Data on OMA_{outer} and correlation with OMA_{TDECQ}

- related to comments #69 and #218

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Background

- This presentation provides some measured data on Comments 218 and 69. They both relate to OMAouter, however, they are quite different

#218. Fix ambiguity in the definition.
Measurement done on all runs (not just one)

Cl **180** *SC* **180.9.5** *P* **476** *L* **42** # 218

Maniloff, Eric — Ciena Corporation

Comment Type **TR** *Comment Status* **D** *OMA_outer (OI)*

OMA_Outer with pattern 6 (SSPRQ) has multiple runs of = 7 threes and = 6 zeroes. In order to obtain consistent measurements, all runs of 7's and 3's should be measured.

SuggestedRemedy

Change text to: δWhen measured with pattern 6, OMA_outer is measured as the difference between the average optical launch power level P3, measured over the central 2 UI of the first 7 UI of
all runs of 7 threes or more, and the average optical launch power level P0, measured over the central 2 UI of the first 6 UI of all runs of 6 zeroes or more.δ. Make similar change in clause 181.9.5, 182.9.5, and 183.9.5

#69. TDECQ equation to use OMA_{TDECQ} instead of OMA_{outer}

Cl **180** *SC* **180.9.6.4** *P* **483** *L* **45** # 69

El-Chayeb, Ahmad — Keysight Technologies Inc

Comment Type **TR** *Comment Status* **D** *TDECQ-OMA (OI)*

OOMA measurement location for TDECQ was changed in draft 2.4 to the reference equalizer input waveform. Input waveform tends to be unstable before the equalizer. OOMA measurement location should be verified using data from real transmitters, not just simulations.

SuggestedRemedy

Suggested remedy: Change OMAouter definition in equation 180-12 from "OMAouter is measured as defined in 180.9.5" to "OMAouter is measured as defined in 180.9.5 except using waveforms captured at the output of the reference equalizer".

Comment 218. Clarifying OMA_{outer} definition in Draft 3.0

Draft 3.0 definition:

180.9.5 Outer optical modulation amplitude (OMA_{outer})

The OMA_{outer} of each lane shall be within the limit given in Table 180–7. The OMA_{outer} is measured using a test pattern specified for OMA_{outer} in Table 180–14 as the difference between the average optical launch power level P_3, measured over the central 2 UI of a run of 7 threes, and the average optical launch power level P_0, measured over the central 2 UI of a run of 6 zeros, as shown in Figure 180–8. OMA_{outer} is measured using the waveforms captured at the output of the reference receiver defined in 180.9.2.

Cl **180** *SC* **180.9.5** *P* **476** *L* **42** # 218

Maniloff, Eric — Ciena Corporation

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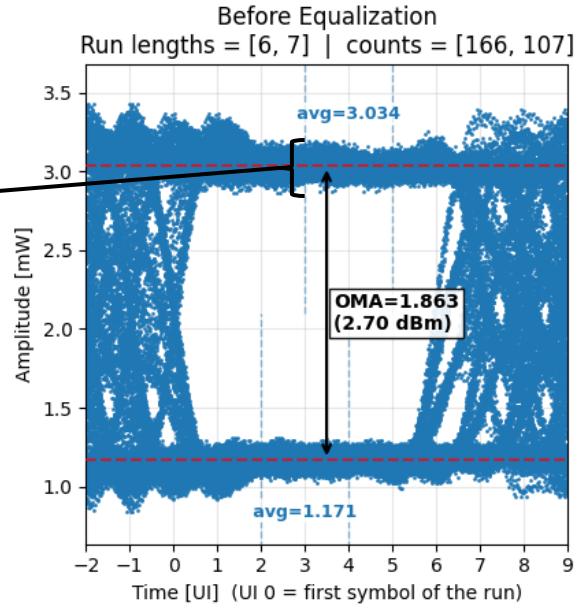
- Unclear whether P3 is defined from:
  - a single run of 7 threes, or
  - the average across all 107 runs in SSPRQ
- Large variation between individual runs
- Averaging across all runs improves measurement stability
- David Leyba (affiliated with Keysight): “current implementation averages across all runs”



