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IEEE 802.3da - Consensus Model Simulations

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Outline

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- Investigation on consensus model implementation
  - https://github.com/SPE-MD/SPMD-Simulations [1]
  - Evaluation of simulation results in conjunction with already presented results
    - https://www.ieee802.org/3/da/public/022223/diminico_SPMD_01_0223.pdf [2]
      - https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf [3]
      - https://www.ieee802.org/3/da/public/0922/diminico_SPMD_01_09142022.pdf [4]
      - https://www.ieee802.org/3/da/public/1122/beruto_3da_20221114_emc_noise_margin.pdf [5]
    - https://www.ieee802.org/3/da/public/0922/paul_02_da_09142022.pdf [6]
- Multidrop clumped topology evaluation with a prototype compensated tee
  - Investigation on contribution of stub length, PoDL inductance and parasitic capacitance to correlator result
  - Evaluation of contribution of unloaded, compensated tees to correlator result

Results Simulation 1

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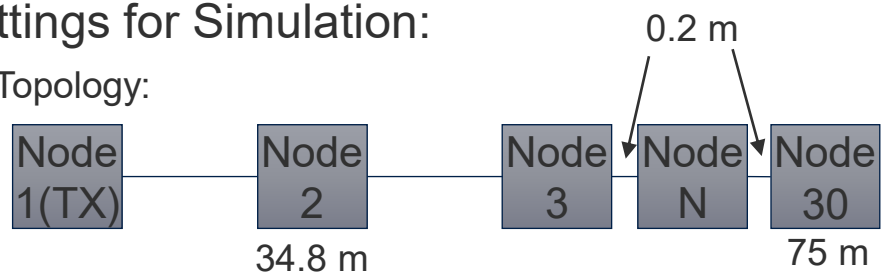
PoDL, Clumped, Uncompensated, Reference: Typical TX Model

- Settings for Simulation:
  - Topology:



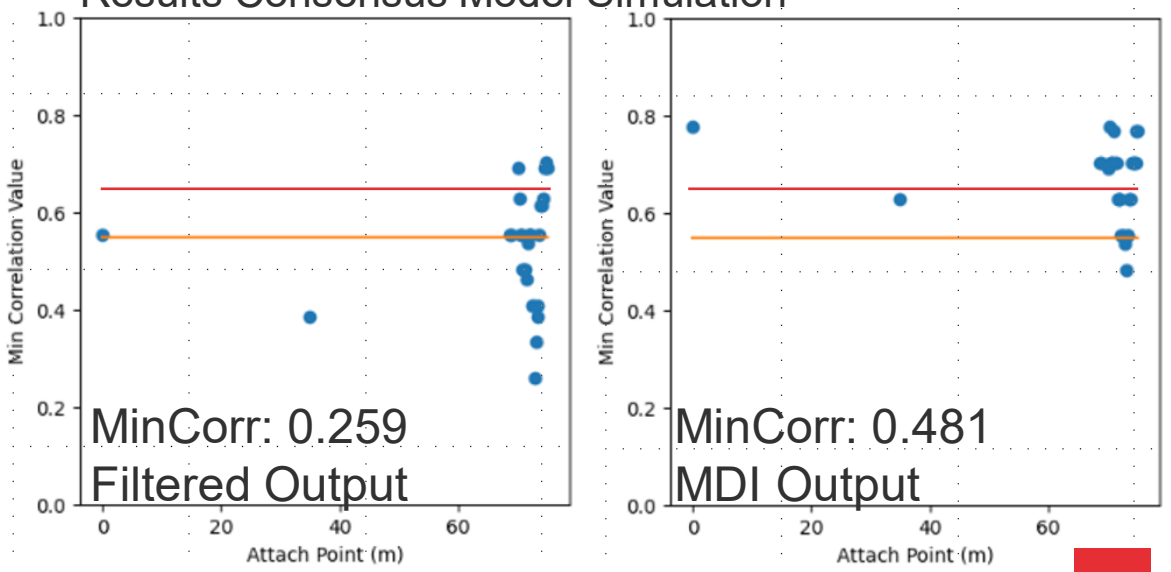
  - Nodes:
    - 30 pF, 80uH PoDL, 10cm Stub, Uncompensated
- Results of Consensus Model Simulation [1]
  - Reference shows a dependency according to CW-Noise, which isn't included in simulation
  - Minimal correlation with no CW-Noise is 0.8 within the reference simulation table
  - Consensus model, which has no CW-Noise, shows a minimal correlation of 0.481, when calculated at the MDI Output
  - By calculating the minimal correlation at the filtered output, the correlation drops to 0.259
  - Both values are below the suggested limit of 0.65

Reference:

CWA (V)	CORR_AVG	CORR_MAX	CORR_MIN	JITTER (ns)	JITTER_MAX (ns)
0	0.960677	1	0.8	1.968523	5
0.05	0.959662	1	0.7625	2.071869	7
0.1	0.956632	1	0.7125	2.303408	9
0.15	0.952067	1	0.65	2.654554	11
0.2	0.945999	1	0.5625	3.105251	13
0.25	0.938646	1	0.4875	3.732132	39
0.3	0.930347	1	0.425	4.686661	39
0.35	0.921262	1	0.4125	5.684006	39
0.4	0.911575	1	0.3875	6.723002	39
0.45	0.90126	1	0.3625	7.974711	39

https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 11

Results Consensus Model Simulation



Results Simulation 1 - Nodes 1 - 10

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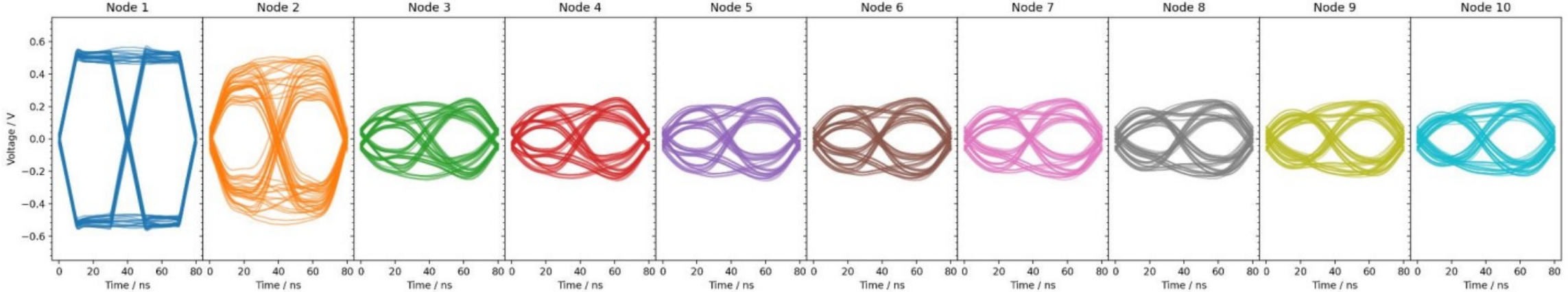
PoDL, Clumped Uncompensated

Eye Filtered

Eye MDI

Ref:



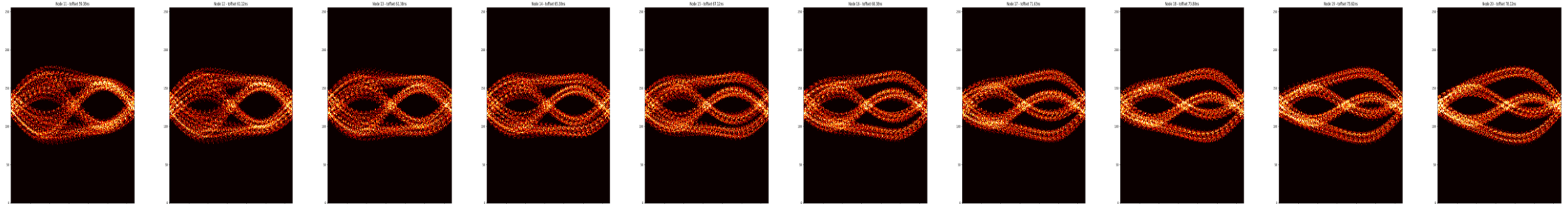
Reference Eyes from: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 10

Results Simulation 1 – Nodes 11 - 20

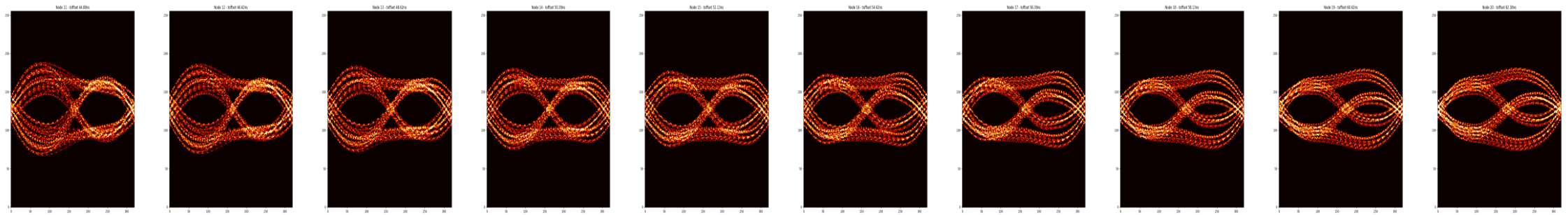
Rosenberger

PoDL, Clumped Uncompensated

Eye Filtered



Eye MDI



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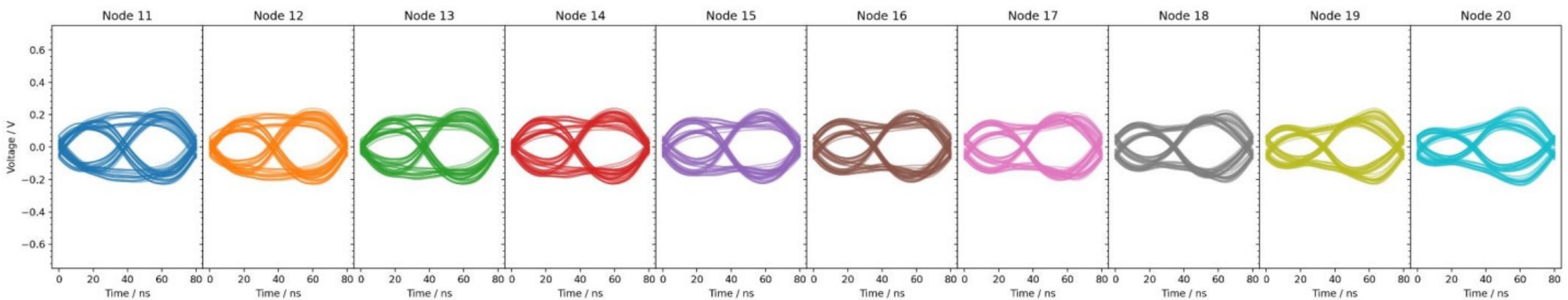

Reference Eyes from: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 10

Results Simulation 1 – Nodes 21 - 30

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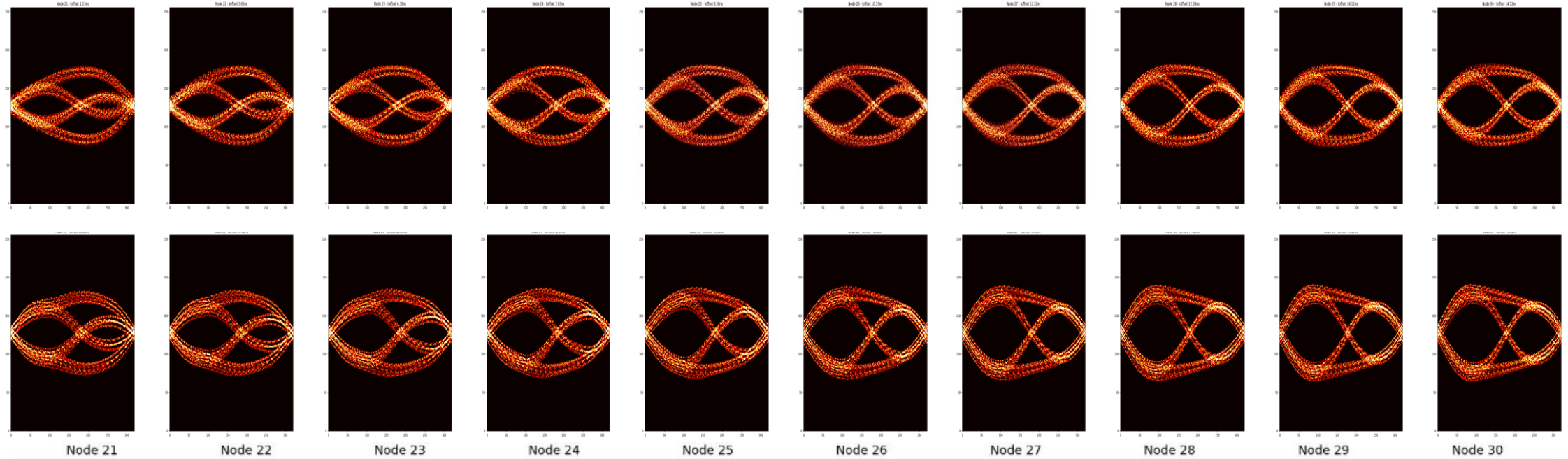
PoDL, Clumped Uncompensated

