

# **Big Ticket Items and supplemental information for 8x50G NRZ**

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**IEEE802.3bs 400GbE Task Force**

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# Big Ticket Items

-This contribution provides:

- Worst case dispersion penalty for a 10km link with 1.3- $\mu$ m EML devices.
- Rx sensitivity using commercially available components.
  - Low BW Tx/Rx components with DSP : wen\_3bs\_01\_0115  
wen\_3bs\_01\_0315
- High BW Tx/Rx components w/o DSP : **this work**

## Big Ticket Items – 10km SMF PMD

- proposals
  - Kojima\_3bs\_01a\_0115.pdf (NRZ)
- Actions:
  - Evaluate Coupling between electrical and optical interfaces
    - RX Technical feasibility
    - Dispersion penalty worst case (in SMF ad hoc)
    - TDP. MPI
    - RX sensitivity

big\_ticket\_items\_3bs\_01\_0115.pdf

# Measurement Setup

- Dispersion penalty of 53.2 Gb/s NRZ was evaluated using 1.3- $\mu$ m wavelength 40 Gb/s components exceeding the worst case dispersion of the proposed wavelength range
- Proposed dispersion range :-50.8 ps/nm to +9.4 ps/nm

- Worst case positive dispersion (1310.19nm): +0.94 ps/nm.km
  - **Worst case positive dispersion 10km (1310.19nm) nm: +9.4 ps/nm**
- Worst case negative dispersion (1272.55nm): -5.08 ps/nm.km
  - **Worst case negative dispersion 10km (1272.55nm): -50.8 ps/nm**

stassar\_01\_0215\_smf.pdf

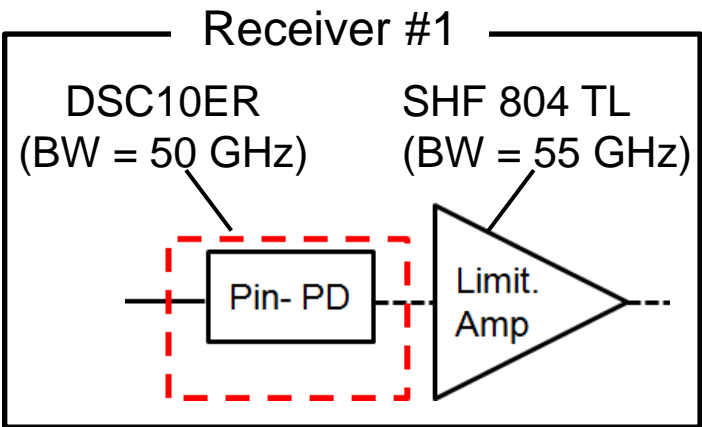
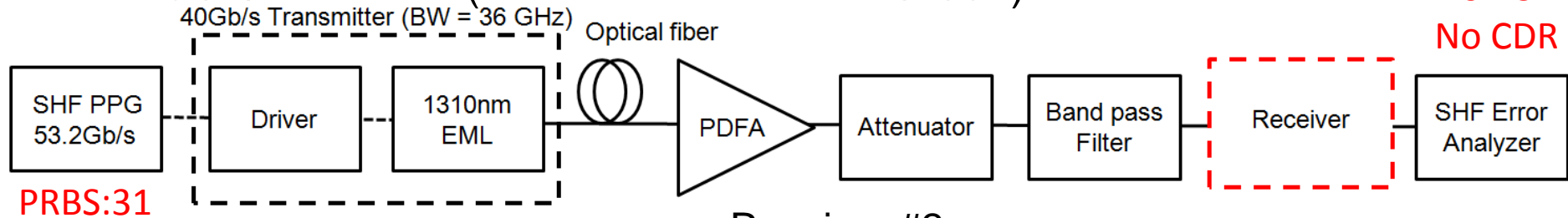
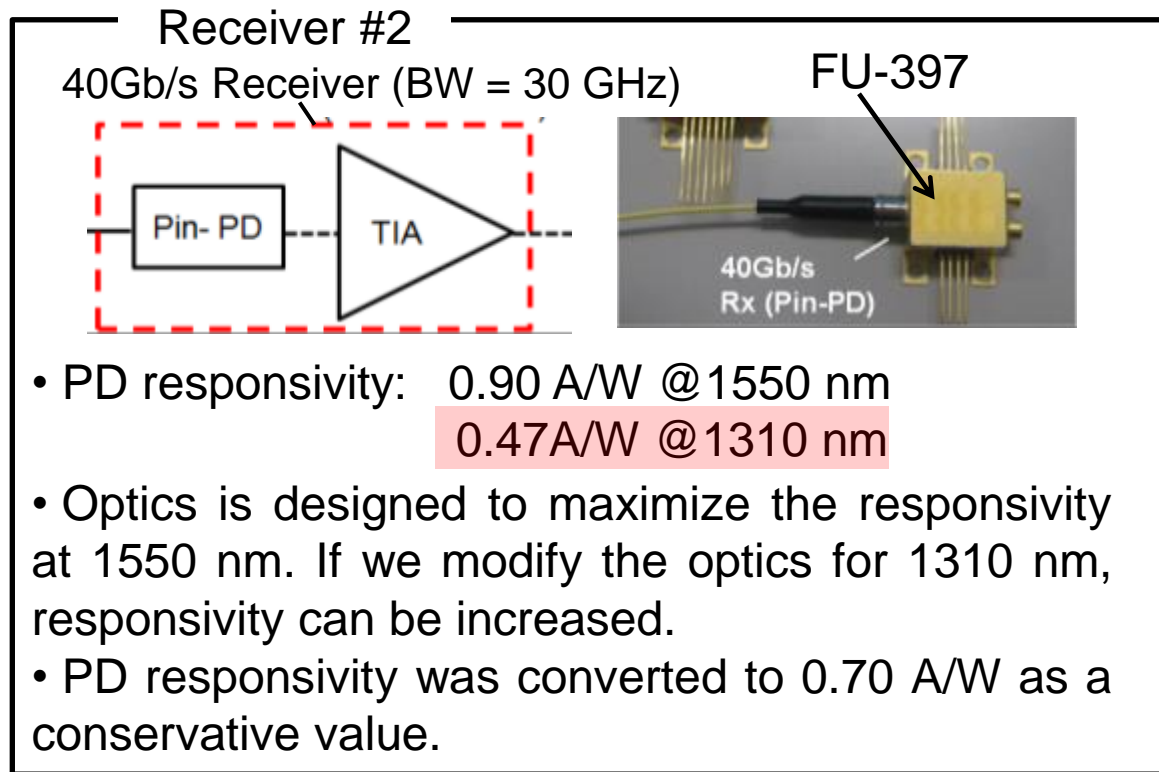
- Three kinds of SMF were prepared to cover the LAN-WDM dispersion range.

