KEYSIGHT

# ETCC Analysis on OFC Plugfest Data

## IEEE P802.3dj ™ - New Orleans, LA, USA - May 2025

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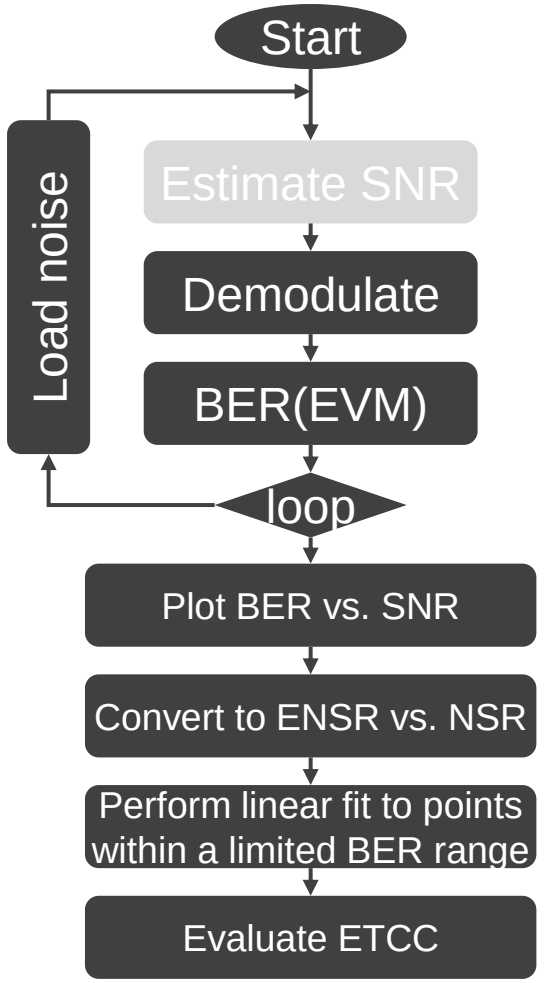
# Agenda

- **ETCC Background**
- **ETCC Post-Processing Draft Implementation**
- **OFC2024 Plugfest Data (400ZR+)**
- **OFC2025 Plugfest Data (400ZR)**
- **OFC2025 Plugfest Data (800ZR)**
- **Summary and Remarks**
- **Areas for Further Study**



# ETCC Background

- Methodology for extended transmitter constellation closure (ETCC) as a coherent transmitter quality metric (TQM) has been outlined in several contributions in OIF, IEEE and ITU
- It comprises a single waveform capture from a transmitter under test using a reference receiver
- The reference receiver post-processing comprises virtual noise loading, signal demodulation and analysis for each virtual noise level and a fitting procedure from which the ETCC value is determined

