

20 and 26 Gbps uncooled 1310nm EMLs for 100 GbE applications

Milind Gokhale

IEEE High Speed Study Group

January 2007, Monterey CA

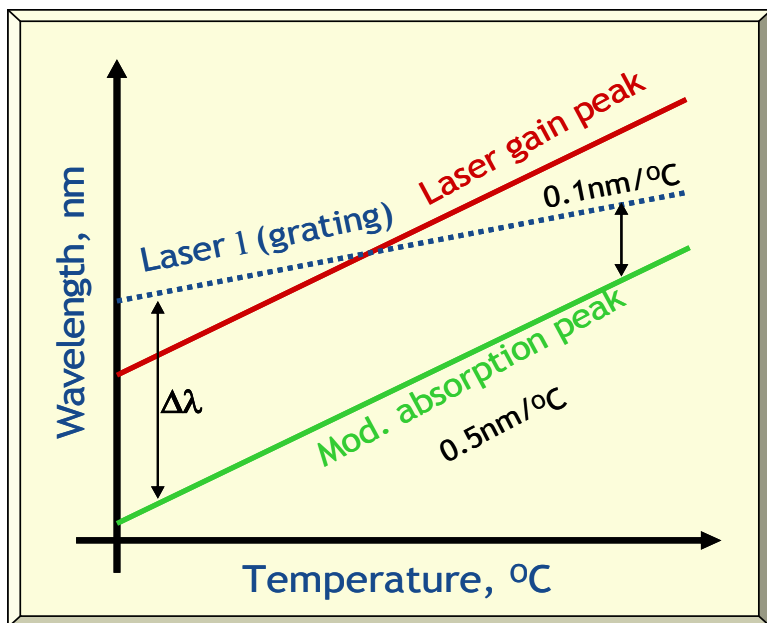


Overview

- For 100 Gbps links up to 10km, two configurations using 1310nm uncooled EMLs have previously been proposed:
 - **5 x 20 Gb/s 1310nm, CWDM EML**
 - **4 x 25 Gb/s 1310nm, CWDM EML**
- We report for the first time uncooled 1310nm EMLs operating at both 20 and 26 Gbps
- 20+ Gb/s uncooled EMLs are extensions to existing 10 Gbps design currently used in 10G-SONET (SR-1) and 10 GbE links
- Data indicates bandwidth > 20GHz, independent of temperature. Large signal uncooled operation up to 30Gb/s and transmission through 10km of fiber is also demonstrated.
- Merits for selecting 4 X 25 Gbps 1310nm based Tx are discussed

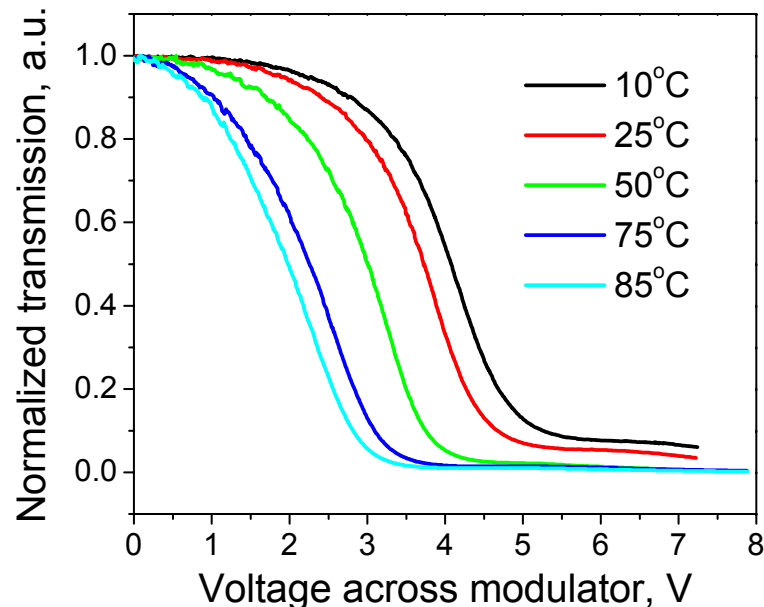


Uncooled EML Design



Detuning ($\Delta\lambda$) between laser and modulator is a function of temperature

