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**Advanced High Density Breakout Design
&
Crosstalk Mitigation Strategies**

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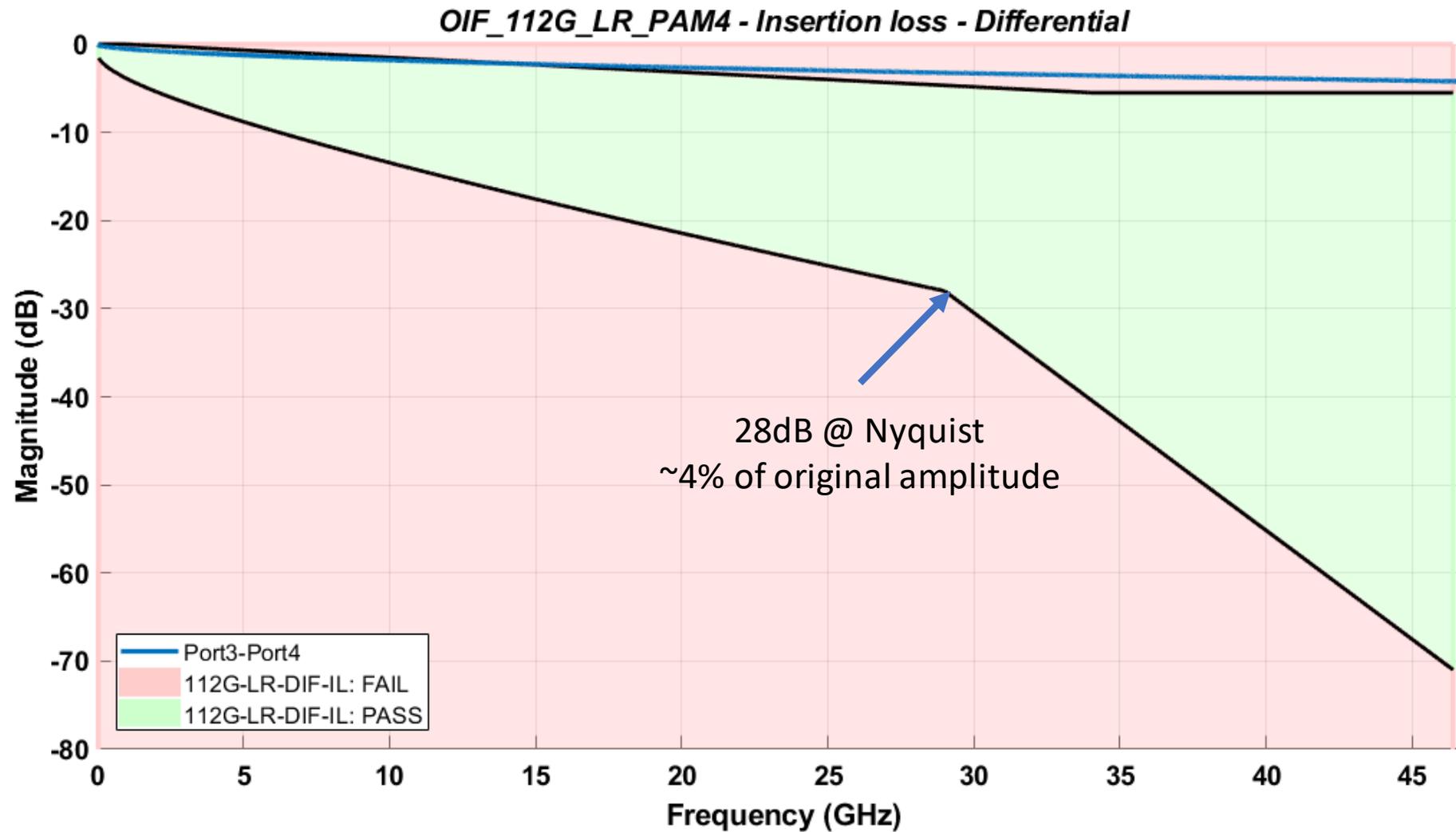
INTRODUCTION

Today's high density connector arrays face significant challenges at the board attach region. Insertion loss and return loss impairments can be mitigated with careful design and simulation. More important especially with PAM4 signals are the crosstalk impairments from the associated via fields. Sympathetic resonators can allow crosstalk to skip across the entire field with minimal attenuation. This presentation will highlight these issues and demonstrate how to improve the connector & board ecosystem to assure successful system designs..

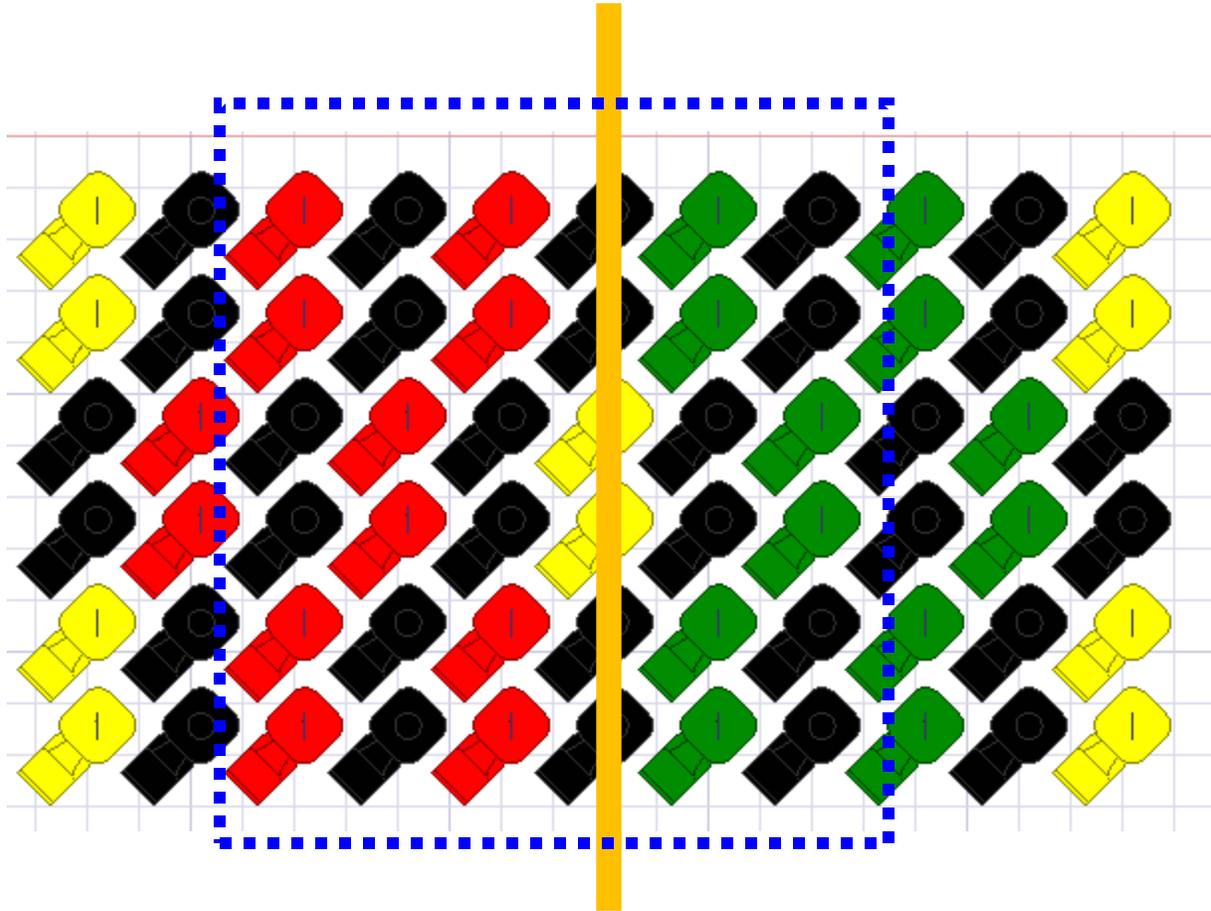
- **Some key points:**

- 112G LR IL Mask
- Beach Head
 - Managing cross talk by segregation of TX and RX IO
- Sympathetic Resonators and the Associated Cross Talk Skipping
 - Secondary Aggressors can influence cross talk when accounting for TX coupling into RX pins.

