

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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- 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

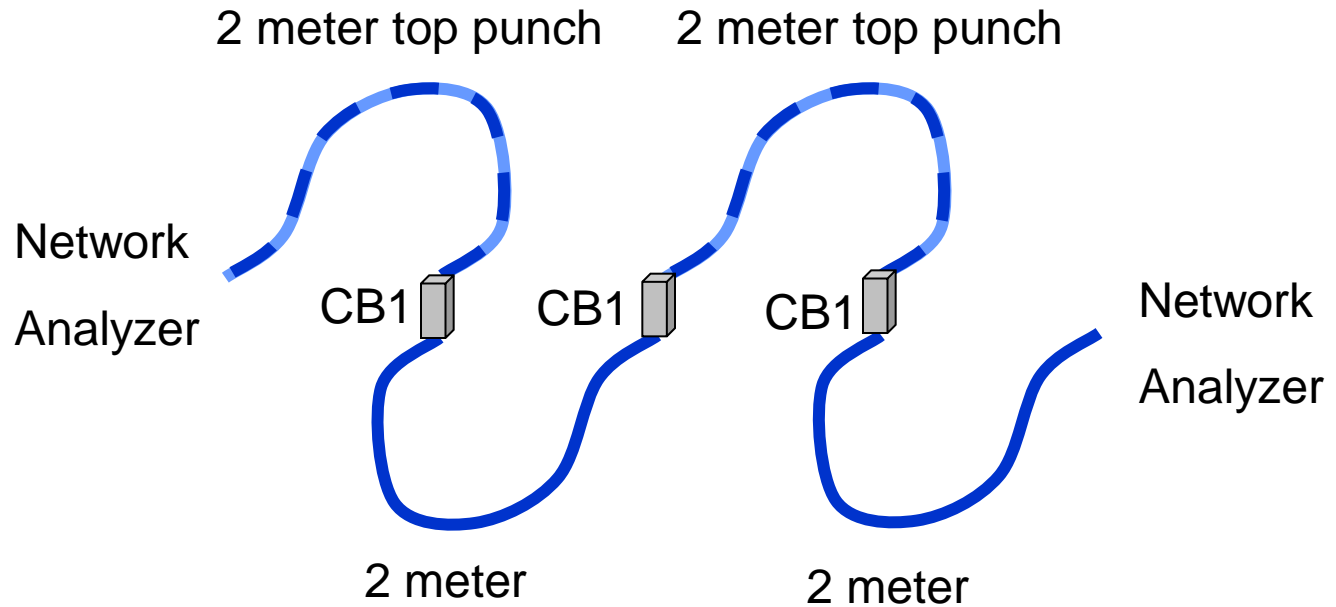
- 1 Pair System Tests:

- 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



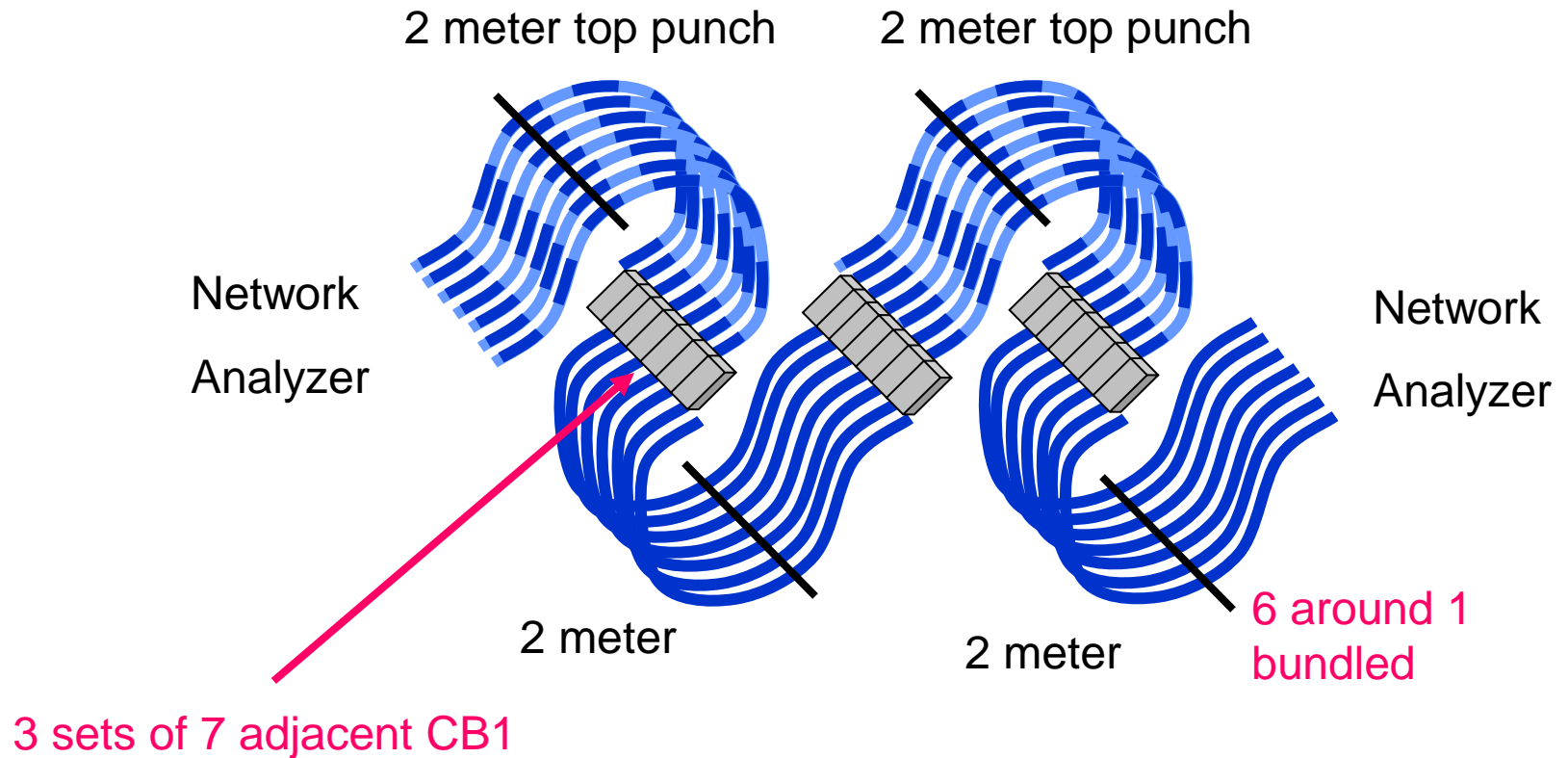
3 Connection 8m Channel

CB1 - one pair connecting block

Top punch cable is the same as the bottom

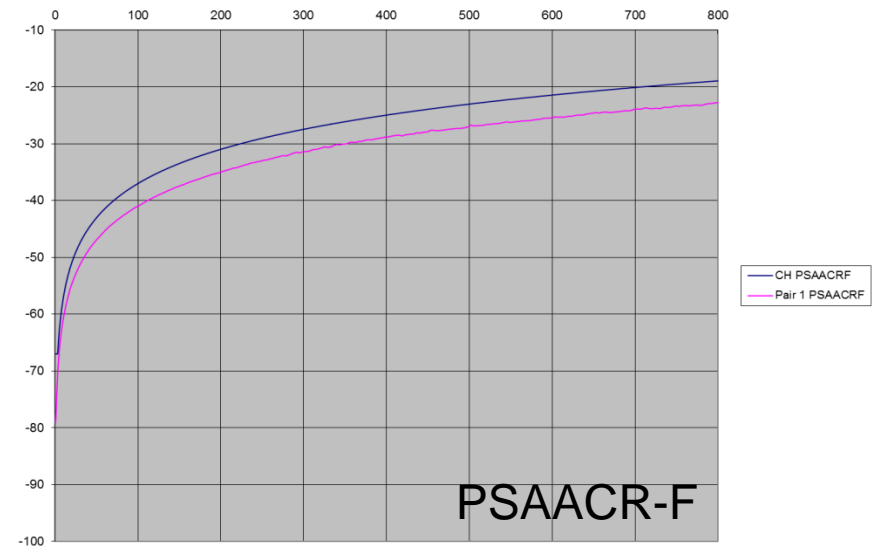
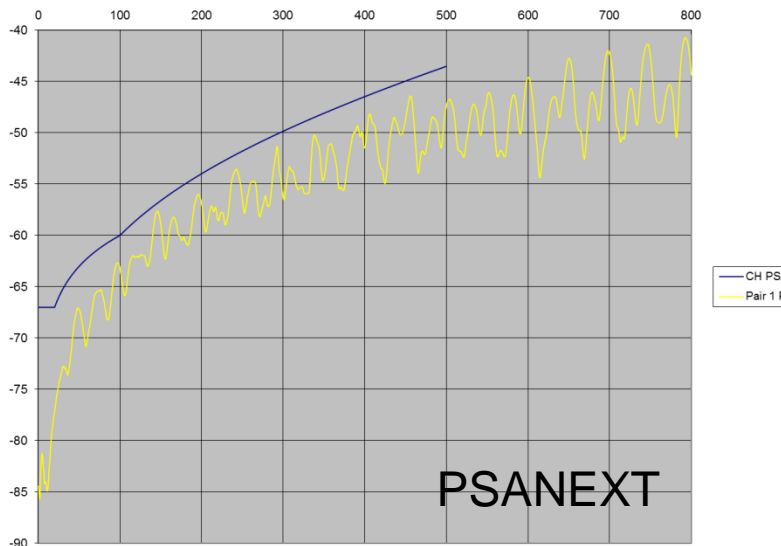
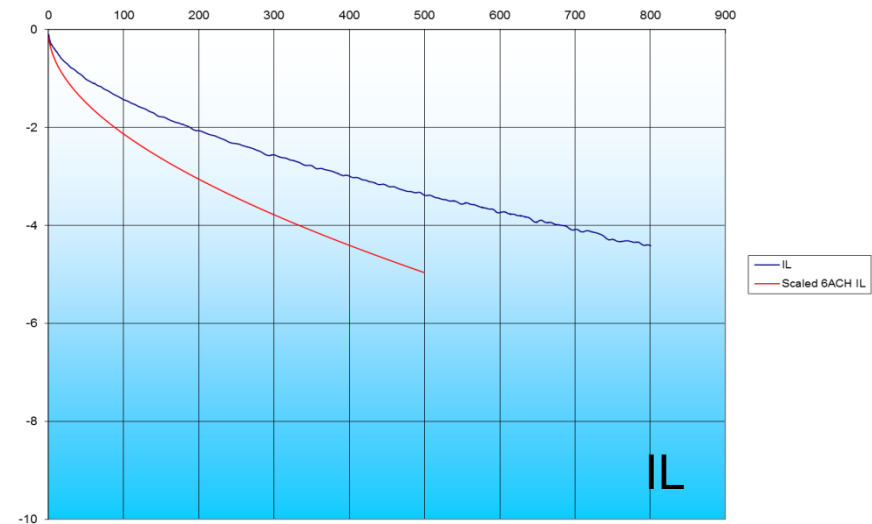
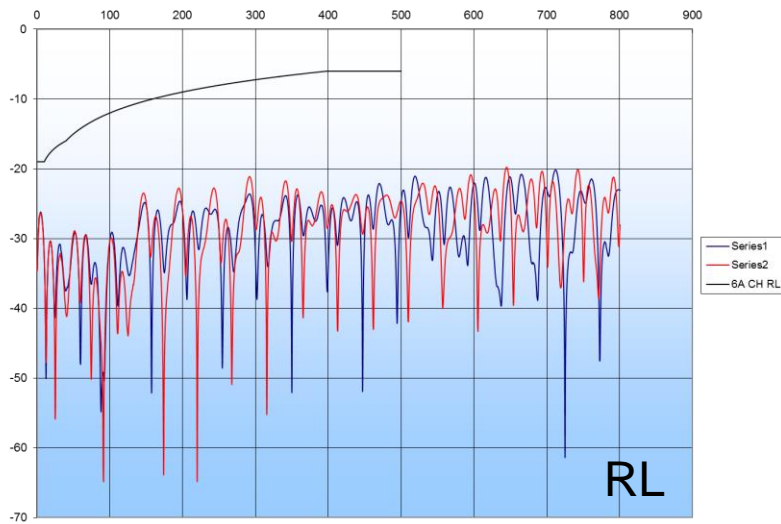
3 Connector, 8m 6-around-1 Channel

- For Alien Crosstalk Testing

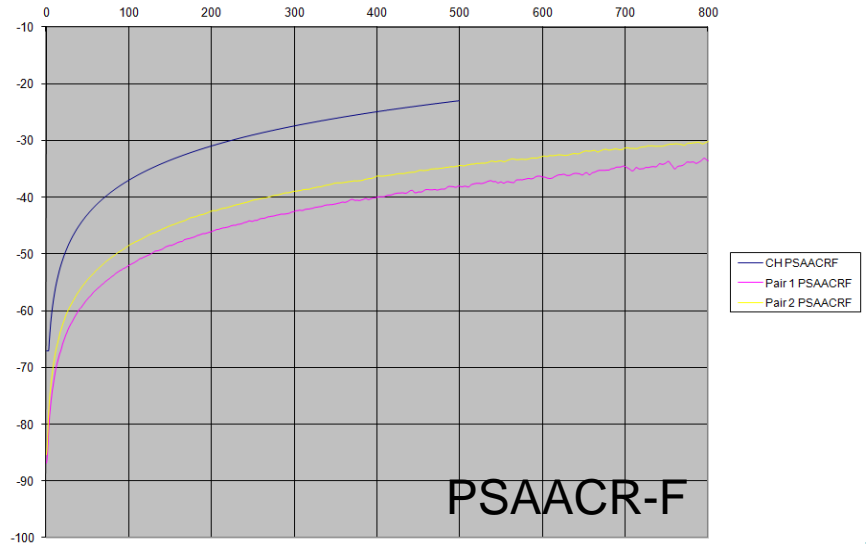
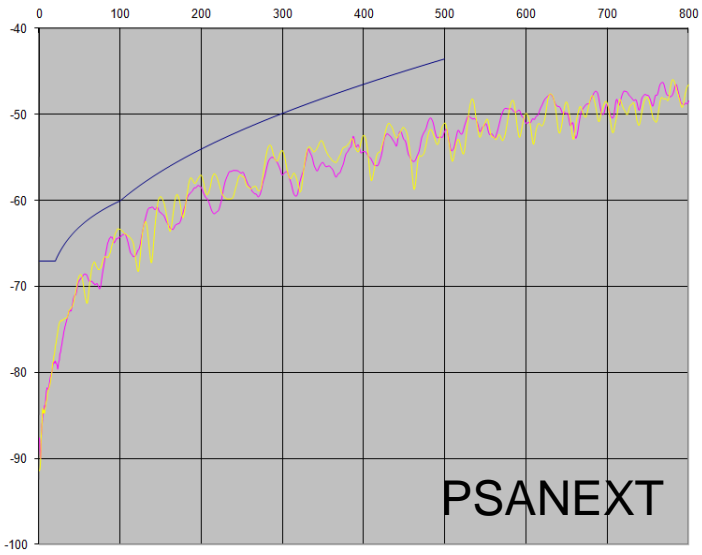
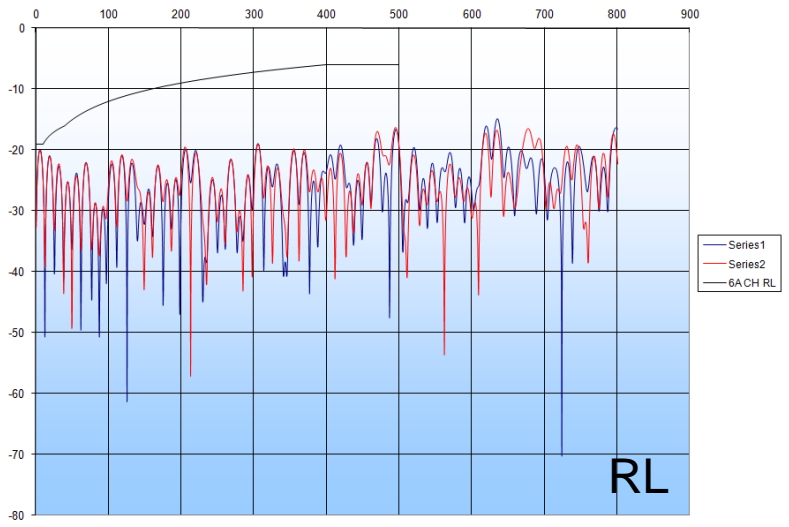


