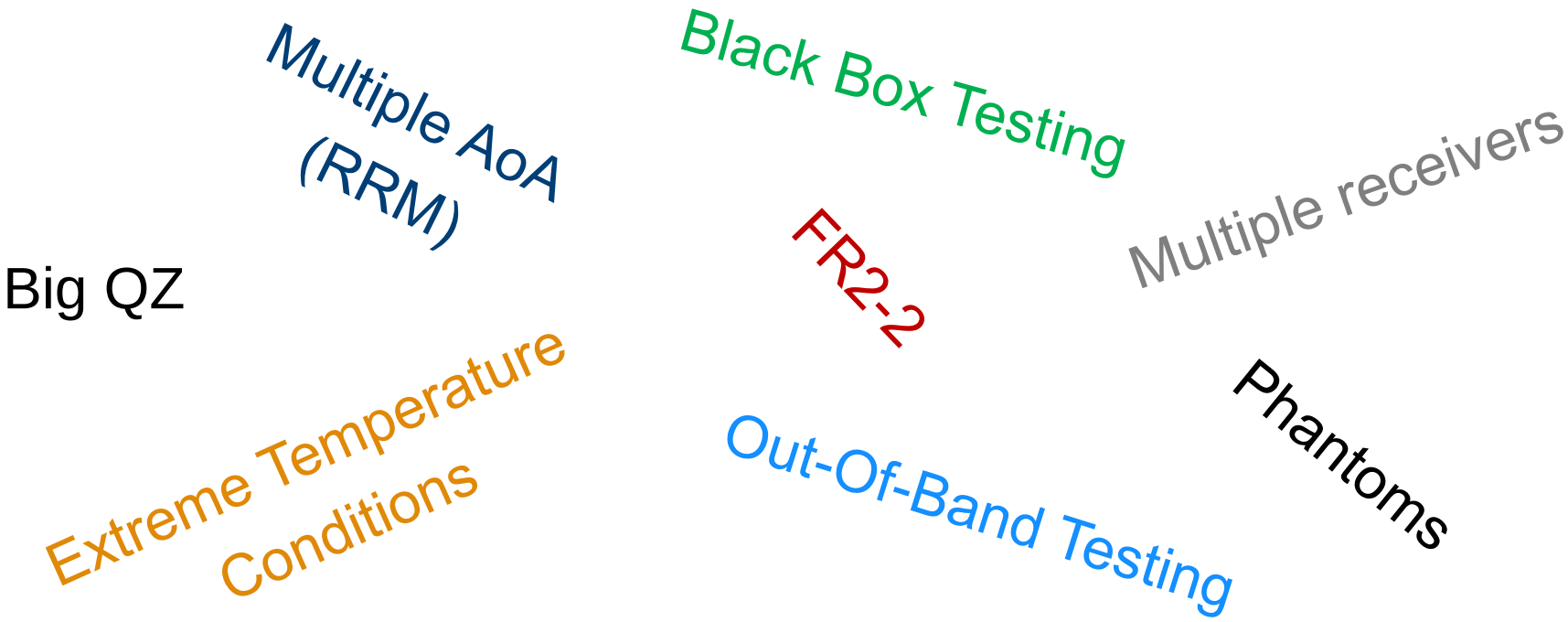
OTA TEST SOLUTIONS FOR 5G NR FR2

Product Management OTA

ROHDE&SCHWARZ

Make ideas real

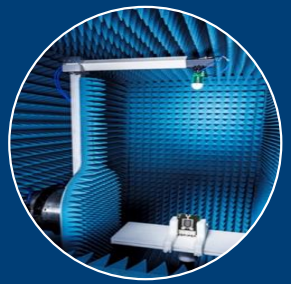
WHAT IS IMPORTANT IN RESPECT TO OTA IN 5G FR2 RF/RRM CONFORMANCE?

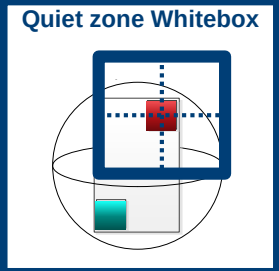


BLACK BOX TESTING

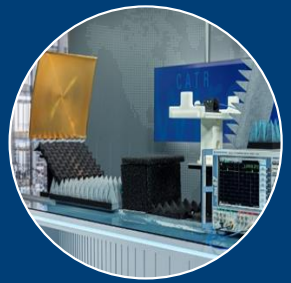
- Conformance tests assume black box testing
  - Big quiet zone (QZ) is required
  - Direct farfield (DFF) systems need to be huge and have high pathloss
  - Indirect farfield (IFF) is used, typically compact antenna test ranges (CATR)

