

# **Robustness of Clause-73-based Autoneg Signaling Under Noisy Conditions**

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# Contributors

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# Outline

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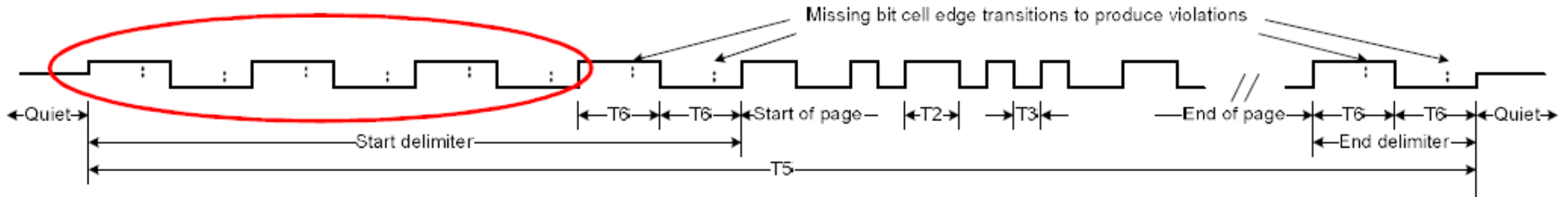
- Review of Clause73 / DME-based approach
- Effect of Cable Channel ISI
  - 2m cable at 22 degC vs. 15m cable at 125 degC
  - Performance under AWGN and NBI
- Effect of PoDL High Pass Filter
  - Performance under AWGN and NBI
- Summary

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# **CL73-BASED AUTONEG SIGNALING**

# Clause 73 / DME-based Approach

From Lo\_3bp\_02a\_0714



- Each bit cell lasts 16 ns ( $T2 = 16\text{ns}$ ,  $T3 = 8\text{ns}$ ).
- Always transition at boundary of bit cells.
- A “1” bit has a transition at middle of bit cell, while a “0” bit does not.
- Assume 1Vpp at transmitter output.
- Assume receiver is based on comparator-type detection at optimal sampling time.

# T3 = 8ns for 100BASE-T1 AFE?

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- 100BASE-T1 baud rate is 66.6̄MHz, corresponding to 15ns of symbol duration.
- Choice of T3 = 8ns probably is not suitable for 100BASE-T1 AFE.
- Instead, one should consider  $T3 \geq 15\text{ns}$ .

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# **EFFECT OF CABLE CHANNEL ISI**

# Effect of Cable Channel ISI

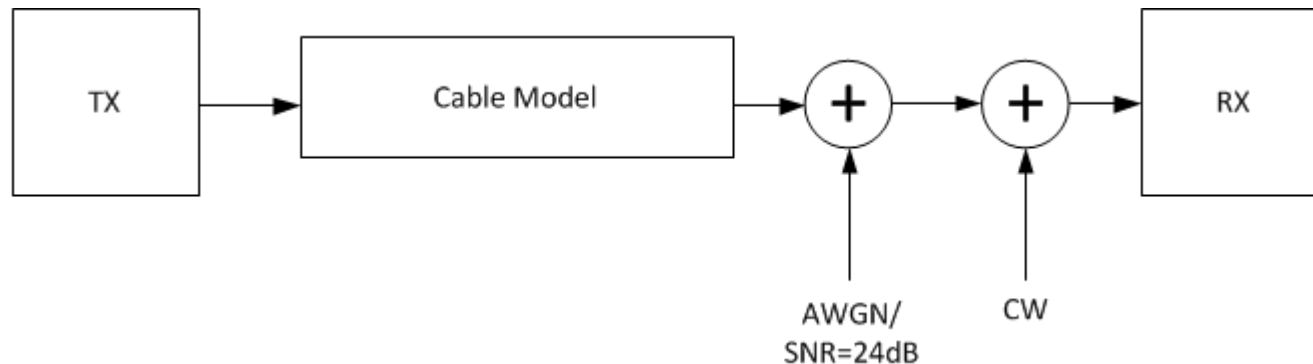
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- Consider 1000BASE-T1 AFE
- Cable #1
  - 2m at 22 degC
- Cable #2
  - 15m at 125 degC
  - includes 4 in-line connectors
- PHY analog HPF bypassed



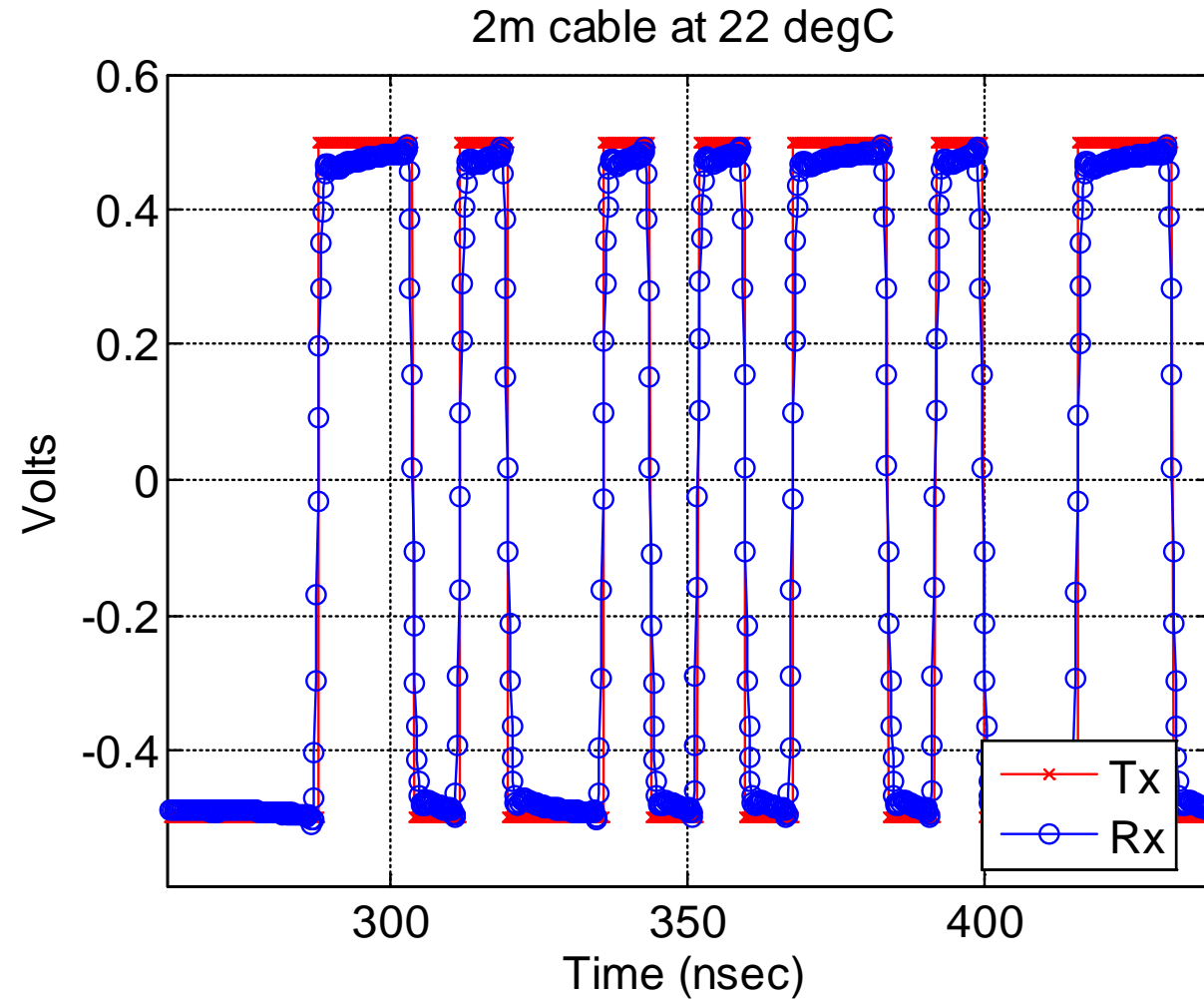
# Channel Modeling With Noises

- AWGN at SNR = 24dB
- Narrow band interference
  - CW
  - 200mV p-p for 2m cable
  - 100mV p-p for 15m cable

