



# 400GBASE-DR4 TP2 Observations

Brian Welch

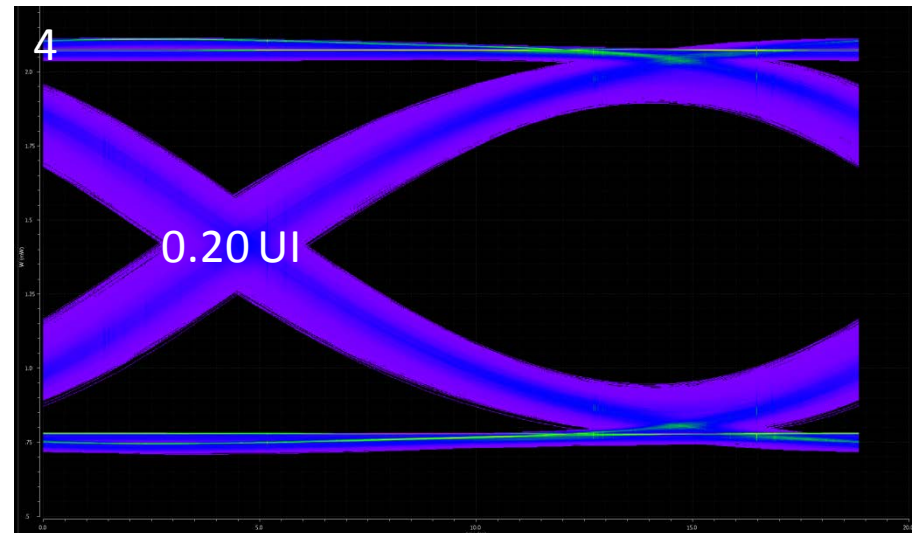
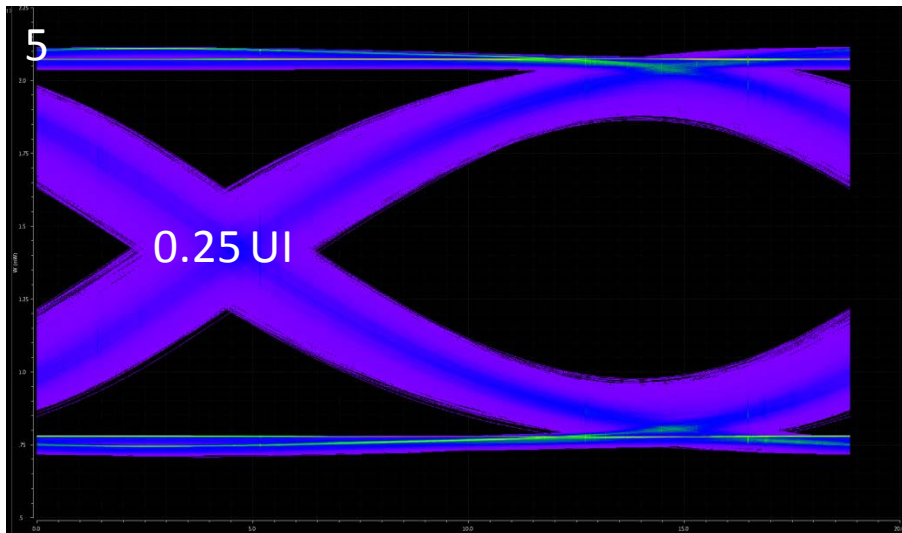
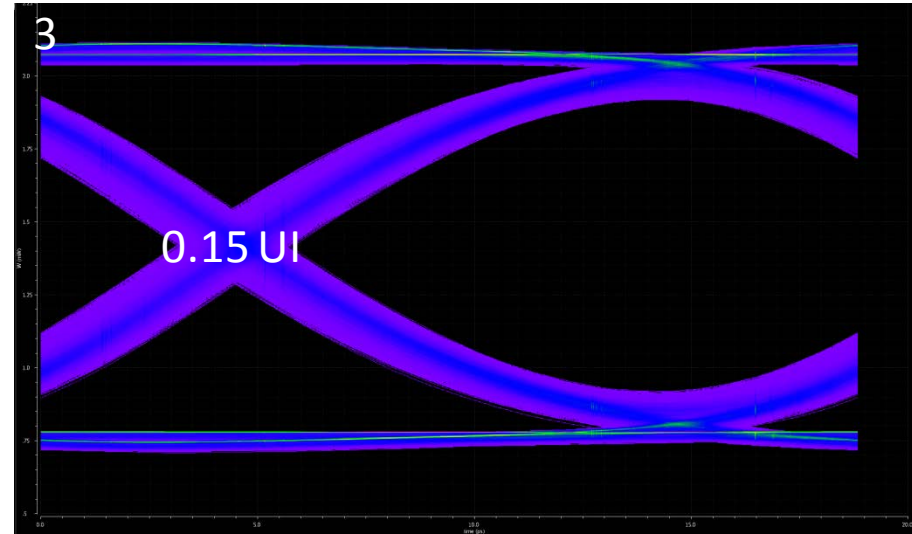
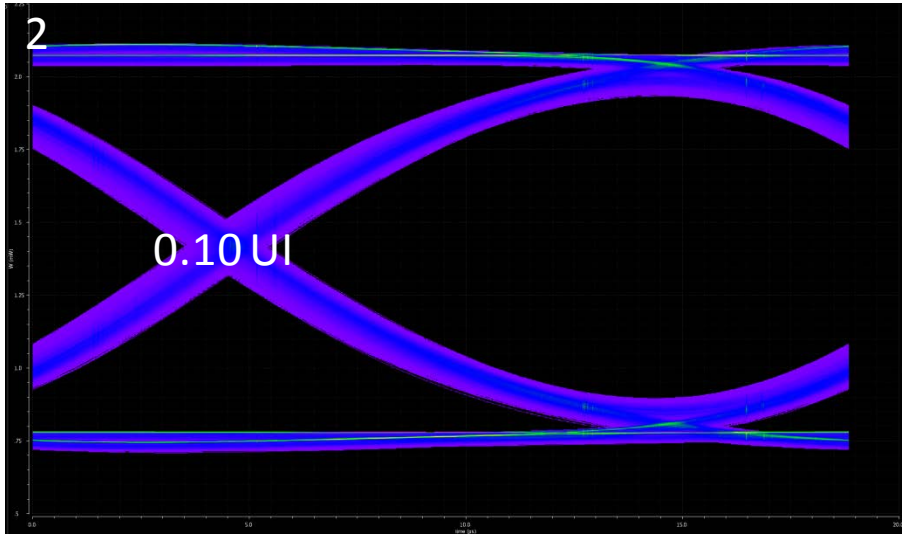
# 400GBASE-DR4 TP2 Observations

- Simulating TP2 characteristics while varying the following parameters
  - Transmitter BW: 22-32 GHz
  - Input Jitter: 2-5x (Normalized Jitter Amplitude)
- Jitter varied as a normalized input jitter amplitude
  - Correlated to TP2 jitter observations of a 25 GHz TX in PAM2 mode
  - Broadband sinusoidal input jitter
    - TX also has additional jitter effects (bounded and Gaussian)
- Observing eye opening and inner eye “VECP”
  - $VECP = (\text{High Frequency Eye Opening}) / (\text{Low Frequency Eye Opening})$
- Looking at effects of reference equalizer on TP2 measurements

