Alexandria University
Faculty of Engineering
Electrical Engineering Department

EE-482 Project

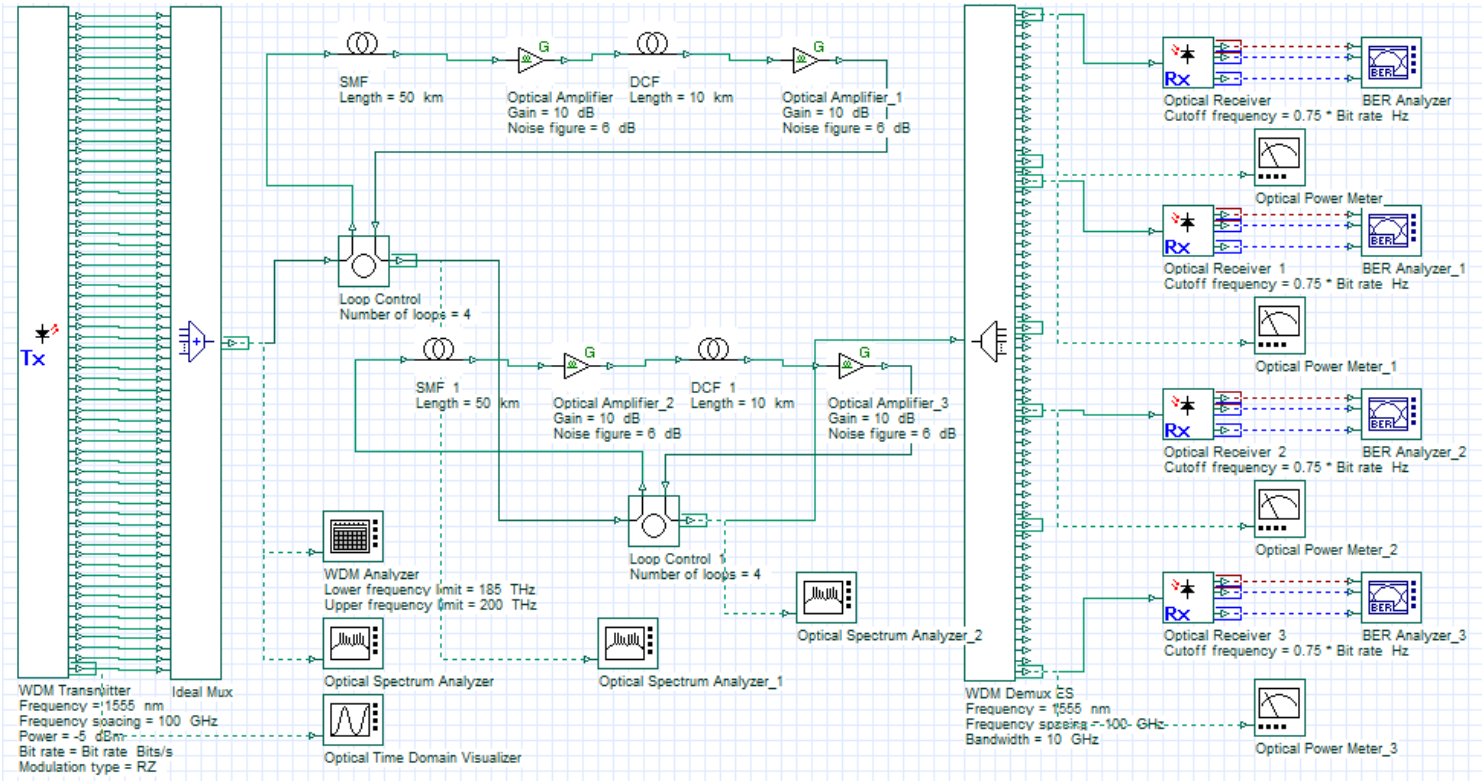
Design of a 64-Channel WDM system and Design a Single carrier system

Mostafa Mahmoud Khalil Hassan

Submitted to: Prof. Hossam Shalaby

1- Design of a 64-Channel WDM system

System Schematic



A. Transmitter

Consists of WDM transmitter that uses NRZ modulation and a 64 ideal Mux

Label: WDM Transmitter Cost$: 0.00

Main | ... | Co... | En... | Sid... | RIN | Chirp | Pol... | Sim... | N... | Ra...

Disp	Name	Value	Units	Mode
☐	Number of output ports	64		Normal
☑	Frequency	1555	nm	Normal
☑	Frequency spacing	100	GHz	Normal
☑	Power	-10	dBm	Sweep
☐	Extinction ratio	30	dB	Normal
☐	Linewidth	0.1	MHz	Normal
☐	Initial phase	0	deg	Normal

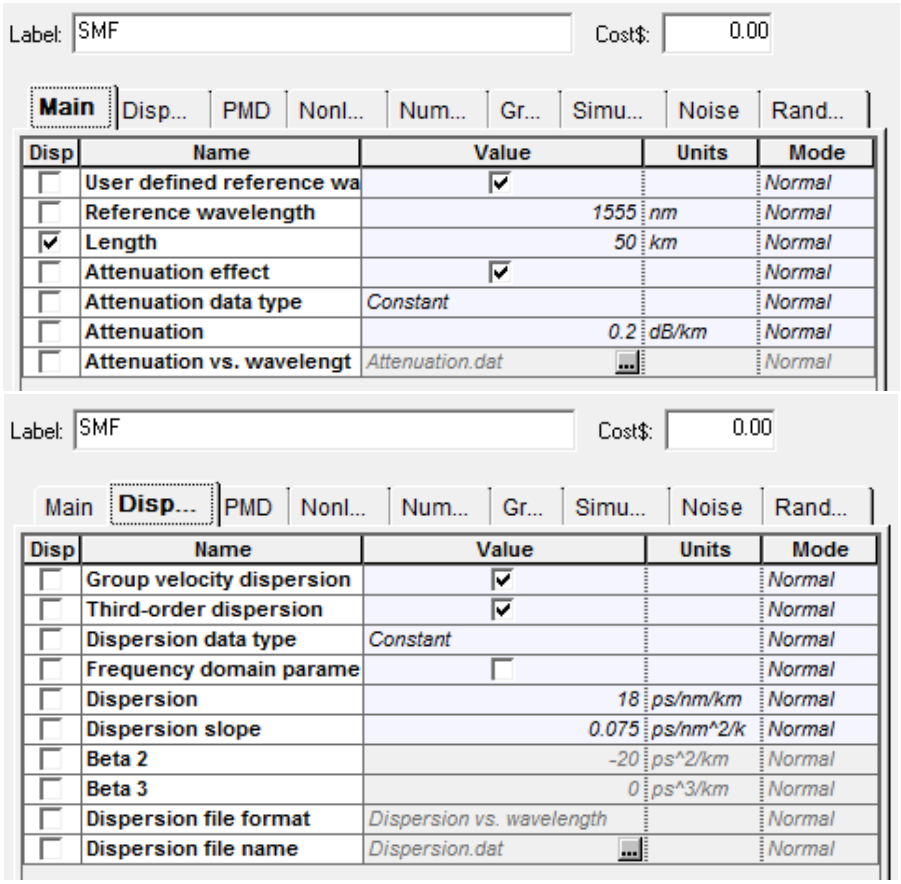
WDM Transmitter parameters

B. Optical Span

Consists of 8 cells of 50 km single mode fiber, and 10 km dispersion compensating fiber, in addition to EDFA optical amplifiers.

