

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

Kanata, ON, Canada

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Mike Tu

tum@broadcom.com

Contributors

- Jay Cordaro
- Mehmet Tazebay

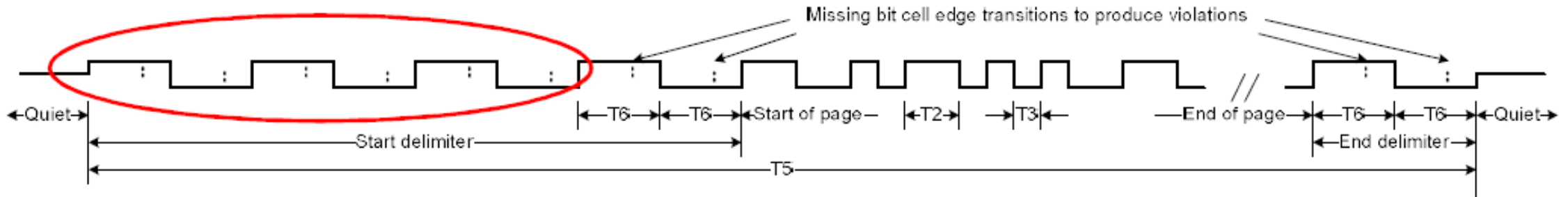
Outline

- 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

CL73-BASED AUTONEG SIGNALING

Clause 73 / DME-based Approach

From Lo_3bp_02a_0714



- Each bit cell lasts 16 ns ($T_2 = 16\text{ ns}$, $T_3 = 8\text{ ns}$).
- 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?

- 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 ≥ 15ns.

