aruba
a Hewlett Packard Enterprise company

AP-735 Antenna Test report

Date: 2023/11/10

Author: Hennry

Contents

Revision History

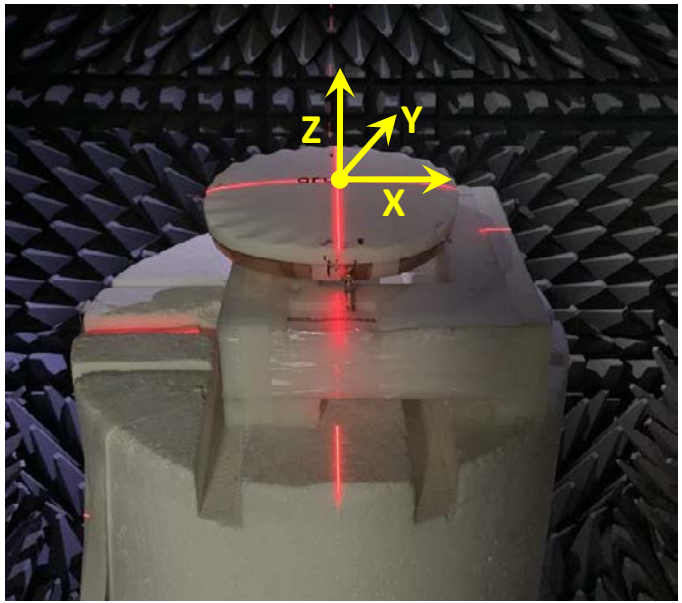
Released Date	Version	Record
2023/11/10	Rev 01	Initial Solution

Test Information

Item	Description
Brand Name	HPE Aruba
DUT Equipment	Wi-Fi 6E 11ax Triple Band Access Point
Test Location	Beijing
Test Condition	RayZone 2800
Test Engineer	Yanzhengsen
Test Environment	Microwave chamber
Test Date	2023/11/10

Test Setup & Procedure

Test Setup for Radiation Pattern Measurement



Test Configuration

Test System

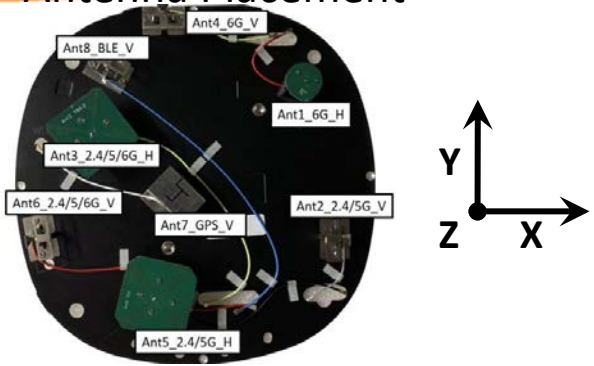
Test Equipment & Calibration

Network analyzer and reference antennas are used for calibration. Path loss and cable loss for different frequency bands can be checked.

Instrument	Brand	Characteristics	Model No.	Serial No.	Calibration Date
Electric dipole sleeve antenna	GTS	600 MHz ~ 700 MHz	RA-L0607DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	700 MHz ~ 800 MHz	RA-L0708DP	19011001	Dec.14, 2022
Electric dipole sleeve antenna	GTS	800 MHz ~ 1000 MHz	RA-L0810DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	1100 MHz ~ 1300 MHz	RA-L1113DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	1400 MHz ~ 1700 MHz	RA-L1417DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	1700 MHz ~ 1900 MHz	RA-L1719DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	1900 MHz ~ 2300 MHz	RA-L1923DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	2300 MHz ~ 2900 MHz	RA-L2329DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	2900 MHz ~ 3200 MHz	RA-L2932DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	3200 MHz ~ 3800 MHz	RA-L3238DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	3800 MHz ~ 4400 MHz	RA-L3844DP	19011002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	4400 MHz ~ 4900 MHz	RA-L4449DP	202011003	Dec.14, 2022
Electric dipole sleeve antenna	GTS	4900 MHz ~ 5900 MHz	RA-L4959DP	202101002	Dec.14, 2022
Electric dipole sleeve antenna	GTS	5900 MHz ~ 6900 MHz	RA-L5969DP	202011003	Dec.14, 2022
Electric dipole sleeve antenna	GTS	6900 MHz ~ 8000 MHz	RA-L6980DP	202101002	Dec.14, 2022
MaxSign Libra	GTS	Control chamber System	RayZone2800C_Z		Non-Calibration Required

Antenna Details

Antenna Placement



Ant No.	Part Number	Operating Band	Type	Size(L*W*H)	Cable Length(mm)	Polarization type	Cable type	Material
A1	ANT1-735-Single	WIFI 6G	Dipole	25.3*22.3*1	105	Horizontal	1.37 normal	GF300
A2	ANT2-735-Dual	WIFI 2+5G	PIFA	27.2*19.2*12.7	79	Vertical	1.37 normal	Steel
A3	ANT3-735-Triple	BLE + WIFI5G/ 6G	Dipole	39.91*39.9*1	190	Horizontal	1.37 normal	GF300
A4	ANT4-735-Single	WIFI 6G	PIFA	27.2*19.2*12.7	55	Vertical	1.37 normal	Steel
A5	ANT5-735-Dual	WIFI 2+5G	Dipole	42*40.73*1	143	Horizontal	1.37 normal	GF300
A6	ANT6-735-Triple	BLE + WIFI5G/ 6G	PIFA	27.2*19.2*12.7	159	Vertical	1.37 normal	Steel
A7	ANT7-735-Dual	GPS L1+L5	PIFA	30*28.2*15.89	95	Vertical	1.37 normal	Steel
A8	ANT8-735-Single	BLE	PIFA	27.2*19.2*12.7	210	Vertical	1.37 normal	Steel

Result Summary------Wifi 2.4G

Results summary for 2.4GHz

Antenna	Detail Spec	Spec	Ant2-Dual Band			Ant5-Dual Band		
Frequency	2.4~2.48GHz	-	2.4GHz	2.44GHz	2.48GHz	2.4GHz	2.44GHz	2.48GHz
Efficiency	>70%	-	86.24	86.02	89.62	76.35	82.14	75.44
Peak Gain for 3D	3dBi< Peak<5dBi		3.91	3.89	4.0	3.95	4.42	4.55
Horizontal cut Average Gain	60°	<10dB	1.45	1.60	1.99	2.77	3.09	2.56
	70°	<10dB	0.86	1.04	1.42	0.90	1.23	0.78
	80°	<10dB	-0.03	0.09	0.38	-1.37	-1.02	-1.46
	90°	<10dB	-0.96	-1.00	-0.86	-3.72	-3.32	-3.78
Horizontal cut Flatness	60°	<10dB	7.21	7.73	7.04	2.08	2.78	4.47
	70°	<10dB	7.38	8.28	7.08	3.01	3.25	4.22
	80°	<10dB	6.92	8.06	7.24	5.66	4.75	6.19
	90°	<10dB	9.93	9.95	8.53	8.18	6.55	8.07

Result Summary------Wifi 5G

Results summary for 5GHz

Antenna	Detail Spec	Spec	Ant2-Dual Band			Ant3-TripleBand		
Frequency	5.15~5.895GHz	-	5.15GHz	5.49GHz	5.895GHz	5.15GHz	5.49GHz	5.895GHz
Efficiency	>70%	-	75.9	79.69	84.2	68.13	63.38	71.58
Peak Gain for 3D	3dBi< Peak<5dBi		5.28	5.42	5.52	4.14	2.85	3.29
Horizontal cut Average Gain	60°	<10dB	0.83	1.51	1.40	2.21	0.58	0.86
	70°	<10dB	1.36	1.75	2.15	1.06	0.59	1.04
	80°	<10dB	0.94	1.02	1.72	-0.69	-0.31	0.41
	90°	<10dB	-0.47	-0.59	-0.06	-2.89	-2.30	-1.30
Horizontal cut Flatness	60°	<10dB	9.69	8.05	8.80	4.07	4.10	6.06
	70°	<10dB	9.76	8.98	5.90	3.18	3.13	6.30
	80°	<10dB	8.69	9.45	5.32	5.09	4.94	5.41
	90°	<10dB	7.78	9.31	4.26	5.17	5.60	5.22

Result Summary------Wifi 5G

Results summary for 5GHz

Antenna	Detail Spec	Spec	Ant5-Dual Band			Ant6-Triple Band		
Frequency	5.15~5.895GHz	-	5.15GHz	5.49GHz	5.895GHz	5.15GHz	5.49GHz	5.895GHz
Efficiency	>70%	-	75.36	67.63	70.29	67.64	64.08	73.69
Peak Gain for 3D	3dBi< Peak<5dBi		4.47	3.57	3.82	2.78	3.37	4.44
Horizontal cut Average Gain	60°	<10dB	2.60	0.91	0.70	-0.90	-1.02	-0.25
	70°	<10dB	1.75	1.15	1.11	0.04	-0.16	1.01
	80°	<10dB	0.20	0.30	0.47	0.18	-0.20	1.09
	90°	<10dB	-1.87	-1.80	-1.51	-0.42	-1.09	-0.08
Horizontal cut Flatness	60°	<10dB	4.63	6.33	5.83	9.97	8.90	7.59
	70°	<10dB	4.75	3.93	4.75	7.78	8.50	5.95
	80°	<10dB	5.28	4.74	4.20	8.04	7.72	6.53
	90°	<10dB	5.18	5.59	4.91	7.01	6.79	10.5

Result Summary------Wifi 6G

Results summary for 6GHz

Antenna	Detail Spec	Spec	Ant1-Single Band			Ant3-Triple Band		
Frequency	5.925~7.125GHz	-	5.925GHz	6.525GHz	7.125GHz	5.925GHz	6.525GHz	7.125GHz
Efficiency	>70%	-	72.76	88.24	73.07	70.91	84.85	64.49
Peak Gain for 3D	3dBi< Peak<5dBi		3.65	4.22	3.07	3.37	4.55	3.93
Horizontal cut Average Gain	60°	<10dB	0.73	1.17	0.16	0.76	1.53	-0.60
	70°	<10dB	1.73	1.90	0.34	0.98	0.73	-2.16
	80°	<10dB	1.68	2.16	0.57	0.37	0.16	-2.72
	90°	<10dB	0.36	1.73	0.80	-1.36	-0.44	-2.68
Horizontal cut Flatness	60°	<10dB	6.51	7.35	5.82	5.80	4.70	7.74
	70°	<10dB	4.90	6.96	7.22	6.70	7.81	7.10
	80°	<10dB	4.56	8.00	7.99	6.05	8.78	7.61
	90°	<10dB	3.09	5.11	5.13	5.51	4.20	7.83

Result Summary------Wifi 6G

Results summary for 6GHz

Antenna	Detail Spec	Spec	Ant4-Single Band			Ant6-Triple Band		
Frequency	5.925~7.125GHz	-	5.925GHz	6.525GHz	7.125GHz	5.925GHz	6.525GHz	7.125GHz
Efficiency	>70%	-	74.95	86.35	80.91	72.57	82.32	67.09
Peak Gain for 3D	3dBi< Peak<5dBi		3.94	4.10	4.99	4.20	4.80	5.25
Horizontal cut Average Gain Flatness	60°	<10dB	-1.01	0.33	0.69	-0.07	0.93	0.17
	70°	<10dB	0.22	1.35	1.39	1.06	1.52	1.12
	80°	<10dB	0.54	1.41	0.99	0.98	1.17	0.67
	90°	<10dB	-0.13	0.41	-0.49	-0.29	-0.05	-1.15
Horizontal cut Flatness	60°	<10dB	9.26	9.90	7.42	7.27	7.54	5.39
	70°	<10dB	5.90	6.41	8.07	5.52	6.89	6.64
	80°	<10dB	6.11	4.85	7.07	5.96	7.76	7.57
	90°	<10dB	6.15	4.84	7.20	9.91	8.55	8.70

Result Summary------BLE&Zigbee

Results summary for BLE&Zigbee

Antenna	Detail Spec	Spec	Ant3-Triple Band			Ant6-Triple Band			Ant8-Single Band		
Frequency	2.4~2.48GHz	-	2.4GHz	2.44GHz	2.48GHz	2.4GHz	2.44GHz	2.48GHz	2.4GHz	2.44GHz	2.48GHz
Efficiency	>70%	-	70.92	79.24	77.72	80.33	78.65	82.9	77.38	77.27	80.35
Peak Gain for 3D	3dBi< Peak<5dBi		3.73	4.47	4.74	3.05	3.30	3.60	4.37	4.51	4.30
Horizontal cut Average Gain	60°	<10dB	2.35	3.00	2.78	0.80	0.70	1.17	0.78	0.95	1.15
	70°	<10dB	0.55	1.01	0.89	0.26	0.16	0.48	0.34	0.42	0.69
	80°	<10dB	-1.62	-1.33	-1.38	-0.39	-0.48	-0.36	-0.57	-0.64	-0.36
	90°	<10dB	-3.78	-3.59	-3.66	-0.98	-1.06	-1.09	-1.74	-1.96	-1.73
Horizontal cut Flatness	60°	<10dB	2.79	3.73	4.56	5.31	5.31	4.95	7.80	8.73	7.25
	70°	<10dB	4.01	4.10	4.82	6.81	6.06	5.76	7.25	8.15	7.79
	80°	<10dB	6.22	6.61	5.94	6.82	5.95	7.25	7.59	7.58	8.29
	90°	<10dB	8.90	9.81	9.37	9.35	8.44	10.6	8.57	8.27	8.93

Result Summary------GNSS

Results summary for 6GHz

Antenna	Detail Spec	Spec	Ant7-Dual Band	
Frequency	1.15~1.61GHz	-	1.176GHz	1.575GHz
Efficiency	>70%	-	70.29	74.57
Peak Gain for 3D	3dBi< Peak<5dBi		3.38	4.26
Horizontal cut Average Gain	60°	<10dB	-0.06	1.02
	70°	<10dB	-0.59	0.15
	80°	<10dB	-1.48	-1.17
	90°	<10dB	-2.66	-2.70
Horizontal cut Flatness	60°	<10dB	5.50	5.32
	70°	<10dB	4.87	5.36
	80°	<10dB	3.67	4.42
	90°	<10dB	2.49	2.67

Result Summary - Uncorrelated Gain & Correlated Gain

	Frequency (MHz)	Uncorrelated Gain (dBi)	Ants included
2.4G Wi-Fi	2400	3.84	A2&A5
	2440	3.76	A2&A5
	2480	3.68	A2&A5
5GHz Wi-Fi	5150	4.08 / 2.49	A2&A5/A3&A6
	5490	3.87 / 2.47	A2&A5/A3&A6
	5895	3.88 / 3.11	A2&A5/A3&A6
6GHz Wi-Fi	5925	3.68 / 2.97	A1&A4/A3&A6
	6525	3.7 / 3.62	A1&A4/A3&A6
	7125	3.84 / 2.66	A1&A4/A3&A6

Calculations

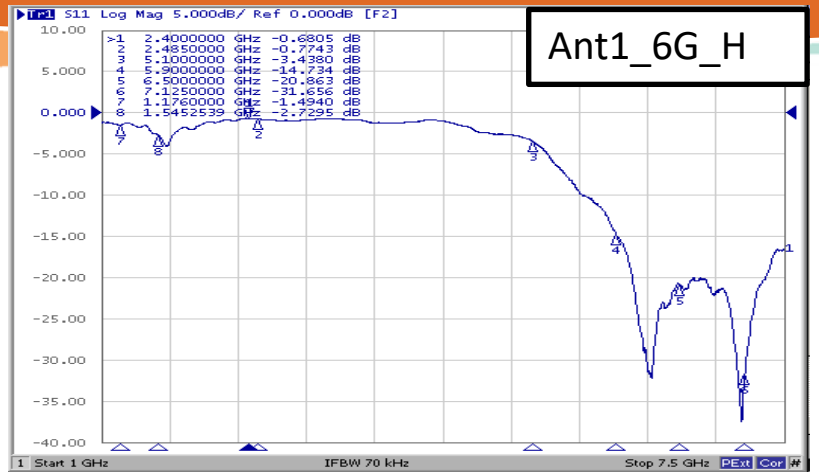
Because the antennas are fixed in location within the device the directional antenna gain for MIMO is calculated over a sphere using the raw spatial data taken at 2 degree steps of theta and phi for each antenna using the equations from KDB 662911 D01. The raw antenna data is located in the appendix of this report.
The uncorrelated antenna gain was calculated using KDB 662911 D01, F(2)(d)(ii)
The uncorrelated gain was calculated for each point in the spatial data, and the highest value reported.

