Improved HVM ATCA Models

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Outline

- Problem Statement
- ATCA Channel Improvements
- Scalable ATCA Model
- Improved Channels
- Conclusions / Next Steps

Problem Statement

- Intel ATCA channels (peters_01_0904) have been shown to be difficult to solve (spagna_01_1104, abler_01_0105, anderson_01_0105, altmann_02_0105).
- The channels do not fully represent a high-volume manufacturing (HVM) implementation of an ATCA system.
- Design trade-offs and improvements are possible within a HVM environment to improve the overall performance.
- Goal: improve the performance of the models within the bounds of HVM design practices.

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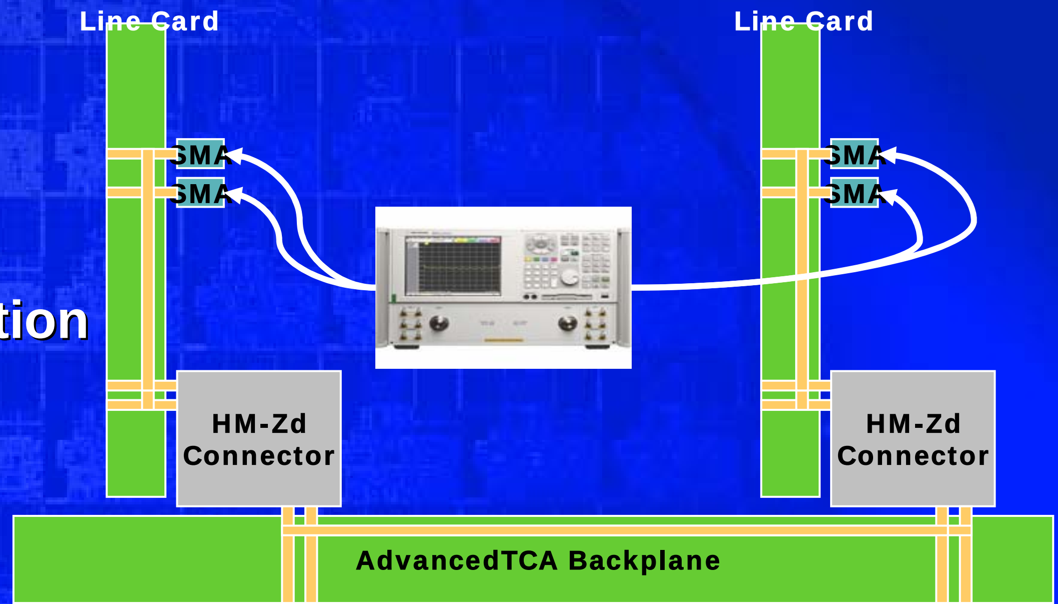
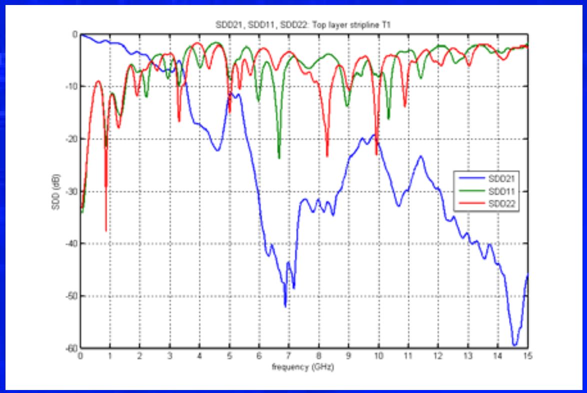
Intel Channel Models

- Channels described in peters_01_0904
- These measured channels represent the TP1-TP4 portion of the overall system interconnect.
- Each channel includes coupling for 2 FEXT aggressors and 6 NEXT aggressors.
- The original channel set of 18 channels has been reduced to 8 channels (T1, T12, T20, M1, M20, B1, B12, B20) for consideration.



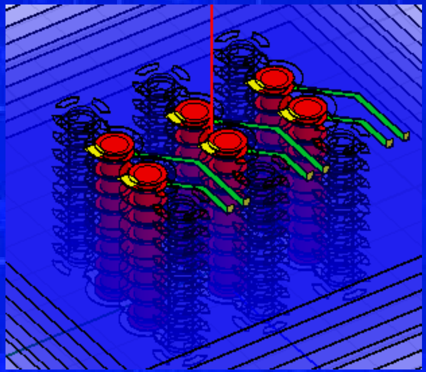
Measurement Setup



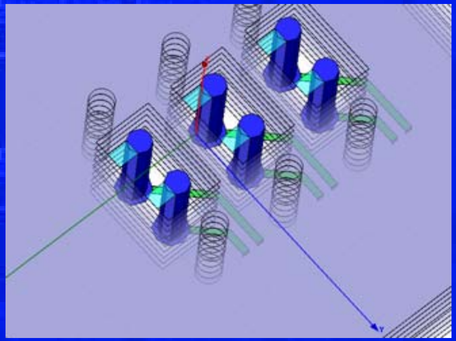
T1 Channel THRU Measurement

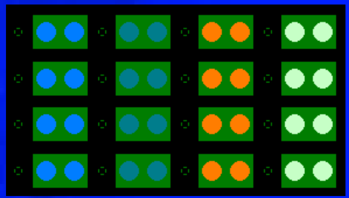
Improved Via / Pad Design

- The peters_01_0904 channels use default manufacturing techniques for via design.
- The improved design minimizes capacitance and stub effects by using a rectangular anti-pad and eliminating non-essential pads.
- The improved design is compatible with HVM design practices and has been implemented in Intel's production backplane as well as backplanes from other vendors.



Peters_01_0904 channels via design





Improved via design

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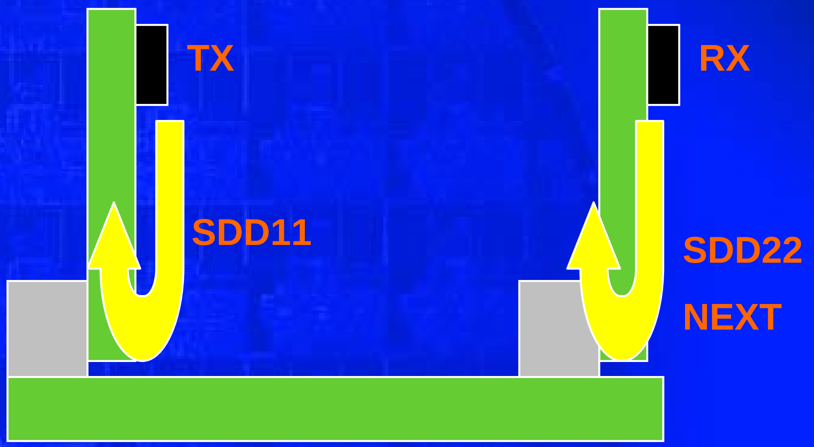
Improved Line Card Design

- In order to follow HVM design practices, low-cost FR-4 is used as the line card material instead of Nelco4000-13.
  - Increases overall system loss
  - Increases attenuation between TX/RX and the HM-Zd connector
- In order to reduce the overall variability of channels to be supported and ensure a minimum attenuation on the line card, a minimum trace length is proposed.
  - Increases overall system loss
  - Increases attenuation between TX/RX and the HM-Zd connector



- Attenuation between the TX/RX and the HM-Zd connector reduces the impact of reflections (SDD11, SDD22) and coupling (NEXT) coming back from the connector.
- Increased overall system loss will decrease the FEXT magnitude as well as the thru (SDD21) response.

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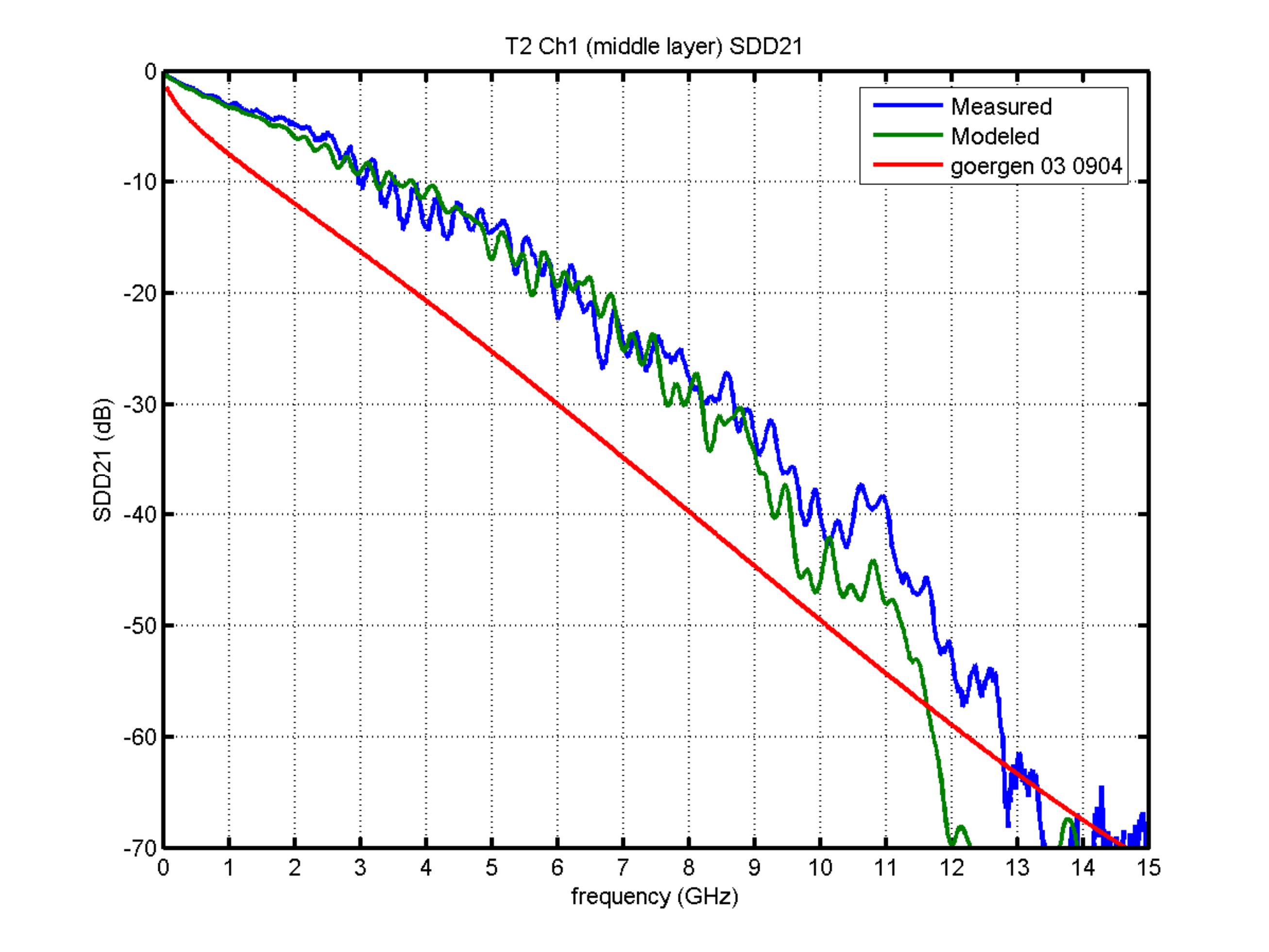
Scalable Model

- The performance of improved models that conform to HVM design practices can be estimated by using a scalable model of HVM ATCA systems.
- A scalable model based on Intel's production ATCA system has been introduced previously to the task force (peters_01_0105).
  - Includes improved via/pad design
  - Includes low cost FR-4 for the line cards
- The scalable model has been updated
  - Updated channel and component models
  - Causality fixed
- Measurement correlation updated
  - SDD21, SDD11, SDD22 and pulse response (ideal 100ps pulse, cursors aligned)

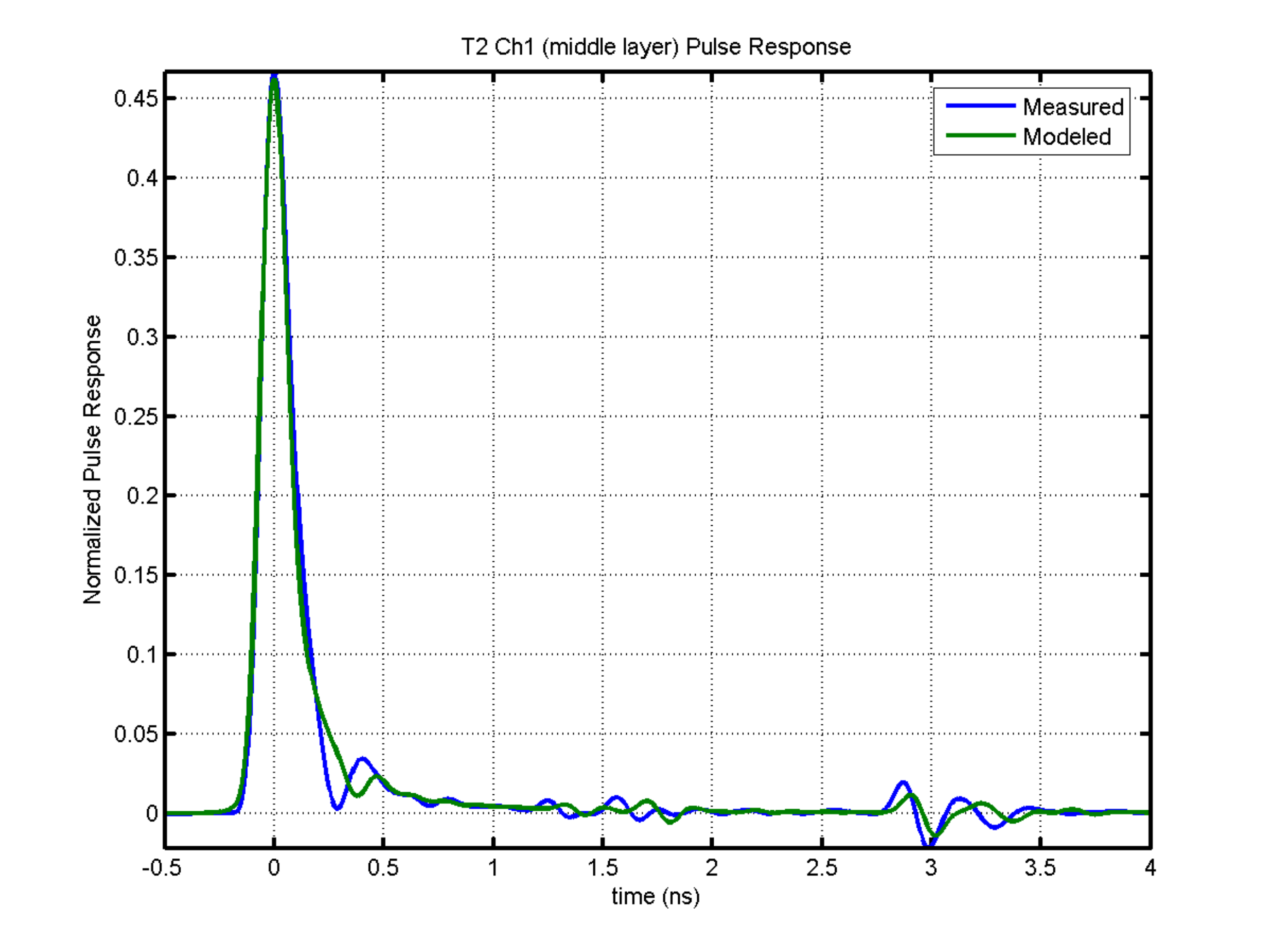
Measurement Correlation Channels

	Middle Layer Ch1	Bottom Layer Ch9
Line card 1 trace length	4”	4”
Line card 1 routing layer	7 bottom	7 bottom
Backplane trace length	9.2”	7.8”
Backplane routing layer	11 middle (76 mil stub)	17 bottom
Line card 1 trace length	4”	4”
Line card 1 routing layer	2 top	3 middle
HM-Zd path	AB CD	AB CD

