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INVESTIGATING THE RAIN IMPACT IN DWDM FSO ENVIRONMENT WITH DIFFERENT MODULATION FORMAT

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Abstract

Because of its high transmission information rates, accessibility of permit to drive range, signal security, and cost proficiency, free space optical (FSO) correspondence is turning out to be progressively appealing as an option for radio recurrence (RF) correspondence. A 32-channel DWDM FSO framework with an information throughput of 1.28 Tbps has been planned in this review. The recommended framework was tried over a scope of distances (5-20 km) and for three distinct sorts of downpour (light, medium, and weighty), with constriction upsides of (1.988, 5.844, and 9.29) dB, individually. The exhibition of elective balance organizations like NRZ and RZ, as well as 5 situations of fluctuating information force of (- 5,- 10,0,5,10) dBm, has been examined in this paper. The framework execution worked on as the information power was expanded, as per the outcomes from the broken down boundaries of QF and BER. Furthermore, it has been found that utilizing RZ creates improved results for light downpour cases in totally input power situations. While the RZ regulation sort performed better in medium downpours for distances up to 5 km, the NRZ adjustment style is suggested for longer distances. Furthermore, in a weighty downpour climate, using 0 dBm and 5 dBm power showed that NRZ is extensively prevalent, while expanding the capacity to 10 dBm furnished substantially more versatile results regarding the got distance of just 5 km.

Keywords: Downpour, Fluctuating Information Force, Free Space Optical, Radio Recurrence.

I. Introduction

As the interest in rapid combined processes has developed alarmingly, there has been a powerful urge to supplement, on the off chance that it does not, the radio recurrence system (RF), which has immersion limitations. Free space optical (FSO) correspondence is turning out to be more famous as a choice to radio recurrence (RF) correspondence in light of its high transmission information speeds, permit free range, signal security, and reasonableness. Because of its high information speeds, permit free range, signal security, and moderateness, In view correspondence, free space optical correspondence sends optically altered information across the climate. Some call it optical fiber correspondence. Information is usually sent using the apparent or infrared groups of frequencies, which are unlicensed and don't require government working charges, dissimilar to most remote correspondences. Weather patterns, including precipitation, haze, snow, and murkiness, might influence the stage and abundance of data conveying signals on the way. Quite possibly one of the most common environmental aggravation, climate choppiness, is terrible. Varieties in medium refractive records cause barometrical choppiness. Air temperature, pressure, wind speed, and others influence medium refractive records [I-V].

Free space optical correspondence (FSO) sends information remotely without fiber optics or other optical foundations, utilizing a balanced optical pillar [V-VII]. Antiquated light (or smoke) signals conveyed data between places. Graham Ringer's patent on the image telephone, which utilized daylight to send sound, may have begun the current FSO methodology [VIII-XII]. FSO frameworks were restored during the 1970s when lasers were generally available and high-yield power, high-rationality light sources permitted accurate light pillar coordination across significant distances. During the 1970s and 1980s, FSO frameworks were most frequently recommended for secure, significant distance correspondence (50-1000 km). These frameworks were produced for ground-satellite or satellite correspondence. This accentuation changed extensively throughout the past ten years as FSO made another market for high-transmission capacity information lines and their coordination across a topographically restricted district [X-XX].

II. Previous Publications

As the interest in fast combined processes has developed alarmingly, there has been a powerful urge to supplement, in the event that does not supplant, the radio recurrence system (RF), which has immersion limitations. Free space optical (FSO) correspondence is turning out to be more famous as a choice to radio recurrence (RF) correspondence in light of its high transmission information speeds, permit free range, signal security, and moderateness. Because of its high information speeds, permit free range, signal security, and reasonableness, In view correspondence, free space optical correspondence sends optically changed information across the climate. Some call it optical fiber correspondence. Information is normally sent using the apparent or infrared groups of frequencies, which are unlicensed and don't require government working charges, not at all like most remote interchanges. Atmospheric conditions, including precipitation, mist, snow, and dimness might influence the stage and sufficiency of data conveying signals on the way. Perhaps the most pervasive barometrical unsettling influence, environmental disturbance, is just plain terrible. Varieties in medium refractive files cause barometrical disturbance. Air temperature, pressure, wind speed, and others influence medium refractive list [I-X].

Various examinations on similar issues were finished to pressure the importance of such recommended arrangements. A 4 km framework might be determined utilizing RZ balance type, transmitter and collector widths, lessening, and distances. The proposed information rate can't deal with future organizational interests. It exhibited 80 Gbps DWDM OWC. It can arrive at 38.500 kilometres with 100 GHz recurrence separating. As per their paper, distance transmission is unrealistic and requires a great deal of gear and intensifiers. Another system gives 1.28 Tbps 40 Gbps x 32 channel DWDM FSO. The recommended framework has great boundaries and remunerating systems. It needs numerous lessening impacts and was intended for a 2 km range. Another examination mimicked a 110 Gbps 10#11 channel DWDM FSO framework. The proposed strategy was assessed across 7-9 miles in a clear, overcast, and blustery climate. The framework has extraordinary QF and BER. The framework's information rates were beneath 5G. The technique has been tried for dimness evacuation at 1-3.5 kilometers. Along these lines, framework distances and information speeds should be taken to the next level. Late recommendations incorporate a 14-channel FSO crossover framework with 20 nm and 0.8 nm recurrence separating. The device can send 140 Gbps over 1.6-2.6 km. The framework tried the FSO in moderate and serious downpours. The recommended innovation requires much more transmitter power and a higher information rate. A blended CWDM-DWDM circumstance includes extra contemplations not tended to in this framework. Another system exhibited a 32-channel 10 Gbps DWDM FSO framework. The 100 GHz-separated, 320 Gbps framework is proposed. The framework was tried in a clear, weighty haze, QF, and BER. Reliable framework execution is proposed. Frameworks should be changed for the 5G foundation. A 1.28 Tbps DWDM FSO framework with 32 40 Gbps channels was likewise shown. Tweak NRZ and RZ utilizing the proposed framework. Each had (10-11) dBm QF. This drive delivered a 1km high-information rate framework. Just four of the 32 getting channels were examined [XII-XXVI].

