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AP-605H Antenna Test report

Date: 12/05/2023

Author: Hennry

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Revision History

Released Date	Version	Record
2023/06/27	Rev 1.0	Initial Solution
2023/06/29	Rev 1.1	Update the format
2023/12/05	Rev 1.2	Update the format

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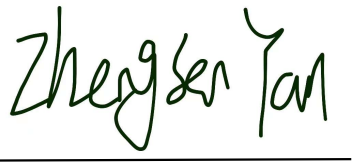
Test Information

Item	Description
Brand Name	HPE Aruba
DUT Equipment	Wi-Fi 6E 11ax Triple Band Access Point
Test Lab Name	Amphenol Beijing R&D Laboratory
Test Lab Address	Haidian District, Beijing
Test Engineer	Zhengsen Yan
Test Environment	Microwave chamber - RayZone 2800
Test Date	2023/06/29

Test engineer signature: 

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Test Configuration

Test System

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Test Equipment & Calibration

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

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

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Antenna Details

Ant No.	Part Number	Operating Band	Type	Size(L*W*H)	Cable Length(mm)	Polarization type	Cable type	Material
A1	ANT1-605H-Dual	WIFI 2+5G	Dipole	28.12*10.15*1	82	vertical	1.37 normal	FR4
A2	ANT2-605H-Dual	WIFI 2+5G	Dipole	30.12*10.15*1	125	vertical	1.37 normal	FR4
A3	ANT3-605H-Dual	BLE + WIFI 6G	Dipole	29.62*10.15*1	63	vertical	1.37 normal	FR4
A4	ANT4-605H-Dual	GPS + WIFI 6G	Dipole	38.50*15.73*1	112	Vertical（6G） Horizontal（GPS）	1.37 normal	FR4

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Result Summary------2.4G

Results summary for 2.4GHz

Antenna	Detail Spec	Spec	Ant1-TriBand			Ant2-TriBand		
Frequency	2.4~2.5GHz	-	2.4GHz	2.45GHz	2.49GHz	2.4GHz	2.45GHz	2.49GHz
Efficiency	>70%	-	59.9	62.1	64.0	64.6	63.4	65.6
Peak Gain for 3D	3dBi< Peak<5dBi		4.1	4.4	5.1	5.0	4.8	4.7
Horizontal cut Gain Flatness	90°	<10dB	6.4	6.3	6.7	9.8	10.5	10.6
	80°	<10dB	6.5	6.1	5.8	10.4	9.8	9.3
	70°	<10dB	6.3	6.0	6.3	9.7	8.7	7.9
	60°	<10dB	6.1	7.8	9.8	7.7	7.4	6.8
Horizontal cut Average Gain	90°	<10dB	2.3	2.1	1.8	1.7	1.4	1.3
	80°	<10dB	1.8	1.5	1.1	0.8	0.9	1.0
	70°	<10dB	0.9	0.7	0.3	0.2	0.4	0.6
	60°	<10dB	-0.1	-0.5	-0.7	0.0	0.0	0.4

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Result Summary------5G

Results summary for 5GHz

Antenna	Detail Spec	Spec	Ant1-TriBand			Ant2-TriBand		
Frequency	5.1~5.9GHz	-	5.15GHz	5.5GHz	5.9GHz	5.15GHz	5.5GHz	5.9GHz
Efficiency	>70%	-	72.8	73.1	72.1	74.1	68.0	70.8
Peak Gain for 3D	3dBi< Peak<5.5dBi		4.4	4.1	4.8	5.1	4.3	4.7
Horizontal cut Gain Flatness	90°	<10dB	10.4	11.2	8.0	15.1	11.6	11.9
	80°	<10dB	9.7	11.5	10.5	12.1	11.7	10.8
	70°	<10dB	9.4	8.4	9.6	10.5	11.1	9.3
	60°	<10dB	10.2	6.4	7.8	7.4	11.5	6.5
Horizontal cut Average Gain	90°	<10dB	1.7	1.4	1.9	0.5	1.2	0.9
	80°	<10dB	1.2	1.5	2.0	0.0	0.9	1.2
	70°	<10dB	1.1	1.4	1.6	0.9	0.6	1.7
	60°	<10dB	0.5	1.2	0.6	2.1	0.5	1.8

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Result Summary------6G

Results summary for 6GHz

Antenna	Detail Spec	Spec	Ant1-TriBand			Ant2-TriBand		
Frequency	5.9~7.125GHz	-	5.9GHz	6.5GHz	7.125GHz	5.9GHz	6.5GHz	7.125GHz
Efficiency	>70%	-	72.3	81.9	76.4	65.0	79.1	68.9
Peak Gain for 3D	3dBi< Peak<5.5dBi		4.7	5.4	5.4	4.3	5.3	5.1
Horizontal cut Gain Flatness	90°	<10dB	10.1	8.4	11.9	8.3	10.6	9.3
	80°	<10dB	10.4	10.3	9.1	9.4	6.5	10.4
	70°	<10dB	9.0	13.3	10.5	9.1	7.8	10.0
	60°	<10dB	6.5	12.4	11.8	7.2	7.6	6.2
Horizontal cut Average Gain	90°	<10dB	2.0	2.0	1.5	-1.1	-0.6	-1.7
	80°	<10dB	1.3	1.7	1.4	-1.1	-0.7	-1.8
	70°	<10dB	0.6	0.8	1.0	-0.6	-0.1	-1.3
	60°	<10dB	-0.2	-0.3	0.4	0.5	1.1	0.0

