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Development of an 8-site Change Kit for Parametric OTA Testing

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Advantest

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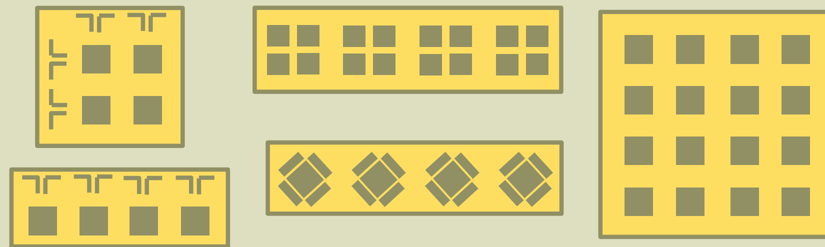
Presentation Outline

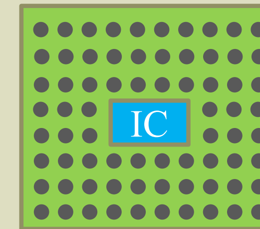
- OTA Testing with ATE in HVM
- OTA Testing and Handler Integration Challenges
- Example of an 8-site OTA Change Kit
- Results with 8-Site OTA DUT Board.
- Conclusions

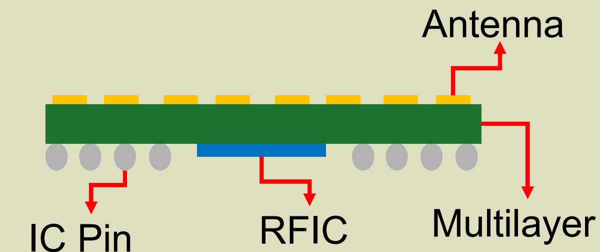
Why Do Chips Need (Over-the-Air)OTA Testing?

- The AiP(Antenna-in-Package) device is a single integrated package unit of antenna and RF circuit by packaging technology. Its structure is very complex because of multiple layers, complex routing and via interconnect.



Different AiP antenna configurations (Top View)





AiP device package (bottom & side View)

- Antennas are built in package.
- Antennas are the only access for mmWave test because of no contact access for RF ports.

OTA Testing is becoming necessary

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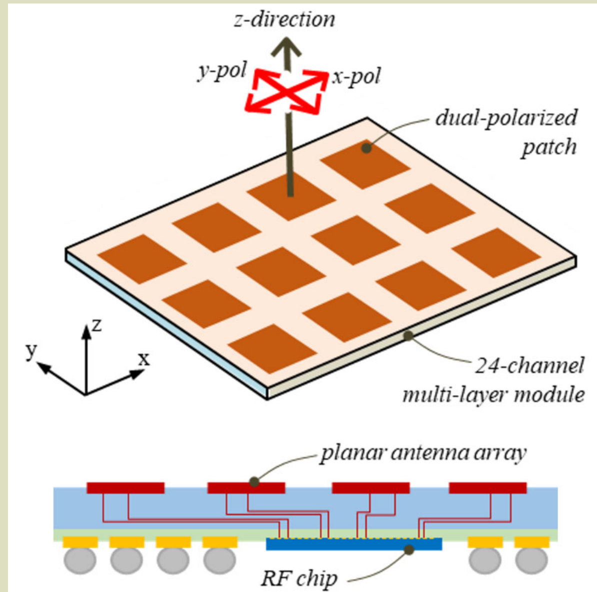
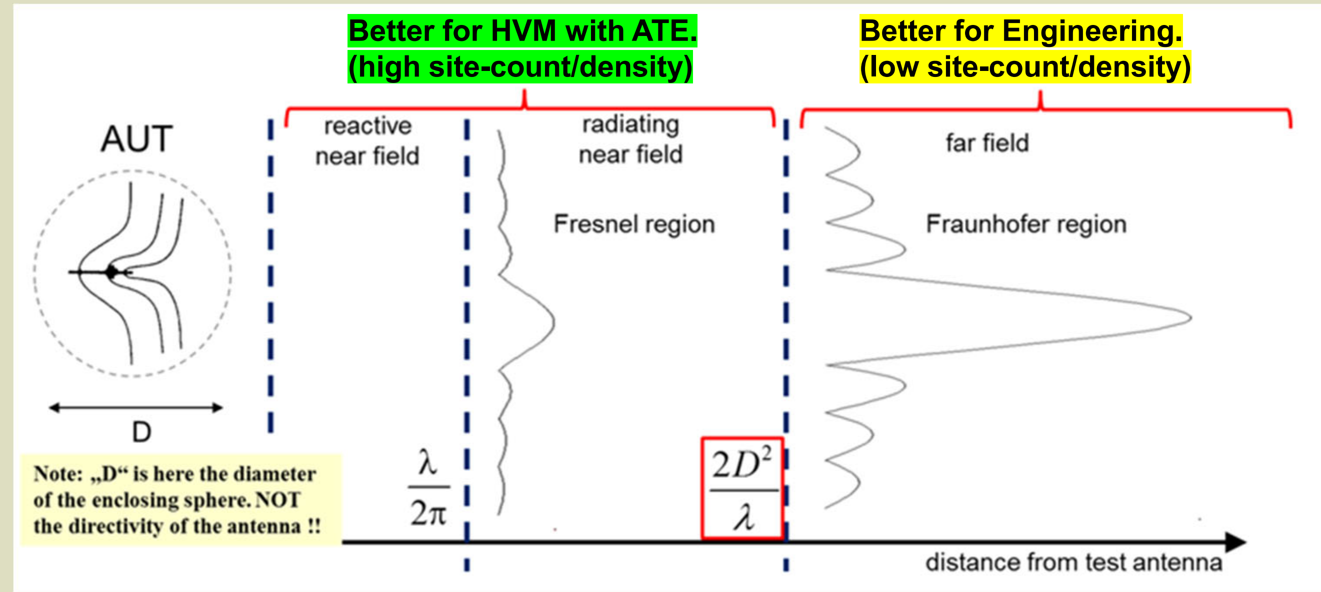
OTA Testing Environment with ATE



