Considerations on definition of “EVM” and “Reference Receiver” for 400GBASE-ZR

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Introduction

- EVM_{RMS} has been included in in-force Recommendation ITU-T G.698.2 as the metric to define the quality of a 100 Gb/s DP-DQPSK transmitter.
  - It contains also the definition of a reference receiver within the definition of EVM_{RMS}
- IEEE P802.3ct™ has adopted the EVM_{RMS} definition used in in-force Recommendation ITU-T G.698.2 with an additional requirement on the clock recovery unit for sample acquisition.
- Work on laboratory measurements investigating the suitability of EVM_{RMS} as the transmitter quality metric also for a DP-16QAM transmitter has been reported in IEEE802.3ct.
- The definition of EVM_{RMS} as a suitable metric for a DP-16QAM transmitter in 80 km 400 Gb/s applications in P802.3cw has to be established including the definition of a reference receiver.
- Test plan and actions towards an appropriate definition of EVM for 400GBASE-ZR based pittala_3ct_01a_0120 has been agreed with Motion #5 during IEEE P802.3ct Task Force interim meeting, Jan 2020, Geneva.
- Presentation nicholl_3cw_01a_210614 calls to Action on EVM test data.
- The current presentation reports some considerations on definition of the “EVM” and “Reference receiver” based on 400 Gb/s lab. measurements.

Process to define “Reference receiver”, “EVM” and “EVM limit value”