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Result Summary------GNSS

Results summary for GNSS

Antenna	Detail Spec	Spec	Ant1-GNSS		
Frequency	1.56~1.61GHz	-	1.56GHz	1.575GHz	1.61GHz
Efficiency	>70%	-	39.7	49.5	41.6
Peak Gain for 3D	3dBi< Peak<5.5dBi		3.4	4.5	3.6
Horizontal cut Gain Flatness	90°	<10dB	12.8	14.1	13.2
	80°	<10dB	16.1	15.5	13.2
	70°	<10dB	16.5	15.8	12.0
	60°	<10dB	14.8	14.4	10.7
Horizontal cut Average Gain	90°	<10dB	-4.8	-3.8	-2.9
	80°	<10dB	-4.6	-3.4	-2.7
	70°	<10dB	-3.6	-2.3	-1.9
	60°	<10dB	-2.3	-1.0	-1.2

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Result Summary------BLE/Zigbee

Results summary for BLE&Zigbee

Antenna	Detail Spec	Spec	Ant1-TriBand		
Frequency	2.4~2.49GHz	-	2.4GHz	2.45GHz	2.49GHz
Efficiency	>70%	-	48.5	57.1	65.6
Peak Gain for 3D	3dBi< Peak<5dBi		2.2	2.4	3.5
Horizontal cut Gain Flatness	90°	<10dB	4.3	5.6	7.5
	80°	<10dB	7.6	8.6	9.2
	70°	<10dB	7.9	8.9	9.3
	60°	<10dB	5.8	5.9	7.9
Horizontal cut Average Gain	90°	<10dB	-2.4	-1.5	-0.3
	80°	<10dB	-3.3	-1.3	-0.1
	70°	<10dB	-3.3	-0.9	0.3
	60°	<10dB	-2.5	-0.5	0.5

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Result Summary - Uncorrelated Gain & Correlated Gain

	Frequency (MHz)	Uncorrelated Gain (dBi)	correlated Gain (dBi)	Ants included
2.4G Wi-Fi	2400	4.4	7.4	A1&A2
	2450	4.1	7.1	A1&A2
	2490	4.1	7.1	A1&A2
5GHz Wi-Fi	5150	4.4	7.4	A1&A2
	5500	3.9	6.9	A1&A2
	5900	3.9	6.9	A1&A2
6GHz Wi-Fi	5900	4.0	7.0	A3&A4
	6500	3.8	6.6	A3&A4
	7125	4.0	6.8	A3&A4

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Calculations (1/2)

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: 4.4dBi
$= 10*\log(((10^{\wedge(G0/10)})+(10^{\wedge(G1/10)}))/2)$
$= 10*\log(((10^{\wedge(3.14/10)})+(10^{\wedge(5.38/10)}))/2)$
This occurs at: 2400MHz, phi 86/theta 110

5GHz uncorrelated calculation:
Maximum uncorrelated gain: 4.4dBi
$= 10*\log(((10^{\wedge(G0/10)})+(10^{\wedge(G1/10)}))/2)$
$= 10*\log(((10^{\wedge(4.44/10)})+(10^{\wedge(4.96/10)}))/2)$
This occurs at: 5150MHz, phi 98/theta 92

6GHz uncorrelated calculation:
Maximum uncorrelated gain: 4dBi
$= 10*\log(((10^{\wedge(G0/10)})+(10^{\wedge(G1/10)}))/2)$
$= 10*\log(((10^{\wedge(4.62/10)})+(10^{\wedge(3.3/10)}))/2)$
This occurs at: 5900MHz, phi 94/theta 74

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Calculations (2/2)

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 correlated antenna gain was calculated using KDB 662911 D01, F(2)(d)(i)
The correlated gain was calculated for each point in the spatial data, and the highest value reported.

2.4GHz correlated calculation:
Maximum correlated gain: 7.4dBi
$= 10*\log(((10^{\wedge(G0/20)})+(10^{\wedge(G1/20)}))^{\wedge 2})/2)$
$= 10*\log(((10^{\wedge(3.27/20)})+(10^{\wedge(5.3/20)}))^{\wedge 2})/2)$
This occurs at: 2450MHz, phi 88/theta 110

5GHz correlated calculation:
Maximum correlated gain: 7.4dBi
$= 10*\log(((10^{\wedge(G0/20)})+(10^{\wedge(G1/20)}))^{\wedge 2})/2)$
$= 10*\log(((10^{\wedge(4.44/20)})+(10^{\wedge(4.96/20)}))^{\wedge 2})/2)$
This occurs at: 5150MHz, phi 98/theta 92

6GHz correlated calculation:
Maximum correlated gain: 7dBi
$= 10*\log(((10^{\wedge(G0/20)})+(10^{\wedge(G1/20)}))^{\wedge 2})/2)$
$= 10*\log(((10^{\wedge(4.62/20)})+(10^{\wedge(3.3/20)}))^{\wedge 2})/2)$
This occurs at: 5900MHz, phi 94/theta 74

