International Journal on Recent and Innovation Trends in Computing and Communication
Volume: 5 Issue: 5

ISSN: 2321-8169
890 – 895

Comparison in Behavior of FSO System under Clear Weather and FOG Conditions

Mohammad Yawar Wani, Prof.(Dr).Karamjit Kaur, Ved Prakash

[1]Student,M.Tech. ECE, ASET, Amity University Haryana

[2]Professor, ECE, ASET, Amity University Haryana

[3]Assistant Professor, ECE, ASET, Amity University Haryana

[1]yawerwani67@gmail.com, 07006607934

Abstract :- Free space Optical (FS0) communication has been emerged as a more conventional means of communication rather than the traditional optical communication. Its high speed of up to 2.5GHz and the license free long range operations makes its more superior system over other communication systems. Not only have these factors made it a better communication system but there are many other advantages of these systems like, small size, high bandwidth and low cost. Free space optical communication has some limitations also like its degradation in bad weather conditions. Weather effects the performance of the free space optical communication by means of scattering. In this paper we will design a FSO system which has range of 1 km and data rate of 2.5Gbps and check its performance in clear weather and fog conditions.

Keywords: *FSO, BER, PRGB.*

*****

1. INTRODUCTION

Free space optics is a communication system that uses free space for the transmission of data .It does not require any medium for the transmission of data unlike fiber optical communication that uses fiber for the transmission of data. FSO provides the same services as that of fiber optics but at a very low cost and very fast deployment speed [1]. FSO is emerged as a viable wireless communication system for long and short haul networks. Free space optics works on the principle of laser driven technology where a laser source is used at transmitting end and a photodetector at receiving end. The FSO network is useful where the physical connection by the means of fiber optic cables is not possible [2]. The main aim of FSO networks is to reduce the cost and to provide high speed for transmission of voice, image and video. FSO have a full duplex capability which increases the performance of the system. FSO networks are not very complicated, they are easy to understand and implement.FSO system uses a high-power optical source (e.g. laser) plus a telescope that transmits light through the atmosphere to another telescope that receives the information, the receiving telescope connects to a high-sensitivity receiver.FSO communication can be used in optical links such as building-to-building, ship-to-ship, aircraft-to-ground and satellite-to-ground.

Free space optics (FSO) communication networks have various advantages over conventional microwave and optical fiber communication systems by presence of their high carrier frequencies that allows large capacity, enhanced security, high data rate and so on. In short, FSO is an optical communication technology that uses light propagating in free space to transmit data between two points. There are some similarities between fiber optic communications and FSO that in both the systems data is transmitted by modulated laser light. The difference is only in the medium through which the data is transmitted, as the fiber optic communication uses glass fiber for the transmission and in FSO a narrow beam of light is transmitted through the space, as light travels through air faster than it does through glass, so it is fair to classify FSO as optical communications at the speed of light. The stability of the link is highly dependent on various atmospheric factors such as rain, fog, dust and heat..The main aim of the project is to check the performance of the FSO networks as the weather changes for clear to fog conditions.