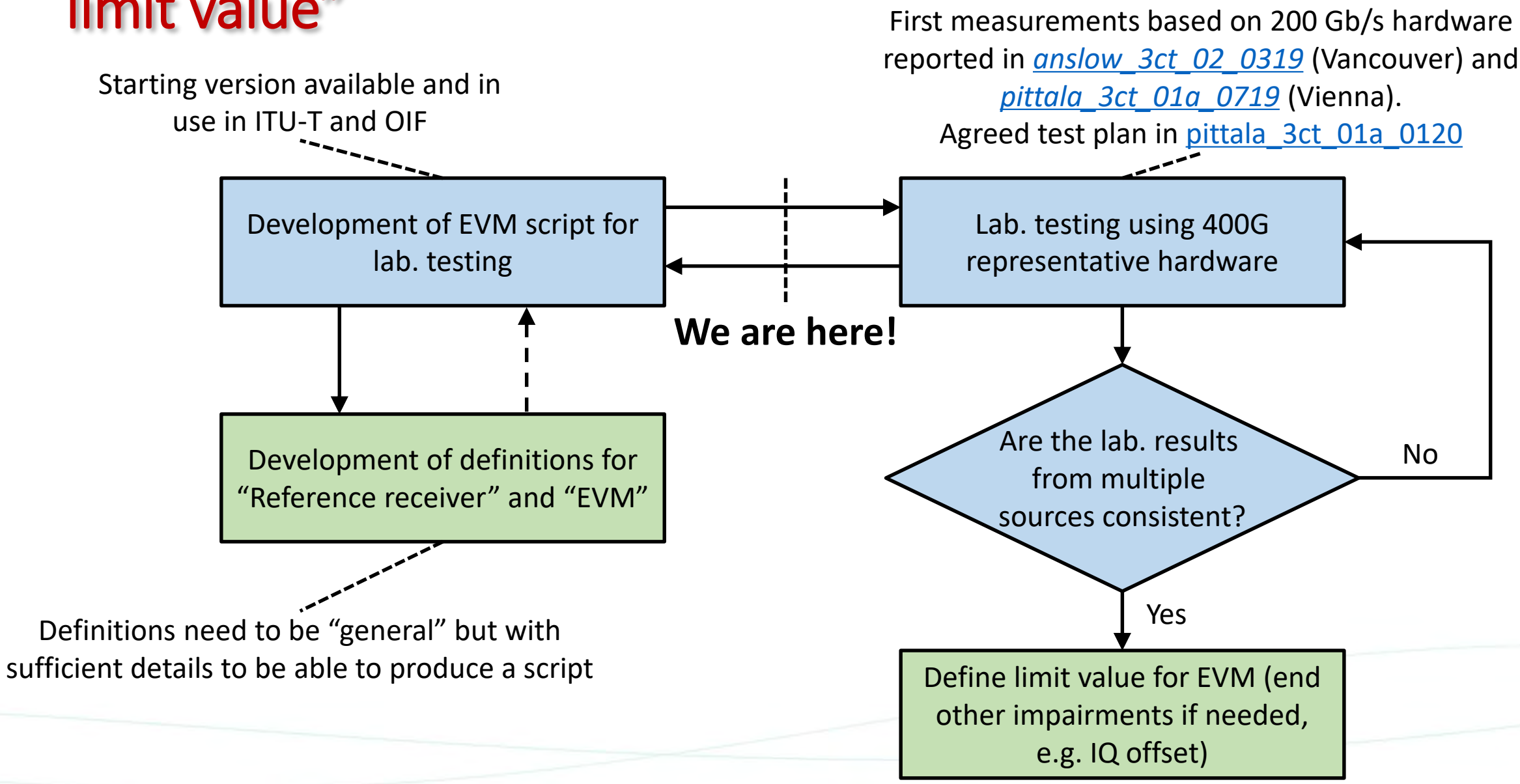
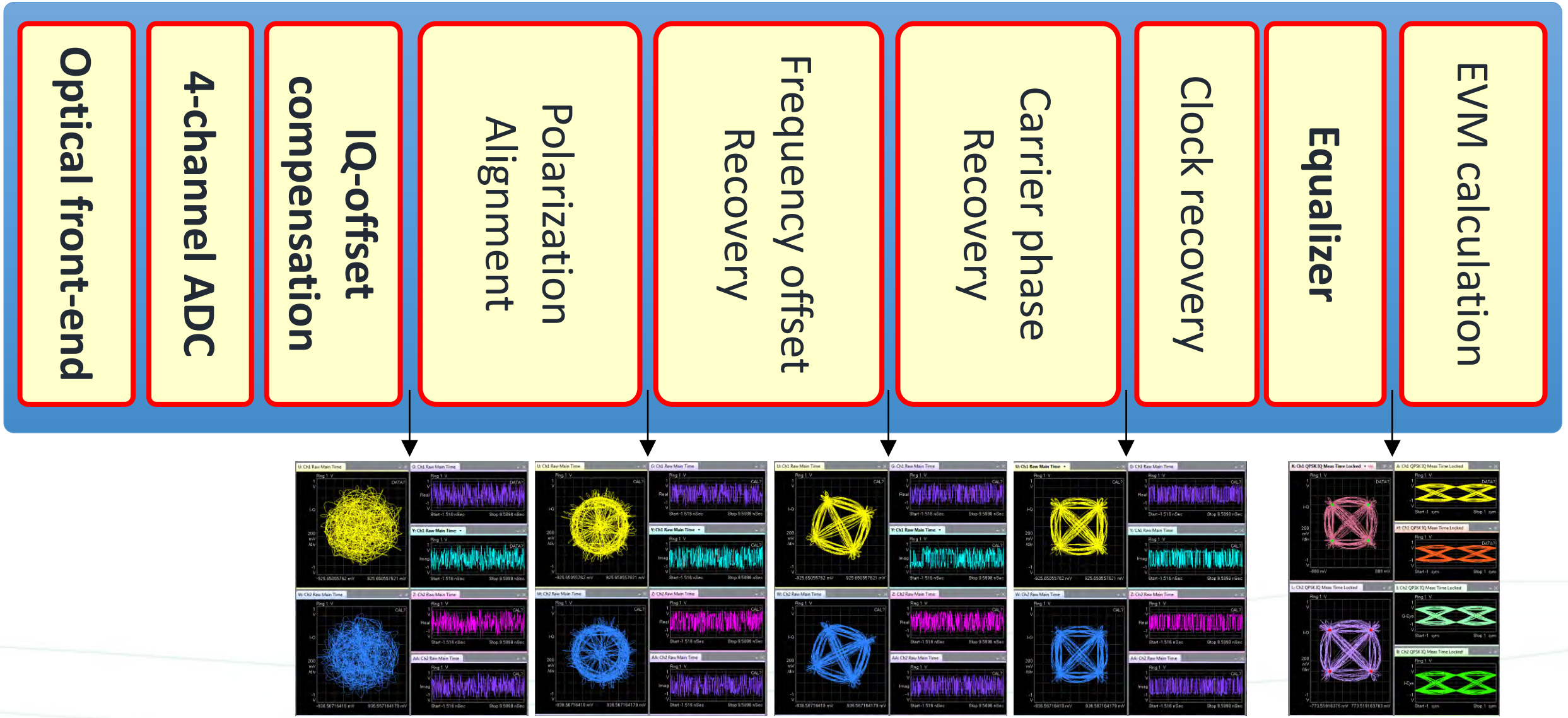