This examination introduced a 32-channel, 40-Gbps DWDM FSO framework in light of these written works. Light-to-high downpour conditions were read up for optical transmission. For transmission lengths of 5,10,15, and 20 km and information abilities of - 10, - 5, 0, 5, and 10 dBm. Two regulation configurations — NRZ and RZ — would be examined to decide the best for FSO-based correspondence. Then, at that point, optical intensification would be utilized to fill transmission holes over high lessening values like weighty downpours. Microstrip devices, IoT, and cybersecurity are as well useful for the DWDM FSO environment [XI, XII, XIV, XX, XXI, XXII, XXX-XXXIV, XXXVIII-XL].

III. Free Space Optic (FSO) Communication

FSO is a wireless line-of-sight technology that uses invisible light beams to offer high-speed wireless connections for sending and receiving speech, video, and data. FSO is a wireless communication technique that employs invisible light beams to create high-speed wireless connections capable of sending and receiving audio, video, and data. FSO technology, which was developed and pushed by Cable Free's optical wireless services, has thus far allowed the creation of a new category of outdoor wireless devices capable of carrying voice, data, and video at speeds up to 1.25 Gbps and supporting a broad variety of applications. Free Space Optics removes the need for expensive fiber-optic cable and the need for radio frequency (RF) solutions to get licenses from the Federal Communications Commission. The usage of light is required by FSO technology. The use of light is similar in concept to optical communications using fiber-optic cables; the only difference is the medium through which the transmission takes place. FSO technology is classified as optical communications that run at the speed of light because light travels faster through air than it does through glass.

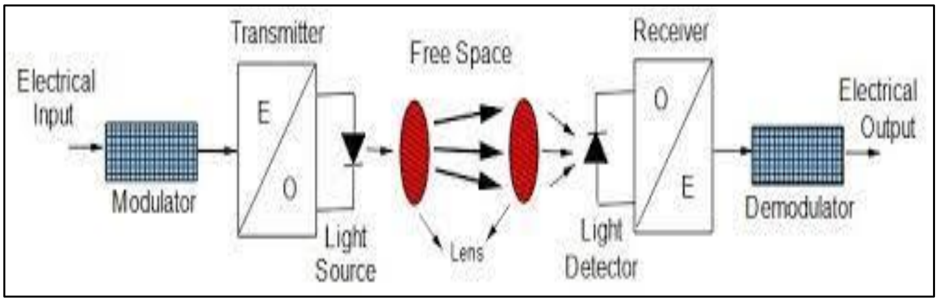

Fig. 1. General Block diagram for FSO communication

Wavelength Division Multiplexing (WDM)

WDM is a fiber-optic transmission method that enables the simultaneous transmission of data across multiple wavelengths (or colors). Two or more colors of light may flow via a single fiber, and an optical waveguide can carry multiple signals at different wavelengths in the optical spectrum. Earlier fiber-optic transmission methods used basic light pulses to encode data onto glass strands. To symbolize digital ones and zeros, a light was flashed on and off. Real light may have almost any wavelength—between about 670 and 1550 nanometers. WDM is a fiber-optic transmission method that mixes several light wavelengths to transmit data over the same medium. In the 1980s, fiber-optic data transfer modems used inexpensive LEDs to transmit near-infrared pulses across inexpensive fiber. As the demand for information increased, the need for bandwidth increased proportionately. Earlier SONET systems used 1310 nm lasers to transmit data streams at 155 Mb/s across very long distances. However, this capacity was quickly depleted. Optoelectronic element advancements throughout time enabled the construction of systems capable of simultaneously transmitting many wavelengths of light across a single fiber, significantly boosting fiber capacity. As a result, WDM was born. Multiple high-bit-rate data streams with distinct throughputs of 10 Gb/s, 40 Gb/s, 100 Gb/s, 200 Gb/s, and, more recently, 400 Gb/s and 800 Gb/s may be multiplexed over a single fiber.

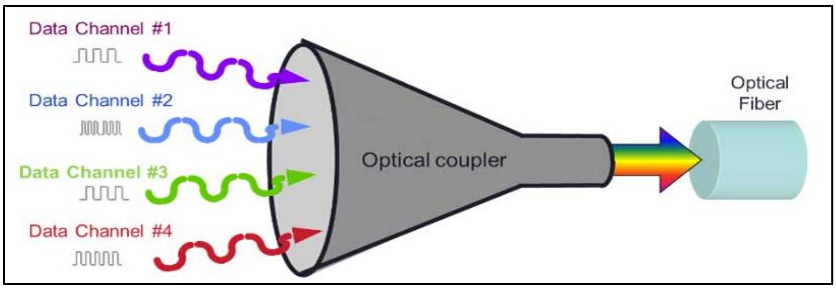

Fig. 2. Concept of WDM technology

IV. Proposed System

The proposed system in this work consists of three main parts. The first represents the transmitter part and consists of the WDM transmitter of 32 channels that are attached to an ideal Multiplexer to mix the optical signal in a single link. The input power would be varied between (-10 to 10) dBm as given in studied cases. The channel spacing is chosen to be 200 GHz along with selecting the beginning frequency of 190 GHz.

