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TM
Workshop
上海
Shanghai
October 21, 2015
Archive - Session 1
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BiTS Burn-in & Test Strategies Workshop 2015 Shanghai

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Session 1

Yuanjun Shi
Session Chair

BiTS Shanghai

The Best of BiTS 2015

"PCB Test Fixture and DUT Socket Challenges for 32 Gbps/GBaud ATE Applications “

Jose Moreira - Advantest

-15 minute break-

"Designing Sockets for Ludicrous Speed (80 GHz)"

Don Thompson - R&D Altanova

"Comparison of Different Methods in Determining Current Carrying Capacity of Semiconductor Test Contacts"

Valts Treibergs - Xcerra Corporation

"The Economics of Semiconductor Test – Challenges and Opportunities for 2016"

John West - VLSI Research Europe

BiTS Burn-in & Test Strategies Workshop 2015 Shanghai

Designing Sockets for Ludicrous Speed (80 GHz)

Don Thompson, Jose Moreira
R&D Altanova, Advantest

2015 BiTS Workshop
Shanghai
October 21, 2015

The Challenge

The Need:

- Automotive radar (77-85 GHz) and some high frequency Near Field Communication (60 GHz) applications are way outside the envelope of traditional socket capabilities
- ATE test cells need a low loss and well behaved socket that works at these frequencies

The Challenge:

- Build and verify a proof of concept 77-85GHz socket for a 0.5mm fine pitch package

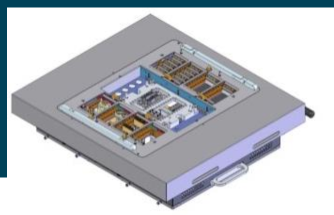
mmWave Integrated ATE Solution
PCB Test Fixture/Socket Challenge

UDI (Universal DUT Interface) Framework
mmW components located between DUT and ATE
Maintains high-performance ATE functionalities
- HVM handler/prober integration
- High fidelity and short signal connections
- Calibration/diagnostics