OIF 112G LR Pam4 IL Mask



Beach Head: Keeping IO Segregated



TX



RX

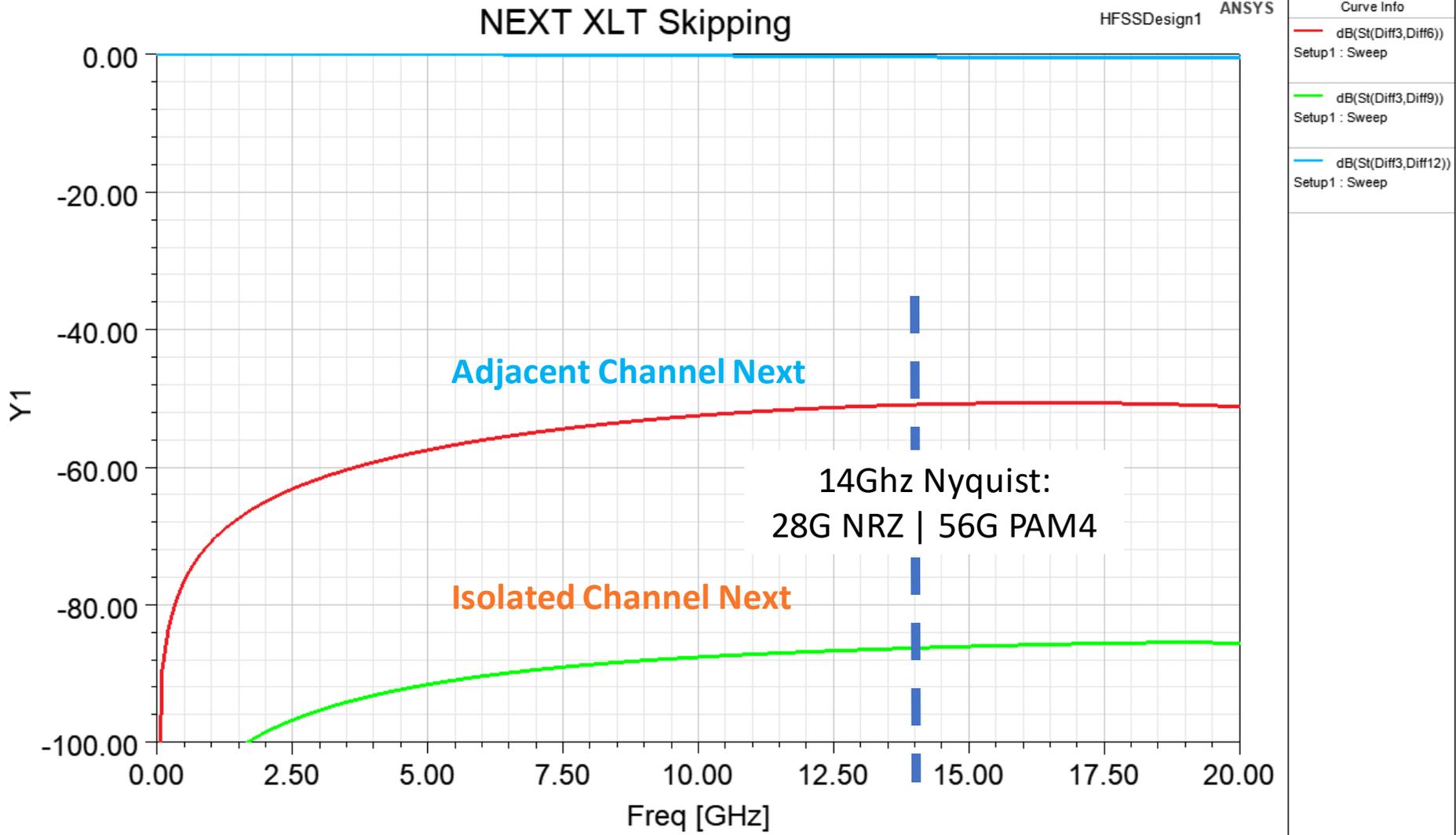
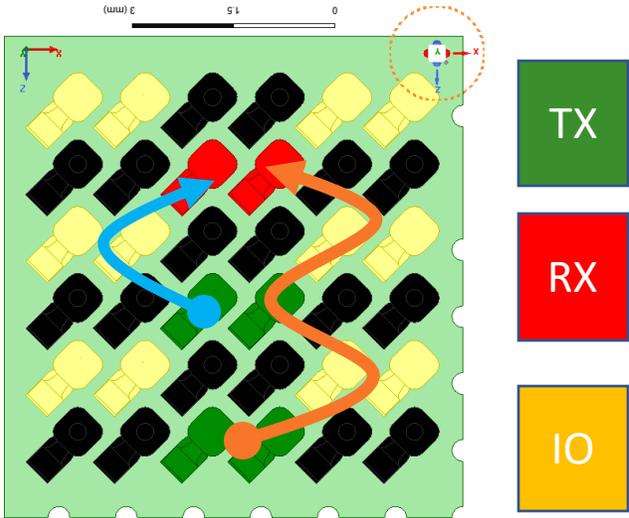


