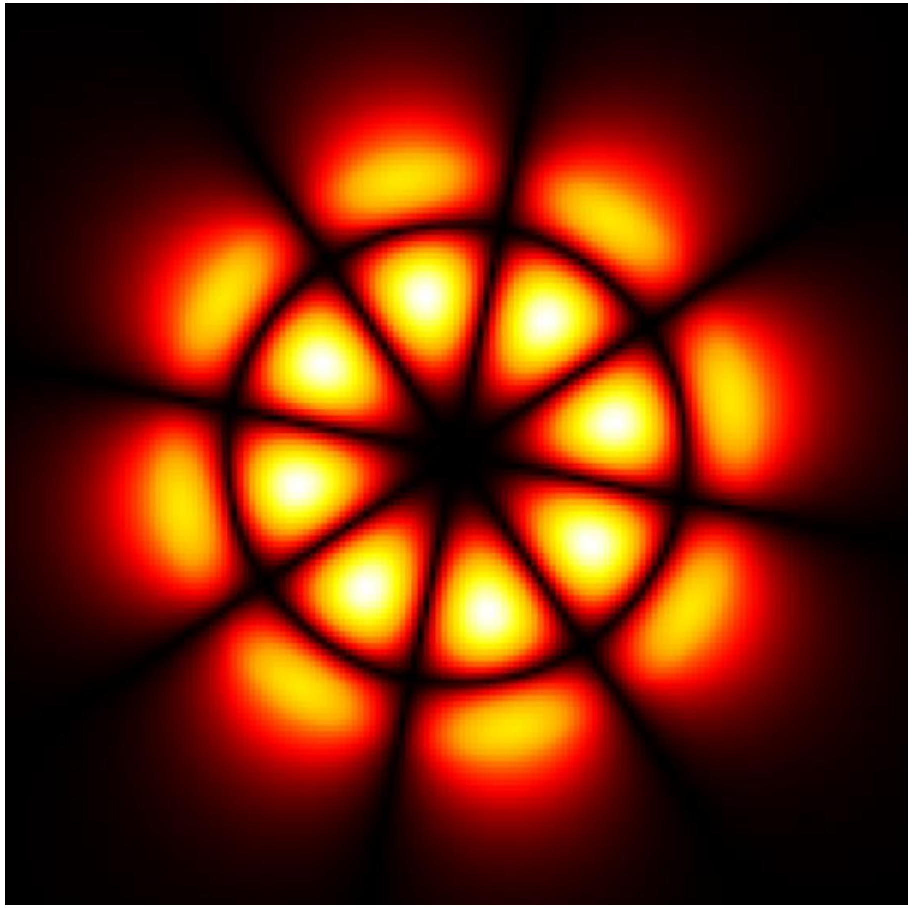
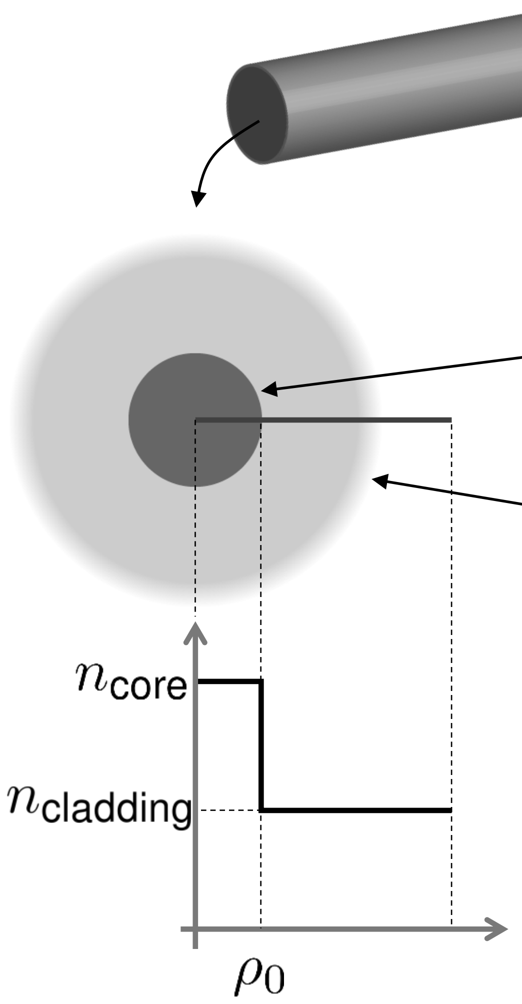
LP Fiber Mode Calculator

