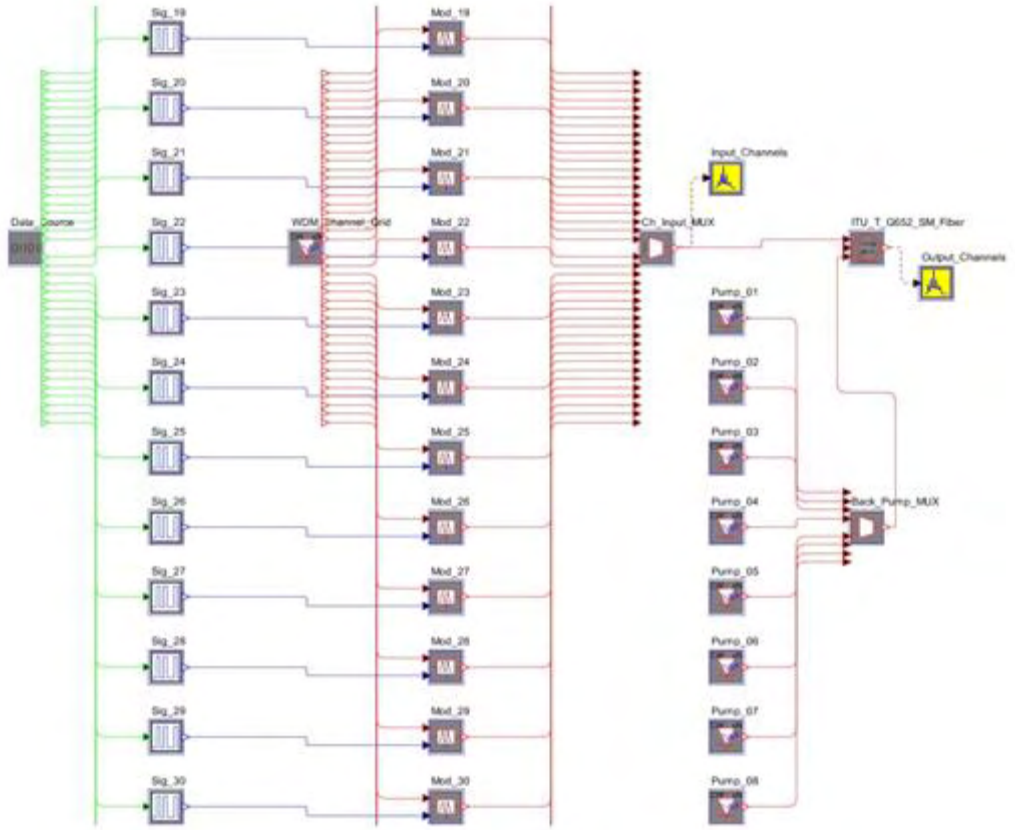
Design of a 40-Channel OC-768 DWDM Link (50 GHz grid) with Multiple Backward Pumped Raman Amplification

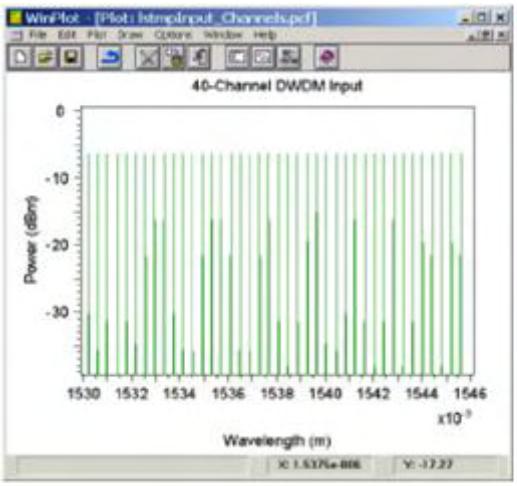
Tool Used: OptSim

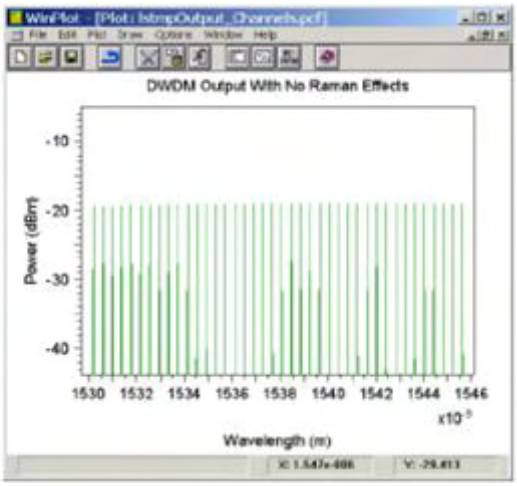
This example simulates a realistic scenario of a 40Gbps DWDM link with inter-channel spacing of 50 GHz. Forty individual channels carrying PRBS data are transmitted over a 50 km length of ITU-T G.652 single mode dispersive fiber. The design objective is to utilize distributed Raman amplification to compensate for the link attenuation thereby effectively increasing the inter-EDFA span in a longer-haul link.

The figure below shows a snap-shot of the layout. The multi-line capability of OptSim's CW laser model makes it very convenient to generate the source-grid for simulating WDM channels.



