



# Proposed Optical parameters for Clauses 182 and 183.

802.3dj Optical and Logic Ad-hoc.

October 31 2024

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# Introduction

- This presentation is in support of comments 146 and 147 against draft 1.2 of IEEE802.3dj.
- Clauses 182 and 183 of Draft 1.2 of 802.3dj contains a number of TBD's that affect the completeness of the draft and therefore possibility of moving to Working Group Ballot.
- This presentation provides suggestions for improvements to some parameter values and values to replace TBDs for other parameters.
- At this stage of the process it is not required that numbers are final as there are many opportunities to refine them during the rest of the process. Providing reasonable numbers to replace TBDs moves us forward.
  - Everything is open for future comments on drafts 2.0 and 3.0 and these numbers if adopted will be open for comment on draft 1.3
  - Having specific values will enable work on providing improved ones.
- There are two key parameters that need to be chosen from which most of the rest of the parameters can be calculated.
  - TDECQ/TECQ (Max)
  - $T_x \text{ OMA}_{\text{outer}} - \text{TDECQ (Min)}$

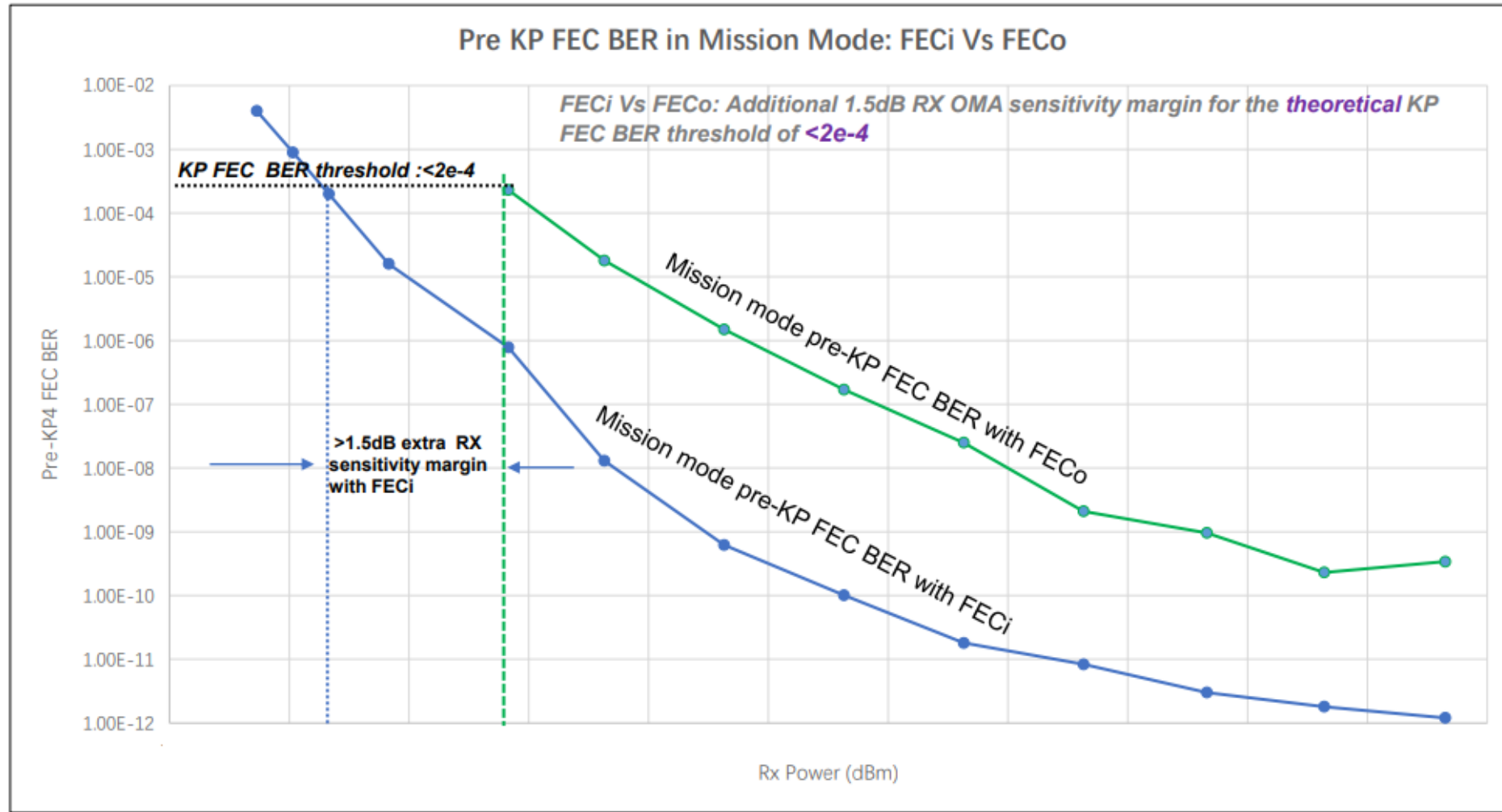
# Draft 1.2 key values and values proposed DR and DR2 specs.