- change in detuning changes extinction ratio (ER) of the modulator
- smaller ER at low temp & lower power at high temperature



Typical extinction curves vs. temperature

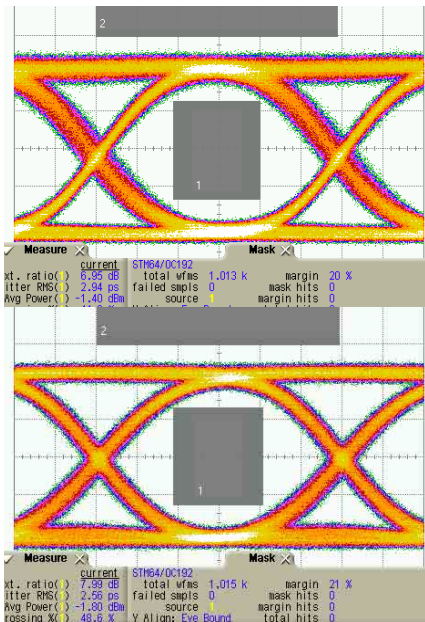
- constant modulator drive (V_{p-p}) used
- modulator DC bias is a linear function of temperature



20+G EML builds on existing 10G technology

- 10G 1310nm uncooled EML based TOSAs have been available for 10GbE (LR) and SONET(SR-1) links
- Predominant design is based on asymmetric twinguide (ATG) technology
- 10G uncooled EMLs at 1310nm and 1550nm have been demonstrated using alternate EML technologies