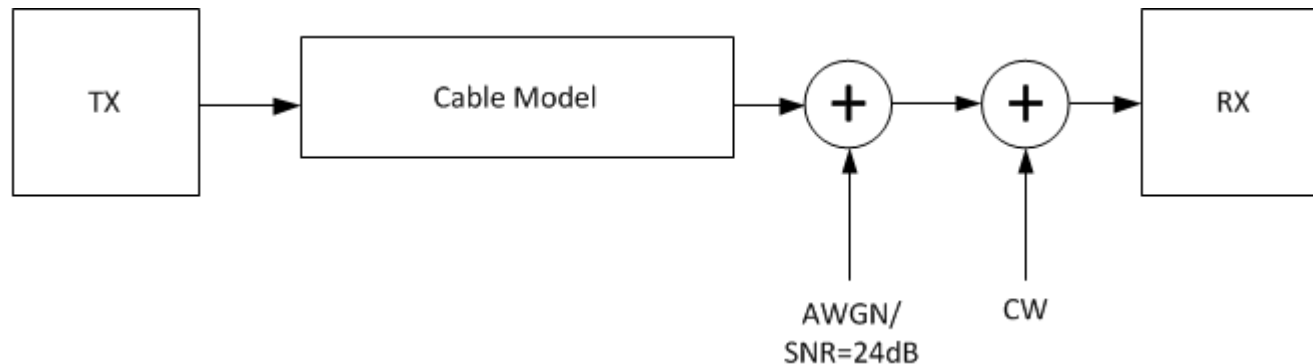
EFFECT OF CABLE CHANNEL ISI

Effect of Cable Channel ISI

- 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

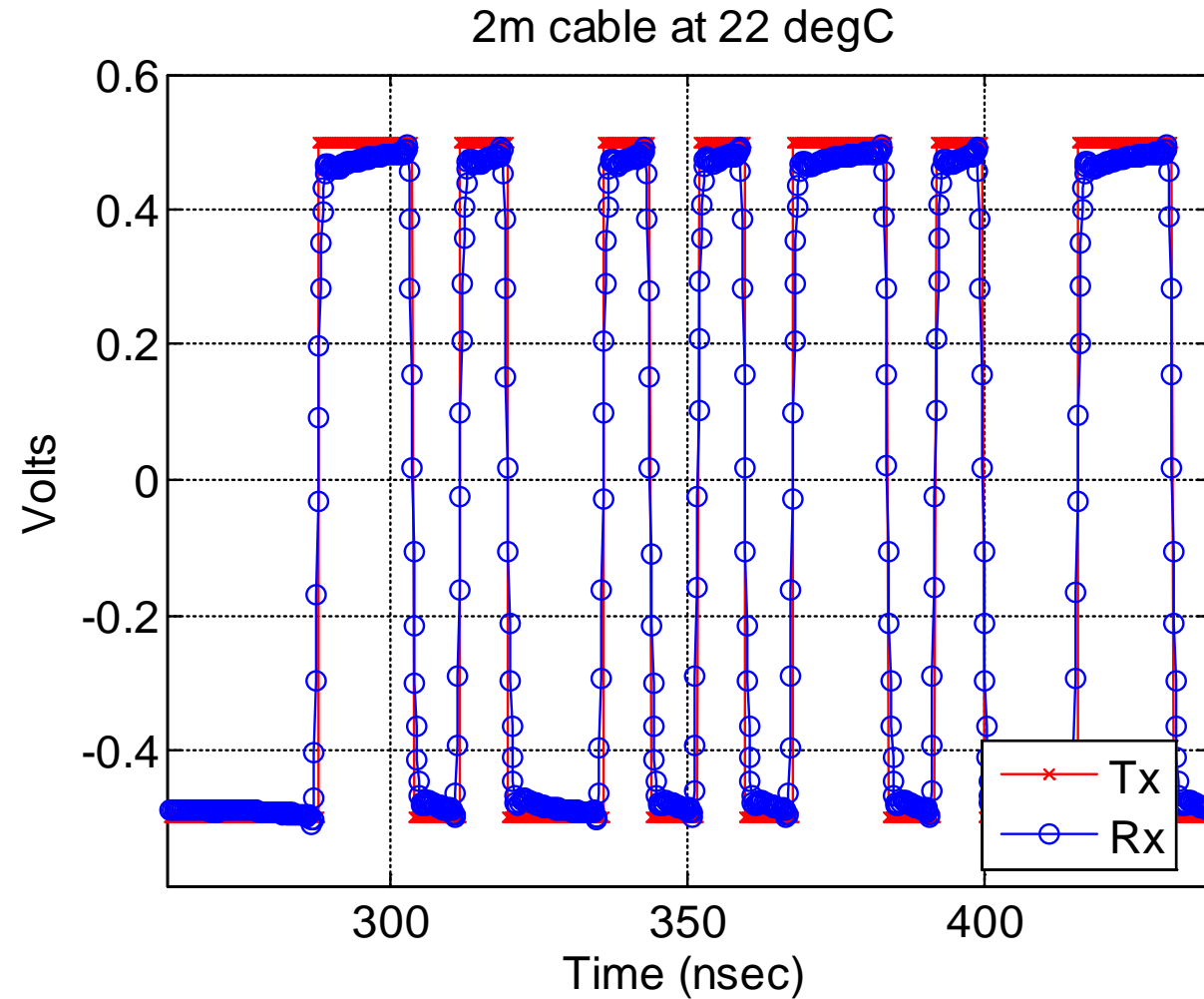
Channel Modeling With Noises

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

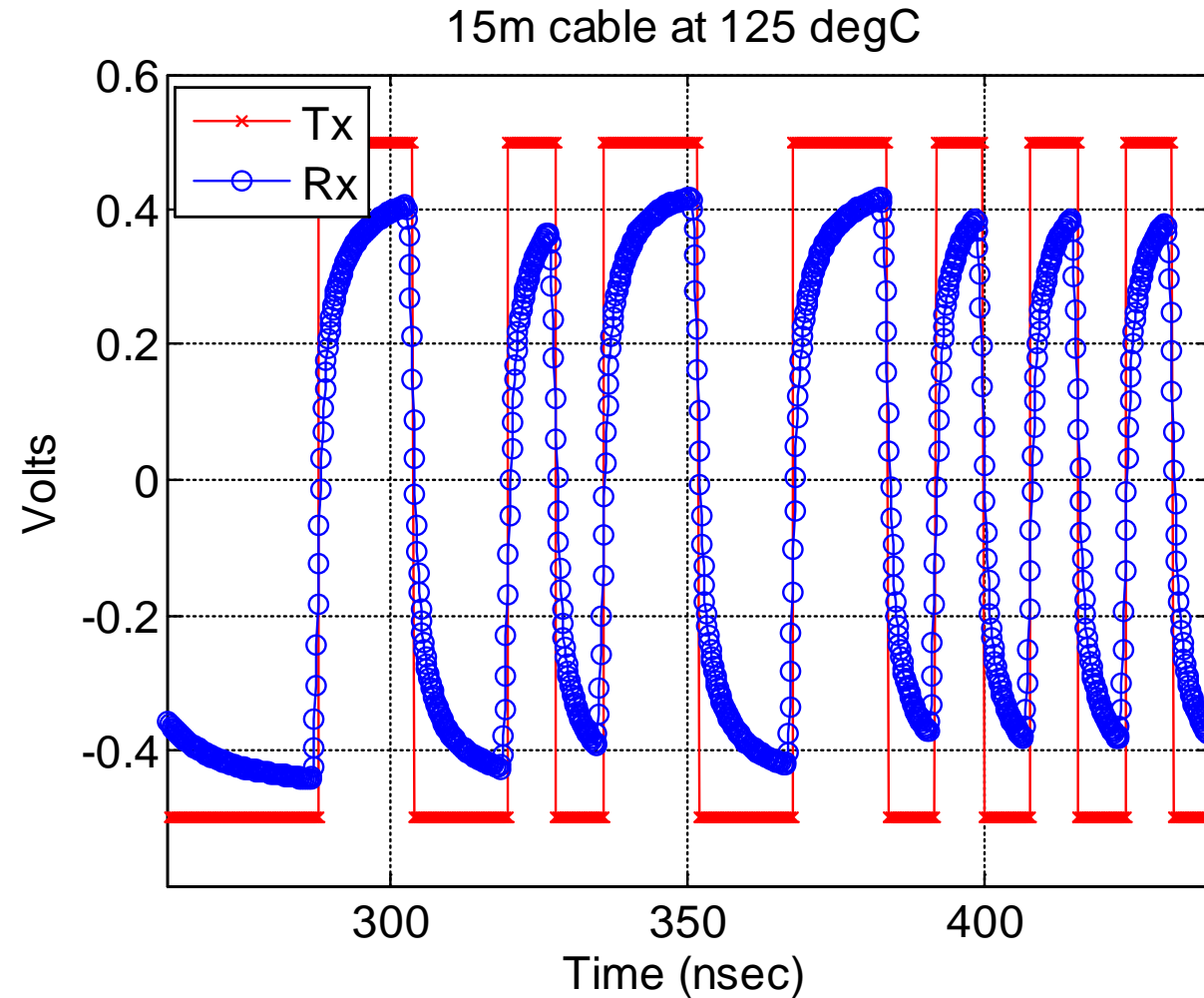


