CD tolerance analysis of 100G x 1ch BiDi 40-km

Fabio Bottoni, Ray Nering (Cisco)

11.09.2023

Sept. 2023, P802.3dk “Greater than 50 Gb/s Bidirectional Optical Access PHYs” Meeting

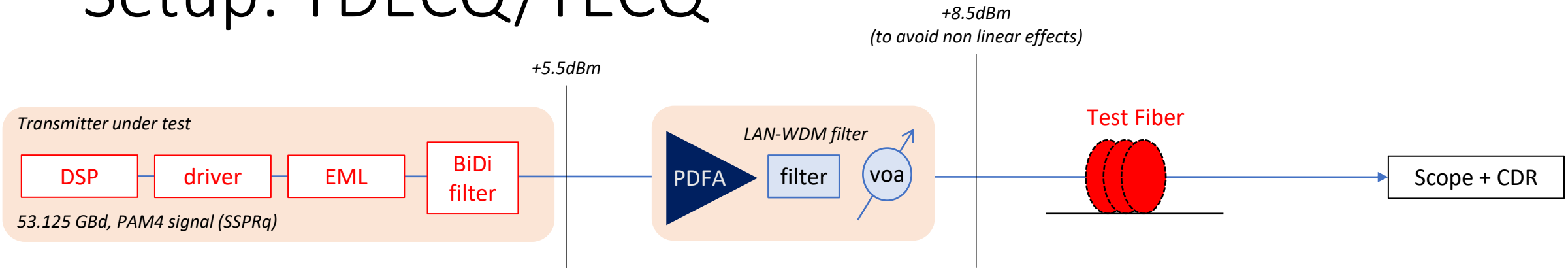
Supporters

- Vince Ferretti, *Corning*
- Dirk Lutz, *Eoptolink*
- John Johnson, *Broadcom*
- Rangchen Yu, *SiFotonics*
- Alessandro Cavaciuti, *Cisco*
- Mark Nowell, *Cisco*
- Carlo Mariotti, *Cisco*

Introduction

- The 100G-BiDi standardization is being discussed by both IEEE and ITU-T.
- This report is following up on a previous presentation, 3dk_jackson_2307 (July 2023) which showed the experimental results for a 100G/λ 40-km transmission.
- This presentation aims to extend the previous analysis by showing TDECQ and BER results; with a focus on chromatic dispersion (CD) tolerance.
- The underlying assumption is to follow and support the spec proposed in 3dk_yu_2307.