Comment 69. Replace OMA_{outer} with OMA_{TDECQ} in Eq 180-12

Draft 3.0 definition:

The RMS noise, R, that could be added by a receiver is given by Equation (180–11).

$$R = \sqrt{\sigma_G^2 + \sigma_S^2} \qquad (180–11)$$

TDECQ is given by Equation (180–12).

$$TDECQ = 10\log_{10}\left(\frac{OMA_{outer}}{6} \times \frac{1}{Q_t R}\right) \qquad (180–12)$$

where

OMA_{outer} is measured as defined in 180.9.5

- The proposed remedy suggests using OMA_{TDECQ} instead of OMA_{outer} in the TDECQ calculation.
- OMA_{TDECQ} and OMA_{outer} are not equivalent measurements, and the introduction of DFE increaseD the difference between them.
- In Eq. 180-12, the receiver noise term R is added before the reference equalizer, therefore, OMA term should be measured before reference equalizer to remain consistent.
- Redefining OMA_{outer} to be measured after the reference equalizer is beyond the scope of this comment, and should consider impact on extinction ratio, overshoot, and RIN.

Cl **180** *SC* **180.9.6.4** *P* **483** *L* **45** # 69

El-Chayeb, Ahmad — Keysight Technologies Inc

Comment Type **TR** *Comment Status* **D** *TDECQ-OMA (OI)*

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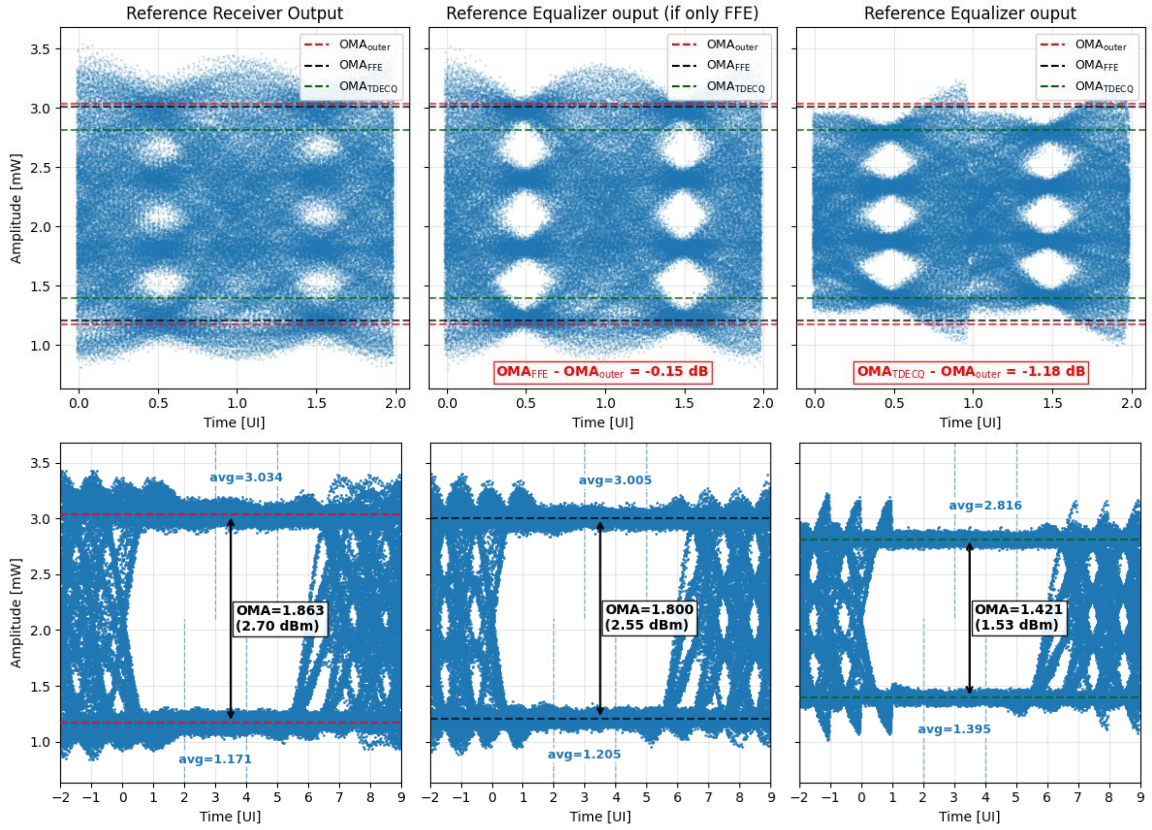
SuggestedRemedy

