# ANALYSIS OF THE EFFECT OF FOGGY CONDITION IN FSO SYSTEM AT THE DISTANCE 900m WITH 6Gbps

Abhishek Ranjan Kushawaha[#1], Er. Mukesh Kumar[*1], A.K. Jaiswal[*2], Er. Neelesh Agrawal[*3]
[#1] *M.Tech. Scholar, ECE Department SHUATS University, Allahabad*
[*1] *Assistant prof.,* [*2] *prof. ,*[*3] *Assistant prof., ECE Department SHUATS University, Allahabad*

***ABSTRACT***
*In the recent past Free Space Optical (FSO) communication has taken over the radio frequency communication and microwave systems due to its advantages such as ,its long-range operations devoid of need of license. Although in this paper we have found that the most effective distance CW laser transmitter suitable for free space optical (FSO) communication. The theoretical analysis of behaviour of an FSO wireless communications system is done Using on off keying with CW laser over fog weather conditions. Based on optical beam propagation at 1550nm on an FSO, the bit error rate (BER) and Q-factor under Fog weather is analyzed.*

**Key words -** *FSO,BER, Q-factor, EYE diagram, Attenuation ,Foggy condition.*

## I.INTRODUCTION

Free space means medium comprising of air, vacuum and outer space. Free-space optical communication (FSO) is an optical communication technology which is uses for light, propagating in free space to transmit data without wire for telecommunications. It is point to point infrared spectrum based optical communication between optical transceivers that are separated by physical medium known as air. It has evolved as a future technology for coming generation indoor and outdoor broadband wireless applications. Indoor wireless optical communication is also called wireless infrared communication; outdoor optical wireless communication is commonly called FSO. FSO communication involves direct Line Of Sight and point-to-point laser links from transmitter to receiver via atmosphere. There are numerous benefits of free space optics: lower costs associated with the system, no fibre cable required, no rooftop installations required and no license is required. Transmission rate of this system is very high, hence can transmit a large amount of data. In future it is expected that it will increase to 10Gbps.This speed is due to the fact that the signals can be transmitted through the air faster than they can be transmitted through fibre optic cables. Interference between signal and radio frequencies is negligible. The FSO technology is line of sight (LOS) link based technology which uses a small divergence angle laser or LED as transmitter and receiver whose field of view(FOV) is very narrow to communicate data between two points. FSO is a cheaper option compared to the fibre optics and RF systems because it offers a bandwidth which is similar to that of optical fibre at a low cost and much ease of deployment. The features of FSO systems such as unregulated spectrum, fast deployment, light weight and a secure communication, make it very attractive for commercial uses. But it also has certain limitations as reliability of an FSO communication system is greatly affected by the atmospheric conditions through which it has to propagate. Aerosol, fog, gases, rain and various other suspended particles in the atmosphere causes the optical beam scattering and absorption which results in a large path loss and as a consequence limiting the link length to less than 100m.Even in clear sky conditions atmospheric turbulence, which are caused by temperature and pressure in homogeneity's present in the atmosphere, leads to refractive index fluctuations in atmospheric layers. When signal propagate through such turbulent atmospheric layers, it will experience random fluctuations. The variations in the amplitude and phase of the received signal due to atmospheric turbulence effect are known as scintillation. Scintillation causes deep signal fading that lead to increased bit error rate and hence degrades the link performance especially for link ranges greater than 1km.
In this paper we establish a FSO system of 900m and examined the performance of such a communication system during foggy condition.

## ATMOSPHERIC TURBULENCE

The following most important difference between Fibre Optics based system and FSO system brings in the following interferences:

A. Thick fog is one of the most complex forms of interference in free space optical Communication.

This occurs because of the moisture in the fog that can reflect, absorb, and scatter the signal.

B. Absorption and scattering both occur when there is a lot of moisture in air. Absorption of the Signal causes a reduction in signal strength. Scattering causes the signal to be dispersed in various directions. This is an issue particularly for long distances.

