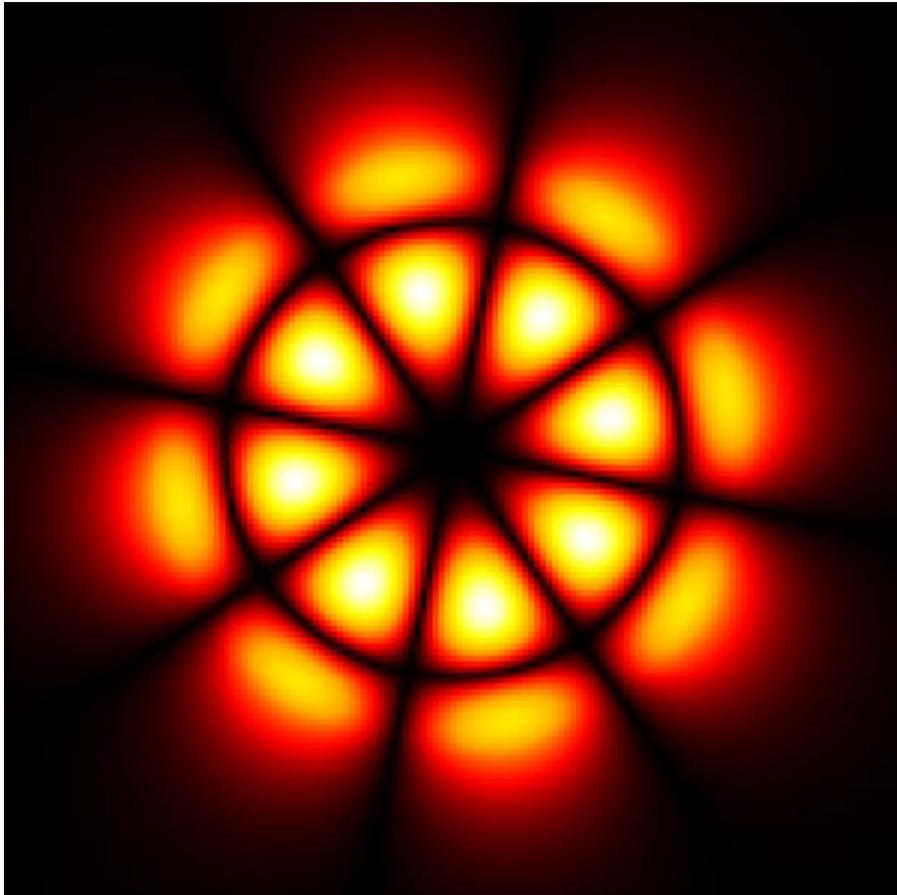


Huiying Zhong

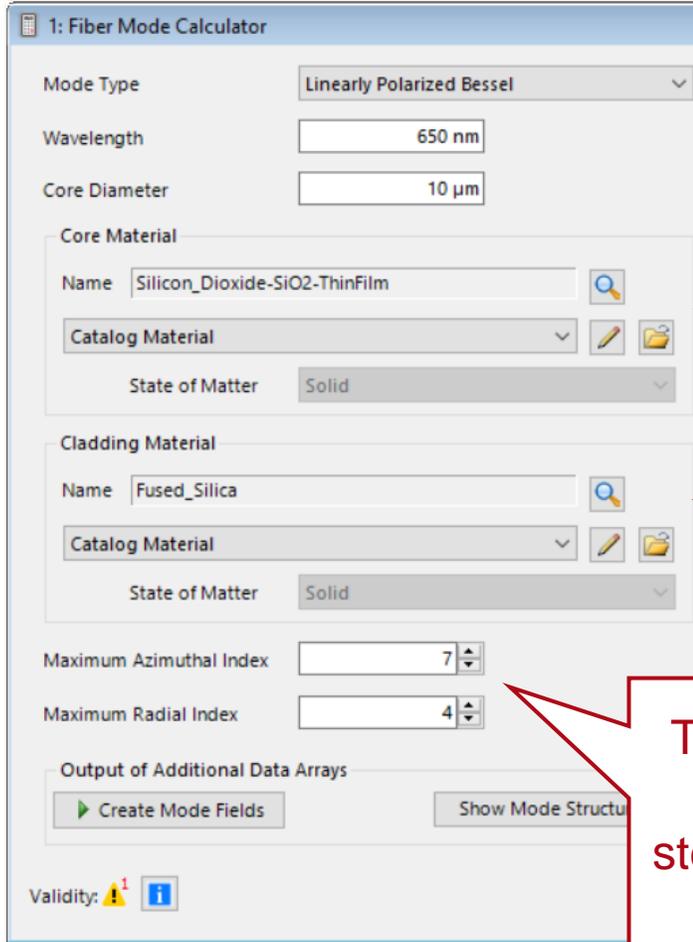
LP Fiber Mode Calculator

Abstract



The Fiber Mode Calculator can be used to calculate linearly polarized (LP) propagation modes in a cylindrically symmetric fiber, either step-index with a single core or graded-index with an infinite parabolic profile. The corresponding