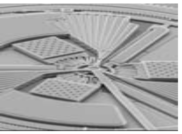
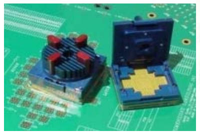
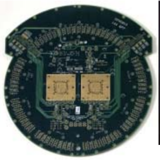
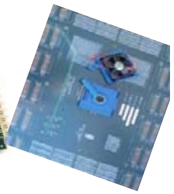
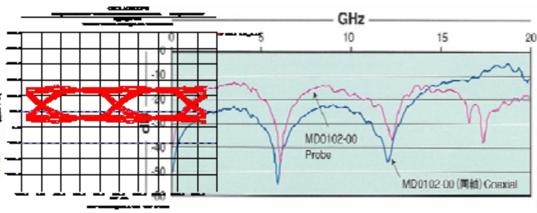
CIRCUIT SPECTRUM

Silicon Valley TEST Conference & Expo San Jose Nov. 8-9, 2010 www.svtest.com



PCB Parameters and Features That Impact Signal Integrity

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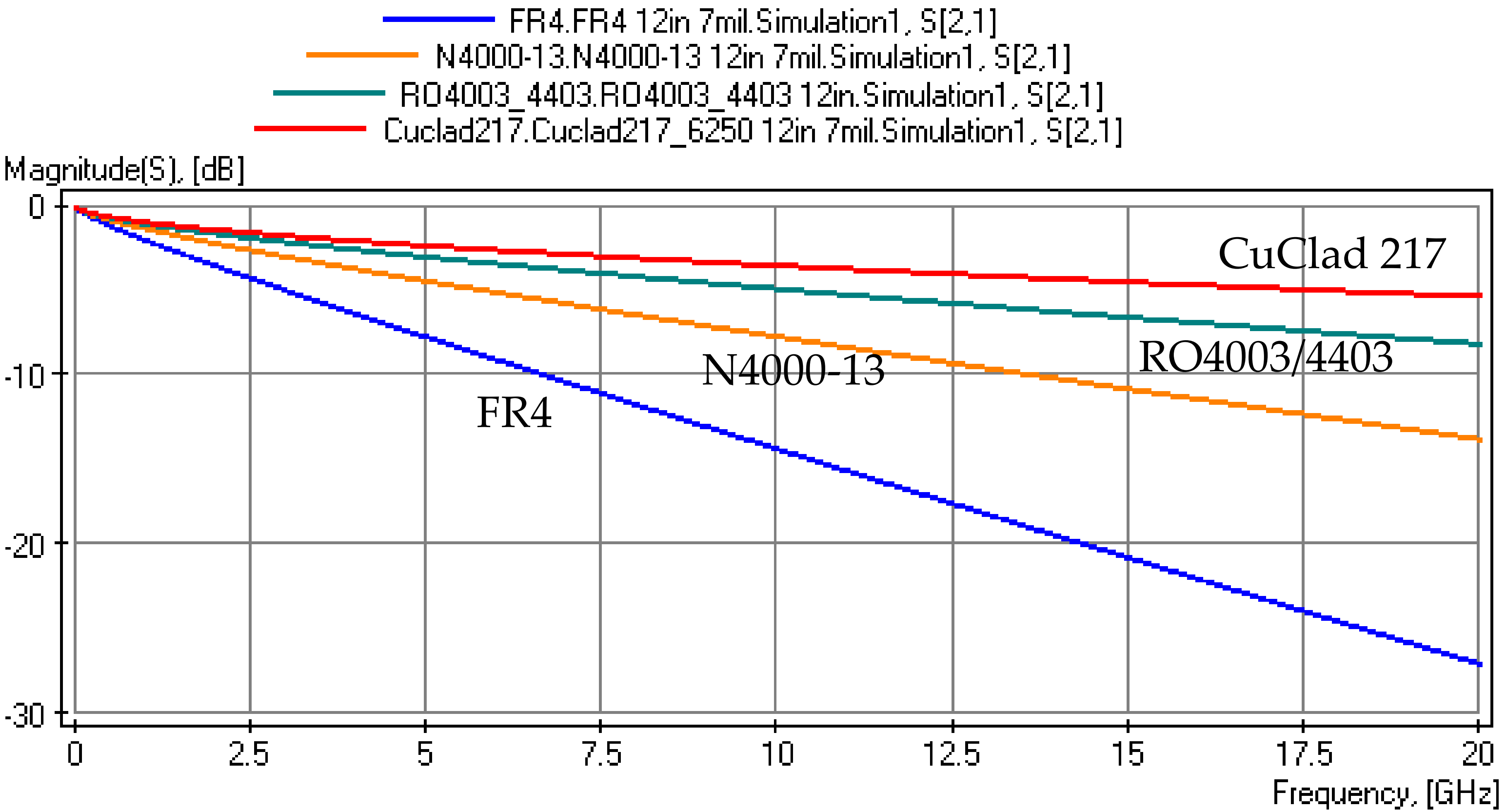
Introduction

Since the printed circuit board is a vital element in our field of semiconductor test, this investigation was undertaken to examine the impact of six different electrical and physical variables in a PCB, each of which plays a definite role in determining the integrity of the signal being transmitted. The focus is on the high-speed digital area. Although extensive use of modeling and simulation tools is made, validation and correlation of results with measured data is also done and will be presented.

Outline

- Dielectric properties
- Conductor skin effect
- Conductor surface roughness
- Via stub effects
- Crosstalk
- Signal return path quality and localization

Comparison of dielectric losses for 12-inch stripline



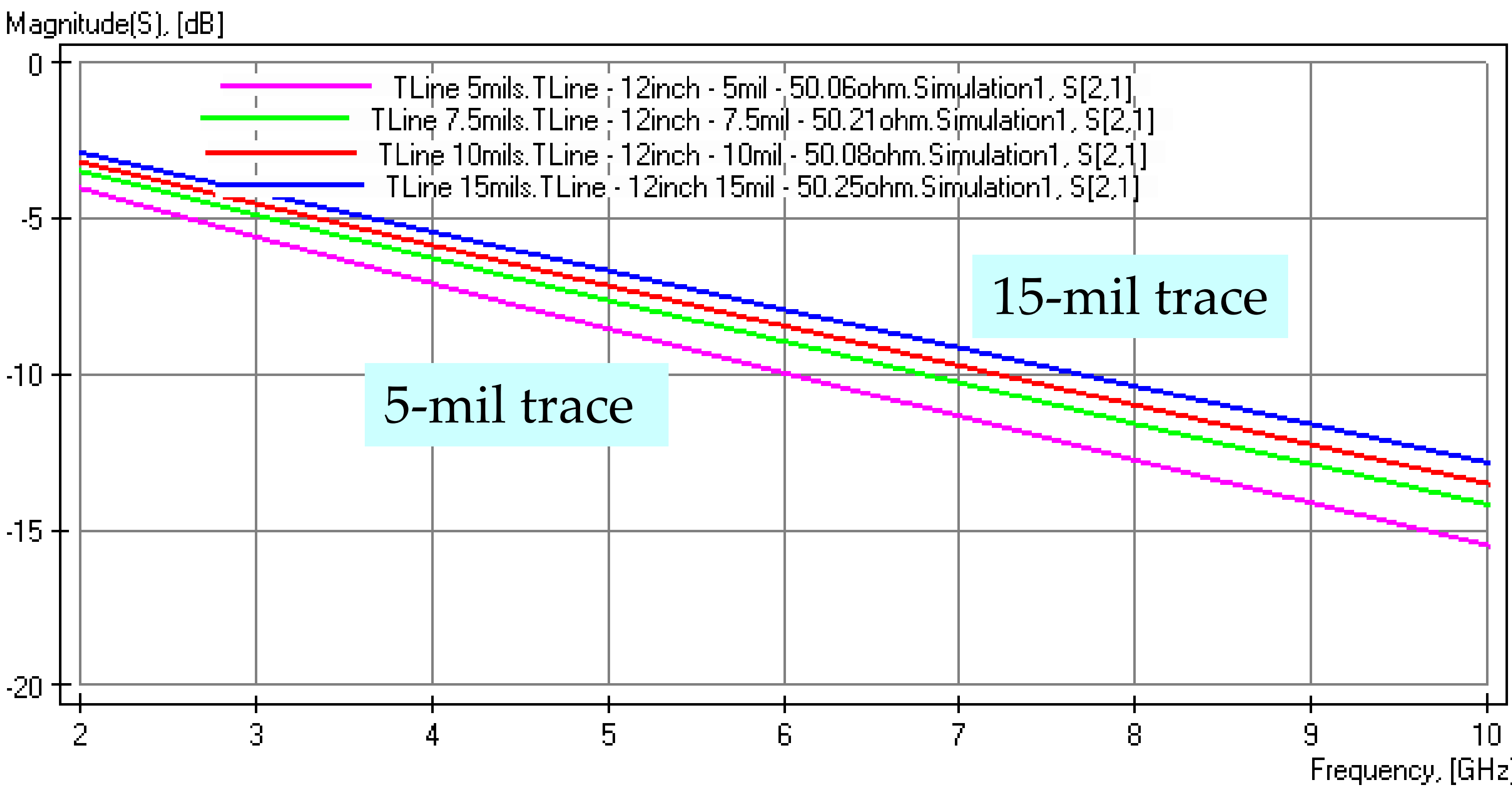
Insertion loss S21 variation due to conductor skin effect

Skin depth

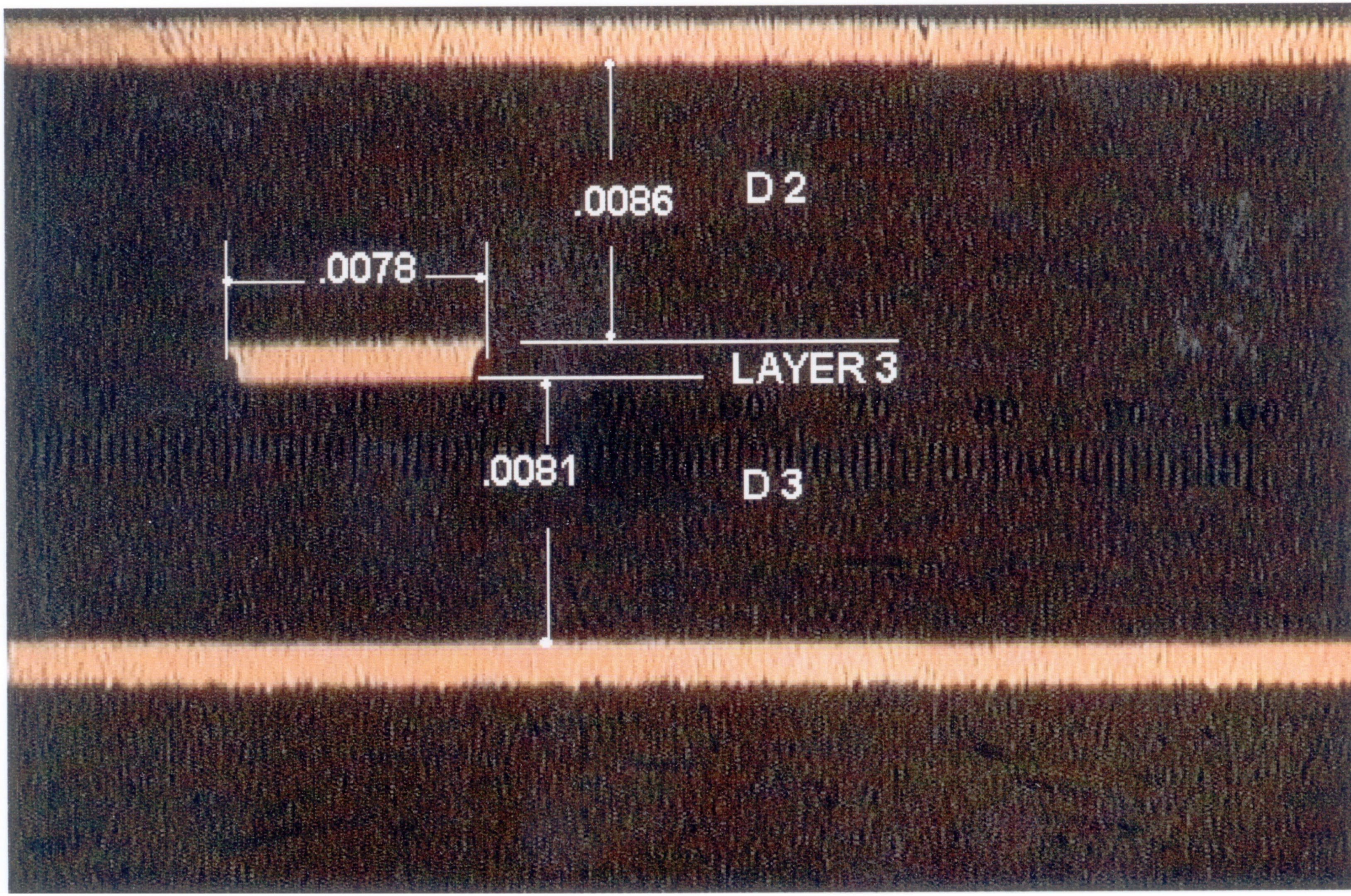
$$\delta = \sqrt{\frac{2\rho}{\omega\mu}} = \sqrt{\frac{2\rho}{2\pi f\mu}}$$