mmW DUT

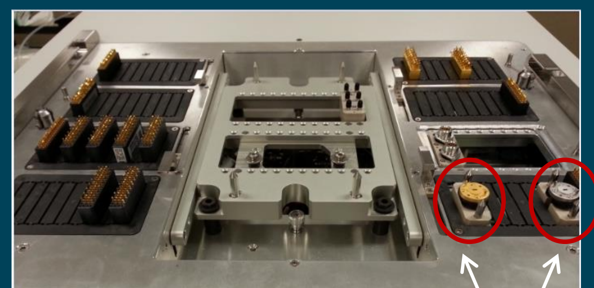
Major Challenge 75-85 GHZ

DUT PCB TEST FIXTURE AND SOCKET

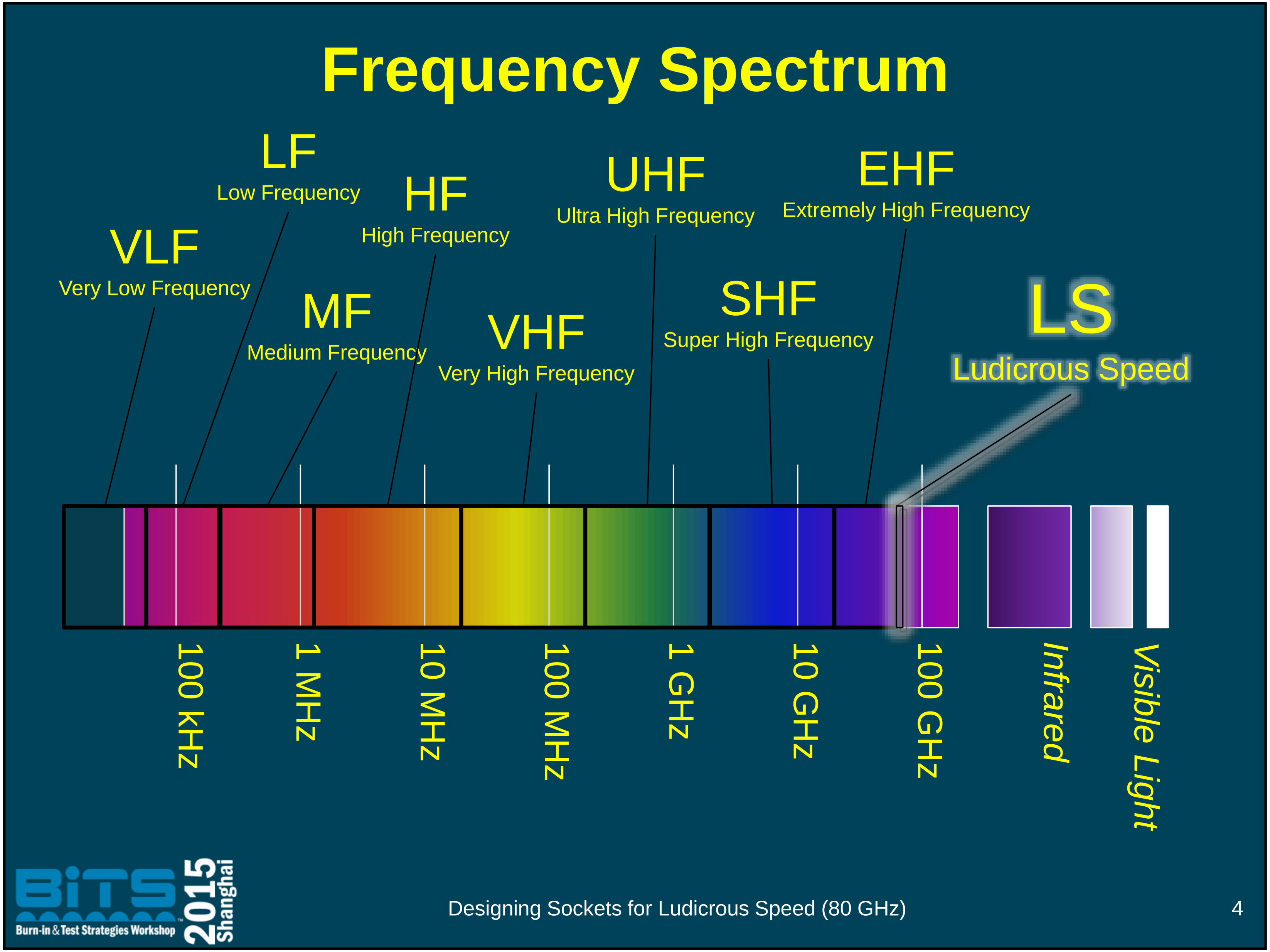


ATE 6GHz RF

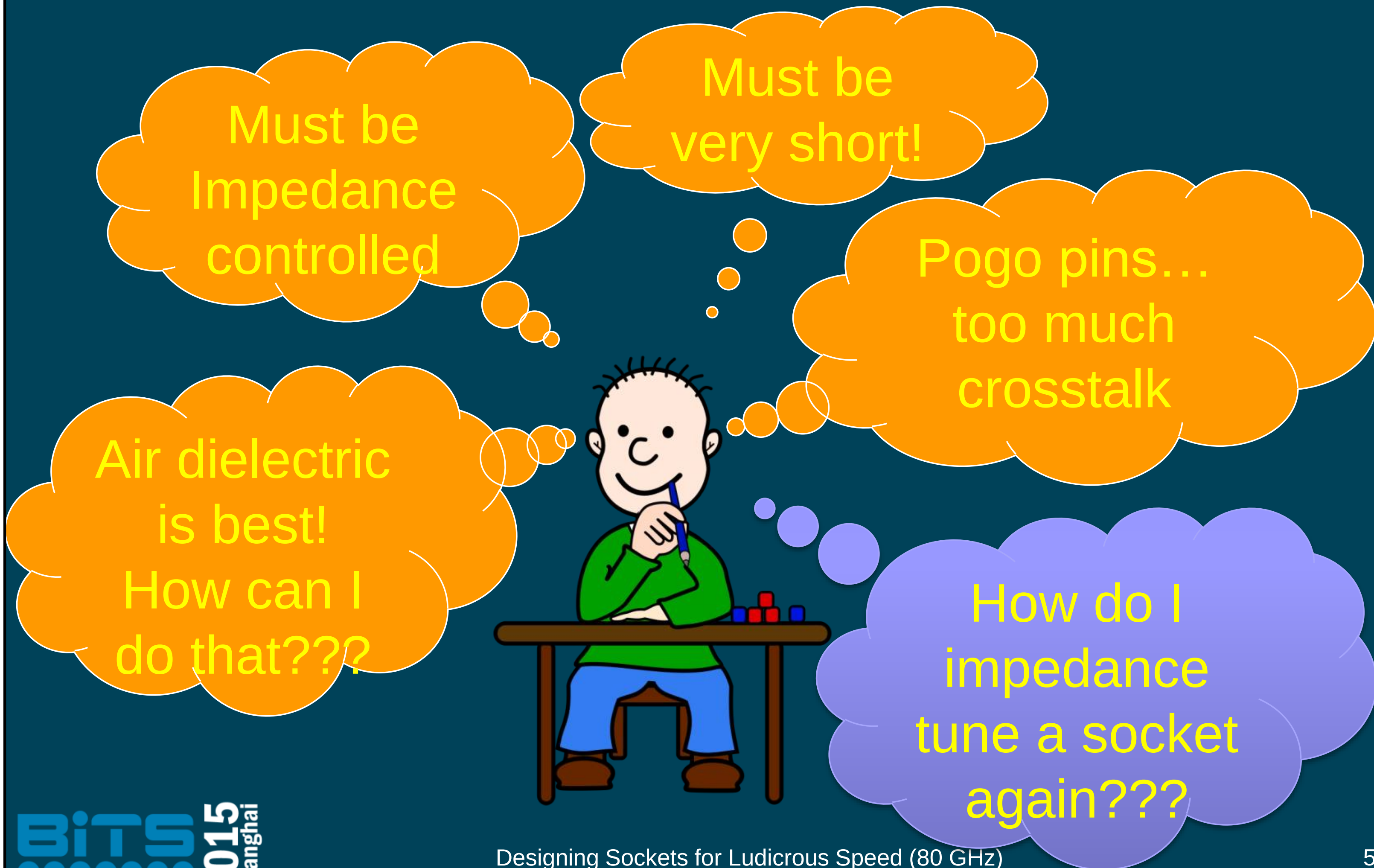
UDI TEST FIXTURE INTERFACE



Waveguide Blind Mate Interface

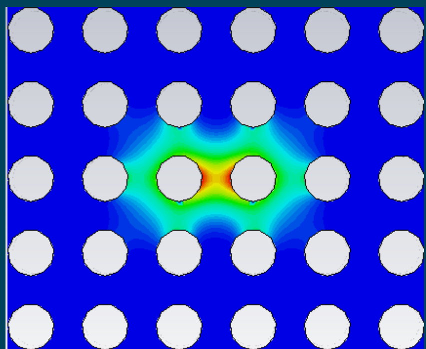

Frequency Spectrum
VLF
Very Low Frequency
LF
Low Frequency
MF
Medium Frequency
HF
High Frequency
VHF
Very High Frequency
UHF
Ultra High Frequency
SHF
Super High Frequency
EHF
Extremely High Frequency
LS
Ludicrous Speed
100 kHz
1 MHz
10 MHz
100 MHz
1 GHz
10 GHz
100 GHz
Infrared
Visible Light
Designing Sockets for Ludicrous Speed (80 GHz)
4