C. Physical obstructions, such as trees and even building, can also be a problem.

D. Scintillation, is heat rising from the earth or man-made, can also disrupt in the signal.

E. Alignment, the main challenge with FSO systems is maintaining transceiver alignment. FSO Transceiver transmits highly directional and narrow beams of light.
When an optical beam propagates in atmosphere, it experiences different refractive indices in its path which causes random variation in its intensity and phases that results in the signal fading.

Following condition are very much prevalent in the free space causing interference and thereby deterioration in the FSO system performance:

*Fog Condition:* Fog is the most pivotal weather phenomenon with respect to FSO as it consists of small water droplets with radii nearly the size of infrared wavelengths. The particle size distribution varies according to different levels of fog. Weather condition is referred to as fog when visibility range lies between 0–2,000 meters. Sometimes it is difficult to describe foggy conditions using physical methods, therefore expressive words such as "advection fog" or" convection fog" are used to characterize the nature of fog .

*Snow Condition:* Snowflakes are ice crystals that come in a variety of sizes and shapes. White out conditions might attenuate the beam, but this problem for FSO systems can be coped with as the size of snowflakes is large in comparison to the operating wavelength. The amount of attenuation in snow condition is 3dB/km to30 dB/km.

*Rain Condition:* Rain has a distance-reducing impact on FSO, but still its influence is significantly less than that of other weather conditions. The influence is due to large difference between the radius of raindrops and the wavelength of typical FSO light sources. Typical rain attenuation values are reasonable in nature.

*Clear Weather Condition:* When there is a clear weather; there is very less attenuation. The Attenuation factor value in the clear weather ranges from 0 to 3 dB/km.

**Table 1: shows the different weather conditions with their attenuations**

| Condition | Attenuation in db/km |
|---|---|
| Clear weather | 0.2-3 |
| Rain | 4-17 |
| Snow | 20-30 |
| Light fog | 40-70 |
| Heavy fog | 80-200 |

## III.MATERIAL& METHOD

FSO design has been modelled and simulated for performance characterization by using Opti system 12.0.The transmitter consists of a PRBS generator at bit rate 6 Gbps, modulation driver, and a directly modulated CW laser at 1550wavelengths. Optical power used in transmitter is 10dBm. The FSO Link has a 900m range with beam divergence angle of 3mrad. The APD receiver is followed by a BER tester for determining Q factor and BER.

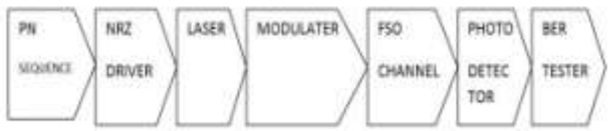


Fig.1. Block diagram of FSO system.

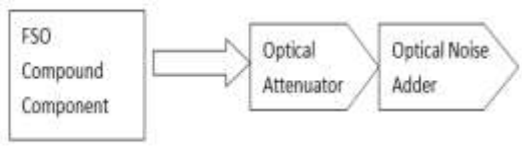


Fig.2. Simulation setup for FSO link.

## IV. RESULT AND DISCUSSION

In this proposed design, performance of the free space optical communication system has been studied with light foggy condition and clear weather condition. Here we took observation on the signal transmission at a larger distance at high speed data transfer with the help of CW laser transmitter for free space optical communication. Results have been taken by selecting various parameters such as wavelength 1550nm, transmitter power 9dBm, data rate 6Gbps, attenuation factor of 40dB/km, divergence angle3mrad and transmission length 900m.By the analysis we get the Q Factor 4.15293 and minimum bit error rate is 1.64102e-005 and eye opening height is 0.0465154.

