Resolution Investigation of a Microscopy System by Abbe Criterion

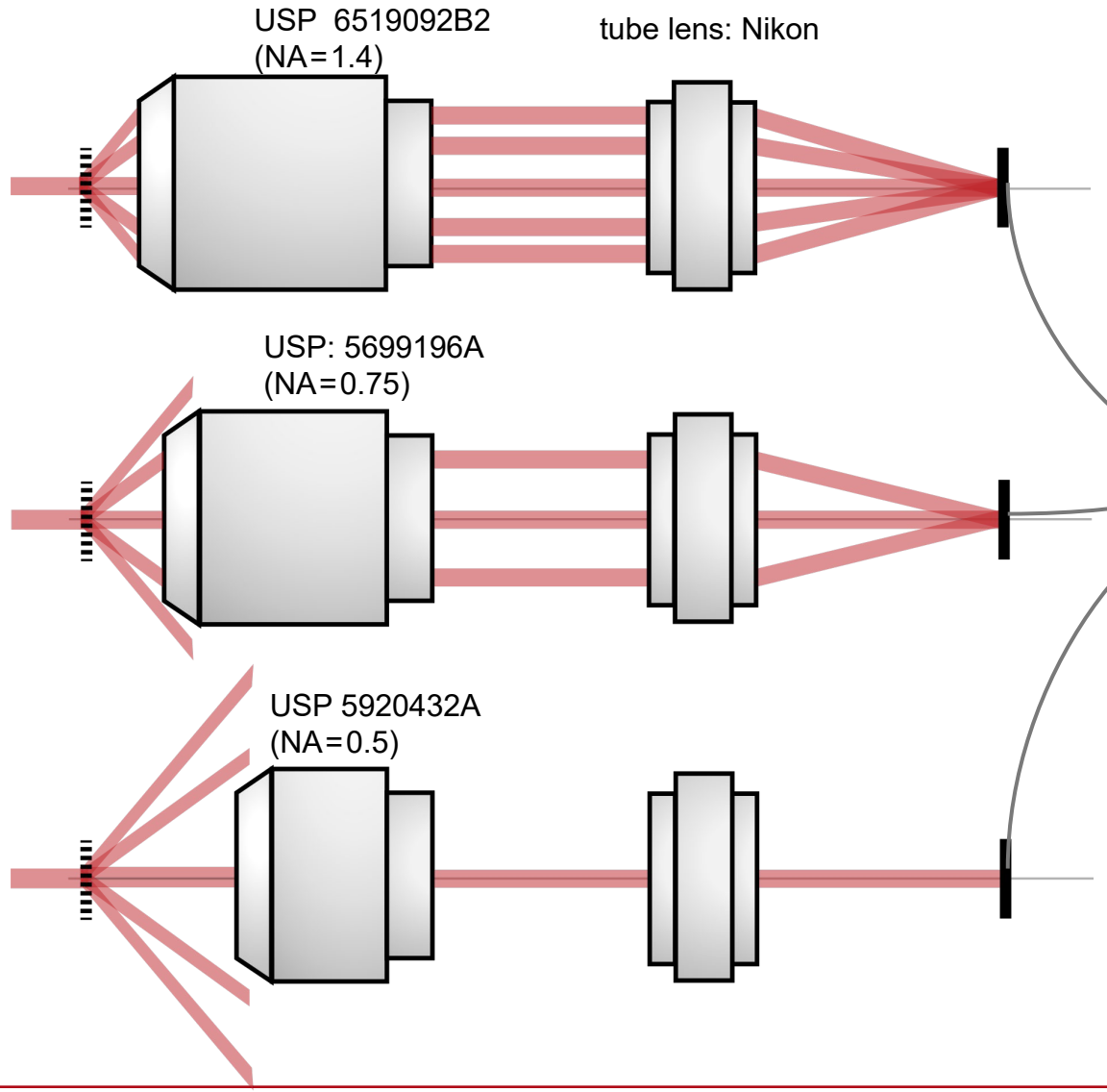
Abstract

The resolution of a microscopy system is often characterized by Abbe criterion. It explained that the filtering of the grating (as a sample) diffraction orders in the back focal plane depends on the numerical aperture (NA) of the objective lens. When the higher diffraction orders are filtered out, the interference at the image plane does not happen, which leads to no image. This use case demonstrates how the NA influences the filtering effect and the resolution.

