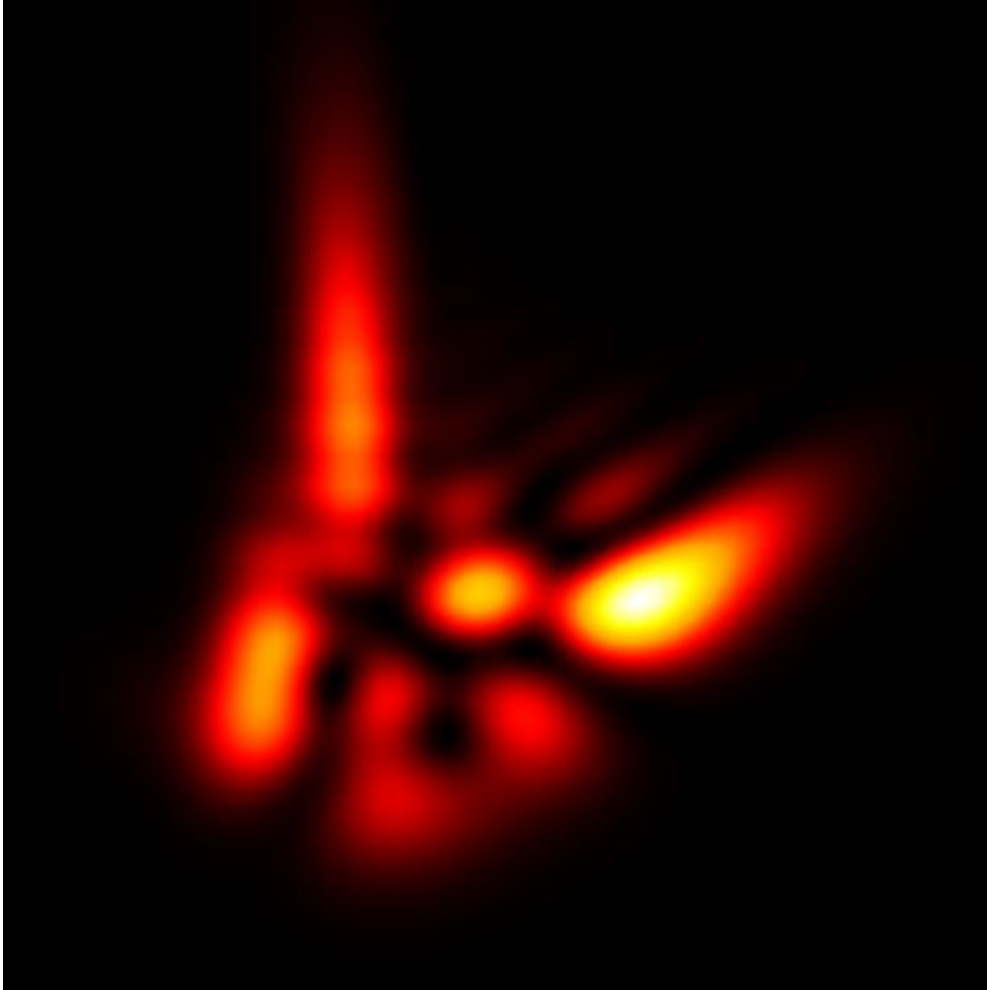


Huiying Zhong

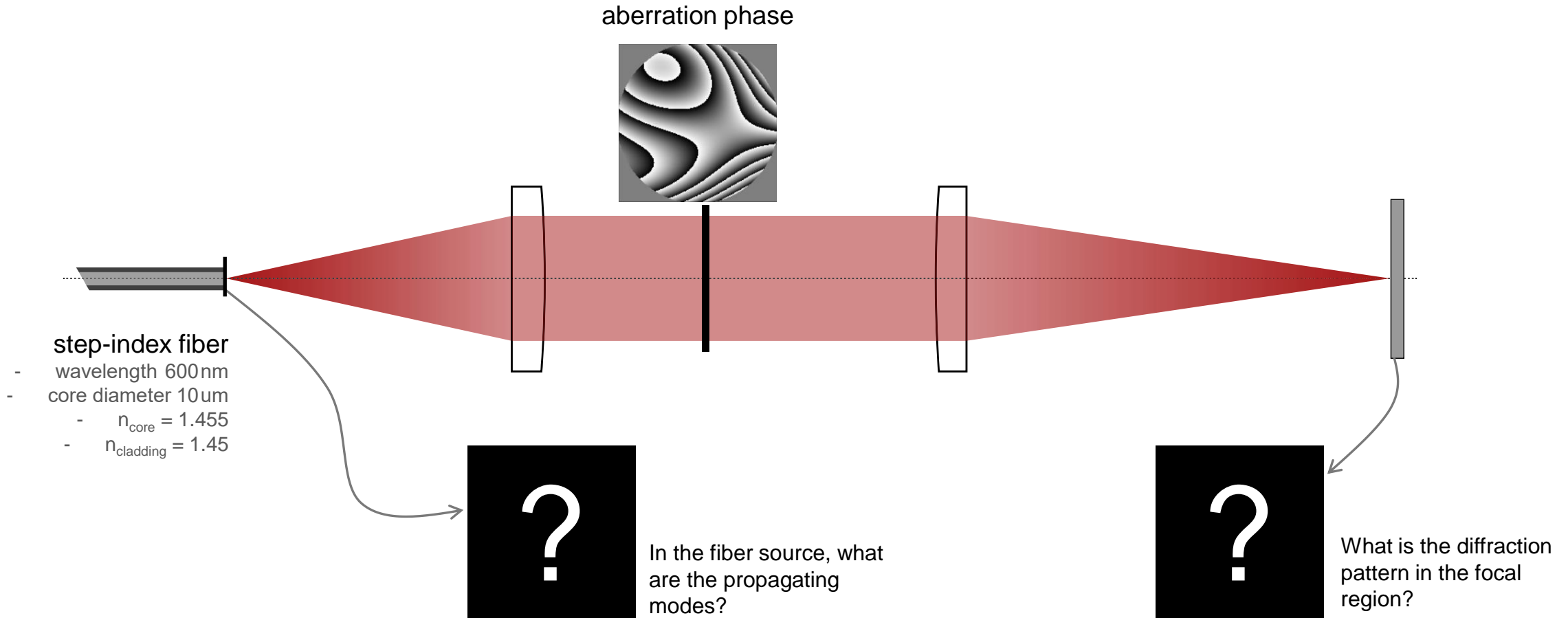
Investigation of Aberration Effects on LP Fiber Modes in the Focal Region

Abstract



Fibers are widely used as sources in optical systems. Investigating the effects of the aberrations of the optical system on the propagation of the fiber modes is therefore worthwhile. In this use case, we employ a specific fiber, either