## Dispersion at 1310nm

- a) +15 ps/nm: Furukawa SMF, 10 km (Specially prepared for 100GBASE-LR4 test)  
 $\lambda_0=1294.1\text{nm}$ ,  $S_0=0.093\text{ps/nm}^2\text{-km}$ ,  $L=10,660\text{m}$ , total dispersion= $14.7\text{ps/nm}@1309.14\text{nm}$
- b) -47 ps/nm: Corning DSF, 2.25 km
- c) -80 ps/nm: TrueWave RS-Fiber, 10km

# Setup and Receiver Configuration

- Two receiver were used for dispersion penalty test. No equalizer was used.
  - High speed PD module (Discovery semiconductor: DSC10ER)
  - 40Gb/s receiver (Mitsubishi Electric: FU-397)

Receiver #2

40Gb/s Receiver (BW = 30 GHz)

Pin- PD

TIA

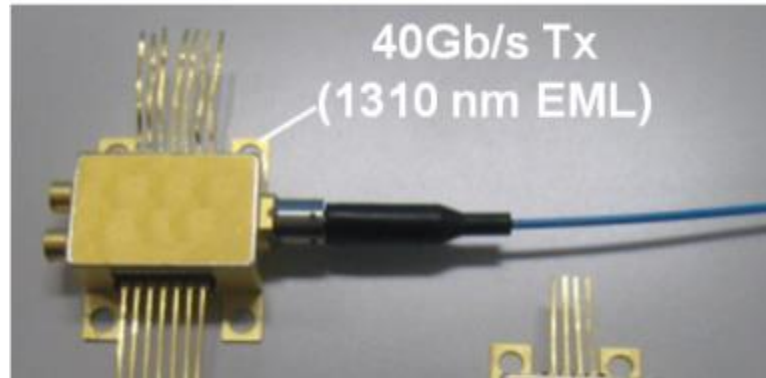
FU-397

40Gb/s Rx (Pin-PD)

- PD responsivity: 0.90 A/W @1550 nm  
0.47A/W @1310 nm
- Optics is designed to maximize the responsivity at 1550 nm. If we modify the optics for 1310 nm, responsivity can be increased.
- PD responsivity was converted to 0.70 A/W as a conservative value.