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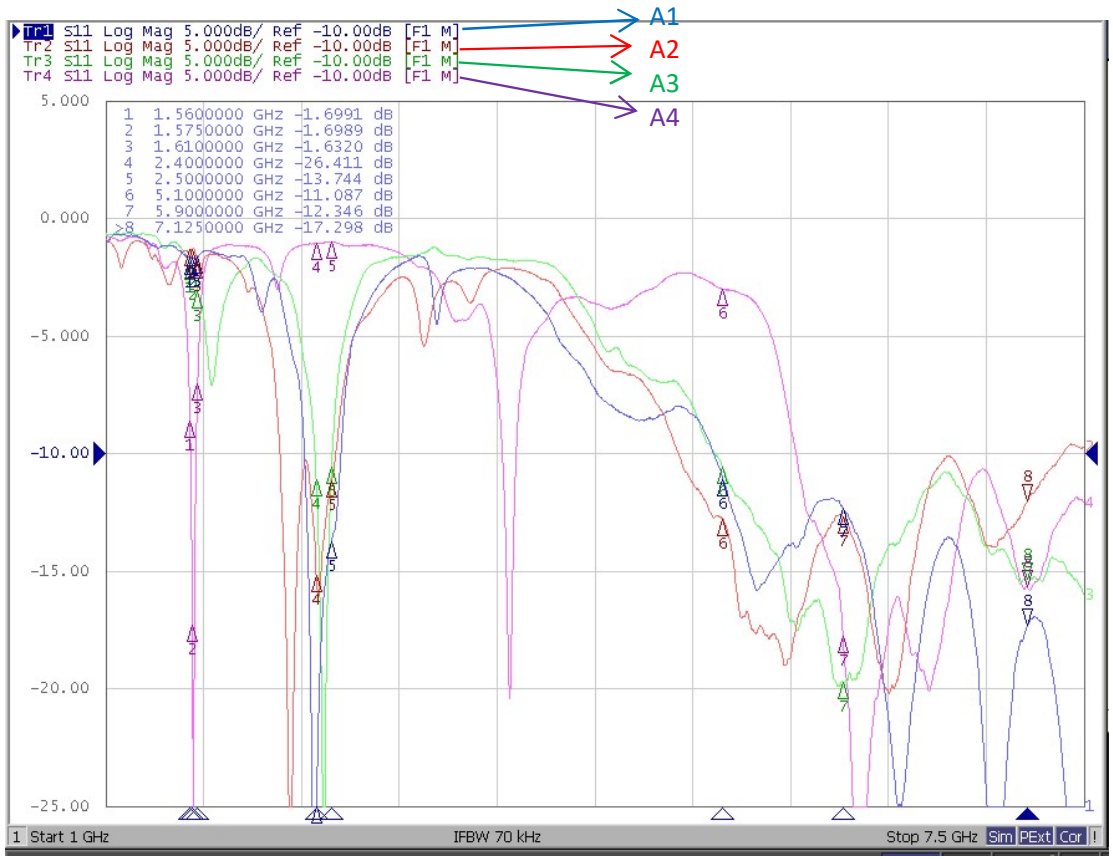
Measurement Data-----Return Loss

S-parameter:Return loss for WIFI&BLE&GNSS



Return Loss	Frequency(MHz)	ANT1	ANT2	ANT3	ANT4
2.4G Wi-Fi&BLE	2400	-26.4	-15.4	-11.8	/
	2450	-18.3	-13.2	-16.5	/
	2490	-13.7	-12.3	-11.2	/
5GHz Wi-Fi	5150	-11.1	-13.6	/	/
	5500	-14.3	-17.9	/	/
	5900	-12.3	-12.4	/	/
6GHz Wi-Fi	5900	/	/	-19.7	-17.6
	6500	/	/	-11.3	-14.8
	7125	/	/	-15.4	-16.3
GNSS	1560	/	/	/	-8.8
	1575	/	/	/	-17.4
	1610	/	/	/	-7.6

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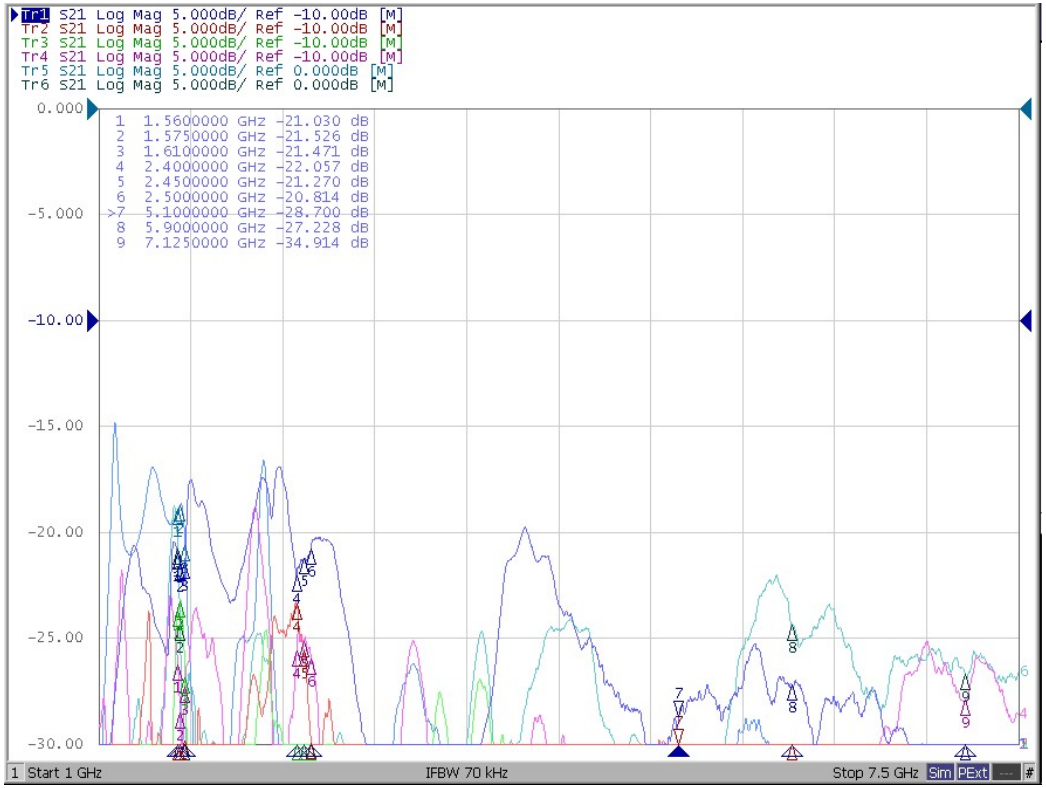
Measurement Data----Isolation



