



SWTest Conference

First Probe Card for DUT Measurement at 120 GHz to Support 1.6 Tbps



Daniel Bock, Christopher Lemoine, Yuka Muto
FormFactor

Introduction

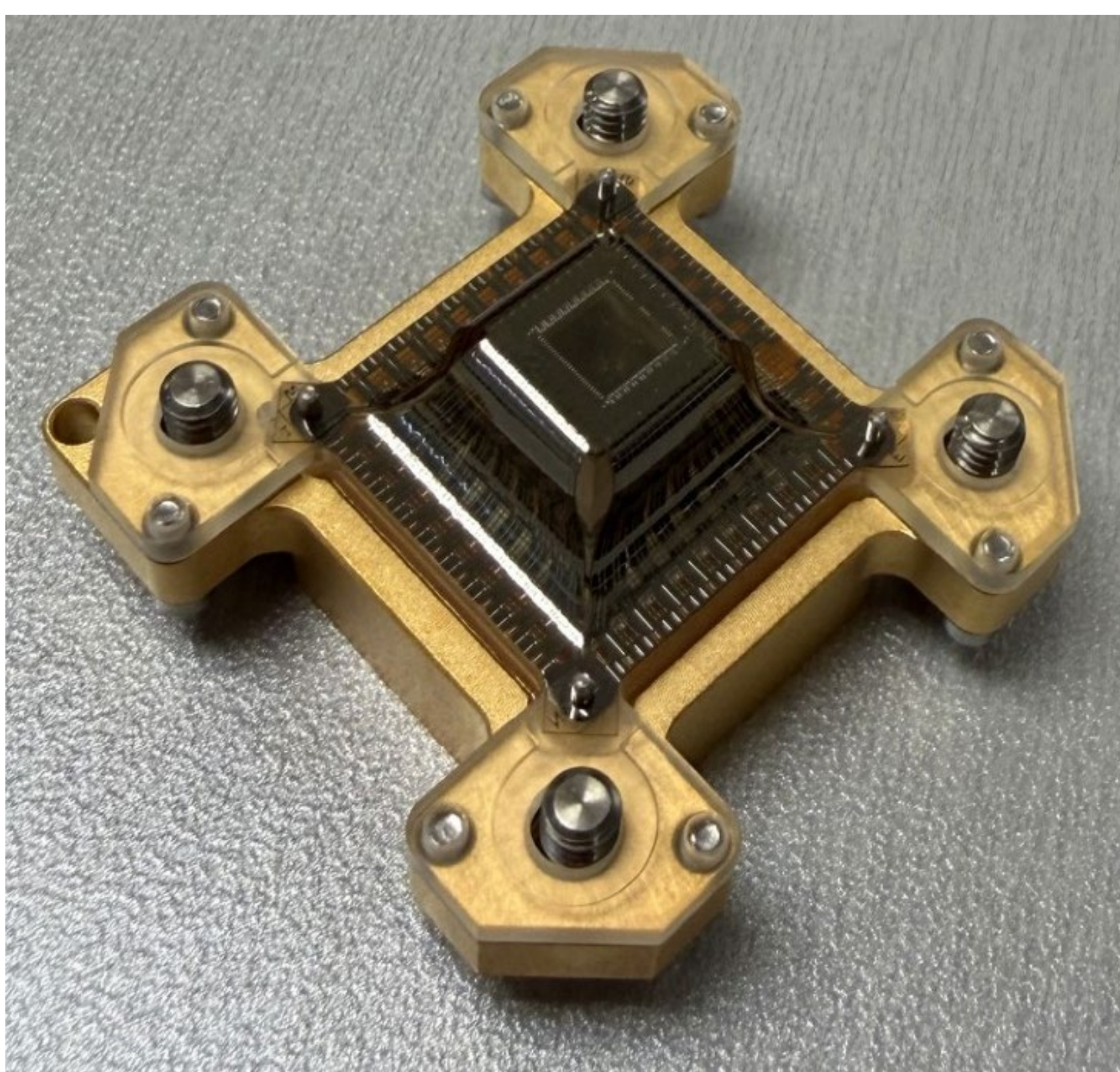
The transition to 1.6 Tbps optical interconnects is driving semiconductor devices operating at 448 Gbps PAM4 per lane, creating demand for wafer-level test solutions capable of supporting frequencies beyond 112 GHz Nyquist bandwidth.

While many digital devices can use on-chip loopback testing, key optical communication components such as Trans-Impedance Amplifiers (TIAs) and optical drivers require direct electrical characterization using external instrumentation such as Vector Network Analyzers (VNAs). These longer direct-connect signal paths create significantly greater signal integrity challenges than conventional loopback testing, pushing beyond the capability of existing production RF probe technologies.

To address these requirements, FormFactor has developed a next-generation 120 GHz production RF probe card architecture based on the Pyramid™ platform. The design incorporates a new high-frequency coax-to-PCB connector, optimized low-loss transmission lines across the PCB and membrane, and an improved PCB-to-membrane launch structure to enable accurate, repeatable wafer-level measurements to 120 GHz and beyond.

