KEYSIGHT

Outer OMA Deep Dive

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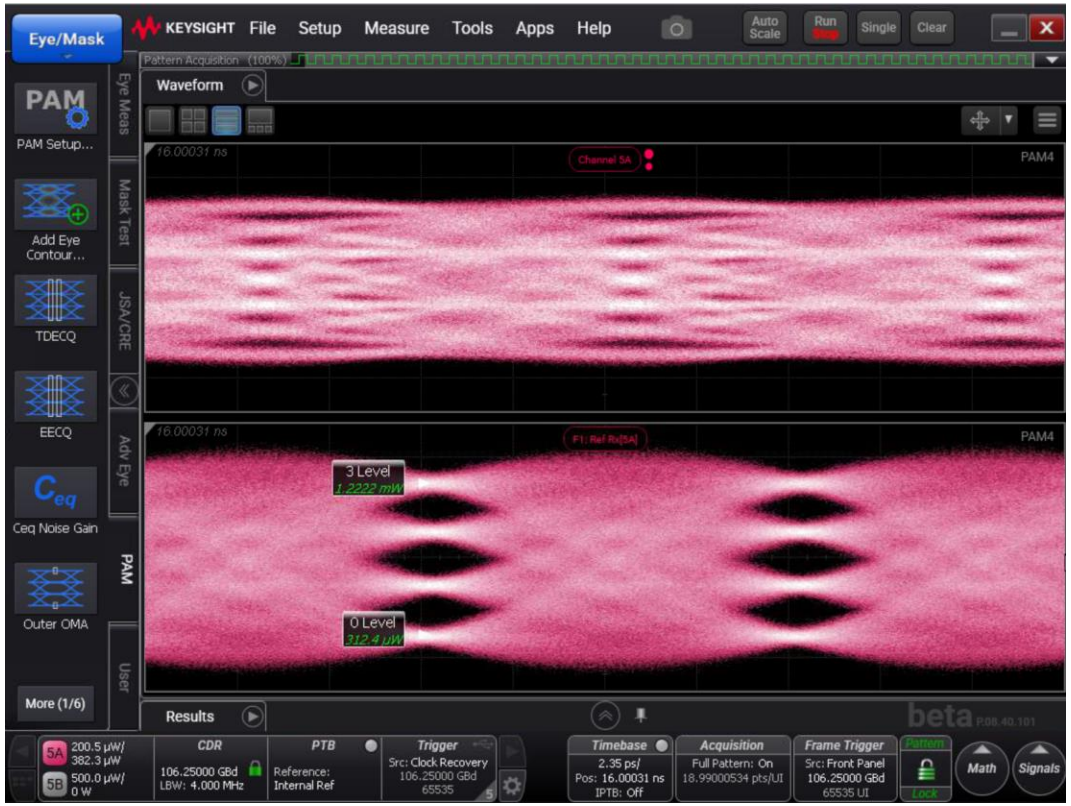
Test Setup

- Equipment:
  - Keysight M8042A BERT
  - Keysight N7718C Reference Transmitter
  - Keysight N1093B Sampling Scope
- Using an SSPRQ pattern and Bert TX FFE to simulate “reflections” on the signal
- Sweep various TX FFE configurations, take 10 measurements on each setup.
- Waveform for channel @ 53.125GHz and output of 15 tap FFE
- Pattern is determined using equalized signal
- Runs of at least length 6 are extracted and saved
- FlexDCA OOMA measurement is not used (it is currently not pattern aware)

Baseline – No TX FFE

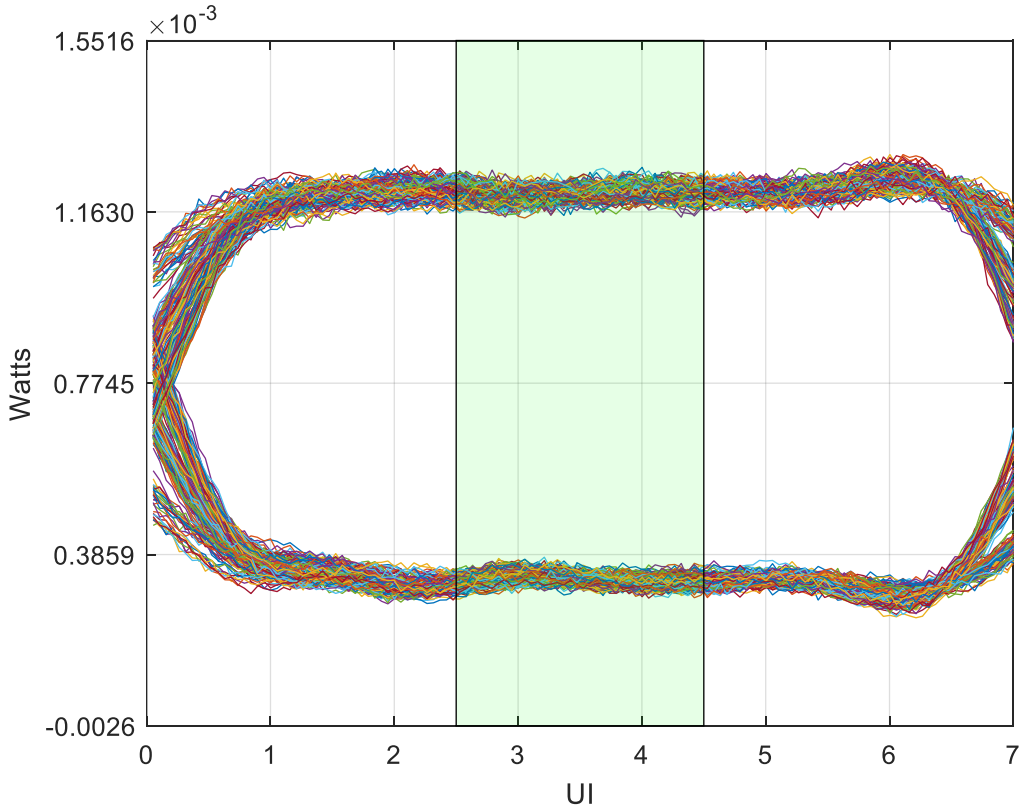
Eye Diagram



- Generated using Keysight BERT + Reference Transmitter into an N1093.
- No TX FFE

Baseline – No TX FFE

Runs of 7 zeros or threes only.

