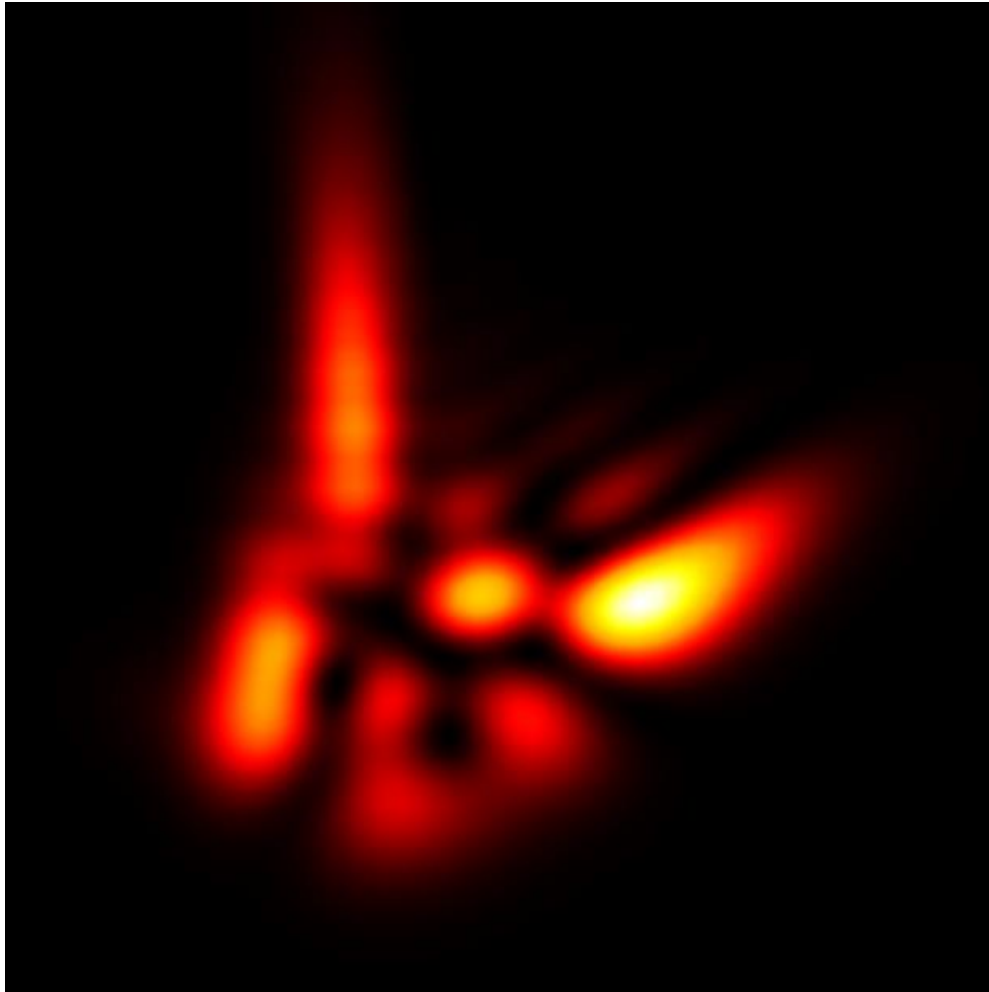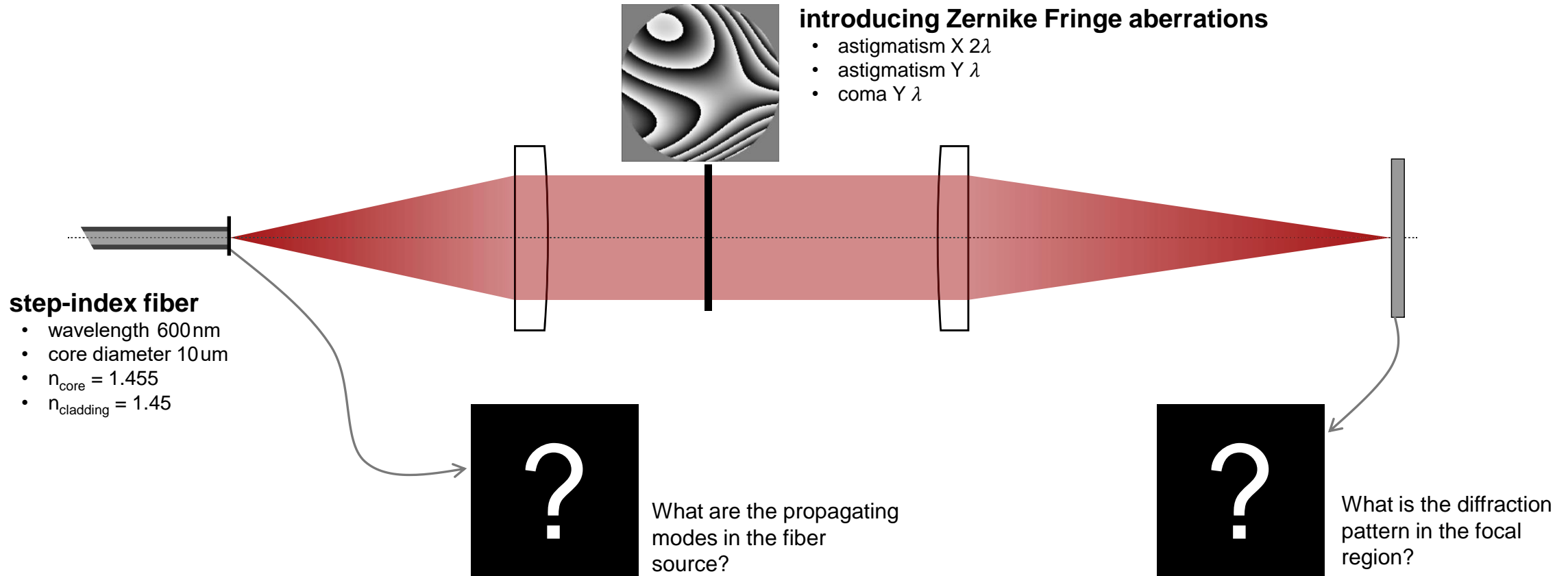# Aberration Effects on Focused Modes from a Fiber Source
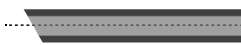
Abstract

