Simulation-Based Models of High Volume Manufacturing (HVM) ATCA Systems

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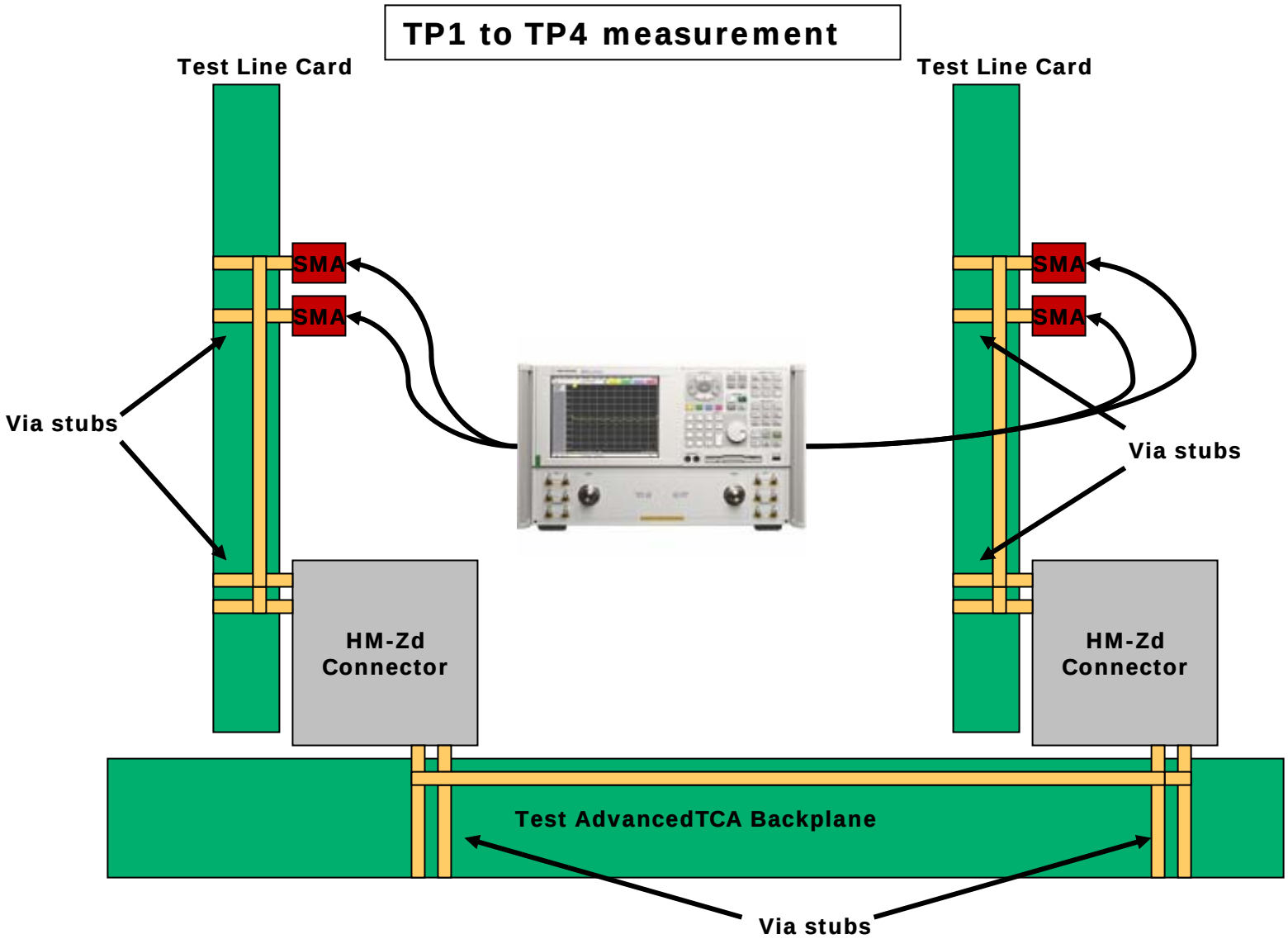
Agenda

- HVM systems introduction
- Modeling
- Correlation with measurements
- HVM models performance
- Conclusions

HVM Channel parameters

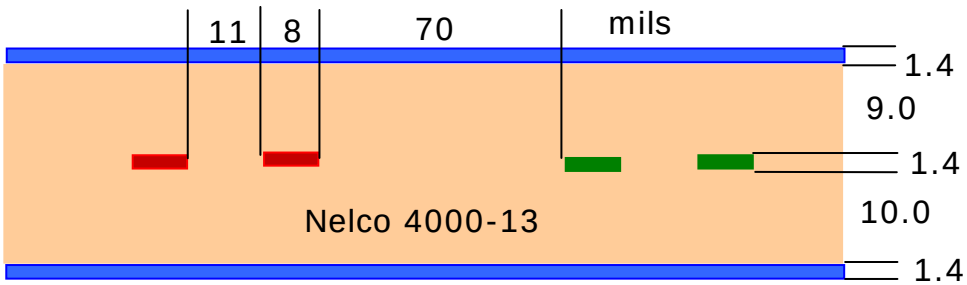
- Case 1: Enterprise
  - Material: Server N4000-6, BP N4000-6
  - Trace length (server + backplane + switch)
    - Min: 2” + 2” + 4”
    - Max: 8” + 12” + 10”
- Case 2: ATCA dual star (current focus)
  - Material: Server N4000-6, BP N4000-13
  - Trace length (server + backplane + switch)
    - Min: 2” + 2” + 4”
    - Max: 6” + 12” + 10”
- Case 3: ATCA small mesh
  - Material: IO N4000-6, BP N4000-6
  - Trace length (server + backplane + switch)
    - Min: 2” + 2” + 2”
    - Max: 8” + 10” + 8”

Measurement System Diagram



AdvancedTCA backplane system properties

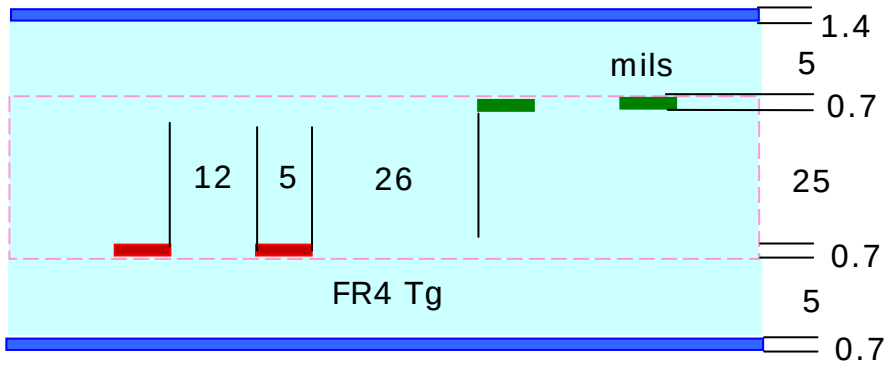
- AdvancedTCA backplane system
- Based on backplane from peters_01_0704, kundu_01_0504
- 8 stripline signal routing layers
- Total board thickness = 187 mils
- Material: Nelco4000-13
  - Core DK=3.69 (2*2116)
  - Prepreg DK=3.66 (2116,2113)
  - DF=0.01
- Nominal differential impedance = 100 Ω
- Trace length up to 12”



