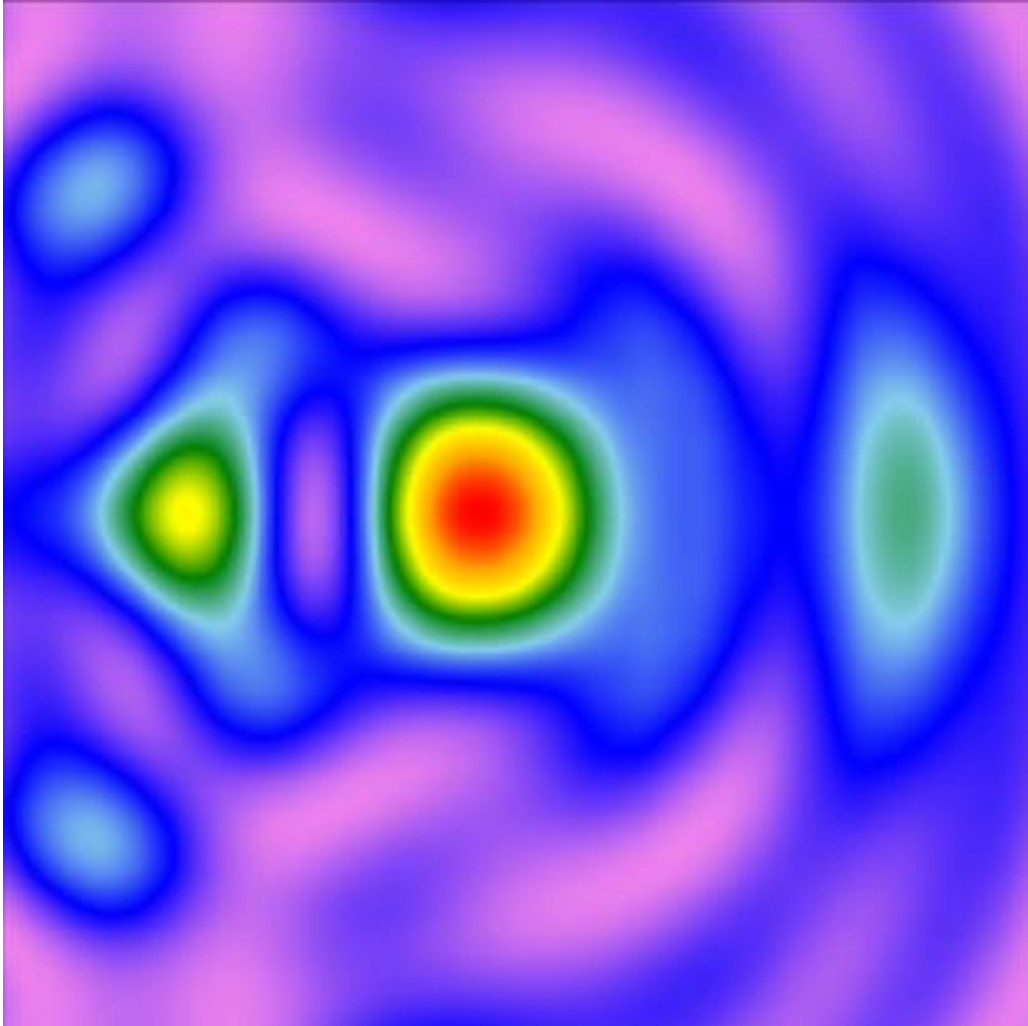


Influence of the Position of the Stop in a Lens System on Point Spread Function (PSF)

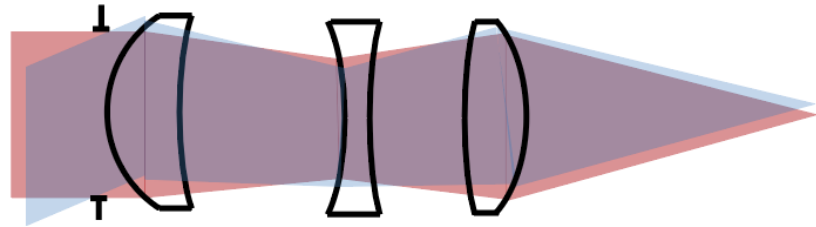
Abstract



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.

