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Comparative Study of Dispersion Compensating Techniques Pre, Post and Mix with 8 Channels

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ABSTRACT: Dispersion is the major factor to hamper long distance communication. To eliminate dispersion different compensation techniques are used, but among these dispersion compensation with DCF is most popular. DCF is used in three different compensation schemes. Quality factor and Bit error rate are analyzed at different fiber length. Dispersion Compensation Fiber has the negative and Single Mode Fiber has the positive Dispersion. These Schemes decrease dispersion and other non linearity effect as much extend. In optical Fiber communication, transmitters transmit optical information and at receivers side optical signal is converted back into electrical signal. Signal becomes distorted or week because of noise, dispersion and other nonlinearity effect. So sending signal over longer distance it is compulsory to suppressed dispersion. So dispersion compensation with Dispersion Compensation Fiber and Fiber Bragg Grating is the best scheme to reduce dispersion. In this paper we studied three different compensation techniques pre, post and mix compensation. It has been seen that mix compensation technique is best as compared to post and pre.

KEYWORDS: Dispersion compensation, Fiber brag grating, EDFA, BER, DCF, wavelength division multiplexing.

I.INTRODUCTION

We apply DCF to enhance the system utility. Three techniques using DCF at a rate of 10 Gb/s with Non return to zero modulation format and FBG give high data rate in optical transmission. .Transmission capability and bandwidth demand become more difficult in information Industry. To increase transmission distance it is compulsory to examine the transmission characteristics. Loss and dispersion decrease the system capacity so more capacity is needed due to fast growth in the number of internet users. EDFA works in 1550 nm wave band to accomplish the requirements of high speed, high bandwidth & high capacity networks WDM system has set up in the optical fiber communication.WDM networks have capability to send multiple signals having different wavelengths simultaneously (1).In these networks different users having different signals and wavelengths are multiplexed. Optical fiber used may be multimode fiber or Single Mode Fiber (SMF) depends upon its use. In this paper, we use Single Mode Fiber (SMF)since it has less distortion. At the transmitter NRZ Encoder with pseudo random bit generator and Continuous Wave to obtain the proper input to the 8: 1 multiplexer LASER and Mach-Zehnder is also used. Here 8: 1 Multiplexer is also designed for all 8- Channels. At receiver PIN diode used as a photo detector with low pass Bessel filter.NRZ modulation format used to produce the optical pulses we have to enhance the speed of transmission mainly latency and throughput between a transmitter and receiver. Because of less dispersion, single mode fiber is used. Finally to simulate the operation Opti-system software is used.WDM implementation would not have been possible without the development of EDFAs. Because these amplifiers function close to the 1550nm wavelength range, they are consistent with optical fibers that also work in the same 1550nm wavelength window. EDFA noise centre frequency also improves signal quality. As a Network is set up in university campuses, office buildings, industrial plants, so, we have to enhance the speed of transmission especially latency and throughput between a transmitter and receiver. The crosstalk acceptable limit is -30dB (2).

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II.LITERATURE SURVEY

Dispersion hampers both digital and analog transmission along optical fiber. Wavelength division multiplexing (WDM) technology combines a number of optical carrier signals into a single fiber with different wavelengths. WDM techniques increase the capacity and offer bidirectional communication. Fiber brag grating blocks certain wavelengths and passed wavelength having same phase. When the signal is send into the fiber, the distortion occurs because of dispersion and nonlinear effects of the fiber. So the distorted signal must be finished to keep the original signal. To decrease the signal distortion, the fibers must have opposite means positive and negative dispersion values. So we are using this topology so that dispersion can be eliminated suitably (3).

A Bessel filter is an analog linear filter which is same as Bessel– Thomson filters. When filter order increases it tends towards the shape of Gaussian filter. For dispersion compensation DCF was proposed in 1980 but when optical amplifiers are invented DCF helps to decrease the dispersion.SMF have positive and DCF have negative dispersion so total dispersion is zero. According to the position of DCF there are three compensation schemes pre compensation, post compensation and mix compensation.