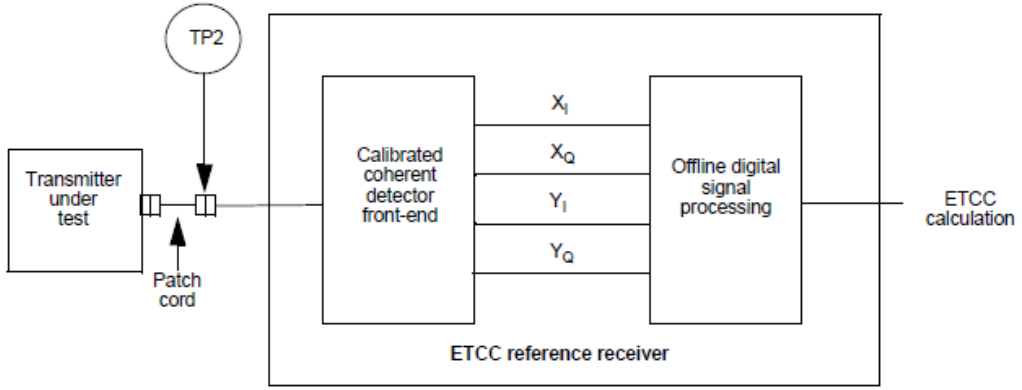



**Figure 185A–1—ETCC test setup**

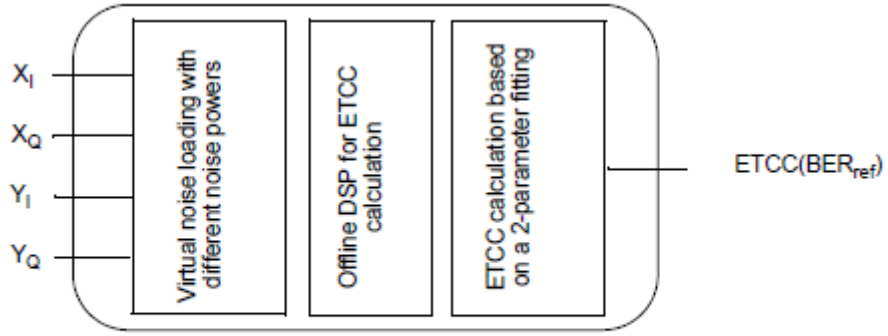
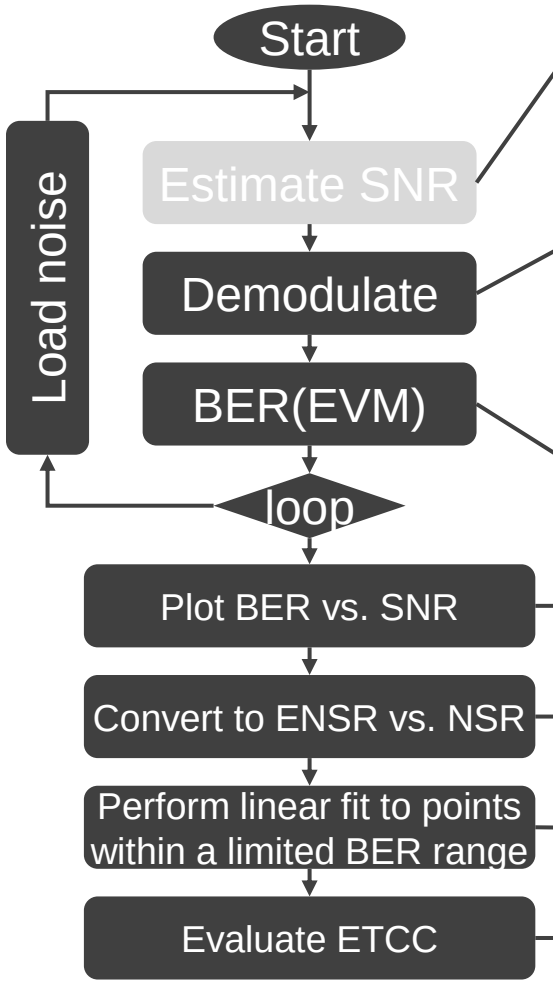



**Figure 185A–5— ETCC calculation flowchart**

IEEE P802.3dj D1.5 – Annex 185A

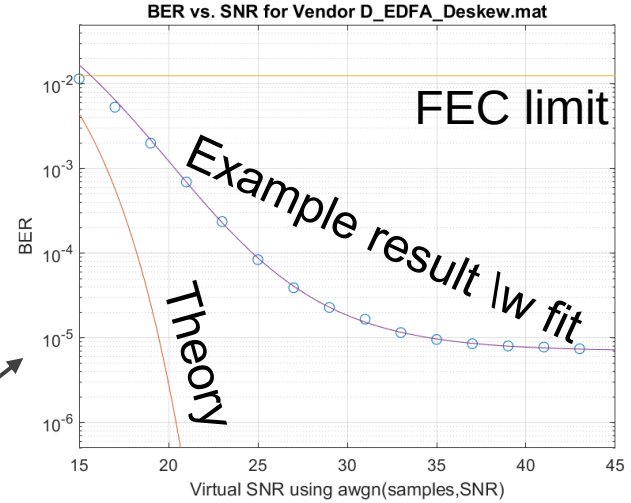
# ETCC Post-Processing Draft Implementation

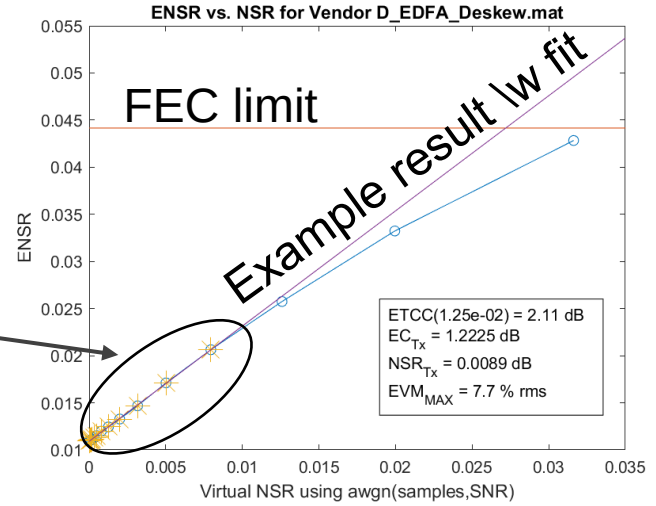



Skipped here, instead use the SNR loaded using Matlab AWGN-function for the x-axis

Leverage previous “EVM script” (latest version oif2018.391.04), more filter taps, no noise loading
Alternative: stream into OMA software

Estimate BER from EVM per polarization and then take arithmetic average for combined BER



