

# **Power Budget of 25G-EPON Upstream**

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# Supporter

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# Motivation

To overcome 25G US power budget, we need higher transmitter power and/or receiver sensitivity.

I checked TP of representative 25G transmitter and compared the budget improvement by  
(1) cooled DML at ONU and (2) SOA-pin at OLT.

# Power Budget of 25G Upstream

Cooled DML can improve the power budget by 4dB for US0-A (1310nm).

25G TOSA	Tx Power/ER (dBm/dB)	Rx Sensitivity @BER=10 <sup>-3</sup> (dBm)	FEC Gain (dB)	Wavelength (nm)	DP (dB)	TP (dB)	Gap=(29+TDP) - (Tx-Rx+FEC) (dB)
Uncooled DML	+5.0 / 4.5	-22.5	1.5	1260-1280	0.0	2.0	2.0 (=31.0-29.0)
				1300-1320	2.0		4.0 (=33.0-29.0)
Cooled DML	+6.5 / 5.0	-23.0	1.5	1260-1280	0.0	1.5	-0.5 (=30.5-31.0)
				1300-1305	0.5		0.0 (=31.0-31.0)

More challenging than -24dBm@ONU

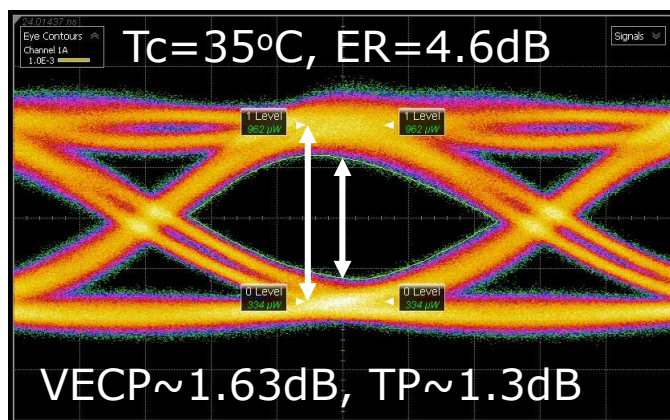
Rx_ave	ER	Rx_OMA
-24.0	8.0	-22.38
-23.0	5.0	-22.83
-22.5	4.5	-22.71

- Tx Power is +5dBm for Uncooled DML and +6.5dBm for Cooled DML (harstead\_3ca\_3\_0917).
- FEC gain is 1.5dB here (Need further study).
- DML: DP@1260-1280nm is ~0dB and DP@1320nm is ~2dB (tanaka\_3ca\_1\_0716 and liu\_3ca\_1\_0917).
- DML: DP@1305nm is ~0.5dB.
- TP of Cooled DML is better than that of Uncooled DML due to lower laser temperature (next slide).

# Representative TP of 25G transmitter

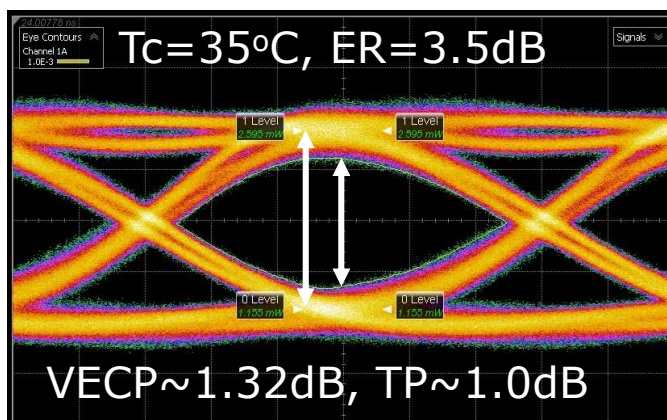
Condition:  $T_c=35^\circ\text{C}/70^\circ\text{C}$ , Rate=25.78125Gb/s, Pattern=PRBS2<sup>31</sup>-1

25G DML #1

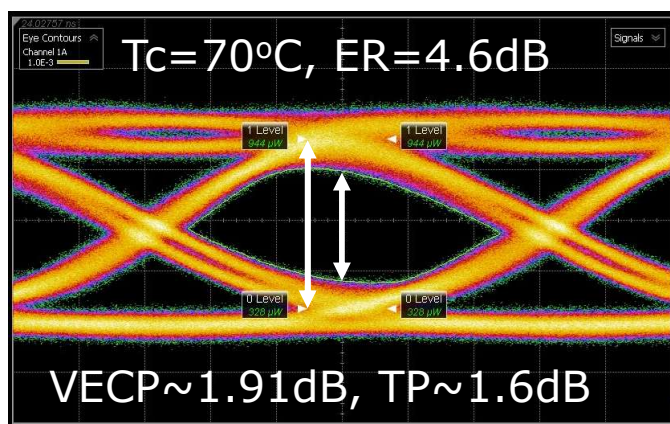
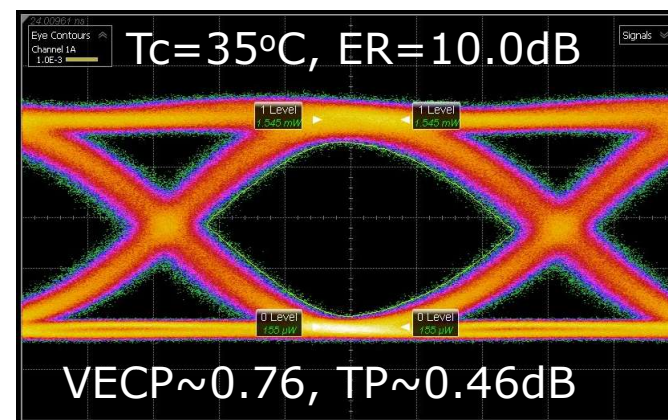


