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WDM system using SOA with gain saturation after mitigating the effect of Rayleigh scattering

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Abstract-The main reason of Rayleigh scattering in SOA is due to amplification of short pulse which is produced by large spectral broadening of the pulses. This also reduces the population inversion in the active medium of the laser which can be effectively avoided by the obtaining gain saturation in the SOA amplifier. In this manuscript, we have transmitted 10 Gbps data to 128 users using SOA amplifier. The frequency and power of WDM transmitters has been Taken At 190 Thz And 3.99 Dbm Respectively. To Mitigate The Effect Of Rayleigh Scattering, We Have Reduced The Width Of Pulses As Compare To The Carrier Lifetime.

Index Terms: Gain Saturation, Rayleigh Scattering, SOA, WDM.

1. INTRODUCTION

Today the researchers are concentrated on WDM systems to execute the requirement in next-generation of high-bandwidth optical access networks for cost-effective user-shared facilities [1, 2]. This technology is well thought-out to be one of the most promising solutions for the next broadband commitment [3]. In WDM networks each user is assigned dedicated channel. The considerable enlargement in today's necessity i.e. demand for audio, internet data, video online, venture connectivity, cloud and data center services etc. can be carried out through this technology [4, 5]. In recent days, huge efforts have been employed to minimize the non- linearity effects in long distance WDM systems. [6]. Propagation losses in optical fiber in WDM systems can be compensated by use of EDFA. EDFA based WDM system uses simplest configuration for its implementation [7]. Such WDM system is designed with a light source to minimize losses. The perfect example of such a light source is Reflective Semiconductor Optical Amplifiers (RSOA) [8, 9]. In RSOA's light seed and upward signal stream are propagated at same wavelength and in opposite direction within common propagation medium i.e. optical fiber [10, 11].

The problem of multipath interference due to seed light and upward signal in WDM system is now eliminated using RSOA's system. This in turn shows positive impact on improvement in system in terms of transmission rate of data [12]. A comprehensive study of impacts of RB in short range WDM system is provided in [13] based on gain of RSOA and without EDFA at remote location. The similar sort of results can 't be expected from long range WDM system as long distance WDM system contain remote EDFA. Remote EDFA amplifies RB signals generated from feeder and fiber. There are basically two different type of noise generated in RB operation. First type of noise is generated at carrier wavelength and second at signal wavelength.

1.1 Simulation Setup

The simulation setup of WDM system of 128 users with SOA is shown in fig. 1.

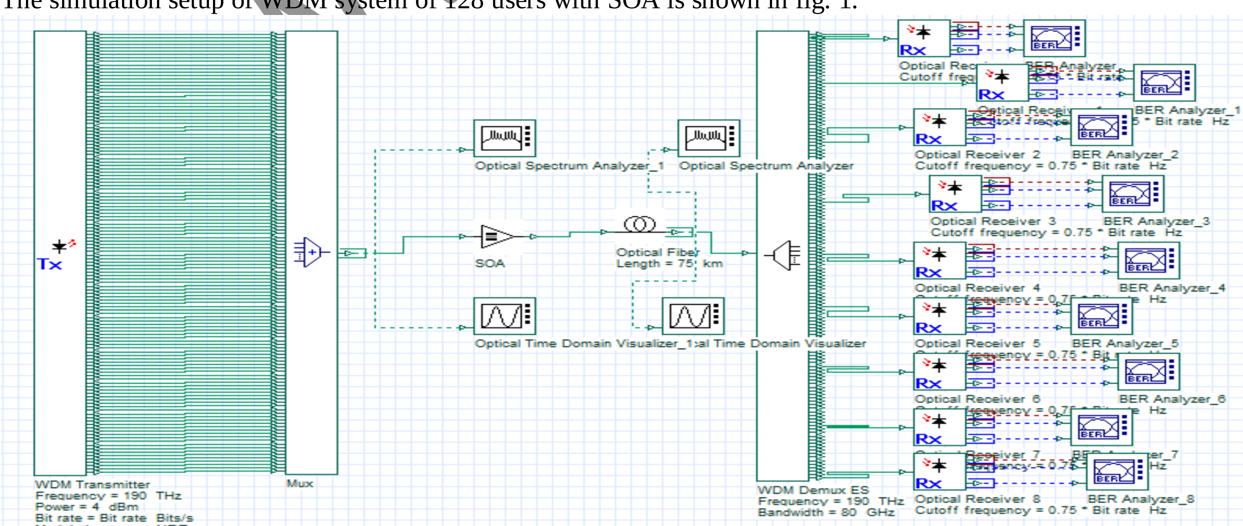

Fig. 1.1Simulation Set Up of WDM System With 128 Users Using SOA With Gain Saturation

