

# Technical Feasibility Update on single wavelength 100Gbps PAM4 modulation

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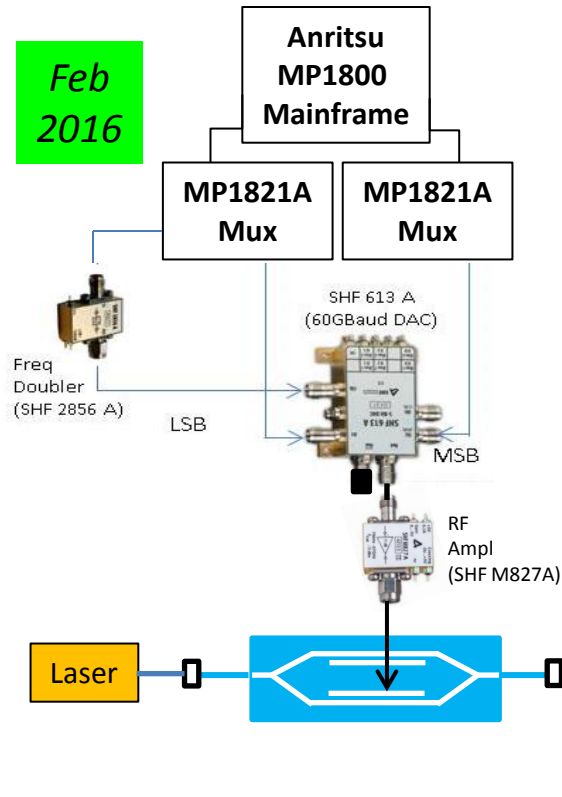
# Past Presentations

- See traverso\_3cd\_01a\_0716
- We were able to capture PRBS20 data & show new results

# 53GBaud PAM 4 TX/RX : improved set-up

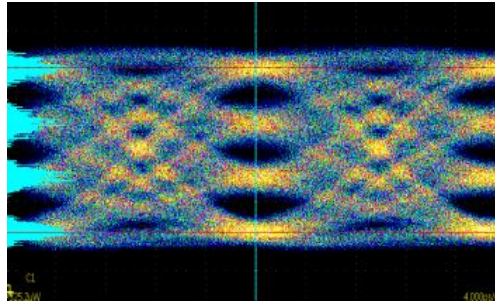
(no change from traverso\_3cd\_01a\_0716)

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Agilent DSA-X  
96204Q-62GHz  
(160Gs/s real time)

Optical RX Characteristics:  
 $\approx 30\text{GHz}$  (3dB) BW  
 $\sim 13 \text{ pA}/\text{VHz}$



## Transmitter Improvements

- RF Amplifier improves swing yet more distortion
- Improves eye opening  $\sim 8\text{dB}$  ER
  - About 1dB power penalty vs. min 5dB ER

## Receiver Improvements

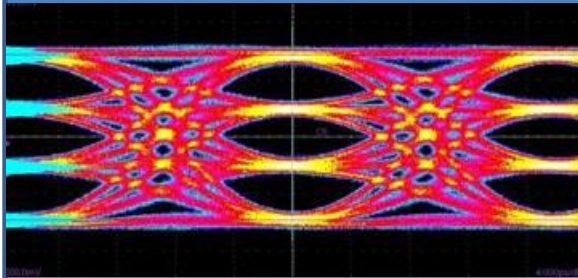
- Macom TIA lower noise than Discovery Semiconductor used in previous setup
- Improved Gain & BW – esp higher AGC output swing

# Transmitter optimization

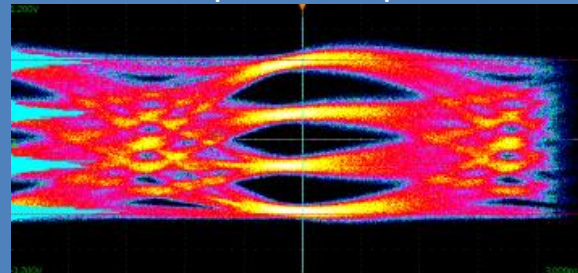
(no change from traverso\_3cd\_01a\_0716)

