



Simulation Study on 100G EPON Wavelength Plan A



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IEEE 802.3ca 100G EPON TF
November, 2016
San Antonio, Texas, USA

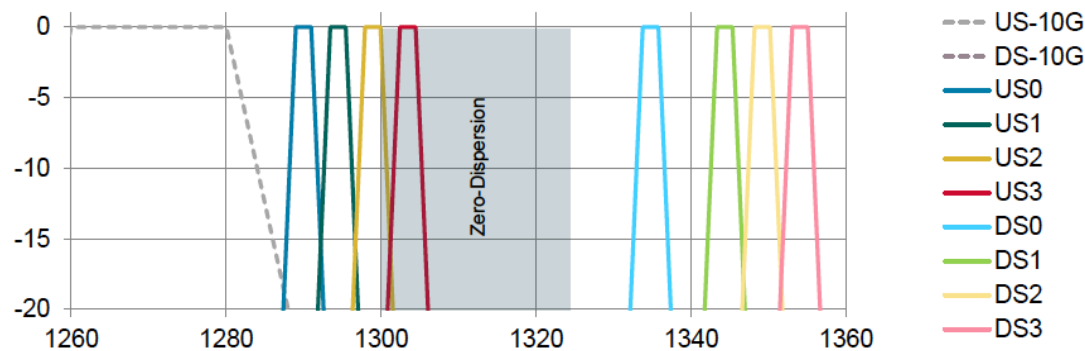
Background

- A all O band wavelength plan was presented at September interim meeting at Dallas in a joint contribution [johnson_3ca_1a_0916.pdf](#). Questions were brought out regarding Huawei's simulations on FWM at zero dispersion region. This contribution provides a comparison study based on the author's works on the same subjects.

Outline

- **Comparison study against Huawei's simulations results on "plan A"**
 - **FWM when zero dispersion is at the center of channel 3**
 - **FWM when zero dispersion is at the middle between channel 3 and channel 2**

All O band wavelength plan A from Dallas meeting*



* P 8, johnson_3ca_1a_0916.pdf

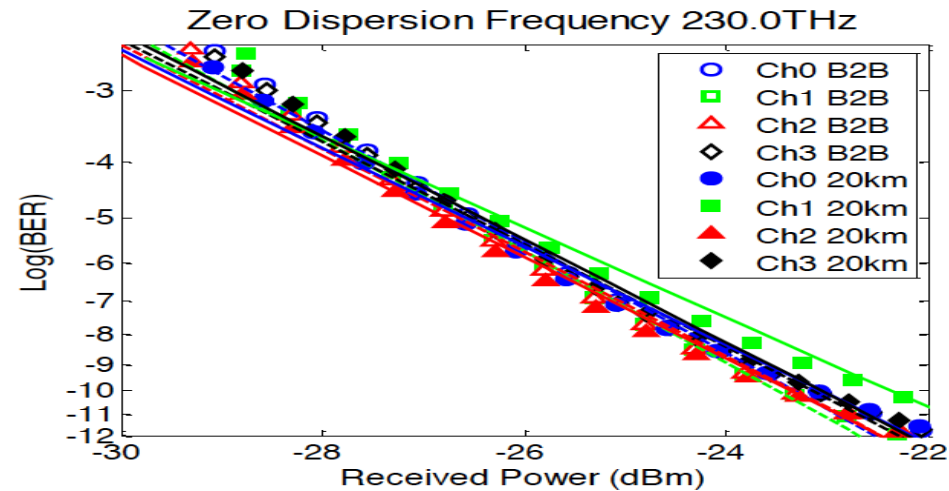
	Center Freq (THz)	Center WL (nm)
US0	232.400	1289.985
US1	231.600	1294.441
US2	230.800	1298.927
US3	230.000	1303.445
DS0	224.600	1334.784
DS1	223.000	1344.361
DS2	222.200	1349.201
DS3	221.400	1354.076