The parameters of SMF and DCF fibers are from [M.I. Hayee and A.E. Willner, IEEE Phot. Technol. Letters, 11, 991, (1999).]

B.1. Single Mode Fiber (SMF)



Label: SMF Cost$: 0.00

Main | Disp... | PMD | Nonl... | Num... | Gr... | Simu... | Noise | Rand...

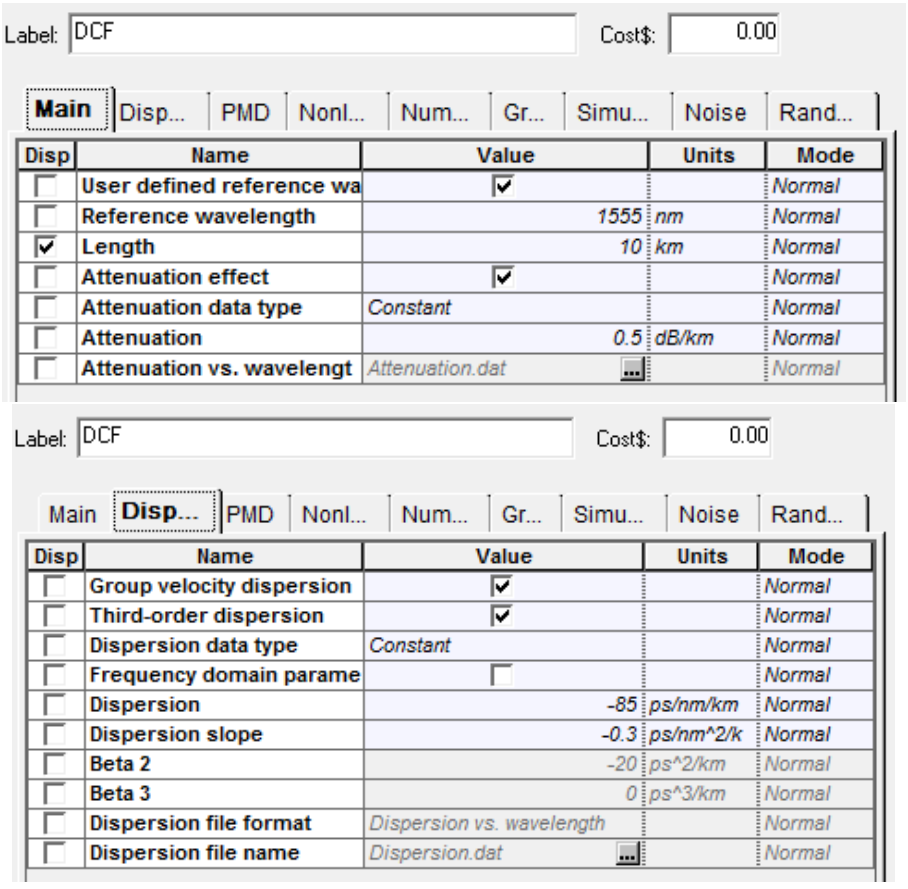
Disp	Name	Value	Units	Mode
☐	User defined reference wa	☑		Normal
☐	Reference wavelength	1555	nm	Normal
☑	Length	50	km	Normal
☐	Attenuation effect	☑		Normal
☐	Attenuation data type	Constant		Normal
☐	Attenuation	0.2	dB/km	Normal
☐	Attenuation vs. wavelengt	Attenuation.dat ...		Normal

Label: SMF Cost$: 0.00

Main | Disp... | PMD | Nonl... | Num... | Gr... | Simu... | Noise | Rand...

Disp	Name	Value	Units	Mode
☐	Group velocity dispersion	☑		Normal
☐	Third-order dispersion	☑		Normal
☐	Dispersion data type	Constant		Normal
☐	Frequency domain parame	☐		Normal
☐	Dispersion	18	ps/nm/km	Normal
☐	Dispersion slope	0.075	ps/nm^2/k	Normal
☐	Beta 2	-20	ps^2/km	Normal
☐	Beta 3	0	ps^3/km	Normal
☐	Dispersion file format	Dispersion vs. wavelength		Normal
☐	Dispersion file name	Dispersion.dat ...		Normal

B.2 Dispersion Compensating Fiber



Label: DCF Cost$: 0.00

Main | Disp... | PMD | Nonl... | Num... | Gr... | Simu... | Noise | Rand...

Disp	Name	Value	Units	Mode
☐	User defined reference wa	☑		Normal
☐	Reference wavelength	1555	nm	Normal
☑	Length	10	km	Normal
☐	Attenuation effect	☑		Normal
☐	Attenuation data type	Constant		Normal
☐	Attenuation	0.5	dB/km	Normal
☐	Attenuation vs. wavelengt	Attenuation.dat ...		Normal

Label: DCF Cost$: 0.00

Main | Disp... | PMD | Nonl... | Num... | Gr... | Simu... | Noise | Rand...

Disp	Name	Value	Units	Mode
☐	Group velocity dispersion	☑		Normal
☐	Third-order dispersion	☑		Normal
☐	Dispersion data type	Constant		Normal
☐	Frequency domain parame	☐		Normal
☐	Dispersion	-85	ps/nm/km	Normal
☐	Dispersion slope	-0.3	ps/nm^2/k	Normal
☐	Beta 2	-20	ps^2/km	Normal
☐	Beta 3	0	ps^3/km	Normal
☐	Dispersion file format	Dispersion vs. wavelength		Normal
☐	Dispersion file name	Dispersion.dat ...		Normal

B.3 EDFA optical amplifier

Label: Optical Amplifier Cost$: 0.00

Main | Polarization | Simulation | Noise | Random numbers

Disp	Name	Value	Units	Mode
☐	Operation mode	Gain Control		Normal
☑	Gain	10	dB	Normal
☐	Power	10	dBm	Normal
☐	Saturation power	10	dBm	Normal
☐	Saturation port	Output		Normal
☐	Include noise	☑		Normal
☑	Noise figure	6	dB	Normal

EDFA optical amplifier parameters

C. Receiver

Consists of WDM demux plus optical receiver, which contains PIN photodetector and a Bessel low pass filter.