Eye Filtered

Eye MDI



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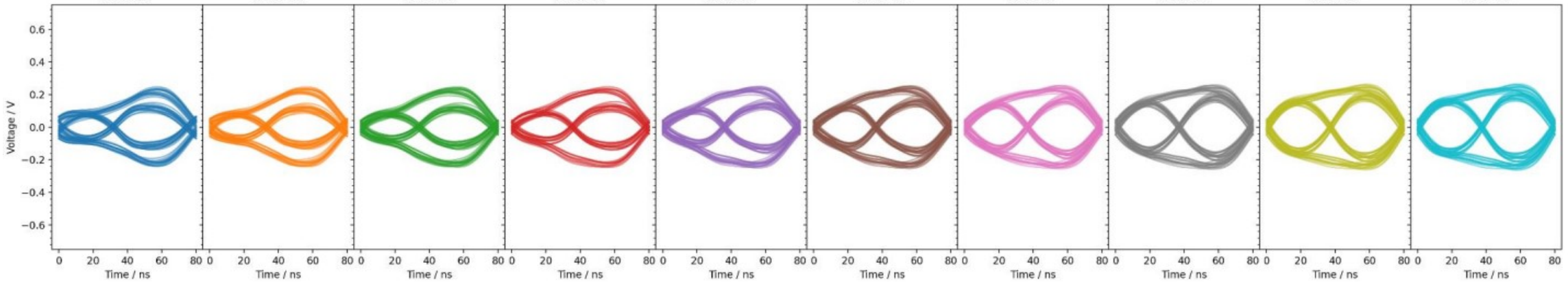

Reference Eyes from: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 10

Results Simulation 2

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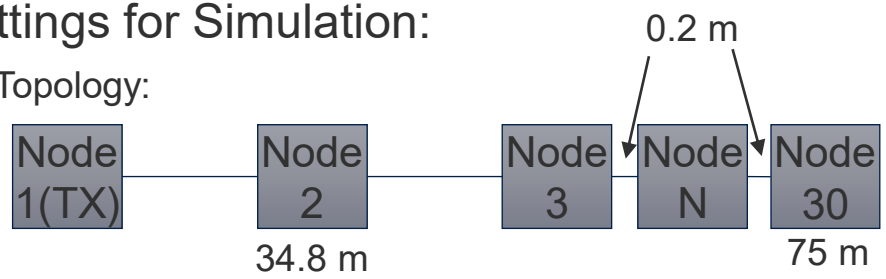
PoDL, Clumped, Compensated, Reference: Typical TX Model

- Settings for Simulation:
  - Topology:



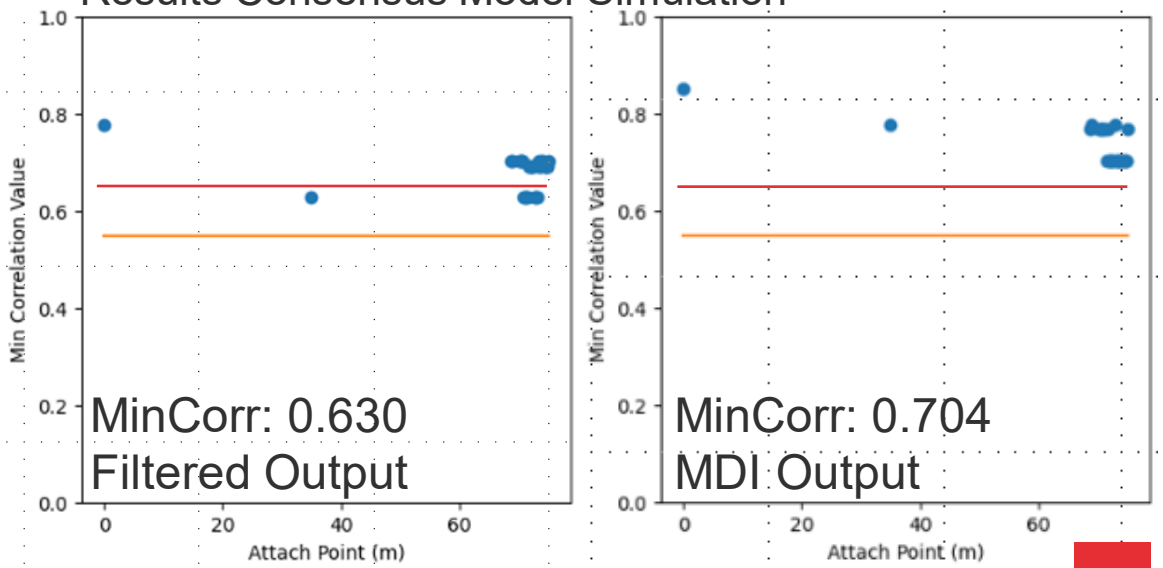
  - Nodes:
    - 30 pF, 80uH PoDL, 10cm Stub, Compensated
- Results of Consensus Model Simulation [1]
  - Reference shows a dependency according to CW-Noise, which isn't included in simulation
  - Minimal correlation with no CW-Noise is 0.8875 within the reference simulation table
  - Consensus model, which has no CW-Noise, shows a minimal correlation of 0.704, when calculated at the MDI Output
  - By calculating the minimal correlation at the filtered output, the correlation drops to 0.630
  - The value of the filtered output are below the suggested limit of 0.65

Reference:

CWA (V)	CORR AVG	CORR MAX	CORR MIN	JITTER (ns)	JITTER MAX (ns)
0	0.975174	1	0.8875	1.964992	6
0.05	0.973562	1	0.8625	2.03217	7
0.1	0.969372	1	0.825	2.241924	9
0.15	0.963706	1	0.775	2.545944	11
0.2	0.956932	1	0.75	2.935691	13
0.25	0.949302	1	0.7	3.388988	16
0.3	0.941119	1	0.65	3.902001	19
0.35	0.932468	1	0.55	4.465008	24
0.4	0.923128	1	0.4875	5.143244	39
0.45	0.913067	1	0.4625	6.092328	39

https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 11

Results Consensus Model Simulation



Differences to reference simulation

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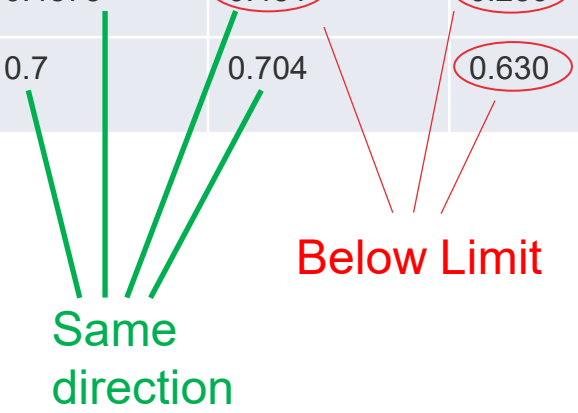
- The minimal correlation at the filtered output of the consensus model are below the suggested limit line of 0.65
- For the reference simulation, both values are above the limit line with a suitable margin
- Eye diagram of node 1 and comment from [4] indicates a difference in the TX-Filter
  - How this is aligned to the “Typical TX Model” statement
- By comparing the reference results with a CWA=0.25 with the consensus model it seems to have the same direction

Simulation	Reference		Consensus Model	
	Minimal Correlation		Minimal Correlation MDI Output	Minimal Correlation Filtered Output
	CWA=0	CWA=0.25		
Uncompensated	0.8	0.4875	0.481	0.259
Ideal Compensated	0.8875	0.7	0.704	0.630



Prototype Tee

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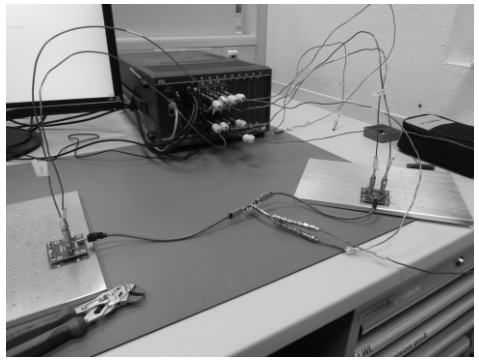
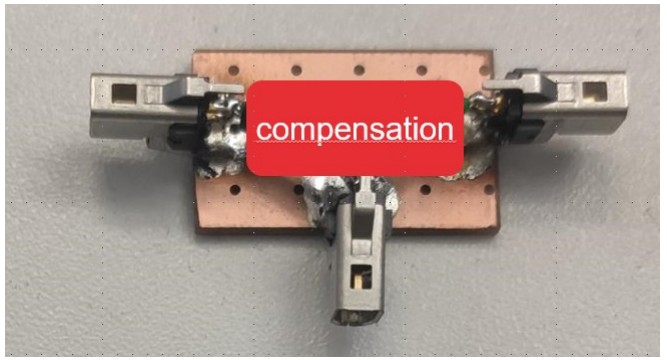
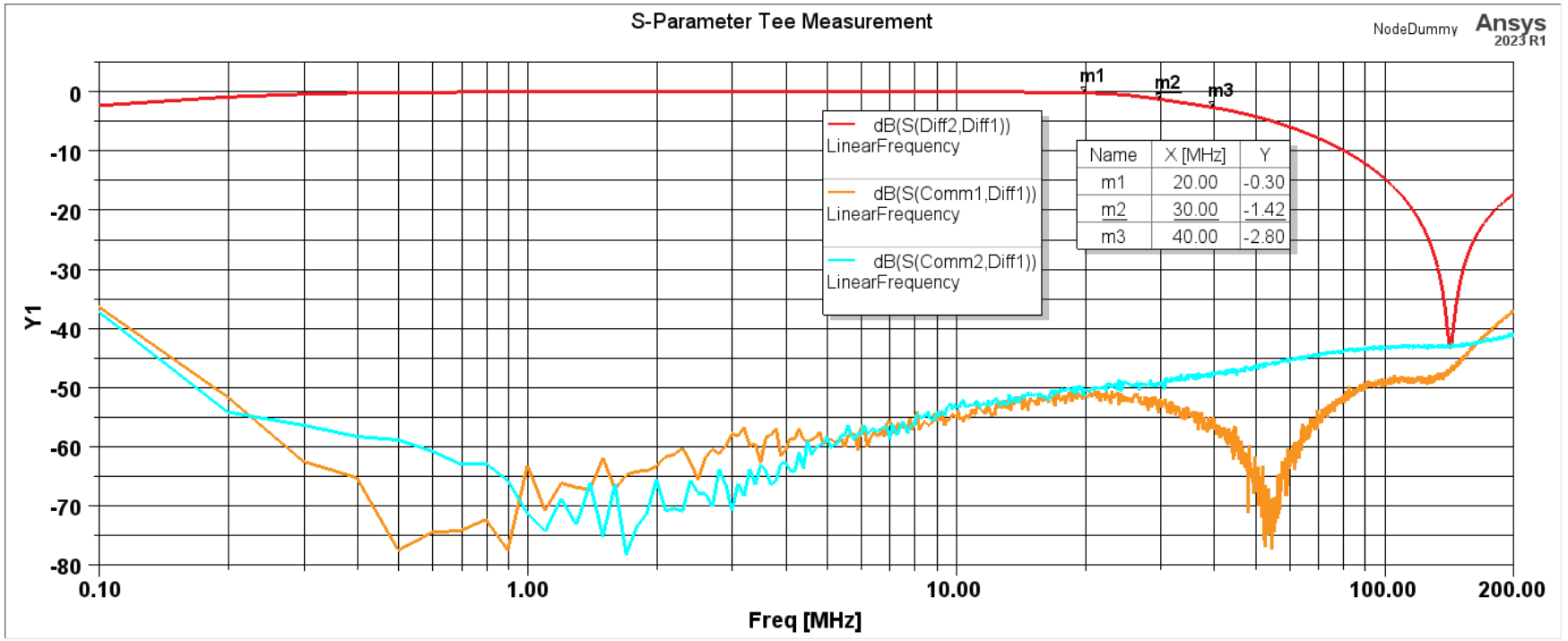
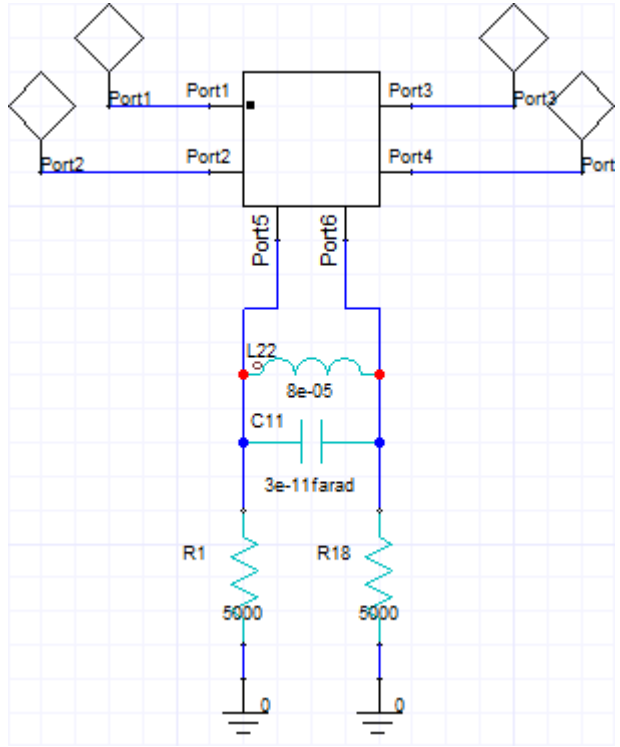
Prototype of a compensated tee