Fibers are widely used as sources in optical systems. Investigating the effects of the aberrations of an optical system on the propagation of the fiber modes is therefore of interest. In this use case we employ the fast physical optics engine in VirtualLab Fusion to demonstrate how the shape of a set of modes generated by either a step- or graded-index fiber, and the total field resulting from their combination, is affected by propagation through an aberrated optical system.

Modeling Task with a Step-Index Fiber

introducing Zernike Fringe aberrations
- astigmatism X 2λ
- astigmatism Y λ
- coma Y λ

step-index fiber
- wavelength 600 nm
- core diameter 10 um
- n_{core} = 1.455
- $n_{cladding}$ = 1.45

What are the propagating modes in the fiber source?

What is the diffraction pattern in the focal region?

Linearly Polarized Mode Calculator

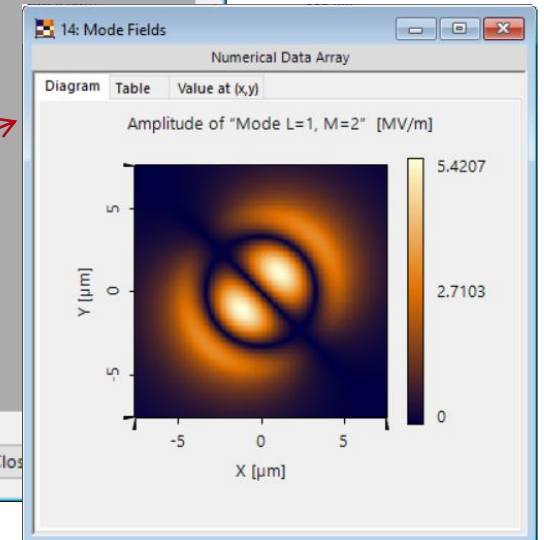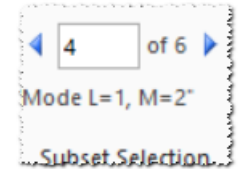**step-index fiber**
- wavelength 600 nm
- core diameter 10 um
- n_{core} = 1.455
- $n_{cladding}$ = 1.45

This calculator gives the propagation constants and mode fields of all existing linearly polarized (LP) modes.

