Active Device Tool
Part IV: DFB's

If you have technical questions, please contact evanh@synopsys.com

Outline

- Introductory Statements
- Gratings
- DFB Modes
- Comparing transmission and gain spectra
- Multimode Simulation
- Optical Spectrum
- Adding a central phase shift
- DBR Modes
- Multimode Simulation
- Optical Spectrum

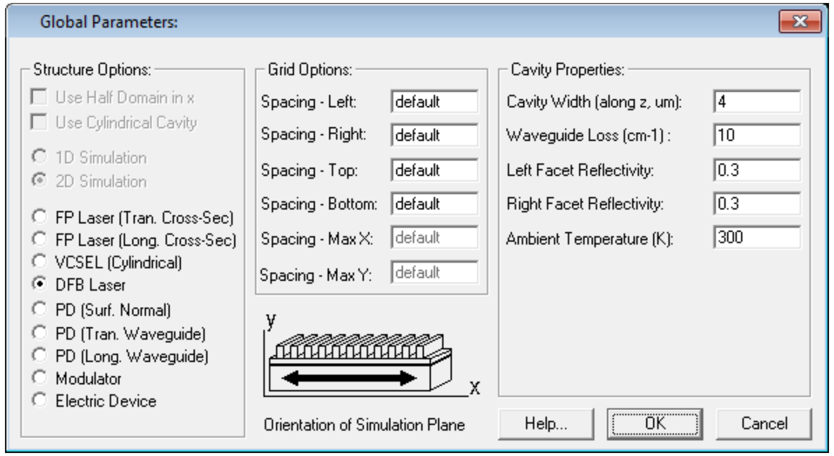
DFB

- Open \RSoft\examples\LaserMOD\dfb_uniform\dfb_uniform.las
- This is a GaInAsP DFB with a single QW.
- Open the Global Parameters Dialog.
- Observe that several controls are disabled for the DFB device type.
- DFB's are always 2D and the full domain is simulated.
- Also, the cavity width is specified here, rather than the length, which is determined

  by the geometry. This is

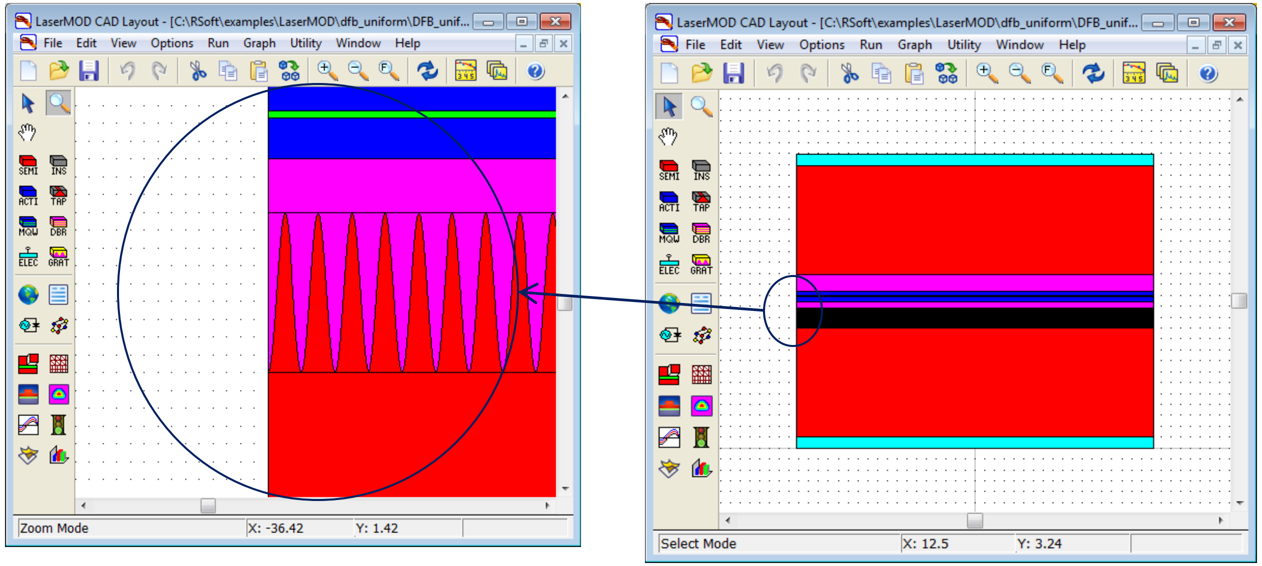
  because the lasing is assumed

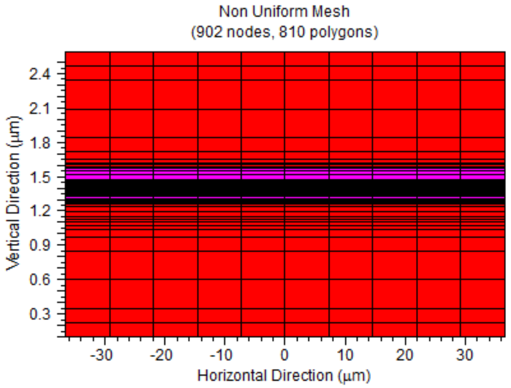
  to be along the x direction.



