Experimental measurements showing technical feasibility for a 56Gbaud PAM4 optical link budget

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Introduction

- There have been several previous presentations related to the use of 56Gbaud PAM4 (100Gb/s per channel) as a fundamental technology for addressing one or more of the 802.3bs SMF objectives.

- This presentation focuses on validating the technical feasibility of a 56Gbaud PAM4 optical link model, through experimental measurements.

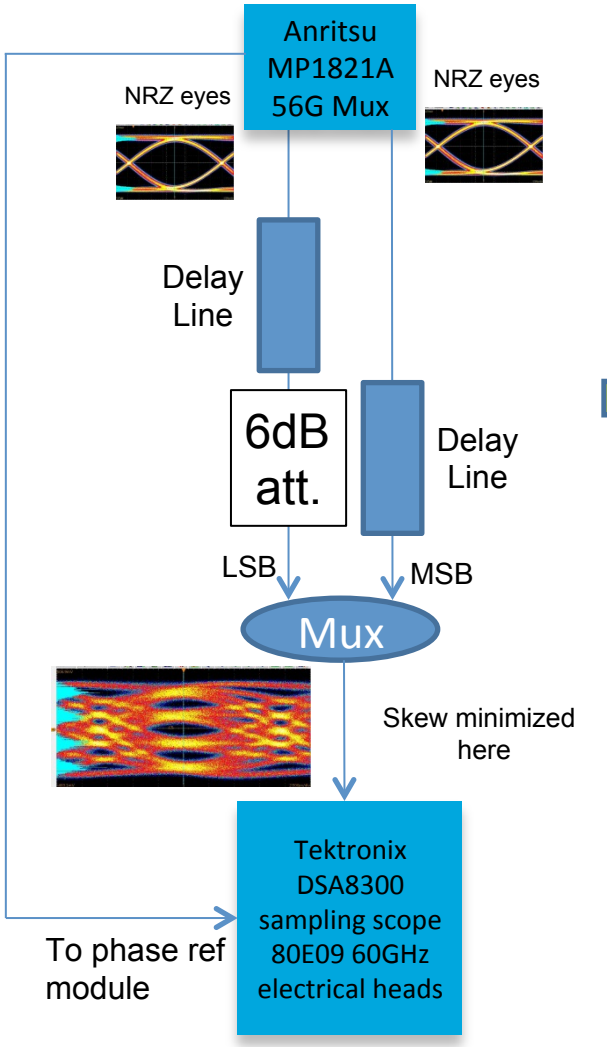
- The experimental setup used to obtain these results is not intended to be an implementation proposal.

Scope of this work

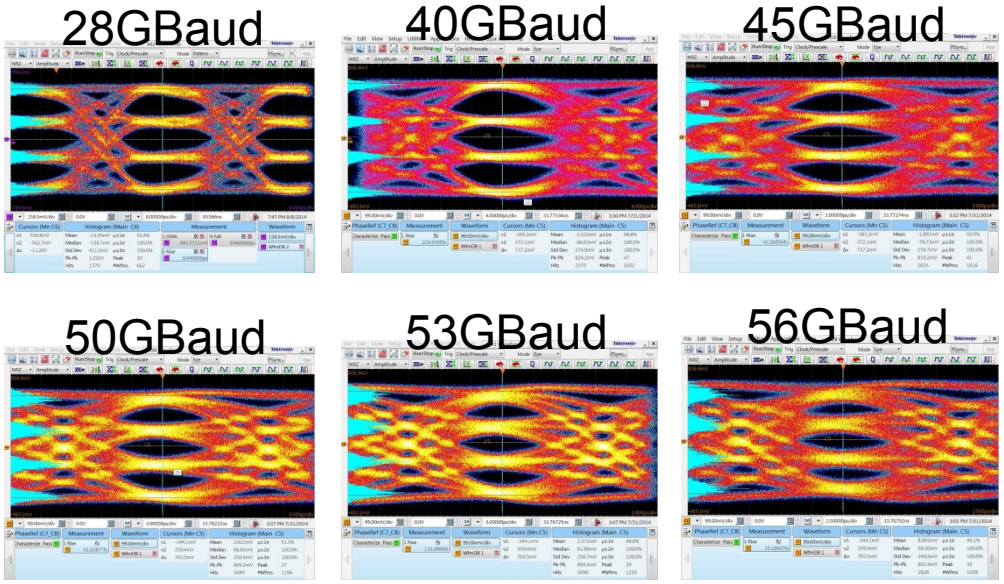
Verify technical feasibility of 56G PAM4 (>100Gb/s each) and proposed link budget.