The middle part represented by the FSO transmission medium with attenuation selected of 1.988, 5.844, and 9.29 dB per km would be considered to represent three cases of rainy weather conditions (light, middle, heavy). The distance chosen for the FSO channel ranged between (5-20) km. Furthermore, this part would be supported by using the optical amplifier of 20 dB gain and a control gain type.

The third part consists of two blocks represented by the optical receiver and BER analyzer to analyze the studied parameters of QF and BER. The main view of the proposed system designed by using optisystem software can be seen in Figure 3. It is worth mentioning that channels 1,6,12,18,24,30 would be selected as sampled for investigation.

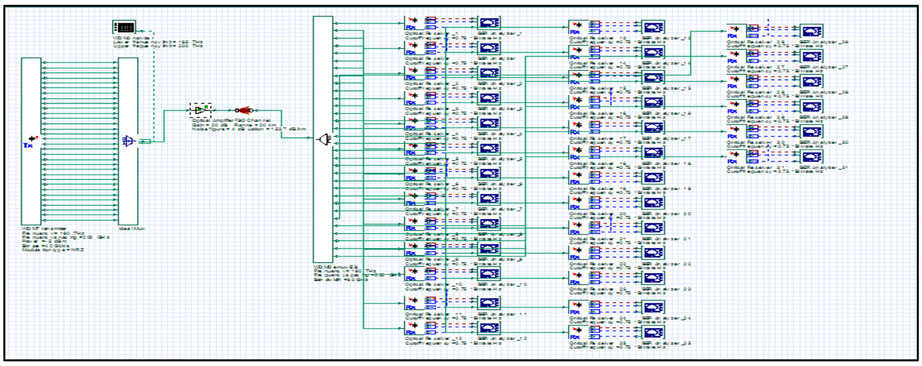

Fig. 3. The designed system using opti system software

V. Results and Discussion

The consequences of the proposed framework will be dissected in this part founded on different degrees of information power, including (- 10, - 5, 0, 5, 10) dBm, as well as different transmission lengths, and for both the QF and BER boundaries.

A- Using -10 dBm Launch Power

For the first scenario, three downpour scenarios (Low-Medium-Heavy) were evaluated per distance, using a launched power level of -10 dBm and investigating framework execution for 5, 10, 15, and 20 km. Tables 1 and 2 present these findings for QF and BER boundaries using NRZ regulation. These findings are explained in Figures 4 and 5. While using − 10 dBm, the gadget can communicate for low downpour and for medium downpour for 5 km. The framework neglects to hand off information under a heavy downpour. QF and BER discoveries for RZ regulation are in Table 3 and Table 4 and displayed in Figures 6 and 7. For as much as 10 kilometers, the framework performed well in a gentle downpour. NRZ beat RZ over longer distances. Be that as it may, 10 dBm RZ power is incapable of extreme downpour.

Table 1: Averaged QF Results of – 10 dBm power with NRZ coding and different attenuation.

Sample Channel	attenuation = 1.988 dB			
	5 km	10 km	15 km	20 km
	25.08248	23.83803	16.22485	6.832187
Sample Channel	attenuation = 5.844 dB			
	5 km	10 km	15 km	20 km
	16.87832	0	0	0
Sample Channel	attenuation = 9.29 dB			
	5 km	10 km	15 km	20 km
	0	0	0	0

Table 2: Averaged BER Results of – 10 dBm power with NRZ coding and different attenuation.

Sample channels	attenuation = 1.988 dB			
	5 km	10 km	15 km	20 km
	1.60E-117	6.83E-101	4.78E-44	6.64E-12
Sample channels	attenuation = 5.844 dB			
	5 km	10 km	15 km	20 km
	1.258E-47	f	f	f
Sample channels	attenuation = 9.29 dB			
	5 km	10 km	15 km	20 km
	f	f	f	f

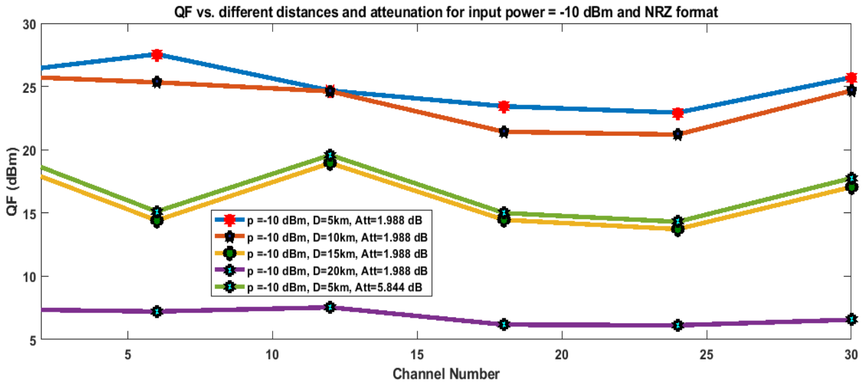

Fig. 4. Averaged QF results for -10 dBm power with different conditions and NRZ coding.

