Maximum distance for 400GBASE-LR4

Peter Stassar, Huawei
Pete Anslow, Ciena

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Introduction

- This presentation provides further considerations on maximum distance for proposed baseline specifications for the 400GBASE-LR4 optical interface specification.

- Over the past meetings a lot of information has been made available with test results of TDECQ, SECQ and TDECQ minus SECQ over the relevant dispersion/wavelength ranges proposed for 400GBASE-LR4

- The proposed and extensively discussed options are a choice between operating the 4 transmitter wavelengths on a 20 nm spaced CWDM grid or on an 800 GHz spaced DWDM grid (also known as LAN-WDM).

Relevant straw poll Vienna meeting July 2019

Straw Poll #3:

If further technical analysis doesn't resolve option A, I would prefer the following option as a way to close the 400G 10km baseline: [A: Further technical analysis to select a single CWDM or LAN-WDM based baseline]

B. CWDM baseline using a restricted fiber approach for 10km and a reduced reach for worst case fiber.
C. Additional objective so both a CWDM and LAN-WDM baselines can be adopted
D. Modify 10km objective to shorter reach or to be based on loss budget
E. Remove 400G 10km objective

Vote for one

Results: B) 3 C) 7 D) 33 E) 0

- Straw poll #3 indicated that if option A was not resolved, there was a strong preference for option D, either modifying the distance to less than 10 km or a budget-based objective.
- Whichever will be chosen, it will be necessary to define a maximum dispersion limited distance in the specification.

Available test results

- Over the past meetings a lot of test results on TDECQ and SECQ versus chromatic dispersion have been made available from a variety of sources.

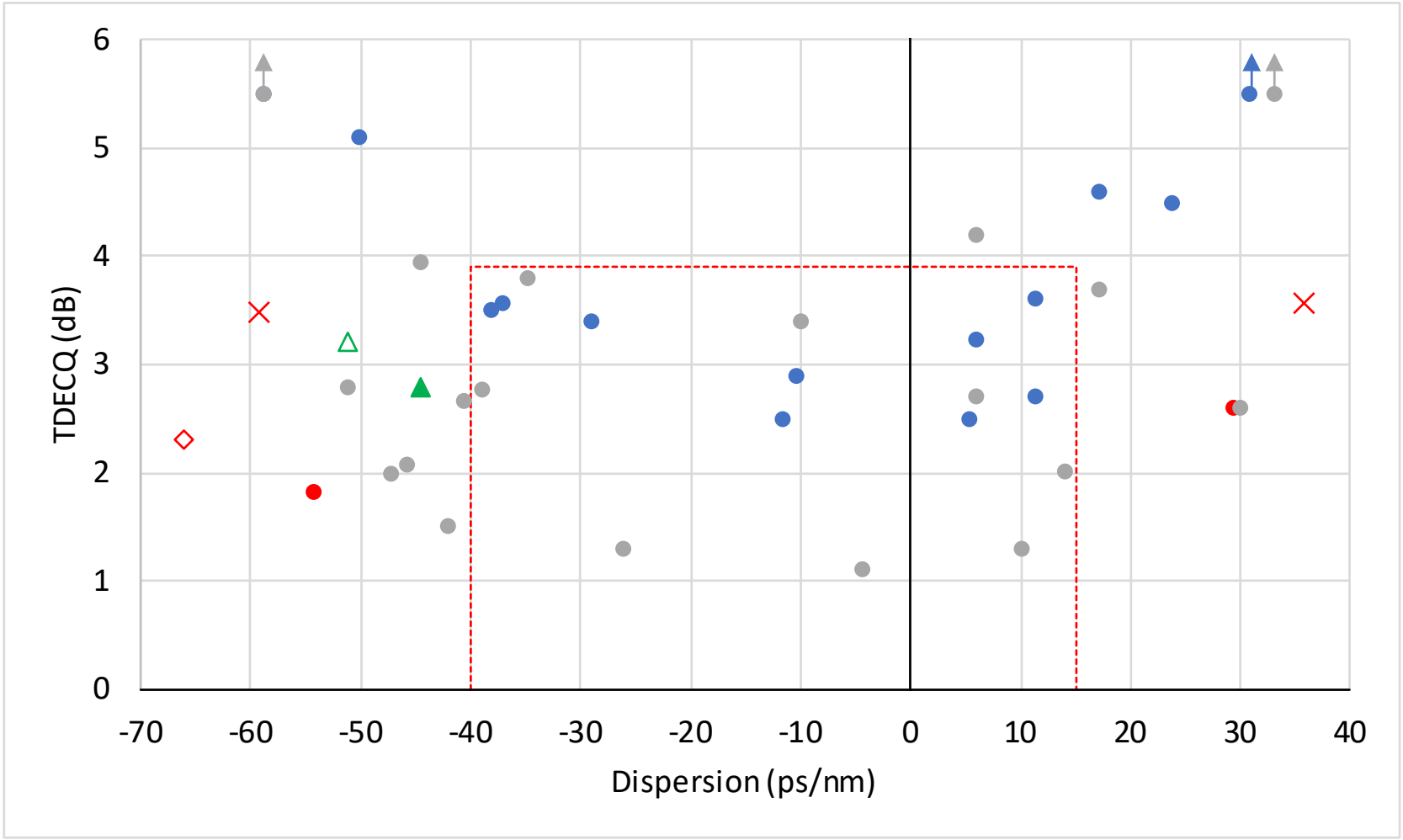
- As discussed in anslow_3cu_02a_0519, Salt Lake City meeting, May 2019, the two most important curves are:

  - TDECQ versus chromatic dispersion

  - TDECQ – SECQ versus chromatic dispersion

- The following 2 slides show updated versions of those curves, including most recent test results.

TDECQ vs dispersion



- johnson_optx_01_0319 un-optimised
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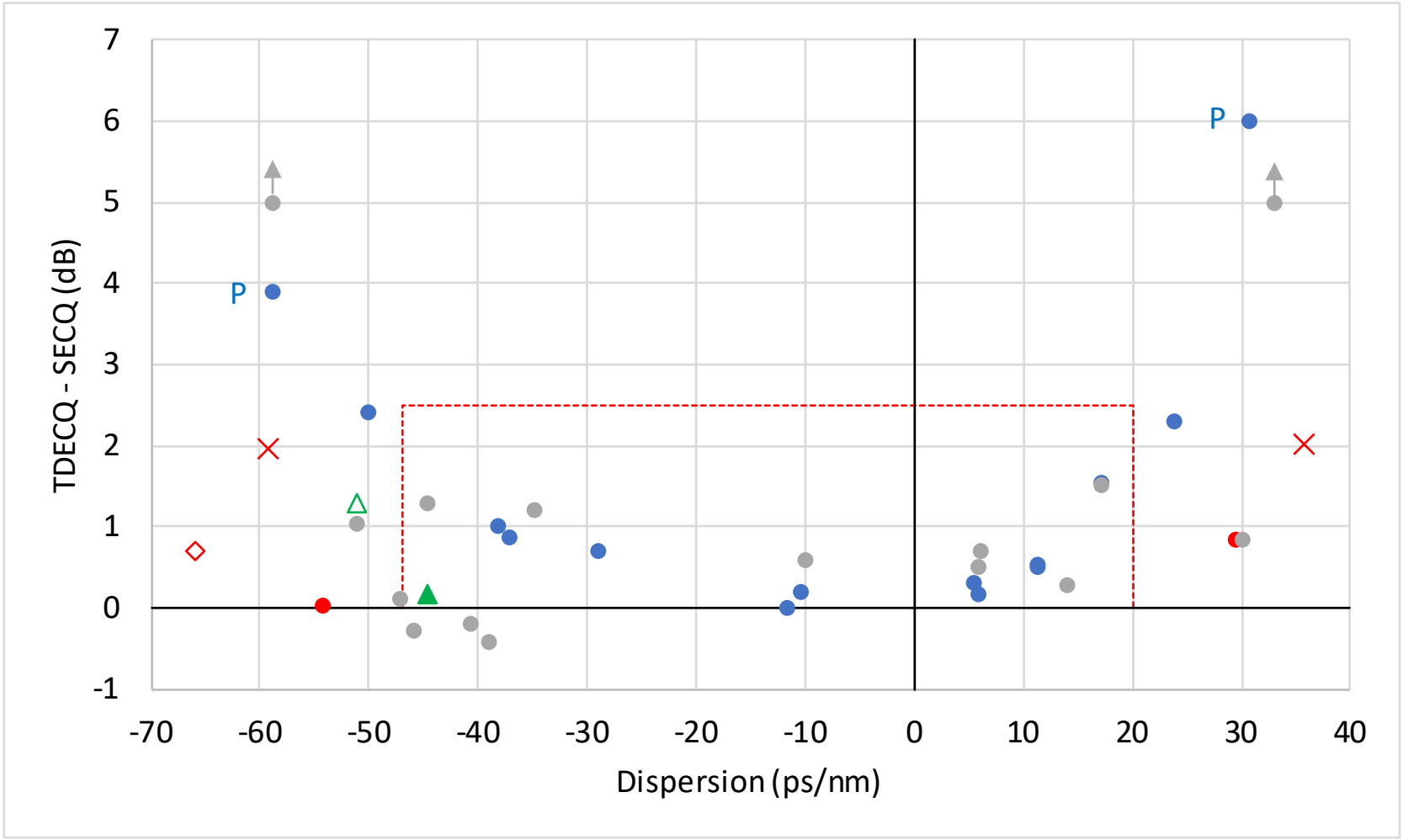
- yu_optx_01a_0319
- P yu_optx_01a_0319 predicted
- lewis_cu_adhoc_041719
- schube_3cu_01_0519 Si Ph (CD pen)
- mazzini_3cu_adhoc_082119 Si Ph
- 100G Lambda MSA
- 100G Lambda MSA excessive
- –40 to 15 ps/nm with 3.9 dB penalty