ISSN: 2321-8169
890 – 895

2. FSO System Design

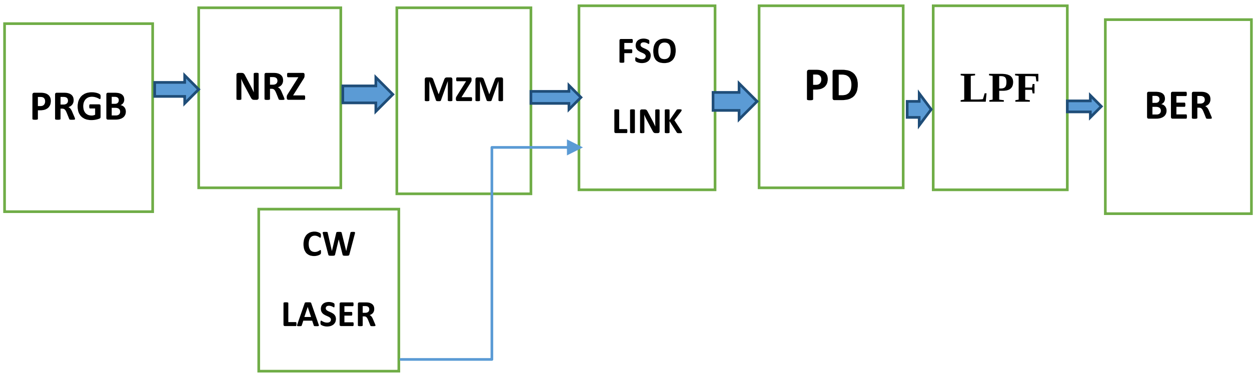

FIG 2: FSO system Design

Figure 2 shows the simple configuration of an FSO system. It consists of

1) Pseudo- Random Bit Generator (PRBG).
2) NRZ Pulse Generator.
3) Continuous Wave (CW) Laser.
4) Mach-Zander Modulator.
5) PIN photo detector.
6) Low Pass Bessel Filter.

Some additional tools provided by our software Opti system 14.0 such as BER Analyzer, Electrical Power Meter are also used. Firstly, Pseudo random bit generator generates the bit sequence i.e. in the form of 1010 etc. and transmits to the NRZ pulse generator. The NRZ pulse generator coverts the logical signal into the electrical signal and passes this signal to the Mach-Zender Modulator. The modulator receives two inputs one is the electrical signal from the NRZ pulse generator and other is from as a continuous wave. The output from the continuous wave laser acts as a carrier signal to the modulator. The function of the modulator is to convert the electrical signal into the optical signal because the system is working on the free space optics. The modulator then forwards the optical signal to the Photo detector through the free space. Then the work of the photo detector is to convert the optical signal back into electrical signal and pass it to the Low pass filter (LPF).LPF removes the unwanted signals and the result output is shown on our BER which is connected to the LPF.

3. ATMOSPHERIC ATTENUATION OF LASER POWER

The changing atmosphere conditions does not provide required communication thus atmosphere is not an ideal channel. The efficiency of Free Space Optical communication system is mainly affected by scattering, absorption and scintillation [3]. The reason behind the absorption is the presence of carbon dioxide and water vapors in the air that is the communication link path.These effects can reduce the power density of transmitted signal and the availability of the system.

The attenuation of laser power through the atmosphere is given by the exponential Beers-Lambert Law[4].

$$\tau\,(R) = \frac{P(R)}{P(0)} = e^{-\sigma R}$$

where

τ(R) = transmittance at range R.
P(R) = laser power at R.
P(0) = laser power at the source.
σ = attenuation or total extinction coefficient (per unit length).

<u>Clear Weather condition:</u> In clear weather the amount of attenuation is negligible, but there is some sort of attenuation. This is because of the divergence of beam and a result the detector receives less power. This type of attenuation in which transmitted beam spreads with increasing range is called as geometrical attenuation and is given by the formula (1):

$$A_{geo}\ (dB)=10\log_{10}\left(\frac{S_d}{S_{capture}}\right)$$

where:

$S_{capture}$: receiver capture surface (m^2)

S_d : surface area of transmitted beam

also:

$$S_d = \frac{\pi}{4}(d.\theta)^2$$

where:

θ: beam divergence(mrad)

d: emitter receiver distance(km)

Typical attenuation coefficients in clear air = (0.43 dB/km)[5].

ISSN: 2321-8169
890 – 895

4. Attenuation under FOG conditions

The attenuation under fog conditions can be attained by means of the visibility factor.The visibility parameter can be easily obtained, either from airport or weather data. Visibility data from most global airports has also been archived for many years by NOAA [6].These visibility distributions can be used in the below Equation 1 to evaluate the attenuation coefficient.

The attenuation coefficient can be obtained with respect to the wavelength by the Empirical formula.

$$\sigma = \frac{3.91}{V}\left(\frac{\lambda}{550nm}\right)^{-q} \qquad (1)$$

Where,
V = Visibility in km
λ = Wave length in nanometers.
q = The size distribution of scattering particles.