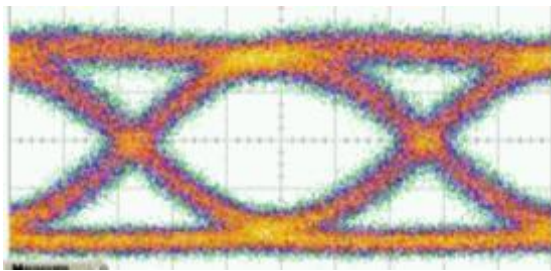
# Transmitter Configuration

- Three transmitter samples were prepared.
- All samples operate at 1310 nm grid.

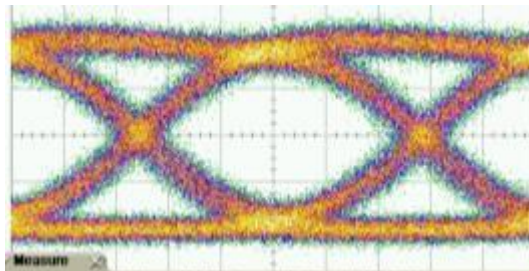


## Optical waveforms at 53.2 Gb/s

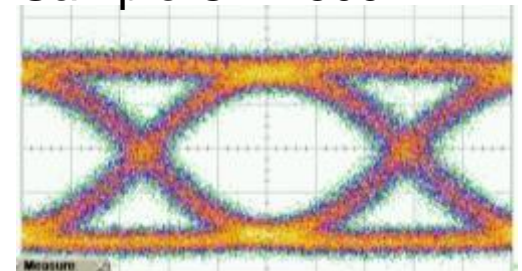
Sample A : 1310.33nm



Sample B : 1311.14nm



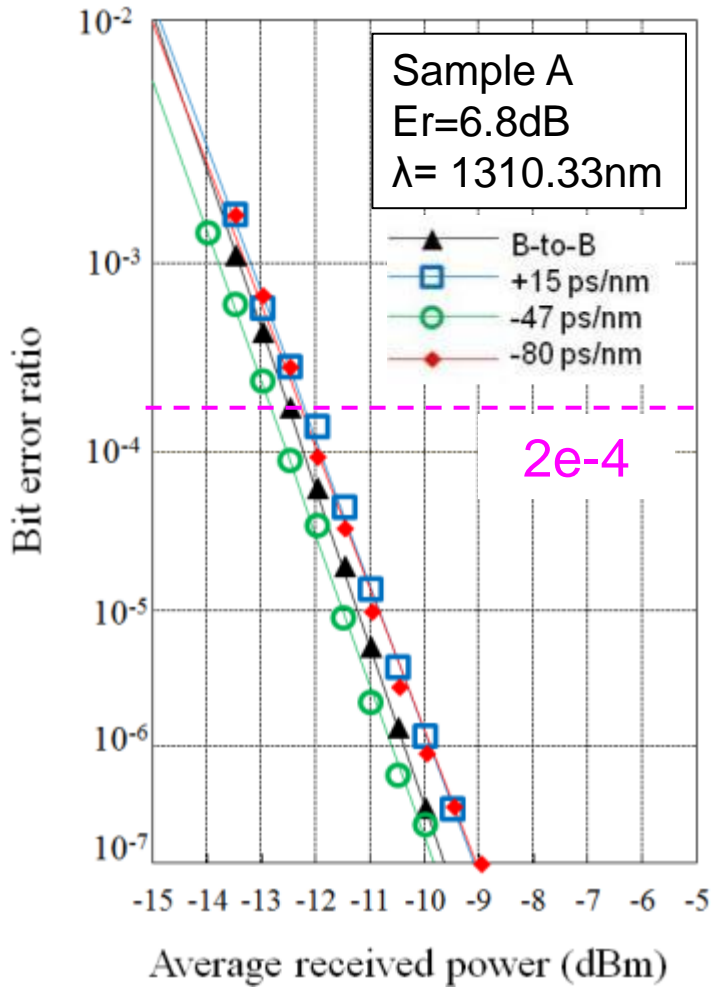
Sample C : 1309.44nm



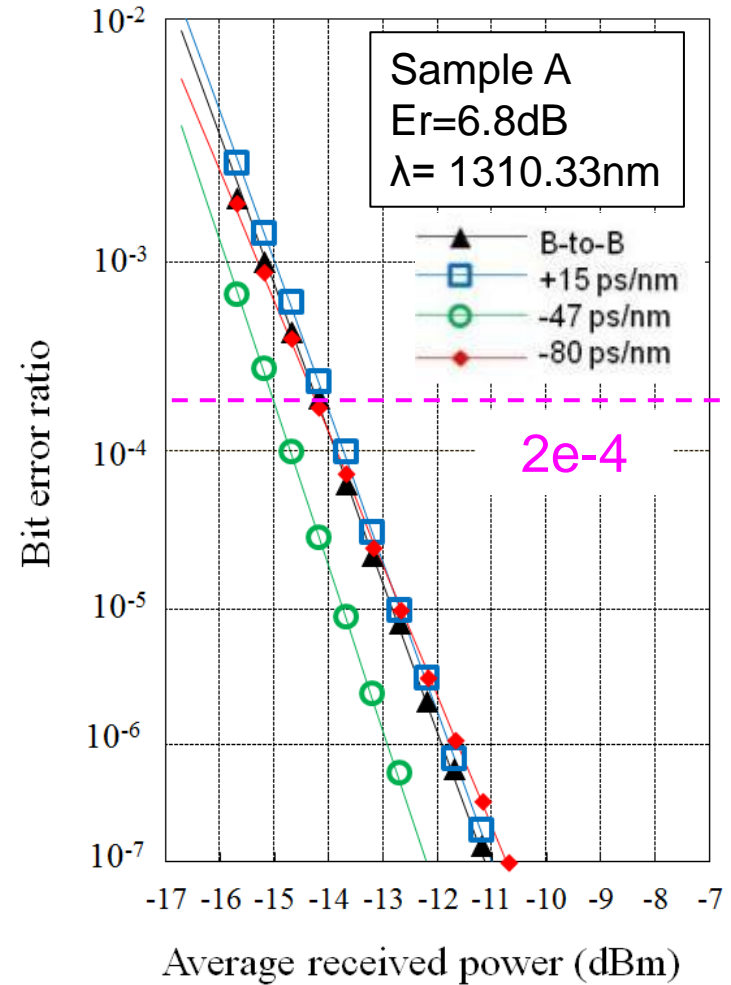
# BER Measurement

-No floor problem in both cases.

