1300nm Optics for Short Reach SMF Application

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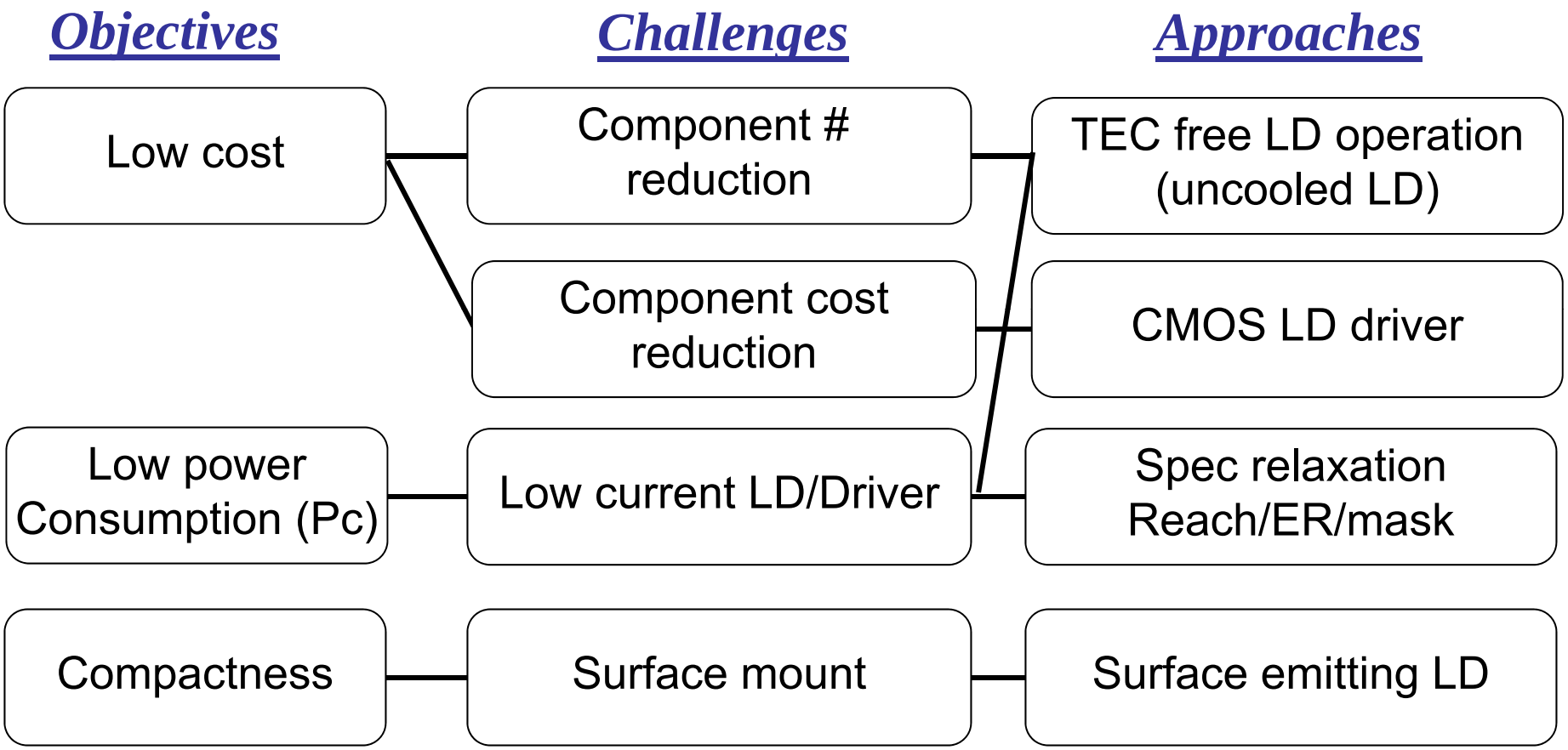
Introduction

- At the Chicago, 2011 meeting of the Next Gen 100GbE Optical SG, alternative Single Mode technology was identified as a key area to be addressed.
- This contribution explores technical feasibility of 4ch x 25G 1310nm optical device technology for short reach SMF (< 2 km) and extended reach MMF (< 300m) applications.
- Characteristics of transceiver power consumption, module form factor and relative cost are analyzed.

