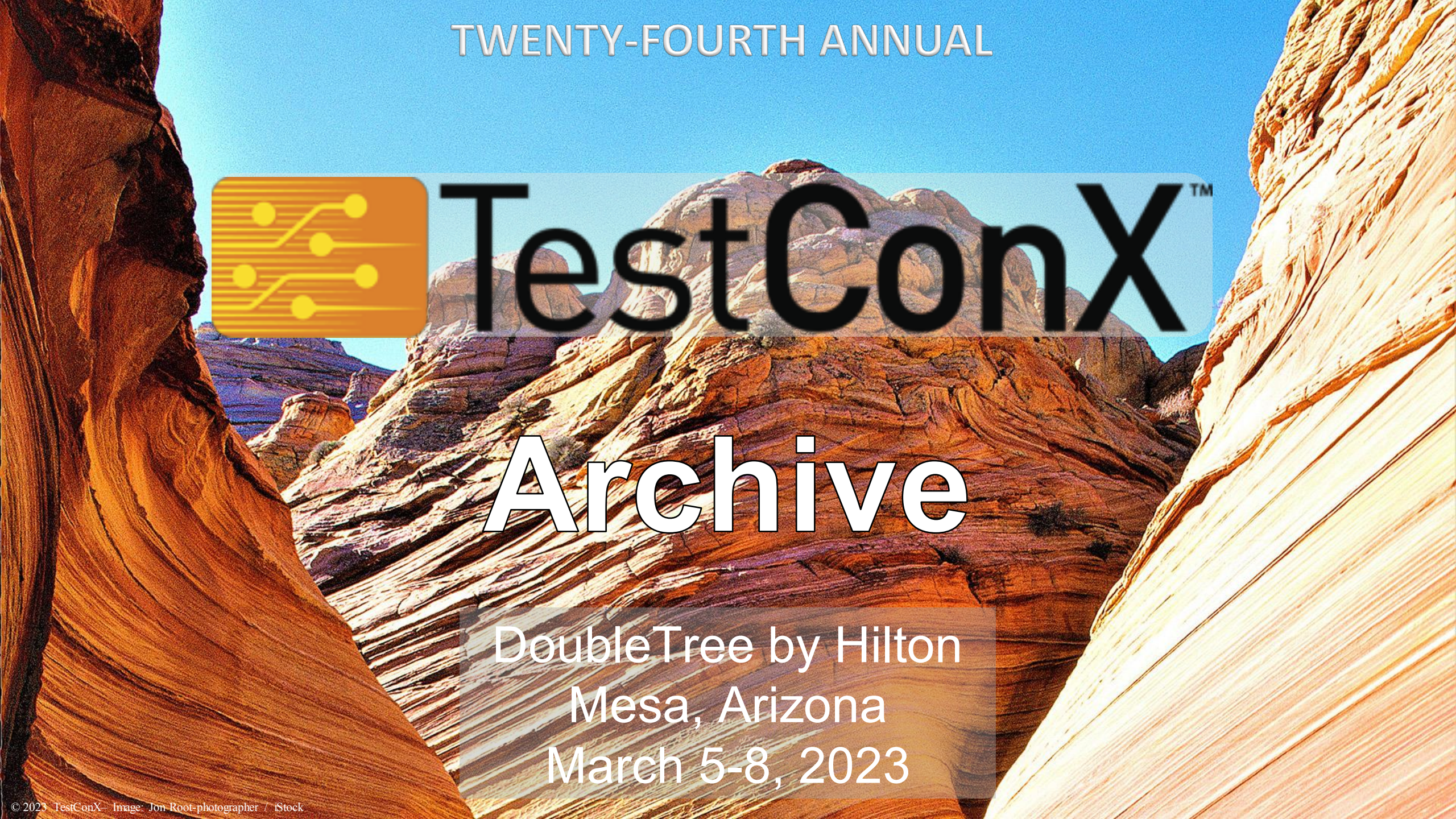

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Utilizing System Level Test to Achieve High-throughput, Automated RF Testing

John Toscano
Teradyne

Mesa, Arizona • March 5-8, 2023

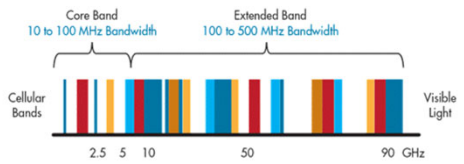
TERADYNE

Contents

- IC device trends and challenges
- Utilizing RF +SLT to address the new challenges
- Combining traditional SLT with RF calibration and verification
- Elements of an SLT RF system
  - Integrated instruments
  - High repeatability RF interconnect
  - Signal splitter for multiple antennas
  - Shielding
  - Calibration
- Emerging applications

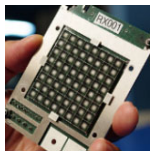
Wireless Industry Trend

Emerging Requirements

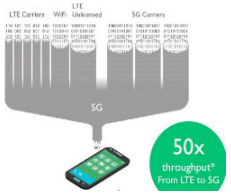


Higher Frequencies (mmWave)
Wider Bandwidths

Device Complexity

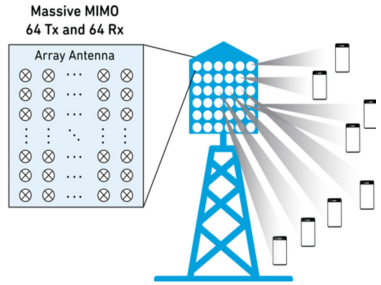


Beamforming Arrays



Carrier Aggregation

mMIMO



"BTS mMIMO Multiplier"

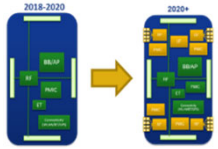
New Applications

Micro-Location

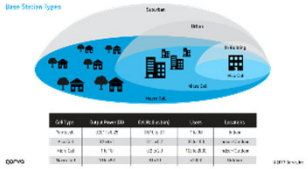
Automotive Connectivity

L3-L5 ADAS mmW

Increasing Volumes



"mmWave Multiplier"



