SUMITOMO ELECTRIC

Further consideration of 25G DML transmission (including temperature dependency)

Naruto TANAKA
Daisuke UMEDA

July 25-27th, 2016
Sumitomo Electric Industries, LTD.

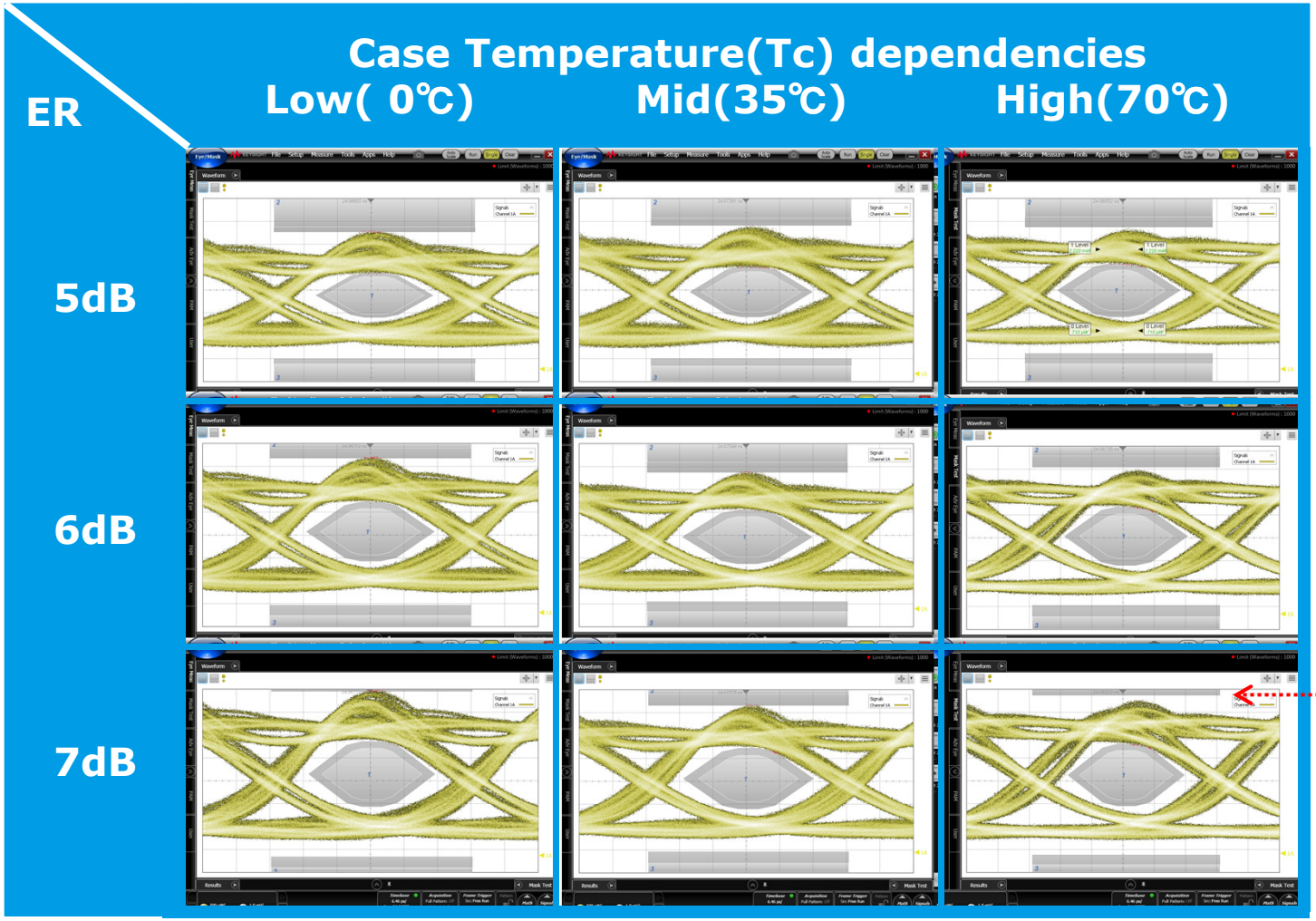
Introduction

- Feasibility of DML transmission was indicated in previous meeting. http://www.ieee802.org/3/ca/public/meeting_archive/2016/03/tanaka_3ca_1_0516.pdf
- 25G uncooled DML performances were interested under several environmental conditions.

- Further performances of 25G DML are informed to consider this feasibility.
  - Waveform quality with high ER
  - Dispersion penalties after fiber transmission
  - Output power
- We reviewed again the possibility of 29dB Ch.I.L. .

ER & Tc dependencies of waveforms

- Waveforms with several ERs are measured at 3 temperature points
- Waveforms aren't distorted so much under all conditions



Pf is controlled within 0.2dB over all temperature.