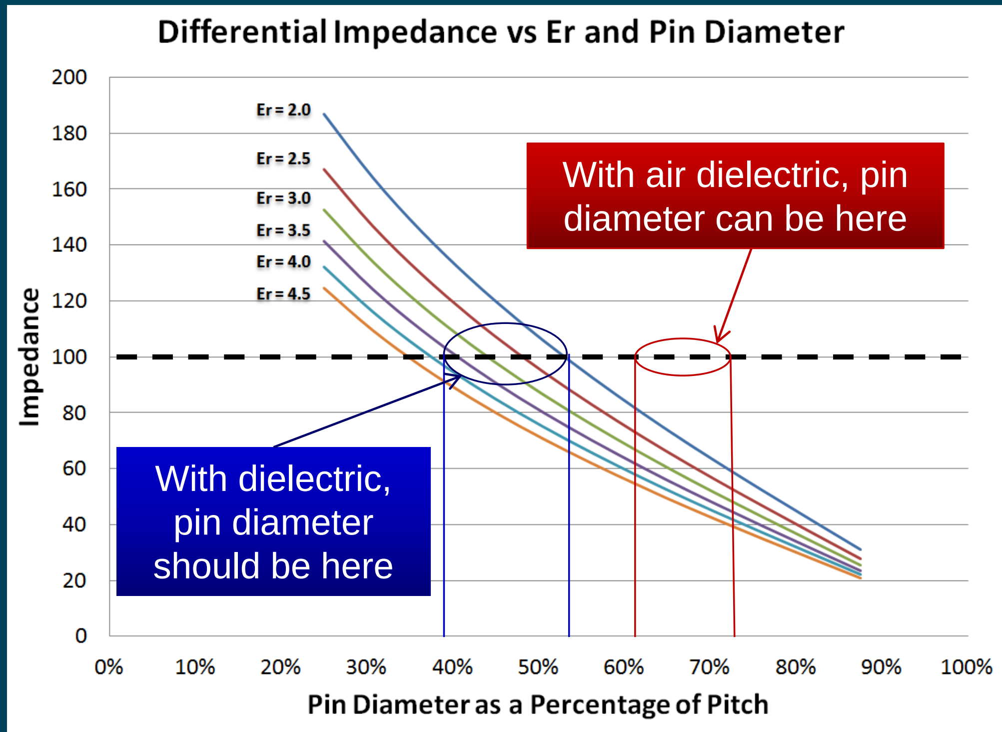
Considerations for building the socket



Review: How to tune a socket

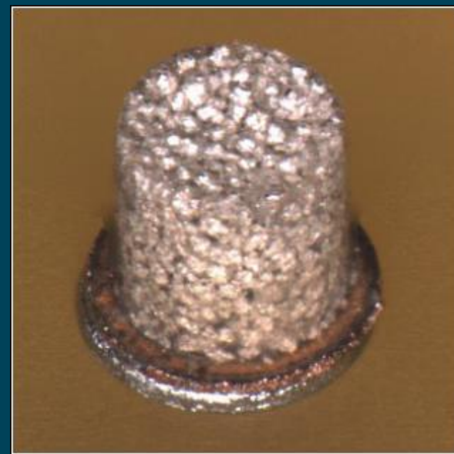
- Socket impedance is determined by pin diameter and dielectric
- Pitch is fixed

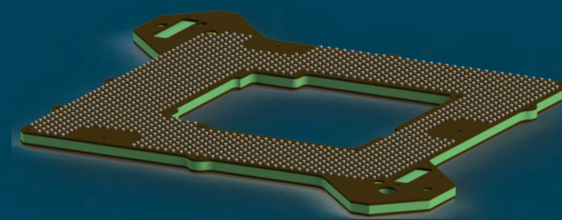




Invisipin

- Discrete elastomeric column
- Pick-and-place solder-able contact
- Available in multiple sizes for different package pitches
- **** Can have an air dielectric ****





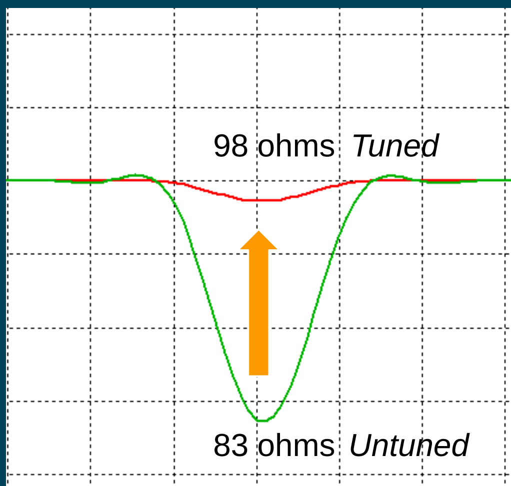
BUT

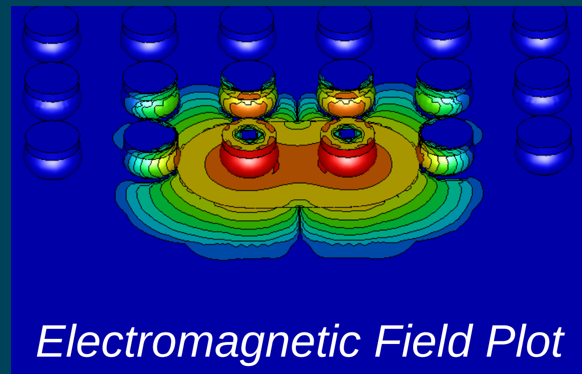
We're still limited to package pinout

Tuning the Invisipin Array

- Adjust Pin Diameter, Dielectric shape (or no dielectric) and tune for 100 ohms differential

$$Impedance = \sqrt{\frac{Inductance}{Capacitance}}$$



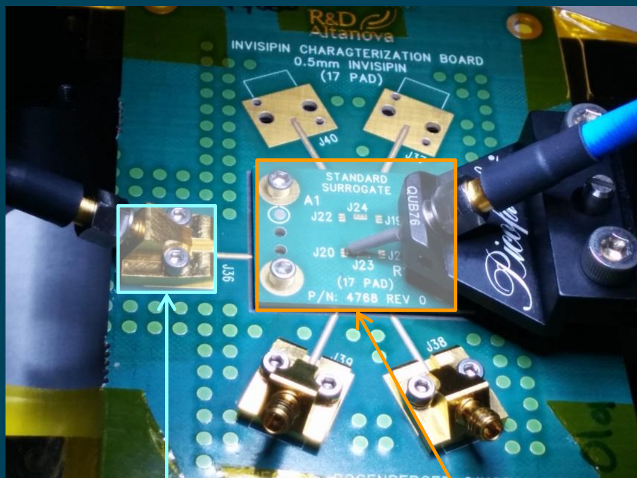


How to test a socket at these speeds

- Must use a high quality PCB
- High performance dielectric
- Rolled Copper
- All transition structures must be impedance tuned
- All test structures must have calibration structures to remove them from the measurements