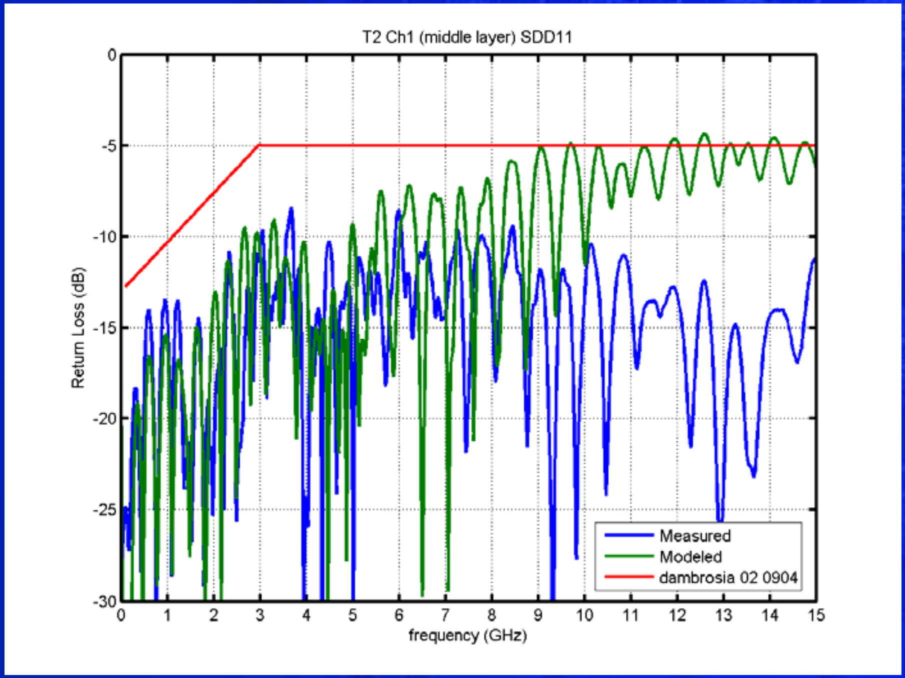
Scalable Model SDD21 Correlation to Measurements (Middle Layer)

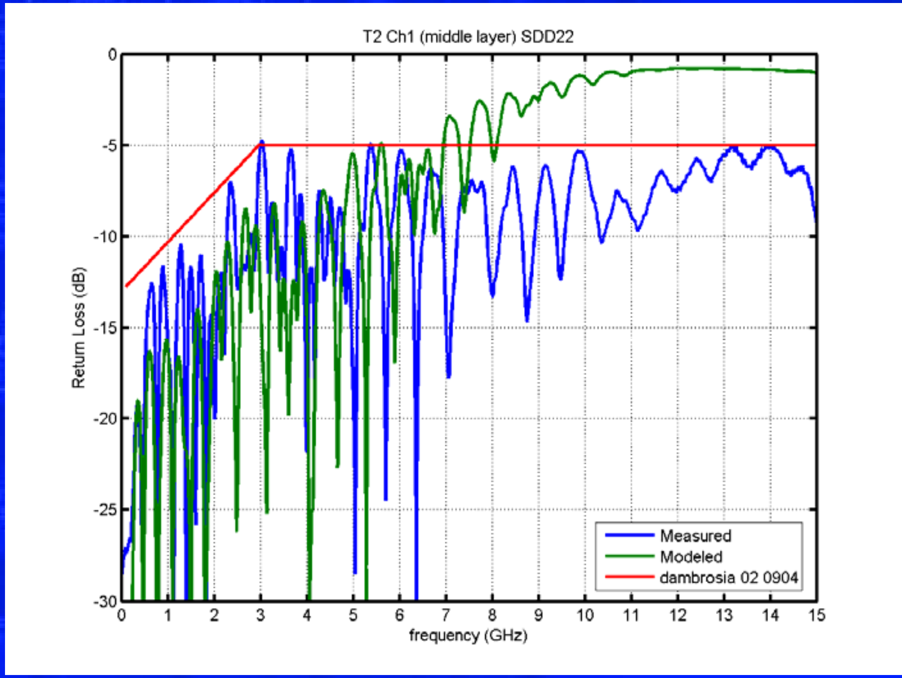


Scalable Model Pulse Response Correlation to Measurements (Middle Layer)

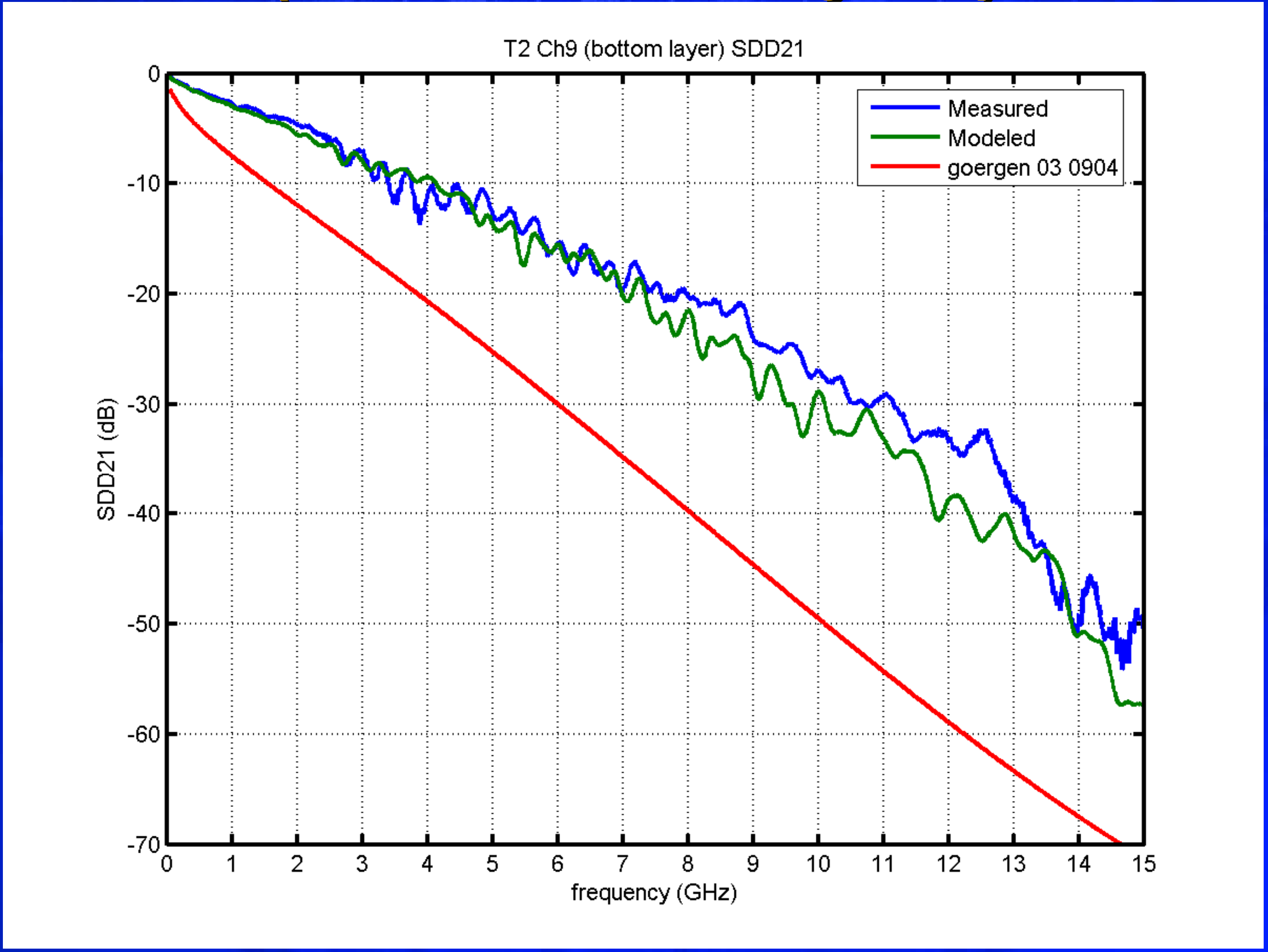


Scalable Model Return Loss Correlation to Measurements (Middle Layer)

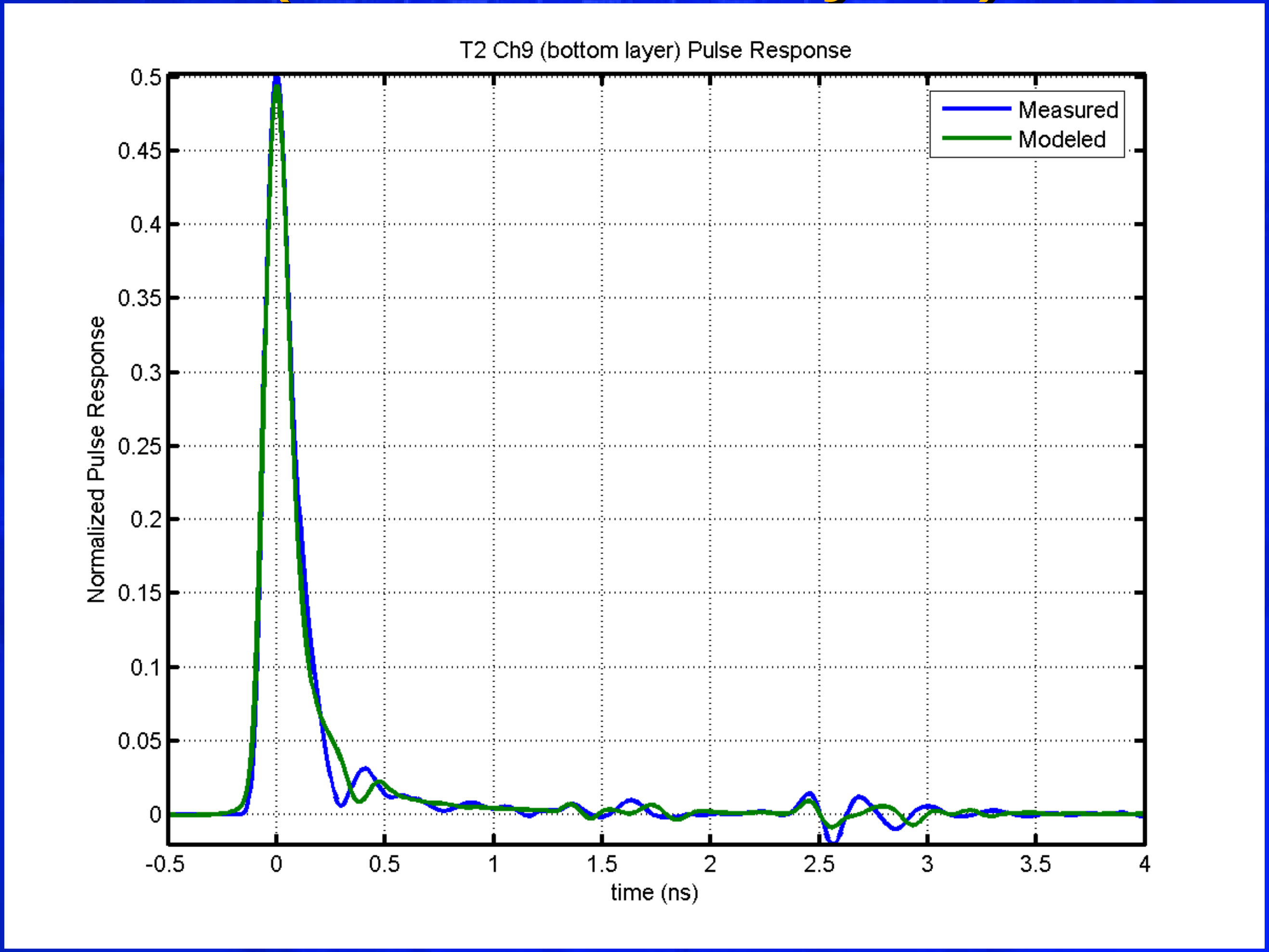




Scalable Model SDD21 Correlation to Measurements (Bottom Layer)



Scalable Model Pulse Response Correlation to Measurements (Bottom Layer)



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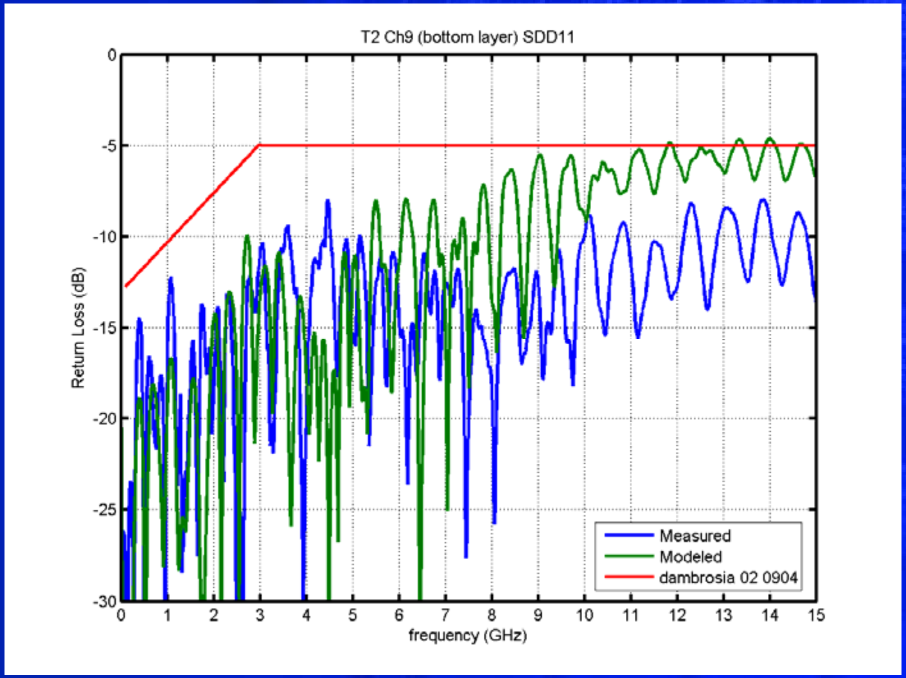
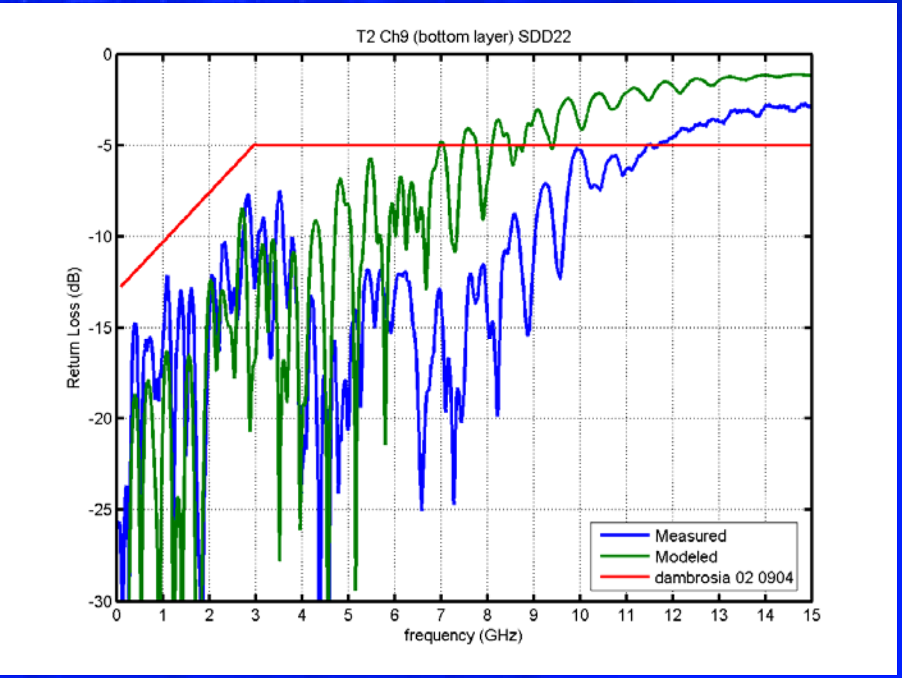
Scalable Model Return Loss Correlation to Measurements (Bottom Layer)