polynomials to describe these modes are Bessel for step-index fibers and Laguerre for graded-index fibers. This use case shows how to use the calculator and the configuration of the sampling parameters of mode fields.

Configuring the Fiber Structure: Step-Index Fiber

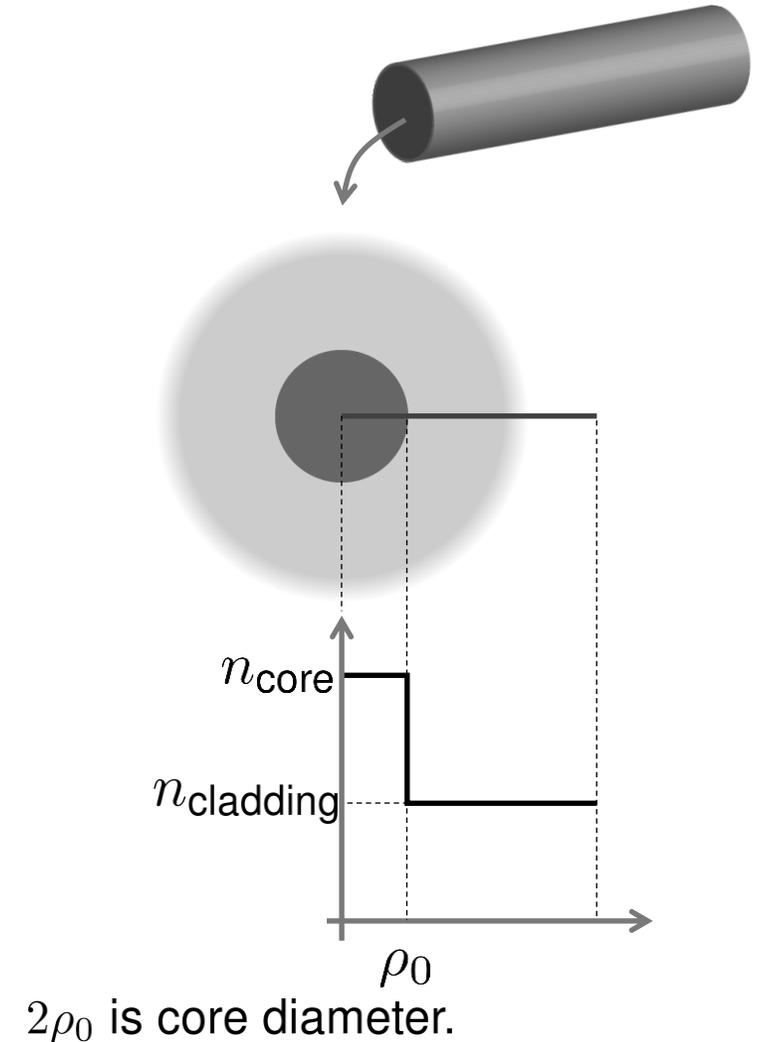


Modes in step-index fiber are mainly based on Bessel polynomials.