- Upstream ch 3 is in the zero dispersion region of G.652 SM fibers
 - Zero dispersion could be at the center of ch 3 (scenario 1)
- Upstream ch 2 is at the edge of zero dispersion region
 - Zero dispersion could be at the middle of ch 3 & ch 2 (scenario 2)

FWM could be problems in both scenarios

Huawei's results on scenario 1*

Upstream Performance zero dispersion at ch3 (230THz)

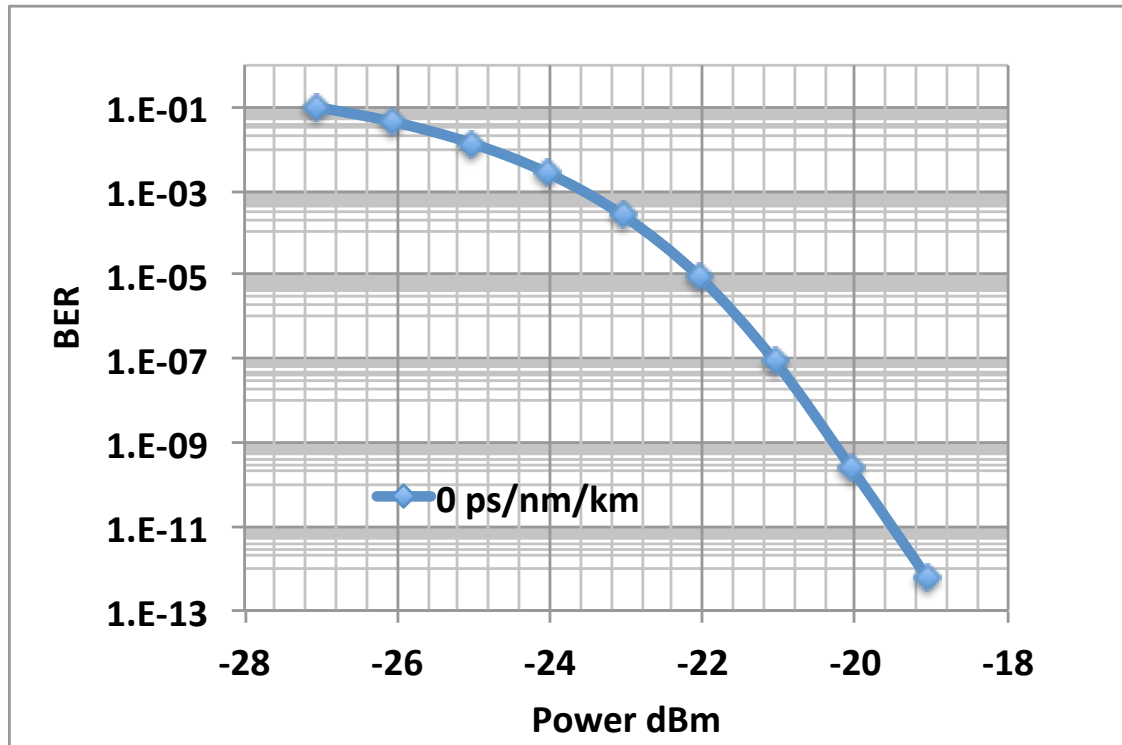


In addition, upstream signal power is decreased by 0.31dB after 20km SMF fiber. due to Raman effect. when the downstream signals are turned on.