In pre compensation scheme DCF is positioned before the SMF and post compensation Scheme DCF is positioned after the single mode fiber and in Mix compensation scheme DCF is positioned before and after the SMF (4)

Fiber length depends upon the signal power, pump power and pump wavelength. Fig shows that input signal carrying wavelength 1550nm and the diode laser signal added by wavelength multiplexer. This signal passes through the EDFA where it get amplified and the we get amplified output signal .WDM combines multiple signals and send over a Single Channel and at Receiver side all channels are separated. (See fig. 1)

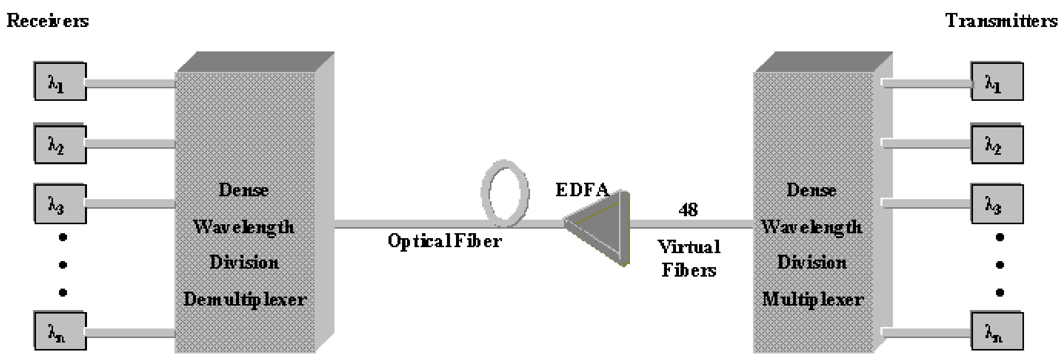

Figure 1: WDM System (5)

In 2013, authors proposed three different Dispersion compensation schemes according to the positions of DCF:

i. Pre –compensation

ii.Post-Compensation

iii.Mix-compensation

In pre-compensation scheme, the DCF is located before the standard single mode fiber (SSMF) to compensate the positive dispersion.

In post-compensation, the DCF is located after the SSMF to compensate the positive dispersion.

In Mix-compensation, both the schemes (pre-, post-compensation) are used i.e. DCF is located before and after the SSMF to get the dispersion (6).

III.PROPOSED METHODOLOGY

We use optic system 7.0 to design and simulation. it is an innovative and powerful software design tool. MATLAB is also used. The Simulation of dispersion compensation schemes is shown in below. Table 2 tells the parameters for the simulation of dispersion compensation systems. The transmitter section made up of modulator driver (NRZ

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driver), laser source and Mach-Zehnder modulator. A pseudorandom sequence of bits is generated by data source at a rate of 10 Gbit/s modulator driver which produces NRZ format pulse with 0.5 duty cycle. Frequecny range is 193.1 to 193.8. Mach-Zehnder modulator have 30db Excitation ratio. One loop has been used. To completely compensate accumulated dispersion in the transmission fiber we have 150 km of SMF and 20 km of DCF. The total length of fiber channel is 170km. and two EDFA used before transmission fiber and DCF. At the receiver side, PIN diode which is used to change the optical signal into electrical signal. A low pass Bessel filter filters the noise. Dispersion is decresed in optical fiber by three dispersion compensation fiber (DCF) techniques. Figures and Tables are shown below

