Influence of Aberration Effects of a Spherical Wave on the Focal Spot
Abstract

Different types of wavefront aberrations have individual influences on the pattern in focus. It is therefore crucial to be able to investigate these effects in detail, e.g. to evaluate the performance of imaging systems. In VirtualLab Fusion, different wavefront aberrations can be generated, and their effects on the focal spot distribution studied, conveniently. As examples, we select several typical aberrations (spherical, coma, astigmatism, ...), vary their values, and calculate the corresponding focal spot distributions.
Modeling Task

spherical wave with different aberrations
- wavelength @532nm
- type of aberration:
  1. defocus
  2. spherical
  3. astigmatism
  4. coma
  5. secondary coma
  6. trefoil

What is focal spot distribution for different aberration?
The Zernike & Seidel Aberrations component is a special type of transmission function that allows the user to define the desired aberrations and multiplies them onto the field, including:

- defocus
- coma
- spherical aberration
- astigmatism
Defocus

no aberration

defocus = 0.2\lambda

defocus = 0.5\lambda

wavefront error @input plane

focal spot
Spherical Aberration

Wavefront error @input plane

Focal spot
Astigmatism

- no aberration
- astigmatism = 0.2\(\lambda\)
- astigmatism = 0.5\(\lambda\)

Wavefront error @ input plane

Focal spot
Coma

- **no aberration**
- **coma = 0.2\(\lambda\)**
- **coma = 0.5\(\lambda\)**

Wavefront error @ input plane

Focal spot
Secondary Coma

no aberration

secondary coma = 0.2\(\lambda\)

secondary coma = 0.5\(\lambda\)

wavefront error @ input plane

circular astigmatism

focal spot
Trefoil

**wavefront error @ input plane**

**focal spot**

- **no aberration**
- **trefoil = 0.2\(\lambda\)**
- **trefoil = 0.5\(\lambda\)**

\[
\text{trefoil} = 0.2\lambda \\
\text{trefoil} = 0.5\lambda
\]
VirtualLab Fusion Technologies

- prisms, plates, cubes, ...
- lenses & freeforms
- apertures & boundaries
- gratings
- diffractive, Fresnel, meta lenses
- HOE, CGH, DOE
- micro lens & freeform arrays
- SLM & adaptive components
- diffractive beam splitters
- scatterer
- waveguides & fibers
- nonlinear components
- crystals & anisotropic components
- free space
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| further reading | • Advanced PSF & MTF Calculation for System with Rectangular Aperture  
• Simulation of Laser Beam in Focal Region of High-NA Asphere |