Performance Analysis of different WDM systems

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Abstract
In this paper, we have analysed different WDM systems. The WDM system has been effected by dispersion and non-linear effects. We have also analysed the use of PIN and APD photo detectors. We have designed three WDM systems amd observed their response using different dispersion values.

Keywords: WDM system, NRZ system, RZ system and CSRZ system, BER performance

INTRODUCTION

The adoption of WDM allows, as a first step, to increase the transmission capacity of the backbones by reusing existing fibre cables. WDM combines cost-effectiveness with scalability. The deployment of WDM offers the operator a number of advantages, but primarily, whole-life cost savings[1]. Since wavelength and frequency are closely related to each other, this form of multiplexing is often called frequency division multiplexing (FDM). Each WDM fiber has a certain bandwidth—the range of frequencies it can carry. One advantage of WDM is that every user can transmit information at the highest rate possible all the time. WDM does not change transfer rates in proportion to the number of users on the line. Another large benefit to WDM is that it increases the amount of information that can be transferred without significant loss of signal integrity. In any two fibers of the same quality, one signal will be lost just as fast as ten or more, so there is nothing to be lost—and much to be gained—from WDM. Even with the new solution to the bandwidth bottleneck, the ground gained by WDM was lost quickly, and another step forward had to be made. The system design engineers should not deploy high-bit-rate (>10 Gbit/s per channel) multiwavelength systems without considering the nonlinear effects and their impact on these systems[2].

New modulation formats that offer large dispersion and nonlinear tolerance pave the way to greatly increased system capacity and transmission distance[3][4]. Increasing spectral efficiency is important for building efficient wavelength division multiplexed (WDM) fiber optic transport systems, since this allows the optical infrastructure to be shared among many WDM channels, and thus reduces the cost per transmitted information bit in a fully loaded system.different modulation format have different response to dispersion and non linear effects.[5][6] Optical components to be shared among many WDM channels include the transmission fiber, optical amplifiers, optical dispersion-compensating modules, and optical equalizers. In order to achieve ultimate spectral efficiency, WDM channel spacings are reduced until the optical spectra of neighboring channels start to noticeably overlap. In this limit of ultra-dense wavelength-division multiplexed (DWDM) systems, coherent crosstalk between adjacent WDM channels becomes a main source of degradation [7]–[8]. Adjacent channels interfere with each other upon detection, and the resulting beating gives rise to signal distortions, provided that the beat frequencies lie within the bandwidth of the detection electronics (coherent in-band crosstalk). The resulting signal distortions are random, since the adjacent WDM channels carry different randomly aligned bit patterns, and since different channels are generated by mutually incoherent laser sources, implying randomly varying optical phase relationships among them.

EXPERIMENTAL SET UP AND RESULTS

We have designed three WDM system, as shown in figure 1, i.e., 4 channel NRZ system, 4 channel RZ system and 4 channel CSRZ system. The NRZ system has designed using NRZ optical transmitters at transmitter side and optical receivers at receiver side as shown in the figure. The frequencies used are 193.1 THz for first channel, 193.1 THz for first channel, 193.1 THz for first channel, 193.1 THz for first channel. These systems has been designed for 10Gbps. As we are using 4 channel system, multiplexers and demultiplexers have been used for multiplexing and demultiplexing purposes. Here equally spaced WDM MUX and DEMUX have been used and the bandwidth of the WDM MUX and DEMUX has been kept at 10GHz. For the simulation results, the length of optical fiber has been varied from 40 to 100km.

The BER analyzer shown in figure 1, has been used for obtaining results. We can obtain bit error aret and Q Factor from the BER analyzer. The optical receiver consists of PIN photodetector with low pass Bessel filter. For the Return to zero system, optical RZ transmitters have been used and for CSRZ system, CSRZ transmitters have been used. The spectrum for NRZ, RZ and CSRZ systems are as shown in figure 2,3,4.