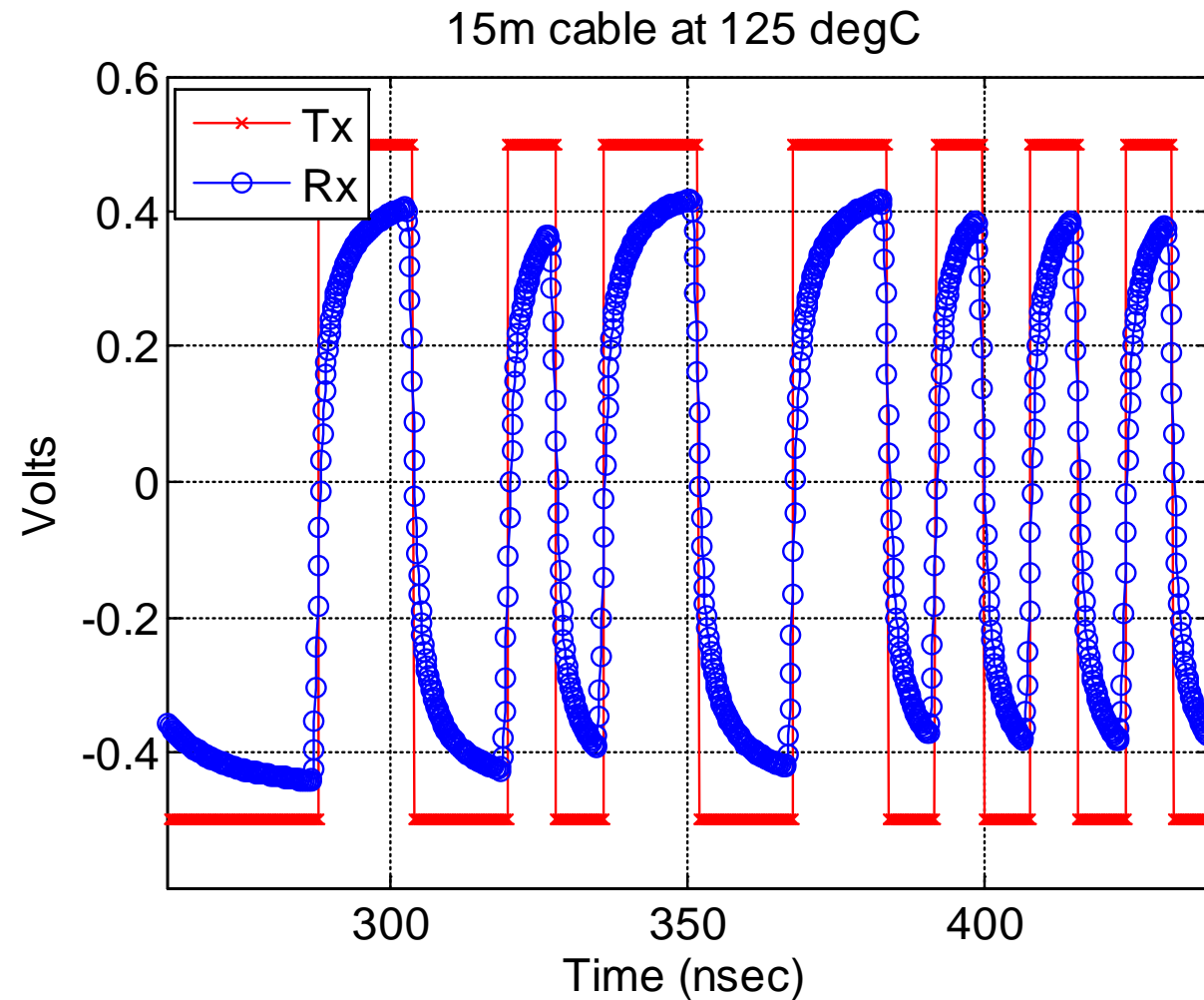


# Tx vs. Rx: 2m cable, ISI only

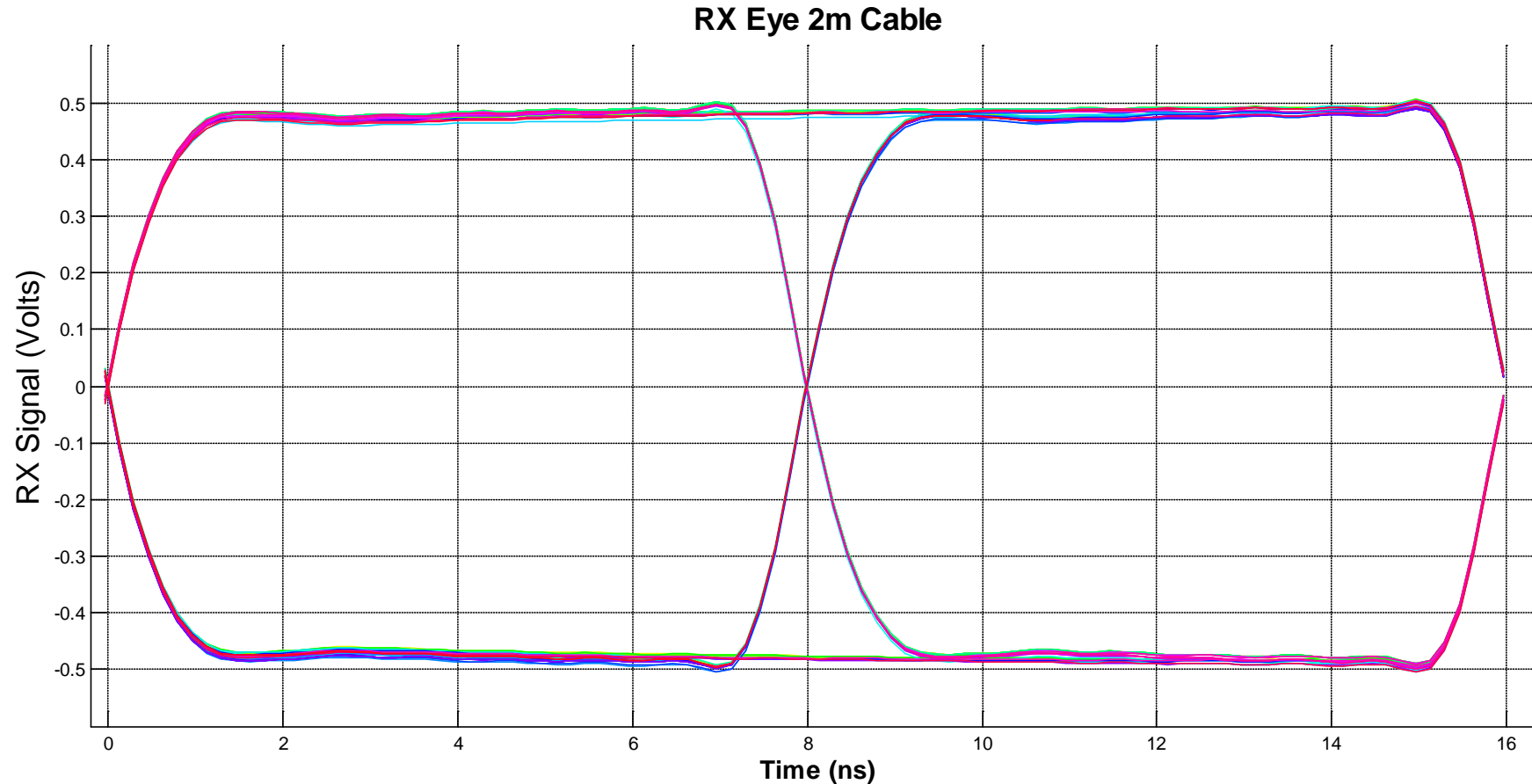
$T_3 = 8\text{ns}$



# Tx vs. Rx:15m cable, ISI only

