

# HB Antenna Proposal for EE4410-00

- Passive measurement report -

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Version: V1.1



# Report Version Information

| Version | Description                                                                     | Date       |
|---------|---------------------------------------------------------------------------------|------------|
| V1.0    | <ul style="list-style-type: none"><li>Simulation evaluation.</li></ul>          | 2024/11/29 |
| V1.1    | <ul style="list-style-type: none"><li>Simulation evaluation (mockup).</li></ul> | 2025/1/7   |
|         |                                                                                 |            |
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|         |                                                                                 |            |
|         |                                                                                 |            |



# Summary

- **Test Environment and Equipment**
  - **DUT Orientation Setting**
  - **Testing Contents – Default Configuration Of HW**
    - Antenna Information
    - Measurement Results:
      - Return Loss & Isolation
      - Antenna Efficiency, Peak Realized gain,
      - 2D Realized Gain Radiation Patterns @Total Polarization



# Test Environment & Equipment

- SATIMO SG 24 Multi-Probe Antenna Measurement System
- Angle between probes:  $15^{\circ}$
- Frequency range: 400 MHz – 8.5 GHz
- Chamber Room Size: 4.0 m L x 4.0 m W x 4.0 m H

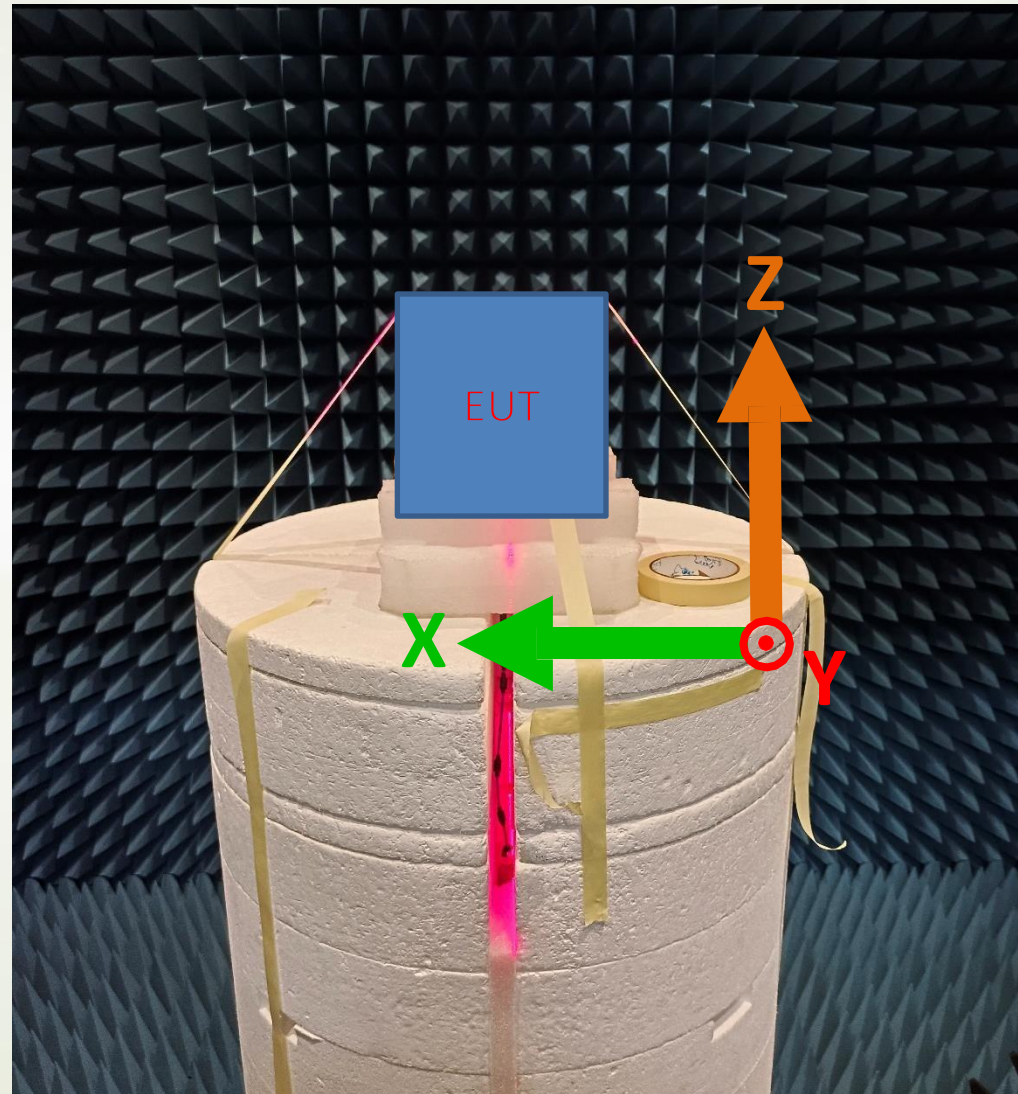


- Agilent and Keysight Vector Network Analyzer
- Frequency range: 100KHz – 8.5GHz
- Ports numbers: 2 ports

- ETS-Lindgren AMS-8500 Antenna Measurement System
- EM Quest EMQ-100 Software
- Model 3164-04 Diagonal Dual Polarized Horn antenna
- Frequency range: 700 MHz - 6 GHz
- Positioning Systems
- Chamber Room Size: 7.32 m L x 3.66 m W x 3.66 m H



# DUT Orientation Setting

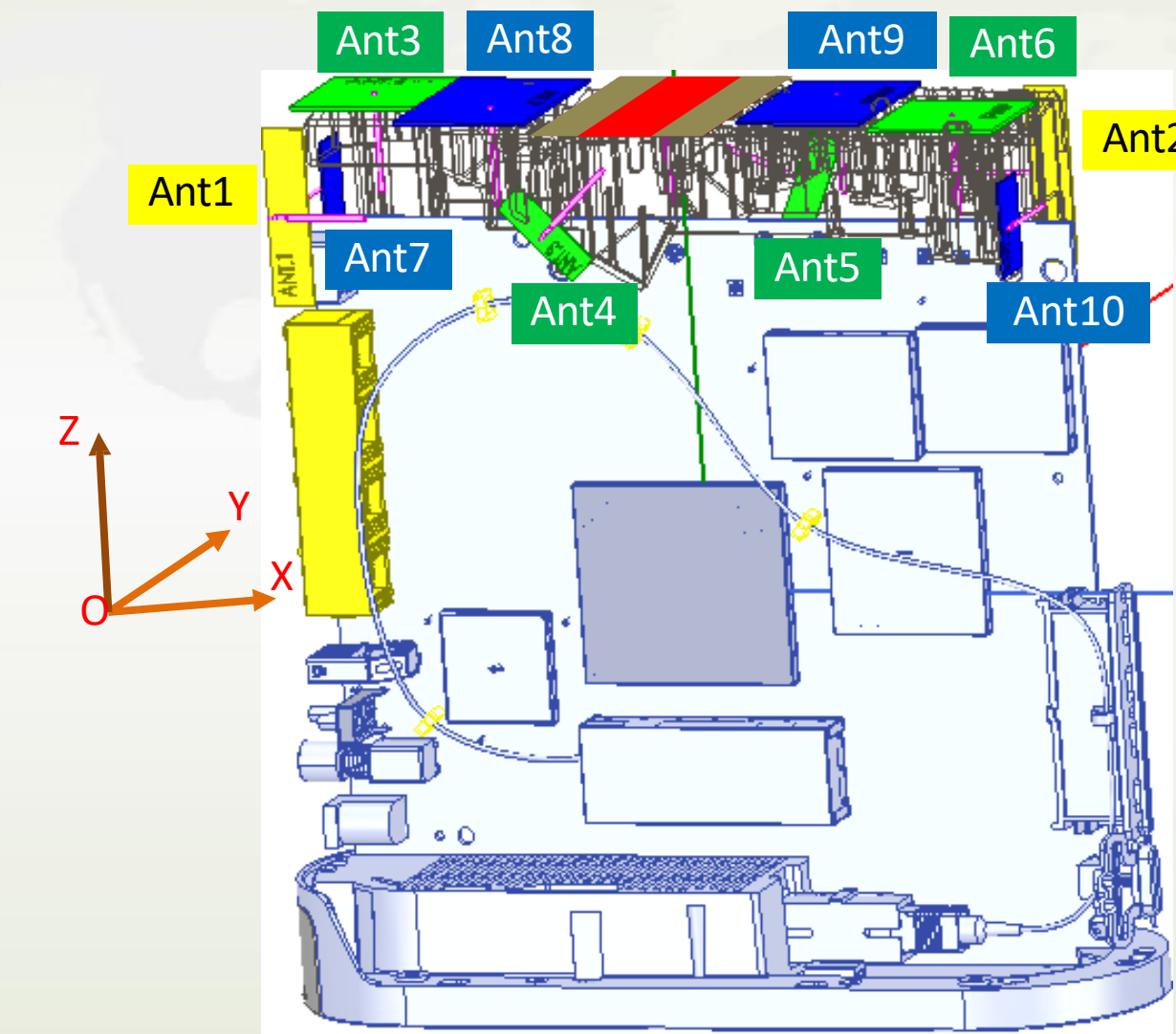


# Default Configuration Of HW

- Antenna Information



# Antenna Photo and Information



| Designator | HB PN | Frequency Range |
|------------|-------|-----------------|
| Ant1       | N/A   | 2400 - 2500MHz  |
| Ant2       | N/A   | 2400 - 2500MHz  |
| Ant3       | N/A   | 5150 - 5850MHz  |
| Ant4       | N/A   | 5150 - 5850MHz  |
| Ant5       | N/A   | 5150 - 5850MHz  |
| Ant6       | N/A   | 5150 - 5850MHz  |
| Ant7       | N/A   | 5925 - 7125MHz  |
| Ant8       | N/A   | 5925 - 7125MHz  |
| Ant9       | N/A   | 5925 - 7125MHz  |
| Ant10      | N/A   | 5925 - 7125MHz  |



# Measurement Results

- Return Loss & Isolation
- Antenna Efficiency, Peak Realized Gain
- 2D Antenna Realized Gain Radiation Patterns @Total Polarization



