Jesper Bevensee Jensen

Jesper Bevensee Jensen, CTO
jbj@bifrostcommunications.com
+45 2514 4047

Reach, fan-out, power-budget and dispersion tolerance of a Quasi-Coherent Super-PON

BIFROST COMMUNICATIONS APS

www.bifrostcommunicatins.com

Spin-out from
Technical University of Denmark

Jesper Bevensee Jensen
CTO, Founder
jbj@bifrostcommunications.com

Outline

1. What is Quasi-Coherent Detection?
2. Sensitivity and reach at 10 Gbps
3. Super-PON ONU launch power requirements with QC receivers in the OLT
4. Going to 25 Gbps with CD compensation built into the receiver
5. Summary

Super-PON Objectives

Super-PON Objectives

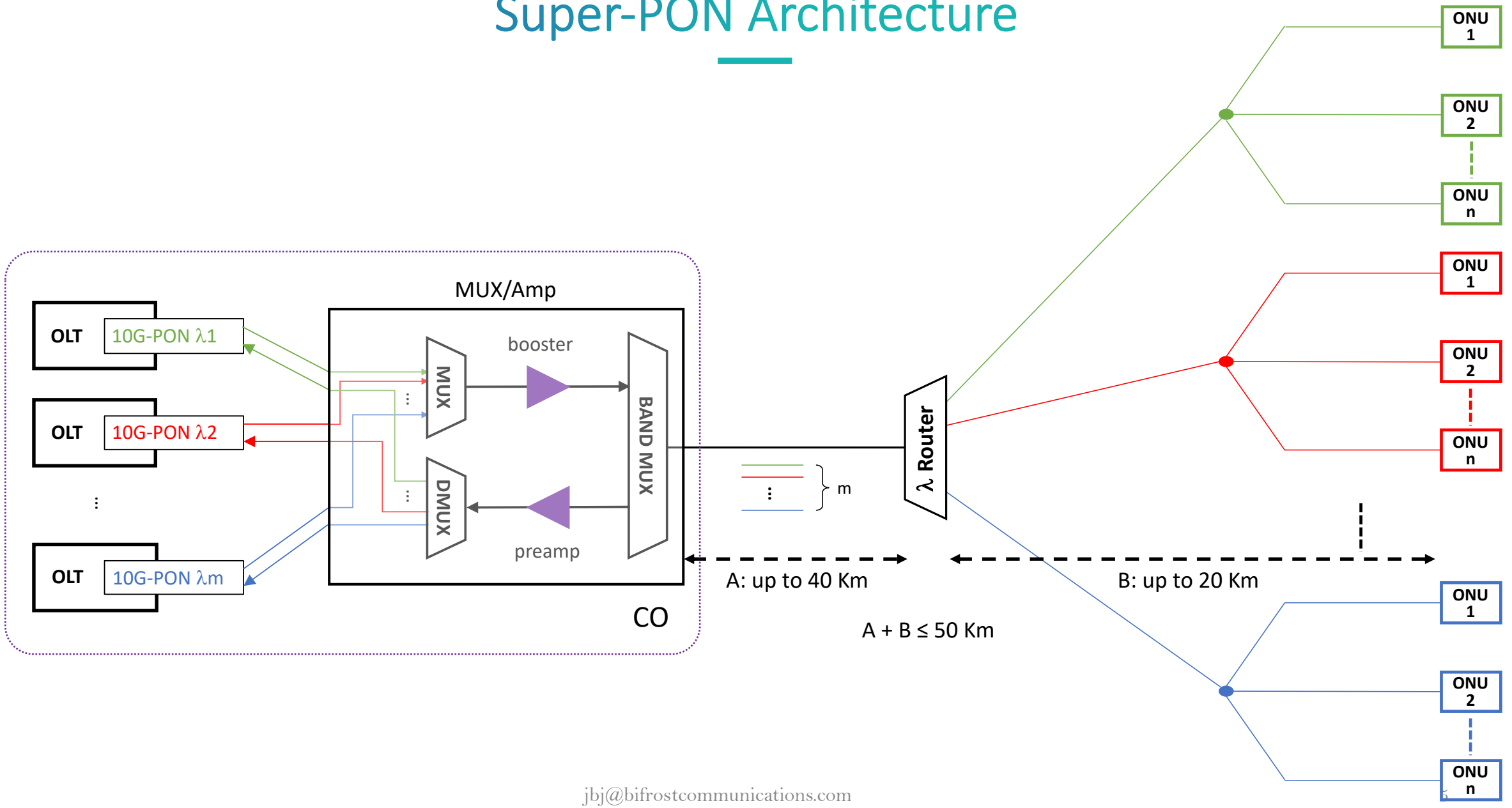
To support a passive point-to-multipoint ODN with a reach of at least 50 km, and with at least 1:64 split ratio per wavelength pair

