

# Technical Feasibility of Gigabit transmission on one or two pair cabling based on Category 6a technology

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# Supporters

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Andrew Jimenez, Anixter

Kirsten Matheus, BMW

- Outline
- Test setups – up to 5 connector/40m
- Alien Crosstalk
- NEXT and FEXT in 2 Connector Setup
- PHY Margin results
- Modular Balance Study
- Conclusions & next steps

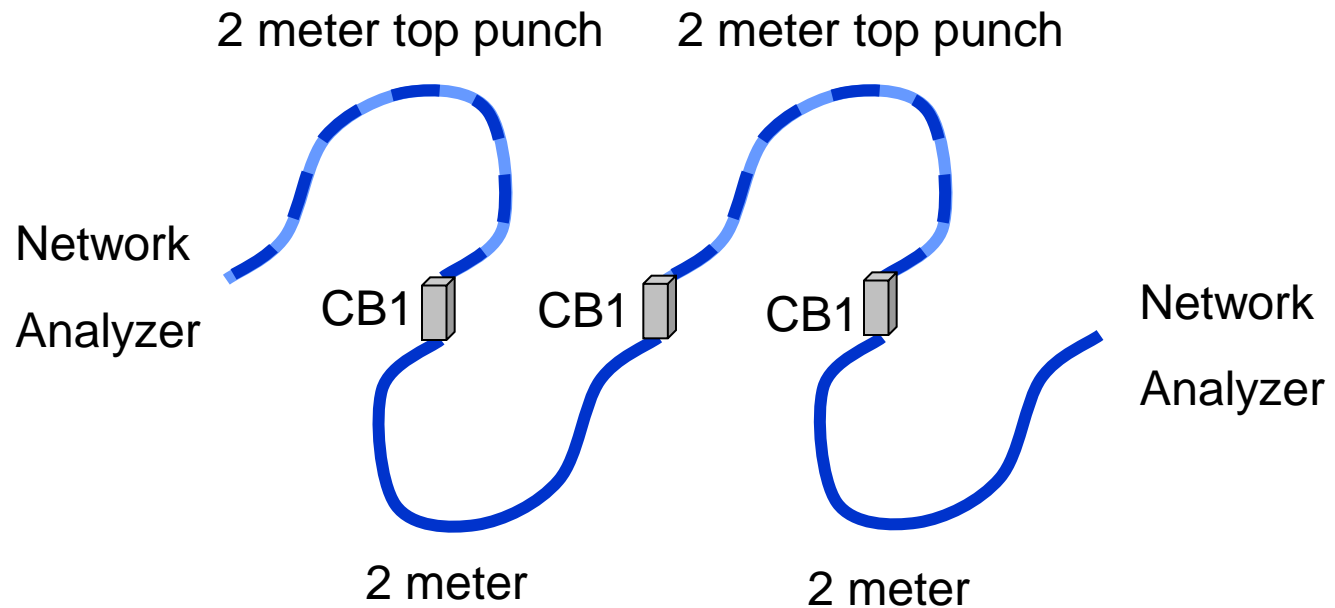
- 1 Pair System Tests:

- 3 Connection, 8m Channel
  - 3 Connection, 8m Channel Bundle for Alien Crosstalk
- 5 Connection, 12m Channel
  - 15m cable-only Channel Bundle for Alien Crosstalk
- 5 Connection, 40m Channel
  - 40m cable-only Channel Bundle for Alien Crosstalk

- 2 Pair System Tests:

- (NEXT and FEXT now collected)
- 3 Connection, 8m Channel
  - 3 Connection, 8m Channel Bundle for Alien Crosstalk
- 5 Connection, 12m Channel
  - 15m cable-only Channel Bundle for Alien Crosstalk
- 5 Connection, 40m Channel
  - 40m cable-only Channel Bundle for Alien Crosstalk

