ANALOG DEVICES

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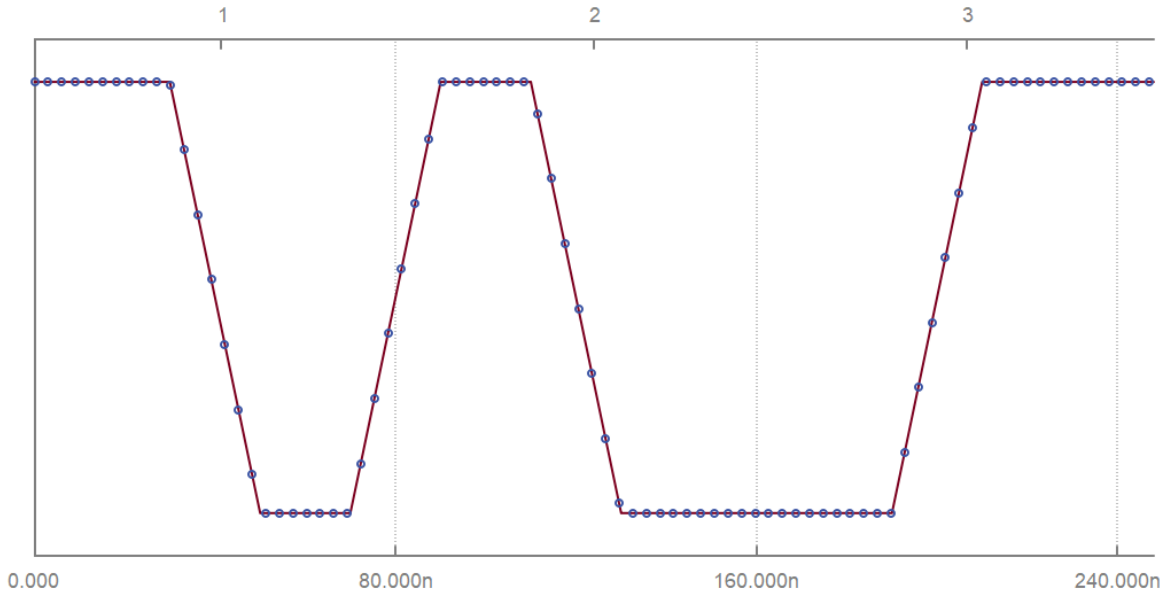
Consensus Model Update

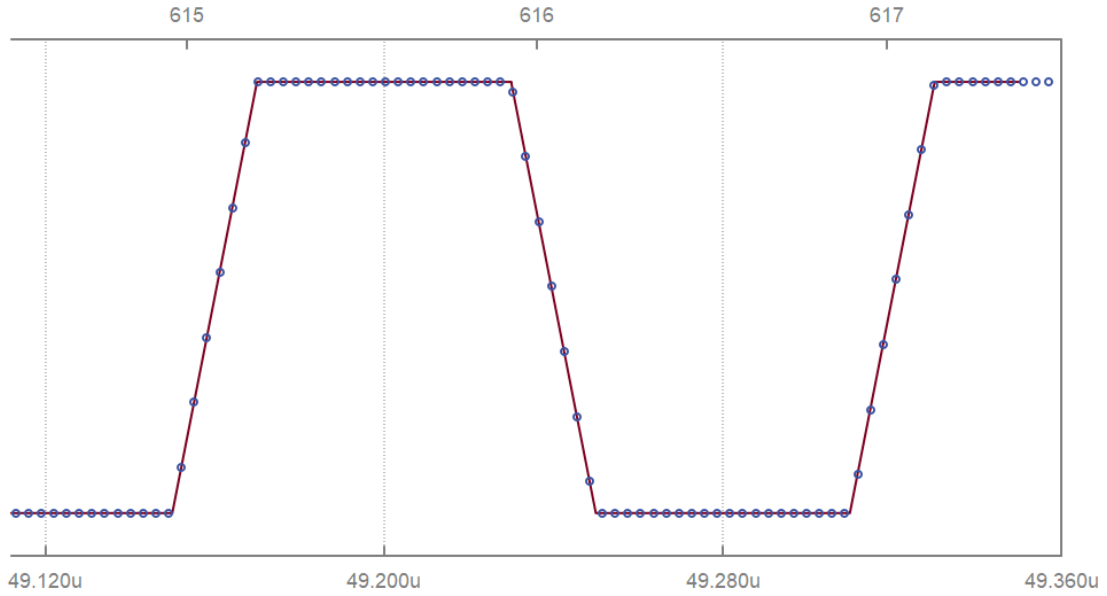
Michael Paul

Outline

- Model Upgrades following Piergiorgio Beruto's presentations
  - RX Model Proposal (July 14,2022)
  - Transmitter Model (May 4, 2022)
- New additions
  - Changed sample rate
    - Required for correlator resolution
  - Tx Model
    - Filters
  - Rx Model
    - Filters
    - Slicer
    - Correlator
- Figure of merit
  - Minimum correlation value

