# SPE Multidrop Enhancements
# Mixing Segment Considerations

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# Background

- Measurement configuration results for LTspice model validation demonstrated.
  - Transient analysis for RX eye

  https://www.ieee802.org/3/da/public/051921/diminico_SPMD_01_0521.pdf

- New cable model developed to use with transient analysis for RX eye
  - Cable model transmission characteristics consistent with cable model developed.

    https://www.ieee802.org/3/da/public/0721/diminico_SPMD_01_0721.pdf

- New cable model developed to consider Link Segment Node Distribution with transient analysis for RX eye
  - Cable model transmission characteristics consistent with prior 18 AWG cable model
  - Transient analysis of 75 m node distributions

    https://grouper.ieee.org/groups/802/3/SPMD/usecase/SPMD_Usecase_Library.pdf

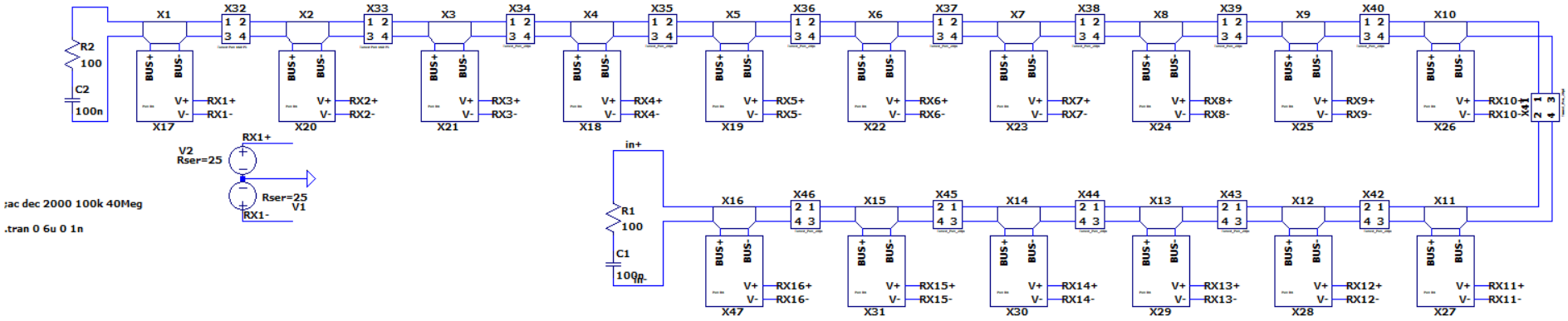
- Clumped distribution tranisent analysis for RX eye

  https://www.ieee802.org/3/da/public/100621/diminico_SPMD_01b_100621.pdf

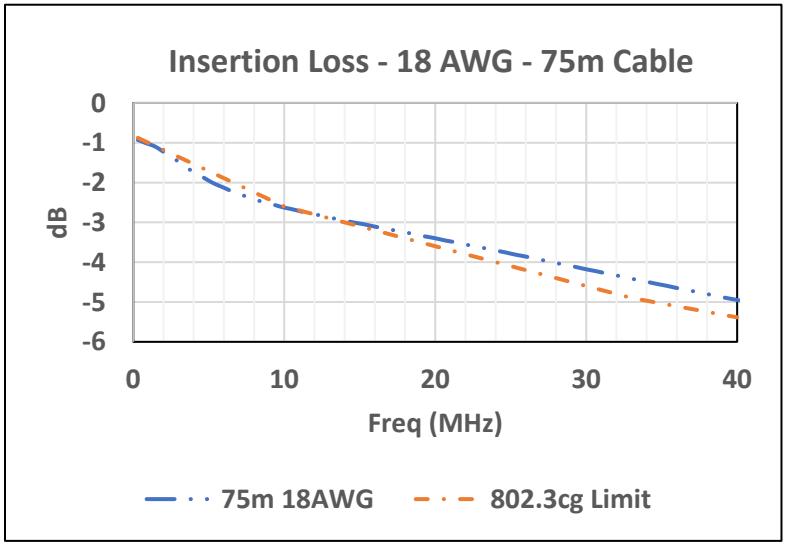
# Purpose

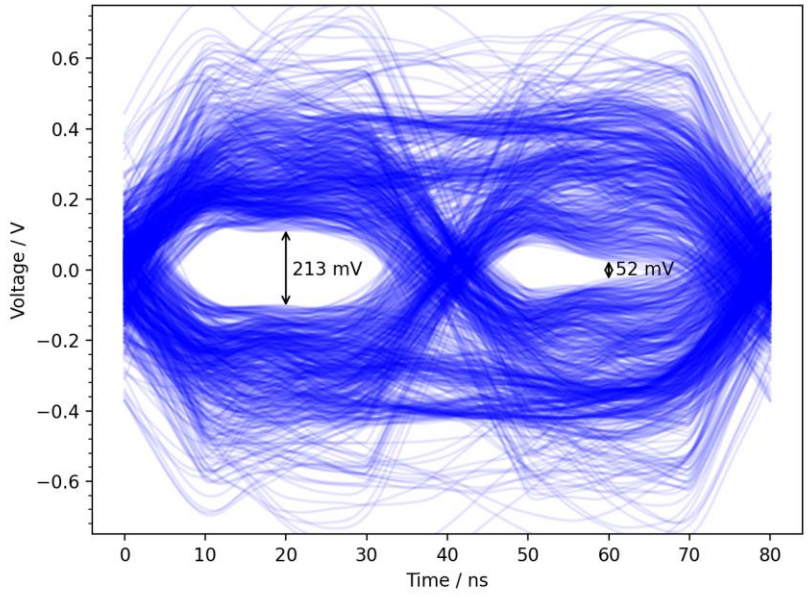
- Capacitive compensation via inductance(s)

# Multidrop Topology - clumped



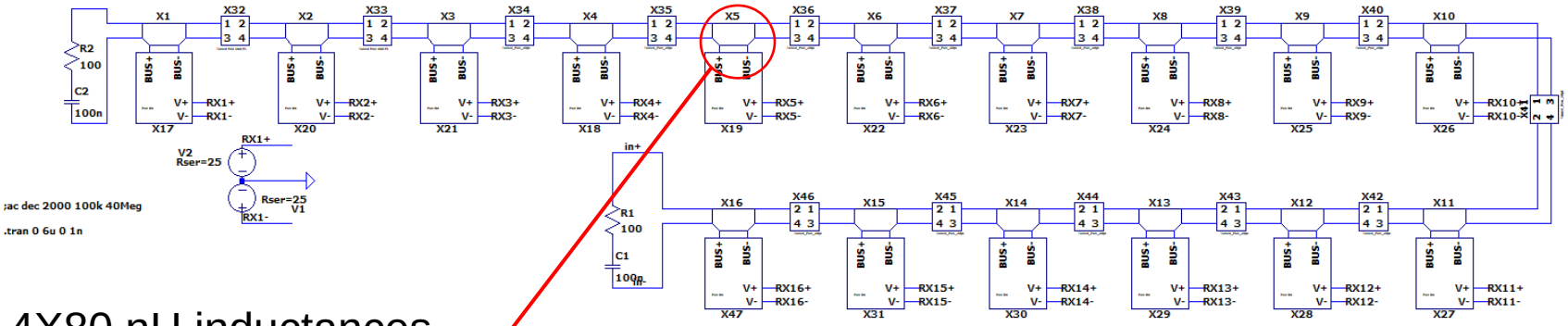

- 50 m, 16 node, clumped topology
- 80 uH, 30 pF node parasitics
- 10 cm stub lengths
- Cable insertion loss scaled



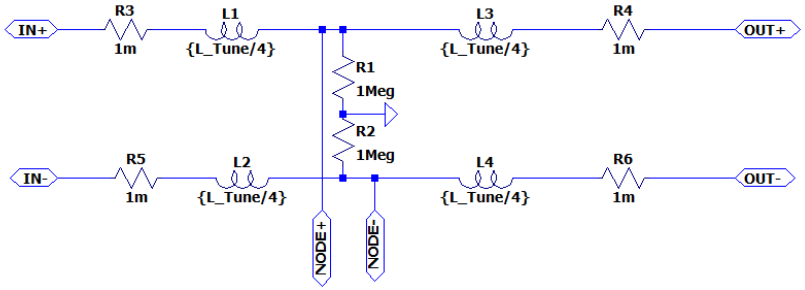



# Multidrop Topology - clumped compensated

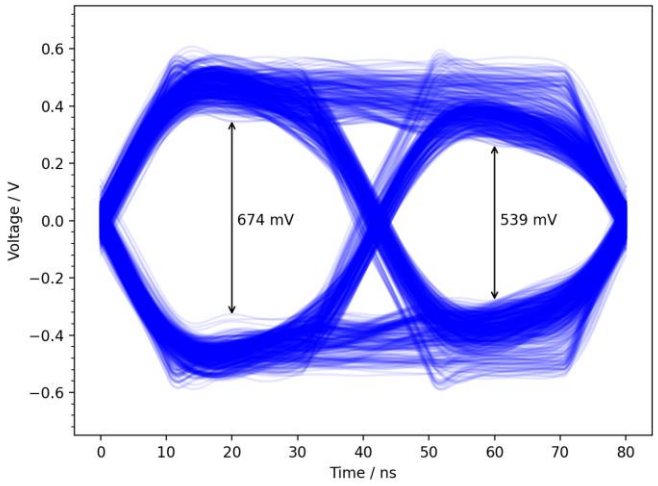
*inductances incorporated in stub connectors*




## 4X80 nH inductances

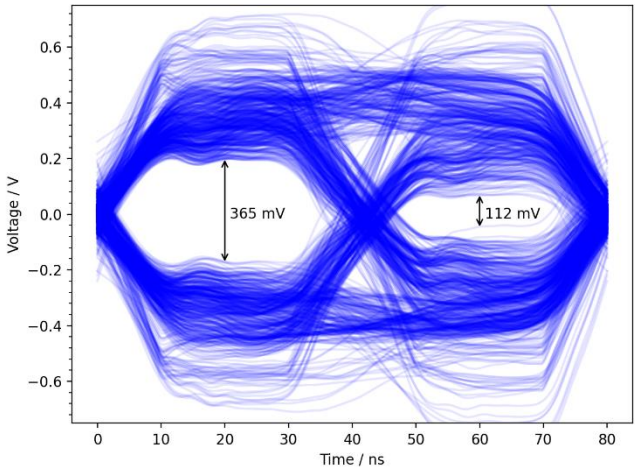



- 50 m, 16 node, clumped topology
- 80 uH, 30 pF node parasitics
- 10 cm stub lengths
- 4X80 nH inductances