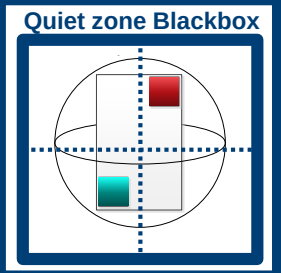
DFF **vs** **IFF**





- Typically has a smaller quiet zone
- Whitebox approach
- R&S DFF solutions: ATS1000 & WPTC





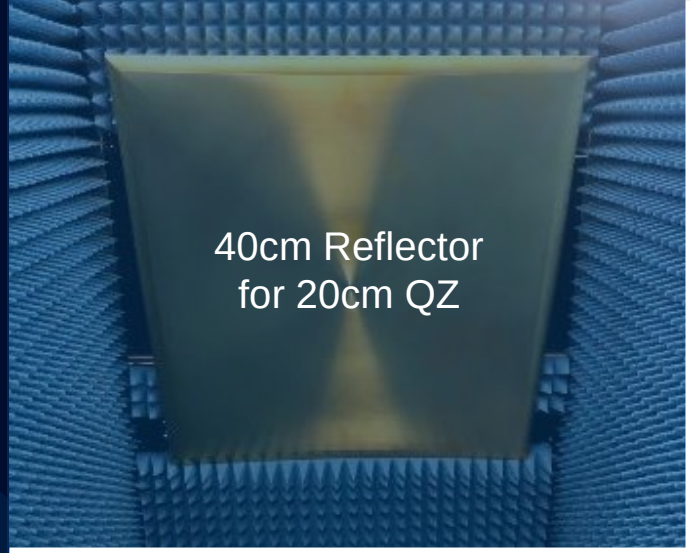
- Quiet zone size depends on reflector size
- Blackbox approach
- R&S CATR IFF solutions: ATS800R, ATS1800C

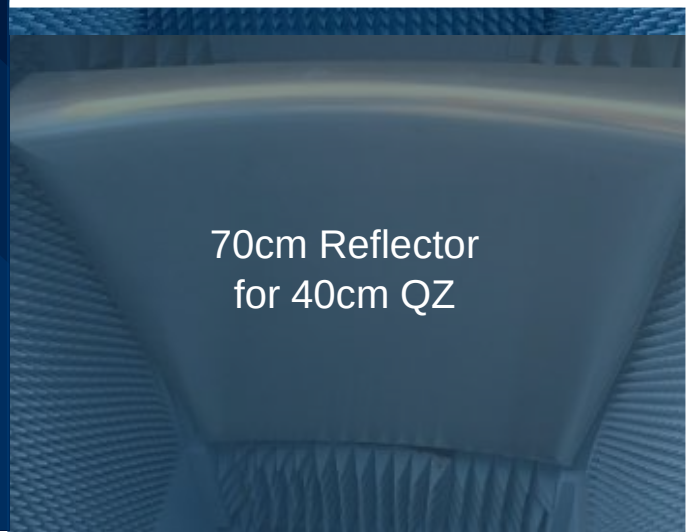
QZ SIZE VS. DUT SIZE

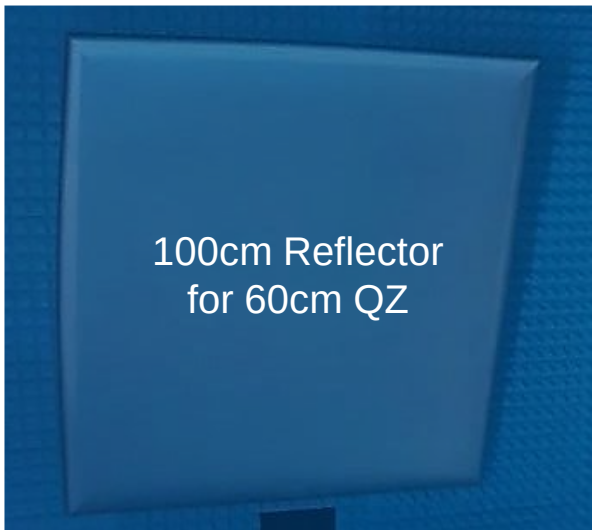
- Conformance tests require a QZ size of
  - 20cm
  - 30cm
  - 40cm
  - 55cm (future)