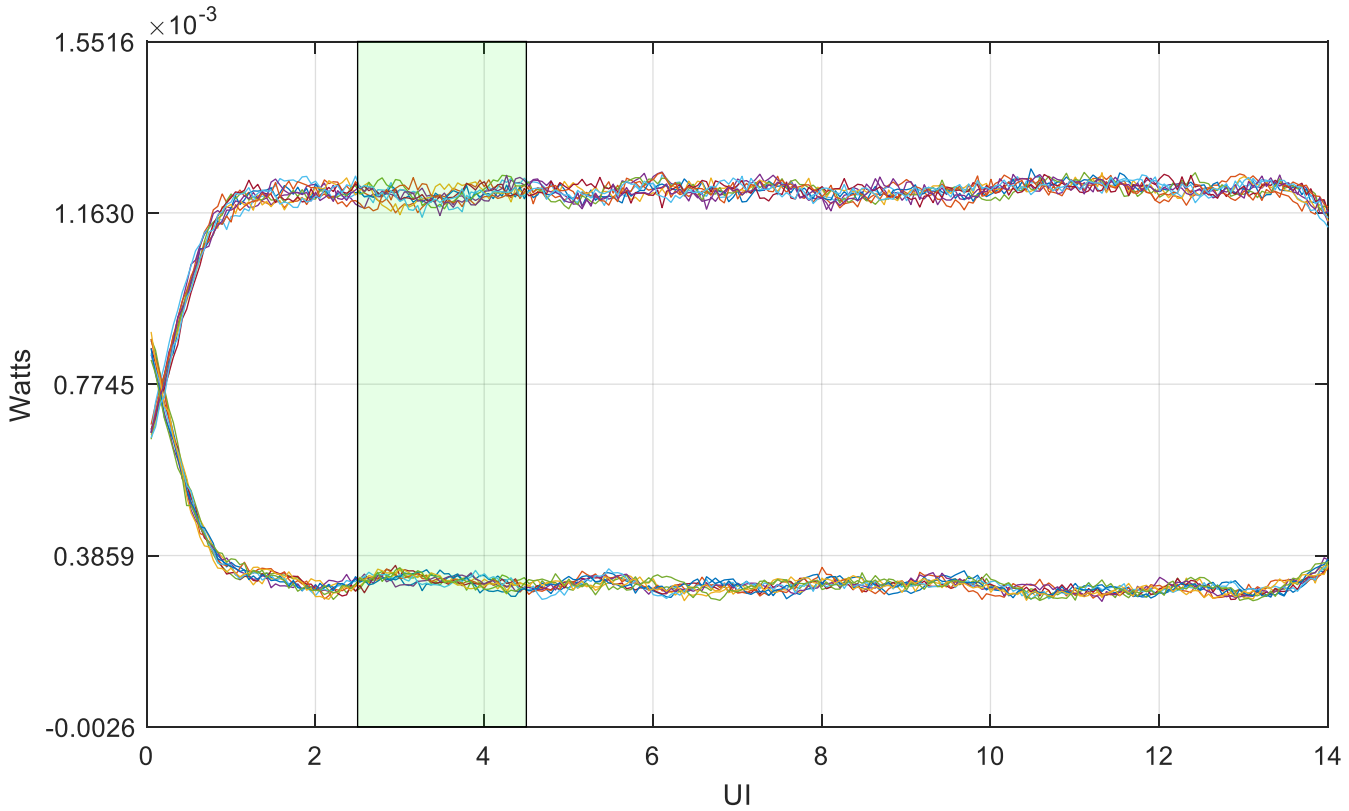


Showing all runs of 7 zeros or 7 threes across all ten trials with no TX FFE

- Simplify by limiting to equal length runs for both zeros and threes.
- Using runs of 7 as the basis, the central 2 UI are measured (from 2.5 UI to 4.5 UI).

Baseline – No TX FFE

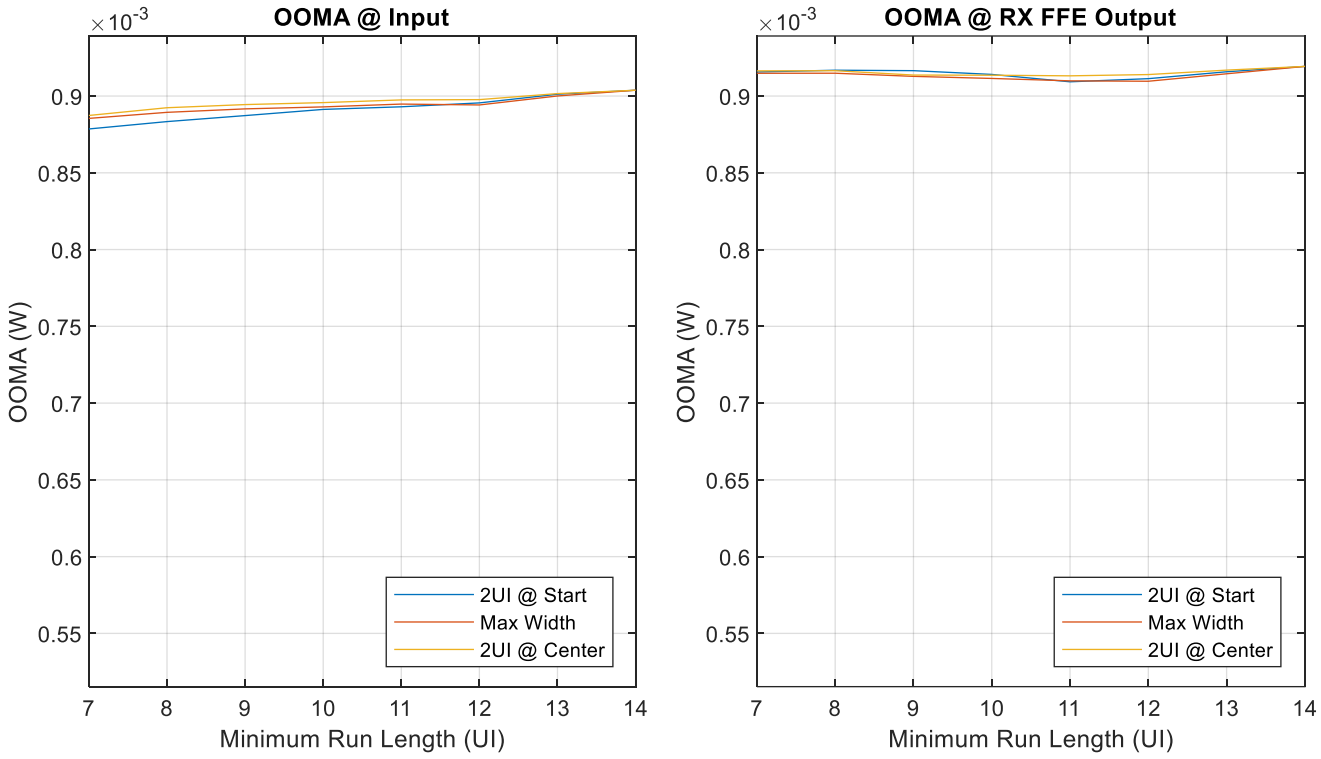
Runs of 14 zeros or threes only.



Showing all runs of 14 zeros or 14 threes across all ten trials with no TX FFE

- We want to include data runs that are longer than the minimum to calculate OOMA. Why? We already have the data, and it increases stability of the measurement.
- For runs longer than the minimum the options we considered are:
  1. Measure the same region as offset from the start of the run.
  2. Remove the same amount from the region (front and back)
  3. Measure the same number of UI from the center of the run.