25G DML #2

(Low TP setting at  $T_c=35^\circ\text{C}$ )



25G EML #3



Note: VECP of Ideal Transmitter is less than 0.5dB.  
Assumed that VECP of Ideal Transmitter = 0.3dB  
and "TP = VECP - 0.3".

# Comparison of Cooled DML at ONU and SOA-pin at OLT

TOSA/ROSA cost per ONU and budget improvement is almost same.  
SOA gain control is challenging and additional cost would be necessary.

	Devices for 25G US		Relative Cost per ONU			Budget Improvement (dB)
	TOSA (ONU)	ROSA (OLT)	TOSA (ONU)	ROSA (OLT)	$\Delta$	
1	Uncooled DML	APD (-22.5dBm)	0.8	1.2/20	-	-
2	Cooled DML	APD	1.2	1.2/20	+0.4	4.0dB (US0-A) 2.5dB (US0-B)
3	Uncooled DML	SOA-pin (-26.0dBm)	0.8	10/20	+0.5	3.5dB

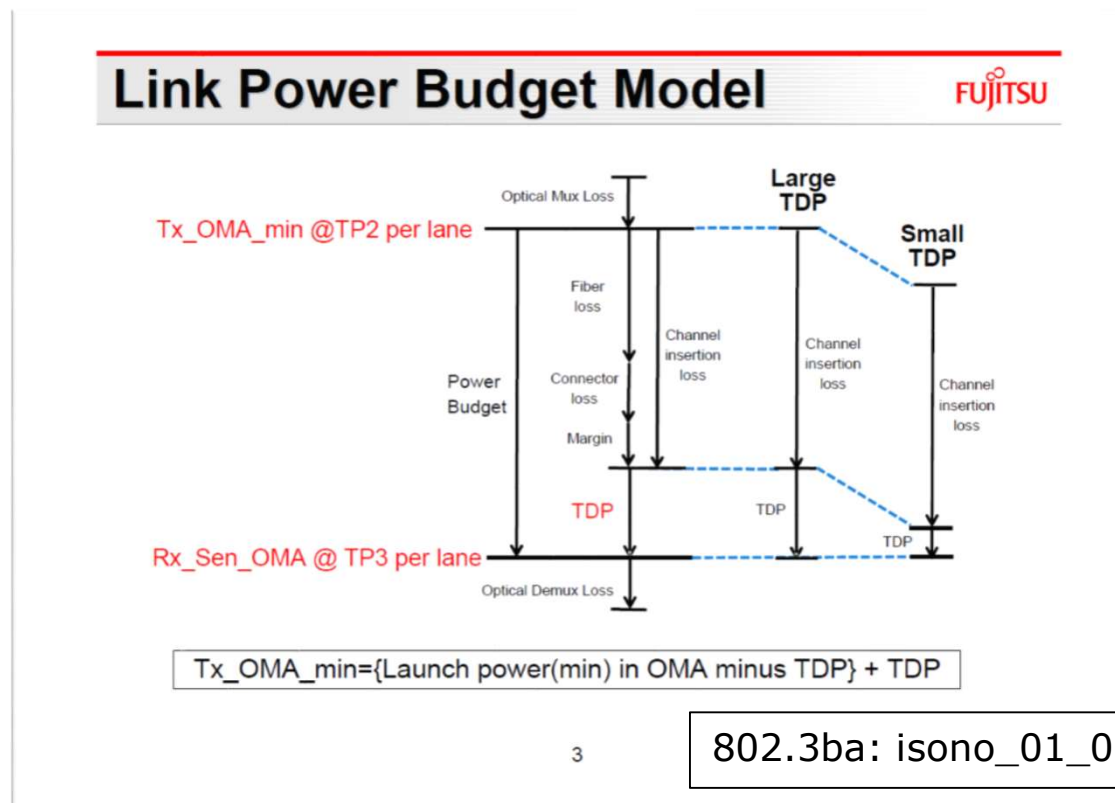
- Relative cost is based on 10G EML TOSA.
- ROSA cost is divided by the number of ONUs.  
It's assumed that the average number of ONUs is 20.

