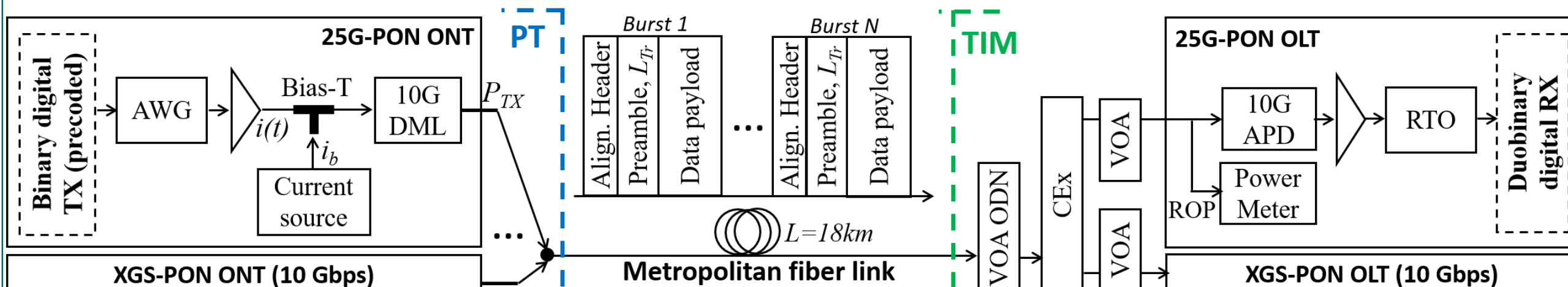


Research context and motivation

- Next-generation high-speed Passive Optical Networks (PON) to support 25 and 50 Gbps.
- To reduce the cost: reusing 10G-class optical transceiver components: e.g., 10G DML (Directly Modulated Lasers), and 7G APD.
- Therefore, DPS (Digital Signal Processing) techniques is adopted to compensate for bandwidth limitations for both CM (Continuous Mode) and BM (Burst Mode) transmission, e.g., FFE (Feed-forward Equalizer) and DFE (Decision Feedback Equalizer).
- A field experiment using 16 km SMF fibres between Telecom Italia (TIM) research centre in Turin and Polito (PT) PhotoNext lab. The used fibre has a significant extra loss because it traverses several central offices and manholes and it is thus a good emulation of a real PON installed link. We show the coexistence of our 25G-PON proposed solution with XGS-PON commercial technology, demonstrating BM transmission for both systems and investigating on the impact of residual crosstalk between them.



