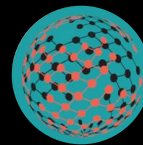




# BTI Supporting Data for 8x50G NRZ

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IEEE802.3bs 400GbE Task Force, Interim, May 2015



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# Big Ticket Items

- This contribution provides:
  - Rx sensitivity using commercial available ROSA (Oclaro)
  - Dispersion penalty using commercial available EML TOSA (Oclaro)
  - Receiver feasibility using CMOS CDR test chip (Credo)
  - The results are effective 500m and 2km 8x50G NRZ applications

Item	Proposal	BTI Actions
10km SMF PMD	Cole_3bs_01_0115.pdf (NRZ)	Evaluate Coupling between electrical and optical interfaces RX Technical feasibility Dispersion penalty worst case (in SMF ad hoc) TDP. MPI RX sensitivity More Test results (prefer real data on all proposals)
	Kojima_3bs_01a_0115.pdf (NRZ)	Evaluate Coupling between electrical and optical interfaces RX Technical feasibility Dispersion penalty worst case (in SMF ad hoc) TDP. MPI RX sensitivity More Test results (prefer real data on all proposals)

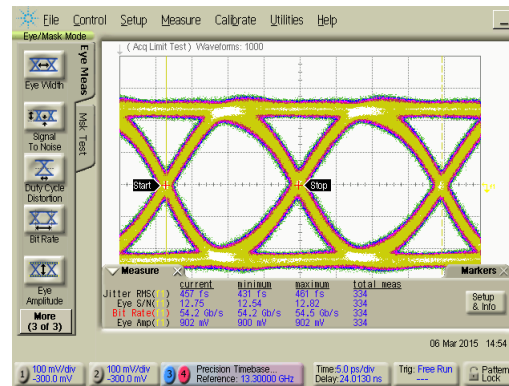
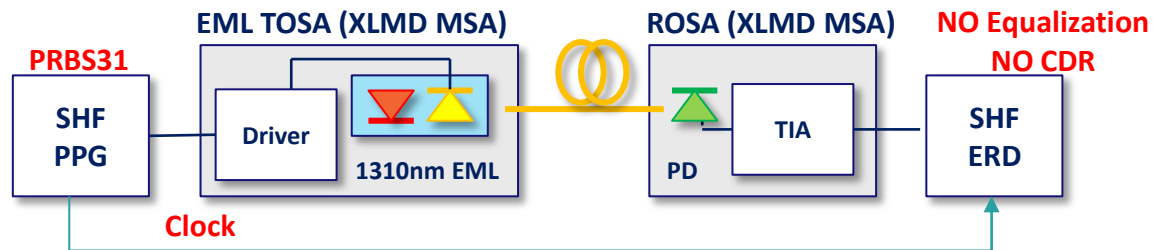
bti\_3bs\_01\_0315.pdf

# Experiment

- 53.2Gbit/s Transmission experiment
  - Commercial available 1310nm EML TOSA and ROSA (Oclaro)
  - High speed PPG and Error detector (SHF)
  - PRBS31 No-FEC
- 50Gbit/s transmission experiment using CMOS CDR test chip
  - Commercial available 1310nm EML TOSA and ROSA (Oclaro)
  - High speed NRZ CDR test chips (Credo)
  - PRBS31 pattern generation and error detection in the test chip
  - Dispersion penalty measurement using different fibers and EML wavelengths

