



JUNIPER AP66D ANTENNA REPORT

Brand: Juniper

Model: AP66D

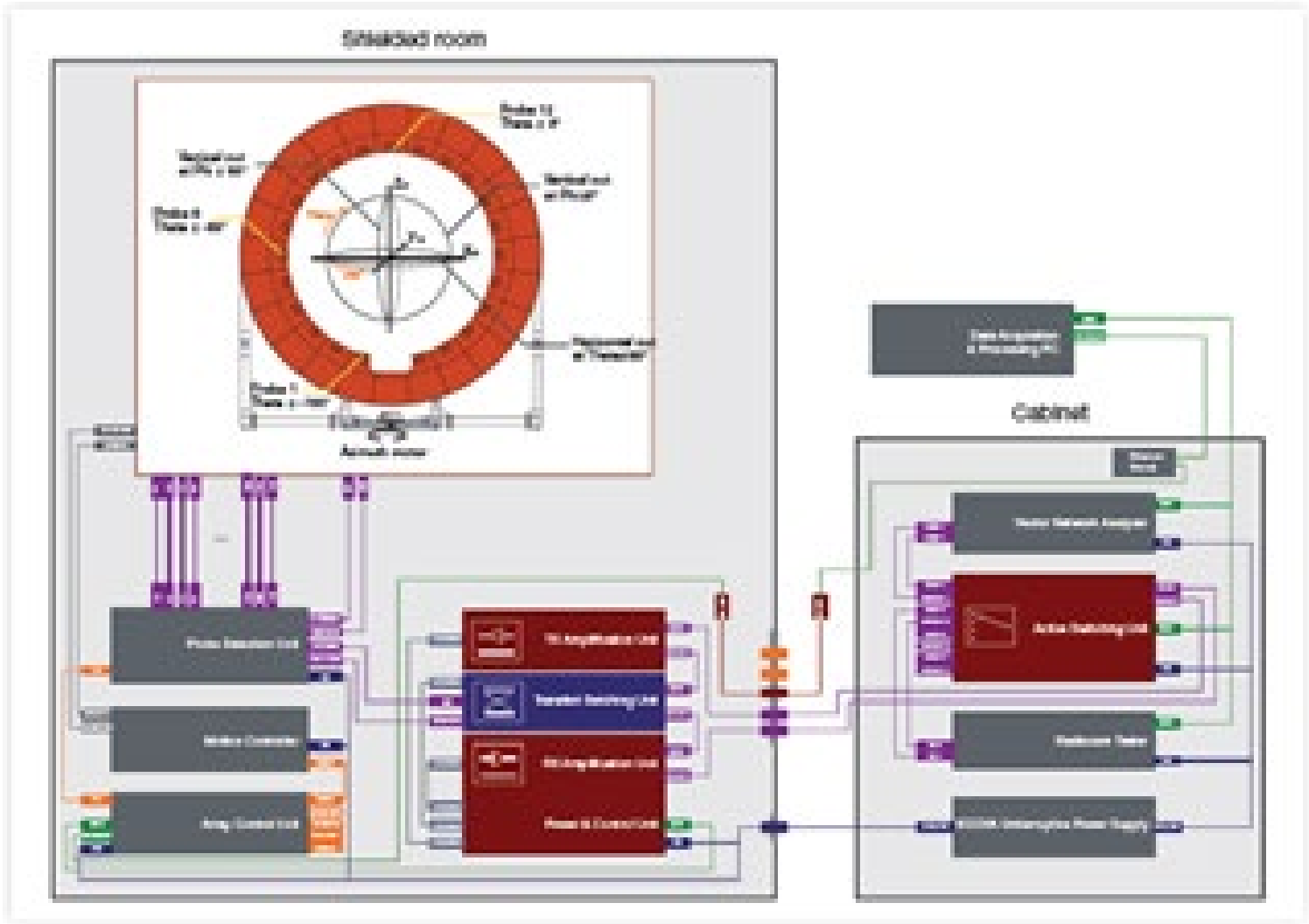
By Juniper Networks, 1133 Innovation Way, Sunnyvale, CA 94089, USA

Contents

- Chamber Information ... P3
- AUT Setup ... P4
- Measurement System: MVG SATIMO SG24-L ... P7
- Antenna Placement and Type...P8
- Antennas Peak Gain Table ... P9
- OTH – Facing Up/ Ceiling/ Wall Mount ... P13
- Directional Antennas XZ Cut & YZ Cut Report ... P22
- Omni Antennas XZ Cut & YZ Cut Report ... P34
- Appendix – Antennas Peak Gain Raw Data

Chamber Information

- Test Date : 20250801
- Test Engineer : Allan Lin
- Measurement System : SATIMO SG24-L
- Software Name : Wave Studio
- Software Version : 22.5.6

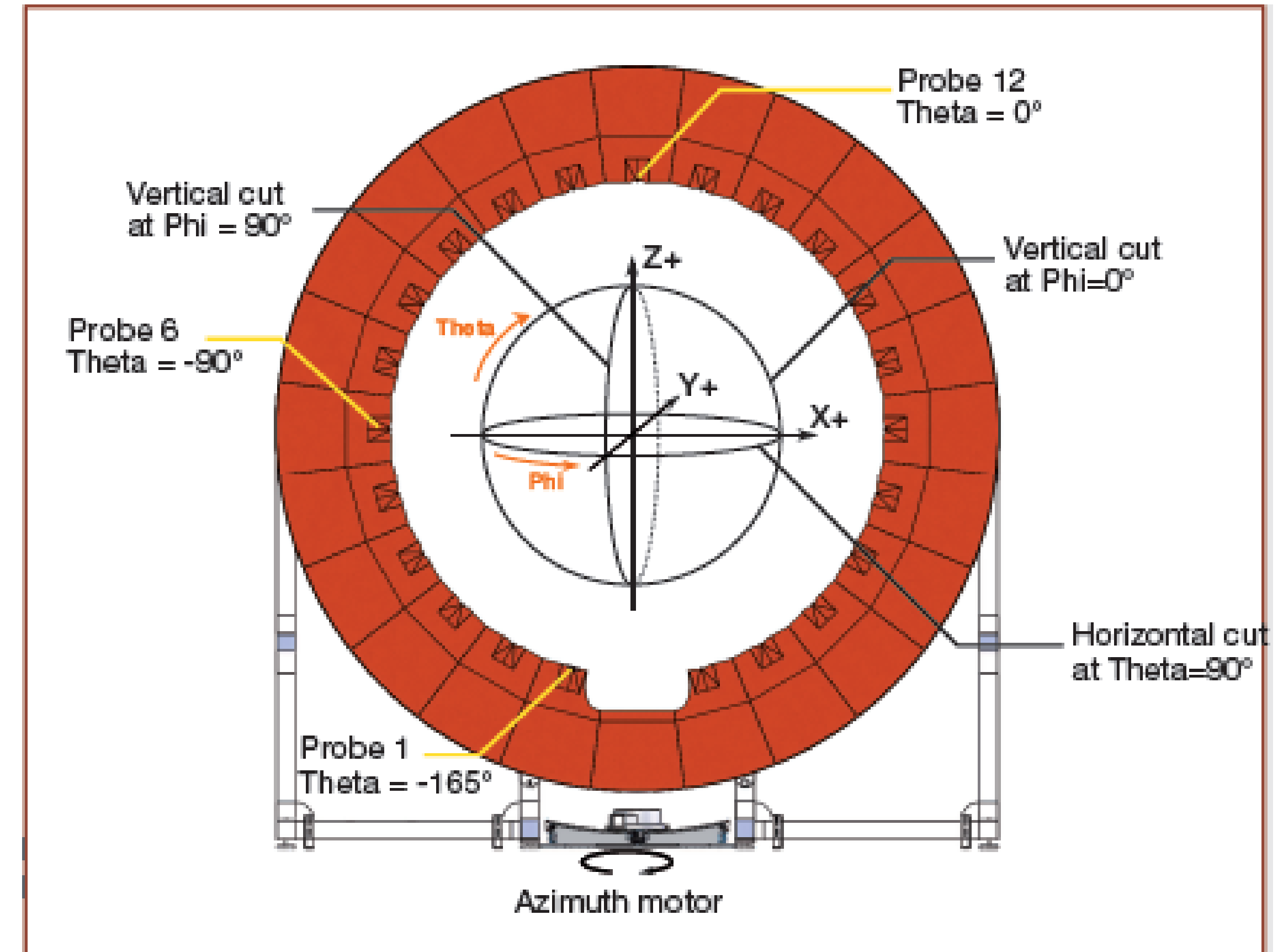


Setup Pictures



Test Procedure

1. Place the device to be tested on the fixture and align it with the center of the chamber.
2. Connect the antenna cable to the RF connector of the chamber.
3. Use the SW to configure parameters (antenna name, frequency points, measurement angles, antenna dimension), and then run the test SW (wave studio).
4. By phi from 0° to 360° and theta from 0° to 180° with a step size of 3 degrees, get the 3D data, including efficiency, peak gain, 2D and 3D radiation patterns.
5. This is far field test for antenna verification.
6. This is passive measurement, which means the device is off and not in any operating mode.



Measurement System : MVG SATIMO SG24-L

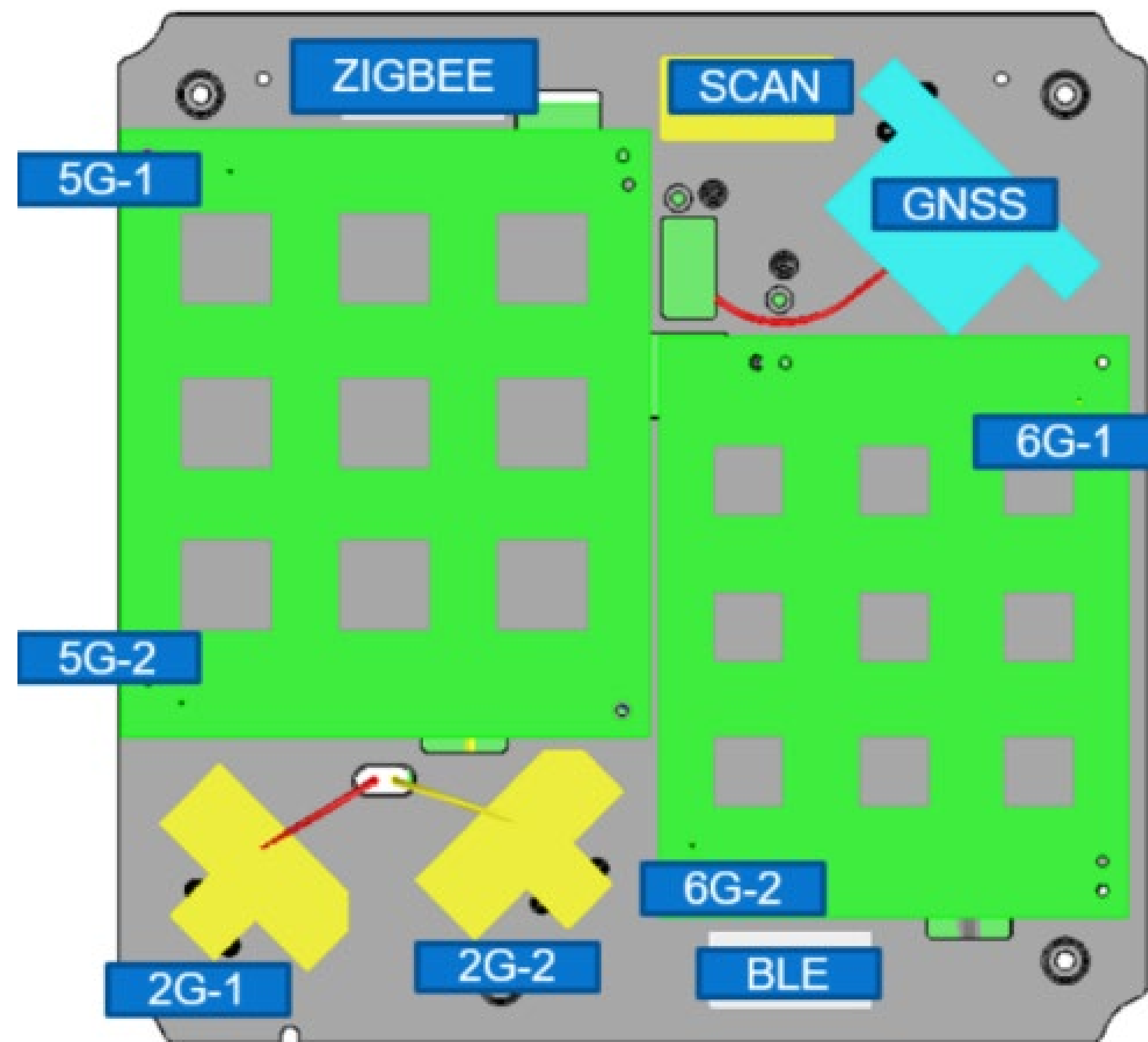
- Antenna Measurement Standard follows KDB 662911 D03
- Traceability: MVG lab in Atlanta is qualified by ISO17025. The certificate no. is 2246.02
- Testing Method is defined by IEEE 149 & IEEE 1720
- Formulas & Calculations:

Please see below. It is the formula we use to calculate the gain.

In the below equation – AUT is antenna under test. G_{GS} is the gain of the reference antenna. They are using to perform the calibration. P_{AUT} is the power received from the AUT and P_{GS} is the power received by the reference antenna. The power received by the reference antenna is stored in the gain.cal file. They use when they are measuring the AUT.

$$G_{AUT \text{ dB}} = G_{GS \text{ dB}} + 10 \cdot \log_{10} \left(\frac{P_{AUT}}{P_{GS}} \right).$$

Antenna Placement and Type



Antenna Plate: 196x196mm

Radio	Antenna Type
2G	PIFA
5G	Dipole
6G	Dipole
Scanning	PIFA
Zigbee	PIFA
BLE	PIFA
GPS	PIFA

Peak Gain Table_Directional Antenna

Unit: dBi

WiFi 2.4GHz

Freq.(MHz)	2400	2450	2500
2G1_Total	5.0	6.0	6.9
2G2_Total	4.9	5.6	6.2
Composite(Total)	7.9	8.5	9.4
2G1_Theta	4.3	5.4	6.3
2G2_Theta	4.8	5.6	6.1
Composite(Theta)	5.1	5.9	6.6
2G1_Phi	4.7	5.8	6.8
2G2_Phi	4.5	5.0	5.1
Composite(Phi)	5.1	6.1	7.1

Peak Gain Table_Directional Antenna

Unit: dBi

WiFi 5GHz Antenna_90x90 State

Freq.(MHz)	5150	5350	5550	5750	5850
5G1_Total	4.0	2.8	3.3	4.2	3.6
5G2_Total	3.2	3.6	4.7	3.6	3.3
Composite(Total)	6.3	5.8	6.8	6.3	6.5
5G1_Theta	1.0	1.2	1.5	1.9	1.3
5G2_Theta	0.7	2.3	2.1	1.4	1.9
Composite(Theta)	2.8	3.5	3.8	4.0	3.9
5G1_Phi	1.6	-0.2	0.5	1.5	2.3
5G2_Phi	0.2	0	1.2	0.4	0.8
Composite(Phi)	3.6	2.9	3.2	3.4	3.8

WiFi 5GHz Antenna_90x30 State

Freq.(MHz)	5150	5350	5550	5750	5850
5G1_Total	6.2	6.6	6.7	6.2	5.6
5G2_Total	6.6	6.5	6.5	6.4	6.3
Composite(Total)	9.4	9.5	9.6	9.3	8.9
5G1_Theta	4.2	4.0	3.5	3.1	3.0
5G2_Theta	4.0	4.2	3.1	2.7	3.6
Composite(Theta)	7.1	7.1	6.3	5.9	6.2
5G1_Phi	2.5	2.4	3.2	3.1	2.8
5G1_Phi	2.4	3.1	3.8	3.8	3.4
Composite(Phi)	5.5	5.8	6.5	6.4	6.0

WiFi 5GHz Antenna_30x30 State

Freq.(MHz)	5150	5350	5550	5750	5850
5G1_Total	9.2	9.3	9.5	10.0	9.5
5G2_Total	9.8	9.4	10.0	9.7	9.6
Composite(Total)	12.5	12.3	12.7	12.8	12.5
5G1_Theta	5.3	6.1	6.3	7.2	6.8
5G2_Theta	6.0	6.5	6.9	6.6	6.7
Composite(Theta)	8.6	9.3	9.6	9.8	9.7
5G1_Phi	6.0	6.0	6.2	6.8	6.2
5G1_Phi	6.1	6.1	6.6	6.9	6.6
Composite(Phi)	9.1	9.1	9.4	9.8	9.4

Peak Gain Table_Directional Antenna

Unit: dBi

WiFi 6GHz Antenna_90x90 State

Freq.(MHz)	5945	6145	6345	6445	6545	6745	6945	7125
6G1_Total	3.9	4.0	5.6	4.4	4.6	5.1	4.5	4.3
6G2_Total	5.8	5.3	7.0	7.4	7.5	6.5	5.7	6.0
Composite(Total)	7.6	6.7	8.4	8.1	8.4	8.1	7.3	7.6
6G1_Theta	0.6	0.8	2.2	2.2	1.7	2.4	0.9	1.4
6G2_Theta	2.6	3.4	4.4	5.4	4.9	4.6	4.1	3.8
Composite(Theta)	4.0	4.1	4.3	4.8	5.2	5.2	4.2	4.5
6G1_Phi	1.5	0.3	1.4	0.7	2.3	3.5	2.5	2.6
6G1_Phi	4.0	2.1	1.9	2.1	2.0	2.4	2.5	2.5
Composite(Phi)	5.2	4.2	4.4	4.1	4.6	4.7	4.0	3.9

WiFi 6GHz Antenna_90x30 State

Freq.(MHz)	5945	6145	6345	6445	6545	6745	6945	7125
6G1_Total	6.7	6.5	7.3	7.6	7.3	6.7	7.2	5.6
6G2_Total	6.7	5.8	6.9	7.4	7.6	6.7	6.6	4.9
Composite(Total)	9.6	9.1	10.1	10.2	10.2	9.7	9.7	7.9
6G1_Theta	4.1	2.8	4.6	4.4	4.8	3.7	4.0	2.8
6G2_Theta	3.8	2.7	3.6	4.4	4.6	4.1	3.2	2.6
Composite(Theta)	6.8	5.5	6.5	7.0	7.3	6.5	6.4	4.7
6G1_Phi	2.8	2.5	3.0	3.6	3.3	3.6	3.4	3.1
6G1_Phi	3.9	3.2	3.9	4.3	4.0	4.2	2.6	2.8
Composite(Phi)	6.3	5.9	6.3	6.7	6.4	6.9	5.9	5.4

WiFi 6GHz Antenna_30x30 State

Freq.(MHz)	5945	6145	6345	6445	6545	6745	6945	7125
6G1_Total	8.7	9.6	10.2	10.1	10.0	10.1	9.1	8.3
6G2_Total	9.2	8.2	9.6	10.0	10.3	10.0	9.3	8.8
Composite(Total)	11.9	11.9	12.9	13.0	13.1	13.0	12.2	11.5
6G1_Theta	5.5	6.0	7.1	6.7	6.9	6.6	6.0	5.1
6G2_Theta	5.6	4.4	6.3	6.8	7.7	7.0	6.7	5.2
Composite(Theta)	8.5	8.2	9.7	9.7	10.3	9.8	9.4	8.1
6G1_Phi	5.8	6.4	6.3	6.0	6.2	6.4	5.2	4.5
6G1_Phi	7.2	5.9	6.3	6.8	6.8	6.5	5.8	5.4
Composite(Phi)	9.5	9.1	9.2	9.4	9.5	9.4	8.5	7.8

Peak Gain Table_Omni Directional Antenna

Unit: dBi

BLE

Freq.(MHz)	2400	2450	2500
BLE_Total	3.7	3.4	3.0
BLE_Theta	2.9	2.9	2.4
BLE_Phi	1.1	0.3	1.0

Zigbee

Freq.(MHz)	2400	2450	2500
Zigbee_Total	3.9	3.4	4.1
Zigbee_Theta	2.3	1.7	3.0
Zigbee_Phi	3.2	2.7	3.4

GNSS

Freq.(MHz)	L5	L1
GNSS	1.1	2.5

Scanning

Freq.(MHz)	2400	2450	2500	5150	5350	5550	5750	5850	5945	6145	6345	6445	6545	6745	6945	7125
Scanning_Total	3.4	3.4	4.0	3.2	4.0	4.9	4.6	5.4	3.8	4.1	5.2	4.4	5.1	4.7	4.5	4.4
Scanning_Theta	2.1	1.7	3.0	3.2	3.6	4.7	4.3	5.0	2.7	3.9	4.6	4.2	5.1	4.5	4.5	4.4
Scanning_Phi	1.2	1.9	3.1	1.8	0.8	1.1	0.8	0.4	-1.2	0.3	2.0	1.1	1.3	2.6	1.8	0.8

OTH_ WiFi 5GHz_Facing up

Unit: dBi

WiFi 5GHz Antenna_90x90 State

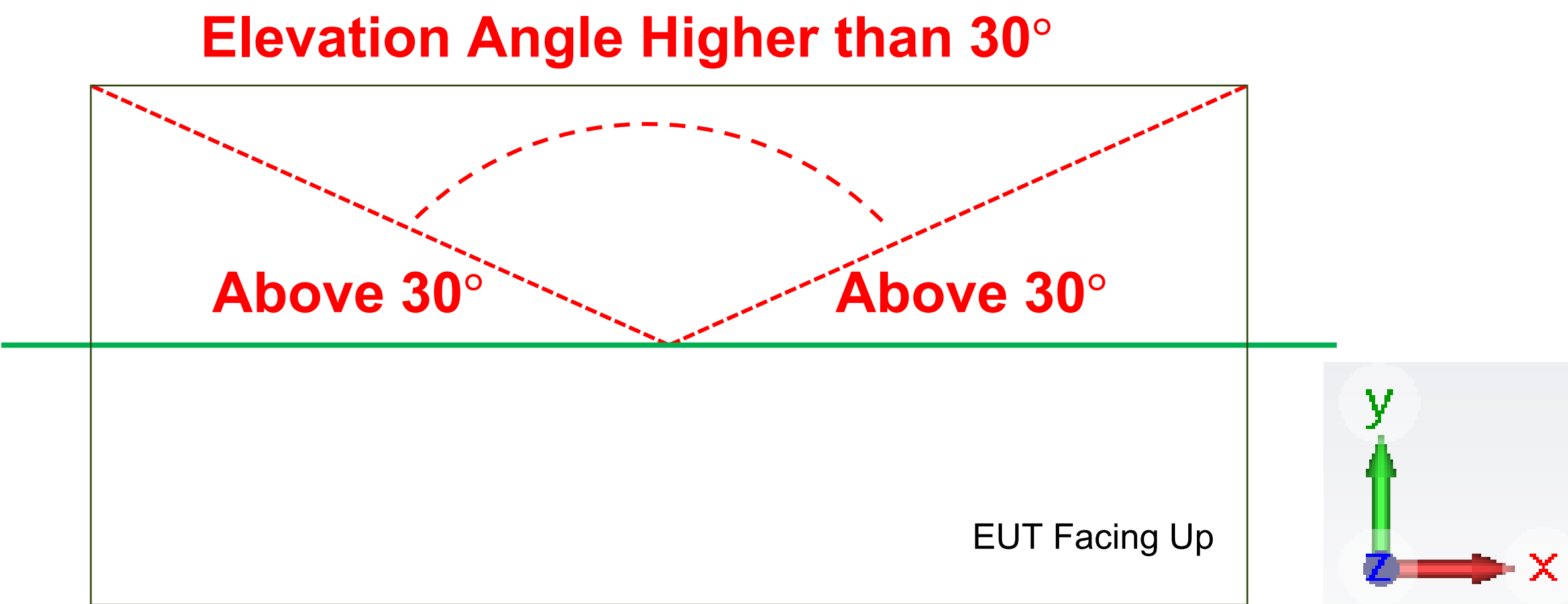
	Freq.(MHz)	5150	5250
Gain(Total)	5G1	4.0	2.8
	5G2	3.2	3.3
	Composite	6.3	5.4
Gain(Theta)	5G1	1.0	-0.1
	5G2	0.7	1.2
	Composite	2.8	2.3
Gain(Phi)	5G1	1.6	0.4
	5G2	0.2	0.6
	Composite	3.6	3.1

WiFi 5GHz Antenna_90x30 State

	Freq.(MHz)	5150	5250
Gain(Total)	5G1	6.2	6.5
	5G2	6.6	6.6
	Composite	9.4	9.5
Gain(Theta)	5G1	4.2	2.9
	5G2	4.0	3.1
	Composite	7.1	6.0
Gain(Phi)	5G1	2.5	2.7
	5G2	2.4	3.0
	Composite	5.5	5.9

WiFi 5GHz Antenna_30x30 State

	Freq.(MHz)	5150	5250
Gain(Total)	5G1	9.2	9.0
	5G2	9.8	9.5
	Composite	12.5	12.2
Gain(Theta)	5G1	5.3	5.3
	5G2	6.0	6.6
	Composite	8.6	8.9
Gain(Phi)	5G1	6.0	5.3
	5G2	6.1	5.7
	Composite	9.1	8.5



OTH_ WiFi 6GHz_Facing up

Unit: dBi

WiFi 6GHz Antenna_90x90 State

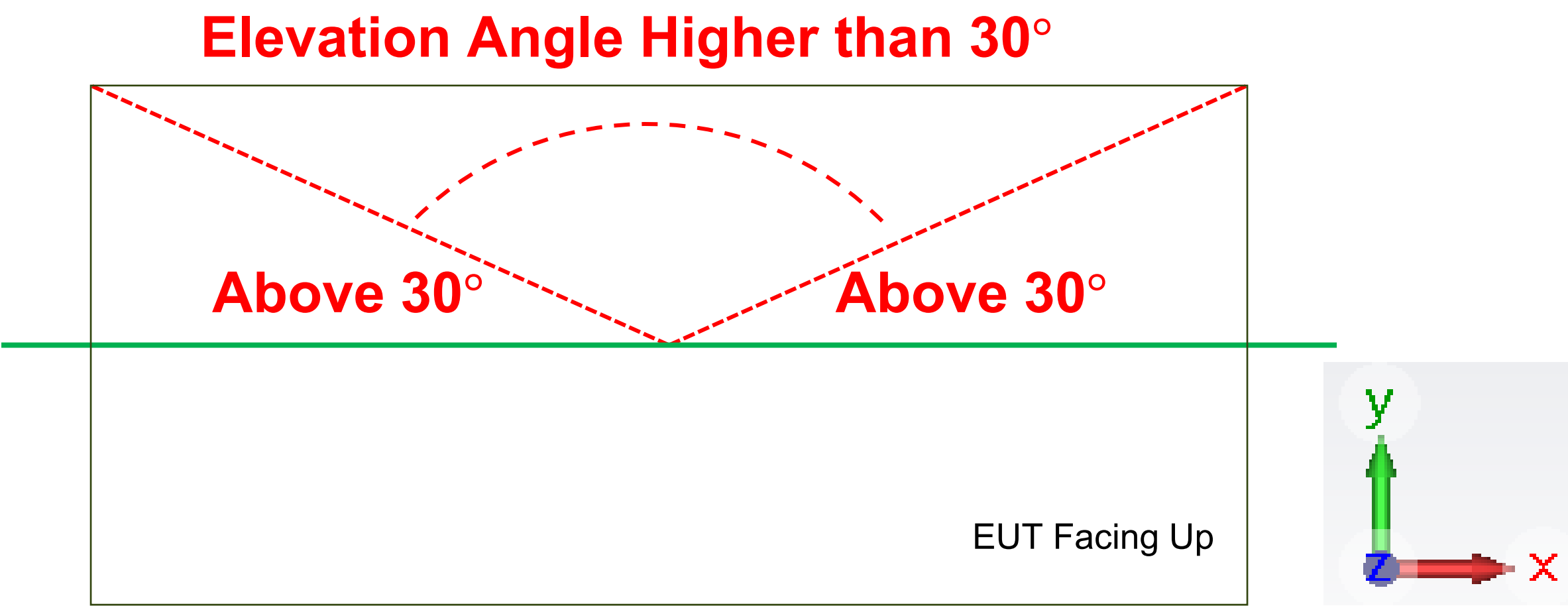
	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	3.9	4.0	5.6	4.4	4.6	5.1	4.8
	6G2	5.8	5.3	7.0	7.4	7.5	6.5	6.5
	Composite	7.6	6.7	8.4	8.1	8.4	8.1	7.3
Gain (Theta)	6G1	0.6	0.8	2.2	2.2	1.7	2.4	1.4
	6G2	2.6	3.4	4.4	5.4	4.9	4.6	2.9
	Composite	4.0	4.1	4.3	4.8	5.2	5.2	4.3
Gain (Phi)	6G1	1.5	0.3	1.4	0.7	2.3	3.5	2.7
	6G2	4.0	2.1	1.9	2.1	2.0	2.4	3.3
	Composite	5.2	4.2	4.4	4.1	4.6	4.7	4.1