### DSC10ER



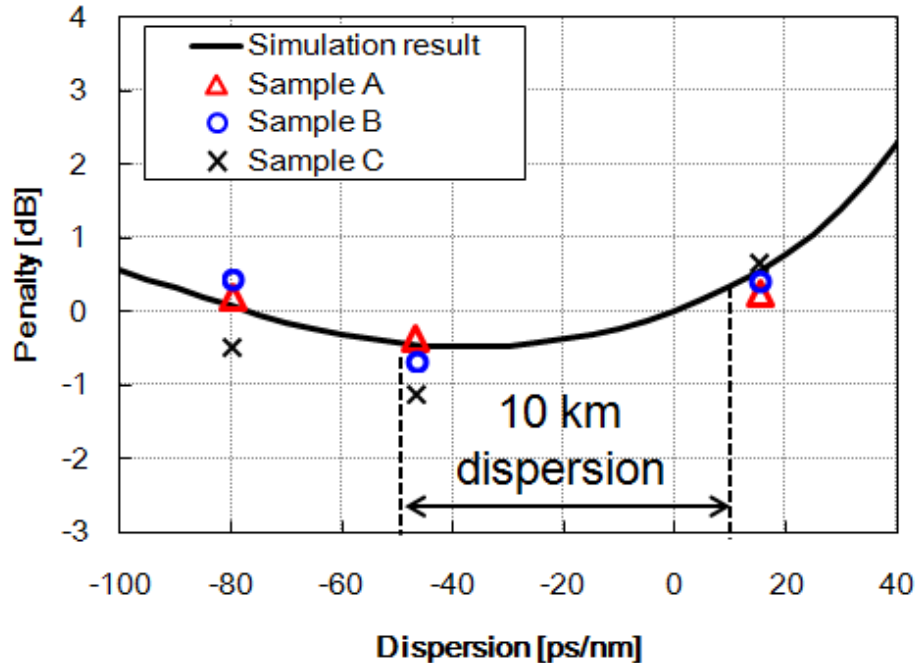
### FU-397



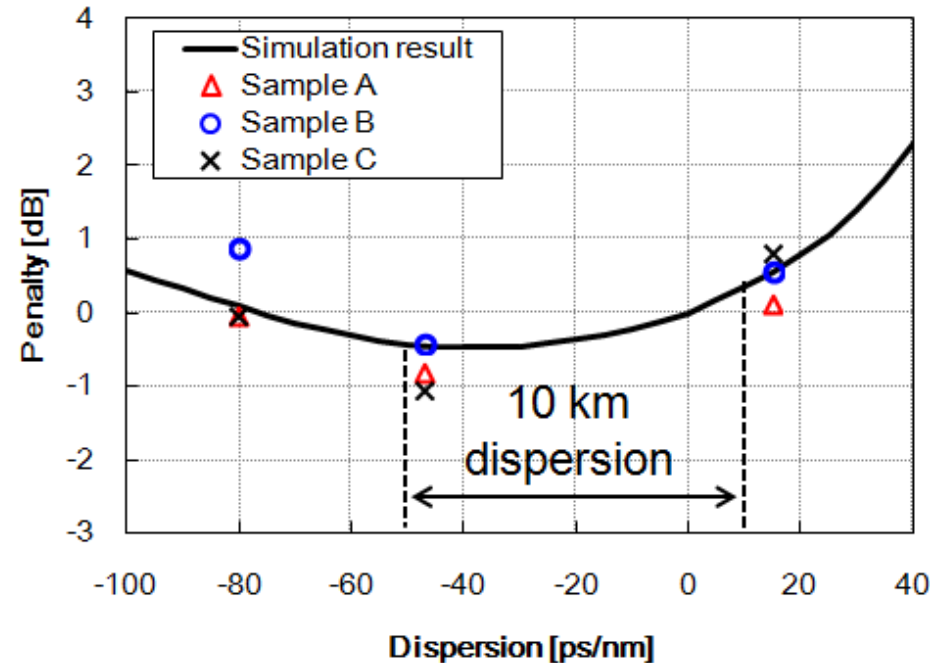
# Dispersion Penalty

- Three-sample results confirmed less than 1dB dispersion penalty over LAN-WDM wavelength range for both receivers.
- The results align with the simulation results presented in January meeting: kojima\_3bs\_01a\_0115.pdf (shown in the graph)
