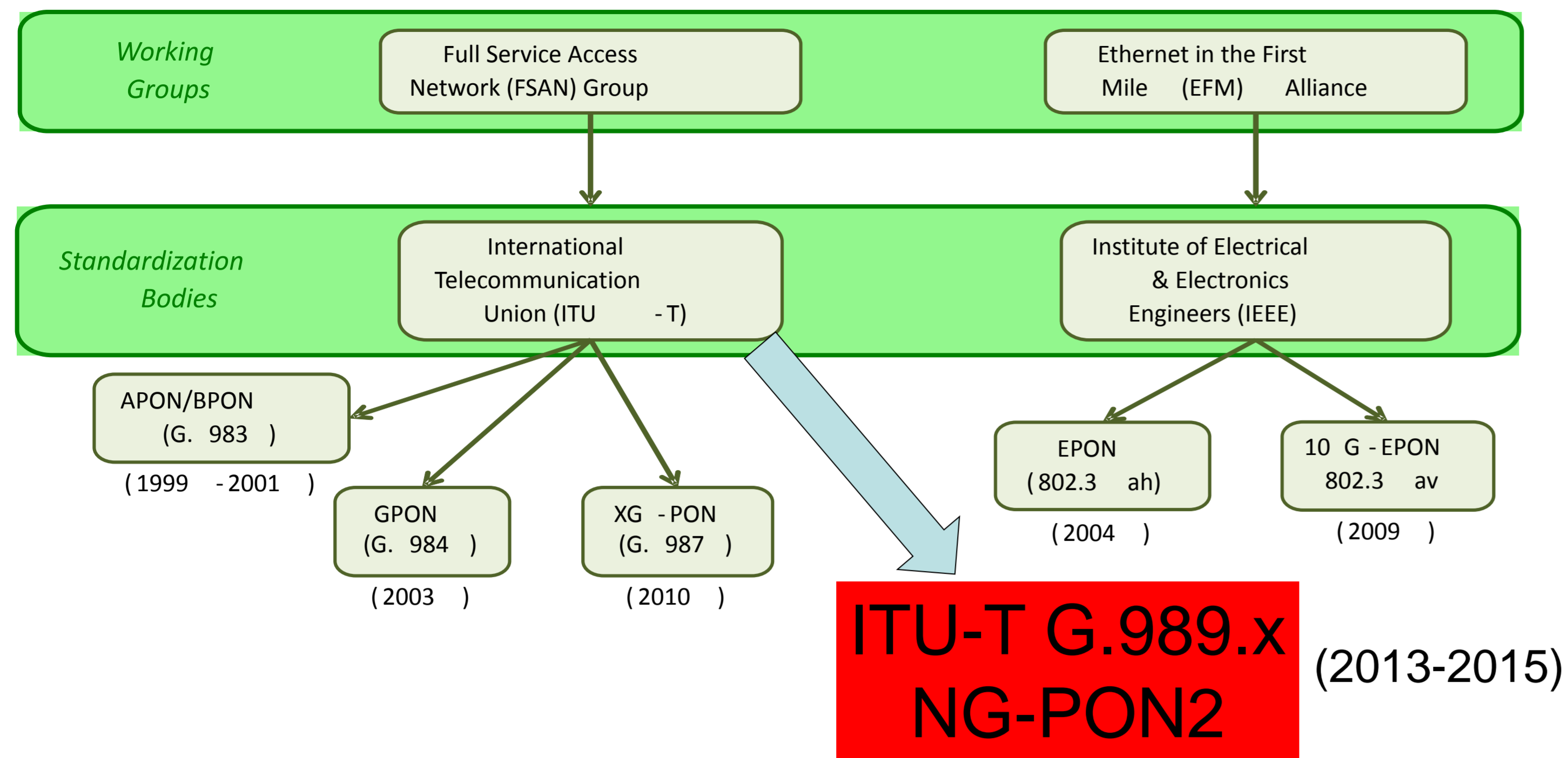


Photon Ranging Techniques for Upstream Signaling in TWDM-PON during ONU Activation

