molex®

one company › a world of innovation

# Technical Feasibility of Twinax Copper Cable for 4x25Gbps Data Transmission

**Mark Bugg**
**Mark.Bugg@molex.com**
**DATE: 01/04/10**

**Ebrahim Abunasrah**
**Ebrahim.abunasrah@molex.com**

# Prospective Loss Budgets

## Loss budget examples

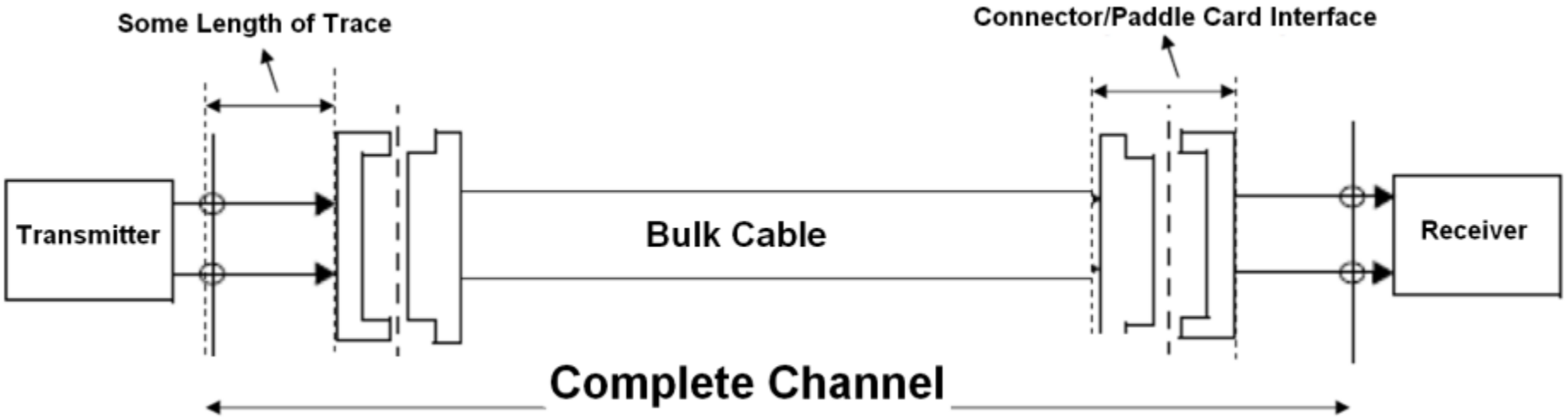
| | 40GBASE-CR4 signal integrity | | "Next generation" signal integrity | |
|---|---|---|---|---|
| **Uncoded rate, Gb/s** | 10.0 | 25.0 | 25.0 | 25.0 |
| **Line code** | NRZ | 4-PAM | 4-PAM | NRZ |
| **Signaling rate, GBd** | 10.3125 | 12.8913 | 12.8913 | 25.7813 |
| **SNR for BER ≤ $10^{-12}$, dB [1]** | 17.0 | 26.6 | 26.6 | 17.0 |
| **Cable length, m** | 7 | 7 | 7 | 3 |
| **Host TX PCB (4") [2], dB** | 3.50 | 4.33 | 2.54 | 4.70 |
| **TX Connector, dB** | 2.07 | 2.31 [3] | 1.41 [4] | 2.00 |
| **Bulk cable, dB** | 13.30 | 16.42 | 13.68 [5] | 10.82 |
| **RX Connector, dB** | 2.07 | 2.31 [3] | 1.41 [4] | 2.00 |
| **Host RX PCB (4"), dB** | 3.50 | 4.33 | 2.54 | 4.70 |
| **Total insertion loss, dB** | **24.44** | **29.70** | **21.58** | **24.22** |

[1] Assumes fixed transmitter peak-to-peak differential output voltage.
[2] Losses are defined at the fundamental frequency for the cited signaling rate.
[3] Derived as 2.07 × sqrt( 6.4453/5.1563 )
[4] Derived as 2.00 × sqrt( 6.4453/12.8913 )
[5] Derived as (7/3) × 7.06 × 0.83 where 0.83 is the reduction in loss for 24AWG cabling relative to 26AWG



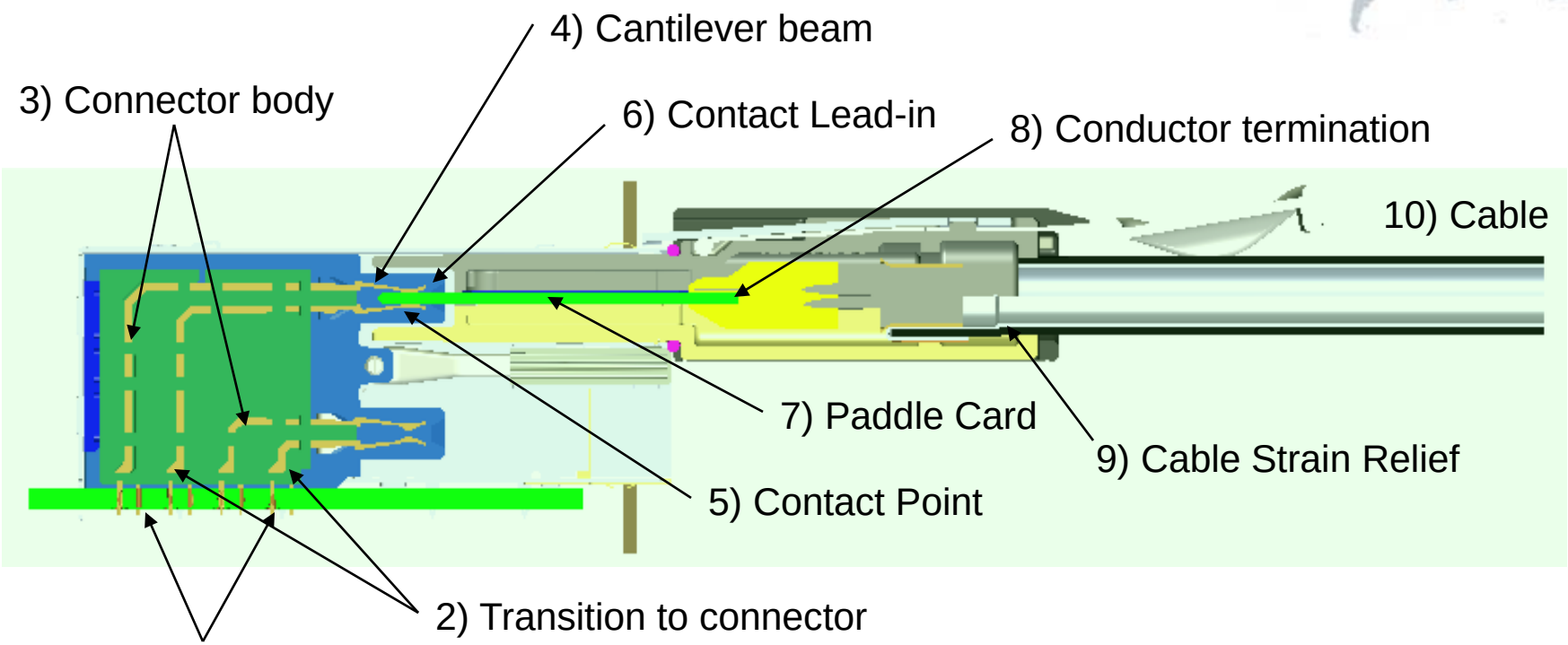
molex

# Channel Description




- Some Length of Trace:
  - 4.7dB will be allotted for each side
- Connector/Paddle Card Interface (including Termination) and Bulk Cable
  - 3M 24AWG: ~ 14.82dB @ 12.89 GHz
  - 5M 24AWG: ~ 17dB @ 12.89 GHz
- Complete Channel using 3 Meters =
  - 14.82 dB (from above) + 2 x 4.7 (Trace) = 24.22 dB
- Complete Channel using 5 Meters =
  - 17 dB (from above) + 2 x 4.7 (Trace) = 26.4 dB