Focus of Proposal for 4ch x 25G Optical Interface

Standard	Fiber	MUX	2011	2012	2013-	Comments
LR4 10km	SMF	WDM	CFP Cooled -EML	CFP2 Cooled -DML	CFP4 Cooled-DML	Density Cost
nR4 (1) ~2km?	SMF	WDM			CFP4 **Low power consumption (Pc) DML**	Data Center
nR4 (2) ~550m?	SMF	parallel			CFP4 **Surface emitting 1.3μm DML**	Data Center
SR4+ >300m?	MMF	parallel			CFP4 **Surface emitting 1.3μm DML**	Data Center New MMF
SR4 60~100m	MMF	parallel			CFP4 VCSEL 850nm +EDC	Data Center

Objectives and Approaches



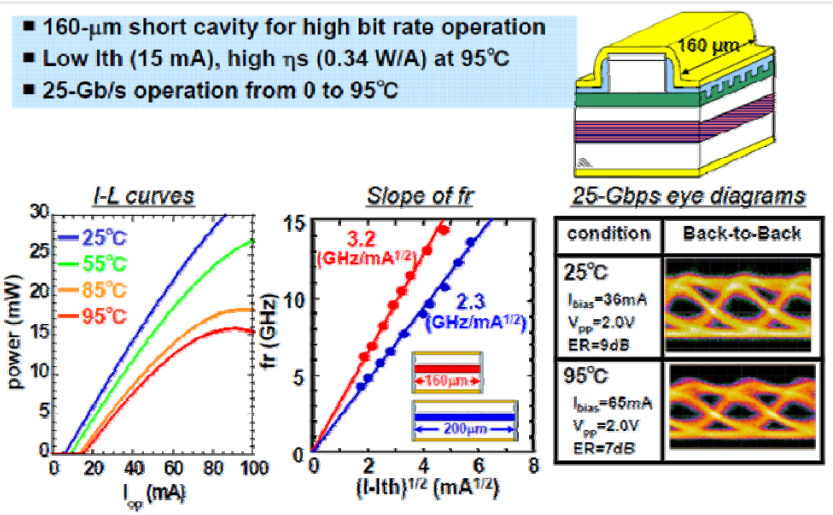
nR4 Proposal

- Reduction of number of components is key to achieve the lowest cost solution for data center application.

Type	Fiber type	length	LD	Isolator	O-MUX deMUX	TEC	Opt. coupling
CFP	SMF	10 km	**Cooled-EML**	**Req.**	**Req.**	**Req.**	**Active**
CFP2/ CFP4	SMF	10 km	**Cooled-DML**	**Req.**	**Req.**	-	**Active**
nR4 (WDM)	SMF	2 km?	Low Pc integrated-DML	**No ?**	**Req.**	-	**Active**
nR4 (Parallel)	SMF	550m?	Surface emitting-DML	**No ?**	-	-	**Active**
SR4+ (Parallel)	**New MMF**	300m?	Surface emitting-DML	-	-	-	Passive
SR4 (Parallel)	MMF	100 m	VCSEL	**EDC/ FEC**	-	-	Passive

Low Pc operation by TEC-free uncooled DML

- **Low power consumption enabled by**
  - **✓TEC-free 25-Gb/s Uncooled DML with CWDM grid using InGaAlAs-QW material system with Improved High-Temperature keeping Static/Dynamic Performance**
- **Uncooled DML is most promising approach to enable 2.5W CFP4.**