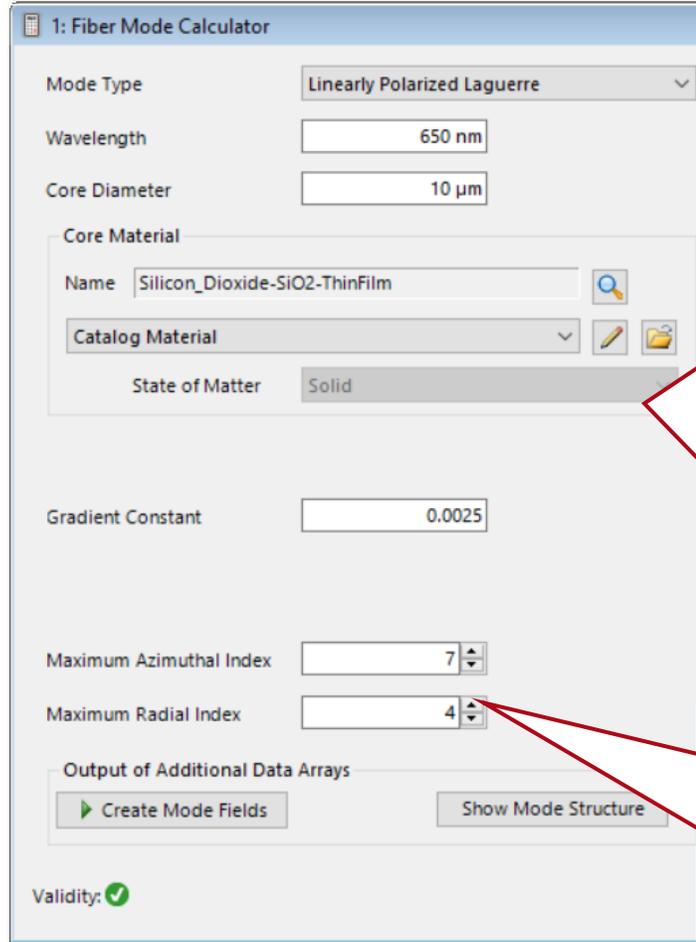
The refractive index n_{core} corresponds to that of the core material.

The refractive index n_{cladding} is that of the cladding material.

The number of propagating modes is limited by the structure of the step-index fiber. Users can manually truncate number of modes.



Setting of the Fiber Structure: Graded-Index Fiber



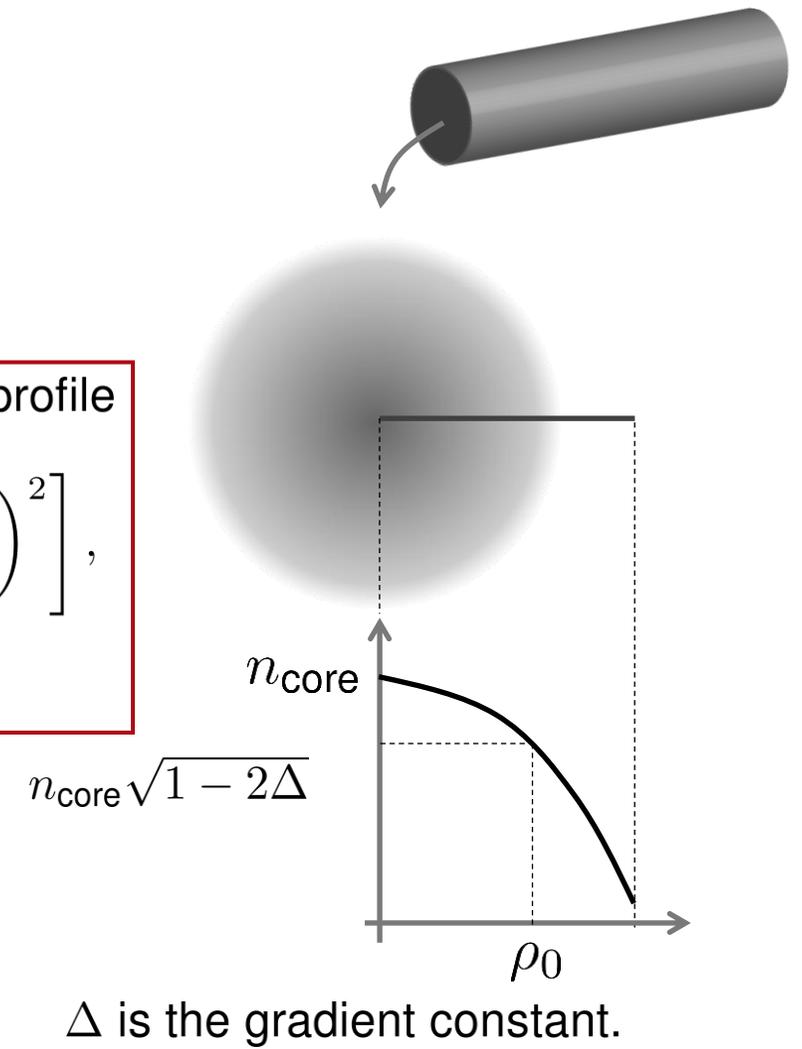
Modes in this type of graded-index fiber are mainly based on Laguerre polynomials.