Tx vs. Rx: 2m cable, ISI only

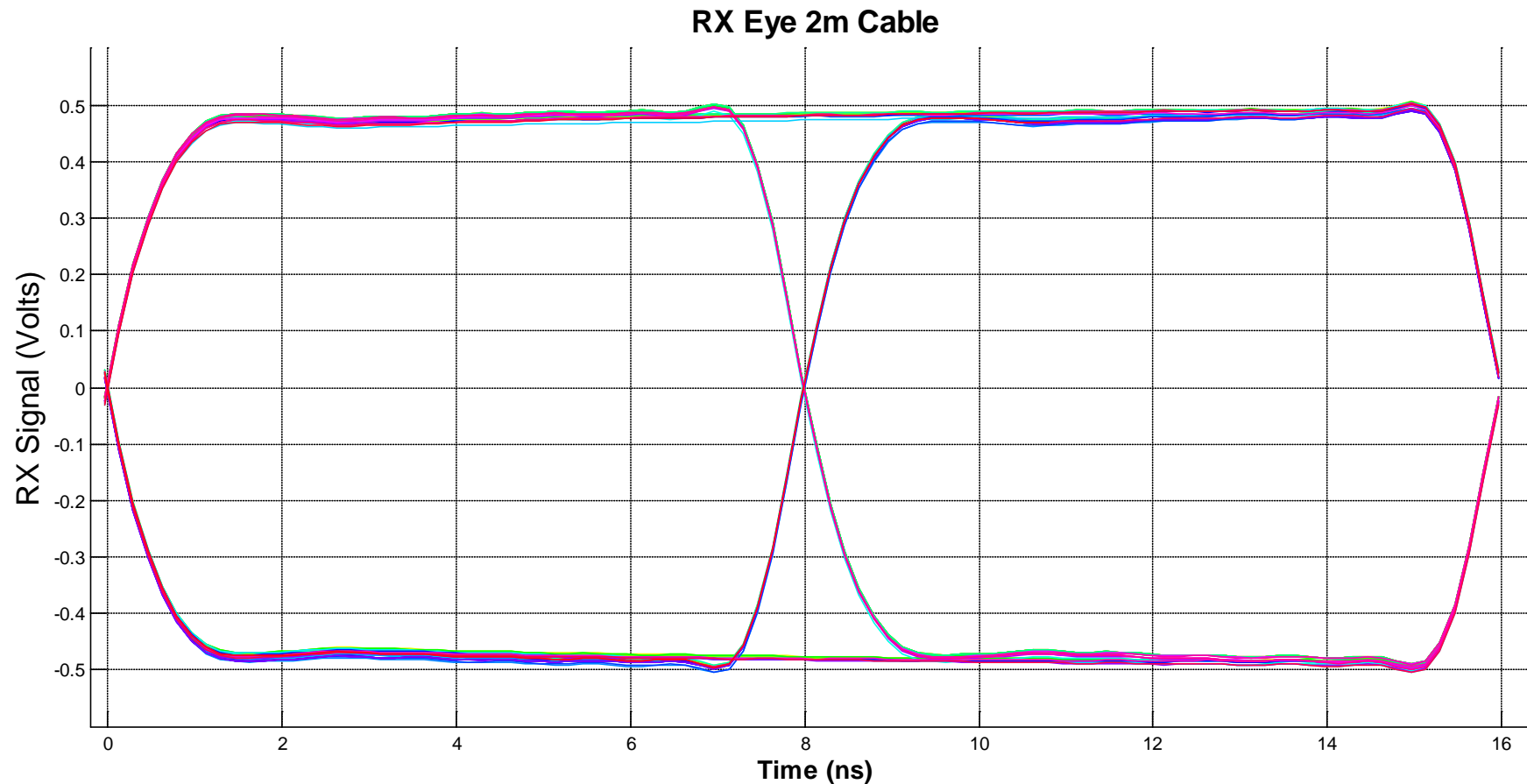
$T_3 = 8\text{ns}$



Tx vs. Rx: 15m cable, ISI only

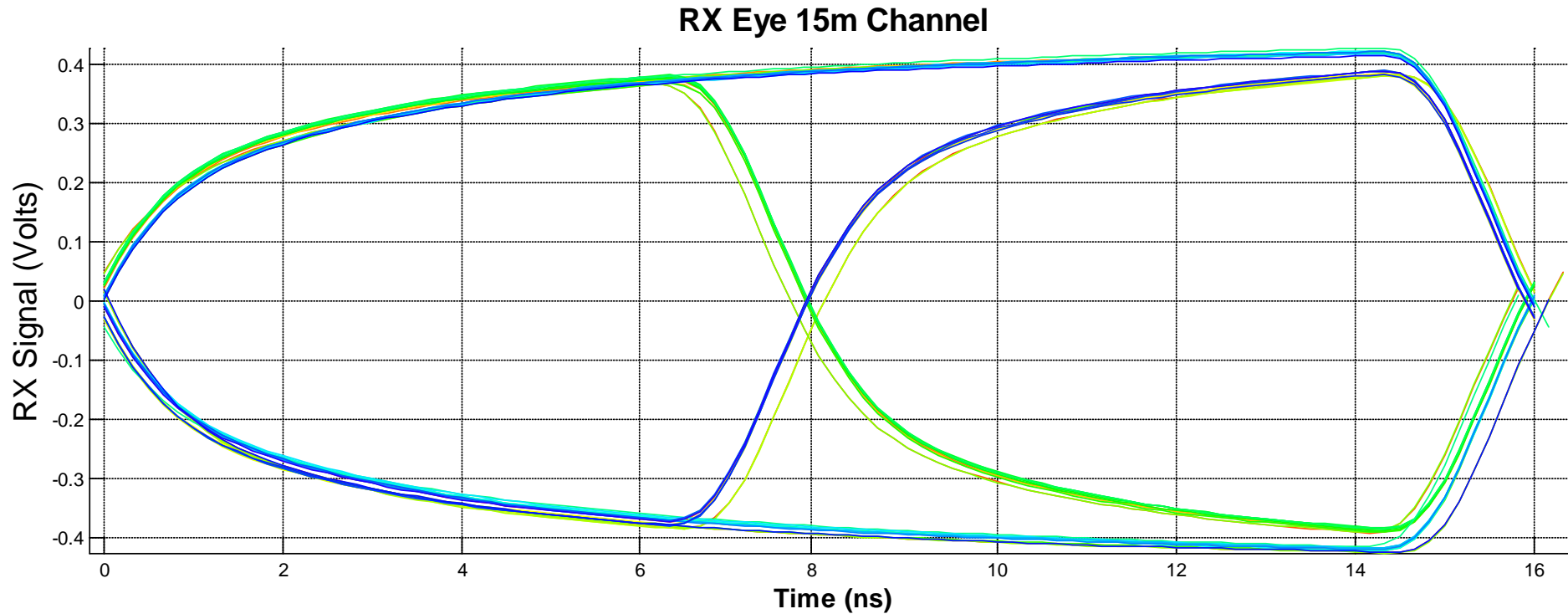


Eye Diagram: 2m cable, ISI only



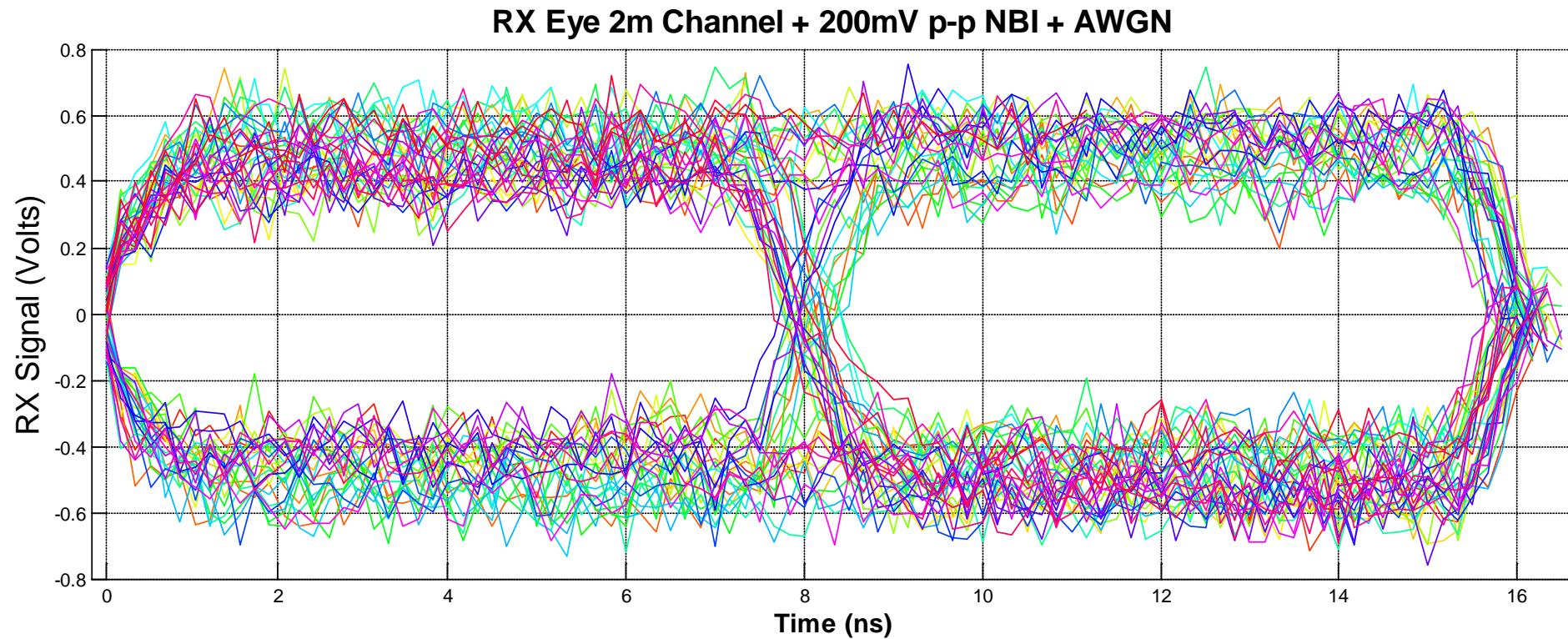
- Clean Eye, minimal ISI
- Both halves of bit cell can be detected