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%		

AdvancedTCA linecard properties

- 4 stripline signal routing layers
- Material:
  - Nelco 4000-6
    - DK=4.0
    - DF=0.022
- Nominal differential impedance = 100 Ω
- Trace length = 2-10”

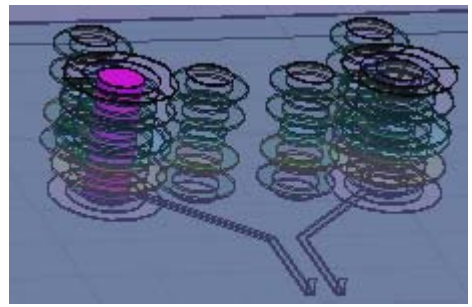


LC stackup			
	Thickness (mils)		Stub lengthh
Layer 1	1.4		
	5		
Layer 2	0.7	Layer 2	76.9
	25		
Layer 3	0.7	Layer 3	51.2
	5		
Layer 4	0.7		
	7		
Layer 5	0.7		
	5		
Layer 6	0.7	Layer 6	32.1
	25		
Layer 7	0.7	Layer 7	6.4
	5		
Layer 8	1.4		
	84		

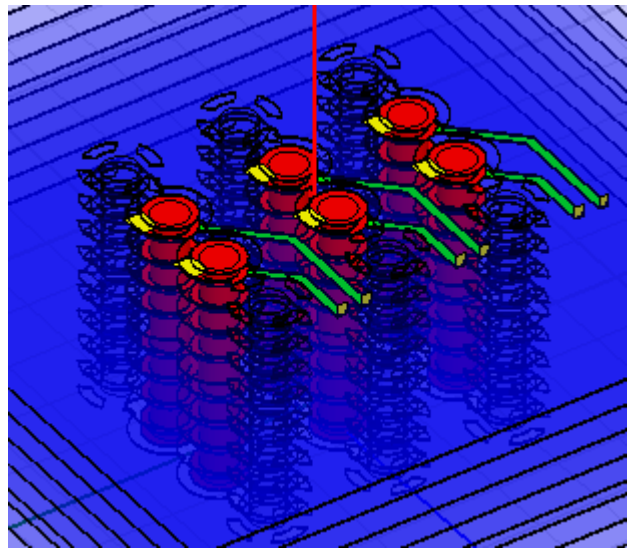
Simulation-based channel models

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 provided s-parameter model**



Linecard SMA footprint via model



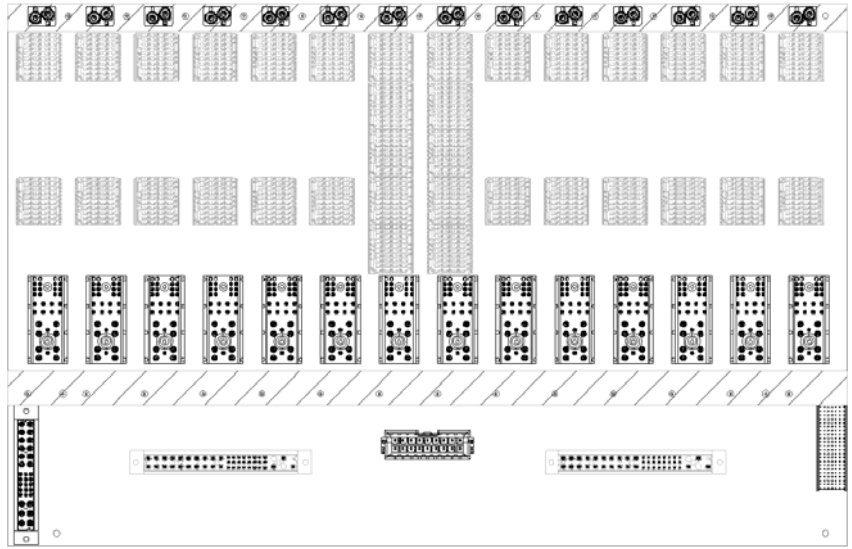
Backplane HMZD footprint via model

Configurable Scalable Channel Model

- A channel model is built from component models
- Can easily modify
  - Backplane, linecard impedance corner
  - Backplane, linecard trace length
  - Backplane, linecard routing layer (via stub)
  - Package model variations
  - DC Block
- 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