# Recommendation

- 25G-EPON upstream without Mux/Demux  
High power and low TDP DML at ONU and APD at OLT
  - Cooled DML is desirable for US0-A(1300-1305nm TBD) to reduce DP.
  - US0-B(1260-1280nm) has small DP and high power uncooled DML could be available in the future.
  
- 50G-EPON upstream with Mux/Demux  
High power and low TDP DML at ONU and SOA-pin at OLT
  - SOA-pin compensates additional insertion loss of Mux/Demux.
  - It's easier to update OLT optics than ONU optics.
  - SOA-pin and Mux/Demux can be installed from 25G-EPON phase.

# Recommendation

- Define “Tx\_OMA - TDP” parameter like 802.3ba and 802.3cc (25G NRZ).
    - It indicates “High power (amplitude) and Low TDP” transmitter.
    - It can relax transmitter requirements by reducing stacked margin.
    - Common transmitter parameters could be defined for US0-A and US0-B.
    - It’s desirable to consider ER dependency of APD receiver.
- “(Tx\_OMA - ErP) - TDP”      ErP: Extinction Ratio Dependent Penalty



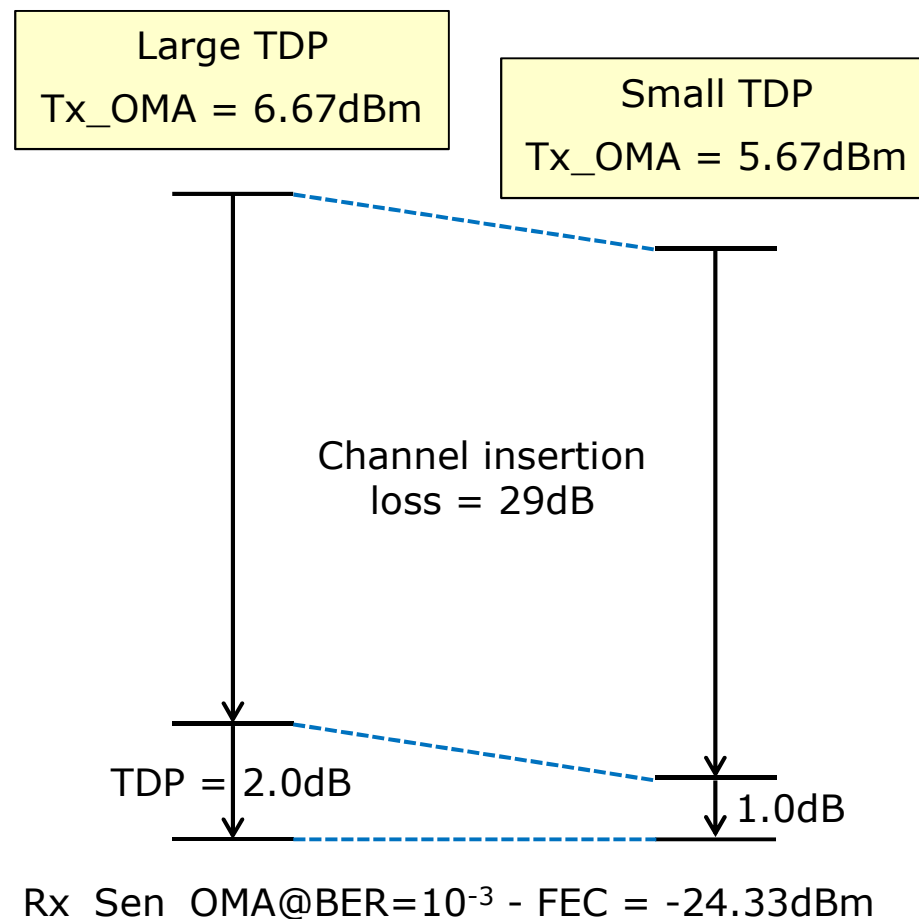


# Example of 25G Upstream Budget

Parameter	Symbol	Value
Launch power	Tx_Ave	6.5 dBm
	Tx_OMA	6.67 dBm
Extinction Ratio	ER	5.0 dBm
Transmitter and Dispersion Penalty	TDP	2.0 dB (TP=2.0dB,DP=0dB)*1 (TP=1.5dB,DP=0.5dB)*2
Launch power minus TDP	Tx_Ave - TDP	4.50 dBm
	Tx_OMA - TDP	4.67 dBm
Sensitivity@BER=10 <sup>-3</sup>	Rx_Sen_Ave	-23.0 dBm
	Rx_Sen_OMA	-22.83 dBm
FEC Gain	FEC	1.5dB

(\*1) uncooled DML@1260-1280nm, 0km

(\*2) cooled DML@1305nm, 20km



**Thank you !**