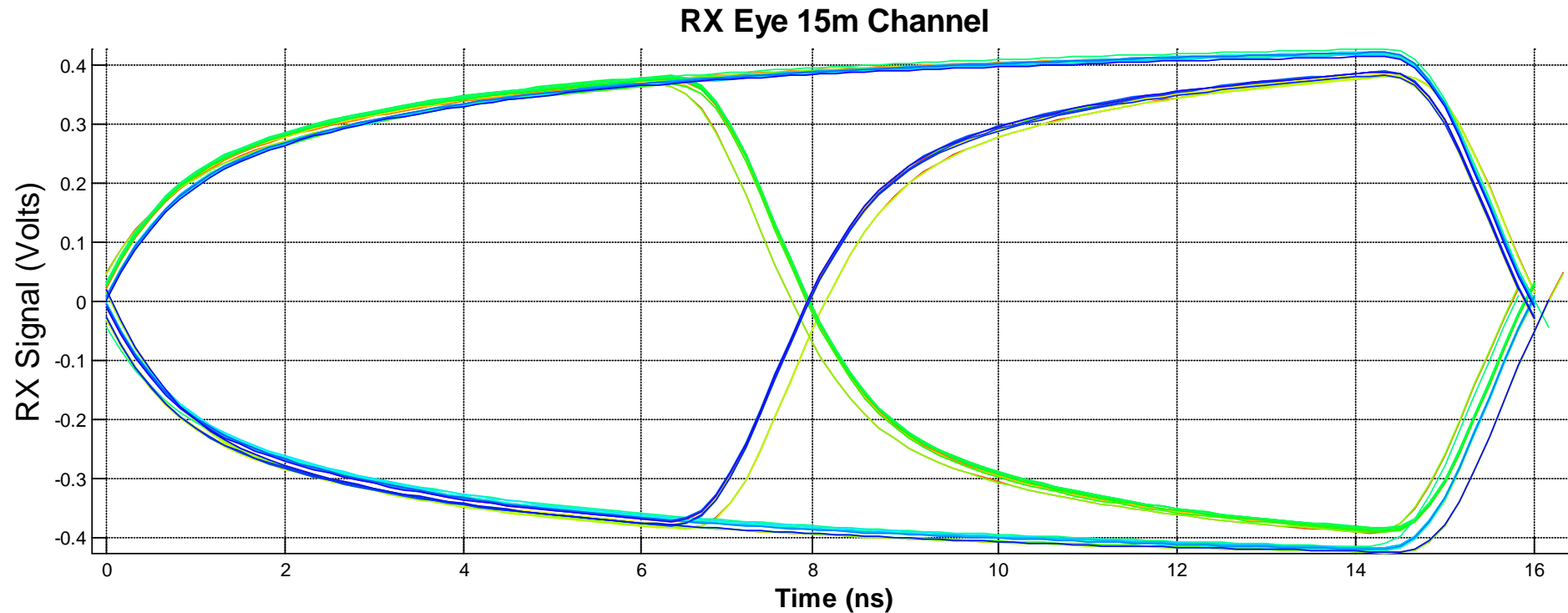


# Eye Diagram: 2m cable, ISI only



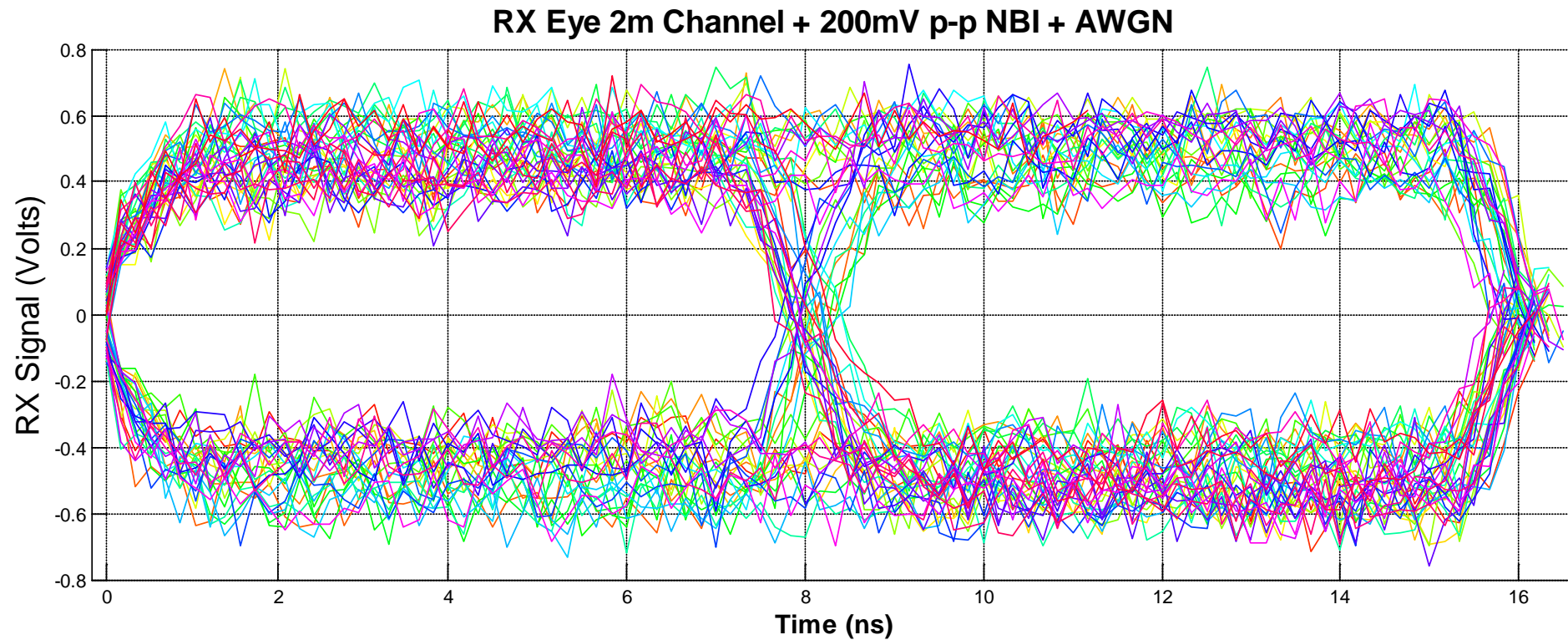
- Clean Eye, minimal ISI
- Both halves of bit cell can be detected

