Component Capabilities for NG-EPON

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Supporters

- Frank Effenberger, Huawei

25G transmitter capabilities

- In this contribution we estimate the commercial capabilities for 25G BOSA transmitters.
  - Extrapolate ongoing and planned improvements in current 25G EML and DML chip performance to volume ramp in 2020.
  - Consider BOSA configurations to make rough estimates of relative cost for 10/10G, 25/10G and 25/25G ONUs.
- 10nm grid wavelength plan with all channels in O-band is assumed for reference (johnson_3ca_1b_0516).
  - Both upstream and downstream channels in O-band for low TDP
  - 10nm channel spacing to increase filter alignment tolerances
  - Enable use of low-cost TO-can BOSA technology
  - Keeping US wavelengths below 1300nm eliminates FWM concerns (johnson_3ca_1_0716).
  - US deployment order was modified to increase guardbands for 25G ONU.
- We present measured 25Gb/s DML eyes over 20km of fiber at bias conditions consistent with the PR-30-like NG-EPON PMD (Hereafter referred to as simply “PR-30”).
  - 1270nm and 1330nm bound the potential range for low TDP.
  - Pavg ~ 7.5dBm with ER = 6dB at Top = 50 to 65 ºC.

Estimated PR-30-like power budget

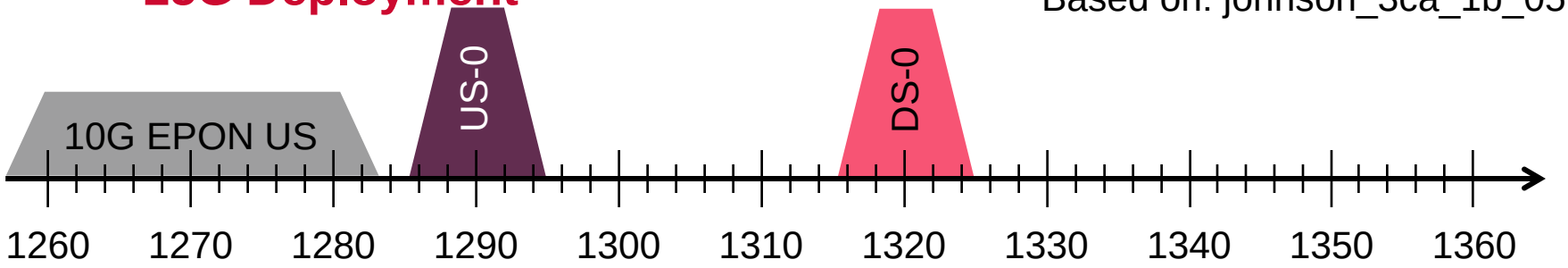
	Unit	Value	
Fiber Channel		**“PR-30” DN**	**“PR-30” UP**
Distance	km	20	20
Split ratio		32	32
Loss, MAX	dB	29	29
Transmitter		**25G EML**	**25G DML**
Bit rate	Gb/s	25.8	25.8
Wavelength, MAX	nm	1350	1300
Avg. launch power, MIN (no margin)	dBm	**7.6**	**7.5**
Extinction ratio, MIN	dB	8	6
Launch OMA, MIN	dBm	9.2	8.3
Transmission dispersion penalty, MAX	dB	1.5	1.5
Receiver		**25G APD**	**25G APD**
BER with RS(255,223) FEC	1/s	1E-03	1E-03
Receiver sensitivity @ ER=9(6)dB	dBm	-23.5	-23.0
Receiver sensitivity @ TX ER	dBm	-23.2	-23.0
Stressed eye closure penalty	dB	1.5	1.5
Receiver sensitivity OMA, MAX	dBm	-21.3	-22.2
Stressed receiver sensitivity OMA, MAX	dBm	-19.8	-20.7

Following the RX sensitivity analysis of harstead_3ca_1a_0516, which assumes 5dB penalty between 10G and 25G APD RX.

