SWTEST

PROBE TODAY, FOR TOMORROW

2023 CONFERENCE

REINVENTING RF WAFER PROBES

PTSL

Don Thompson

PTSL CTO

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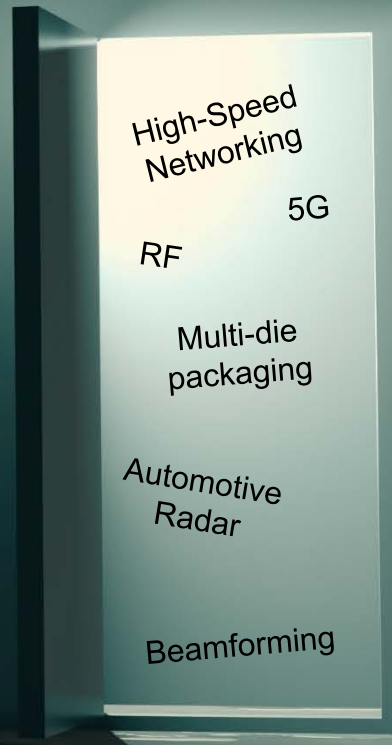
Opening the Door to Innovation



- Many technologies are already here or on the horizon that are moving us to do more high-speed testing at wafer sort
- While RF testing methodologies have stabilized at a plateau there are still huge gaps in capabilities that can solved through both innovation and intelligent applications of today's technologies
- Through new technologies our industry can open the door and enable the mass implementation of these new technologies

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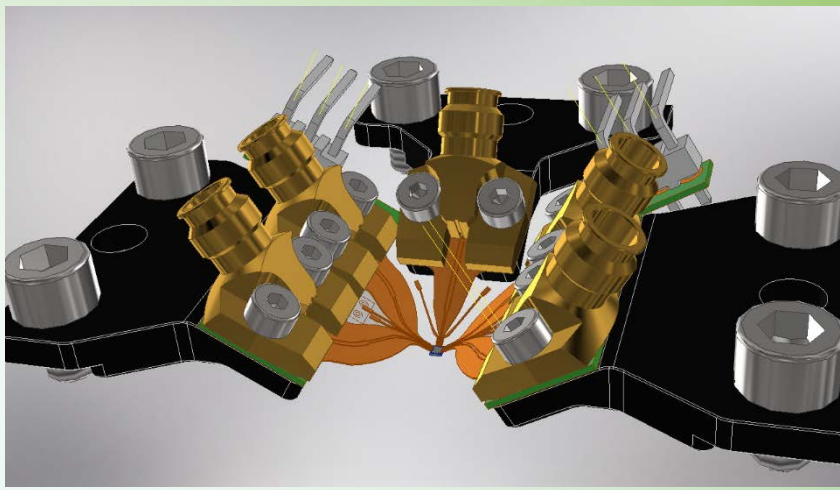
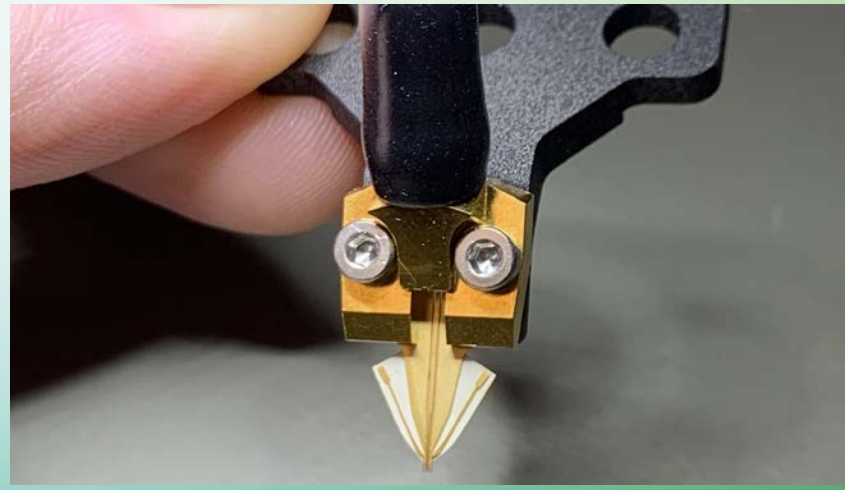
Step 1: Acquisition of ThinkMEMs