TDECQ – SECQ vs dispersion



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- mazzini_3cu_adhoc_082119 Si Ph
- 100G Lambda MSA
- 100G Lambda MSA excessive
- –47 to 20 ps/nm with 2.5 dB penalty

Observations

- The results for TDCEQ versus chromatic dispersion are quite scattered

- The results for TDECQ – SECQ are much better correlated and are quite consistent
  - These also confirm that it would be prudent to keep TDECQ – SECQ below 2 – 2.5 dB, because for higher penalties the penalty could significantly increase for small increases of chromatic dispersion
  - Because of testing at room temperature one could look at the dispersion levels for 2 dB penalty, yielding limits of –47 ps/nm and 20 ps/nm
  - For worst case fiber: ~7.9 km (@ –47 ps/nm) and ~6 km (@ 20ps/nm)
  - Thus positive dispersion limit is more restrictive than negative dispersion
  - Reducing lambda range of the 1331 nm channel to 1324.5 – 1330.5 nm, then the maximum distance increases from ~6 km to ~7.3 km.

Observations, continued

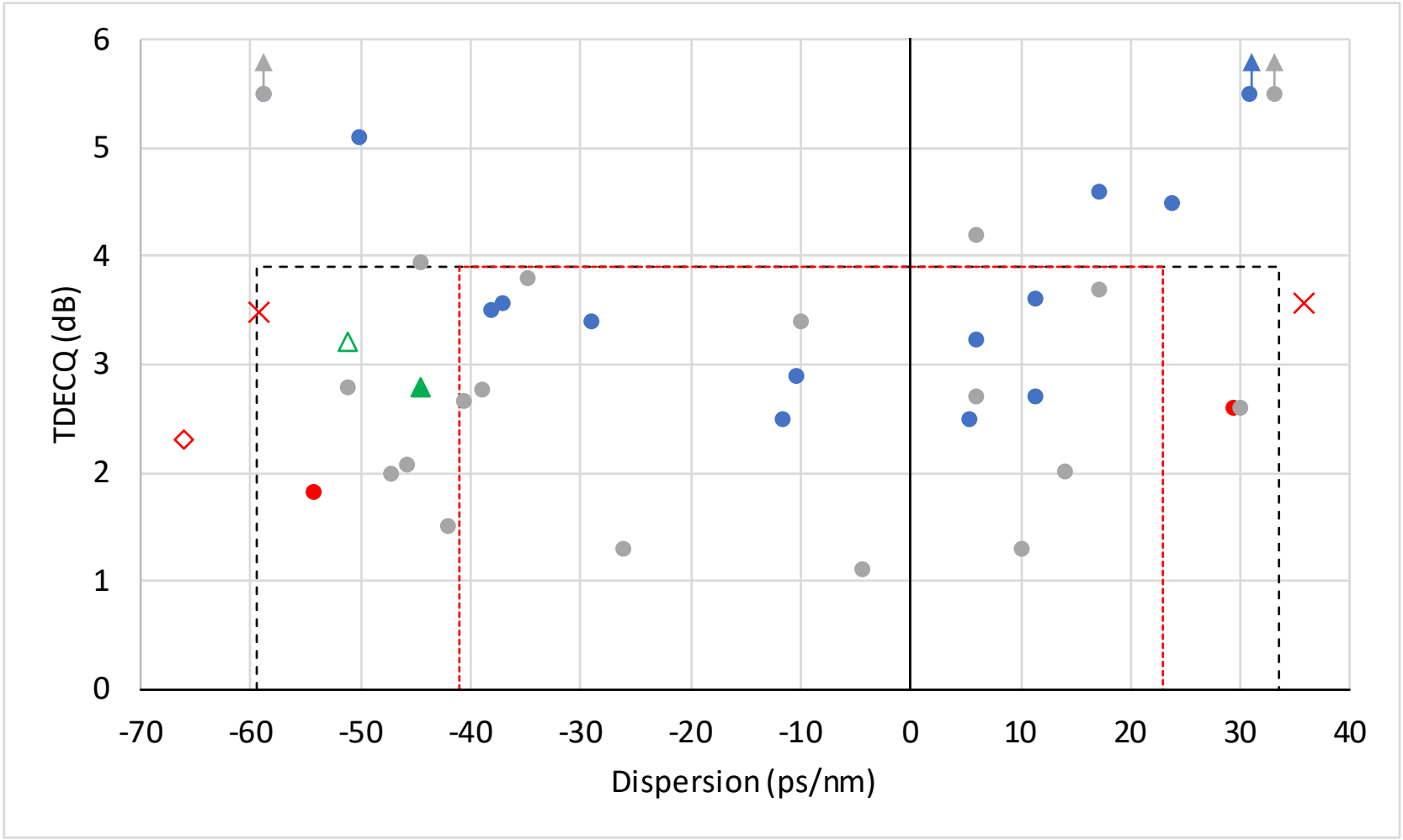
- Looking again at the results for TDCEQ versus chromatic dispersion in a similar way as for TDECQ – SECQ
  - For the proposed 3.9 dB limit, a dispersion window of –40 to +15 ps/nm could be assumed.
  - –40 ps/nm translates to a maximum distance of ~6.7 km and 15 ps/nm to ~4.5 km.
  - If we apply the same restricted CWDM wavelength of 1324.5 – 1330.5 nm then the maximum distance increases to ~5.5 km.

- The TDECQ – SECQ results suggest maximum dispersion limited distances of 6 – 7 km for CWDM based transmitters, allowing both SiP and EML based transmitters.

Considerations

- The philosophy behind TDECQ for PAM4 based transmitters (as TDP for NRZ based transmitters) is to allow trade-off between transmitter distortion and penalties due to chromatic dispersion.
- Since the consideration of TDECQ values in the range of 3.9 dB (higher than current in-force values of up to 3.4 dB), transmitters causing TDECQ – SECQ penalties in excess of 2.5 dB, have become likely, which should be avoided.
- Therefore it would not be overly conservative to introduce an additional parameter TDECQ – SECQ, with a strawman limit of 2.5 dB for this specific interface.
- If P802.3cu favours a CWDM solution rather than an 800 GHz spaced solution, then a proposed strawman maximum dispersion limited distance would be 7 km.
- For worst case G.652 fiber this would imply chromatic dispersion limits of –41 to +23 ps/nm for worst case CWDM grid, as shown on next two slides