- Very simple soldered prototype
  - Includes compensation components
  - Implementation shows low pass characteristic, which might be beneficial









Results of Prototype Tee – Simulation 3

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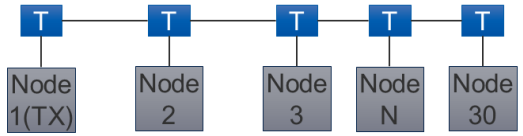
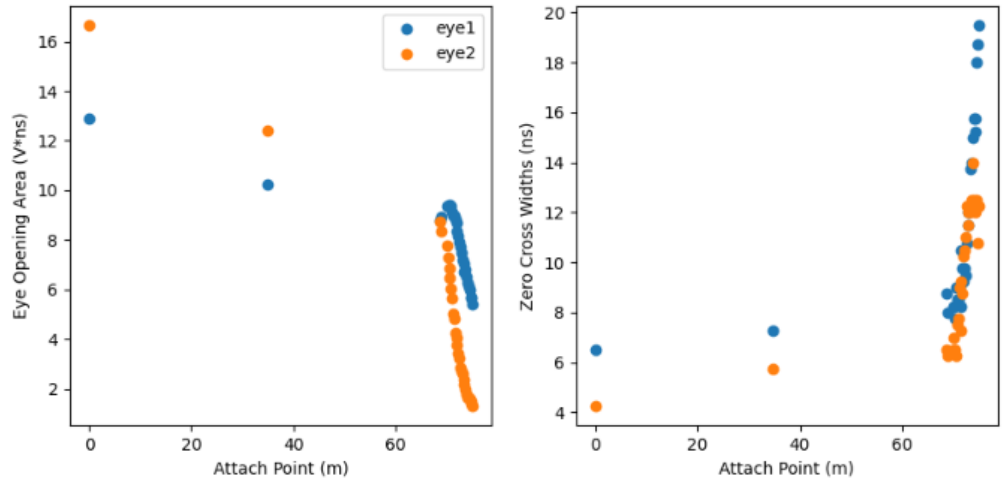
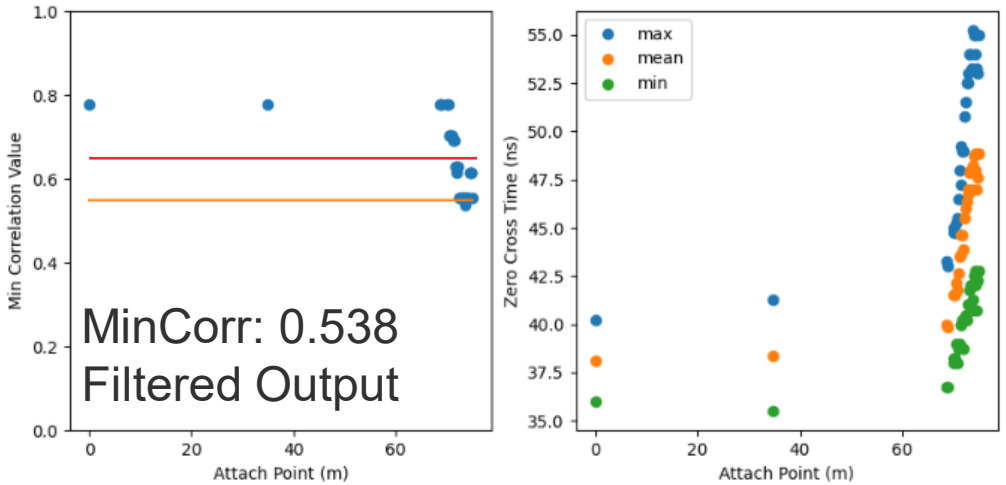
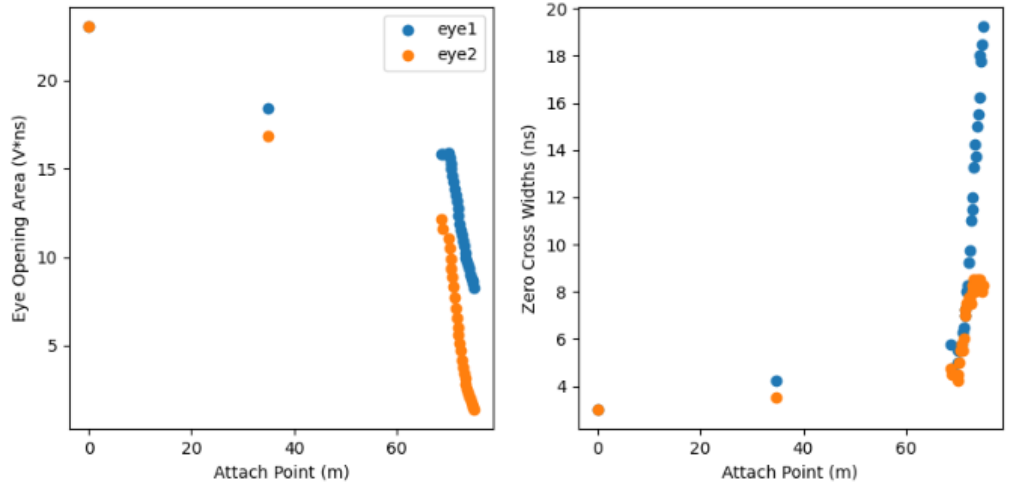
Setting: S-Parameter Tee, Stub 10cm, PoDL 80uH, clumped topology

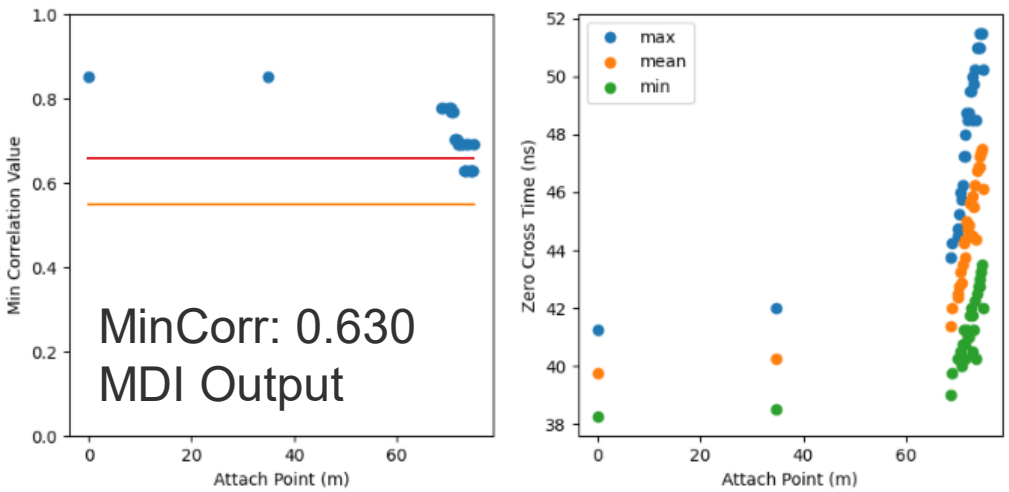
Differences to Simulation 2: S-Parameter Tee











Results of Prototype Tee – Simulation 4

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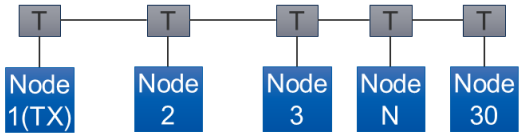
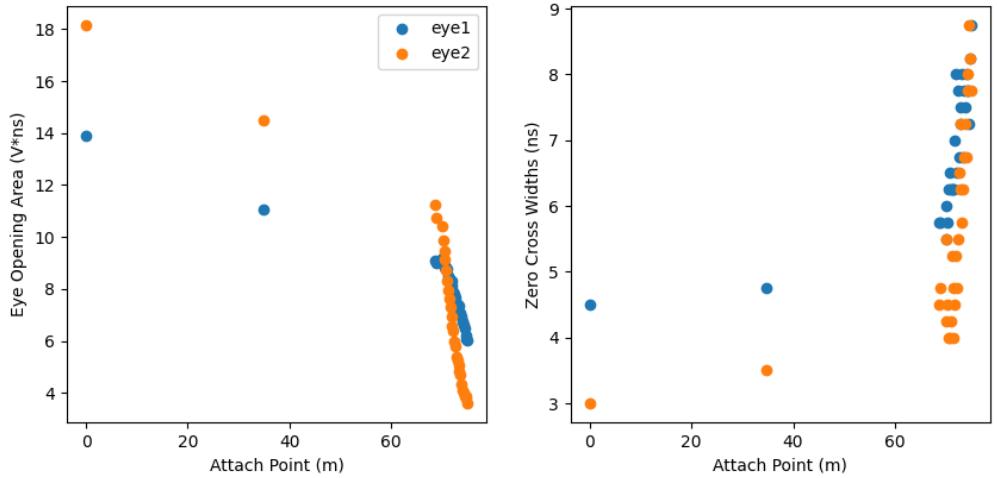
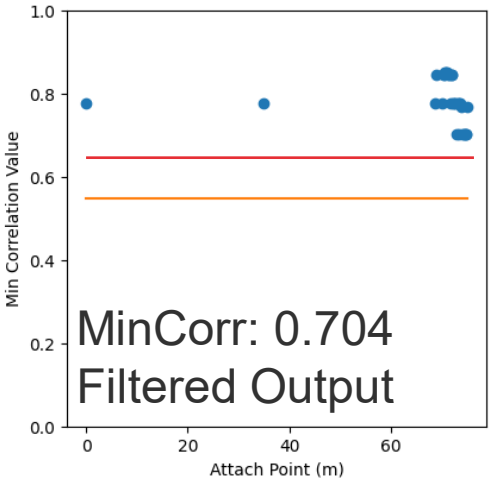
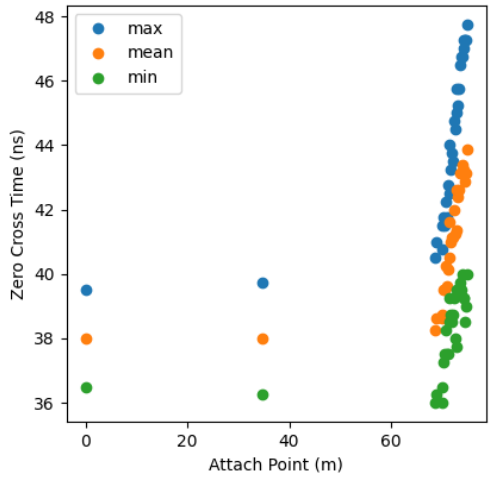
Setting: S-Parameter Tee, Stub 10cm, PoDL 180uH, clumped topology

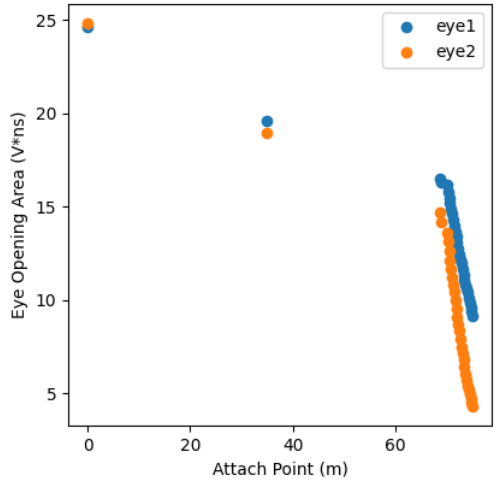
Differences to Simulation 3: PoDL = 180 uH

