



ATCA Channel Data for Backplane Ethernet Task Force

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Objectives

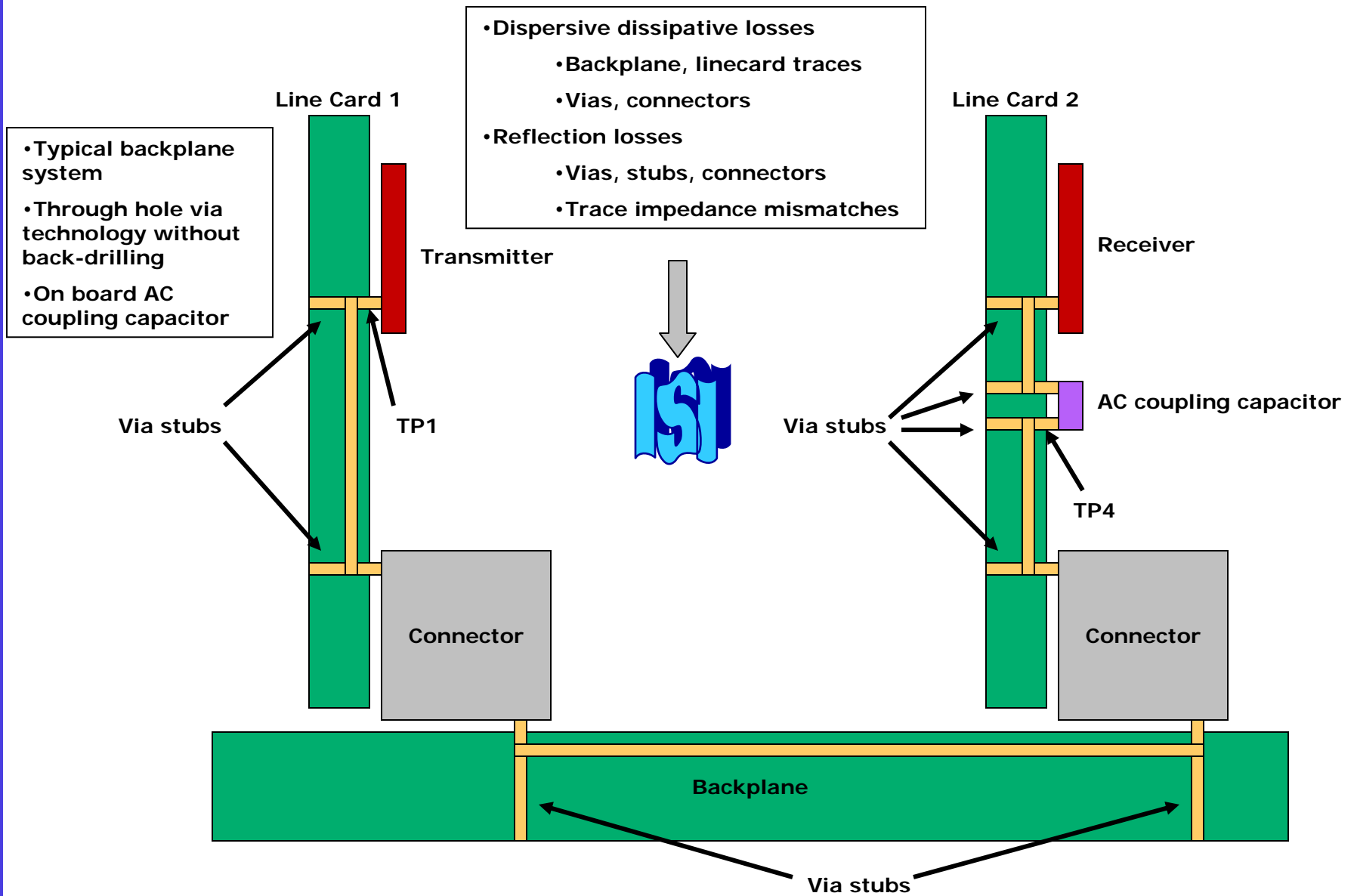
An AdvancedTCA backplane test system was designed, fabricated and measured. This system features backplane channels with various lengths and configurations. The measurements show:

- **The effects of channel length on the channel S-parameters**
- **The effects of via stubs on the channel S-parameters**

AdvancedTCA simulation models were generated based on the ATCA system featured in peters_01_0704 and kundu_01_0504.

- **Model structure, capabilities and planned enhancements**
- **Correlation to measurement**
- **Show the effect of manufacturing / environmental variation on channel insertion loss**


















Backplane System Diagram



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AdvancedTCA backplane system properties




















- AdvancedTCA backplane test system
- Based on backplane from peters_01_0704, kundu_01_0504
- 8 stripline signal routing layers
- Total board thickness = 187 mils
- Material: Nelco4000-13
 - Core DK=3.69 (2*2116)
 - Prepreg DK=3.66 (2116,2113)
 - DF=0.01
- Nominal differential impedance = 100 Ω
- Trace length from 1.25" to 32"
- Trace width = 8 mils, separation = 11 mils, 1 oz Cu

Thickness(inches)			
0.0014		Layer1	Plane
0.009			
0.0014		Layer2	Routing
0.01			
0.0014		Layer3	Plane
0.009			
0.0014		Layer4	Routing
0.01			
0.0014		Layer5	Plane
0.009			
0.0014		Layer6	Routing
0.01			
0.0014		Layer7	Plane
0.009			
0.0014		Layer8	
0.01			
0.0014		Layer9	Plane
0.01			
0.0014		Layer10	Plane
0.01			
0.0014		Layer11	
0.009			
0.0014		Layer12	Plane
0.01			
0.0014		Layer13	
0.009			
0.0014		Layer14	Plane
0.01			
0.0014		Layer15	
0.009			
0.0014		Layer16	Plane
0.01			
0.0014		Layer17	
0.009			
0.0014		Layer18	Plane
0.1872	+/- 10%		

