

Antenna Composite Gain Test Report

1. Test Information

Equipment	GTS
Brand Name	Nokia
Model Name	Beacon 24
Applicant	Nokia
Manufacturer	Nokia

2. Testing Location

Testing Location	
INPAQ	ADD: No. 81, Antai 1st Road, Xishan District, Wuxi City, Jiangsu Province, China

Test Condition	Test Engineer	Test Environment (°C / %)	Test Date
Radiated	Hao Qin	20-24 / 45-60	11.09.2023~11.09.2023

3. Test Frequency

Band (MHz)	Test Frequency (MHz)
2400-2500	2400 / 2450 / 2500
5150-5350	5150 / 5250 / 5350
5500-5825	5500 / 5675 / 5825

4. Antenna Information

Ant. Position	Brand Name	Model Name	Ant. Type	Connector
Antenna A (2G/5G)	Nokia		Dipole	I-PEX
Antenna B (2G/5G)	Nokia		Dipole	I-PEX
Antenna C (2G/5G)	Nokia		Dipole	I-PEX
Antenna D (2G/5G)	Nokia		Dipole	I-PEX
Antenna 1 (5G)	Nokia		Dipole	I-PEX
Antenna 2 (5G)	Nokia		Dipole	I-PEX
Antenna 3 (5G)	Nokia		Dipole	I-PEX
Antenna 4 (5G)	Nokia		Dipole	I-PEX

7. Test Method

The “great circle” cut method, whereby the Measurement Antenna remains fixed and the EUT is rotated about two axes in sequential order. The radiated RF performance of the Equipment Under Test (EUT) is measured by sampling the radiated transmit power of the mobile at various locations surrounding the device. A three-dimensional characterization of the 'transmit' performance of the EUT is pieced together by analyzing the data from the spatially distributed measurements.

Data points taken every 15 degrees in the theta and in the phi axes are deemed sufficient to fully characterize the EUT's Far-Field radiation pattern and total radiated power. All of the measured power values will be integrated.

8. Measured Values and Calculation of Correlated /

Uncorrelated Gains

Antenna Peak Gain Table (Ant. Position: 2G/5G Ant.A~D)

Band (MHz)	2400-2500		
Frequency (MHz)	2400	2450	2500
Ant.A Max Gain (dBi)	2.10	1.84	0.95
Ant.B Max Gain (dBi)	2.11	1.17	1.75
Ant.C Max Gain (dBi)	2.20	2.13	2.43
Ant.D Max Gain (dBi)	2.31	3.11	2.11
Max Gain (dBi)	2.31	3.11	2.11

Band (MHz)	5500-5825		
Frequency (MHz)	5500	5675	5825
Ant.A Max Gain (dBi)	1.72	2.07	2.07
Ant.B Max Gain (dBi)	1.81	1.65	1.80
Ant.C Max Gain (dBi)	1.74	1.70	1.40
Ant.D Max Gain (dBi)	2.31	2.10	3.11
Max Gain (dBi)	2.31	2.10	3.11

Antenna Peak Gain Table (Ant. Position: 5G Ant.1~4)

Band (MHz)	5150-5350		
Frequency (MHz)	5150	5250	5350
Ant.1 Max Gain (dBi)	1.57	2.62	1.84
Ant.2 Max Gain (dBi)	1.27	2.14	3.12
Ant.3 Max Gain (dBi)	2.40	2.16	1.96
Ant.4 Max Gain (dBi)	1.73	2.16	1.73
Max Gain (dBi)	2.40	2.62	3.12

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 15 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 uncorrelated antenna gain was calculated using KDB 662911 D01, F(2)(d)(ii).

The uncorrelated and correlated gains were calculated for each point in the spatial data, and the highest values reported.

Note :
KDB 662911 D01, F(2)(d)(i)

$$\text{Correlated Gain} = 10 \log \left[\left(10^{\frac{G_1}{20}} + 10^{\frac{G_2}{20}} + \dots + 10^{\frac{G_n}{20}} \right)^2 / N_{Ant.} \right] \text{ dBi}$$

KDB 662911 D01, F(2)(d)(ii)

$$\text{Uncorrelated Gain} = 10 \log \left[\left(10^{\frac{G_1}{10}} + 10^{\frac{G_2}{10}} + \dots + 10^{\frac{G_n}{10}} \right) / N_{Ant.} \right] \text{ dBi}$$

$N_{Ant.}$: Number of antenna
 G_n : Gain of antenna

Maximum Correlated / Uncorrelated Gain Calculation

(Ant. Position: 2G Ant.A~D)

Frequency (MHz)	2400	2450	2500
Ant.A Gain (dBi)	2.10	-5.86	0
Ant.B Gain (dBi)	-3.33	0.57	-10.6
Ant.C Gain (dBi)	-1.65	-2.55	2.43
Ant.D Gain (dBi)	-4.21	1.17	-1.57
Phi (°)	15	165	120
Theta (°)	60	75	60
Beamforming	4.60	4.78	4.74
Non Beamforming (CDD MODE)	4.60	4.78	4.74

(Ant. Position: 5G Ant.A~D)

Frequency (MHz)	5500	5675	5825
Ant.A Gain (dBi)	-4.19	-5.25	0.32
Ant.B Gain (dBi)	-1.40	-0.77	-4.82
Ant.C Gain (dBi)	0.69	-3.54	1.39
Ant.D Gain (dBi)	2.22	1.56	-0.58
Phi (°)	165	165	75
Theta (°)	90	90	90
Beamforming	5.67	4.41	5.39
Non Beamforming (CDD MODE)	5.67	4.41	5.39

(Ant. Position: 5G Ant.1~4)

Frequency (MHz)	5150	5250	5350
Ant.1 Gain (dBi)	-3.45	0.41	-3.07
Ant.2 Gain (dBi)	-4.31	2.14	-3.70
Ant.3 Gain (dBi)	2.31	-2.90	1.96
Ant.4 Gain (dBi)	-0.74	-3.52	0.10
Phi (°)	180	0	180
Theta (°)	105	90	105
Beamforming	4.87	5.37	5.15
Non Beamforming (CDD MODE)	4.87	5.37	5.15

Calculation example :

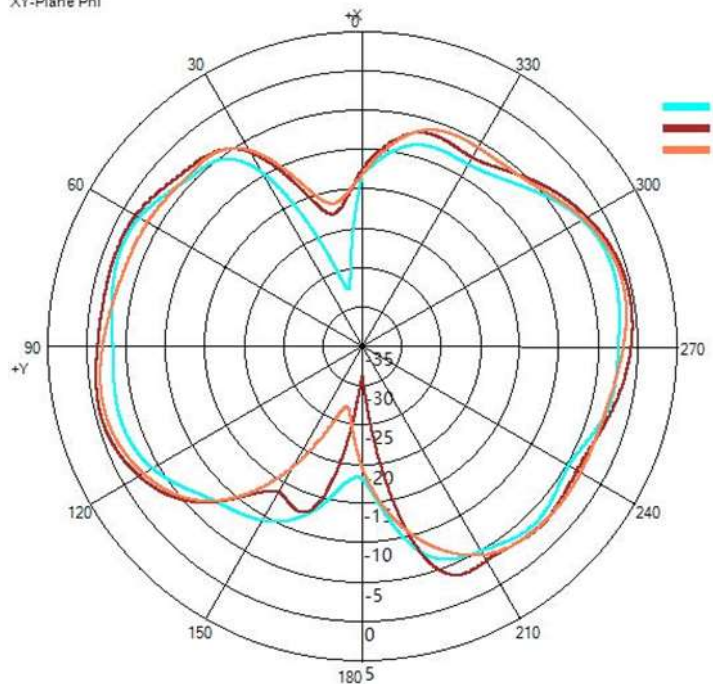
$$10 \times \log\left\{\left[10^{(-3.45 \text{ dBi} / 20)} + 10^{(-4.31 \text{ dBi} / 20)} + 10^{(2.31 \text{ dBi} / 20)} + 10^{(-0.74 \text{ dBi} / 20)}\right]^2 / 4\right\} = 4.87 \text{ dBi}$$

9. Radiation Pattern

Ant. Position: 2G/5G Ant.A~D

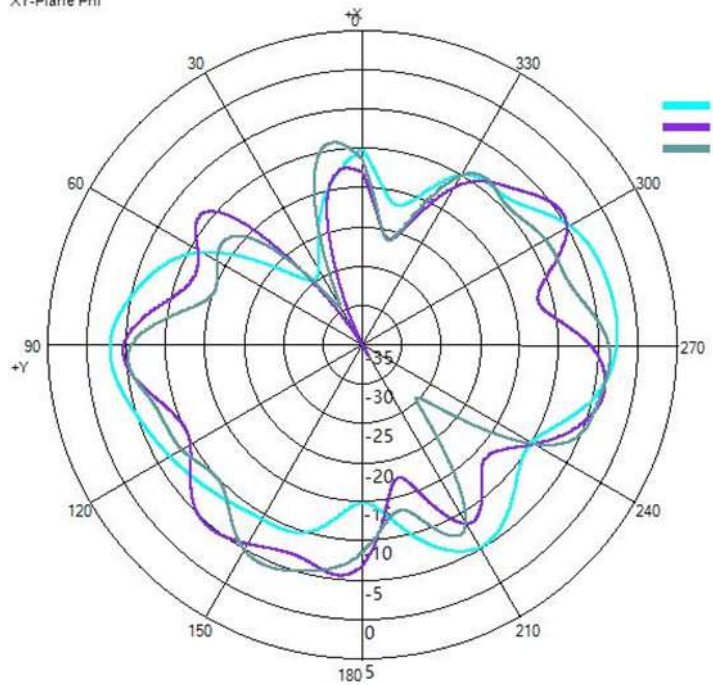
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XY-Plane Phi



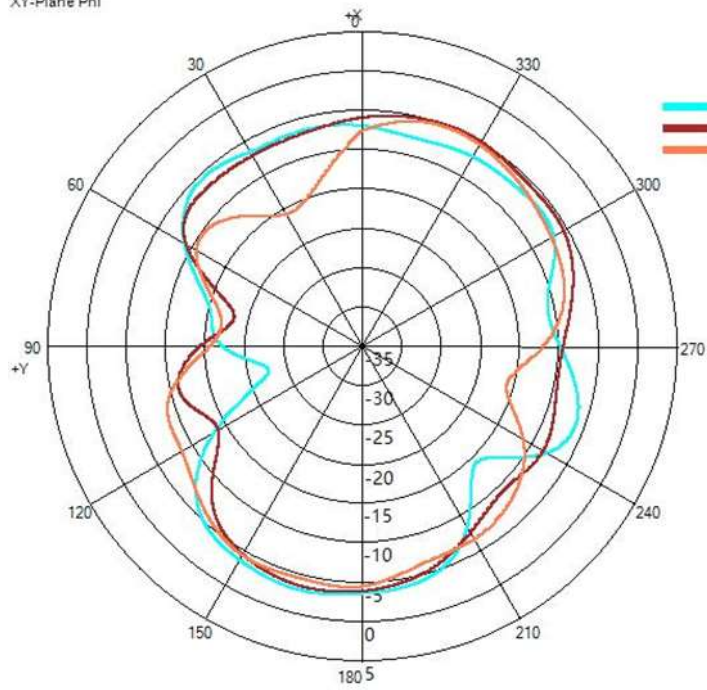
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XY-Plane Phi



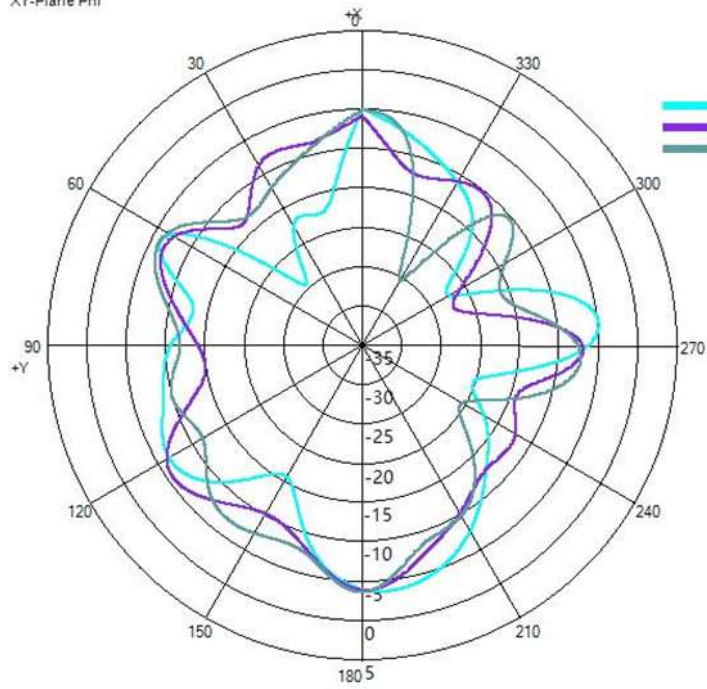
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XY-Plane Phi



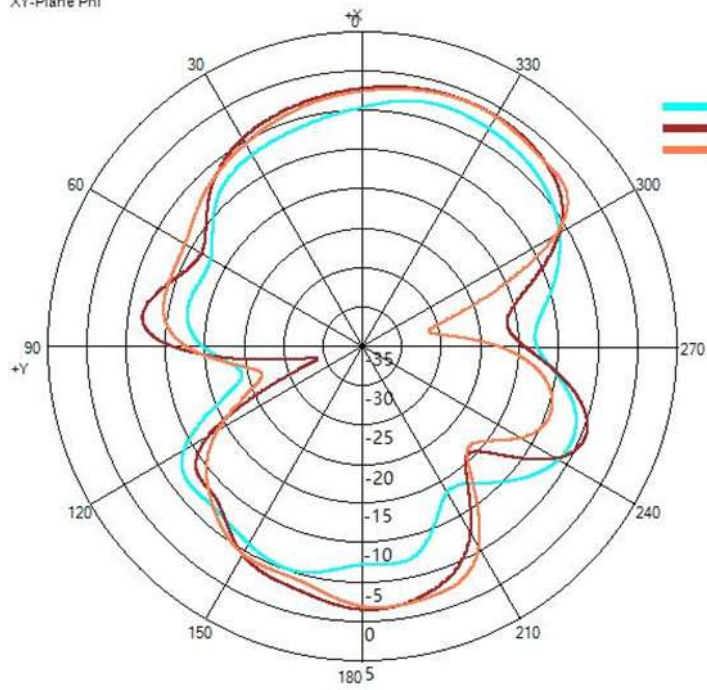
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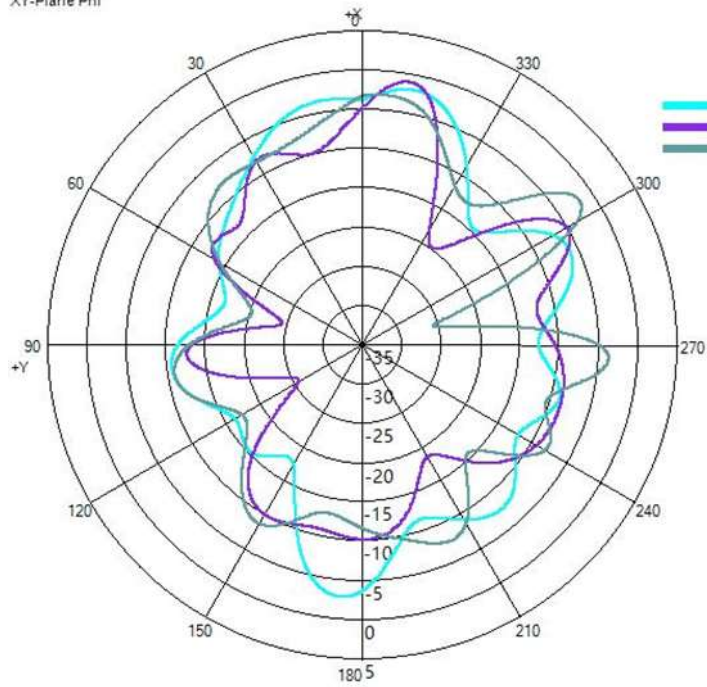
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XY-Plane Phi