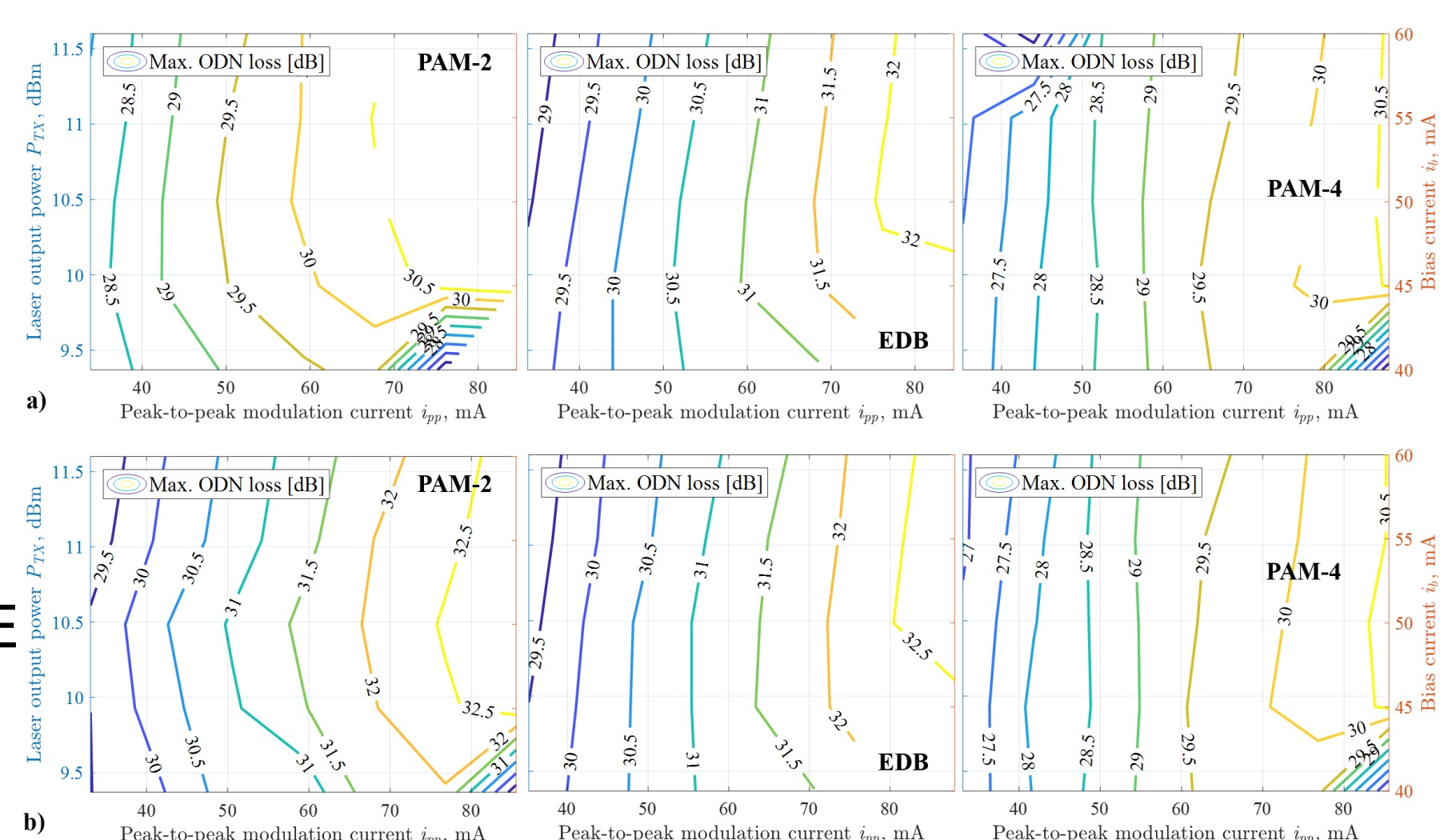
- Some simulations were also performed to confirm the experimental results, and to extend the results by changing the f_{3dB} and f_{20dB} bandwidth of both DML and APD.