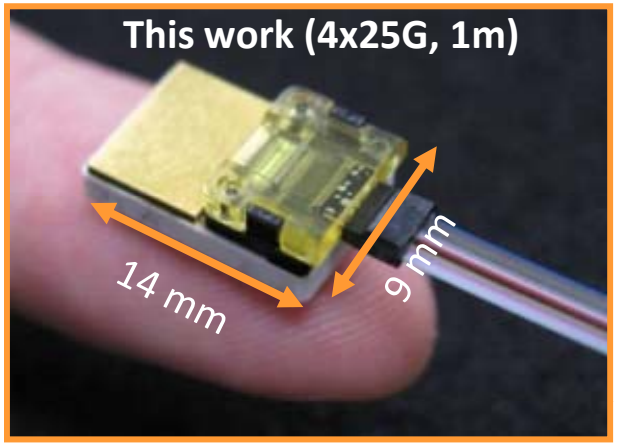
○ : Achievable with existing technology × : Not feasible in near future

Ref: T. Fukamachi et. al., ECOC2009, 8.1.5, (2009)

Target application		EA		DML	
		Cooled	Uncooled	Cooled	Uncooled
CFP2	8W	○	–	○	–
CFP4	4W	TLD=55℃ Vmod=1V ILD=40mA	Vmod=1V ILD=50mA	New Driver TLD=55℃ Ibias=60mA	New Driver Ibias=70mA
	3.5W	×	Vmod=1V ILD=40mA	New Driver TLD=55℃ Ibias=50mA	New Driver Ibias=60mA
	2.5W	×	×	×	New Driver Ibias=30mA

Prototype 4 x 25G transceiver

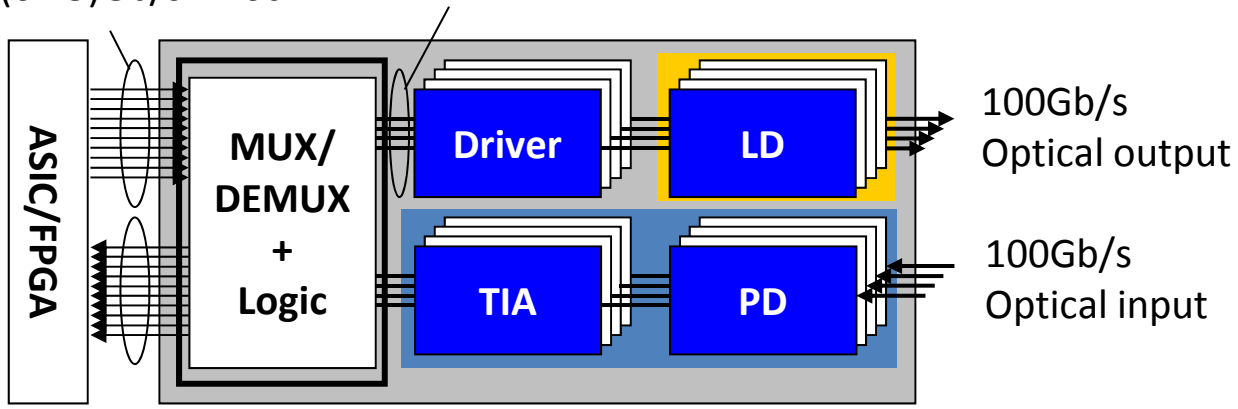
Foot print: 144 x 78 mm^2
Power: 30W



Foot print : 14 x 9 mm^2 (1/100)
Power: 2W (1/15)