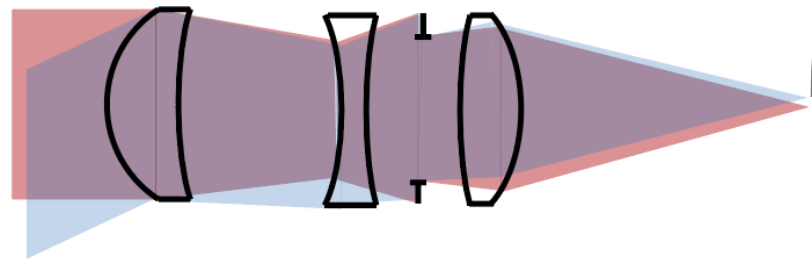
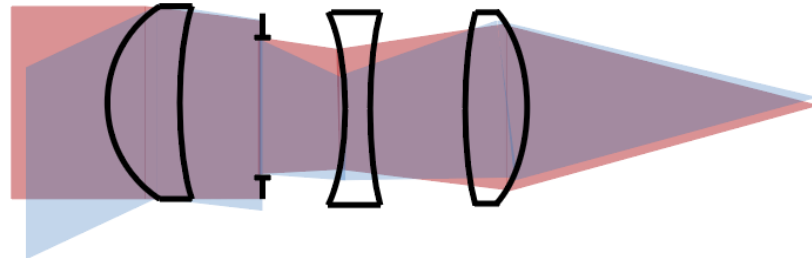
Scenario

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

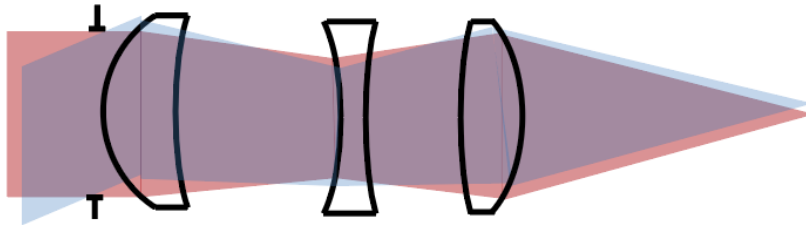
System Building Blocks

The diagram shows an optical system with a light beam passing through three lenses. Three arrows point from the system to three software windows:

- Edit Plane Wave**: Shows parameters for the plane wave source, including Wavelength (1.064 μm) and Weight (1).
- Edit Lens System Component**: Shows the lens system structure and a table of surface parameters.
- Edit Camera Detector**: Shows detector parameters, including Coherence Parameters (Summation Type: Coherent Summation) and Components to Integrate (Ex-Component, Ey-Component, Ez-Component).

Index	Distance	Position	Type	Homogeneous Medium	Comment
1	0 mm	0 mm	Conical Surface	Index_d_1.81_Abbe_25	Enter your comr
2	.7961203 r	5.2796120	Conical Surface	Air (Zemax OS) in Homc	Enter your comr
3	.0955104 r	11.389160	Conical Surface	Index_d_1.75_Abbe_52	Enter your comr
4	.1091836 r	22.498340	Conical Surface	Air (Zemax OS) in Homc	Enter your comr
5	9.979426 r	22.778320	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

Solvers for Components



Edit Lens System Component

Solver Sampling

Component Solver Local Plane Interface Approximation (LPIA) Edit

The LPIA solver works in the spatial domain (**x domain**), locally, in a pointwise manner. The solver follows that

1. the input field on the surface is treated as a composition of local plane waves (LPWs),
2. the part of the surface seen by each LPW is considered a plane interface (locally), and,
3. the interaction of the LPW with the local plane interface can be modeled by the Fresnel (or the layer) matrix.

At an arbitrary location on the curved surface, an approximate local boundary condition is applied, which assumes the interaction of the LPW with the local plane interface. Thus, the Fresnel matrix (or layer matrix for coatings) can be used to connect input and output fields. [Learn more about this solver.](#)

A diagram illustrating the Local Plane Interface Approximation (LPIA) solver. It shows a curved surface with an input LPW (Local Plane Wave) and an output LPW. The input LPW is shown as a red wave entering from the left, and the output LPW is shown as a red wave exiting to the right. The surface is curved, and the LPWs are shown as red lines with arrows indicating their direction. The diagram also shows a coordinate system with x and z axes, and a small angle α' between the surface normal and the x-axis.

