Modal Noise Penalty for PAM4

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Jonathan King, Finisar, and Mike Dudek, Marvell

Referencing Pepeljugoski's work:

- http://www.ieee802.org/3/aq/public/nov04/pepeljugoski_1_1104.pdf

Improvements to Modal Noise Penalty Calculations

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Link Configuration

- Uses Worst Case MN Link agreed by the group
  - 2 connectors with 7 μm offset separated by 10m fiber, one with 4 μm offset after 220m
- High Coherence Laser Diode with α=0.98 and β=0.47 (Fabry-Perot)
- Fiber bandwidth 500 MHz·km
- First set of slides without correction for receiver bandwidth, assumes Gaussian fiber TF
- Second set takes into account actual fiber TF, and uses MMF launch
- Mode Partition Noise factor k is parameter

Calculations were for 10Gb/s NRZ over MMF (LRM), no FEC.
Note: TF= transfer function

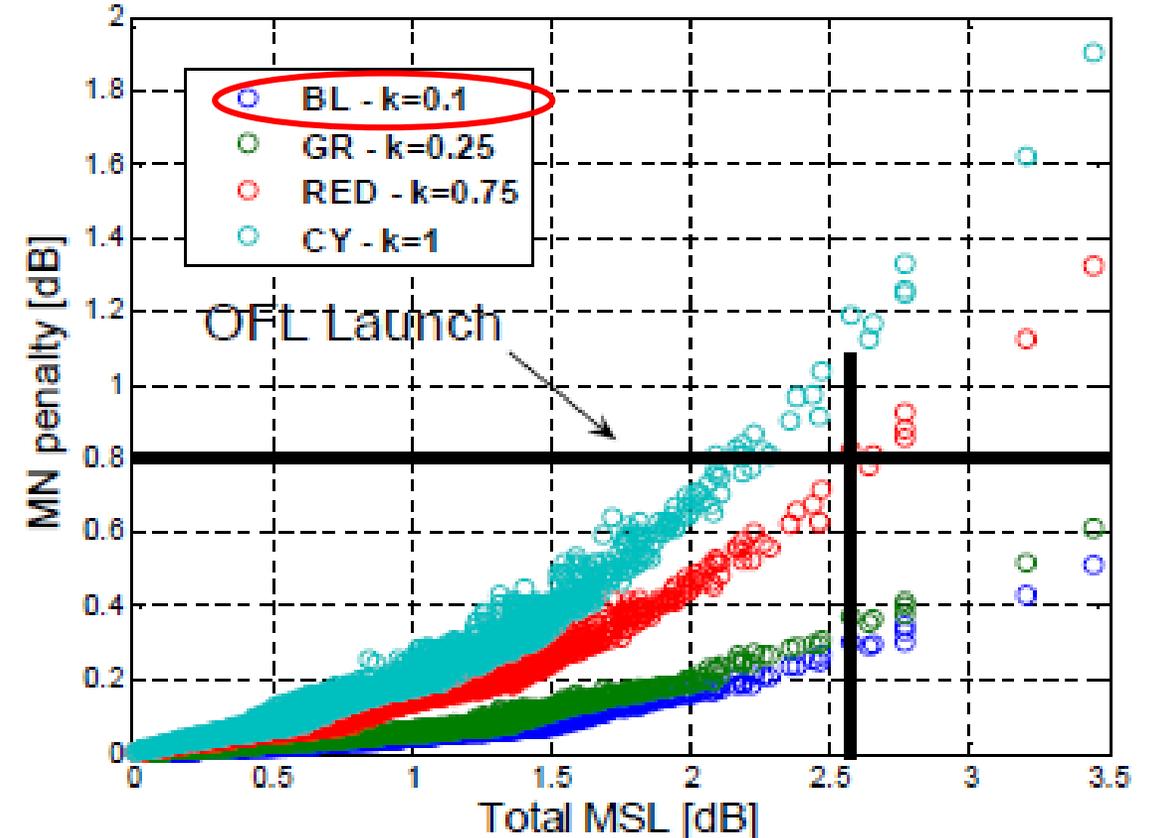# Estimate of MN Penalty from Pepeljugoski work

NRZ

- For total 1.5 dB connector loss, ~ 1dB is MSL (mode selctive loss)

- Mode partition noise factor k =0.1,

- For 1 dB MSL and k = 0.1, the modal noise penalty is ~0.04 dB

- This is for an NRZ system without FEC.

PAM4

- KP4 FEC doubles the allowed RMS modal noise

- PAM4 relative eye height (1/3) increases the relative modal noise penalty

- Resulting PAM4 MN penalty estimate is still <0.1 dB

- Note: the Pepeljugoski work included a Monte Carlo model of connector offsets, 5% of which would have exceeded the 0.75 dB maximum loss limit per connector

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