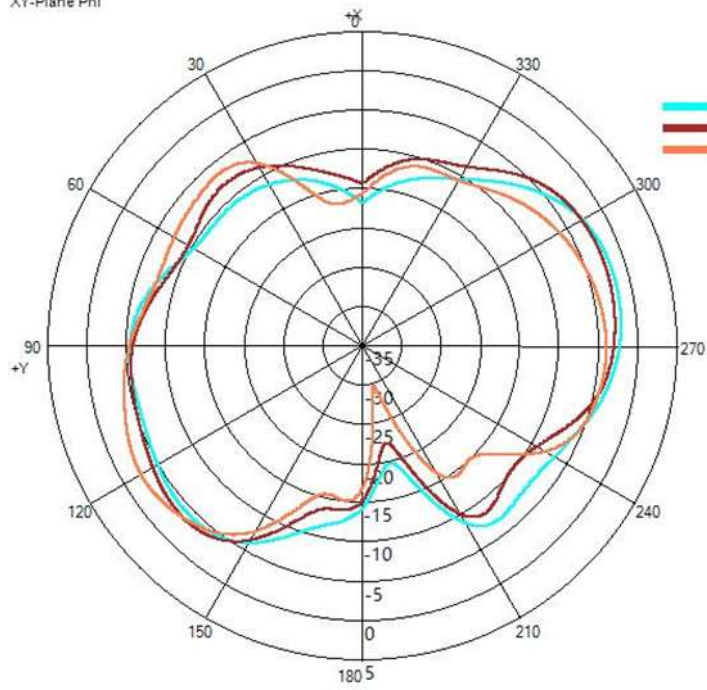
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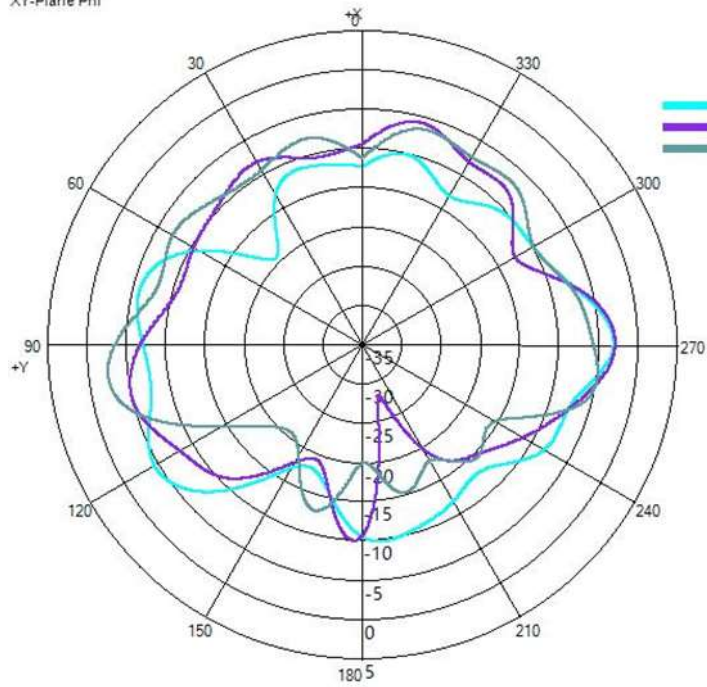
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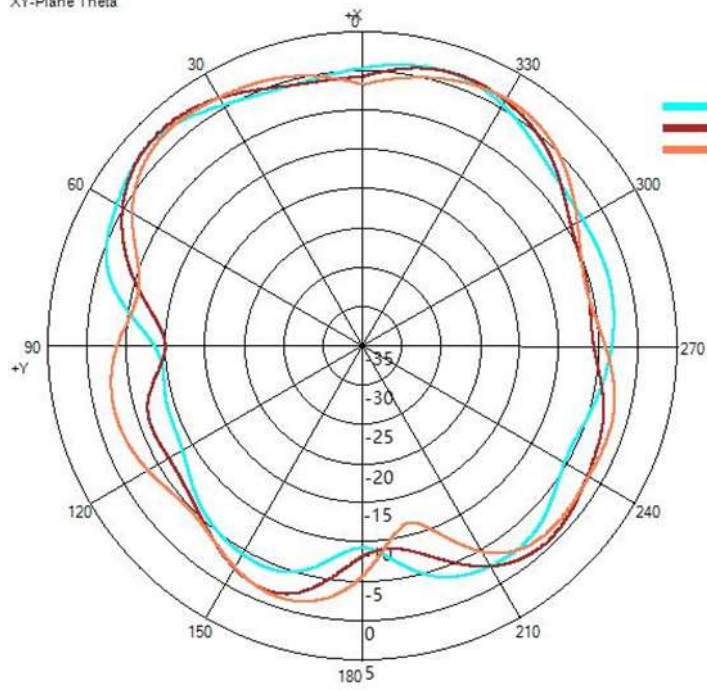
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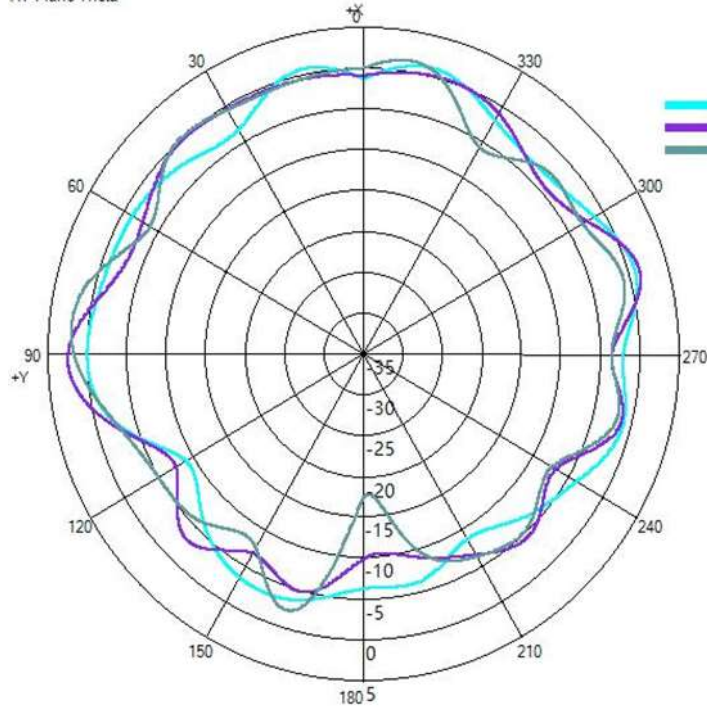
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XY-Plane Theta



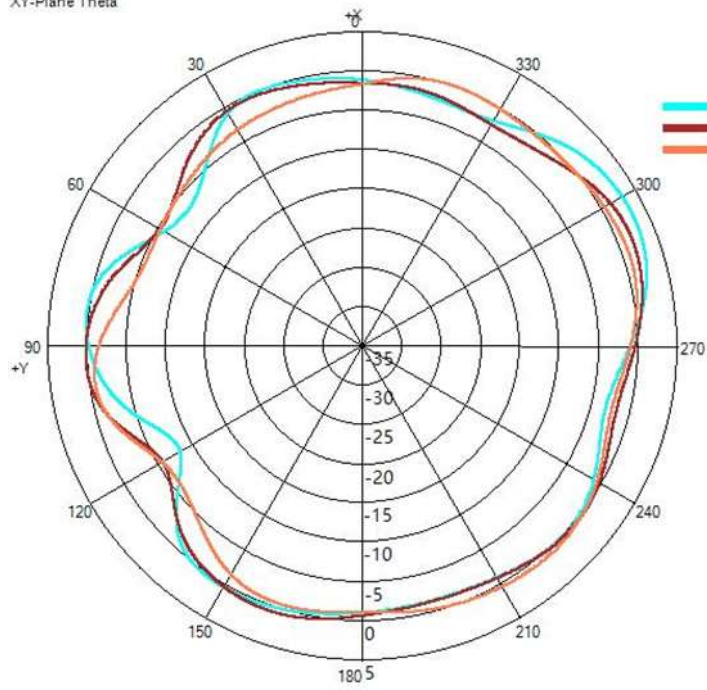
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XY-Plane Theta



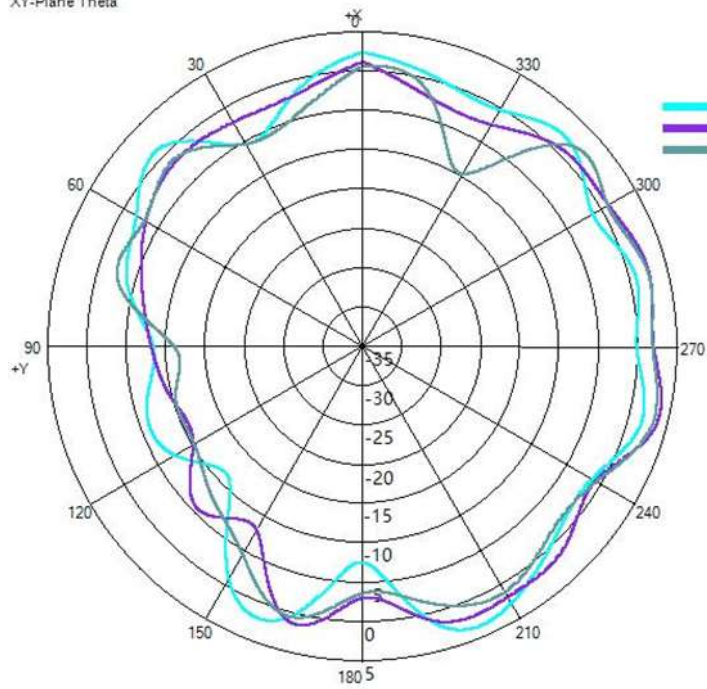
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XY-Plane Theta



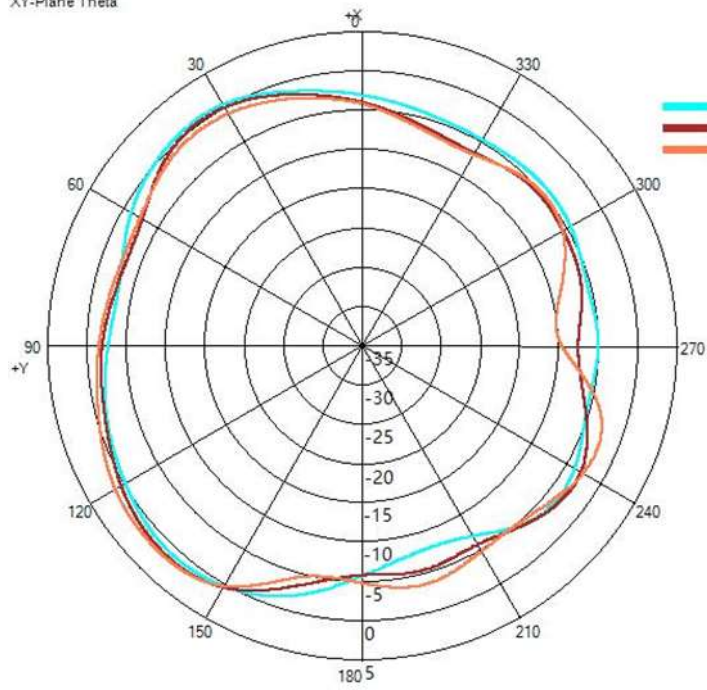
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XY-Plane Theta



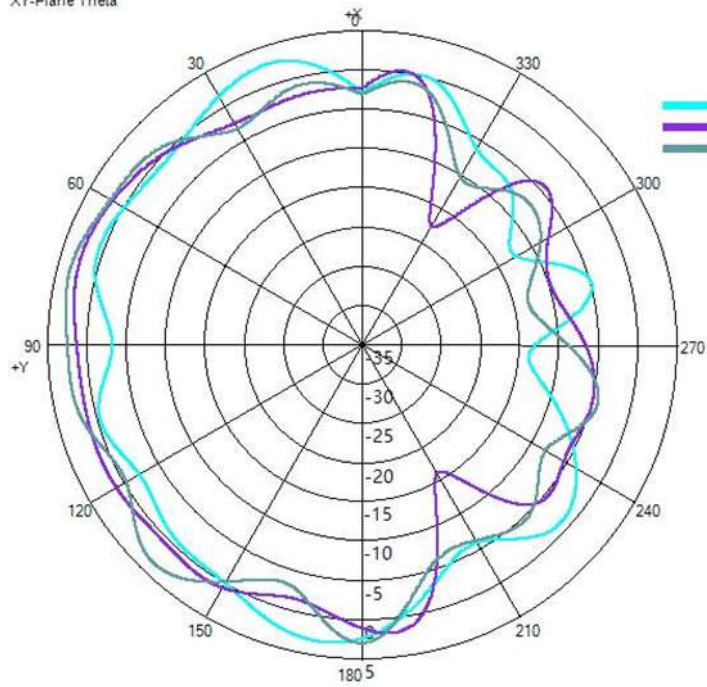
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XY-Plane Theta



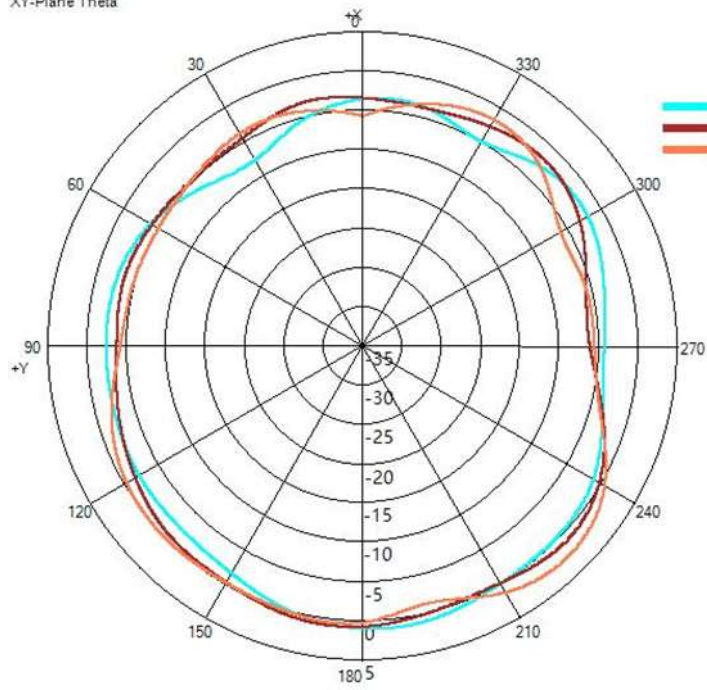
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XY-Plane Theta