## 3 Connector, 8m Channel



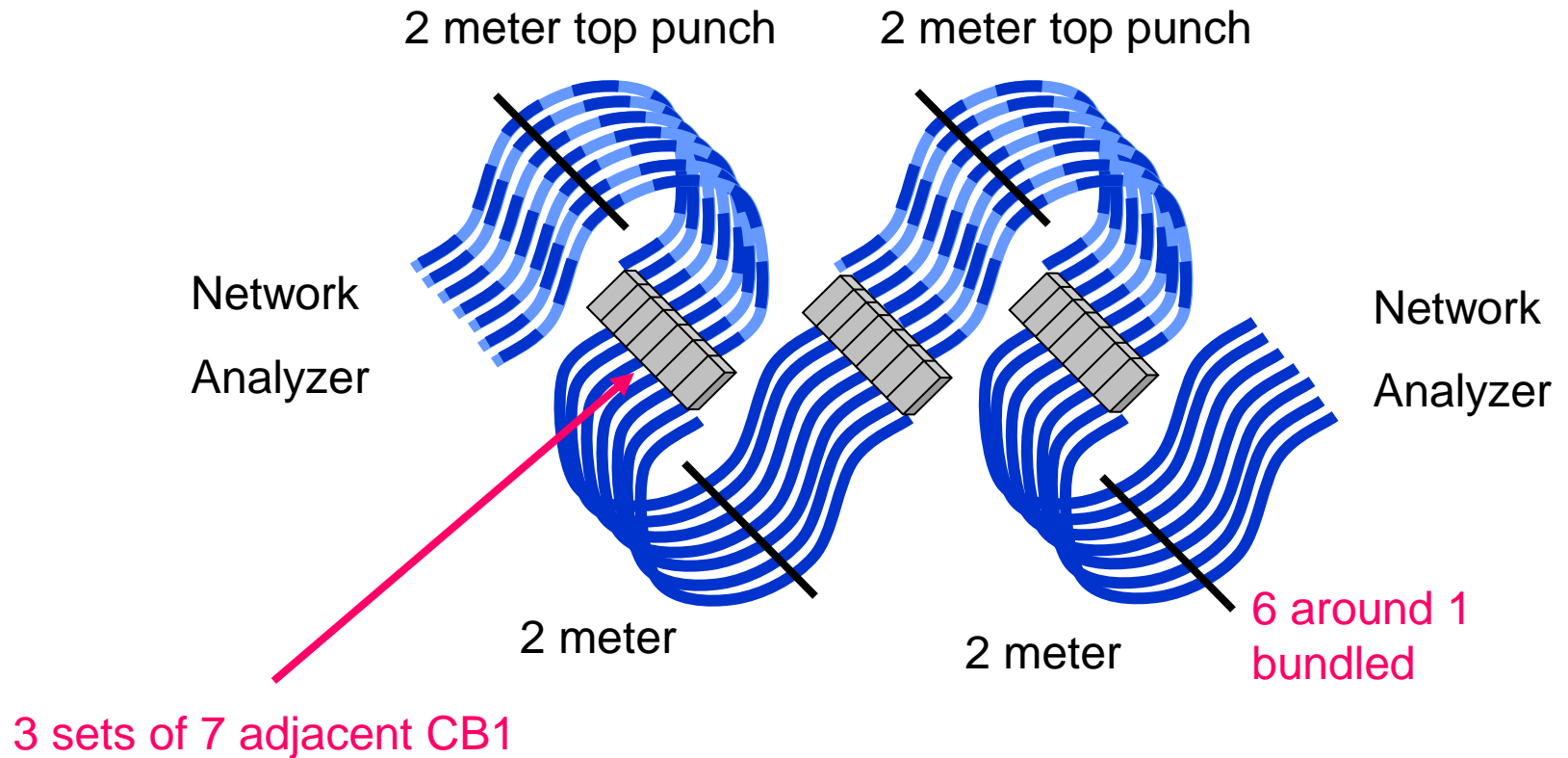
CB1 - one pair connecting block

Top punch cable is the same as the bottom

3 Connection 8m Channel

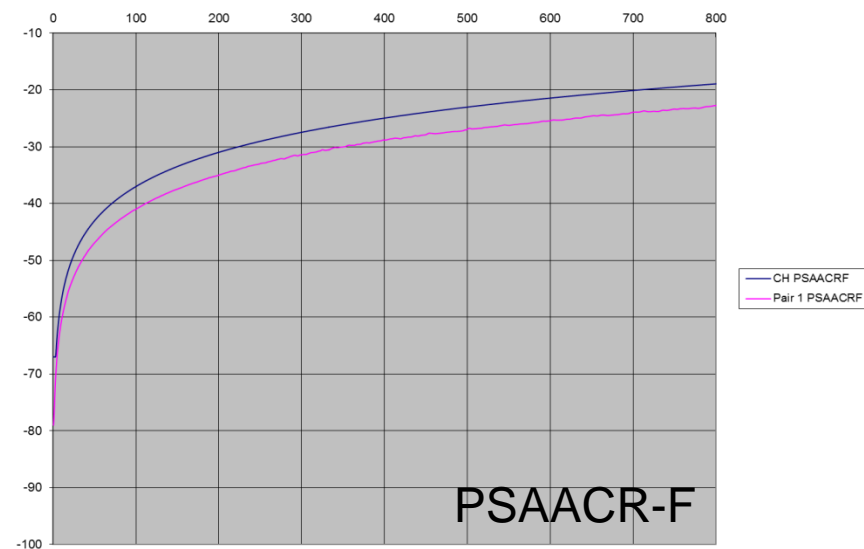
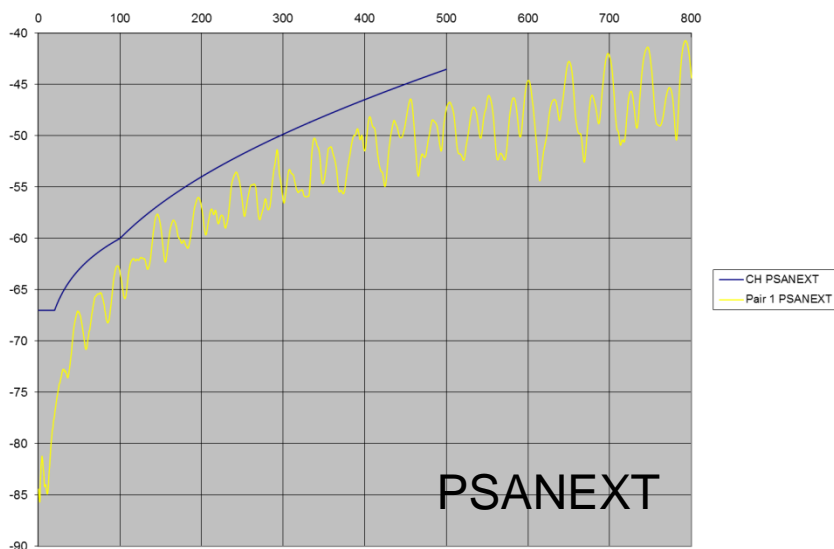
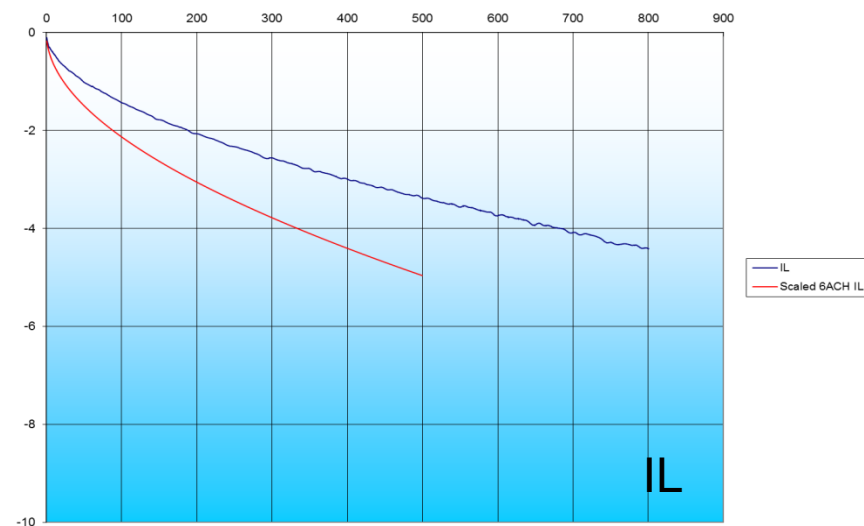
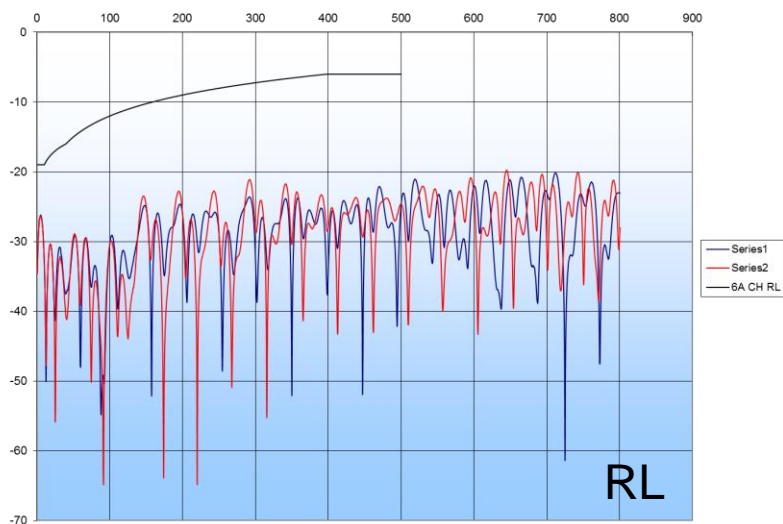
## 3 Connector, 8m 6-around-1 Channel

- For Alien Crosstalk Testing

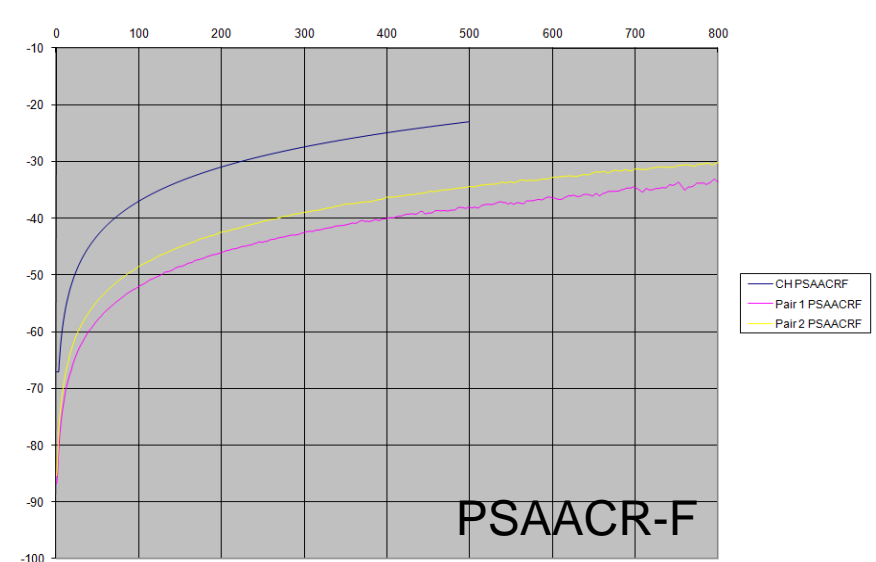
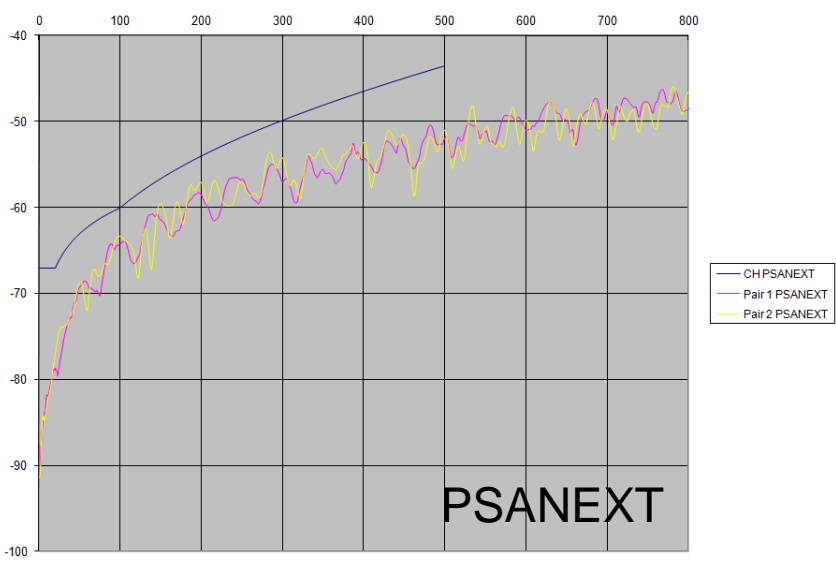
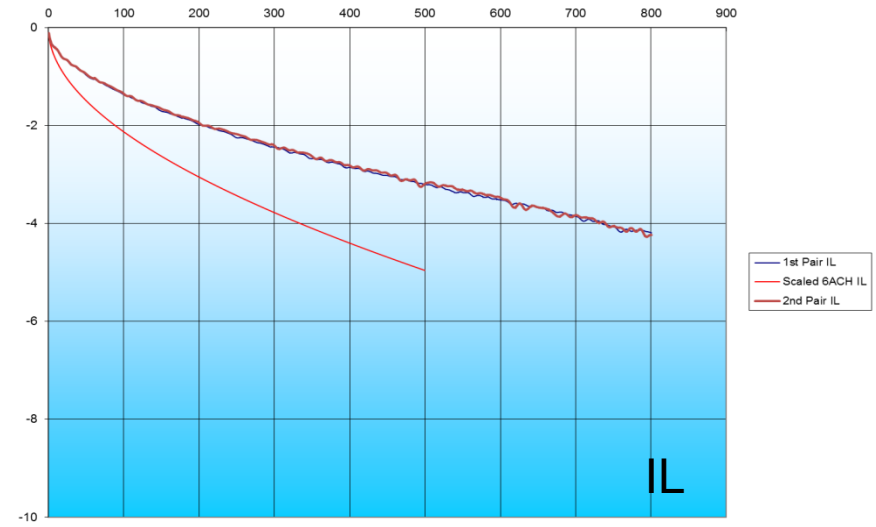
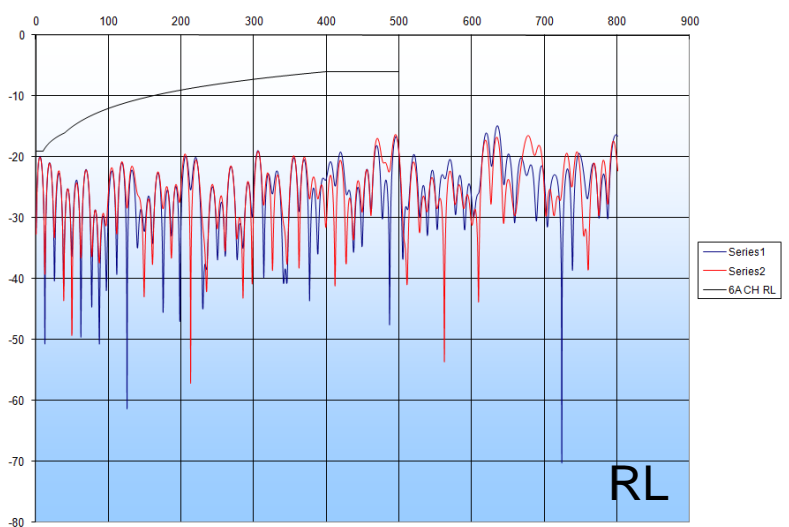