Suggested remedy: Change OMAouter definition in equation 180-12 from "OMAouter is measured as defined in 180.9.5" to "OMAouter is measured as defined in 180.9.5 except using waveforms captured at the output of the reference equalizer".



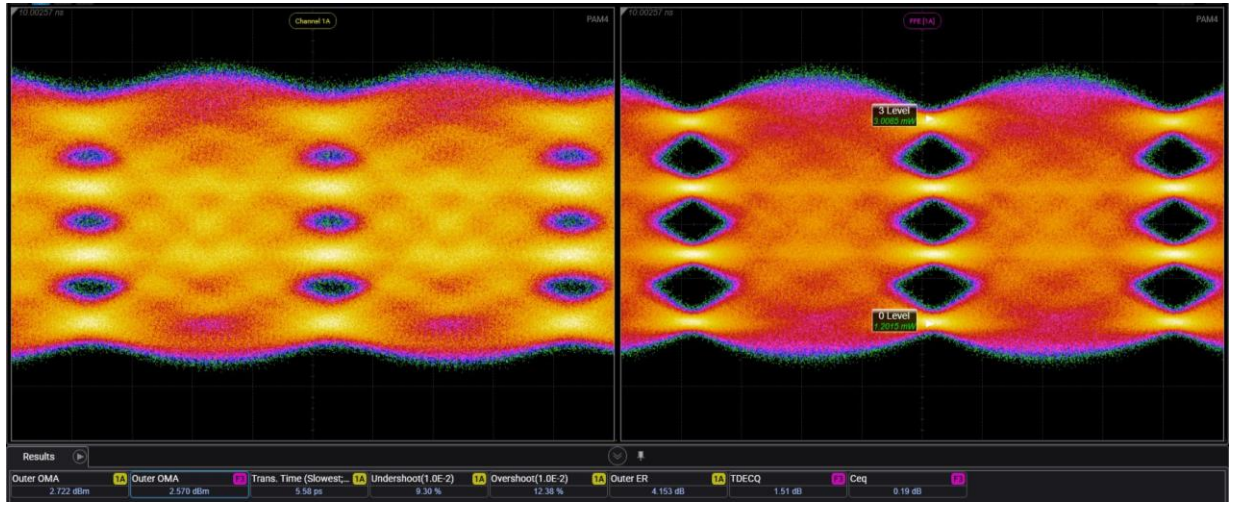
Additional Data on OMA before and after equalization