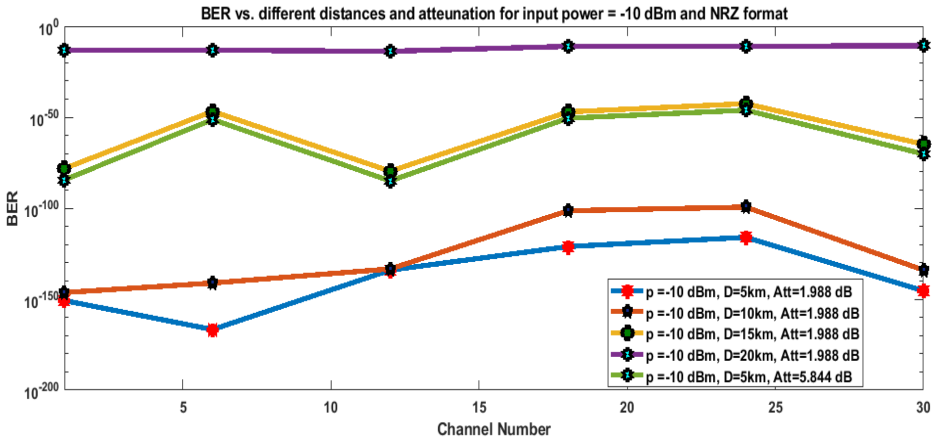

Fig. 5. Averaged BER results for -10 dBm power with different conditions and NRZ coding

Table 3: Averaged QF Results of – 10 dBm power with RZ coding and different attenuation..

Sample channels	attenuation = 1.988 dB			
	5 km	10 km	15 km	20 km
	55.9655	39.11935	16.26063	7.623615
Sample channels	attenuation = 5.844 dB			
	5 km	10 km	15 km	20 km
	19.18427	0	0	0
Sample channels	attenuation = 9.29 dB			
	5 km	10 km	15 km	20 km
	0	0	0	0

Table 4: Averaged BER Results of – 10 dBm power with RZ coding and different attenuation.

Sample channels	attenuation = 1.988 dB			
	5 km	10 km	15 km	20 km
	0	0	1.70E-42	1.47E-11
Sample channels	attenuation = 5.844 dB			
	5 km	10 km	15 km	20 km
	5.58E-59	f	f	f
Sample channels	attenuation = 9.29 dB			
	5 km	10 km	15 km	20 km
	f	f	f	f

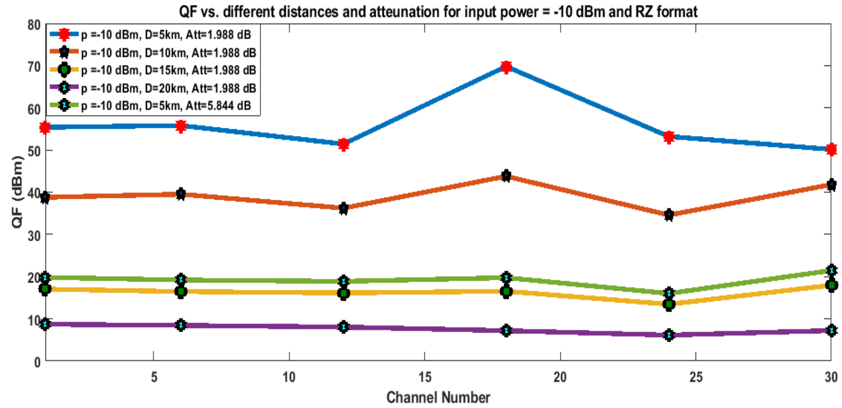

Fig. 6. Averaged QF results for -10 dBm power with different conditions and RZ coding.

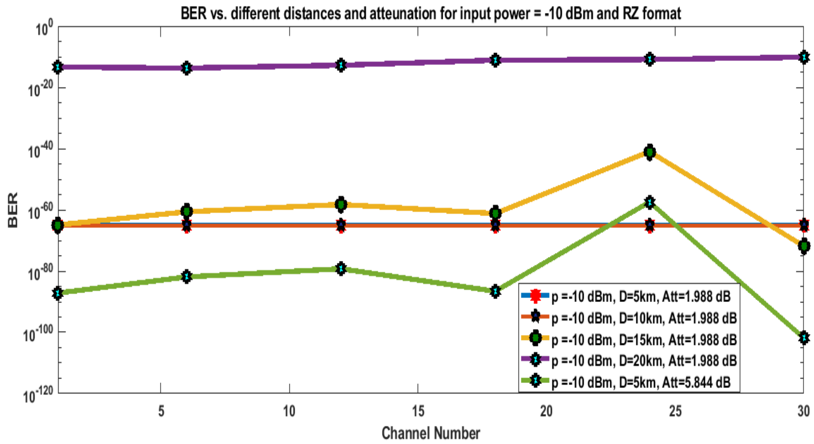

Fig. 7. Averaged BER results for -10 dBm power with different conditions and RZ coding.

B- Using -5 dBm Launch Power

Power was changed at - 5 dBm to survey framework execution at different distances and three downpour situations. Figures 8 and 9 give QF and BER boundaries to NRZ tweak. Obviously, the proposed strategy worked effectively in weighty downpours for 5 km and medium downpours for 10 km. All discoveries surpassed the 6 dBm QF limit. QF and BER results for RZ regulation are introduced in Figures 10 and 11. For lengths up to 15 km, the RZ performed better compared to the NRZ-based framework in moderate downpour, however for longer distances, the NRZ performed better. In serious climates, the RZ performed ineffectively contrasted with the NRZ in transmission taking care of for 5 km.