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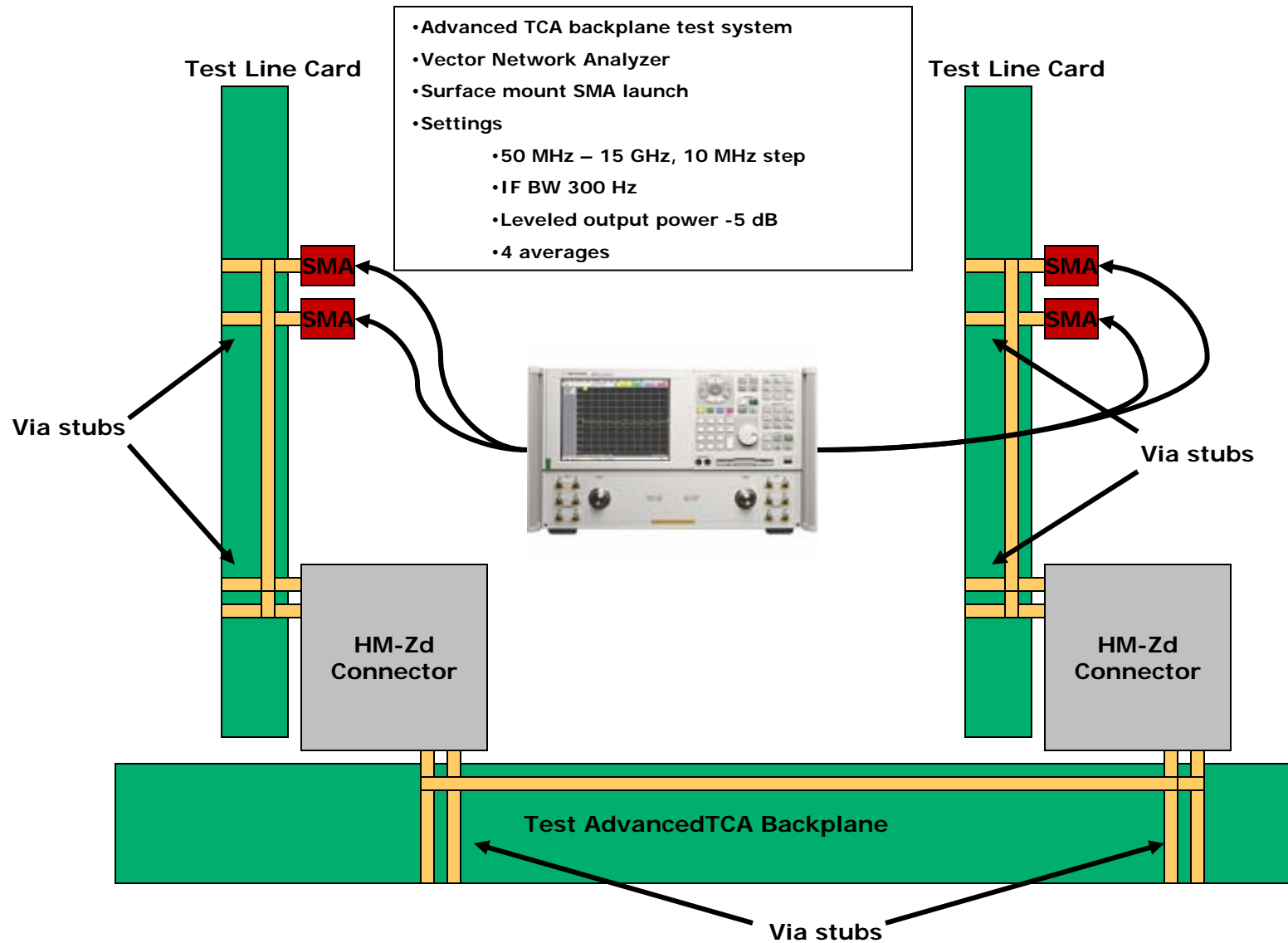
AdvancedTCA linecard properties

- 4 stripline signal routing layers
- Material: Nelco4000-13
 - Core DK=3.67
 - Pre-preg DK=3.41
 - DF=0.01
- Nominal differential impedance = 100 Ω
- Trace length = 2-6"
- Trace width = 5.25 mils, separation = 4.75 mils, 1 oz Cu

Layer	stack up	Thickne ss	Material
1		0.7mil	Copper
Pre-Preg		4.8mil	Nelco4000-13 -1080
2		1.4mil	Copper
CORE		5mil	Nelco4000-13 -2116
3		1.4mil	Copper
Pre-Preg		4.8mil	Nelco4000-13 -1080
4		1.4mil	Copper
CORE		5.0mil	Nelco4000-13 -2116
5		1.4mil	Copper
Pre-Preg		5.3mil	Nelco4000-13 -1080
6		1.4mil	Copper
CORE		5.0mil	Nelco4000-13 -2116
7		1.4mil	Copper
Pre-Preg		4.8mil	Nelco4000-13 -1080
8		1.4mil	Copper
CORE		5.0mil	Nelco4000-13 -2116
9		1.4mil	Copper
Pre-Preg		4.8mil	Nelco4000-13 -1080
10		0.7mil	Copper

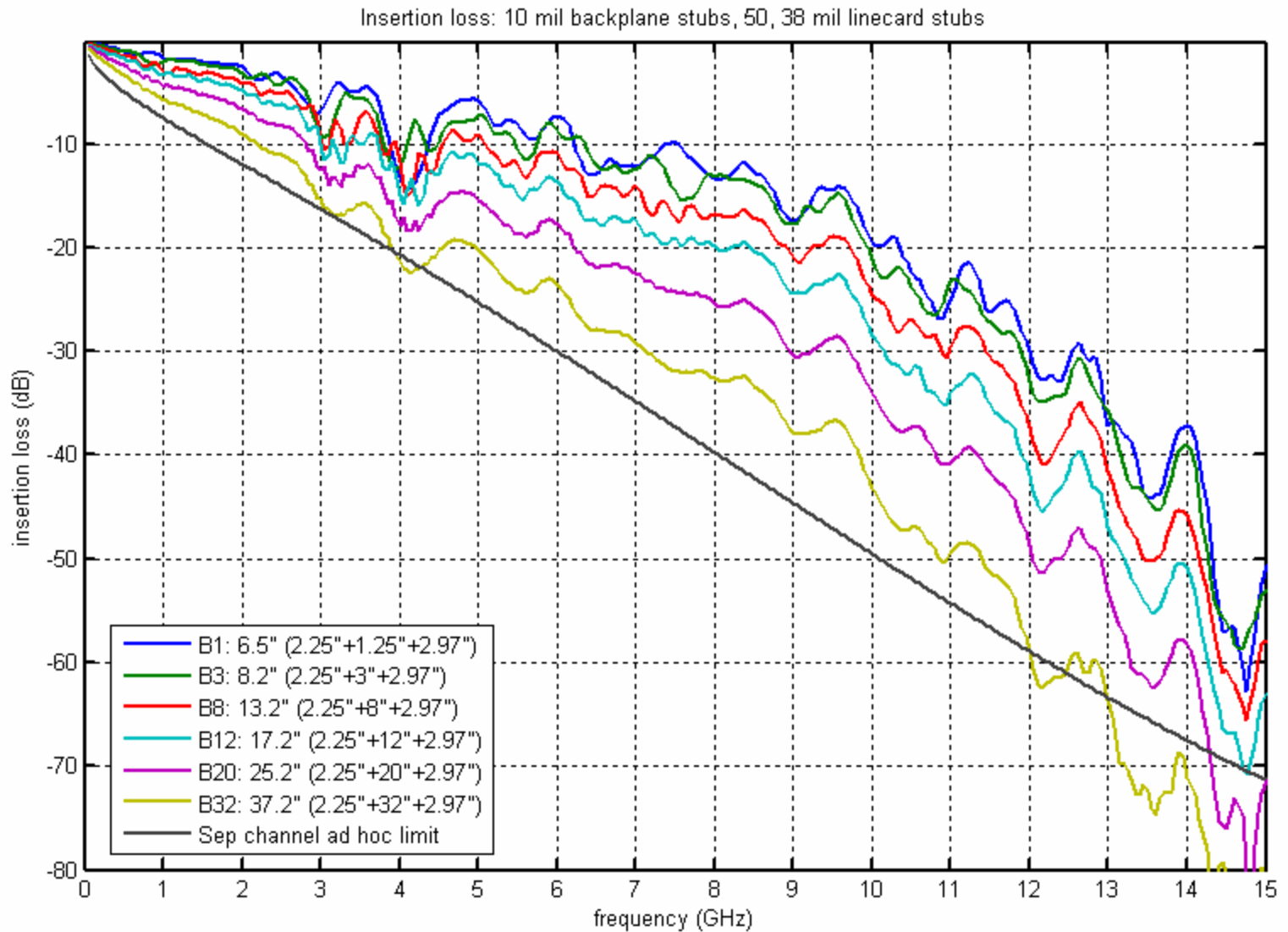
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Measurement System Diagram