- DAC settings were optimized (swing, Xpoint, etc)
- Waveforms were capture on sampling scope & via real time scope
- Analysis conducted on real time scope waveforms in Matlab via offline processing

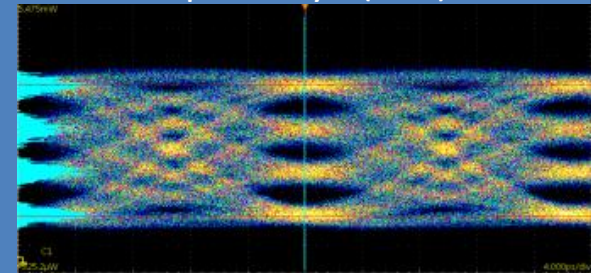
DAC output



Amplifier output

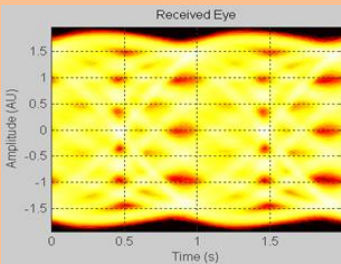


Optical eye (TP2)

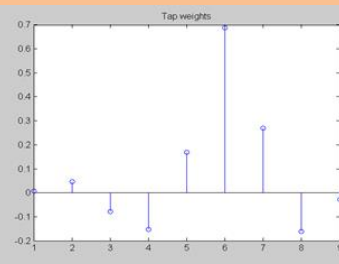


Sampling Scope

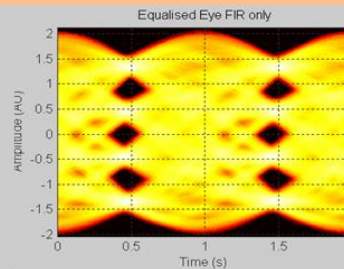
Raw Data from TIA



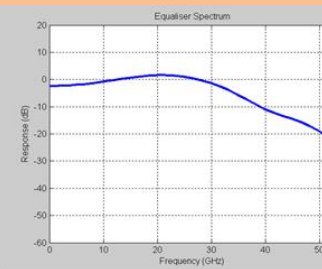
FFE Coeff.