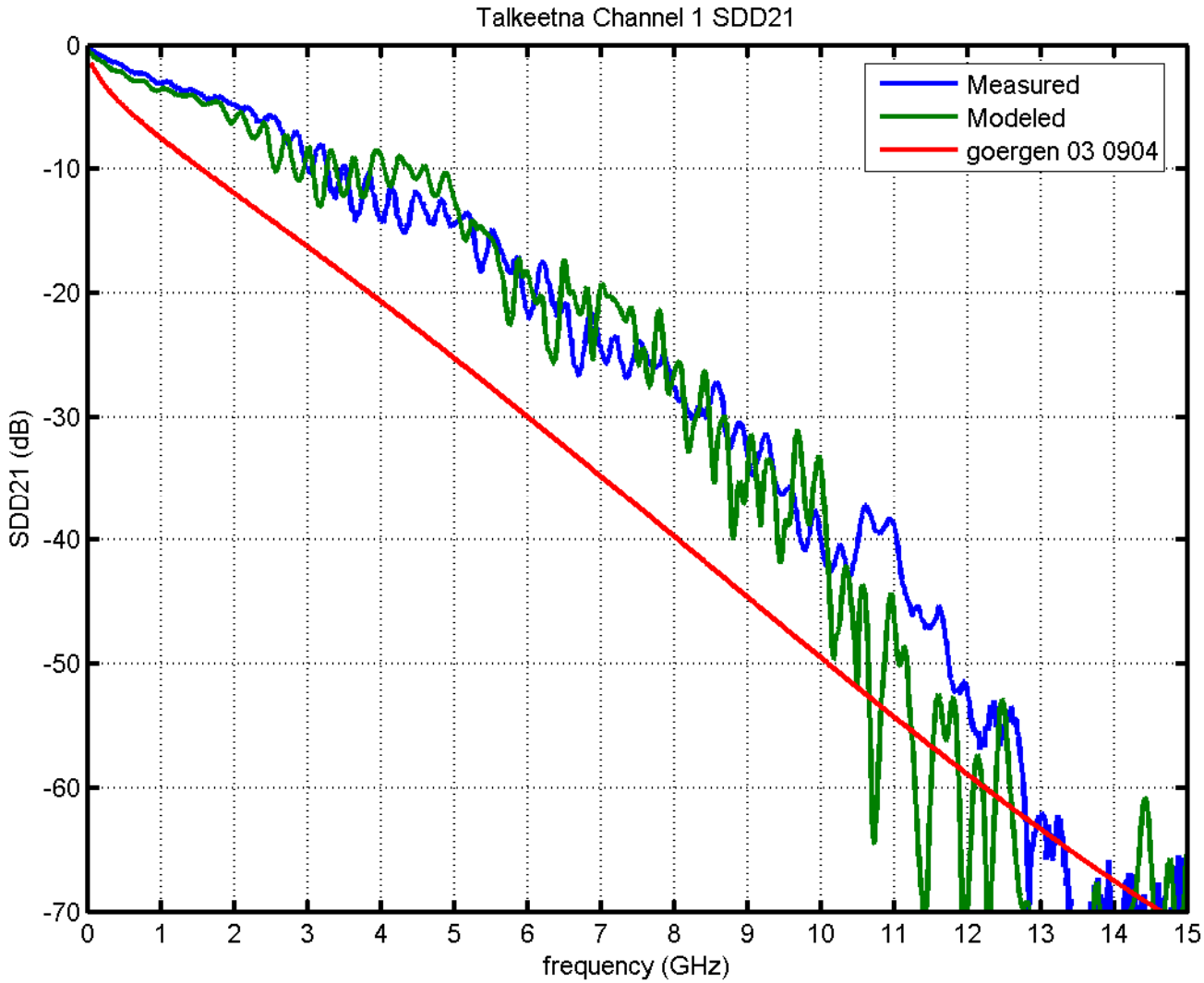
ATCA model correlation system properties

- Dual star ATCA with switch blades in the center
- Max trace length on the backplane <10”
- Correlation
  - SDD21
  - SDD11,SDD22
  - Pulse response (ideal 100ps pulse)

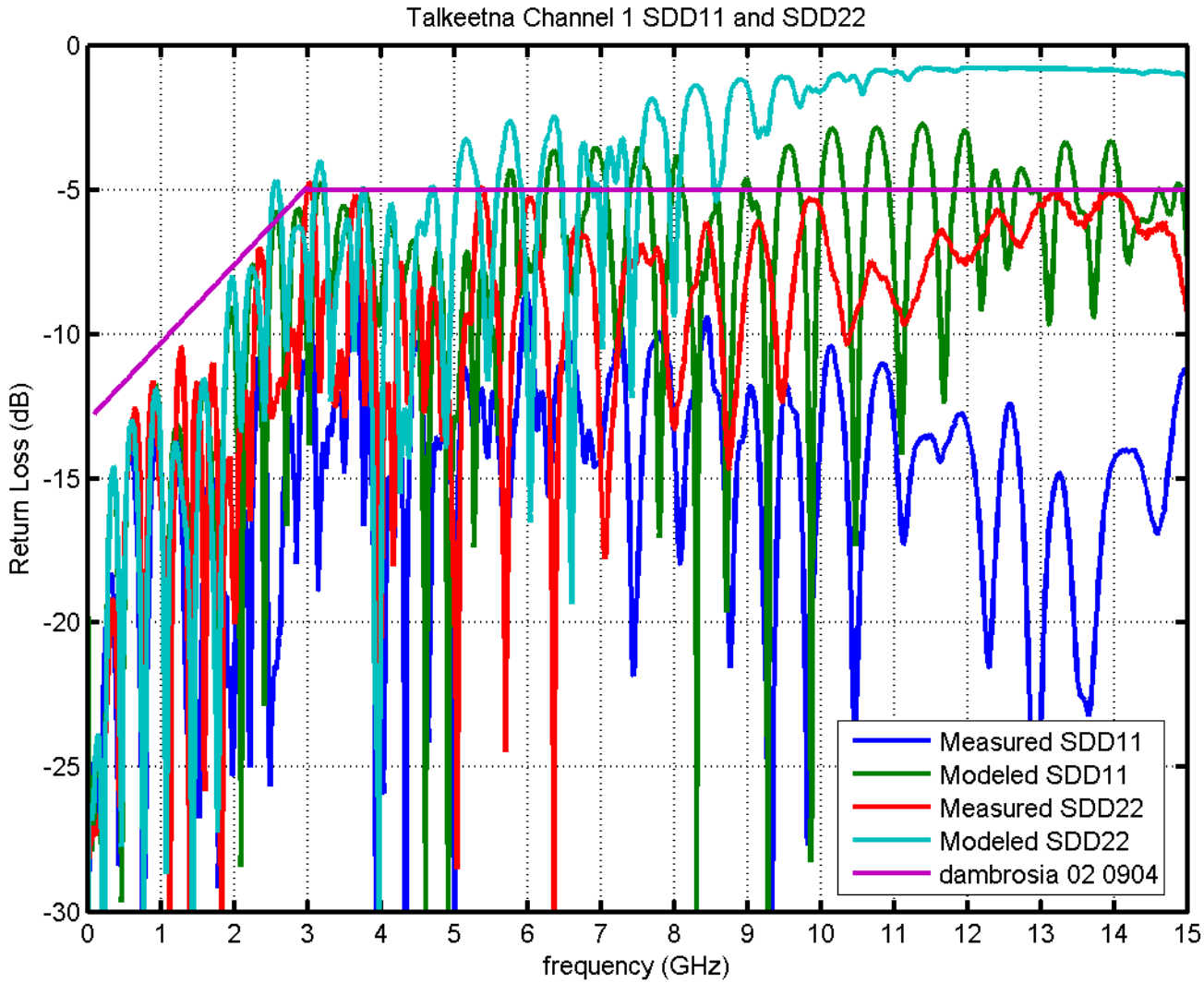


	riser card 1			backplane			riser card 2				
channel	mils	layer	materi	mils	layer	materia	mils	layer	materi	HMZD1	HMZD2
1	4005	7	FR4	9202	11	N4000-13	3999	2	FR4	AB	CD
2	3995	2	FR4	9556	13	N4000-13	4004	7	FR4	CD	AB
3	4008	7	FR4	9203	11	N4000-13	4005	2	FR4	AB	CD
4	4010	2	FR4	9556	13	N4000-13	3987	7	FR4	CD	AB
5	4010	3	FR4	9201	15	N4000-13	4000	6	FR4	EF	GH
6	3993	6	FR4	9556	17	N4000-13	4004	3	FR4	GH	EF
7	4046	6	FR4	9201	15	N4000-13	4003	6	FR4	EF	GH
8	3989	6	FR4	9556	17	N4000-13	3987	3	FR4	GH	EF
9	4019	7	FR4	7791	17	N4000-13	4039	3	FR4	AB	CD
10	3968	2	FR4	8141	15	N4000-13	4040	2	FR4	CD	AB
11	4025	6	FR4	7788	13	N4000-13	4012	7	FR4	EF	GH
12	4016	3	FR4	8145	11	N4000-13	4009	6	FR4	GH	EF

