Uncooled CWDM 25-Gbps EA/DFB Lasers for Cost-Effective 100GbE transceiver for 10km SMF

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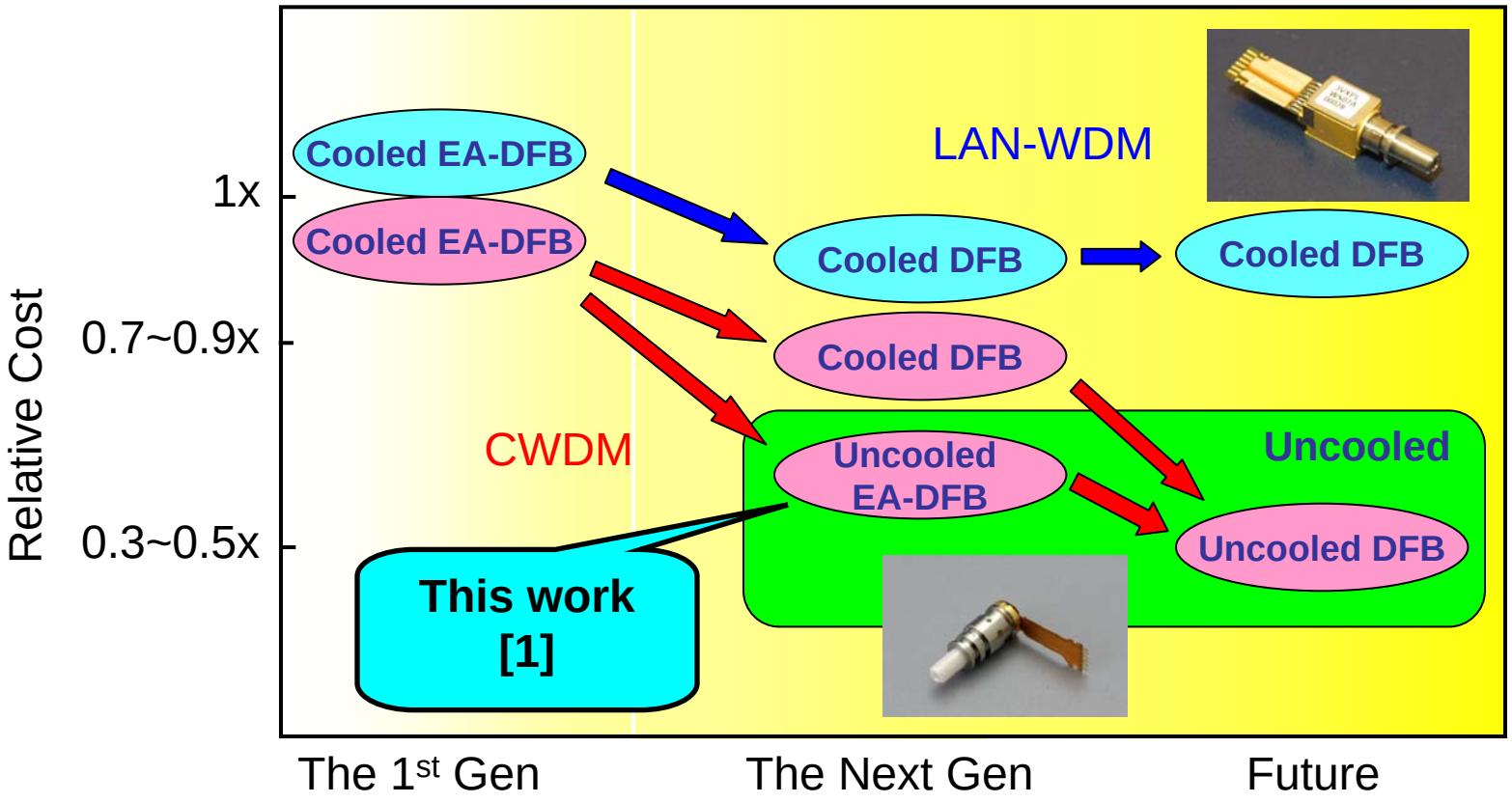
Scenario for cost reduction for the future 100GbE transceiver for 10km SMF

- Uncooled solutions will achieve the lowest cost
- Successful demonstration of low cost CWDM uncooled EA-DFB operating at 25.8Gbps.



