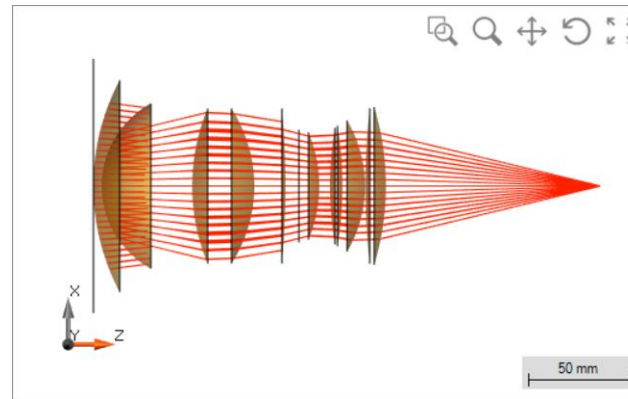
Ray Tracing Simulations

Ray Tracing Results: Normal Incidence

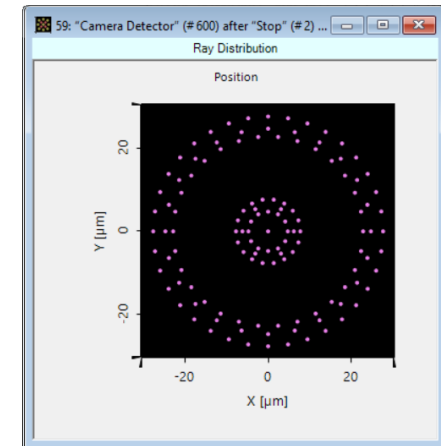
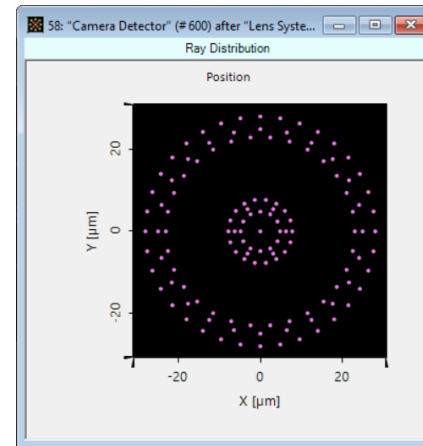
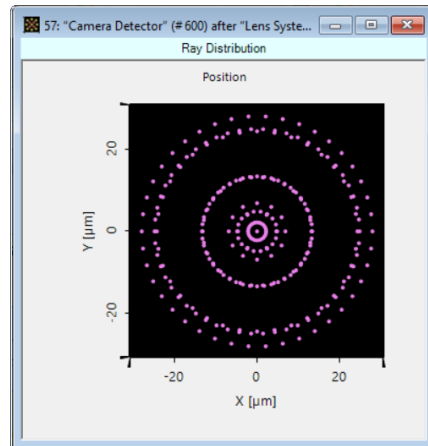
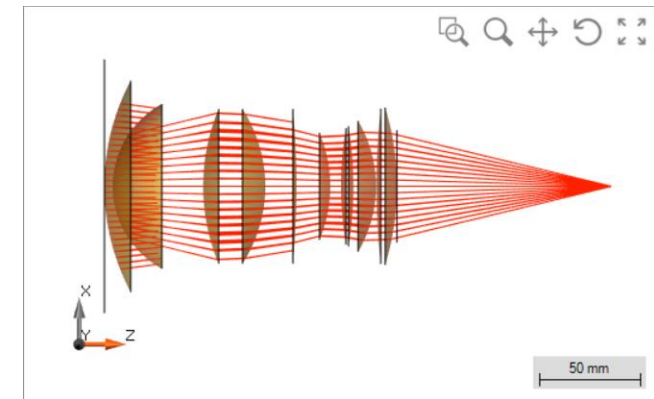
Stop at the Front