TDECQ vs dispersion



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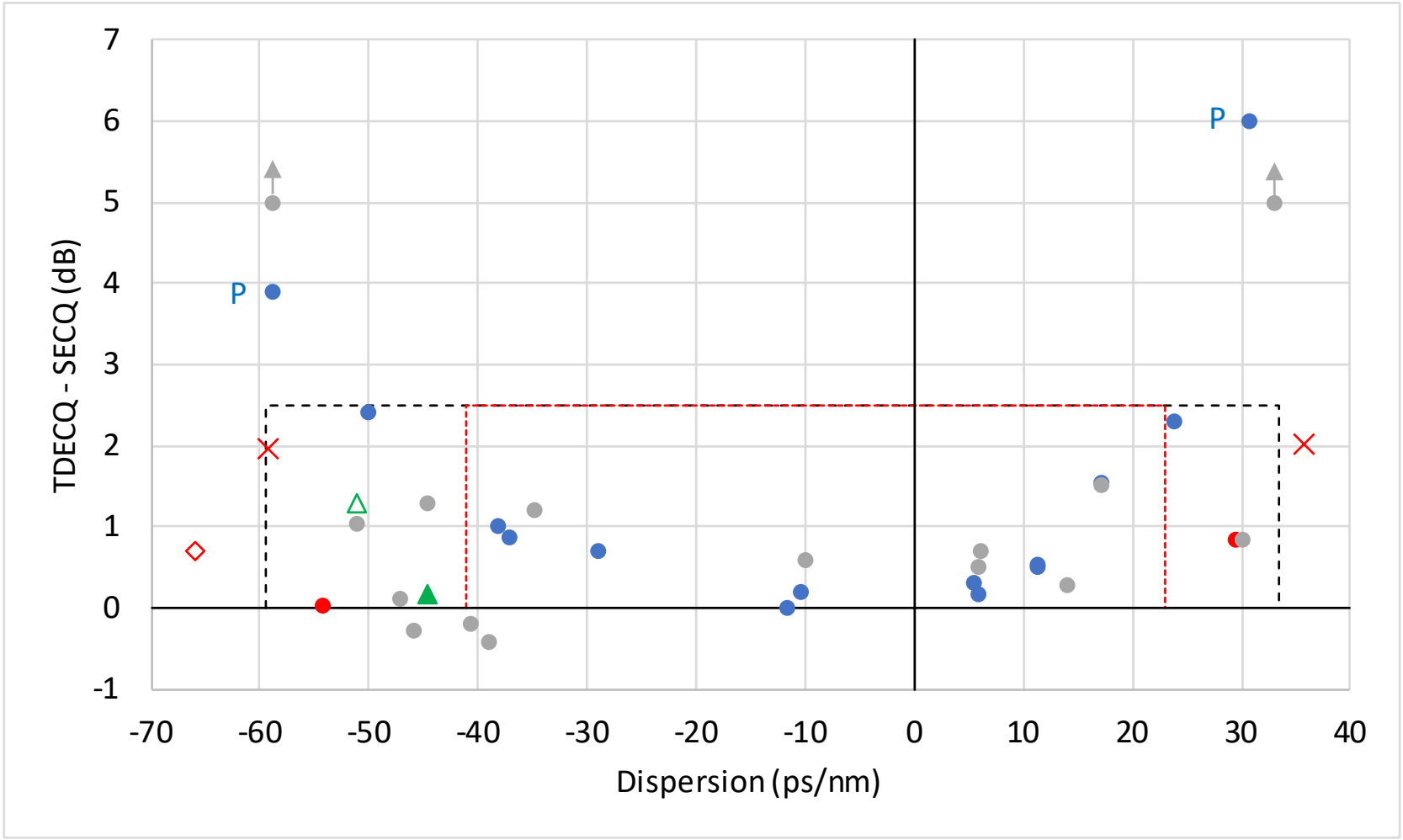
- CWDM grid 10 km
- CWDM grid 7 km

TDECQ – SECQ vs dispersion



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Proposals

- Perform a straw poll on the preference for:
  - Option A: 800 GHz based configuration with distances up to 10 km.
  - Option B: CWDM based configuration with distances up to 7 km.

- Introduce an additional parameter TDECQ – SECQ, with a strawman limit of 2.5 dB.

Thanks!