Sample Parameter Setup



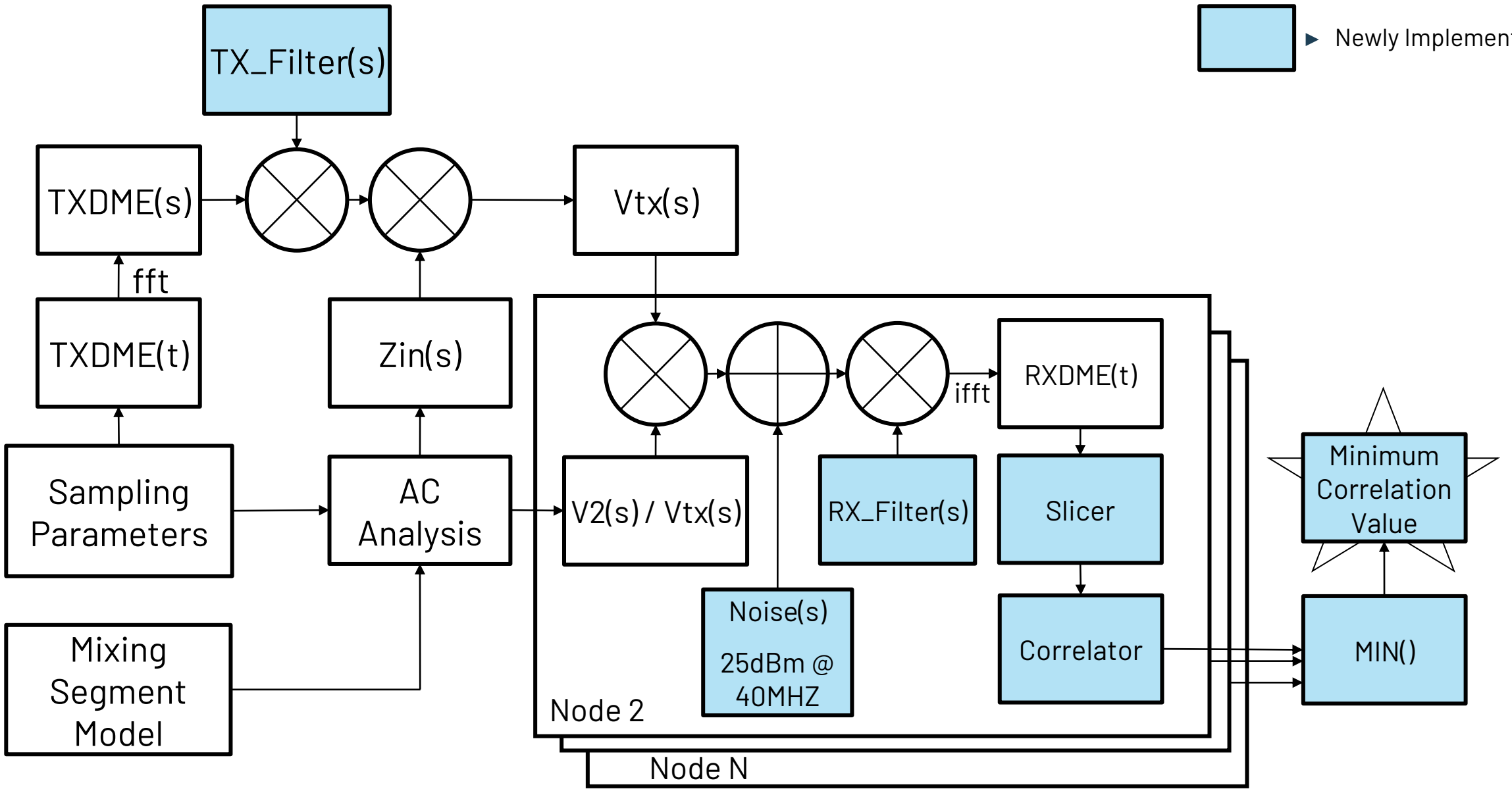


- Coherent Sample a DME Signal
  - 16,384 samples
  - 617 bit periods
  - 16384 / 617 * 80ns = Fs
    - Fs = 332MHz
  - Nyquist Frequency = 166MHz

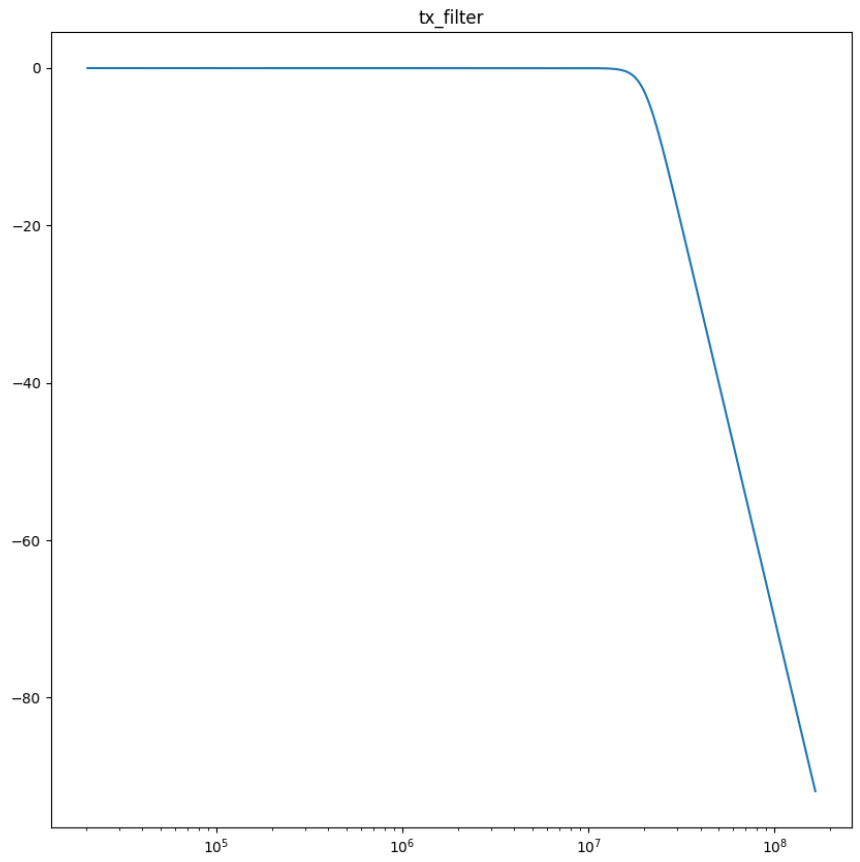
- Align AC analysis with Coherent Samples
  - .ac lin <nsamples> <step_size> <end_freq>
    - `nsamples  = 16384 / 2  = 8192`
    - `step_size = Fs / 16384 = 20.259k`
    - `end_freq  = Fs / 2     = 332MHz`