For further information:
LP Fiber Mode Calculator

fields of all LP modes

Source of Fiber Modes

introducing Zernike Fringe aberrations
- astigmatism X 2λ
- astigmatism Y λ
- coma Y λ

step-index fiber
- wavelength 600 nm
- core diameter 10 um
- n_{core} = 1.455
- $n_{cladding}$ = 1.45

(l,m)   (0,1)   (0,2)   (1,1)   (1,2)   (2,1)   (3,1)

fiber mode

20 um

irradiance of existing LP modes in the step-index fiber

Diffraction Patterns

introducing Zernike Fringe aberrations
- astigmatism X 2λ
- astigmatism Y λ
- coma Y λ

step-index fiber
- wavelength 600 nm
- core diameter 10 um
- n_{core} = 1.455
- $n_{cladding}$ = 1.45

For single mode, the *LP Mode Source* is used for modeling.

(l,m)	(0,1)	(0,2)	(1,1)	(1,2)	(2,1)	(3,1)

fiber mode

pattern

20um

100um

different modes result in different diffraction pattern

irradiance of diffraction pattern in the focal region

Switch from Single Mode Source to Multiple Light Source

Edit Multiple Light Source ✕

Combination Mode [Coherent ▾]

Light Source Name	Light Source	Use
Fiber Mode 01	LP Mode Source	☑
Fiber Mode 02	LP Mode Source	☑
Fiber Mode 11	LP Mode Source	☑
Fiber Mode 12	LP Mode Source	☑
Fiber Mode 21	LP Mode Source	☑
Fiber Mode 31	LP Mode Source	☑

[Add] [Remove]

Validity: ✓ Tools ▾ [OK] [Cancel] [Help]

step-index fiber
- wavelength 600 nm
- core diameter 10 um
- n_{core} = 1.455
- $n_{cladding}$ = 1.45