# 1310nm 53Gbit/s NRZ Transmission

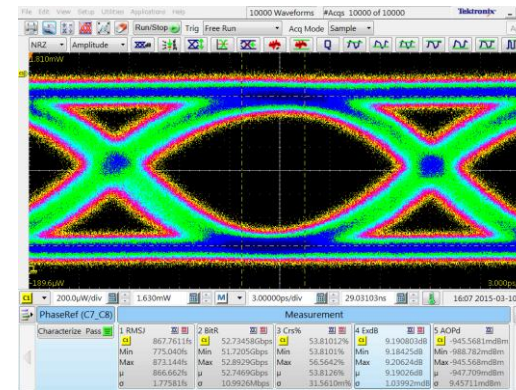
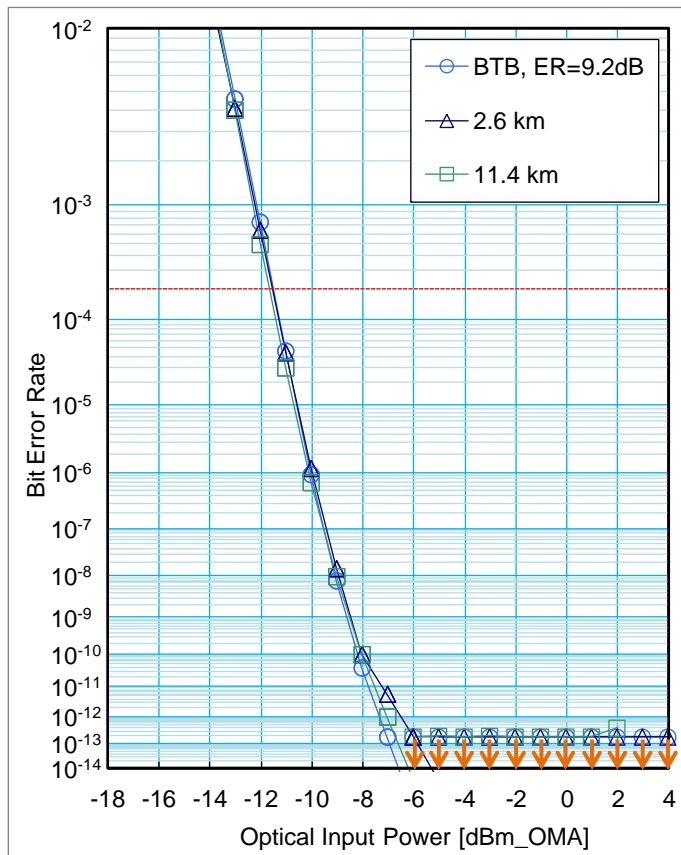
- 53.2Gbit/s transmission experiment using 1310nm EML TOSA
  - PRBS31, No-Equalization, No-CDR
  - TIA: Equivalent input noise current=  $20\text{pA}/\sqrt{\text{Hz}}$
  - $E_r=8.93\text{dB}$