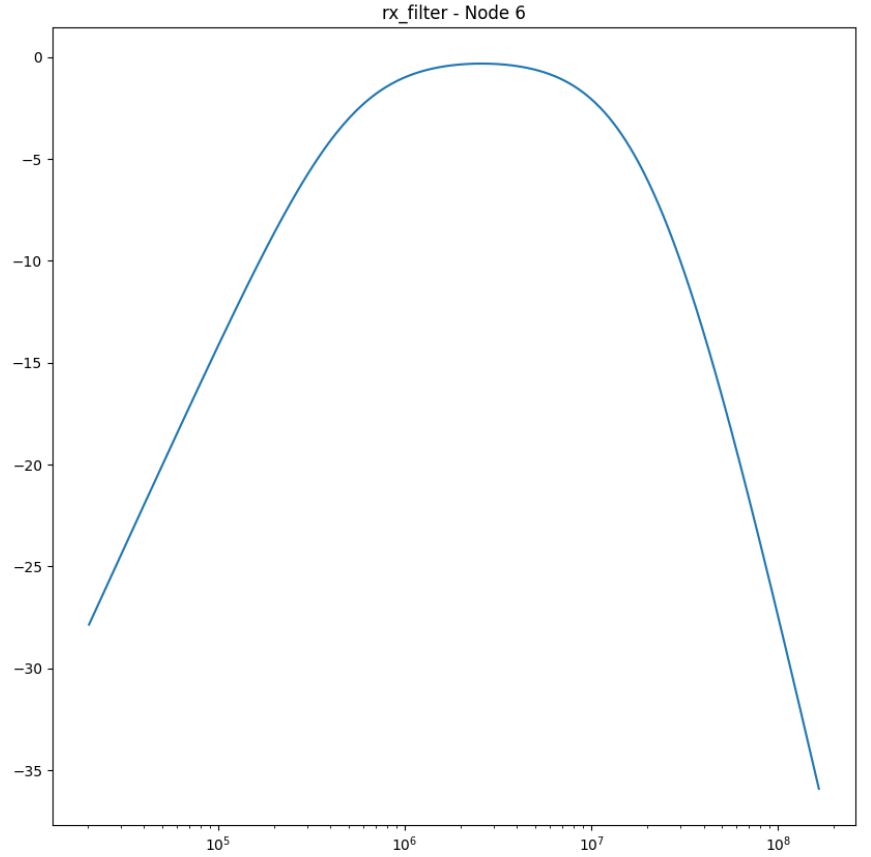
*Previous Model settings resulted in ~7 samples per bit

Signal Chain



Tx / Rx Programmable Filters



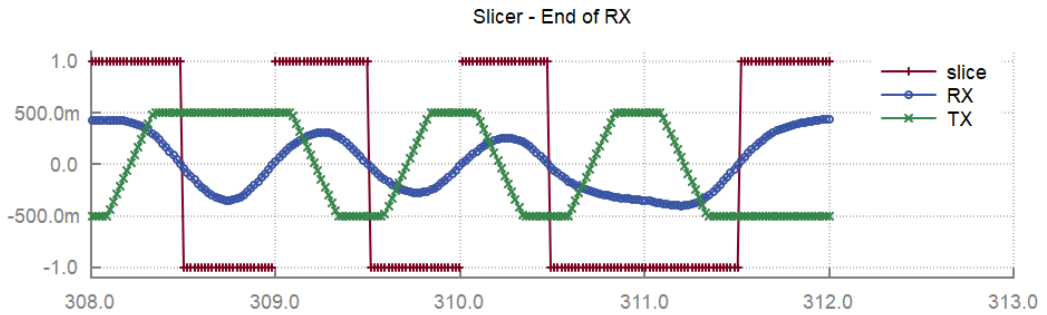


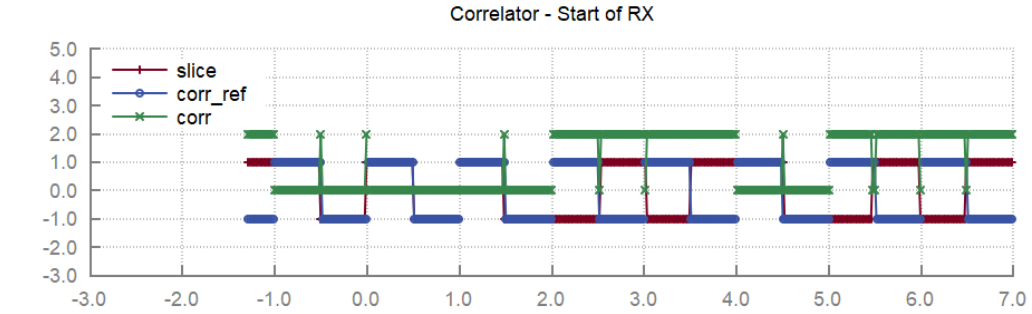

```
dme_tx.add_filter(filter_type="lpf",cutoff=20e6,order=5)
```

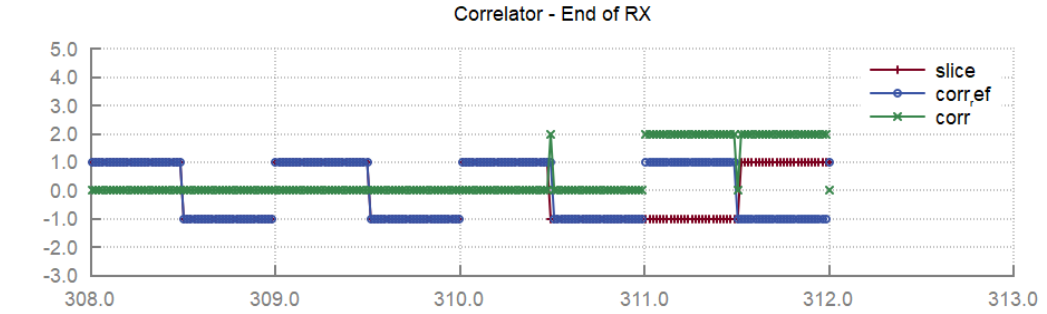
```
rx.add_filter(filter_type="hpf",cutoff=500e3,order=1)
rx.add_filter(filter_type="lpf",cutoff=15e6 ,order=1)
rx.add_filter(filter_type="lpf",cutoff=30e6 ,order=1)
```