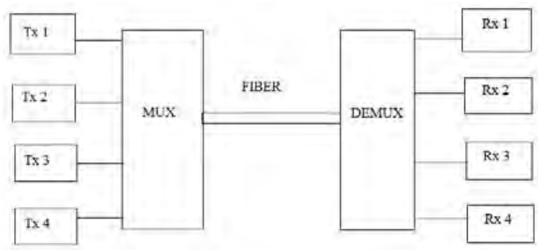

Figure 1. Four channel WDM system

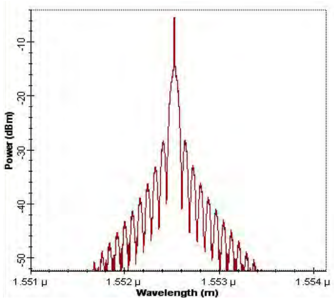

Figure 2 Spectrum for NRZ signal

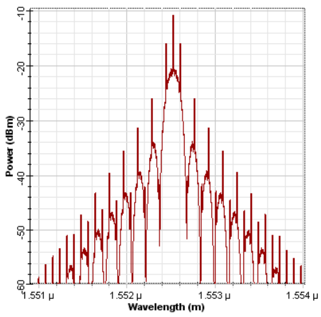

Figure 3. Spectrum for RZ signal

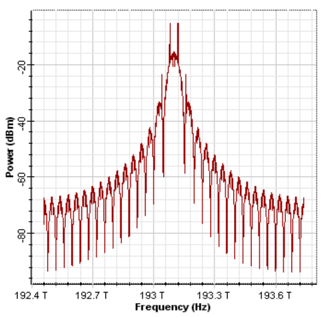

Figure 4. Spectrum for CSRZ signal

(a) Results for three WDM systems using PIN photodetector

The results for three WDM systems discussed above have been taken at dispersion 3ps/nm-km. The results shown are for the first channel of the each WDM system operating at 10Gbps. The BER versus fiber length plot is shown in the figure 5. At low value of dispersion, the RZ and CSRZ WDM system has good response. The results at dispersion 8 ps/nm-km are as shown in the figure 6. At this value of dispersion the response of NRZ decreases further. But RZ and CSRZ system has almost unaffected. The RZ system has good performance upto 55km. No one of these system achieve fiber length reach above 60km.as we further increase the dispersion value, then the performance of all three WDM system degrades.

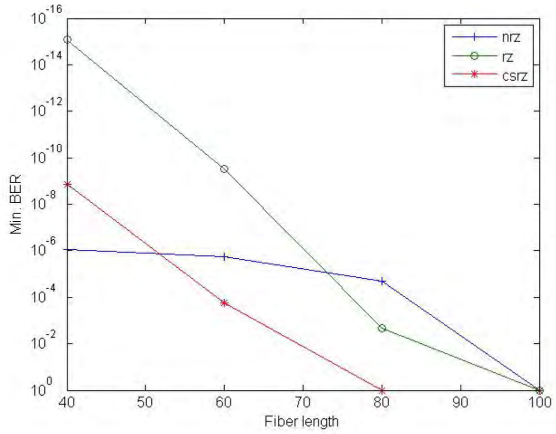

Figure 5. Min. BER plot for three WDM system at dispersion 3ps/nm-km

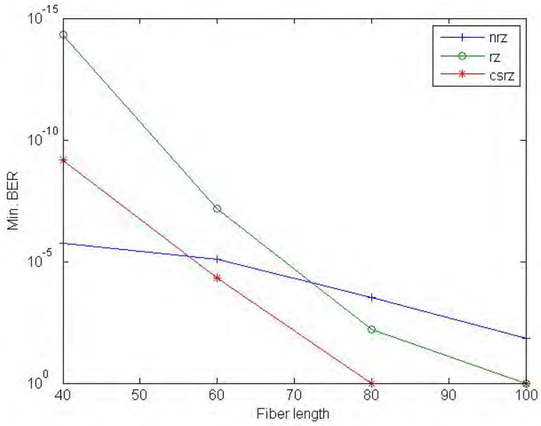

Figure 6. Min. BER plot for three WDM system at dispersion 8 ps/nm-km

(b) Results for three WDM systems using APD

The results, shown in figure 7, have been taken at dispersion 3ps/nm-km using APD at the receiver side. It is clearly observed from figure that by using the APD photo detector, results have been improved. The values for Q Factor has been also improved. The RZ system reach is now upto 85km and for CSRZ system, it is upto 65km. For dispersion value set to 8 ps/nm-km, the response of the three WDM systems degrades as shown in figure 8. It is observed that with increase in dispersion value the response of all these WDM system decreases.