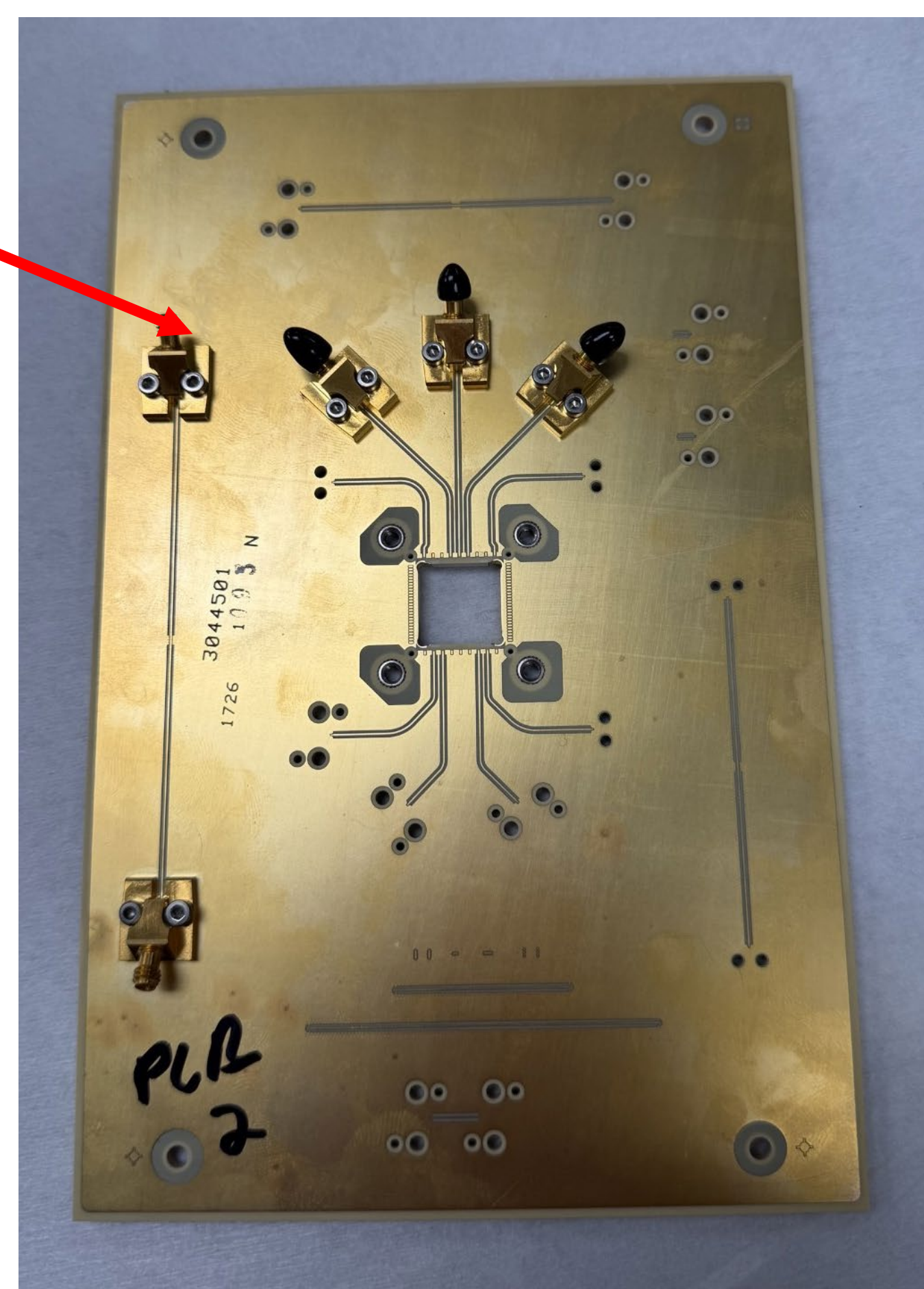
Materials and Methods

We manufactured a new Pyramid Probe design that is capable of 120 GHz, as well as a PCB for a full probe card solution. The PCB is using new, advanced PCB materials that are capable of very high speeds with 1 mm Rosenberger connectors that are compression mount



RFC Pyramid Probe to evaluate 120 GHz performance

1 mm Rosenberger
compression
mount connector



4.5" Probe card with Rosenberger 1 mm Compression mount connectors. This PCB also includes 3.5 in thru structure to measure the dB loss/in of the PCB material

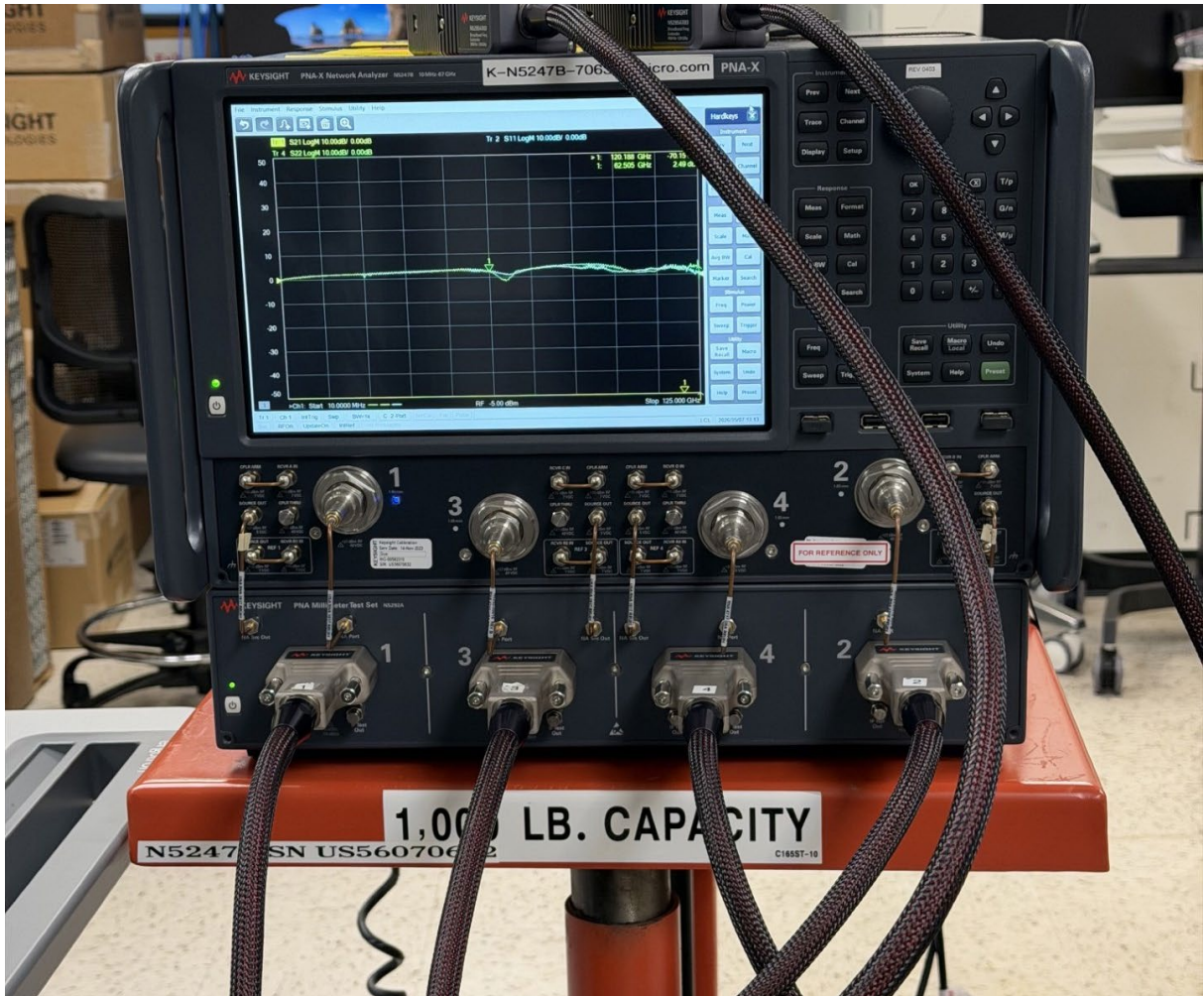
Measurement Methods:

In order to characterize the performance of the full probe card, we used:

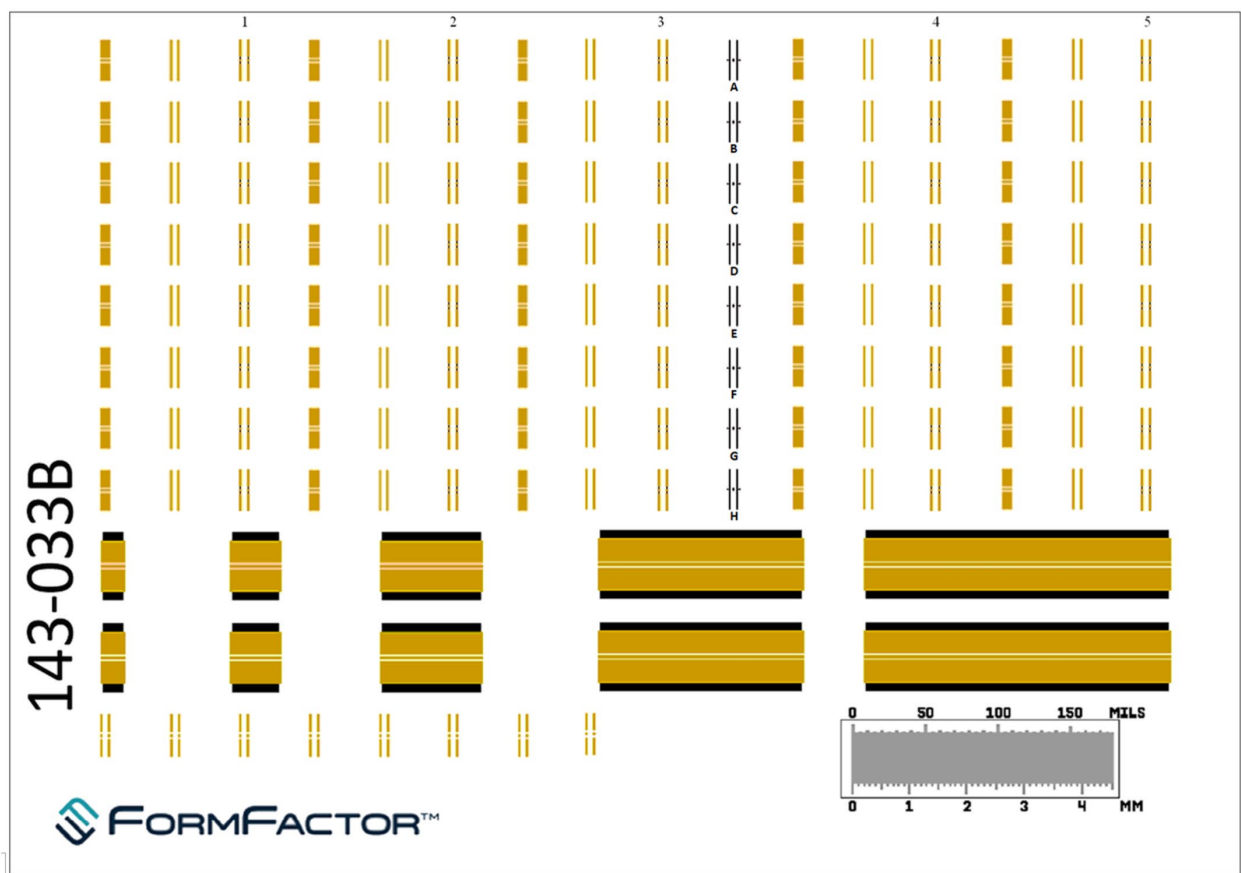
- Keysight VNA up with extender heads up to 125 GHz
- Cascade Summit 12000
- 143-033B calibration substrate

To characterize the performance of the PCB material, we used Rosenberger compression mount 1mm connectors, and measured a 3.5 inch long transmission line to check loss and return loss of the PCB material and the connectors

