OPTICAL COMMUNICATION COMPONENTS
Lab 3

Nicola Simoni, Tadewos Somano, Melkamsew Tenaw

University of Brescia, Faculty of Engineering
A.Y. 2013-2014

Exercise 1

After six loops the weak pulse has the maximum red shift. The fiber length is 5 Km, so the corresponding distance is approximatively 30 Km.

Question 1

There is a distance where the spectrum of the weak pulse is maximally shifted, because the weak and the strong pulses in time domain travel with different speeds. They get closer until the distance of 30 Km where they overlap each other. In this point the effect of the cross phase modulation is maximum and so, the weak pulse is maximally red shifted.

Question 2

The spectral evolution of the weak pulse is dominated by cross phase modulation effect, in fact it increases its bandwidth until the two pulses get closer and cross each other. After that point the effect diminishes and the bandwidth starts to get narrower. The spectral evolution of the strong pulse, instead, is dominated by self phase modulation effect. In fact, it always increases its bandwidth and it is not affected by the crossing with the weak pulse.

Exercise 2

We turn off the third laser and we measure the power of the in-band FWM product at the center frequency of the turned-off WDM channel (193.125 THz) after 50 Km. The bit rate is 10 Gbit/s (with a channel spacing of 50 GHz) and the fiber is a DSF with dispersion 0.2 $[ps/(nm\ Km)]$. The power measures are:

- Peak value: -28.234 dBm
- Average power: -21.437 dBm

Exercise 3

Now we repeat the same experiment of Exercise 2 but changing the fiber dispersion to 2 $[ps/(nm\ Km)]$. The power measures are:

- Peak value: -49.589 dBm
- Average power: -38.171 dBm

Respect to the previous case, because of the higher dispersion, the peak power is 21.355 dBm lower and the average power is 16.734 dBm lower.

Exercise 4

We change the dispersion to 0.2 [$ps/(nm\ Km)$] and the channel spacing to 100 GHz. The power measures are:

- Peak value: -46.536 dBm
- Average power: -31.939 dBm

The power received is lower respect than the one in Exercise 2 because, even if we have the same value of dispersion, the channel spacing is higher and this reduces the four-wave mixing effect. The received power is higher than the one in Exercise 3 because, even if the channel spacing is increased, the dispersion is lower and this increases the four-wave mixing effect.

Question 3

Two methods for reduce four-wave mixing efficiency are:

- Use larger fiber dispersion
- Use larger channel spacing

Exercise 5

We judge three different compensation schemes (pre, post and hybrid) in the presence of strong SPM with no amplifier noise. We vary the peak power from 0 to 11 dBm, with steps of 1 dB, and we plot the eye opening penalty. In Figure 1 is shown the relative graph.

The hybrid-compensation scheme is the one with the lowest penalty, while the post-compensation scheme is the one with the highest penalty.

Exercise 6

We repeat the same test in Exercise 5 but considering a noisy amplifier. In Figure 2 is shown the relative graph.

The penalty values are higher at the starting point respect to the previous case. They decrease until a certain power value and then they increase again.

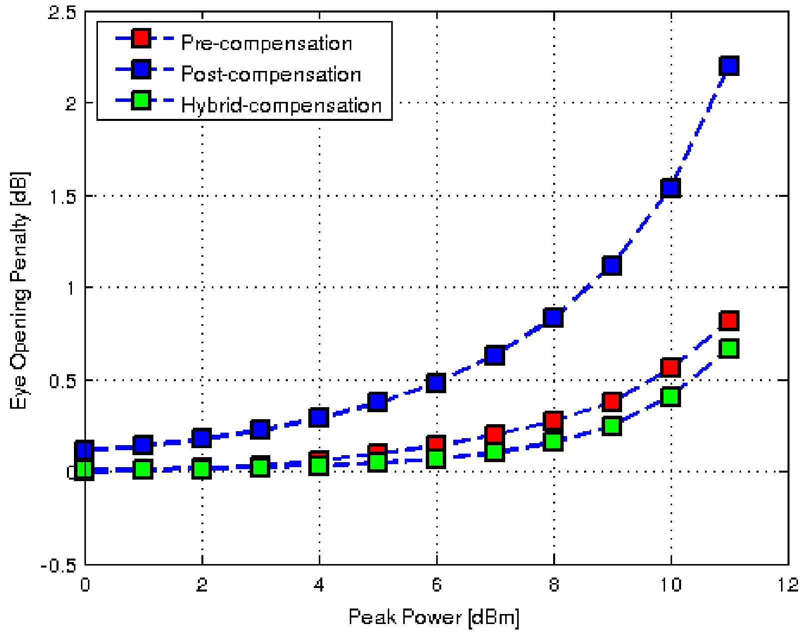

Figure 1: Eye opening penalty vs peak power (without noise).

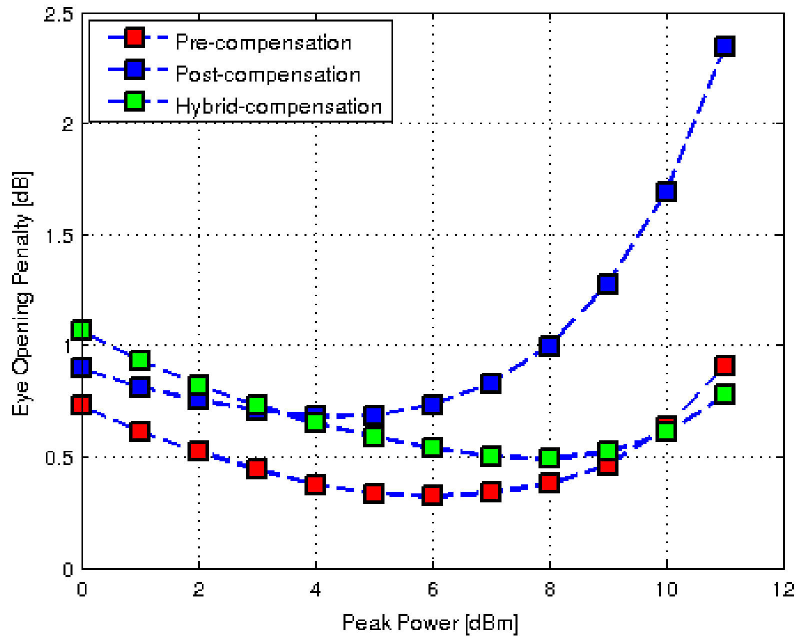

Figure 2: Eye opening penalty vs peak power (with noise).