Innovative R&D by NTT

Technical Feasibility to support beyond 10km on 400GbE

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Background

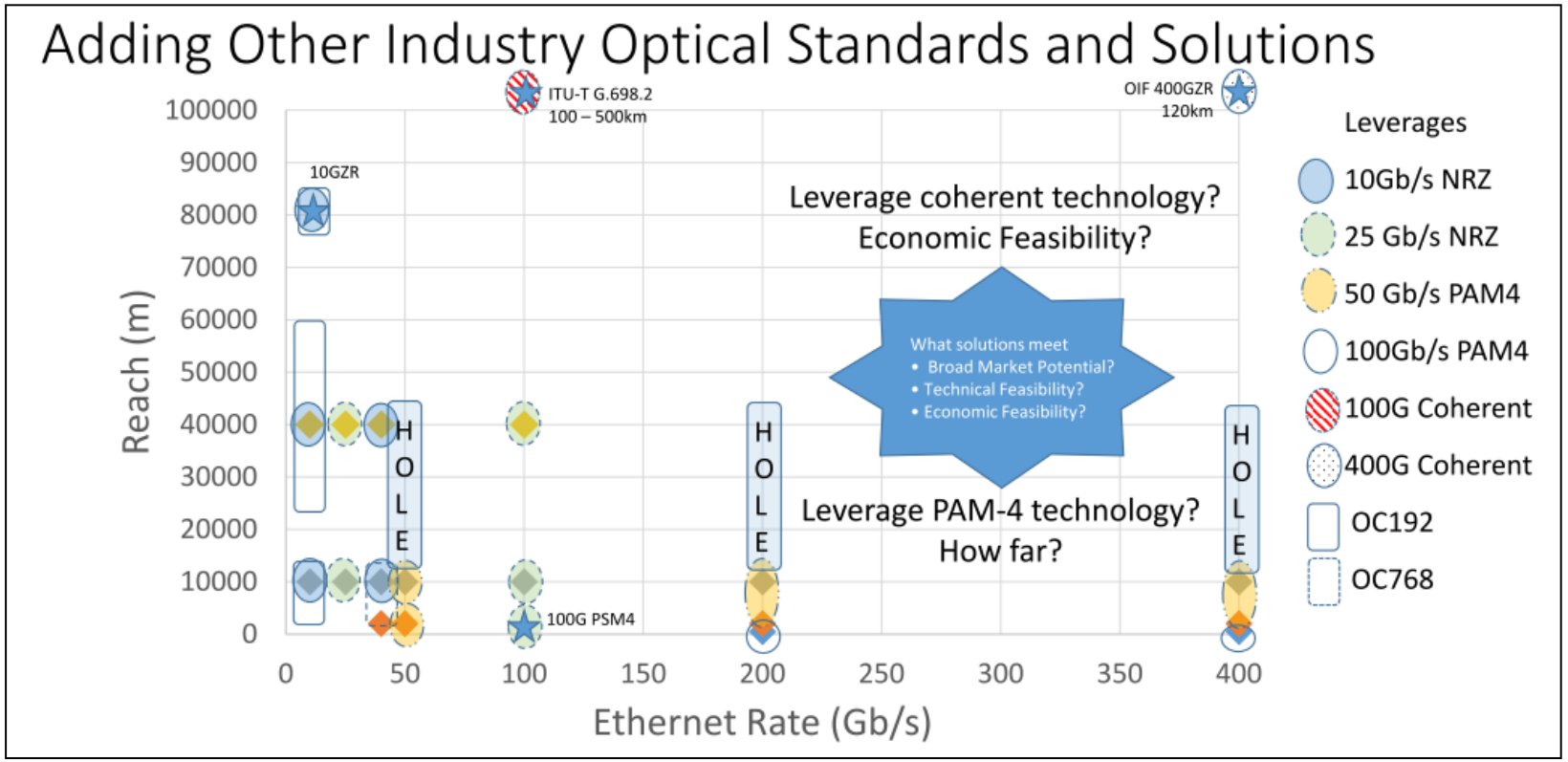
- In NEA Ad-hoc, we have confirmed the need for > 10km reach and also identified “solution hole” for 50GbE/200GbE/400GbE beyond 10km.