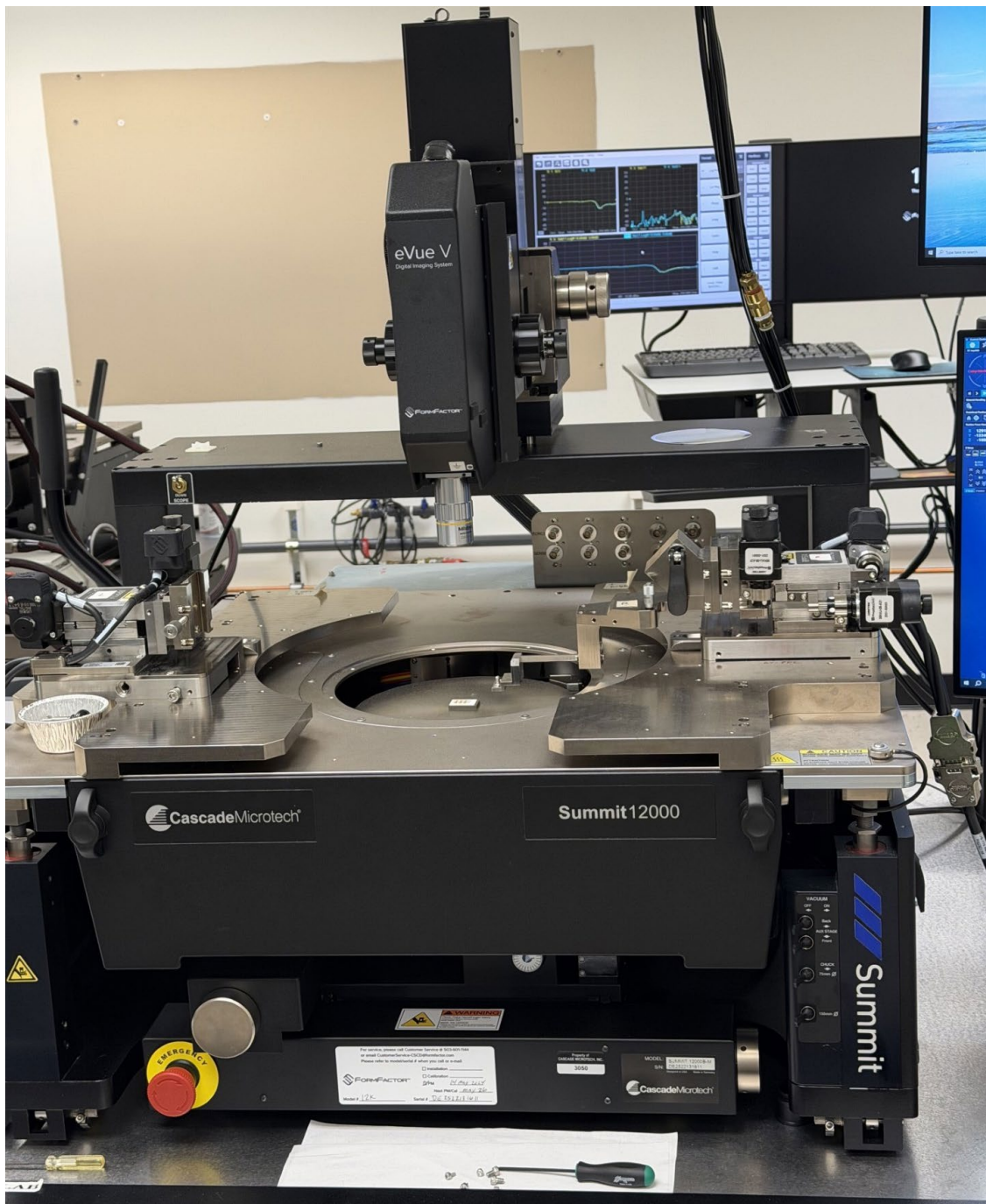
The 2-port performance of the probe card was then calculated by measuring short, load, and open. We then used WinCal’s 2nd tier calibration method to generate the 2-port parameters of the probe card



Keysight VNA – PNA-X with 125 GHz extenders



143-033B Calibration Substrate from FormFactor for pitches 100-250 micron up to 145 GHz