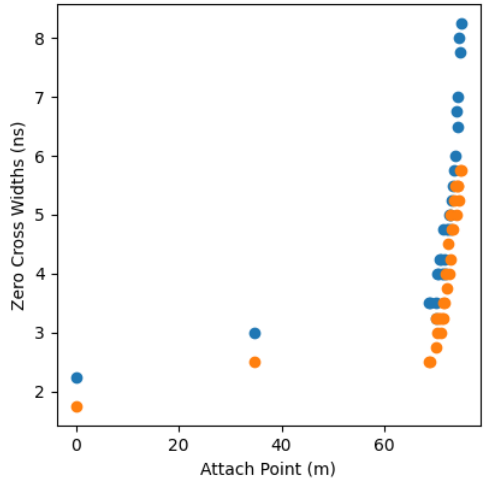


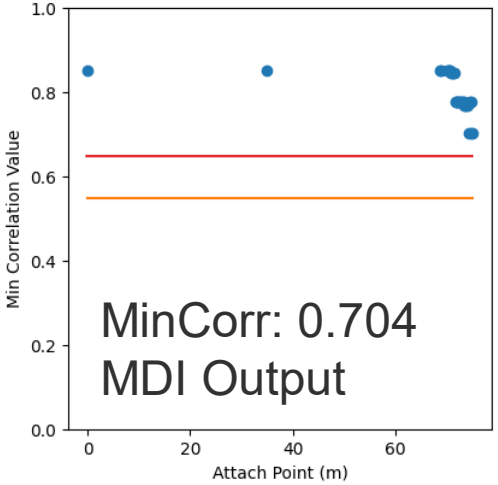


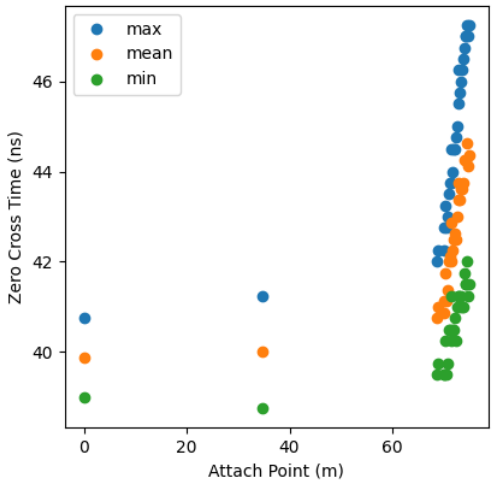












Results of Prototype Tee – Simulation 5

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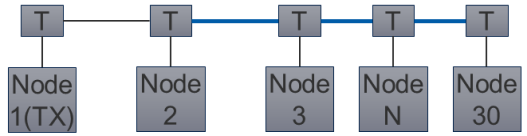
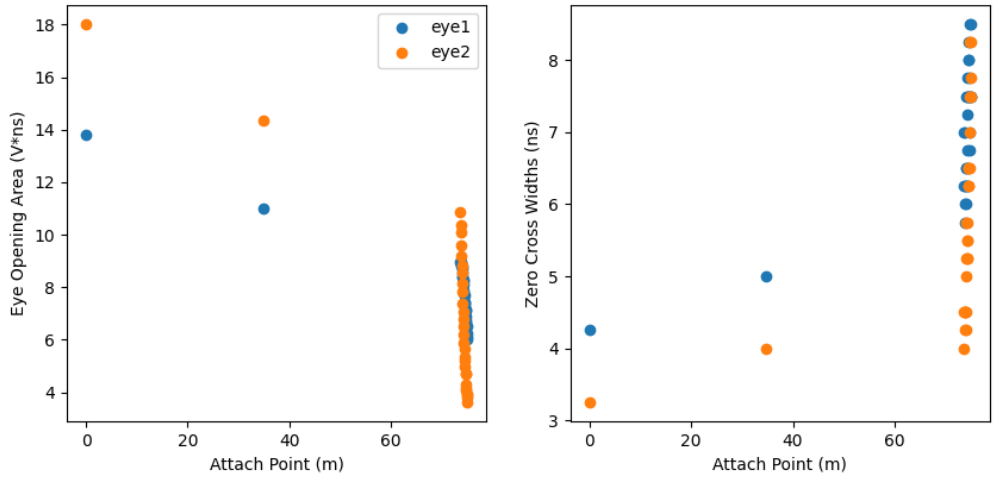
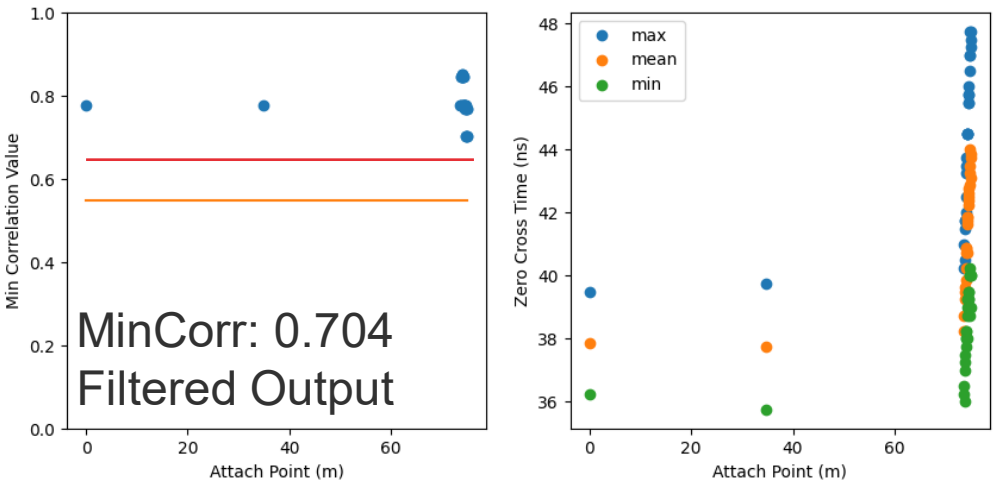
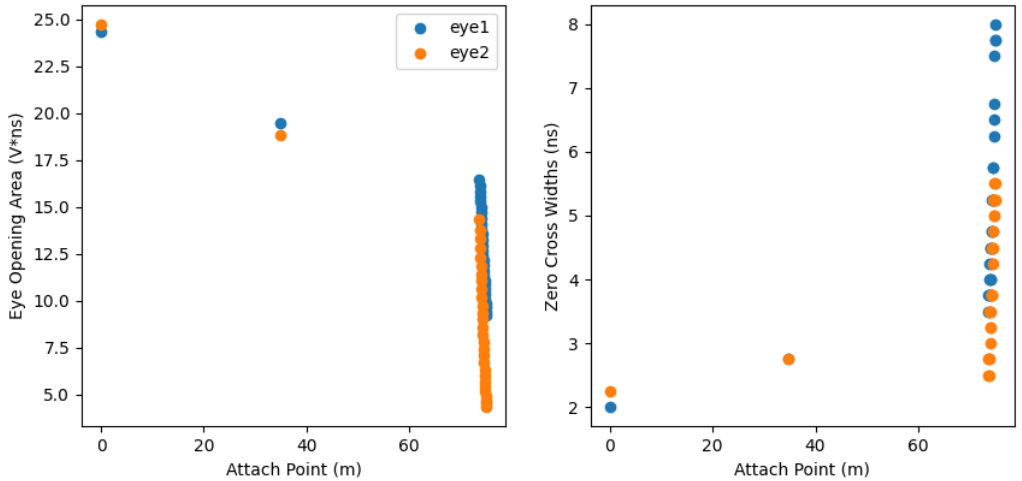
Setting: S-Parameter Tee, Stub 10cm, PoDL 180uH, Adapted clumped distances

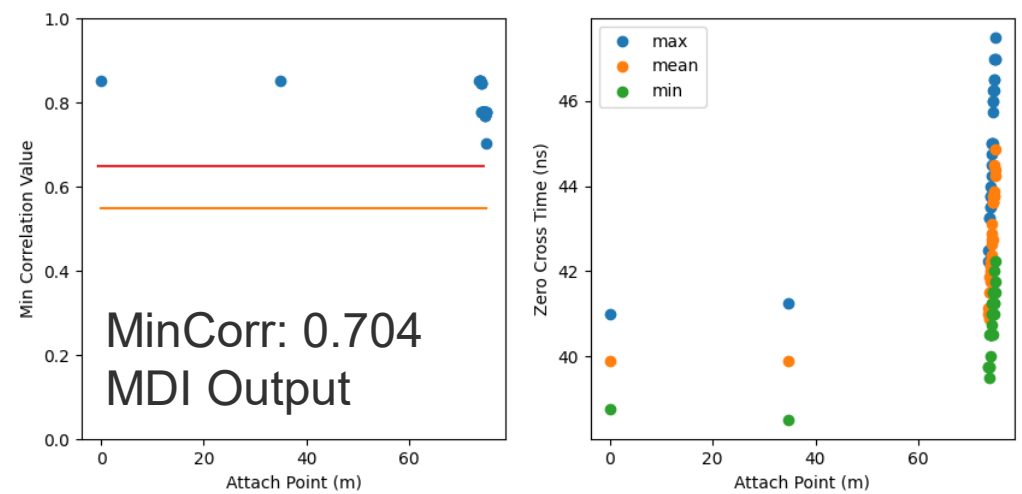
Differences to Simulation 4: Clumped distances reduced to 5cm











Results of Prototype Tee – Simulation 6

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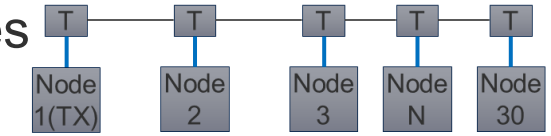
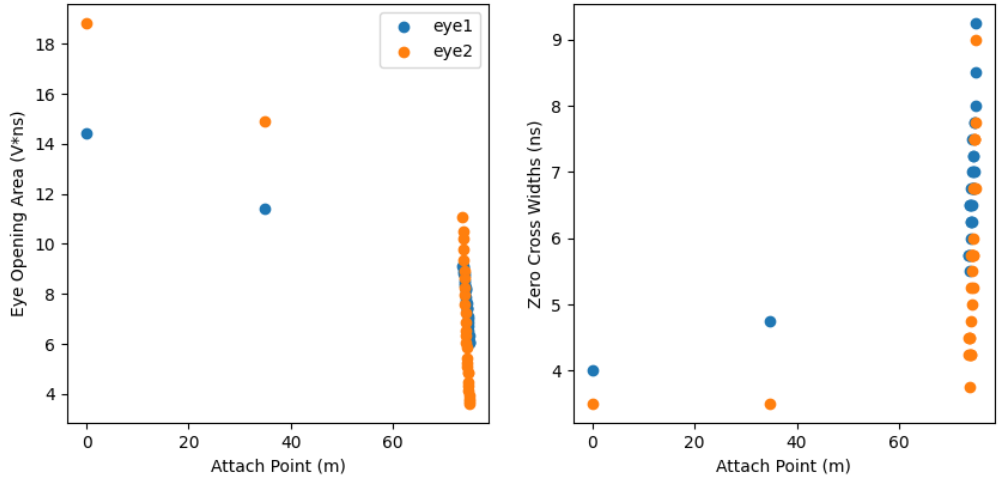
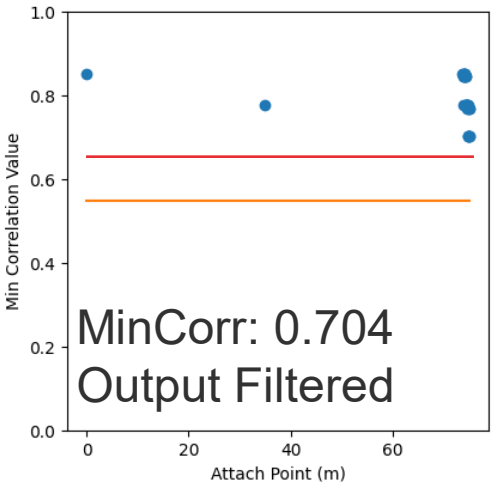
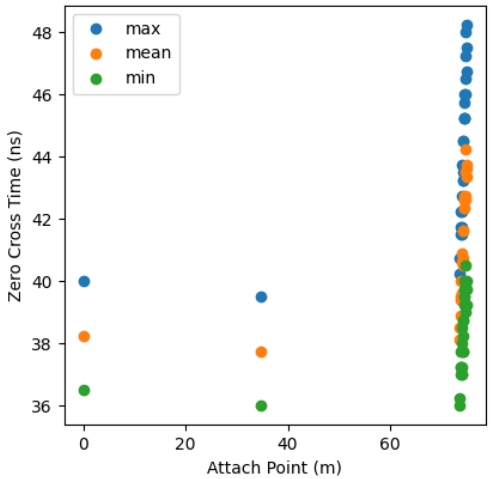
Setting: S-Parameter Tee, Stub 20 cm, PoDL 180uH, Adapted clumped distances

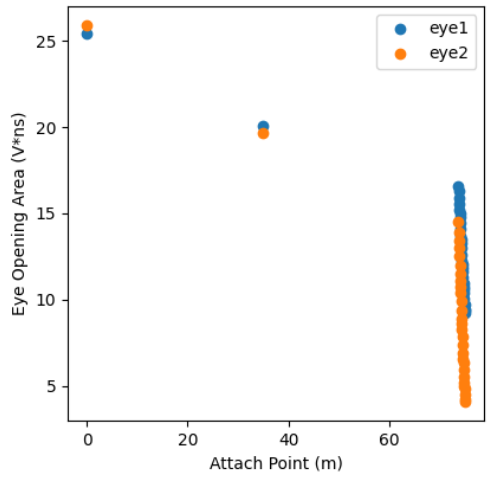
Differences to Simulation 5: Stub = 20 cm