- At least 16 wavelength pairs for point-to-multipoint PON operation
- Support the MAC data rate of 10Gb/s downstream
- Support the MAC data rates of 2.5Gb/s and 10Gb/s upstream
- Tunable transmitters

Potential with Quasi Coherent receivers

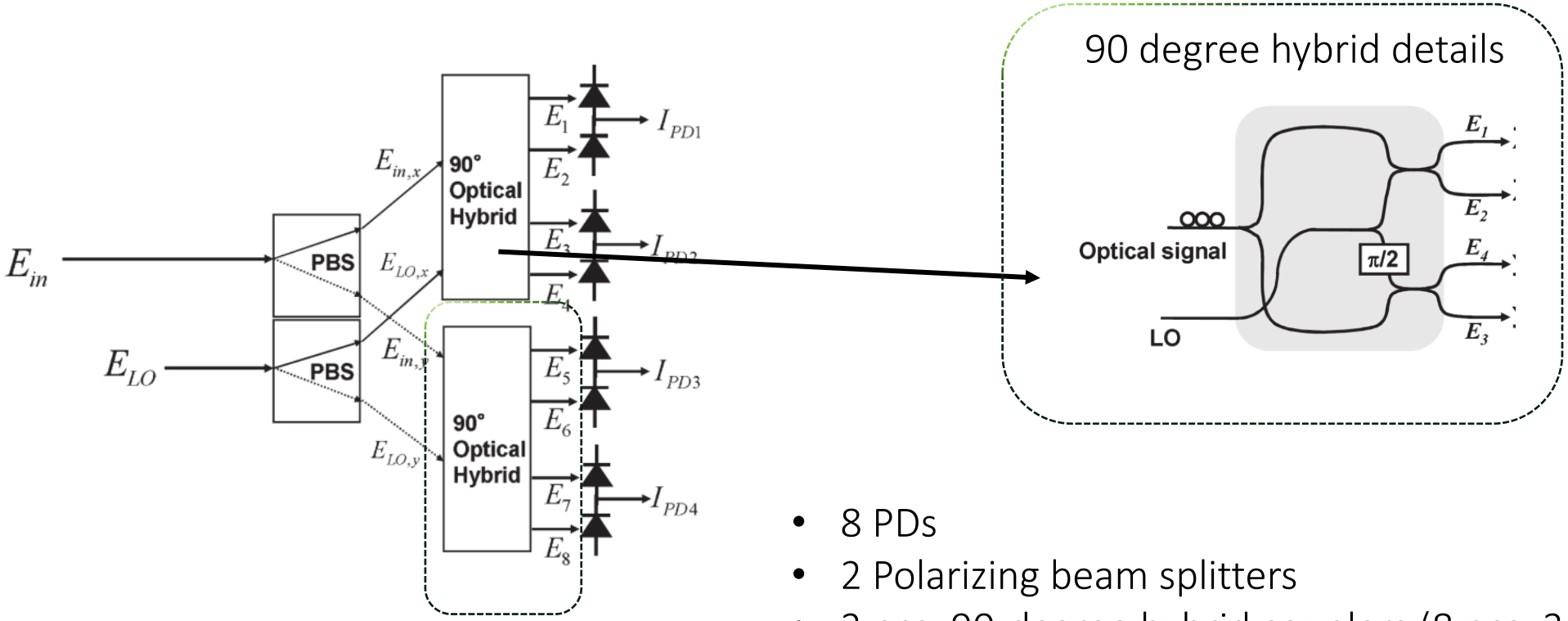
- Increase EML transmitter reach to 80 km @ 10 Gbps by including CD compensation in the receiver
- Reduce ONU launch power (and cost) by utilizing –35 dBm sensitivity
- Enable a 25 Gbps line rate, 20 km class for high density applications (e.g. 5G)