step- or graded-index, as a source to generate a couple of propagating modes, and evaluate the diffraction pattern after the propagation of said modes through an aberrated optical system.

Modeling Task with a Step-Index Fiber



Linearly-Polarized Mode Calculator

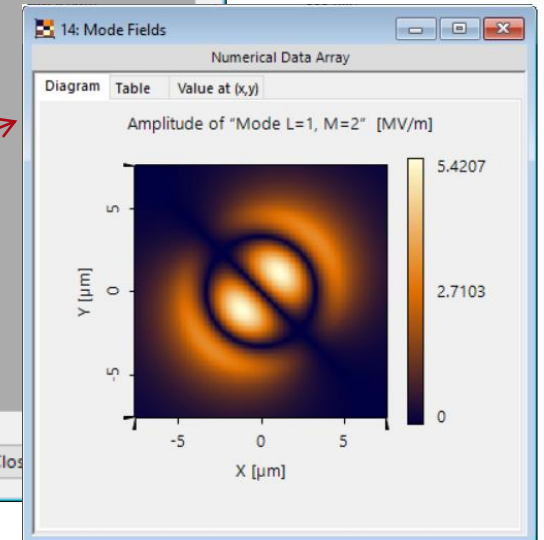


- step-index fiber
- wavelength 600nm
- core radius 5μm
 - $n_{\text{core}} = 1.455$
 - $n_{\text{cladding}} = 1.45$