Stop in the Middle

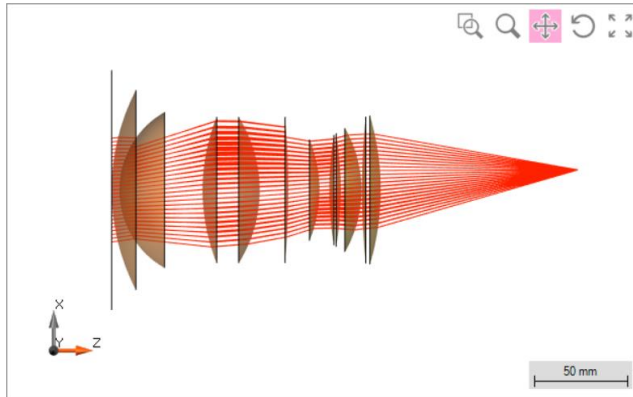


Stop at the End

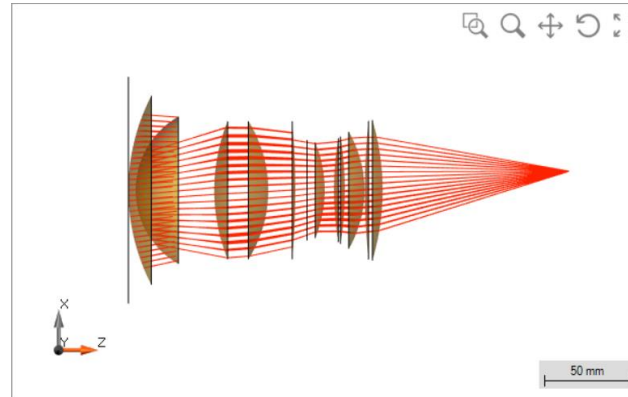


Ray Tracing Results: Inclined Incidence

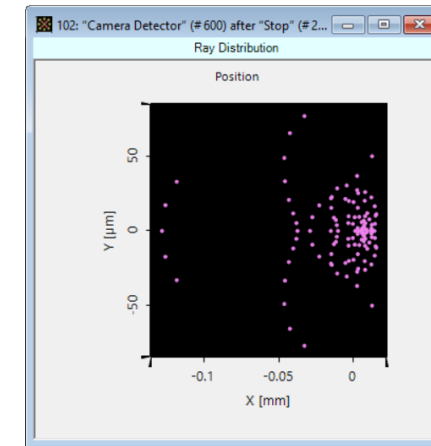
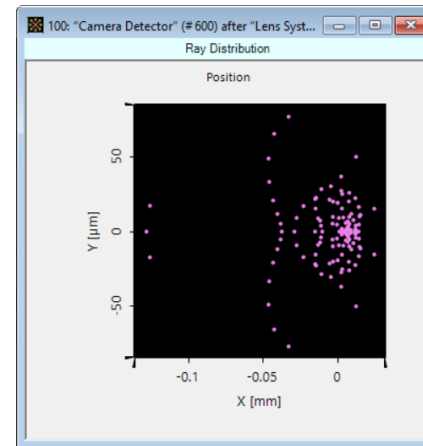
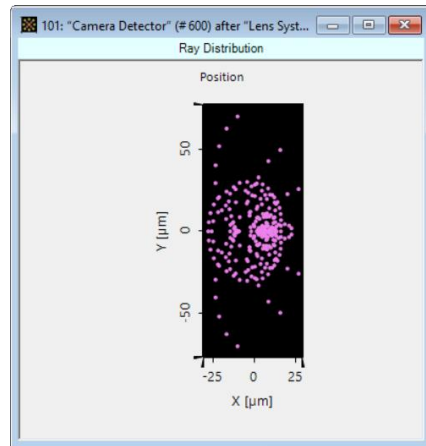
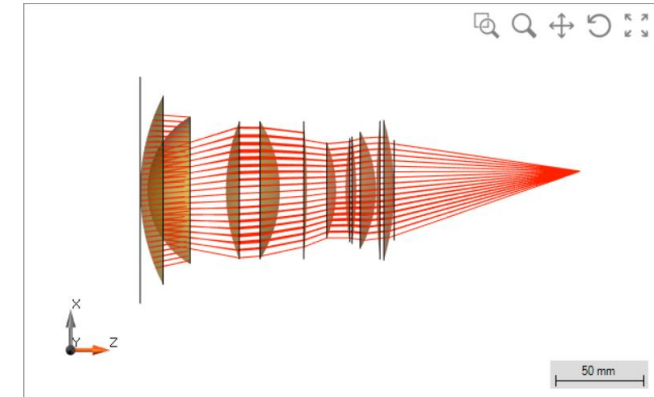
Stop at the Front