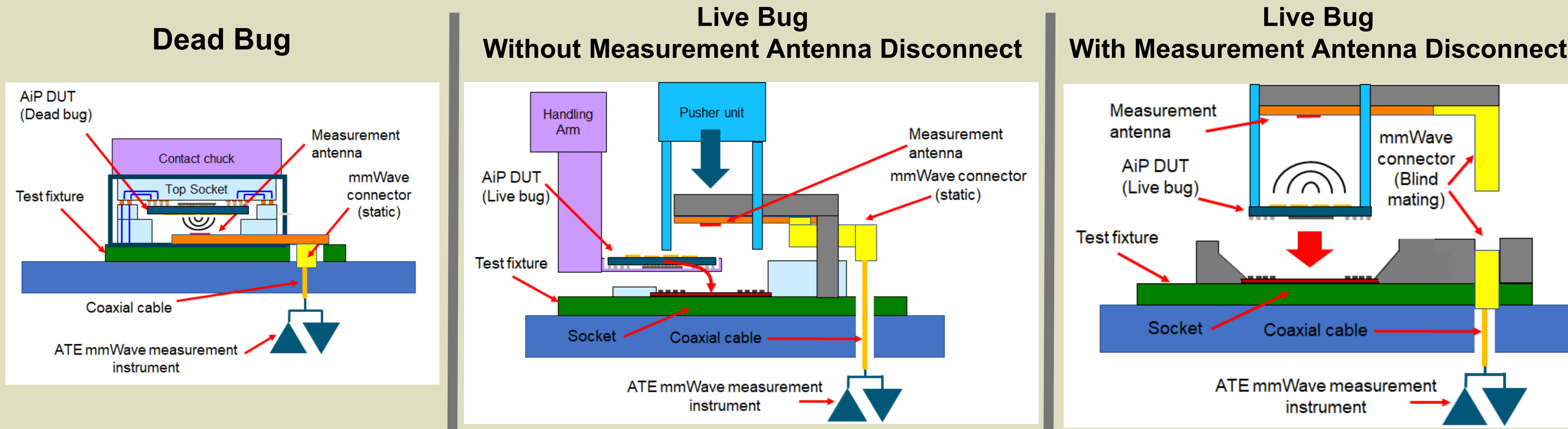


Key objectives of an ATE parametric OTA test cell:

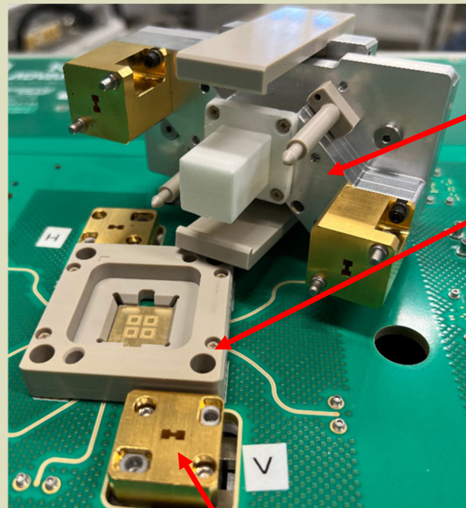
- **Use commercial ATE and handler (no handler or ATE customization).**
- **Multi-site (8-sites).**
- **Parametric correlation between anechoic chamber characterization measurements and HVM setup.**

Near Field OTA Handler Integration Options

- Three different approaches are possible for AIP DUT handling in a handler test cell setup:
  - dead bug (radiating down).
  - live bug (radiating up) without measurement antenna disconnect.
  - live bug (radiating up) with measurement antenna disconnect.

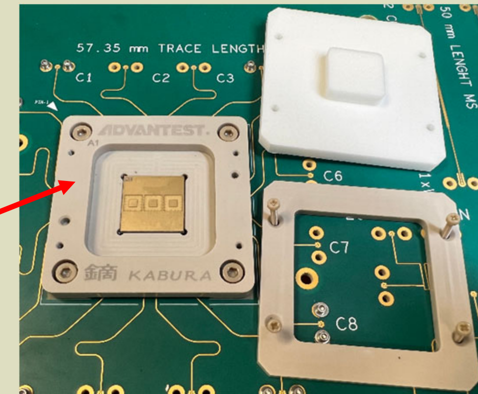


OTA Socket Design Challenges

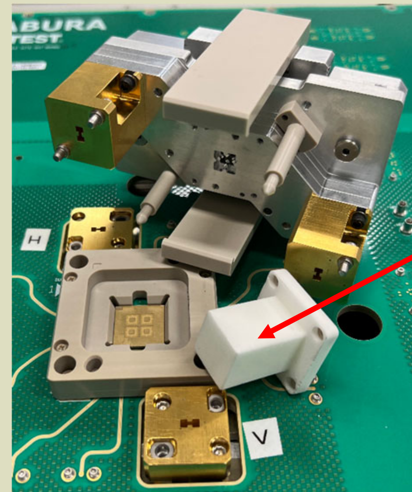


Near-field antenna design:
+ meet frequency/bandwidth requirements
+ minimal height to comply with handler requirements

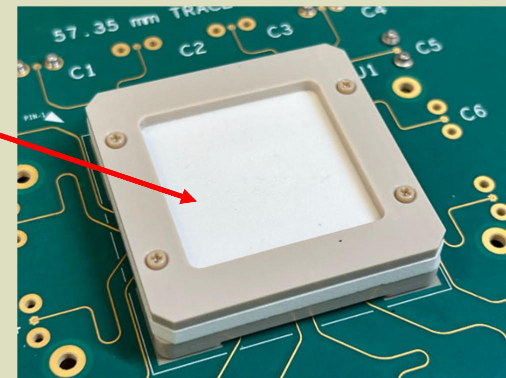
Socket body material and geometry:
+ good mechanical performance (self-alignment of DUT)
+ minimize reflections/impact on near-field testing.