[1] S. Makino, et al, OFC2008, PDP21, Feb, 2008 and live demonstration at OFC2008

10km SMF Link Budgets for CWDM

- Uncooled EML solution enables link budget near term avoiding the challenges of uncooled DML to achieve low alpha and dispersion penalty.
- Uncooled DFB performance needs to be improved to achieve low chirp in future.

10km SMF 25G TP2 → TP3	Cooled EA-DFB λ = 1271nm ER = 7dB	Uncooled EA-DFB λ = 1271nm ER = 7dB	DML λ = 1331nm ER = 4.5dB
Fiber Loss (G. 652 A&B)	4.7	4.7	4.3
ER penalty (vs. ER=10dB)	1.0	1.0	2.5
CD	1.0(*1)	1.0(*1)	2.25(*2)
Connector & Other losses	3.0	3.0	3.0
Total budget	9.7	9.7	12.1

Above table from cole_03_0108(p3), Jan, 2008
[1] α = +1.0 case, positive α is easier fabricated than negative for EML
[2] α = 3.0 simulation, traverso_01_0907

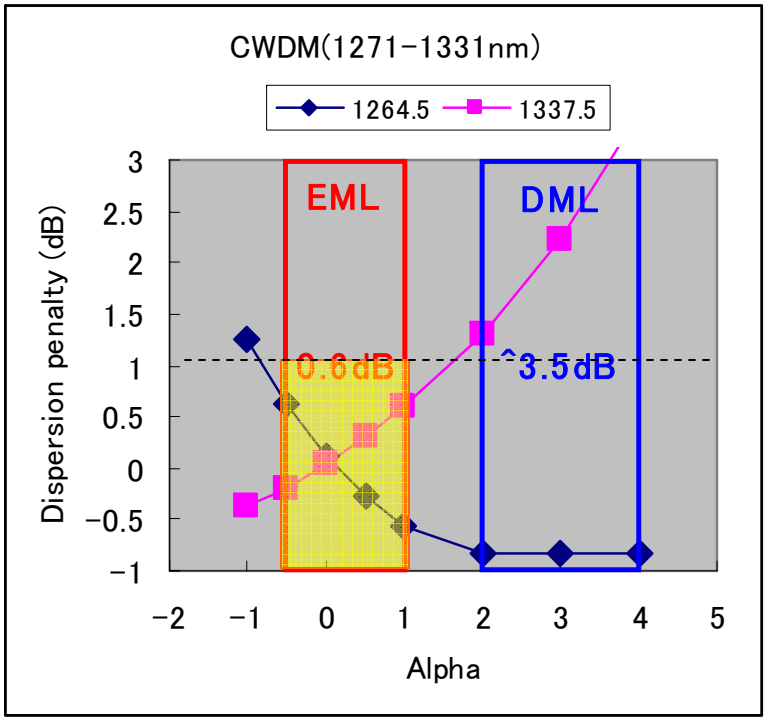


Fig. Simulation results of alpha parameter vs. dispersion penalty

Structure of uncooled 1310nm EA-DFB

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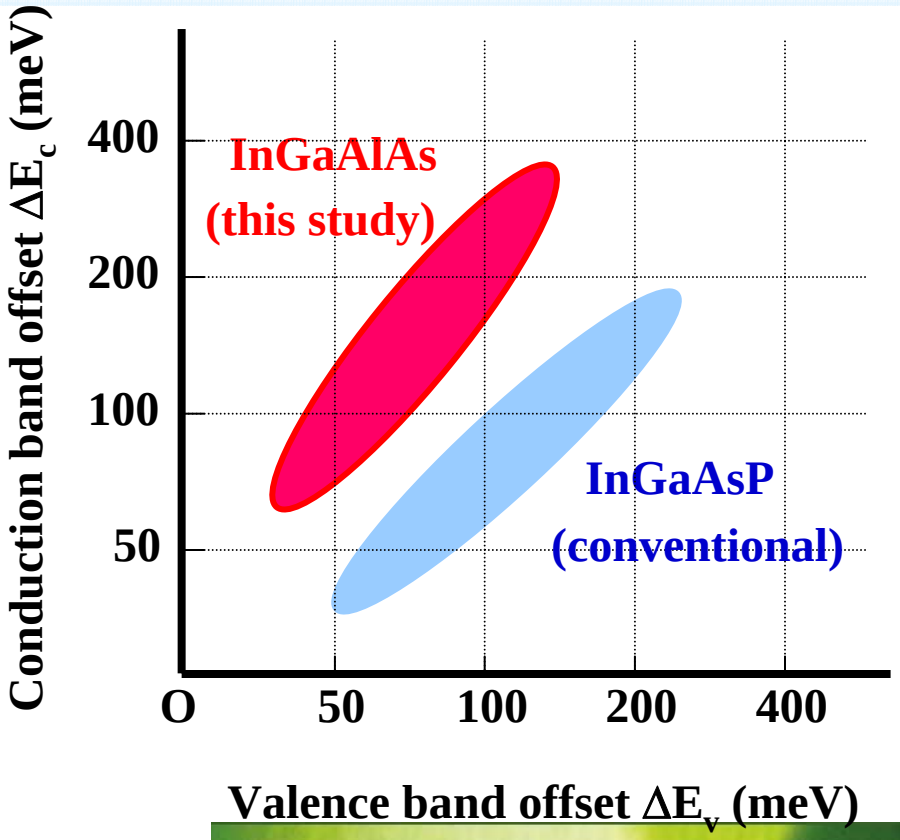
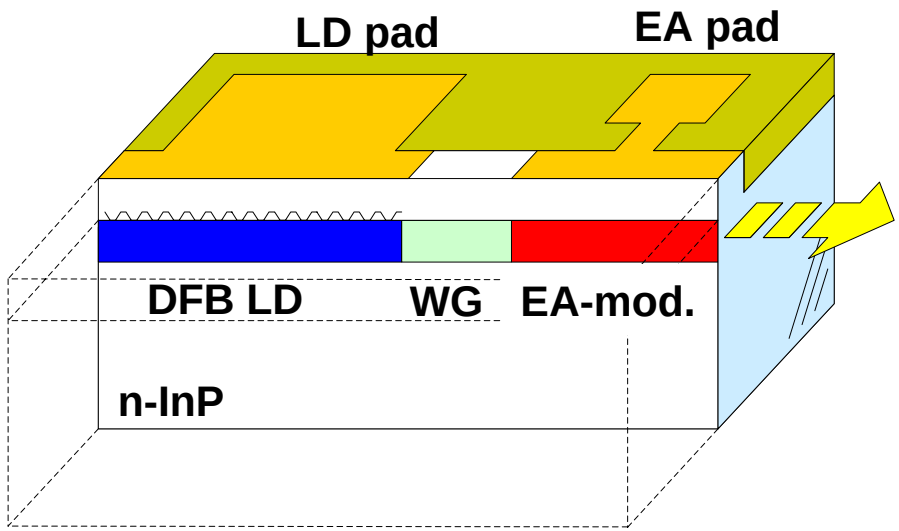
- 1300-nm range Al-based butt-joint technology is established.
- All optical components (EA, LD and WG) can be optimized independently.
- Low capacitance using 40G EA-DFB structure





EA modulator: 100 μm
DFB laser: 400 μm

[1] S. Makino, et al, OFC2008, PDP21, Feb, 2008 and live demonstration at OFC2008

