FIBER OPTIKA TECHNOLOGIES PVT. LTD.

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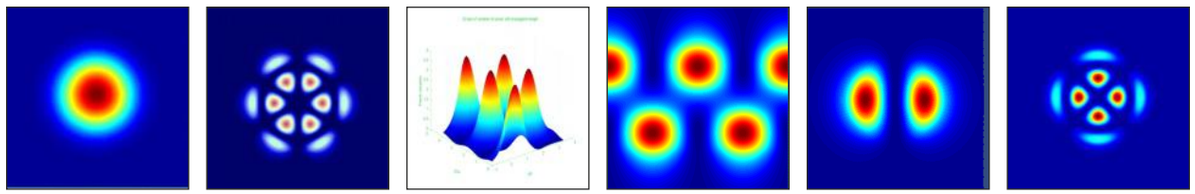
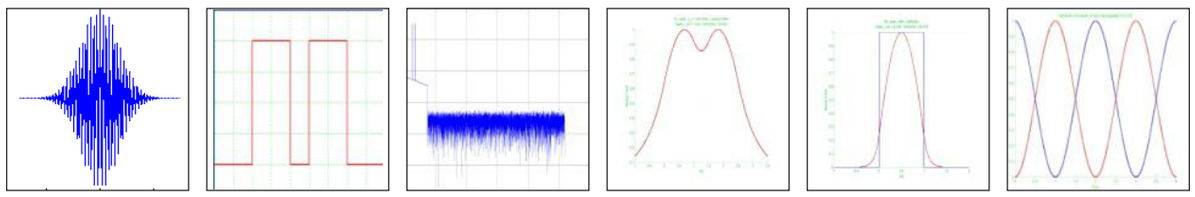


Simulation Software For Optical Fiber & Planar Waveguide



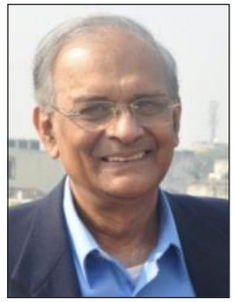
LightSIM is user friendly simulation software, Designed for Teaching/Training students, researchers & telecom engineers to get better understanding in the field of Fiber Optics and Planar Waveguide. It has been designed and Developed in association with IIT Delhi and IIT Roorkee.

LightSIM is high quality educational software, which covers broad range of topics such as Modal analysis in step index and Graded index fiber, Spot Size and Offset losses calculation using various methods, Attenuation, Dispersion measurement for various Refractive index profiles, Modal Analysis in Multi-Layer Symmetric and Asymmetric Planar Waveguides, Design of Directional Coupler using Planar Waveguides, Fiber Optic Link Design etc. It has been designed in such a way the user can actually play with various input parameters which helps user to learn the subject from fundamental to advance levels.

Documentation and Help menu provided will improve Knowledge of user with better understanding of technical terms related to the subject. LightSIM user can Visualize the various complex optical Phenomena through graphs and animation

Development Team:

Prof. Ajoy Ghatak (Retd. Prof. IIT Delhi)



Ajoy Ghatak obtained his MSc from Delhi University and PhD from Cornell University and has recently retired as Professor of Physics from IIT Delhi. He received the 2008 SPIE Educator award in recognition of “his unparalleled global contributions to the field of fiber optics research, and his tireless dedication to optics education worldwide..” and the 2003 OSA Beller award in recognition of his “outstanding contributions to optical science and engineering education”. He is also a recipient of the CSIR SS Bhatnagar award, 16th Khwarizmi International award, the International Commission for Optics Galileo Galilei award, the UGC Meghnad Saha Award for his research work in the area of fiber optics.

Dr. R.K. Varshney (Prof. IIT Delhi)

Dr. R. K. Varshney received the B. Sc. And M. Sc. degree from the Agra University and Ph.D. degree from the Indian Institute of Technology, New Delhi (India) in, 1979, 1981 and 1987, respectively. He worked as Fullbright Fellow during 1985-86 at Department of Electrical Engineering, University of Florida (Florida, USA). During 1990-91 and 1999, he was visiting scientist at University of Strathclyde (Glasgow, UK). He was awarded Marie Curie Fellowship of the Commission of European Community to work at University of Twenty (The Netherlands) from 1994-95. In 1988, he joined Indian Institute of Technology, New Delhi, where he is presently working as Professor.

He is the co-author (with A.K. Ghatak and I.C. Goyal) of book: Fiber Optica (New Delhi,India: Viva Books, 1999). He has published over 110 research papers in refereed journals and conferences. His current research interests are in the fields of Fiber and Integrated Optics, Fiber Optic Sensors, Non-linear Optics. He is a Member of Optical Society of America (OSA) and Fellow of Optical Society of India (OSI).

Dr. Vipul Rastogi (Associate Prof. IIT Roorkee)

Dr. Vipul Rastogi obtained his BSc from Rohilkhand University, Bareilly, India in 1991, MSc from University of Roorkee (now IIT Roorkee), India in 1993, and PhD from the Indian Institute of Technology, Delhi, India in 1998. From 1998 to 1999 he worked as a postdoctoral fellow in LPMC, Université de Nice Sophia-Antipolis, Nice, France and from 2000 to 2003 he worked as a research fellow in the Department of Electronic Engineering, City University of Hong Kong. In November 2003 he joined Physics Department at Indian Institute of Technology Roorkee, where he is currently associate professor.

His current research interests are novel large mode area fibers, leaky optical fibers and rectangular waveguides, fiber optic sensors, and long period waveguide gratings. He has published over 90 research papers in refereed journals and conferences. Dr. Rastogi is a Fellow of Optical Society of India, Senior Member of Optical Society of America and Life Member of Indian Laser Association.