3 Connection 8m Alien Test

# 1-Pair System – 3 inline connectors, 8m

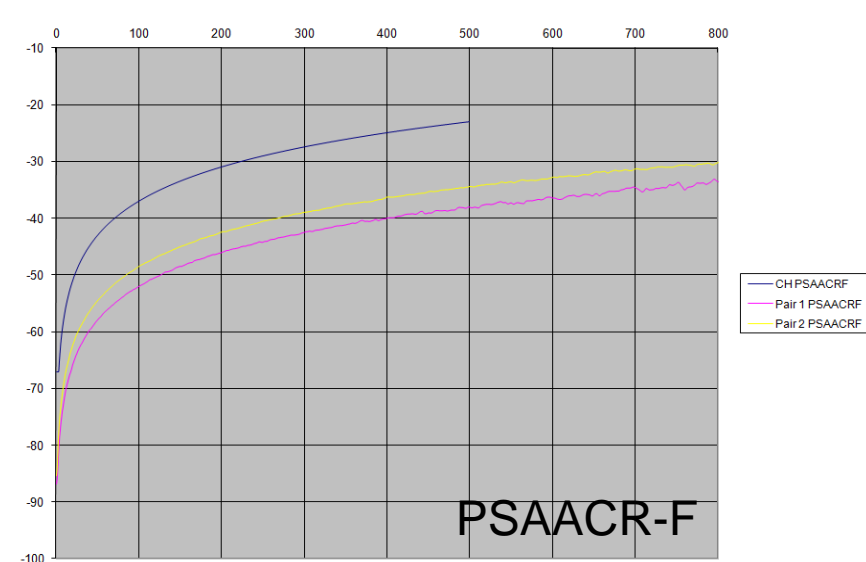
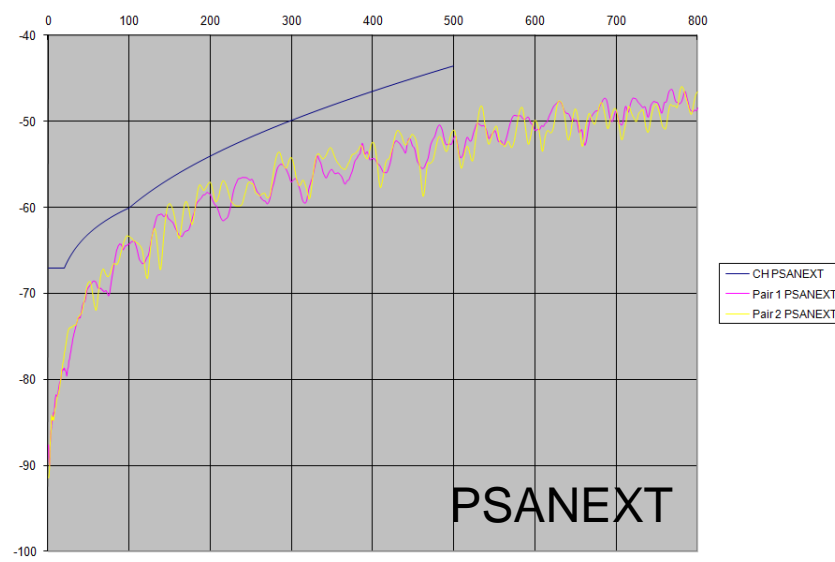
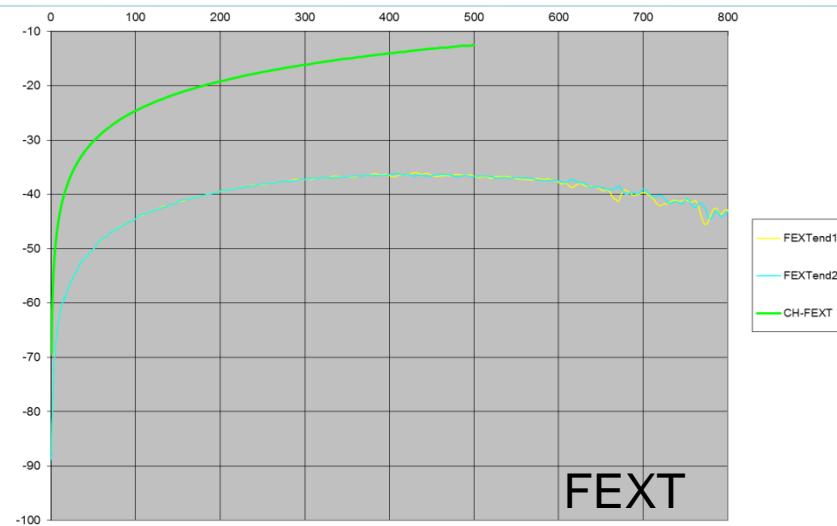
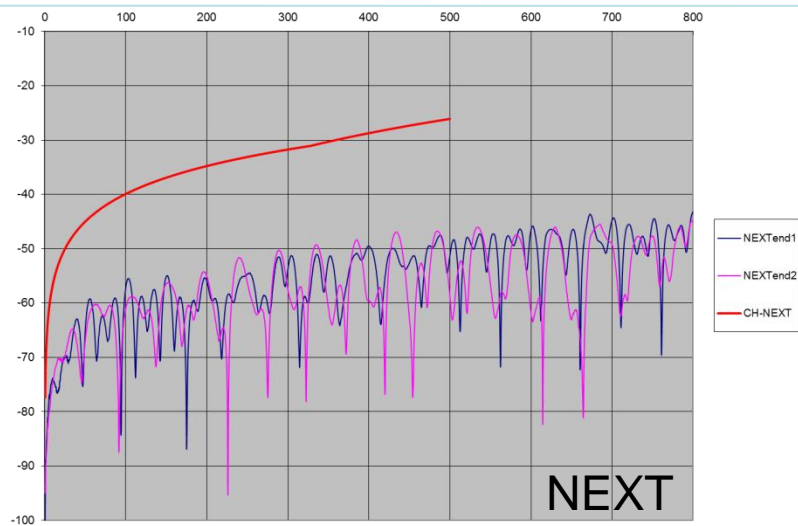