Measurement Description

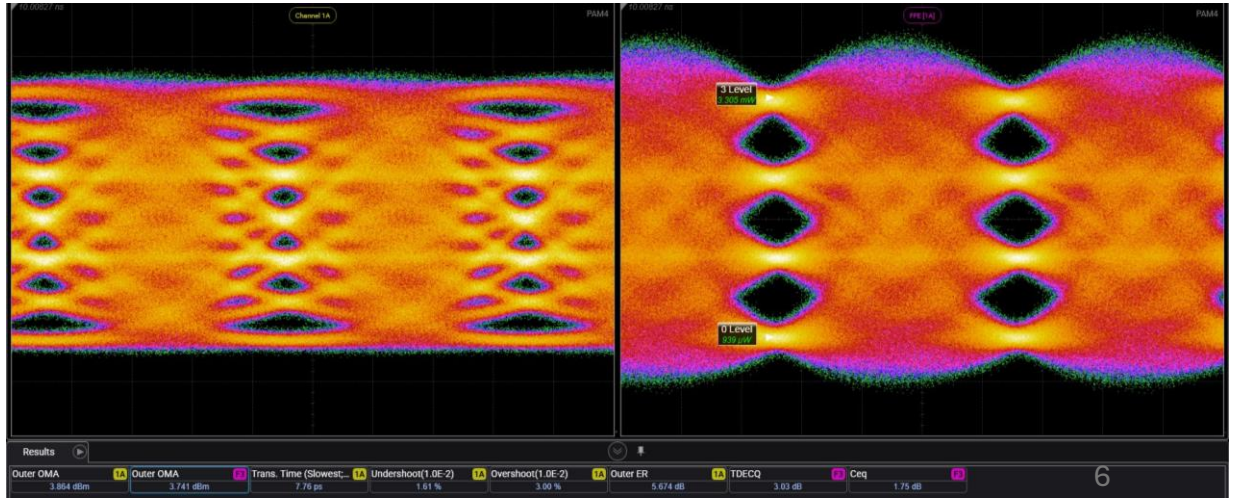
Capturing waveforms in the DCA for:

- 200G/lane SiPho-based lanes
  - Faster Tx
  - Slower Tx
- Equalization:
  - Before EQ
  - FFE only
  - 15-tap FFE+1-tap DFE (standard)
- OMA offline processing:
  - 6 UI runs: Avg of 166 sequences
  - 14 UI run for single step response