- Understand pre-FEC limits over:
  - 2 km link (objective on Duplex SMF).
  - Up to 56 Gbaud (PAM4) on optical lanes.
- Steps followed:
  - Built PAM4 (up to 56GBaud) electrical generator.
  - Emulate PAM4 (up to 56GBaud) optical link.
  - Acquire waveforms, run post-processing.

PAM-4 Electrical Test Setup

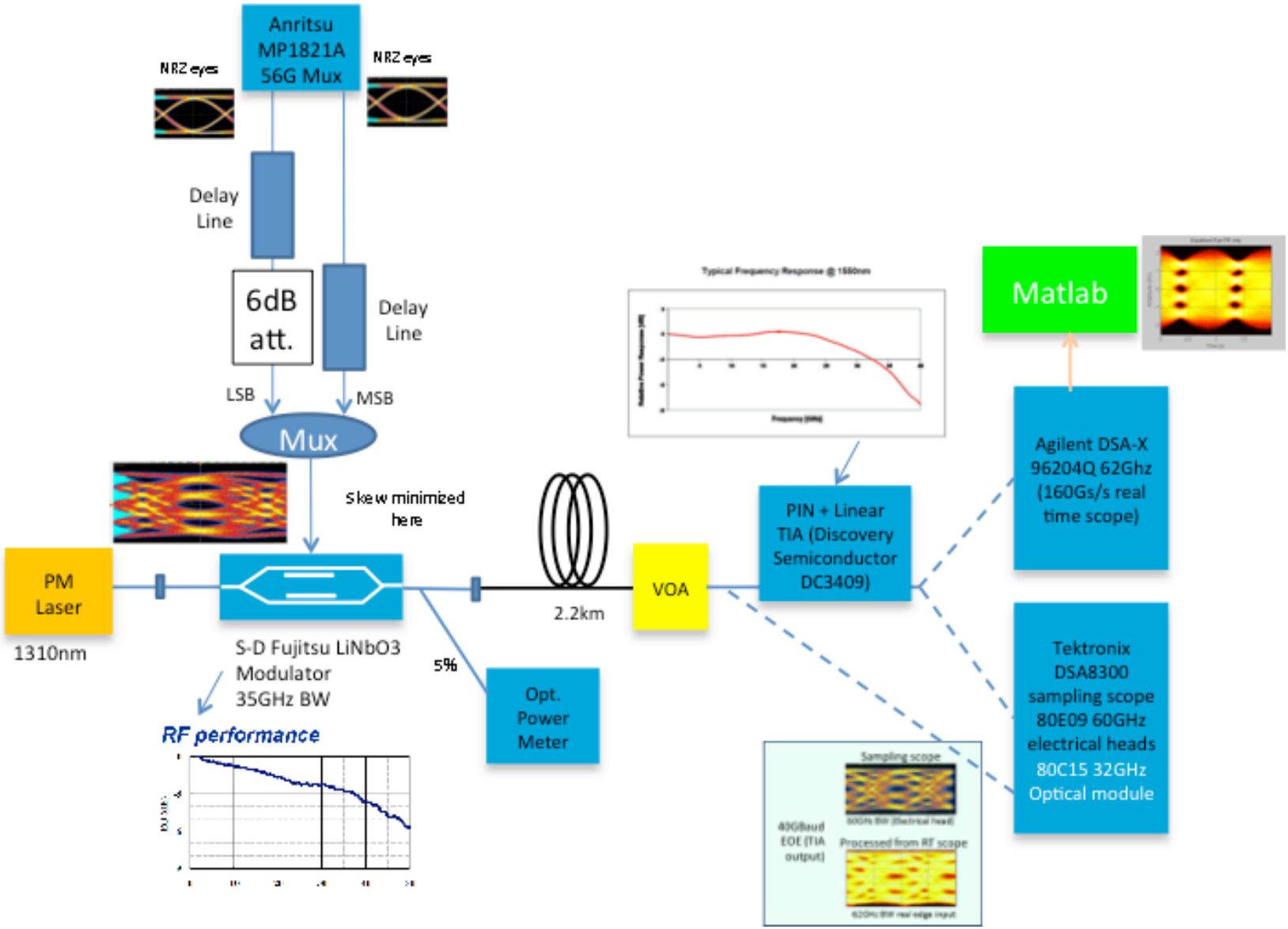


PRBS31 electrical eyes

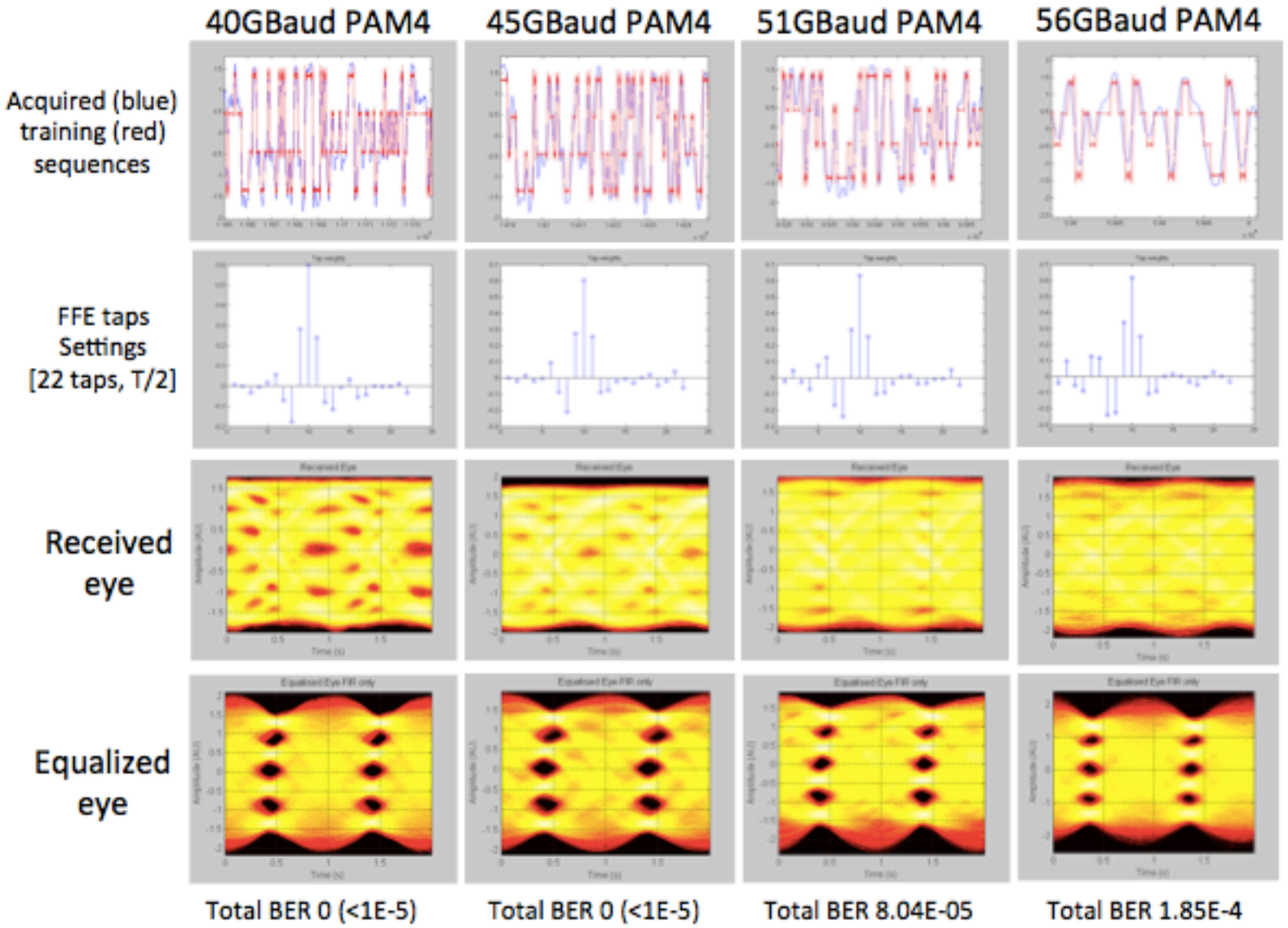


Increasing the bit rate RN also DN contribution (ISI due to BW limitations) increase.