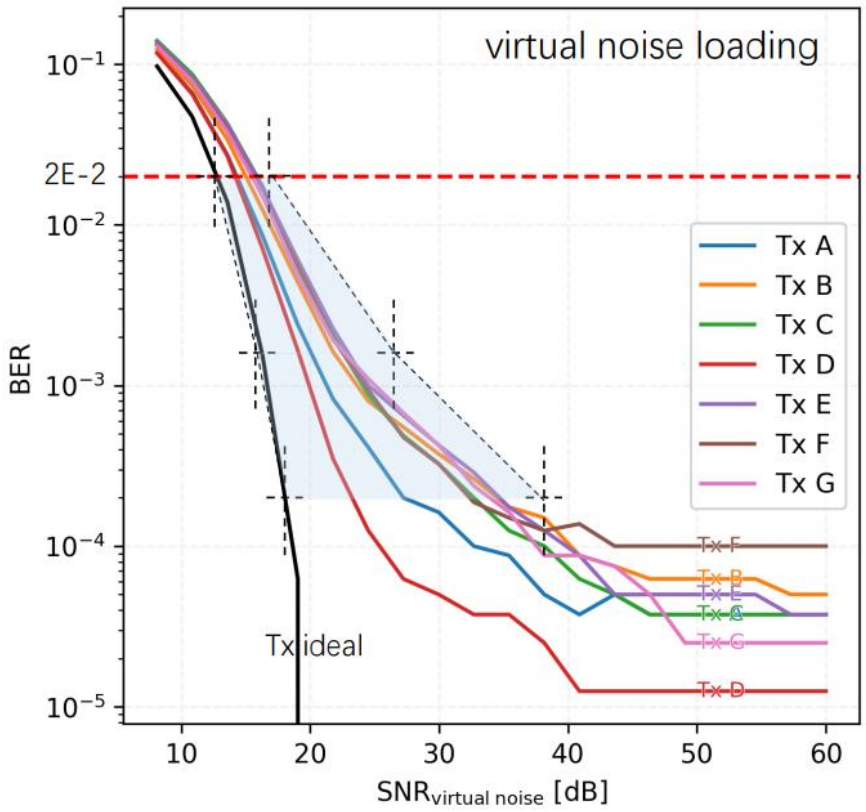




First guesstimate for good BER range: 1e-3 – 5e-7

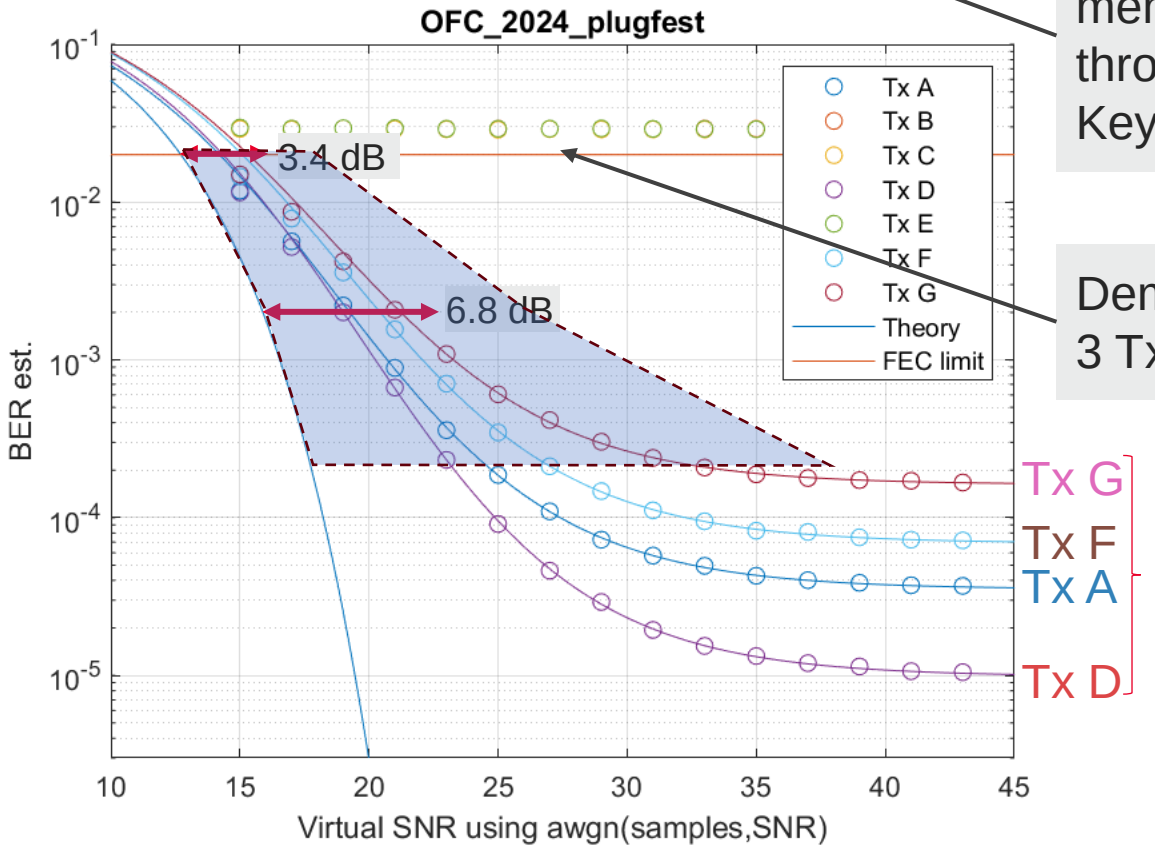
So far w/o intrinsic receiver noise calibration.