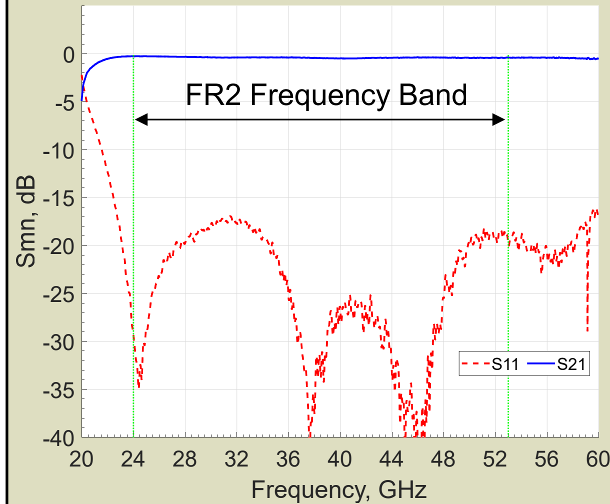
Interconnect to ATE is critical!
+ high reliability
+ consistent performance.

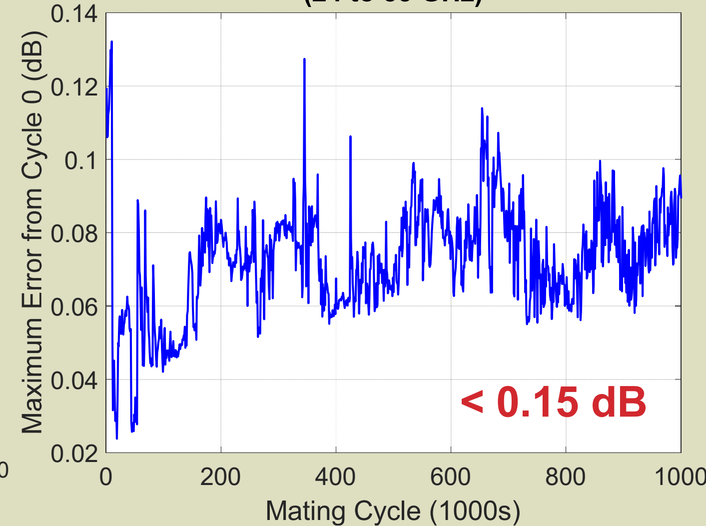


Pusher material must be carefully chosen to provide:
+ electromagnetic transparency
+ mechanical strength/density