DFB

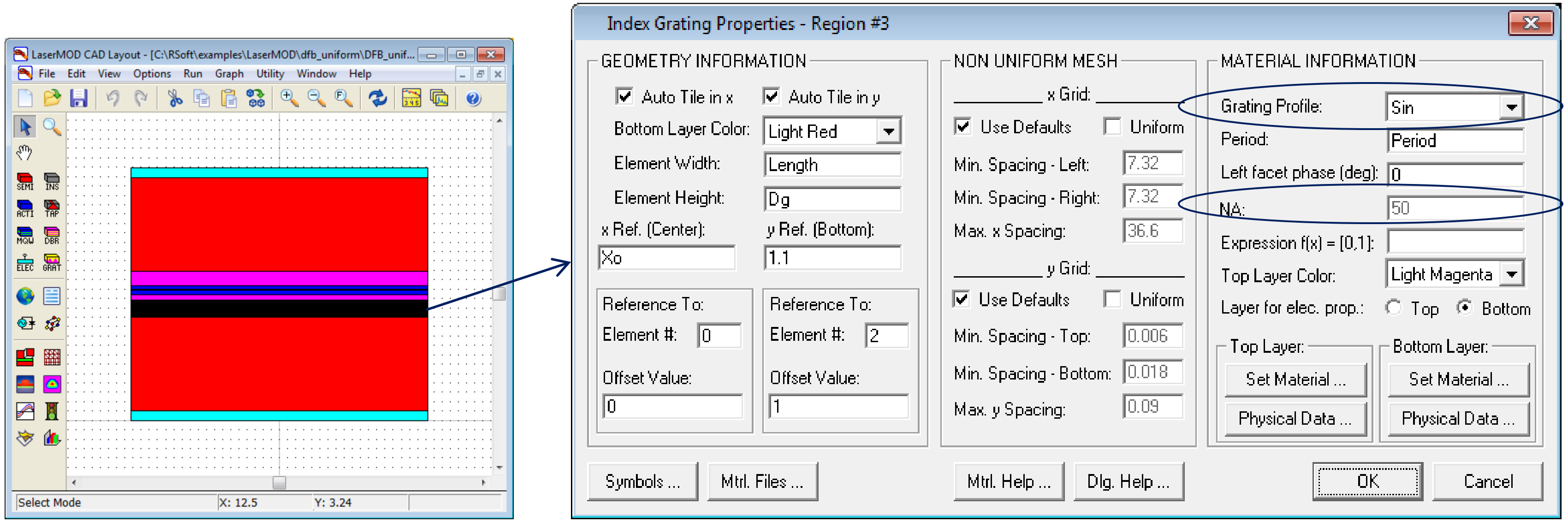
- Zoom in on the grating region to see the individual periods.
- The period and phase of the grating at the left facet are specified in the Grating Region Properties.
- The number of periods = (region width) / (period).
- The phase of the grating at the right facet is determined by the left facet phase and the number of periods.





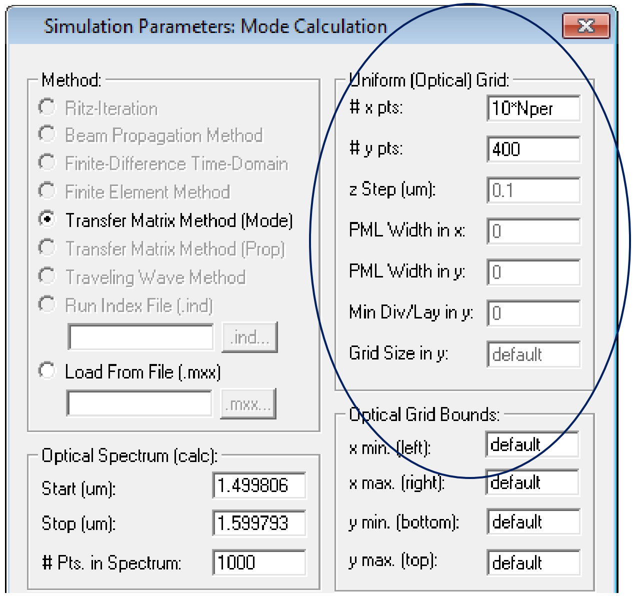
Grating Region

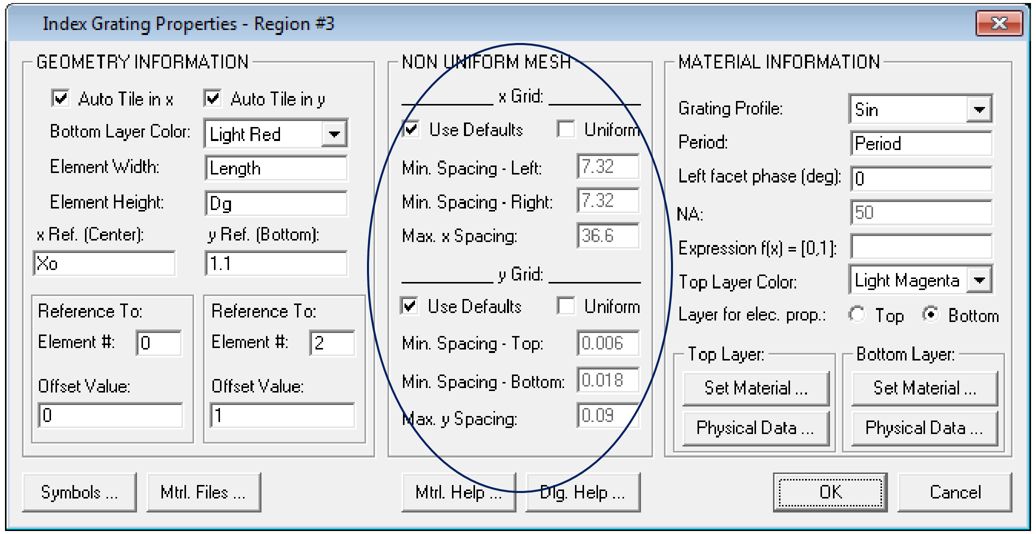
- Right Click on the grating region to see its properties.
- A variety of grating profiles are available, including; sinusoidal, square, and custom.
- There is a control field, usually for duty cycle, associated with certain profiles. For the others, it will show as “NA”.
- A custom expression field will be enabled for the custom profile.



