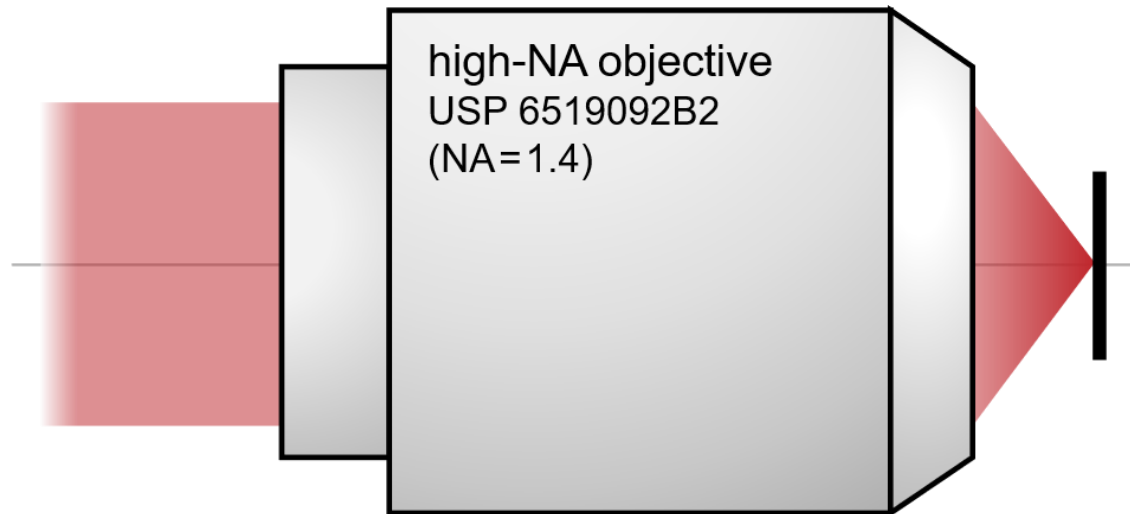


Resolution Investigation for Microscope Objective Lenses by Rayleigh Criterion

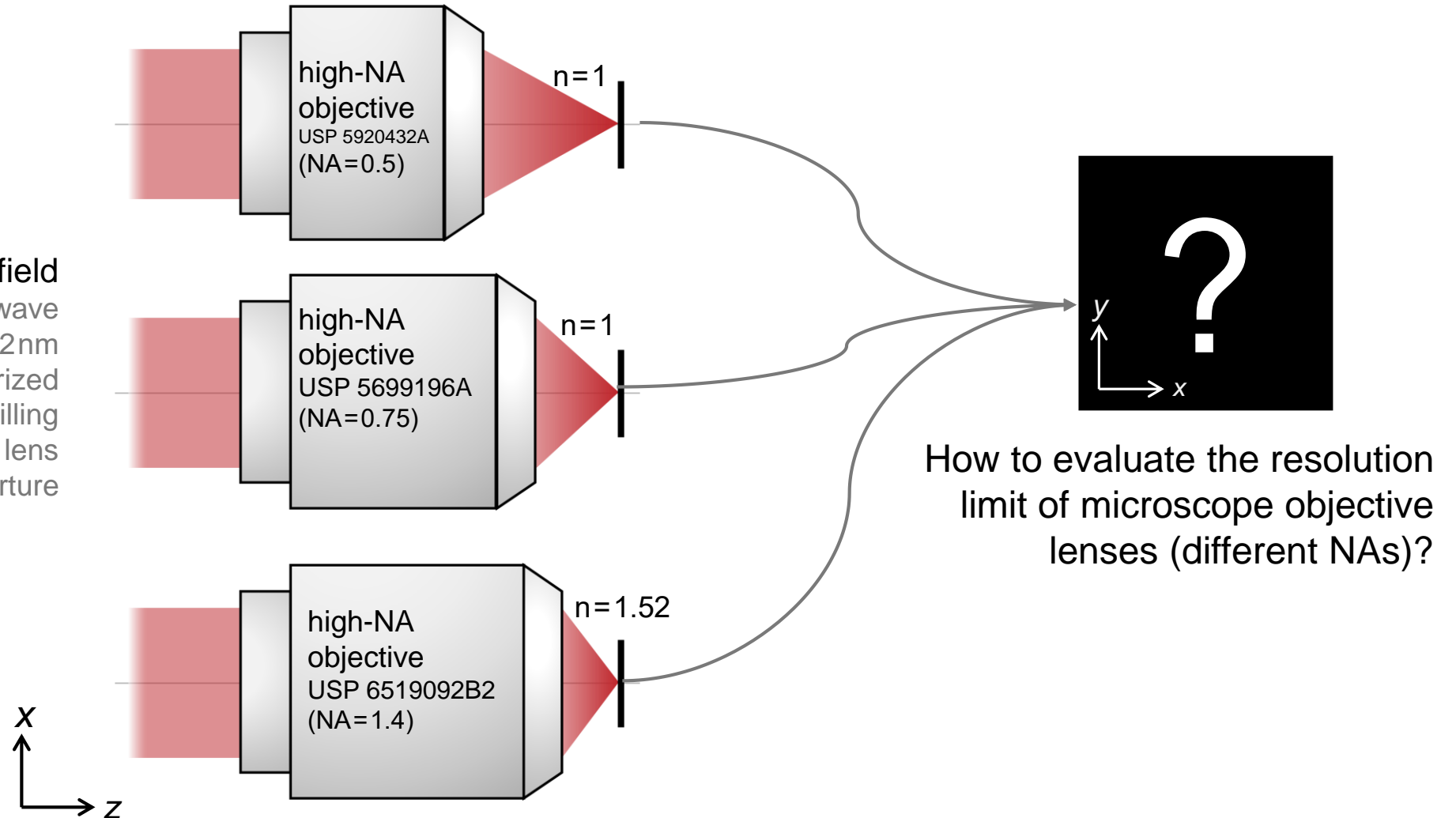
Abstract



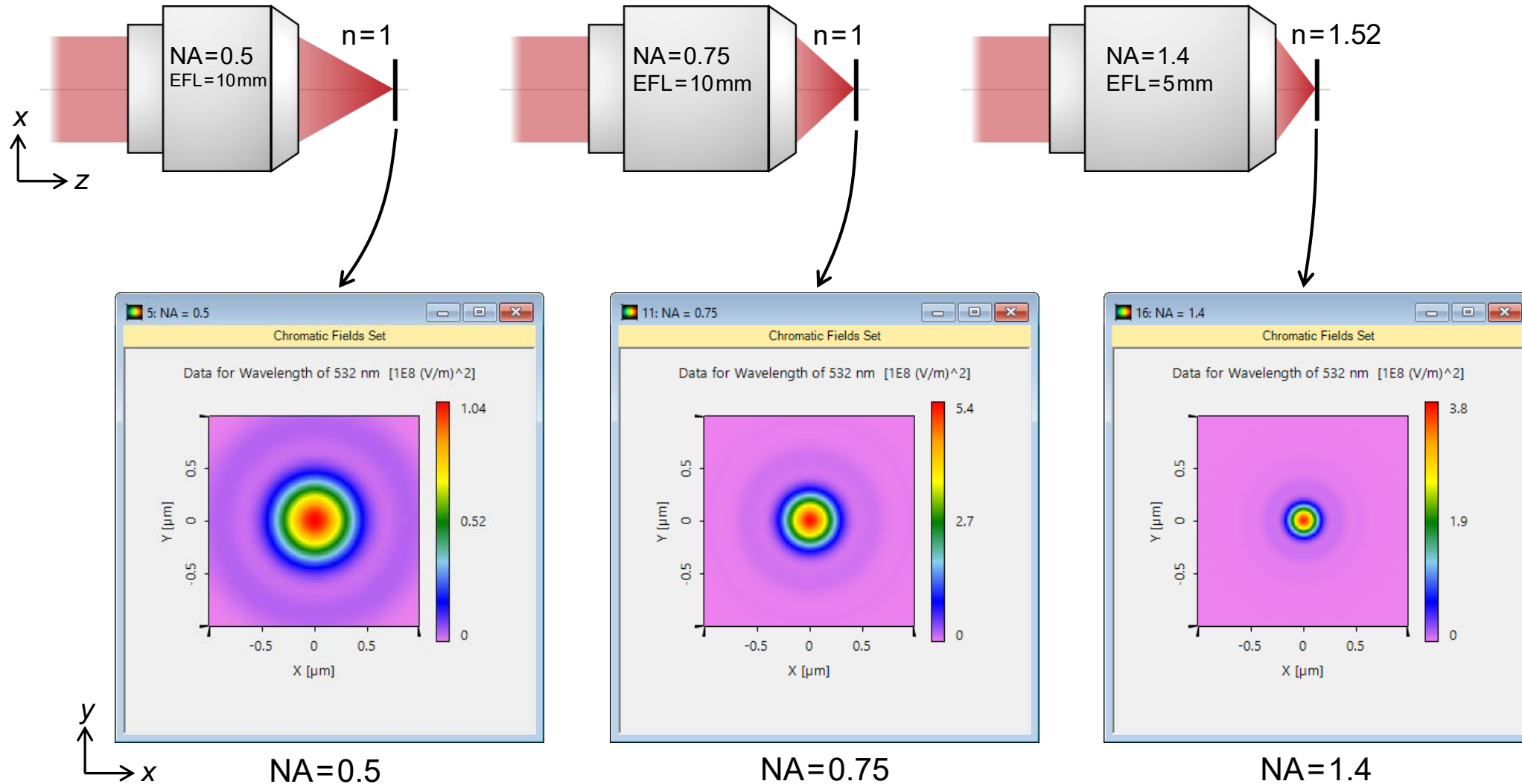
To characterize the resolution of a microscope, it is often practical to following the theory of “Rayleigh Criterion” which was invented by John William Strutt, 3rd Baron Rayleigh in 1896. The theory defines that when the center of one Airy pattern is just overlapped with the first minimum of another, then they can just be resolved. In this example, we follow Rayleigh’s theory and check the resolution for microscopy objective lenses with different numerical aperture (NA) values.