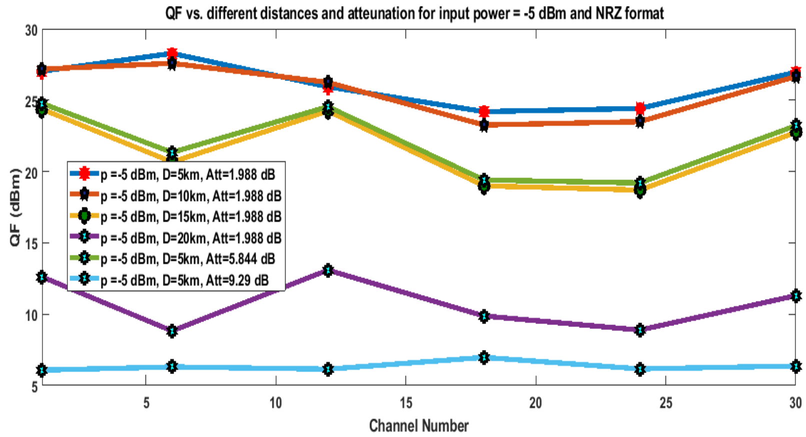

Fig. 8. Averaged QF results for -5 dBm power with different conditions and NRZ coding.

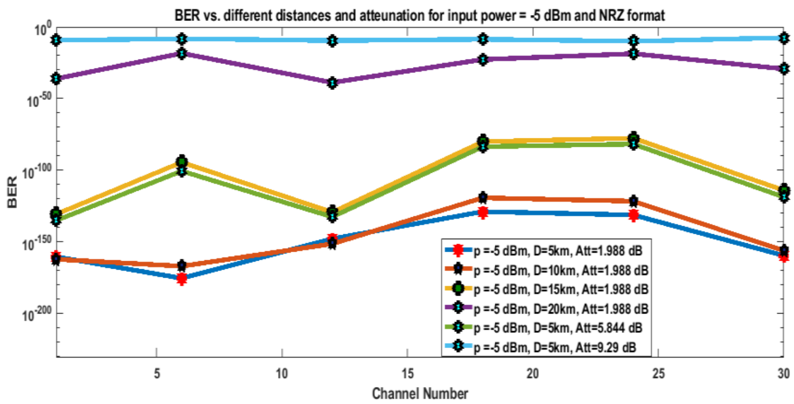

Fig. 9. Averaged BER results for -5 dBm power with different conditions and NRZ coding.

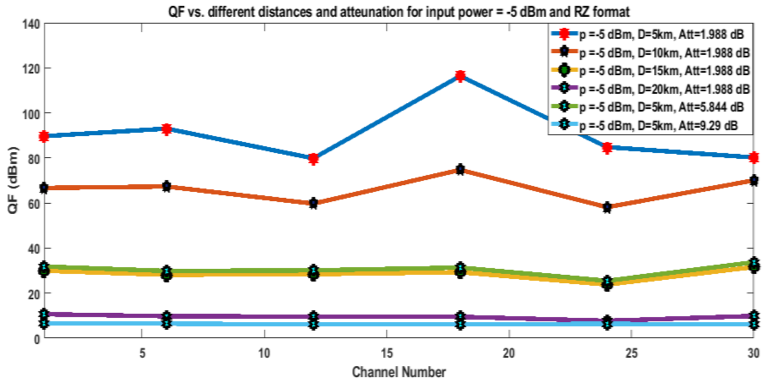

Fig. 10. Averaged QF results for -5 dBm power with different conditions and RZ coding.

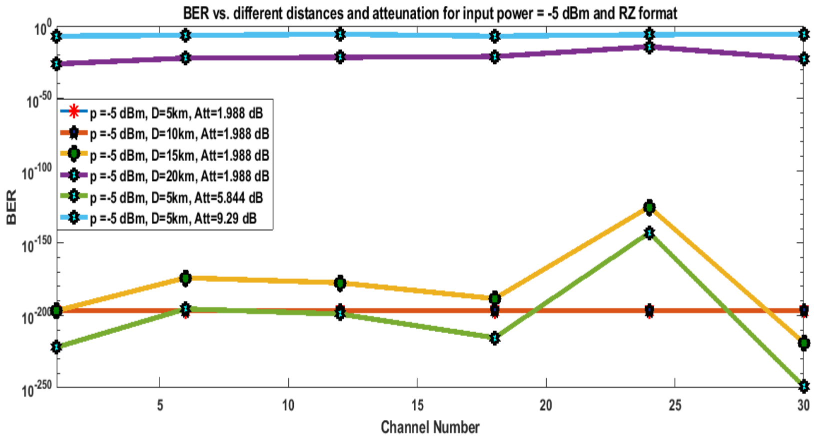

Fig. 11. Averaged BER results for -5 dBm power with different conditions and RZ coding.

C- Using 0 dBm Launch Power

Power was set to 0 dBm to evaluate framework execution at different distances and three downpour situations. Figures 12 and 13 give QF and BER boundaries to NRZ balance. The complete presentation improved with higher info power than in case 2, which worked for 5 km of medium downpour and 5 km of weighty downpour. Conversely, Figures 14 and 15 show the RZ balance for QF and BER. The execution impact was bigger with the recommended framework. NRZ is superior to RZ while overseeing 0 dBm power for 5 km transmission in extreme downpours, yet the framework falls flat.