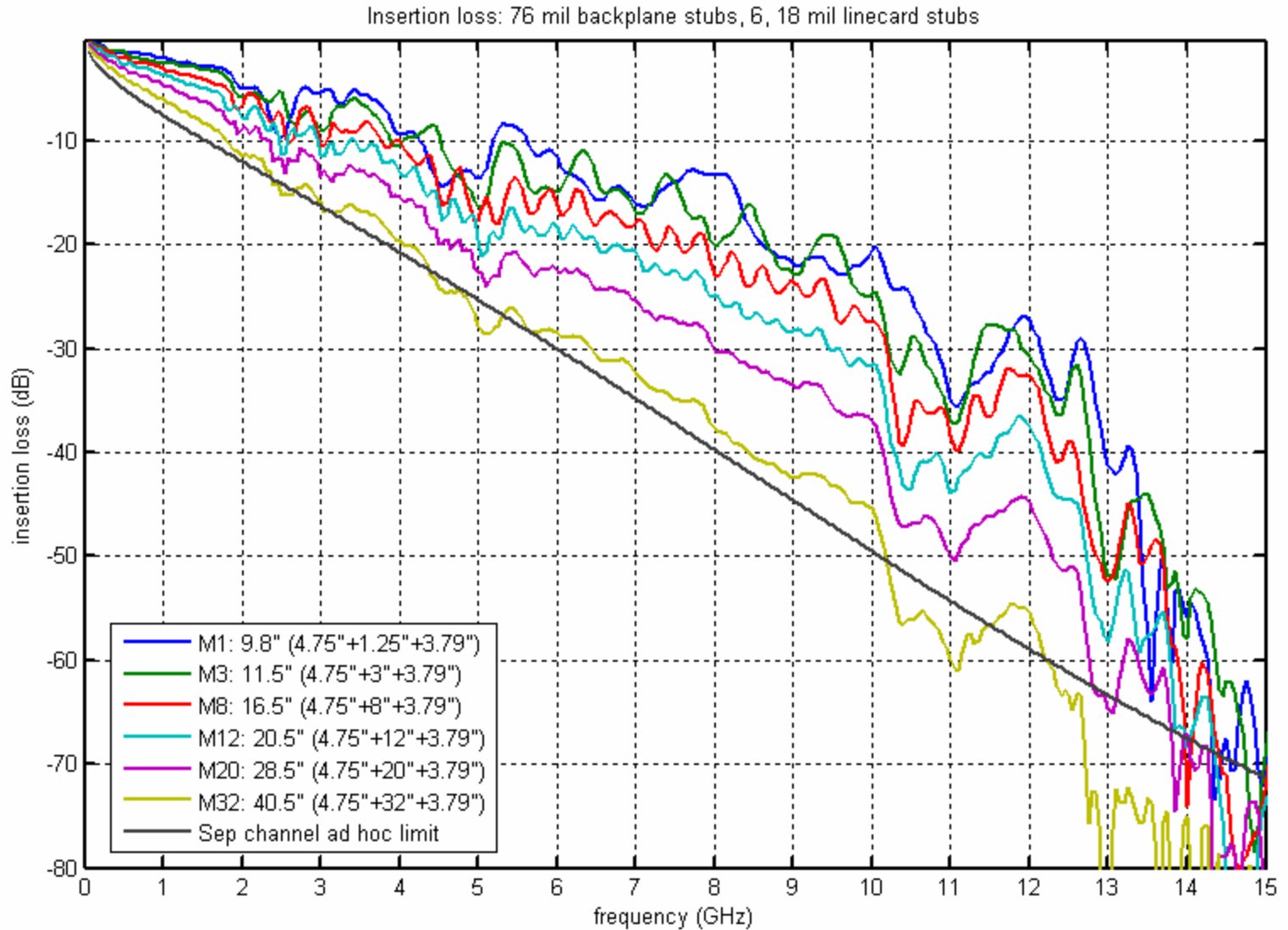
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Measurement: IL, Bottom Layer Stripline