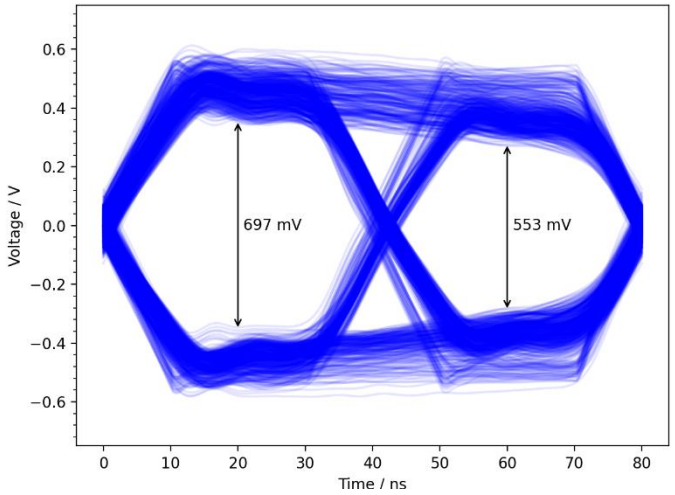


# Multidrop Topology - 40m - 16 node - clumped

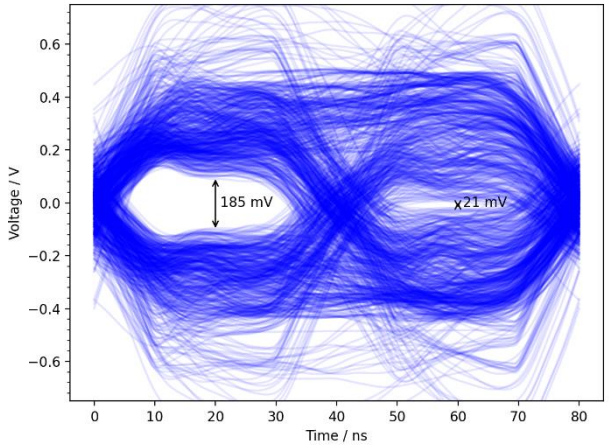
Length(m)_MDI(pF)_Stub(cm)_ 80uH PoDL



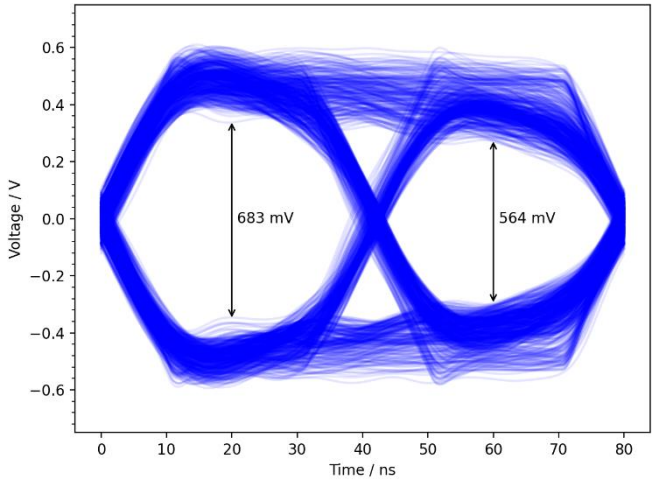

40m_15pF_10cm




40m_15pF_10cm - compensated



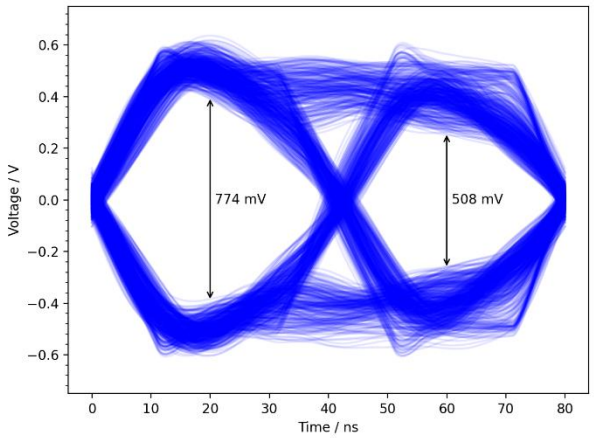

40m_30pF_10cm



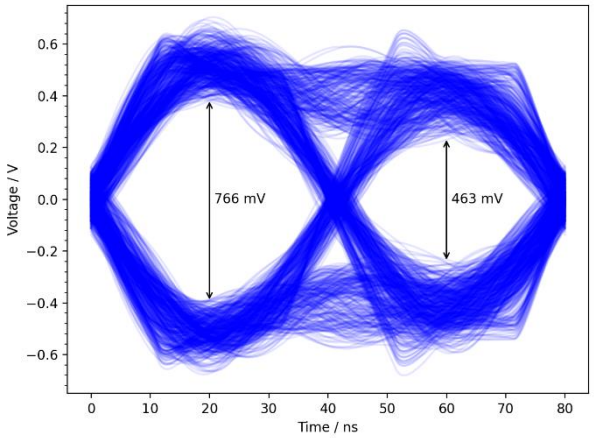

40m_30pF_10cm - compensated

# Multidrop Topology - 40m - 16 node - clumped

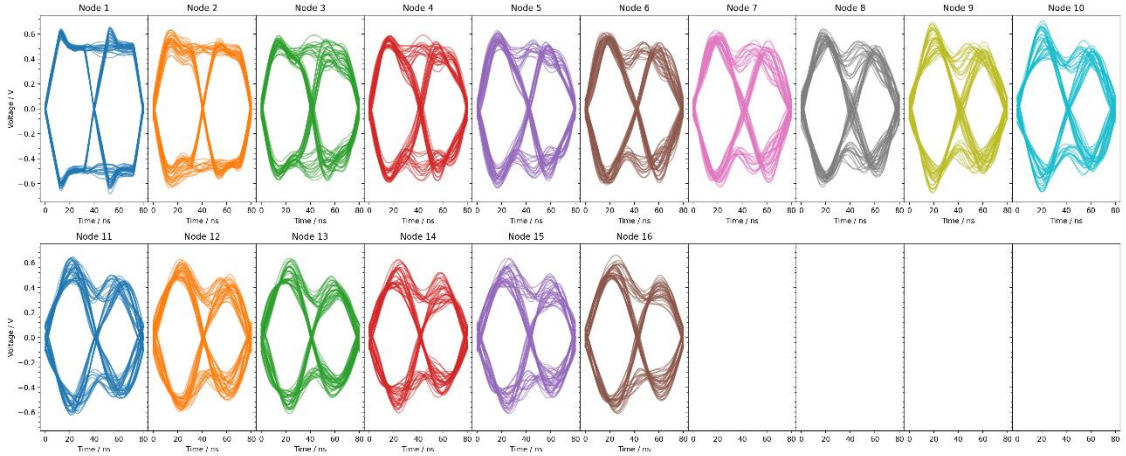
Length(m)_MDI(pF)_Stub(cm)_ 80µH PoDL




40m_15pF_30cm - compensated



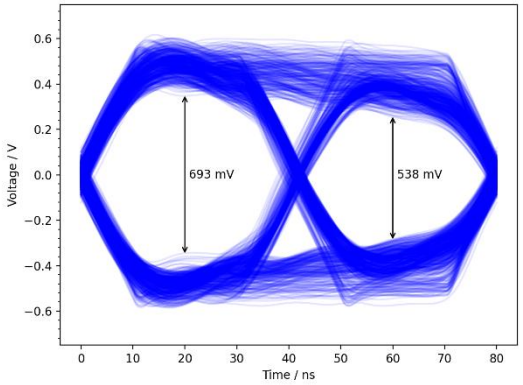

40m_15pF_50cm - compensated



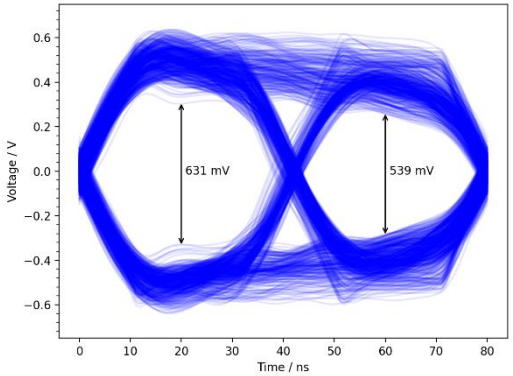

multi_eye_diagram_40m_30pF_50cm - compensated

# Multidrop Topology - 40m - 16 node - clumped

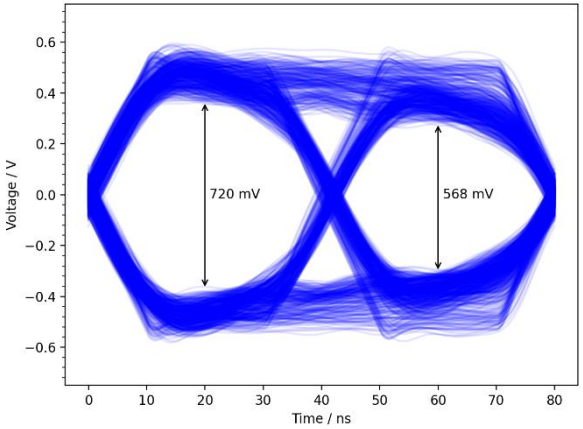
| | 10% | | 10% |
|---|---|---|---|
| | Min | Nom | Max |
| L comp (nH) | 72 | 80 | 88 |
| C node (pF) | 27 | 30 | 33 |