* p15

- From the graph above, the 10^{-3} BER power is about -29 dBm, and that is too optimistic for a 25 Gbps NRZ rate with 4 WDM channels in the presence of fiber nonlinear impairments such as FWM, XPM, etc., especially in the zero dispersion region
- At a 25 Gbps rate, even for a single channel the -29 dBm receiving power at $10^{-3\text{BER}}$ is challenging
- The comparison simulation study generally disagrees with Huawei's

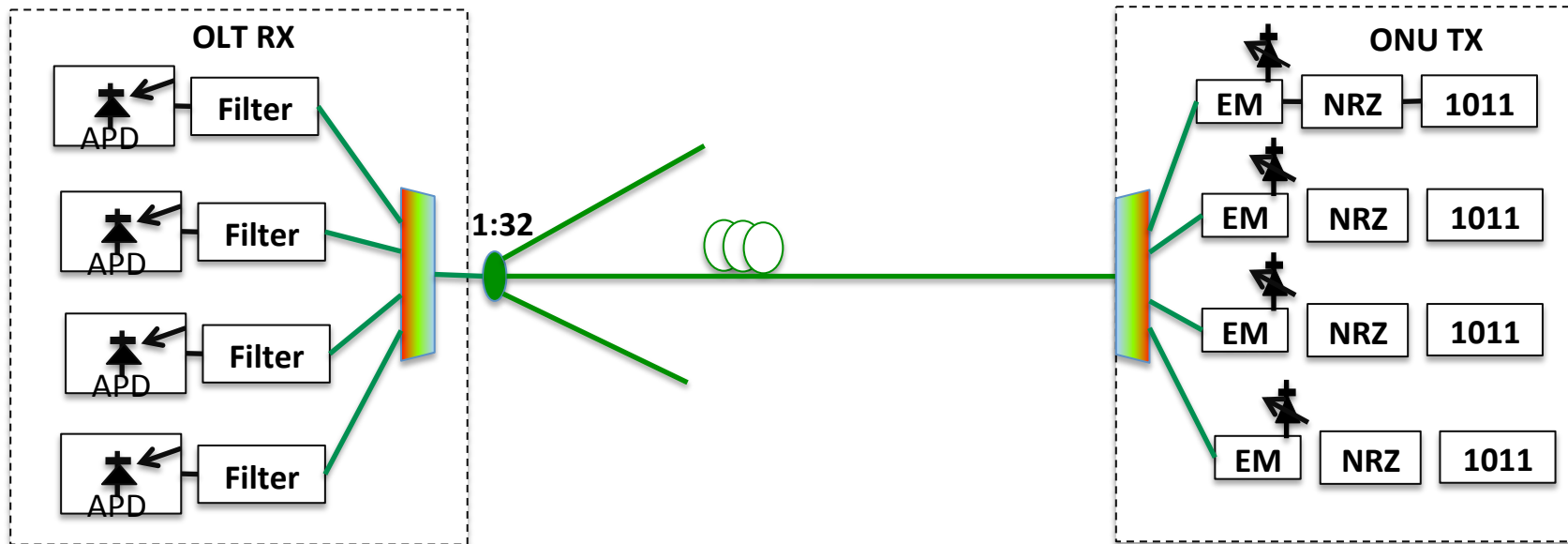
Performance of single channel 25Gbps NRZ



- As a baseline reference, the performance of a P2P 25 Gbps NRZ link was evaluated under the PON ODN loss (24 dB)
- External modulation and APD receiver were used
- Fiber dispersion was set to zero

- **The 10^{-3} BER reference power is at – 23.6 dBm**
- **The result is inline with PR 30**

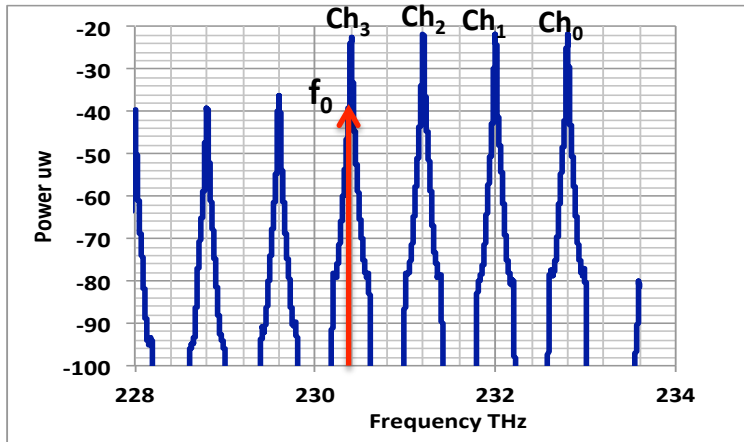
4X25 Gbps PON WDM upstream simulation setup