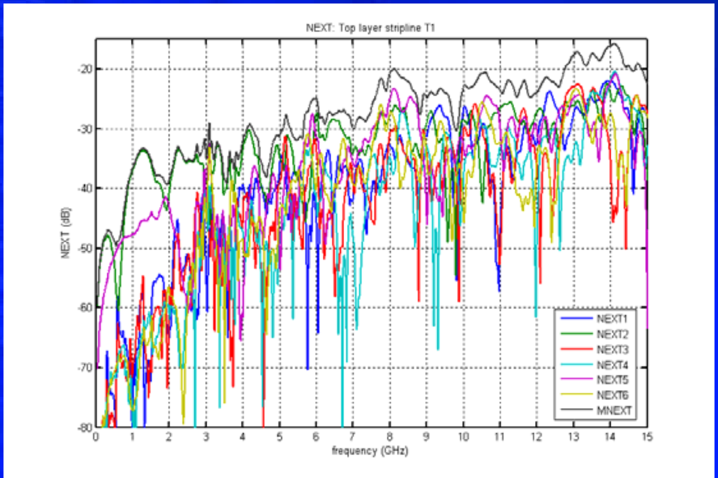


Scalable ATCA Model to Measurement Correlation Summary

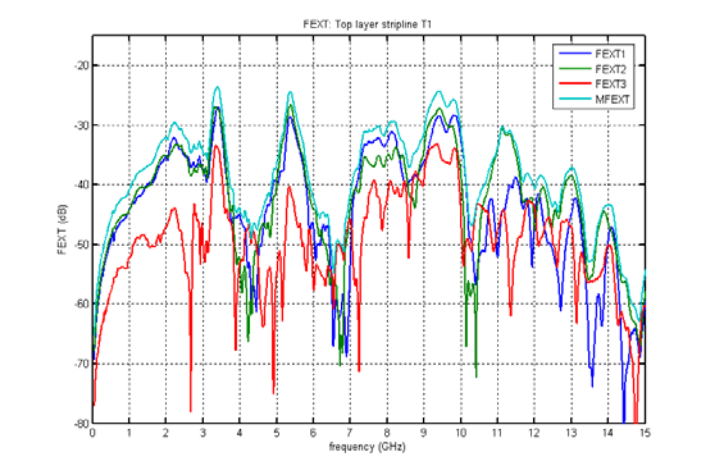
- Modeled insertion loss and pulse responses match the measurements well with only a few minor discrepancies.
- Modeled return loss matches the measurements adequately up to 5+ GHz. The return loss does not match well at higher frequencies; the modeled return loss is pessimistic in this range.
- Models of middle layer (stub=76mils) and bottom layer routing on the backplane have been correlated to measurement. Consistent modeling techniques have been used to model top layer (stub=175mils) routing.
- The models yield a causal pulse response.

Crosstalk Coupling

- The synthesized channel models do not include NEXT, FEXT
- Measured NEXT/FEXT coupling can be used as a substitute
  - The majority of coupling occurs in the connector region. The via layer configuration and HM-Zd path is similar to that of the measured channels. Expect to get a similar frequency profile.
  - Measured coupling is expected to be pessimistic for the synthesized channels since the increased loss in the line cards will attenuate the crosstalk



T1 NEXT



T1 FEXT

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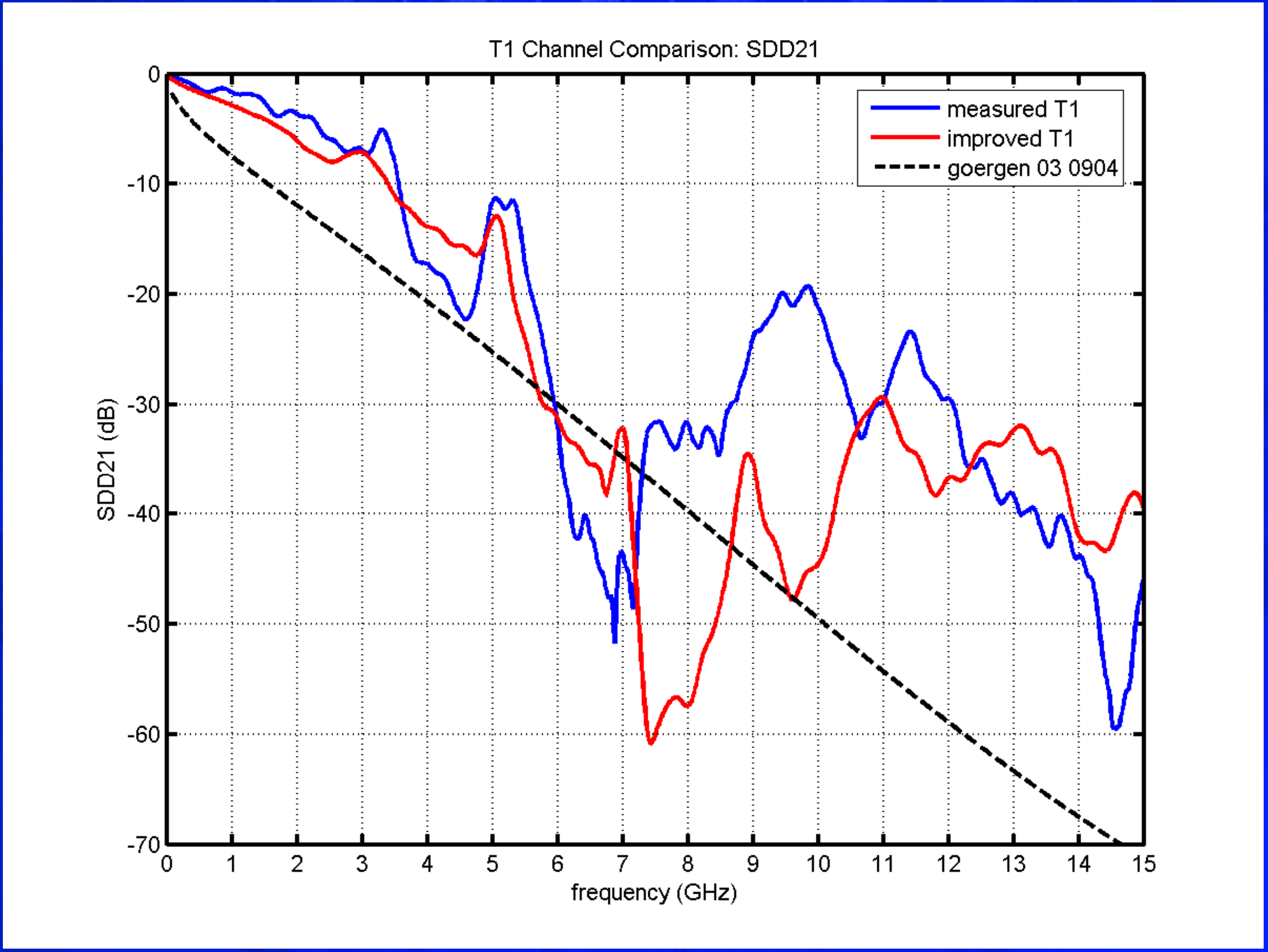
Generation of Improved Channels

- 8 channels have been synthesized using our scalable model to match the 8 measured channels under consideration.
- The original and synthesized channels share the essential characteristics of backplane trace length, routing layer and stub length.
- The correlated scalable model already incorporates the improved via/pad design and the HVM line card material. Trace lengths can be varied.
- Crosstalk coupling from the respective measured channel can be used with the synthesized channels.

Channel characteristics

	Line card material	Line card trace length	Line card routing layer	HM-Zd footprint
T channels	Nelco 4000-13	2.7”, 3.2”	top, middle	default
M channels	Nelco 4000-13	4.8”, 3.8”	bottom, middle	default
B channels	Nelco 4000-13	2.3”, 3.0”	top, middle	default
All synthesized channels	High Tg FR-4	5”	top, top	improved

T1 Channel Insertion Loss



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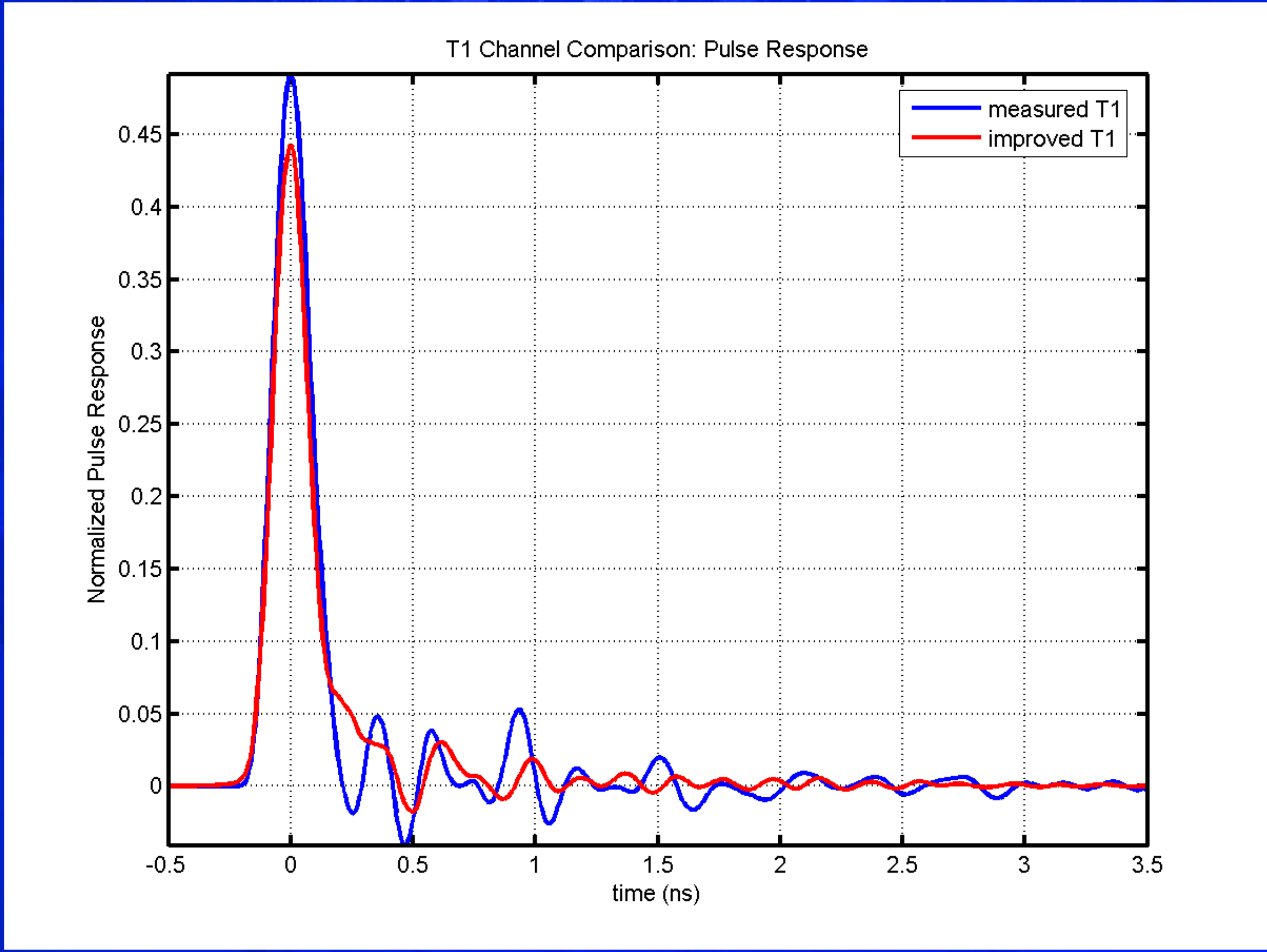
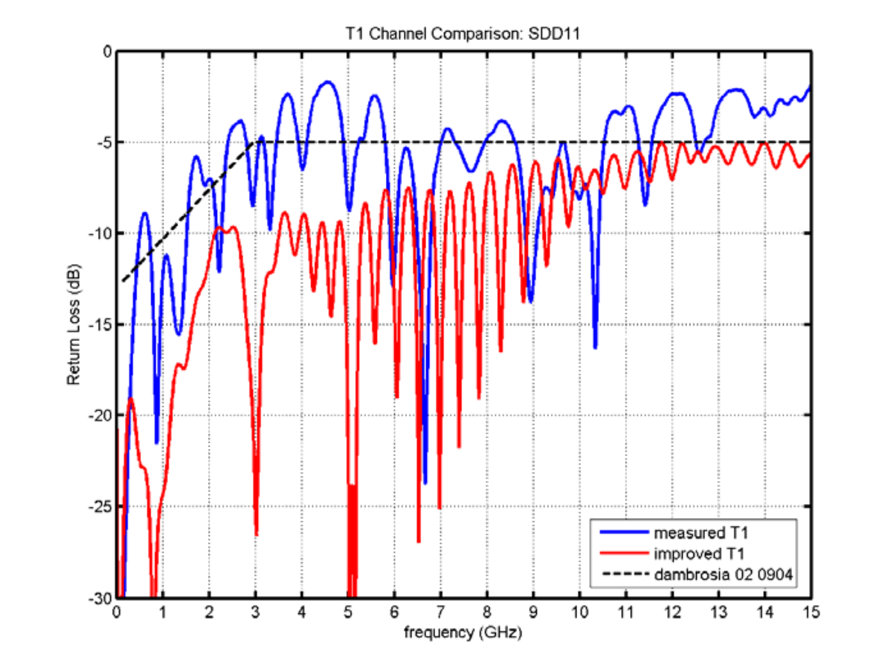
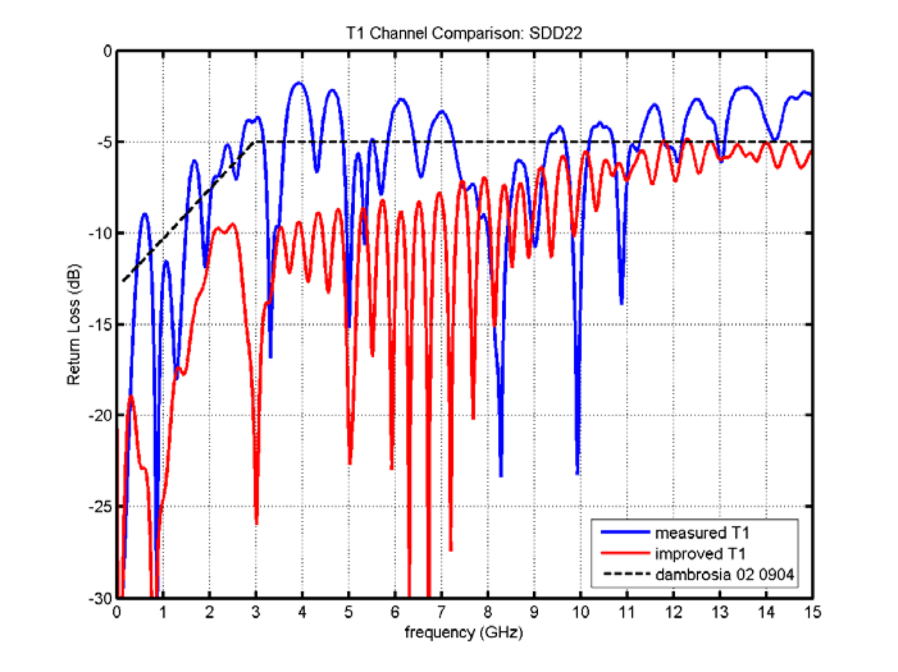
T1 Channel Pulse Response

