INVESTIGATION ON THE EFFECT OF NON LINEARITY FOR DENSE WAVELENGTH DIVISION MULTIPLEX (DWDM) SYSTEMS AT DIFFERENT CHANNEL SPACING

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ABSTRACT

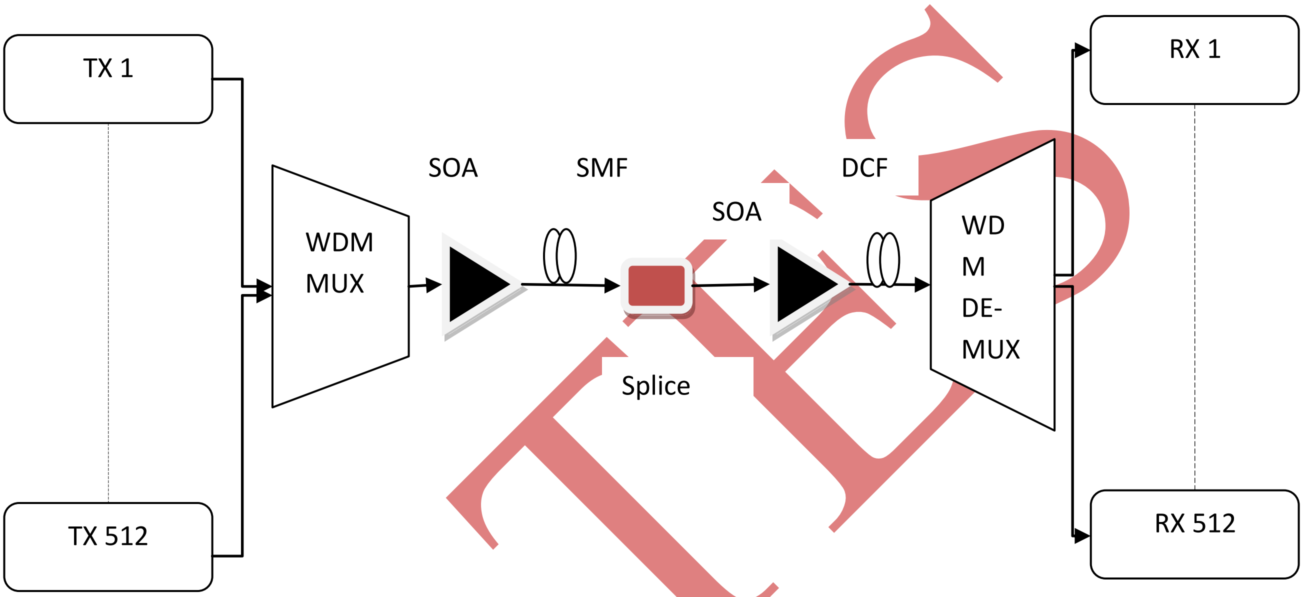
In this paper, we have investigated the effect of fiber non linearity on dense wavelength division multiplex (DWDM) systems at different channel spacing. The effect of crosstalk is analyzed for different numbers of users i.e. for 128, 256 and 512 number of users with respect to different data rates i.e. at 2.5, 5 and 10 Gbps data rates. Two different fibers viz. single mode fiber (SMF) and dispersion compensated fibers ((DCF) of 100 km length each are installed at the channel. Semiconductor optical amplifier (SOA) is used to boost up the signals in between these fibers. Non return to zero modulation formats are used as line coding of the signals. It is also observed that at high data rate i.e. 10 Gbps experiences more crosstalk than lesser data rates i.e. 2.5 and 5 Gbps. It is also shown that crosstalk increases as number of users increases.