# 25 Gbps I/O Technology – Critical Zones



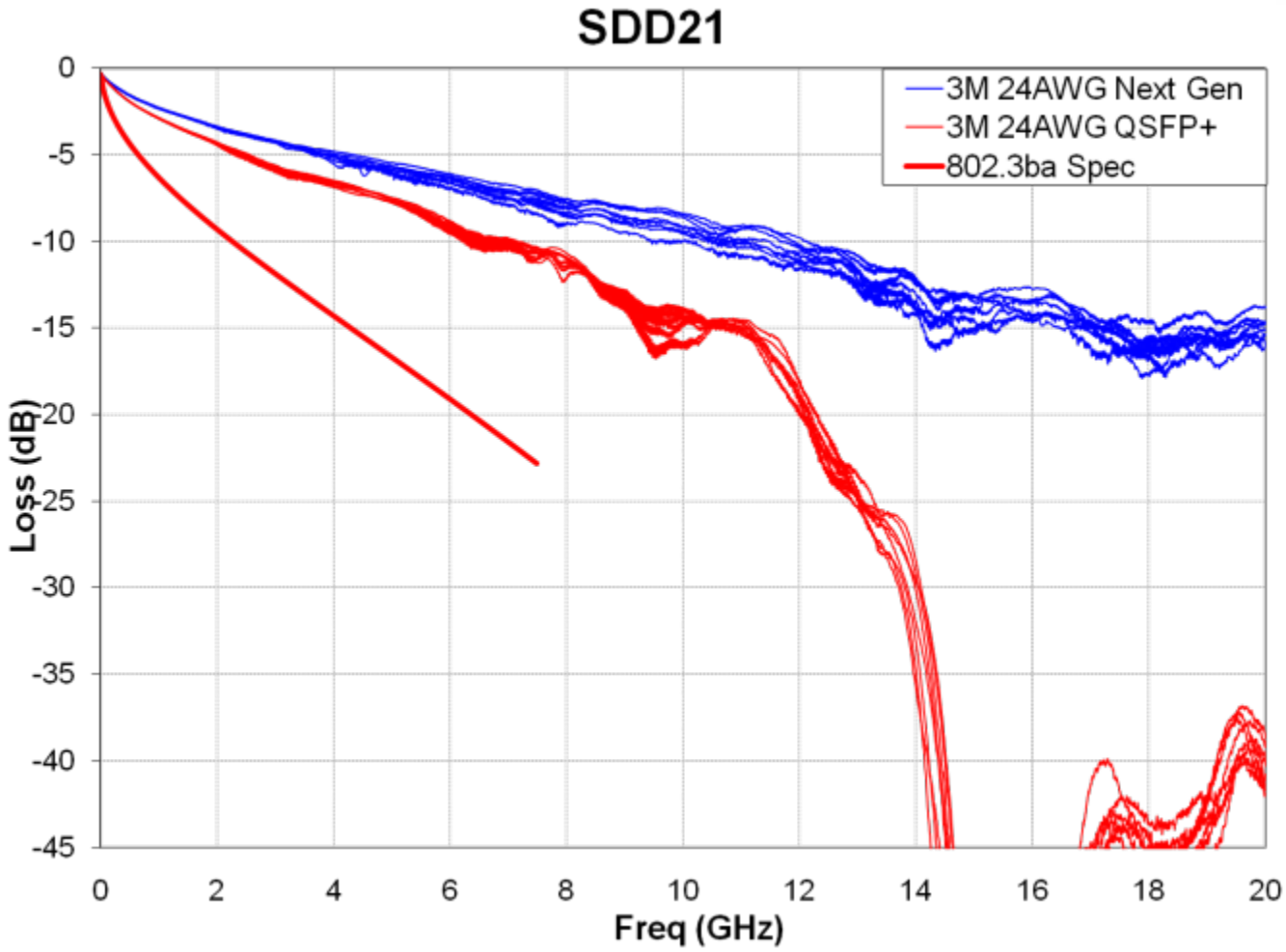

- Technical improvements since 802.3ba include: connectors, paddle card design, connector launch, conductor termination and raw cable

# Testing Setup

- **Device Under Test**
  - 1 X 3m QSFP+ cable assembly – 10Gbps QSFP+ production cable assembly
  - 1 X 3m and 1 X 5m Next Gen. cable assembly – Production raw cable, prototype paddle card and process

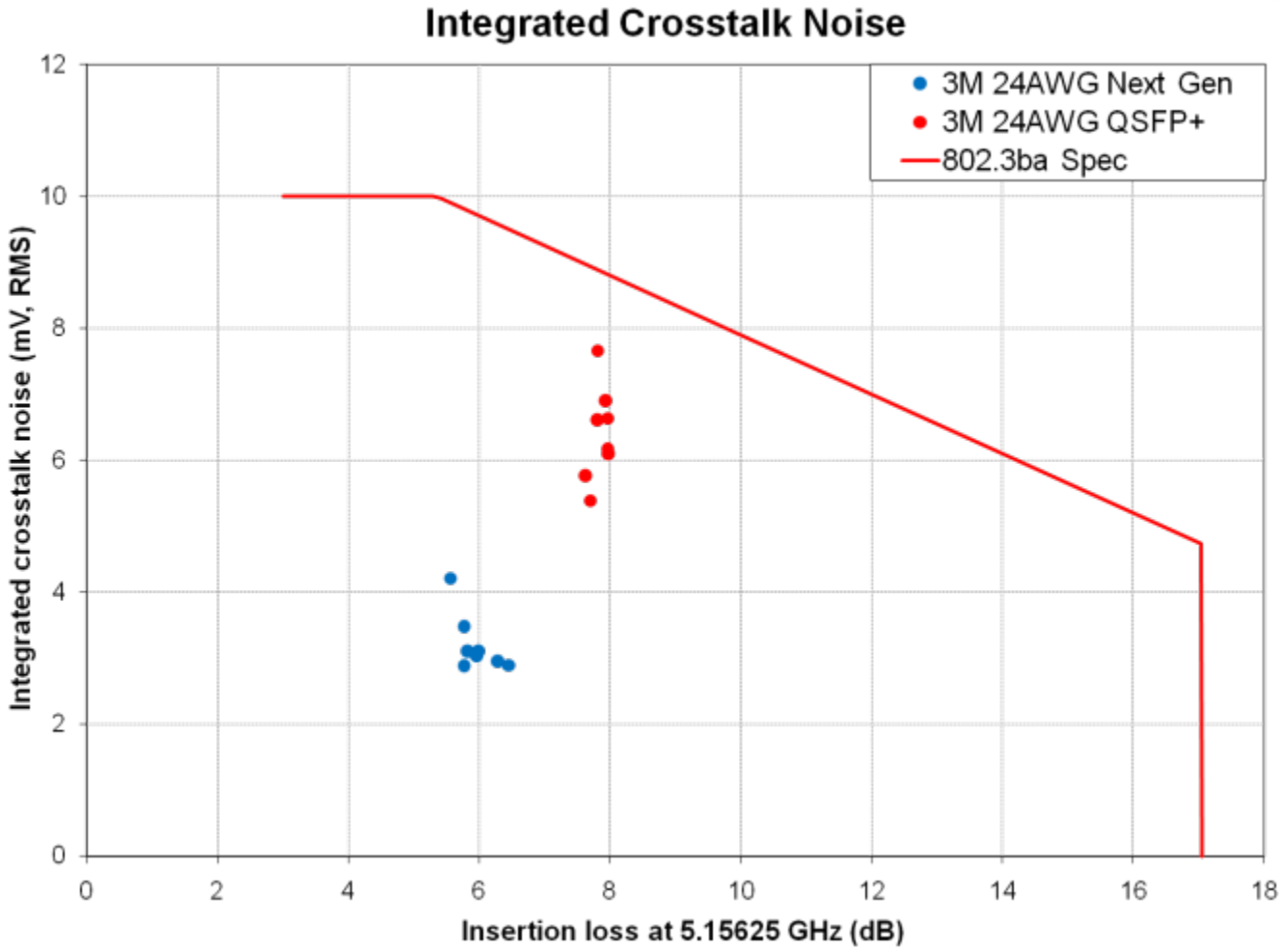
- **Test Equipment**
  - Differential Insertion Loss, MDNEXT, MDFEXT,ICN –
    - N5230A Vector Network Analyzer – 4000 pts. 10MHz-20GHz
  - Test Boards
    - Molex QSFP+ Cable Test Boards – Nelco 4000-13 SI
    - 150mm PCB trace – PCB trace was de-embedded
    - Molex zQSFP+ Connector Test boards – Nelco 4000-13 SI
    - 120 mm PCB trace – PCB trace was de-embedded