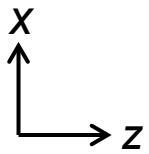
Scenario

input plane wave
- wavelength 532nm
- linearly polaried along *y* direction

grating period
- 800 nm

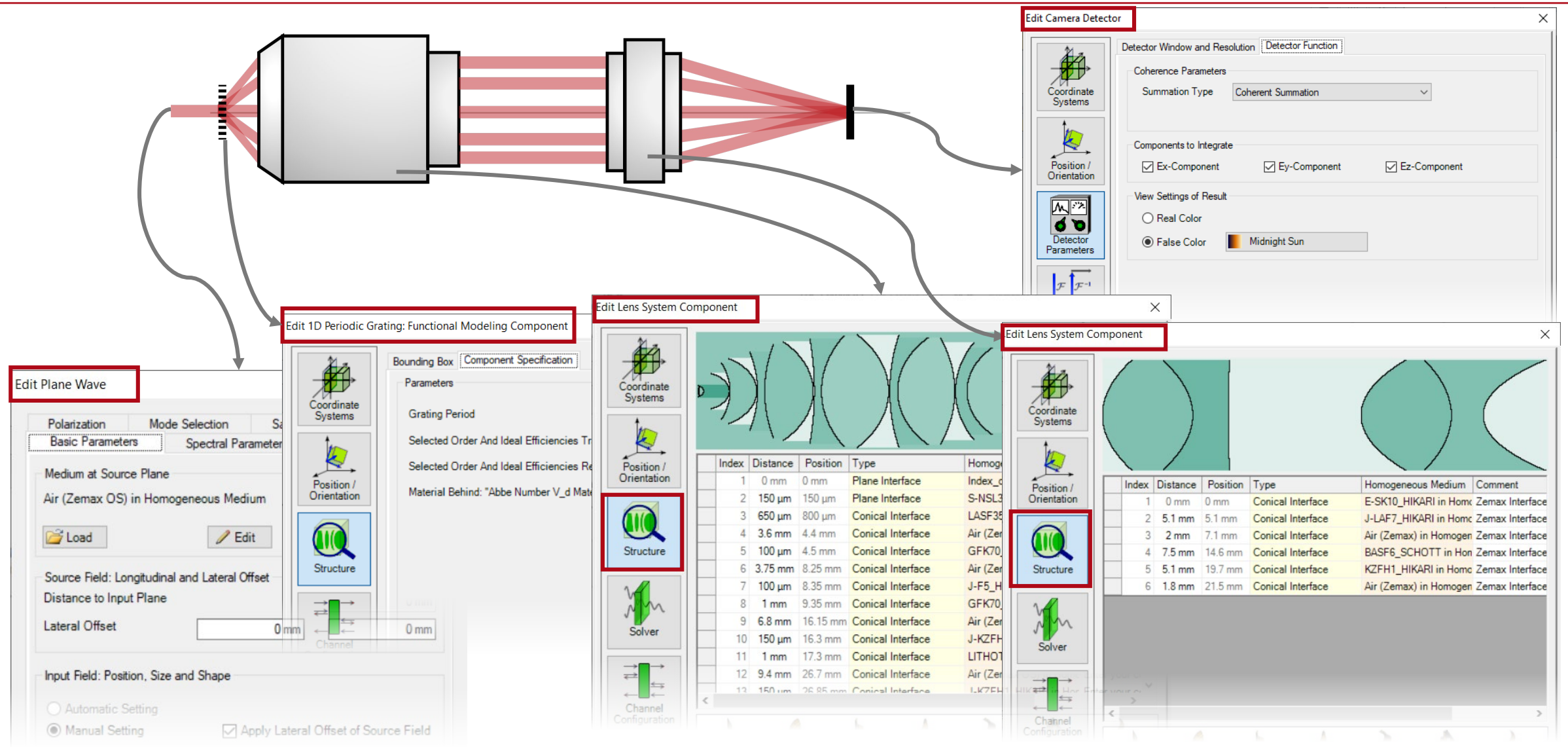


How are the images of the grating, defined by the interference patterns, influenced the different NAs of the objective lenses?