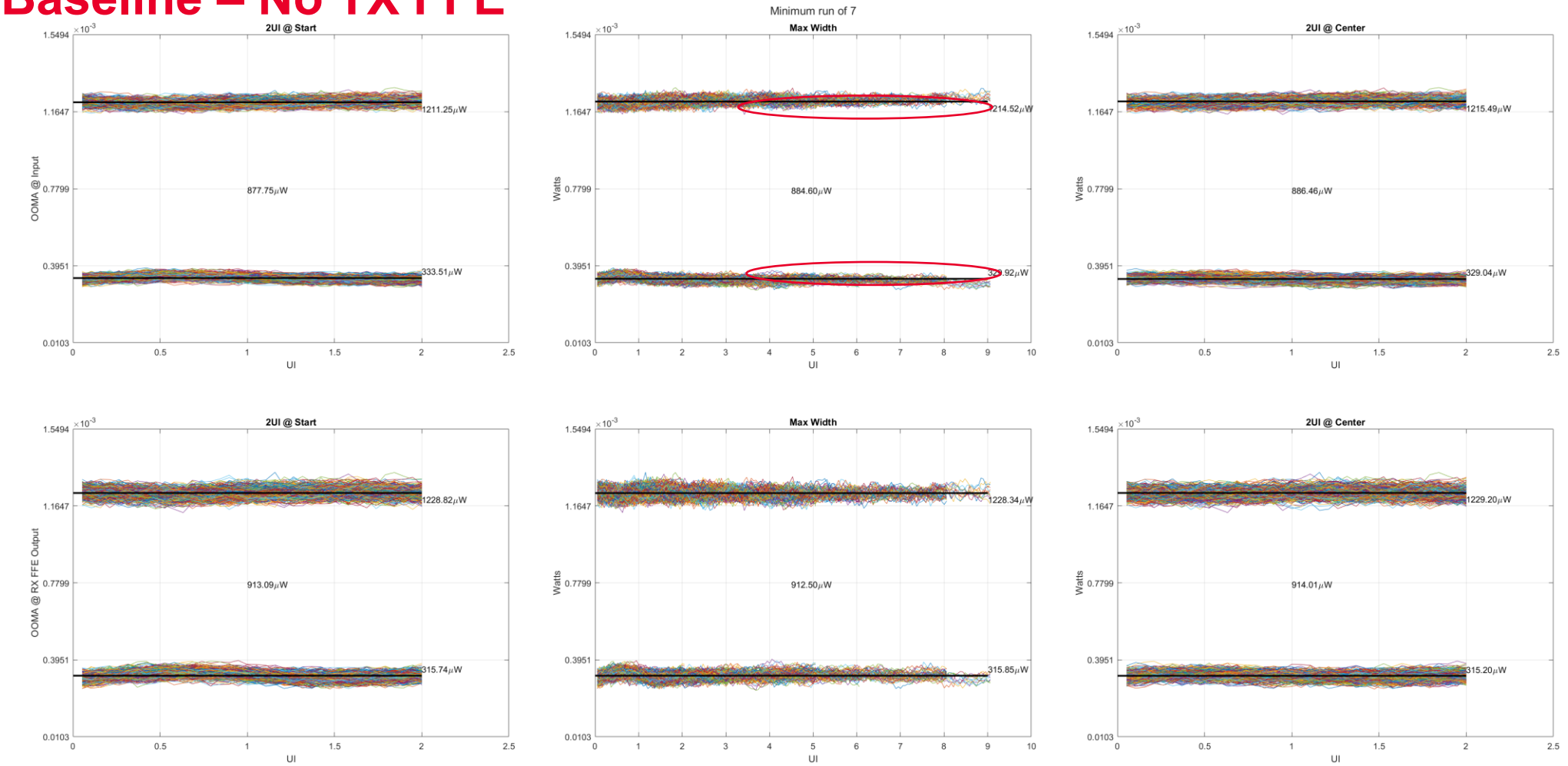
Baseline – No TX FFE



Slow increase in OOMA vs Minimum run length when no FFE (Tx or Rx) in use.

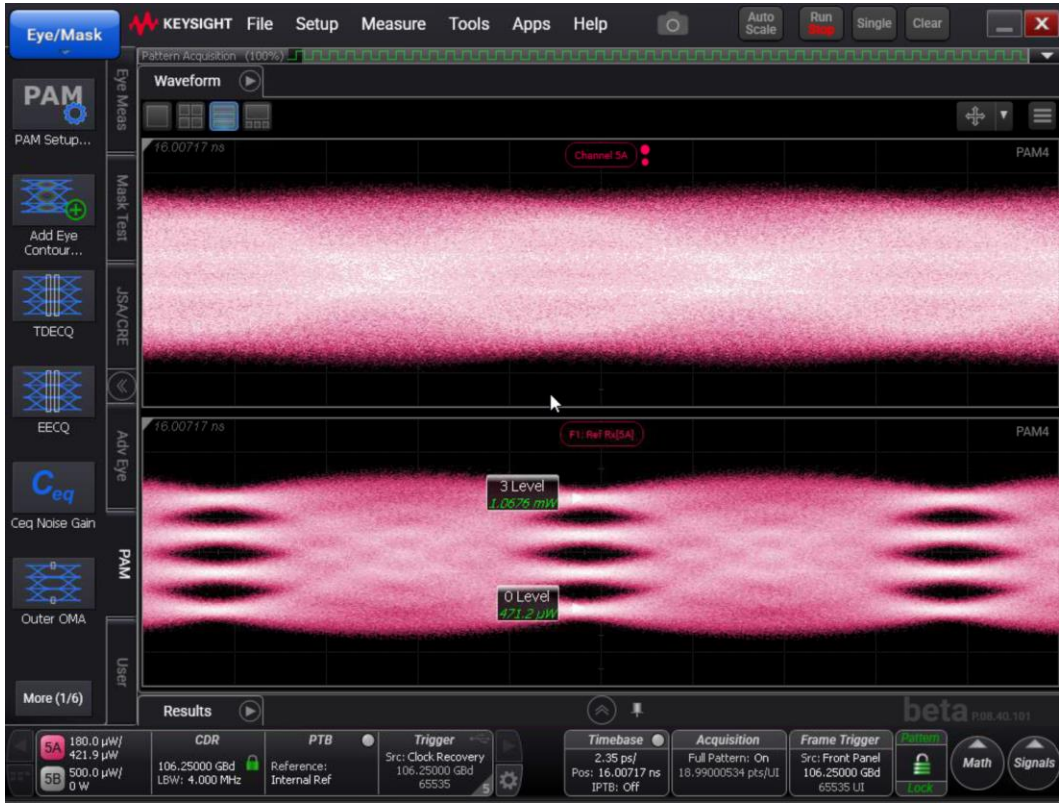
- The experiment:
  - Sweep minimum run lengths from 7 to 14
  - Measure OOMA using the three methods with a target of at least 2 UI.
  - All three methods are equivalent if min run length == max run length.
  - The methods are:
    - **(2UI @ Start)**
      - The starting location is ½ *(Min Run Length – 2 UI). (2.5 for min run length of 7)
      - Measure 2 UI from there.
    - **(Max Width)**
      - The margin from start/end of the run is also ½ *(Min Run Length – 2 UI).
      - Measure everything between the two margins
    - **(2UI @ Center)**
      - The starting location is ½ *(Current Run Length – 2 UI).
      - Measure 2 UI Starting from there.