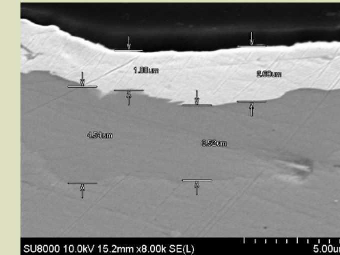


Waveguide Blindmate Performance/Durability

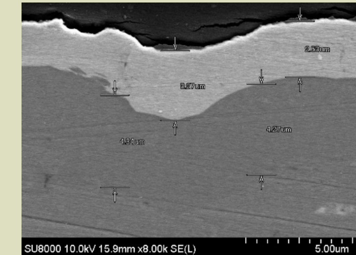




0 cycles



1 million cycles

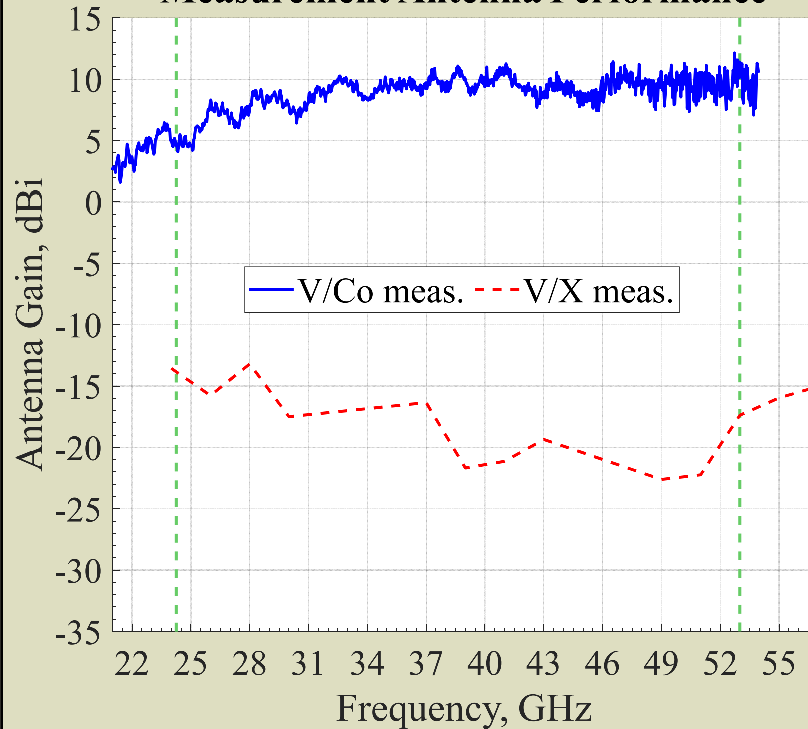


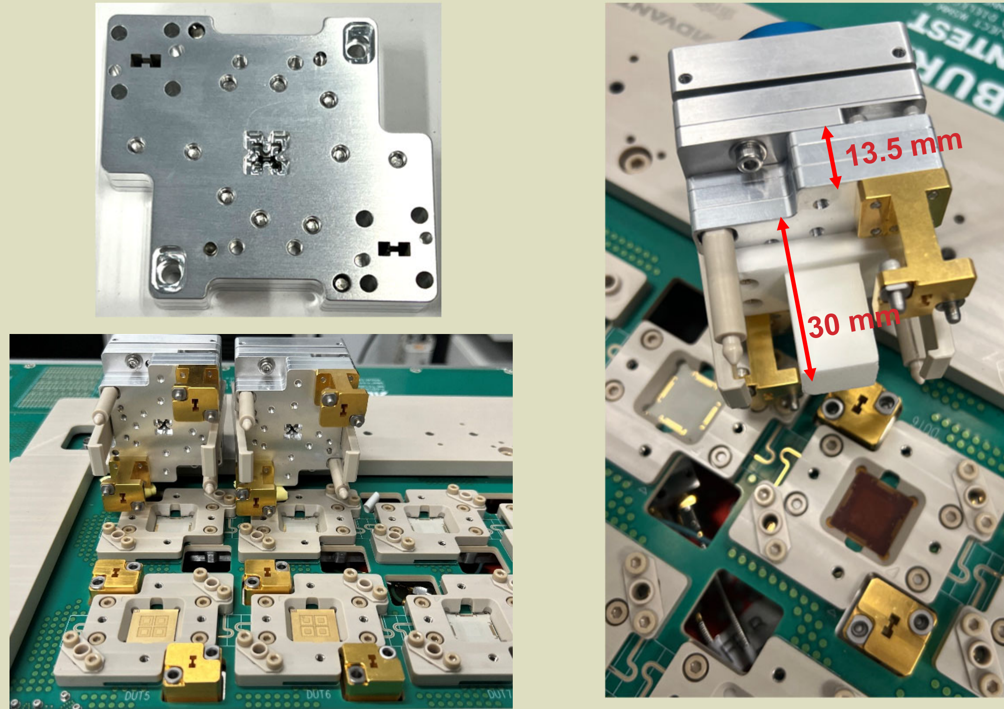
Minimal degradation to the Ni/Au Mating Surface observed after 1 Million Cycles

Better than 15 dB Return Loss across the 24-53 GHz Frequency Band

Less than 0.15 dB absolute variation across the 24-53 GHz Frequency Band throughout 1 million docking cycles

OTA Measurement Antenna Design (24-53 GHz)





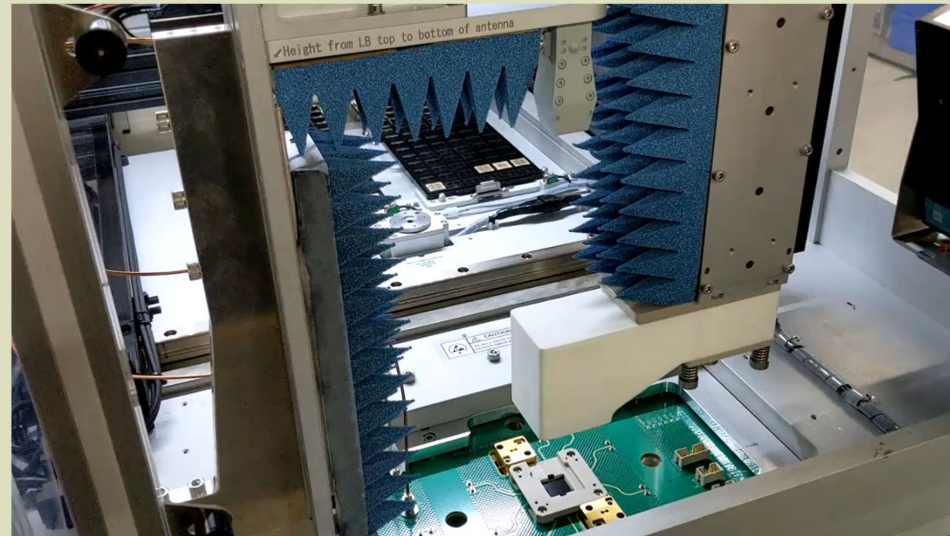
Patent pending

- Antenna total thickness is critical for handler integration (13.5 mm).
- Full bandwidth antenna avoids multiple insertions.