According to the Kruse model, q is given as:
= 1.6 for high visibility V > 50 km.
= 1.3 for average visibility 6 km <V< 50 km.
= 0.585 V1/3 for low visibility V < 6 km.
While Kim model defines q as :
= 1.6 for visibility V > 50 km.
= 1.3 for visibility 6 km <V< 50 km.
= 0.16V+0.34 for visibility 1 km<V<6 km
= V - 0.5 for visibility 0.5 km<V<1 km
= 0 for visibility V<0.5 km

On the basis of visibility factor we have evaluated three different types of Fog conditions and using equation 1, we have obtained their attenuation values.

Visibility(km)	dB/km 1550nm	TYPE
1	9	LIGHT FOG
0.5	21	MEDIUN Fog
0.2	34	Heavy Fog

Table 1 A table of atmospheric losses (in dB/km) as a function of visibility for 1550nm calculated using equation 1.

5. Result and Discussion

The design and simulation of the system was done in the powerful software opti system 14.0 and results of given FSO system can be taken out by using the following parameters: Data Rate = 20 Gbps; Power = 30 mW; Wavelength =1550 nm; Beam Divergence = 2 mrad; Receiver Aperture = 20 cm; Transmitter Aperture = 5 cm.

FSO system basic design was modeled and simulated for by using OptiSystem 14.0 which is a powerful software design tool that enables to plan, test and simulate optical link in the transmission layer of a broad spectrum of optical networks from LAN, MAN to ultra-long haul. The advantage of this software is that it minimizes time requirement and decrease cost related to the design of optical systems, links and even components. There are several parameters of the system varied to obtain the optimum system performance. The main parameter that was considered is the laser propagation distance between the specific FSO channels. The FSO design model is illustrated in Fig. 2

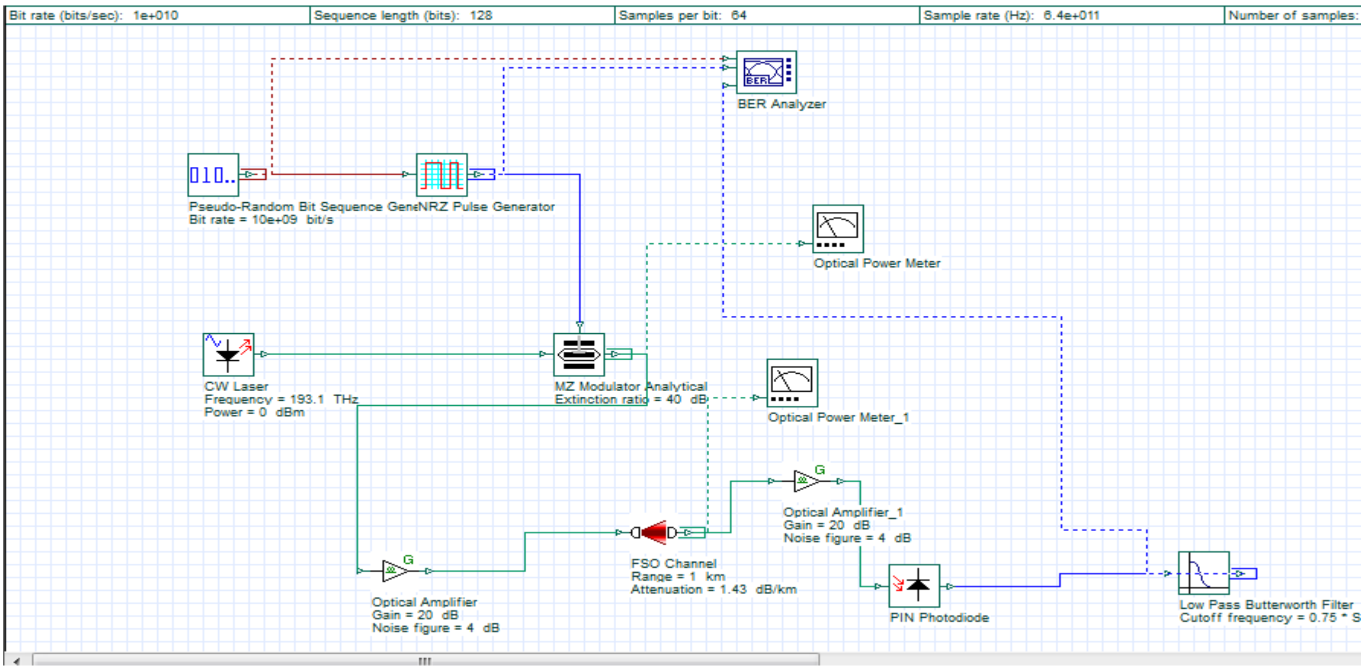

Figure 2 FSO systems Design

Figure 3 Evaluation of Q factor under clear weather conditions, where attenuation is 0.43db/km.