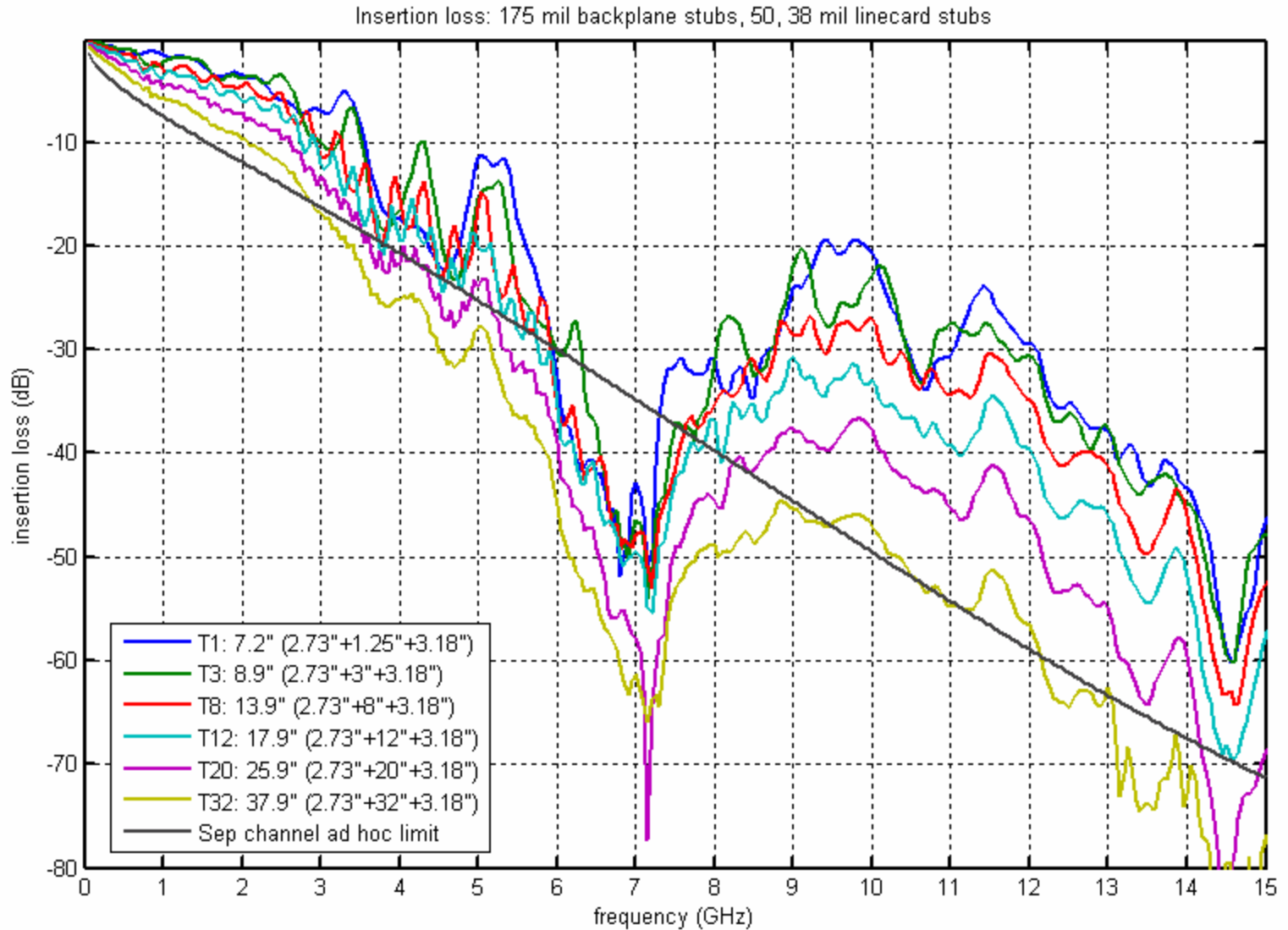
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Measurement: IL, Middle Layer Stripline



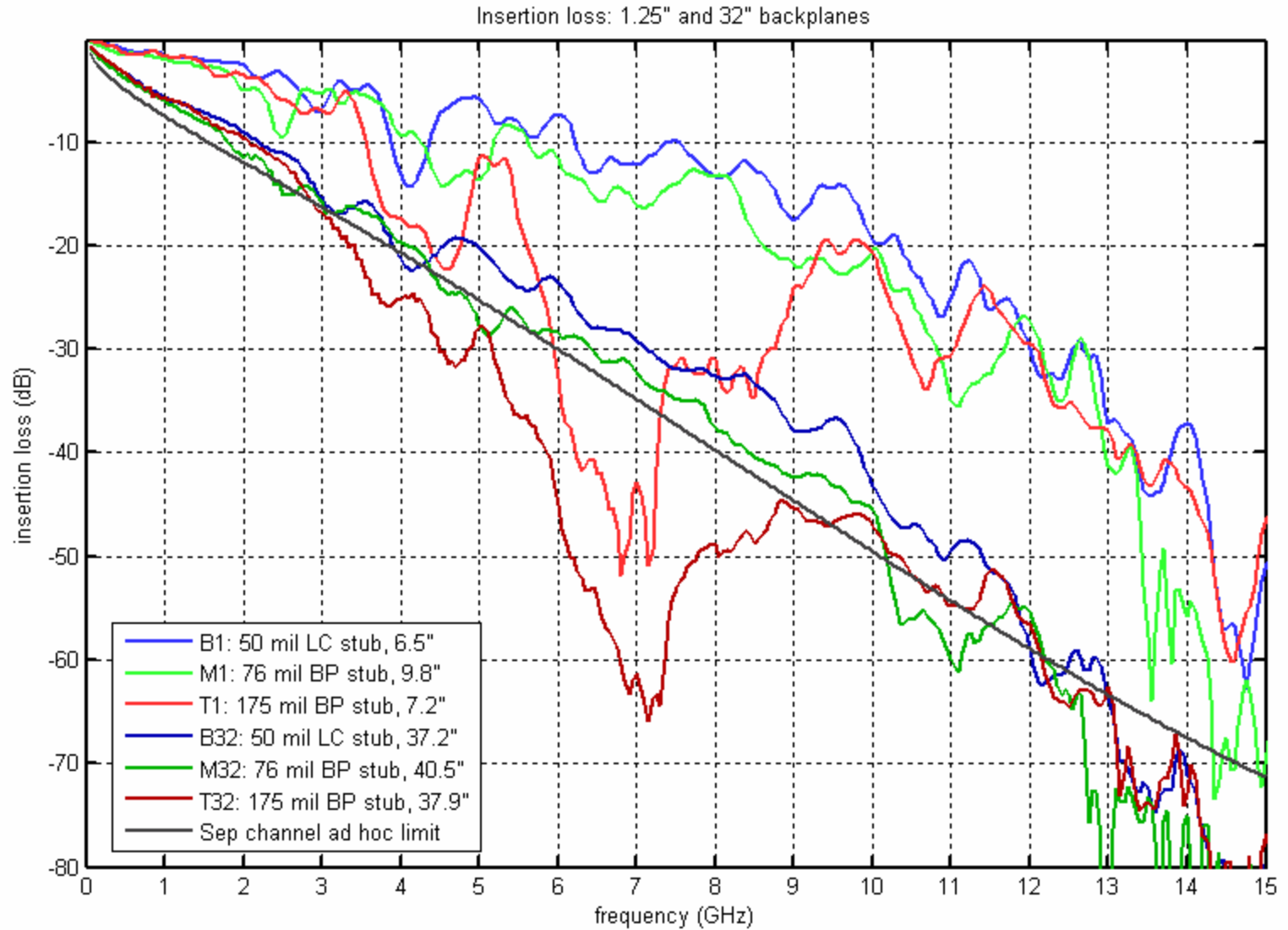
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Measurement: IL, Top Layer Stripline