Lasing Spectra of CWDM EA-DFB Lasers

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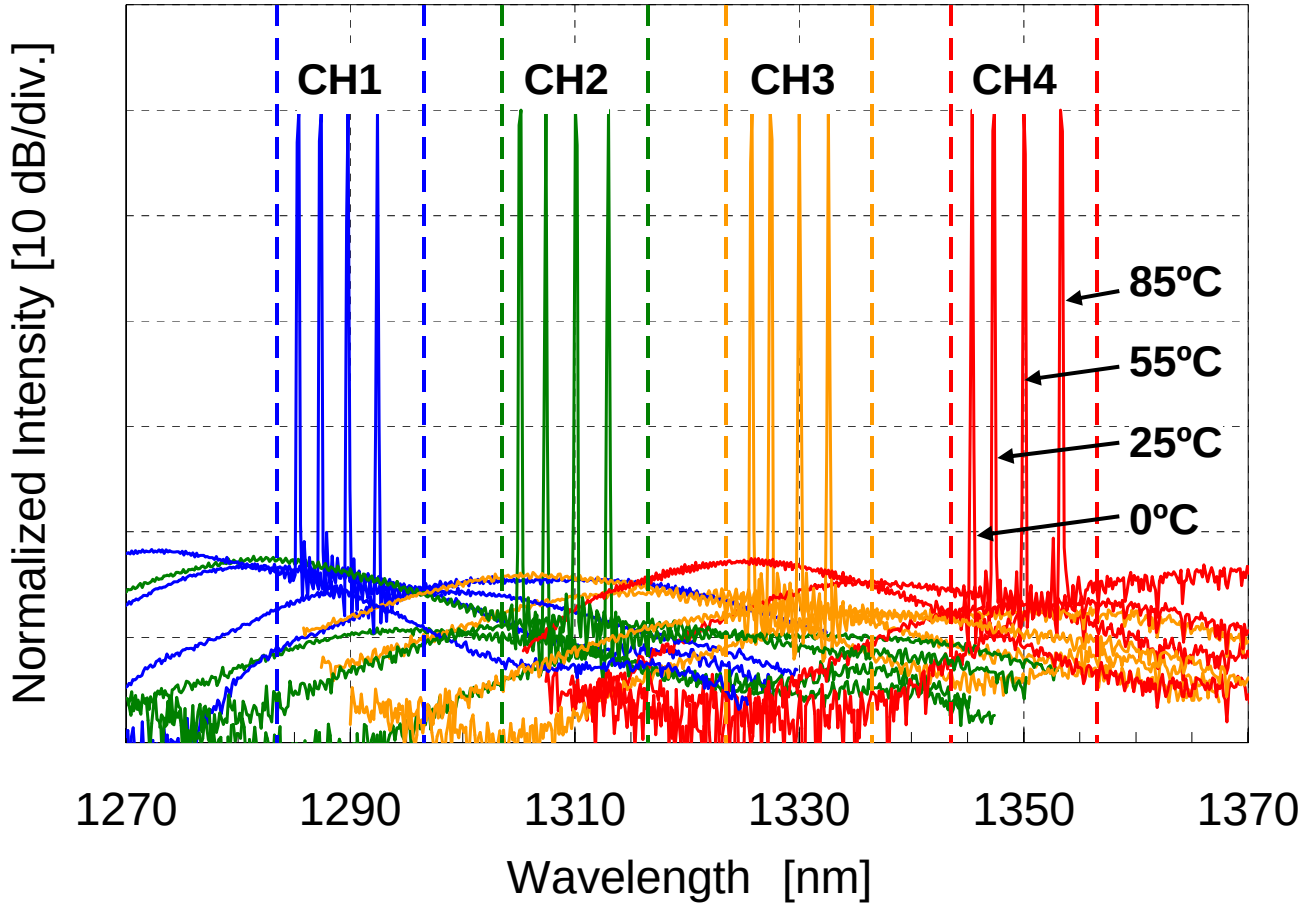
- λ=1290-, 1310-, 1330-, 1350-nm (20-nm wavelength spacing)
- Stable single mode operation (SMSR > 40 dB) over wide temperature range.



[1] S. Makino, et al, OFC2008, PDP21, Feb, 2008 and live demonstration at OFC2008