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

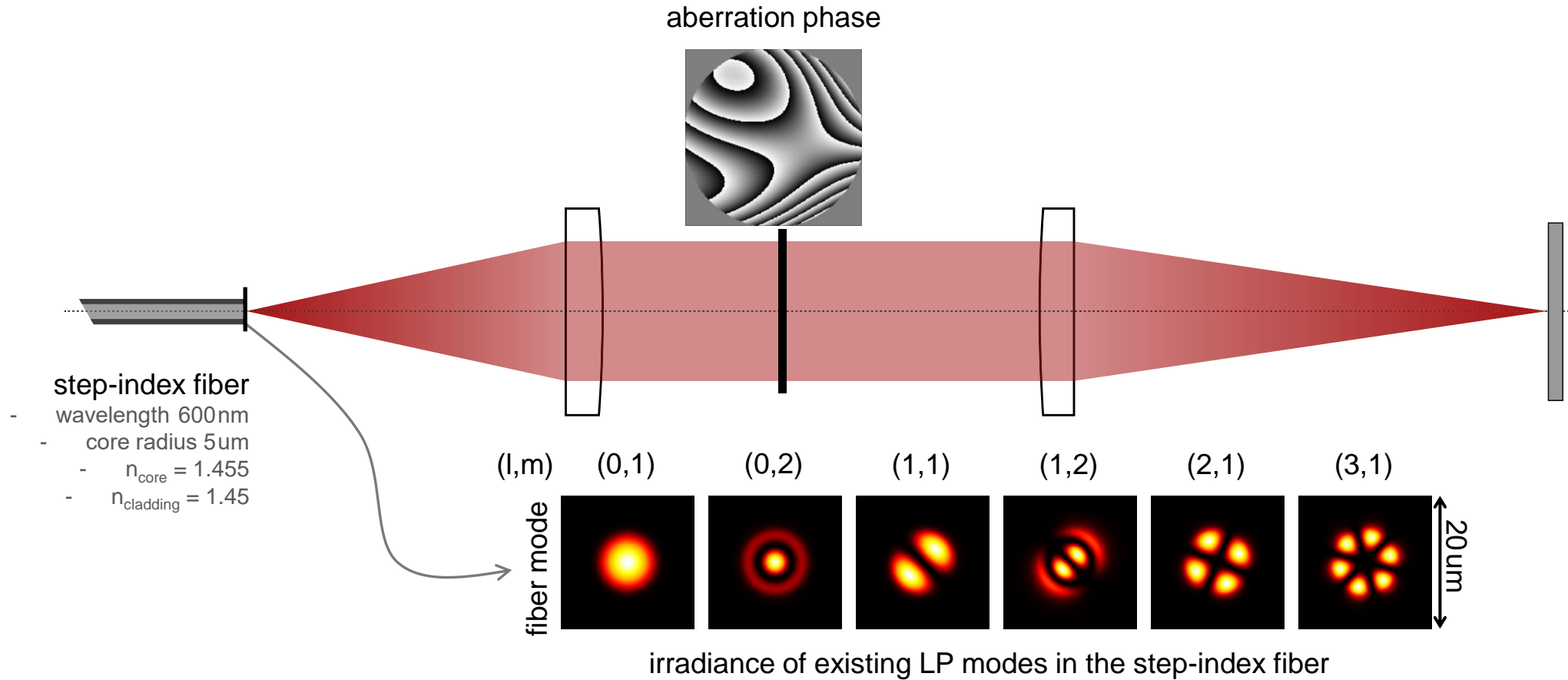
Index	Azimuthal Order L	Radial Order M	Propagation Constant β	Effectiv...
1	0	1	1.5231E+07 m ⁻¹	1.4545
2	0	2	1.5208E+07 m ⁻¹	1.4522
3	1	1	1.5223E+07 m ⁻¹	1.4536
4	1	2	1.5192E+07 m ⁻¹	1.4507
5	2	1	1.5212E+07 m ⁻¹	1.4526
6	3	1	1.5198E+07 m ⁻¹	1.4513

