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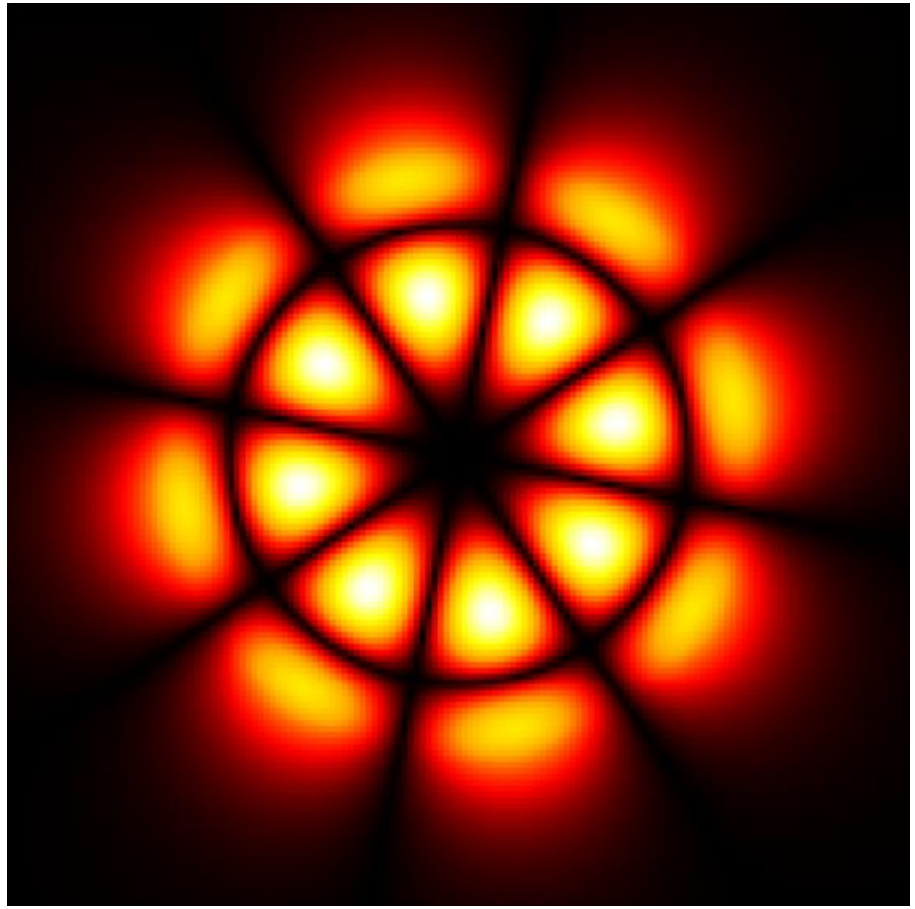
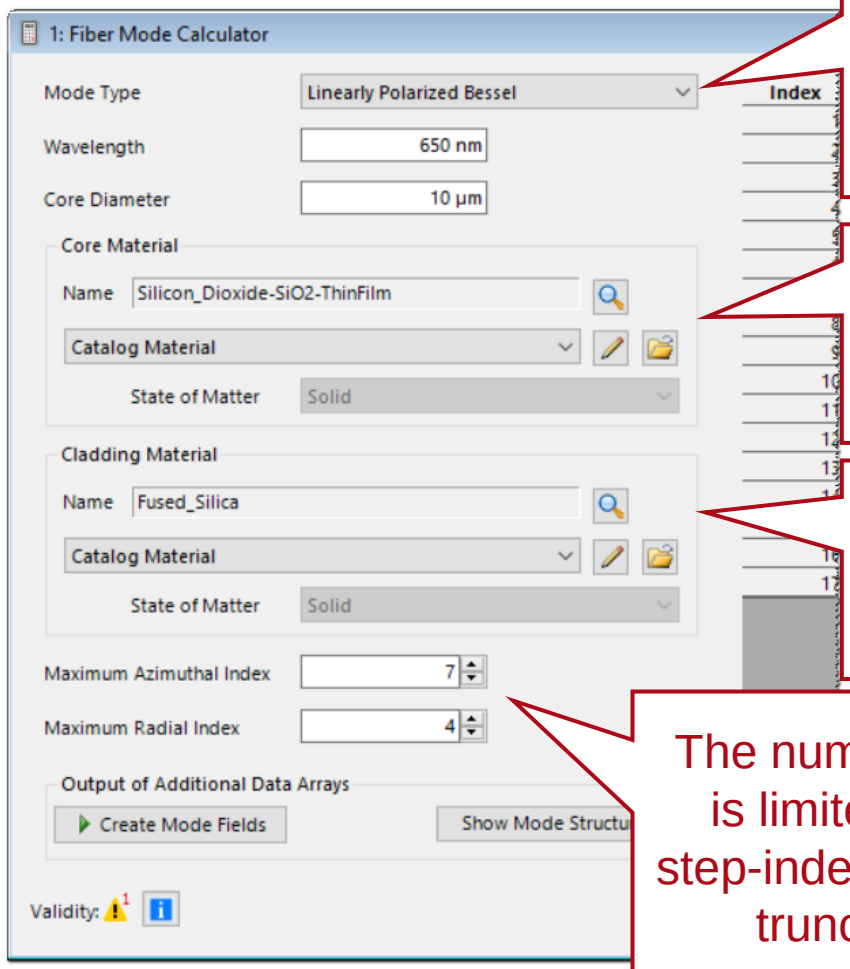
LP Fiber Mode Calculator