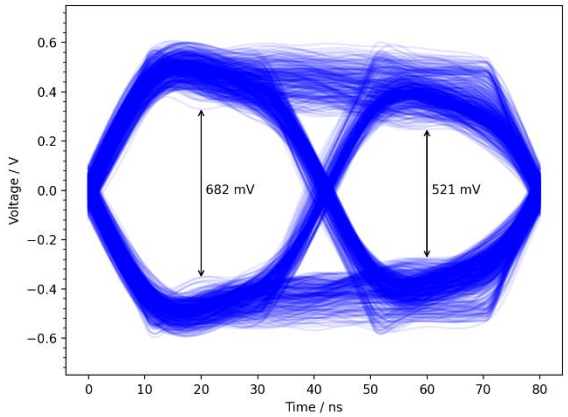

27pF_72nH




27pF_88nH



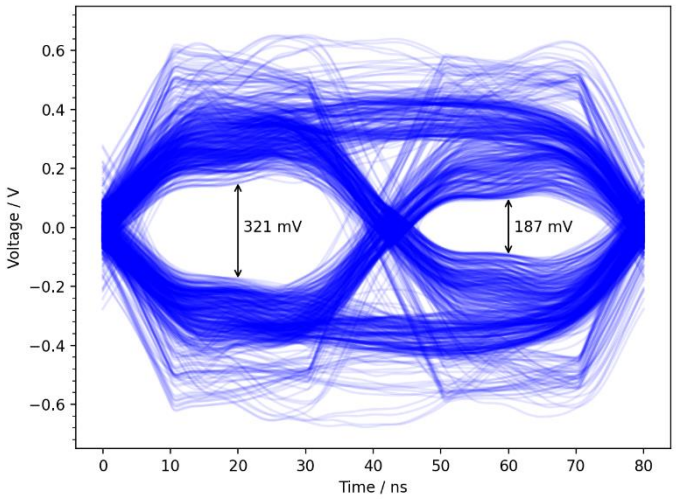

33pF_72nH



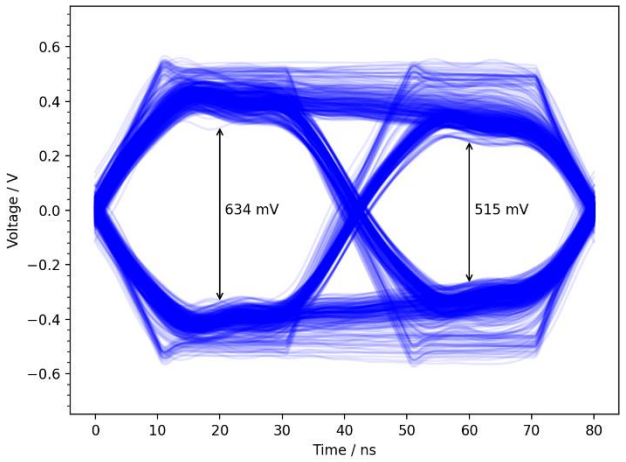

33pF_88nH

# Multidrop Topology - 70m - 16 node - clumped

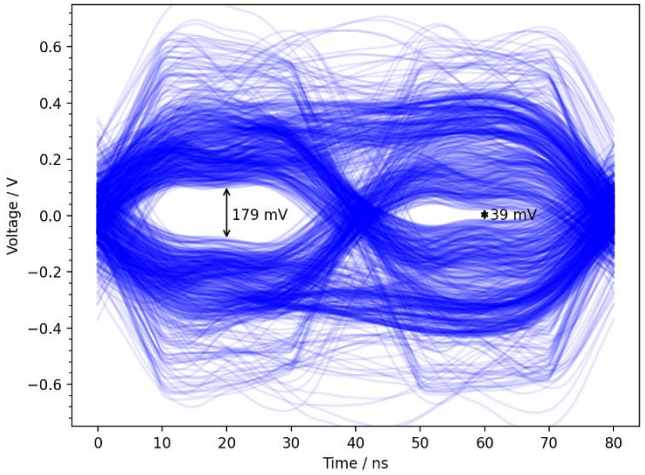
Length(m)_MDI(pF) Stub(cm)_ 80µH PoDL



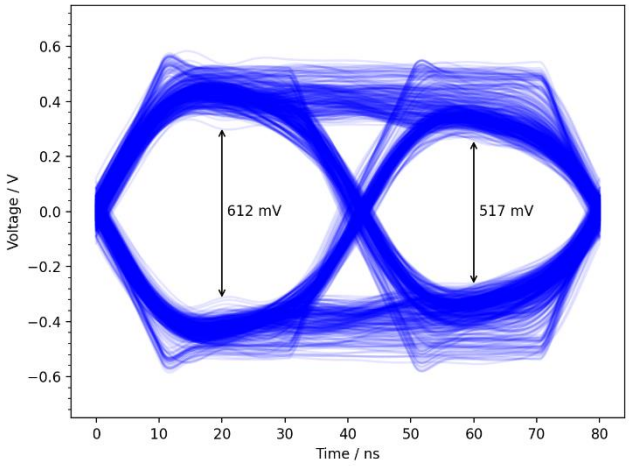

70m_15pF_10cm




70m_15pF_10cm-compensated



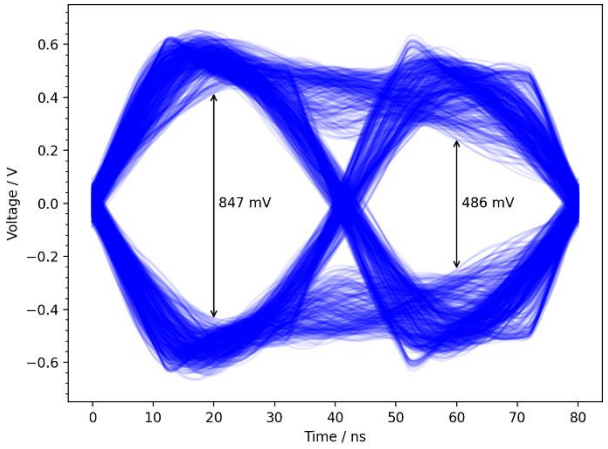

70m_30pF_10cm



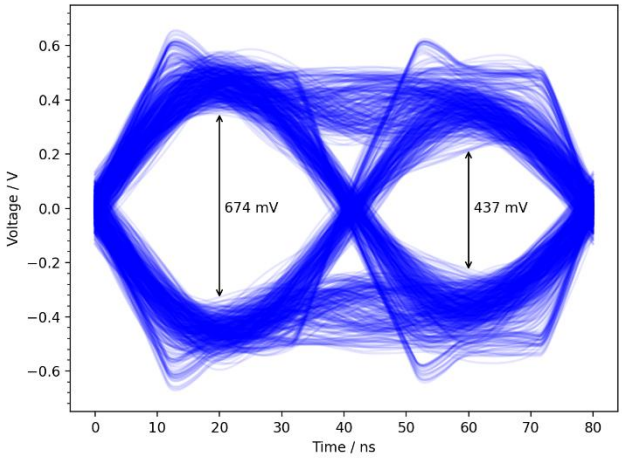

70m_30pF_10cm-compensated

# Multidrop Topology - 70m - 16 node

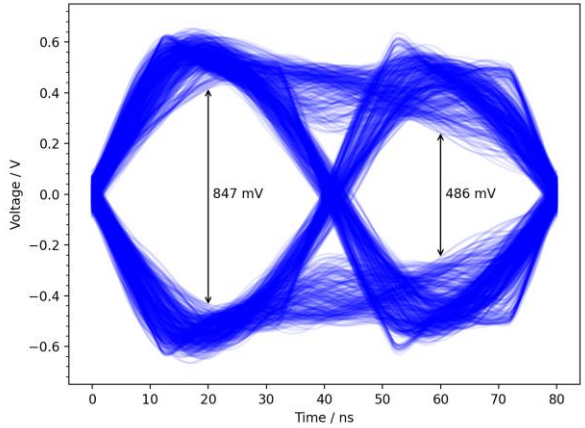
Length(m)_MDI(pF)_Stub(cm)_80 µH PoDL




70m_30pF_50cm-clumped



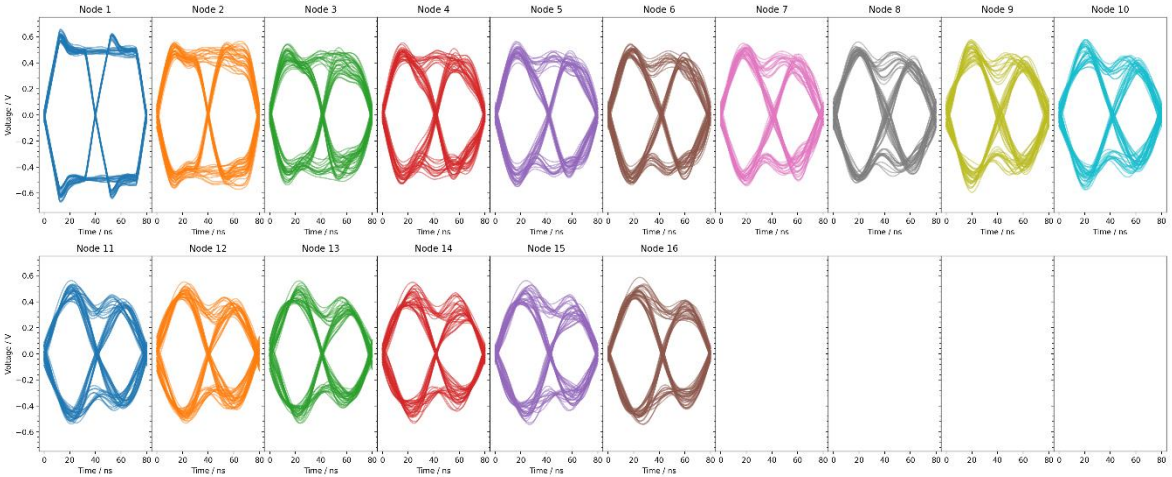

70m_30pF_50cm-clumped-compensated



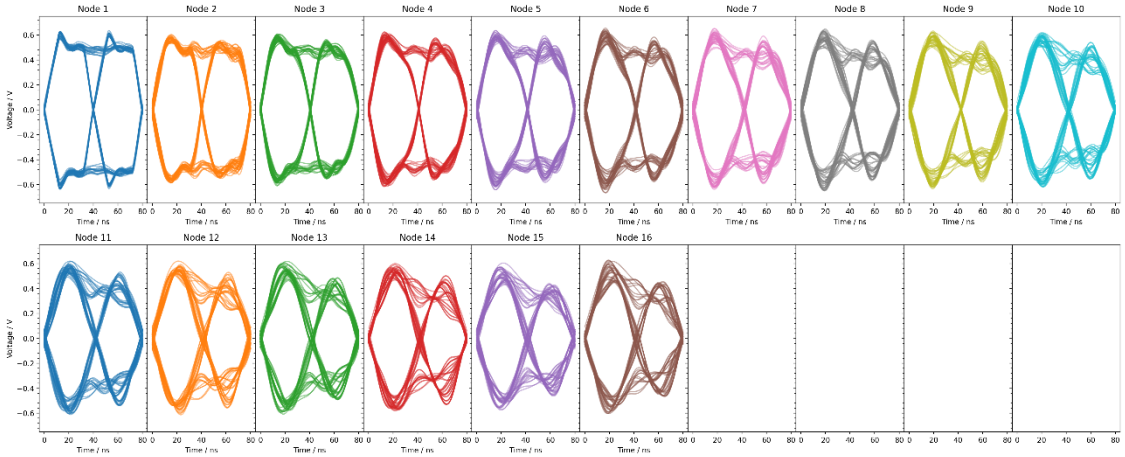

70m_30pF_50cm - even distribution - compensated

# Multidrop Topology - 70m - 16 node

Length(m)_MDI(pF)_Stub(cm)_80 µH PoDL




Multi_eye_diagram_70m_30pF_50cm-compensated



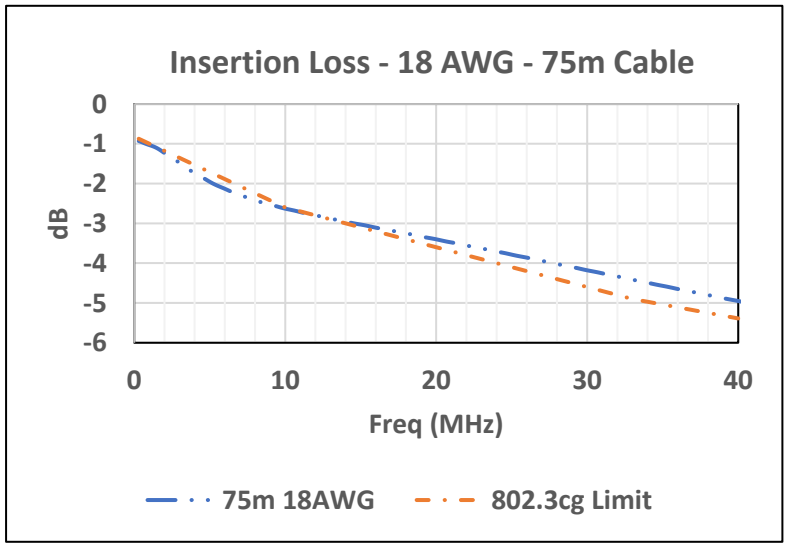

multi_eye_diagram_70m_30pF_50cm - even- compensated

# Summary

- 802.3da desired use cases may be possible to support with capacitive compensation via inductance(s).
- Does not preclude interoperability with Clause 147 multidrop

| Use Cases | No. of Nodes Minimum/Desired | Length, meters Minimum/Desired |
|---|---|---|
| Lighting Controls | 8/16 | 30/50 |
| Industrial Edge Networks | 8/32 | 50/75 |
| Industrial In-Cabinet Usage | 40/64 | 25/75 |
| Elevators | 16/24 | 50/75 |

Source: https://www.ieee802.org/3/SPMD/usecase/SPMD_Usecase_Library.pdf




**-MDI impedance limit parameters**

| Parameter name | Unit of measure | Minimum value | Maximum value |
|---|---|---|---|
| $R$ | kΩ | 10 | — |
| $L$ | μH | 80 | — |
| $C_{tot}$ | pF | — | 180 |
| $C_{node}$ | pF | — | 15 |

Source: IEEE Std 802.3cg™-2019

# Next Steps

- Capacitive compensation via inductance(s)
  - consider use cases slide 12
- Evaluate corresponding mixing segment characteristics for baseline.

# Backup

# Cable Model – 75 m – Panduit

- Cable model transmission characteristics consistent with referenced cable model

# Link Segment Node Characteristics

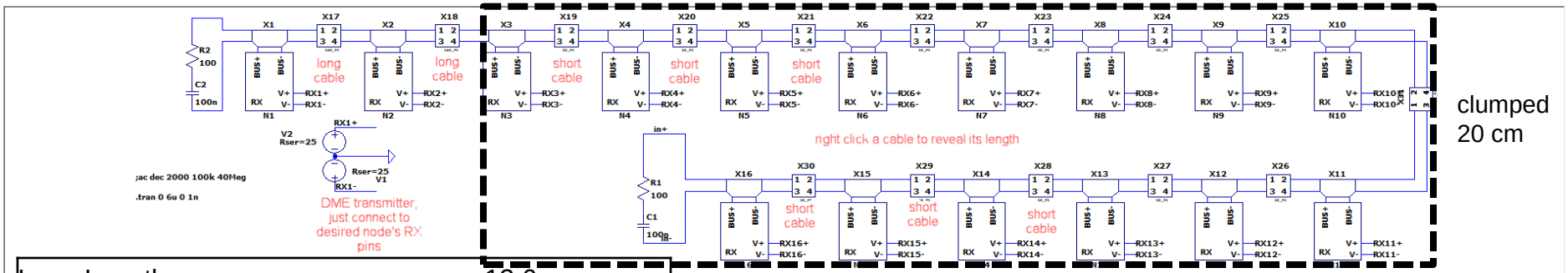
- **802.3cg - backward compatibility**

**–MDI impedance limit parameters**

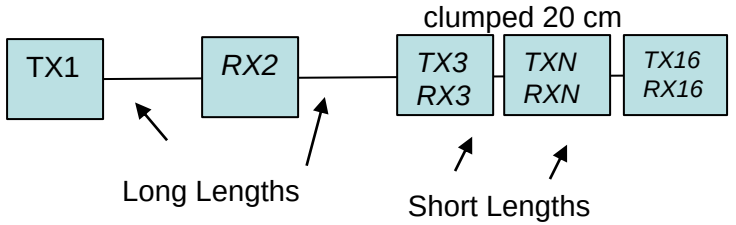
| Parameter name | Unit of measure | Minimum value | Maximum value |
|---|---|---|---|
| $R$ | kΩ | 10 | — |
| $L$ | μH | 80 | — |
| $C_{tot}$ | pF | — | 180 |
| $C_{node}$ | pF | — | 15 |

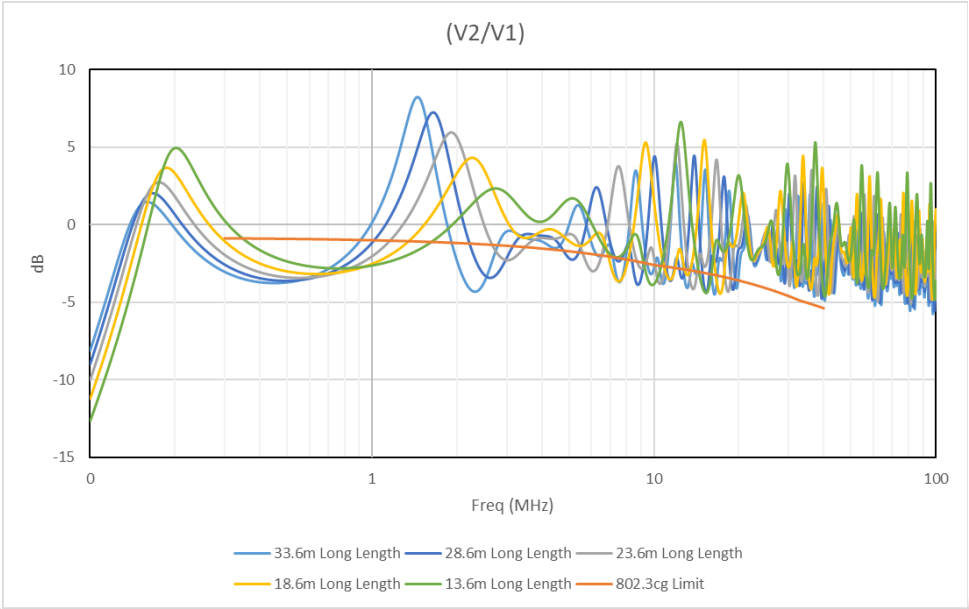
Source: IEEE Std 802.3cg™-2019

# Clumped Distribution Analyzed

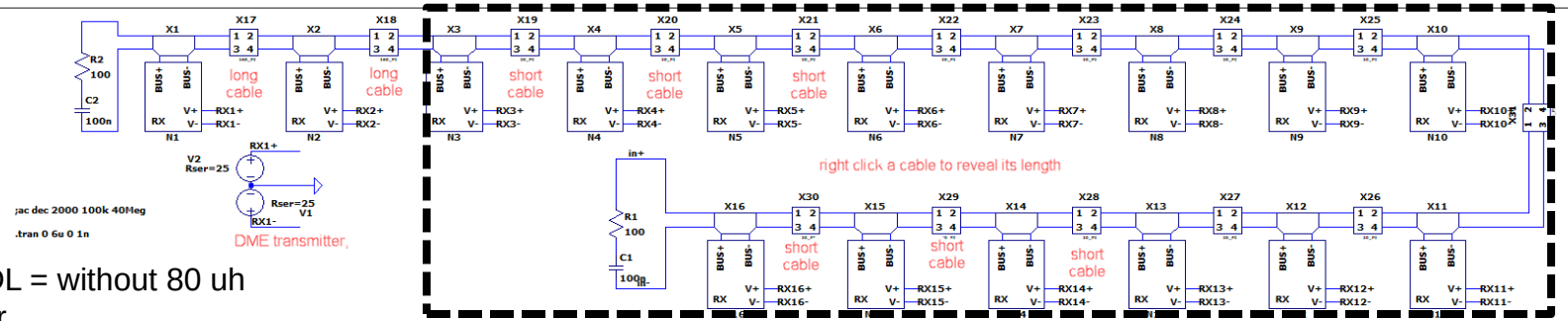



| | |
|---|---|
| Long Length | 13.6m |
| Short Length (2xstub) | 20cm |
| Total Channel Length | 30m |
| | |
| Long Length | 18.6m |
| Short Length (2xstub) | 20cm |
| Total Channel Length | 40m |
| | |
| Long Length | 23.6m |
| Short Length (2xstub) | 20cm |
| Total Channel Length | 50m |
| | |
| Long Length | 28.6m |
| Short Length (2xstub) | 20cm |
| Total Channel Length | 60m |
| | |
| Long Length | 33.6m |
| Short Length (2xstub) | 20cm |
| Total Channel Length | 70m |



# Clumped Distribution Analyzed (no PoDL)




No PoDL = without 80 uh inductor

| | |
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| Long Length | 13.6m |
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| Total Channel Length | 30m |
| | |
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| Short Length (2xstub) | 20cm |
| Total Channel Length | 40m |
| | |
| Long Length | 23.6m |
| Short Length (2xstub) | 20cm |
| Total Channel Length | 50m |
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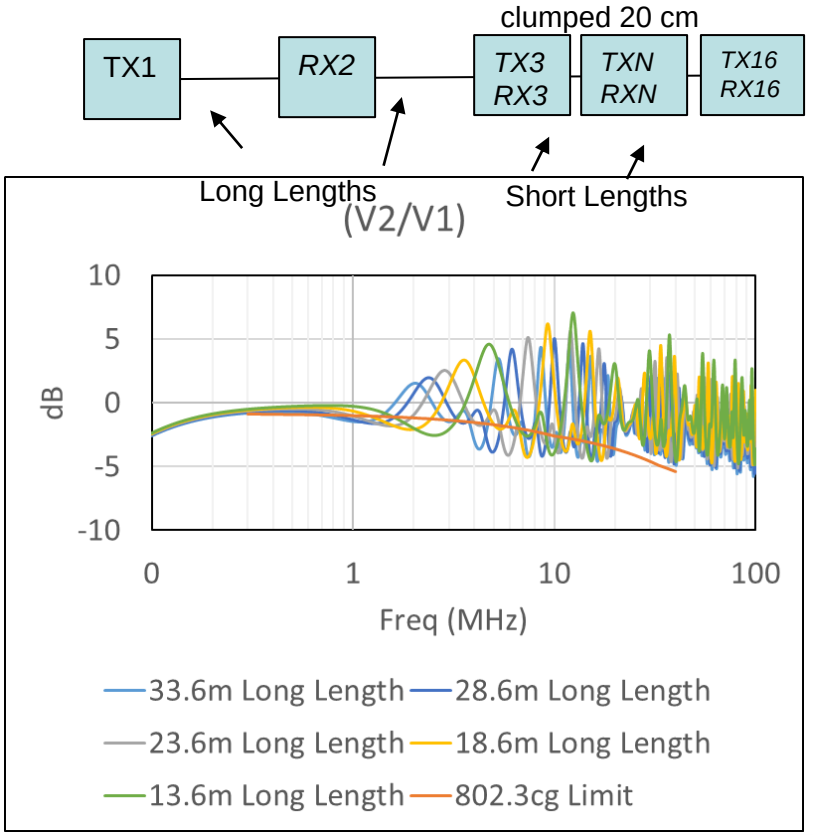