Grating Region

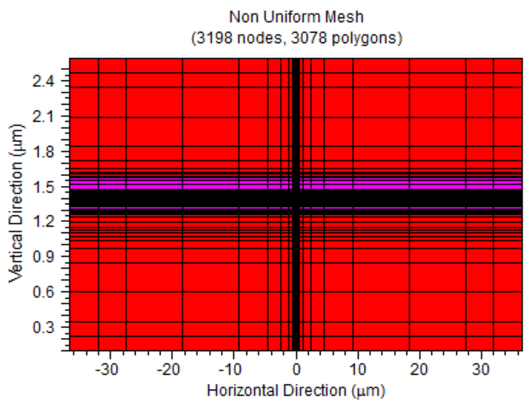
- As with the Index DBR region used for VCSELs, the grating region only profiles the refractive index, while treating all other material properties as constant.
- A uniform optical mesh, set in the Mode Calculation Dialog, is used to resolve the index profile and the modes, while the non-uniform mesh, set in the Region Properties, is used for the electro-thermal calculation.

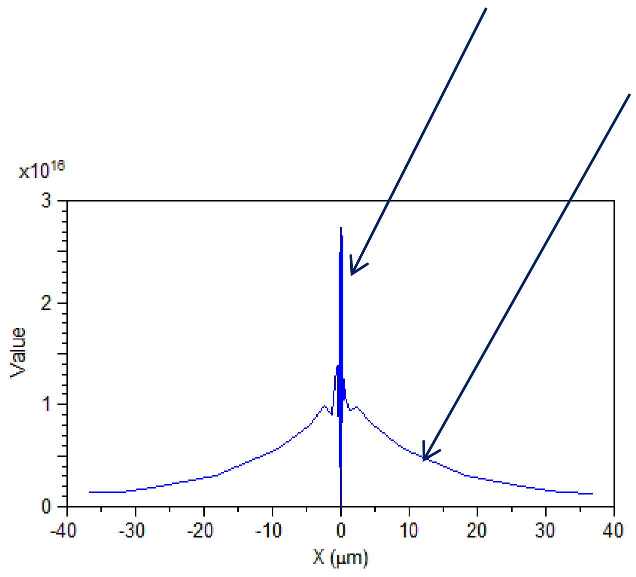




Grating Region

- Unlike the DBR region, there is no “full grating” which uses the same optical and electronic mesh. This is because the mesh needed to resolve all the periods in a typical device would lead to an intractable simulation.
- Modal intensities are interpolated from the optical mesh onto the electronic mesh. So, the mode profile will be resolved on the electronic mesh where it is fine, and its envelope will be resolved where the mesh is coarse.





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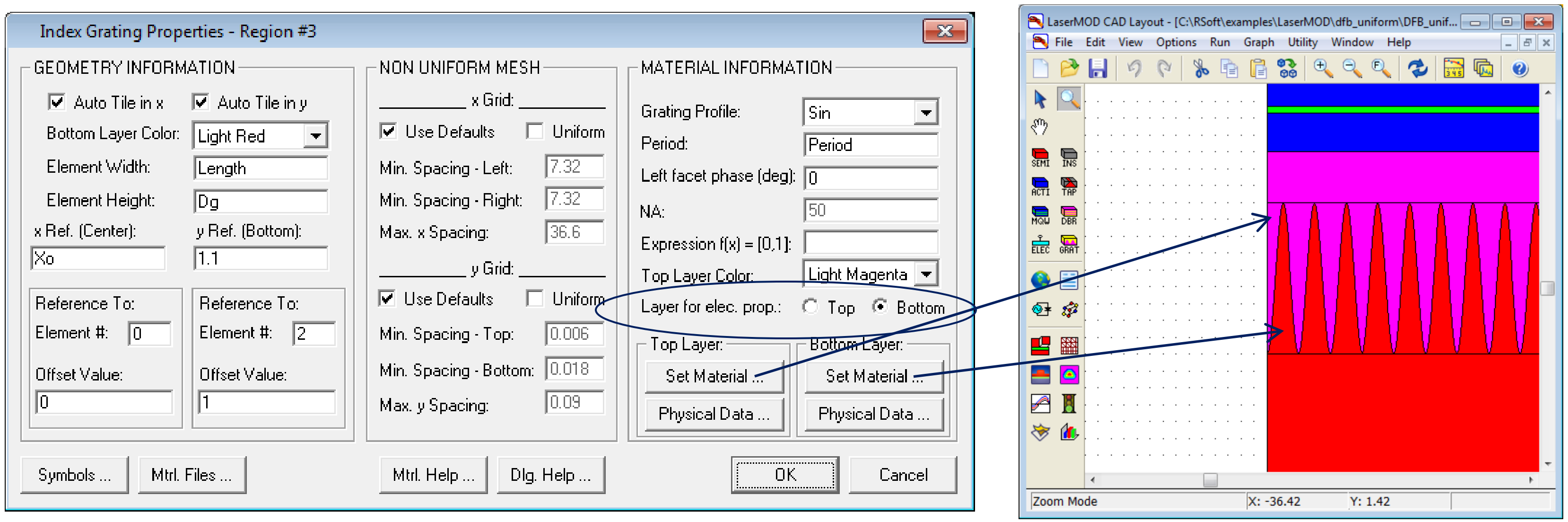
Grating Region

- Lastly, the grating region, like the QW and DBR regions, is a two material region, with separate materials for top and bottom layers.
- The grating profile defines the interface between these two materials.
- Either layer may be used to define the electro -thermal properties. Here, the bottom layer is selected.