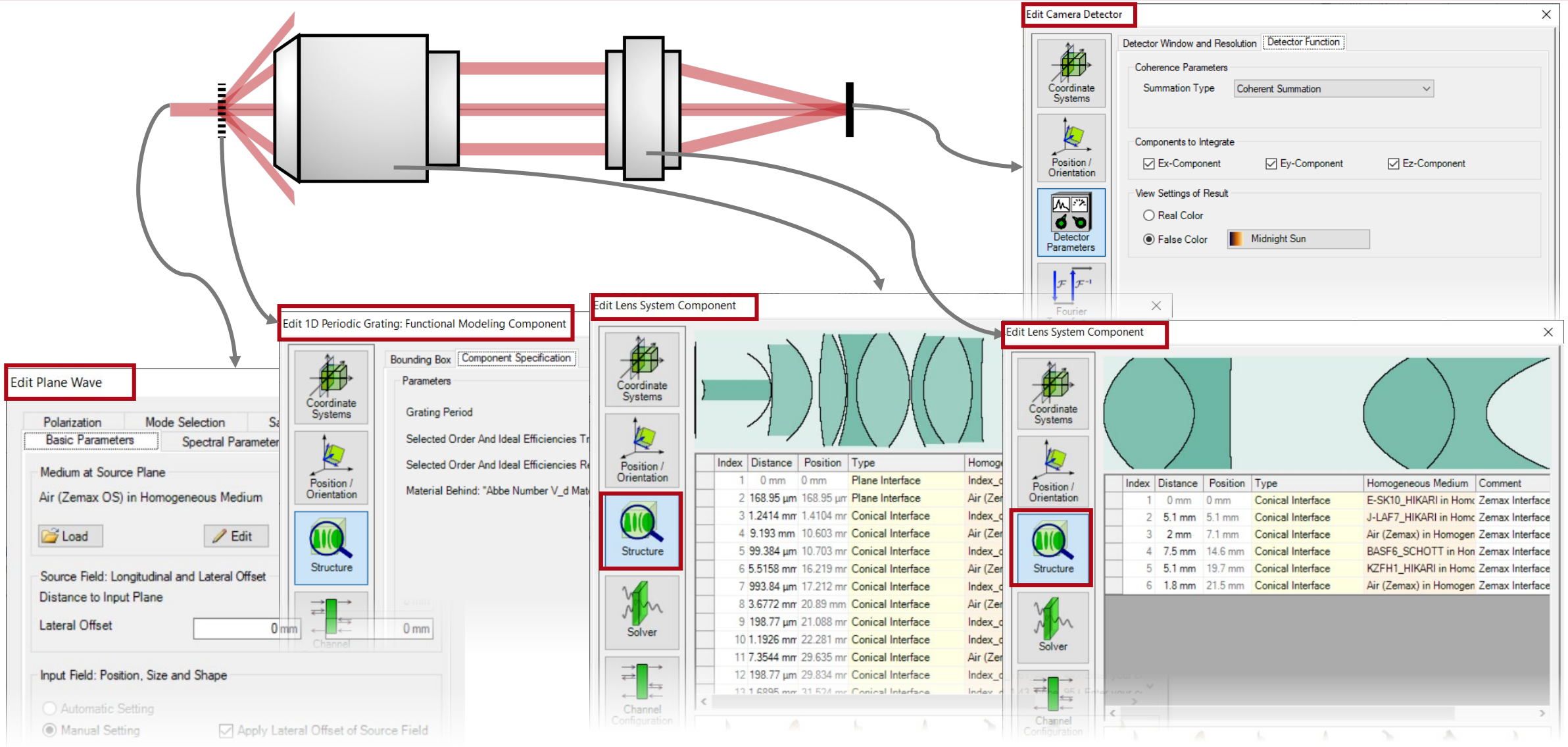


Building the System in VirtualLab Fusion

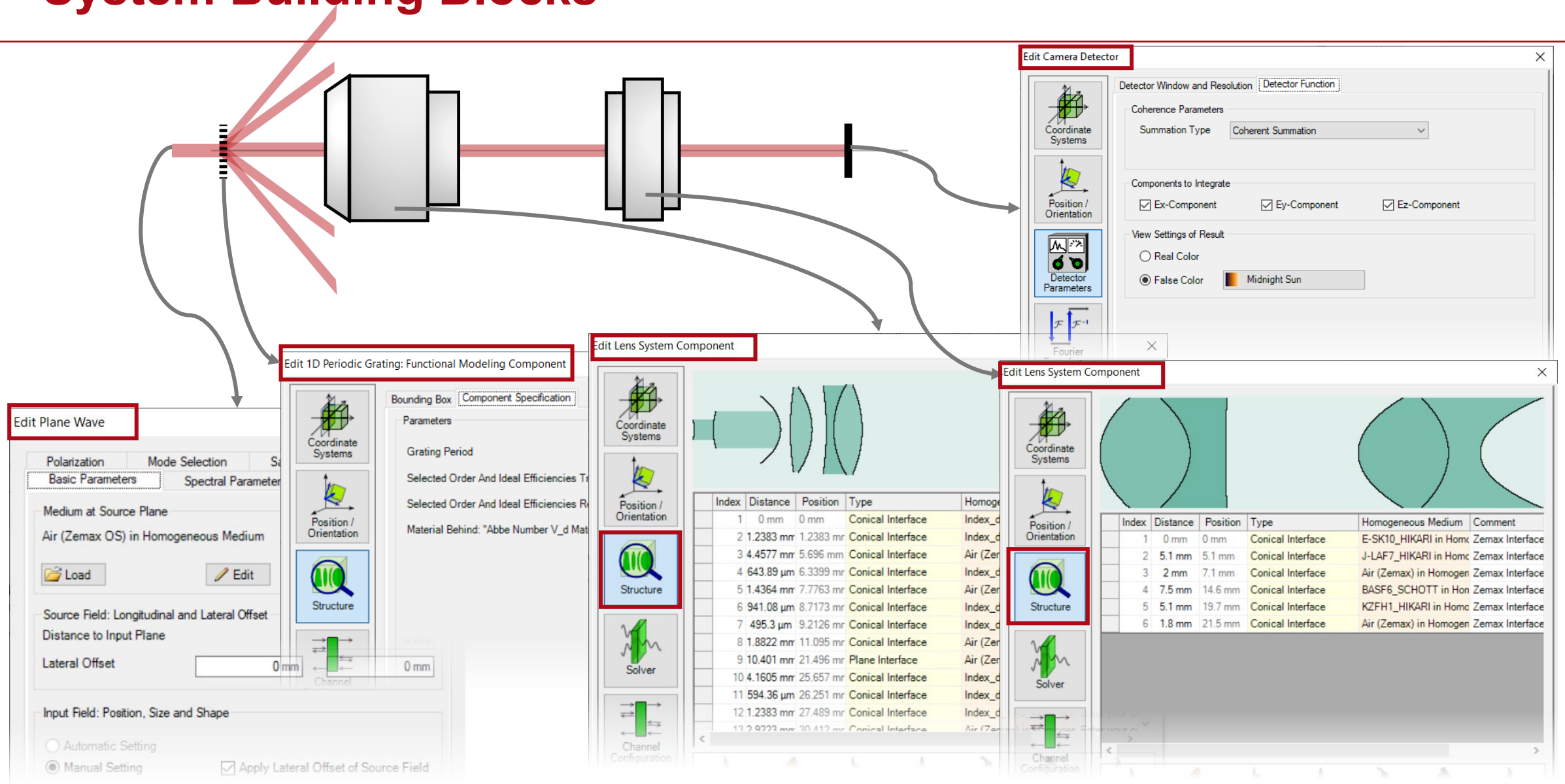
System Building Blocks