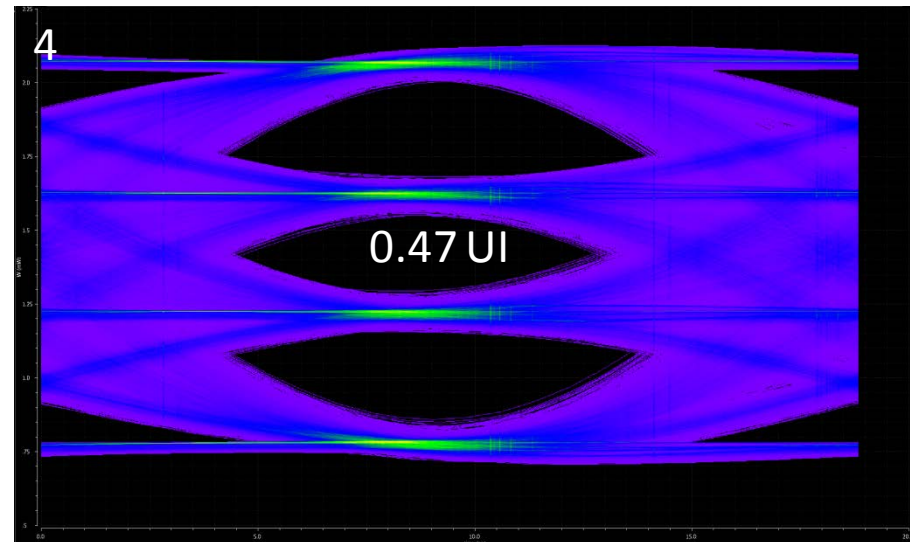
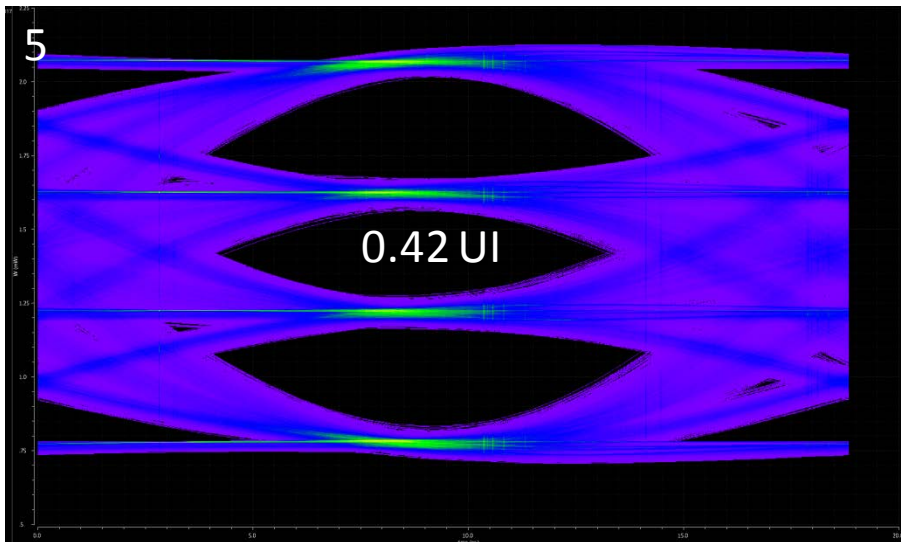
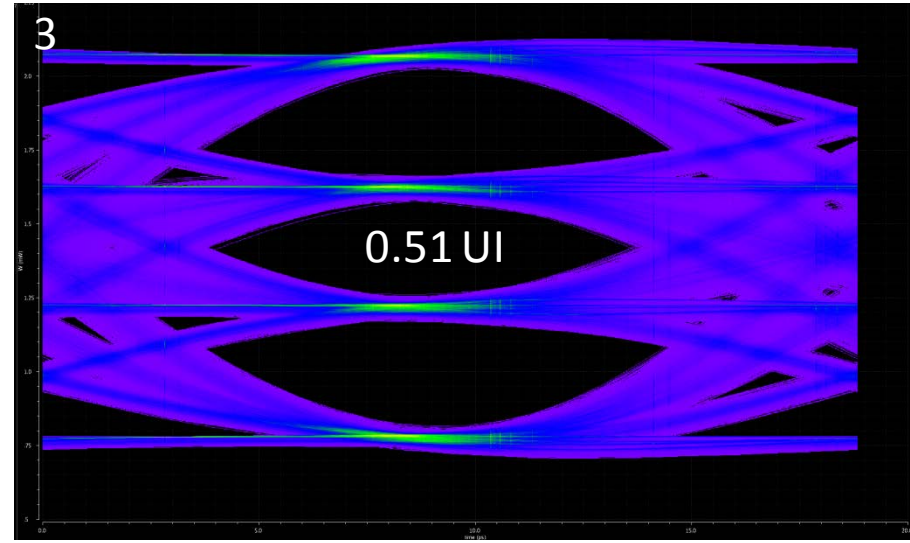
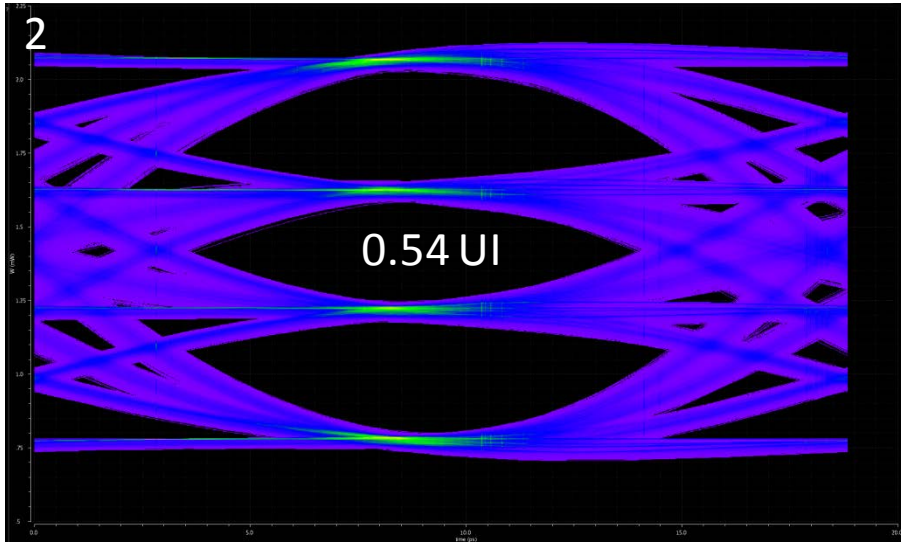
# Direct TP2 Observations