Copper skin depth as a function of frequency

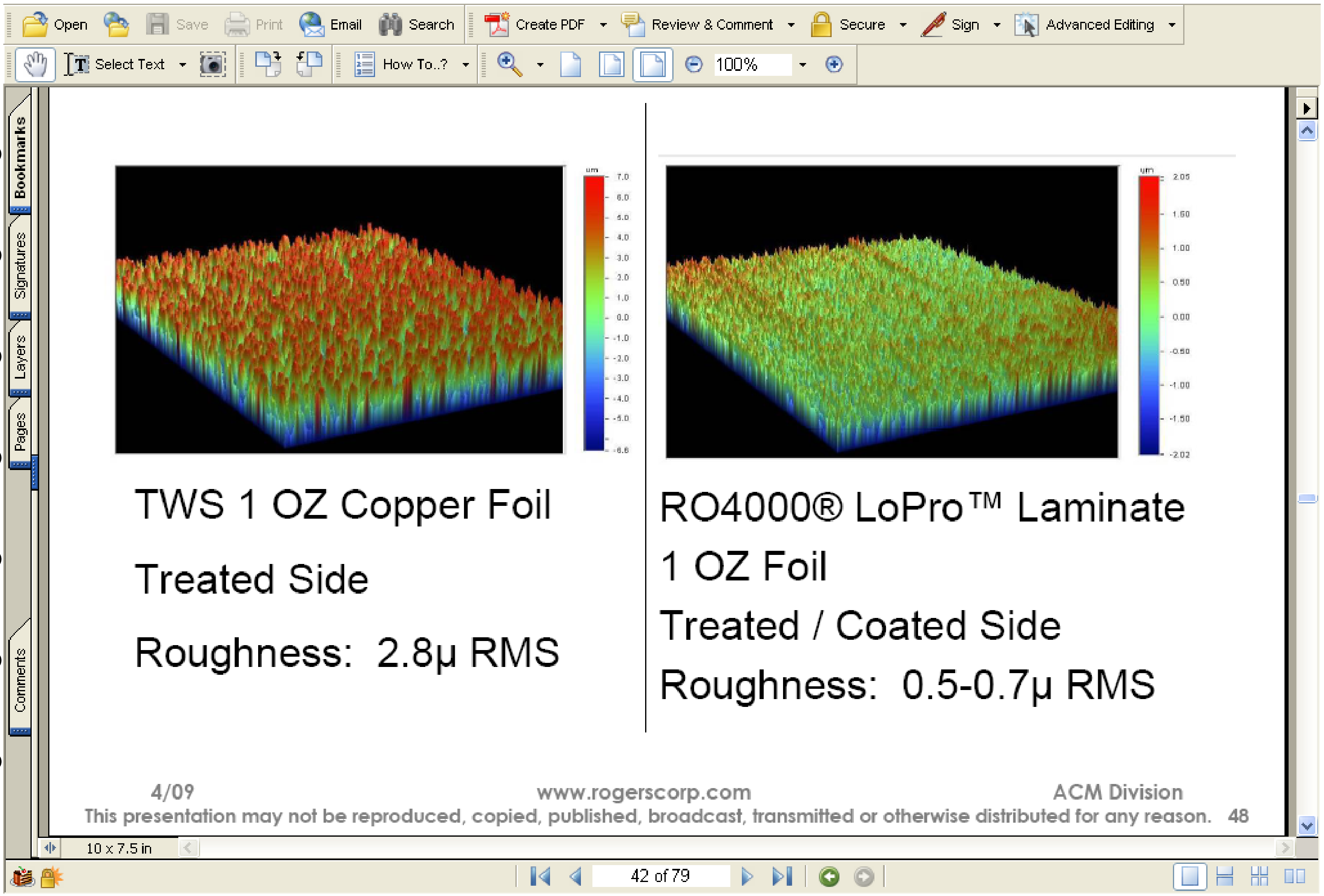
Frequency	Skin depth (micron)
10 MHz	21.00
100 MHz	6.60
1 GHz	2.10
10 GHZ	0.66
1 oz. copper thickness = 30.5 microns	



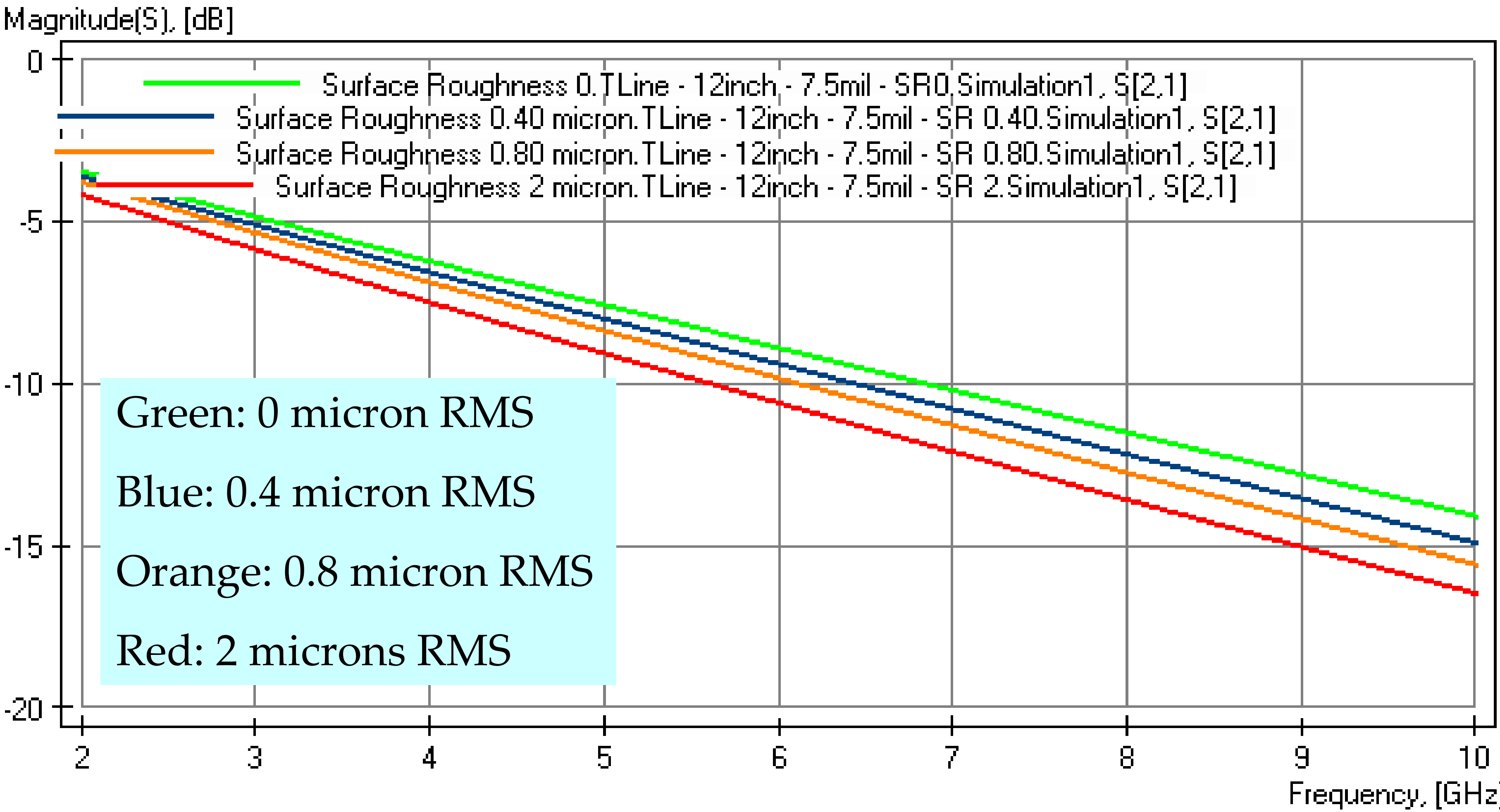
Conductor surface roughness



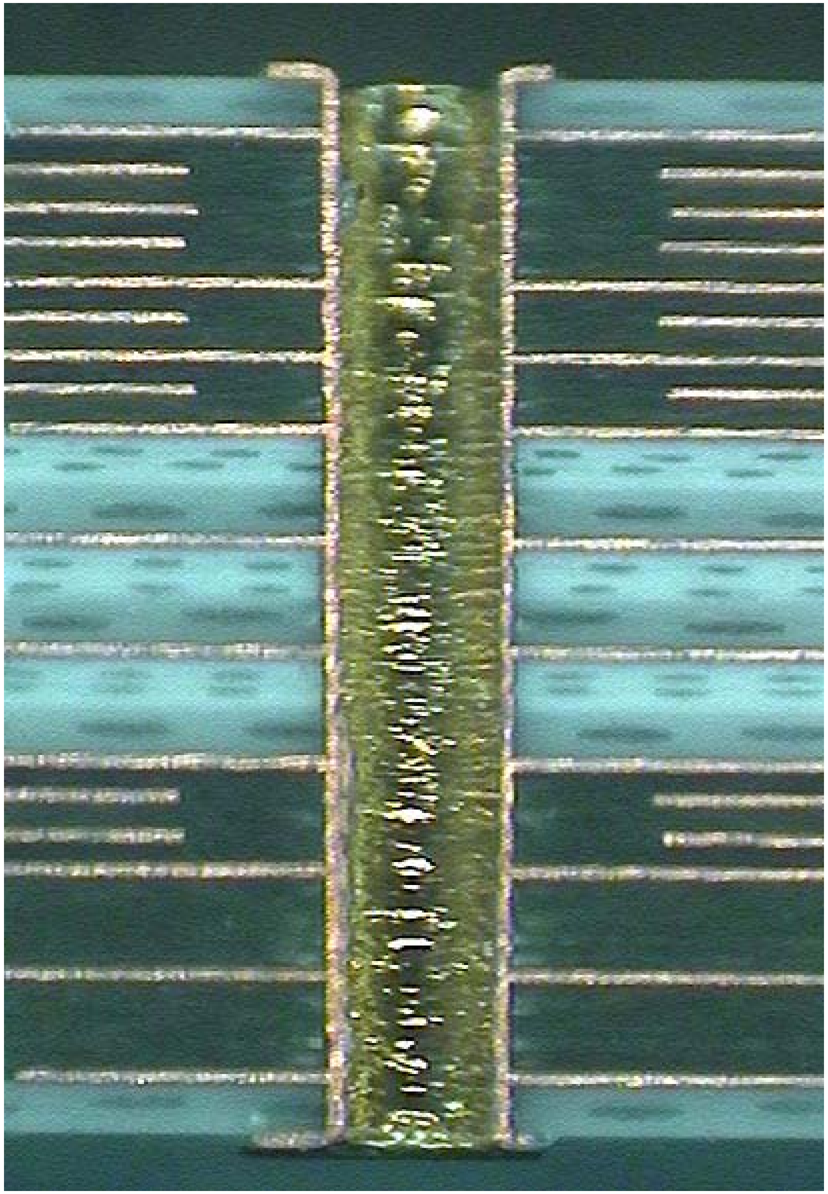
Conductor surface roughness (cont’d)



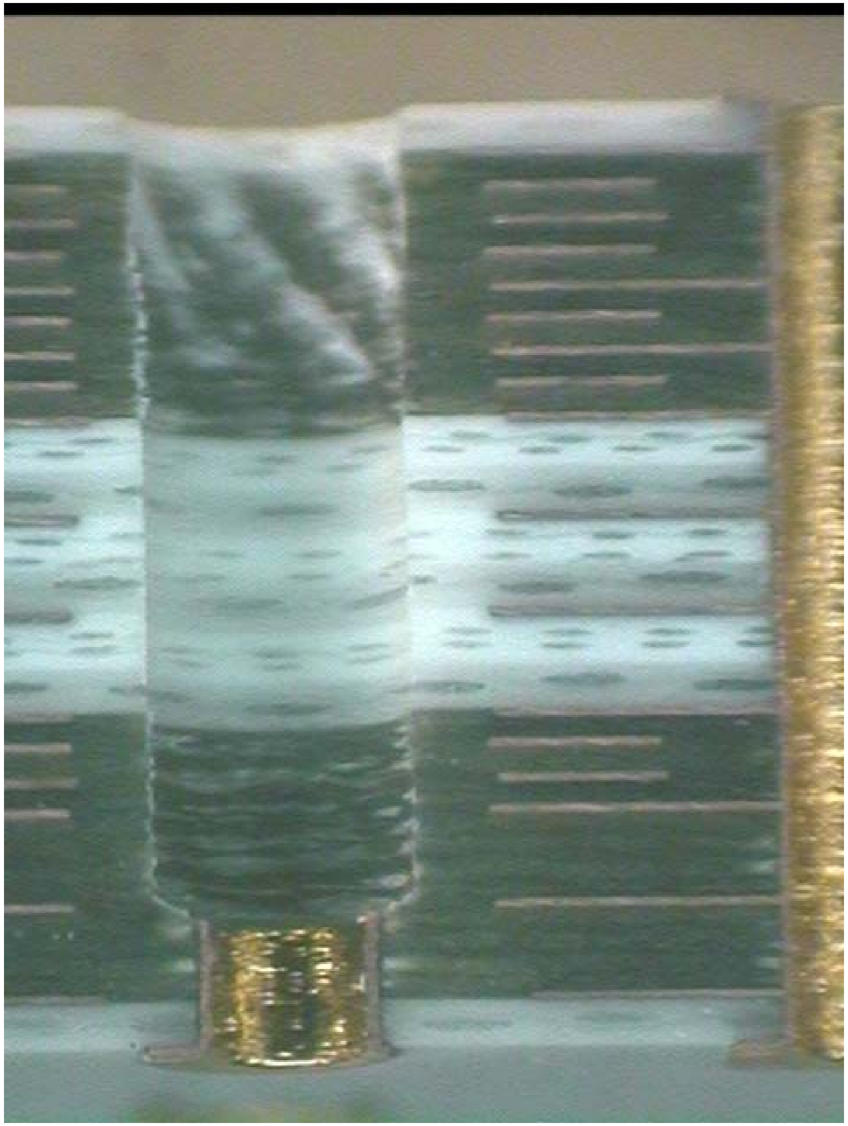
Insertion loss S21 variation due to conductor surface roughness