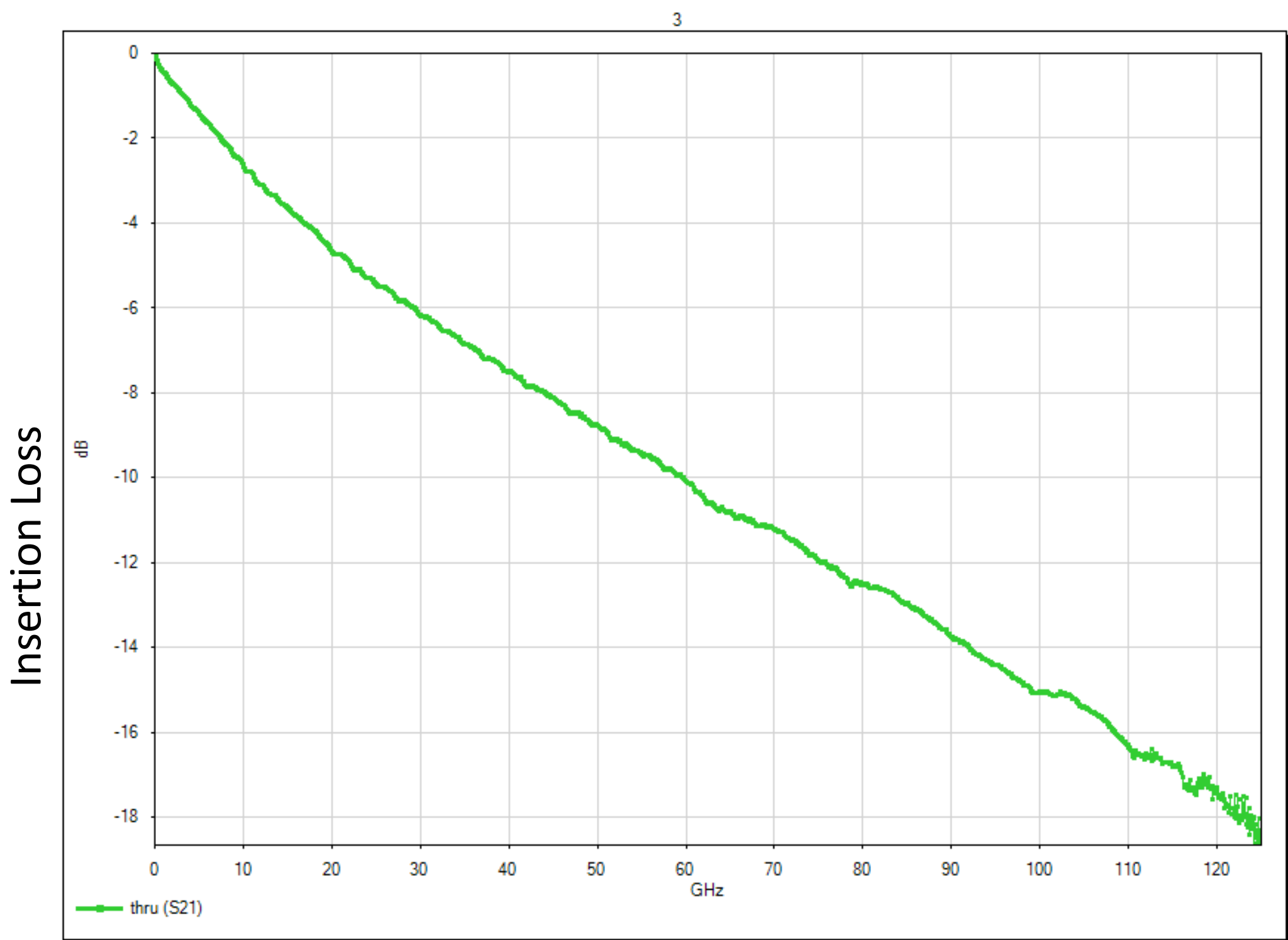


Cascade Summit 12000, semi-automatic prober

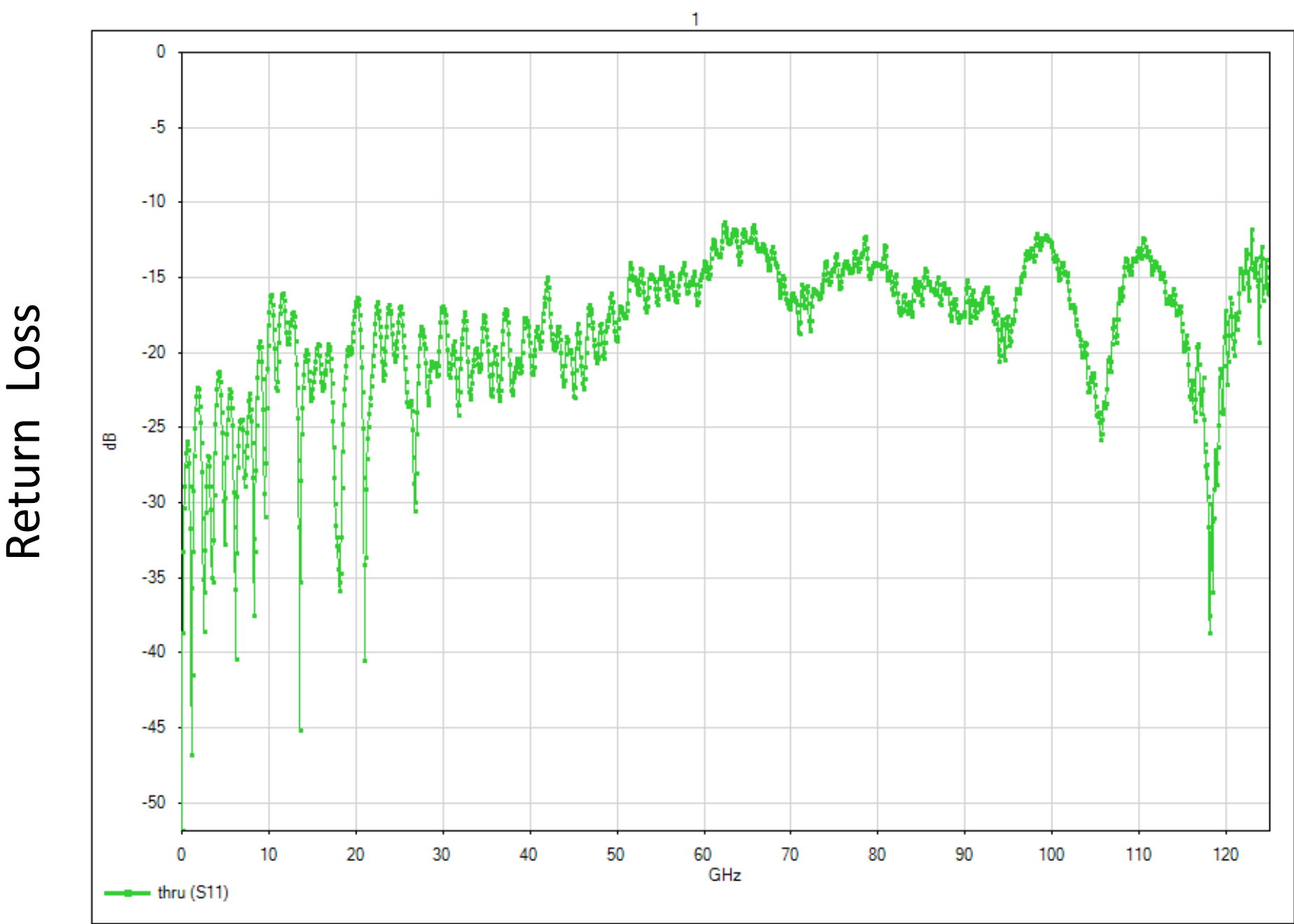
Results – Thru PCB-only Measurements

Measurements of the 3.5” thru structure on the PCB show that the loss is around 5 dB/in, and that the impedance control of the connectors with the trace have better than 12 dB return loss.

