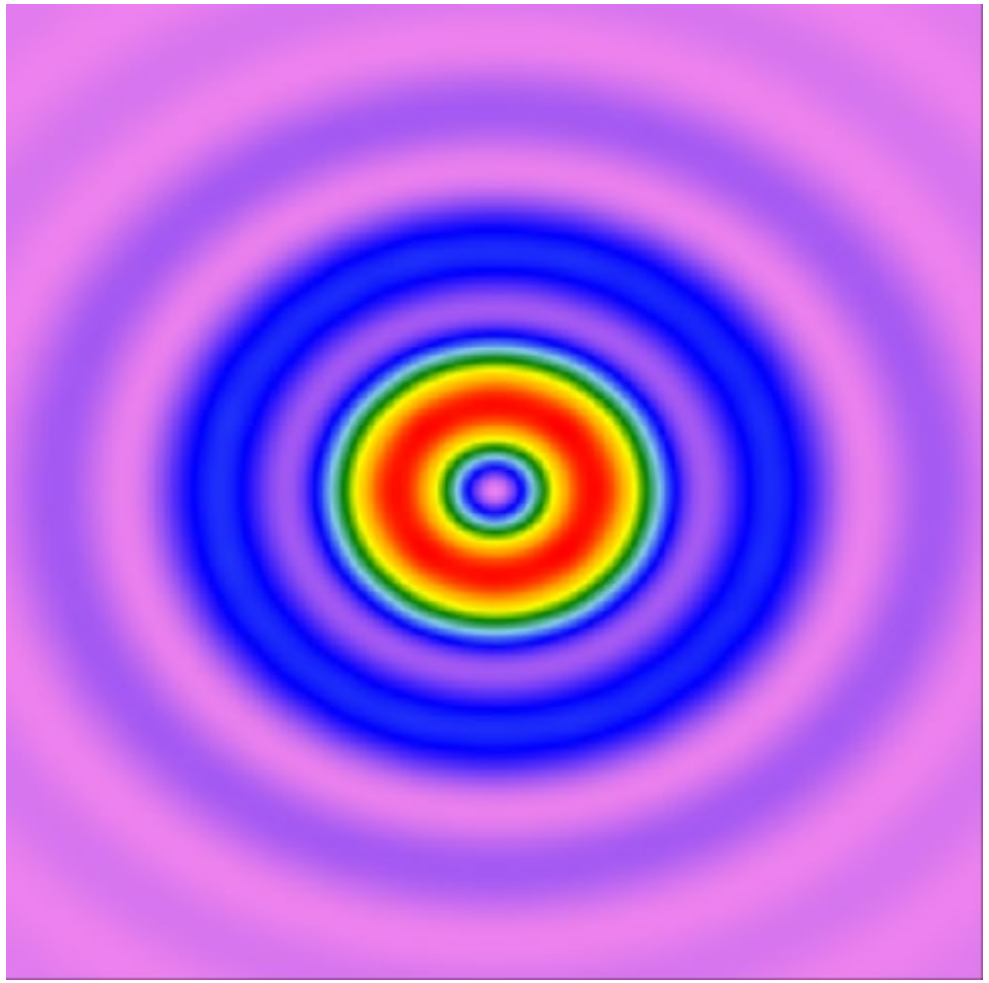
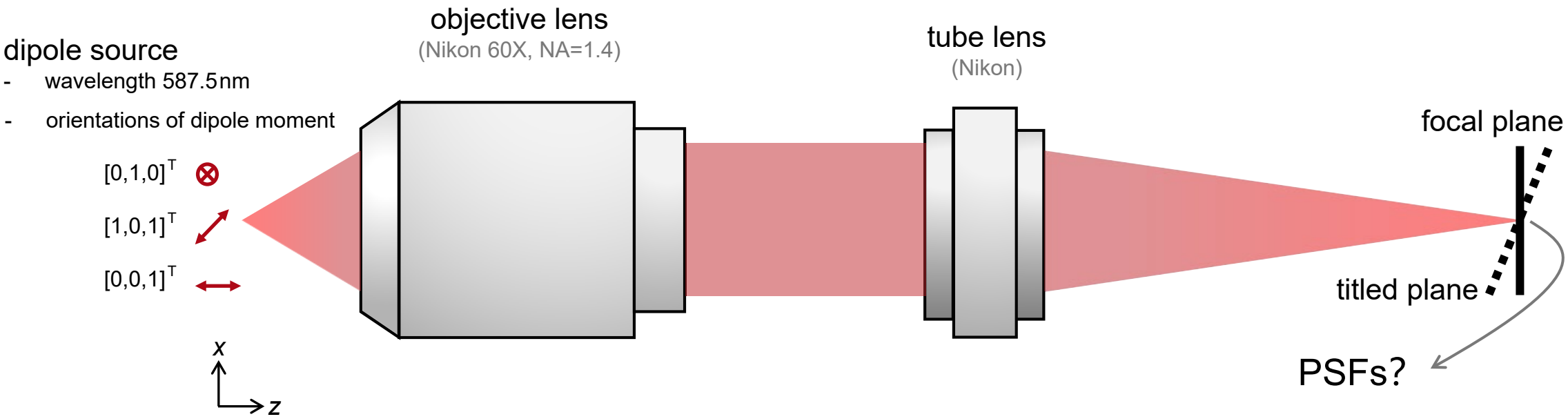
Analysis of PSF of a Dipole Source by a High-NA Microscopy System