# IL Data – Next Gen 3m vs. QSFP+ 3m



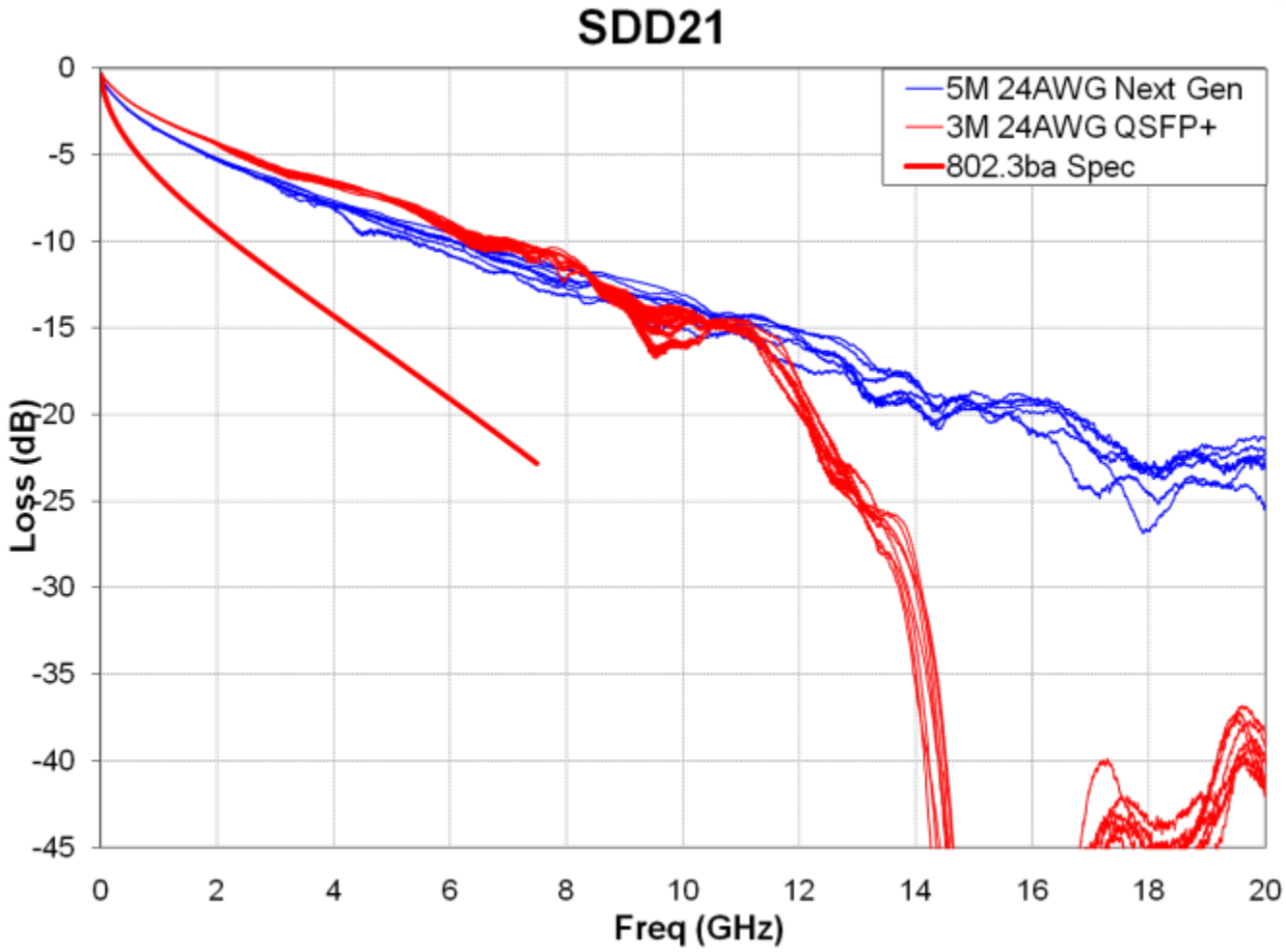

molex

# ICN – Next Gen 3m vs QSFP+ 3m



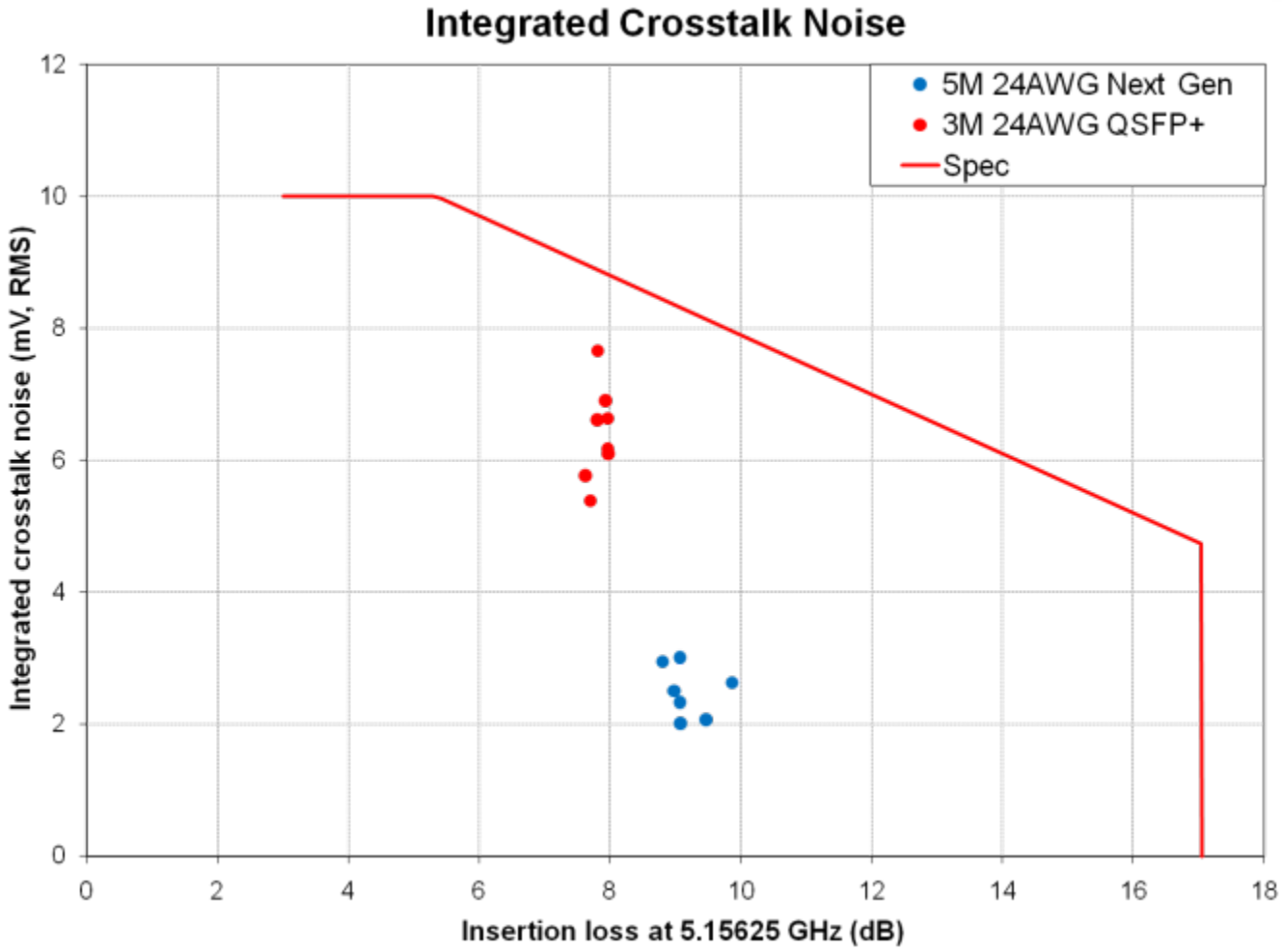

molex

# IL Data – Next Gen 5m vs QSFP+ 3m

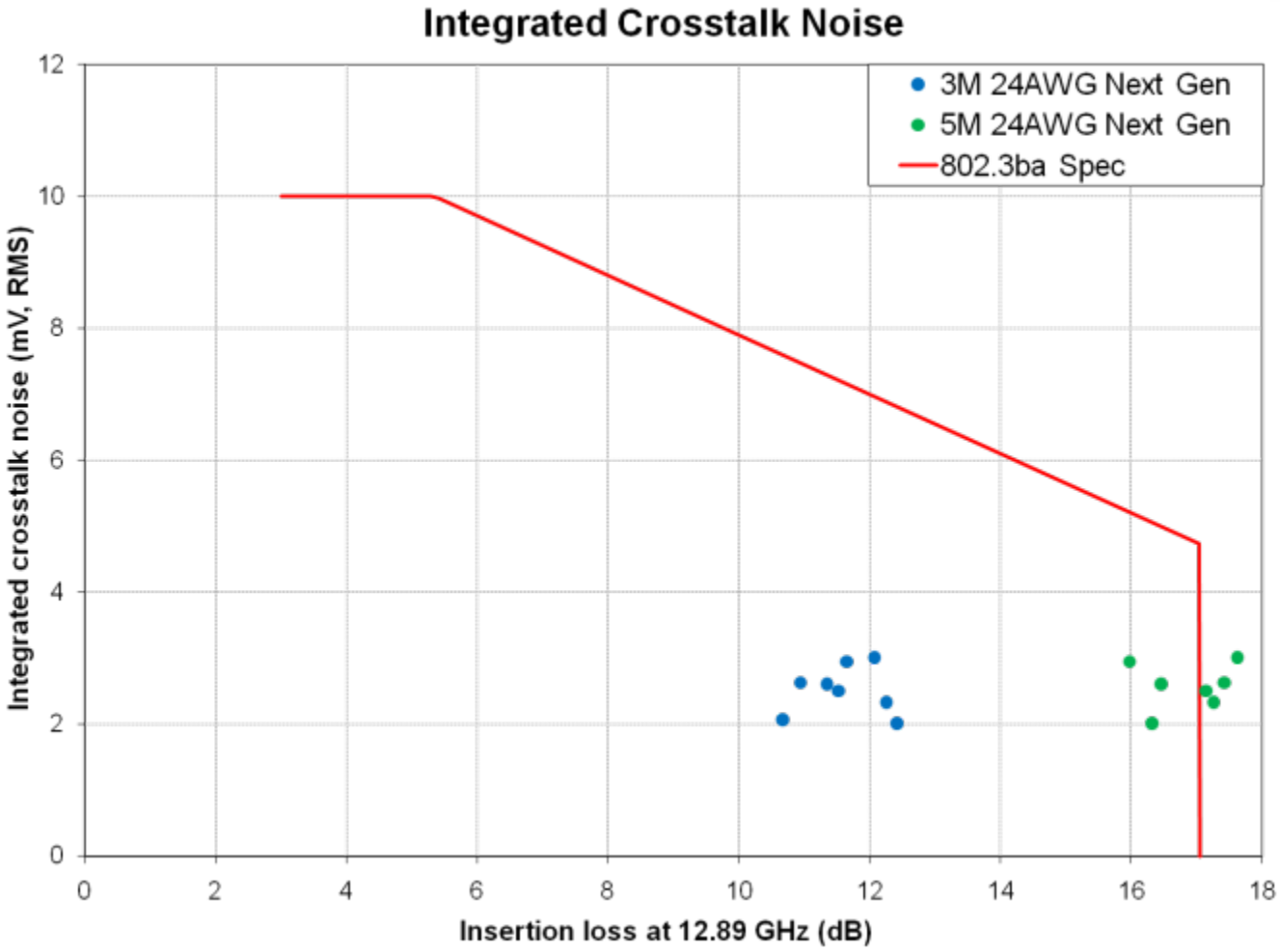



molex

