

Security Level:

# SOA as Pre-amplifier for DML transmitter in 100G EPON

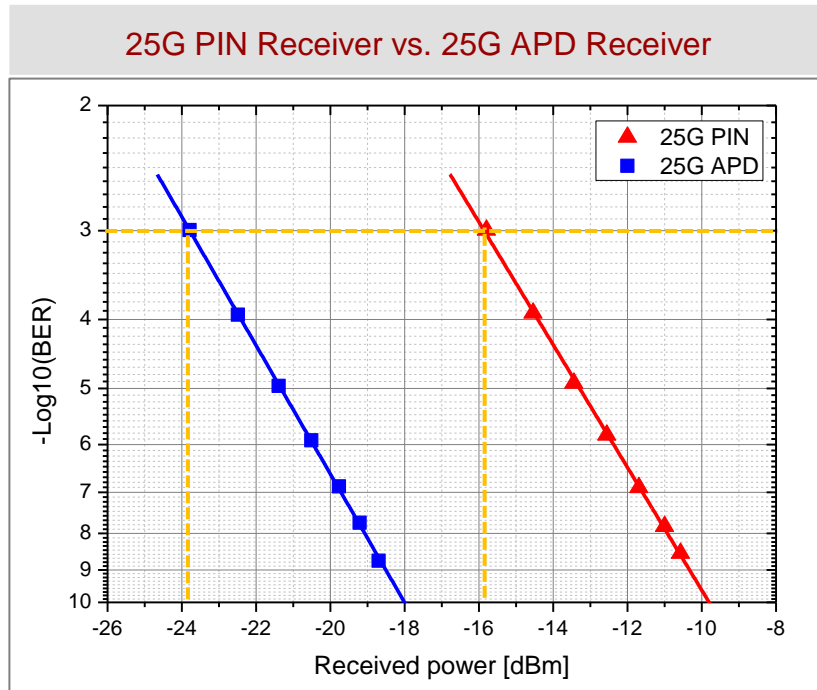
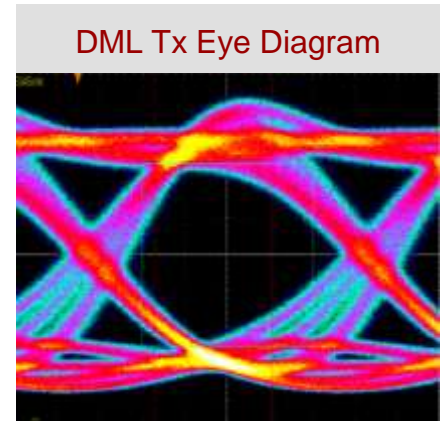
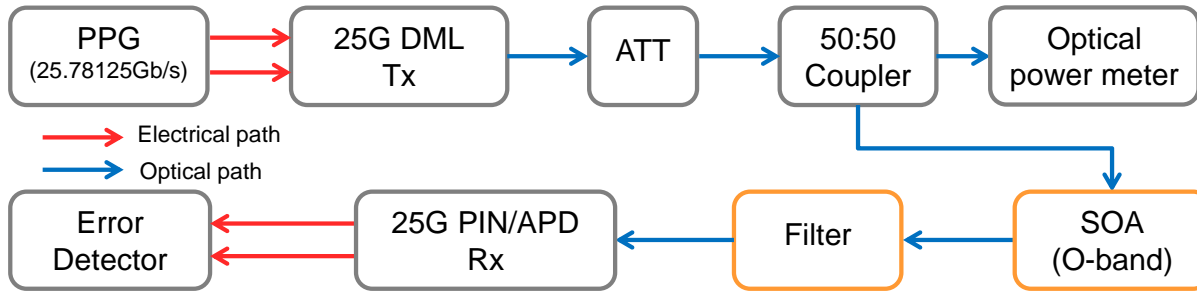
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March, 2017

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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 .
- Initial experimental results of SOA as pre-amplifier of EML TOSA for 100G EPON has been demonstrated in [\*liu\\_3ca\\_1\\_0117.pdf\*](#).
- For low cost consideration, ONU may use DMLs as the transmitter, this contribution shows experimental results of SOA as pre-amplifier for DML transmitter in 100G EPON, and also the impact of SOA's operating temperature have been demonstrated.