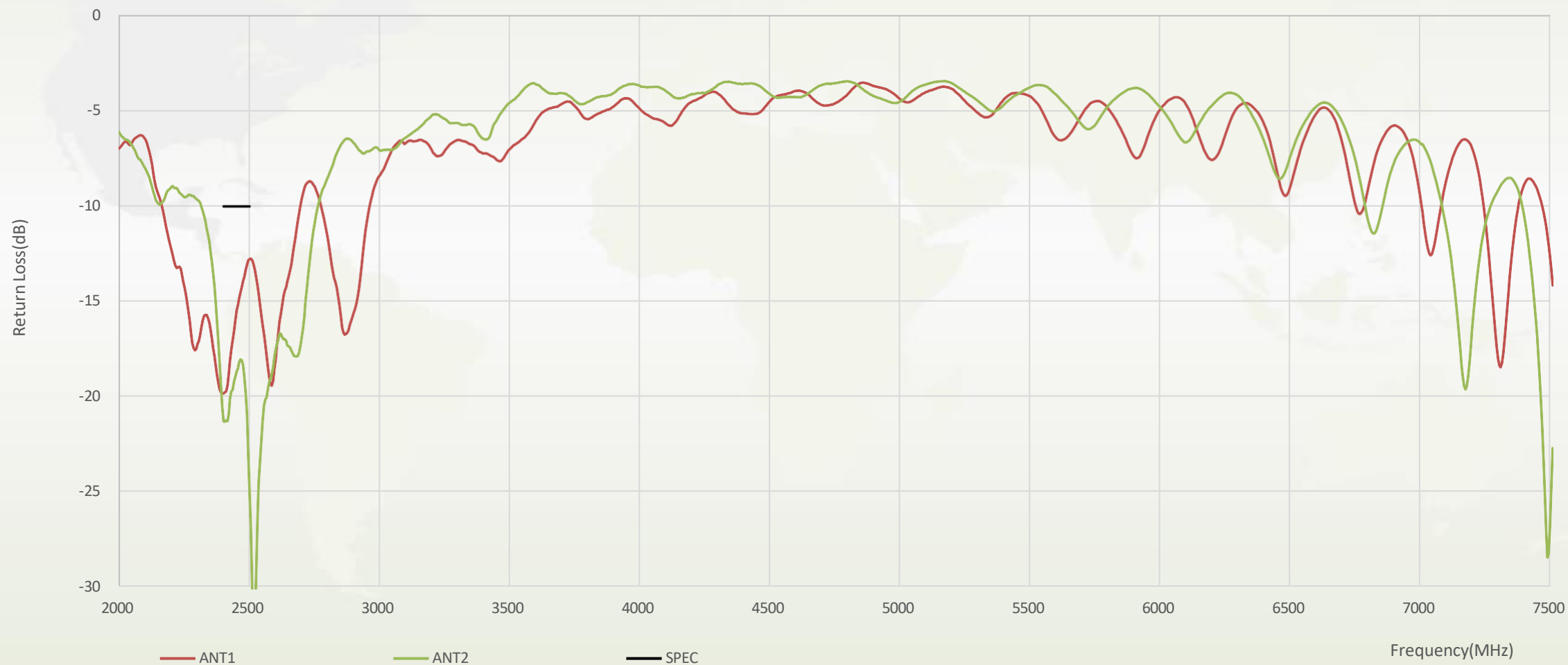
# S-Parameters

- Return Loss
- Isolation



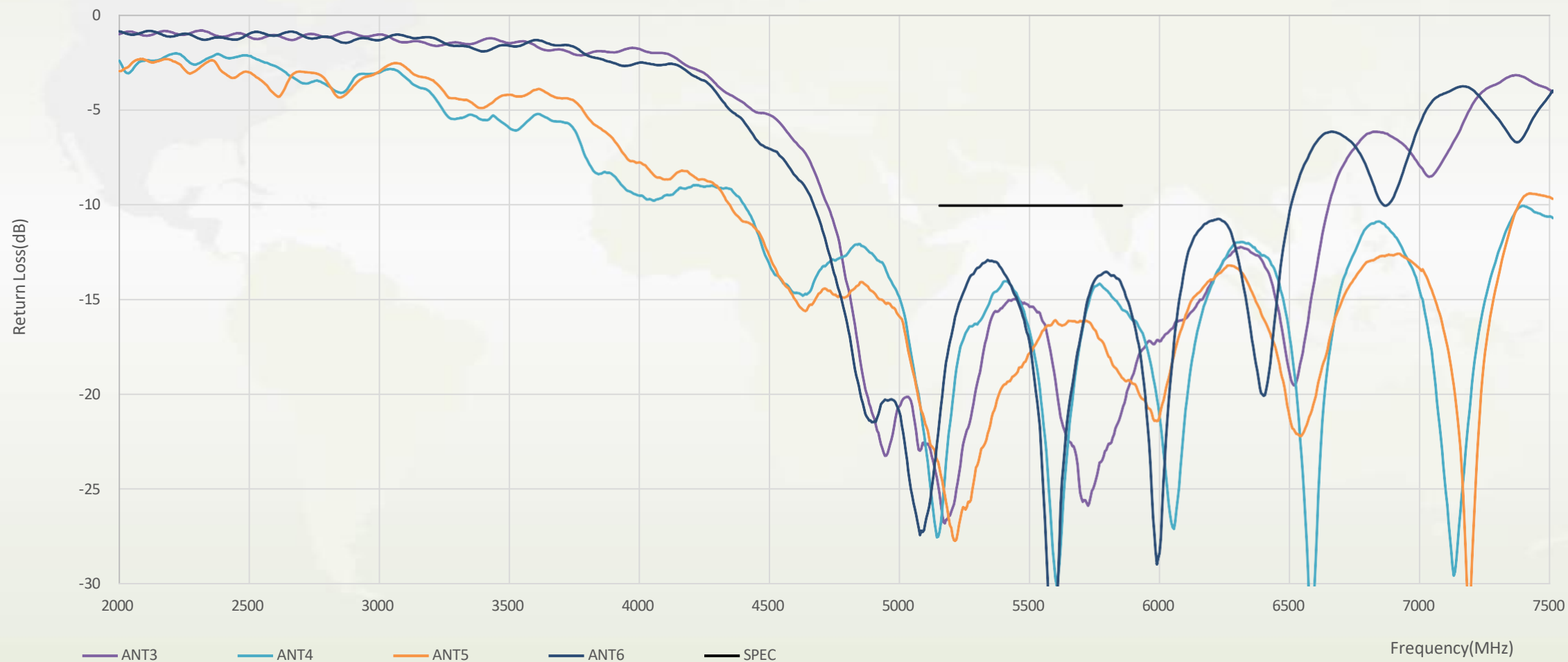
# Return Loss of 2G Antennas

Return Loss 2G

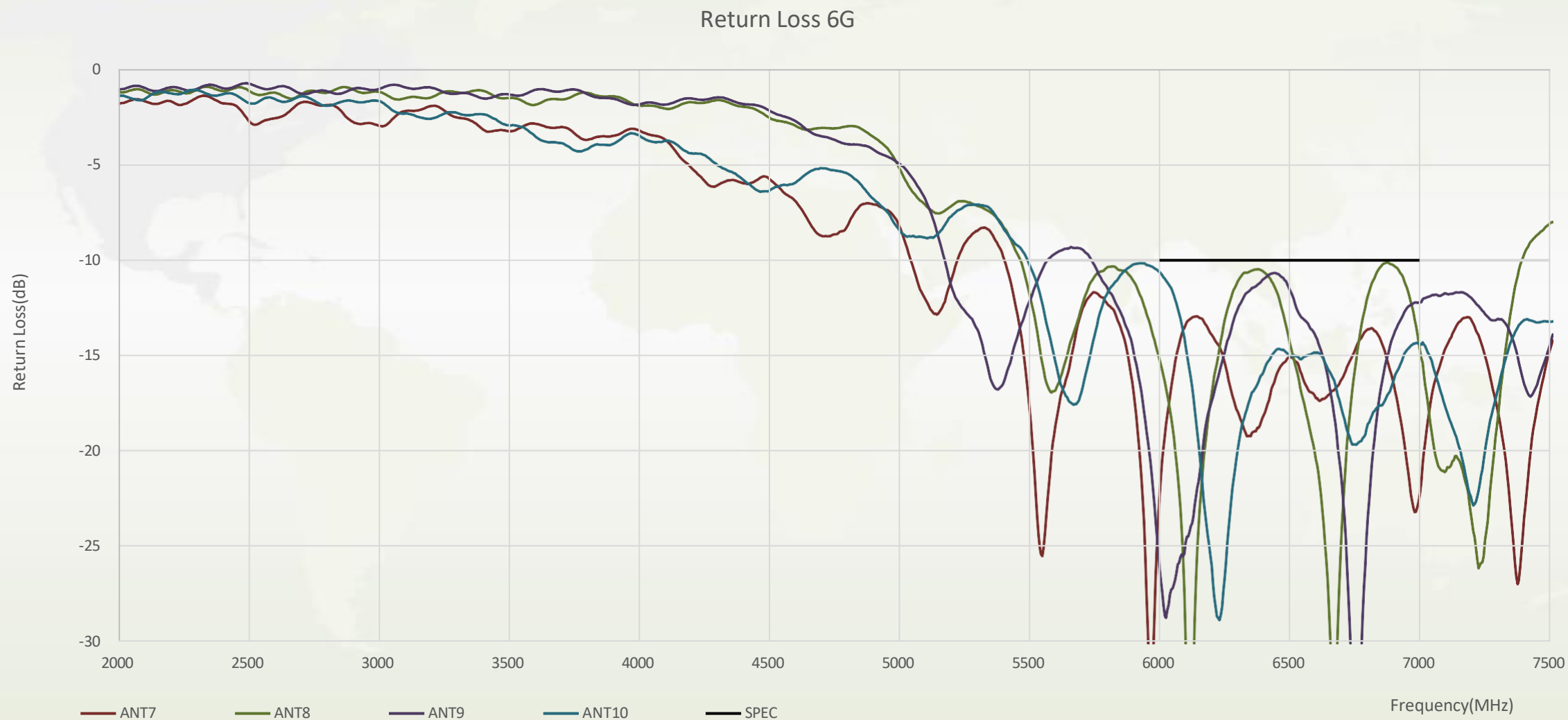


# Return Loss of 5G Antennas

Return Loss 5G

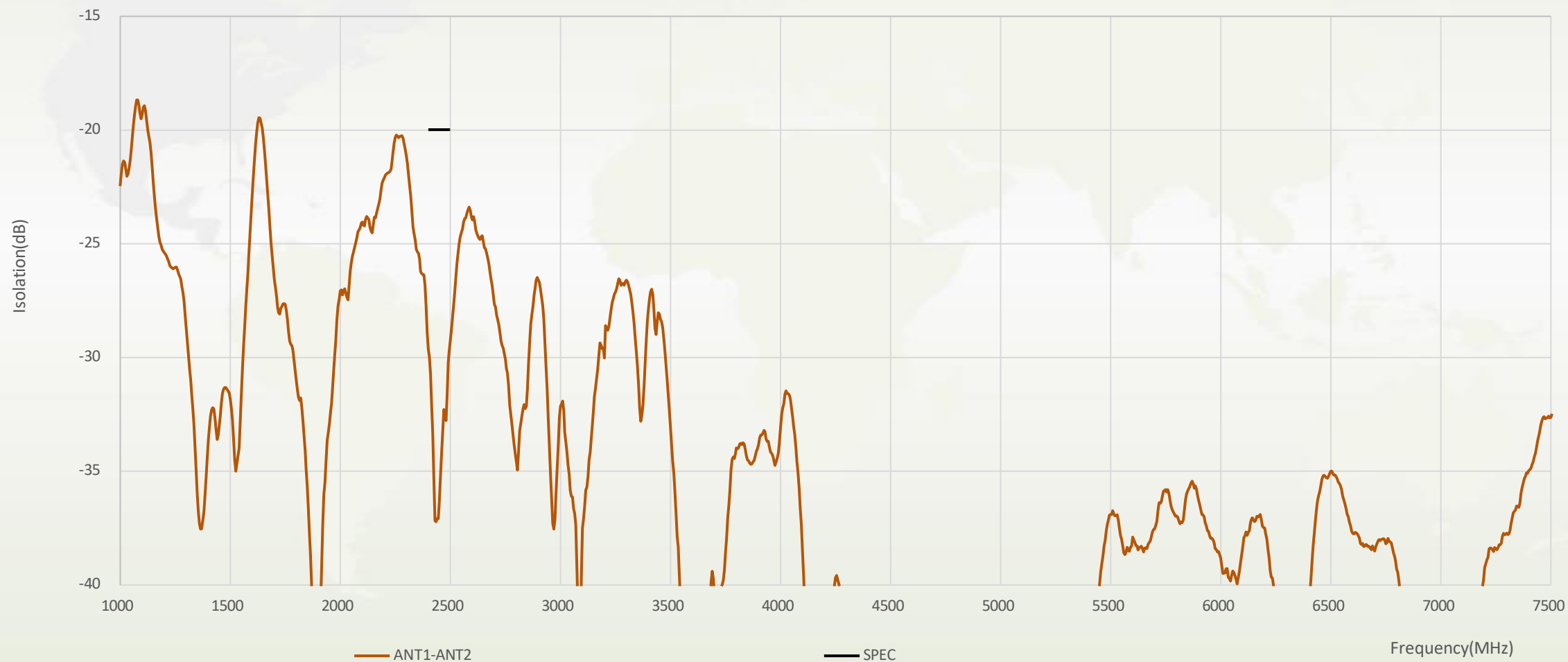


# Return Loss of 6G Antennas



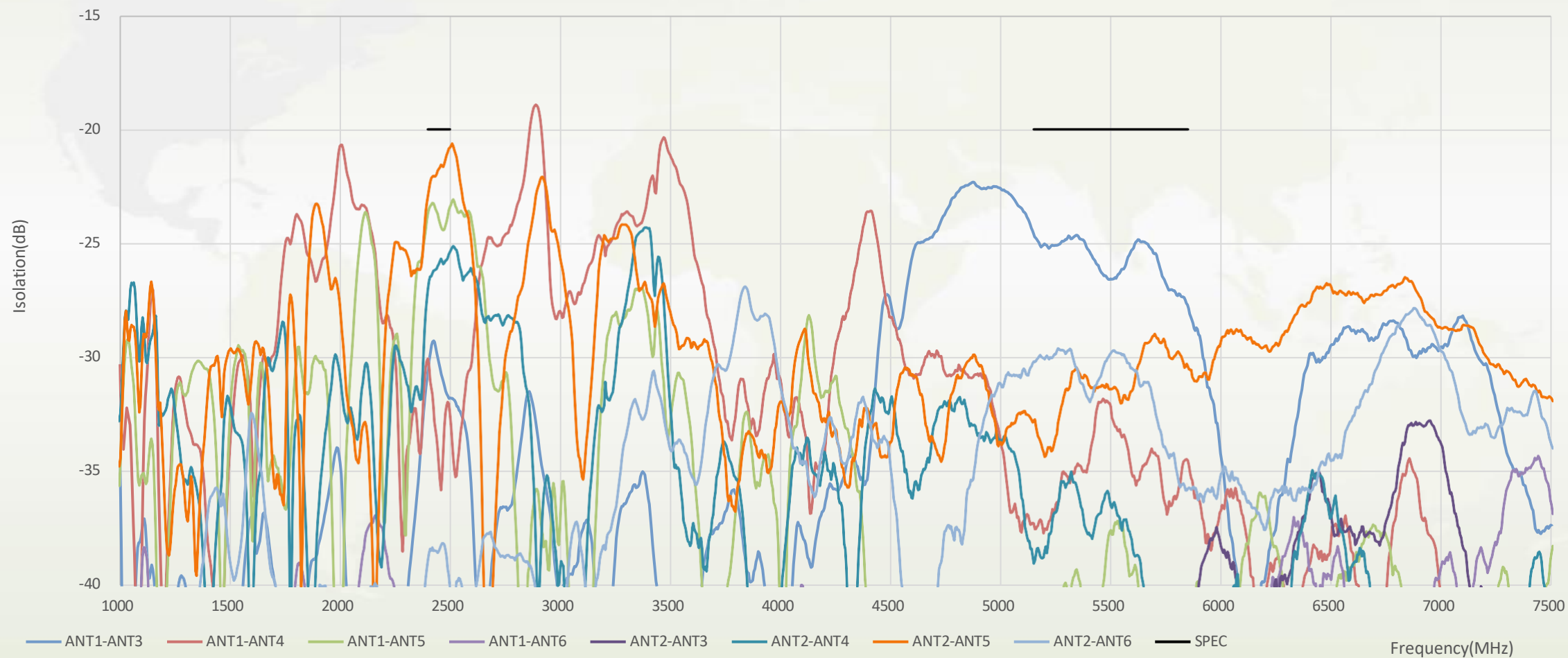
# Isolation Between Antennas 2G – 2G

Isolation 2G-2G



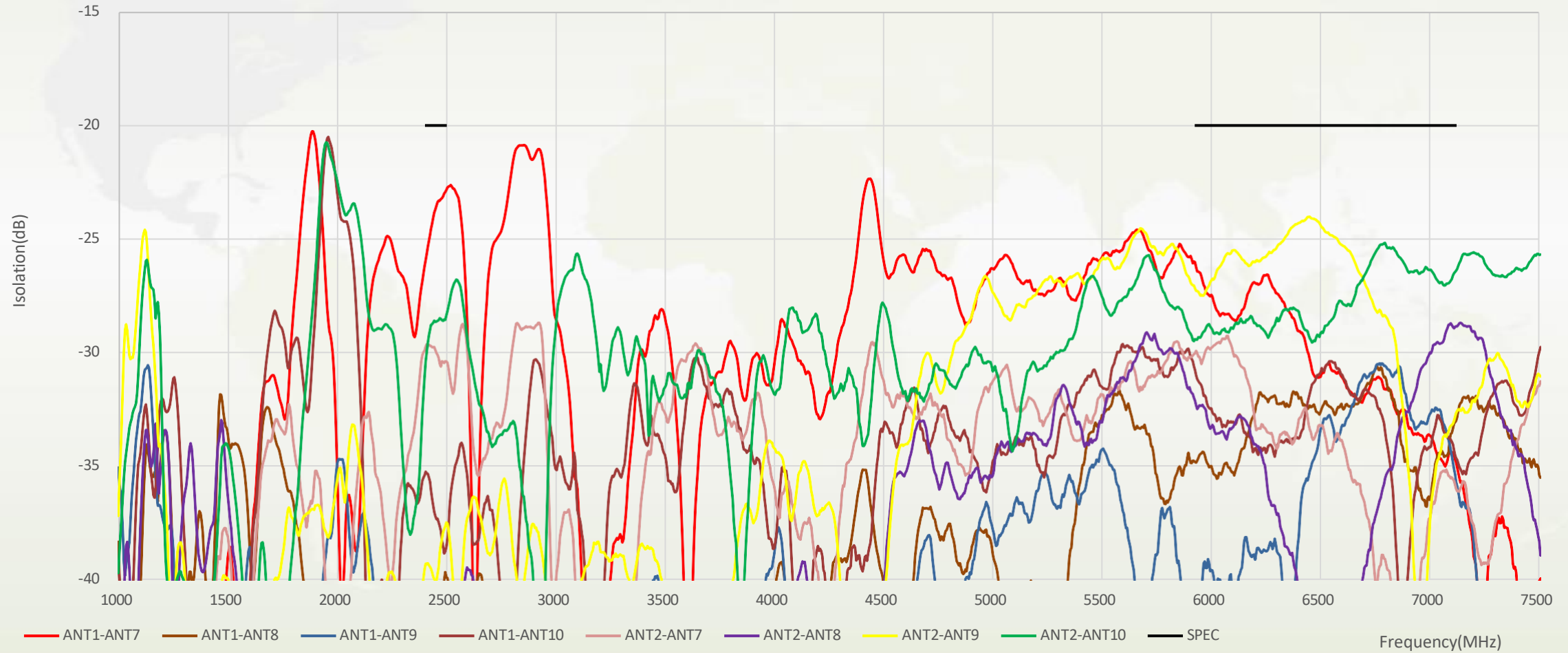
# Isolation Between Antennas 2G – 5G

Isolation 2G-5G



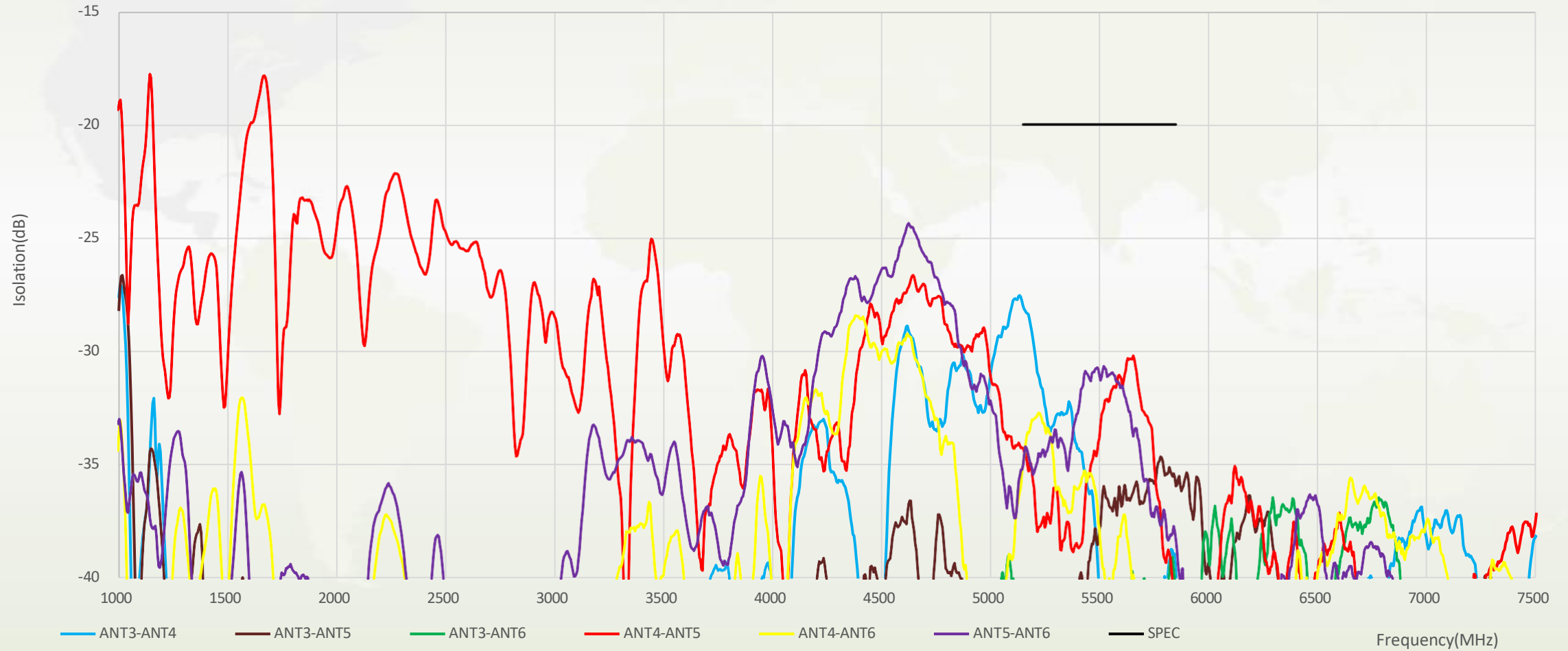
# Isolation Between Antennas 2G – 6G

Isolation 2G-6G



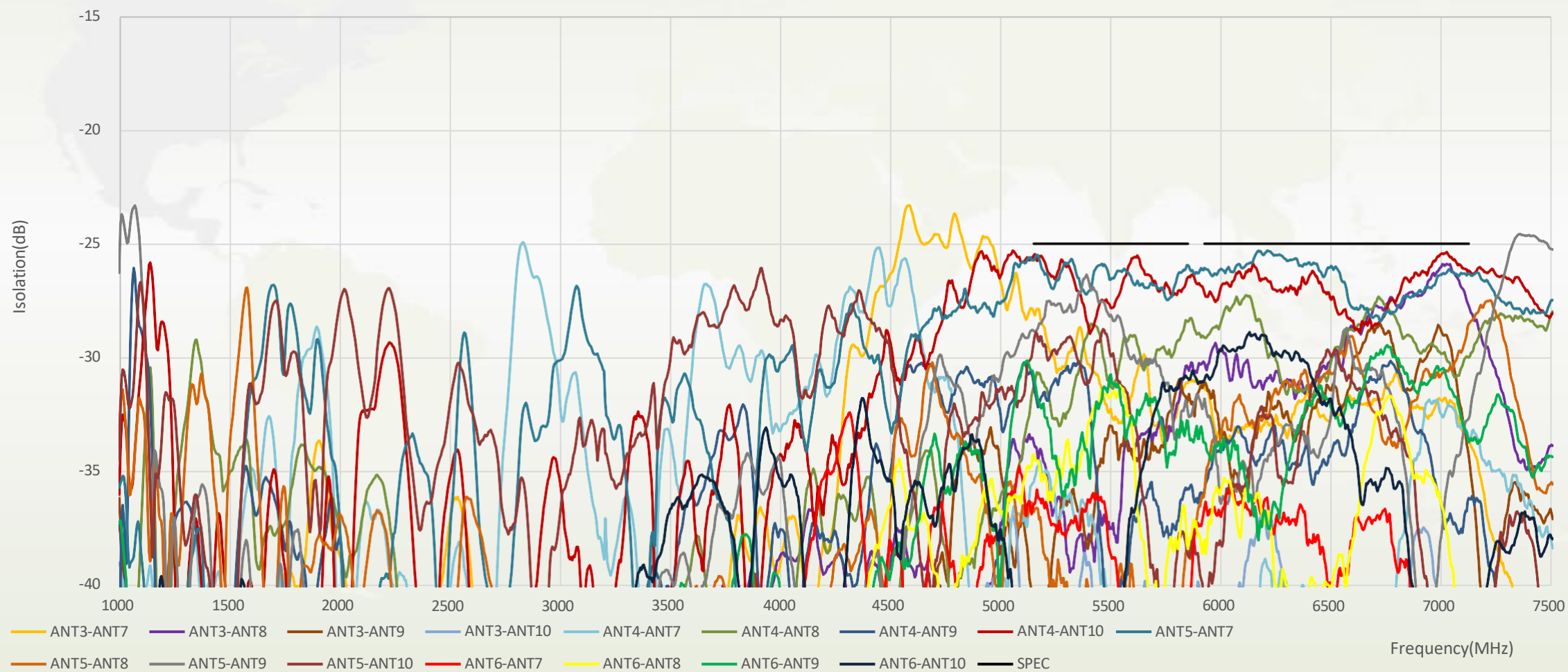
# Isolation Between Antennas 5G – 5G

Isolation 5G-5G



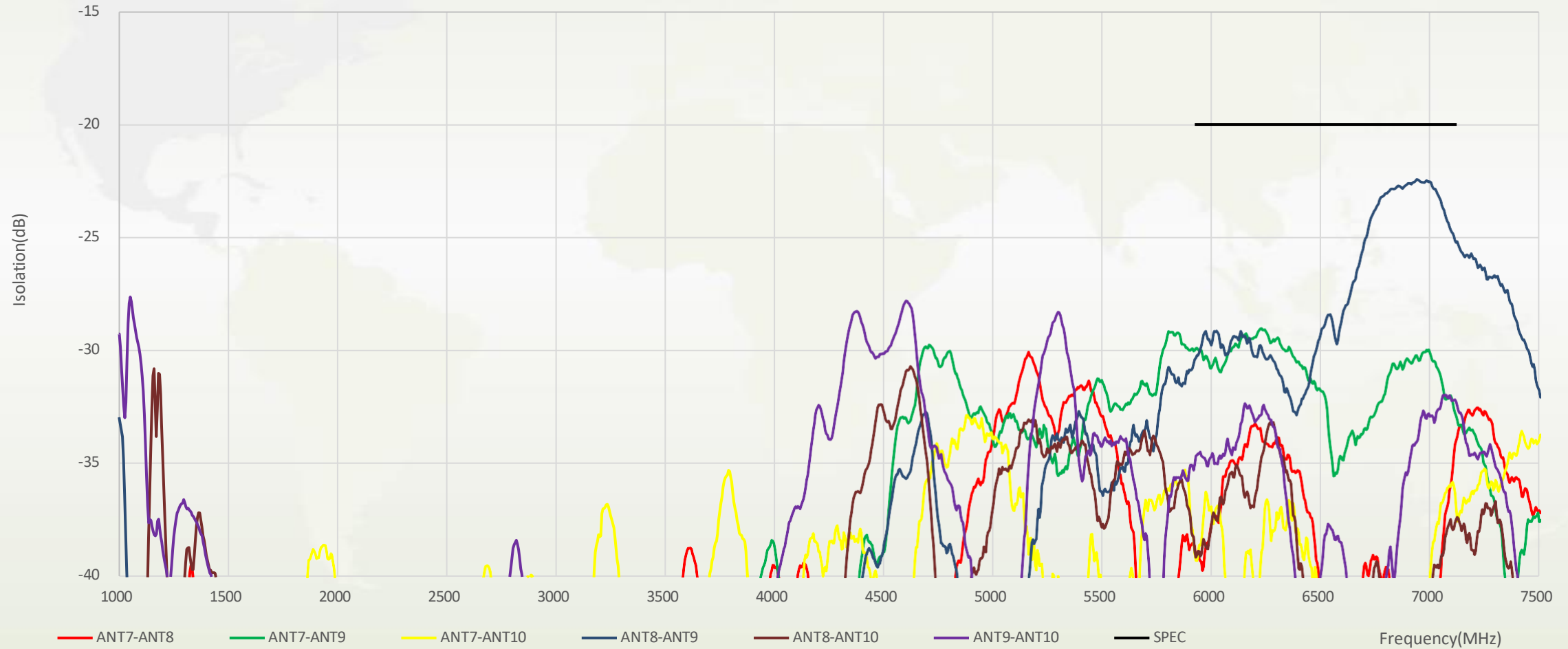
# Isolation Between Antennas 5G – 6G

Isolation 5G-6G



# Isolation Between Antennas 6G – 6G

Isolation 6G-6G



# Radiated Performance

- Realized Efficiency
- Peak Realized Gain



# Realized Efficiency of Ants

| Frequency (MHz) | 2400 | 2410 | 2420 | 2430 | 2440 | 2450 | 2460 | 2470 | 2480 | 2490 | 2500 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| Ant1(%)         | 71   | 71   | 70   | 69   | 69   | 69   | 68   | 66   | 65   | 65   | 65   |
| Ant2(%)         | 71   | 70   | 69   | 69   | 69   | 69   | 69   | 68   | 68   | 69   | 70   |

| Frequency (MHz) | 5150 | 5200 | 5250 | 5300 | 5350 | 5400 | 5450 | 5500 | 5550 | 5600 | 5650 | 5700 | 5750 | 5800 | 5850 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Ant3(%)         | 70   | 68   | 67   | 66   | 67   | 69   | 69   | 71   | 71   | 72   | 73   | 75   | 76   | 70   | 67   |
| Ant4(%)         | 75   | 70   | 69   | 69   | 69   | 71   | 71   | 74   | 75   | 75   | 75   | 76   | 74   | 70   | 68   |
| Ant5(%)         | 74   | 72   | 72   | 70   | 70   | 73   | 72   | 75   | 73   | 73   | 75   | 76   | 76   | 71   | 69   |
| Ant6(%)         | 72   | 68   | 67   | 66   | 67   | 69   | 70   | 73   | 72   | 73   | 75   | 76   | 76   | 70   | 65   |

| Frequency (MHz) | 5925 | 6000 | 6100 | 6200 | 6300 | 6400 | 6500 | 6600 | 6700 | 6800 | 6900 | 7000 | 7100 | 7125 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Ant7(%)         | 75   | 73   | 71   | 70   | 73   | 74   | 72   | 72   | 68   | 67   | 68   | 67   | 72   | 71   |
| Ant8(%)         | 75   | 74   | 76   | 74   | 70   | 70   | 75   | 74   | 66   | 66   | 68   | 65   | 72   | 71   |