Addressed research questions/problems

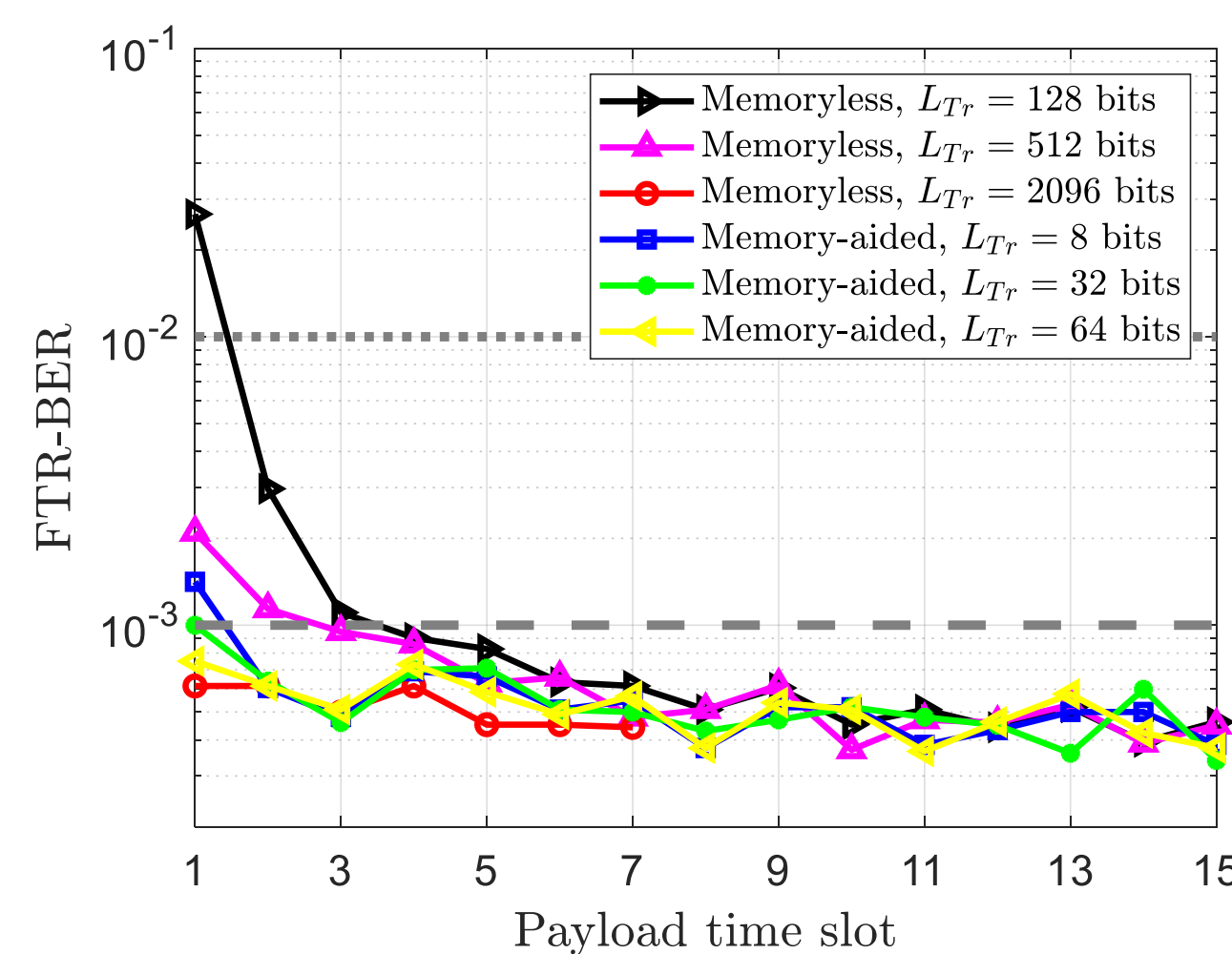
For CM transmission, a set of experiments have been presented to compare the performance of different modulation formats (PAM2, PAM4 and EDB) and two equalization strategies (FFE and FFE+DFE) in terms of the maximum ODN loss.

For BM transmission, setting the 'best' condition obtained for CM (EDB and FFE), using the TIM-PT experimental setup, and applying the BM-AE approaches to the bursts.

- CM transmission: maximum ODN loss as a function of transmitter parameters with target BER = 10^{-2} (25Gbps, a) FFE and b) FFE+DFE