# 2-Pair System – 3 inline connectors, 8m

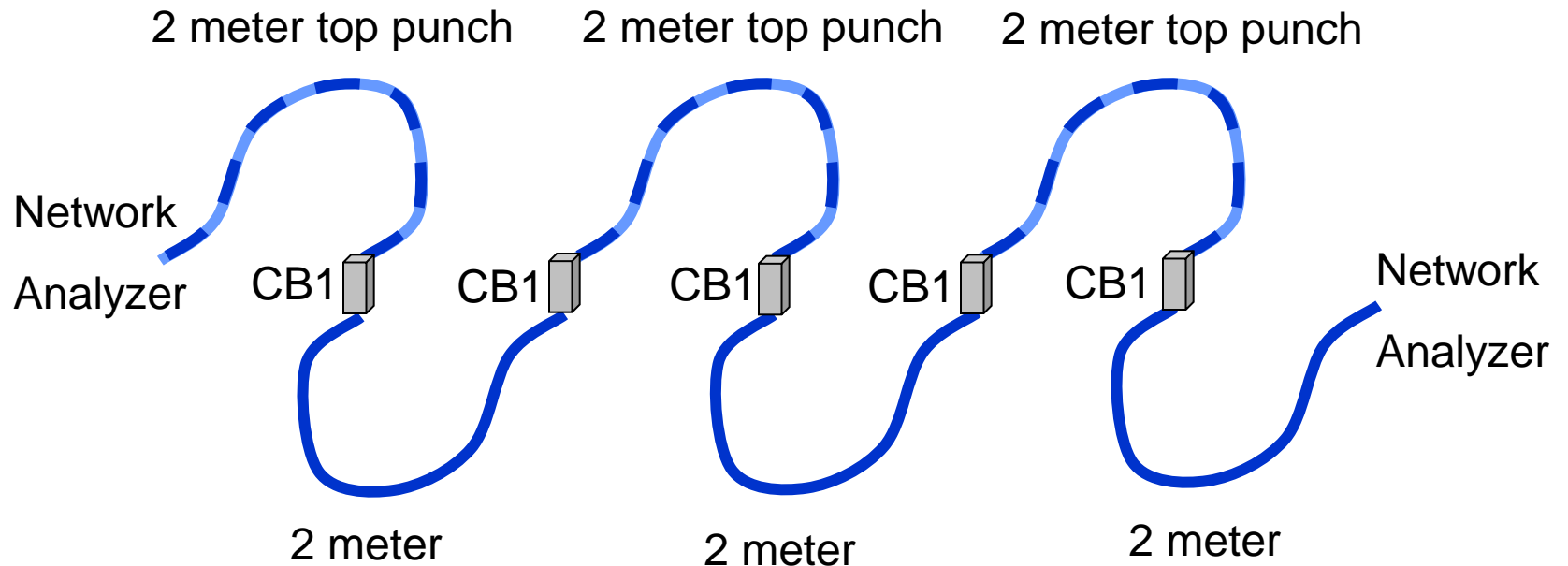




# 2-Pair System – 3 inline connectors, 8m, NEXT/FEXT

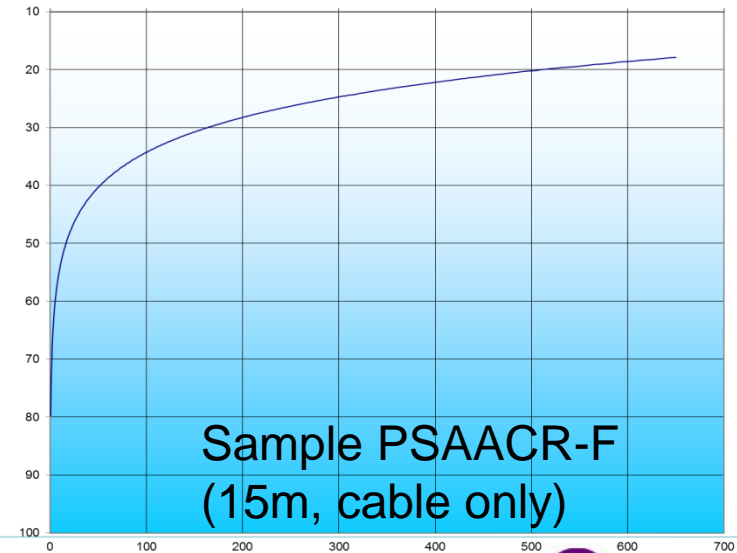
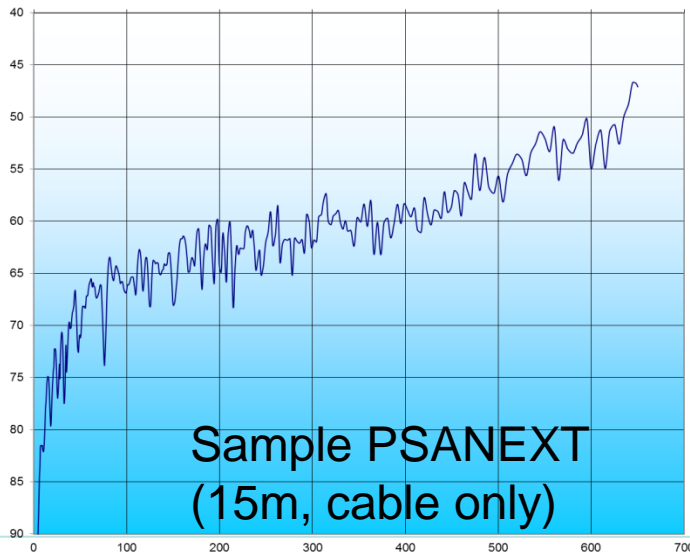
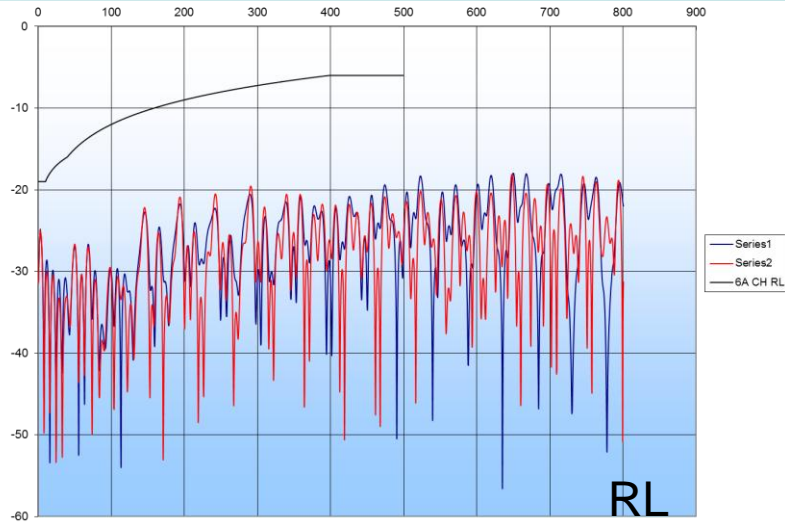


## 5 Connector, 12m Channel

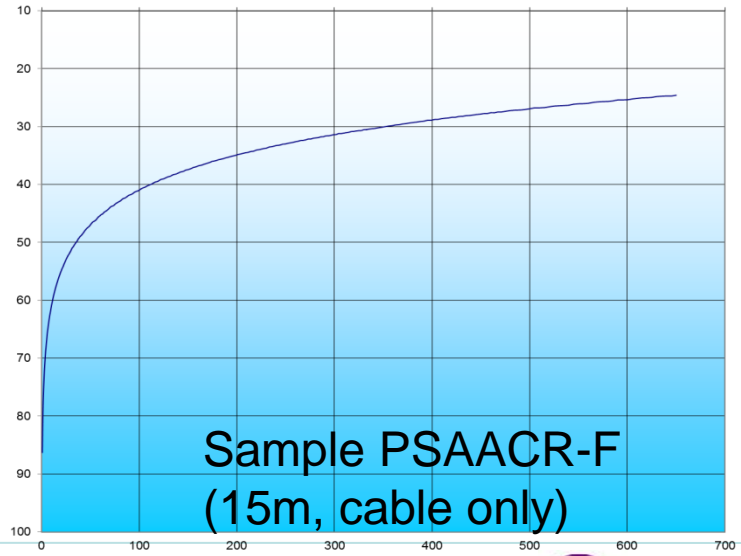
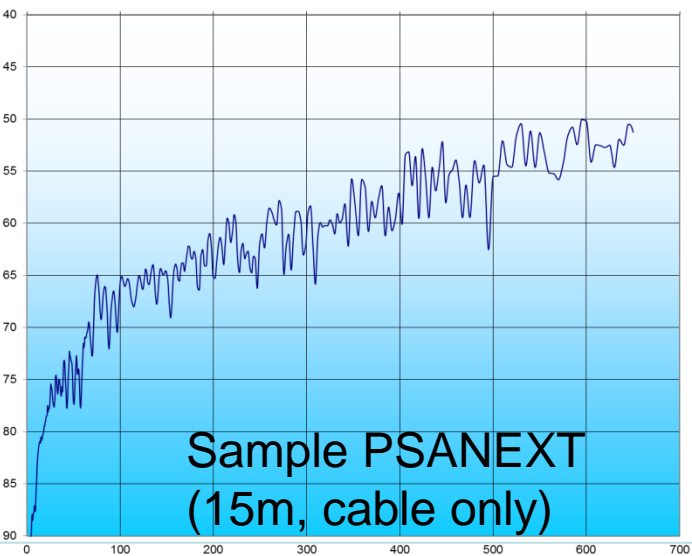
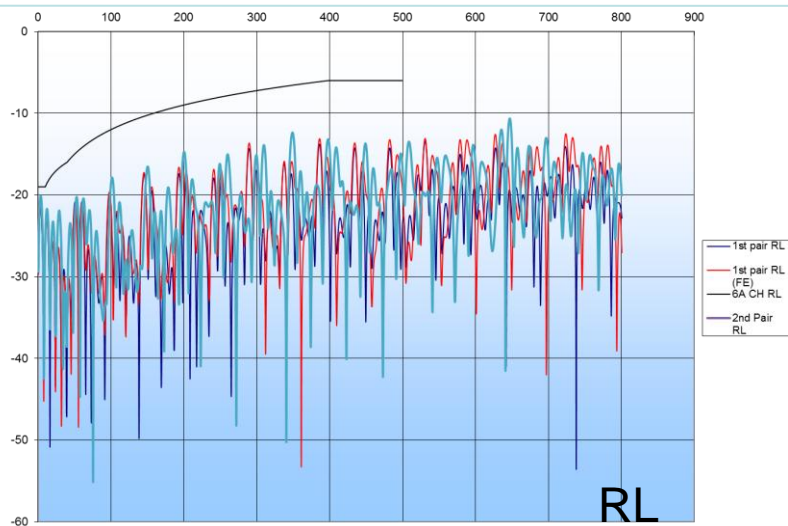