  Depending on DUT size

QZ SIZE DEPENDS ON REFLECTOR SIZE





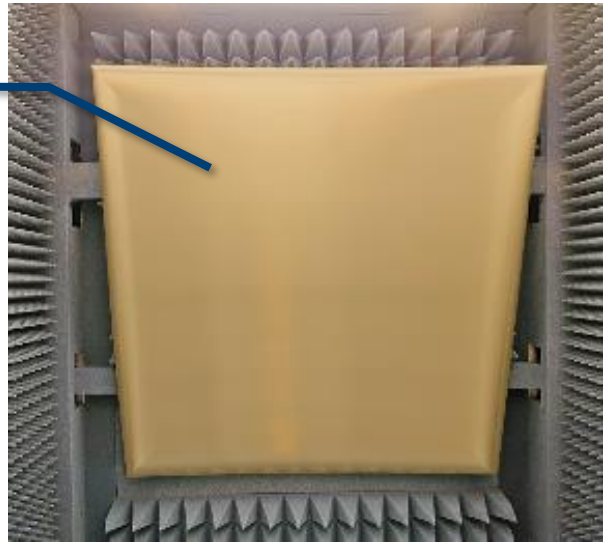


ATS1800C

ATS1800C – GOLD PLATED REFLECTOR FOR 30CM QZ SIZE

Ultra-wideband reflector with rounded edges

Frequency range: 6..90 GHz +

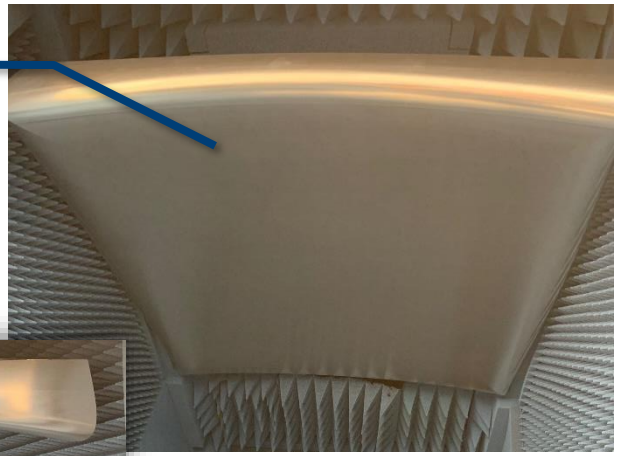


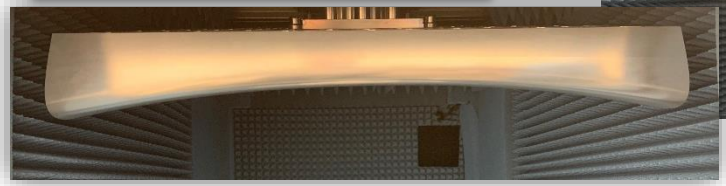
Specification	Value
Frequency Range	6 GHz to 90 GHz +
Quiet Zone Ø	30 cm
Average Amplitude Taper (Inband)	< 1.5 dB
Average Amplitude Ripple (Inband)	< 0.5 dB
Surface roughness (RMS)	< 1 µm
Dimension	54 cm x 56 cm

ATS1800C – PASSIVATED REFLECTOR FOR 40CM QZ SIZE

Ultra-wideband reflector with rounded edges

Frequency range: 6..90 GHz +



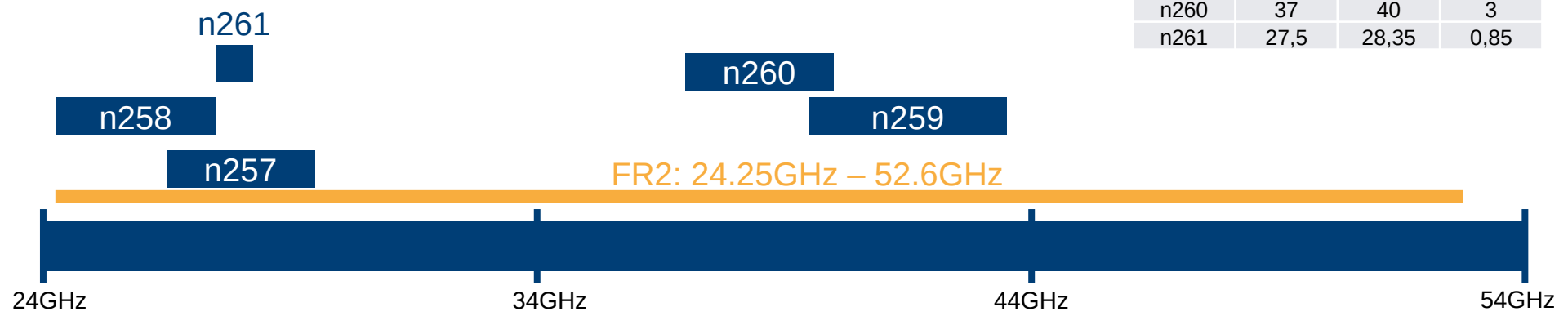


Specification	Value
Frequency Range	6 GHz to 90 GHz +
Quiet Zone Ø	40 cm
Average Amplitude Taper (Inband)	< 1.5 dB
Average Amplitude Ripple (Inband)	< 0.5 dB
Surface roughness (RMS)	< 1 µm
Dimension	69 cm x 71 cm