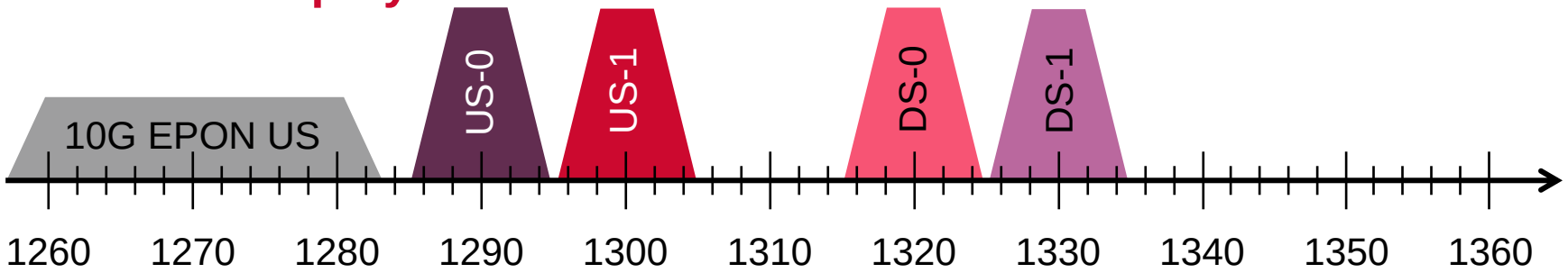
Proposed wavelength plan

25G Deployment

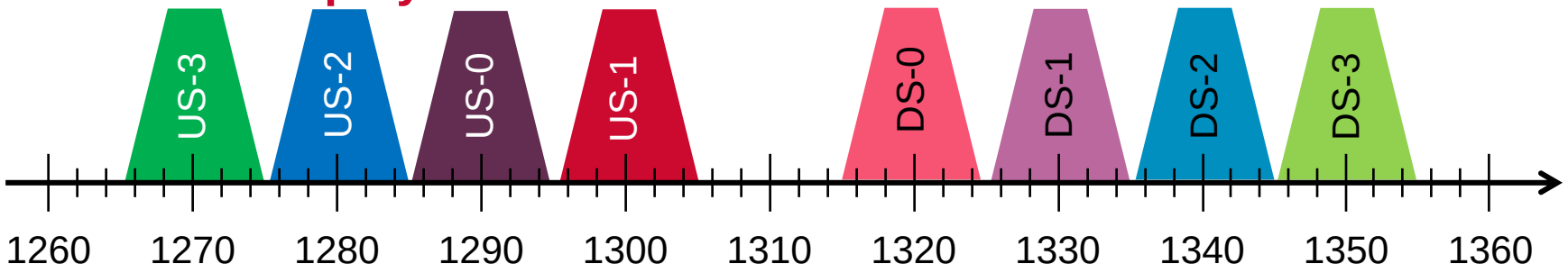
Based on: johnson_3ca_1b_0516



50G Deployment



100G Deployment



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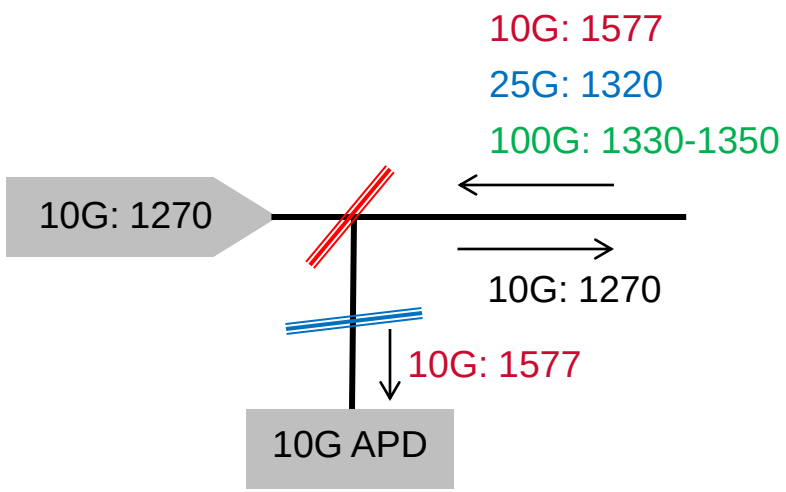
10G/10G ONU BOSA configuration



Receive:

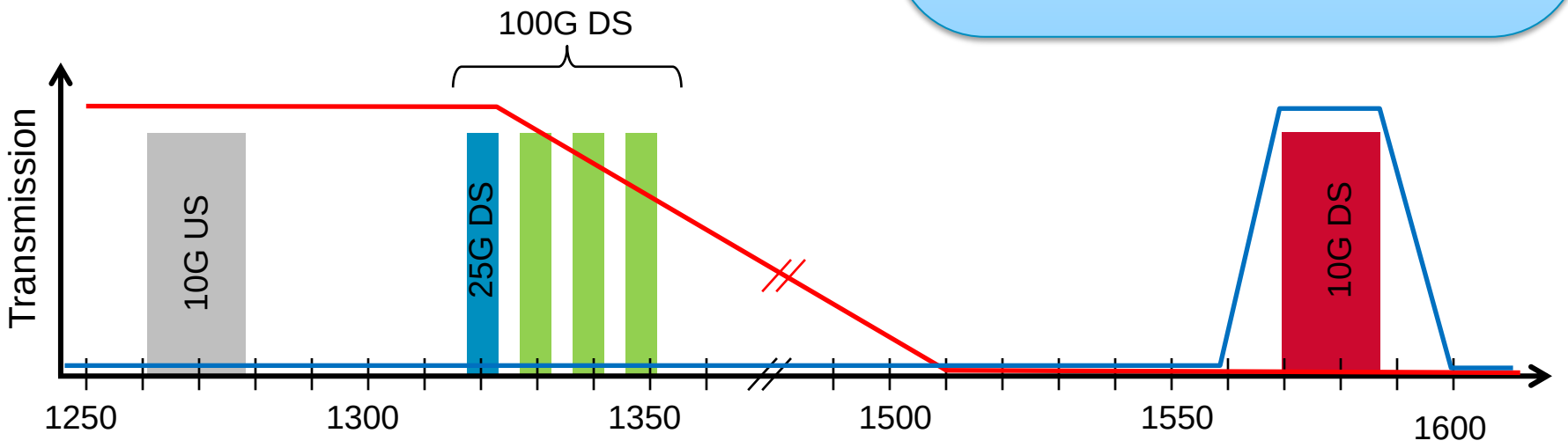
10G DS: 1577nm

Block:

100G DS: 1320-1350, 10nm grid proposed

Transmit:

10G US: 1270nm uncooled DML



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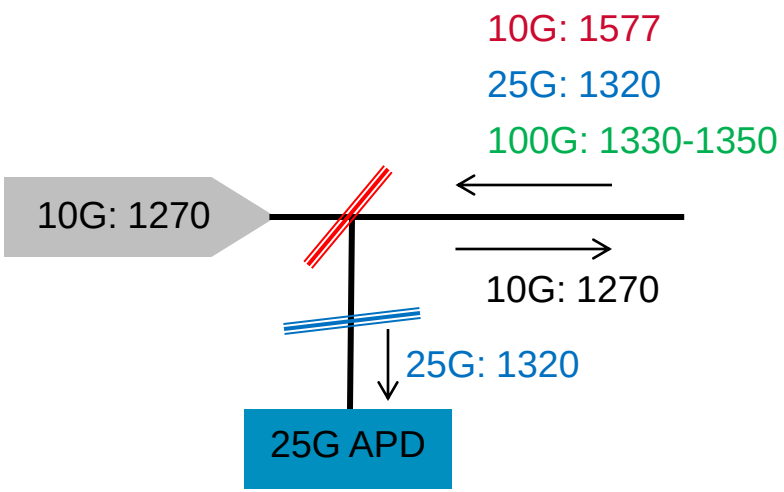
25G/10G ONU BOSA configuration



Receive:

25G DS: 1320nm proposed

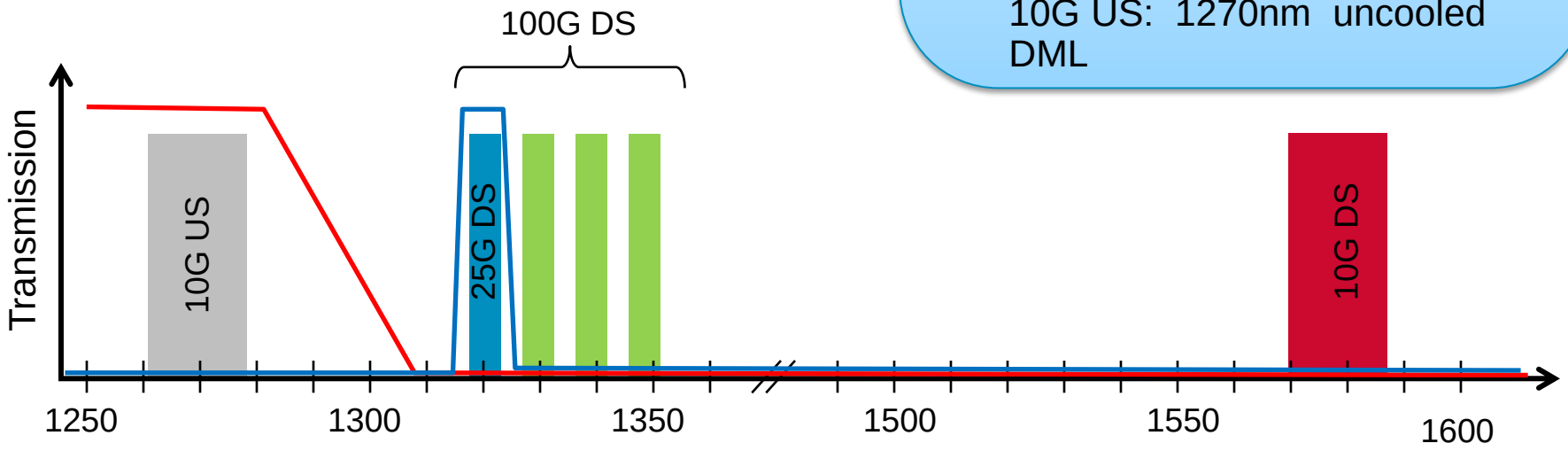
Block:

10G DS: 1577nm

100G DS: 1330-1350, 10nm grid proposed

Transmit:

10G US: 1270nm uncooled DML



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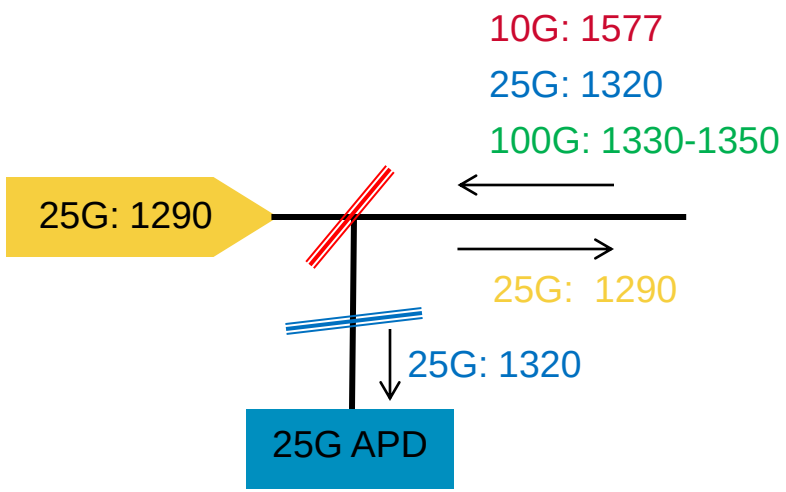
25G/25G ONU BOSA configuration



Receive:

25G DS: 1320nm proposed

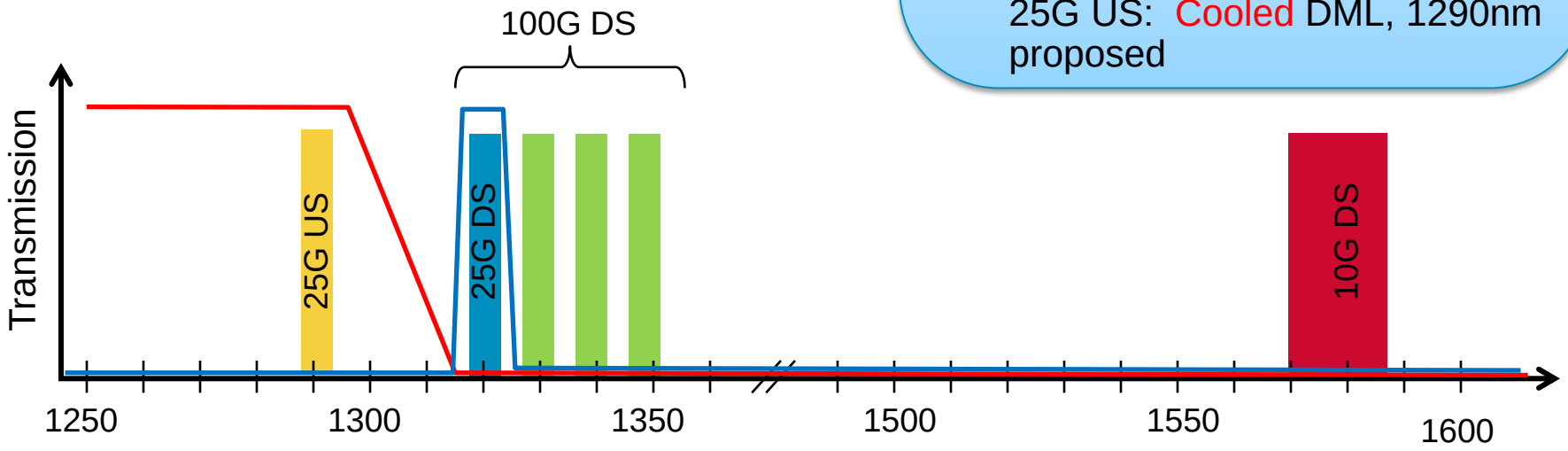
Block:

10G DS: 1577nm

100G DS: 1330-1350, 10nm grid proposed

Transmit:

25G US: Cooled DML, 1290nm proposed



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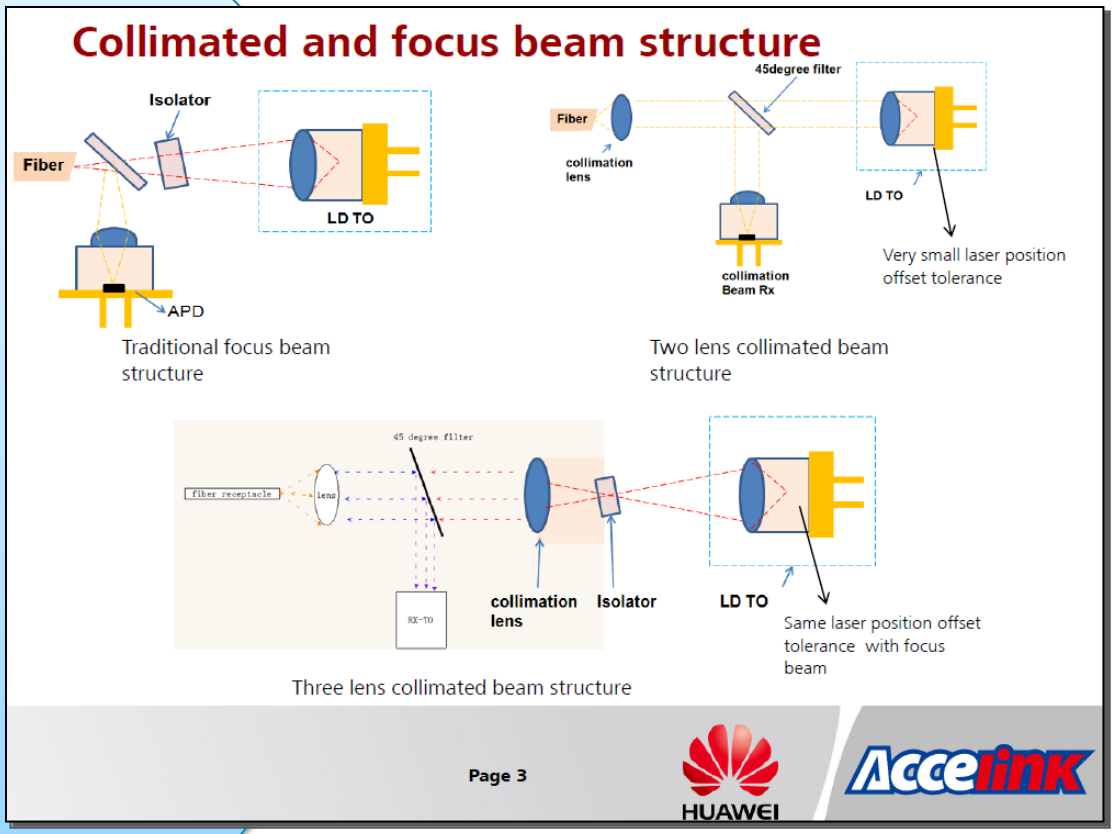
ONU BOSA construction

As described in liu_3ca_2_0516, a DS/US channel separation less than ~40nm or blocking filter with < ~10nm guardband requires the use of a collimated beam.