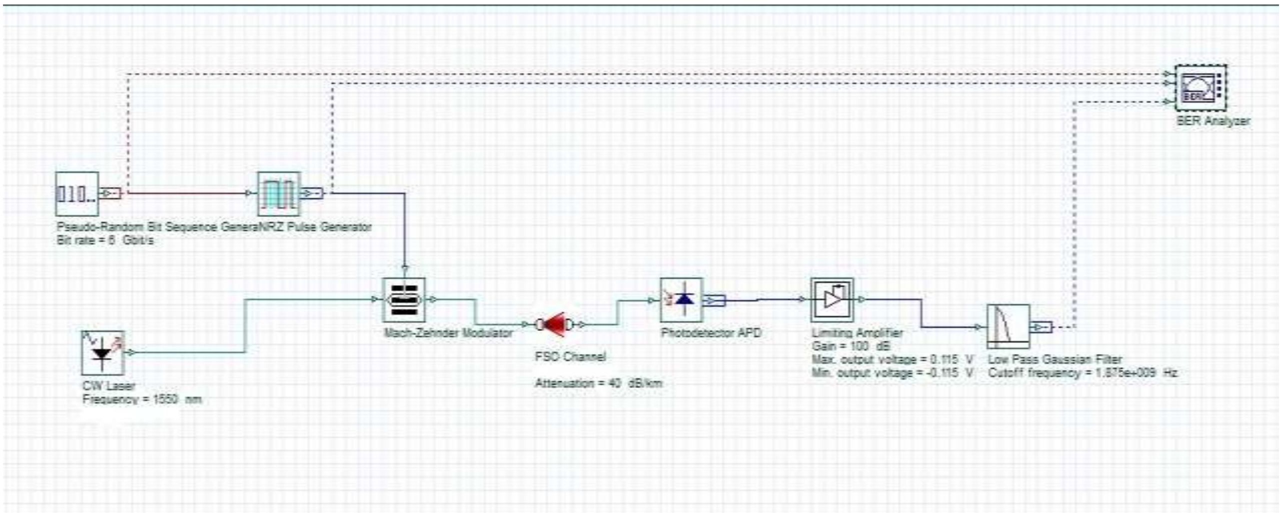


Fig.3. Shows the simulated design of proposed FSO system with light fog condition.