- ThinkMEMs joined PTSL in Nov 2023
- ThinkMEMs has a line of individual wafer probes as well as expertise in building complex microwave probes
- Through partnership, PTSL leveraged this technology and we are using it for more complex and elaborate solutions for ATE 110 GHz RF wafer probing





Step #2: Integration

Success Requires a Team

Innovative Manufacturing
ThinkMEMs

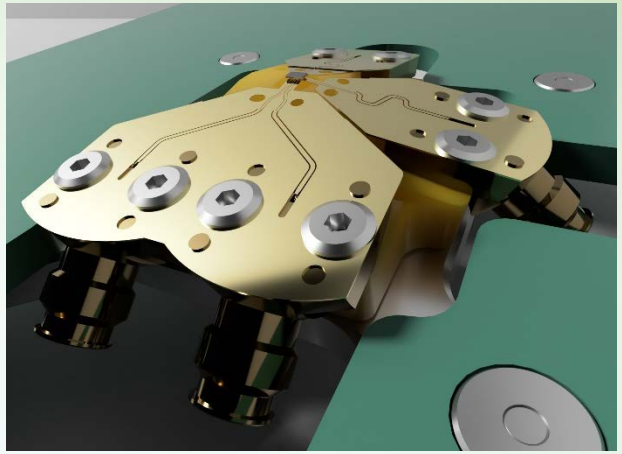
Signal Integrity
Simulations and validation

High-Speed PCB Design & Project Management

Probe Head
Design & Manufacturing

Step 3: Extreme High-Speed Periphery Probing

Characterization Probes
NuvoRF



ATE RF Probe Card
PhazorRF

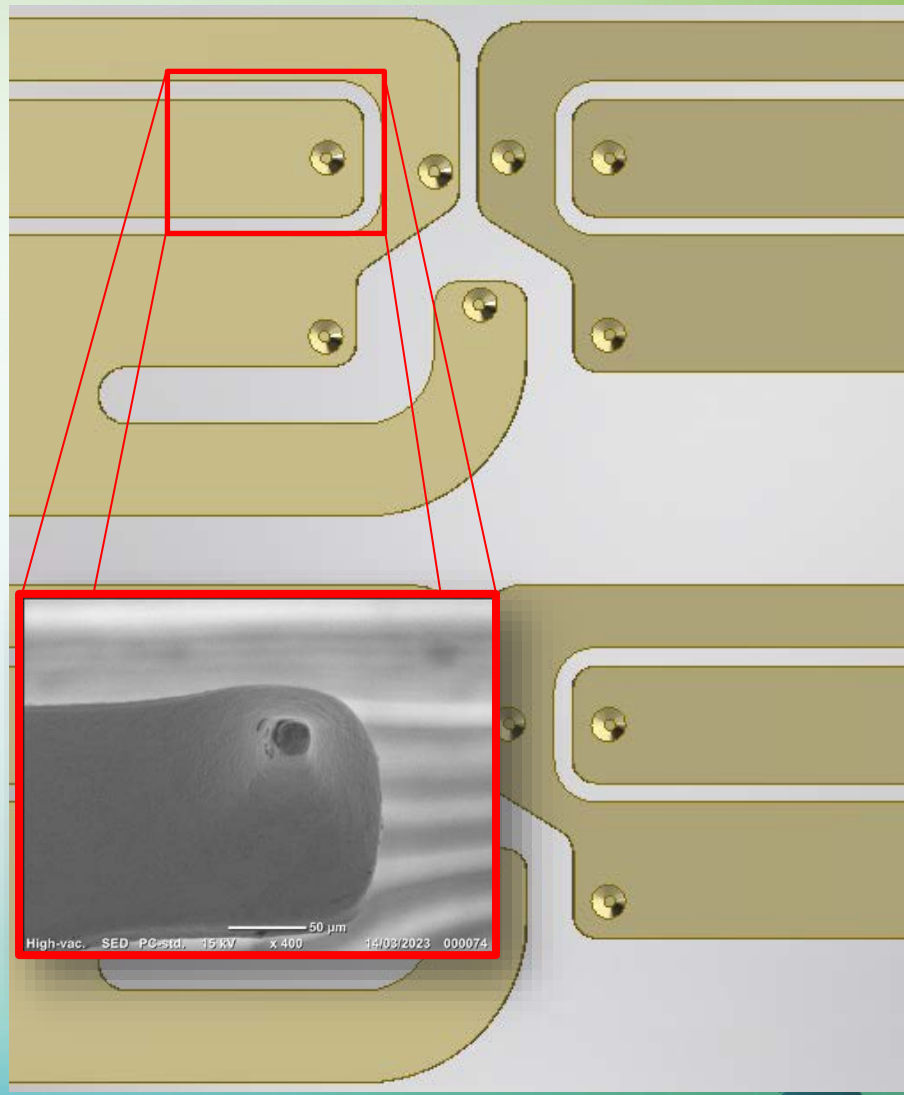
Combines existing NuvoRF technology into a single integrated PhazorRF ATE solution