IN BAND VS. OUT OF BAND

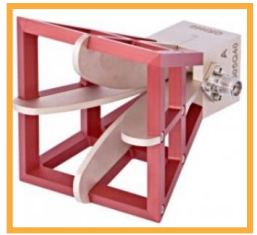
- RF conformance tests are to be performed in
  - 5G FR2 in-band
  - Out-of-band from 6GHz to 2nd harmonic

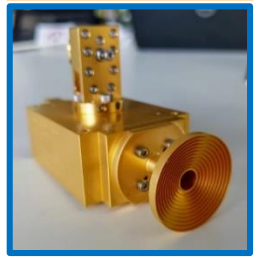
Band	Low	High	BW
n257	26,5	29,5	3
n258	24,25	27,5	3,25
n259	39,5	43,5	4
n260	37	40	3
n261	27,5	28,35	0,85

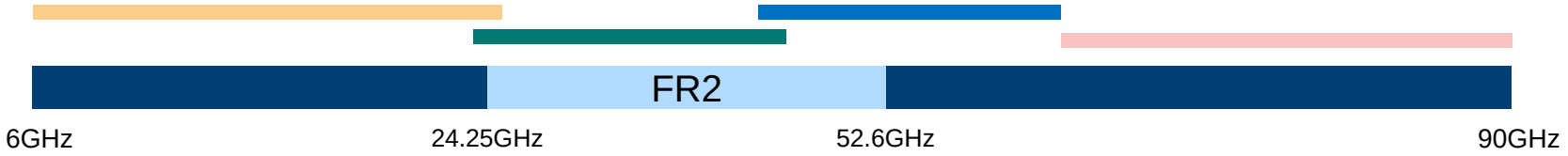


GOOD FEED ANTENNAS ARE BAND LIMITED

- 4 different antennas required to cover the frequency range from 6GHz to 90GHz
  - Current ATS1800C inband feed OMT+Horn CATR-FE40
    - 23.5GHz…44GHz
  - New feed antenna CATR-FE4 for low frequencies
    - 6GHz…25GHz
  - New feed OMT+Horn CATR-FE60 for higher frequencies
    - 37GHz…61GHz
  - New feed OMT+Horn CATR-FE90 for high frequencies
    - 59GHz…92GHz







AUTOMATIC FEED SWITCHER

AMBIENT TEMPERATURE VS. EXTREME TEMPERATURE CONDITIONS (ETC)

- RF conformance tests are to be performed in three temperature conditions
  - Normal (room temperature): +15°C…+35°C
  - TL (temperature low): -10°C
  - TH (temperature high): +55°C

Table 6.2.1.1.4.1-1: Test Configuration Table

Default Conditions					
Test Environment as specified in TS 38.508-1 [10] subclause 4.1				Normal, TL, TH	
Test Frequencies as specified in TS 38.508-1 [10] subclause 4.3.1				Low range, Mid Range, High range	
Test Channel Bandwidths as specified in TS 38.508-1 [10] subclause 4.3.1				Lowest, 100 MHz, Highest	
Test SCS as specified in Table 5.3.5-1				120 kHz	
Test Parameters					
Test ID	**ChBw**	**SCS**	**Downlink Configuration**	**Uplink Configuration**	
		Default	-	**Modulation**	**RB allocation (NOTE 1)**
1	50			DFT-s-OFDM QPSK	Inner_Full for PC2, PC3
2	100				and PC4
3	200				Inner_Full_Region1 for
4	400				PC1
NOTE 1: The specific configuration of each RF allocation is defined in Table 6.1-1 for PC2, PC3 and PC4 or Table 6.1-2 for PC1.					
NOTE 2: Void					

  - More than 25 tests in chap.6/7 of 38.521-2

Regarding FR2 the UE shall fulfil all requirements in the temperature range defined in Table 4.1.1-2.

Table 4.1.1-2: Temperature conditions for FR2

+15°C to +35°C	For normal (room temperature) conditions with relative humidity of 25% to 75%
-10°C to +55°C	For extreme conditions

Outside this temperature range the UE, if powered on, shall not make ineffective use of the radio frequency spectrum. In no case shall the UE exceed the transmitted levels as defined in TS 38.101-2[8] clause 6.2 for extreme operation.

The normative reference for this requirement is TS 38.101-2 [8] Annex E.2.

Some tests are performed also in extreme temperature conditions. These test conditions are denoted as TL (temperature low, -10°C) and TH (temperature high, +55°C).