Stop in the Middle



Stop at the End

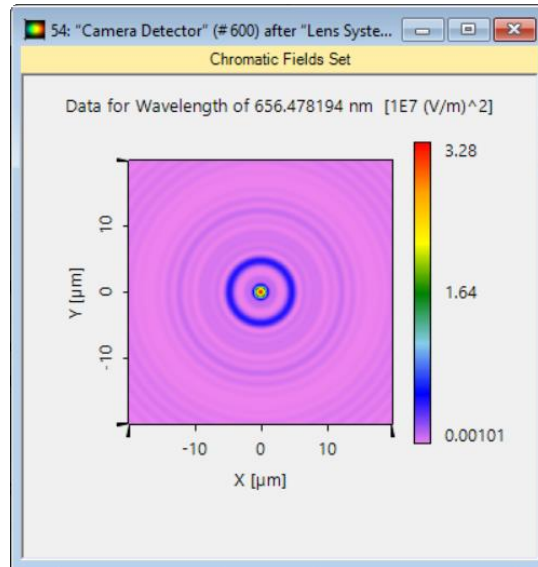


Fast Physical-Optics Simulations

Field Tracing Result: Normal Incidence

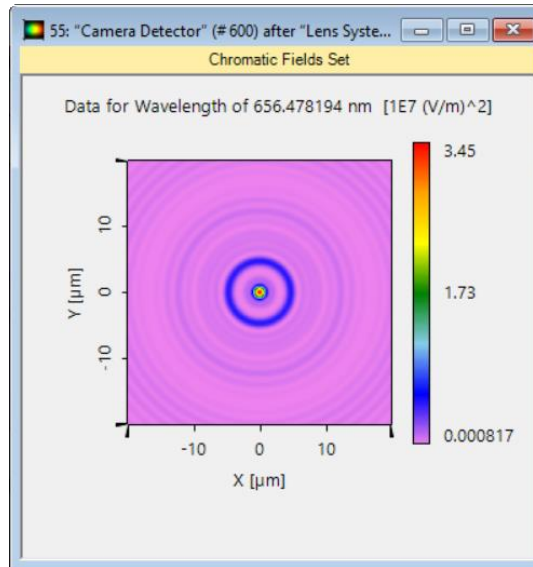
Stop at the Front

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



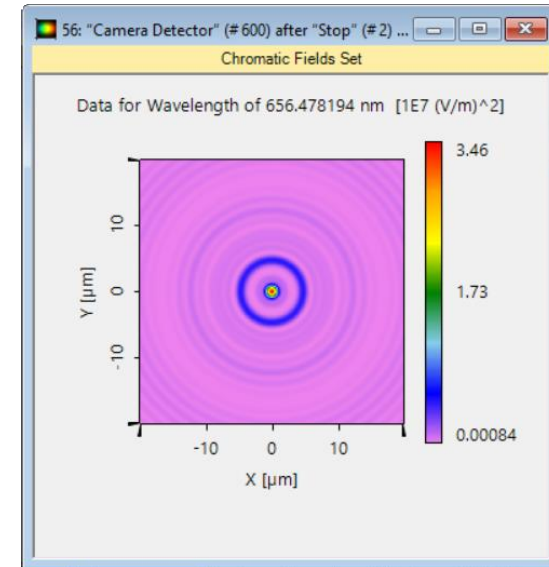
Stop in the Middle

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



Stop at the End

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

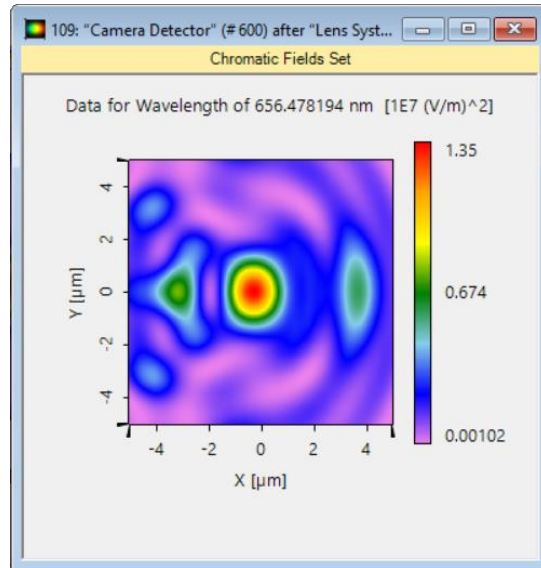


The results have slight difference, which means the position of stop is not important in the case of normal incidence.

Field Tracing Result: Inclined Incidence with Angle 8°

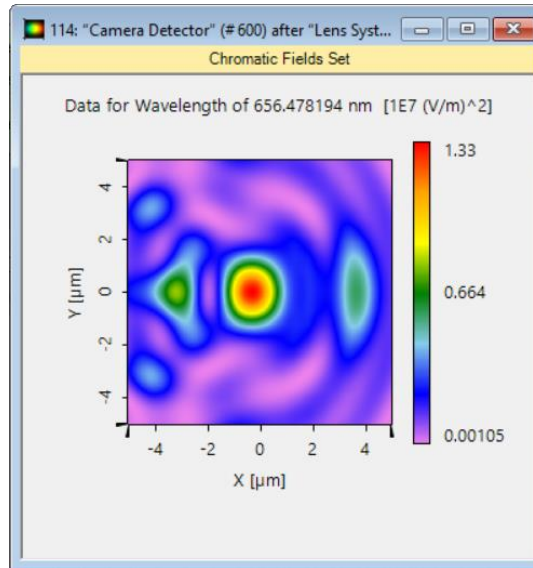
Stop at the Front

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