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| Short Length (2xstub) | 20cm |
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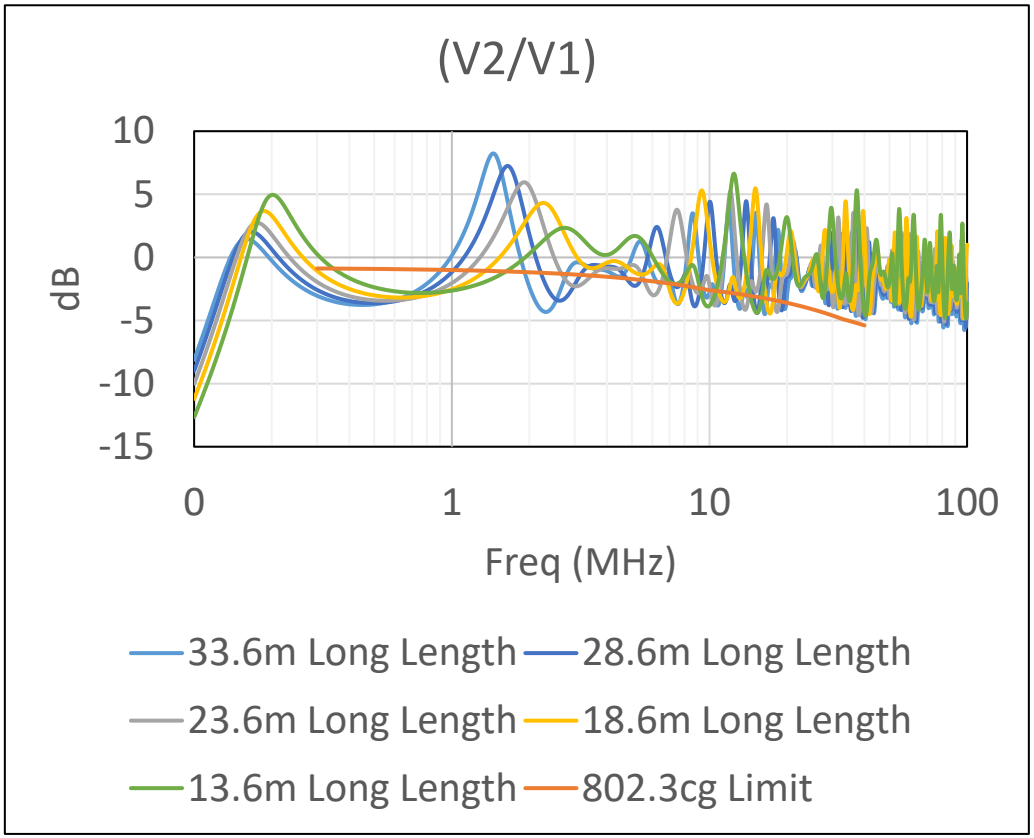

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No PoDL = without 80 uh inductor

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|---|---|
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| Total Channel Length | 30m |
| | |
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| Short Length (2xstub) | 20cm |
| Total Channel Length | 40m |
| | |
| Long Length | 23.6m |
| Short Length (2xstub) | 20cm |
| Total Channel Length | 50m |
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| Short Length (2xstub) | 20cm |
| Total Channel Length | 60m |
| | |
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| Short Length (2xstub) | 20cm |
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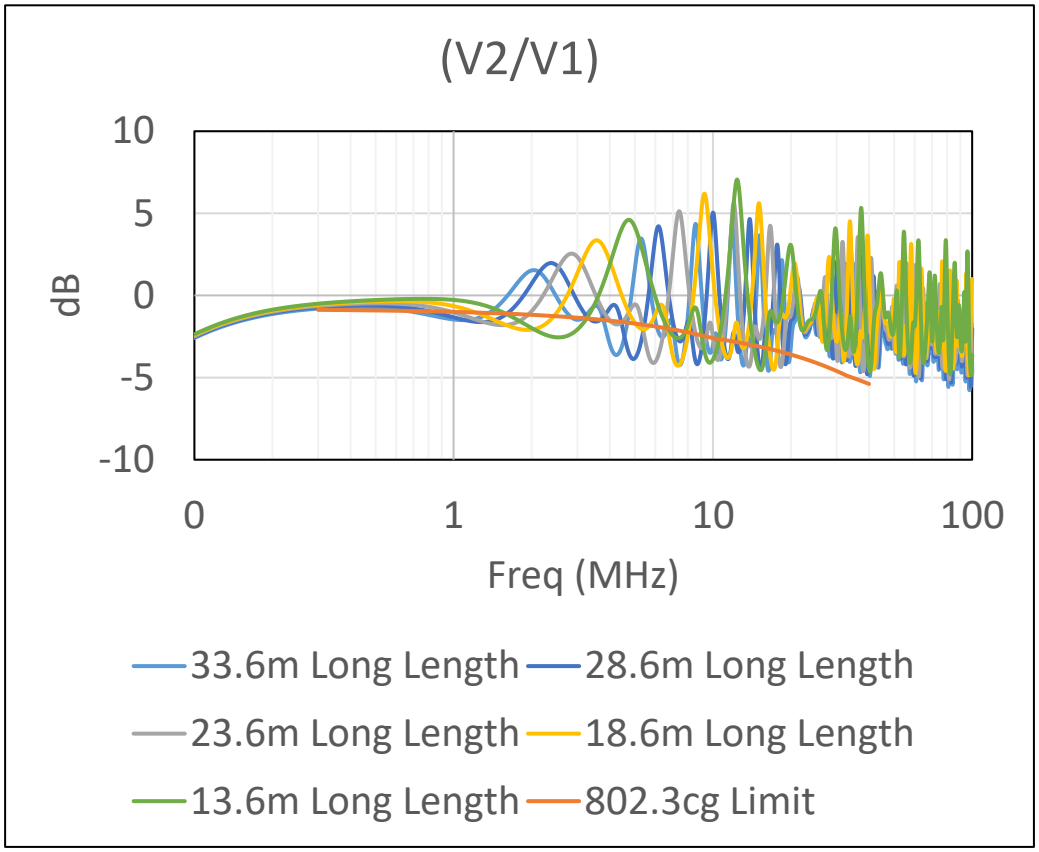
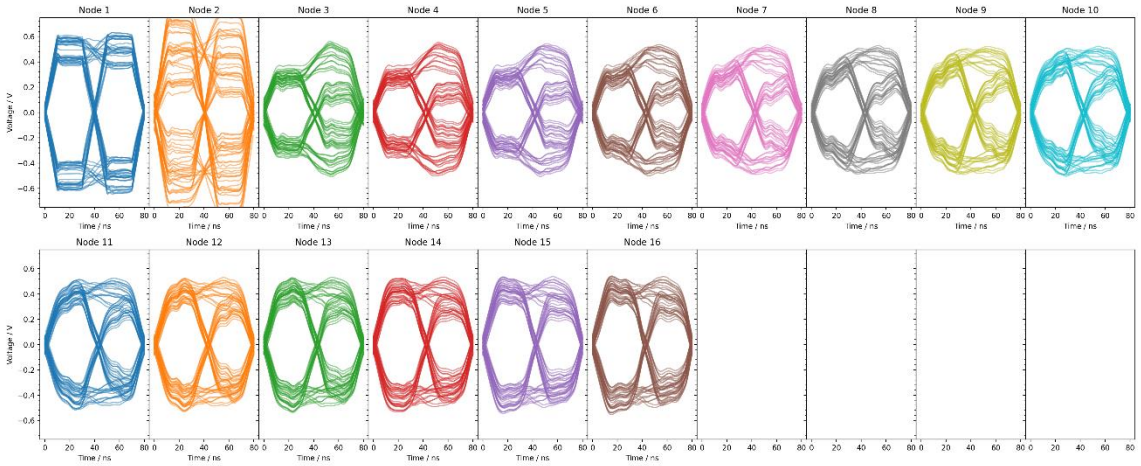
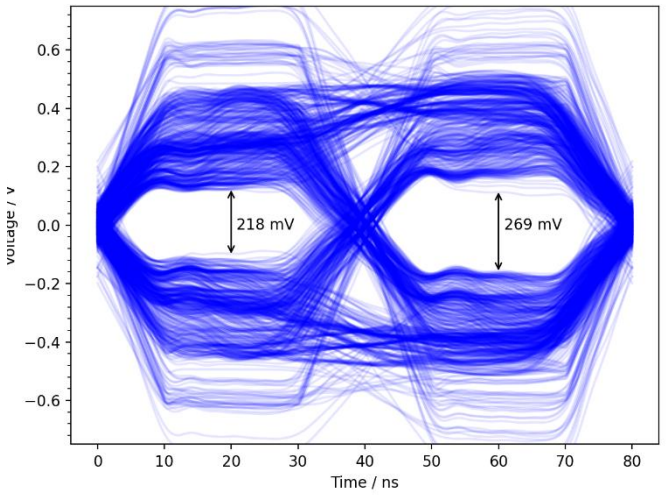
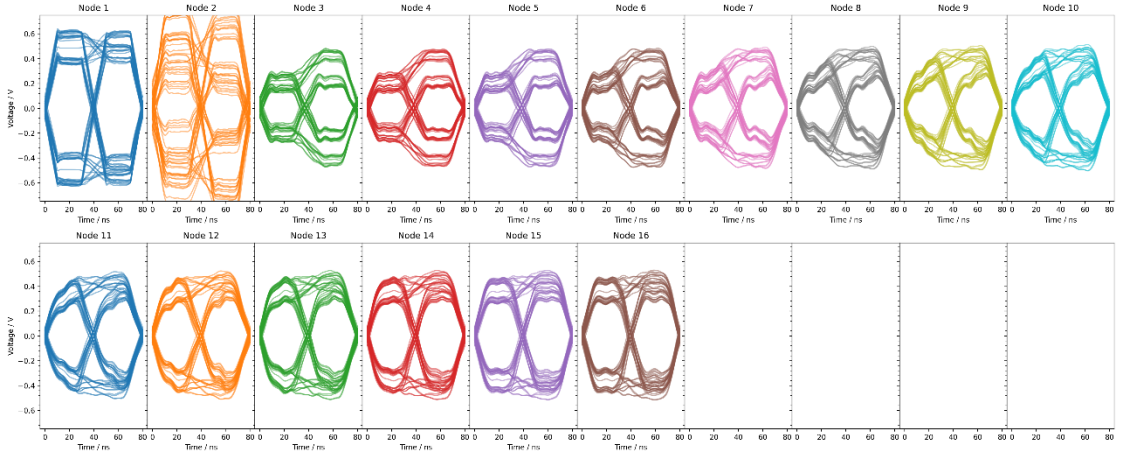


