L BAND REPEATERLESS DWDM FIELD TRIAL OVER 160 KM OF DSF FIBER

Rosolem J.B., Arradi. R., Juriollo A. A. , Said C. J., et al.

rosolem@cpqd.com.br - phone 19 3705.6796 - fax 19 3705.6119

CPqD - CEP13088-902 - Campinas - SP - Brazil

Abstract - In this paper we present the results of L band repeaterless DWDM field trial over 160 km of Dispersion Shifted Fiber. The test was successfully implemented in 8x2.5 GB/s using high power levels. No evidence of any impairment due non-linear effects was observed.

1 - Introduction

In the beginning of the 90's dispersion shifted fibers (DSF) were largely installed around the world as a promised solution to solve the dispersion impairments in long distance transmission. By the same time, the first commercial available erbium doped fiber amplifier (EDFA) arrived to the market, closely followed by commercial WDM transmission systems. All of those products driven by technology development were addressed to improve system capacity but, as the optical power increased, the fiber non-linear threshold could easily be reached.

In particular the DSF has the zero dispersion wavelength in the EDFA gain bandwidth, which increases the non-linear efficiency and reduces the non-linear threshold. The nonlinearities could be problematic for the use of DSF and amplified DWDM. Many demonstrations of DWDM transmission over DSF and interesting results have been published [1,2]. The impairments can be reduced by using unequal channel spacing, or avoiding the wavelengths that produce non linearities in the fiber or using the so called L band of the EDFA that ranges from 1570 nm to 1610 nm . In this paper we report the results of field demonstration of high power DWDM transmission in L band, with a span loss superior to 50 dB without any in-line amplification.

2 - Experiment Set-up

The experimental setup is shown in Figure 1. Eight DFB lasers in the L band, passively multiplexed, compose the transmitter. Those channels were intensity modulated through an external modulator with a STM 16 signal from a BER test set. The multiplexed signal was amplified in two stages. We used 9 km of standard single mode fiber between the stages of amplification in order to obtain 8 uncorrected channels. The amplified multiplexed signal was launched into the fiber that is installed in an optical powered ground wire cable (OPGW) connecting two cities in Brazil. The fiber length measured with an OTDR was nearly 160 km. At the receiver end we use pre-amp and a tunable filter to select the channel to be tested.

The channel allocation and the optical output power per channel are shown in Table 1. The channel spacing was 1.2 nm. To our knowledge it was the first time that high optical power per channel was used in L -band DWDM field trial over DSF.

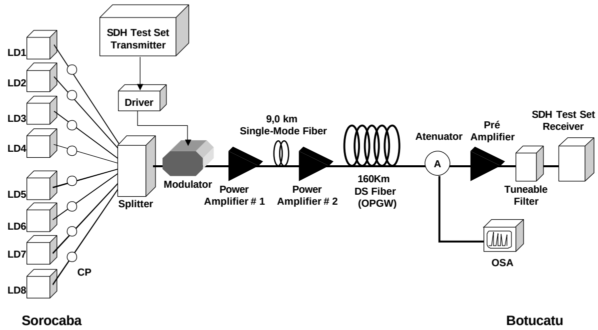

Figure 1: Field Trial Set-up to L Band

Table 1 - Channel allocation and the optical output power per channel

Channel	Wavelength (nm)	Launched Power (dBm)
1	1588.0	11,00
2	1590.2	12,15
3	1592.4	12,60
4	1594.6	12,00
5	1596.8	12,60
6	1599.0	12,20
7	1601.2	11,60
8	1603.4	11,30

3 - Results

We measured the spectral attenuation and the dispersion of the installed fiber and in one similar fiber in our lab. The attenuation results are shown in the Figure 2. Concerning to the installed fiber, there is high attenuation near the 1585 region, which is not typical and for which we don't have any reasonable explanation. This effect was observed in all fibers of the cable. Because of that we had to use high optical power at transmission in order to obtain 3 dB minimum margin at the receiver terminal. Total span losses range between 48.5 and 52.5 dB, depending on the wavelength and on the fiber. The zero dispersion wavelengths measured ranges from 1545 nm to 1560 nm.

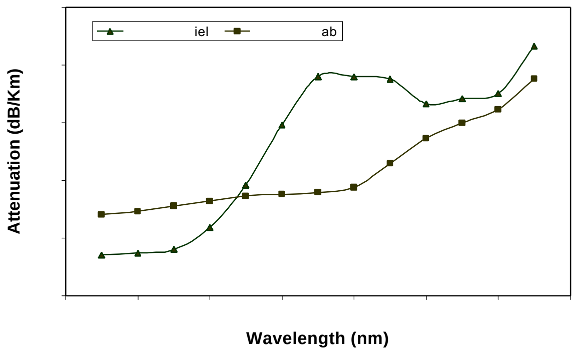

Figure 2: Fiber spectral attenuation in the L Band.