5 Connection 12m Channel

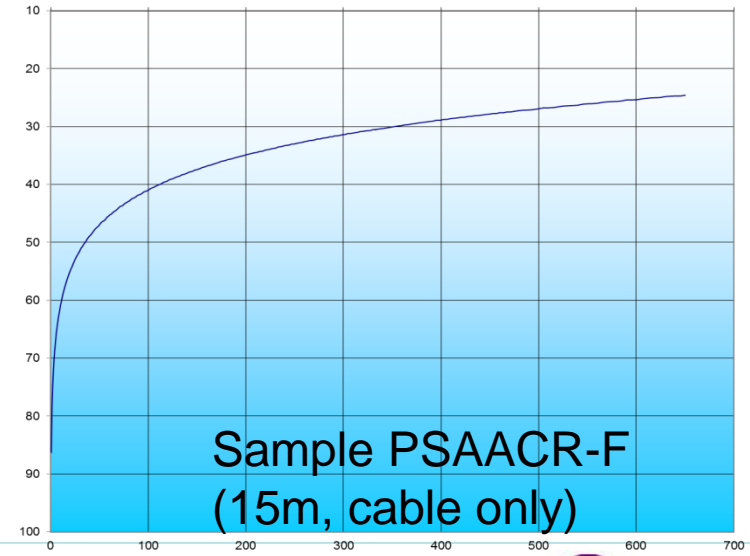
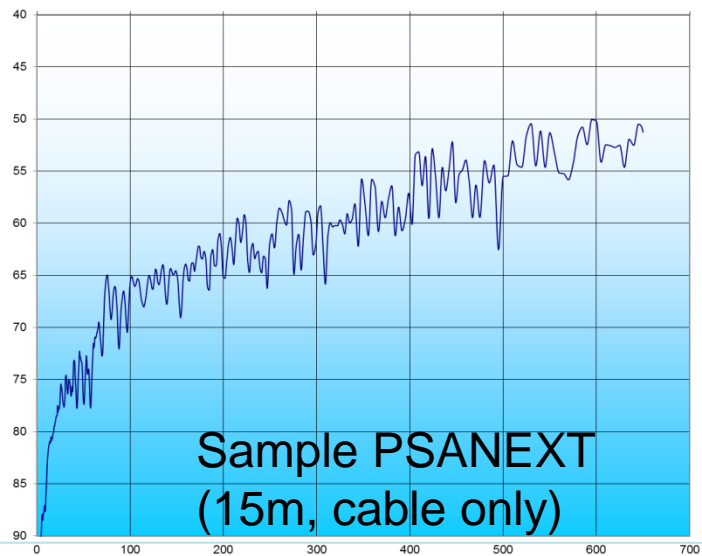
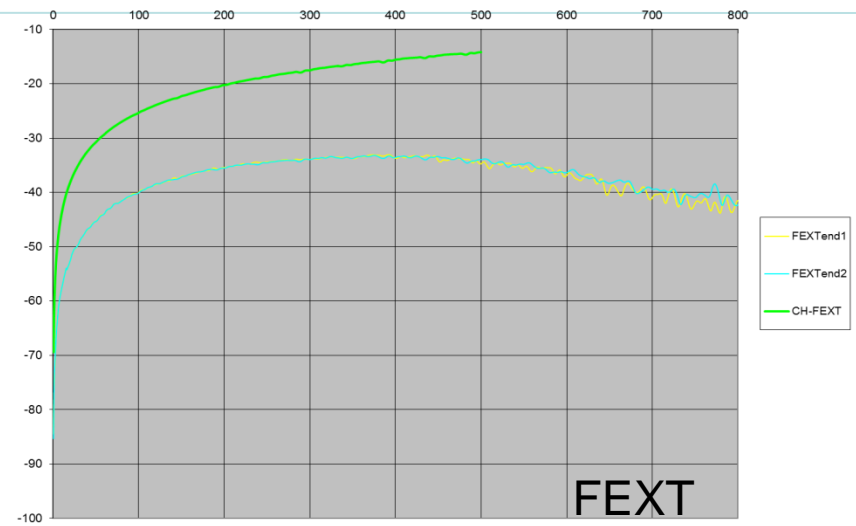
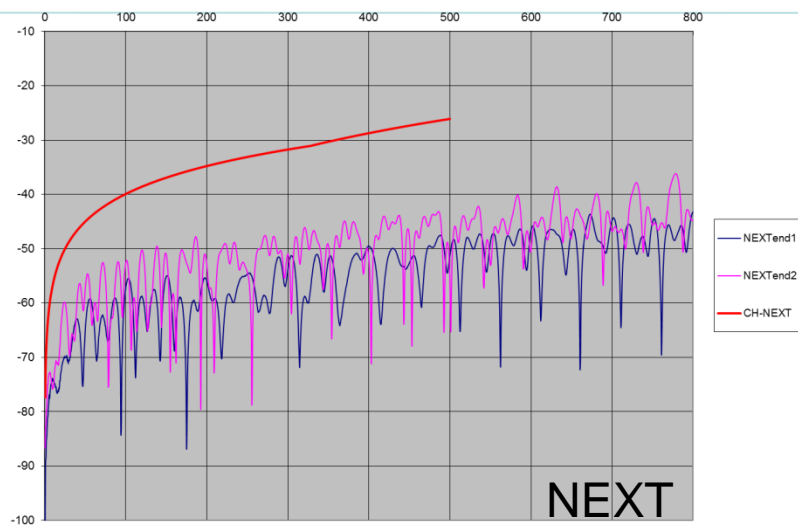
# 1-Pair System – 5 inline connectors, 12m



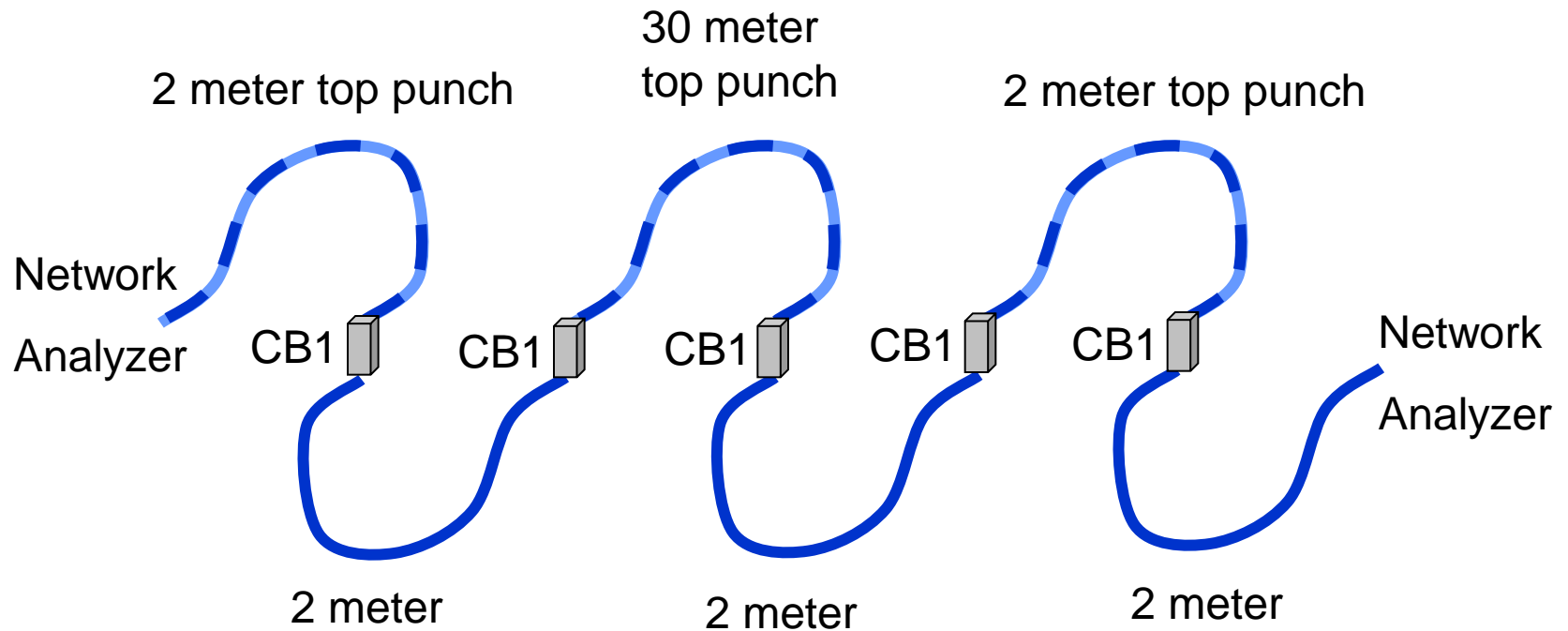
# 2-Pair System – 5 inline connectors, 12m