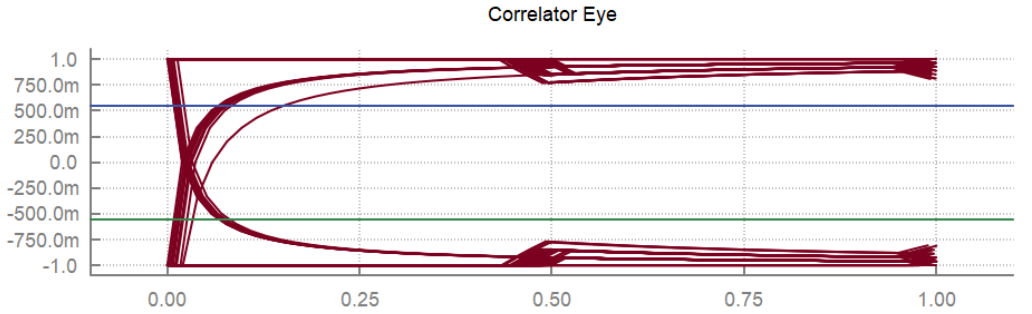
Correlator

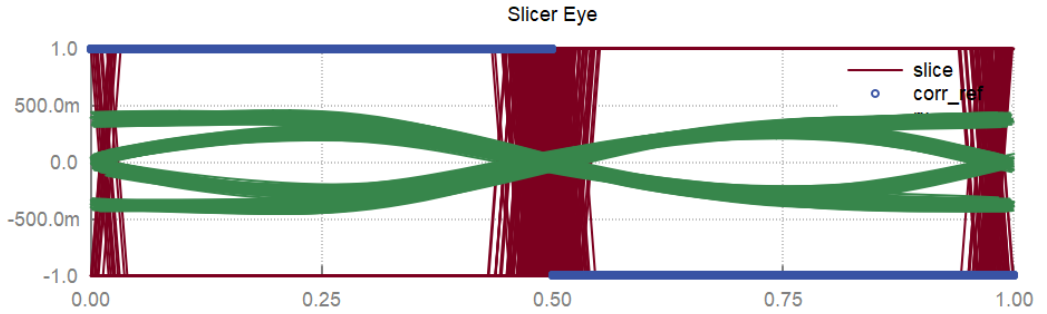

Slicer - Start of RX
slice
RX
TX
1.0
500.0m
0.0
-500.0m
-1.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0


Slicer - End of RX
slice
RX
TX
1.0
500.0m
0.0
-500.0m
-1.0
308.0
309.0
310.0
311.0
312.0
313.0


Correlator - Start of RX
slice
corr_ref
corr
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0


Correlator - End of RX
slice
corr_ref
corr
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
308.0
309.0
310.0
311.0
312.0
313.0


Correlator Eye
1.0
750.0m
500.0m
250.0m
0.0
-250.0m
-500.0m
-750.0m
-1.0
0.00
0.25
0.50
0.75
1.00


Slicer Eye
slice
corr_ref
1.0
500.0m
0.0
-500.0m
-1.0
0.00
0.25
0.50
0.75
1.00

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Thank You

https://github.com/SPE-MD/SPMD-Simulations/tree/main/ADI_model

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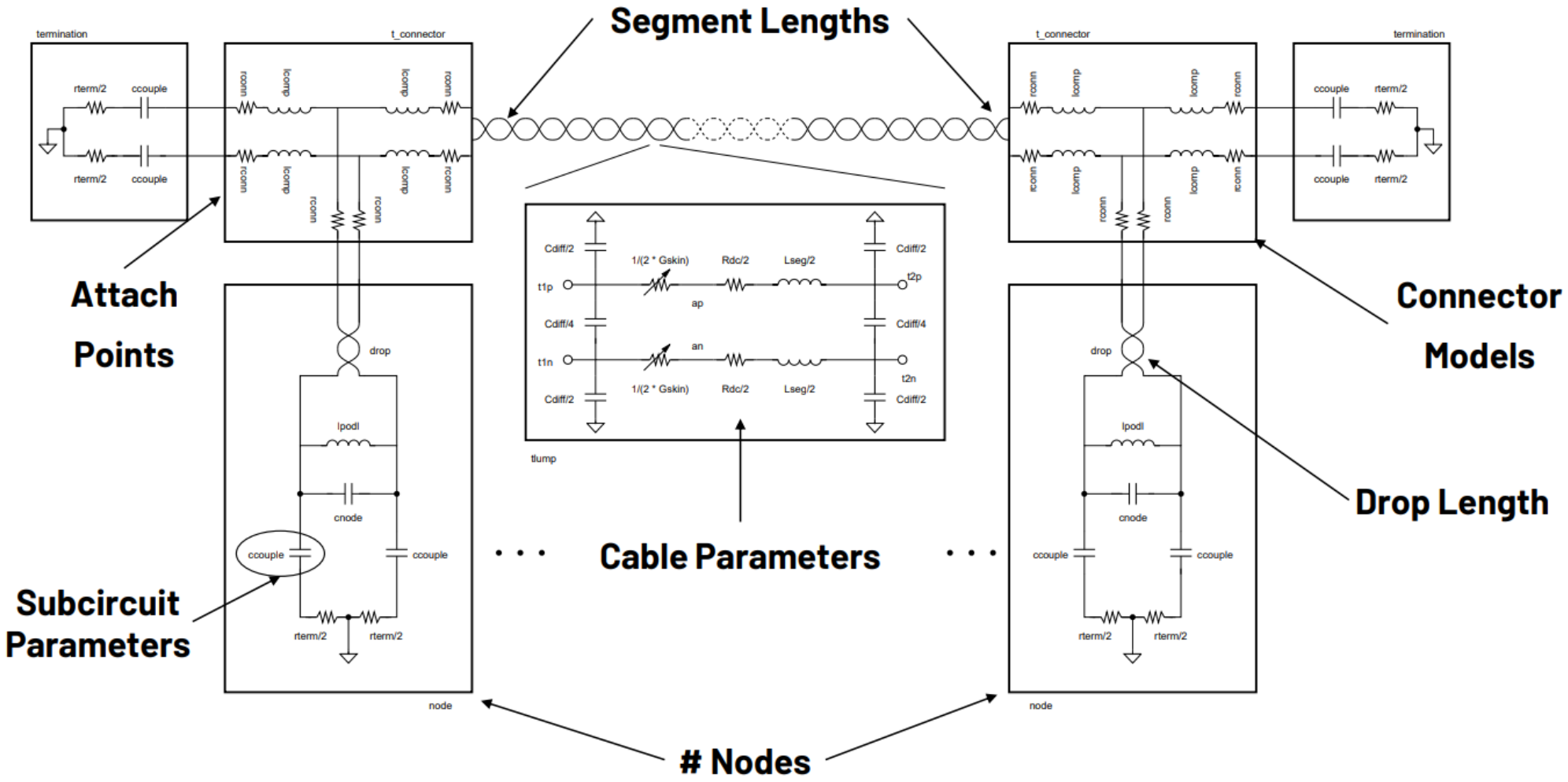
Appendix