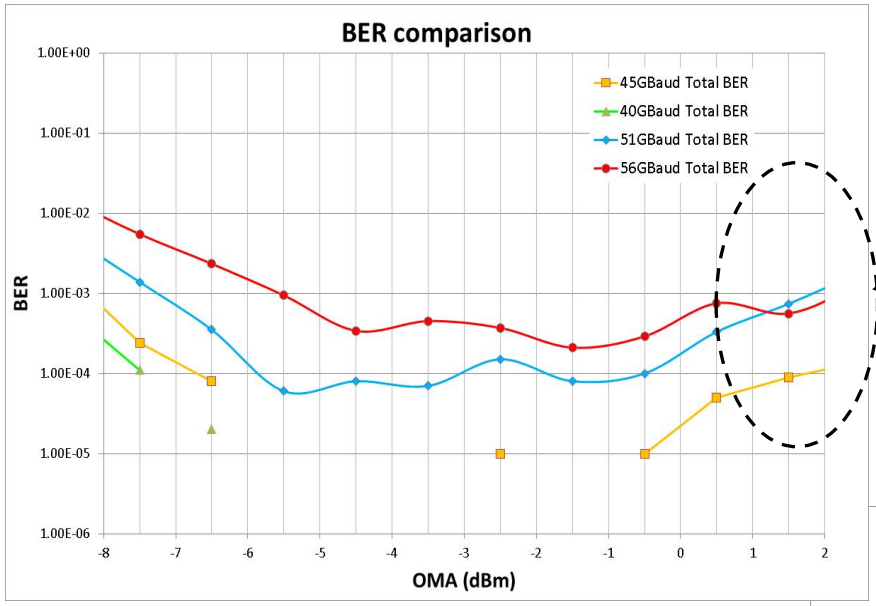
PAM-4 Optical Test Setup



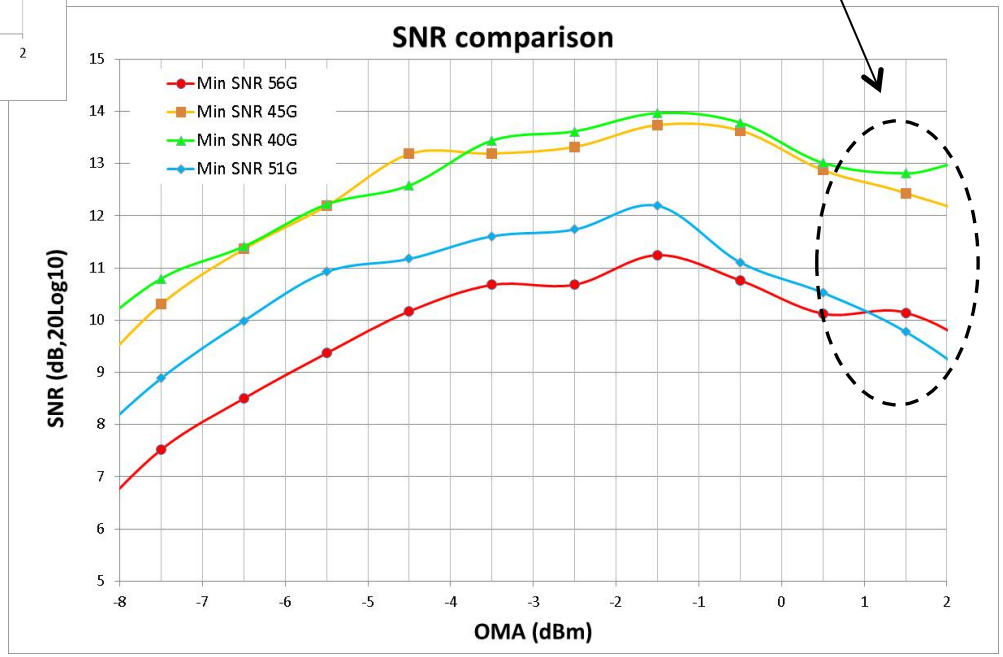
Processing at different rates (-3dBm I/P power)



SNR and BER ‘versus’ date rate and OMA



Degrations
due to PIN TIA overload
distortion (see backup)



