EFFECT OF RAMAN AND RAYLEIGH SUPPRESSION IN WDM SYSTEMS

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Abstract- We have analyzed a WDM system for Raman and Rayleigh scattering effect and their suppression methods. We have transmitted 10 Gbps data to 128 users. To increase the distance, we have employed SOA amplifiers in the channel. The frequency and power of WDM transmitters has been taken at 190 THz and 3.99 dBm respectively. The injection current of 0.5A has been given to the amplifier. The data is transmitted at 1550 nm wavelength to reduce the effect of attenuation.

Keywords: SOA, WDM, Raman scattering, Rayleigh Scattering

1. Introduction

In today's world, the biggest technical challenge for communication network systems is to take more information carrying capacities [1]. The volume of information produced increases rapidly with the substantial growth in data traffic, so the need for higher capacity optical systems increases [2, 3]. To reduce effect of non-linearity in long range WDM systems is most important issue in optical communication these days [4]. One solution of this problem seems to be lies through Distributed Raman Optical Amplifier which has flat and low noise characteristics over its wide band of operation [5]. In such long distance WDM systems to compensate for the transmission losses over length of optical fiber Erbium-doped fiber amplifier (EDFA) are used. EDFA based WDM system uses simplest configuration for its implementation. Such WDM system is designed with a light source to minimize losses [6]. The perfect example of such a light source is Reflective Semiconductor Optical Amplifiers (RSOA). 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 [7]. Accumulation effect is responsible for reduced system performance in a typical long distance WDM system [8]. So, complete mitigation of DRB is not possible. Practically, to suppress DBR and reject backscattering signal optical isolator is used in system. here, generated DRB noise is analyzed using optical fiber Raman amplifier in both forward and backward pumping. Impact of isolator position is more pronounced in Raman amplification due to non-linearity [9]. Optical amplifiers produce noise as they amplify the signals and are not perfect devices for optical communication. One of the major sources of noise in Raman amplifier is the amplified spontaneous emission (ASE) produced by spontaneous Raman scattering mechanism [10]. When optical amplification takes place, the spontaneous emission noise generated by the optical amplifiers rolls up along the length of fiber and is amplified by the same mechanism.

2. Simulation Setup

The simulation setup of WDM system of 128 users to analyze the suppression method of Raman and Rayleigh scattering is shown in figure 1.