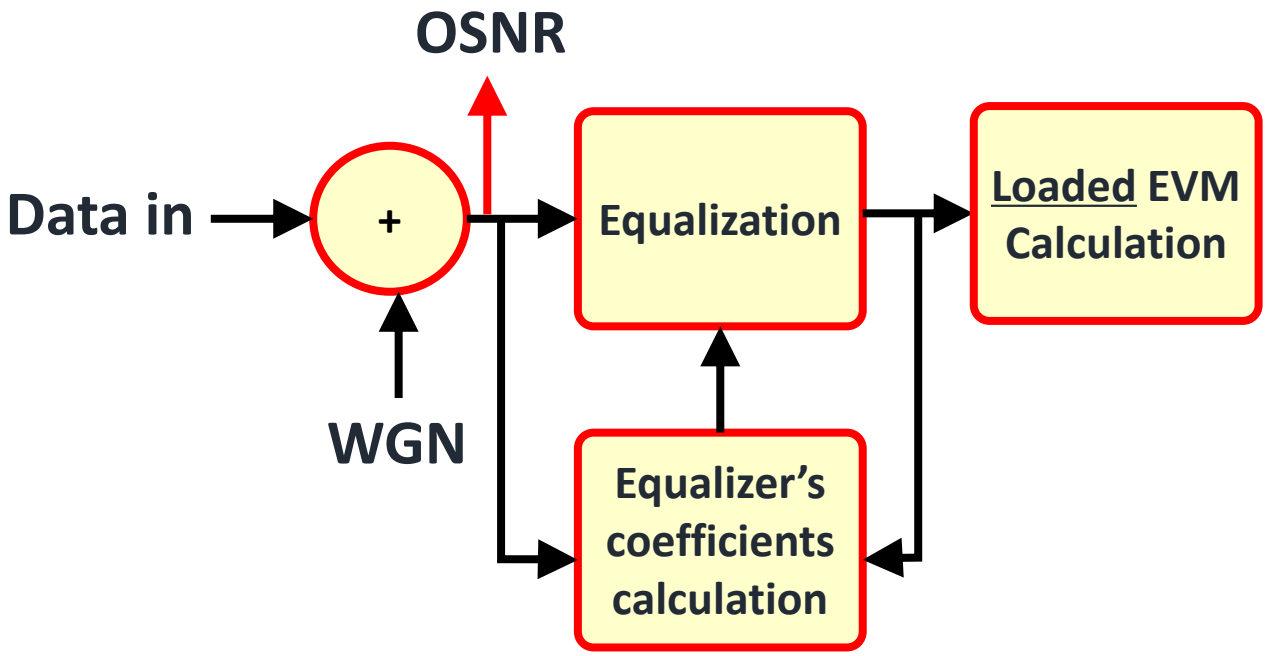
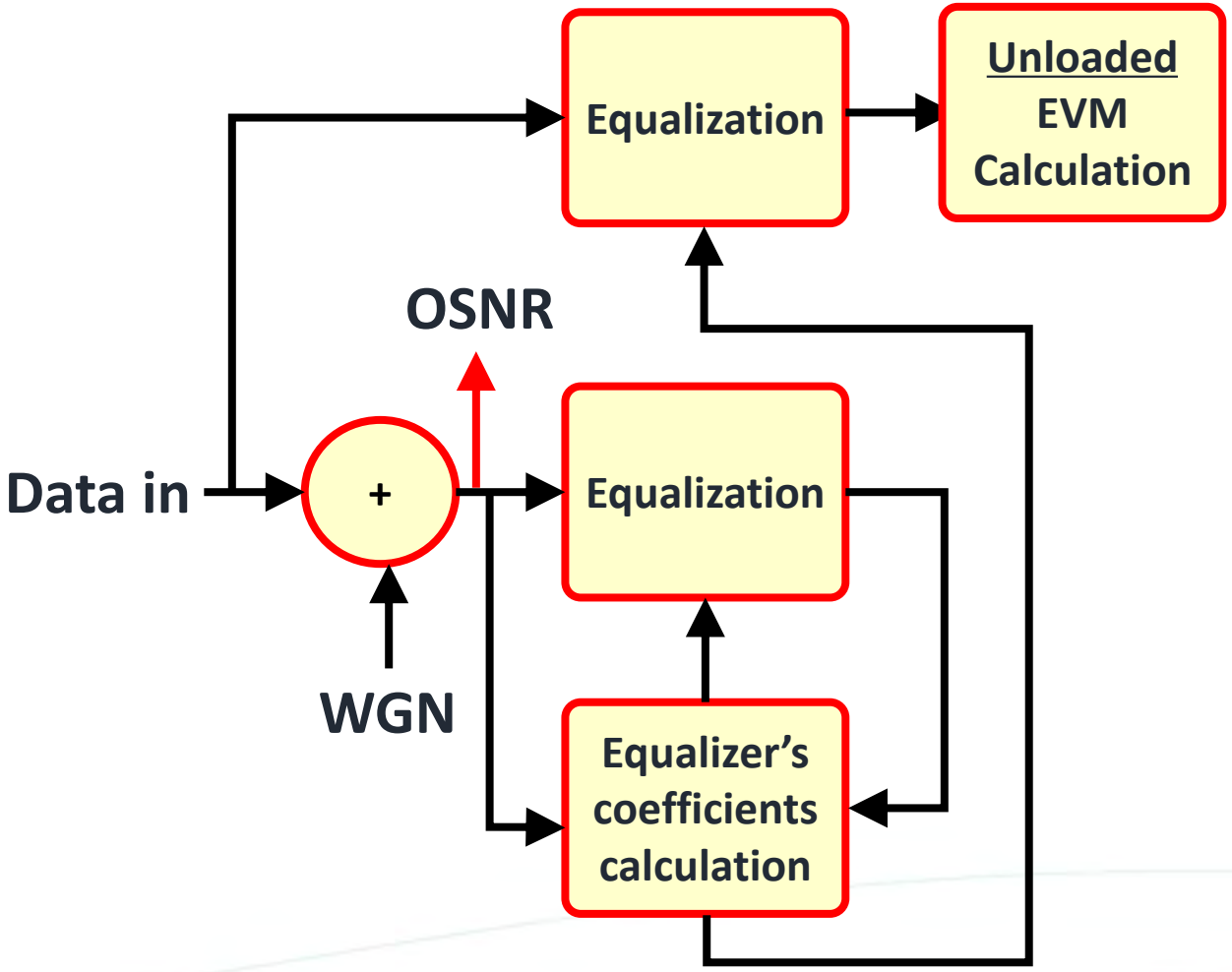