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In this setup, we have transmitted 10 Gbps data to 128 users using SOA amplifier. The frequency and power of WDM transmitters has been taken at 190 THz and 3.99 dBm respectively. The injection current of 0.5 A has been applied to the amplifier. The main reason of Rayleigh scattering in SOA is due to amplification of short pulse which are produced by large spectral broadening of the pulses. This also reduces the population inversion in the active medium of the laser which can be effectively avoided by the obtaining gain saturation in the SOA amplifier.

2. RESULT AND DISCUSSION

To mitigate the effect of Rayleigh scattering, we have reduced the width of pulses as compare to the carrier lifetime. So, we have taken the parameters for the setup as given in Table1:

Table-2.1The parameters for the setup

S.No.	Parameter	Value
1	carrier wavelength of pulse	1.55nm
2	Carrier life time	1.45 ns
3	Saturation Energy	4.1 pJ
4	Amplification factor	6 dB

Fig. 2.1 (a and b) shows the optical spectrum obtained without gain saturation and after gain saturation respectively.

Fig. 2.1(a) Optical Spectrum Without Gain Saturation

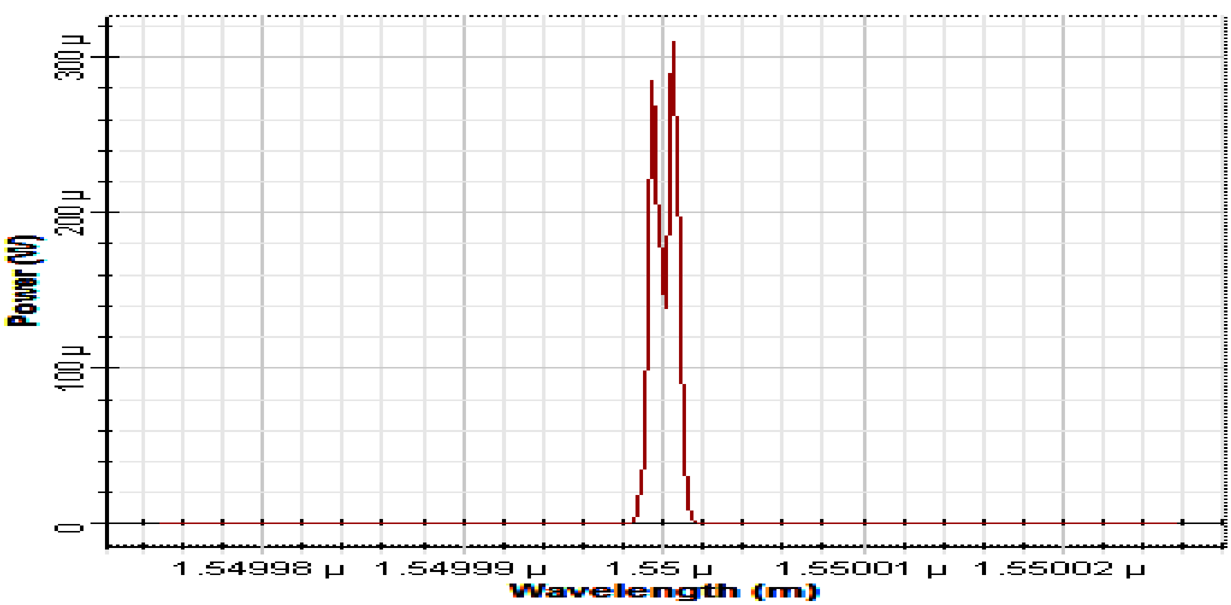

Fig. 2.1(b) Optical Spectrum After Gain Saturation

In order to maintain the shorter pulse width as compare to life time, the pulse energy has been gained as increased as SOA saturation energy. Fig. 2.2 (a and b) shows the optical signal in time domain obtained without gain saturation and after gain saturation respectively.

