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ECONOMY



Copper Interconnect Innovations for Realizing 400G Electrical

Andrew Kim *Luxshare-Tech*

Jinhua Chen *Luxshare-Tech*

OCP SILVER Member

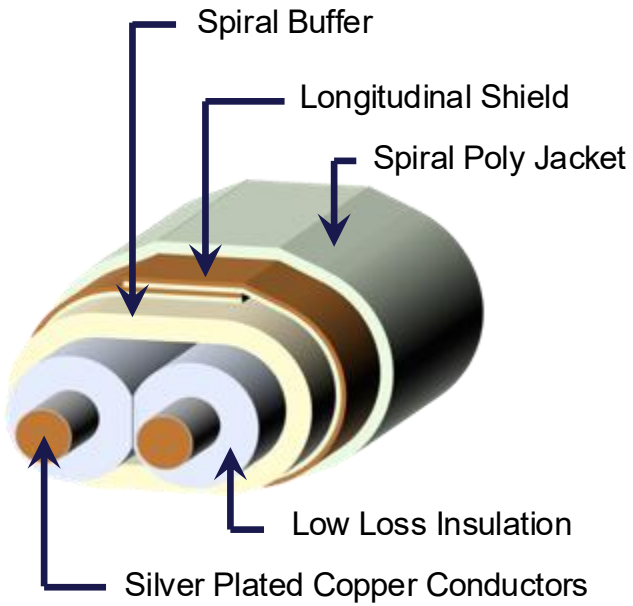
LUXSHARETECH

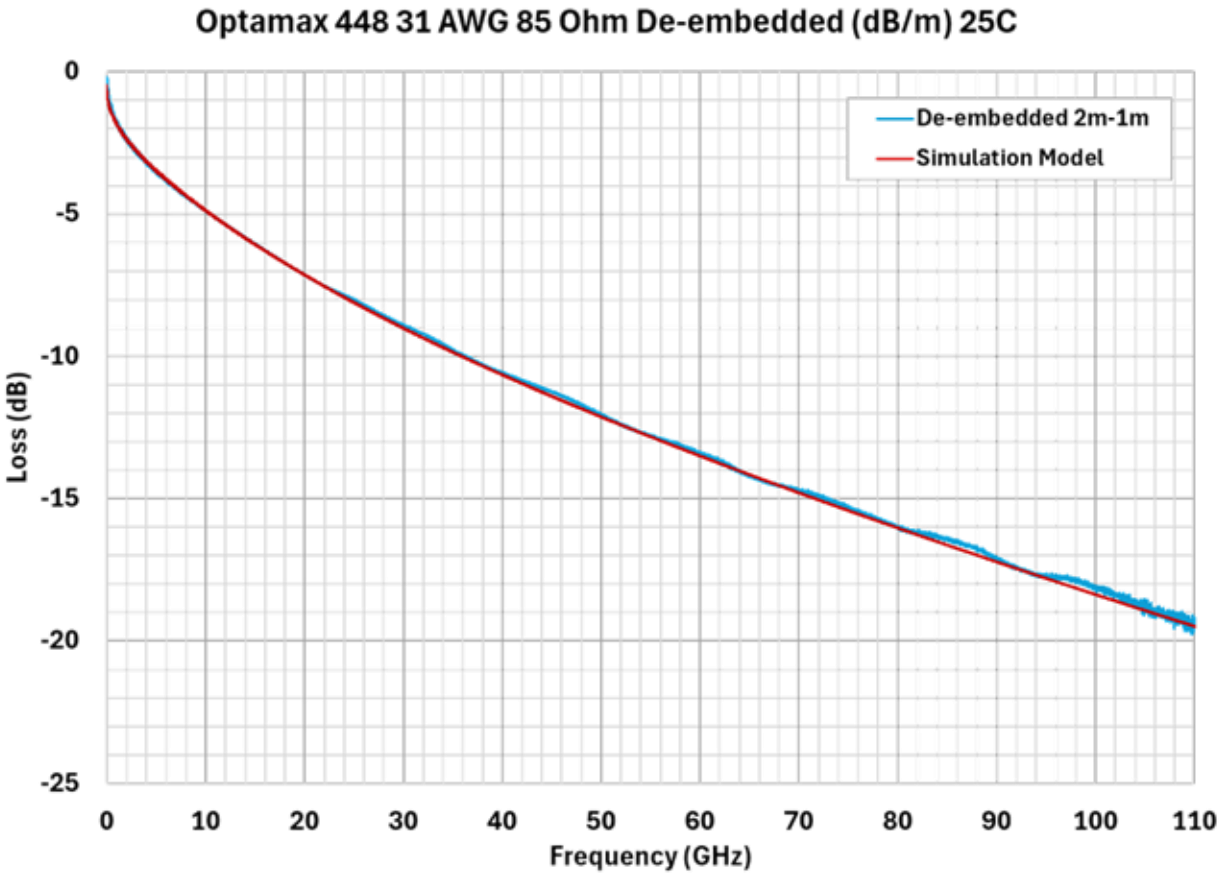
Intro/Overview

- Industry racing to define a 400G/lane interconnect, e.g. OIF CEI-448G and IEEE 400GPL
  - SI specs on the copper channel will be challenging
- To assist, we want to advise where we are in terms of our best VSR/C2M and LR/CR/KR channel candidates
- Twin-ax will serve as the primary medium for the bulk of the 400G channel
- Connectors will be the primary limiting element
  - Board—to—Twinax, e.g. CPC, NPC, or on an active front-panel module
  - Twinax—to—Twinax, e.g. front panel DAC or cable backplane
- Elastomeric-based CPC showing excellence SI performance
- Backplane-adapted twinax-twinax mating structure showing promising performance

Twinax Cabling

- Better choice (vs PCB) for traversing the bulk of the channel length
  - Lower loss-per-meter than PCB
  - Fewer impedance discontinuities → better BW & ILD