No Equalization Applied

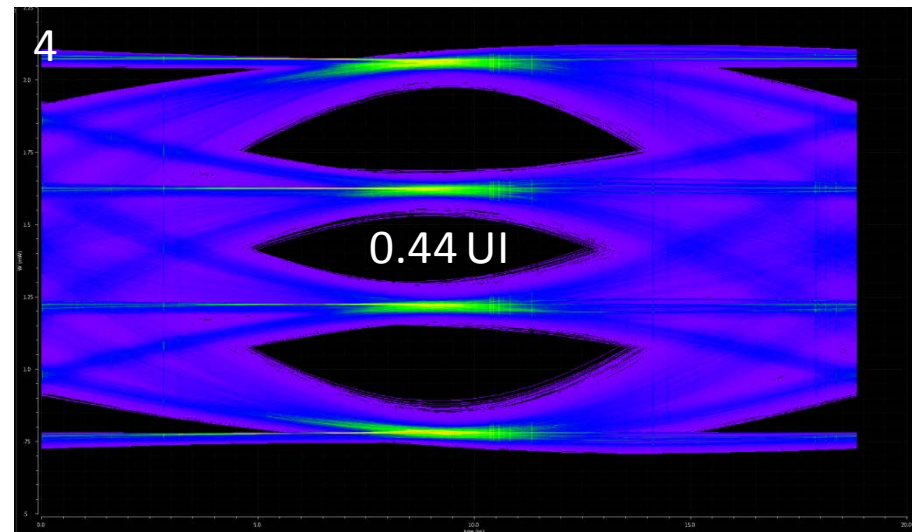
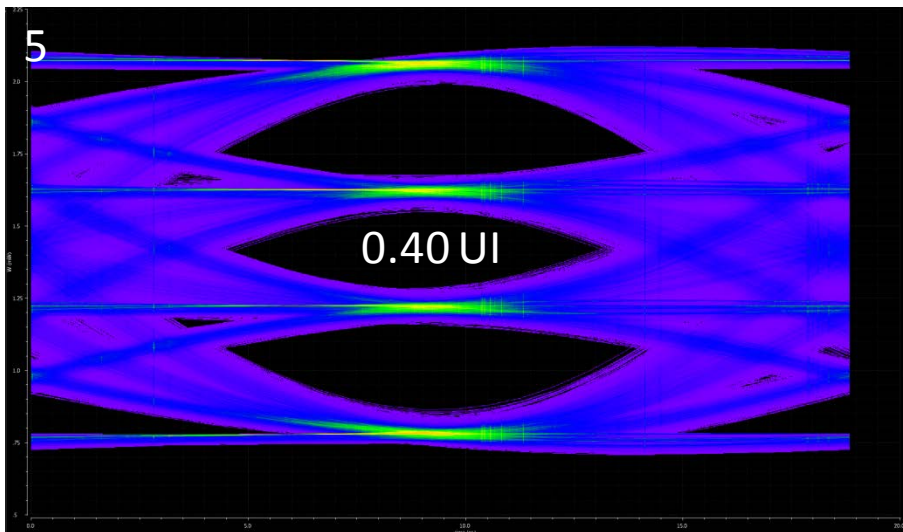
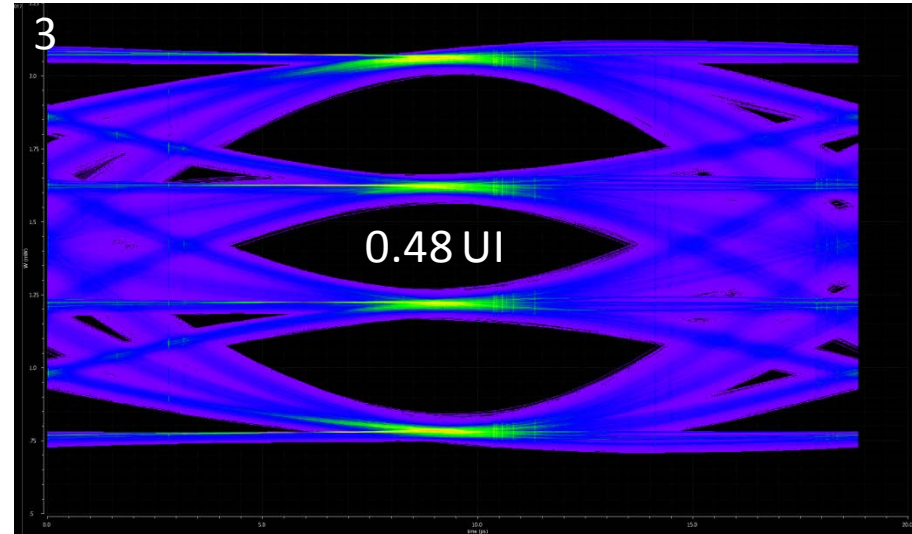
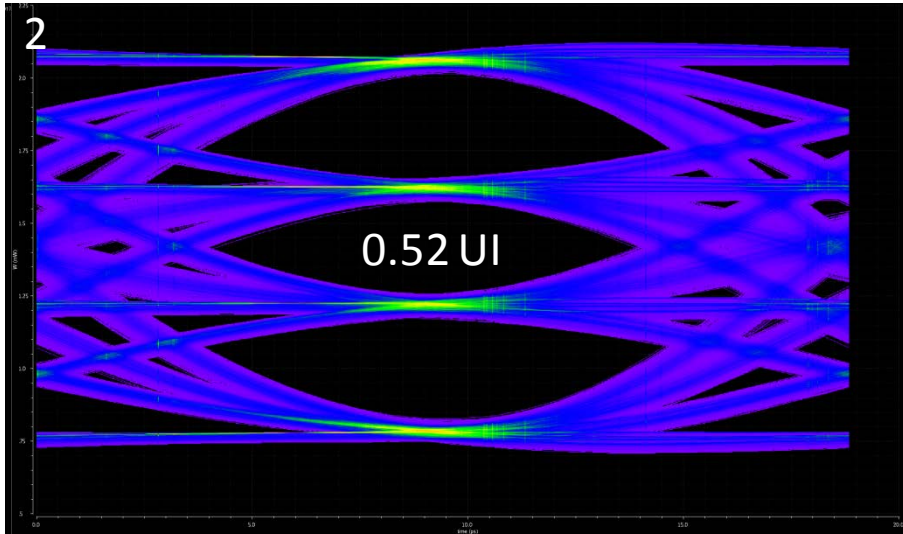
# Reference TX ~ 25 GHz BW (PAM2 Mode)