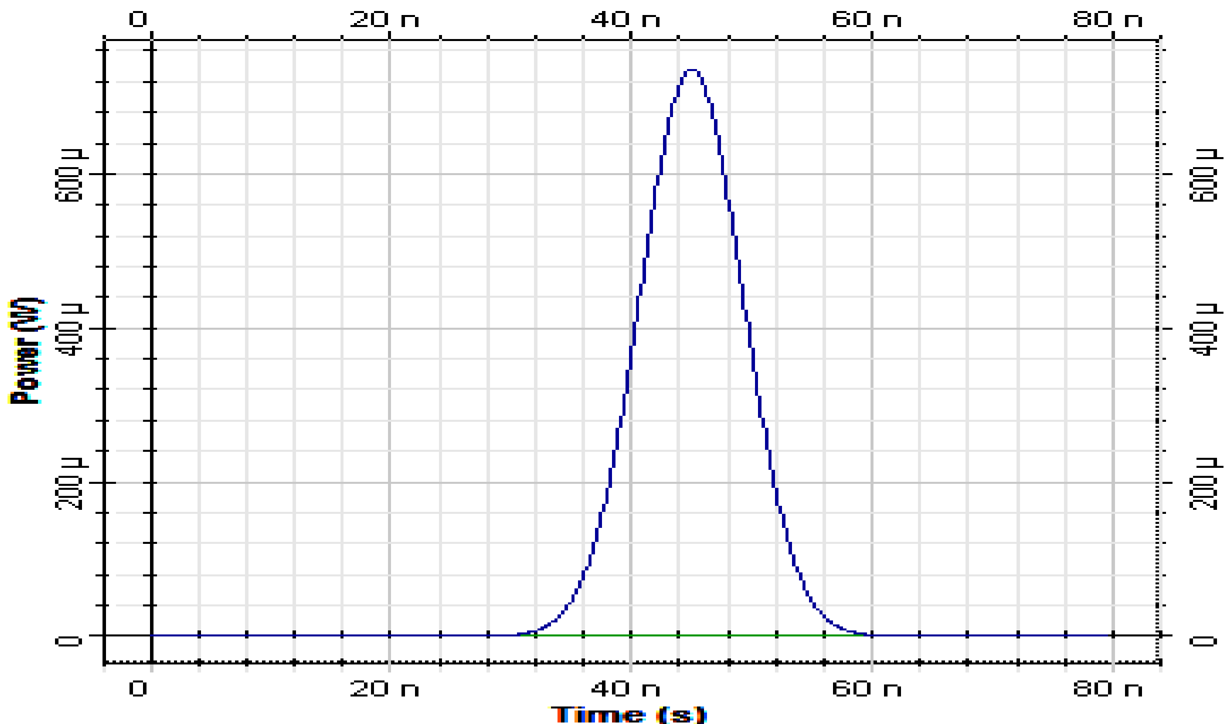

Fig. 2.2(a) Optical Spectrum Without Gain Saturation

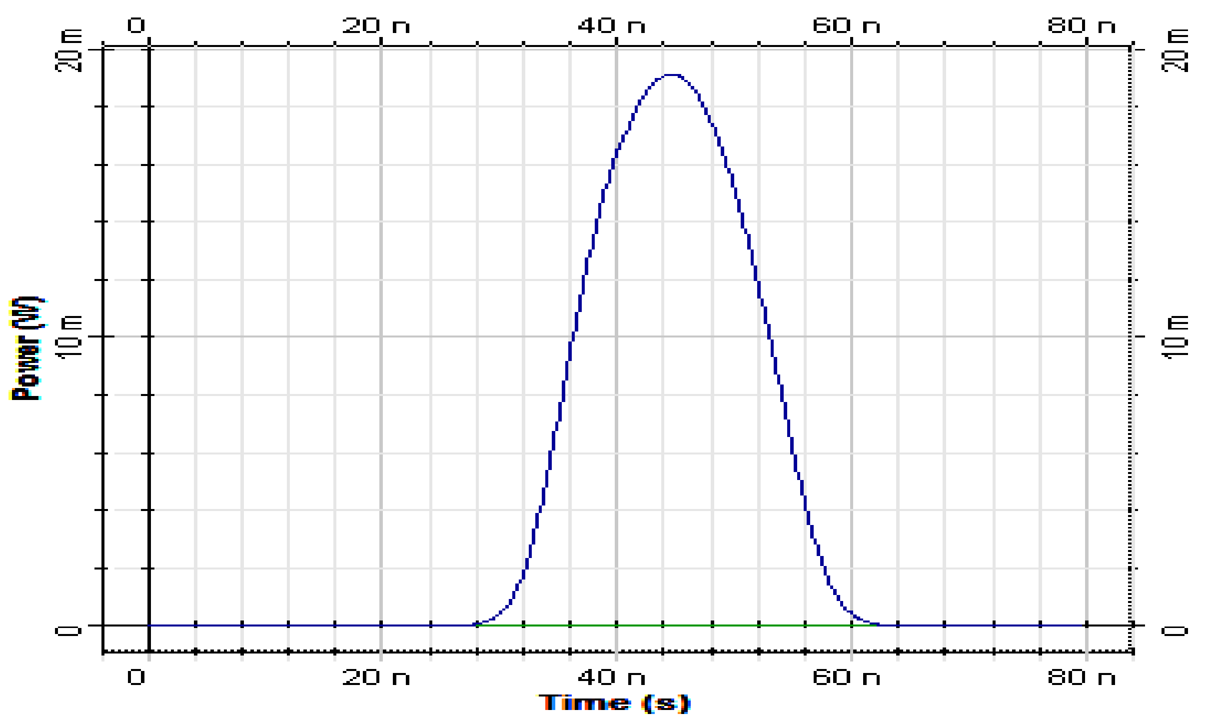

Fig. 2.2(b) Optical Spectrum After Gain Saturation

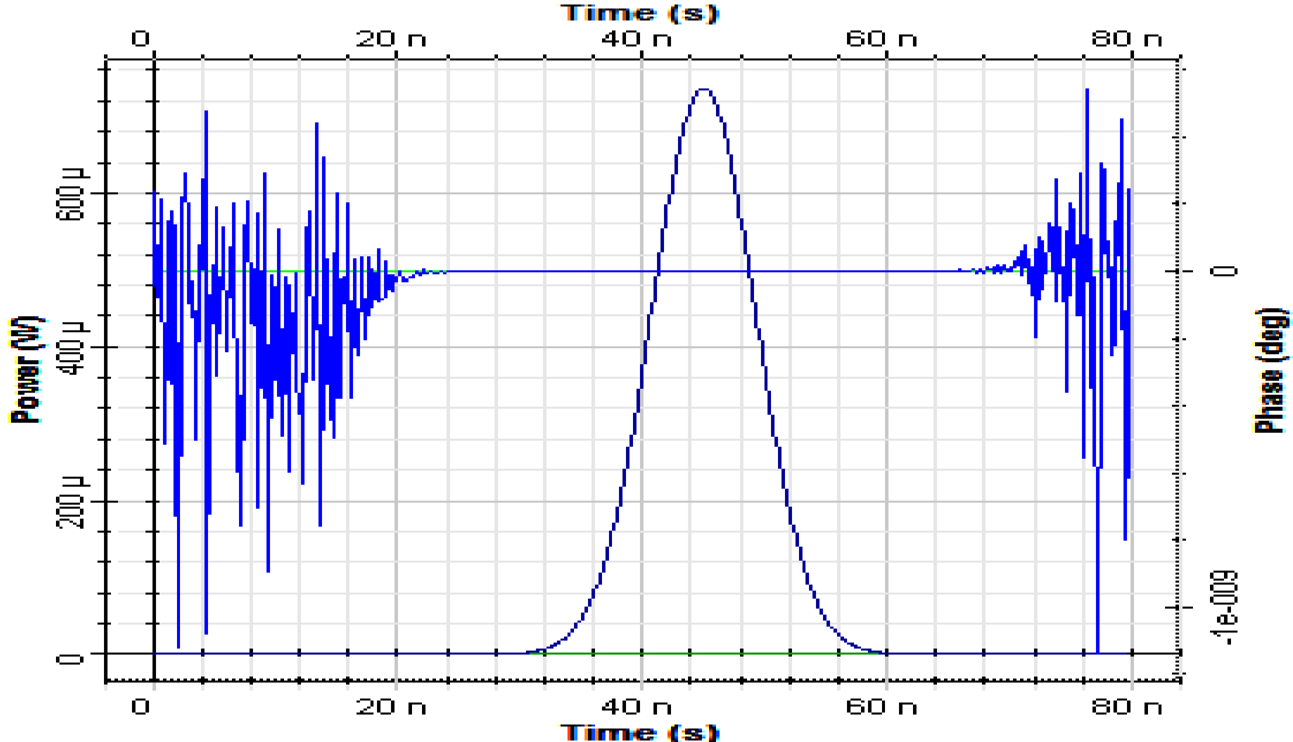

Fig. 2.3(a) Chirp Induced in Optical Spectrum Without Gain Saturation

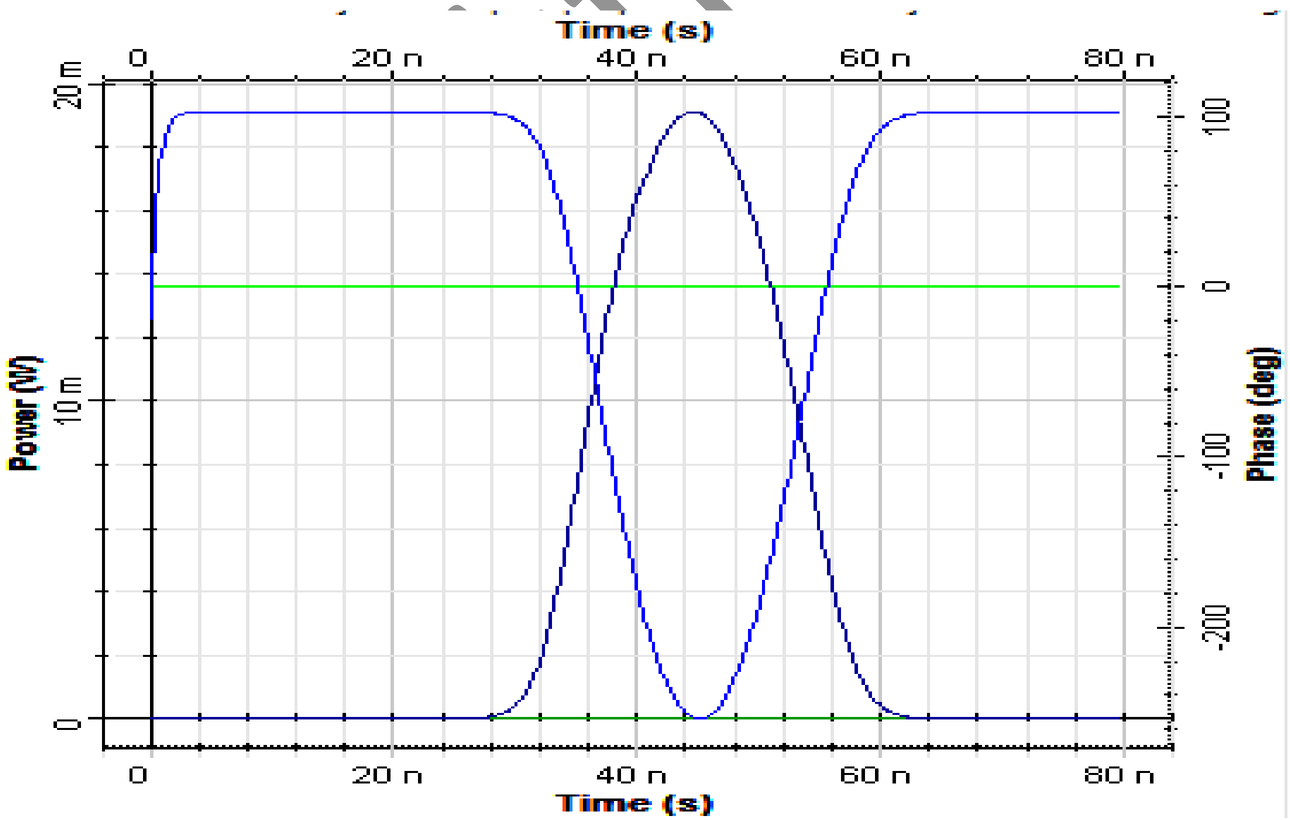

Fig. 2.3(b) Chirp Removed in Optical Spectrum After Gain Saturation

Fig. 2.3(a and b) show the shape and spectrum of optical signal with and without gain saturation