I. INTRODUCTION

Dense wavelength-division-multiplexing (DWDM) comes into picture to enable the very high-capacity photonic networks required by our communication thirsty society [1]. The dispersion and fiber nonlinearities are the parameter which restricts the transmission distance and bandwidth of DWDM systems [2, 3]. Fiber nonlinearities become a problem, when several channels are co propagating in the same fiber [4]. Nonlinear effects arose as data rate, repeater-less transmission length, number of wavelengths, and optical power levels are increased [5, 6]. The optical fiber is designed in such a way that all the nonlinearities inside the fiber have to be minimized and optimized to reproduce the original signal at the receiver. Linear dispersions such as chromatic dispersion and Polarization Mode Dispersion have become significant at high optical power levels and have become more important since the development of high bit rate, WDM and DWDM systems. Since Chromatic dispersion is stable, it can be compensated by the Dispersion Compensated Fibers (DCF) directly without adopting any specific compensating techniques [7]. In this investigation, we have proposed DWDM systems at different channel spacing with crosstalk effect. The effect of crosstalk is analyzed for different numbers of users i.e. for 128, 256 and 512 number of users with respect to different data rates i.e. at 2.5, 5 and 10 Gbps data rates. Two different fibers viz. single mode fiber (SMF) and dispersion compensated fibers ((DCF) of 100 km length each are installed at the channel. Semiconductor optical amplifier (SOA) is used to boost up the signals in between these fibers. Non return to zero modulation formats are used as line coding of the signals. This paper is organized into four sections. In Section 1, introduction to DWDM networks is described. In Section 2, the system setup for proposed DWDM network is described. In Section 3, results and discussion have been reported. Finally in Section 4, conclusions are made.

II. SYSTEM SETUP

The block diagram of the proposed DWDM system using single mode fiber (SMF) and dispersion compensated fiber (DCF) is shown in Figure 1. The system set up contains a number of components models represented by block icons like transmitter TX, WDM multiplexer, SOA, demultiplexer, splice and receiver.



The proposed DWDM system for 512 users for fiber non linearity effect is simulated in optsim software. Firstly, we have 512 transmitters represented by TX 1 to TX 512. The data from each transmitter is multiplexed by wavelength division multiplexer (WDM). The system is simulated at different data rates i.e. 2.5 Gbps, 5 Gbps and 10 Gbps. Two types of fibers: single mode fiber (SMF) and dispersion compensated fiber (DCF) are inserted between these amplifiers as shown in figure to mitigate the effect of fiber non linearity.

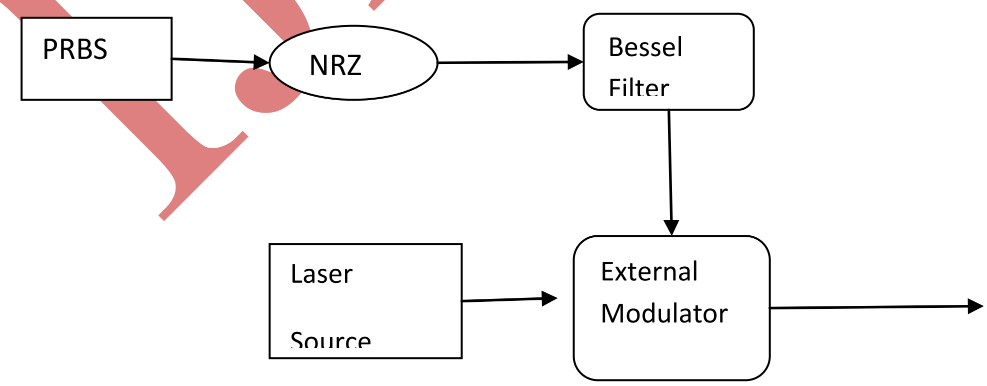


Figure 2 Setup of Transmitter

These signals are again split to the respective receivers according with respect to their wavelength. The signal is decoded in the original form at the 512 receivers namely RX1 to RX 512 which are shown by block icon in the figure. The setup of transmitter section is shown in figure 2. This setup consists of pseudorandom binary sequence generator (PRBS generator) (which produces data at different rates i.e. 2.5, 5 and 10 Gbps), signal generator (which is used to select desired data format), Bessel filter (to maintain the data in desired band), CW Lorentzian LASER (to convert data in to optical form) and Machzender inferometer modulator (to modulate the data to channel).

Non Return to Zero is used the proposed system. The setup of receiver section is shown in figure 3, this section is composed of optical Lorentzain filter, PIN photodiode indicated by the component name RX, PIN and low-pass Bessel filter indicated by the component name Bessel.