3 Connection 8m Alien Test

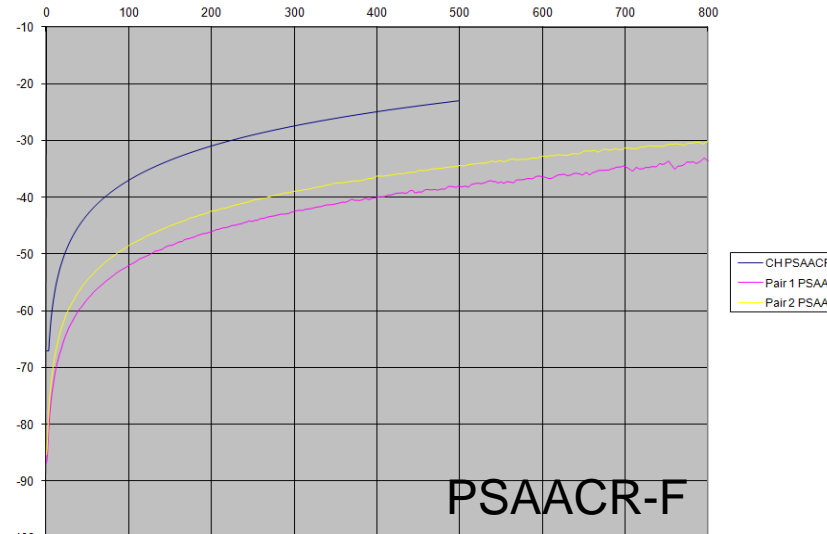
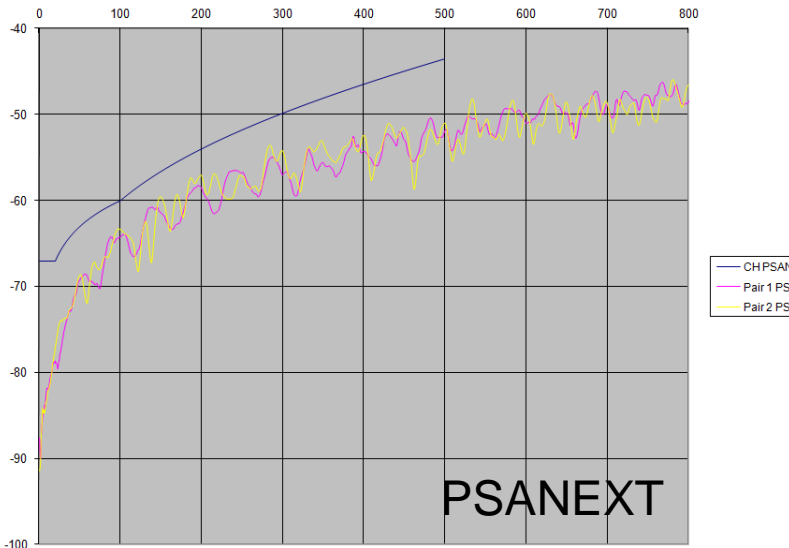
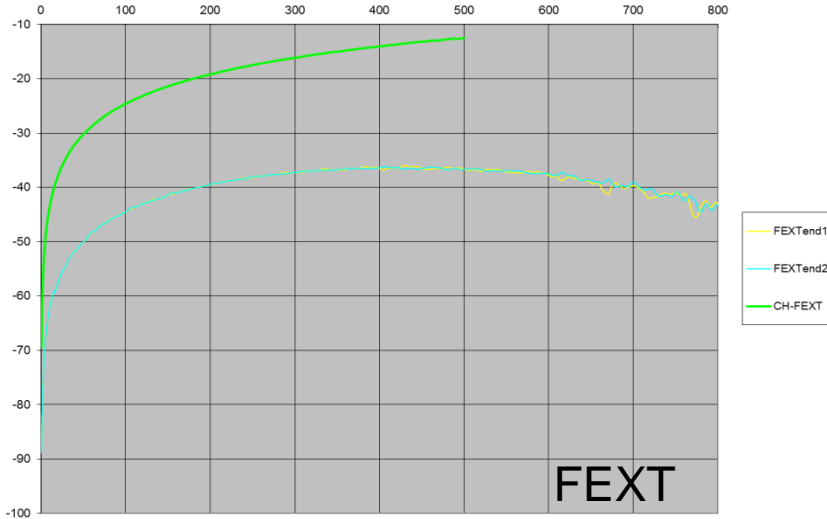
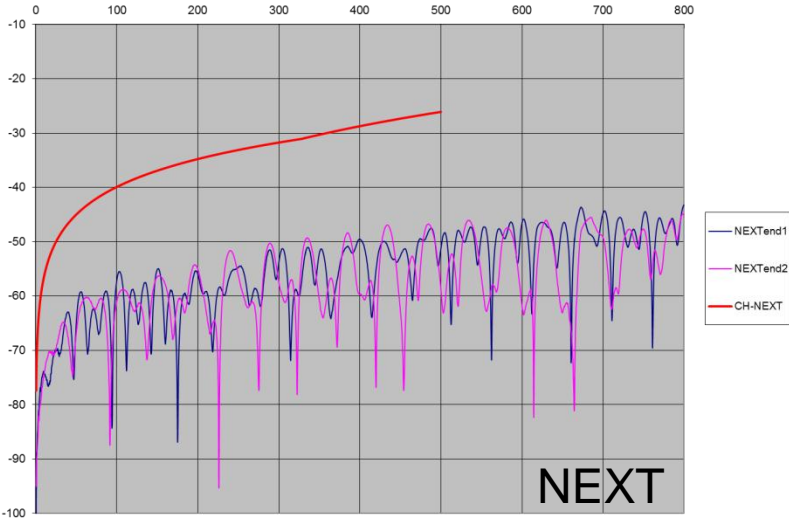
1-Pair System – 3 inline connectors, 8m