Baseline – No TX FFE



Can see from the top middle graph, the raw response of the BERT + Ref TX has a slowly approaches a final value. Causing OOMA to go up slightly as minimum run length increases.

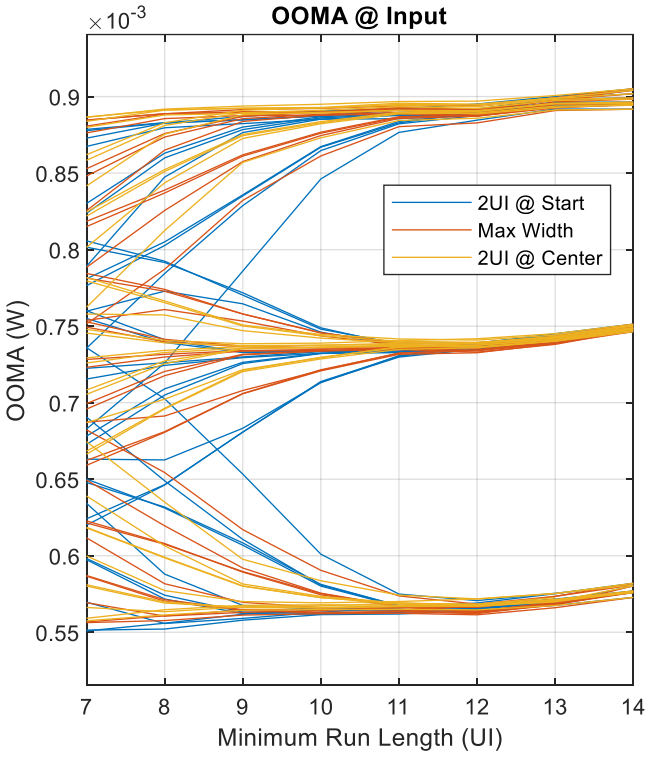
TX FFE

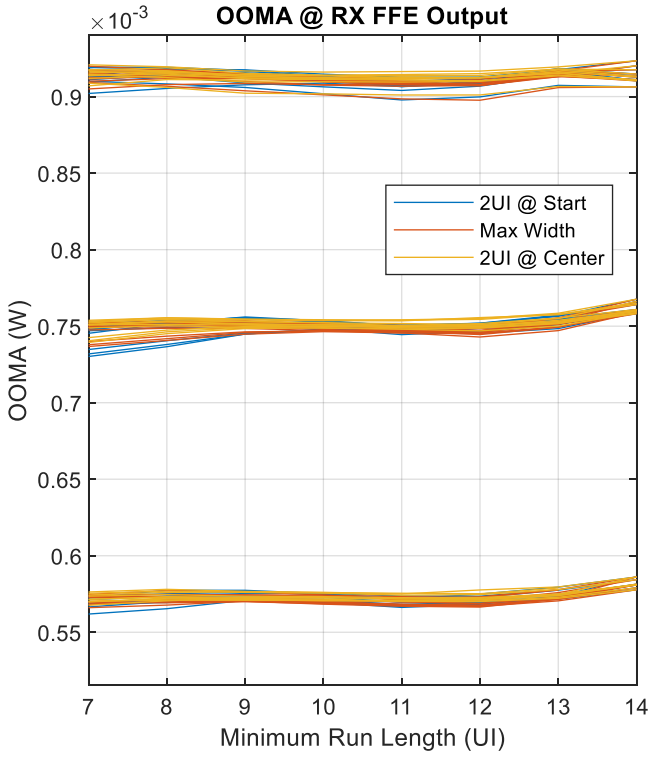


- BERT FFE has 7 taps with up to 4 post cursors and forces $\sum|w_i| = 1$
- Main tap is kept at $w_0 = 0.8$, so other tap magnitudes sum to 0.2.
- Limited post cursor weights to be $0, \pm 0.1, \pm 0.2$ and no pre-cursors
- Swept through all possible post cursor combinations. eg
  - [0.8, 0.0, 0.0, 0.1, 0.1]
  - [0.8, 0.1, 0.0, -0.1, 0.0]
  - [0.8, 0.0, -0.2, 0.0, 0.0]