# Clumped Distribution Analyzed (30 m)

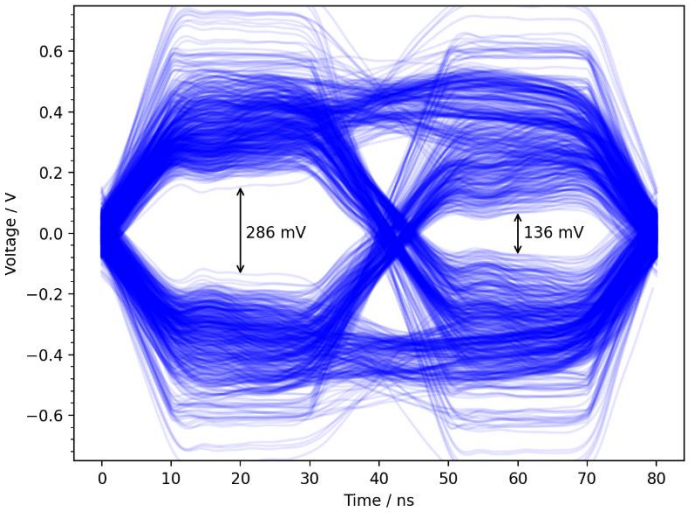



## No PoDL

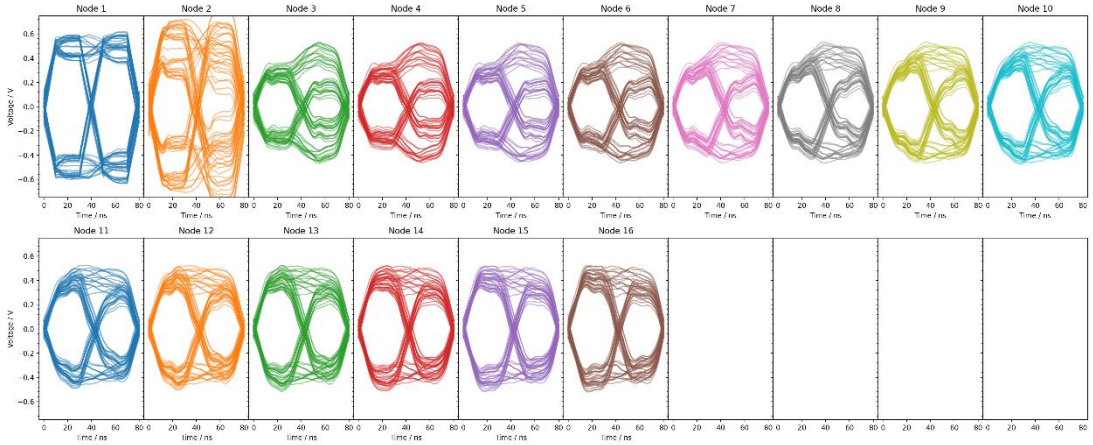


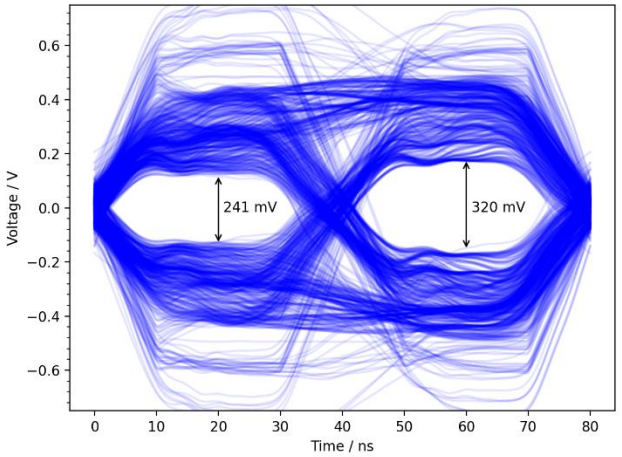

## PoDL

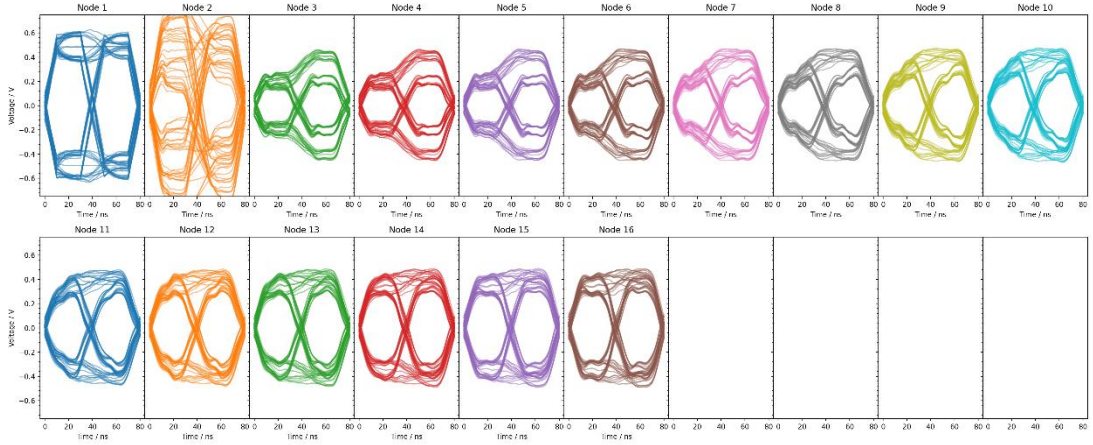


# Clumped Distribution Analyzed (40 m)

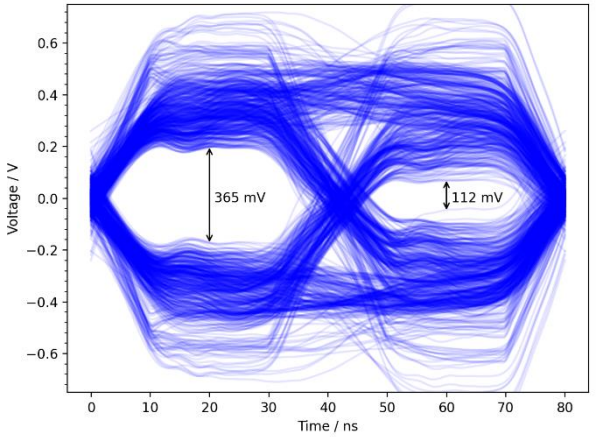



## No PoDL

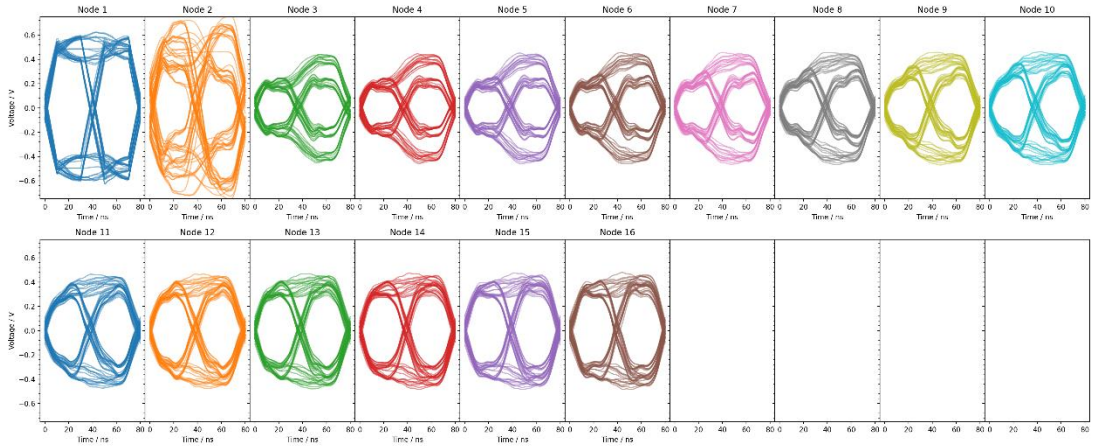


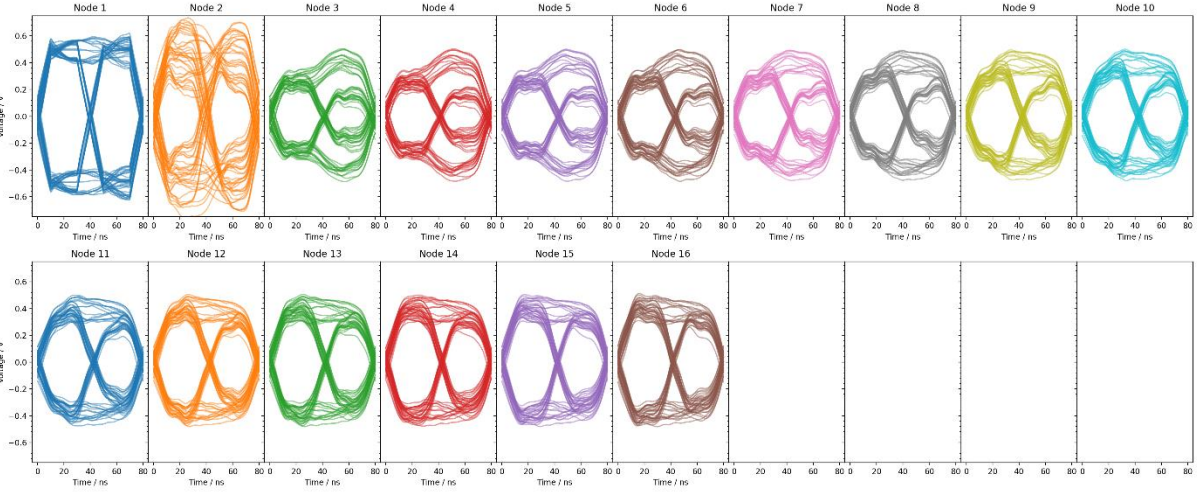




## PoDL

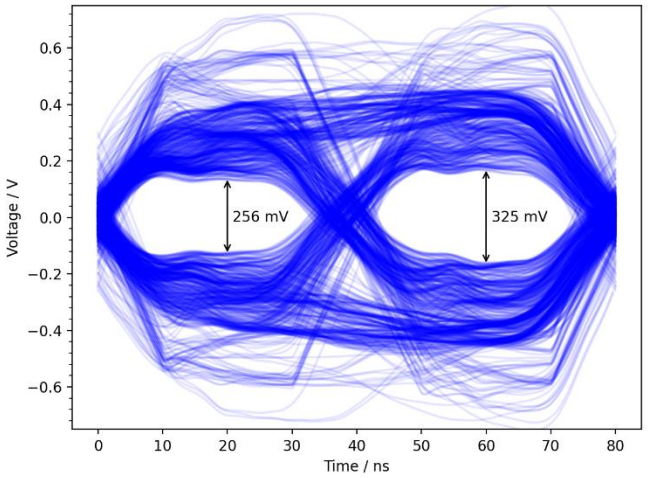


# Clumped Distribution Analyzed (50 m)

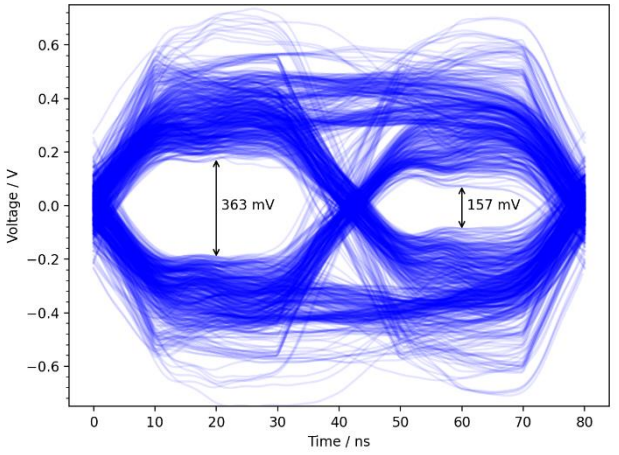


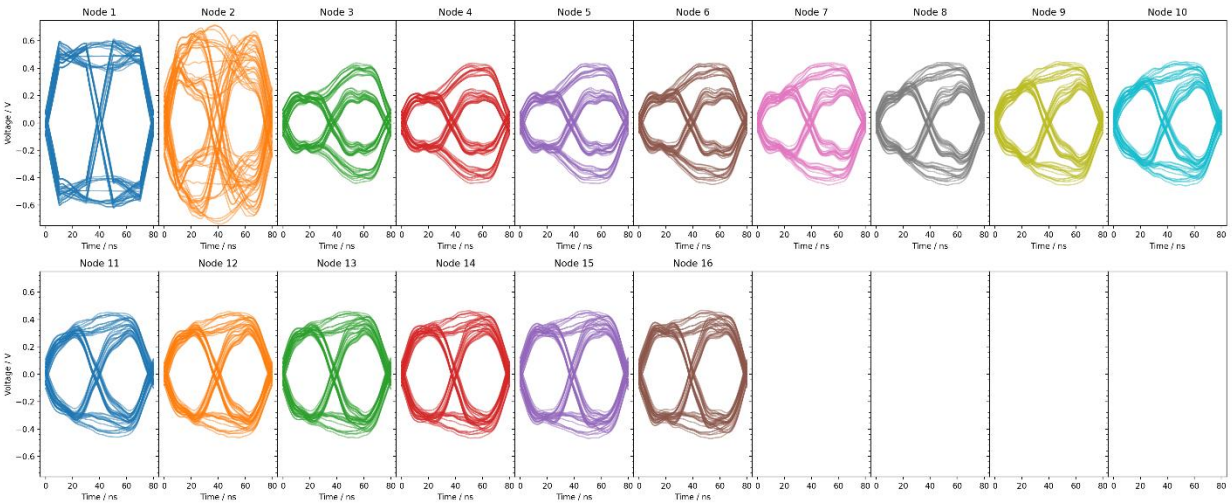

## No PoDL




## PoDL



# Clumped Distribution Analyzed (60 m)

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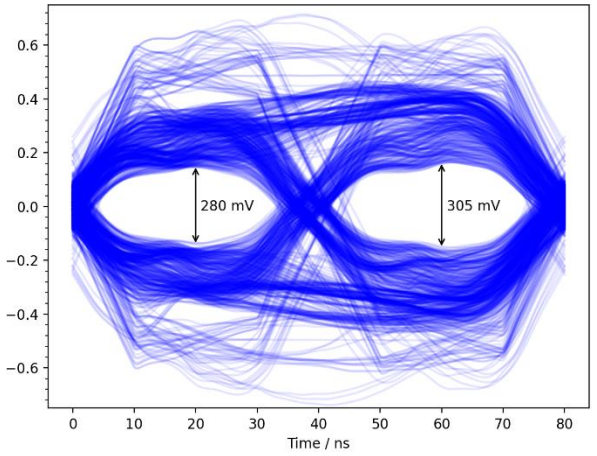
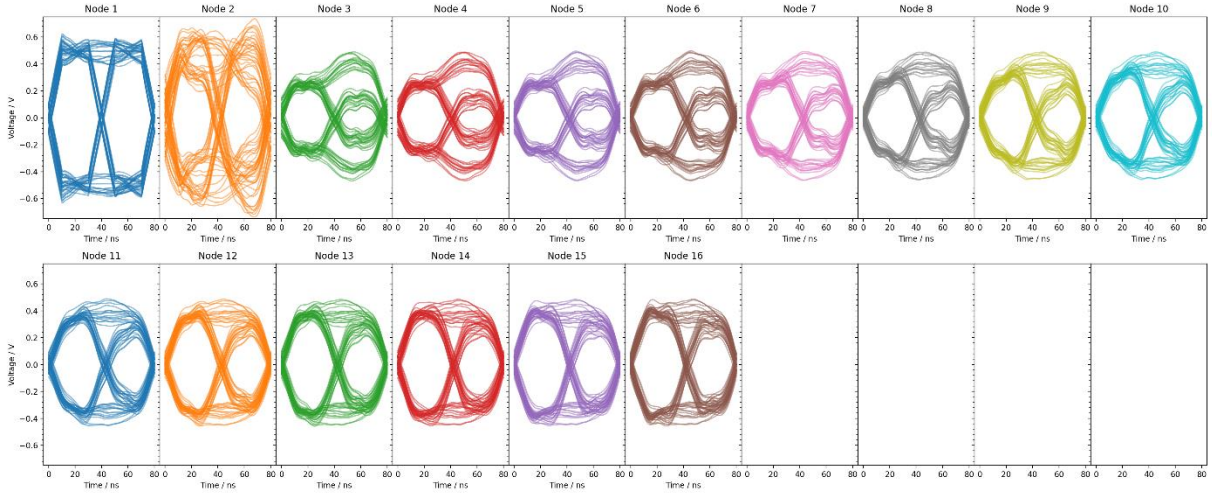
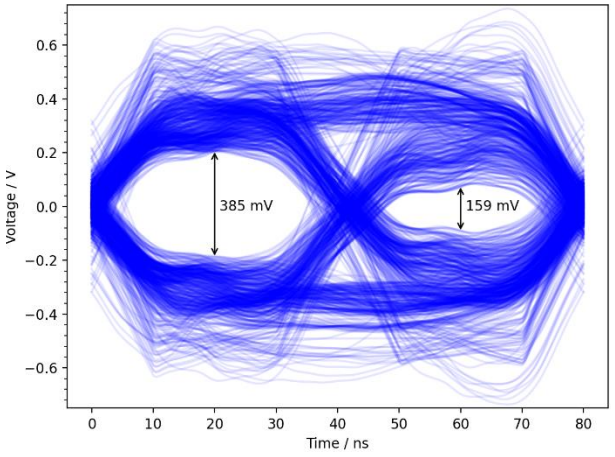
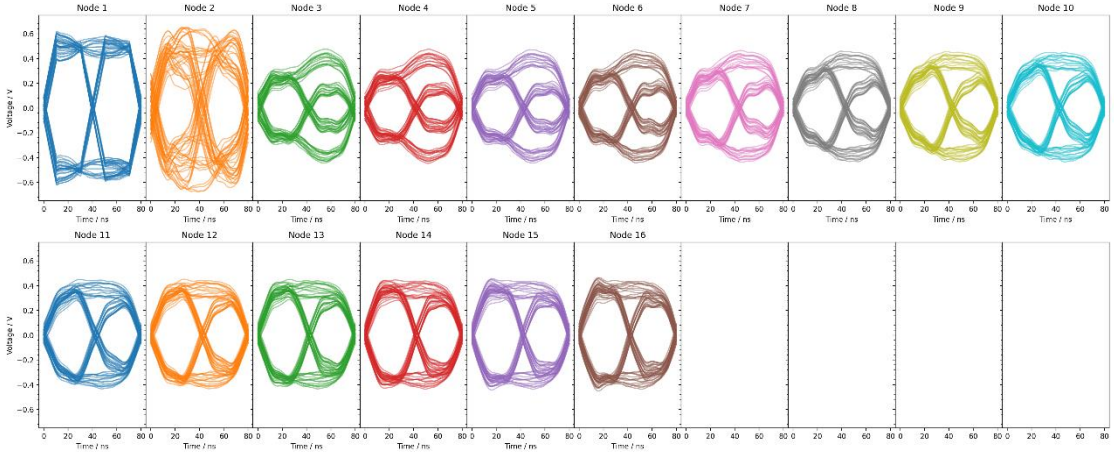


