

Security Level:

Analysis of Multi-channel Crosstalk with SOA as Pre-amplifier in 100G EPON

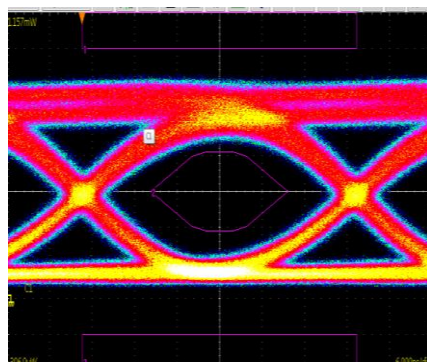
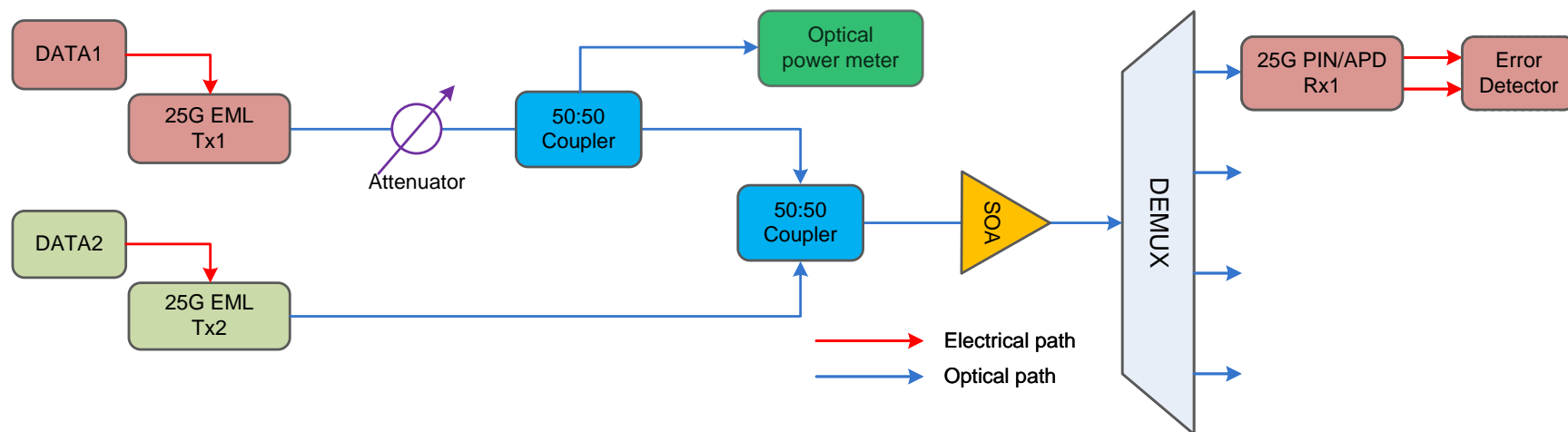
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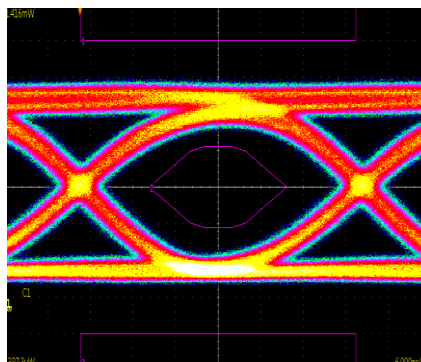
Background

- Due to the lower receiver sensitivity at 25Gb/s line rate and the extra loss of mux/demux, 100G EPON high likely needs optical pre-amplifiers to meet the PR30 power budget requirement .
- From both implementation and cost consideration, 4 channels of 100G share a same pre-amp SOA is a more practical solution.
- Due to the fast carrier recovery time in SOA, when multiple channels share a same SOA, some crosstalk between channels will happen.
- This contribution study the crosstalk effect between channels when a shared pre-amp SOA is used for 100G EPON and shows some initial experiment results.