IO

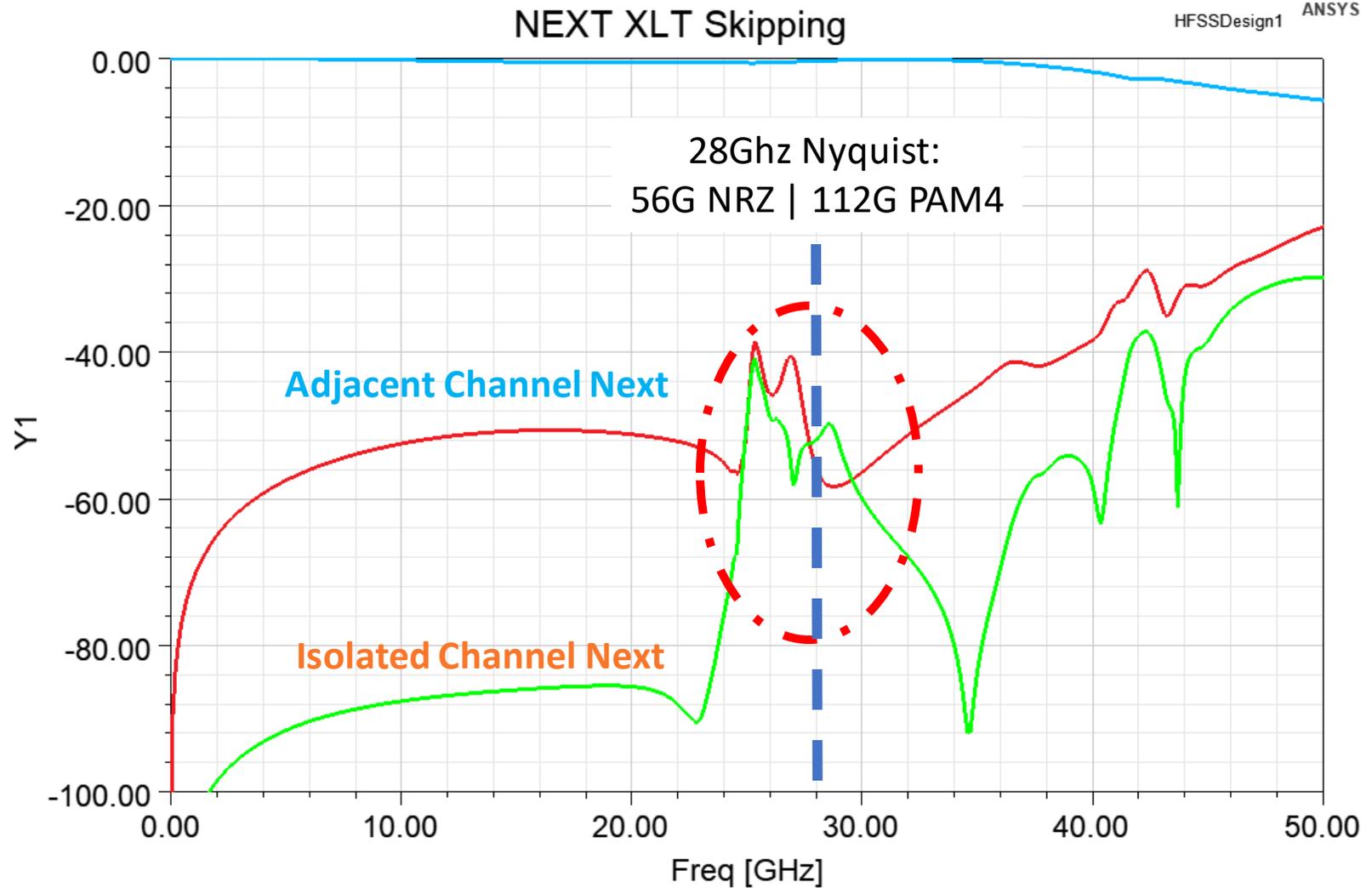
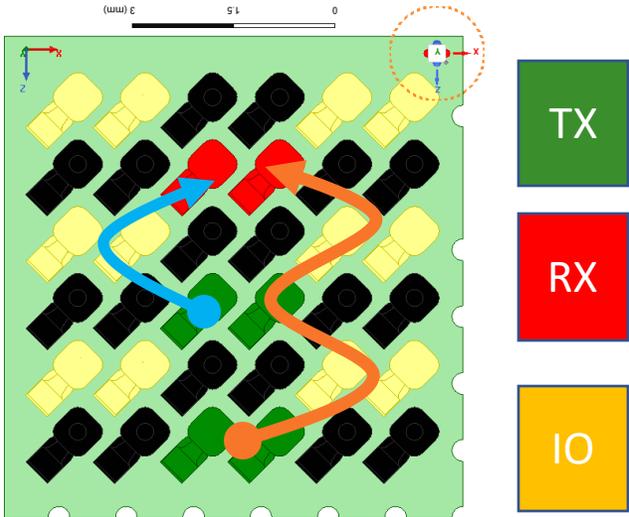
- Isolation Boundary

- Transmitter near end cross talk must not degrade the received signals.
- Isolation requirements are protocol dependent.
- 112G PAM4 signals operate at 28Ghz Nyquist
- The isolation boundary may “will” require more rows of IO pins to achieve adequate Isolation.