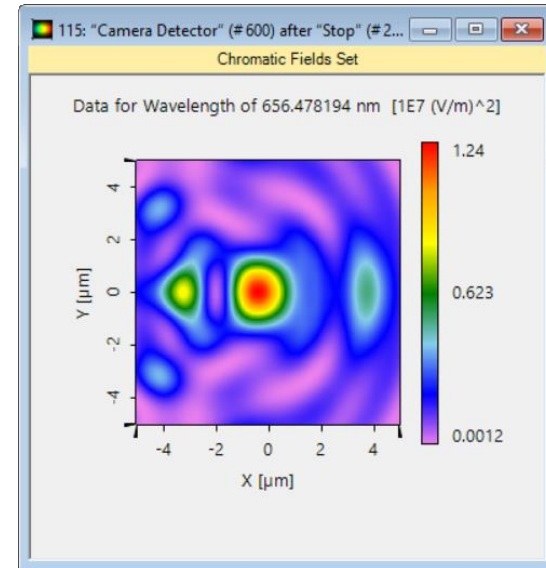
Stop in the Middle

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



Stop at the End

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



The results have difference, which means the position of stop needs to be considered well in the case of inclined incidence.

Document Information

title	Influence of the Position of the Stop in a Lens System on Point Spread Function (PSF)
document code	MIC.0021
version	1.1
edition	VirtualLab Fusion
software version	2024.1 (Build 1.132)
category	Application Use Case
further reading	<ul style="list-style-type: none">- Debye-Wolf Integral Calculator- Analyzing High-NA Objective Lens- Resolution Investigation for Microscope Objective Lenses by Rayleigh Criterion