LightSIM features:

- Photonic simulations in single platform
- LightSIM simulations are classified into- Basic and Advanced
- User friendly Graphical user interface, easy to handle
- Large coverage of Photonics concepts
- Real time research oriented experimental troubleshoot possible
- Modes are analyzed by Matrix method (Developed by IIT Delhi team)
- Accurate analysis
- Graphical and theoretical evaluation of photonics concepts
- Product and detailed documentation of each module in PDF format
- Tabulated Data tables for each experiments
- Scope of saving data table, graphs for future use
- Animated visualization of photonics concepts
- Teaching purpose Basic Module has been developed
- Advanced for all Research Simulations

LIGHTSIM SIMULATIONS

Optical Fiber

- Modes in SI Fiber
- Modes in GI Fiber
- Modes in Multilayer Fiber
- Material Dispersion
- Intermodal Dispersion
- Total Dispersion on SMF
- Dispersion in GI Fiber
- Dispersion in Multilayer Fiber
- Total Dispersion in MMF
- Spot size in SI Fiber
- Attenuation
- Offset Losses
- Light Emitting Diode
- Laser Diode
- Si Photodiode
- FBG Simulator
- EDFA

Planar Waveguides

- 3 Layer Symmetric
- 3 Layer Asymmetric
- Multilayer Symmetric
- Multilayer Asymmetric
- GI Planar Waveguide
- Directional Coupler

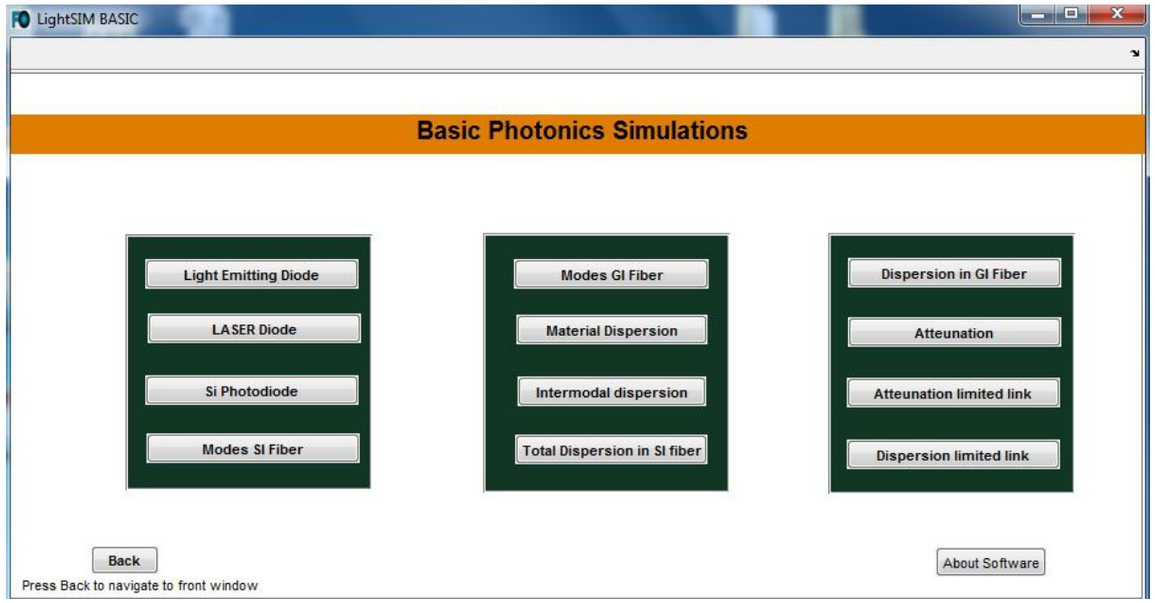
Non Linear Effects

- Self Phase Modulation
- Cross Phase Modulation
- Stimulated Raman Scattering
- Stimulated Brillouin Scattering
- Optical Soliton