Small Cells

Heterogeneous Connectivity

802.11be

Wi Fi 6 CERTIFIED

Wi-Fi 802.11ax

UWB

Wi SUN

LoRa

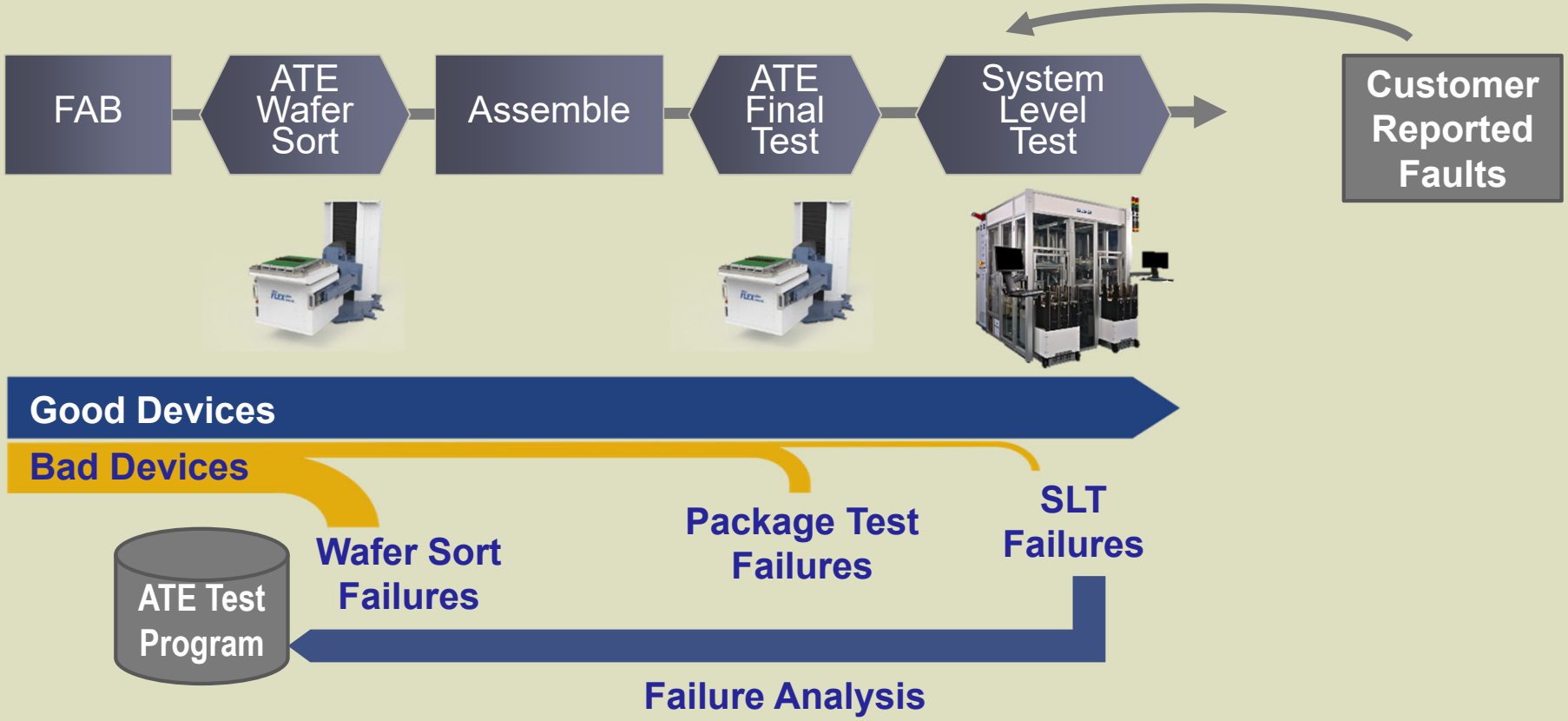
ZigBee

HaLow

Z-WAVE

SIGFOX

SLT Role in Failure Analysis



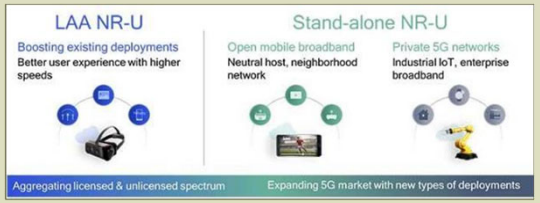
SLT/RF Platform Key Considerations

Key considerations for SLT

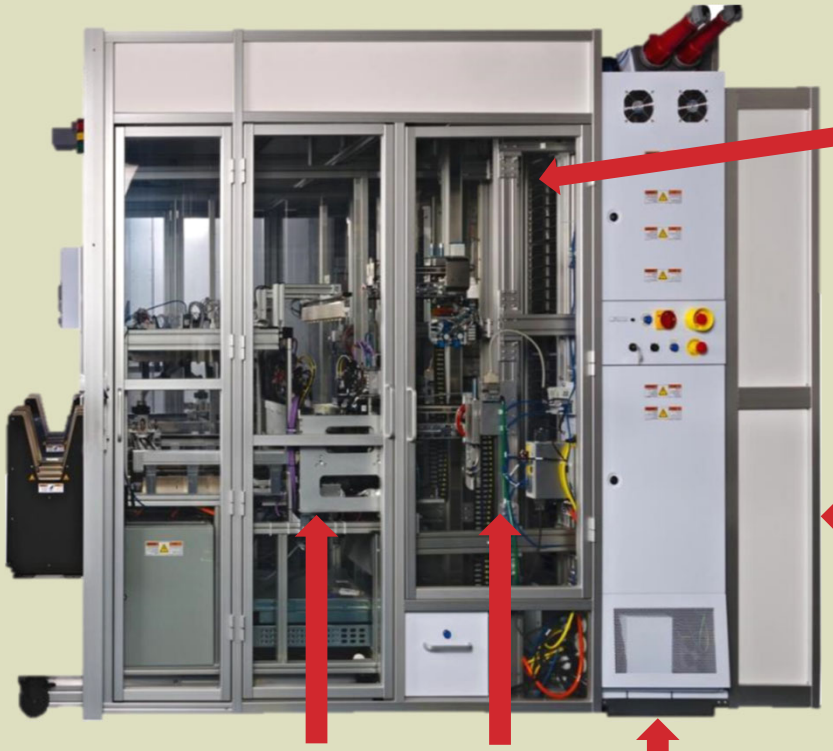
- Asynchronous testing is critical to reducing the cost of test
- Optimize uptime and utilization rate to increase operating efficiency
- Compact floor space to save operating cost