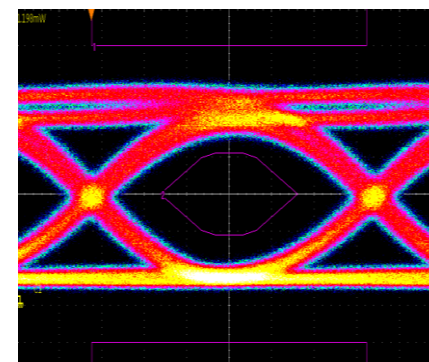
Experimental setup



1294.6 nm, ER=8.5dB

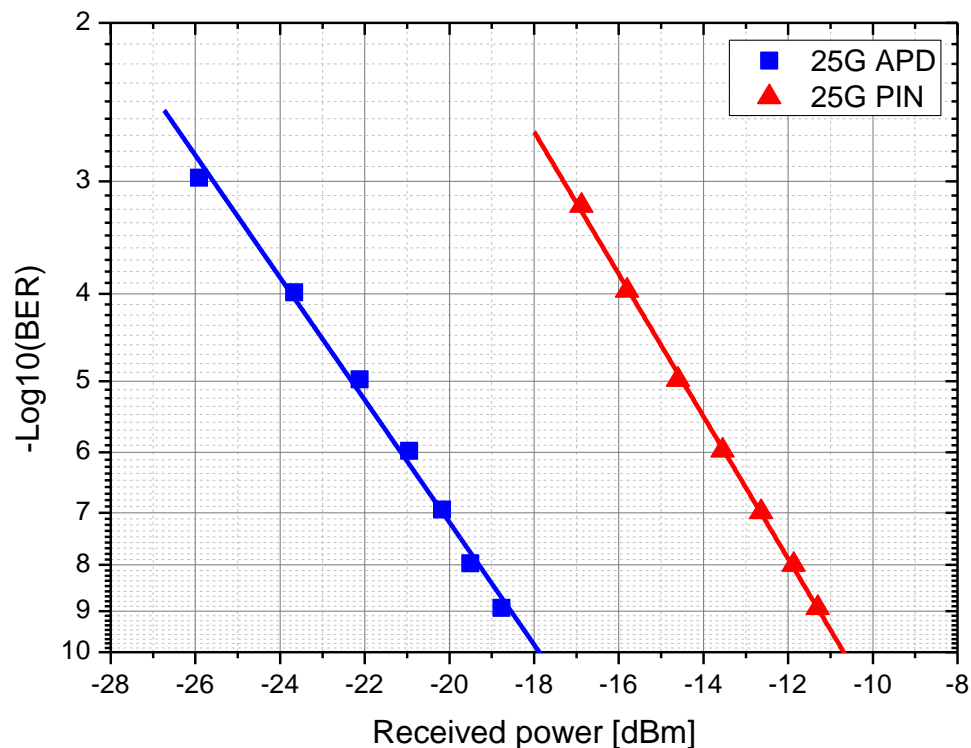


1299.9 nm, ER=8 dB



1308.3 nm, ER=9.5dB

Sensitivity of 25G APD & 25G PIN

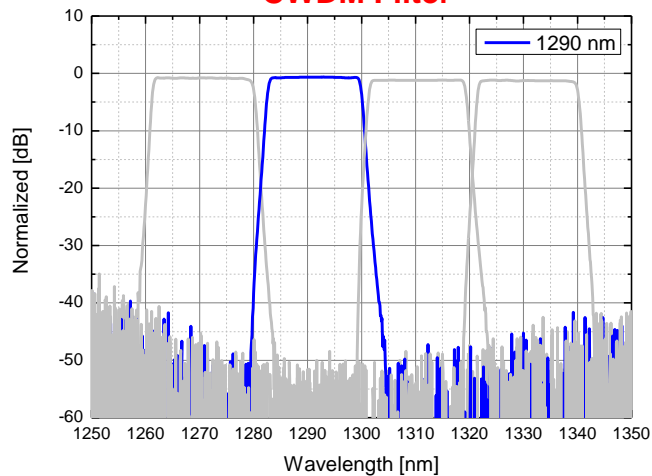


Test conditions: back-to-back, NRZ, PRBS=2³¹-1

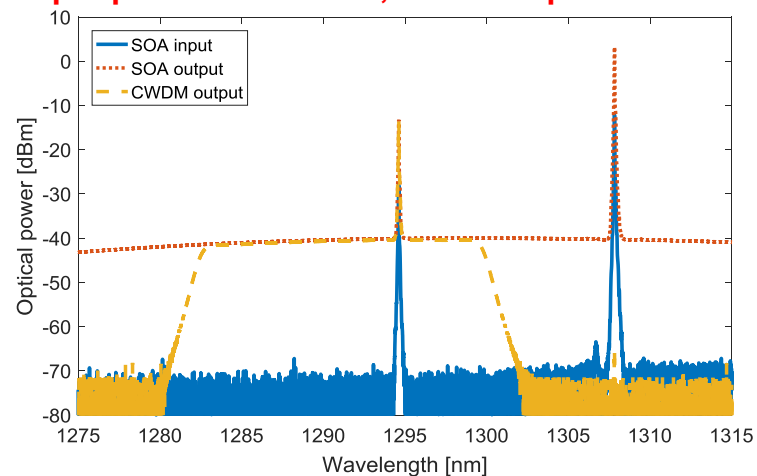
Parameter	Value	Unit
Tx bit rate	25.78125	Gb/s
Tx wavelength	1294.6	nm
Tx output power	2	dBm
Tx ER	8.5	dB
Rx responsivity	APD: 3~6	A/W
	PIN: 0.75	
Rx sensitivity (@BER=1E-3)	APD: -25.9	dBm
	PIN: -17.2	