Super-PON Architecture



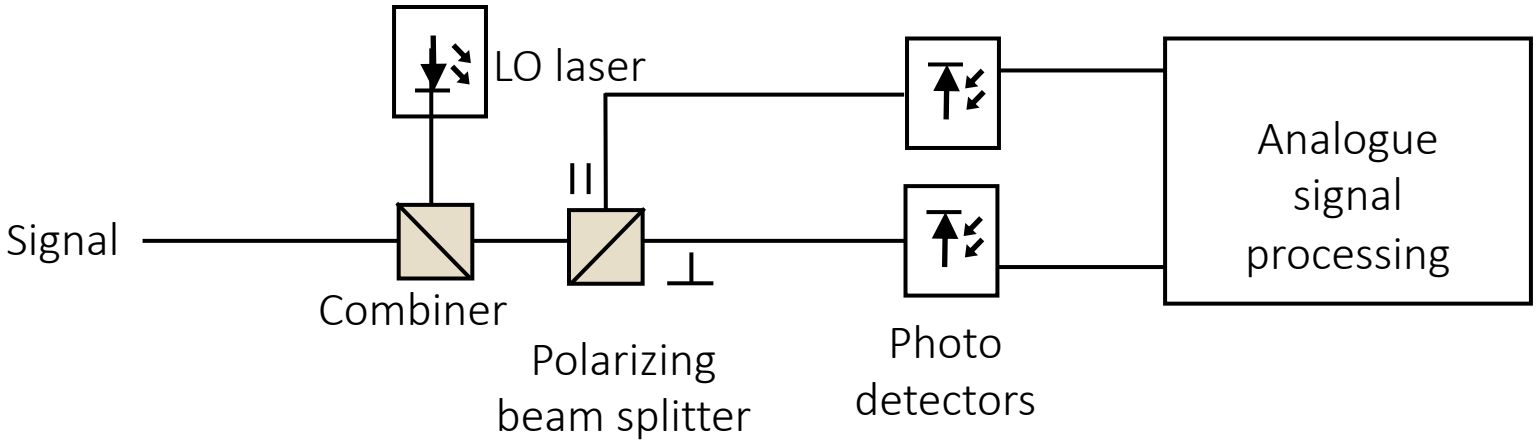
jbj@bifrostcommunications.com

Digital Coherent Receiver – The Conventional Way



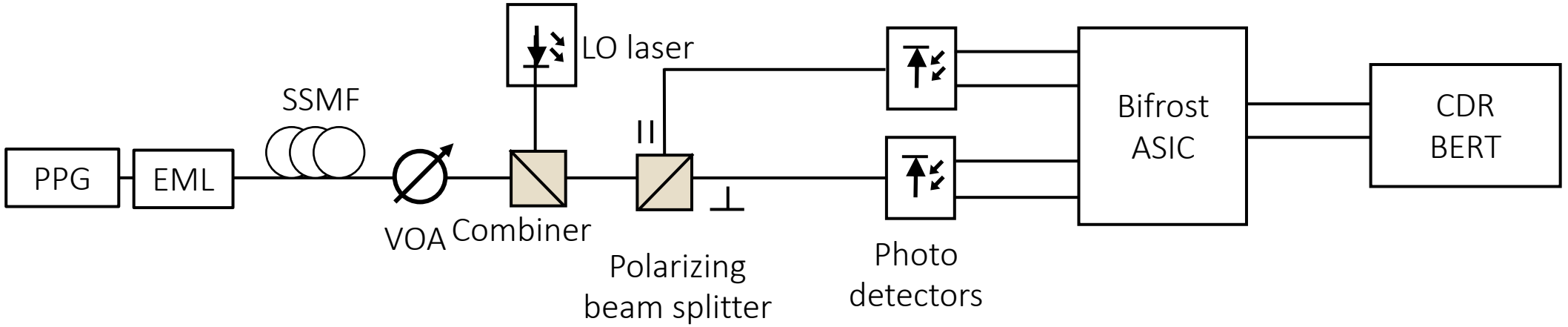
- 8 PDs
- 2 Polarizing beam splitters
- 2 pcs. 90-degree hybrid couplers (8 pcs. 3dB couplers)
- DSP engine operating at sample rate of 2* RX bandwidth