Link Design & Testing

- Attenuation Limited Link
- Dispersion Limited Link
- Link Budget
- OTDR

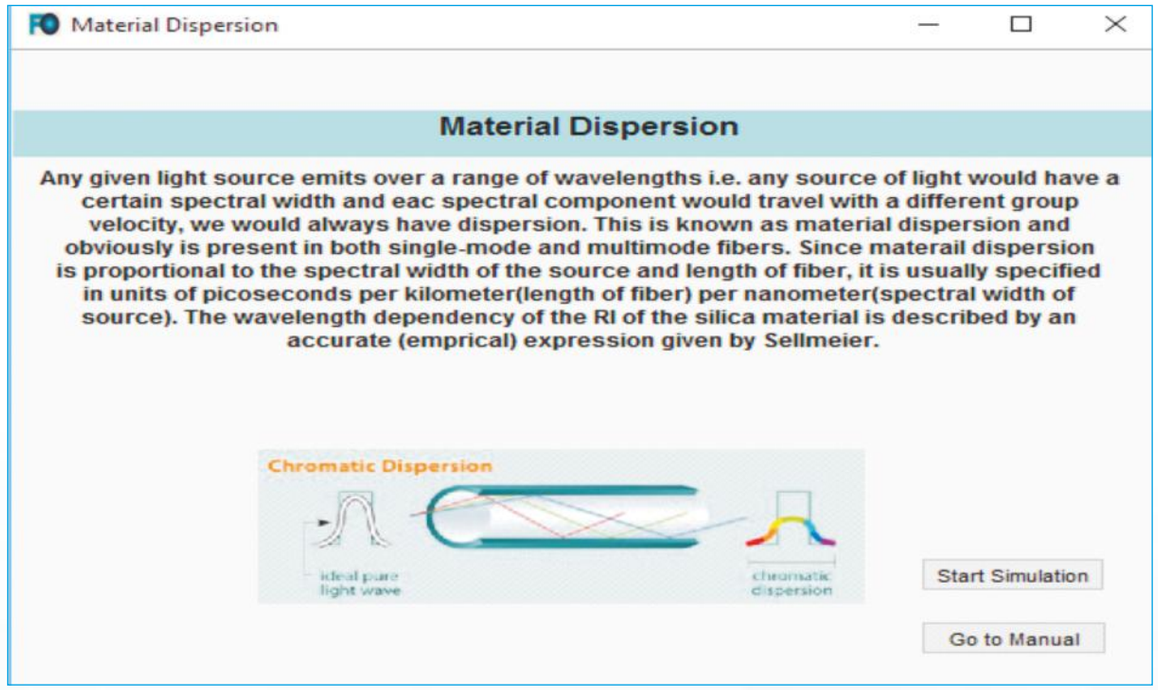
Basic Module



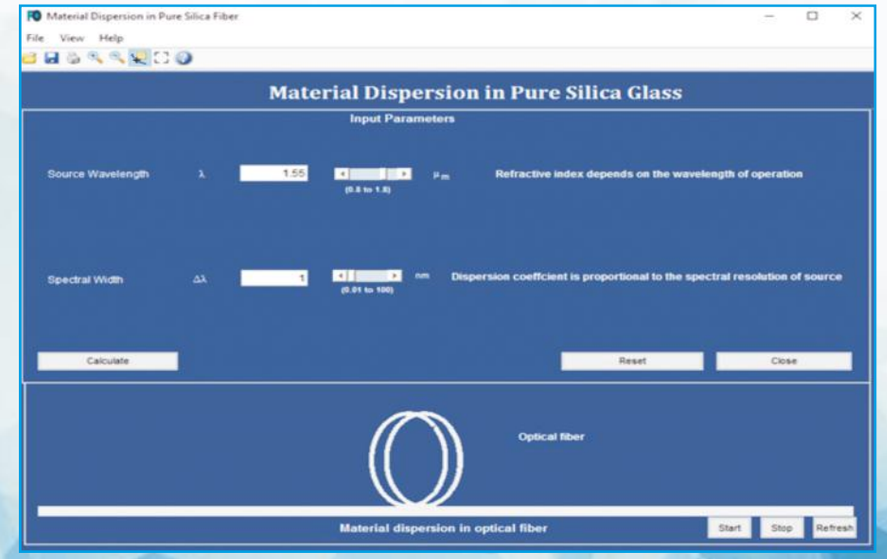
Advanced module:

SIMULATION STEPS

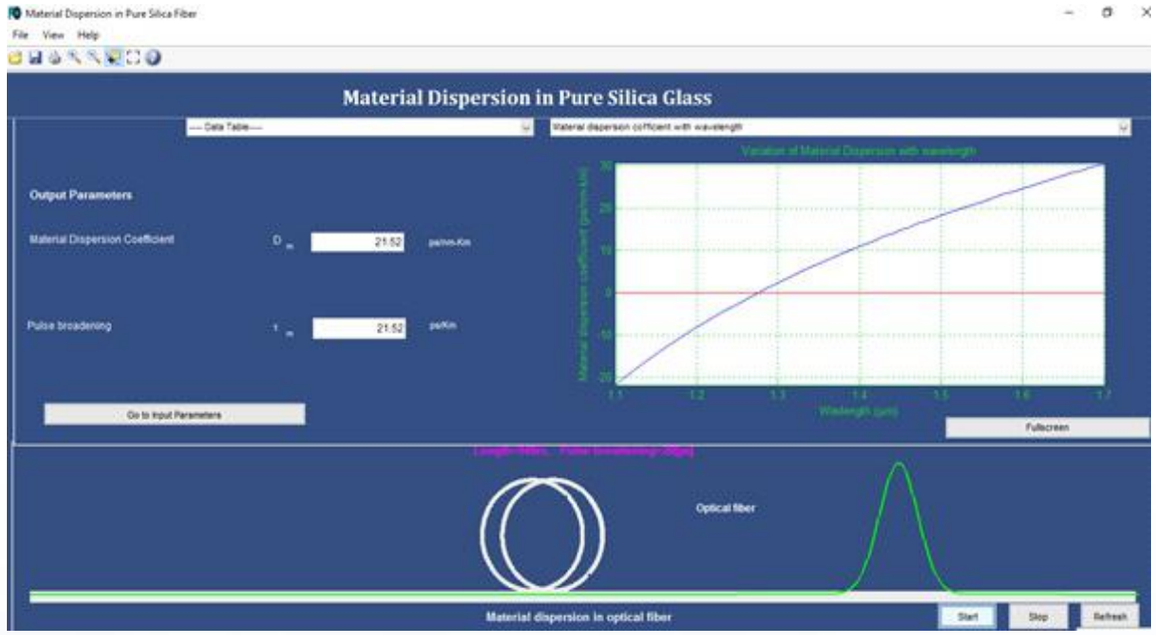
One module is chosen, e.g, material dispersion to describe how each module is oriented.
In the front window, a brief description about the module and 'go to manual' button for theoretical description is available.



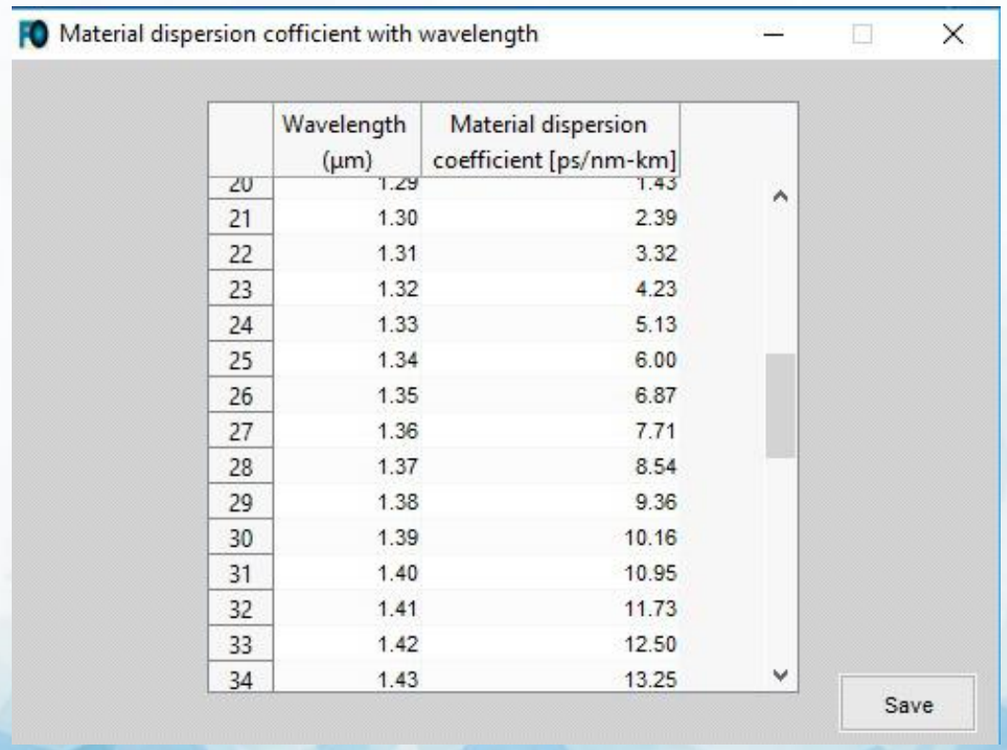
By pressing “start simulation” button, it will be navigated to “input parameters” window. Here some default values are preset and can change the input parameters by the help of sliders. Freedom to play with the input parameters in GUI, are provided without changing anything in the backend, after setting the input parameter user has to press the calculate button to see the results.