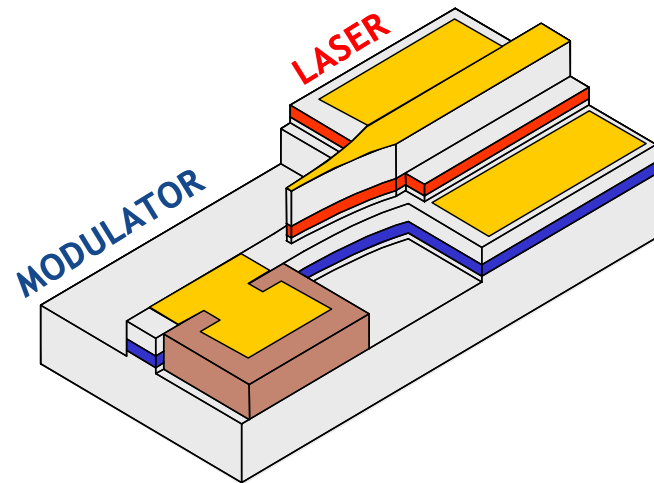
Eyes for 10G EML in TO-can TOSA



-20°C, -1.4 dBm
7dB ER, 20% MM

90°C, -1.8 dBm
8 dB ER, 21% MM

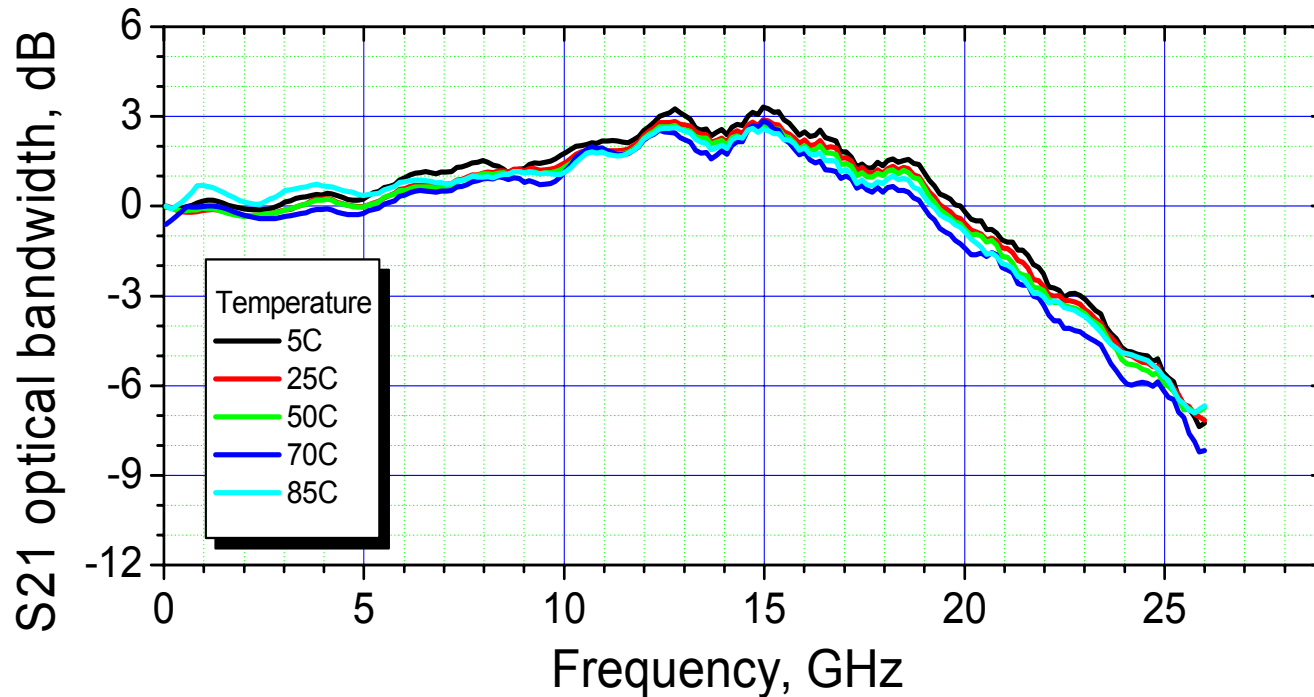
ATG based EML chip schematic



Reference: paper PD-42, OFC March 2003



Uncooled EML: Small-signal bandwidth



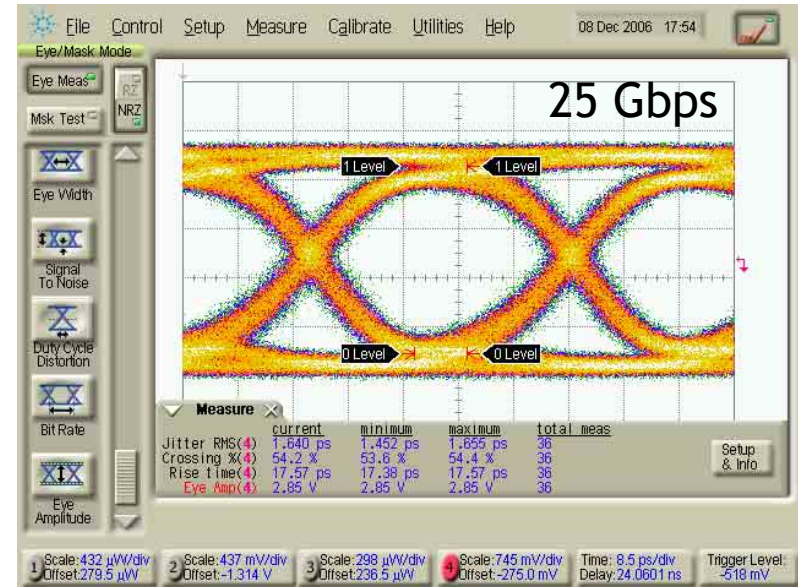
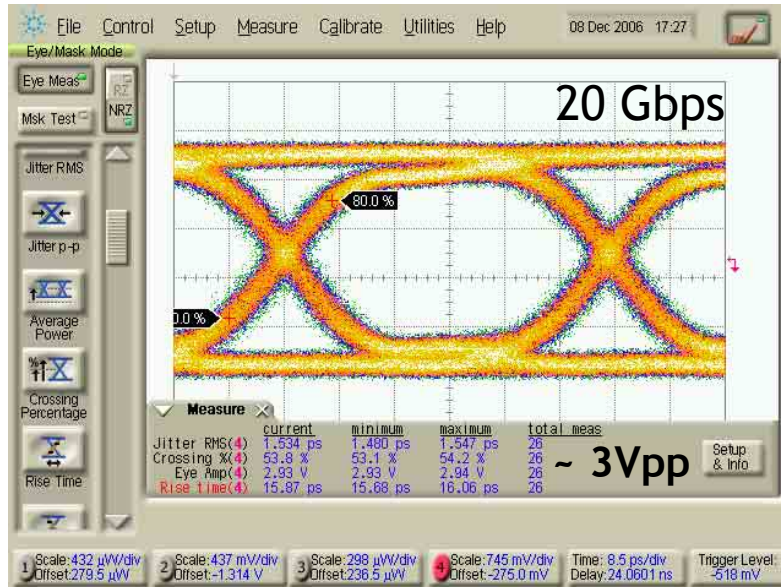
- 3dB bandwidth is ~22GHz, independent of temperature
- Measurement for chip on submount from 5C to 85C