	200GBASE-DR1 etc.	200GBASE-DR1-2 etc.		
Tx	Draft 1.2	Draft 1.2	Proposed	
Average launch power, each lane (min)	-3.3	-2.6	-3.3	dBm
OMA <sub>outer</sub> for max TECQ, TDECQ <0.9dB	-0.3	0.4	-0.3	dBm
OMA <sub>outer</sub> minus TDECQ/TECQ for 3.4dB <(max (TECQ, TDECQ ))<0.9dB	-1.2	-0.5	-1.2	dBm
TDECQ(max)	3.4	TBD	3.4	dBm
TECQ (max)	3.4	TBD	3.4	dB
Absolute value (TDECQ-TECQ) (max)	2.5	TBD	2.5	dB
Rx				
Average receive power each lane (min)	-6.3	-6.6	-7.3	dBm
Receiver sensitivity (OMA <sub>outer</sub> ) (TECQ <0.9dB)	-3.4	-4	-4.7	dBm
Receiver sensitivity-TECQ (OMA <sub>outer</sub> )(0.9dB<TECQ <SECQ)	-4.3	-4.9	-5.6	dBm
Stressed receiver sensitivity (OMA <sub>outer</sub> )(max)	-0.9	TBD	-2.2	dBm
Stressed eye closure for PAM4 (SECQ)	3.4	TBD	3.4	dBm
OMA <sub>outer</sub> of each aggressor lane	2.9	TBD	2.9	dBm
Illustrative Link Power budget.				
Power budget (for max TDECQ)	6.5	TBD	7.8	dB
Allocation for penalties (for max TDECQ)	3.5	TBD	3.8	dB

# Justification for Optical output $\text{OMA}_{\text{outer}}$ – TDECQ (DR-2)

- The channel loss budget for the DR specifications is only 1dB larger for 2km versus 500m, and allocated additional penalties for DGD and MPI is 0.4dB at 2km versus 0.1dB at 500m.
- The existing D1.2 spec is requiring the 2km DR specs to have an extra 0.7dB output OMA and 0.6dB better receiver sensitivity.
- The 2km specifications use inner FEC which is shown to improve receiver sensitivity by >1.5dB in Yu\_3dj\_01b\_2407( [800G \(4x200G-PAM4\) Module Test Data with FECi and FECo \(ieee.org\)](#) ) (see next slide)
- It is also likely that the effect of MPI and DGD will have smaller penalties with the inner FEC due to the higher allowed pre-FEC BER so the 0.4dB additional penalty above TDECQ is probably conservative.
- Asking for 0dB additional output OMA from the Tx and 1.3dB better sensitivity from the Rx is a better compromise than the existing draft 1.2 requirements.