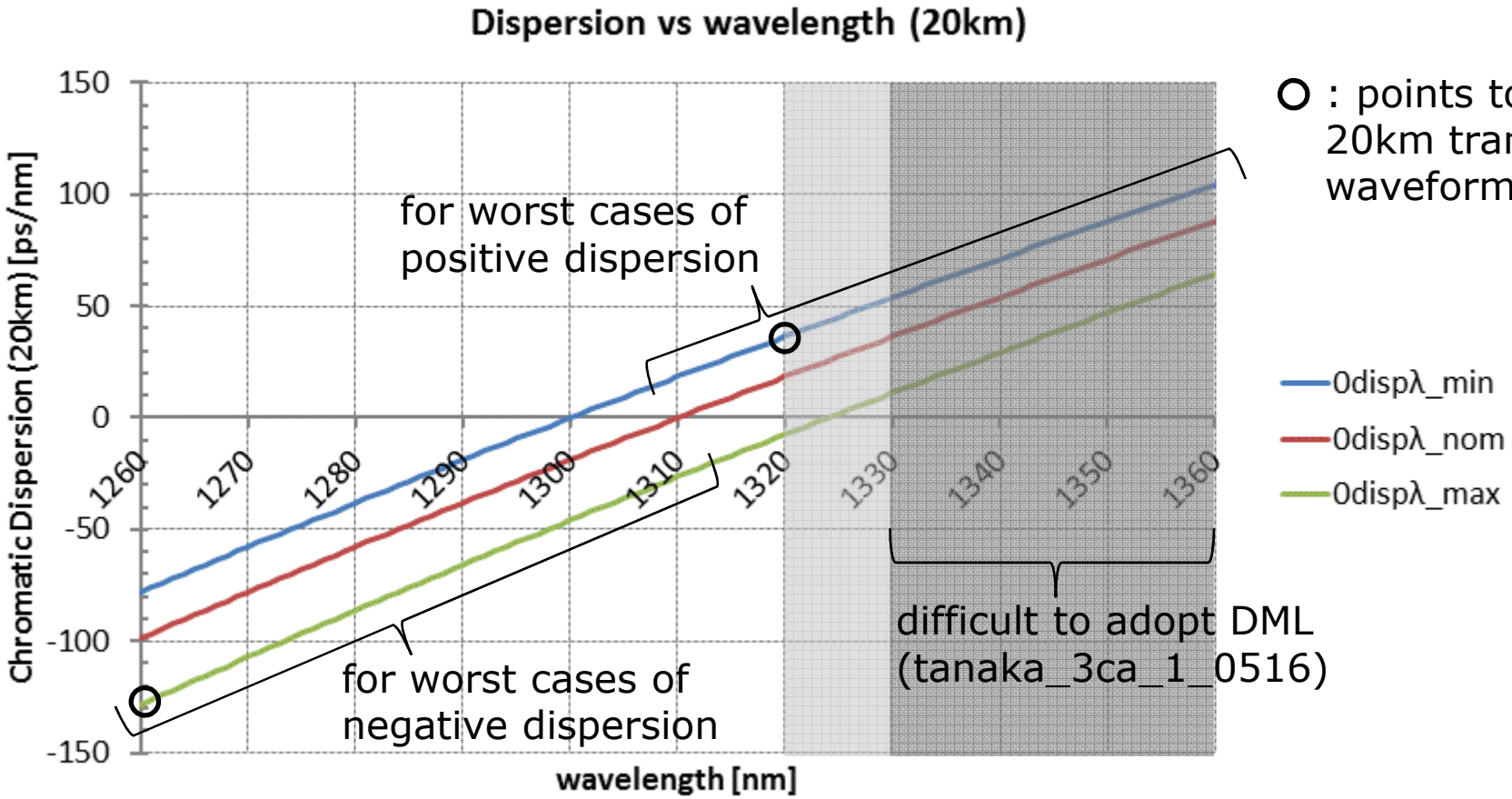
…**marginal** with **7**dB ER at **high** Tc

100GBASE_LR4 eye mask is applied

Evaluation points for influences of dispersion

TRC (12)

- 1300 or 1324nm is used as zero dispersion wavelength to estimate the worst influence of positive or negative dispersion respectively.
  - Referred to Liu_3ca_3_0516 and other contributions
- Evaluated at 3 temperature points with several ER tuning



Worst cases of negative dispersion(wfms)

- 20km transmitted waveforms in worst cases of negative dispersion
  - 0 dispersion wavelength: 1324nm / Center wavelength of DUT: shifted to 1260nm
- Waveforms with several ER tuning are evaluated at 3 temperature points.
- Waveforms are distorted but **opened** under all conditions.