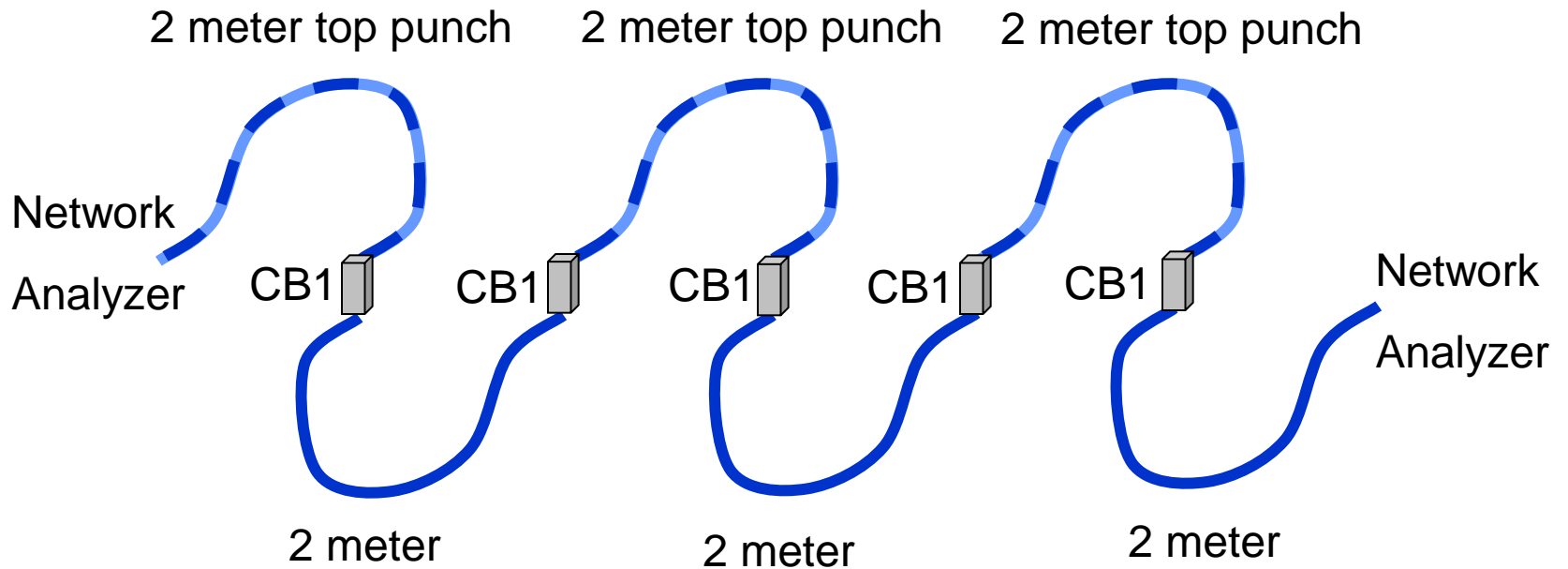
2-Pair System – 3 inline connectors, 8m



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

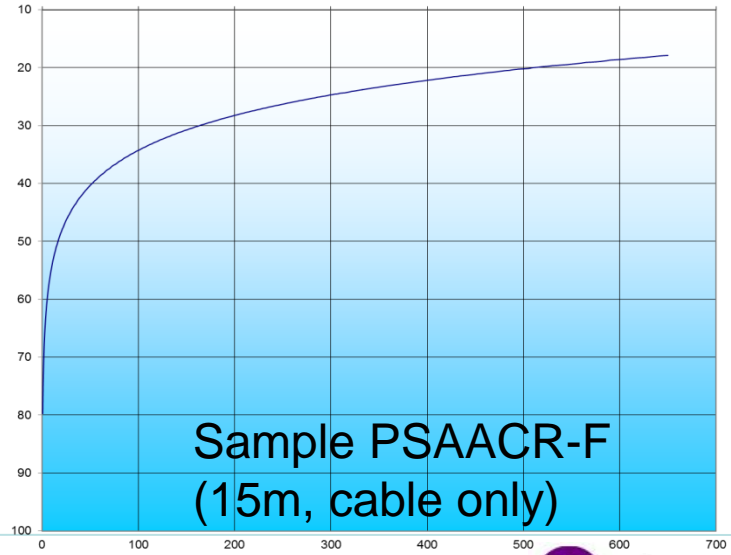
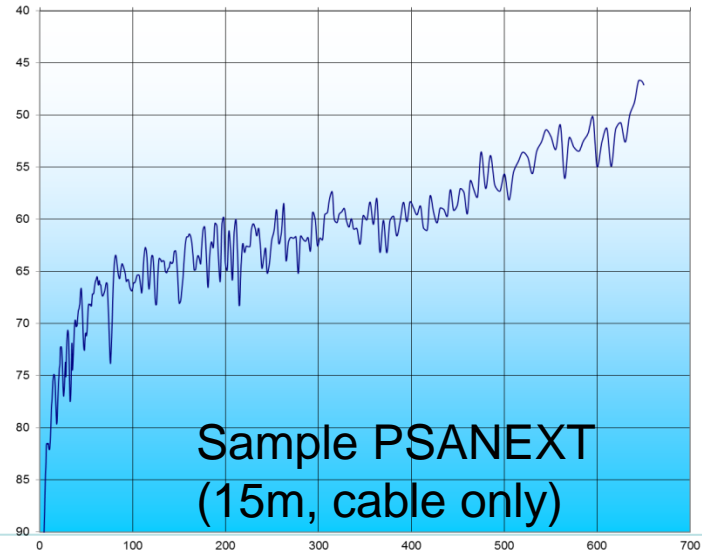
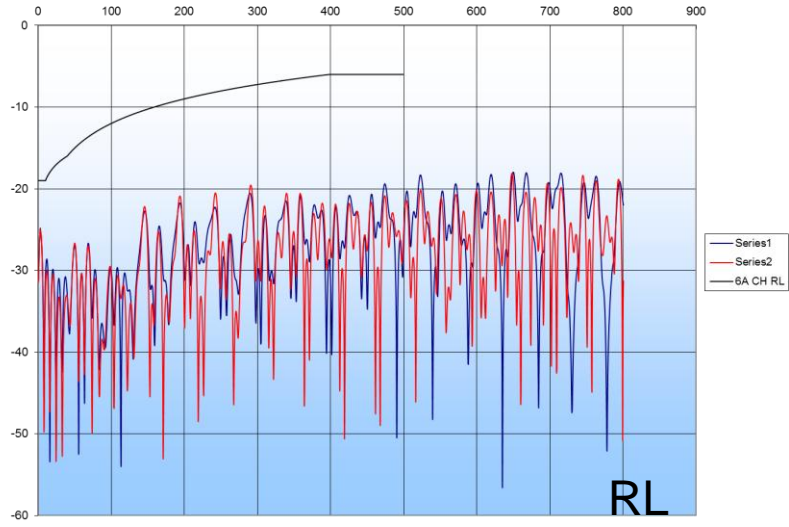


5 Connector, 12m Channel

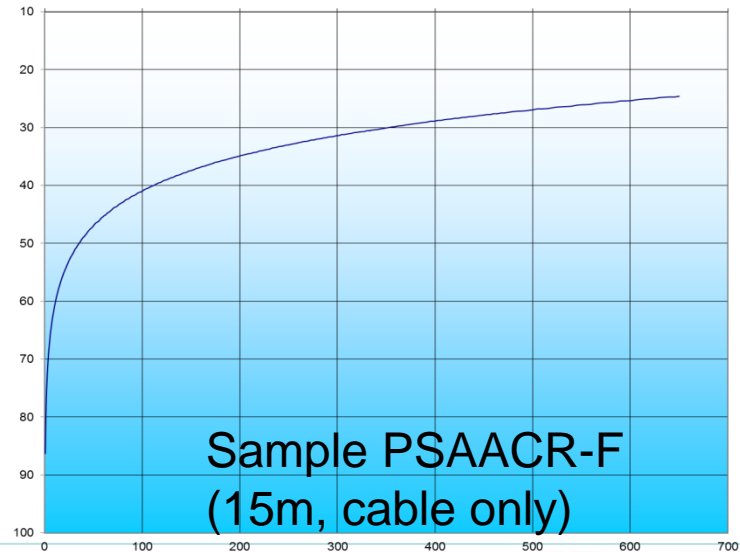
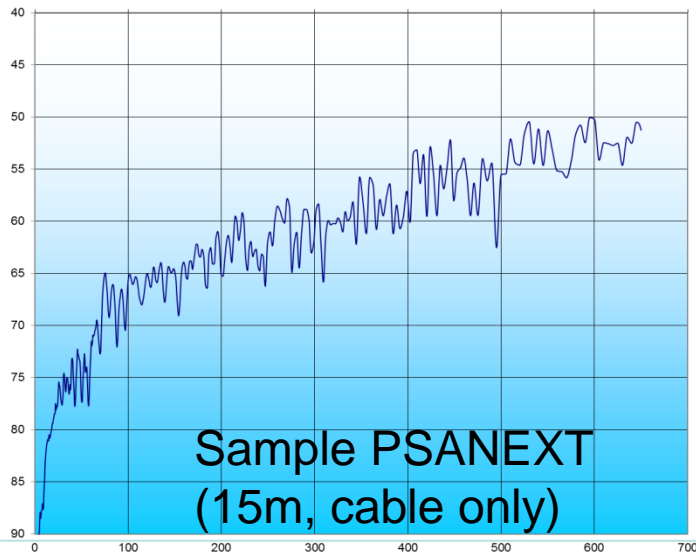
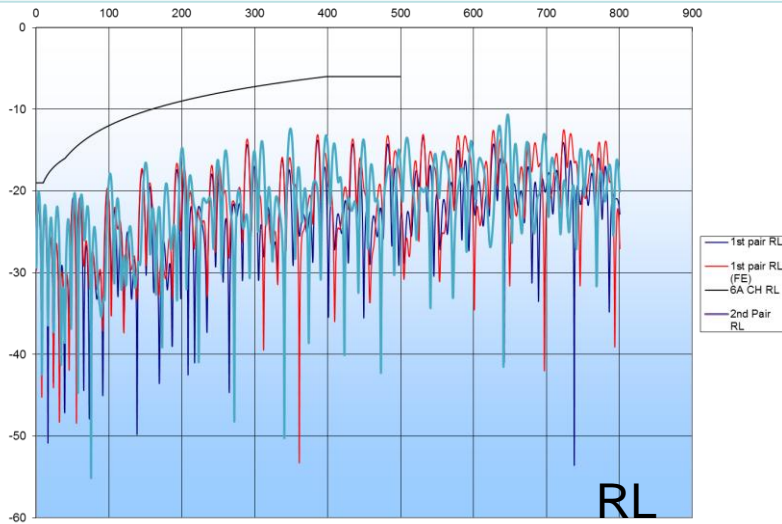


