Short Reach Communication: is finally time for coherent transceivers?

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News

When Will Access Networks Go Coherent?

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Takeaways

Mobile access networks are still comfortable with direct detect technology, but coherent is already starting to impact cable networks and business services. Furthermore, coherent is already established as a solution to interconnect edge data centers.

Favorable coherent component cost-reduction trends are expected to continue, technological advancements will enable higher performance, and simpler implementations will make coherent technology more pervasive in the access network to achieve exponential capacity growth.

www.effectphotonics.com

Eindhoven, July 27, 2022

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time is over

OE SOLUTIONS

Press Release

Categories Archives

September 15, 2022

OE Solutions Launches Digital Coherent Optical Transceiver Portfolio for Access Network Applications

BY OE SOLUTIONS

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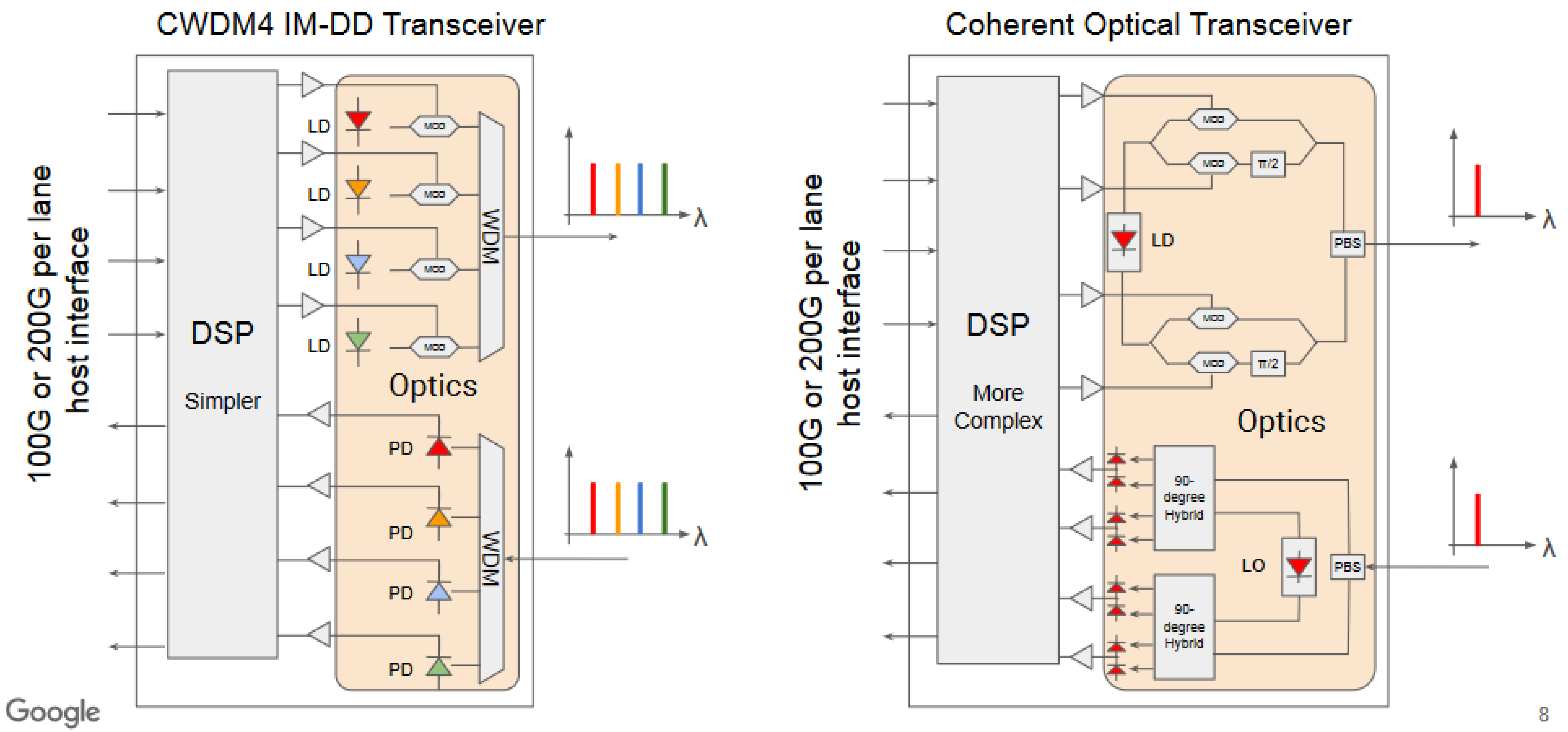
Transceiver Architectures (CWDM4 vs. Coherent) *