Channel 1 – Insertion loss

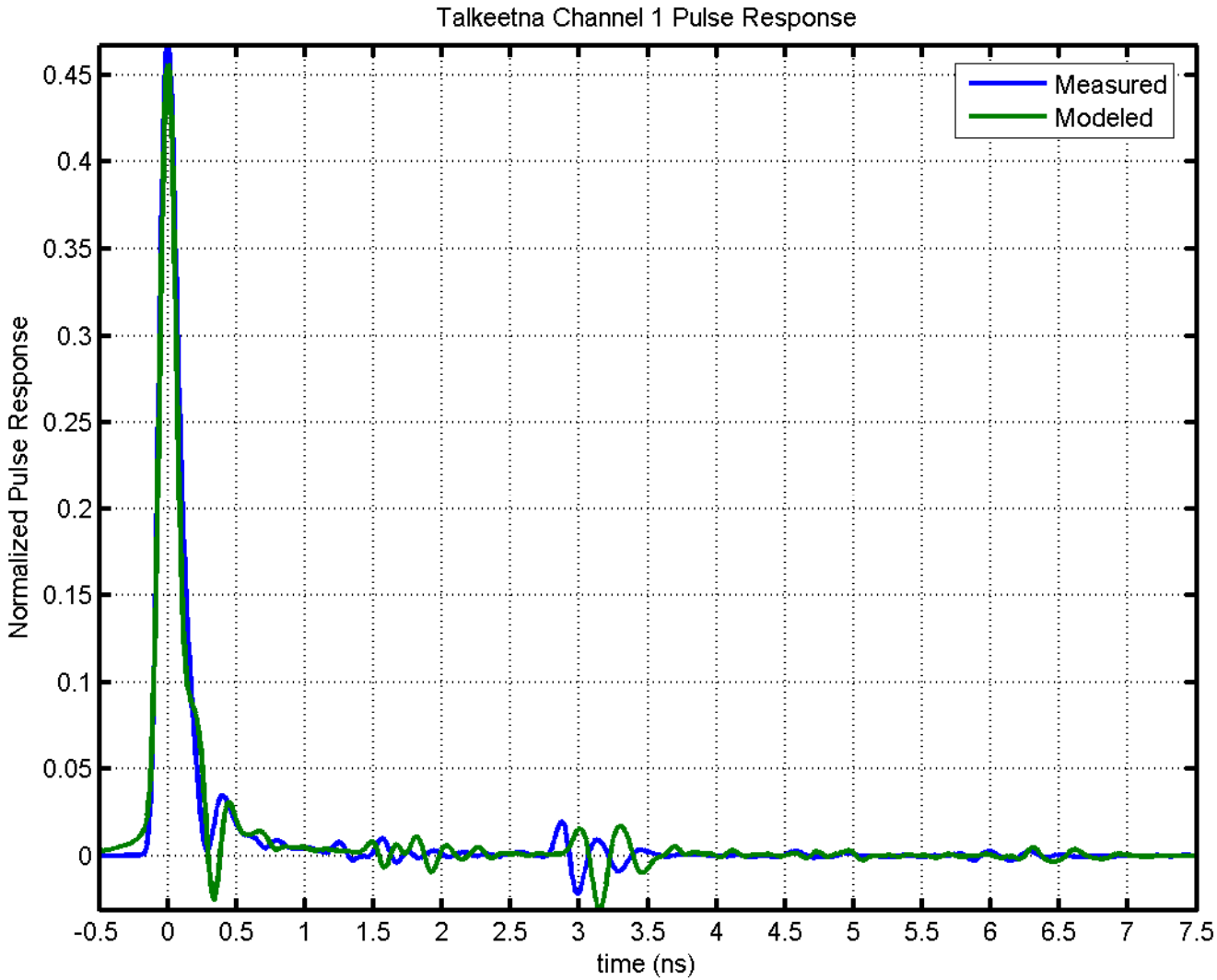


Channel 1 – Return loss

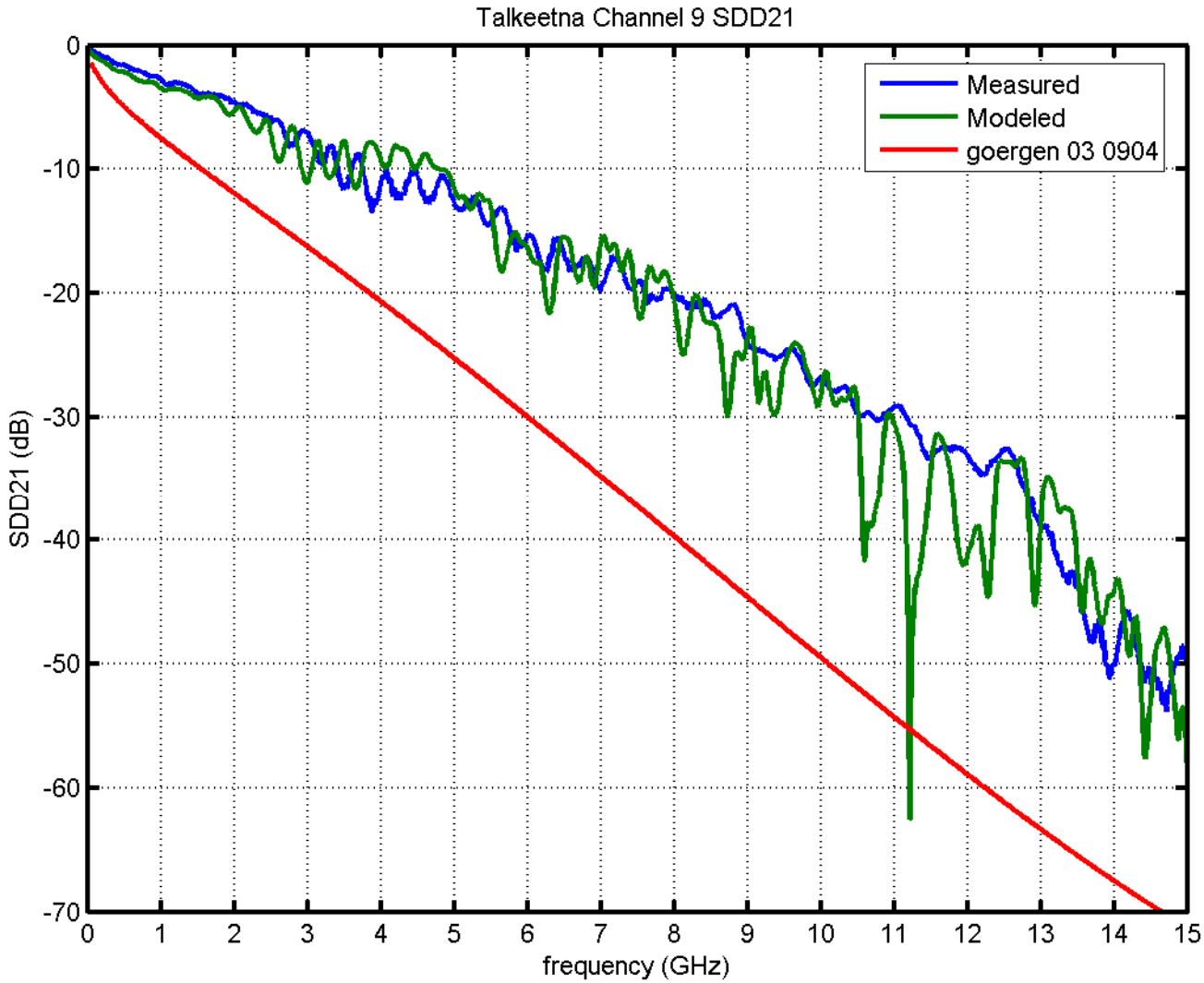


Return loss matches adequately up to 5-6 GHz

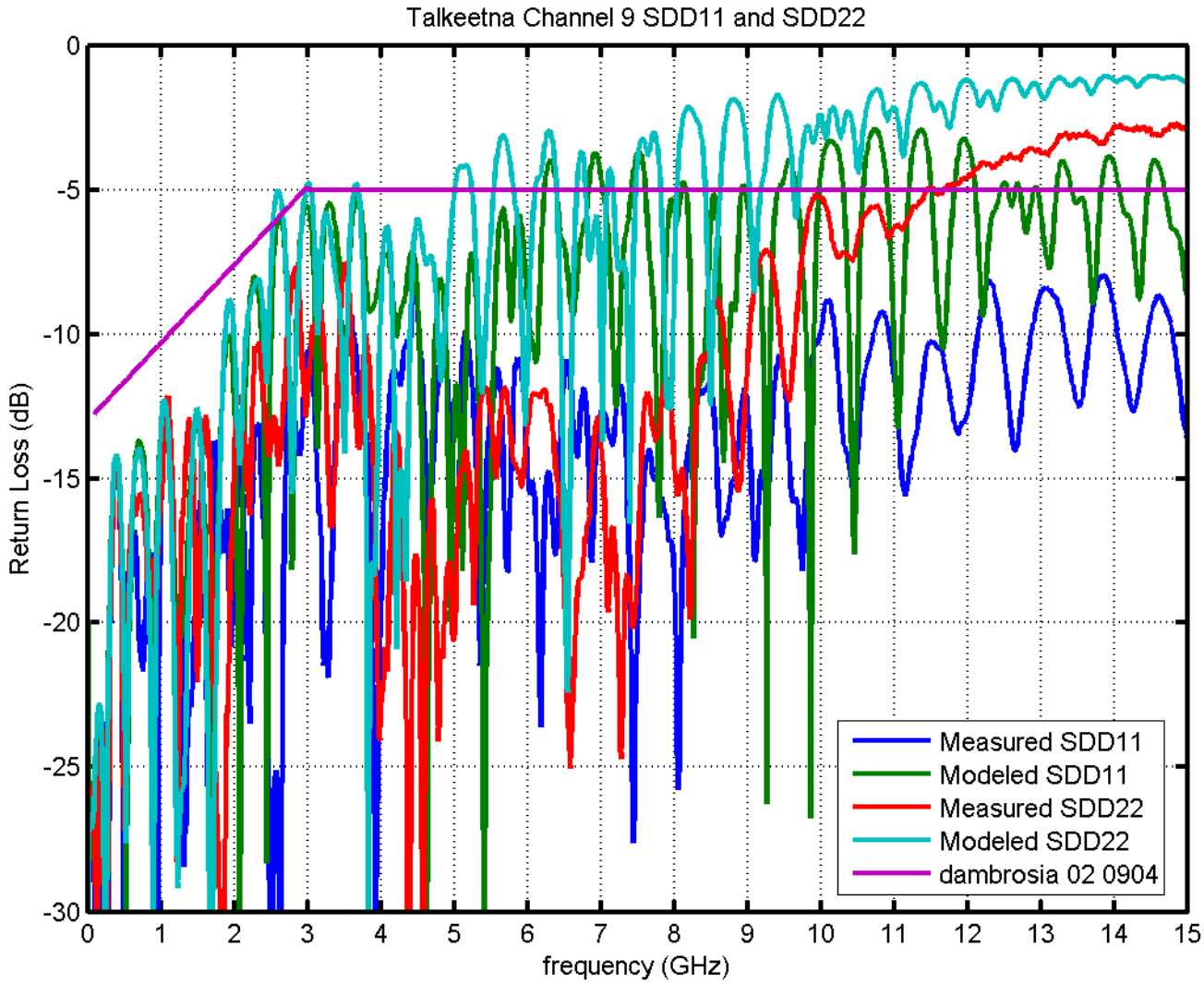
Channel 1 – Pulse Response



Channel 9 – Insertion loss

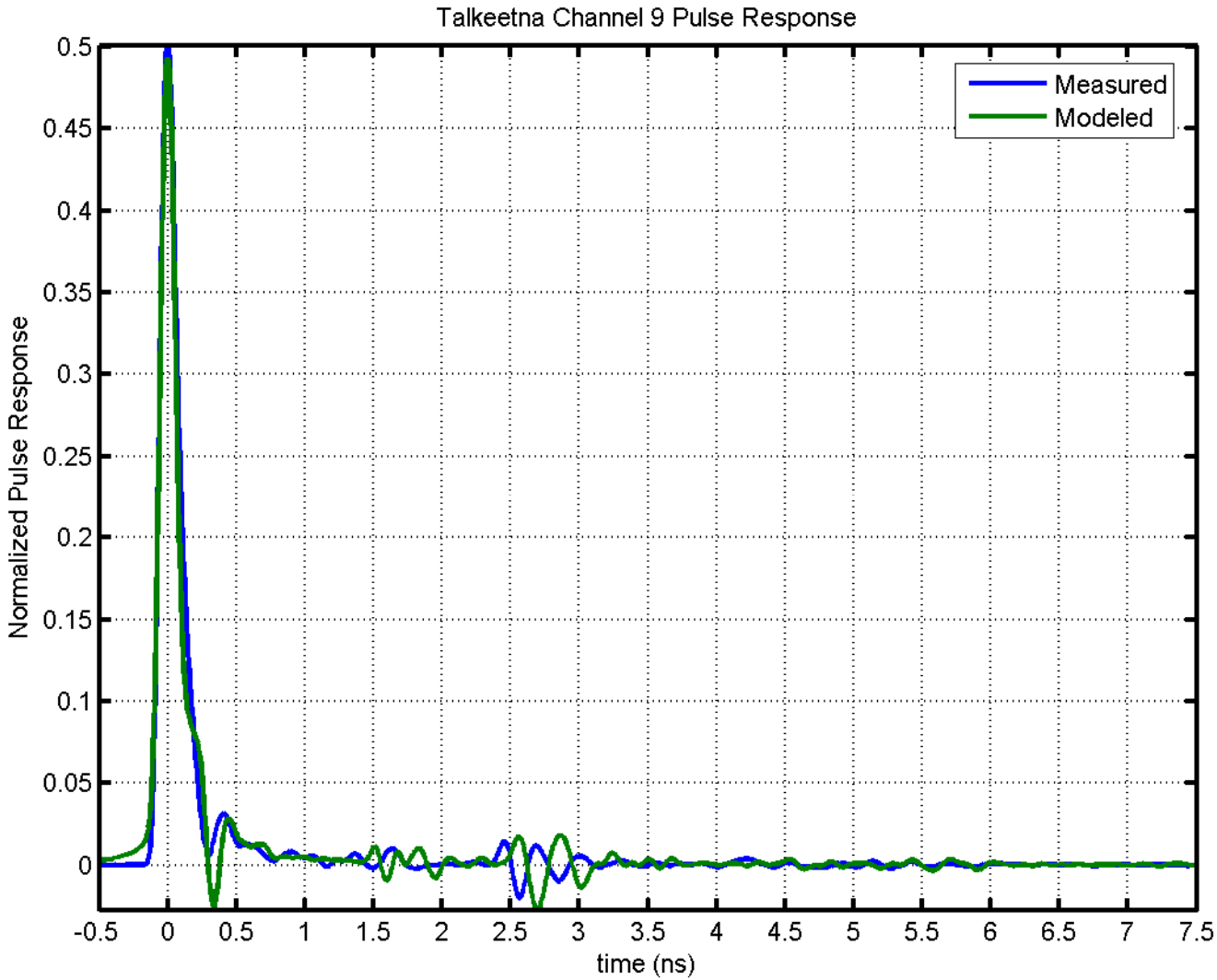


Channel 9 – Return loss