# ICN – Next Gen 5m vs QSFP+ 3m



# ICN – Next Gen 3m and 5m – 12.89 GHz



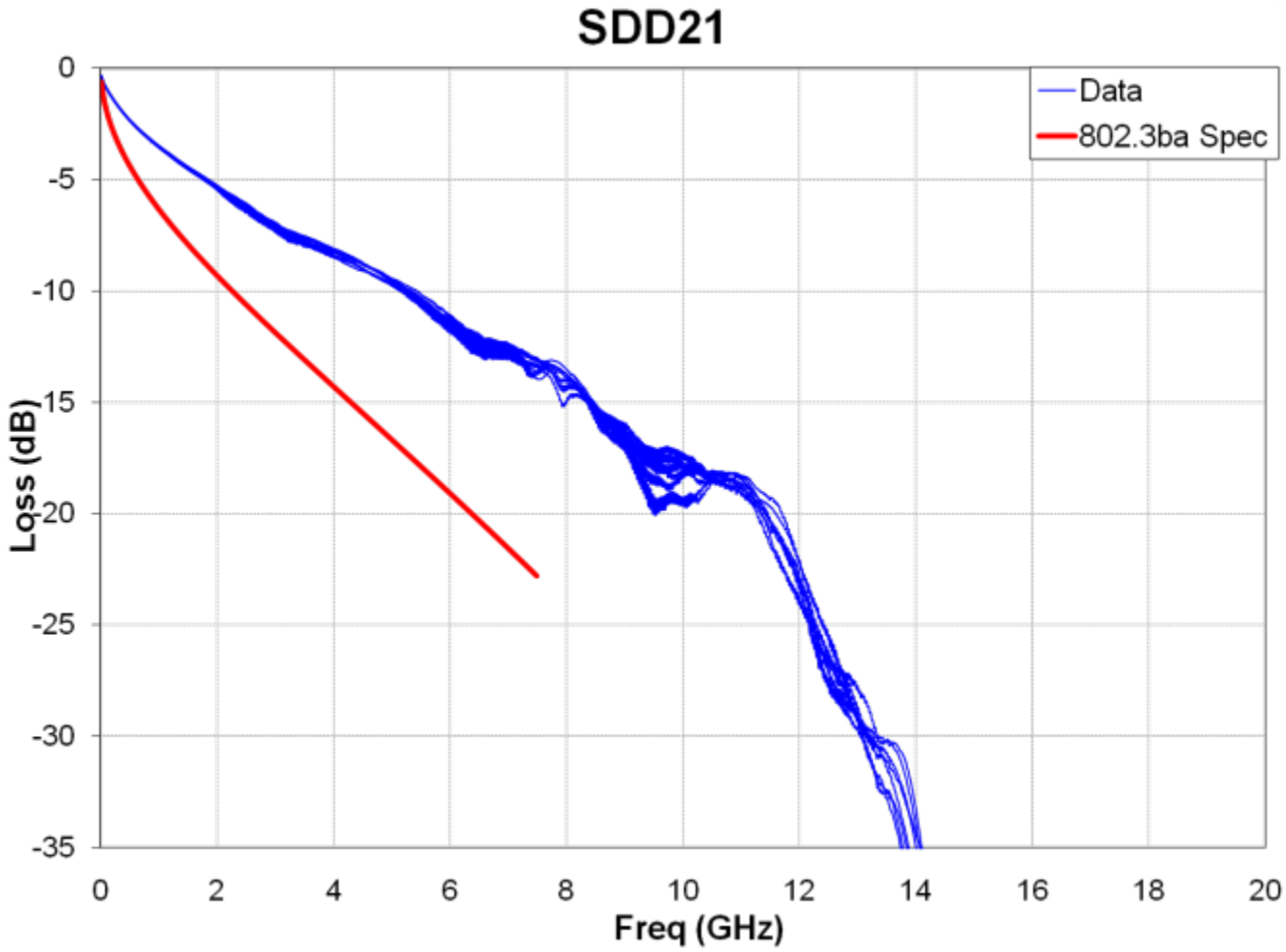

molex

# Conclusion

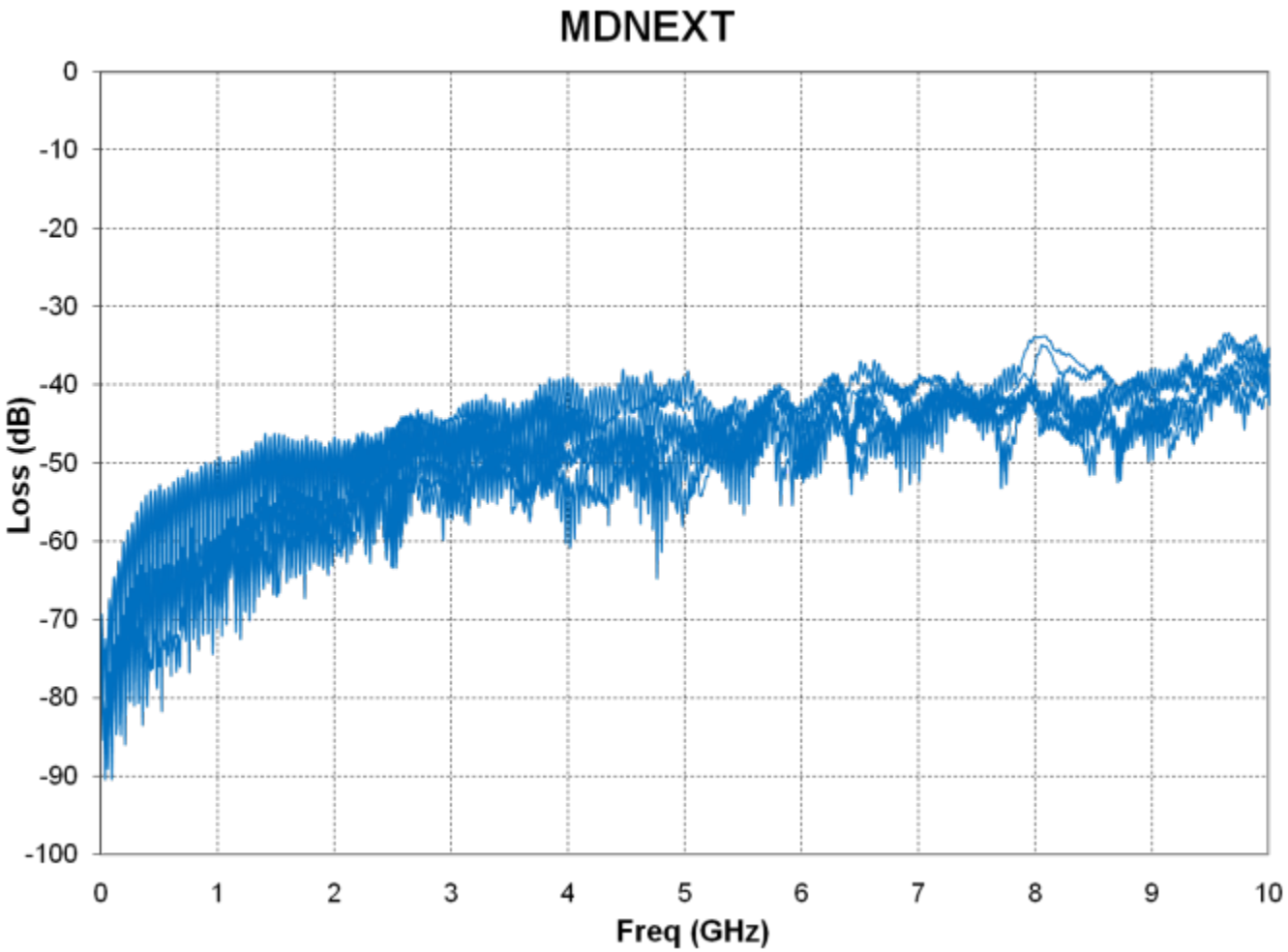
- 3m Next Gen. cables are technically feasible for 25Gbps applications assuming similar limits as set by IEEE 802.3ba
- 5m Next Gen. cables may be technically feasible for 25Gbps applications by leveraging improved noise reduction and updating the limits set by IEEE 802.3ba.
- Development of the 802.3 100Gb/s Copper Cable and Backplane specification should discuss the use of 5m Copper Cable as a length target