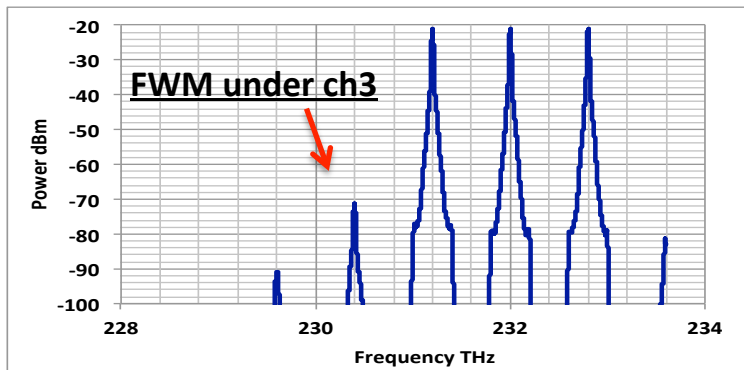
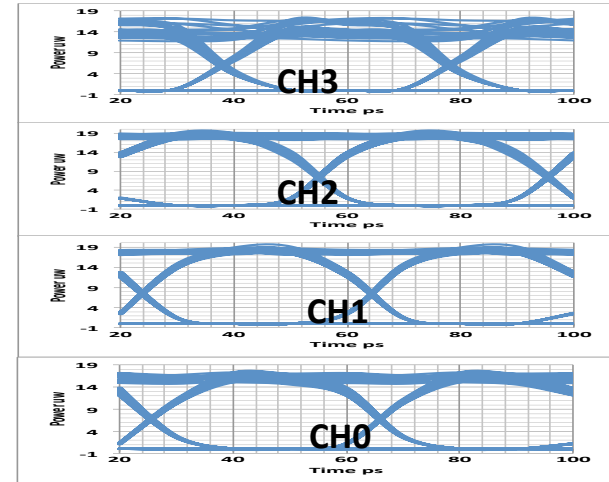
- To simulate US worst case, power splitters were placed at CO/HE
- 20 km ODN with with loss and other link penalties = 24 dB
- All channels transmit at the same optical power levels, from 2 dBm to 10 dBm in 1 dBm step
- FWM, XPM and other nonlinear effects were considered