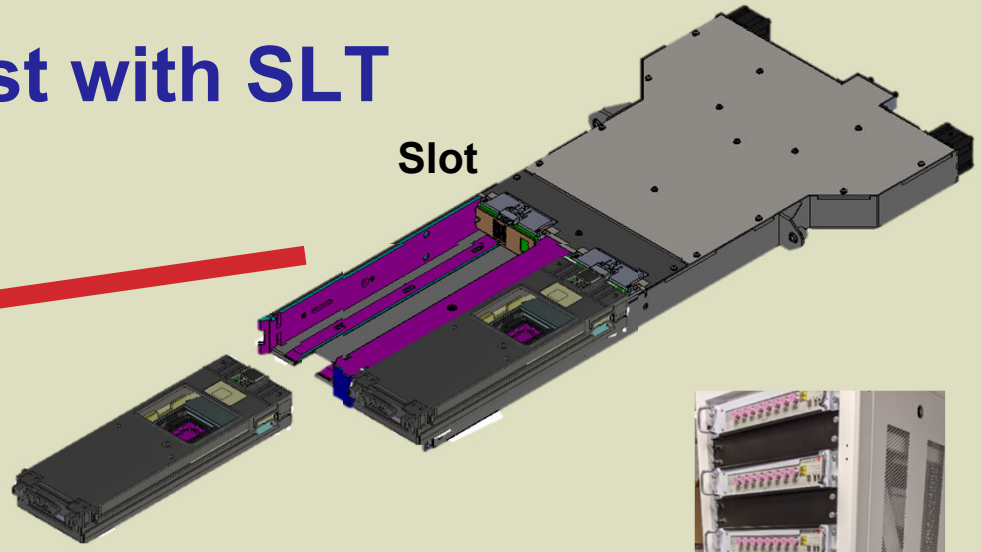
Key considerations for RF instrument

- Cover the frequency bands required by your device and roadmap
- High density instrument architecture
- Instrument resource sharing capability
- High output signal power to overcome fixture losses



Implementation of RF Test with SLT





Tray Feeders

Precision Stage

Column Robot

Slot Rack

RF test instrument

RF Support Cabinet

TestConX™

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Utilizing SLT RF Test to Reduce Field Failures

Utilize SLT to achieve high-throughput, automated RF Testing:

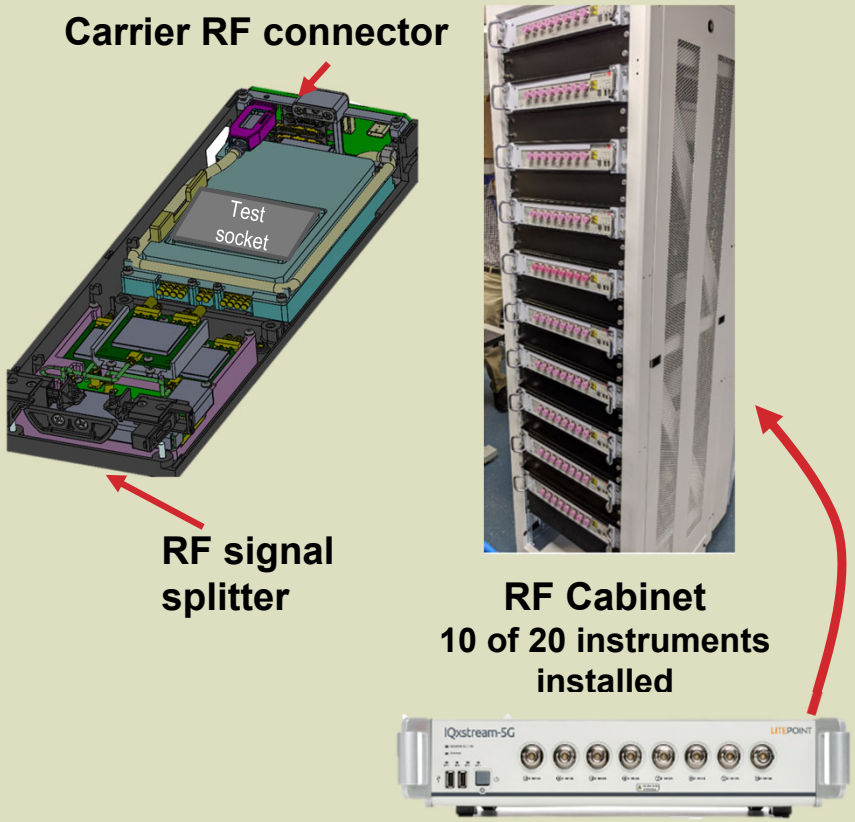
- Easy to create operation-mode functional tests which can be challenging to do in ATE
- Finds faults missed by traditional ATE

Integrated RF Test for SLT:

- Integrated automated SLT system with RF instruments
- Use RF instrument function calls in the Test Program
- Connect with dedicated or shared RF resource
- High-reliability connector carrier to slot

Application example with SLT and RF

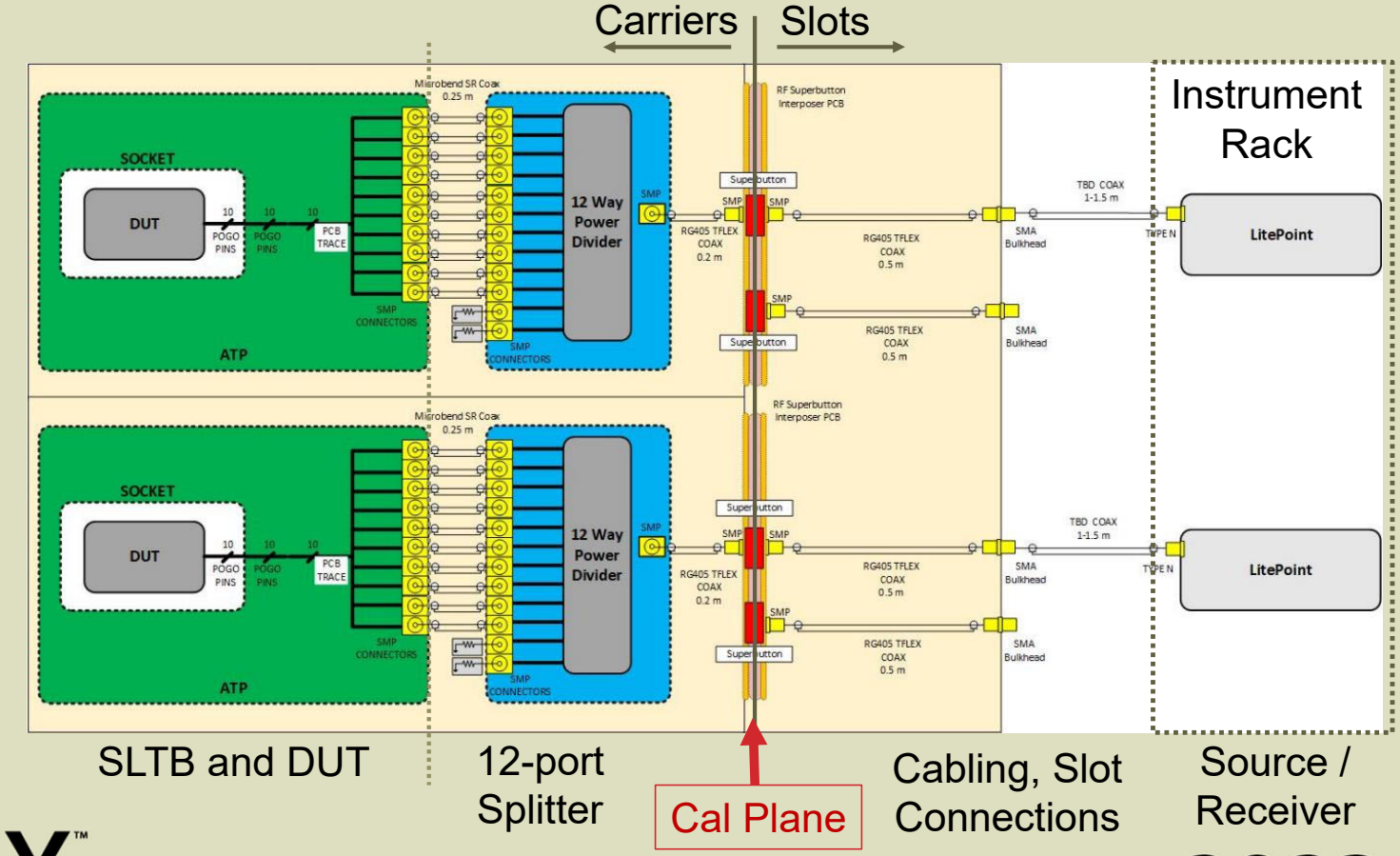
- Frequency range **400MHz to 6GHz***
- **-25dBm** power delivery to all ports*
- Power level accuracy **+/- 1.5 dB** (k=3)
- **>60 dB** site-to-site shielding effectiveness