Output parameters contain the output results, complete data table and animation:



Data Table

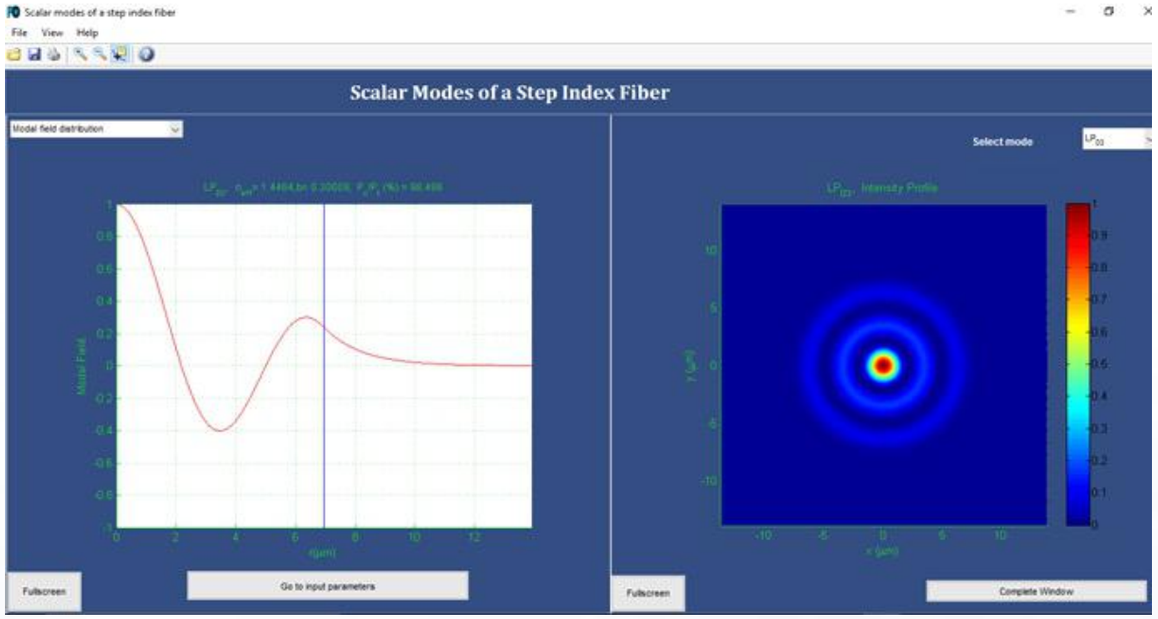


	Wavelength (μm)	Material dispersion coefficient [ps/nm-km]
20	1.29	1.43
21	1.30	2.39
22	1.31	3.32
23	1.32	4.23
24	1.33	5.13
25	1.34	6.00
26	1.35	6.87
27	1.36	7.71
28	1.37	8.54
29	1.38	9.36
30	1.39	10.16
31	1.40	10.95
32	1.41	11.73
33	1.42	12.50
34	1.43	13.25

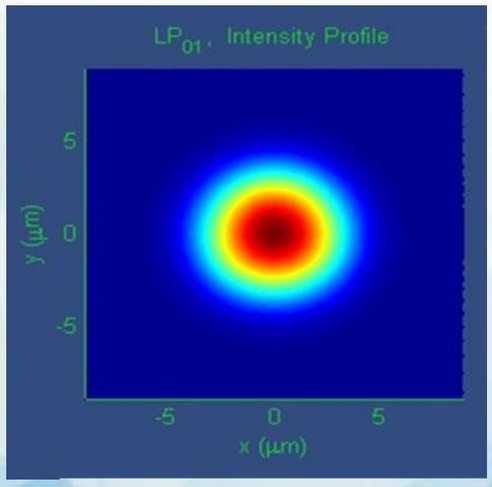
A BRIEF DESCRIPTION OF OPTICAL FIBER MODULE

In this module, from the very basic properties of optical fiber like attenuation, material dispersion, total dispersion in SI and GI fiber to modes in SI and GI fiber, modes in multilayer fiber all are covered. Laser diode and PIN photodiode characteristics are also included and fiber based devices like EDFA and FBG are covered.

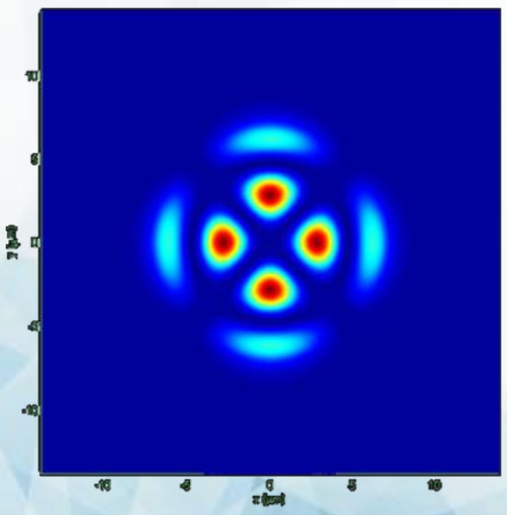
Modes in fiber: A very accurate analysis of modes in fiber can be done and all the supported modes and their field distribution can be visualized. Some images of module in step index fiber is shown below:



Graphs contain some important parameters value like effective index, b number etc which can be saved and used in future.