Test Setup

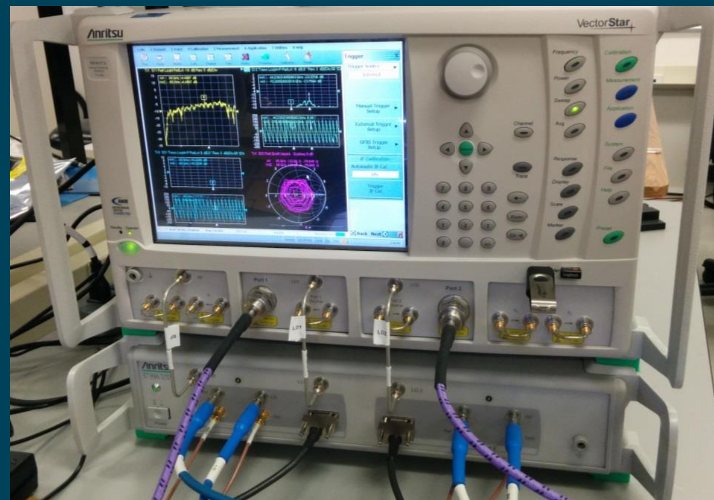
Extremely high performance Test PCB
- Taconic EZIO Dielectric
- Rolled Copper
- Microstrip construction



