5G - NEW REQUIREMENTS FOR COMPONENT TESTS

2. FMD Innovation Days
Microwave and Terahertz
Frankfurt (Oder)

ROHDE&SCHWARZ

Make ideas real

5G GENERAL REQUIREMENTS

- Enhanced Mobile Broadband requires higher frequency bands
- Sub 6GHz for ´basics´ : Mobility, coverage, connectivity
- Difference in downlink data rates between LTE and 5G for <6GHz not so big

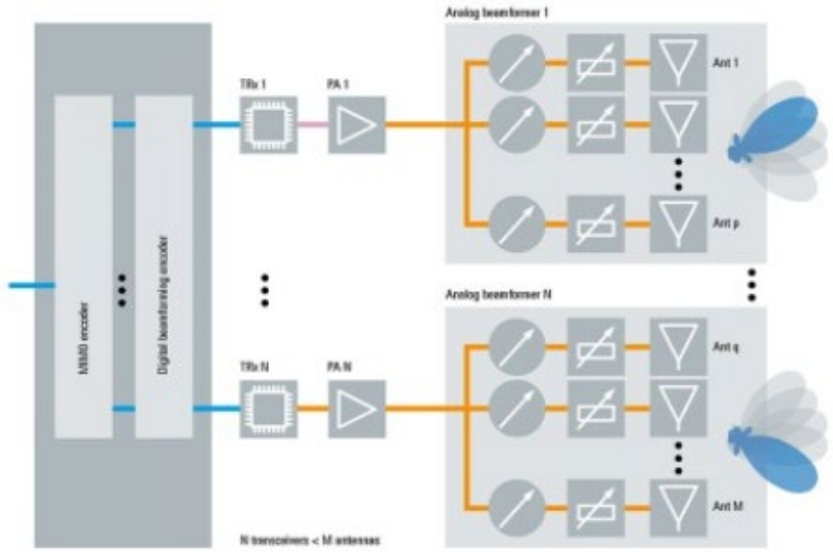
- Big increase in data rates due to increase in bandwidth
- Millimeter wave (28GHz, 39GHz)
  for high data traffic / hotspots

- Backhaul: Millimeter Wave / E-band or fiber links

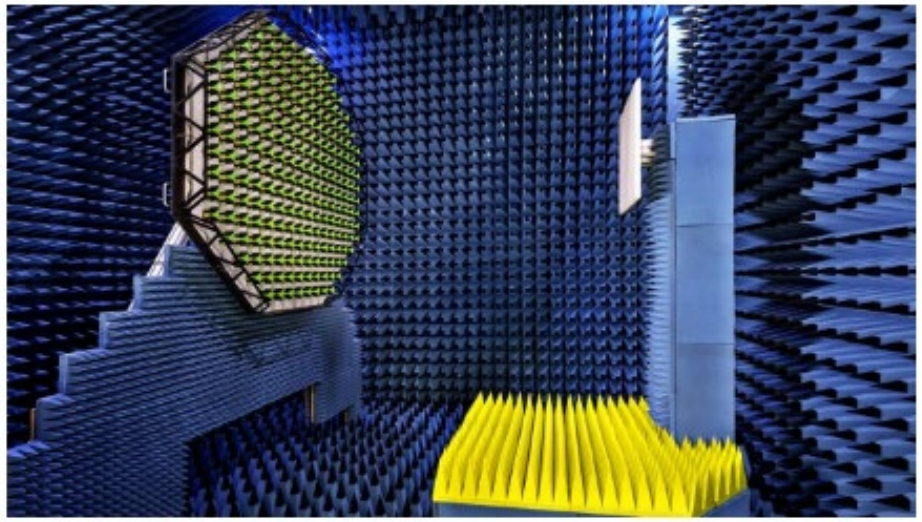
- Beamforming and Massive MIMO – Antenna arrays

5G COMPONENTS AND HOW TO TEST THEM

- Integration of transceiver frontend and antenna array
- Over-the-air (OTA) testing for modules
- Far field conditions at short distances
- Shielded Chambers