Label: WDM Demux ES Cost$: 0.00

Main | Simulation | Noise

Disp	Name	Value	Units	Mode
☐	Number of output ports	64		Normal
☑	Frequency	1555	nm	Normal
☑	Frequency spacing	100	GHz	Normal
☑	Bandwidth	10	GHz	Normal
☐	Insertion loss	0	dB	Normal
☐	Depth	100	dB	Normal
☐	Filter type	Bessel		Normal
☐	Filter order	2		Normal

WDM Demux parameters

Label: Optical Receiver Cost$: 0.00

Main | Low Pass ... | 3R Regen... | Downsam... | Noise | Random n...

Disp	Name	Value	Units	Mode
☐	Photodetector	PIN		Normal
☐	Gain	3		Normal
☐	Ionization ratio	0.9		Normal
☐	Responsivity	1	A/W	Normal
☐	Dark current	10	nA	Normal

Label: Optical Receiver Cost$: 0.00

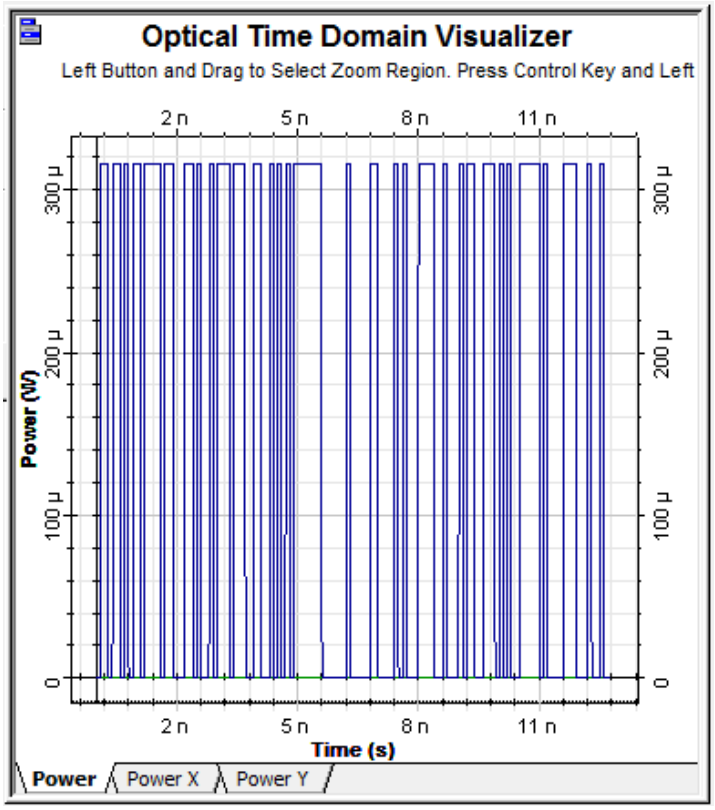
Main | Low Pass ... | 3R Regen... | Downsam... | Noise | Random n...

Disp	Name	Value	Units	Mode
☑	Cutoff frequency	0.75 * Bit rate S	Hz	Script
☐	Insertion loss	0	dB	Normal
☐	Depth	100	dB	Normal
☐	Order	4		Normal