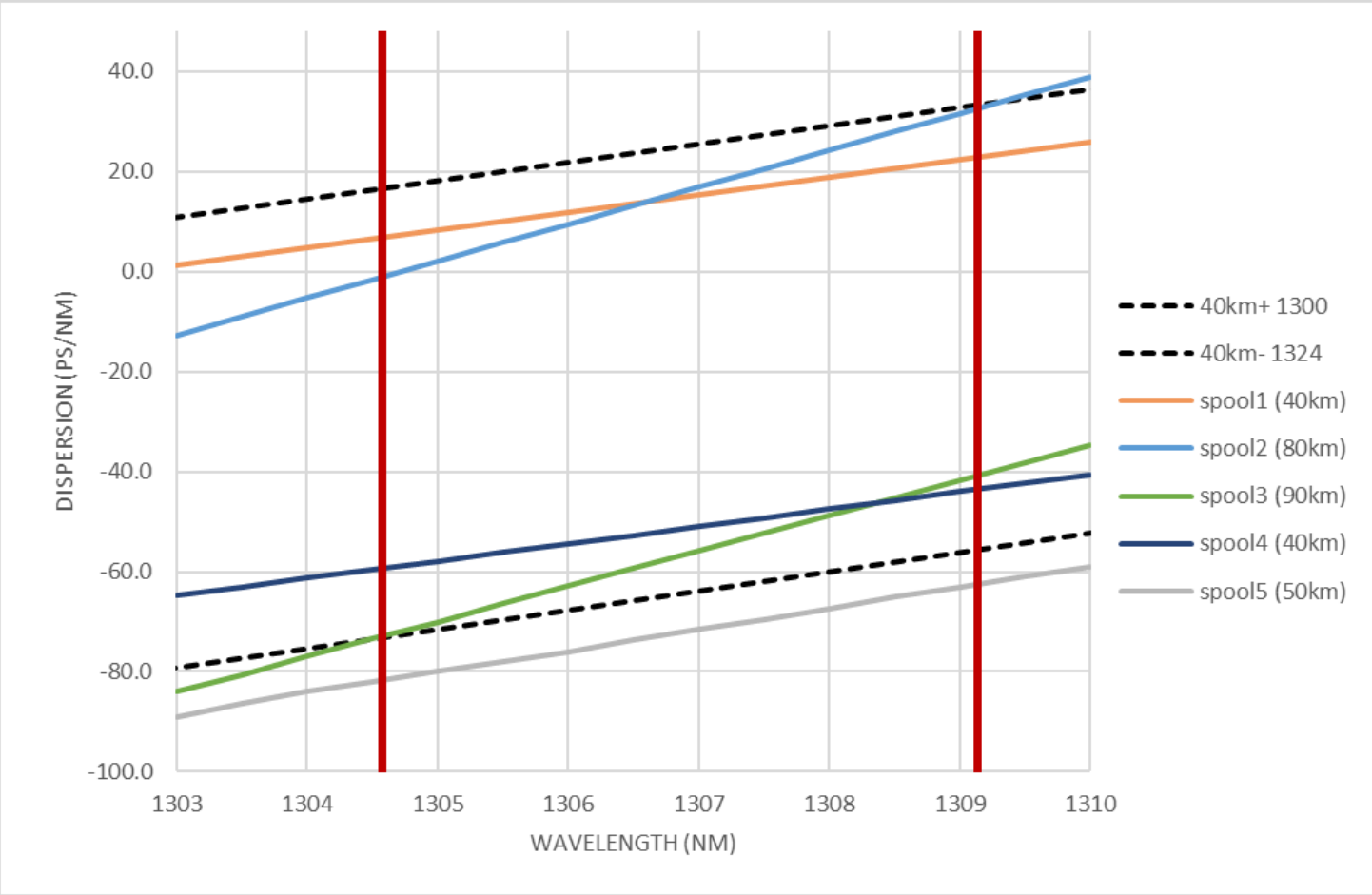
Setup: TDECQ/TECQ



DSP: digital signal processing, EML: external modulated laser, VOA: variable optical attenuator, CDR: Clock and Data recovery, TDECQ: Transmitter and Dispersion Eye Closure Quaternary, TECQ: Transmitter Eye Closure Quaternary

- Investigated effect of chromatic dispersion with a λ around 1304.6/1309.1
- Measured TDECQ, TECQ

Setup: Test fibers vs current CD limits



40km CD limits taken from the MSA/IEEE

Table 3-3: Transmitter compliance channel specifications

Type	Dispersion[a] (ps/nm)		Insertion loss[b]	Optical return loss[c]	Max mean DGD
	Minimum	Maximum			
100G-LR1-20	$0.46*\lambda*[1-(1324/\lambda)^4]$	$0.46*\lambda*[1-(1300/\lambda)^4]$	Minimum	15.6 dB	0.8 ps
100G-ER1-30	$0.69*\lambda*[1-(1324/\lambda)^4]$	$0.69*\lambda*[1-(1300/\lambda)^4]$	Minimum	15 dB	0.8 ps
100G-ER1-40	$0.92*\lambda*[1-(1324/\lambda)^4]$	$0.92*\lambda*[1-(1300/\lambda)^4]$	Minimum	15 dB	0.8 ps

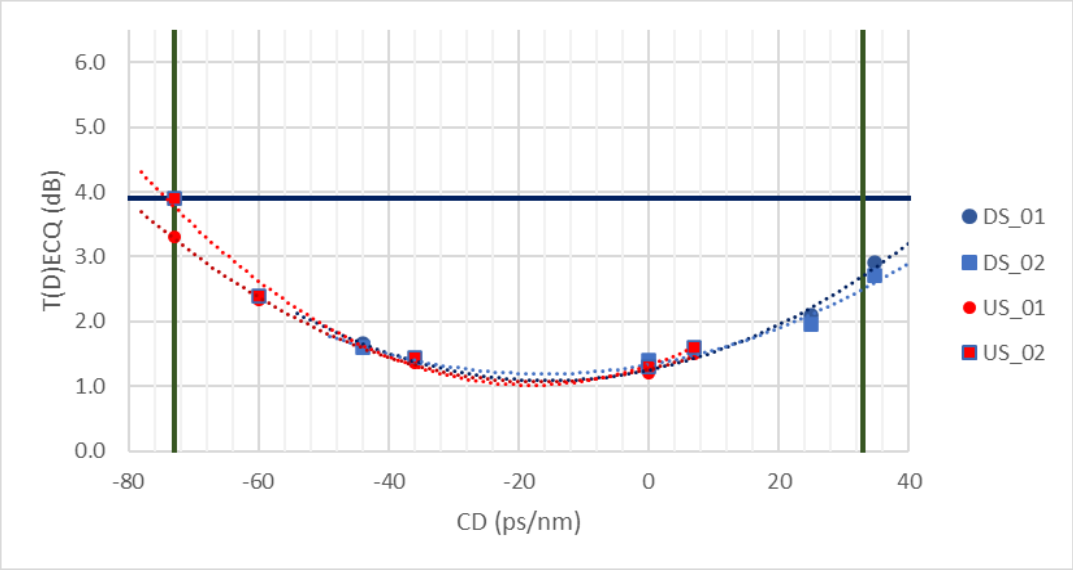
[a] The dispersion is measured for the wavelength of the device under test (λ in nm). The coefficient assumes 20 km for 100G-FR1-20, 30km for 100G-ER1-30 and 40 km for 100G-ER1-40.