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

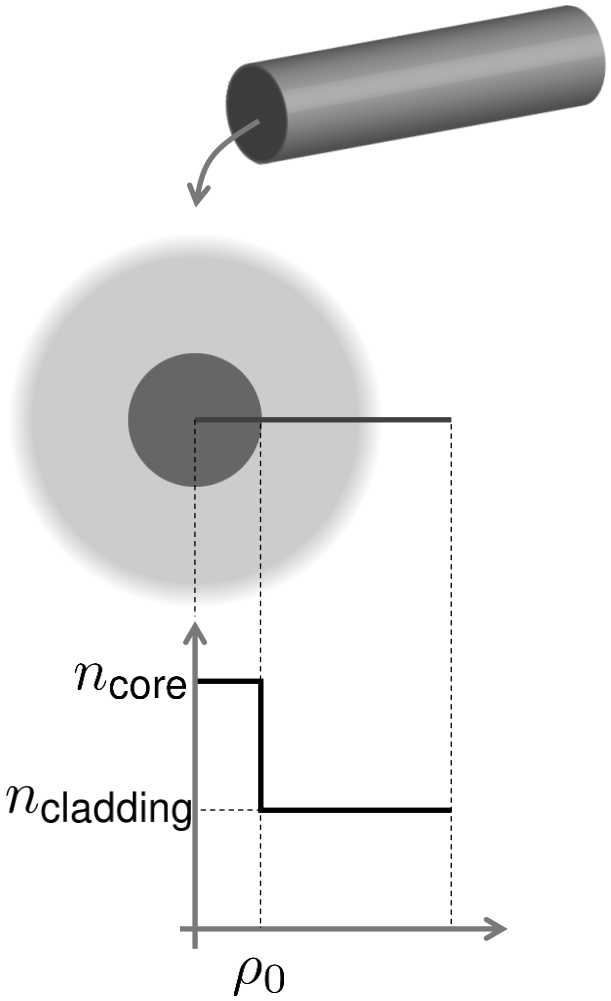


Modes in step-index fiber are mainly based on Bessel polynomials.