Components

Solvers

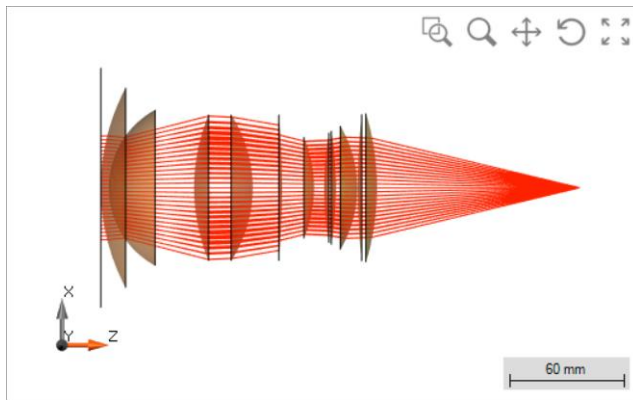
Lens system

Local Plane Interface Approximation (LPIA)

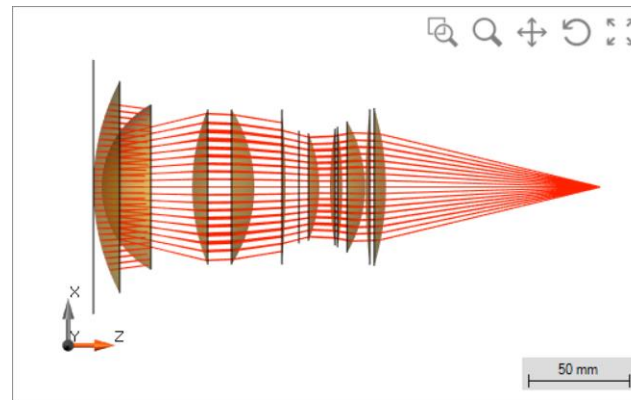
Ray Tracing Simulations

Ray Tracing Results: Normal Incidence

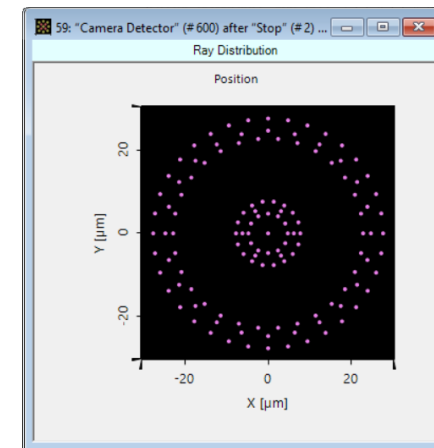
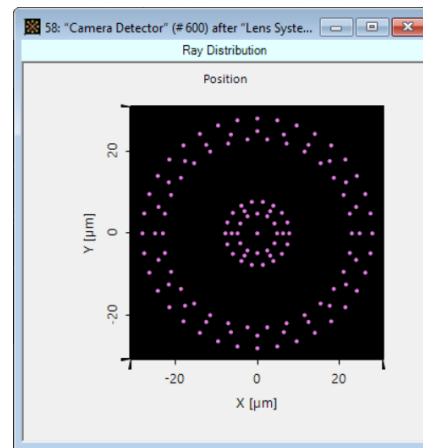
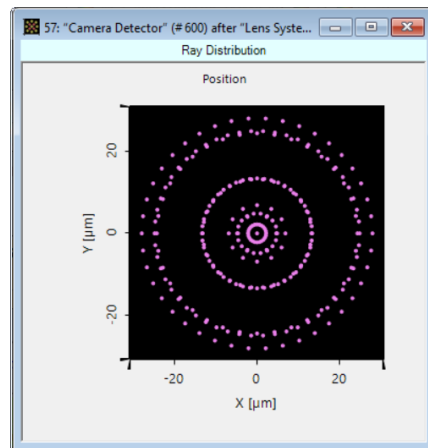
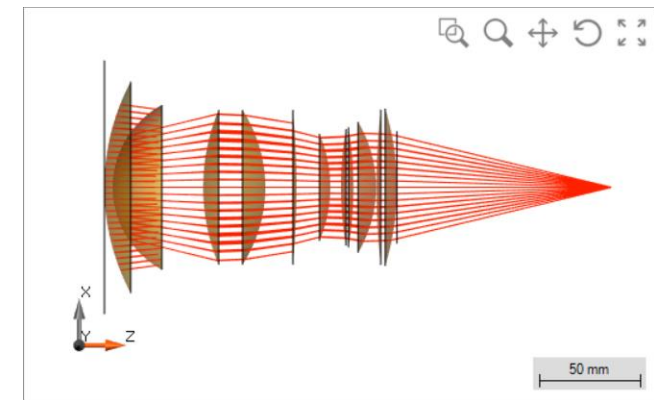
Stop at the Front