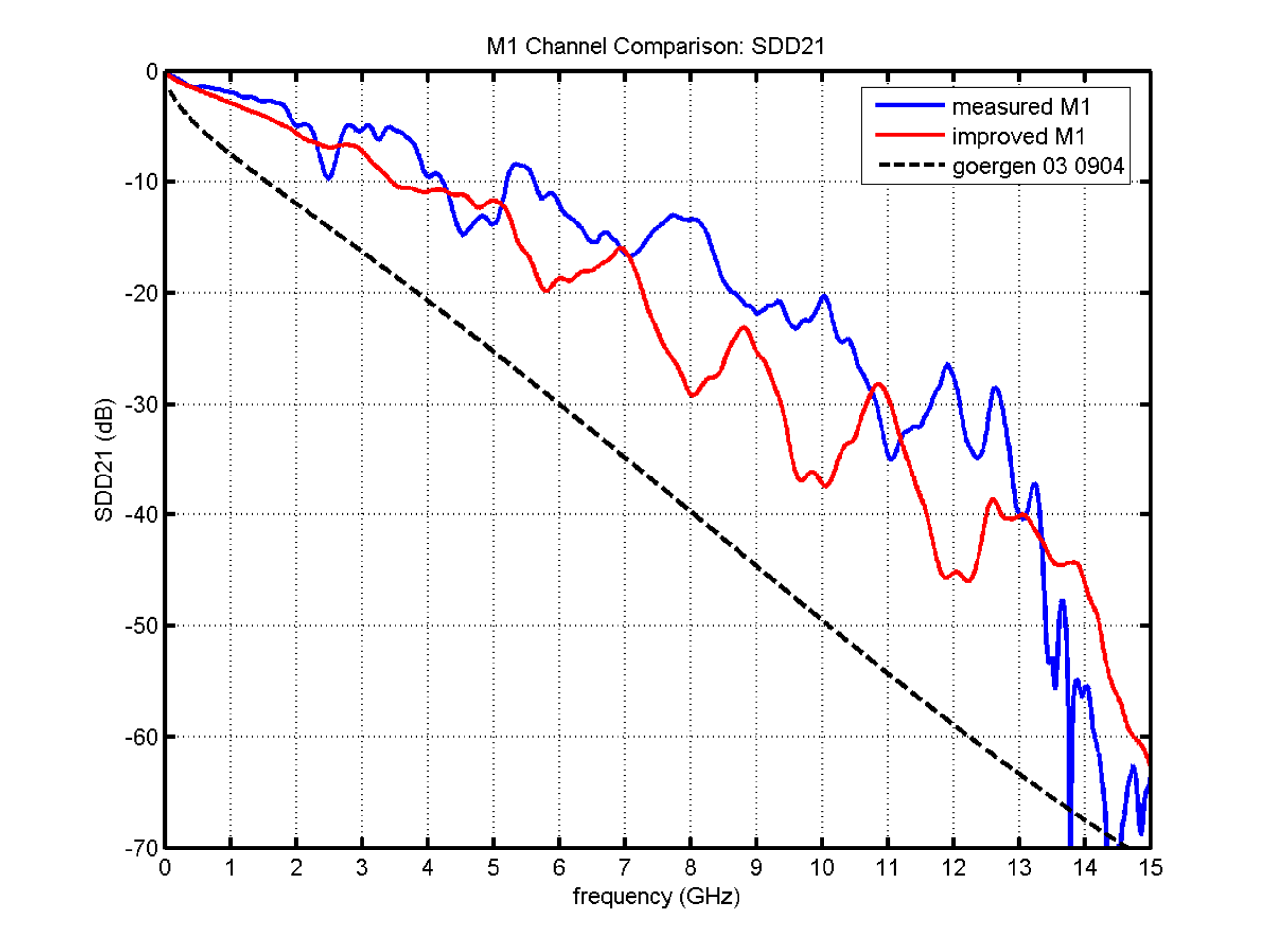


T1 Channel Return Loss

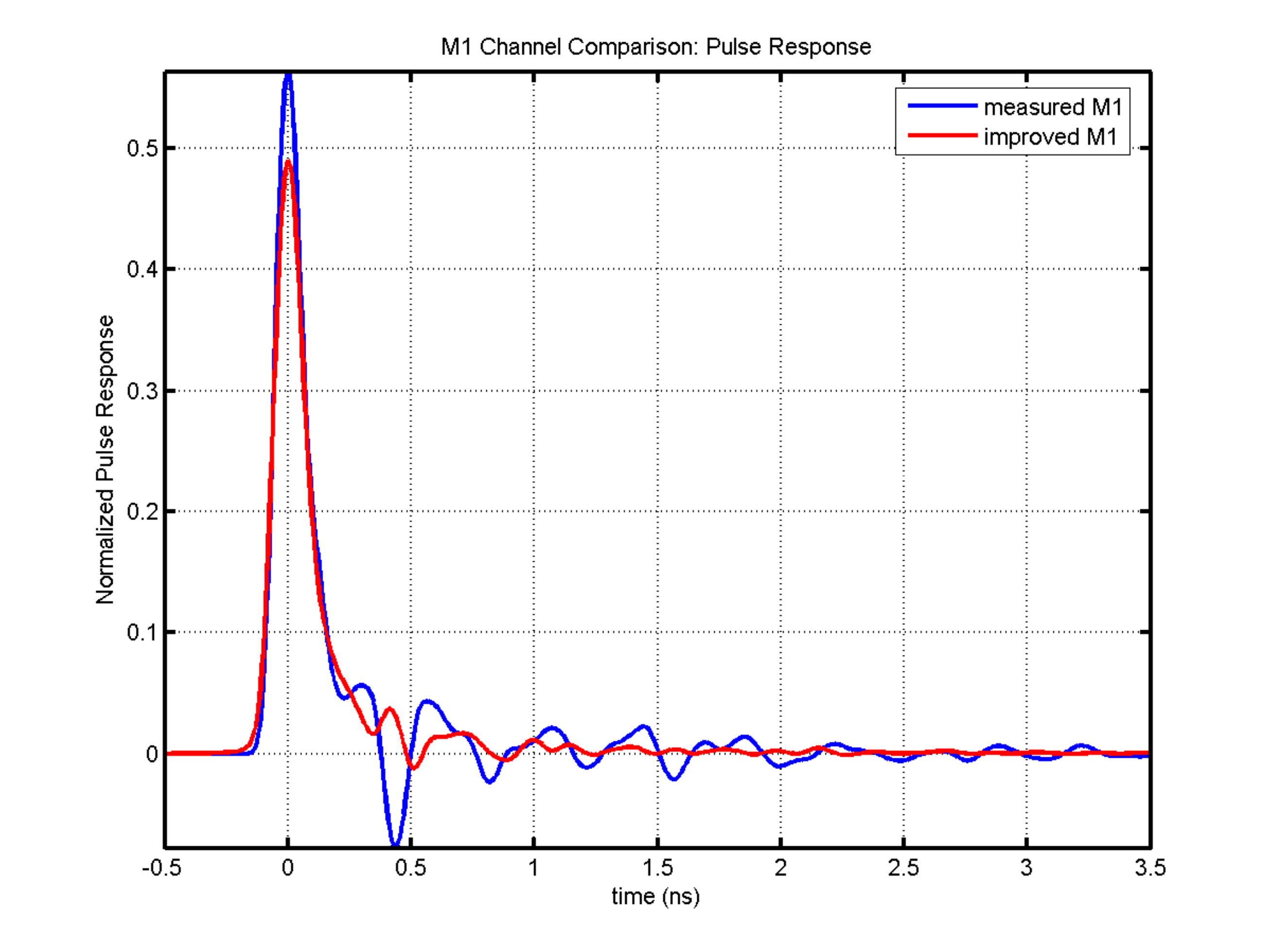




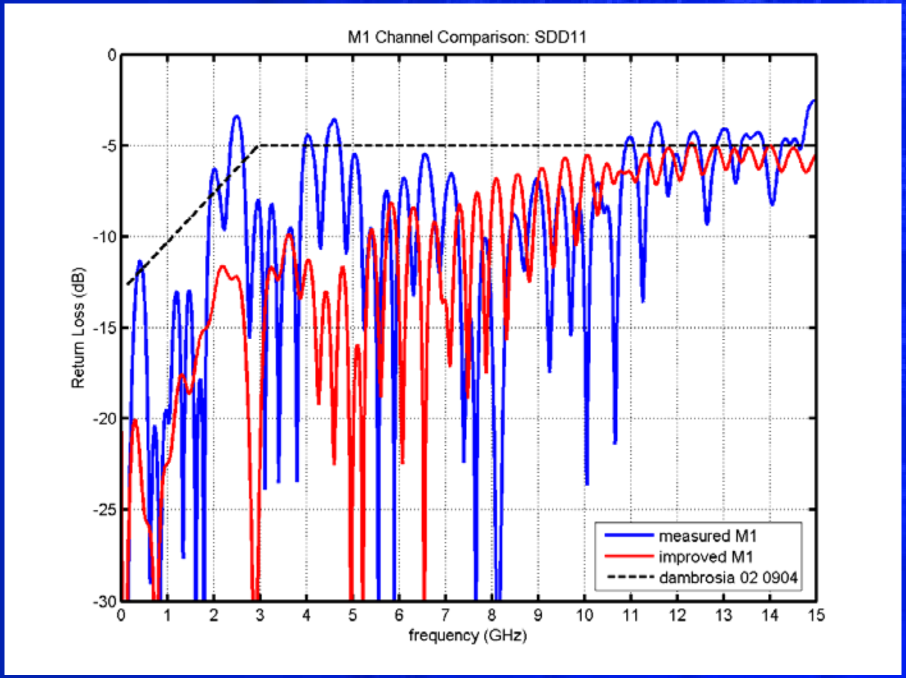
M1 Channel Insertion Loss

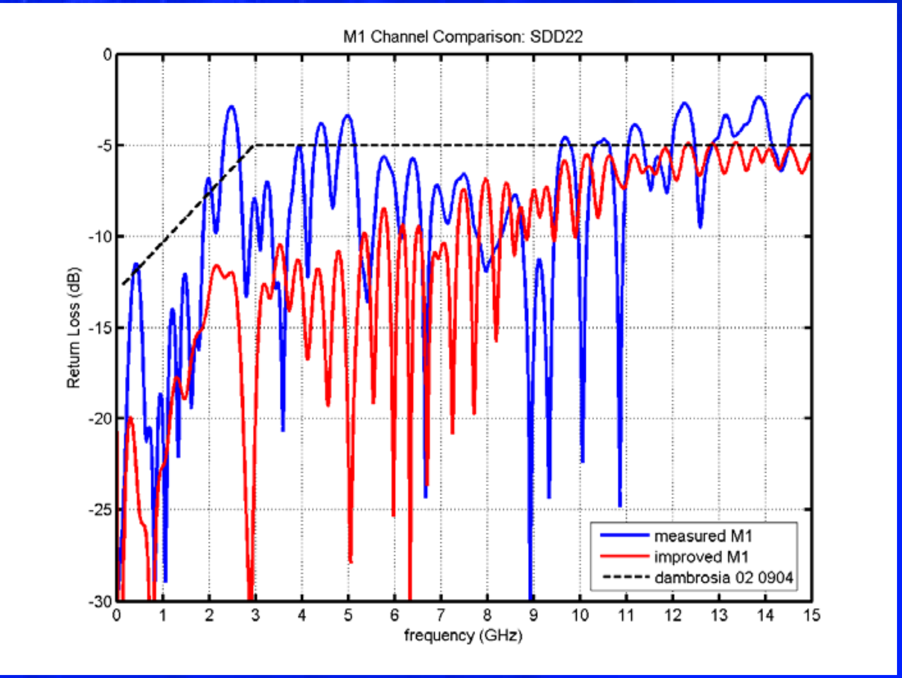


M1 Channel Pulse Response

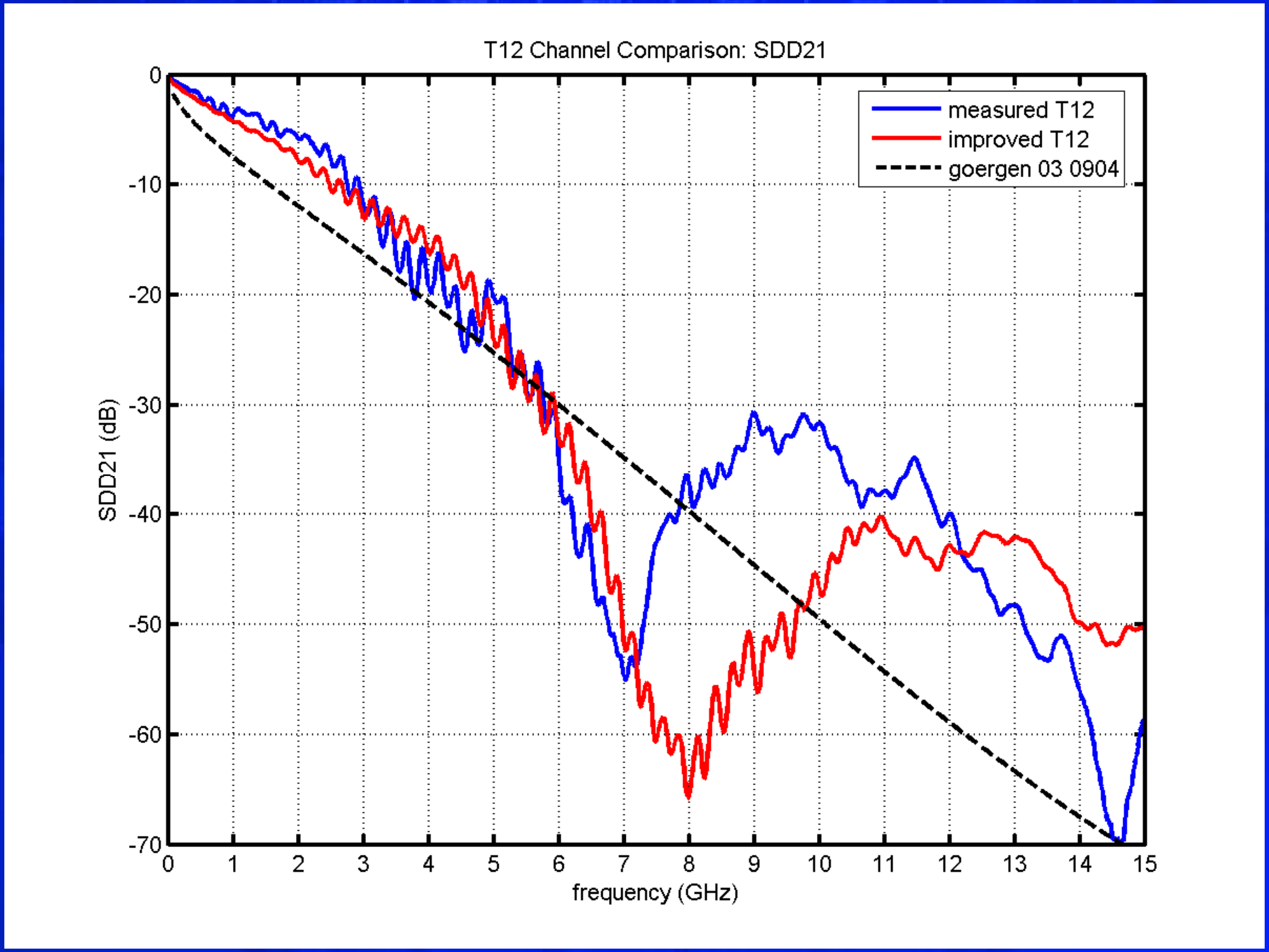


M1 Channel Return Loss

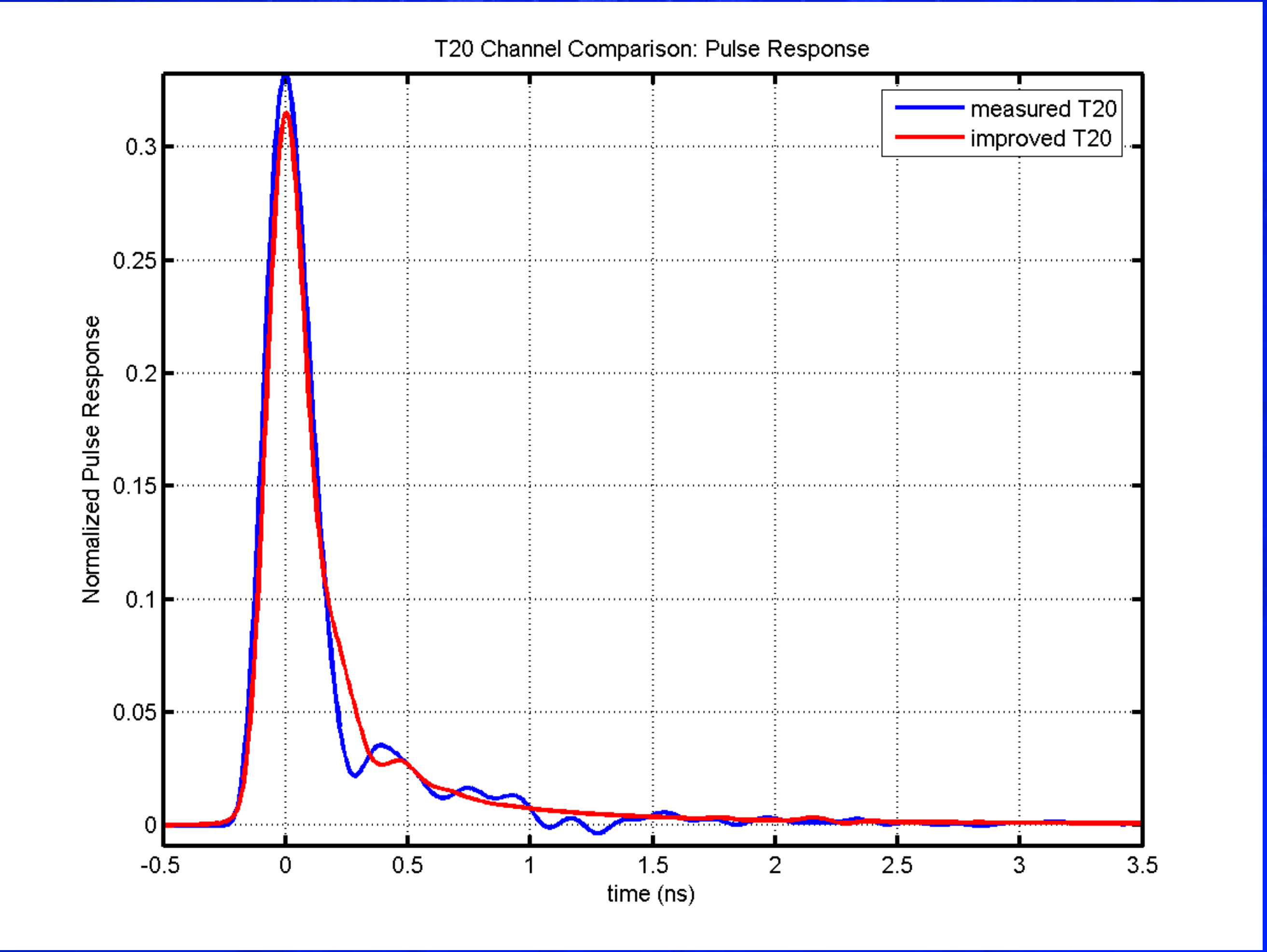




T20 Channel Insertion Loss



T20 Channel Pulse Response



Improved Channels Summary

- 8 channels have been synthesized based on the 8 Intel channels under consideration. The original and synthesized channels share the essential characteristics of backplane trace length, routing layer and stub length.
- The SDD21 responses of the improved channels show more loss and less ripple than those of the original measured channels. Also, the via stub null frequency is moved to a higher frequency.
- The pulse responses of the improved channels exhibit a decreased peak value compared to the original measured channels, but also have a reduced and more quickly decaying trailing ripple.