Frequency(GHz) / Isolation(dB)	1.56	1.575	1.61	2.4	2.45	2.49	5.15	5.5	5.9	6.5	7.125
ANT1&ANT2				22	21	20	28	27	27		
ANT1&ANT3				23	25	28	32	31	49	38	35
ANT1&ANT4	23	23	26				35	36	44	38	39
ANT2&ANT3				25	25	25	41	32	39	29	27
ANT2&ANT4	18	18	20				41	30	33	43	46
ANT3&ANT4	20	24	29						25	27	27

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Appendix

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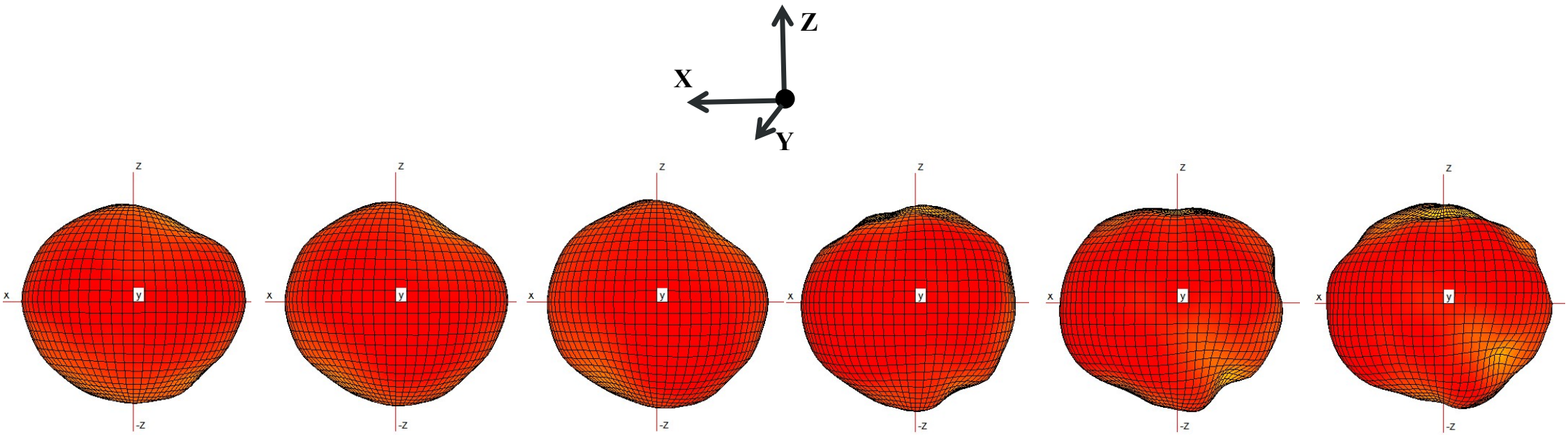
3D Radiation Pattern-ANT1



2.4G 2.45G 2.49G 5.15G 5.5G 5.9G

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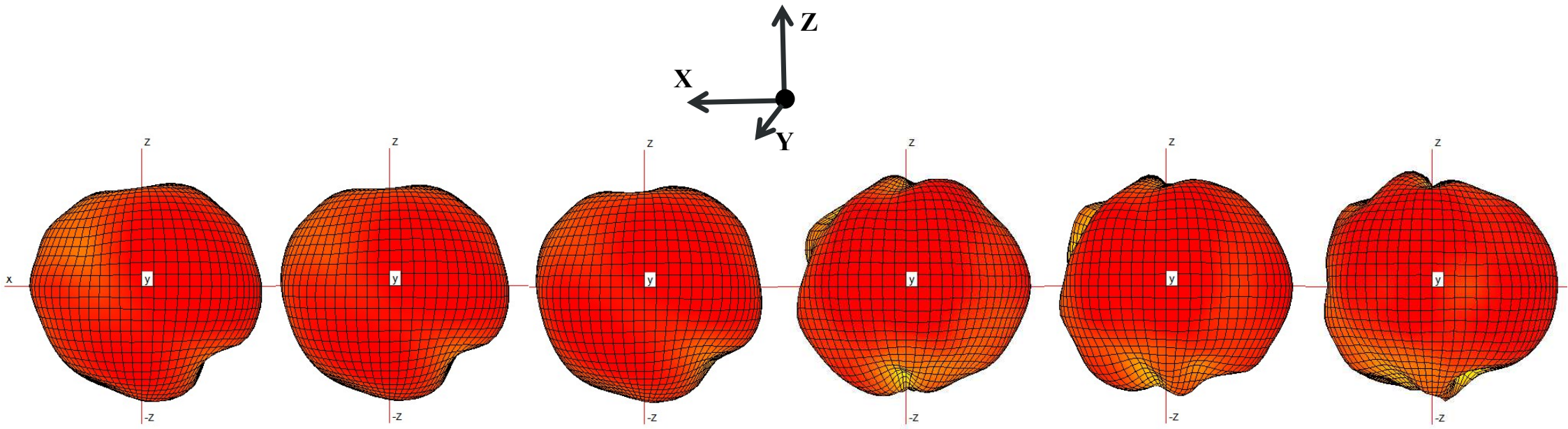
3D Radiation Pattern-ANT2