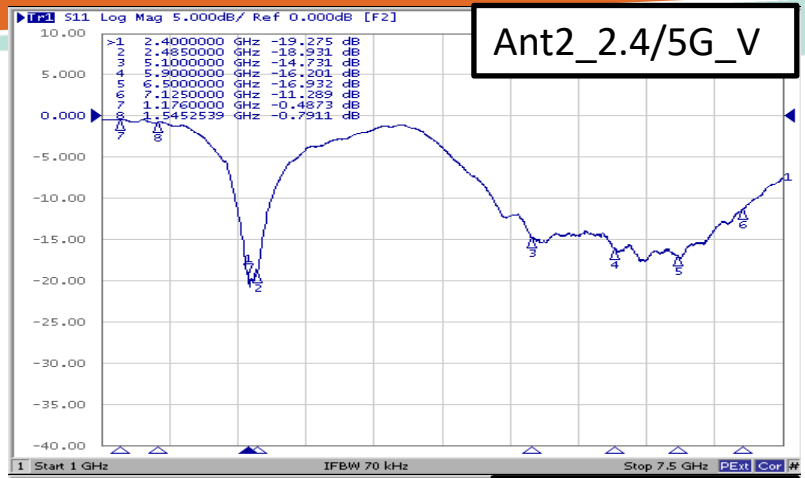
2.4GHz uncorrelated calculation:
Maximum uncorrelated gain: 3.84dBi
$= 10*\log(((10^{\wedge(G0/10)})+(10^{\wedge(G1/10)}))/2)$
$= 10*\log(((10^{\wedge(3.8/10)})+(10^{\wedge(3.89/10)}))/2)$
This occurs at: 2400MHz, phi 74/theta 54

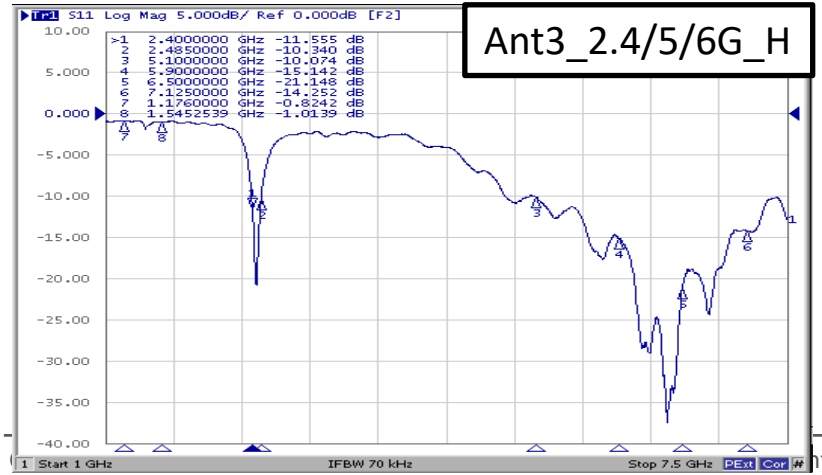
5GHz uncorrelated calculation:
Maximum uncorrelated gain: 4.08dBi
$= 10*\log(((10^{\wedge(G0/10)})+(10^{\wedge(G1/10)}))/2)$
$= 10*\log(((10^{\wedge(4.29/10)})+(10^{\wedge(3.86/10)}))/2)$
This occurs at: 5150MHz, phi 162/theta 198

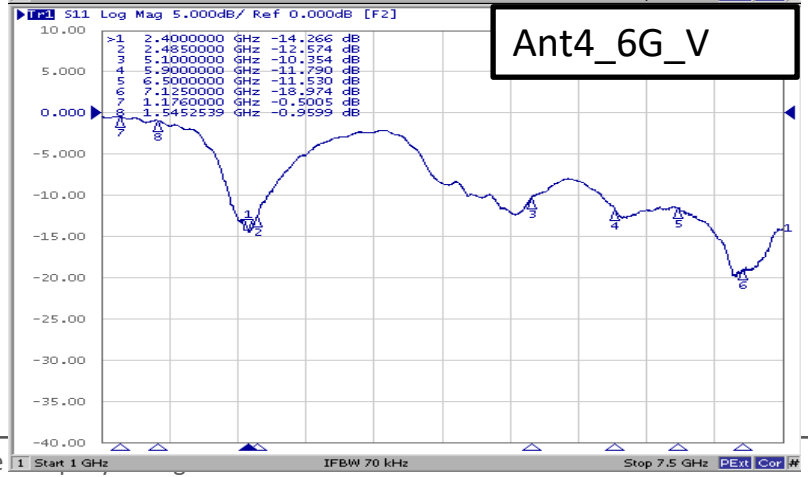
6GHz uncorrelated calculation:
Maximum uncorrelated gain: 3.84dBi
$= 10*\log(((10^{\wedge(G0/10)})+(10^{\wedge(G1/10)}))/2)$
$= 10*\log(((10^{\wedge(2.33/10)})+(10^{\wedge(4.96/10)}))/2)$
This occurs at: 7125MHz, phi 118/theta 286

Measurement Data-----Return Loss

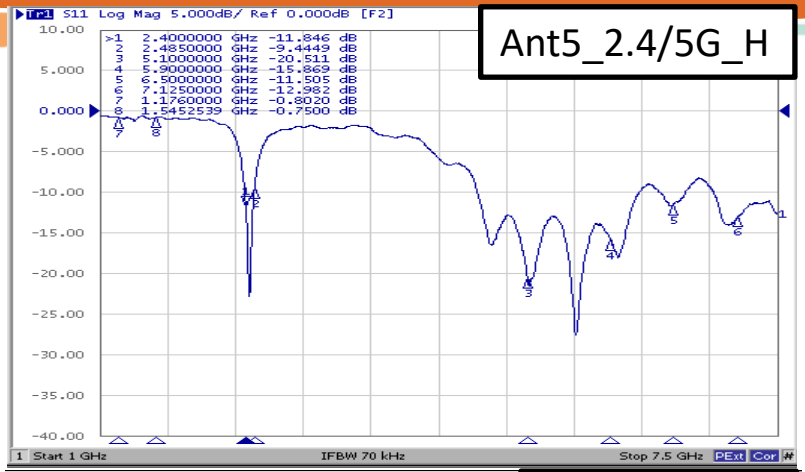




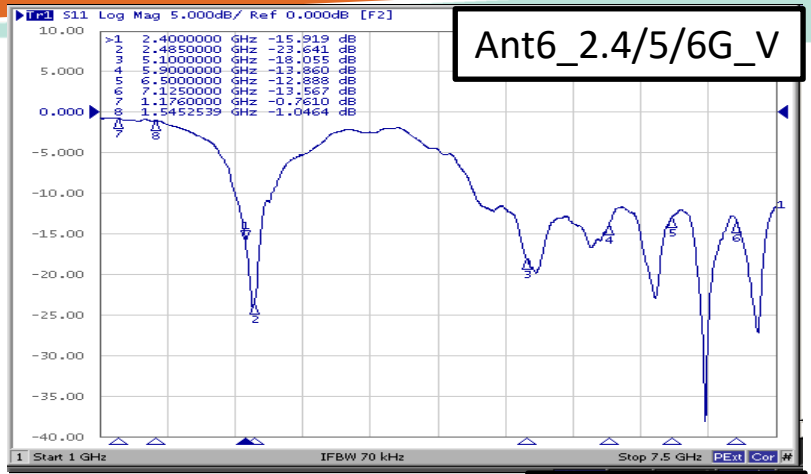




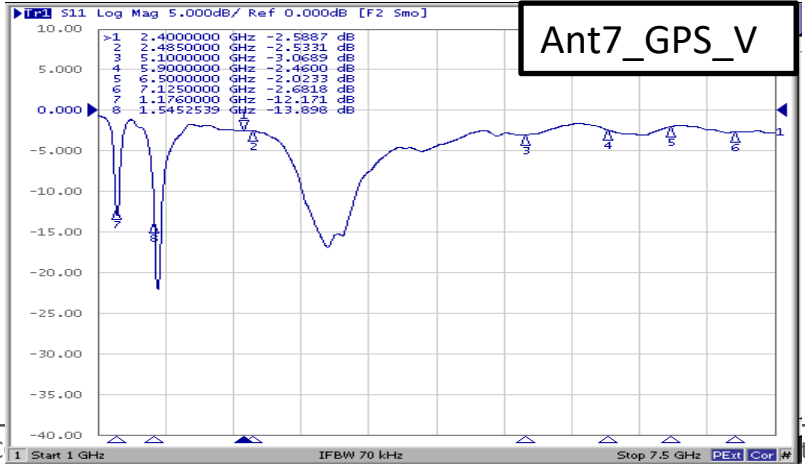
Measurement Data-----Return Loss



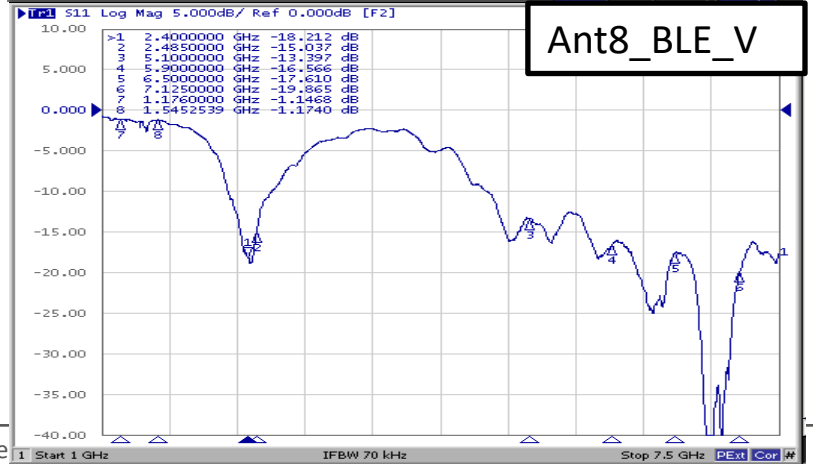
Ant5_2.4/5G_H



Ant6_2.4/5/6G_V



Ant7_GPS_V

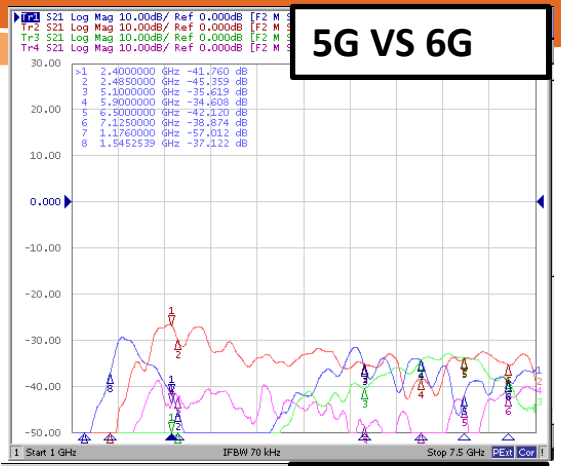


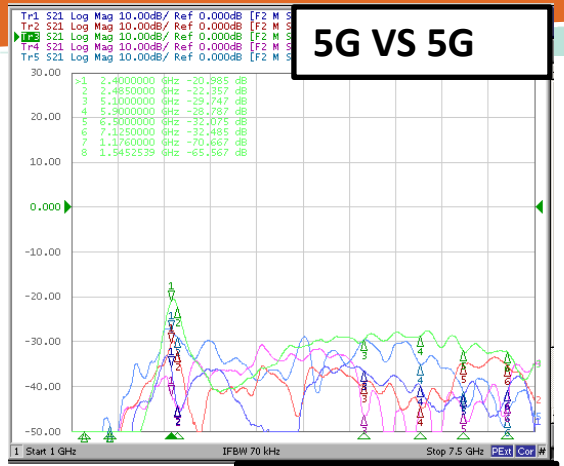
Ant8_BLE_V

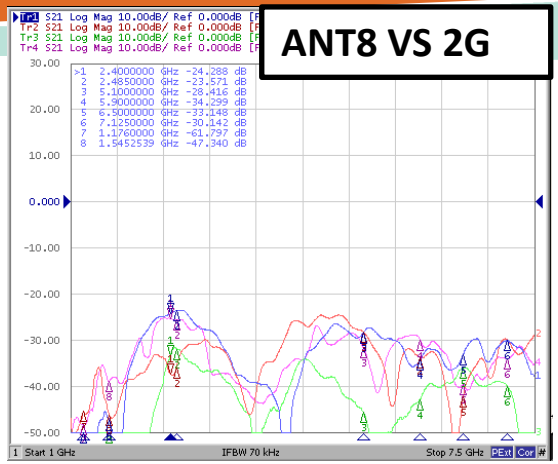
Measurement Data-----Return Loss

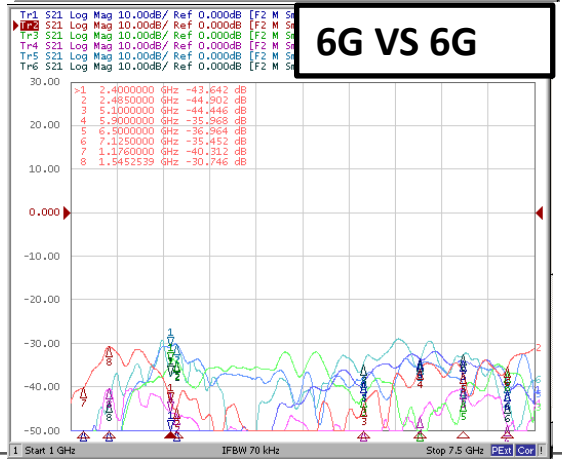
Return Loss	Frequency (MHz)	ANT1	ANT2	ANT3	ANT4	ANT5	ANT6	ANT7	ANT8
2.4G Wi-Fi&BLE	2440	--	-19.2	-10	--	-11.2	-15.9	--	-15.3
	2440	--	-19.4	-19.3	--	-21.6	-19.2	--	-16.2
	2480	--	-18.9	-11	--	-10	-23.6	--	-15.7
5GHz Wi-Fi	5150	--	-14.7	-10	--	-20.8	-18	--	--
	5490	--	-15.5	-12.7	--	-17.7	-14.9	--	--
	5895	--	-16.2	-15.1	--	-15.4	-13.8	--	--
6GHz Wi-Fi	5925	-14.7	--	-15.3	-11.7	--	-14.1	--	--
	6525	-20.8	--	-21.3	-11.5	--	-12.8	--	--
	7125	-30.6	--	-14.2	-18.9	--	-13.6	--	--
GNSS	1176	--	--	--	--	--	--	-12.2	--
	1575	--	--	--	--	--	--	-13.1	--