| Ant9(%)         | 75   | 75   | 76   | 71   | 69   | 69   | 73   | 72   | 66   | 68   | 70   | 65   | 68   | 67   |
| Ant10(%)        | 68   | 68   | 70   | 69   | 69   | 69   | 70   | 71   | 70   | 72   | 72   | 70   | 75   | 75   |



# Peak Realized Gain of antennas

| Frequency (MHz) | 2400 | 2410 | 2420 | 2430 | 2440 | 2450 | 2460 | 2470 | 2480 | 2490 | 2500 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|
| Ant1(dBi)       | 3.6  | 3.5  | 3.4  | 3.3  | 3.3  | 3.3  | 3.2  | 3.0  | 2.9  | 2.8  | 2.9  |
| Ant2(dBi)       | 3.0  | 3.0  | 2.8  | 2.8  | 2.8  | 2.7  | 2.8  | 2.9  | 3.0  | 3.0  | 2.9  |

| Frequency (MHz) | 5150 | 5200 | 5250 | 5300 | 5350 | 5400 | 5450 | 5500 | 5550 | 5600 | 5650 | 5700 | 5750 | 5800 | 5850 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Ant3(dBi)       | 3.6  | 3.5  | 3.5  | 3.3  | 3.6  | 3.2  | 3.4  | 3.8  | 3.9  | 4.1  | 4.0  | 3.9  | 4.2  | 4.1  | 3.8  |
| Ant4(dBi)       | 4.9  | 4.4  | 4.4  | 4.6  | 4.9  | 5.5  | 6.0  | 6.3  | 6.3  | 6.3  | 6.6  | 6.6  | 6.2  | 5.9  | 5.2  |
| Ant5(dBi)       | 4.8  | 4.7  | 4.6  | 4.6  | 4.4  | 4.7  | 4.4  | 4.4  | 3.8  | 3.9  | 4.2  | 4.4  | 4.3  | 4.0  | 3.9  |
| Ant6(dBi)       | 3.4  | 3.3  | 3.4  | 3.7  | 3.9  | 4.6  | 4.9  | 5.6  | 5.6  | 5.7  | 5.7  | 5.5  | 5.1  | 4.5  | 4.1  |

| Frequency (MHz) | 5925 | 6000 | 6100 | 6200 | 6300 | 6400 | 6500 | 6600 | 6700 | 6800 | 6900 | 7000 | 7100 | 7125 |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Ant7(dBi)       | 3.9  | 4.0  | 3.7  | 3.3  | 4.0  | 4.1  | 3.9  | 4.1  | 4.2  | 3.9  | 4.3  | 4.2  | 4.5  | 4.1  |
| Ant8(dBi)       | 5.5  | 5.6  | 6.2  | 5.9  | 5.7  | 6.2  | 6.4  | 5.8  | 4.8  | 5.2  | 4.9  | 5.1  | 5.5  | 5.5  |
| Ant9(dBi)       | 5.6  | 5.8  | 6.0  | 5.2  | 4.4  | 4.4  | 4.8  | 4.1  | 4.2  | 5.1  | 5.8  | 5.5  | 4.9  | 4.3  |
| Ant10(dBi)      | 3.6  | 3.4  | 4.3  | 3.8  | 3.6  | 3.2  | 3.3  | 3.3  | 3.9  | 4.5  | 4.6  | 3.9  | 3.8  | 3.8  |



# Correlated Directional gain & Un-correlated aggregated Directivity

| Total     |                 |                   |
|-----------|-----------------|-------------------|
| Frequency | 2G              |                   |
|           | Correlated Gain | Uncorrelated Gain |
| 2400      | 5.68            | 2.72              |
| 2410      | 5.70            | 2.69              |
