Optimized Dispersion Compensation with Post Fiber Bragg Grating in WDM Optical Network

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Abstract-In this paper demonstrates the possibility for dispersion compensation in a 10 Gbps WDM with the help of fiber Bragg Grating created with the Fiber Grating component. This component allows design of apodized and chirped fiber gratings that are able to provide dispersion compensation in optical system. The physical idea behind this compensation scheme is the creation of an apodised linear chirped grating allows us to create a time delay between different spectral components of the signal. Because of this different velocity of propagation of different spectral components, the pulse spreads. If we create fiber grating with period linearly reducing along the grating, because the higher frequencies will reflect after longer propagation in the grating a time delay between lower and higher frequency components will appear which is just opposite to this created in the SMF. Therefore propagating and reflecting our pulse in this device will allow to compensate the dispersion broadening of transmitting pulse .

Index Term- Dispersion, fiber bragg grating and wave division multiplexing

I. INTRODUCTION

Wavelength division multiplexing (WDM) is a technology which multiplexes a number of optical carrier signals onto a single optical fiber by using different wavelengths (i.e. colours) of laser light. This technique enables bidirectional communications over one strand of fiber, as well as multiplication of capacity [1]. The term wavelength-division multiplexing is commonly applied to an optical carrier (which is typically described by its wavelength), whereas frequency-division multiplexing typically applies to a radio carrier (which is more often described by frequency). Since wavelength and frequency are tied together through a simple directly inverse relationship, the two terms actually describe the same concept.

II DESIGN OF WDM SYSTEM WITH POST FBG

A WDM system uses a multiplexer at the transmitter to join the signals together, and a de multiplexer at the receiver to split them apart. With the right type of fiber it is possible to have a device that does both simultaneously, and can function as an optical add-drop multiplexer.

We will now show how the amount of compensating dispersion affects system performance. We will use an Ideal Dispersion Compensation FBG as the dispersion compensation module as shown in figure 1 . In this case, we selected a post-compensation scheme because it is simple compared to the symmetrical compensation scheme. All schemes perform similar in low power regions. Project is given in Dispersion compensation post with FBG.

The transmitter section includes one wave division multiplexer which has four input points. Each of its point is feeding with a modulated signal comes from Mach zehnder modulator. There are four modulators are used. Each modulator has an optical carrier signal for which four CW lasers are used whose frequencies are 193.1 THz,193.2 THz, 193.3 THz & 193.4 THz respectively. Each laser has a power of 20 dB. The electrical information signal is generated by Pseudo random bit sequence generator and is modulated in NRZ format.

This WDM network consist an optical span which has a loop control. This loop control can be used to run the transmission of signal one or more time in optical fiber . an 80 Km long optical fiber cable is used as transmission medium.

The receiver section has 1x4 WDM DMUX . The information signal can be received by its one out pin. Now this signal can be converted again into electrical signal with the help of optical receiver PIN diode. The received electrical signal is filtered by low pass Bessel filter[2].

The received signal can be examine by BER analyzer.

For example, in SMF at 1.55μm, group velocity dispersion creates a negative chirp of the pulses, which means that the higher frequencies (which propagate faster) are in the leading

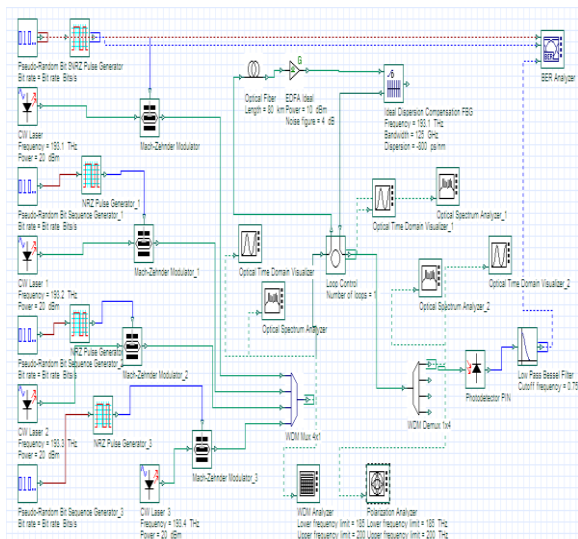part of the pulse and the lower (propagating slower) in the trailing one.

