University of Asia Pacific

Course Title: Data Communication Lab
Course Code: CSE 304

Experiment No: 02
Experiment Name: Dispersion in Optical Fiber

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Objective: To analyze and investigate the dispersion phenomenon in optical fiber communication through experimental observation in a laboratory setting.

List Of Components:

Pseudo-Random Bit Sequence Generator - 2
NRZ Pulse Generator - 2
CW Laser - 2
Mach-Zehnder Modulator – 2
WDM Mux 2x1 – 1
Optical Fiber – 1
Optical time Domain Visualizer – 2

Theory: Dispersion in optical fiber communication refers to the spreading of a light pulse as it propagates through the fiber. This occurs because different components of the light pulse travel at different speeds, causing the pulse to broaden over time. As a result, the originally sharp, well-defined signal becomes blurred.

The main consequence of dispersion is a reduction in data transmission efficiency. As the pulse spreads, distinguishing between individual pulses becomes increasingly difficult. In severe cases, this can lead to Inter-Symbol Interference (ISI), where overlapping pulses cause errors in data reception. This makes it challenging for the system to accurately differentiate between consecutive bits, leading to potential errors in signal recovery.

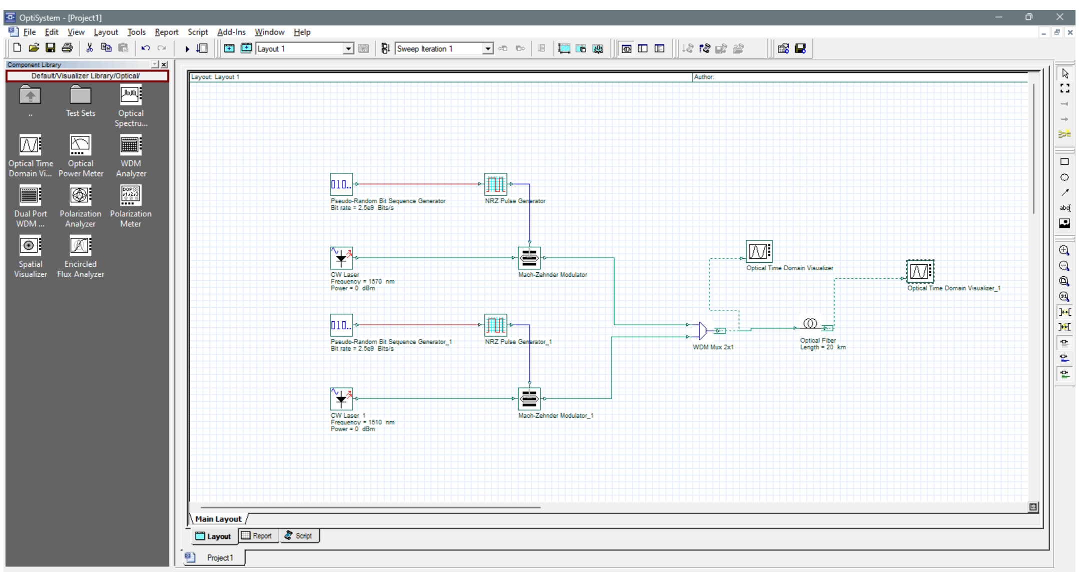
Ultimately, dispersion limits the maximum data rate that can be reliably transmitted over long distances. To maintain high-speed, reliable communication in optical fiber systems, managing and compensating for dispersion is essential.