MLD Interface 10(6.25)Gb/s x 10ch

25Gb/s x 4ch

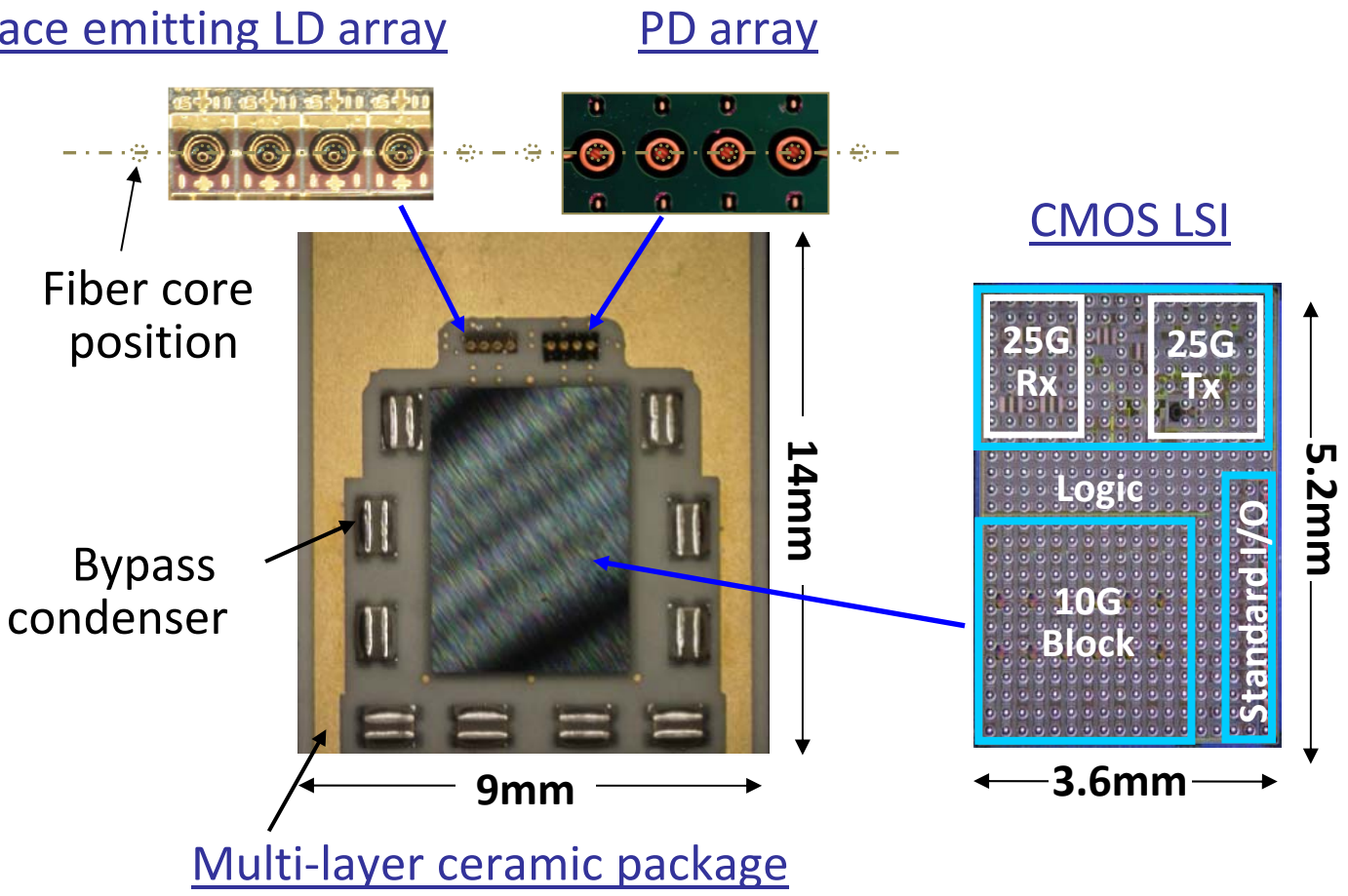


Ref: T. Takemoto et al., ECOC 2011, Th.12.B.5 (2011).

A part of this work was performed under management of the PETRA supported by NEDO.

Prototype 4 x 25G transceiver internal view

- Surface mount with passive alignment enables low cost module.



Ref: T. Takemoto et al., ECOC 2011, Th.12.B.5 (2011).