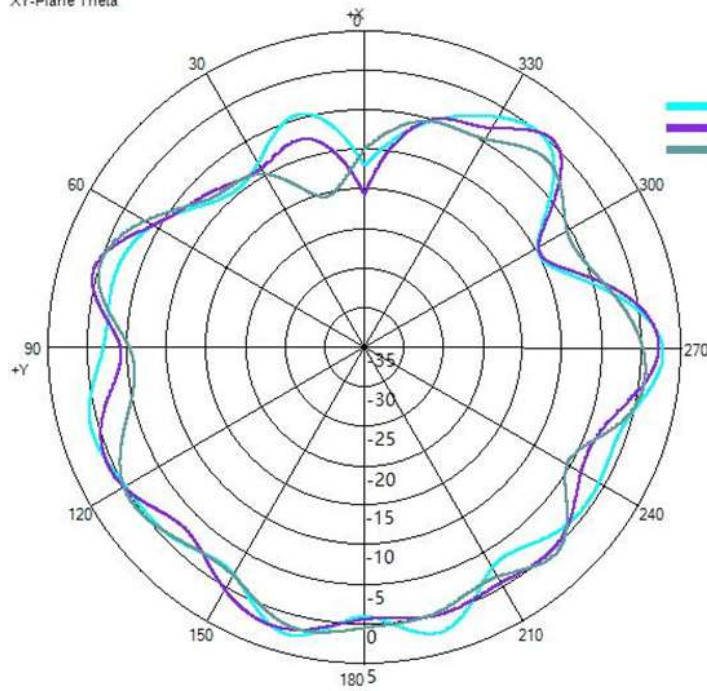
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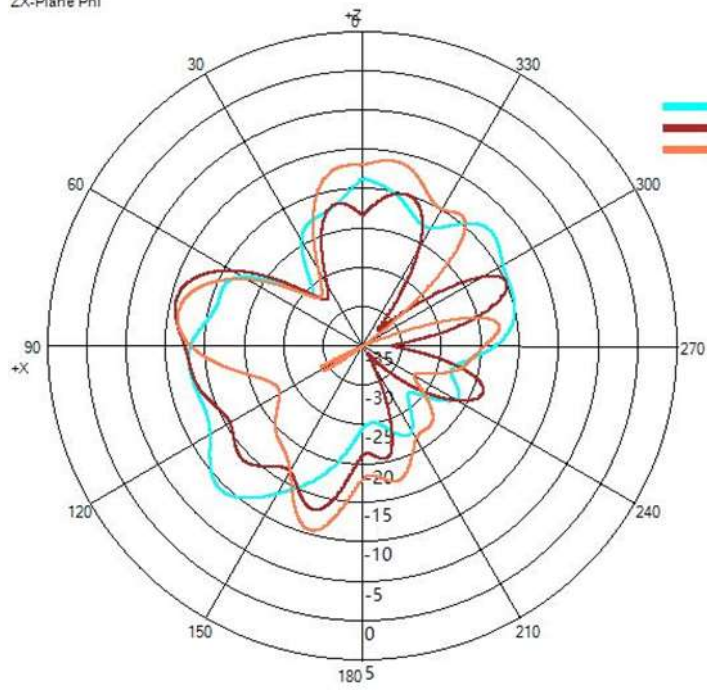
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XY-Plane Theta



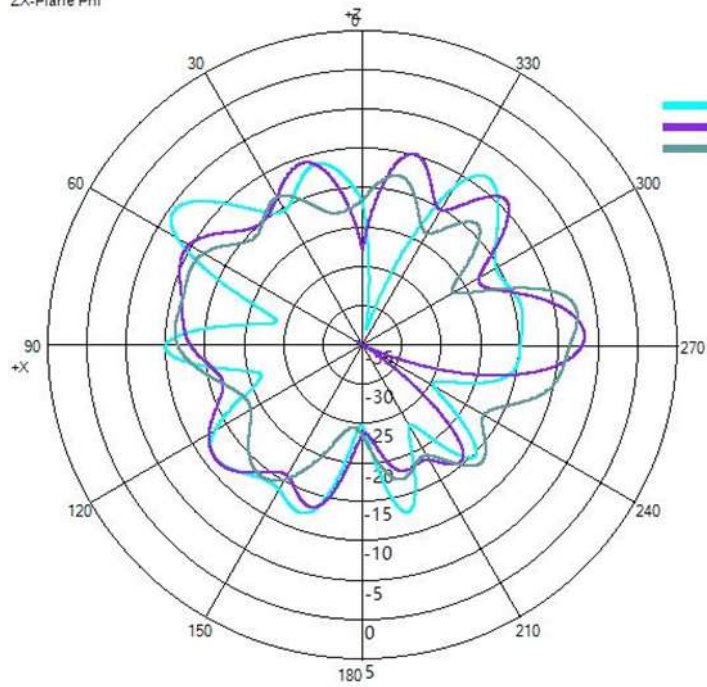
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ZX-Plane Phi



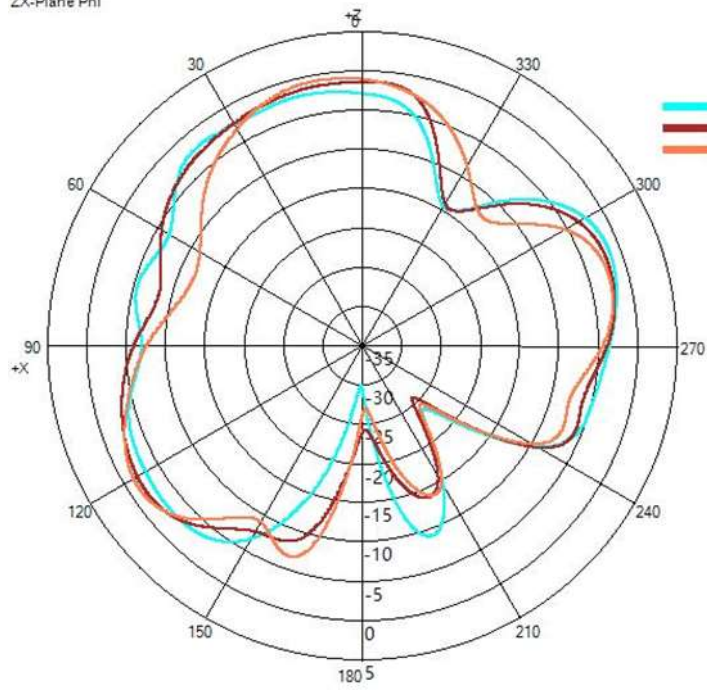
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ZX-Plane Phi



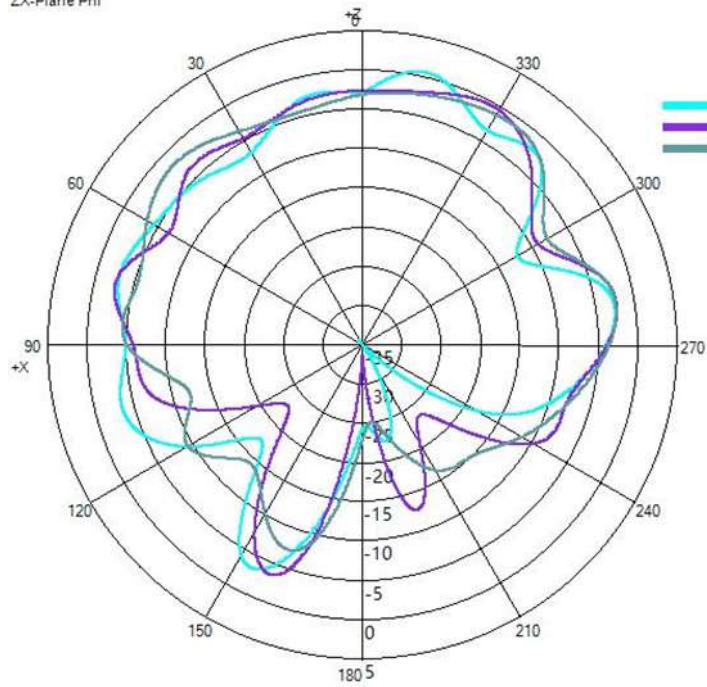
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ZX-Plane Phi



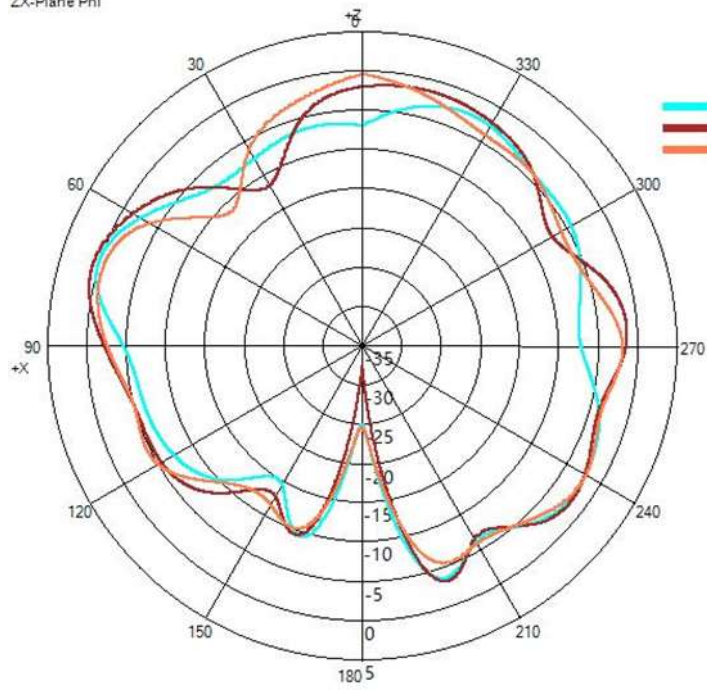
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ZX-Plane Phi



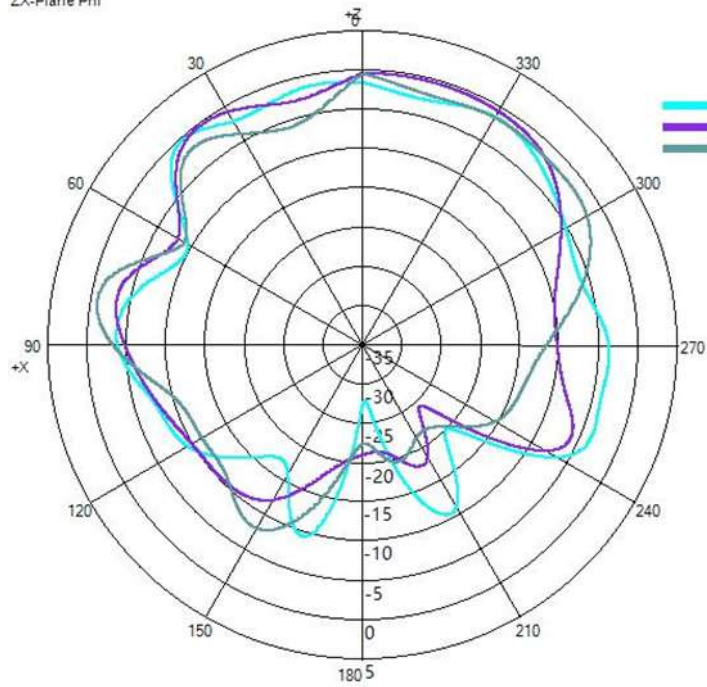
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ZX-Plane Phi



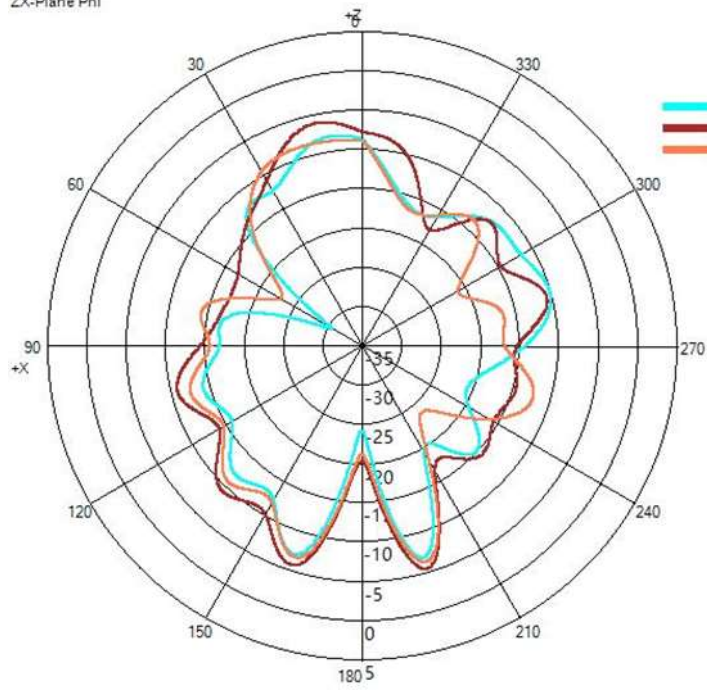
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ZX-Plane Phi



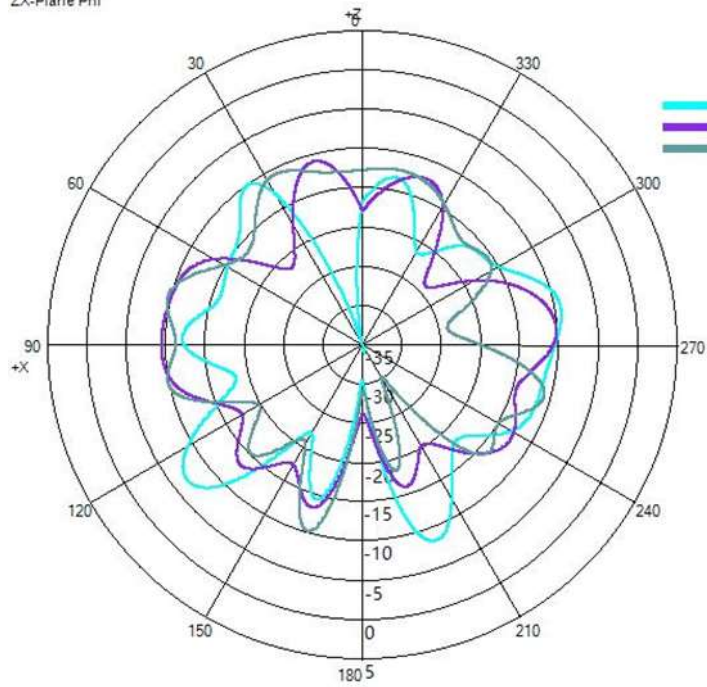
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ZX-Plane Phi



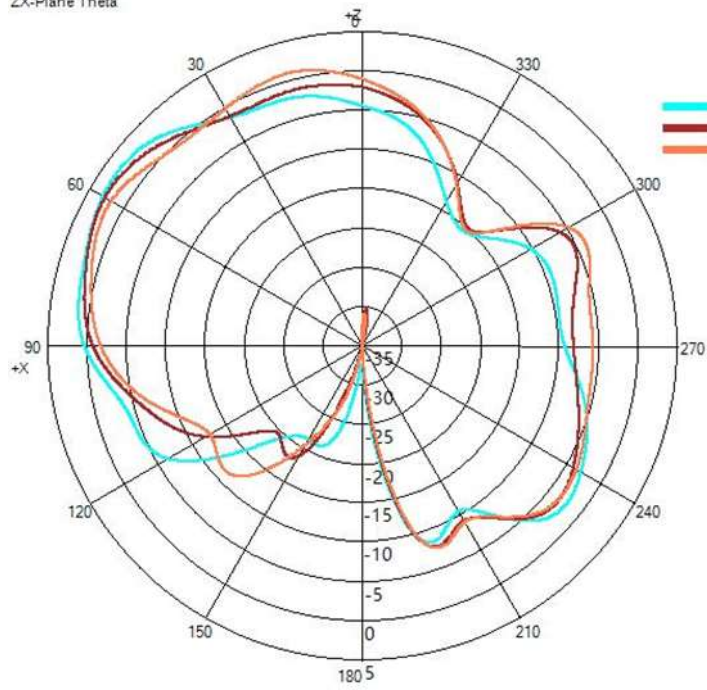
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ZX-Plane Phi