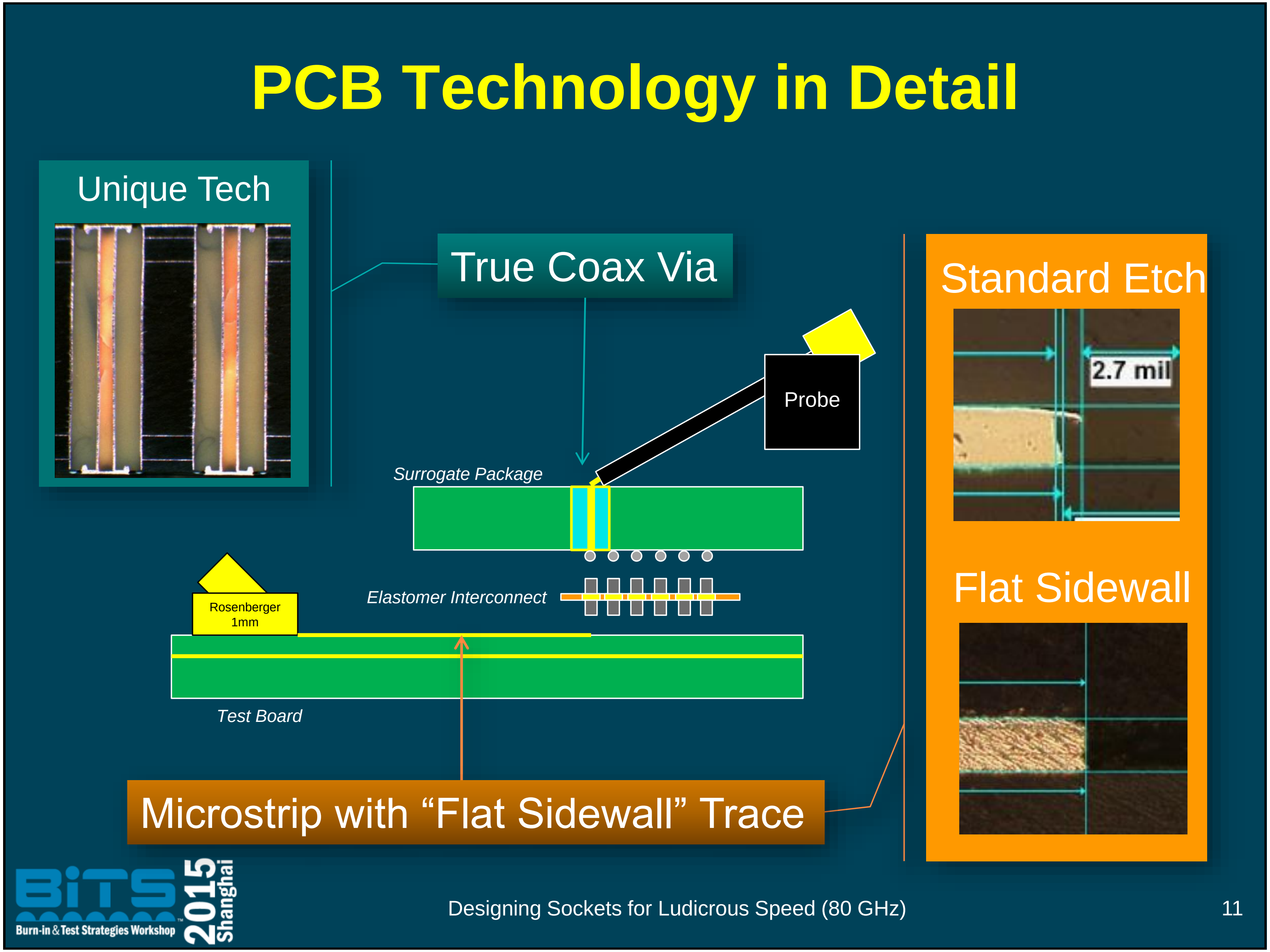
0.5mm Pico-Probe

Surrogate Package

Rosenberger
1mm Connector + 2cm trace



Anritsu MS4647A
110 GHz VNA


PCB Technology in Detail
Unique Tech
True Coax Via
Probe
Surrogate Package
Elastomer Interconnect
Rosenberger 1mm
Test Board
Microstrip with “Flat Sidewall” Trace
Standard Etch
2.7 mil
Flat Sidewall
Designing Sockets for Ludicrous Speed (80 GHz)
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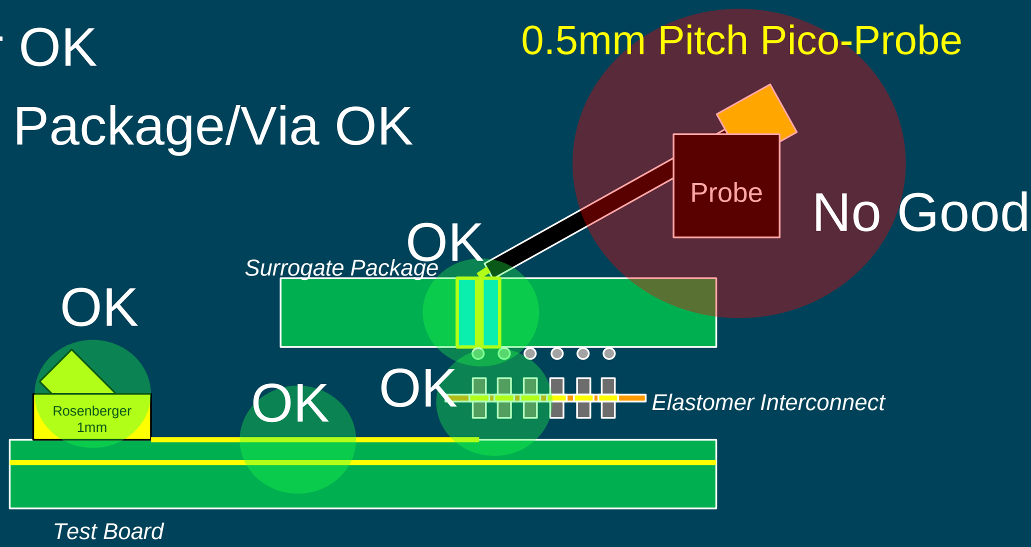
Calibration Plan

- Using Keysight PLTS AFR
  - Remove trace and connector by using 2x AFR (Automatic Fixture Removal)

  - Pico Probe was removed by shorting it to ground and using 1x AFR

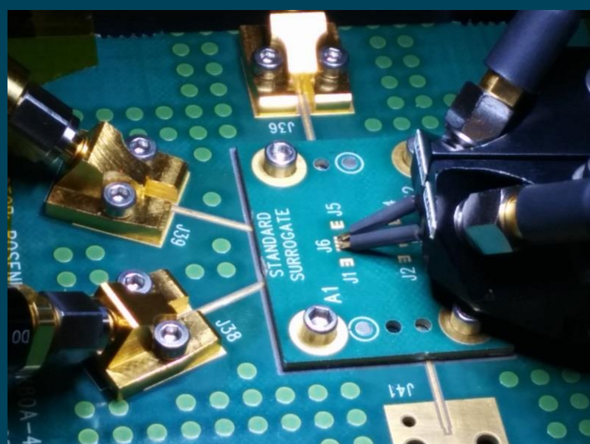
Hurdles to overcome