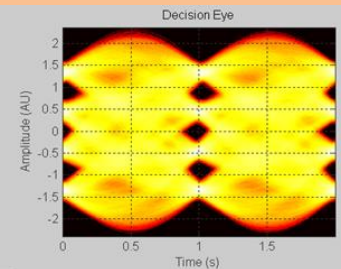
Eye - FIR only Equalized



Eq. spectrum

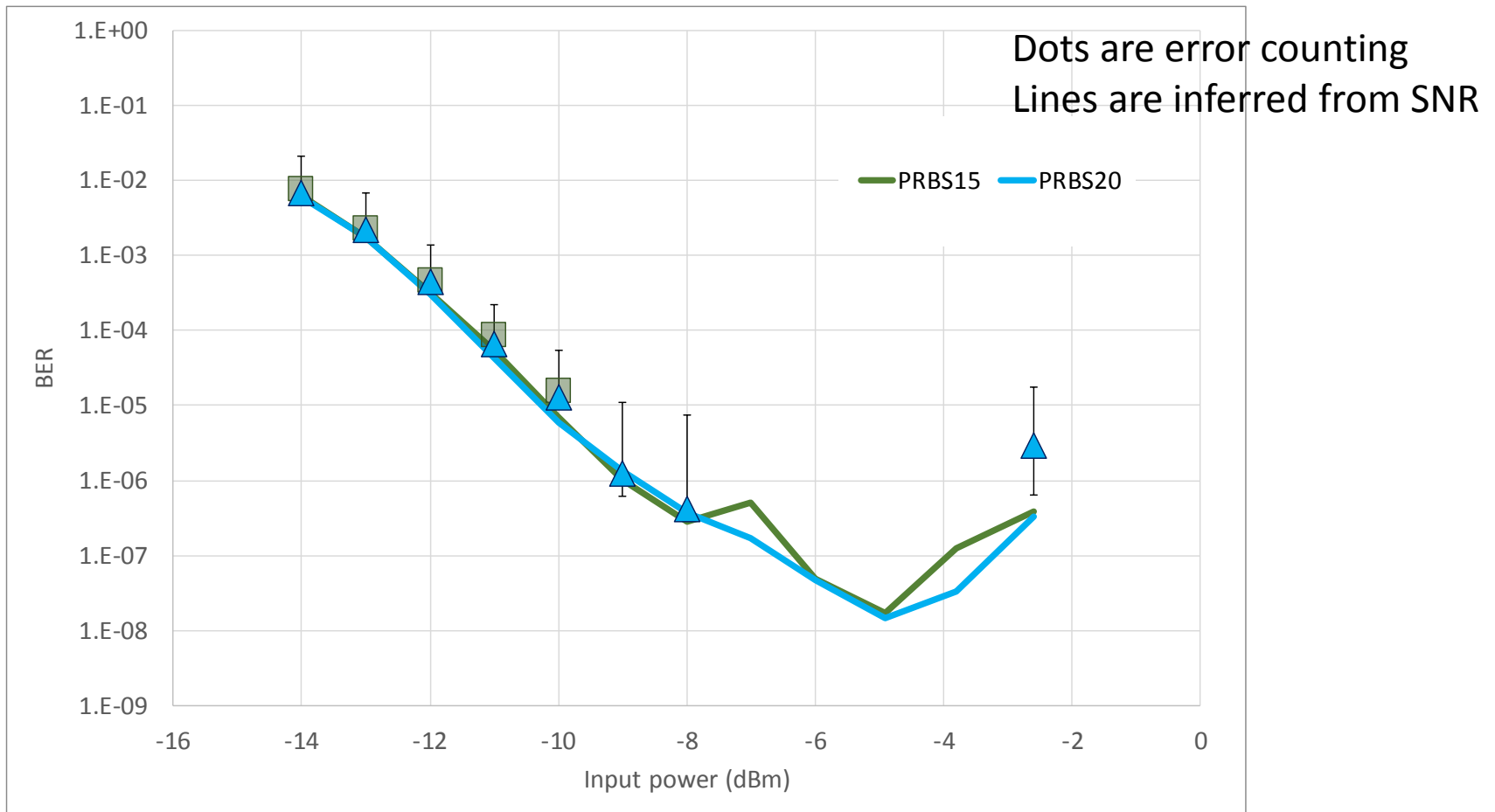


Decision Eye



Captured/Stored Waveforms

# PRBS15 and PRBS20



- PRBS20 with 1.2M symbols ; PRBS15 with 160k symbols

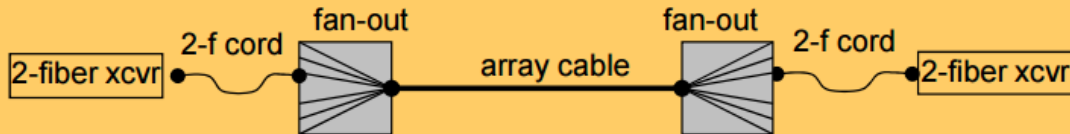
# **LINK CONFIGURATION & MPI PENALTY**

# Common channel implementations

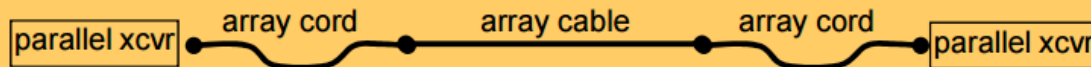
[kolesar 3bs 01 0514](#)