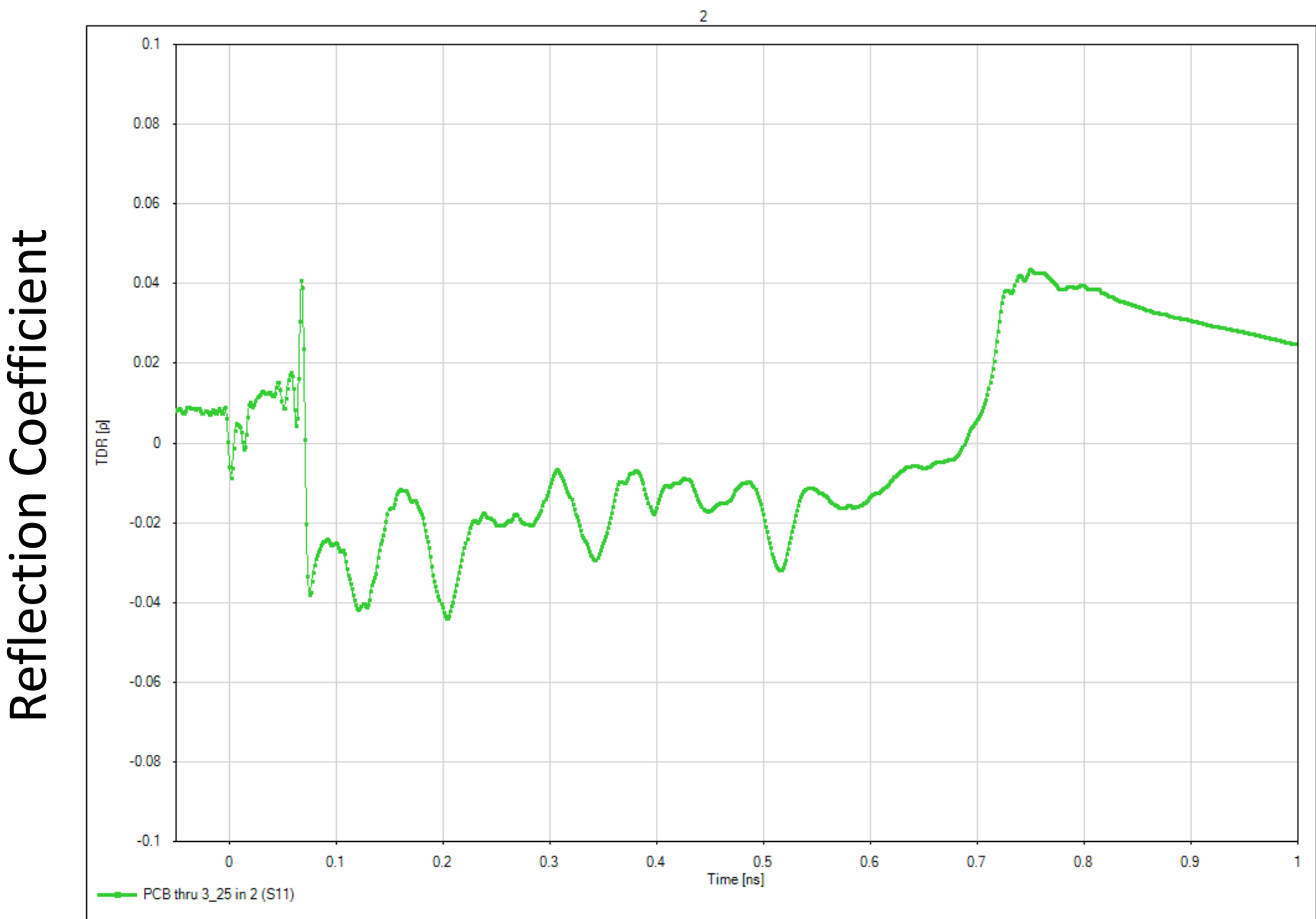
The measurements also show that the Rosenberger connectors have linear response up to 120 GHz, and reasonable control in impedance that show that the combination can be used for probe cards