Transmitted waveforms

$\lambda_{0\ dispersion}$:**1324**nm

λ_{center} : ->**1260**nm

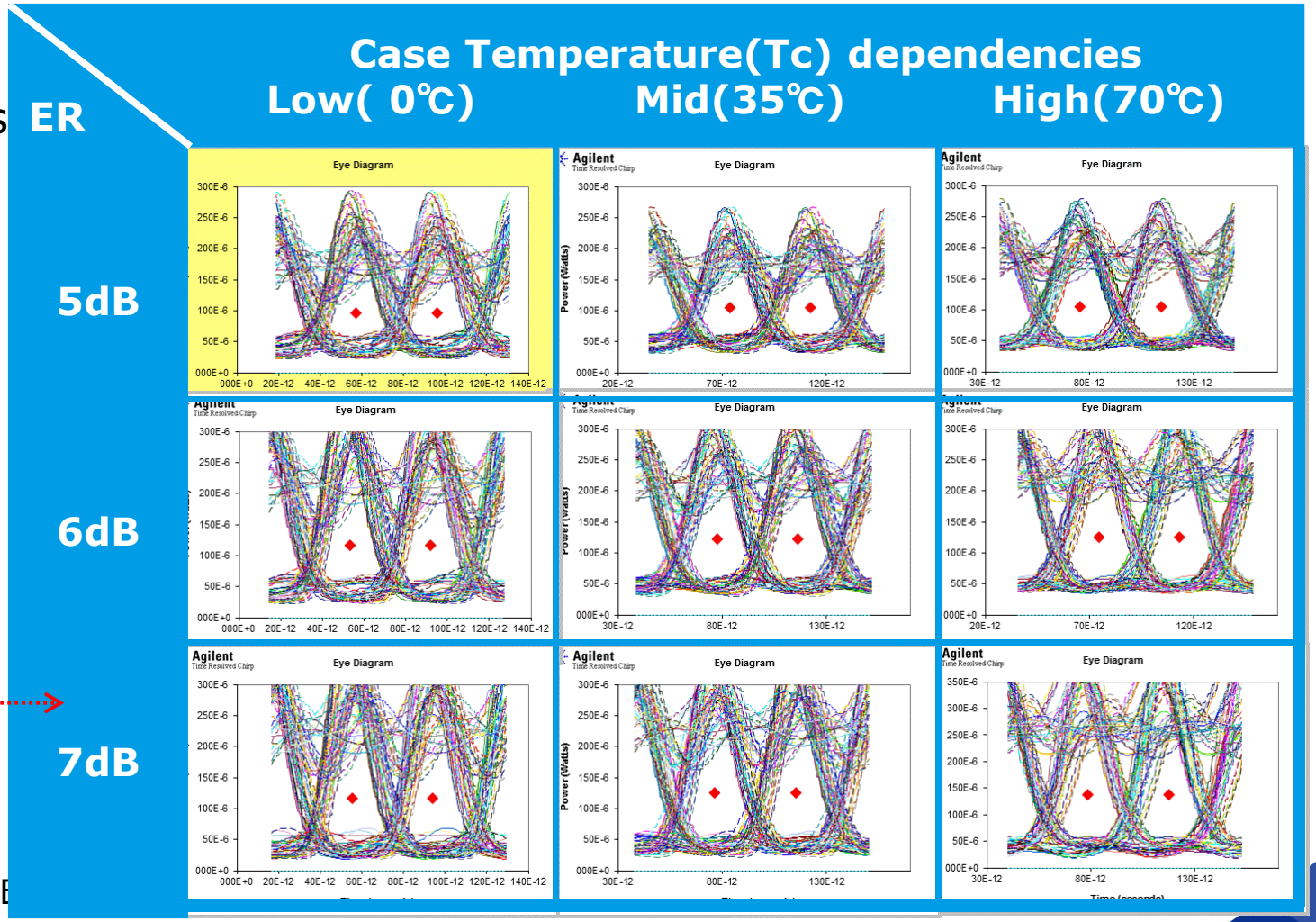
Fiber length:**20**km

Worst penalty

TDP: 0.12dB

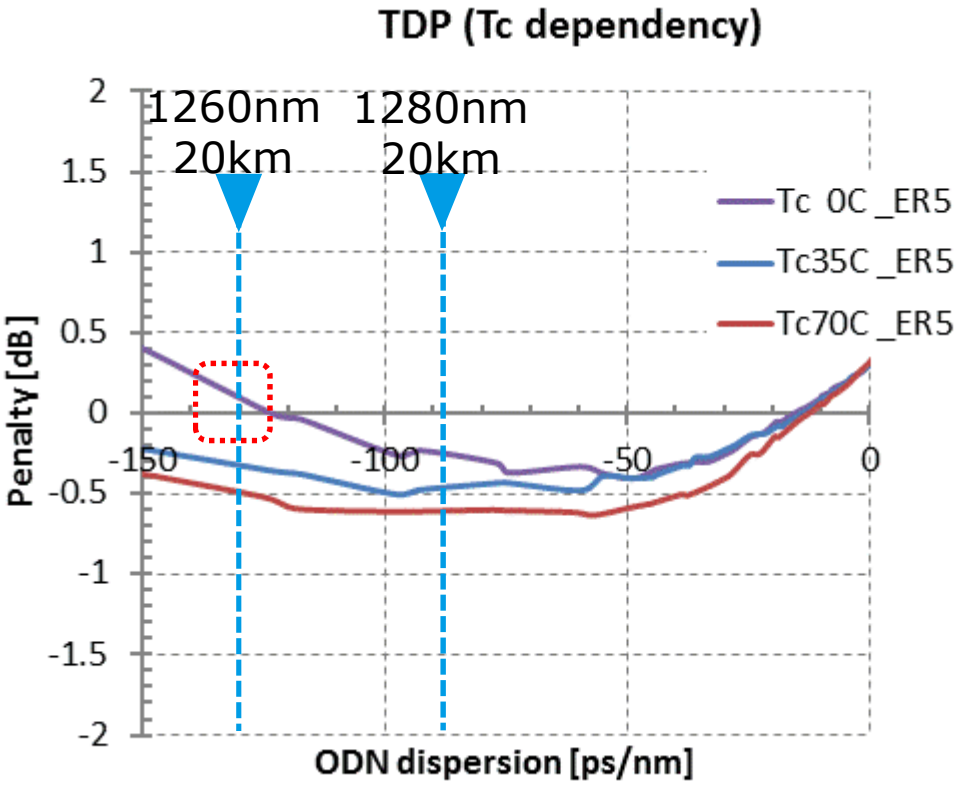
DP :-0.23dB

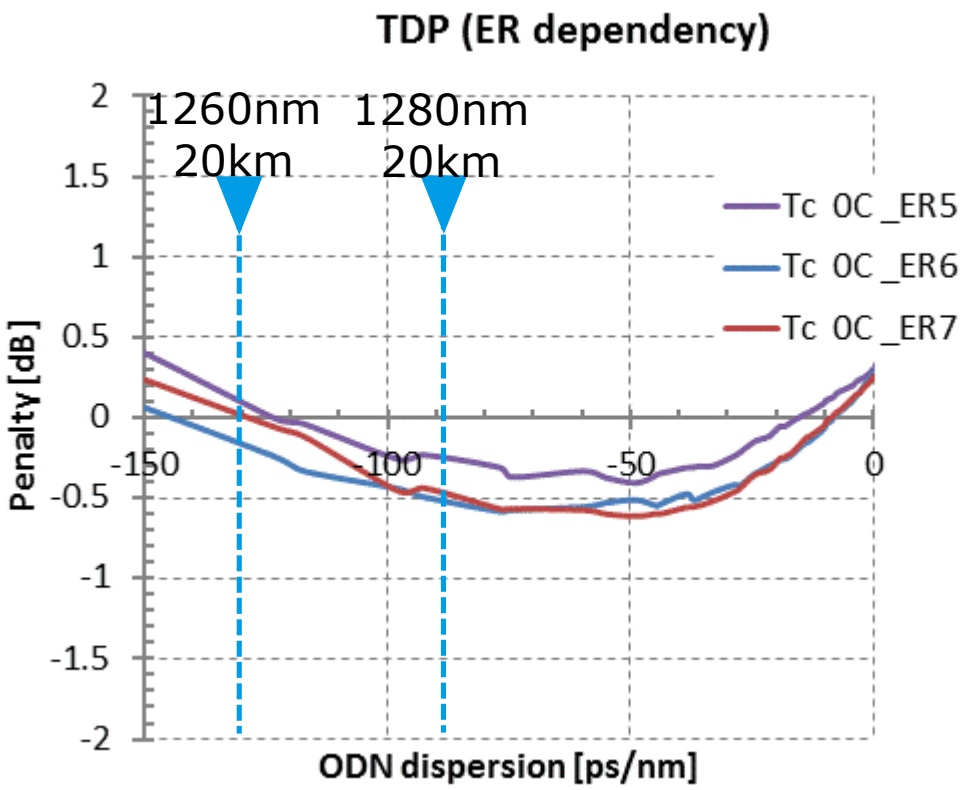
Eyes are opened with large overshoot.



Worst cases of negative dispersion (TDP)

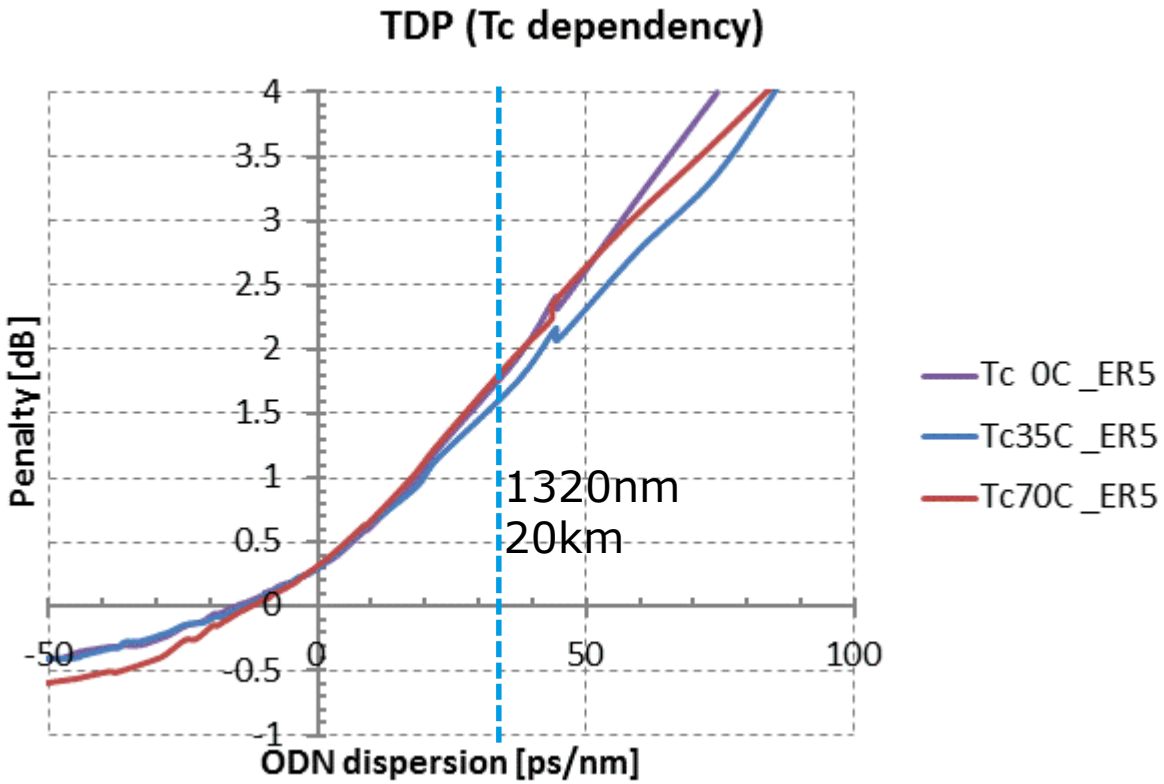
- TDPs in worst cases of negative dispersion
  - 0 dispersion wavelength: 1324nm
- Estimated at 3 temperature points with several ER tuning.
- TDPs would increase under 1280nm at low temperature but must be better than around zero dispersion wavelength. ER dependency isn't noticeable.





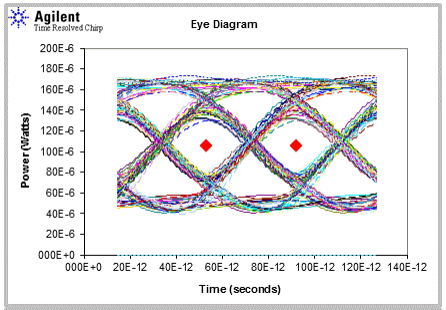
Worst cases of positive dispersion

- TDPs in worst cases of positive dispersion
  - 0 dispersion wavelength: 1300nm
- Simulated at 3 temperature points with several ER tuning.
- TDPs increase over 1320nm at low temperature especially.
  - DML isn't appropriate over 1320nm.