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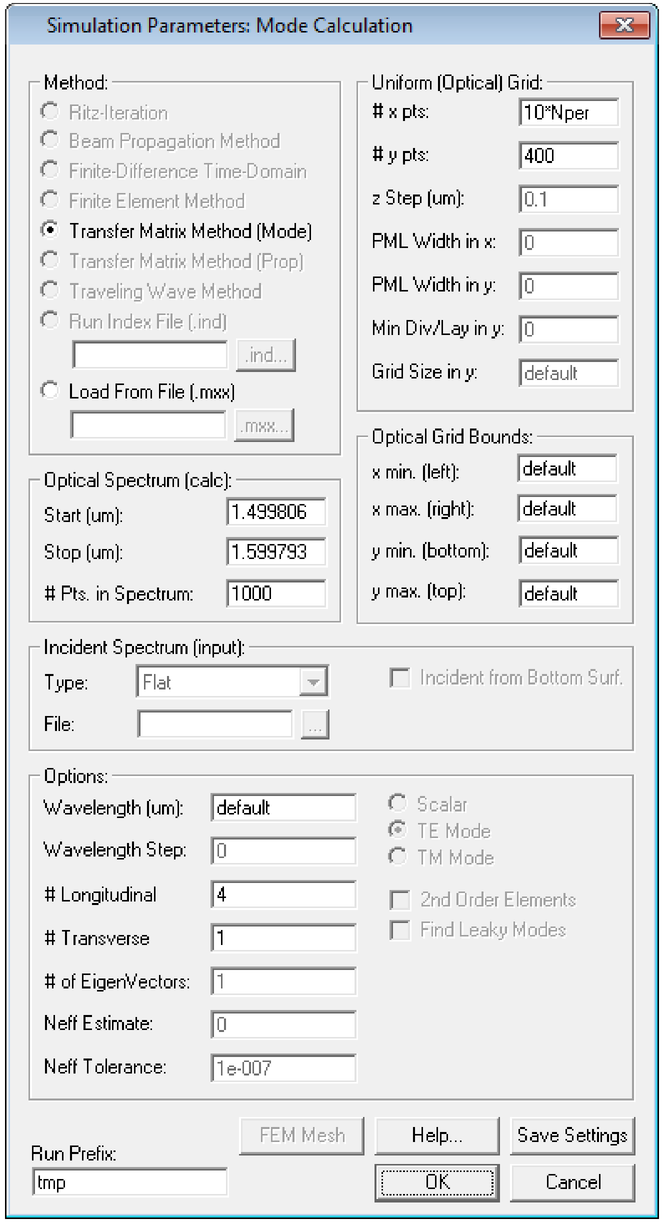
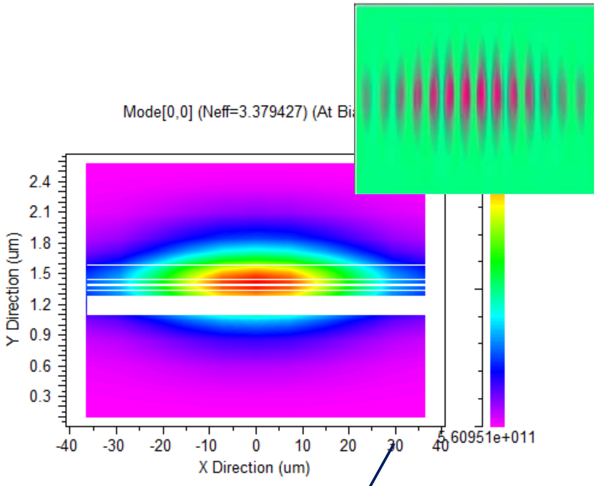
DFB Modes

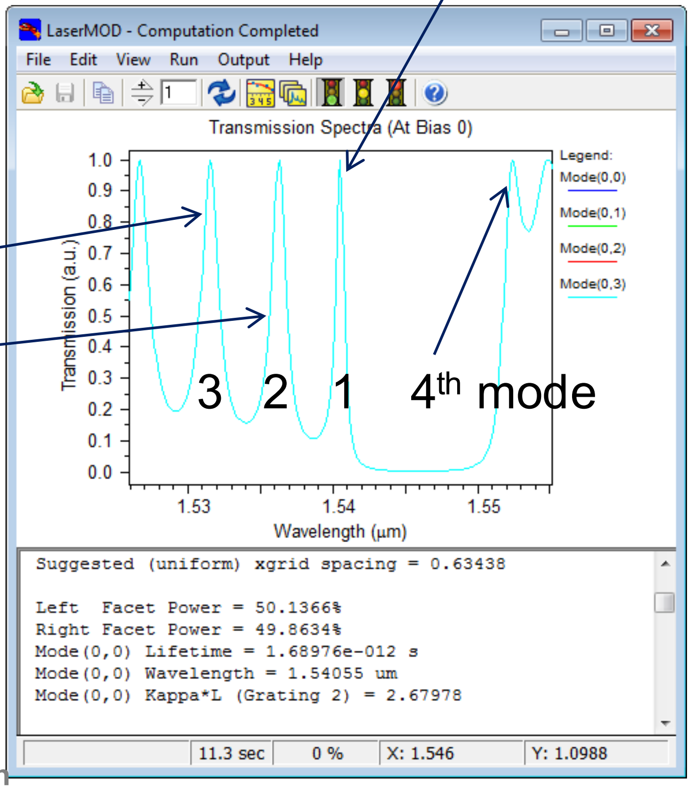
- In the Mode Calculation Dialog, only a Transfer Matrix Method is allowed.
- Here, '# x-pts' is parameterized by the number of periods.
- The spectral range is set from 1.5 to 1.6um, with 1000 points.
- 4 longitudinal modes are selected. meaning that the 4 lowest loss modes will be tracked by the simulation.
- Only 1 transverse mode is used since typically, waveguides along the y direction are single-mode.