# Supporting Documentation

# Measured IL Data – QSFP 3m

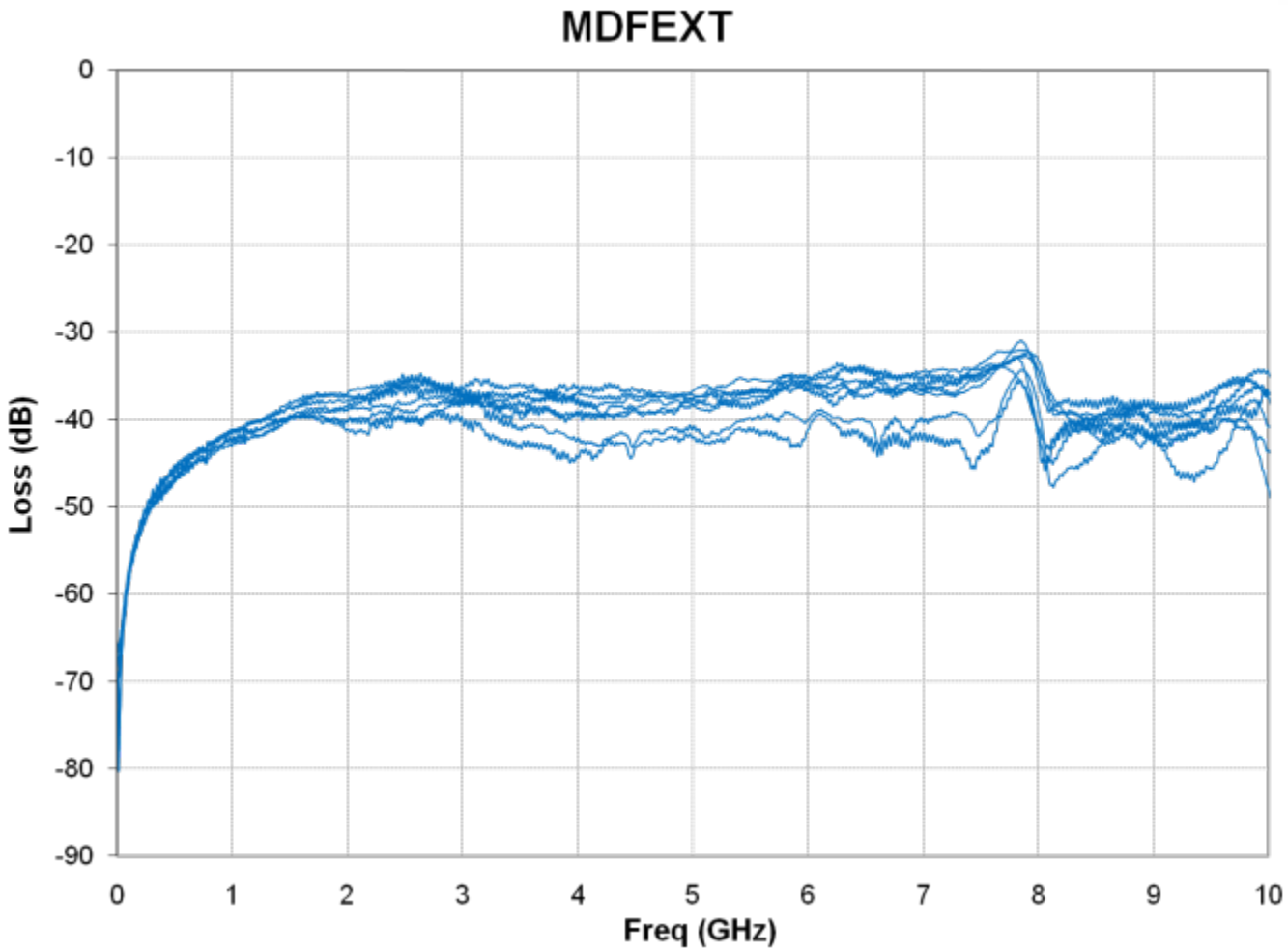


# MDNEXT – QSFP 3m



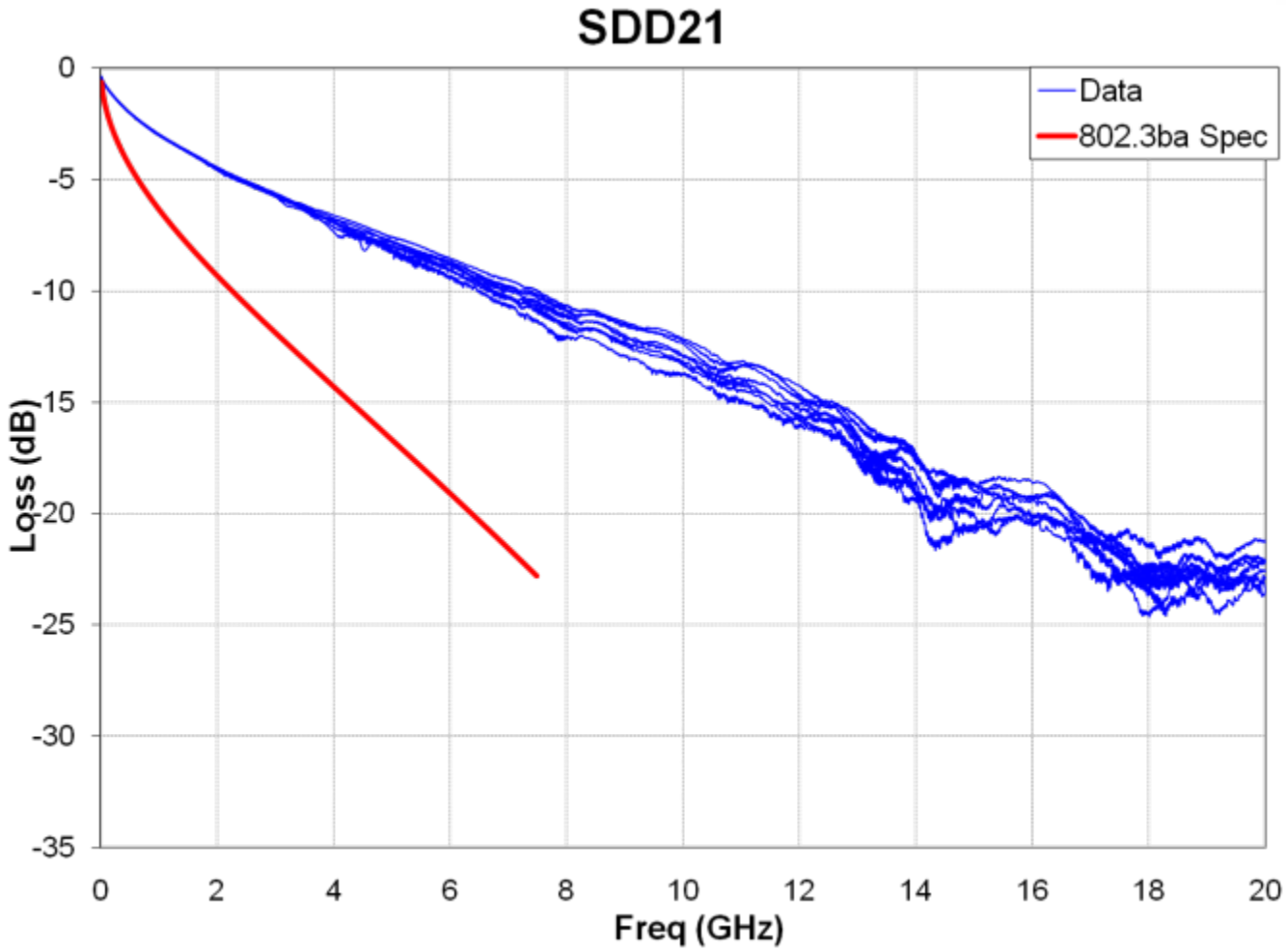

molex