in optical domain. A chirp has been introduced in the optical signal when it is processed without gain saturation but when we have reduce the pulse width and show a larger carrier lifetime, the chirp has been removed as shown in fig. fig. 2.3(b).

We have further analyzed the system setup for different channel spacing. Fig. 2.4 shows the Q factor with respect to number of users at 25 GHz channel spacing for the proposed WDM system.

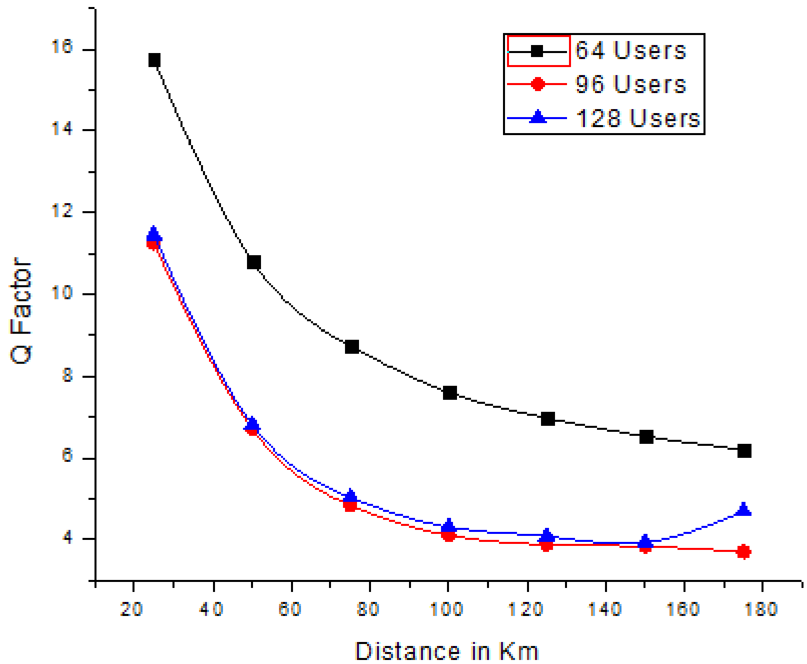

Fig. 2.4 Q factor With Respect to Distance at Various Number of Users at 25 GHz Channel Spacing for the Proposed WDM System

We have analyzed the system setup for 64, 96 and 128 number of users at varying distance. It has been observed that as we increase the distance, the Q factor decreases and we obtained large value of Q factor at lesser number of users. It is evident that Q factor of 15.7455 to 6.2, 11.2455 to 3.7 and 11.4455 to 4.7 observed with respect to 64, 96 and 128 number of users at 25 GHz respectively. Table 2 shows the value of Q factor for 64, 96 and 128 number of users at 25 GHz channel spacing.

Table-2.2 Q-Factor for 64, 96 and 128 Number of Users at 25 GHz Channel Spacing

S. No.	Distance	64 Users	96 users	128 users
1	25	15.7455	11.2455	11.4455
2	50	10.8105	6.7105	6.8105
3	75	8.73542	4.83542	5.03542
4	100	7.60698	4.10698	4.30698
5	125	6.97822	3.87822	4.07822
6	150	6.53174	3.83174	3.93174
7	175	6.2	3.7	4.7

Fig. 2.5 shows the Q factor with respect to number of users at 50 GHz channel spacing for the proposed WDM system.