# Eye Diagram: 15m cable, ISI only

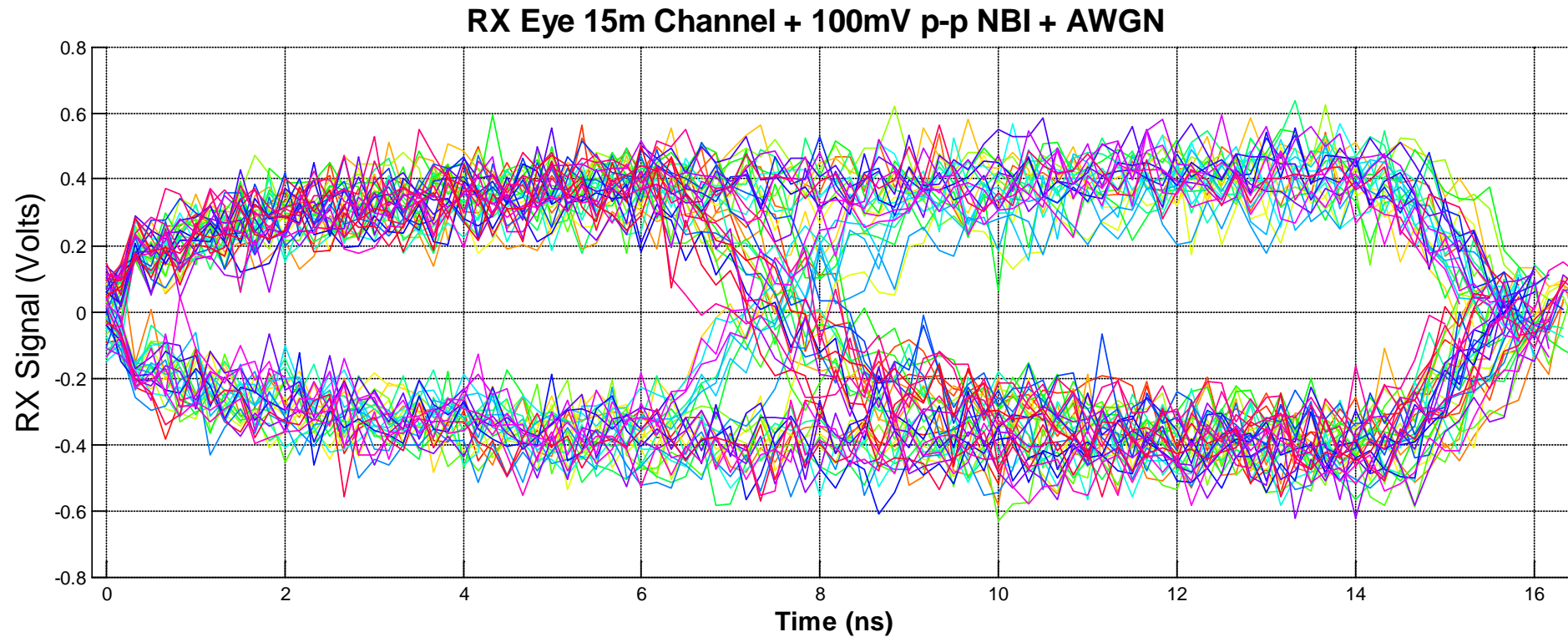


- More ISI than 2m cable, but eye is wide open

# 2m cable with AWGN and NBI



# 15m cable with AWGN and NBI



# Summary: Effect of Cable Channel ISI

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- DME signals with  $T_3 = 8\text{ns}$  can be detected reliably by 1000BASE-T1 PHY for both 2m and 15m cables, under AWGN and NBI.



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# **EFFECT OF PODL HIGH PASS FILTER**

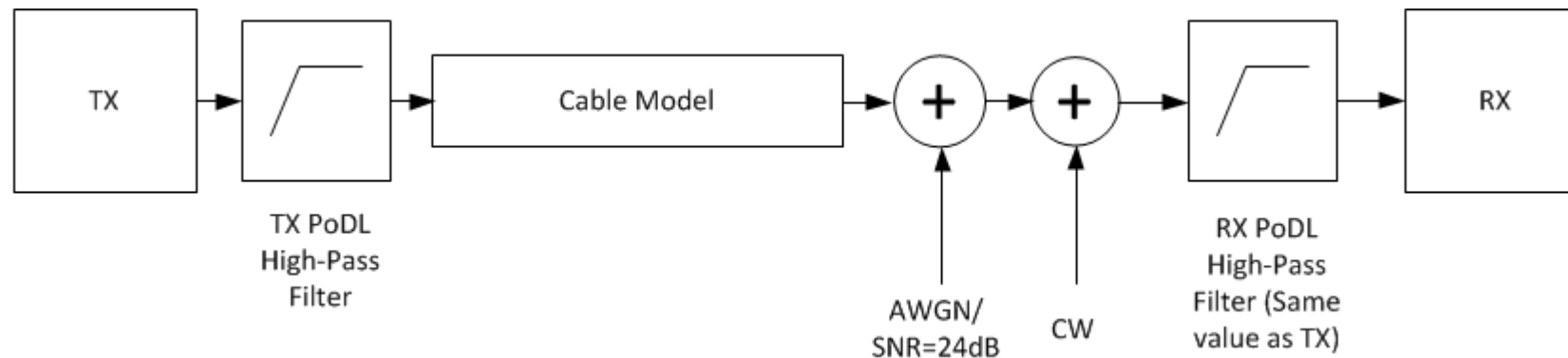
# PoDL High Pass Filter

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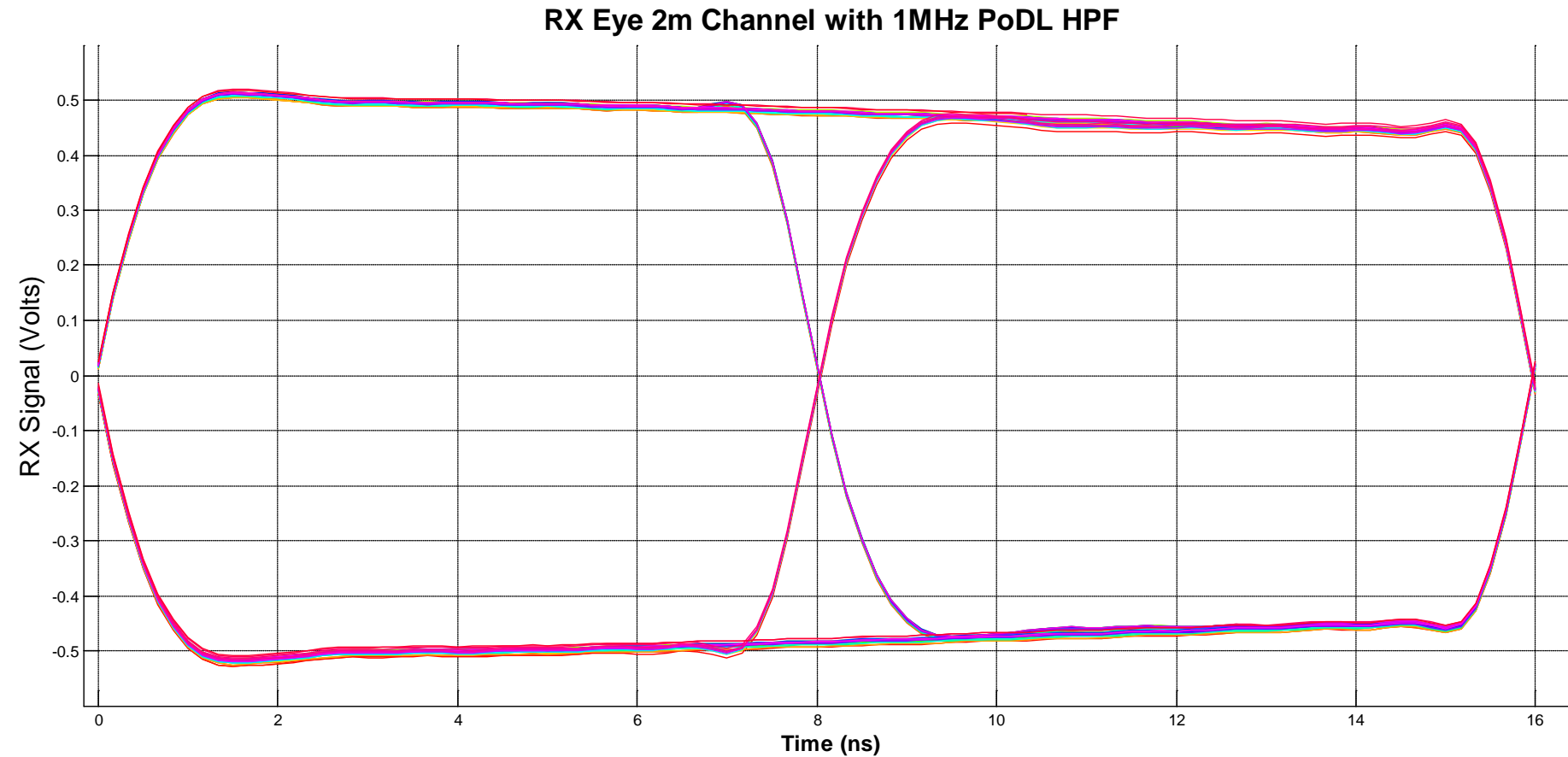
- High pass filters are required to support PoDL
  - HPF corner is 1-2MHz for 100BASE-T1.
  - HPF corner is about 11MHz for practical 1000BASE-T1 designs.
  - The increased HPF corner frequency is due to wider bandwidth requirement for 1000BASE-T1.
- These filters are external to the PHY and hence are not bypassable.