| 2420      | 5.72            | 2.71              |
| 2430      | 5.74            | 2.73              |
| 2440      | 5.83            | 2.82              |
| 2450      | 5.86            | 2.85              |
| 2460      | 5.81            | 2.80              |
| 2470      | 5.59            | 2.59              |
| 2480      | 5.46            | 2.46              |
| 2490      | 5.35            | 2.36              |
| 2500      | 5.26            | 2.27              |

| Total     |                 |                   |
|-----------|-----------------|-------------------|
| Frequency | 5G              |                   |
|           | Correlated Gain | Uncorrelated Gain |
| 5150      | 6.98            | 1.19              |
| 5200      | 6.68            | 1.07              |
| 5250      | 6.79            | 1.20              |
| 5300      | 6.66            | 1.07              |
| 5350      | 7.00            | 1.31              |
| 5400      | 7.54            | 1.81              |
| 5450      | 7.50            | 1.78              |
| 5500      | 7.64            | 1.92              |
| 5550      | 7.31            | 1.68              |
| 5600      | 7.11            | 1.54              |
| 5650      | 7.08            | 1.45              |
| 5700      | 7.06            | 1.46              |
| 5750      | 7.14            | 1.33              |
| 5800      | 6.83            | 1.02              |
| 5850      | 6.45            | 0.65              |

| Total     |                 |                   |
|-----------|-----------------|-------------------|
| Frequency | 5G              |                   |
|           | Correlated Gain | Uncorrelated Gain |
| 5925      | 8.88            | 2.93              |
| 6000      | 8.57            | 2.75              |
| 6100      | 8.76            | 3.15              |
| 6200      | 8.55            | 2.88              |
| 6300      | 8.30            | 2.65              |
| 6400      | 8.83            | 3.22              |
| 6500      | 8.88            | 3.27              |
| 6600      | 8.58            | 2.94              |
| 6700      | 7.89            | 2.05              |
| 6800      | 8.15            | 2.37              |
| 6900      | 8.71            | 3.04              |
| 7000      | 8.97            | 3.24              |
| 7100      | 9.49            | 3.68              |
| 7125      | 9.27            | 3.48              |