# Experimental setup

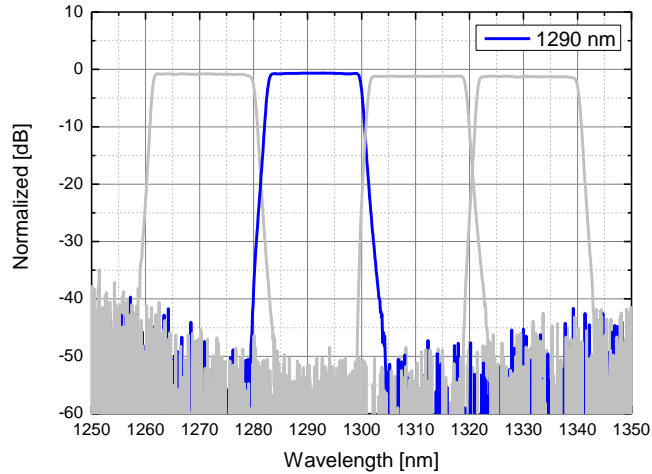


Test conditions: back-to-back, NRZ, PRBS=2<sup>31</sup>-1

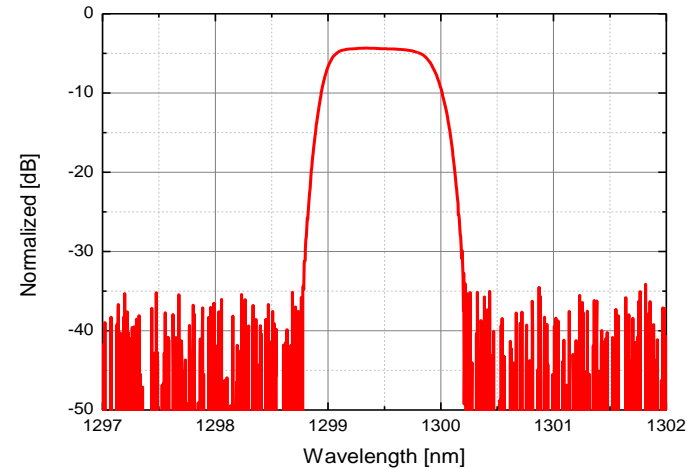
Parameter	Value	Unit
Tx bit rate	25.78125	Gb/s
Tx wavelength	1295.3	nm
Tx output power	5.2	dBm
Tx ER	5.6	dB
Rx responsivity	APD: 3~6	A/W
	PIN: 0.75	
Rx sensitivity (@BER=1E-3)	APD: -23.8	dBm
	PIN: -15.8	