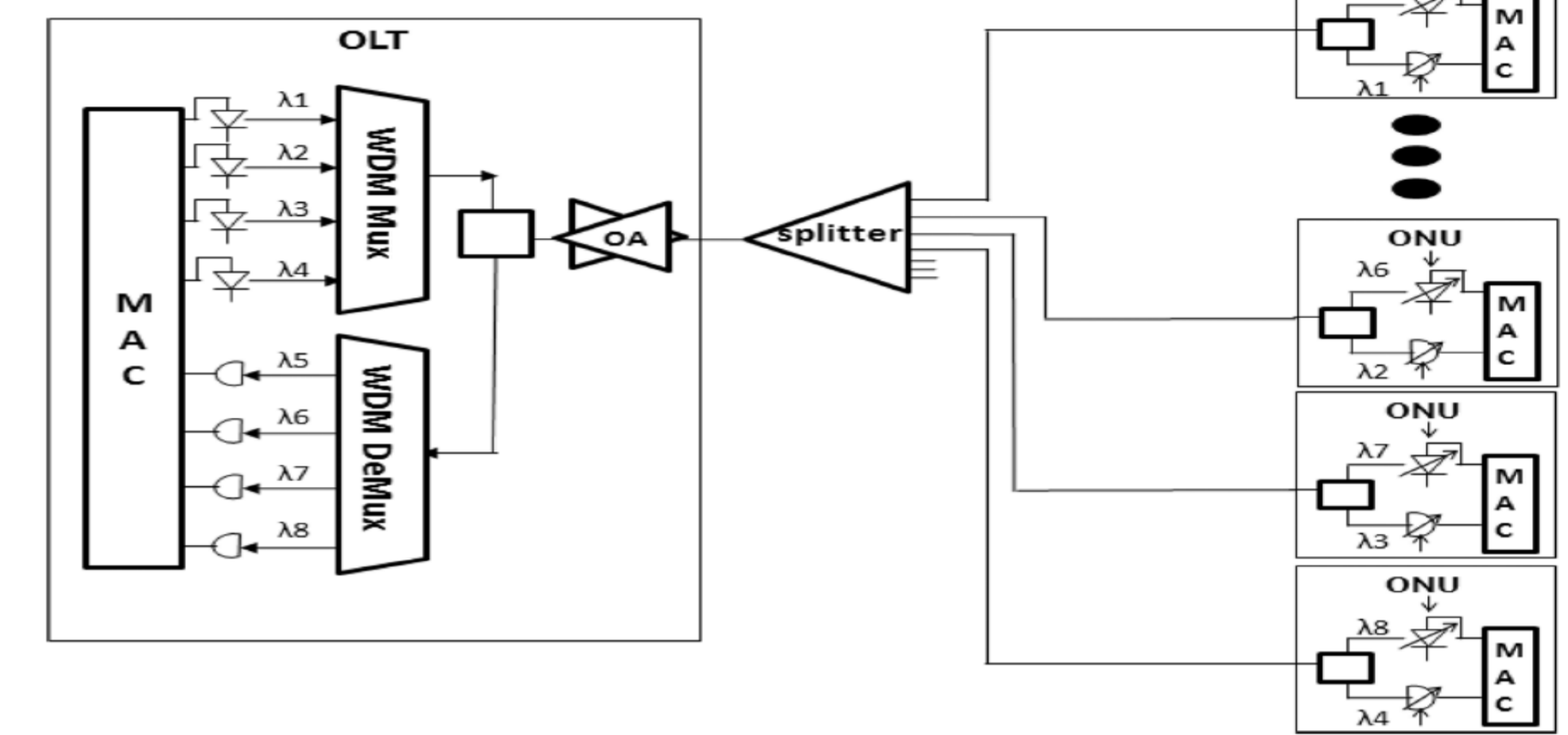
L. Bertignono, S. Capriata, V. Ferrero, L. Greborio, R. Mercinelli, M. Valvo and R. Gaudino



The Scenario: TWDM-PON (ITU-T NG-PON2 G.989.x)

TWDM-PON: (at least) Four wavelengths per direction

- Nominal rate 10/2.5G DS/US per channel
- Symmetric 10G or 2.5G per channel as options