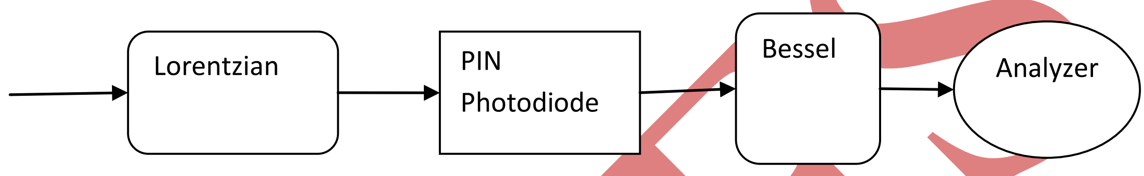


Figure 3 Setup of Receiver

To compensate the dispersion losses, we divided the optical link in two identical spans with splice. In first span, we use SMF fiber and in second span we use DCF fiber to compensate dispersion. Then SOA amplifier is used as pre amplifier and data is given to receiver. At receiver, users can extract their data, Lorentzian filter is used to assign desired wavelength to individuals. PIN photodiode is used to detect the original data. Various analyzers are used to calculate different performance parameters.

III. RESULT AND DISCUSSION

The effect of crosstalk is analyzed for different numbers of users i.e. for 128, 256 and 512 number of users with respect to different d for different data rates i.e. at 2.5, 5 and 10 Gbps data rates. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 2.5 Gbps data rates for 128 users is shown in figure 4.

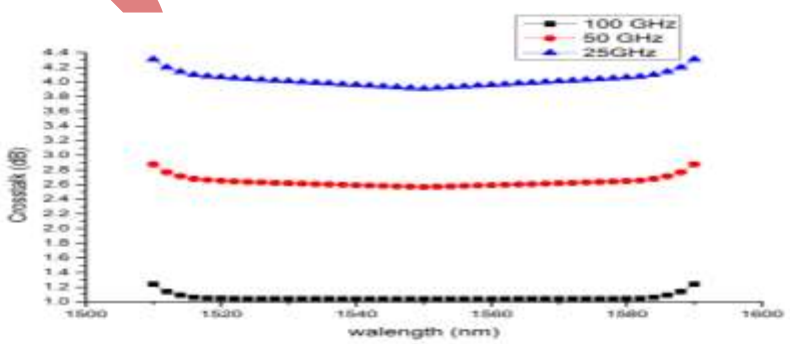


Figure 4 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 2.5 Gbps data rates for 128 users

It is observed that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 128 users are 1.0405 dB at 100 GHz, 2.5665 dB at 50 GHz and 3.9105 dB at 25 GHz with 2.5 Gbps data rate at 1550 nm signal wavelength are observed. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 5 Gbps data rates for 128 users is shown in figure 5.

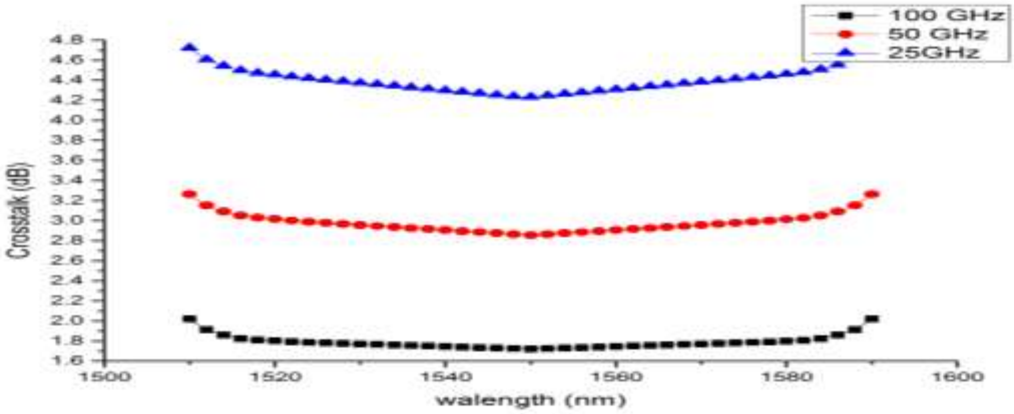


Figure 5 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 5 Gbps data rates for 128 users

It is evident that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 128 users are 1.7205 dB at 100 GHz, 2.8565 dB at 50 GHz and 4.2355 dB at 25 GHz with 5 Gbps data rate at 1550 nm signal wavelength are observed. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 10 Gbps data rates for 128 users is shown in figure 6.