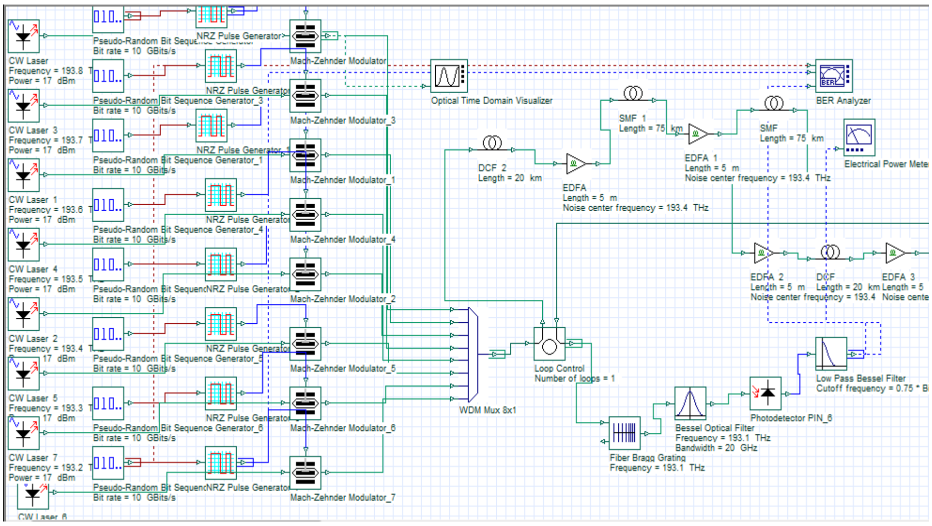

Figure 2: symmetrical compensation

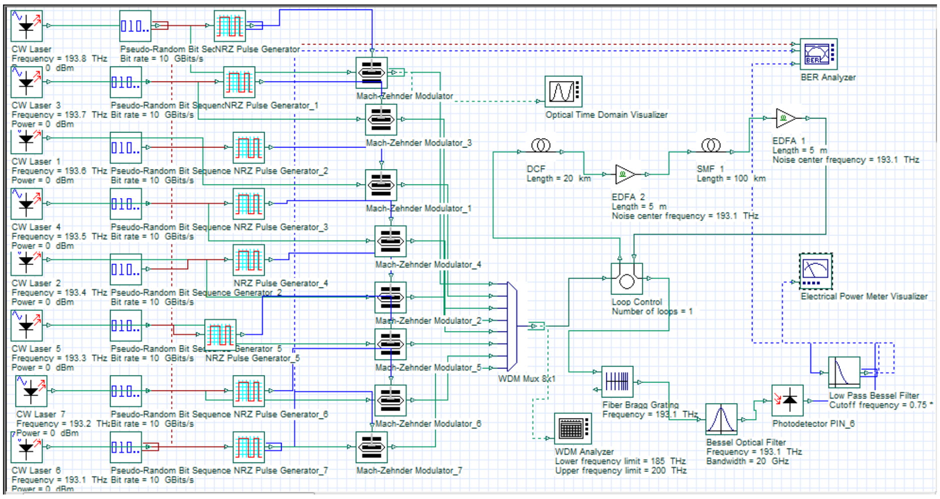

Figure 3: pre compensation

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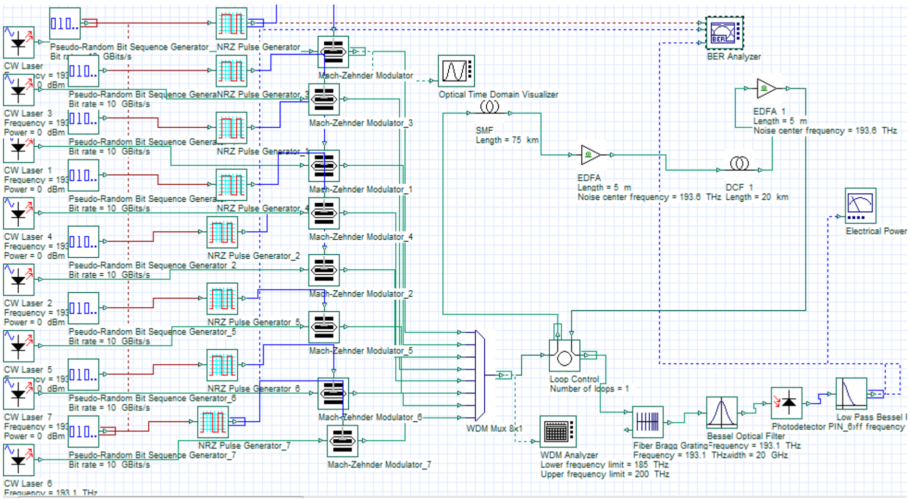

Figure 4: post compensation

Table 1: Fiber parameter

Simulation Parameters	SMF	DCF
Length(Km)	150	20
Attenuation(db/km)	0.2	0.6
Dispersion (ps/nm/km)	16	-80
Differential slope (ps/nm^2 /km)	0.08	0.2
Differential group delay(ps/km)	0.5	0.5
PMD coefficient([ps/km)	0.5	0.5

Table 2: Simulation parameter

Parameter	Value
Bit rate	10 Gb/s
Sequence length	128
Samples per bit	64
Central frequency of first channel	193.1
Channel spacing	100 Ghz
Capacity	8channel,10 Gb/s

Table 3: FBG Parameter

Parameters	Value
Frequency(THz)	193.1
Effective index	1.45
Length of Grating	2 mm
Linear Parameter	0.0001um
Apodization function	Uniform
Tanh parameter	0.5