4 of 6
Mode L=1, M=2
Subset Selection

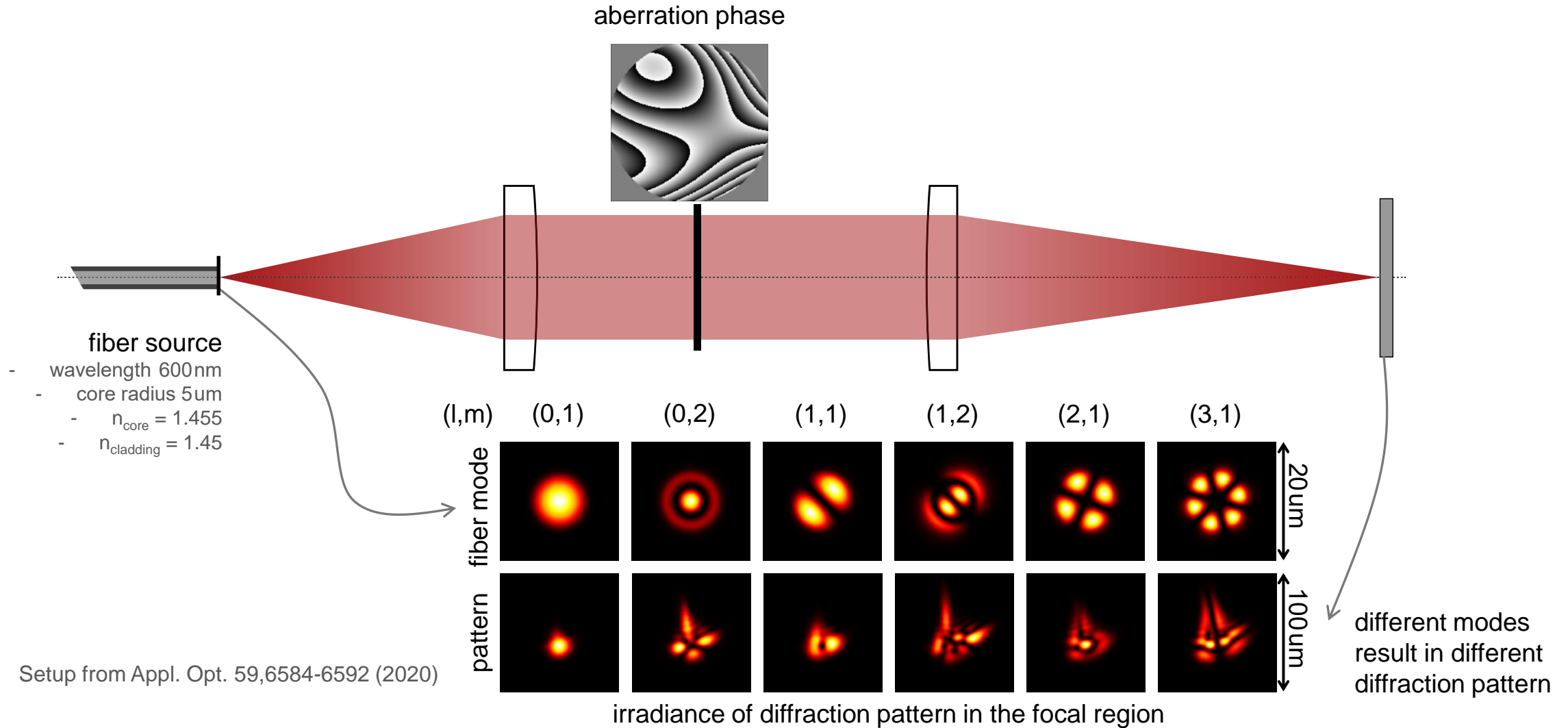


fields of all LP modes

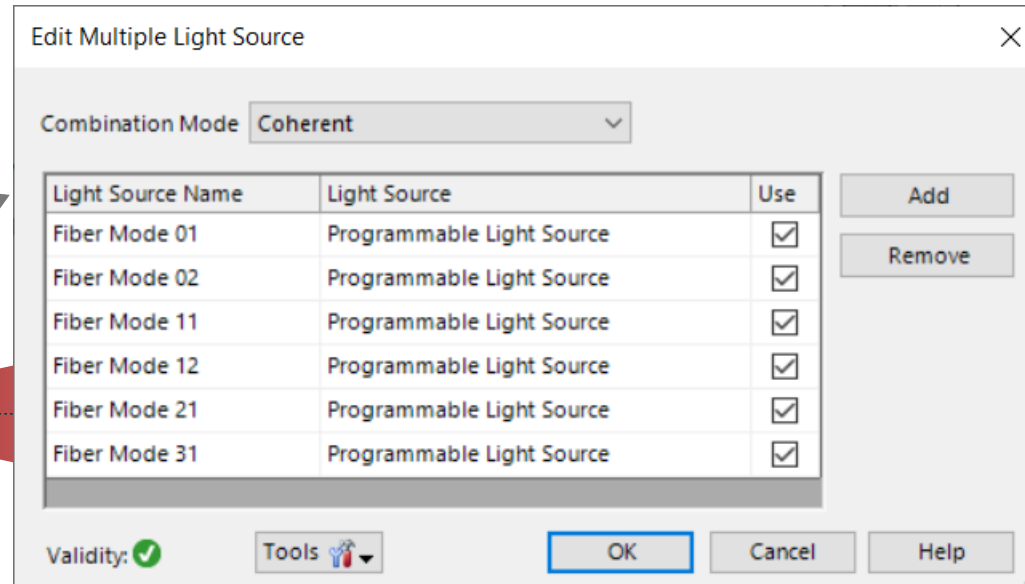
Source of Fiber Modes



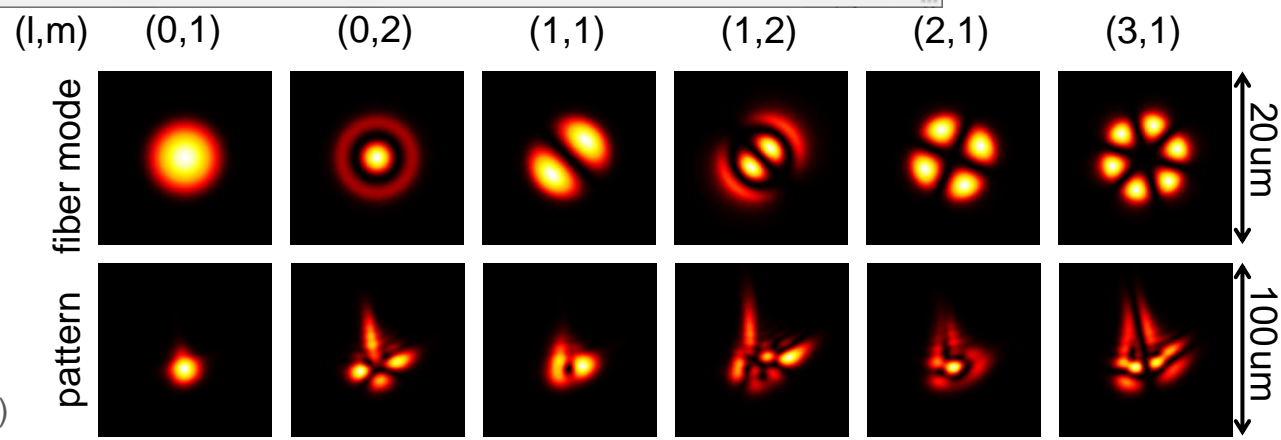
Diffraction Patterns



Switch from Single Mode Source to Multiple Light Source



- fiber source
- wavelength 600nm
 - core radius 10um
 - $n_{\text{core}} = 1.455$
 - $n_{\text{cladding}} = 1.45$