WiFi 6GHz Antenna_90x30 State

	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	6.7	6.5	7.3	7.6	7.3	6.7	6.8
	6G2	6.7	5.8	6.9	7.4	7.6	6.7	6.8
	Composite	9.6	9.1	10.1	10.2	10.2	9.7	9.7
Gain (Theta)	6G1	4.1	2.8	4.6	4.4	4.8	3.7	3.4
	6G2	3.8	2.7	3.6	4.4	4.6	4.1	3.4
	Composite	6.8	5.5	6.5	7.0	7.3	6.5	6.4
Gain (Phi)	6G1	2.8	2.5	3.0	3.6	3.3	3.6	3.3
	6G2	3.9	3.2	3.9	4.3	4.0	4.2	3.1
	Composite	6.3	5.9	6.3	6.7	6.4	6.9	6.1

WiFi 6GHz Antenna_30x30 State

	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	8.7	9.6	10.2	10.1	10.0	10.1	9.4
	6G2	9.2	8.2	9.6	10.0	10.3	10.0	9.6
	Composite	11.9	11.9	12.9	13.0	13.1	13.0	12.5
Gain (Theta)	6G1	5.5	6.0	7.1	6.7	6.9	6.6	6.0
	6G2	5.6	4.4	6.3	6.8	7.7	7.0	6.7
	Composite	8.5	8.2	9.7	9.7	10.3	9.8	9.3
Gain (Phi)	6G1	5.8	6.4	6.3	6.0	6.2	6.4	5.5
	6G2	7.2	5.9	6.3	6.8	6.8	6.5	6.1
	Composite	9.5	9.1	9.2	9.4	9.5	9.4	8.8

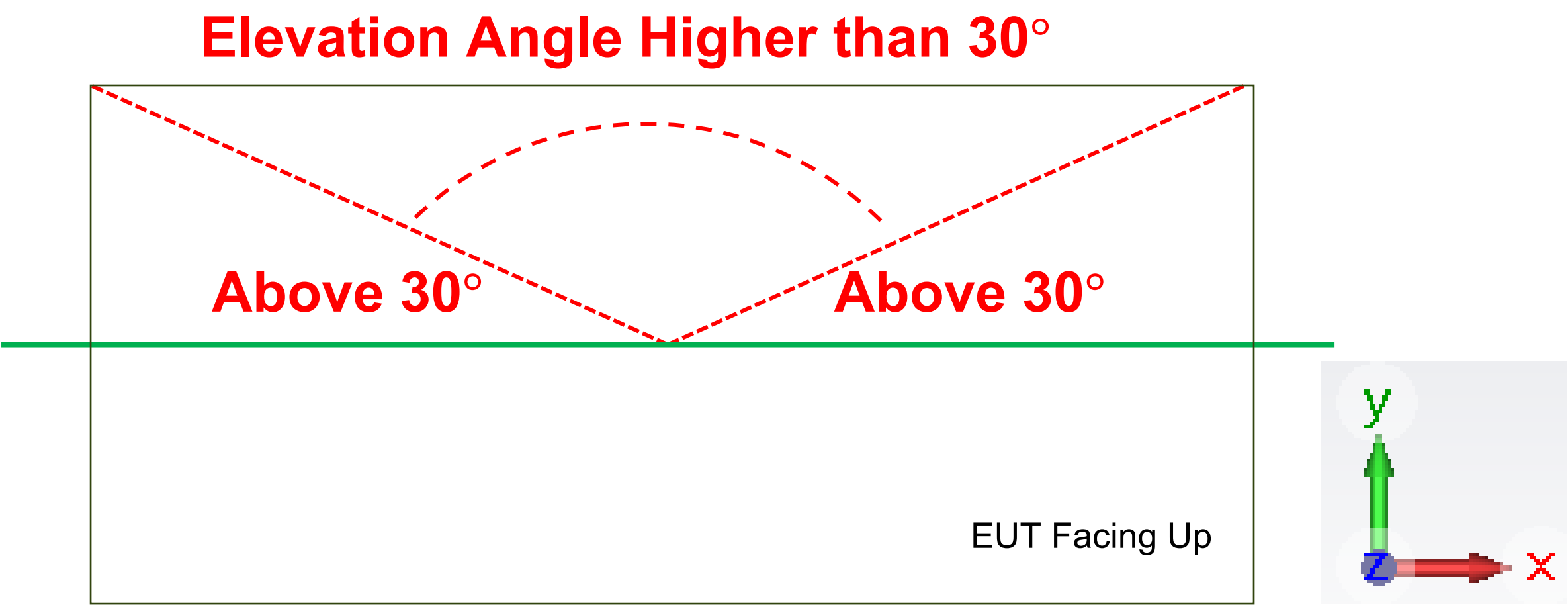


OTH_Scanning_Facing up

Unit: dBi

Scanning

Gain(Total)	Freq.(MHz)	5150	5250	5945	6145	6345	6445	6545	6745	6845
	Scanning	3.0	3.7	3.8	2.7	5.2	4.4	5.1	4.7	4.4
Gain(Theta)	Scanning	2.6	3.6	2.7	1.8	4.6	4.2	5.1	4.5	3.8
Gain(Phi)	Scanning	1.7	2.2	-1.2	0.2	2.0	1.1	1.3	2.6	2.2



OTH_ WiFi 5GHz_Celling

Unit: dBi

WiFi 5GHz Antenna_90x90 State

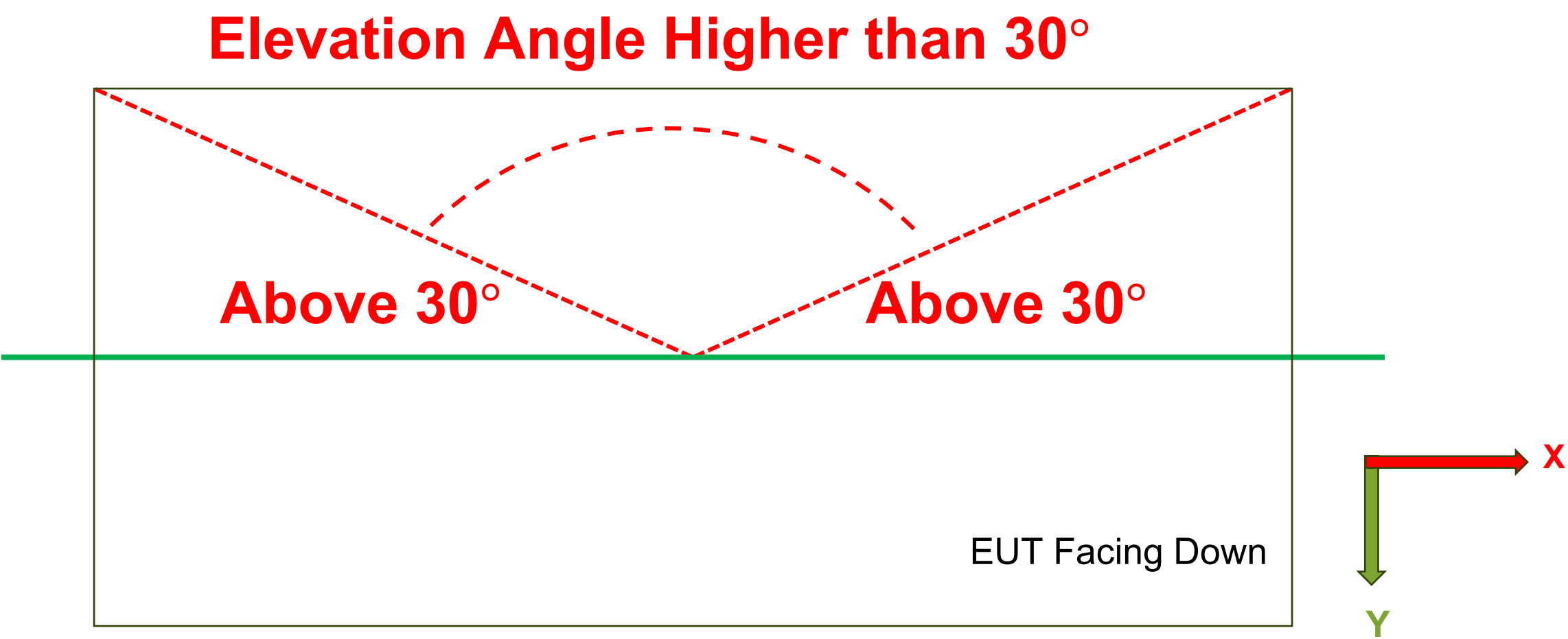
Gain(Total)	Freq.(MHz)	5150	5250
	5G1	-9.8	-11.1
	5G2	-12.3	-11.1
	Composite	-9.0	-9.6
Gain(Theta)	5G1	-13.2	-13.3
	5G2	-16.6	-16.4
	Composite	-12.5	-13.6
Gain(Phi)	5G1	-11.1	-12.0
	5G2	-12.5	-11.5
	Composite	-11.1	-11.4

WiFi 5GHz Antenna_90x30 State

Gain(Total)	Freq.(MHz)	5150	5250
	5G1	-12.8	-13.4
	5G2	-14.2	-14.6
	Composite	-12.4	-12.2
Gain(Theta)	5G1	-16.0	-17.3
	5G2	-21.0	-22.1
	Composite	-16.2	-16.9
Gain(Phi)	5G1	-15.0	-14.3
	5G2	-15.0	-14.3
	Composite	-11.9	-11.3

WiFi 5GHz Antenna_30x30 State

Gain(Total)	Freq.(MHz)	5150	5250
	5G1	-16.6	-17.1
	5G2	-23.0	-20.1
	Composite	-17.5	-17.3
Gain(Theta)	5G1	-17.0	-18.0
	5G2	-23.2	-22.8
	Composite	-18.4	-19.1
Gain(Phi)	5G1	-20.8	-22.0
	5G2	-26.3	-23.3
	Composite	-20.8	-22.6



OTH_ WiFi 6GHz_Celling

Unit: dBi

WiFi 6GHz Antenna_90x90 State

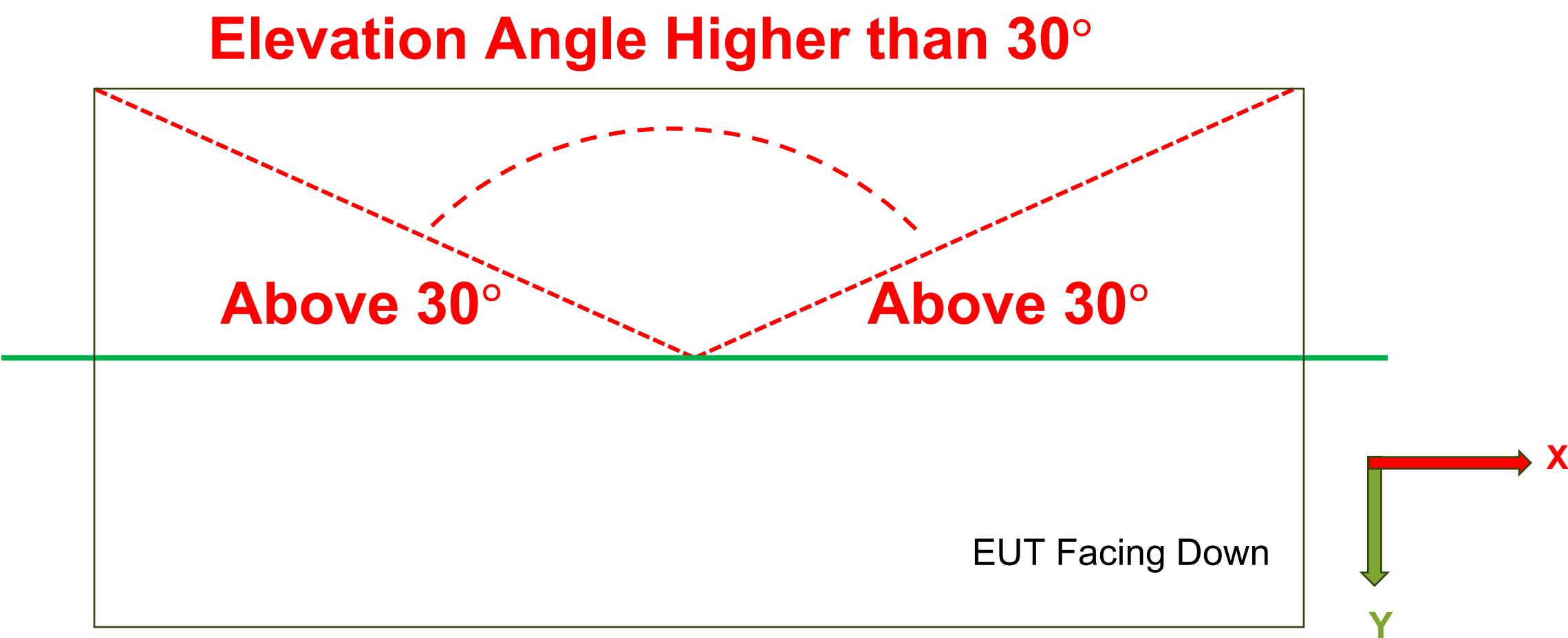
	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	-11.5	-12.8	-13.5	-15.4	-13.3	-13.2	-13.6
	6G2	-13.9	-12.7	-9.5	-12.0	-11.4	-11.9	-12.4
	Composite	-11.5	-11.3	-9.5	-10.7	-11.3	-11.5	-11.0
Gain (Theta)	6G1	-15.9	-17.0	-16.7	-16.7	-14.5	-14.5	-14.4
	6G2	-18.4	-17.1	-15.7	-15.3	-16.3	-15.3	-13.3
	Composite	-15.5	-16.1	-15.0	-14.0	-13.8	-13.8	-14.0
Gain (Phi)	6G1	-11.6	-13.0	-13.9	-16.3	-13.3	-15.2	-16.0
	6G2	-14.3	-12.8	-10.0	-12.2	-12.2	-13.7	-12.8
	Composite	-12.1	-11.6	-10.3	-12.1	-13.1	-12.6	-12.5

WiFi 6GHz Antenna_90x30 State

	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	-15.3	-16.9	-17.0	-16.9	-18.9	-16.3	-14.6
	6G2	-15.1	-16.3	-15.5	-15.8	-14.2	-12.9	-12.4
	Composite	-13.1	-14.4	-14.2	-14.4	-13.6	-11.7	-10.7
Gain (Theta)	6G1	-18.1	-17.8	-18.0	-17.0	-19.4	-18.9	-15.9
	6G2	-18.0	-20.9	-21.0	-17.7	-18.2	-19.5	-17.9
	Composite	-15.2	-17.0	-18.7	-16.9	-16.6	-16.8	-15.3
Gain (Phi)	6G1	-16.5	-21.5	-18.4	-19.0	-19.8	-17.1	-17.0
	6G2	-15.2	-16.6	-16.7	-16.0	-16.4	-13.4	-12.9
	Composite	-14.1	-15.9	-15.4	-15.0	-15.3	-12.4	-12.2

WiFi 6GHz Antenna_30x30 State

	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	-21.9	-19.9	-17.8	-19.9	-15.4	-16.7	-18.0
	6G2	-20.3	-21.1	-21.0	-17.5	-18.4	-18.3	-16.9
	Composite	-18.9	-17.8	-18.0	-17.0	-16.3	-16.2	-15.6
Gain (Theta)	6G1	-23.2	-21.4	-17.9	-20.2	-15.4	-16.9	-18.1
	6G2	-20.6	-21.7	-21.6	-17.5	-18.4	-19.3	-17.0
	Composite	-20.1	-19.0	-19.3	-17.2	-16.5	-16.4	-16.3
Gain (Phi)	6G1	-23.7	-24.0	-22.2	-23.5	-23.6	-26.9	-23.0
	6G2	-25.3	-24.6	-23.2	-25.4	-25.5	-20.9	-23.3
	Composite	-21.9	-23.4	-22.8	-23.1	-22.8	-21.6	-21.9

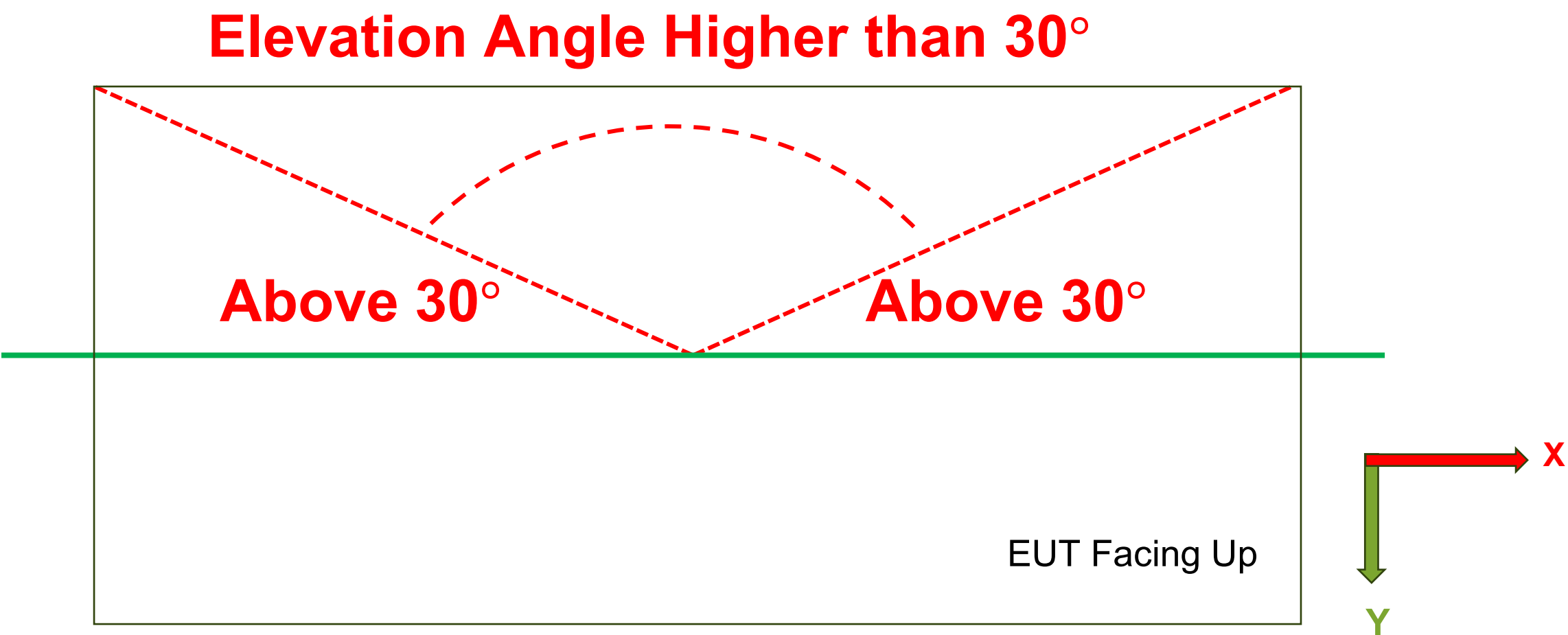


OTH_Scanning_Celling

Unit: dBi

Scanning

Gain(Total)	Freq.(MHz)	5150	5250	5945	6145	6345	6445	6545	6745	6845
	Scanning	-4.2	-5.2	-6.3	-6.2	-4.0	-4.7	-5.4	-4.6	-2.7
Gain(Theta)	Scanning	-6.5	-8.4	-8.1	-5.5	-5.0	-4.1	-5.1	-3.7	-1.9
Gain(Phi)	Scanning	-7.5	-7.0	-8.7	-7.6	-6.3	-7.7	-7.7	-7.5	-8.4



OTH_ WiFi 5GHz_Wall Mount

Unit: dBi

WiFi 5GHz Antenna_90x90 State

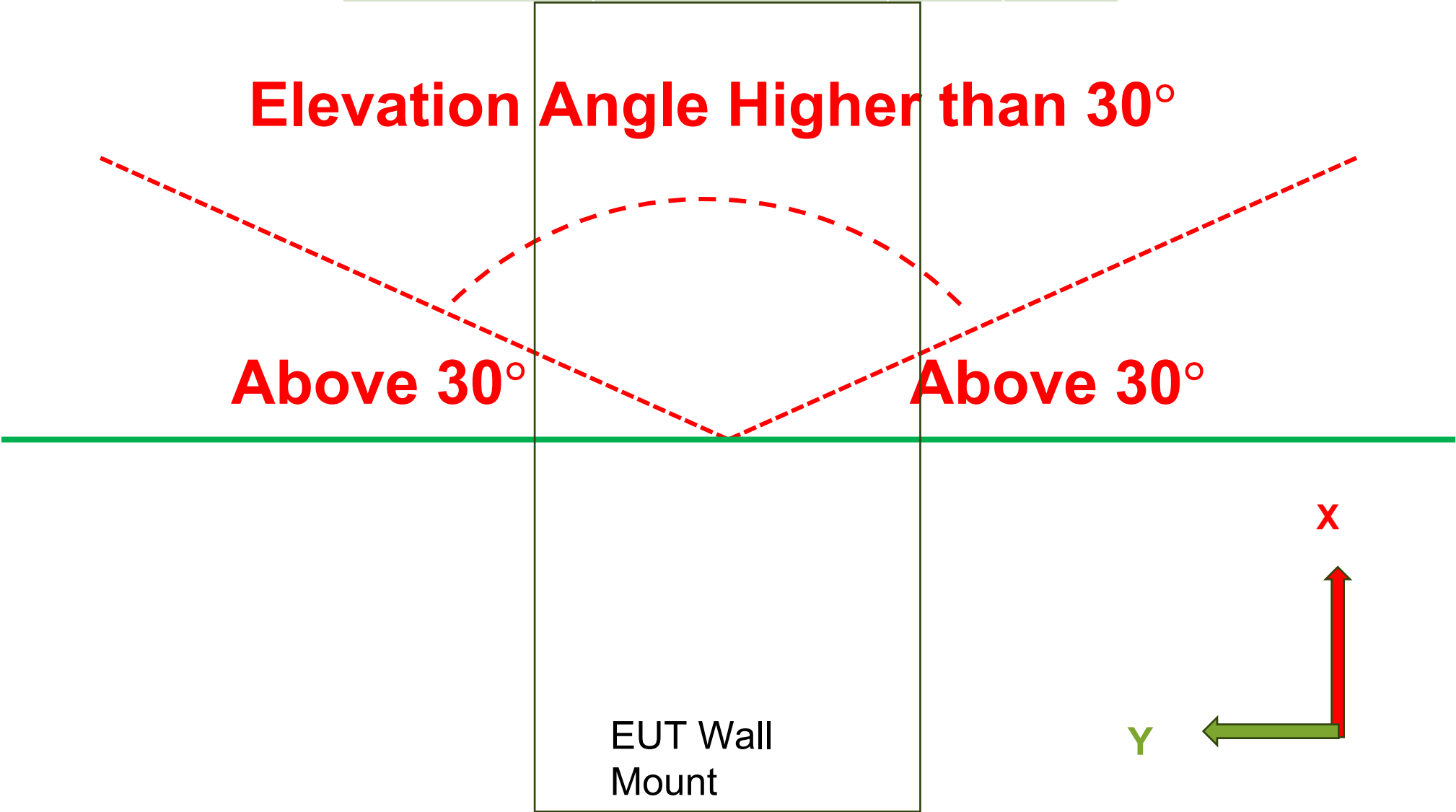
	Freq.(MHz)	5150	5250
Gain(Total)	5G1	1.8	0.8
	5G2	1.5	1.7
	Composite	4.6	3.7
Gain(Theta)	5G1	-0.2	-0.6
	5G2	0.4	1.0
	Composite	2.0	0.8
Gain(Phi)	5G1	-0.3	-2.1
	5G2	-1.6	-0.7
	Composite	0.9	1.2

WiFi 5GHz Antenna_90x30 State

	Freq.(MHz)	5150	5250
Gain(Total)	5G1	-5.6	-4.2
	5G2	-5.1	-3.5
	Composite	-2.8	-1.5
Gain(Theta)	5G1	-5.8	-5.4
	5G2	-7.9	-4.9
	Composite	-5.6	-3.9
Gain(Phi)	5G1	-6.3	-5.5
	5G2	-7.3	-6.9
	Composite	-4.7	-4.5

WiFi 5GHz Antenna_30x30 State

	Freq.(MHz)	5150	5250
Gain(Total)	5G1	-2.2	-0.8
	5G2	-0.6	0.0
	Composite	1.6	2.6
Gain(Theta)	5G1	-6.2	-3.4
	5G2	-3.2	-2.0
	Composite	-1.9	0.1
Gain(Phi)	5G1	-4.0	-3.9
	5G2	-3.9	-4.1
	Composite	-1.0	-1.0



OTH_ WiFi 6GHz_Wall Mount

Unit: dBi

WiFi 6GHz Antenna_90x90 State

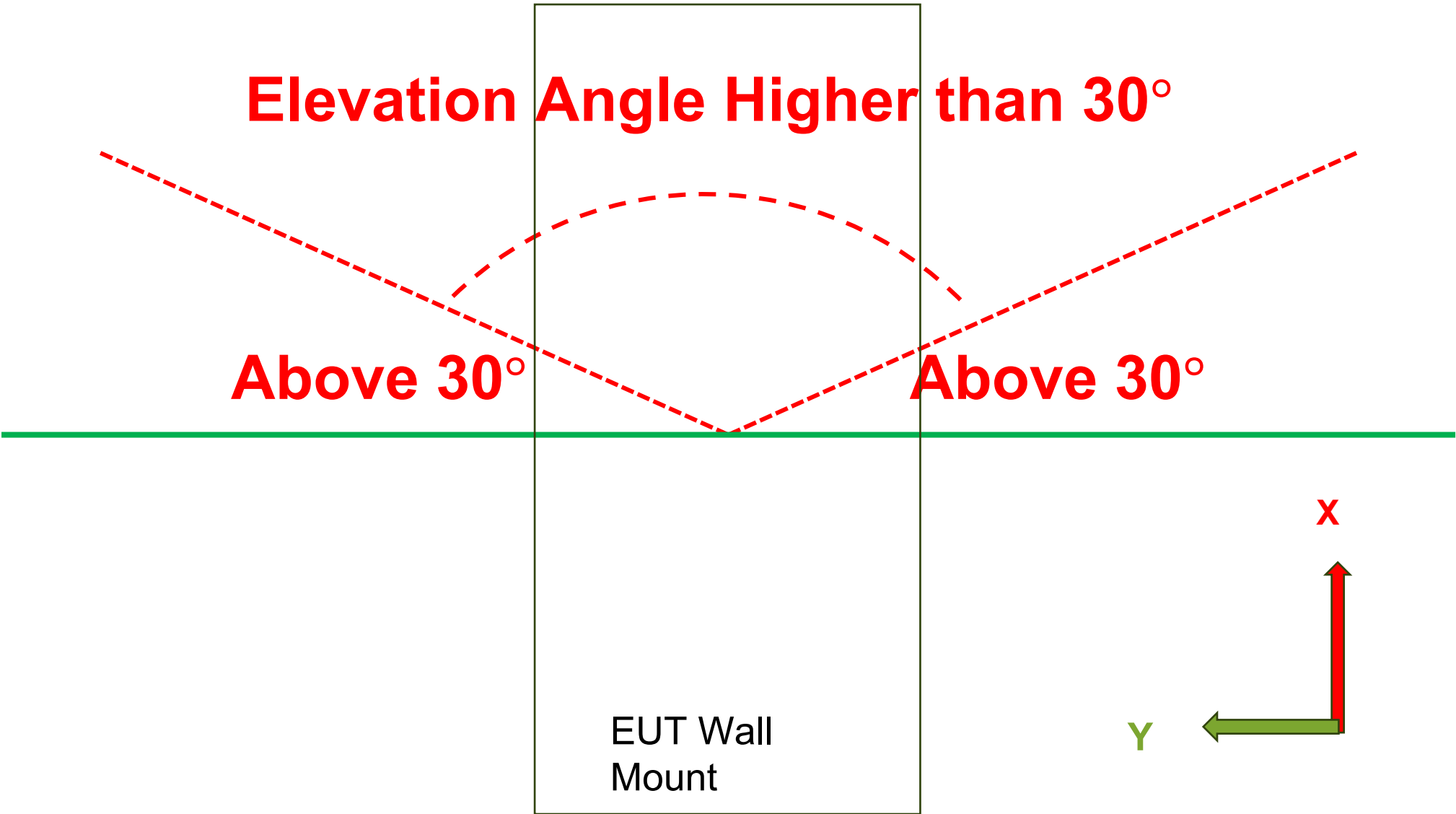
	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	1.8	-0.3	1.9	2.2	2.9	3.2	2.5
	6G2	3.8	4.9	2.9	0.4	1.0	4.4	4.6
	Composite	4.5	5.5	5.0	4.1	4.9	5.9	5.4
Gain (Theta)	6G1	0.6	-2.3	-0.1	0.4	0.6	0.5	0.1
	6G2	5.0	3.5	4.1	3.5	3.6	2.9	3.0
	Composite	0.1	2.7	0.7	-2.7	-2.4	1.6	0.7
Gain (Phi)	6G1	-1.6	-2.2	-1.7	-1.3	-0.4	0.0	-1.1
	6G2	1.9	0.9	-0.7	-2.6	-0.2	1.6	2.5
	Composite	2.4	2.1	1.6	1.1	2.5	3.1	3.1