- According to the straw poll in Huntington beach meeting, Most is expecting we move forward for “Beyond 10km” CFI

- In this presentation, the technical feasibility is investigated for 400GbE Beyond 10km SMF PMD based on 50G PAM4.

Revisiting “Beyond 10km” in Jan

- Investigating on technical feasibility of PAM4 is needed for 400GbE with beyond 10km, such as 20km, 30km, 40km, etc.



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Review: Technical approach for ER PMD

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■ Optical transmission performance evaluation
(sone_ecdc_01b_0516)

400GBase-LR8 reach can be extended with some approaches

1) APD-receiver,
2) higher power EML
3) Stronger FEC

■ FEC options for extended reach 50G/200G/400GbE
(wang_ecdc_01_0316)

Several stronger HD-FEC options exist other than KP4.

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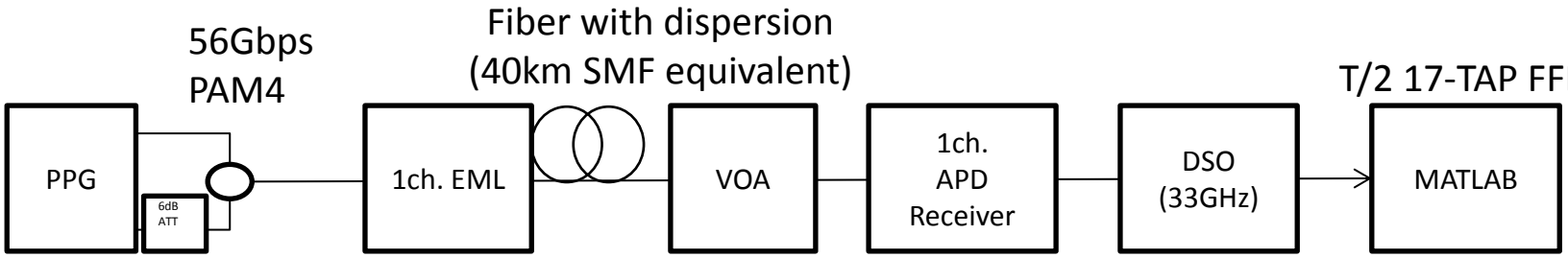
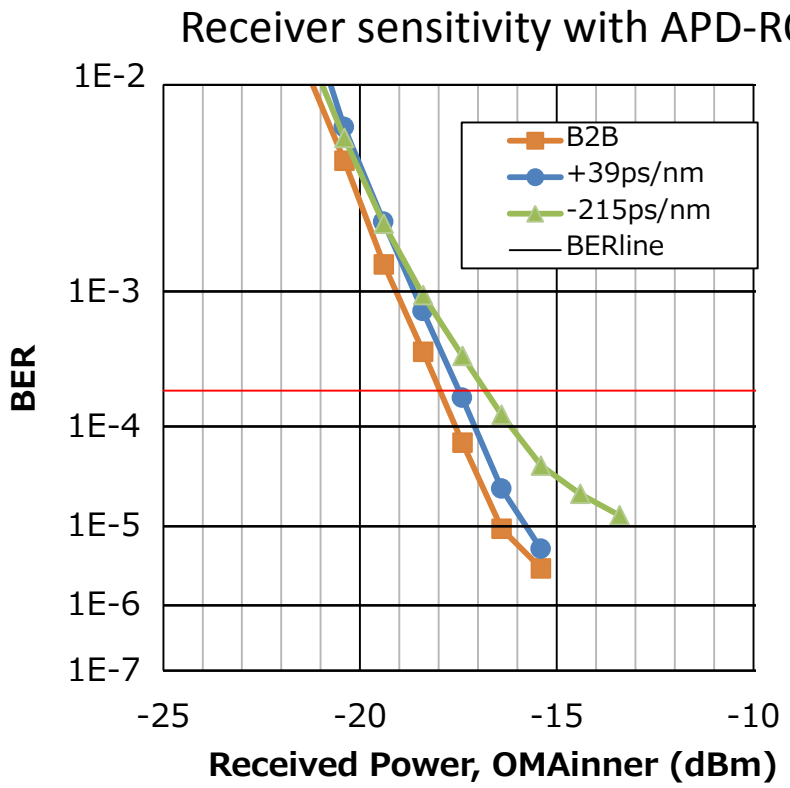
Receiver sensitivity with APD ROSA