# Transmission Spectra of Filters

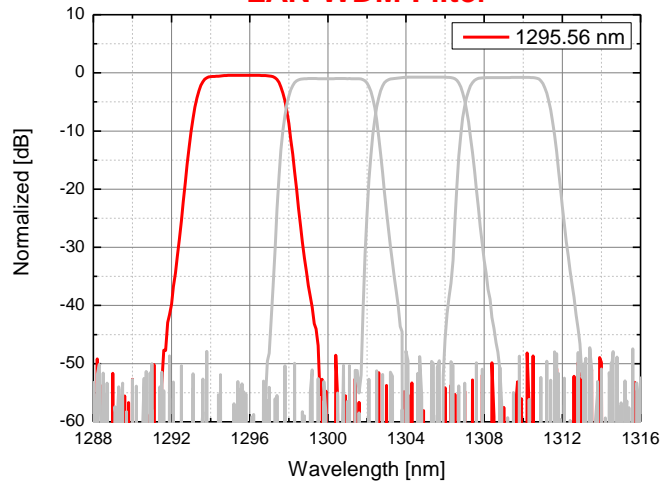
**CWDM Filter**



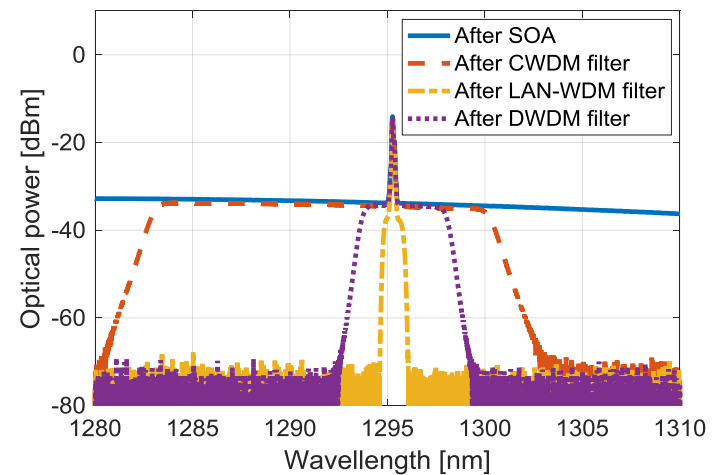
**DWDM Filter**



**LAN-WDM Filter**

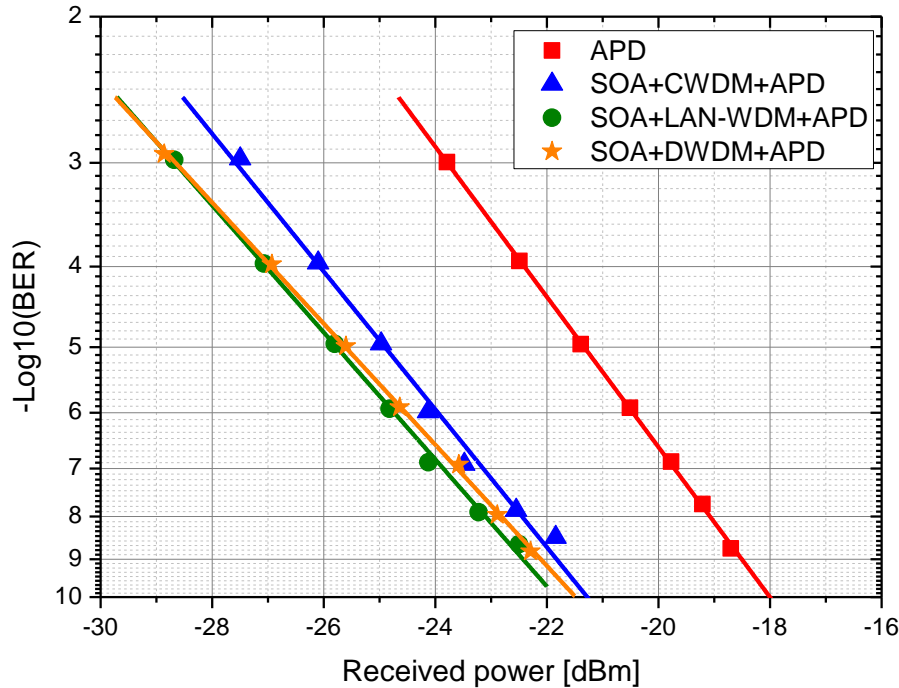


**For SOA input power of -30dBm**



# Rx1: 25G APD with SOA & Filter

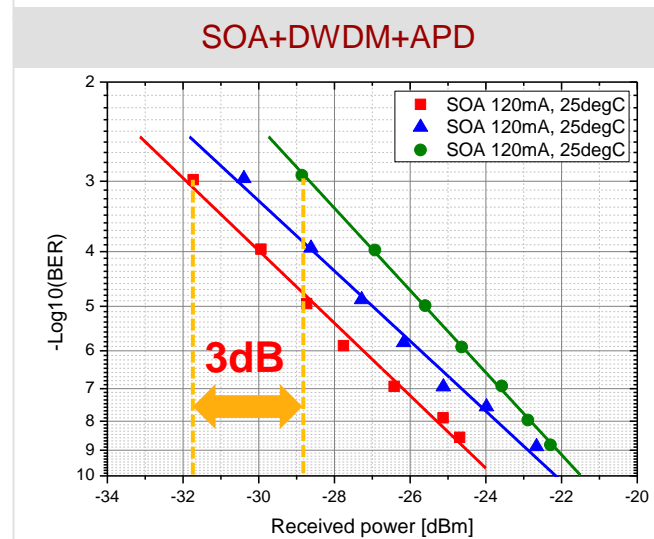
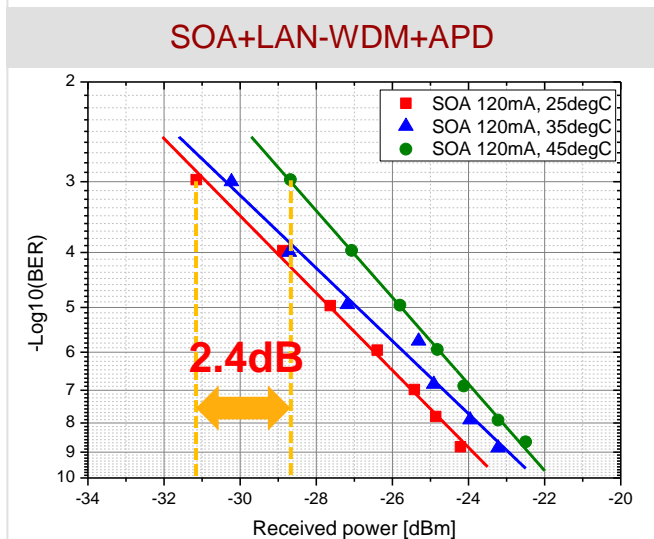
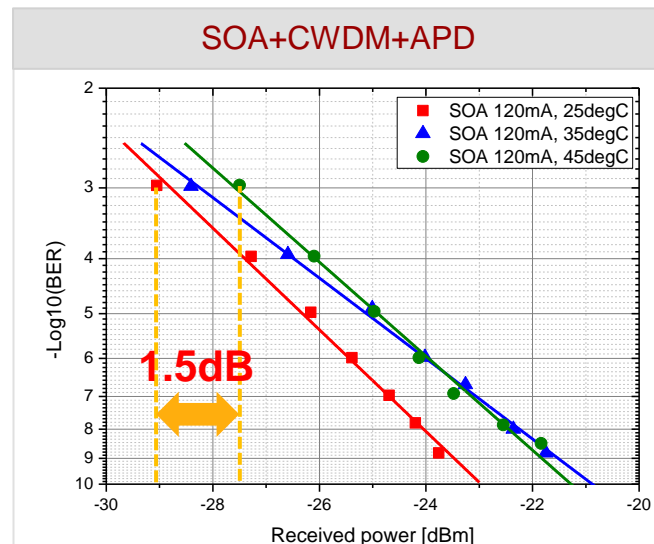
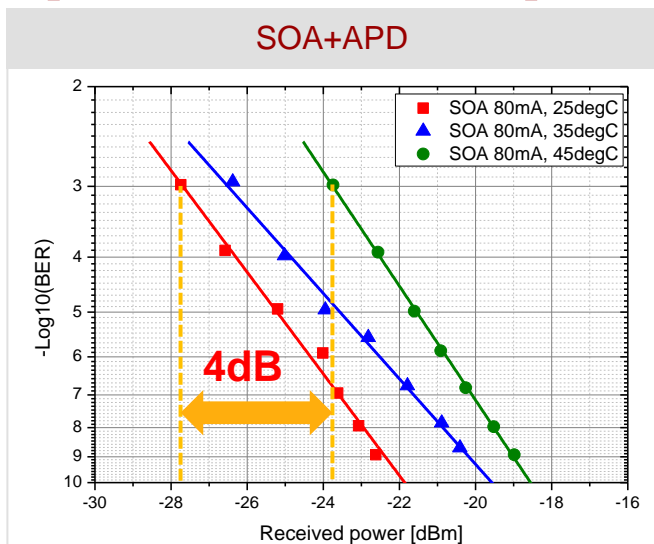
25G APD ROSA, SOA 120mA 45degC