Google «Coherent-Lite for beyond 400GbE» - IEEE 802.3 B400G SG Meeting, 07/2021

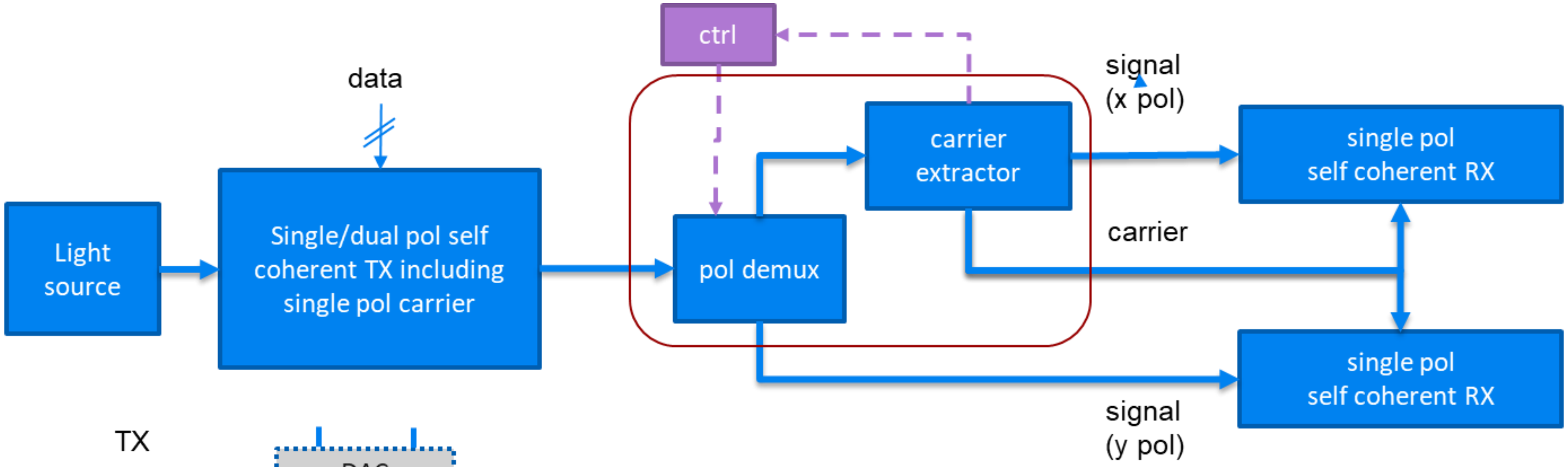
CWDM4 vs. Coherent Comparison

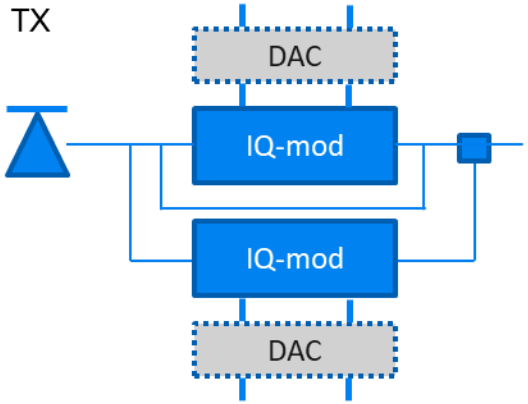
- **CWDM4 PAM-4 and PM-16QAM coherent share similar 200Gbps per lane component requirements**
  - 4 optical modulators of similar baud rates
  - 4 ADC and DAC pairs of similar baud-rate
  - High performance FEC, equalizers etc.
  - Same host interface and framer
- But CWDM4 requires 4 wavelengths (4 lasers) whereas PM-16QAM requires only 1 laser and more complex DSP
- Coherent takes natural advantage of polarization multiplexing which leads to simpler PIC implementations.

Conclusions

- Coherent transmission scales better with bit-rate and reach.