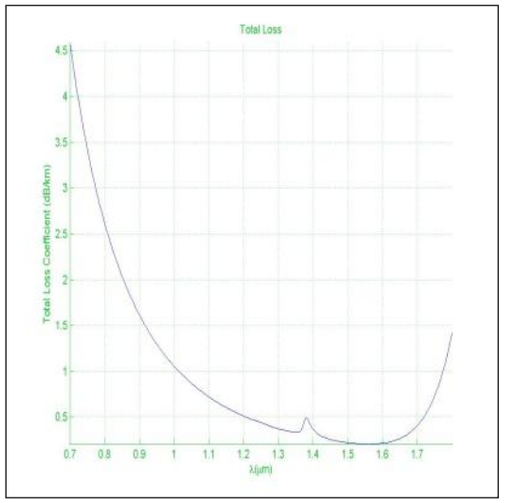


LP01 Intensity Profile

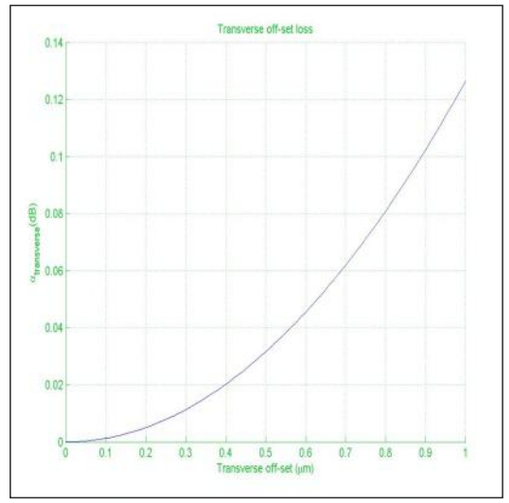


LP22 Intensity Profile

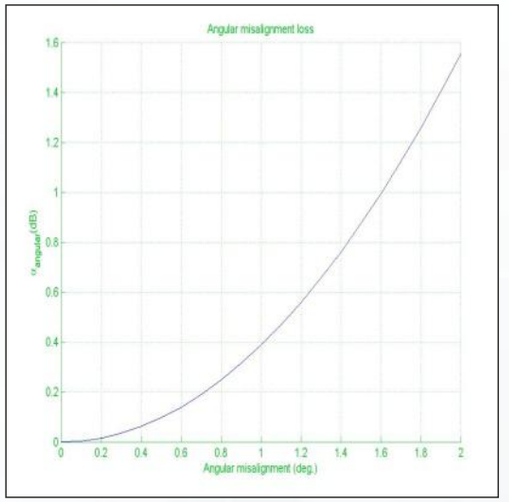
Some results from other simulations in optical fiber module are shown below



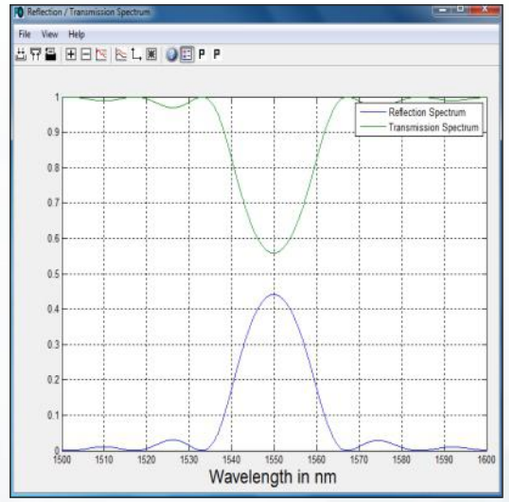
Total Attenuation



Transverse Misalignments Loss



Angular Misalignment Loss



FBG spectrum:

LightSIM help in better Understanding of several concepts in Optical Fiber Module

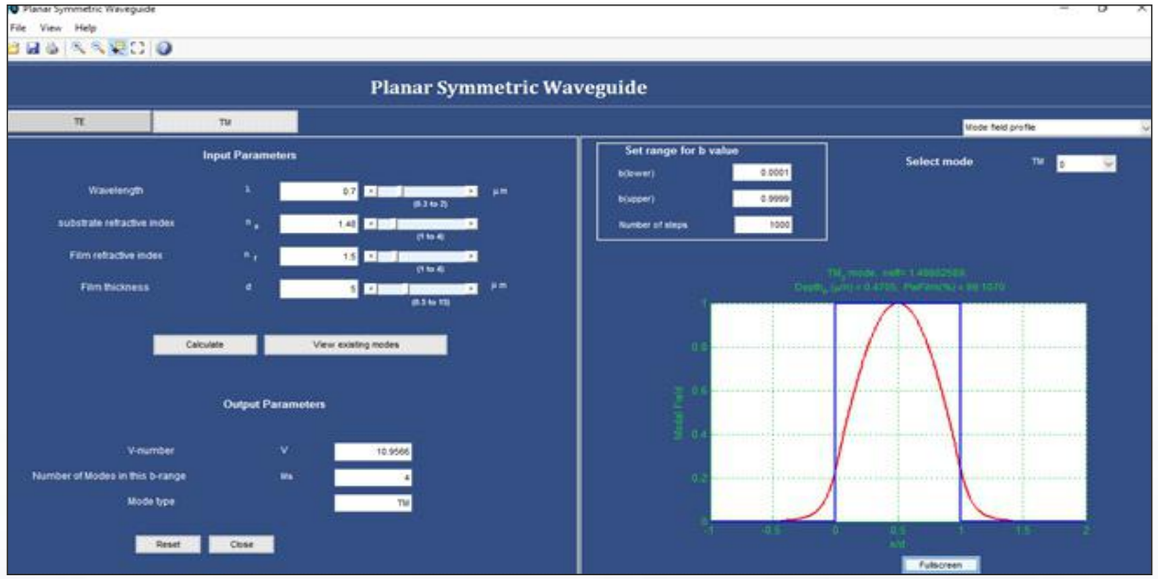
- How an optical fiber works and what are the important parameters of a fiber?
- What is fiber mode, how it looks?
- How to find out total number of modes by seeing the graphs and how to control number of modes in an optical fiber to make it single mode fiber ?
- What is dispersion, how it behaves and how it affects fiber performance?
- What is attenuation, different types of attenuation and how it limits fiber performance?
- How to design a graded index (GI) fiber, what are the important parameters of a GI fiber?
- Modes in a GI fiber?