Setup for 20+ Gbps testing

- Packaged 20+ Gbps EML chip used for demonstrating uncooled operation
 - Standard 7-pin, 10G package with GPO connector rated to ~26GHz
 - Temperature (0 to 85 °C) refers to thermistor on EML submount
 - 40G EA driver with ~ 3 Vpp electrical drive
- 10 Gbps, $2^{31}-1$ PRBS streams electrically multiplexed to generate 20 to 30 Gbps PRBS data
- Optical eyes measured using Agilent 86109A plug-in with 30GHz optical module

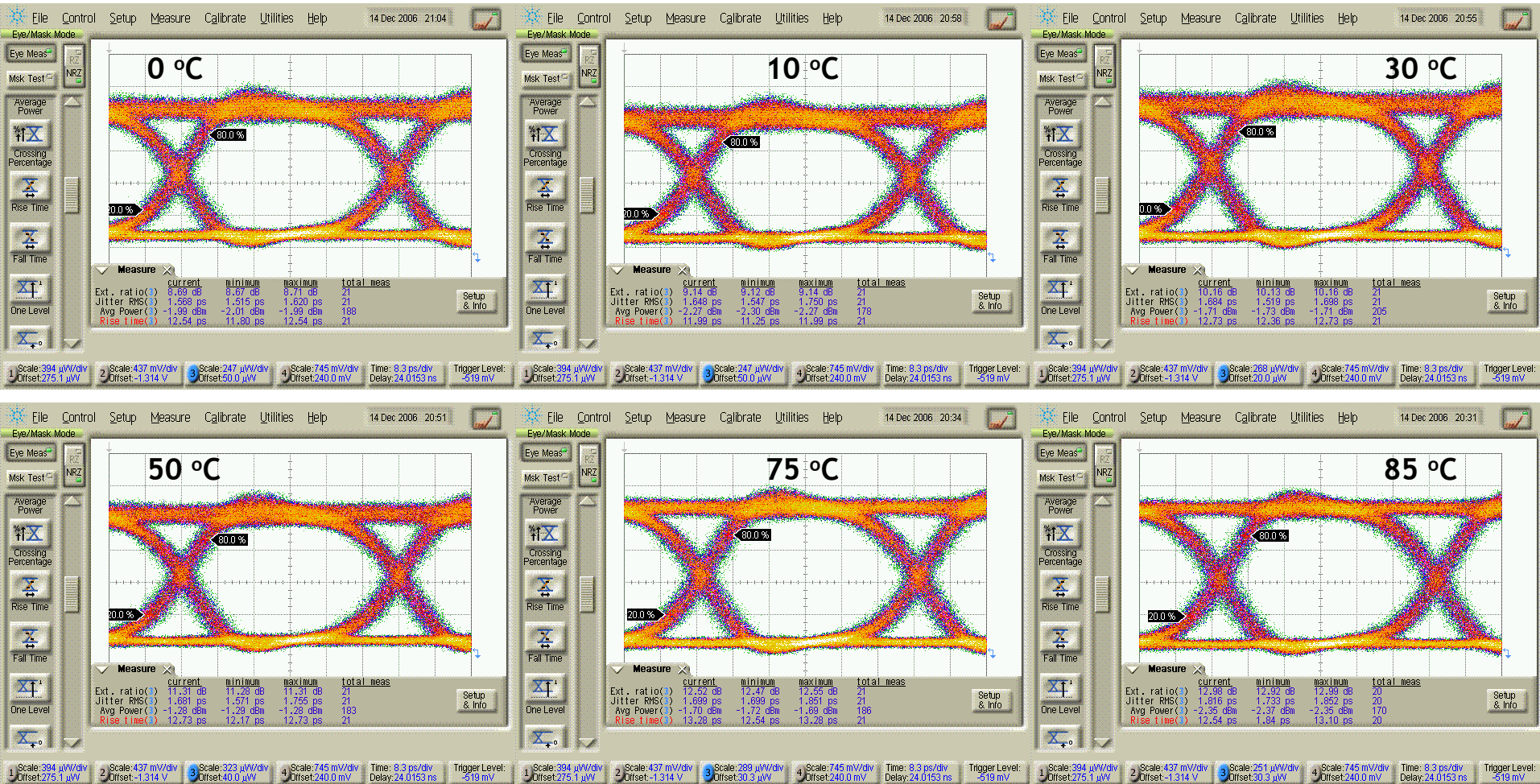


Electrical eyes with 40G driver



- 20G and 25 Gbps electrical eyes shown on same time scale
- Data measured with driver after mux with long cable to DCA
- DCA does not have precision time base module

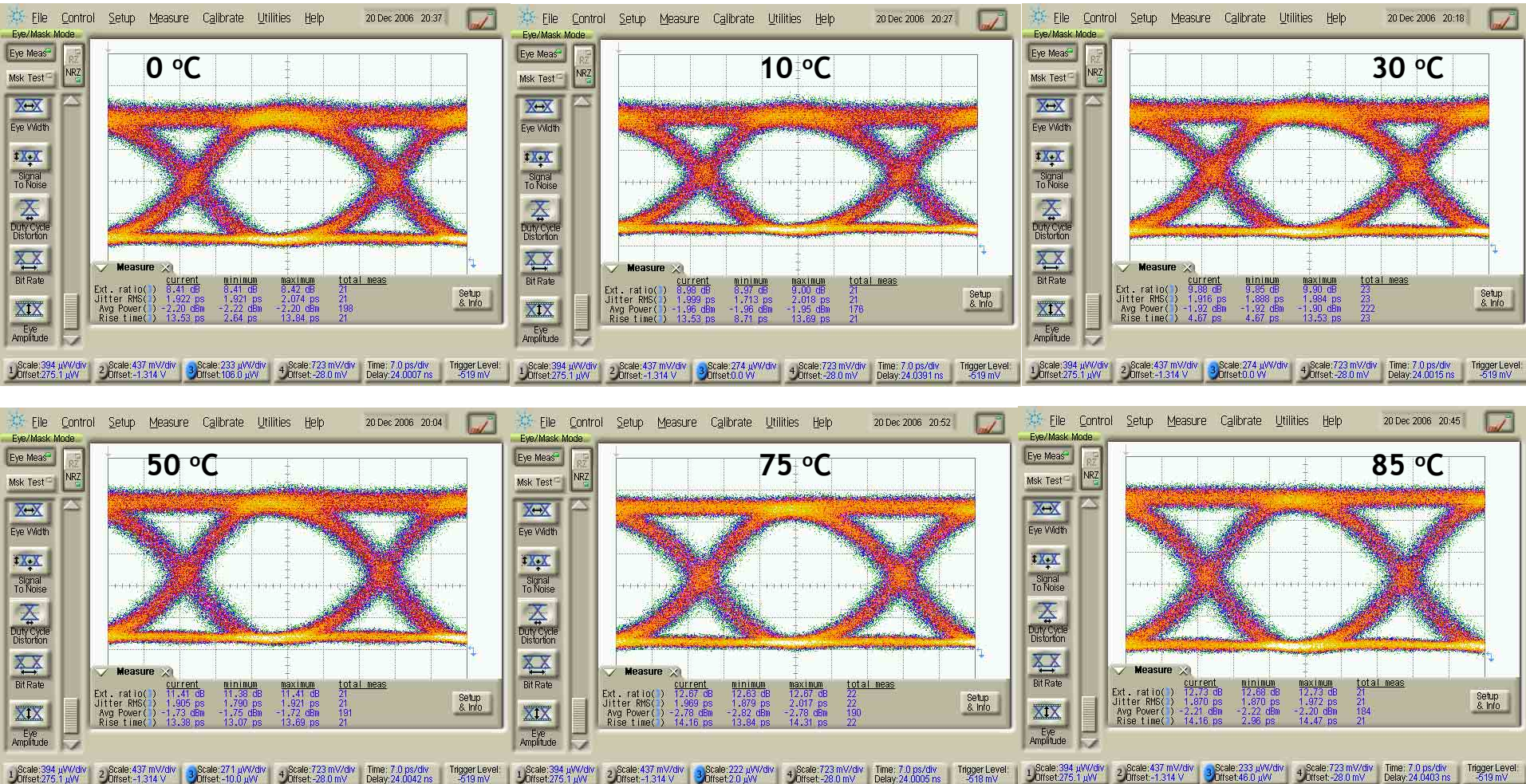
20 Gbps optical eyes (0 km) vs. temperature