Typical architecture of a massive MIMO active antenna system



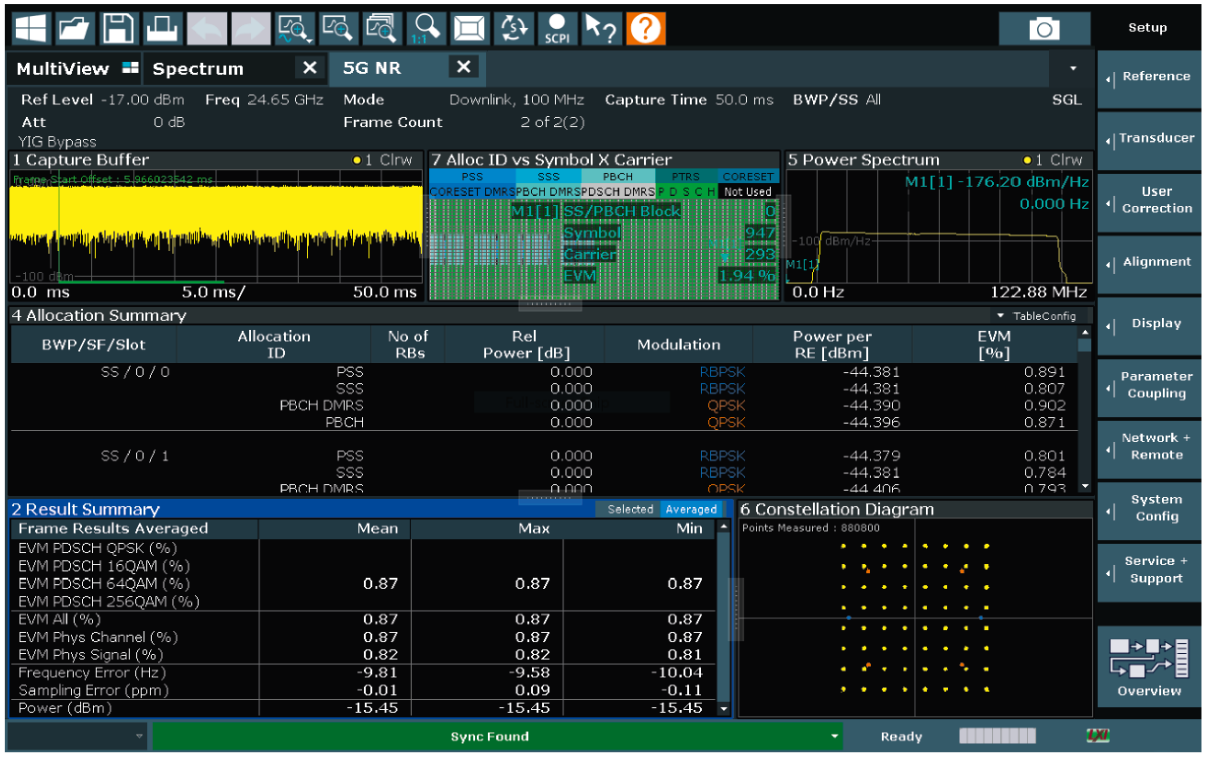
R&S®PWC200 plane wave converter

5G COMPONENTS AND HOW TO TEST THEM

Signal Generator / Spectrum Analyzer

- More complex modulation (16/64/256 QAM)
  - EVM measurements are important
  - Constellation Diagrams
- Broadband for signal generation and spectrum analysis
  - 2GHz internal bandwidth (R&S)
  - 5GHz in combination with oscilloscope (R&S)

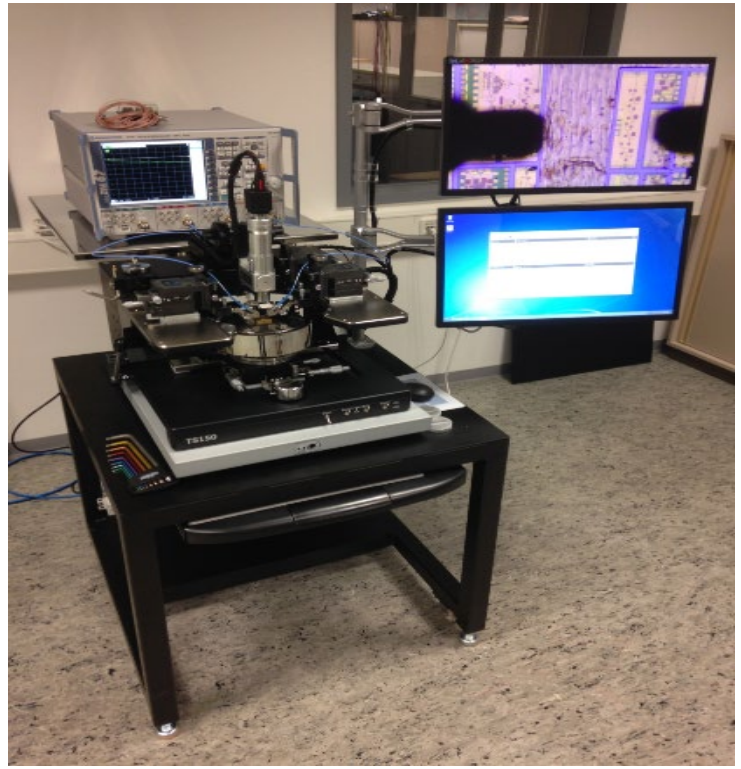
The R&S®FSW-K144 5G New Radio downlink measurement application