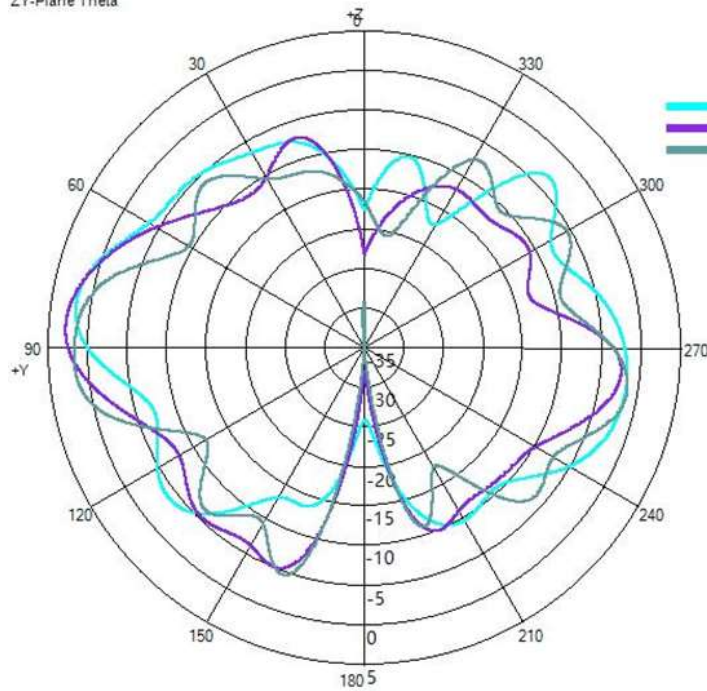
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ZX-Plane Theta



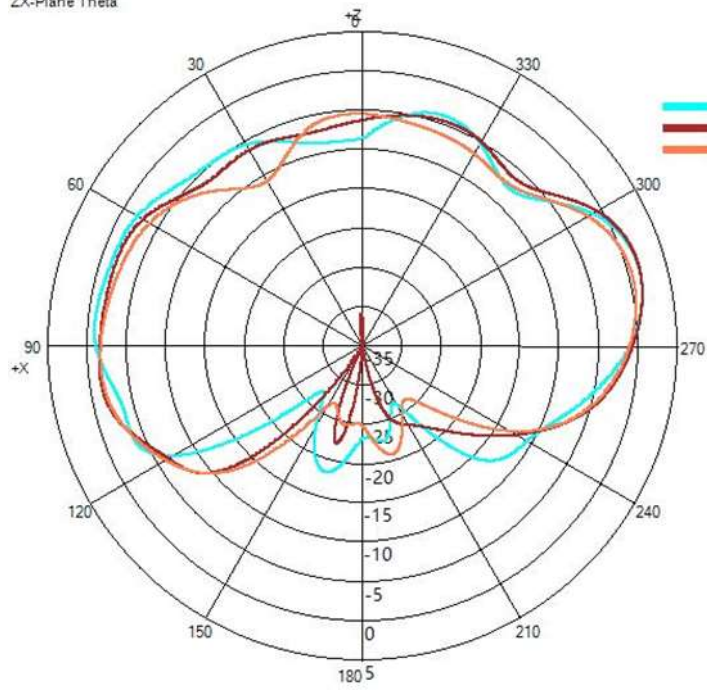
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ZY-Plane Theta



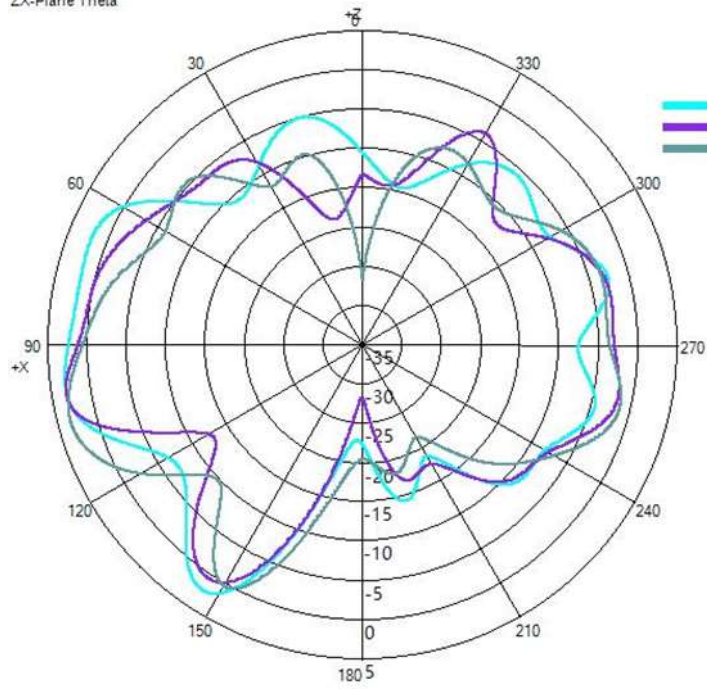
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ZX-Plane Theta



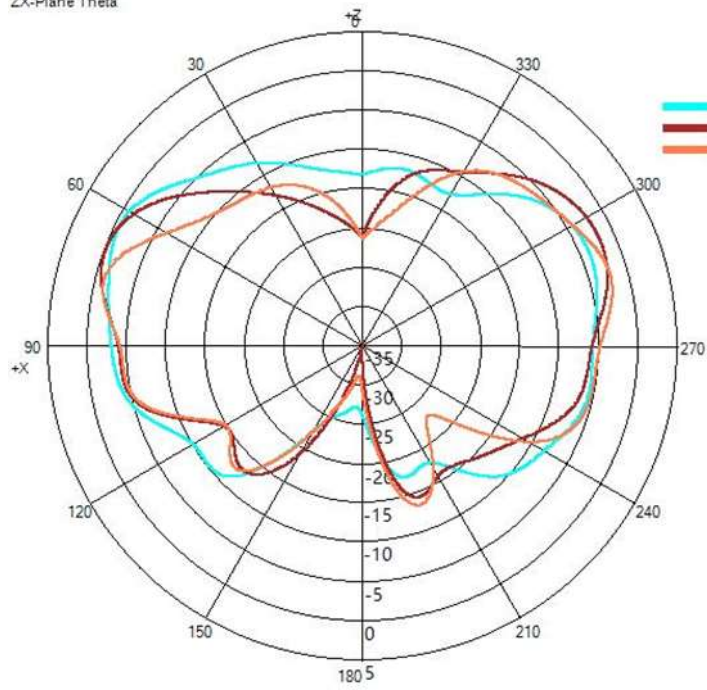
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ZX-Plane Theta



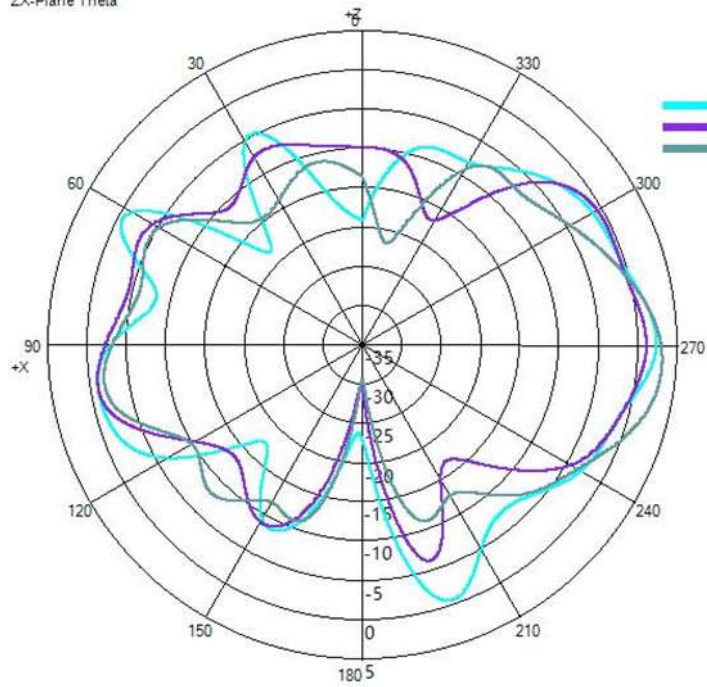
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ZX-Plane Theta



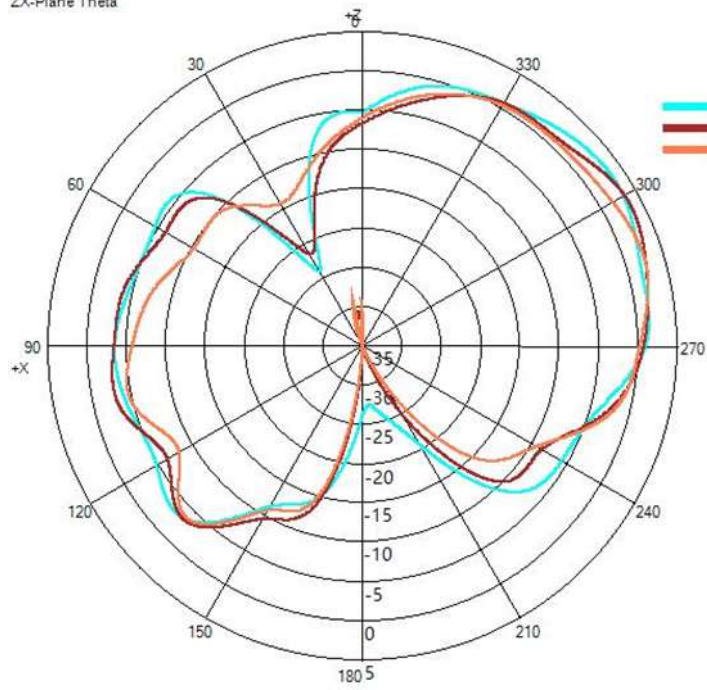
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ZX-Plane Theta



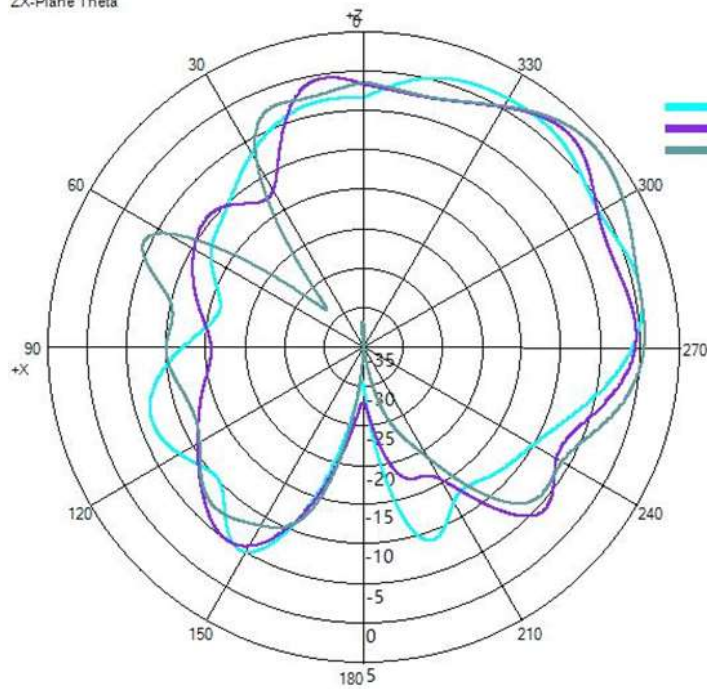
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ZX-Plane Theta



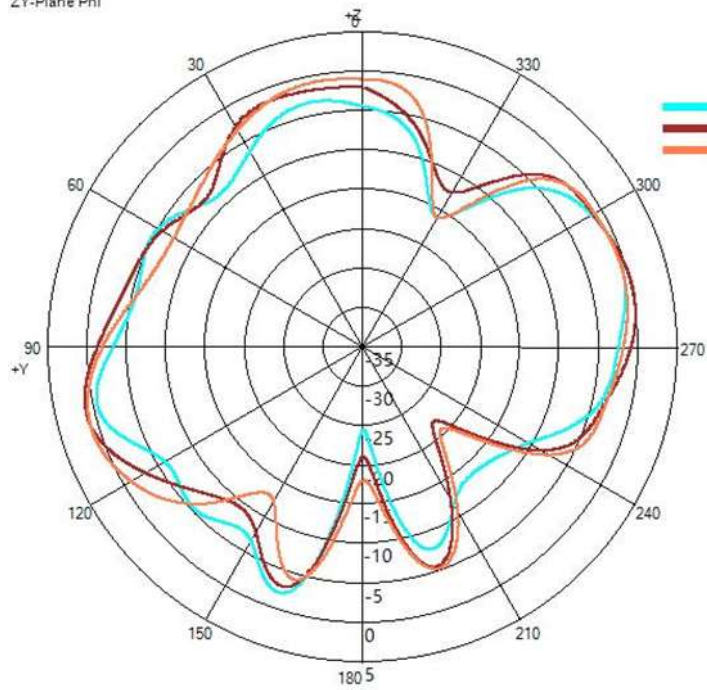
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ZX-Plane Theta



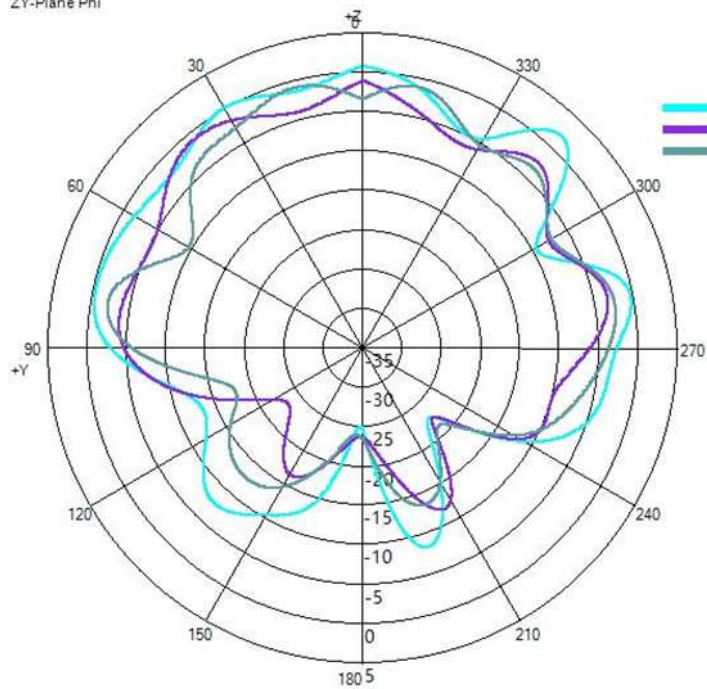
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ZY-Plane Phi