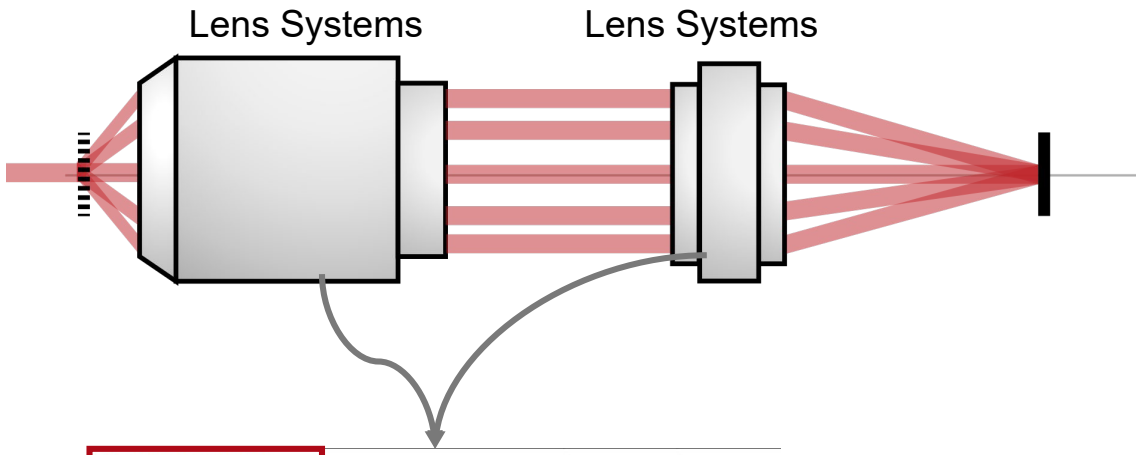
System Building Blocks

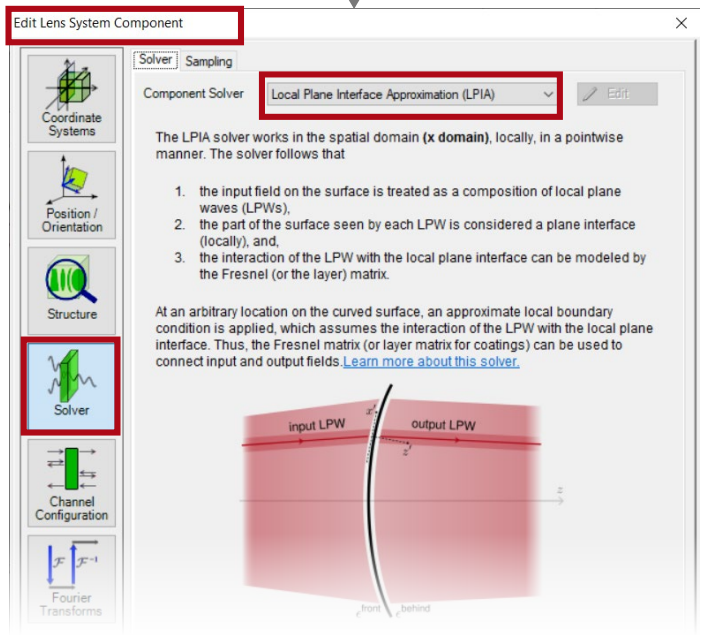


System Building Blocks