5G COMPONENTS AND HOW TO TEST THEM

Vector Network Analyzer:

- On-Wafer characterization of components in millimeter wave range
- Amplifiers, Mixers, Antennas,…
- S-Parameters
- IMD, Harmonics
- Compression
- Noise Figure
- Load Pull
- ….



COHERENT SOURCES FOR BEAMFORMING

Defined Coherence Mode

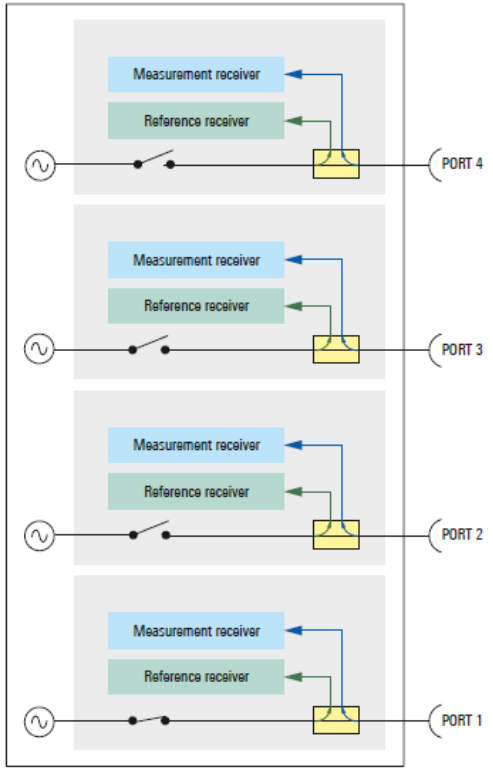
Reference Port: 1 Same for all Ports!

Phys Port #	Gen	Def'd Phase Coherence	Ref Port	Relative Amplitude	Relative Phase
1	☑	☑	v	0 dB	0°
2	☑	☑		1 dB	30°
3	☑	☑		-1 dB	40°
4	☑	☑		-2 dB	120°