# Mission Mode: FECi vs. FECo BER vs. Rx\_OMA

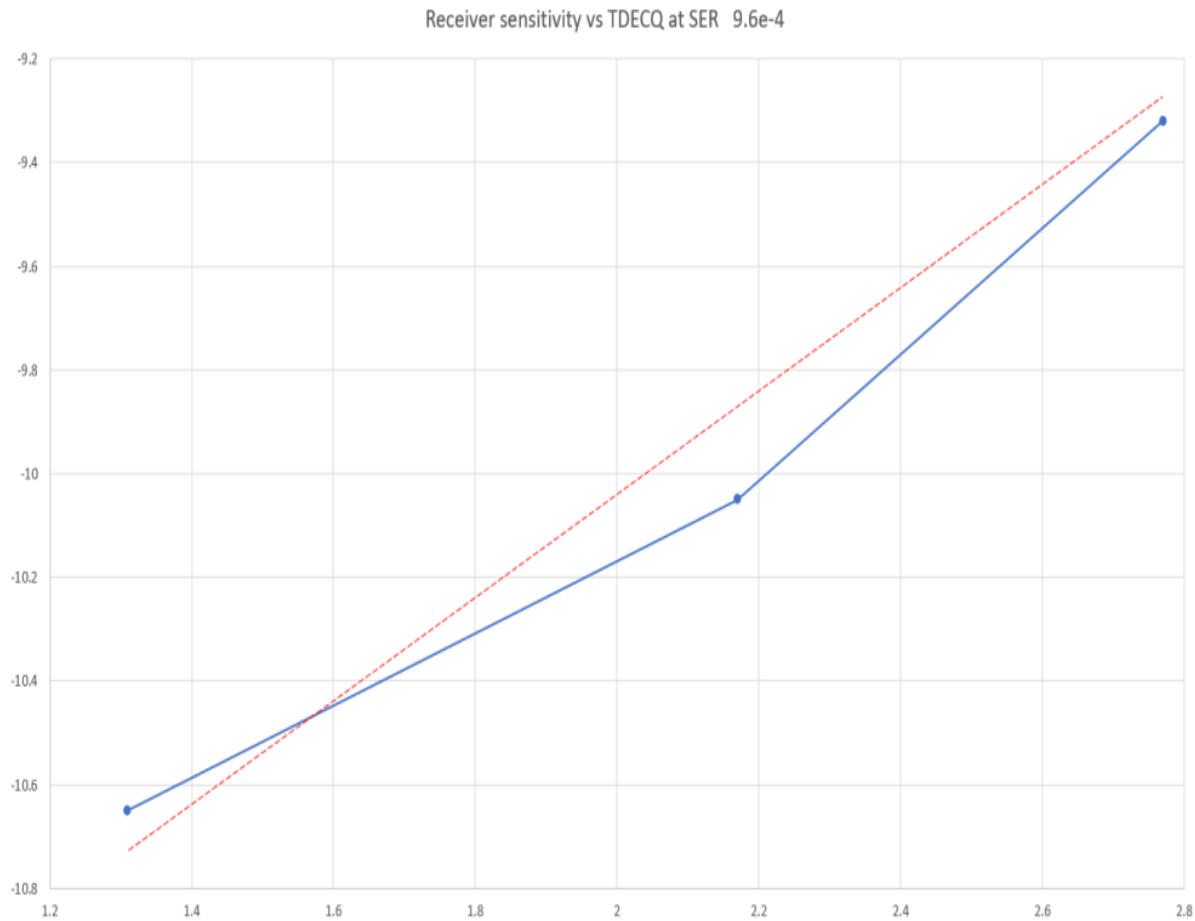


Slide 6 from Yu\_3dj\_01b\_2407

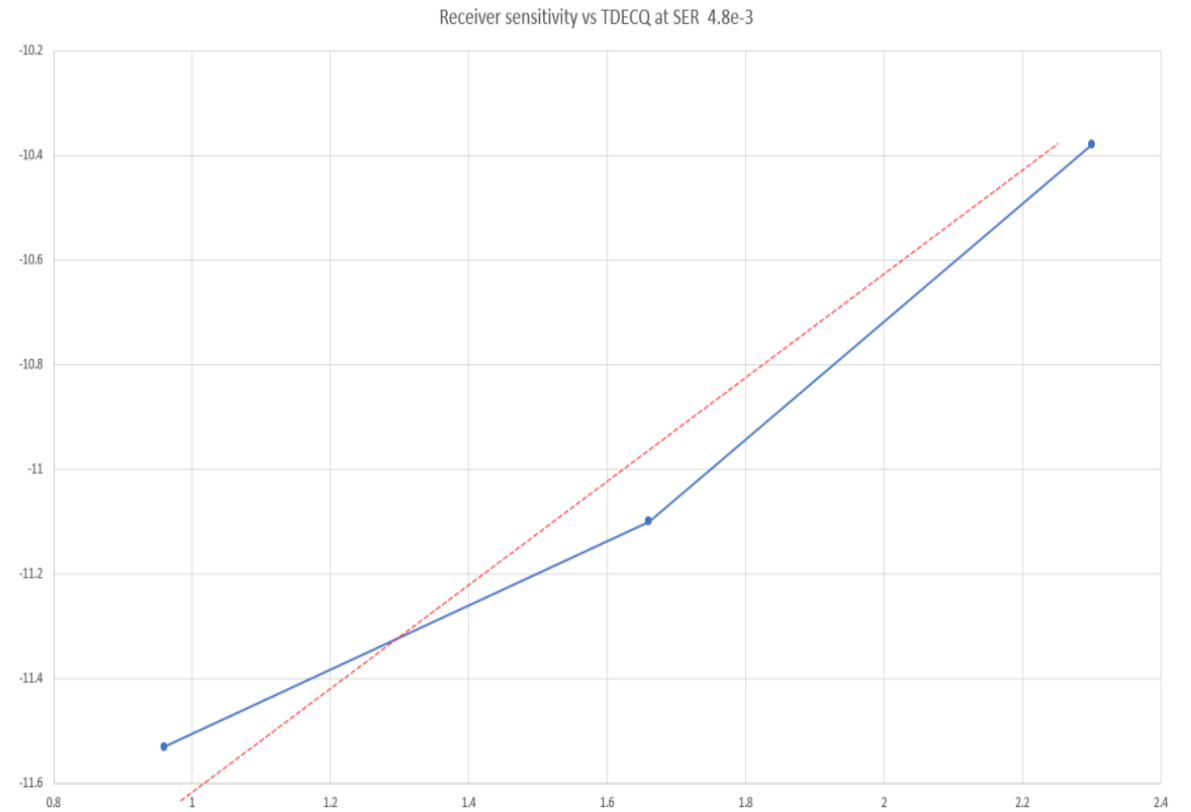
# Justification for Maximum value of TDECQ/TECQ

- The max value of TDECQ/TECQ is currently TBD in D1.2 for the 2km specs
- Proposed value is the same as for the 500m specifications which is a reasonable value.
- No evidence has been shown that receivers would have problems with this high a value of SECQ(TECQ) at 200G. Evidence that this is not an issue at higher SER has been shown at 100G in [Study on the Dependence of TDECQ on SER \(ieee.org\)](#) (simulations) and [Physical measurements for TDECQ versus SER \(ieee.org\)](#) (practical measurements). See following slides for some examples of the measurements.
- Replacing a TBD with a reasonable number moves the project forward and there is plenty of time to refine the number later when more practical measurements are available.