56G PAM4 reach extension is achieved.

APD receiver can achieve rec. sensitivity of
-16.7 dBm for the worst case dispersion(neg.)*
-18.0 dBm for the worst case dispersion (Pos.)
(* assumed 8-lane LAN-WDM over SMF)

Assuming KP4 FEC but still 56Gpps can Accommodate stronger FEC overhead.

Link budget example with High-power EML

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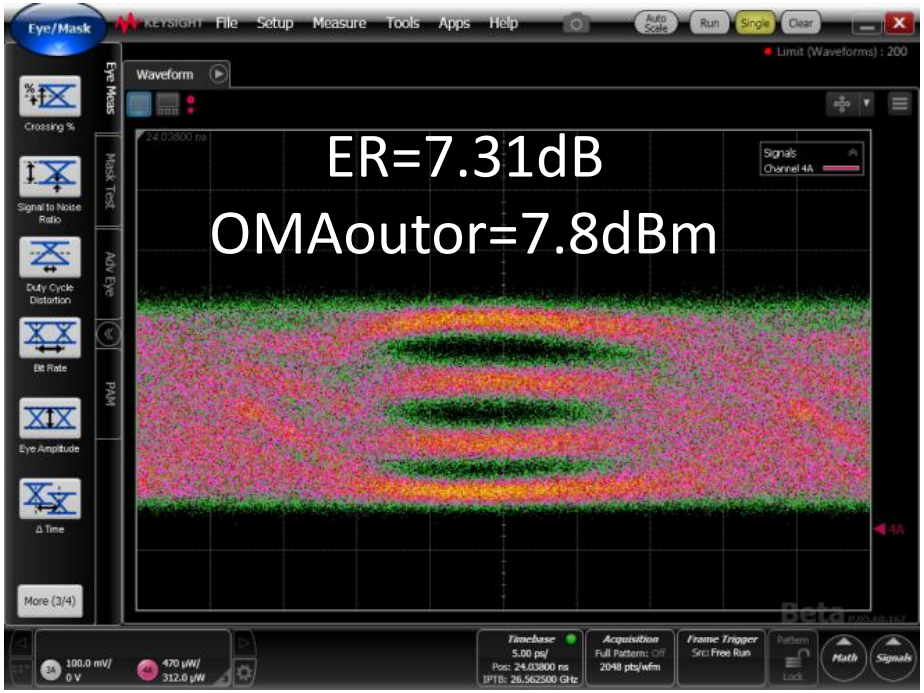
Evaluation result using high power EML and APD-ROSA
Link-budget=24.9dB（1ch B2B, KP4 FEC limit ）

PAM4 tx eye with high power EML



7.8dBm
(EML)

24.9dB*
(1ch-B2B)

-17.16dBm
(APD=ROSA)