Eye Diagram: 15m cable, ISI only

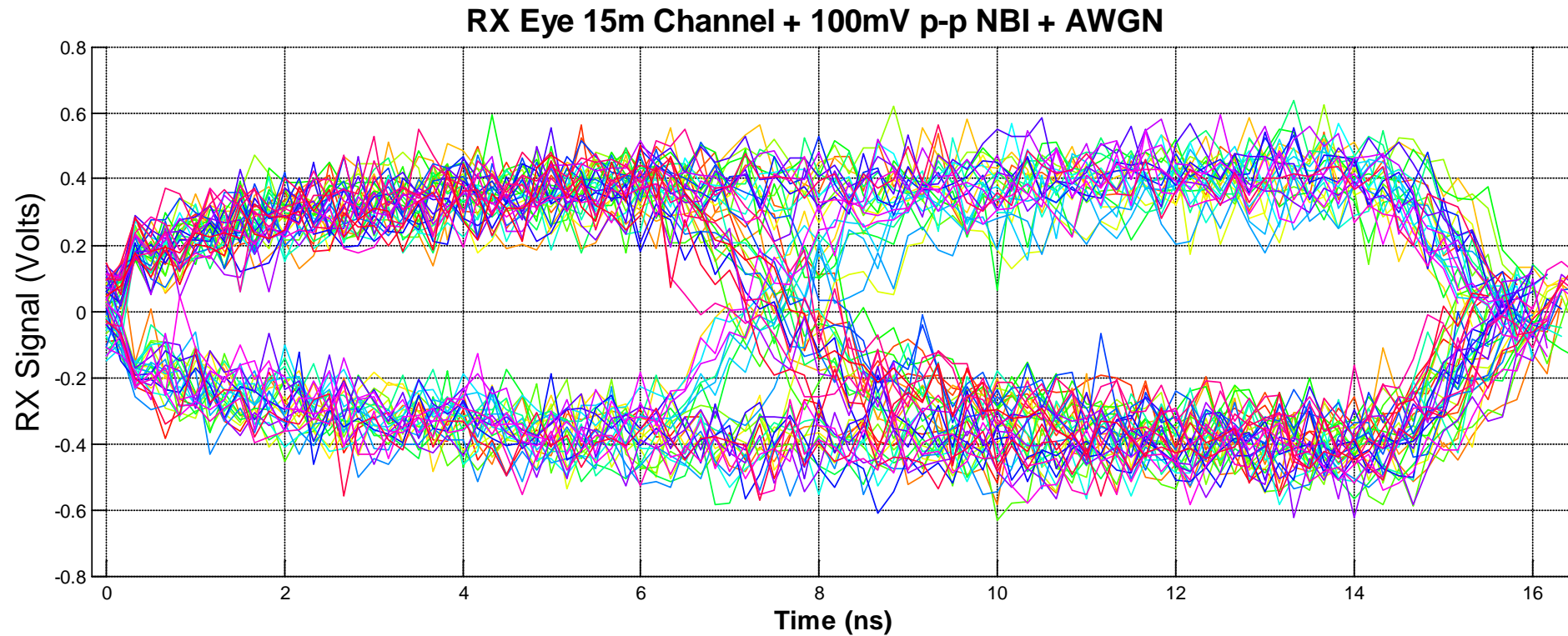


- More ISI than 2m cable, but eye is wide open

2m cable with AWGN and NBI



15m cable with AWGN and NBI



Summary: Effect of Cable Channel ISI

- 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.

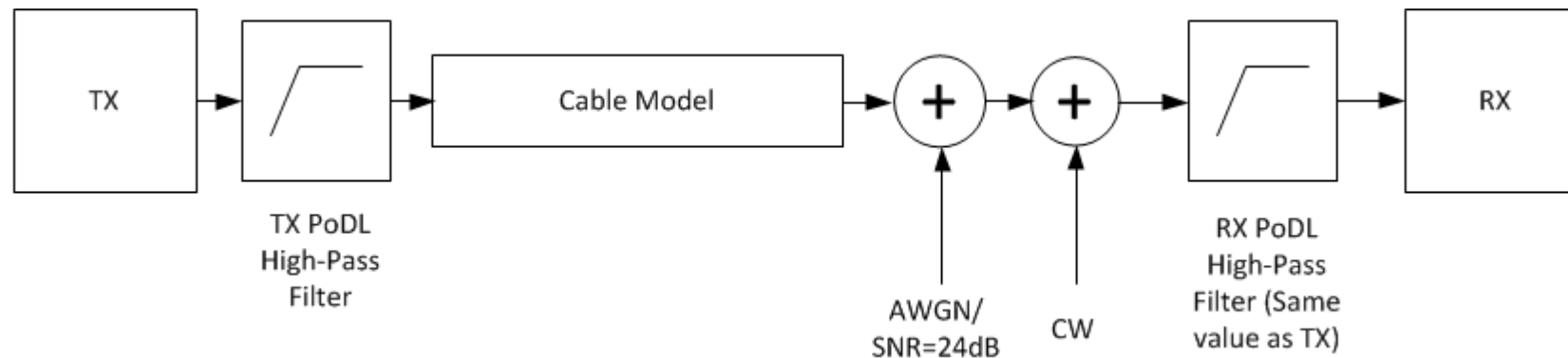
EFFECT OF PODL HIGH PASS FILTER

PoDL High Pass Filter

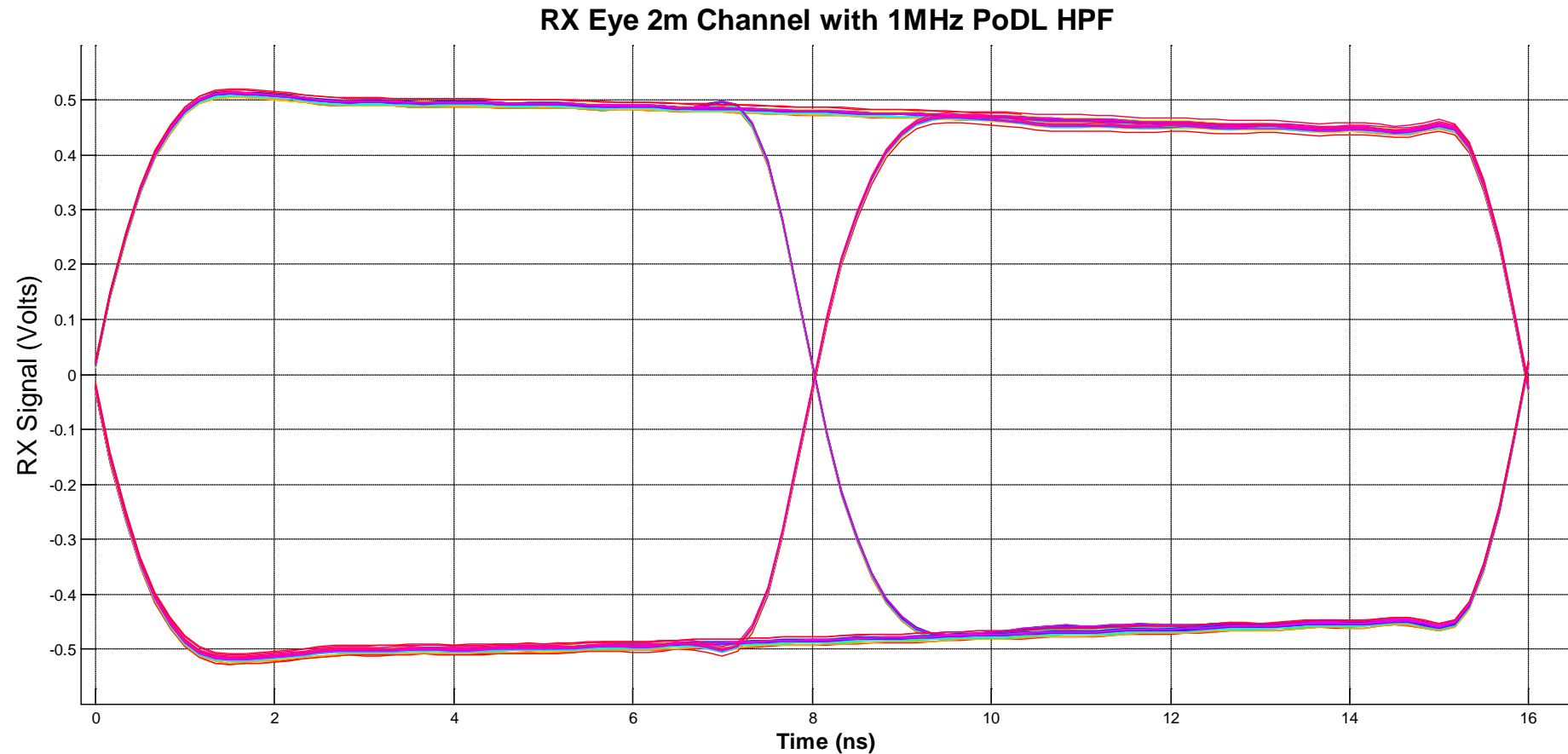
- High pass filters are required to support PoDL
 - HPF corner is 1-2MHz for 100BASE-T1.
 - HPF corner is about 11MHz for practical 1000BASE-T1 designs.
 - The increased HPF corner frequency is due to wider bandwidth requirement for 1000BASE-T1.
- These filters are external to the PHY and hence are not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