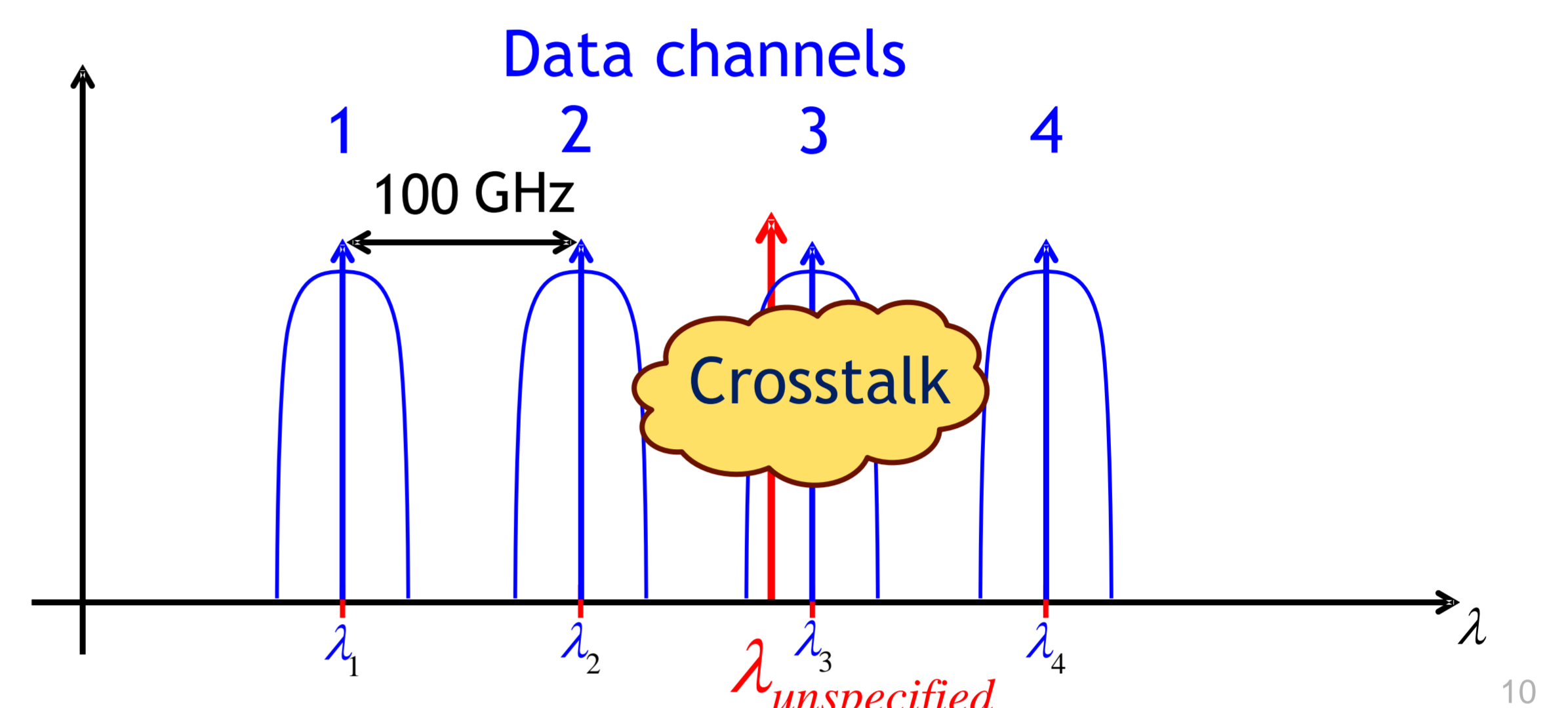
The Research Work Scenario

How to manage the new ONU activation to avoid out of service of the already active ONUs?