# MDFEXT – QSFP 3m

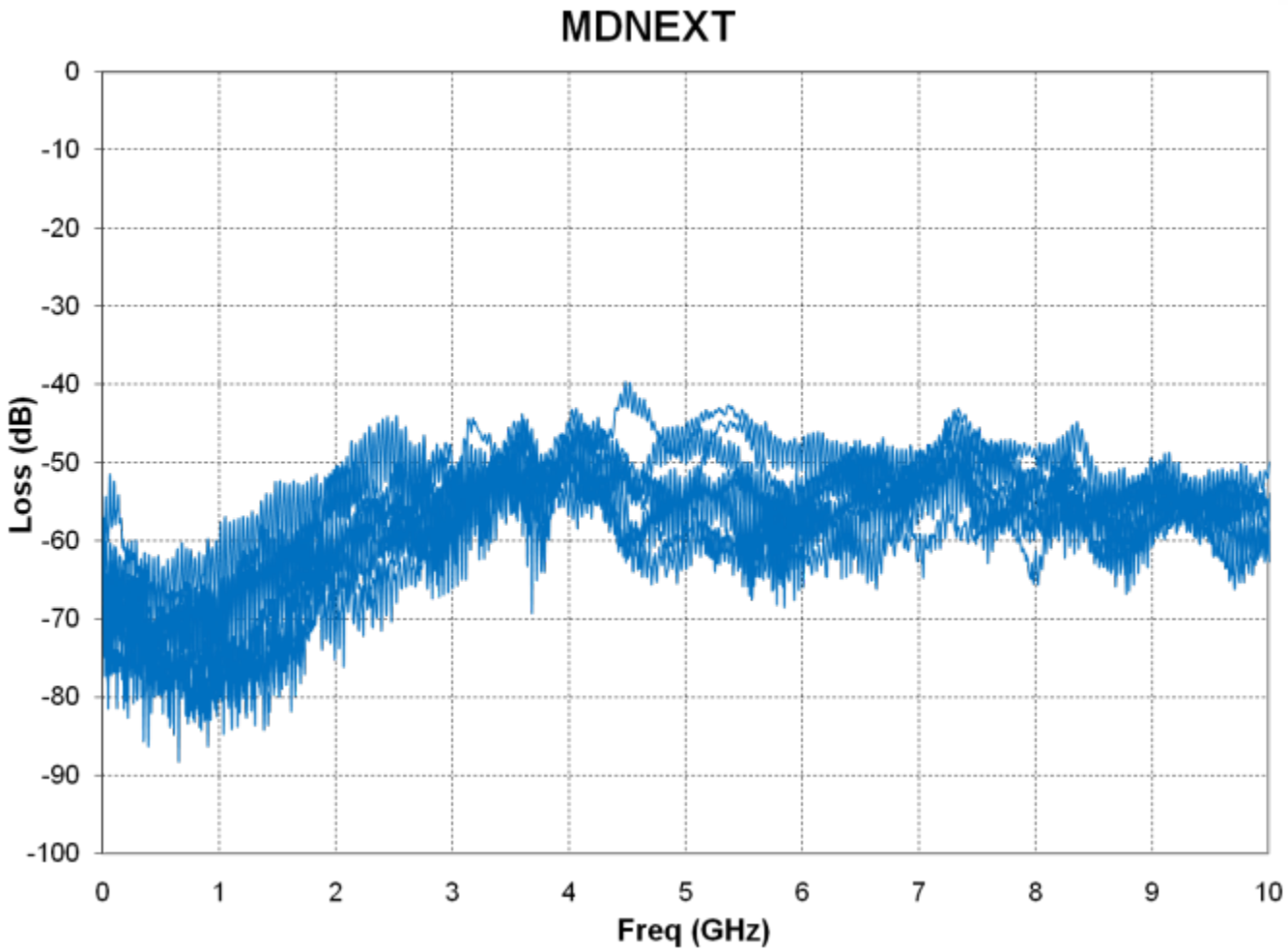



molex

# Measured IL Data – Next Gen 3m

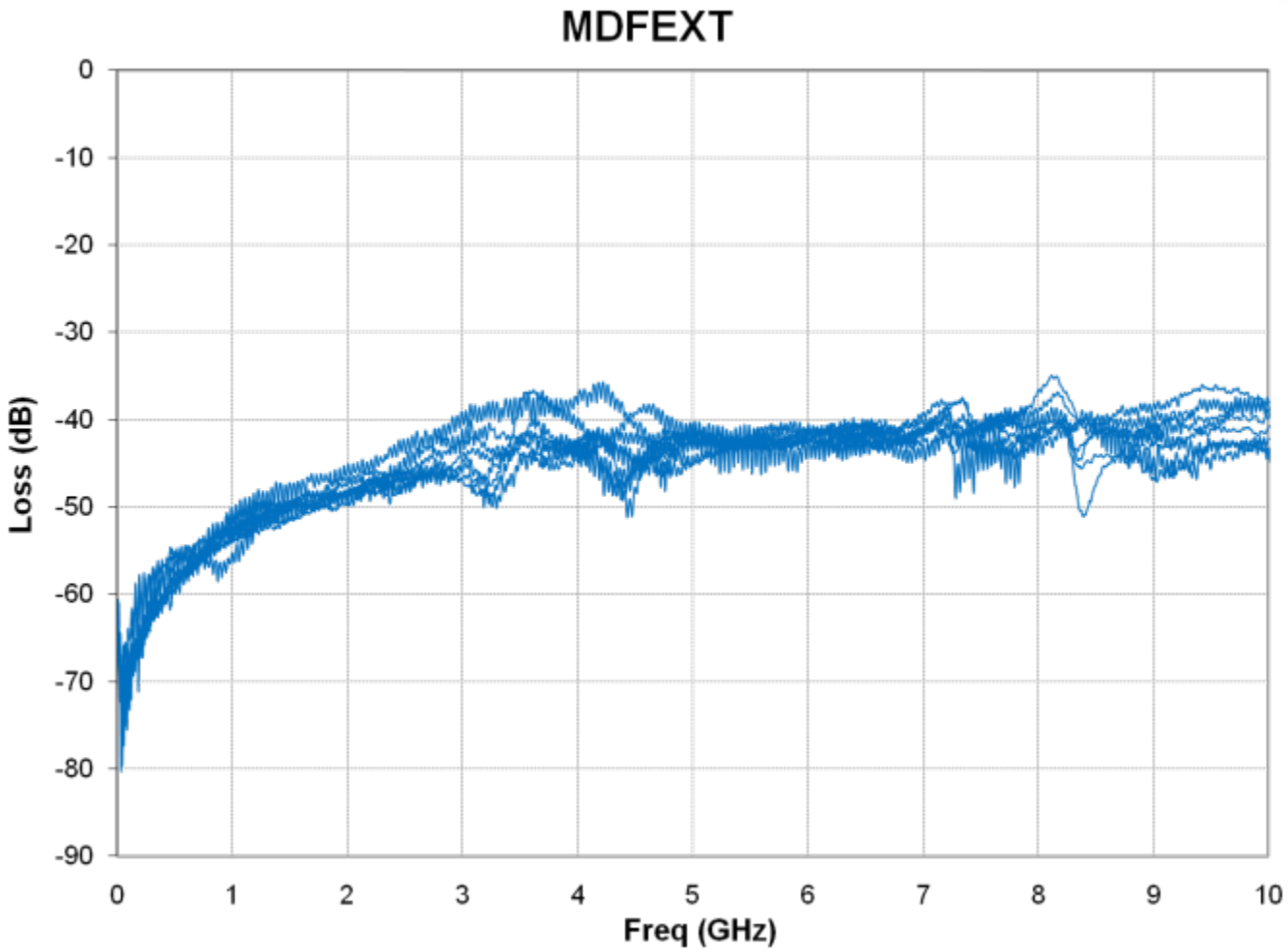


# MDNEXT – Next Gen 3m



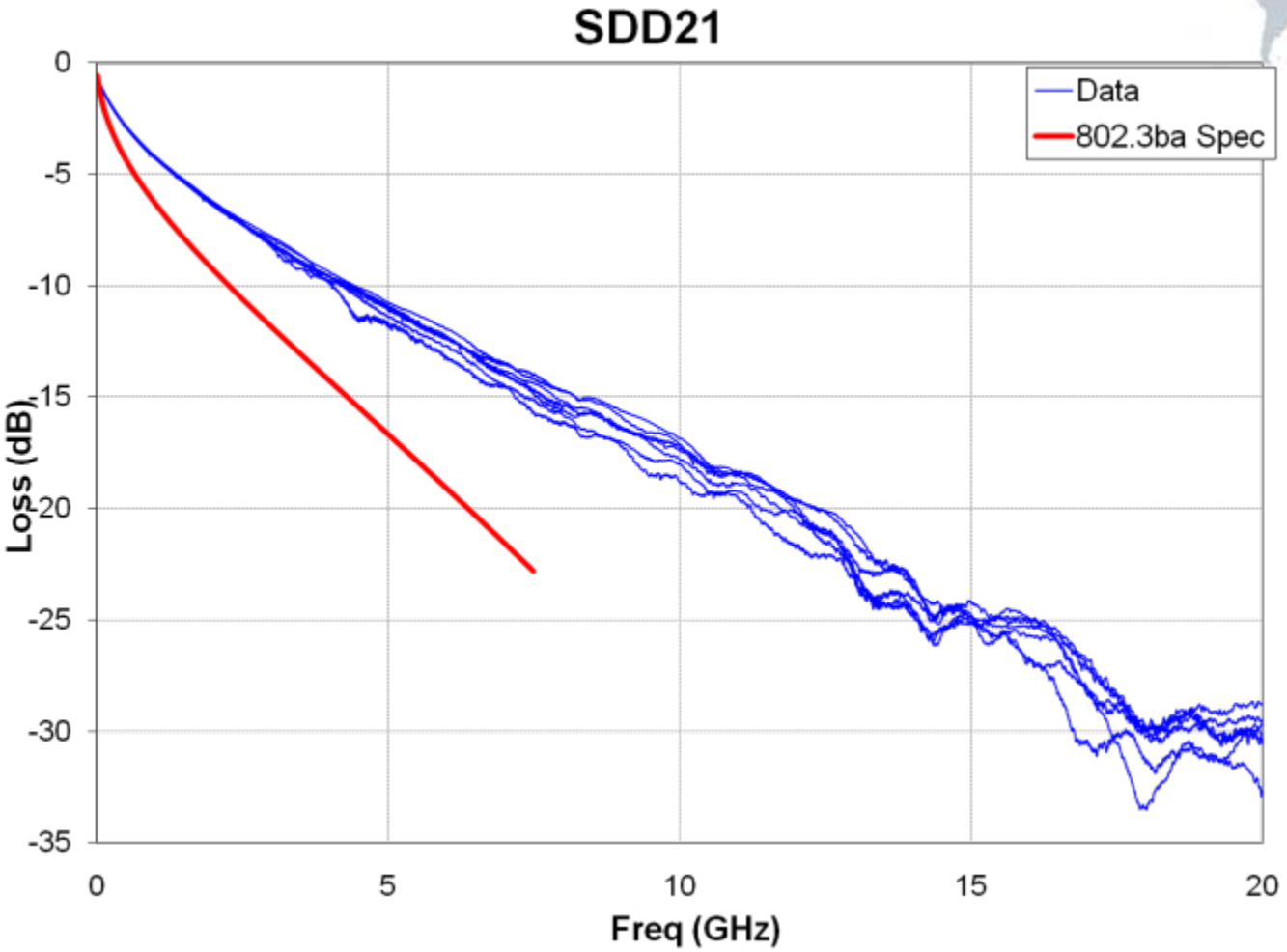