# OFC2024 Plugfest Data (400ZR+) Compared to fan_3dj_02a_2407

From fan_3dj_02a_2407.pdf




Demod with EVM script (oif2018.391.04), settings see slide 11




Available to OIF members or through Keysight

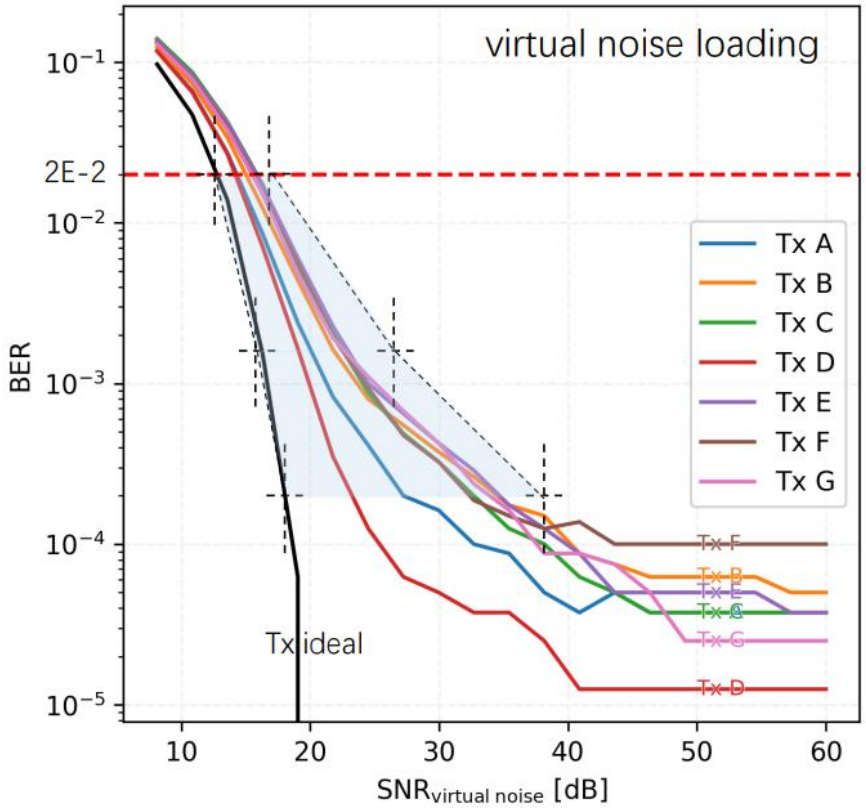
Demod fails for 3 Tx waveforms

Font color to compare with fan_3dj_02a_2407

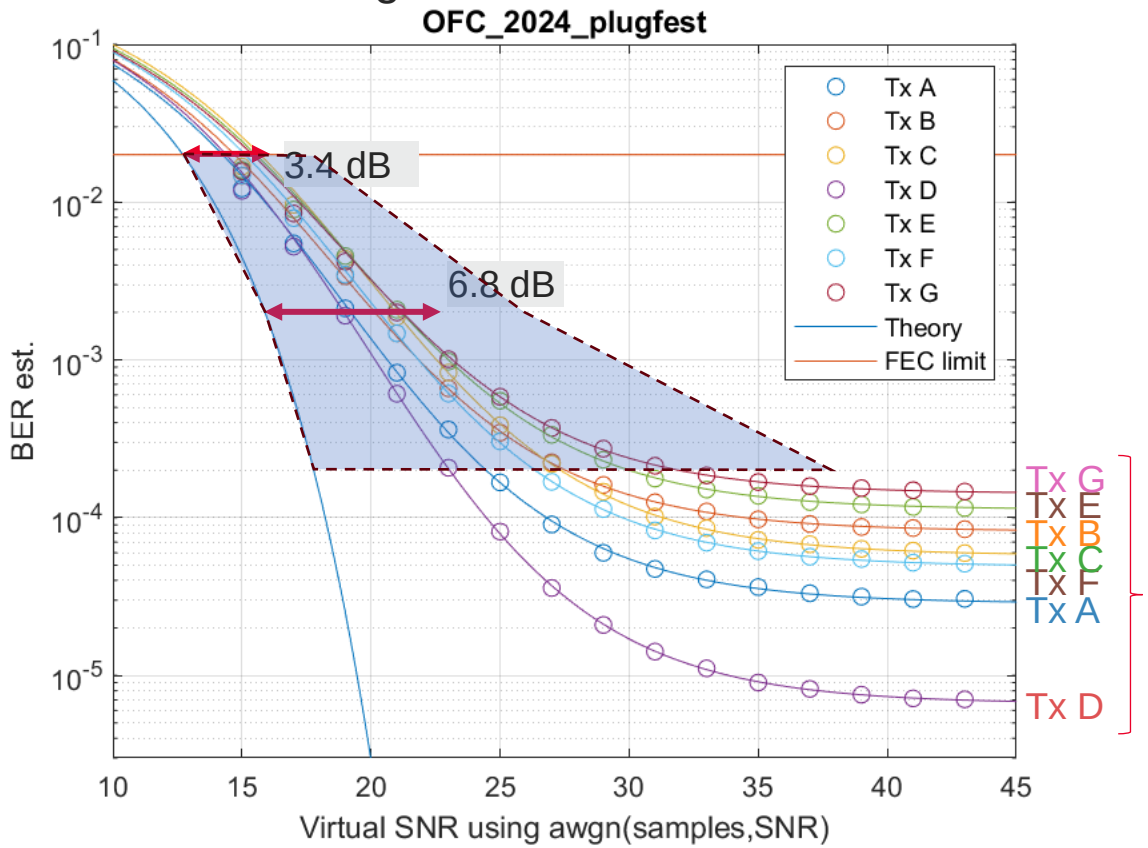
4 Tx show similar behavior up to ~30 dB virtual SNR