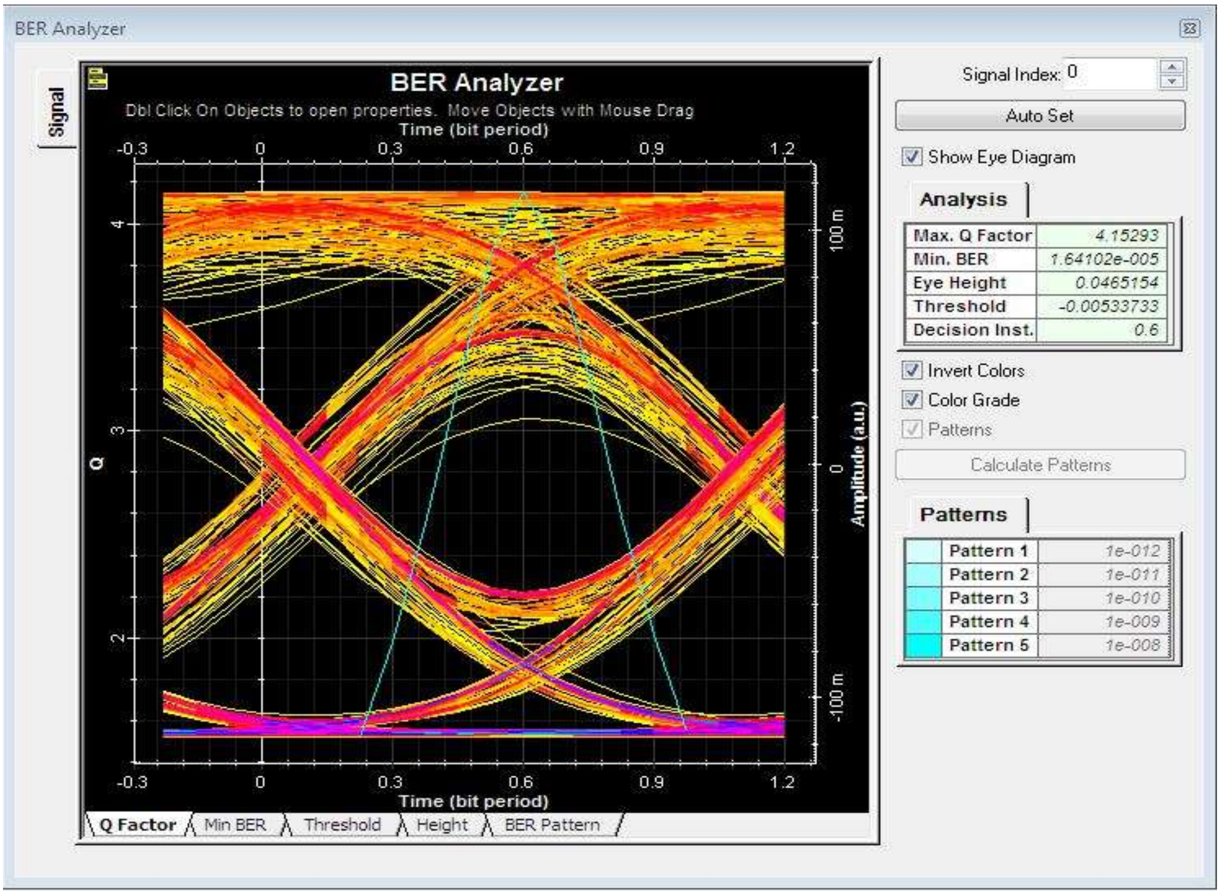


Fig.4.Eye diagram at 6Gbps at 900m with 9 dBm power in Foggy condition.

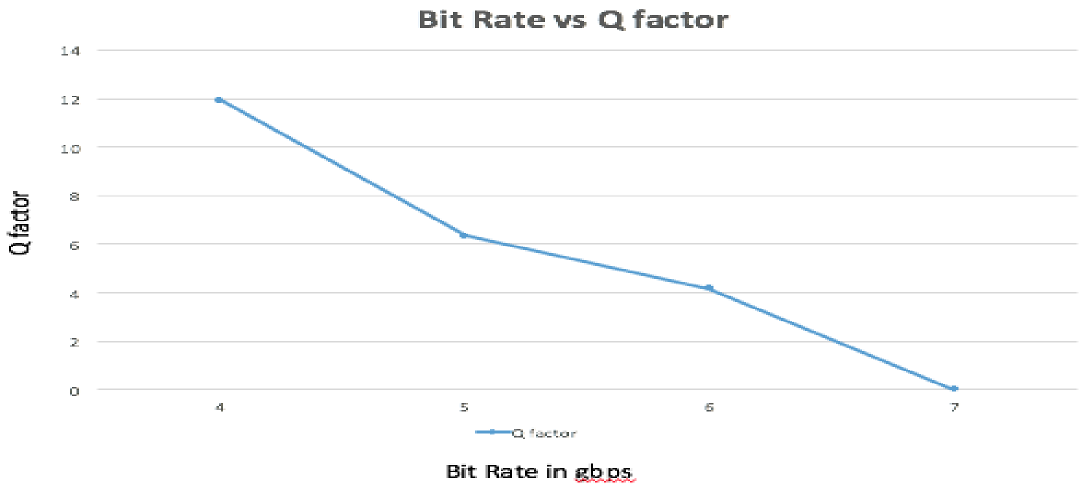


Fig.5. Graph showing variation of Q factor with bit rate in foggy condition.

The graph in fig. 5 reveals that maximum Q factor occur at the 4 Gbps at 900m distance and minimum (0) at 7Gbps, the maximum bit rate.

However the most convenient bit rate observed to be 6 Gbps to cover 900 m with Q factor 4.15293.

