IEEE 802.3CY – BEYOND 10G ELECTRICAL AUTOMOTIVE ETHERNET PHY TF

Link Segment Insertion Loss Measurements
Updated with 7 meters
Updated with long term aging

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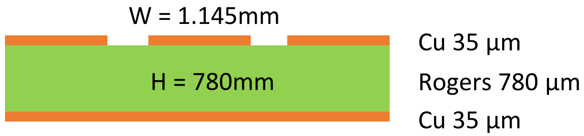
Purpose of the Analysis

- Measure insertion loss of available automotive cables with attached connectors up to 10 GHz
- Consider various operating temperatures and environmental conditions
  - Additional long term aging (1000 hours @ 105C)
- Focus on 11m & 7m link segments without inline connectors

Fixture description and de-embedding

- PCB Trace length: 20mm
- PCB Stackup:



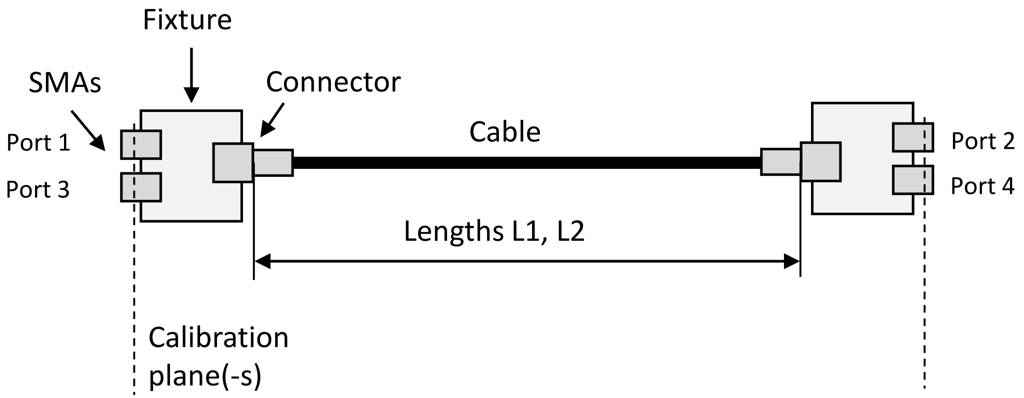
- PCB total loss (x2 to consider loss at both sides)

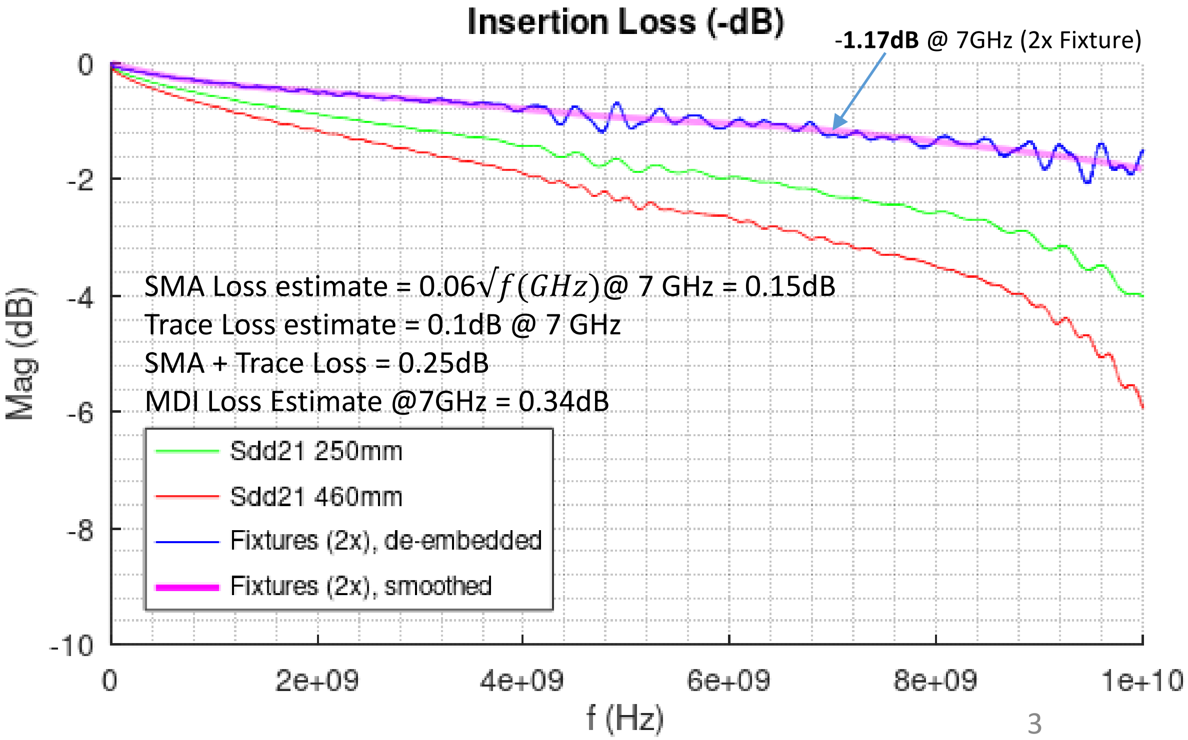
  - simple de-embedding by measuring 2 cable lengths incl. fixtures and subtraction of LogMag ILs:

$$IL_{2x\ Fixture} = IL_{Cable\ 1+2xFix} - \frac{L1}{L2 - L1}\left(IL_{Cable\ 2+2xFix} - IL_{Cable\ 1+2xFix}\right)$$

  - smoothing to eliminate ripples

  → sufficient accuracy to consider the fixtures IL





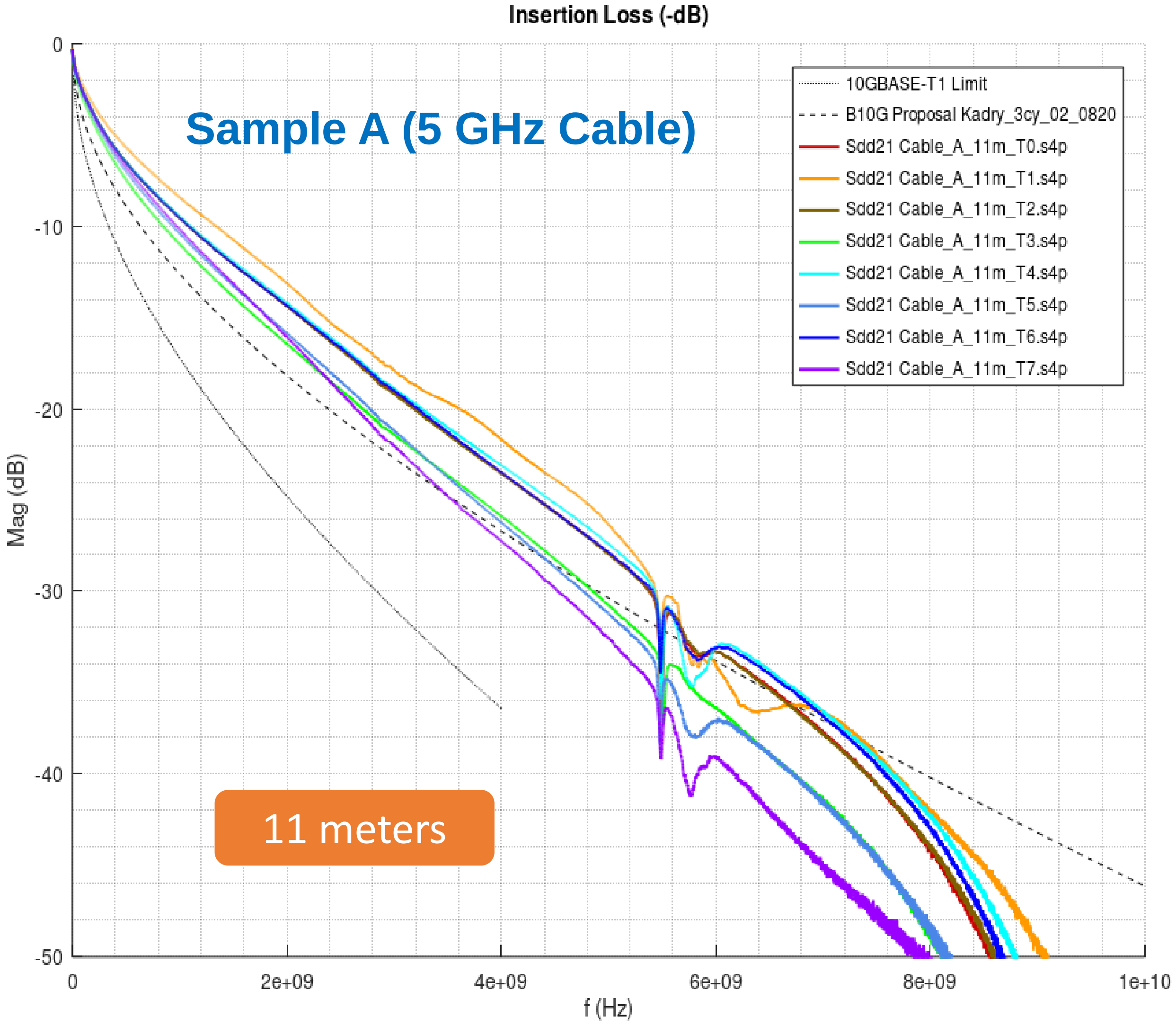
Test Sequence and Samples

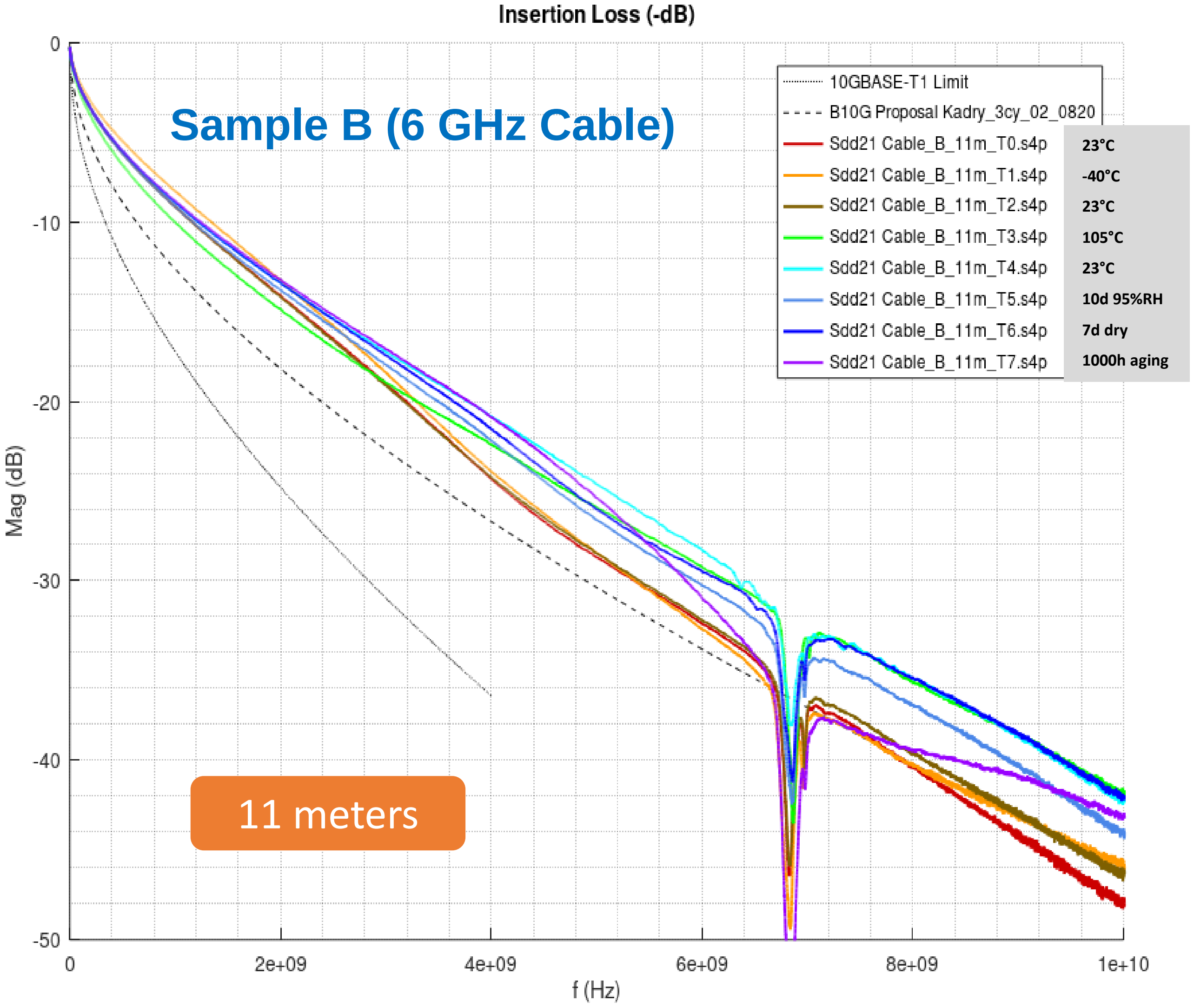
- S-parameter were captured at different temperatures in the following sequence (same cable assemblies):
  - T0 = 23°C
  - T1 = -40°C
  - T2 = 23°C
  - T3 =105°C
  - T4 = 23°C
  - T5 = 23°C, measurements done after 10 days storage at 95% relative humidity and 40°C
    (90 min relaxation at room temperature after taking samples out of climate chamber to allow temperature adaptation)
  - T6 = 23°C, measurements done after another 7 days storage at < 45% relative humidity and 23°C
  - T7 = 23°C, measurements done after additional 1000h storage at 105°C (long term aging)