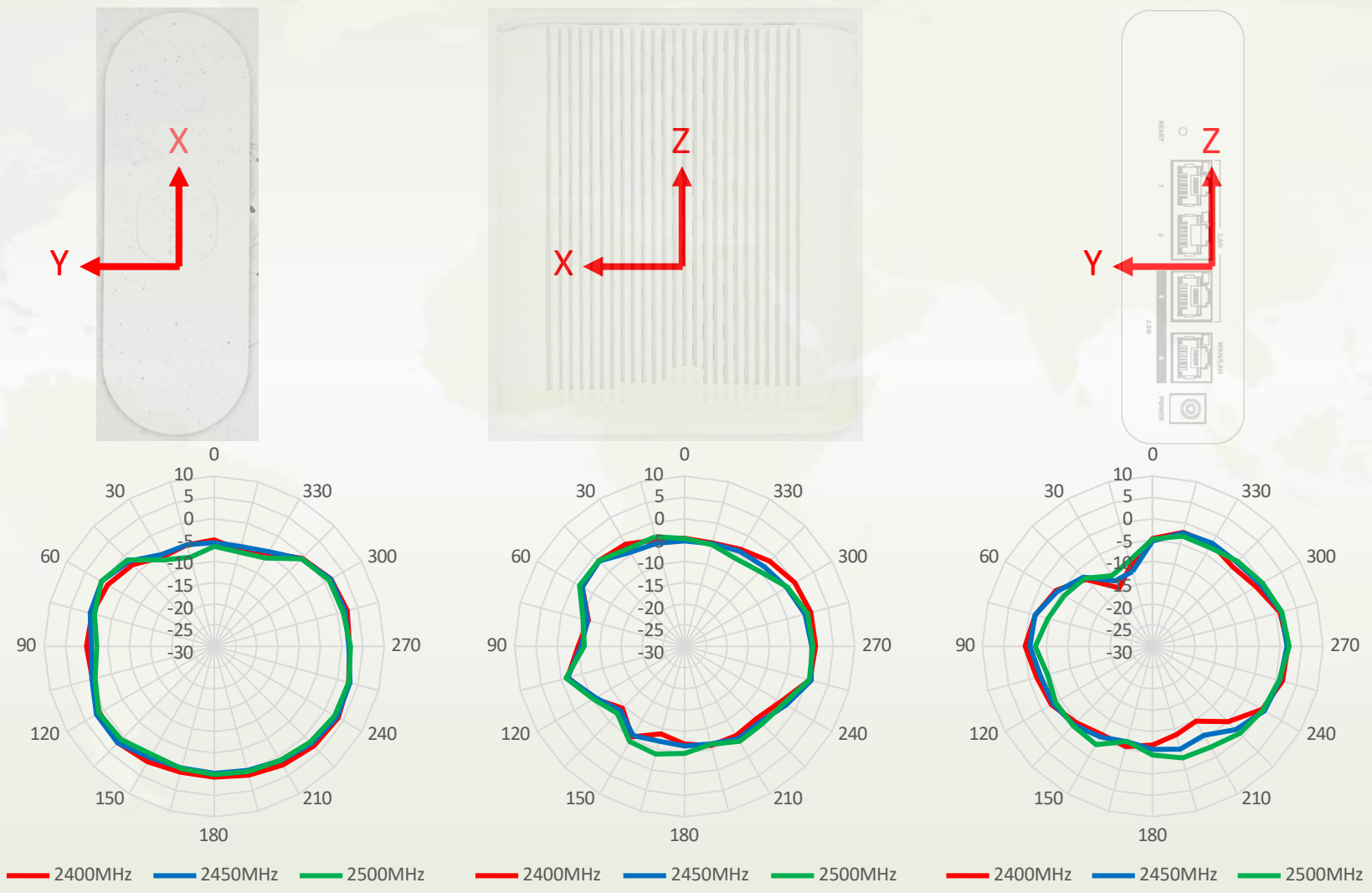


# Radiation Patterns in Principal Planes

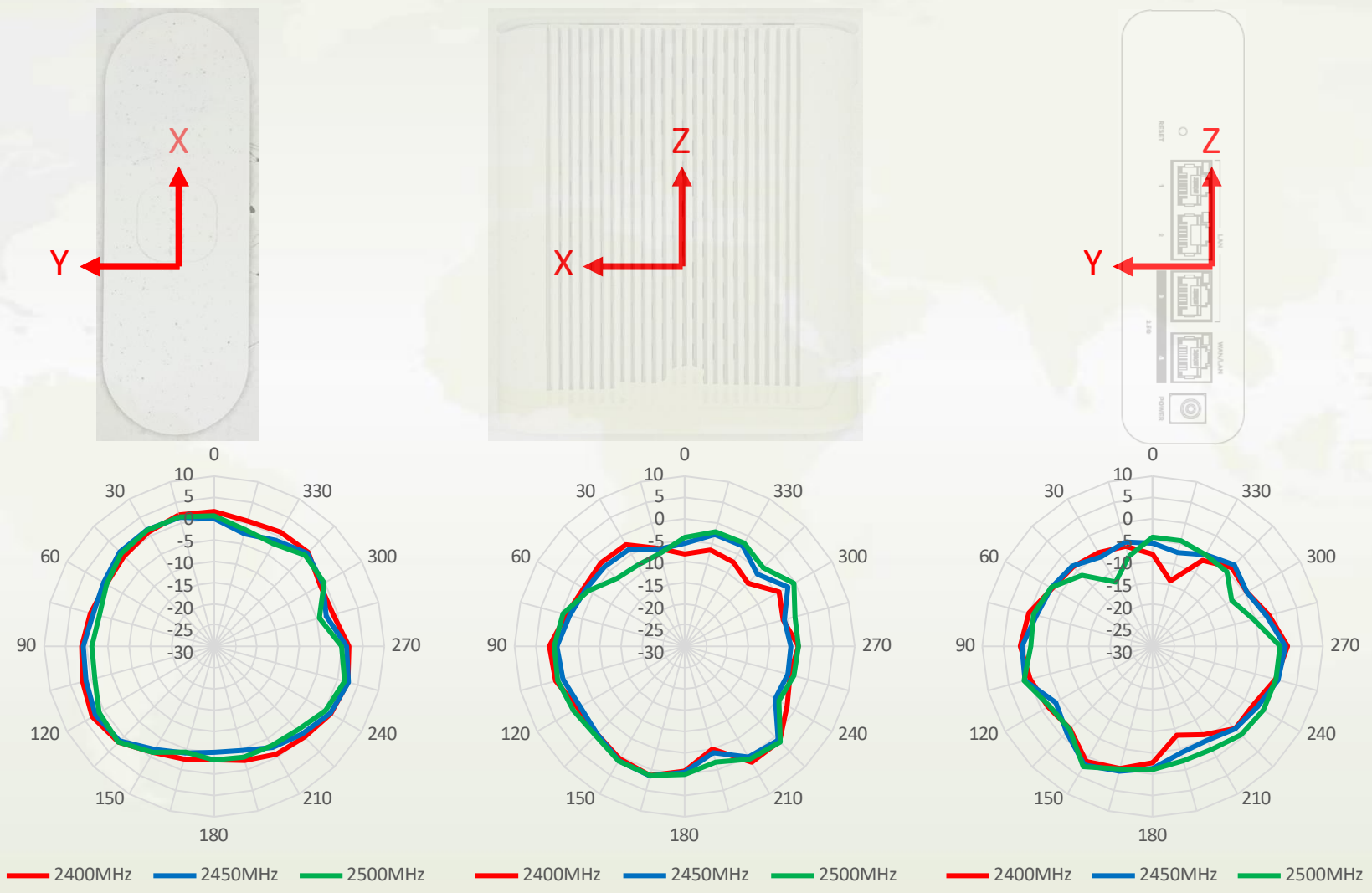
- Realized Gain



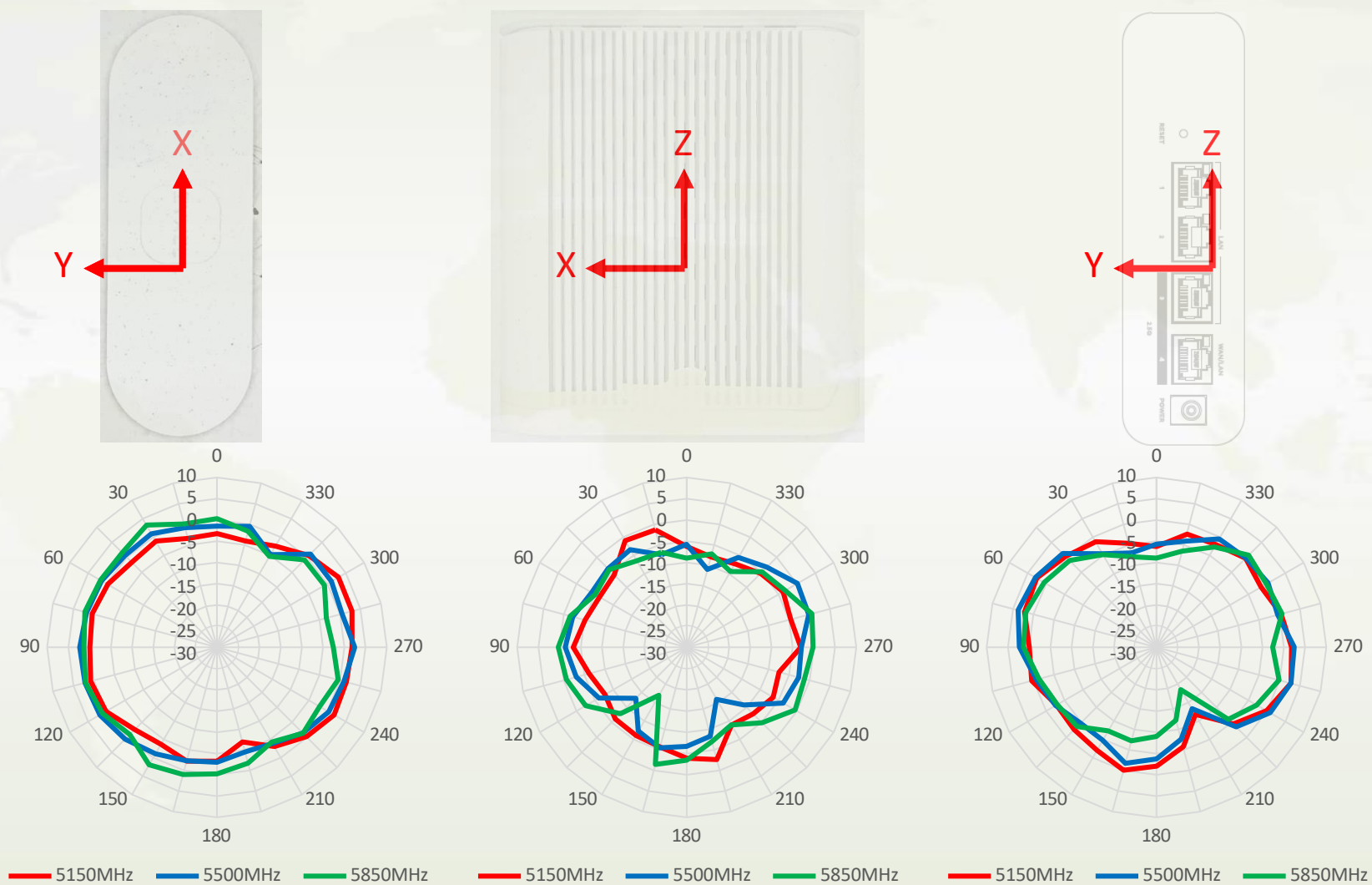
# Realized Gain Pattern of Ant1 in 2GHz Band



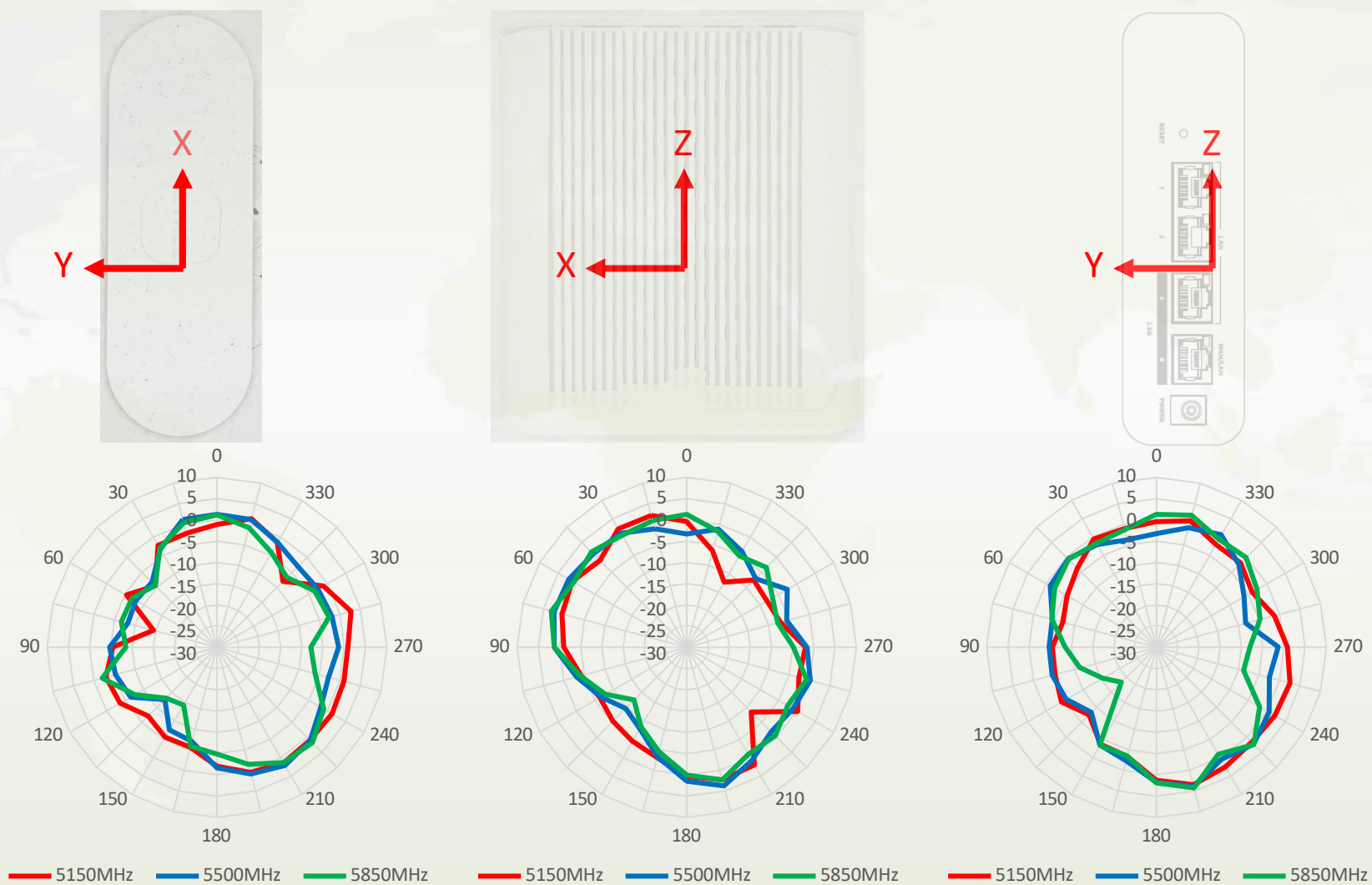
# Realized Gain Pattern of Ant2 in 2GHz Band