2.4G 2.45G 2.49G 5.15G 5.5G 5.9G

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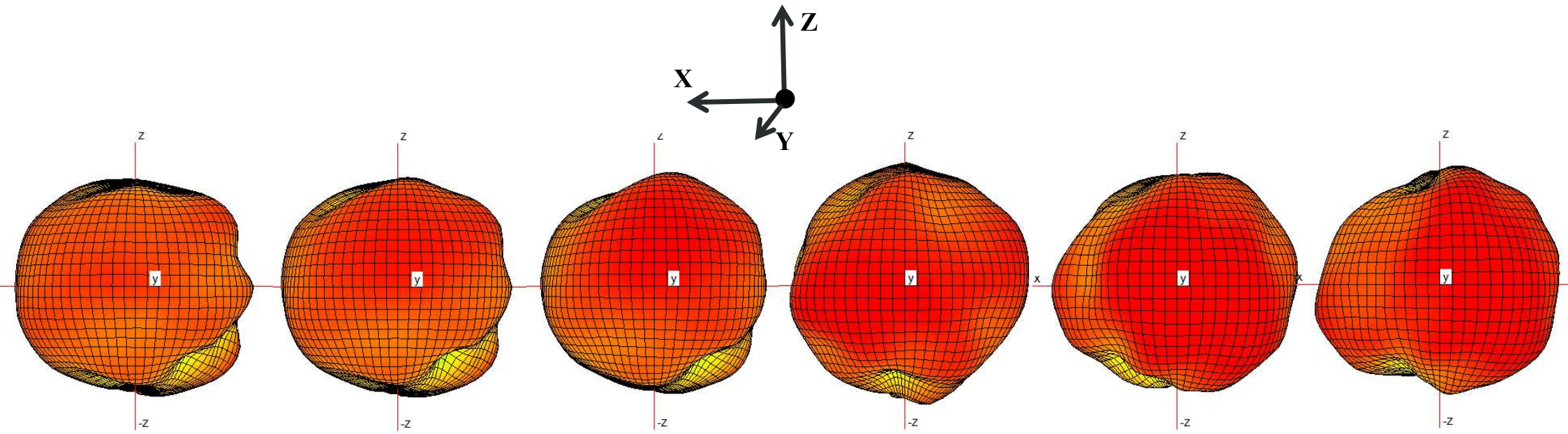
3D Radiation Pattern-ANT3



2.4G 2.45G 2.49G 5.9G 6.5G 7.125G

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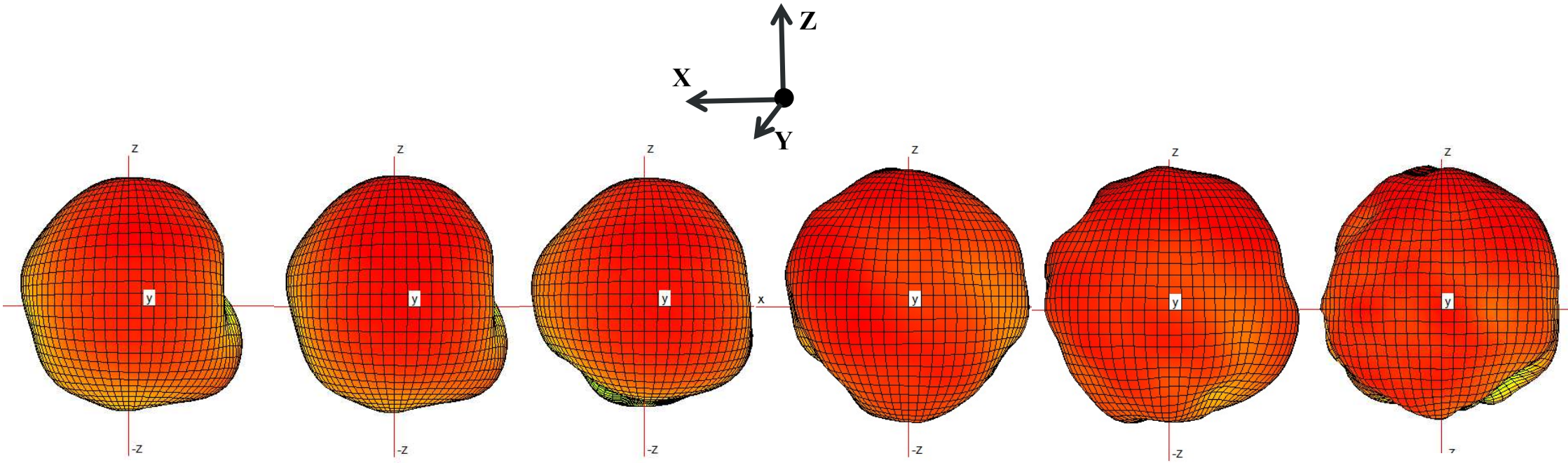
3D Radiation Pattern-ANT4