Faster Tx: Transition Time = 5.58ps, Overshoot = 12.4%

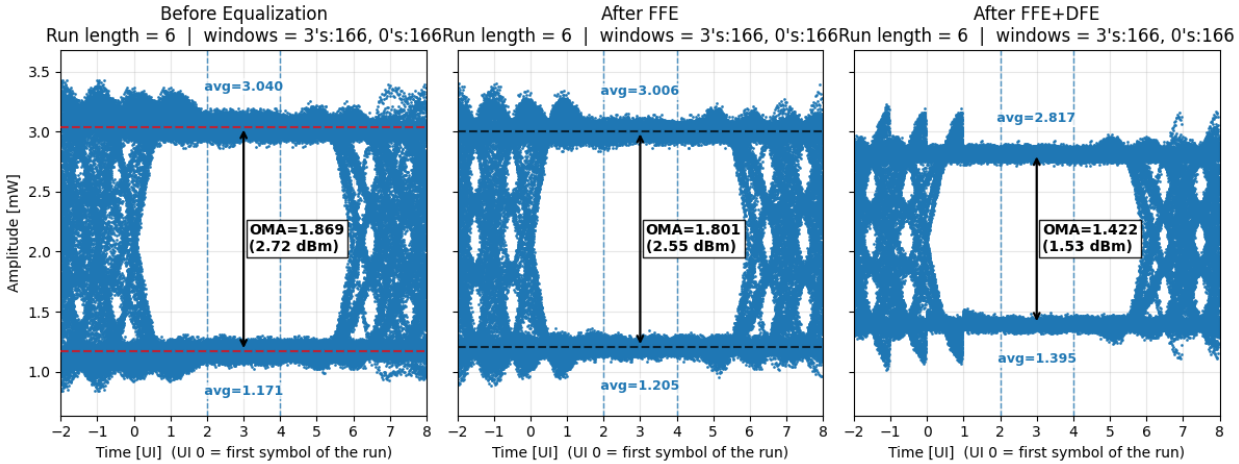


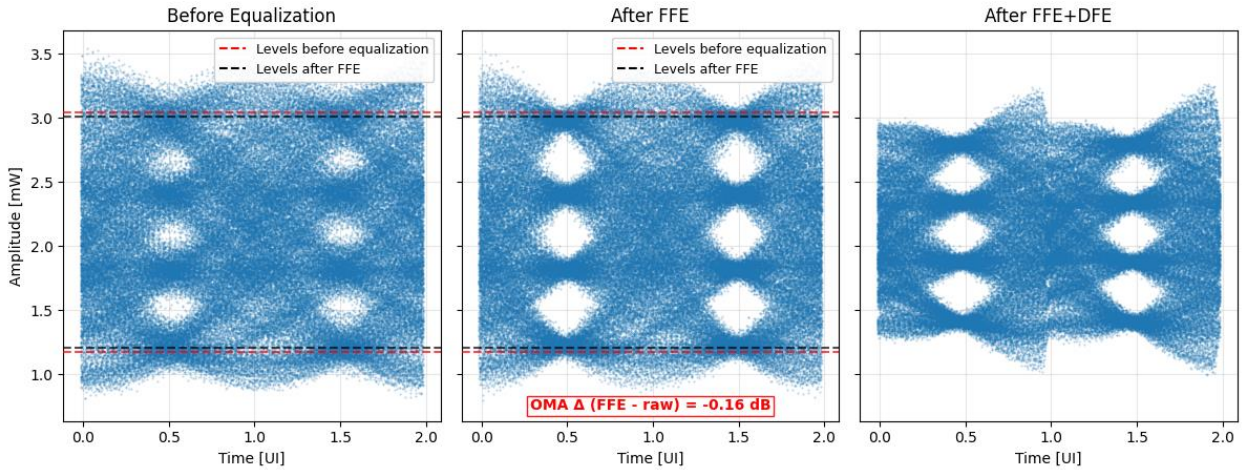
Slower Tx: Transition Time = 7.76ps, Overshoot = 3%