WiFi 6GHz Antenna_90x30 State

	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	-3.4	-4.4	-2.2	-3.5	-3.1	-4.8	-4.8
	6G2	-1.6	-0.4	-2.3	-4.7	-3.2	-3.7	-7.5
	Composite	0.6	0.9	-0.7	-1.8	-1.1	-1.5	-3.6
Gain (Theta)	6G1	-6.6	-6.8	-7.7	-8.0	-6.9	-7.5	-7.0
	6G2	-5.5	-3.4	-6.6	-9.1	-6.7	-5.9	-11.6
	Composite	-3.6	-2.2	-4.1	-7.1	-3.9	-3.7	-6.1
Gain (Phi)	6G1	-5.5	-5.8	-3.4	-4.8	-4.8	-7.8	-8.5
	6G2	-3.4	-2.5	-4.1	-5.4	-5.6	-7.1	-9.3
	Composite	-1.4	-1.8	-3.2	-3.5	-2.9	-4.4	-6.8

WiFi 6GHz Antenna_30x30 State

	Freq.(MHz)	5945	6145	6345	6445	6545	6745	6845
Gain (Total)	6G1	-0.1	-1.1	-3.0	-3.7	-3.0	-2.9	-3.2
	6G2	0.8	1.5	-0.7	0.5	1.2	-1.6	-0.5
	Composite	3.4	3.3	1.1	1.6	2.2	0.8	1.2
Gain (Theta)	6G1	-2.8	-4.1	-6.3	-7.4	-6.2	-5.2	-6.1
	6G2	-2.3	-0.7	-5.2	-3.3	-2.2	-5.1	-2.4
	Composite	0.5	0.8	-2.8	-2.1	-1.0	-2.2	-1.1
Gain (Phi)	6G1	-3.2	-3.5	-5.2	-5.8	-5.6	-5.6	-5.8
	6G2	-2.0	-2.4	-2.7	-1.8	-1.4	-4.0	-5.0
	Composite	0.2	-0.1	-1.0	-0.7	-0.7	-2.0	-2.4

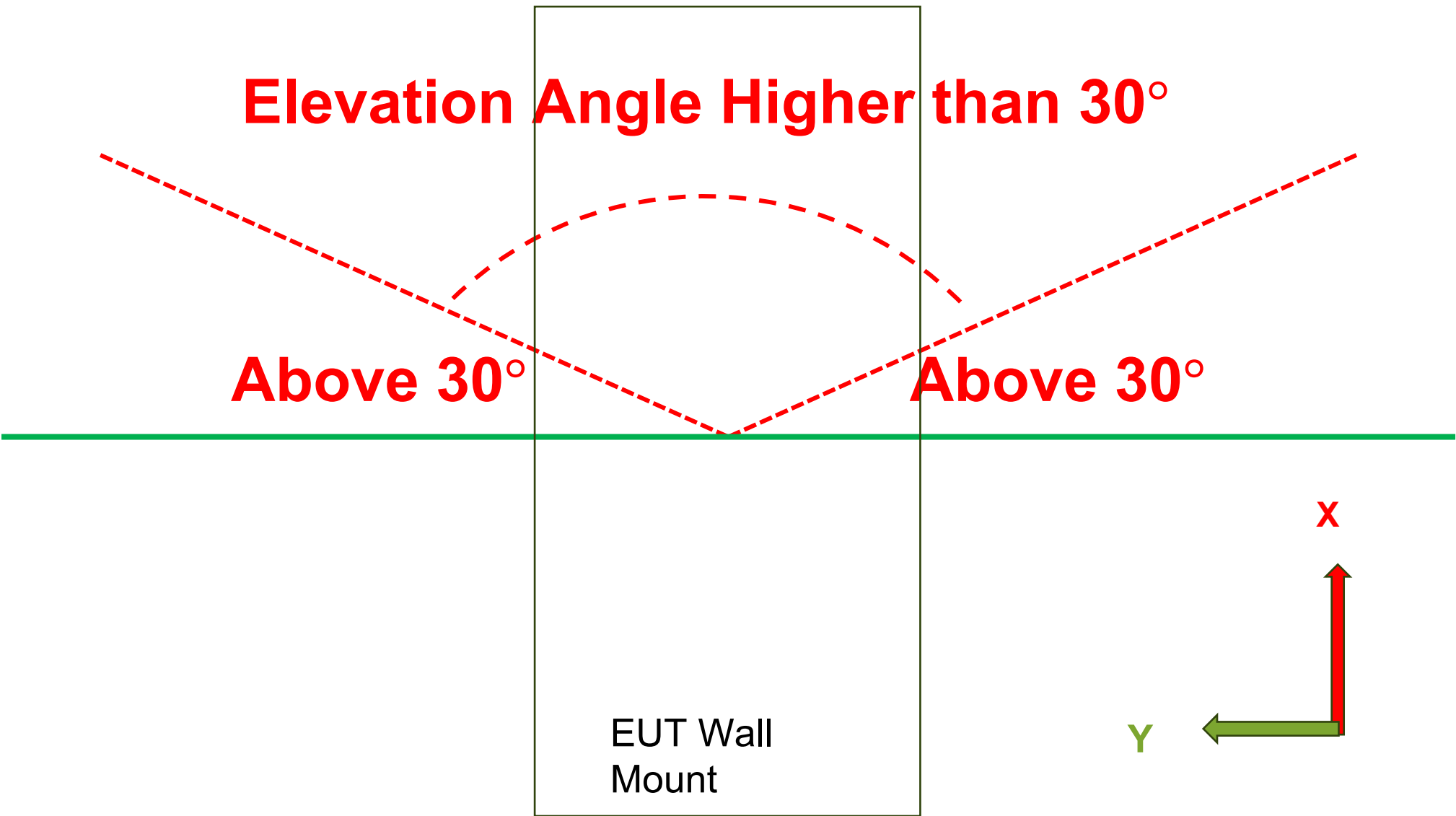


OTH_Scanning_Wall Mount

Unit: dBi

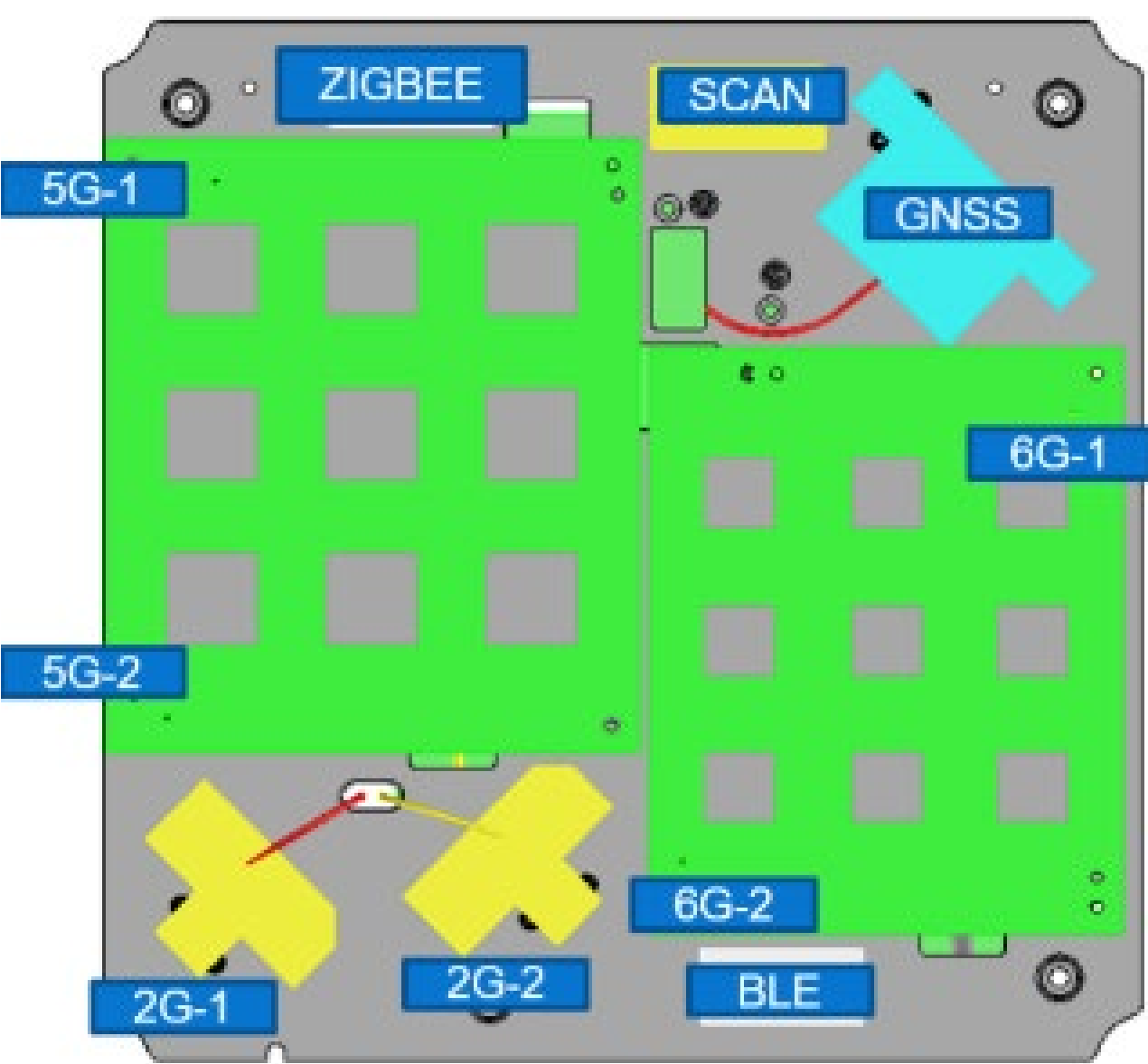
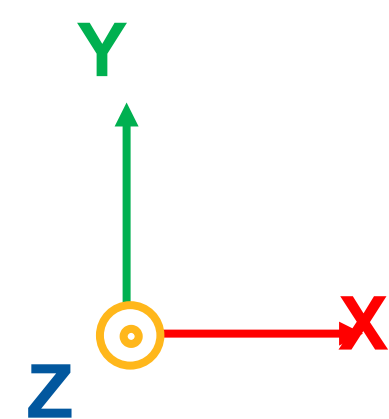
Scanning

Gain(Total)	Freq.(MHz)	5150	5250	5945	6145	6345	6445	6545	6745	6845
	Scanning	3.7	5.1	5.4	5.1	5.2	4.0	4.5	3.7	3.5
Gain(Theta)	Scanning	1.1	2.5	5.1	3.6	0.8	1.5	2.4	1.7	1.4
Gain(Phi)	Scanning	3.3	5.0	3.1	2.9	4.2	2.5	3.0	2.1	1.9



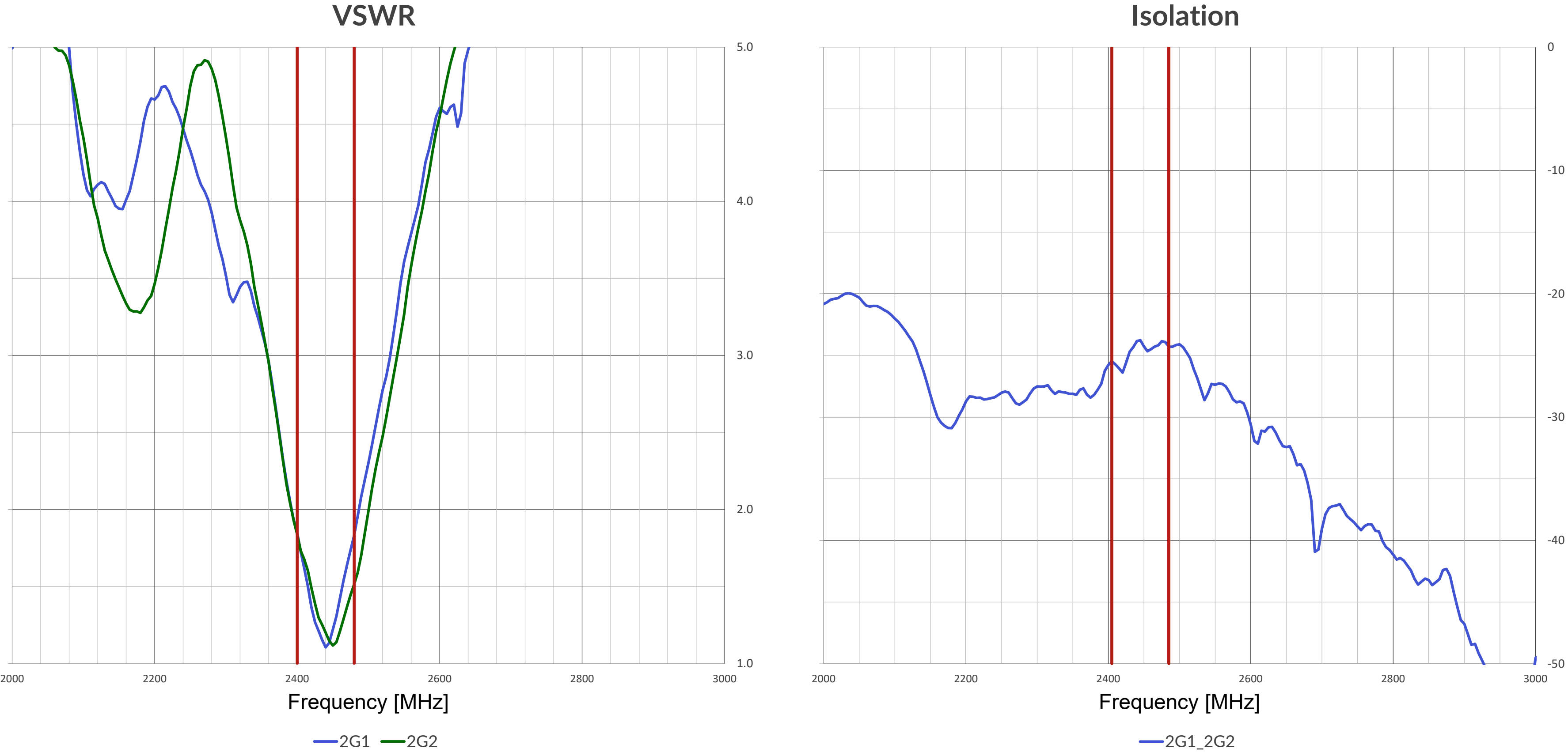
Summary – Directional Antenna

- Dipole antennas for WiFi 2.4GHz, and antenna array for WiFi 5GHz & WiFi 6GHz
- The average SLL (side lobe level) is < -17dBr from the peak gain

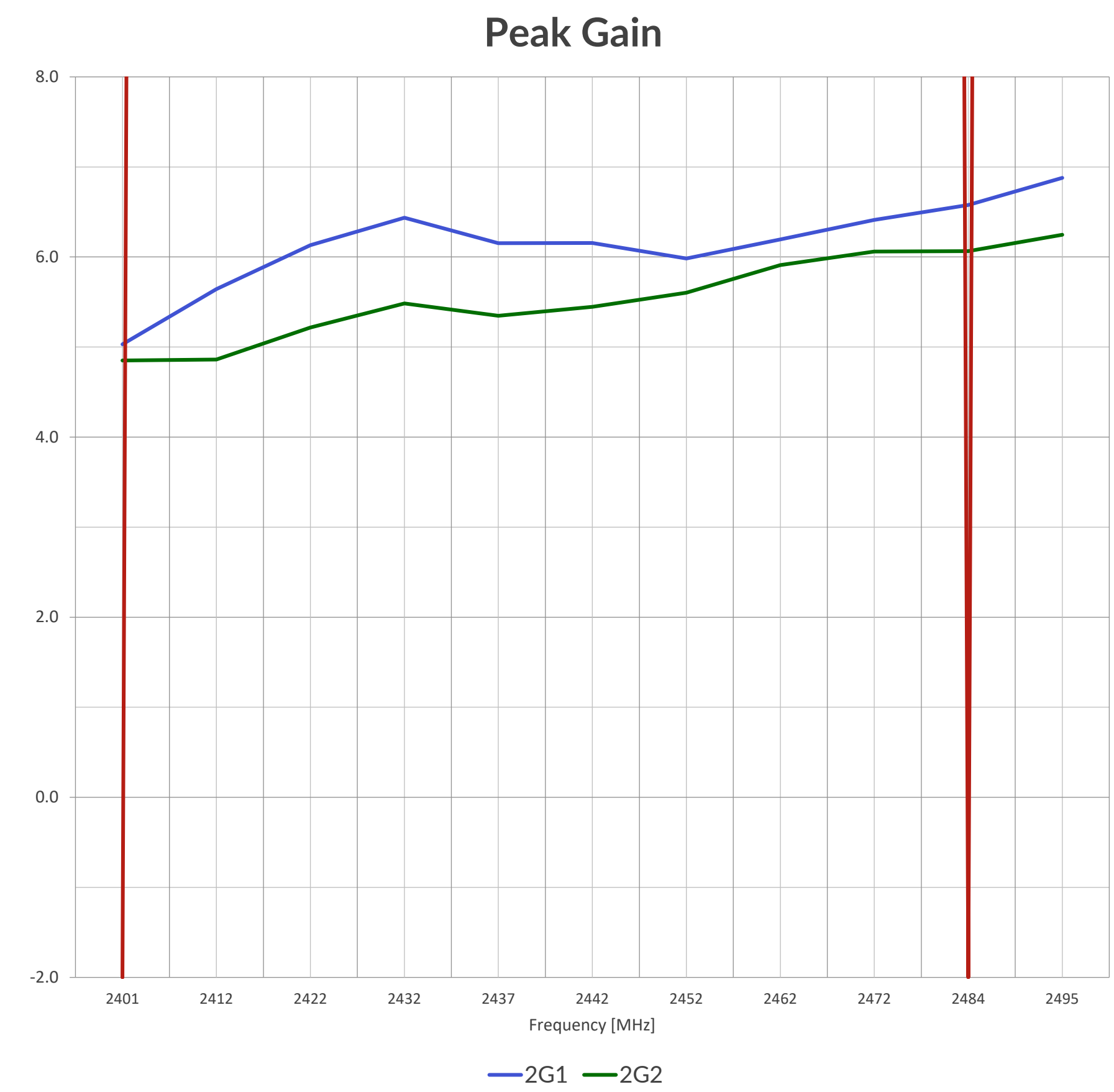
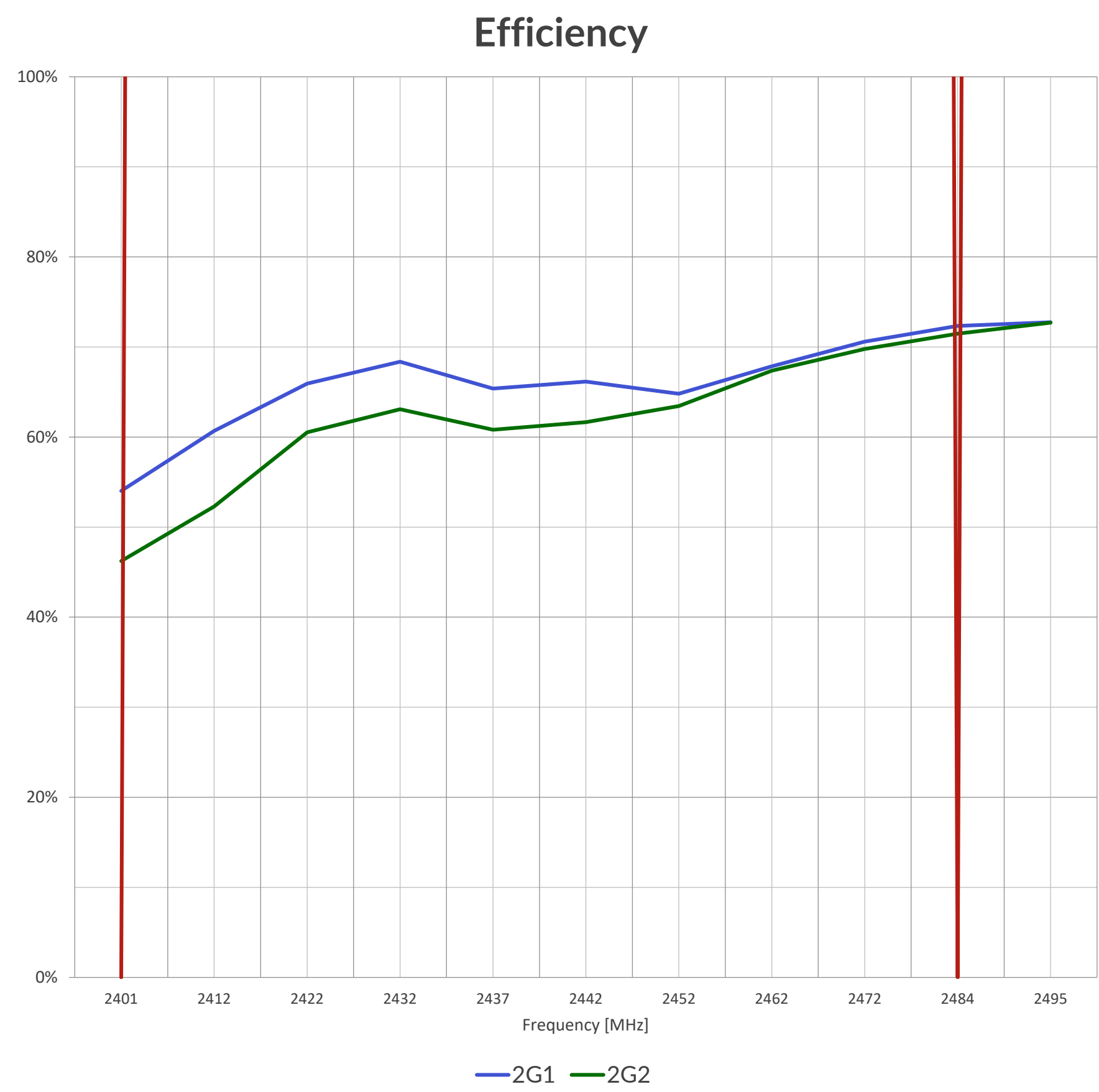


	90x90						90x30							30x30							
	Avg Peak Gain (dBi)	Avg Eff (%)	Avg. Beamwidth (°)				Avg. Peak Gain (dBi)	Avg Eff (%)	Avg. Beamwidth (°)			SLL(dB)		Avg. Peak Gain (dBi)	Avg Eff (%)	Avg. Beamwidth (°)		SLL(dB)			
			XZ		YZ				XZ		YZ	YZ				XZ		YZ			
			3dB	4dB	3dB	4dB			3dB	4dB	3dB	Range	Avg			3dB	3dB	Range	Avg	Range	Avg
2GHz-1	5.8	66	82	94	87	93															
2GHz-2	5.5	63	90	106	72	83															
5GHz-1	3.3	39	91	100	83	103	6.2	35	93	100	31	17~24	20	9.5	30	36	34	19~25	22	18~24	21
5GHz-2	3.3	42	101	108	88	97	6.5	36	95	103	32	20~28	23	9.7	31	35	34	20~26	23	17~30	23
6GHz-1	4.2	36	87	96	60	72	6.8	32	80	87	31	15~20	18	9.5	28	34	32	15~23	21	17~25	21
6GHz-2	5.1	43	76	90	64	81	6.5	33	90	99	33	17~24	20	9.4	29	35	33	15~27	21	18~27	21