Modeling PoDL High Pass Filter

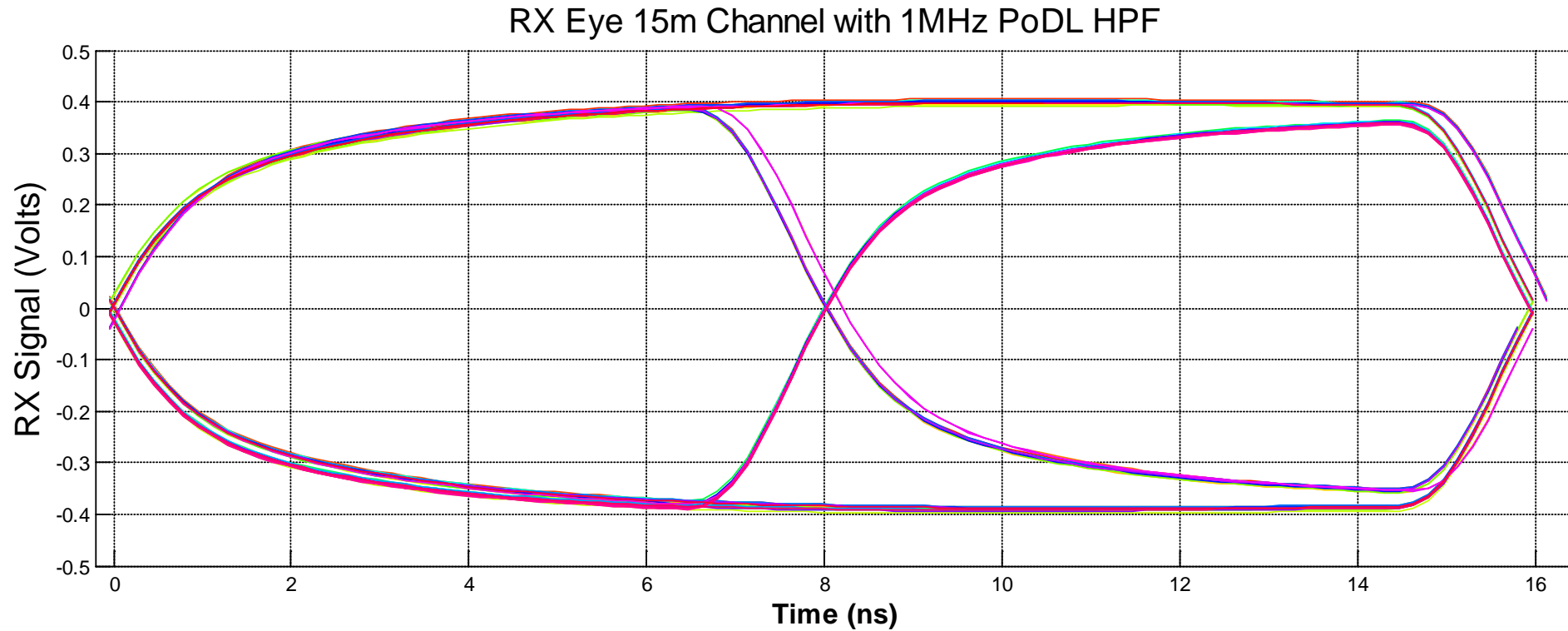
- 1st order HPF
- HPF corner frequency considered: 1MHz and 11MHz