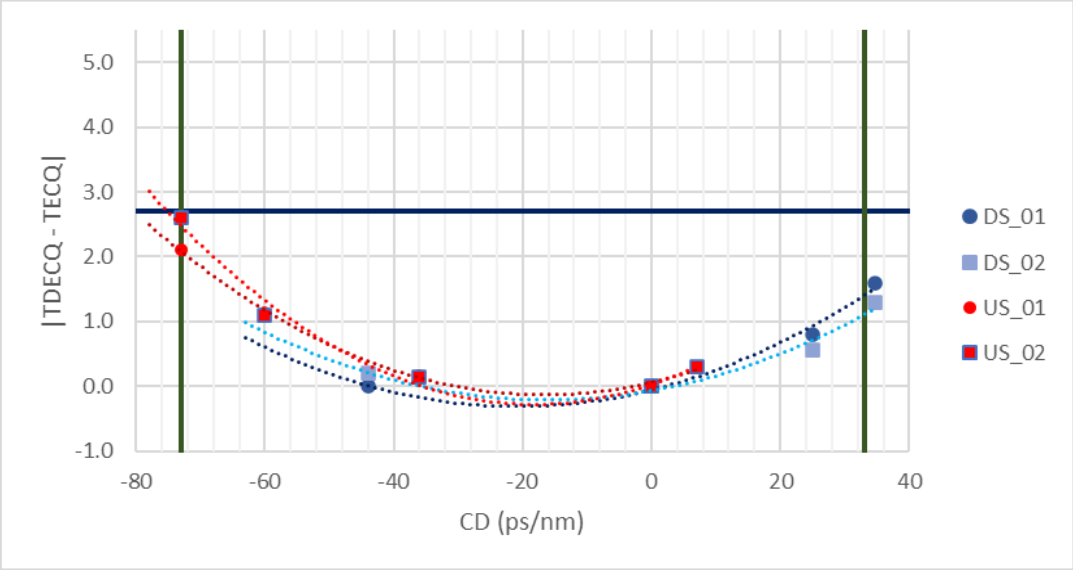
[b] There is no intent to stress the sensitivity of the BERT's optical receiver.

[c] The optical return loss is applied at TP2, i.e. after a 2 meter patch cord.

TDECQ/TECQ results

* TDECQ reference equalizer (current definition): 5-tap, T-spaced, feed-forward equalizer (FFE)





- TDECQ* marginal/close to fail in one specific corner (min CD, -73ps/nm)
- External lines: current CD limits

The underlying assumption is to follow the TDECQ limit proposed in 3dk_yu_2307_1r1