Routing is done in a low-loss air-dielectric Coplanar Waveguide (CPW) transmission line

The CPW structure provides great performance up and beyond 110 GHz

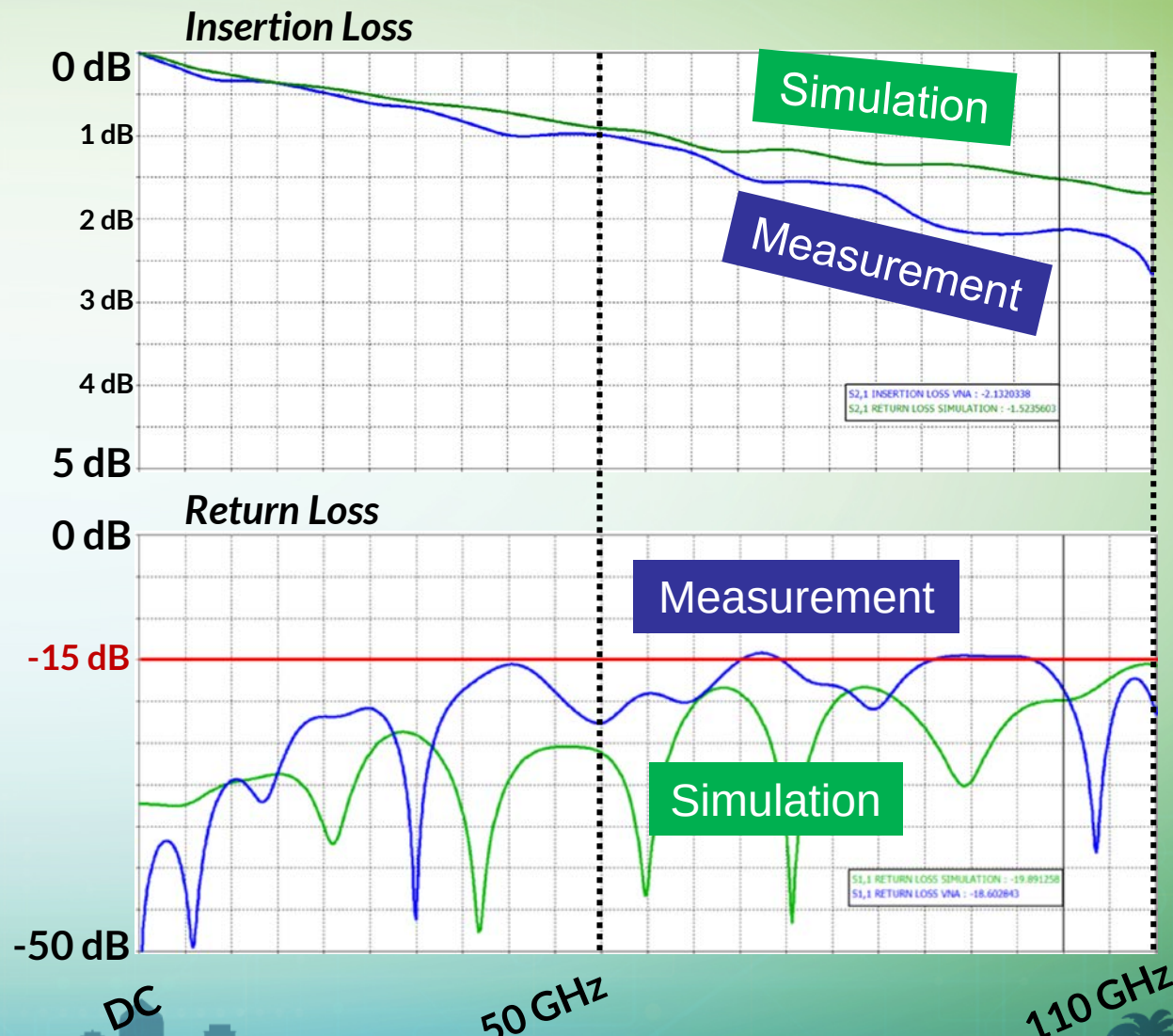
Probe Tips

- Probe tips are formed on each beam with extreme precision
- Probe compliance is controlled by a lever arm attached to each probe
- Force is “programmable” by adjusting the parameters of the lever arm
- 1st order behavior: *(From Euler–Bernoulli beam equation)*
  - Force is inversely proportional to Length cubed
  - Force is proportional to beam thickness cubed
  - Force is directly proportional to beam width
- More advanced behavior such as non-straight beams is calculated using FEA simulations