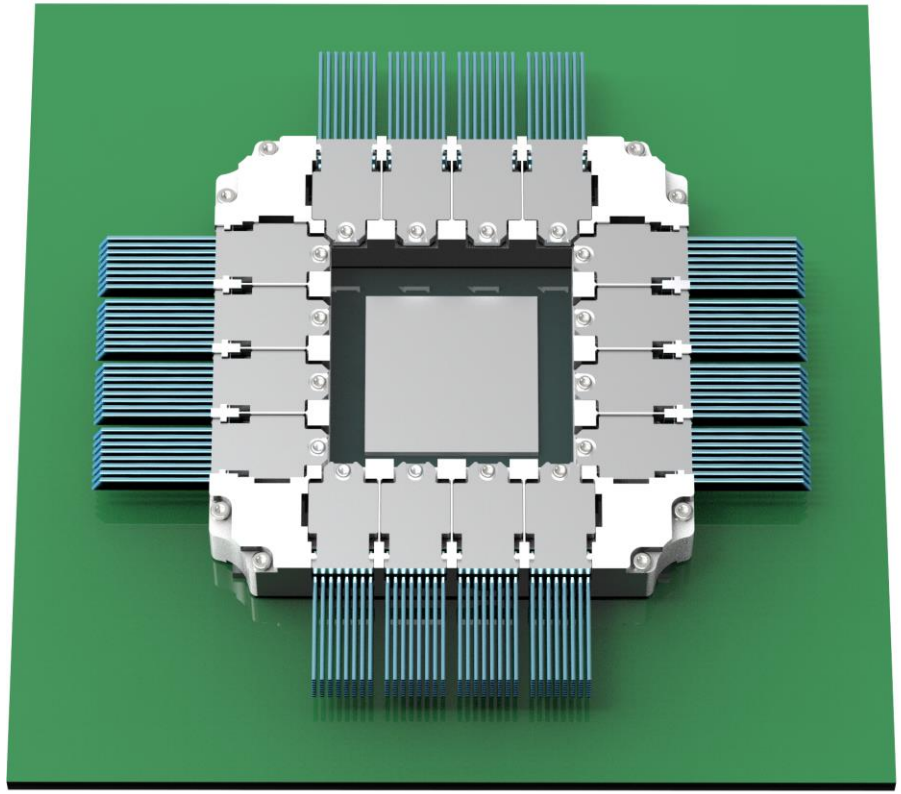
Puts the Onus On Producing a Suite of Good Connectors

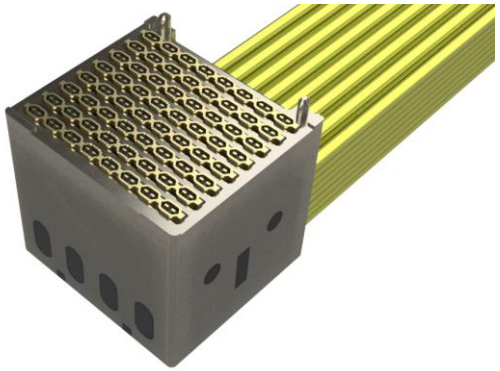
- Need a good set of connectors that also have high fidelity
- CPC get from chip to port over the internal cabling
- front panel / backplane connector for shelf-to-shelf external cabling
  - Cable-to-cable variant for DAC and cable backplane
  - Cable-to-PCB variant for chip-based applications, e.g. optics/AEC/ACC



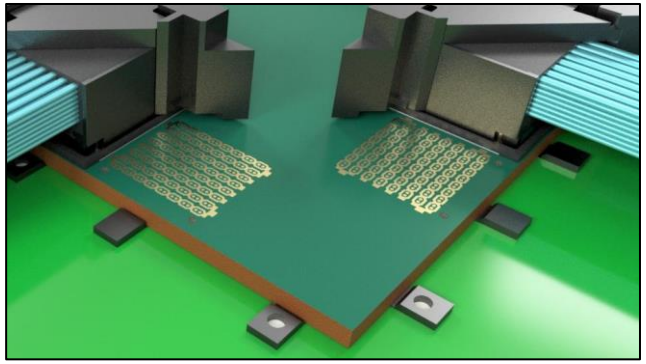
Elastomeric-Based CPC

- Introduced at 2024 and 2025 OCP Global Summits to excellent reception
- Stubless interface affords high BW – no resonance out to 120+GHz
- Full 360° shielding along entire length of channel → high crosstalk isolation
- Dense (1.9mm x 1.7mm) diff pair pitch