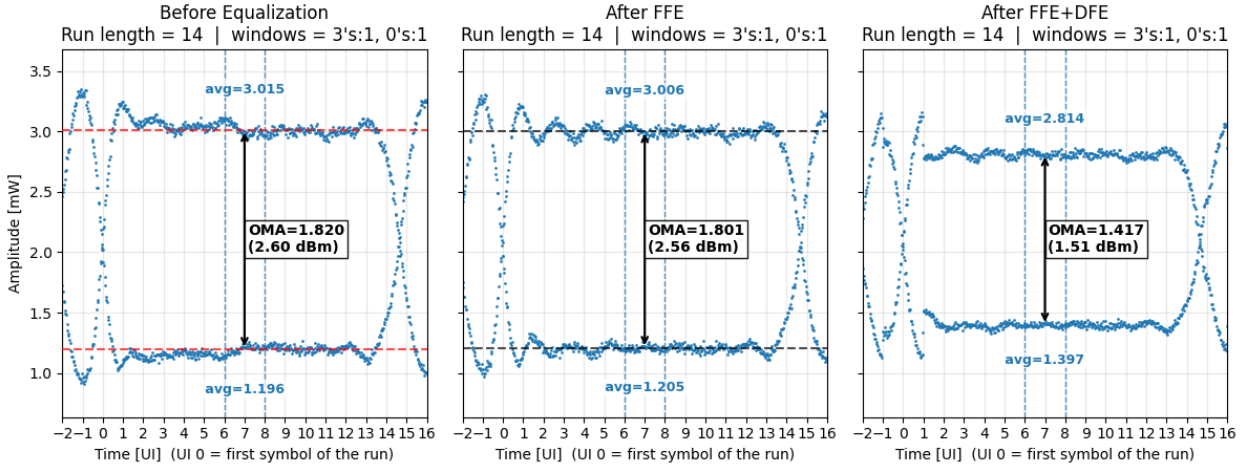
OMA comparison on Faster Tx

6 UI runs





14 UI run

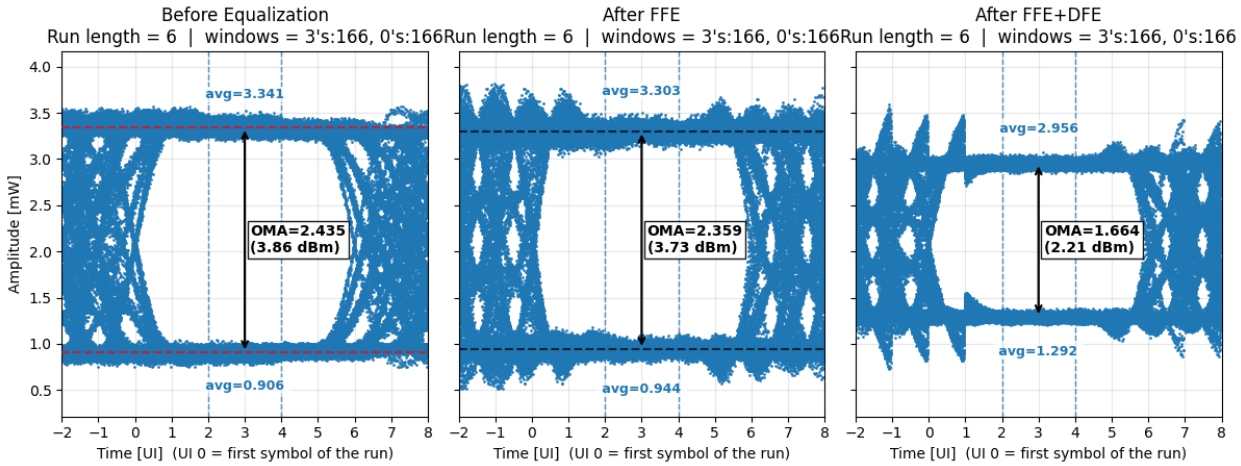


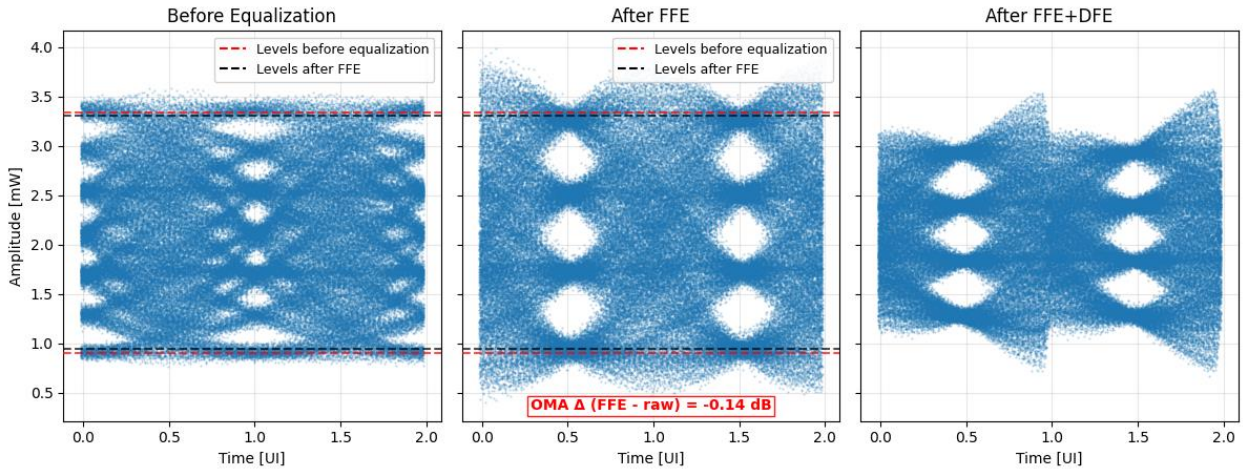
OMA (dBm)