Transmission spectra of filter

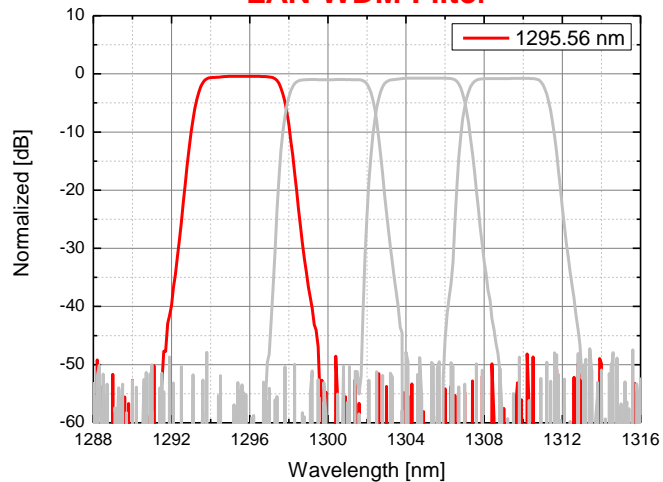
CWDM Filter



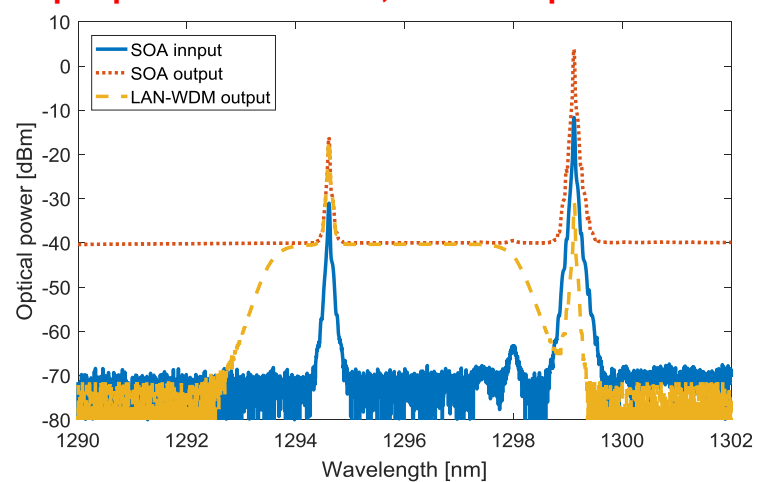
For input power of -25 dBm, crosstalk power of -9 dBm



LAN-WDM Filter

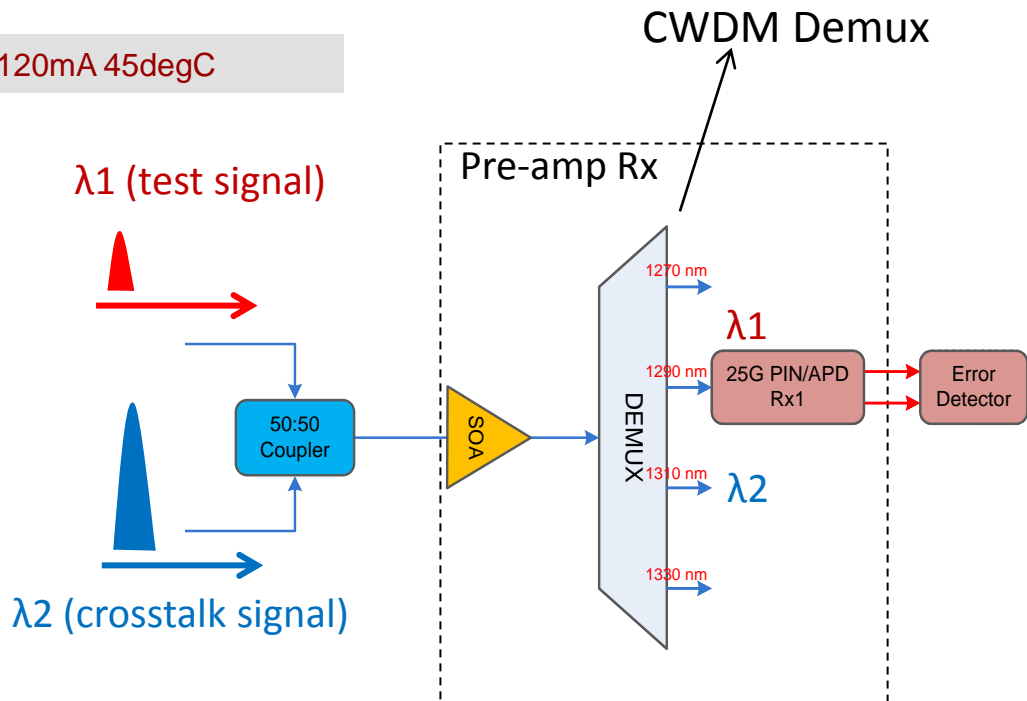
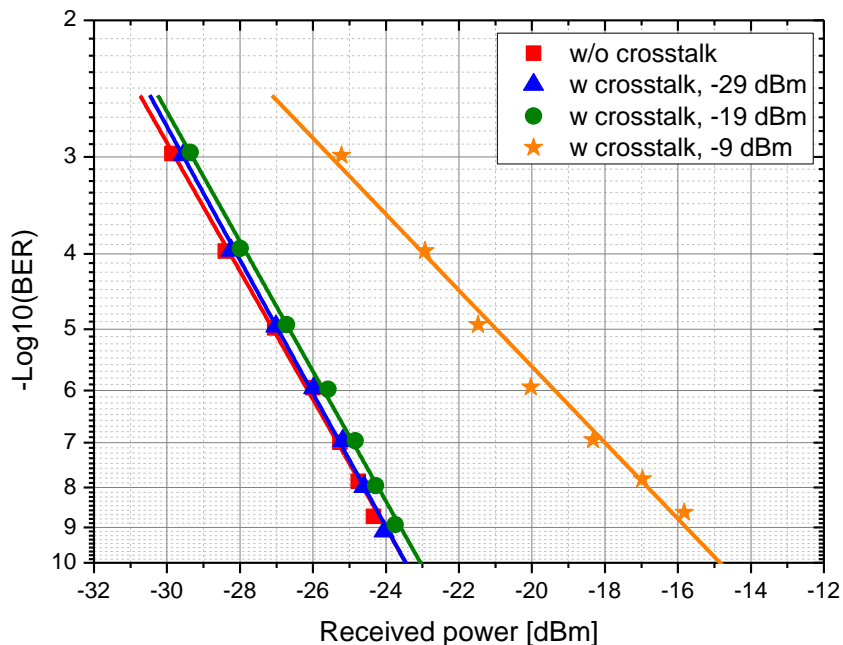