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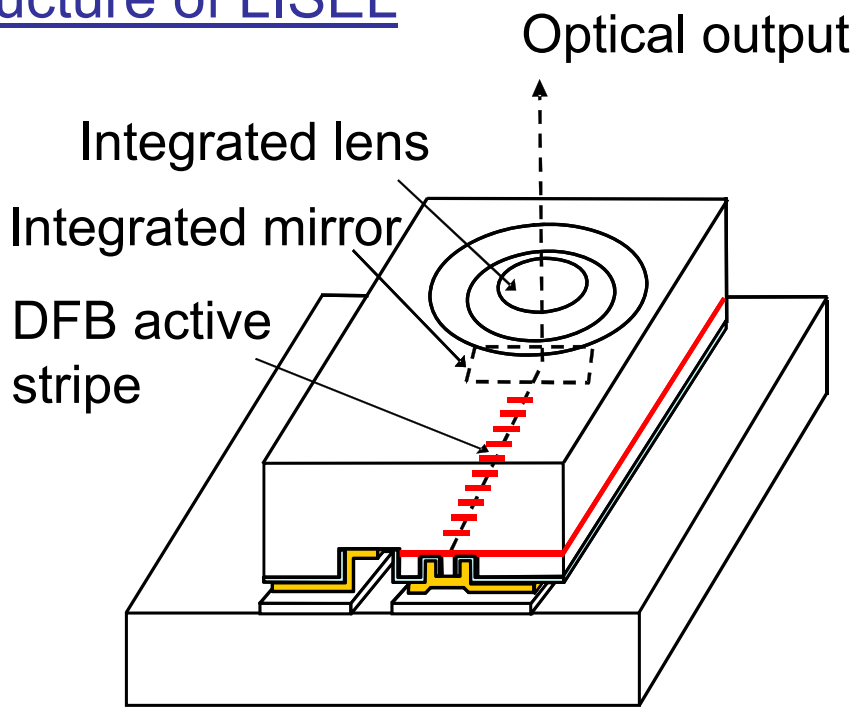
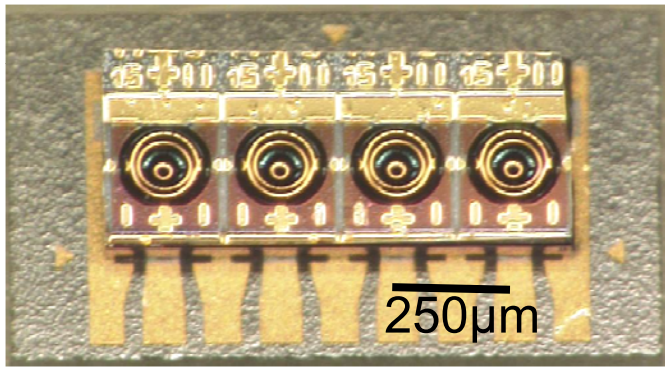
Surface emitting DFB LD

- Lens Integrated Surface Emitting Laser (LISEL)
- 1.3μm operation with low Ith (~15 mA @85°C)
- High speed (25Gb/s) up to 100 °C
- Surface emitting/ Flip-chip mount

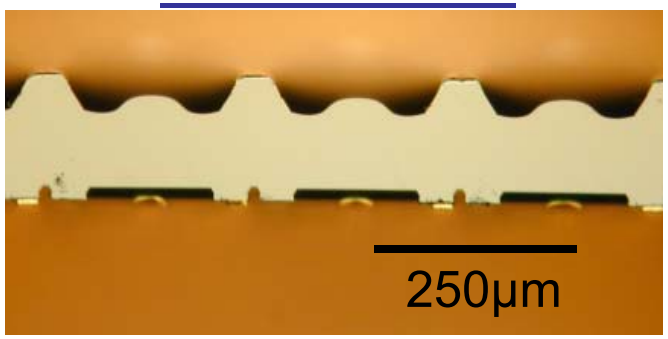
Structure of LISEL



4ch-LISEL array



Cross section



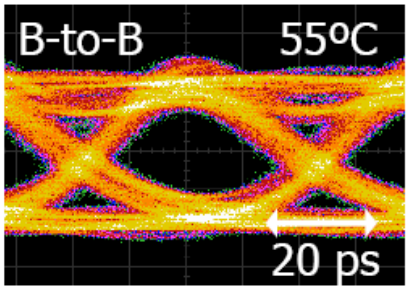
Ref: K. Adachi et al., J. Lightwave Tech. 29, 2899 (2011)

A part of this work was performed under management of the PETRA supported by NEDO.