# 2-Pair System – 5 inline connectors, 12m, NEXT/FEXT



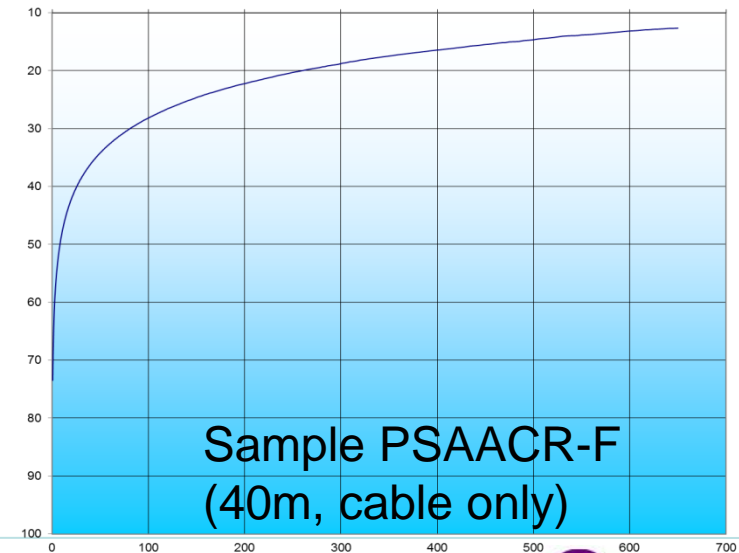
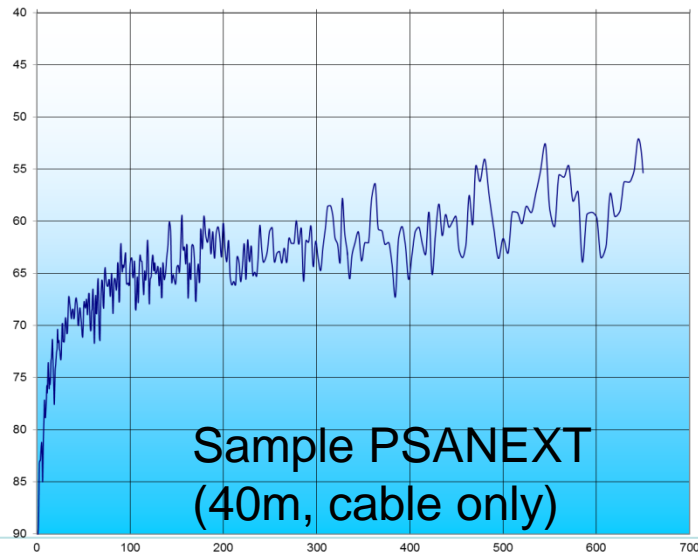
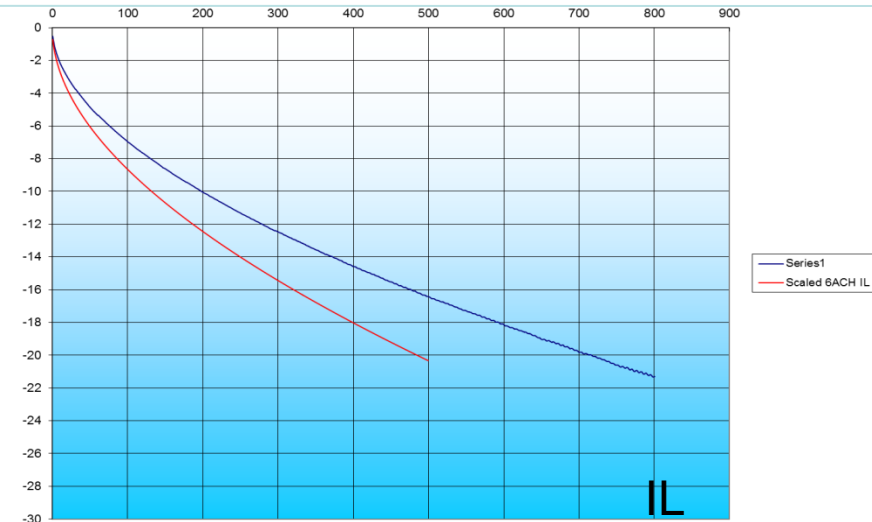
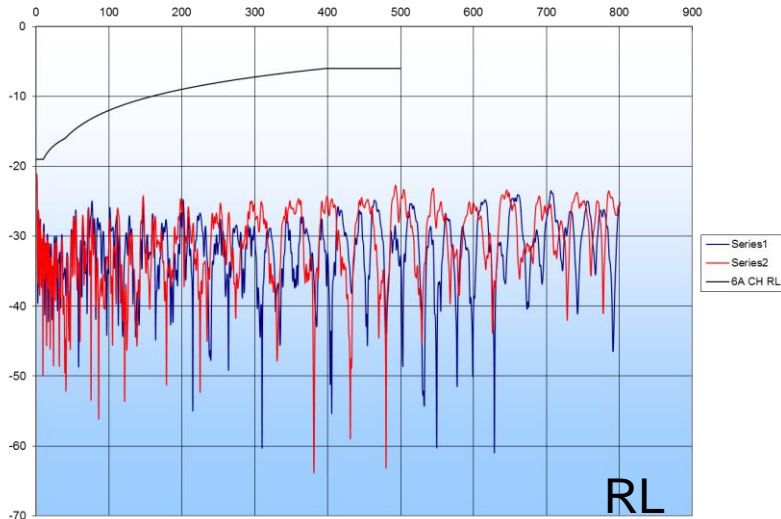
## 5 Connector, 40m Channel



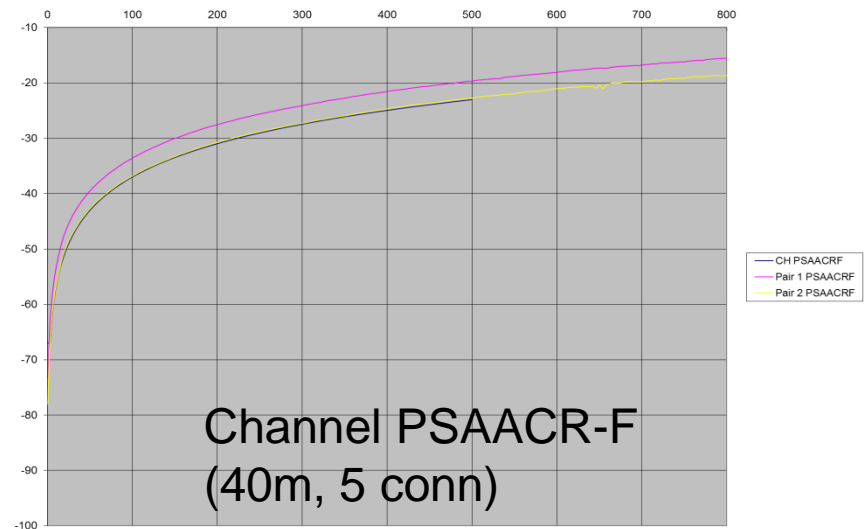
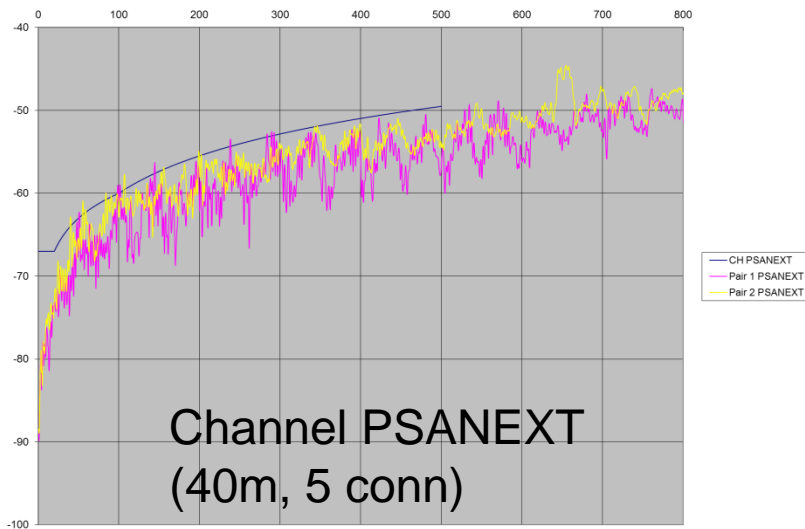
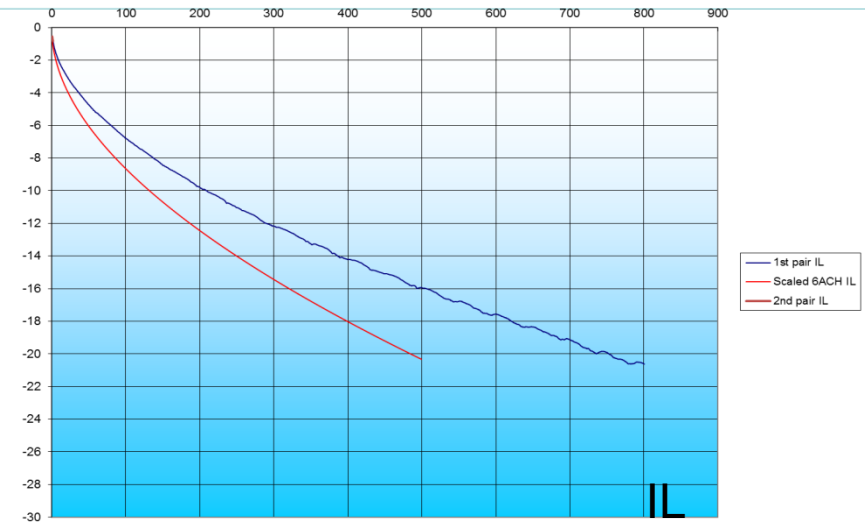
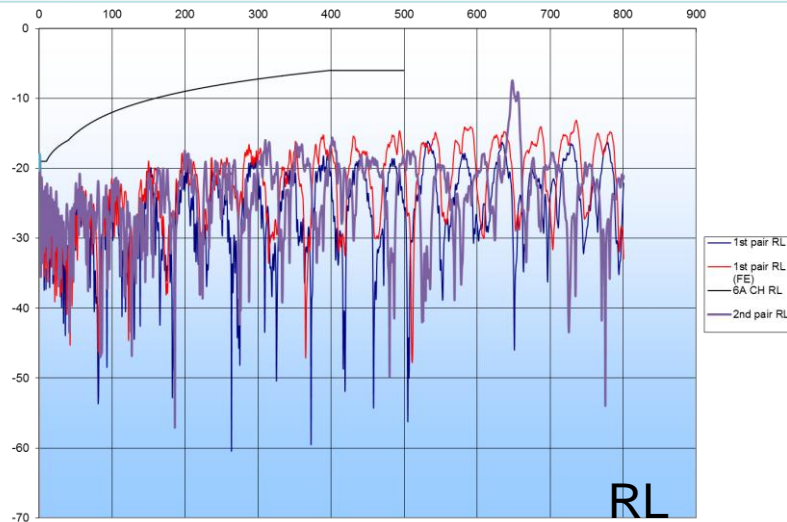
5 Connection 40m Channel