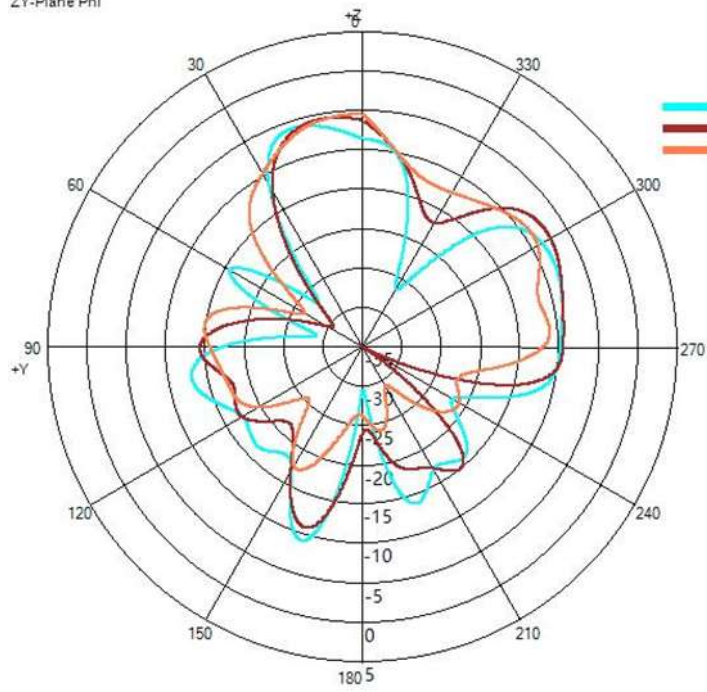
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ZY-Plane Phi



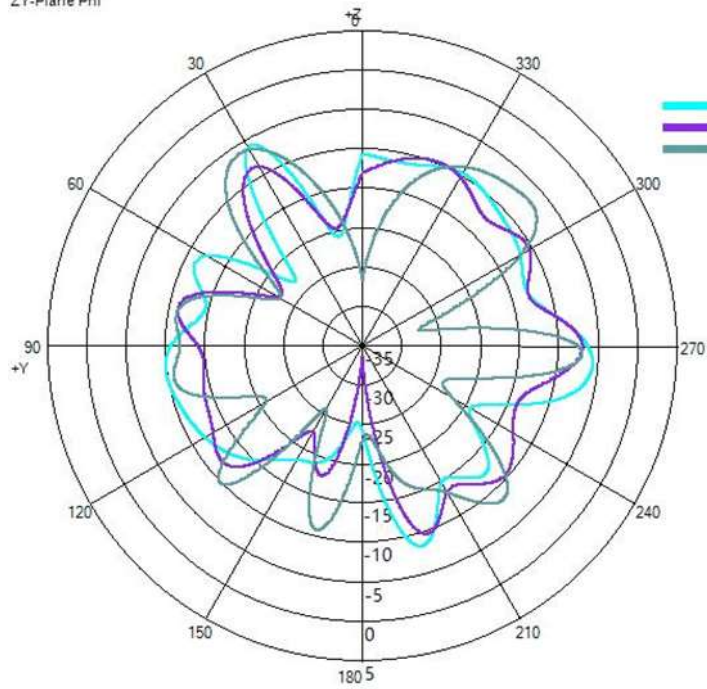
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ZY-Plane Phi



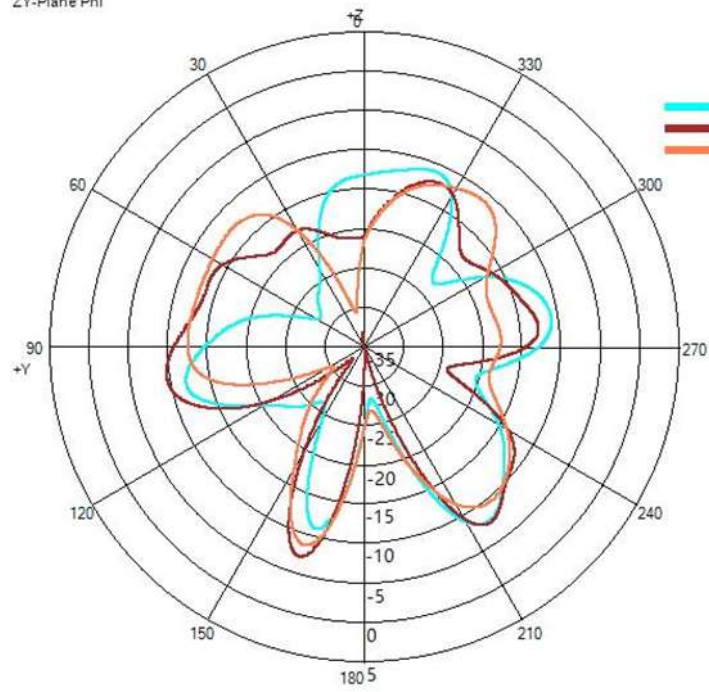
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ZY-Plane Phi



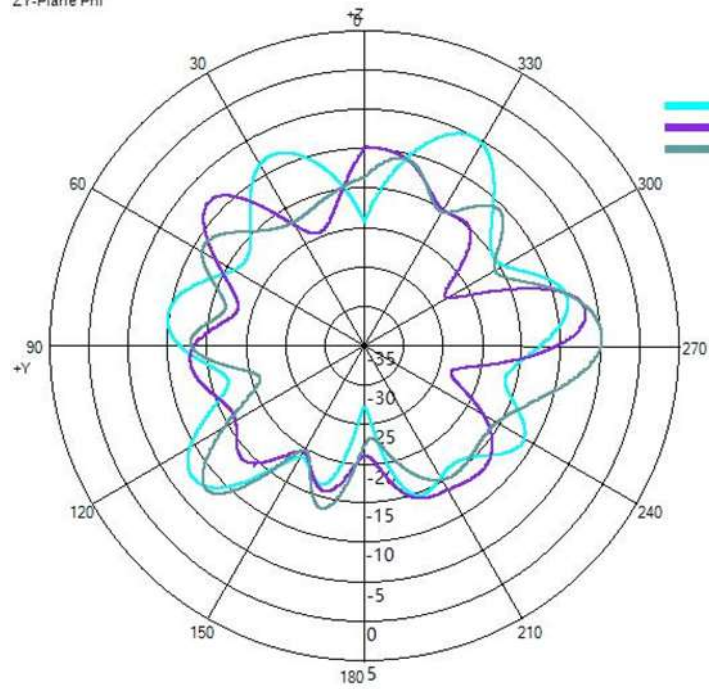
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ZY-Plane Phi



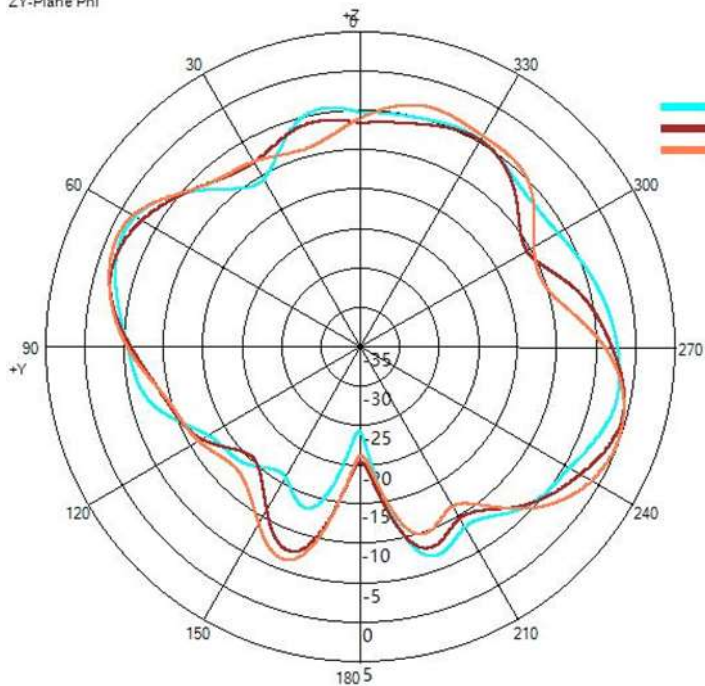
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ZY-Plane Phi



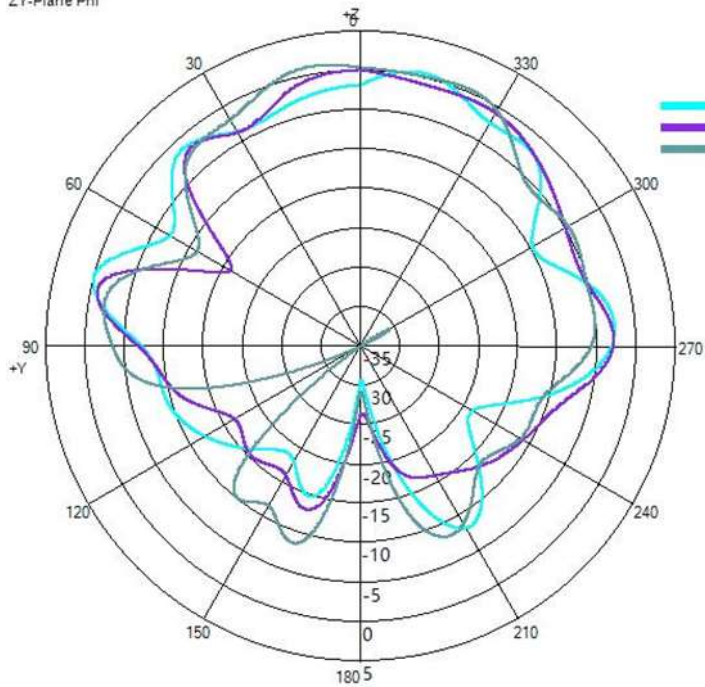
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ZY-Plane Phi



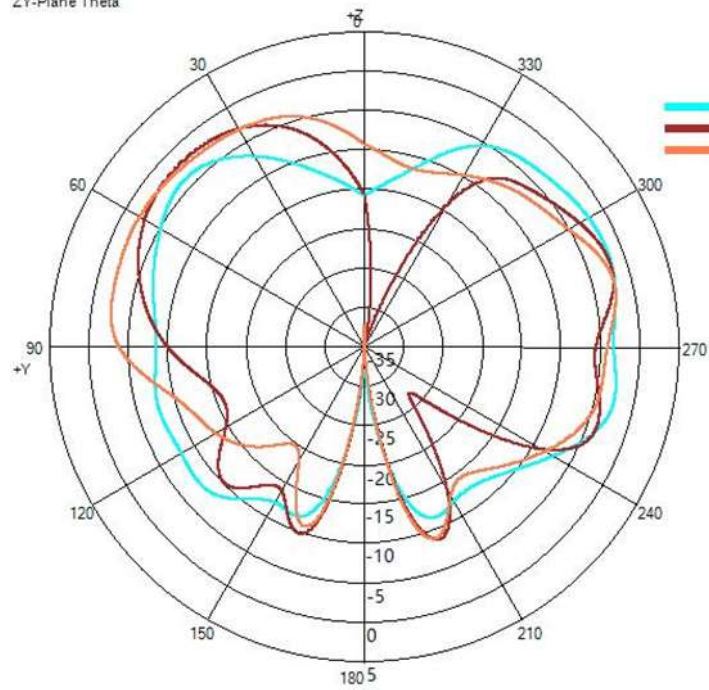
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ZY-Plane Phi



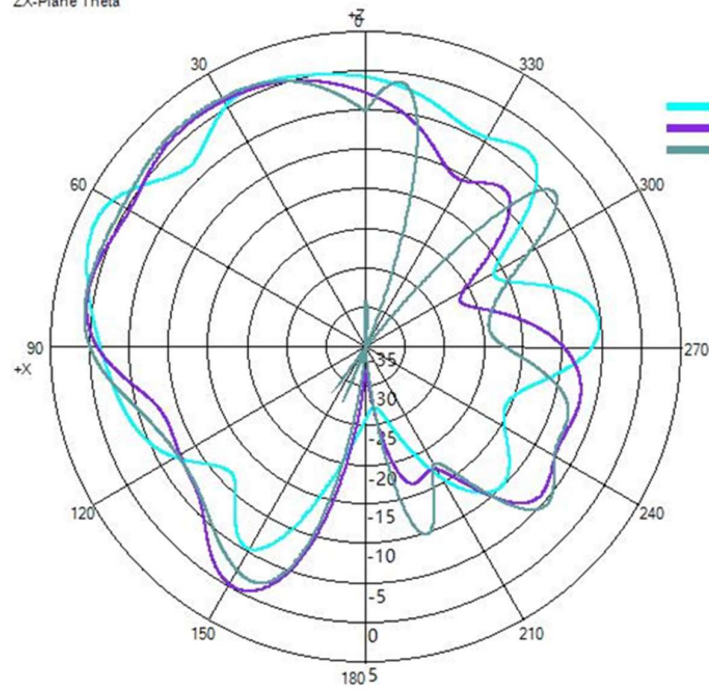
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ZY-Plane Theta



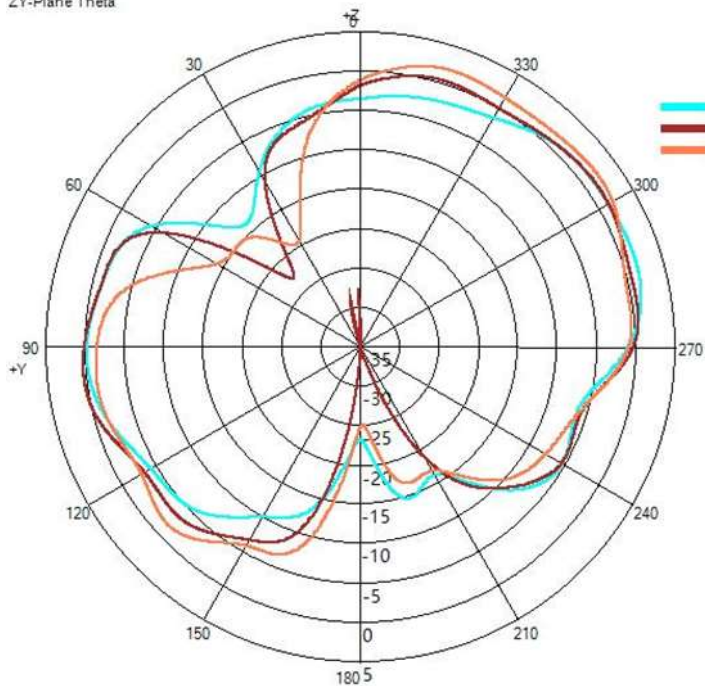
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ZX-Plane Theta



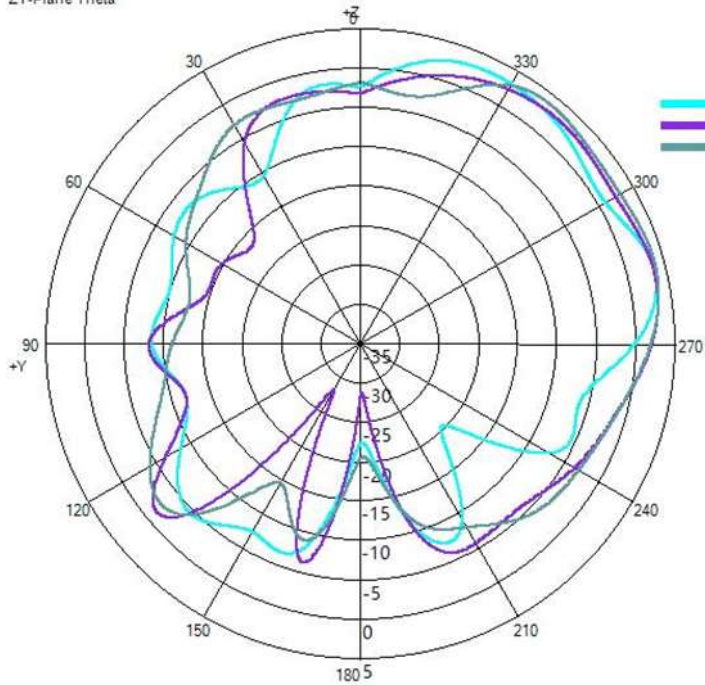
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ZY-Plane Theta