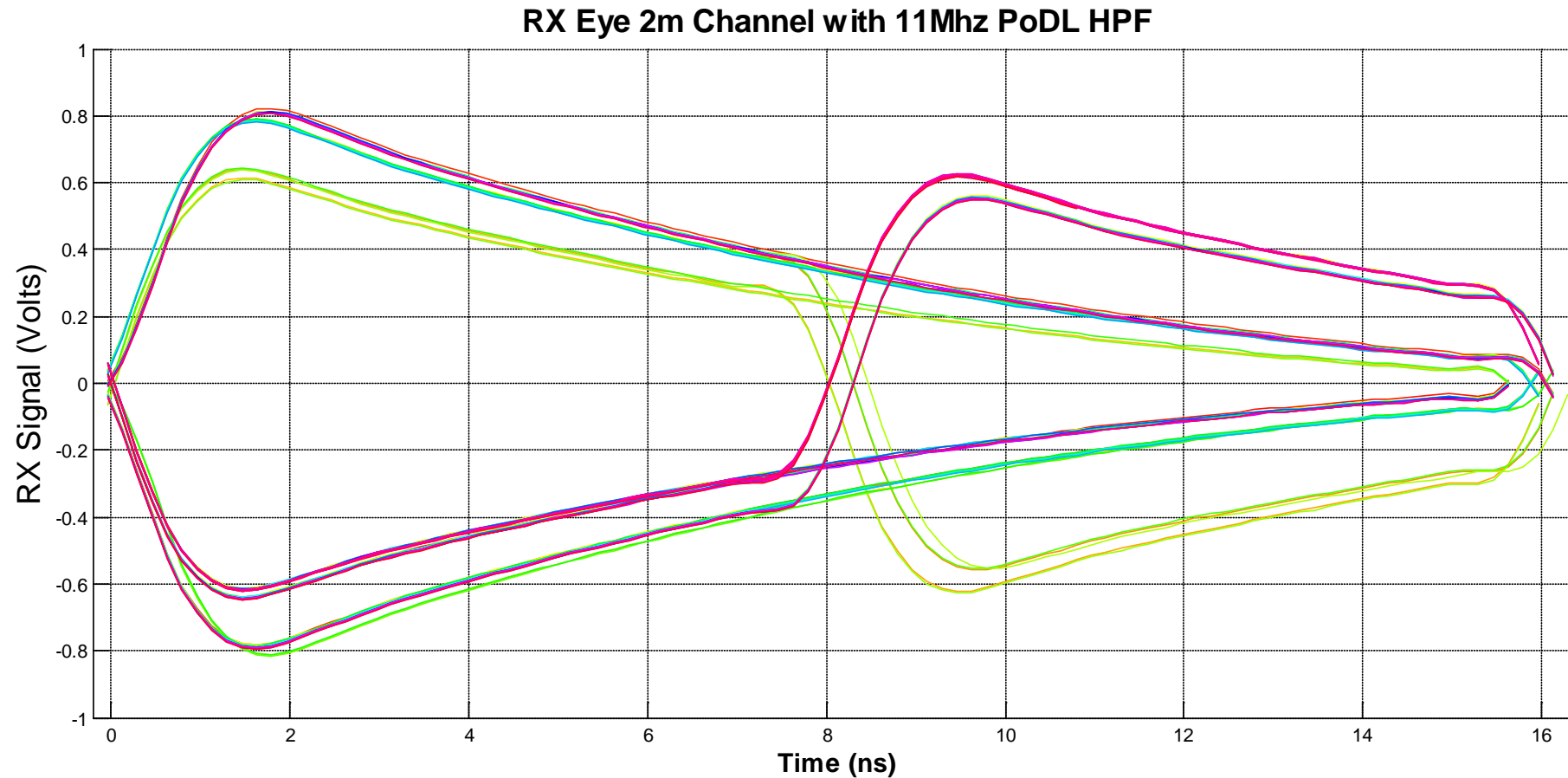
2m channel with 1MHz HPF



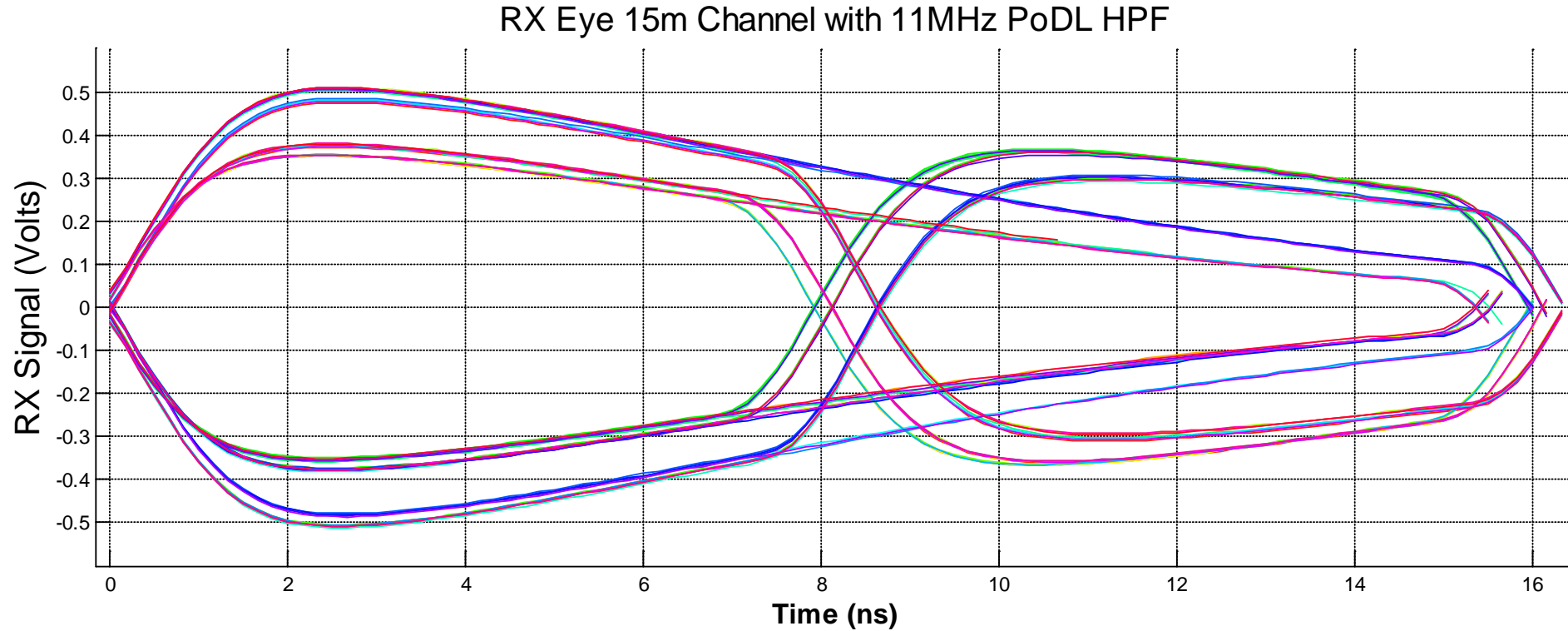
15m channel with 1MHz HPF



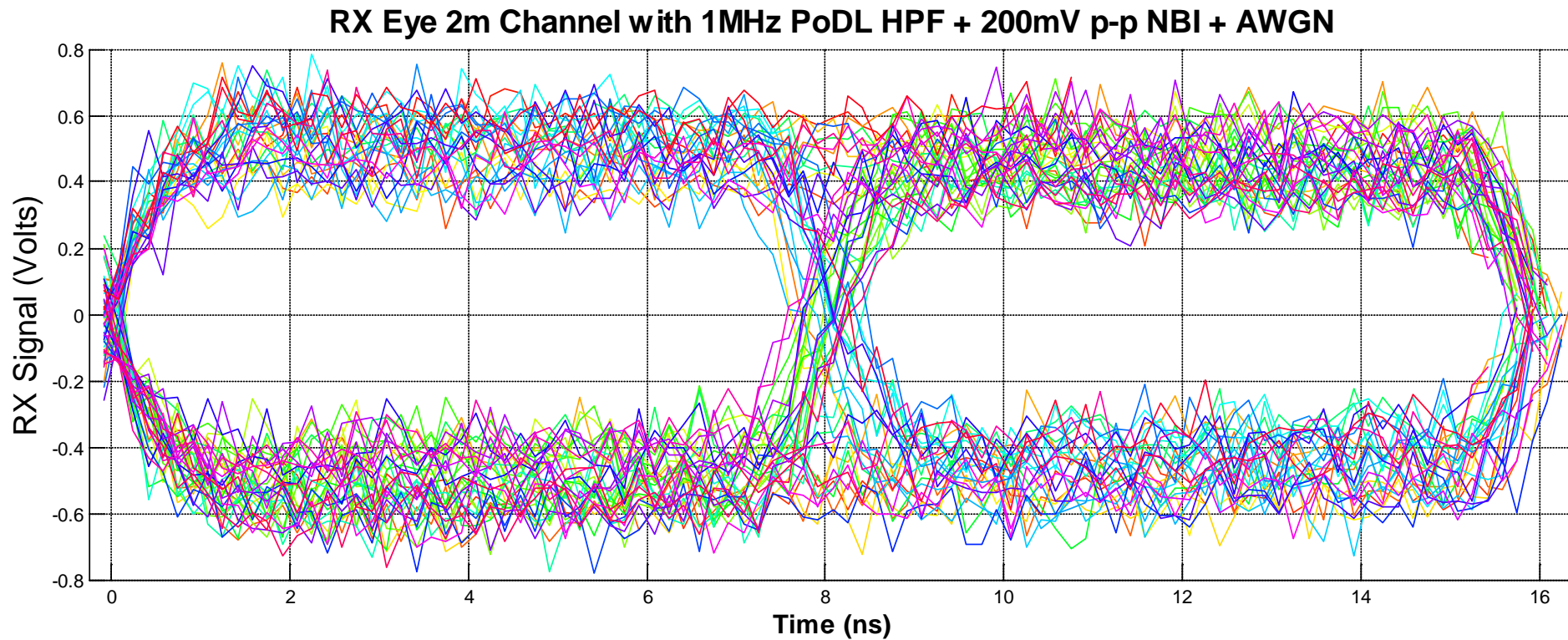
2m channel with 11MHz HPF



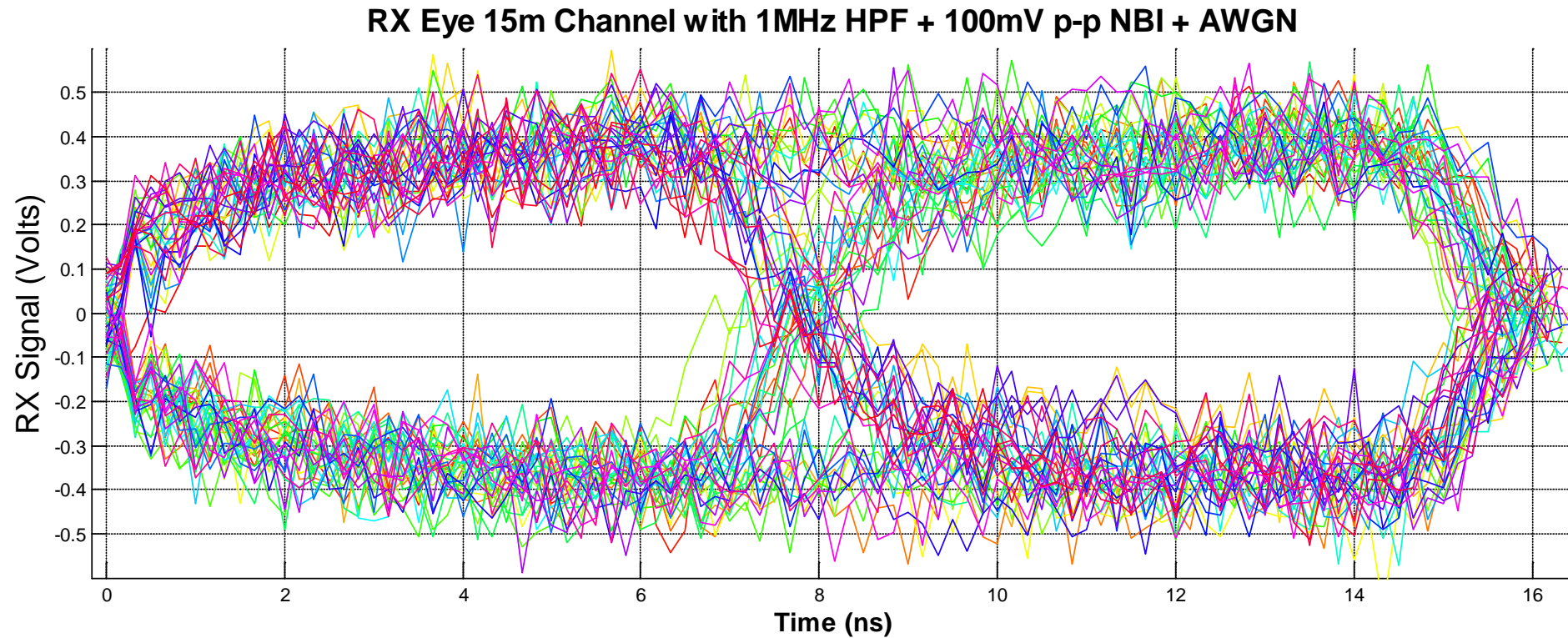