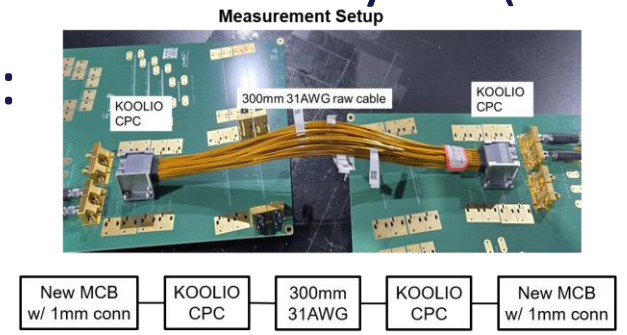




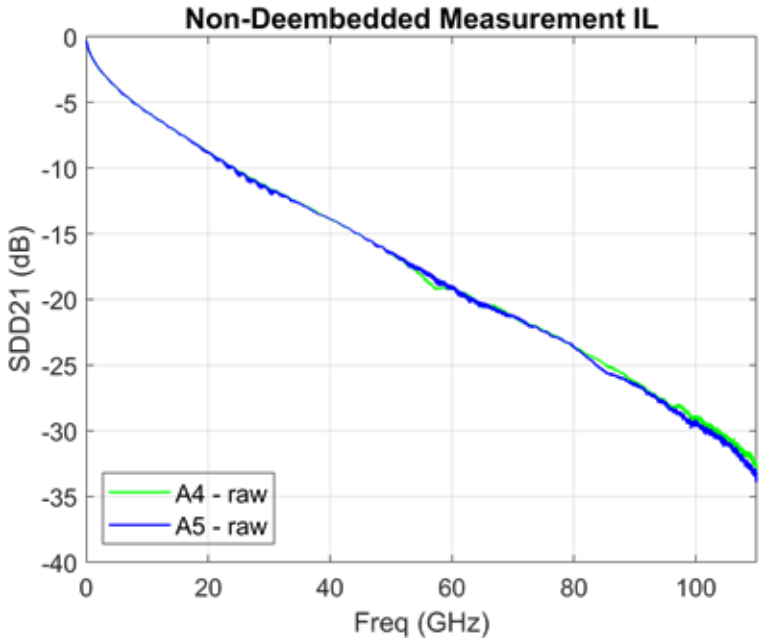


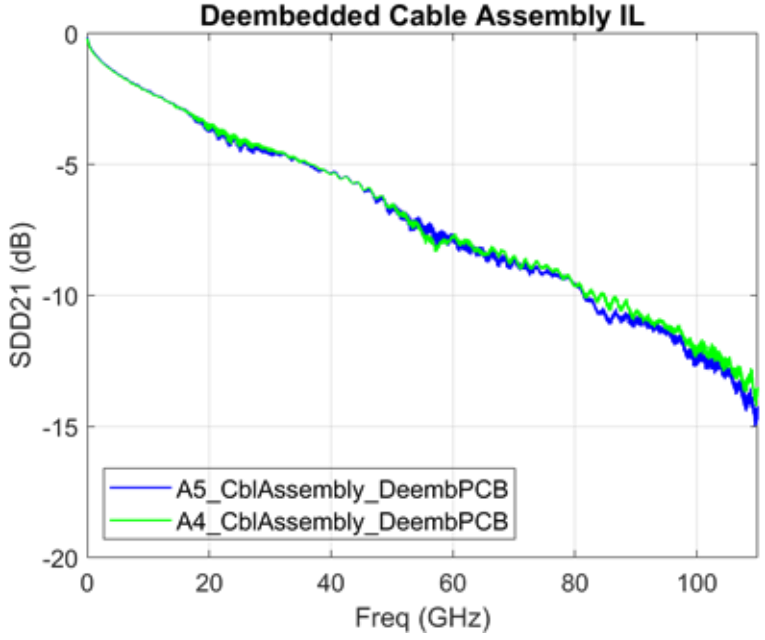
CPC Channel Performance

- Number of improvements have been made in the last year (but all internal to conn.)
- DUT is a 300mm CPC-CPC cable assembly:



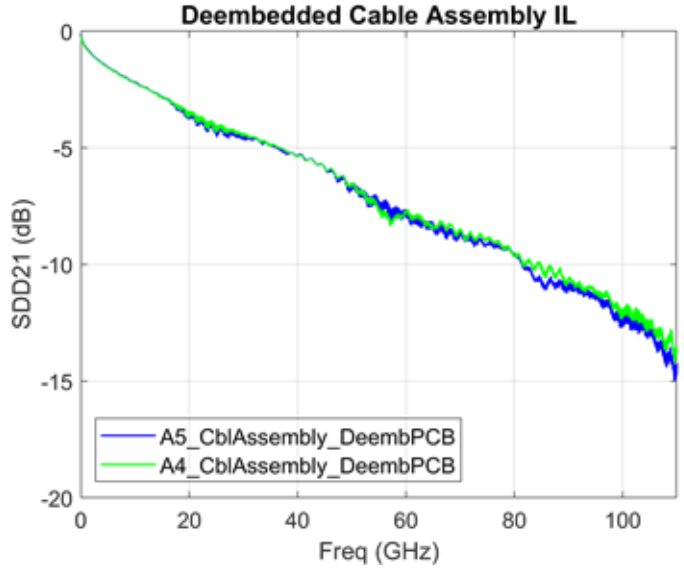
- Smooth IL out to the 110GHz measurement capabilities of the VNA
  - No resonance
  - Very low ILD