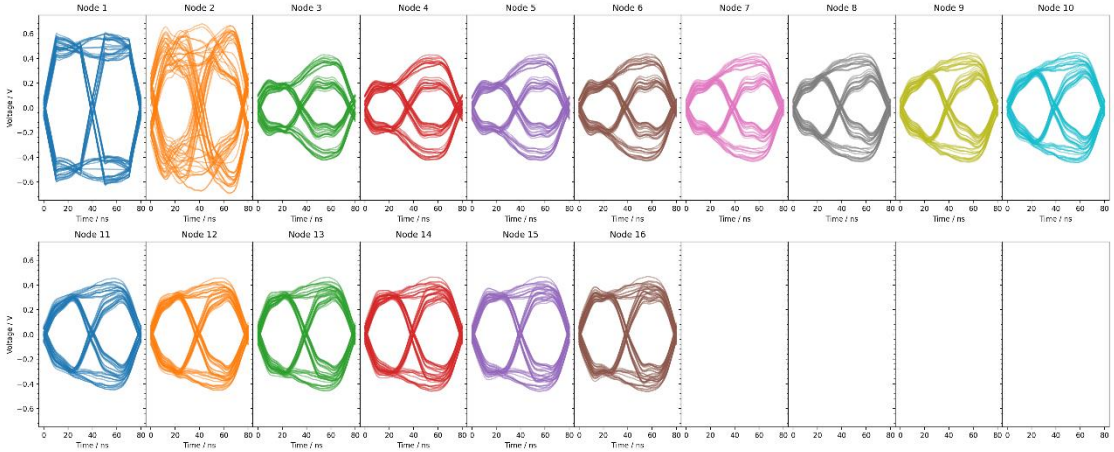




## PoDL



# Clumped Distribution Analyzed (70 m)

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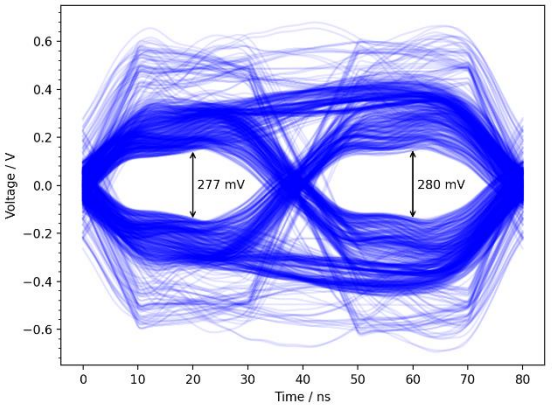
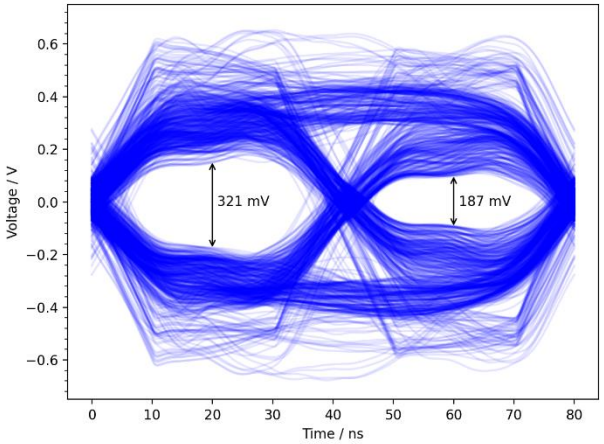


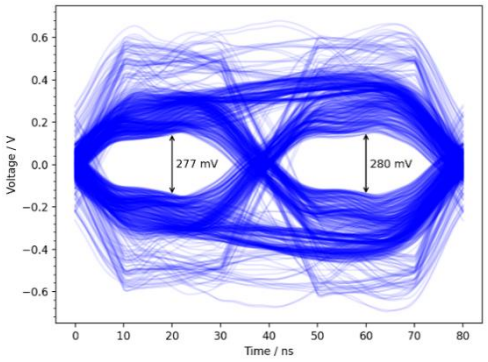

## PoDL



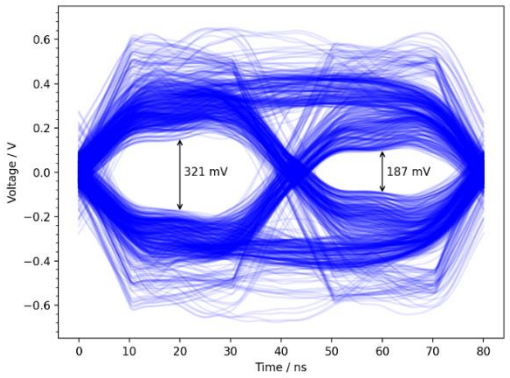
# Summary/Next Steps

- New cable model developed to consider Link Segment Node Distribution with transient analysis for RX eye
- Clumped distribution tranisent analysis for RX eye
- Next Steps - Mixing segment RX eye metrics
  - Backward compatible - 802.3cg Mixing segment and MDI impedances
  - 802.3da specific

**No PoDL**

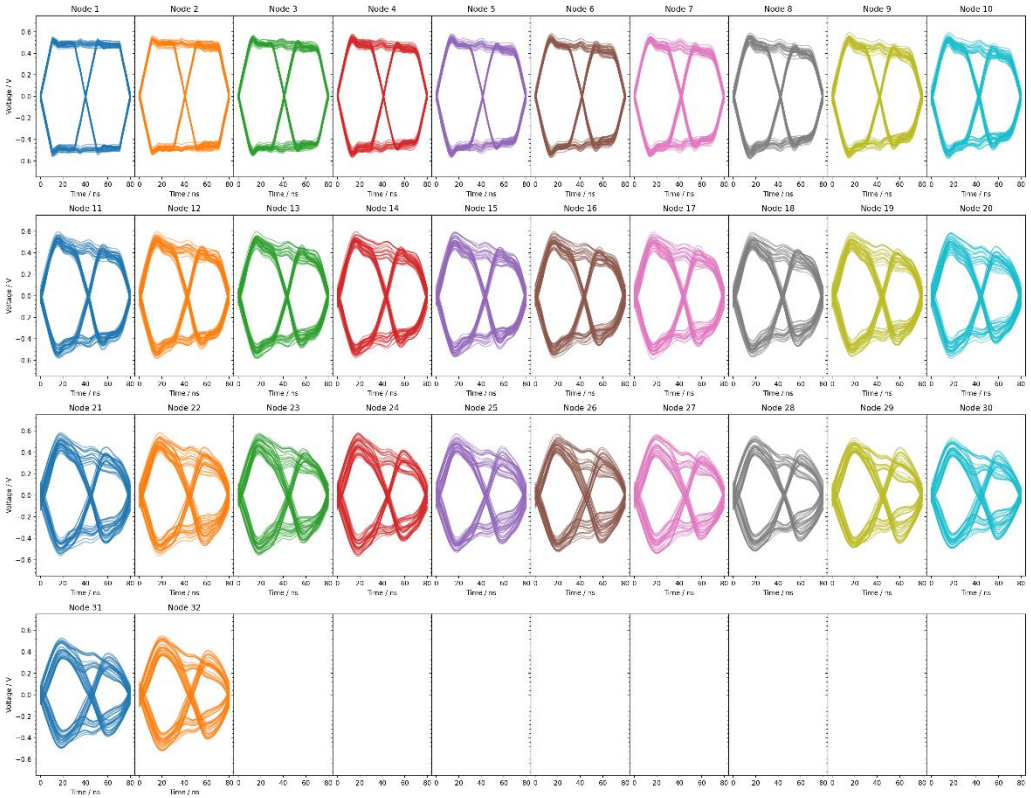


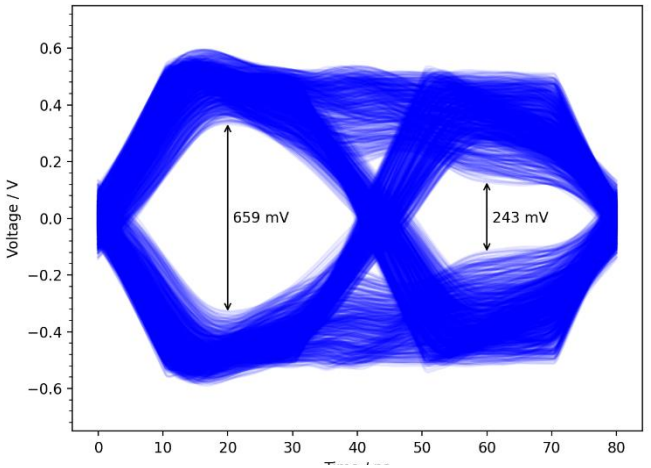

**PoDL**

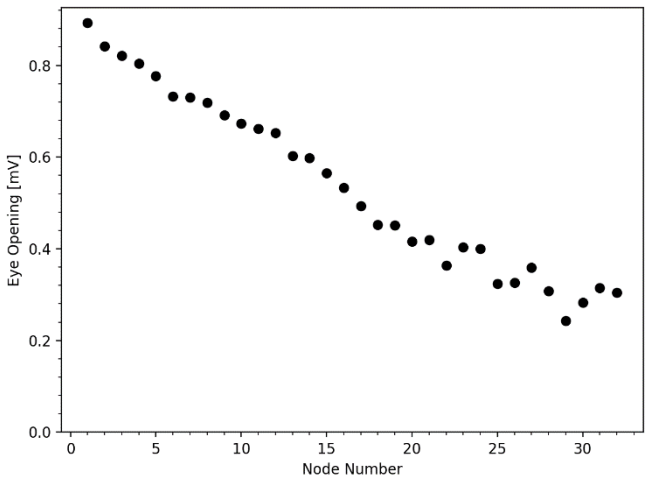


# Link Segment Node Distribution

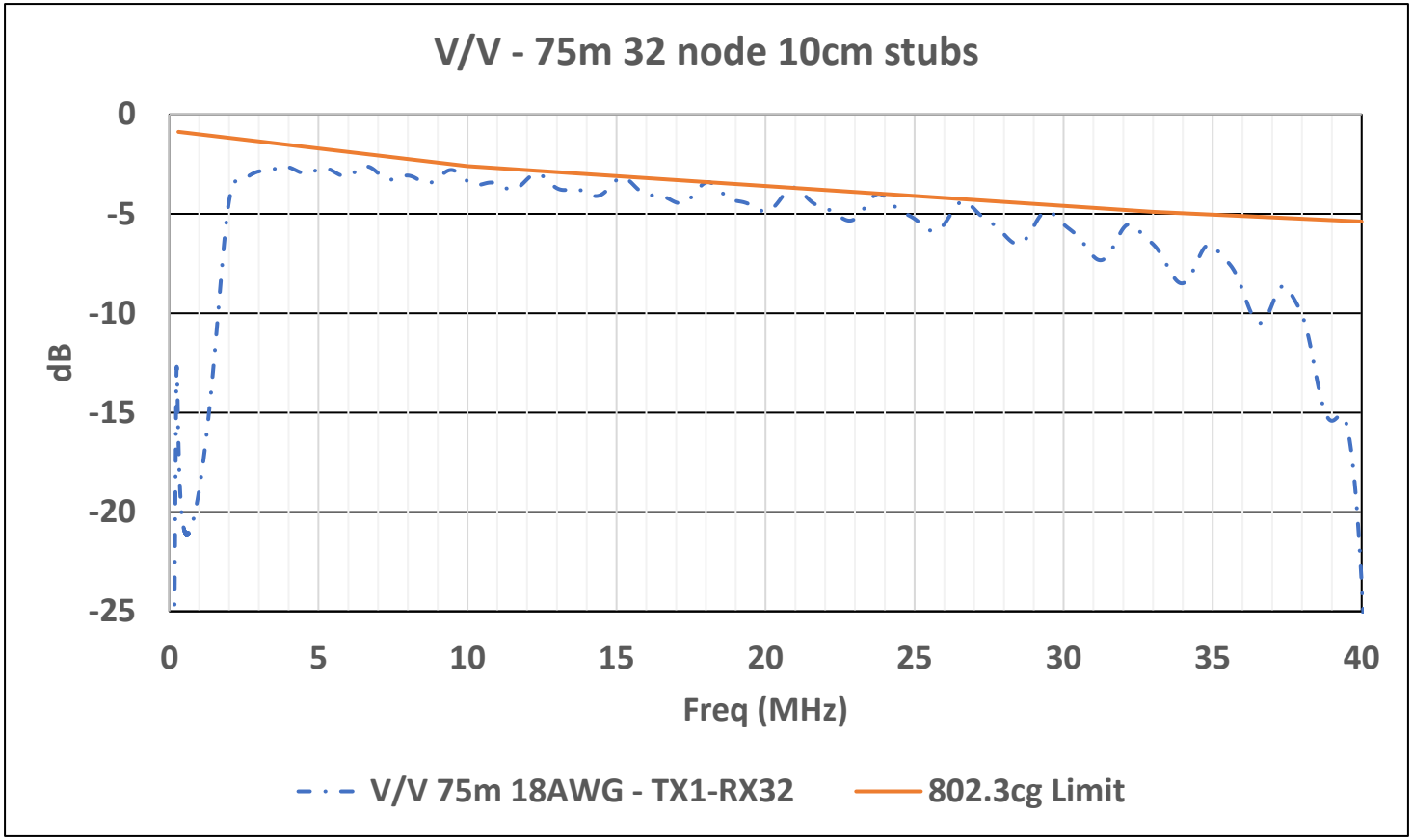
- 75m 18AWG cable, 32 nodes,10 cm stub lengths,80 uH, 15 pF, evenly spaced (2.419 m)