Potential new CD limits

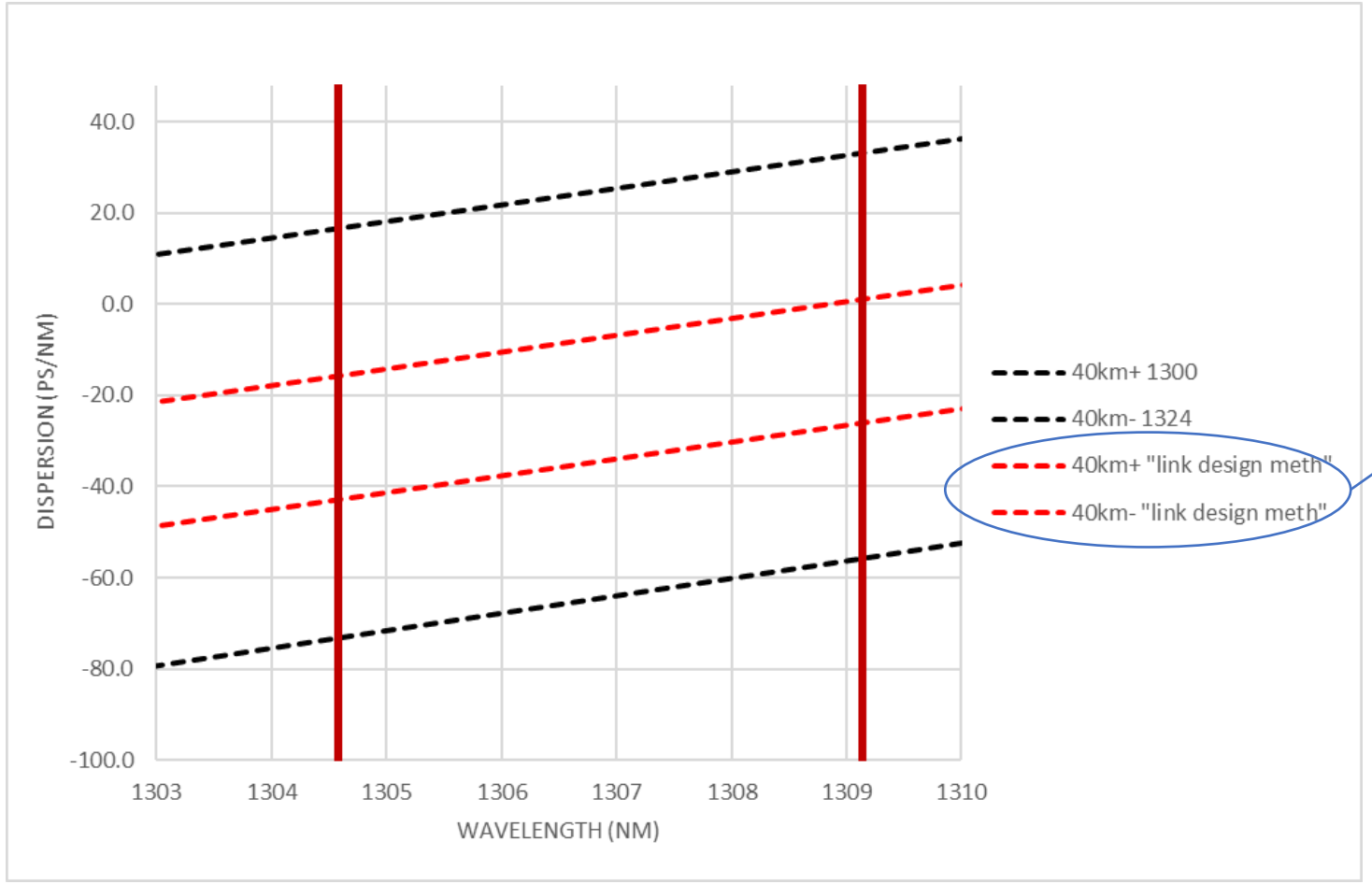
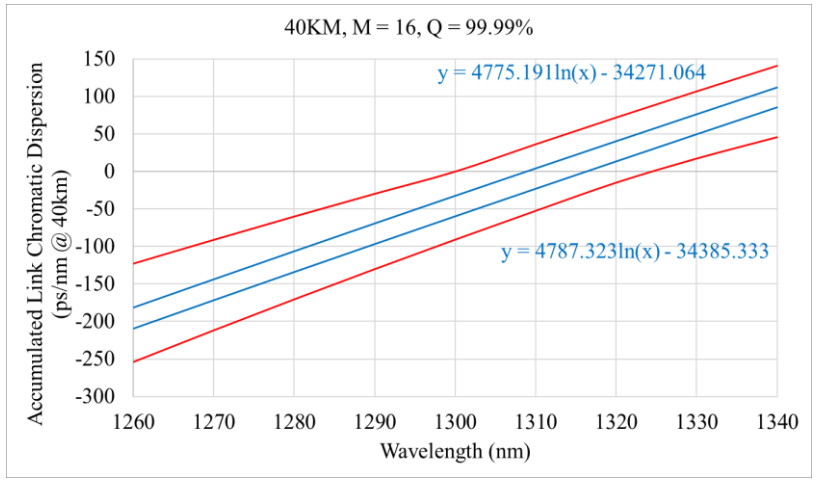