Measured insertion loss of the thru on the PCB



Measured return loss of the thru on the PCB

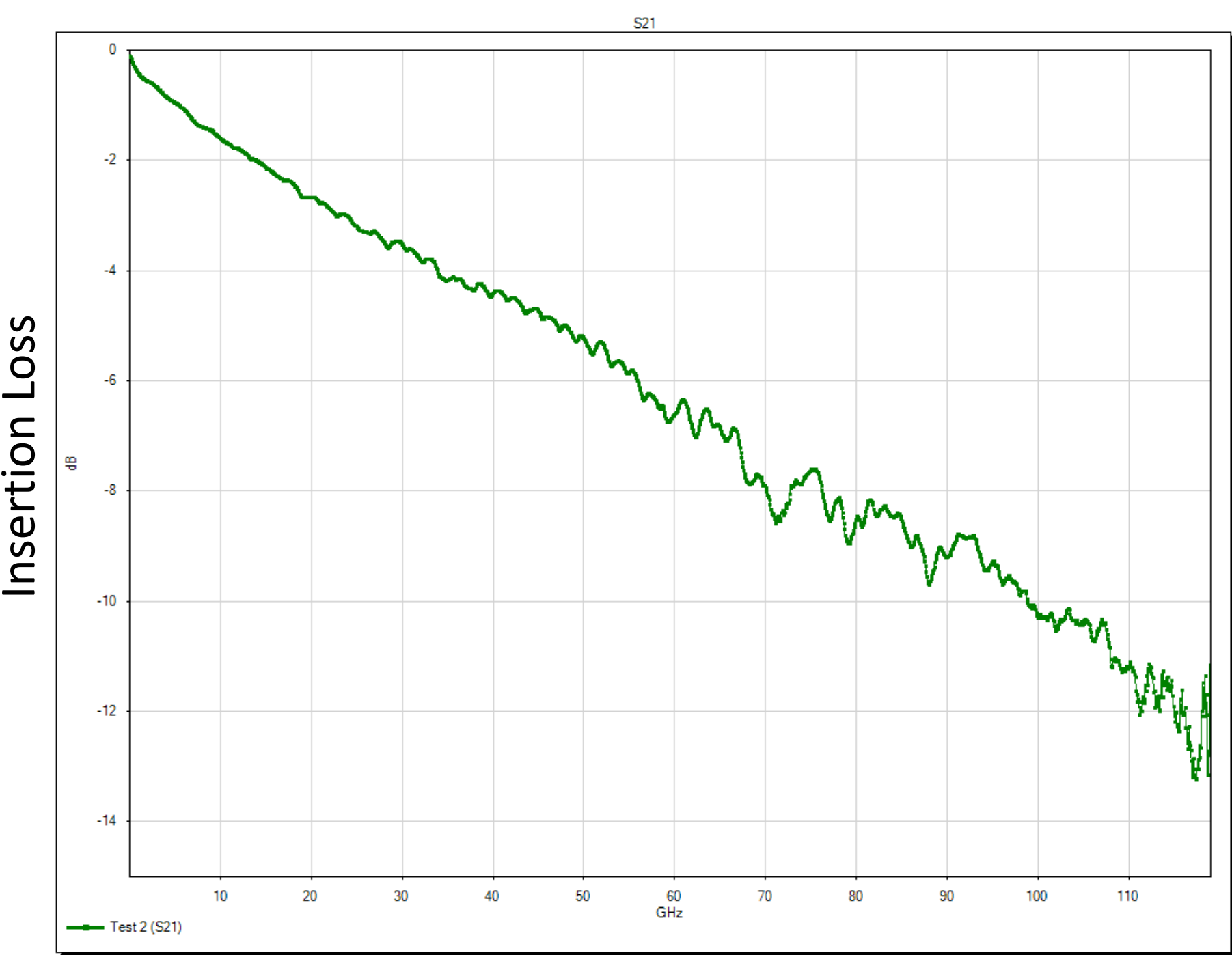


TDR of the signal path: this shows the compression mount connector is well controlled, as well as PCB at around 47 Ohm for the thru