Tolerance

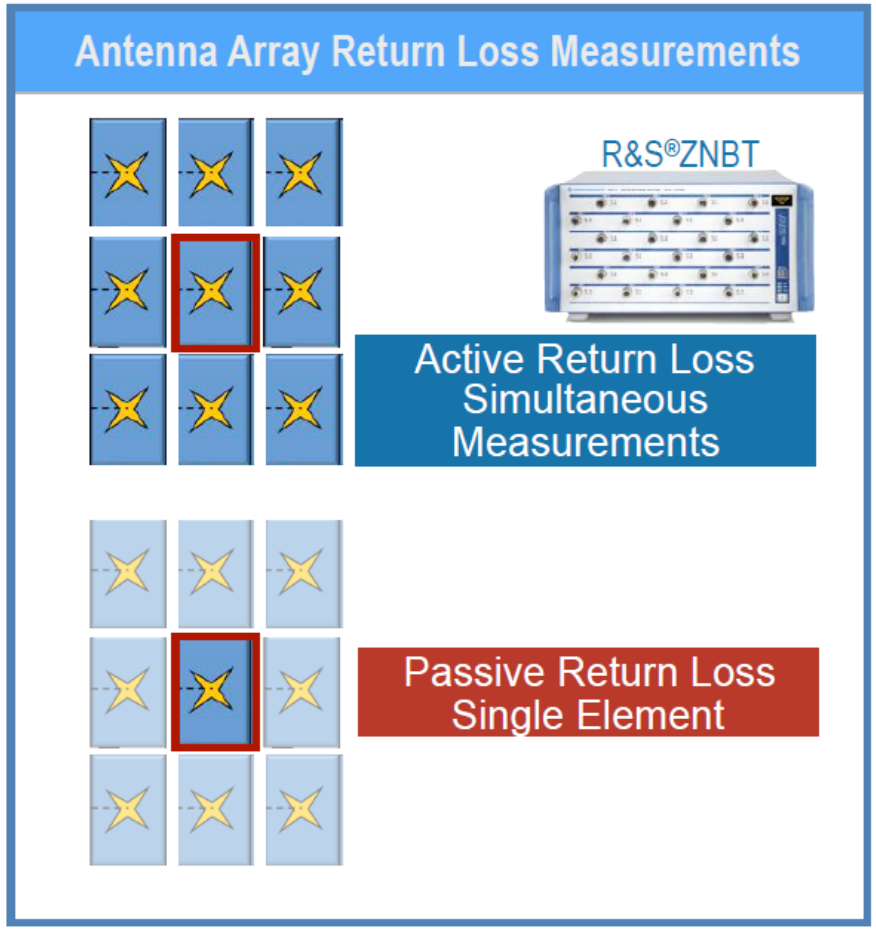
Amplitude: 0.1 dB Phase: 1.1°

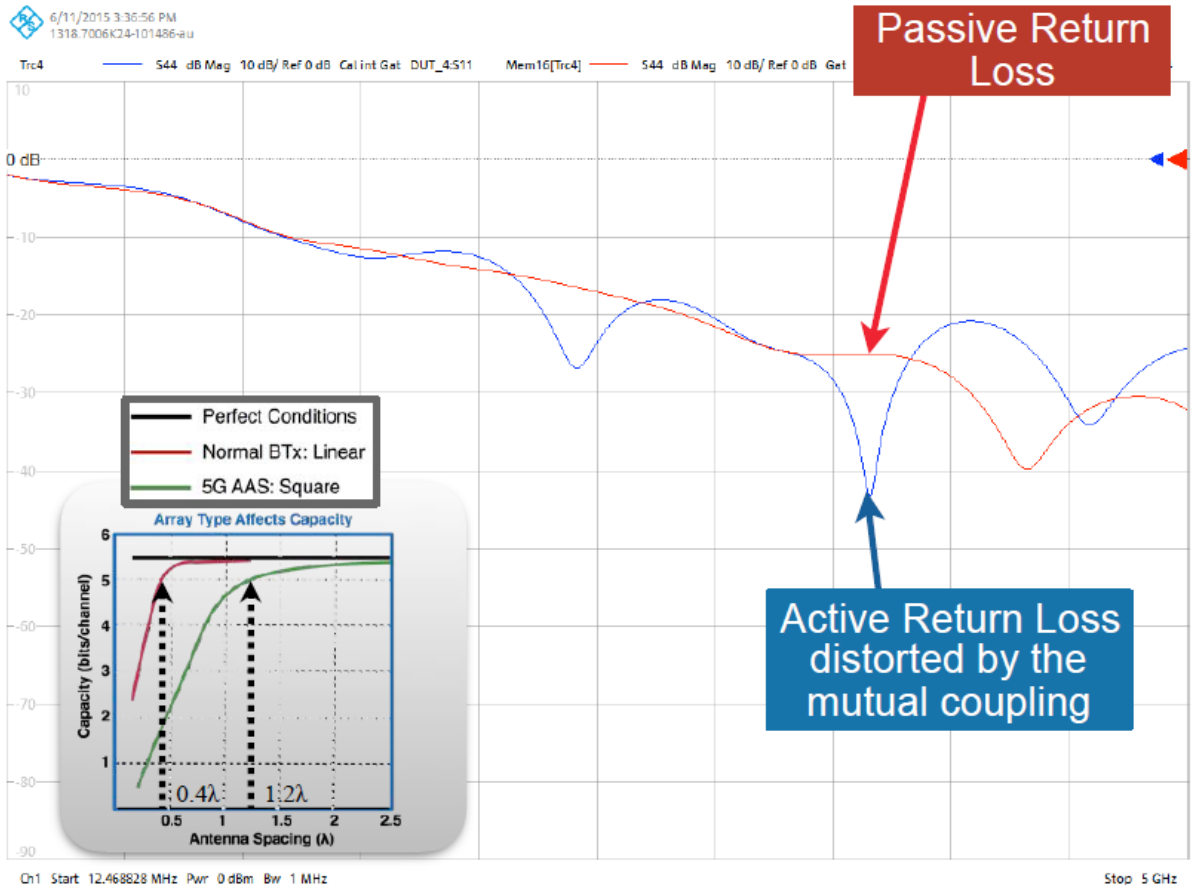
Close Help