- Compared with 25G APD, using SOA as pre-amp. and CWDM filter, Rx. Sen. increased **3.7 dB**.
- Using SOA and LAN-WDM filter, Rx. Sen. increased **4.8 dB**.
- Using SOA and DWDM filter, Rx. Sen. increased **4.9 dB**.

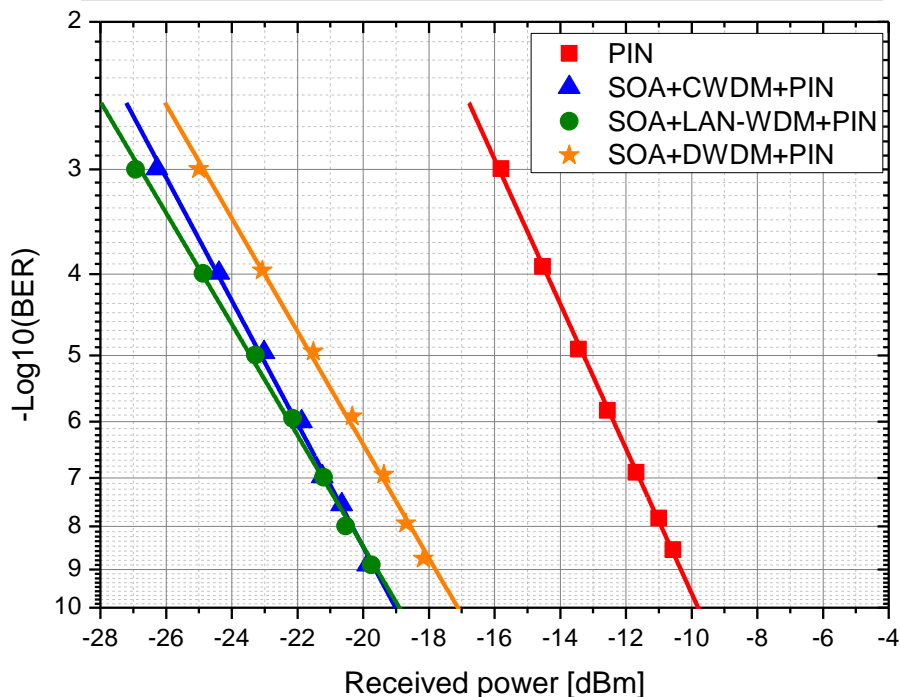
	25G APD	APD+SOA W/O filter	w. SOA+CWDM filter (16.8 nm)	w. SOA+LAN-WDM filter (4.09 nm)	w. SOA+DWDM filter (0.9 nm)
<b>Rx. Sen. (@BER=1E-3)</b>	-23.8 dBm	-23.74dBm	-27.5 dBm	-28.6 dBm	-28.7 dBm