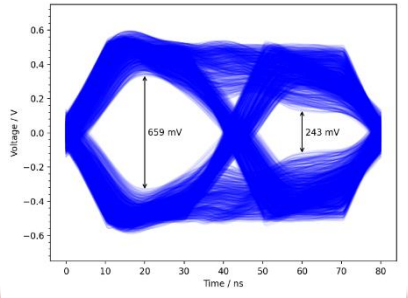


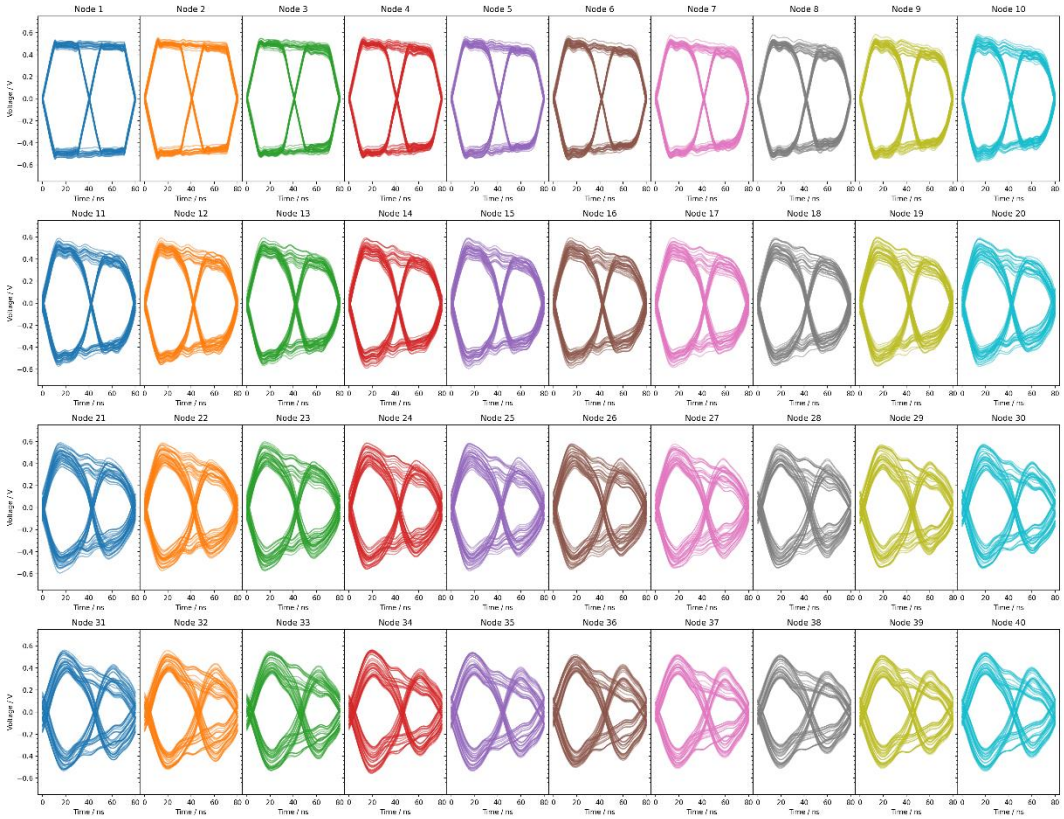
# Link Segment Node Distribution

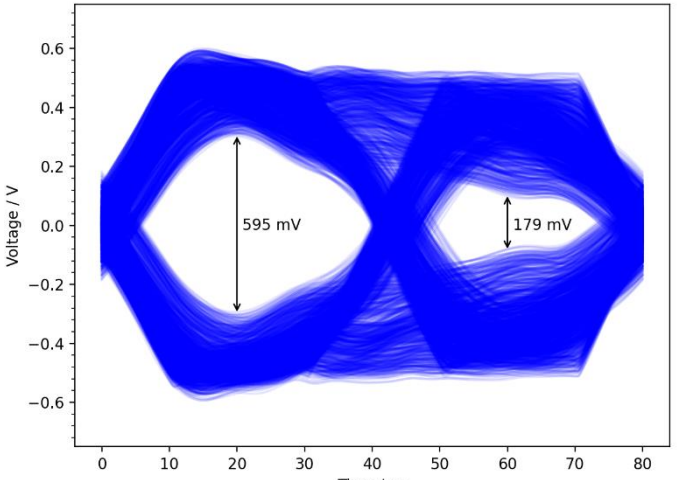


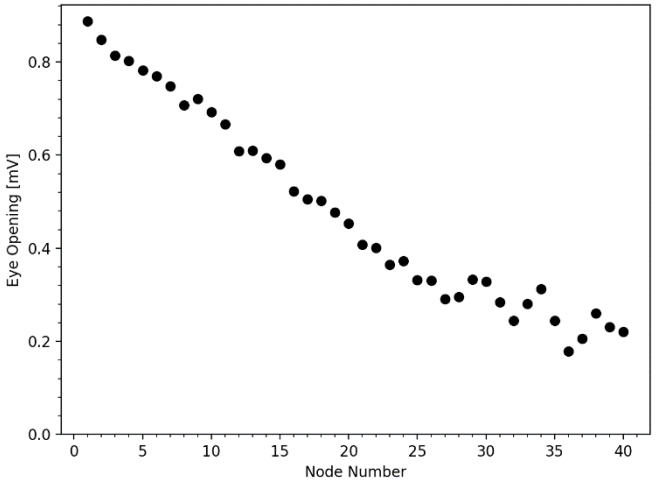



# Link Segment Node Distribution

- 75m 18AWG cable, 40 nodes,10 cm stub lengths,80 uH, 15 pF, evenly spaced 1.923 m

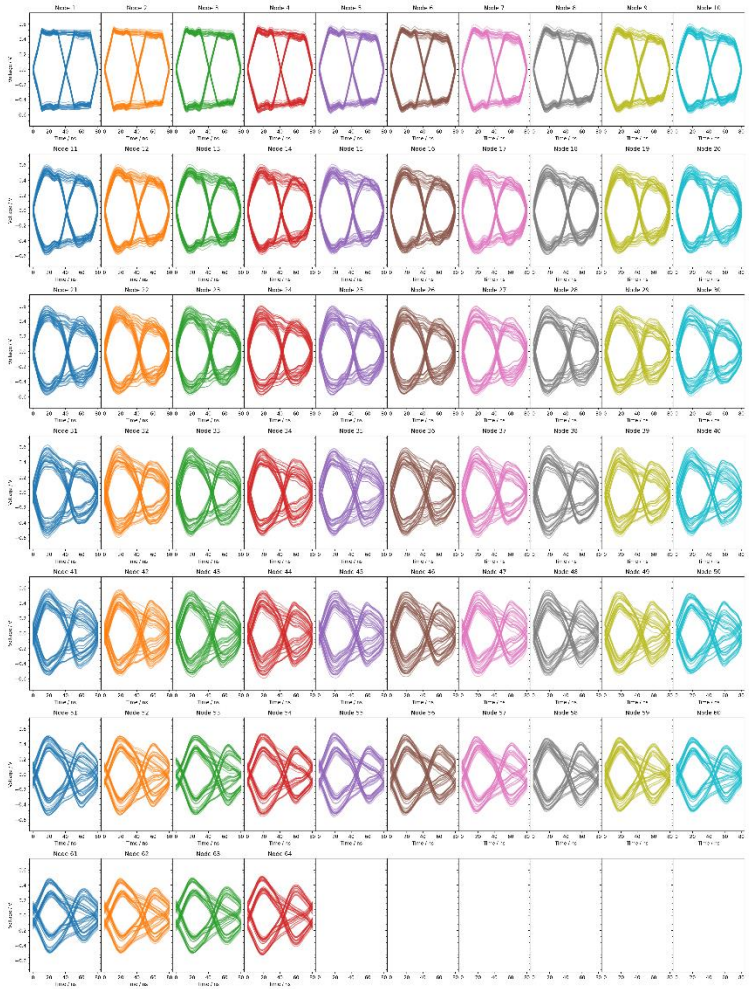


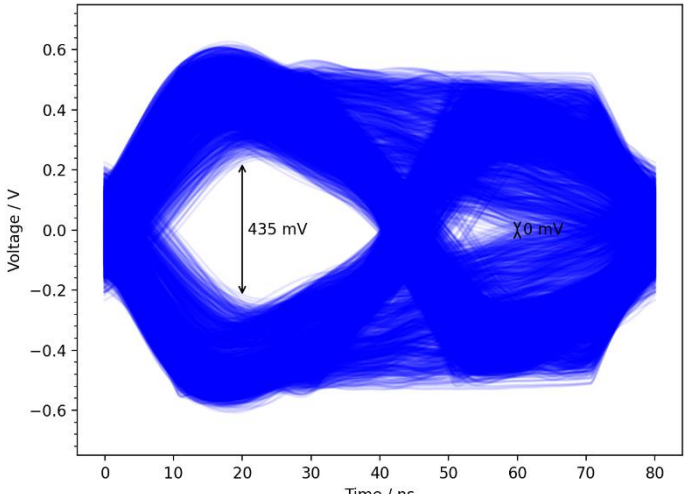



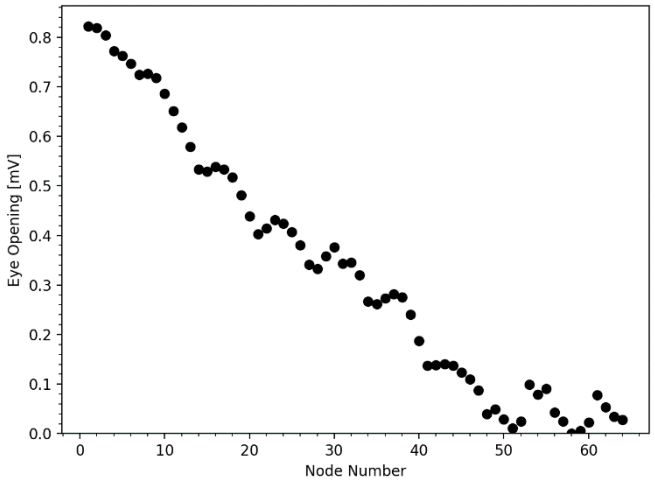



# Link Segment Node Distribution

- 75m 18AWG cable, 64 nodes,10 cm stub lengths,80 uH, 15 pF, evenly spaced 1.91 m

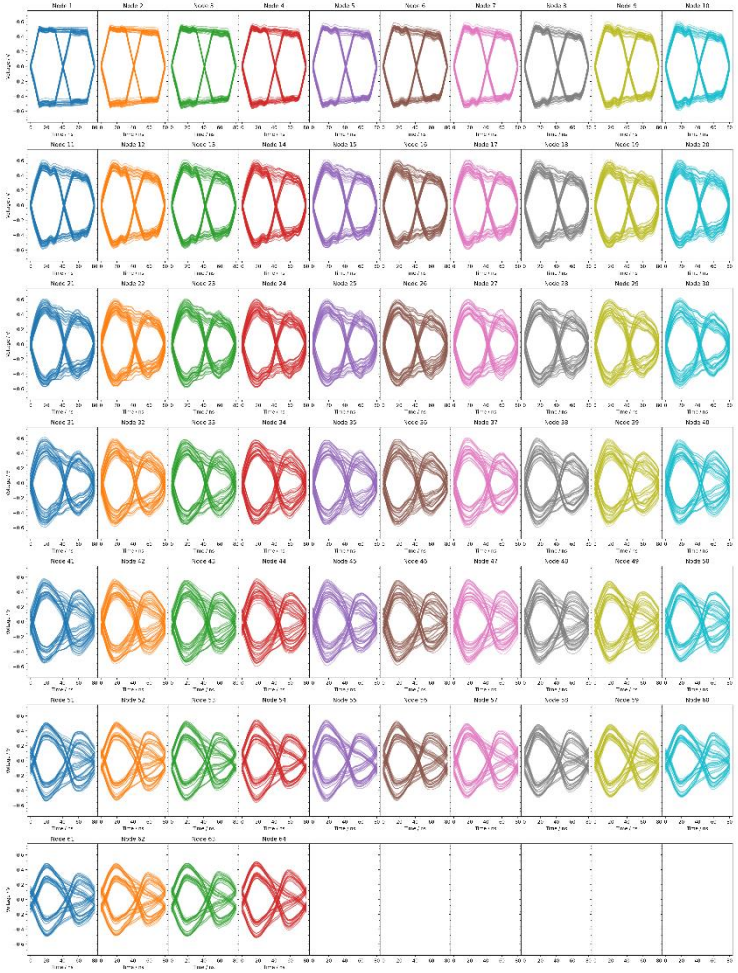


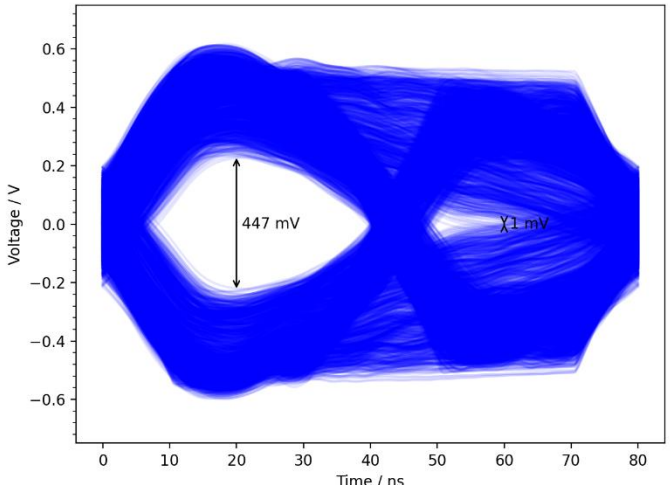


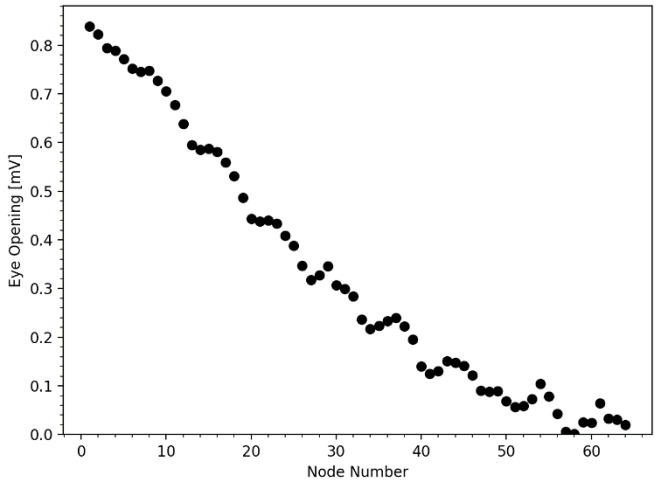



# Link Segment Node Distribution

- 75m 18AWG cable, 64 nodes, 5 cm stub lengths,80 uH, 15 pF, evenly spaced 1.91 m