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

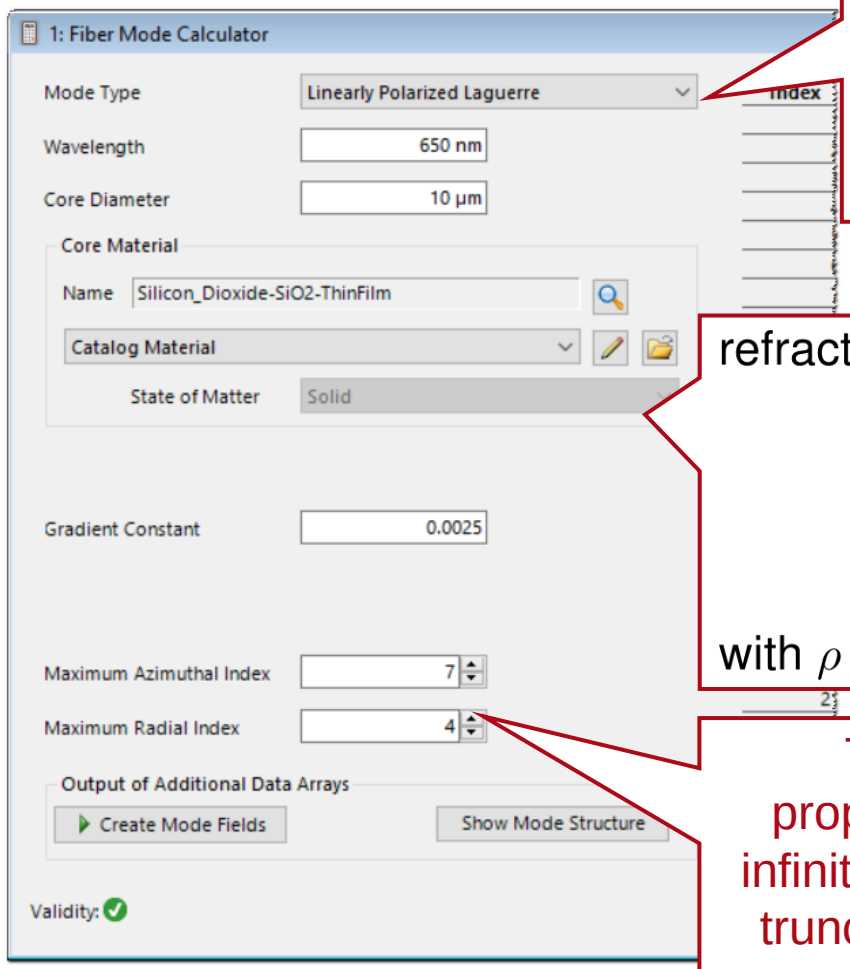
The refractive index n_{cladding} is that of the cladding material.

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



$2\rho_0$ is core diameter.