TX FFE

OOMA vs Minimum run Length for the three methods

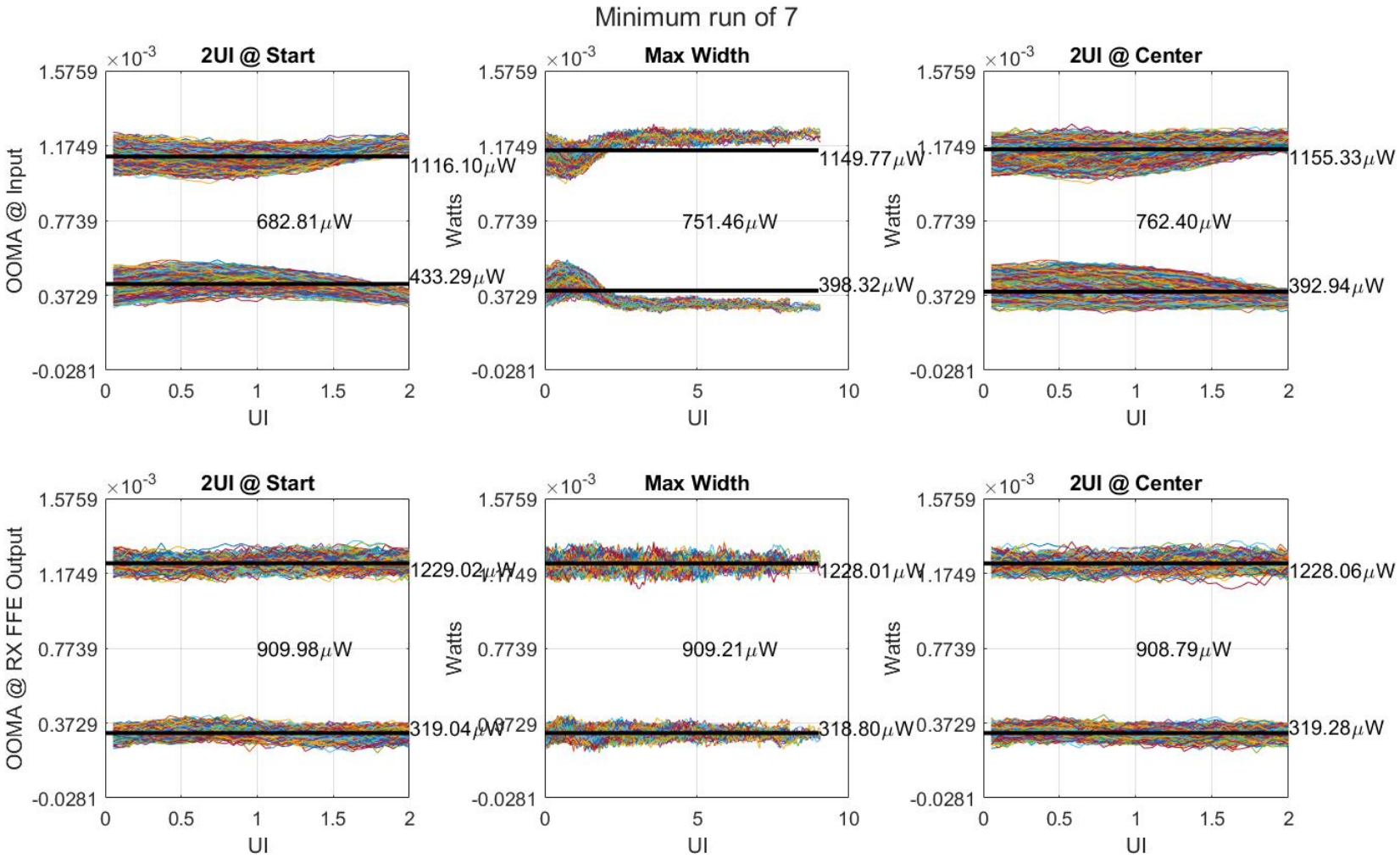




- Generates three different amplitudes depending on the sum of signed tap values (0.6, 0.8, 1.0)
- Measuring on the input waveform results in large variations in OOMA between different sets of taps
- Function is relatively stable, regardless of minimum run length.

In Depth Look

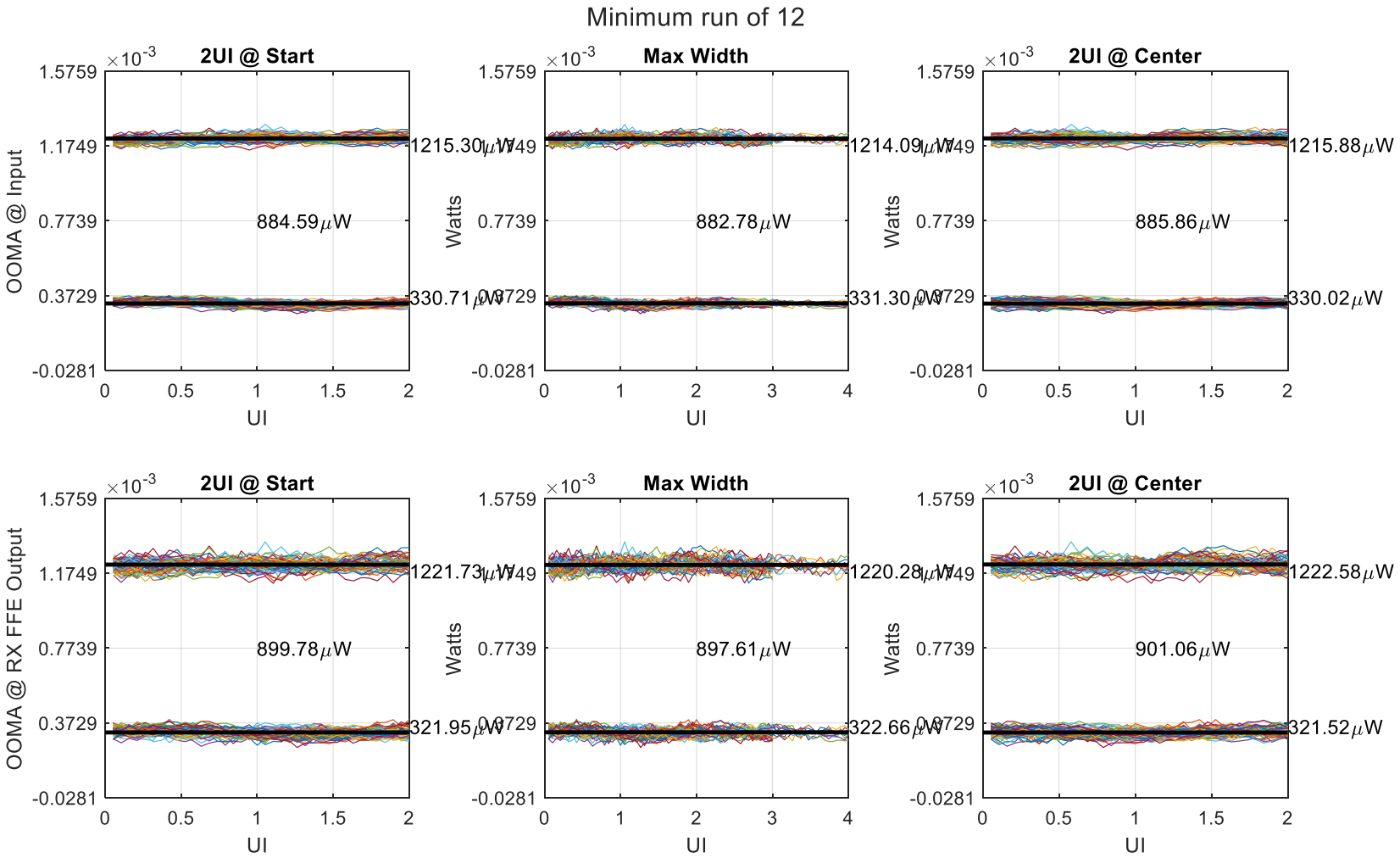
TX FFE - [0.8, 0.0, 0.0, 0.0, 0.2] – Minimum run of 7 CID



- Very different values for OMA between the three algorithms when using the Input waveform
- Consistent results between algorithms when using the FFE output
- Which OMA is correct?
  - ~0.76 dBm difference between Input and FFE OMA.