(replace middle punch with 30 meter)

# 1-Pair System – 5 inline connectors, 40m

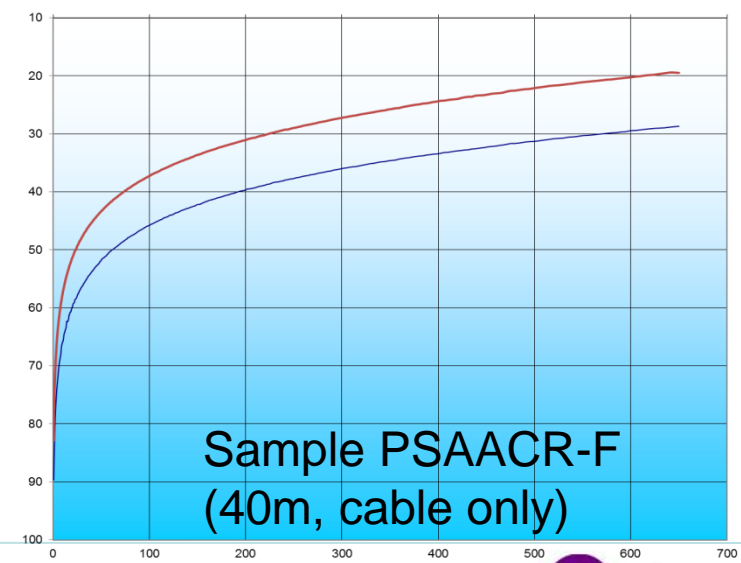
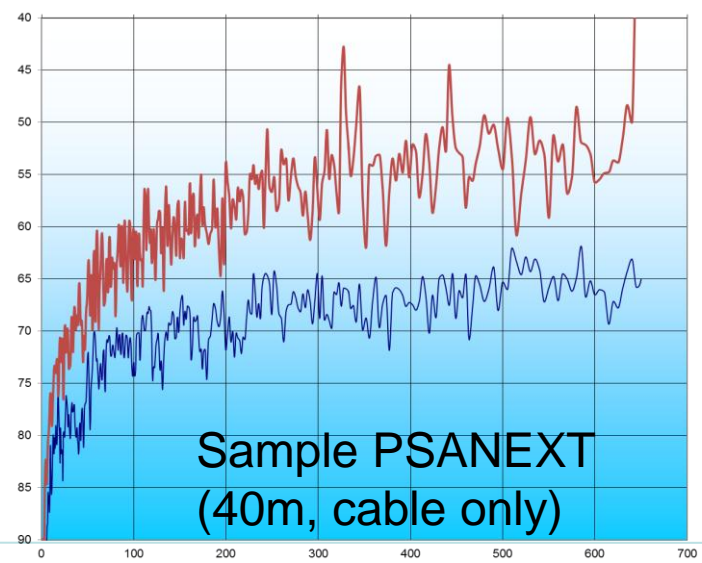
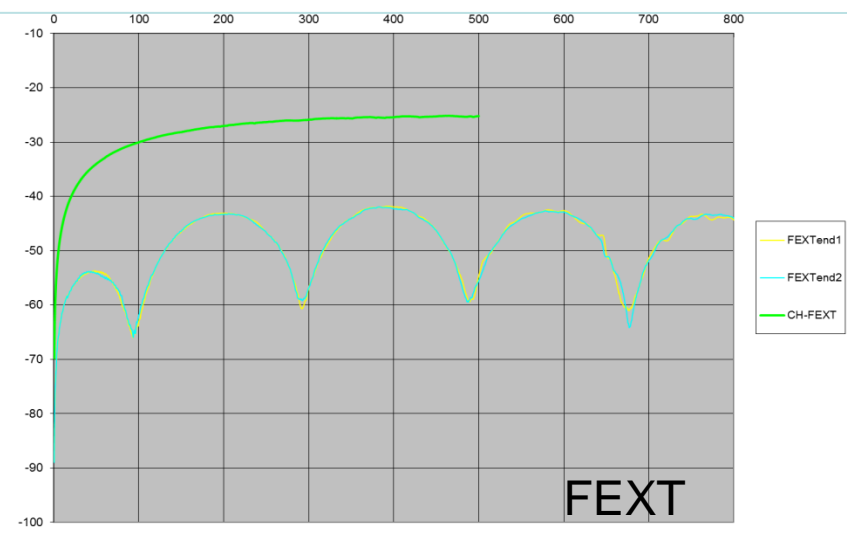
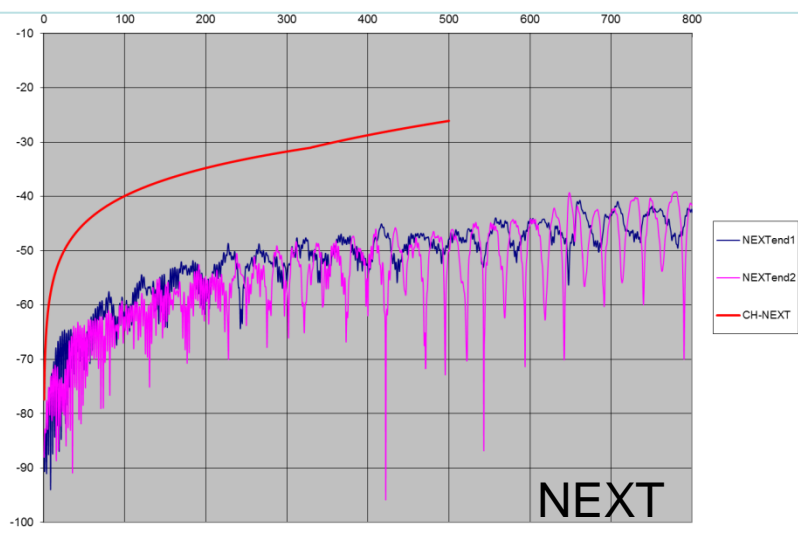


# 2-Pair System – 5 inline connectors, 40m



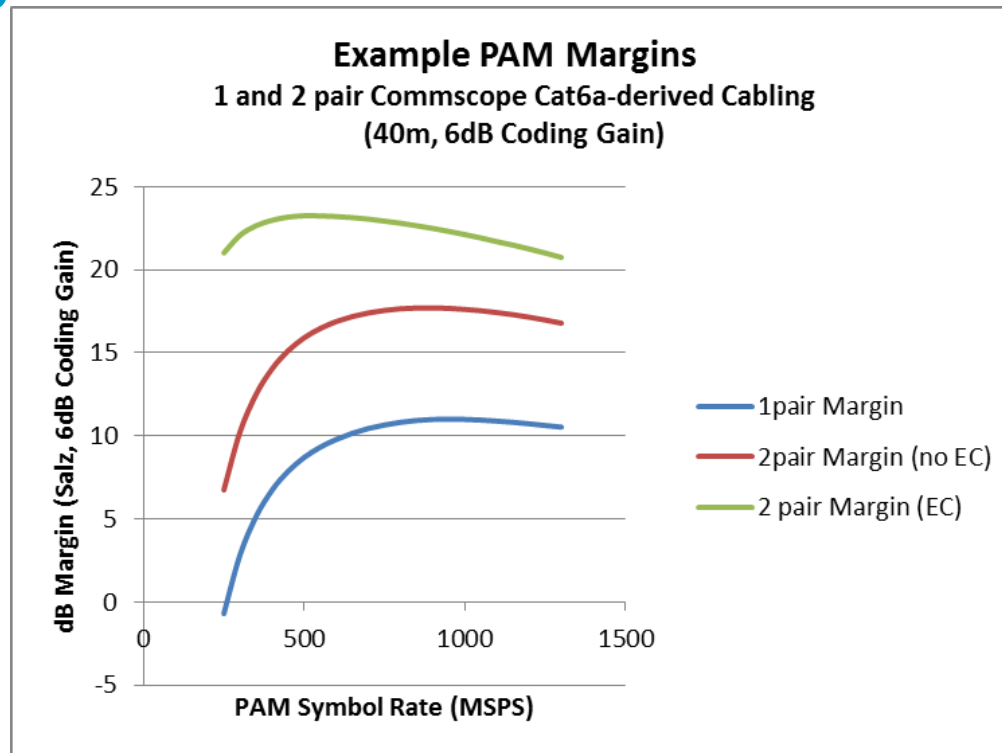


# 2-Pair System – 5 inline connectors, 40m, NEXT/FEXT



- Estimated PAM Margin vs. Symbol Rate for 40m channels using Salz (Optimal DFE Modelling)
- Parameters:
  - PAM Modulation + 6dB coding gain
  - No NEXT or FEXT cancellation
    - Alien Crosstalk levels are similar or greater than internal crosstalk
  - 40dB Echo Cancellation
  - Salz (Optimal DFE) Modelling

# Example PAM Margins vs. Signalling Rate



- Results show signalling from PAM-2 to PAM-5 provides margin
- No NEXT or FEXT cancellation used, coding similar to 1000BASE-T
- Margins are sufficient to allocate implementation losses, aging and impulse immunity coding
  - Gap between 1 pair and 2 pair (no EC) is a result of the alien crosstalk levels in these cables