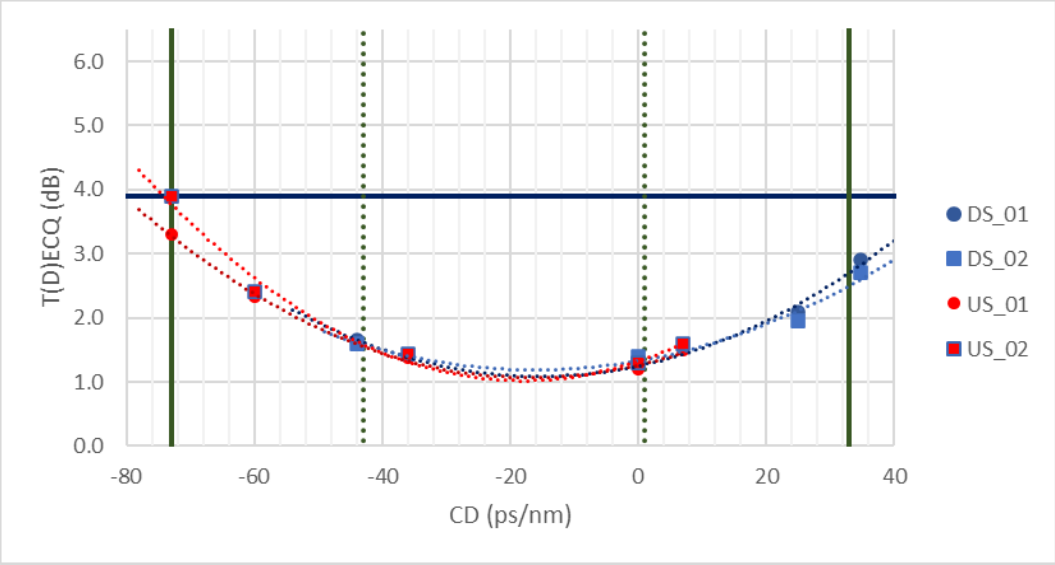
Chart provided by Vince Ferretti

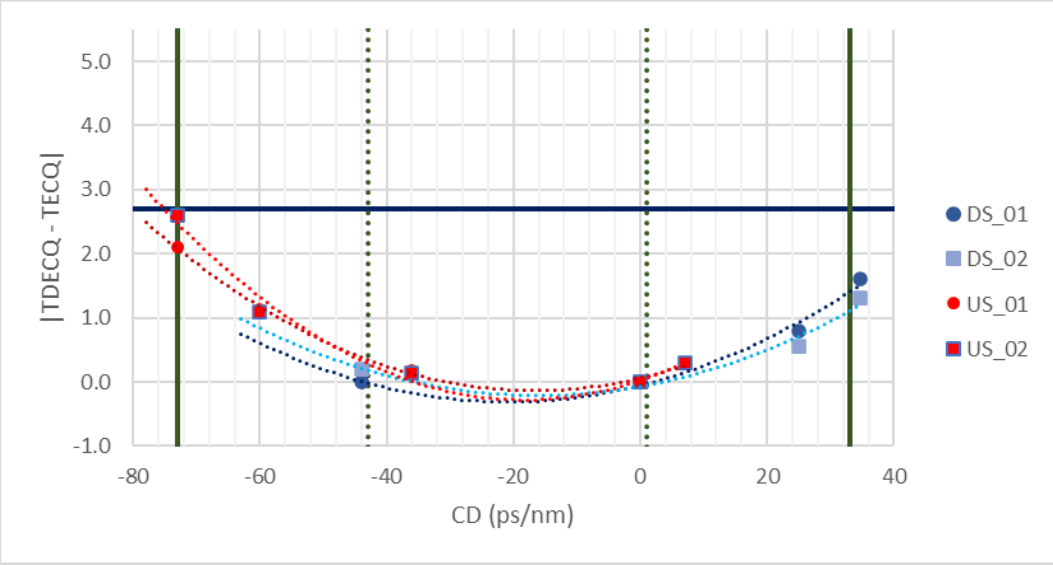


- ITU-T Q2/15, Q5/15, and Q6/15 agreed to start discussion on the applicability of statistical dispersion design approach.
- IEC 86A WG1 fiber manufacturers agreed to examine lambda-zero and zero-dispersion-slope statistics for each manufacturer to support the above discussion.
- This analysis will tighten the total channel chromatic dispersion range to a more realistic value versus the worse-case assumptions currently used

* TDECQ reference equalizer (current definition): 5-tap, T-spaced, feed-forward equalizer (FFE)