A BRIEF DESCRIPTION OF PLANAR WAVEGUIDE MODULE

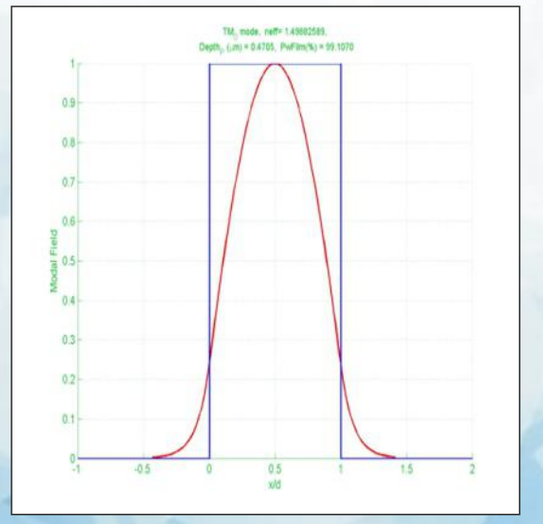
In planar waveguides module, simulation starting from 3 layer symmetric and 3 layer asymmetric to multilayer symmetric and multilayer asymmetric structures are provided. One can theoretically design multilayer waveguide to get the desired output results. Matrix Method (developed by IIT Delhi) is used to find the Modes in Optical Waveguide, TE and TM modes and corresponding field distributions can be seen and saved with important parameters for future use.

Effective index up to 8 decimal accuracy can be obtained.

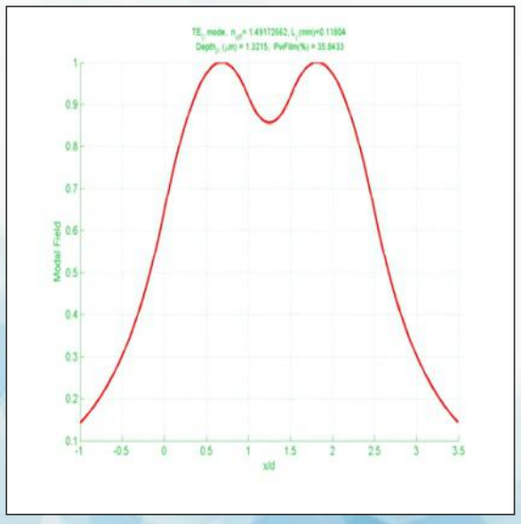
Screenshot of Planar Symmetric Wave guide



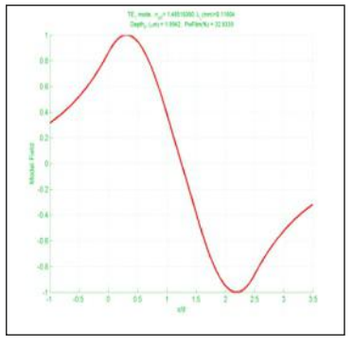
Another experiment with directional coupler is provided in Planar waveguides module in which Normal Mode analysis is used to find the propagation characteristics of modes:



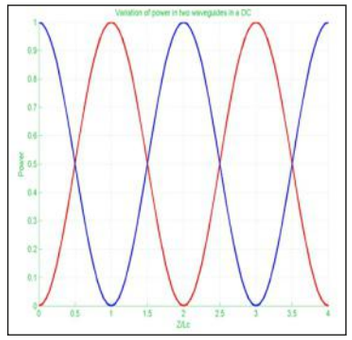
TM_0 **Mode in symmetric wave guide**



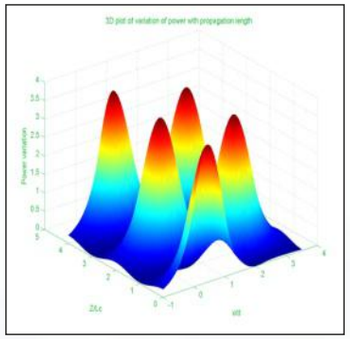
TE_0 **Mode in directional coupler**



TE_1 **Mode in Identical Directional Coupler**

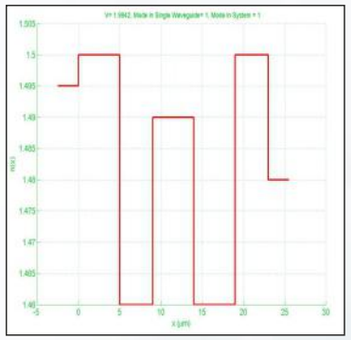


Power Transfer in Identical Directional Coupler

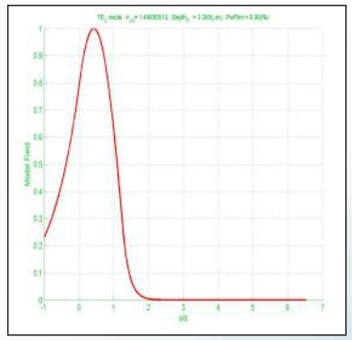


Power Transfer in Identical Directional Coupler 3D View

Moreover, Analysis of multilayer symmetric and asymmetric waveguides can be done accurately:



Refractive Index Distribution In Multilayer Waveguides



TE_0 **Mode in Asymmetric Waveguide**

LightSIM help in better Understanding of several concepts in Planar Waveguide Module like

- How a planar symmetric and asymmetric waveguide works, what are the parameters important for a planar waveguide?
- Symmetric and asymmetric TE/TM modes of a planar waveguide
- How to control number of modes by optimizing various input parameters in a planar waveguide?
- How to design GI planar waveguide with different refractive index profiles?
- Various modes of a GI planar waveguide.
- Design of a directional coupler using planar waveguide.

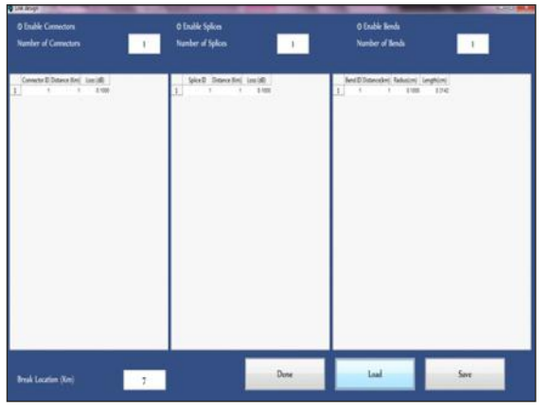
A BRIEF DESCRIPTION OF LINK DESIGNING & TESTING MODULE

In this module simulation related to power budgeting, rise time budgeting and total link budgeting are carried out in link designing part and for testing the link, OTDR simulation is designed.