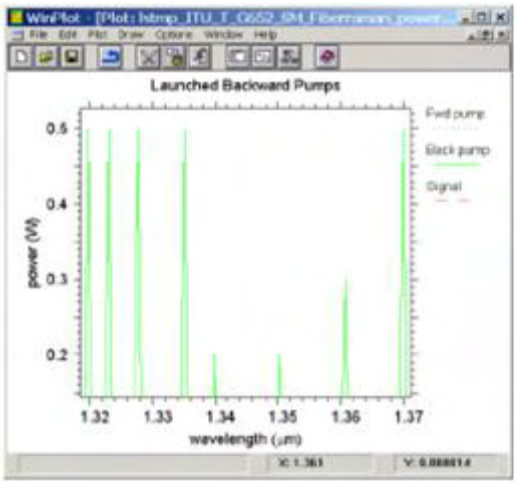
Since backward pumping helps in averaging out power ripples at the receiver end, we choose a backward pumping scheme that employs eight CW pump signals with carefully chosen nominal wavelengths and power values. Figure below depicts spectra of input and output channels in absence of Raman effects. The 50-km length of fiber induces ~ 13 dB of attenuation.

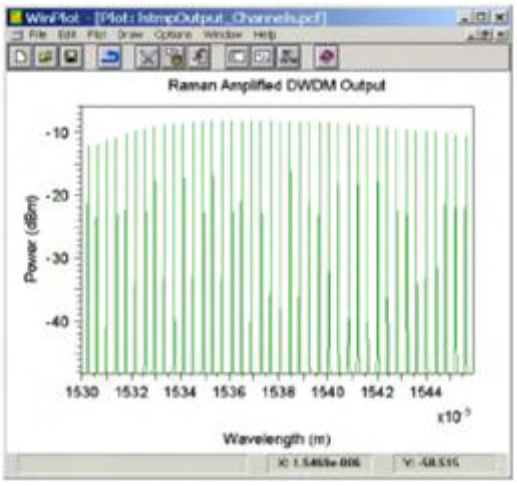




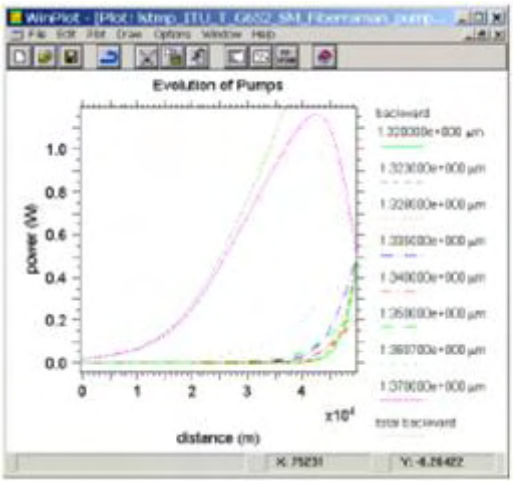
Raman amplification is a wide-band phenomenon having a highly irregular gain profile over wavelength. The highest Raman gain is observed for a frequency differential range (range of difference between pump signal and data signal nominal frequencies) of 8 to 12 THz. Outside this range, the gain profile exhibits a sharp decline. Therefore, if the number of pumps, their wavelengths, and the power values are chosen carefully, we can achieve the desired gain shape for the input DWDM channels.

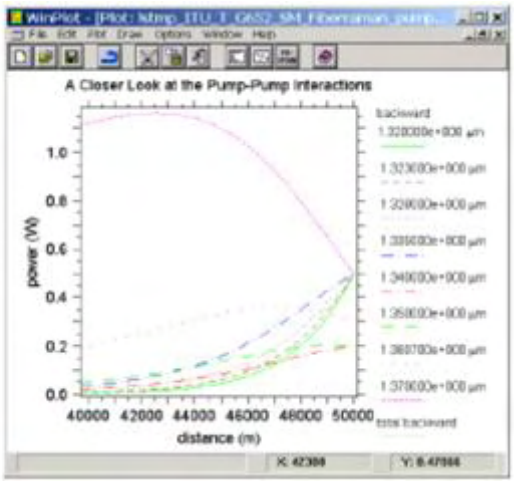
Figure below shows numerical values of eight pump-power and wavelengths selected after several simulation pre-runs and the Raman amplified output.





The output spectrum above takes in to account the pump-signal and the signal-signal interactions. Besides, the pumps interact with each other, too. Shorter wavelength pumps provide power to longer wavelength pumps. As a result, we can expect rise in longer wavelength pump powers and corresponding depletion of shorter wavelength pumps at the launch end of the fiber before finally showing overall link attenuation as shown in the figure below.


WinPlot - [Plot: Idtmp_ITU_T_G652_SM_Fiberraman_pump...
Evolution of Pumps
power (W)
distance (m)
x10^4
backward
1.328000e+000 µm
1.323000e+000 µm
1.328000e+000 µm
1.339000e+000 µm
1.340000e+000 µm
1.358000e+000 µm
1.369700e+000 µm
1.378000e+000 µm
total backward


WinPlot - [Plot: Idtmp_ITU_T_G652_SM_Fiberraman_pump...
A Closer Look at the Pump-Pump Interactions
power (W)
distance (m)
backward
1.328000e+000 µm
1.323000e+000 µm
1.328000e+000 µm
1.339000e+000 µm
1.340000e+000 µm
1.358000e+000 µm
1.369700e+000 µm
1.378000e+000 µm
total backward