# OFC2024 Plugfest Data (400ZR+) Compared to fan_3dj_02a_2407 – Continued

From fan_3dj_02a_2407.pdf




Demod with OMA software, settings see slide 11




Font color to compare with fan_3dj_02a_2407

Very similar behavior up to ~30 dB virtual SNR

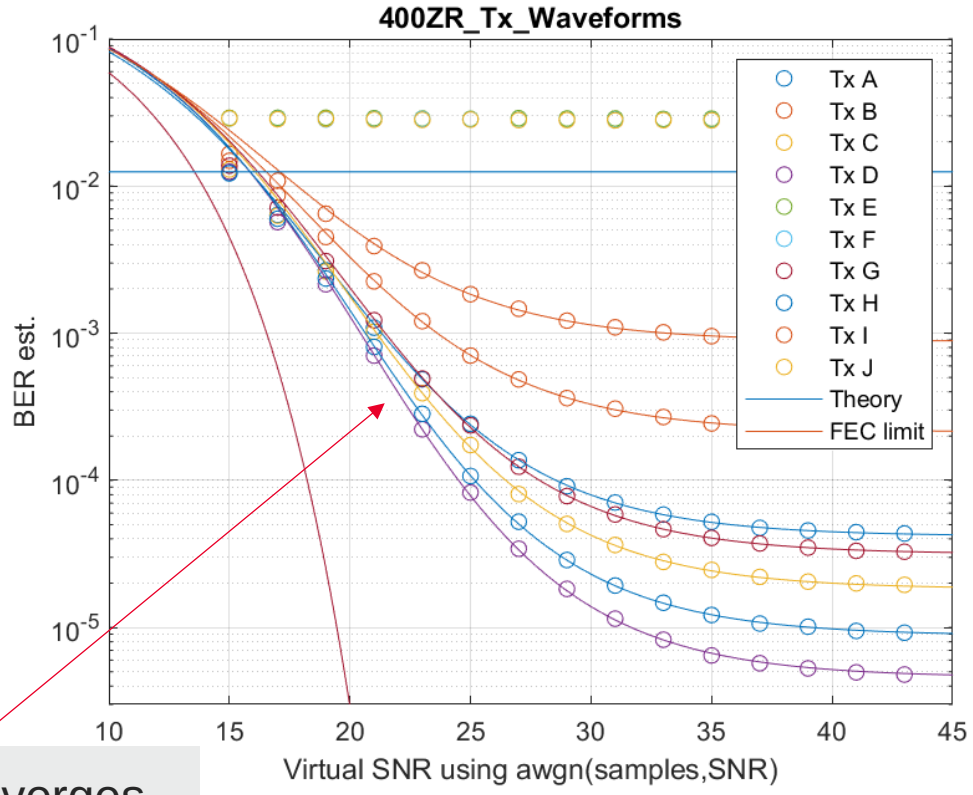
# Preliminary OFC2024 Plugfest ETCC Results Compared to kota_3dj_02_2407

| | Vendor | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|---|
| Marvell contribution: oif2024.430.01 | Rx1 | 1.5 | 2.7 | 3.4 | 1.3 | 2.6 | 3.0 | 2.6 |
| | Rx2 | 1.1 | 2.2 | 3.2 | 0.9 | 2.2 | 2.5 | 2.2 |
| | Rx3 | 1.3 | 2.9 | 3.4 | 1.3 | 2.5 | 2.9 | 3.2 |
| | Rx4 | 1.1 | 2.4 | 2.9 | 1.0 | 2.1 | 2.6 | 2.7 |
| This contribution: | EVM script demod | 1.5 | - | - | 1.6 | - | 2.4 | 2.6 |
| | OMA SW demod | 1.5 | 2.0 | 3.0 | 1.7 | 2.8 | 2.4 | 2.7 |

Similar trends!
Methodology seems to be useful in principle
Need consensus on detailed reference receiver post-processing