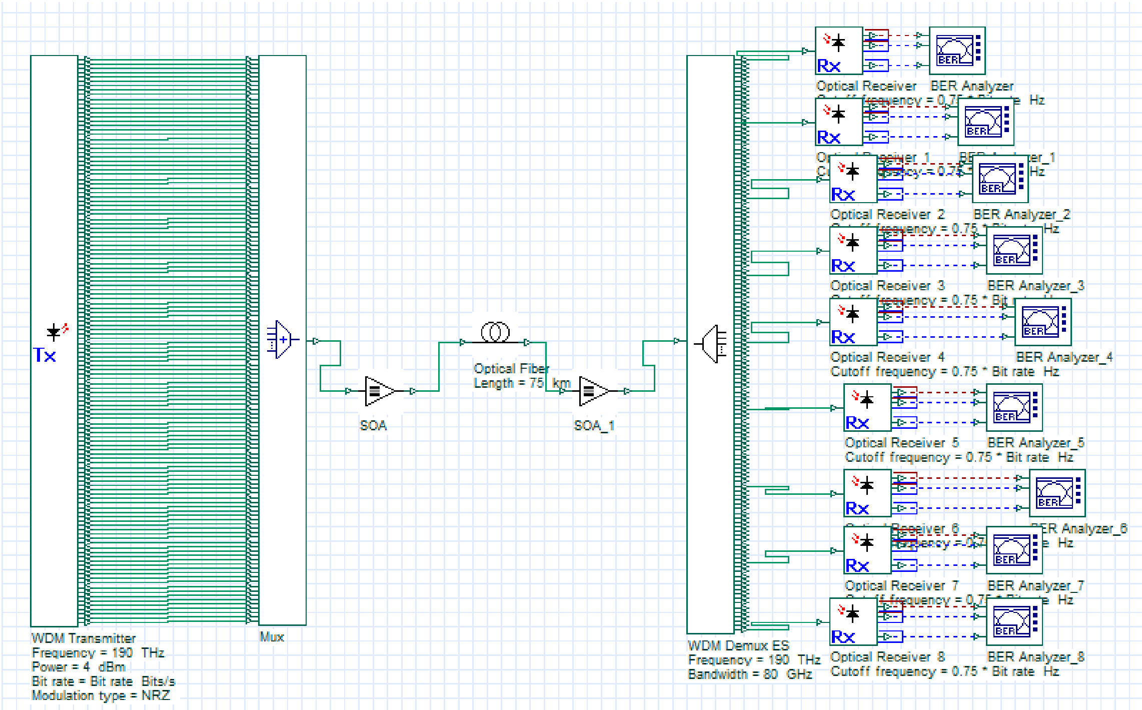

Figure 1: Simulation set up of WDM system with 128 users to analyze the effect of Raman and Rayleigh scattering

In this setup, we have transmitted 10 Gbps data to 128 users. To increase the distance, we have employed SOA amplifiers in the channel. 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 data is transmitted at 1550 nm wavelength to reduce the effect of attenuation.

3. Result and Discussion

Figure 2 shows the visualized oscilloscope of the data at 10 Gbps at the PRBS. This data has been fed to the 128 numbers of users.

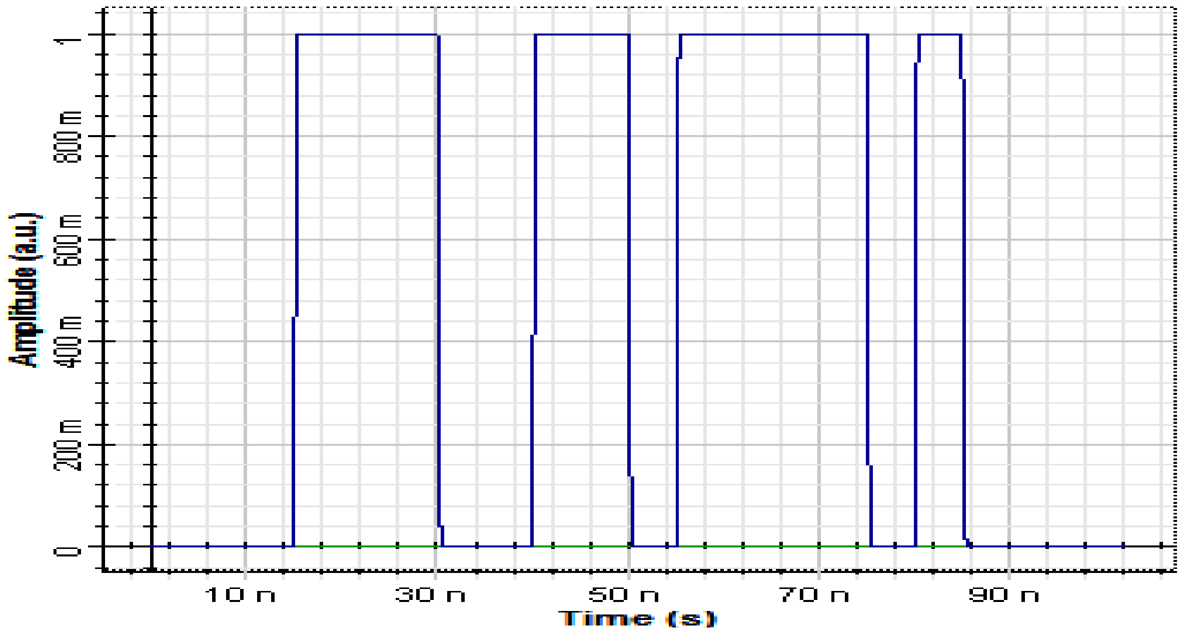

Figure 2: visualized oscilloscope of the data at 10 Gbps

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. Figure 3 and 4 show the Optical Spectrum in wavelength and time domain of the data at 10 Gbps at the PRBS. This data has been fed to the 128 numbers of users.