Solvers for Components



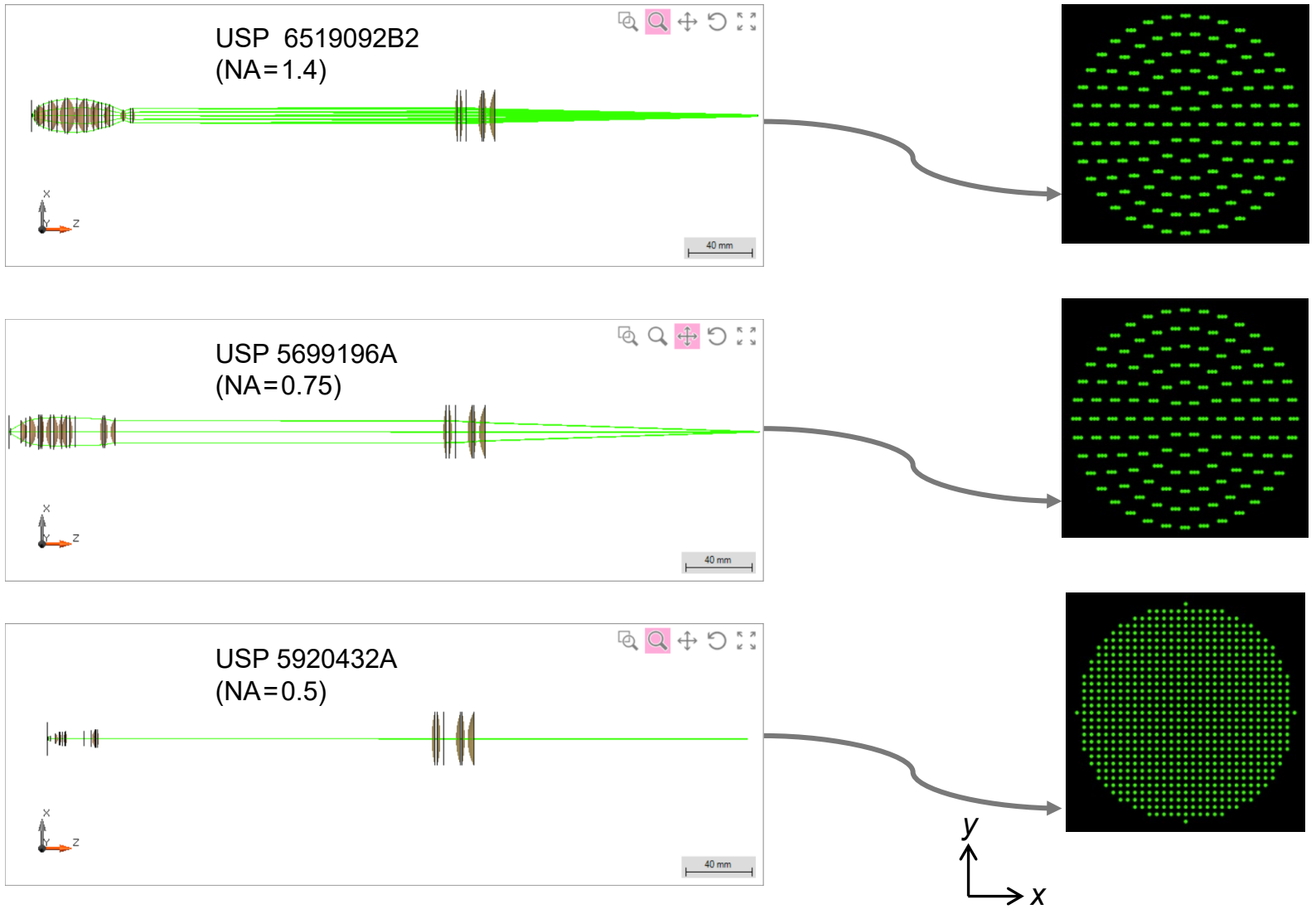


Components	Solvers
Lens Systems	Local Plane Interface Approximation (LPIA)