Fig 1 WDM system topology with ideal FBG

The total accumulated dispersion of the SMF is 16x80 = 1280 ps/nm. We swept the total dispersion of FBG from -30 to -3000 ps/nm. The bit rate is set to 10 Gbps. In this simulation, we want to investigate the dispersion-limited performance of the system. To avoid triggering fiber nonlinearity, we keep the received power at -3 dBm. Effects of residual dispersion to nonlinear effects will be considered in other examples. This simulation shows that in the linear regime (low power), completely compensating fiber dispersion gives the best result[3]. Over-compensating degrades the system performance.

II SIMULATION OF WDM SYSTEM WITH POST FBG

In this techniques I will use ideal dispersion compensation FBG to reduce dispersion. An 80 km long optical fiber will conduct a user defined bit sequence. The signal can be analyzed with the help of optical time domain visualizer and spectrum analyzer.

We will now show how the amount of compensating dispersion affects system performance. In this case, we selected a post-compensation scheme because it is simple compared to the symmetrical compensation scheme[4]. All schemes perform similar in low power regions. Project is given in Dispersion compensation post with FBG. We can analyzed different parameters like Q factor, Min BER , eye height and BER pattern. In this simulation Q factor is better as shown in figure 2. This demonstrates the possibility for dispersion

compensation with the help of fiber Bragg Grating created with the Fiber Grating component.

This component allows design of apodized and chirped fiber gratings [5][6] that are able to provide dispersion compensation in optical system. Fig 3 shows min BER graph.

Fiber Bragg Grating with following properties has been used: frequency 193.1 THz, reffective index =1.45, length = 6 mm, apodization uniform, index of modulation 0.0001, linear chirp with a linear parameter 0.0001, number of segments 101 and maximum number of spectral points 1000.
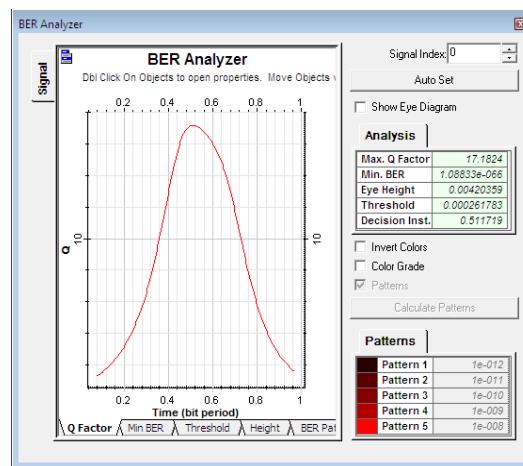
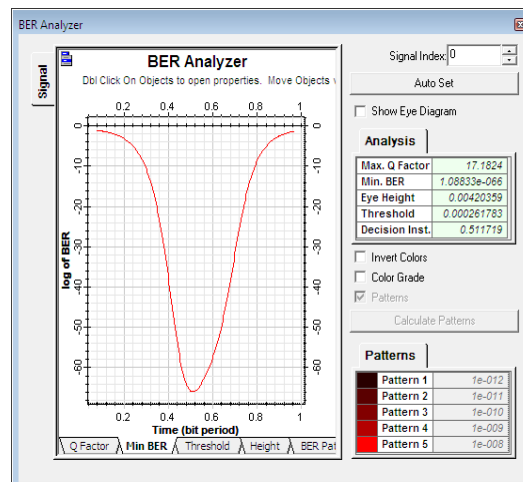