	No EQ	FFE only
6 UI run	2.72	2.55
14 UI run	2.60	2.56

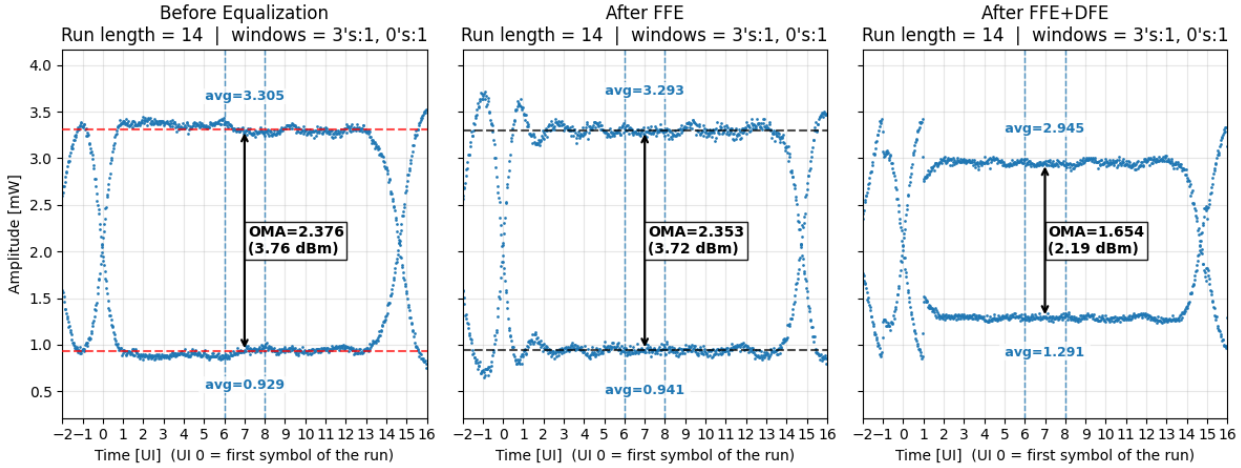
OMA comparison on Slower Tx

6 UI runs





14 UI run



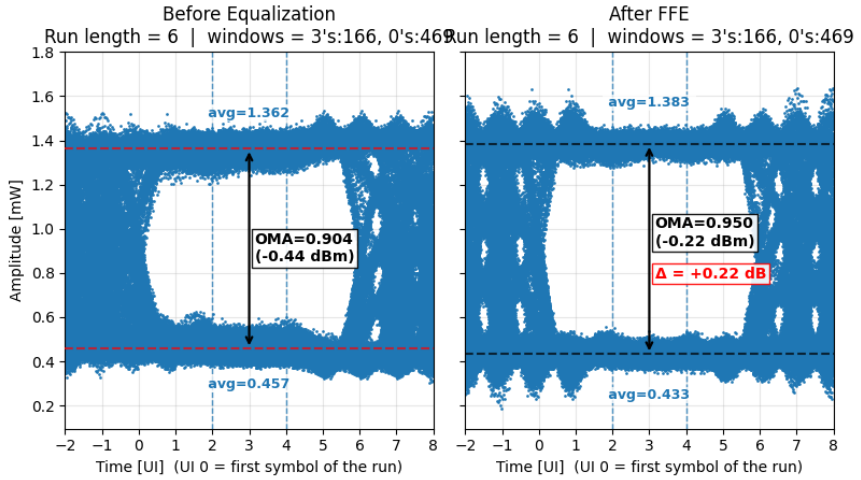
OMA (dBm)