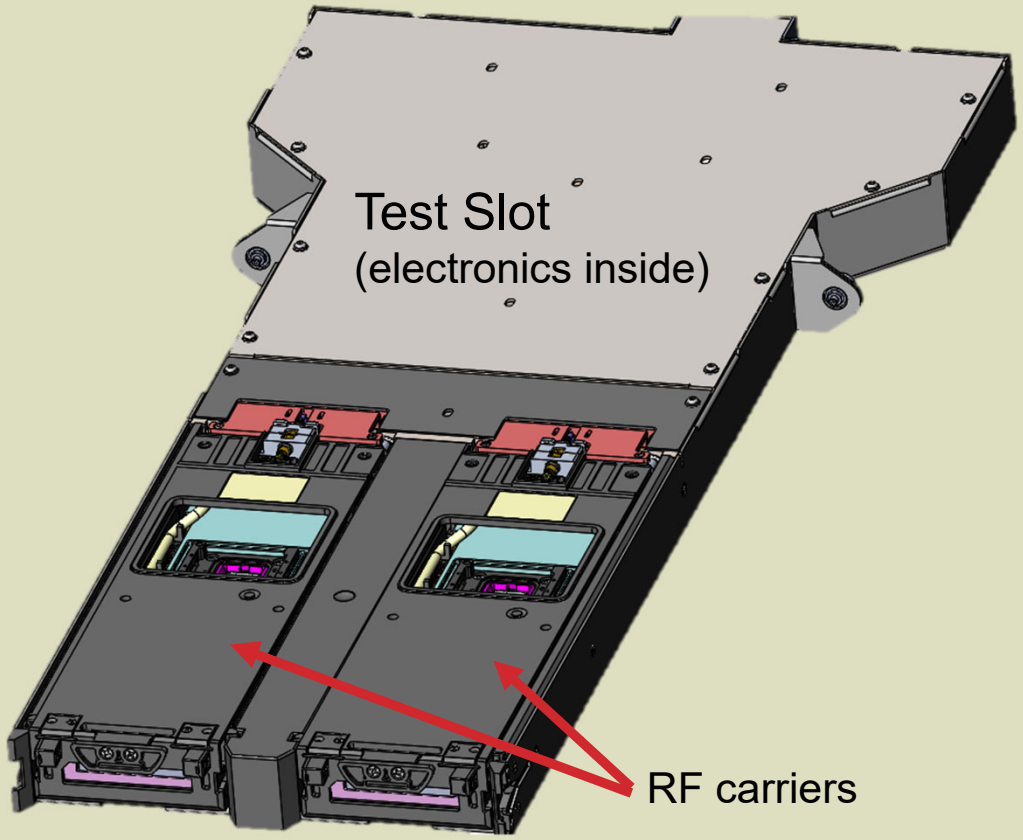
RF Signal Path Architecture

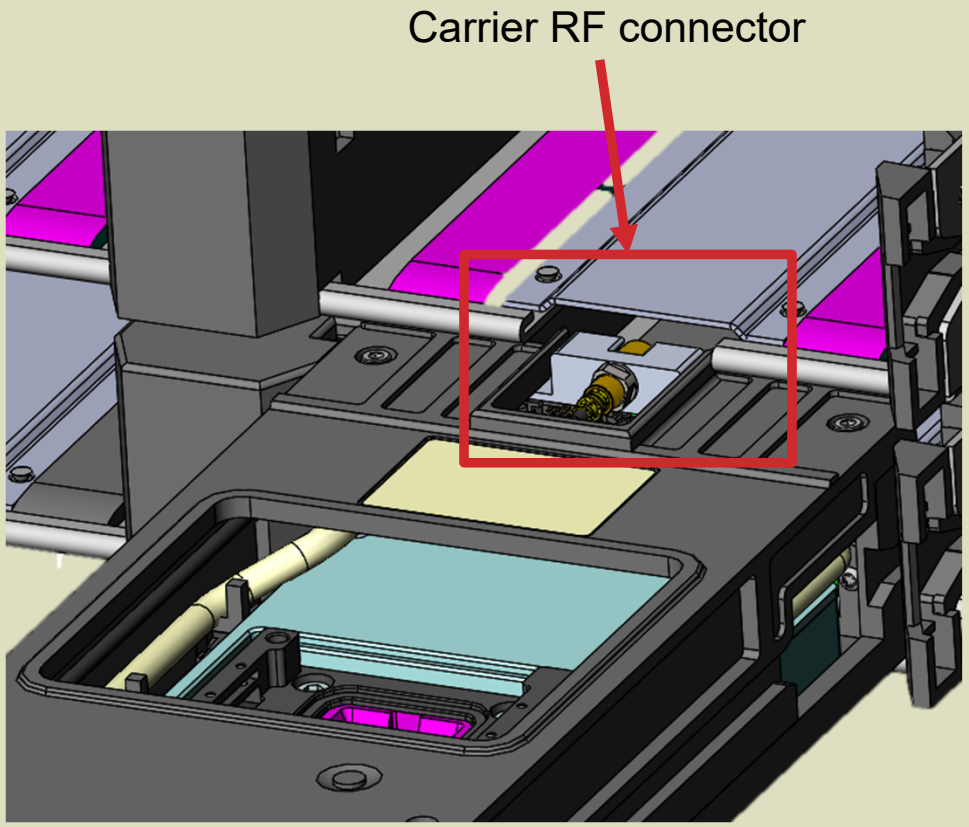
Key Components:

- RF Source/Receiver
  - 1:4 sharing ratio
  - Housed in external racks
- Slot-side cables and connections
- Carrier cables and connections
- 12-port splitter in carrier
- SLT board and DUT

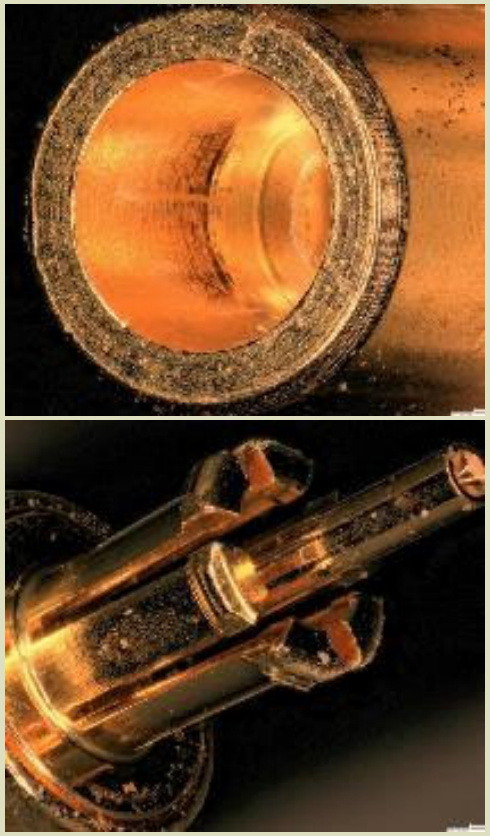


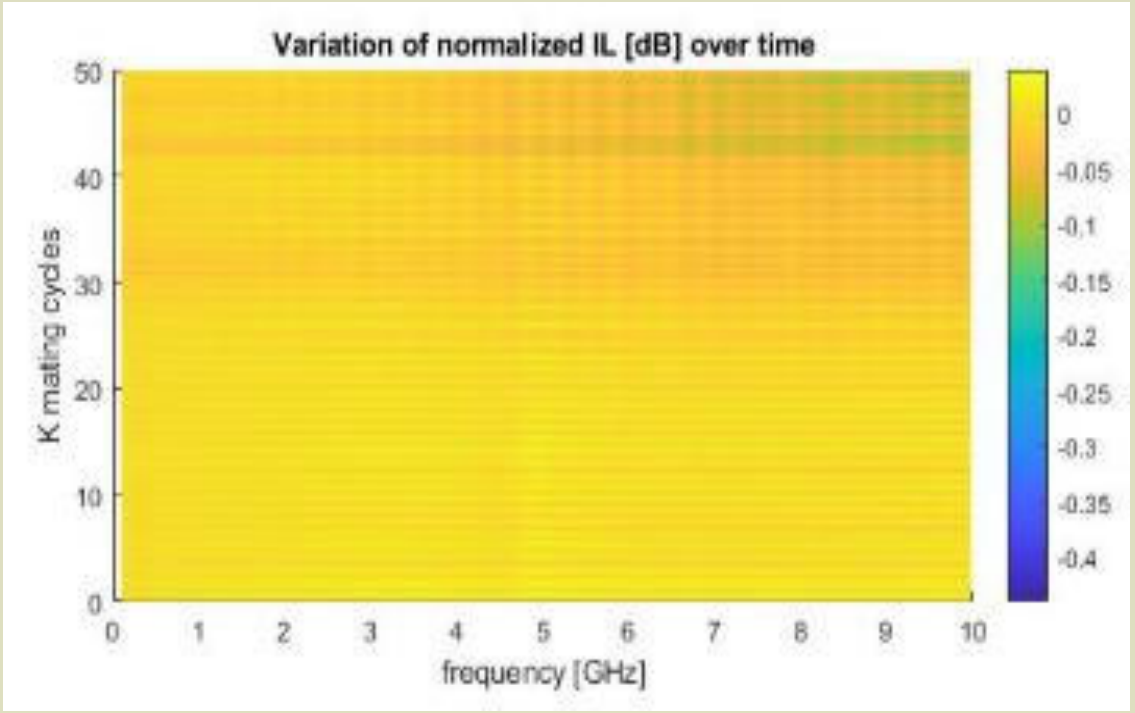
SLT/RF Carrier and Slot





S21 Repeatability testing up to 50k mating cycles

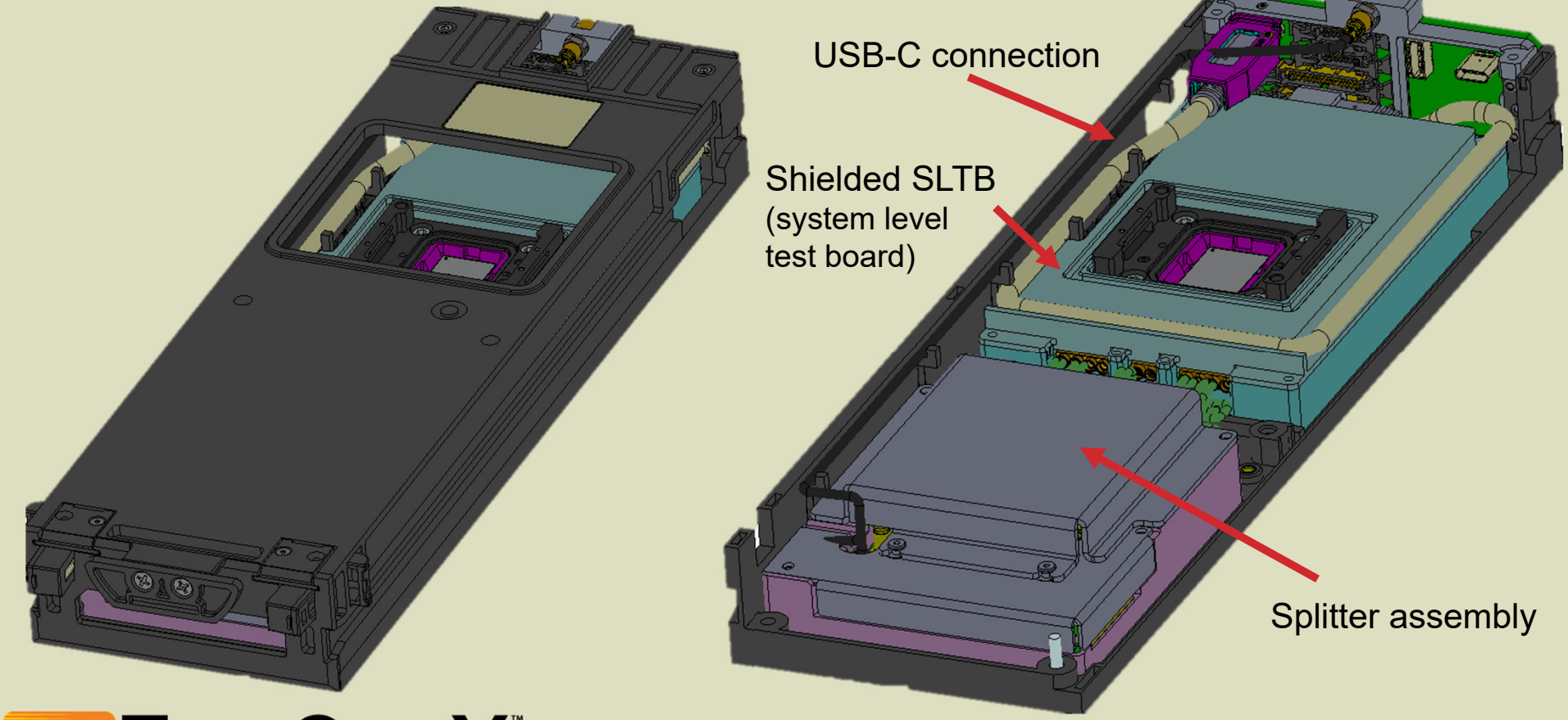




0.05dB change up to **30k** cycles

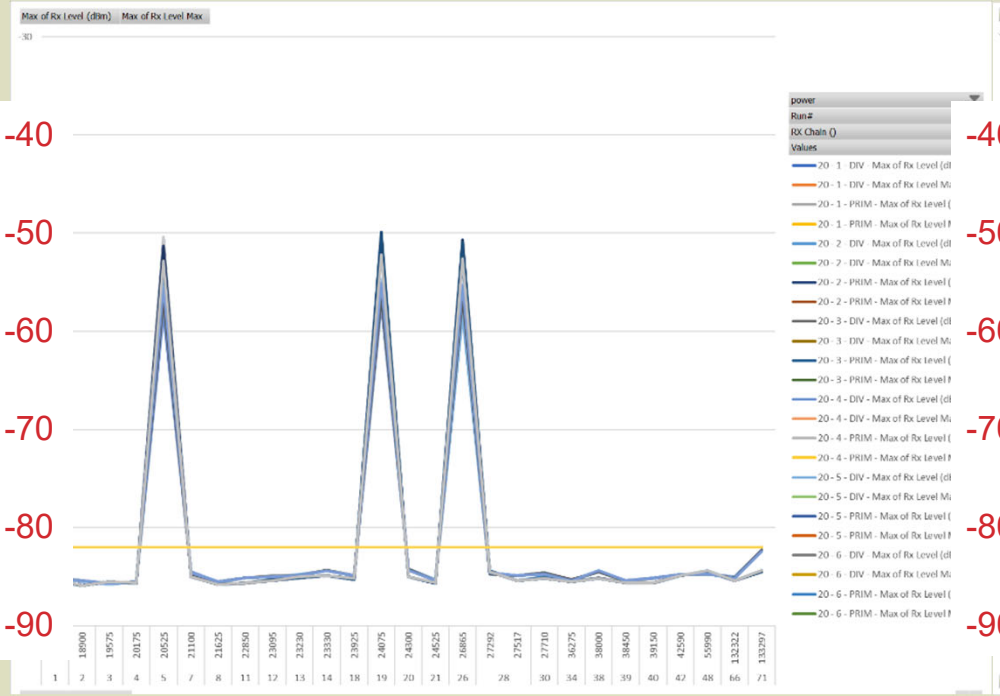
0.1dB change up to **50k** cycles

RF Carrier Details

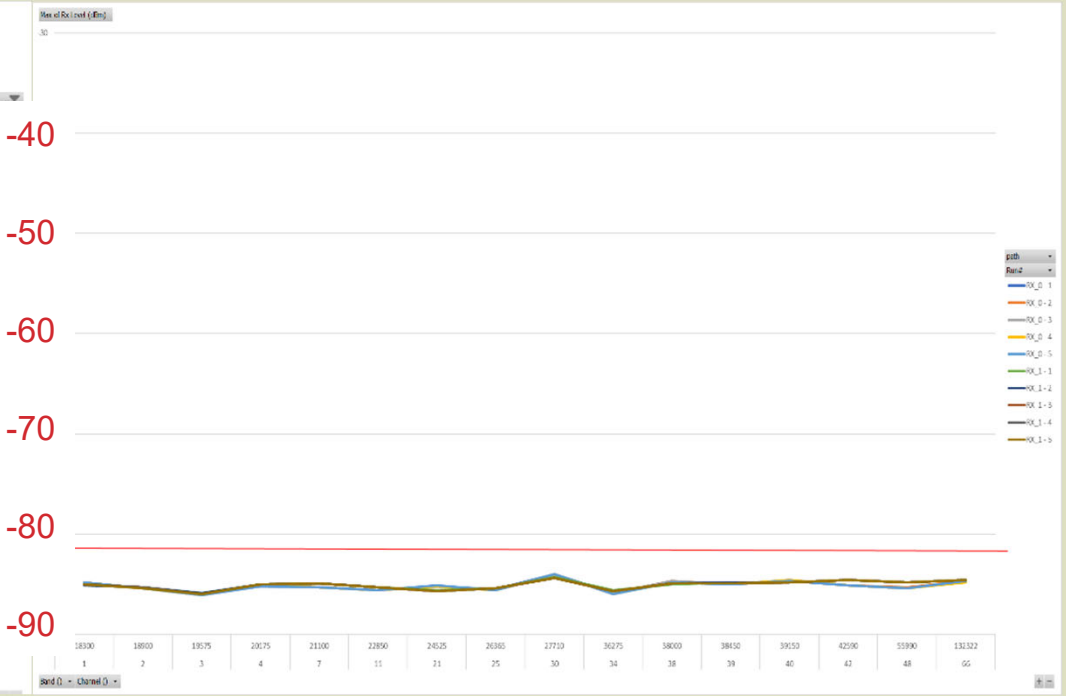


Example Shielding Test: Band 5 Interferer @ 882MHz