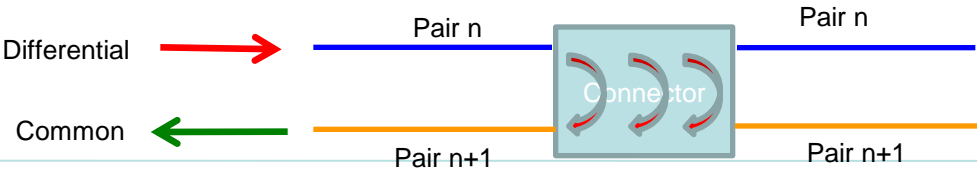
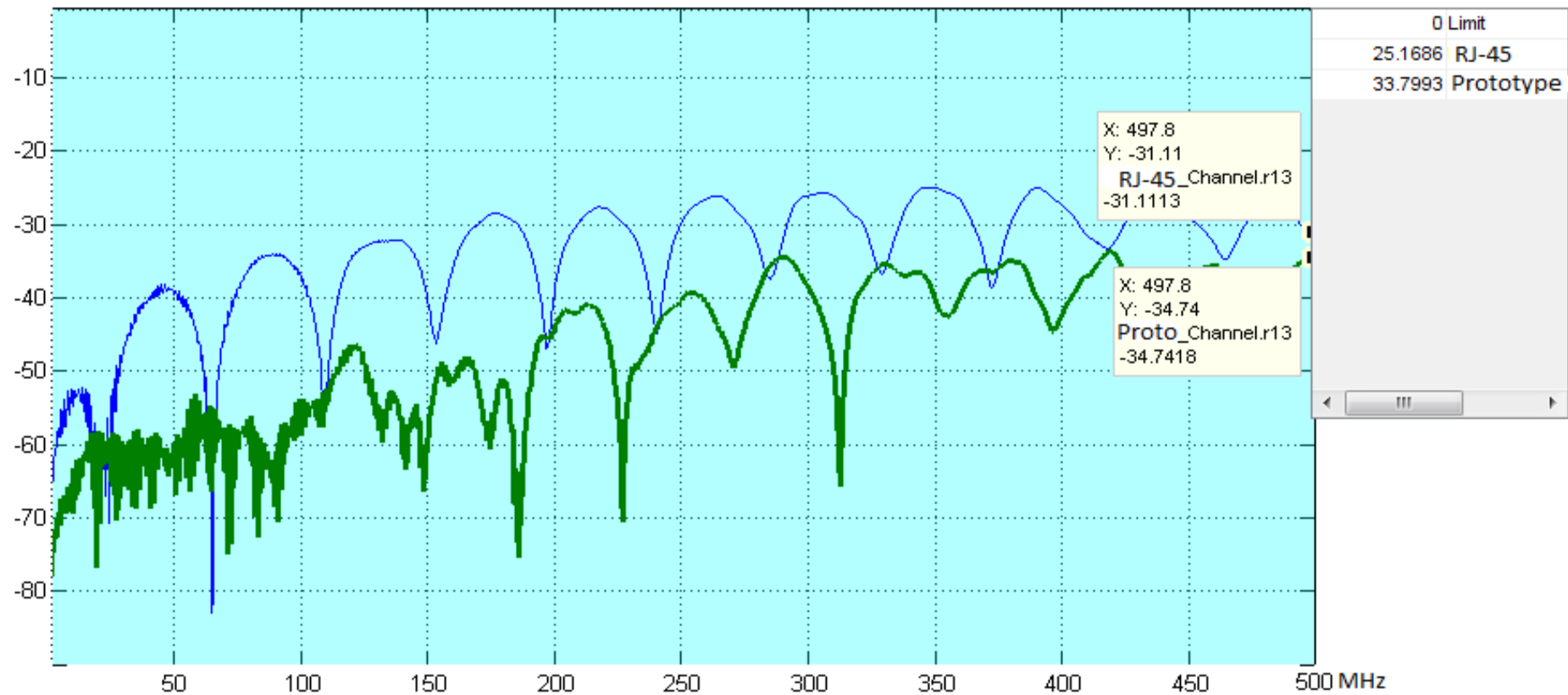
- These models were provided to multiple PHY vendors for independent Feasibility Analysis
- Both 1 pair and 2 pair were feasible, with choice of modulation type (PAM-2 or PAM-4/5)
- See PHY vendor contributions for analysis
  - Huang\_01\_0712.pdf

## Next Steps

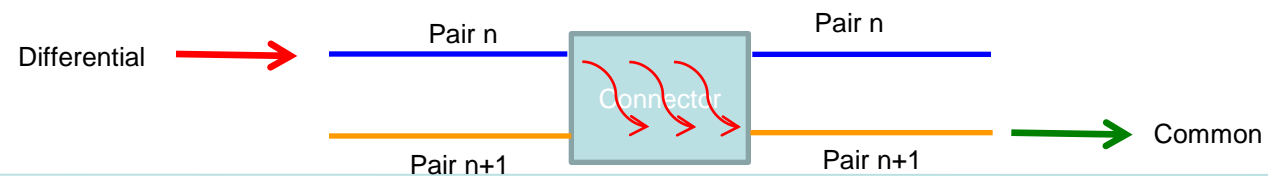
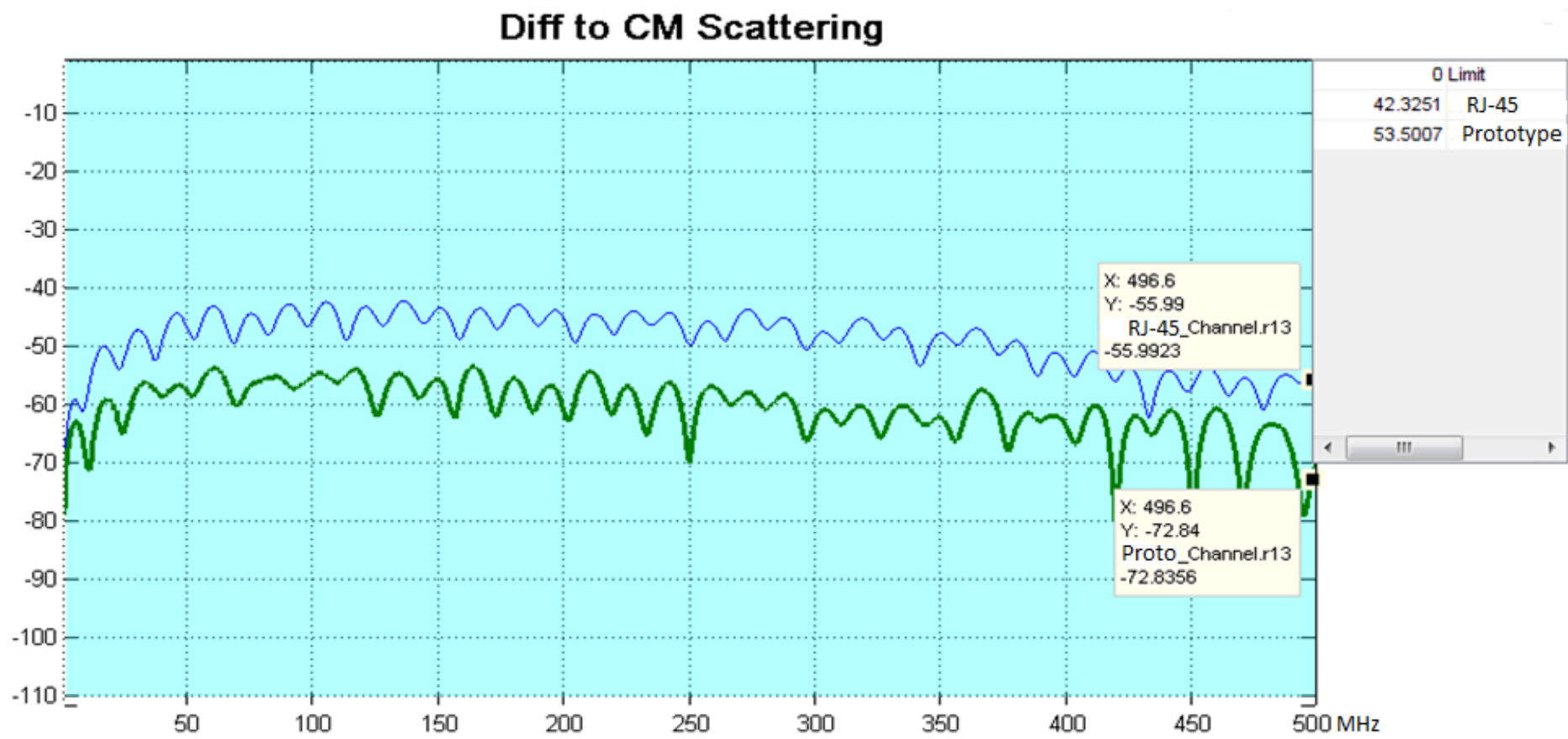
- Feasibility for cabling should examine aging & EMC properties
- First step in EMC properties is balance/mode conversion
- Channel-level balance measurements show performance superior to traditional Ethernet cabling

# Channel Level Balance (Mode Conversion)

Diff to CM Scattering



# Channel Level Balance (Mode Conversion)



- 1 and 2 pair cabling channels with up to 5 connectors based on Category 6a cores have been presented
  - Both 1 pair and 2 pair systems are technically feasible, this data suggests that the number of pairs will be determined by other parameters
- PHY technical feasibility for >40m transmission has been shown with margin by multiple vendors
- EMC / Aging effects are for further study
  - Initial balance results look promising