Cross Talk Skipping: Simple Example, Connector Only

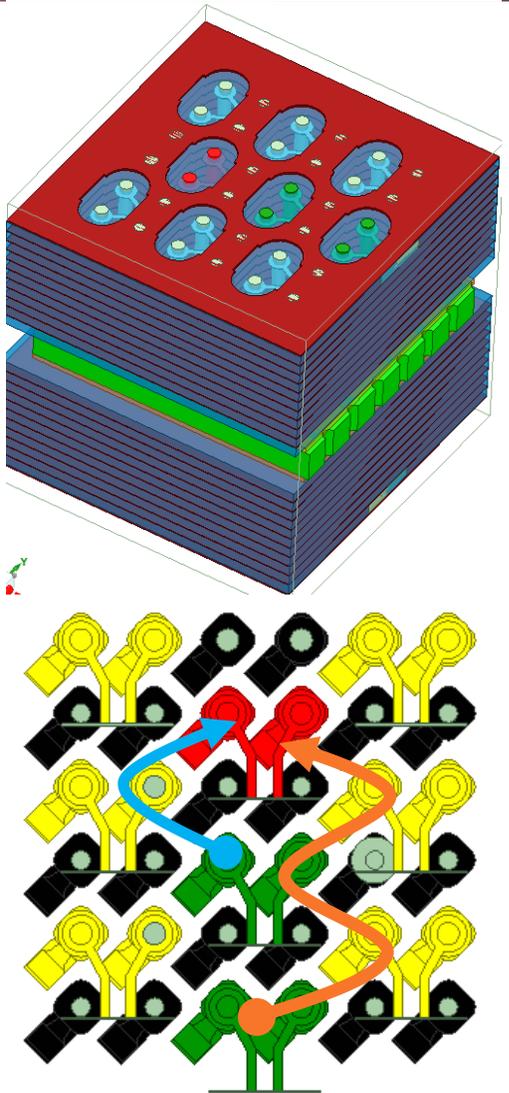


Cross Talk Skipping: Simple Example, Connector Only

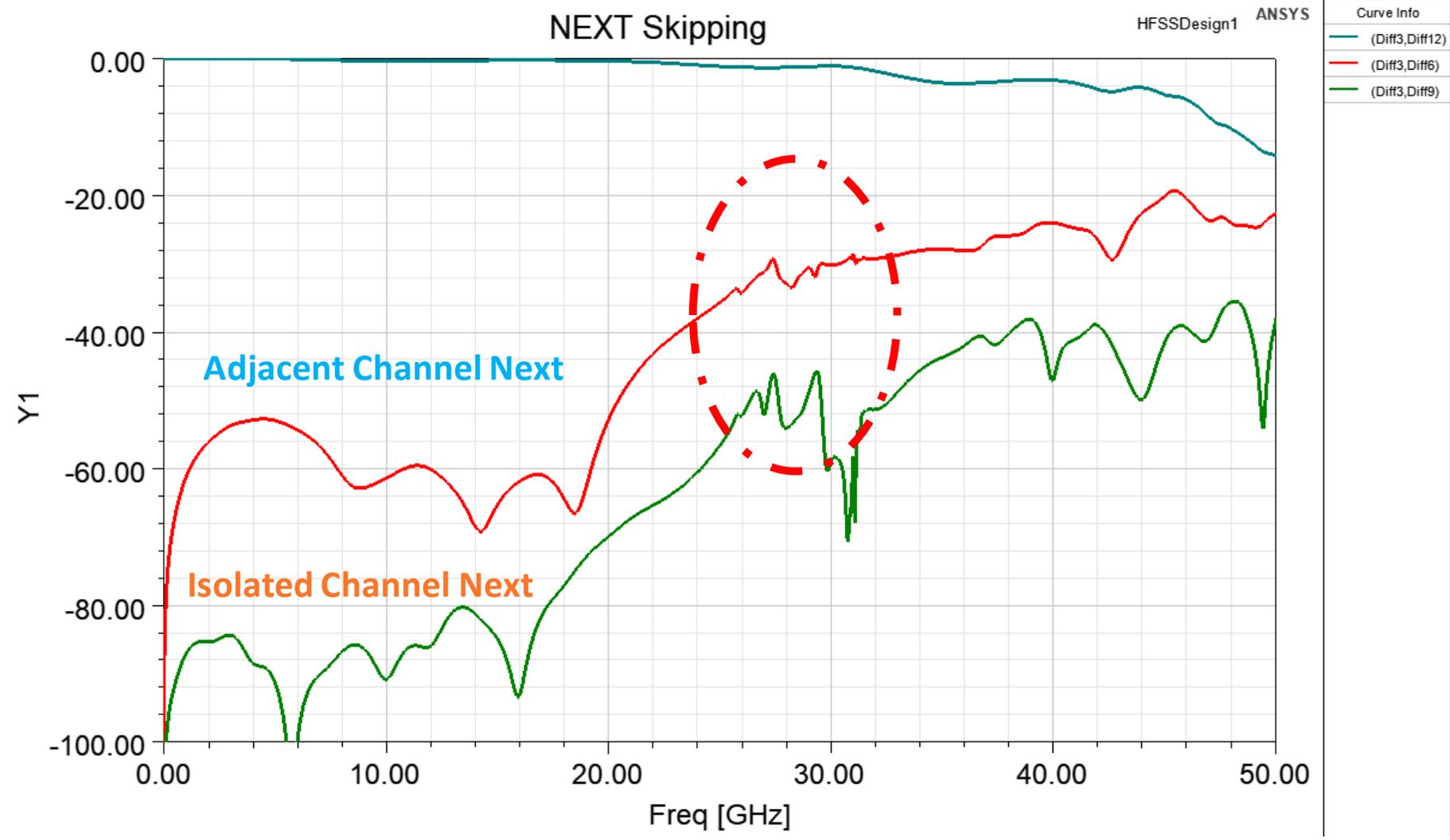


Curve Info
— dB(St(Diff3,Diff6)) Setup1 : Sweep
— dB(St(Diff3,Diff9)) Setup1 : Sweep
— dB(St(Diff3,Diff12)) Setup1 : Sweep

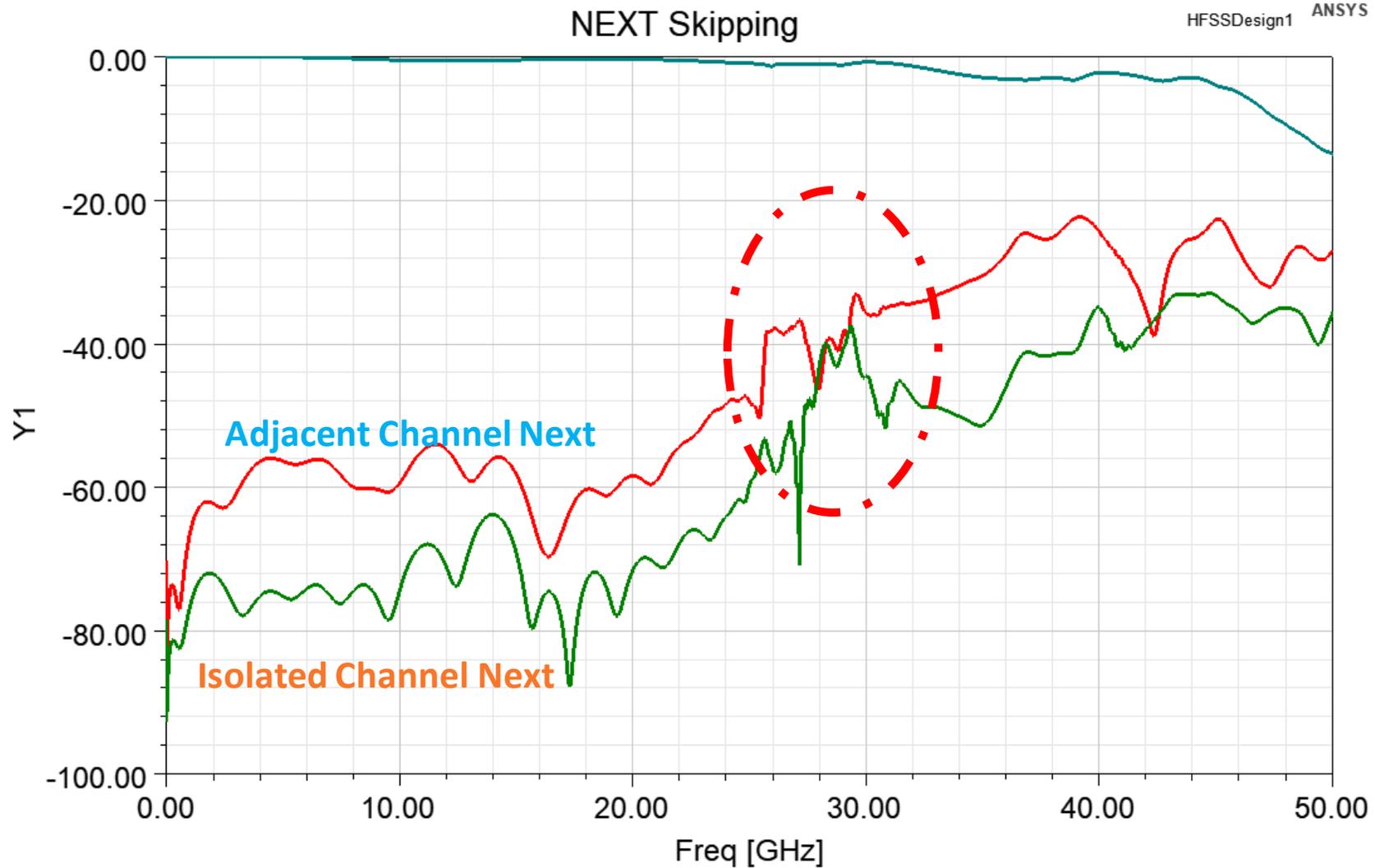
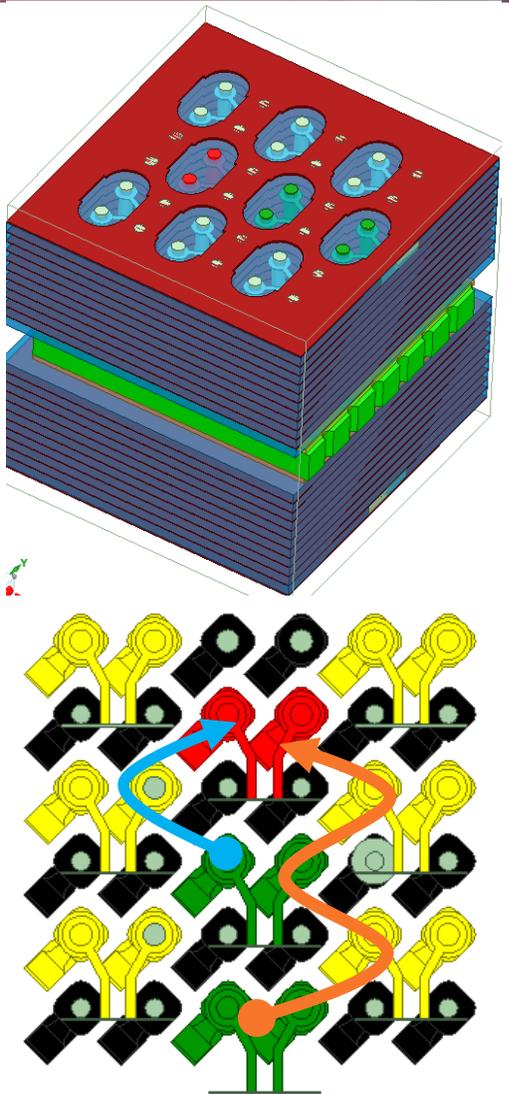
Cross Talk Skipping: Connector with Complex BOR