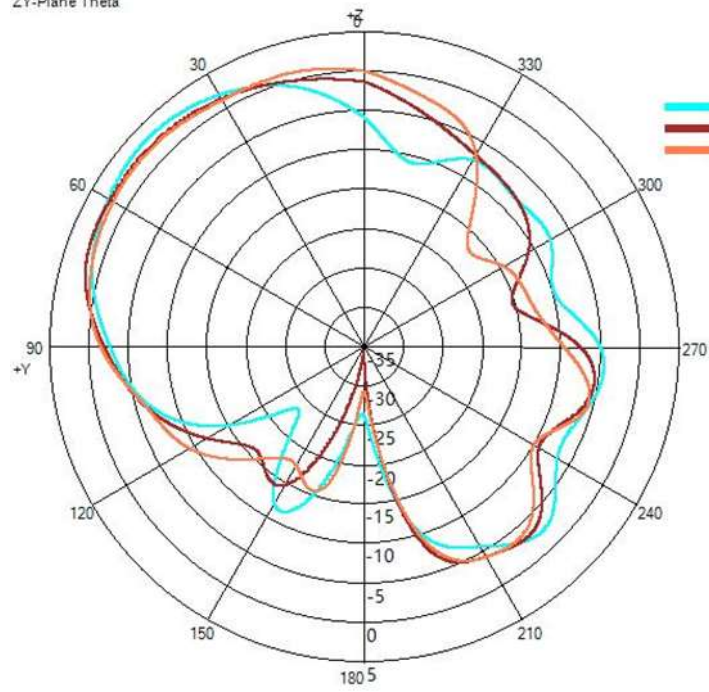
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ZY-Plane Theta



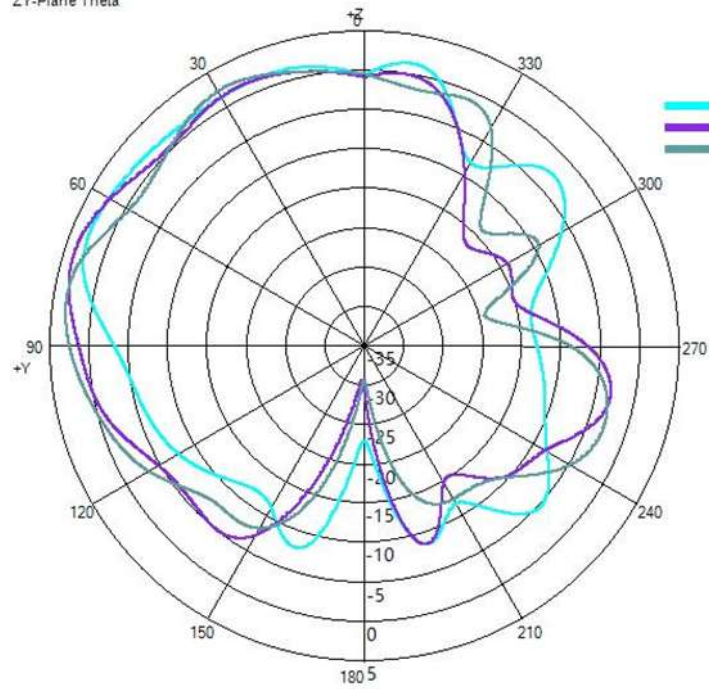
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ZY-Plane Theta



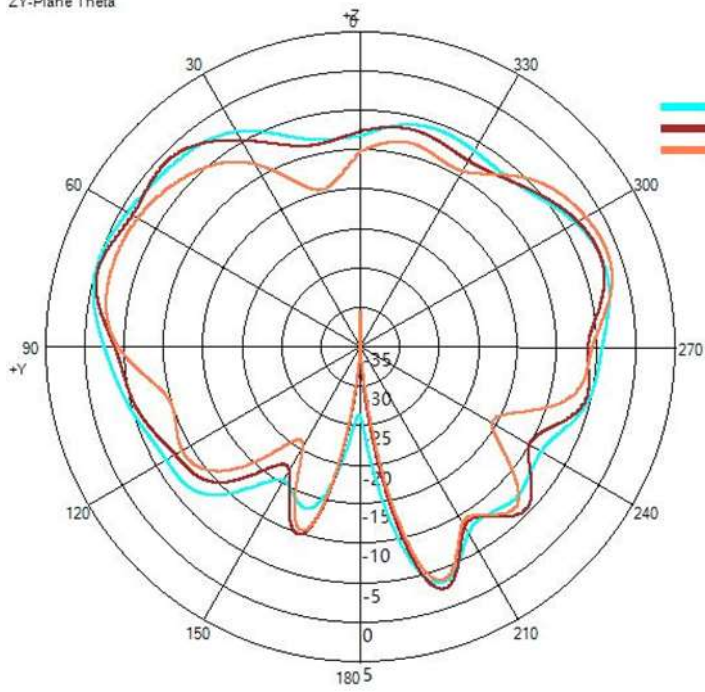
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ZY-Plane Theta



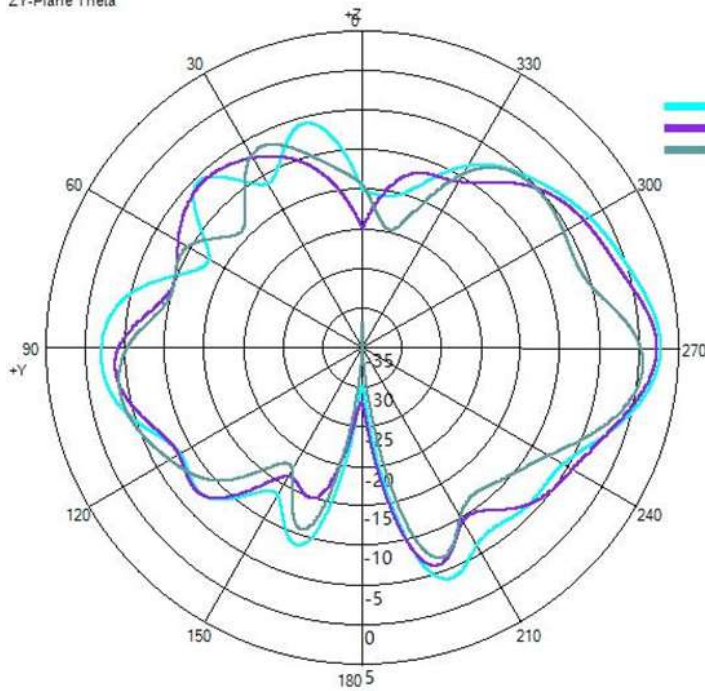
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ZY-Plane Theta



YZ_Pol_theta_Ant.D@5.xG

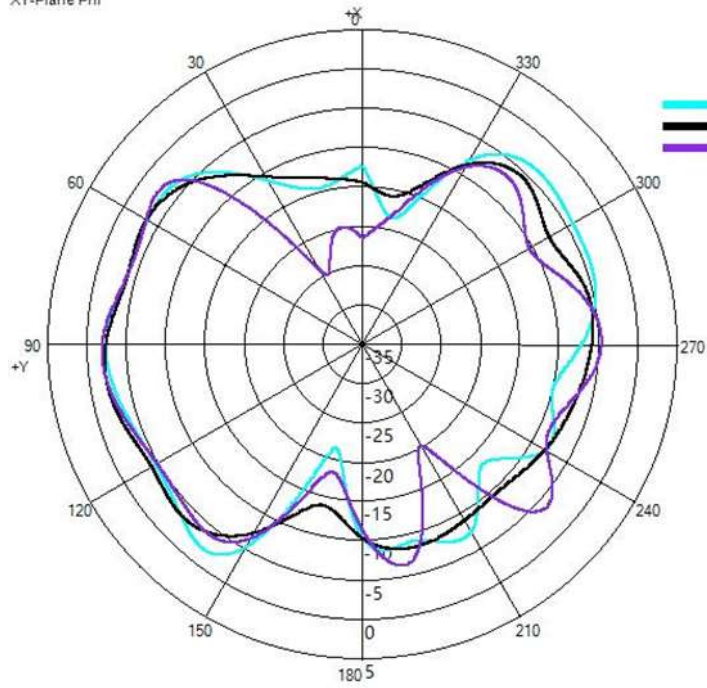
ZY-Plane Theta



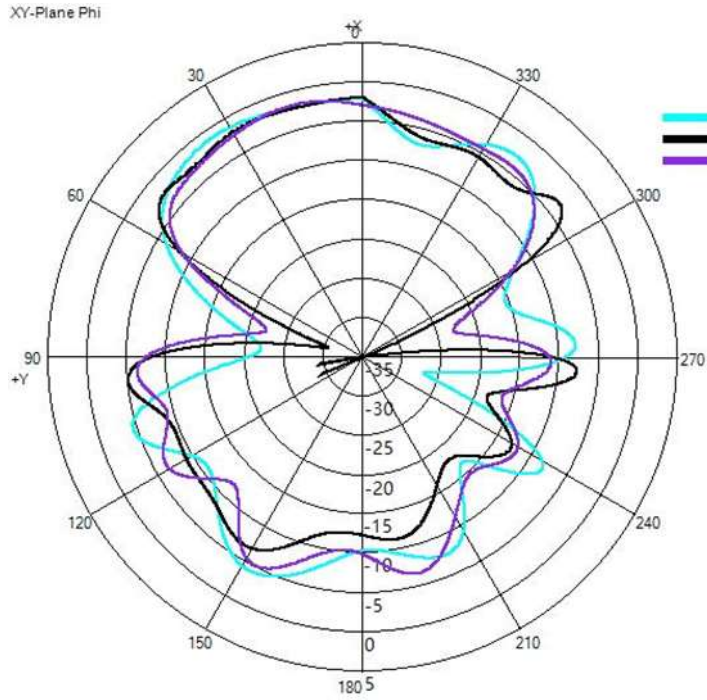
Ant. Position: 5G Ant.1~4

XY_Pol._Phi_Ant.1

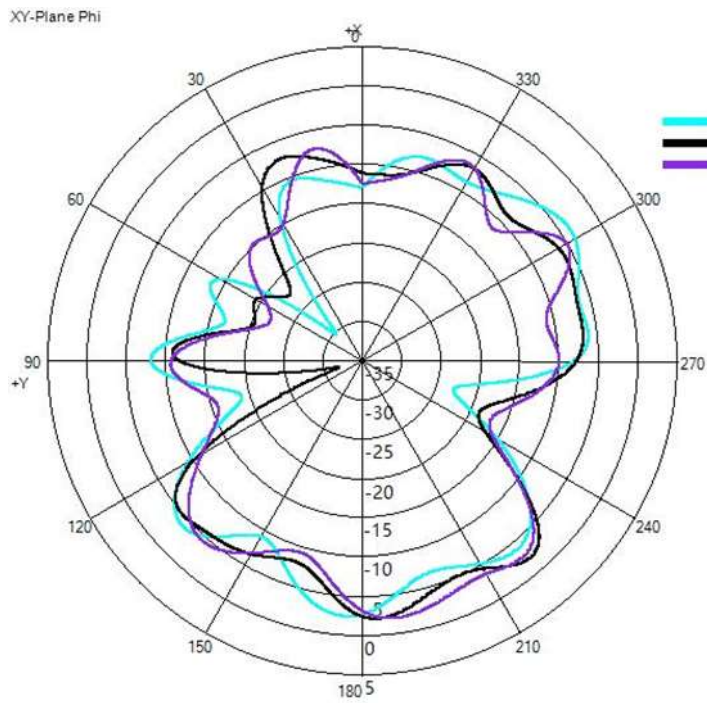
XY-Plane Phi



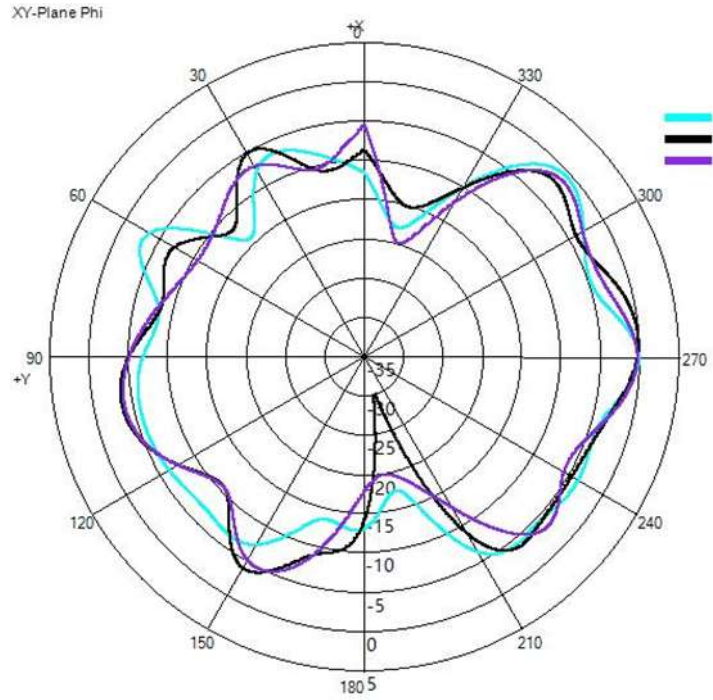
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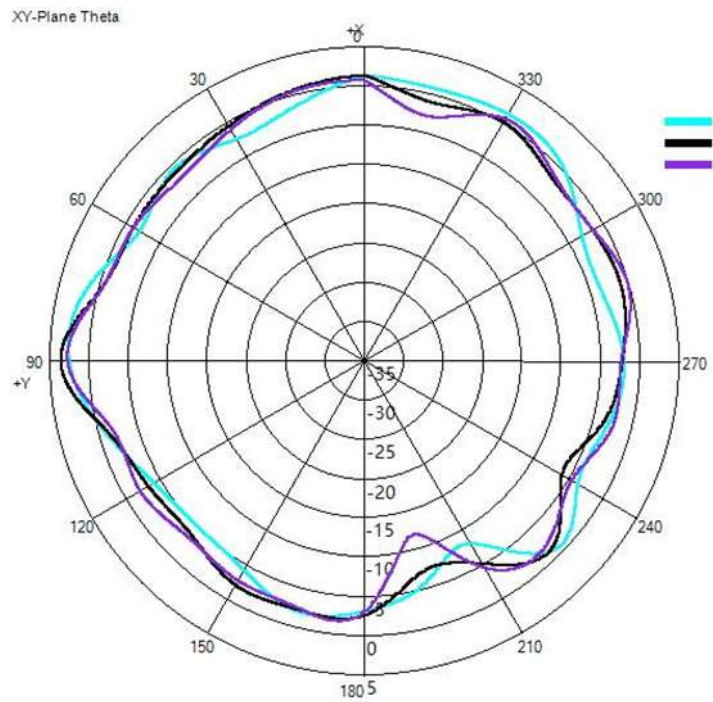
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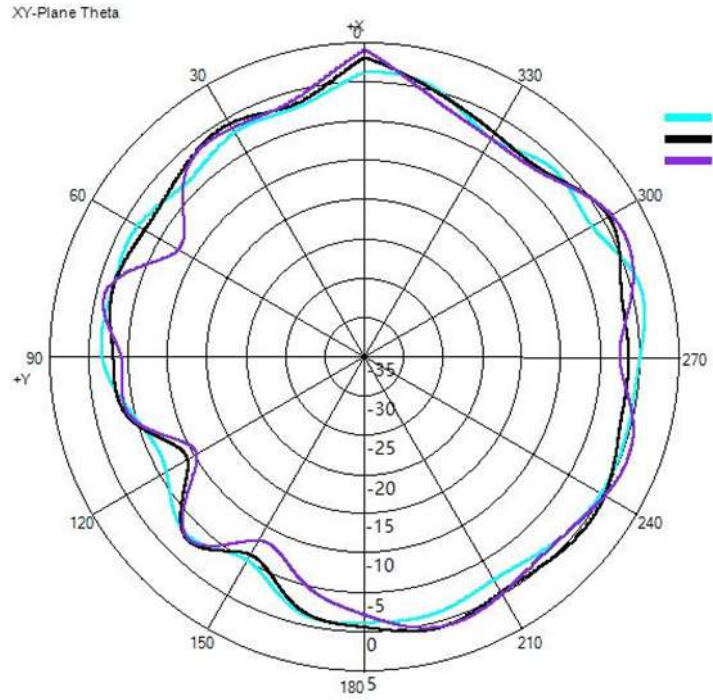
XY_Pol._Phi_Ant.4