Abstract

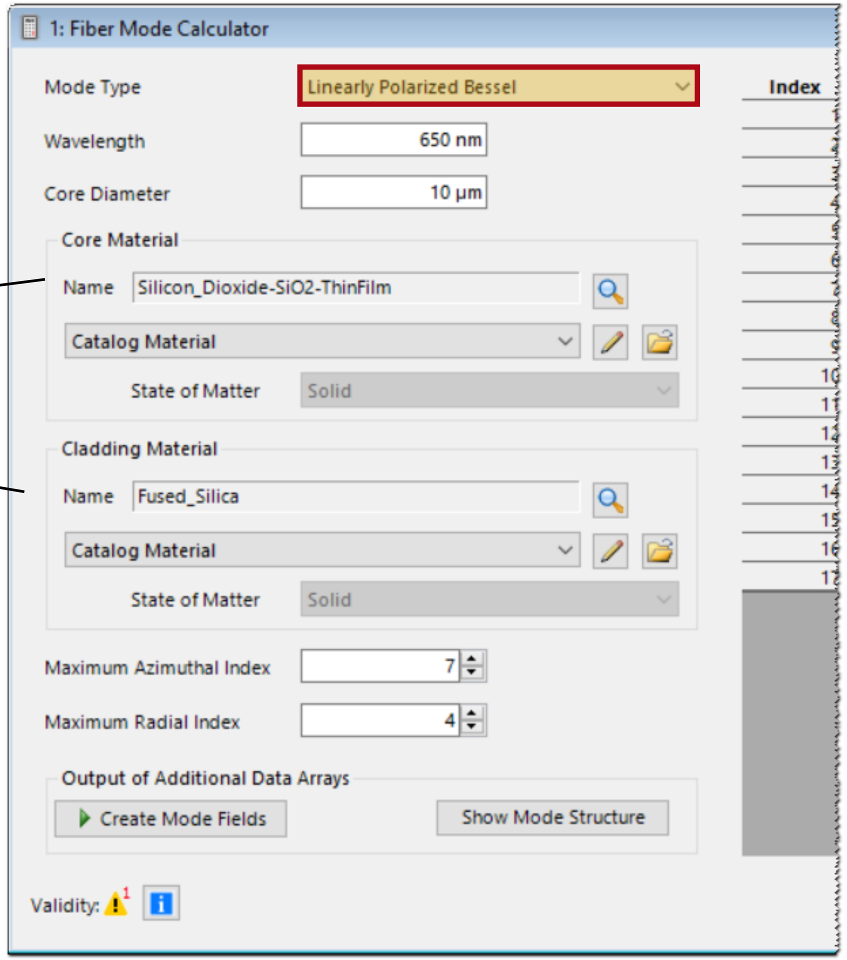


The Fiber Mode Calculator can be used to calculate linearly polarized (LP) modes propagating in a cylindrically symmetric fiber, either step-index with a single core or graded-index with an infinite parabolic profile. The corresponding polynomials to describe these modes are Bessel for step-index fibers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