Modeling Task

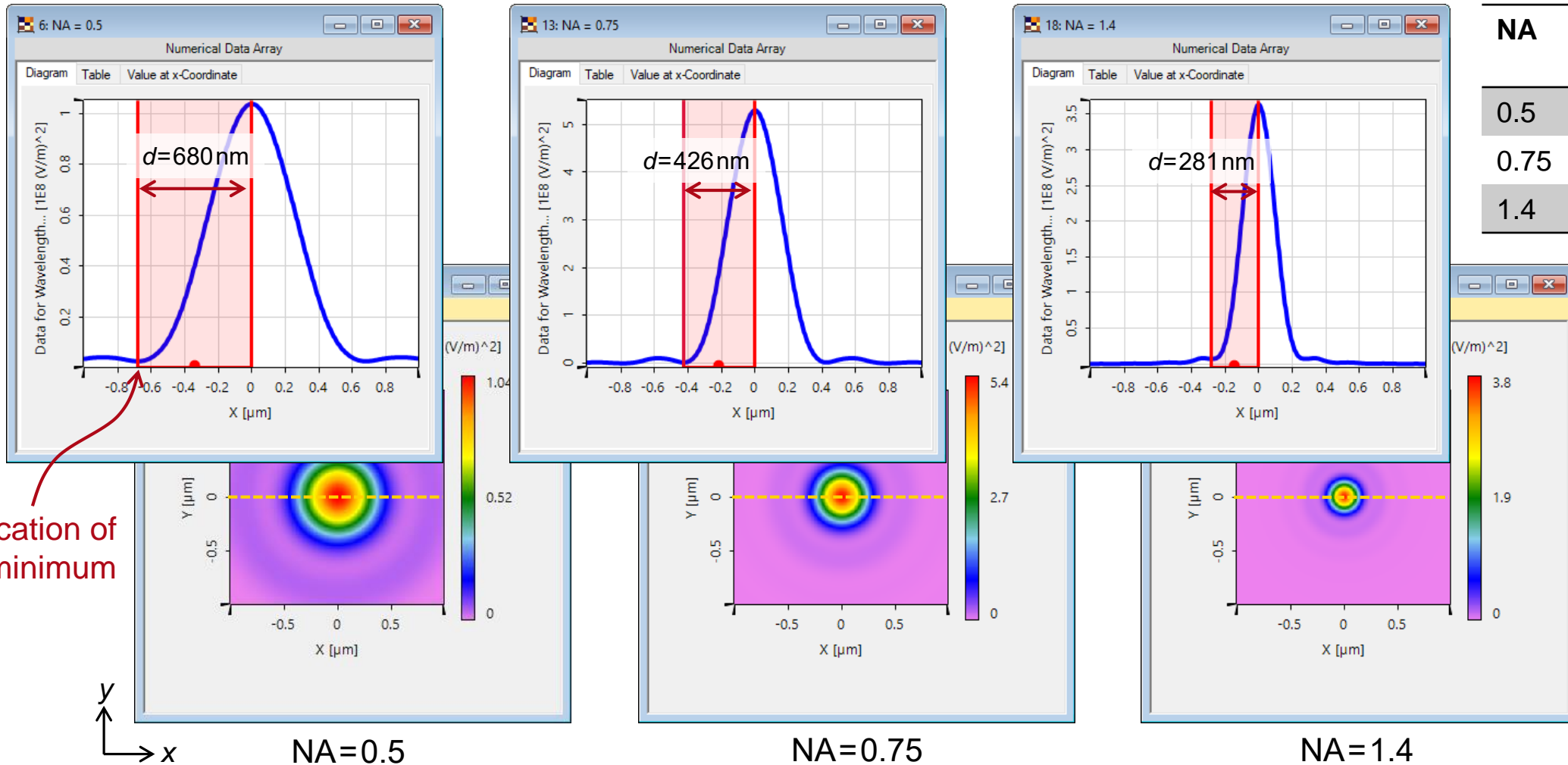
- illumination field
- plane wave
 - wavelength 532nm
 - circularly polarized
 - field size fulfilling corresponding lens aperture



