System performance of new types of dispersion compensating fibres

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with dispersion of $-17$, $-40$, $-54$ and $-100$ ps/(nm.km), corresponding to SMF to DCF length ratios of about $k=1$ (inverse dispersion fibre - IDF), 2, 3 and 6 (conventional DCF) respectively are shown in Fig. 1. All these fibres also provide dispersion slope compensation. It can be seen that when the absolute value of the dispersion is reduced from DCF to IDF values, both attenuation and non-linear coefficient are significantly reduced. As all these new fibres are designed to be cabled (therefore the DCF is part of the span length), and as it has also been shown that conventional DCF can be cabled successfully, their use in real systems needs to be compared.

In spans like the ones in Fig. 2, and assuming a constant span length, the DCF will be placed closer to optical amplifiers when the absolute value of its dispersion is reduced from conventional DCF to IDF values. Therefore a trade-off has to be found between increased input power and decreased non-linear coefficient, resulting in an optimal dispersion map. Numerical simulations based on the split-step method have been performed to compare the different dispersion maps for a fixed span length of 50 km and for NRZ modulation at 10 Gbit/s. The interaction of dispersion, Kerr effect non-linearities and amplifier noise is included in the simulations. WDM simulations have been performed on an 8 channel system with 35 GHz spacing in order to investigate the effects of cross-channel non-linear effects. Pseudo random sequence lengths of 1024 bits were used in the simulations for realistic penalty calculations, and WDM channels were uncorrelated.

Fig. 3 shows the maximum number of spans which can be cascaded for 3 dB power penalty (PIN receiver) as a function of SMF average input power per channel. For WDM transmission, only the worst-case channel is represented (one of the innermost channels). In the single channel case, $k=1$ performs the best whatever the power level and proves to be more robust to self-phase modulation. Owing to increased span loss, $k=6$ shows degraded performance at low power levels where the system is limited by noise. The poorer performance seen in the WDM case is attributed to cross-phase modulation which reduces the efficiency of the $k=1$ span when the system is no longer noise limited. Therefore $k=2$ and 3 appear as good compromises for WDM, offering lower span loss than conventional DCF while still being resistant to cross-phase modulation.

References

CFA2 Fig. 1. Evolution of the dispersion compensating fibres attenuation and non-linear coefficient as a function of dispersion (based on average measurements on manufactured fibres).

CFA2 Fig. 2. Dispersion maps under investigation for SMF to DCF length ratios between 1 and 6.

CFA2 Fig. 3. Number of cascaded spans for 3 dB penalty as a function of span average input power per channel for single and 8 channel WDM transmission (worst channel).