15m channel with 11MHz HPF



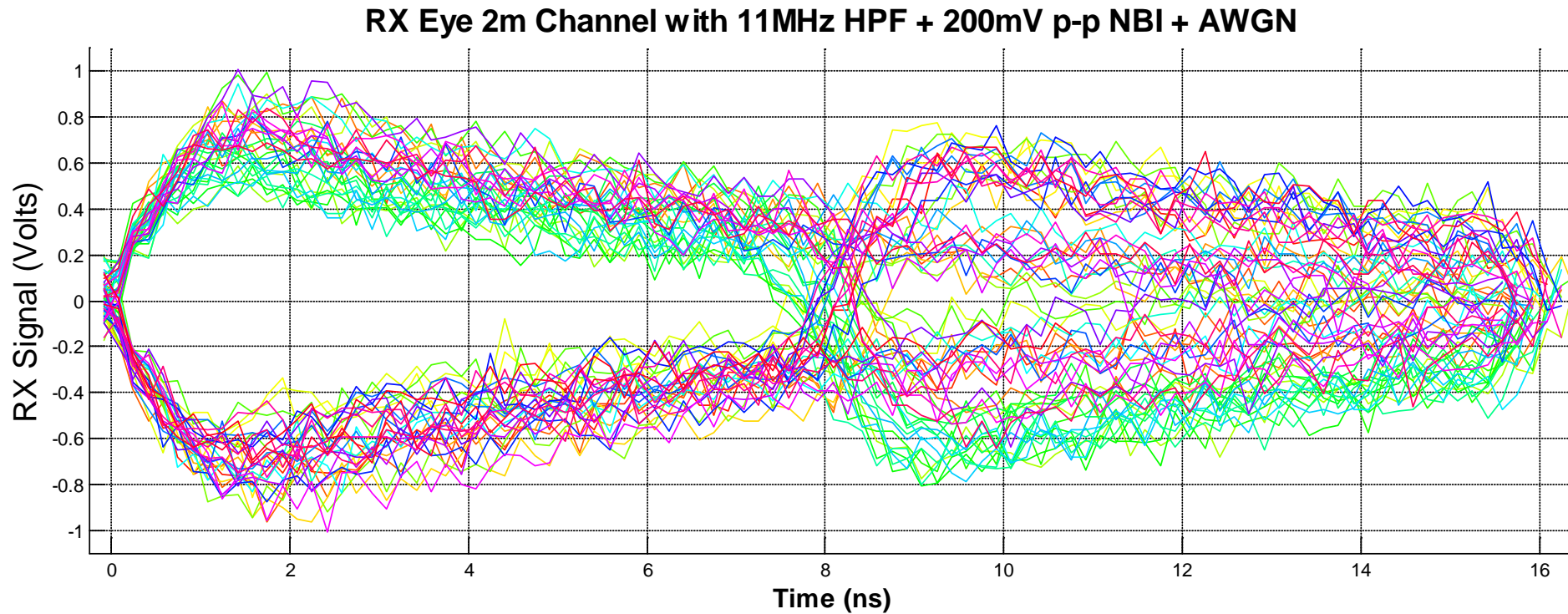
2m Channel with 1MHz HPF and Noise



15m Channel with 1MHz HPF and Noise

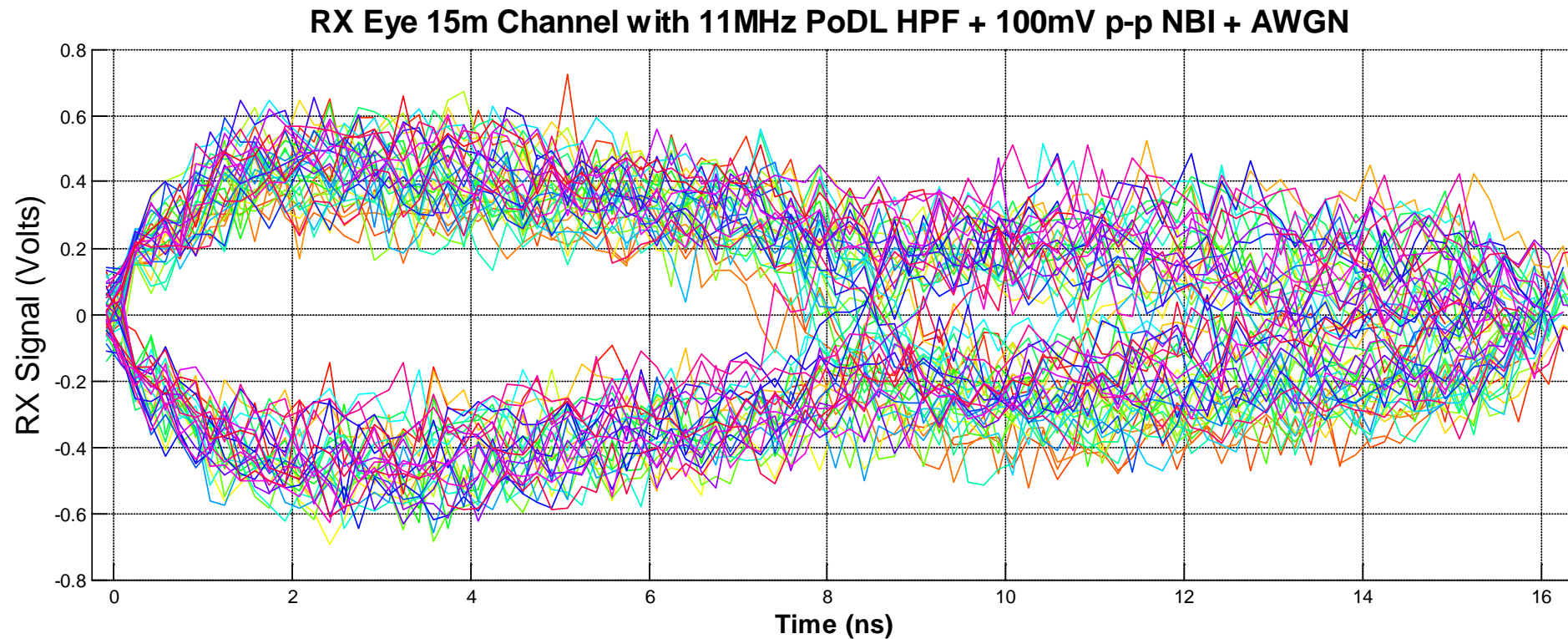


2m cable with 11MHz HPF and Noise



Eye closed: cannot detect 2nd part of bit cell