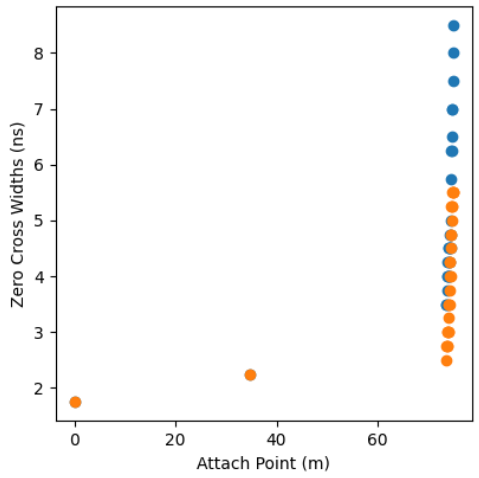


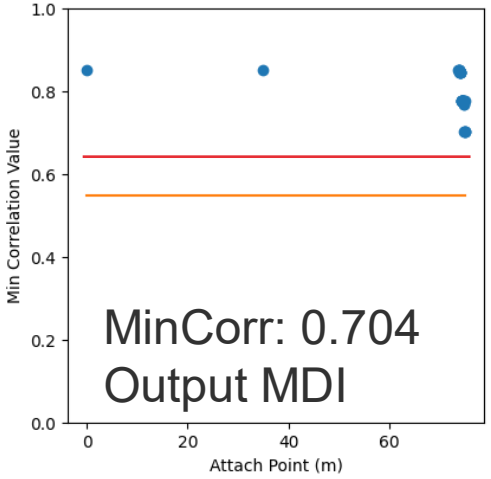


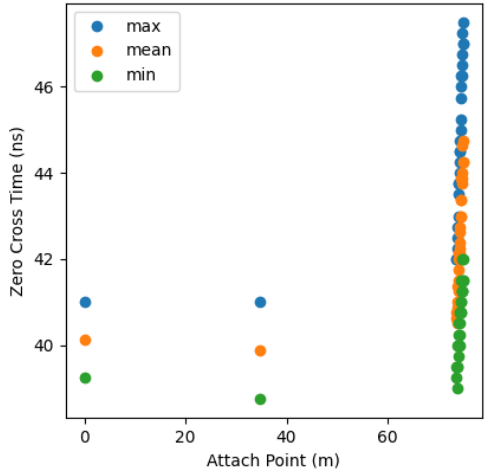












Results of Prototype Tee – Simulation 7

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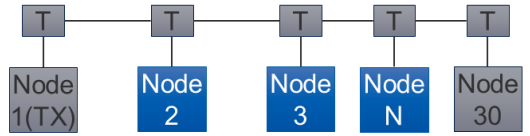
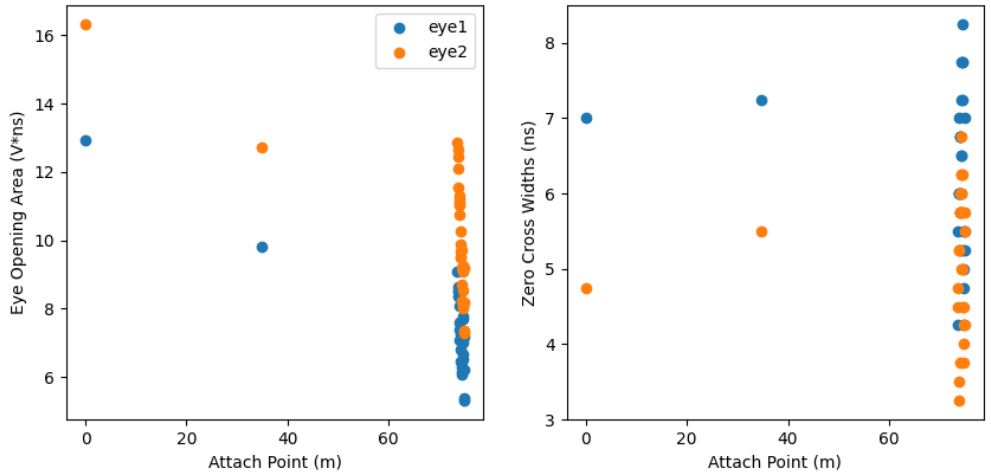
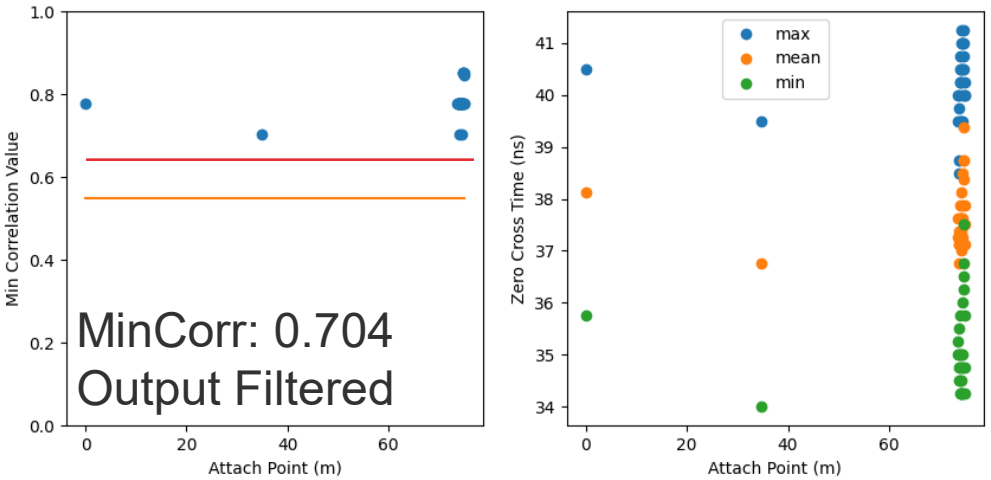
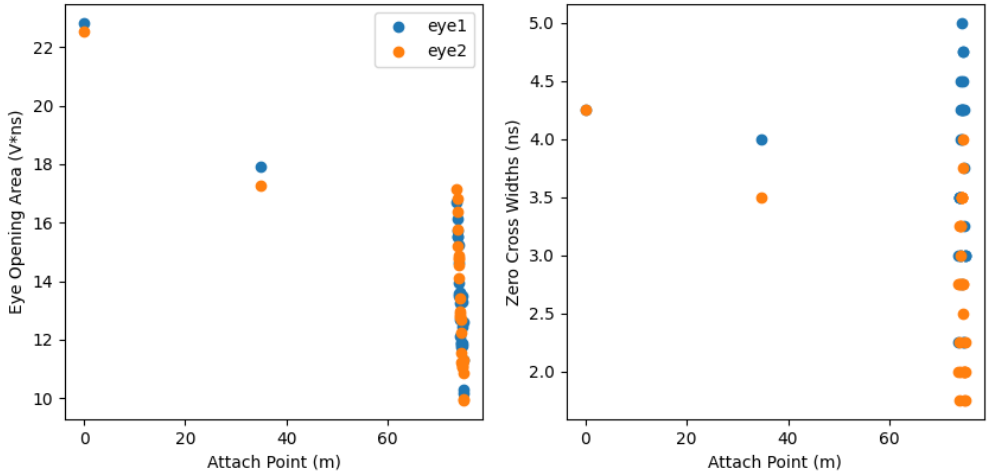
Setting: S-Parameter Tee, Stub 20cm, PoDL 180uH, Mid Nodes unloaded

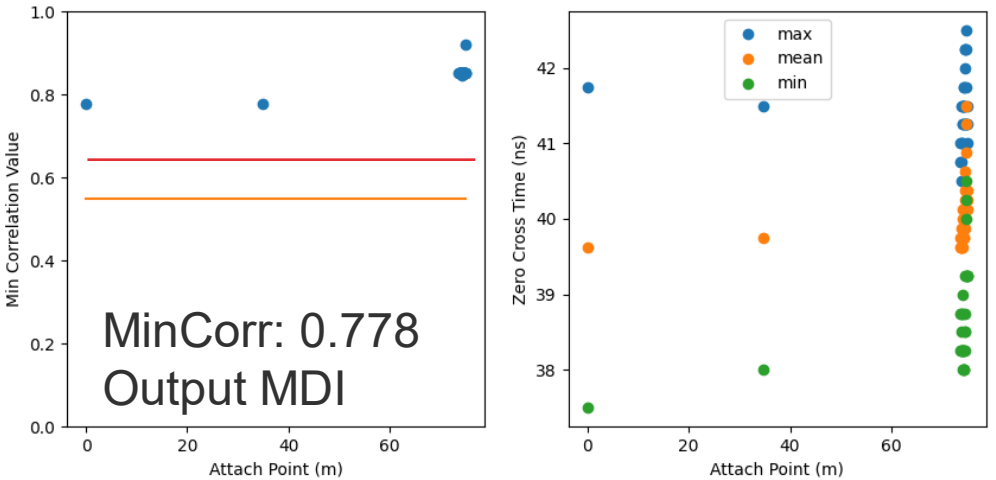
Differences to Simulation 6: Nodes 2 – 29 [0.1pF, PoDL=1H, R=1MΩ]







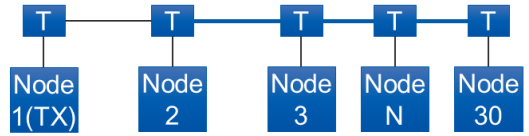




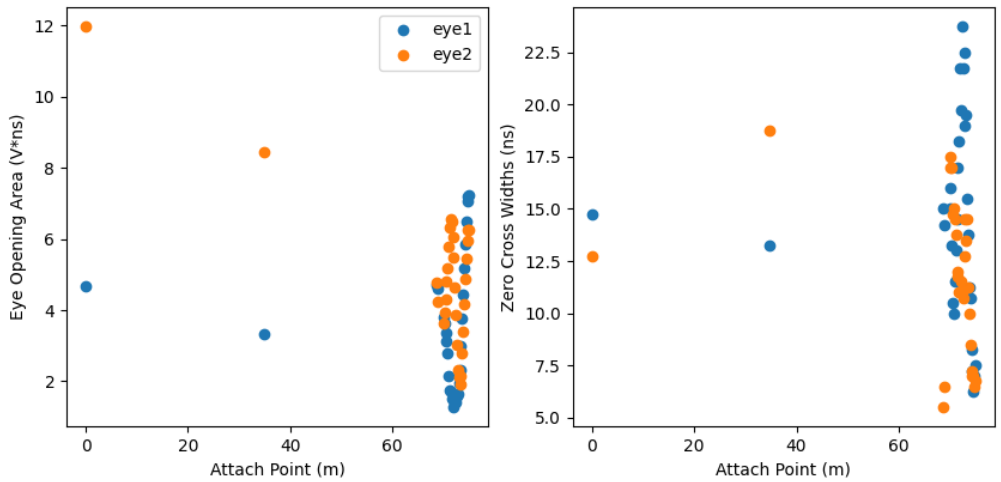
Results Basic Model – Simulation 8

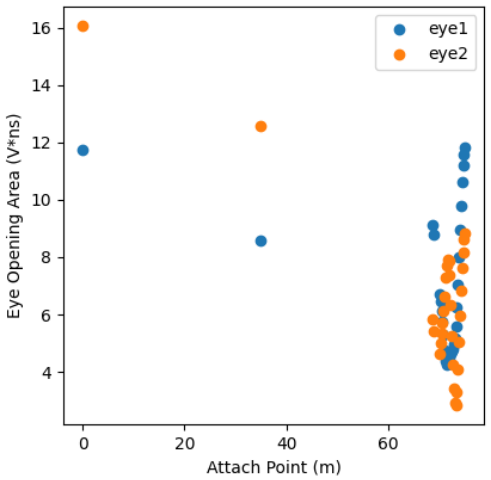
Rosenberger

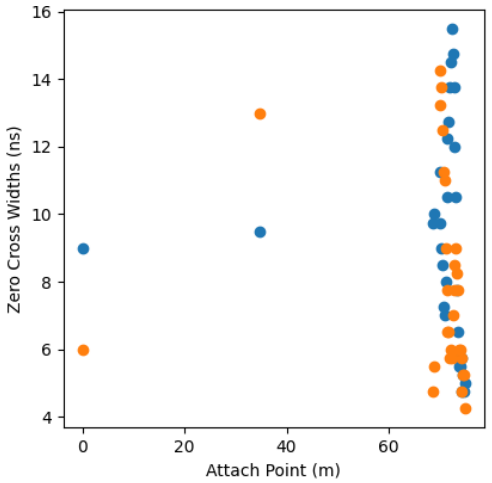
Setting: Uncompensated Tee, Stub 20cm, PoDL 180uH, Clumped Distribution

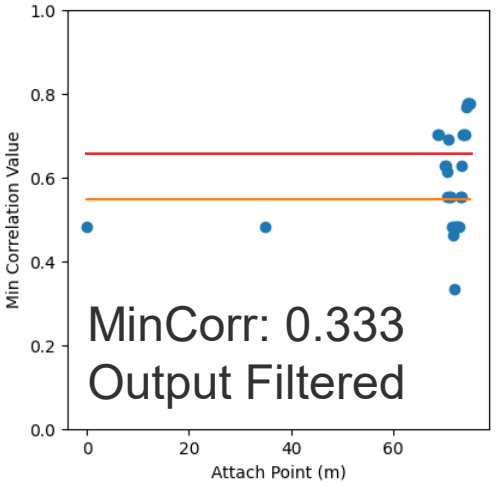


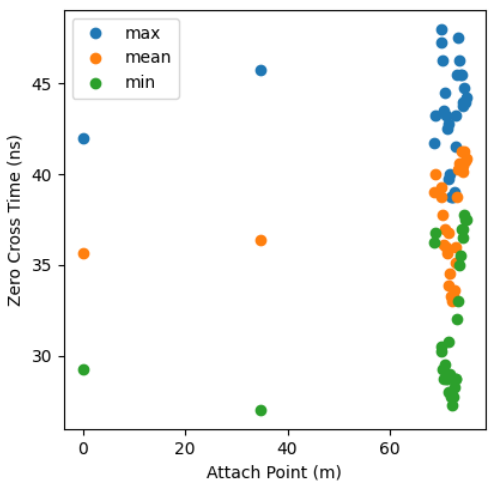
Differences to Simulation 7: Initial Clumped Distribution, Uncompensated Tee, All Nodes 30pF, PoDL 180uH, R=10kΩ