Table 4: EDFA Parameter

	Mix	pre	Post
Noise centre frequency	193.4THz	193.1THz	193.6THz

IV. RESULT AND DISCUSSION

The results obtained by performing various experiments, as described in Section 3.Central frequency of laser is 193.1.different results are taken at constant fiber length and power. Eye diagrams of mix, pre and post

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compensation schemes are shown below

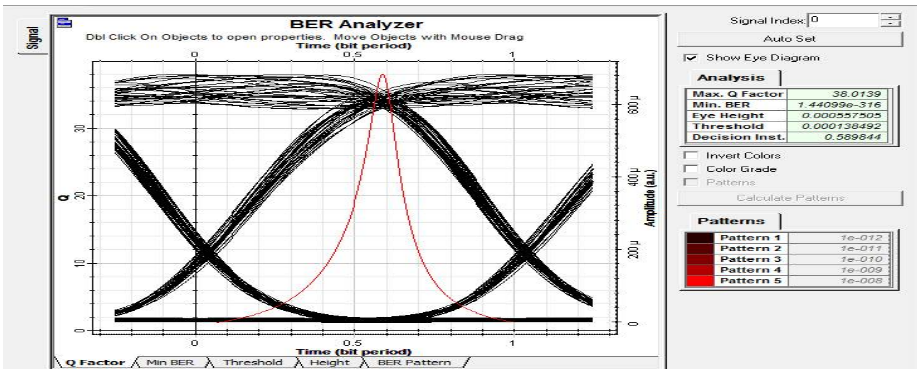

Figure 5: Eye Diagram of mix Compensation Scheme

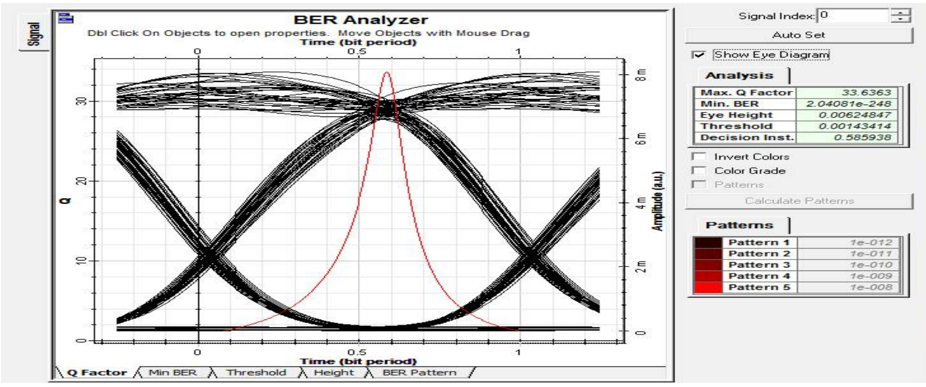

Figure 6: Eye Diagram Of pre Compensation Scheme

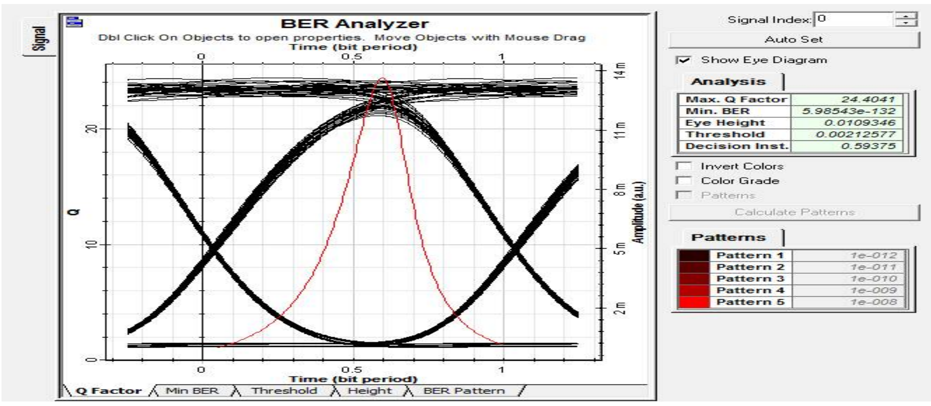

Figure 7: Eye diagram of post compensation scheme.

4.1 Results Based on Different length of SMF at constant Power

Power of CW laser in mix compensation scheme is 17 db, in pre compensation scheme is 0 db and in post compensation scheme is 0 db.