Abstract



The emission light of a fluorescent molecule and the scattered light of a nanosphere are well modeled by dipole sources. Therefore, a dipole source is a good model for a point source which considers the vectorial effects in practice. Analysis of the PSF of such point source is important. The dipole source is built in VirtualLab Fusion. By connecting with a complex high-numerical-aperture microscopy system, the PSF is directly calculated in VirtualLab Fusion.

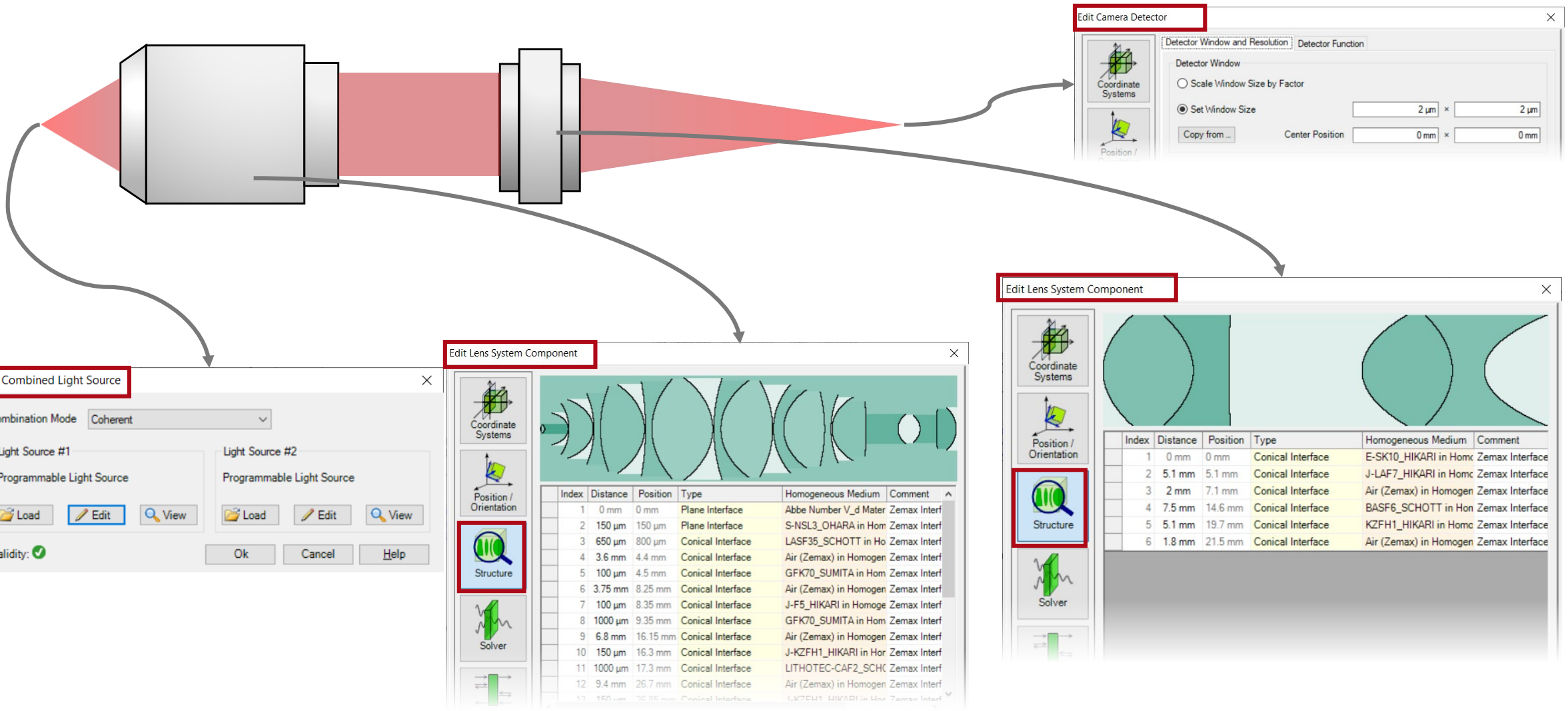
Modeling Task



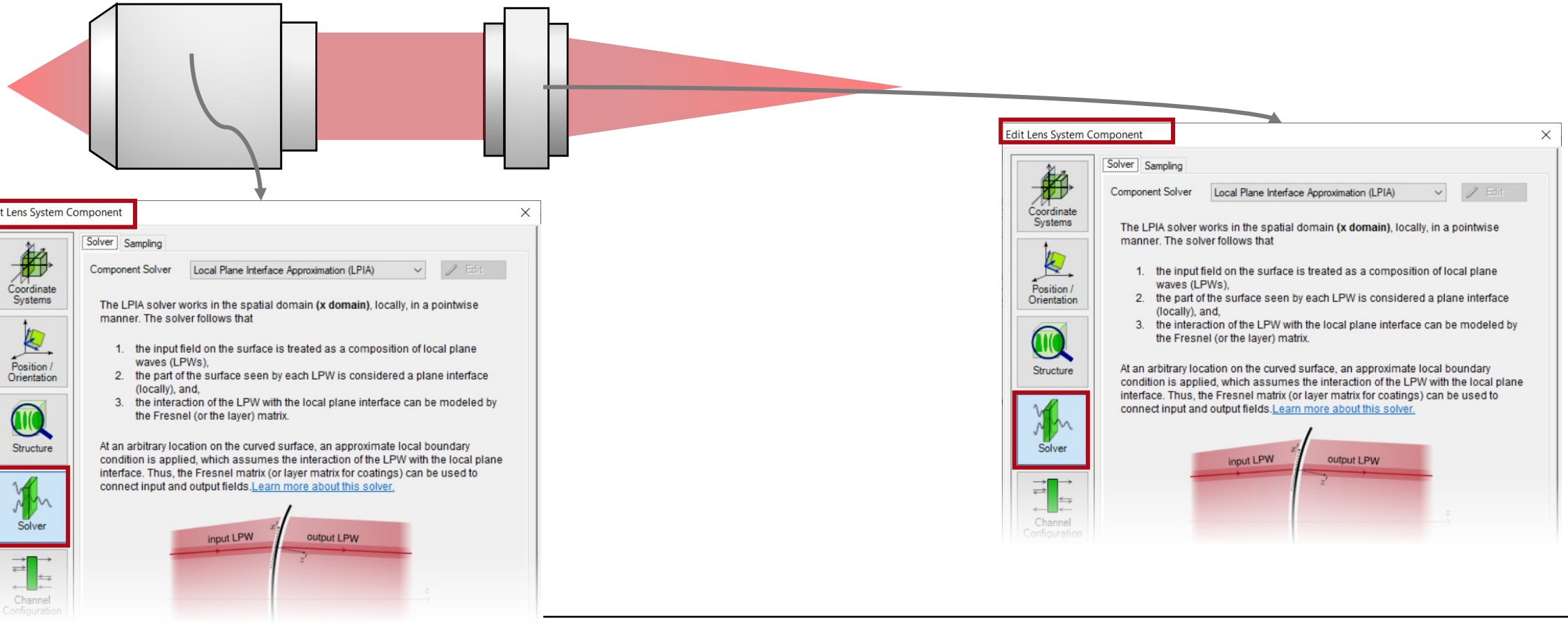
What are the PSFs of a dipole source with different orientations? And what are these PSFs on the tilted plane?