- Coherent-Lite would be a cost-effective solution for 10km campus networking at > 800Gbps
- 800G coherent-Lite shares similar optoelectronics component requirements with 200G/lane IM-DD solutions
- The industry should optimize coherent solutions (DSP, laser, PIC, etc.) for intra-datacenter connectivity.

A possible approach: self-coherent



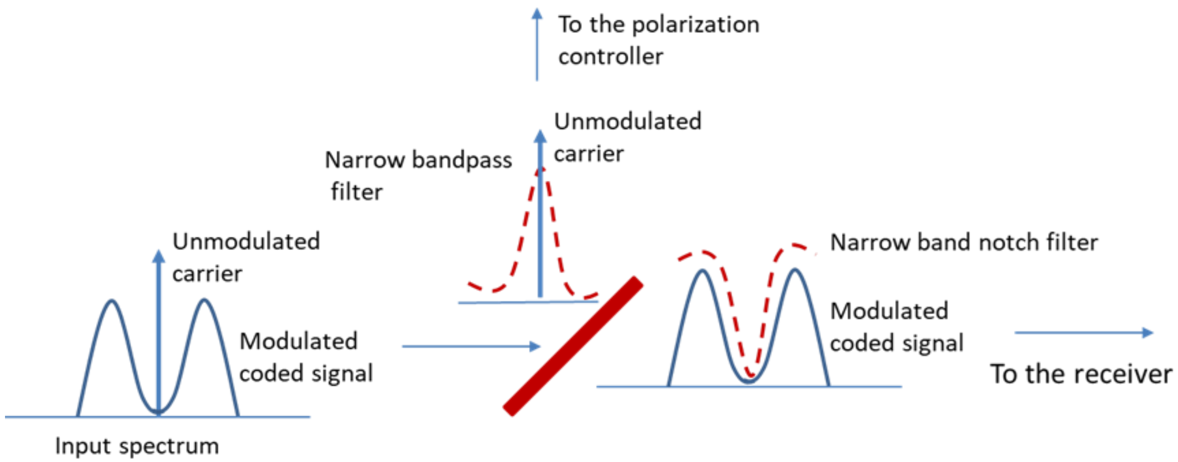


High performance
High-capacity transmission
Low cost
Low Power consumption
Low complexity
Easy to generate

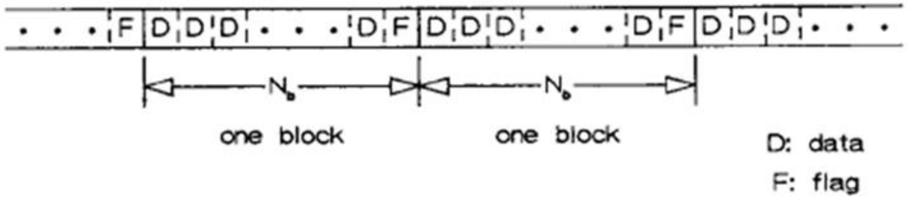
P. N. Goki, T. T. Mulugeta, F. Cavaliere and L. Potí, "Low-Complexity Self-Homodyne Coherent System for Short-Haul Optical Communications," 2022 27th OptoElectronics and Communications Conference (OECC) and 2022 International Conference on Photonics in Switching and Computing (PSC), 2022, pp. 01-04