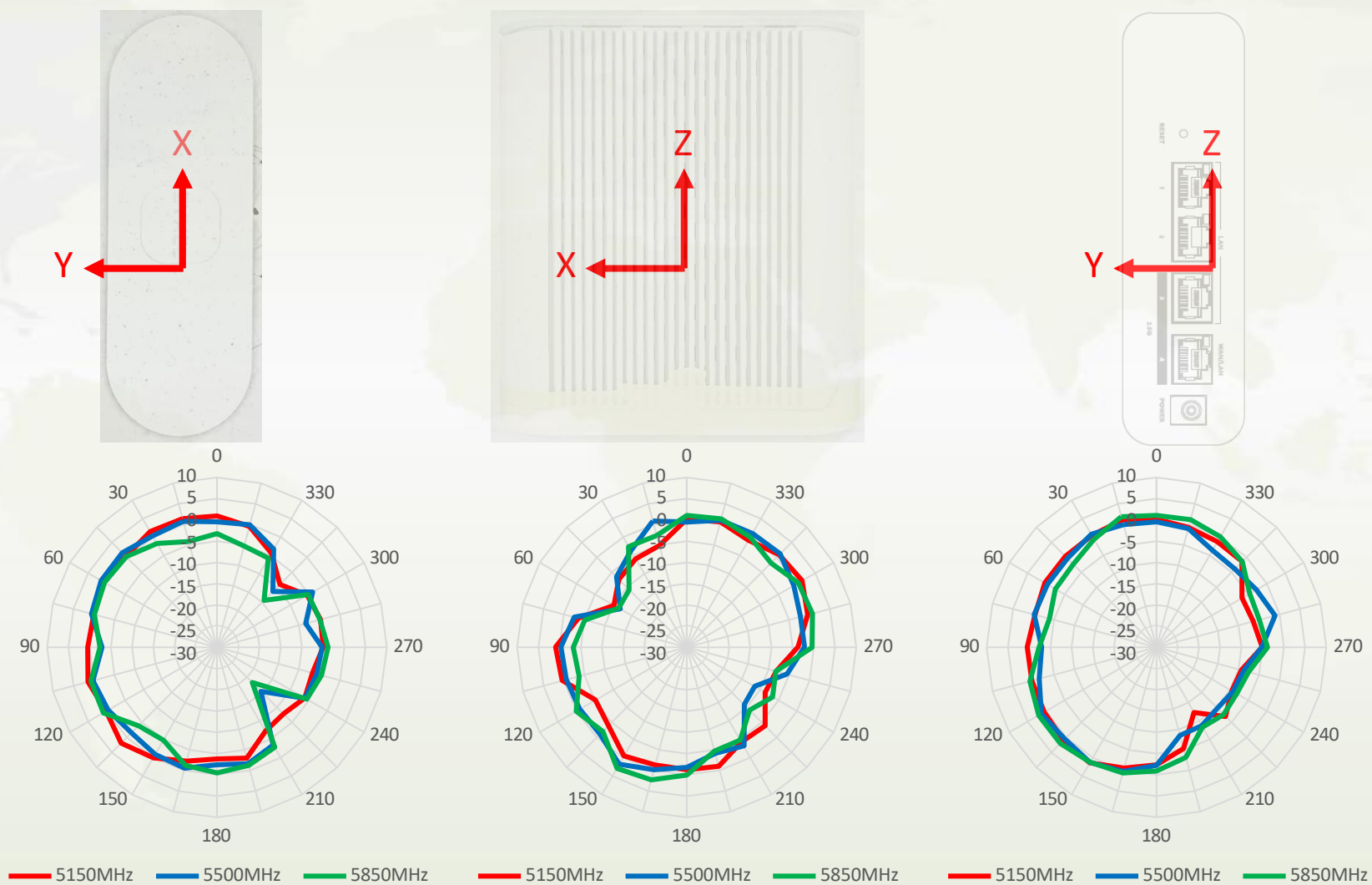
# Realized Gain Pattern of Ant3 in 5GHz Band



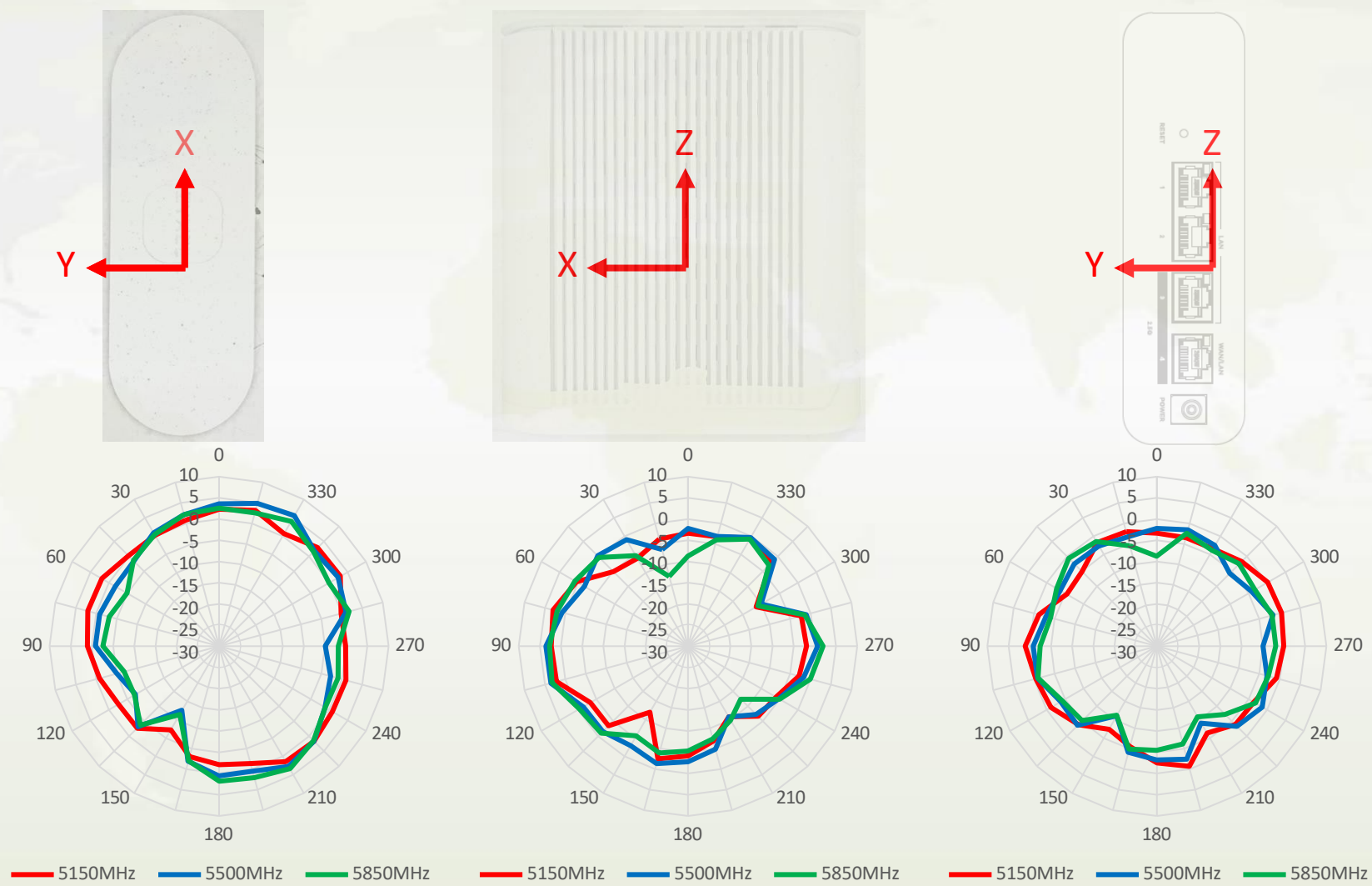
# Realized Gain Pattern of Ant4 in 5GHz Band



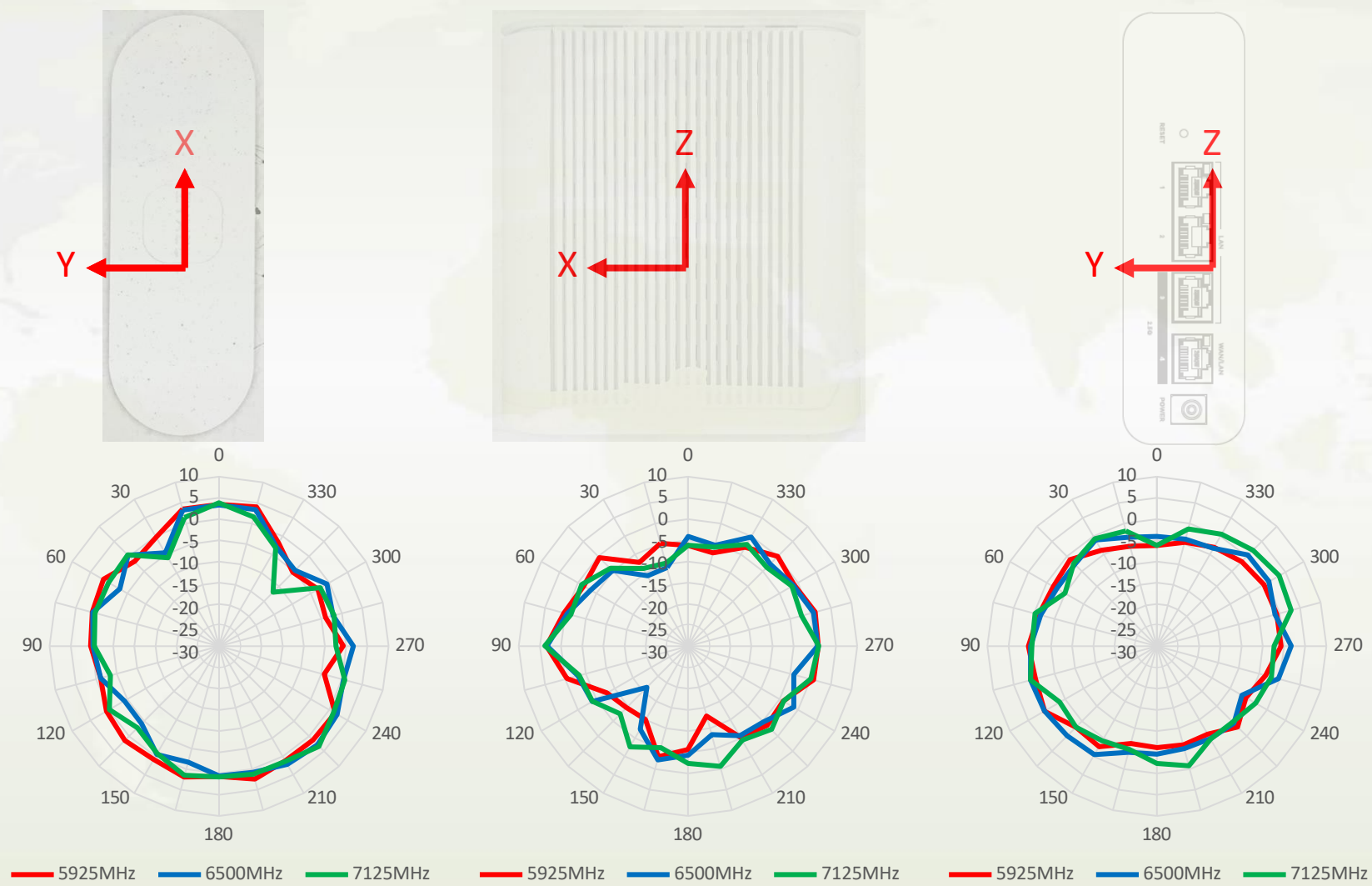
# Realized Gain Pattern of Ant5 in 5GHz Band