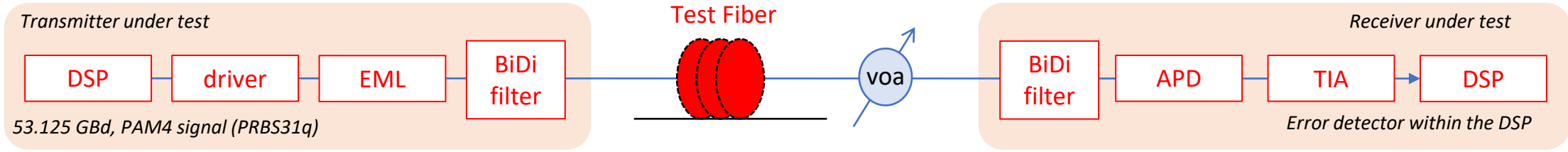
TDECQ/TECQ results vs new CD limits





- TDECQ* marginal/close to fail in one specific corner (min CD, -73ps/nm)
- External lines: current CD limits
- Internal lines (dotted): potential new CD limits updated using the “link design method accumulated dispersion methodology“

Setup: BER

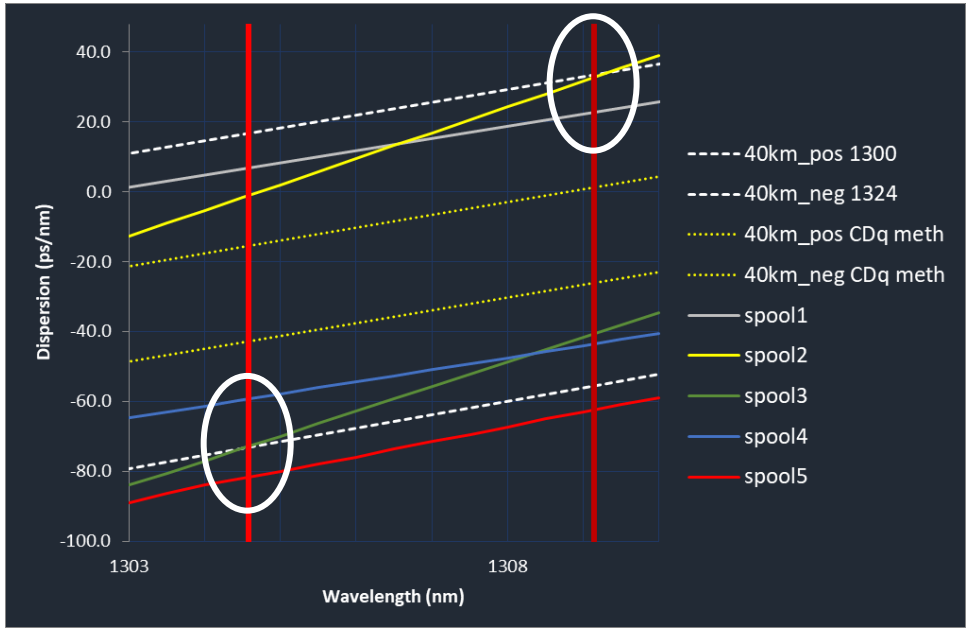


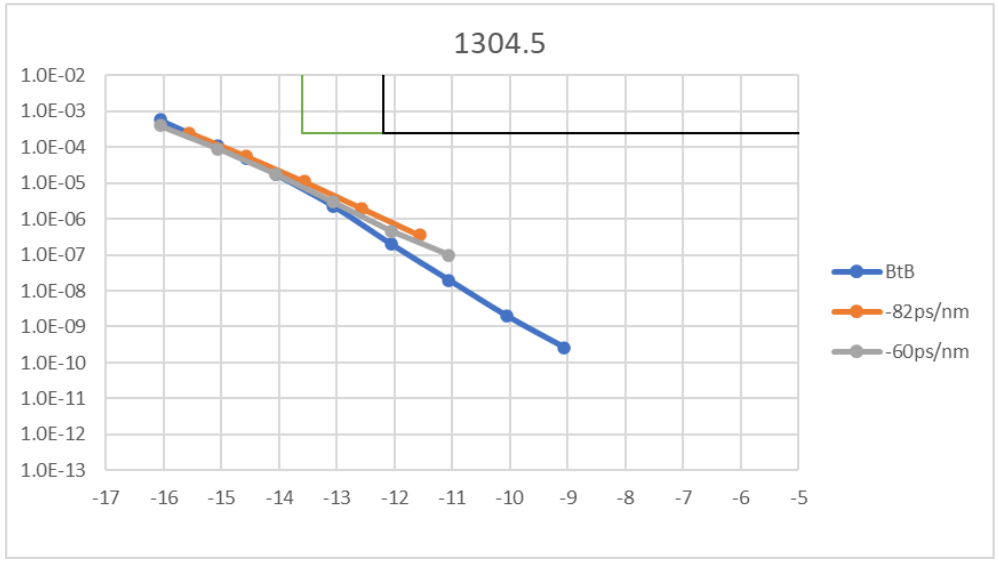
DSP: digital signal processing, EML: external modulated laser, VOA: variable optical attenuator, APD: Avalanche PhotoDiode, TIA: trans-impedance amplifier