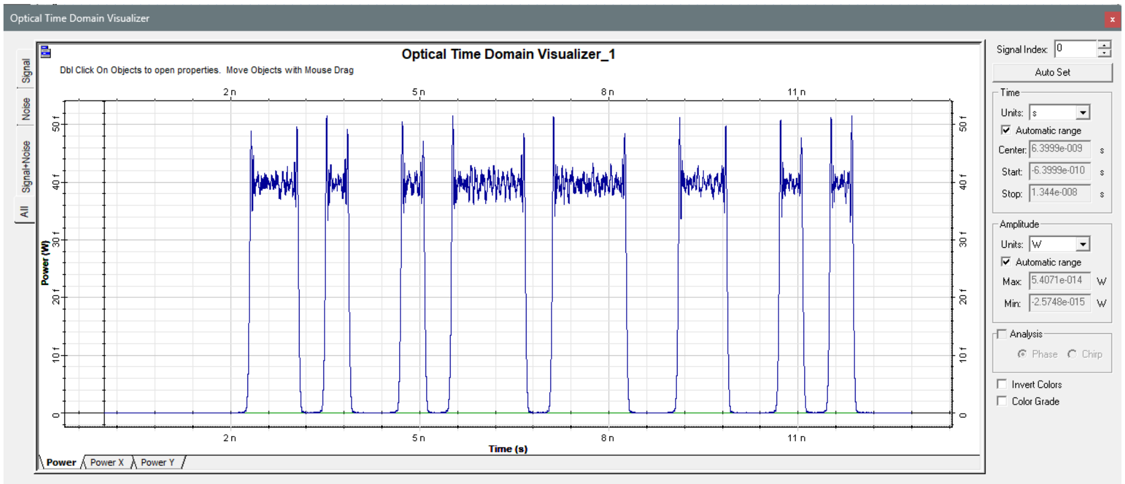
For the laboratory purpose, we use the following formula:

Dispersion, $\Delta\tau = L.D.\ \Delta\lambda$

L =length of the link, D = Dispersion parameter, $\Delta\lambda$ = Spectral width

Screenshot of Layout:




Optical Time Domain Visualizer
Optical Time Domain Visualizer_1
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Signal
Noise
Signal+Noise
All
Power (W)
Time (s)
2 n
5 n
8 n
11 n
Power
Power X
Power Y
Signal Index: 0
Auto Set
Time
Units: s
Automatic range
Center: 6.3999e-009 s
Start: -6.3999e-010 s
Stop: 1.344e-008 s
Amplitude
Units: W
Automatic range
Max: 5.4071e-014 W
Min: -2.5748e-015 W
Analysis
Phase
Chirp
Invert Colors
Color Grade

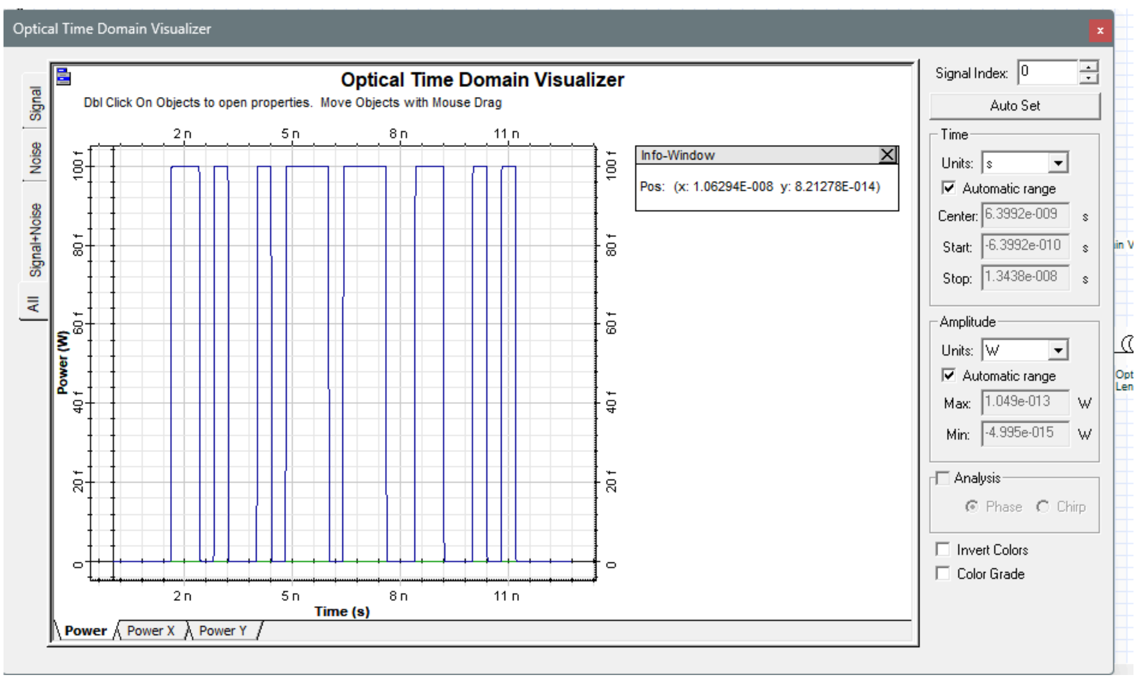
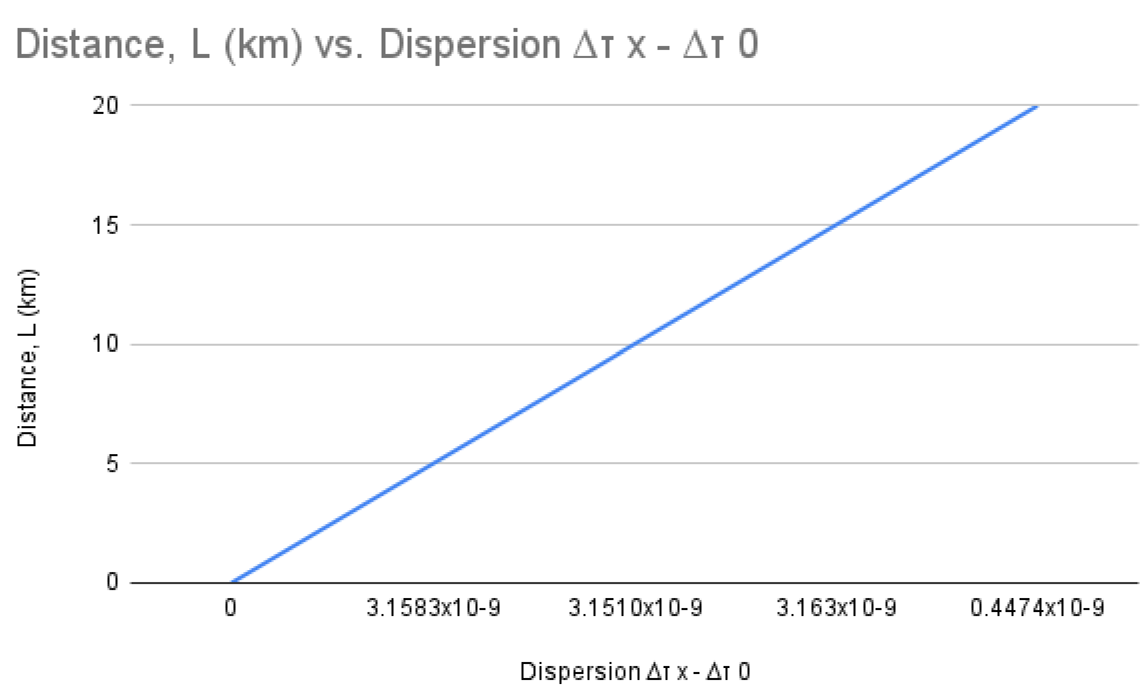