# Receiver sensitivity versus TDECQ with different SER



Slide 14



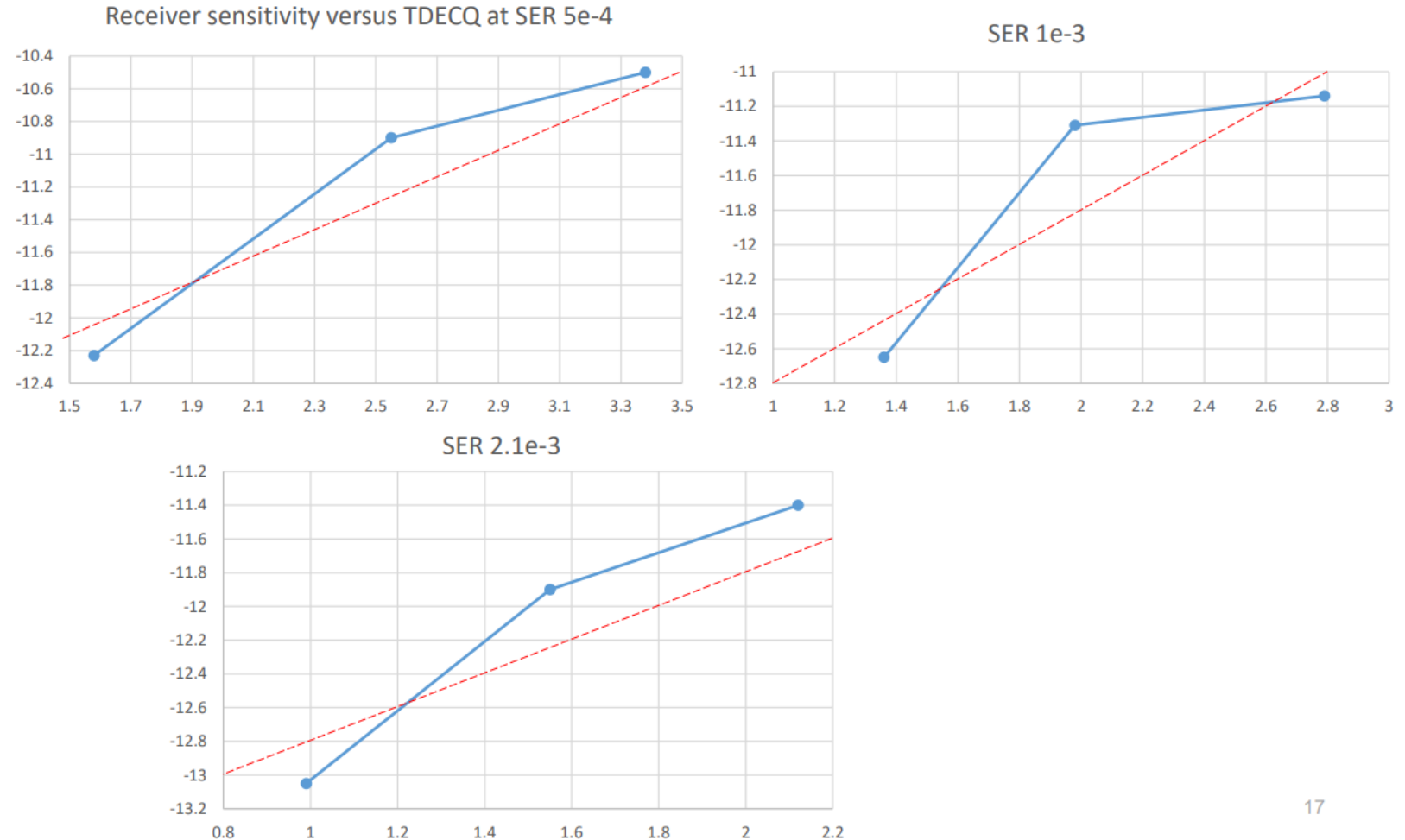
Slide 16

Slides 14 and 16 of [Physical measurements for TDECQ versus SER \(ieee.org\)](https://www.ieee.org)