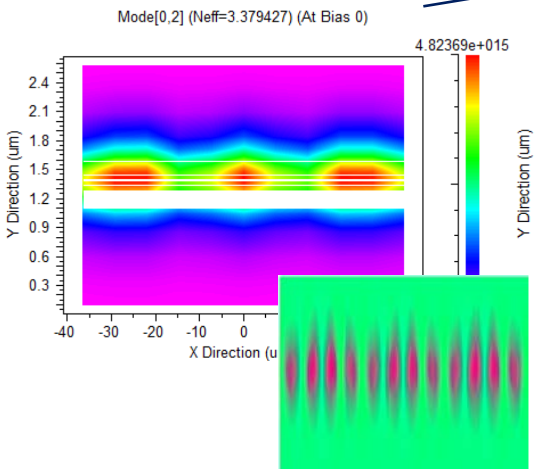


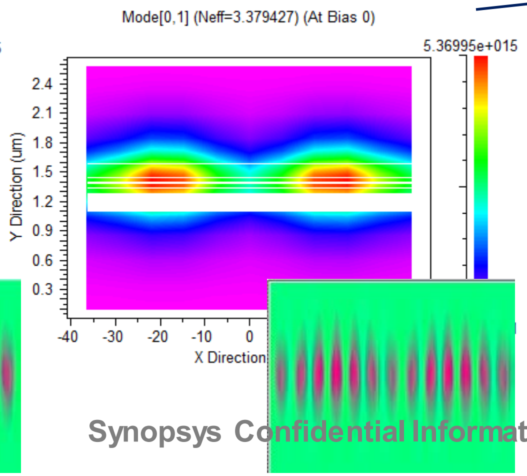
DFB Modes

- Calculate the modes and observe the resulting spectrum and mode profiles (first 3 are shown here).
- Note that the mode wavelengths, reported in the text window, corresponds to the narrowest (i.e. lowest loss) peaks in the spectrum.









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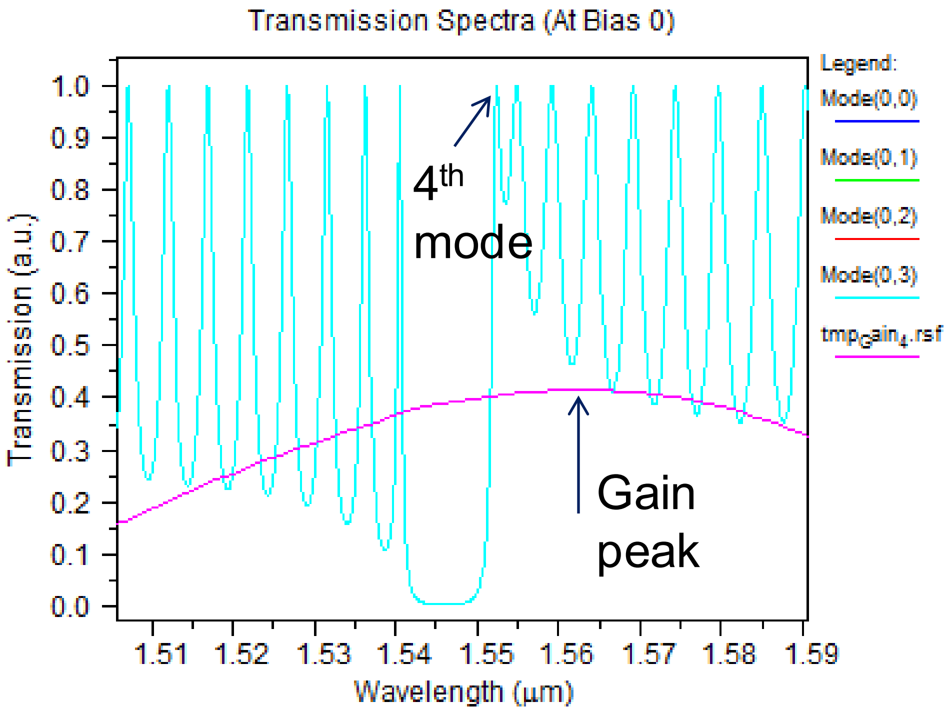
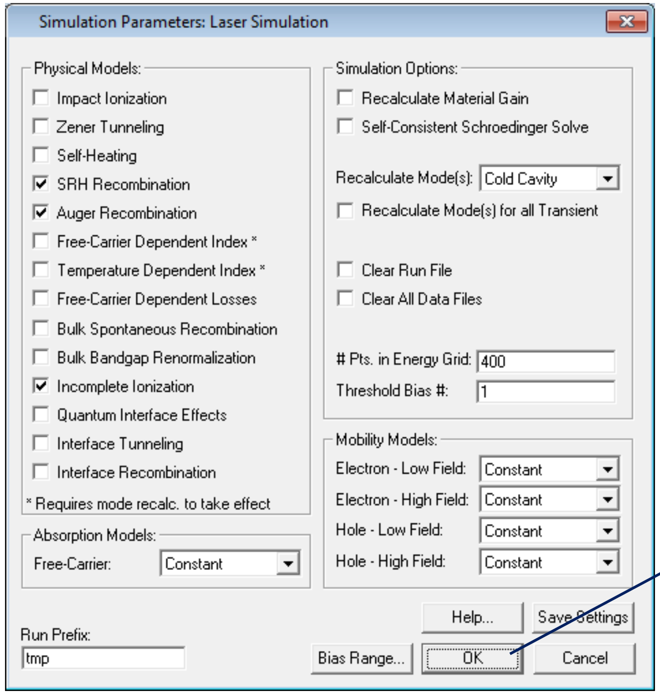
Comparing Mode and Gain Spectra