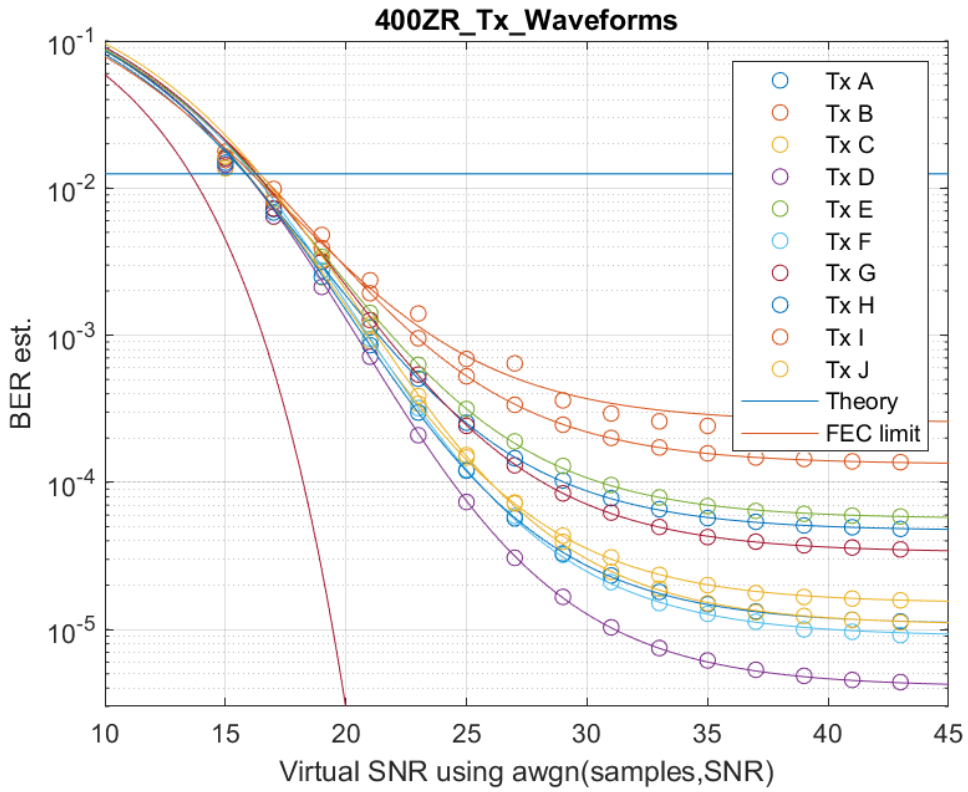
# OFC2025 Plugfest Data (400ZR)