- Samples:
  (available automotive cables / cable prototypes)

Cable A	Cable B
- construction A - 5 GHz type - 2x 0.14mm² (AWG 26) stranded	- construction B - 6 GHz type - 2x 0.14mm² (AWG 26) stranded

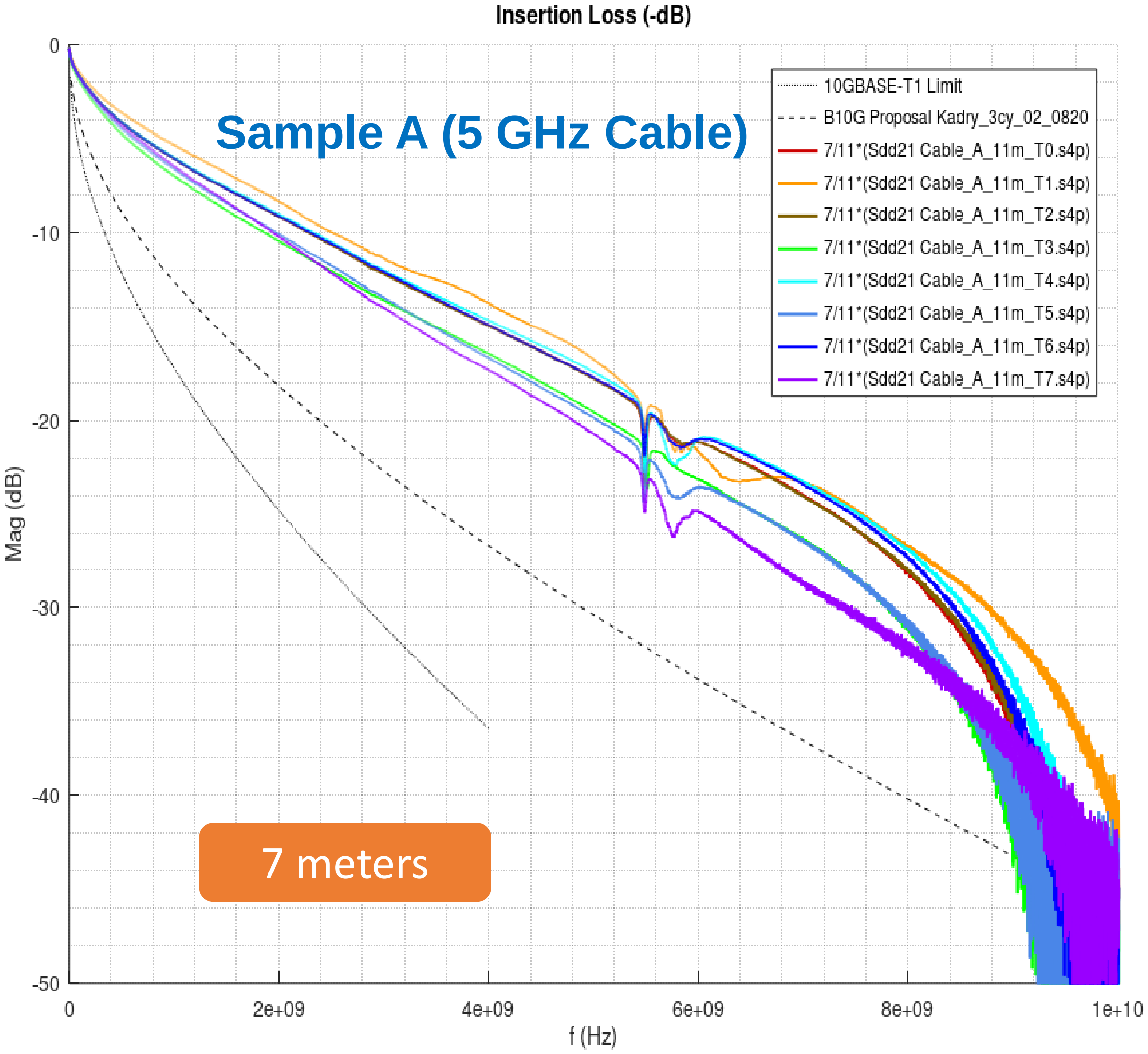
Insertion Losses (fixtures *not* removed)