5 Connection 12m Channel

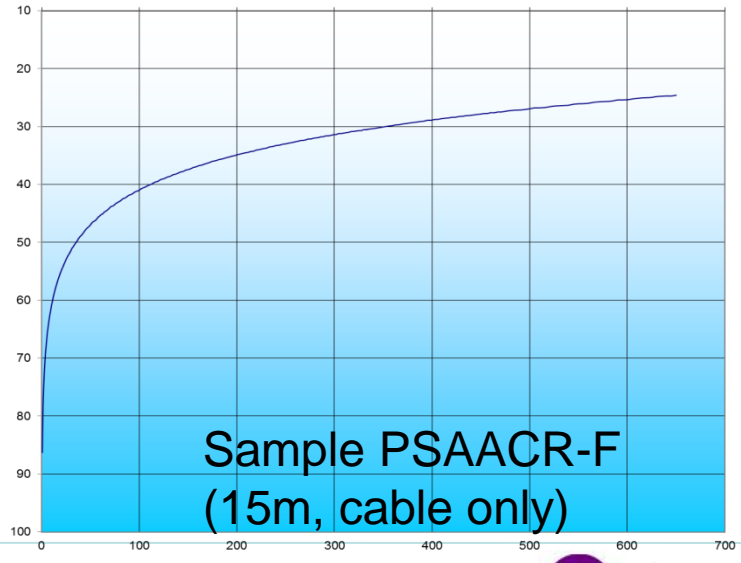
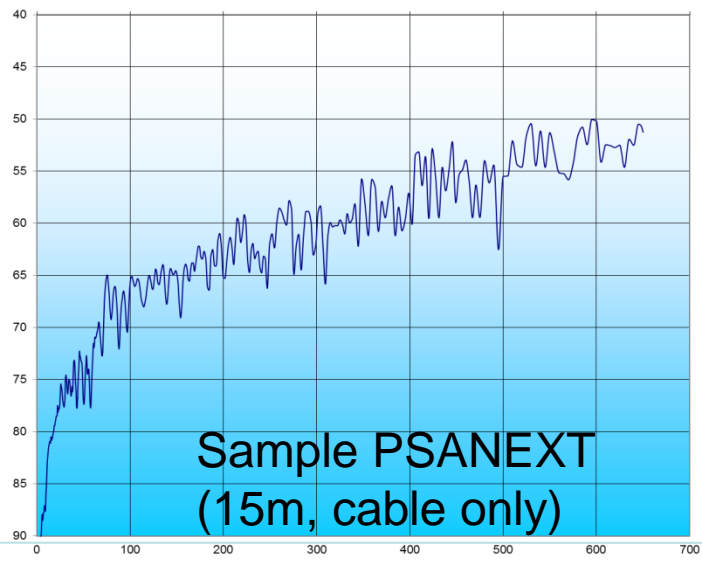
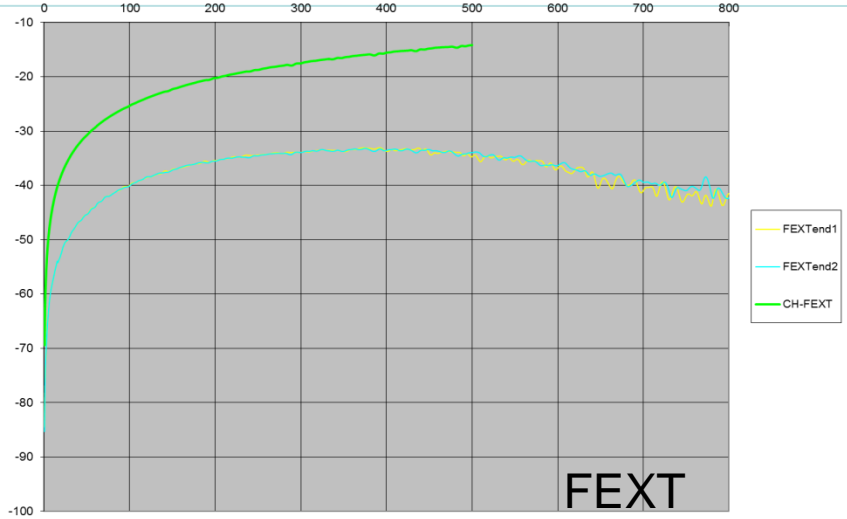
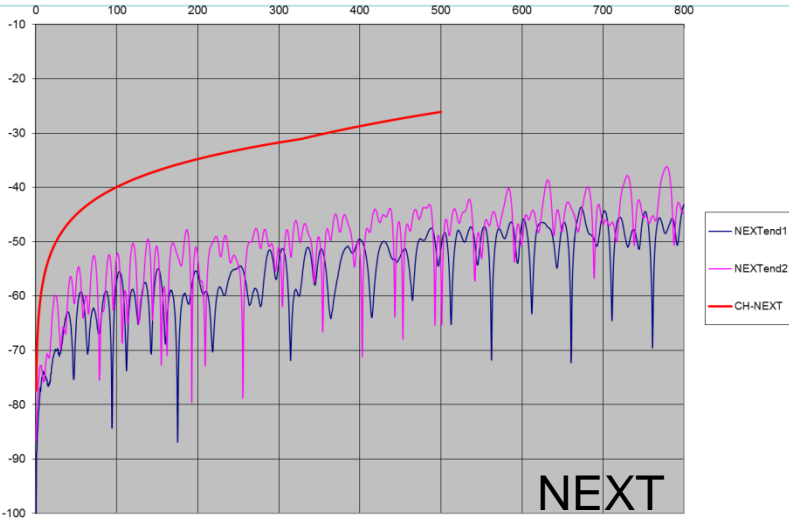
1-Pair System – 5 inline connectors, 12m



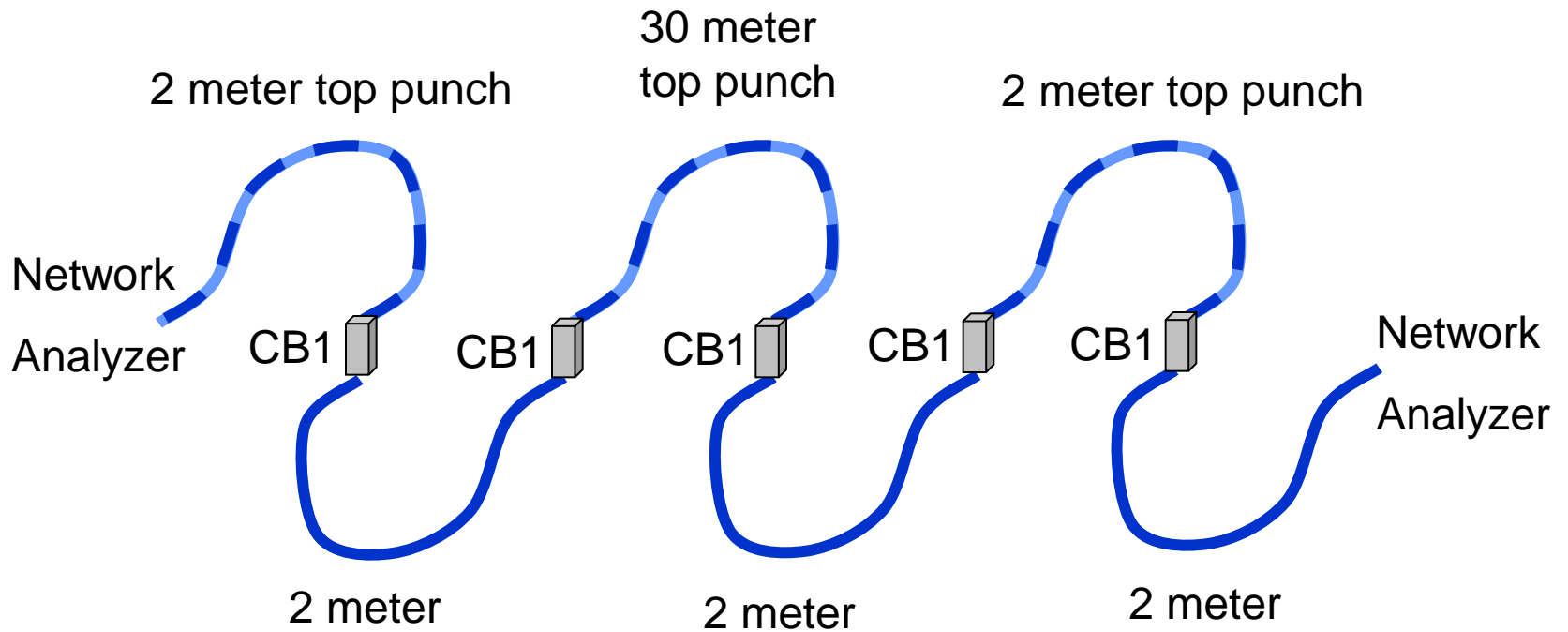
2-Pair System – 5 inline connectors, 12m