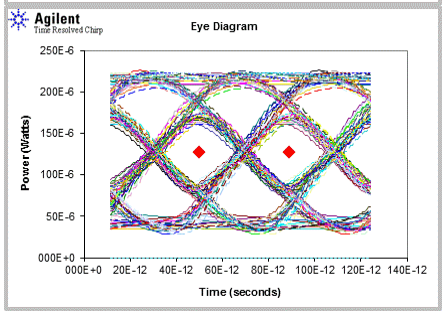


Waveforms at Tc0C on 1320nm

ER5

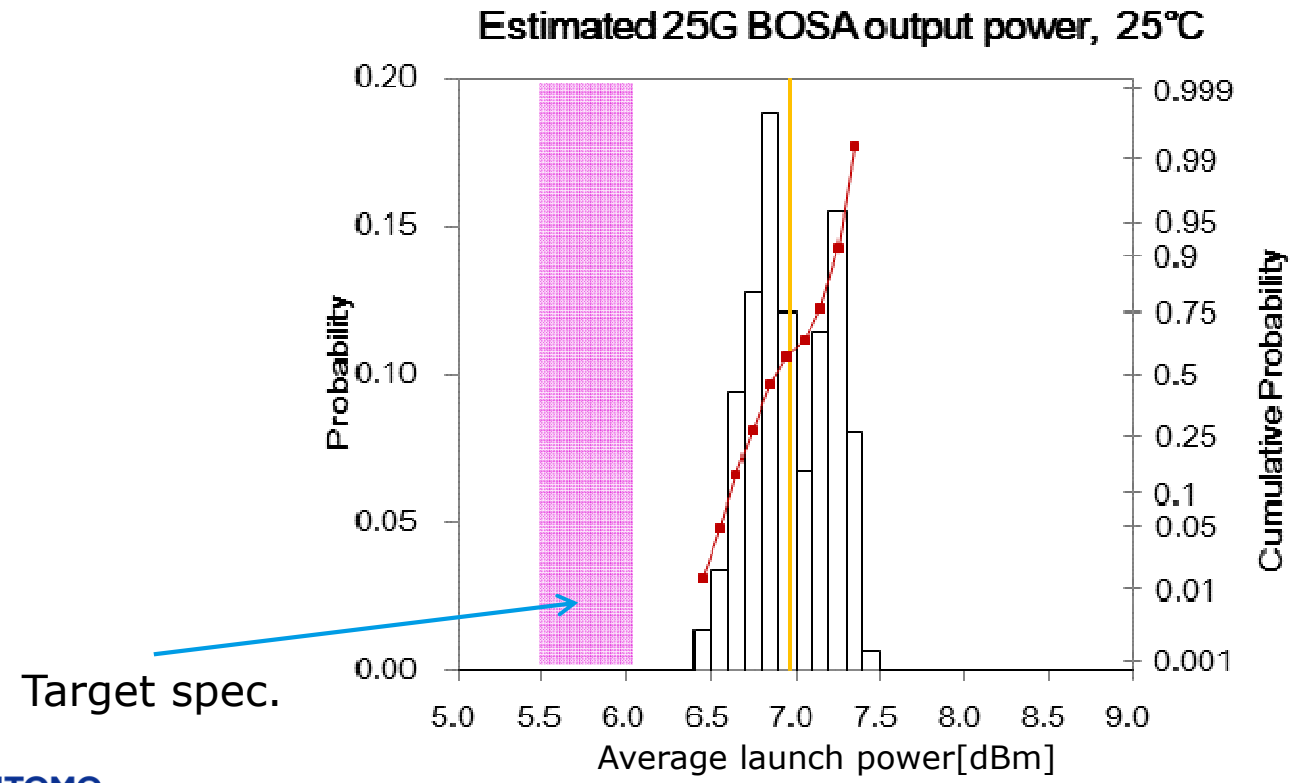


ER7



Launch power

- 25G TOSAs are assembled without de-focusing (10-20 samples)
  - **Practical** light coupling efficiency from LD to 25G TOSA was ***40***% as average.
- 25G BOSA power is considered again with this efficiency.
  - LD power distribution is same as applied for tanaka_3ca_1_0516.
- Min. +5.5dBm is achievable to be specified now. +6.5dBm is expected to be realized potentially if collimated structures are applicable.



29dB Ch.I.L. with DML Tx+ APD Rx

- Possibility of 29dB channel insertion loss same as 10GBASE-PR30,

Parameter	10G	25G un-cooled			Notes
		realistic	possible	collimate	
(1) Tx output power min. [dBm]	4	5.5 (ER5dB)	5.5	6.5	realistic: ER 5dB other: ER 6dB
Launch OMA min. [dBm]	4.78	5.67	6.28	7.28	
(2) Rx sensitivity max. at BER=10^{-3} [dBm]	-28	-22.4 (TxER5dB)	-23	-23	realistic: Tx ER 5dB other: Tx ER 6dB
Rx sensitivity OMA max.[dBm]	-27.22	-22.22	-22.22	-22.22	
(3) Transmitter and Dispersion Penalty [dB]	3	2	2	2	1260-1310nm
Channel insertion loss [dB]	29	25.9	26.5	27.5	(1)-(2)-(3)

- Cases of 25G un-cooled DML
  - realistic: *Realistic* specifications using the available technologies
  - possible: 6dB ER will be *possible* including the production margin with improvement of LD driver performance.
  - collimate: Predictable specifications using the *collimated* structure as a example of applicable technologies

Summary

- Experimental results under environmental conditions are added to consider the feasibility of 25G DML transmission.
- Although TDPs are degraded at low temperature a little, relaxing TDP specification to +2dB is possible in negative dispersion area under all environmental conditions.
- 29dB channel insertion loss isn't and won't be easy to realize using 25G un-cooled DML.
  - 25dB Ch.I.L. is feasible. So, PR20 may have worth to be considered.
  - Can we allocate 25G US channel on 1270nm optionally with believing the future enhancements of technologies?