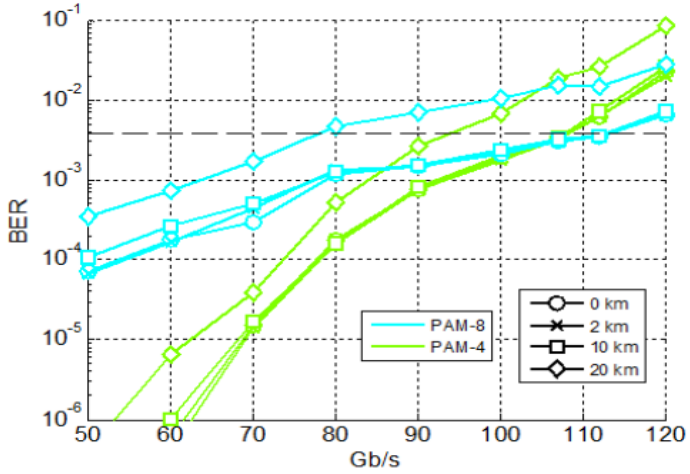
Note: BER measured and SNR calculated.

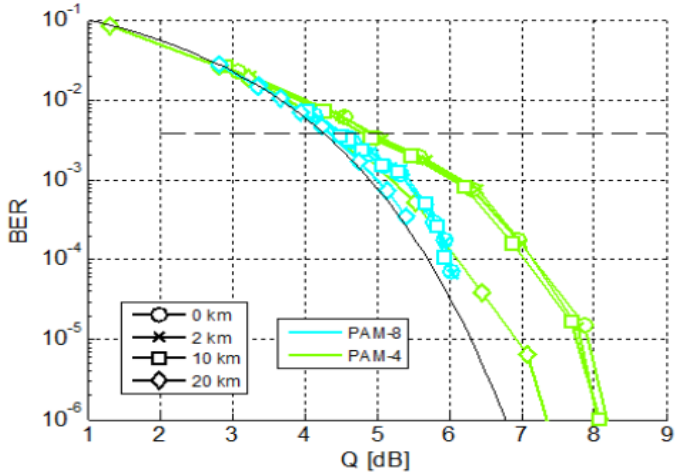
SNR (dB) calculated as:

```
EyeOpens = MeanLevel(2:end)-MeanLevel(1:end-1);
EyeNoise = StdLevel(1:end-1)+StdLevel(2:end);
EyeSNR = 20*log10(EyeOpens./EyeNoise);
```