Scenario 1: Zero dispersion at ch 3

800 GHz even channel spacing, zero dispersion at channel 3



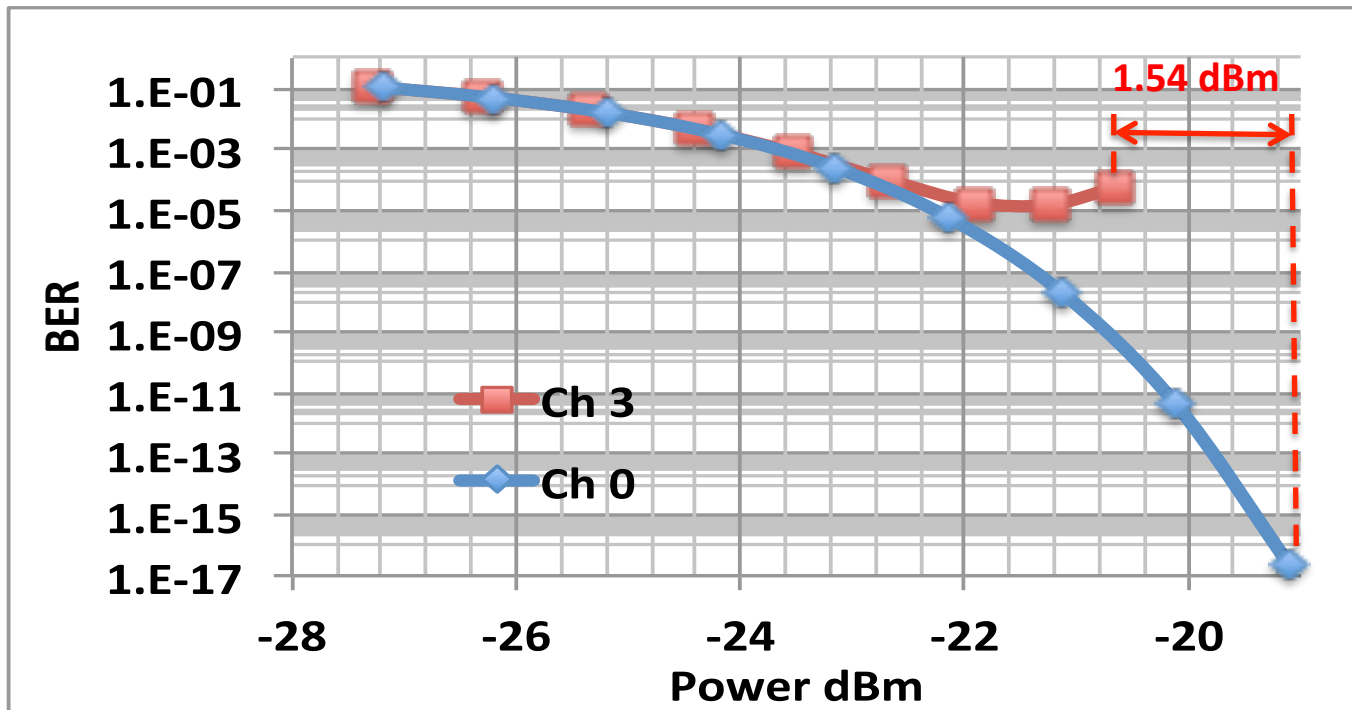
Optical spectrum of 4 channels



Optical spectrum of 3 channels

- Zero dispersion and ch 3 was set at 230.4THz
- Eye diagrams show the FWM penalty at ch 3

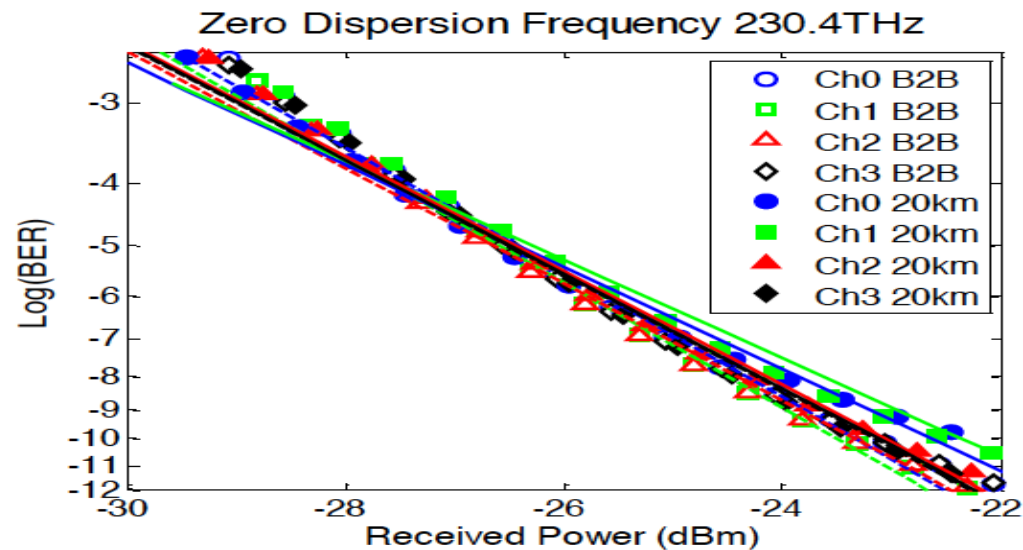
Scenario 1: Zero dispersion at ch 3



- Ch 3 shows 1.54 dBm optical power penalty due to FWM and other nonlinear effects
- FWM significantly impacts the BER of ch 3