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



5 Connector, 40m Channel

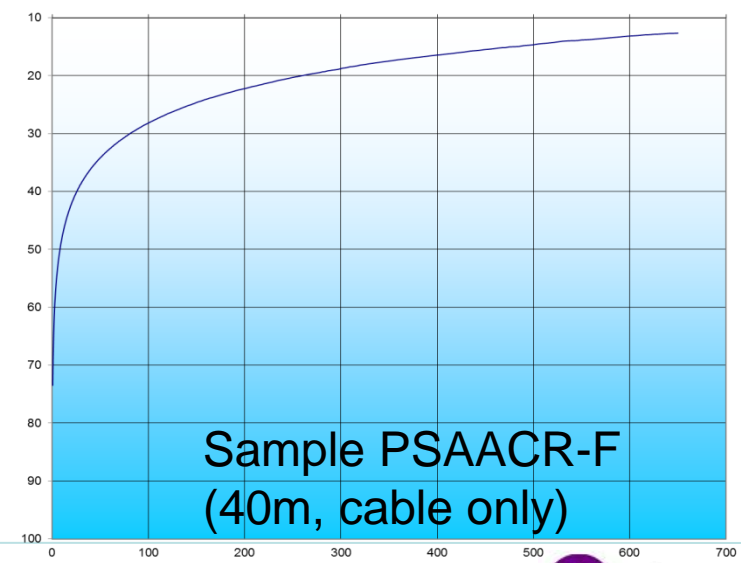
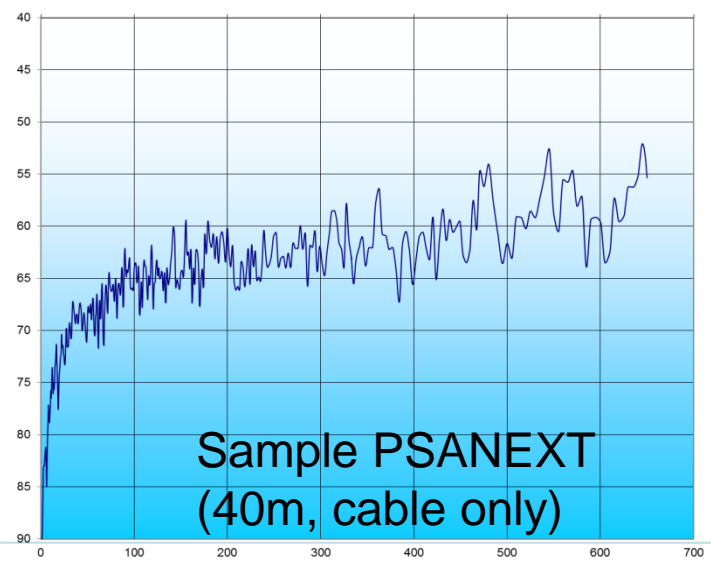
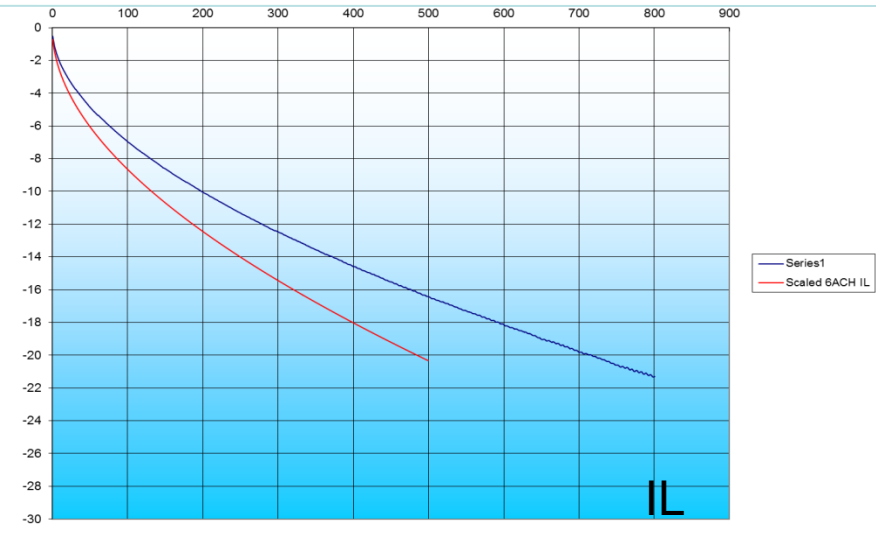
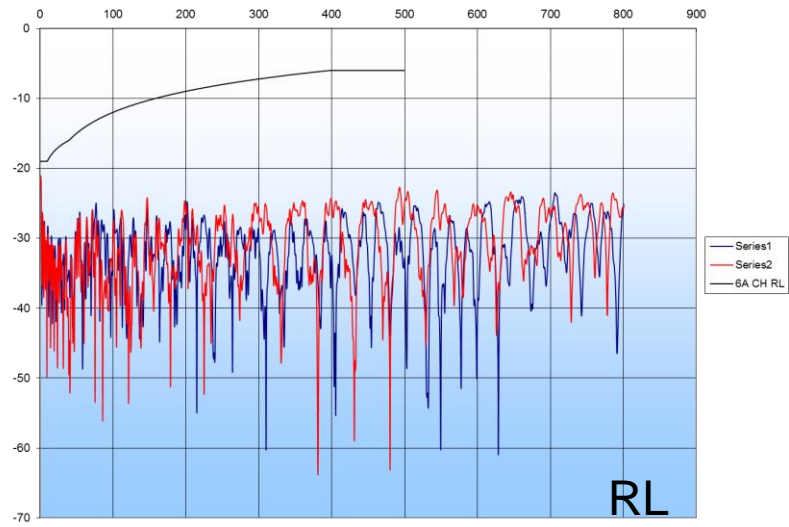


5 Connection 40m Channel

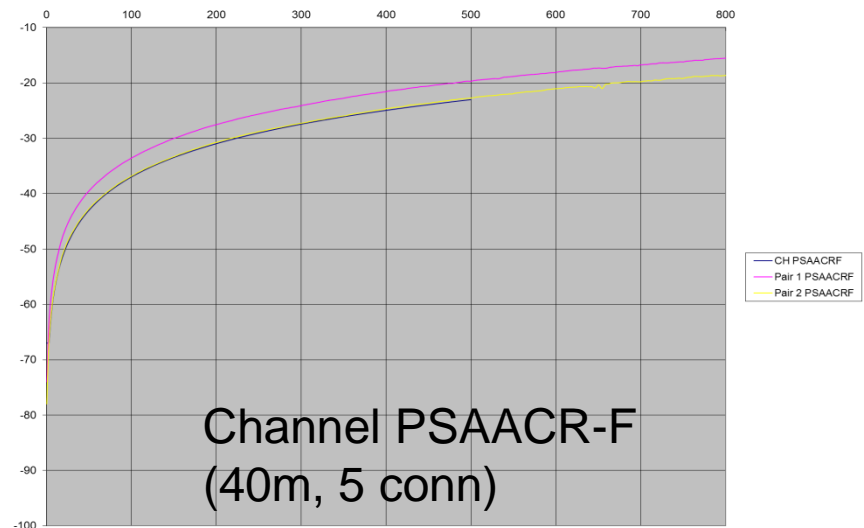
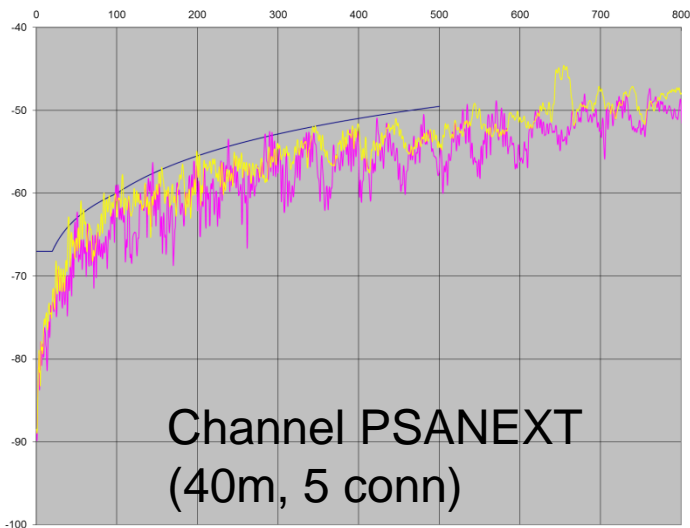
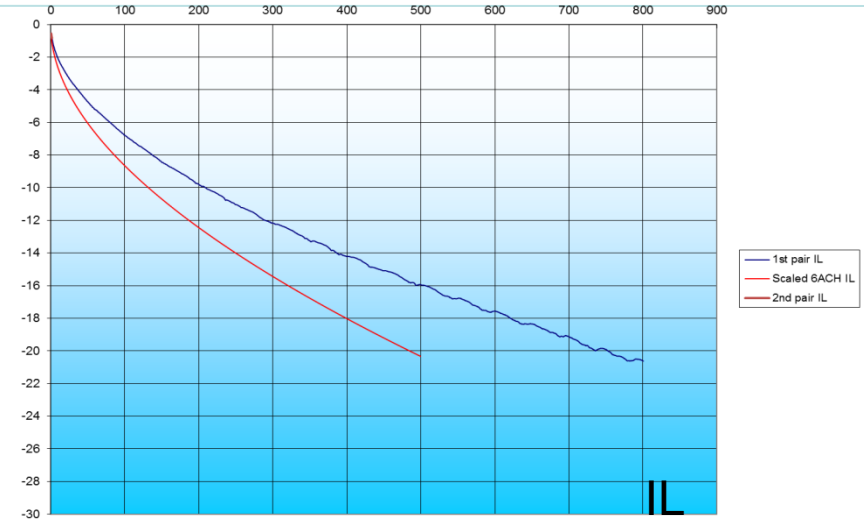
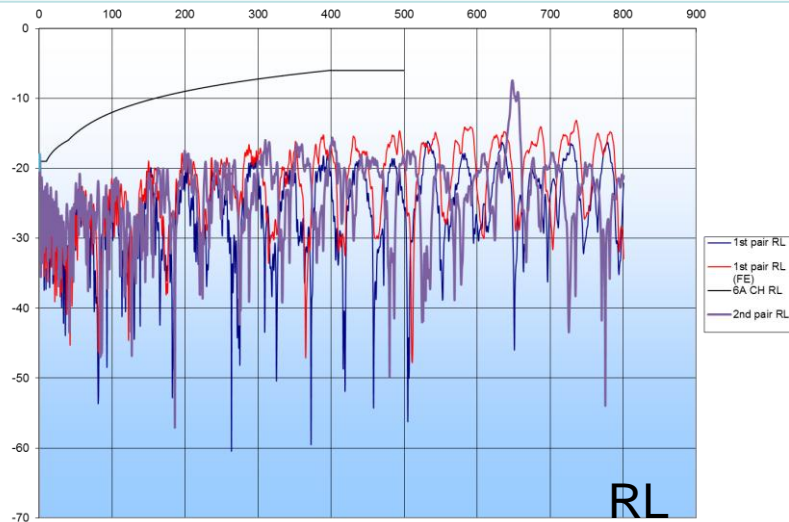
(replace middle punch with 30 meter)