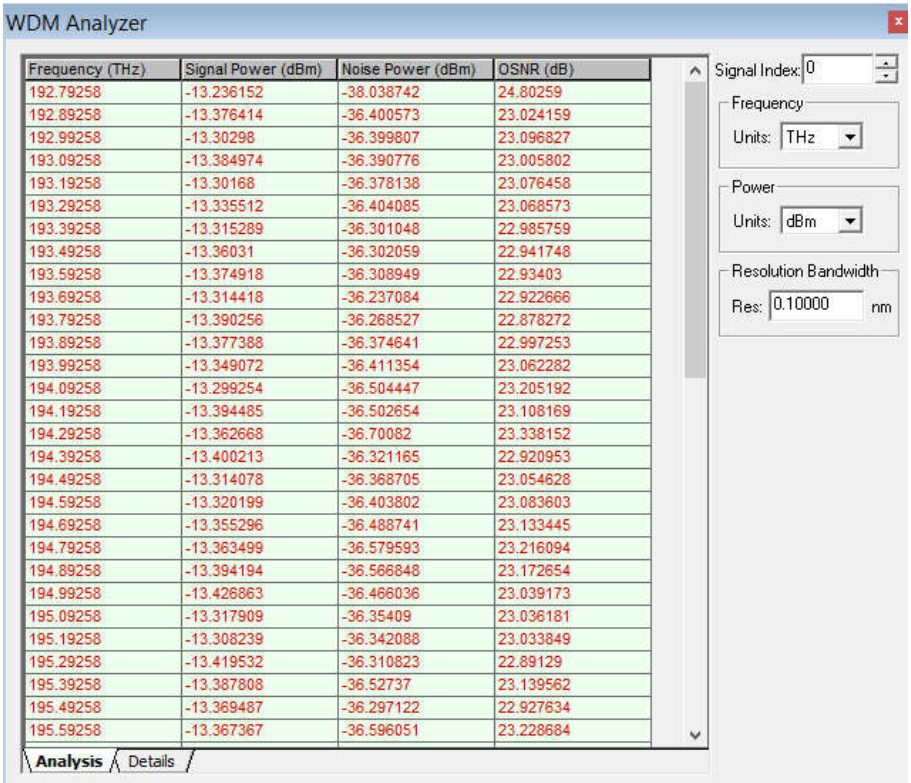
Optical Receiver Parameters

Results

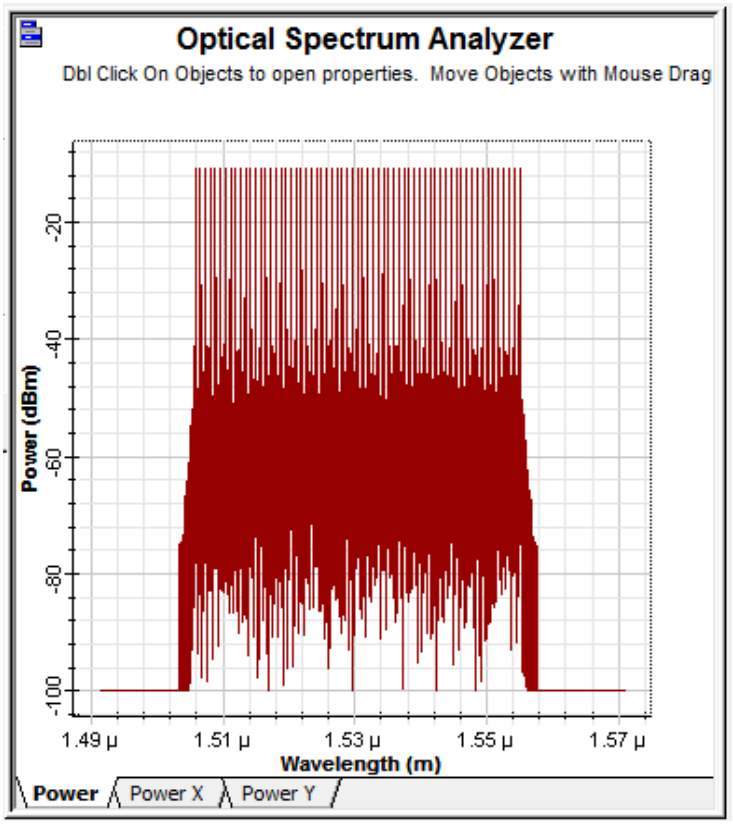
Optical Time Domain Visualizer



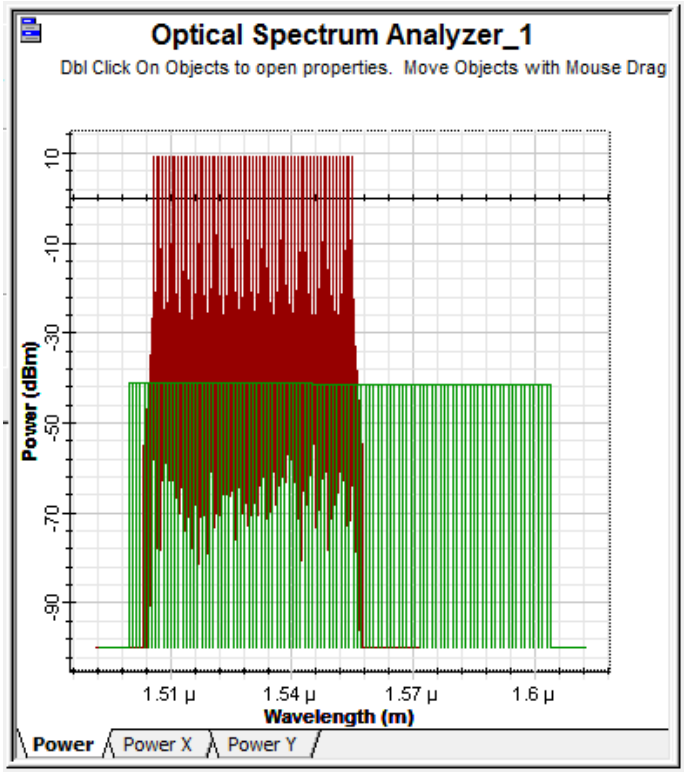
WDM Analyzer