* WDM mux/demux loss is not included

Beyond 10km :Stronger FEC

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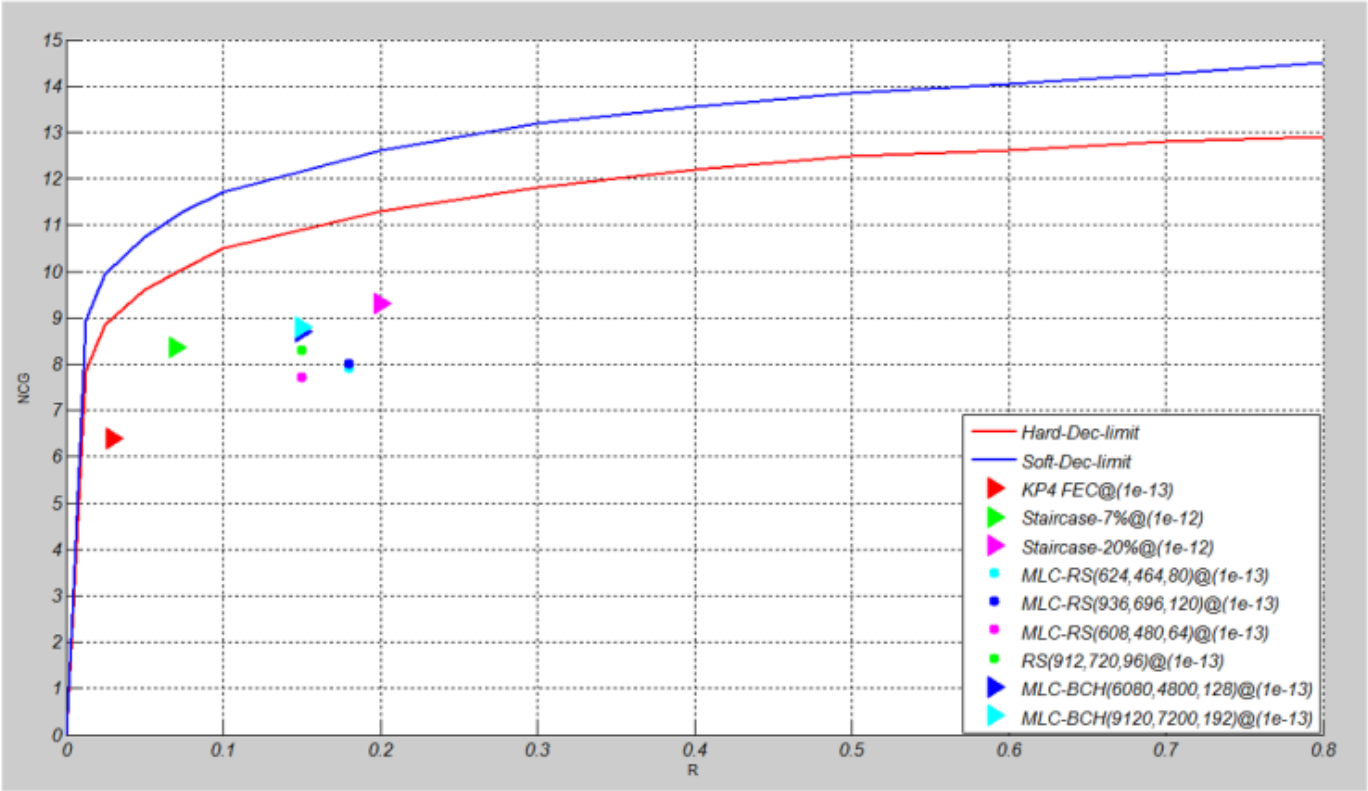
Several Potential HD-FECs with 8-9dB NCG can help to achieve beyond 10km 400GbE

RS-FEC, BCH-FEC, MLC-FEC or Staircase FEC. (wang_ecdc_01_0316)



NCG for HG FEC options, Assuming post BER@1E-13 objective.