- We confirmed dispersion penalty worst case of 8 x 50 Gb/s NRZ for a 10km link is less than 1dB. (In fact the dispersion is equivalent to 15 km SMF in the worst case scenario.)

DSC10ER



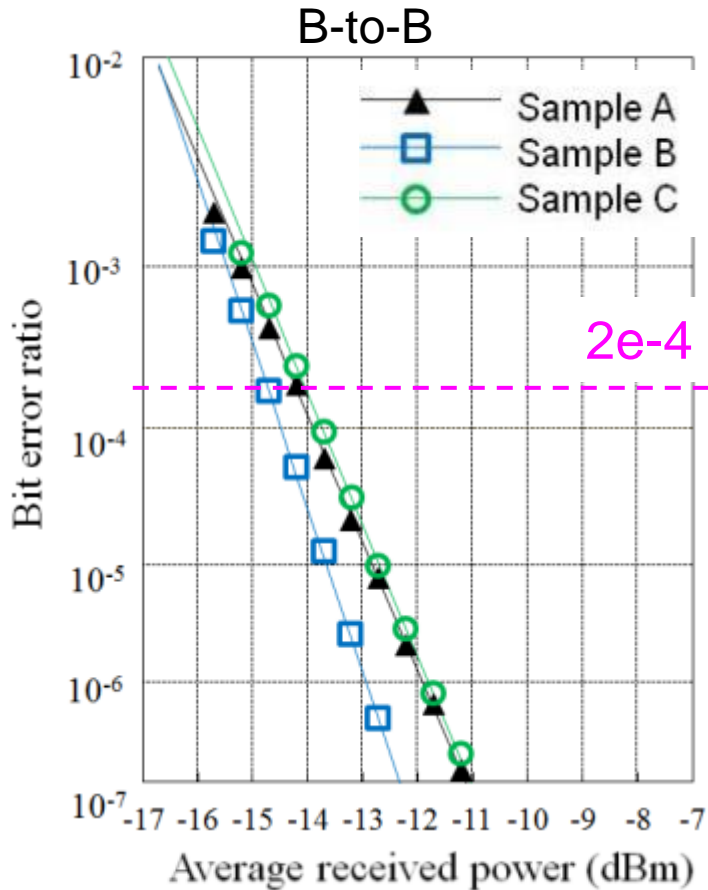
FU-397





# Receiver Sensitivity

- Minimum receiver sensitivity was evaluated using FU-397.
- Receiver sensitivity is better than -12.8 dBm, which satisfy the proposed values of -12.0 dBm for 10km (kojima\_3bs\_01a\_0115.pdf).