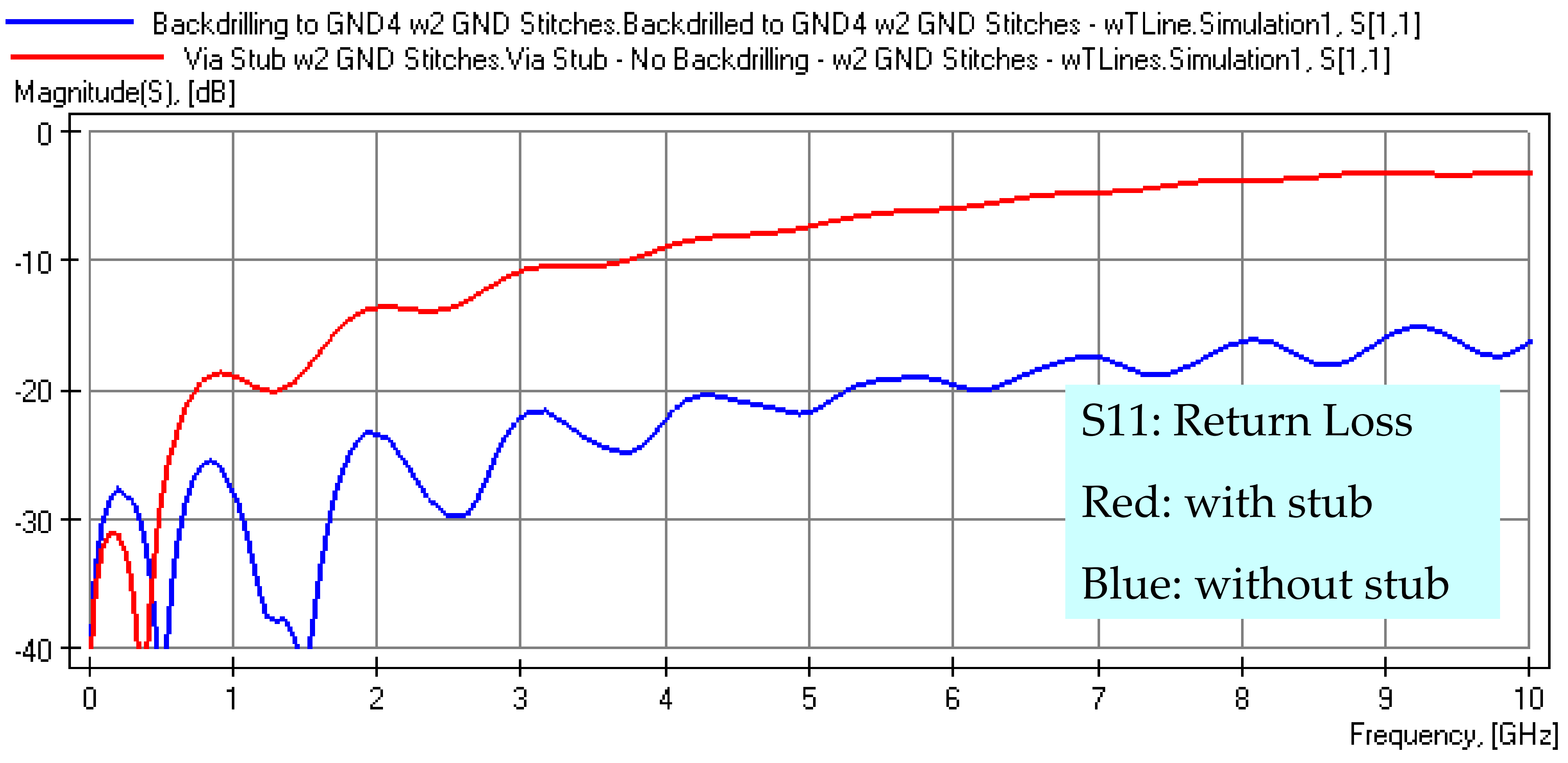
Via cross section photo



Via stub drilling

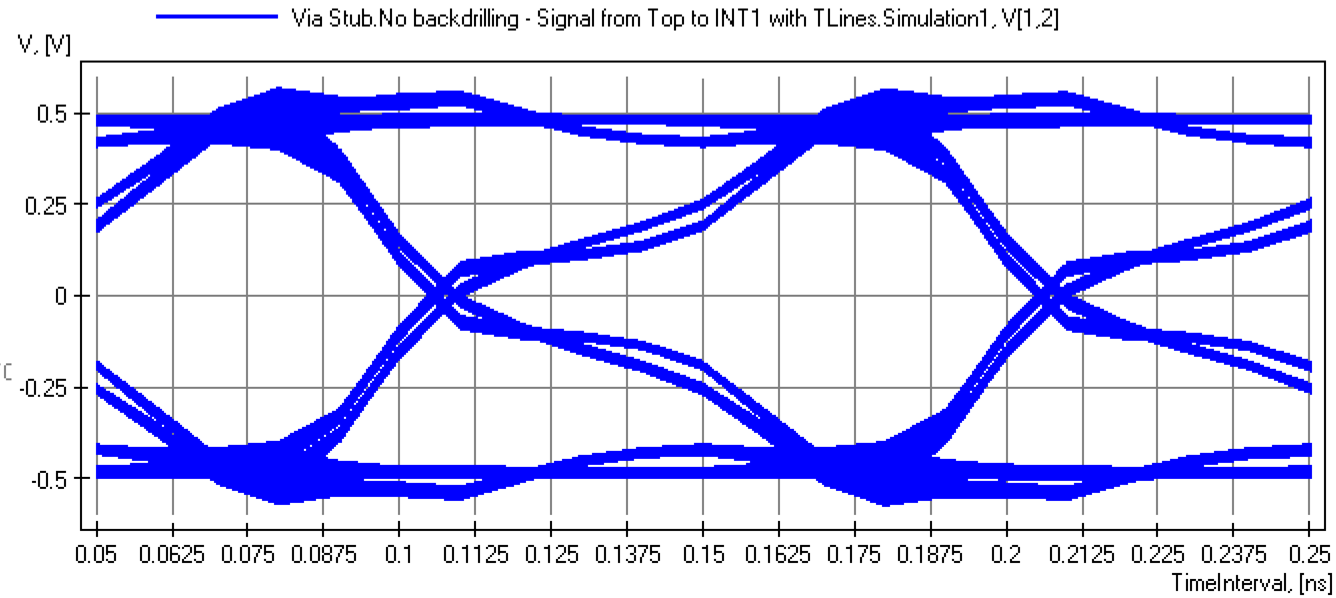


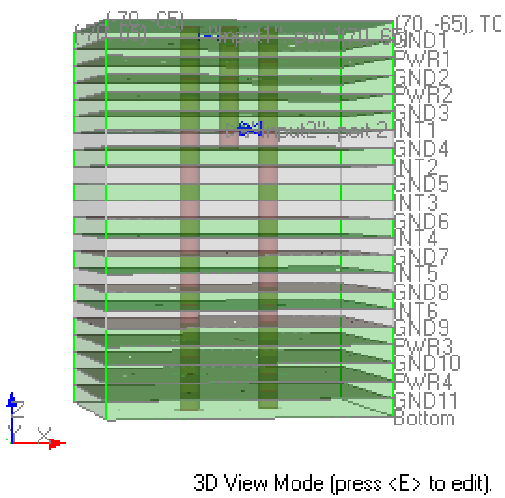
Return loss S11 for via example with and without stub



