Focal Spots for Different Aberrations
Abstract

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

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

What is focal spot distribution for different aberration?
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

No aberration

Spherical = 0.2\(\lambda\)

Spherical = 0.5\(\lambda\)
Astigmatism

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

Wavefront error @ input plane

Focal spot
Coma

wavefront error @input plane

focal spot

no aberration
coma=0.2\lambda
coma=0.5\lambda
Secondary Coma

wavefront error @ input plane

focal spot

no aberration

secondary coma = 0.2λ

secondary coma = 0.5λ
Trefoil

Wavefront error @ input plane

Focal spot

No aberration

trefoil = 0.2\lambda

trefoil = 0.5\lambda

Data for Wavelength of 532 nm [EJ (V/m)^2]

Data for Wavelength of 532 nm [EJ (V/m)^2]

Data for Wavelength of 532 nm [EJ (V/m)^2]
Peek into VirtualLab Fusion

- Customizable wavefront aberrations
- Fast calculation and flexible visualization of focal spot
- Visualization of wavefront error
VirtualLab Fusion Technologies

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

Field Solver

11
### Focal Spots for Different Aberrations

<table>
<thead>
<tr>
<th>title</th>
<th>Focal Spots for Different Aberrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>document code</td>
<td>MISC.0002</td>
</tr>
<tr>
<td>version</td>
<td>1.1</td>
</tr>
<tr>
<td>toolbox(es)</td>
<td>Starter Toolbox</td>
</tr>
<tr>
<td>VL version used for simulations</td>
<td>VirtualLab Fusion Summer Release 2019 (7.6.1.18)</td>
</tr>
<tr>
<td>category</td>
<td>Application Use Case</td>
</tr>
<tr>
<td>further reading</td>
<td>Advanced PSF &amp; MTF Calculation for System with Rectangular Aperture</td>
</tr>
<tr>
<td></td>
<td>Simulation of Laser Beam in Focal Region of High-NA Asphere</td>
</tr>
</tbody>
</table>