Electrical input

# Experimental Result: 1310nm 53.2Gbit/s NRZ Transmission

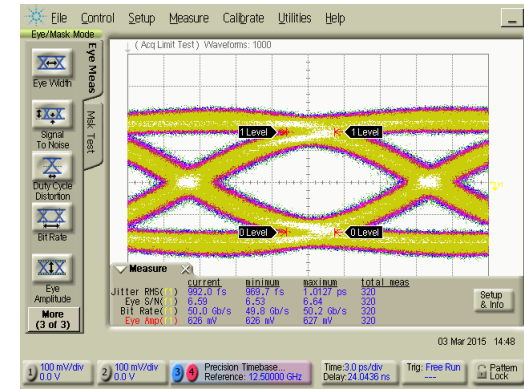
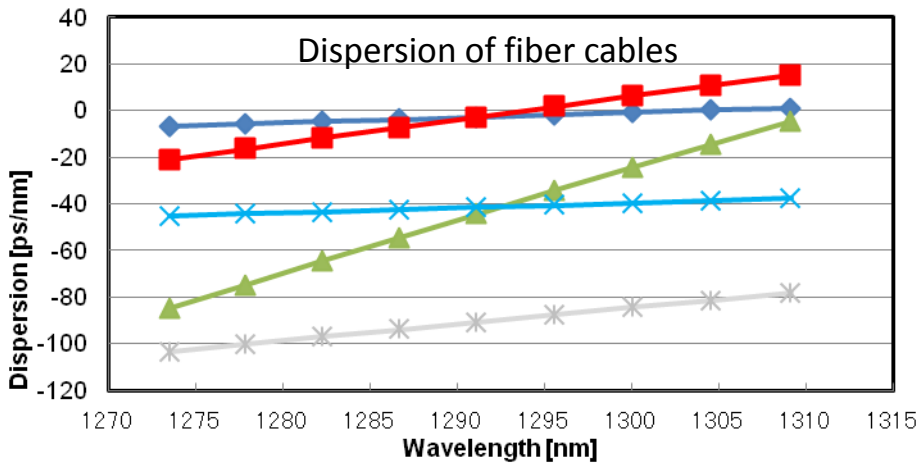
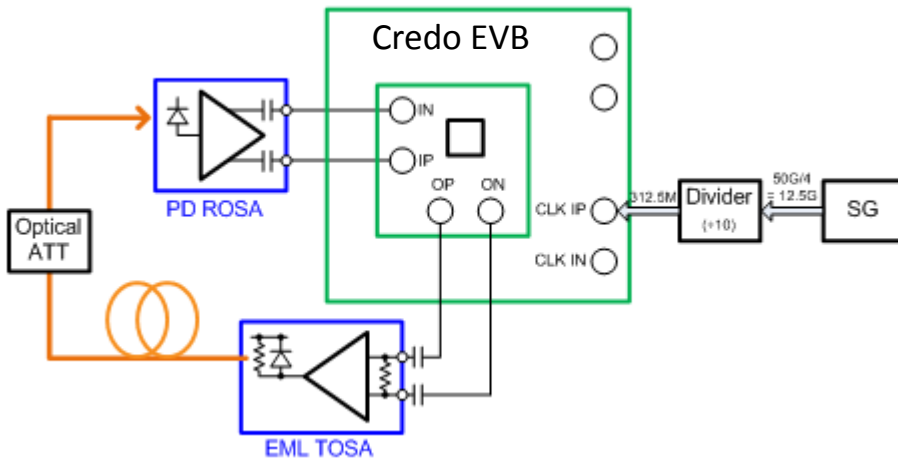
- 53.2Gbit/s transmission experiment using 1310nm EML TOSA
  - No error floor down to  $2e-14$
  - BER curve bent was observed at low BER of  $<1e-11$  due to No-CDR
  - OMA sensitivity was lower than expected due to no equalization in receiver



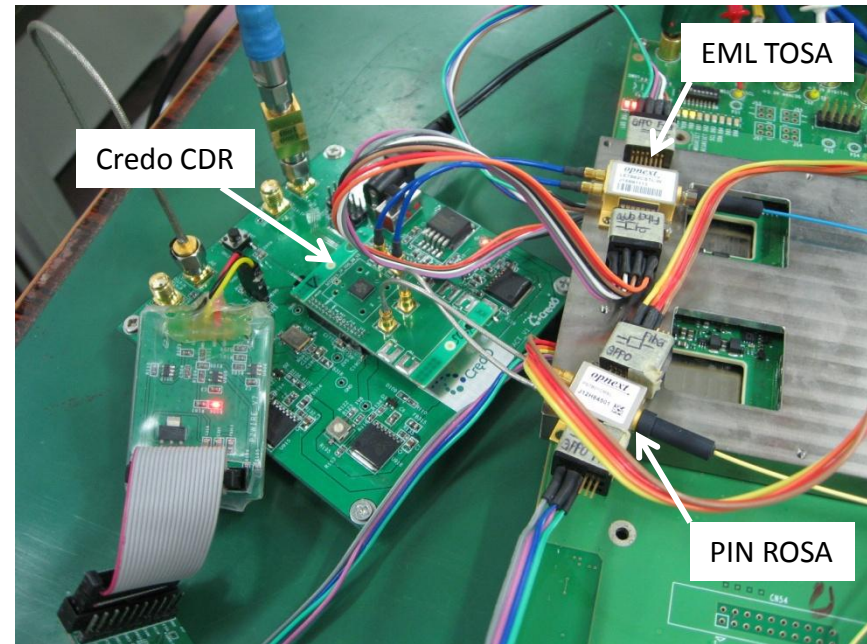
Optical output (Filtered)