# Modeling PoDL High Pass Filter

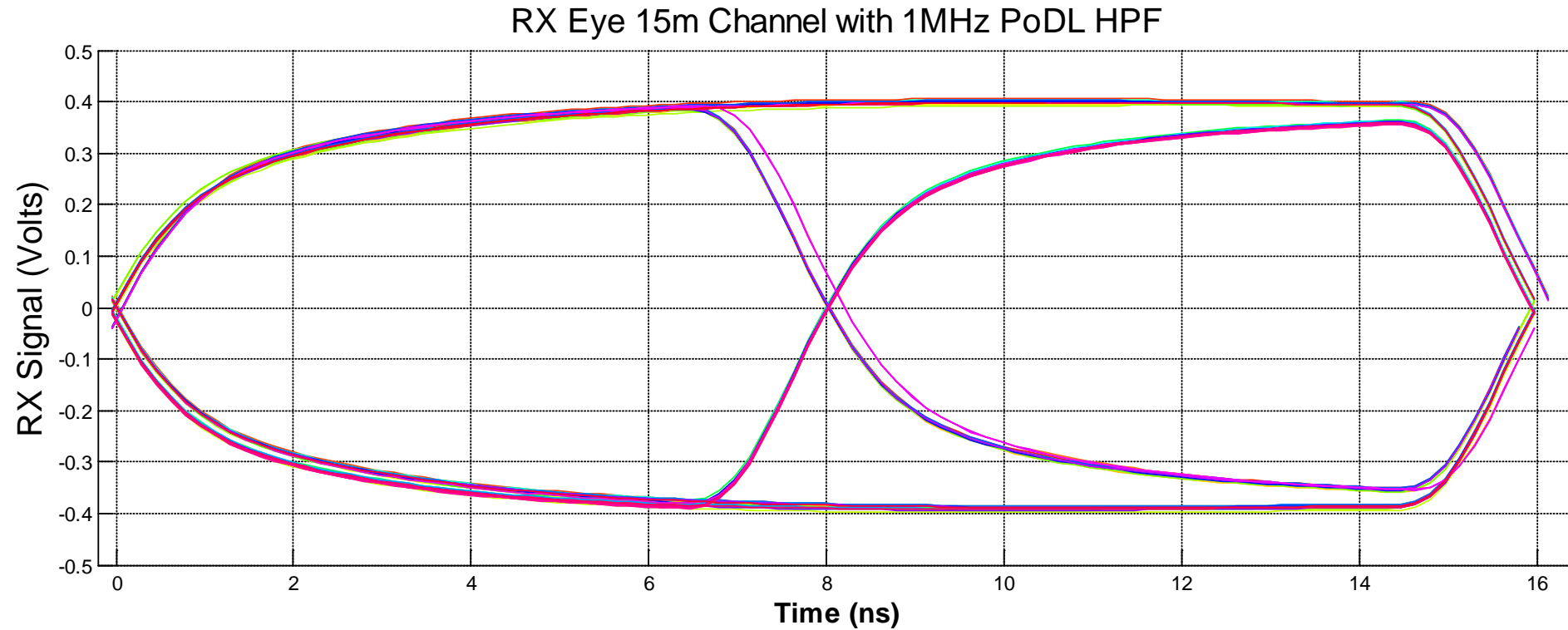
- 1<sup>st</sup> order HPF
- HPF corner frequency considered: 1MHz and 11MHz