molex

# MDFEXT – Next Gen 3m

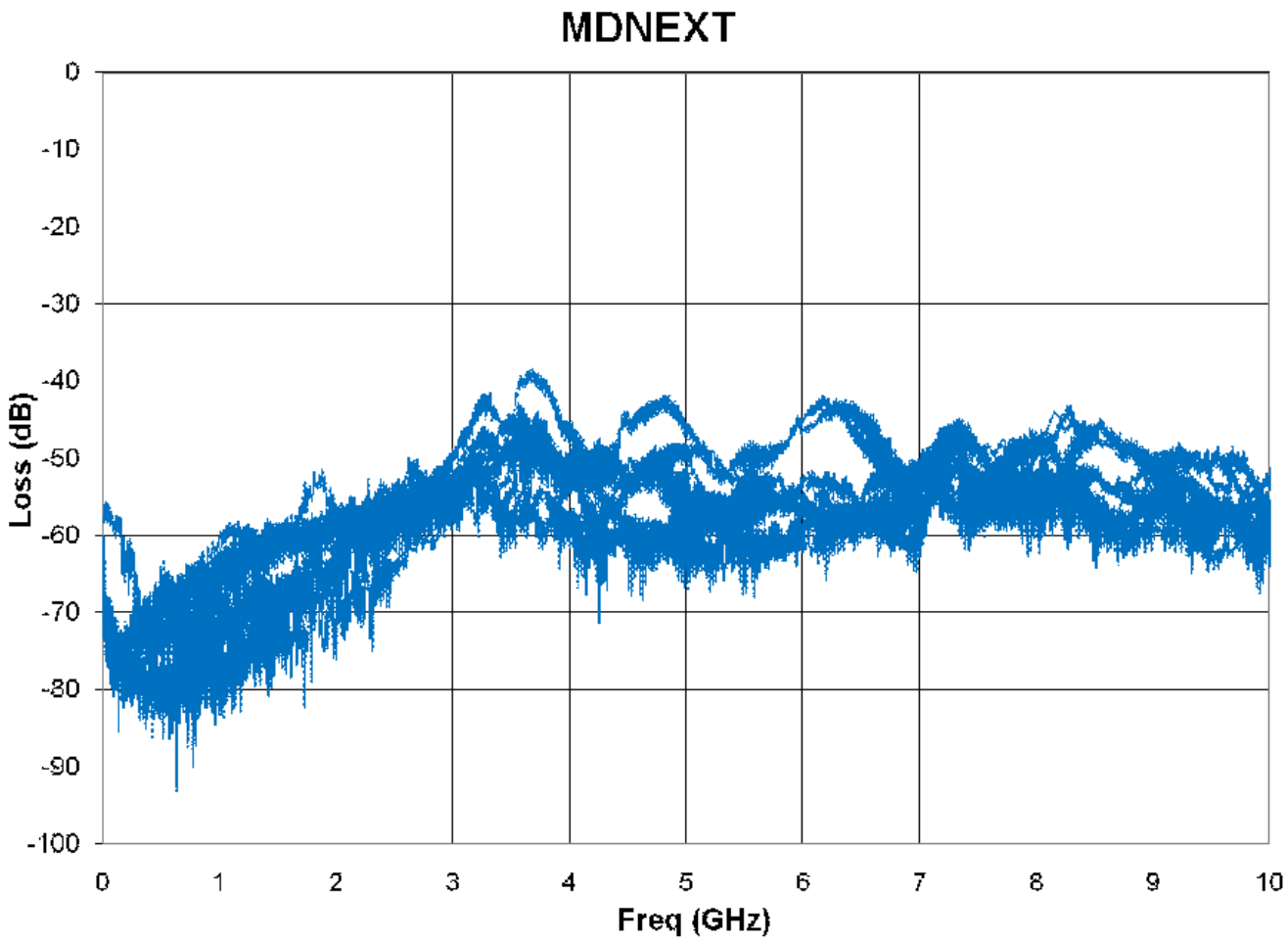



molex

# Measured IL Data – Next Gen 5m



# MDNEXT – Next Gen 5m



# MDFEXT – Next Gen 5m