In Depth Look

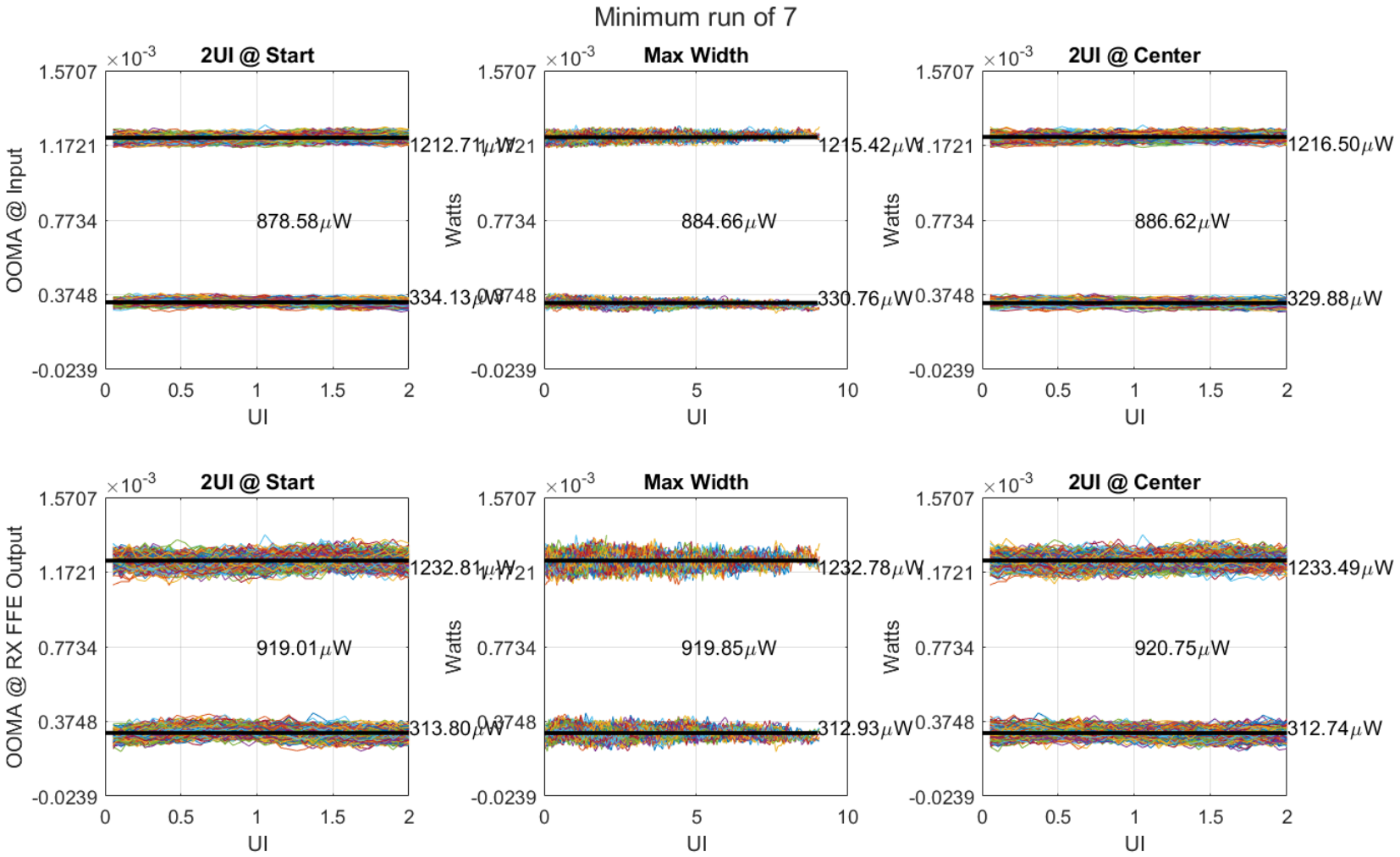
TX FFE - [0.8, 0.0, 0.0, 0.0, 0.2] – Minimum run of 12 CID



- Consistent results across algorithms for either input waveform or FFE output
- FFE output is still slightly higher.
- Which OMA is correct?
  - <0.1dBm difference

In Depth Look

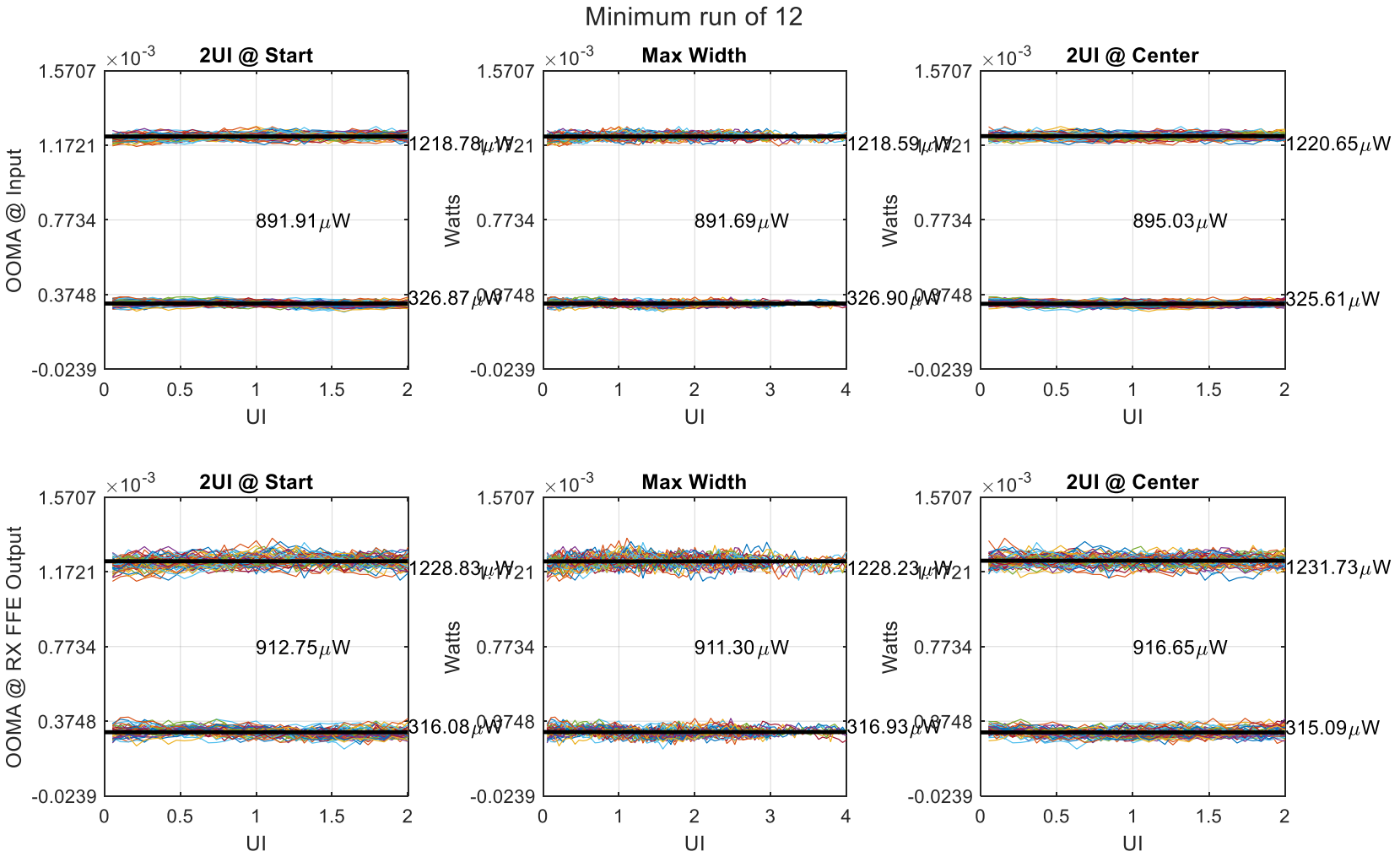
TX FFE - [0.8, 0.2, 0.0, 0.0, 0.0] – Minimum run of 7 CID



- Reflection is before the range, so consistent results
- FFE output is still slightly higher.
- Which OMA is correct?
  - ~0.15dBm difference