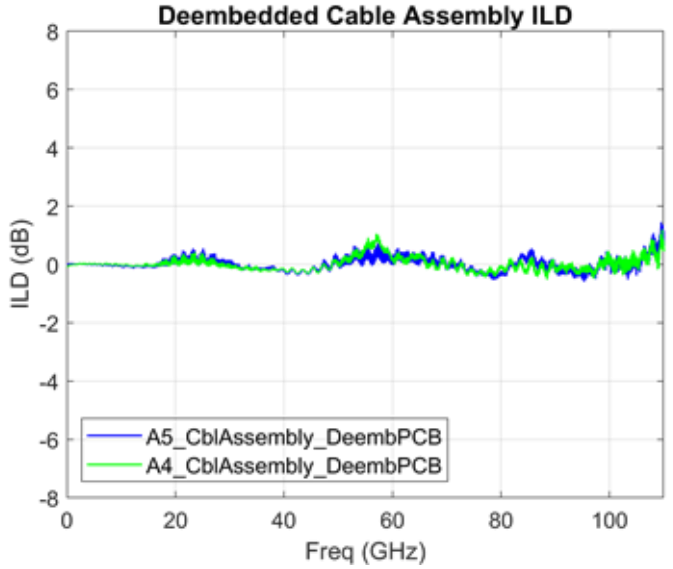


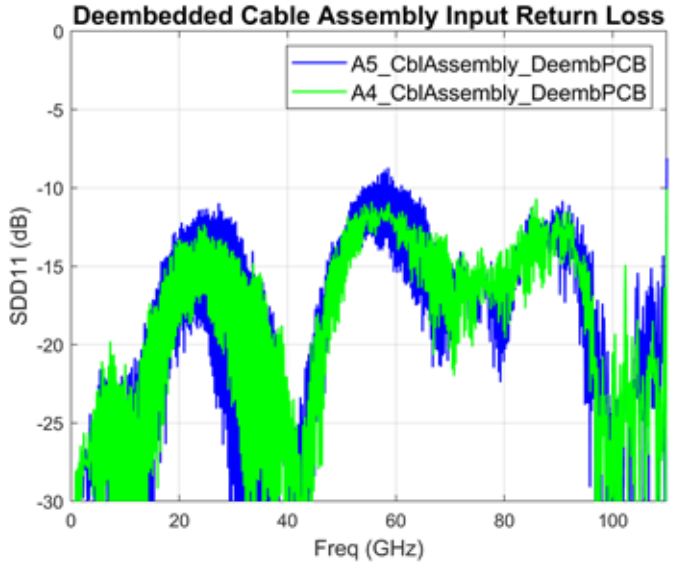


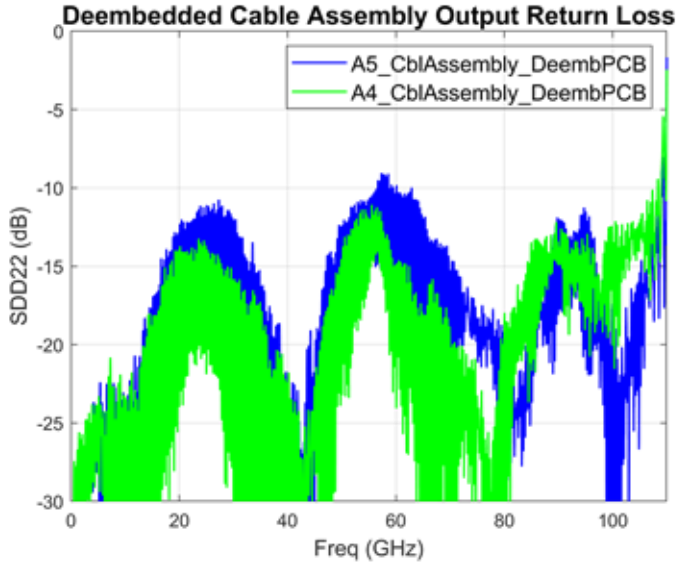
Return Loss and Mode Conversion

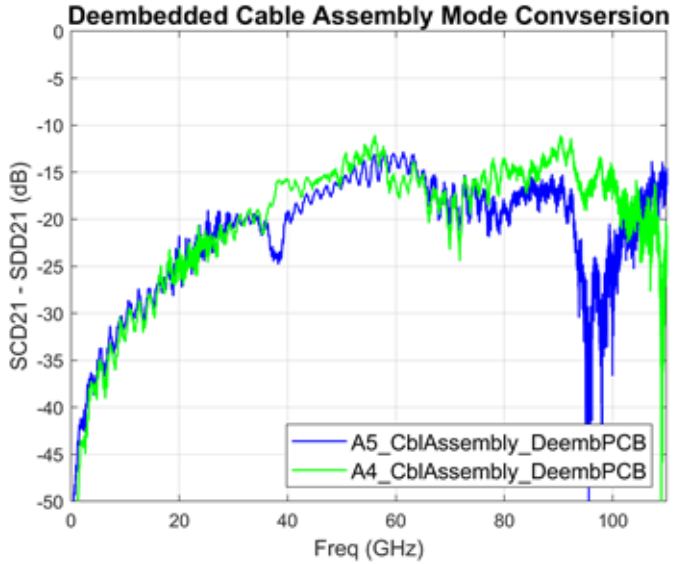
- RL is quite clean (generally below -10dB)
- Mode conversion is well-controlled





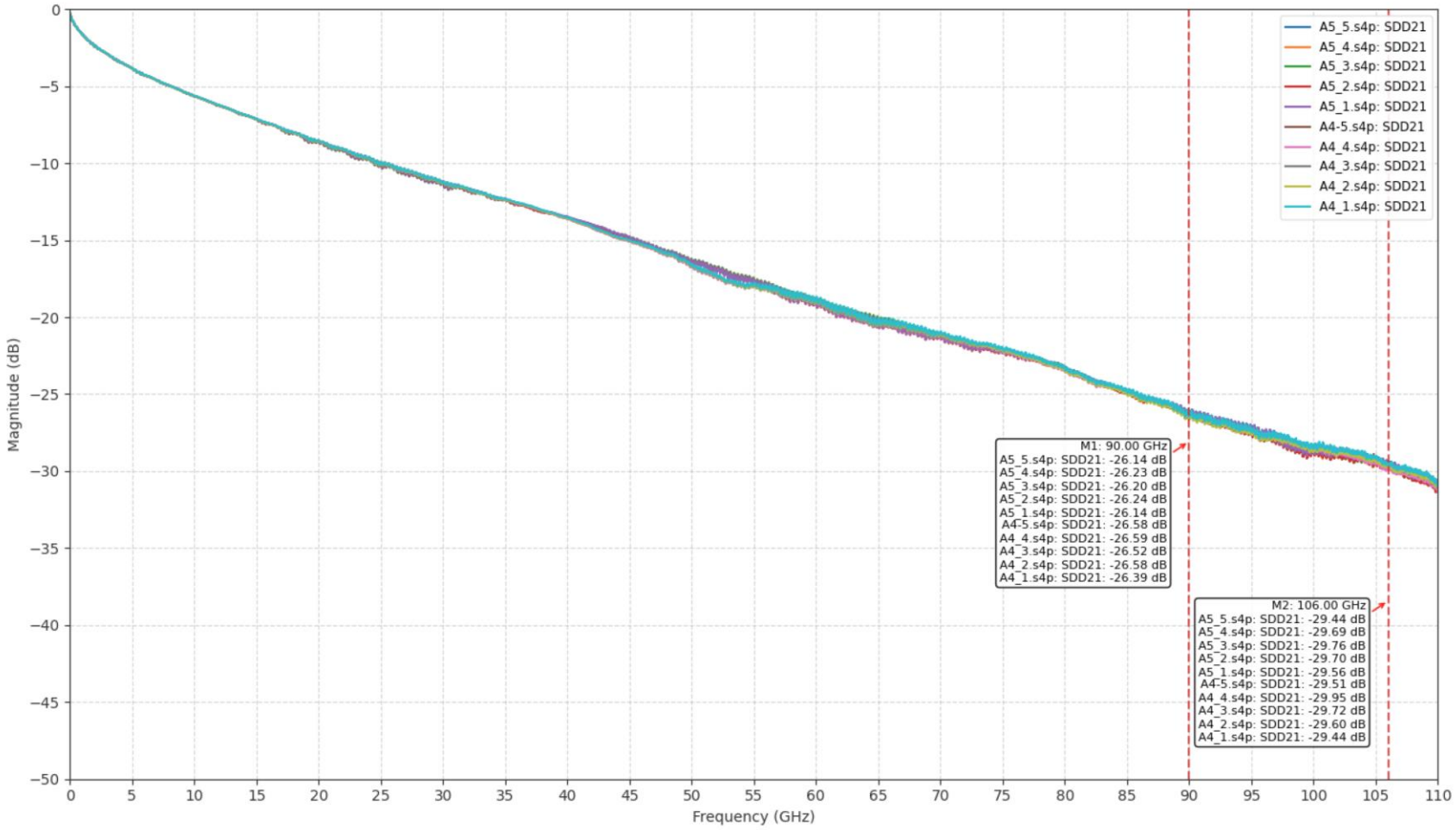






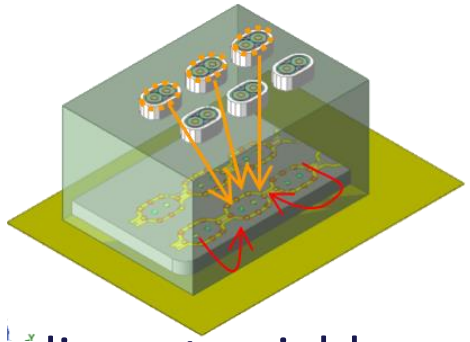
Repeated Mating

- 5 times: remove & reseat connector
- Very minimal SI variation
- Min-Max delta of 0.51 dB