• Eyes measured with 30GHz 86109A Agilent plugin



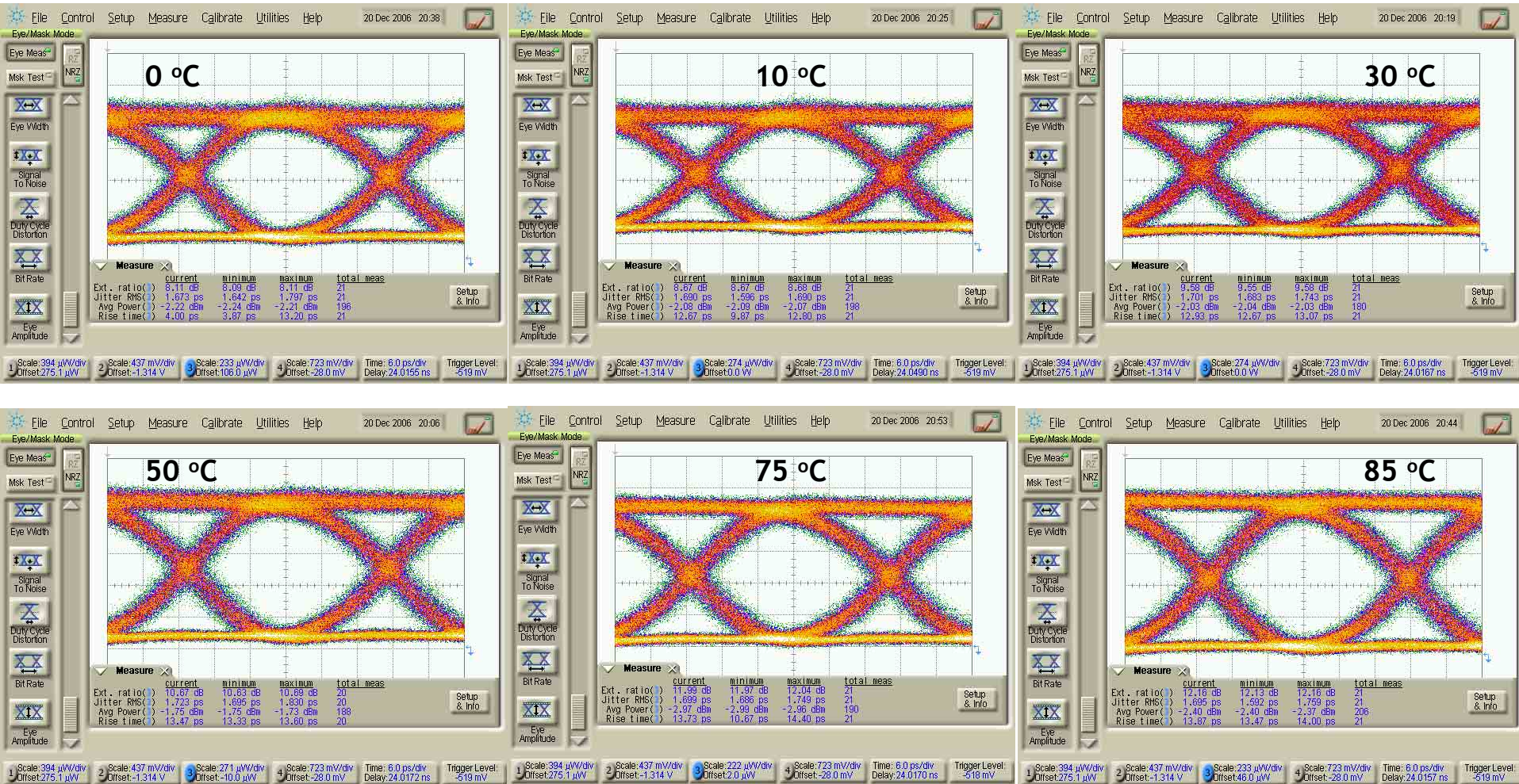
26 Gbps optical eyes (0 km) vs. temperature