- TX
- RX
- IO

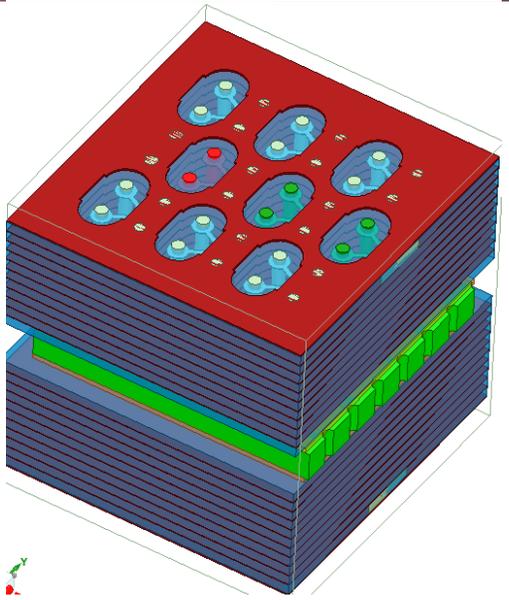


Cross Talk Skipping: Complex BOR minor via pitch tweak



Curve Info
(Diff3, Diff12)
(Diff3, Diff6)
(Diff3, Diff9)

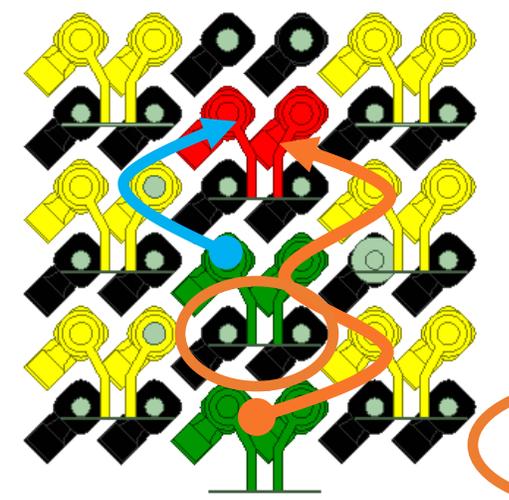
Cross Talk Skipping: Scaled to 0.8X “produces nice shift in resonances.”