## • Single-link

Connection & Splice Tally\*



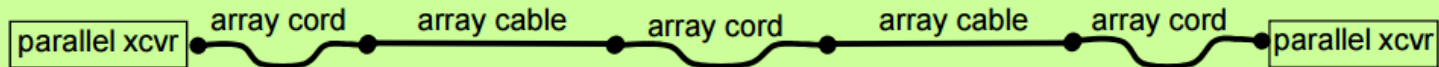
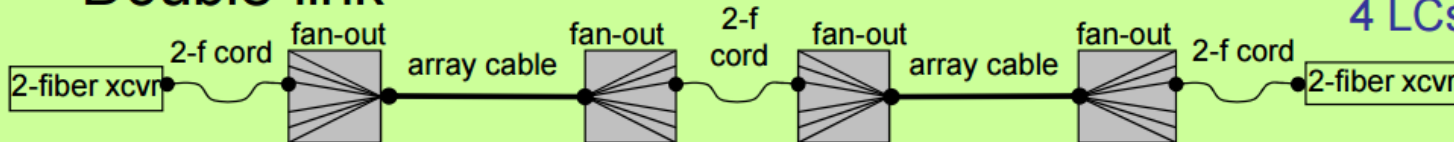
2 LCs + 2 MPOs



2 MPOs

## • Double-link

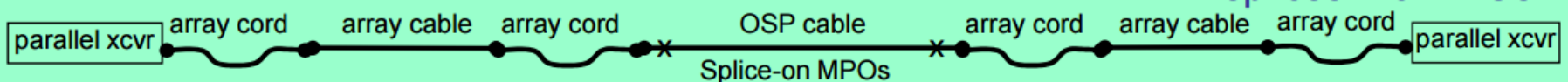
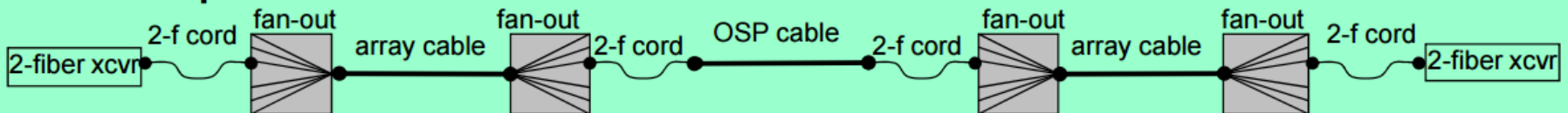
4 LCs + 4 MPOs