• Eyes measured with 30GHz 86109A Agilent plugin



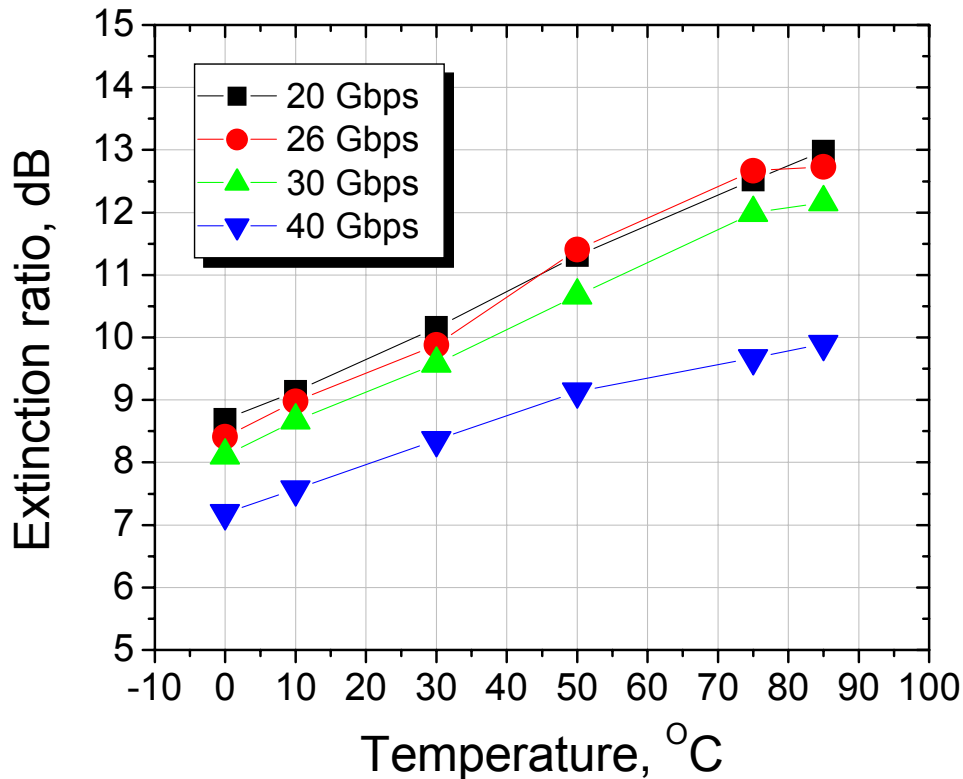
30 Gbps optical eyes (0 km) vs. temperature



• Eyes measured with 30GHz 86109A Agilent plugin



Extinction ratio versus bit-rate



ER increases with temperature at ~ 0.45 dB/°C from 0 to 85°C

- Constant drive voltage ~ 3 Vpp
- Lower drive voltage at higher temperature eases requirements for driver IC
- ER for 20G and 26G almost identical
- ER drops significantly for 40G; ER > 7dB demonstrated over temperature

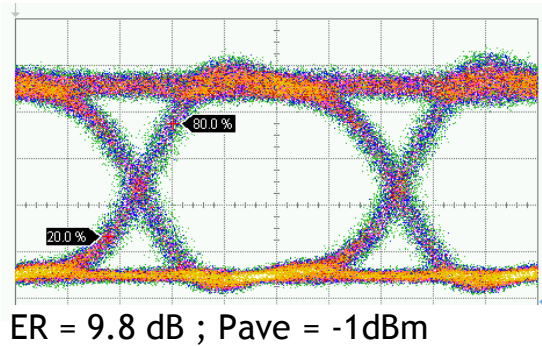
Unfiltered ER measured with 30GHz Agilent 86109A plug-in



