

PhotoNext Researcher's Day

VCSEL Nonlinear Digital Pre-Distortion for high-speed Data Center Intra-connects

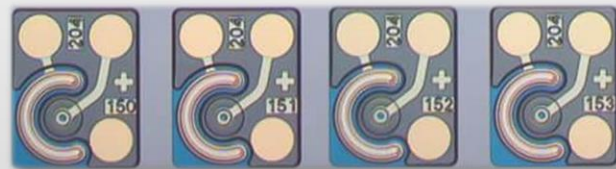
Leonardo Minelli

Short-reach Data Center Intra-connects

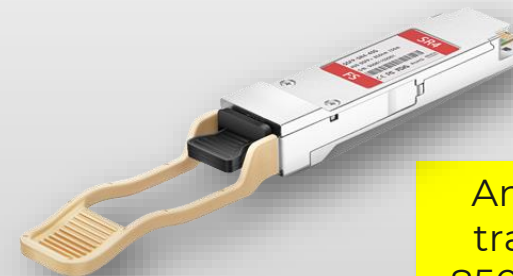
Data Center Intra-connects up to 100 m are based on cost-efficient optical links, using:

- *Vertical-Cavity Surface-Emitting Lasers (VCSEL)*
- *Multi-mode fibers (MMF)*

Next-generation transceivers target a net 100 Gb/s/ λ data rate



An array of four 850 nm VCSELs



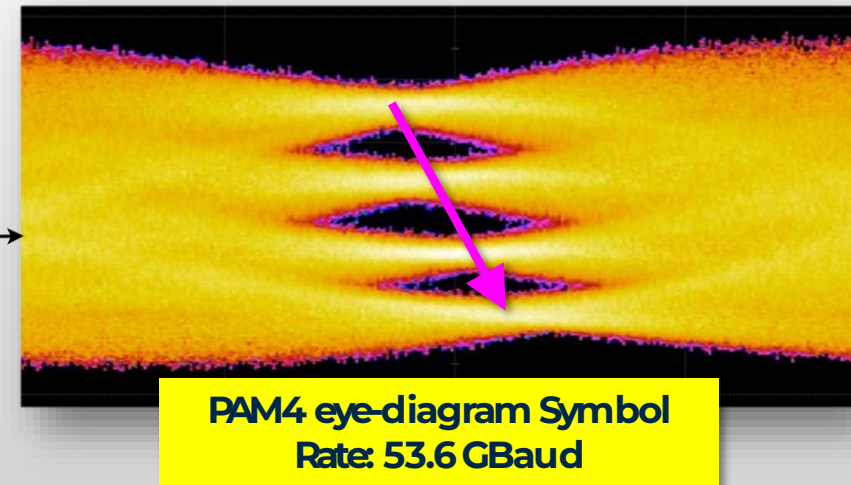
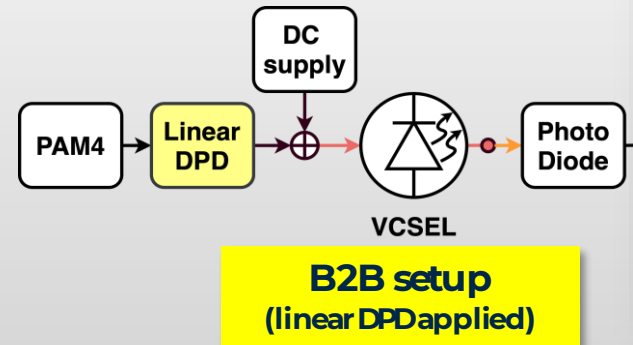
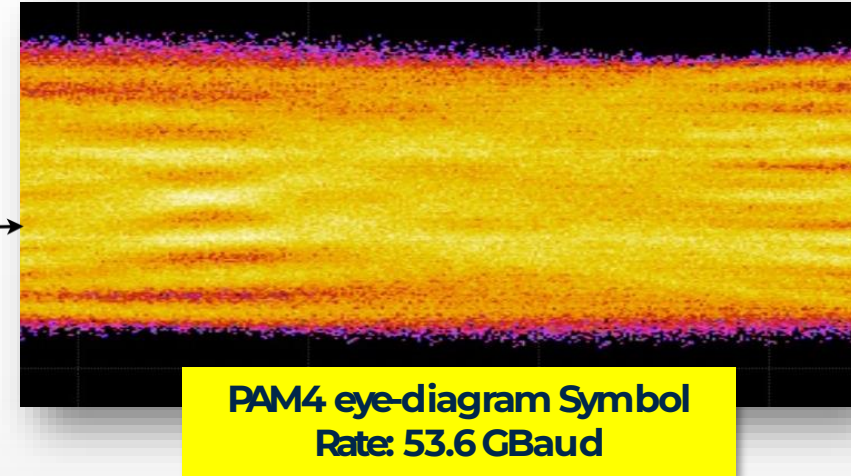
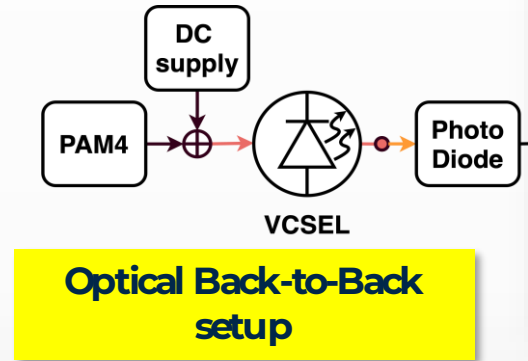
An example of today optical transceiver in this segment: 850nm 100m MMF 4x25 Gbps