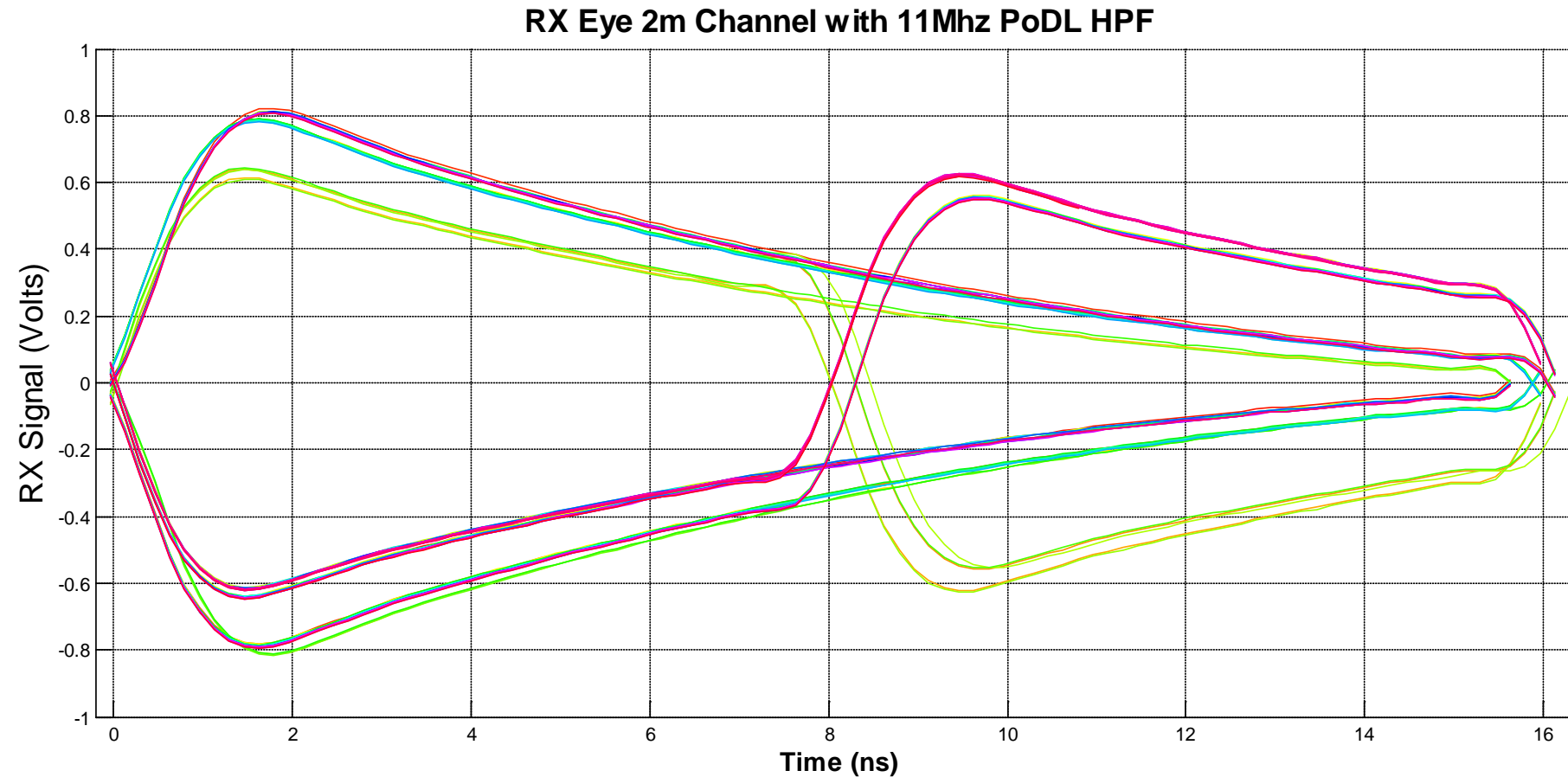
# 2m channel with 1MHz HPF



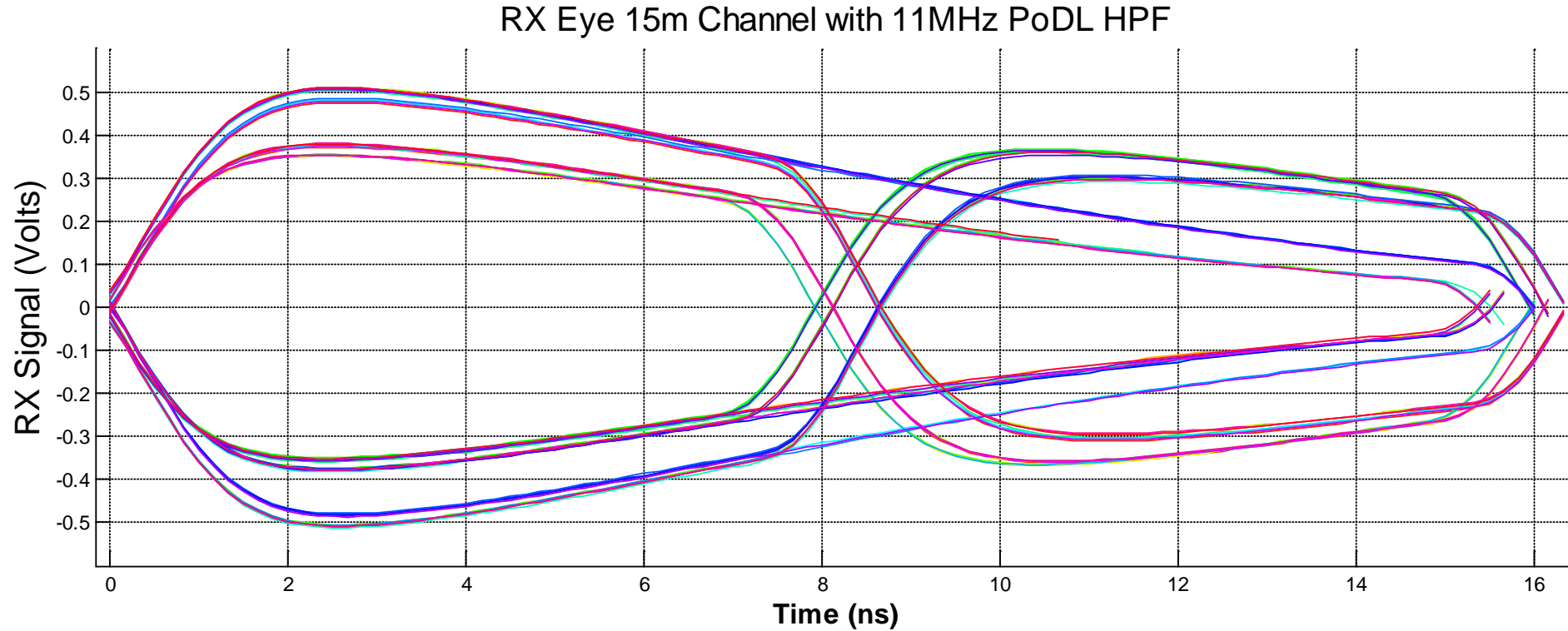
# 15m channel with 1MHz HPF



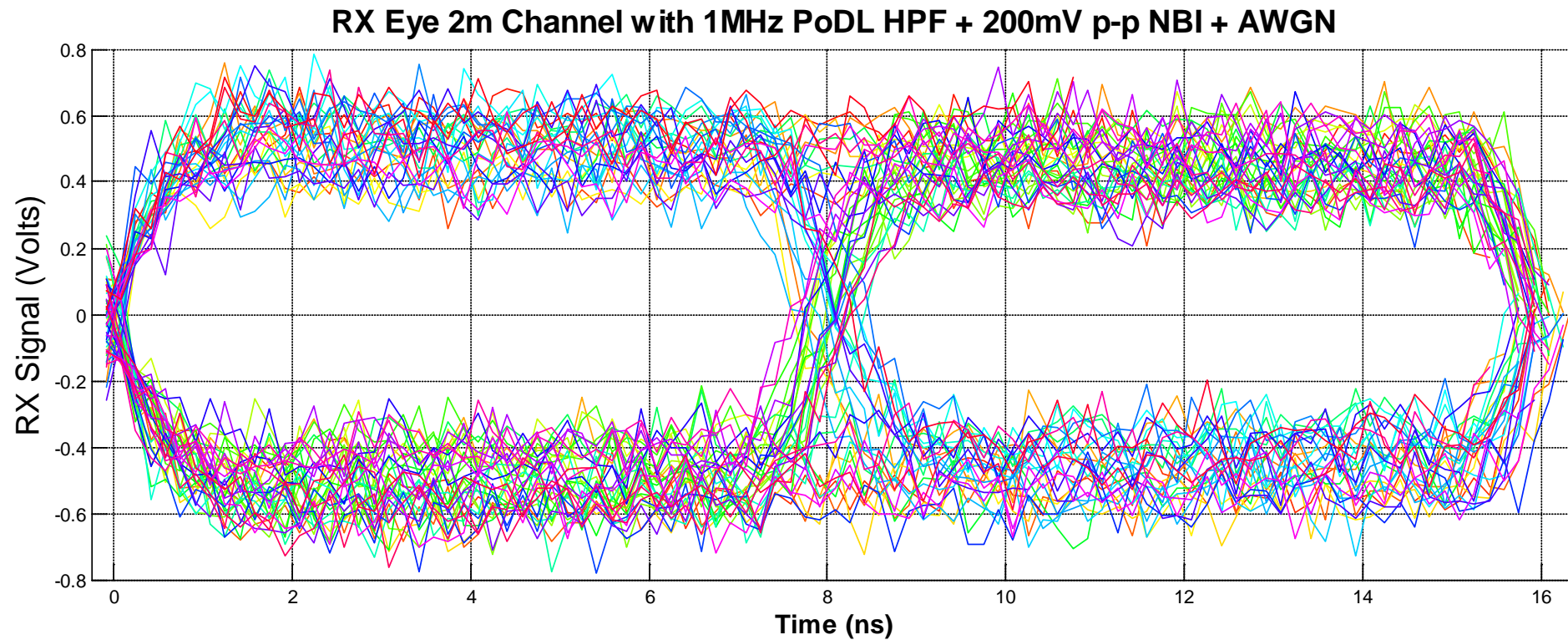
# 2m channel with 11MHz HPF



# 15m channel with 11MHz HPF

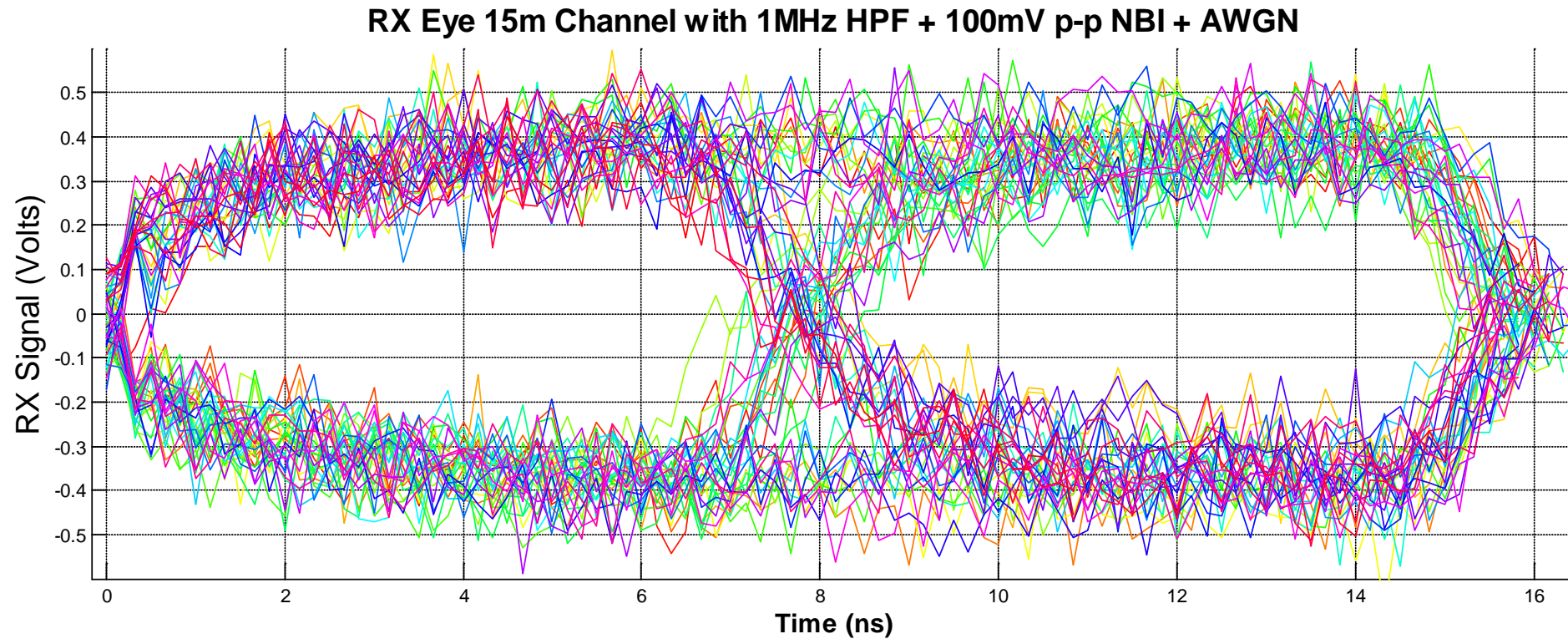


# 2m Channel with 1MHz HPF and Noise

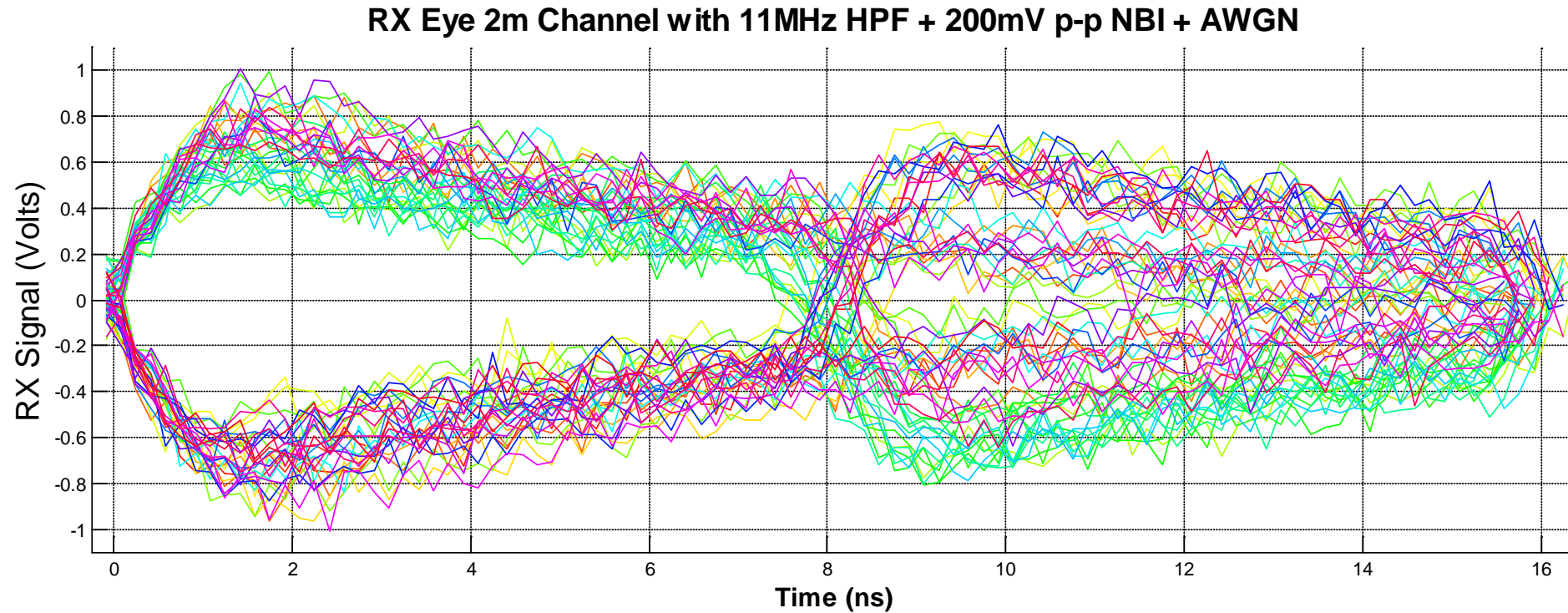




# 15m Channel with 1MHz HPF and Noise

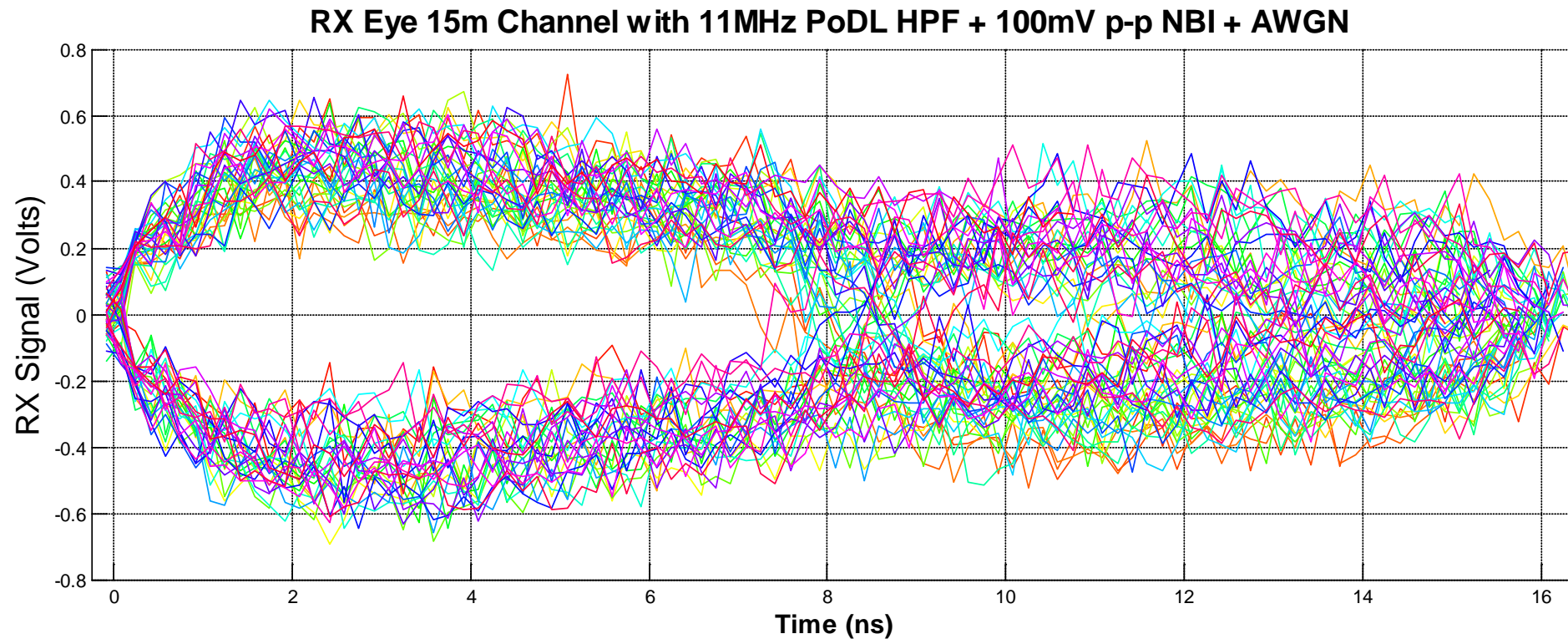