Configuring the Fiber Structure: Step-Index Fiber



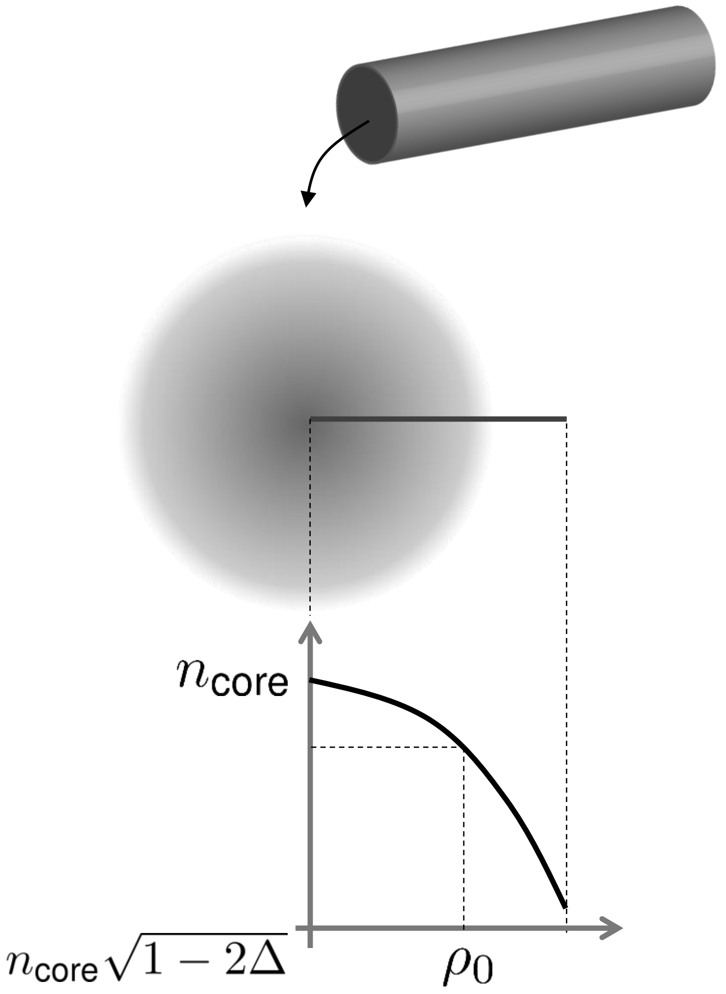
$2\rho_0$ is core diameter.



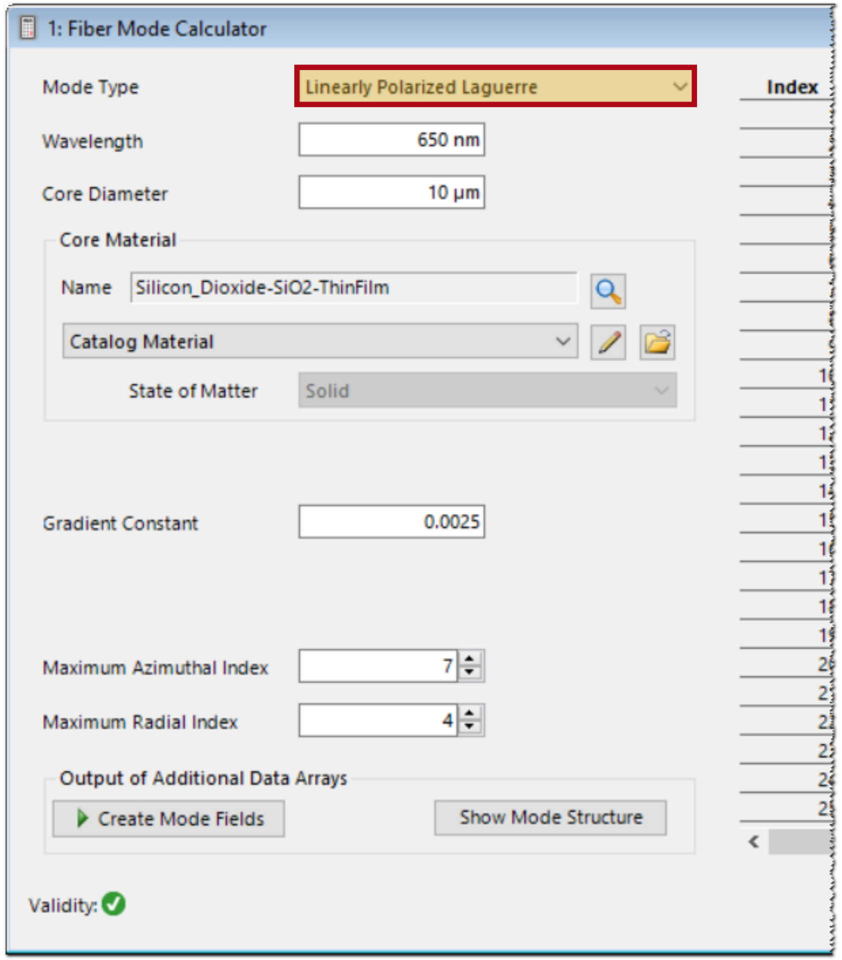
The *Fiber Mode Calculator* allows for the definition of Linearly Polarized Bessel modes and Linearly Polarized Laguerre modes.

In step-index fibers the propagating modes are of Bessel type. For this configuration, the material for core and cladding needs to be defined and the number of propagating modes must be specified (all other modes are truncated).

Configuring the Fiber Structure: Graded-Index (GRIN) Fiber



Δ is the gradient constant.