Transmission at +100 Gbps over VCSEL-MMF links

VCSEL+MMF links make up *low-cost* and *efficient* DCIs...

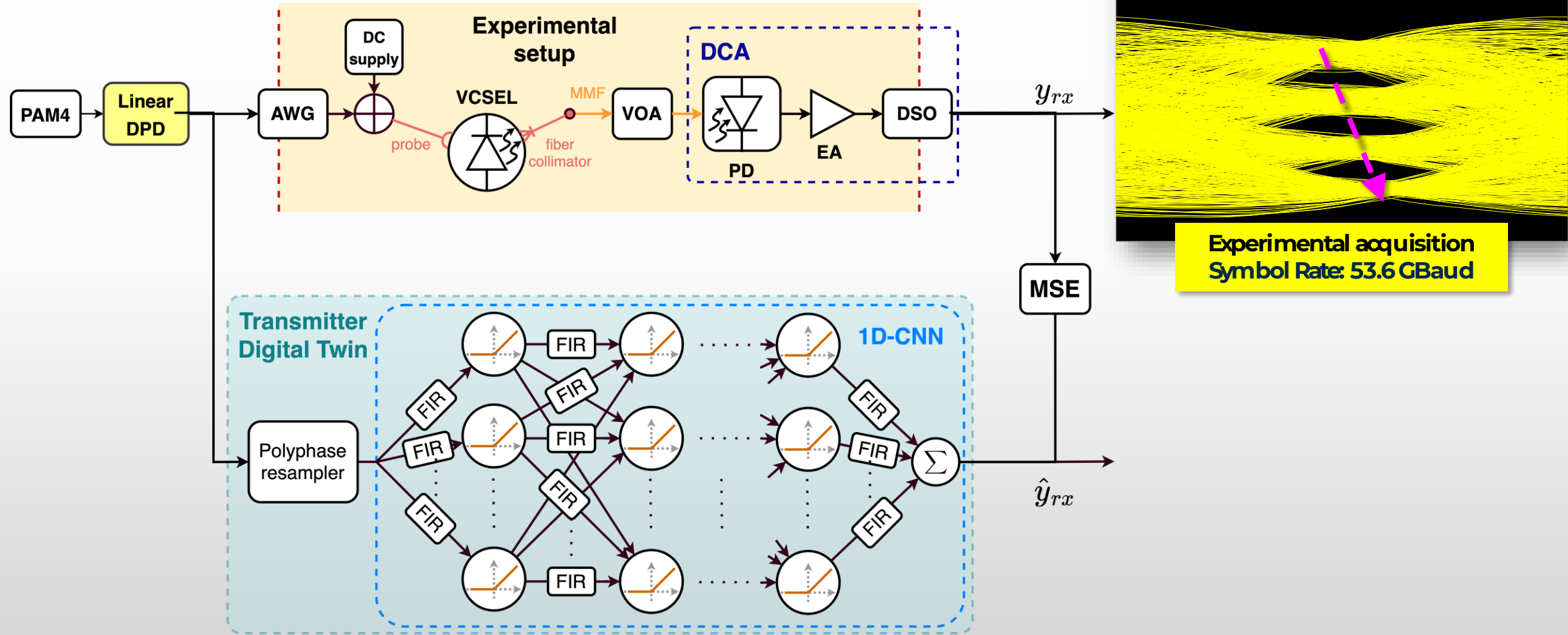
... *but* +100 Gbps transmission is quite challenging:

- Strong bandwidth limitations
 - Solution: *linear DPD*
- *Nonlinear VCSEL distortions*
 - Solution: **Nonlinear DPD**
(*Neural Nets, Volterra equalizers...*)

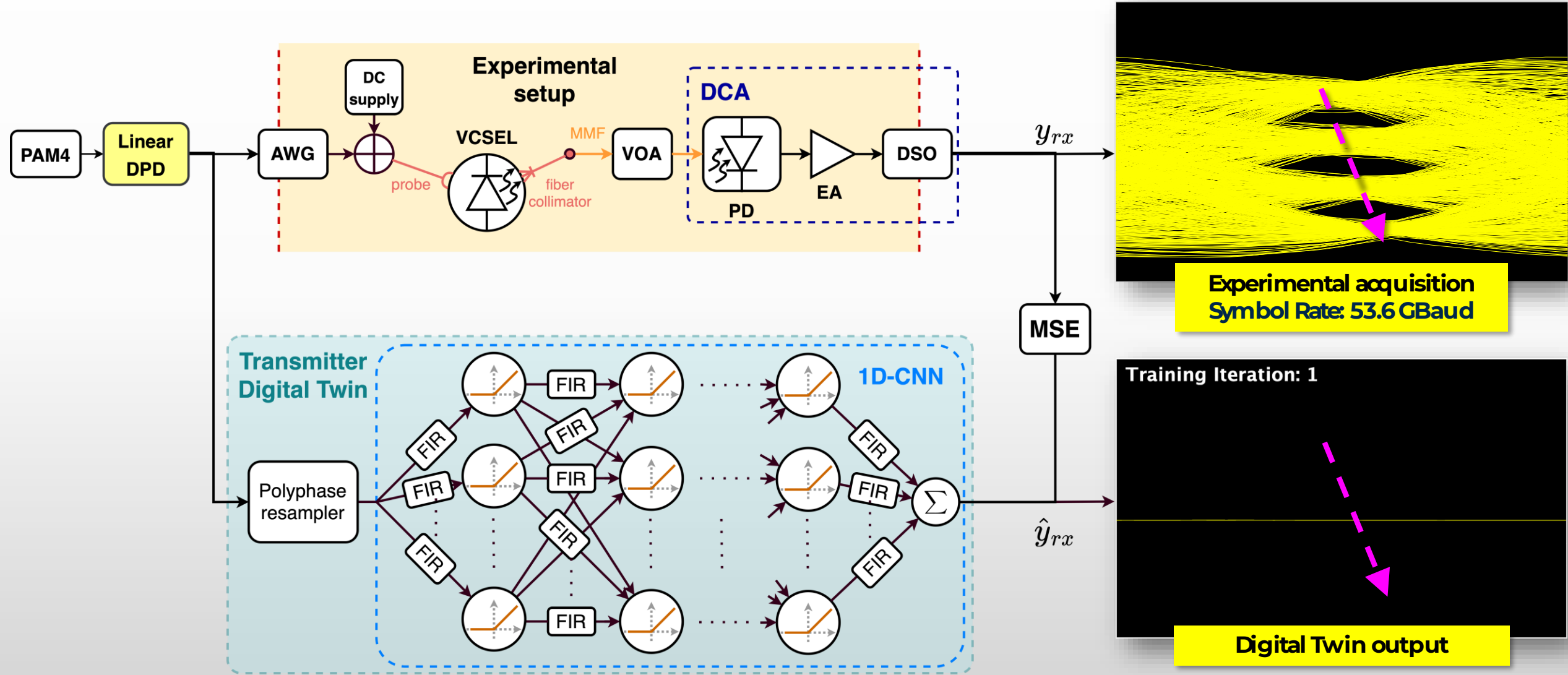


DPD: Digital Pre-Distortion

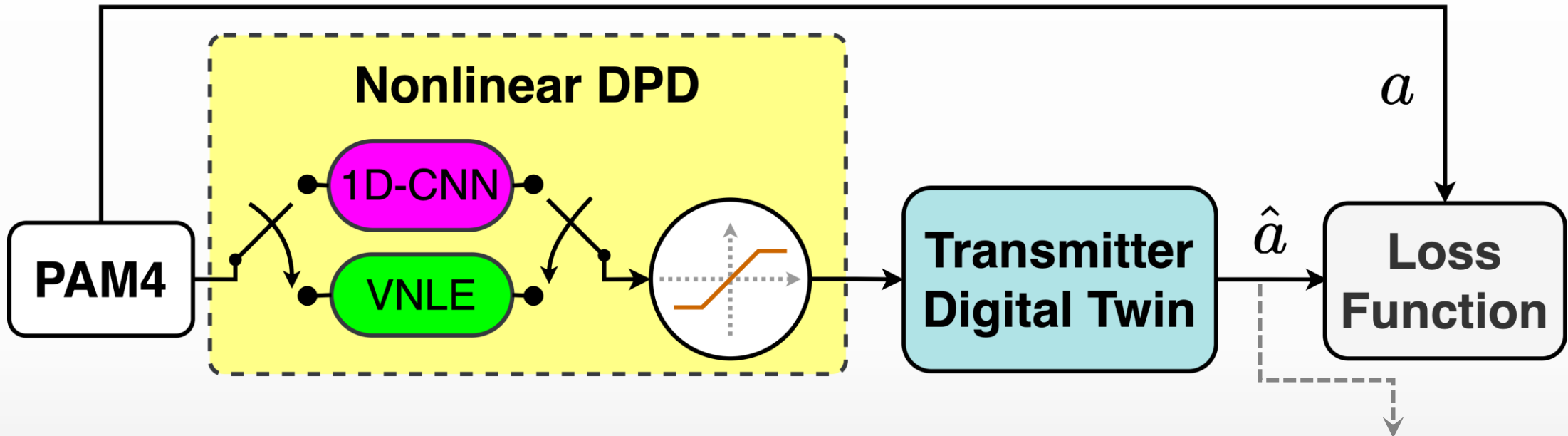
Digital Twin of an experimental VCSEL-based optical transmitter



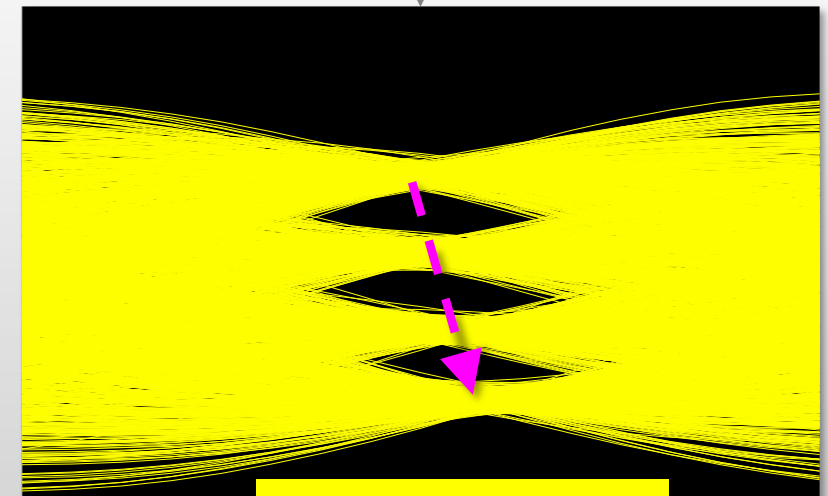
Digital Twin of an experimental VCSEL-based optical transmitter