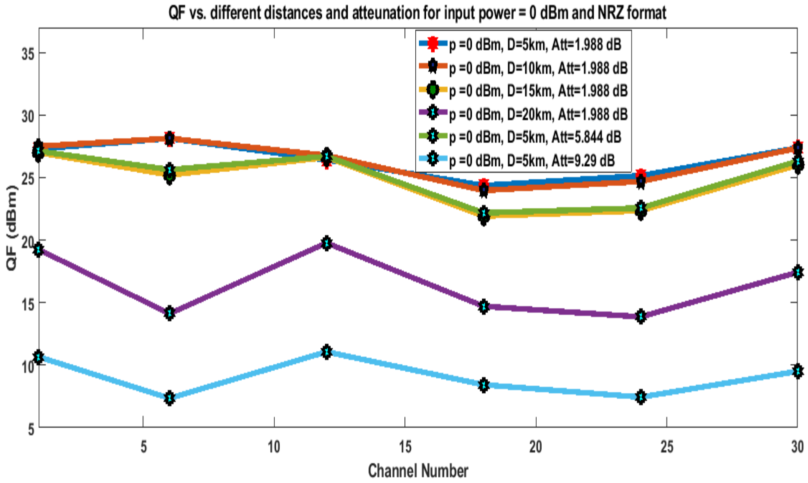

Fig. 12. Averaged QF results for 0 dBm power with different conditions and NRZ coding.

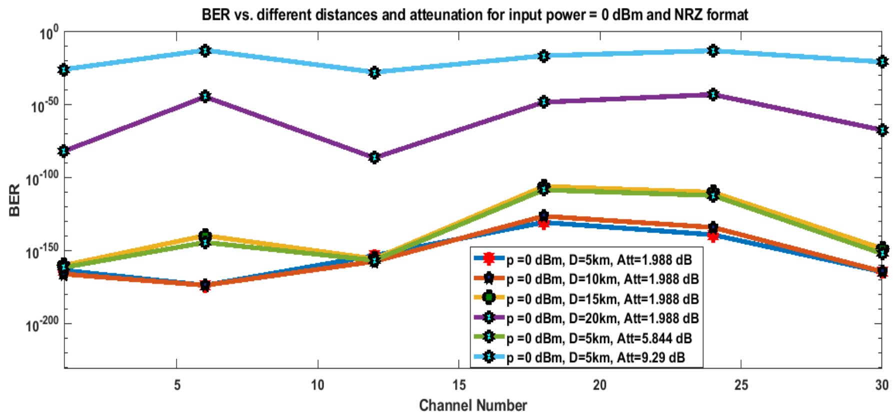

Fig. 13. Averaged BER results for 0 dBm power with different conditions and NRZ coding.

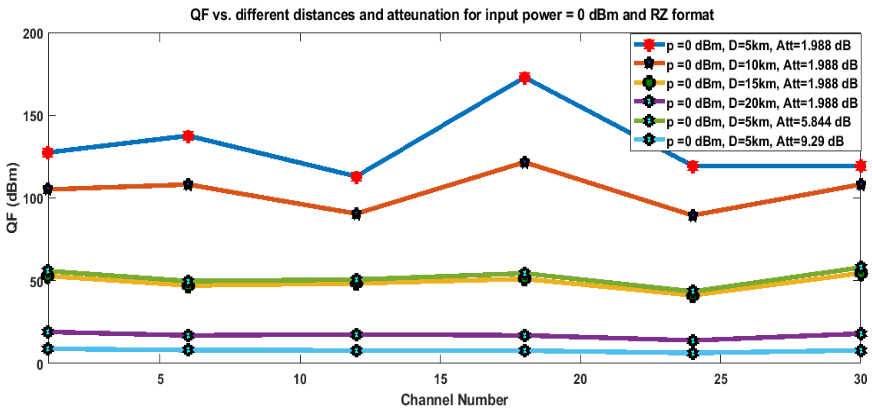

Fig. 14. Averaged QF results for 0 dBm power with different conditions and RZ coding.

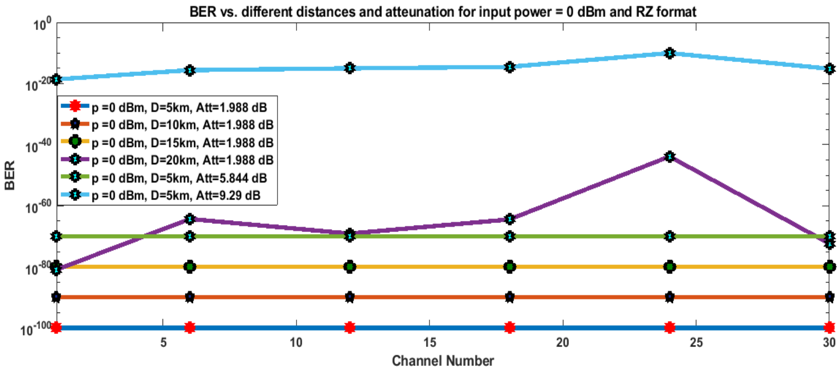

Fig. 15. Averaged BER results for 0 dBm power with different conditions and RZ coding.

D- Using 5 dBm Launch Power

Power was changed at 5 dBm to evaluate framework execution at different distances and three downpour situations. Figures 16 and 17 give QF and BER boundaries to NRZ tweak. By and large, execution improved with higher info power than in example 3, which worked for medium downpours for 5 km and serious downpours for 5 km. NRZ balance yielded more reliable and versatile results.