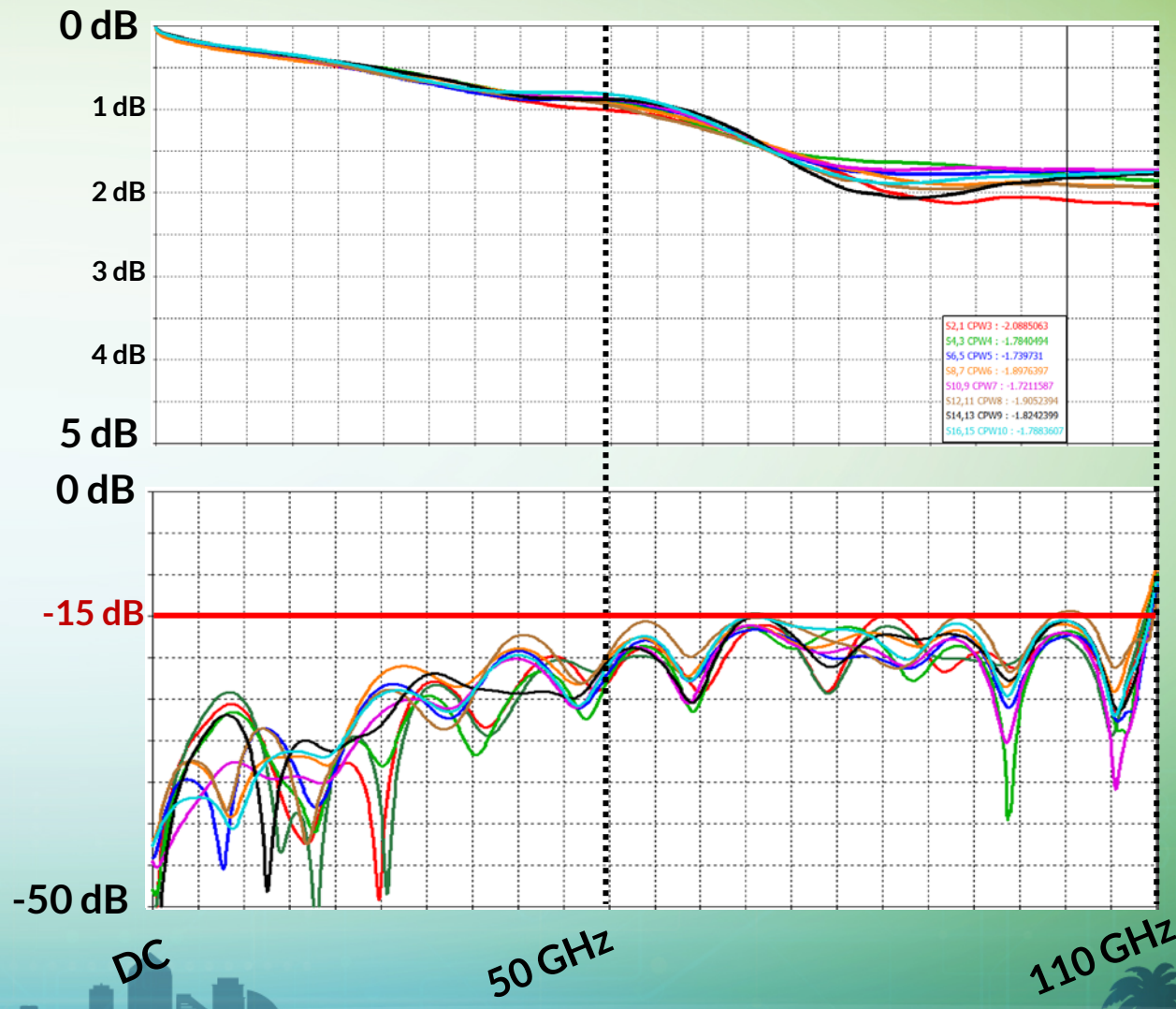
Performance

- High performance prototype:
  100um GSG configuration
- Performance good to 110 GHz
  - 2.5dB Insertion Loss
  - 15dB Return Loss
- Insertion loss is dependent trace length which is a function of design density



Repeatability

- 100um GSG Prototype used
- Manufacturing repeatability
- Part to part variation is minimal
- VNA calibration changes cause a greater impact on measurements than part variations!