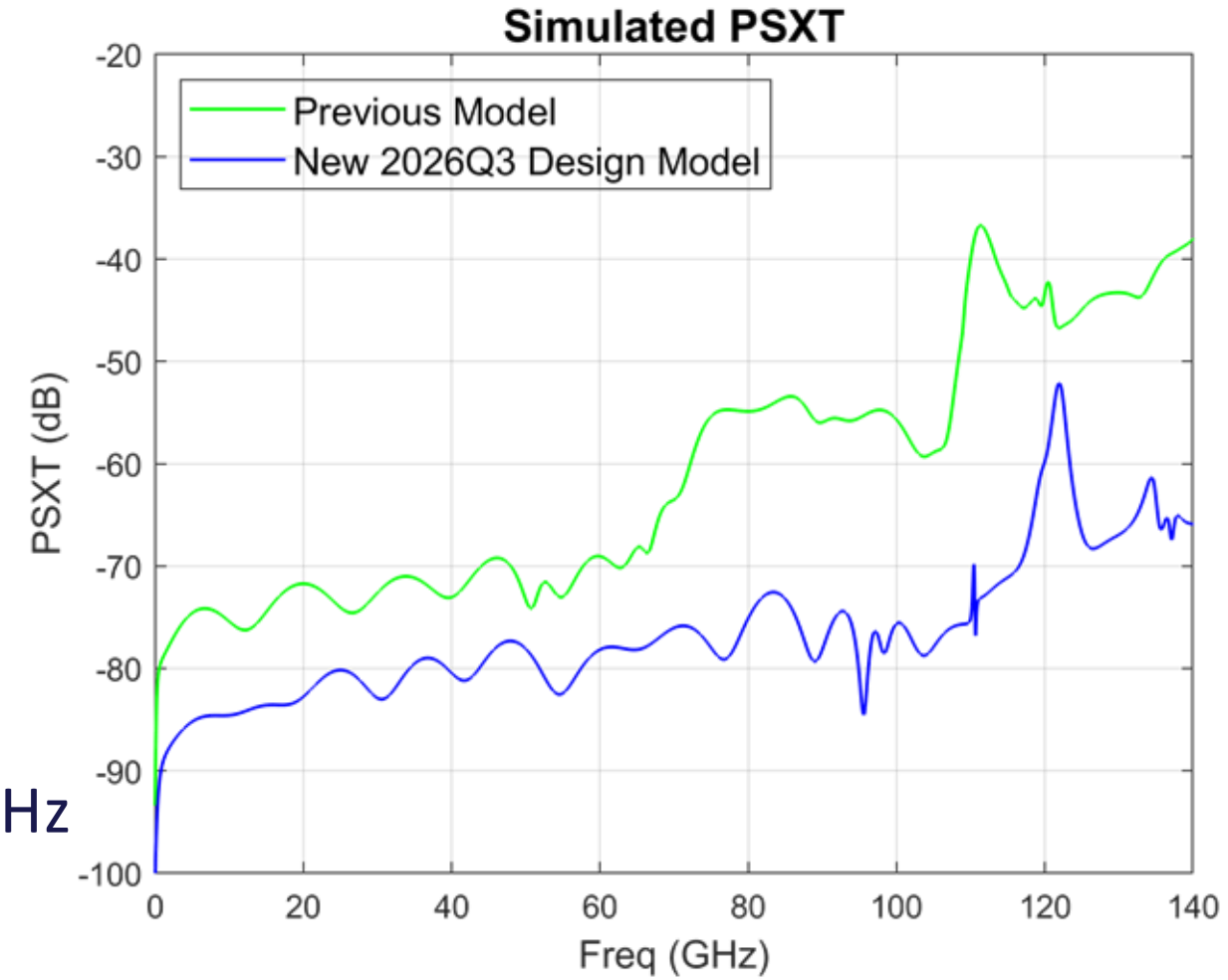


Crosstalk Simulation

- Crosstalk based on a 2x3 diff pair subset model



  - 2 NEXT adjacent neighbors (substrate side)
  - 3 FEXT from the other row (cable side)
- Improved shielding reduces the coupling across the entire band
- Pushes the peak response out from 110GHz to 120GHz
  - And it's ~15dB lower

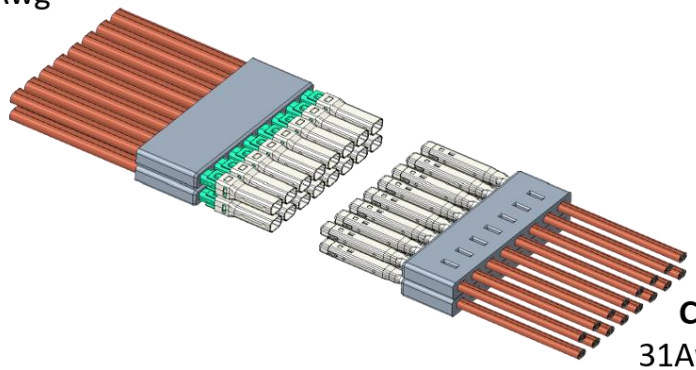


Twinax—Twinax Mating Structure

- Serves as the core component of either a cable backplane or front-panel DAC interface

Mating Interface

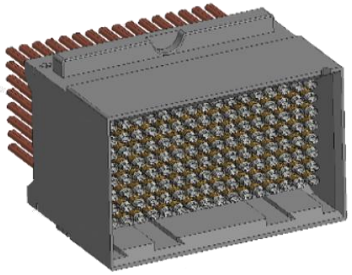
DAC: 27Awg Cable



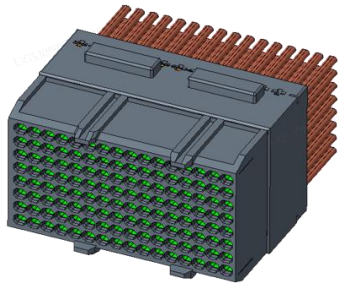
CPC: 31Awg Cable

Cable Backplane Application

Vertical Header (Cartridge)