# Experiment using Oclaro TOSA/ROSA and Credo CDR

- Credo CDR test chip
  - On chip PPG and ERD
- Five fiber cables

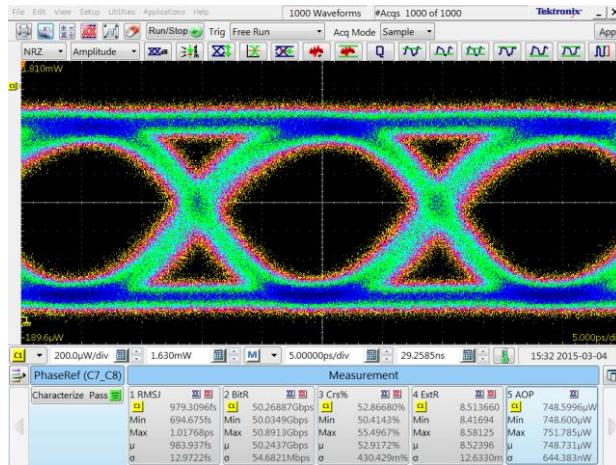
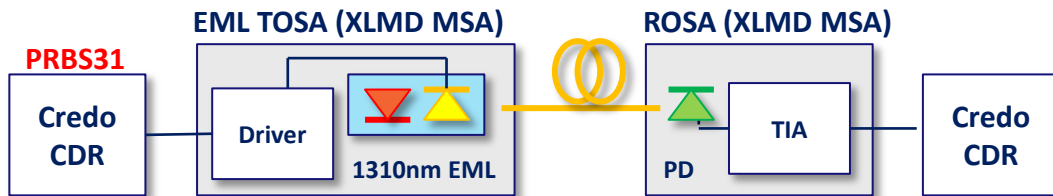


Electrical Waveform

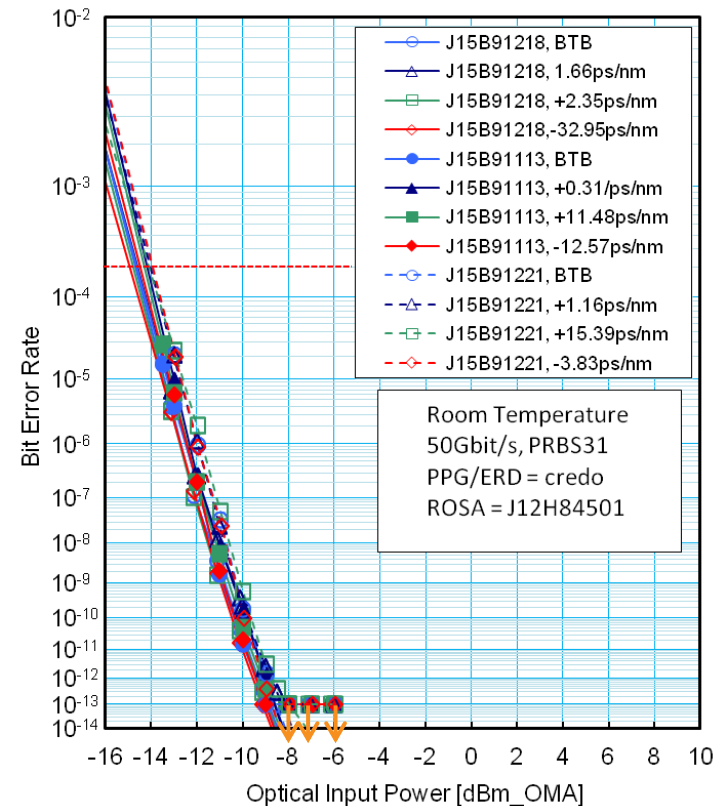


# Measurement Result

- Credo CDR shows good performances for stable transmission
  - Equalization seemed to work effectively
- No error floor confirmed BER of down to  $1e-13$ 
  - PRBS31, No-FEC
- OMA sensitivity of  $<-14\text{dBm}$  was obtained
  - TIA: Equivalent input noise current=  $20\text{ pA}/\sqrt{\text{Hz}}$