Stop in the Middle

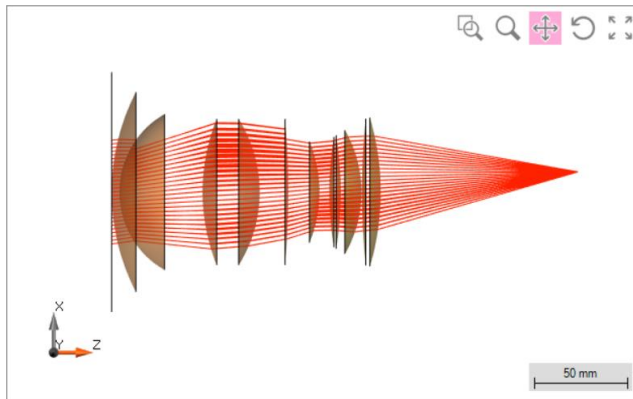


Stop at the End

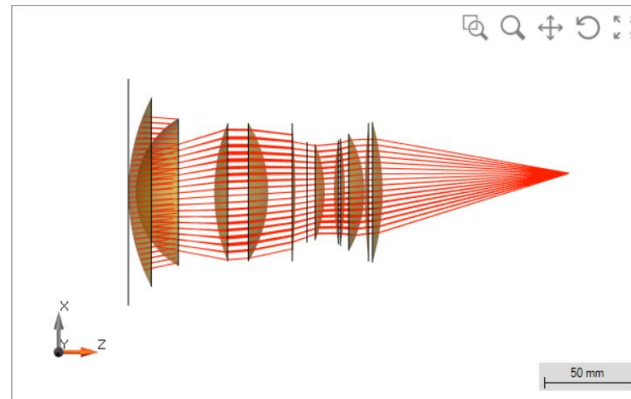


Ray Tracing Results: Inclined Incidence

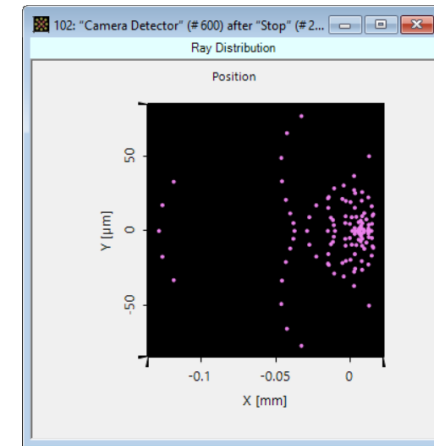
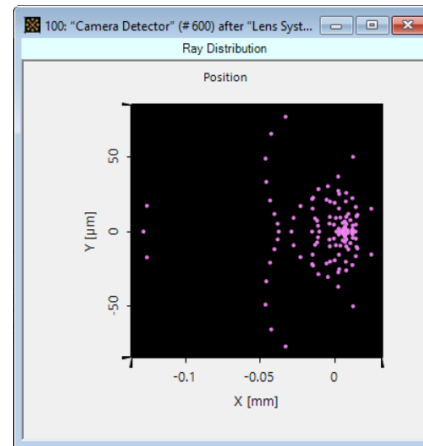
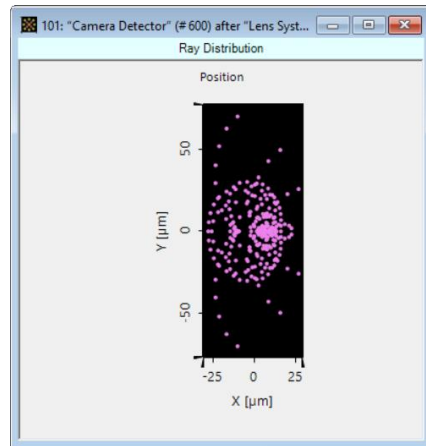
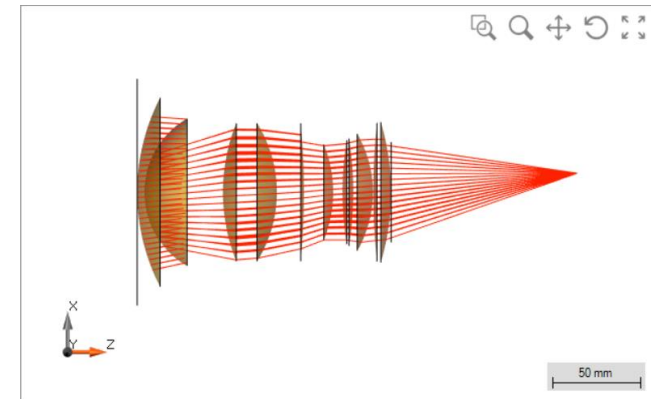
Stop at the Front