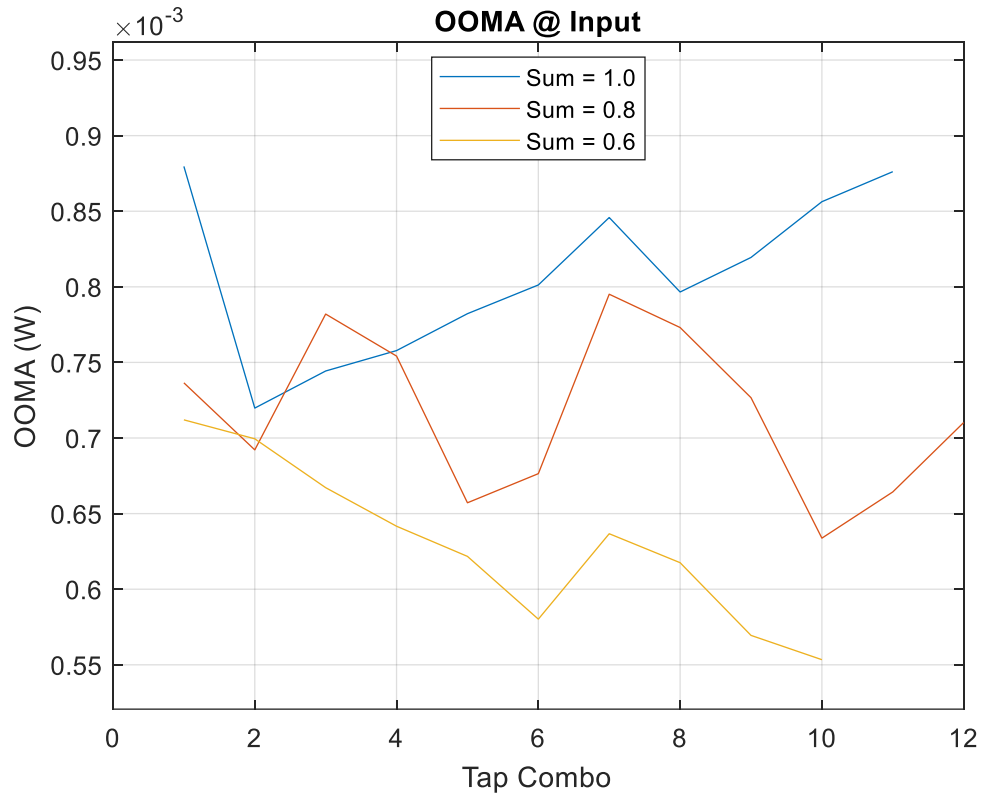
In Depth Look

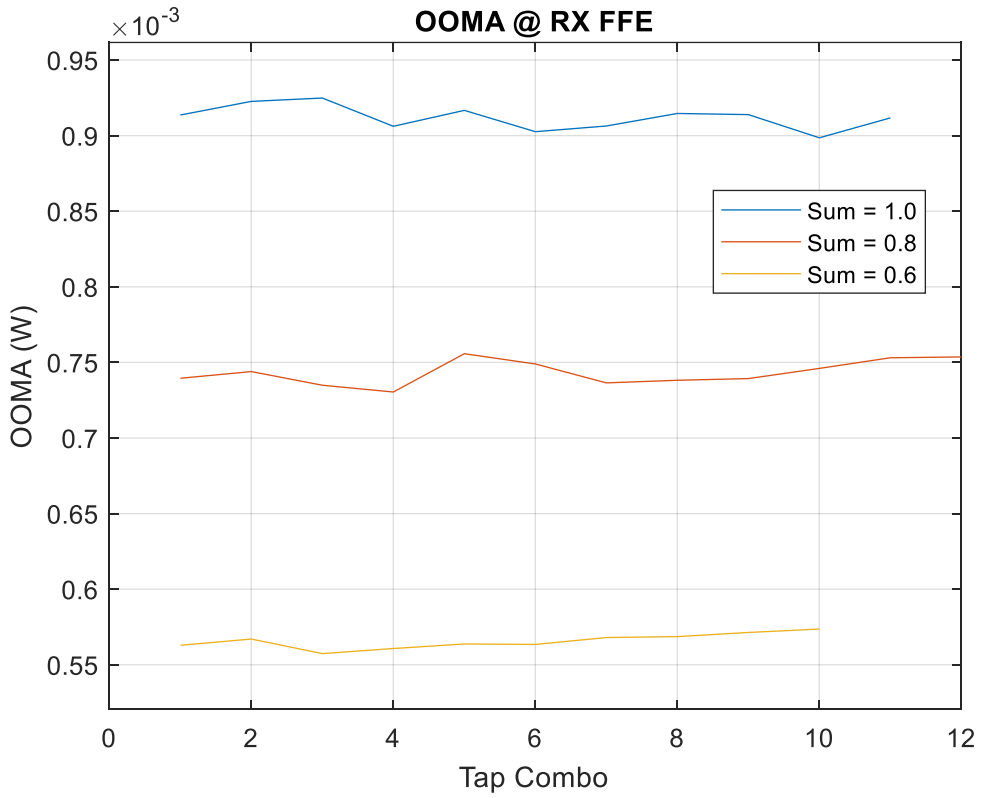
TX FFE - [0.8, 0.2, 0.0, 0.0, 0.0] – Minimum run of 12 CID



- Reflection is before the range, so consistent results
- FFE output is still slightly higher.
- Which OMA is correct?
  - ~0.1dBm difference