20Gbps transmission through 10km fiber

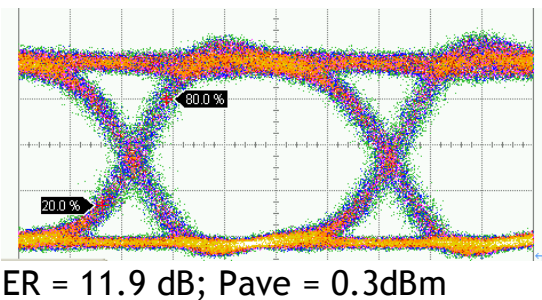
Optical eye: 0 km

0 °C

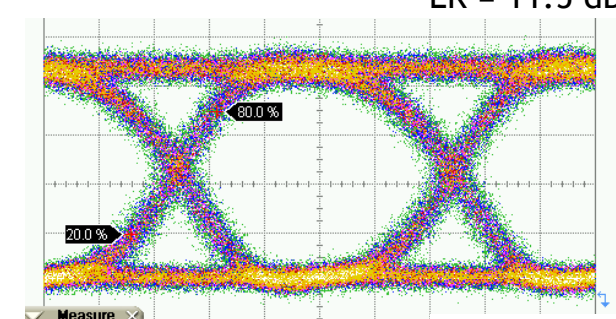
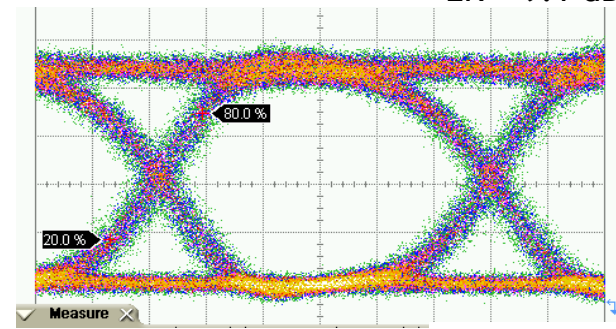
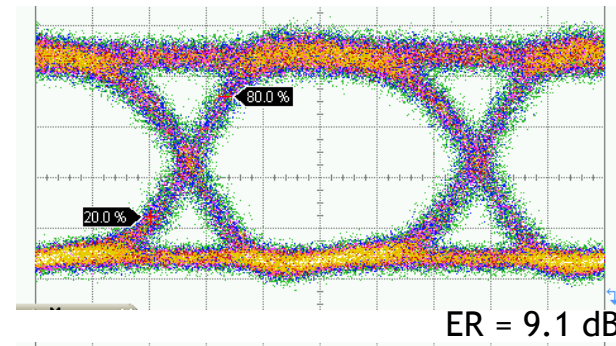
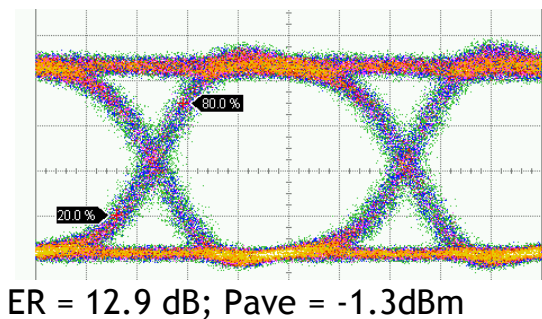


Optical eye: 10 km

50 °C



85 °C



1310nm wavelength and EML Tx yields negligible dispersion penalty over 10km



Conclusion and recommendations

- Technical feasibility demonstrated for higher speed, single channel, uncooled 1310nm EMLs operating up to 30 Gbps
 - CWDM versions on 20 or 25nm spacing feasible
- Uncooled 4 x 25 Gbps CDWM configuration recommended
 - 1310 EML performance suggests no clear preference for 20G over 25G
 - For discrete transmitters, “4 X” will be cheaper than “5 X”
 - Uncooled TO-can style TOSA package is feasible
 - “4 X” (LX4 type) optical mux widely available
 - Assumes that “gear-box” IC is largely agnostic of channel count
 - 25 Gbps driver ICs with < 3 Vpp possible using SiGe/GaAs/InP
- Next steps
 - Link budget and receiver configuration will set transmitter power requirement