Nonlinear Digital Pre-Distorter Optimization

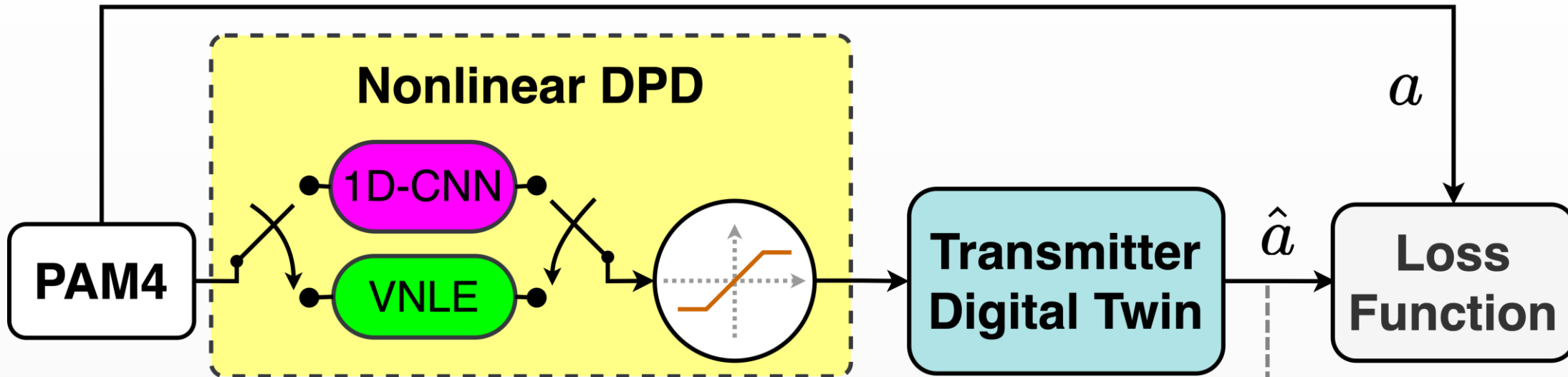


- The DPD and the Digital Twin together form an Artificial Neural Network (ANN)
- By training the ANN, the DPD learns how to pre-compensate the VCSEL nonlinearities