Diagram block of “EVM” and “Reference Receiver”



Loaded vs Unloaded EVM



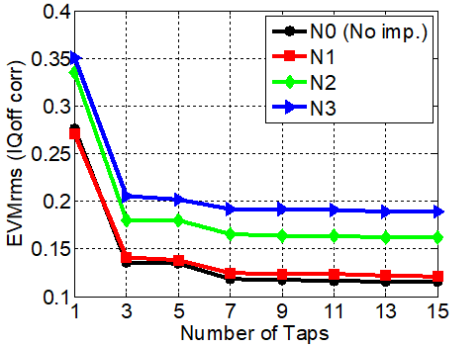


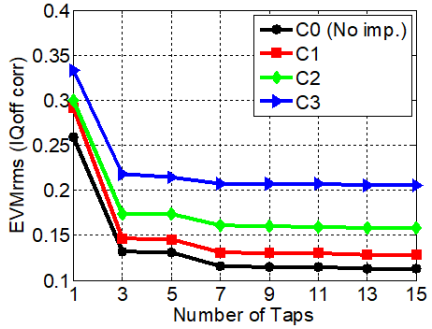
WGN = White Gaussian Noise

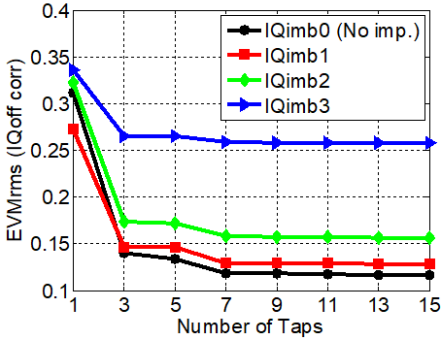
Considerations on Equalizer (100Gb/s DP-QPSK example)

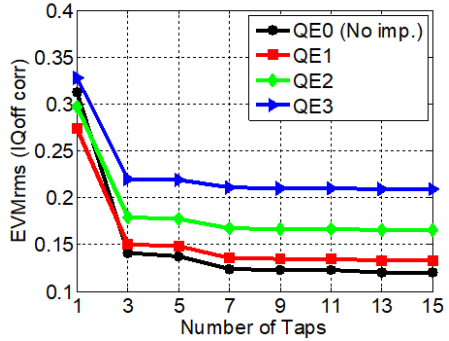
The current definition of (loaded) EVM, in the IEEE P802.3 ct project, considers a 7-tap T-spaced equalizer based on 100 Gb/s DP-QPSK experimental results reported by Huawei in WD06-17 ITU-T SG15/Q6 interim meeting held in Hangzhou, China (Oct. 2017).

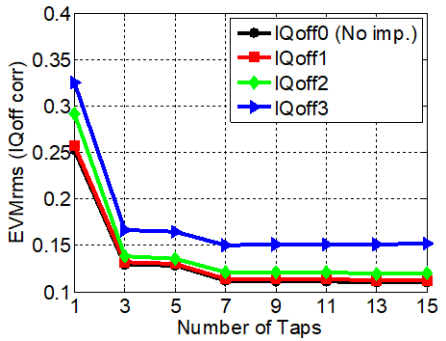
T-spaced equalizer:



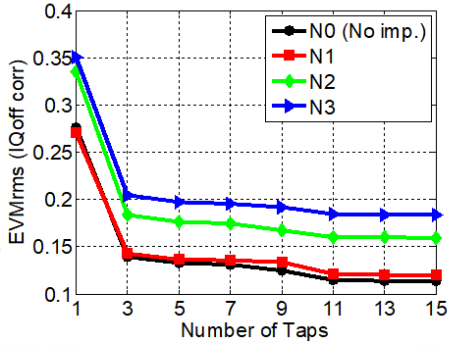


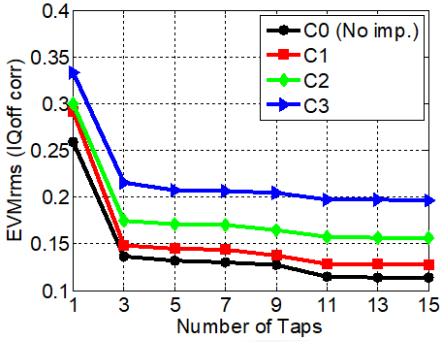


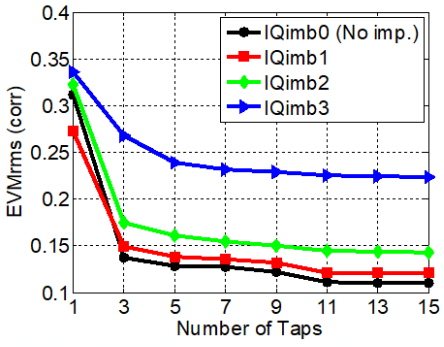


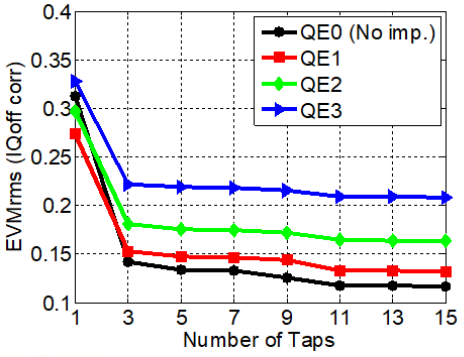


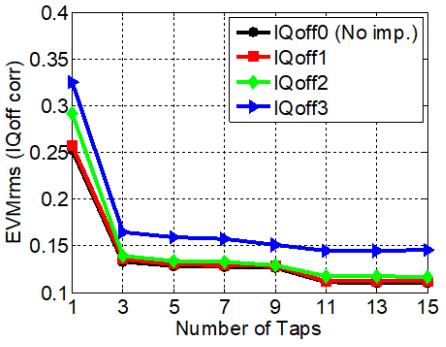
T/2-spaced equalizer:





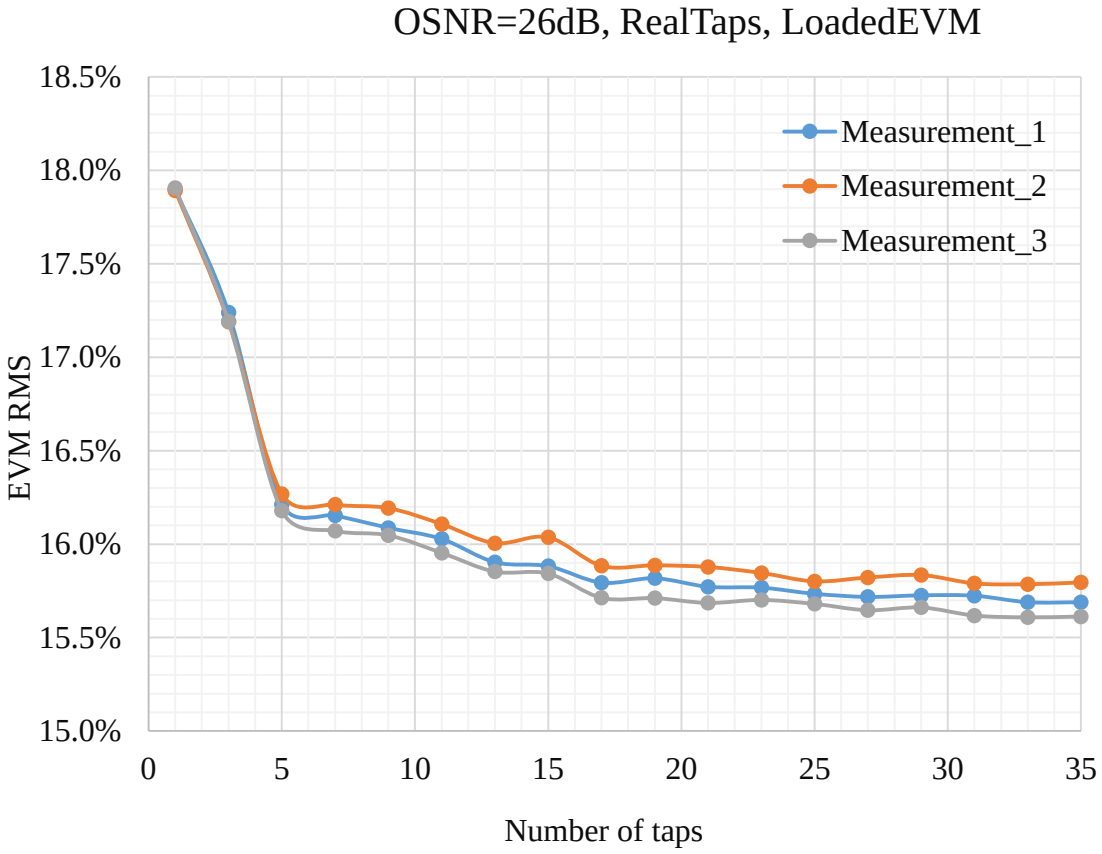


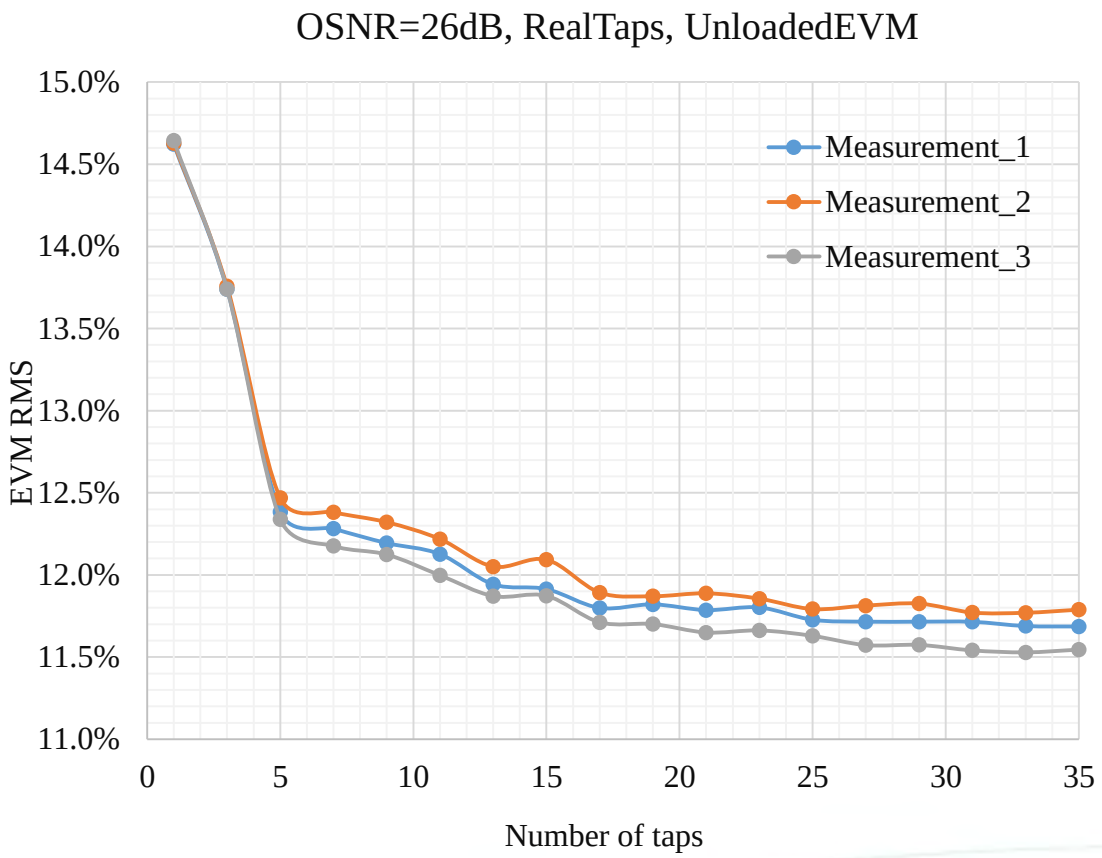




Considerations on Equalizer (400 Gb/s DP-16QAM)

Preliminary results: Loaded vs Unloaded EVM





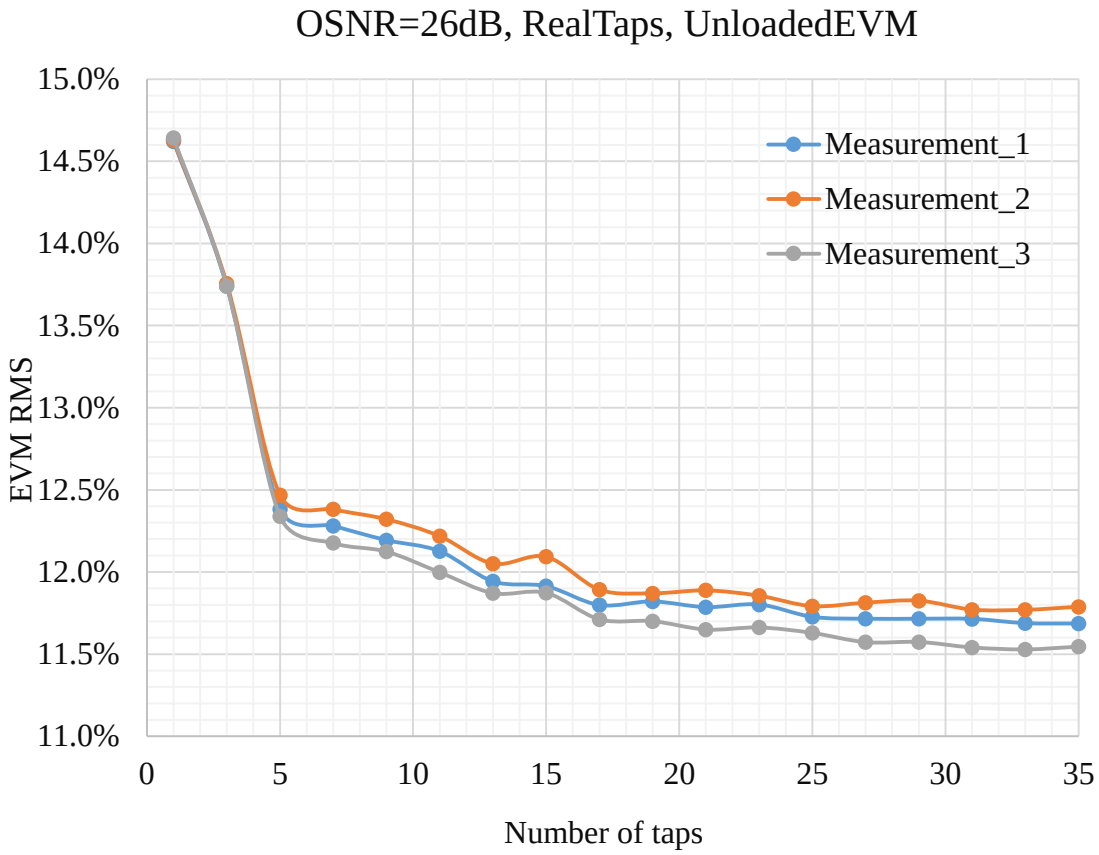
The number of taps required for 400G DP-16QAM could be larger than 7.