The system was tested in 12 fibers in the cable. Figure 3 shows the typical BER versus received power, indicating no evidence of BER floor. We plot the power penalty statistics (12 fibers x 8 channels) in Figure 4, and we observe that there is no penalty higher than 0.75 dB. In order to estimate the FWM level, we turned off channel #3. The FWM product, showed in Figure 5, is 38 dB below the signal level. As the dispersion is not null, XPM could also generate some impairments in the system. Comparing the spectra of channel #8 at the transmission and at the reception (Figure 6a and b) we can see that the broadening due to XPM or SPM modulation is very small.

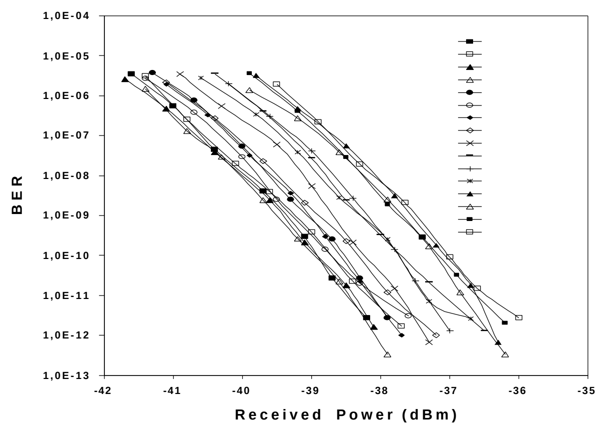

Figure 3: BER performance of 8 channels

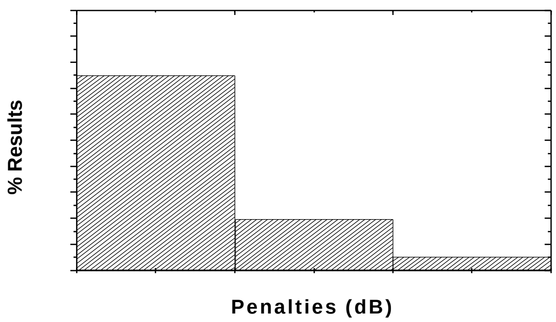

Figure 4: Penalty statistics of Field Trial

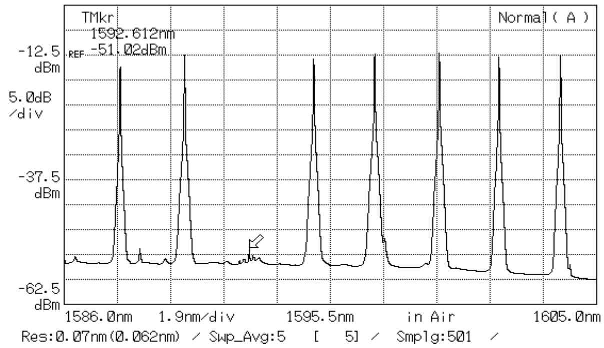

Figure 5: Small interference signal due to FWM on channel #3.

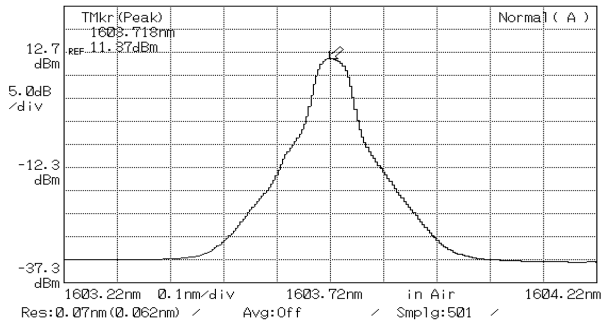

Figure 6(a). Channel #8 at the transmitter side.

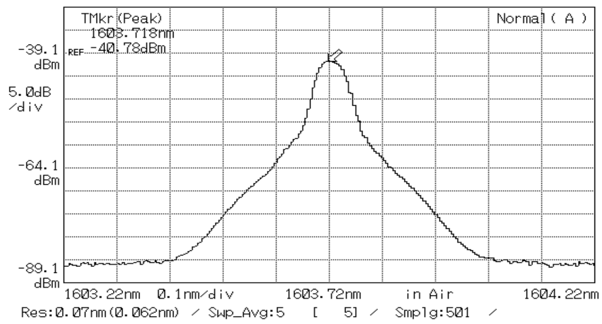

Figure 6(b). Channel #8 at the receiver side.

4 - Conclusion

We reported a successful demonstration of field trial transmission in the L-band over 160 km of DSF, installed in an OPGW. Despite the use of both, high power (more than 11 dBm per channel) and close channel spacing (1.2 nm), no evidence of any impairment due non-linear effects was observed**.**

References

[1] M. Jinno et al, "First Demonstration of 1580 nm Wavelength Band WDM Transmission For Doubling Usable Bandwidth and Suppressing FWM on DSF", Electron. Lett. , vol.33, n 10, 1997.

[2] A . K. Srivastava et al., "L-Band 64x10Gb/s DWDM transmission over 500 Km DSF with 50 GHz channel spacing", ECOC'98, Madrid, Spain, 1998, pp 73-75.