Evaluation of Real Objective Lenses



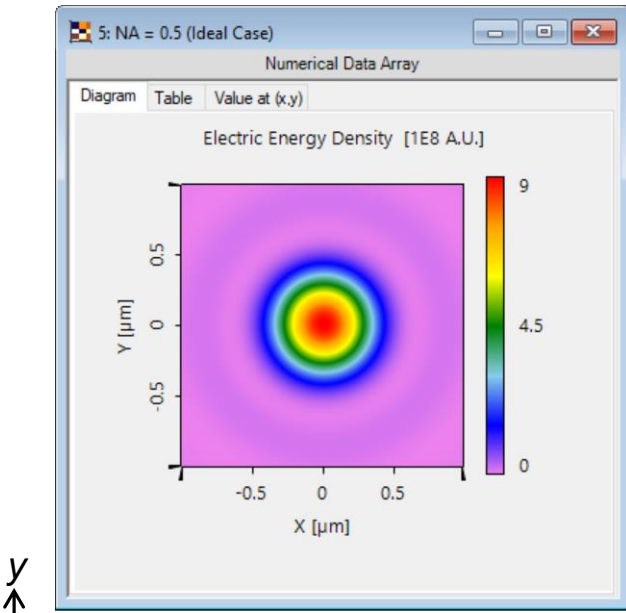
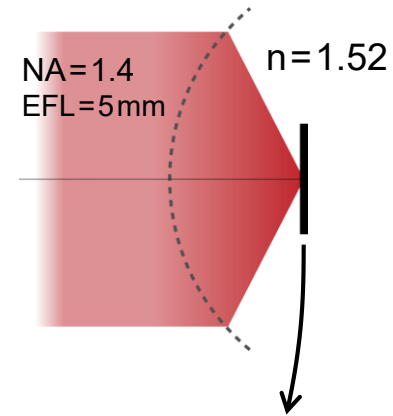
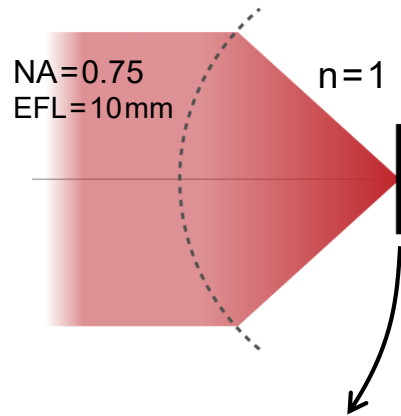
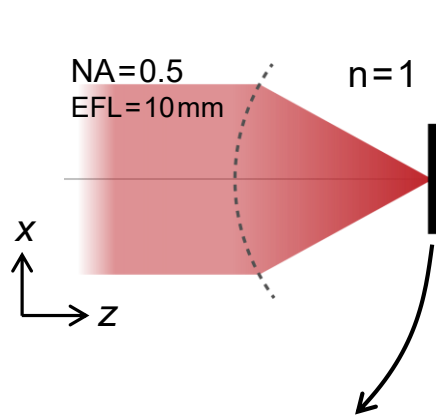
Evaluation of Real Objective Lenses



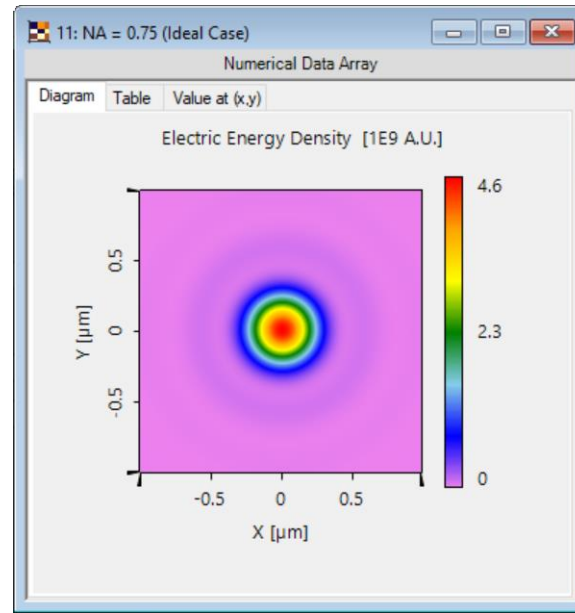
NA	Rayleigh criterion D
0.5	649nm
0.75	433nm
1.4	232nm