Setting of the Fiber Structure: Graded-Index Fiber



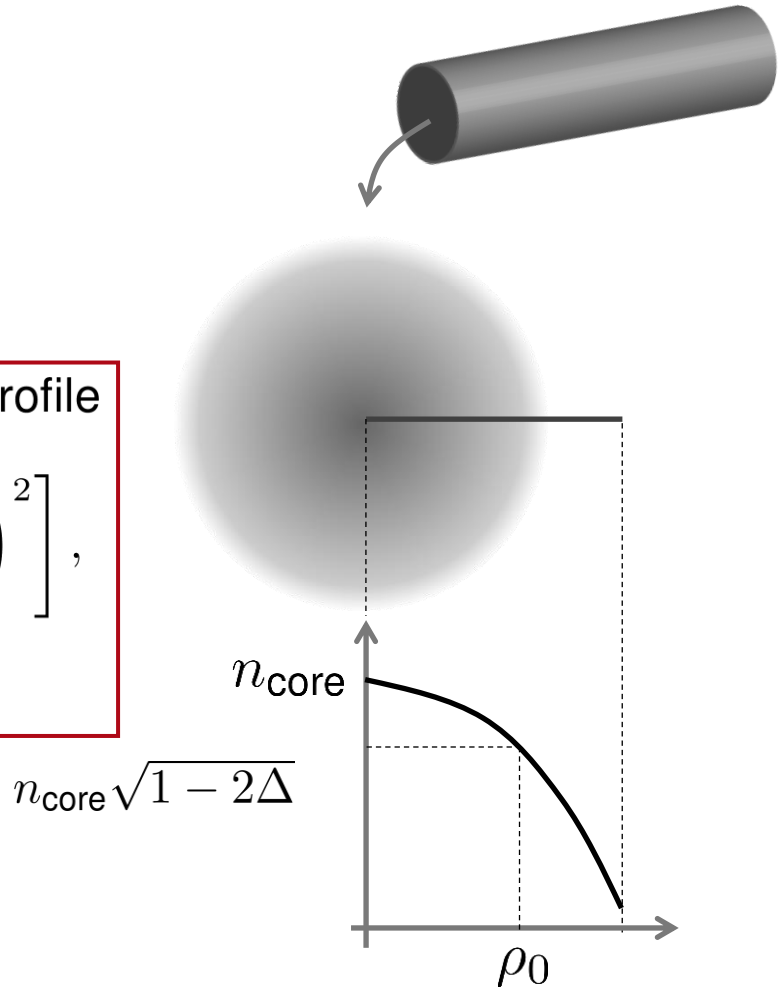
Modes in this type of graded-index fiber are mainly based on Laguerre polynomials.