Building the System in VirtualLab Fusion

System Building Blocks



Solvers for Components

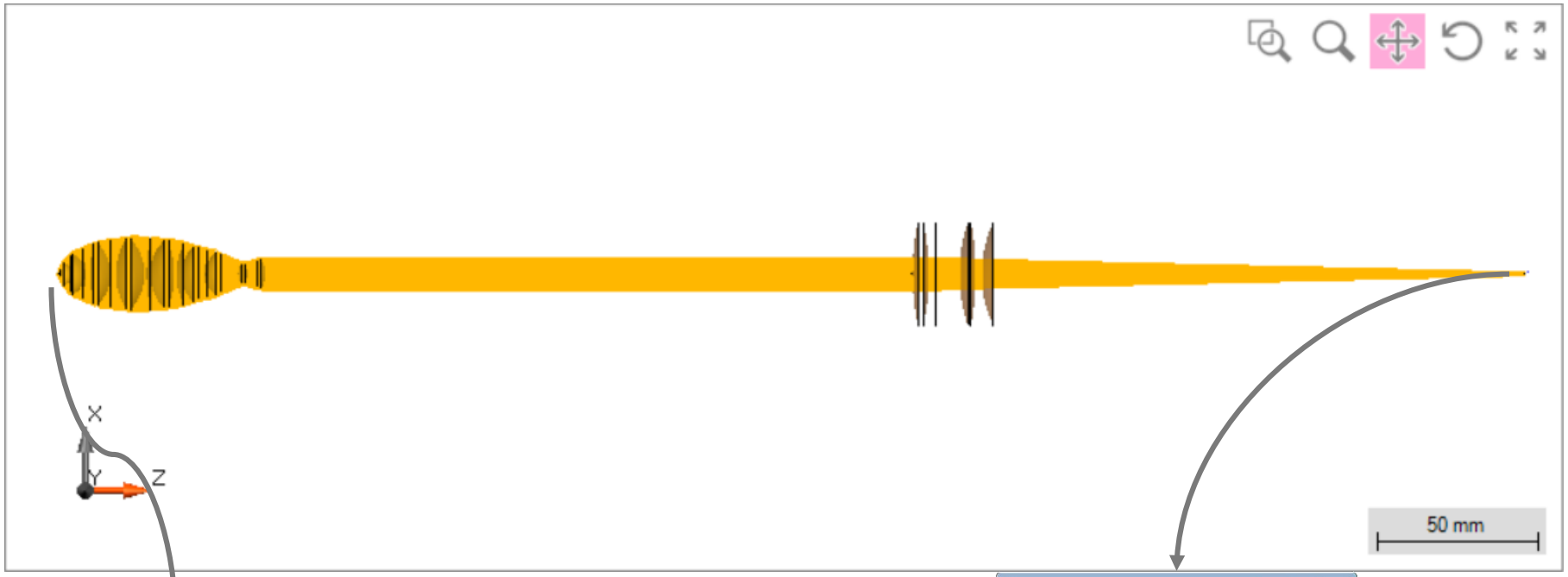


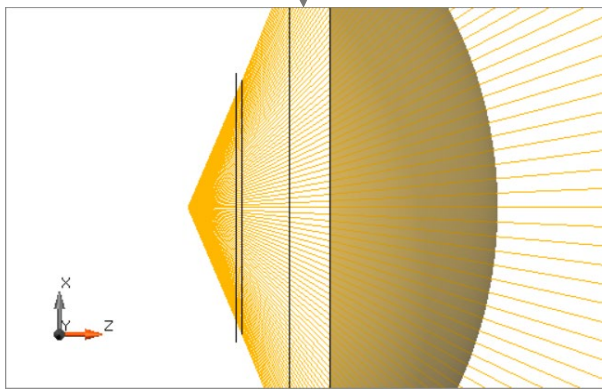
Components	Solvers
Lens Systems	Local Plane Interface Approximation (LPIA)

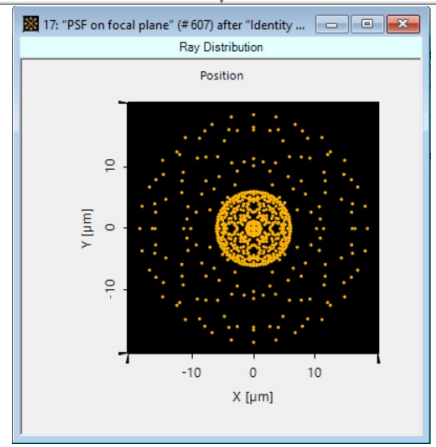
Geometric-Optics Simulations

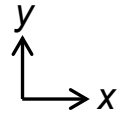