# Receiver sensitivity versus TDECQ with different SER (cont)

**Experiment 3: Three FR4 EML transmitters with TDECQ range 1.5, 2.5, 3.5 (at SER 5e-4)**

- 2.1e-3 highest observable SER



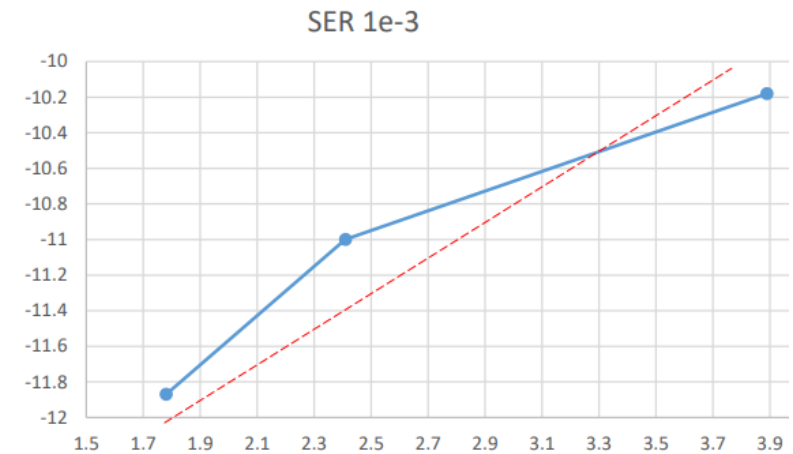
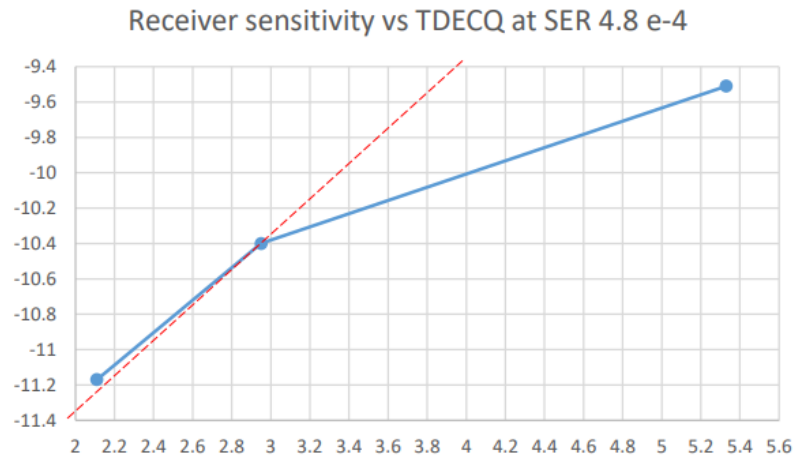


# Receiver sensitivity versus TDECQ with different SER (cont 2)

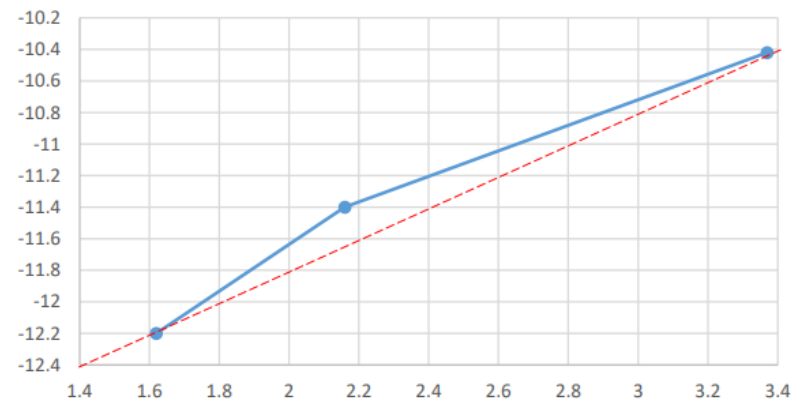
## Experiment 4: 100G FR4 10km span

High TDECQ

- TDECQ as high as 5.6 dB (at SER 4.8e-4) achieves a working link
- Very good correlation at SER 1.5e-3 (highest observable SER)



RX sens at SER 1.5e-3 (highest SER observable)