- The return loss of the improved channels shows a marked improvement over that of the original measured channels.

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Conclusions

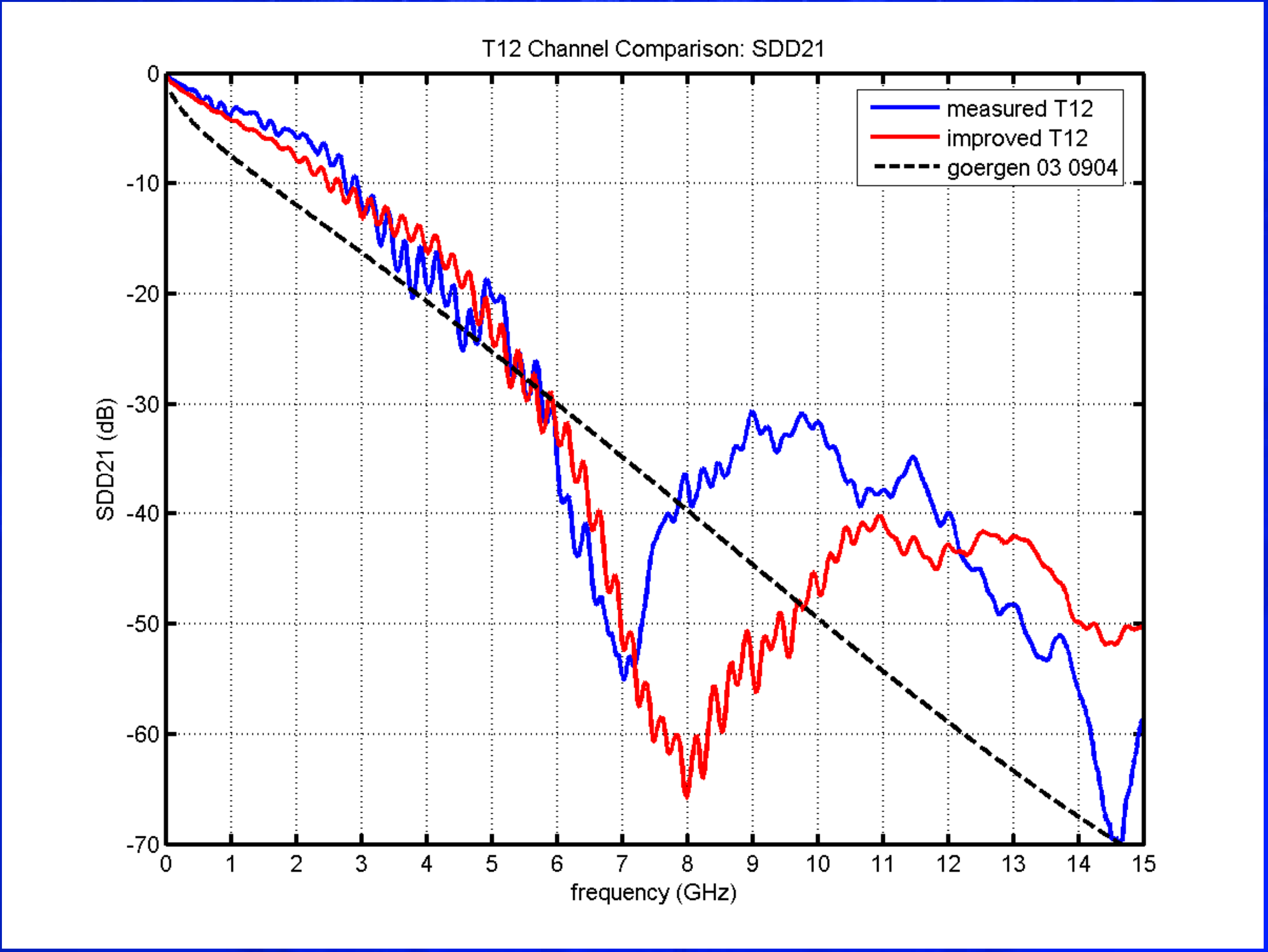
- Scalable HVM models have been well correlated to measurements and can provide a good estimate of the thru performance of improved HVM T, M and B channels.
- The frequency and time domain responses of the synthesized improved channel models indicate an overall improved performance.
- The improved models may be used to assess the performance of HVM ATCA systems with reasonable design improvements and tradeoffs.

Next Steps

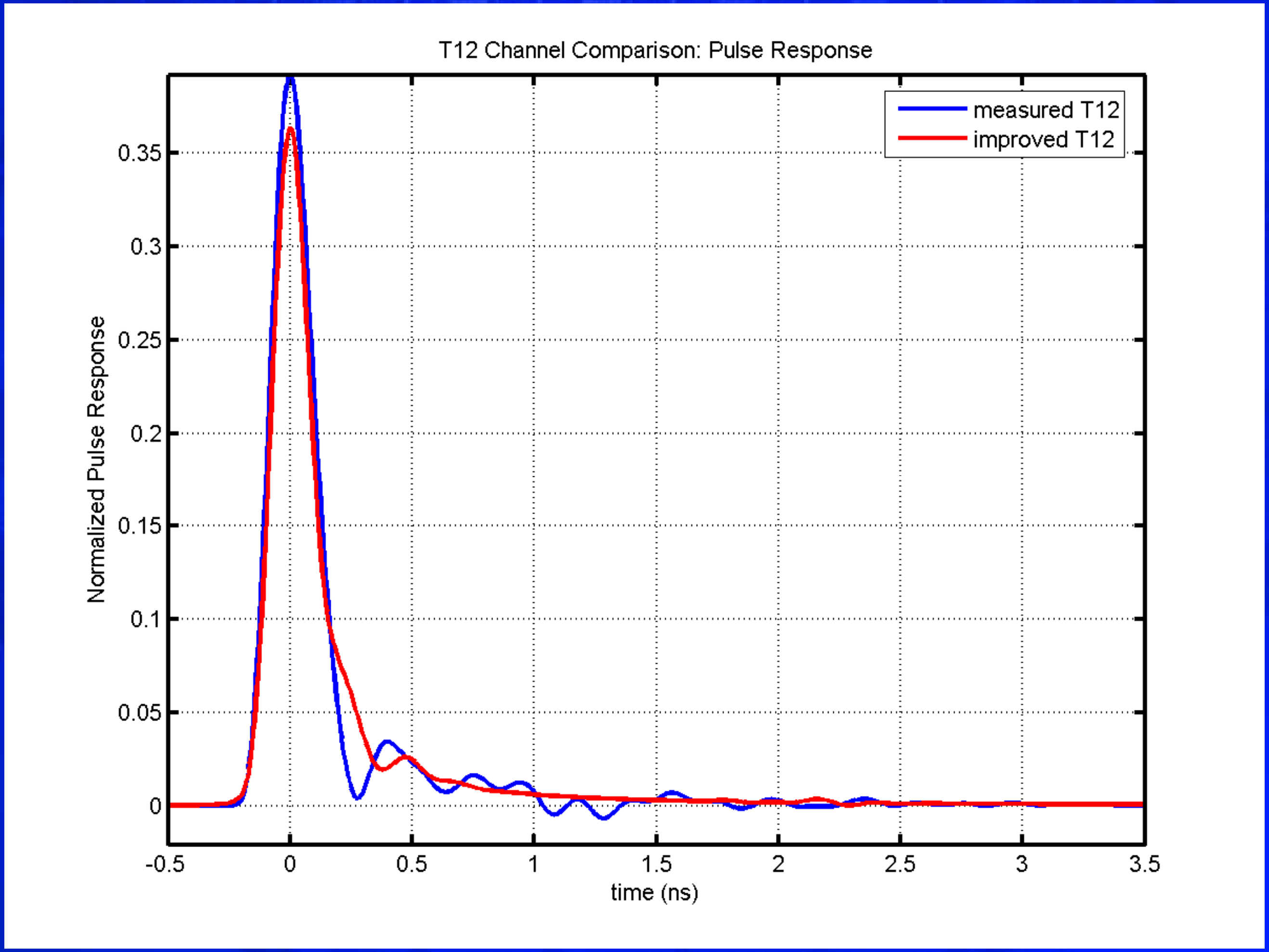
- Improved models will be made available for use by the task force.
- A physical system is being designed to incorporate the changes being proposed. This system will be used to validate the accuracy of the synthesized improved models.