4 MPOs

## • Triple-link

6 LCs + 4 MPOs



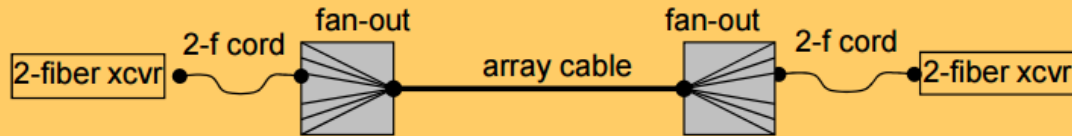
2 splices + 6 MPOs

\*Connections to transceivers (at MDI) are not counted in standard loss budget

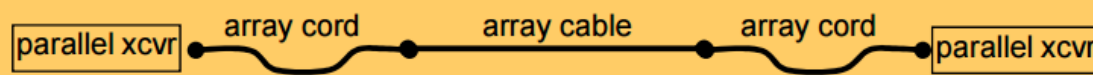
# Breakout Variation: Single-link

- Single-link

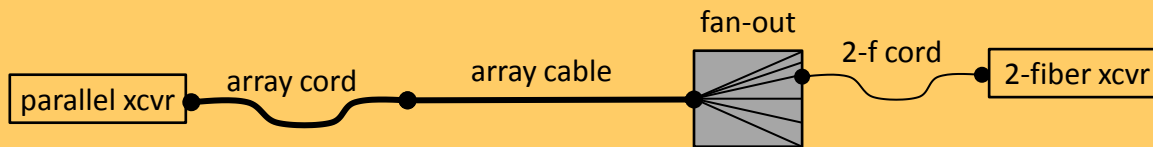
Connection & Splice Tally\*



2 LCs + 2 MPOs



2 MPOs



1 LCs + 2 MPOs



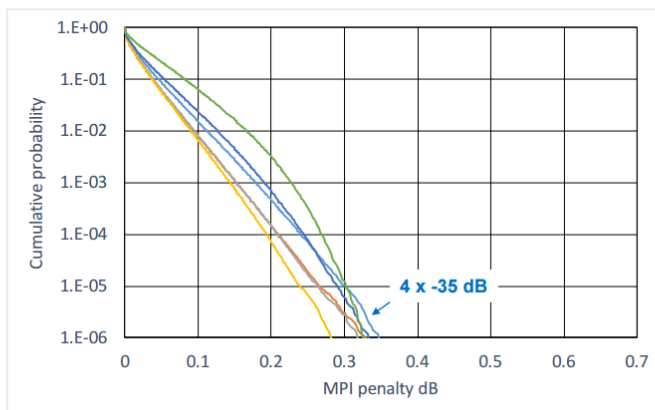
# MPI Penalty

- Propose 0.3dB MPI penalty to align with channel corresponding to Double-link configuration
- Need to confirm using methodology like [anslow 03 0816](#) or [king 02a 0116 smf.7z](#) – this work to be done

## FR4, FR8 0.3 dB penalty

BER 2.4E-4  
ER 4.5 dB

-26	-40	-40	-40	-40	-40	-40	-40	-40	-40	-40	4.0	-26
-26	-39	-39	-55	-39	-39	-39	-39	-55	-39	-39	4.0	-26
-26	-38	-55	-55	-38	-38	-38	-38	-55	-55	-38	4.0	-26
-26	-35	-55	-55	-55	-35	-35	-55	-55	-55	-35	4.0	-26
-26	-31	-55	-55	-55	-55	-55	-55	-55	-55	-31	4.0	-26
-26	-55	-55	-55	-55	-55	-25	-55	-55	-55	-55	4.0	-26



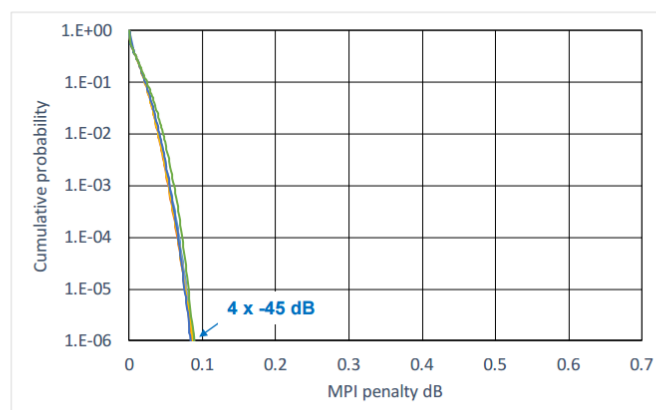
[Return](#)

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## DR4, DR4 0.1 dB penalty

BER 2.4E-4  
ER 4.5 dB

-26	-49	-49	-49	-49	-49	-49	-49	-49	-49	-49	3.0	-26
-26	-48	-48	-55	-48	-48	-48	-48	-55	-48	-48	3.0	-26
-26	-47	-55	-55	-47	-47	-47	-47	-55	-55	-47	3.0	-26
-26	-45	-55	-55	-55	-45	-45	-55	-55	-55	-45	3.0	-26
-26	-42	-55	-55	-55	-55	-55	-55	-55	-55	-42	3.0	-26
-26	-55	-55	-55	-55	-55	-37	-55	-55	-55	-55	3.0	-26



[Return](#)

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[anslow 03 0816 smf](#)

# Conclusion

- Longer pattern results show good consistency with shorter pattern
  - Targeting to have even longer pattern testing available by November meeting
- Double link configuration proposed with MPI penalty of 0.3 dB as a strawman – this would add 0.2dB to link budget
- RX sensitivity has margin compared 400GBASE-DR4 specification as of D2.0
- Waveform data can be made available for others to analyze & assist in identifying reference equalizer