Four coherent sources with definable amplitude and phase differences

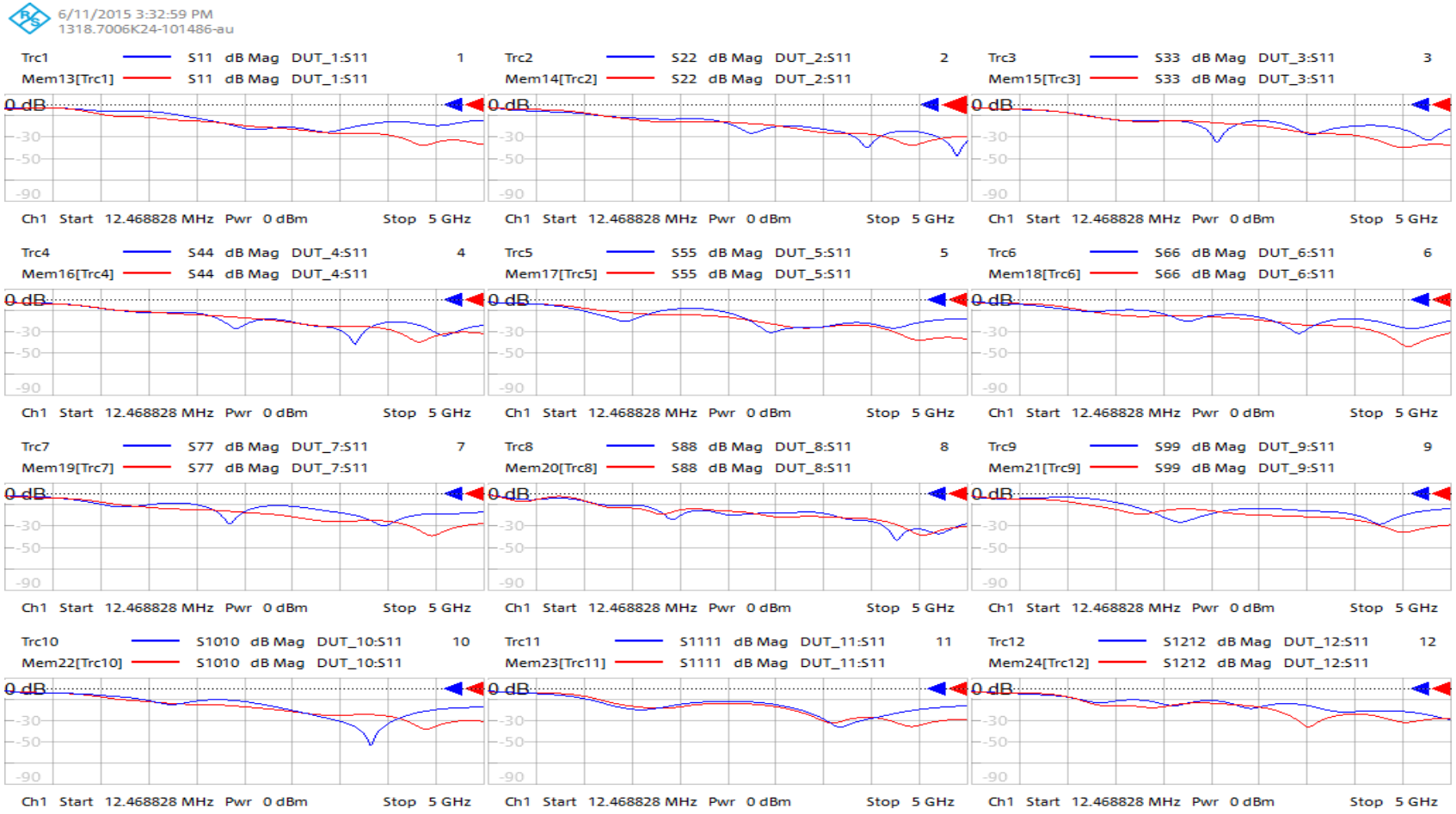
ACTIVE AND PASSIVE ANTENNA RETURN LOSS MEASUREMENT