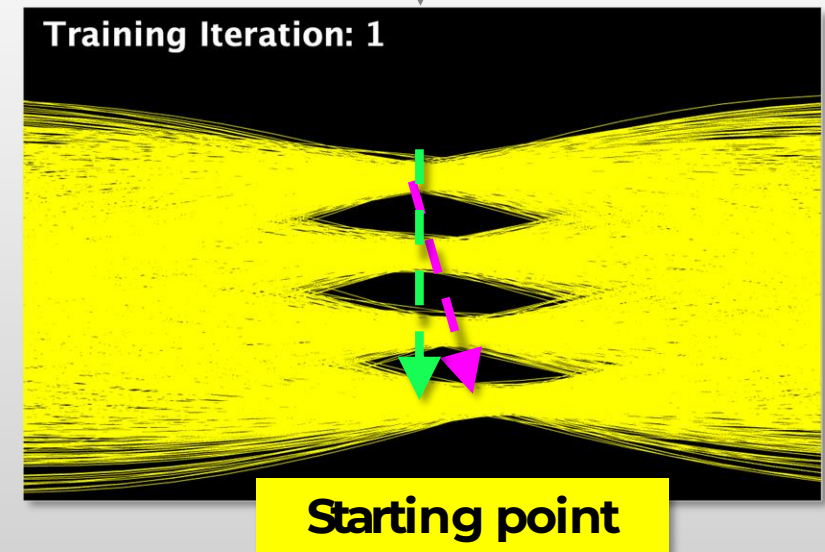


Starting point

Nonlinear Digital Pre-Distorter Optimization

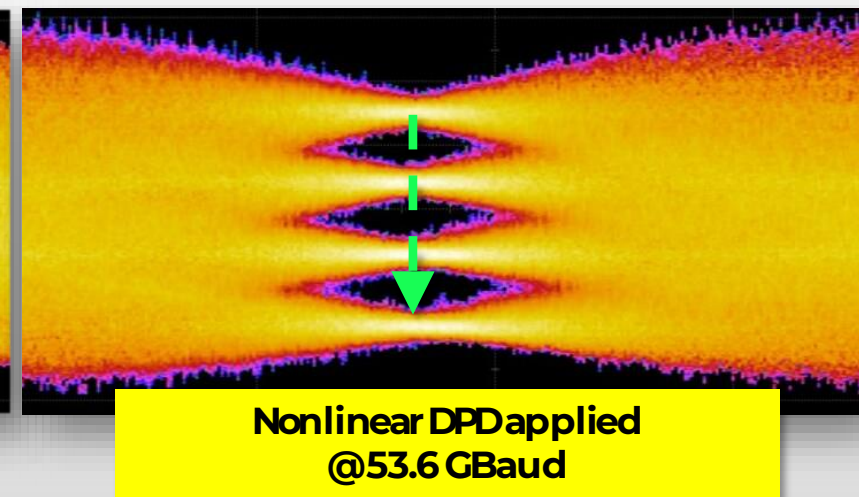
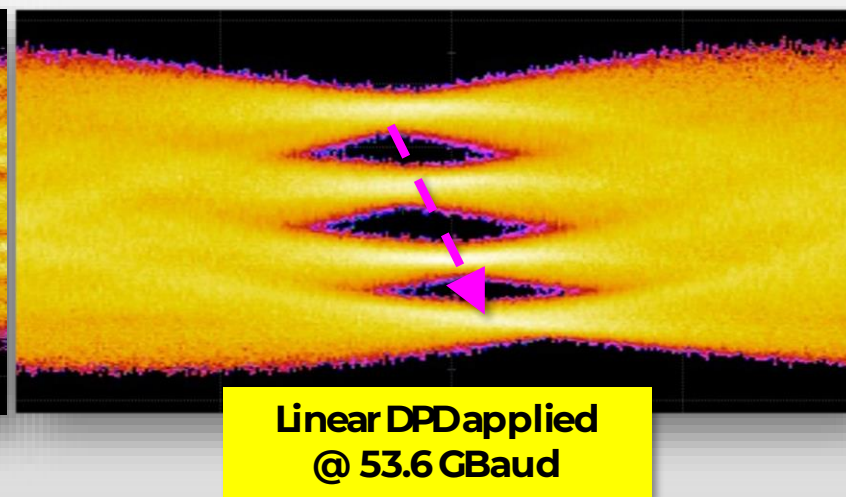
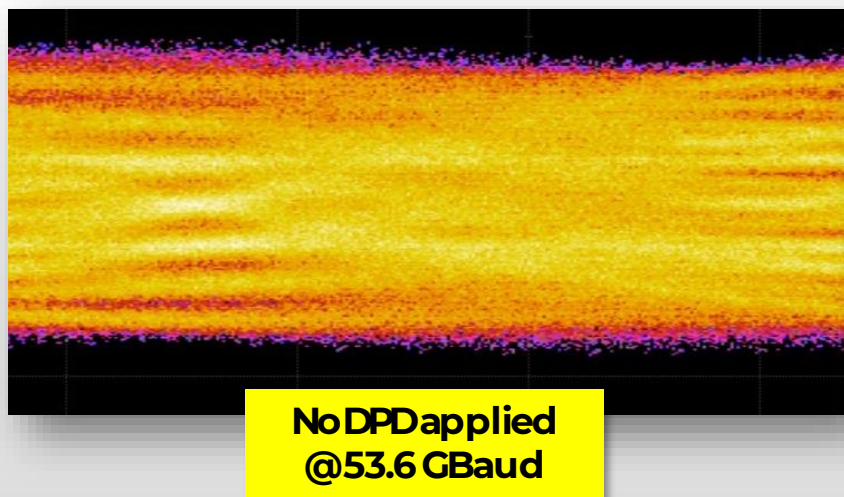
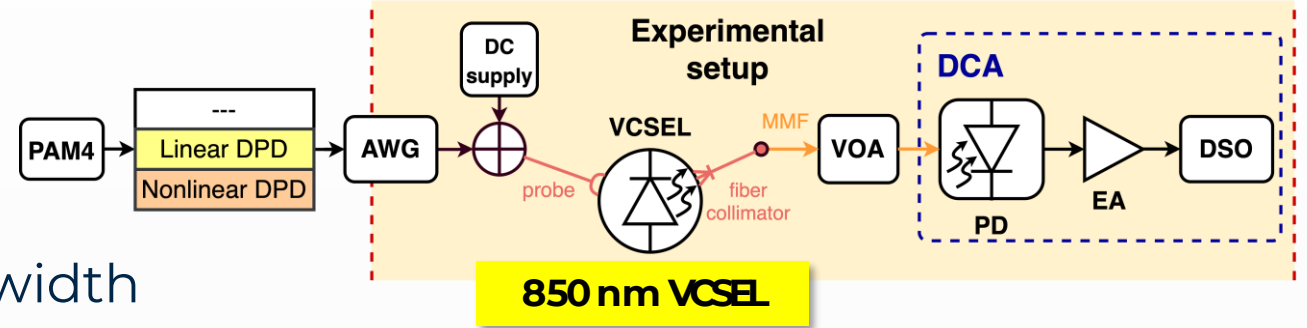


- The DPD and the Digital Twin together form an Artificial Neural Network (ANN)
- By training the ANN, the DPD learns how to pre-compensate the VCSEL nonlinearities



Experimental Results

- The optimized pre-distorter is tested experimentally on the same setup
- Nonlinear VCSEL distortions and bandwidth limitations are fully compensated



Thank you for your attention

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Acknowledgments:

This work was carried out under a research contract with Cisco Photonics.
We also acknowledge the PhotoNext Center at Politecnico di Torino, Cisco
Optical GmbH and Links Foundation