# Impact of Temperature



# Rx2: 25G PIN with SOA & Filter

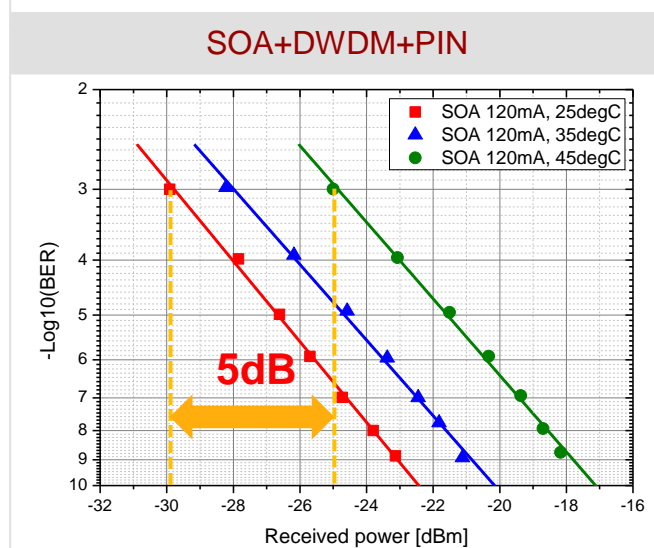
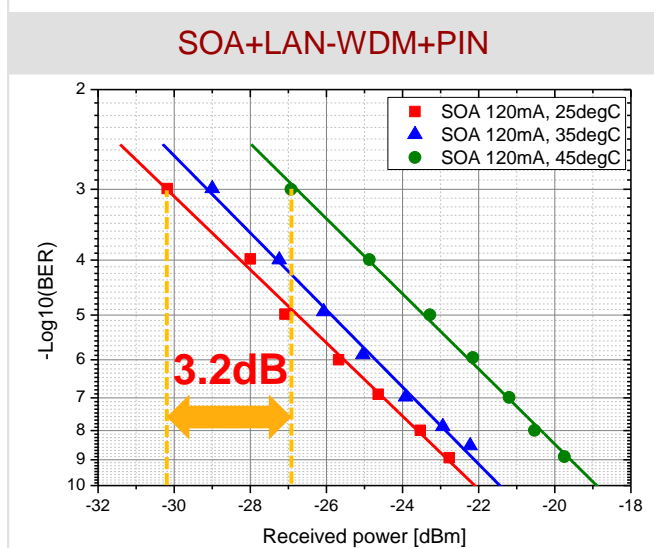
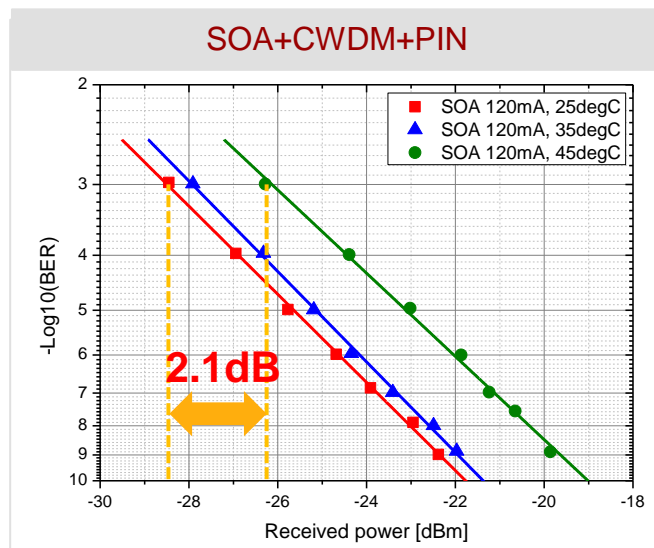
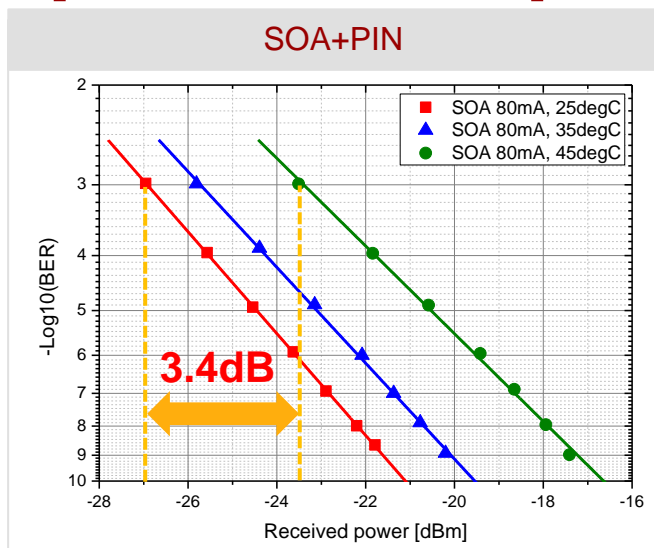
25G PIN ROSA, 45degC