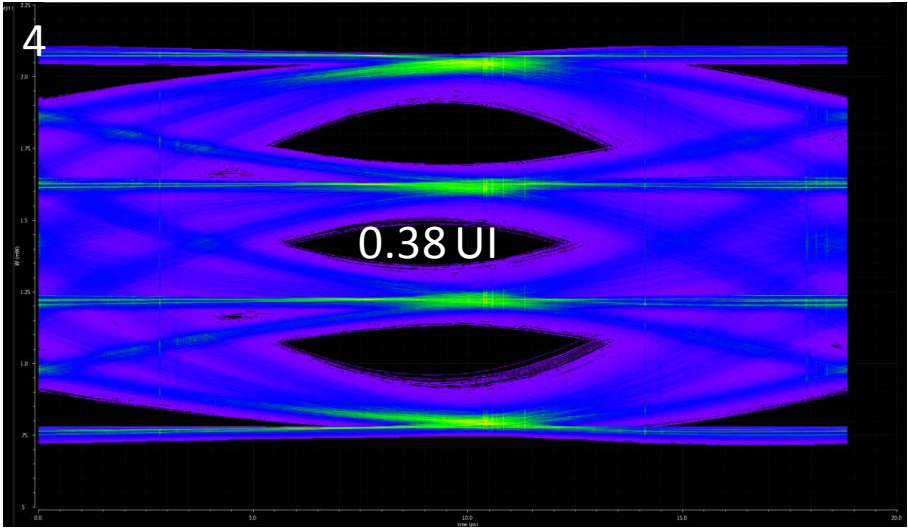
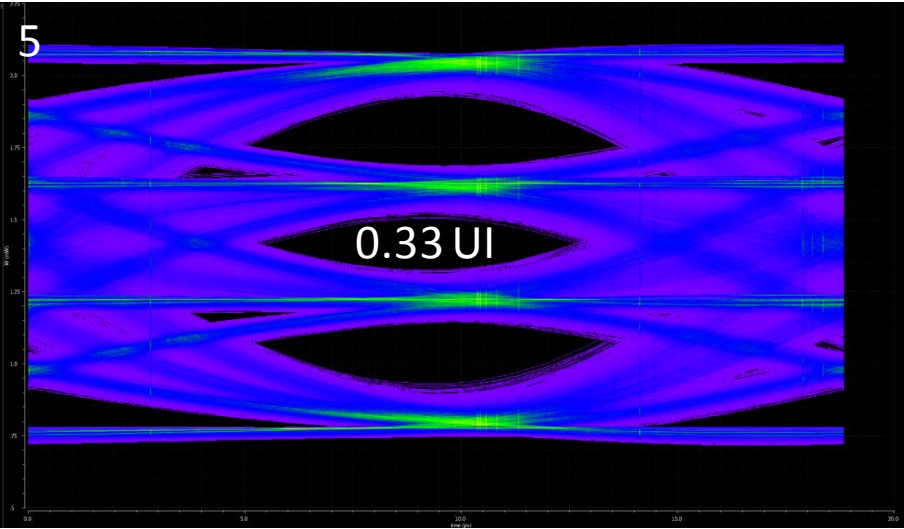
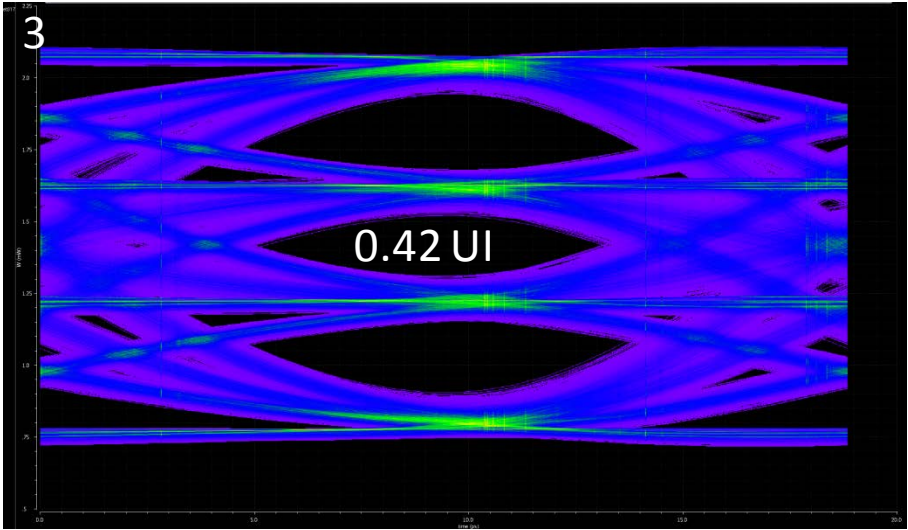
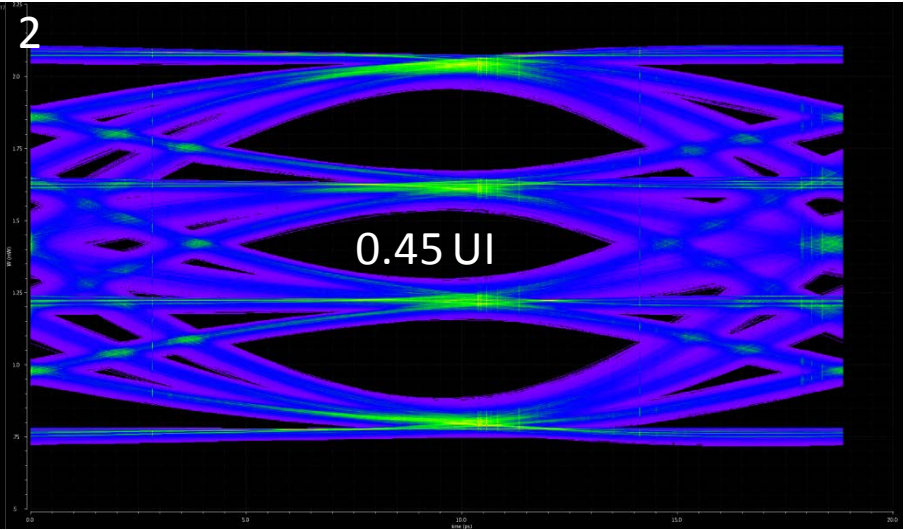
# Transmitter 1 ~ 32 GHz BW