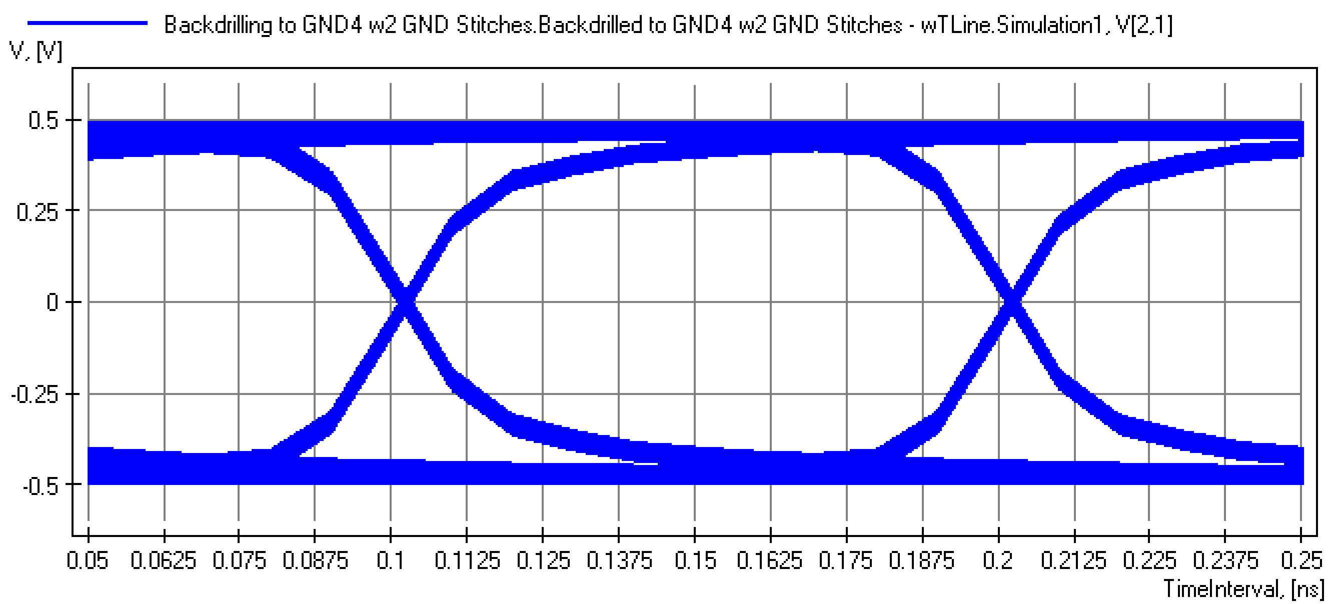
Eye diagrams for via example

Via with stub

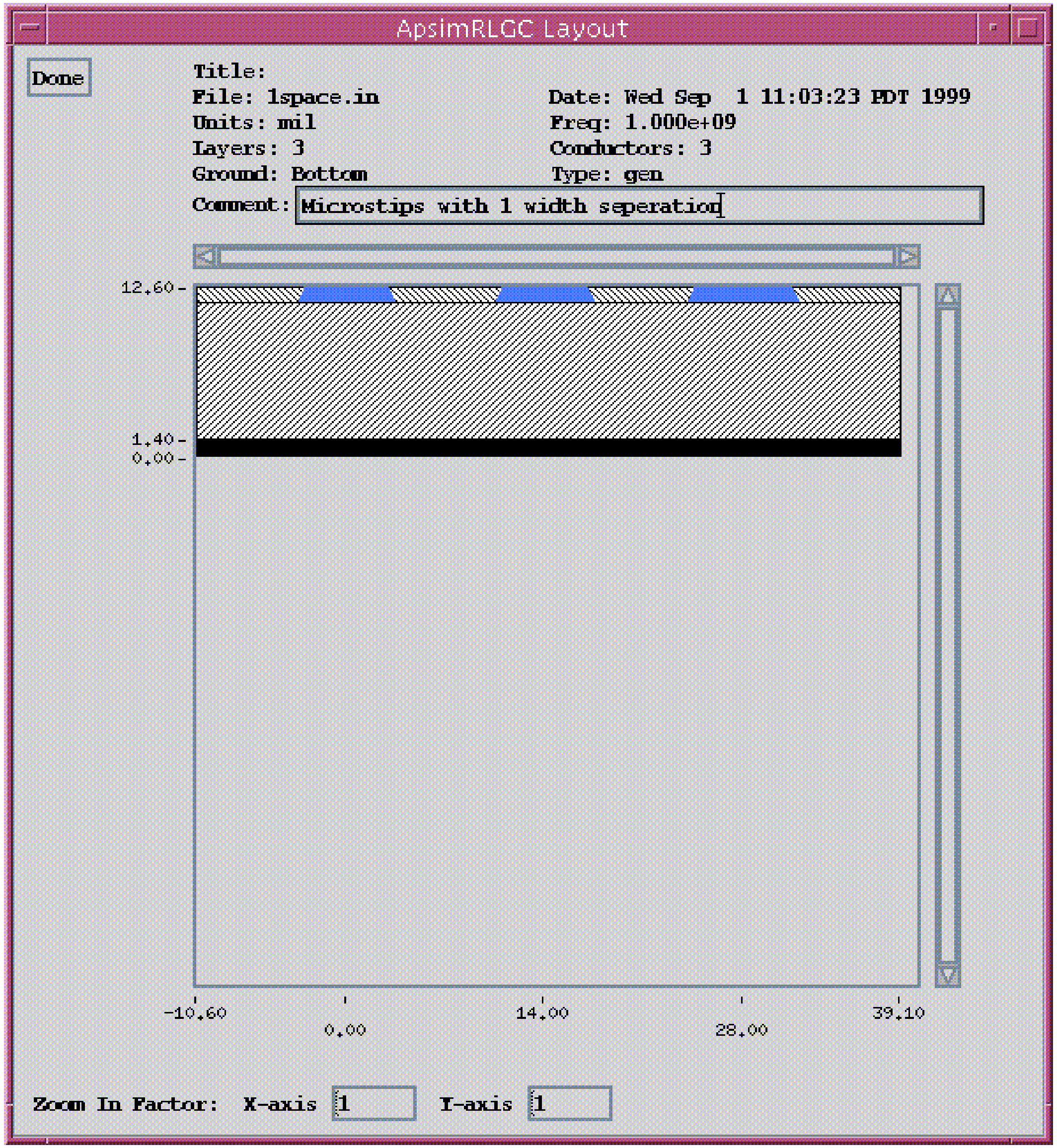




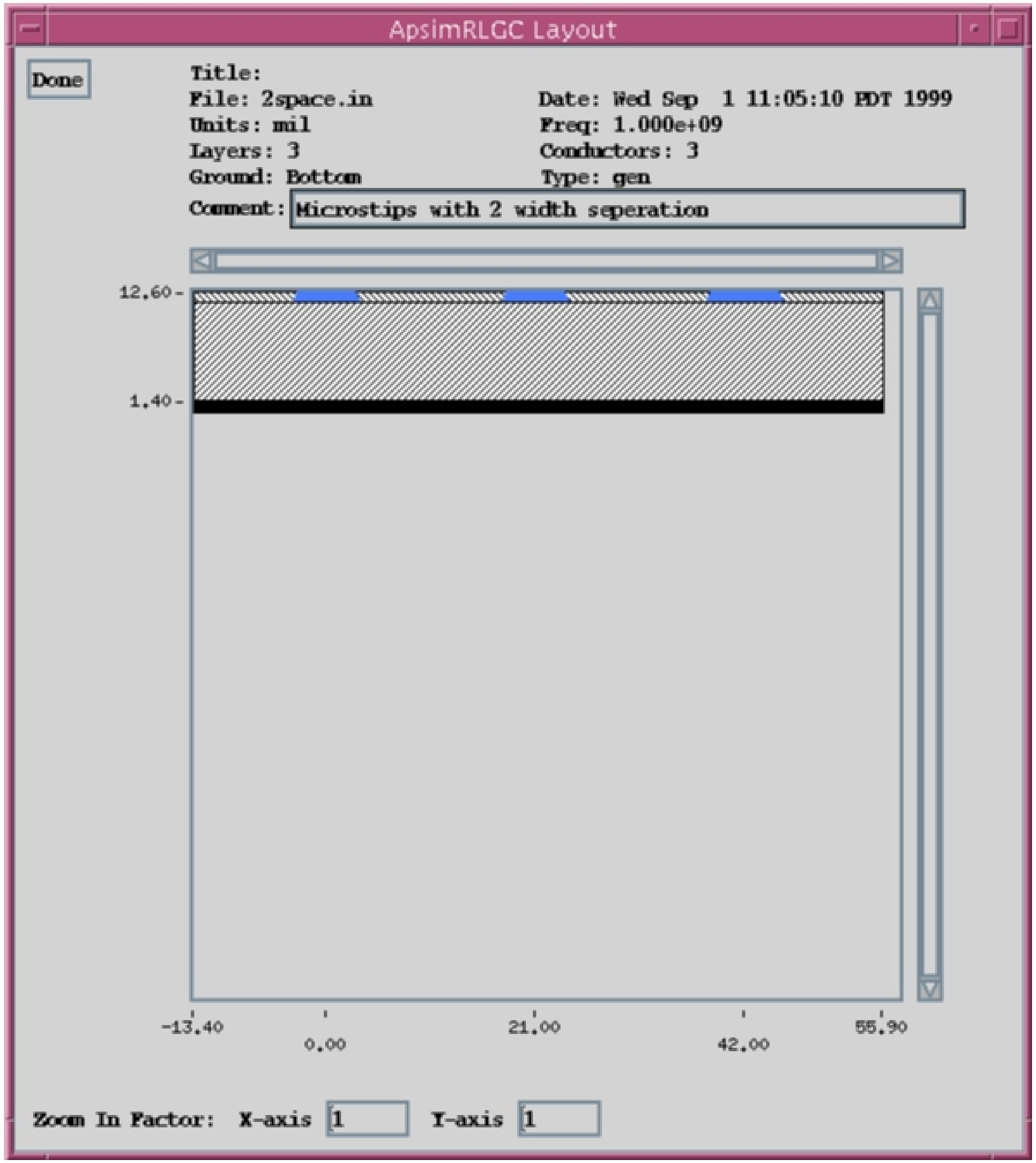
Via with stub removed



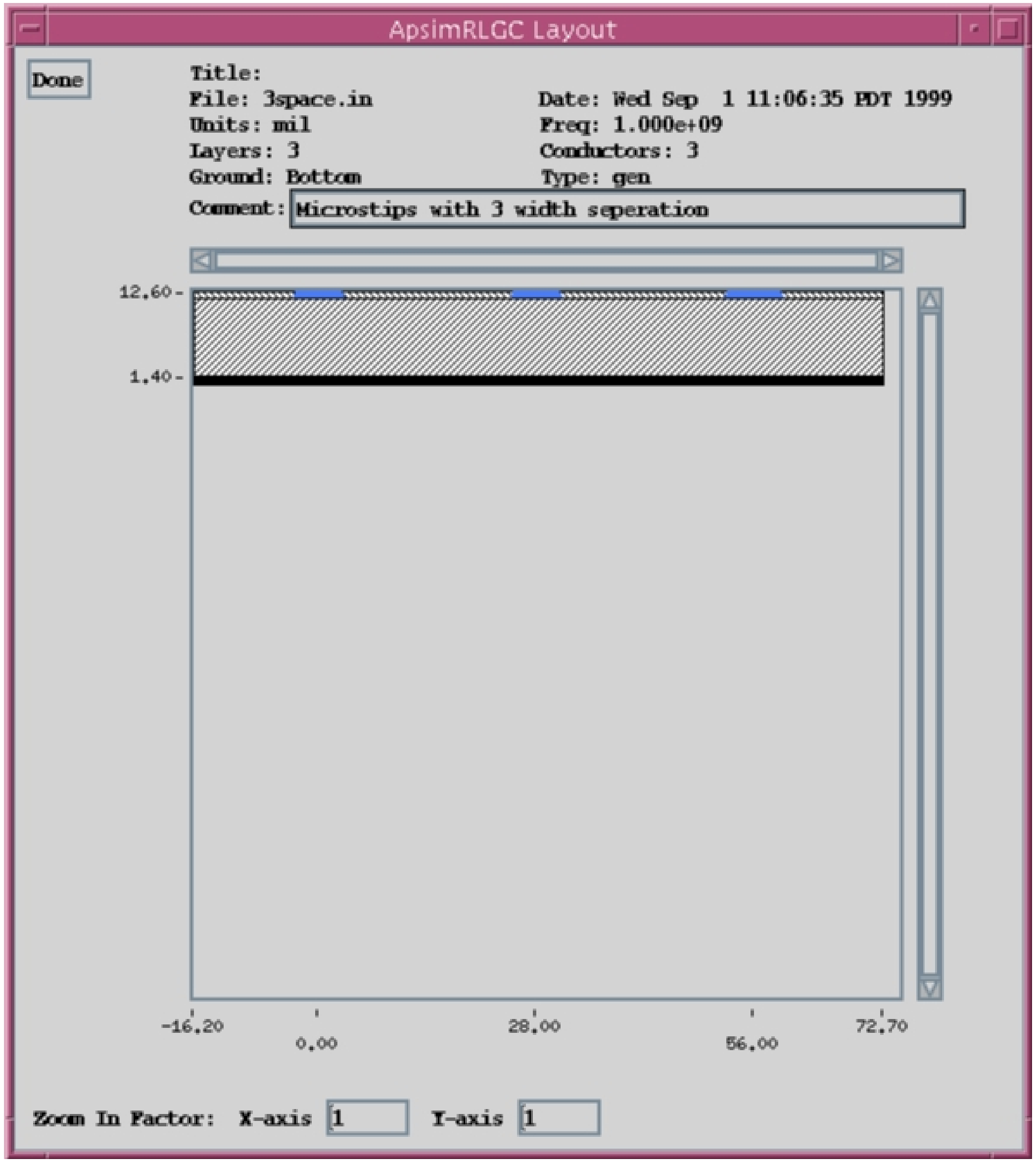
Conductor to conductor crosstalk



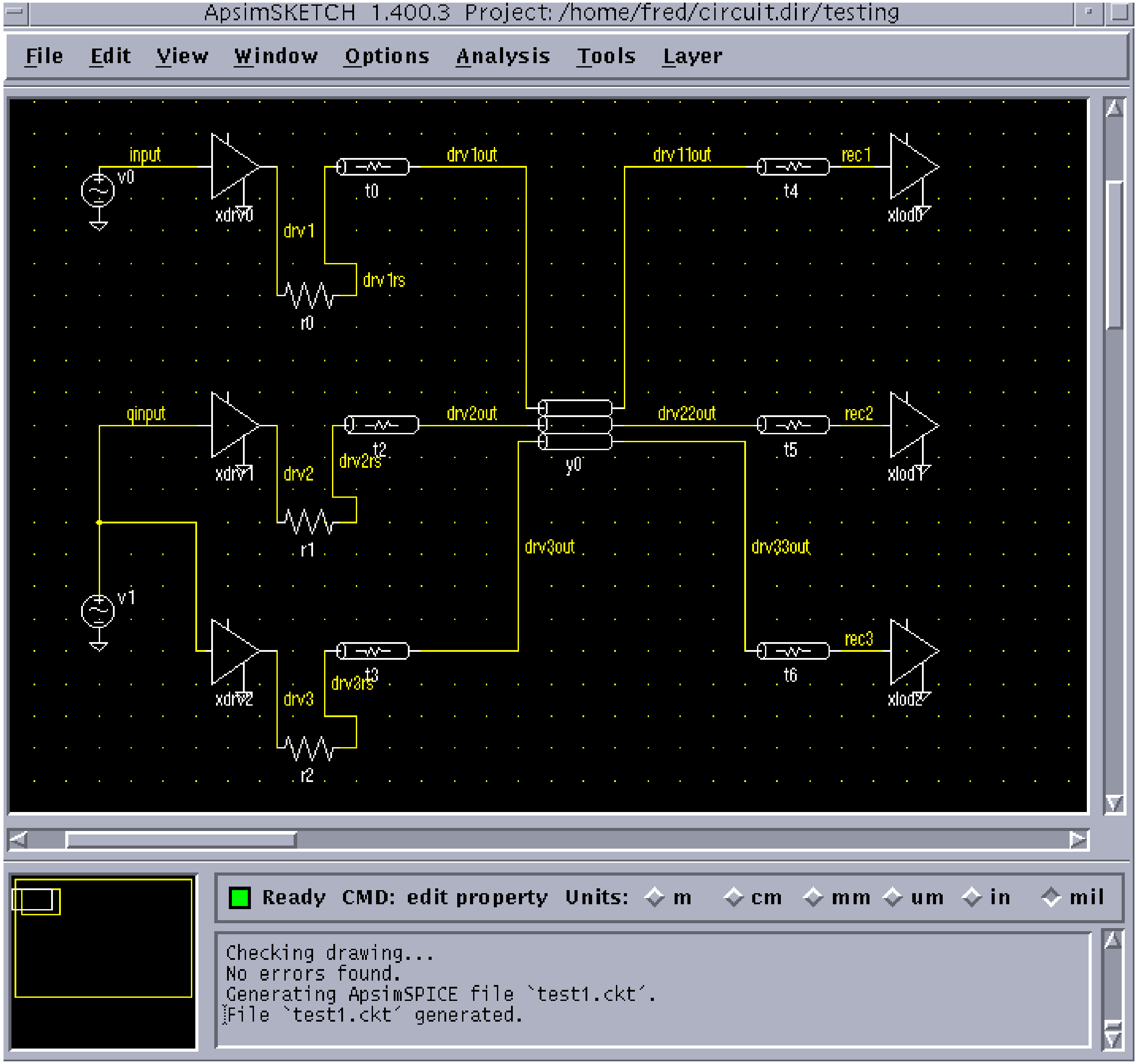
Conductor to conductor crosstalk (cont'd)



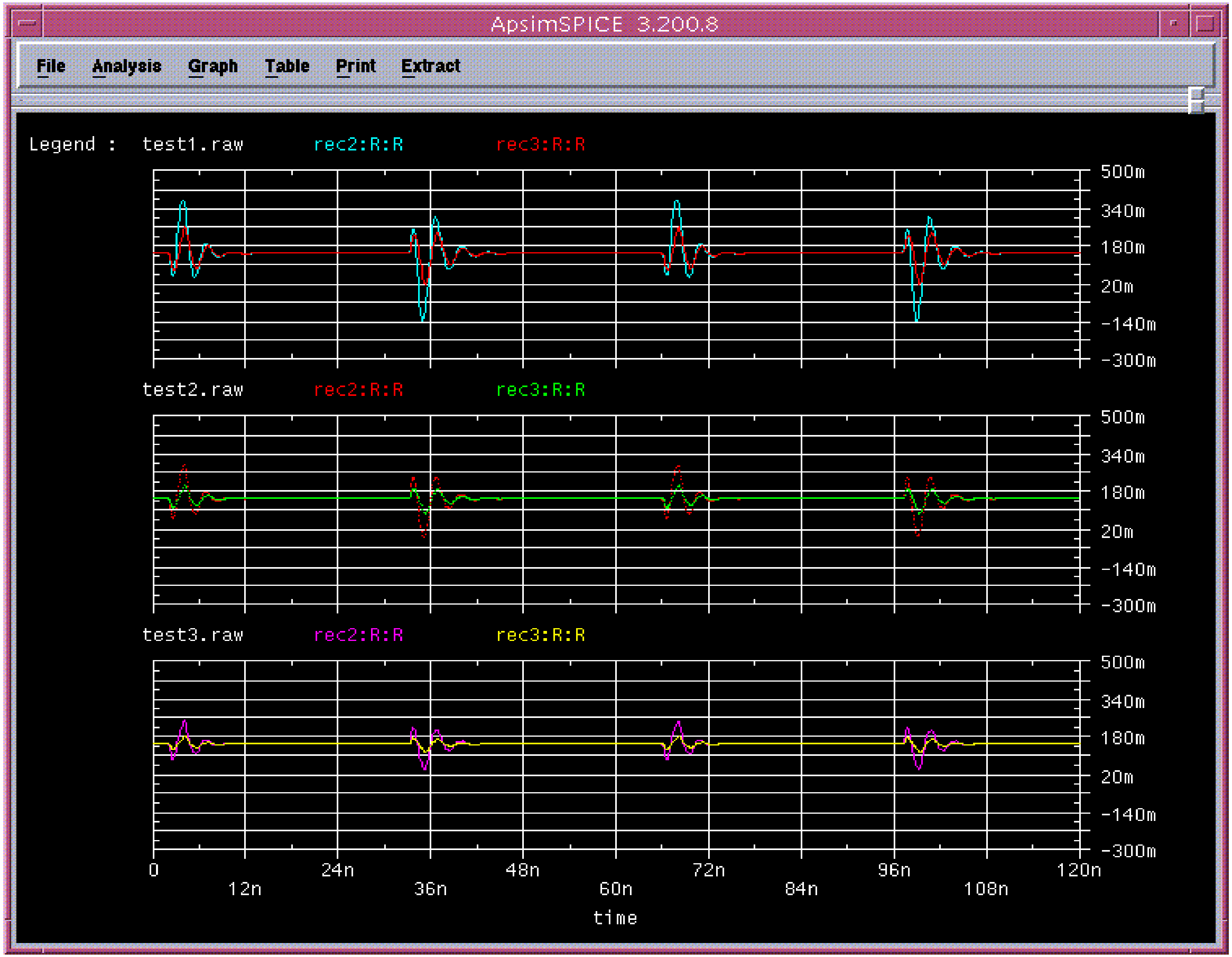
Conductor to conductor crosstalk (cont'd)