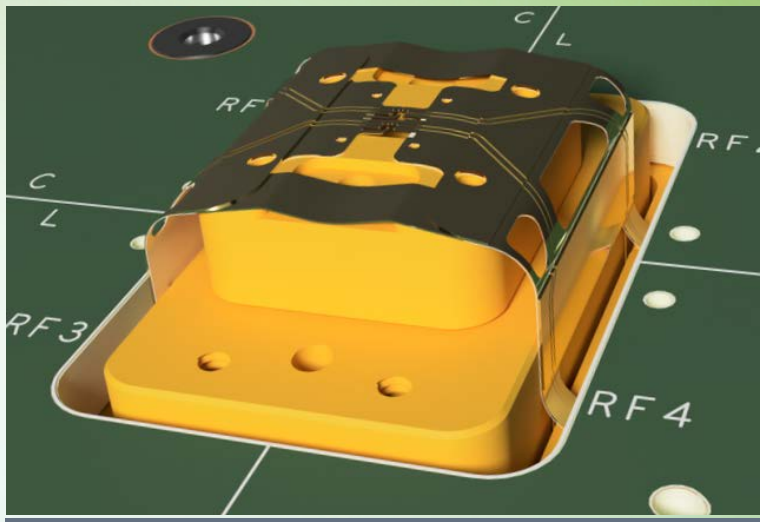


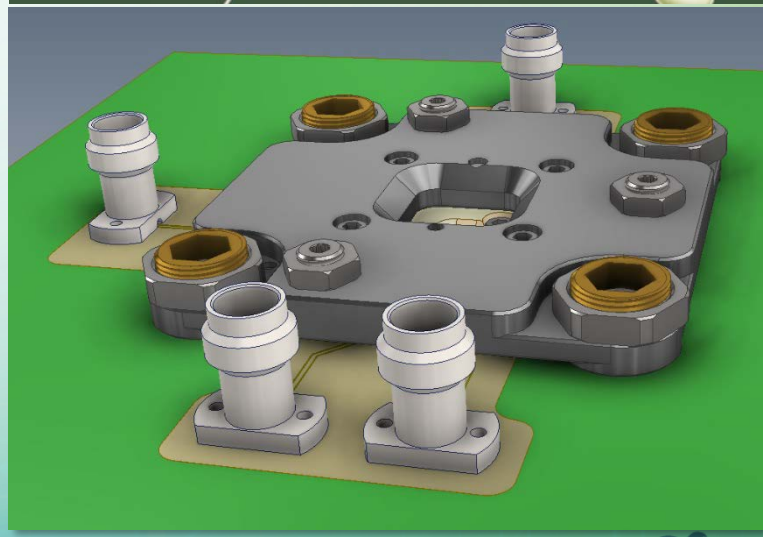
Step 4: PCB Interface

- Leverages existing wafer probe interface, but adds a direct-to-PCB interface

- Mounts from back-side of PCB
  - Allows for circuits on probe card for muxing, filters, BALANs, impedance matching, etc.
  - Allows for easy replaceability in the field
  - Keeps probe interface closer to probe card