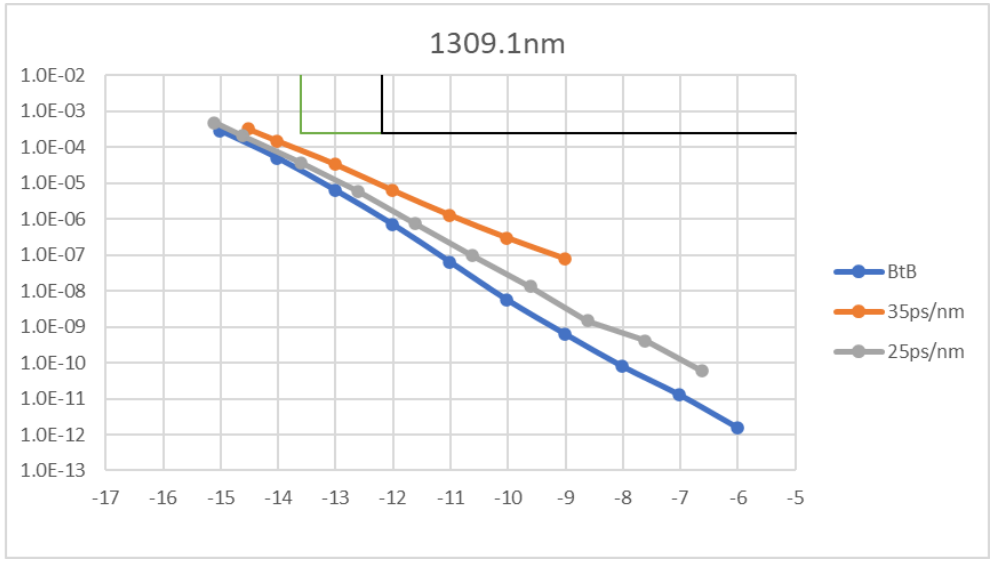
- Investigated effect of chromatic dispersion with a λ around 1304.6/1309.1
- Measured BER

BER results

- CD penalty for -82 to 35 ps/nm was less than 1 dB.
- Rx sensitivity limits taken from MSA 100G-ER1 specs
- BER @1304.5nm not aligned with TDECQ (to be further analyzed?)





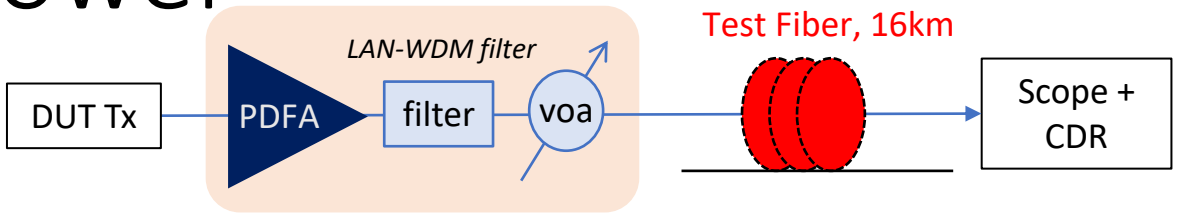


The underlying assumption is to follow the sensitivity limits proposed in 3dk_yu_2307_1r1