15m cable with 11MHz HPF and Noise



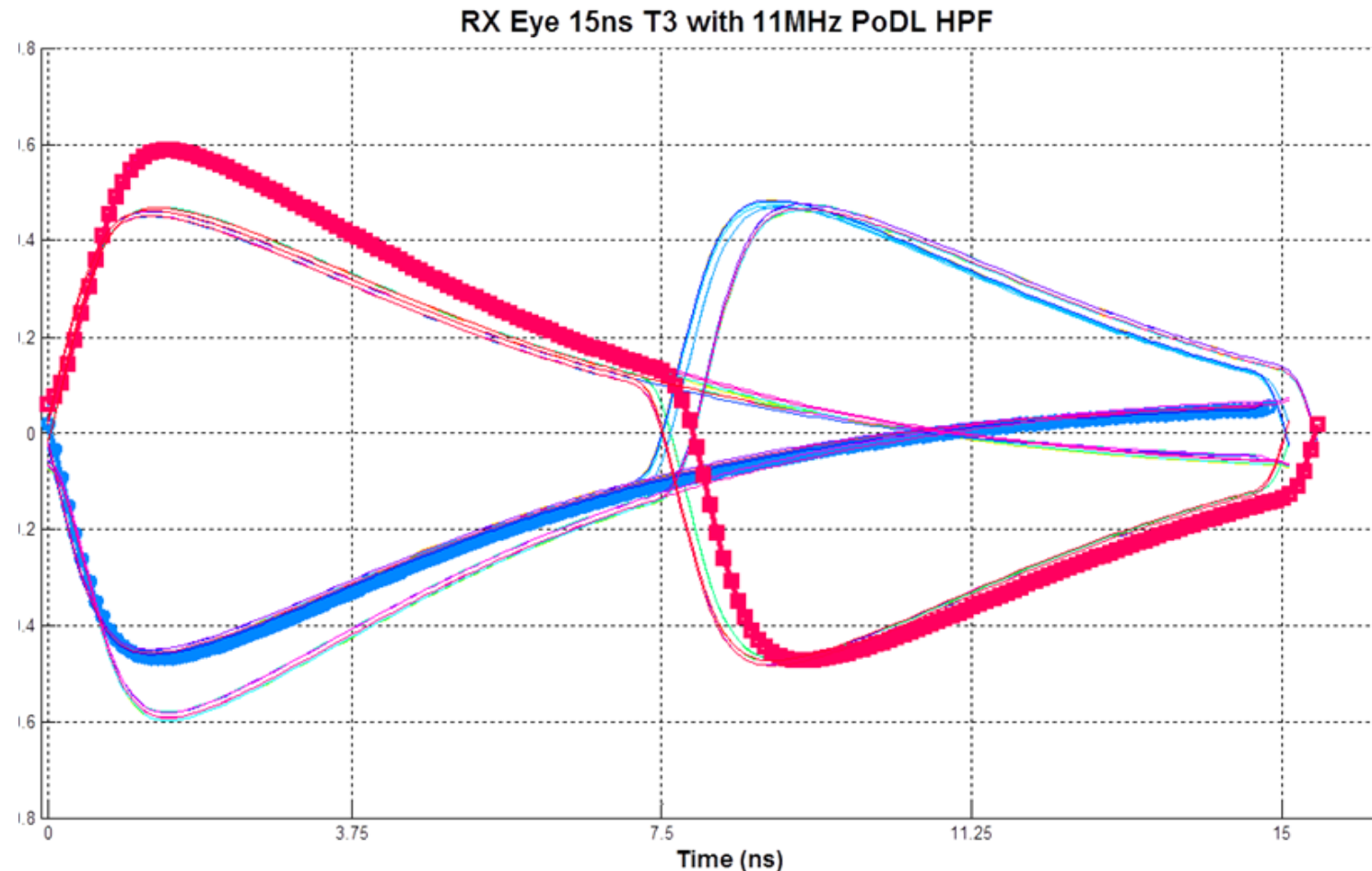
Eye closed: cannot detect 2nd part of bit cell

Summary

- 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.

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