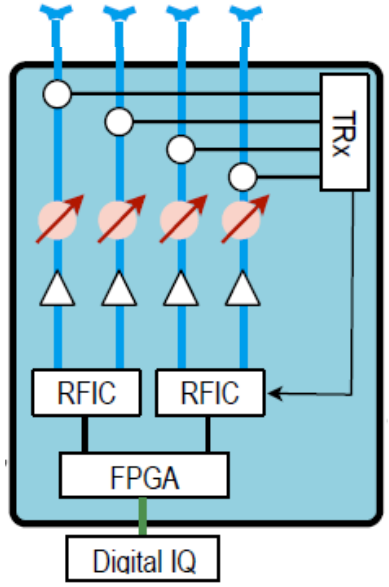


Source: Signal Processing Magazine, IEEE, Jan 2013

ACTIVE AND PASSIVE ANTENNA RETURN LOSS MEASUREMENT



Coupling effects between antenna elements, active and passive measurement



ON-WAFER MEASUREMENTS WITH PROBE STATION

Millimeter Wave Systems for E- and W-band

Millimeter Wave Prober system

Component characterization in E- and W-Band requires

- High output power of converter for active device characterization
- Power sweep and compression point capability

AUTOMOTIVE RADAR

What are the trends ?

- 76GHz to 81GHz instead of / in addition to 24GHz band
- Higher frequency bands in future
- Higher resolution (4cm vs 75cm) and accuracy compared to 24GHz due to higher bandwidth
- Smaller in size

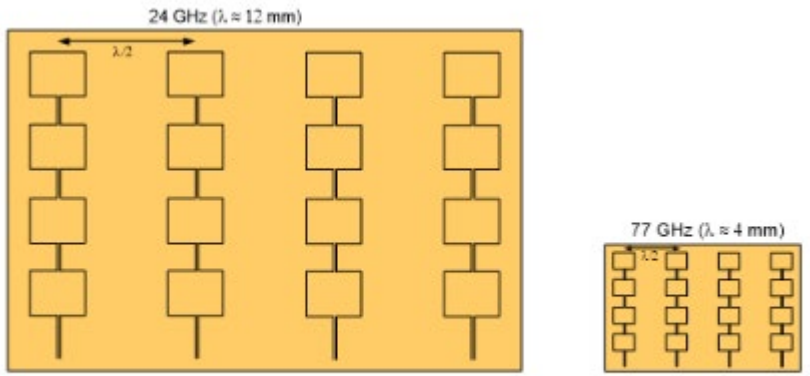
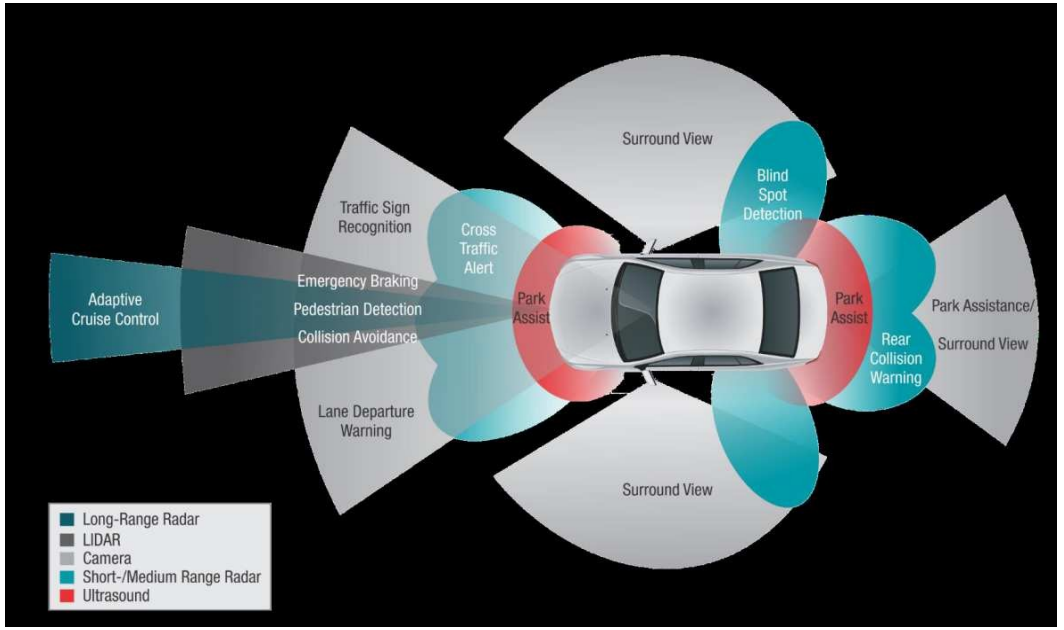