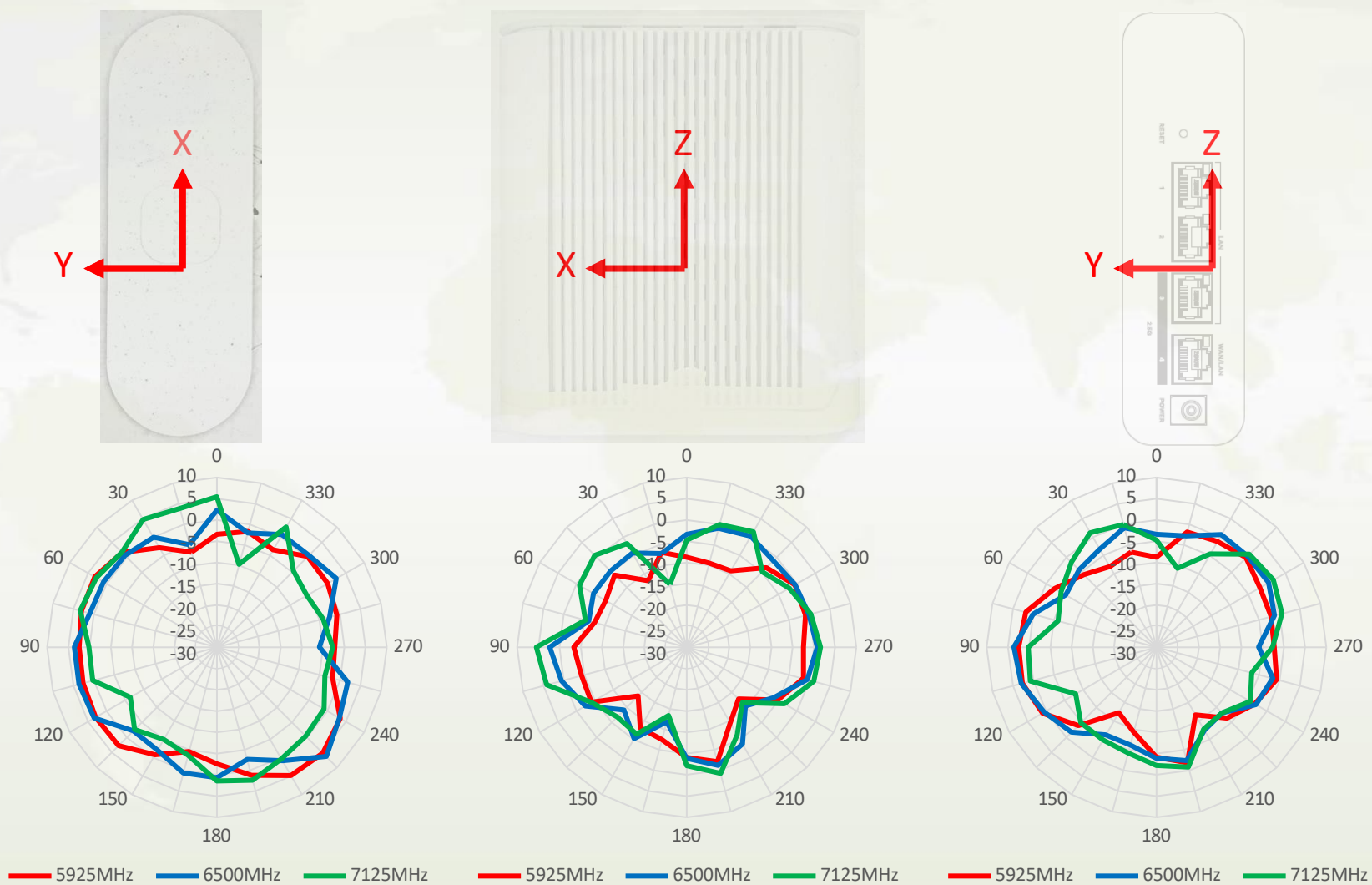
# Realized Gain Pattern of Ant6 in 5GHz Band



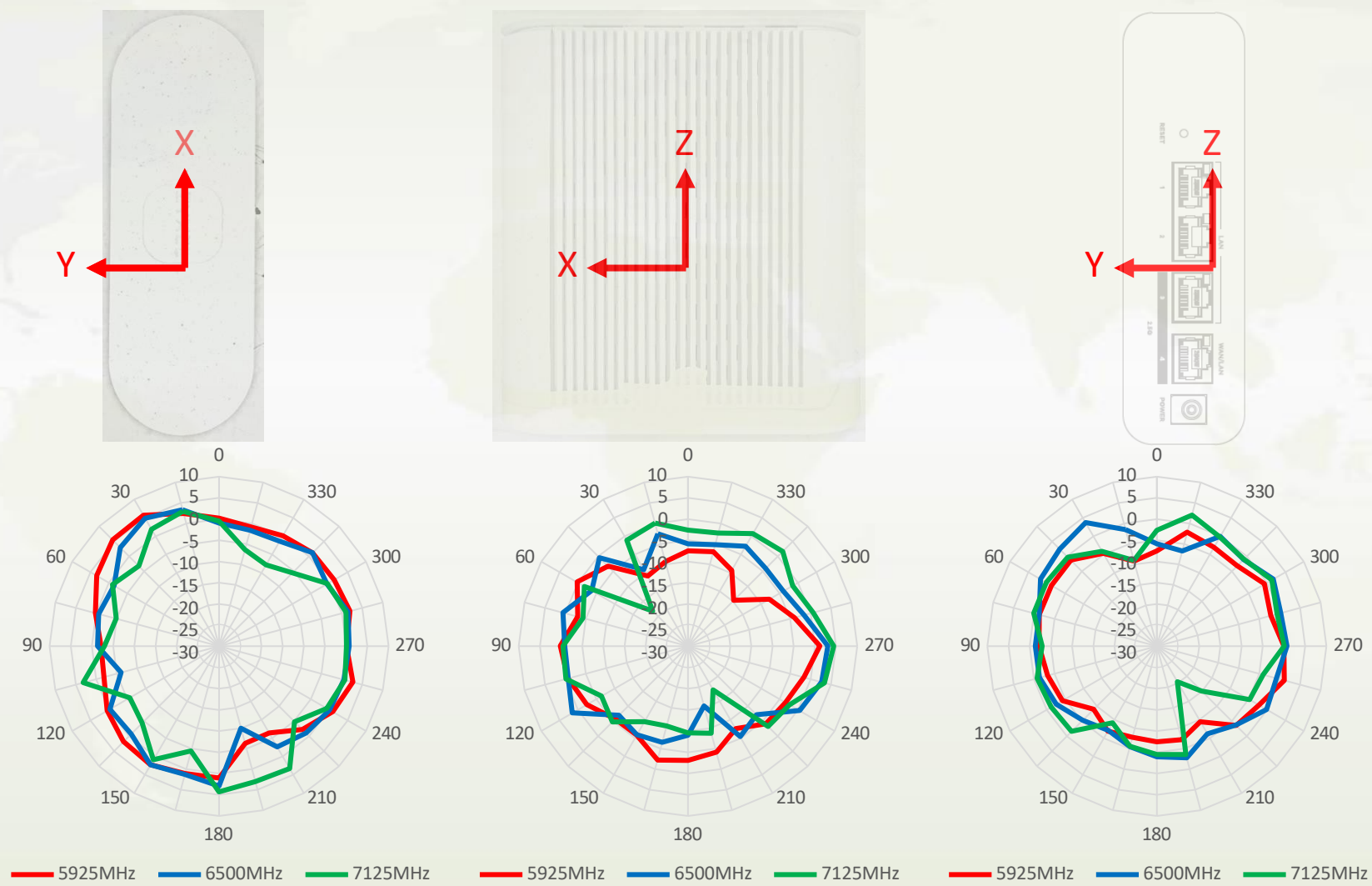
# Realized Gain Pattern of Ant7 in 6GHz Band



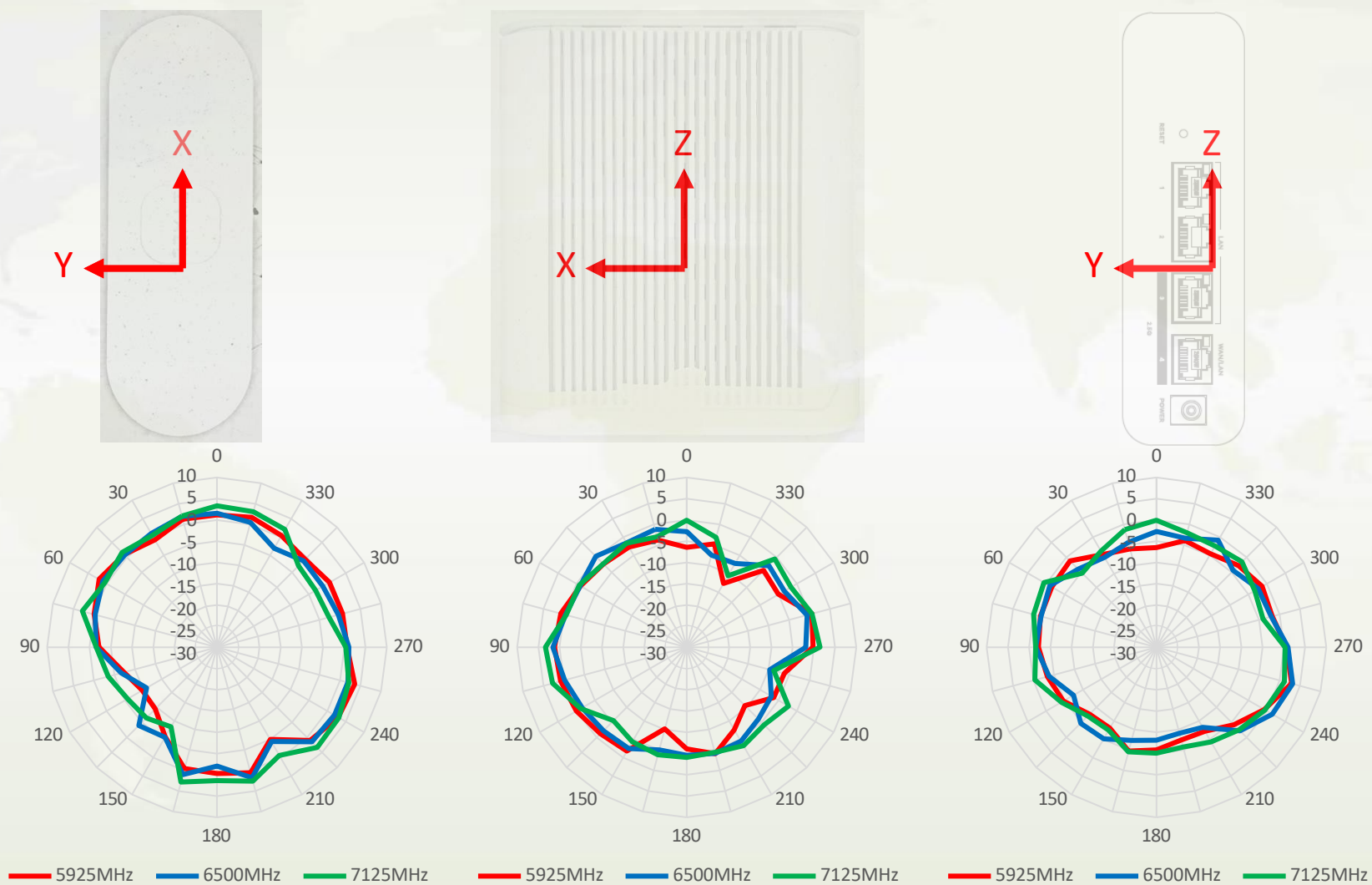
# Realized Gain Pattern of Ant8 in 6GHz Band