- High-speed low-cost connector interface from PCB using off the shelf connectors





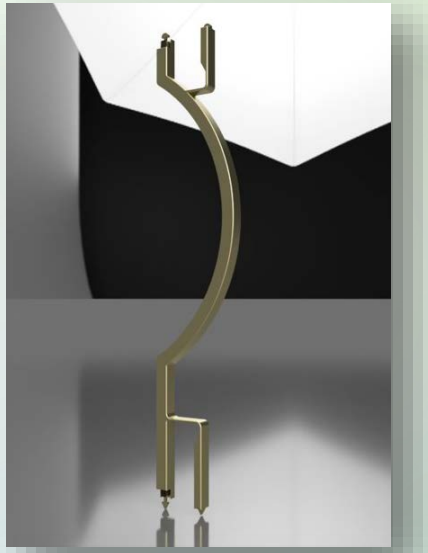
Step 5: High-Speed Vertical Probe

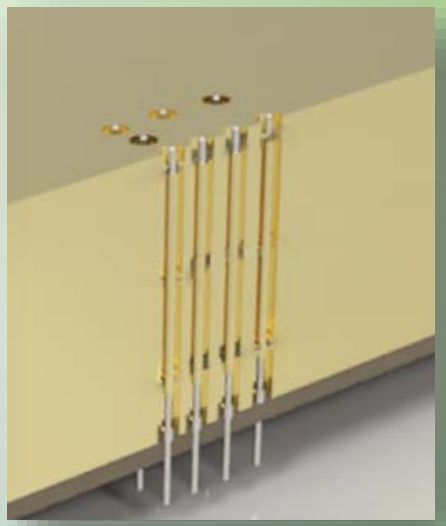
Solutions for RF Vertical Probe:

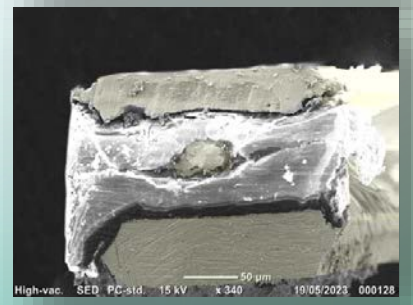
- Coax probe interfaces are a challenge at fine pitches < 200um. This means they only solve a part of the market need.