# 2m cable with 11MHz HPF and Noise



Eye closed: cannot detect 2<sup>nd</sup> part of bit cell

# 15m cable with 11MHz HPF and Noise



Eye closed: cannot detect 2<sup>nd</sup> part of bit cell

# Summary

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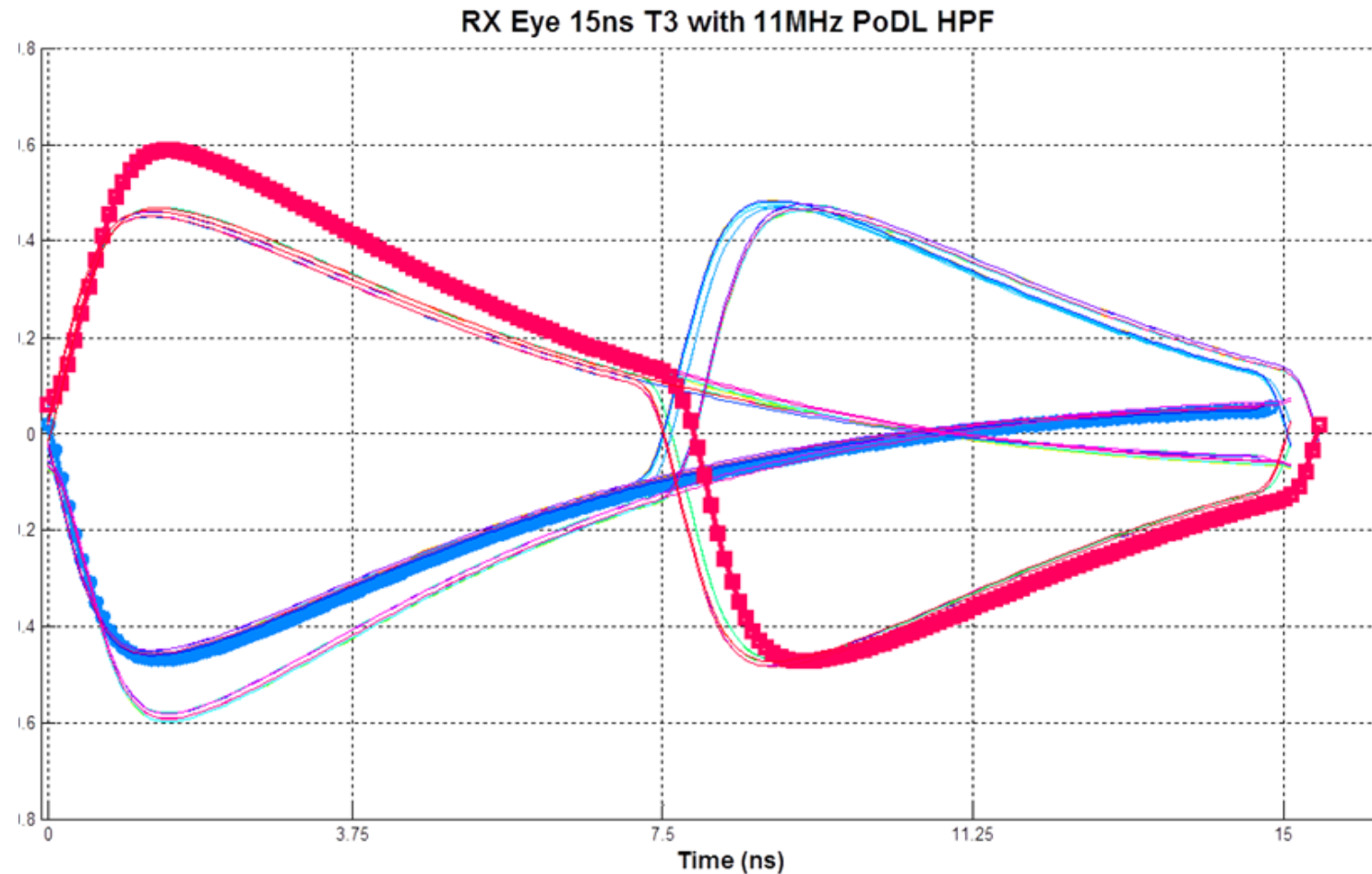
- For 100BASE-T1 PHY, it requires  $T3 \geq 15$  ns due to AFE baud rate being 66.6MHz.
- For 1000BASE-T1 with PoDL, the DME signaling does not work with  $T3 \geq 8$  ns.
  - PoDL HPF corner frequency is about 11MHz due to wider bandwidth of 1000BASE-T1
- The DME based autoneg signaling cannot support both 100BASE-T1 and 1000BASE-T1 with PoDL with a common  $T3$  parameter.

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# **BACKUP SLIDE**



# RX EYE 15ns T3 with 11MHz PoDL HPF



A 15ns T3, is more compatible with 100BASE-T1 channel and Baud rate.  
On the 1000T1 Channel with PoDL, a '1' symbol (absence of transition) is completely distorted. Even without noise, almost impossible to detect with a comparator receiver