Double-Helix PSF for 3D Imaging Microscopy
Abstract

The Double-Helix (DH) PSF engineering provides a high resolution in the longitudinal direction for 3D imaging. It can be produced by adding a phase mask with vortices in the pupil plane [Ginni Grover et al., Opt. Exp. 2012]. VirtualLab Fusion provides a fast and convenient way to calculate the DH PSFs for small defocuses of a high-NA microscopy system. This use case demonstrates the DH-PSFs have obvious changes with a defocus of \(~130\) nm.
Modeling Task

spherical wave with defocus
- circularly polarized
- wavelength 532nm

objective lens
- Nikon 60X, NA=1.4

tube lens
- Nikon

SLM with phase mask

How is the double helix PSF change for a small defocus in longitudinal direction?
System Building Blocks
### Components

- Lens Systems

### Solvers

- Local Plane Interface Approximation (LPIA)
Geometric-Optics Simulations

by Ray Tracing
Results: Ray Tracing
Fast Physical-Optics Simulations

by Field Tracing
Double Helix PSFs at Image Plane for Different Defocuses

- $d=135$ nm
- $d=0$
- $d=-135$ nm
# Double-Helix PSF for 3D Imaging Microscopy

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**further reading**
- [Debye-Wolf Integral Calculator](#)  
- [Analyzing High-NA Objective Lens](#)  
- [Resolution Investigation for Microscope Objective Lenses by Rayleigh Criterion](#)