Fig-2 graph for Quality factor

Fig 3 Graph for Min BER

This is noted that this linear chirping reduces the period of grating during the propagation of the pulse in the grating. Therefore the higher frequencies will travel more in the grating before being reflected than the lower one[7]. The threshold value of signal is shown in figure-4 and eye height in figure 5
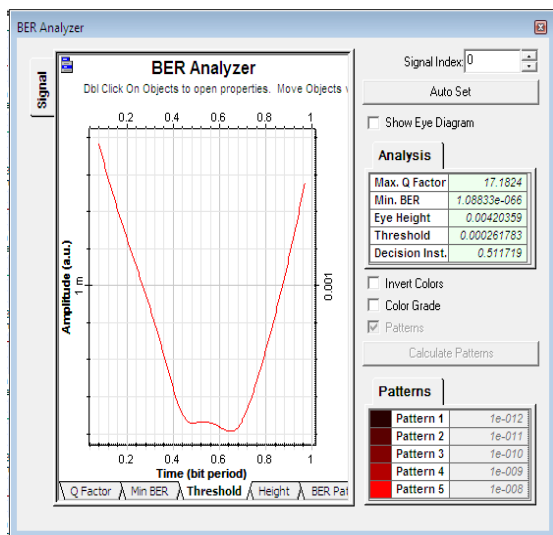
Fig 4 Graph for Threshold

Figure shows that Q factor is 17.1824 , Min BER is 1.08833e-066, Threshold is 0.000261783, Eye Height is 0.00420359.
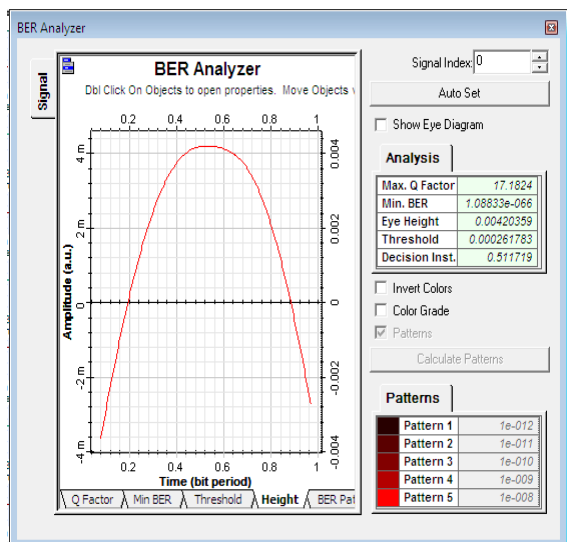

Fig-5 Graph for Eye Height

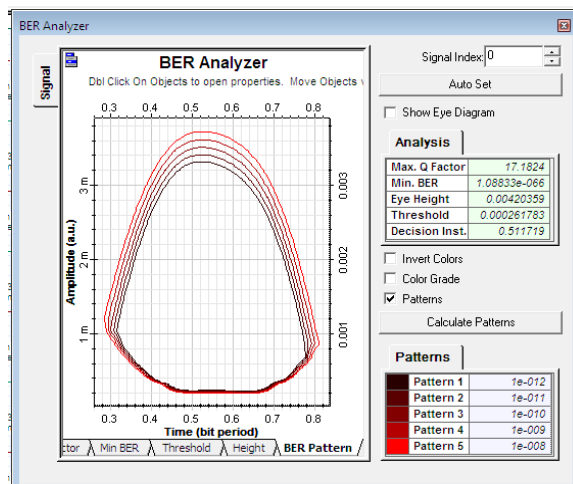Fig 5 shows eye height and fig 6 shows BER patterns at receiving end.
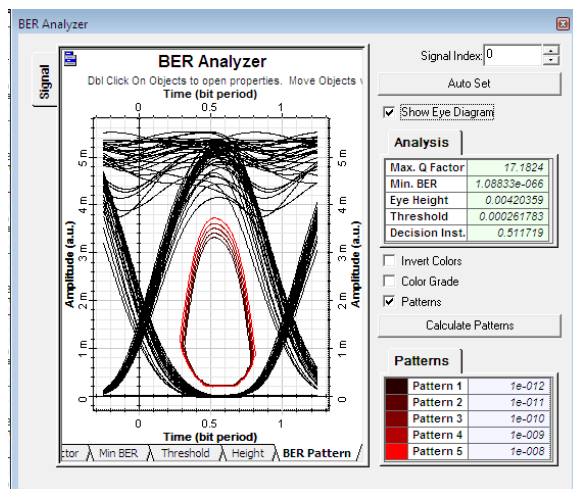