Single-Site Handler Integration Example

Far-Field

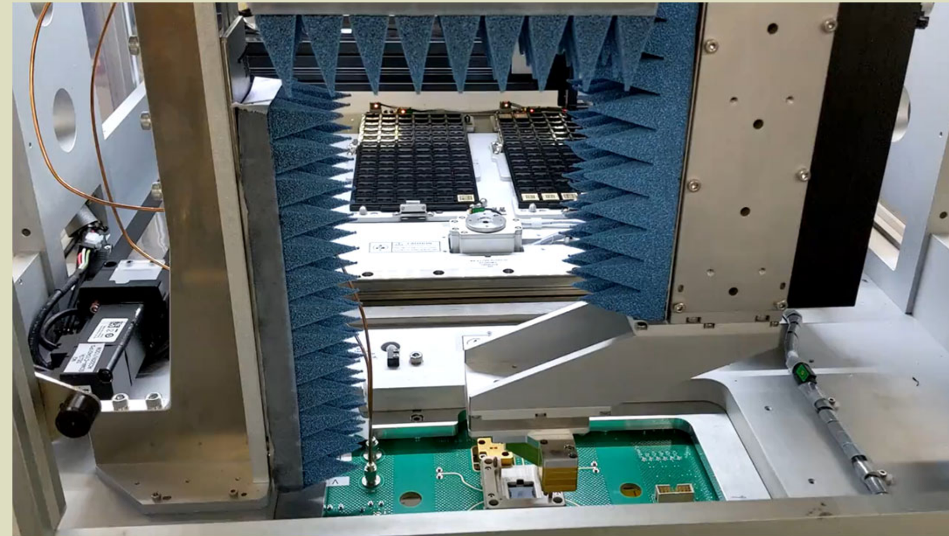
VIDEO



VIDEO

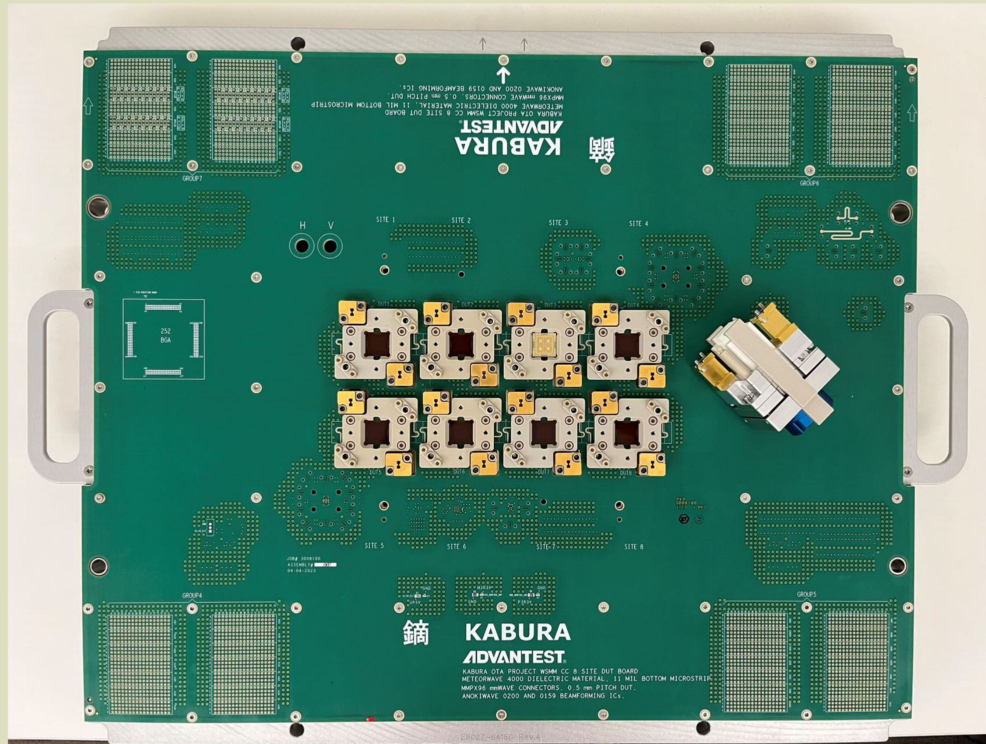
Near-Field

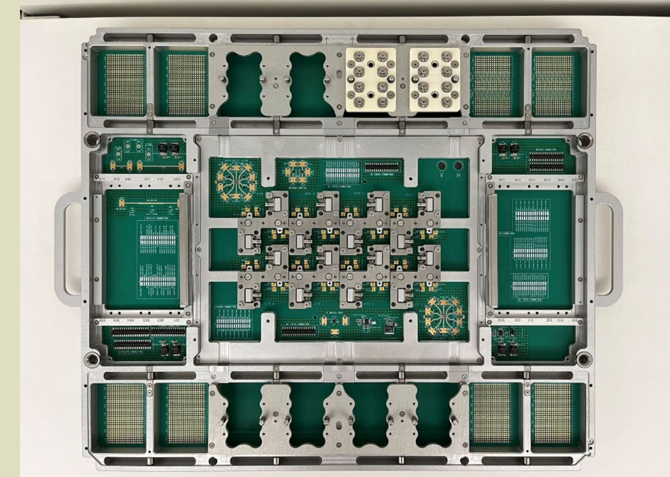
VIDEO

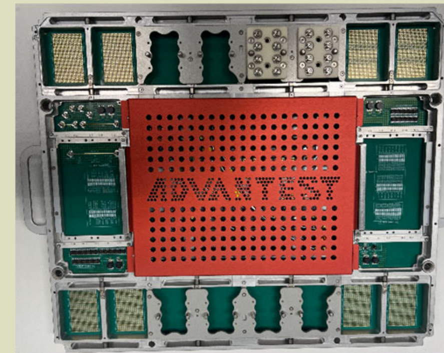