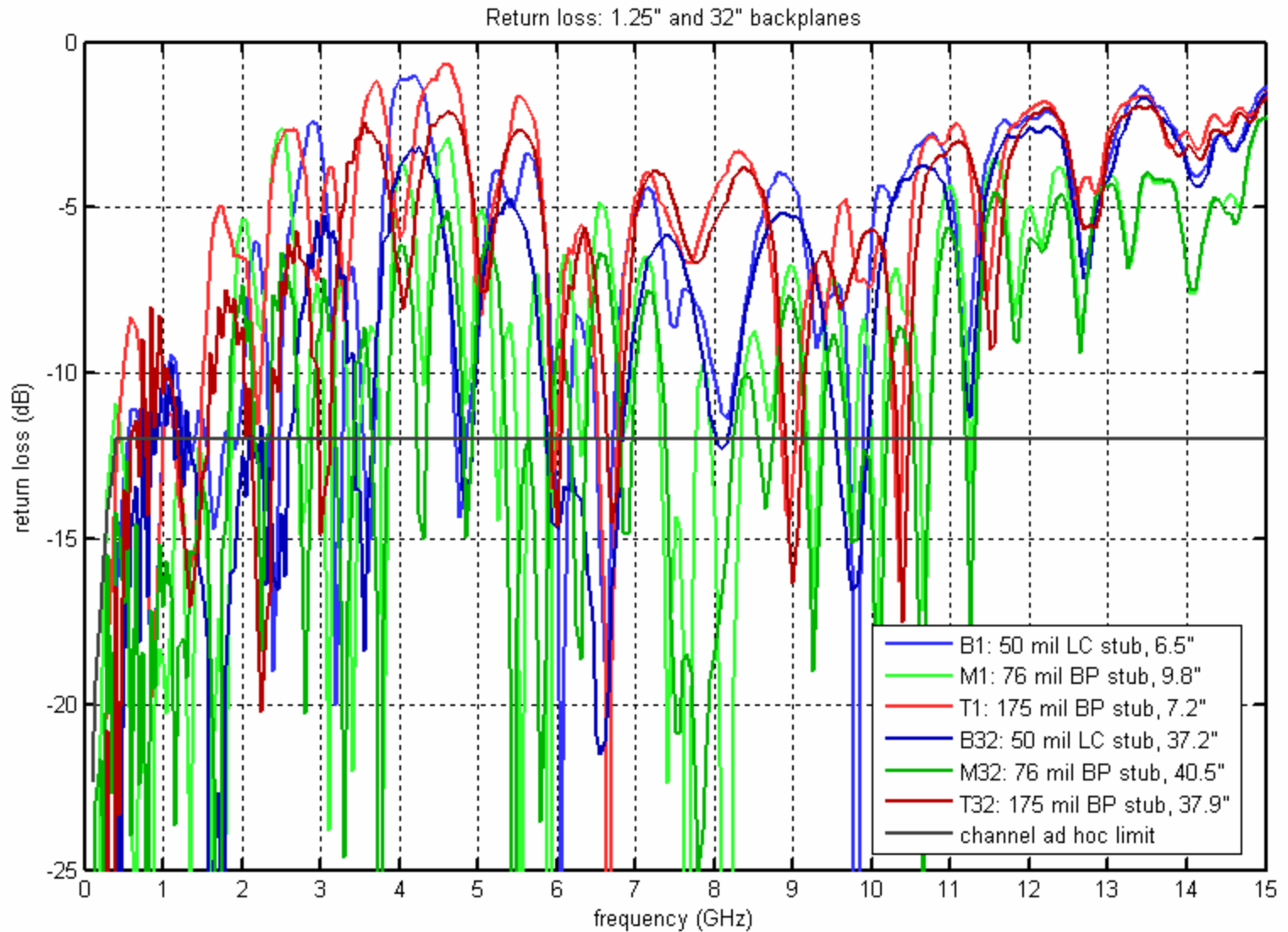
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Measurement: Insertion Loss



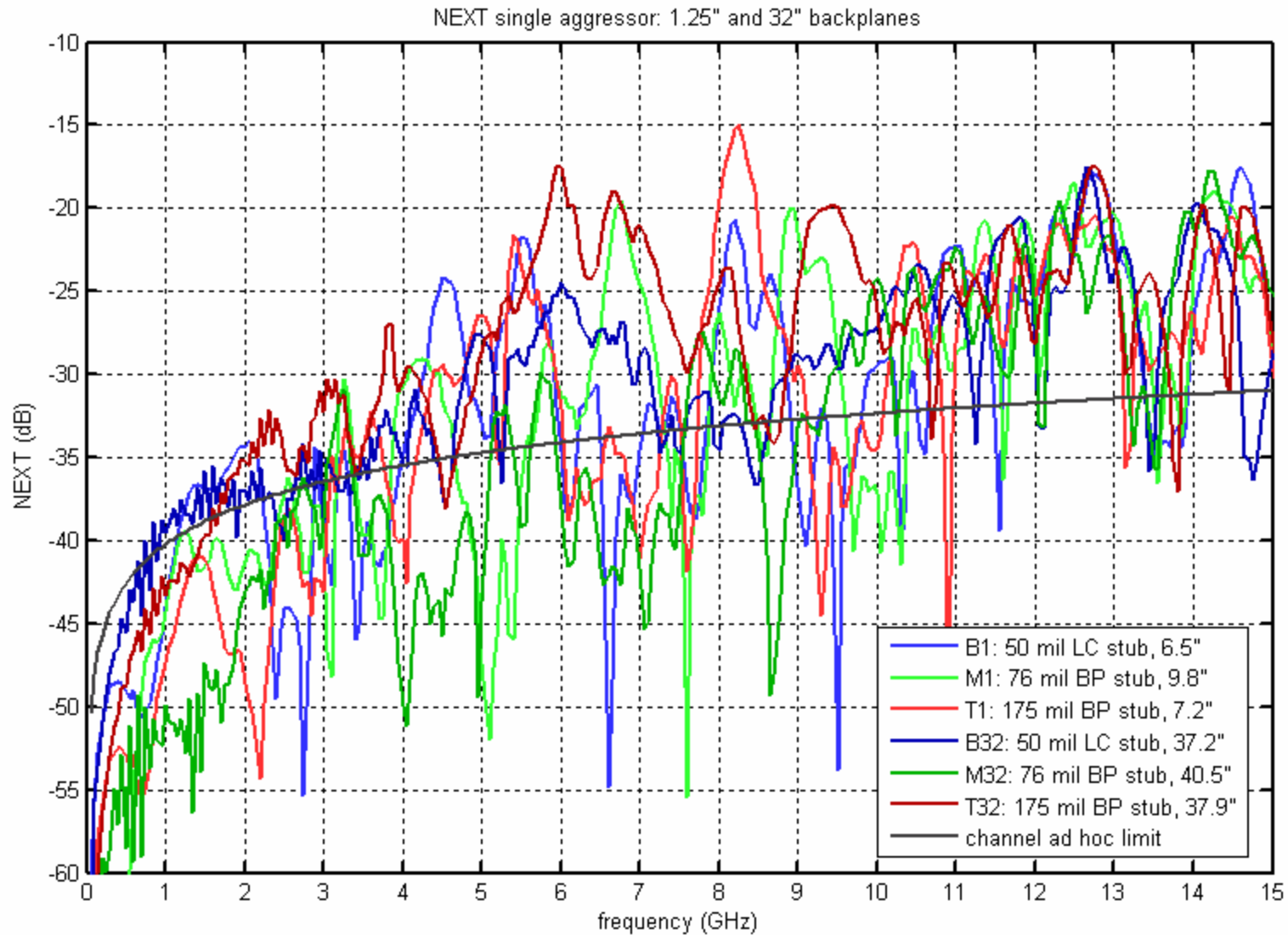
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Measurement: Return Loss