Backup Slides

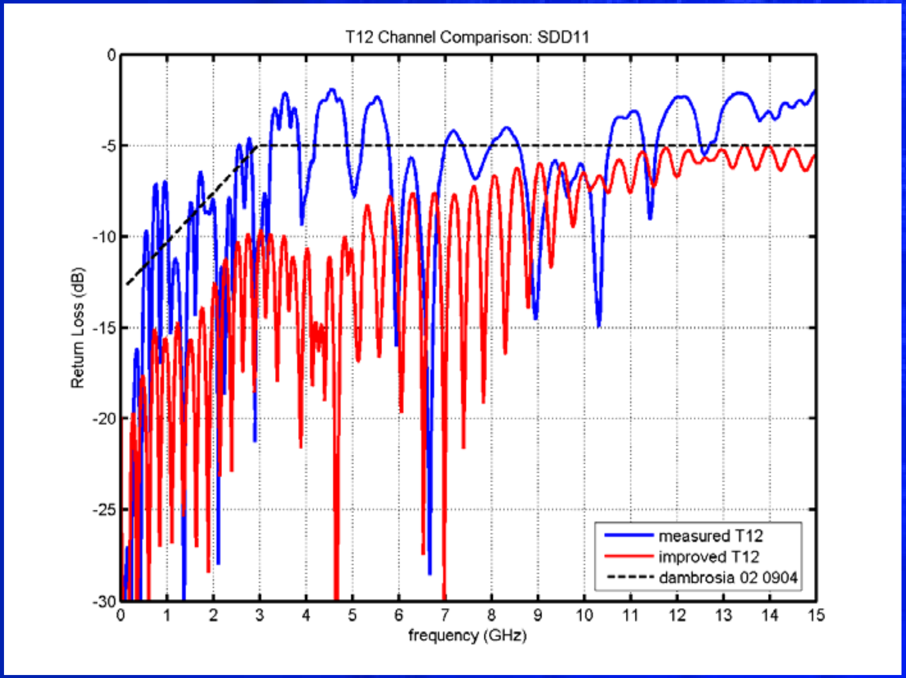
T12 Channel Insertion Loss

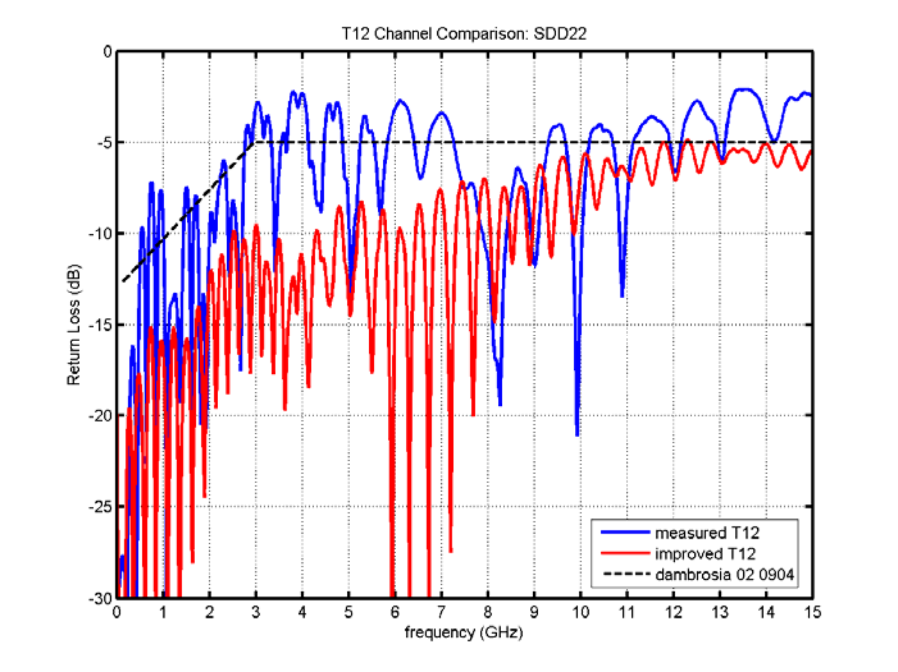


T12 Channel Pulse Response

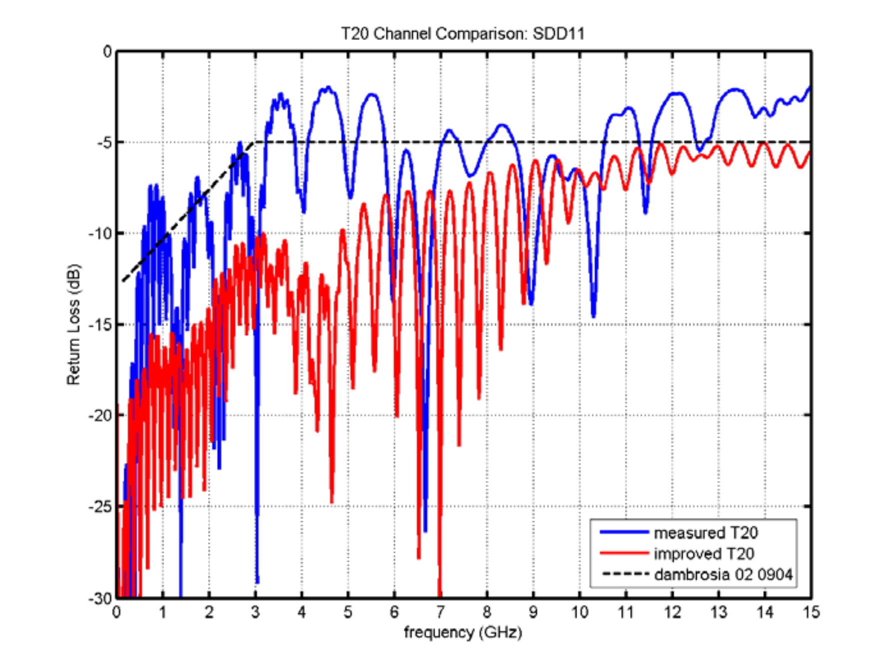


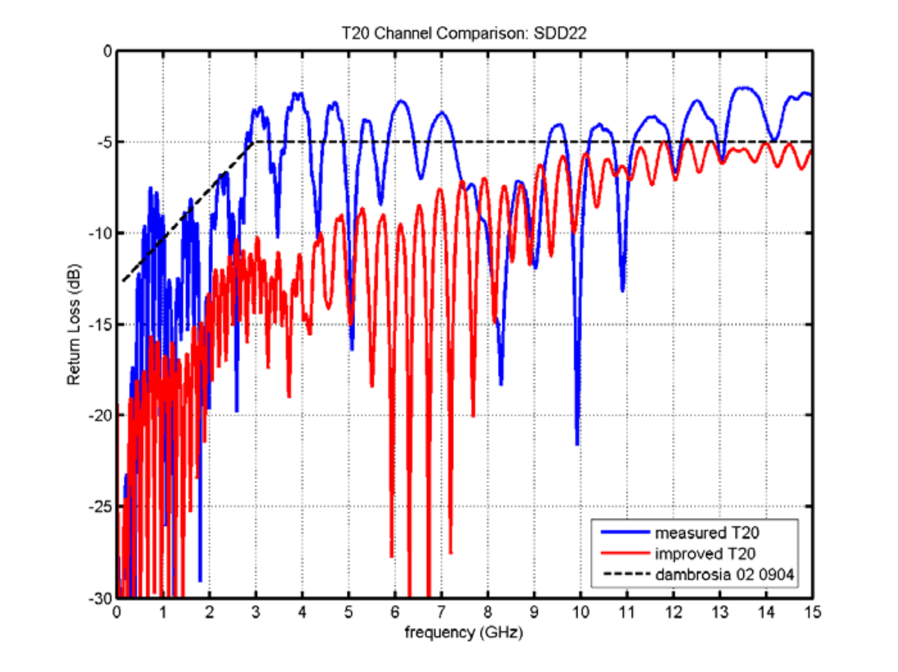
T12 Channel Return Loss



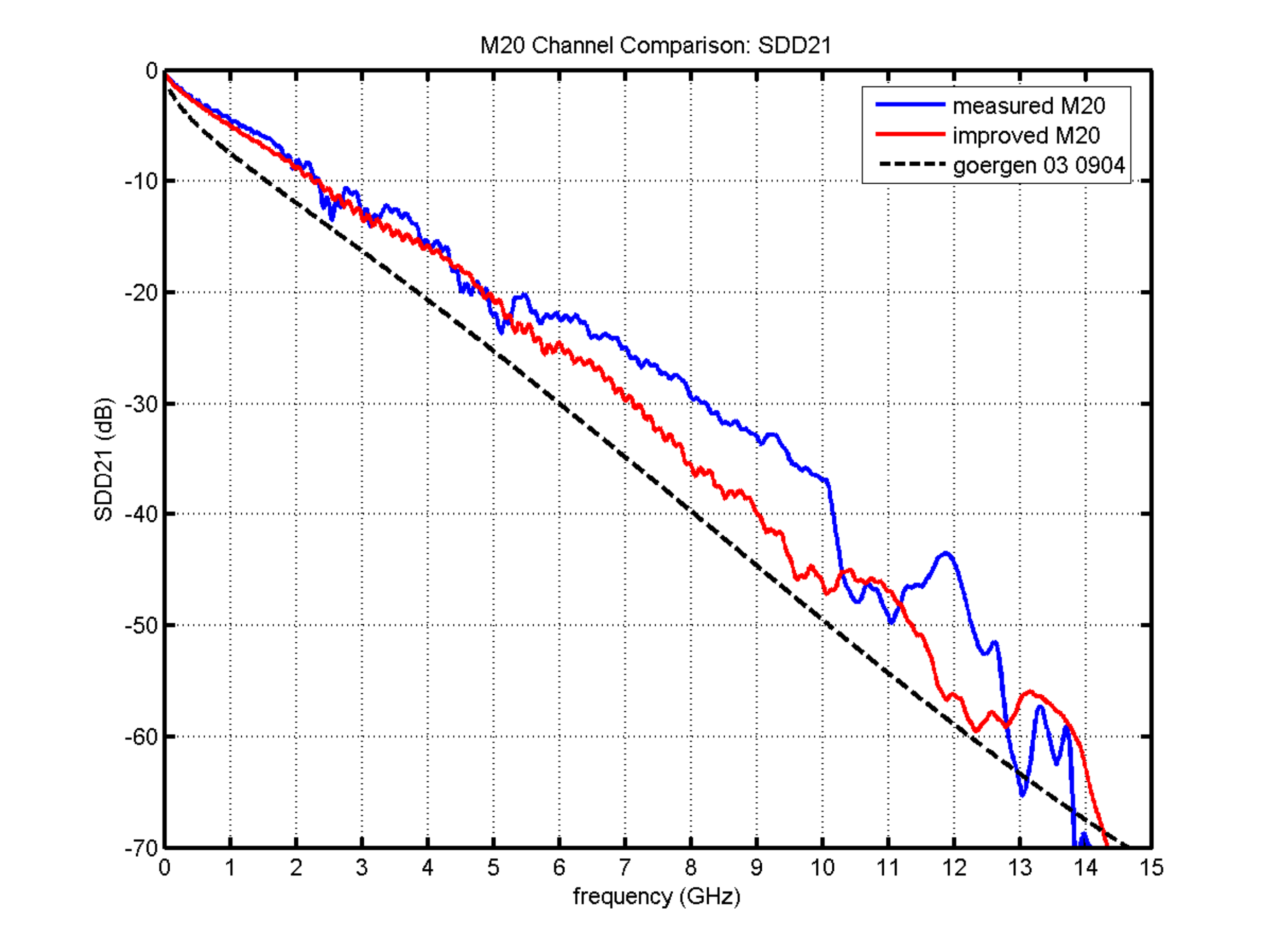


T20 Channel Return Loss

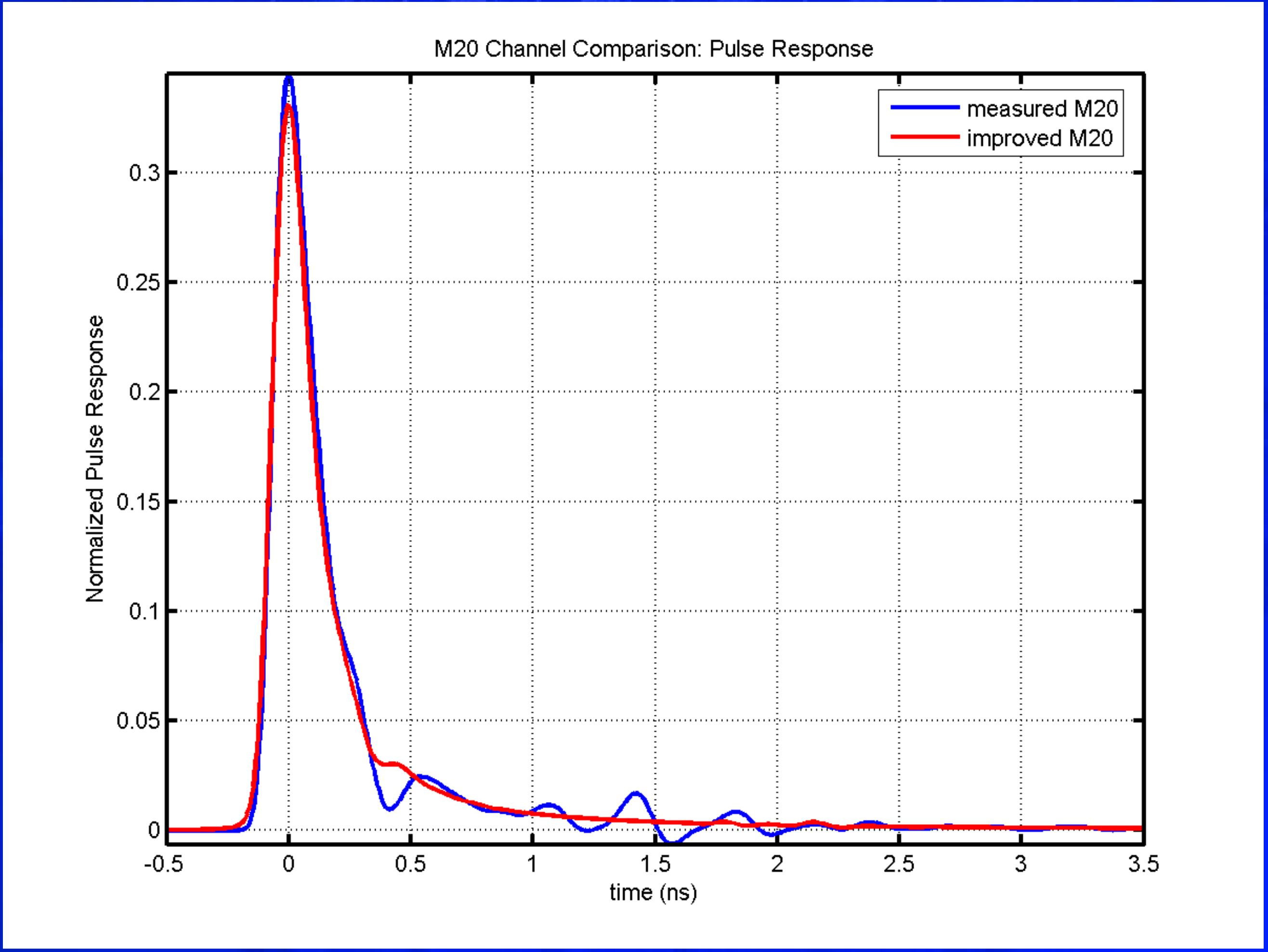




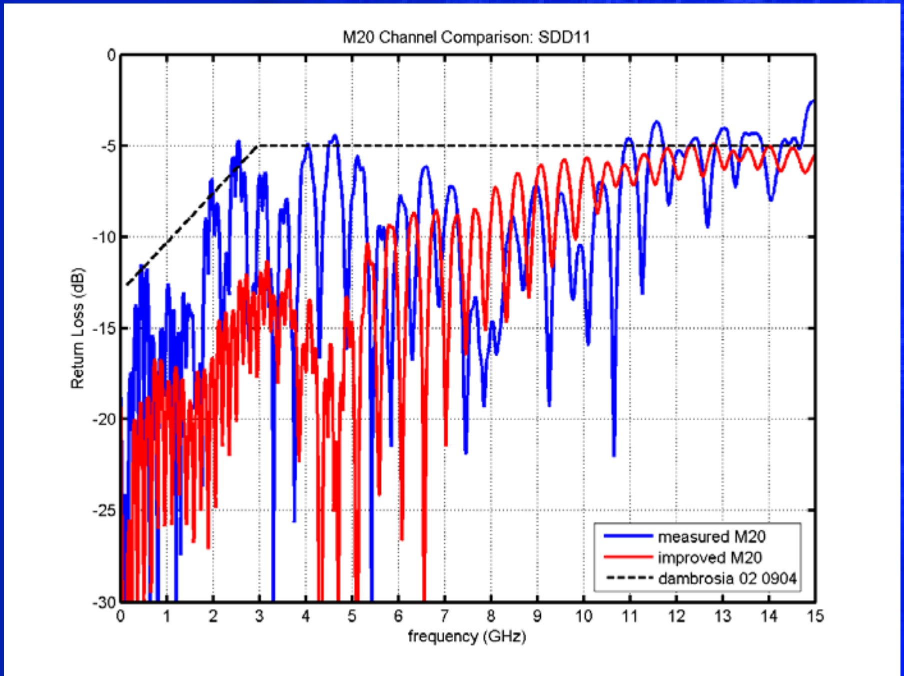
M20 Channel Insertion Loss

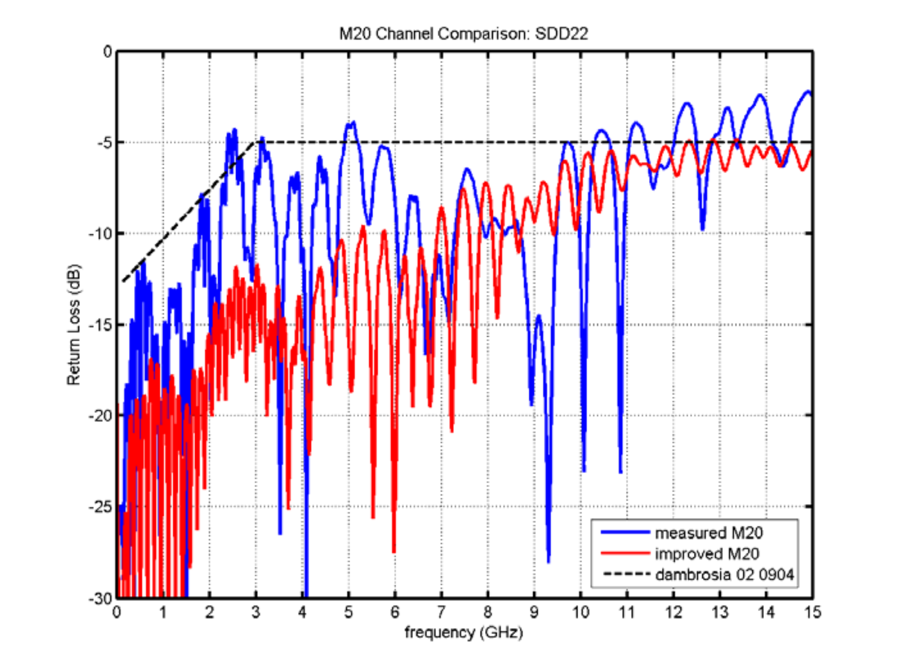