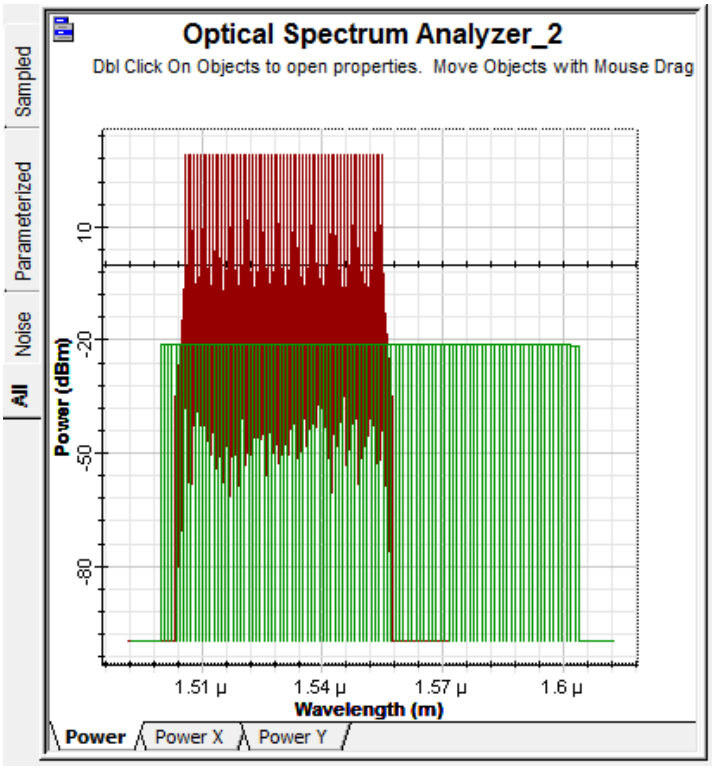


Optical Spectrum Analyzer at 0 km

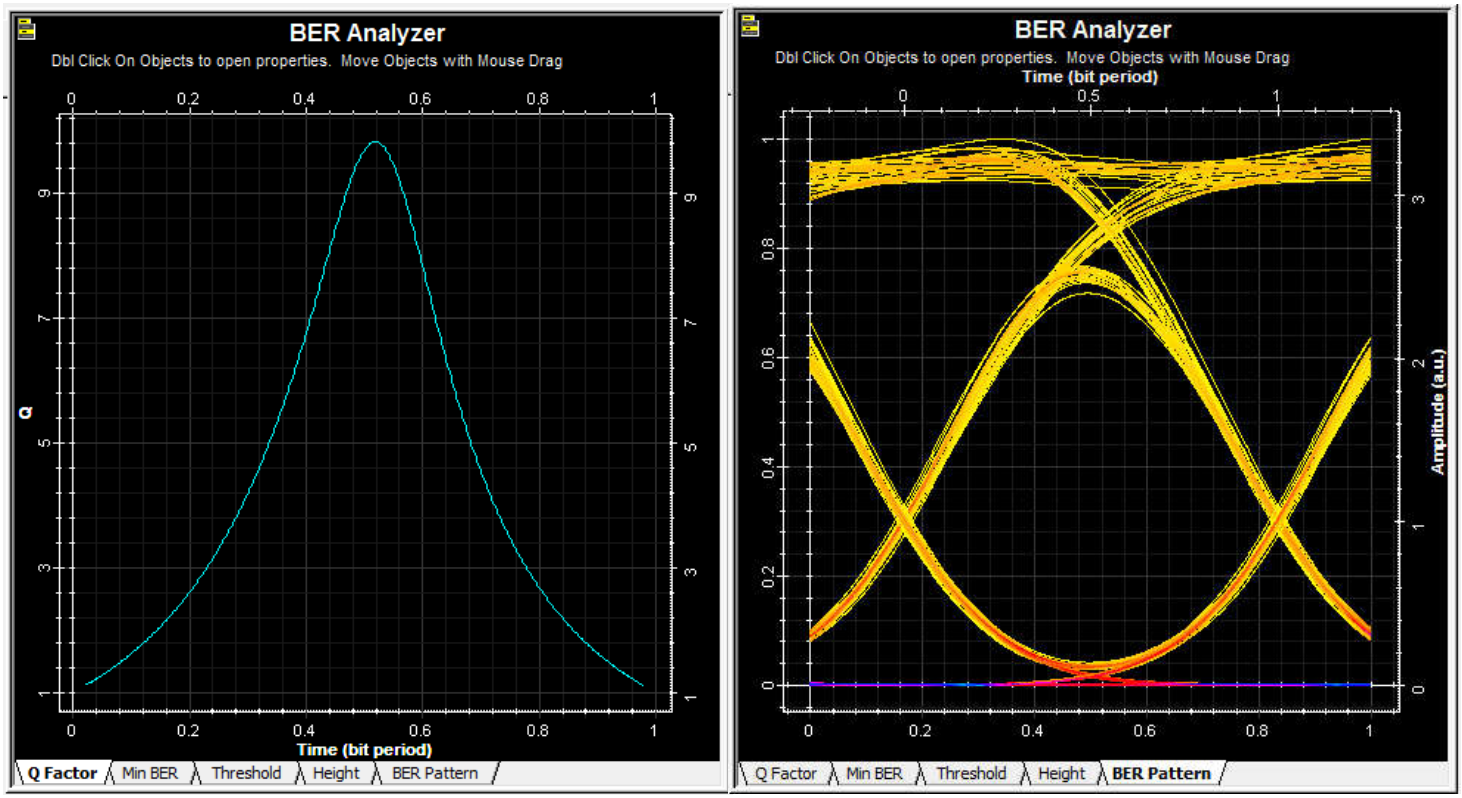


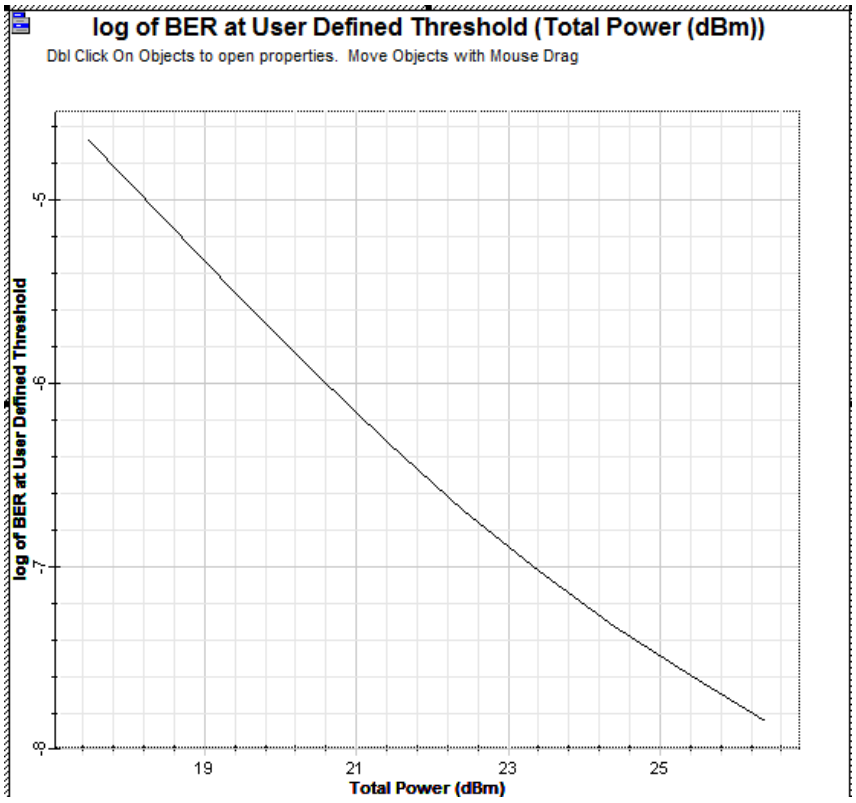
Optical Spectrum Analyzer at 200 km and at 400 km