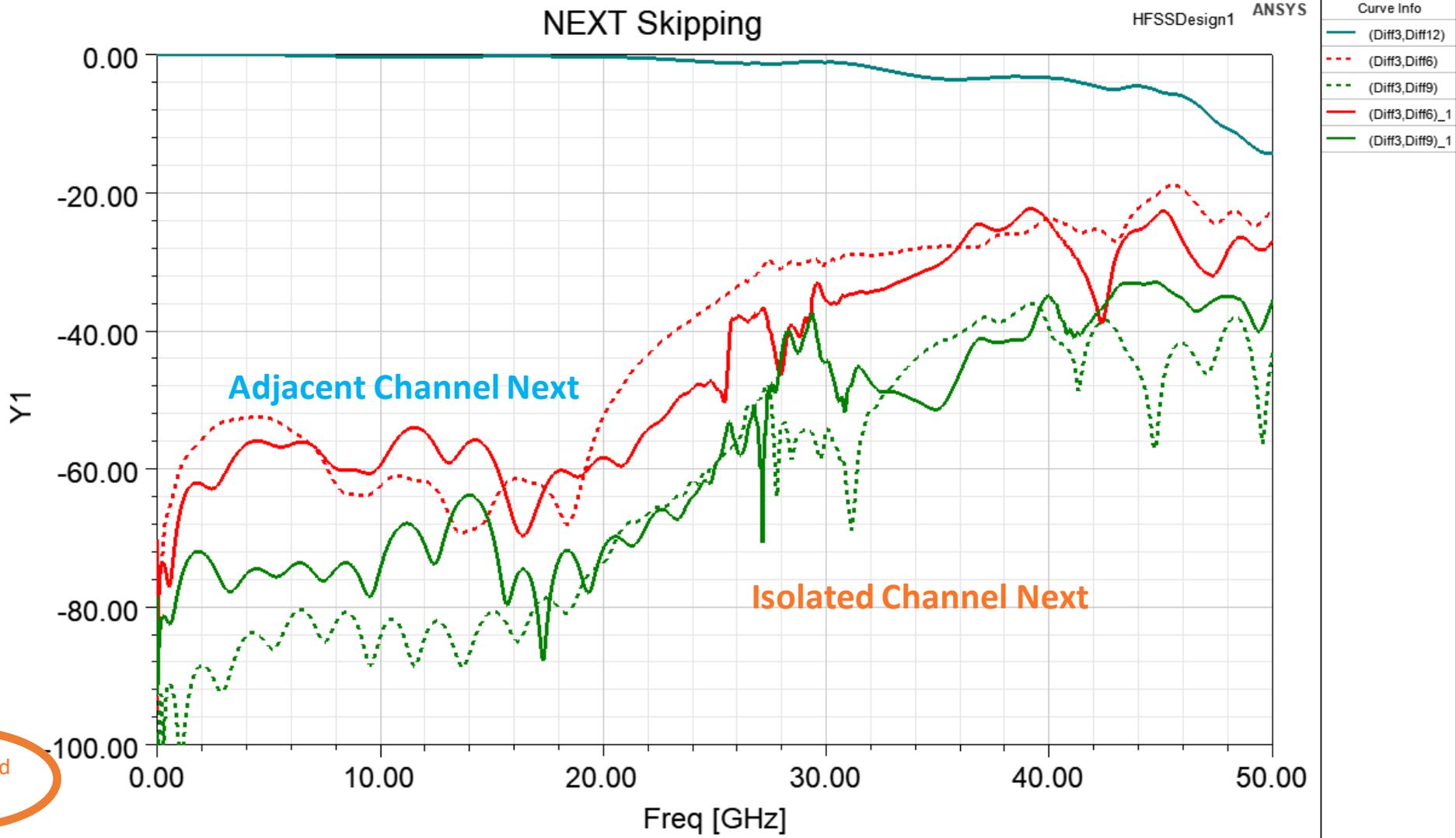
TX

RX

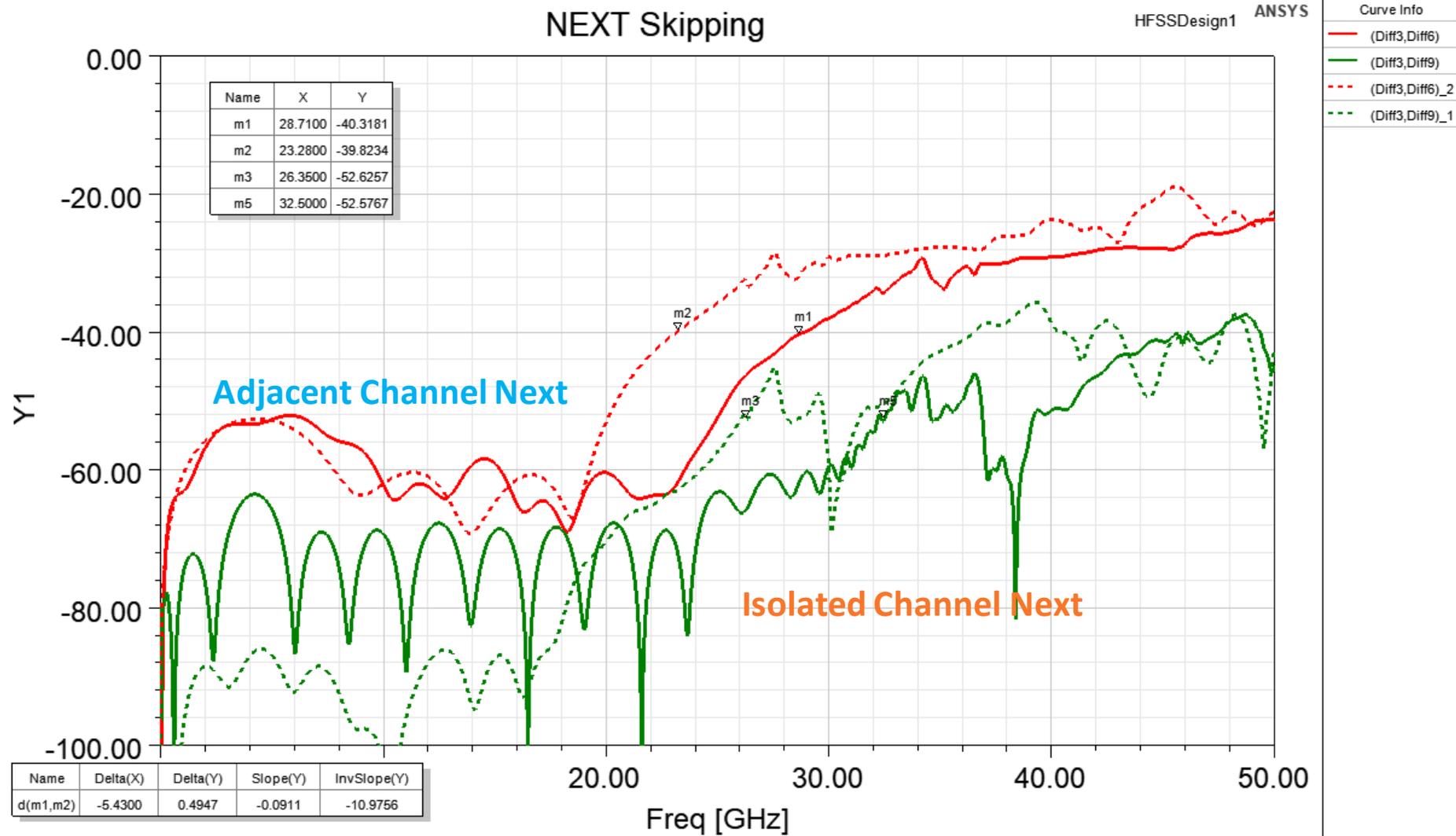
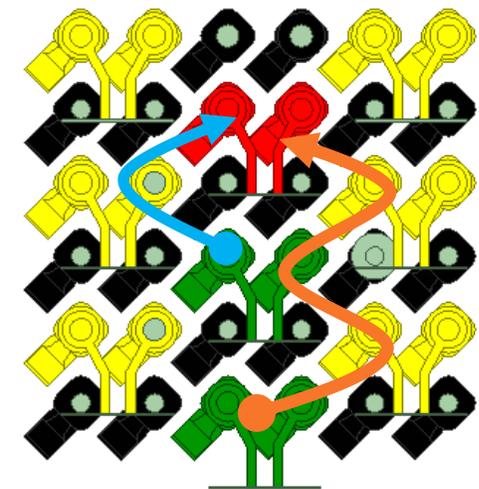
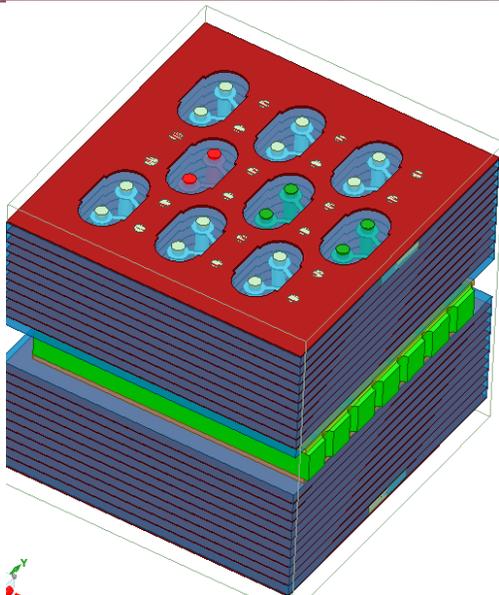
IO