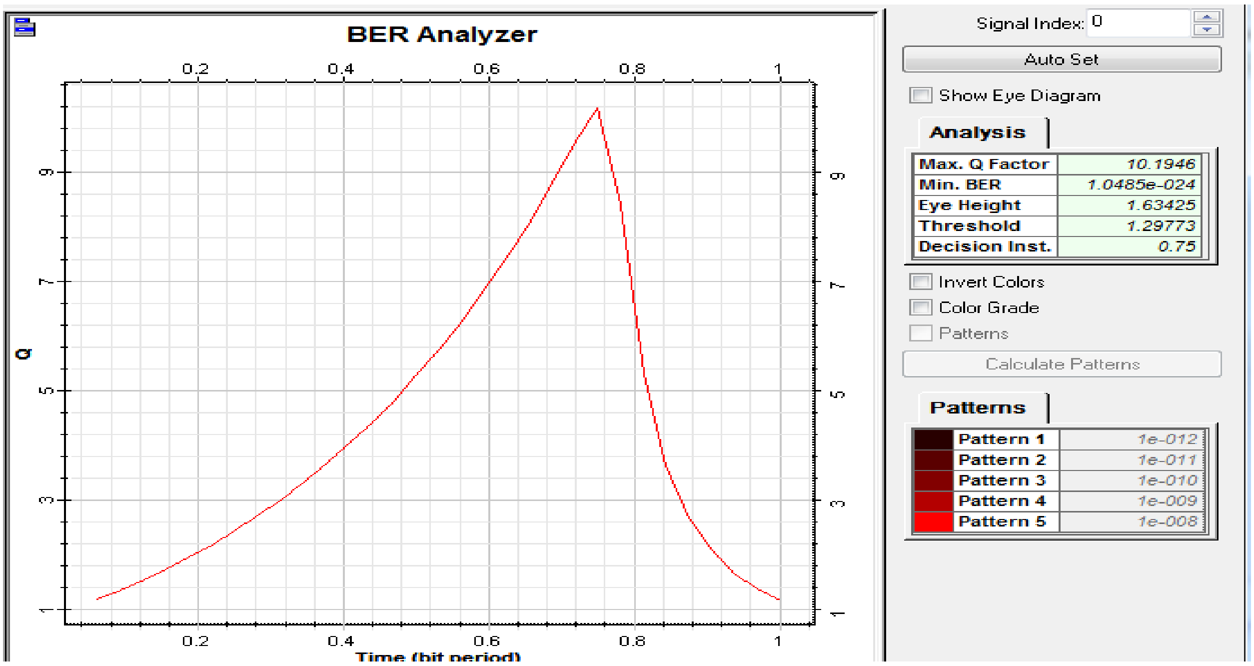

Figure 3 Q factor under clear weather conditions

Figure 4 Evaluation of Q factor under light FOG conditions, where attenuation is 9 dB/km.