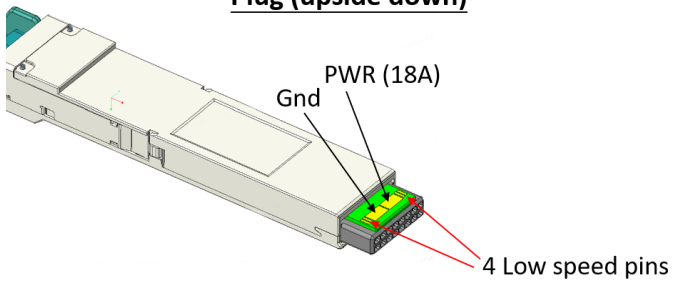


Vertical Receptacle (to CPC)

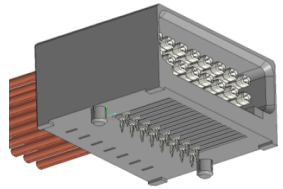


Front Panel DAC Application

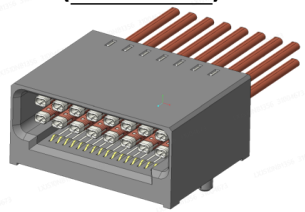
Plug (upside down)



Receptacle (from below)



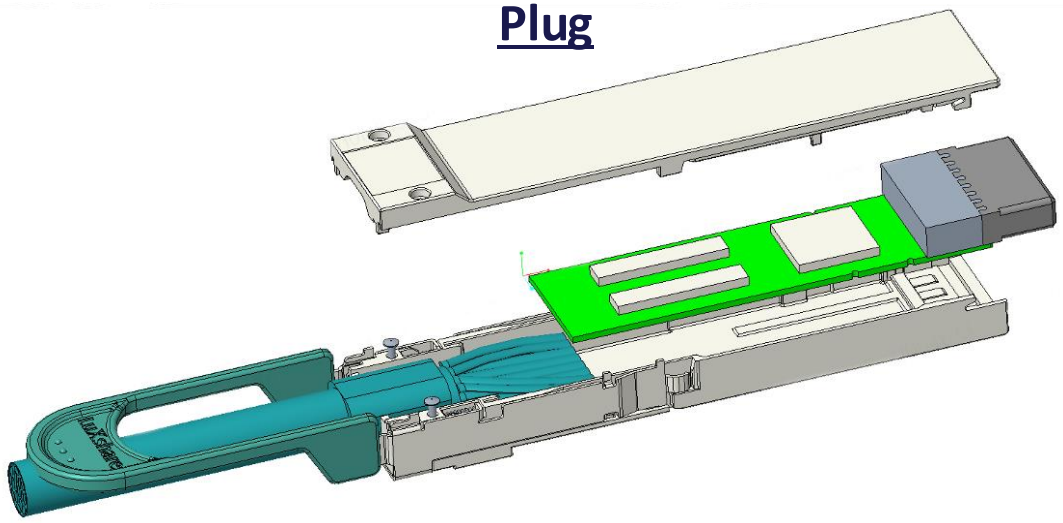
Receptacle (from above)



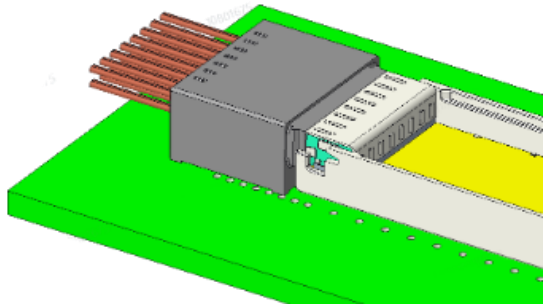
Paddle Card Application

- Mating structure can also be incorporated to a paddle card in the plug
  - E.g. AOC, AEC, ACC

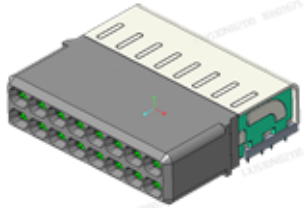
Plug



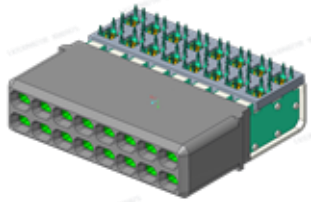
Mated Plug-Receptacle



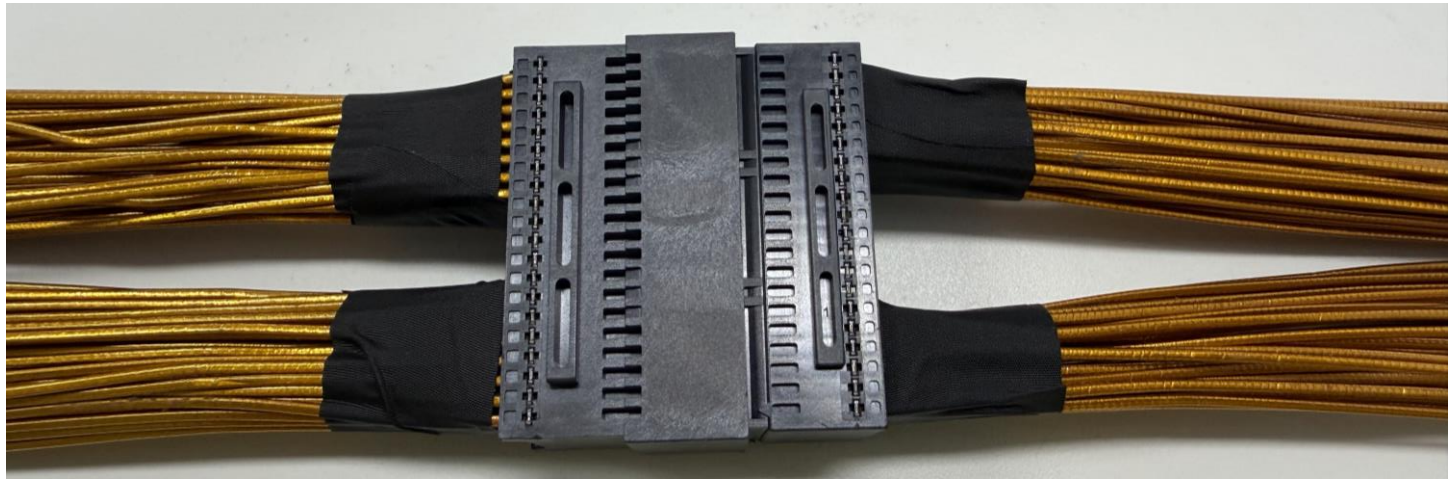
Plug Tip (from above)