Novelty of the scheme

- At the Rx, after the adative pol. demux, the optical carrier is extracted by a tunable narrow bandpass filter that rejects the modulated signal, only keeping the unmodulated carrier.
- Proper **signal coding** is applied so that the modulated power around the DC is negligible.
- A second port of the filter performs the inverse operation acting as a notch filter, i.e. it rejects the carrier and extracts the modulated signal.
- Pol demux and carrier extraction can be integrated in a single silicon photonics device.
- The extracted carrier can be used as a single control variable, which makes the control very simple (the pol mux is adjusted until the detected carrier power is maximized).



The BBC code



We introduced a Binary Block Code (BBC)

Key parameter: block length N_b

providing code efficiency:

$$0 < \eta_b = (N_b - 1)/N_b < 1$$

and a net rate

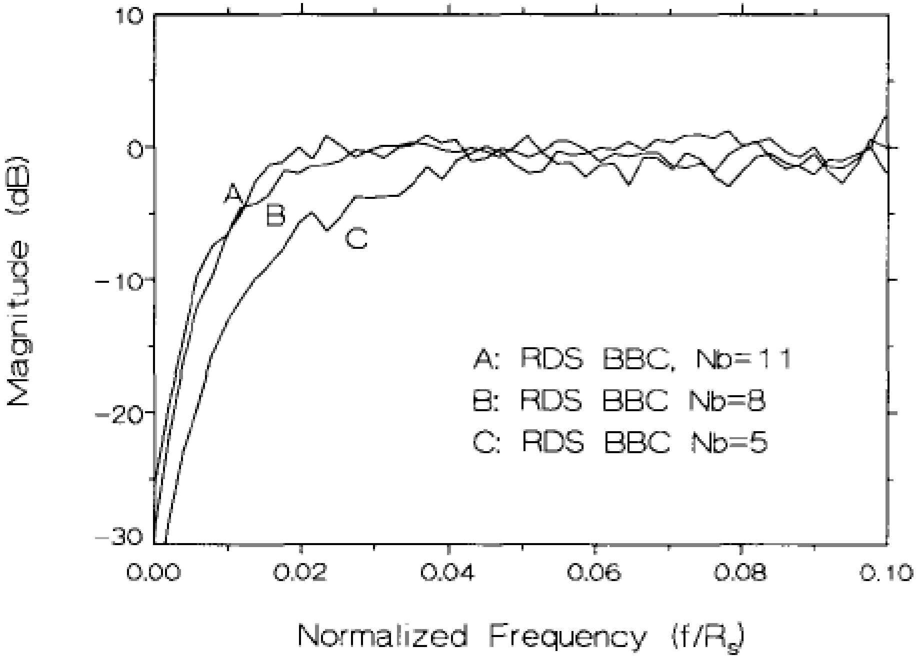
$$R = \eta_b \cdot R_G \text{ (gross rate)}$$

Ex. 28 Gaud, 2 pol $R_G = 224\text{GBbps}$

if $N_b = 10 \rightarrow \eta_b = \frac{9}{10} \rightarrow R = 201.6\text{Gbps}$

Flag bit can be easily calculated after definition of Running Interference Sum (RIS) and Running Digital Sub (RDS) as $RIS(i) = \sum_{j=0}^{N_b-1} y(iN_b + j)$, and $RDS(r) = \sum_{i=-\infty}^{r} F(i)RIS(i)$.