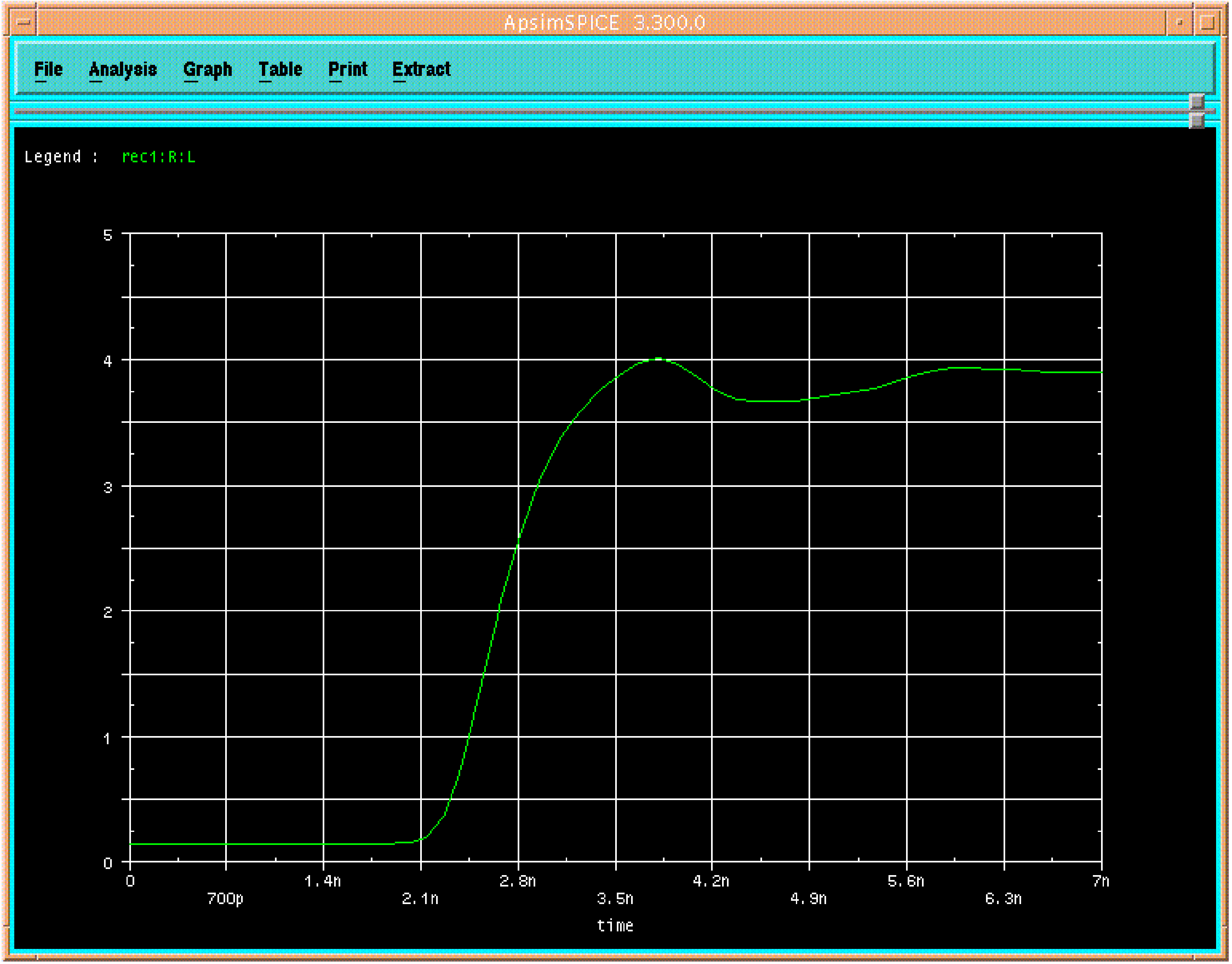
Crosstalk simulation circuit



Noise on adjacent victim lines

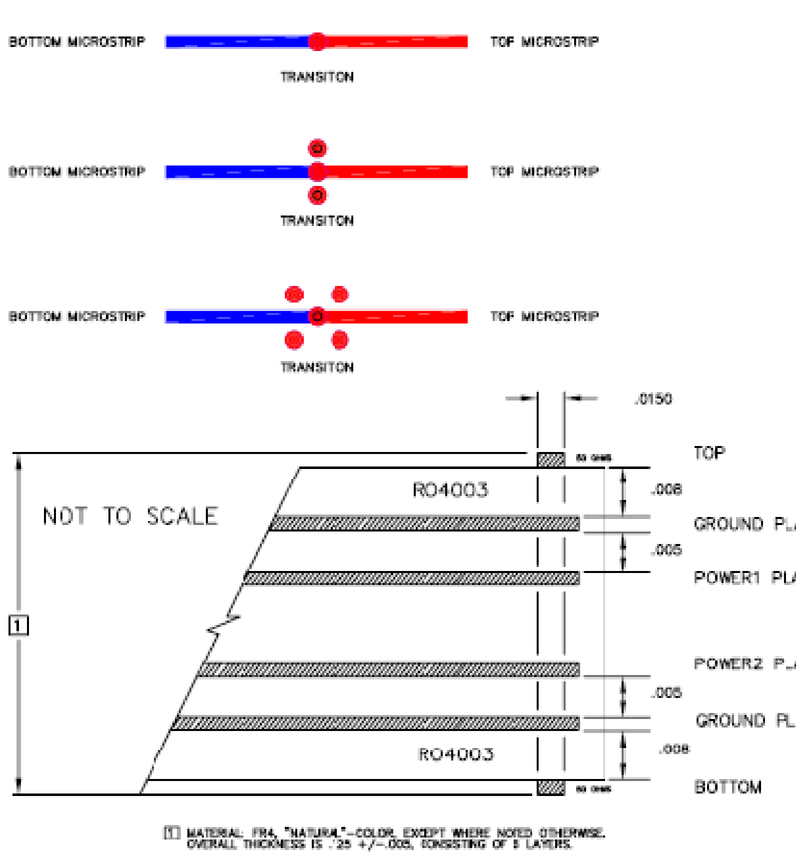


Square wave leading edge

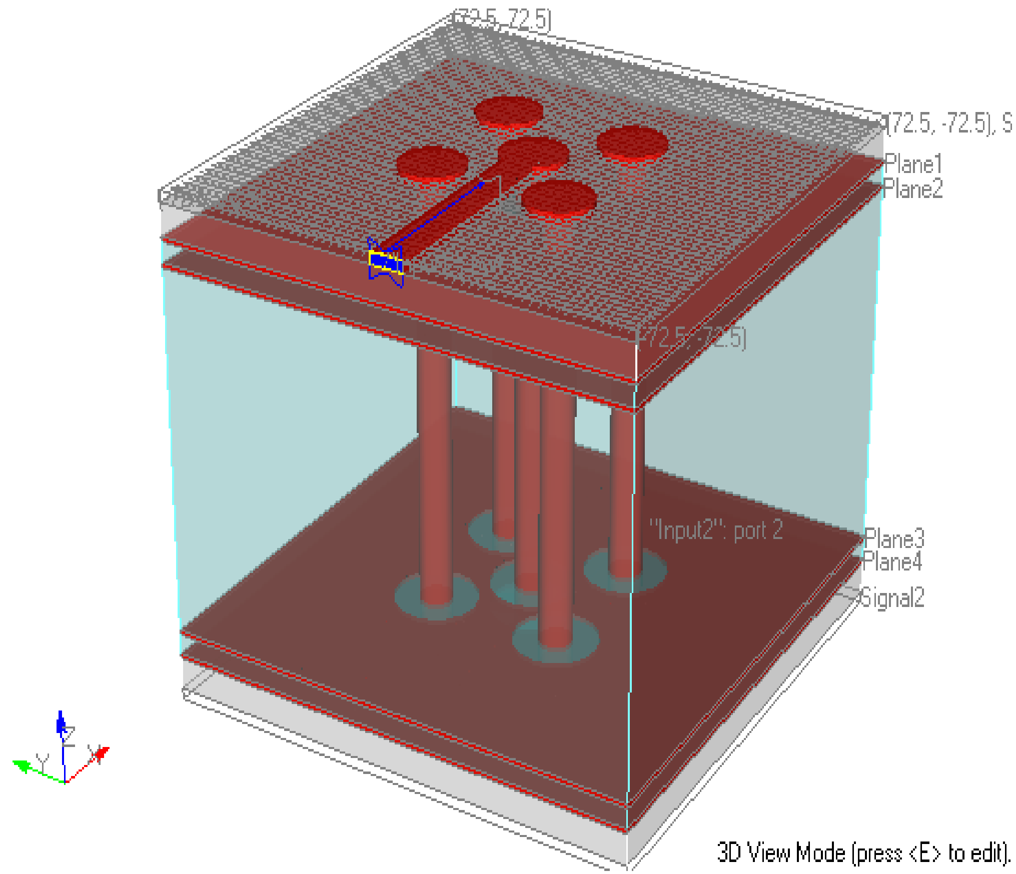


Signal return path quality and localization

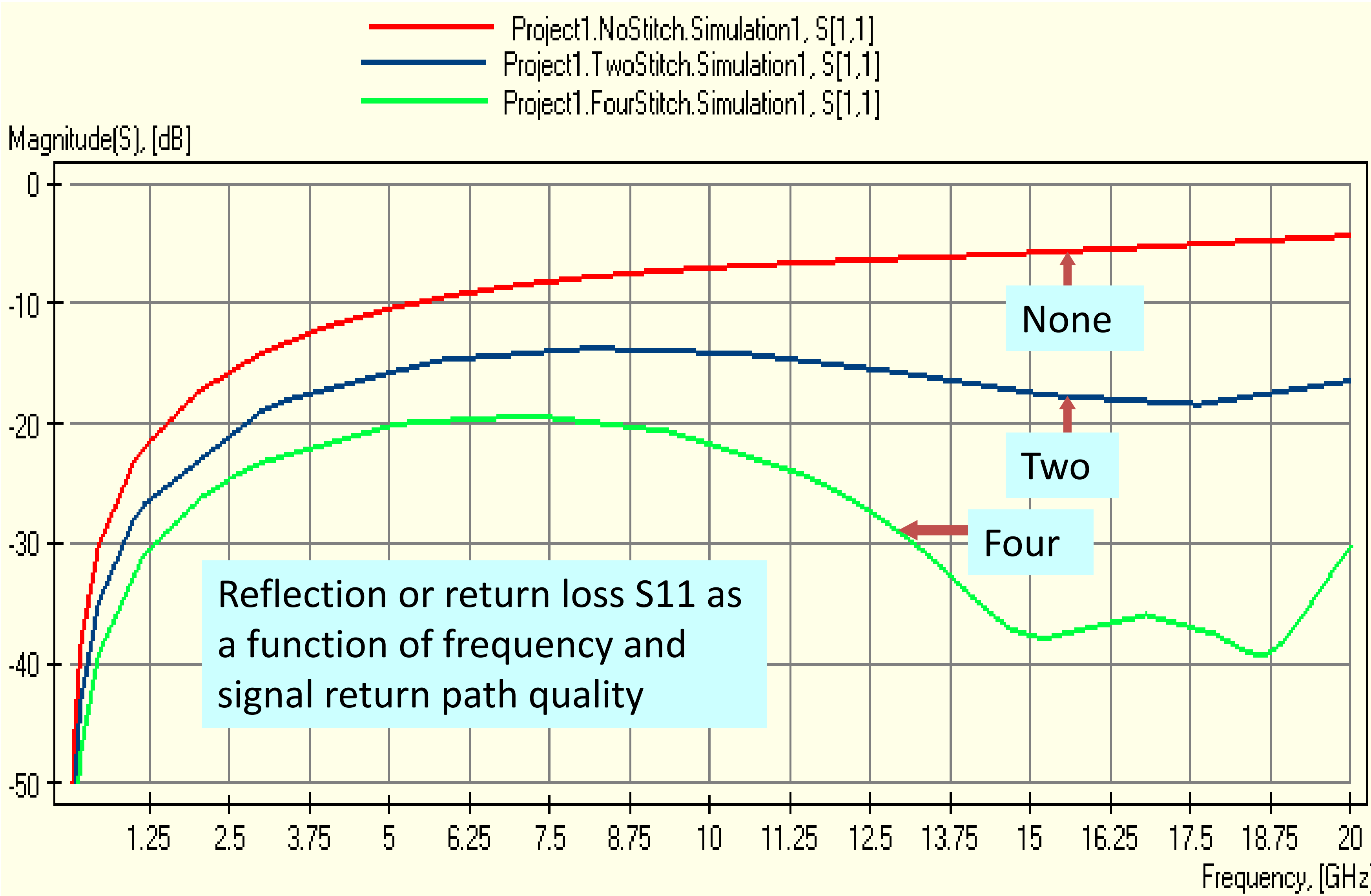
From CAD



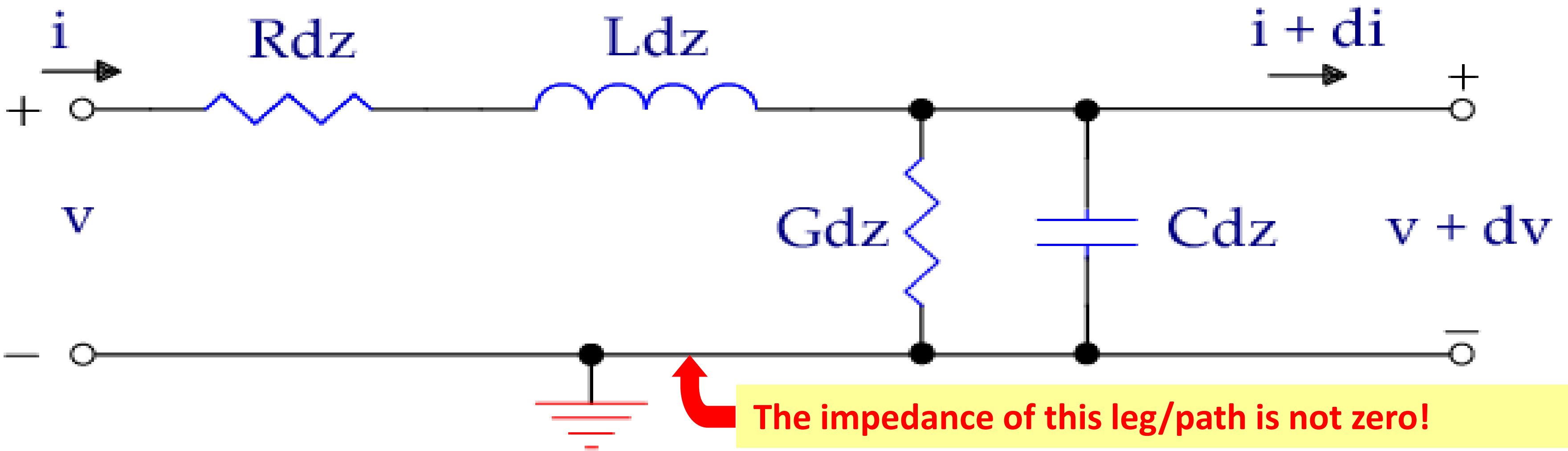
Modeling in Simbeor