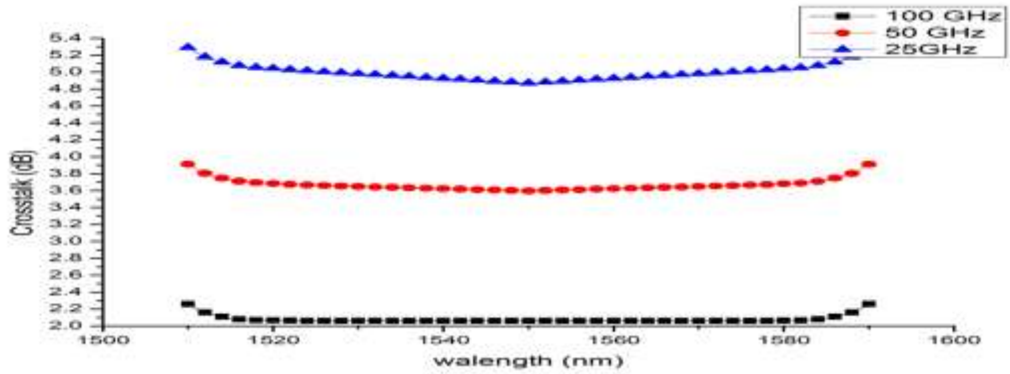


Figure 6 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 10 Gbps data rates for 128 users

It is observed that with increase in data rate, the crosstalk also increases. It is also shown that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 128 users are 2.0605dB at 100 GHz, 3.5975dB at 50 GHz and 4.8715dB at 25 GHz with 10 Gbps data rate at 1550 nm signal wavelength are observed. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 2.5 Gbps data rates for 256 users is shown in figure 7.

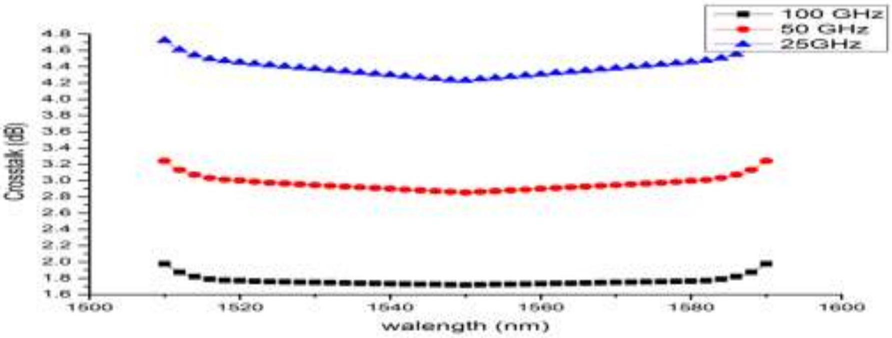


Figure 7 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 2.5 Gbps data rates for 256 users

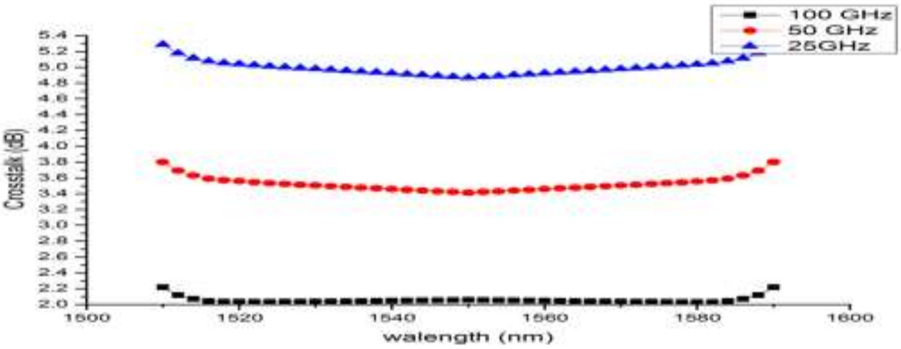


Figure 8 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 5 Gbps data rates for 256 users

It is evident that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 256 users are 2.0575dB at 100 GHz, 3.4135 dB at 50 GHz and 4.8685dB at 25 GHz with 5 Gbps data rate at 1550 nm signal wavelength are observed. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 10 Gbps data rates for 256 users is shown in figure 9.