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Table 5: Mix compensation scheme at constant power

Fiber length	Q factor	Min BER
50 km	5.39194	3.39742e-008
75 km	38.0139	1.44099e-316
100 km	11.3494	3.24868e-030
125 km	2.08129	00172131

Table 6: pre compensation scheme at constant power

Fiber length	Q factor	Min BER
25 km	5.97108	1.14149e-009
50 km	11.1096	5.41783e-029
75 km	18.6386	7.06533e-078
100 km	33.6363	2.04081e-248
125 km	20.3218	3.53712e-092
150 km	9.69243	1.44117e-022

Table 7: post compensation scheme at constant power

Fiber length	Q factor	Min BER
25 km	6.02358	8.24988e-010
50 km	13.3826	3.42453e-041
75 km	24.4041	5.98543e-132
100 km	14.7791	9.41728e-050
125 km	6.89448	2.60351e-012
150 km	3.65253	0.000125256

4.2 Results Based on Constant Fiber Length

Now we take different observation on different input power at constant length. In Mix compensation Length is 75 km and in pre compensation Length is 100 km and in post compensation Length is 75 km.

Table 8: Mix compensation scheme at constant fiber length

Input power(DB)	Q factor	Min BER
-21	5.78635	2.77244e-009
-17	9.08791	3.69177e-020
-13	13.0057	4.08025e-039
-9	16.853	3.62653e-064
-5	19.8575	3.50964e-088
-1	22.0575	3.03451e-108
0	22.3184	9.19407e-111
1	22.9122	1.32407e-116
5	24.5289	2.76632e-133
9	27.651	1.05831e-168
13	32.916	5.24343e-238
17	38.0139	1.44099e-316
21	23.5916	1.77989e-123

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Table 9: pre compensation scheme at constant fiber length

Input power(DB)	Q factor	Min BER
-21	7.00153	9.01346e-013
-17	11.4002	1.43884e-030
-13	17.2939	1.8646e-067
-9	24.221	5.09212e-130
-5	30.6445	1.25758e-206
-1	33.7929	1.03587e-250
0	33.6363	2.04081e-248
1	32.238	2.11446e-228
5	25.1718	3.13974e-140
9	18.6151	8.75545e-078
13	14.1752	4.50173e-046
17	10.2435	4.19073e-025
21	5.84367	1.58417e-009

Table 10: post compensation scheme at constant fiber length

Input power (DB)	Q factor	Min BER
-21	6.01786	6.30404e-010
-17	9.68637	1.18738e-022
-13	14.7944	5.61548e-050
-9	20.4092	5.15795e-093
-5	24.4708	1.17201e-132
-1	24.6573	1.19051e-134
0	24.4041	5.98543e-132
1	23.7708	2.57861e-125
5	19.9785	3.15618e-089
9	14.9947	2.84049e-051
13	9.09651	3.29017e-020
17	3.74889	6.80721e-005
21	1.76263	0.0329065

Results Comparison of Transmission Influence of three Compensation Schemes

Comparison among three compensation schemes and it observed that mix compensation scheme is best as compared to pre and post.

Table 11: Comparison Table among Three different compensation Schemes

Compensation Scheme	Q factor	Min. BER
Mix Compensation	38.0139	1.44099e-316
Pre Compensatiom	33.6363	2.04081e-248
Post Compensation	24.4041	5.98543e-132

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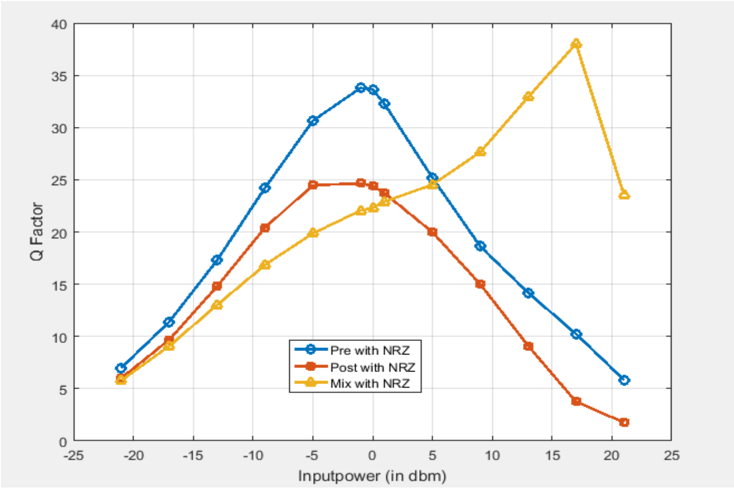