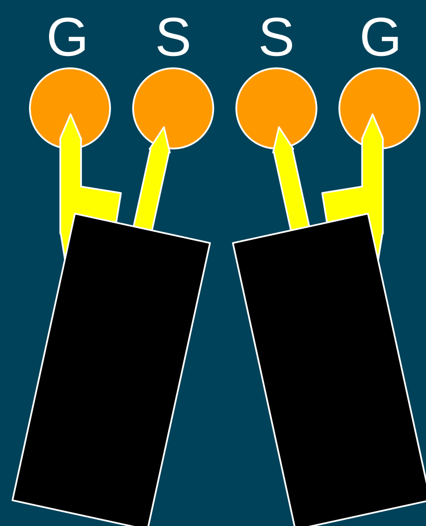
- 0.5mm Differential Pico Probe Connector performance was sub par for this frequency NG
- 1mm Connector OK
- Trace/launch OK
- Elastomer OK
- Surrogate Package/Via OK



Why?

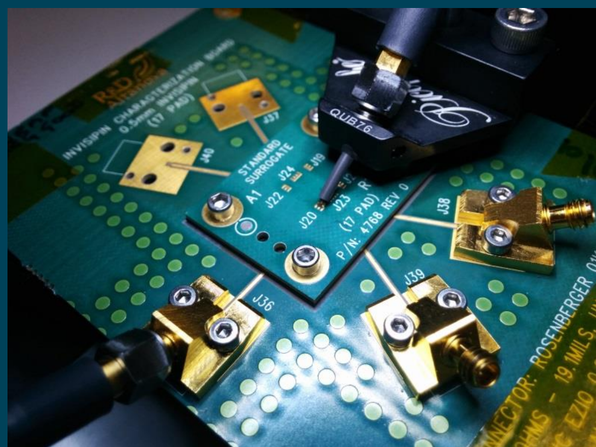
- Touchdown was directly on package pads. At 80 GHz this was too wide a spacing for GSSG probes.
- The probes would also have been higher performance if it was a GSGSG configuration at a smaller pitch

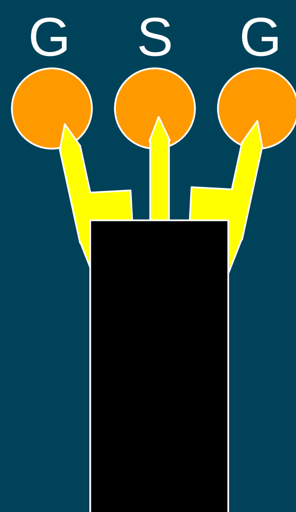




Work Around:

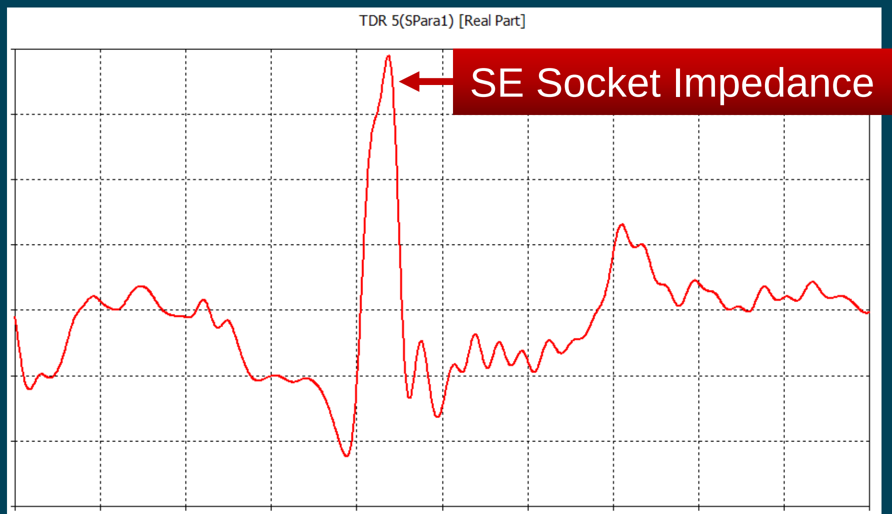
- Single Ended GSG Probe performance was an improvement for these tests but it still didn't allow for accurate de-embedding
- Data shown here will be GSG configuration but the final application will be GSSG



