Investigation of influence of thermal coefficients on 2-D WH/TS OCDMA code propagation in optical fiber

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In this paper we present an extension of our previous investigation [1] of the effect of environmental temperature variation on the bit error rate (BER) performance of multiwavelength 2- dimensional wavelength hopping time spreading optical code division multiple access (2D-WH/TS OCDMA) signals that utilises picosecond pulses for code formation. Using equations already derived in [1] for modelling the effects of temperature variation on autocorrelation signal resulting from the decoding of an incoherent 2D-WH/TS OCDMA encoded signal which consists of w wavelength pulses each having a pulsewidth of τ after propagating in L (Km) of fibre, we arrive at the expression for the envelope of the resulting autocorrelation peak S_t.

$$S_t = \sum_{k=0}^{w-1} P_p \ \exp\left\{-2.77\left[\frac{t-k[D_{temp}\times \Delta T\times \Delta\Lambda \times L\,]}{\tau-[D_{temp}\times \Delta T\times \Delta\lambda\times L]}\right]^2\right\} \qquad (1)$$

D_{temp} (ps/nm•km/°C) is the thermal coefficient of the fiber [2,3], ΔT (°C) is the average change in temperature experienced by transmission fiber, $\Delta\Lambda$ (nm) is the spectral spacing between 2D-WH/TS OCDMA code wavelengths pulses, and $\Delta\lambda$ (nm) is the pulse spectral line width of each wavelength pulse within the code.

Having obtained the maximum possible autocorrelation peak S_t for each degree of temperature change, we analysed the effect of this reduction in S_t with respect to temperature variation by substituting S_t for th in the equation for Pe (BER) as previously derived in [1] and we obtain the equation below

$$P_e = \frac{1}{2}\sum_{j=0}^{St} (-1)^j \binom{w}{j}\left(1-\frac{j(\frac{w}{2.N_c})}{w}\right)^{K-1} \qquad (2)$$

Figure 1 shows the envelope of S_t for an 8 wavelength 2D-WH/TS OCDMA signal after propagation in a 10km optical fibre link ($D_{temp} = -0.0025$ ps/nm•km/°C , $\Delta\Lambda = 0.8nm$ and $\Delta\lambda = 1.4nm$, N_c= code length) with initial pulsewidth of 2ps. Three different scenarios have been illustrated in the figure for ΔT = 0, 10 and 20 degrees respectively.

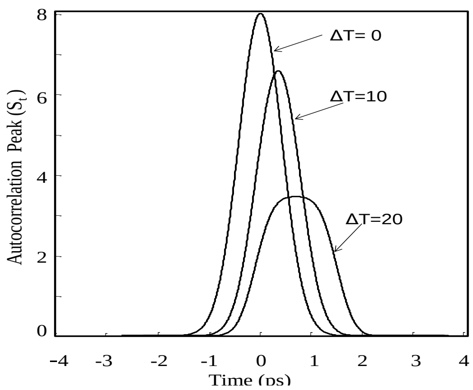

Fig. 1. *Maximum obtainable autocorrelation peak (S_t) as ΔT increases over a 10 km.*

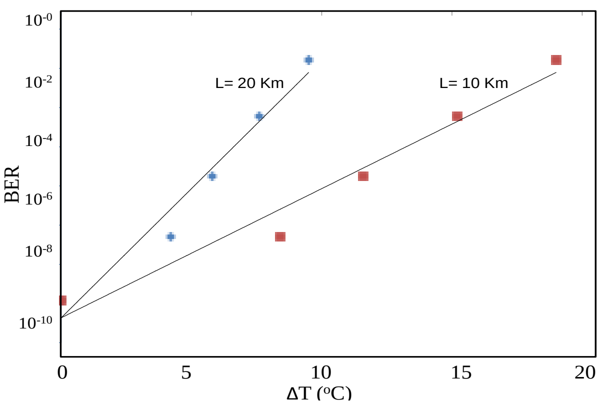

Fig. 2. *Minimum obtainable BER as ΔT increases over a 10 km and 20 km link respectively with 32 simultaneous users.*

To evaluate the effect of the ΔT induced reduction in S_t, the minimum possible bit error rate performance for K = 32 simultaneous users at 2.4Gb/s data rate was recorded from calculations obtained using Eq. 2 for ΔT between 0 and 20°C over a 10km and 20km fiber optic link. The results are presented in Figure 2. We found that trade-offs must be made between number of simultaneous users and transmission distance in order to maintain performance.

References

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