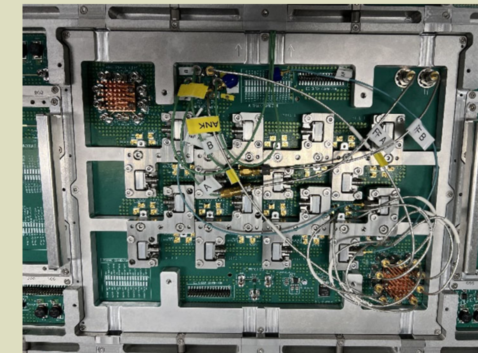
VIDEO

8-Site OTA Test-Cell Demonstration DUT Board





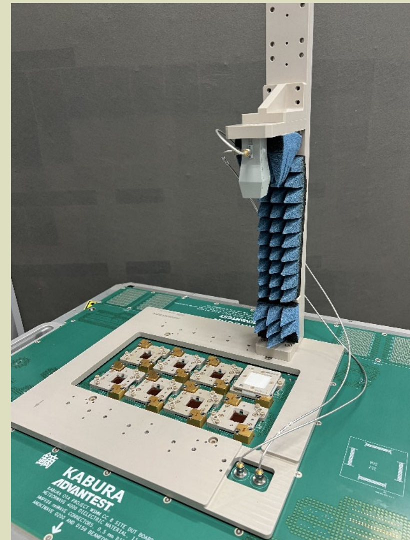




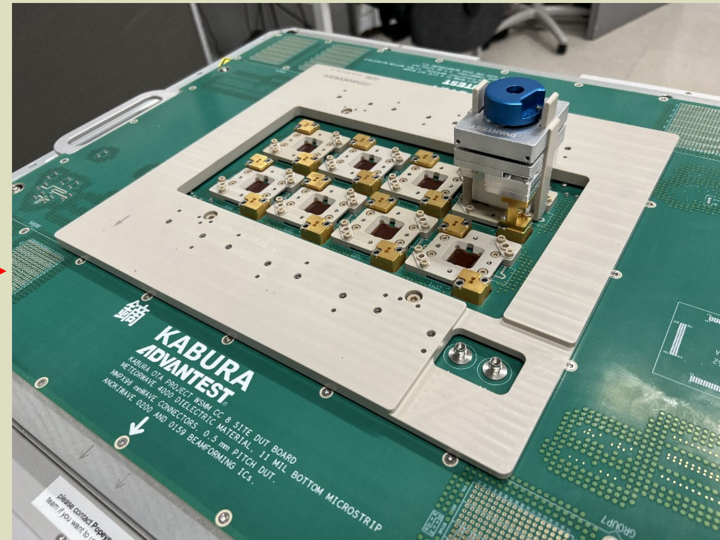
- Multi-site pitch: 60 mm by 63.5 mm
- Advantest OTA Demo AiP package (17x17 mm)