by Ray Tracing

Results: Ray Tracing





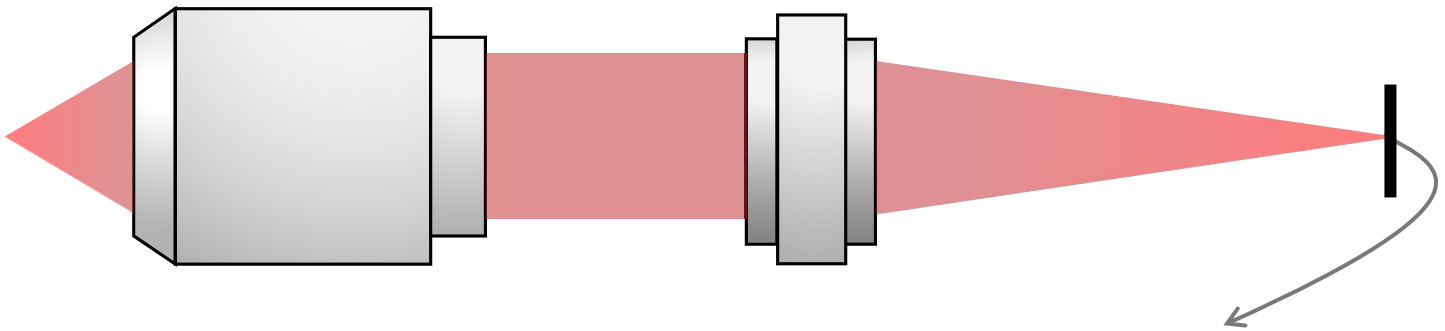




Fast Physical-Optics Simulations

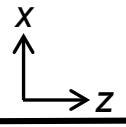
by Field Tracing

PSFs at the Focal Plane



The asymmetry of the PSFs is shown. The donut-shaped PSF is obtained when the orientation of the dipole moment is along z axis.