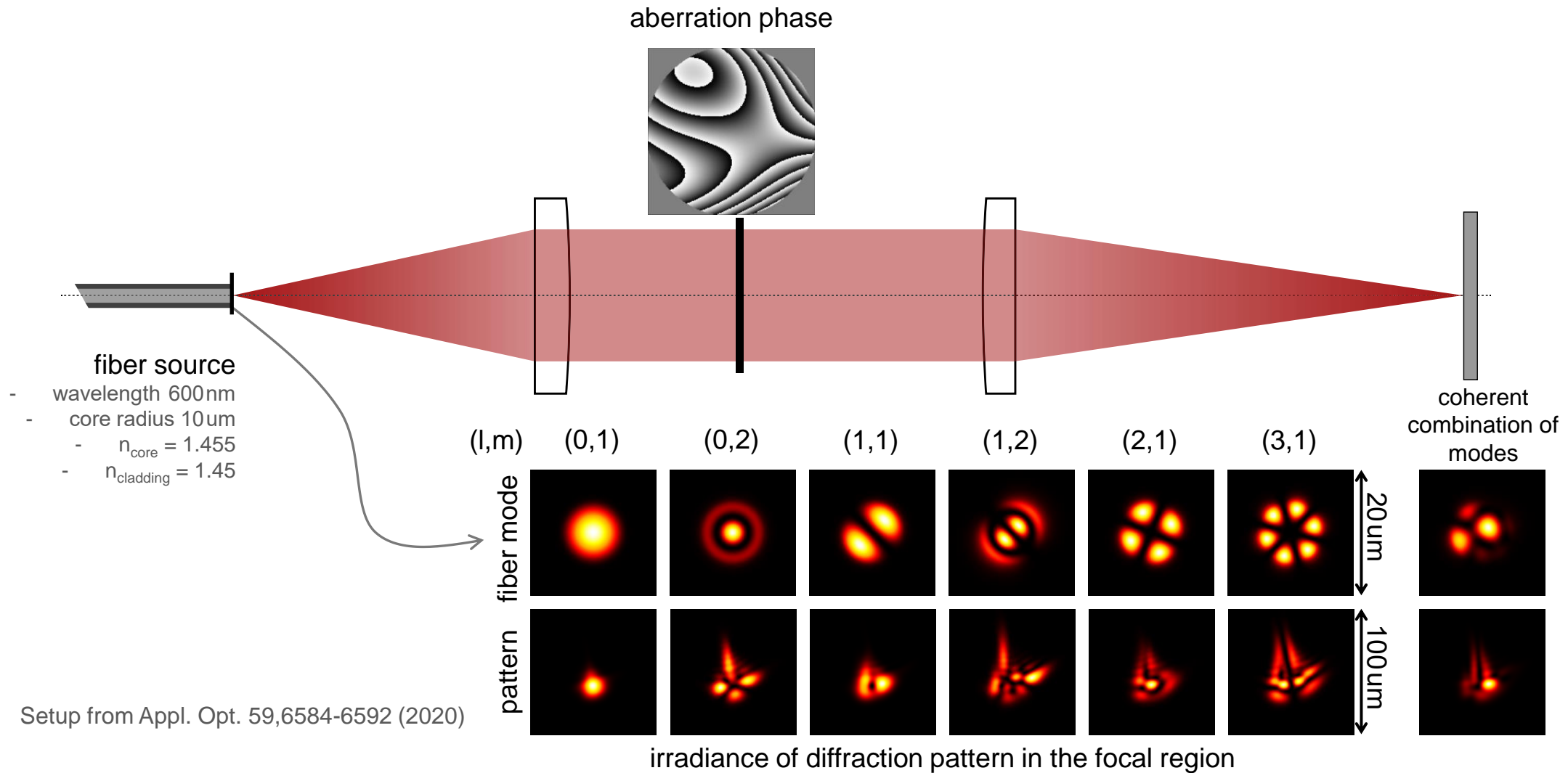


Setup from Appl. Opt. 59,6584-6592 (2020)

irradiance of diffraction pattern in the focal region

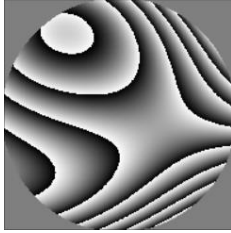
different modes result in different diffraction pattern