$$D = \frac{0.61\lambda}{NA}$$

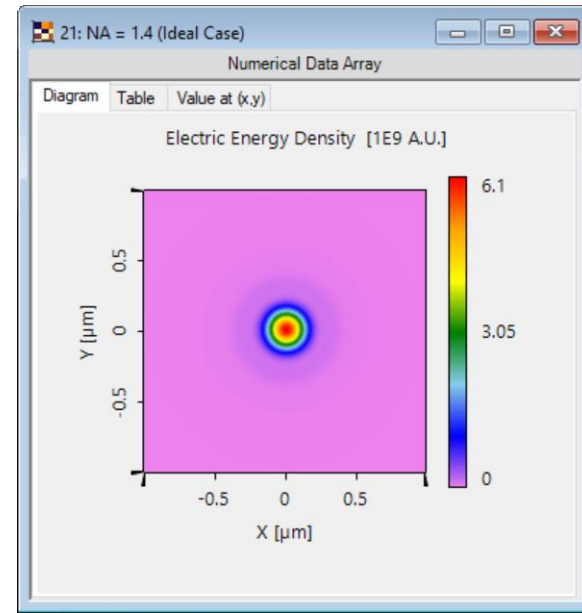
Evaluation of Idealized Lenses by Debye-Wolf Integral