For input power of -28 dBm, crosstalk power of -9 dBm



Case1: 25G APD with CWDM filter

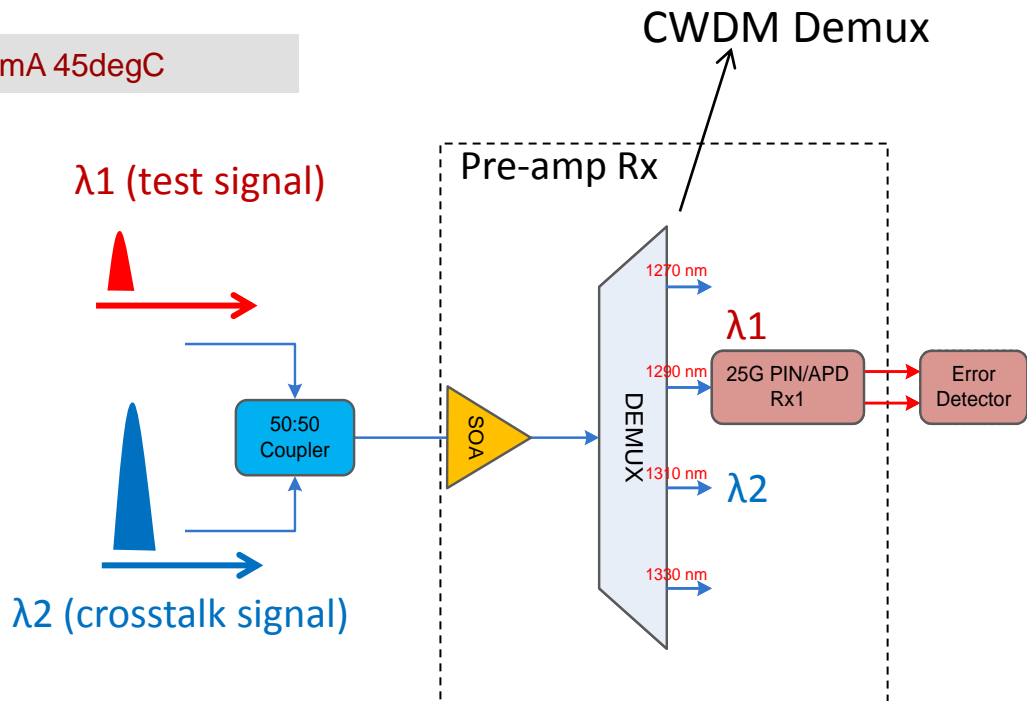
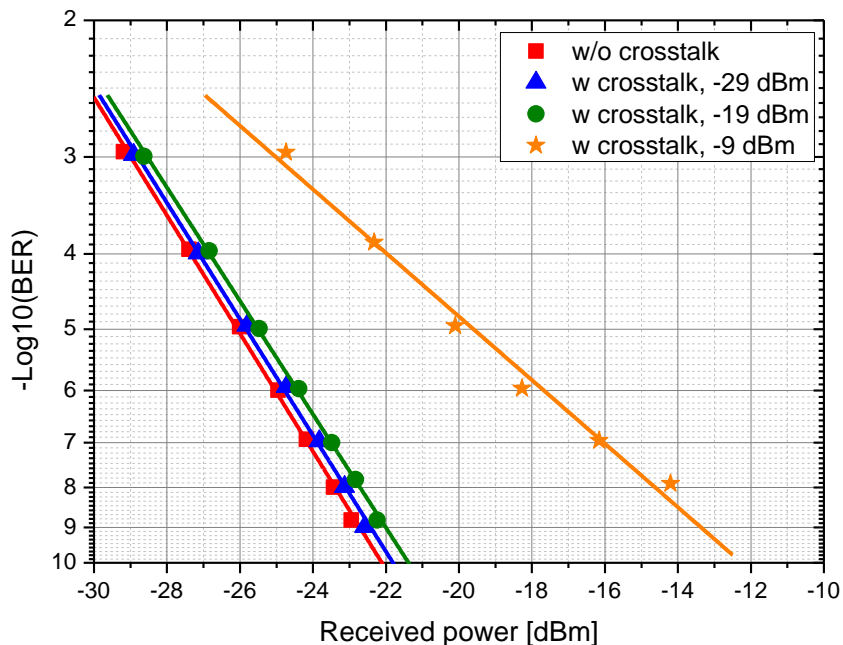
25G APD ROSA, SOA 120mA 45degC