Switch from Single Mode Source to Multiple Light Source



Modeling Task with a Graded-Index Fiber

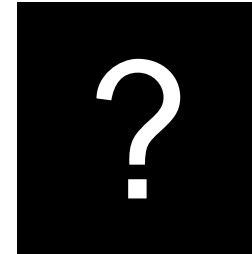
aberration phase



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

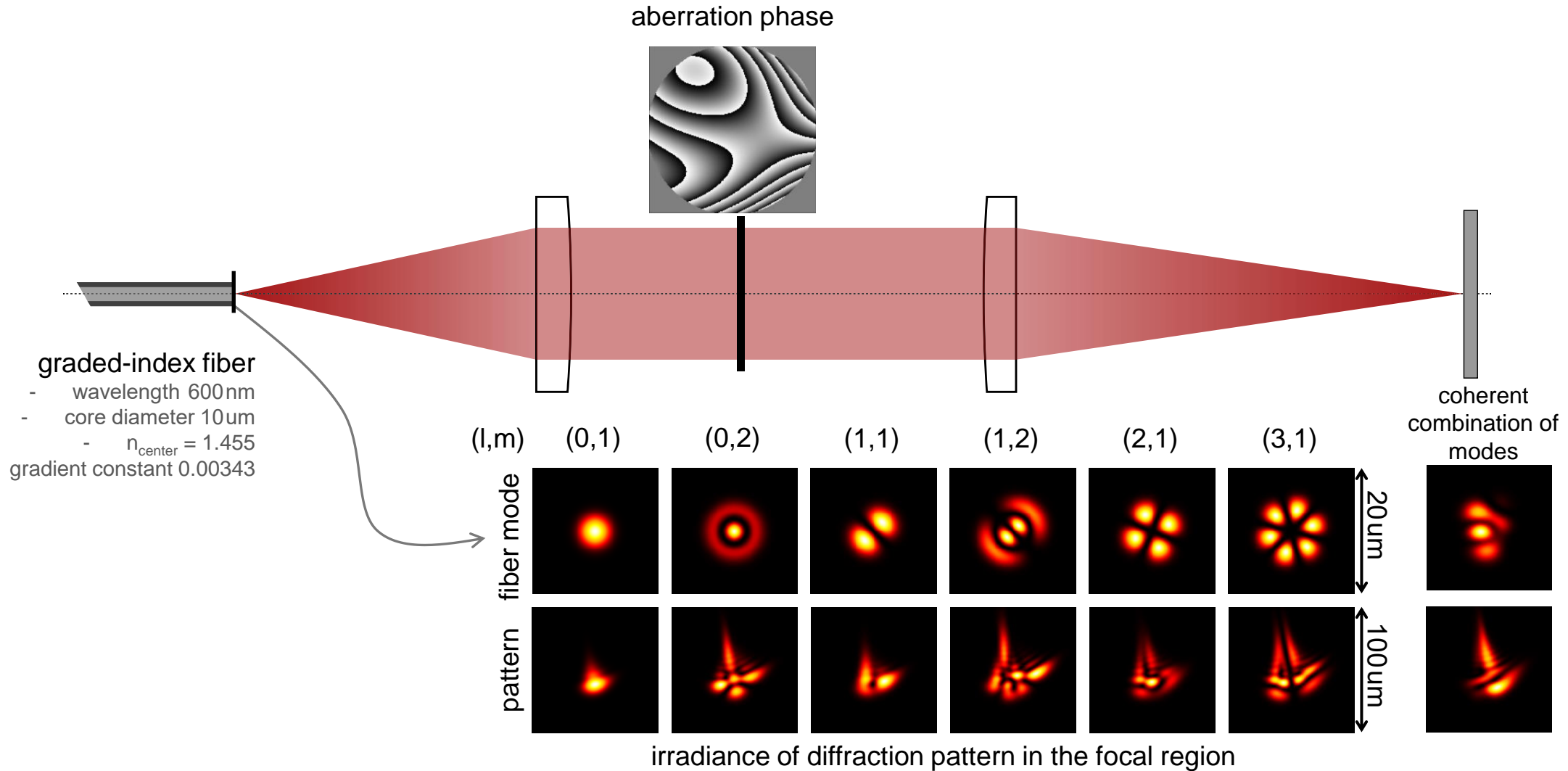


In the fiber source, what is the propagation modes?



What is the diffraction pattern in the focal region?

Source Modes and Diffraction Patterns



Peek into VirtualLab Fusion

single mode fiber source with specified mode index

n	Name	Value [λ]
4	Defocus	0
5	Astigmatism X	2
6	Astigmatism Y	1
7	Coma X	0
8	Coma Y	1
9	Spherical	0
10	Trefoil X	0