For combined simulation, either a *Multiple Light Source* or the *Parameter Run* can be used.
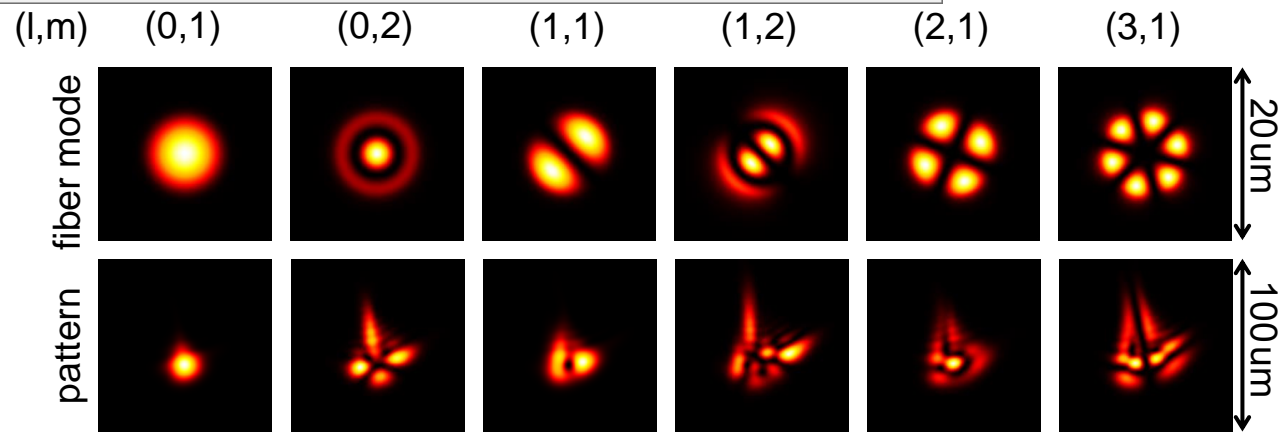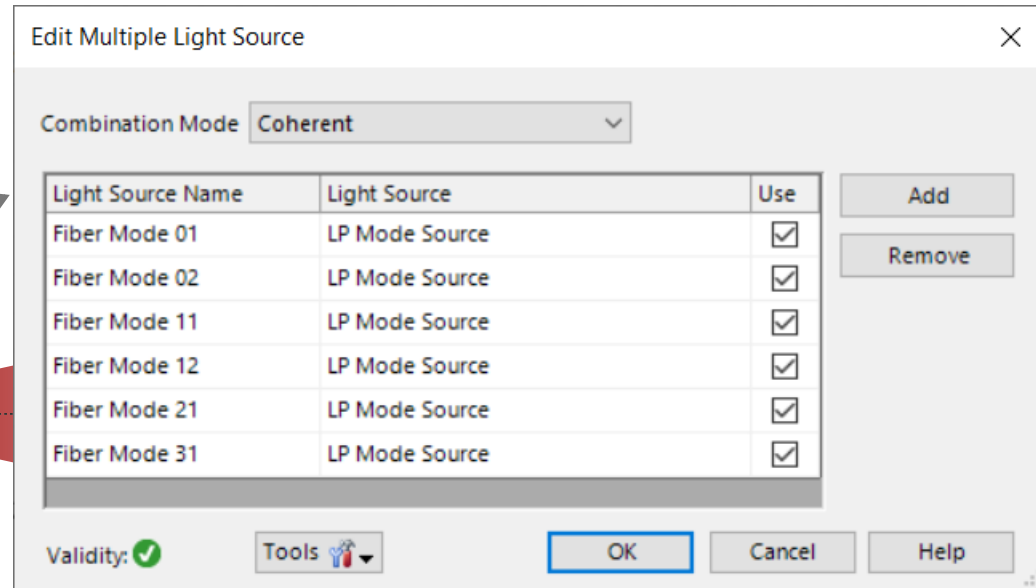
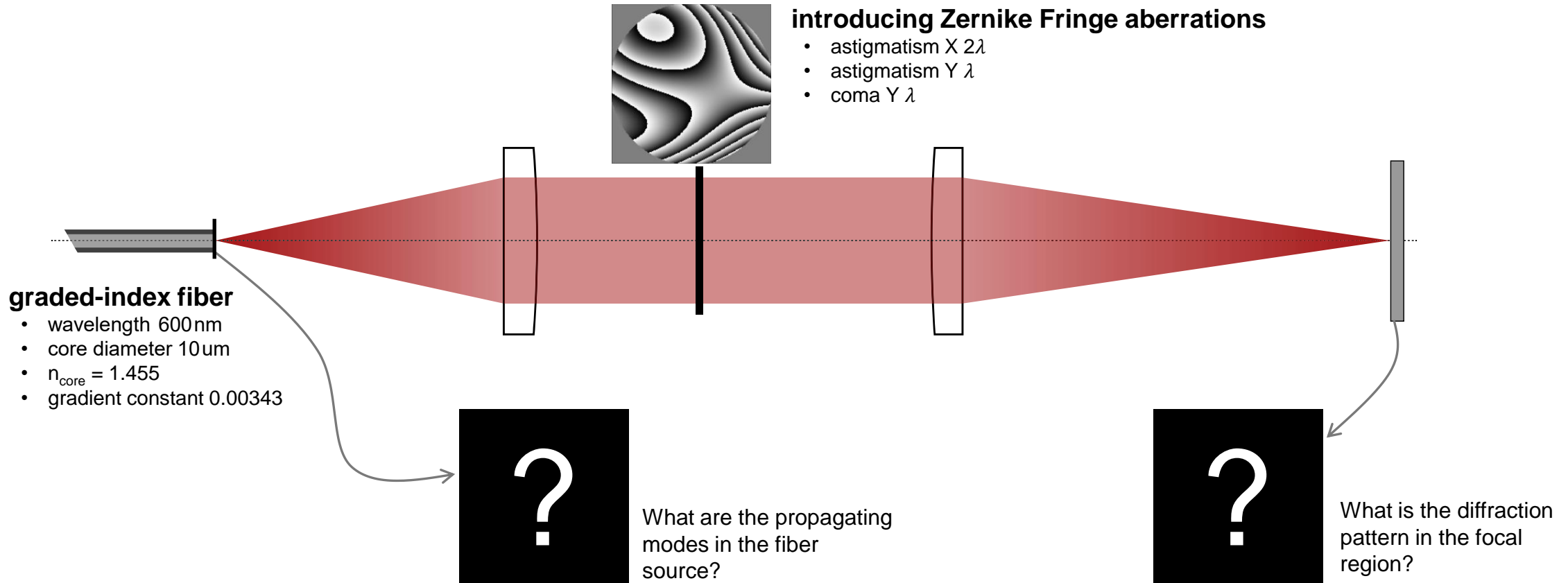(l,m) (0,1) (0,2) (1,1) (1,2) (2,1) (3,1)