# Draft 1.2 key values and values proposed specs.

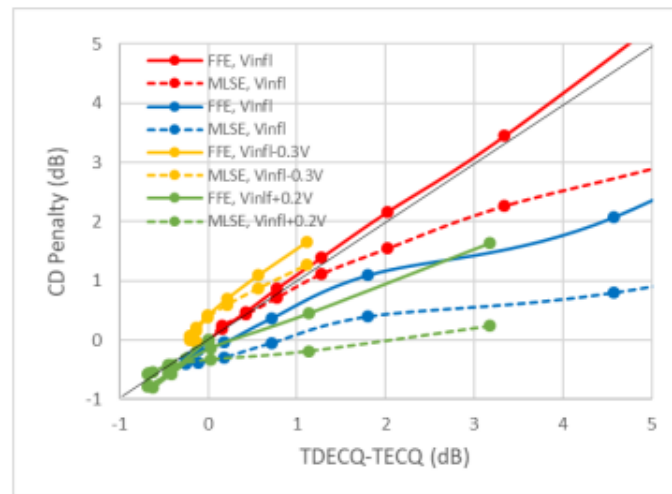
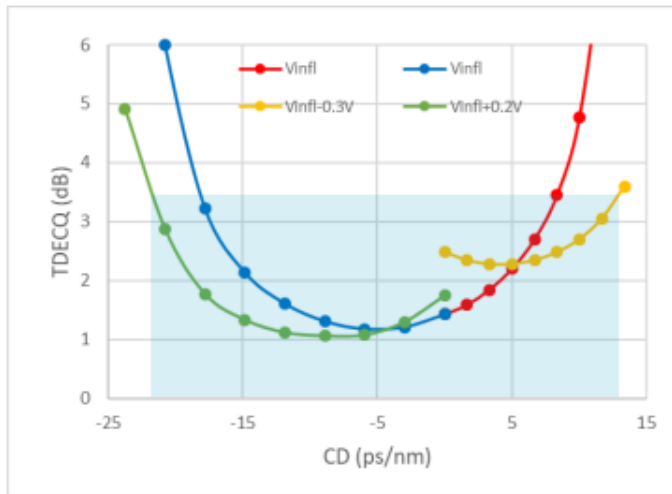
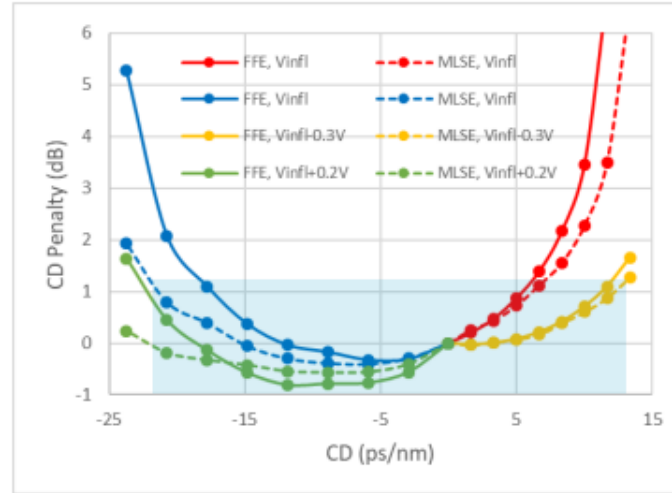
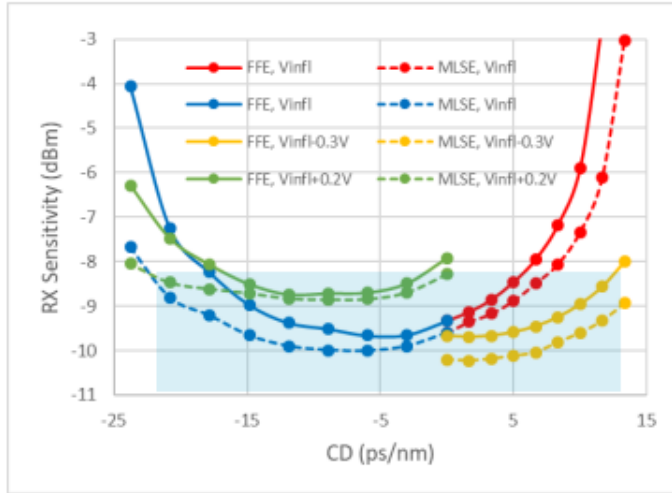
	200GBASE-DR1	200GBASE-DR1-2 etc.		800BASE-FR4-500	800GBASE-FR4		
	etc.	Draft 1.2	Proposed	Draft 1.2	Draft 1.2	Proposed	
Tx	Draft 1.2	Draft 1.2	Proposed	Draft 1.2	Draft 1.2	Proposed	
Average launch power, each lane (min)	-3.3	-2.6	-3.3	-2.2	-2.2	-2.2	dBm
OMA <sub>outer</sub> for max TECQ, TDECQ <0.9dB	-0.3	0.4	-0.3	0.8	0.8	0.8	dBm
OMA <sub>outer</sub> minus TDECQ/TECQ for 3.4dB <(max (TECQ, TDECQ ))<0.9dB	-1.2	-0.5	-1.2	-0.1	-0.1	-0.1	dBm
TDECQ(max)	3.4	TBD	3.4	3.4	TBD	3.4	dBm
TECQ (max)	3.4	TBD	3.4	3.4	TBD	3.4	dB
Absolute value (TDECQ-TECQ) (max)	2.5	TBD	2.5	2.5	TBD	2.5	dB
Rx							
Average receive power each lane (min)	-6.3	-6.6	-7.3	-5.7	-6.2	-6.2	dBm
Receiver sensitivity (OMA <sub>outer</sub> ) (TECQ <0.9dB)	-3.4	-4	-4.7	-3.2	-3.7	-3.7	dBm
Receiver sensitivity-TECQ (OMA <sub>outer</sub> )(0.9dB<TECQ <SECQ)	-4.3	-4.9	-5.6	-4.1	-4.6	-4.6	dBm
Stressed receiver sensitivity (OMA <sub>outer</sub> )(max)	-0.9	TBD	-2.2	-0.7	TBD	-1.2	dBm
Stressed eye closure for PAM4 (SECQ)	3.4	TBD	3.4	3.4	TBD	3.4	dBm
OMA <sub>outer</sub> of each aggressor lane	2.9	TBD	2.9	1.9	0.8	0.8	dBm
Illustrative Link Power budget.							
Power budget (for max TDECQ)	6.5	TBD	7.8	7.4	TBD	7.9	dB
Allocation for penalties (for max TDECQ)	3.5	TBD	3.8	3.9	TBD	3.9	dB