Conversely, Figures 18 and 19 show the RZ balance for QF and BER. The execution impact was bigger with the recommended framework. In the extreme downpour, the framework falls flat in light of the fact that NRZ performs better compared to RZ while overseeing 5 dBm power for transmission for 5 km or more.

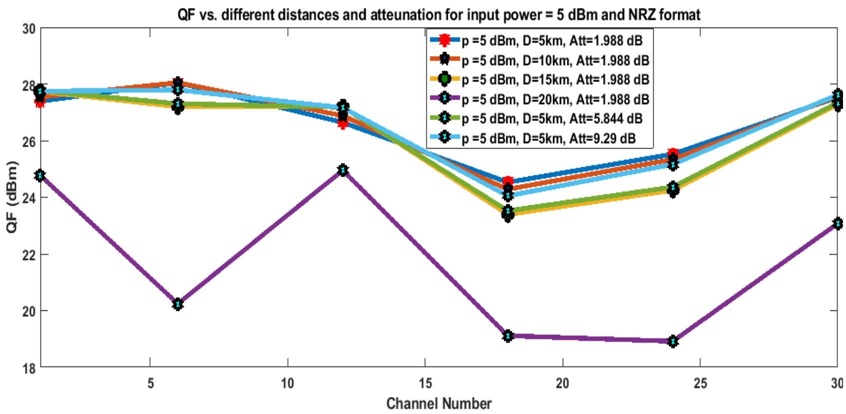

Fig. 16. Averaged QF results for 5 dBm power with different conditions and NRZ coding.

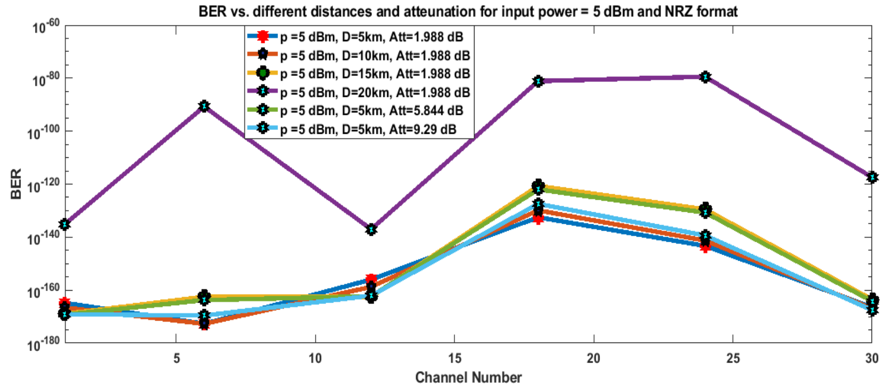

Fig. 17. Averaged BER results for 5 dBm power with different conditions and NRZ coding.

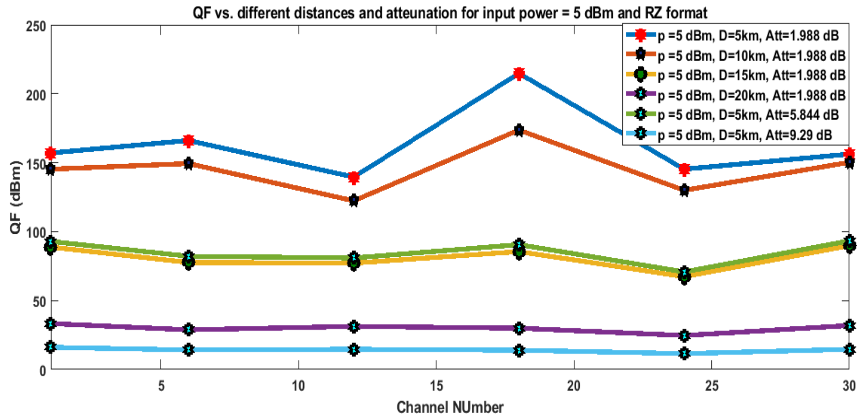

Fig. 18. Averaged QF results for 5 dBm power with different conditions and RZ coding.

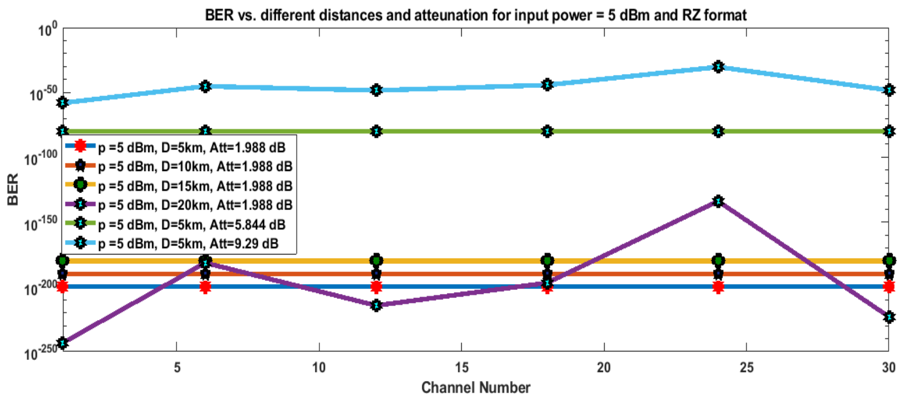

Fig. 19. Averaged BER results for 5 dBm power with different conditions and RZ coding.