- The ONU tunable lasers should be accurate on a 100 GHz grid (or even 50 GHz)
- An option for the ONU is to use uncalibrated lasers (to reduce ONU cost):
 - The central office "drives" the wavelength operating point remotely
 - The TWDM PON system uses the "quiet window" method for new ONU activation
 - ...but this requires μ s-time synchronization among all channels (VERY TRICKY IN A MULTI-OPERATOR ENVIRONMENT OR WHEN OLTs ARE AT DIFFERENT LOCATIONS)

We propose a Photon Ranging technique based on an Auxiliary Management and Control Channel (AMCC)

The AMCC signaling constrains



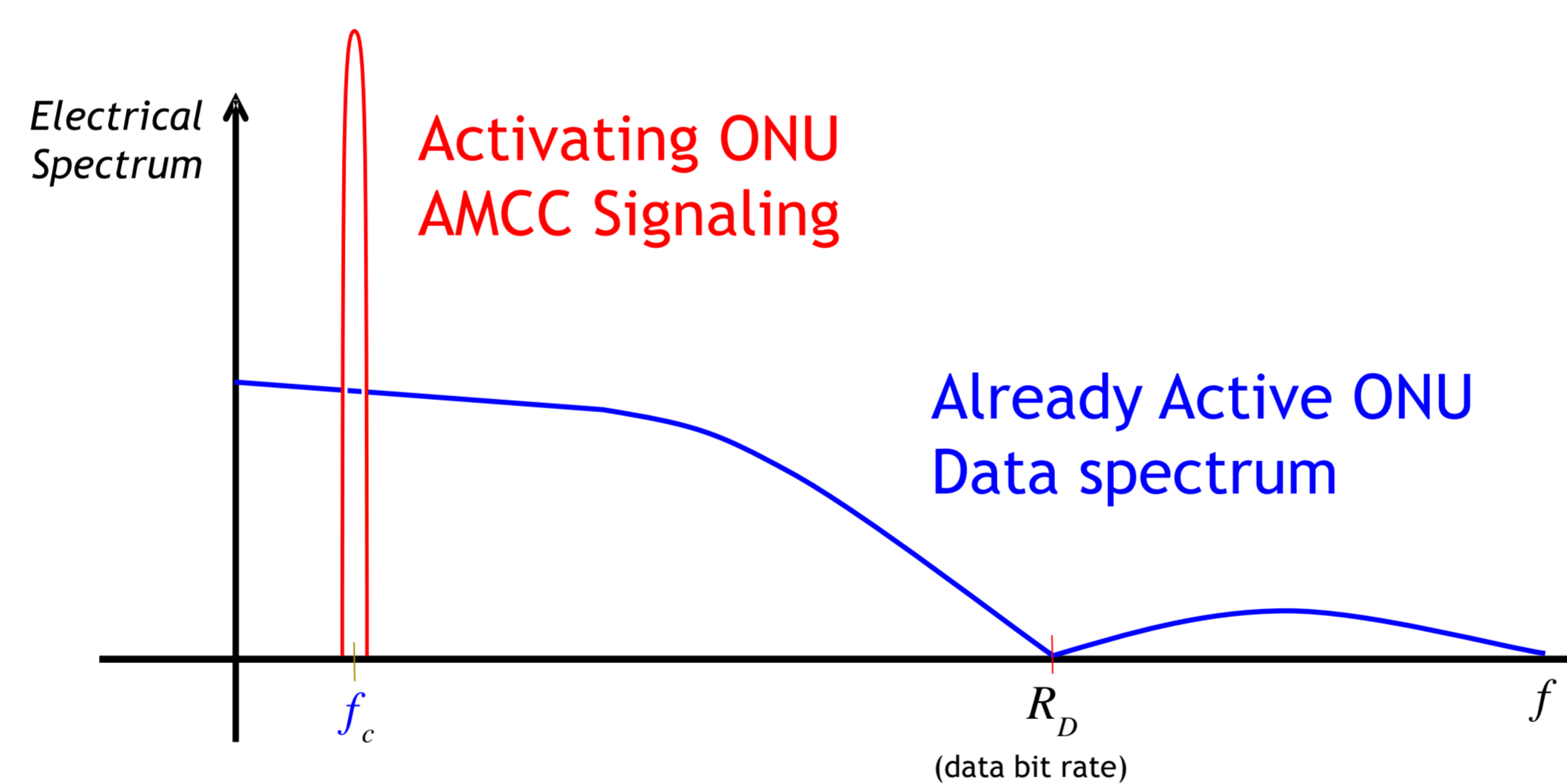
During the ONU activation procedure:

- The activating ONU wavelength is unspecified
- The activating ONU and someone of the already active channels may be both affected by crosstalk

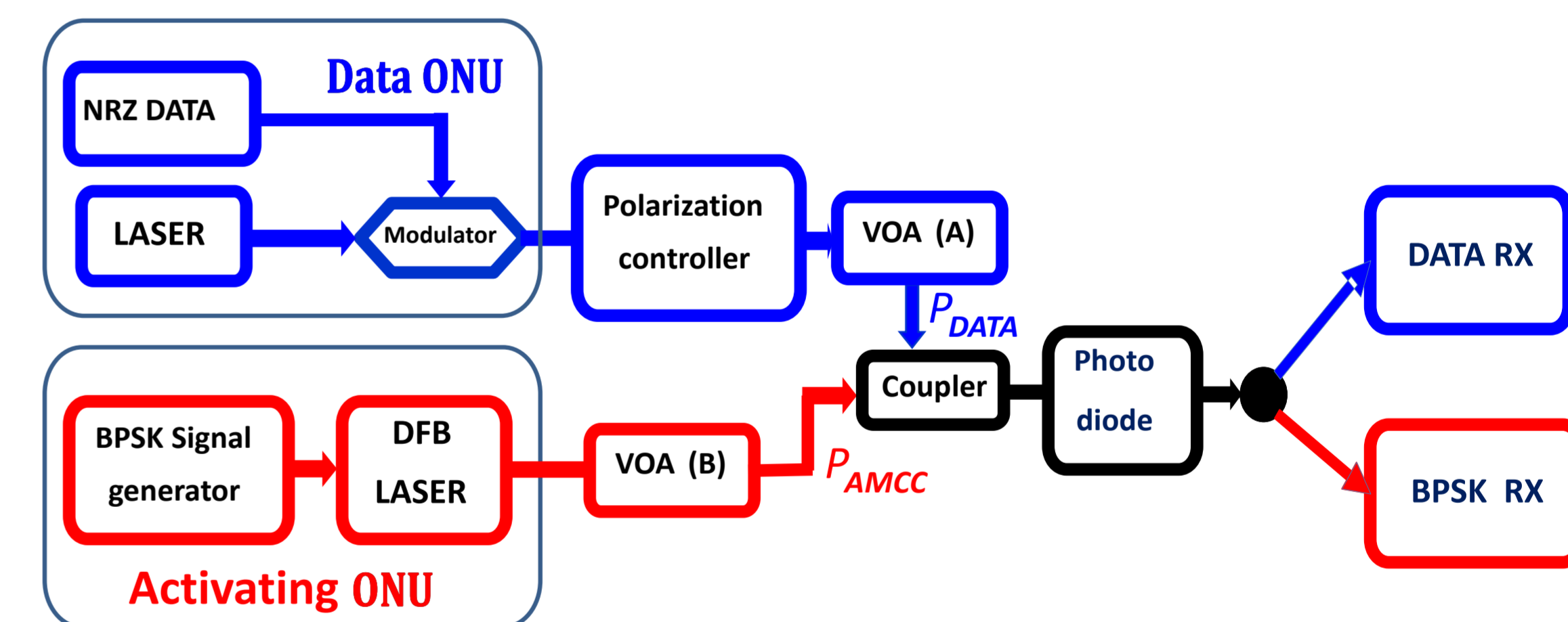
The Photon ranging proposal for the ITU-T AMCC Signaling

- The AMCC Signaling (Activating ONU):**
 - Low-frequency low bit rate subcarrier signaling:
 - Electrical subcarrier frequency = 2.5 MHz
 - Electrical subcarrier Modulation : BPSK @ $R_c = 2.5$ Kbps
 - Opt Receiver (PIN) with 1.87 GHz Electrical Bandwidth
- The DATA channel (Already Active ONU) :**
 - Optical Modulation: OOK @ $R_D = 2.5$ Gbps
 - NRZ with rectangular shape
 - Opt Receiver (PIN) with 1.87 GHz Electrical Bandwidth