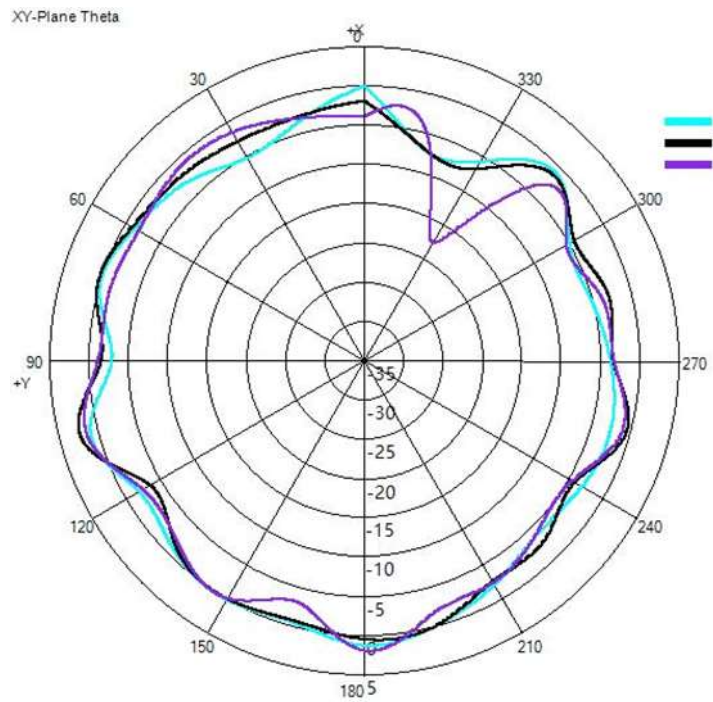
XY_Pol._theta_Ant.1



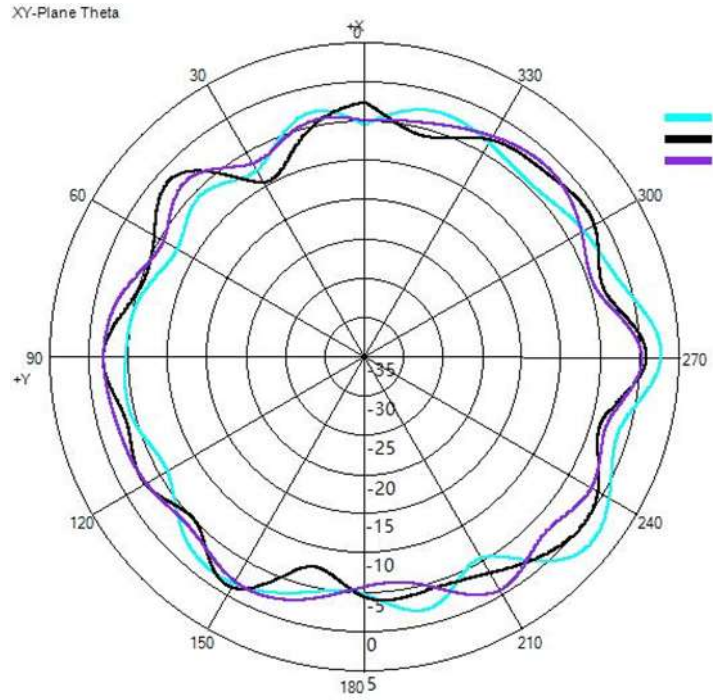
XY_Pol._theta_Ant.2



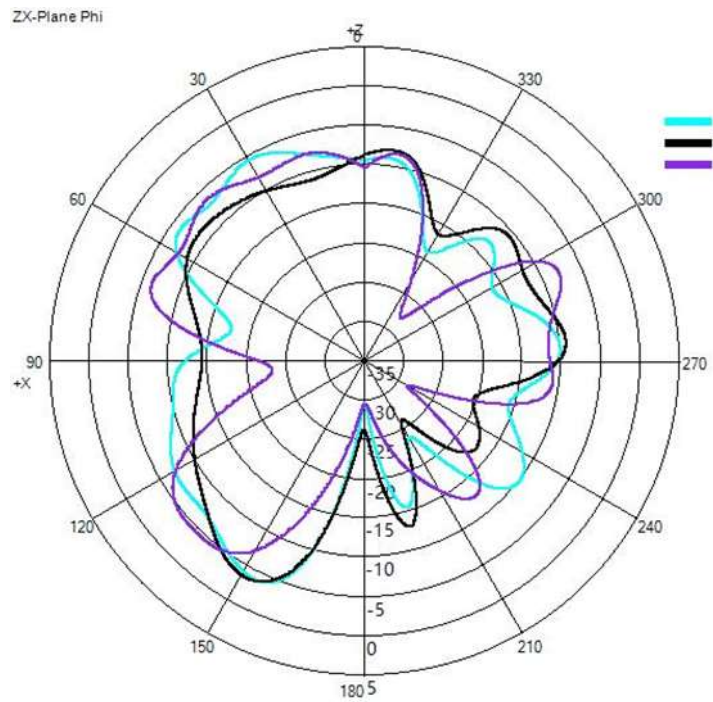
XY_Pol._theta_Ant.3



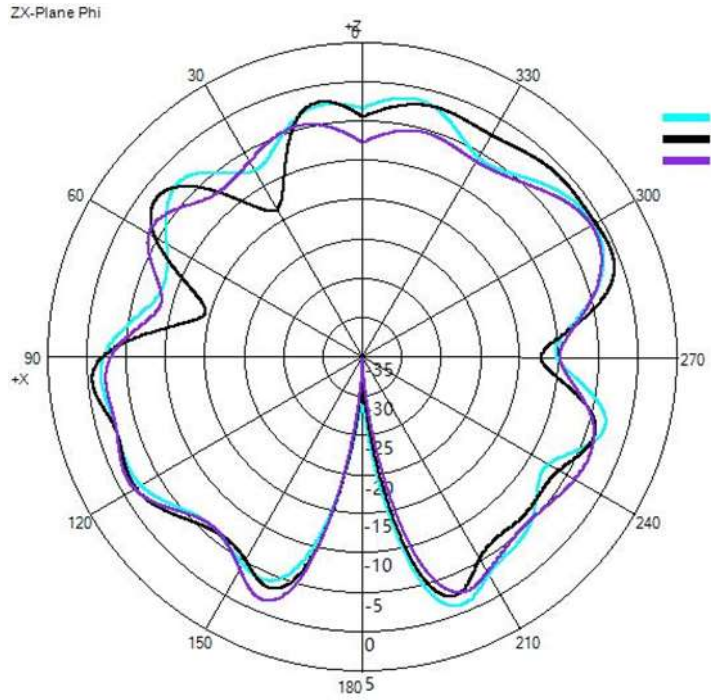
XY_Pol._theta_Ant.4



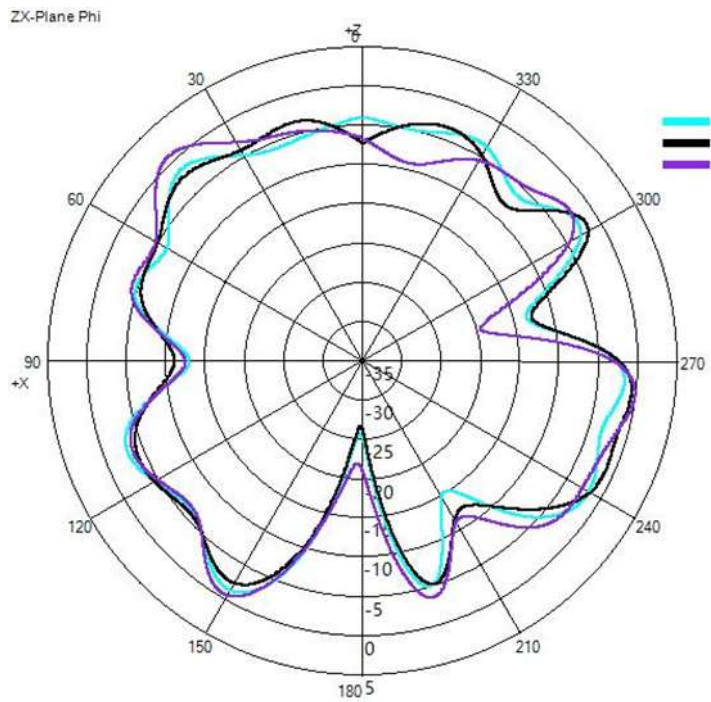
XZ_Pol._Phi_Ant.1



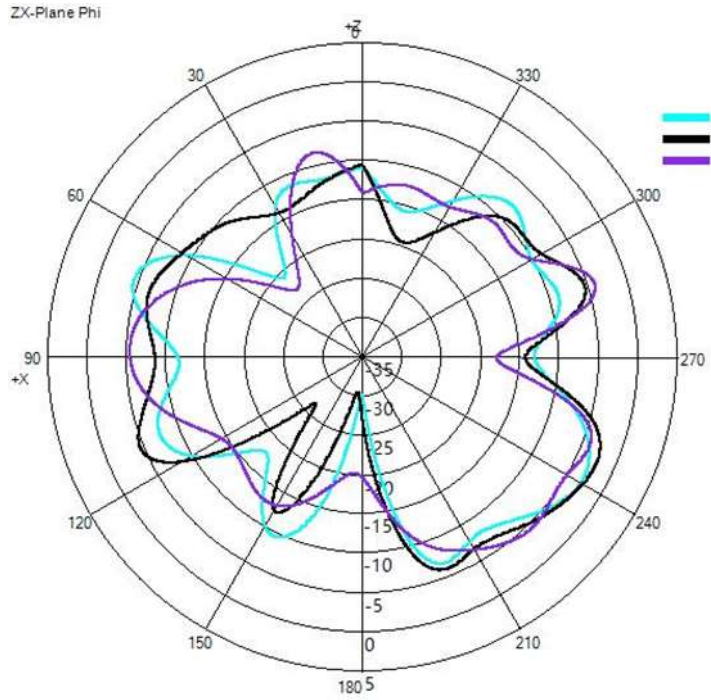
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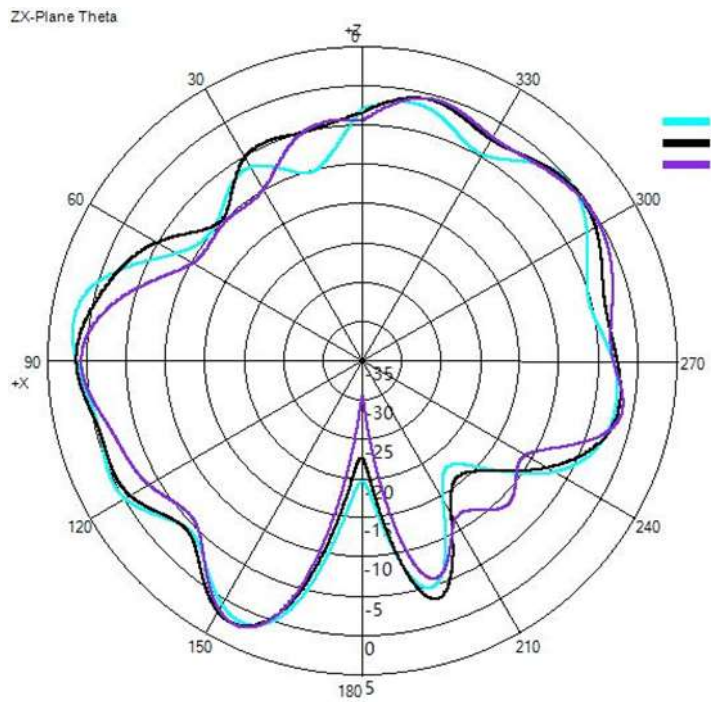
XZ_Pol._Phi_Ant.3