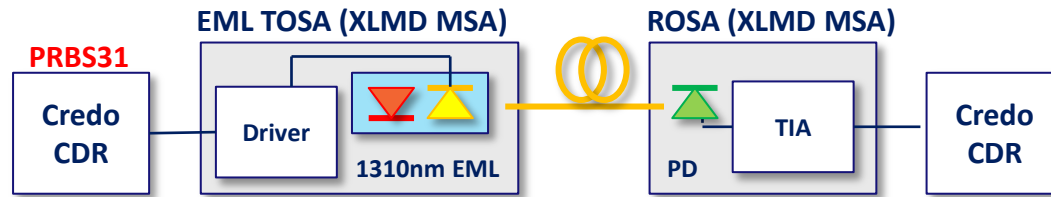
Optical Waveform





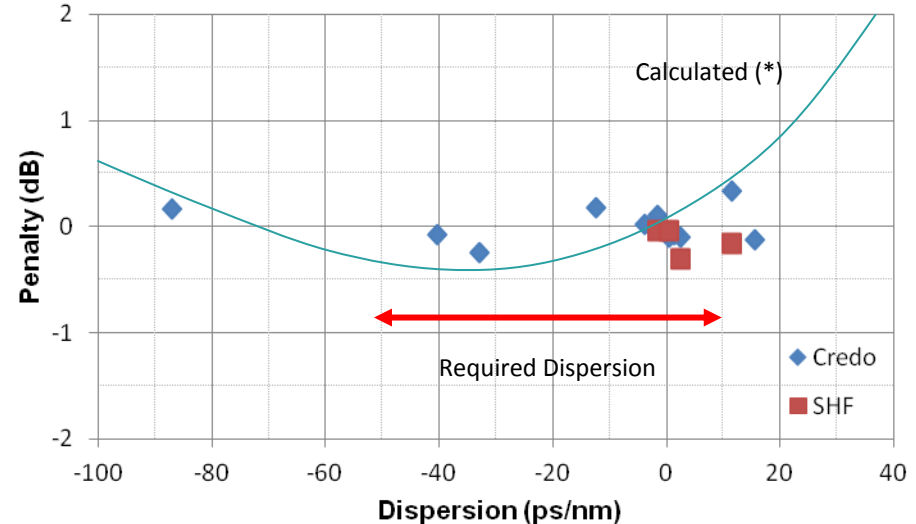
# Sensitivity and Dispersion Penalty

- Less than 1dB penalty within expected dispersion for LAN WDM wavelengths



Samples, B-to-B Sensitivities

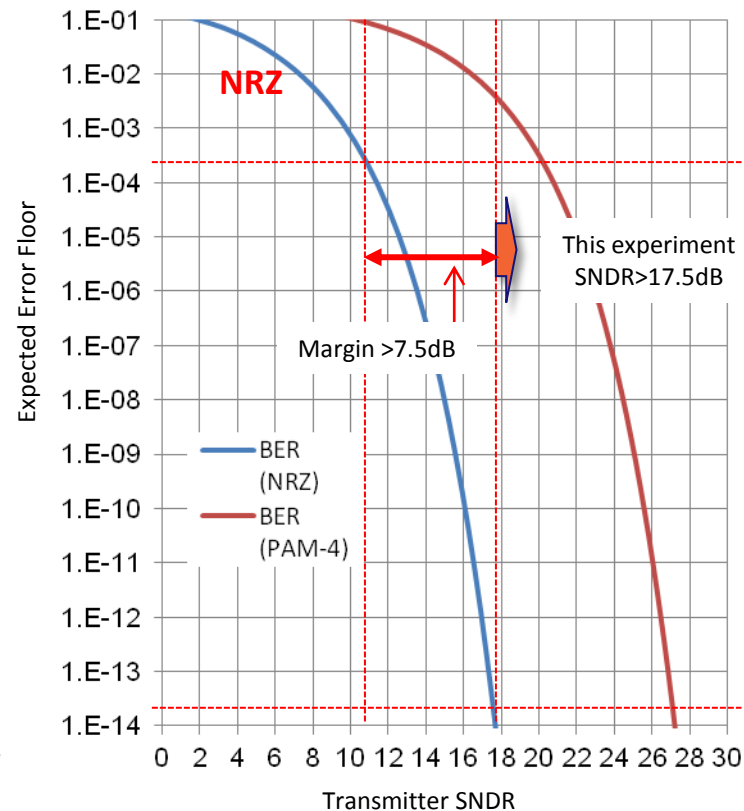
	L4-218	L6-113	L7-221
Wavelength	1296.2 nm	1305.4 nm	1309.4 nm
B2B Pr OMA	-14.7 dBm	-14.6 dBm	-14.0 dBm