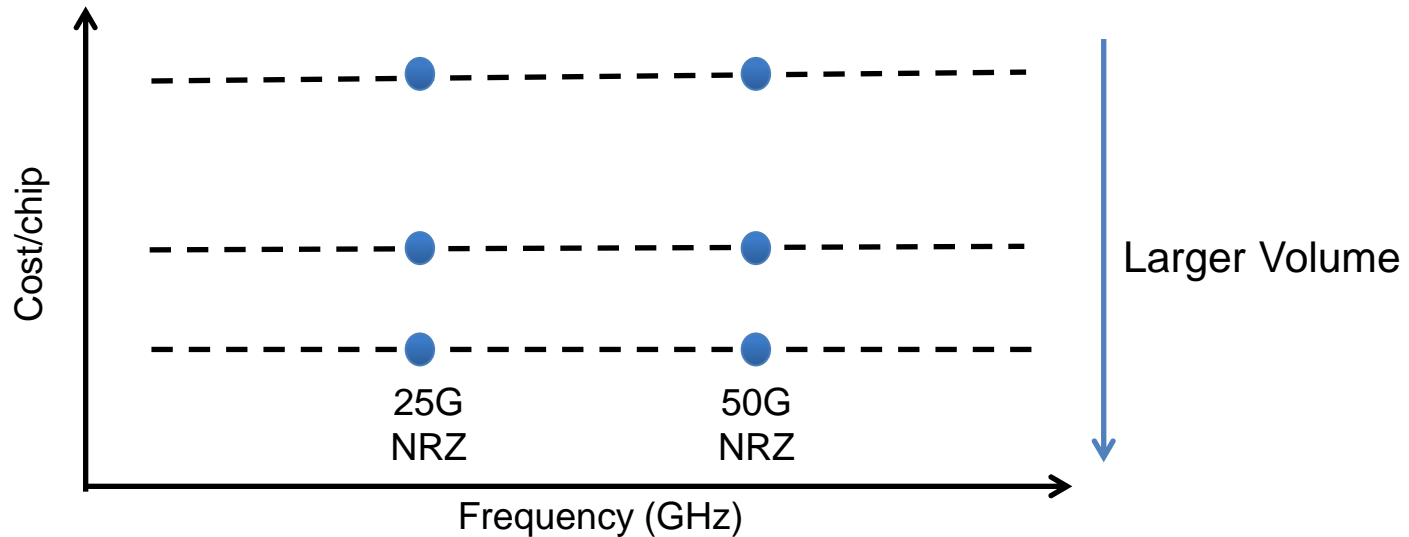
	Ave. Rx Sens. min. [dBm]	Er [dB] <sup>1)</sup>	Rx Sens. OMA min. [dBm]
Sample A	-14.3	6.8	-13.1
Sample B	-14.1	7.1	-12.8
Sample C	-14.7	7.9	-13.1

- 1) Extinction ratio was measured using high speed optical receiver module (86116C-041, 65GHz) without Bessel filter

# Receiver Sensitivity

Parameter	Current	Possible Improvement	Expected RX Sensitivity Improvement
TX Bandwidth	36 GHz	42 GHz	0.2 dB
TIA Noise	20 pA/√Hz (est.)	15 pA/√Hz	1.2 dB
PD responsivity	0.7 A/W	0.8 A/W	0.6 dB
Equalizer	W/o EQ	With EQ	TBD
TDP	2.5 dB	TBD	TBD
MPI	0.5 dB	TBD	TBD

# Relative EML Chip Cost Estimate



- EML chip cost for all the formats will be essentially the same as long as the volume is the same.
- We need to investigate the detail of modulator specifications for PAM4 and DMT modulation.

# Summary

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- The worst case dispersion penalties and receiver sensitivities of  $8\lambda \times 53.2\text{Gb/s}$  NRZ were experimentally evaluated using 1.3- $\mu\text{m}$ -wavelength EMLs.
- The dispersion penalty worst case of  $8 \times 50 \text{ Gb/s}$  NRZ is less than 1dB for a 10km link.
- Estimated receiver sensitivity satisfies proposed baseline proposal.
- EML chip cost depends strongly on volume, not on speed