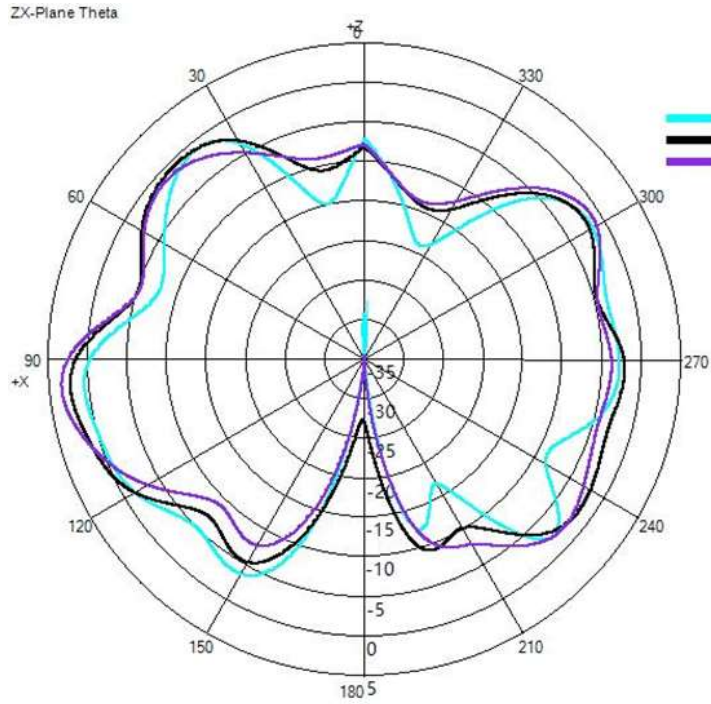
XZ_Pol._Phi_Ant.4



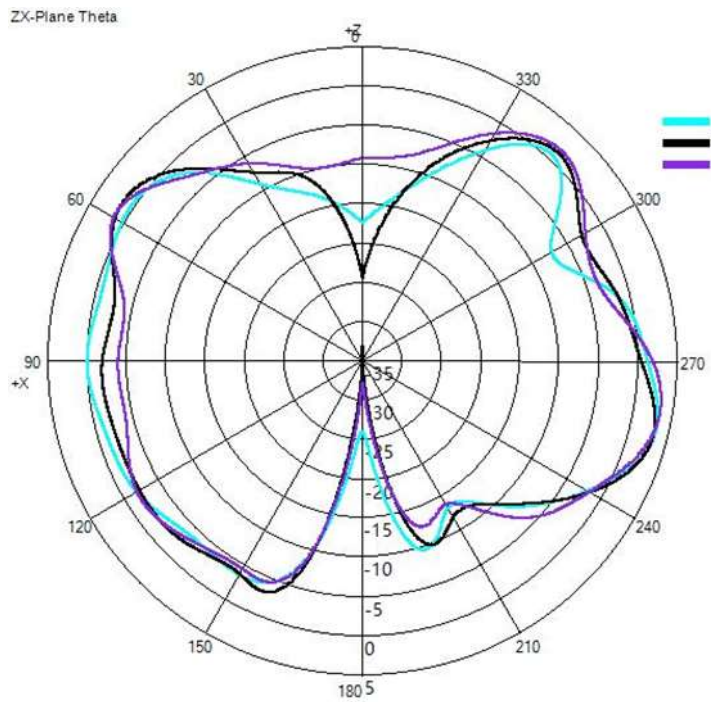
XZ_Pol._theta_Ant.1



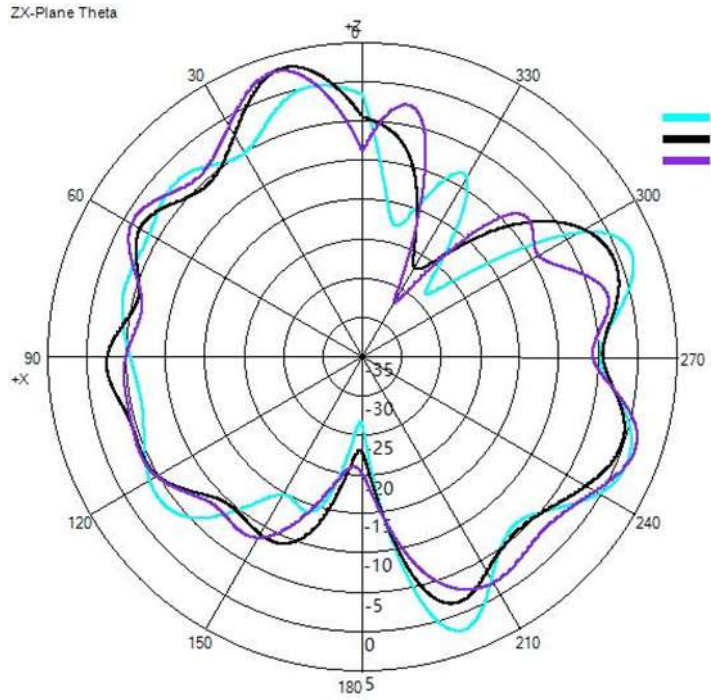
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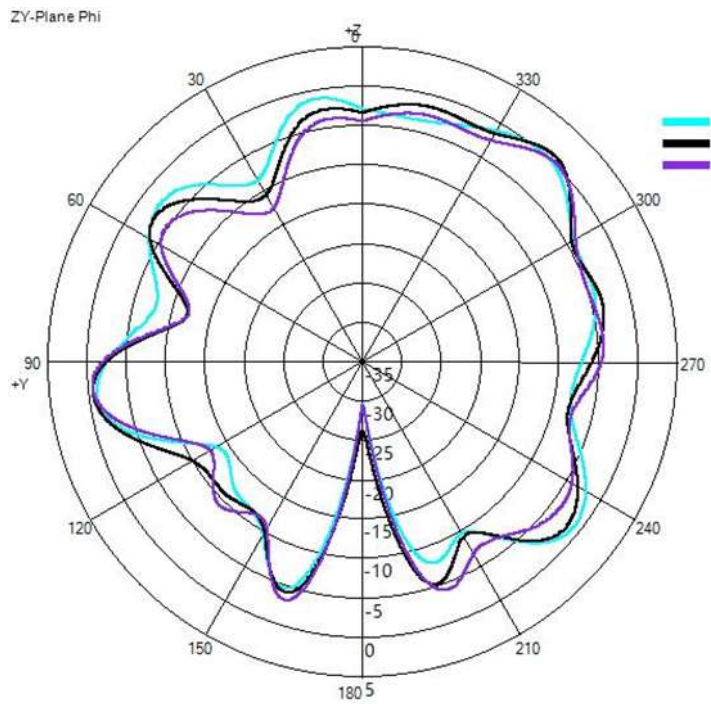
XZ_Pol._theta_Ant.3



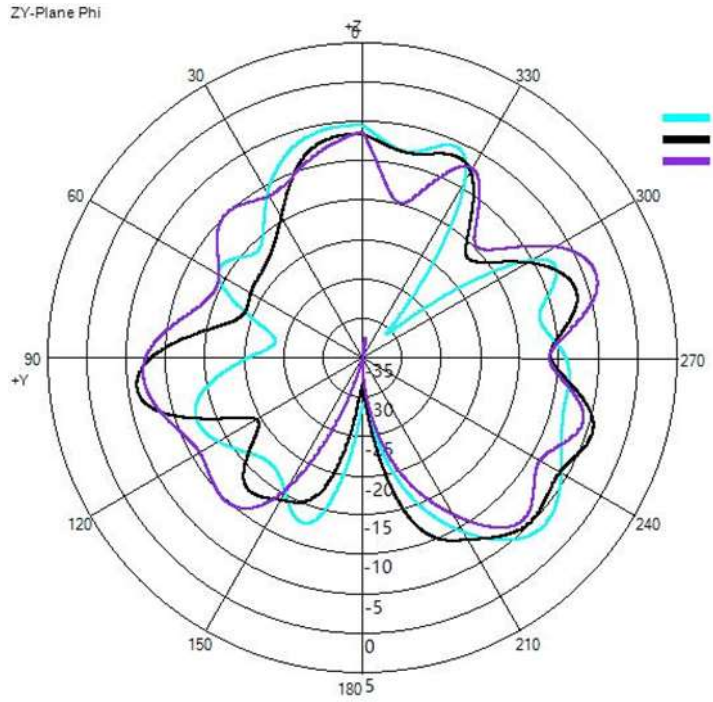
XZ_Pol._theta_Ant.4



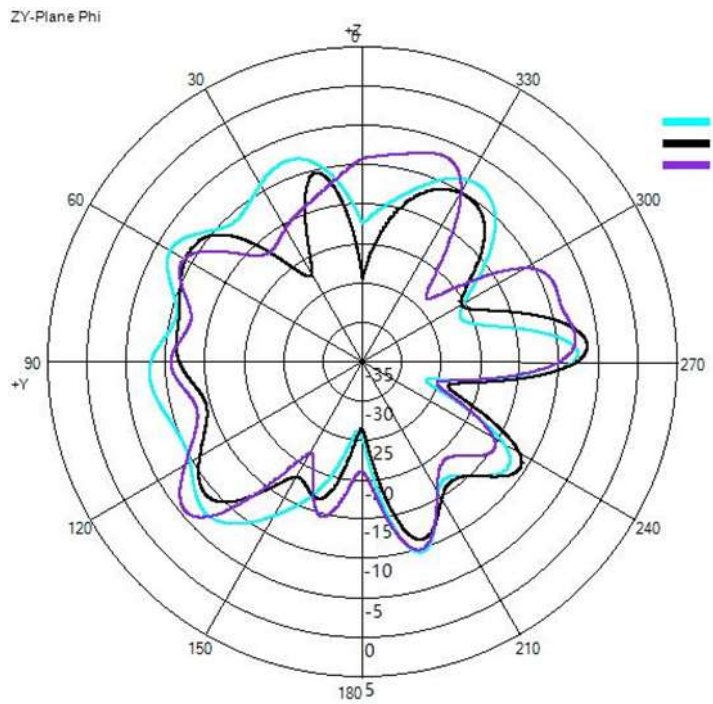
YZ_Pol._Phi_Ant.1



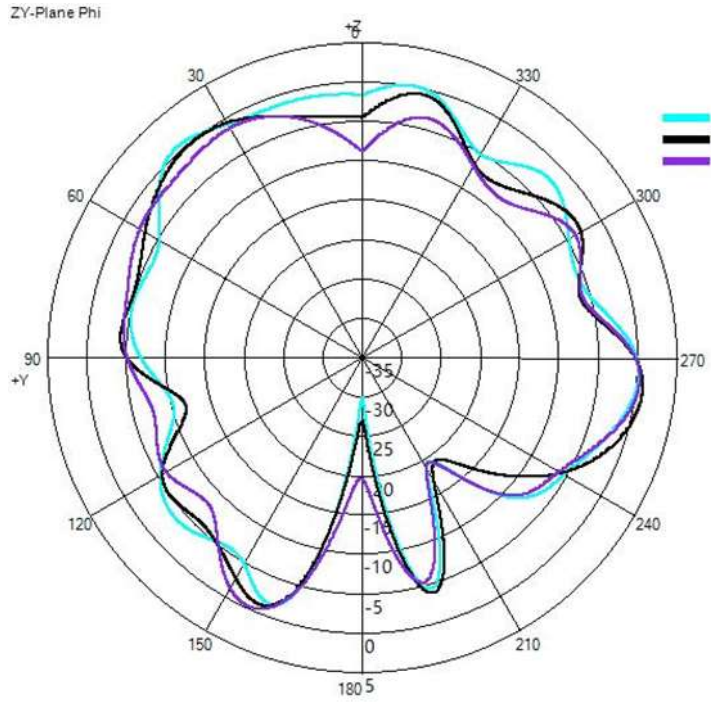
YZ_Pol._Phi_Ant.2



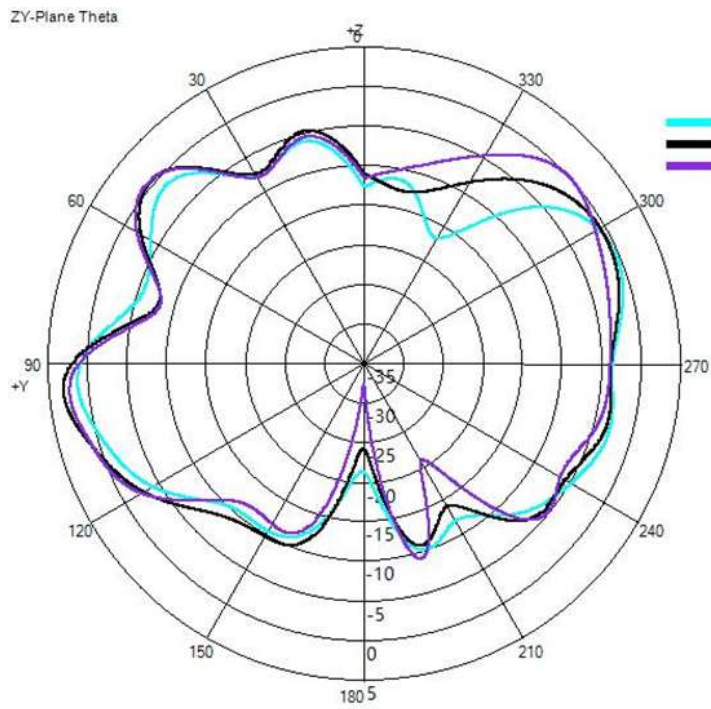
YZ_Pol._Phi_Ant.3



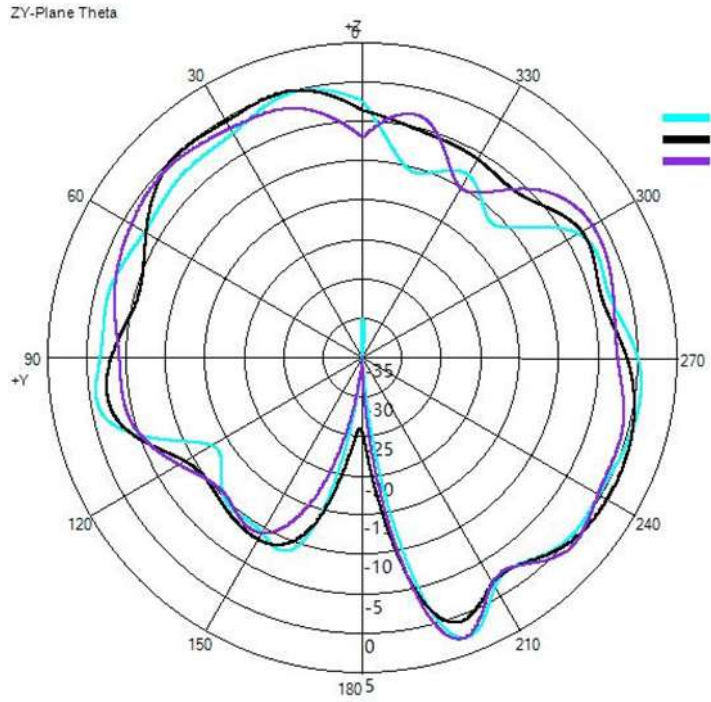
YZ_Pol._Phi_Ant.4



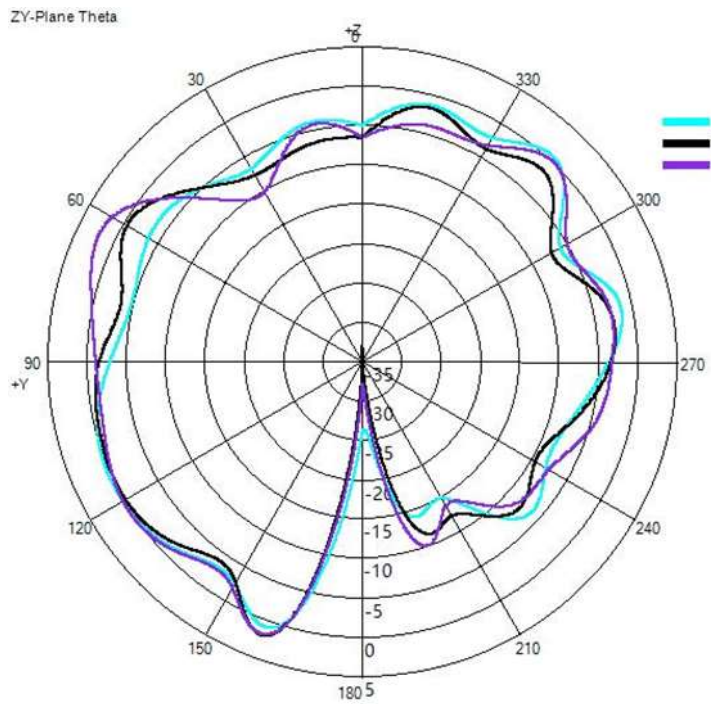
YZ_Pol._theta_Ant.1



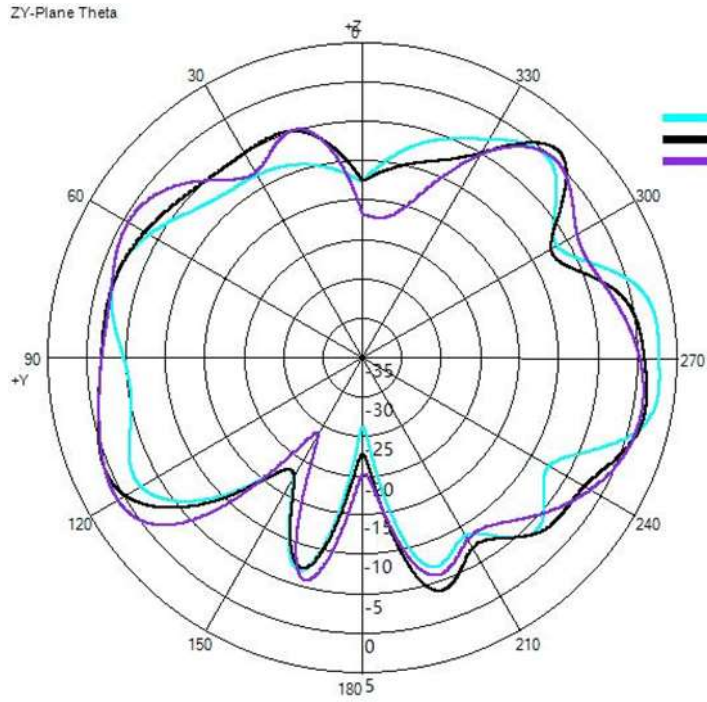
YZ_Pol._theta_Ant.2



YZ_Pol._theta_Ant.3



YZ_Pol._theta_Ant.4



Appendix _Radiated Total Gain Result

Ant. Position: 2G/5G ANT A GAIN PHI