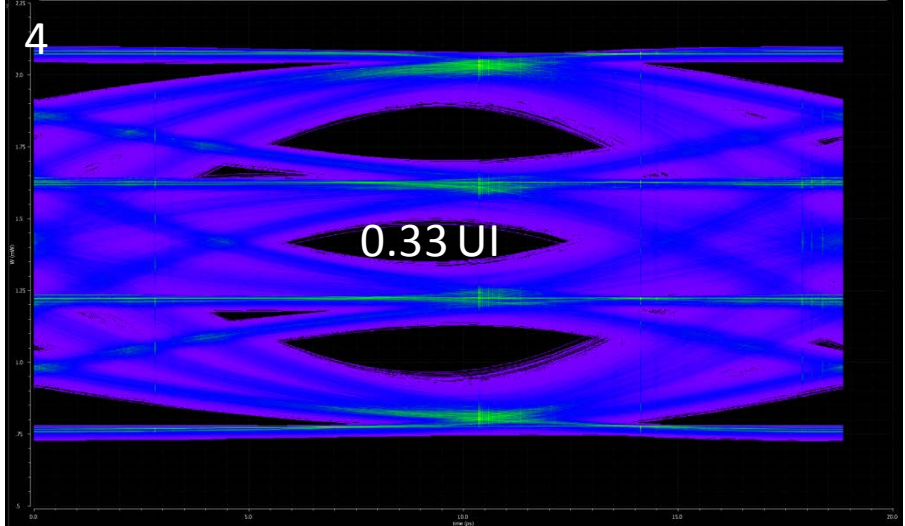
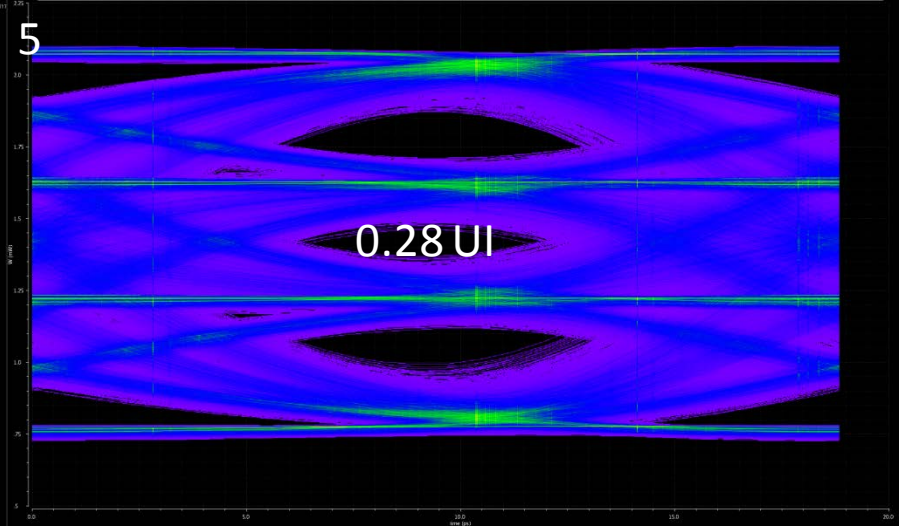
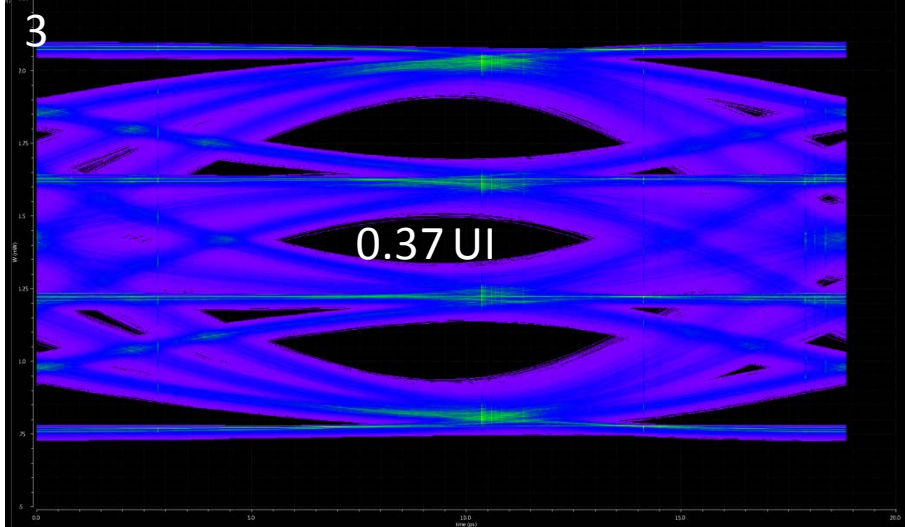
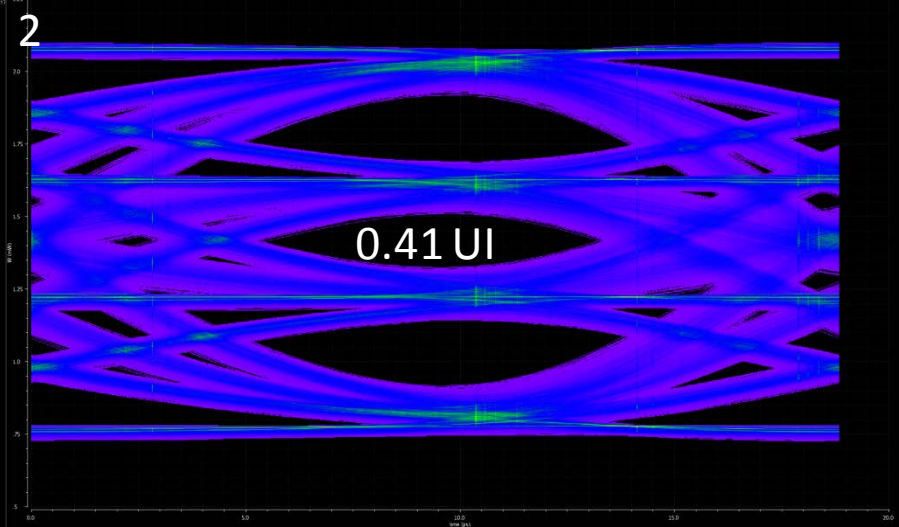
# Transmitter 2 ~ 29 GHz BW