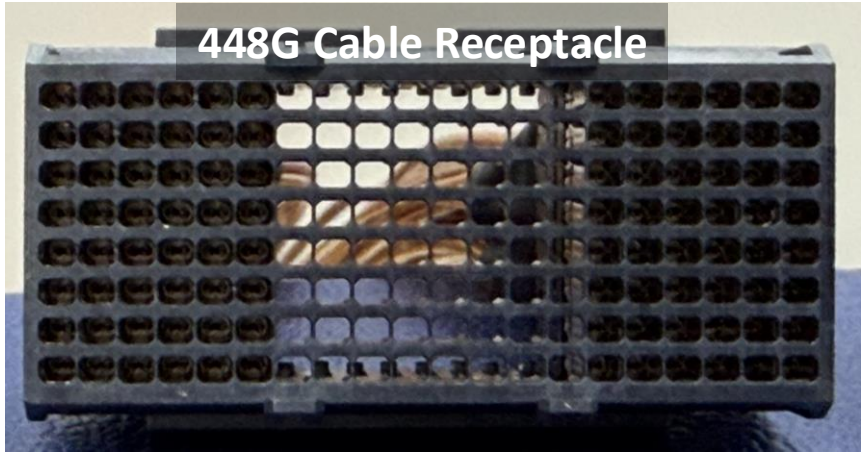
Plug Tip (from below)



