Analyzing High-NA Objective Lens Focusing
Abstract

High-NA objective lenses are widely used in optical lithography, microscopy, etc. Consideration of the vectorial nature of light in the simulation of the focusing is therefore fundamental. VirtualLab supports both ray and field tracing analysis of such lenses with great ease. With field tracing, the asymmetric focal spot can be clearly demonstrated, which stems from the vectorial effects. The camera detector and the electromagnetic field detector provide full flexibility in the investigation of the field in focal region, with insights into the vectorial effect.
Modeling Task

input plane wave
- wavelength 266.08 nm
- beam diameter 3 mm
- linearly polarized in x direction

How to perform ray tracing analysis of the complete system?

high-NA objective (NA=0.85)

How to calculate the intensity distribution of the focal spot including vectorial effect?
Overview

- The sample system is preset with the high-NA objective lens included.
- Next, we demonstrate how to perform simulation on the sample system following the recommended workflow in VirtualLab.
Ray Tracing Simulation

- Choose Ray Tracing System Analyzer as the simulation engine at first.
- Click on Go!
- The 3D ray tracing result is obtained.
Ray Tracing Simulation

• Then, select Ray Tracing as the simulation engine.
• Click Go!
• As a result, the dot diagram (2D ray tracing result) is obtained.
Field Tracing Simulation

- Switch to field tracing and select Field Tracing 2\textsuperscript{nd} Generation as the simulation engine.
- Click Go!
Field Tracing Results (Camera Detector)

- The top figure shows the intensity by integrating $E_x$ and $E_y$ field components only.
- The bottom figure shows the intensity by integrating $E_x$, $E_y$ and $E_z$ components: an obvious asymmetry is seen due to the relatively large $E_z$ component in high-NA situation.
Field Tracing Results (Electromagnetic Field Detector)

- All electromagnetic field components are obtained by using the Electromagnetic Field Detector.

amplitude of $E_x$  

amplitude of $E_y$  

amplitude of $E_z$
Field Tracing Results (Electromagnetic Field Detector)

- All electromagnetic field components are obtained by using the Electromagnetic Field Detector.

amplitude of $H_x$

amplitude of $H_y$

amplitude of $H_z$
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