refractive index of infinite parabolic profile

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

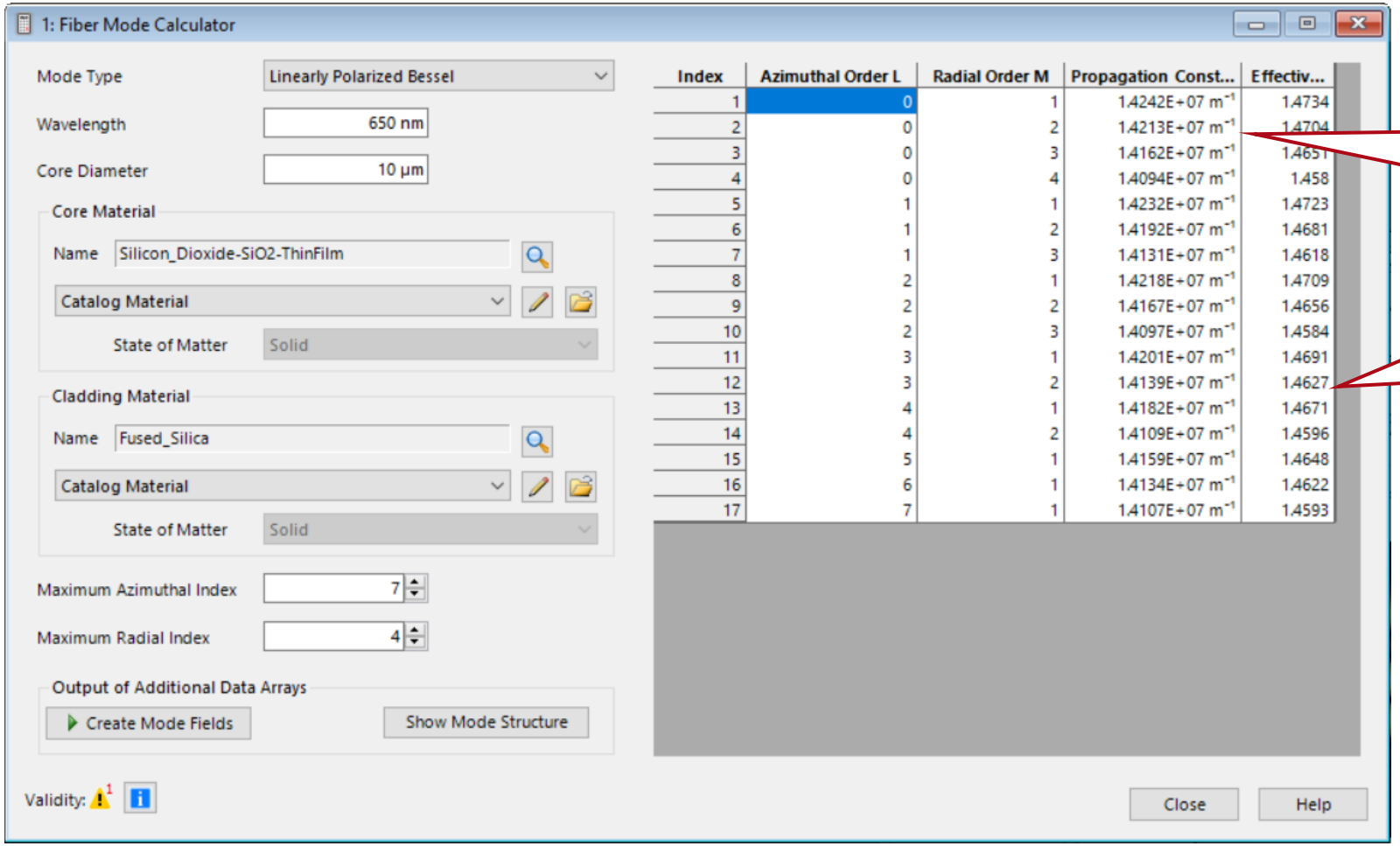
with $\rho = \sqrt{x^2 + y^2}$

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



Δ is the gradient constant.