Demod with EVM script (oif2018.391.04), settings see slide 11



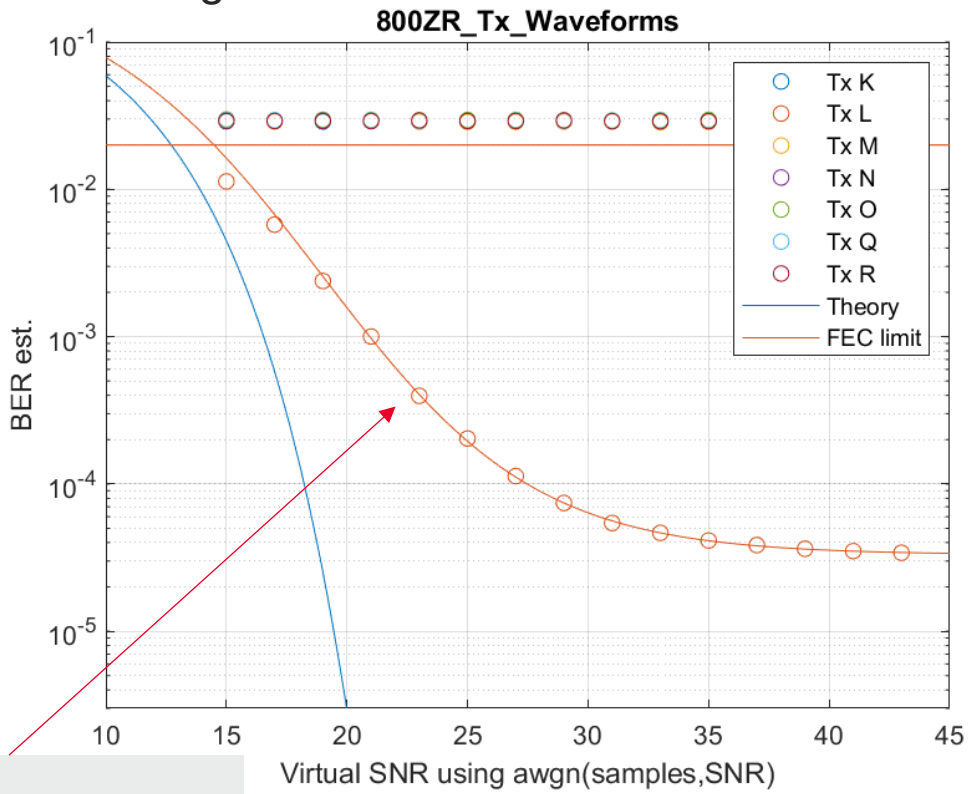

Demod converges for 7 of 10 Tx

Demod with OMA software, settings see slide 11



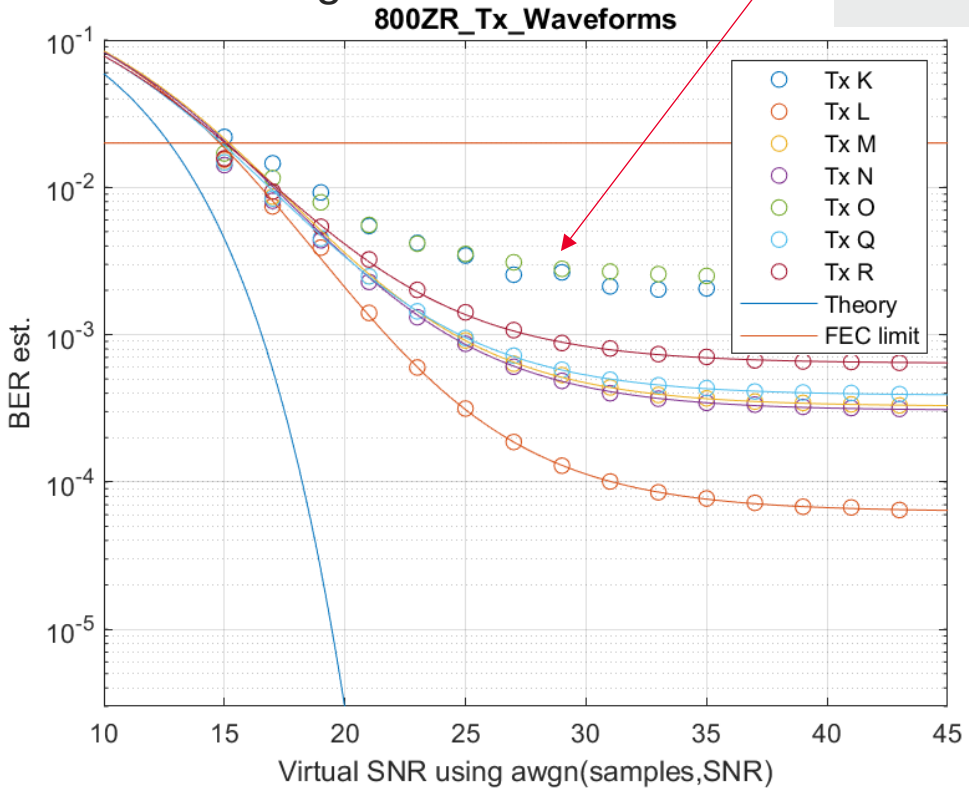
# OFC2025 Plugfest Data (800ZR)

Demod with EVM script (oif2018.391.04), settings see slide 11




Demod converges only for one Tx

Demod with OMA software, settings see slide 11




All data points within BER range that is excluded from fitting

# Preliminary OFC2025 Plugfest ETCC Results

400ZR

| Vendor | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| EVM script demod | 2.3 | 3.0 | 2.5 | 2.3 | - | - | 2.6 | 2.3 | 2.6 | - |
| OMA SW demod | 2.3 | 2.9 | 2.3 | 2.3 | 2.7 | 2.6 | 2.7 | 2.3 | 2.6 | 2.9 |

800ZR

| Vendor | K | L | M | N | O | P | Q | R |
|---|---|---|---|---|---|---|---|---|
| EVM script demod | - | 1.8 | - | - | - | - | - | - |
| OMA SW demod | NaN | 2.1 | 2.5 | 2.4 | NaN | NA | 2.2 | 2.3 |

**Legend:**

- `-` Demodulation failed
- `NaN` Fitting procedure failed
- `NA` Module missed during measurement session

# Demodulator Settings

- EVM script (oif2018.391.04)
- Changes compared to OIF-400ZR-03.0 Appendix C:
  - OSNR = Inf (no noise loading for EQ training)
  - numTaps = 45
  - receiveFilter = 'RootRaisedCosine'
  - receiveBT = 0.2