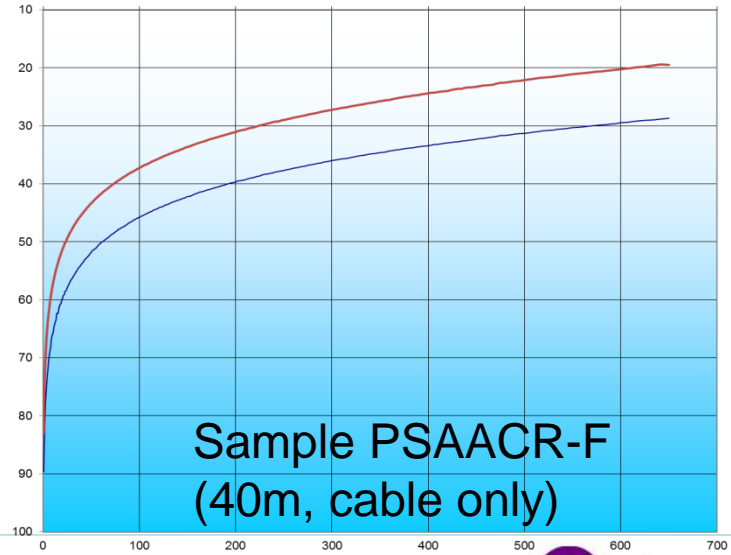
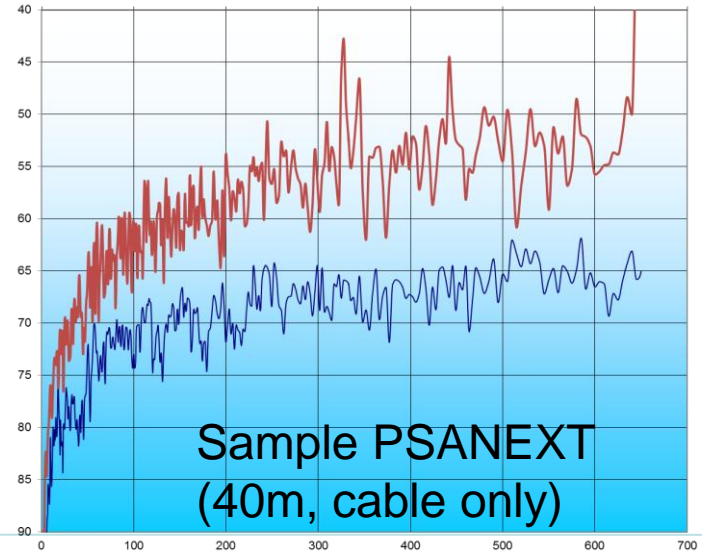
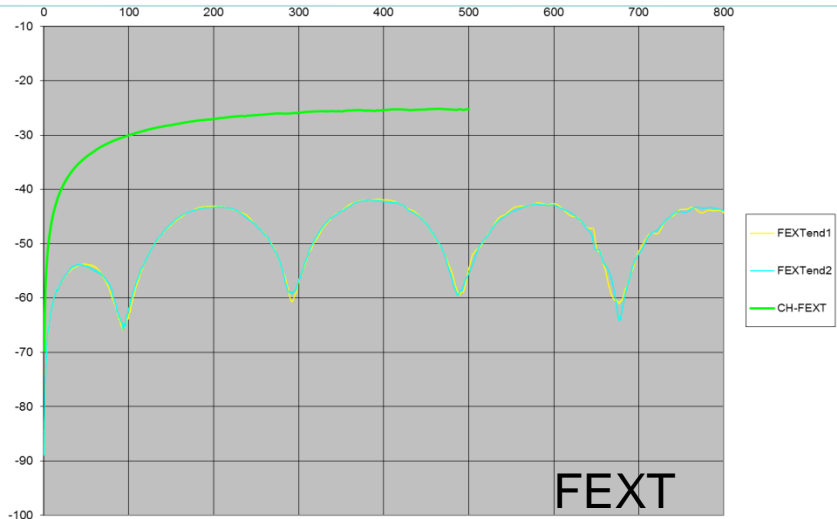
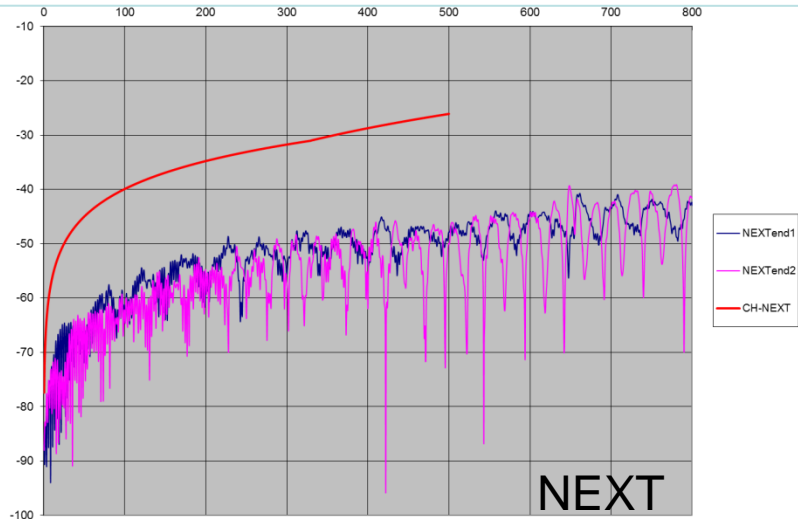
1-Pair System – 5 inline connectors, 40m