OLT Upstream Optical Receiver



Experimental Setup



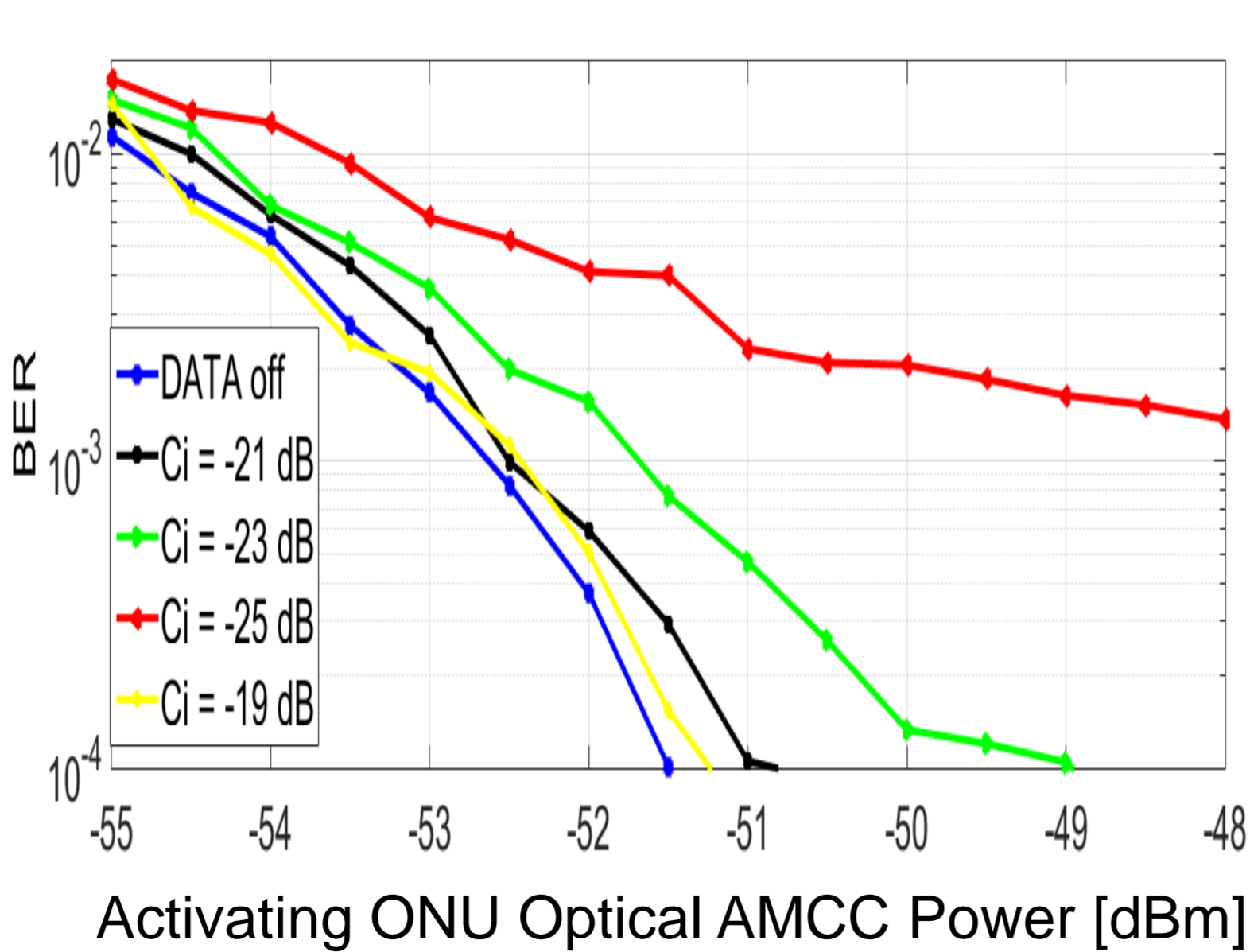