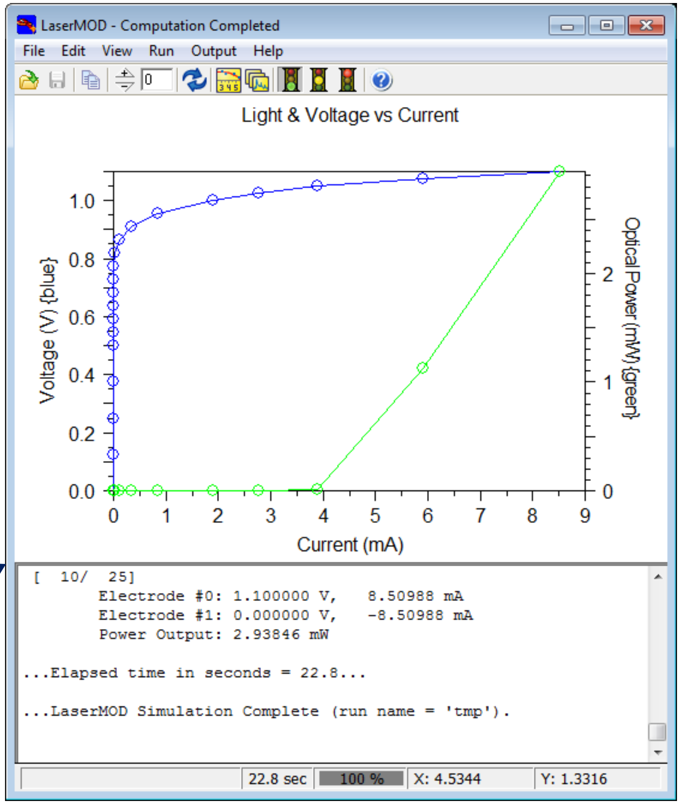
- Open The Gain Calculation Dialog and click OK.
- Open both the gain and spectrum plots using the View Graphs button on the top toolbar of the CAD.
- Copy the data file line from the gain plot script to the spectrum script, and scale it by 2e-4 using the '/sy' command.



Multimode Simulation

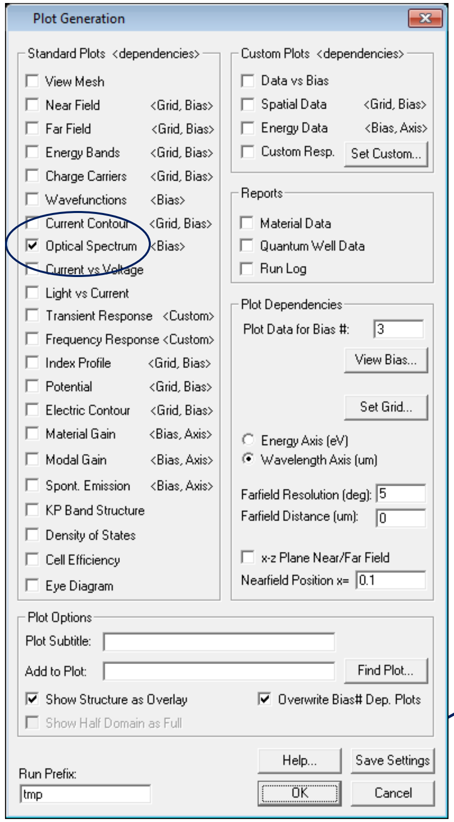
- Run a full simulation.
- Recall, 4 modes are being tracked