fiber mode

20um

pattern

100um

different modes result in different diffraction pattern

irradiance of diffraction pattern in the focal region

Setup concept from Appl. Opt. 59,6584-6592 (2020)

Switch from Single Mode Source to Multiple Light Source

introducing Zernike Fringe aberrations
- astigmatism X 2λ
- astigmatism Y λ
- coma Y λ

step-index fiber
- wavelength 600 nm
- core diameter 10 um
- n_{core} = 1.455
- $n_{cladding}$ = 1.45

coherent combination of modes

(l,m)   (0,1)   (0,2)   (1,1)   (1,2)   (2,1)   (3,1)

fiber mode — 20um

pattern — 100um

irradiance of diffraction pattern in the focal region
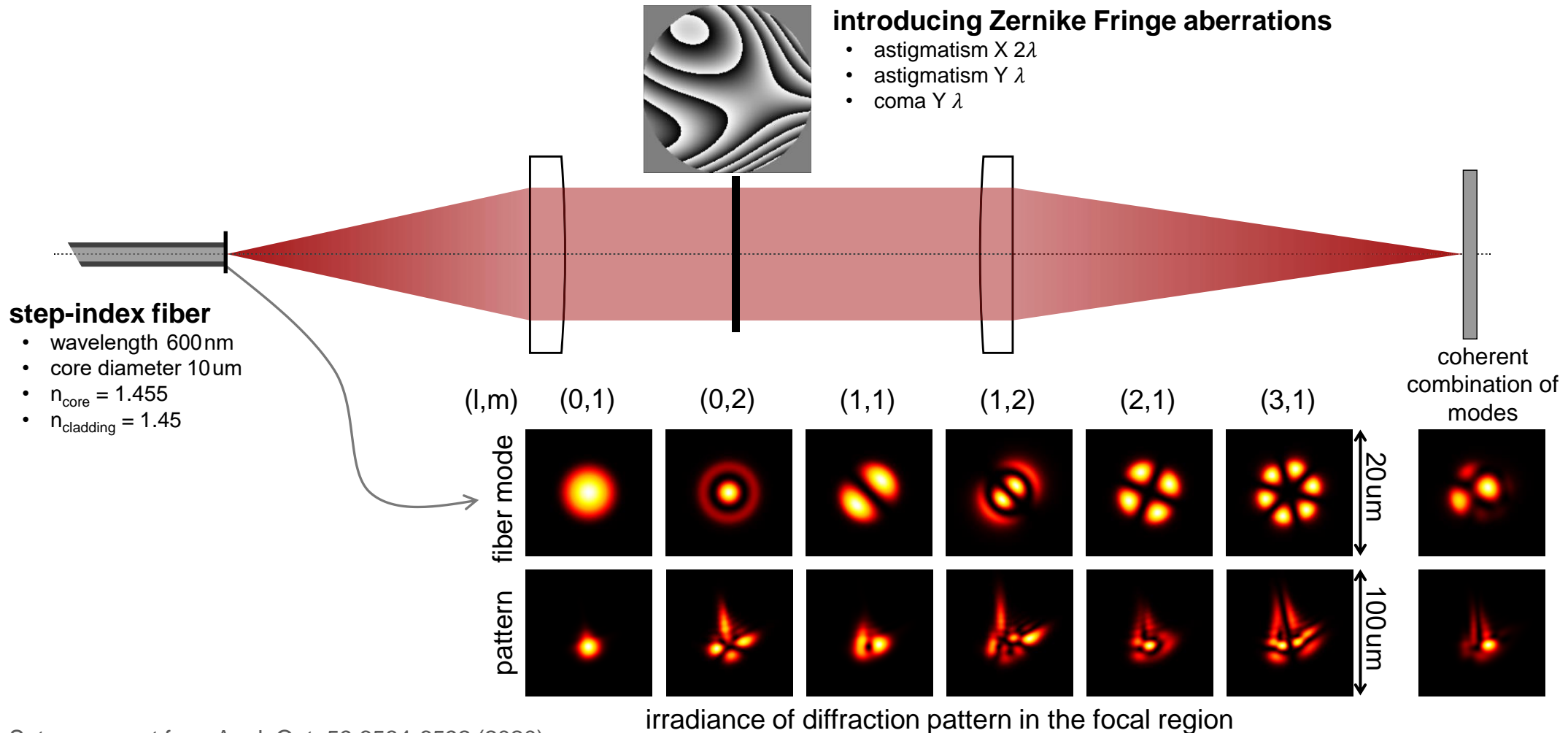
Source Modes and Diffraction Patterns