2GHz Antenna Result – VSWR/ Isolation

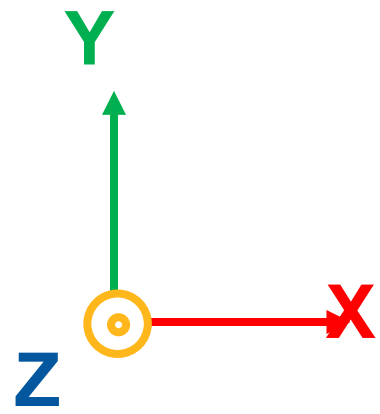
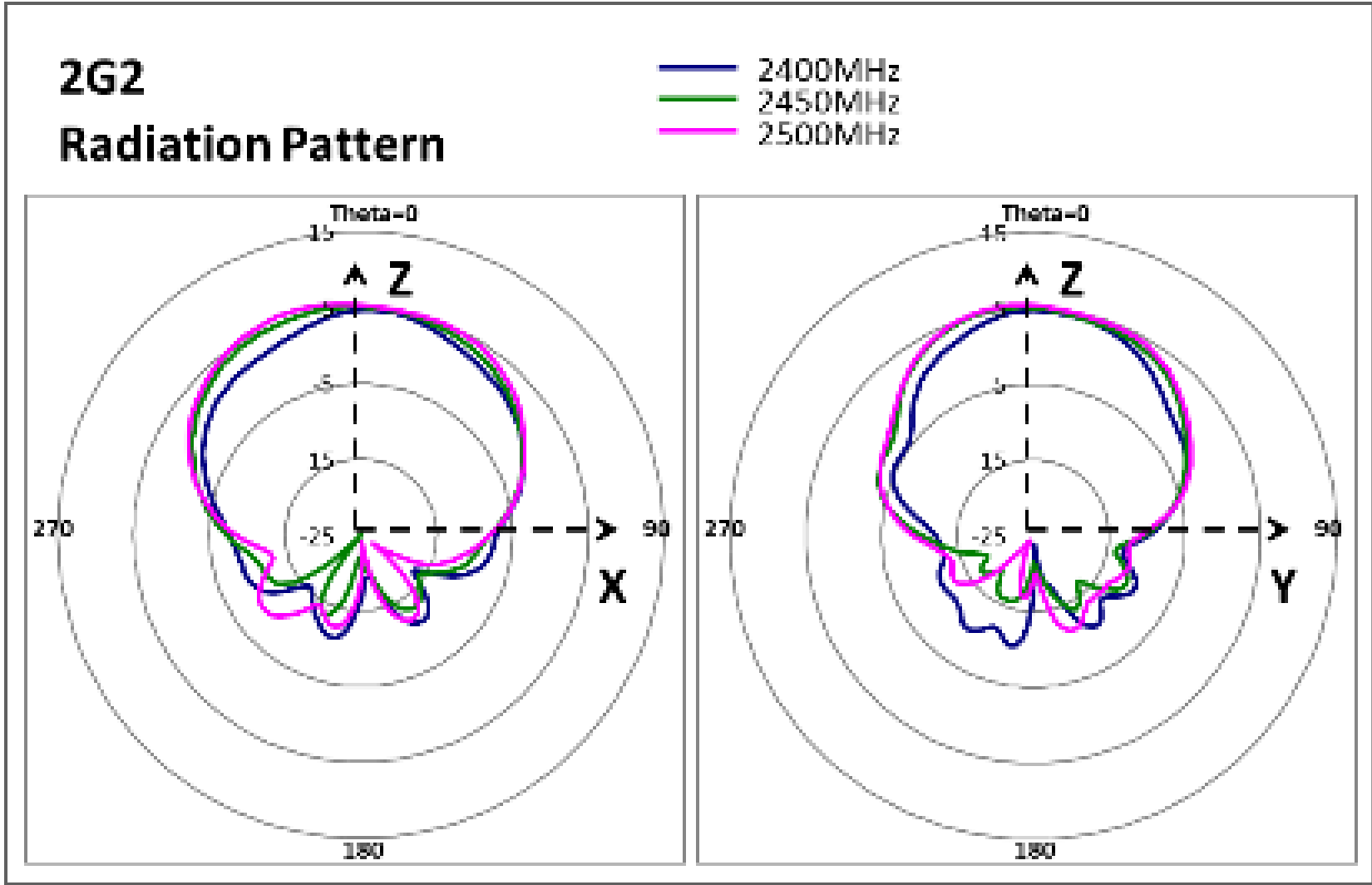
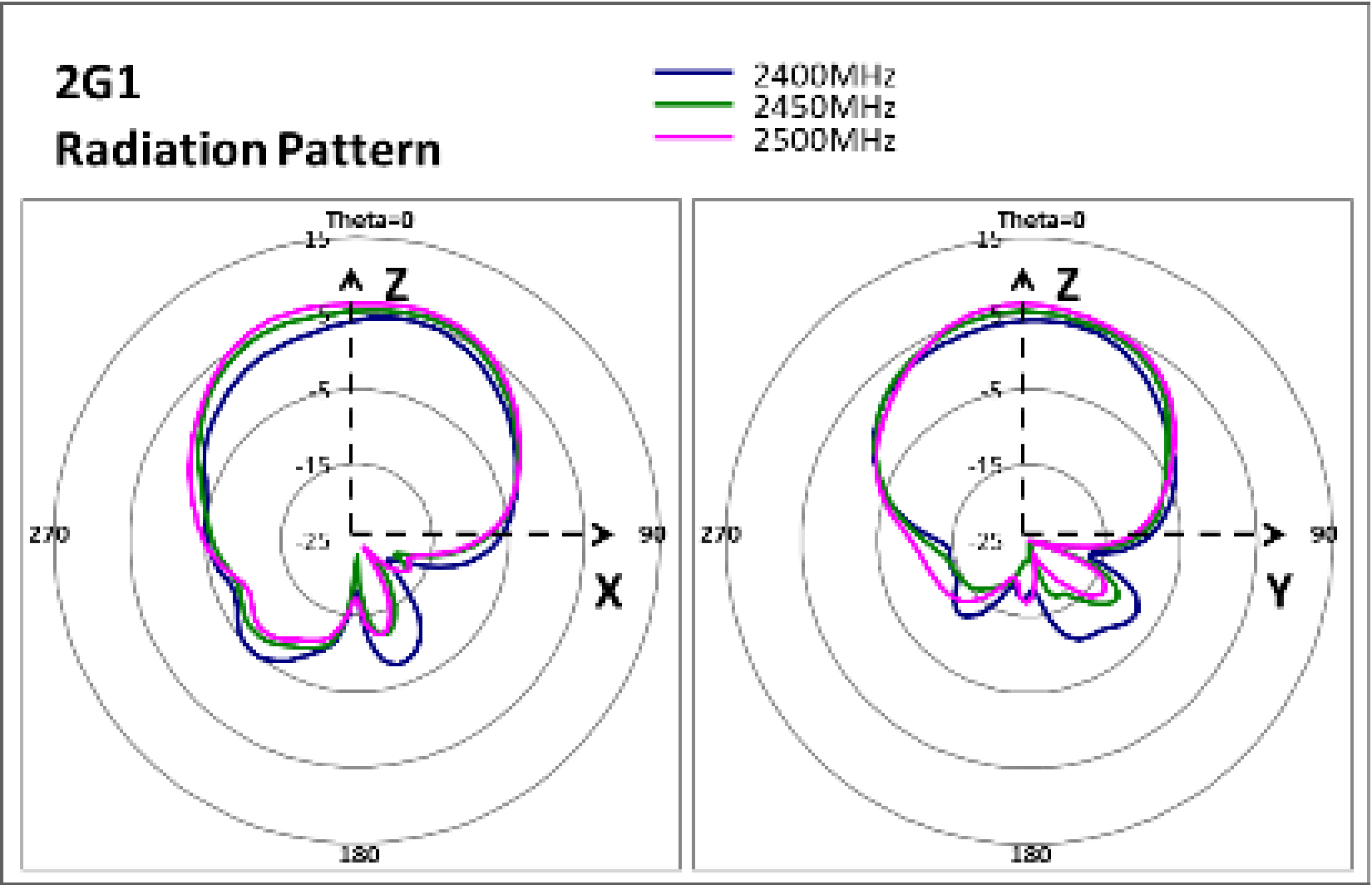
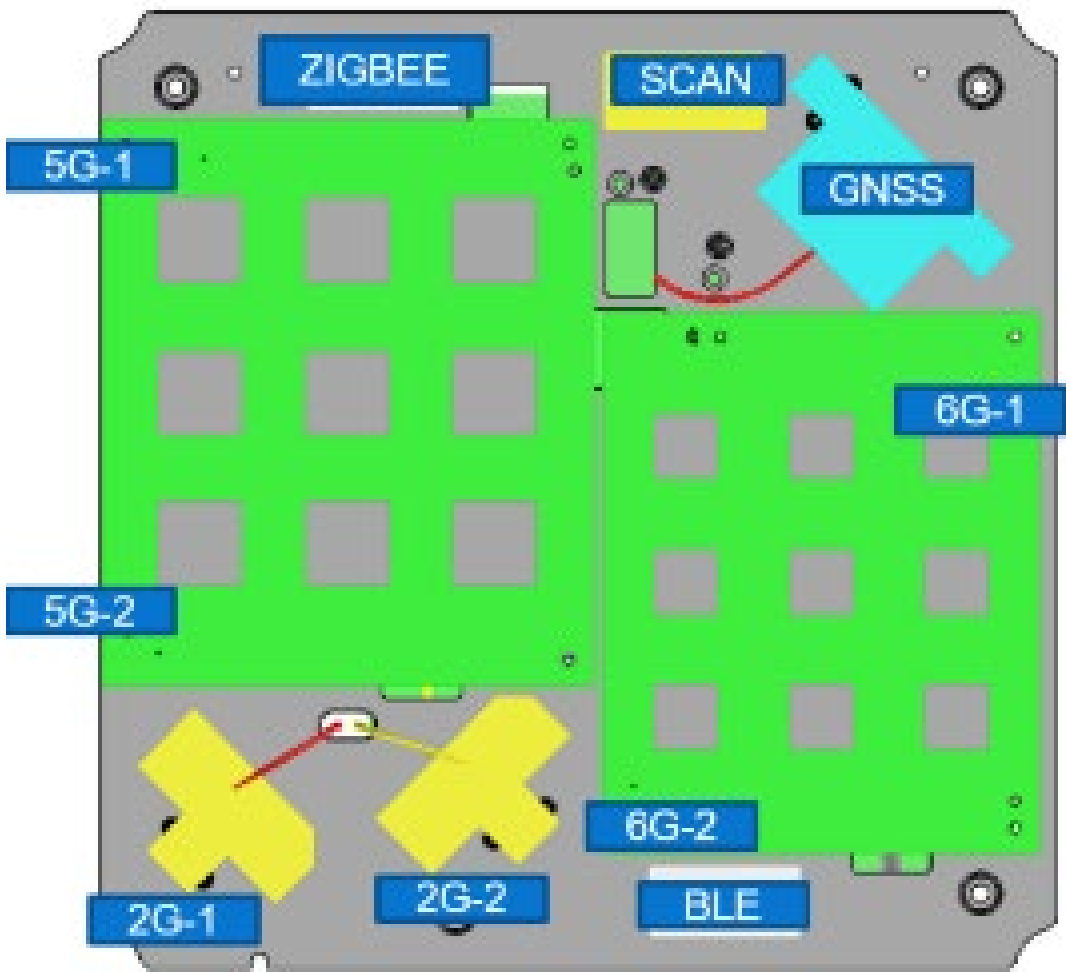


2GHz Antenna Result – Efficiency/ Peak Gain



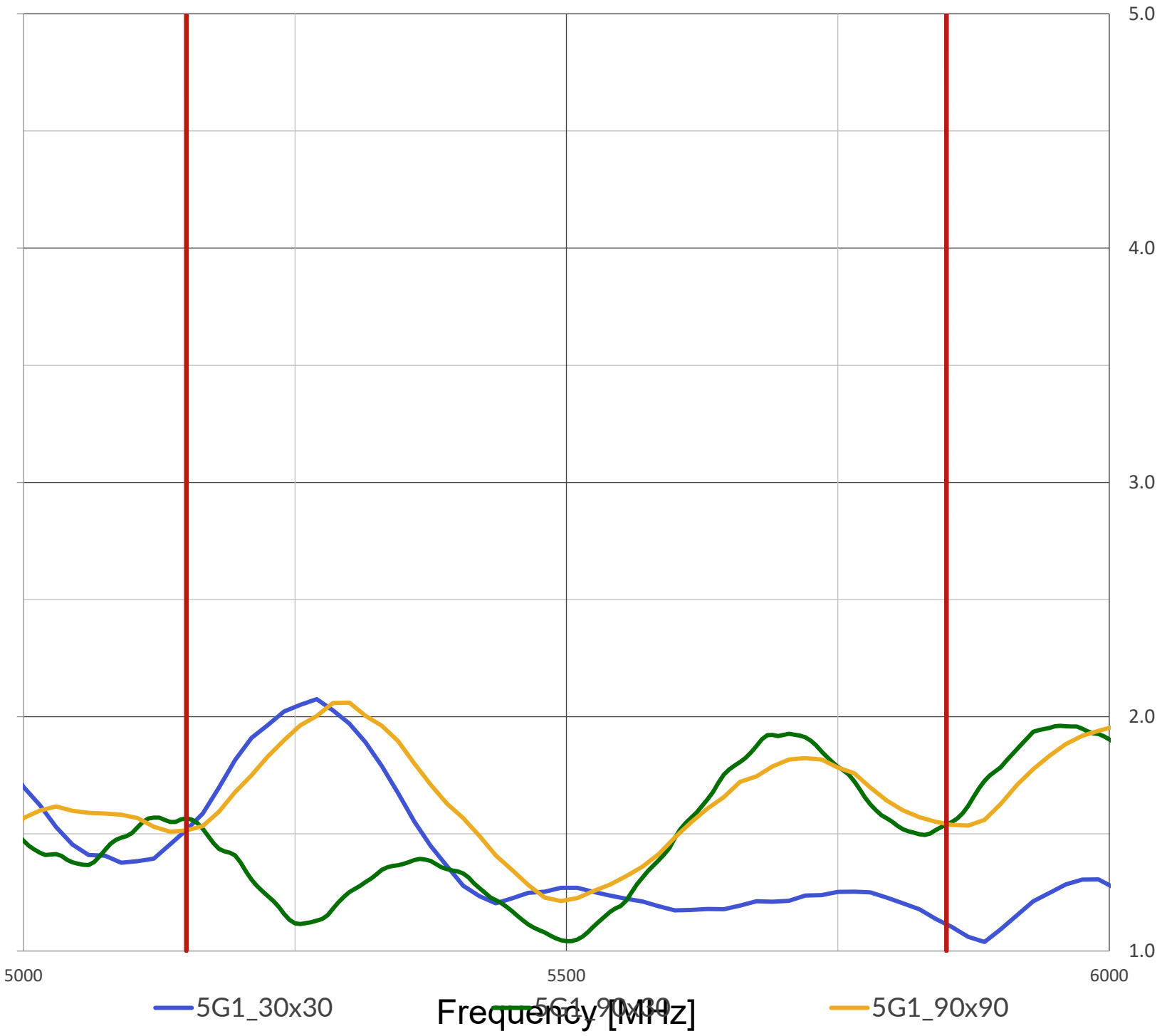
2GHz Antenna Result – Radiation Pattern

Freq (MHz)	2G1									2G2								
	Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		Pea Gain (dBi)					4dB BW (°)		3dB BW (°)	
		XZ		YZ		XZ	YZ	XZ	YZ		XZ		YZ		XZ	YZ	XZ	YZ
		+/-45°	+/-45°	+/-45°	+/-45°													
2400	5.0	1.8	0.4	-0.6	1.8	90	93	75	87	4.8	1.5	1.1	-0.3	-2.5	102	75	75	63
2450	5.9	2.7	2.4	0.5	1.9	96	87	87	81	5.3	2.1	3.2	1.6	-0.1	111	96	87	75
2500	6.6	3.4	2.9	1.3	1.0	96	78	84	69	6.3	2.9	3.9	2.1	0.3	105	99	87	78
Avg	5.8	2.6	1.9	0.4	1.6	94	86	82	79	5.5	2.2	2.7	1.1	-0.8	106	90	83	72

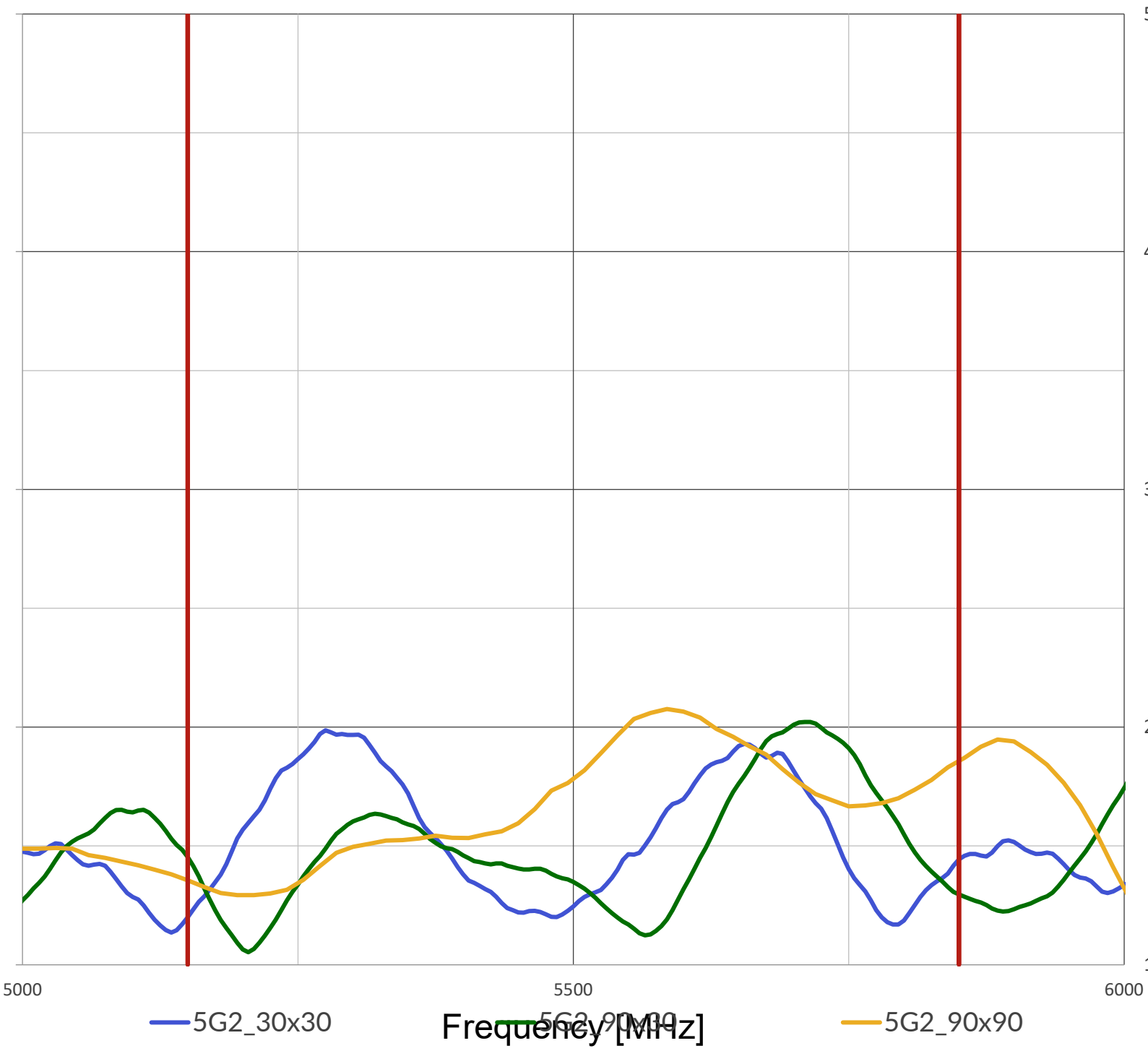


5GHz Array Result – VSWR/ Isolation

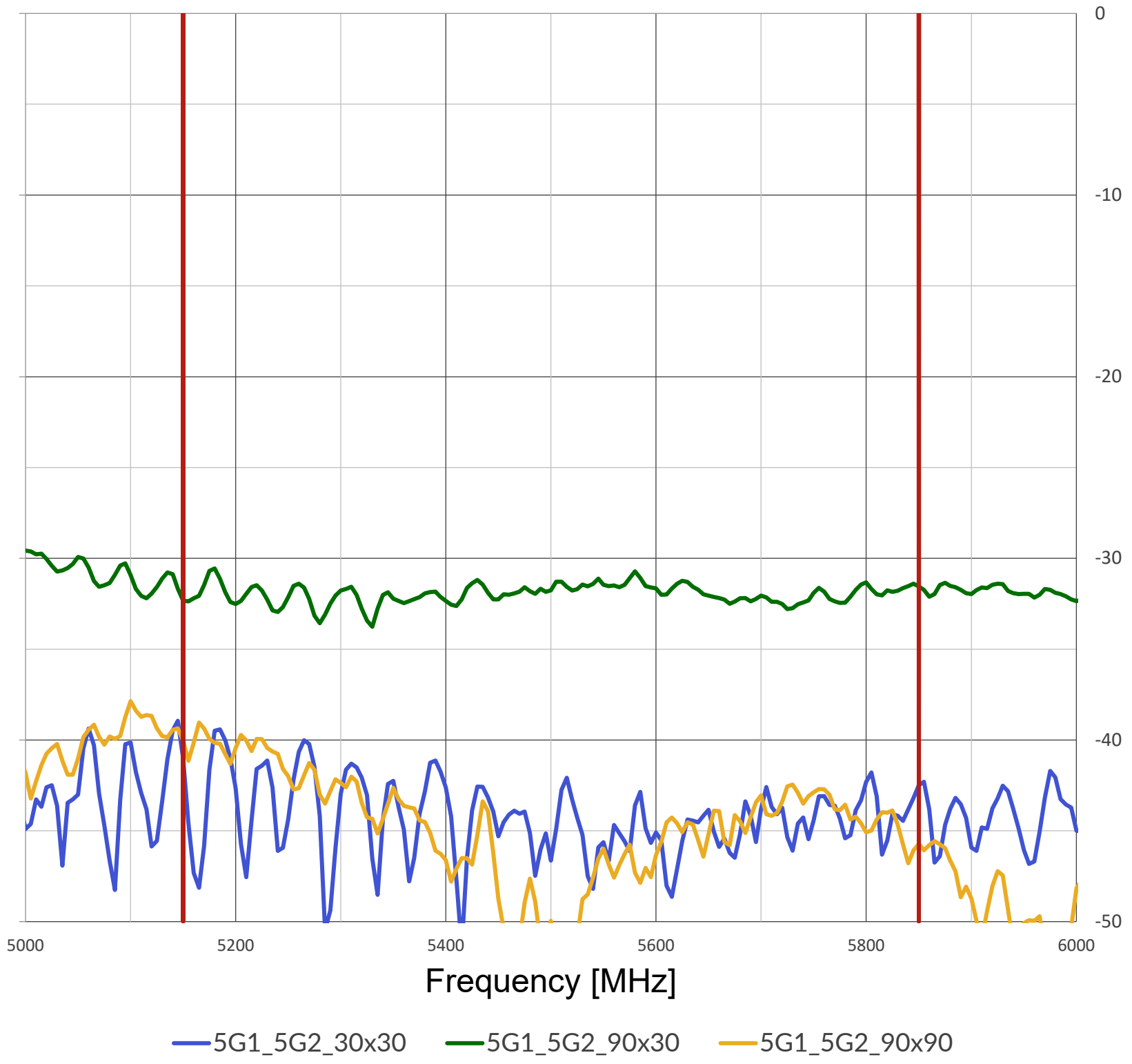
VSWR_5G1



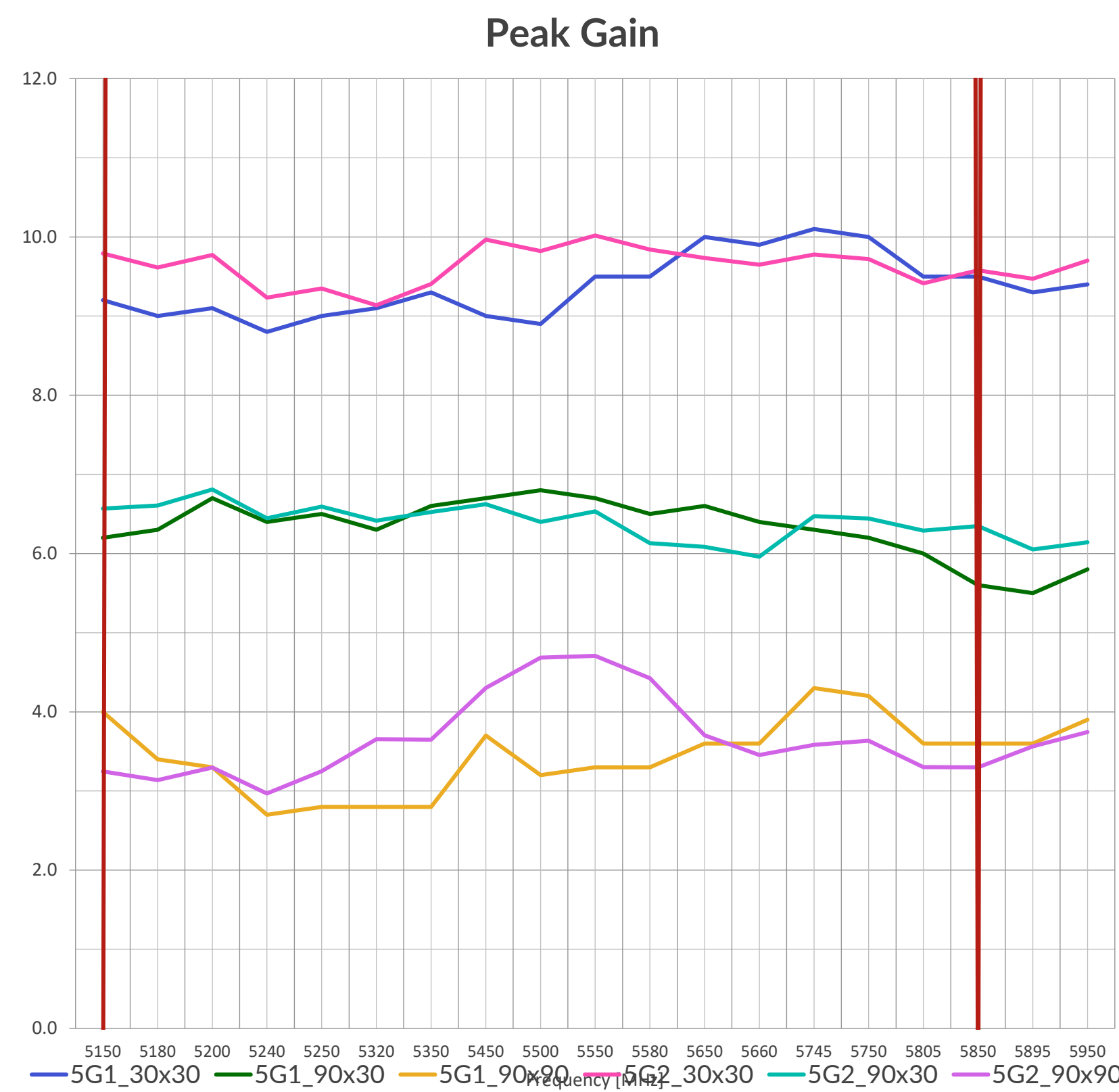
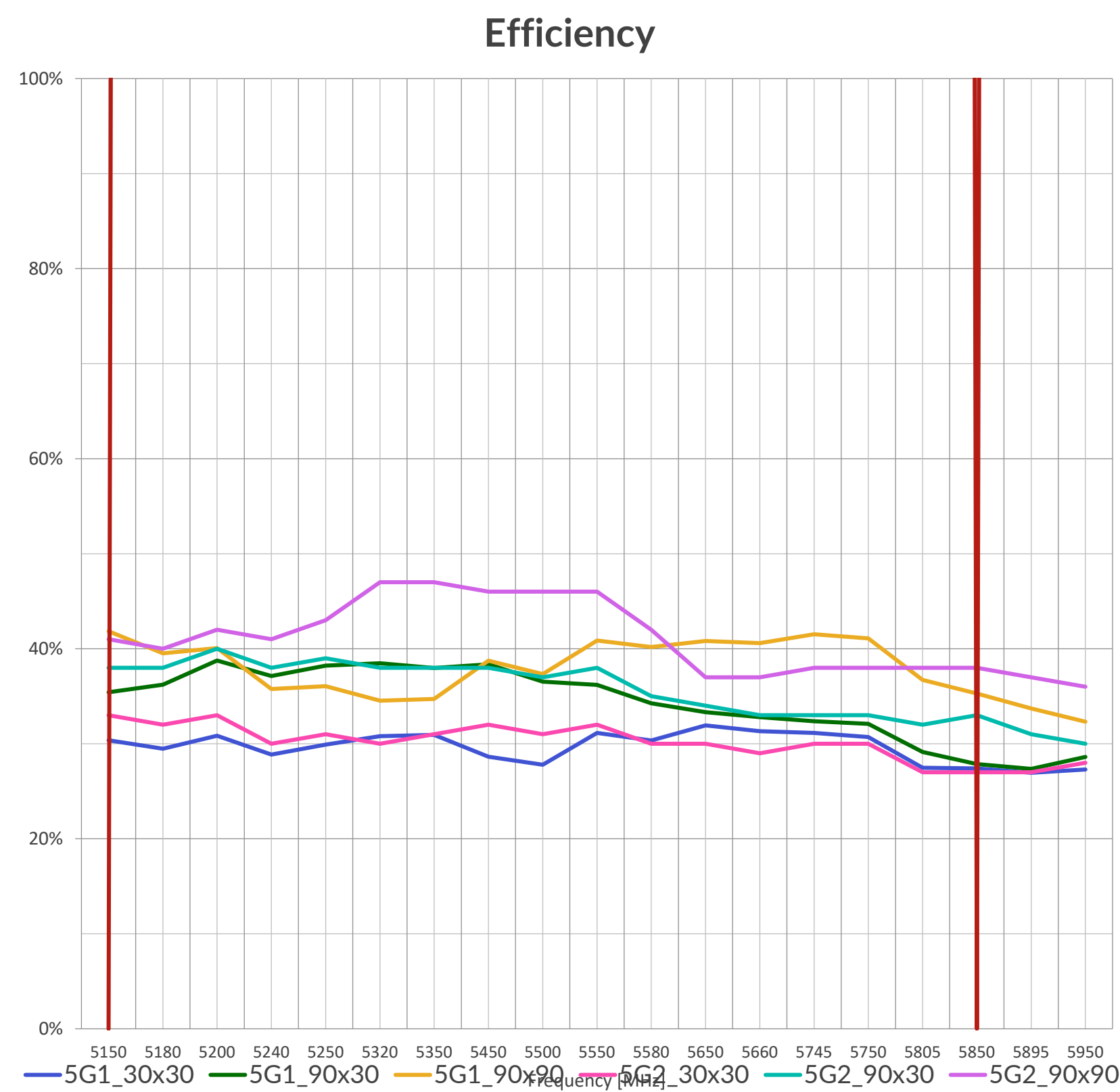
VSWR_5G2



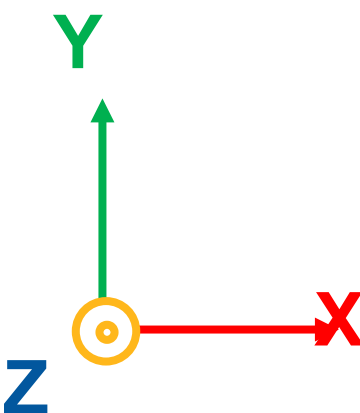
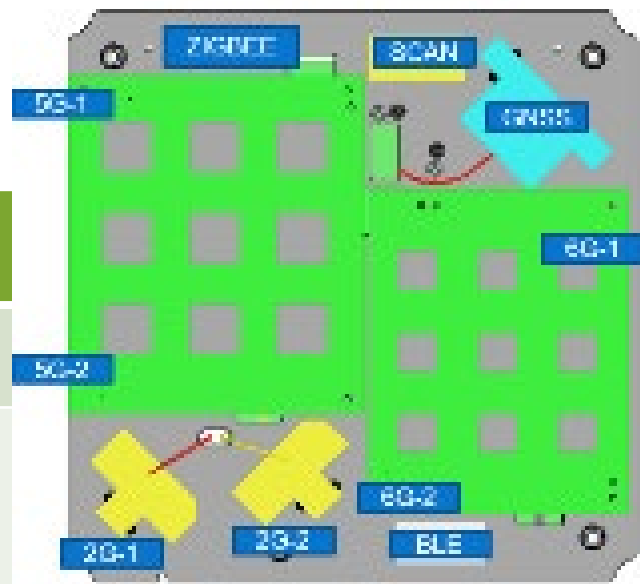
Isolation_5G to 5G