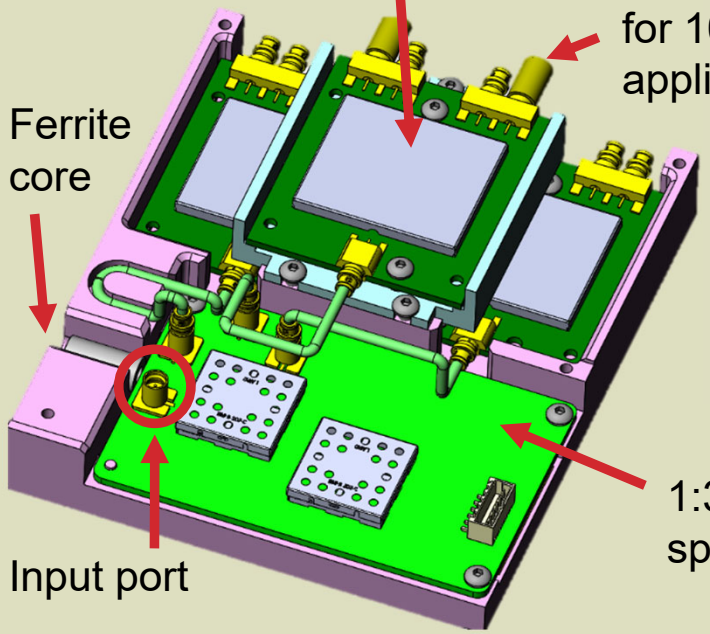
Unshielded baseline

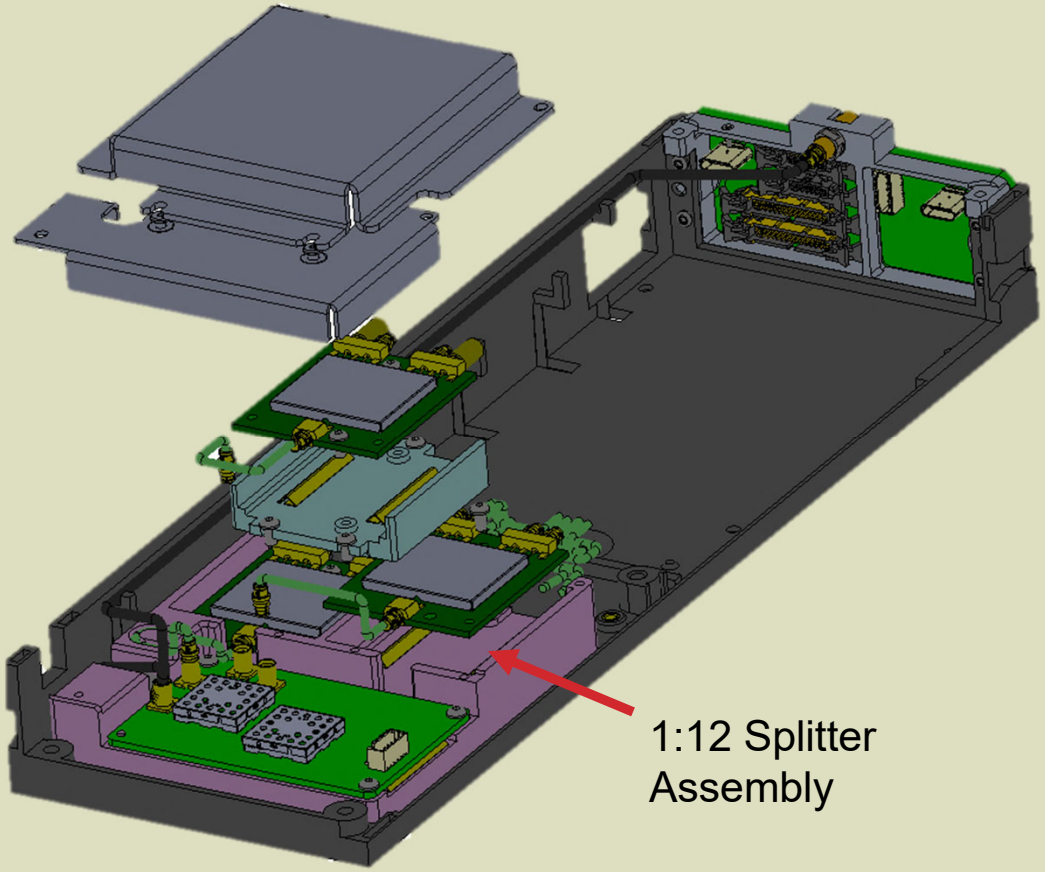


Shielded



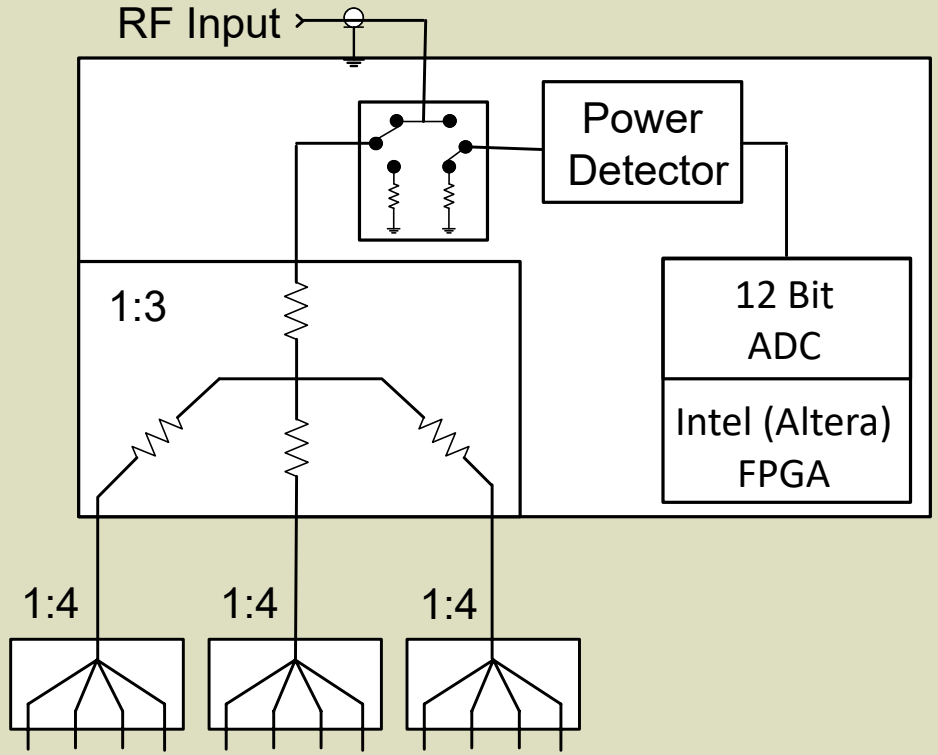
12-port Splitter





RF Splitter Block Diagram

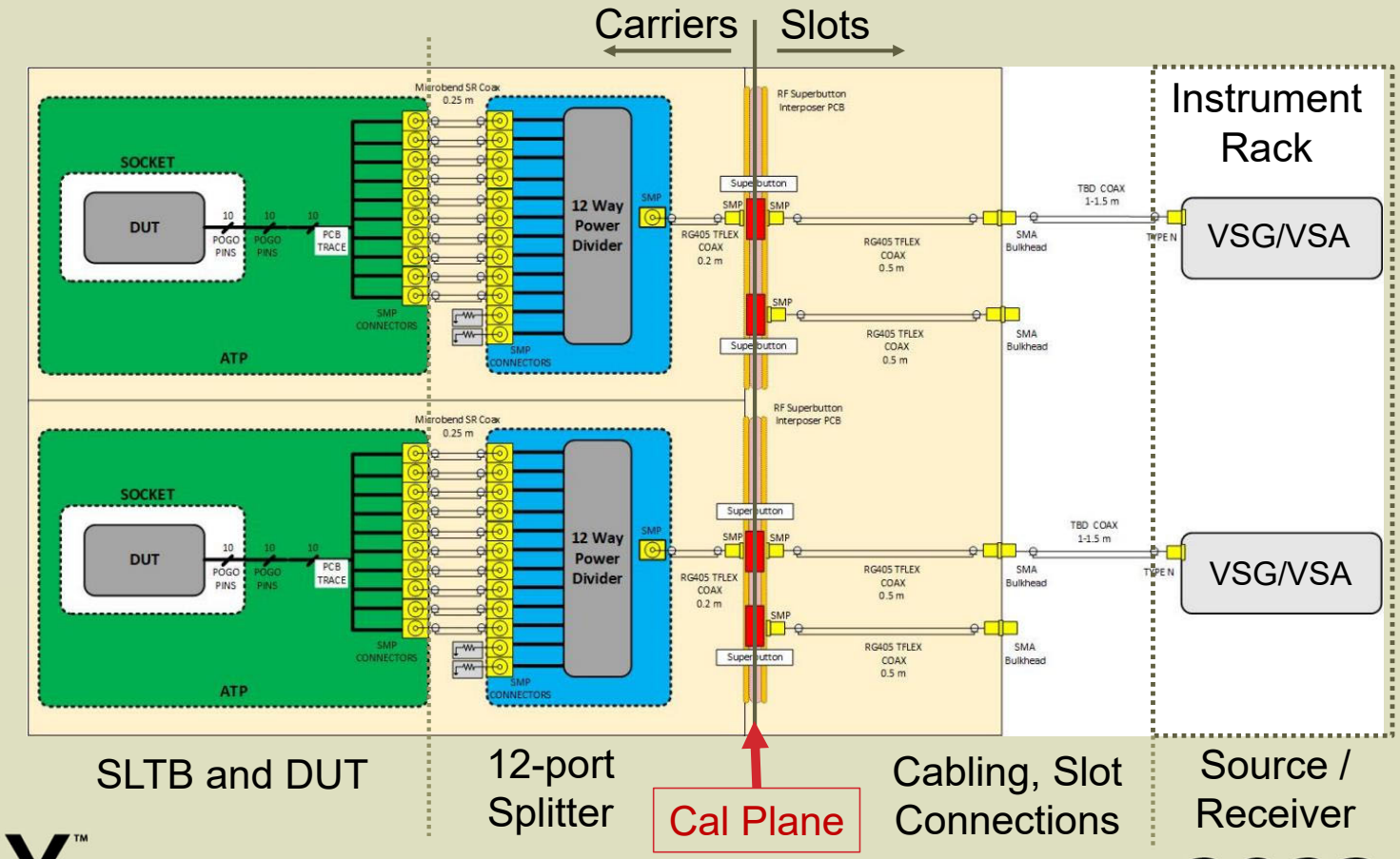
- **1:3 Resistive splitter**
  - Power Meter (Detector)
  - High-isolation RF switch to divert signal to power meter
  - Onboard temperature sensor
  - FPGA
    - Provides serial (I^2C) interface to Slot hardware
    - Controls switch and enables Power Meter
    - Provides serial interface to temperature sensor
    - Internal ADC to measure power meter output