Stop in the Middle



Stop at the End

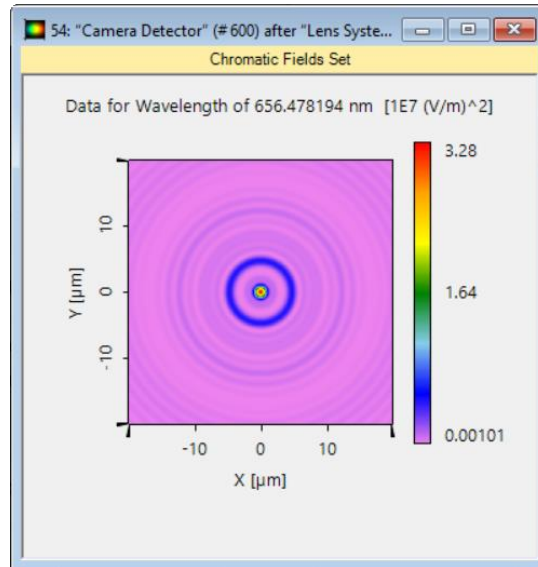


Fast Physical-Optics Simulations

Field Tracing Result: Normal Incidence

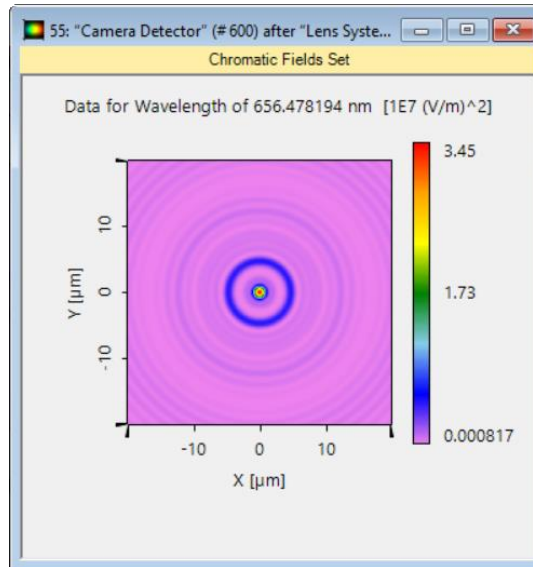
Stop at the Front

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



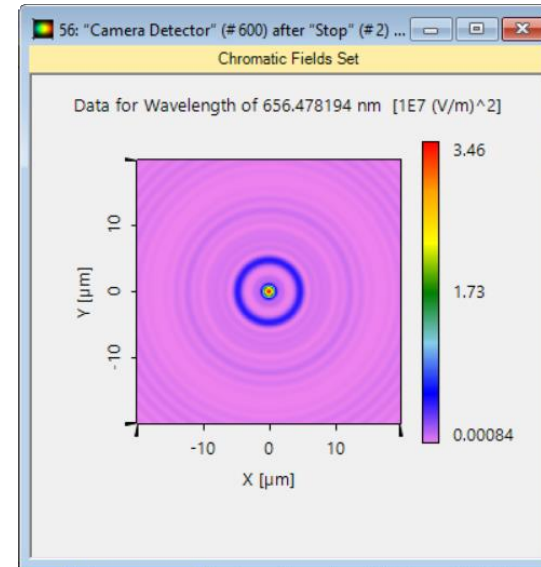
Stop in the Middle

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



Stop at the End

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

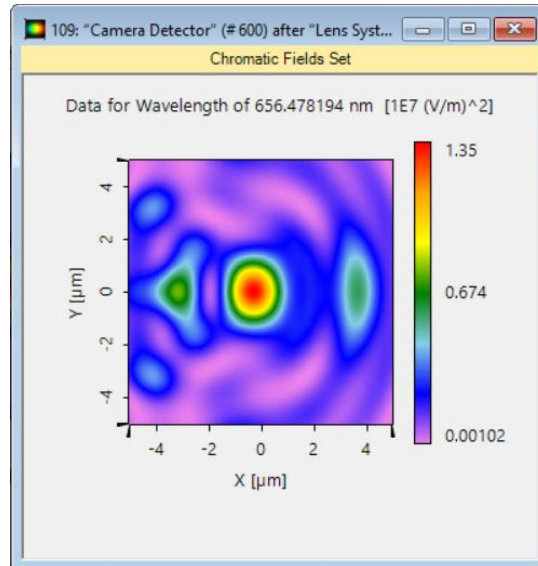