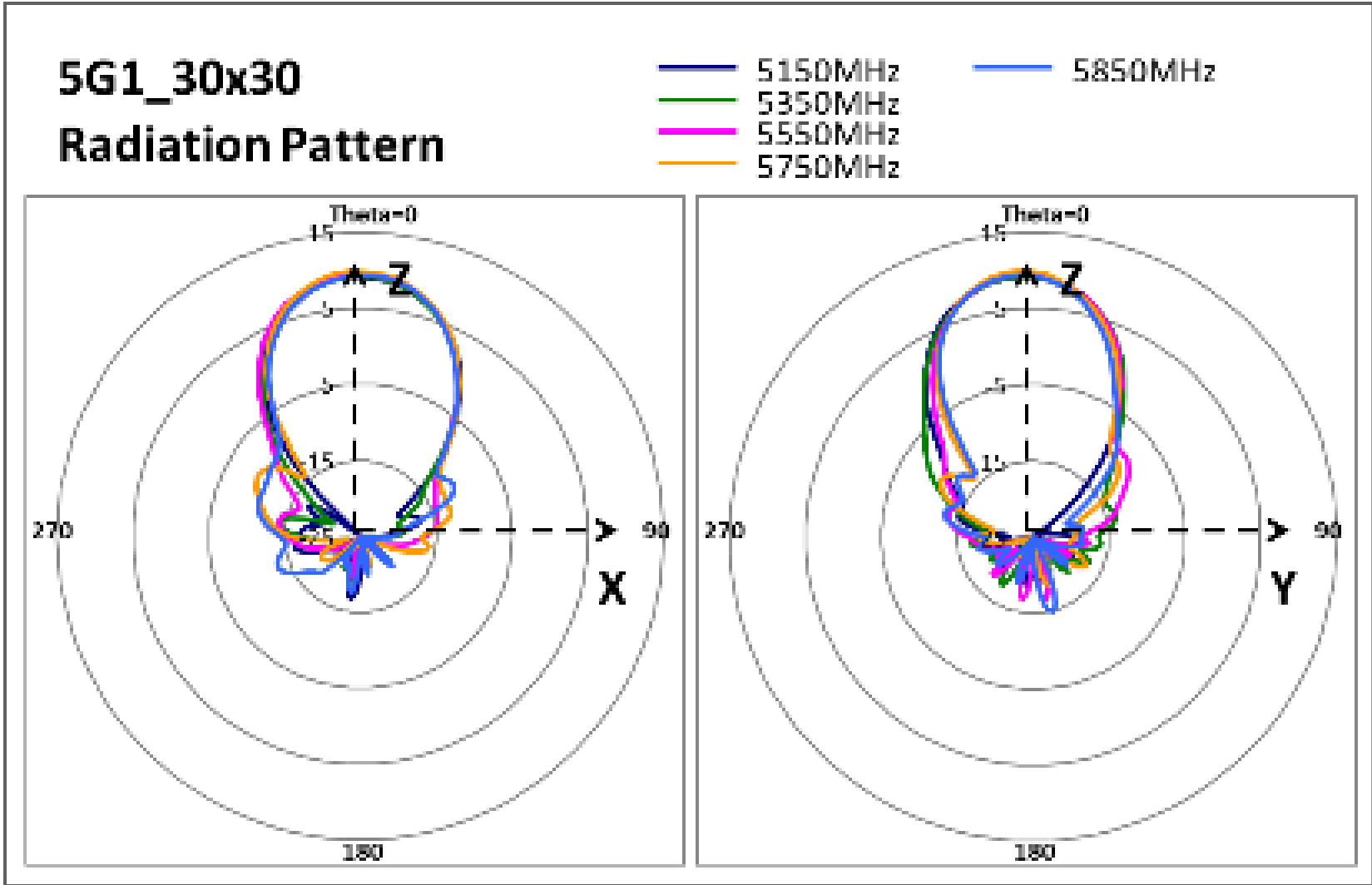
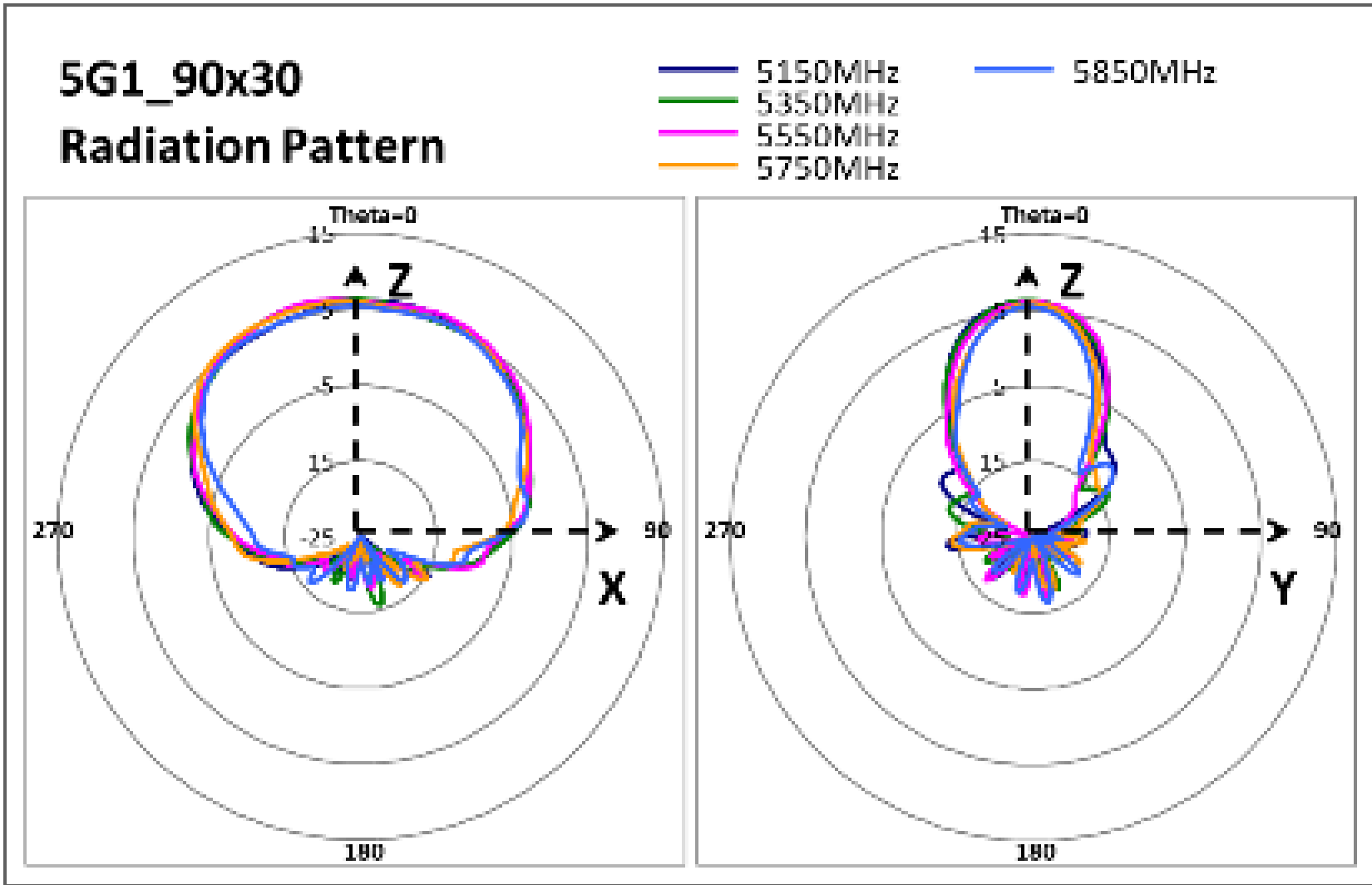
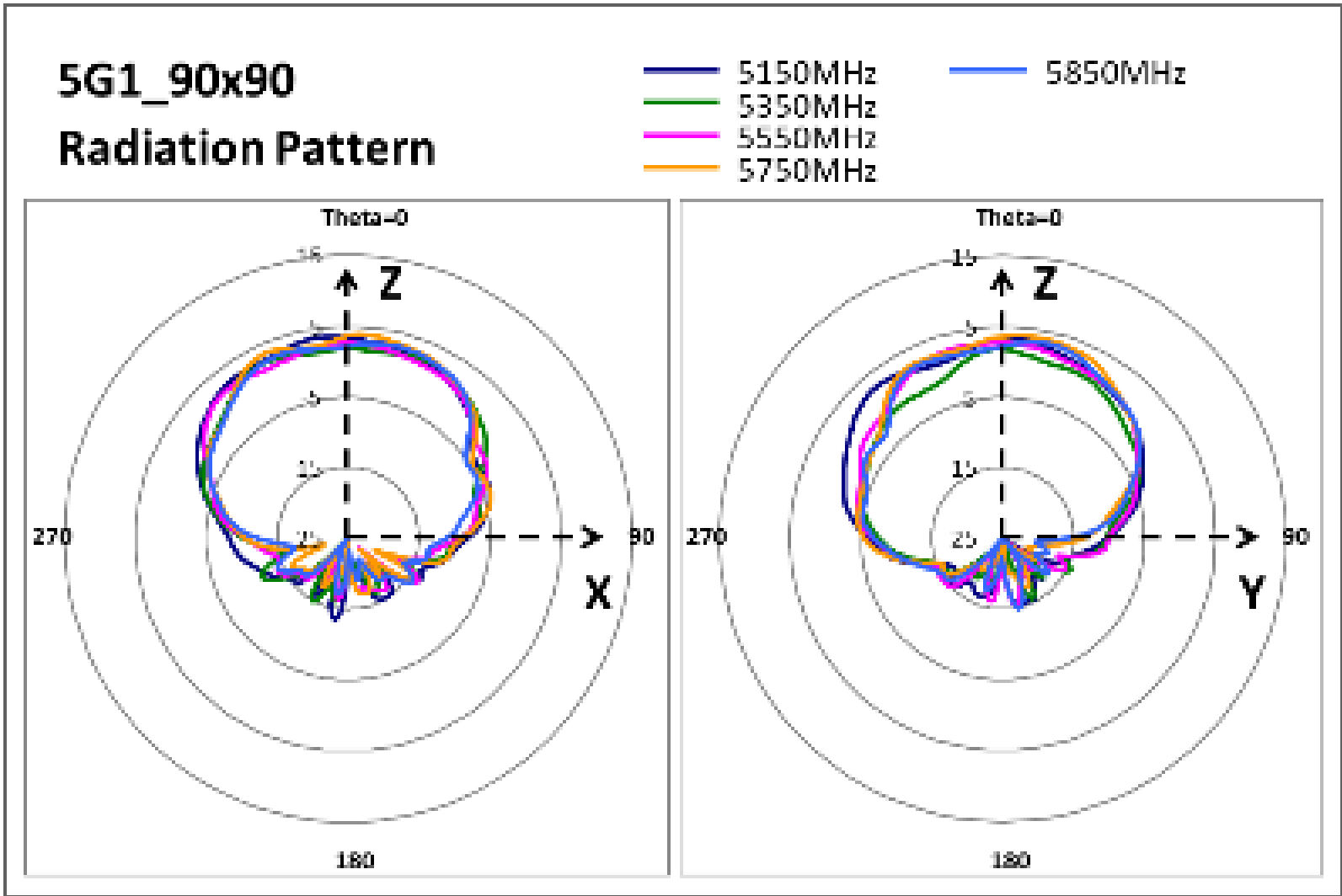
5GHz Array Result – Efficiency/ Peak Gain



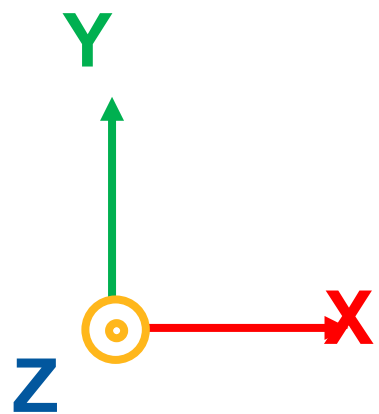
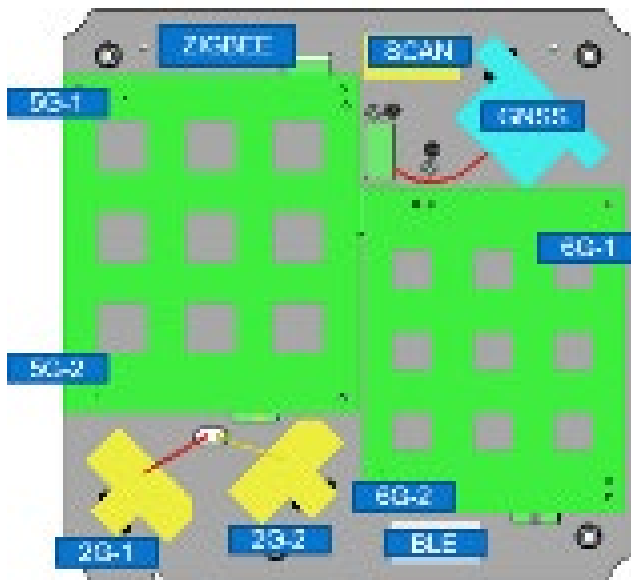
5GHz Array Result – 5G1 Radiation Pattern



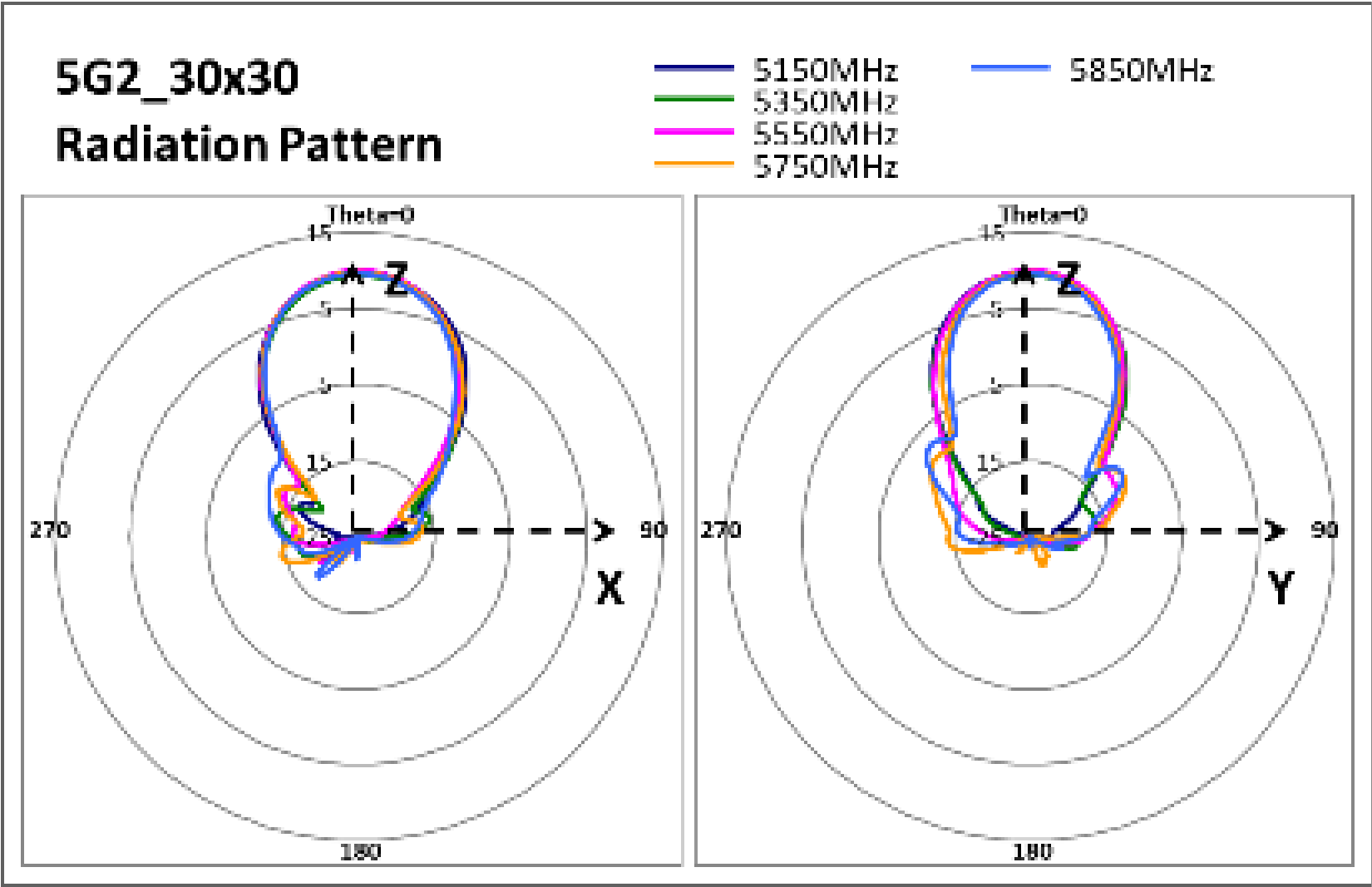
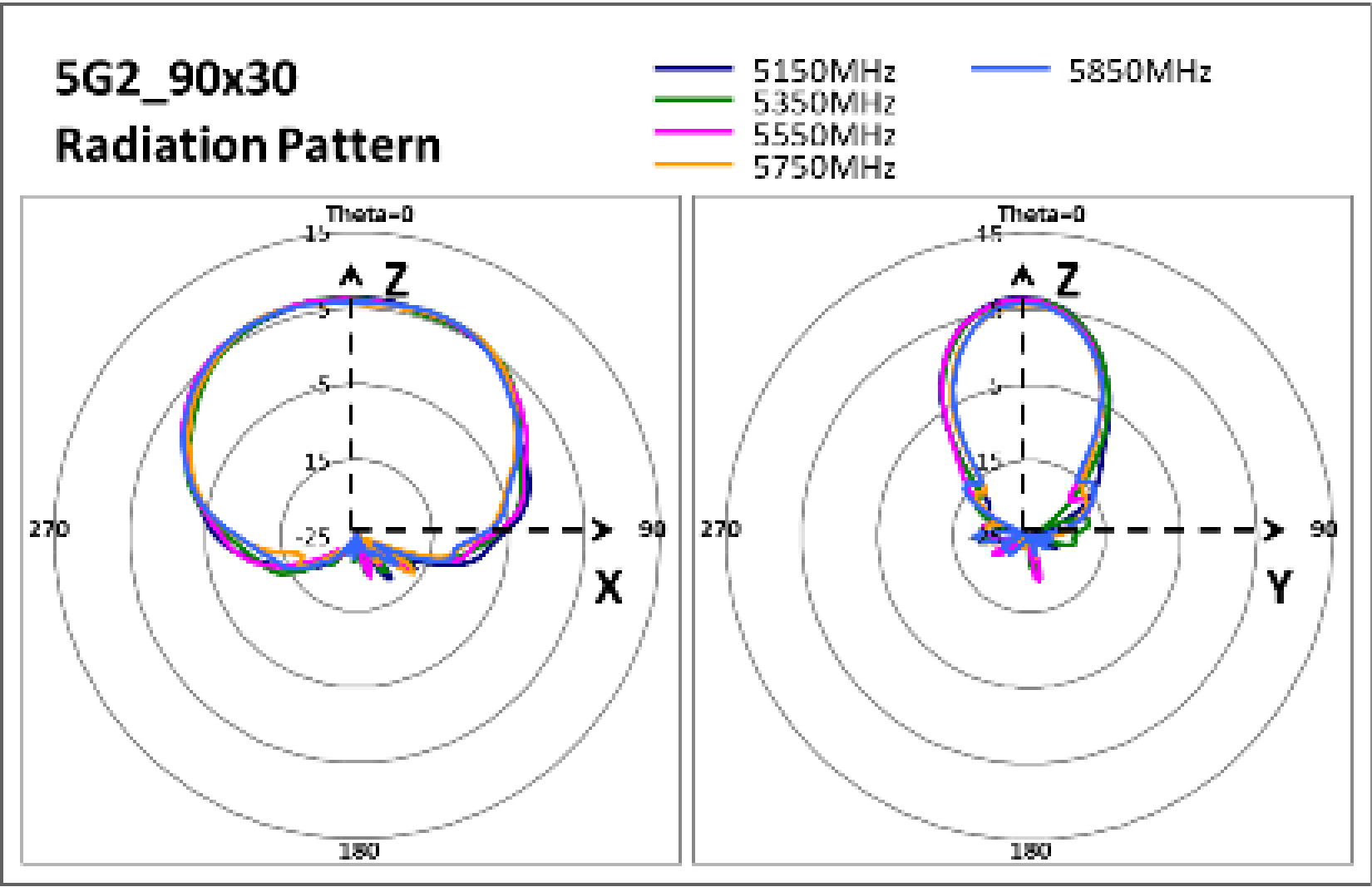
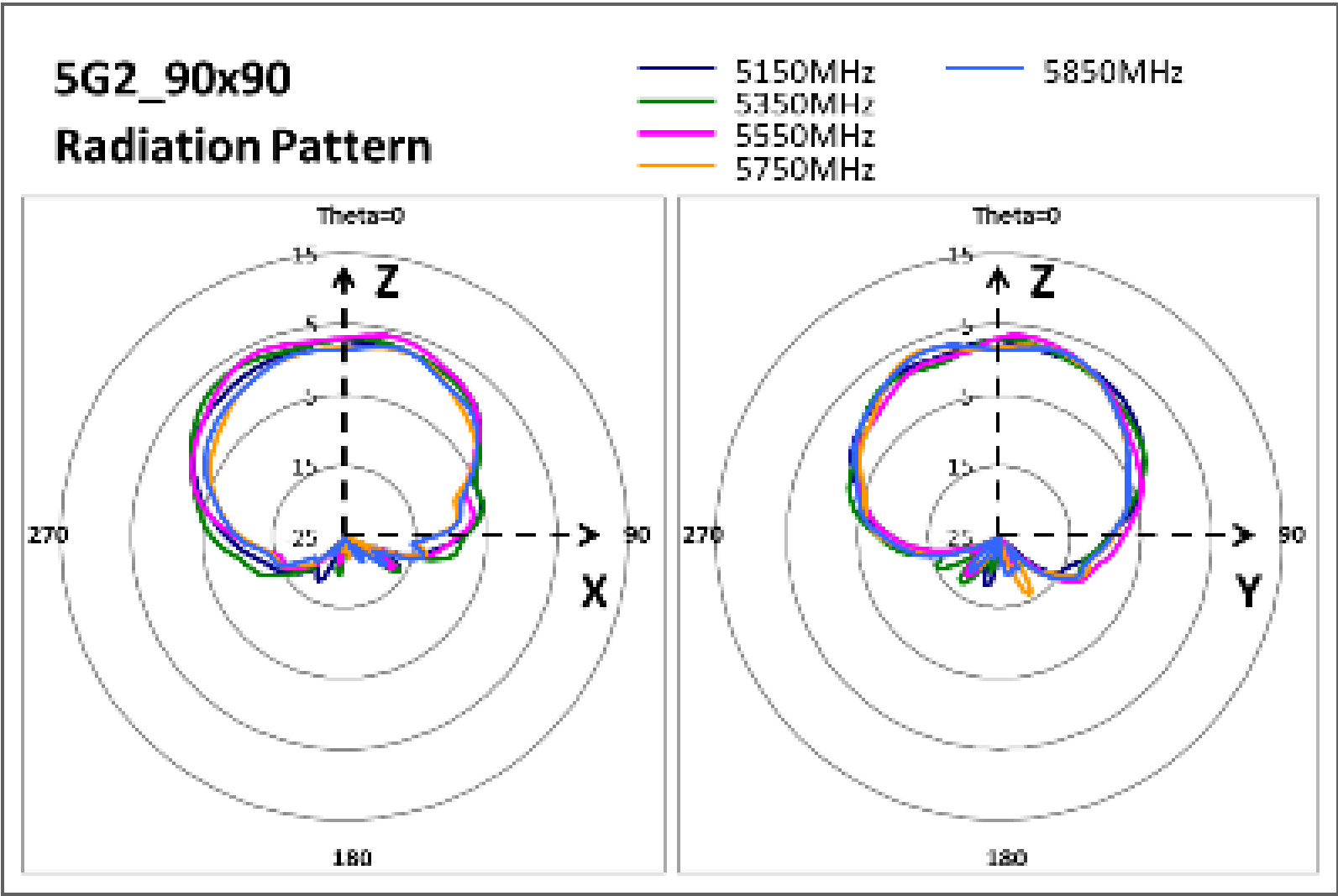
Freq (MHz)	90x90									90x30										30x30								
	Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		SLL(dB)		Peak Gain (dBi)				3dB BW (°)		SLL(dB)	
		XZ		YZ		XZ	YZ	XZ	YZ		XZ		YZ		XZ	XZ	YZ	YZ		XZ		YZ		XZ	YZ	XZ	YZ	
		+/-45°	+/-45°	+/-45°	+/-15°						+/-15°	+/-15°	+/-15°															
5150	3.8	-0.8	2.0	0.1	2.7	102	117	90	99	6.2	3.1	3.7	2.9	5.0	102	90	33	17	9.2	7.3	7.6	6.4	8.2	39	36	25	24	
5350	2.5	0.4	-0.2	-1.3	-1.6	111	102	99	66	6.5	3.6	3.6	3.5	4.7	111	93	33	20	9.3	7.4	7.4	6.7	8.1	33	36	23	23	
5550	2.8	-0.6	1.8	0.2	-0.8	105	111	99	87	6.7	3.9	3.8	3.9	4.1	105	93	33	24	9.5	7.7	7.9	6.7	8.1	39	33	23	18	
5750	3.9	0.2	-0.6	0.1	-0.9	90	90	78	81	6.2	2.9	4.6	2.4	3.0	90	93	27	20	10	7.9	8.1	6.4	8.5	33	33	19	20	
5850	3.4	-0.5	-0.5	0.3	-2.1	93	93	87	81	5.5	2.8	3.5	1.4	2.9	93	96	27	17	9.5	7.6	7.2	5.7	8.2	36	33	20	22	
Avg	3.3	-0.3	0.5	-0.1	-0.5	100	103	91	83	6.2	3.3	3.8	2.8	3.9	100	93	31	20	9.5	7.6	7.6	6.4	8.2	36	34	22	21	



5GHz Array Result – 5G2 Radiation Pattern

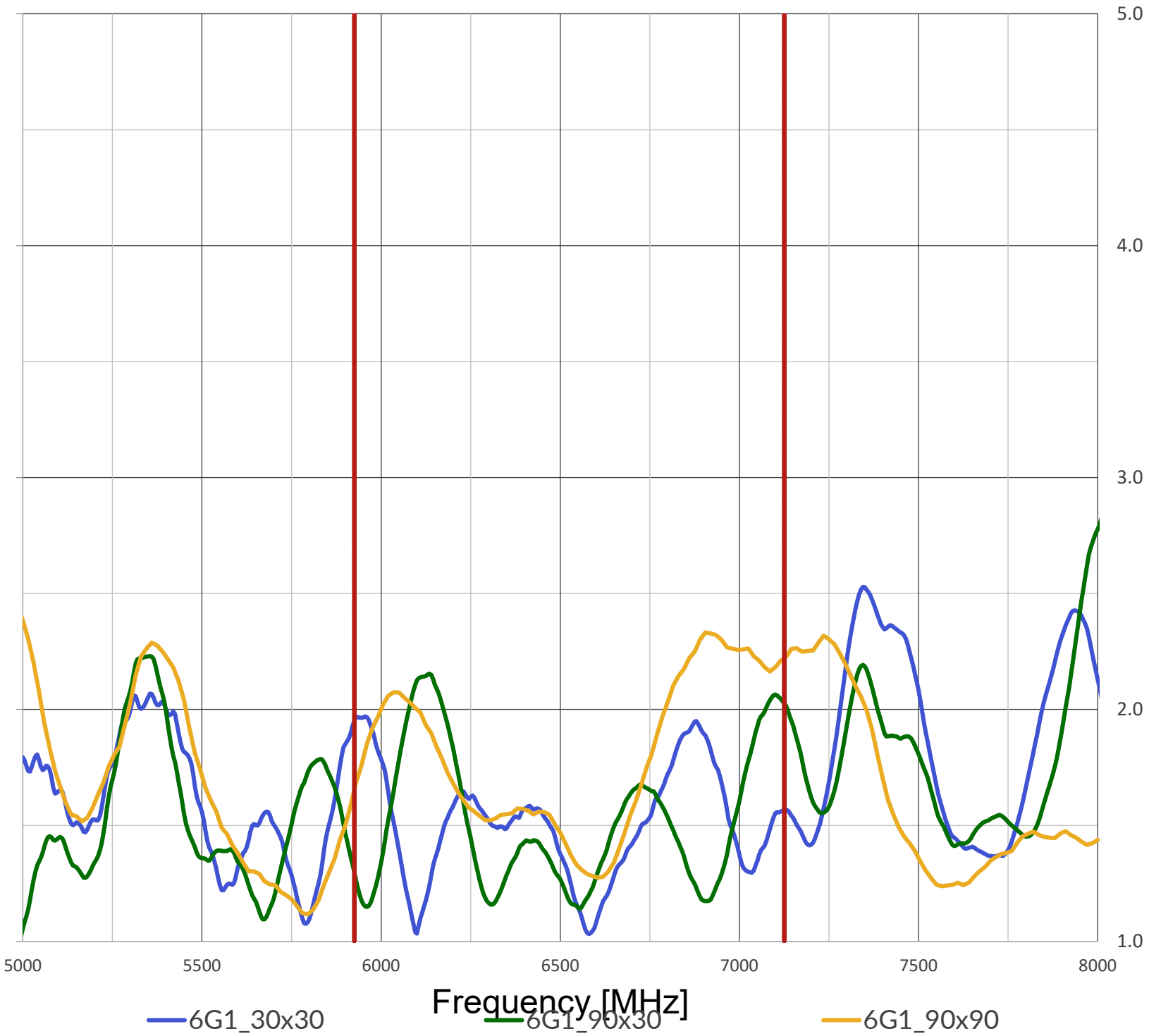


Freq (MHz)	90x90									90x30									30x30										
	Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		SLL(dB)		Peak Gain (dBi)					3dB BW (°)		SLL(dB)	
		XZ		YZ		XZ	YZ	XZ	YZ		XZ		YZ		XZ	XZ	YZ	YZ		XZ		YZ		XZ	YZ	XZ	YZ		
		+/-45°									+/-45°		+/-15°							+/-15°		+/-15°							
5150	2.8	1.1	1.1	0.8	0.6	117	108	120	108	6.6	3.1	4.1	3.8	5.2	102	93	33	28	9.8	8.3	7.9	7.3	8.1	36	36	26	30		
5350	3.3	0.6	2.6	-0.1	1.0	117	105	111	93	6.5	3.9	3.5	3.7	4.8	99	93	36	23	9.4	7.8	7.4	7.5	7.6	36	33	23	25		
5550	4.0	1.1	1.6	-0.7	-0.6	105	96	87	72	6.5	3.6	4.8	3.2	5.0	108	99	33	22	10.0	8.2	8.1	7.8	7.9	36	33	24	22		
5750	3.4	-0.8	-1.2	-1.3	-0.1	96	84	87	81	6.4	3.4	3.9	2.9	3.7	102	93	30	22	9.7	8.0	7.9	7.3	7.4	36	33	22	19		
5850	3.2	0.2	-0.5	-1.2	0.8	105	90	99	87	6.3	2.8	4.5	2.9	3.7	102	96	30	20	9.6	7.7	7.7	6.9	7.0	33	33	20	17		
Avg	3.3	0.4	0.7	-0.5	0.3	108	97	101	88	6.5	3.4	4.2	3.3	4.5	103	95	32	23	9.7	8.0	7.8	7.4	7.6	35	34	23	23		