Geometric-Optics Simulations

by Ray Tracing

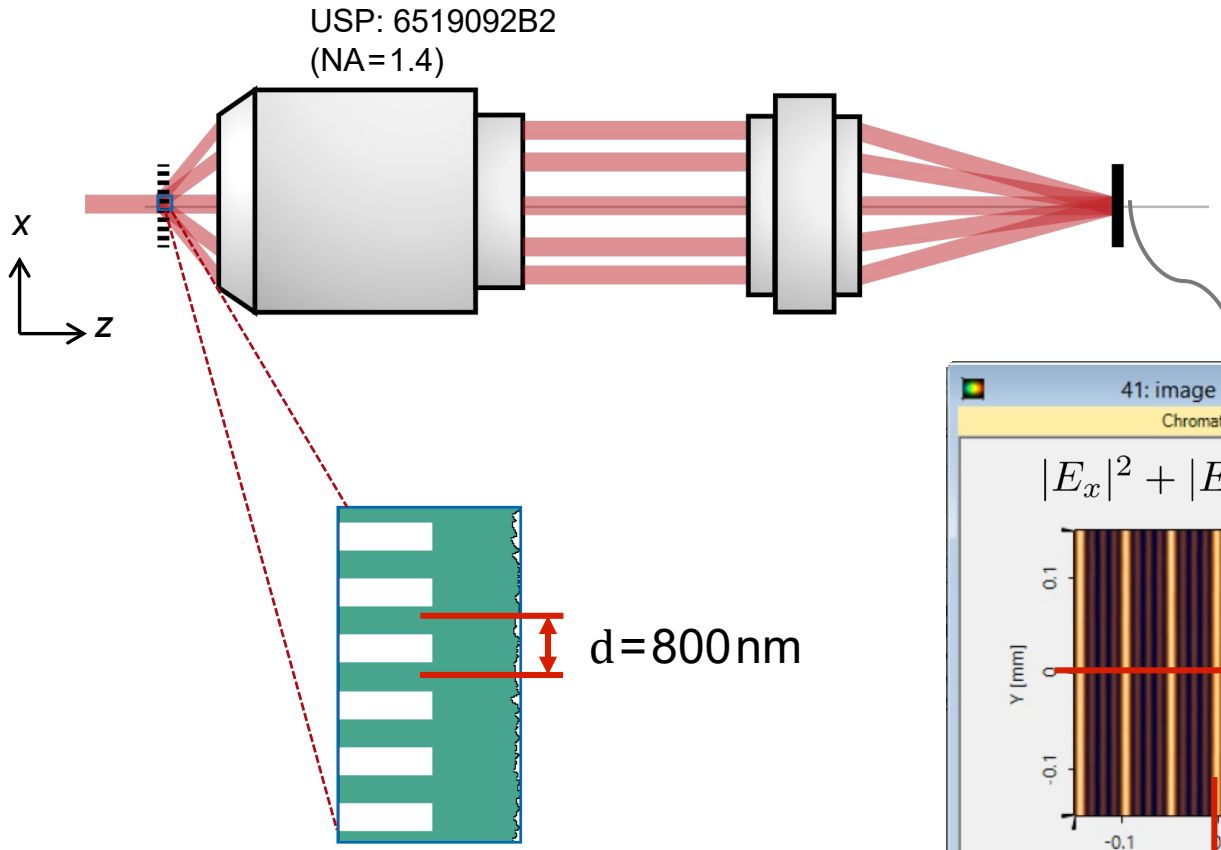
Results: Ray Tracing



Fast Physical-Optics Simulations

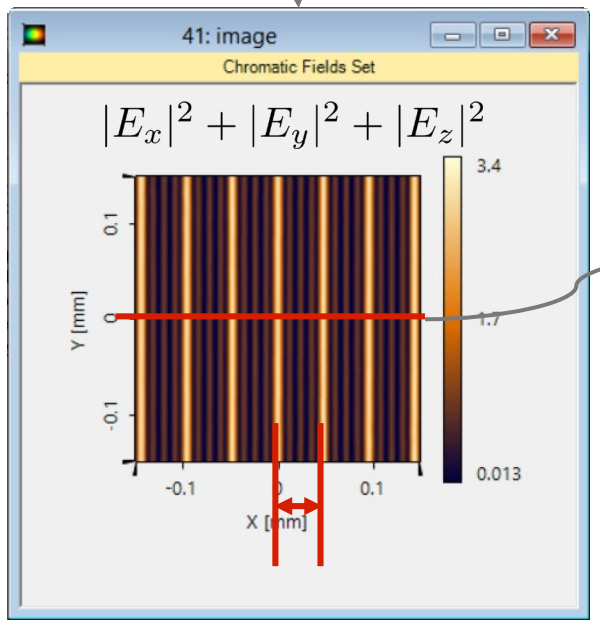
by Field Tracing

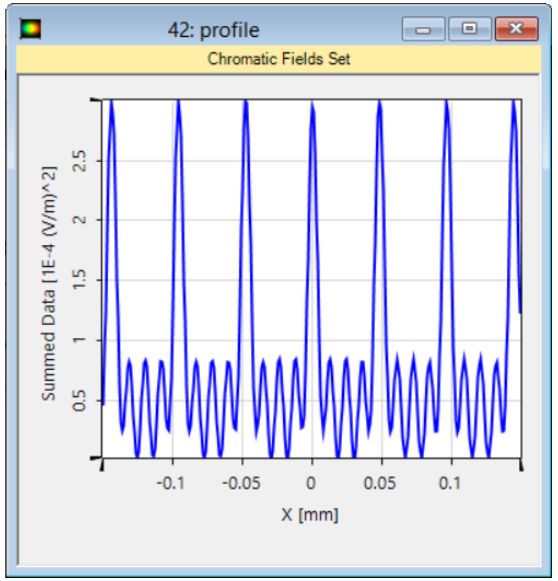
Results: Image of Grating for NA=1.4

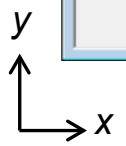


Abbe:

$$d = \frac{\lambda}{NA} = 380\,nm$$

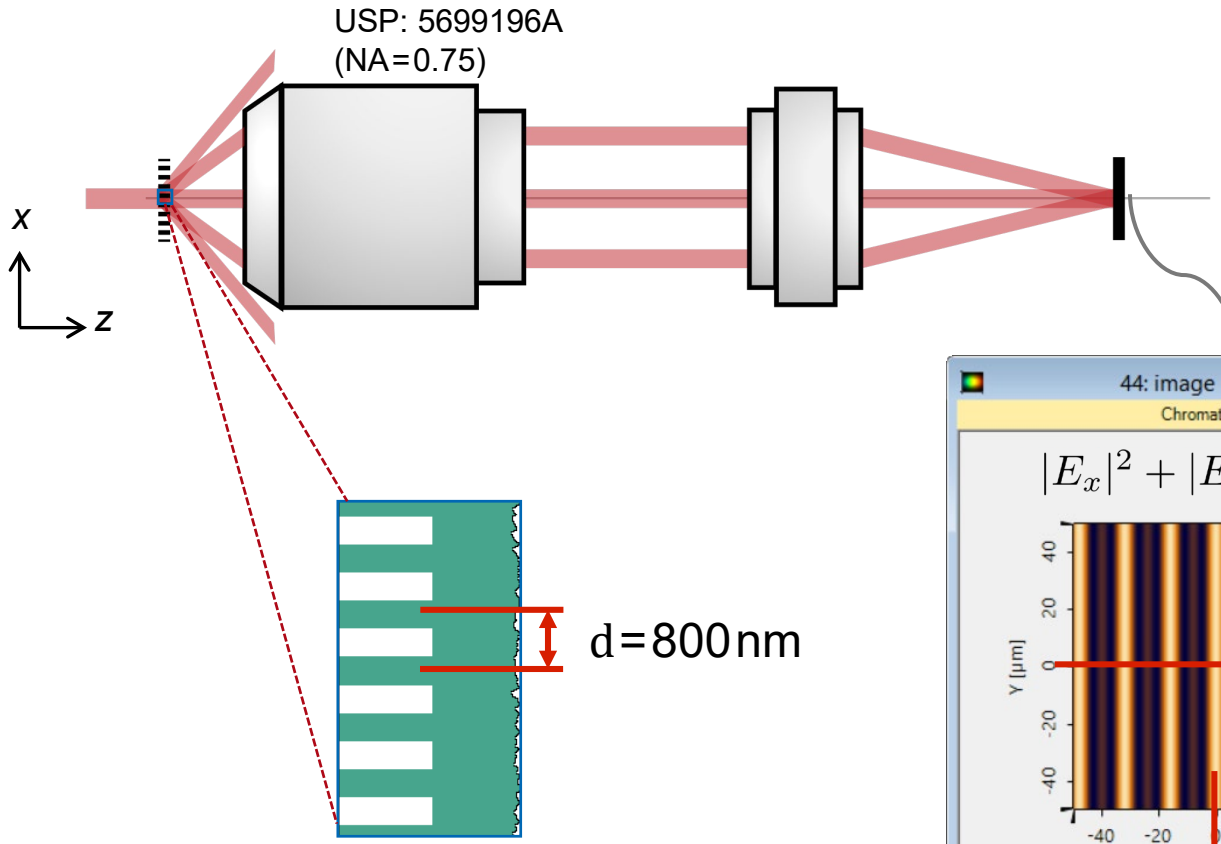






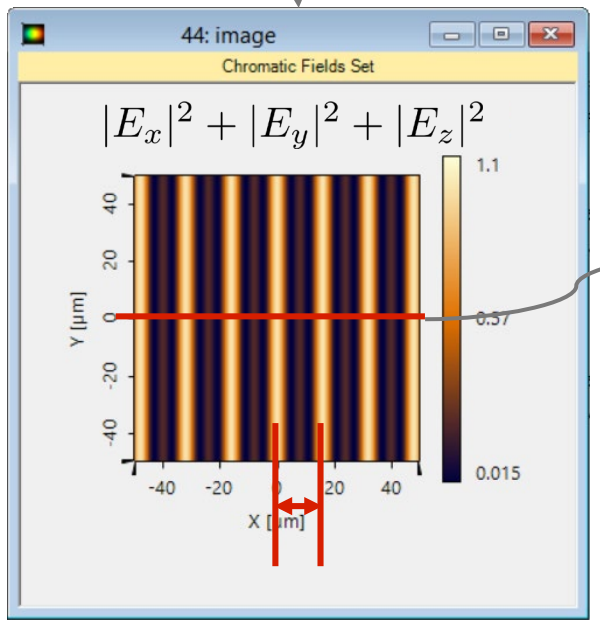
$d' \approx 48\,\mu m$

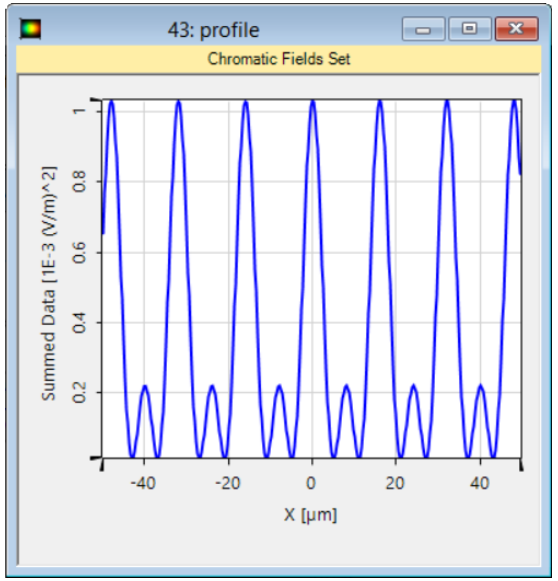
Results: Image of Grating for NA=0.75



Abbe:

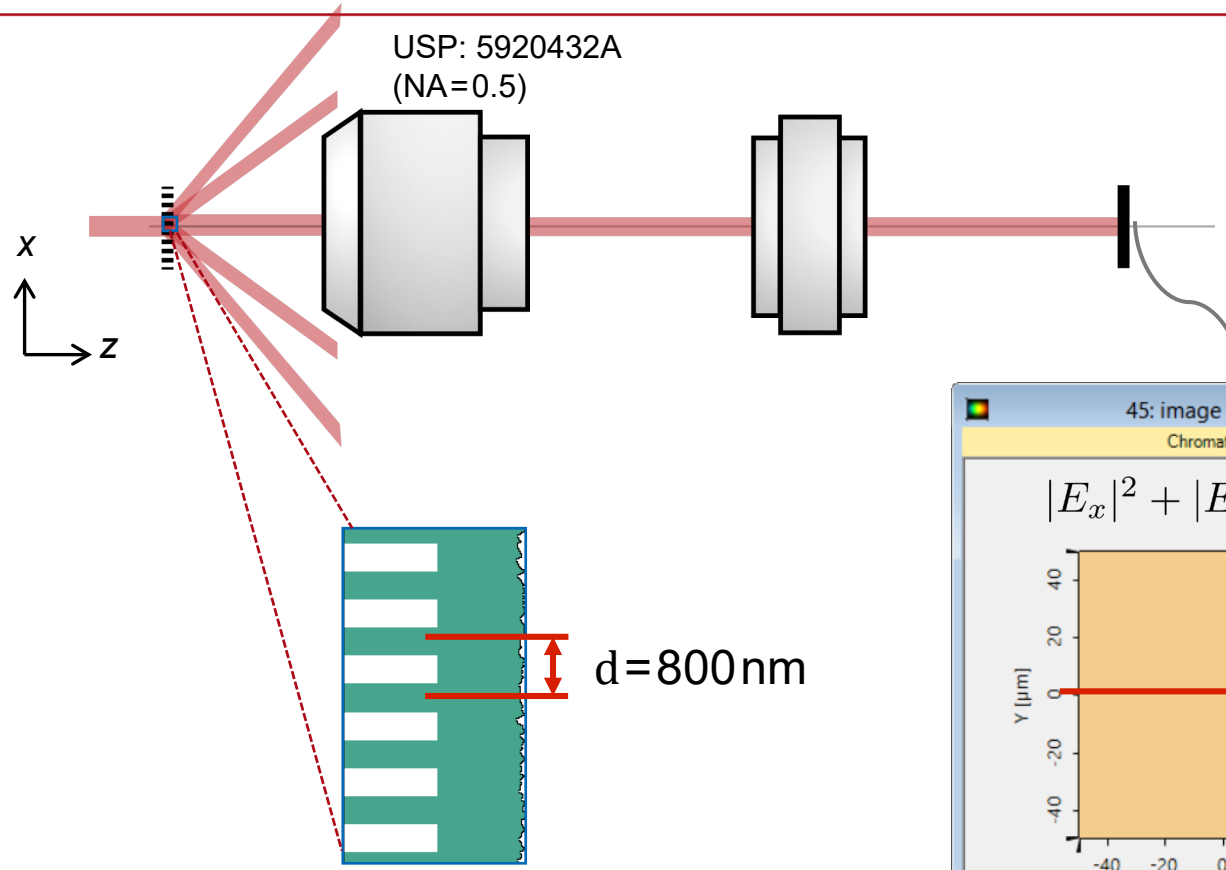
$$d = \frac{\lambda}{NA} = 709\,nm$$





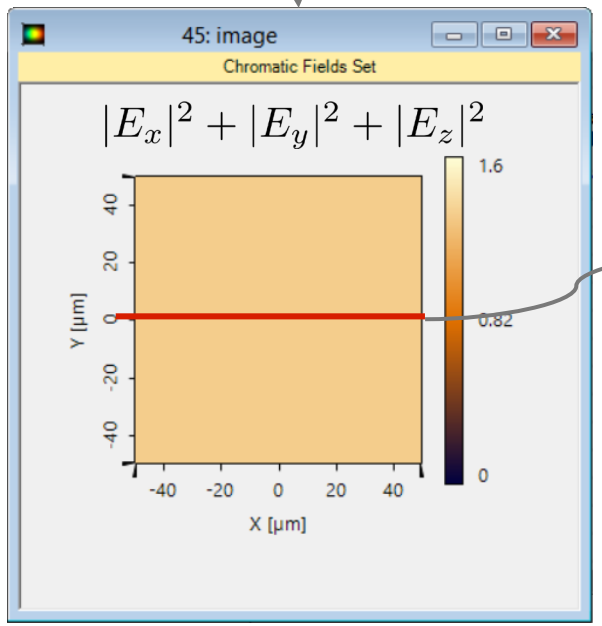
$d' \approx 16\,\mu m$

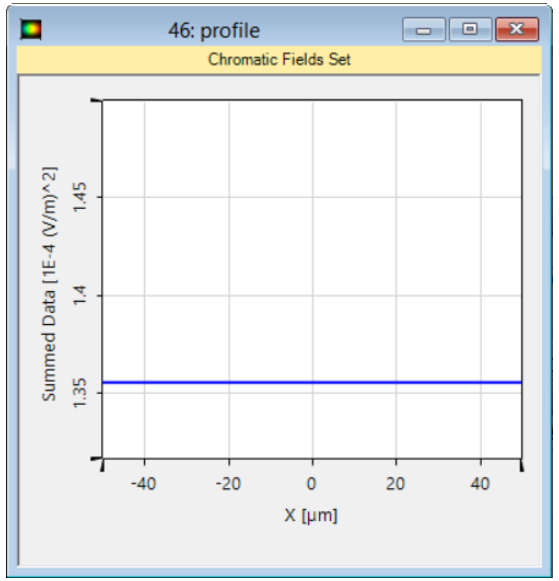
Results: Image of Grating for NA=0.5



Abbe:

$$d = \frac{\lambda}{NA} = 1064\,nm$$





y
x

Document Information

title	Resolution Investigation of a Microscopy System by Abbe Criterion
document code	MIC.0020
version	1.0
edition	VirtualLab Fusion Basic
software version	2020.2 (Build 1.116)
category	Application Use Case
further reading	- Debye-Wolf Integral Calculator - Analyzing High-NA Objective Lens - Resolution Investigation for Microscope Objective Lenses by Rayleigh Criterion