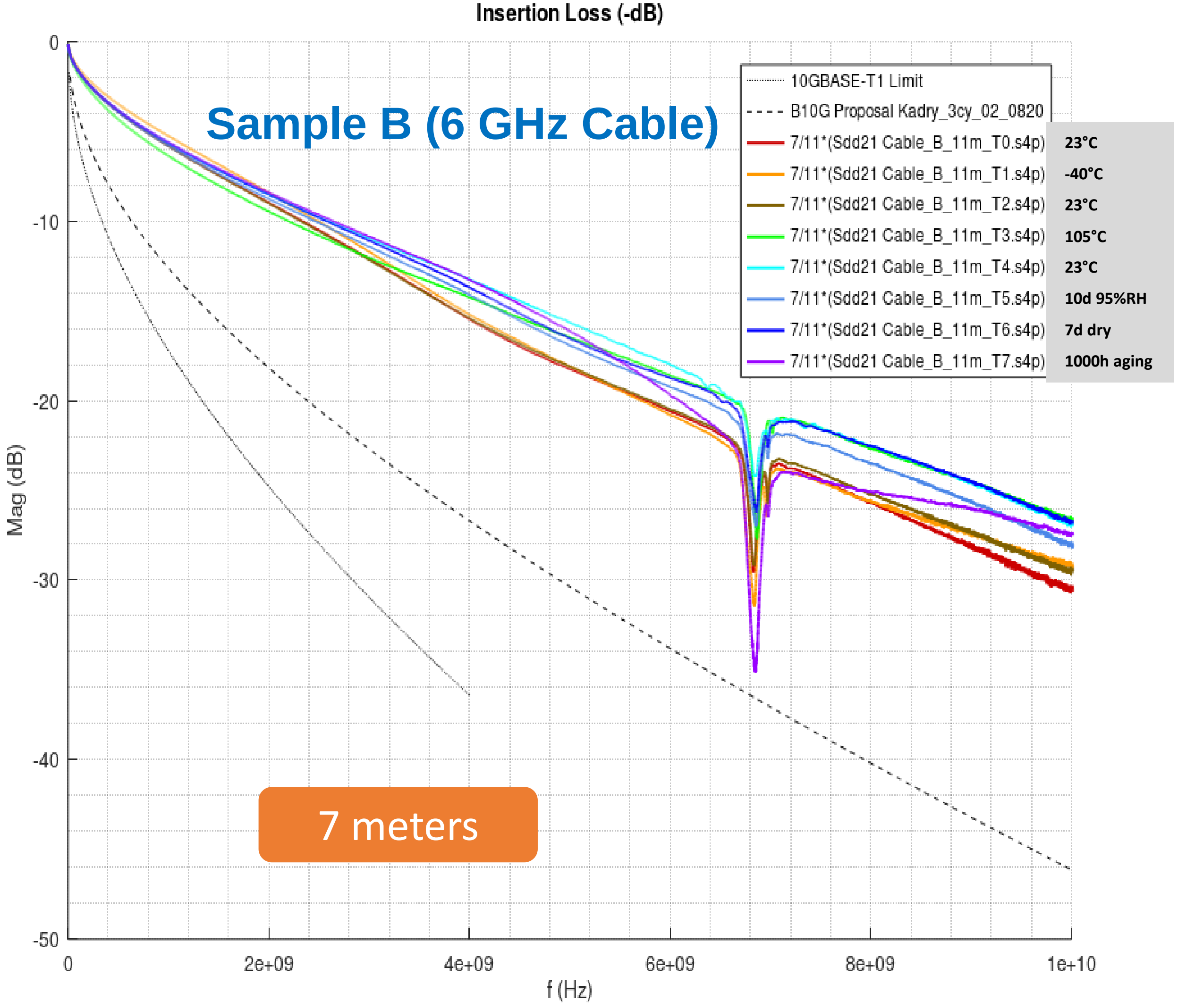




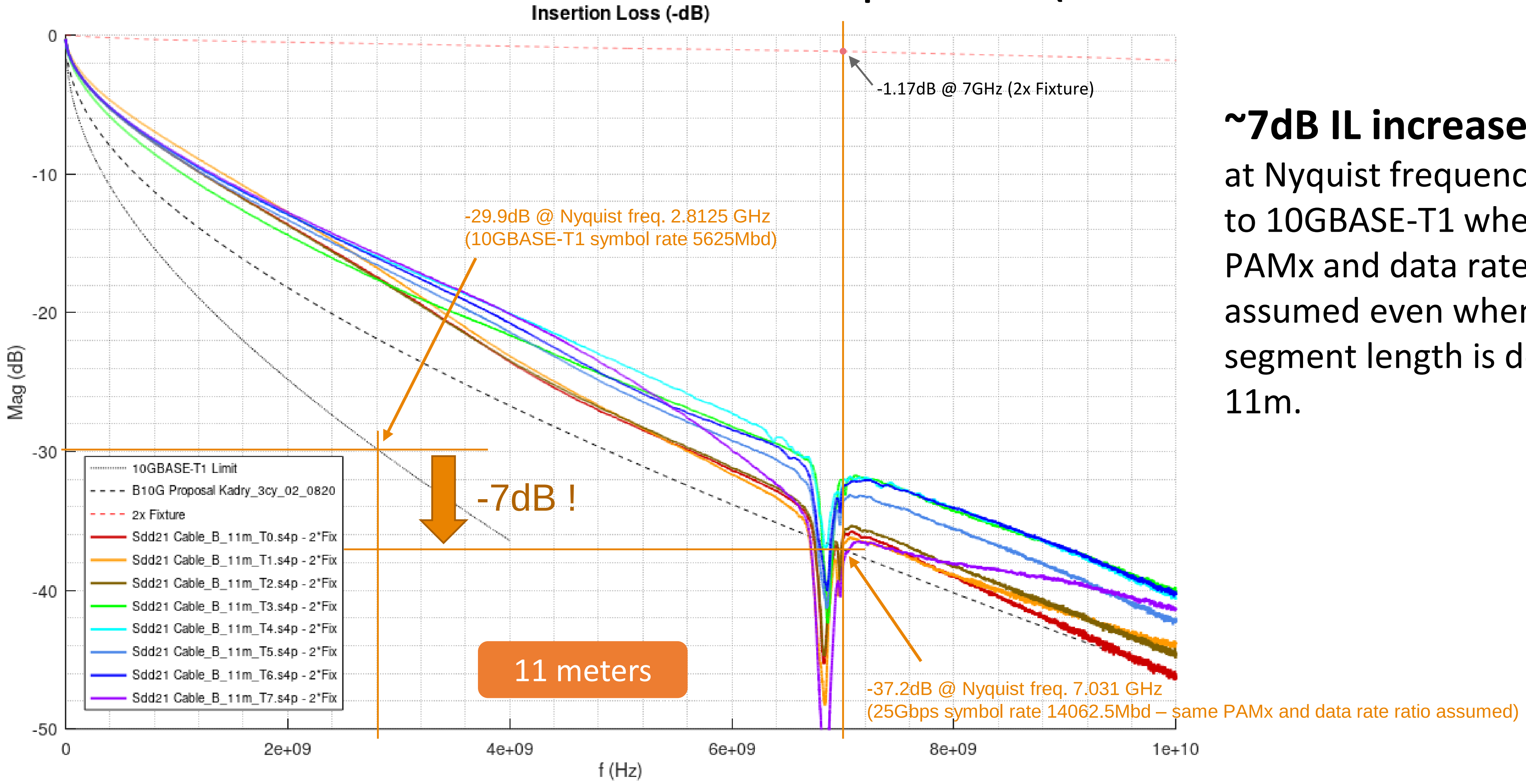
Scaled by 7/11

Insertion Losses (fixtures *not* removed)