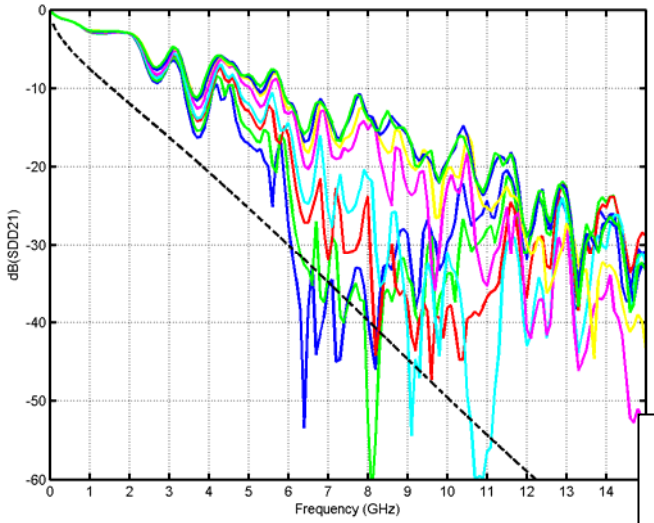


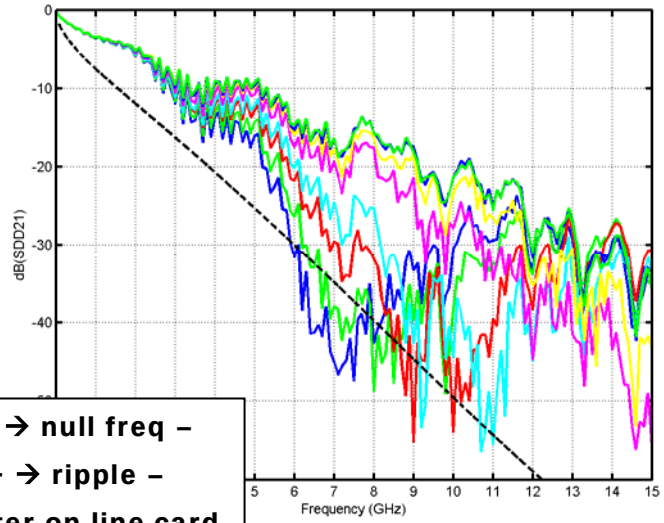
Modeled return loss is pessimistic

Channel 9 – Pulse Response



Backplane stub effect: SDD21

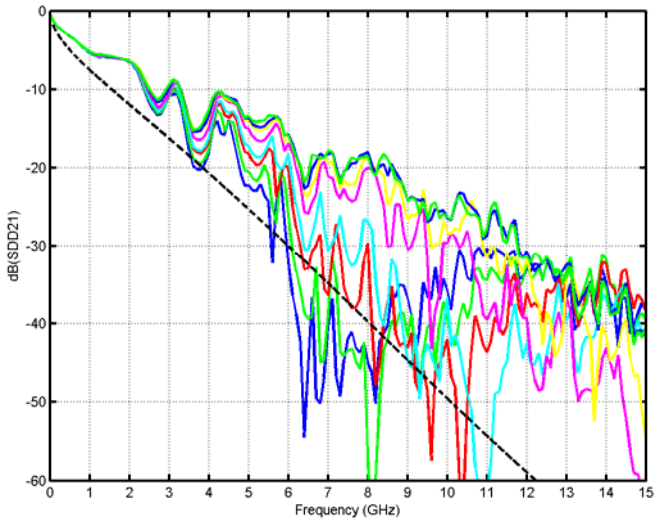


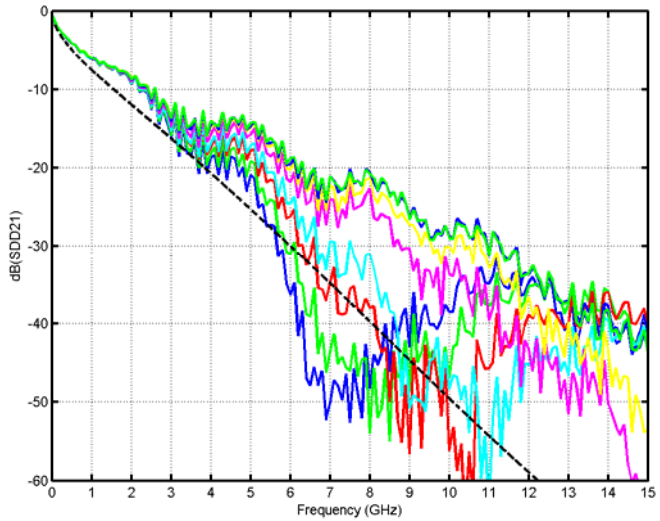


BP stub + → null freq –

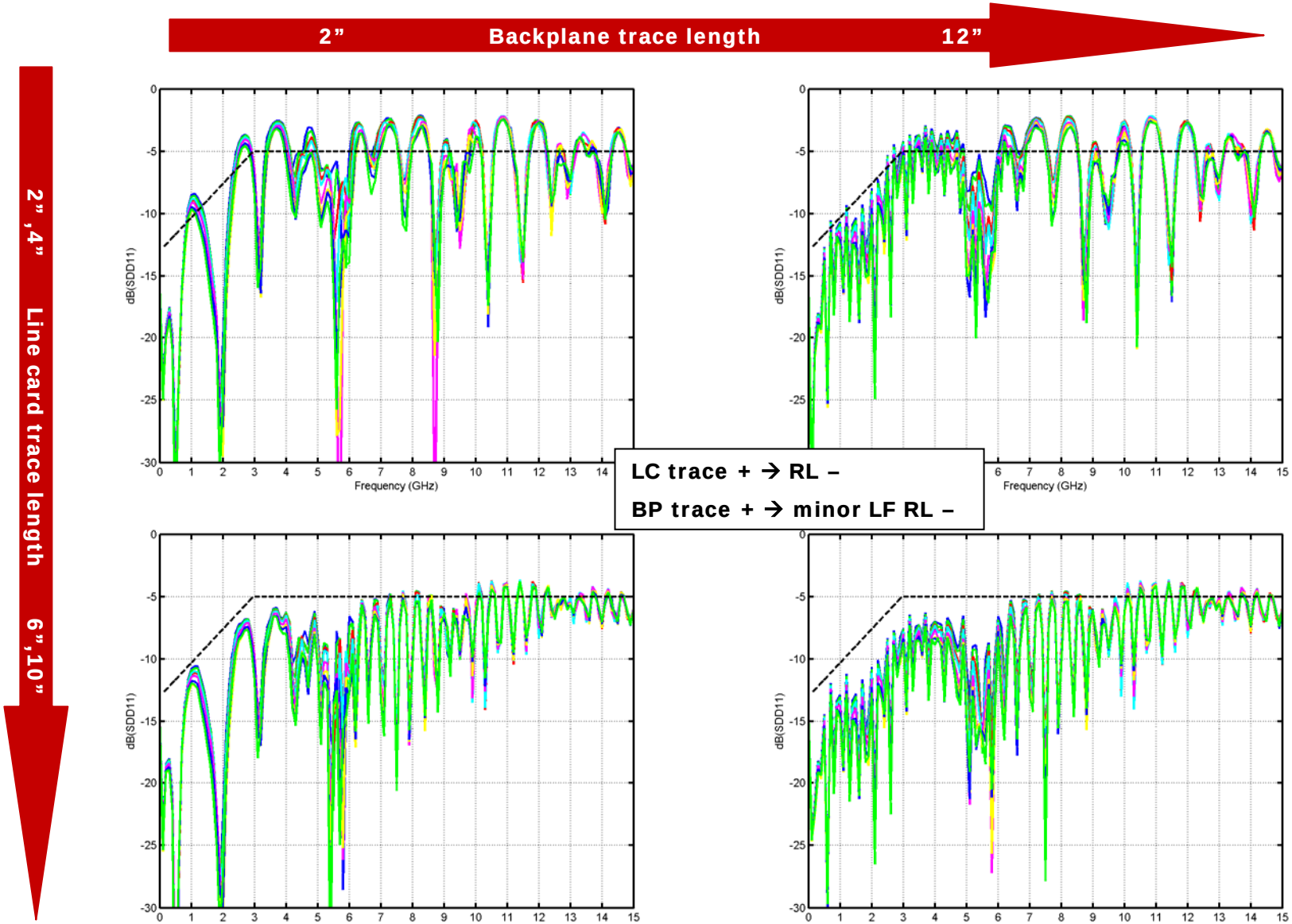
BP trace + → ripple –

Loss greater on line card