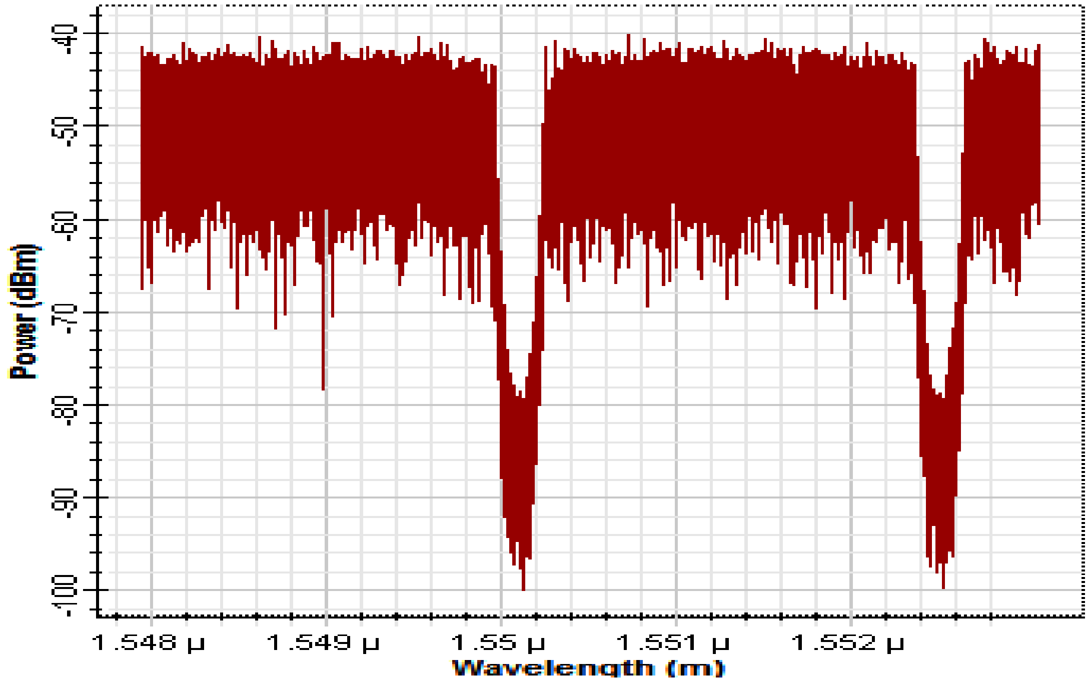

Figure 3: Optical Spectrum Analyzer

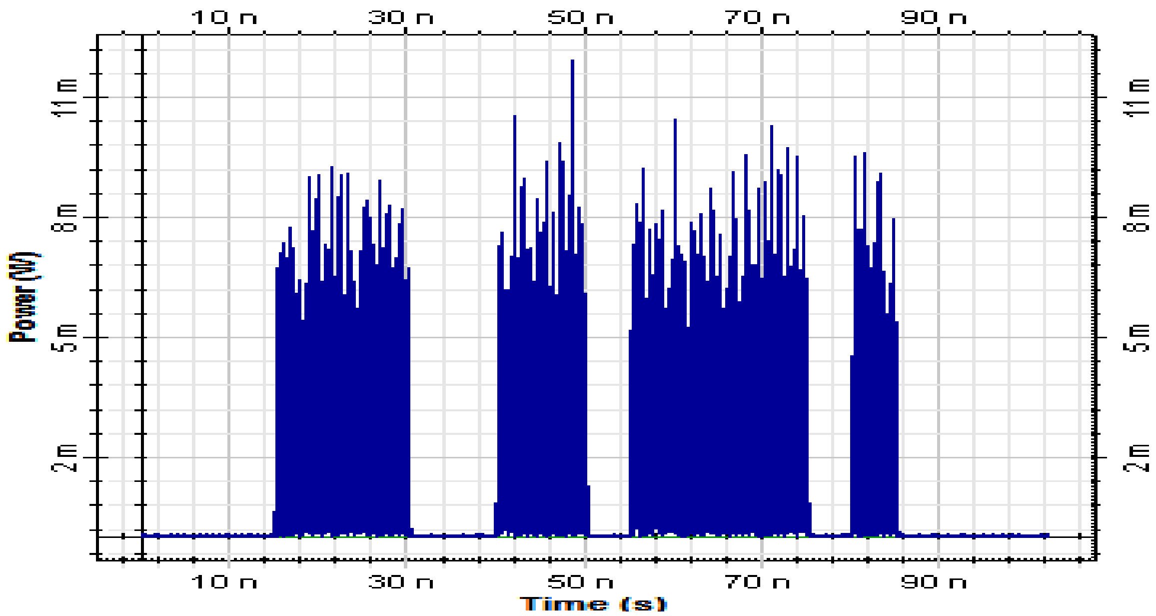

Figure 4: Optical Time Domain Visualizer

To mitigate the effect of Rayleigh scattering and Raman scattering, we have reduced the width of pulses as compare to the carrier lifetime. So, we have taken the following parameters:

Table 1: System Parameters used in the Simulation

Parameters	Value
Wavelength	1550nm
Thermal Noise	$1 * 10^{-23}$w/hz
Dark Current	10nA

Responsively	1 A/W
Optical Bandwidth	$b_o = 3.75Thz$
Attenuation	0.25dB/km
No. of Users	128

The system is further analyzed for the effect of Raman and Rayleigh scattering effects. We have proposed a system after suppressing the effects of Raman and Rayleigh scattering. Figure 5 shows the Q factor with respect to input optical power with and without Raman and Rayleigh scattering.