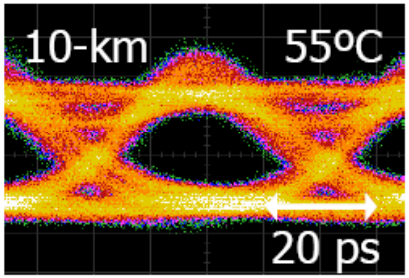
Measurement of SMF transmission

- Four-wavelength 25-Gb/s 10-km error-free transmission (minimum received power: -11 dBm after 10-km SMF transmission)

25-Gb/s eye diagram

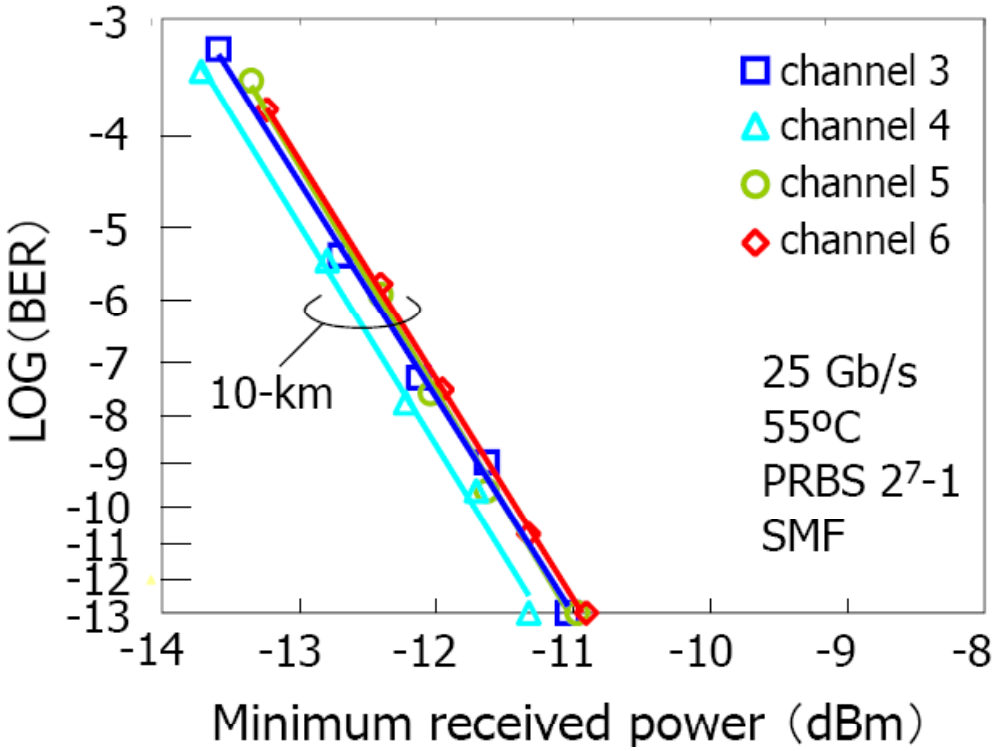


I_{bias}=50 mA; I_{mod}=33 mA_{pp}



I_{bias}=55 mA; I_{mod}=33 mA_{pp}

Bit-error-rate performance



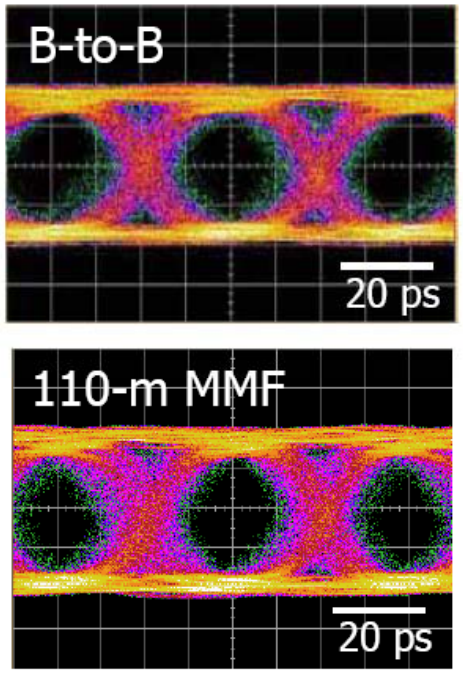