E- Using 10 dBm Launch Power

At last, set capacity to 10 dBm and test framework execution at fluctuated distances and the same three downpour situations. Figures 20 and 21 give QF and BER boundaries to NRZ regulation. The framework performed much the same way to example 4 for all distances in light downpours. Medium downpour permits it to go 10 km, though extreme downpour restricts it to 5 km.

Conversely, Figure 22 shows QF RZ regulation. The recommended strategy performed better in light downpours. In gentle downpour, the framework performed best at 5 km yet the NRZ beat the RZ at 10 km. This recommends that the RZ-based framework can deal with bigger transmission distances. It outflanks the NRZ for 5 kilometers in a weighty downpour. These five situations exhibit trustworthy framework execution in different downpour conditions to pick the best information power and abatement power utilization.

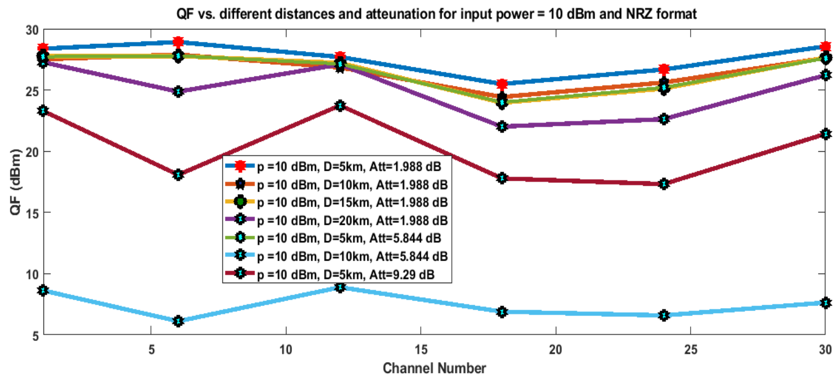

Fig. 20. Averaged QF results for 10 dBm power with different conditions and NRZ coding.

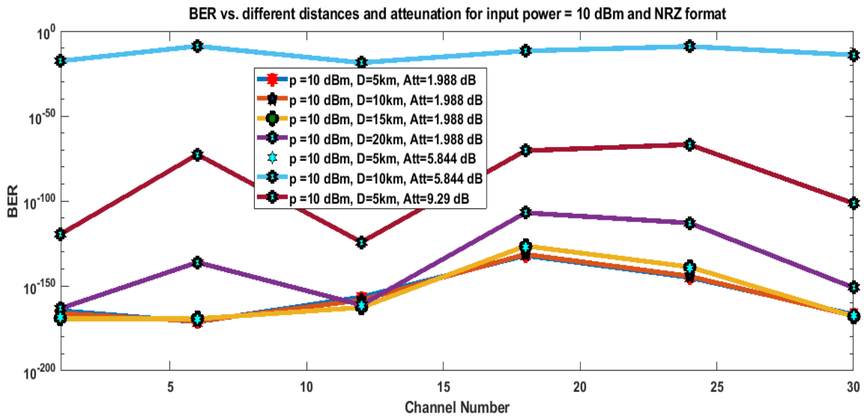

Fig. 21. Averaged BER results for 10 dBm power with different conditions and NRZ coding.

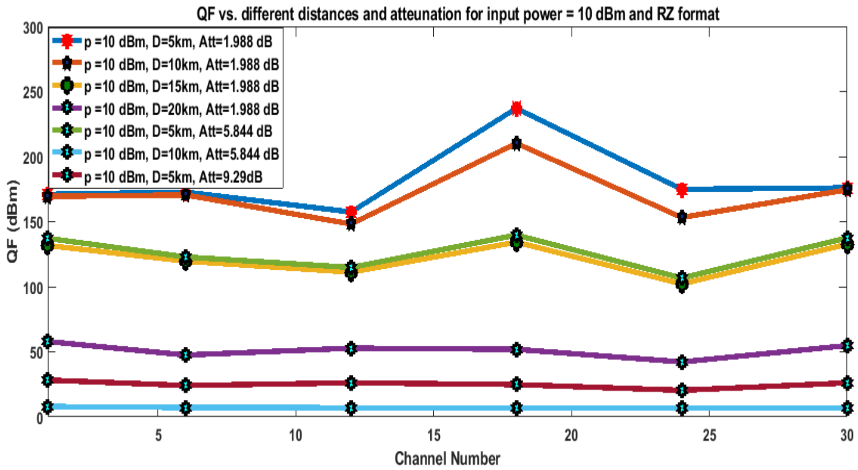

Fig. 22. Averaged QF results for 10 dBm power with different conditions and RZ coding.

VI. Conclusion

This study gives a 32-channel DWDM FSO framework 1.28 Tbps information rate. The proposed framework was assessed at 5-20 km and three downpour conditions (light-medium-weighty) with a lessening of 1.988, 5.844, and 9.29 dB. This study inspected the presentation of NRZ and RZ regulation arrangements with five information power levels of - 5,- 10,0,5,10) dBm. QF and BER results show that framework execution increments with input power. RZ likewise performs better in light downpour situations paying little mind to enter power. For medium downpours, the RZ performed better up to 5 km, however for longer distances, the NRZ tweak type is encouraged. Under weighty downpours, NRZ is unrivaled at 0 and 5 dBm, while at 10 dBm, RZ balance is more versatile north of 5 km.

Conflict of interest:

The author declares that there was no conflict of interest regarding this paper.

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