Bifrost Simplified Quasi-Coherent Receiver



- Only very little equipment (2 PDs, 1 PBS, 1 pcs. 3 dB coupler)
- No DSP (Analog signal processing chip only consumes 10 mW)
- Vast simplification
- Coherent potentially ready for low cost access networks

Experimental Validation @ 10 Gbps



- SFP transmitter, 1550 nm wavelength, 8 dB extinction ratio
- 15 dBm LO power, RIN = -145 dBm/Hz
- 33 GHz PD/TIA bandwidth

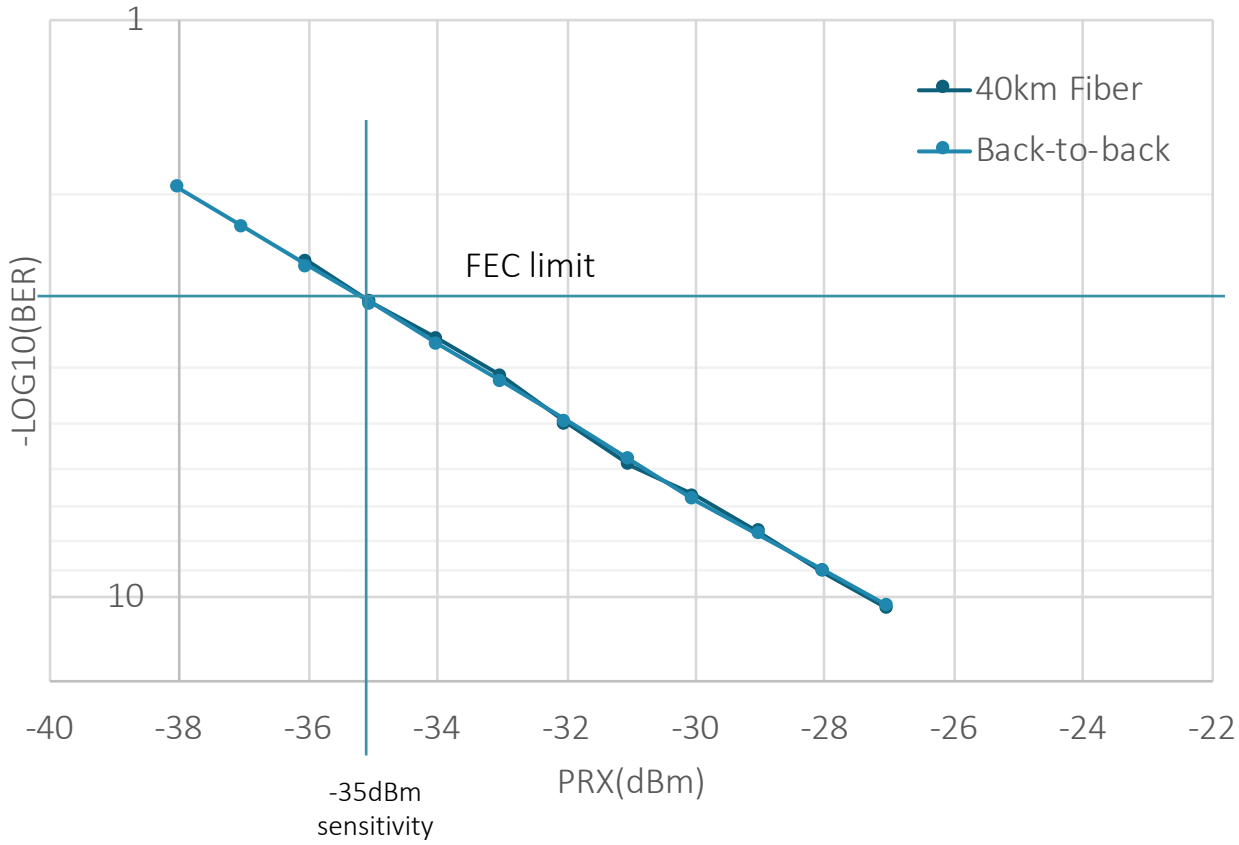
10 Gbps BER B2B and after 40 km SSMF

1550nm EML transmitter

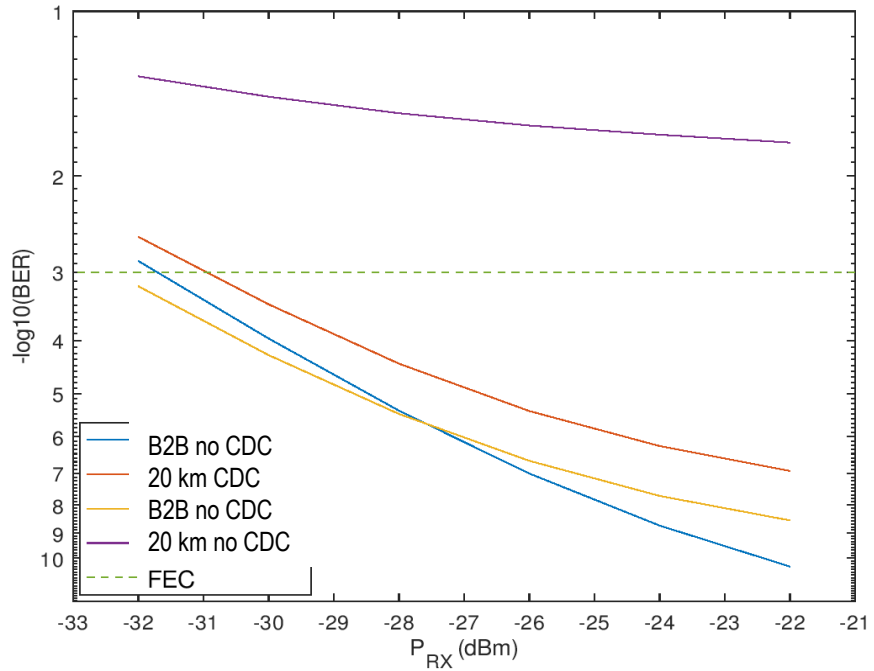
-35 dBm sensitivity