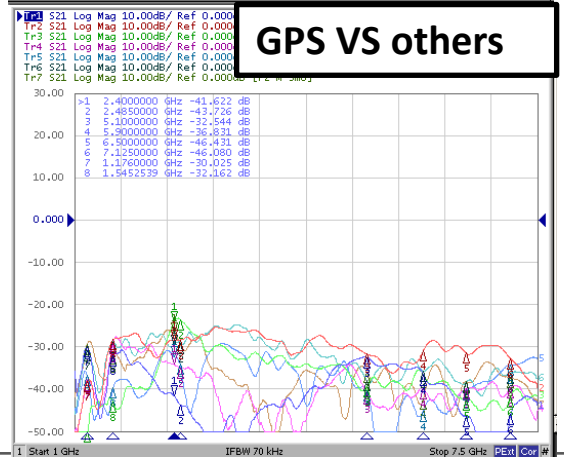
Measurement Data----Isolation





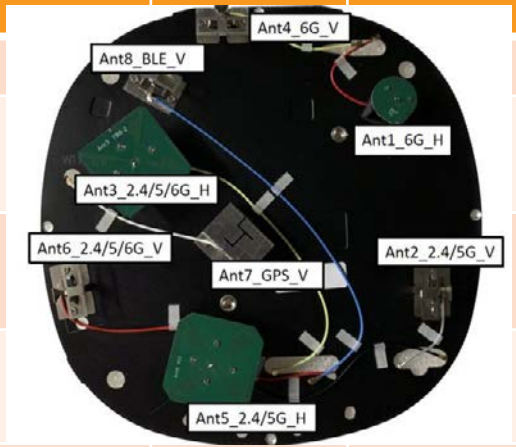






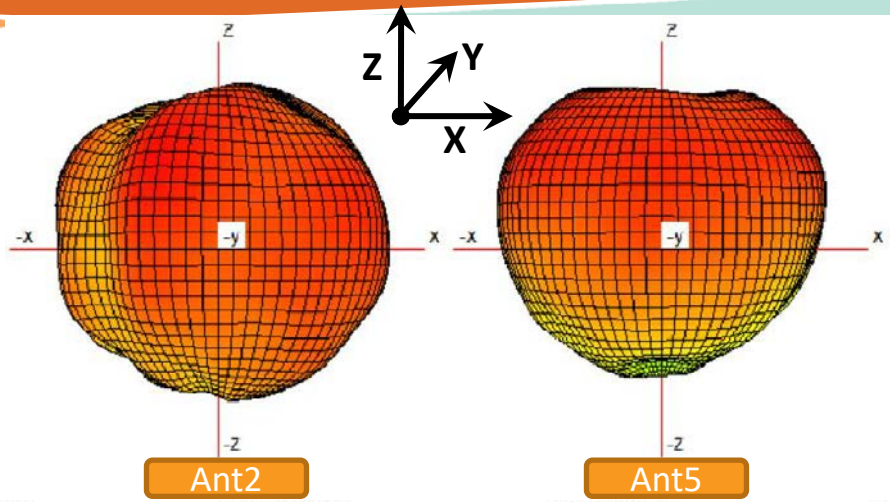
Measurement Data----Isolation

Isol (dB)	ANT1		ANT2		ANT3	ANT4		ANT5	ANT6
1	-		-		-	-			
2	5G: 5785~5895:35/36 5695~5785:30/36 5150~5695:25/37	6G: 5945~5995:35/36 5995~6025:30/36 6025~7125:25/31	-		-	-			
3		6G: 5945~6325:30/31 6325~6675:35/34 6675~7125:30/32	2.4G↔BLE: 25/38 5G↔5G: 27/38		-	-			
4		6G: 5.9G~7.2G 25/30	5G: 5785~5895:35/38 5695~5785:30/35 5150~5695:25/34	6G: 5945~5995:35/36 5995~6025:30/35 6025~7125:25/31	6G: 5945~6325:30/38 6325~6675:35/39 6675~7125:30/41	-			
5	5G: 5785~5895:35/35 5695~5785:30/34 5150~5695:25/34	6G: 5945~5995:35/34 5995~6025:30/33 6025~7125:25/31	2.4G: 20/28 5G↔5G: 25/32		2.4G↔BLE: 25/20 5G↔5G: 27/29	5G: 5785~5895:35/37 5695~5785:30/36 5150~5695:25/40	6G: 5945~5995:35/37 5995~6025:30/37 6025~7125:25/36	-	-
6		6G: 5945~6325:30/40 6325~6675:35/41 6675~7125:30/40	2.4G↔BLE: 25/27 5G↔5G: 27/31		BLE↔BLE: 20/29 5.1G~7.2G: 25/33		6G: 5945~6325:30/32 6325~6675:35/35 6675~7125:30/31	2.4G↔BLE: 25/30 5G↔5G: 27/40	-
7	2G: 2.4G~2.5G 30/28 5G: 5.1G~5.9G 40/26 6G: 5.9G~7.2G 40/30								
8			2.4G↔BLE: 20/24		BLE↔BLE: 20/30			2.4G↔BLE: 20/34	2.4G↔BLE: 20/23

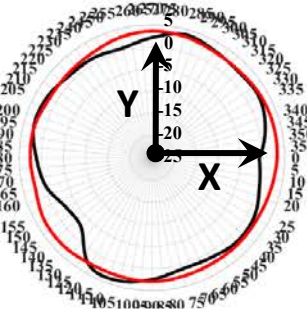


Appendix

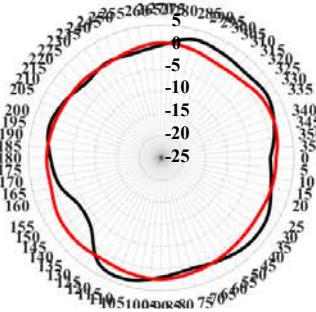
Radiation Pattern- WiFi @ 2.4GHz



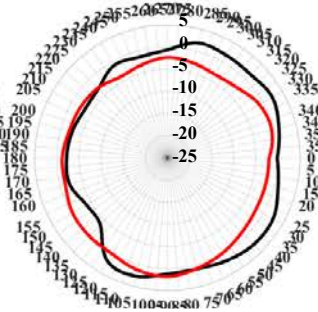
ANT2_2400
ANT5_2400



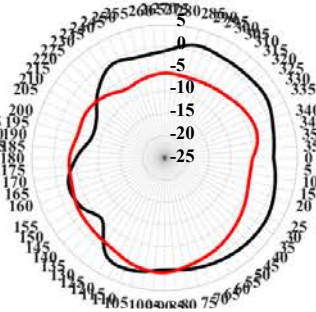
Theta 60°



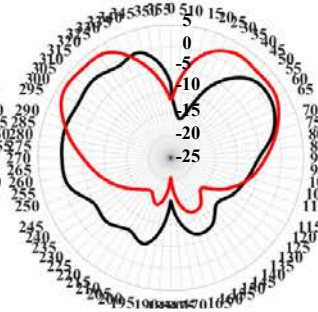
Theta 70°



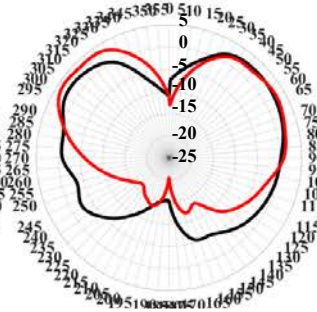
Theta 80°



Theta 90°(XY cut)

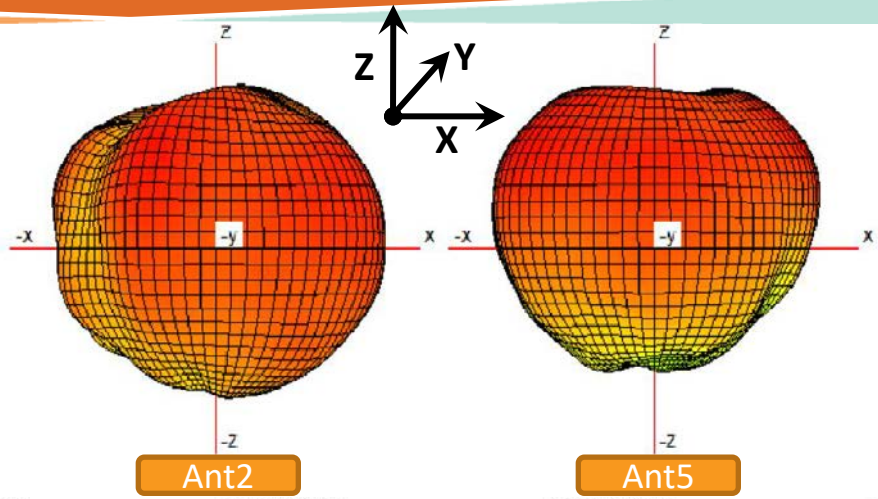


XZ Cut

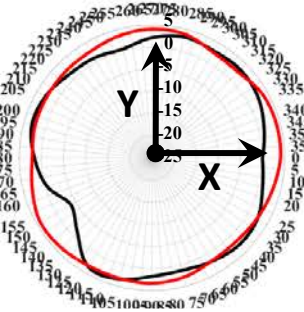


YZ Cut

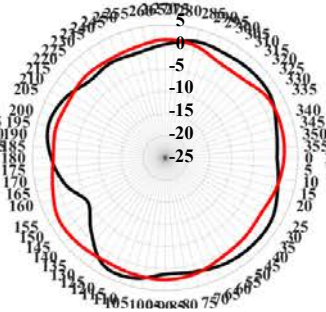
Radiation Pattern- WiFi @ 2.44GHz



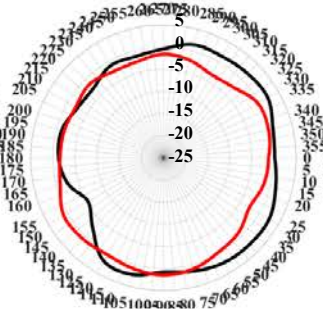
ANT2_2440
ANT5_2440



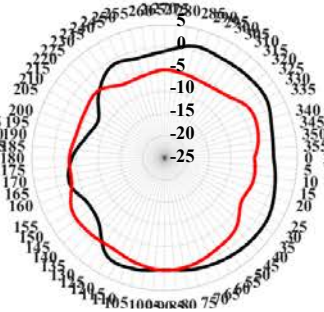
Theta 60°



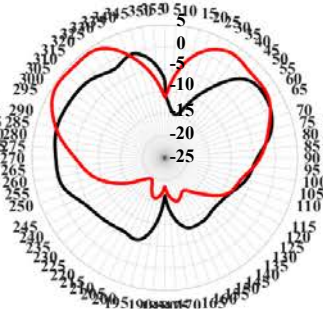
Theta 70°



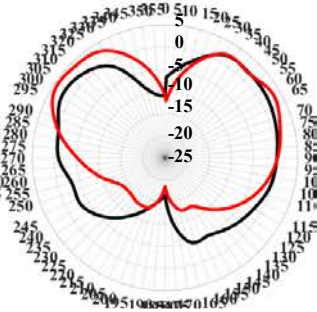
Theta 80°



Theta 90°(XY cut)

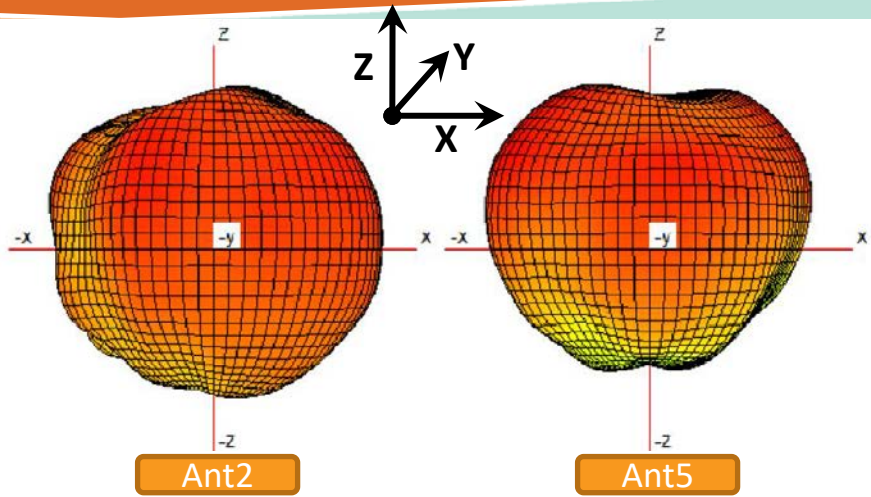


XZ Cut

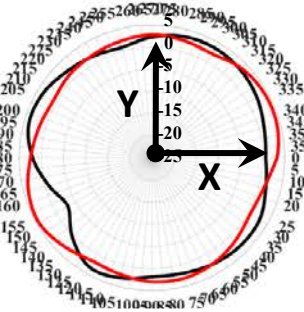


YZ Cut

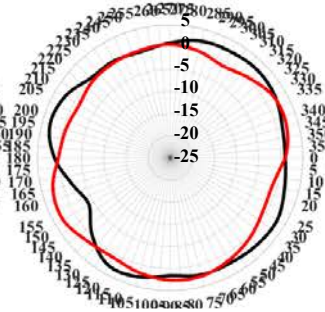
Radiation Pattern- WiFi @ 2.48GHz



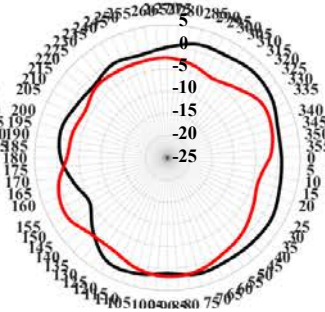
ANT2_2480
ANT5_2480



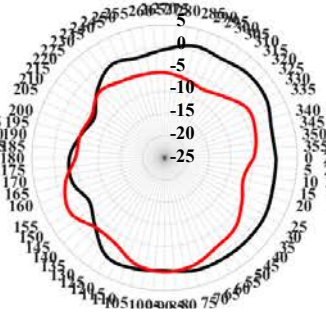
Theta 60°



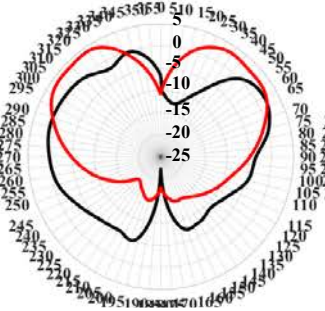
Theta 70°



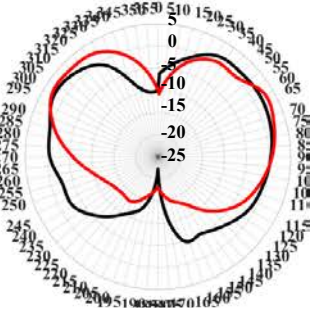
Theta 80°



Theta 90°(XY cut)