2-Pair System – 5 inline connectors, 40m

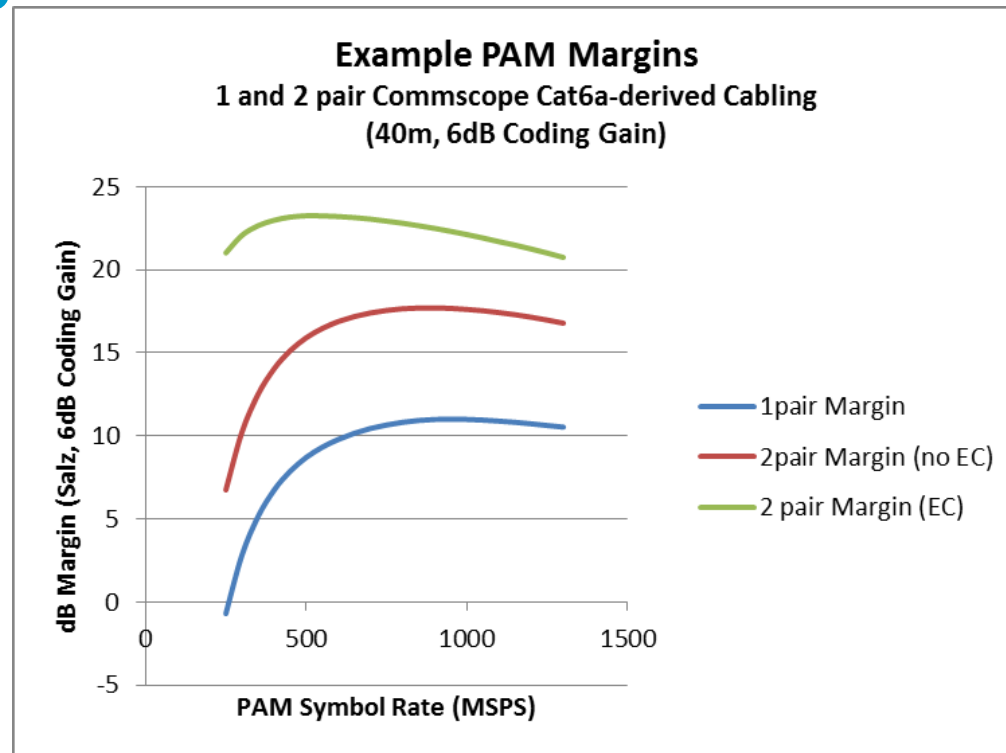


2-Pair System – 5 inline connectors, 40m, NEXT/FEXT



- 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

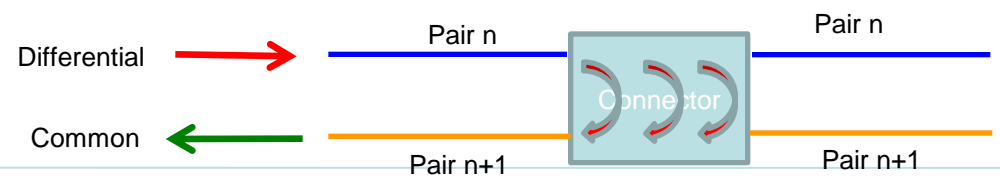
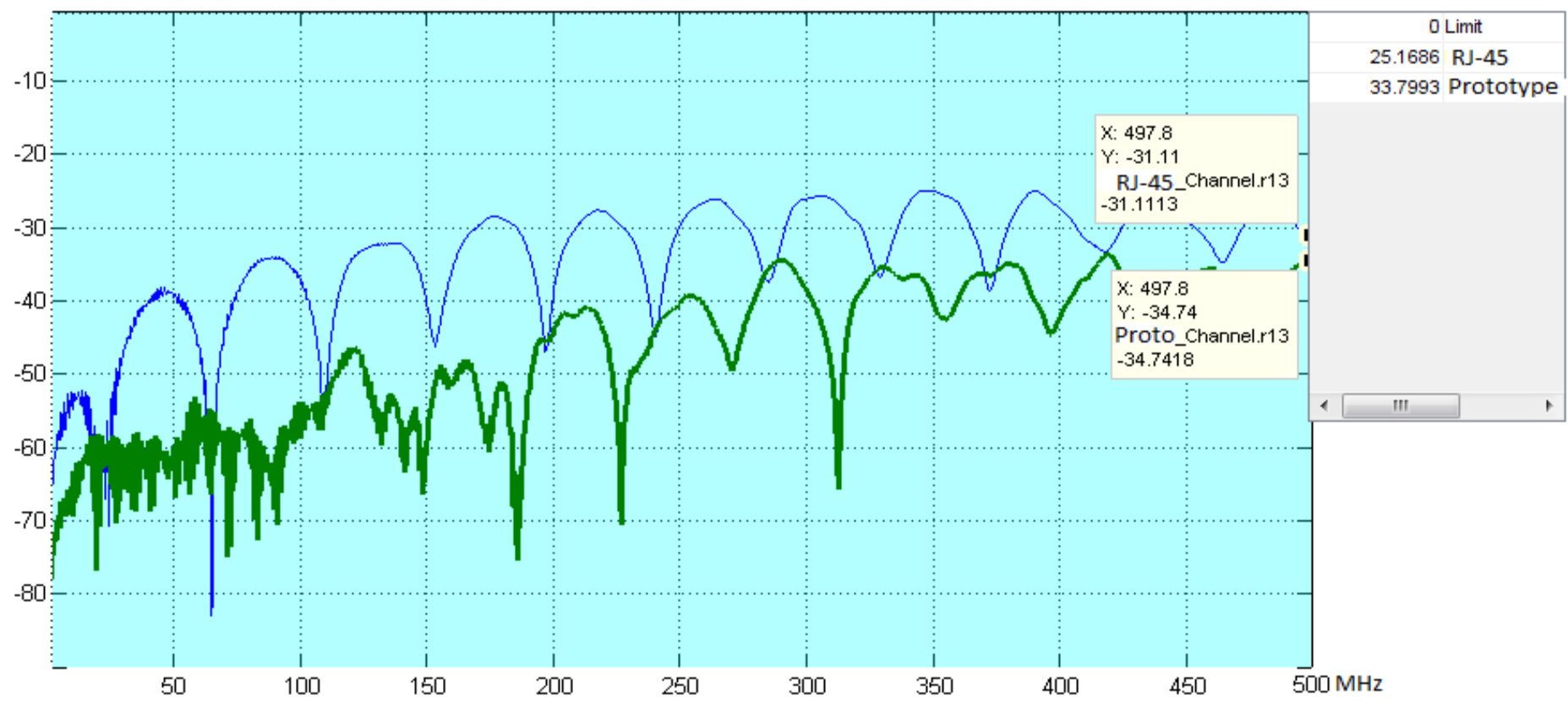
- These models were provided to multiple PHY vendors for independent Feasibility Analysis
- Both 1 pair and 2 pair were feasible, with choice of modulation type (PAM-2 or PAM-4/5)
- See PHY vendor contributions for analysis
 - Huang_01_0712.pdf

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

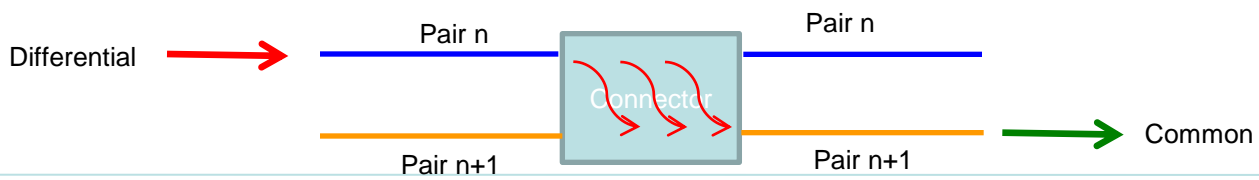
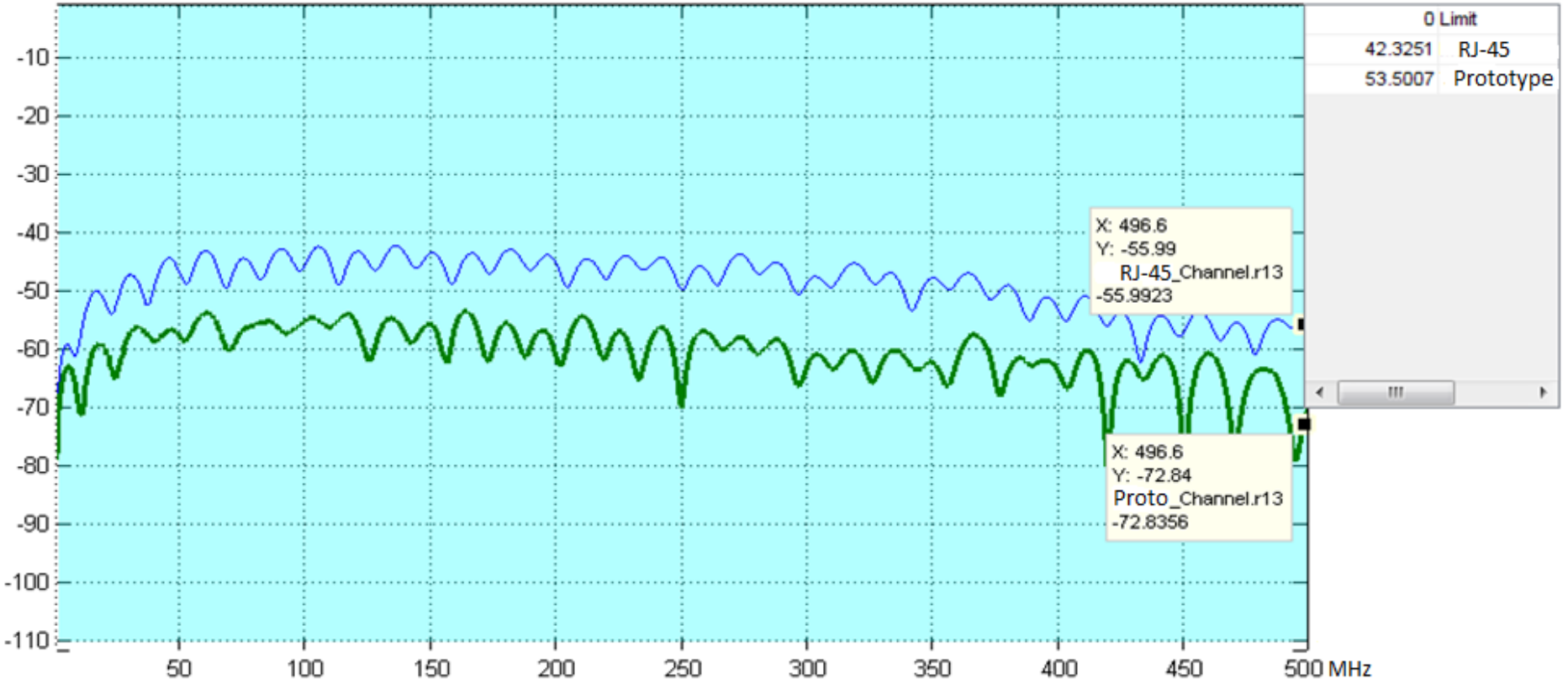
Channel Level Balance (Mode Conversion)

Diff to CM Scattering



Channel Level Balance (Mode Conversion)

Diff to CM Scattering



- 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