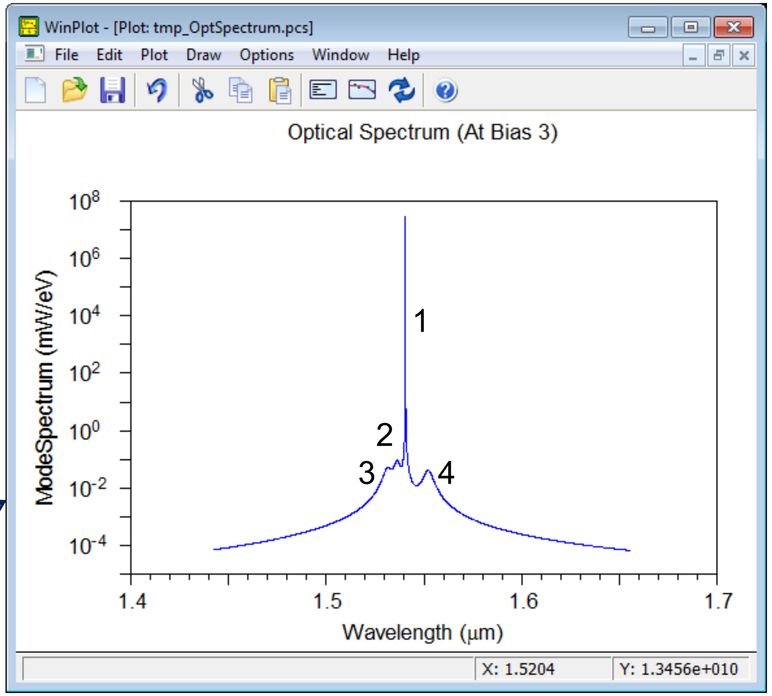




Output Spectrum

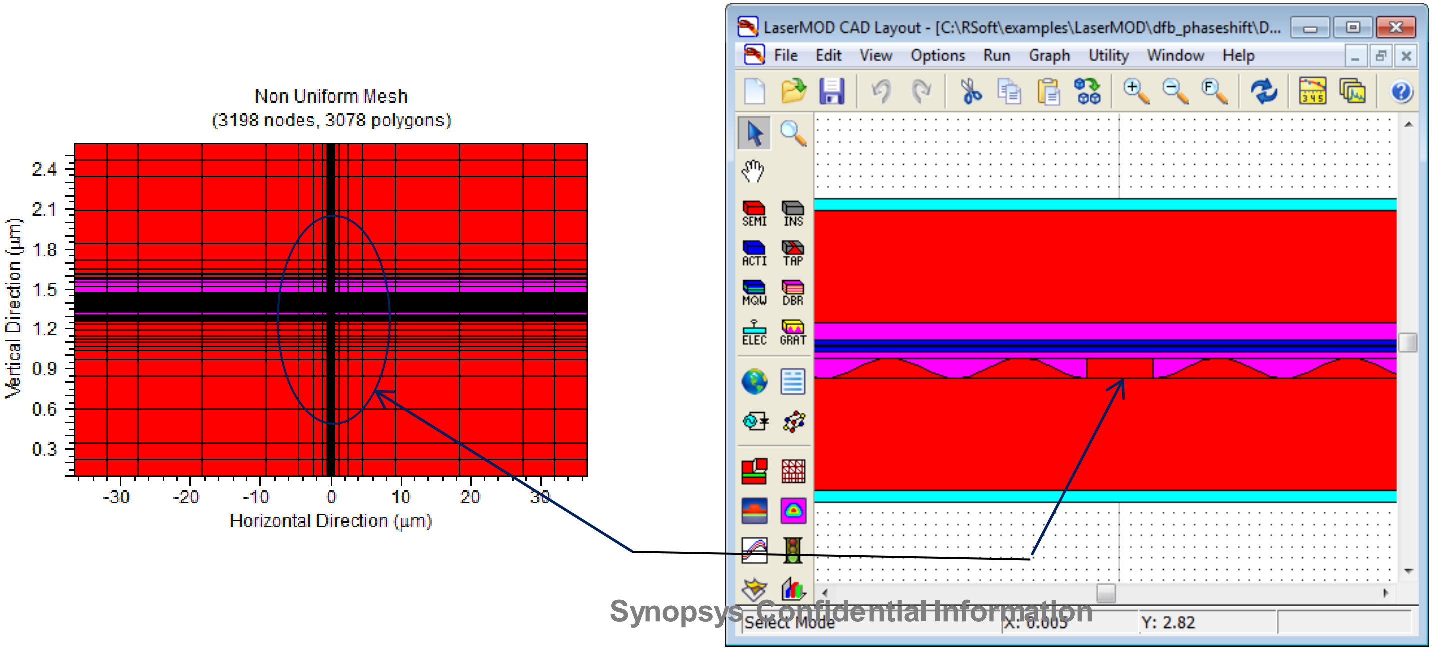
- Go to the Plot Generation Dialog and select “optical spectrum”.
- Note that only the first mode is above threshold, but the presence of all 4 modes can be seen.