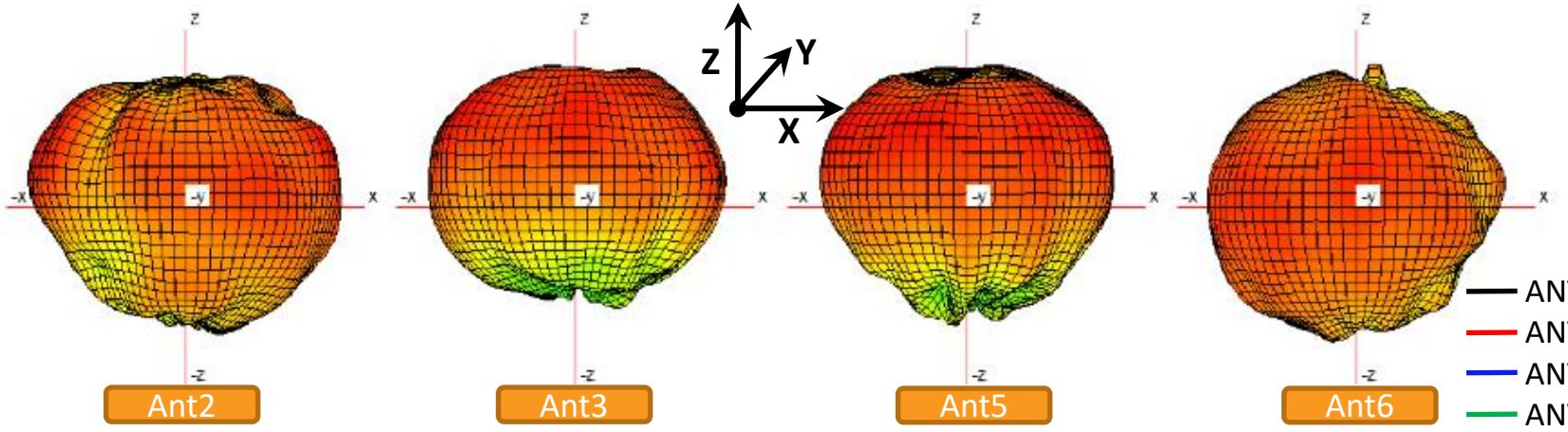


XZ Cut

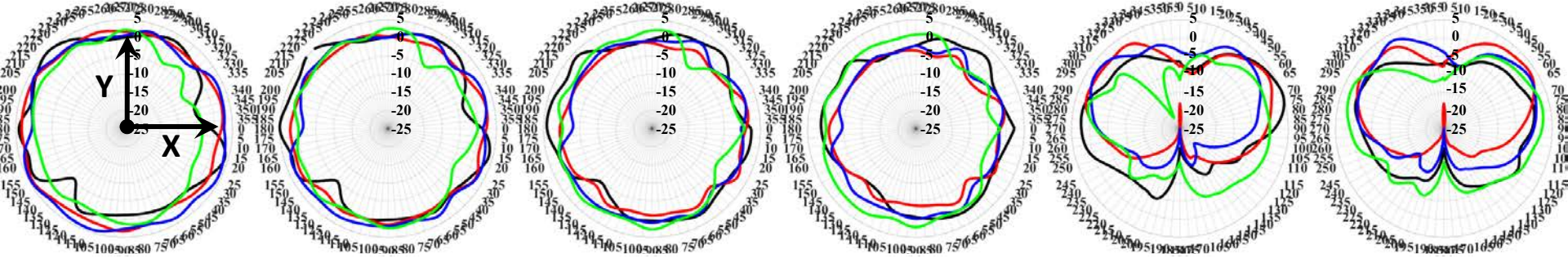


YZ Cut

Radiation Pattern- WiFi @ 5.15GHz

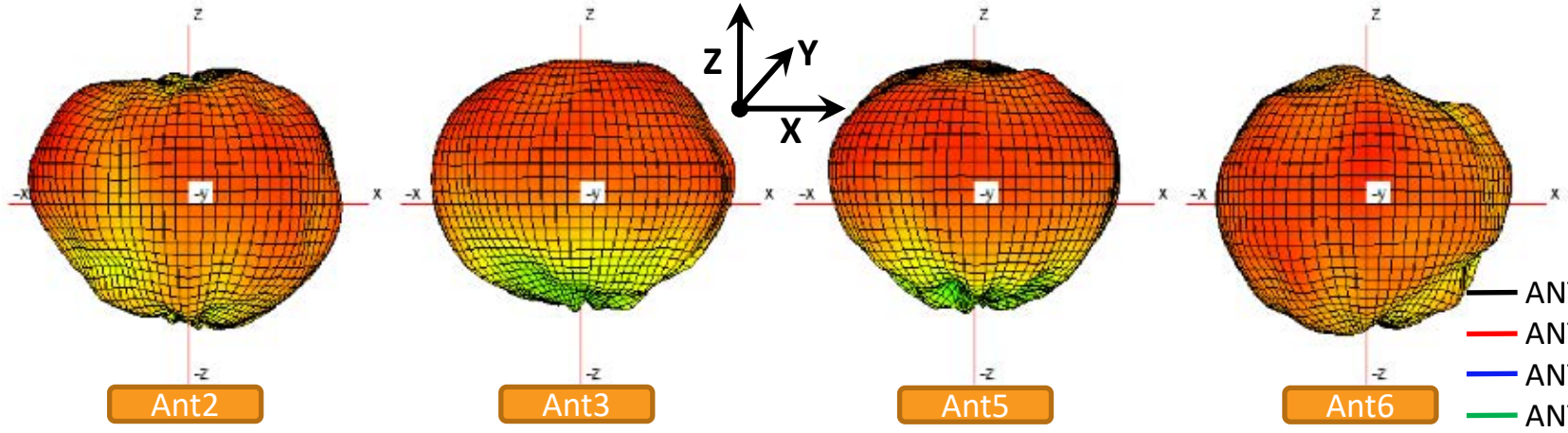


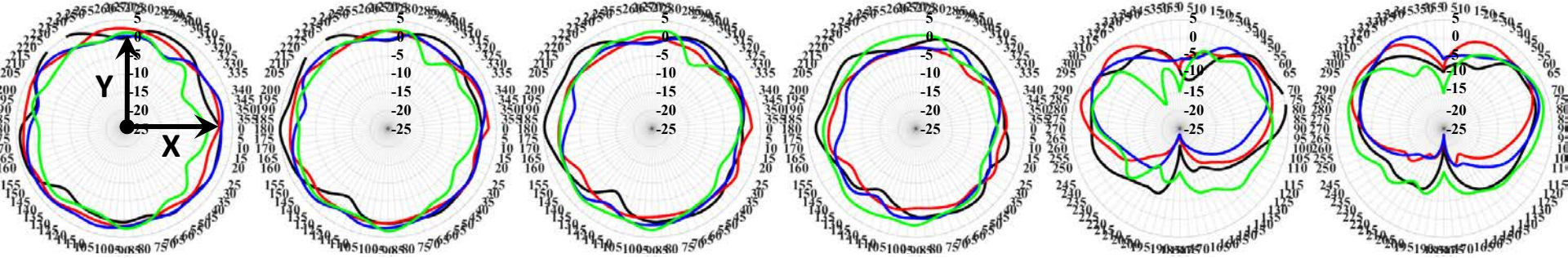
ANT2_5150
ANT3_5150
ANT5_5150
ANT6_5150



Theta 60˚ Theta 70˚ Theta 80˚ Theta 90°(XY cut) XZ Cut YZ Cut

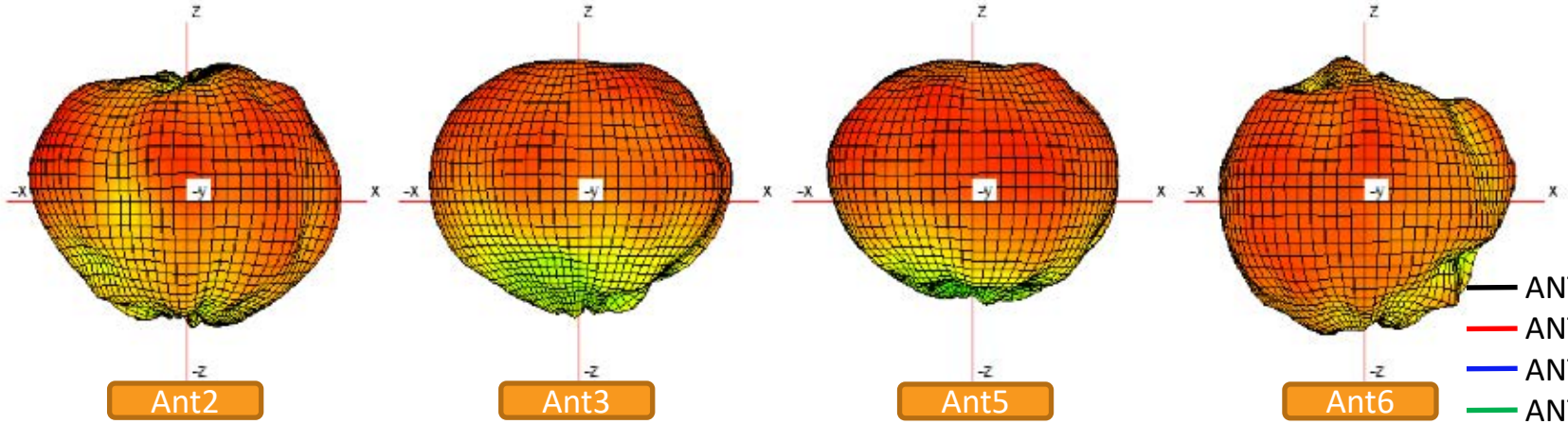
Radiation Pattern- WiFi @ 5.35GHz

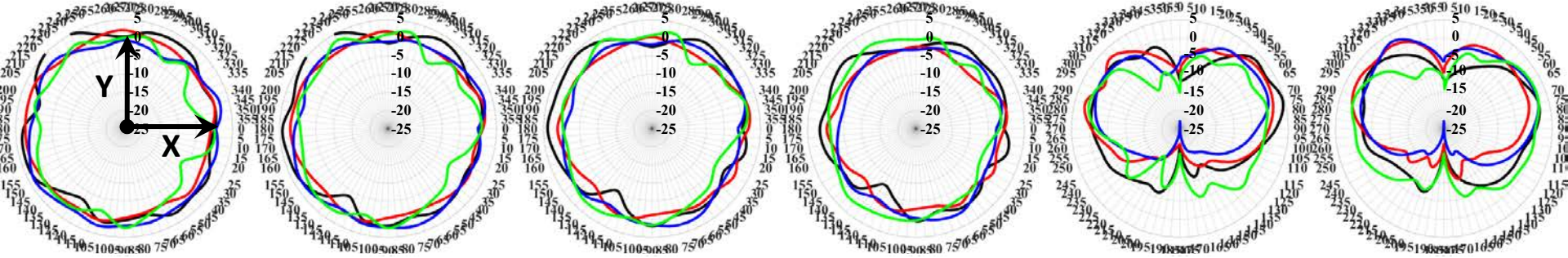




Theta 60˚ Theta 70˚ Theta 80˚ Theta 90°(XY cut) XZ Cut YZ Cut

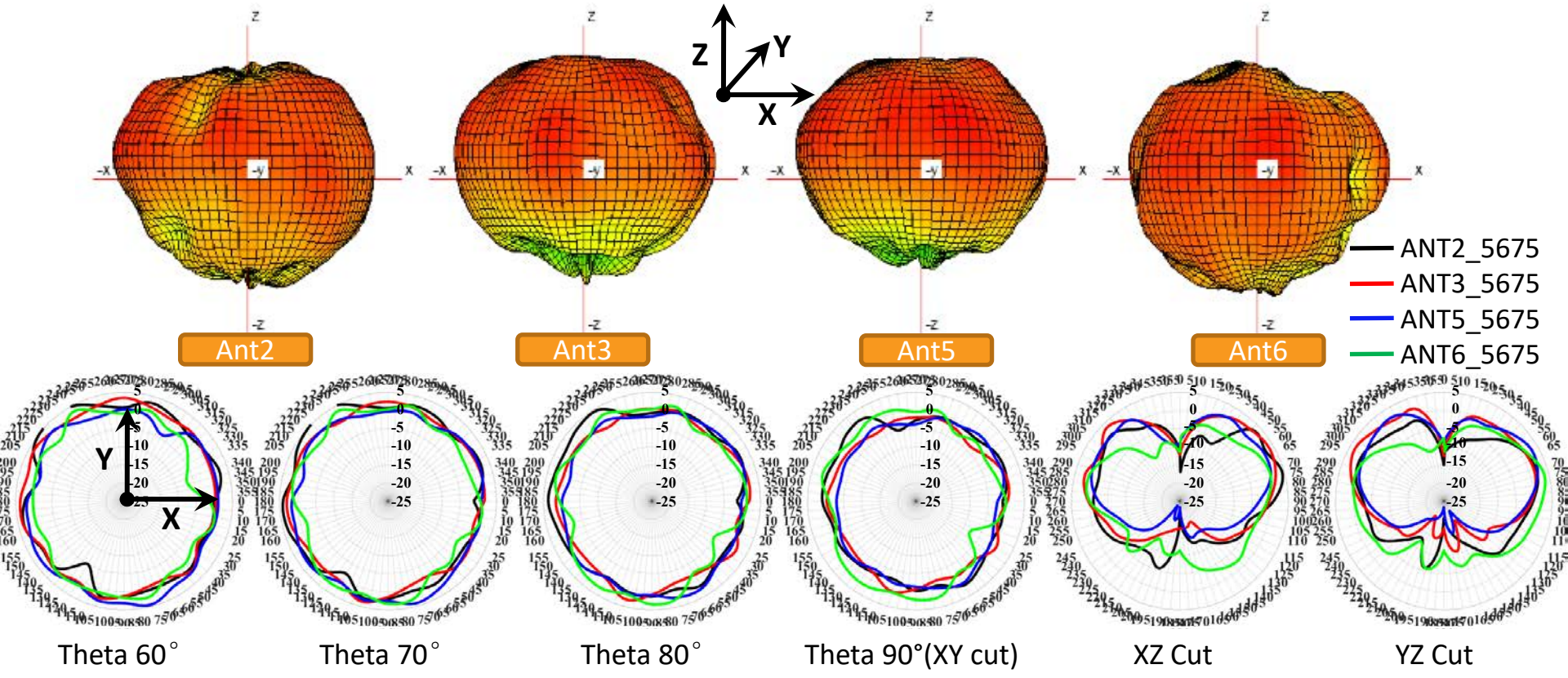
Radiation Pattern- WiFi @ 5.49GHz