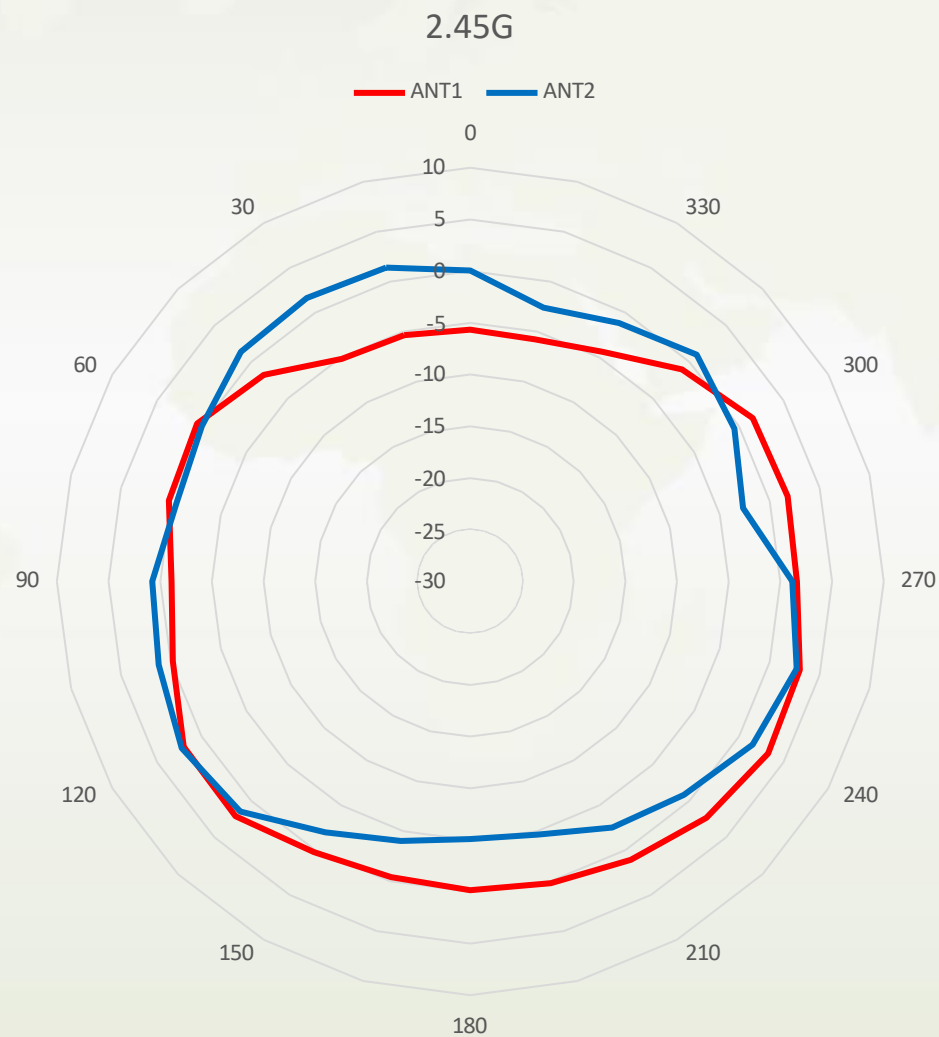
# Realized Gain Pattern of Ant9 in 6GHz Band



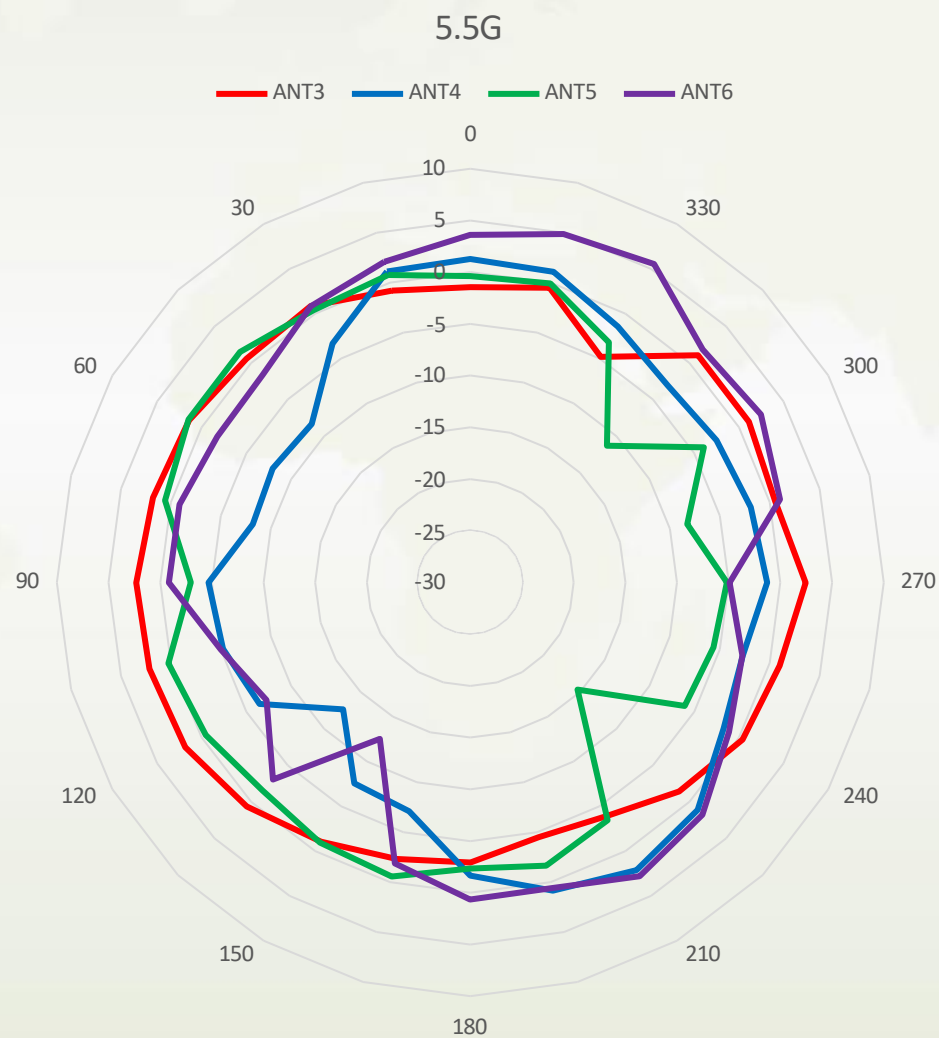
# Realized Gain Pattern of Ant10 in 6GHz Band



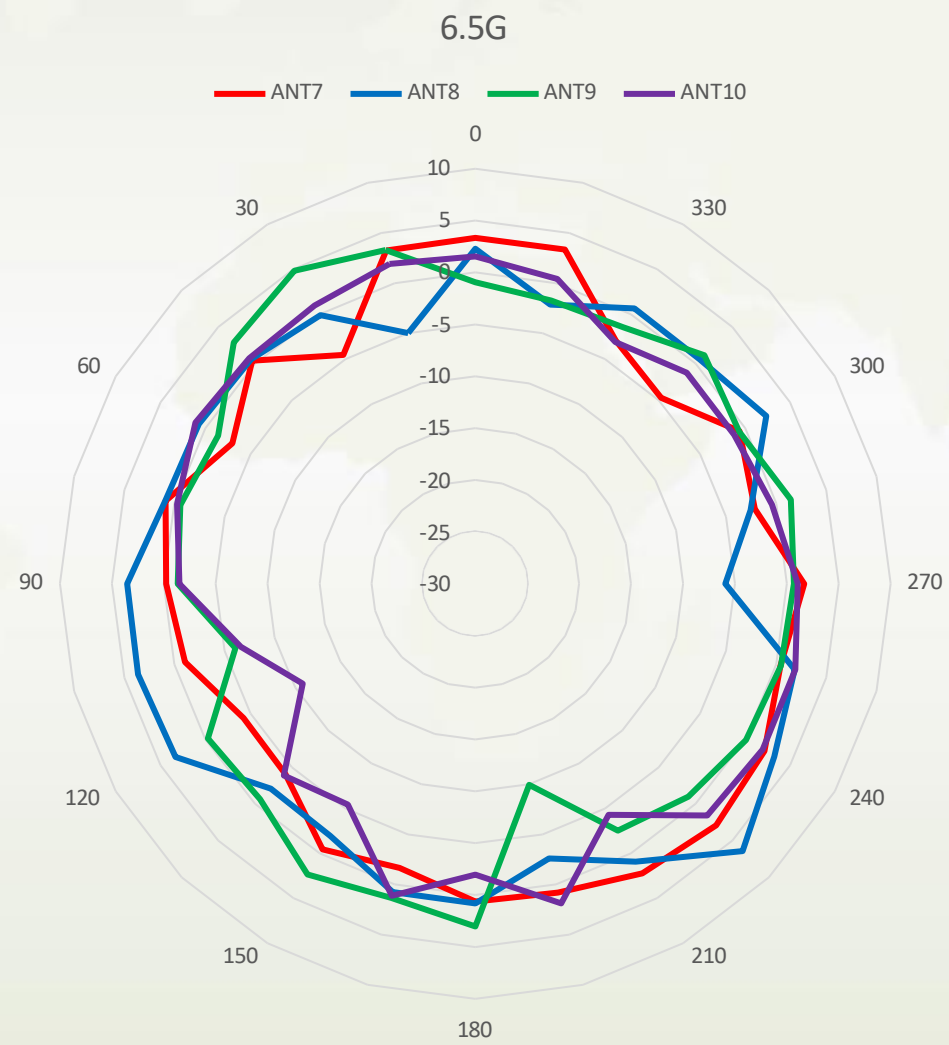
# Realized Gain Pattern of Ant1~2 in 2.45GHz Band



# Realized Gain Pattern of Ant3~6 in 5.5GHz Band



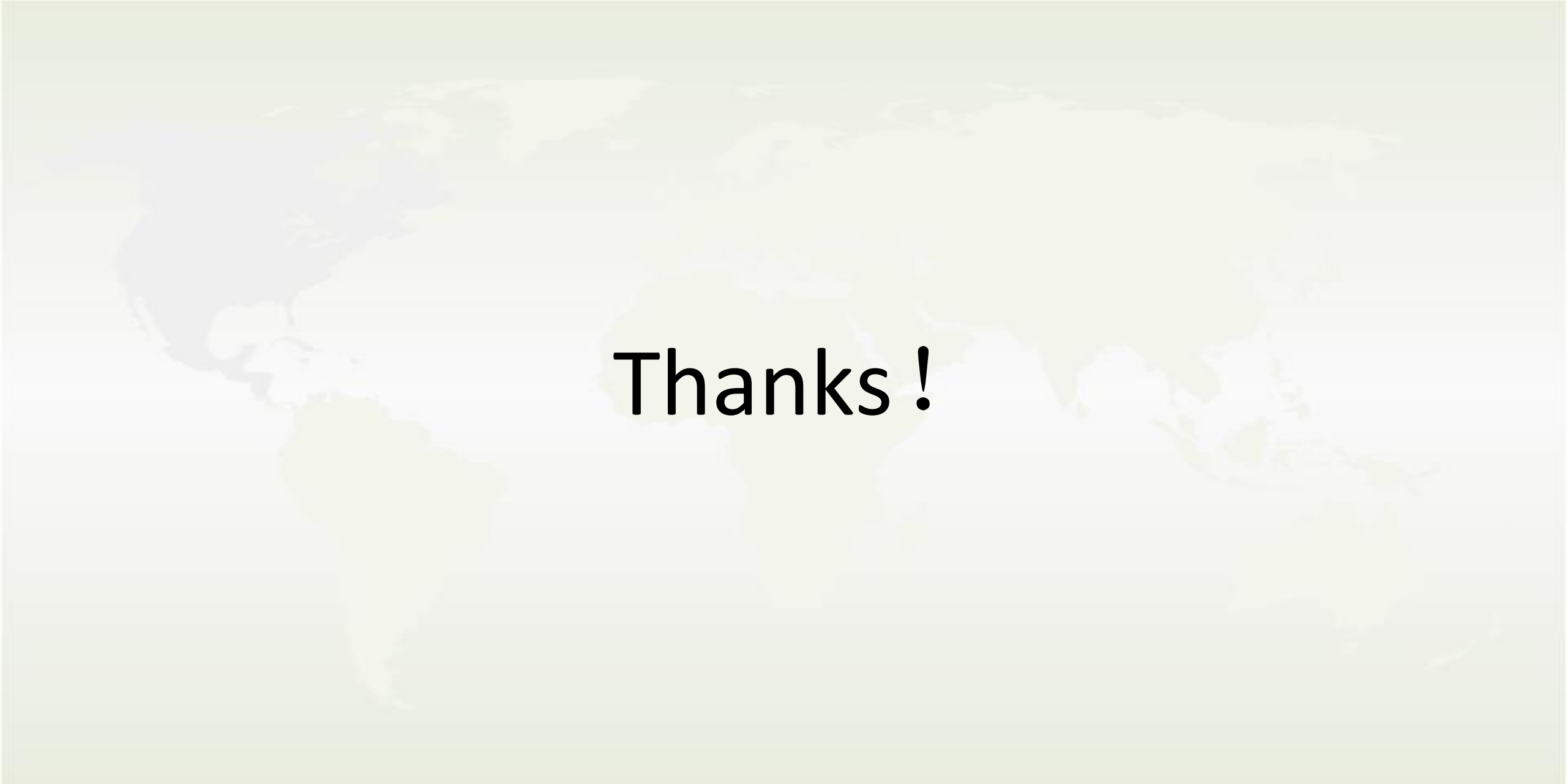
# Realized Gain Pattern of Ant7~10 in 6.5GHz Band



# Conclusion

- Measurement results of antenna for EE4410-00 Project were presented.
- Antenna exhibits
  - Return Loss
    - > 10 dB for all antennas.
  - Isolations
    - > 20 dB for GPS - 2/5/6G bands.
    - > 20 dB for 2G - 2/5/6G bands.
    - > 20 dB for 5G - 5G, 6G - 6G bands
    - > 25 dB for 5G - 6G bands.
  - Efficiency
    - > 65% for all antennas.





Thanks !