Calculation of Propagation Constants

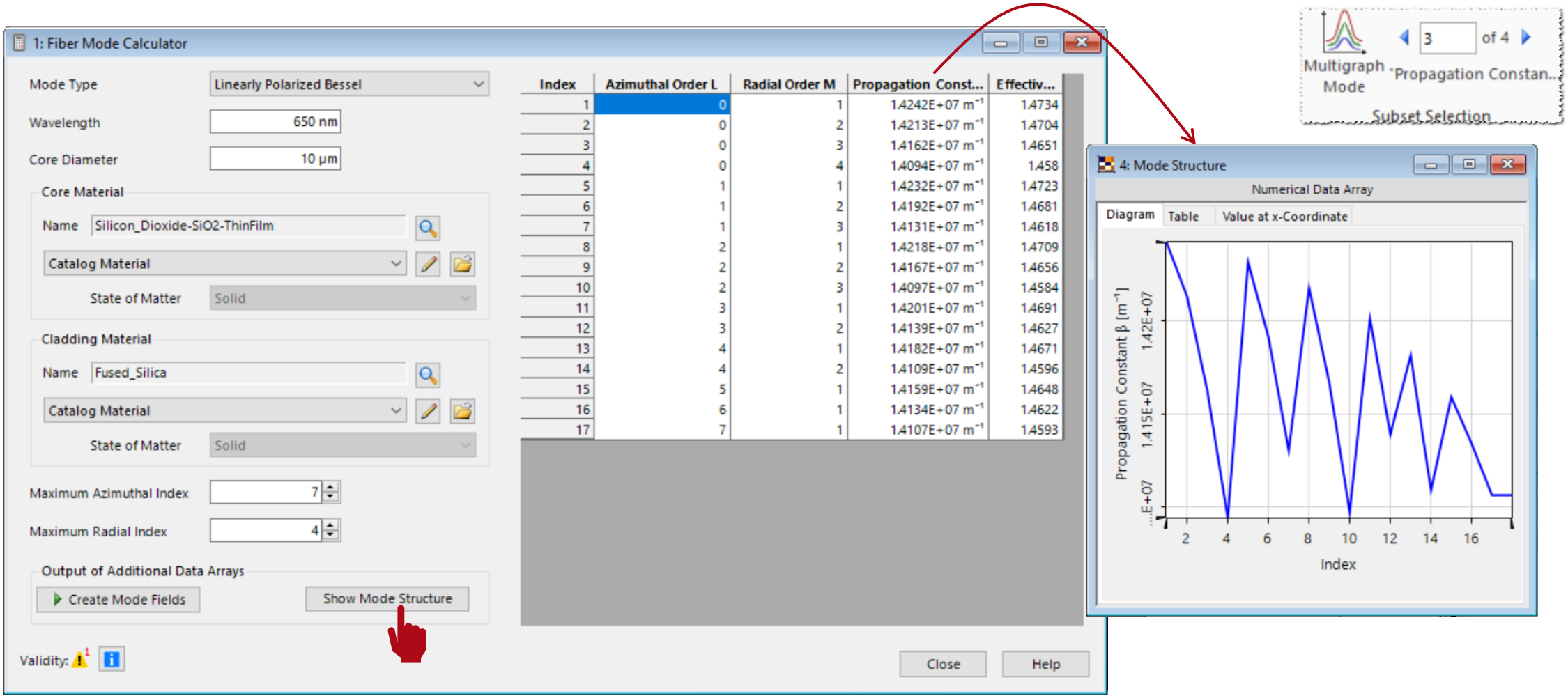


Index	Azimuthal Order L	Radial Order M	Propagation Const...	Effectiv...
1	0	1	1.4242E+07 m^{-1}	1.4734
2	0	2	1.4213E+07 m^{-1}	1.4704
3	0	3	1.4162E+07 m^{-1}	1.4651
4	0	4	1.4094E+07 m^{-1}	1.458