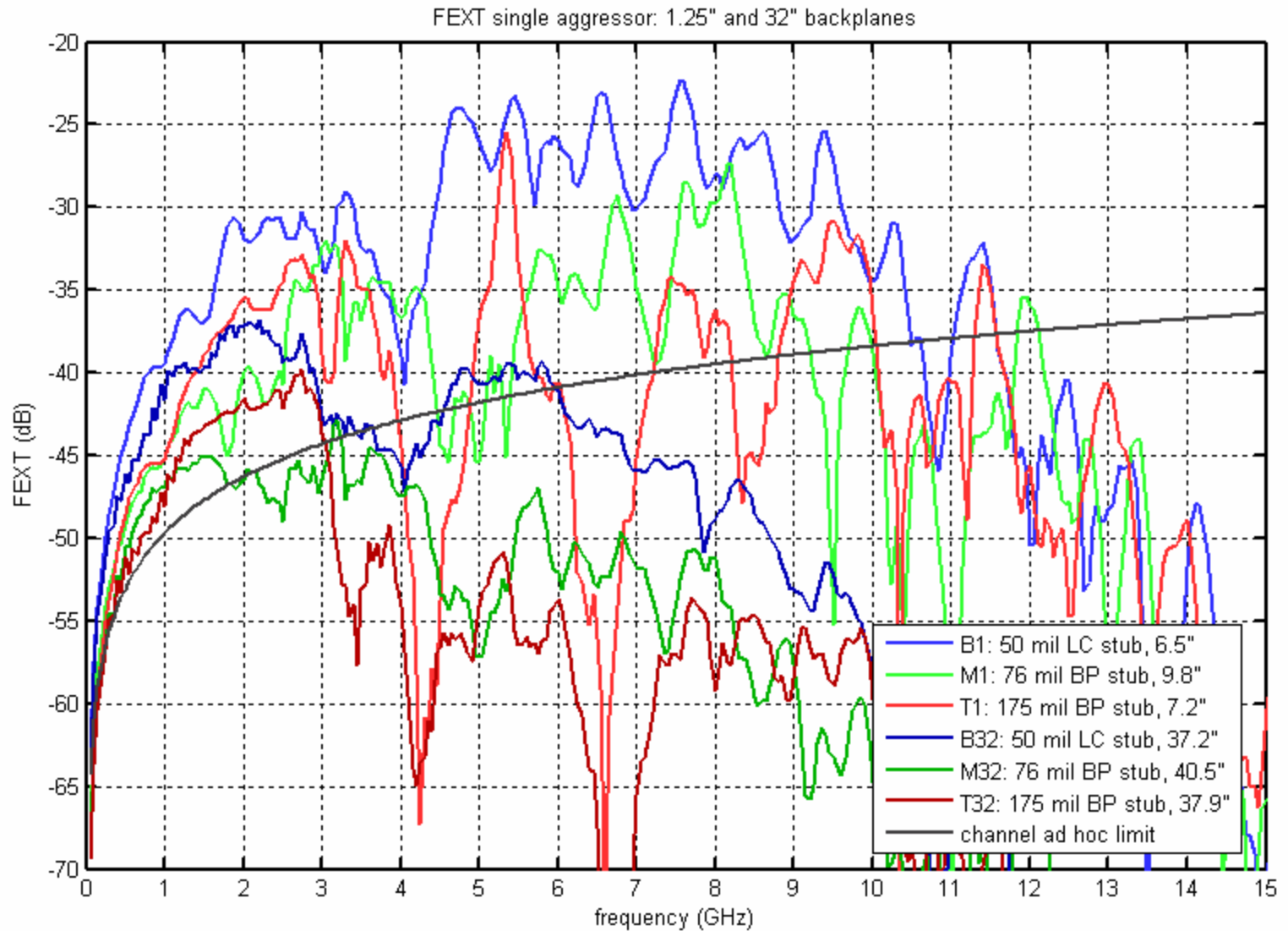
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Measurement: NEXT single aggressor



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Measurement: FEXT single aggressor



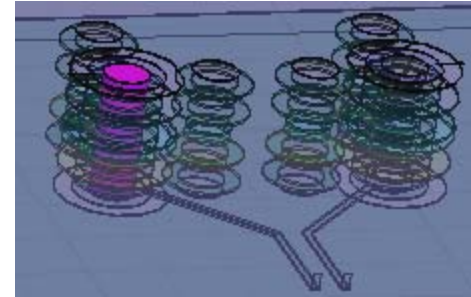
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Simulation-based channel models