NA=0.5

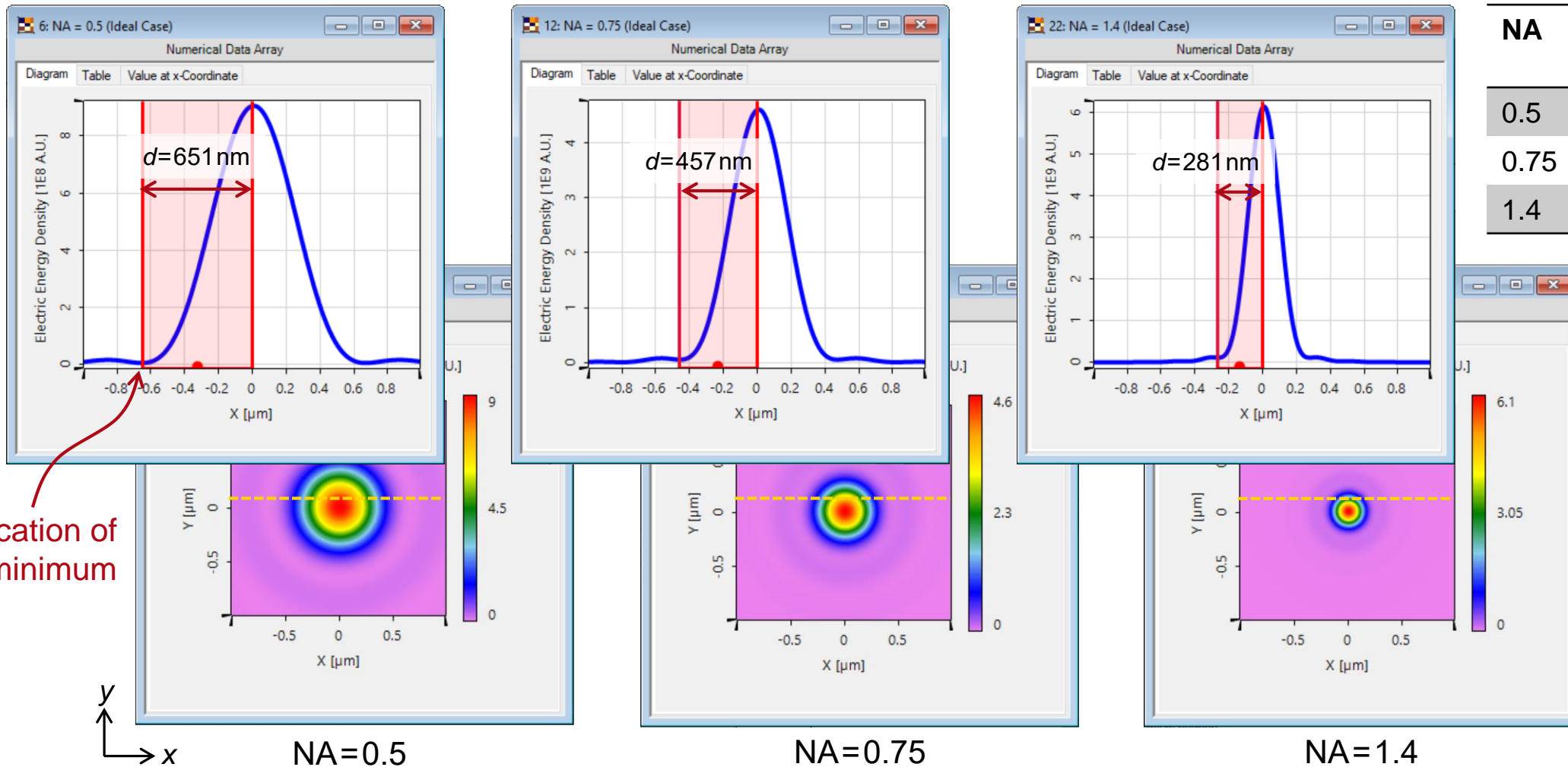


NA=0.75



NA=1.4

Evaluation of Idealized Lenses by Debye-Wolf Integral



NA	Rayleigh criterion D
0.5	649nm
0.75	433nm
1.4	232nm

$$D = \frac{0.61\lambda}{\text{NA}}$$

Peek into VirtualLab Fusion

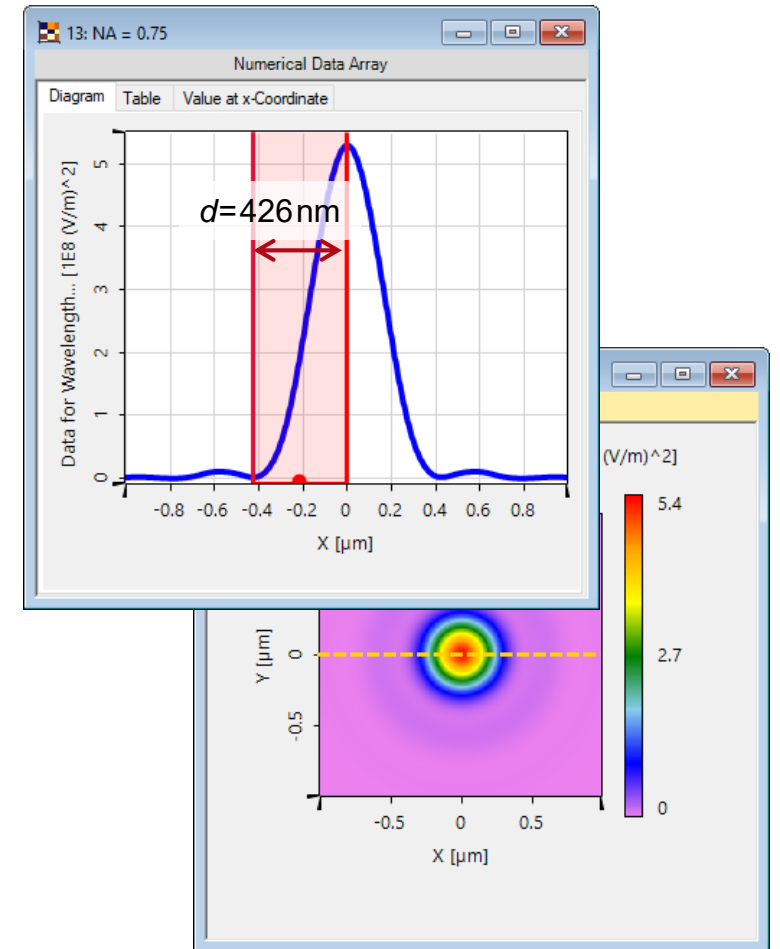
The screenshot shows the VirtualLab Fusion software interface. On the left is the 'File' menu with options: New, Open, Save, Save As, Import, Export, Global Options, Online Help, and Exit. The 'Import' menu is expanded, showing options like 'Import to Numerical Data Array', 'Import Harmonic Field Data from Bitmap File', 'Import a Chromatic Fields Set from Bitmap File', 'Import Harmonic Field Data from Text', 'Import Old VirtualLab Files', 'Import optiSLang Results', 'Import Zemax OpticStudio Lens File', and 'Import Zemax OpticStudio Beam File'. The 'Import Zemax OpticStudio Lens File' option is highlighted. In the center, the 'Edit Optical Interface Sequence' dialog box is open, displaying a 3D schematic of an optical system and a table of interface parameters.