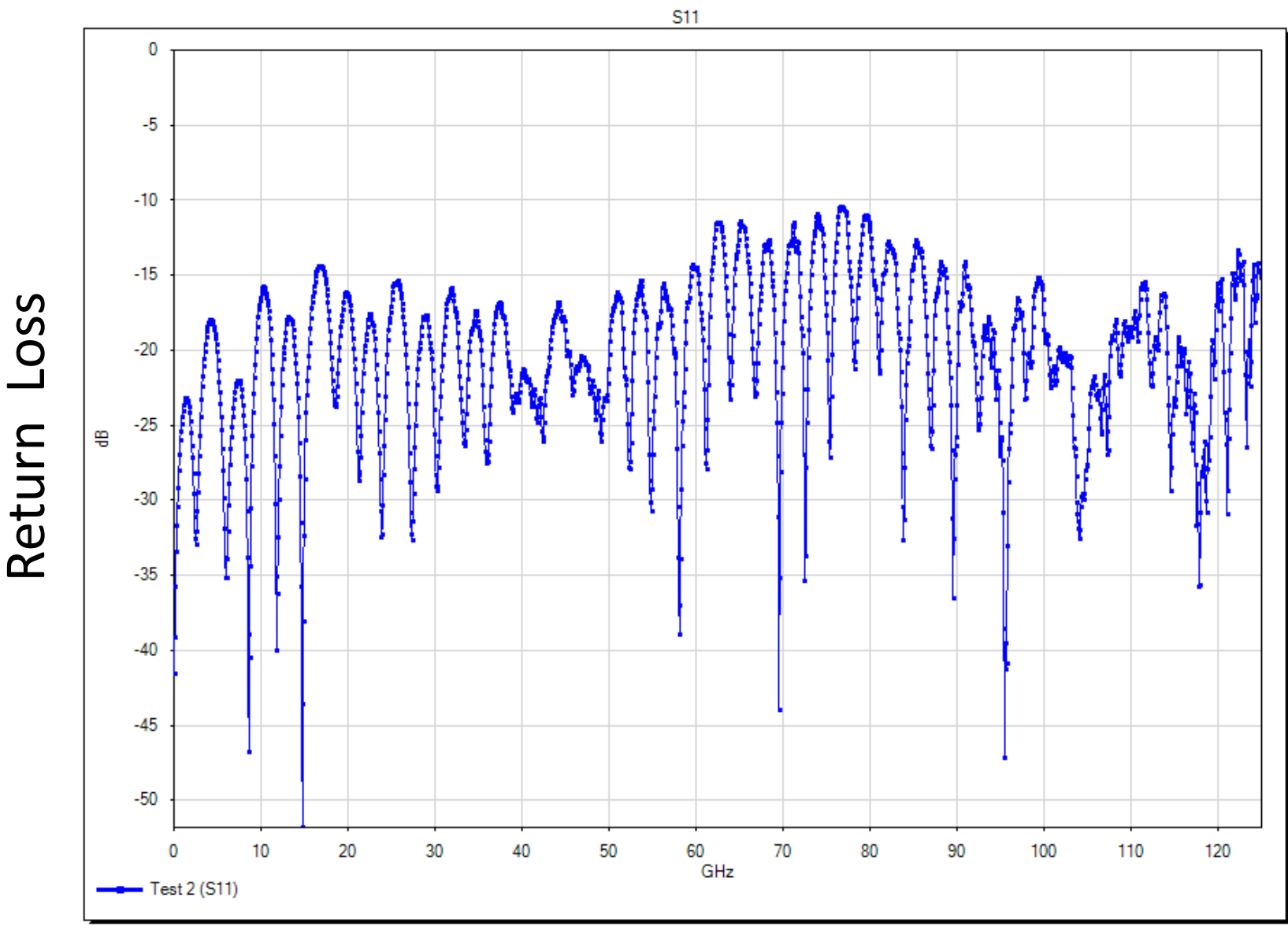
Results – Probe Card Measurements

Measurements of the probe card show that it has linear response loss versus frequency, and that the return loss is below 10 dB up to 120 GHz. These show that the technology could be used at these speeds

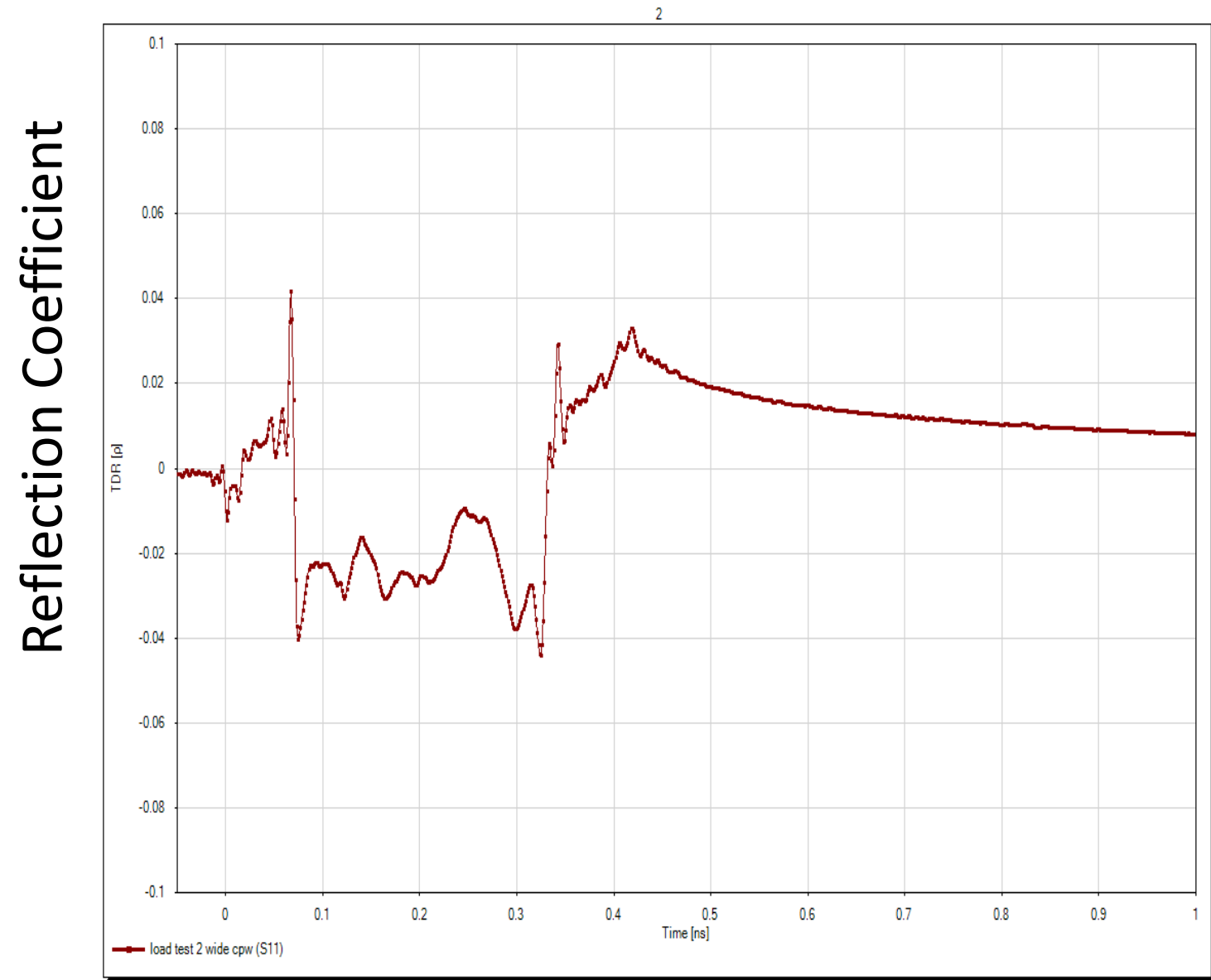
The TDR measurements also show that it is well controlled with the PCB, Pyramid Probe, and the Rosenberger connector, operating in +/- 3 Ohm.



Measured insertion loss of the Probe card 1 mm connector to probe tip



Measured Return loss of the probe card showing better than 10 dB return loss out to 120 GHz



TDR of the signal path: this shows the compression mount connector is well controlled, as well as PCB at around 47 Ohm, and the membrane is at 52 Ohm

Conclusions

The first 120 GHz probe card for measuring devices that will support 448 Gbps PAM4 was manufactured and tested by FormFactor. By measuring it with short, open, and load standards, the 2 port performance was measured and confirmed that it is appropriate for wafer sort at these speeds. The probe card is shown meeting specifications up to 120 GHz of the following RF performance metrics:

- Better than 10 dB RL out to 120 GHz
- About 12.5 dB insertion loss at 120 GHz

Contact Information

If you have any questions, please contact

Daniel Bock	Christopher Lemoine
Technical Director	Product Marketing Director
Daniel.bock@formfactor.com	Christopher.Lemoine@formfactor.com