Algorithmic Model Assembly



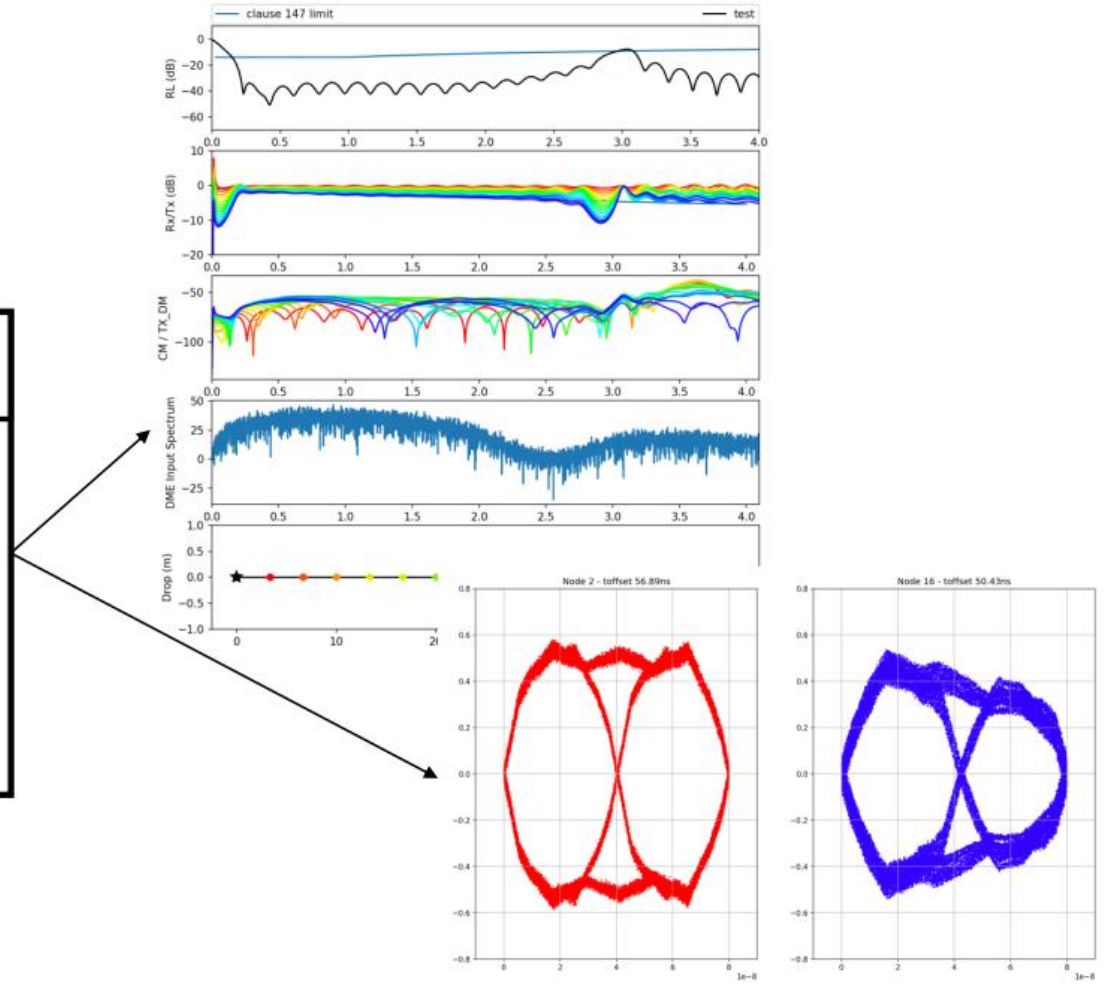
Running the Model

Configure System (.json)