OTA Testing: Engineering to HVM

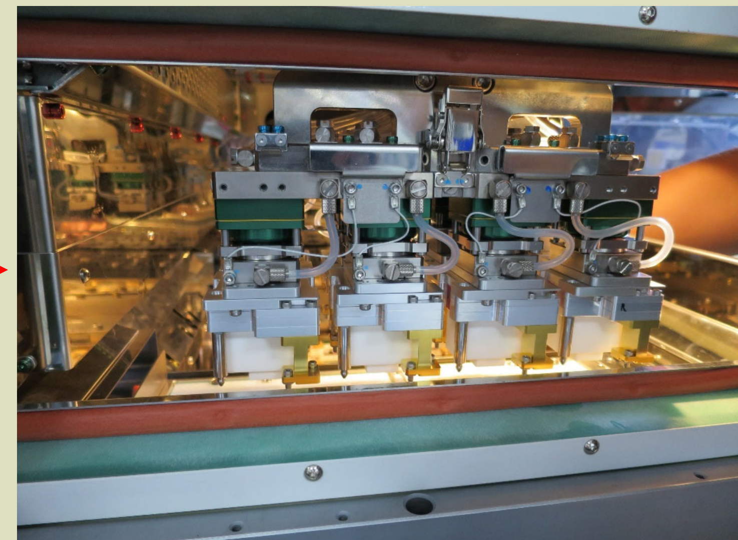
Far-Field Engineering



Near-Field Engineering



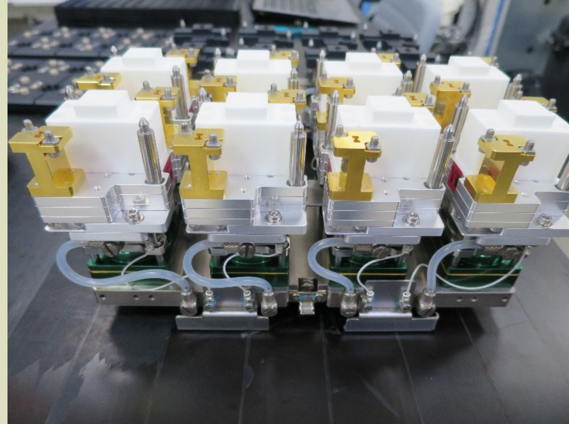
Near-Field HVM

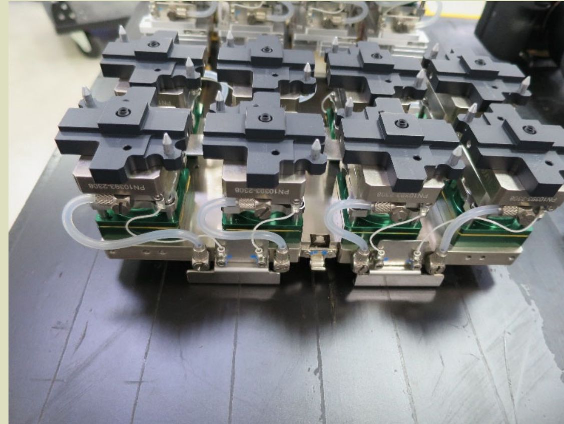


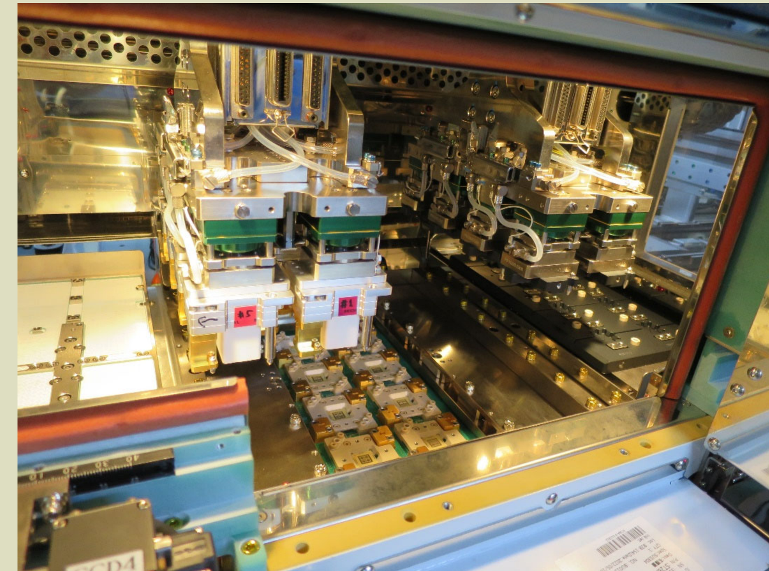
Utilize the same Test Program

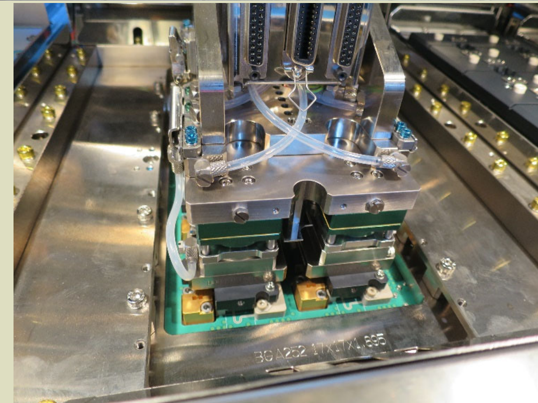
Utilize the same DUT Board (Test Fixture)

8-Site Handler OTA Change Kit









8-Site Handler OTA Change Kit

Development of an 8-site Change Kit for Parametric OTA Testing

VIDEO

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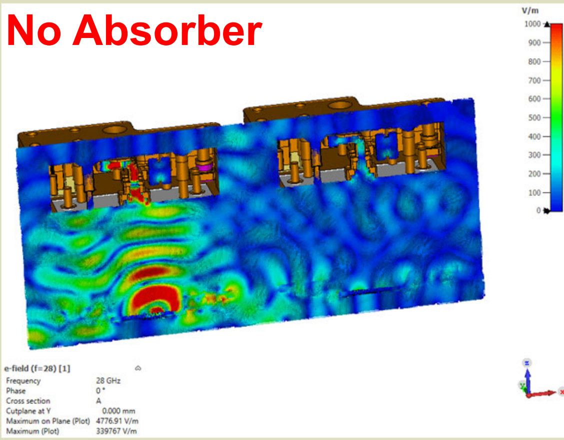
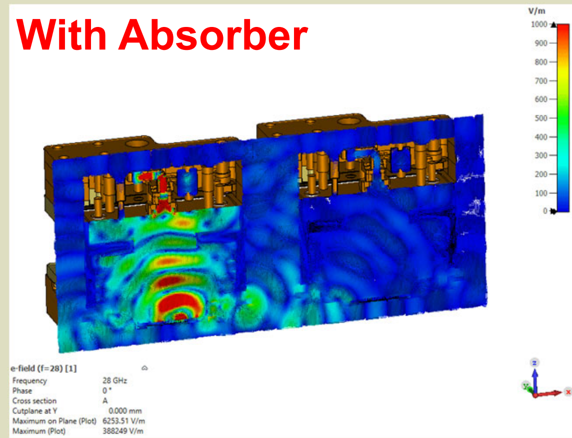
8-Site Handler OTA Change Kit

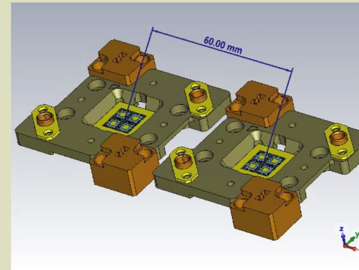
Development of an 8-site Change Kit for Parametric OTA Testing