- Compared with 25G PIN, using SOA as pre-amp. and CWDM filter, Rx. Sen. increased **10.6 dB**.
- Using SOA and LAN-WDM filter, Rx. Sen. increased **11.2 dB**.
- Using SOA and DWDM filter, Rx. Sen. increased **9.2 dB**.

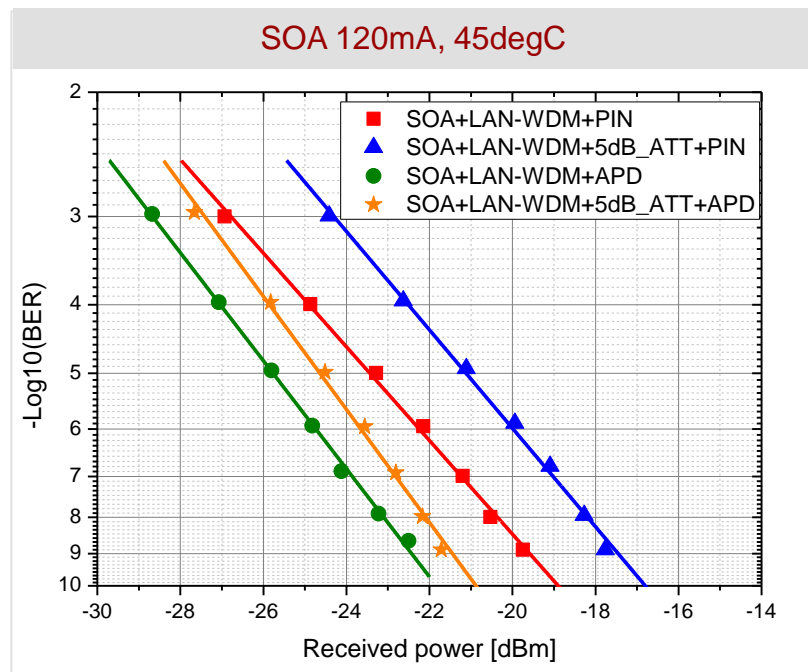
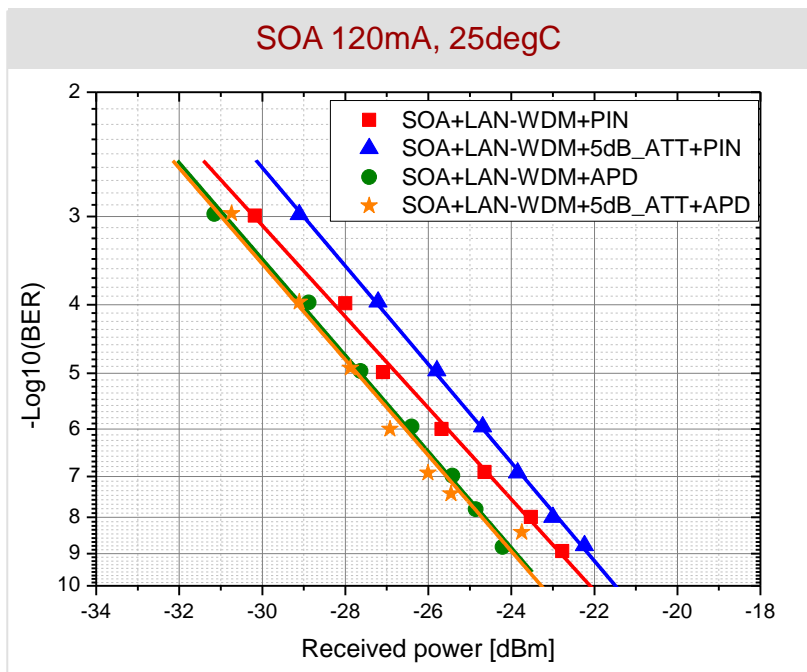
	25G PIN	PIN+SOA W/O filter	w. SOA+CWDM filter (16.8 nm)	w. SOA+LAN- WDM filter (4.09 nm)	w. SOA+DWDM filter (0.9 nm)
<b>Rx. Sen. (@BER=1E-3)</b>	-15.8 dBm	-23.5dBm	-26.4 dBm	-27.0 dBm	-25.0 dBm