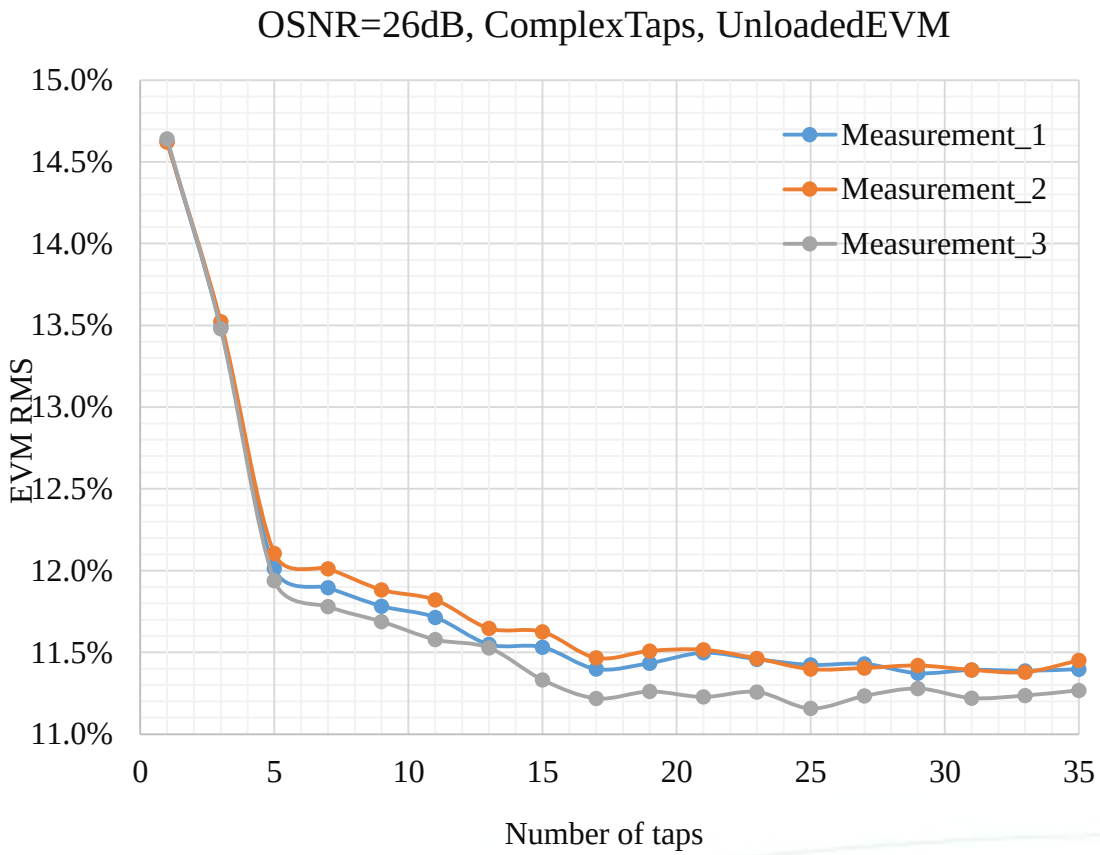
Loaded EVM: EVM calculated with WGN digitally added to the signal.

Unloaded EVM: Taps of the equalizer calculated with AWGN digitally added to the signal, but EVM calculated on the signal without additional noise.

Considerations on Equalizer (400 Gb/s DP-16QAM)