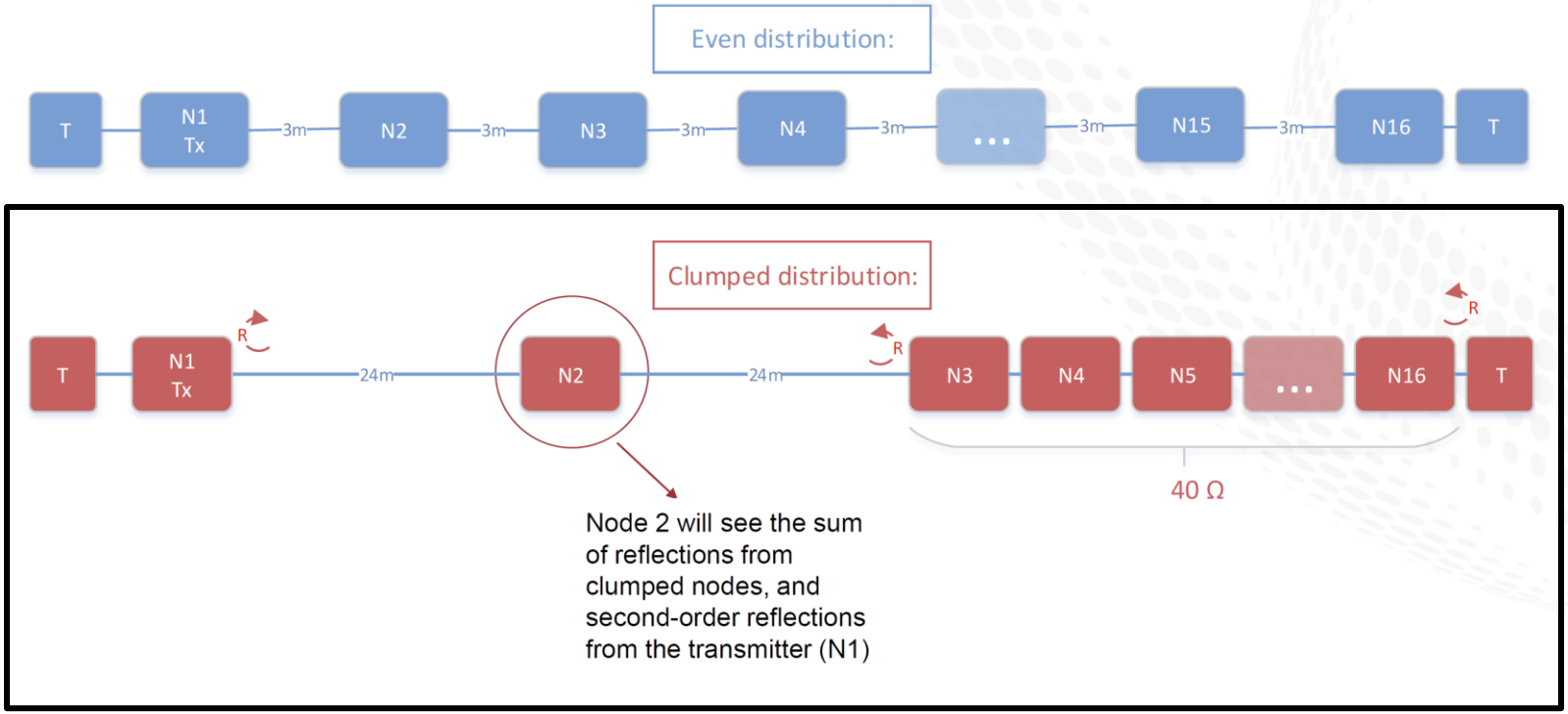




# Clumped Distribution Analyzed

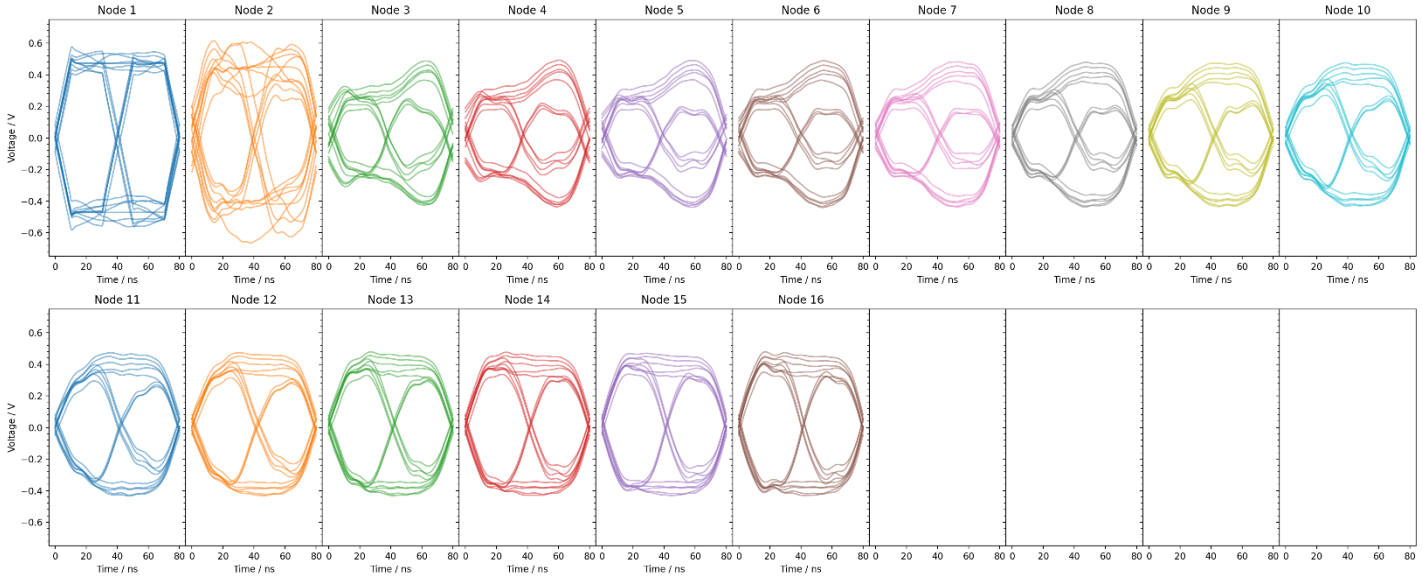
## Node distribution – time domain simulation



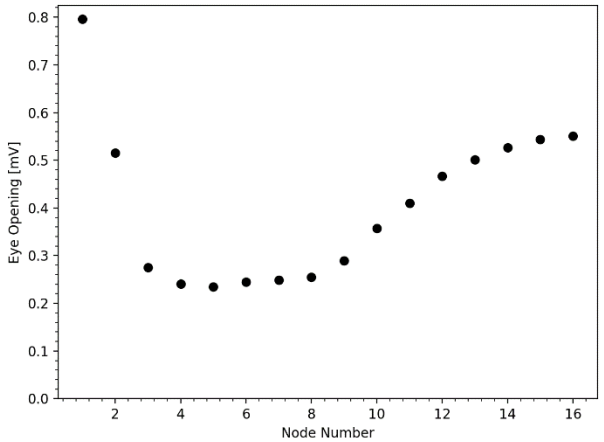

Source: Koczwara_Griffiths_Brandt_MultidropNodeDistributionChallenges_20201202_v1.1.pdf

# Clumped Distribution Transient results – 50 m Limit Cable

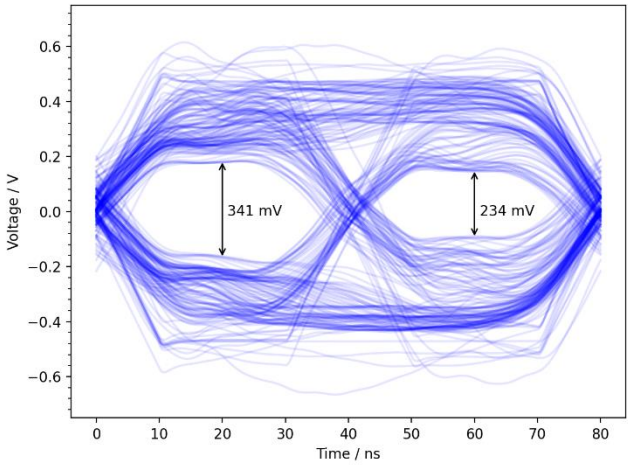
## Multi-eye




## Multi-eye distribution

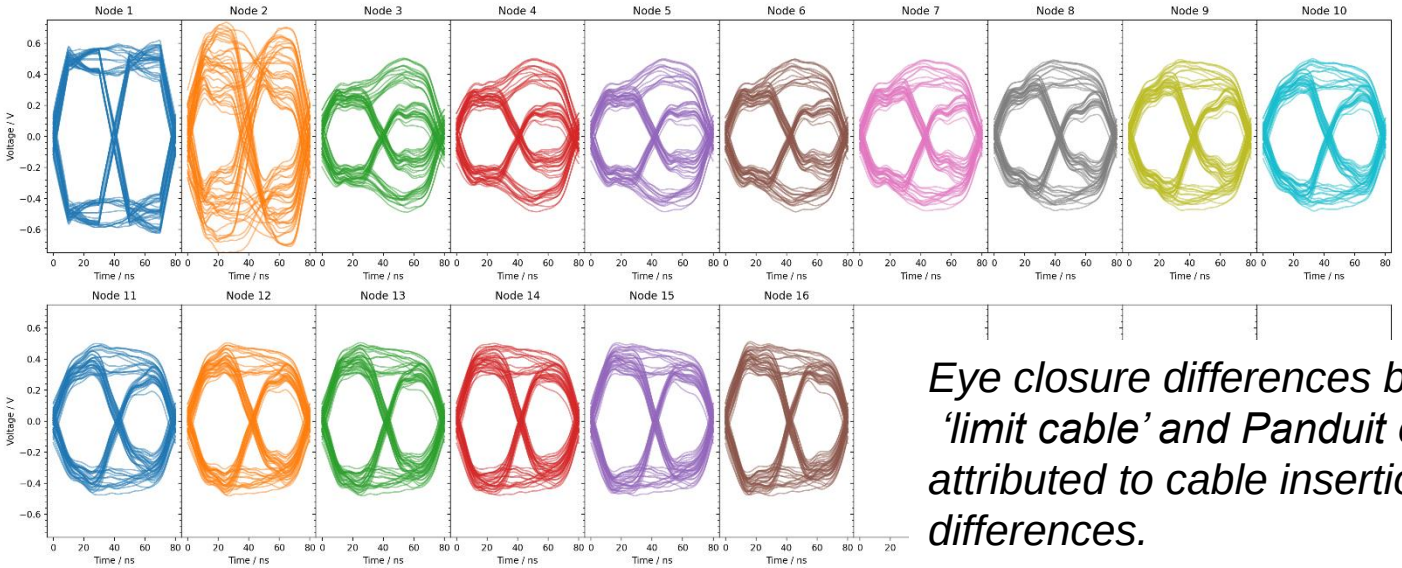



## Combined-eye



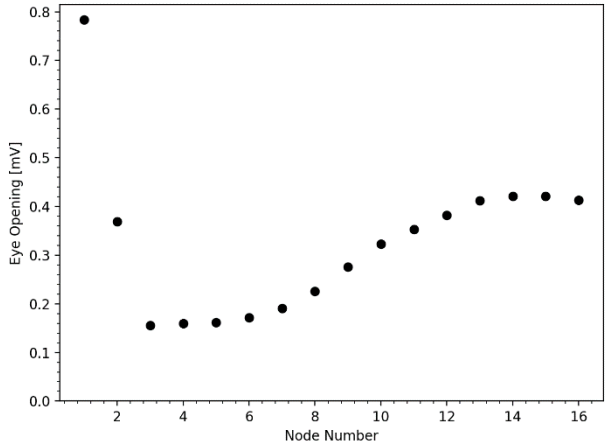
# Clumped Distribution Transient results – 50 m Panduit Cable

## Multi-eye

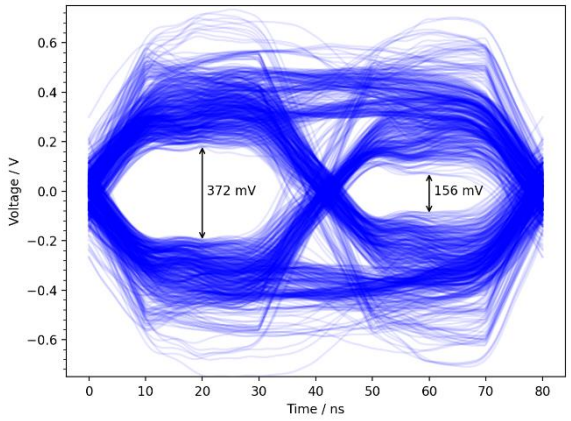



*Eye closure differences between 'limit cable' and Panduit cable attributed to cable insertion loss differences.*

## Multi-eye distribution




## Combined-eye



# Summary

- New cable model developed to use with transient analysis for RX eye
  - Cable model transmission characteristics consistent with prior cable model
- Eye closure differences between ‘limit cable’ and Panduit cable attributed to cable insertion loss differences.
- Validated cable models with transient results to be applied to mixing segment proposal(s)