5	1	1	1.4232E+07 m^{-1}	1.4723
6	1	2	1.4192E+07 m^{-1}	1.4681
7	1	3	1.4131E+07 m^{-1}	1.4618
8	2	1	1.4218E+07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

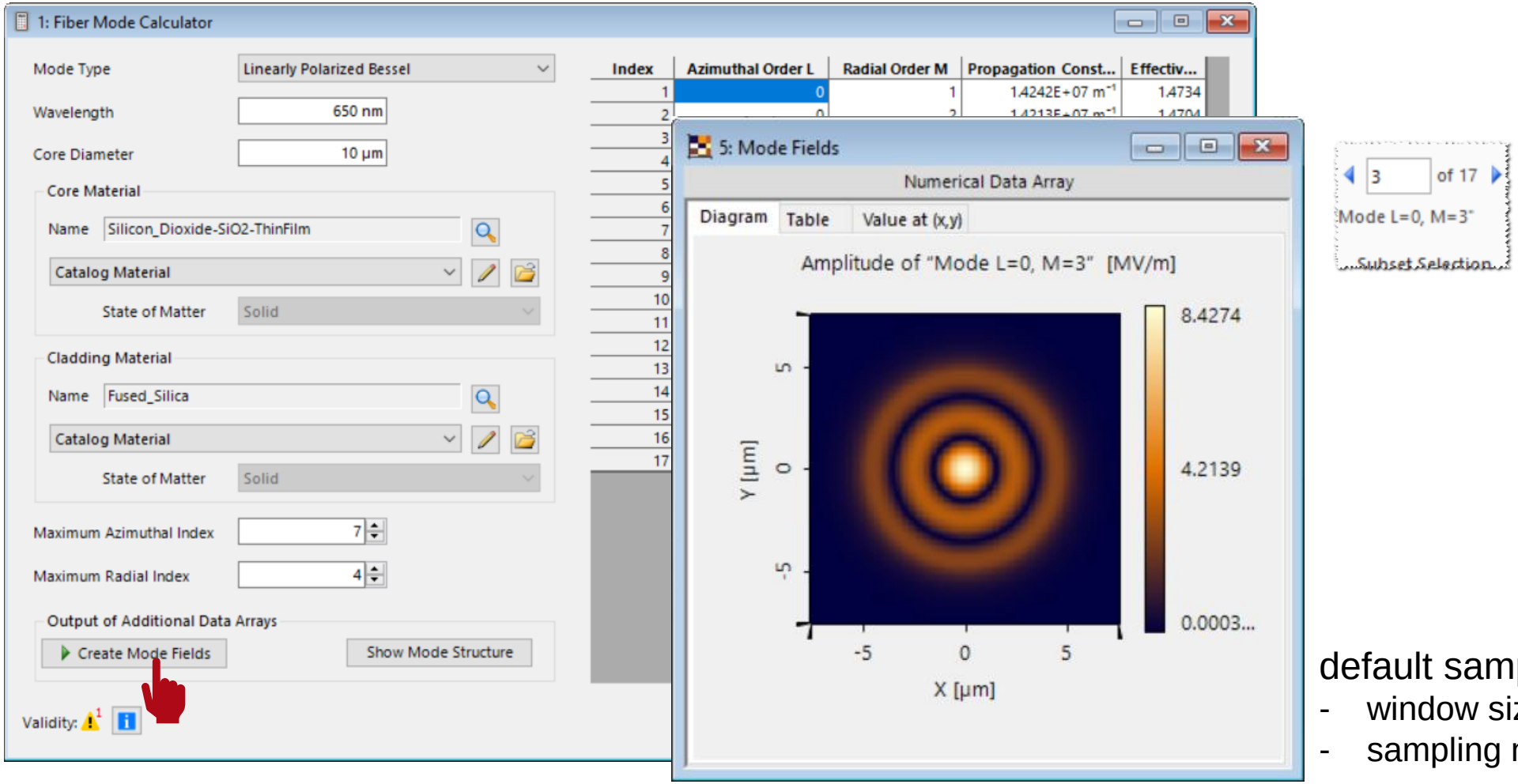
Propagation constant β for each mode is calculated on-the-fly.