Return loss S11 for three ground stitch patterns



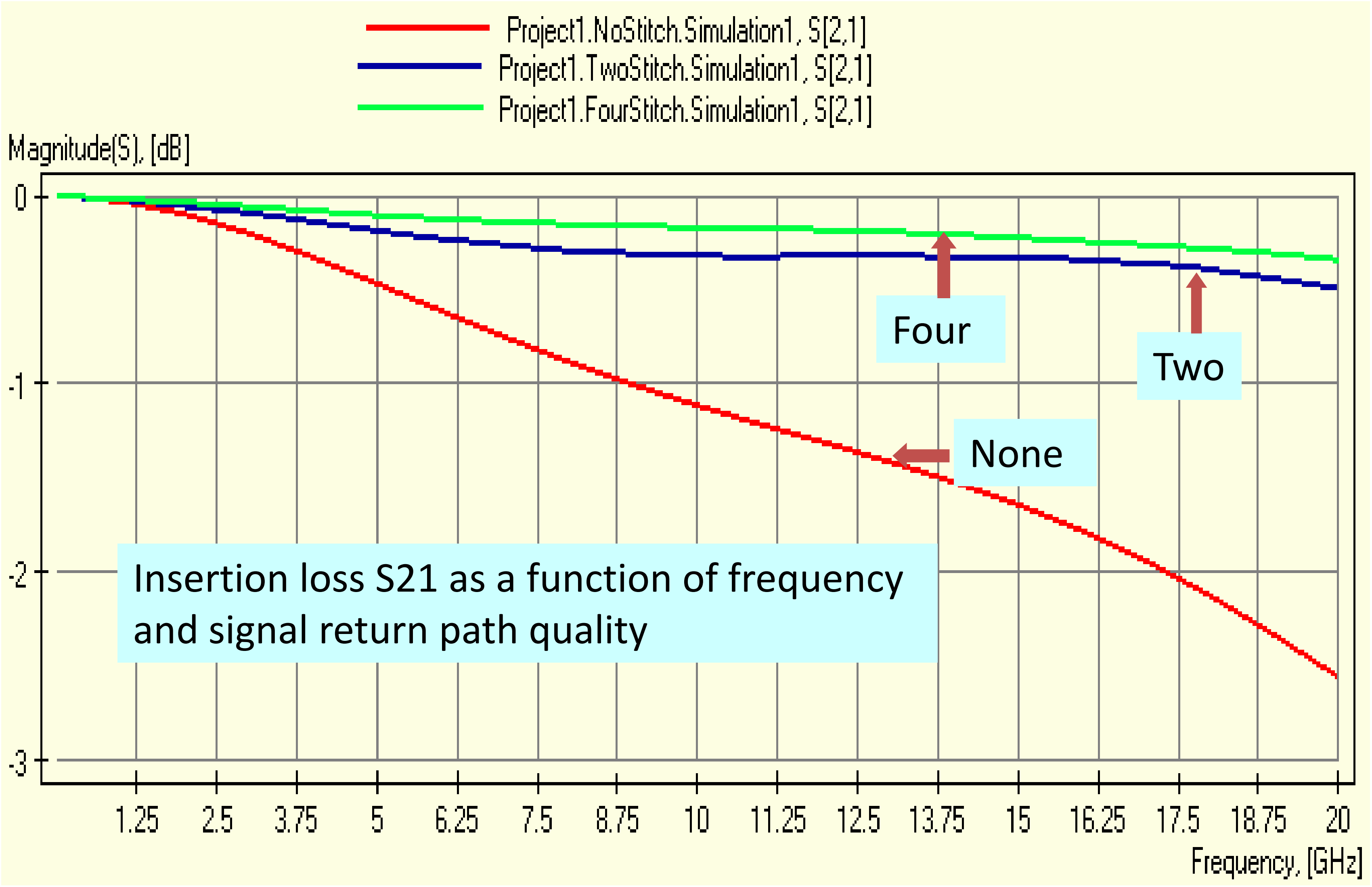
RLGC model for length dz



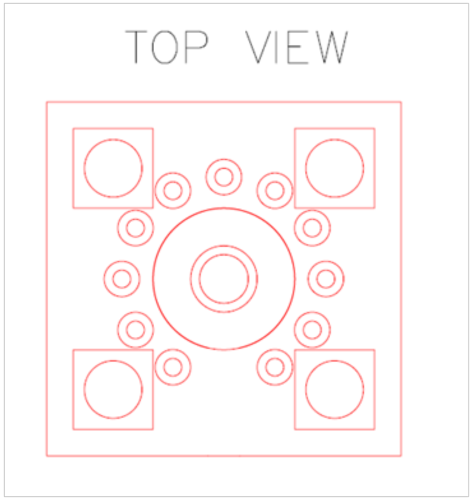
$$\frac{dv}{dz} = -L\,\frac{di}{dt} - R\,i$$

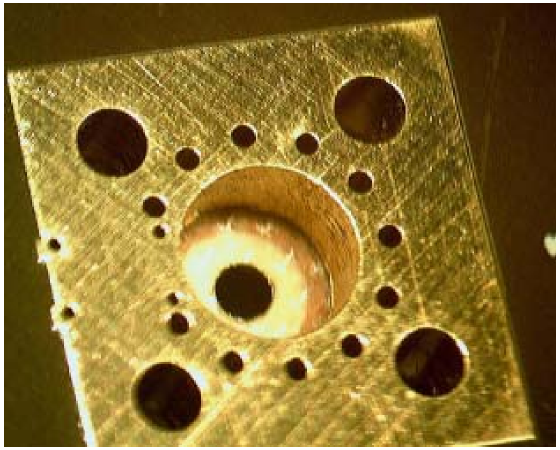
$$\frac{di}{dz} = -C\,\frac{dv}{dt} - G\,v$$

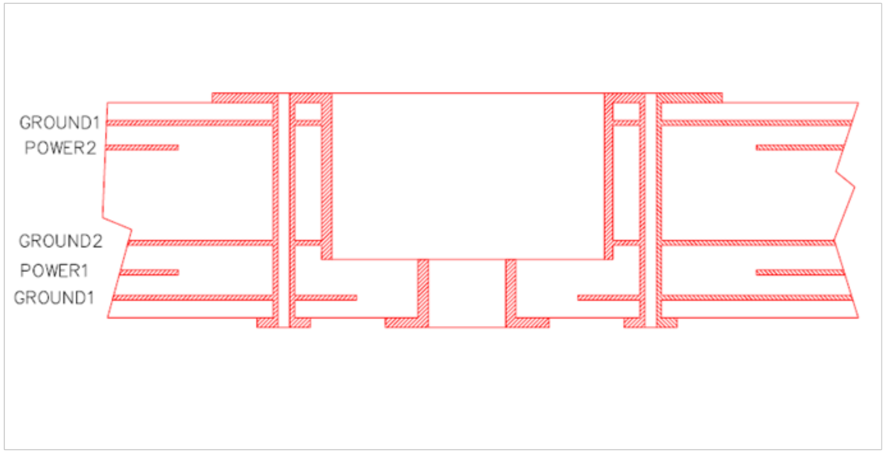
Insertion loss S21 for three ground stitch patterns