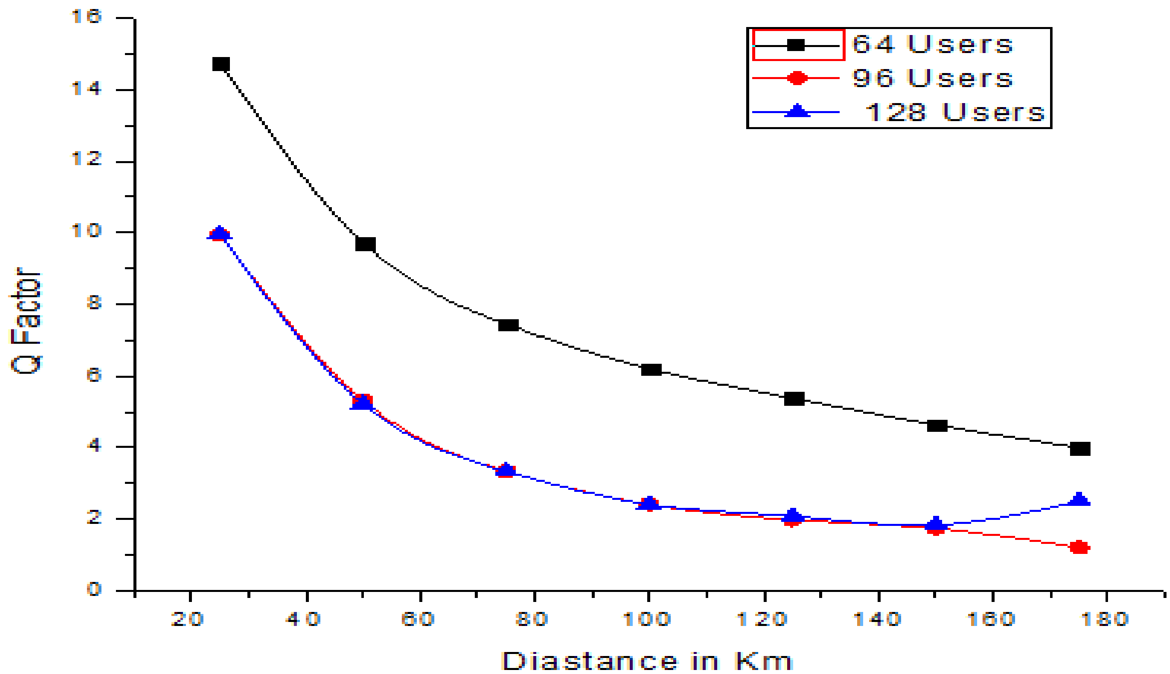

Fig. 2.5 Q-Factor With Respect to Distance at Various Number of Users at 50 GHz Channel Spacing for the Proposed WDM System

We have analyzed the system setup for 64, 96 and 128 number of users at 50 GHz channel spacing at varying distance. It has been observed that as we increase the distance and number of users, the Q factor decreases and we obtained lower value of Q factor at lesser channel spacing. It is evident that Q factor of 14.7455 to 4, 9.95 to 2.5 and 9.9 to 1.2 observed with respect to 64, 96 and 128 number of users at 25 GHz respectively. Table 3 shows the value of Q factor for 64, 96 and 128 number of users at 50 GHz channel spacing.

Table-2.3 Q-Factor for 64, 96 and 128 Number of Users at 50 GHz Channel Spacing

S. No.	Distance	64 Users	96 users	128 users
1	25	14.7455	9.95	9.9
2	50	9.7105	5.3105	5.2105
3	75	7.43542	3.33542	3.33
4	100	6.20698	2.40698	2.4
5	125	5.37822	1.97822	2.07822
6	150	4.63174	1.73174	1.83174
7	175	4	2.5	1.2

CONCLUSION

We have proposed a WDM system with 10 Gbps data to 128 users using SOA amplifier. The frequency and power of WDM transmitters has been taken at 190 THz and 3.99 dBm respectively. The injection current of 0.5 A has been applied to the amplifier. The main reason of Rayleigh scattering in SOA is due to amplification of short pulse which are produced by large spectral broadening of the pulses. This also reduces the population inversion in the active medium of the laser which can be effectively avoided by the obtaining gain saturation in the SOA amplifier. To mitigate the effect of Rayleigh scattering, we have reduced the width of pulses as compare to the carrier lifetime.

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