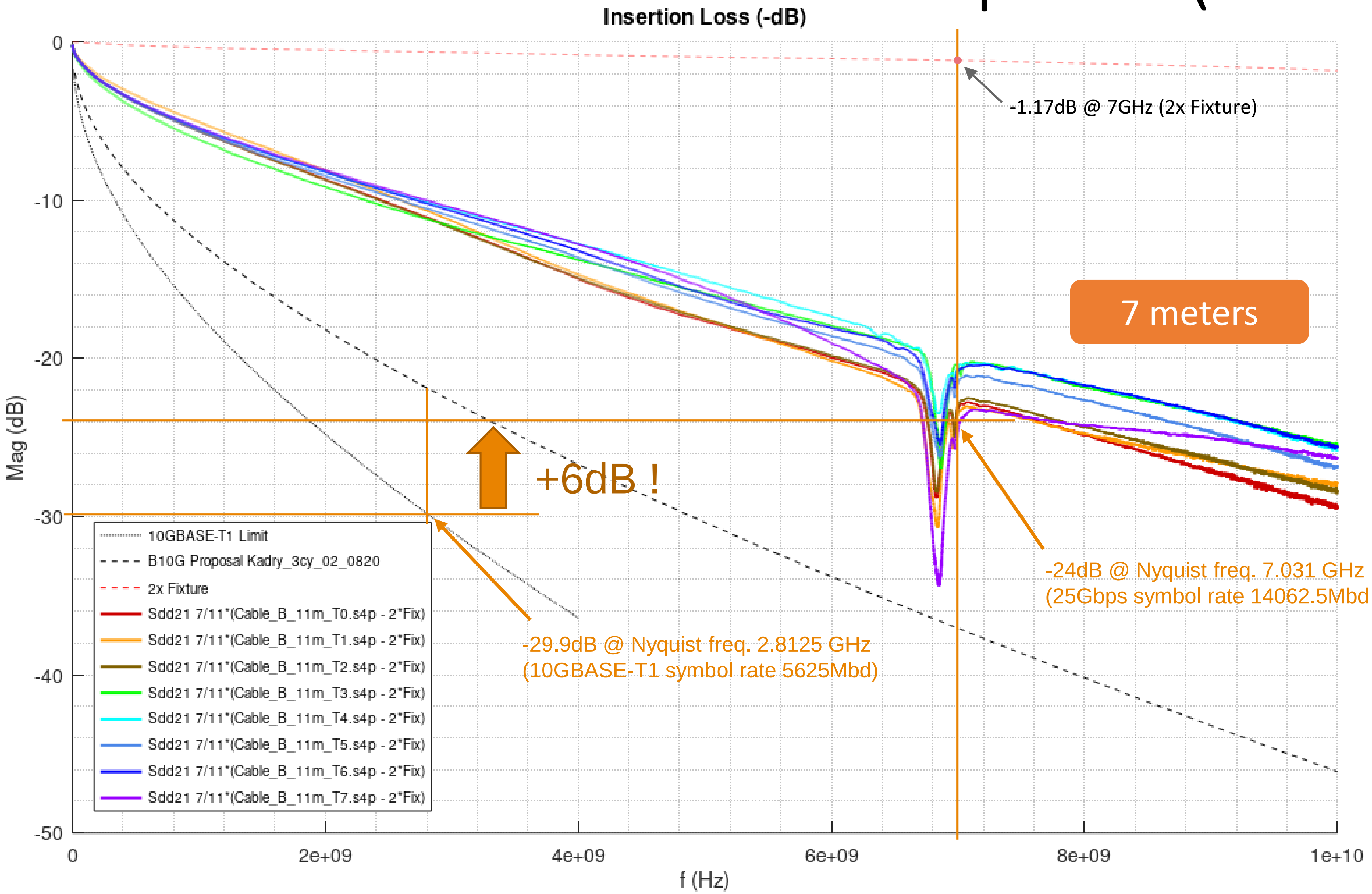
Insertion Losses – Sample B (fixtures removed)



~7dB IL increase

at Nyquist frequency compared to 10GBASE-T1 when same PAMx and data rate ratio is assumed even when link segment length is decreased to 11m.

Scaled by 7/11
Insertion Losses – Sample B (fixtures removed)



~6dB IL decrease

at Nyquist frequency compared to 10GBASE-T1 when same PAMx and data rate ratio is assumed when link segment length is decreased to 7m.

Conclusions / T.b.d.'s

- IL proposal in Kadry_3cy_02_0820.pdf can be met with Sample B, but only up to its maximum specified frequency of 6GHz
- Using existing AWG26 cables for 11m results in 7 dB additional IL compared to the 10GBASE-T1 link segment budget at corresponding Nyquist frequency for same data modulation ratio
- Using existing AWG26 cables for 7m results in 6 dB less IL compared to the 10GBASE-T1 link segment budget at corresponding Nyquist frequency for same data modulation ratio
- Potential for achieving higher frequencies with changed cable constructions (moving "notch" toward higher frequencies)
  - Discuss which max. frequency is needed (Kadry_3cy_02_0820.pdf proposes 7 GHz)
  - Discuss PAMx modulation level to reduce Nyquist frequency
- Reduction of IL requirement by defining 2 link segment options (Ex. 0-7m / 7-11m)
- Additional permanent long term degradation can be seen depending on cable construction
  → see also https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/presentations/d2-07_ohni_influence_of_aging_effects_v2.0.pdf
- What additional IL margin may be needed?
  - IL dips due to corresponding RL peaks (connectors, cable bends, cable squeezing)

Thank You!!!