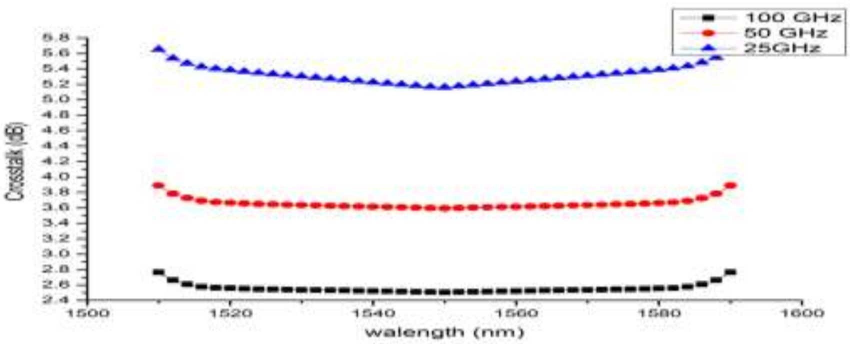


Figure 9 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 10 Gbps data rates for 256 users

It is observed that with increase in data rate, the crosstalk also increases. It is also shown that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 256 users are 2.5075 dB at 100 GHz, 3.5945 dB at 50 GHz and 5.1625 dB at 25 GHz with 10 Gbps data rate at 1550 nm signal wavelength are observed. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 2.5 Gbps data rates for 512 users is shown in figure 10.

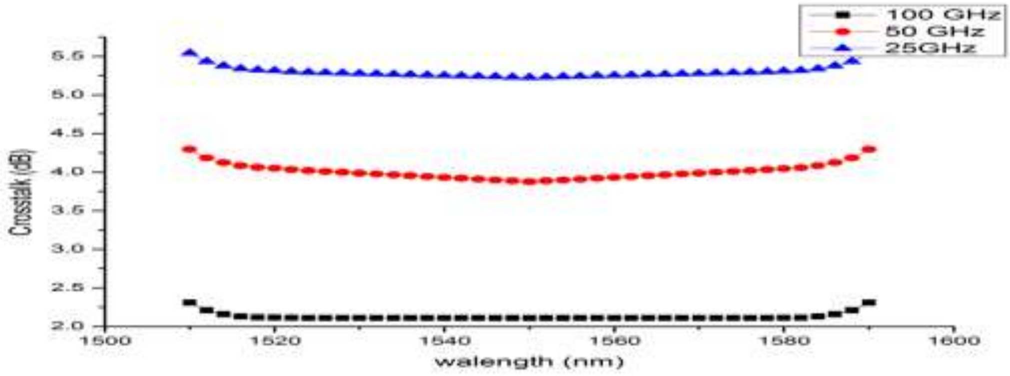


Figure 10 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 2.5 Gbps data rates for 512 users

It is observed that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 512 users are 2.1105dB at 100 GHz, 3.8765 dB at 50 GHz and 5.2275 dB at 25 GHz with 2.5 Gbps data rate at 1550 nm signal wavelength are observed. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 5 Gbps data rates for 512 users is shown in figure 11.