No degradation after 40 km fiber

80 km is possible with CD compensation built into receiver

15 dB better than PIN DD
3-6 dB better than APD DD



25 Gbps Chromatic Dispersion Compensation



Optics modelled in VPI using datasheet values

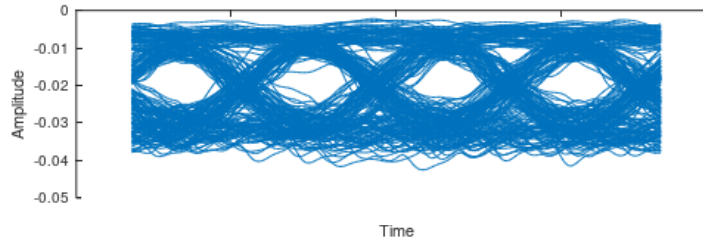
- 10 MHz LO linewidth, -145 dB/Hz LO RIN, 15 dBm LO power
- PD 3-dB bandwidth = 40 GHz
- PD responsivity 0.7 A/W
- TX Extinction ratio 8dB (1550 nm EML)

Bifrost ASIC EM simulated in Microwave Office

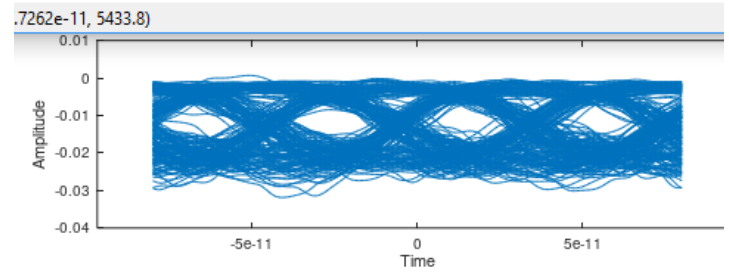
Better than -30 dBm sensitivity B2B and after 20 km SSMF