## Justification for Maximum value of TDECQ/TECQ for 800GBASE-FR

- The max value of TDECQ/TECQ for 800GBASE is currently TBD in D1.2 for the 2km specs.
- Proposed value for TDECQ is the same as for the 500m specifications which is a reasonable value as discussed on slides 6 - 9.
- Johnson\_3df\_01a\_221011( [Chirp characteristics and chromatic dispersion tolerance of 200G EML transmitters \(ieee802.org\)](https://www.ieee802.org) ) showed that chromatic dispersion effects on receiver sensitivity are no more severe than TDECQ predicts. i.e. TDECQ is either a good predictor or a conservative measurement depending on dispersion slope. See next slide.
- All other proposed values are direct calculations from the value of TDECQ/TECQ max or no change from draft 1.2
- Replacing a TBD with a reasonable number moves the project forward and there is plenty of time to refine the number later when more practical measurements are available.

# The effect of Chromatic dispersion on TDECQ and Receiver sensitivity

## Simulated CWDM Transmission Results



- Biasing more negative for lower chirp is necessary to reduce TDECQ and CD Penalty for the 1330nm channel at 2km
- Biasing more positive for more positive chirp is less necessary for the 1270nm channel, but can improve TDECQ and CD Penalty at the expense of B2B Sensitivity
- TDECQ < 3.4dB is achieved over -21.5 to +12.8 ps/nm CD, supporting up to 3.5km CWDM transmission
- Using FFE+MLSE RX, through fiber Sensitivity < -8.3dBm and CD Penalty < 1.2 dB is achieved with this RX model
- TDECQ minus TECQ overestimates CD penalty for negative dispersion