Modulation Sensitivity of CWDM EA-DFB Lasers

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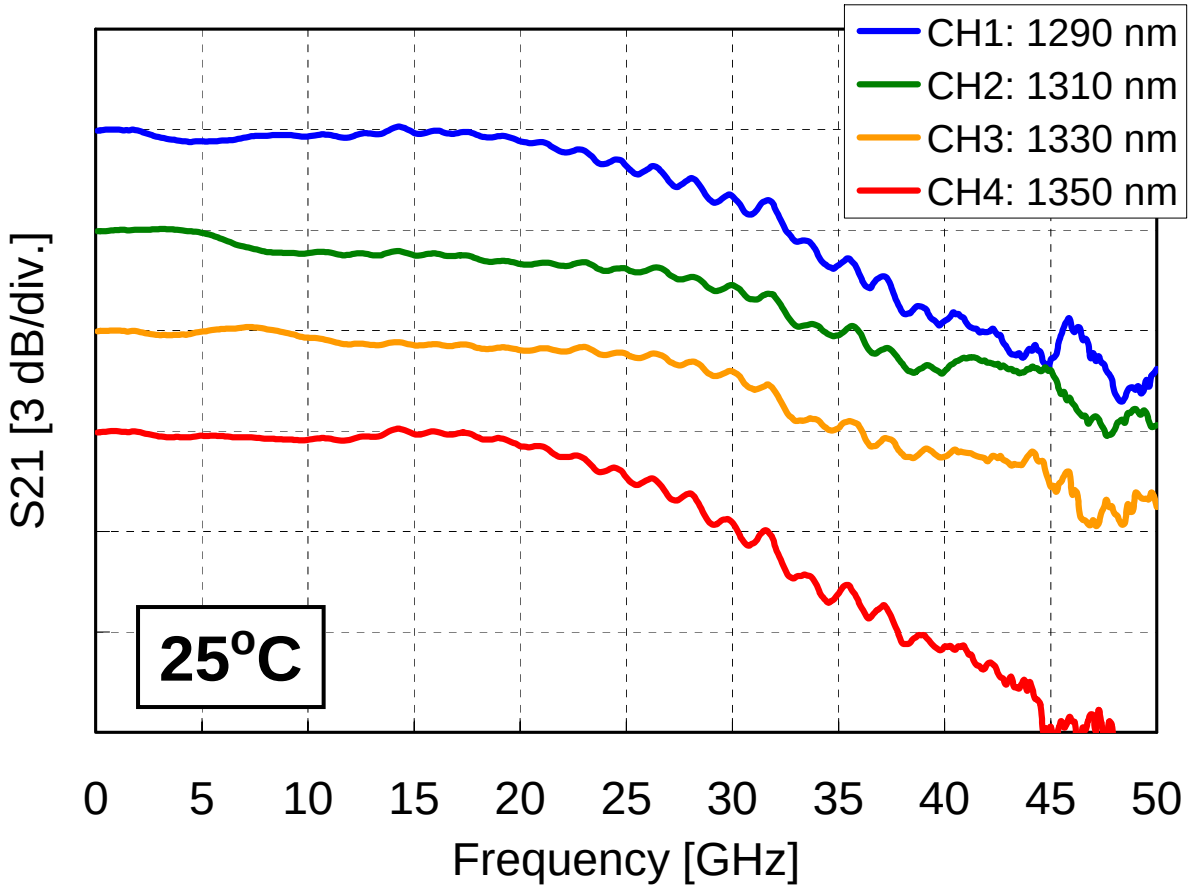
- **Over 30GHz f_3dB bandwidth at all channel.**
- **Low capacitance EA structure based on 40-Gbps EA/DFB laser technology.**



[1] S. Makino, et al, OFC2008, PDP21, Feb, 2008 and live demonstration at OFC2008