AIRFLOW CHAIN FOR ETC

Set limits in Thermostream

+100°

+55°

Max. 700 l/min

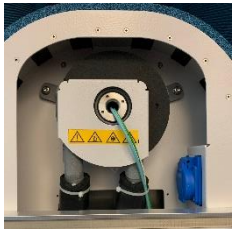
Target DUT temperature range

-10°

-30°

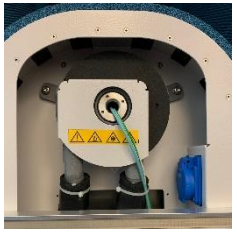
Thermo stream

Air Feedthrough RF filtered

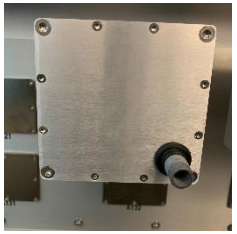


Air rotary joint for full 3D movement

Bubble RF transparent foam material



Air rotary joint for full 3D movement

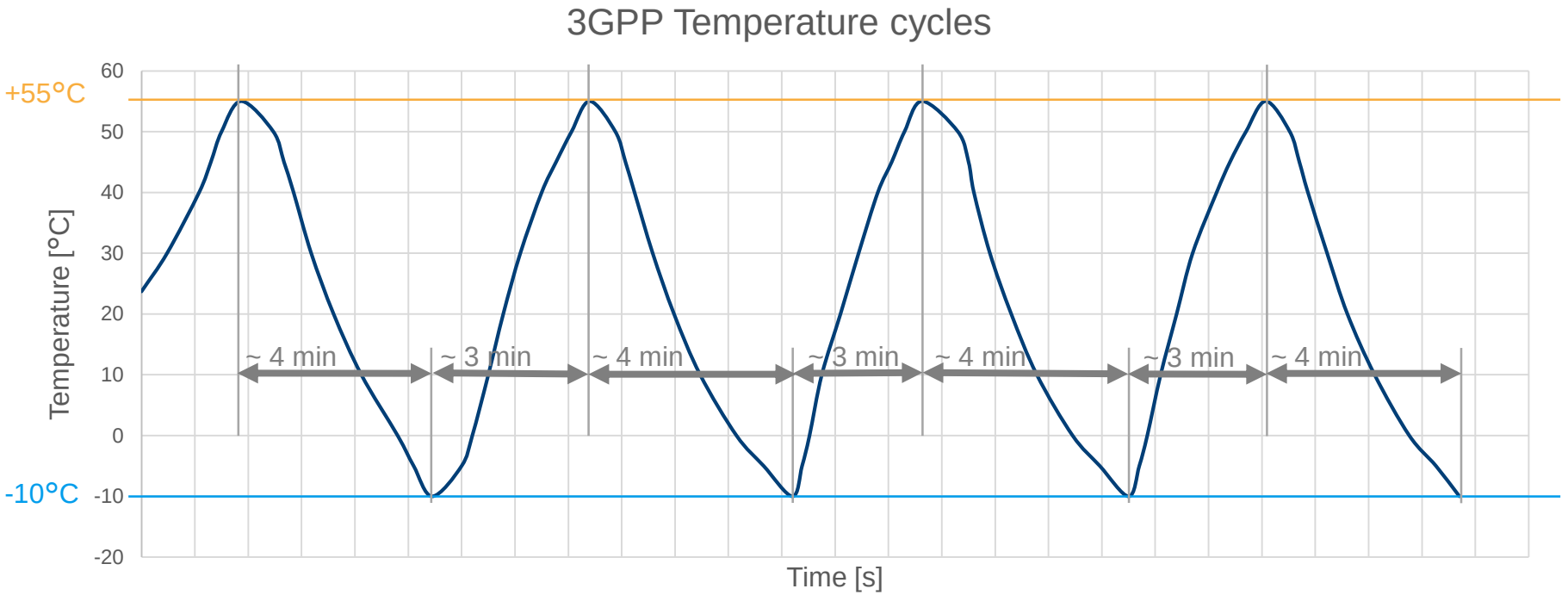


Air Feedthrough RF filtered

TEMPERATURE TEST SOLUTIONS

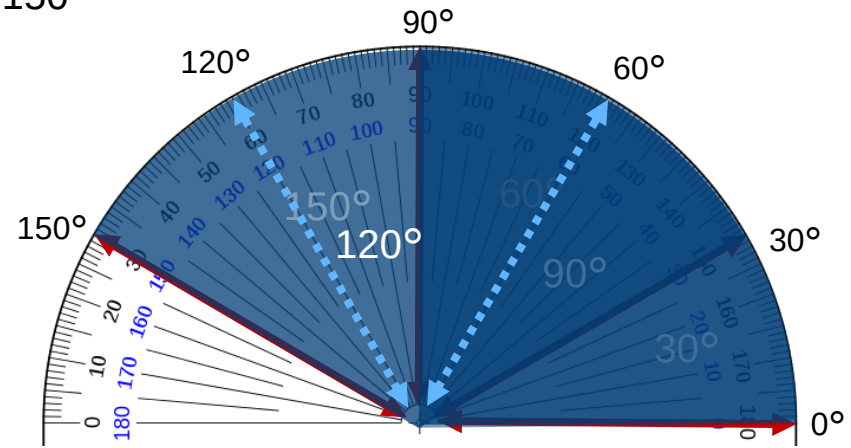
3GPP TEMPERATURE CYCLES

Feed volume: 700 l/min
Feed temp: -60°C / +125°C
Bubble volume: 50 l