Ref: K. Adachi et al., IPC 2011, TuD3 (2011).

A part of this work was performed under management of the PETRA supported by NEDO.

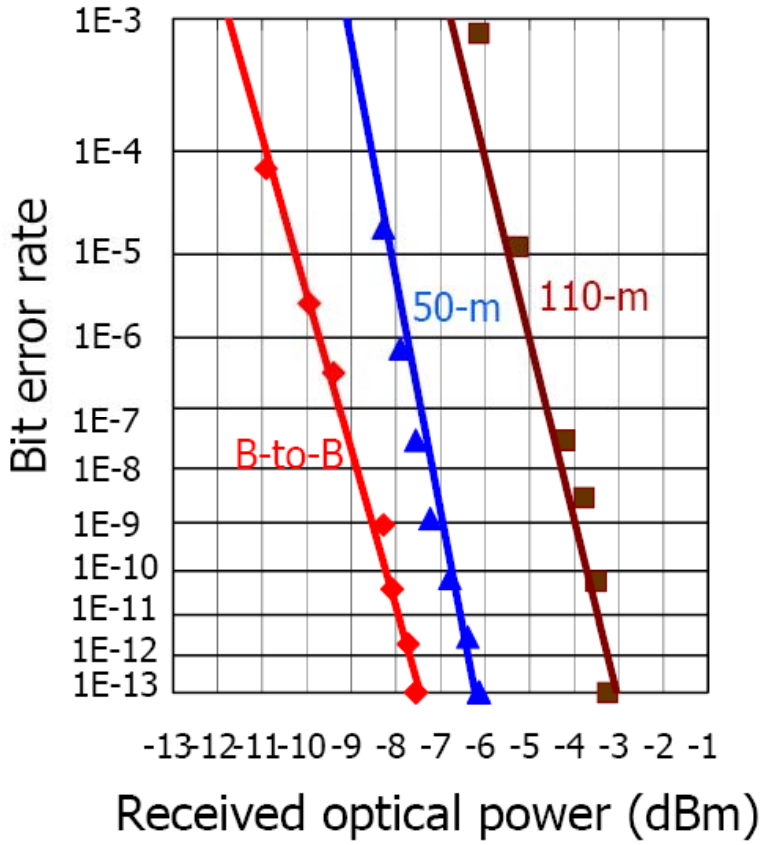
Measurement of MMF transmission

- 110-m MMF error-free transmission @ BER of 10^{-12}

25-Gb/s eye diagram



Bit-error rate



Used GI MMF : 1444 MHz·km @ 1.3 μm

Ref: Y. Lee et al., ECOC 2011, We.10.P1.57 (2011)