1.56G 1.575G 1.61G 5.9G 6.5G 7.125G

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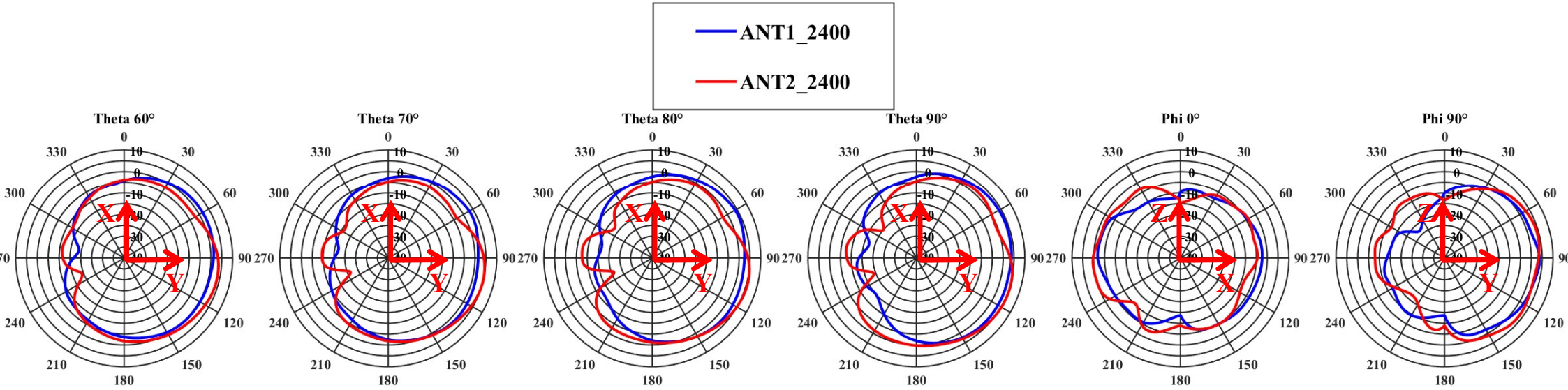
2D Radiation Pattern- WiFi ANT1&ANT2 @ 2.4GHz



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

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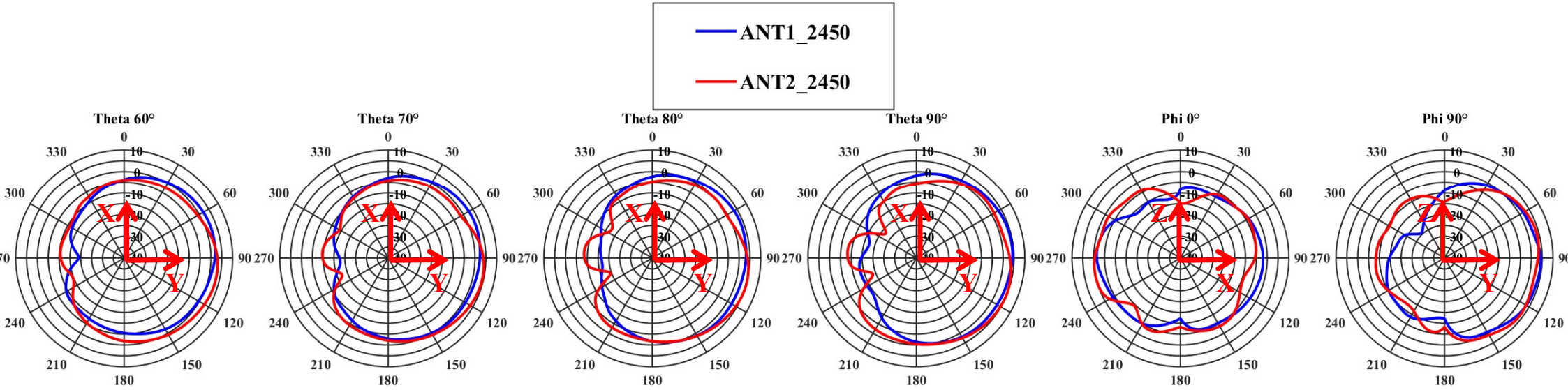
2D Radiation Pattern- WiFi ANT1&ANT2 @ 2.45GHz



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

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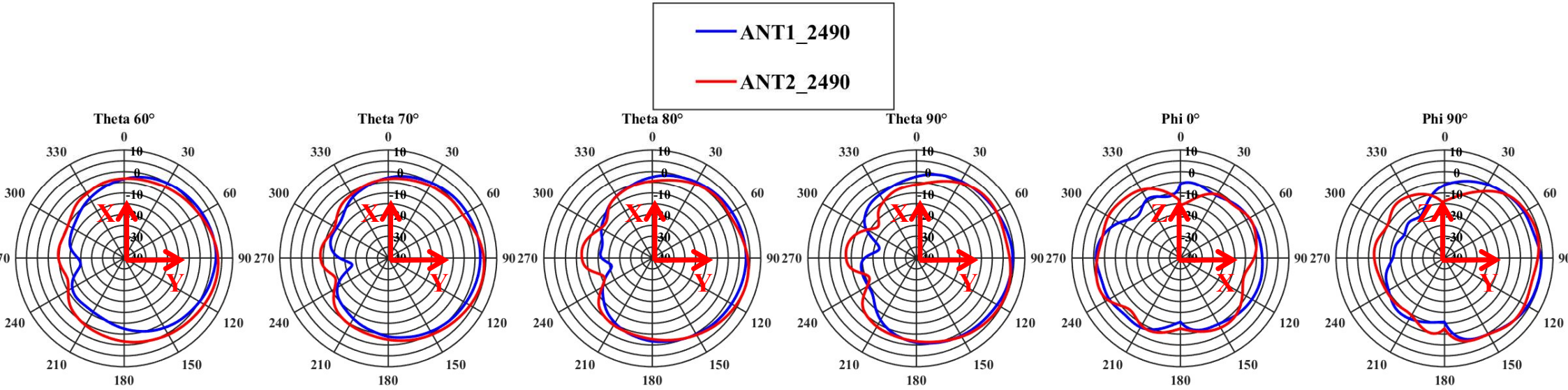
2D Radiation Pattern- WiFi ANT1&ANT2 @ 2.49GHz



