400GBASE-ZR Performance versus Tx EVM

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Overview

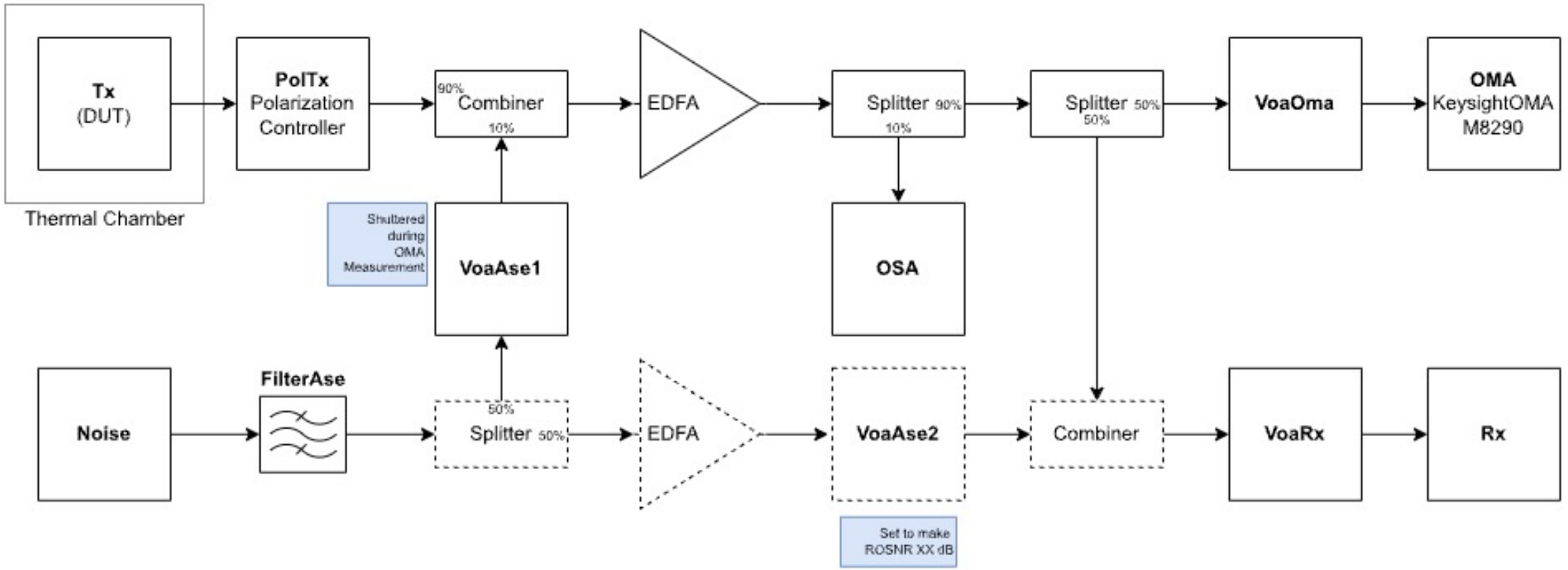
- 802.3cw has identified EVM as a Transmit Quality Metric
  - EVM was selected to provide a Transmit Quality Metric emcompassing multiple Tx impairments

- Data on the dependence of Receiver Required OSNR on EVM arising from multiple transmit impairments is presented in this contribution

Background

- Previously presentations covering QPSK and 16QAM EVM penalties were presented
  - https://www.ieee802.org/3/ct/public/19_03/anslow_3ct_02_0319.pdf
  - https://www.ieee802.org/3/ct/public/19_07/pittala_3ct_01a_0719.pdf
  - Older versions of analysis scripts were used
- Measurements of EVM with the Tx specs in the OIF 400ZR IA versus tap count were presented in Ciena ITU Contribution SG15-C-2270, Sept 2020
  - A summary of this data is presented in this presentation
- Data showing ROSNR versus EVM has been requested