	No EQ	FFE only
6 UI run	3.86	3.73
14 UI run	3.76	3.72

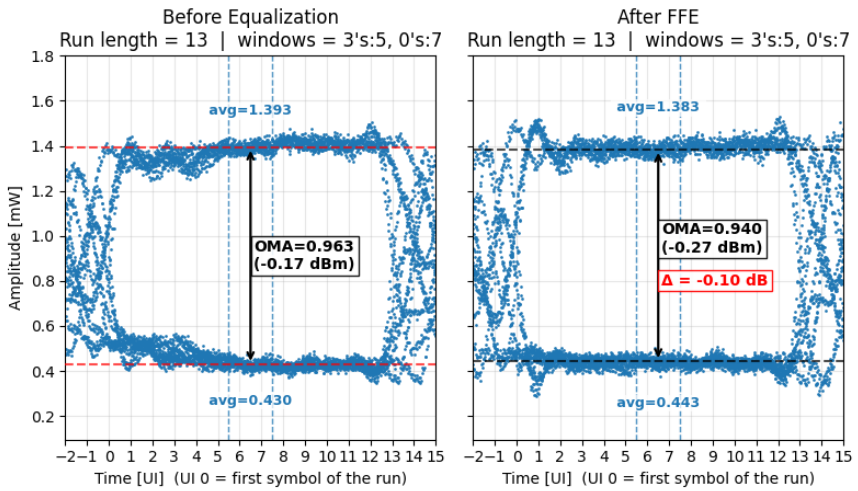
How reflections influence measured OMA

Reflections ~ 5UI

6UI run



13UI run

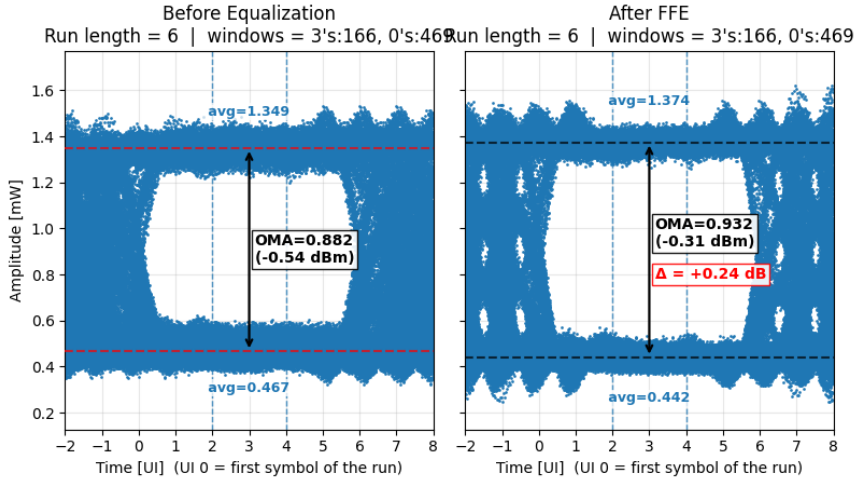


OMAs (dBm)

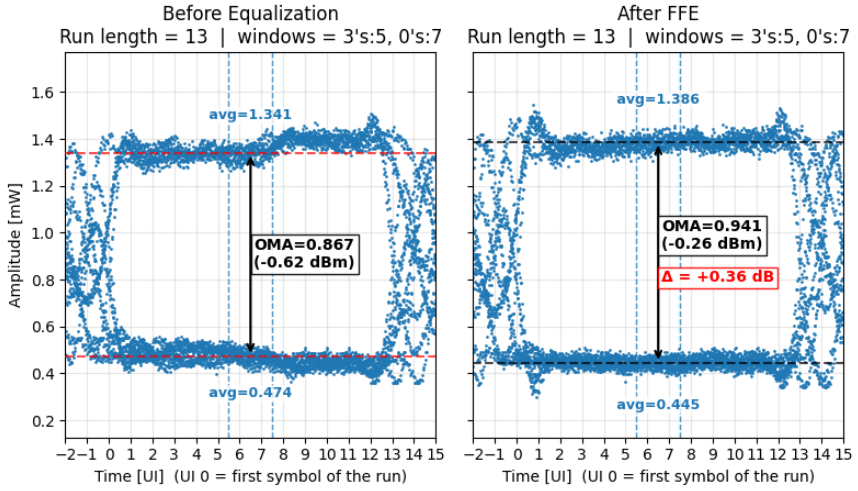
	No EQ	FFE only
6 UI run	-0.44	-0.22
13 UI run	-0.17	-0.27

Reflections ~ 8UI

6UI run



13UI run



OMAs (dBm)

	No EQ	FFE only
6 UI run	-0.54	-0.31
13 UI run	-0.62	-0.26