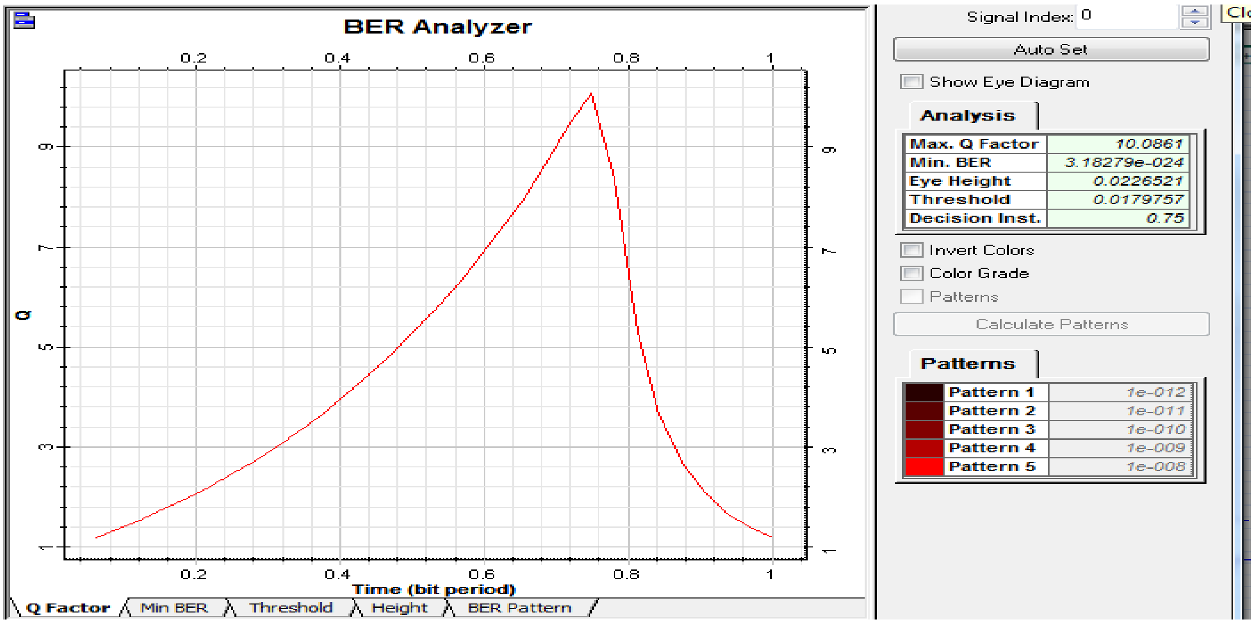

Figure 4 Q factor under light Fog conditions

Figure 5 Evaluation of Q factor under light FOG conditions, where attenuation is 21 dB/km.