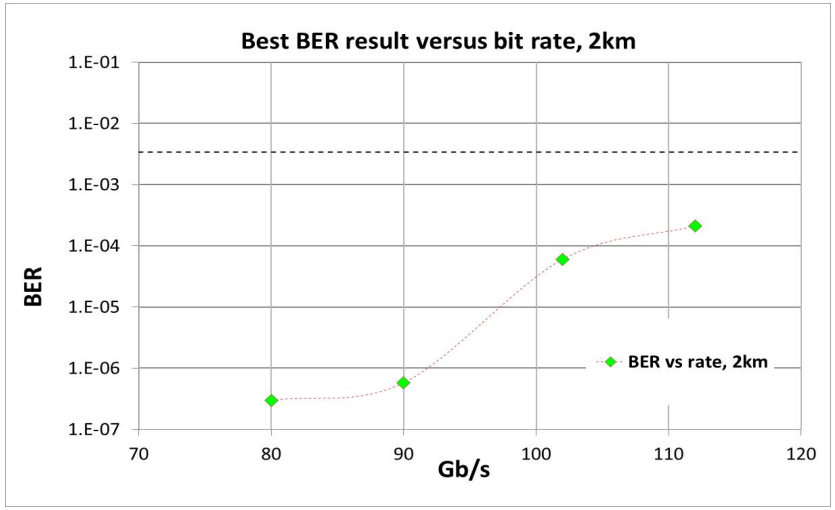
Comparison with bhatt_3bs_01a_0714

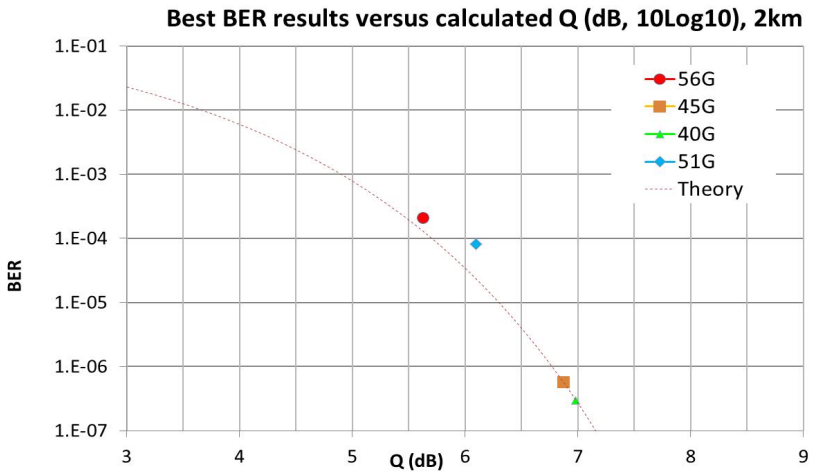
bhatt_3bs_01a_0714





mazzini_3bs_01a_0714



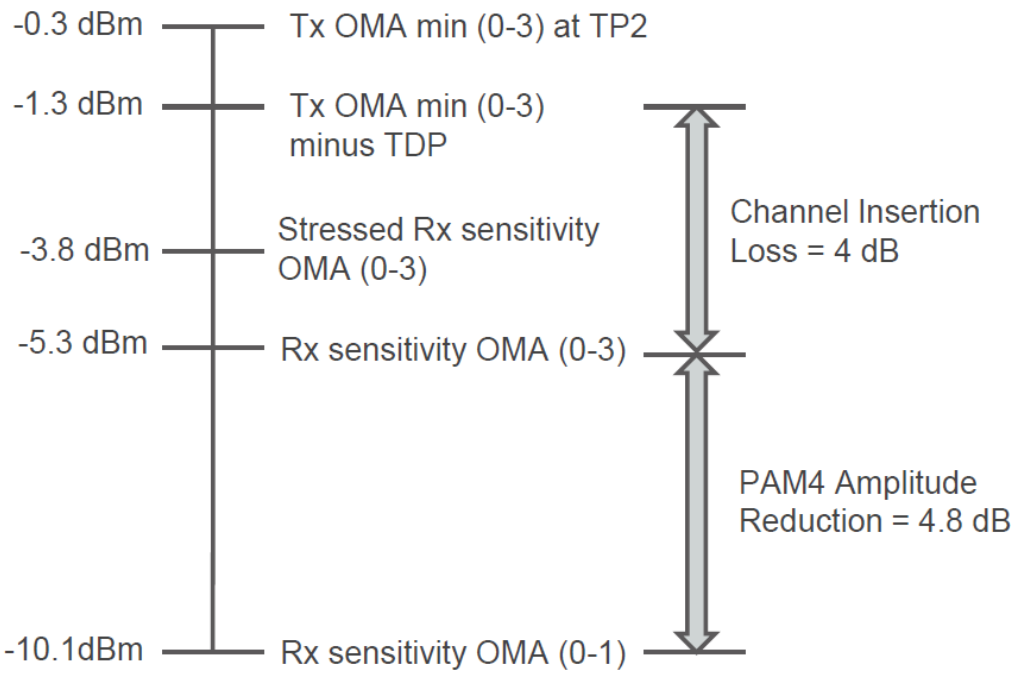


Summary

- Verified technical feasibility of 56Gbaud PAM-4 as a potential 4 Lane 400Gb/s solution
- Optical Link model validation (2km Duplex SMF) results are in line with previous works.
- Measured optical sensitivity in the ball park as required by several link budget analysis
- Discrete lab setup is certainly non-optimum
  - Expect better results with improved PAM-4 electrical generator and improved ADC (ENOB > 5 bits)
- Work ongoing. Will bring in further results as become available.

Thank You

Link model (proposed in bhatt_3bs_01a_0714)



Penalties:
About 2.5 dB (1.5 dB residual ISI after equalization, 1 dB other penalties)

Assumptions:
WDM mux + demux loss: 4.6 dB, included in TP2, TP3 specs.
Effective TIA NEP: 21 pA/sqrt(Hz)
Tx bandwidth: 28 GHz
Rx bandwidth: 28 GHz

Methodology:
Use equalization in Rx to reduce ISI penalty.
Make up for PAM4 amplitude reduction with KP4 FEC.
Pre-FEC: Q ~ 4, BER ~ 1e-5
Post-FEC: Q > 7.34, BER < 1e-13
Plan for margin