# Transmitter 3 ~ 25 GHz BW



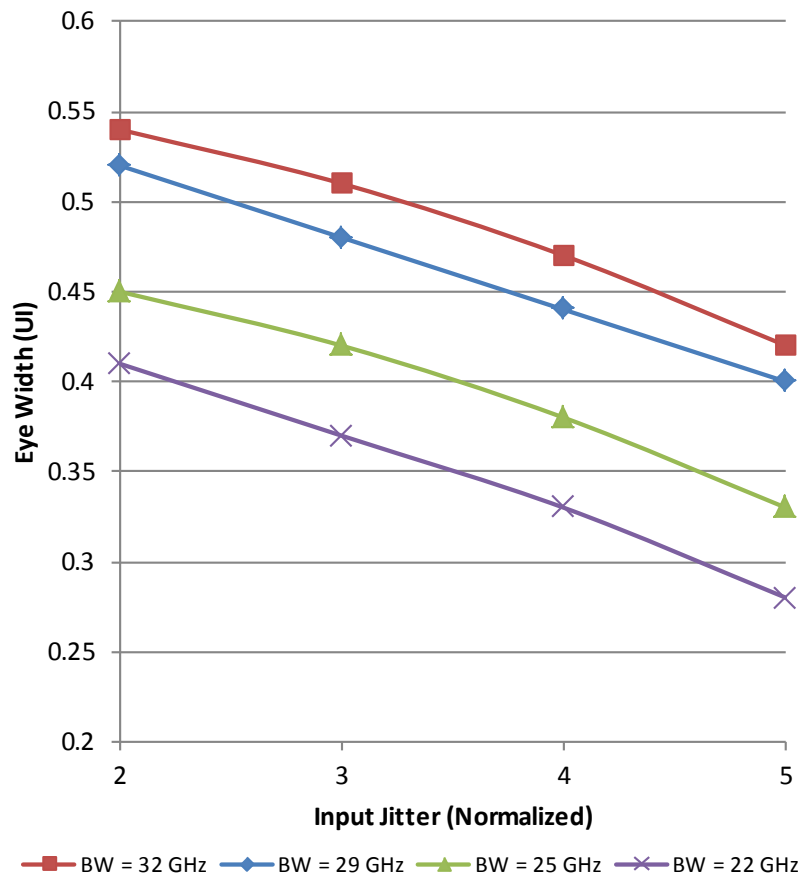
# Transmitter 4 ~ 22 GHz BW



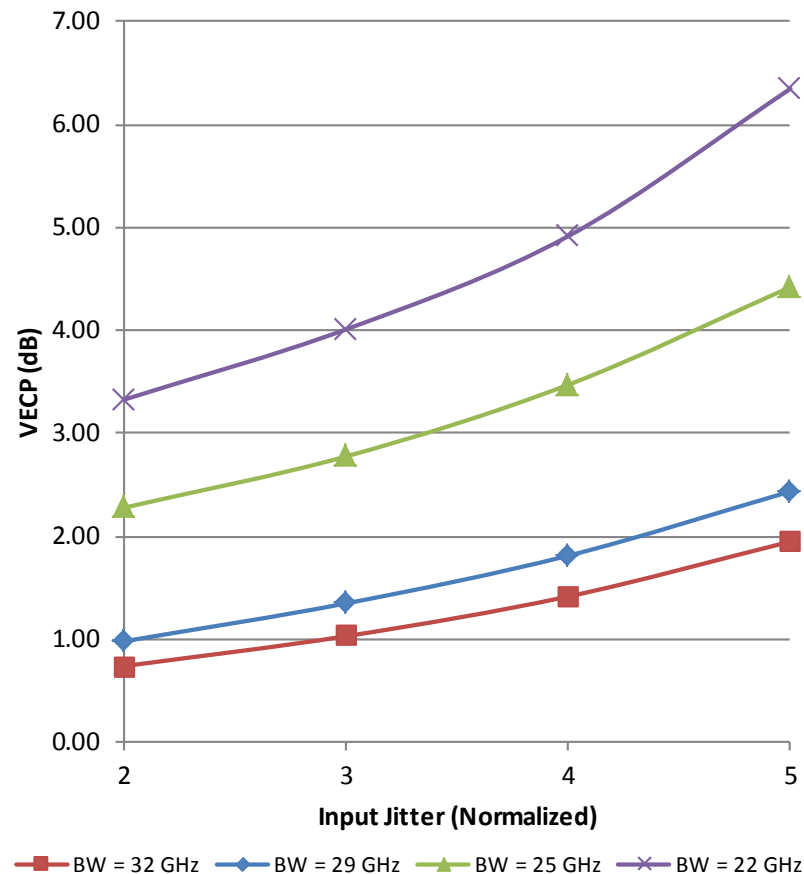


# Direct TP2 Observations

## Eye Width (UI)



## VECP (dB)



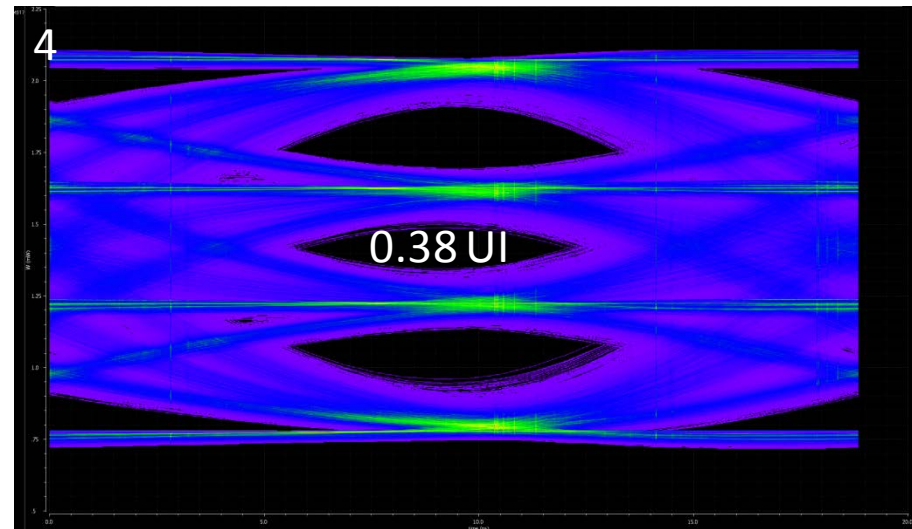
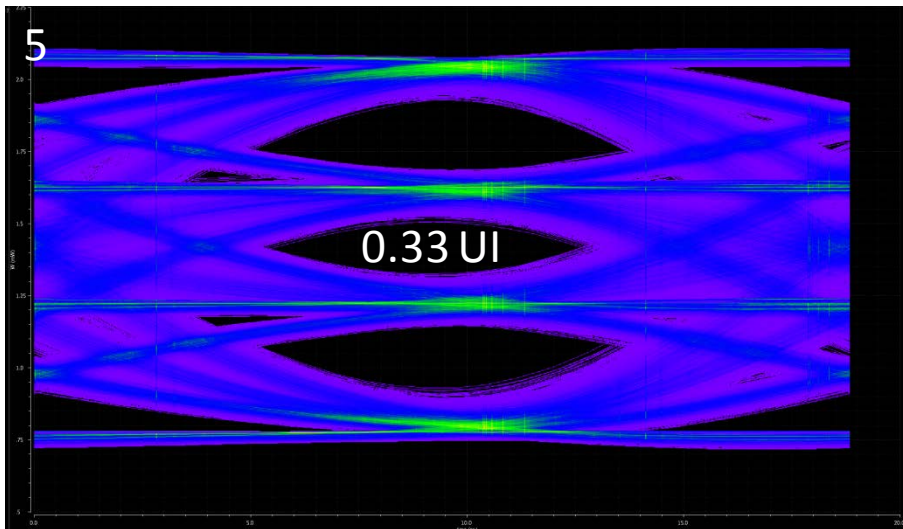
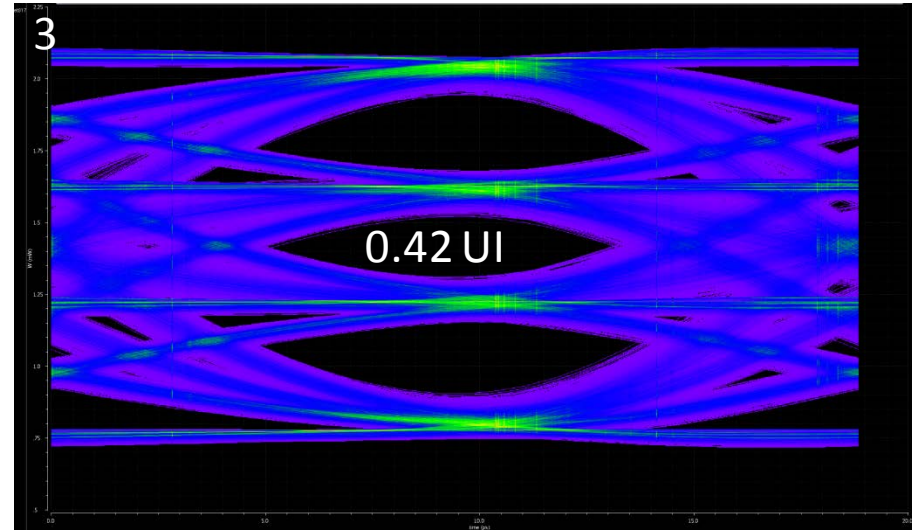
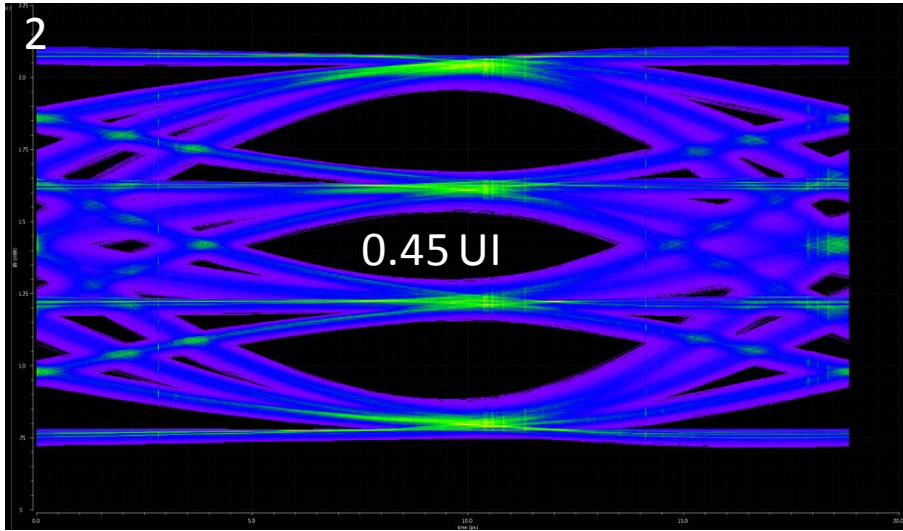
# Uncorrected TP2 Observations