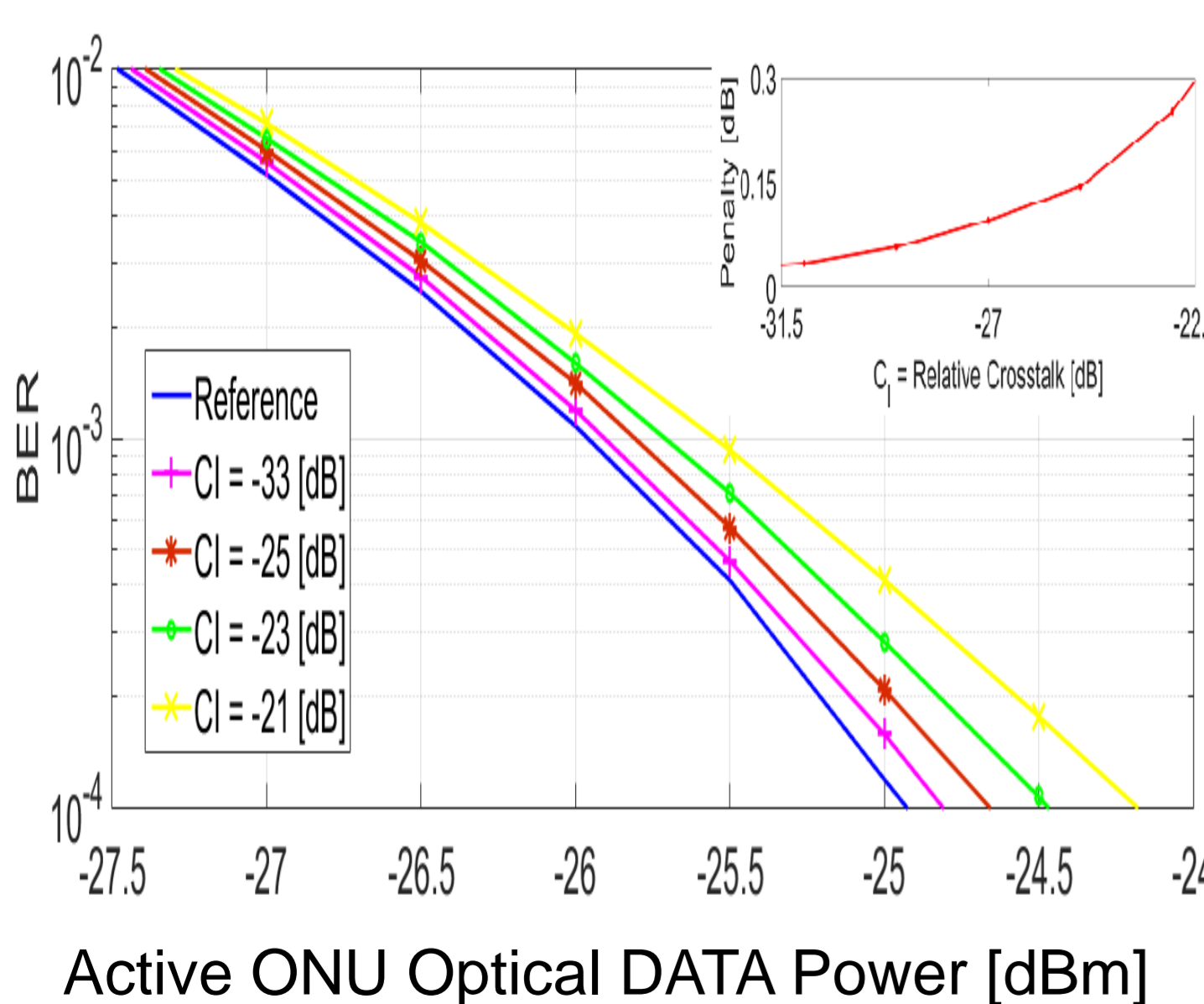
Experimental Results