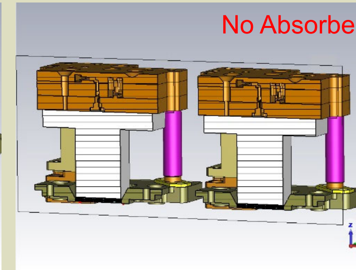
VIDEO 14

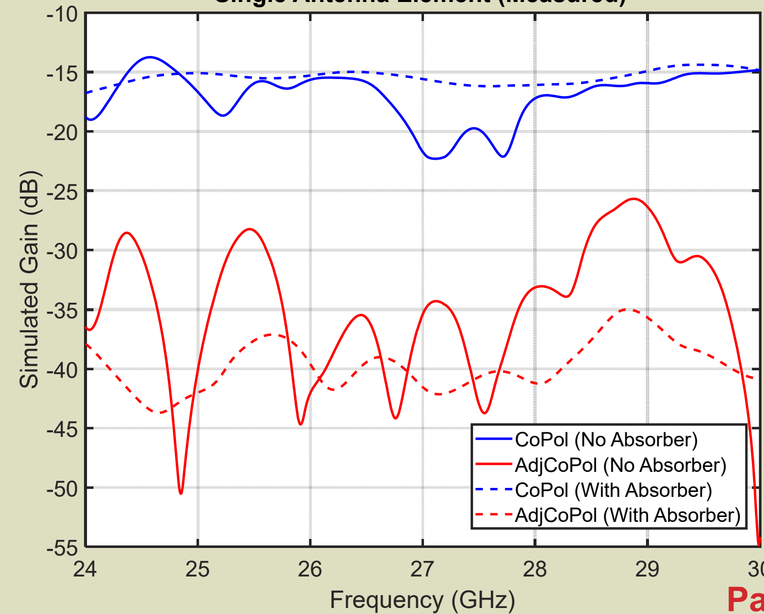
Site-to-Site Isolation





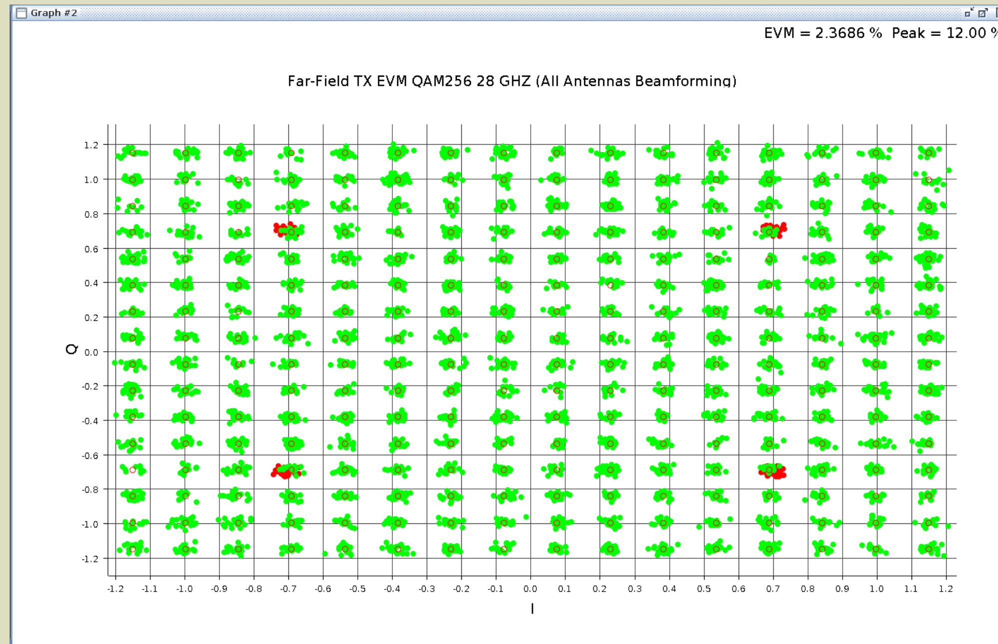


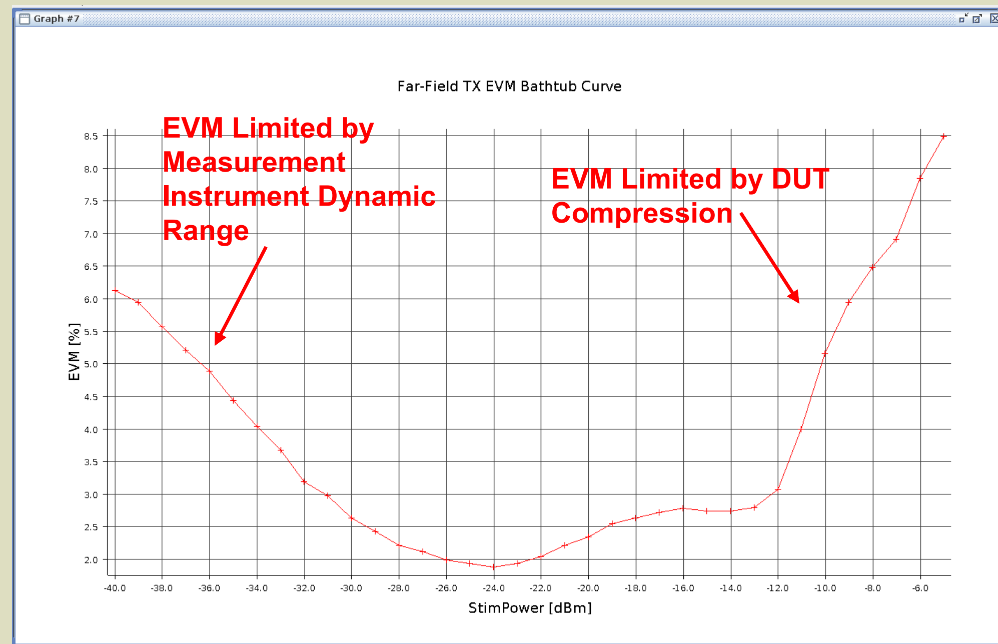




Patent pending

OTA Results with 8-Site DUT Board





- Test results are consistent with traditional conductive testing.

OTA Handler Integration

Item	8-Site Handler Integration	Single Site handler	Note
OTA measurement method	Near-Field	Near-Field and Far-Field	
Parallelism	x8 (Near-Field)	x1(Far-Field and Near-Field)	
Temperature range	-40 to +85 degC (Temperature Chamber)	Room temperature	
UPH	3800 UPH (x8)	156 (x1)	Units Per Hour
Index time	6s	23s	Time from test end to test start
Package size	5x5 to 24x24mm (x8) 45x45mm (x4)	45x45mm (x1)	
Measurement Antenna to DUT AiP Antenna Array Distance	11 to 40 mm	11 to 40 mm	Radiating near-field

Conclusions

- It is possible to design/deliver a multi-site OTA change kit for a "traditional" handler which supports up to 8-sites for HVM.
- This enables the flexible usage of existing mmWave ATE test cells for conductive and OTA testing without any customization.

Additional Information/References

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- Jose Moreira, "Testing AiP modules in high-volume production for 5G applications (Part 2)," *Chip Scale Review*, Nov/Dec 2020.
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- Jose Moreira, S. Churkin and O. Zhuravleva, "A Calibration Kit for a 5G-FR2 Band Double-Ridged Waveguide," IEEE Workshop on Signal and Power Integrity, 2023.
- Jose Moreira, Frank Goh, Yasuyuki Kato, Natsuki Shiota, Hiroyuki Mineo, Aritomo Kikuchi, Sui-Xia Yang and Hiromitsu Takasu, "Challenges of HVM OTA Testing for mmWave Devices," Advantest VOICE Users Conference 2022.
- Jose Moreira, Sui-Xia Yang, Roger Nettles, Frank Goh, Takasu Hiromitsu, Mineo Hiroyuki, Kato Yasuyuki Shiota Natsuki, "A Training and Demonstration Setup for OTA Testing with the Advantest V93000 Platform," Advantest VOICE Users Conference 2023.
- Jose Moreira, S. Churkin and M. Kirillova, "A Dual-Polarized Quad-Ridged Waveguide Antenna for OTA Near-Field ATE Socket in 5G-FR2 band", to be presented at the 28th IEEE Workshop on Signal and Power Integrity, 2024.

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