- EVM script (oif2018.391.04) available to OIF members or through Keysight

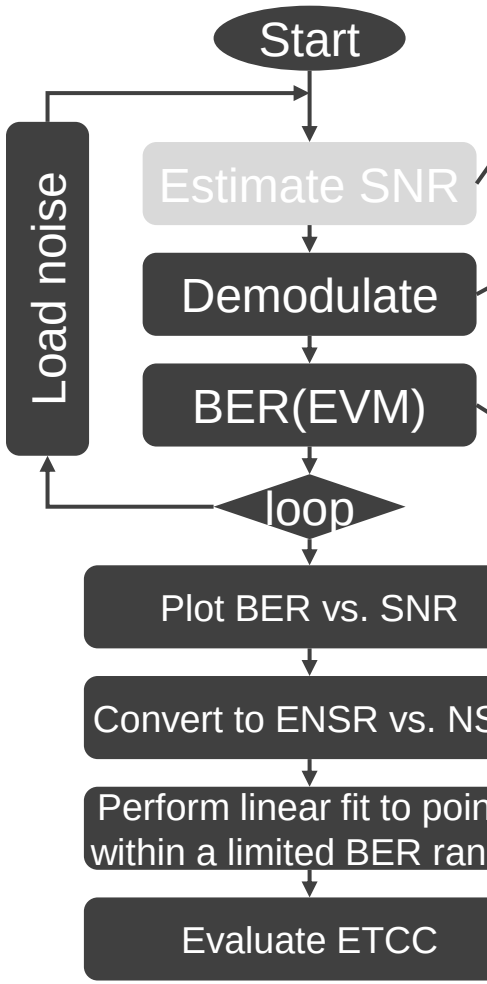
These settings are also described in OFC-2025-TQM-White-Paper-4_17.pdf available via: https://www.oiforum.com/wp-content/uploads/OFC-2025-TQM-White-Paper-4_17.pdf

- OMA software demod:
- Pre-processing algorithms:
  - Transmitter Phase Response Equalizer ***(used for 800ZR only)***
  - PolStokesAlign
  - Frequency Offset Compensation
- Custom IQ demodulator
  - Constellation: 16QAM
  - Result Length: 1000 Symbols
  - Measurement Filter: Root Raised Cosine
  - Reference Filter: Raised Cosine
  - Alpha/BT: 0.2
  - Filter Length: 45
  - Convergence: 5E-07
  - Frequency Estimation: Normal

# Summary and Remarks

- Draft implementation of ETCC reference receiver post-processing flow with T&M toolsets delivers qualitatively comparable results to Huawei contribution fan_3dj_02a_2407 and Marvell contribution kota_3dj_02_2407
- Reference receiver post-processing needs to be defined with high-level of detail to ensure consistent results across different implementations
- Need close collaboration between transceiver and test equipment vendors – suggested main areas “for further study” see next slide

# ETCC Post-Processing Draft Implementation




Skipped here, instead use the S… using Matlab AWGN-function i…

Leverage pr… ript" (l… version oif201… aps, no noise… g Alterna… MA softw…

Estimate BER from EVM… nd then take arithmetic avera… bined BER

First guesstim… BER ra… -3 – 5e-7

So far w/o intrinsic receiver no… ration.

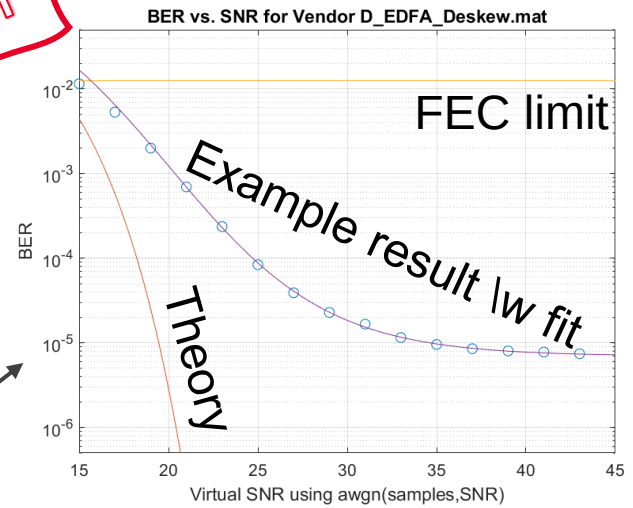
FFS
SNR$_{ase}$ estimation

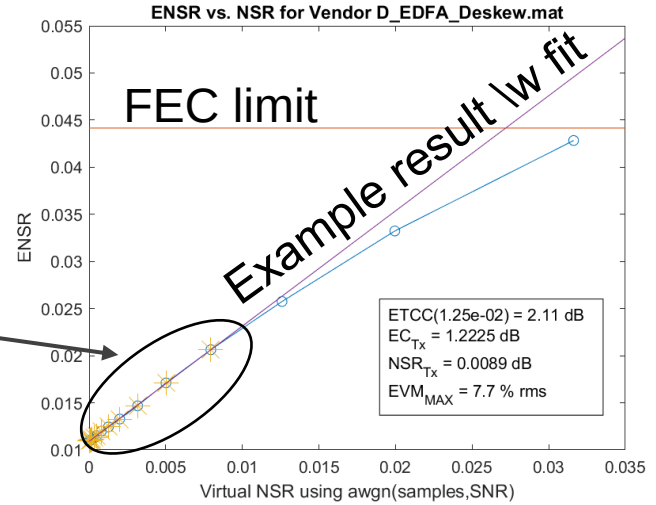
FFS
Digital Demod.

FFS
BER est vs. bit counting

FFS
Fit range

FFS!



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# Thank you