Figure 8: Comparison of Transmission influence of three compensation scheme

Table 12: WDM analyzer for Mix compensation scheme

Frequency(THz)	Signal power (dbm)	Noise Power(dbm)	OSNR(db)
193.1	13.590407	-30.803553	44.393959
193.2	13.529239	-27.814472	41.343711
193.3	13.433687	-30.695331	44.129018
193.4	-23.218527	-30.47325	7.2547236
193.5	-18.279434	-36.998065	18.718631
193.6	-18.28349	-37.437039	19.153549
193.7	-23.827659	-30.591037	6.7633786
193.8	13.576671	-42.217303	55.793974

Table 13: WDM analyzer for pre compensation scheme

Frequency(THz)	Signal power (dbm)	Noise Power(dbm)	OSNR(db)
193.1	-3.44261	-49.002121	45.559511
193.2	-3.5074208	-46.031064	42.523644
193.3	-3.5956754	-48.86562	45.269945
193.4	-40.591644	-48.559677	7.9680333
193.5	-36.784543	-54.979364	18.19482
193.6	-36.763674	-55.482634	18.71896
193.7	-41.280517	-48.754696	7.4741787
193.8	-3.4532691	-60.083229	56.62996

Table 14: WDM analyzer for post compensation scheme

Frequency(THz)	Signal power (dbm)	Noise Power(dbm)	OSNR(db)
193.1	-3.4426101	-49.002422	45.559812
193.2	-3.5074212	-46.031043	42.523622
193.3	-3.5956716	-48.864409	45.268738
193.4	-40.408269	-48.563079	8.1548094
193.5	-36.790994	-54.882614	18.09162
193.6	-36.838718	-55.469854	18.631136
193.7	-41.280348	-48.745545	7.4651976
193.8	-3.4532691	-60.083229	56.62996

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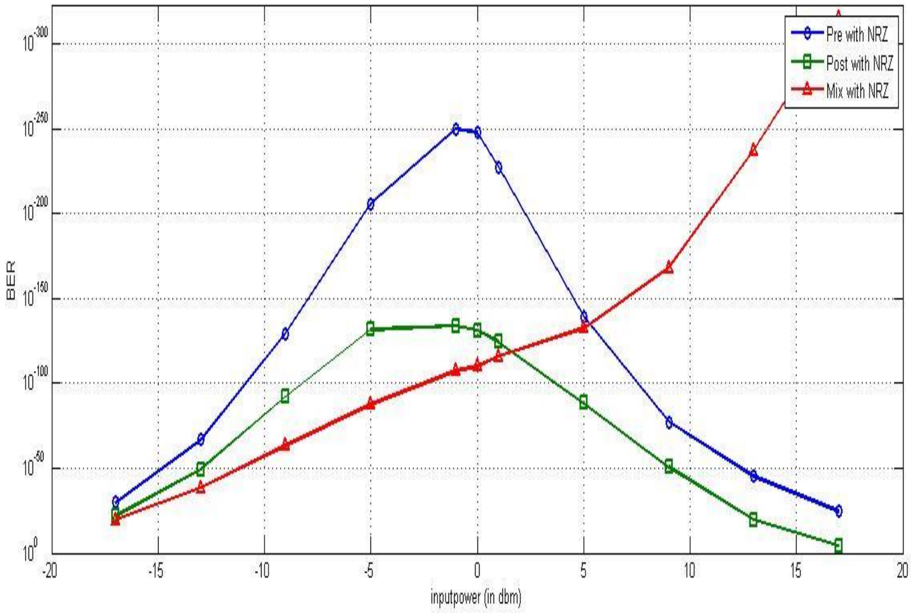