Measurement Setup

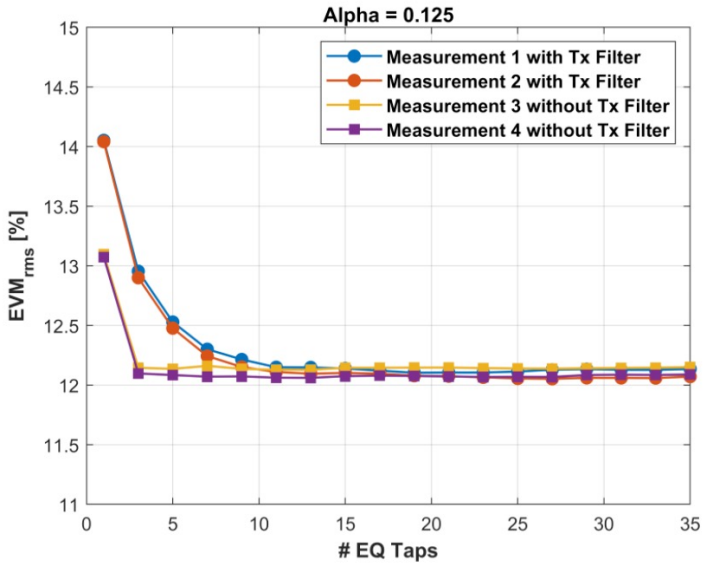


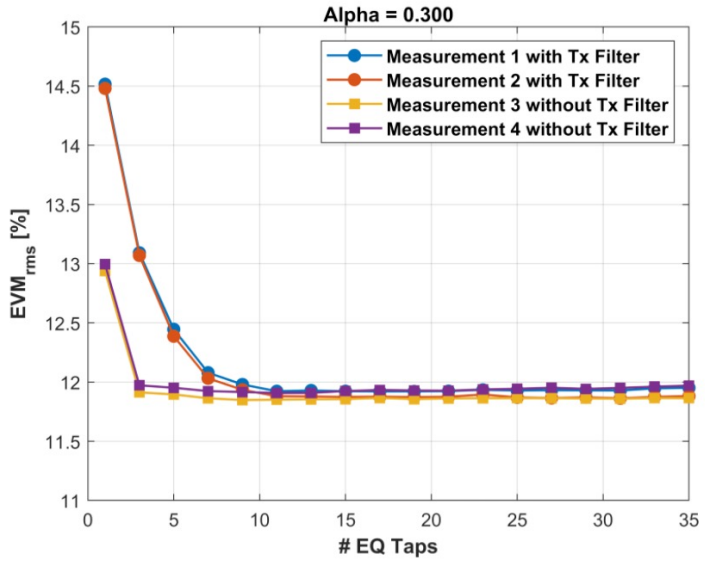
- EVM measurements are performed unloaded
- Noise loading into a separate Rx is provided to measure performance penalty
- Measurements of three transmitters are performed at 193.1 THz

EVM data for fixed Tx settings

- Data below shows EVM versus tap count for filtered transmitters
  - Calibrated and intentionally impaired transmitters to add ISI are shown
  - Tx intentionally degraded to worst-case specifications as detailed in the OIF 400ZR IA

Tx Conditions:
I-Q Skew: 0.75 ps
I-Q Phase Imbalance: +5 degrees
I-Q Amplitude Imbalance: 1 dB





Reference: Ciena ITU Contribution SG15-C-2270, Sept 2020

Test Procedure

- Each Tx impairment was measured independently
- At each point captured waveforms were analyzed to determine the EVM
  - Tx EVM is measured with no additional noise
  - Keysight script OIF2018.391.04 was used to process the data
  - Matched Rx filtering was used, along with 35 taps
- Required OSNR was determined using ASE noise loading
- The captured curves show the impact of each impairment on EVM, and the corresponding Rx optical penalty's dependence on EVM