Preliminary results: real- vs complex-valued equalizer taps

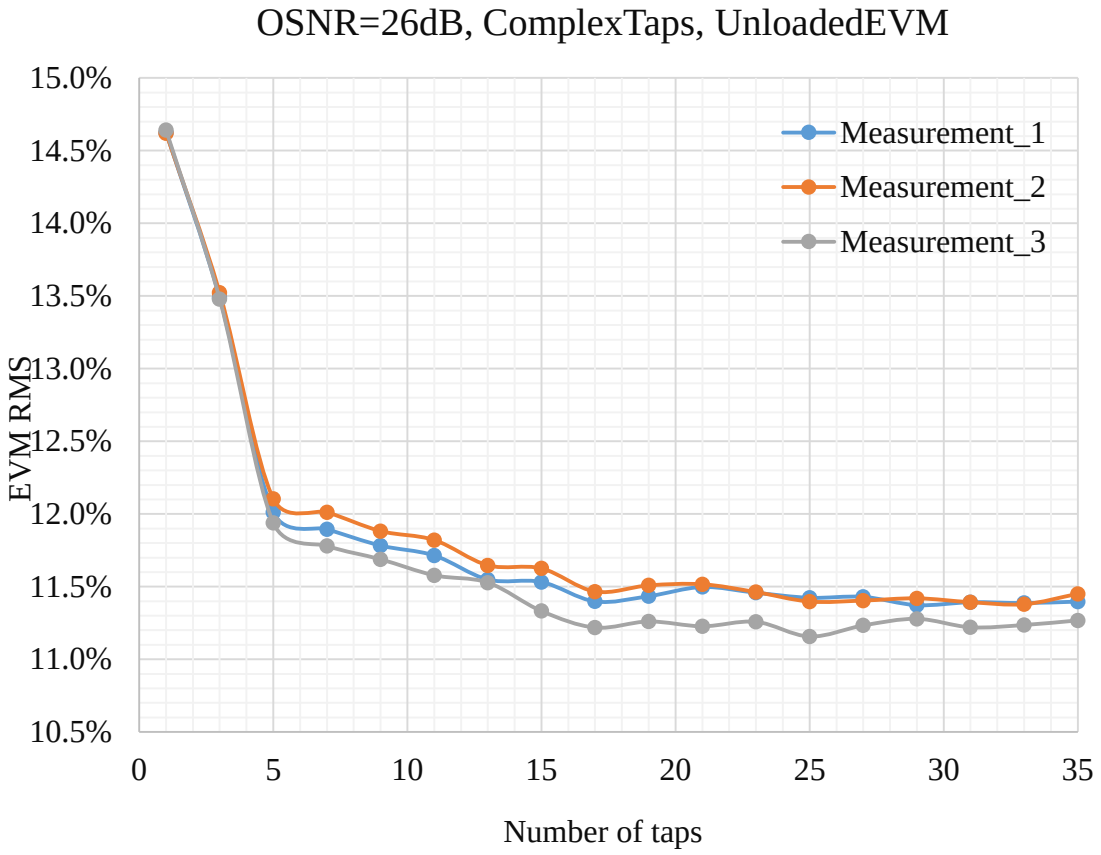


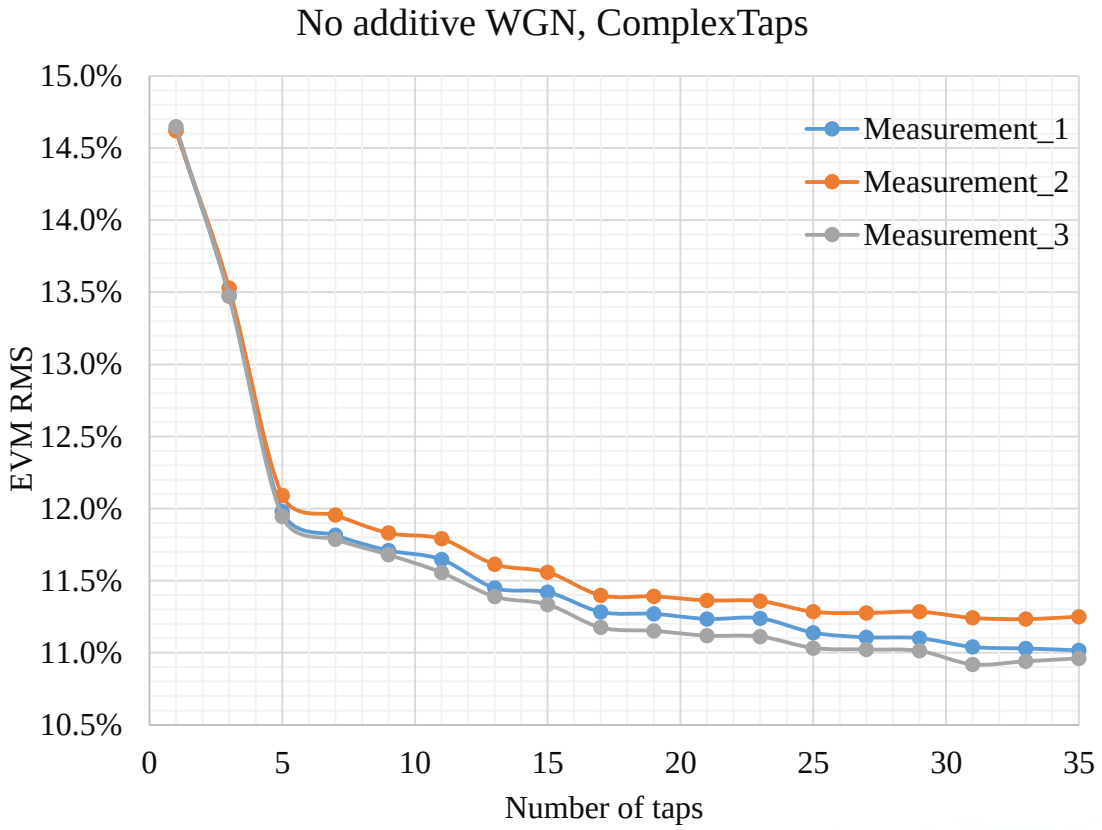


Lower EVM observed with an equalizer having complex-valued taps

Considerations on Equalizer (400 Gb/s DP-16QAM)

Preliminary results: 26dB OSNR vs no digital AWGN





Adding noise before the calculation of the equalizer taps has only a marginal effect on the unloaded EVM

Conclusions

The equalizer is part of the definition of the “Reference receiver” and the following features need to be investigated further:

- Number of taps (T-spaced vs T/2-spaced)
- Real- vs complex-valued taps
- EVM calculation: unloaded EVM or loaded EVM (as in 100G P802.3 ct project).

Thank You!