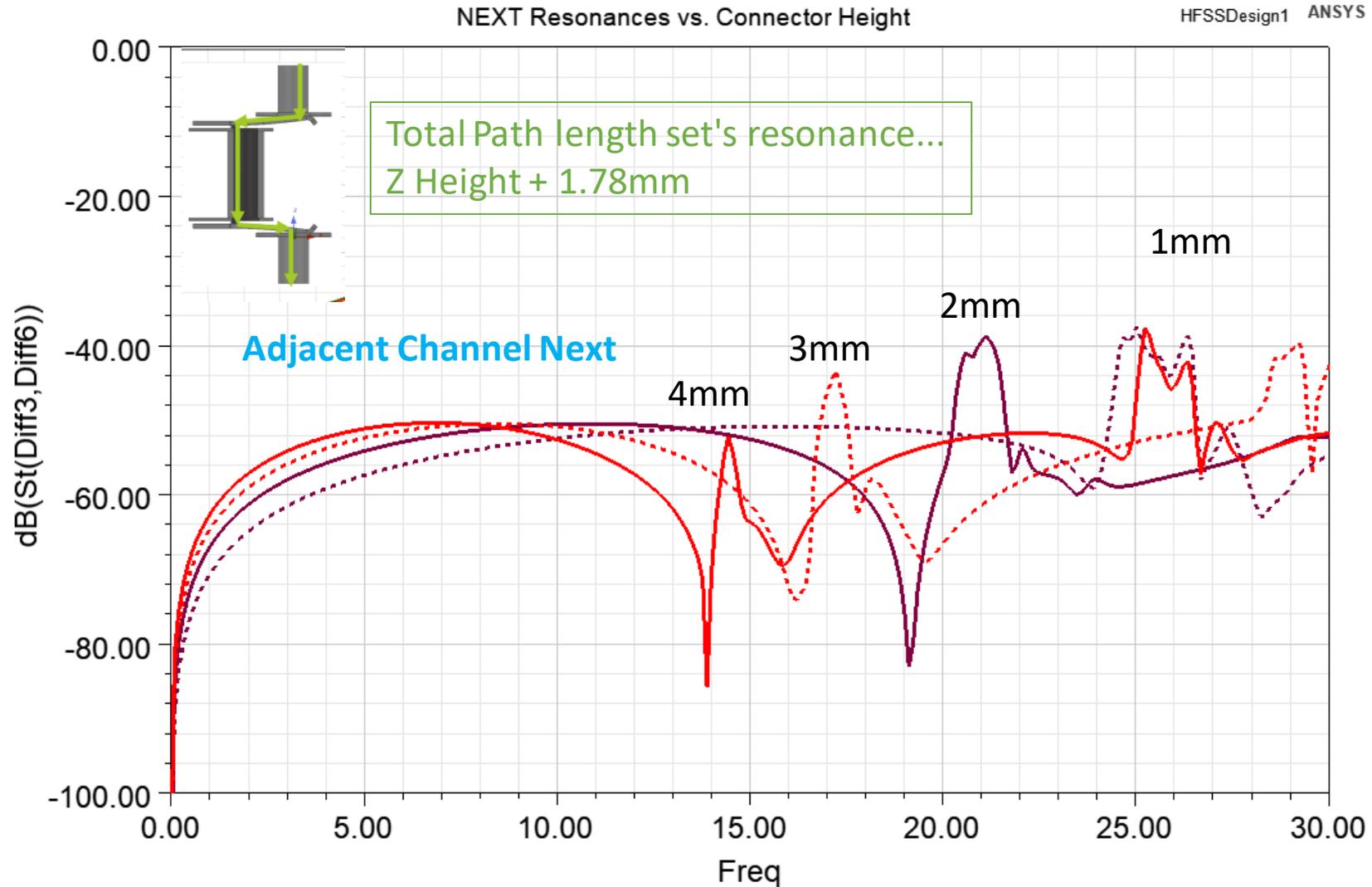
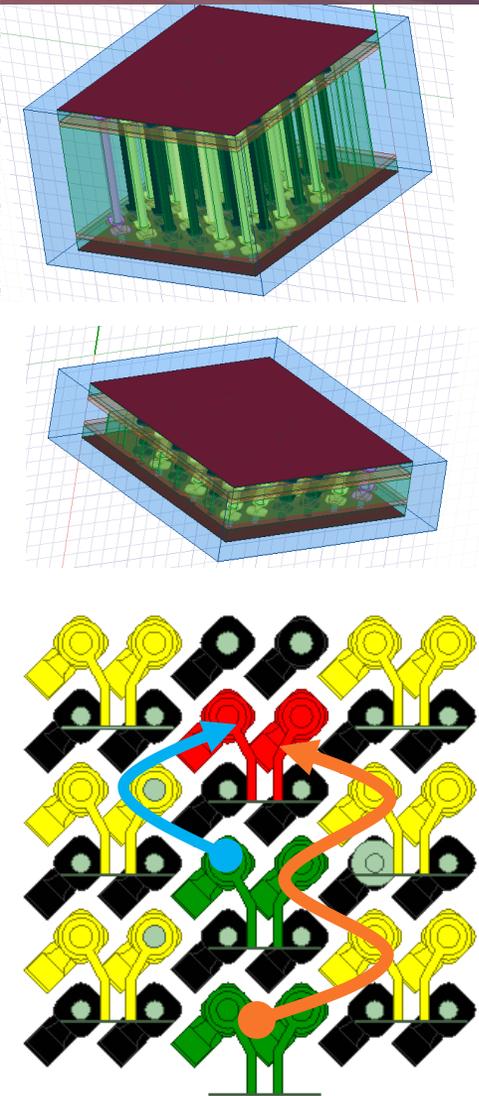
Terminated one side



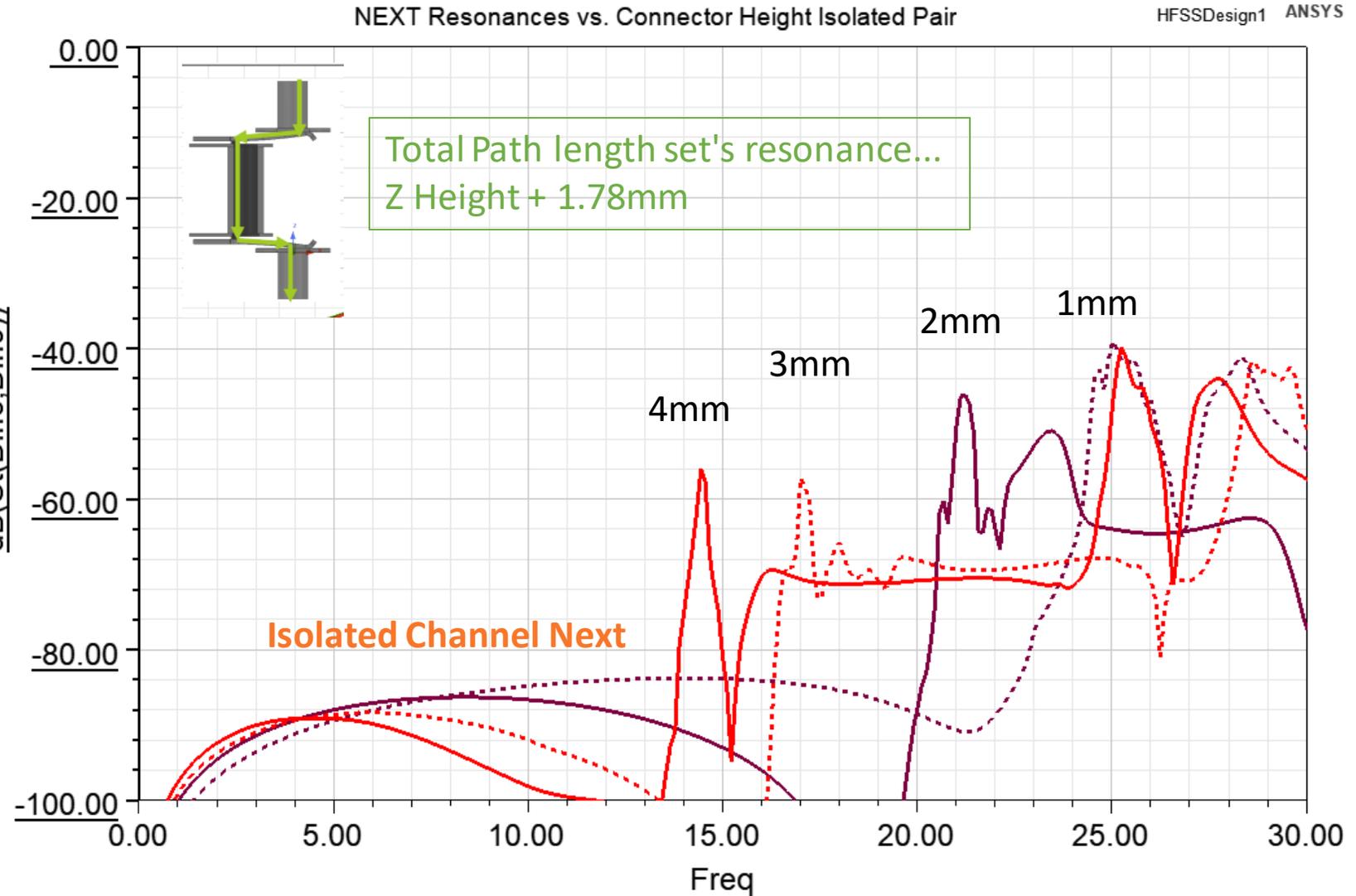
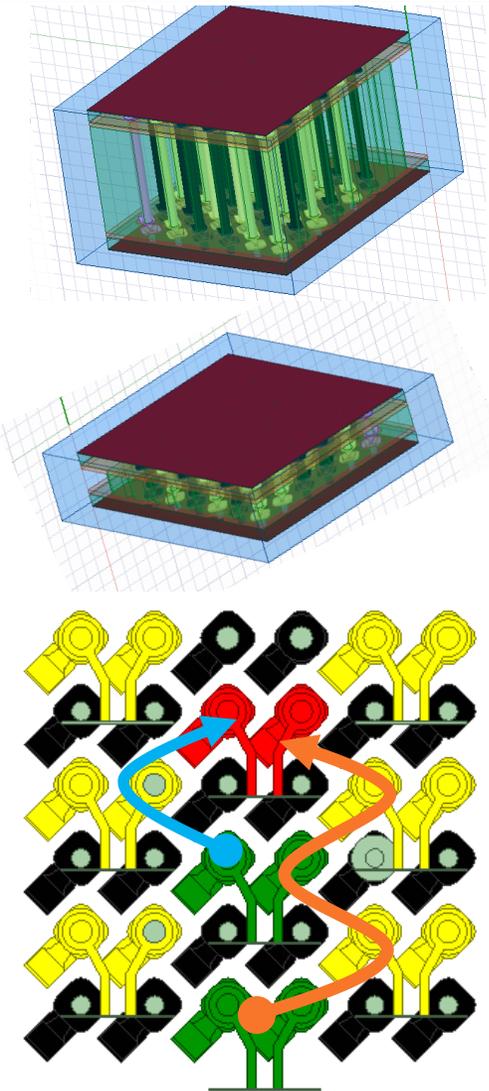
Cross Talk Skipping: Scaled to 0.8X “produces nice shift in resonances.”