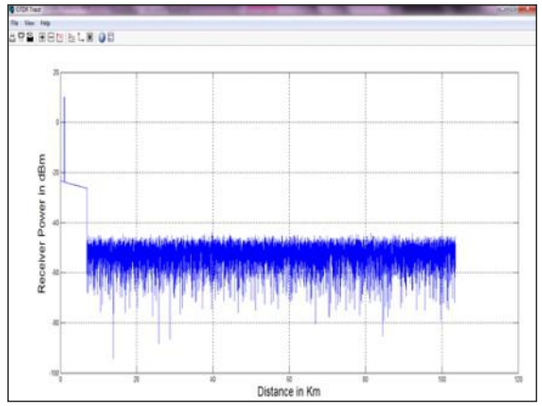
In the OTDR module one can design their link with N number of connectors, splices and bends and see the OTDR trace, diagrams are depicted below:

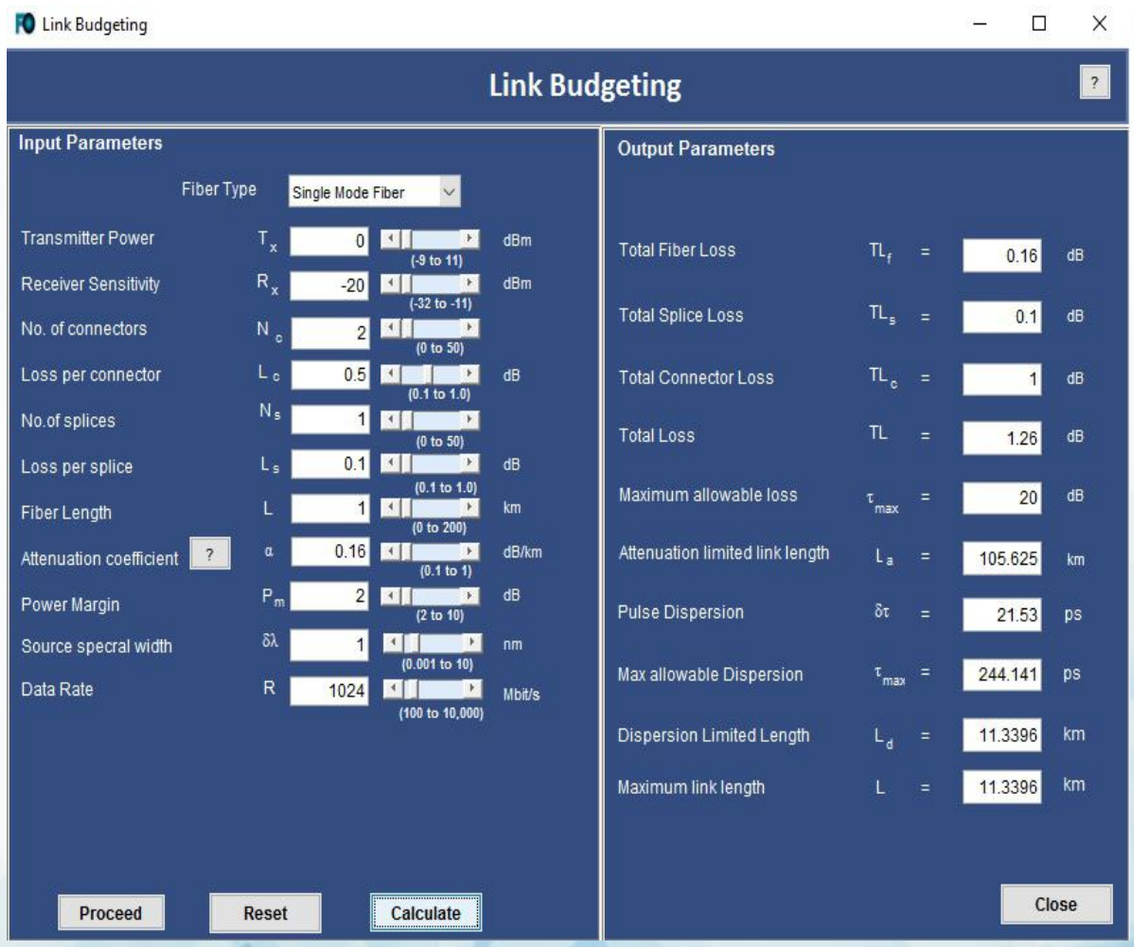
OTDR Simulation Window

Customized Link Design With Splices, Connectors, Bending



OTDR TRACE



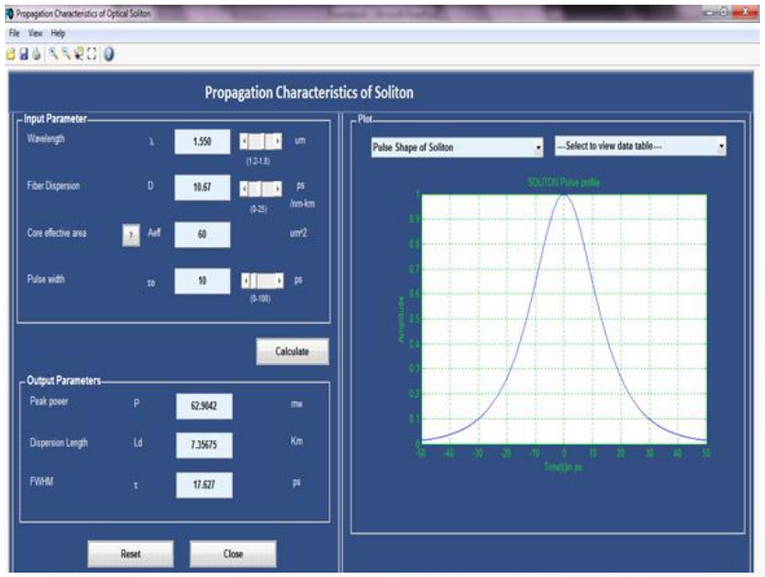


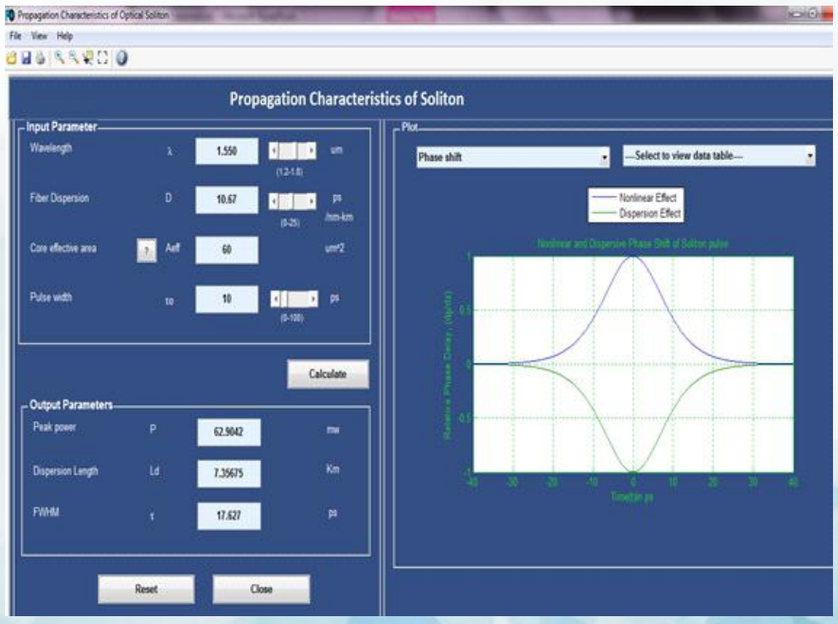
Total Link Budgeting Module Simulation Window

A BRIEF DESCRIPTION OF NON-LINEAR EFFECTS MODULE

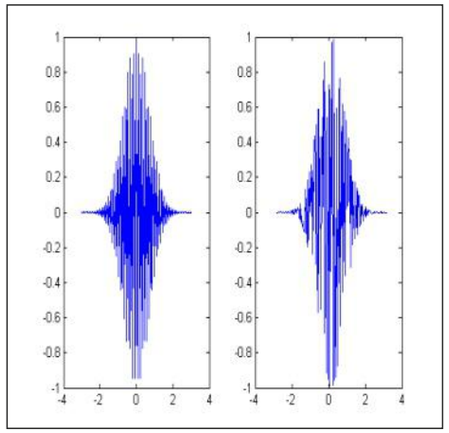
Four types of non-linear effects e.g. self phase modulation, cross phase modulation, stimulated Raman scattering and stimulated Brillouin scattering are covered in this module. Solitonic