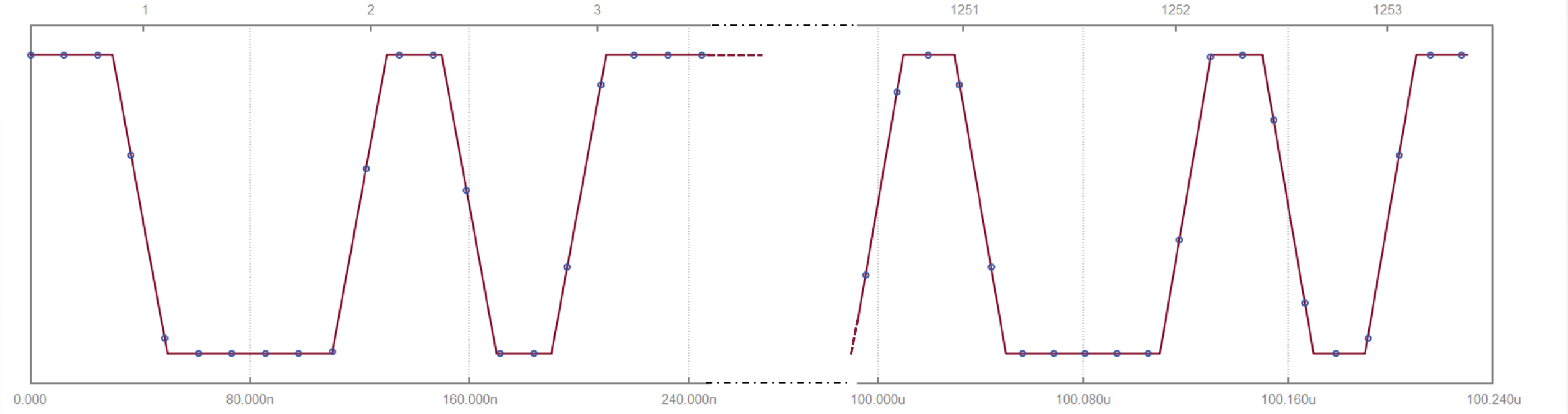
e.g. your_test.json

python cmodel.py –json=your_test.json

- Build netlist
- Run LTSpice
- Extract + Process Data



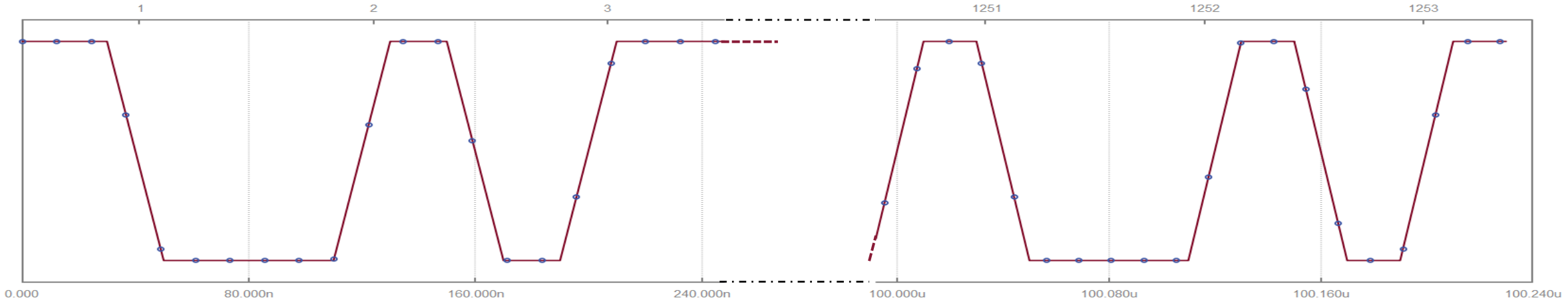
Sample Parameter Setup



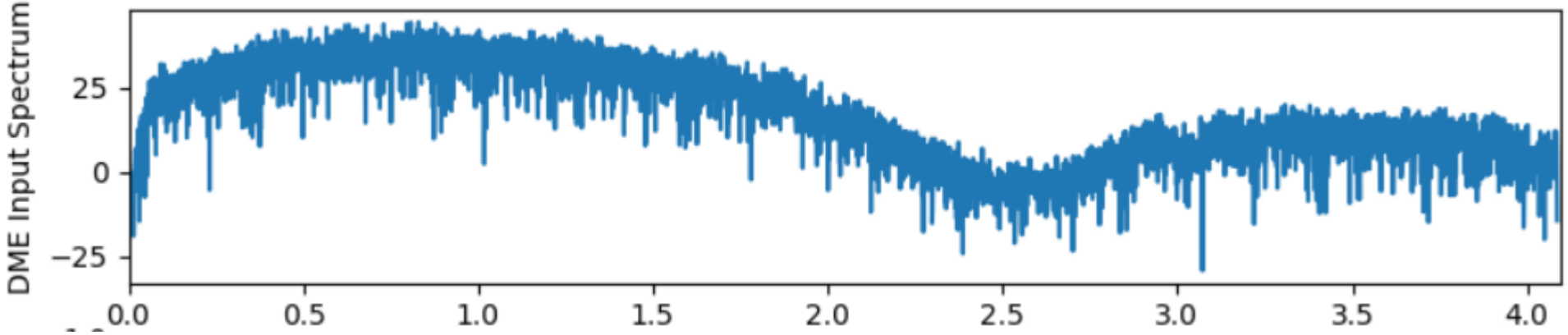
- Coherent Sample a DME Signal
  - 8192 samples
  - 1253 bit periods
  - 8192 / 1253 * 80ns = Fs
    - Fs = 81.723MHz
  - Nyquist Frequency = 40.861MHz

- Align AC analysis with Coherent Samples
  - .ac lin <nsamples> <step_size> <end_freq>
    - `nsamples  = 8192 / 2  = 4096`
    - `step_size = Fs / 8192 = 9.976k`
    - `end_freq  = Fs / 2    = 40.861MHz`