Note: The applied GRIN model of this *Fiber Mode Calculator* (Mode Type *Linearly Polarized Laguerre*) neglects a constant refractive index of the cladding.

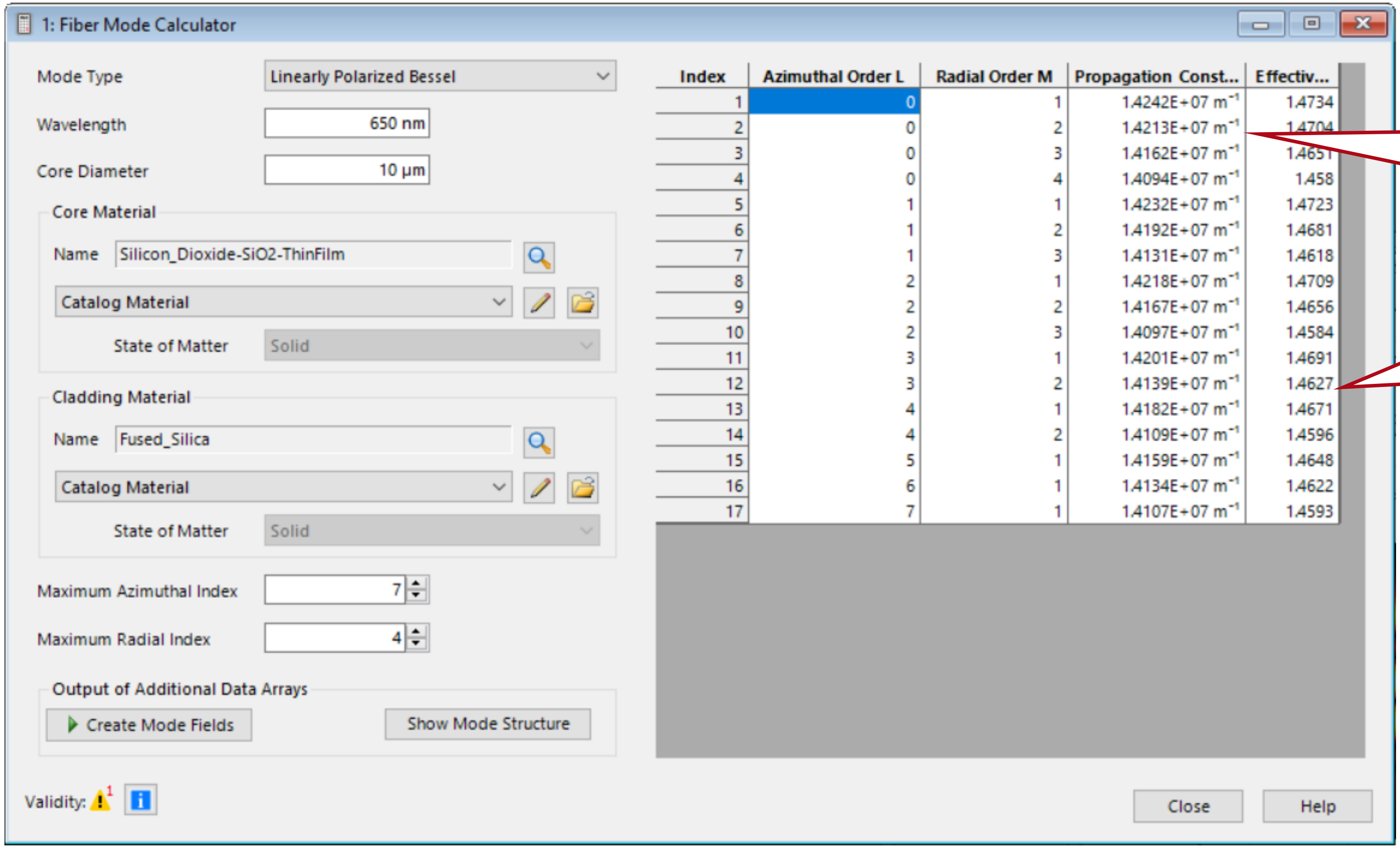
The *Fiber Mode Calculator* allows for the definition of Linearly Polarized Bessel modes and Linearly Polarized Laguerre modes.

For GRIN Fibers, a *Gradient Constant* is defined. The refractive index is then calculated by

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

As in the previous case, the number of desired propagating modes needs to be defined.