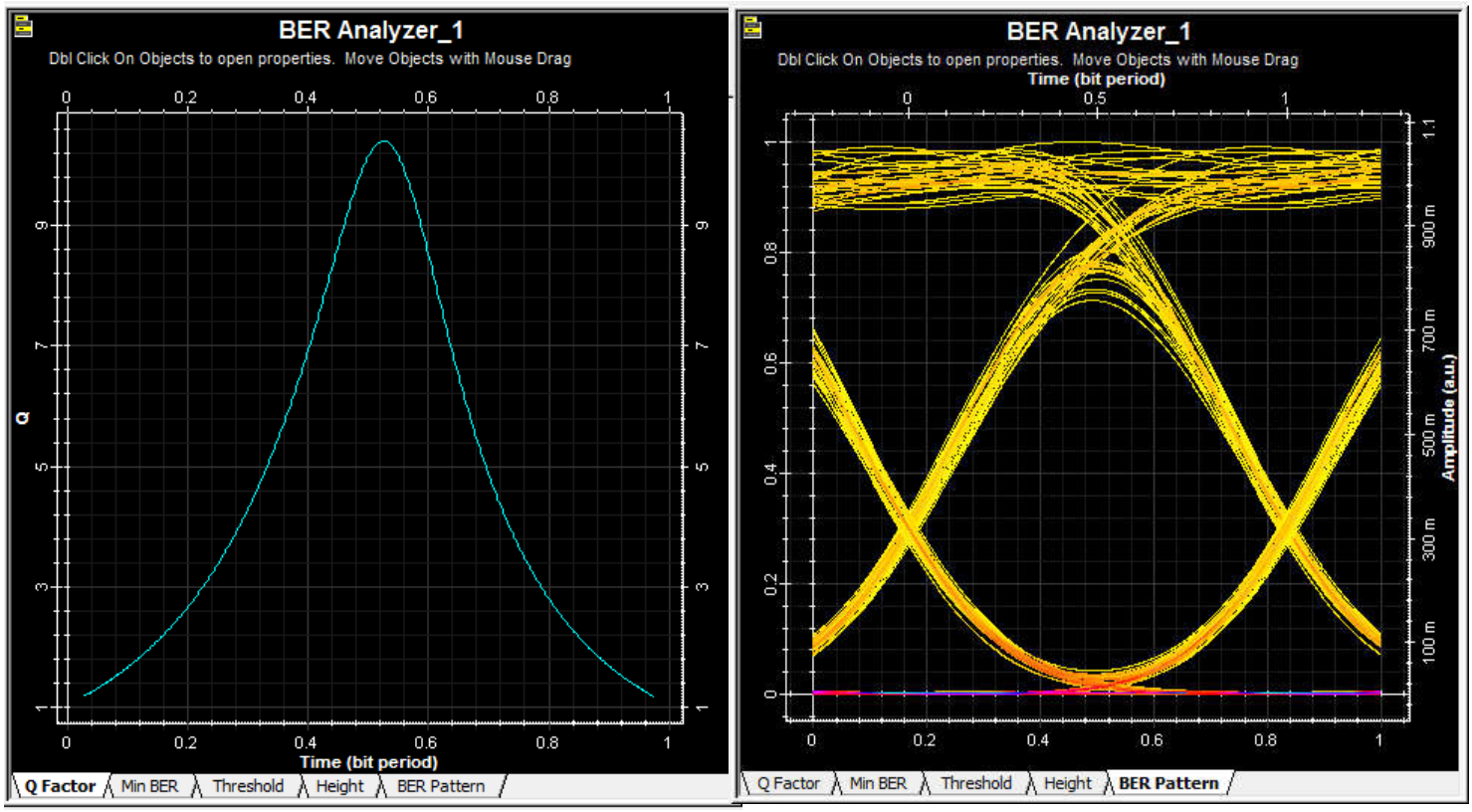
BER analyzer (Q-factor and Eye diagram) - Channel 1

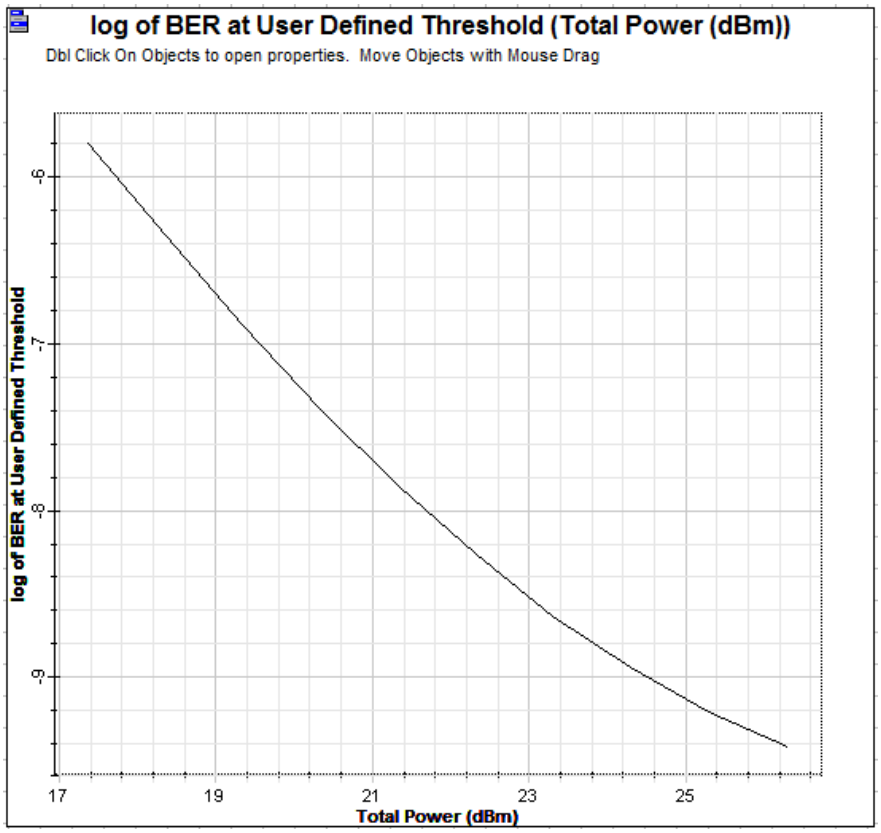




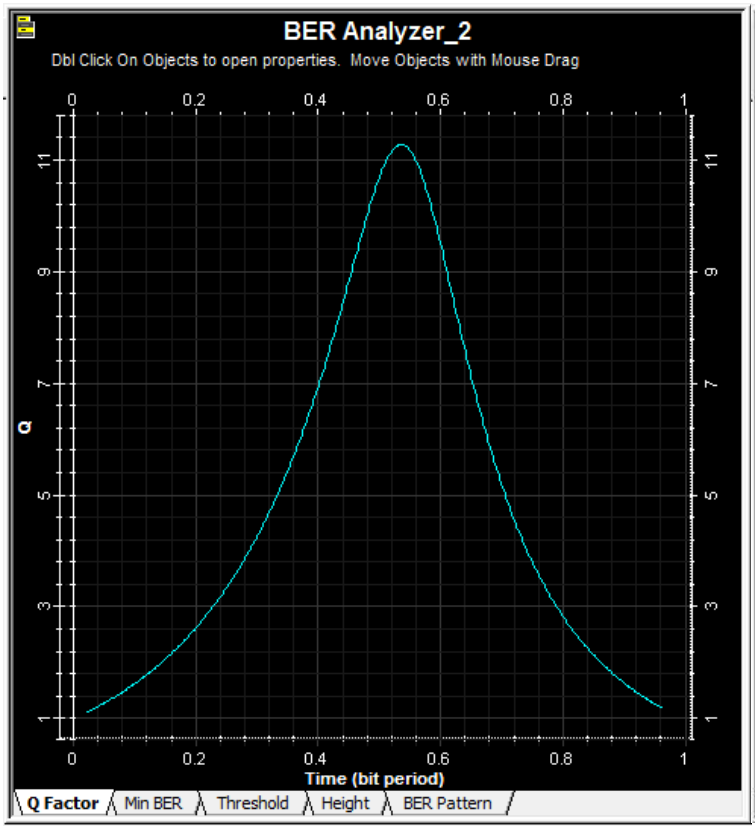
Log of BER against total received optical power. A sweep was performed on the transmitter power from -20 dBm to -10 dBm