The results have slight difference, which means the position of stop is not important in the case of normal incidence.

Field Tracing Result: Inclined Incidence with Angle 8°

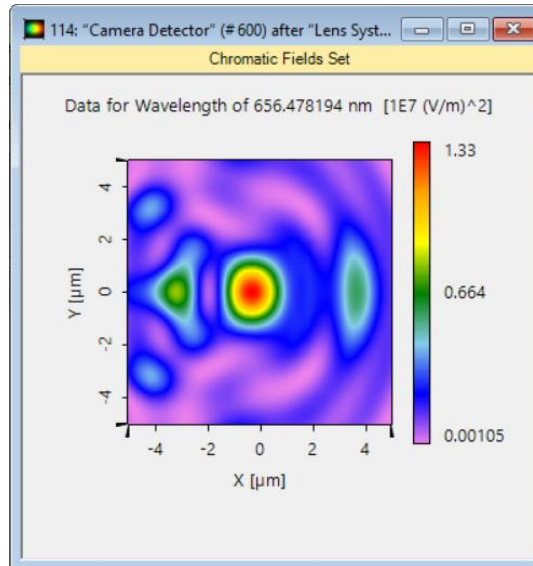
Stop at the Front

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



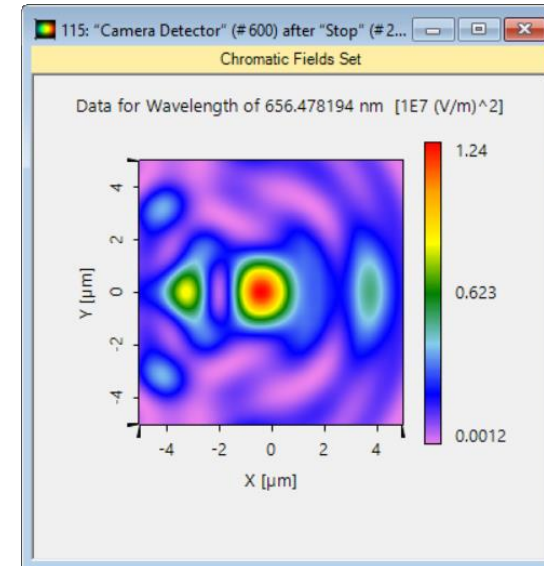
Stop in the Middle

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



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 Basic
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