- Prior results did not apply equalization to the optical TP2 observations
- As expected the lower bandwidth transmitters subsequently showed greater horizontal/vertical eye closure
- Real receivers are expected to have some equalization ability, such that an equalized TP2 observation should be more accurate
- Following slides look at the 25 GHz bandwidth case with a simple (passive) equalizer
  - Simulation time prohibited analyzing all cases for this meeting
  - Equalizer type/setting not optimized

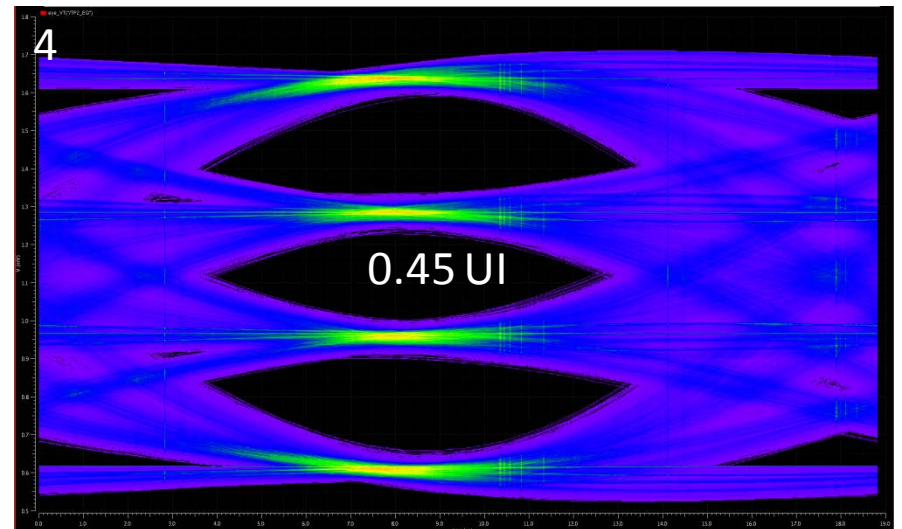
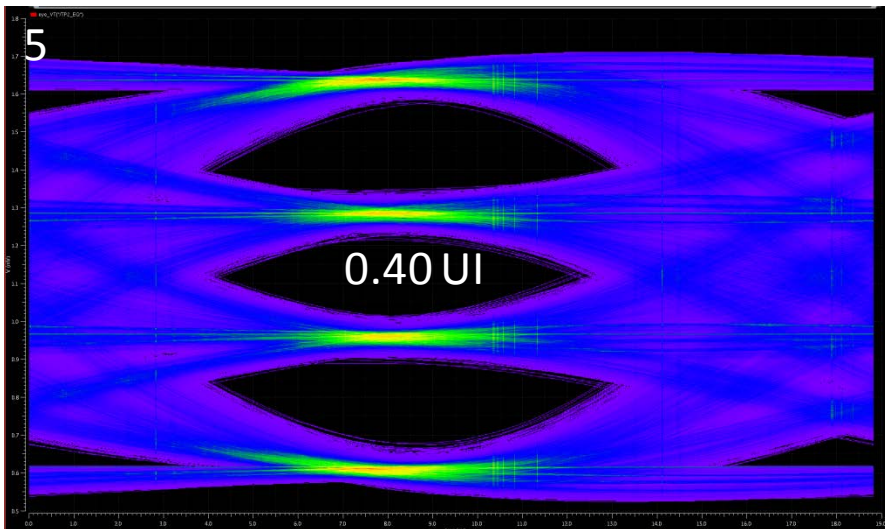
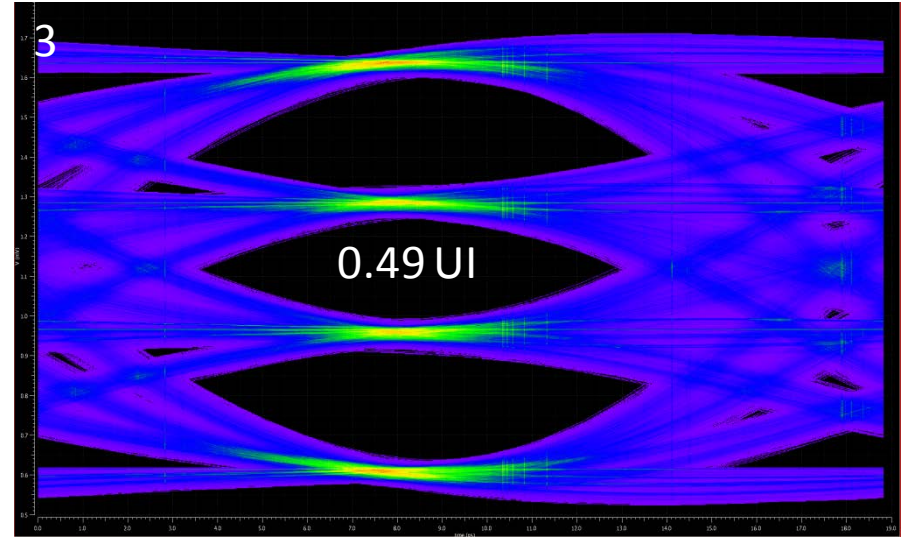
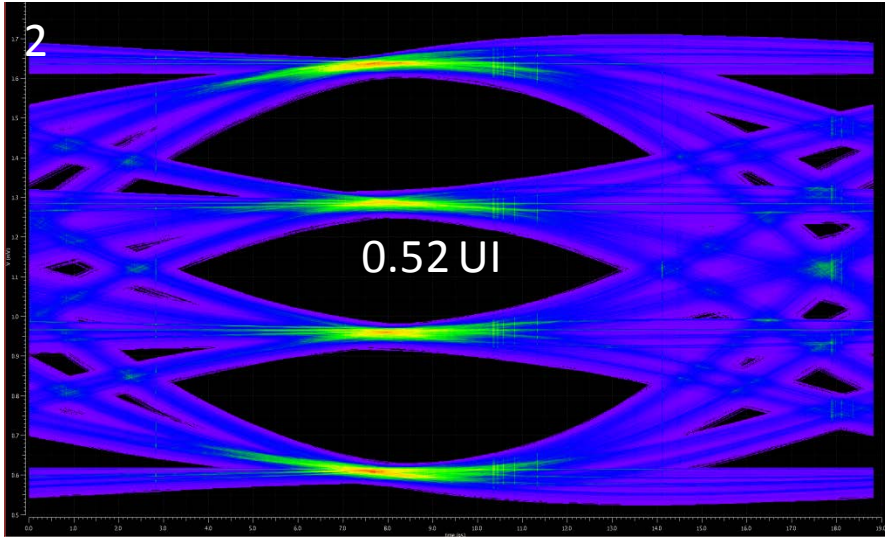
# Corrected TP2 Observations