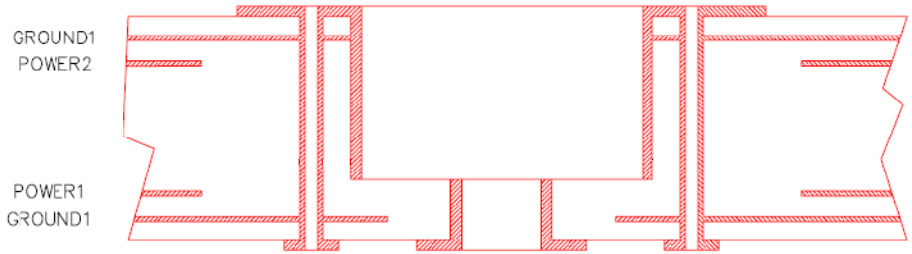
SMA launch detail





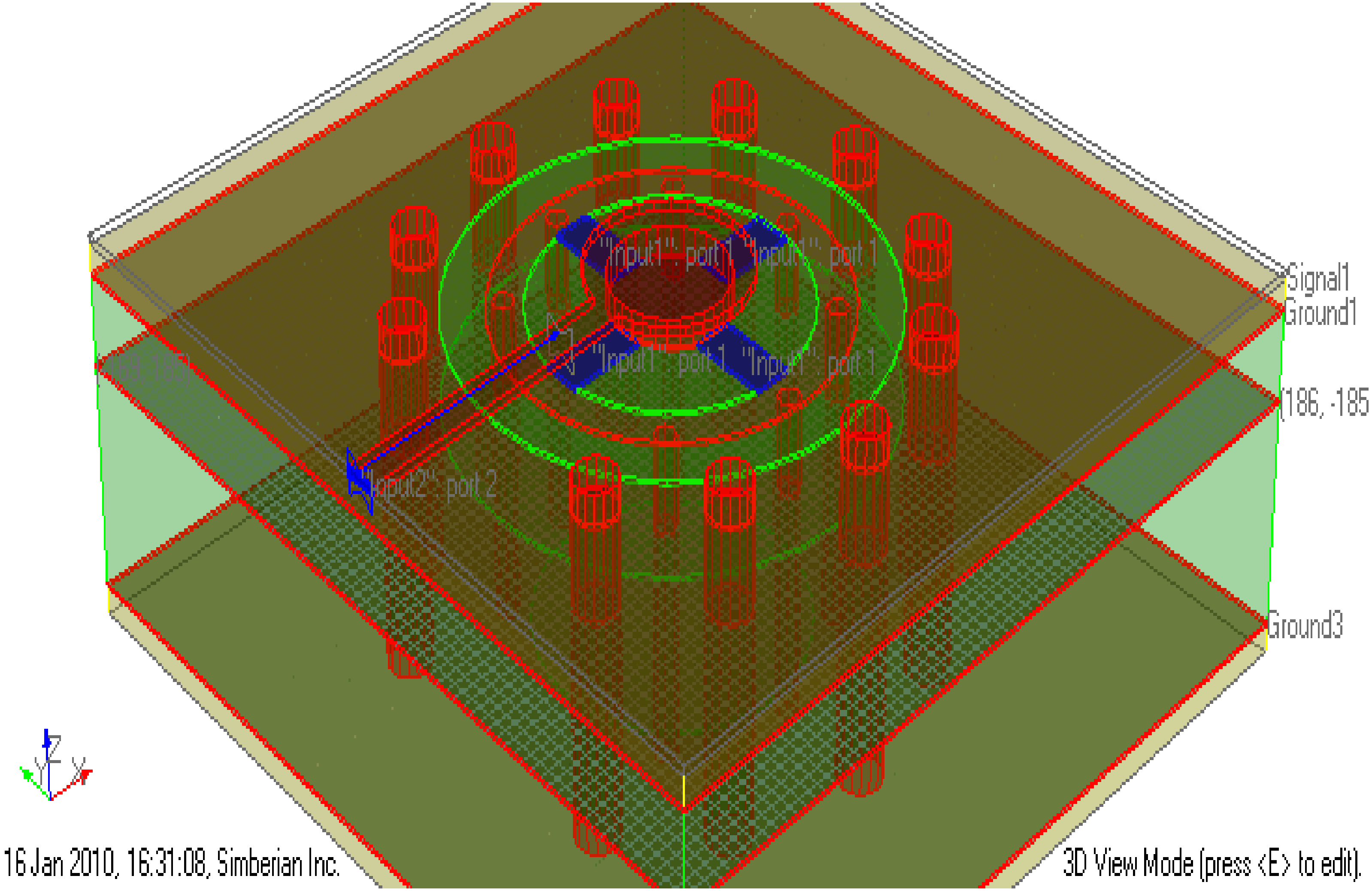


Improved signal return path

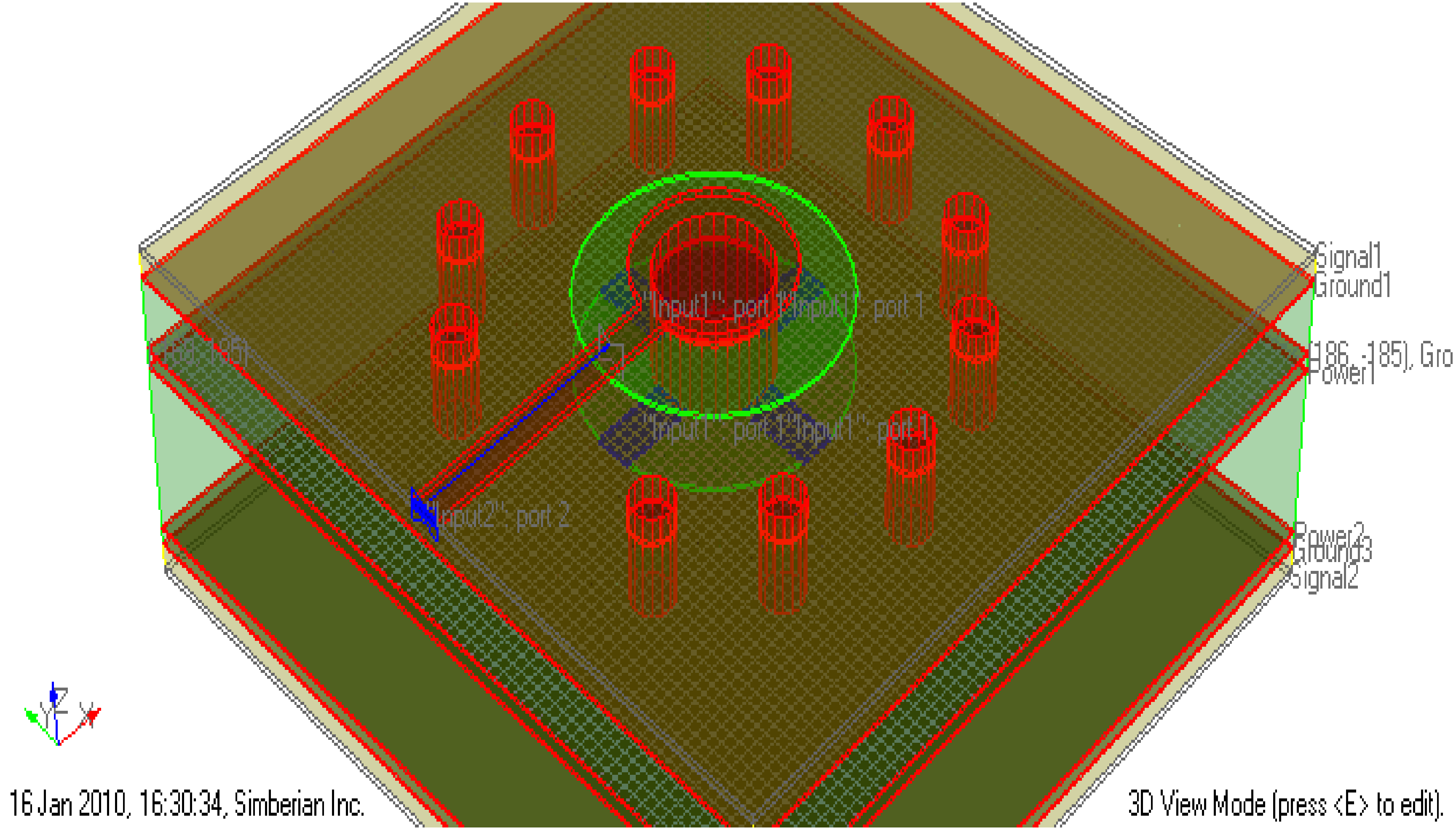


Poor signal return path

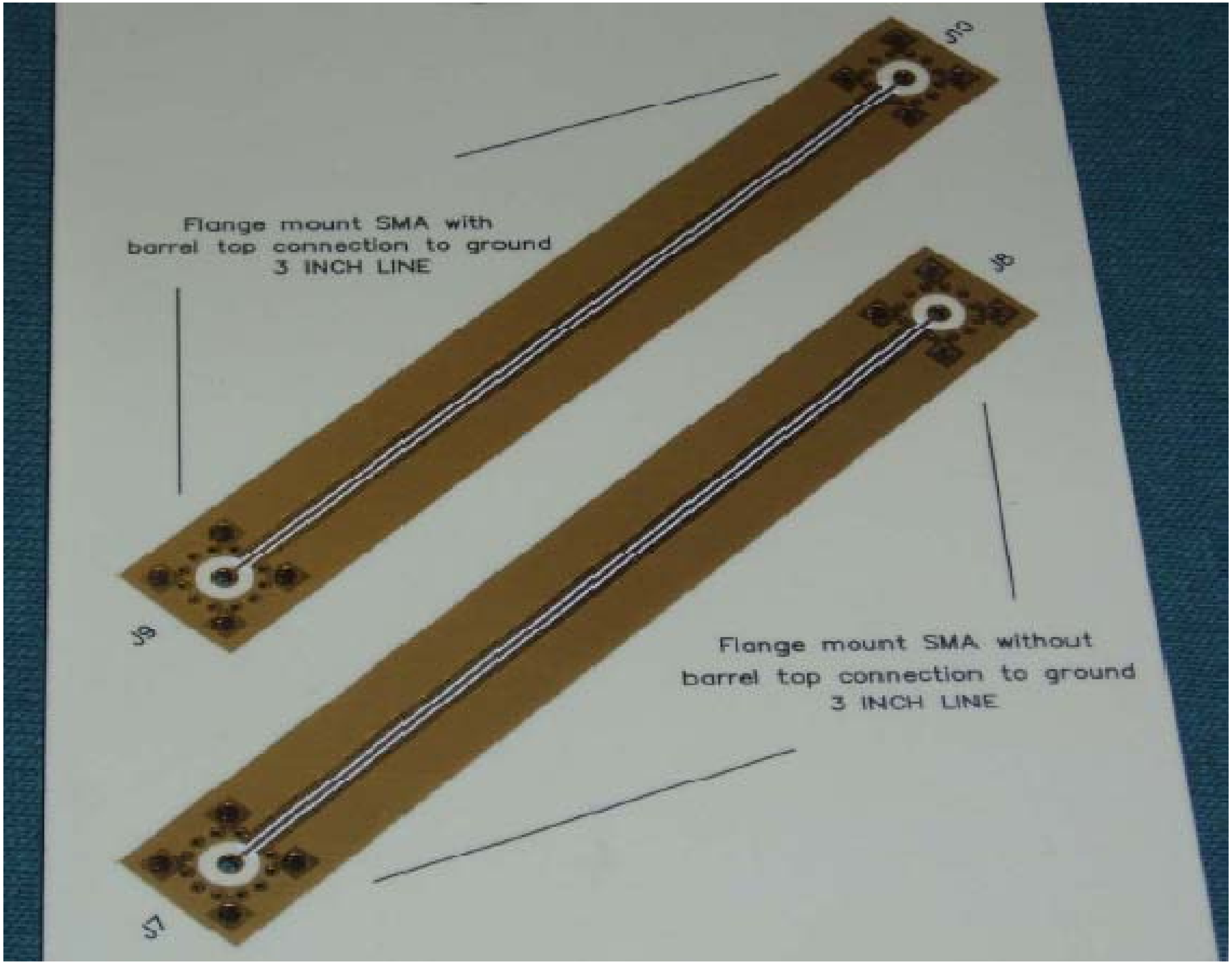
Poor return path model



Improved return path model

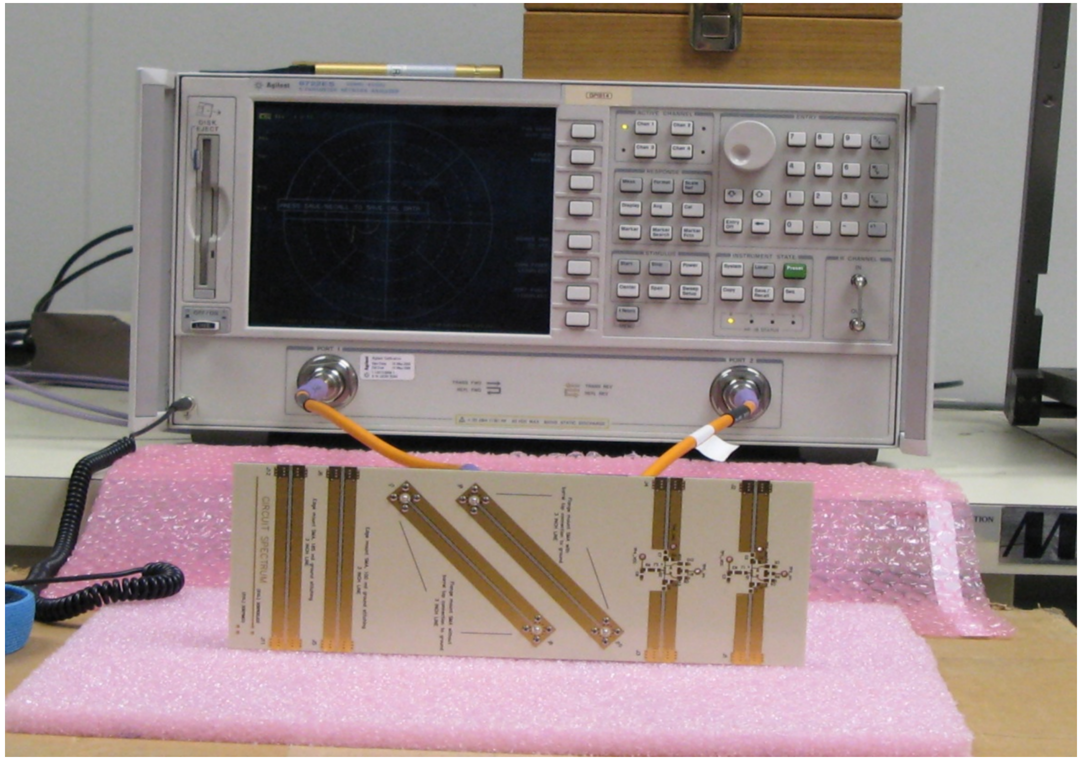


SMA launches joined by co-planar microstrips



VNA and test board

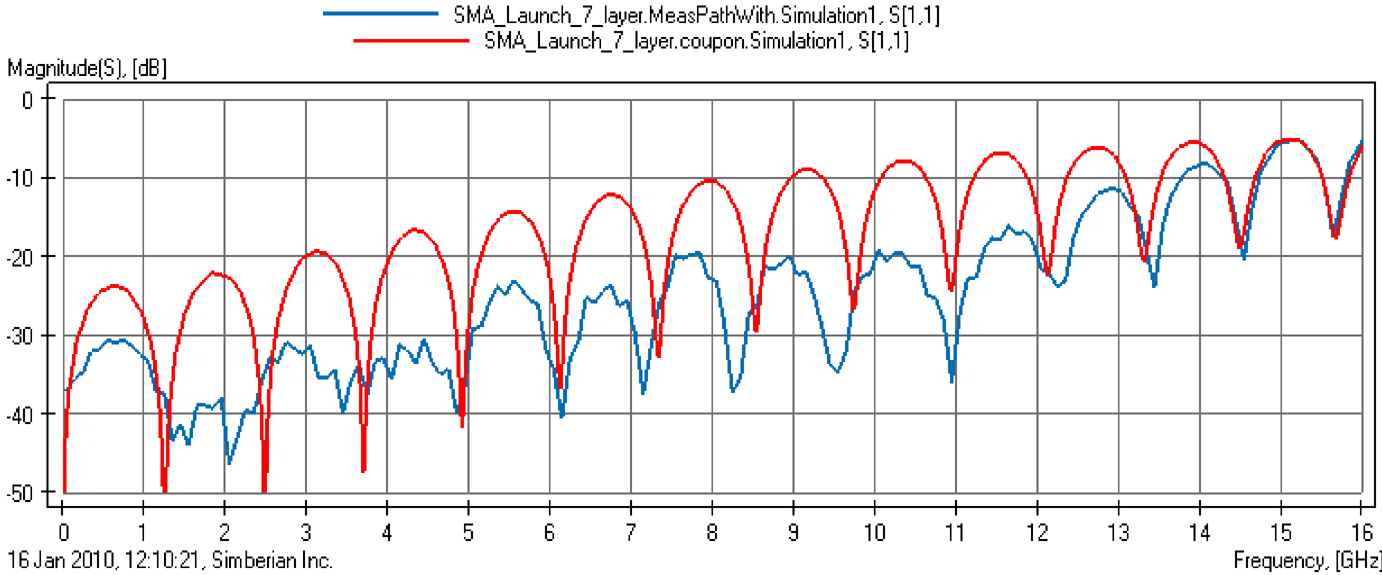
Agilent E8722ES



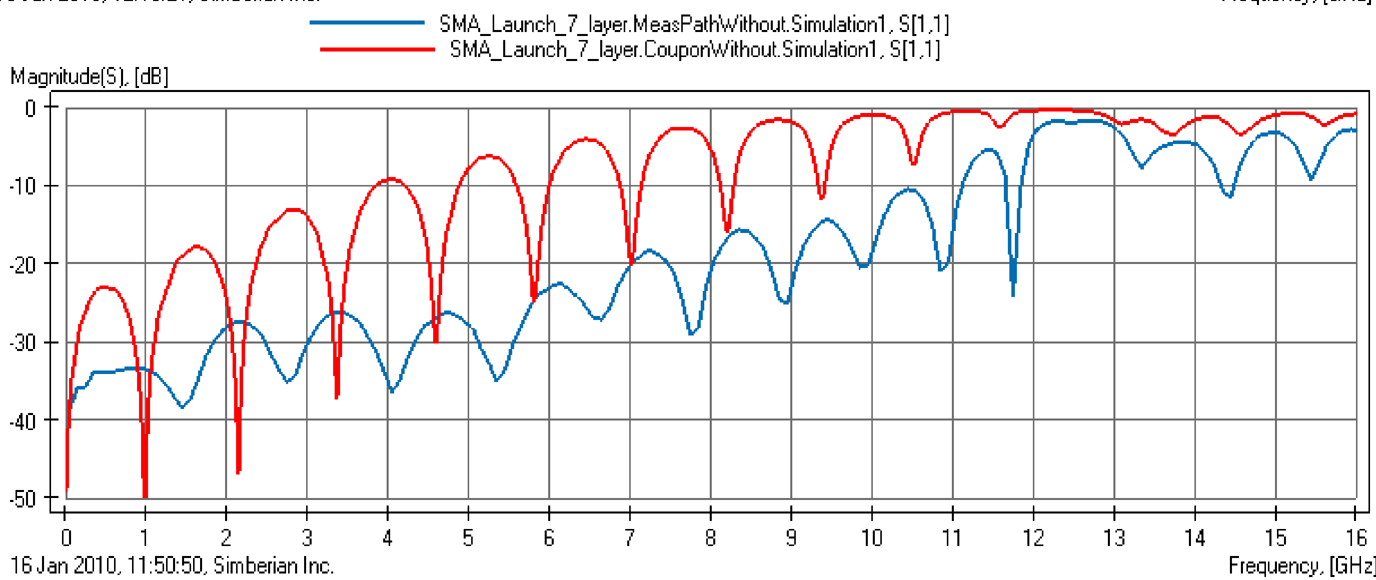
The VNA provides measured responses over a frequency range (S-parameters) that can be saved in a Touchstone file format, allowing importing into a simulator for comparison