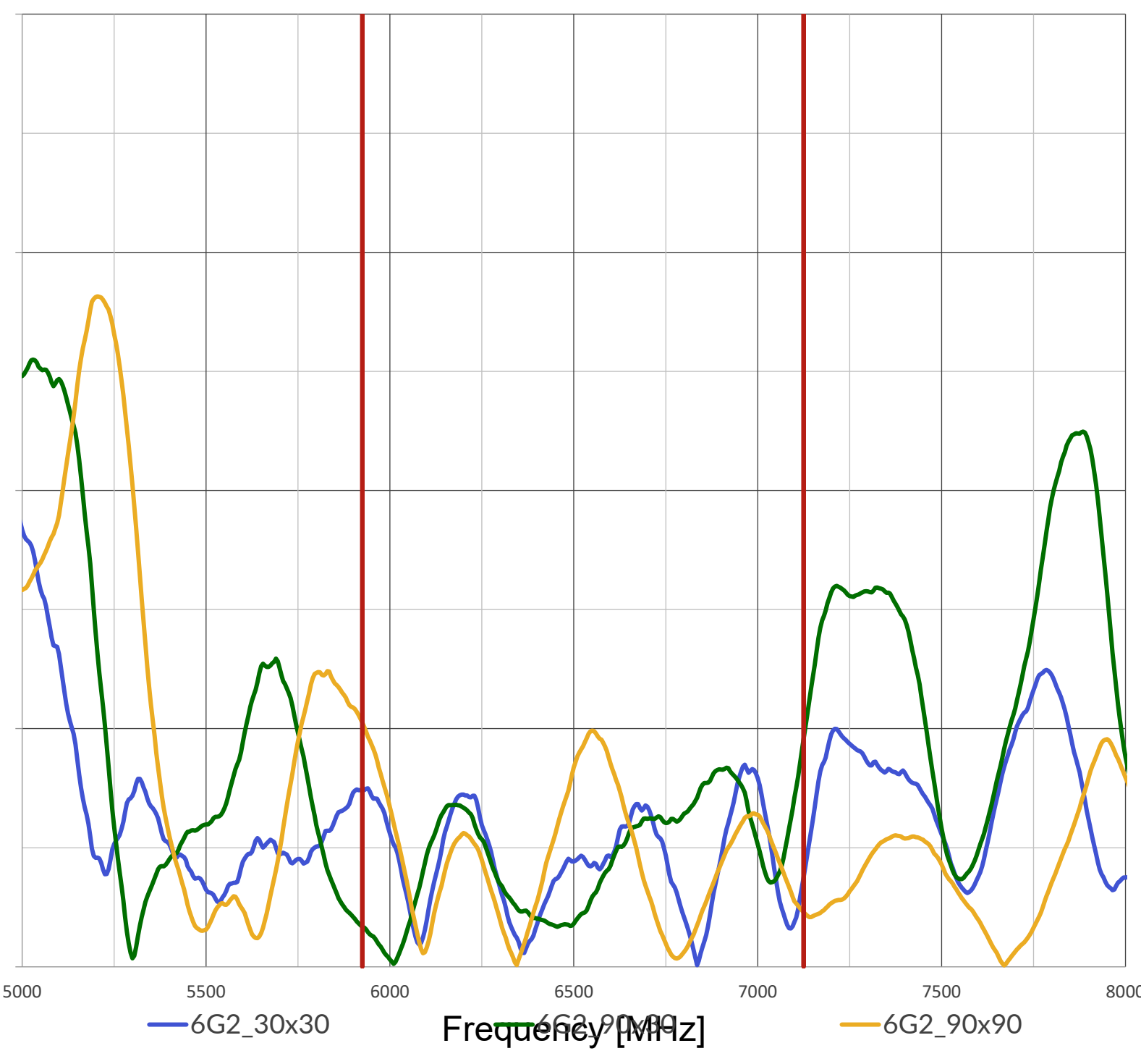


6GHz Array Result – VSWR/ Isolation

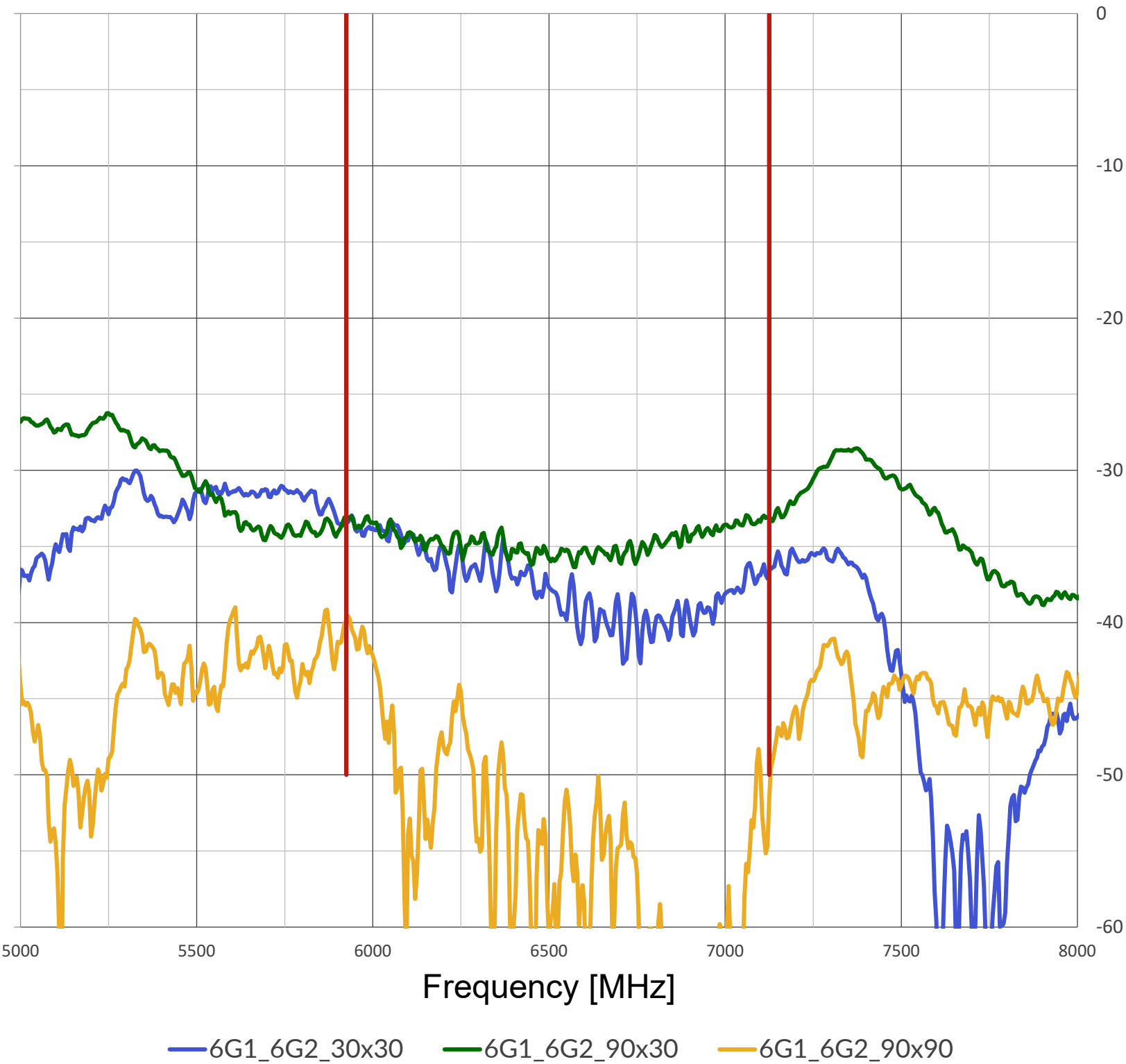
VSWR_6G1



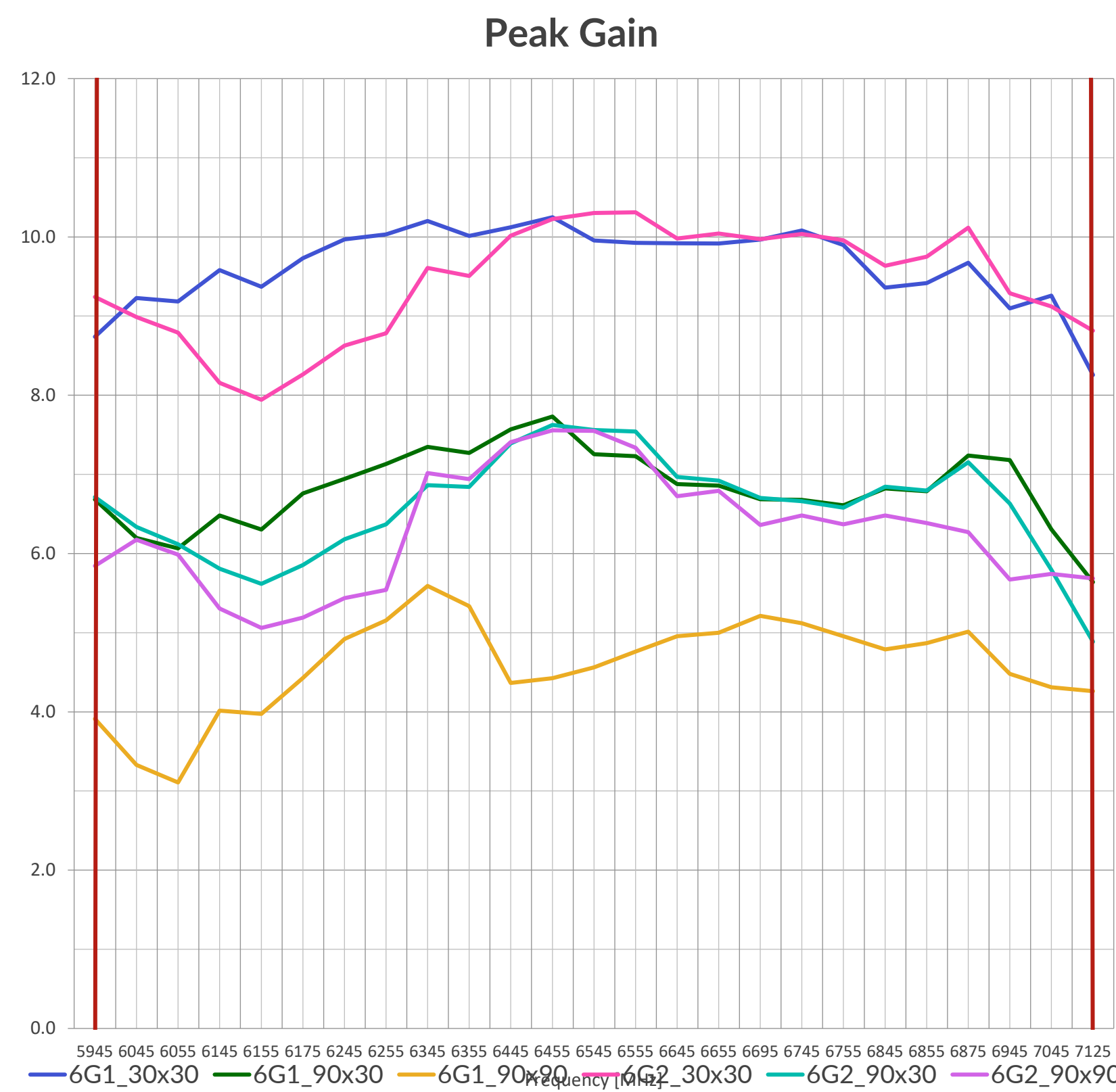
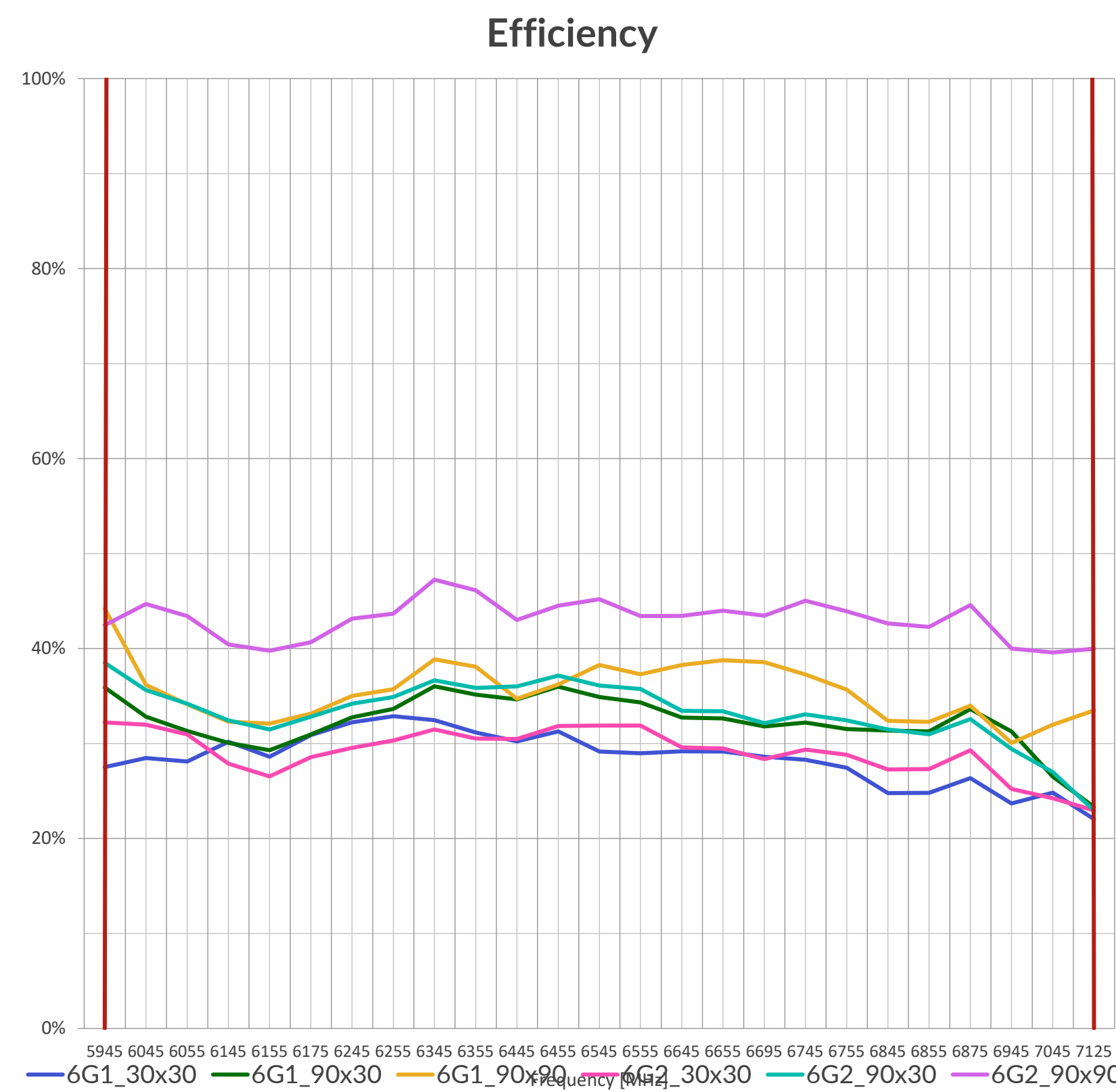
VSWR_6G2



Isolation_6G to 6G

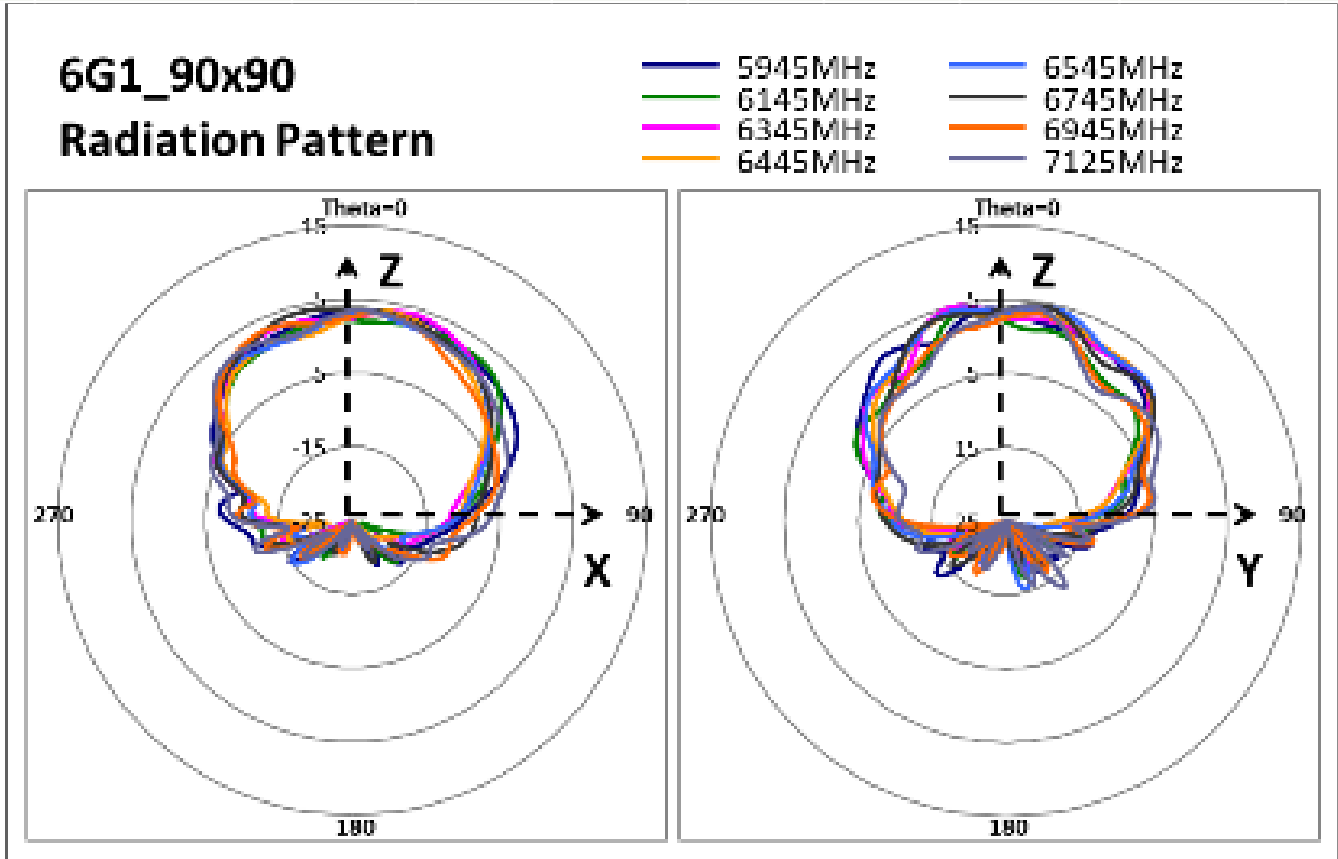
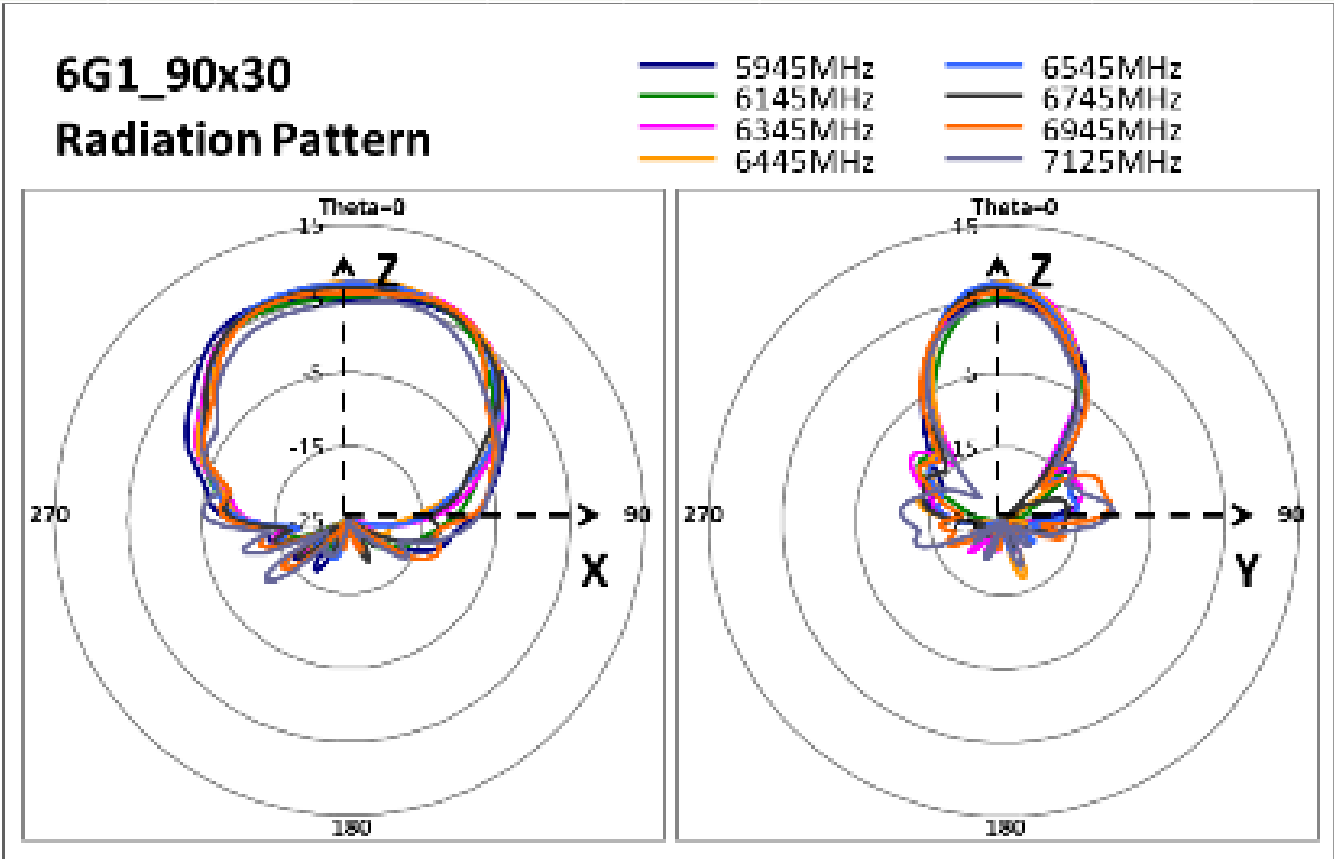
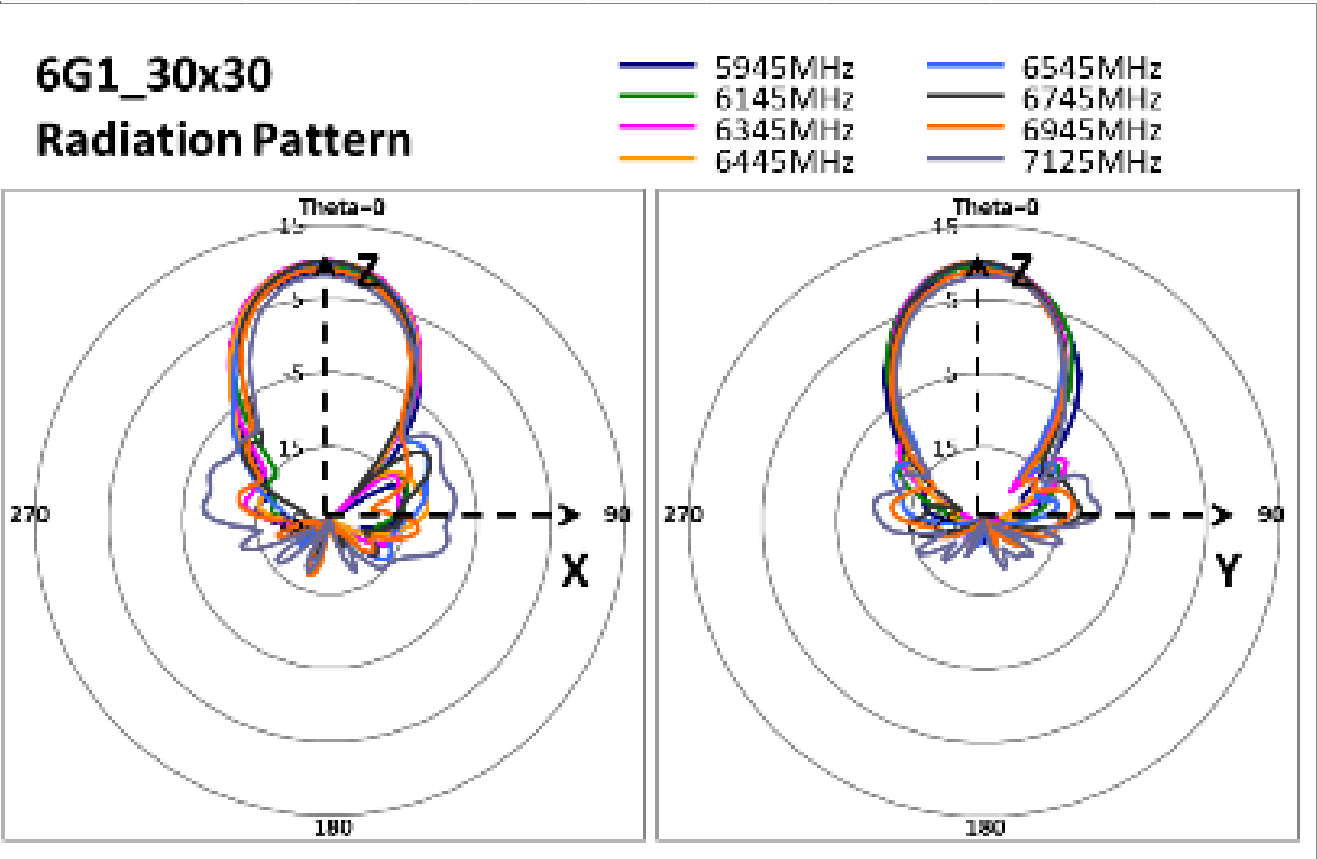
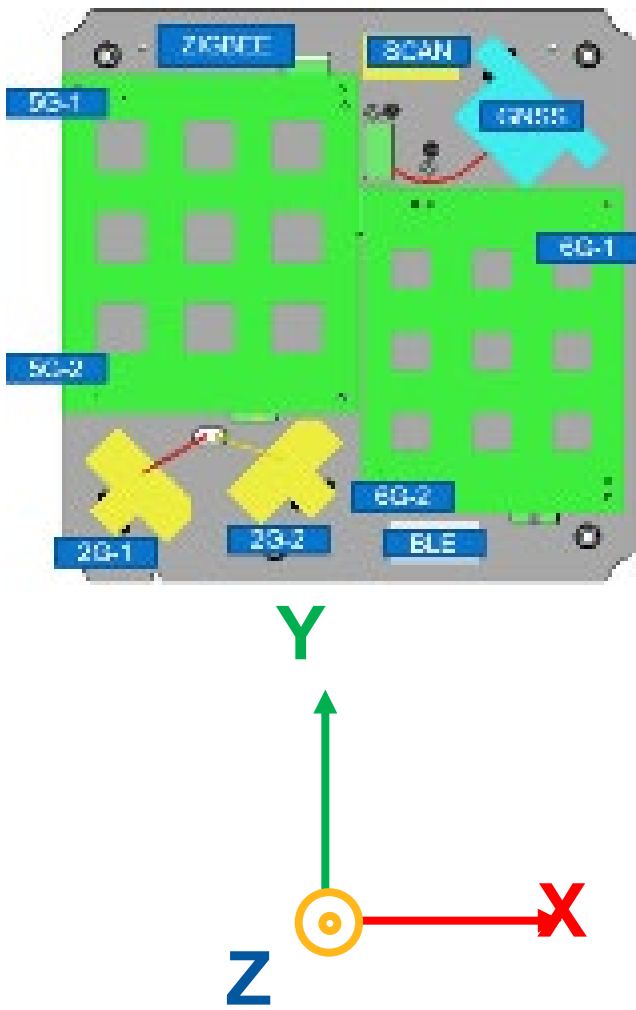