# Impact of Temperature





# Impact of Insertion Loss (for LAN-WDM case)



	SOA+LAN-WDM+PIN	SOA+LAN-WDM+5dB_ATT+PIN
<b>Rx. Sen. (@1e-3 BER)</b>	-30.2 dBm	-29.1 dBm
	SOA+LAN-WDM+APD	SOA+LAN-WDM+5dB_ATT+APD
<b>Rx. Sen. (@1e-3 BER)</b>	-31.0 dBm	-30.5 dBm

	SOA+LAN-WDM+PIN	SOA+LAN-WDM+5dB_ATT+PIN
<b>Rx. Sen. (@1e-3 BER)</b>	-27.0 dBm	-24.4 dBm
	SOA+LAN-WDM+APD	SOA+LAN-WDM+5dB_ATT+APD
<b>Rx. Sen. (@1e-3 BER)</b>	-28.6 dBm	-27.6 dBm

# Overview comparison

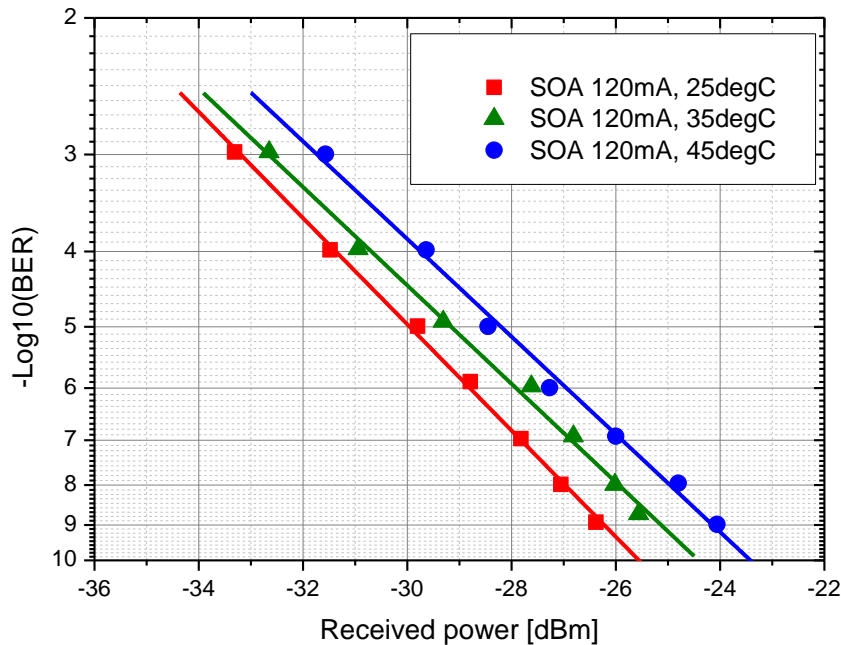
	25G PIN	w. SOA (80 mA)	w. SOA(120mA)+CWDM filter (16.8 nm)	w. SOA(120mA)+LAN- WDM filter (4.09 nm)	w. SOA(120mA)+DWDM filter (0.9 nm)
<b>Rx. Sen. (@BER=1E-3) T<sub>SOA</sub>=45 degC</b>	-15.8 dBm	-23.6 dBm	-26.4 dBm	-27.0 dBm	-25 dBm
<b>Rx. Sen. (@BER=1E-3) T<sub>SOA</sub>=35 degC</b>	-15.8 dBm	-25.8 dBm	-27.9 dBm	-29.0 dBm	-28.2 dBm
<b>Rx. Sen. (@BER=1E-3) T<sub>SOA</sub>=25 degC</b>	-15.8 dBm	-27.0 dBm	-28.5 dBm	-30.2 dBm	-30.0 dBm
	25G APD	w. SOA (80 mA)	w. SOA(120mA)+CWDM filter (16.8 nm)	w. SOA(120mA)+LAN- WDM filter (4.09 nm)	w. SOA(120mA)+DWDM filter (0.9 nm)
<b>Rx. Sen. (@BER=1E-3) T<sub>SOA</sub>=45 degC</b>	-23.8 dBm	-23.7 dBm	-27.5 dBm	-28.6 dBm	-28.7 dBm
<b>Rx. Sen. (@BER=1E-3) T<sub>SOA</sub>=35 degC</b>	-23.8 dBm	-26.4 dBm	-28.4 dBm	-30.2 dBm	-30.4 dBm
<b>Rx. Sen. (@BER=1E-3) T<sub>SOA</sub>=25 degC</b>	-23.8 dBm	-27.7 dBm	-29.0 dBm	-31.0 dBm	-31.7 dBm