 ISSN: 2321-8169
890 – 895

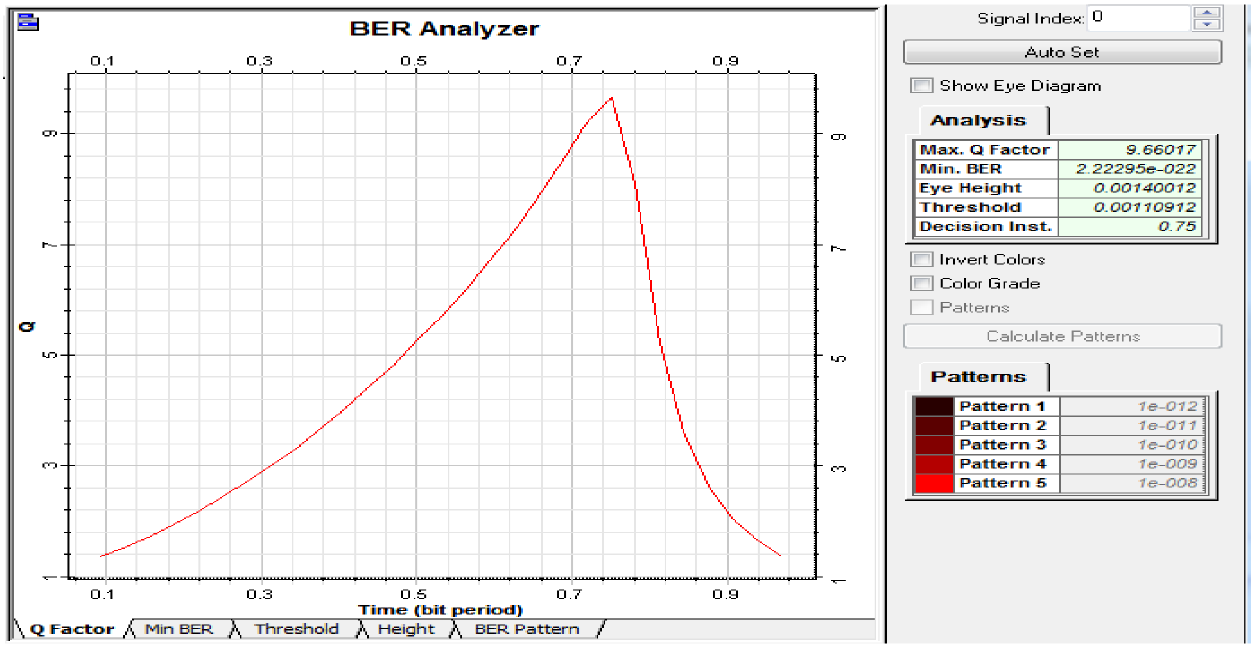

Figure 5 Q factor under medium Fog conditions

Figure 6 Evaluation of Q factor under light FOG conditions, where attenuation is 34dB/km.

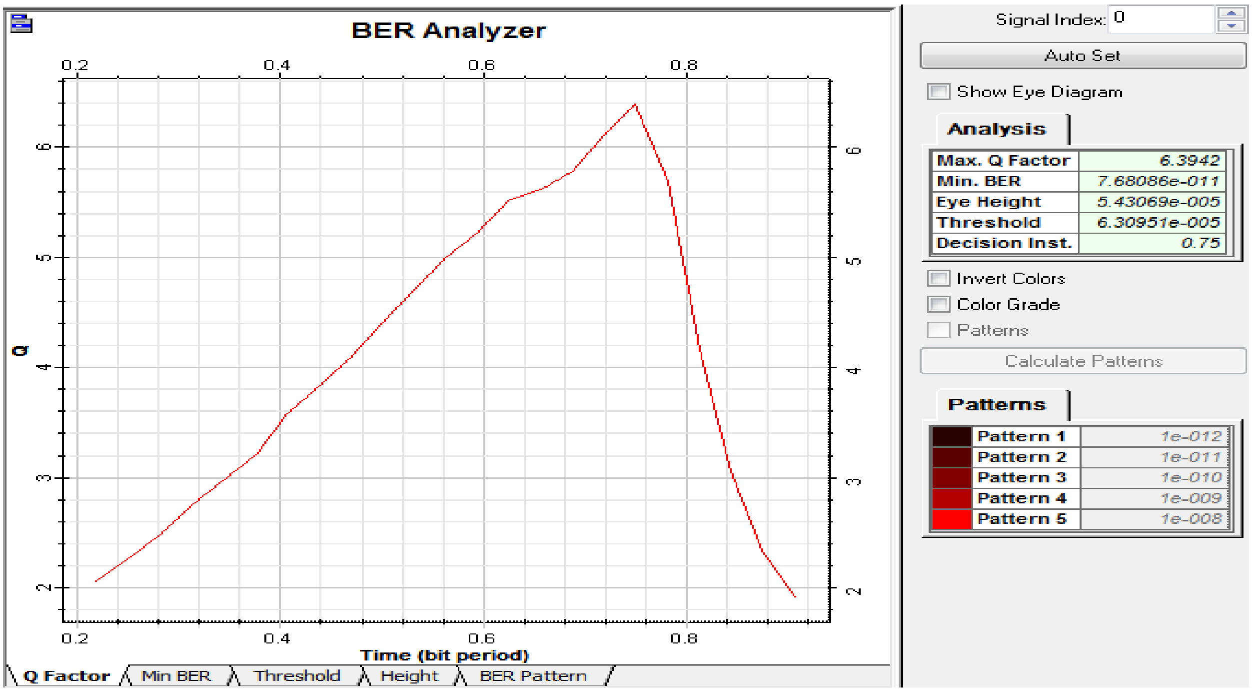

Figure 6 Q factor under heavy Fog conditions

Figure 7(a) and & 7(b) shows the comparison as how much our signal gets distorted as we move from clear weather to heavy Fog.