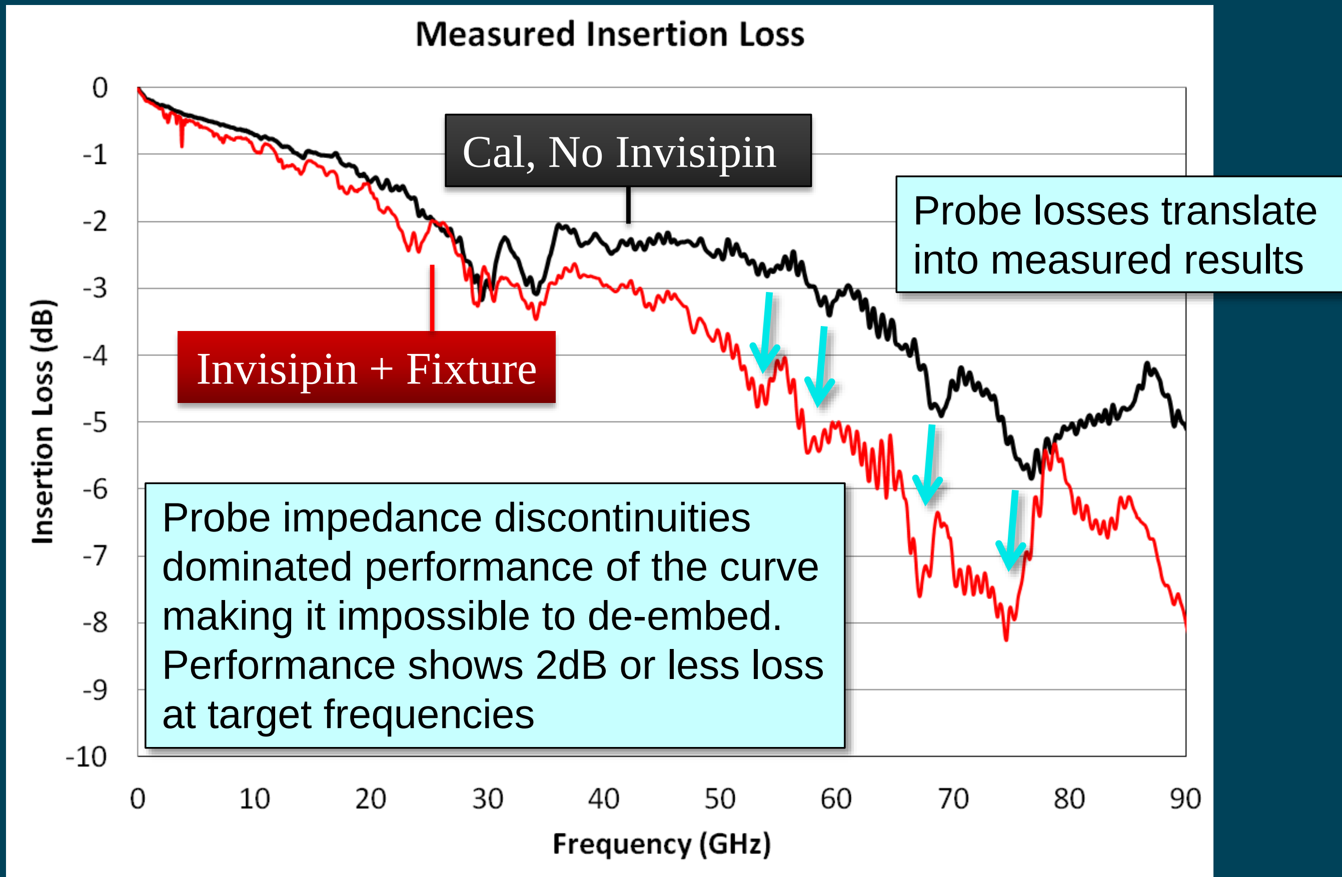


Trade Offs for Work Around

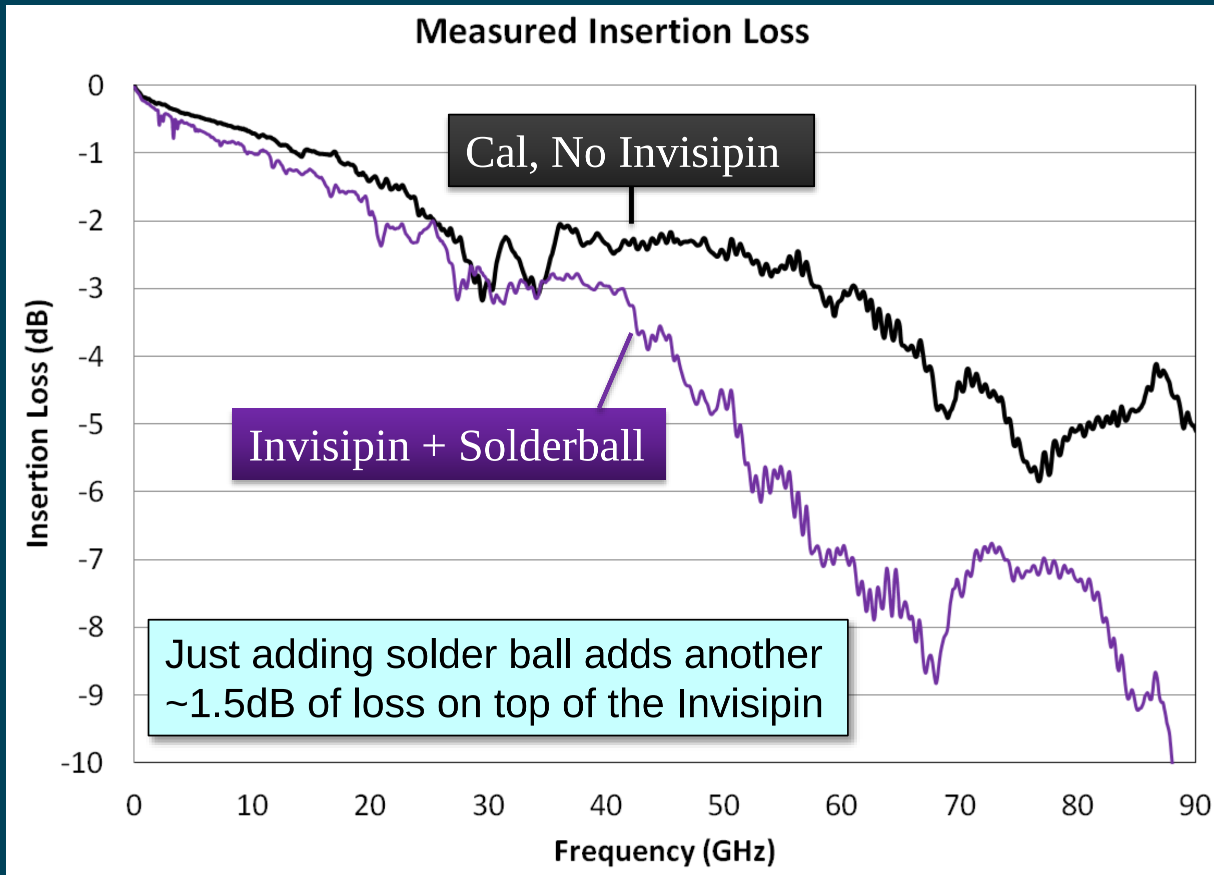
- Socket was tuned for 100 ohm differential. Single ended plots will be higher than 50 ohms impedance.
- Differential performance will be better than single ended since the impedance discontinuity will be much smaller!