- **1:4 Splitter**
  - SMP Connectorized design
  - Low-loss Wilkinson design



Calibration Strategy

Calibration steps:

- Measure both sides of the Cal plane, store the values in memory
- Cal values from the SLTB, Carrier, and Slot are added together for each test
- Slot side measured with Cal carrier
- Carrier side measured during manufacturing

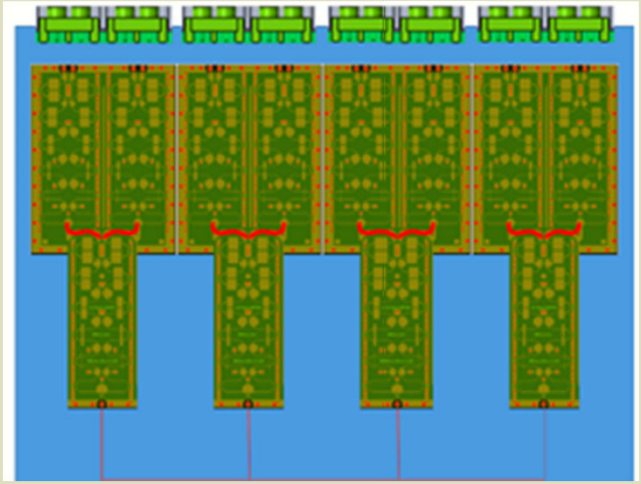


Key benefits of an SLT RF Platform

- Ability to perform parallel testing with high site count while still meeting RF test requirements with high repeatability and less human error
- Achieve significant floor space savings
- Achieve operator labor savings
- Maximize the device RF performance by characterizing the device in the final system level application environment

Where do we go from here?

- New use cases
  - Make wireless call to system integrated “cell tower”
  - Connect wirelessly to GPS repeater integrated into the system
- Additional instruments
  - Application-specific electronics in the carrier
- Roadmap technical enhancements
  - Support for additional antennas per device
  - 5G bands up to 8GHz
  - Signal amplifier



Acknowledgements

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