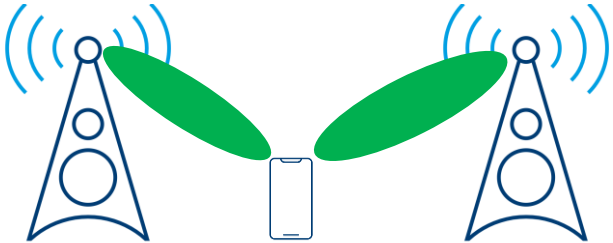
SINGLE ANGLE VS. MULTIPLE ANGLE OF ARRIVAL TESTING (RRM)

- RRM conformance tests (Rel.15) require 2AoA (two angles of arrival) tests to be performed
  - Angular Difference: 30°, 60°, 90°, 120°, & 150°
  - 4 antennas required
    - @0°, 30°, 90°, 150° degrees
    - 60° = Ant3-Ant2
    - 120° = Ant4-Ant2



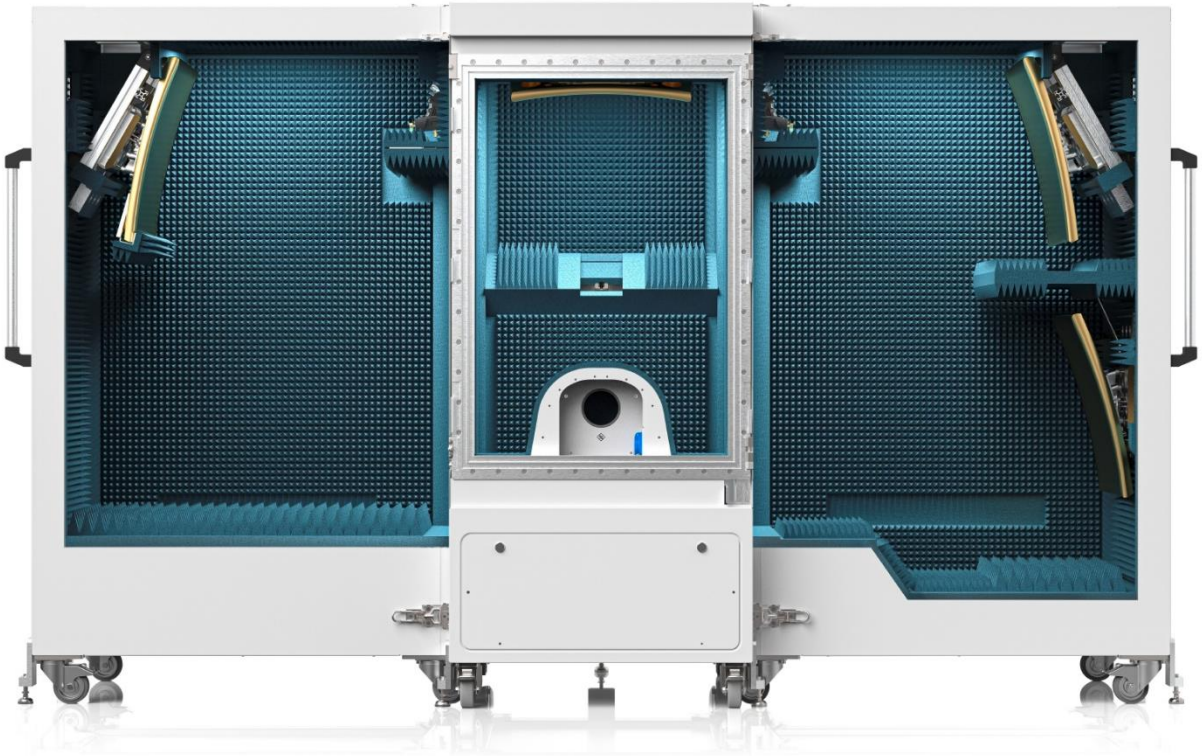
FUTURE REQUIREMENT
MULTI PANEL RECEPTION OR MULTIPLE RECEIVER TESTING

- Increase datarate in FR2 by virtually increasing the MIMO layers
  - 2x2 MIMO in FR2
  - Two receivers with 2x2MIMO in FR2 combined datarate
  - Two receivers get dual polarized signal from two different directions