	25G APD	w/o crosstalk	w. crosstalk power of -29 dBm	w. crosstalk power of -19 dBm	w. crosstalk power of -9 dBm
Rx. Sen. (@BER=1E-3)	-25.9 dBm	-29.8 dBm	-29.5 dBm	-29.3 dBm	-25.3 dBm

Case2: 25G PIN with CWDM filter

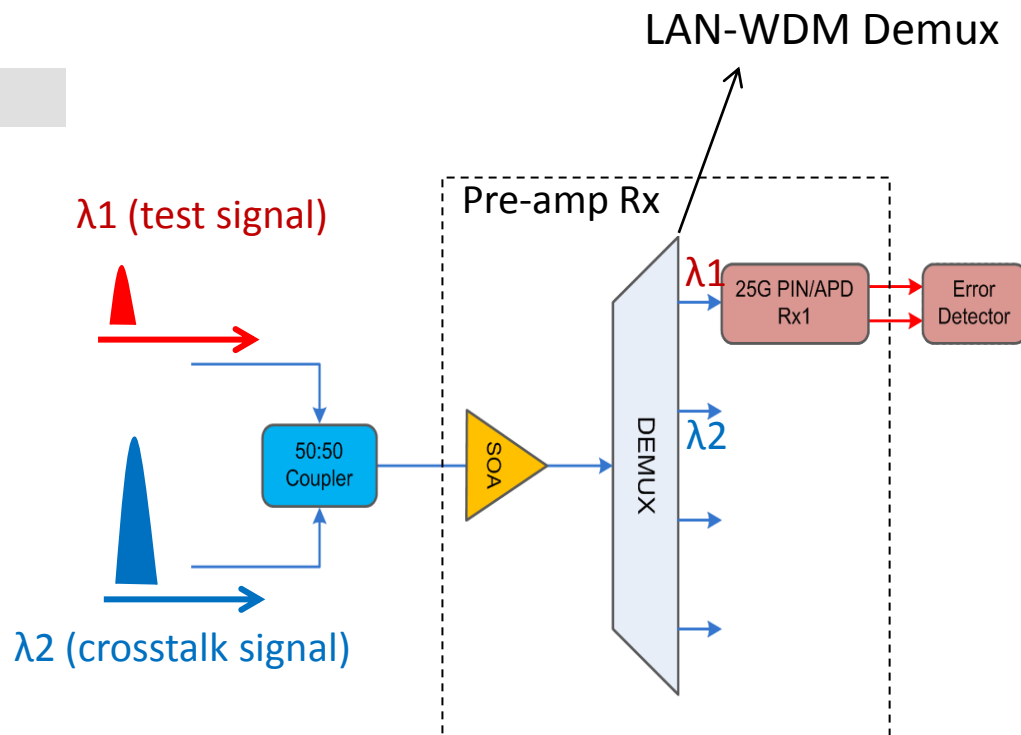
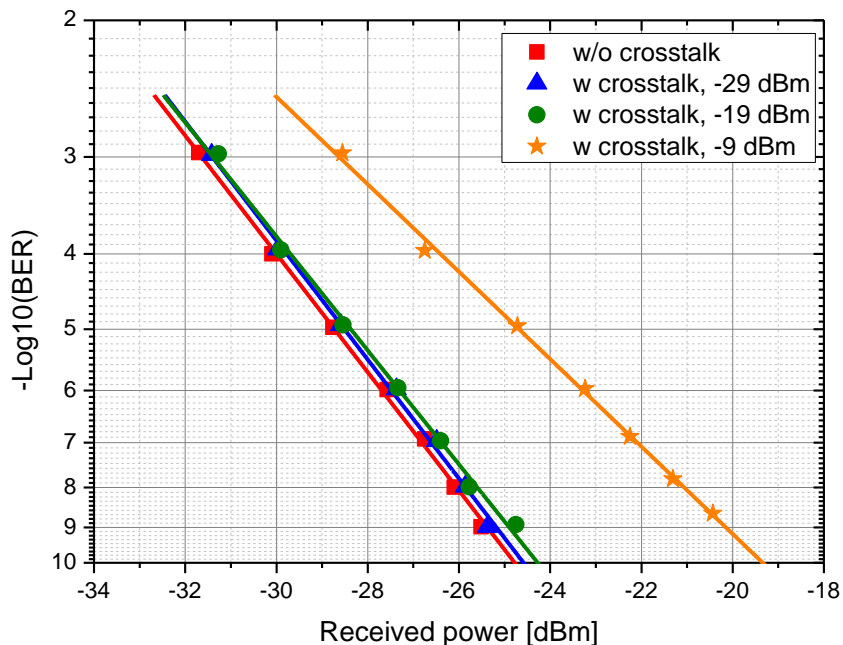
25G PIN ROSA, SOA 120mA 45degC