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

Display of Propagation Constants



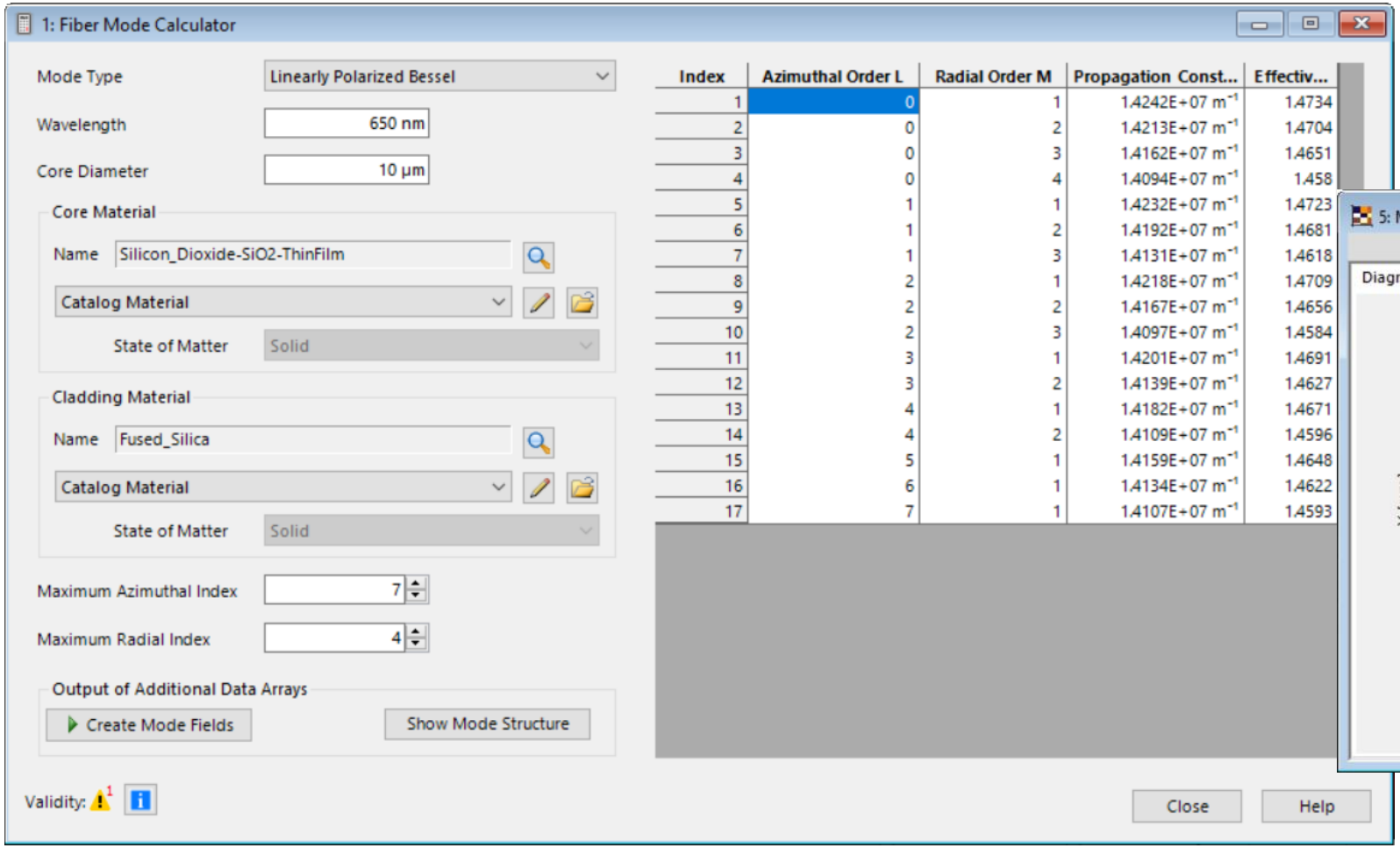
Calculation and Display of Propagation Modes



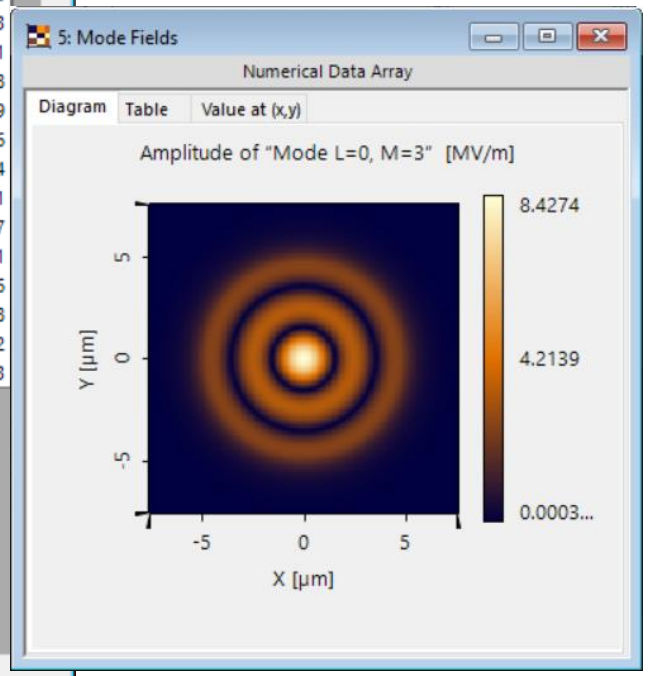
default sampling parameters

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

Peek into VirtualLab Fusion



convenient setting of fiber structure



mode field of a specific fiber

Document Information

title	Fiber Mode Calculator
document code	FCP.0005
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software version	2021.1 (Build 1.176)
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further reading	- Linearly-Polarized (LP) Mode Solver