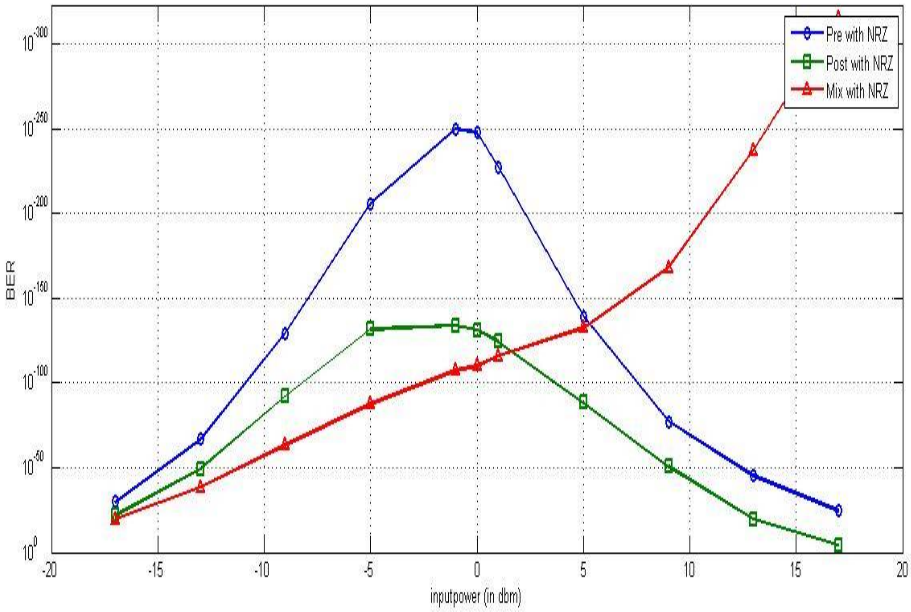

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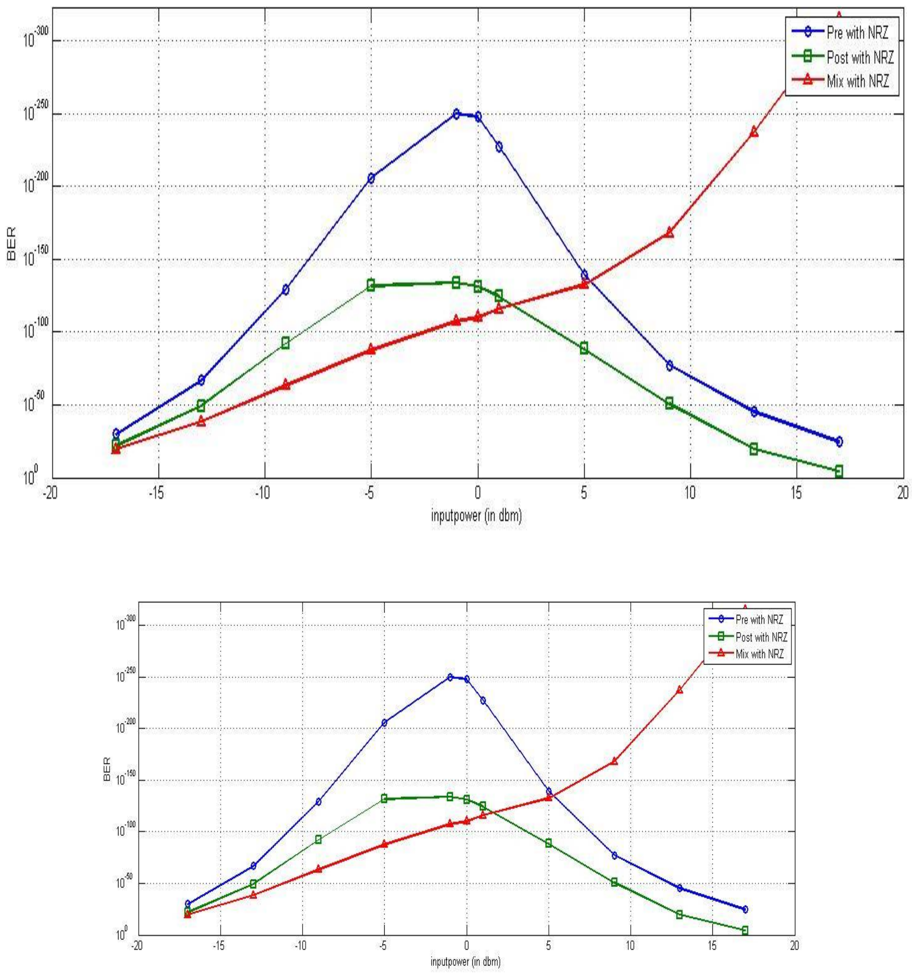