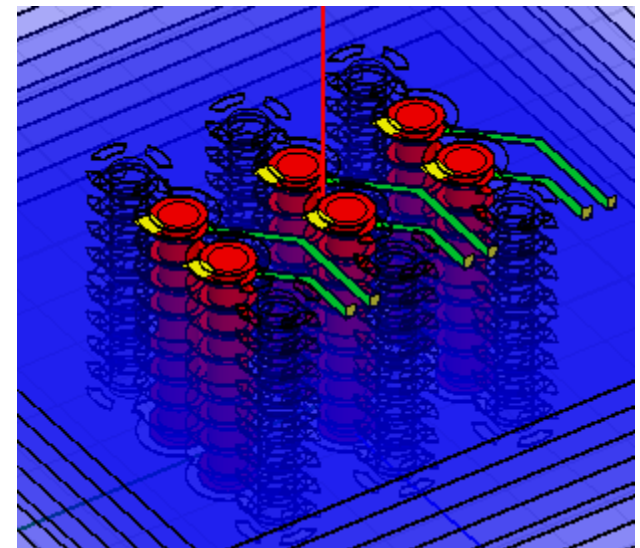
Models were generated component by component using physical geometry and material properties

- Vias, connector footprints: 3D Full-wave EM field solver models
- Stripline traces: Created with 2D transmission line field solver including dispersive losses (skin effect and dielectric loss).
- Connector: vendor model

Full channel correlation to representative channels
(peters_01_0704, kundu_01_0504)



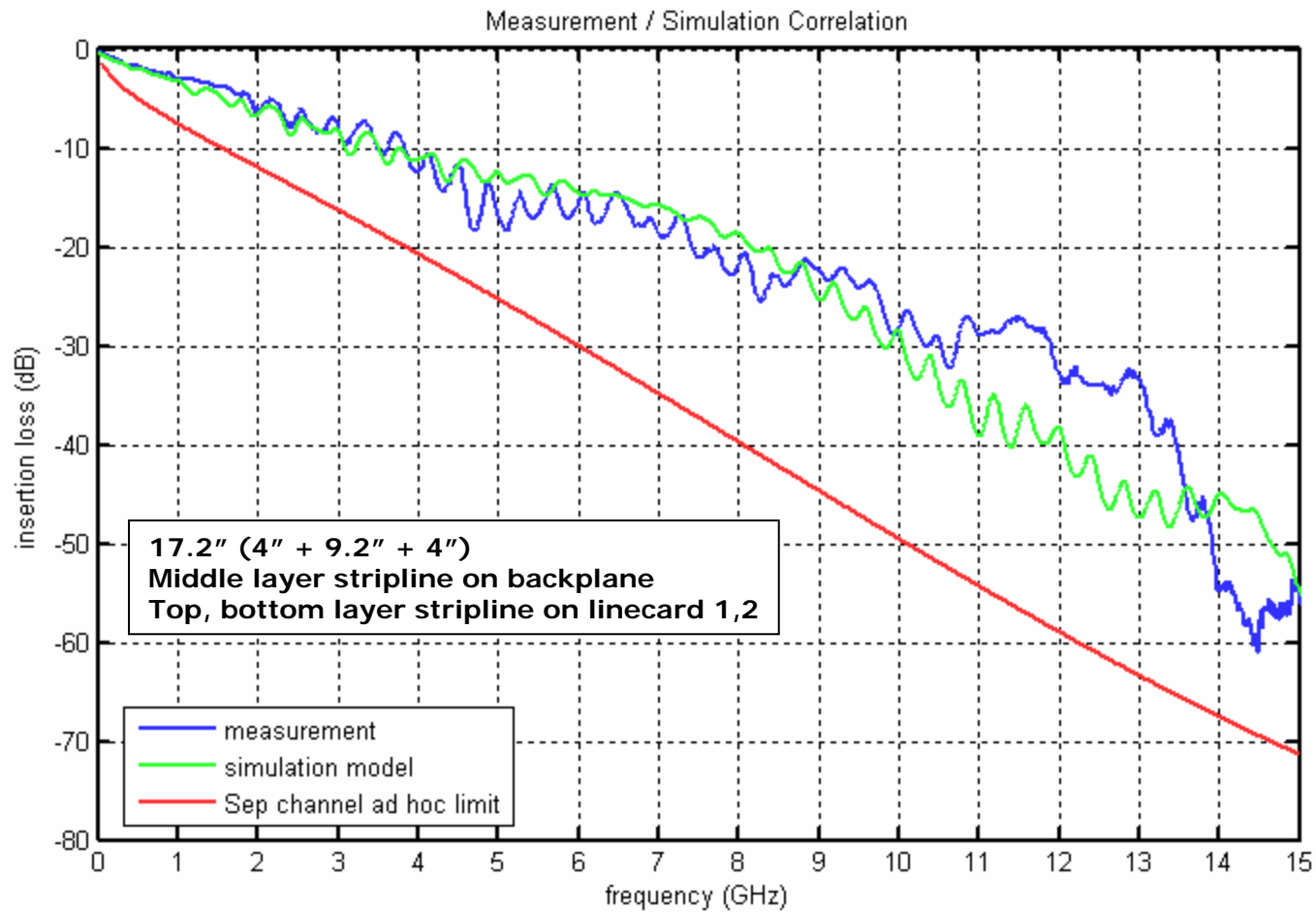
Linecard SMA footprint via model



Backplane HMZD footprint via model

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Representative IL correlation