ATS1800M – OUTSIDE VIEW

ATS1800M – INSIDE VIEW

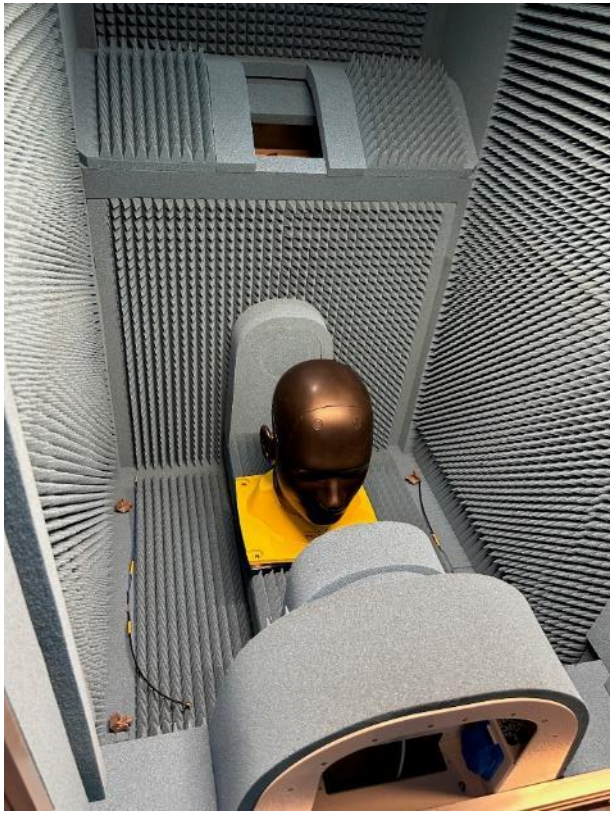


FUTURE REQUIREMENT
MMW PHANTOM TESTING

- Requirement in CTIA mmW test plan
  - Phantom heads and hands required
  - Heavy – phantom head weight is about 8kg

Positioning system		
DUT load capability (centered)	on snowflake (standard fixture) [5]	8 kg, 3GPP alignment option 2
	on clamp (standard fixture) [5]	1 kg, 3GPP alignment options 1 and 3
	on R&S®CATR-HFIX1 (opt.)	20 kg, 3GPP alignment option 2
DUT dimensions	max.	Ø 520 mm

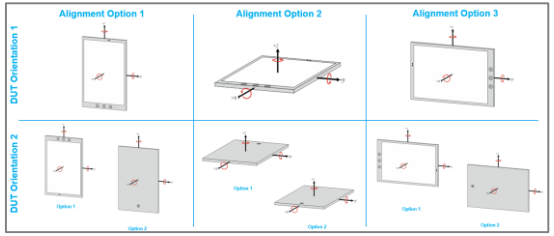
PHANTOM HEAD / HAND HOLDER (OPTIONAL) CATR-HFIX1



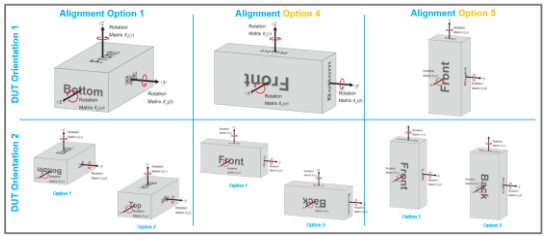
Specification	Value
Spherical Range (degrees)	+/- 180 (Azimuth) +- 90 (Elevation)
Phantoms	SPEAG Head and hands

DUT FIXTURES

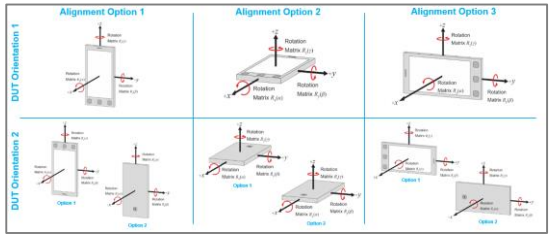
- 3GPP fixture requirements for different DUT types