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

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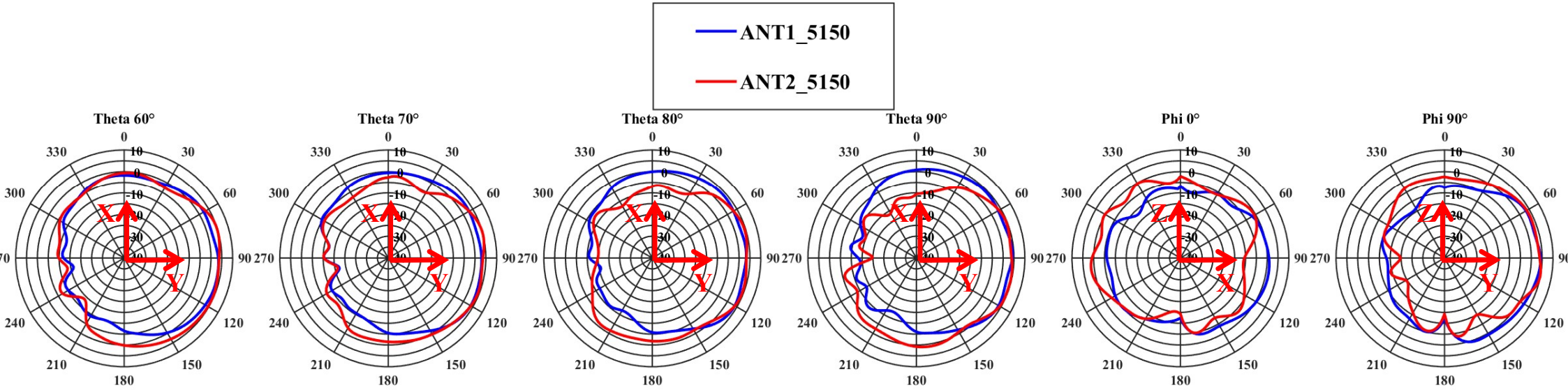
2D Radiation Pattern- WiFi ANT1&ANT2 @ 5.15GHz



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

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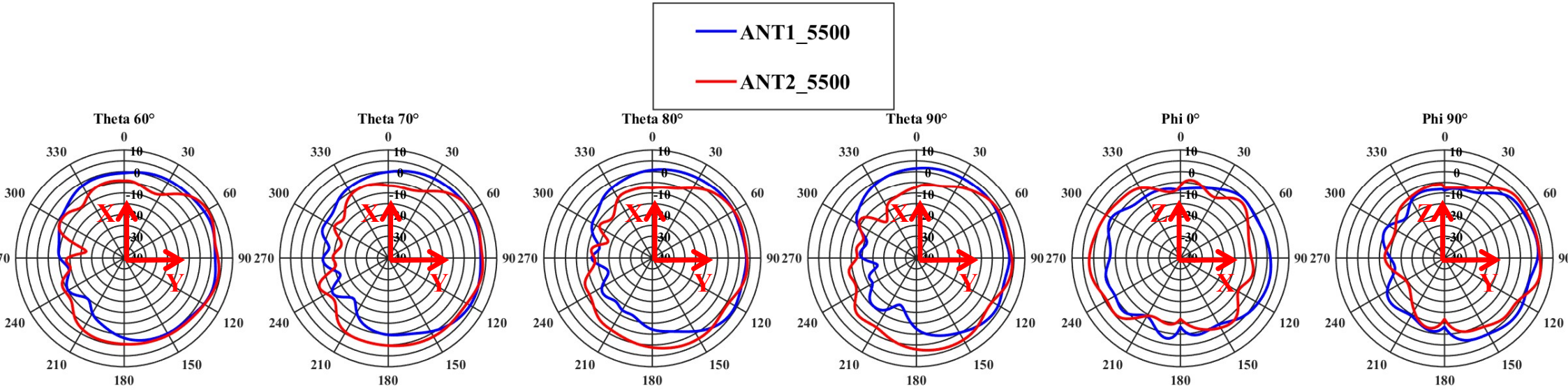
2D Radiation Pattern- WiFi ANT1&ANT2 @ 5.5GHz