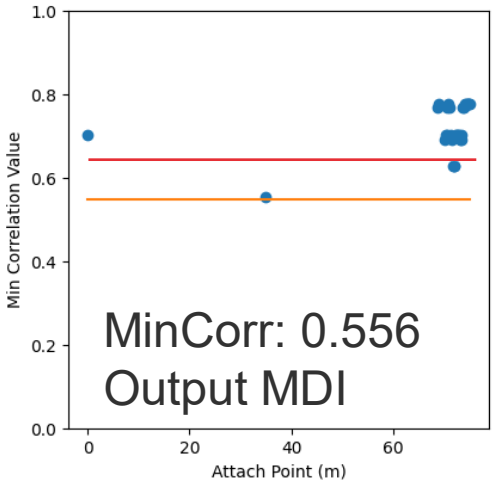












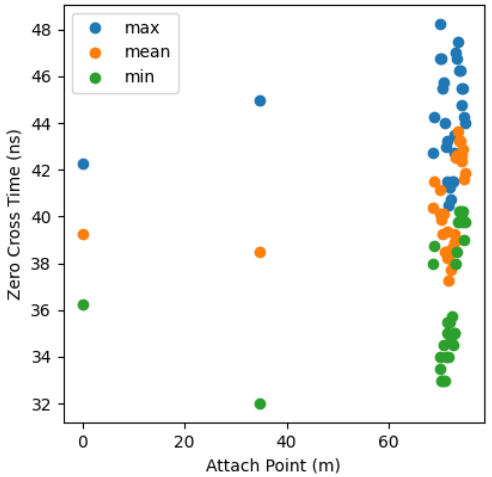


Table of Results

Rosenberger

Sim. Nr.	Topology	Tee	Node Capacity	PoDL Inductance	Stub Length	Min. Corr. MDI	Min. Corr. Filtered
1	Clumped	Default uncompensated	30 pF	80 uH	10 cm	0.481	0.259
2	Clumped	Default compensated	30 pF	80 uH	10 cm	0.704	0.630
3	Clumped	Prototype Tee Compensated	30 pF	80 uH	10 cm	0.630	0.538
4	Clumped	Prototype Tee Compensated	30 pF	180 uH	10 cm	0.704	**0.704**
5	Clumped with reduced distance in clump section	Prototype Tee Compensated	30 pF	180 uH	10 cm	0.704	**0.704**
6	Clumped reduced	Prototype Tee Compensated	30 pF	180 uH	20 cm	0.704	**0.704**
7	Clumped reduced	Prototype Tee Compensated	First Node: 30 pF Last Node: 30 pF Others: 0.1 pF	First Node: 180 uH Last Node: 180 uH Others: 1H	20 cm	0.778	**0.704**
8	Clumped	Default uncompensated	30 pF	180 uH	20 cm	0.556	0.333

Conclusion

Rosenberger

- Consensus model simulations with measured S-Parameters of a prototype tee with integrated compensation elements provide good results.
  - PoDL inductance seems to be a major contributor to signal integrity
  - Correlation results of consensus model become more stable by increasing the PoDL inductance to 180uH and using the S-Parameters of the measured tee
  - Stub length has minor influence
  - First results of unloaded tees are promising but further investigation neccessary, especially the influence of CW-Noise
- Outsourcing the compensation elements within the DTE, might not solve the topology dependent behaviour
- Objectives 4 (Support interoperability with Claus 147 multidrop) and 11 (Support addition and removal of a node or set of nodes to a countinously operationg powered mixing segment) will not be met.

Rosenberger

Thank you for your attention!

Questions?

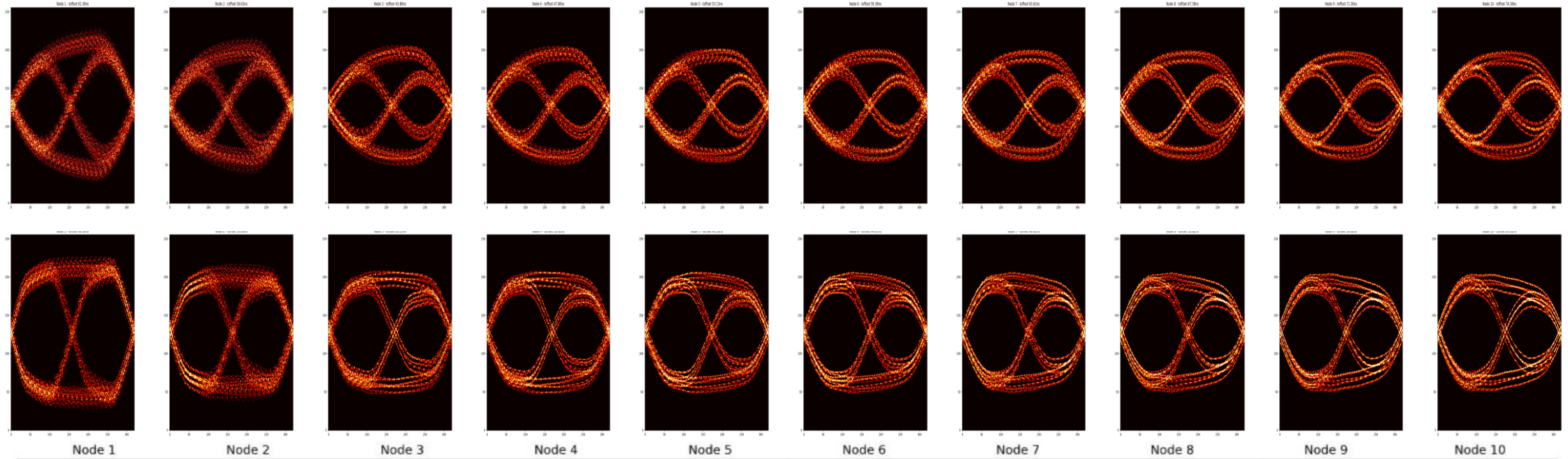
Appendix - Results Simulation 2: Nodes 1 - 10

Rosenberger

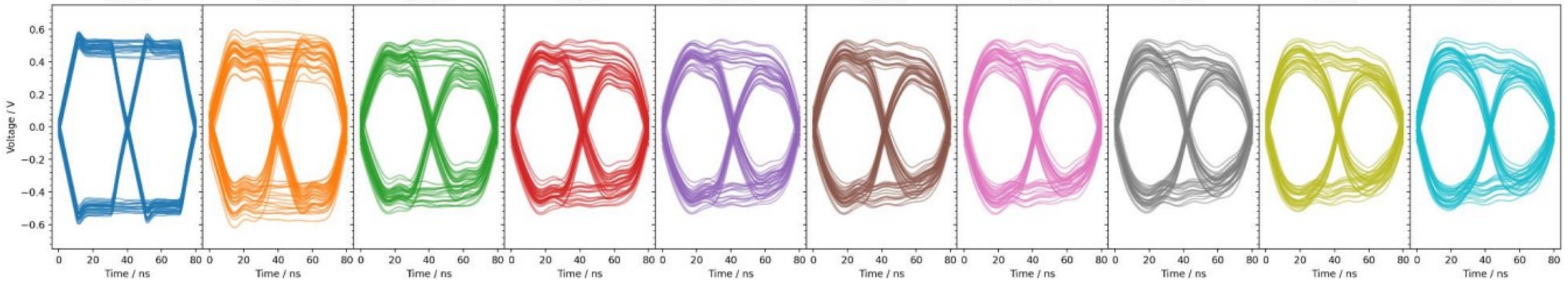
PoDL, Clumped Compensated

Eye Filtered

Eye MDI



Ref:



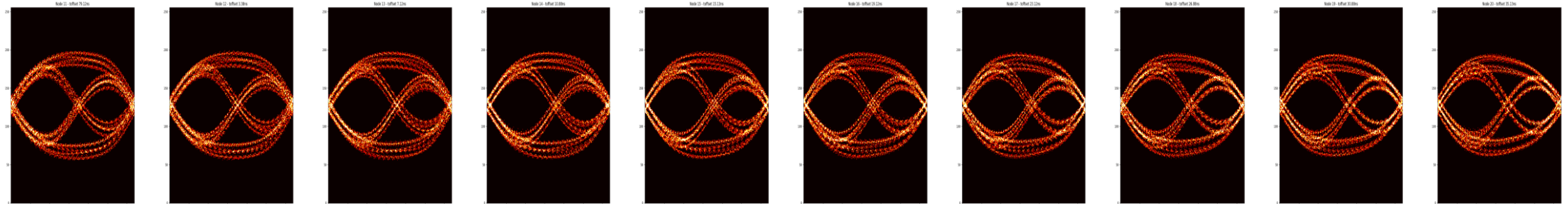
Reference Eyes from: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 16

Appendix - Simulation 2: Nodes 11 - 20

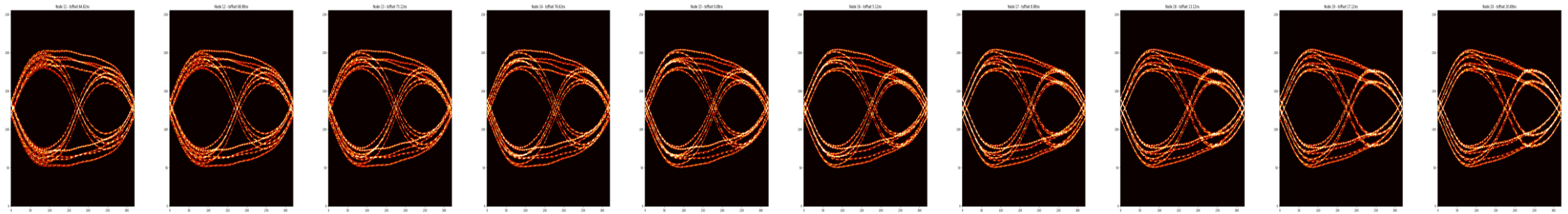
Rosenberger

PoDL, Clumped Compensated

Eye Filtered



Eye MDI



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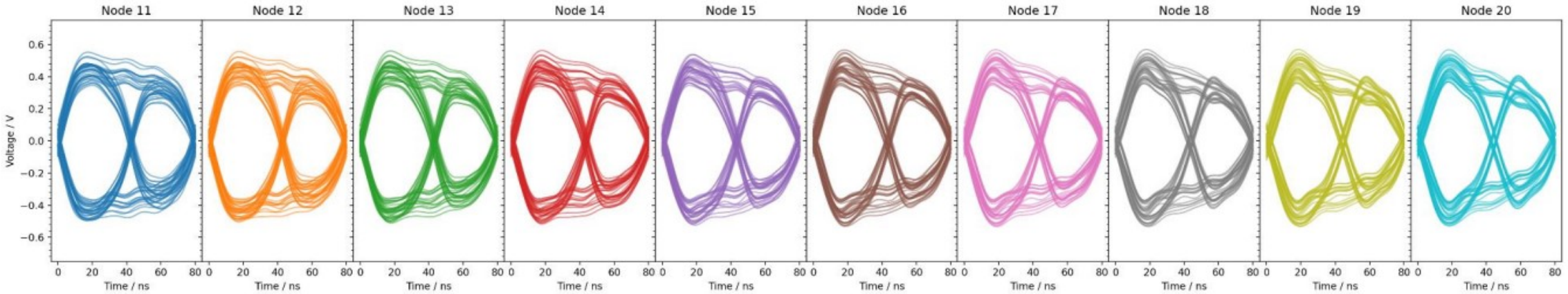


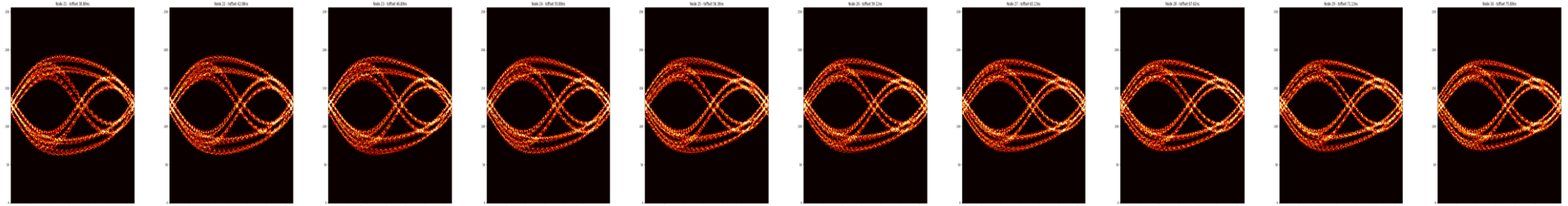
Reference Eyes from: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 16