Calculation of Propagation Constants

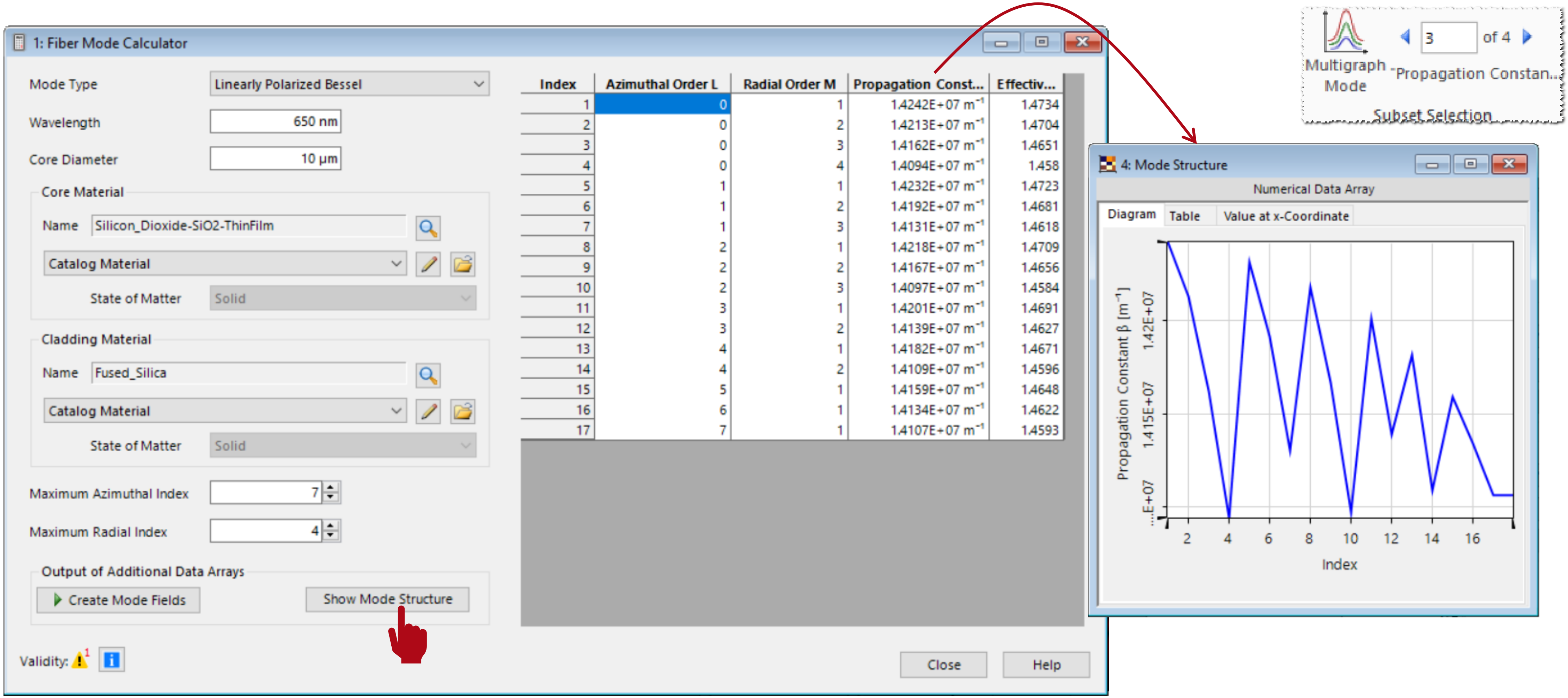


Index	Azimuthal Order L	Radial Order M	Propagation Const...	Effectiv...
1	0	1	1.4242E+07 m⁻¹	1.4734
2	0	2	1.4213E+07 m⁻¹	1.4704
3	0	3	1.4162E+07 m⁻¹	1.4651
4	0	4	1.4094E+07 m⁻¹	1.458
5	1	1	1.4232E+07 m⁻¹	1.4723
6	1	2	1.4192E+07 m⁻¹	1.4681
7	1	3	1.4131E+07 m⁻¹	1.4618
8	2	1	1.4218E+07 m⁻¹	1.4709
9	2	2	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