Return loss S11 for SMA launch and microstrip

Improved path



Poor path

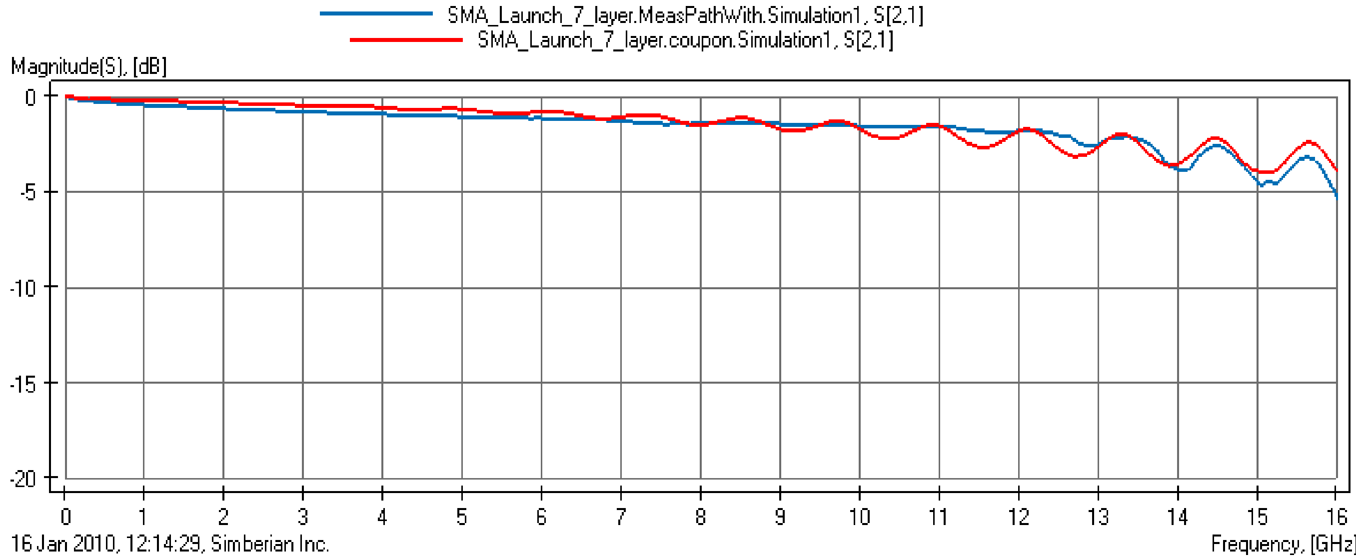


Measured response in blue, simulated in red

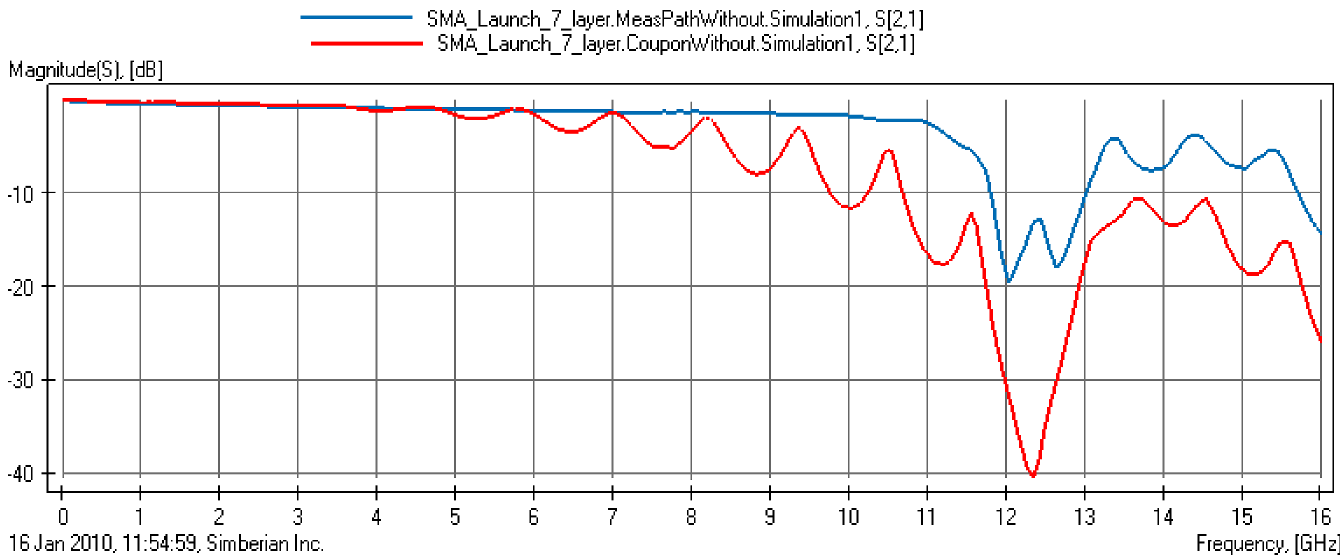
CIRCUIT SPECTRUM

Insertion loss S21 for SMA launch and microstrip

Improved path

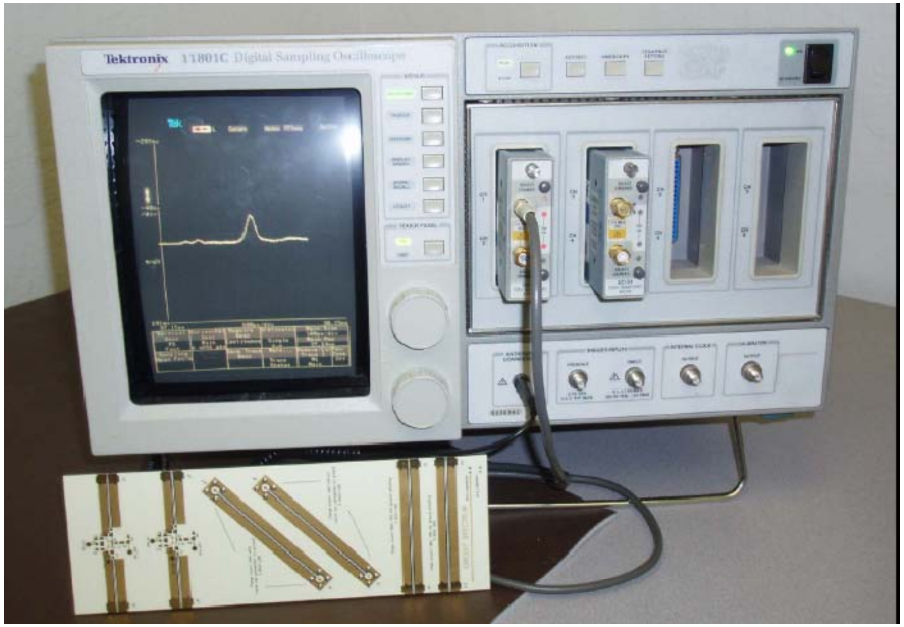


Poor path

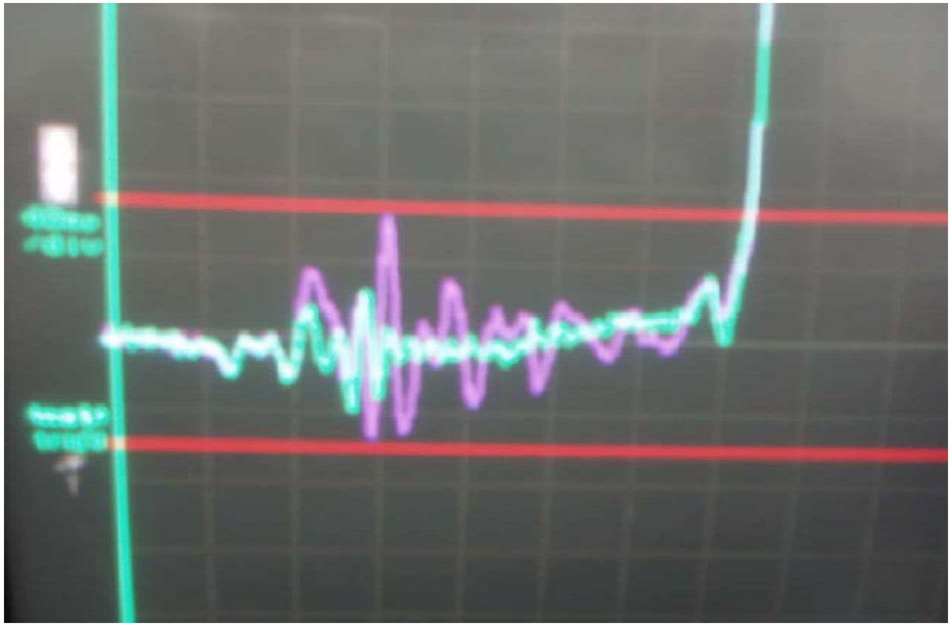


Measured response in blue, simulated in red

TDR scope and test board



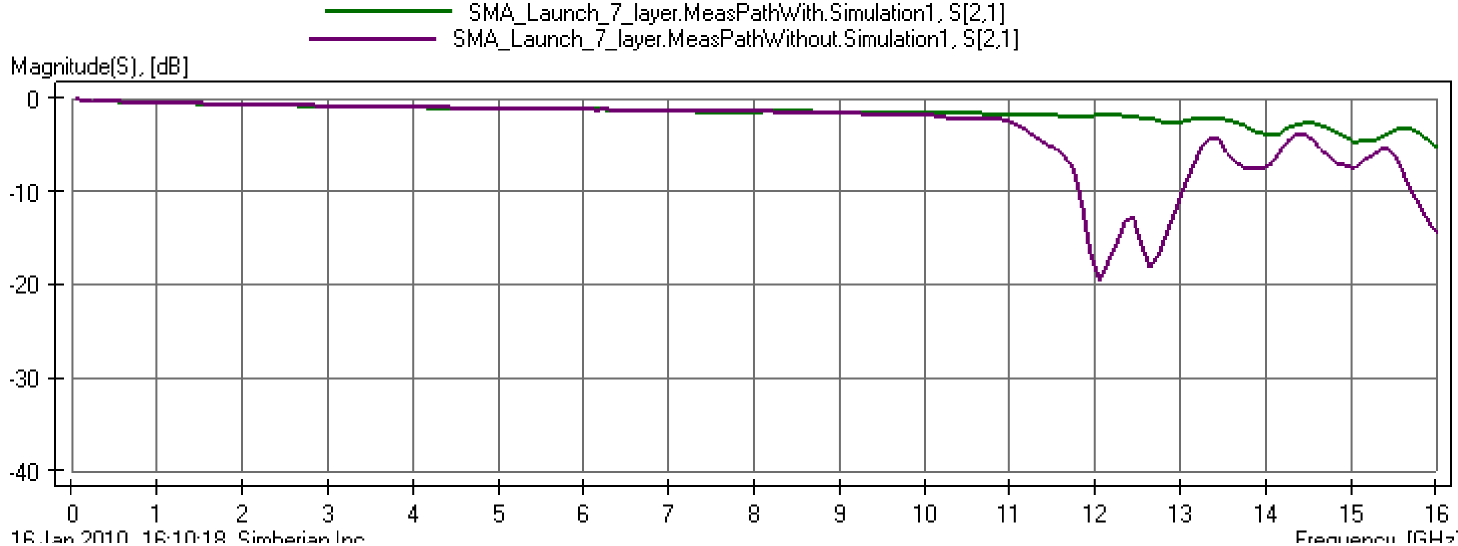
Tektronix 11801C



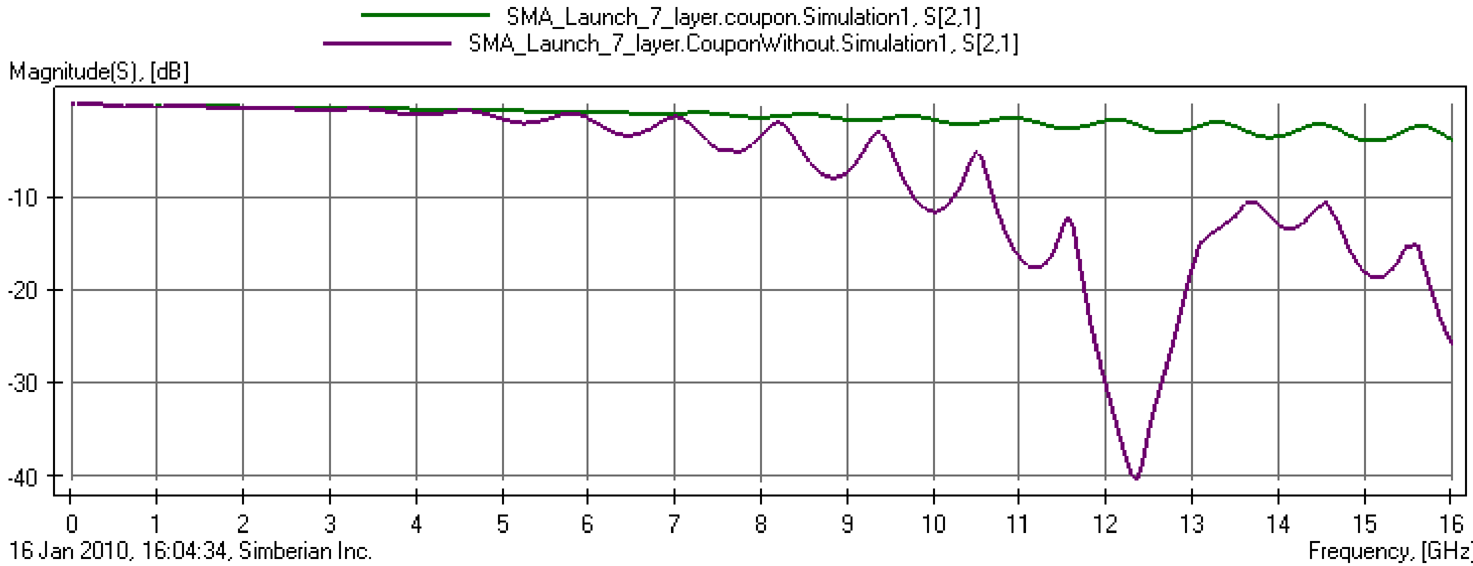
Improved path in green, poor path in purple

Insertion loss S21 - improved vs poor

Measures data



Simulation data



Improved path in green, poor path in purple