6GHz Array Result – Efficiency/ Peak Gain



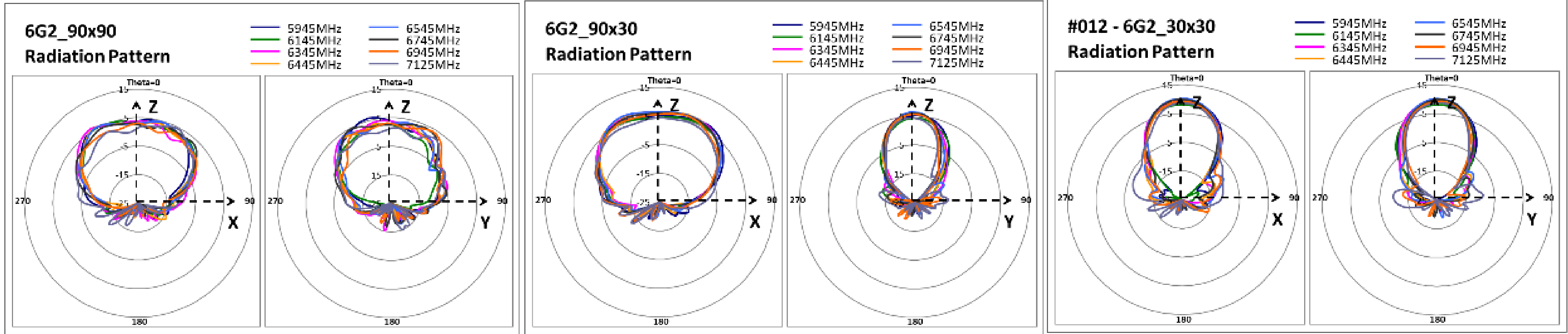
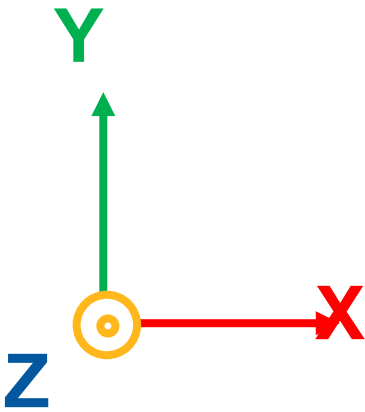
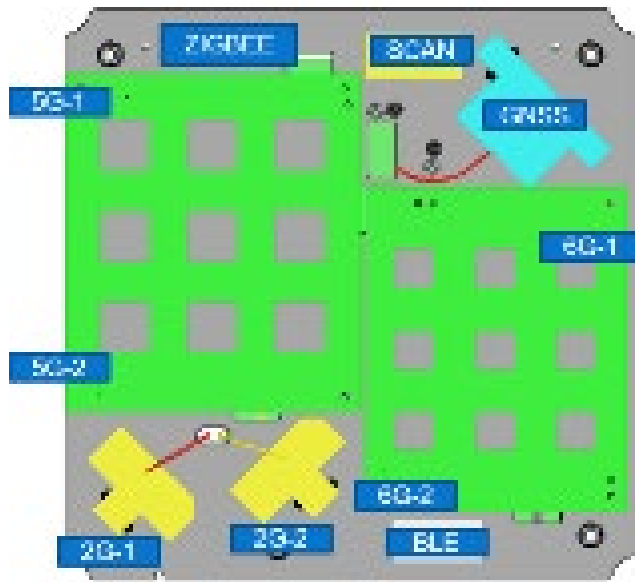
6GHz Array Result – 6G1 Radiation Pattern

Freq (MHz)	90x90								90x30								30x30											
	Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		SLL(dB)	Peak Gain (dBi)					3dB BW (°)		SLL(dB)	
		XZ		YZ		XZ	YZ	XZ	YZ		XZ		YZ		XZ	XZ	YZ	YZ		XZ		YZ		XZ	YZ	XZ	YZ	
		+/-45°	+/-45°	+/-45°	+/-15°						+/-15°	+/-15°	+/-15°															
5945	3.8	1.8	-0.1	0.6	1.3	111	102	99	90	6.6	3.9	3.9	3.1	3.7	99	93	39	18	8.7	6.7	7.4	6.3	7.4	36	36	23	25	
6145	4	2.3	-1.1	-1.7	-2.0	102	51	96	42	6.5	1.9	2.3	3.3	2.4	87	81	30	16	9.6	7.3	8.2	7.2	8.0	36	36	23	20	
6345	4.8	0.5	-0.8	1.5	0.0	90	78	81	51	7.3	3.7	2.4	4.5	4.4	90	81	27	17	10.2	7.8	8.8	6.9	8.4	36	30	23	20	
6445	4.0	-0.4	-0.6	1.1	-0.6	87	90	75	81	7.6	3.7	1.5	3.1	3.6	84	75	27	19	10.1	7.8	8.6	6.7	7.9	36	30	21	23	
6545	4.5	0.2	0.5	1.8	0.2	99	93	90	78	7.2	2.8	2.0	3.7	4.9	84	78	30	20	10.0	7.4	8.2	6.4	8.1	33	30	19	21	
6745	4.5	0.3	0.3	1.3	-2.2	93	63	81	54	6.6	3.3	2.2	2.9	4.5	90	84	30	20	10.0	7.2	8.3	6.6	8.0	30	30	19	22	
6945	3.5	-1.4	0.6	-2.0	-2.8	87	54	78	48	7.0	1.3	0.8	2.8	4.1	78	72	30	16	9.1	6.4	7.6	5.9	6.9	33	30	21	21	
7125	4.2	0.8	1.3	-1.7	-2.6	102	42	93	36	5.3	0.6	0.2	2.0	3.0	84	75	36	15	8.2	5.5	6.4	6.1	6.3	33	33	15	17	
Avg	4.2	0.5	0.0	0.1	-1.1	96	72	87	60	6.8	2.7	1.9	3.2	3.8	87	80	31	18	9.5	7.0	7.9	6.5	7.6	34	32	21	21	



6GHz Array Result – 6G2 Radiation Pattern

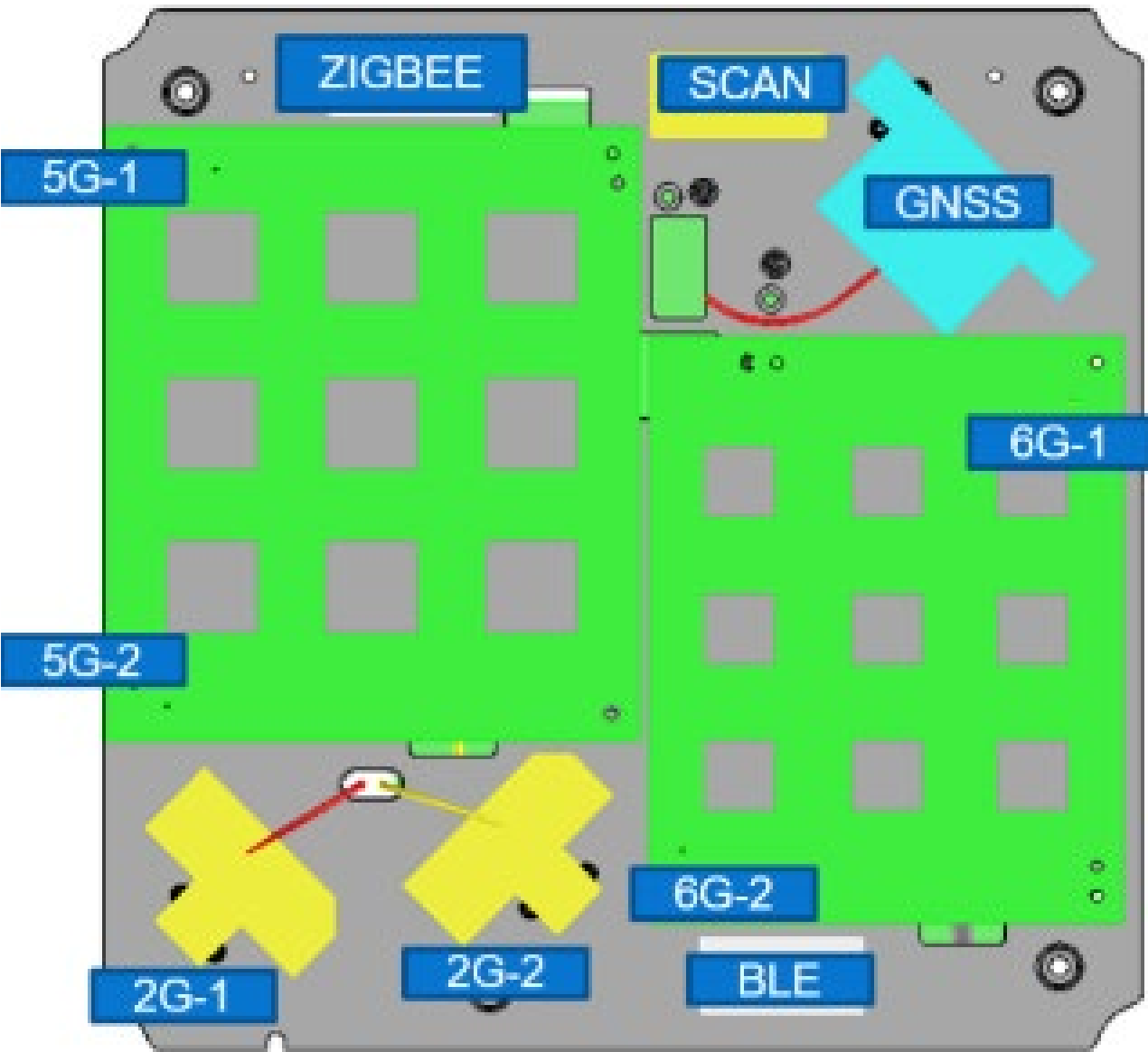
Freq (MHz)	90x90									90x30									30x30									
	Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		Peak Gain (dBi)					4dB BW (°)		3dB BW (°)		SLL(dB)	Peak Gain (dBi)					3dB BW (°)		SLL(dB)	
		XZ		YZ		XZ	YZ	XZ	YZ		XZ		YZ		XZ	XZ	YZ	YZ		XZ		YZ		XZ	YZ	XZ	YZ	
		+/-45°	+/-45°	+/-45°	+/-15°						+/-15°	+/-15°	+/-15°															
5945	5.8	-0.2	3.0	-2.2	0.8	90	51	81	39	6.7	5.1	4.3	4.2	2.7	105	96	39	24	9.2	8.1	7.2	7.8	7.1	39	36	24	27	
6145	5.3	2.0	1.7	-5.9	0.1	93	78	48	60	5.7	3.8	3.9	3.0	2.5	105	99	39	18	8.2	6.8	6.9	6.7	6.6	42	39	27	21	
6345	5.9	1.5	4.2	-4.0	2.2	72	87	66	69	6.8	3.7	4.5	3.5	4.1	99	90	33	19	9.6	8.1	7.7	7.5	7.7	36	33	22	21	
6445	5.5	1.6	2.0	-4.0	1.5	90	87	69	78	7.3	3.6	4.2	3.5	3.9	93	84	30	21	10.0	8.4	8.2	8.0	7.7	33	33	19	21	
6545	5.4	1.6	2.0	-5.7	1.2	93	84	84	81	7.5	4.0	3.7	3.4	3.9	93	87	30	17	10.3	8.3	8.2	8.3	7.6	33	30	17	20	
6745	4.7	3.2	2.0	-2.8	-0.2	114	84	108	78	6.7	3.4	3.1	3.5	4.0	93	87	30	21	10.0	7.9	8.0	8.1	7.0	33	30	22	21	
6945	4	1.0	1.7	-0.2	-3.4	117	81	111	81	6.5	2.4	3.1	2.7	3.7	90	81	30	21	9.3	7.2	7.1	7.2	6.6	33	30	19	22	
7125	4.5	0.3	-1.6	-1.8	0.0	48	99	42	24	4.5	1.6	2.8	1.4	2.9	111	99	30	17	8.8	6.7	6.0	6.9	6.0	30	30	15	18	
Avg	5.1	1.4	1.9	-3.3	0.3	90	81	76	64	6.5	3.5	3.7	3.2	3.5	99	90	33	20	9.4	7.7	7.4	7.6	7.0	35	33	21	21	



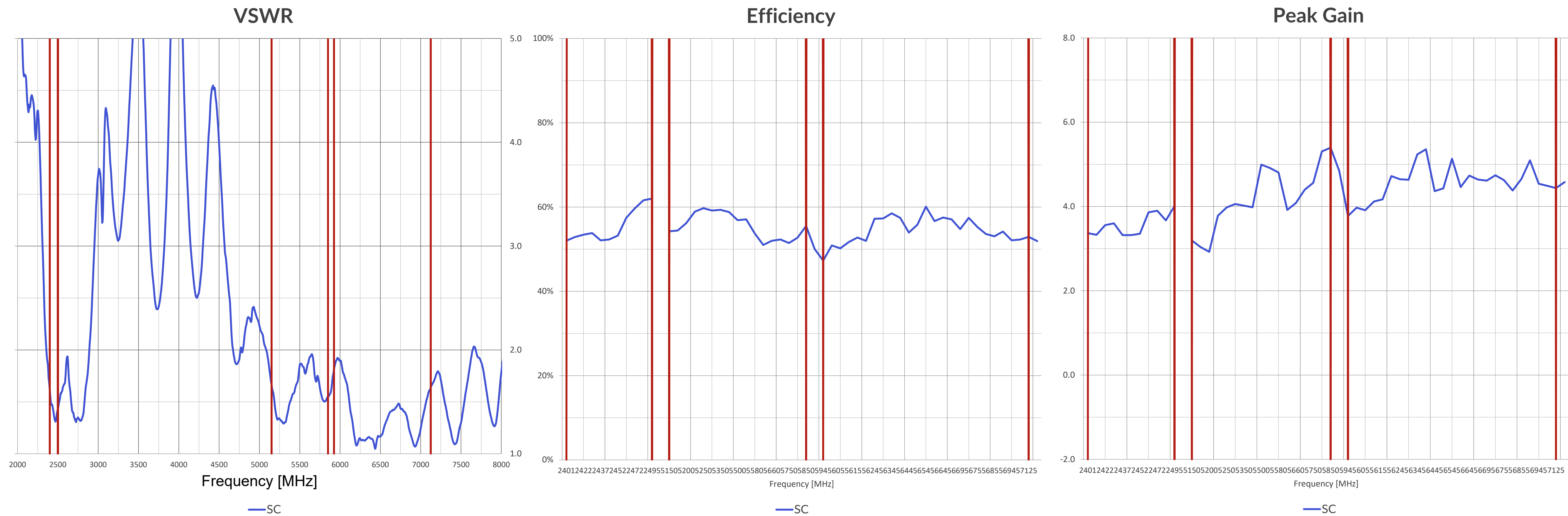
Summary – Omni Antenna

- PIFA for scanning, BLE, Zigbee, GNSS
- The antenna performance meets the requirements

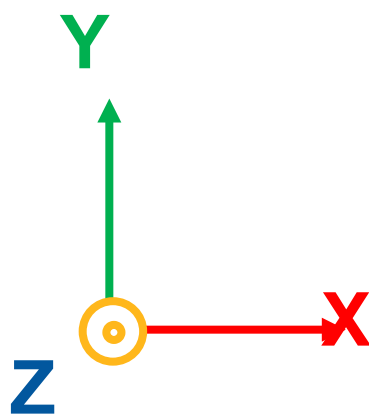
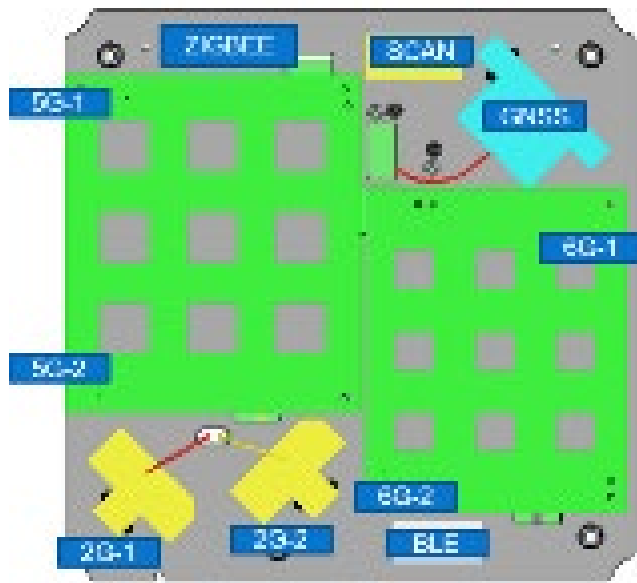
	Type	Frequency	Peak Gain	Avg Eff
SC Radio	PIFA	2.4-2.5GHz	<4.0dBi	~51%
		5.15-5.85GHz	<5.4dBi	~57%
		5.925-7.125GHz	<5.4dBi	~55%
Zigbee	PIFA	2.4-2.5GHz	<4.1dBi	~57%
BLE	PIFA	2.4-2.5GHz	<3.8dBi	~59%
GNSS	PIFA	L5	1.1dBi	~46%
		L1	2.5dBi	~59%



SC Antenna Result – VSWR/ Efficiency/ Peak Gain



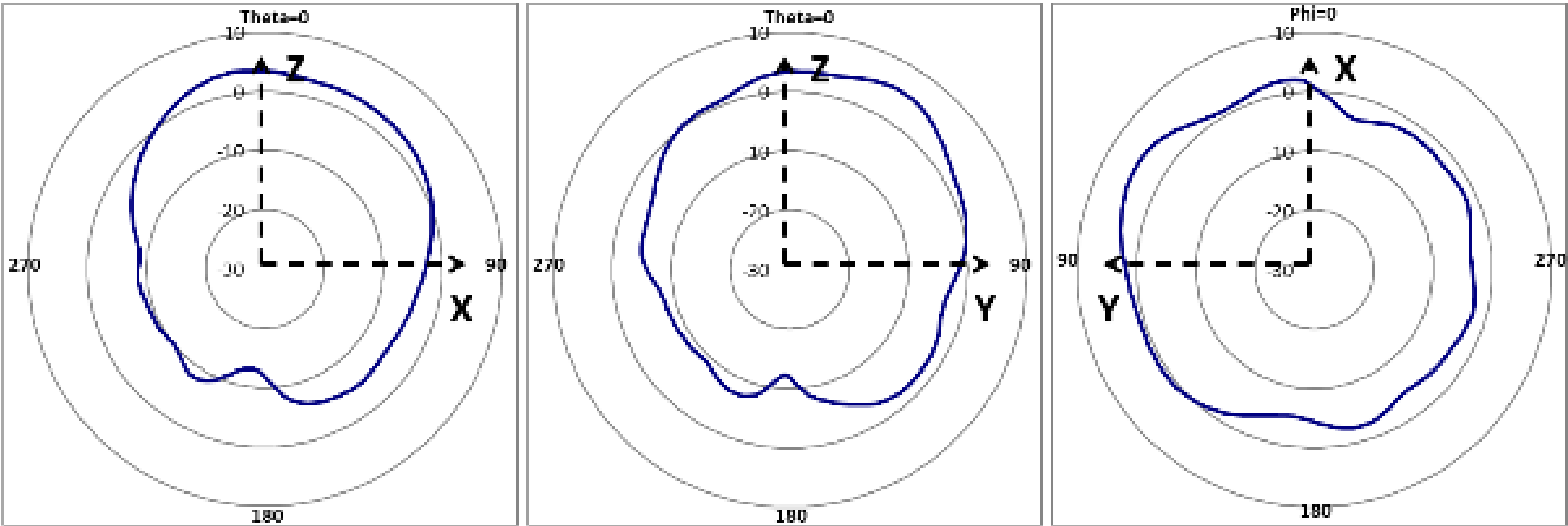
Scanning Antenna Result – Radiation Pattern



SC
Radiation Pattern

2.4GHz

XY (θ:60°)



Gain Variation
on XY Plane

2.4GHz

5GHz

6GHz

Scanning

9.7dB

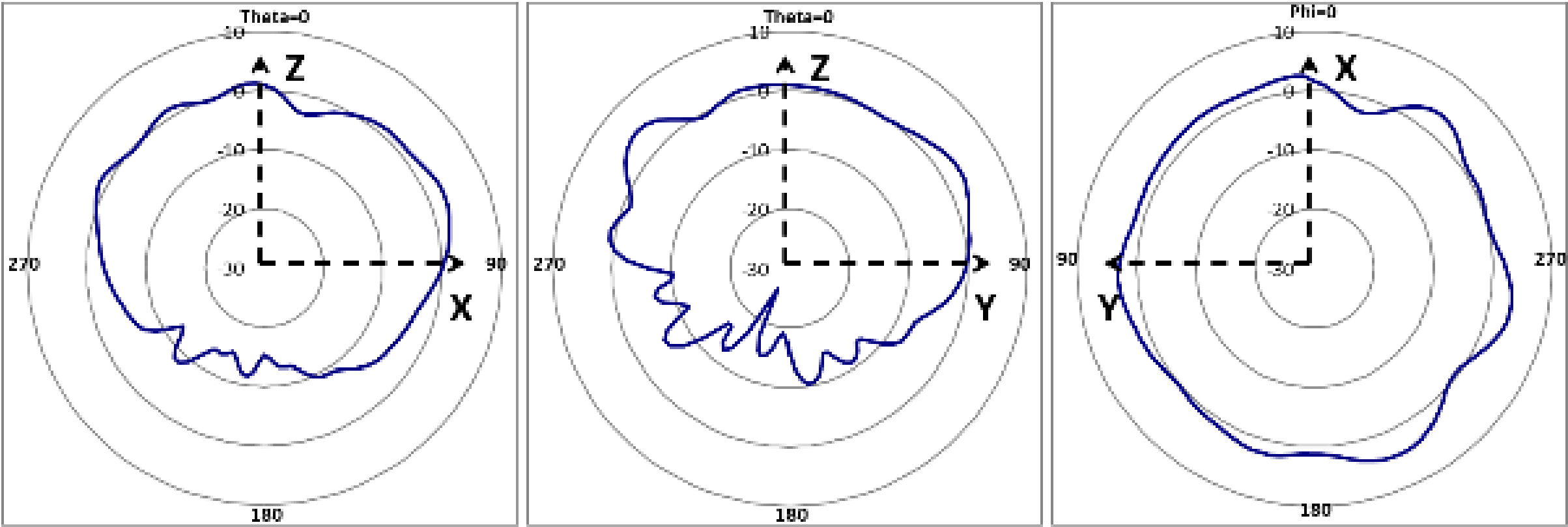
6.8dB

8.5dB

SC
Radiation Pattern

5GHz

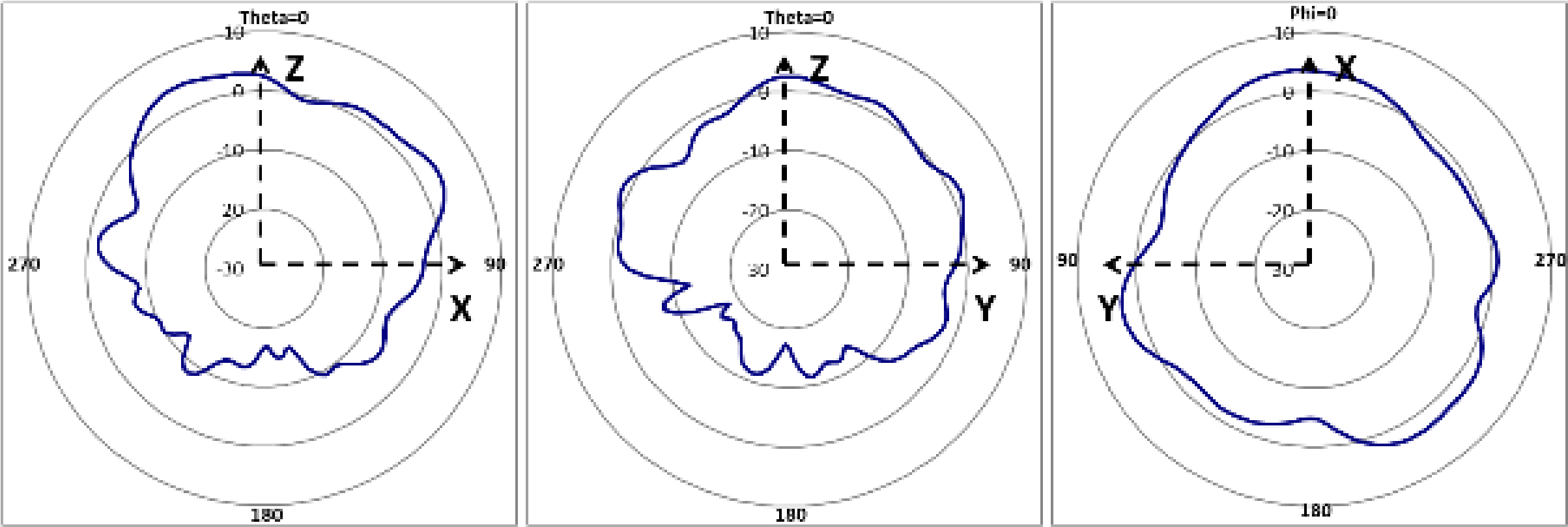
XY (θ:60°)



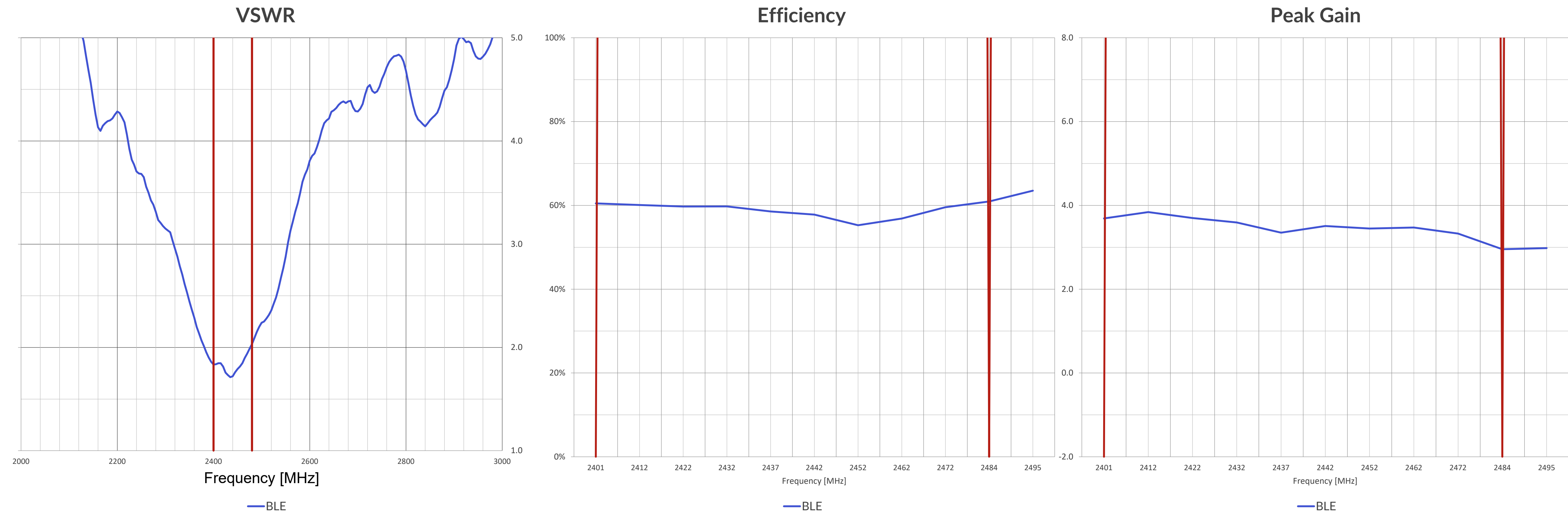
SC
Radiation Pattern

6GHz

XY (θ:60°)