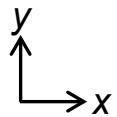
Dipole moment $[p_x, p_y, p_z]^T$



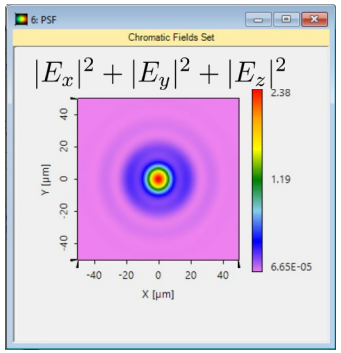
$[0,1,0]^T$

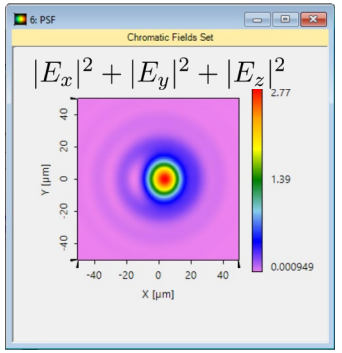
$[1,0,1]^T$

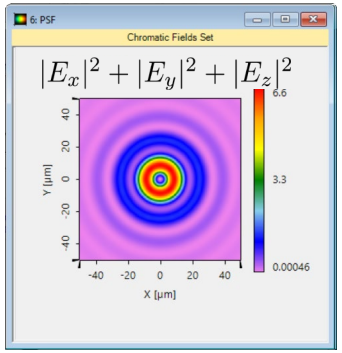
$[0,0,1]^T$



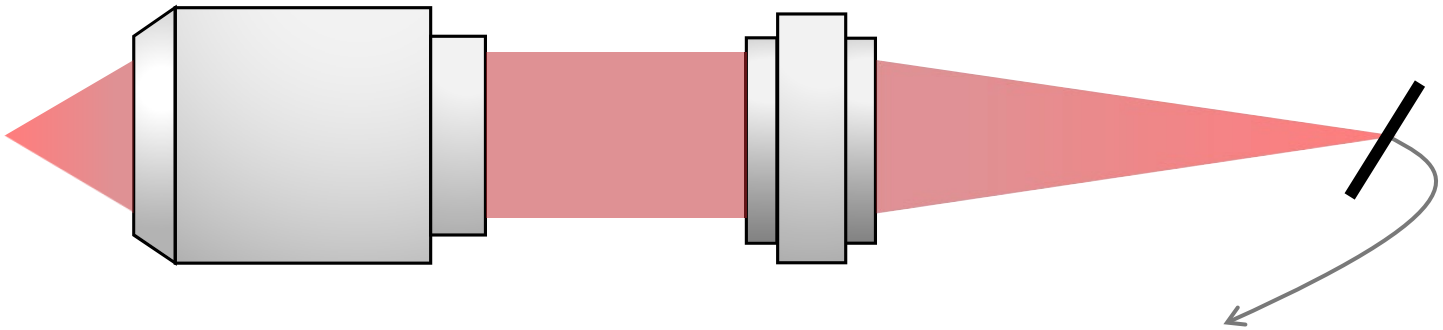
PSFs on focal plane





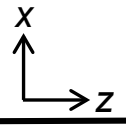


PSFs at the Tilted Plane with 30° in x Direction



The PSFs is elongated in x direction when the detector is tilted.