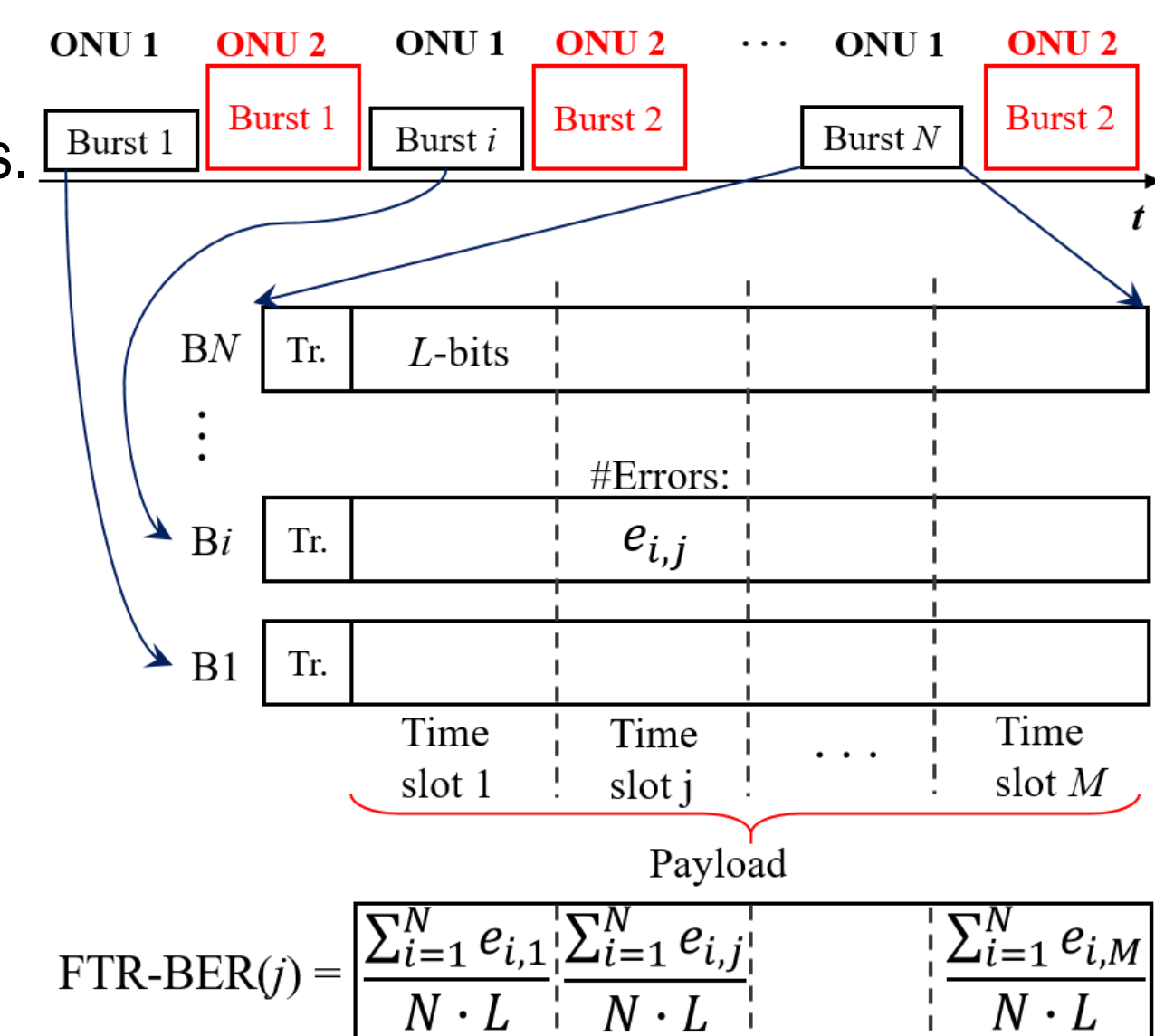
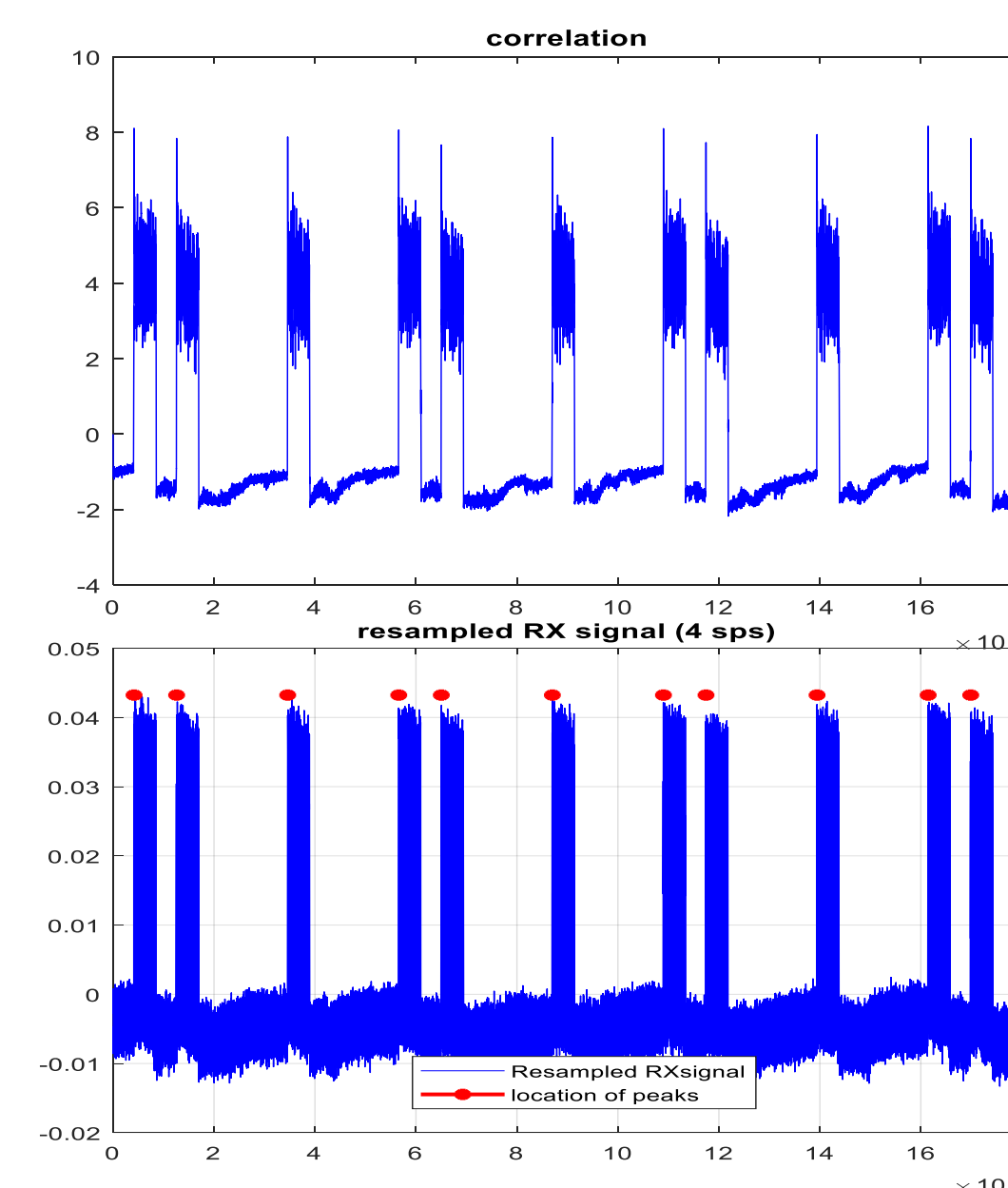
- FTR-BER over each of the 385-bits time slots for BM-AE approaches with training length L_{Tr} .