Equalization Applied

# Transmitter 3 ~ 25 GHz BW (Uncorrected)

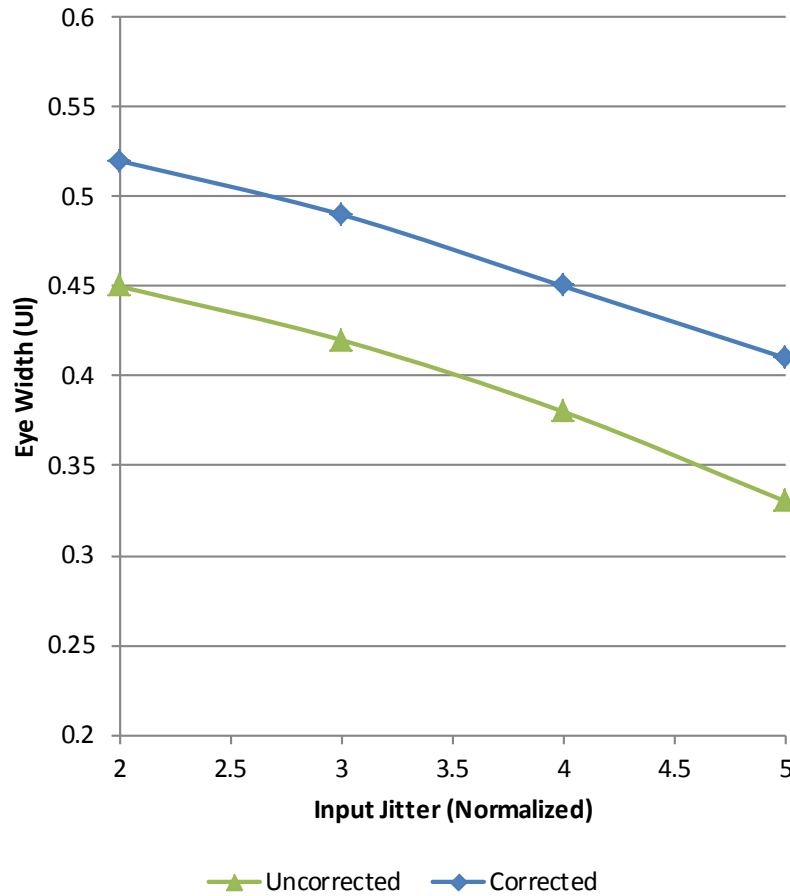


# Transmitter 3 ~ 25 GHz BW (Corrected)

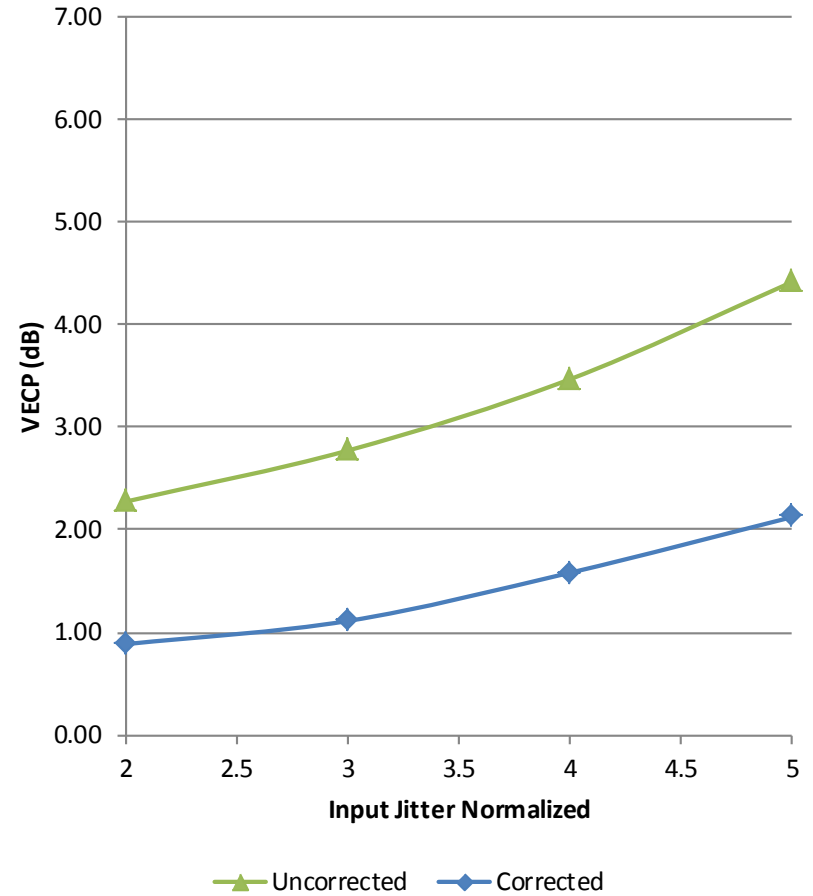


# Corrected TP2 Observations (25 GHz Transmitter)

## Eye Width (UI)



## VECP (dB)



# Corrected TP2 Observations and Summary

- With low bandwidth transmitters, equalization can have a significant impact on TP2 eye quality
  - 25 GHz transmitter saw almost 0.08 UI eye width improvement with simple equalizer
  - 25 GHz transmitter saw over 2dB eye height improvement with simple equalizer
- TP2 eye width definitions of 0.4-0.5 UI horizontal eye width should be achievable
  - Low bandwidth transmitters will likely need reference equalizer to meet
- TP2 “VECP” definitions of  $< 2.5$  dB should be achievable
  - Again requiring reference equalizers for low bandwidth transmitters

**Thank You**