-30 dBm eye diagrams

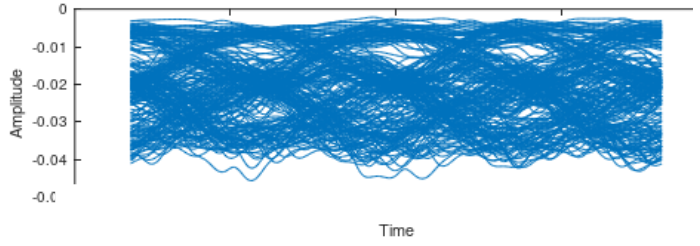
B2B No CDC



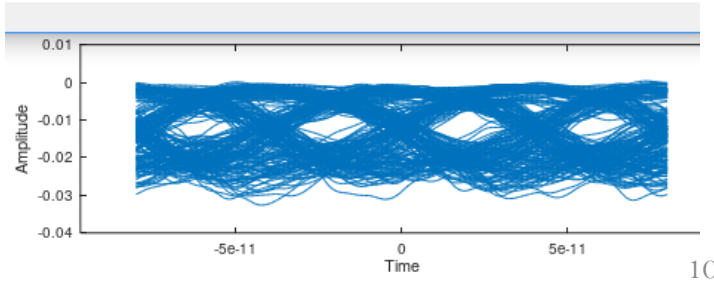
B2B with CDC



20 km No CDC



20 km with CDC



Quasi-Coherent Super-PON

Potential with Quasi Coherent receivers

- Reduce ONU launch power by utilizing the high –35 dBm sensitivity
- Increase EML transmitter reach to 80 km at 10 Gbps by including CD compensation in the receiver
- Enable a 25 Gbps line rate, 20 km class for high density applications (e.g. 5G)

Quasi-Coherent 50 km Super-PON

"To support a passive point-to-multipoint ODN with a reach of at least 50 km, and with at least 1:64 split ratio per wavelength pair"

Conventional Optics requirements		QC-optics Requirements	
Sensitivity	-28.5 dBm	Sensitivity	-35 dBm
ONU launch power	+4 to +9 dBm (requires EML+SOA)	ONU launch power	-2 to +3 dBm (no SOA required)
CD compensation	Optical DCF required for DMLs	CD compensation	Built-into receiver

Quasi-Coherent 80 km Super-PON

"To support a passive point-to-multipoint ODN with a reach of at least 80 km, and with at least 1:64 split ratio per wavelength pair"

QC-optics Requirements	
Sensitivity	-35 dBm
ONU launch power	+4 to +9 dBm (requires EML+SOA)
CD compensation	Built-into receiver
AMP/MUX gain (US)	14.5 dBm
AMP/MUX gain (DS)	12 dBm

Quasi-Coherent Super-PON for 25 Gbps and 20 km reach

"To support a passive point-to-multipoint ODN with a reach of up to 20 km, line rate of 25 Gbps and with at least 1:64 split ratio per wavelength pair"

QC-optics Requirements	
Sensitivity	-30 dBm
ONU launch power	-3 to +2 dBm (EML+SOA)
CD compensation	Built-into receiver
AMP/MUX gain (US)	14.5 dBm
AMP/MUX gain (DS)	12 dBm

Quasi-Coherent Super-PON Optics Requirements

LO laser

- 15 dBm CW power
- < -145 dBm/Hz RIN
- +/- 1 GHz wavelength stability

Wavelength plan

- 40 GHz spectral window allocated for each channel

PD/TIA

- 40 GHz BW (to avoid burst-to-burst retuning)
- PIN (APD not required)
- Linear TIA

SUMMARY

Quasi-coherent	10 Gbps (50 km)	10 Gbps (80 km)	25 Gbps (20 km)
Up to -35 dBm sensitivity @ 10 Gbps Up to -30 dBm sensitivity @25 Gbps	50 km C-band transmission CD-compensation in receiver -2 to +3 dBm ONU launch power	80 km C-band transmission CD-compensation in receiver +4 to +9 dBm ONU launch power	20 km C-band transmission CD-compensation in receiver -3 to +2 dBm ONU launch power