Investigation of Idealized Vectorial Focusing Situation Using Debye-Wolf Integral
Abstract

Knowing the vectorial electric field distribution near the focus of a high-NA objective lens is of great importance for applications e.g. microscopy, optical tweezer, laser machining, etc. Debye-Wolf integral provides the semi-analytical solution of the vectorial field near the focal plane, and it is widely used in the community. We demonstrate how to use the Debye-Wolf integral calculator in VirtualLab Fusion to investigate focal field properties with respect to different parameters.
Modeling Task

input plane wave
- wavelength: 532 nm, 632.8 nm
- polarization: linearly polarized in y direction and in x-y diagonal direction

idealized high-NA objective lens
- NA=0.9
- NA=0.5

defocus

How does the following parameters affect the focal spot distribution?
- wavelength
- NA of objective
- polarization
- defocus

How does the following parameters affect the focal spot distribution?
Influence from Wavelength

- varying wavelength: 532nm or 632.8nm
- fixed lens NA 0.9
- fixed linear polarization in y
- no defocus

\[ E_x^2 + E_y^2 + E_z^2 \]

632.8nm

|FWHM x direction: 339nm|

532nm

|FWHM x direction: 285nm|
Influence from NA of Objective

- fixed wavelength 532 nm
- varying lens NA: 0.5 or 0.9
- fixed linear polarization in y
- no defocus

\[ NA = 0.9 \]

\[ |E_x| \quad |E_y| \quad |E_z| \quad E_x^2 + E_y^2 + E_z^2 \]

FWHM x direction: 536 nm

FWHM x direction: 285 nm
Influence from Polarization

- fixed wavelength 532 nm
- fixed lens NA 0.9
- varying linear polarization: \textit{in y, or x-y diagonal}
- no defocus

\[ |E_x| + |E_y| + |E_z| \]
Influence from Defocus

800nm away

$\left| E_x \right|^2 + \left| E_y \right|^2 + \left| E_z \right|^2$

parameters
- fixed wavelength 532nm
- fixed lens NA 0.9
- fixed linear polarization in y
- defocus with 800nm or exactly at focus
Peek into VirtualLab Fusion

various input parameters including polarization for the focal spot investigation

access to all field quantities for result analysis
VirtualLab Fusion Technologies

Debye-Wolf integral

Field Solver

- crystals & anisotropic components
- waveguides & fibers
- scatterers
- diffusers
- diffractive beam splitters
- SLM & adaptive components
- micro lens & freeform arrays
- nonlinear components
- free space
- lenses & freeforms
- apertures & boundaries
- gratings
- diffractive, Fresnel, meta lenses
- HOE, CGH, DOE

# idealized component
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