Fig 6 Graph for BER pattern

Fig-6 Eye diagram

In this simulation we are observing that the Q factor is 17.1824 , Min BER is 1.08833e-066, Threshold is 0.000261783, Eye Height is 0.00420359. In this technique we can see the dispersion in 193.1 Thz is reduced from 2.16587e+008ps/ns to 1.19493e+008ps/ns, noise is also reduce. OSNR ratio is improved. The power of these signals is decreased this is only one drawback and it can be overcome by using optical amplifier at output side. For 193.2 THz OSNR reduces while dispersion increase, power of signal is decrease. We can see only for this signal the results are not in our favor while other signals are received with fine parameters. For 193.3 THz, dispersion is reduced from 3.59741e+007 ps/nm to 1.84029e+008 ps/nm while noise reduces and OSNR improves. For 193.4, dispersion is reduced from 6.33977e+007 ps/nm to 1.09279e+006ps/nm, noise is reduced and OSNR improved.
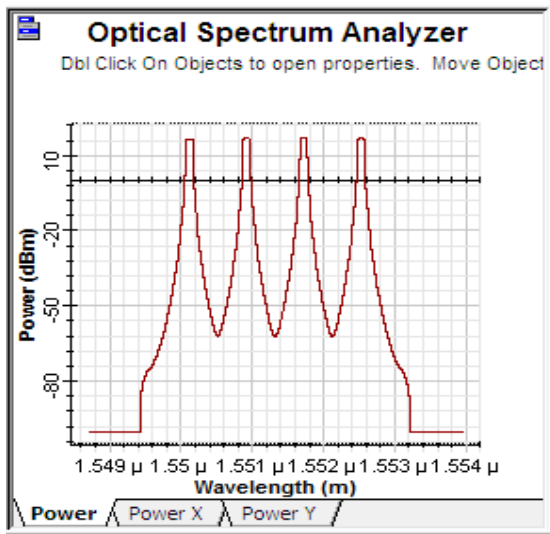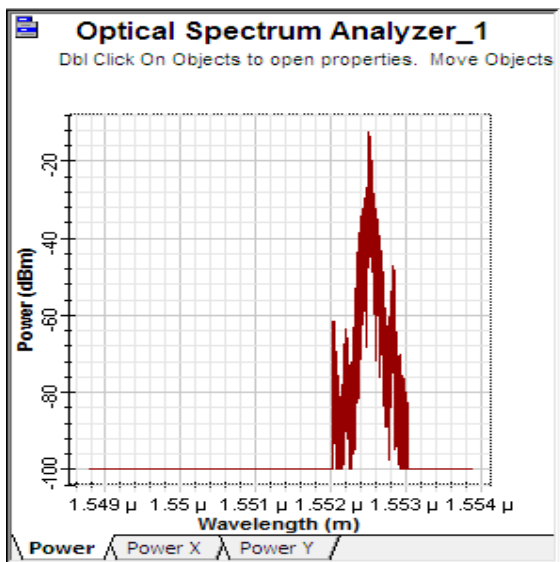
Fig-7 Optical spectrum after WDM

Fig-8 –Optical spectrum at receiving end

III CONCLUSION

It is shown in this paper that the recent advances in fiber brag grating technology now allow the realization of a high performance, high speed optical fiber with good in line dispersion compensation. The characteristics of optical fiber are analyzed in 4x1 WDM environments. The dispersion is computed by sending a NRZ modulated pulse as an in put for 80 Km length WDM network this is observed that the over all dispersion at the receiving end is approximate 40ps/nm/km.This is impossible to remove all dispersion but in our simulation we have succeeded to compensate dispersion . That's why fiber bragg grating is worthy compensation system in optical fiber communication. A narrow bandwidth is observed for data transmission in fiber bragg grating. In our simulation this is widened at a satisfactory value but for 40 Gbps system and for more length of 320 km(4 loop of 80 Km) it is required to compensate more dispersion than this simulation. So the future work this paper is chosen as to solve the problem using fiber bragg grating beyond 320km and 40 Gbps system.

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