25.8-Gbps 12-km Transmission Performance

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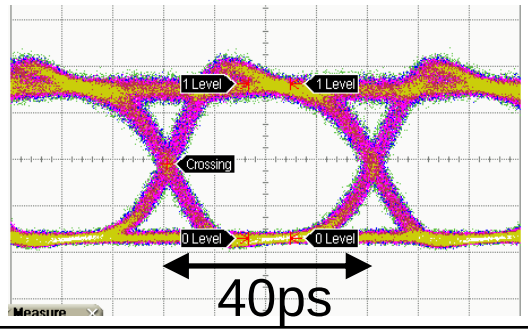
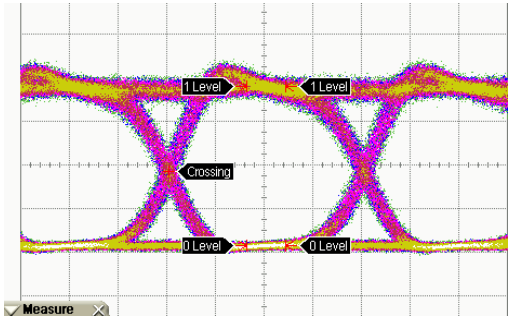
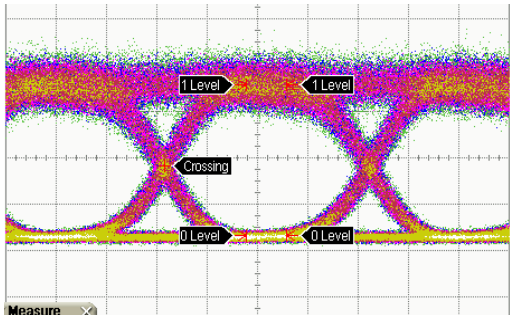
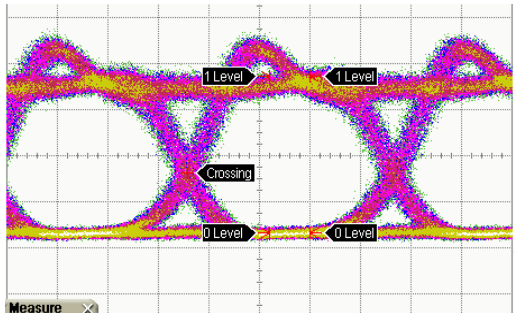
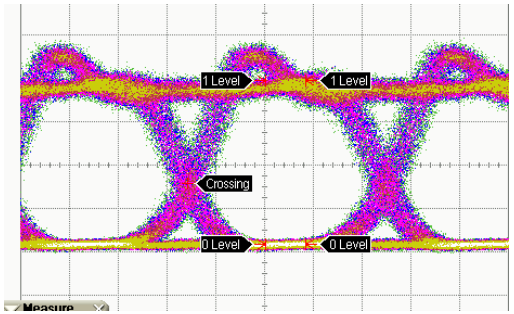
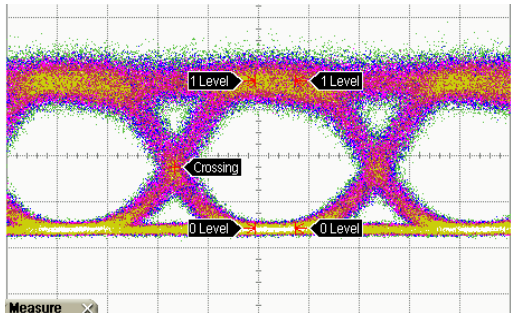
CH1(1290-nm), Chip in Package, NRZ, 2^{31}-1 PRBS

T_{LD}	0ºC	25ºC	85ºC
DER	9.85 dB	12.02 dB	9.61 dB
Xp	48.1%	46.4%	46.6%
VOH	-1.5 V	-1.1 V	-0.65V
BTB			
12-km SMF			