propagation characteristics, in which self phase modulation compensates the dispersion effect to achieve high speed long distance propagation of pulse without broadening , is also covered. Phase shift, frequency shift, pulse propagation in the presence of non-linearity can be visualized.

Soliton module screenshots

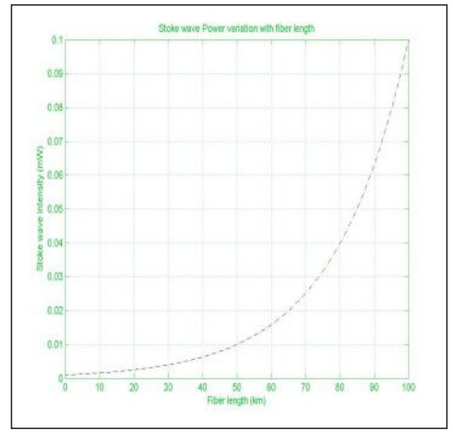




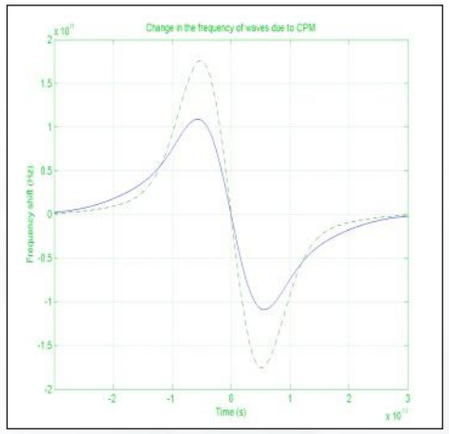
Some diagrams from other nonlinear effects are shown below:



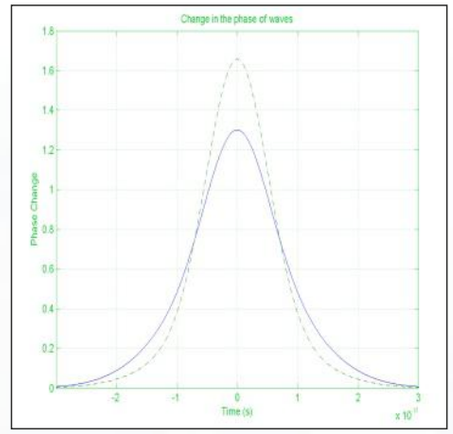
Pulse Evolution Due to SPM



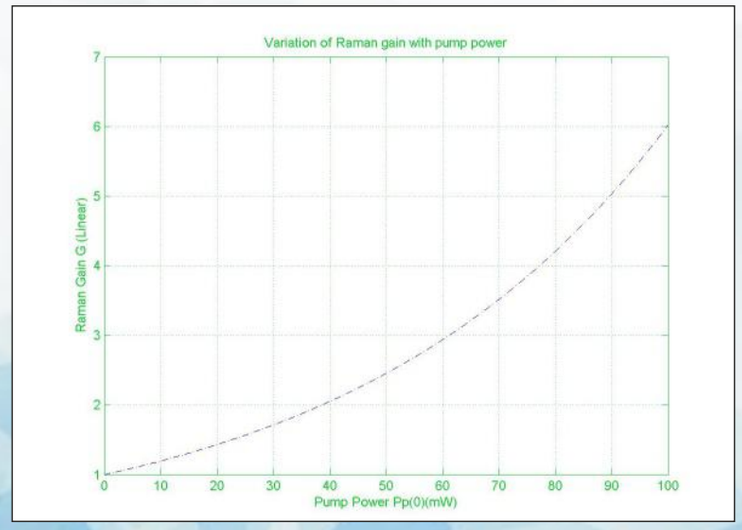
Stokes Wave Power Variation With Fiber Length



Change In Frequency Due To CPM



Change In Phase Due To CPM



Variation of Raman Gain With Pump Power