introducing Zernike Fringe aberrations
- astigmatism X 2λ
- astigmatism Y λ
- coma Y λ

graded-index fiber
- wavelength 600 nm
- core diameter 10 um
- n_{core} = 1.455
- gradient constant 0.00343

coherent combination of modes

| (l,m) | (0,1) | (0,2) | (1,1) | (1,2) | (2,1) | (3,1) |

irradiance of diffraction pattern in the focal region
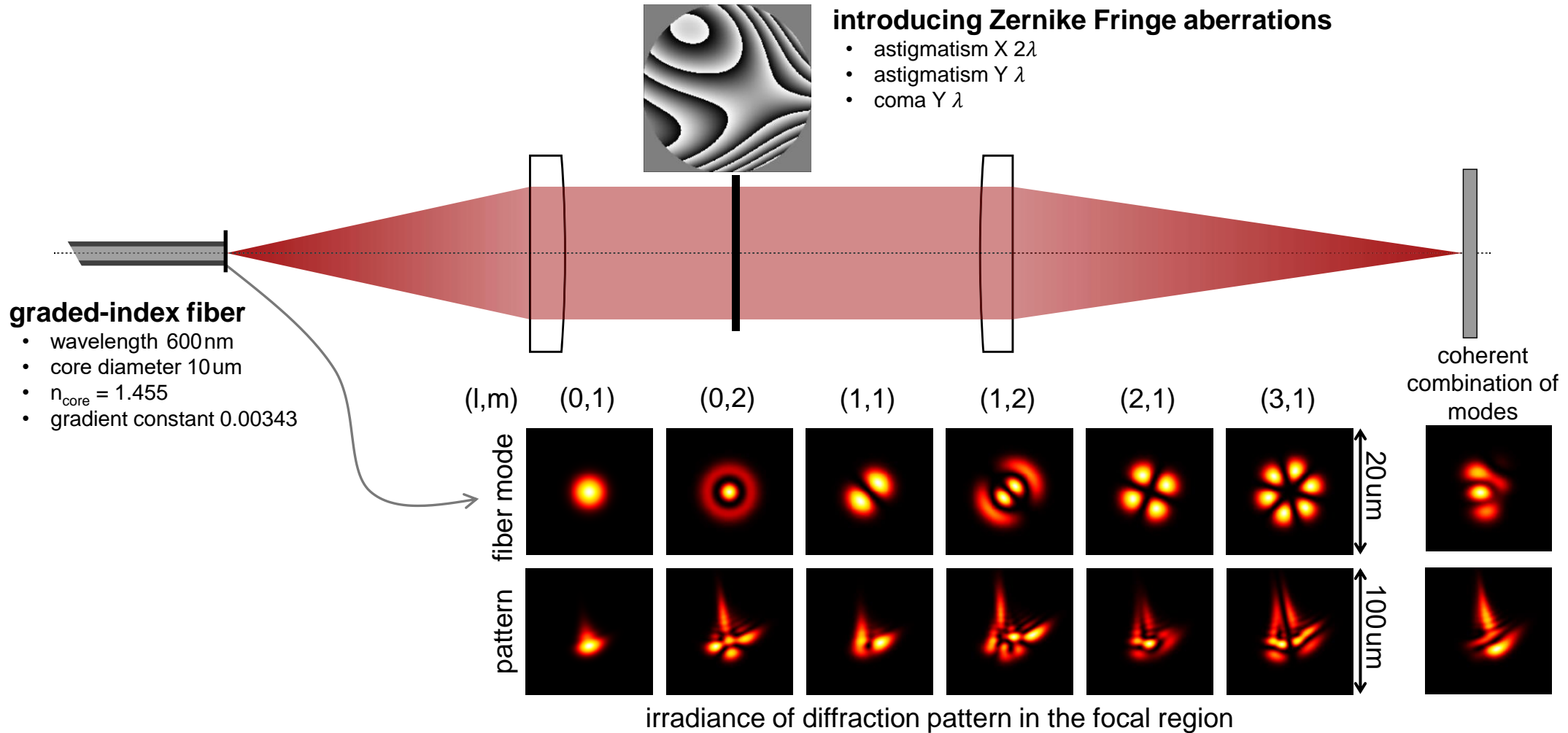
VirtualLab Fusion Technologies
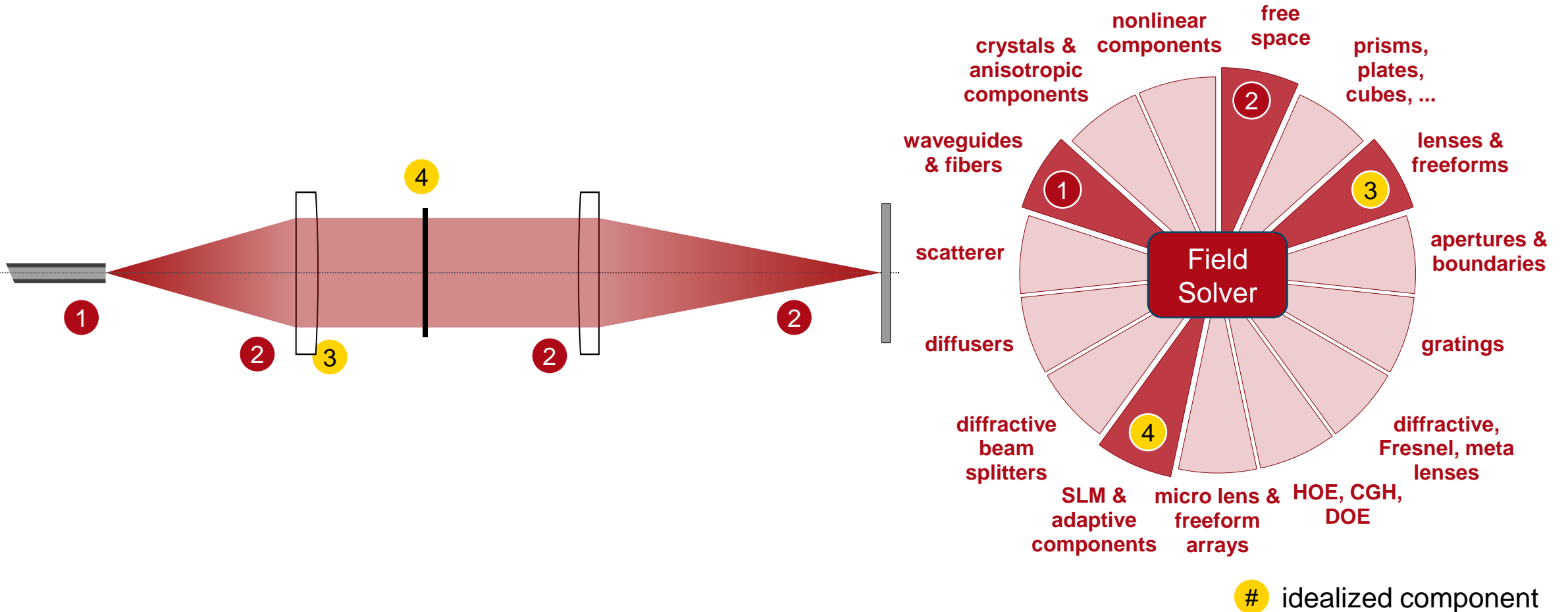
Document Information

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