# Summary

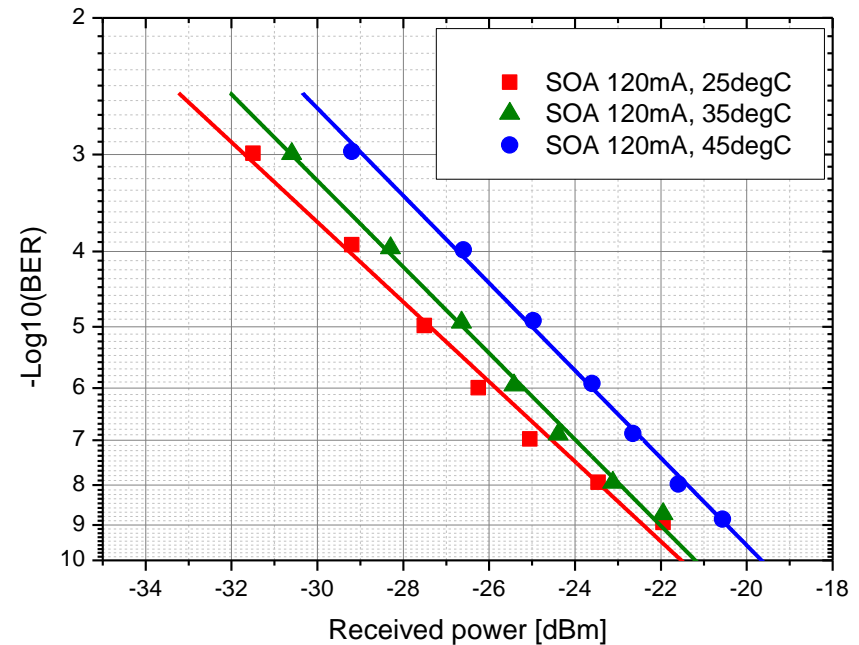
- Experimental results of SOA as pre-amplifier of DML TOSA for 100G EPON has been demonstrated.
  - Same trend with EML TOSA case in previous works (liu\_3ca\_1\_0117.pdf).
  - SOA+APD has less than 2dB sensitivity advantage compared with SOA+PIN.
  - The bandwidth of pass band filter has an important impact on the sensitivity gain for SOA+APD/PIN.
- Temperature of SOA has significant impact on Rx. Sen.
- SOA+PIN is more sensitive to temperature and insertion loss than SOA+APD.

# 25G EML Rx for comparison (LAN-WDM case)

SOA+25G APD ROSA



SOA+25G PIN ROSA



- For 25G APD ROSA, when the temperature of SOA is set as 45degC, Rx. Sen. decreased **1.7 dB** comparing with 25degC.
- For 25G PIN ROSA, when the temperature of SOA is set as 45degC, Rx. Sen. decreased **2.3 dB** comparing with 25degC.

# 25G EML Rx for comparison (LAN-WDM case)

Test conditions: w. SOA (120 mA)+LAN-WDM filter (4.09 nm)

	Rx. Sen. (@BER=1E-3) T <sub>SOA</sub> =45 degC	Rx. Sen. (@BER=1E-3) T <sub>SOA</sub> =35 degC	Rx. Sen. (@BER=1E-3) T <sub>SOA</sub> =25 degC
EML Tx, PIN Rx.	-29.3 dBm	-30.7 dBm	-31.6 dBm
EML Tx., APD Rx.	-31.5 dBm	-32.6 dBm	-33.2 dBm
Difference between APD & PIN	2.2 dB	1.9 dB	1.6 dB
DML Tx., PIN Rx.	-27.0 dBm	-29.0 dBm	-30.2 dBm
DML Tx., APD Rx.	-28.6 dBm	-30.2 dBm	-31.0 dBm
Difference between APD & PIN	1.6 dB	1.2 dB	0.8 dB

**Thank you**

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