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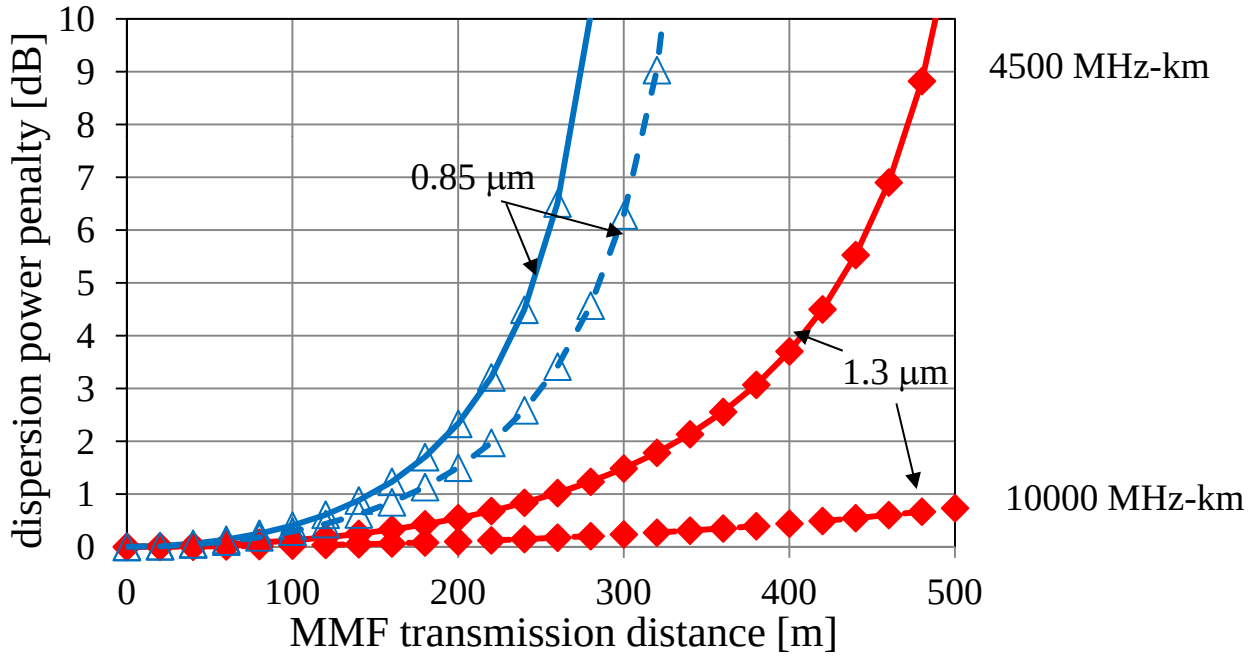
MMF Dispersion Penalty Improvement

Calculated dispersion power penalties for various MMFs with different modal bandwidths and for various wavelengths.



(*) Solid lines: 4500MHz･km MMF, Dashed lines: 10000MHz･km MMF

Ref: Y. Lee et al., ECOC 2011, We.10.P1.57 (2011)

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Relative Cost Analysis

Type	Fiber type	length	TOSA			LDD	O-MUX	Opt. coupling	Relative cost (TOSA+LDD+O-Mux)
			LD	Isolator	TEC				
CFP	SMF	10 km	**Cooled EML**	**Req.**	**Req.**	GaAs	**Req.**	**Active**	**2.0**
CFP2/ CFP4	SMF	10 km	Cooled-DML	**Req.**	**Req.**	SiGe	**Req.**	**Active**	**1.0**
nR4 (WDM)	SMF	2 km?	Low Pc integrated-DML	**No ?**	No	CMOS	**Req.**	**Active**	**0.4**
nR4 (Parallel)	SMF	550m?	Surface emitting-DML	**No ?**	No	CMOS	No	**Active**	**0.15**
SR4+ (Parallel)	**New MMF**	300m?	Surface emitting-DML	No	No		No	Passive	**<0.15**
SR4 (Parallel)	MMF	100 m	4-VCSEL	**EDC**	No		No	Passive	

Summary

- Technical feasibility of 1310nm optical device for short reach SMF (< 2 km) and extended reach MMF (< 300m OM4-like bandwidth) is demonstrated.
- Relative cost analysis indicates significant cost reduction in transmitter chain may be possible.
- Propose SG to study 1310nm optical device specifications in order to lower cost, power consumption and size of optical transceiver for nR4 application:
  1. Optical specification relaxation of 100GBASE-LR4; wavelength grid, ER, mask, etc.
  2. Feasibility of parallel SMF reachs beyond 550m.
  3. New MMF to achieve -300m reach using 1310nm surface emitting LD.

End of Contribution

Thanks!