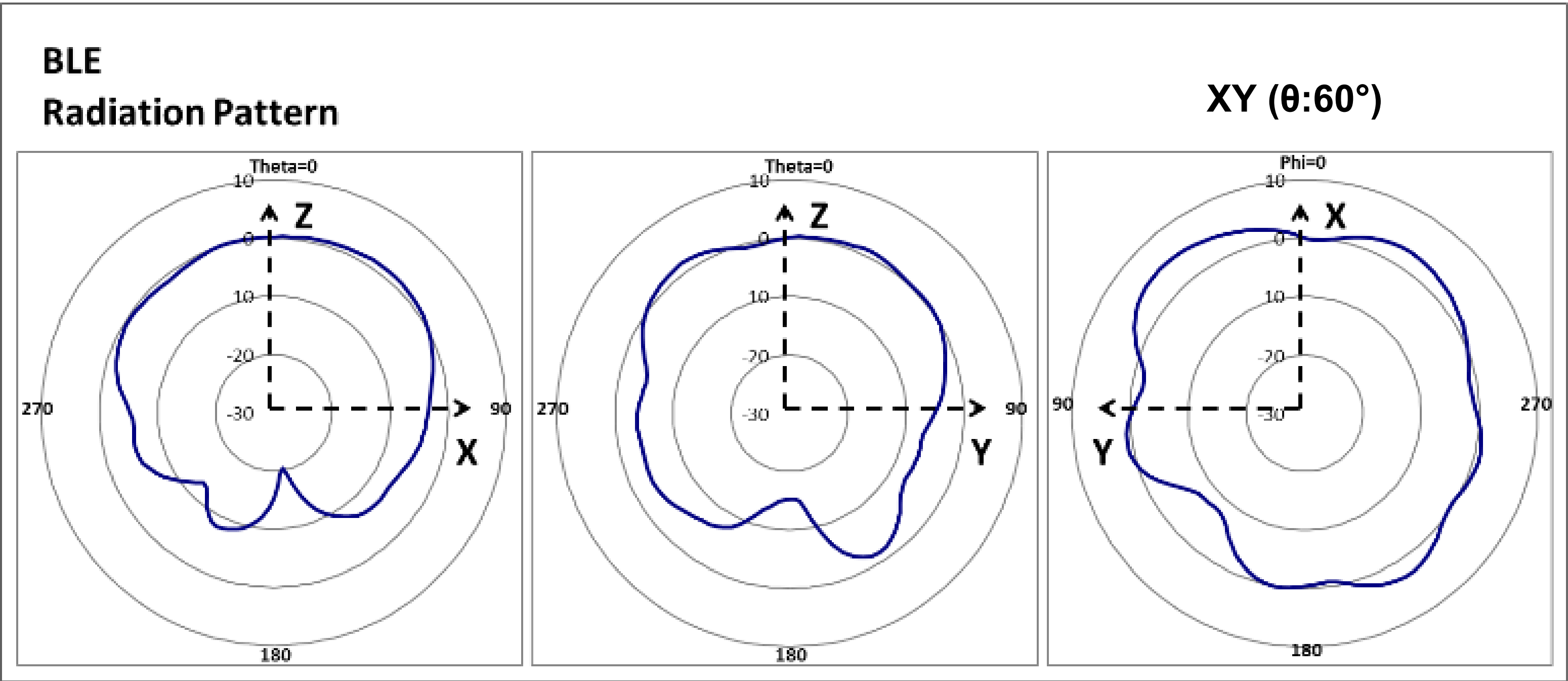
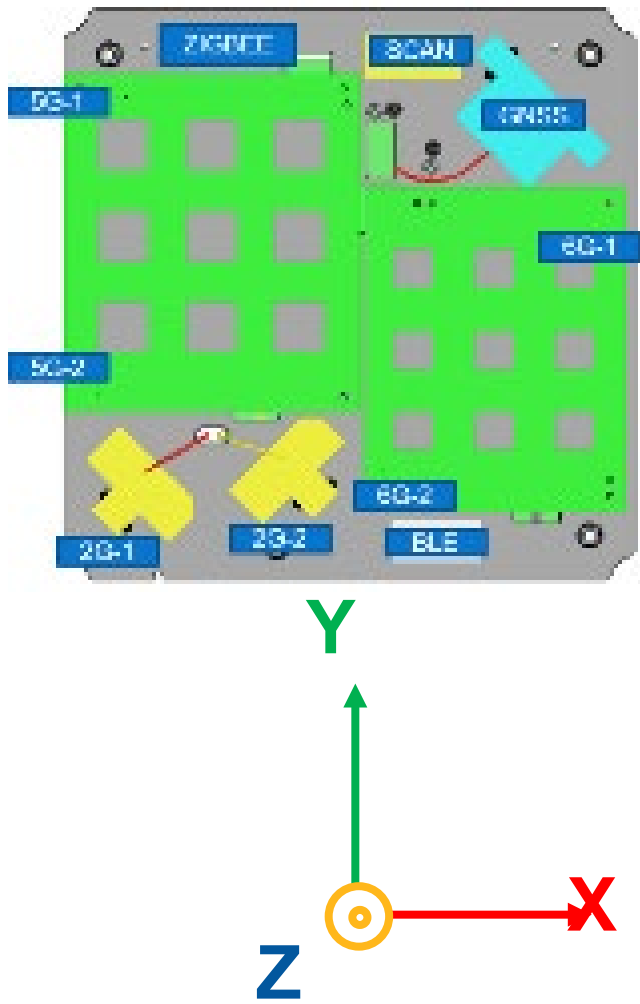


BLE Antenna Result – VSWR/ Efficiency/ Peak Gain

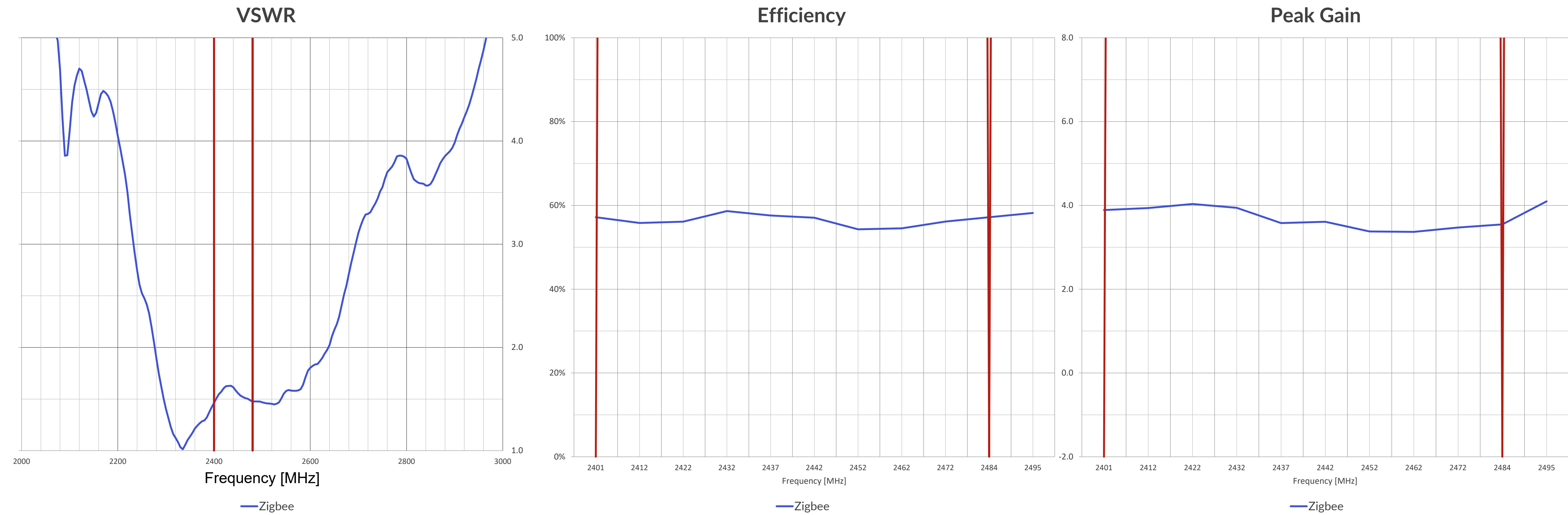


BLE Antenna Result – Radiation Pattern

Gain Variation on XY Plane	2.4GHz
BLE	11.5dB

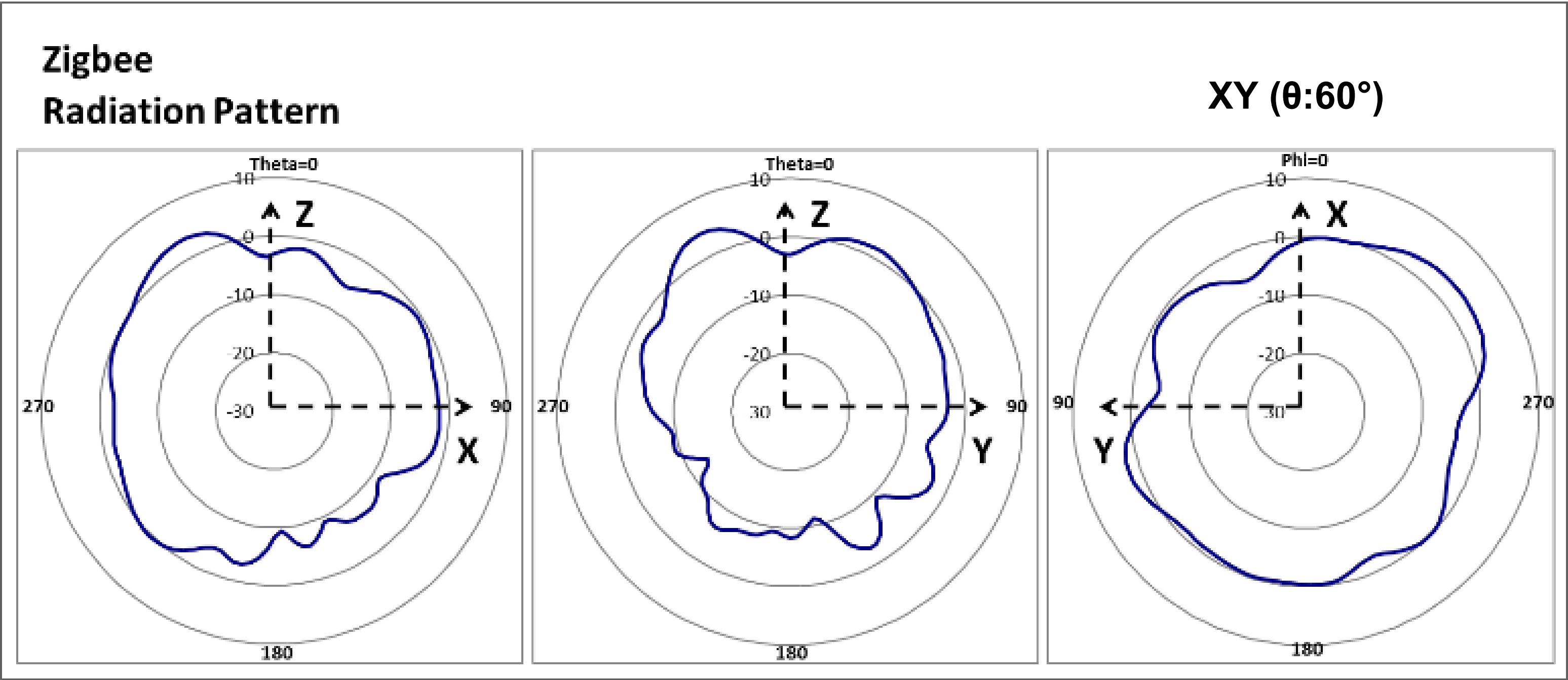
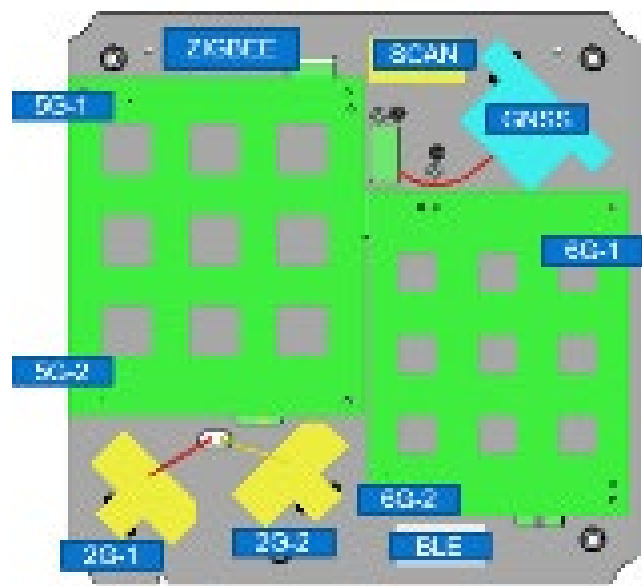


Zigbee Antenna Result – VSWR/ Efficiency/ Peak Gain

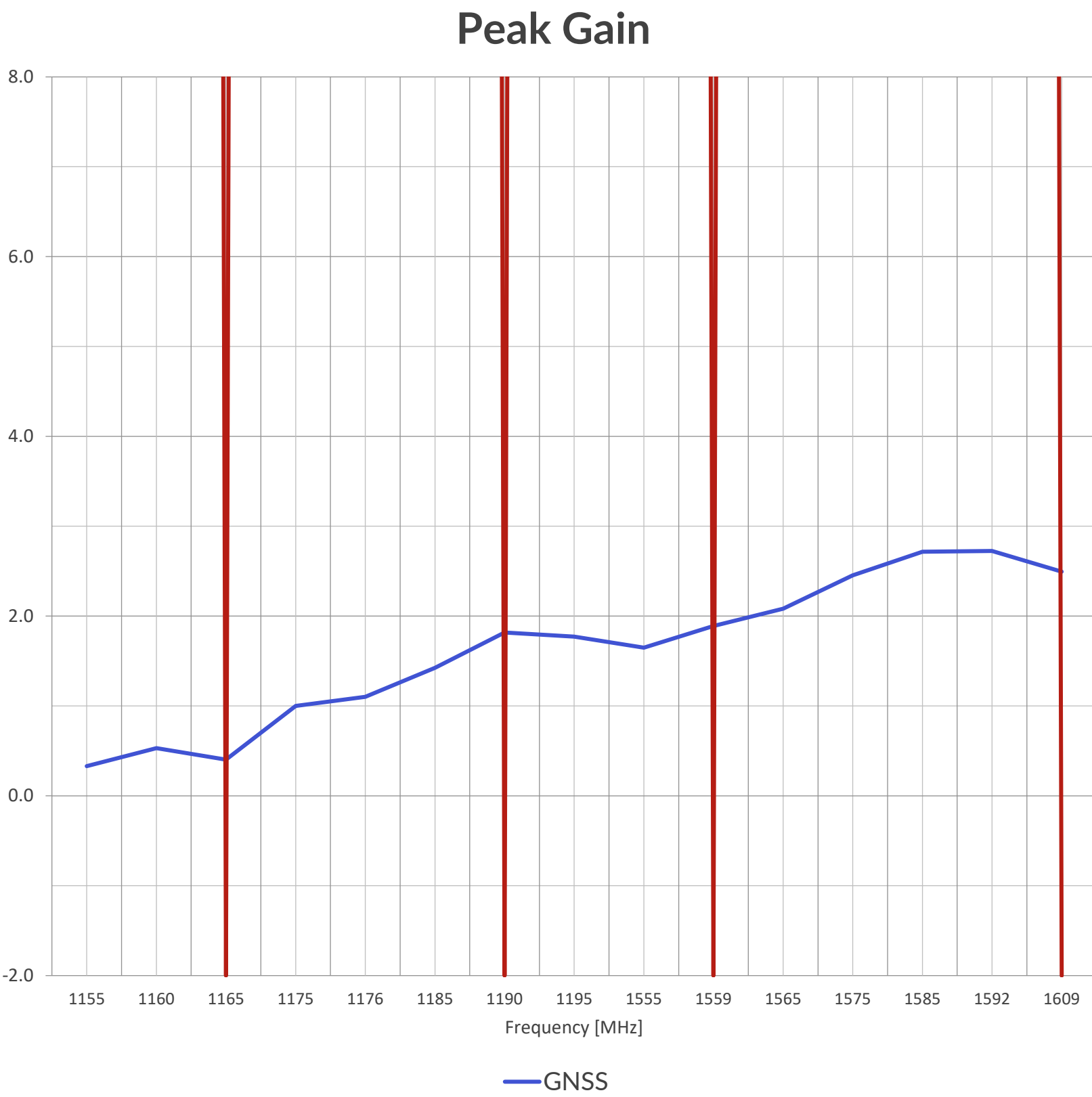
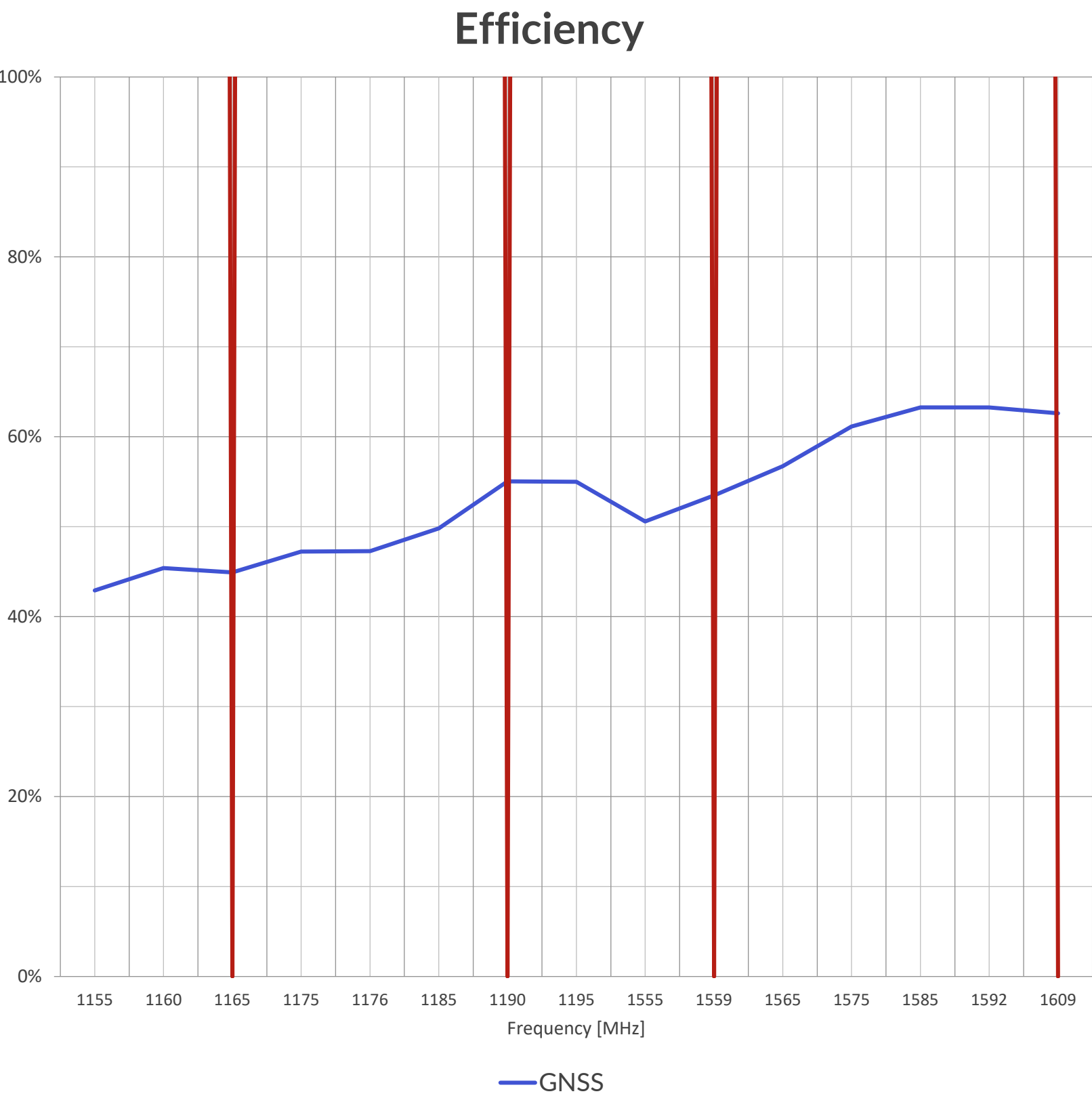
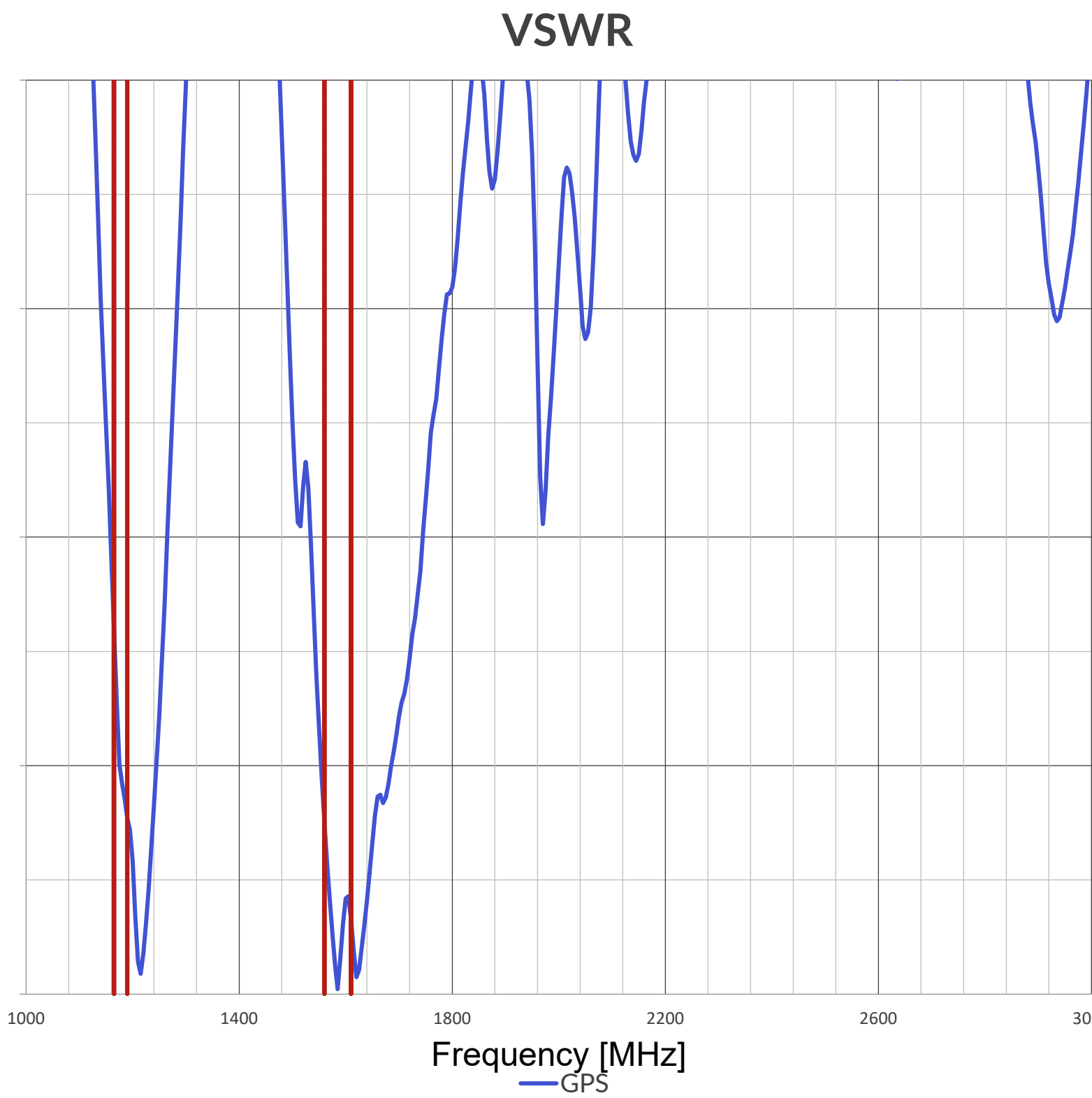


Zigbee Antenna Result – Radiation Pattern

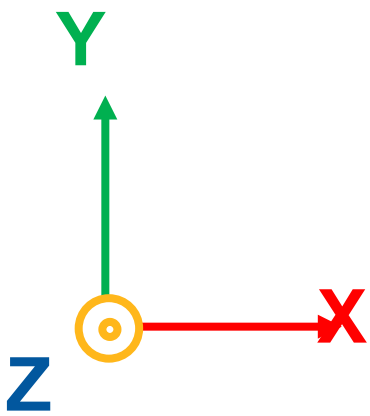
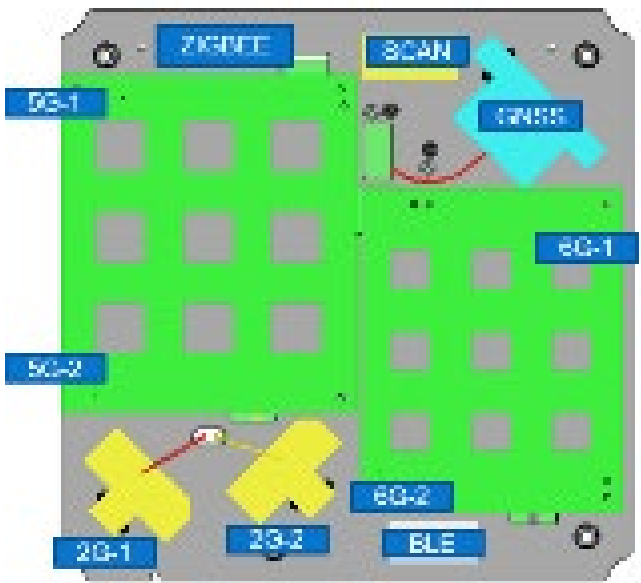
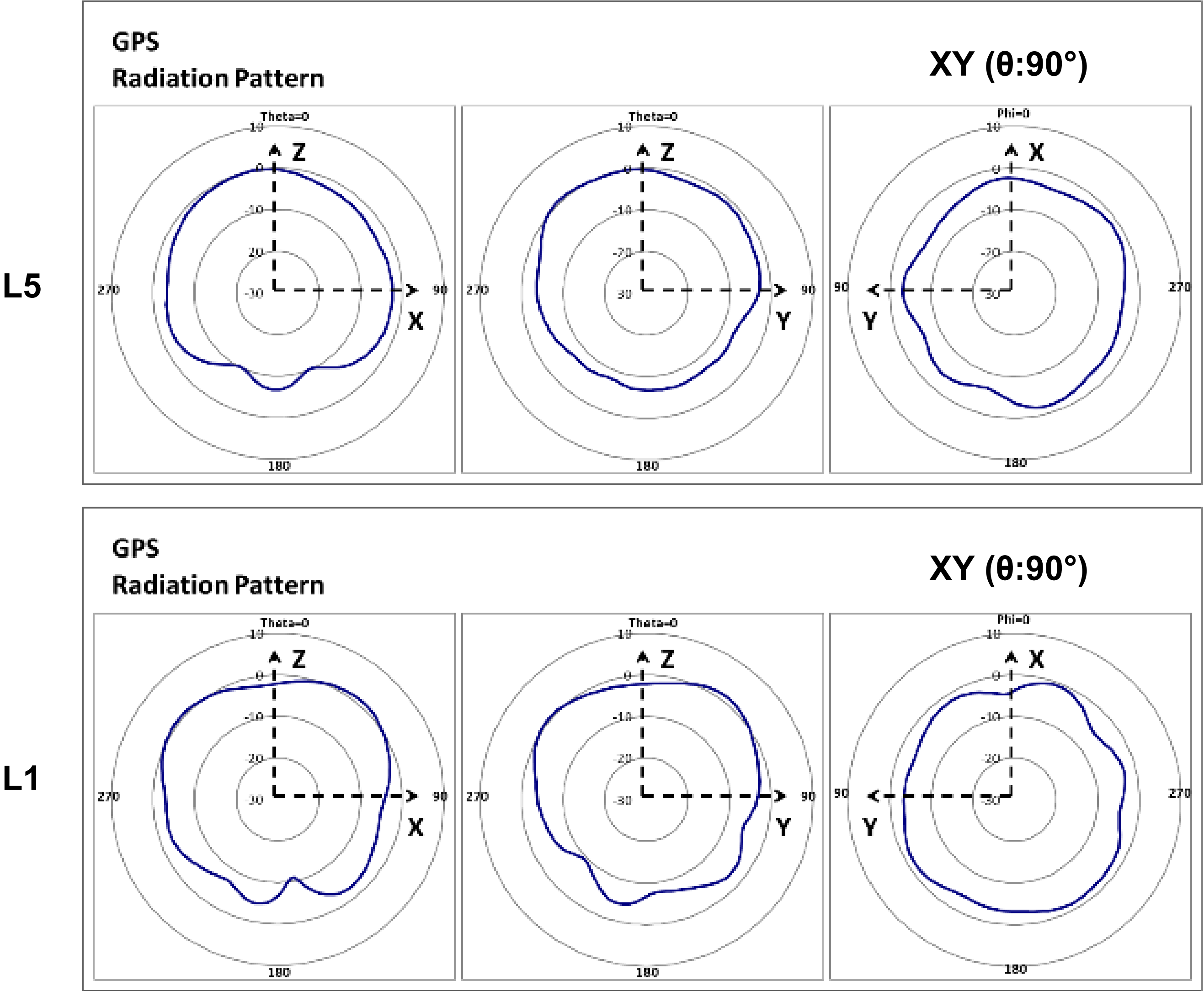
Gain Variation on XY Plane	2.4GHz
Zigbee	8.8dB



GNSS Antenna Result – VSWR/ Efficiency/ Peak Gain



GNSS Antenna Result – Radiation Pattern



Gain Variation on XY Plane	L5	L1
GNSS	4.6dB	4.4dB