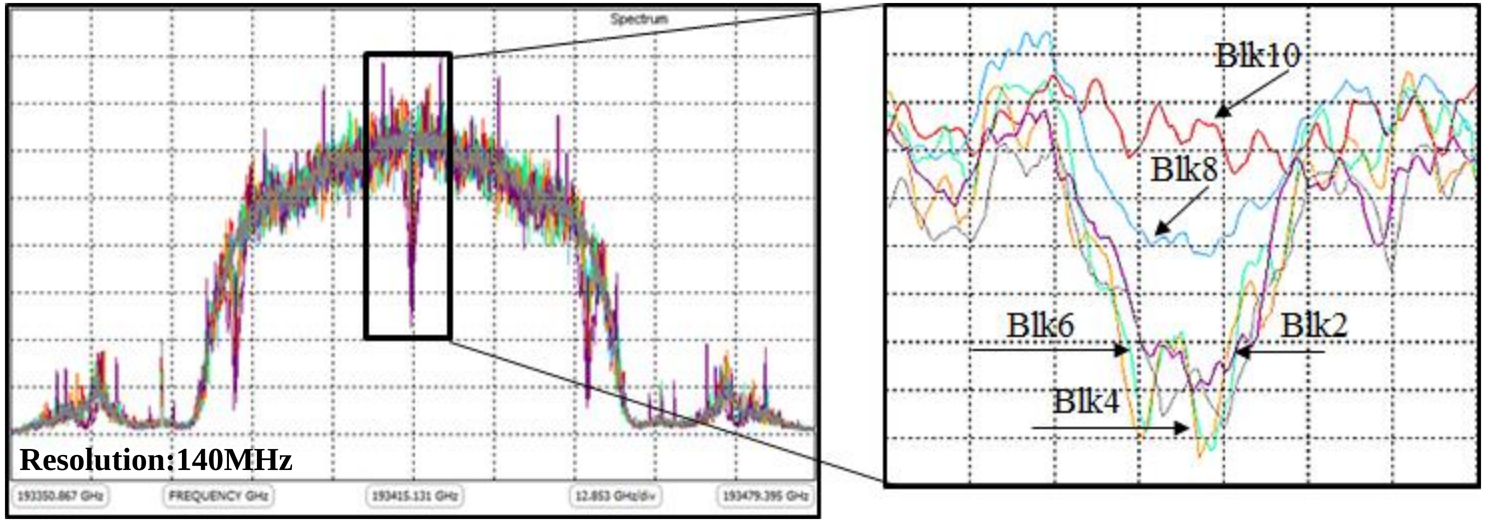
$$F(i) = \begin{cases} 1, & \text{if } RIS(i)RDS(i-1) \leq 0 \\ -1, & \text{otherwise} \end{cases}$$

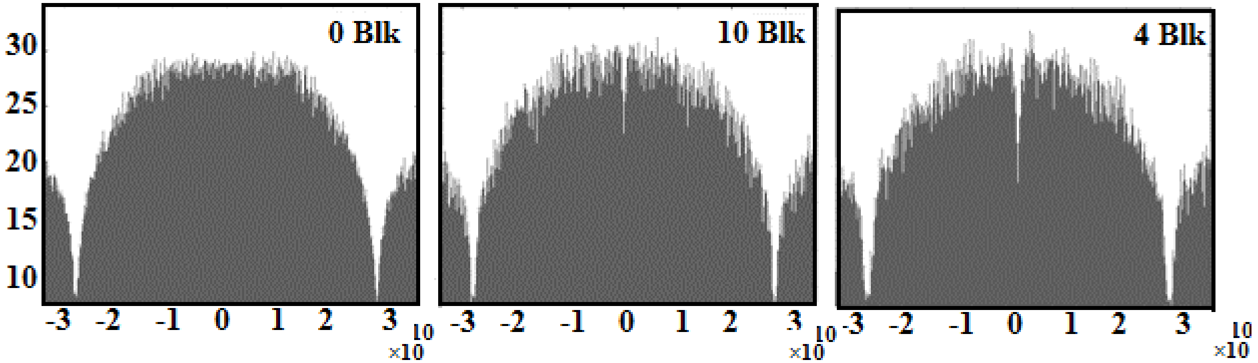


L. J. Greenstein, "Spectrum of a binary signal block coded for DC suppression," in *The Bell System Technical Journal*, vol. 53, no. 6, pp. 1103-1126, July-Aug. 1974.
J. K. Cavers and R. F. Marchetto, "A new coding technique for spectral shaping of data," in *IEEE Transactions on Communications*, vol. 40, no. 9, pp. 1418-1422, Sept. 1992.