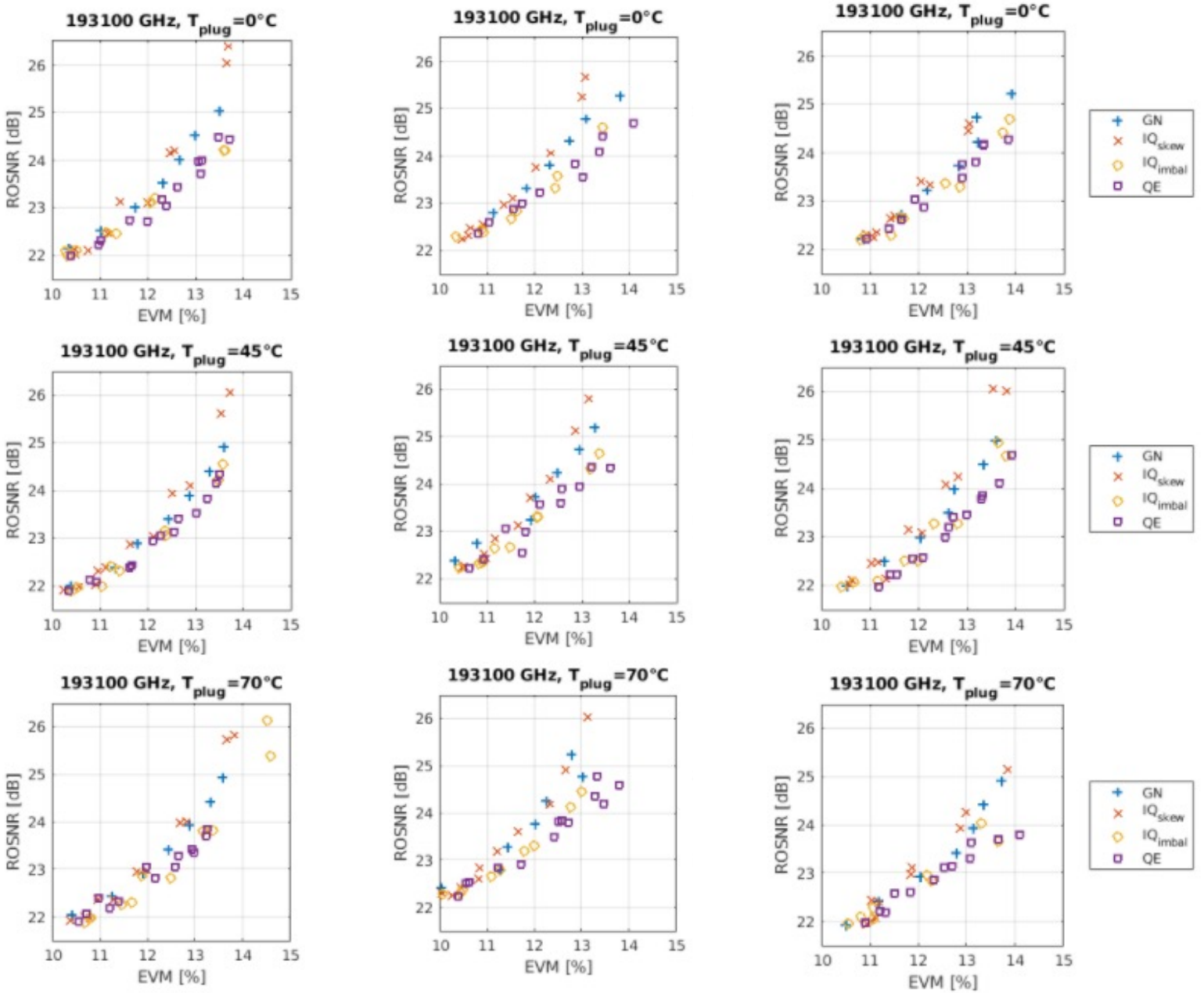
Parameters tested

- The following parameters were tested:
  - I/Q Skew
    - Range: ± 2.5 ps
  - I/Q Imbalance
    - Range: ± 2.5dB
  - Quadrature Error
    - Range: ± 5.5 degrees
  - ASE addition (AWGN)

  - Note: Rx compensation loops intentionally disabled to measure impact of Tx impairments

Data Sets

Measurements performed on three transmitters



Summary

- Previous data showed that for worst case values of I/Q Skew, I/Q Imbalance, and Quadrature error defined in the OIF 400ZR IA resulted in 12% EVM for RRC Tx shapes with 0.125 and 0.3 roll-offs
- Data show that I/Q Skew, I/Q Imbalance, and Quadrature error result performance penalties vs Tx EVM similar to AWGN
- EVM can be used capture these parameters for the 400GBASE-ZR Tx definition

Thanks!