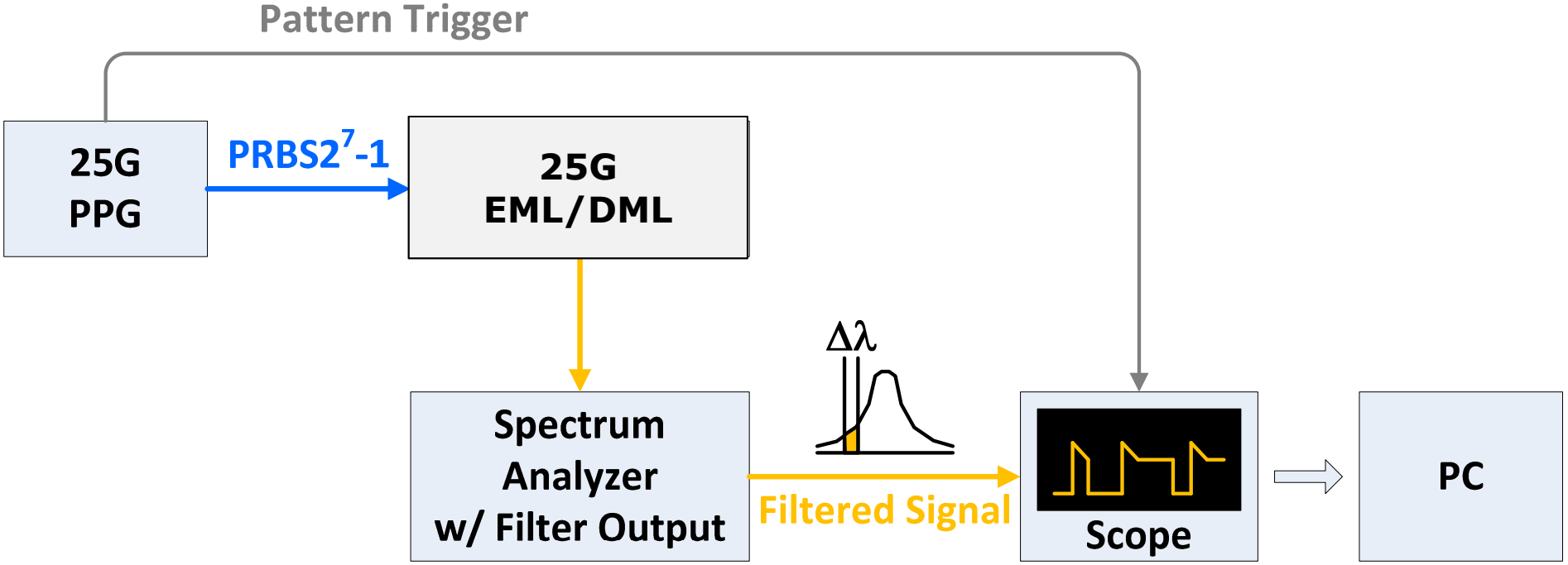
Thank you

Back Up

Time Resolved Chirp (TRC)

Return

- TRC is a method to estimate TDP based on chirp measurement.
- Measure the time variation of the optical power and frequency of a transmission by monitoring the filtered signal and simulate the waveform after transmission.
- It's possible to estimate TDP in other wavelengths.
- BER contours are calculated to estimate TDP in the eye opening of the simulated transmitted waveform.



Worst cases of positive dispersion(wfms)

- 20km transmitted waveforms in worst cases of negative dispersion
  - 0 dispersion wavelength: 1300nm / Center wavelength of DUT: shifted to 1320nm
- Waveforms with several ER tuning are evaluated at 3 temperature points.
- Eyes are closed to around half of peak amplitude on waveforms.