Create Frequency Domain Signal

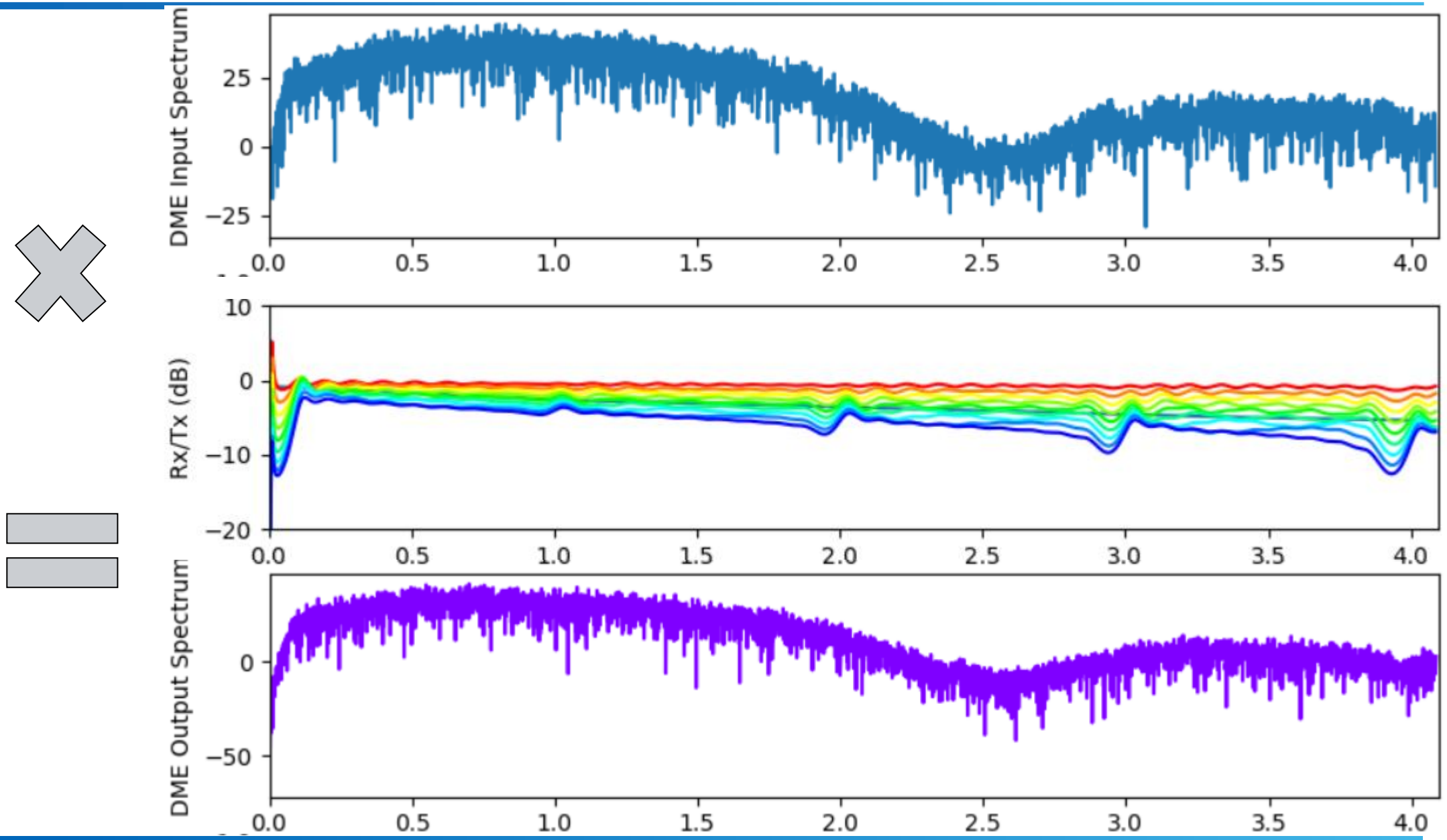


FFT

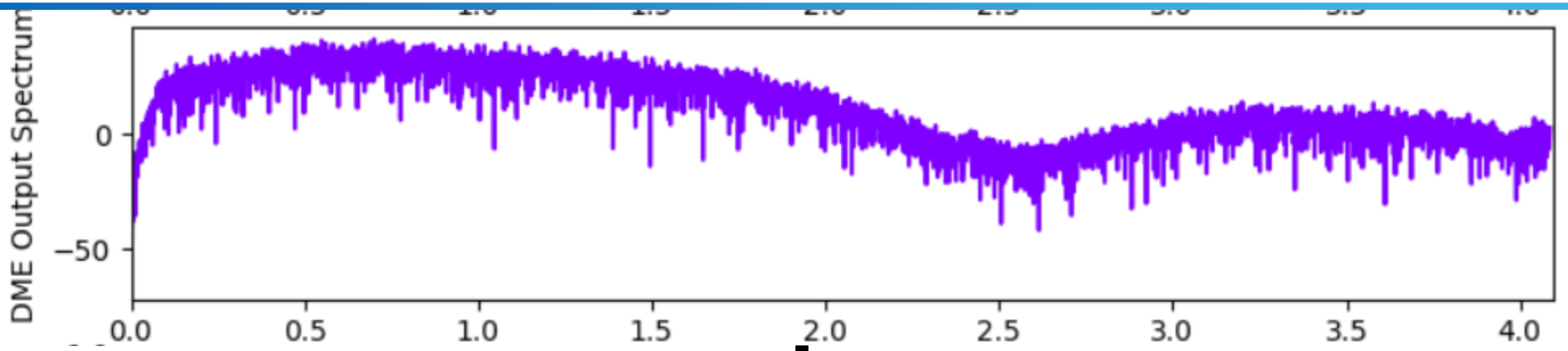


x10MHz

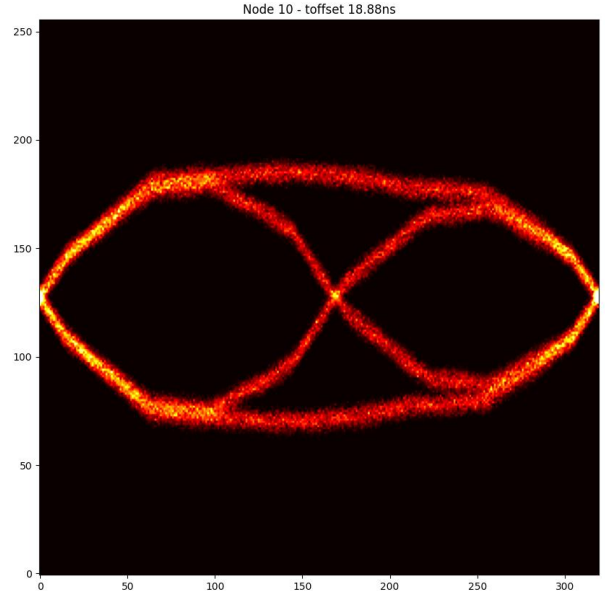
Transform Input Signal by Gain to Different Nodes



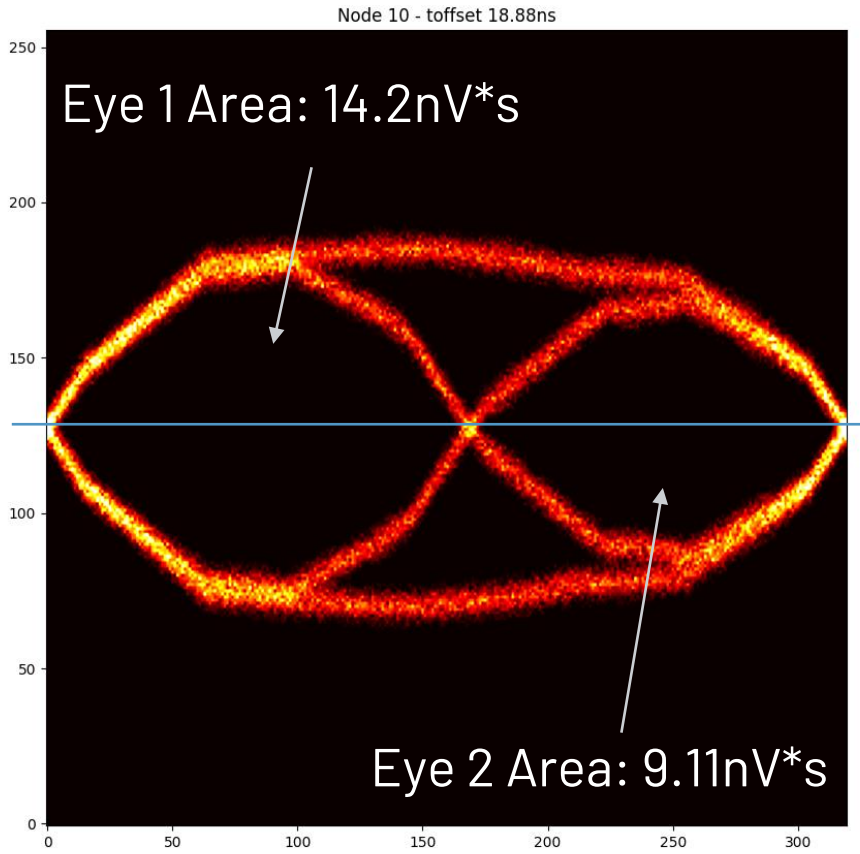