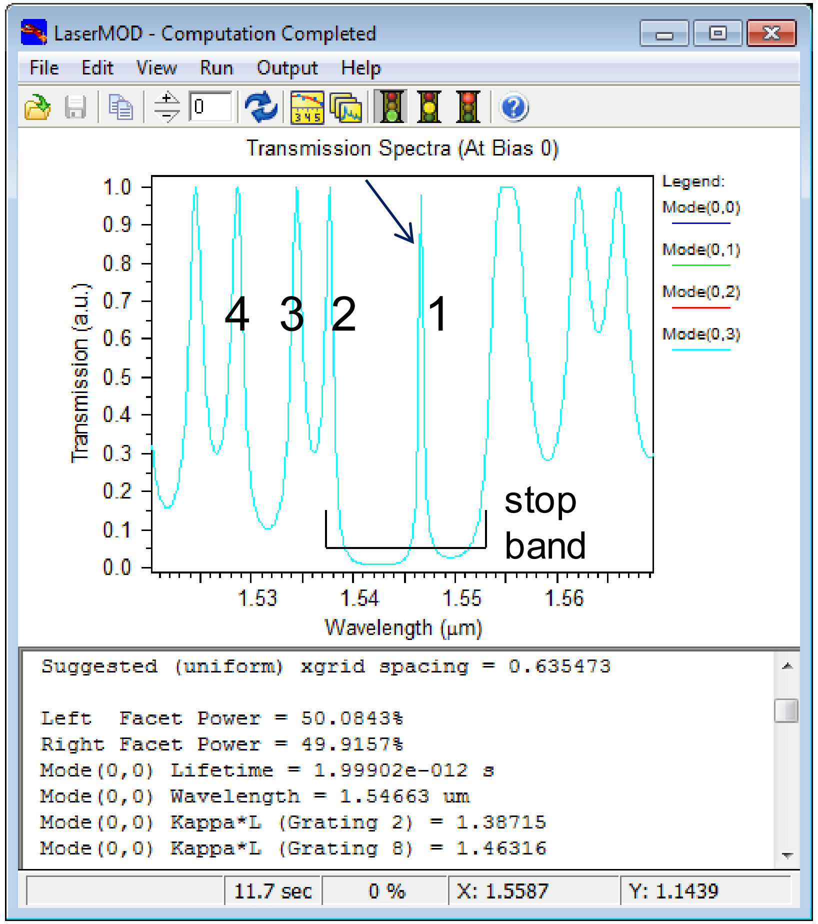
DFB with Phase Shift

- As a second example, open \RSoft\examples\LaserMOD\dfb_phaseshift\dfb_phaseshift.las
- This is also a GaInAsP DFB with a single QW, but it has a central phase shift in the grating which forms a DBR cavity.
- Zoom in around x=0 to see that a bulk region of width, Period/2, has been placed between 2 identical gratings.



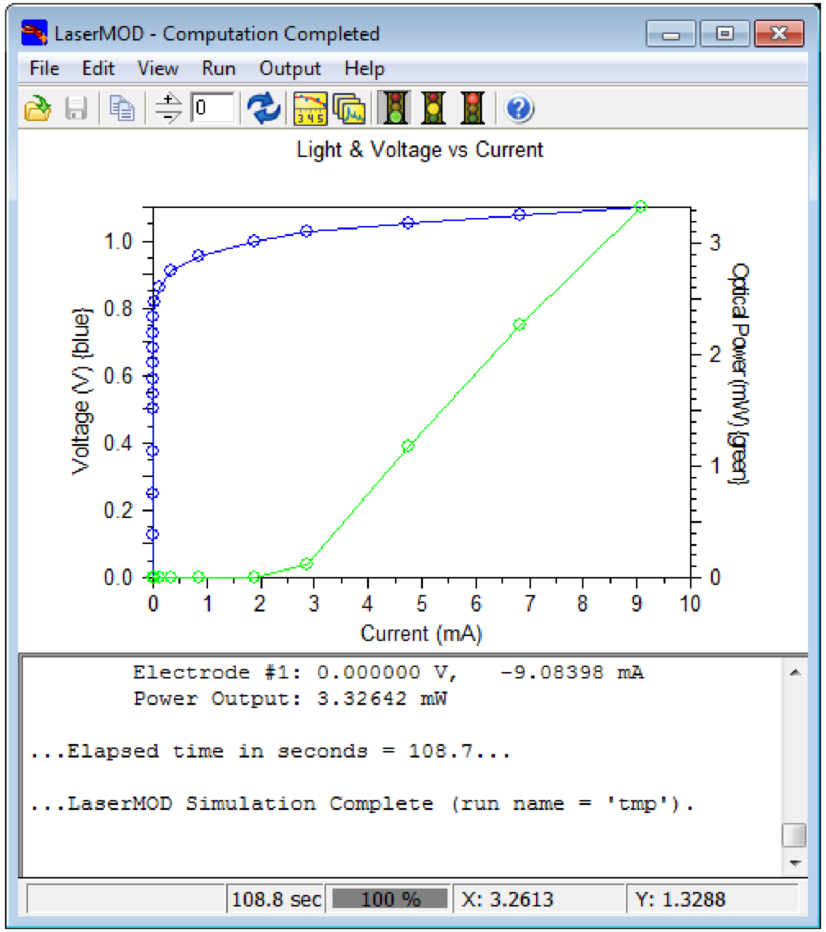
DFB with Phase Shift

- Perform a mode calculation, again with 4 modes.
- A Fabry-Perot peak now resides in the center of the stop-band.
- This is due to the central phase shift.



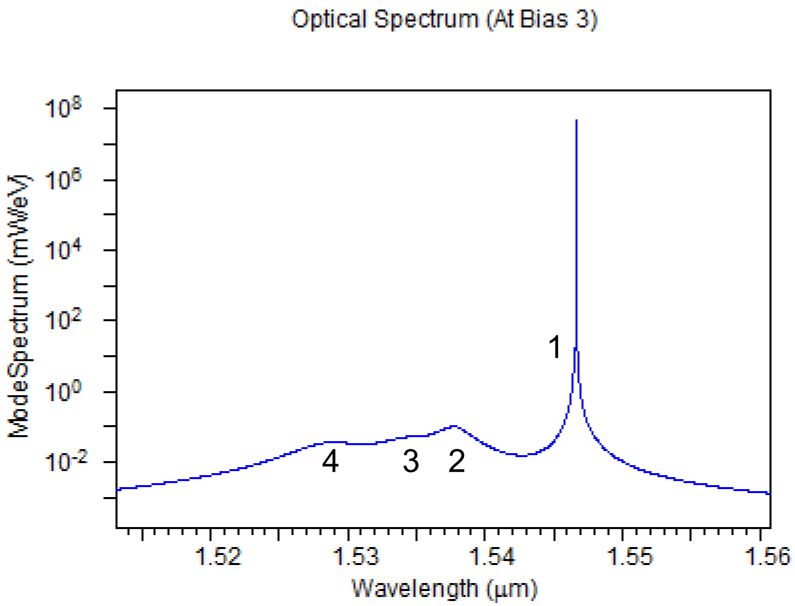
Multimode Simulation

- Run a full simulation.



Output Spectrum

- Generate an “optical spectrum” once again.
- As with the DFB, only the first mode is above threshold, but the presence of all 4 modes can be seen.
- The separation between modes 1 & 2 is clearly larger than it was in the DFB case, which could help improve the Sideband Suppression Ratio (SSR).



Q & A

Thank You