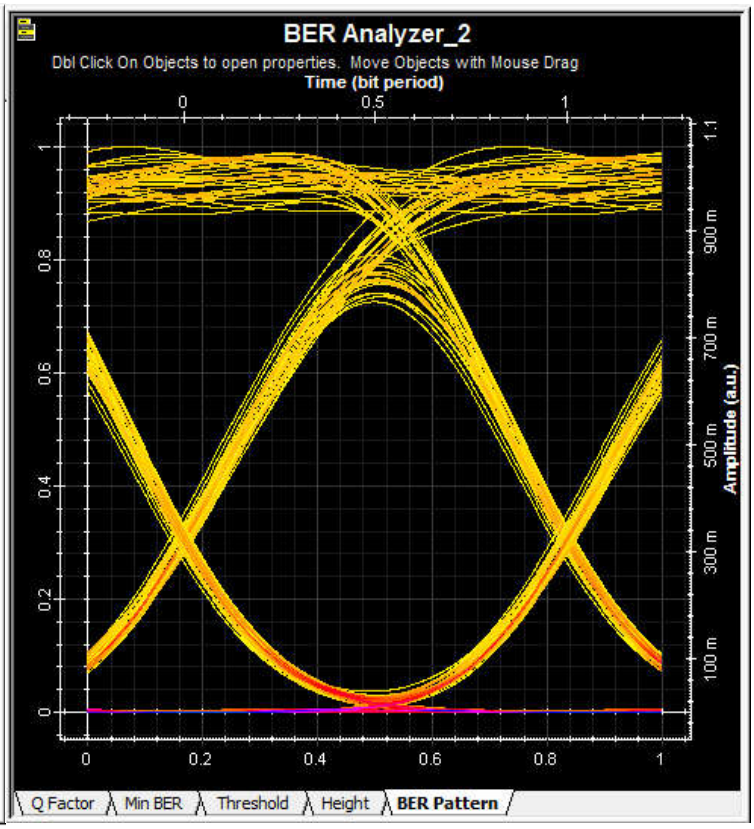
Channel 17

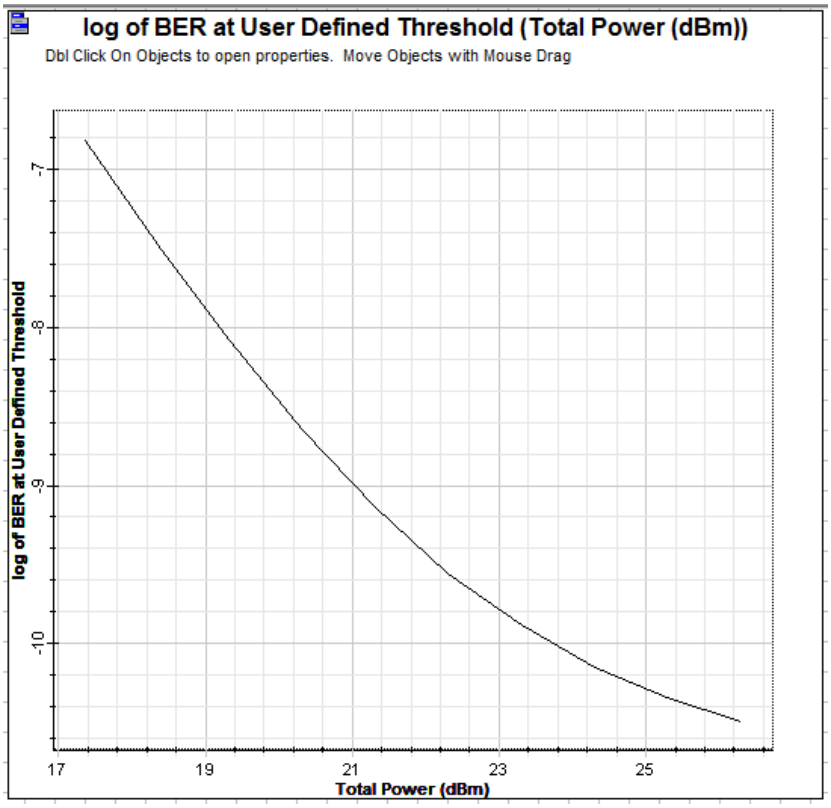

BER Analyzer_1
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Q
Time (bit period)
Q Factor
Min BER
Threshold
Height
BER Pattern
BER Analyzer_1
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Time (bit period)
Amplitude (a.u.)
Q Factor
Min BER
Threshold
Height
BER Pattern


log of BER at User Defined Threshold (Total Power (dBm))
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
log of BER at User Defined Threshold
Total Power (dBm)