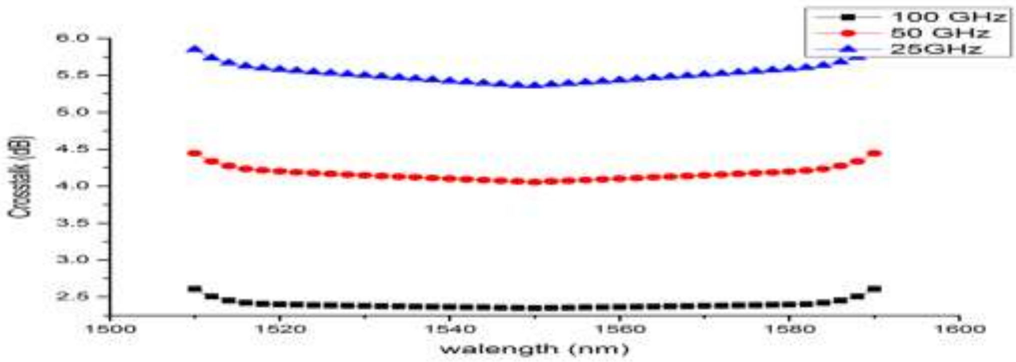


Figure 11 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 5 Gbps data rates for 512 users

It is evident that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 512 users are 2.3495 dB at 100 GHz, 4.0565 dB at 50 GHz and 5.3605 dB at 25 GHz with 5 Gbps data rate at 1550 nm signal wavelength are observed. The Variation of crosstalk (dB) with respect to wavelength at different channel spacing i.e. 25, 50 and 100 GHz with 10 Gbps data rates for 512 users is shown in figure 12.

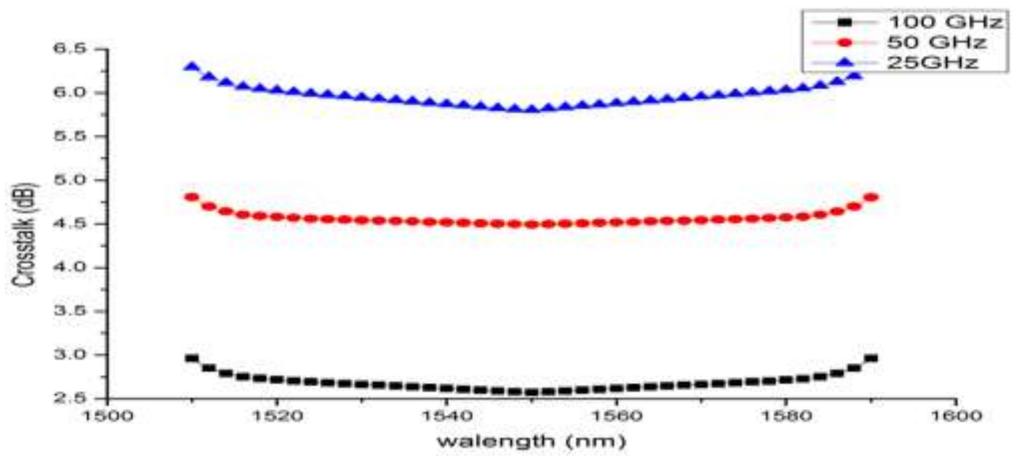


Figure 12 Crosstalk Vs wavelength at 25, 50 and 100 GHz channel spacing with 10 Gbps data rates for 512 users

It is observed that with increase in data rate, the crosstalk also increases. It is also shown that with the decrease in channel spacing of the system, the crosstalk increases. The values of crosstalk for 512 users are 2.5725 dB at 100 GHz, 4.4925 dB at 50 GHz and 5.8065 dB at 25 GHz with 10 Gbps data rate at 1550 nm signal wavelength are observed.

IV. CONCLUSION

In this paper, we have investigated the effect of fiber non linearity on DWDM systems at different channel spacing i.e. 25, 50 and 100 GHz channel spacing. The effect of crosstalk is analyzed for different numbers of users i.e. for 128, 256 and 512 number of users with respect to different data rates i.e. at 2.5, 5 and 10 Gbps data rates. Two different fibers viz. single mode fiber (SMF) and dispersion compensated fibers ((DCF) of 100 km length each are installed at the channel. It is also observed that at high data rate i.e. 10 Gbps experiences more crosstalk than lesser data rates i.e. 2.5 and 5 Gbps. It is also shown that crosstalk increases as number of users increases. It is also shown that with the decrease in channel spacing of the system, the crosstalk increases.

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