Index	Distance	Position	Type	Homogeneous Medium	Comment
1	0 mm	0 mm	Conical Interface	Index_d_1.52_Abbe_58.!	Enter your co
2	.89148391	1.7889148	Conical Interface	Index_d_1.72_Abbe_37.!	Enter your co
3	.16712555	6.3605860	Conical Interface	Air (Zemax OS) in Homc	Enter your co
4	.057761324	21.566362	Conical Interface	Index_d_1.61_Abbe_44.!	Enter your co
5	.19940505	22.858356	Conical Interface	Index_d_1.43_Abbe_95.!	Enter your co
6	.38567800	29.517094	Conical Interface	Index_d_1.61_Abbe_44.!	Enter your co
7	.95306814	31.206625	Conical Interface	Air (Zemax OS) in Homc	Enter your co
8	.383155000	31.405393	Conical Interface	Index_d_1.43_Abbe_95.!	Enter your co
9	.427671899	38.759821	Conical Interface	Index_d_1.67_Abbe_38.!	Enter your co
10	.26098927	39.952431	Conical Interface	Air (Zemax OS) in Homc	Enter your co
11	.383155000	40.151199	Conical Interface	Index_d_1.5_Abbe_82.5.	Enter your co
12	.13835899	43.828413	Conical Interface	Air (Zemax OS) in Homc	Enter your co
13	.115772999	44.822255	Conical Interface	Index_d_1.5_Abbe_82.5.	Enter your co

Below the table is a toolbar with icons for Plane, Conical, Cylindrical, Aspherical, Polynomial, Sampled, and Programmable. At the bottom of the dialog are 'Add', 'Insert', and 'Delete' buttons, and 'OK', 'Cancel', and 'Help' buttons.