200 Waveforms

HITACHI
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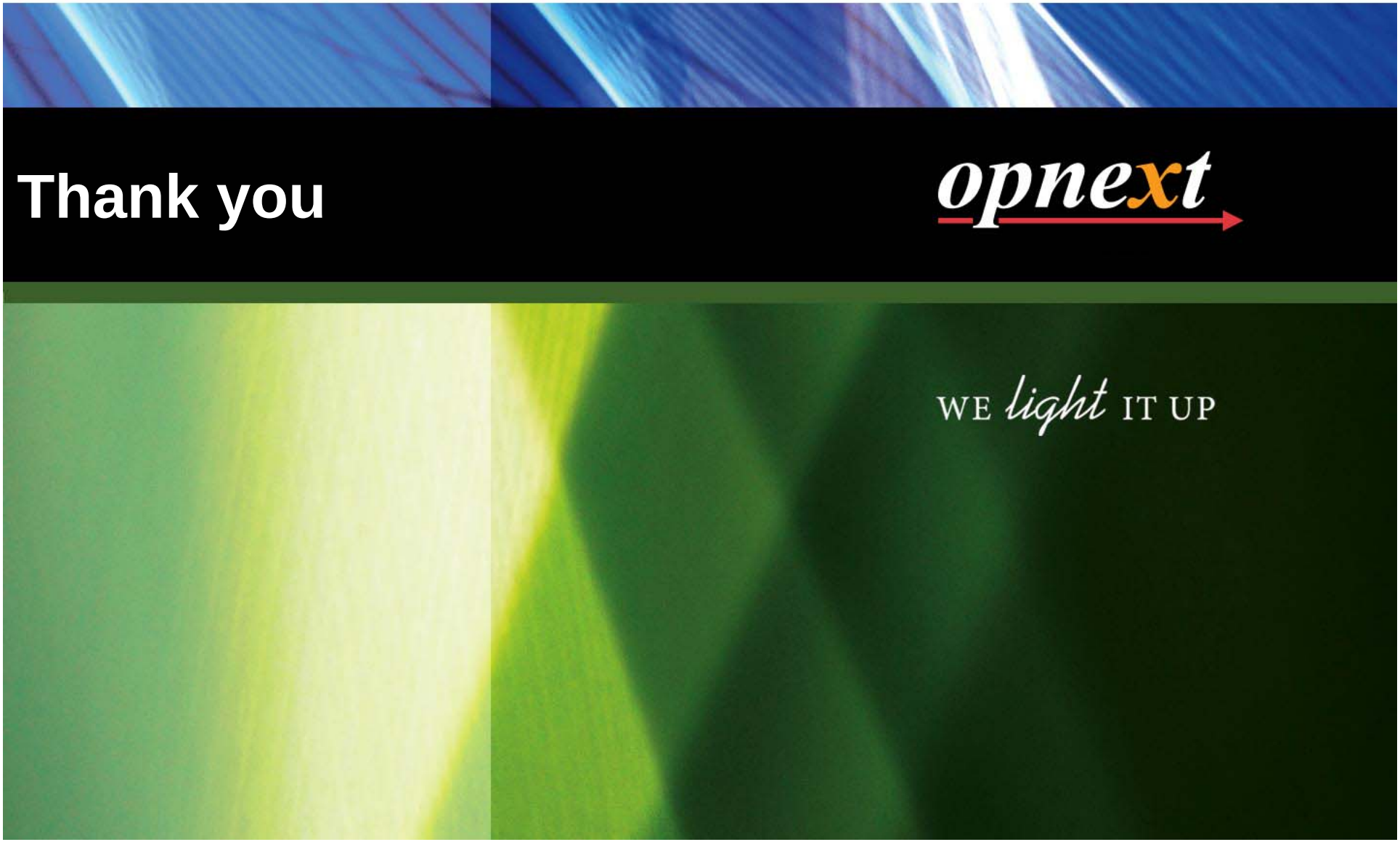
[1] S. Makino, et al, OFC2008, PDP21, Feb, 2008 and live demonstration at OFC2008

Summary

- Uncooled 4-channel CWDM 1.3-um InGaAlAs EA/DFBs are demonstrated,
  - –Enables low cost next generation 100GbE modules for 10km SMF application.
- 25-Gbit/s, 12-km SMF transmissions were achieved from 0ºC to 85ºC with extinction ratio over 9dB and clear eye opening.
- Opnext will improve the performances of uncooled DML for lowest cost 100GbE module in future.

Thank you



10km SMF Power Budgets

- CWDM cooled DML is feasible and uncooled DML will be also feasible with improving high temperature performance or chirp in the future

10km SMF 25G λs Power in dBm (Average)	CWDM Cooled EML λ = 1271nm ER = 7dB	CWDM Uncooled EML λ = 1271nm ER = 7dB	CWDM UnCooled DML(*1) λ = 1331nm ER = 4.5dB(*1)
TX Min / Max	1.2 / 4.2(*1)	1.2 / 4.2(*1)	4.8 / 7.8(*1)
TP2 TX Min 2.5dB Mux loss	-1.3(*)	-1.3(*)	2.3(*1)
TP2 4λ TX Max (TX Min + 9dB)	7.7(*1)	7.7(*1)	11.3 (<12.0)(*1) (feasible)
Link Budget (dB)	9.7(*1)	9.7(*1)	12.1(*1)
TP3 RX Min 2.5dB DeMux loss	-11	-11	-11
RX Min / Max (ER =10dB)	-13.5 / -16.5	-13.5 / -16.5	-13.5 / -16.5

 # Above table from cole_03_0108(p4), Jan, 2008 **[1] Updated by previous foil**