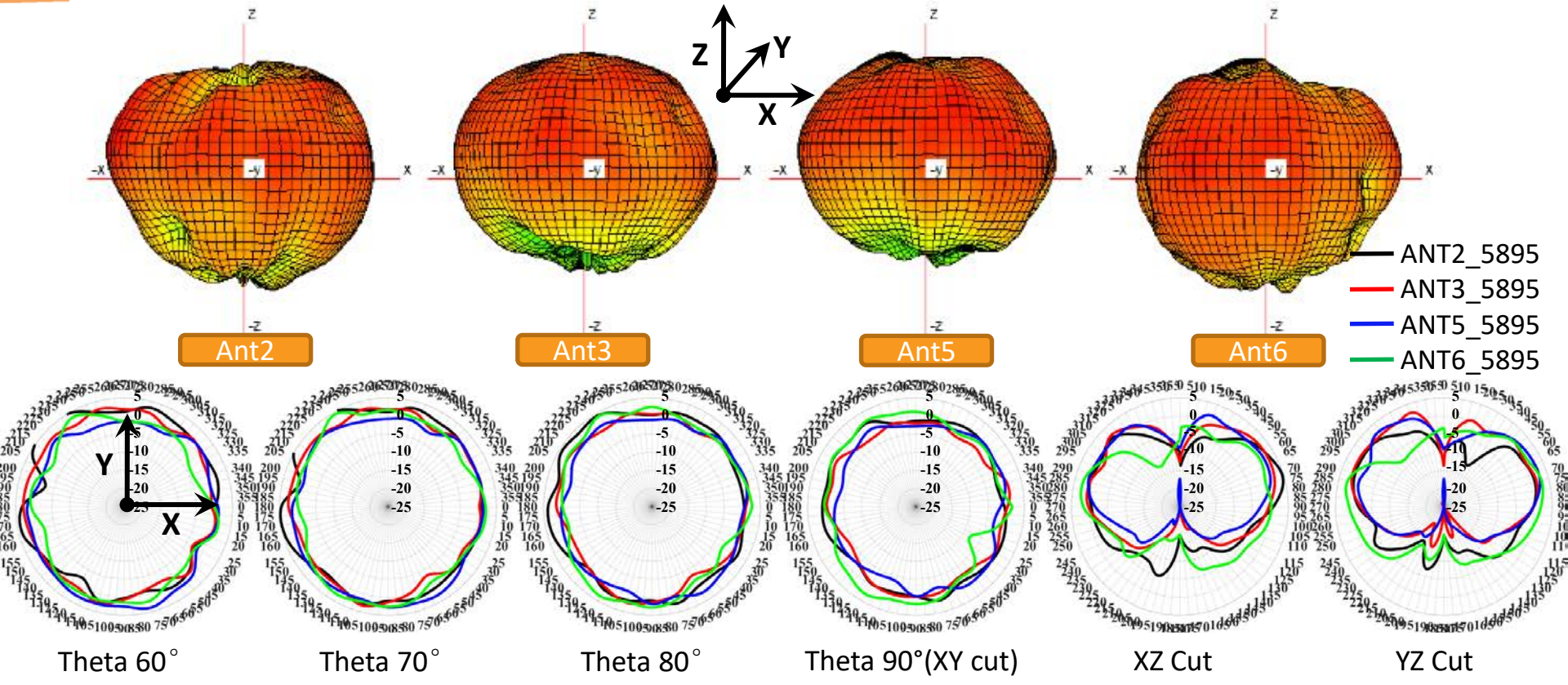


Theta 60° Theta 70° Theta 80° Theta 90°(XY cut) XZ Cut YZ Cut

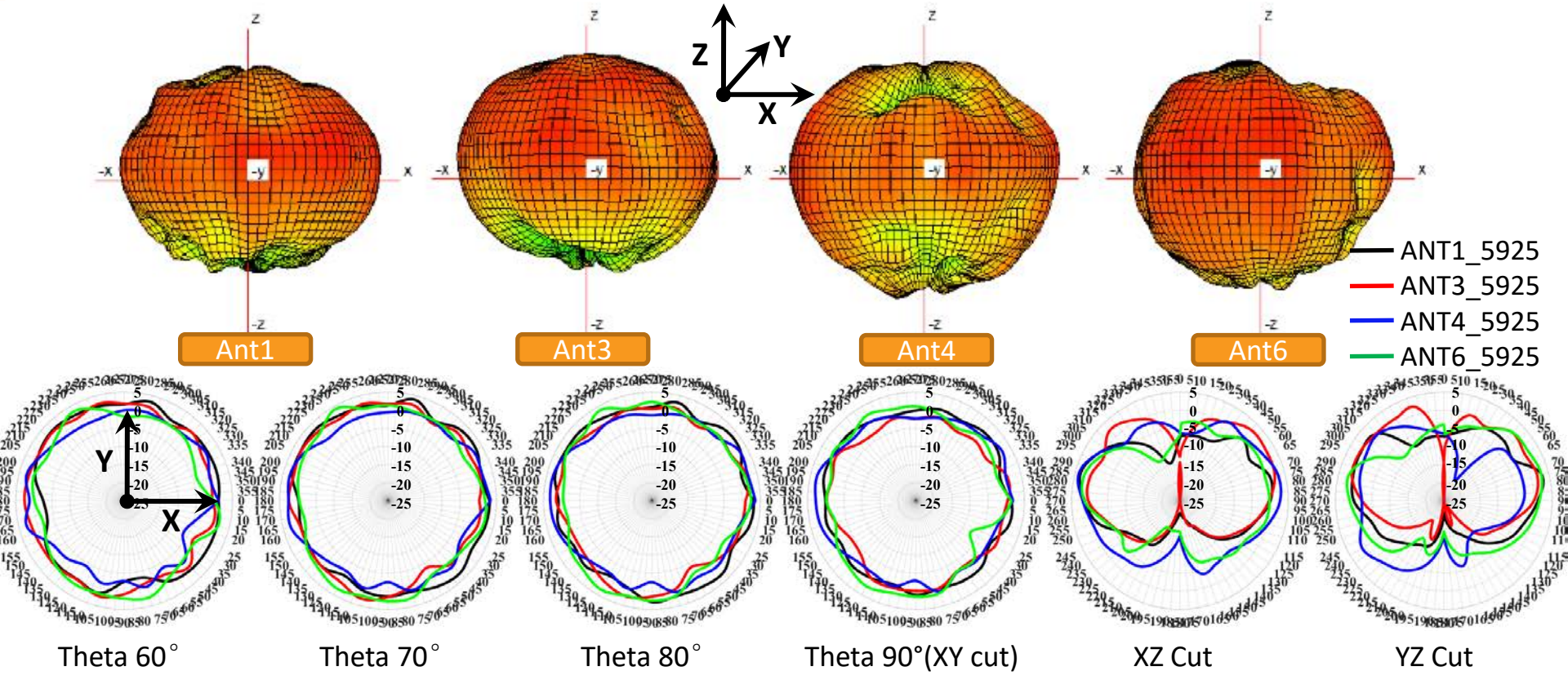
Radiation Pattern- WiFi @ 5.675GHz



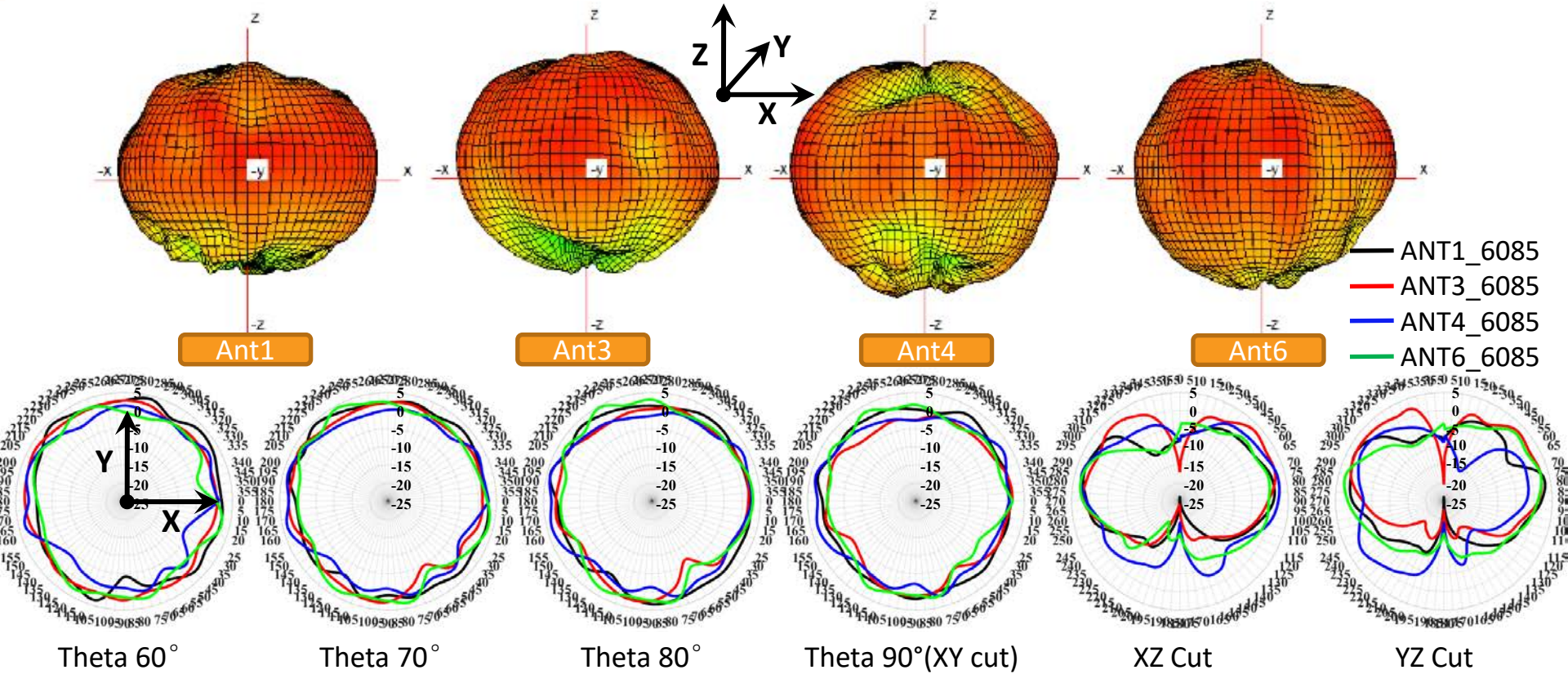
Radiation Pattern- WiFi @ 5.895GHz



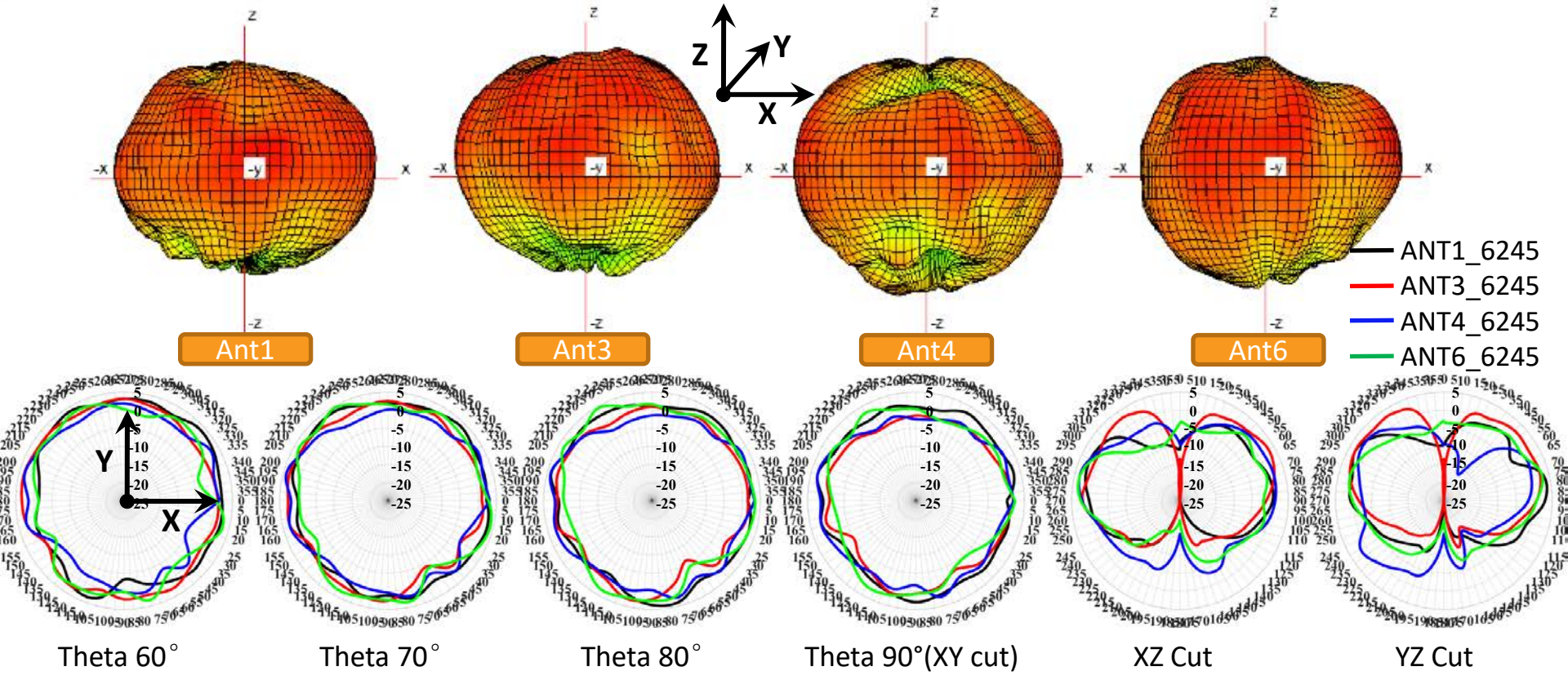
Radiation Pattern- WiFi @ 5.925GHz



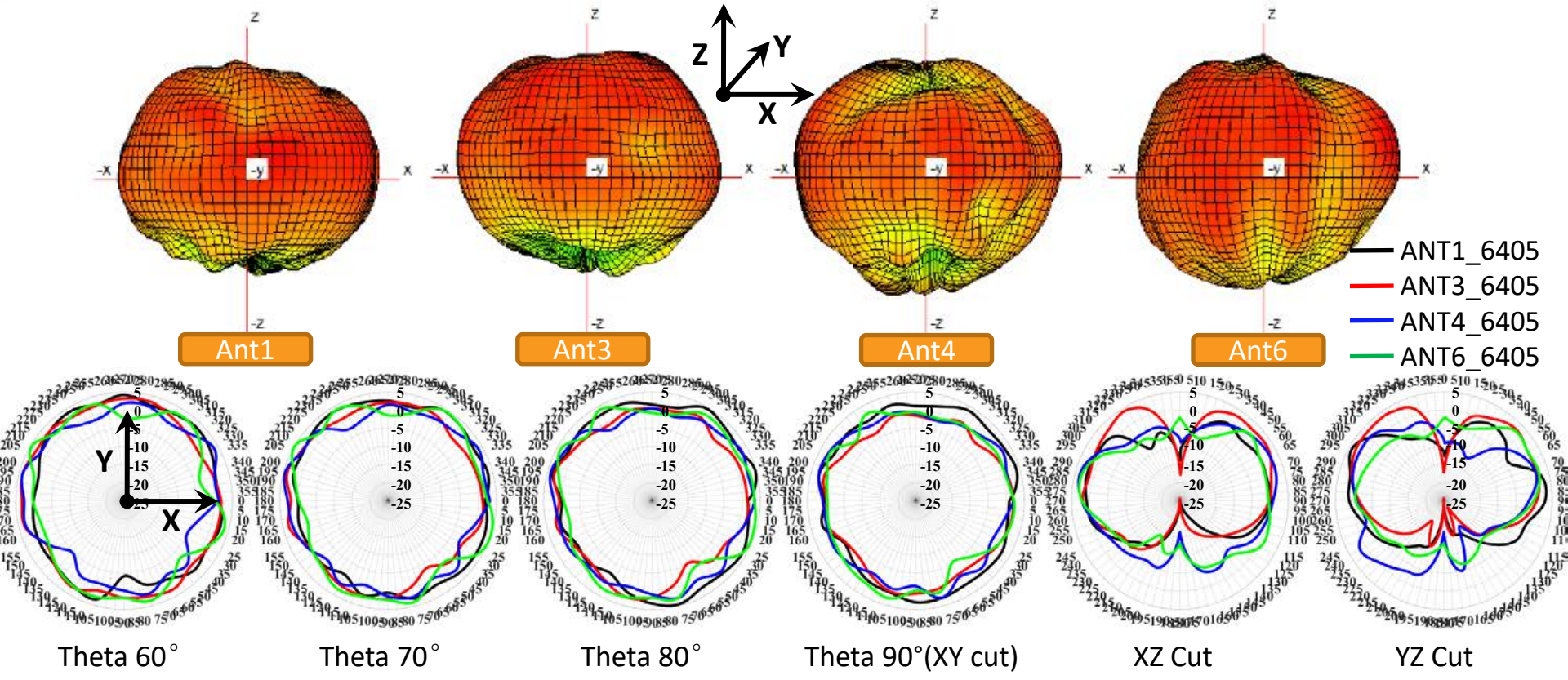
Radiation Pattern- WiFi @ 6.085GHz



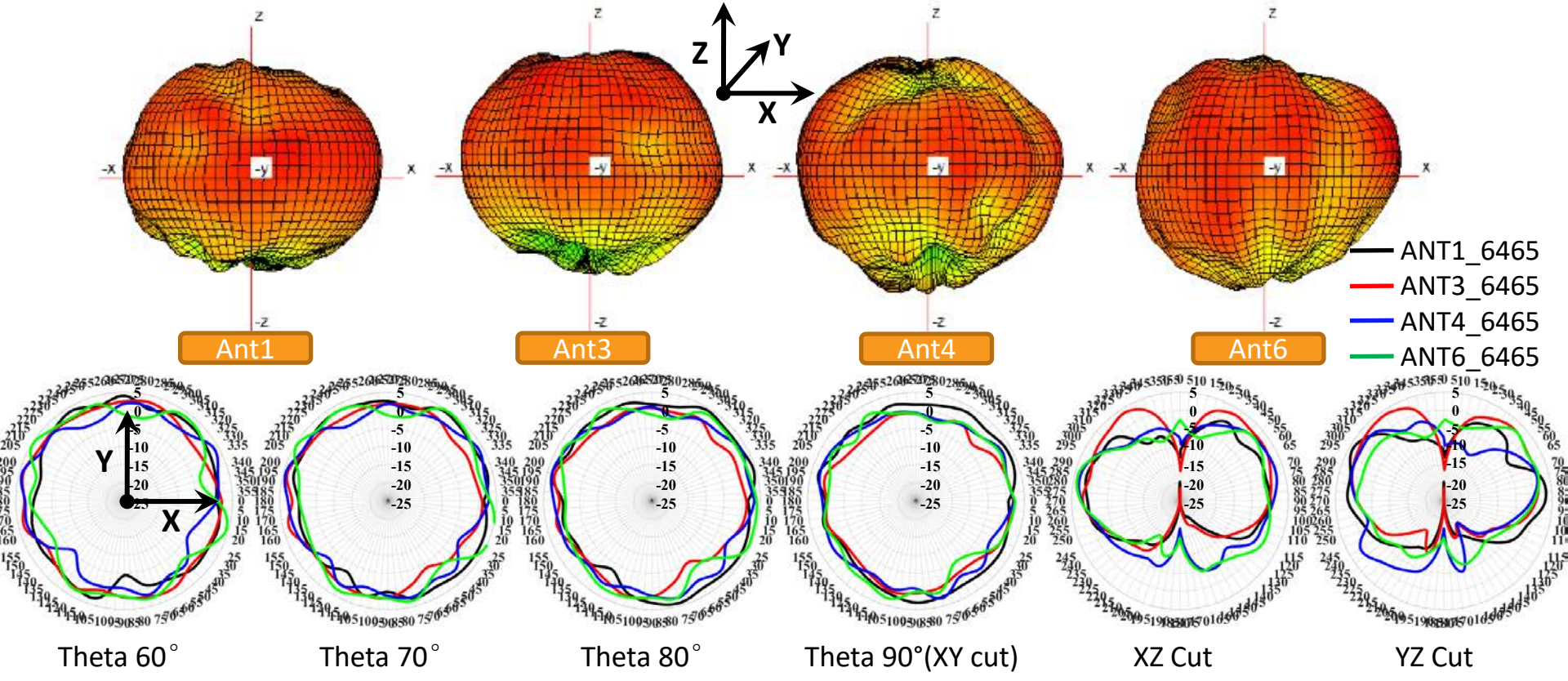
Radiation Pattern- WiFi @ 6.245GHz



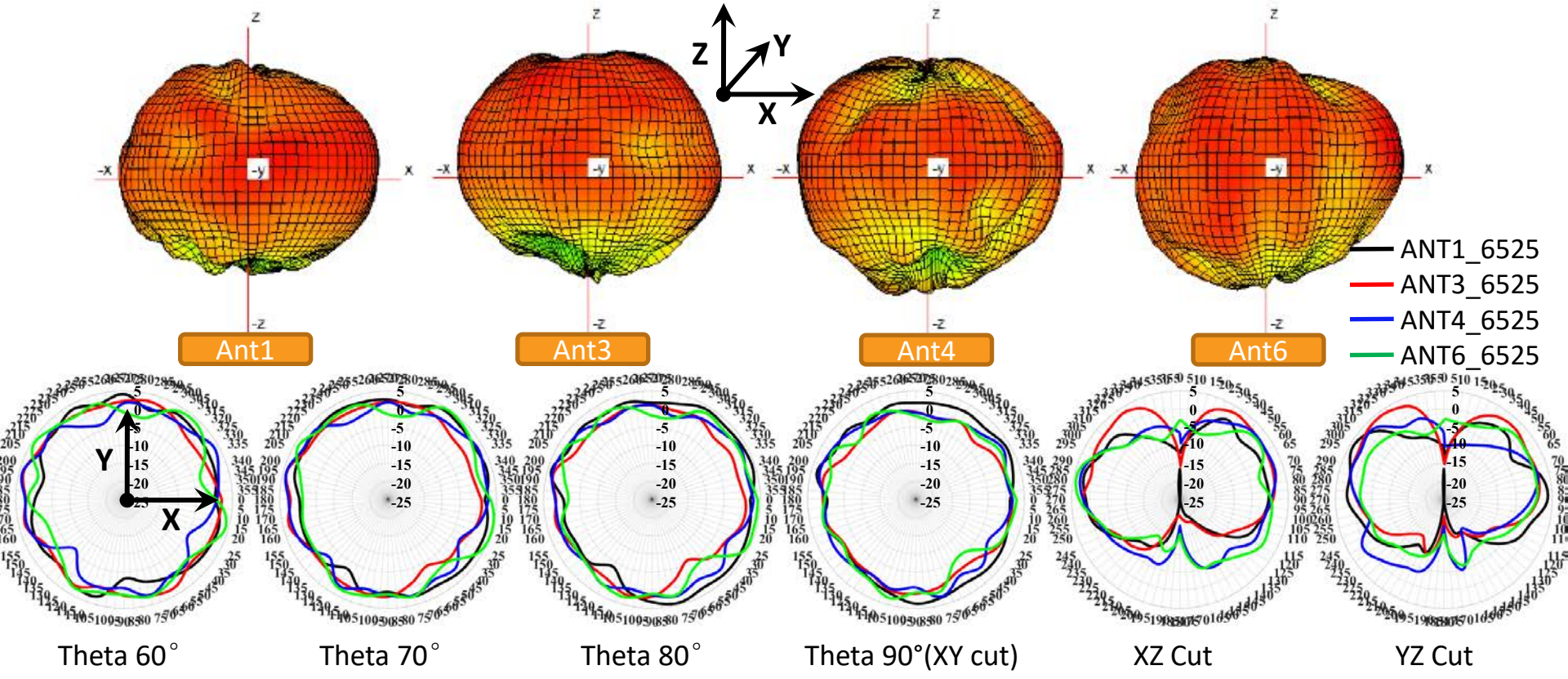
Radiation Pattern- WiFi @ 6.405GHz