	25G PIN	w/o crosstalk	w. crosstalk power of -29 dBm	w. crosstalk power of -19 dBm	w. crosstalk power of -9 dBm
Rx. Sen. (@BER=1E-3)	-17.2 dBm	-29.1 dBm	-28.9 dBm	-28.6 dBm	-24.9 dBm

Case3: 25G APD with LAN-WDM filter

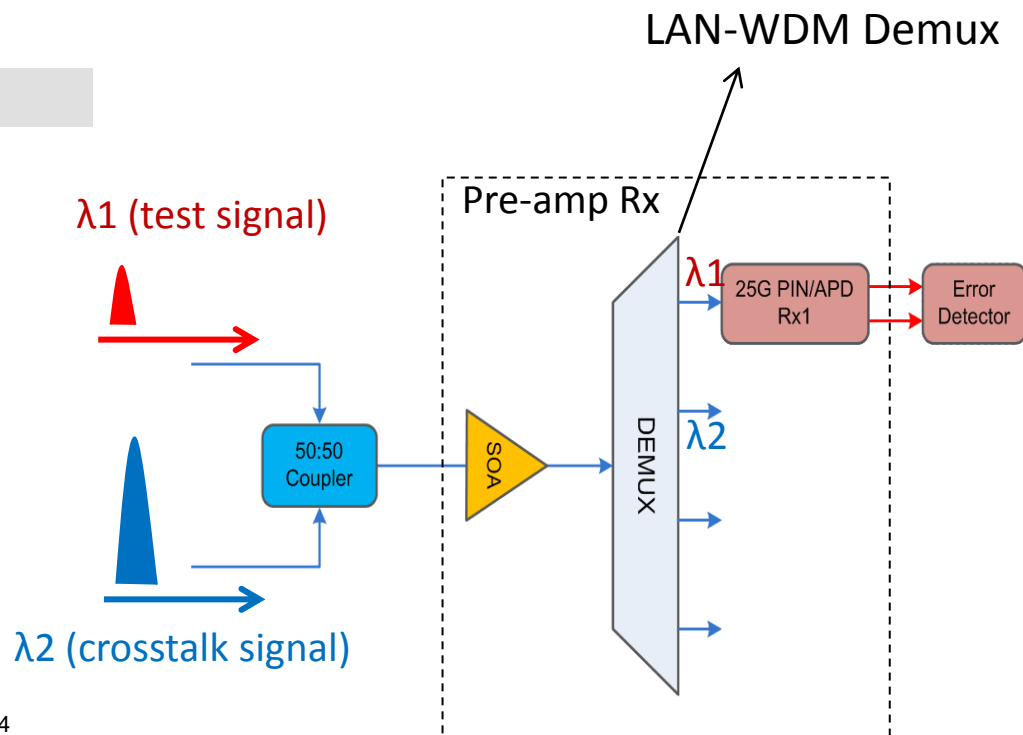
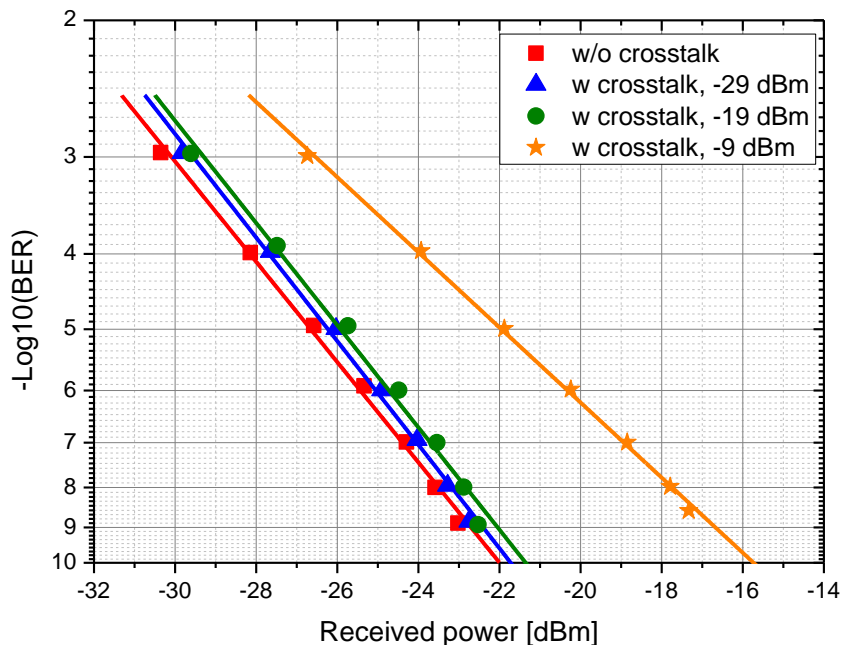
25G APD ROSA, SOA 120mA 45degC