Huawei's results on scenario 2*

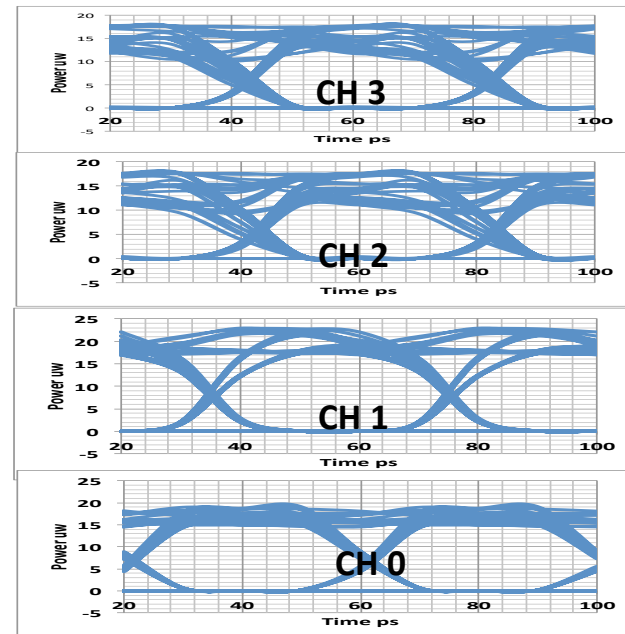
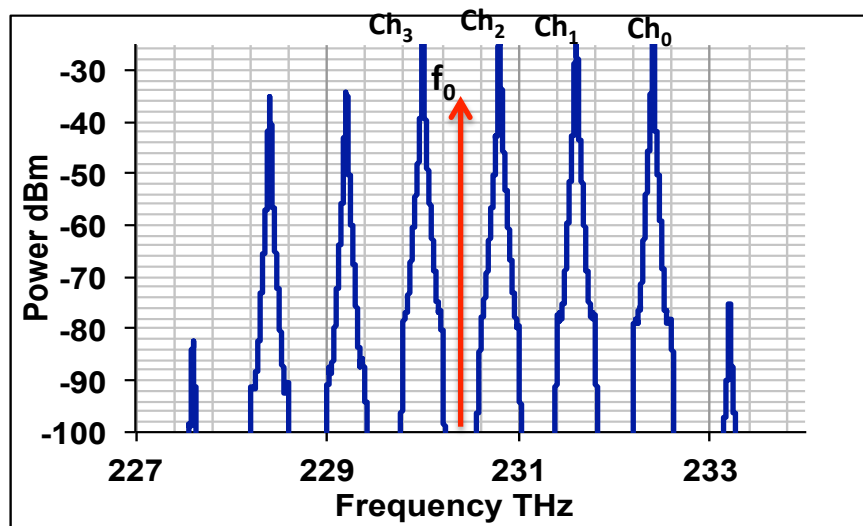
Upstream Performance *zero dispersion in the middle of Ch3 (230.0THz) and Ch2 (230.8THz)*