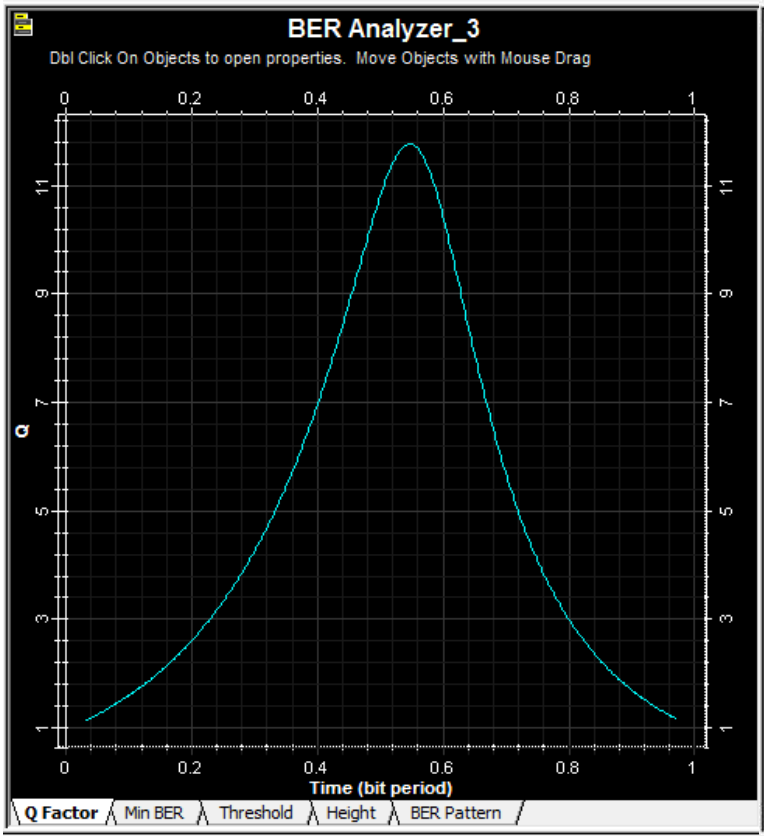
Channel 39

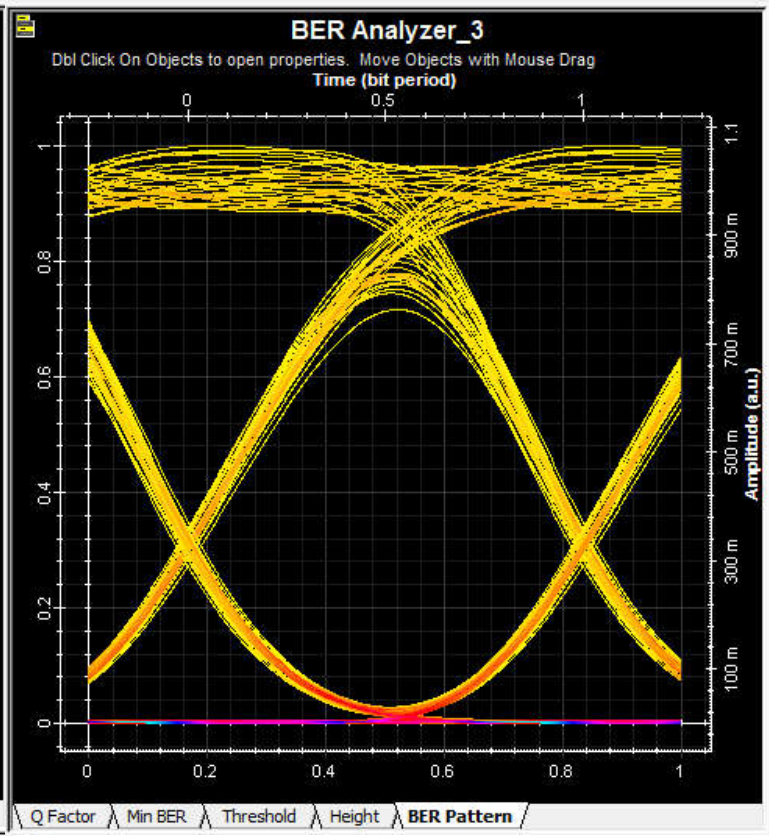

BER Analyzer_2
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Q
Time (bit period)
Q Factor
Min BER
Threshold
Height
BER Pattern

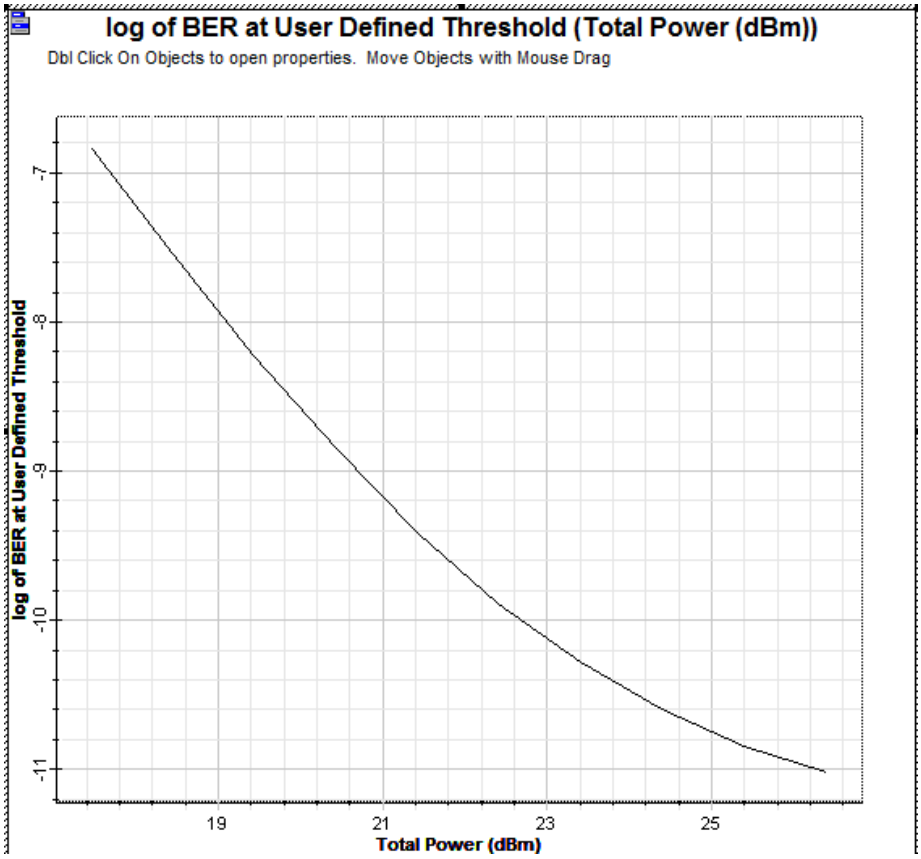

BER Analyzer_2
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Time (bit period)
Amplitude (a.u.)
Q Factor
Min BER
Threshold
Height
BER Pattern


log of BER at User Defined Threshold (Total Power (dBm))
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
log of BER at User Defined Threshold
Total Power (dBm)

Channel 64


BER Analyzer_3
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Q
Time (bit period)
Q Factor
Min BER
Threshold
Height
BER Pattern


BER Analyzer_3
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Time (bit period)
Amplitude (a.u.)
Q Factor
Min BER
Threshold
Height
BER Pattern


log of BER at User Defined Threshold (Total Power (dBm))
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
log of BER at User Defined Threshold
Total Power (dBm)

Appendix - Datasheets

EDFA Optical Amplifiers - EM316EA-PR1013

Gain: 10 dB, Max. noise factor: 6.0, Max power consumption: 5 W

http://www.mrv.com/sites/default/files/datasheets/us_pdfs/mrv-fd-edfa_2.pdf

Corning SMF-28e+ optical fiber

At the wavelength used 1555 nm,

Max attenuation: 0.2 dB/km, max dispersion value: 18 ps/(nm.km)

https://www.corning.com/media/worldwide/coc/documents/PI1463_07-14_English.pdf

Corning single mode fiber DCM Modules

Dispersion compensation for wavelength 1525nm-1565nm, 100 percent dispersion slope compensation

http://course.ee.ust.hk/elec342/lab/corning%20single%20mode%20fiber%20DCM%20modules.pdf