	25G APD	w/o crosstalk	w. crosstalk power of -29 dBm	w. crosstalk power of -19 dBm	w. crosstalk power of -9 dBm
Rx. Sen. (@BER=1E-3)	-25.9 dBm	-31.7 dBm	-31.4 dBm	-31.2 dBm	-28.5 dBm

Case4: 25G PIN with LAN-WDM filter

25G PIN ROSA, SOA 120mA 45degC



	25G PIN	w/o crosstalk	w. crosstalk power of -29 dBm	w. crosstalk power of -19 dBm	w. crosstalk power of -9 dBm
Rx. Sen. (@BER=1E-3)	-17.2 dBm	-30.1 dBm	-29.7 dBm	-29.4 dBm	-26.6 dBm

Overview comparison

CWDM case

	w/o SOA	w/o crosstalk	w. crosstalk power of -29 dBm	w. crosstalk power of -19 dBm	w. crosstalk power of -9 dBm
25G APD Rx. Sen. (@BER=1E-3)	-25.9 dBm	-29.8 dBm	-29.5 dBm	-29.3 dBm	-25.3 dBm
25G PIN Rx. Sen. (@BER=1E-3)	-17.2 dBm	-29.1 dBm	-28.9 dBm	-28.6 dBm	-24.9 dBm

LAN-WDM case

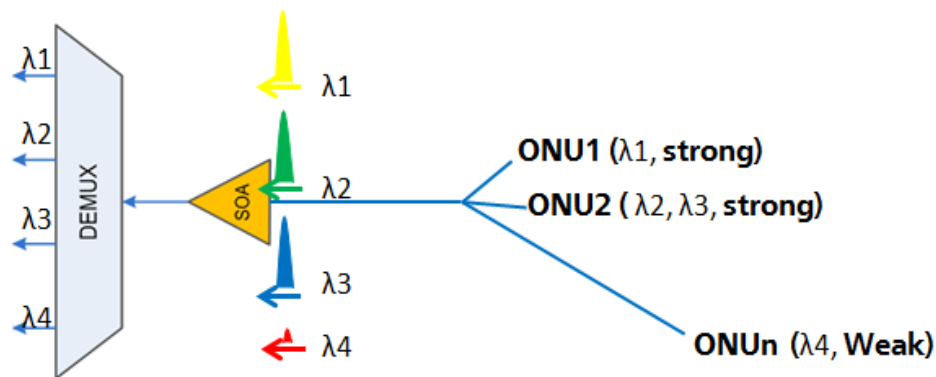
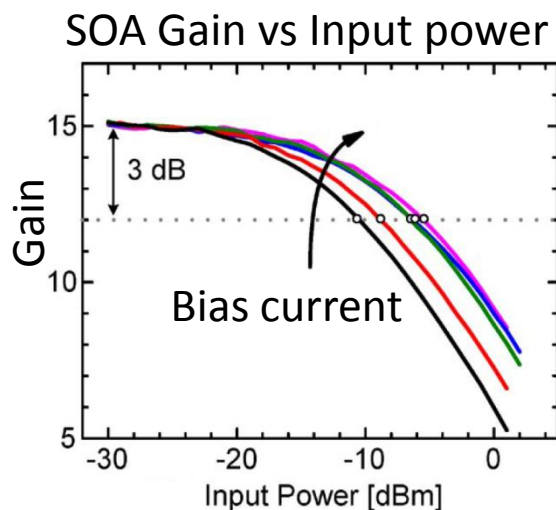
	w/o SOA	w/o crosstalk	w. crosstalk power of -29 dBm	w. crosstalk power of -19 dBm	w. crosstalk power of -9 dBm
25G APD Rx. Sen. (@BER=1E-3)	-25.9 dBm	-31.7 dBm	-31.4 dBm	-31.2 dBm	-28.5 dBm
25G PIN Rx. Sen. (@BER=1E-3)	-17.2 dBm	-30.1 dBm	-29.7 dBm	-29.4 dBm	-26.6 dBm

Summary

When multiple channels share a same pre-amp SOA:

- The crosstalk penalty for other channels is less than 1dB if the input power of crosstalk channel is comparable with that of the test channel.
- If the input power of crosstalk channel is distinctly higher than that of test channel (such as 20dB more), there will be serious crosstalk penalty.