M20 Channel Pulse Response

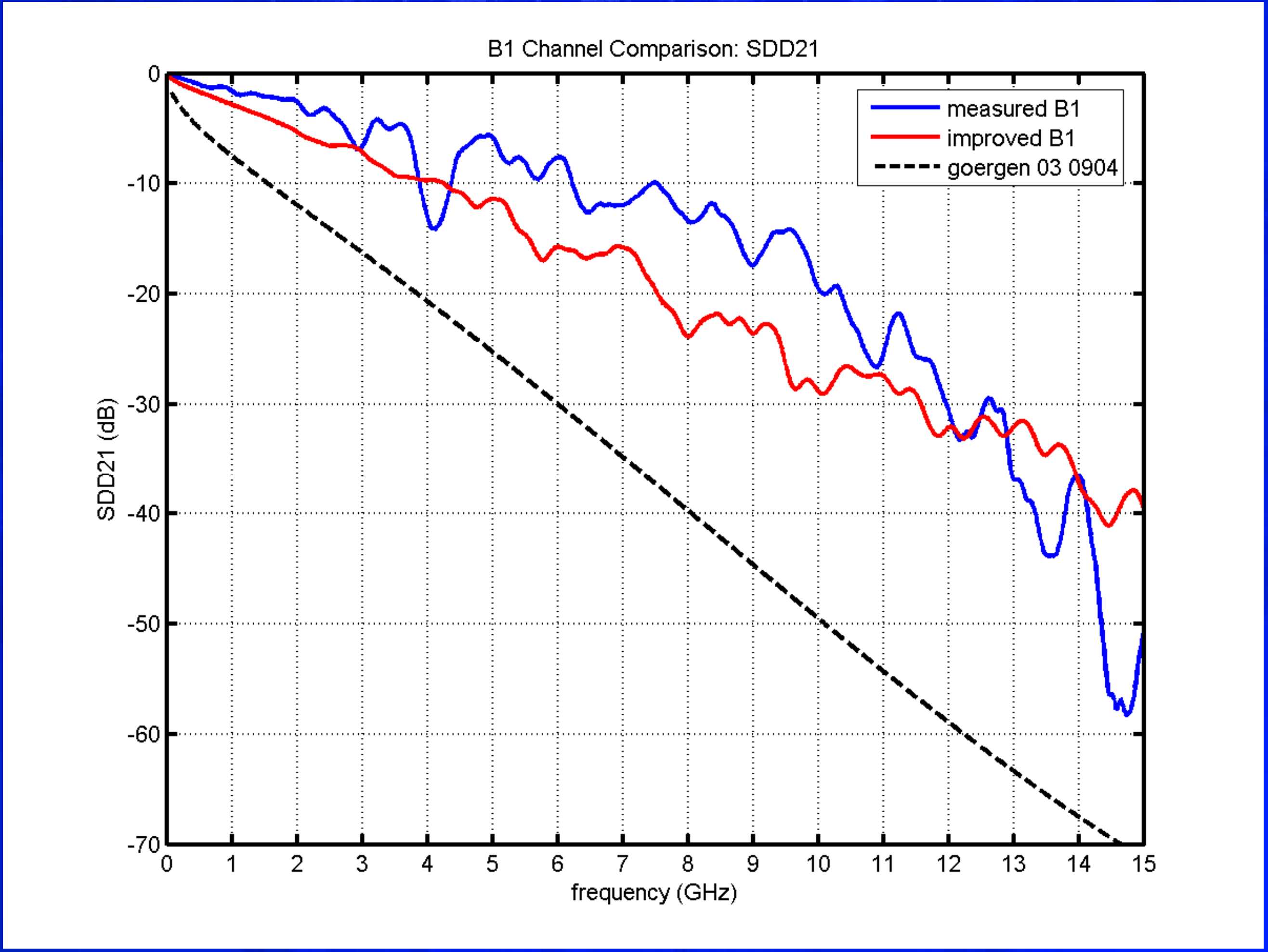


M20 Channel Return Loss

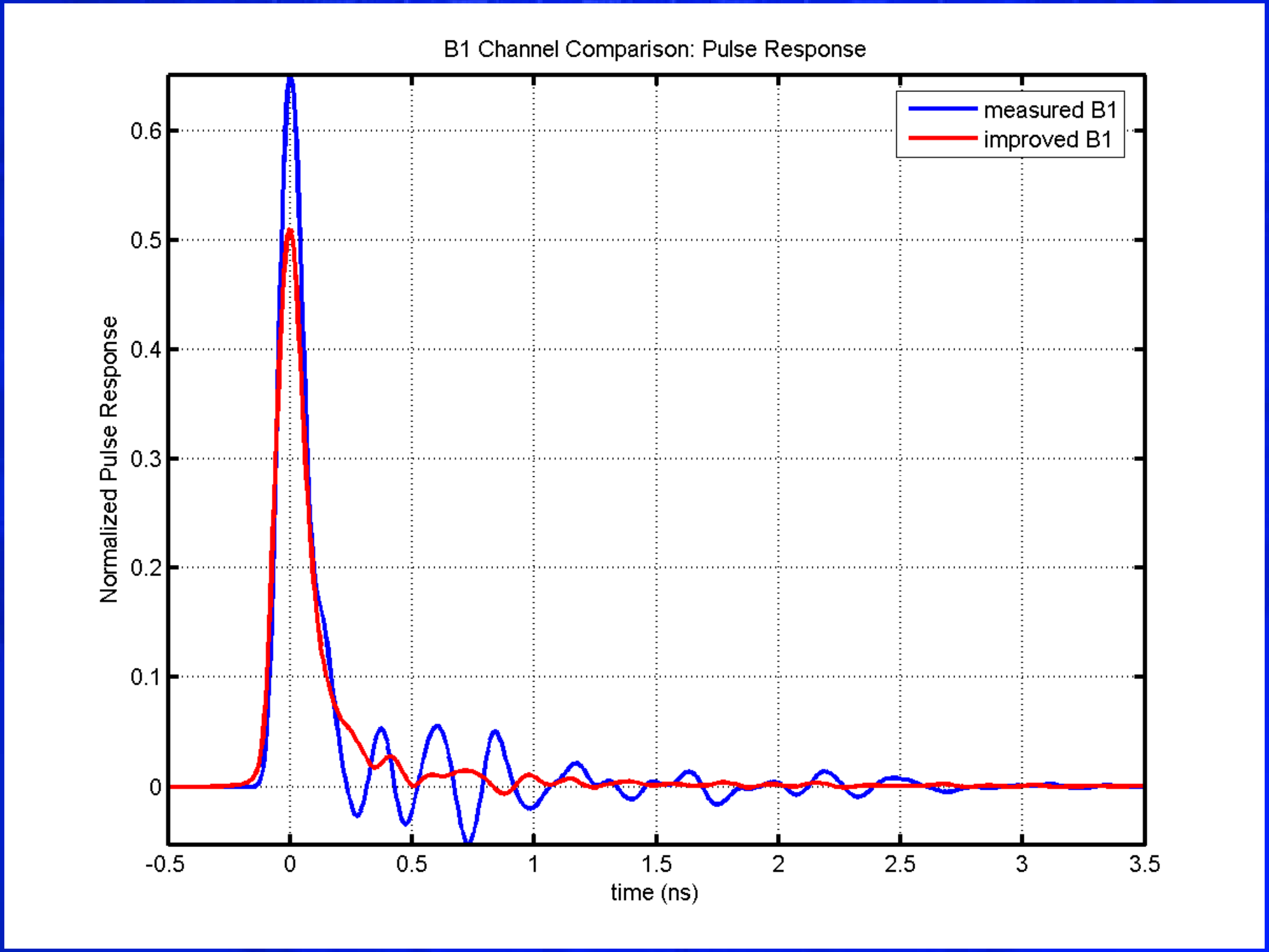




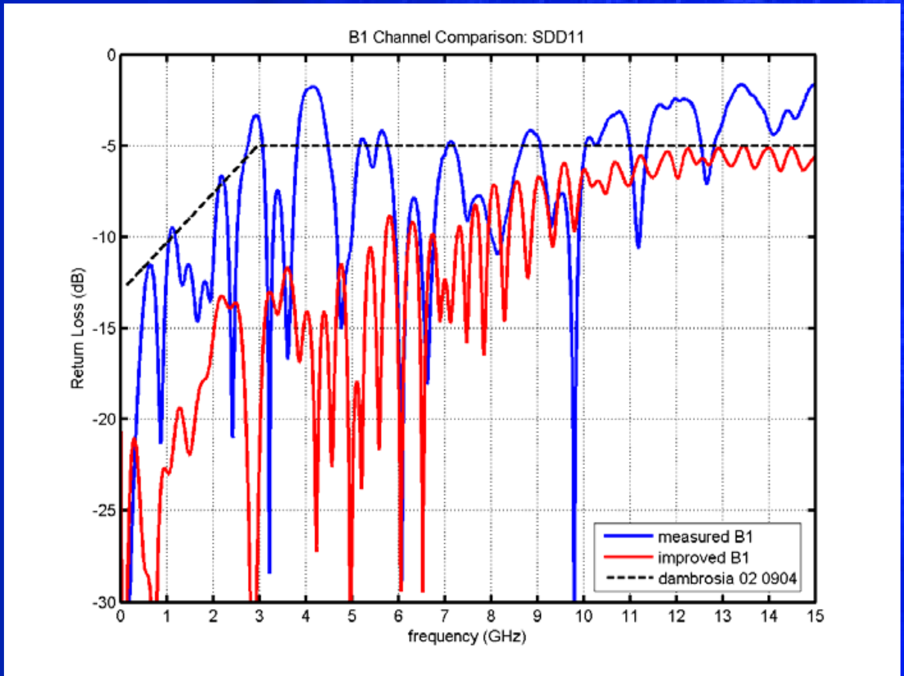
B1 Channel Insertion Loss

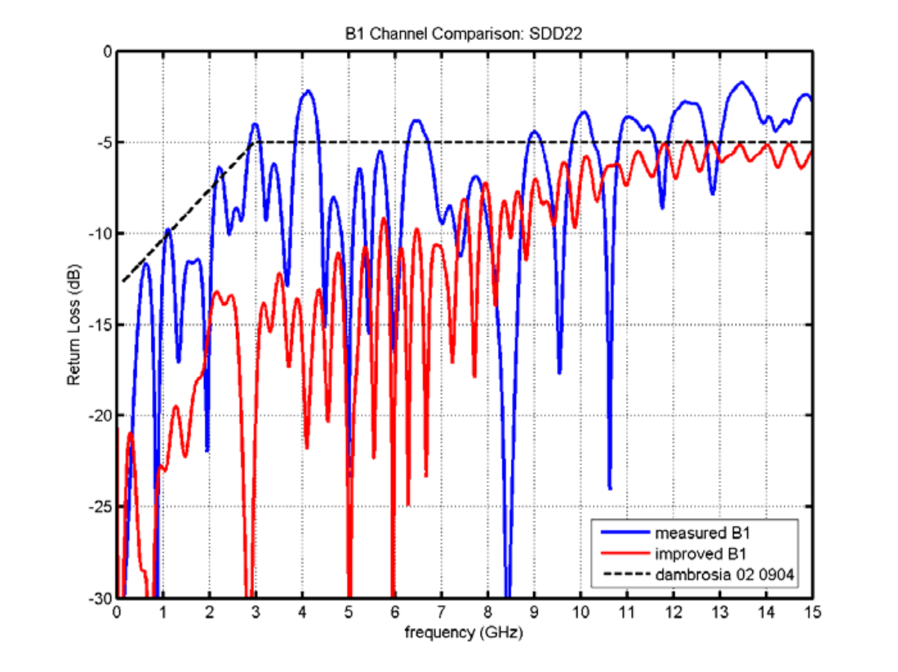


B1 Channel Pulse Response



B1 Channel Return Loss





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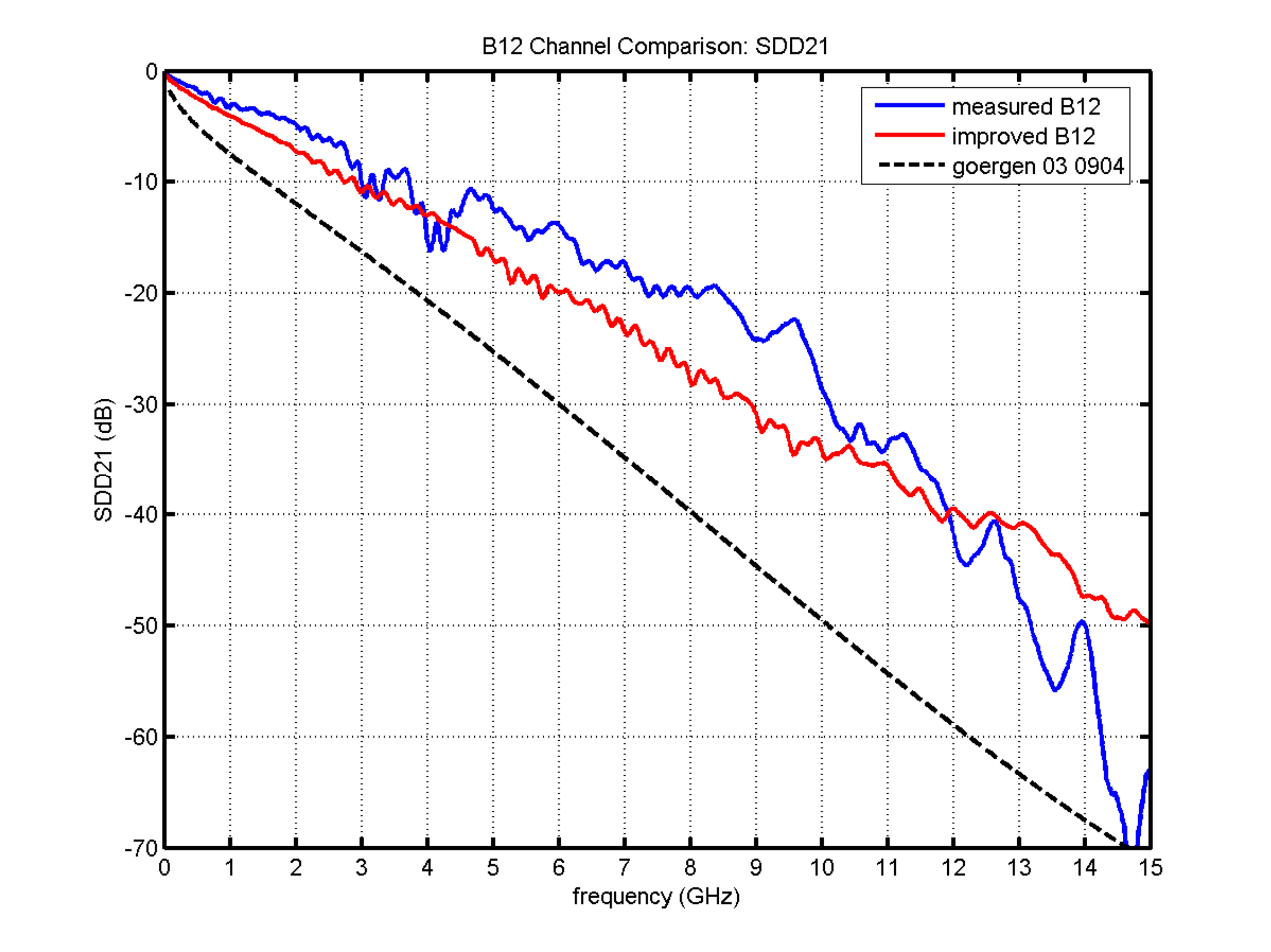
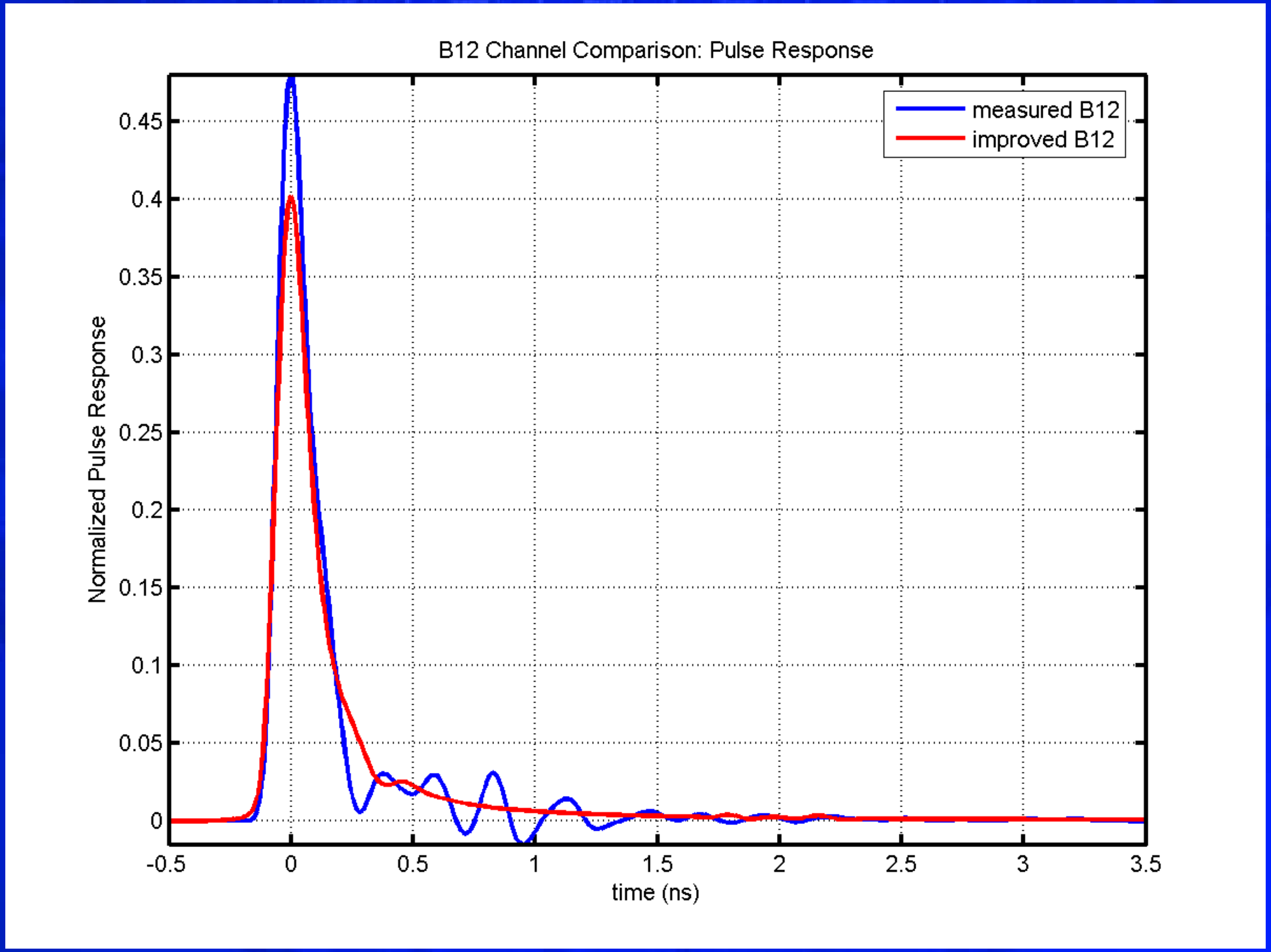
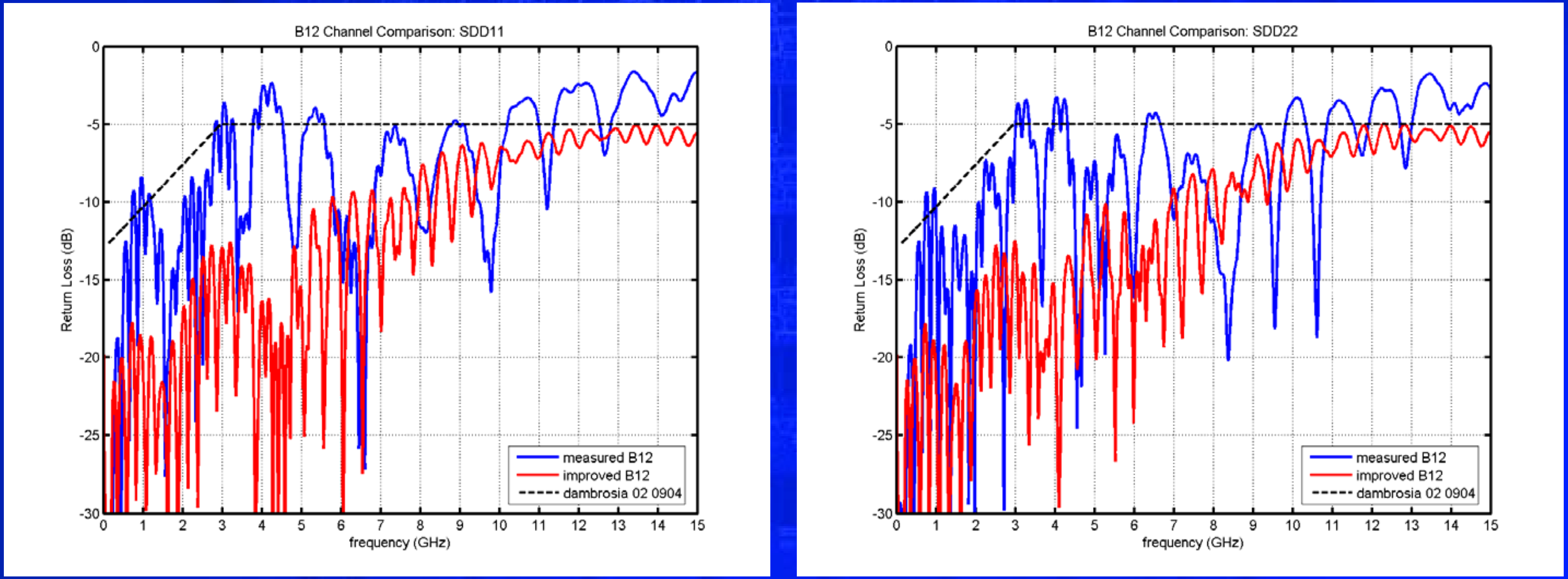
B12 Channel Insertion Loss