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

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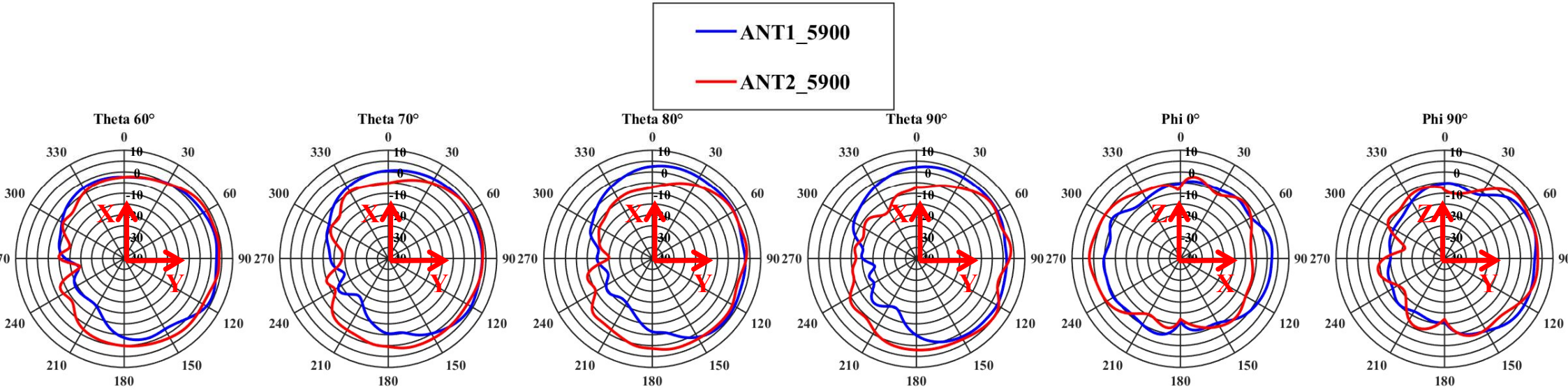
2D Radiation Pattern- WiFi ANT1&ANT2 @ 5.9GHz



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

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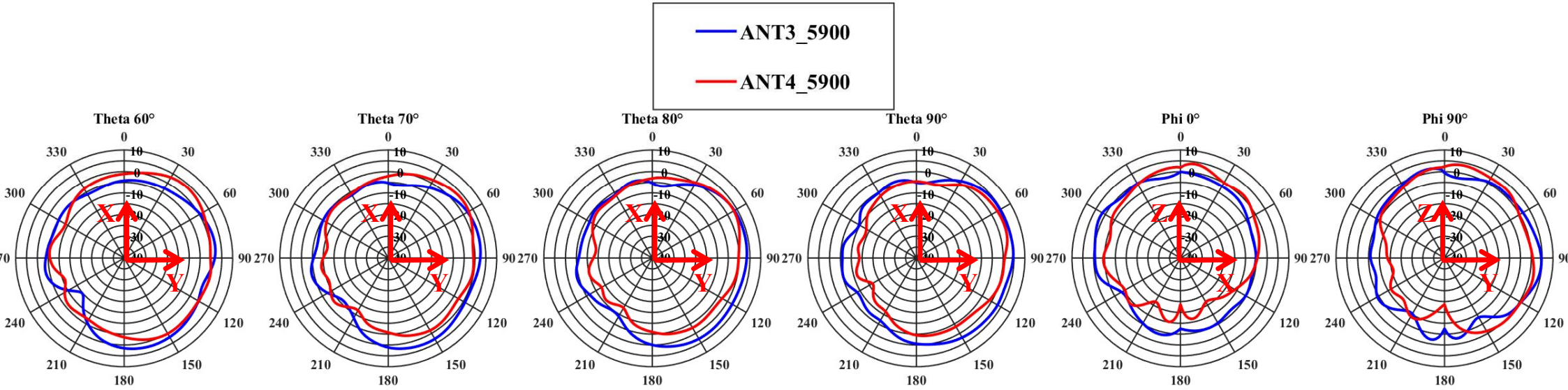
2D Radiation Pattern- WiFi ANT3&ANT4 @ 5.9GHz



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

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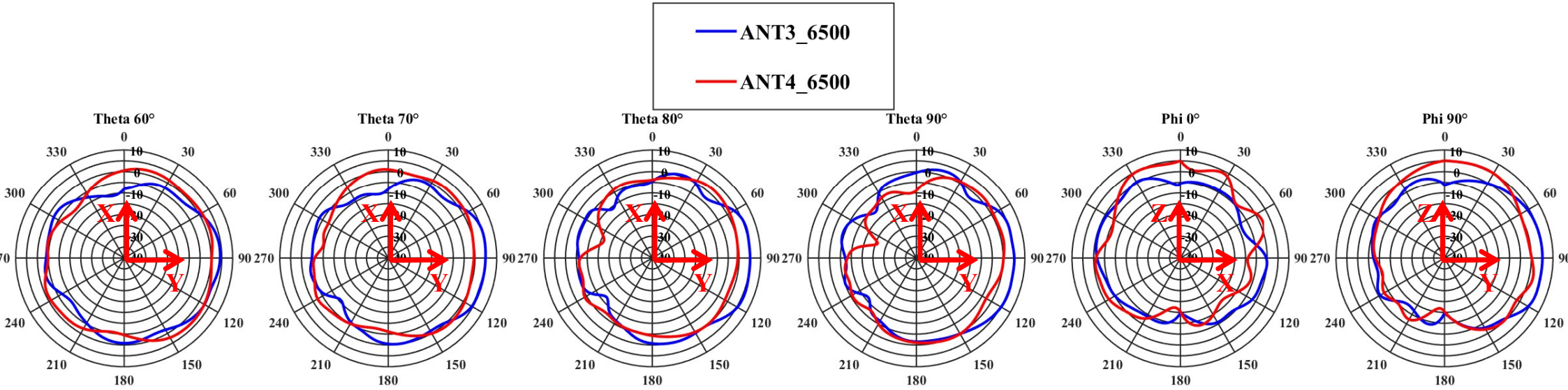
2D Radiation Pattern- WiFi ANT3&ANT4 @ 6.5GHz



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

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