Analysis:

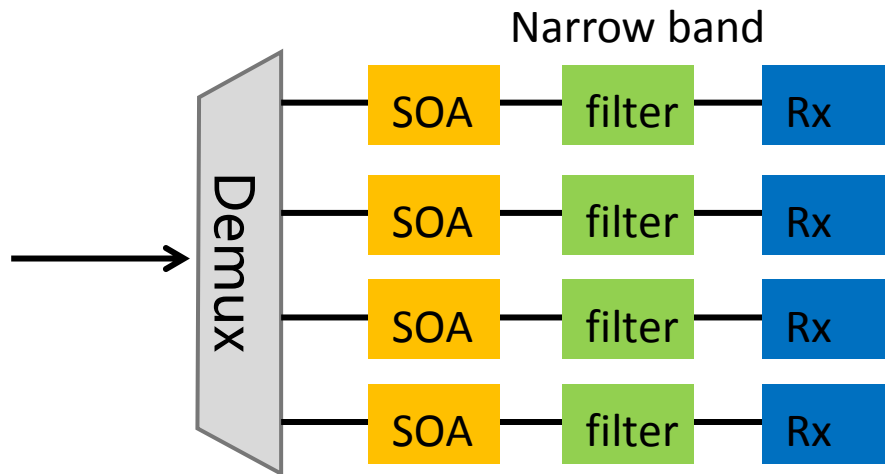


If three strong signal together with one weak signal arrive the OLT at the same time, the SOA will become saturated and can't provide enough gain for weak signal

- The gain of SOA will decrease as the total input power increases.
- In worst case, the total power of $\lambda_1, \lambda_2, \lambda_3$ can be **24dB** higher than λ_4 . (14dB ODN dynamic range, 5dB ONU launch power spread range together with $\log_{10}(3)$)
- Such a big dynamic range in PON upstream will be the killer for the shared pre-amp SOA used in OLT for upstream.

How to solve this issue?

Solution (1)-single channel SOA

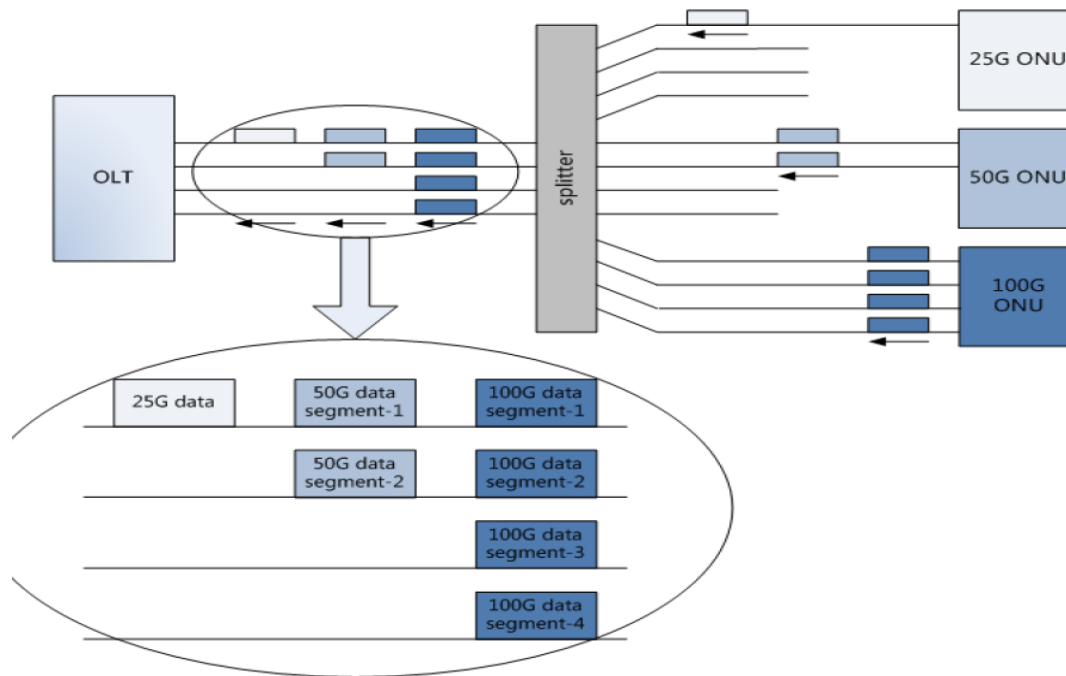


- It needs more SOA gain due to the insertion loss of Demux
- For discrete components solution:
 - Cost is very high, size is very big, heat dissipation is very challenging
- For optical integration solution:
 - Narrow band filter is very difficult to design
 - Both filter and SOA must be polarization insensitive
 - Size and heat dissipation is very challenging
 - Technical maturity is poor

It's not a good solution for commercialization in foresee near term

Solution(2) –single domain DBA

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- All 4 sub-channels in a single scheduling domain
- **This will result in huge bandwidth wasting**

Final thoughts:

- There still be a lot of issues on the feasibility of 100G EPON pre-amp SOA to overcome the needed power budget issue.
- The task force need to decide which way we should go or explore some more potential solutions.

Thank you
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