refractive index of infinite parabolic profile

$$n(\rho) = n_{\text{core}} \left[1 - 2\Delta \left(\frac{\rho}{\rho_0} \right)^2 \right],$$

with $\rho = \sqrt{x^2 + y^2}$

The number of propagating modes is infinite, so users need to truncate the number of orders.



Calculation of Propagation Constants

1: Fiber Mode Calculator

Mode Type: Linearly Polarized Bessel

Wavelength: 650 nm

Core Diameter: 10 μm

Core Material: Silicon_Dioxide-SiO2-ThinFilm

Cladding Material: Fused_Silica

Index	Azimuthal Order L	Radial Order M	Propagation Const...	Effectiv...
1	0	1	1.4242E+07 m ⁻¹	1.4734
2	0	2	1.4213E+07 m ⁻¹	1.4704
3	0	3	1.4162E+07 m ⁻¹	1.4651
4	0	4	1.4094E+07 m ⁻¹	1.458
5	1	1	1.4232E+07 m ⁻¹	1.4723
6	1	2	1.4192E+07 m ⁻¹	1.4681
7	1	3	1.4131E+07 m ⁻¹	1.4618
8	2	1	1.4218E+07 m ⁻¹	1.4709
9	2	2	1.4167E+07 m ⁻¹	1.4656
10	2	3	1.4097E+07 m ⁻¹	1.4584
11	3	1	1.4201E+07 m ⁻¹	1.4691
12	3	2	1.4139E+07 m ⁻¹	1.4627
13	4	1	1.4182E+07 m ⁻¹	1.4671
14	4	2	1.4109E+07 m ⁻¹	1.4596
15	5	1	1.4159E+07 m ⁻¹	1.4648
16	6	1	1.4134E+07 m ⁻¹	1.4622
17	7	1	1.4107E+07 m ⁻¹	1.4593

Propagation constant β for each mode is calculated on-the-fly.

Effective refractive index n_{eff} is $n_{\text{eff}} = \frac{\beta}{k_0}$, with k_0 the vacuum wave number.

Display of Propagation Constants

1: Fiber Mode Calculator

Mode Type: Linearly Polarized Bessel

Wavelength: 650 nm

Core Diameter: 10 μm

Core Material: Silicon_Dioxide-SiO2-ThinFilm

Cladding Material: Fused_Silica

Maximum Azimuthal Index: 7

Maximum Radial Index: 4

Output of Additional Data Arrays:

Index	Azimuthal Order L	Radial Order M	Propagation Const...	Effectiv...
1	0	1	1.4242E+07 m ⁻¹	1.4734
2	0	2	1.4213E+07 m ⁻¹	1.4704
3	0	3	1.4162E+07 m ⁻¹	1.4651
4	0	4	1.4094E+07 m ⁻¹	1.458
5	1	1	1.4232E+07 m ⁻¹	1.4723
6	1	2	1.4192E+07 m ⁻¹	1.4681
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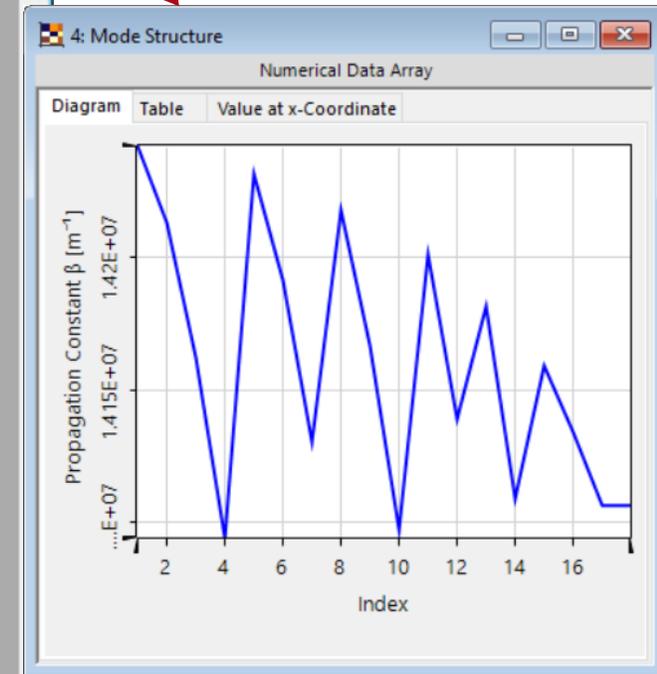
Validity:

Multigraph - Propagation Constants

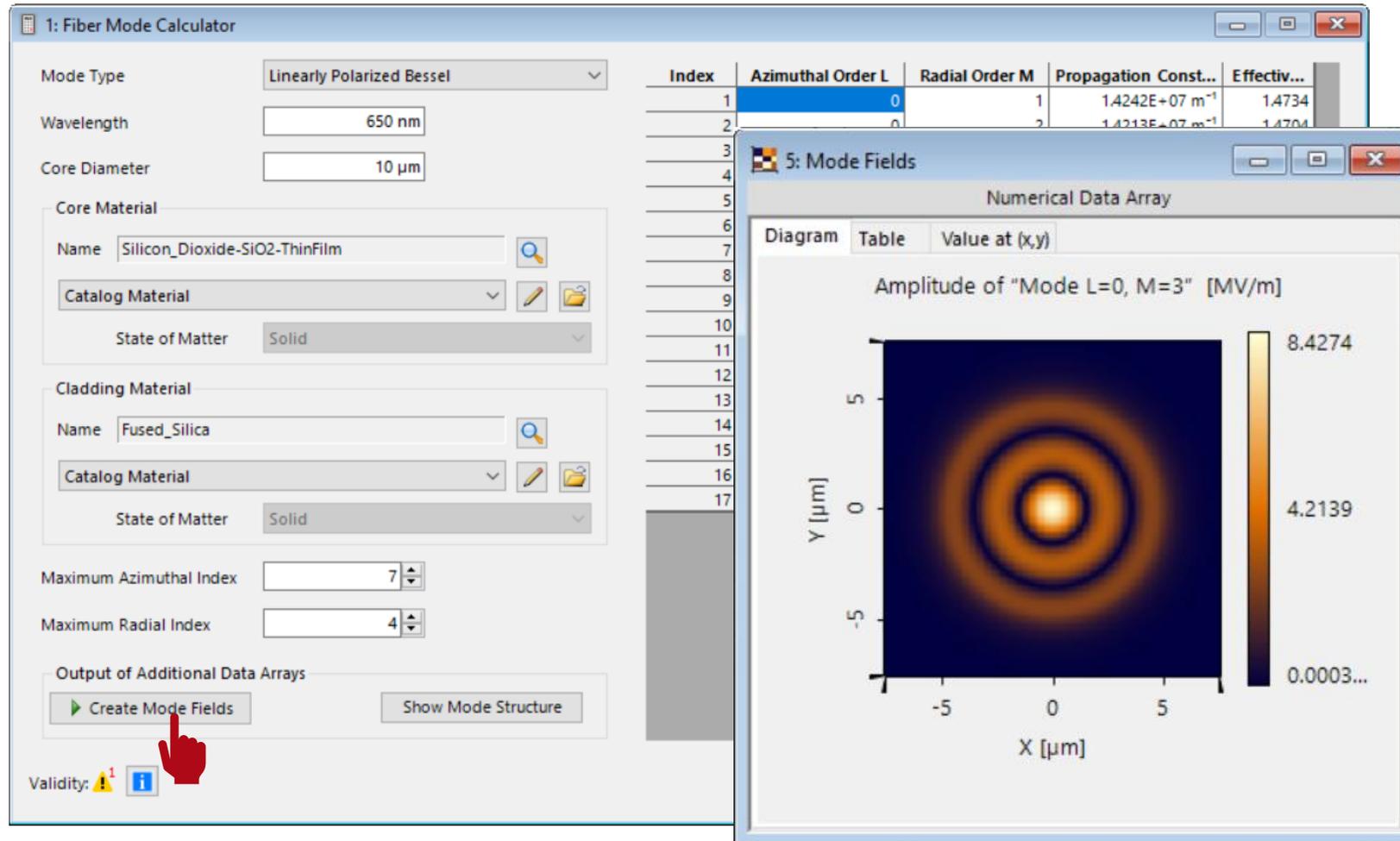
Mode

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Subset Selection



Calculation and Display of Propagation Modes

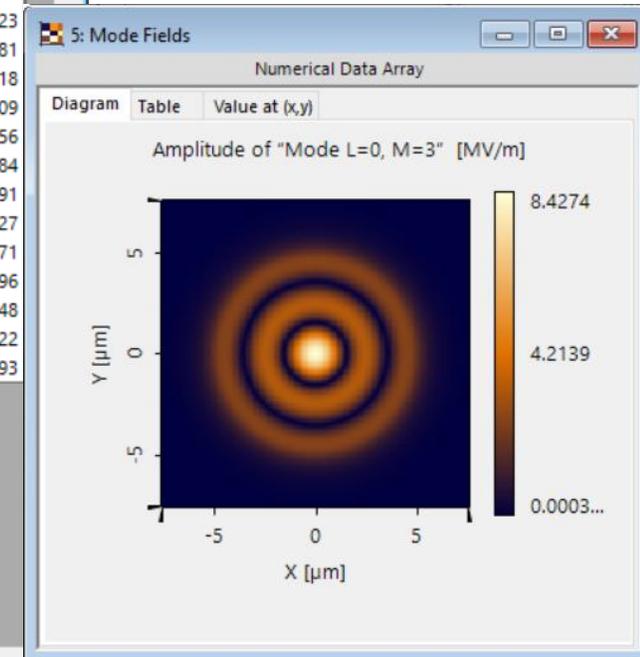


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Mode L=0, M=3
Subset Selection

- default sampling parameters
- window size is $3\rho_0 \times 3\rho_0$
 - sampling number is 151×151

Peek into VirtualLab Fusion

Index	Azimuthal Order L	Radial Order M	Propagation Const...	Effectiv...
1	0	1	1.4242E+07 m ⁻¹	1.4734
2	0	2	1.4213E+07 m ⁻¹	1.4704
3	0	3	1.4162E+07 m ⁻¹	1.4651
4	0	4	1.4094E+07 m ⁻¹	1.458
5	1	1	1.4232E+07 m ⁻¹	1.4723
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15	5	1	1.4159E+07 m ⁻¹	1.4648
16	6	1	1.4134E+07 m ⁻¹	1.4622
17	7	1	1.4107E+07 m ⁻¹	1.4593



mode field of a specific fiber

convenient setting of fiber structure

Document Information

title	Fiber Mode Calculator
document code	FCP.0005
version	1.0
edition	VirtualLab Fusion Basic
software version	2021.1 (Build 1.176)
category	Feature Use Case
further reading	- Linearly-Polarized (LP) Mode Solver