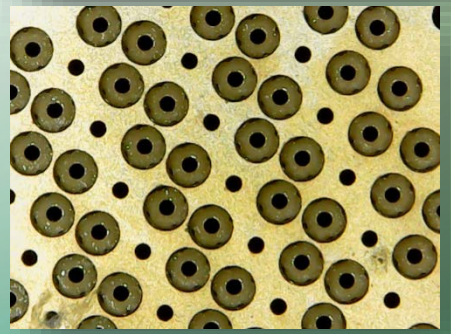
- MEMs probes can be used to achieve high frequency probes and less than 200 um

- Higher density solutions are required for highly integrated SOC devices as well as large digital networking devices







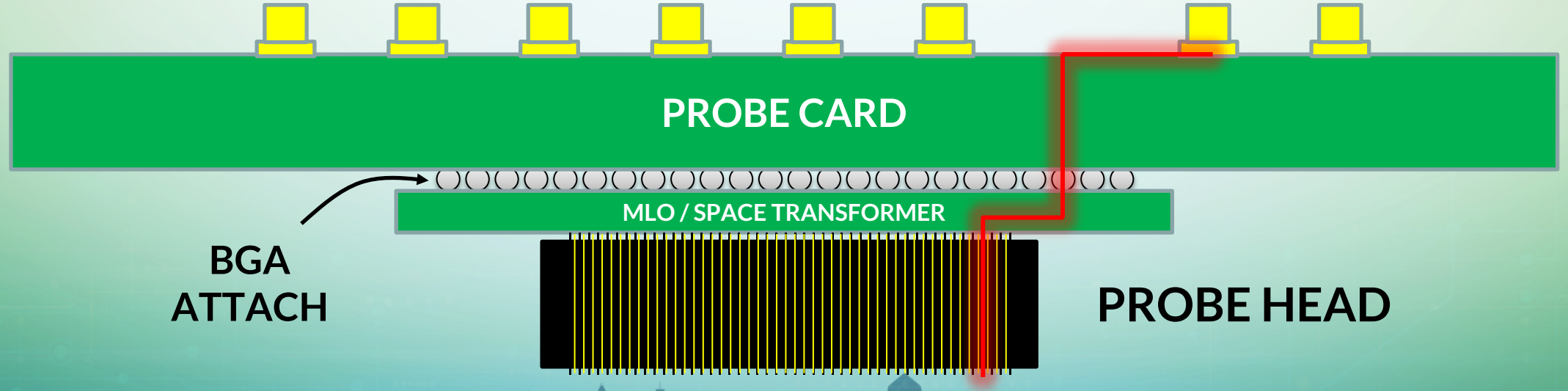


Vertical Probe Performance

- Simulated data shown for 150um pitch probe interface
- Vertical probe heads can perform at high bandwidth
- The probe card must also be able to support the bandwidth and fan out from wafer pitch
- Capable of supporting
  - 5G RF
  - 112 Gbps PAM4 SERDES