Code impact on signal spectrum

Experimental measurements

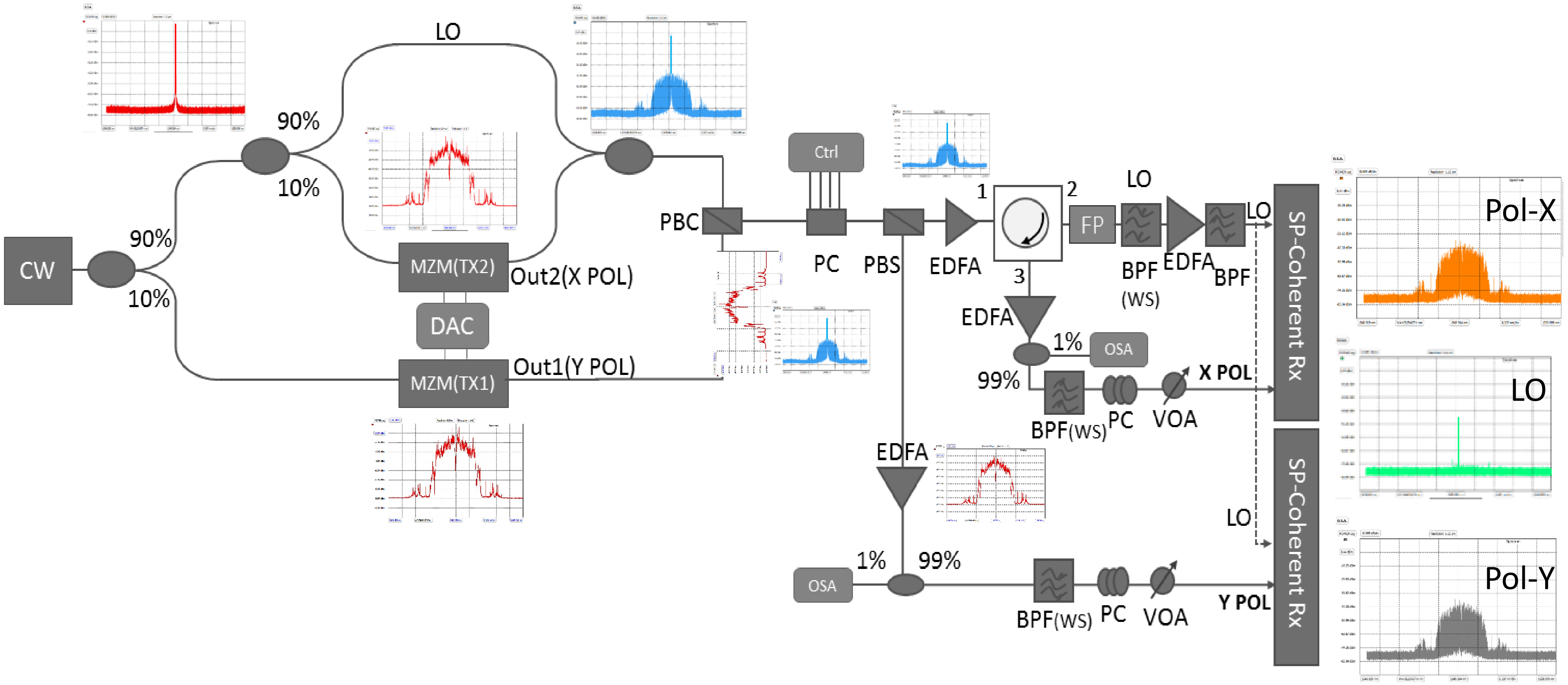




Simulated

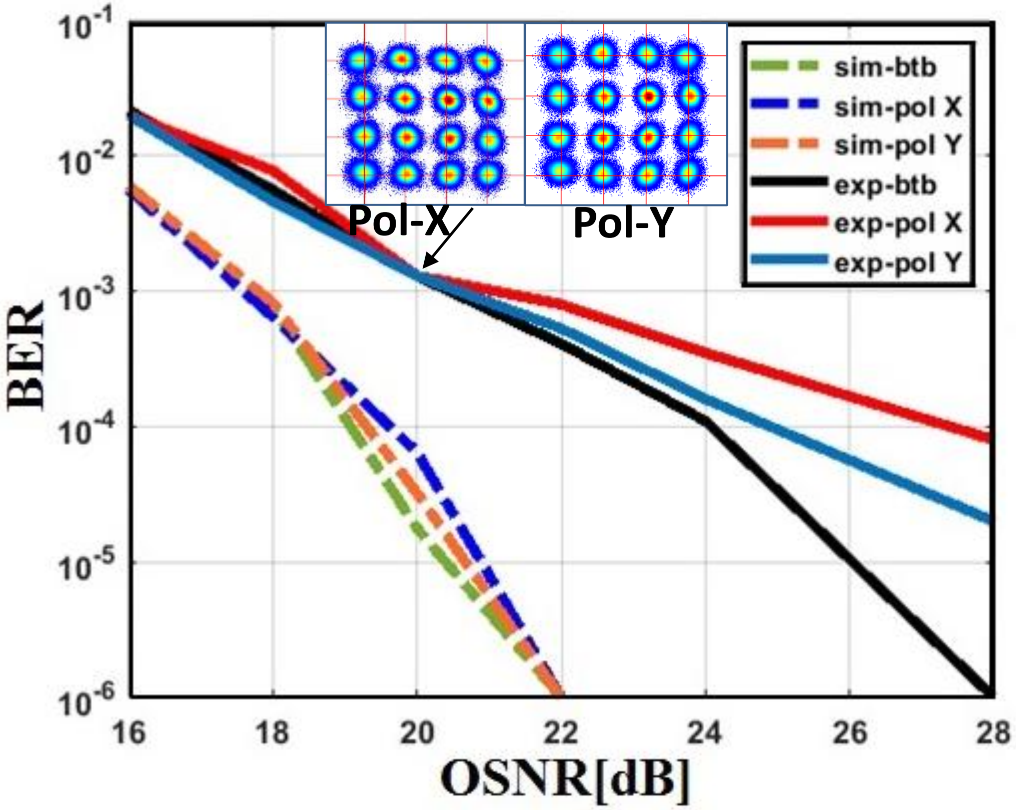
Experimental Setup

16-QAM_ BBC=4_28 Gbaud



FP Filter: FSR ~ 1nm, ER ~33dB, BW ~1GHz

Results



An implementation penalty of about 2.2 dB at a BER of 10-3 was observed when a 3-tap equalizer was used, thus demonstrating a very low receiver DSP complexity.

Conclusions

- We proposed and optimized a self-homodyne coherent system based on a novel technique for carrier transmission/extraction
    - Signal spectrum shaping using code techniques at Tx
    - Carrier extraction through narrowband filter at Rx
- SHCT can be considered as a potentially cost-effective and energy efficient solution for the optical access segment
- 28Gbaud DP-16QAM transmission is demonstrated
- System optimization was carried out based on finding the optimal BBC code length and optimal CSPR
- SHCT diminishes the DSP complexity down to a 3-tap FFE without any need for FFT, IFFT, and frequency offset recovery

Short Reach Communication:
is finally time for coherent transceivers?

YES

we just have to optimize coherent solutions!

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Thank you for your attention!

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