Transmitted waveforms

$\lambda_{0\ dispersion}$:**1300**nm

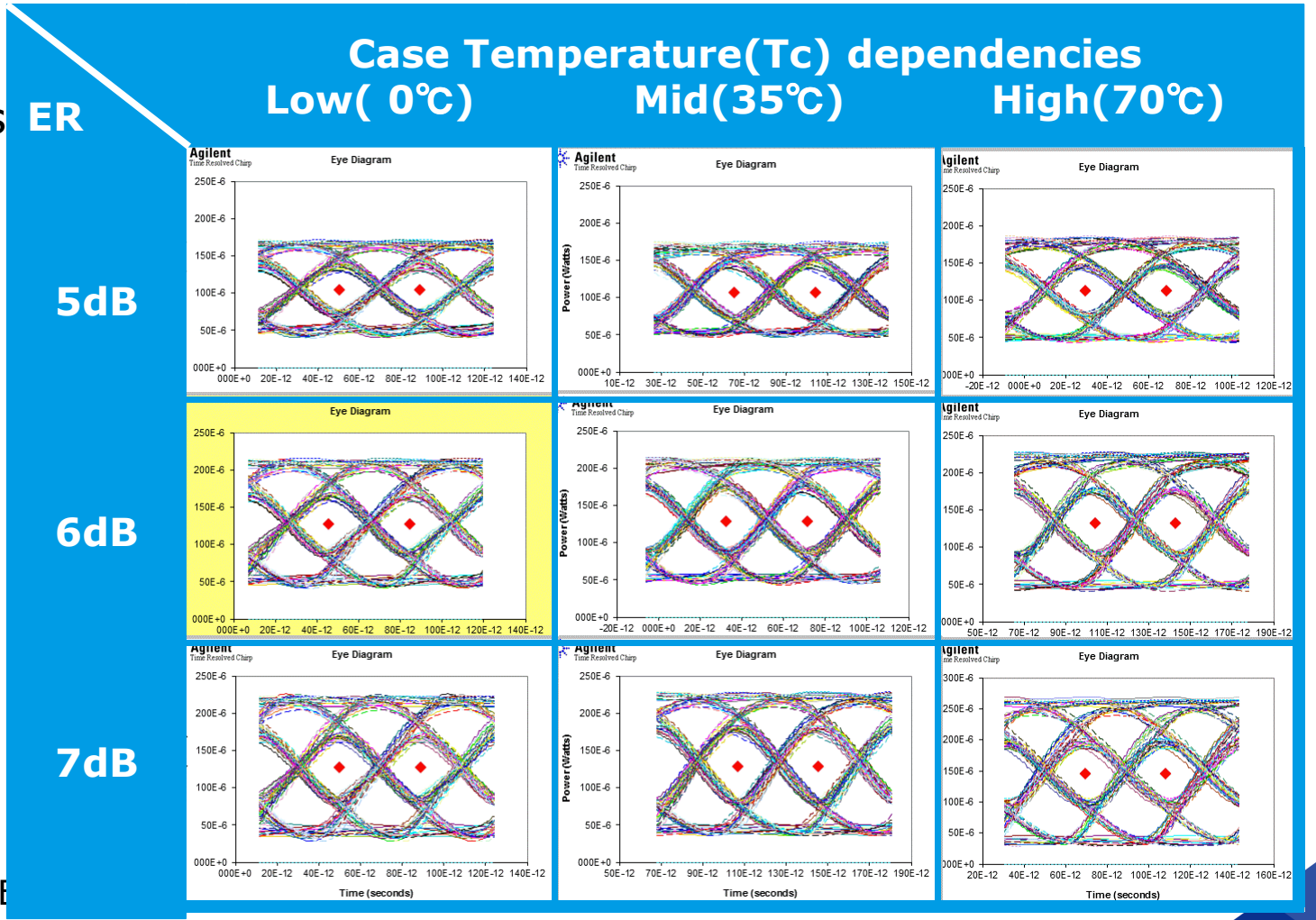
λ_{center} : ->**1320**nm

Fiber length:**20**km

Worst penalty

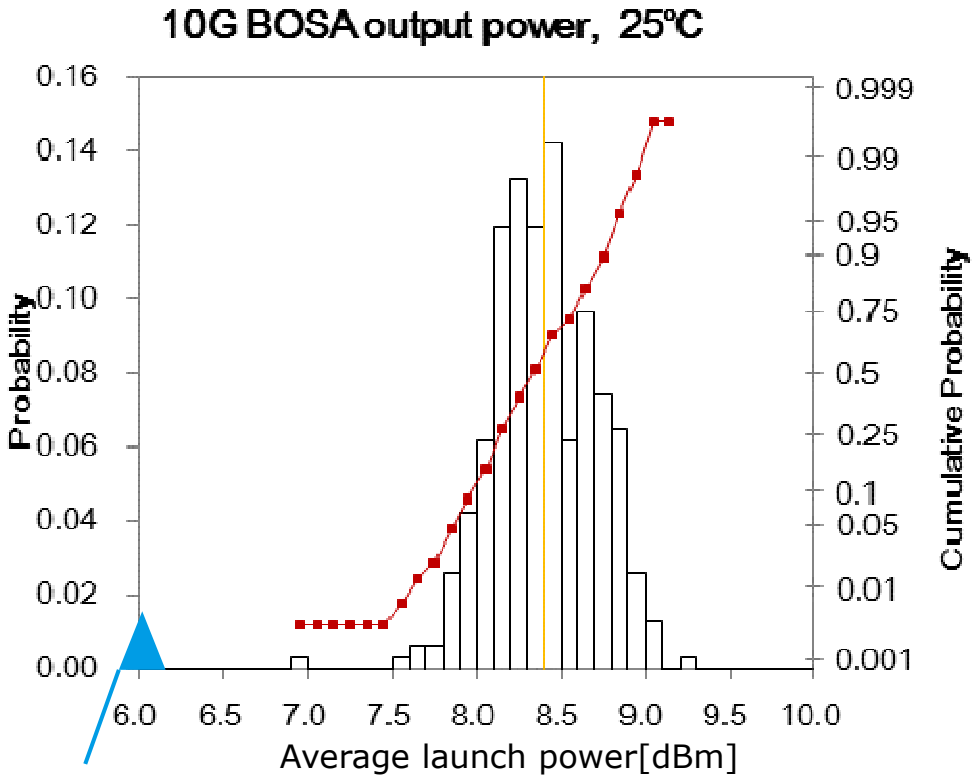
TDP :2.29dB

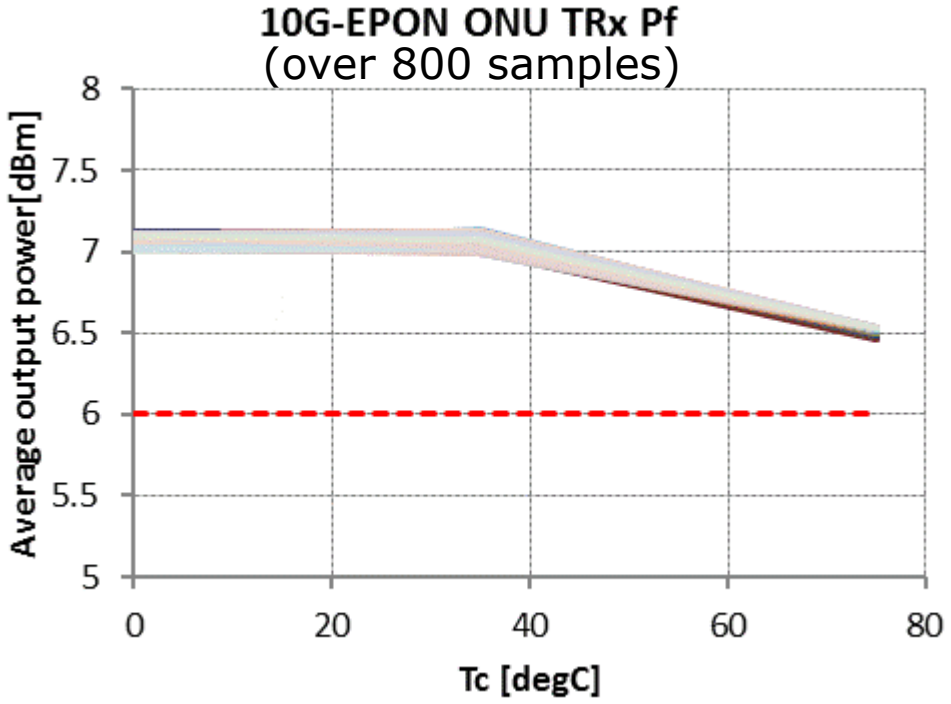
DP :2.01dB



Launch power of 10G-EPON ONU PMD

- Average launch power of 10G BOSA
  - light coupling efficiency from LD to BOSA :***>50***% (non collimated)
- Average launch power of 10G-EPON ONU Transceivers
  - well controlled to be specified to 6dBm minimum
  - We are still considering the possibility for improvement of the light coupling efficiency of 25G TOSA.



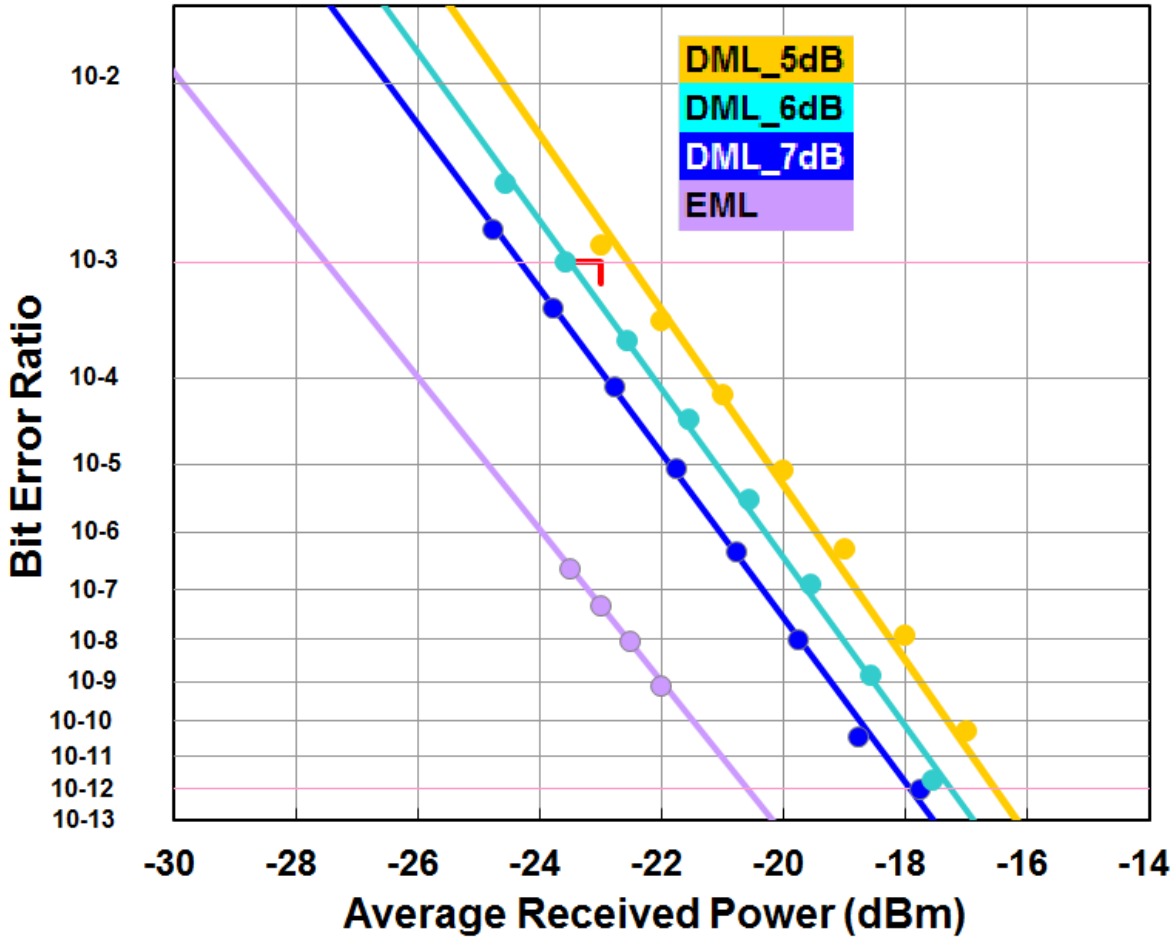


Target spec. (PR-U4)

Measured BER with APD Rx (tanaka_3ca_1_0516)

- Min. sensitivity -23.5dBm @1e-3 BER with DML (ER is tuned to 5.9dB)
- Min. sensitivity -27.5dBm @1e-3 BER with EML (ER is 10.0dB)

Notes; Sensitivity would be improved 1.5dB from this result by ROSA assembly optimization or simple equalization.



Measured at room temperature

5dB worse than 10G w/DML

Measured BER with APD Rx (simply plotted vs. OMA)

- Min. OMA sensitivity -22.8dBm @1e-3 BER with DML
- Min. OMA sensitivity -25.4dBm @1e-3 BER with EML

2dB difference w/o ER dependency of APD

Notes; Sensitivity would be improved 1.5dB from this result by ROSA assembly optimization or simple equalizer.