Appendix - Simulation 2: Nodes 21 - 30

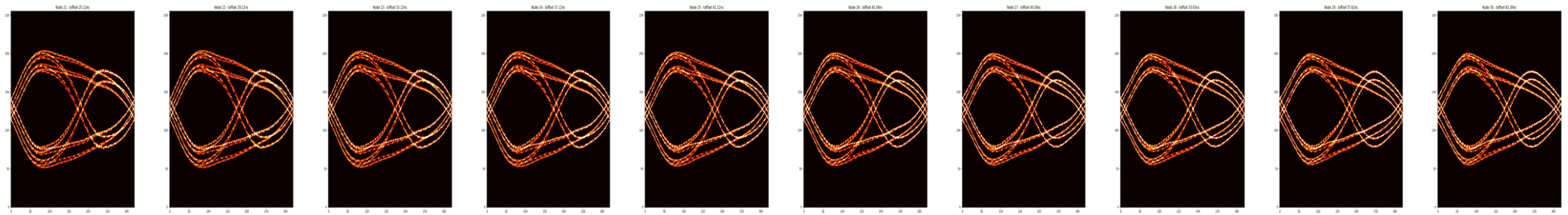
Rosenberger

PoDL, Clumped Compensated

Eye Filtered



Eye MDI



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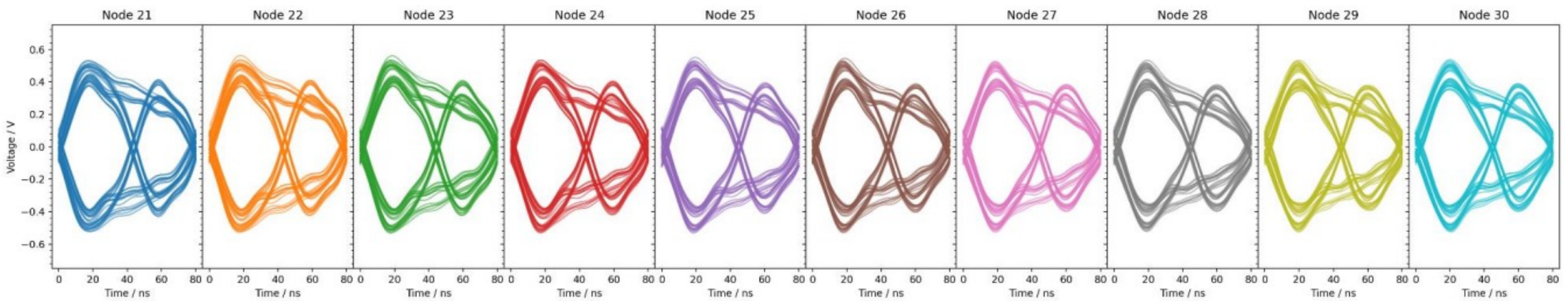
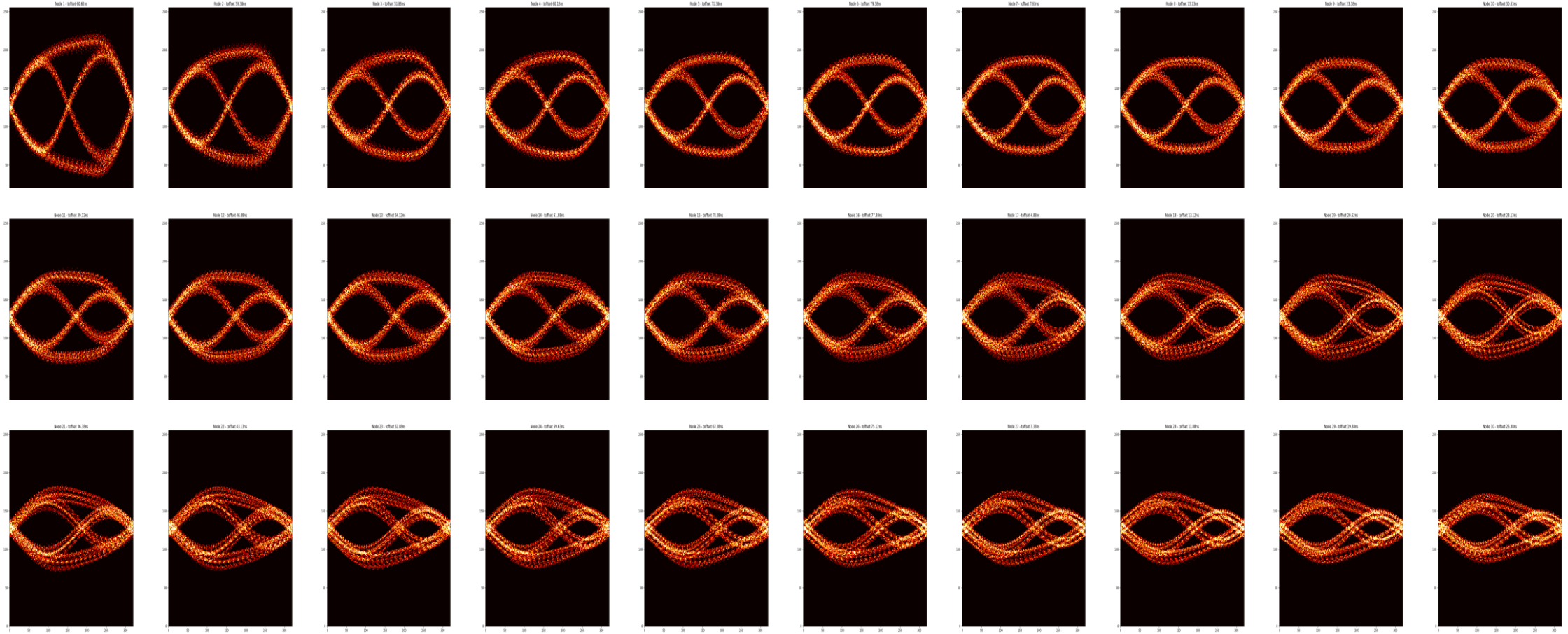


Reference Eyes from: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf, Page 16

Appendix - Results of Prototype – Simulation 3

Rosenberger

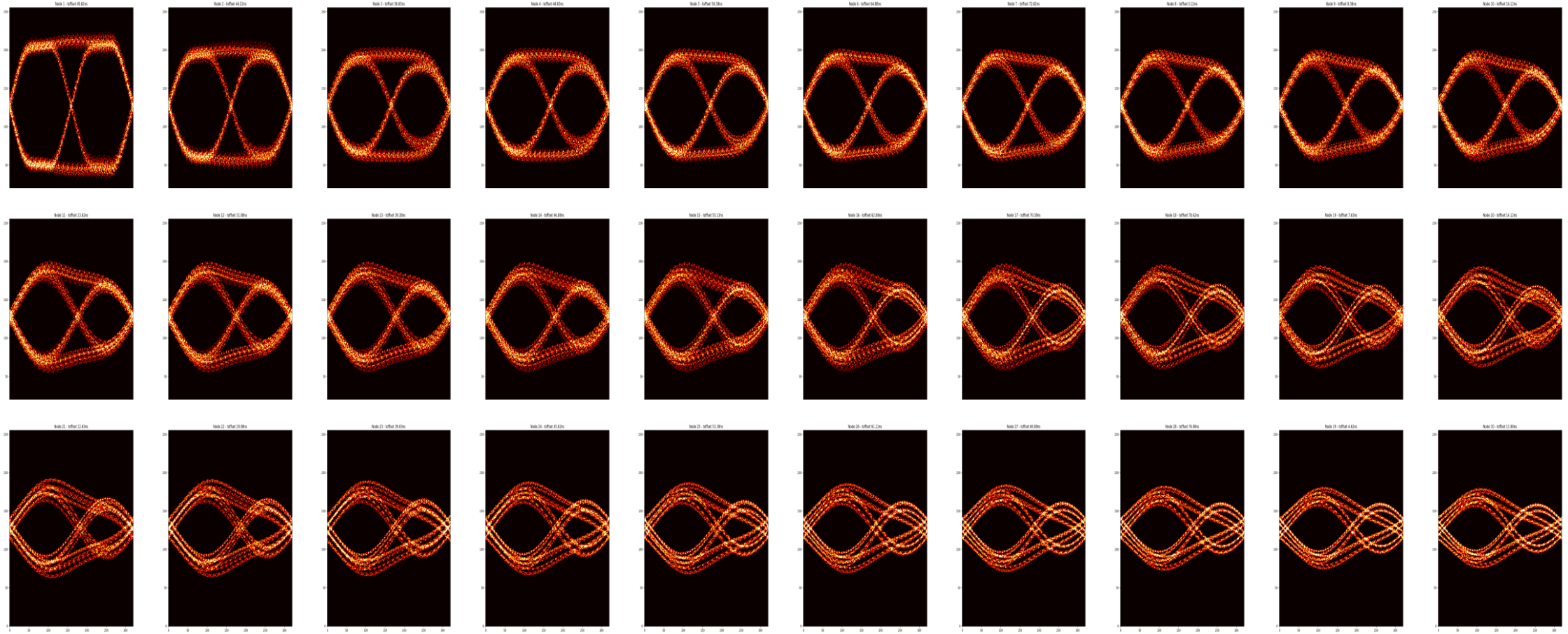
Setting: S-Parameter Tee, Stub 10cm, PoDL 80uH, clumped topology, Eye Filtered



Appendix - Results of Prototype – Simulation 3

Rosenberger

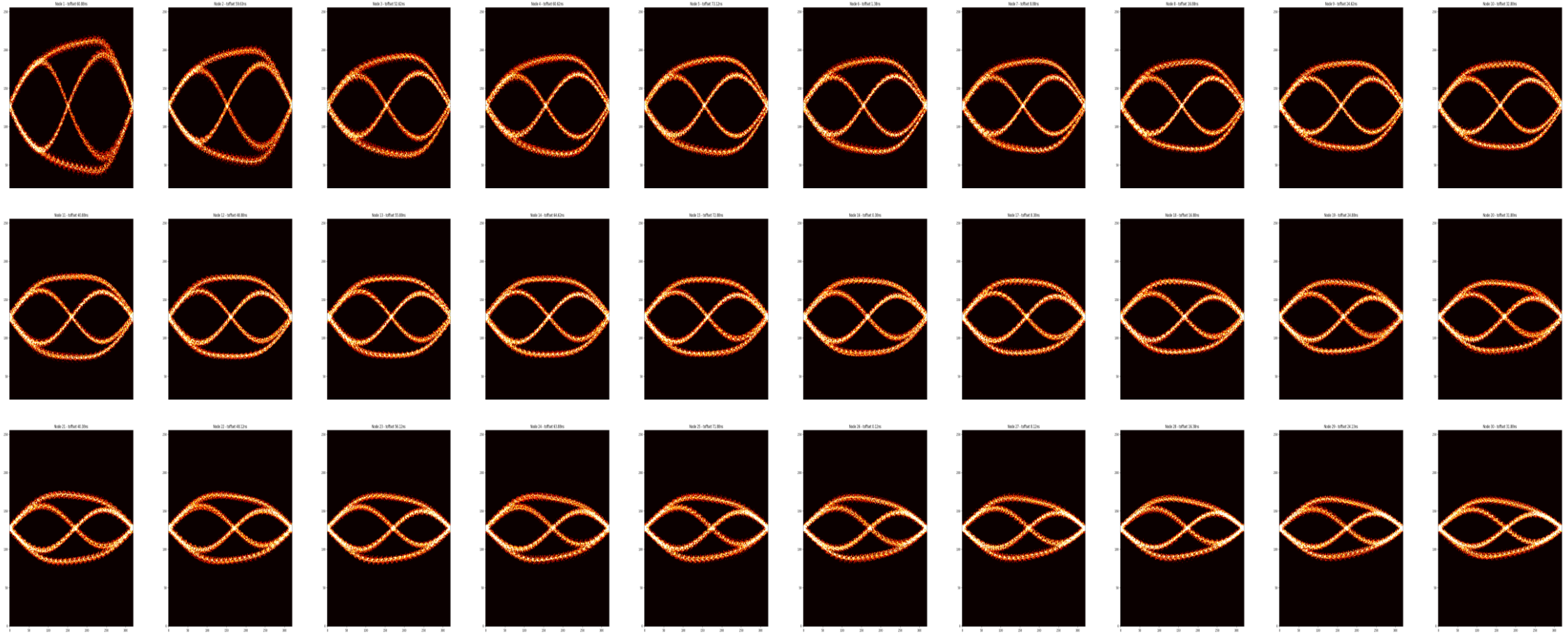
Setting: S-Parameter Tee, Stub 10cm, PoDL 80uH, clumped topology, Eye MDI