convenient setting of aberration phase

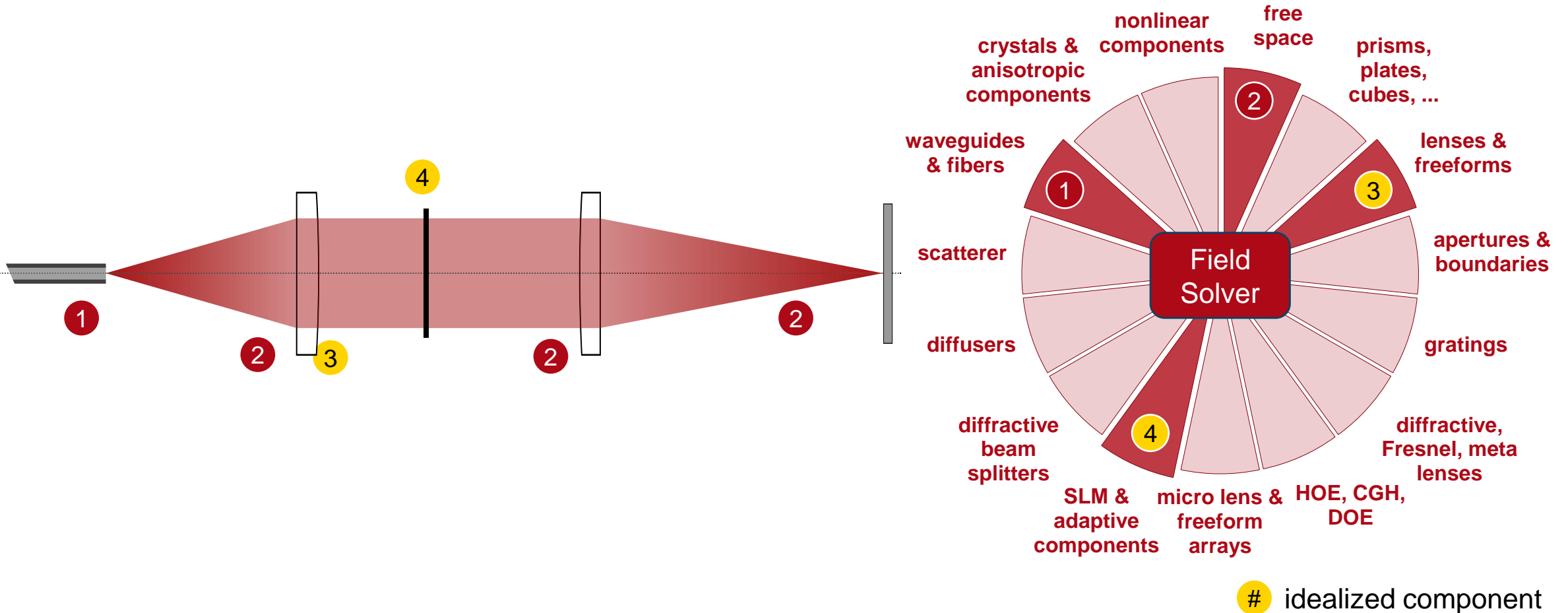
Workflow in VirtualLab Fusion

- Set the programmable light source
 - [How to work with the programmable light source in VirtualLab Fusion and Example \(Gaussian Beam\)](#) [Use Case]
- Set the position and orientation of components
 - [Position and Orientation](#) [Video]



```
Source Code Editor
Source Code Global Parameters Snippet Help Advanced Settings
48
49 lic Complex GetLocalDataPoint(double x, double y) {
50
51 #region Main method
52 Complex FieldValue = new Complex(0, 0);
53
54 double k0 = Math.PI * 2.0 / Wavelength;
55 double epsilonCore = nCore * nCore;
56 double epsilonCladding = nCladding * nCladding;
57
58 bool ifModeExist = false;
59
60 LPMode SingleLPModeFunction = LPModeSupport.CalculateSingleLPModeFunction(Wavelength,
61
62 if (ifModeExist) {
63     ...
64     FieldValue = SingleLPModeFunction.GetValue(new VectorD(x, y));
65 }
66
67 return FieldValue;
68 #endregion
69
70
Check Consistency Validity: ✓ OK
```

VirtualLab Fusion Technologies



Document Information

title	Investigation of Aberration Effects on Fiber Modes in the Focal Region
document code	FCP.0006
version	1.0
edition	VirtualLab Fusion Basic
software version	2021.1 (Build 1.176)
category	Application Use Case
further reading	<ul style="list-style-type: none">- Fiber Mode Calculator- Linearly-Polarized (LP) Mode Solver- Few-Mode Fiber Coupling under Atmospheric Turbulence