We introduce the relative optical crosstalk parameter: $C_I = P_{AMCC} / P_{DATA}$

The performances are measured in the worst case scenario (to maximize the crosstalk: perfect wavelength alignment, perfect optical polarization alignment)

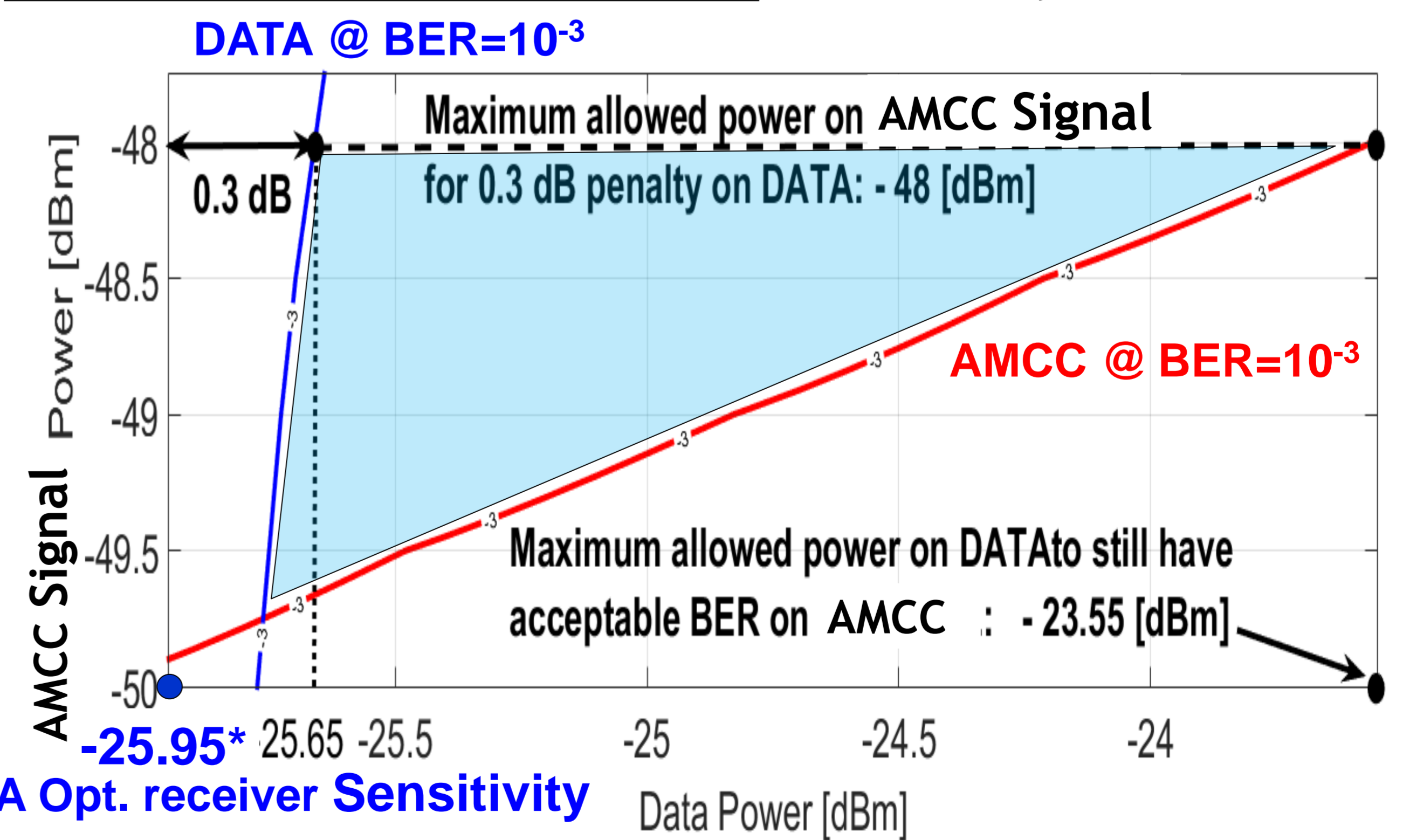
Performances on DATA Branch

Performances on AMCC Signaling



Experimental Results and Conclusions

Due to the AMCC activating ONU interference, we allow **maximum 0.3 dB crosstalk penalty** on the already active DATA ONU



In the light blue region both the Activating ONU and the Already Active Data ONU may work in parallel (with 2.4 dB Margin on the Data Optical Power variation)

For further Information see the accepted JLT paper (DOI: 10.1109/JLT.2015.2480962):

Photon Ranging for Upstream ONU Activation Signaling in TWDM-PON

L. Bertignono, V. Ferrero, M. Valvo and R. Gaudino

Available soon in the IEEE Open Access platform