Figure 9: Input power and Min BER Of three compensation Schemes

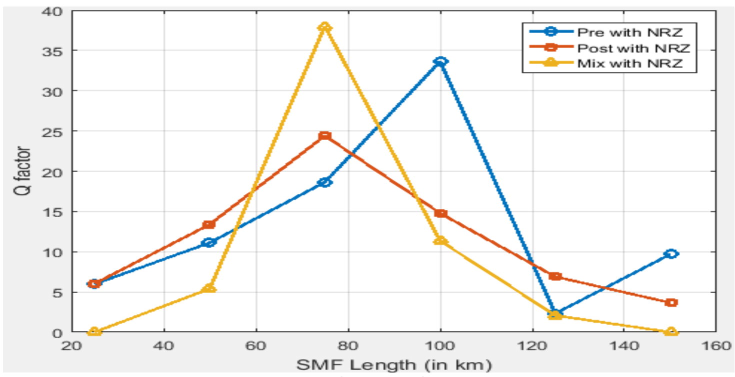

Figure 10: Fiber Length and Q factor of three compensation Schemes

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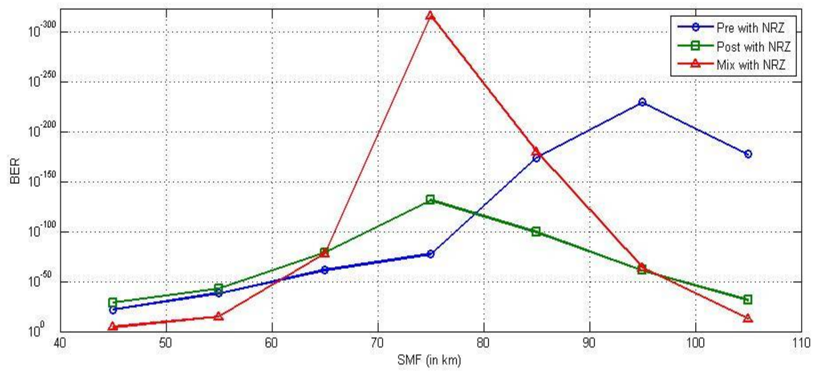

Figure 11: Fiber Length and Min BER of three compensation Schemes

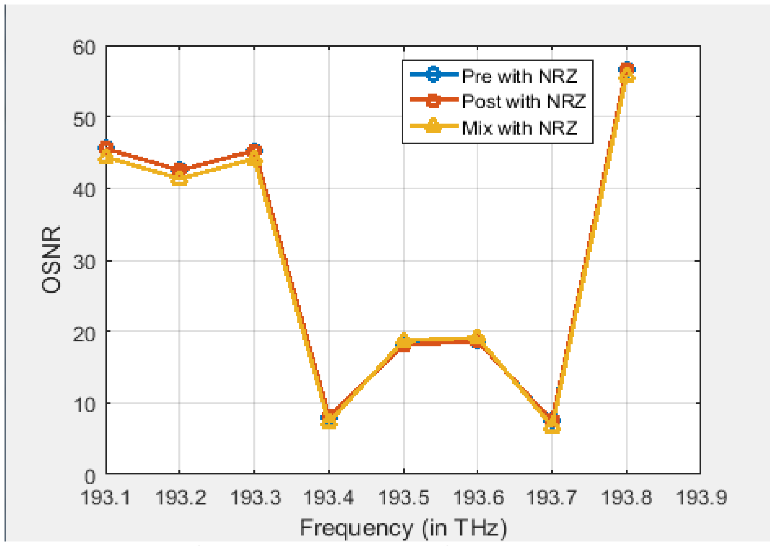

Figure 12: Input frequency and OSNR of three compensation Schemes

V.CONCLUSION

It has been seen that chromatic dispersion and other non linearity effects can be properly decreased using dispersion compensation fiber. Central frequency of Continuous wave is 193.1.EDFA noise centre frequency can be different for each compensation technique to get good quality of signal. At different length of fiber Q factor and BER is analyzed. Results are taken at constant fiber length and power .It has been analyzed that dispersion is decreased properly by compensation but in symmetrical compensation scheme dispersion reduces to maximum amount. Symmetrical Compensation Scheme is useful to reduce dispersion and quality factor that we get from this scheme is 38.0139. We used 8 channel WDM system at 10 gbps per channel for different dispersion compensation schemes using DCF and FBG. We observed that mix compensation technique is superior than of the pre and post-compensations techniques.

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