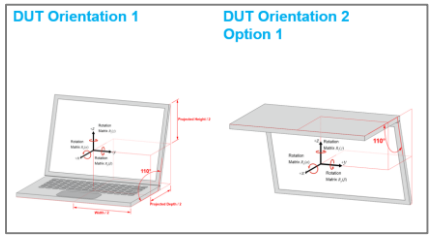
Tablets



CPEs



UEs

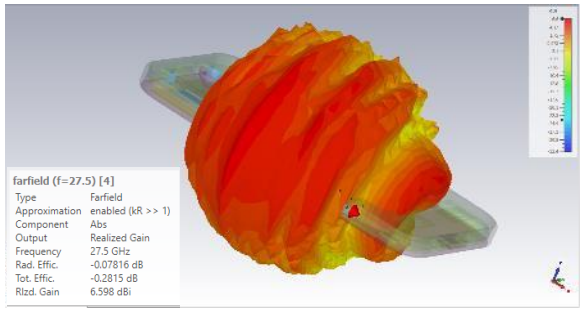


Laptops

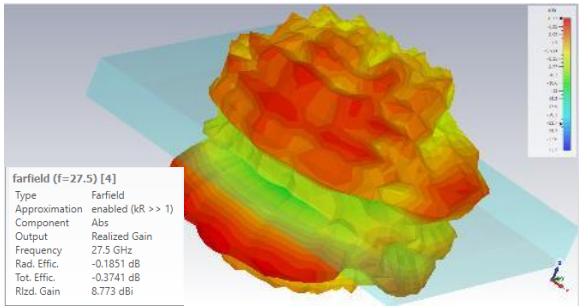
DUT FIXTURES

- Fixture impact on DUT radiation should be minimal to none

Radiation pattern phone only



Radiation pattern phone on fixture



ATS1800C – ADDITIONAL DUT FIXTURES

- Matrix of different fixtures to choose from depending on DUT type, orientation, best fit, etc.

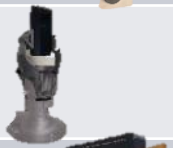
DUT Type	Alignment 1	Alignment 2	Alignment 3
UE			
Tablet			
CPE			
Laptop	…	…	…

Table shows examples only

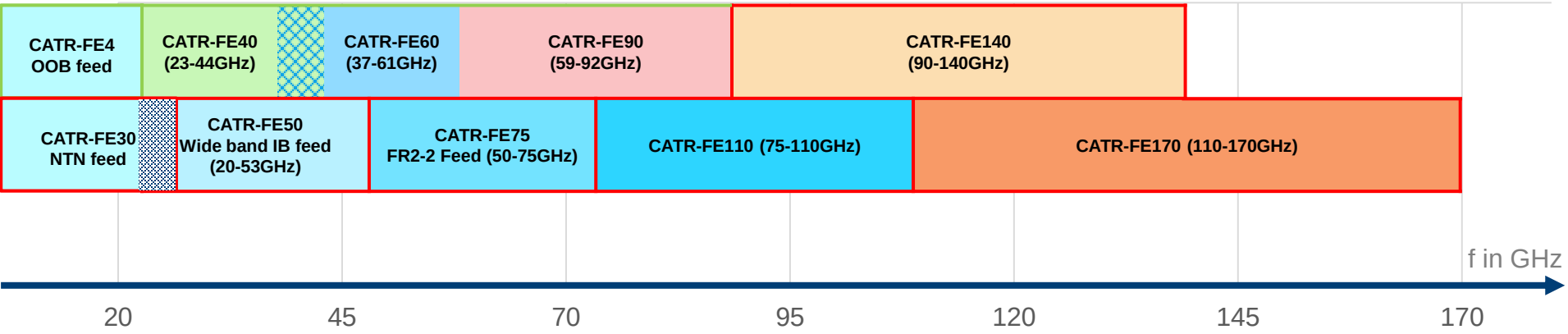
ATS1800C – QUALITY OF QUIET ZONE FIXTURES

- Option TS-QOQZIB provides
  - All required fixtures to achieve all test antenna orientations on all seven points
  - For ATS1800C legacy (K02) as well as ATS1800C facelift (K03)
  - For 30cm QZ size (CATR-REFL1) as well as 40cm QZ size (CATR-REFL6)
  - Including probe antenna and cables for In-Band testing
  - SW support and user guidance will be implemented in CONTEST

- Option TS-QOQZOOB planned for OOB testing

FUTURE REQUIREMENT
FR2-2 IN-BAND TESTING

- New frequency range FR2-2 specified above FR2(-1)
  - FR1 400MHz…7.125GHz
  - FR2-0 7.125GHz…24.25GHz
  - FR2-1 24.25GHz…52.6GHz
  - FR2-2 52.6GHz…71GHz



ROHDE & SCHWARZ ATS1800C – THE CATR CHAMBER FOR ALL RF AND RRM CONFORMANCE TEST NEEDS

THANK YOU