B12 Channel Pulse Response



B12 Channel Return Loss



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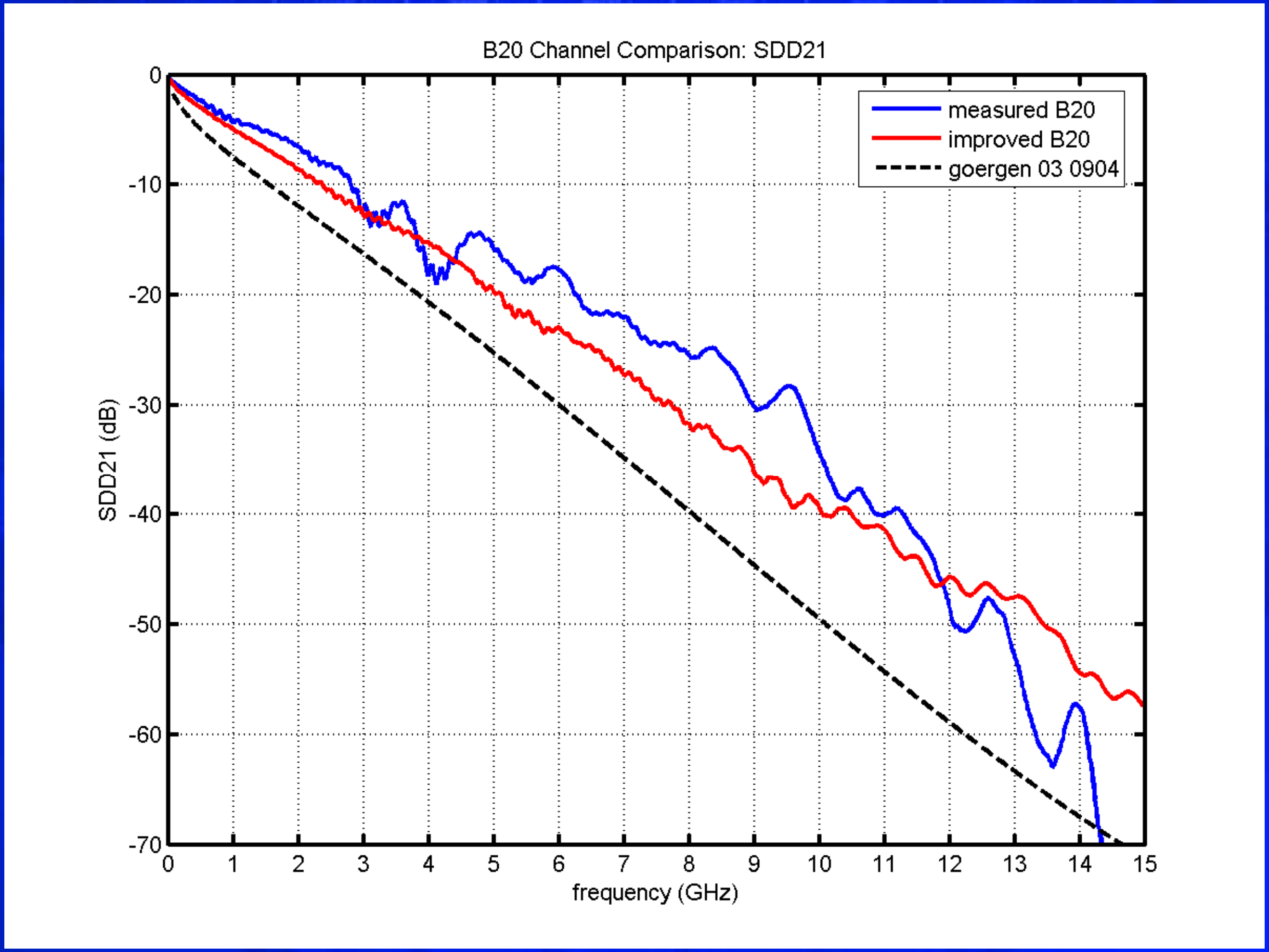
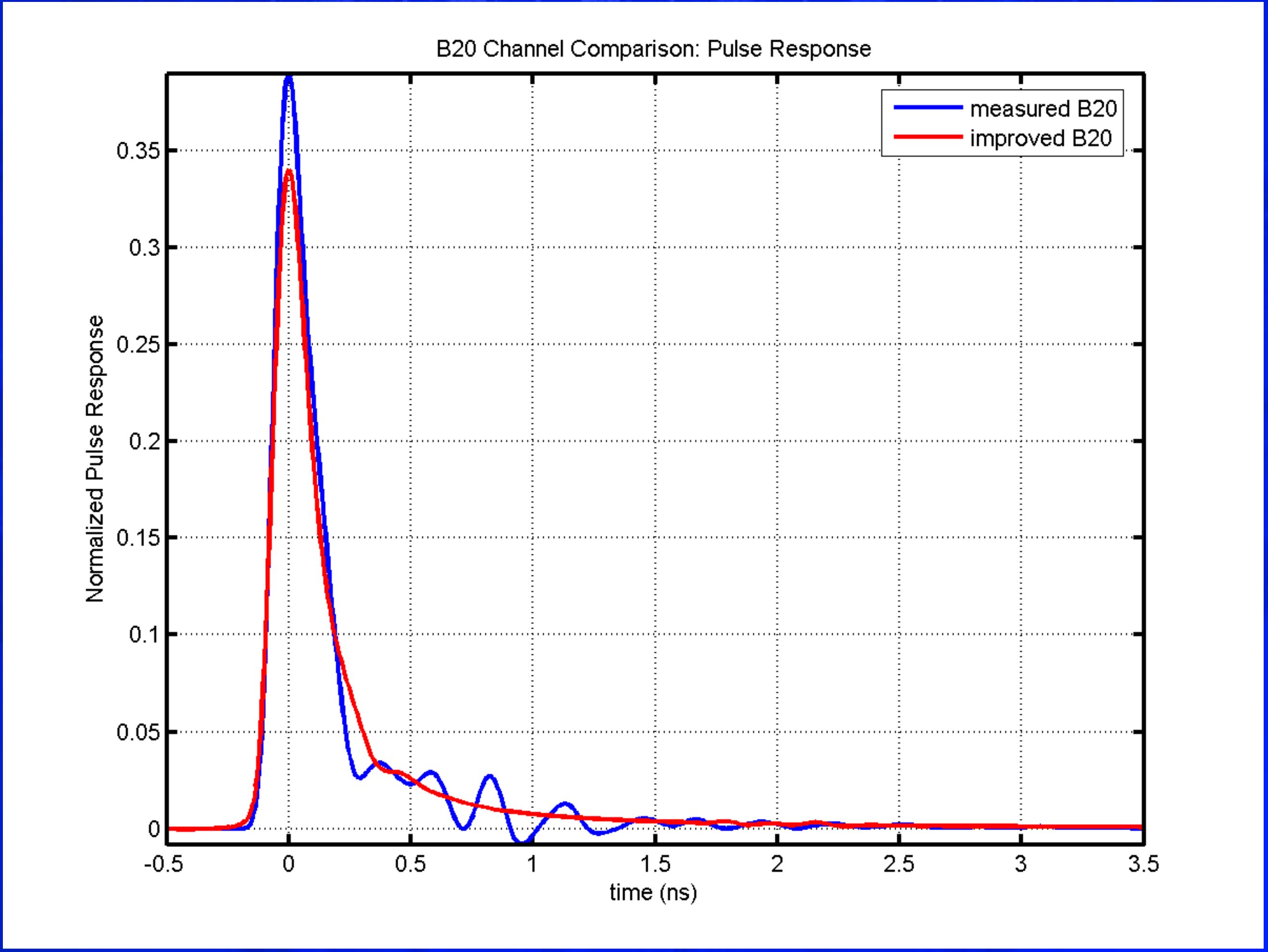
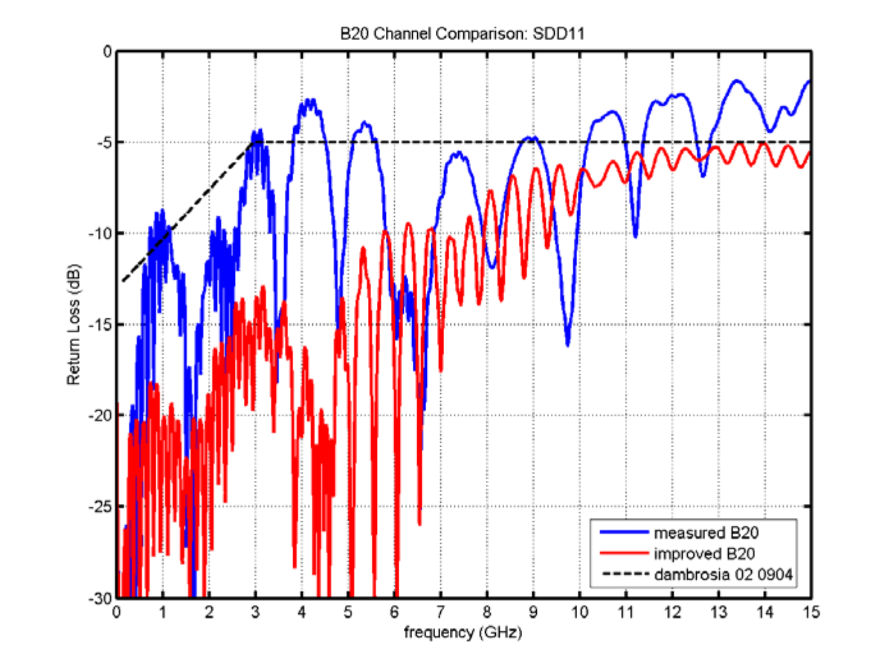
B20 Channel Insertion Loss

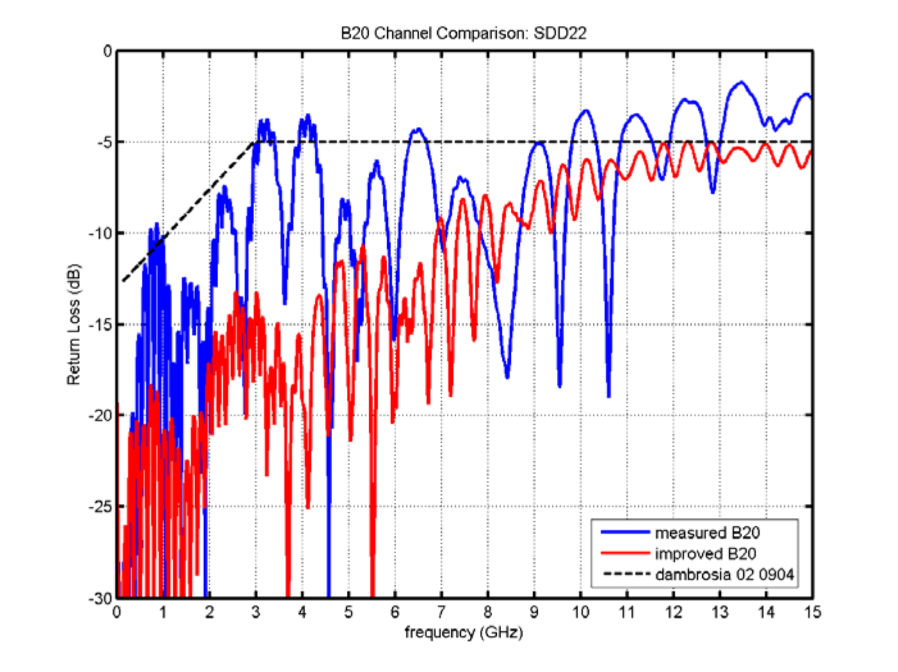


B20 Channel Pulse Response



B20 Channel Return Loss





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