PRBS13Q

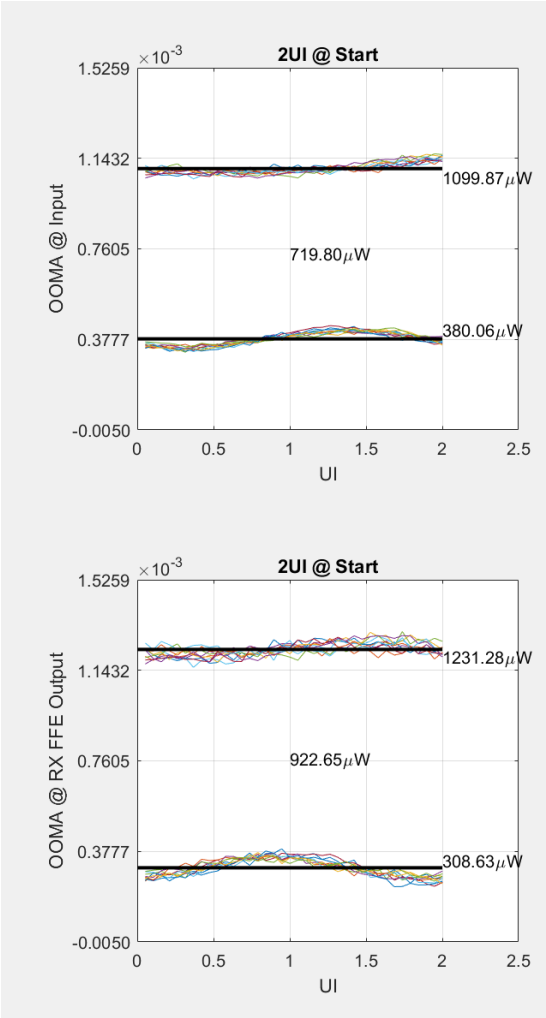


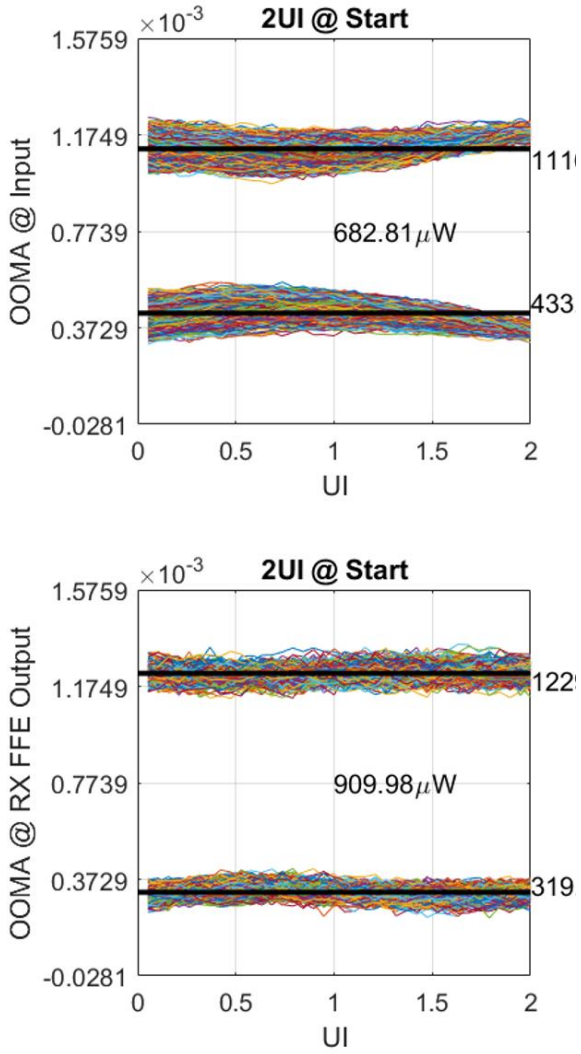


- Measuring OOMA on PRBS13Q, with various TX FFE (grouped by sum of taps).
- Large variability when measuring at the raw channel.
- Consistent results at the output of RX FFE

In Depth Look

TX FFE - [0.8, 0.0, 0.0, 0.0, 0.2] – PRBS13Q vs SSPRQ

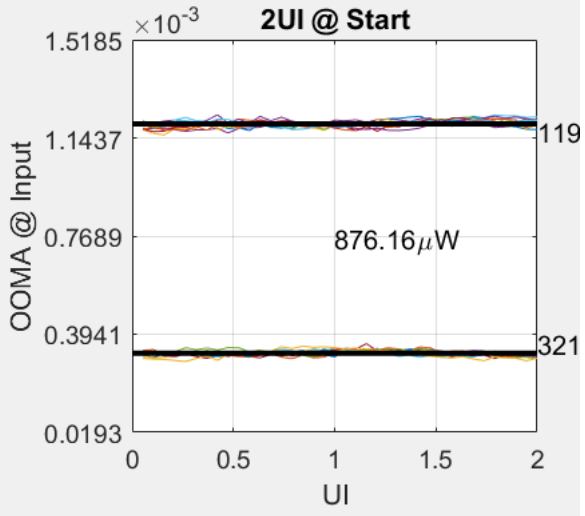


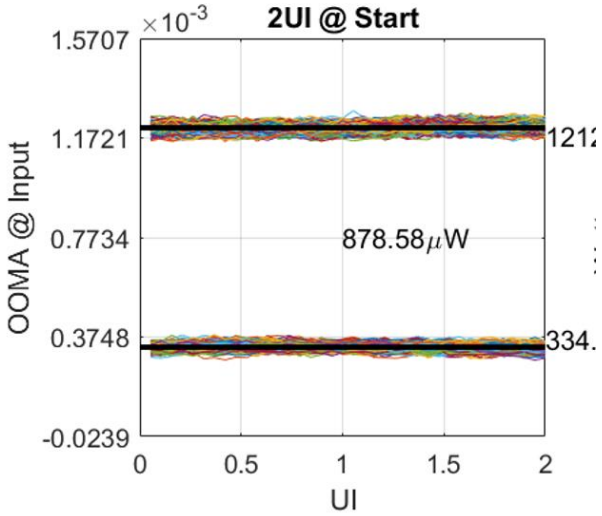


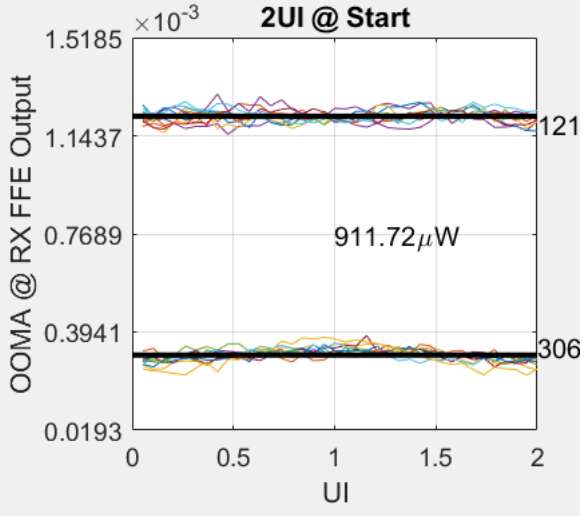
- PRBS13Q, all three methods are equivalent
- For simplicity, looking at runs of length 6
- Left is PRBS13Q with runs of 6.
- Right is SSPRQ, runs of 7.
- Fairly large deviation of OOMA when using the channel waveform but not when using the output of the FFE.

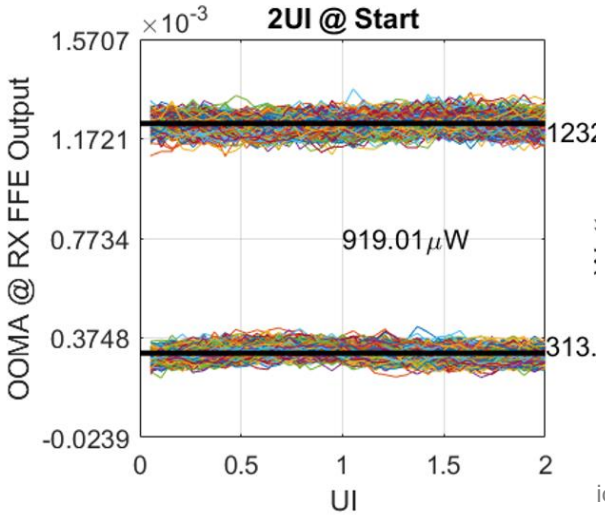
In Depth Look

TX FFE - [0.8, 0.2, 0.0, 0.0, 0.0] – PRBS13Q vs SSPRQ









- PRBS13Q, all three methods are equivalent
- For simplicity, looking at runs of length 6
- Left is PRBS13Q with runs of 6.
- Right is SSPRQ, runs of 7.
- Both are consistent because the reflection is before the range.

KEYSIGHT

Thank you