(\*) worst case calculation, shirao\_3bs\_01a\_0315

# Discussion on Experimental Result (I)

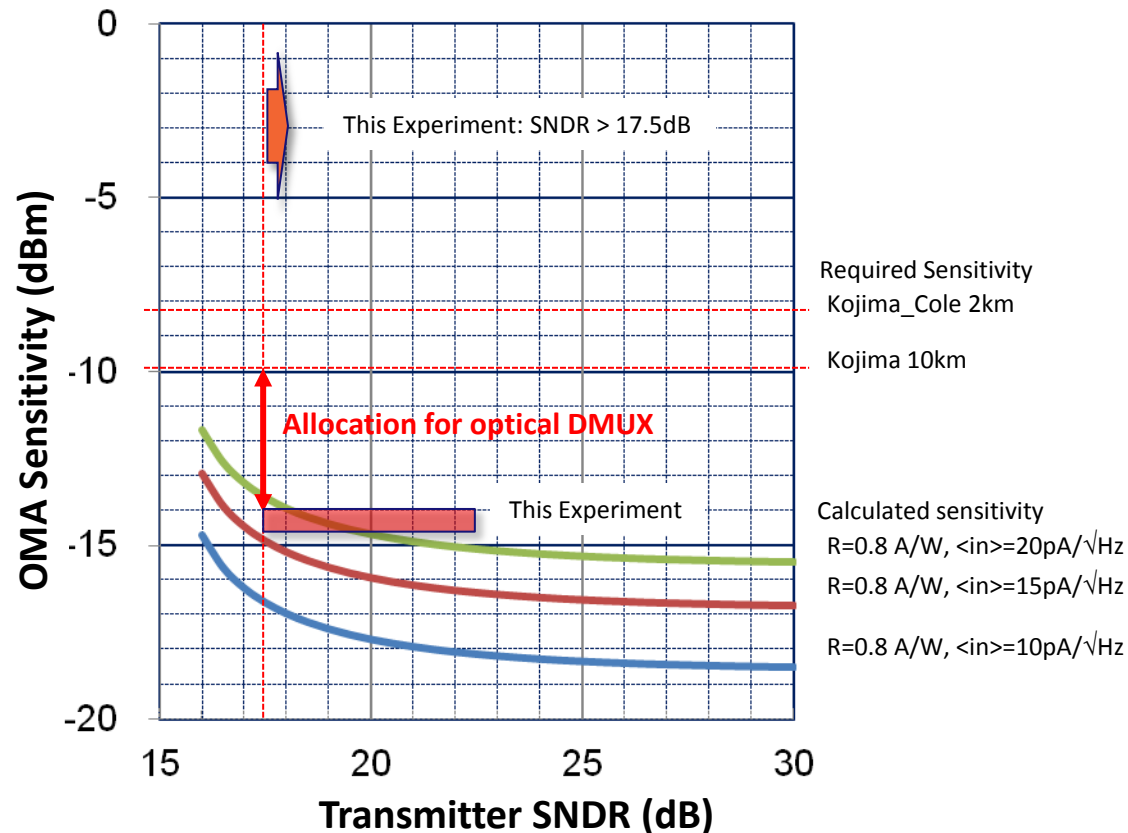
- We expect  $>7\text{dB}$  Transmitter SNDR margin
  - Estimated SNDR  $> 17.5\text{dB}$ : No error floor observed down to BER of  $2\text{e-}14$
  - Margin is defined as delta from SNDR for  $2\text{e-}4$  error floor ( $=10.6\text{dB}$ )



Relationship between Transmitter SNDR and error floor caused by SNDR

# Discussion on Experimental Result (II)

- 4dB margin of OMA sensitivity: Allocation for optical DMUX
  - Equivalent noise current of used TIA is  $20\text{pA}/\sqrt{\text{Hz}}$
  - Use of TIA with  $15\text{pA}/\sqrt{\text{Hz}}$  will increase the margin by 1dB



Thank you