Liu estimated that the 3-lens scheme adds 30% to the cost of a 10G BOSA and ~6mm in length.



Source: liu_3ca_2_0516

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Estimated 25G ONU BOSA cost

Parameter	10/10G ONU	25/10G ONU	25/25G ONU
BOSA Optics	Focused Beam →	Collimated Beam	Collimated Beam
Transmitter	1270nm 10G Uncooled DFB	1270nm 10G Uncooled DFB →	1290nm 25G Cooled DFB
Receiver	10G APD+TIA →	25G APD+TIA	25G APD+TIA
Diplexer Filter	1270/1577 →	1270/1320 →	1290/1320
Blocking Filter	1577 →	1320	1320
Estimated relative cost	1.0	1.6	2.7

Values are estimated commercial capability in 2020.

These are still very rough estimates – more study is necessary.

→ Increased cost/complexity

→ Incremental increase

Estimated 25G BOSA TX capability

Parameter	25G Cooled EML (OLT)	25G Uncooled EML (OLT)	25G Cooled DML (ONU)	25G Uncooled DML (ONU)
Top (ºC)	55 ±5	-5 to 75	55 ±5	-5 to 85
Wavelength (nm)	1320-1350		1270-1300	
Max Iop (mA)	120	120	55	55
Min Pavg (dBm)	7	5	10	7
Min OMA (dBm)	8.6	6.6	10.8	7.8
Min ER (dB)	8	8	6	6
Meets target Pavg > 7.5 dBm?	No	No	Yes	No

Values are estimated commercial capability in 2020.

Collimated beam optics assumed. Focused beam optics may have higher loss.