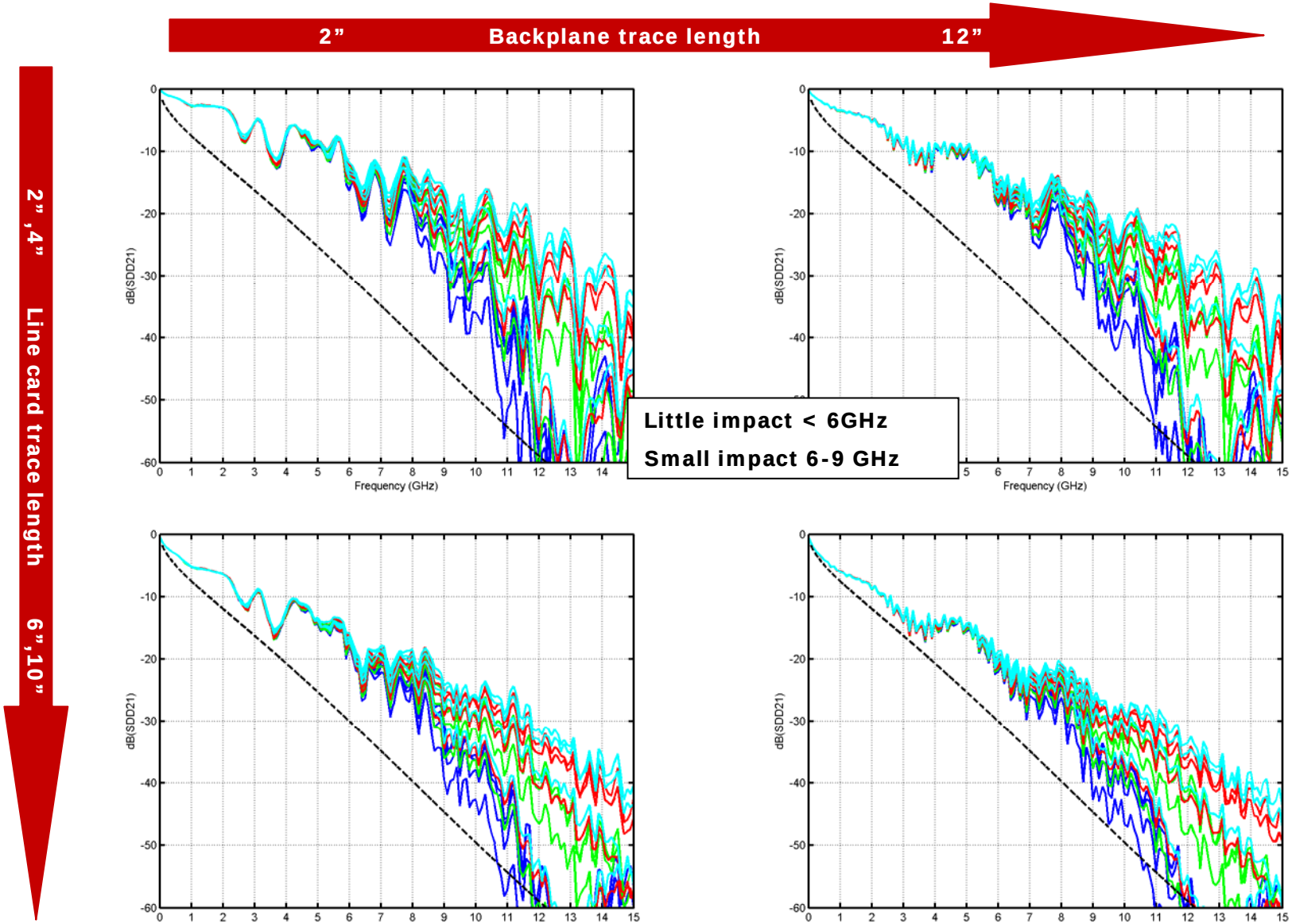




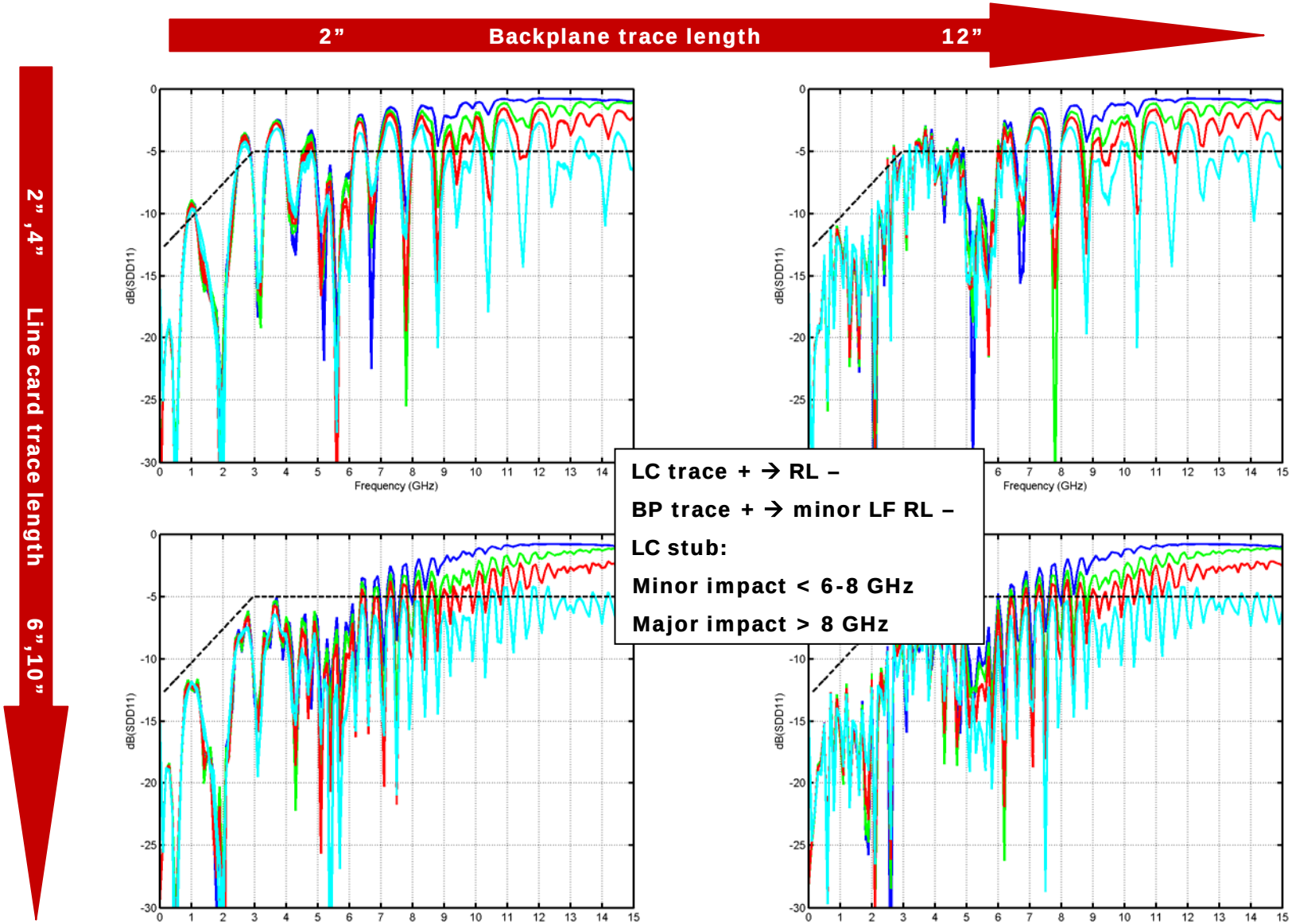
Backplane stub effect: SDD11



Linecard stub effect: SDD21



Linecard stub effect: SDD11



HVM Model Result Conclusions

Return Loss Factors

- Minor effects from backplane layer and trace length up to 6GHz
- Mostly dominated by near end line card
  - Inversely related to line card trace length, major impact
  - Minor impacts from line card stubs below approx 8GHz, major impacts above

Insertion Loss Factors

- Major impact from backplane via stubs: longer stubs push null frequency lower. Minor impact < 3GHz
- Short traces on the backplane lead to increase IL ripple
- Line card loss impacts are greater than that of the backplane
- Line card stubs have minor impact below 8GHz, significant impact above 8GHz

Conclusions

Scalable Model

- Models based on the physical parameters of a dual star ATCA system have been generated.
- The simulated models have been well correlated to measured VNA data.
- Results can be used as basis for the development of a channel specification
- Additional models can be generated as needed