Cross Talk Skipping: Connector Only @ Different Heights 1, 2, 3 and 4mm

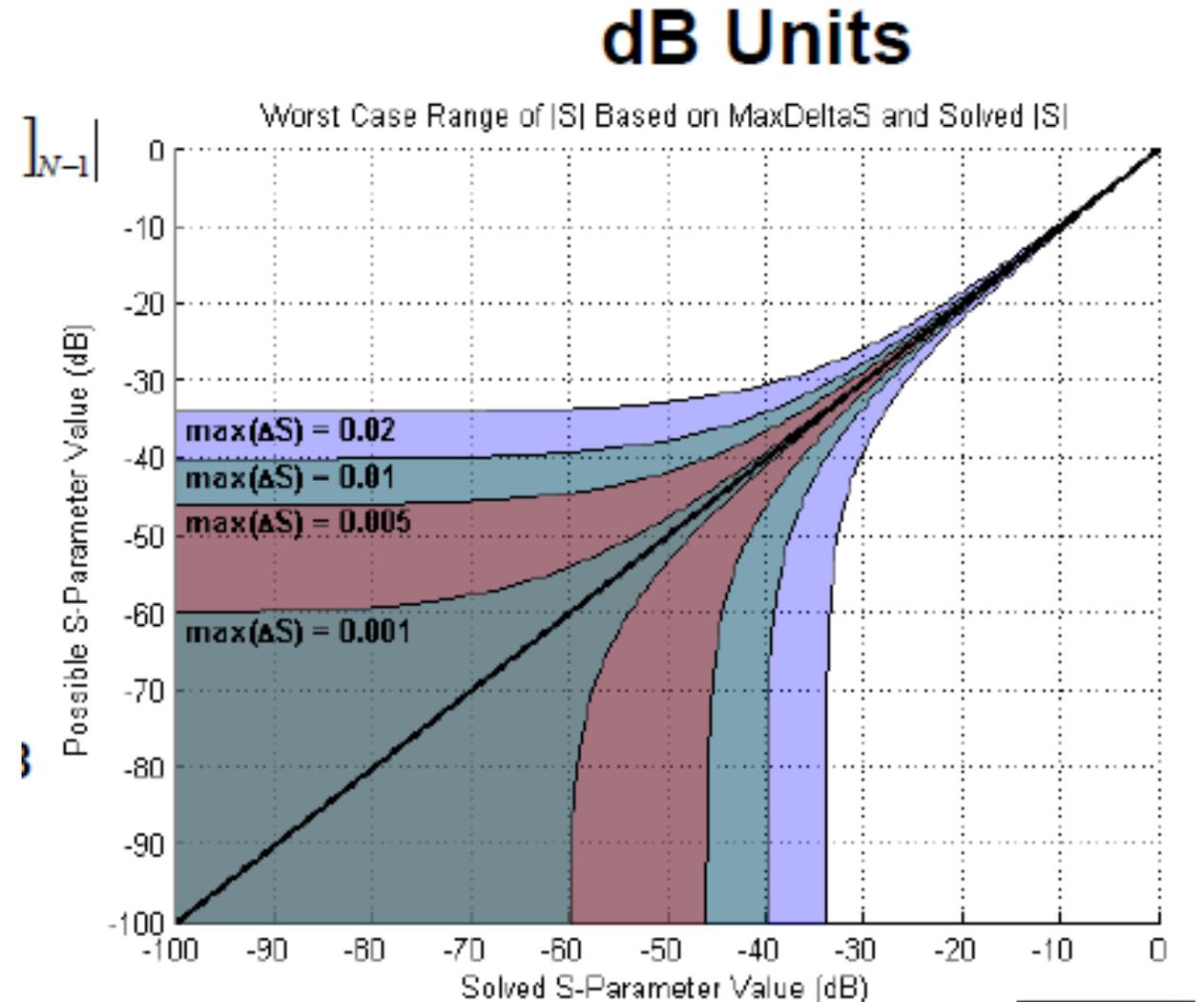


Cross Talk Skipping: Connector Only @ Different Heights 1, 2, 3 and 4mm



Simulation Times

- Using a 48 core machine with 650Gbytes of memory the average simulation time for this study was 10 hours.
- Expect these simulations to take closer to 30 hours on a standard 16 core workstation.



Key Elements for Success

- Fully modeling channel IO arrangement to capture XLTK issues
- Understanding NEXT impacts for TX/RX impairments
- Isolation techniques
 - Distance
 - Terminating floating pins
 - Ground vias
 - Terminating instead of grounding pins
- Adequate Delta S settings in HFSS to resolve cross talk.

SUMMARY

1. Cross talk issues in PAM 4 systems are becoming the dominate design challenge.
2. Cross talk simulations are expensive.
 1. Even for a simple system these simulations take upwards of 12 hours.
 2. Making sure the model includes the full details of the connector and breakout region takes time and effort.
 3. Cross talk can be a lot like a game of whack a mole....
 4. Many iterations might be necessary to achieve acceptable cross talk at the system level.
3. When your ground structure starts to resonate it can couple energy with little or no attenuation.



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