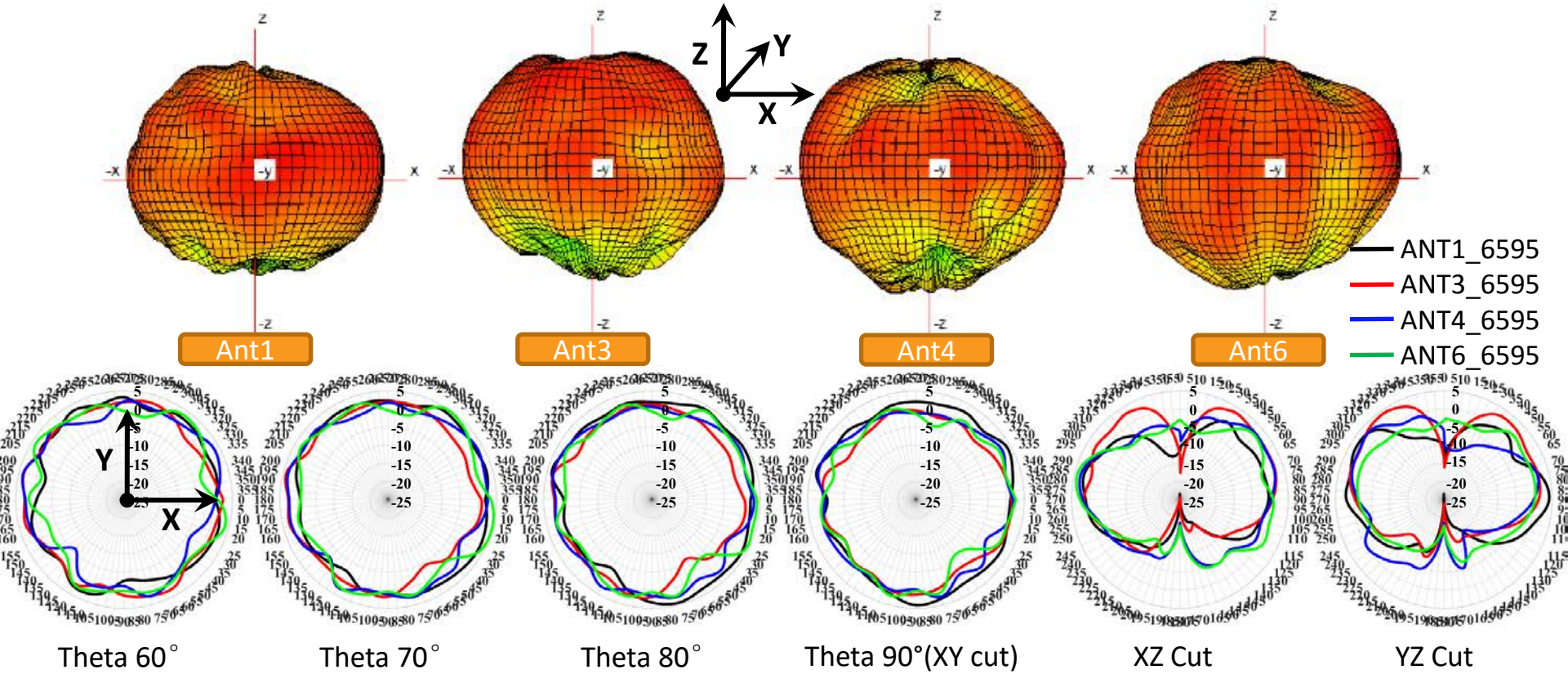
Radiation Pattern- WiFi @ 6.465GHz



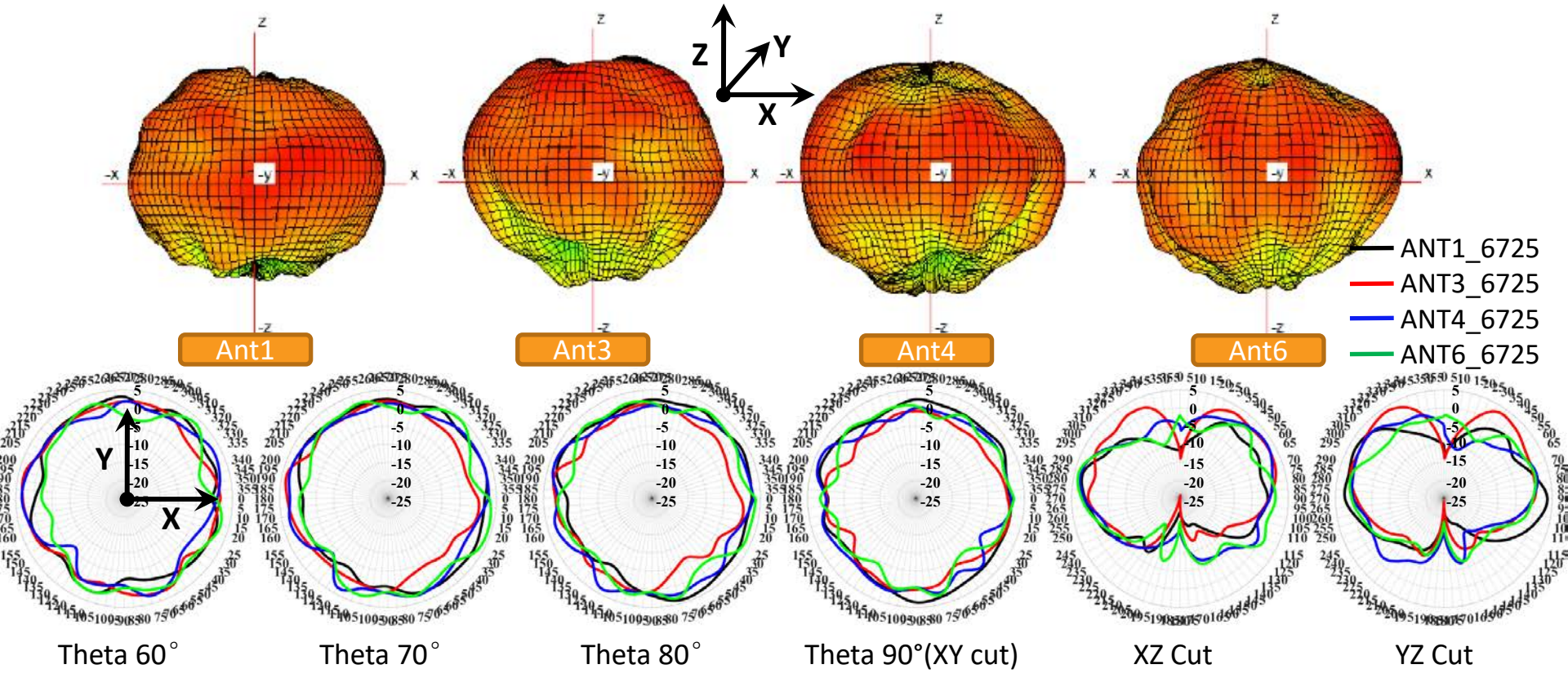
Radiation Pattern- WiFi @ 6.525GHz



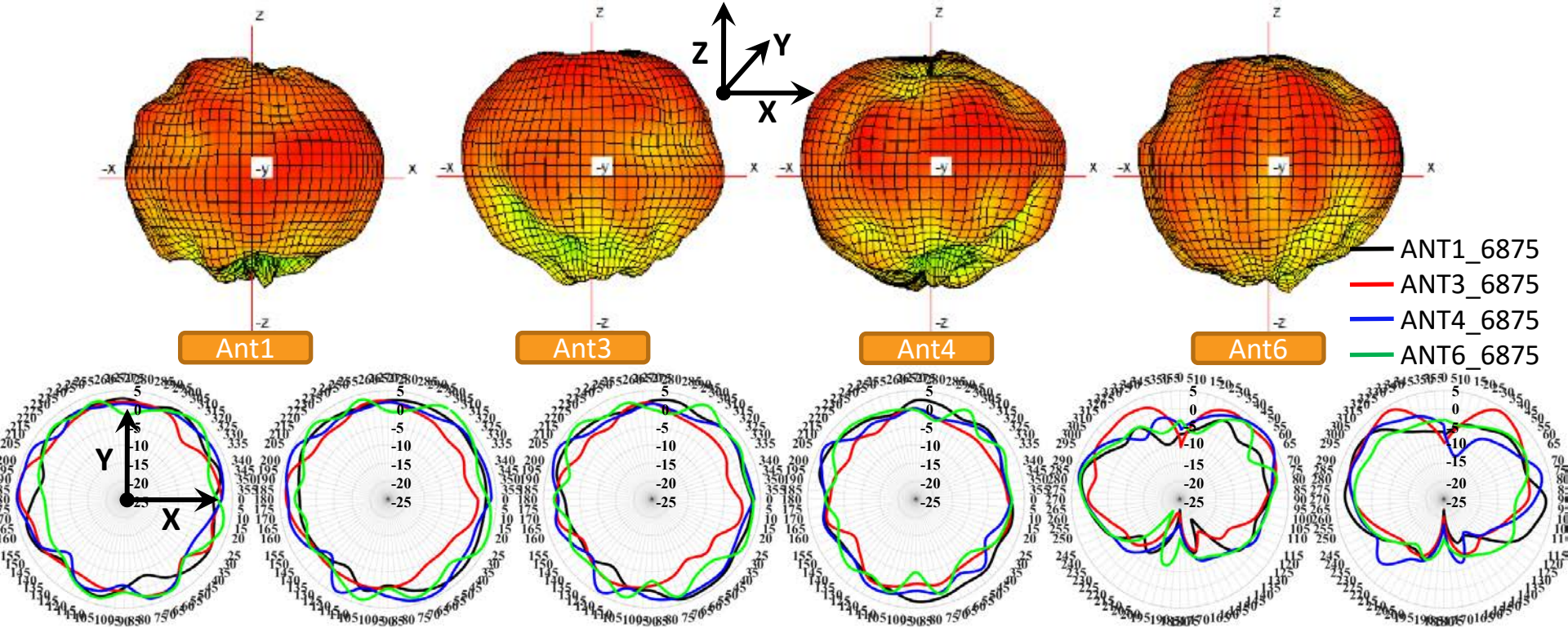
Radiation Pattern- WiFi @ 6.595GHz



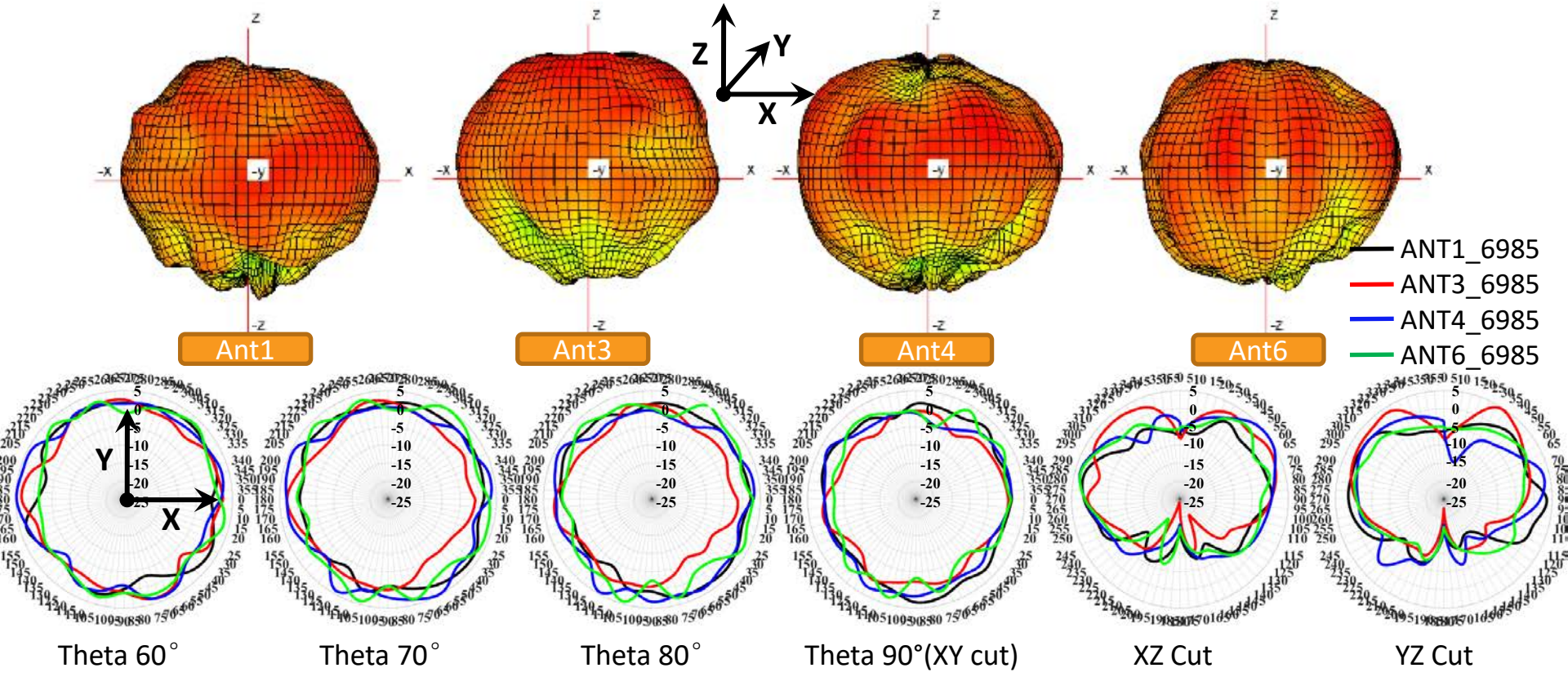
Radiation Pattern- WiFi @ 6.725GHz



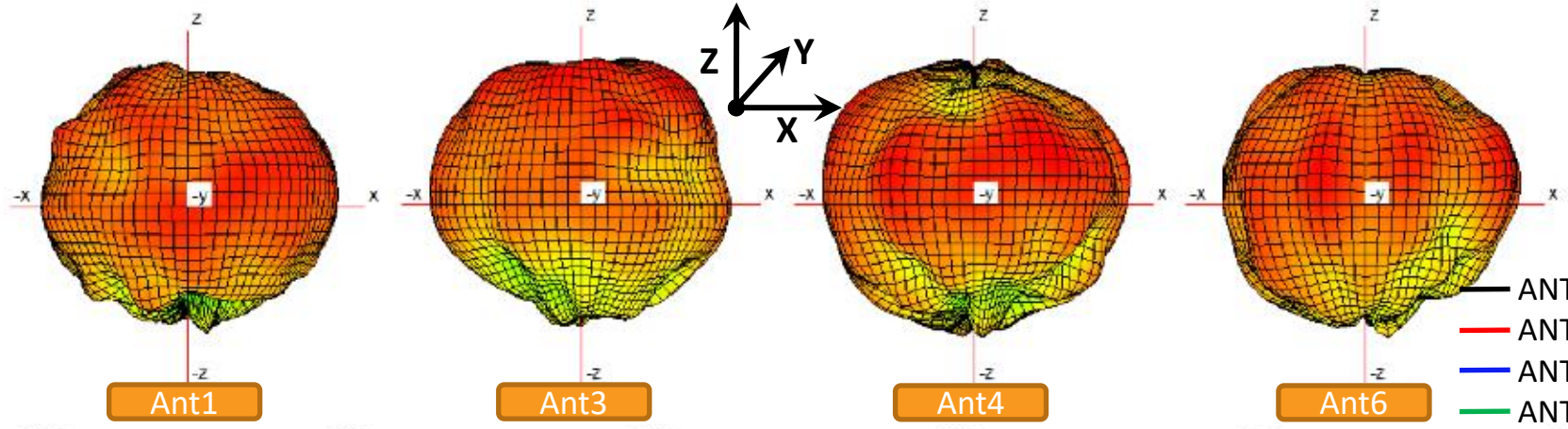
Radiation Pattern- WiFi @ 6.875GHz

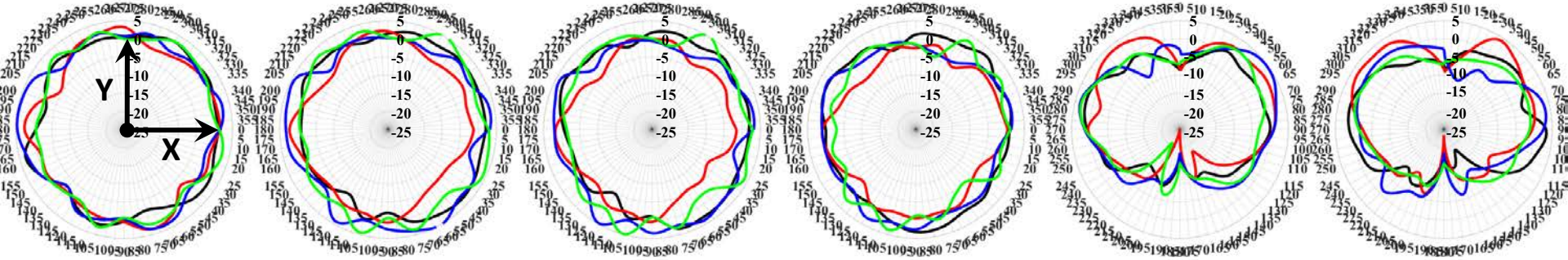


Radiation Pattern- WiFi @6.985GHz



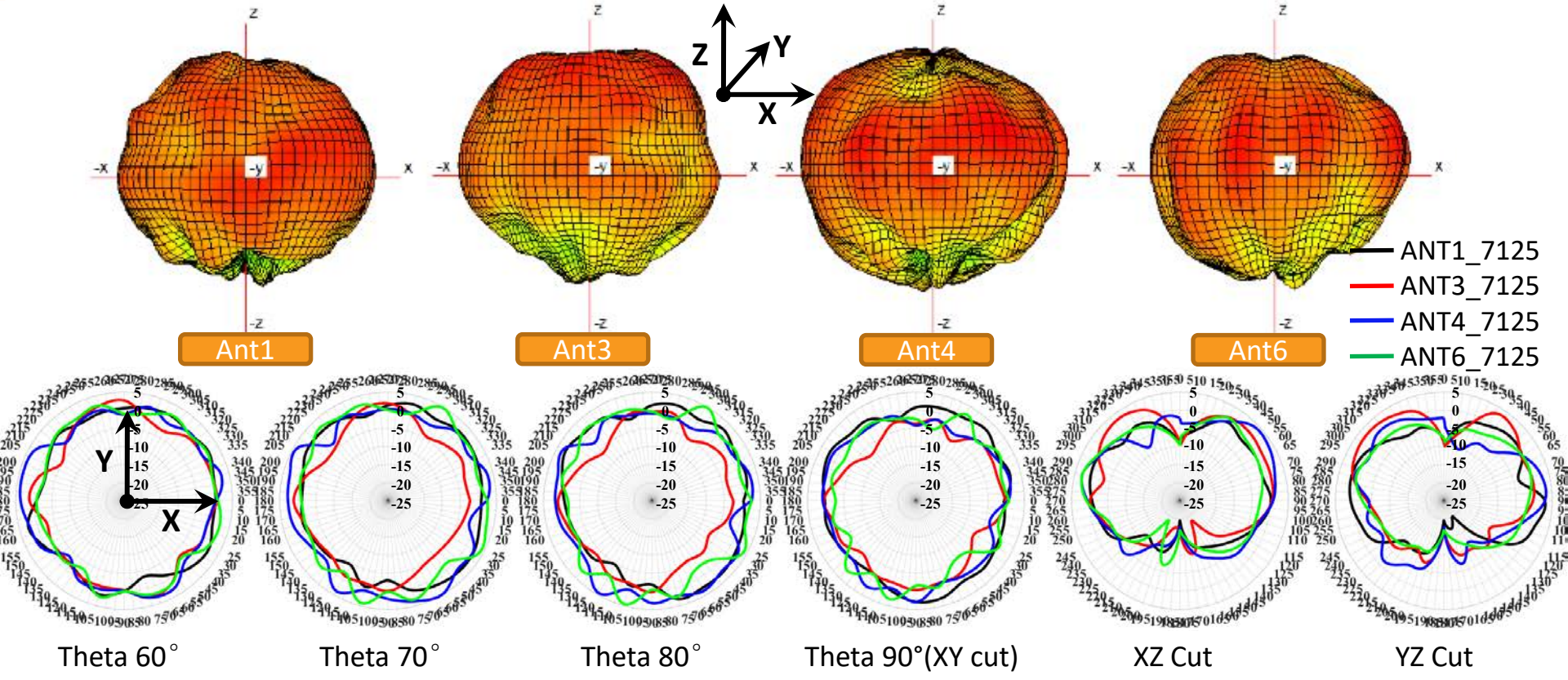
Radiation Pattern- WiFi @ 7.065GHz



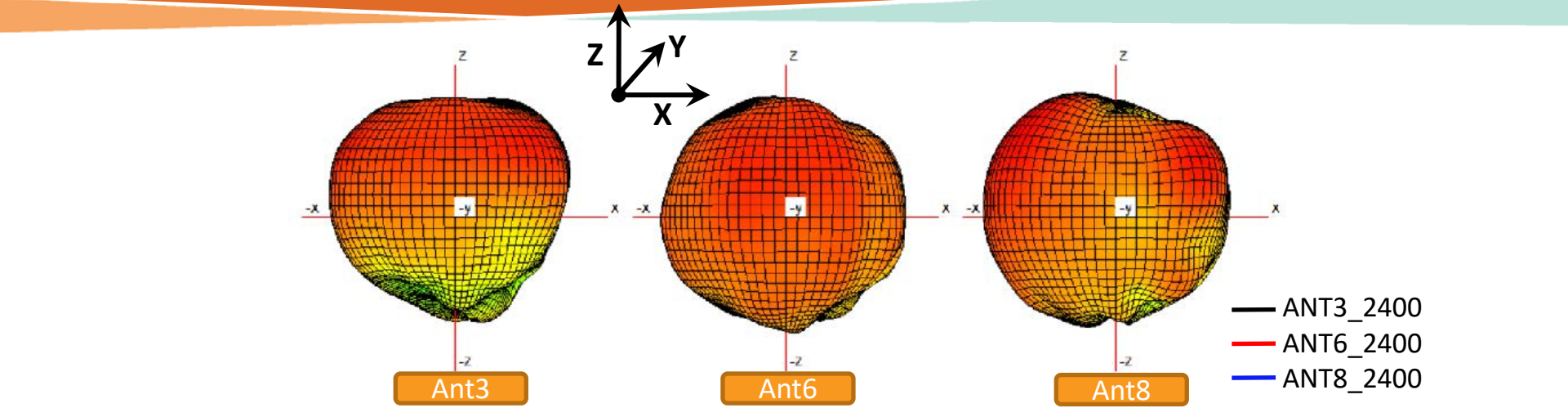