Optical Time Domain Visualizer
Optical Time Domain Visualizer
Dbl Click On Objects to open properties. Move Objects with Mouse Drag
Signal
Noise
Signal+Noise
All
Power (W)
Time (s)
2 n
5 n
8 n
11 n
Info-Window
Pos: (x: 1.06294E-008 y: 8.21278E-014)
Power
Power X
Power Y
Signal Index: 0
Auto Set
Time
Units: s
Automatic range
Center: 6.3992e-009 s
Start: -6.3992e-010 s
Stop: 1.3438e-008 s
Amplitude
Units: W
Automatic range
Max: 1.049e-013 W
Min: -4.995e-015 W
Analysis
Phase
Chirp
Invert Colors
Color Grade

Table: Practical Dispersion of fiber

Distance, L (km)	Total Spread, $\Delta\tau$	Dispersion $\Delta\tau_x - \Delta\tau_0$
0	9.644×10^{-9}	0
5	12.8023×10^{-9}	3.1583×10^{-9}
10	12.795×10^{-9}	3.1510×10^{-9}
15	12.8076×10^{-9}	3.163×10^{-9}
20	10.0914×10^{-9}	0.4474×10^{-9}

Graph for (Dispersion vs Length in km):



Discussion:

The experimental study of dispersion in optical communication systems has provided important insights into the temporal broadening of light pulses and its effect on data transmission. This research has explored the relationship between dispersion and key factors such as the optical link length (L), the dispersion parameter (D), and the spectral width ($\Delta\lambda$). These findings offer a deeper understanding of how these variables impact the overall performance of optical communication systems.

The total spread ($\Delta\tau$), increases as we go from a value of 9.644x10-9 seconds at 0 km to 10.0914x10-9 seconds at 20 km.We can see it is difficult to maintain signal strength at long distances.