Recover Time Domain Signal at Node X



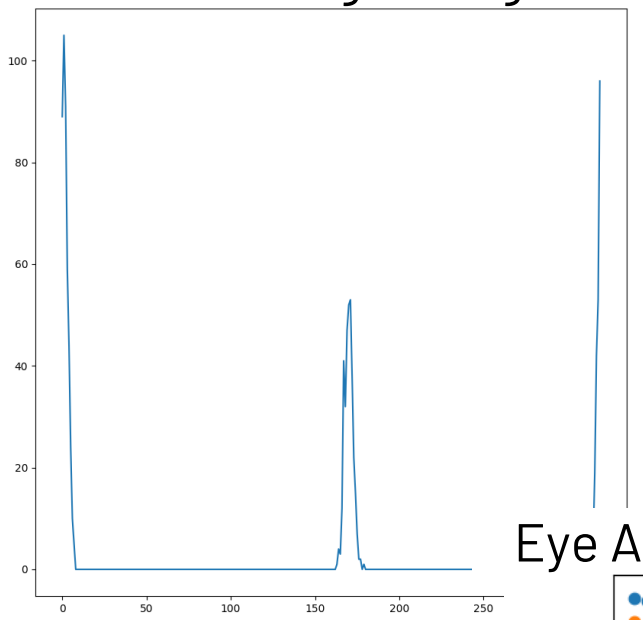
iFFT



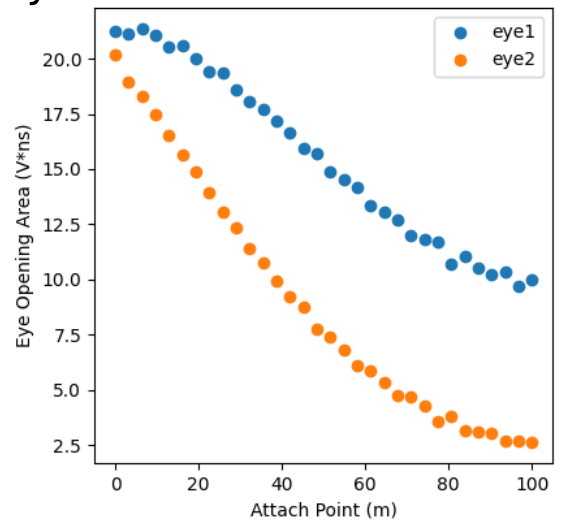
Eye Diagrams are 2D Histograms



Zero Crossing Histogram



Eye Area vs Attach Point



- Histogram eye output enables easier analysis
- Generate figures of merit