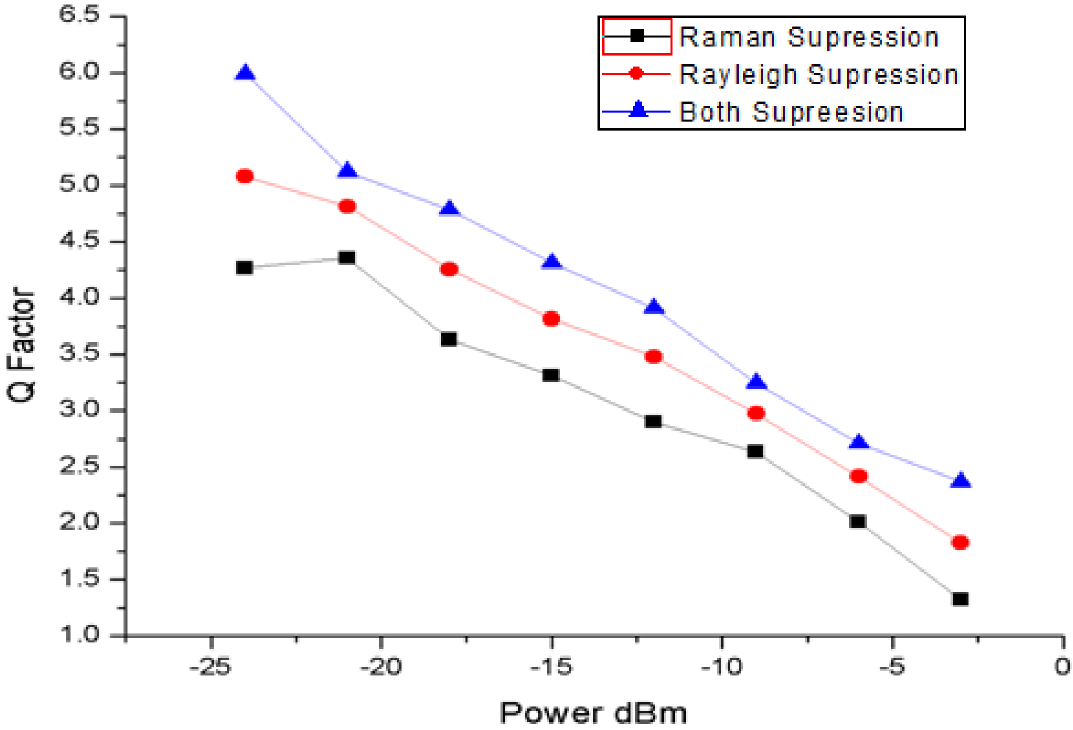

Figure 5: Q factor with respect to input optical power with and without Raman and Rayleigh scattering

It is evident that the Q factor decreases as we have added the scattering effects. The system observes a Q factor of 4.3 to 1.25, 5.1 to 2.1 and 6.05 to 2.7 after Raman suppression, Rayleigh suppression and both (Raman and Rayleigh) suppressions respectively. Figure 6 shows Q factor with respect to length of the fiber with and without Raman and Rayleigh scattering

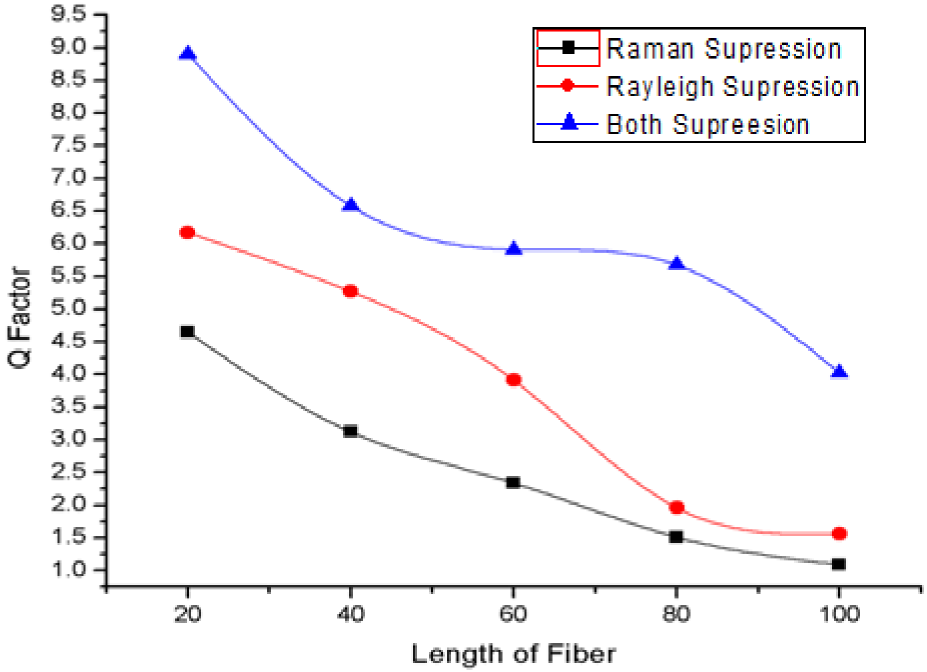

Figure 6: Q factor with respect to length of the fiber with and without Raman and Rayleigh scattering

We have varied the length of the fiber from 20 Km to 100 Km and analyzed the effect of suppression of the Raman and Rayleigh scatterings. It is evident that the Q factor decreases as we increases the distance of the fiber. The system observes a Q factor of 4.52 to 1.2, 6.3 to 2.1 and 9.06 to 4.8 after Raman suppression, Rayleigh suppression and both (Raman and Rayleigh) suppressions respectively.

4. Conclusion

In this manuscript, we have analyzed a WDM system for Raman and Rayleigh scattering effect and their suppression methods. We have transmitted 10 Gbps data to 128 users. To increase the distance, we have employed SOA amplifiers in the channel. 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 data is transmitted at 1550 nm wavelength to reduce the effect of attenuation.

5. References:

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