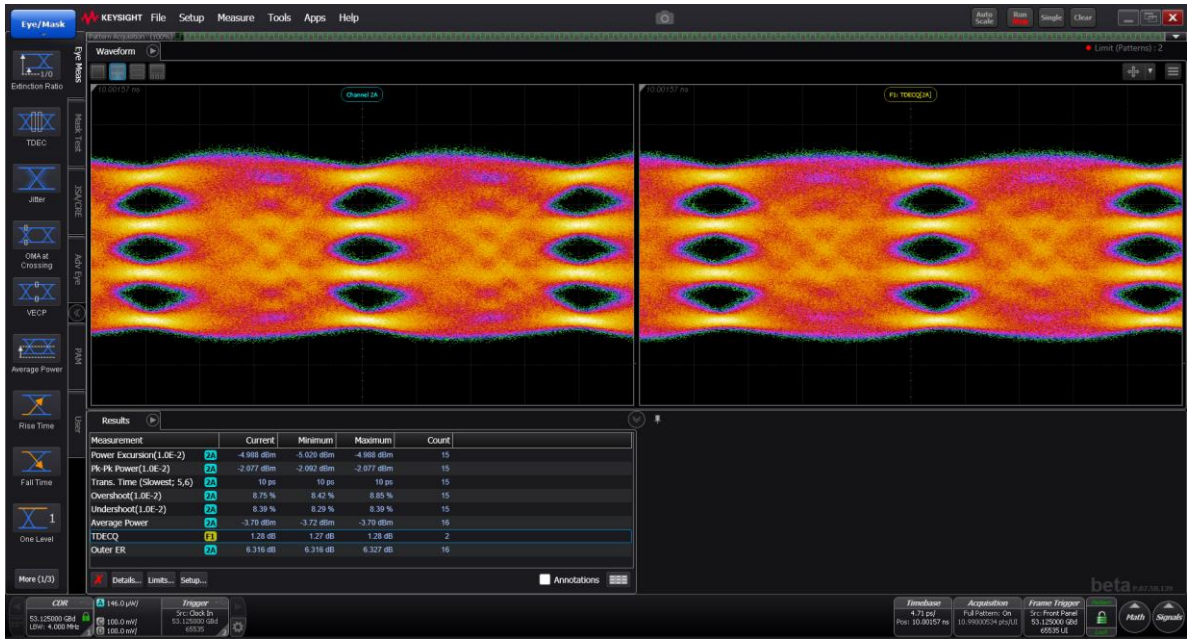
Conclusions

- Test data are presented to analyze the CD tolerance of a 1x100G BiDi 40km solution. Underlying assumption is to follow specs proposed in 3dk_yu_2307
- CD tolerance analysis of 100G x 1ch BiDi 40-km: assuming the “link design method accumulated dispersion methodology“ will be adopted by the ITU/IEEE, TDECQ and BER results show that a 1x100G BiDi 40km solution is well tolerant against max/min CD and provide good margins.
- Concern: TDECQ vs BER miscorrelation at 1304.5nm (with min dispersion values)…to be further analyzed with optics suppliers/scope manufactures?

TDECQ vs PDFA output power

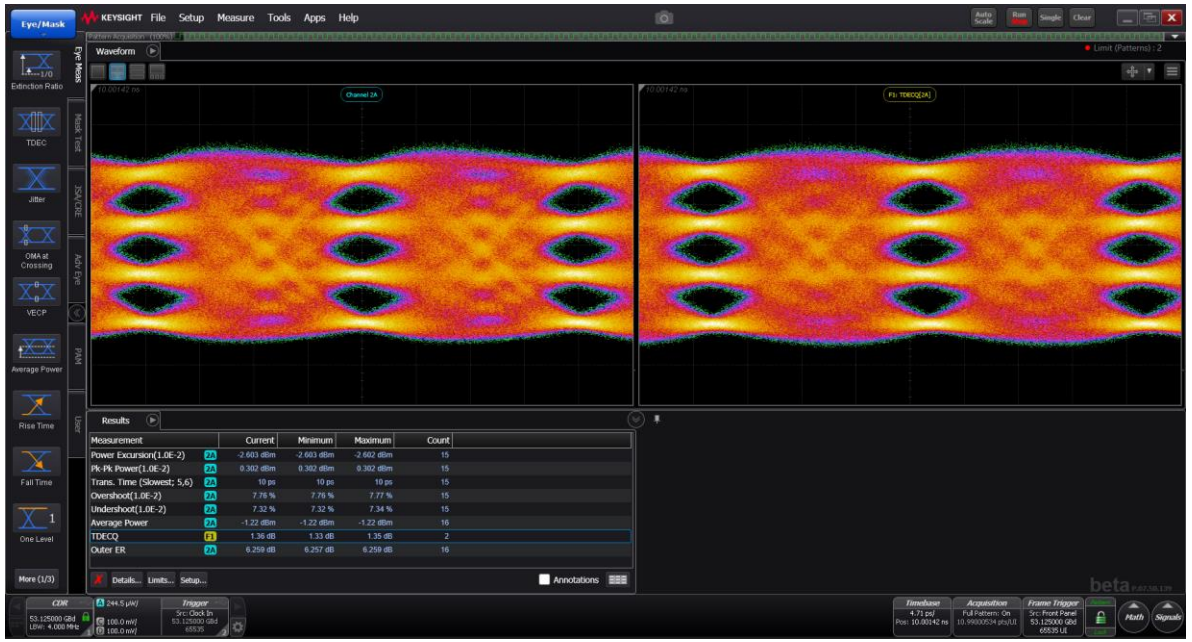


No PDFA



US_01, TDECQ = 1.3dB

With PDFA (+9dBm)



US_01, TDECQ = 1.3dB