25Gb/s directly modulated DFB – chip on carrier

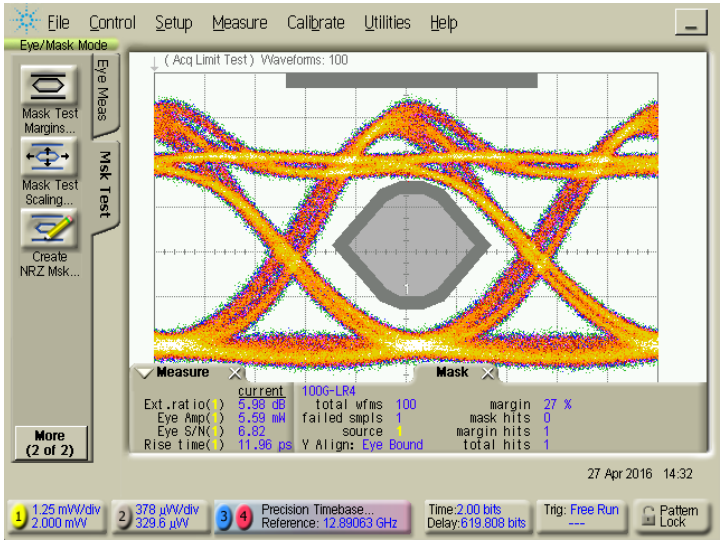
1270nm

50ºC, 60mA

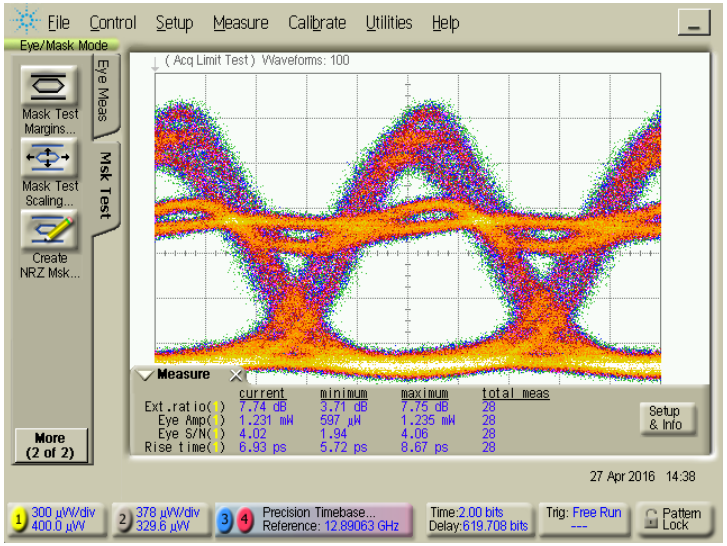
ER = 6dB

Pavg ~ 7.5dBm

0km



20km

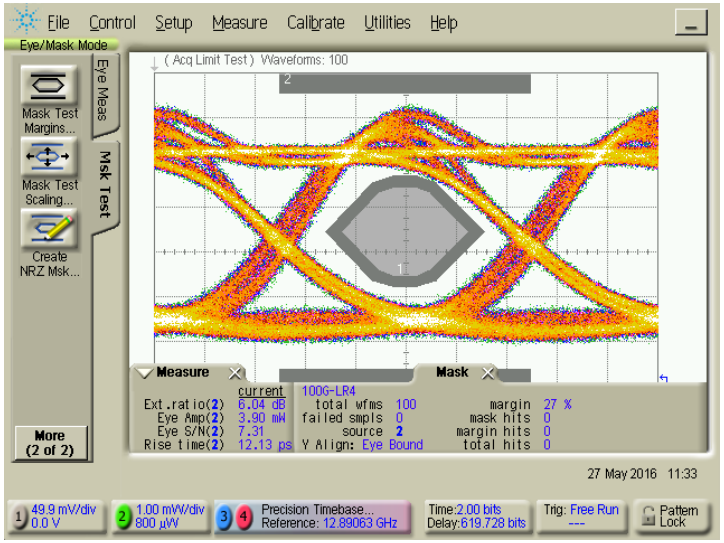


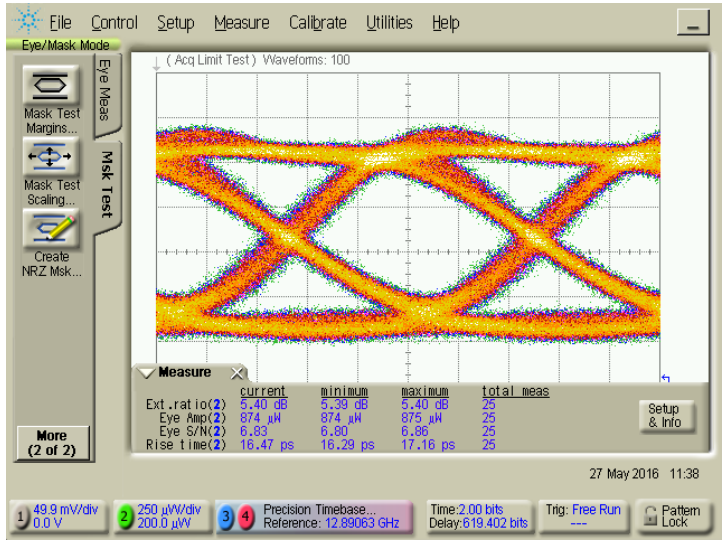
1330nm

65ºC, 60mA

ER = 6dB

Pavg ~ 7.5dBm





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Conclusions

- Asymmetric 25/10G ONUs using 25G APD and uncooled 10G DFB laser will be a key component to enable cost-effective early deployment of NG-EPON.
- Cooled 25G DML in O-band will have sufficient output power for “PR-30” PMD and expect low TDP, but the ONU BOSA cost in 2020 is still expected to be high.
  - Collimated beam optics are needed for the case of all US and DS wavelengths in O-band.
  - 25G headers and flex require higher manufacturing tolerances than 10G components. This will relax as the 25G DML RF performance matures creating more margin.
  - Measurements demonstrate open 25Gb/s eyes with 6dB ER through 20km fiber from 1270nm to 1330nm.
- Uncooled 25G DML will be marginal for “PR-30” PMD even using collimated beam optics for improved coupling loss.
  - Additional study is required to reduce TDP and increase FEC gain.
  - Requires a wavelength plan with a mix of uncooled 25G and cooled 50/100G channels, complicating multiplexing for 100G modules.
- Cooled 25G O-band EML output power will be marginal to what is needed for “PR-30” downstream PMD.
  - Additional study is required to reduce TDP and increase FEC gain, but may not be sufficient.
  - Amplification (integrated SOA or external amplifier) will be required to meet the output power, with increased cost and power consumption.
- Of the laser technologies considered, only the cooled DML has the potential for meeting the “PR-30” power budget for 4x25G WDM ONU without optical amplification.

Thank You