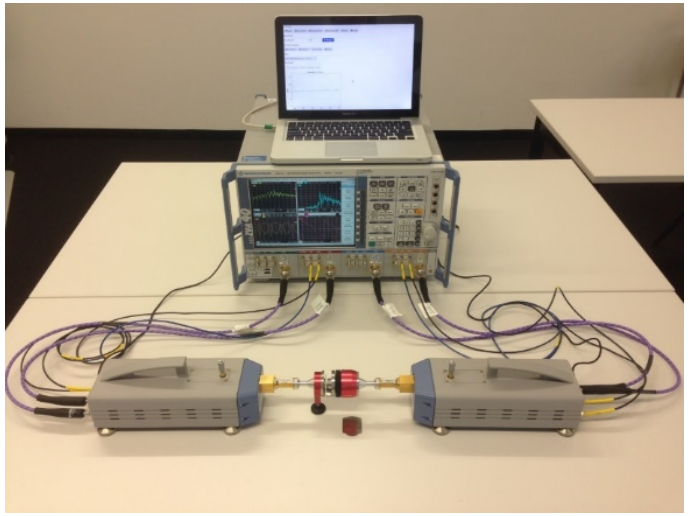
Figure 3: Relative antenna sizes for 24GHz and 77GHz



MATERIAL MEASUREMENTS

Material characterization of mobile phones and shielding materials for automotive radar gets more important

- Basic measurement of Epsilon and Tan Delta versus frequency with VNA
- More antennas in handsets
- Millimeter Wave Frequencies



TECHNOLOGIES IN 5G

There will be a mix of different technologies in 5G

- CMOS (e.g. Tablets)
- SiGe (e.g. Small Cells)
- GaAs (e.g. Mobile Phones)
- GaN (e.g.T/R module of BTS)

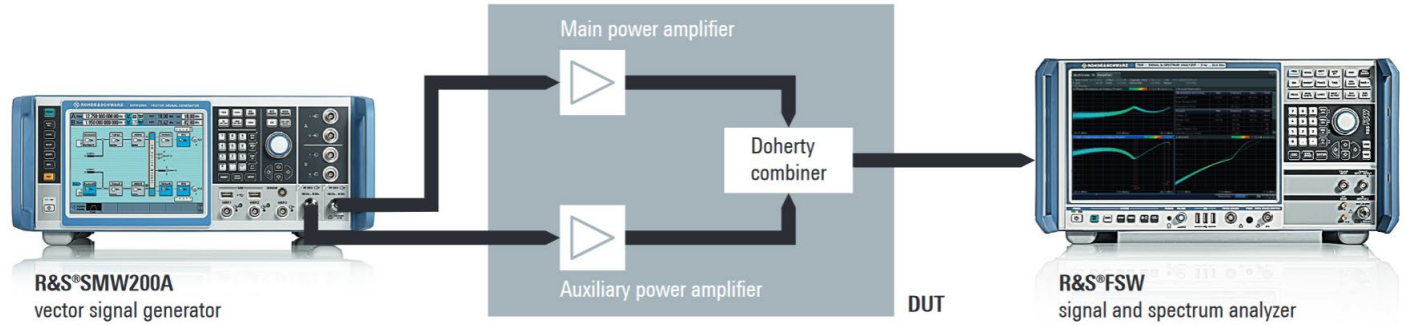
- Combination of different technologies for different devices
- Combination of different technologies in one device
- Evolving while 5G is progressing

TECHNOLOGIES IN 5G

GaN Power Amplifier for 5G BTS

- Mainly used in Aerospace & Defense Applications so far
- High efficiency (e.g. Doherty PA) leads to less antenna elements and smaller antenna arrays
- High Output Power
- Higher voltage in smaller space
- Low power consumption
- Capable of millimeter wave frequencies