Novel contributions

- Fine time-resolved BER (FTR-BER) evaluation scheme

- For BM transmission, aligning the signals only by using the preamble with just 127 bits.



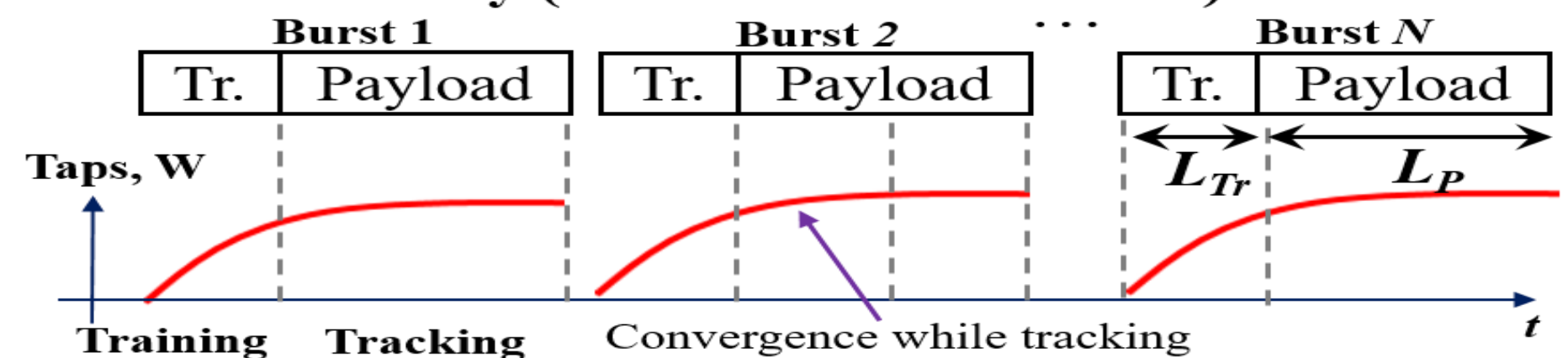
$$FTR-BER(j) = \frac{\sum_{i=1}^N e_{i,1}}{N \cdot L} \quad \frac{\sum_{i=1}^N e_{i,j}}{N \cdot L} \quad \frac{\sum_{i=1}^N e_{i,M}}{N \cdot L}$$

Adopted methodologies

The research has been mainly implemented by the experiments, and exploited DSP after acquiring the received signal. This is the so-called off-line processing approach.