Appendix - Results of Prototype – Simulation 4

Rosenberger

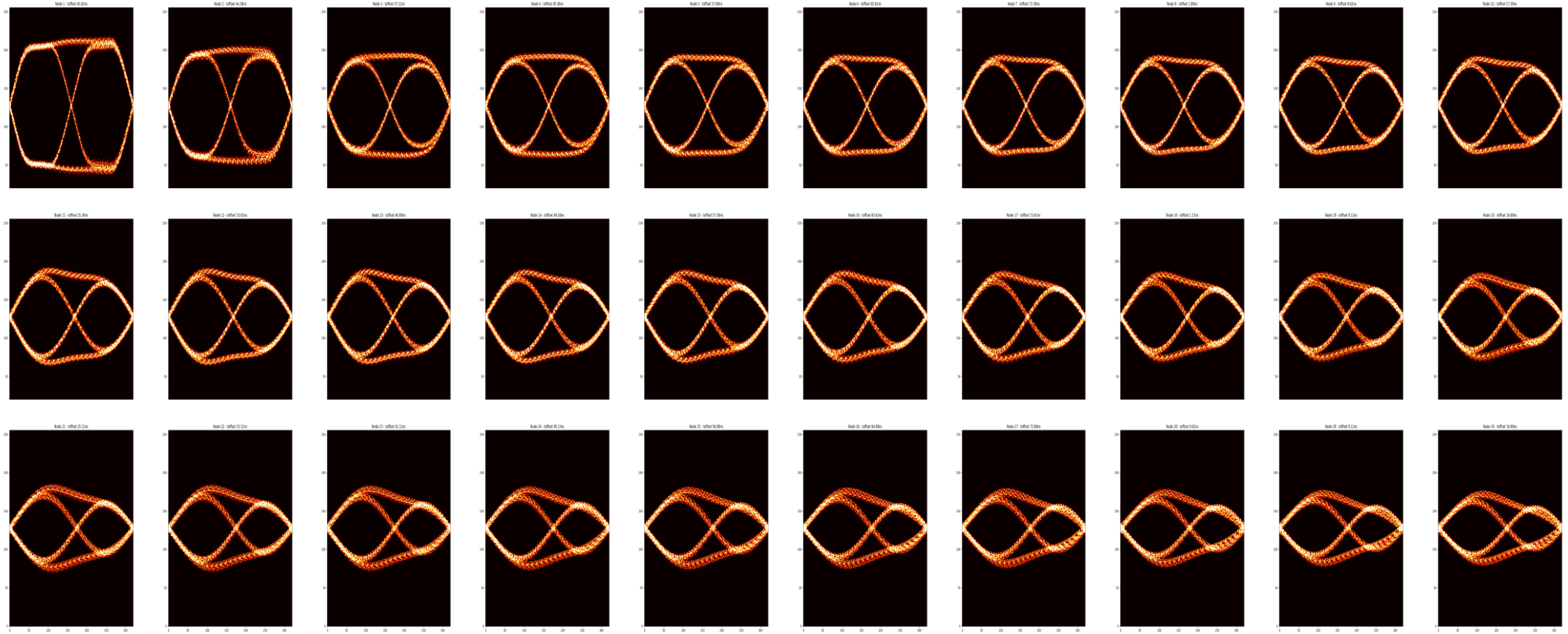
Setting: S-Parameter Tee, Stub 10cm, PoDL 180uH, clumped topology, Eye Filtered



Appendix - Results of Prototype – Simulation 4

Rosenberger

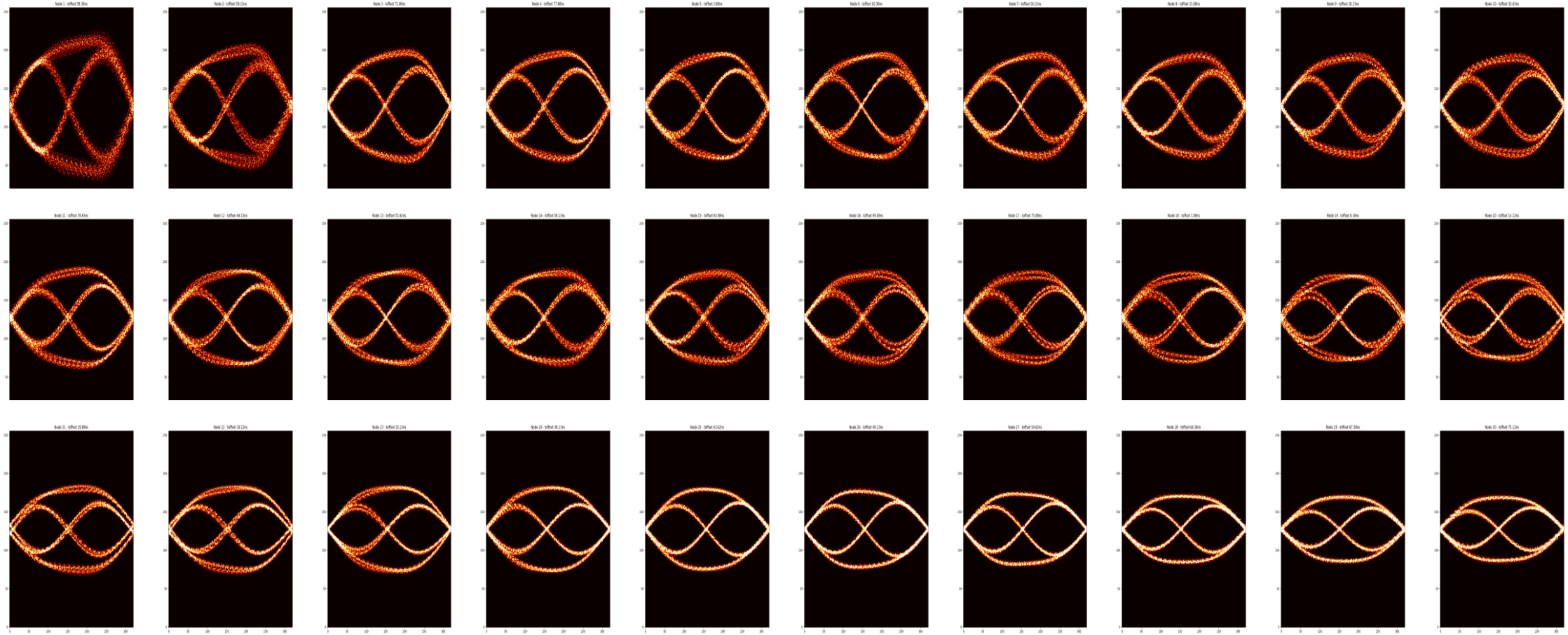
Setting: S-Parameter Tee, Stub 10cm, PoDL 180uH, clumped topology, Eye MDI



Appendix - Results of Prototype – Simulation 7

Rosenberger

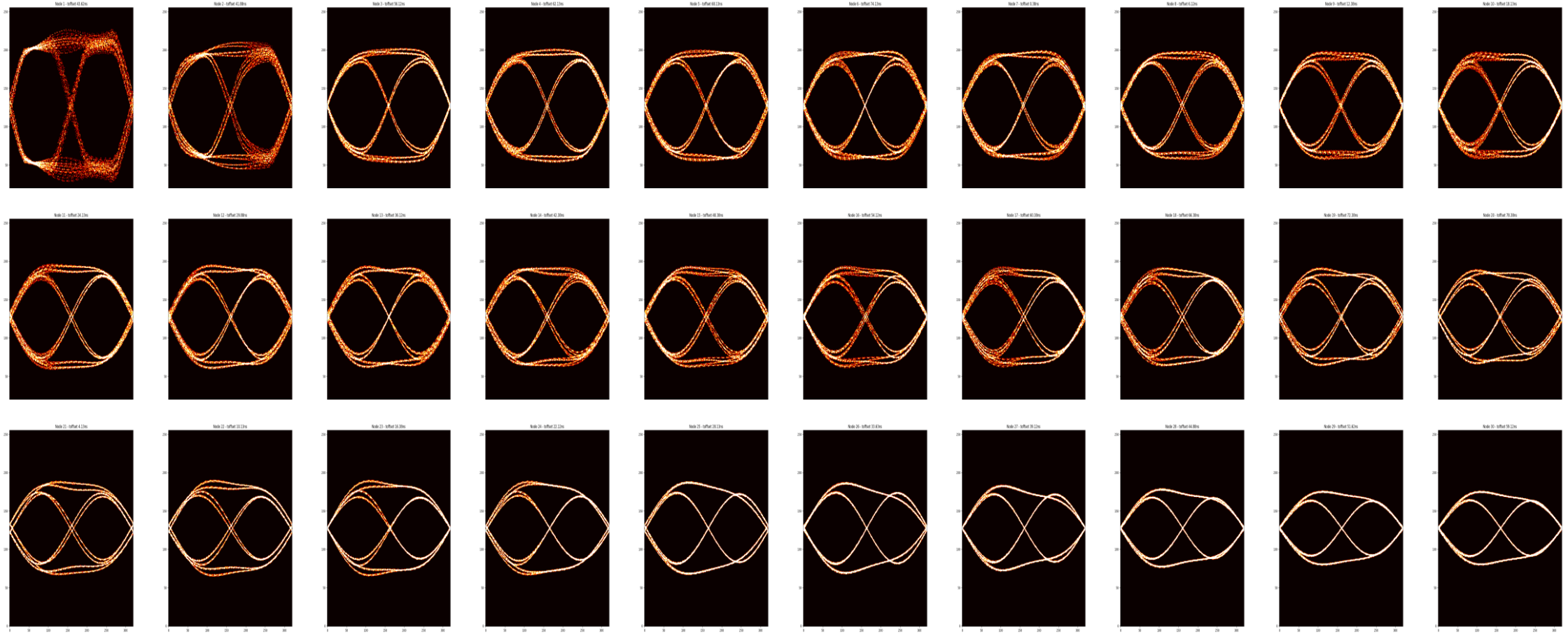
Setting: S-Parameter Tee, Stub 20cm, PoDL 180uH, Mid Nodes unloaded, Eye Filtered



Appendix - Results of Prototype – Simulation 7

Rosenberger

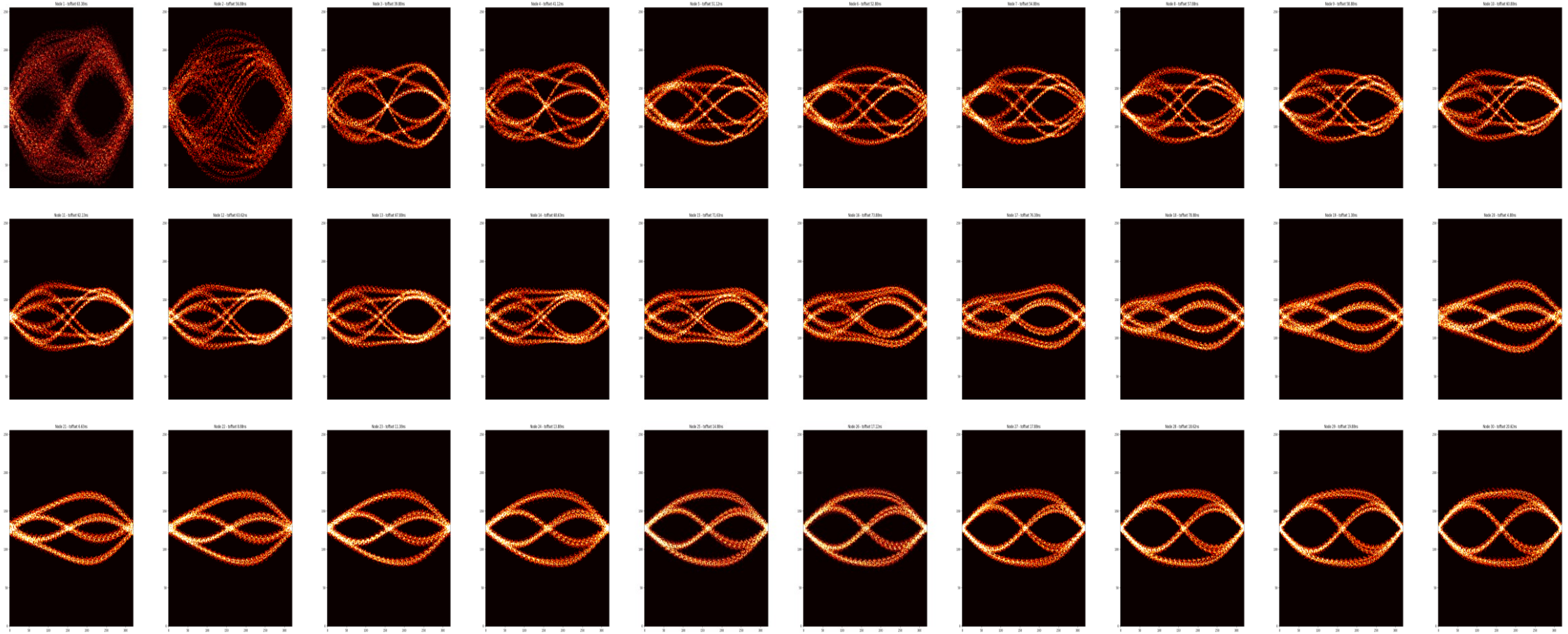
Setting: S-Parameter Tee, Stub 20cm, PoDL 180uH, Mid Nodes unloaded, Eye MDI



Appendix - Results Initial – Simulation 8

Rosenberger

Setting: Uncompensated Tee, Stub 20cm, PoDL 180uH, Clumped Distribution, Eye Filtered



Appendix - Results Initial – Simulation 8

Rosenberger

Setting: Uncompensated Tee, Stub 20cm, PoDL 180uH, Clumped Distribution Eye MDI