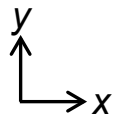
Dipole moment $[p_x, p_y, p_z]^T$



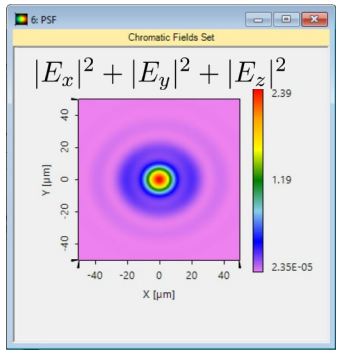
$[0,1,0]^T$

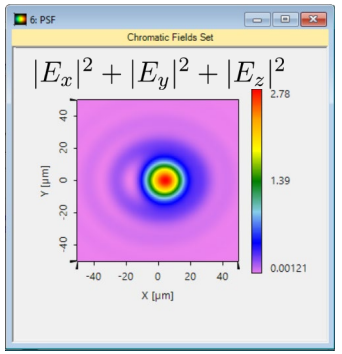
$[1,0,1]^T$

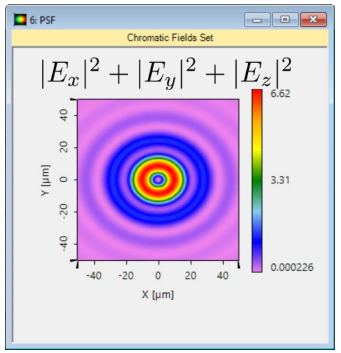
$[0,0,1]^T$



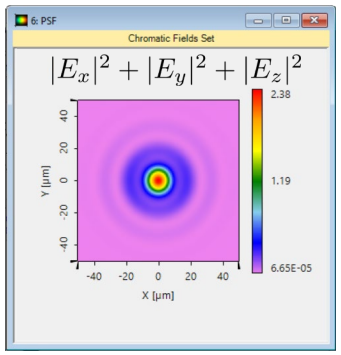
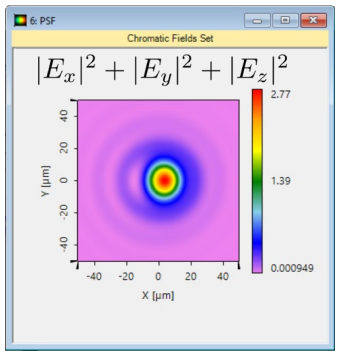
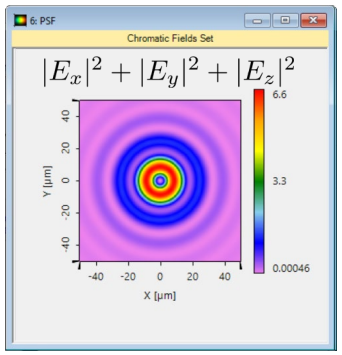
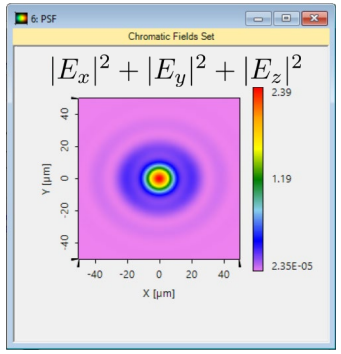
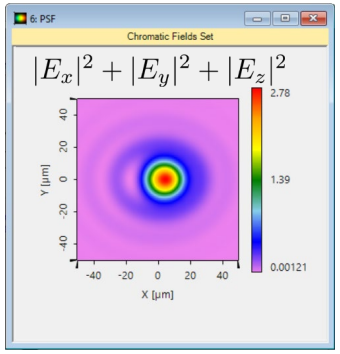
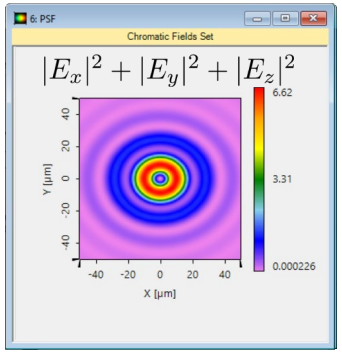
PSFs on titled plane at focal postion with 30° in x direction







Summary

Dipole moment $[p_x, p_y, p_z]^T$	$[0,1,0]^T$	$[1,0,1]^T$	$[0,0,1]^T$
PSFs on focal plane			
PSFs on titled plane at focal postion with 30° in x direction			

Document Information

title	Analysis of PSF of a Dipole Source by a High-NA Microscopy System
document code	MIC.0018
version	1.0
edition	VirtualLab Fusion Basic
software version	2020.2 (Build 1.116)
category	Application Use Case
further reading	- Analyzing High-NA Objective Lens - Resolution Investigation for Microscope Objective Lenses by Rayleigh Criterion - Single Molecule Imaging by High-NA Fourier Microscope