Vertical Probing + MLOs and PCBs

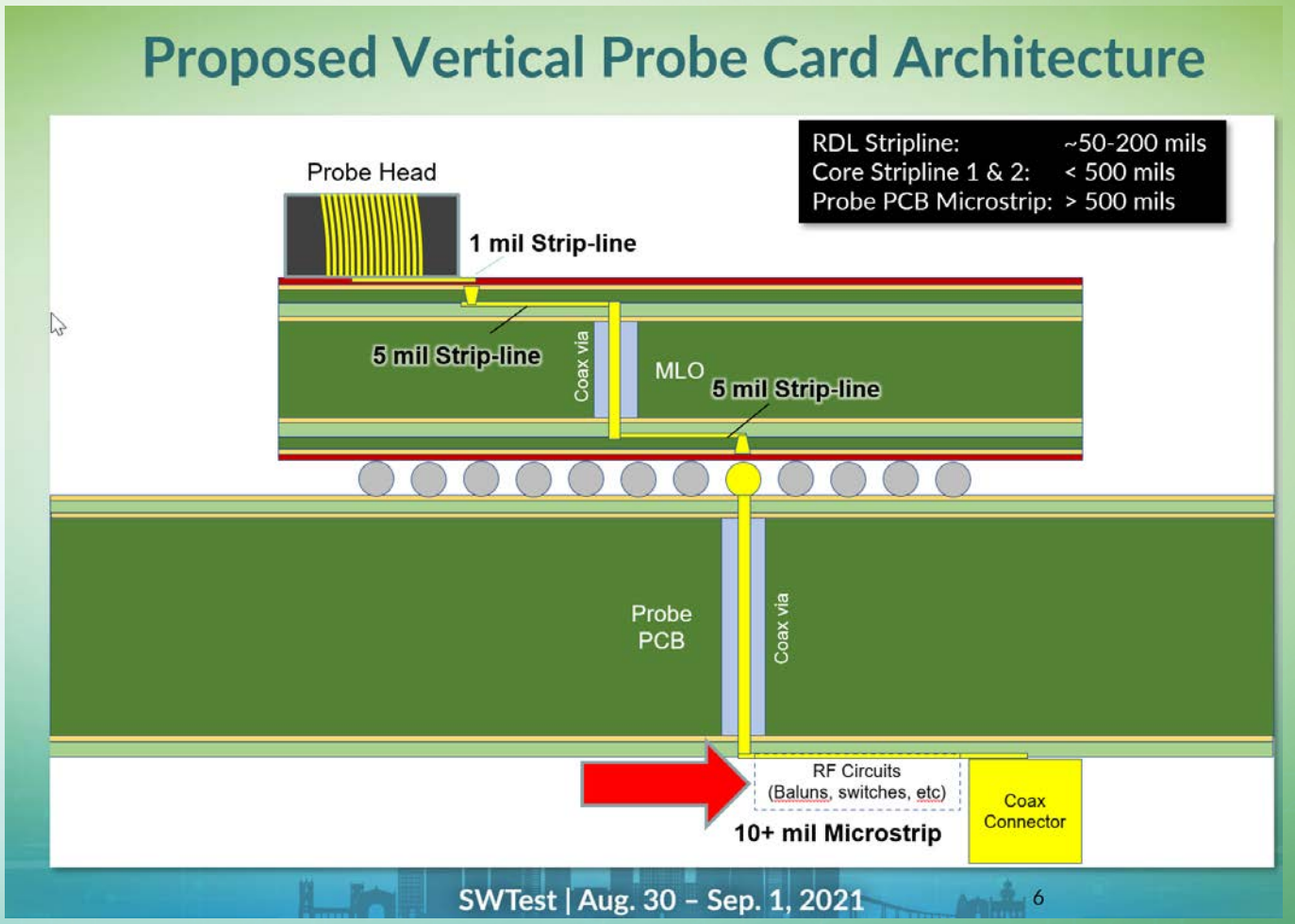
- A big part of the RF vertical probe challenge is the part of the system above the probe head. With a vertical probe head the SI signal must route from the footprint of the probe head, through the MLO, through the BGA interconnect, and through the probe head.
- Half the RF challenge is routing the signal from probe head to connector



MLO & Probe Card Capabilities

- In "*A Vertical Probe Solution for High-Density RF*", presented at SW Test 2021, laid out a path to get to 50 GHz MLO and Probe Cards

- A vertical probe head with a well-designed MLO can achieve high site count and frequencies >50 GHz



Conclusion

Success in RF Wafer Probing

Success in RF wafer probing requires a team that is strong in design, SI, and manufacturing. All of these parts are required for successful implementation of RF probe heads.

New designs for RF probe heads

Using MEMs manufacturing, we can create new designs for RF probe heads that have new advantages over existing technologies

A portfolio of RF and high-speed wafer probes

PTSL is committed to creating a portfolio of RF and high-speed wafer probes that will open up new capabilities and options in ATE

Special thanks to the team

Robin Cedeno
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PTSL

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PTSL

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PTSL