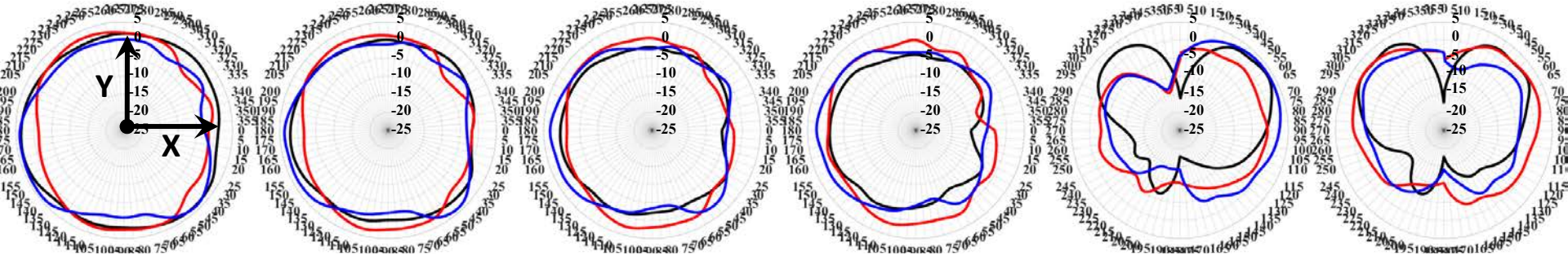
Theta 60° Theta 70° Theta 80° Theta 90°(XY cut) XZ Cut YZ Cut

Radiation Pattern- WiFi @ 7.125GHz



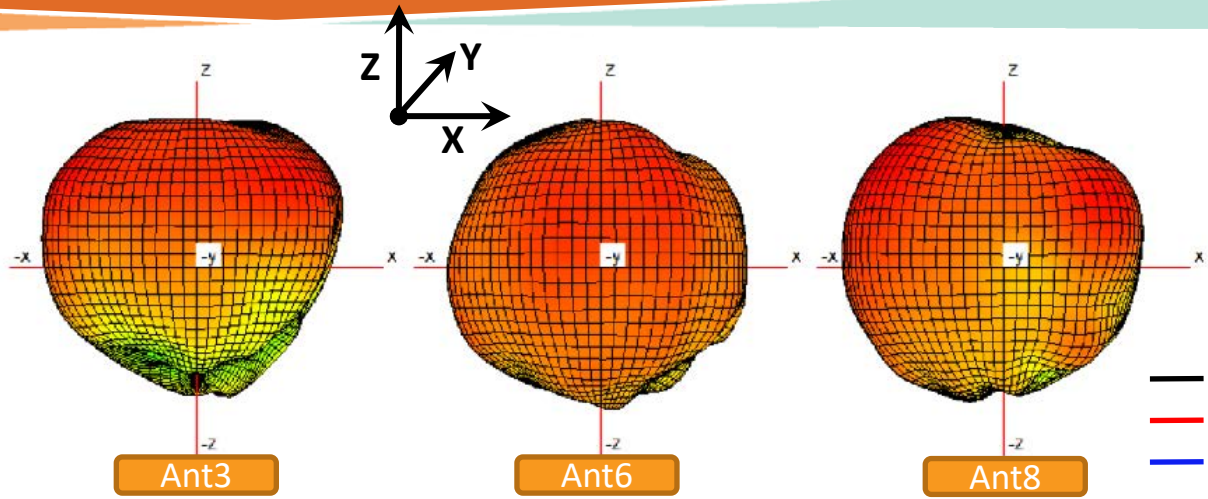
Radiation Pattern- BLE @ 2.4GHz



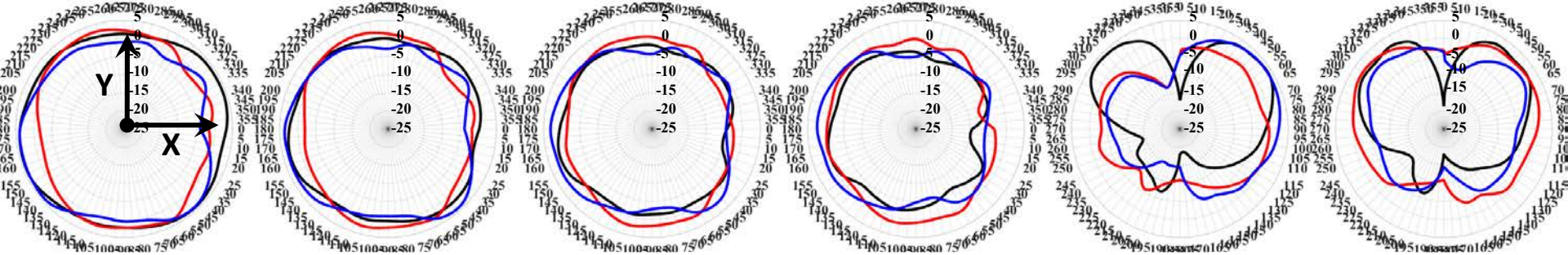


Theta 60° Theta 70° Theta 80° Theta 90°(XY cut) XZ Cut YZ Cut

Radiation Pattern- BLE @ 2.44GHz

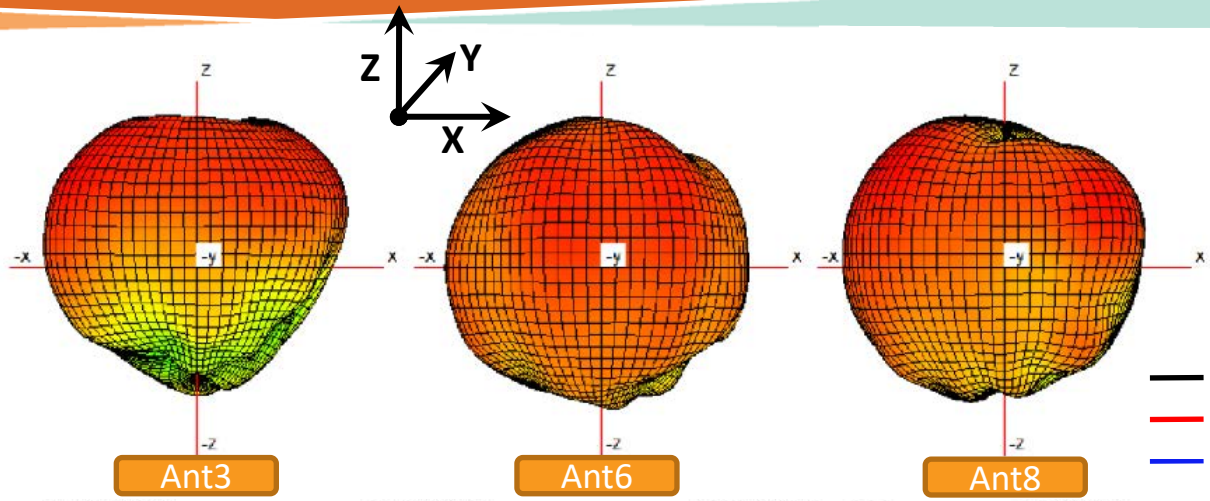


ANT3_2440
ANT6_2440
ANT8_2440

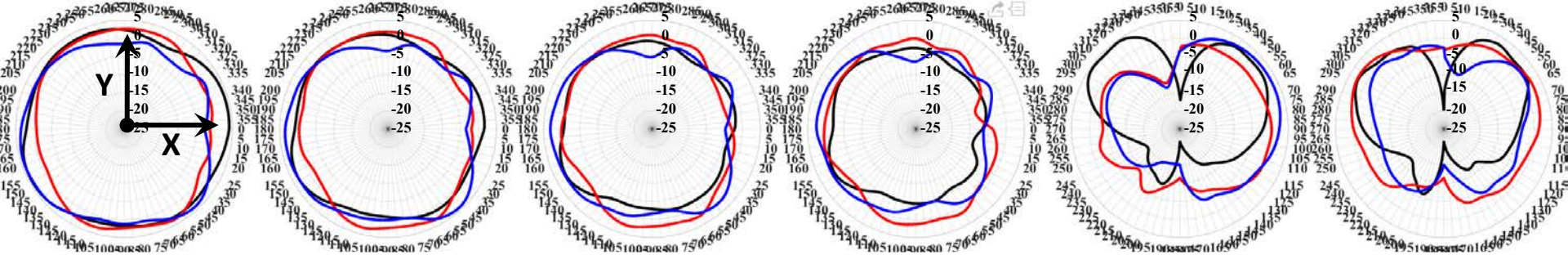


Theta 60° Theta 70° Theta 80° Theta 90°(XY cut) XZ Cut YZ Cut

Radiation Pattern- BLE @ 2.48GHz

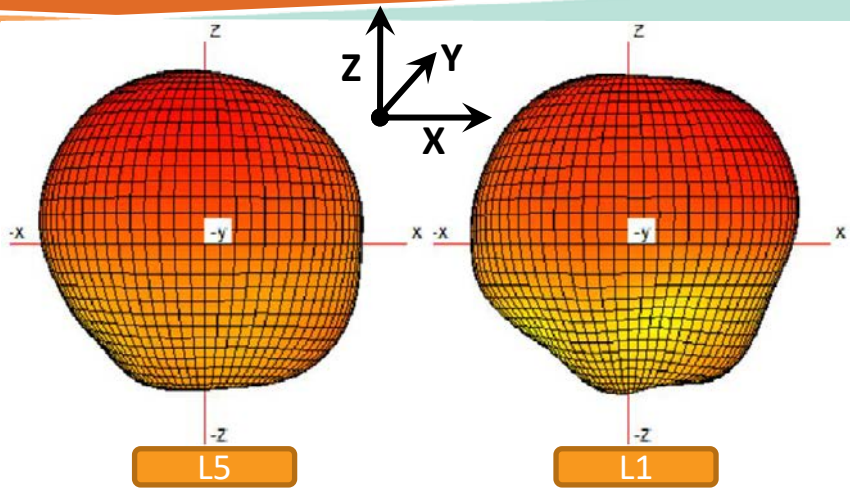