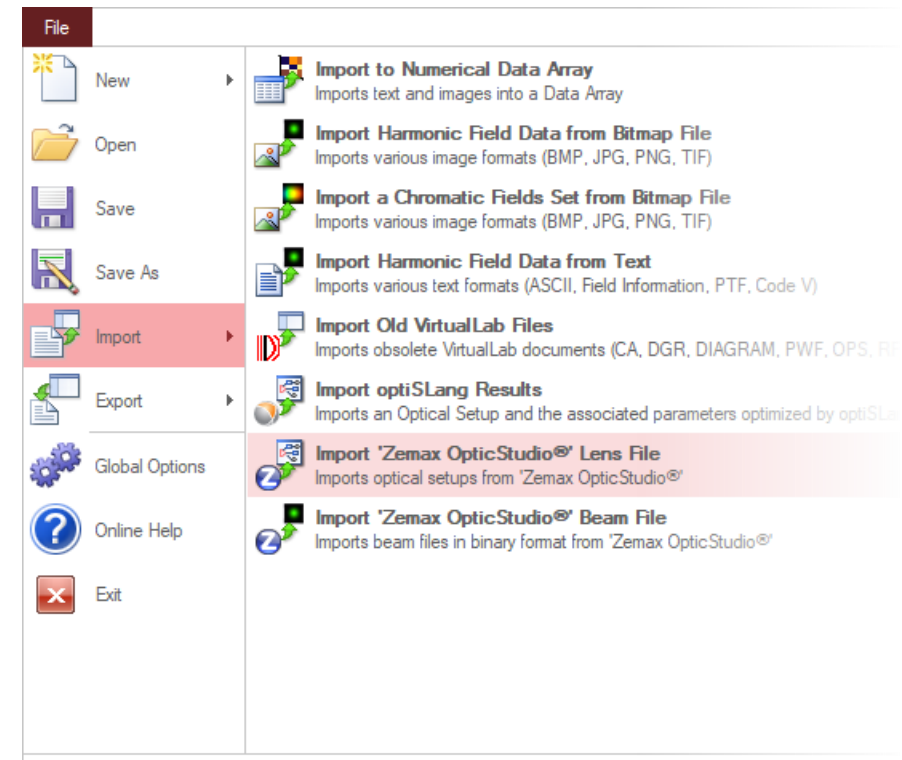
import from
Zemax OpticStudio®

physical optics evaluation

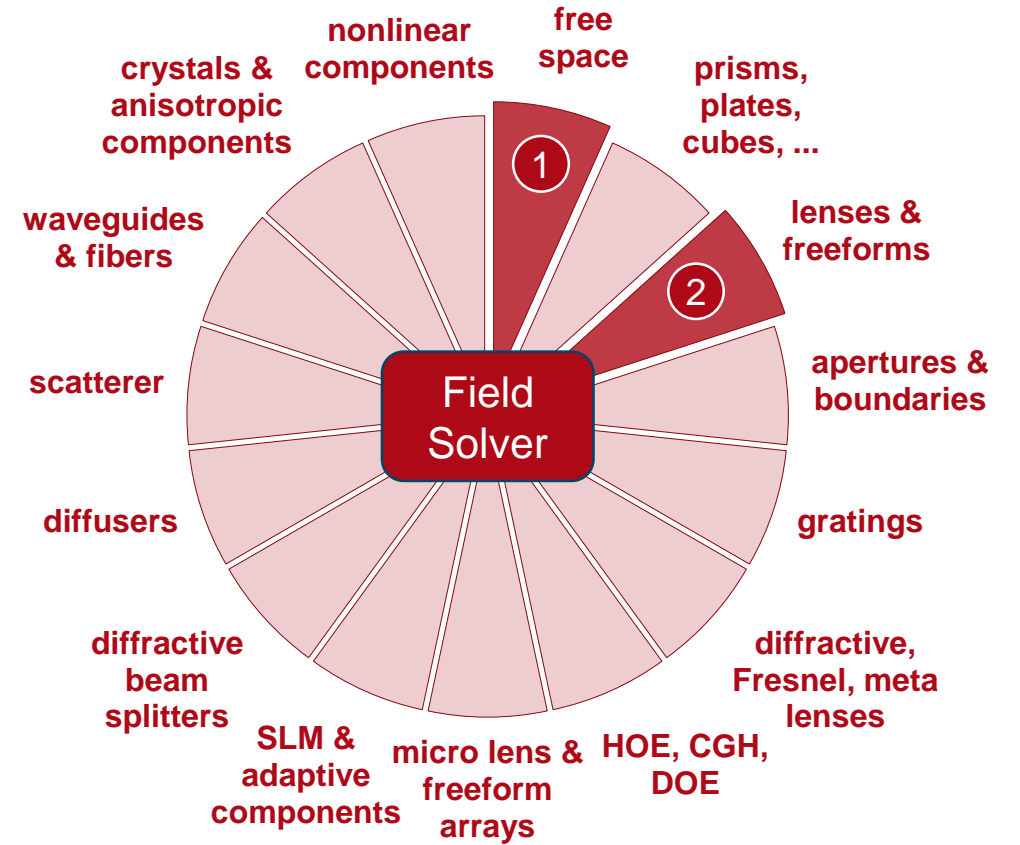
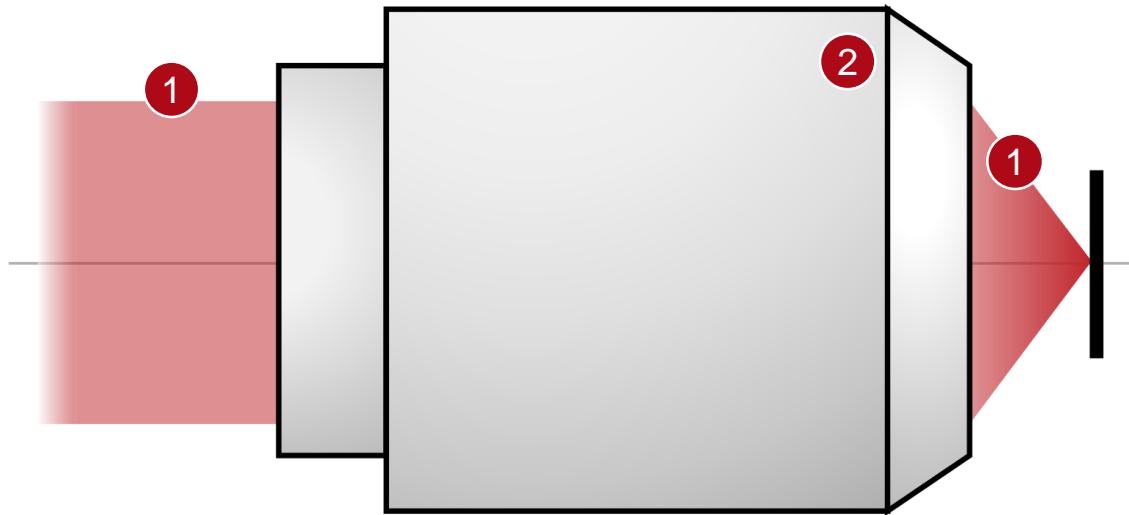


Workflow in VirtualLab Fusion

- 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]
- Use Debye-Wolf integral as a reference
 - [Debye-Wolf Integral Calculator](#) [Use Case]



VirtualLab Fusion Technologies



Document Information

title	Resolution Investigation for Microscope Objective Lenses by Rayleigh Criterion
document code	MIC.0006
version	1.0
toolbox(es)	Starter Toolbox
VL version used for simulations	VirtualLab Fusion 2019 Summer Release (7.6.1.18)
category	Application Use Case
further reading	<ul style="list-style-type: none">- Analyzing High-NA Objective Lens Focusing- Debye-Wolf Integral Calculator- Investigation of Idealized Vectorial Focusing Situation Using Debye-Wolf Integral