Insertion Loss of Invisipin

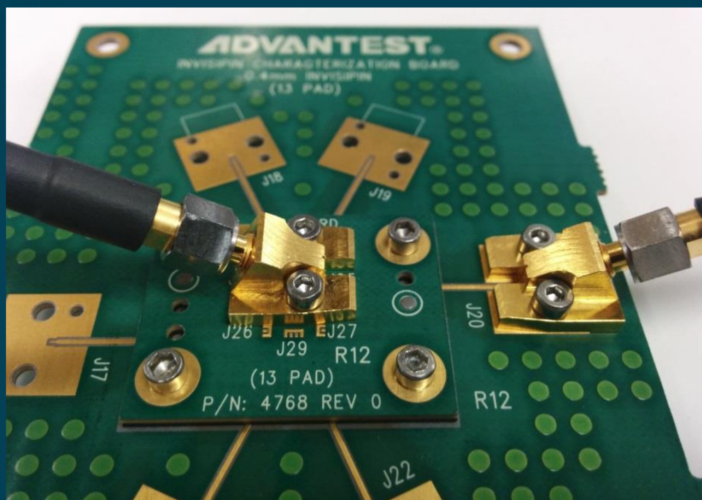


Insertion Loss of Invisipin with Solder Ball

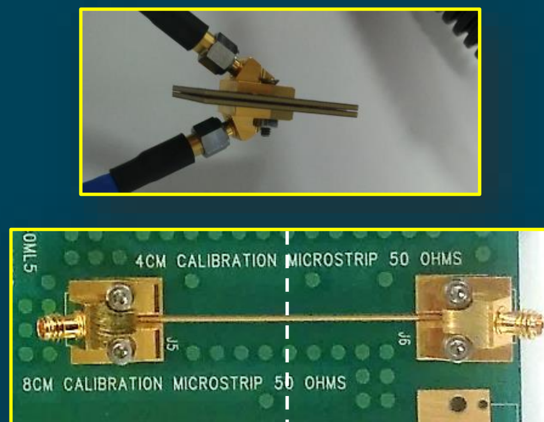


Work Around - Try 2

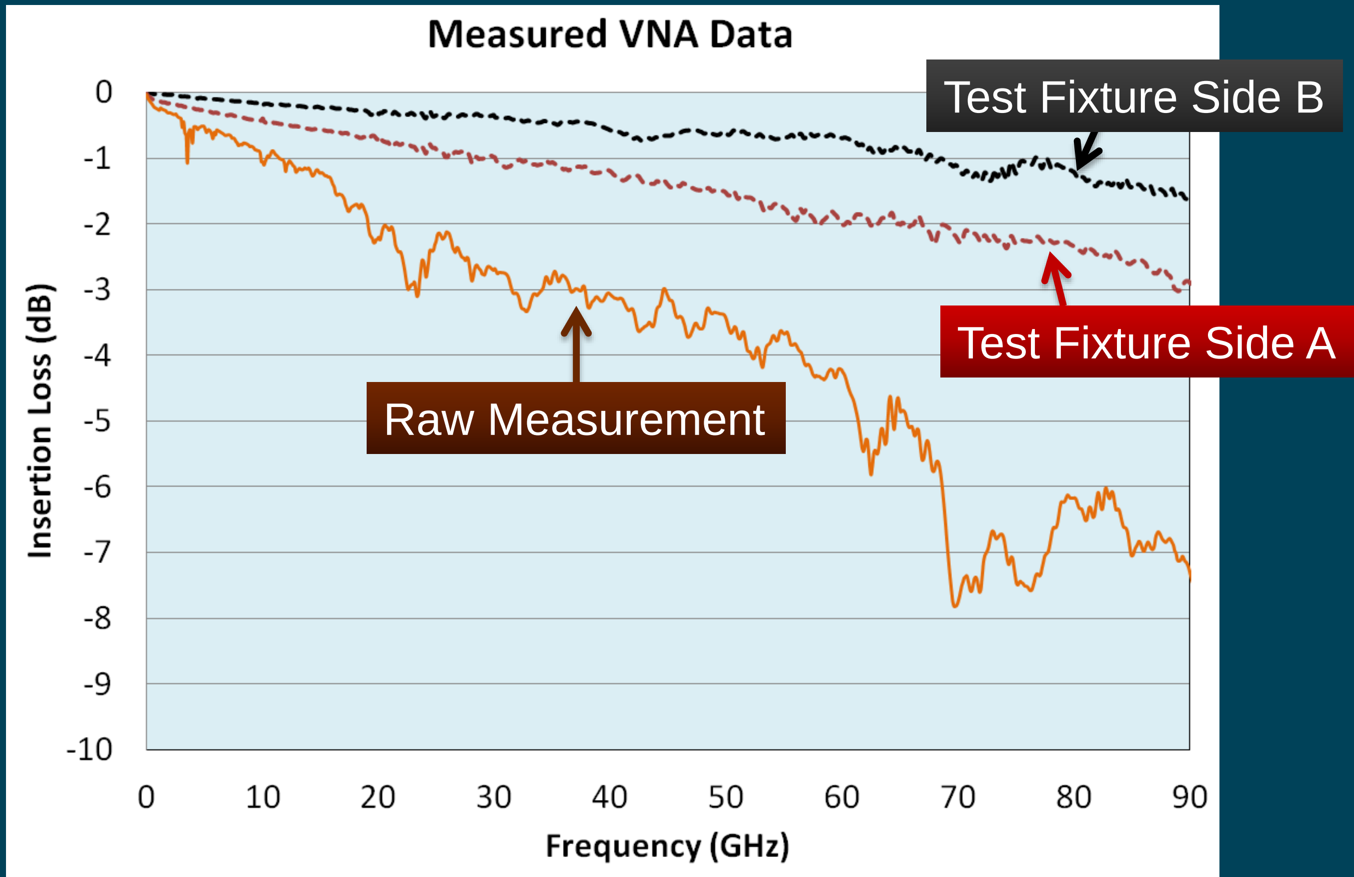
- Modify board to accept Rosenberger connector on topside
- Still SE results only
- Allows for full de-embedding of test boards



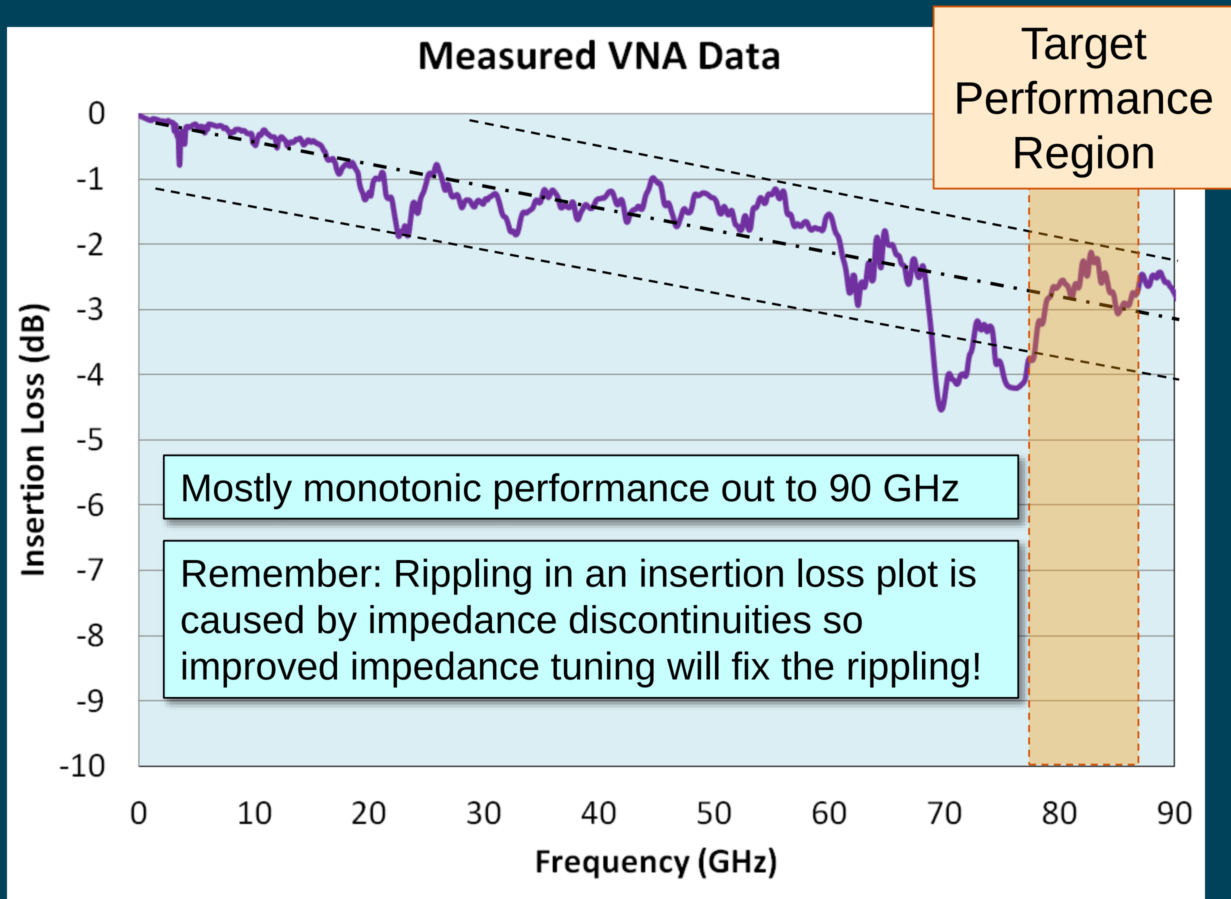
De-embedding Structures



Non De-Embedded Data



De-Embedded Results



Conclusion

- The Invisipin elastomer socket performed well at the target frequencies as well as over the full range of DC – 90 GHz
- Data shown is for single ended data, however differential performance should be even better since the socket was tuned for differential performance!
- 77-85 GHz sockets are possible with both extreme care in socket design and expert validation techniques