* p17

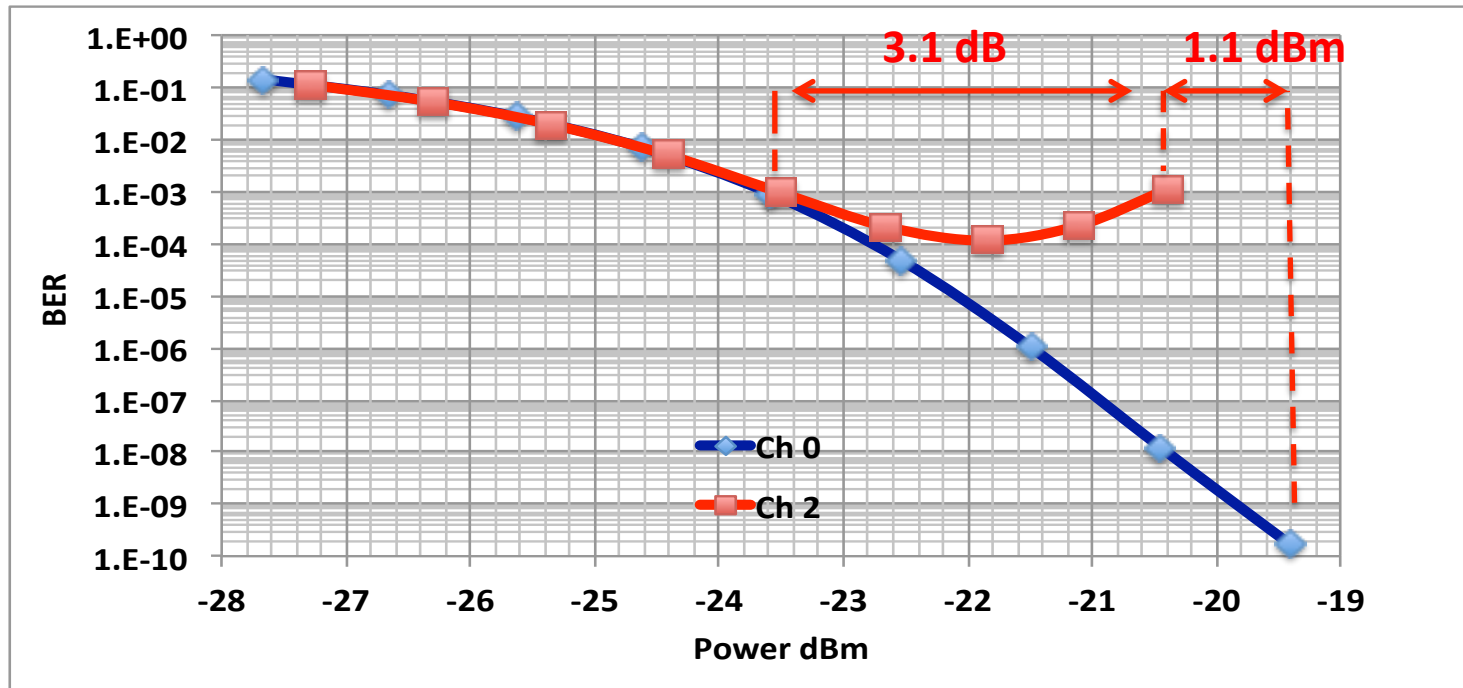
- Same as scenario 1, the 10^{-3} BER power is about -29 dBm, and that is too optimistic for a 25 Gbps NRZ rate with 4 WDM channels
- The comparison simulation study generally disagrees with Huawei's

Scenario 2: Zero dispersion is in the middle of ch 3 and ch 2



- 800 MHz even channel spacing and the zero dispersion is in the middle of Ch 2 and Ch 3
- Eye diagrams of Ch 3 and ch 2 show strong noises

Scenario 2: Zero dispersion is in the middle of ch 3 and ch 2



- Ch 2 (noisy ch) shows 1.1 dBm optical power penalty due to the FWM and other nonlinear effects in comparison with ch 0 (clean ch)
- FWM has significant impacts on the BER of ch 2
- FWM and other nonlinear penalties limit the the dynamic range of receiving power of ch 2 to be ~ 3 dB

Conclusions

- **FWM and nonlinear effects are significant when zero dispersion is at the center of channel 3**
- **FWM and other nonlinear effects are significant when zero dispersion is at the middle of channel 3 and channel 2**
- **The results of the comparison study in general in disagree with Huawei's simulation results**
- **The origins of the observed results will be discussed in dai_3ca_1_1116**



Thanks

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