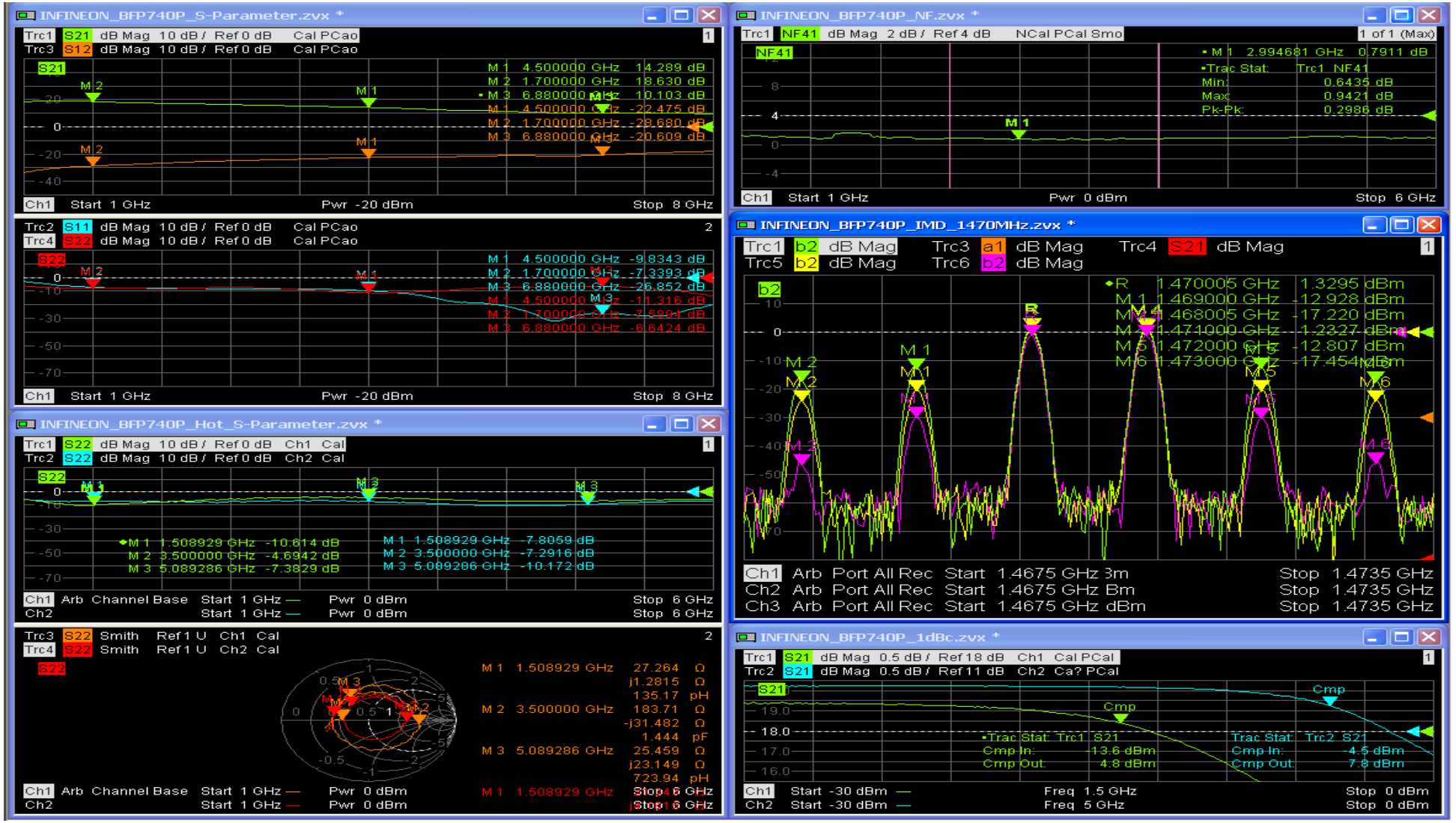
Dual-input Doherty amplifier test setup with the R&S®SMW200A, the R&S®FSW and the DUT



Drawbacks:

- Thermal challenge due to higher power density
- Expensive compared to Si
  - Cost reduction by higher integration or lower cost substrates (e.g. Si) necessary

AMPLIFIER CHARACTERIZATION - EXAMPLE



THANK YOU FOR YOUR ATTENTION

1950 : World´s first Vector Network Analyzer
- made by R&S

Direct display of S-Parameters in a complex plane

> 65 years of experience in network analysis