First Samples Built of Cable Backplane Connector

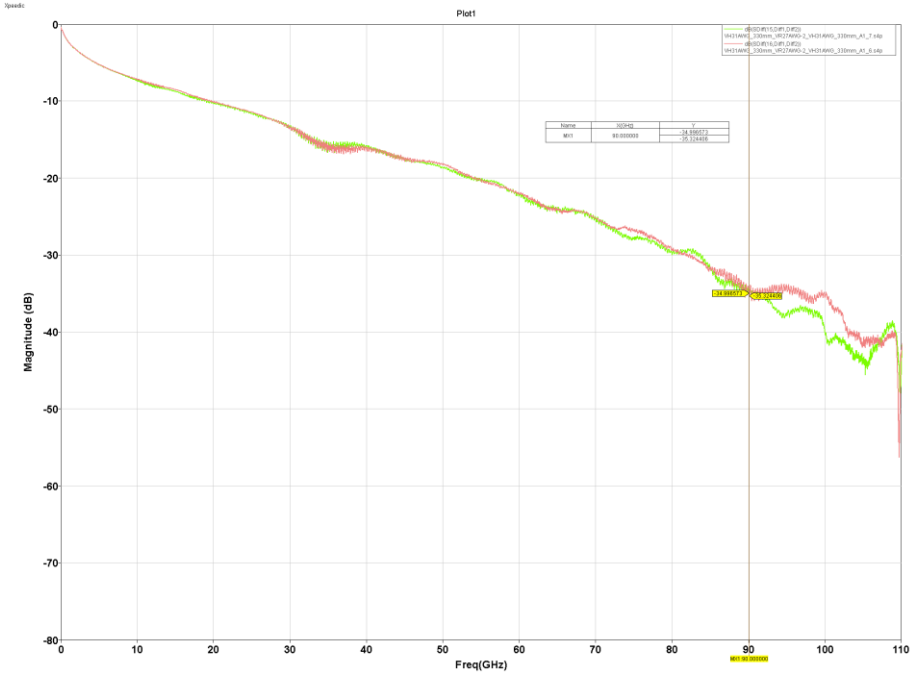


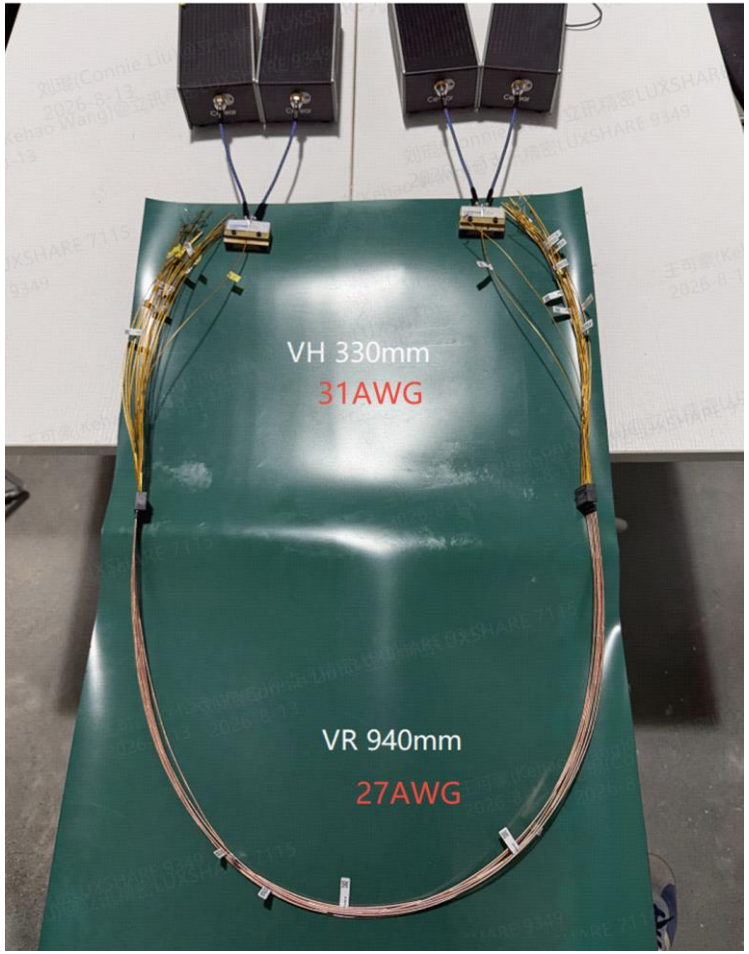




Initial Measurement of Cabling Segment

- Clean response out to 100GHz
- No resonance until just at 110GHz

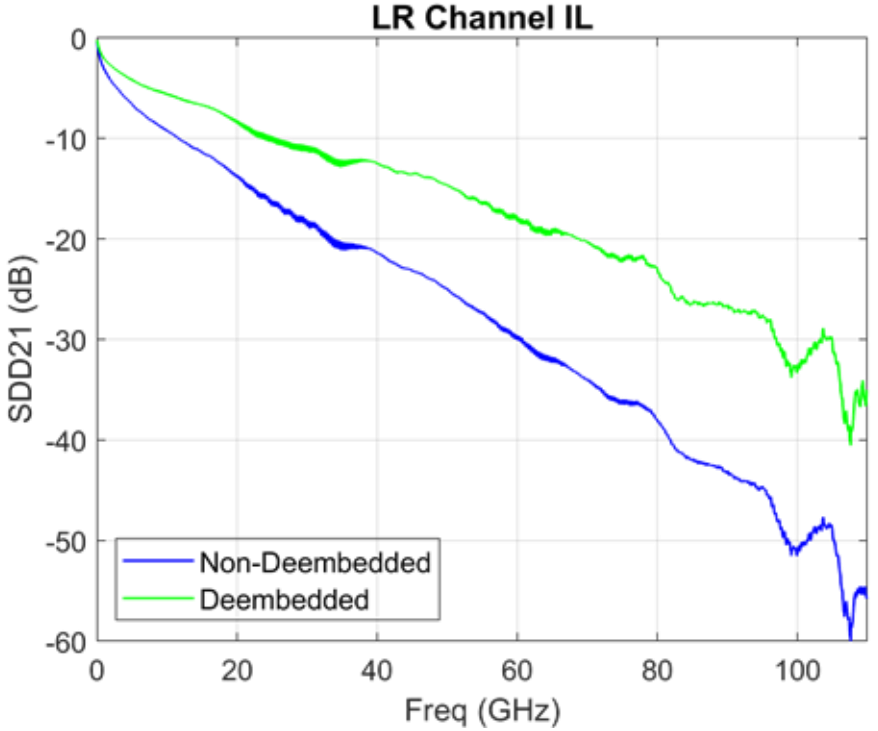


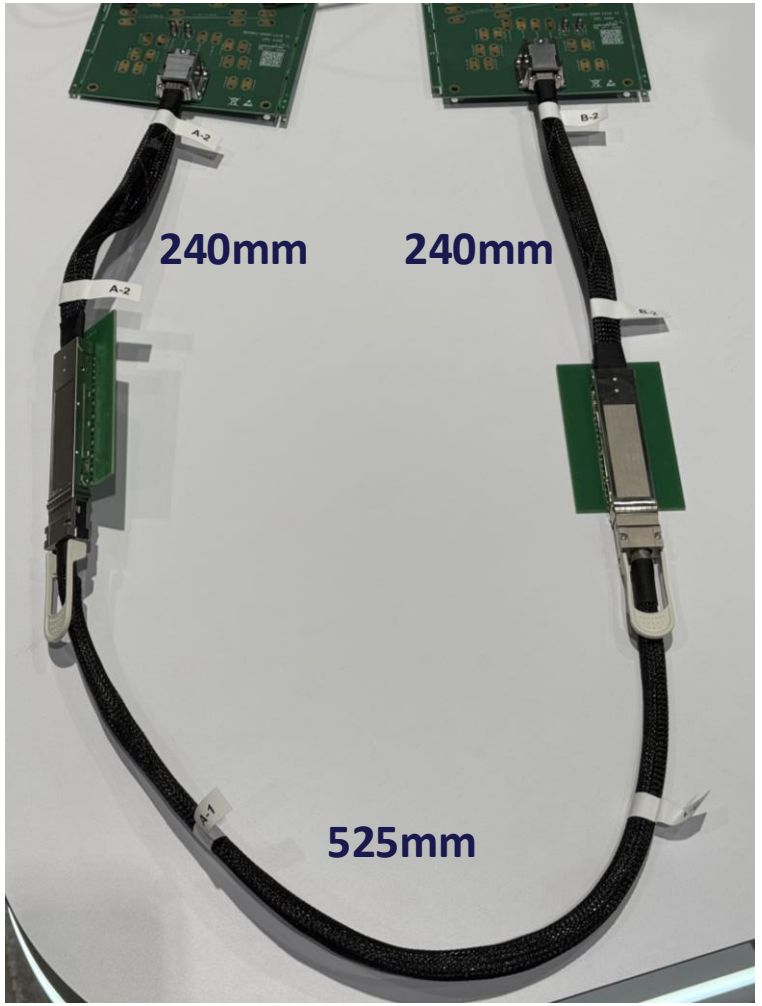


Twinax Test Fixture	**330mm 31awg** Twinax	Mated VH-VR Conn	**940mm 27awg** Twinax	Mated VR-VH Conn	**330mm 31awg** Twinax	Twinax Test Fixture

Initial Measurement of LR Segment (Front Panel)

- Clean response out to 100GHz
- No major resonance
- Prelim sample, manufacturing process being refined to improve tolerance issues
- On demo at **booth A31**







Summary

- 400G/lane electrical solutions being built around high performance twin-ax
  - Lower loss & ILD, and better bandwidth
- We presented candidates for the array of accompanying connectors needed
  - CPC is getting quite advanced with clean response out to 120GHz
- First instance of the twinax—twinax are quite promising especially given the known manufacturing issues being fixed at the moment
- PAM-6 (90GHz) looks to be viable in the very near term
- PAM-4 (112GHz) also looks within reach
- Experience a live SI demo of the LR-style connection at Luxshare-Tech's booth (**A31**)

Call to Action

- AI demands accelerating the need for 400G/lane links, and to keep the power down, copper is need for shorter link segments
- Standards bodies (OIF & IEEE) have formally started in the past year to define the specifications
- Interconnect vendors to work with OCP server project group on connector & channel loss information to facilitate adoption of 400G (and 256G) per lane based links
  - Mechanical drawings
  - SI characteristics
- Additional information:
  - OIF CEI-448G Framework Launch (link)
  - IEEE 400GPL Study Group (link)
  - Luxshare-Tech's Designcon'26 Tutorial on 224G and 448G interconnects (link)
  - Luxshare-Tech's OCP'25 400G Presentation (link)

Thank You!