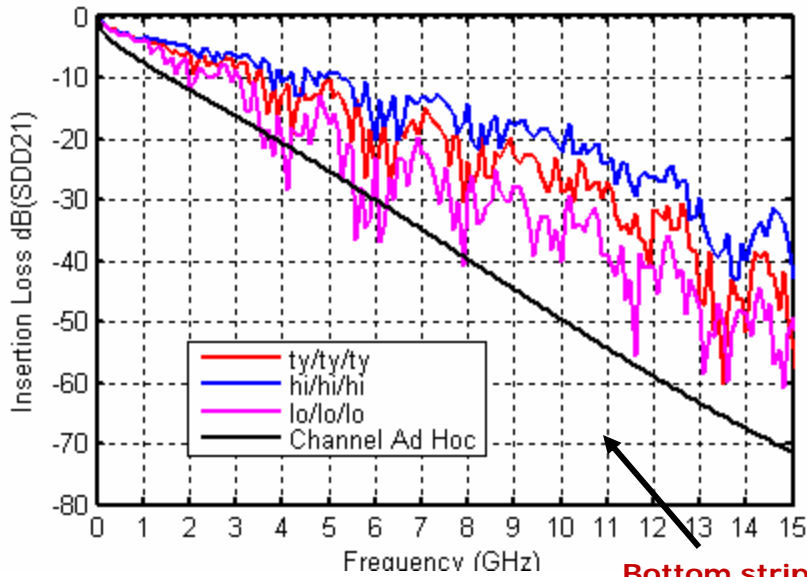


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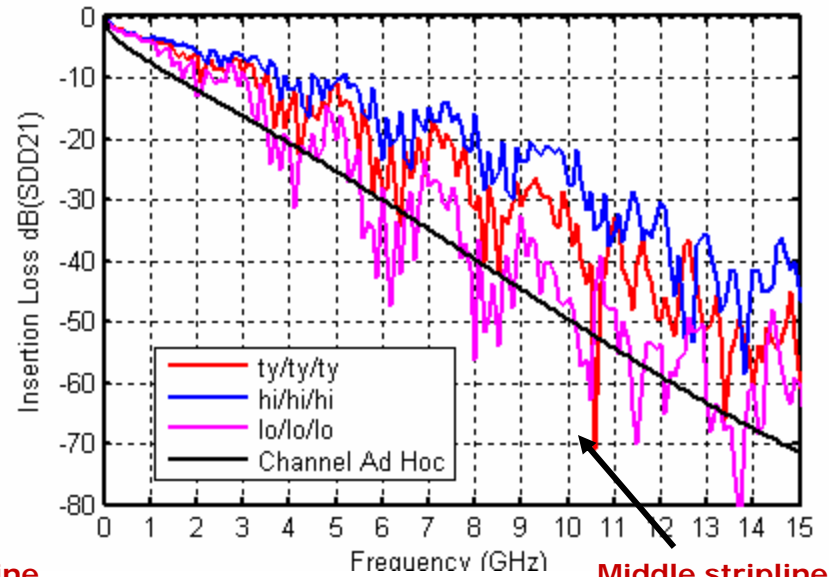
Configurable Scalable Channel Model

- A channel model is built from component models
- Can easily modify
 - Backplane, linecard impedance corner (10% variation)
 - Backplane, linecard trace length
 - Backplane, linecard routing layer (via stub)
 - Package model
- Each board's impedance corner is varied independently. Vias and traces on the same board are varied dependently
- Can be used for worst-case analysis
- Planned work
 - Correlate models for ATCA test system
 - Evaluate high Tg FR4, N4000-13, N4000-13 SI for linecards and backplane
 - Worst case analysis
 - Generate realistic test case models

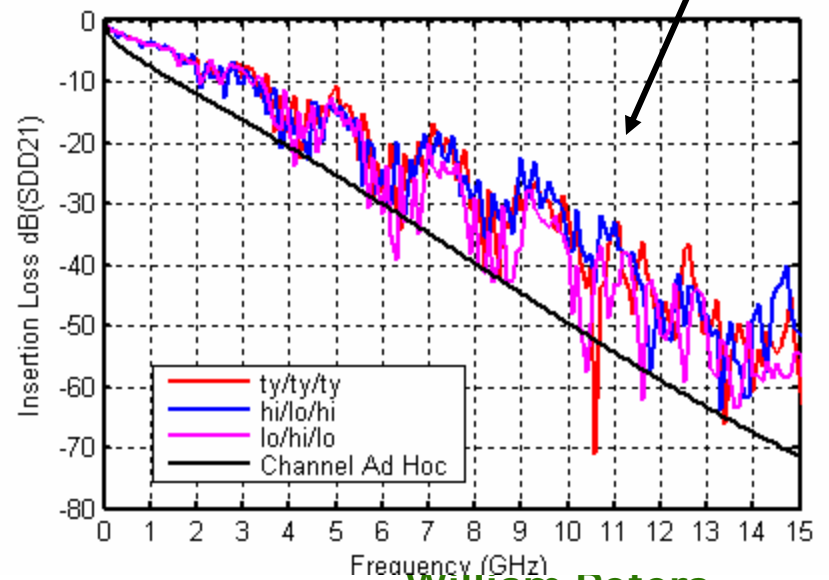
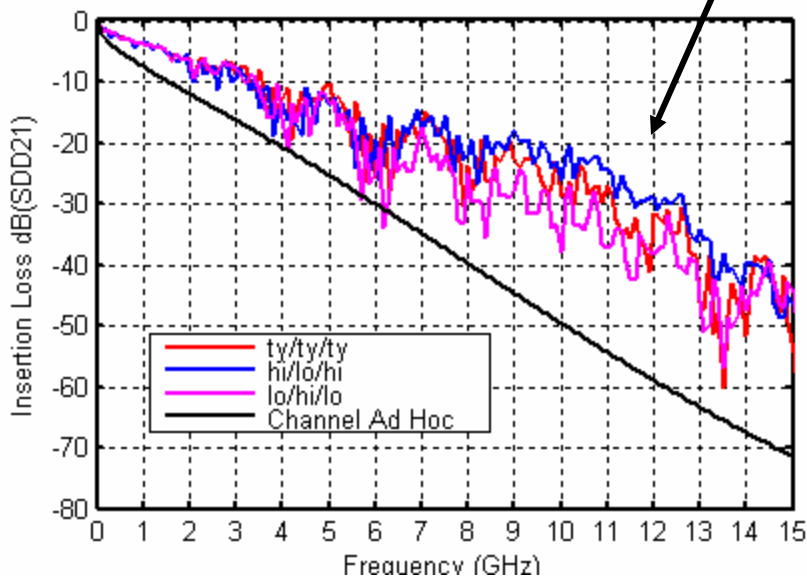
Simulated Insertion Loss 20" (5" + 10" + 5")



Bottom stripline



Middle stripline



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Conclusions

- Vias stubs of 50mils or greater have a major impact on channel insertion loss compliance to the ad hoc channel model. As stub size is increased, the resulting null increases in depth and moves down in frequency. Line card vias as well as backplane vias contribute to this problem.
- Many channels failed to meet the channel IL limit between 10 and 15 GHz.
- All channels studied have good margin between 0 and 2 GHz.
- Return Loss peaks at between -1.5 to -3 dB. Return loss peaks are correlated with nulls in the insertion loss.
- NEXT peaks between -15 to -20 dB.
- FEXT peaks between -22 to -43 dB.
- Environmental and manufacturing variation of the backplane and line card circuit boards causes an additional degradation of performance compared to test systems.

Proposals

PROPOSAL1 :

Modify the channel model to be specified up to only 10GHz or less (further specified by the channel ad hoc)

PROPOSAL2 :

Change channel model insertion loss limit from a hard limit to a soft limit. Deviations below the line will be allowed (further specified by the channel ad hoc)

PROPOSAL3 :

Recommend an informative point that board impedance varies up to 10%