ISSN: 2321-8169
890 – 895

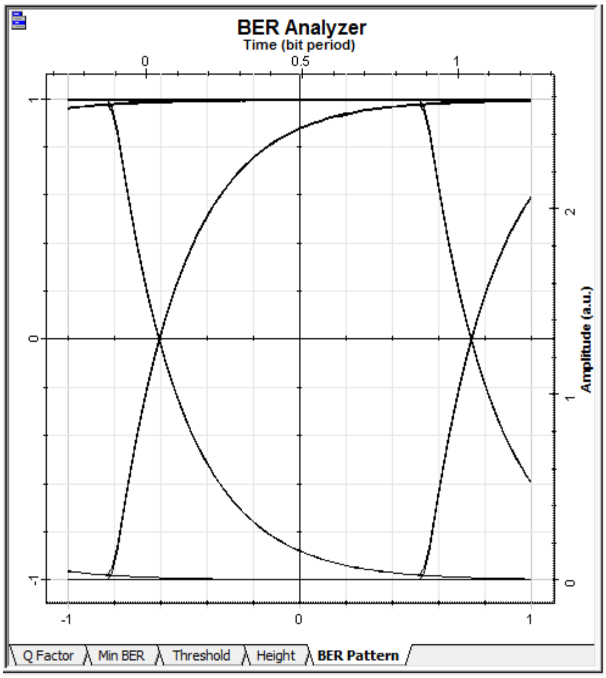

Figure 7(a) Eye Diagram
(Clear weather)

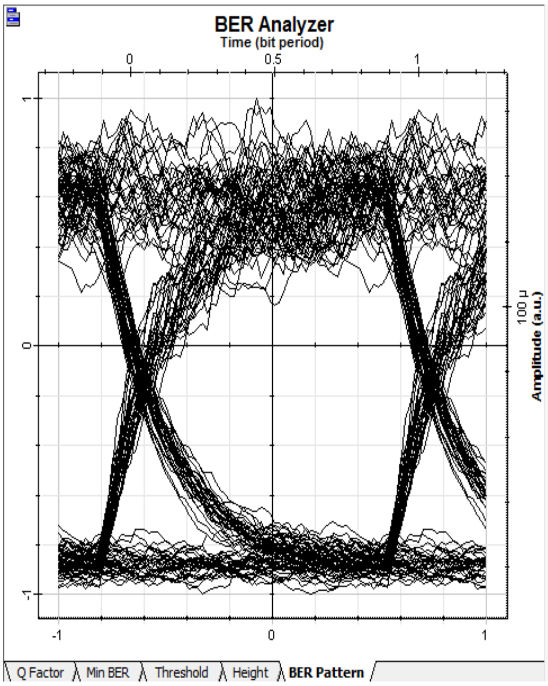

Figure 7(b) Eye Diagram
(Heavy FOG)

6. CONCLUSION

In this paper we have designed a 20 Gbit/s FSO system with the help of the software opti system 14.0.Analysis of 20 Gbit/s FSO system with different weather condition by distance of 1 km was done. From the result it is clear as we move from clear weather to heavy fog Q factor decreases. We presented an FSO system whose maximum transmission range is 1 km at attenuation 0.4 dB/km which is clear weather conditions. But as the weather conditions changes from clear to fog it effects the transmission in our FSO systems very badly which is clearly depicted from the results obtained in this paper. The Q factor decreases as the Fog conditions occur more immensely i.e when changes from light to heavy Fog.

REFERENCES

[1] KOLKA, Z., WILFERT, O., KVICALA, R., FISER, O. COMPLEX MODEL OF TERRESTRIAL FSO LINKS. PROCEEDINGS OF SPIE, 2007, VOL. 6709, P. 67091J.

[2] C.C. Davis, I.I. Smolyaninov, .Effect of atmospheric turbulence on bit-error rate in an on-off-keyed optical wireless system,.in Free-Space Laser.

[3] K. Kiaseleh, “Performance of Coherent DPSK Free Space Optical Communication System in Distributed Turbulence”, IEEE Transactions Communication, vol. 54, (2006).

[4] H. Weichel, Laser Beam Propagation in the Atmosphere, SPIE, Bellingham WA, 1990.

[5] E. J. McCartney, Optics of the Atmosphere, J. Wiley & Sons, New York, 1976.

[6] International station meteorological climate summary. Ver. 4.0, Federal Climate Complex Asheville, 1996.