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Emerging latest technology in OFC2017

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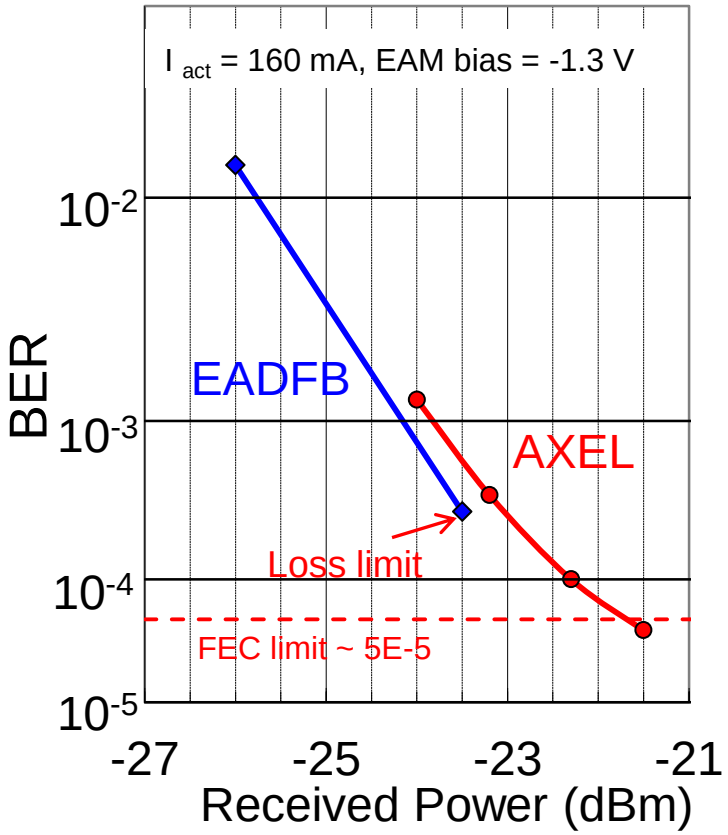
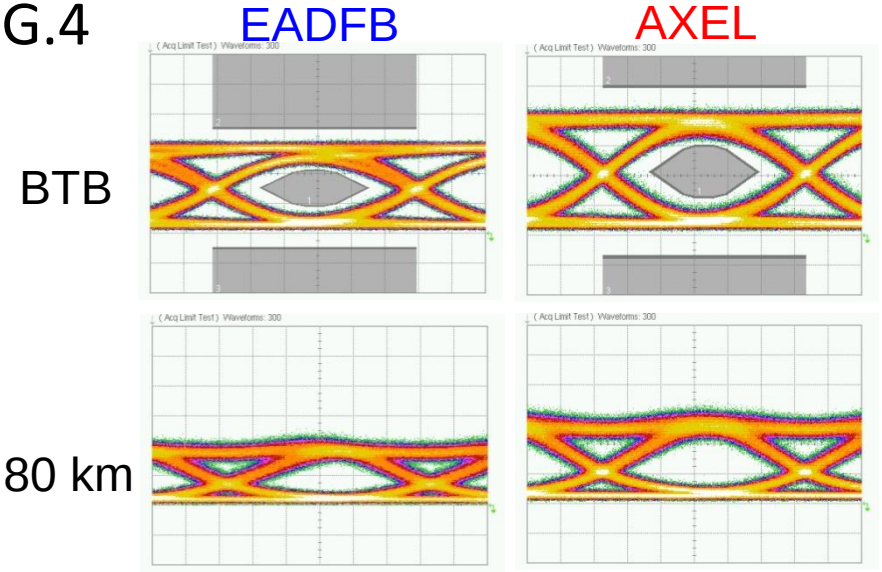
Hasebe et.al, OFC2017, paper Th4G.4





Output power(dBm)	5.7	**8.7**
Extinction ratio (dB)	8.5	**8.9**
OMA (dBm)	7.5	**10.4**
Mask margin	8%	**9%**

Achievement: 28 Gbit/s, 80-km transmission
Modulated average power P_{avg} = 8.7 dBm

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Summary

- From technical perspective, beyond 10km reach is feasible for 8x50G PAM4.

- The exact available maximum reach need to be further investigated in Study Group.