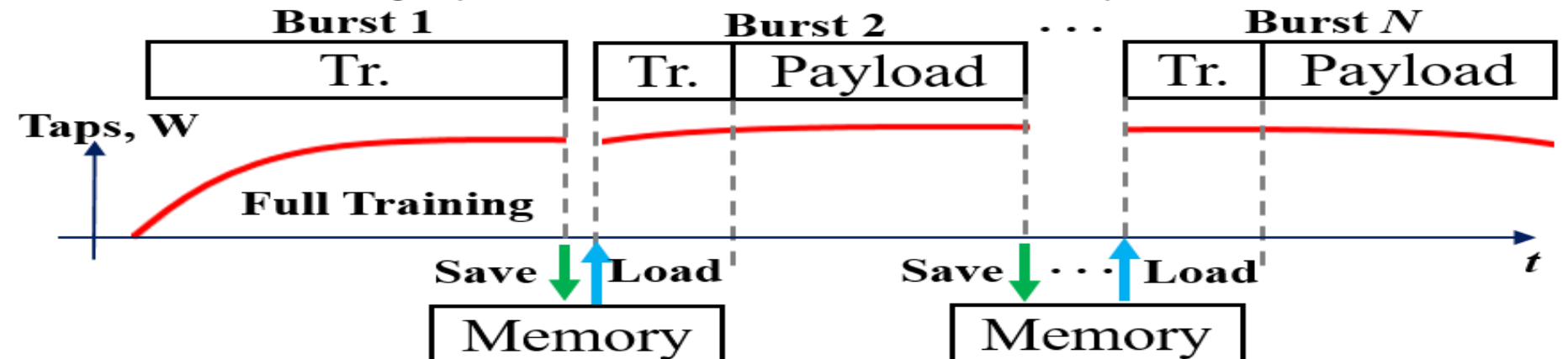
- Two BM-AE (Burst Mode Adaptive Equalization) approaches:

Without memory (Burst from same ONU)



Memoryless

With memory (Burst from same ONU)



Memory-aided

- Compared the performances of numerous conditions (i.e., for modulation formats, we compare PAM-2, PAM-4, and EDB, with FFE and DFE at receiver side, for CM and BM transmissions.) in terms of maximum ODN loss (by using the contour plot) and BER.

Future work

- In CM transmission, using SOA+PIN in the receiver side to reduce the bandwidth limitation of the system.
- In CM transmission, simulating IQ-modulator and performing dispersion pre-compensation.

List of attended classes

- 01LCPRV – Experimental modeling: costruzione di modelli da dati sperimentali (10/5/2019, 6)
- 01TEVRV – Deep learning (4/6/2019, 6)
- 01QORRV – Writing Scientific Papers in English (6/6/2019, 3)
- 02RHORV – The new Internet Society: entering the black-box of digital innovations (23/6/2019, 1)
- 02LWHRV – Communication (24/6/2019, 2)
- 01QRRRV – Advanced iterative techniques for digital receivers (25/6/2019, 4)

Submitted and published works

- Torres-Ferrera, P.; Wang, H.; Ferrero, V.; Mercinelli, R.; Gaudino, R. "Towards 50 Gb/s in High-Speed PON: Optimization of Modulation Formats Using Pre-Chirping", 20th International Conference on Transparent Optical Networks, ICTON 2018.
- Torres-Ferrera, P.; Wang, H.; Ferrero, V.; Pagano, A.; Valvo, M.; Mercinelli, R.; Gaudino, R. "FIELD DEMONSTRATION OF 25G-PON AND XGS-PON BURST-MODE UPSTREAM COEXISTENCE", The 45th European Conference on Optical Communication, ECOC 2019.
- Torres-Ferrera, P.; Wang, H.; Ferrero, V.; Valvo, M.; Gaudino, R. "Optimization of band-limited DSP-aided 25 and 50 Gbps PON using 10G-class DML and APD", Journal of Lightwave Technology, JLT (submitted).