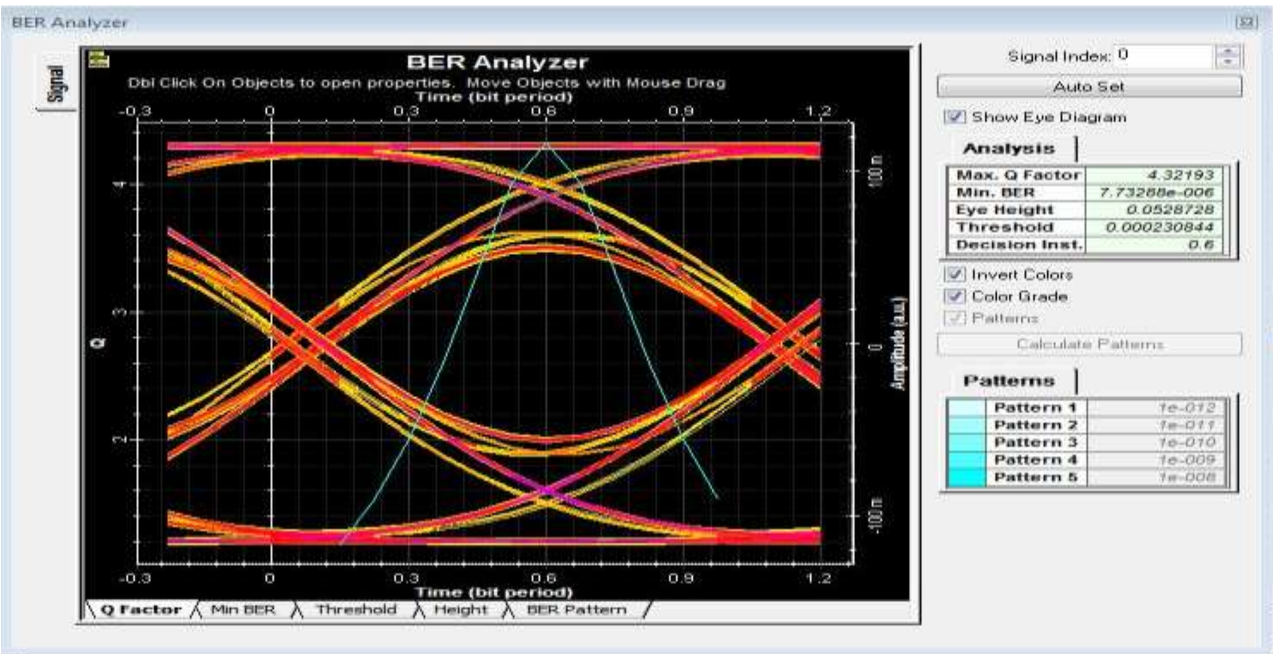


Fig.6. Eye diagram at 6Gbps at 900m with 9 dBm power in clear weather condition.

By the Fig.4 and Fig.6 we get the Q-factor and BER of foggy condition and clear weather condition. In this we get the Q –Factor 4.32193 in clear weather and 4.15293 in foggy condition and bit error rate is 7.73288e-006 in clear weather and 1.64102e-005 in foggy condition.

## V. **CONCLUSION**

In this work, FSO communication link is established for 900m length between transmitter and receiver at data rate of 6 Gbps. Results show that CW Laser provides better result at long distance when used at 1550nm wavelength for FSO Communication under foggy conditions (40db/km) on the basis of BER and Q-Factor. If the power or bit rate are increased further then a large amount of attenuation occurs and additionally more signal distortion, so we found a large amount of bit error rate. We found that 900m is the maximum distance in FSO communication at 6Gbps bit rate which is most effective for the data transmission in the proposed design.

By comparing the different transmitting power, bit rate and distances it has been observed 900m is the maximum distance for transmitting the information in FSO at 6Gbps rate and 9dBm power is the maximum power observing the Eye diagram and Q factor revealed the better and efficiently performing FSO system.

By analyzing the weather with clear and foggy condition, we observed that Q-factor is approximately similar but bit error rate is varied and found to be larger in the foggy weather condition. This is due to the fact that attenuation is more in the foggy condition as compared to clear weather condition where in dust particles and droplets of larger dimensions are occurring in the atmosphere.

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