ANT3_2480
ANT6_2480
ANT8_2480

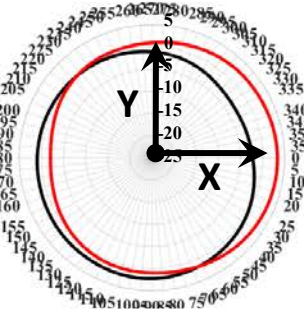


Theta 60° Theta 70° Theta 80° Theta 90°(XY cut) XZ Cut YZ Cut

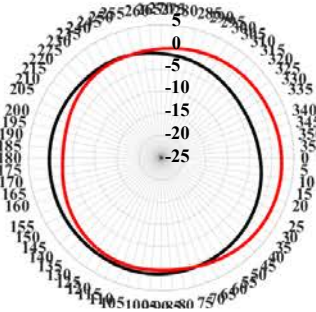
Radiation Pattern- GNSS @ 1.176&1.575GHz



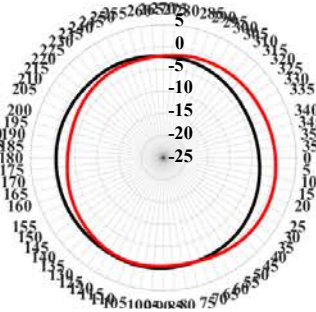
GPS_L5
GPS_L1



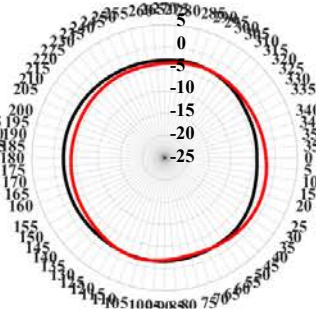
Theta 60°



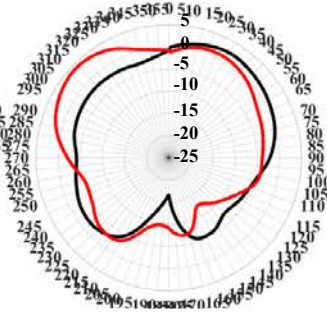
Theta 70°



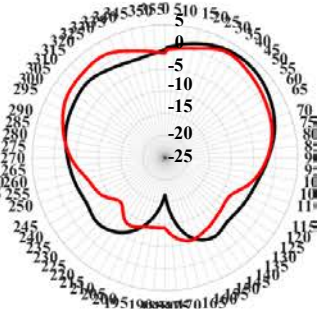
Theta 80°



Theta 90°(XY cut)



XZ Cut



YZ Cut

THANK YOU

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a Hewlett Packard
Enterprise company