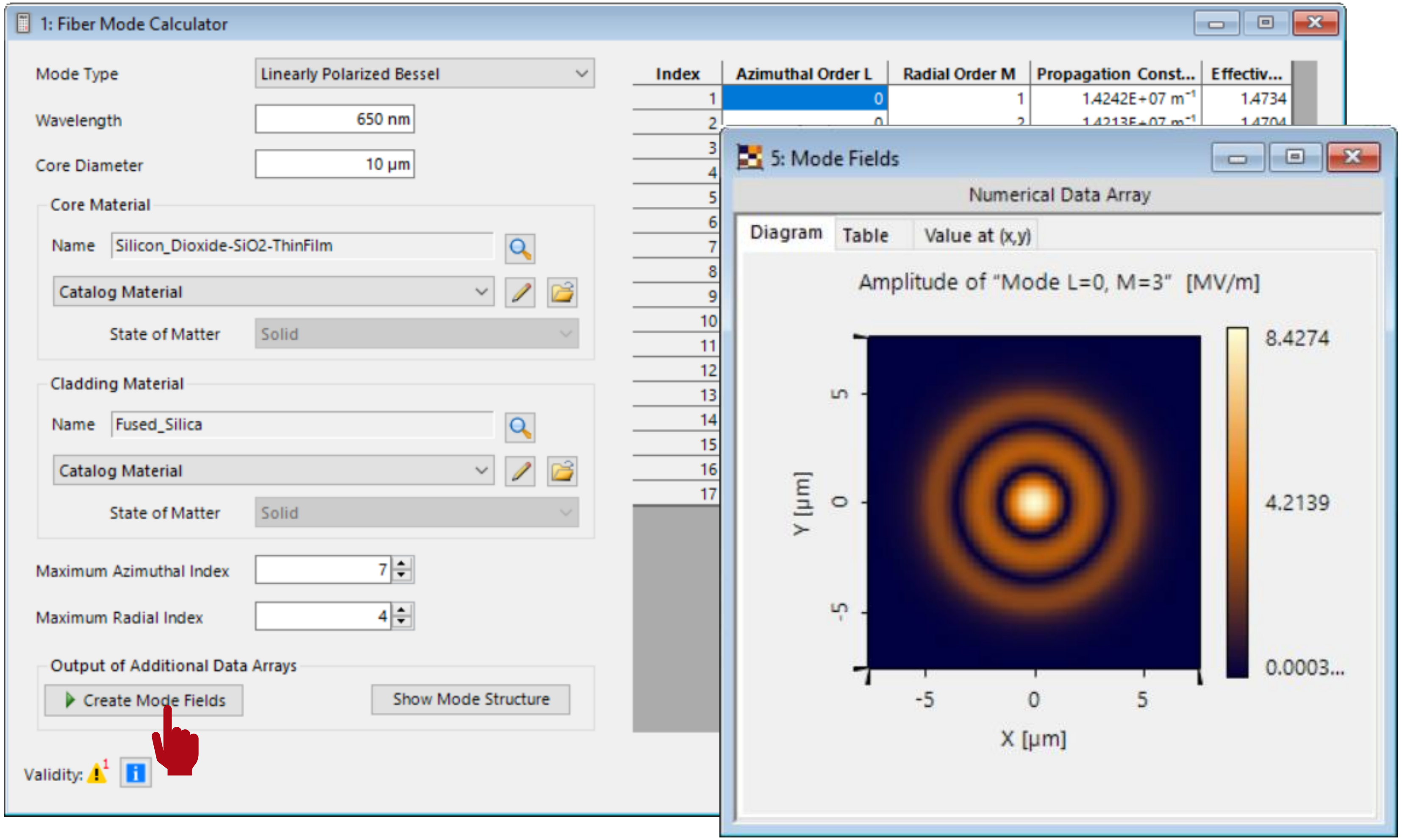
Propagation constant β for each mode is calculated on-the-fly.

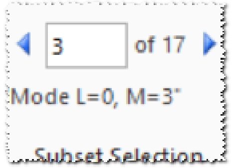
Effective refractive index n_{eff} is $n_{\mathrm{eff}} = \frac{\beta}{k_0}$, with k_0 the vacuum wave number.

Plot Order Indices, Propagation Constants and n_{eff}



Calculation and Display of Propagating Modes





default sampling parameters

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

Document Information

title	Fiber Mode Calculator
document code	FCP.0005
document version	1.1
software edition	VirtualLab Fusion Basic
software version	2021.1 (Build 1.180)
category	Feature Use Case
further reading	