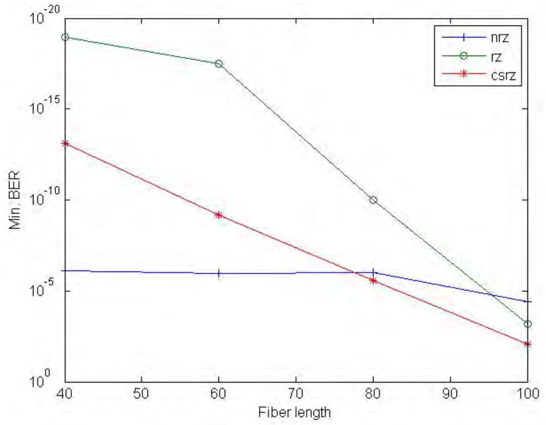

Figure 7. Min. BER plot for three WDM system at dispersion 3 ps/nm-km

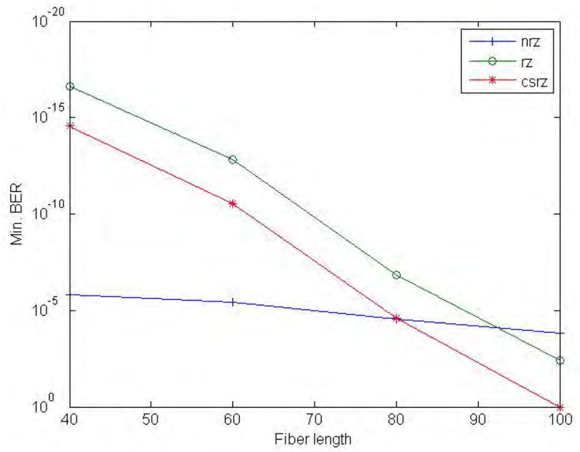

Figure 8. Min. BER plot for three WDM system at dispersion 8 ps/nm-km

(c) Effect of dispersion values on different WDM systems

In this simulation, we have analyzed the effect of different dispersions on three WDM systems discussed above. The three dispersion are used for simulation are 3, 8 and 16.75ps/nm-km. it is noted that with the increase of dispersion values, the performance of the WDM system decreases. Also, with these three values of dispersion, the change in performance of CSRZ system is less but for RZ system it is more as shown in figure 9. It is observed that effect of dispersion values for NRZ system as shown in figure 10.

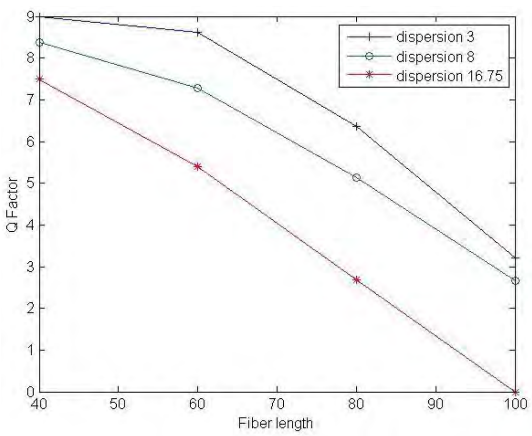

Figure 9. Plot for 4 channel WDM RZ system with three dispersion values

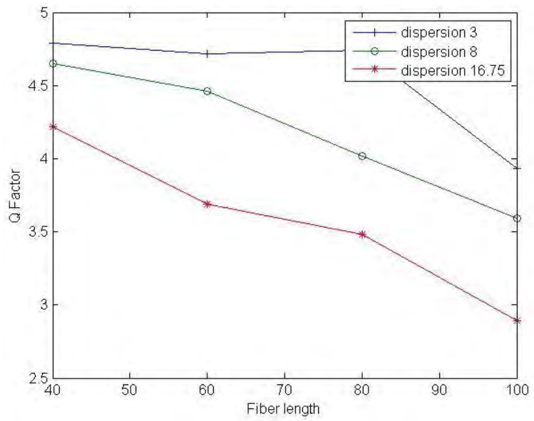

Figure 10. Plot for 4 channel WDM NRZ system with three dispersion values

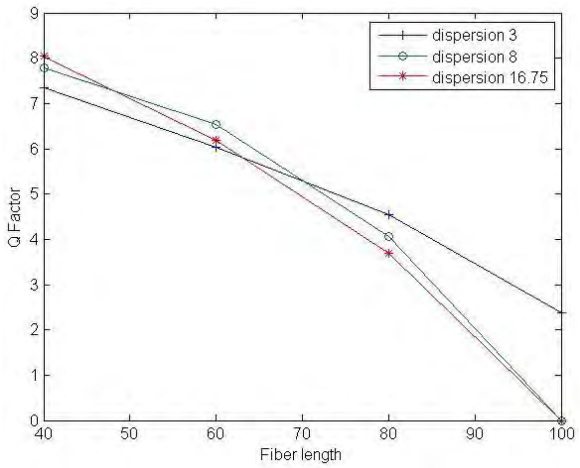

Figure 11. Plot for 4 channel WDM CSRZ system with three dispersion values**.**

Conclusion

We have analysed the performance of the three WDM systems. We have studied the effect of different dispersion values on the three different 4 channel WDM system. The CSRZ signal is far less sensitive to fiber nonlinear effects and provides better robustness against transmission impairments. The RZ system has reduced dispersion tolerance and a reduced spectral efficiency of RZ based WDM systems. The NRZ system has improved dispersion tolerance but it has the effect of inter-symbol interference between the pulses this modulation format is not suitable when high bit rates and distance.

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