



TAOGLAS®



Datasheet

Synergy X 8-in-1

Part No:
MA1558.W.AK.001

Description

8in1 Multiband GNSS: 4*5G/4G MIMO 3*Wi-Fi® with 5m TGC-200 Braided Cable Assembly

Features:

Low-profile Permanent Mount Enclosure

4* 5G/4G MIMO 600-6000MHz

3* Wi-Fi® MIMO 2.4/5.8/7.125 GHz (Including Wi-Fi® 6)

1* Multiband GNSS

Worldwide 5G/4G Bands

IP67 Waterproof Enclosure

Dimensions: Ø161.3mm * 67mm

Cable: 300mm RG-174 with 4700mm TGC-200 Braided Cable Assembly

Connectors: SMA(M)/RP-SMA(M)

RoHS & Reach Compliant

1.	Introduction	2
2.	Specification	3
3.	Mechanical Drawing	7
4.	Installation Instructions	8
5.	Packaging	10
6.	Antenna Characteristics	11
7.	Radiation Patterns	23
	Changelog	118

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1. Introduction



The Taoglas **Synergy X MA1558** is an 8-in-1 next-generation permanent mount antenna designed for exceptional performance when used in conjunction with the next generation of routers.

It has been designed for high precision applications and provides excellent performance on the full GNSS spectrum including (GPS/QZSS L1/L2/L5/L6, GLONASS G1/G2/G3, Galileo E1/E5a/E5b/E6, Bei Dou B1/B2a/B2b/B3, NAVIC L5, as well as SBAS (WAAS/EGNOS/GAGAN/SDCM/SNAS) for high-performance cm-level positional accuracy which allows the user to achieve higher location accuracy, as well as stability of position tracking in urban environments with their device and with the next generation of routers.

The 8 antennas inside support 5G/4G, Multi-Band GNSS, and Wi-Fi® (2.4GHz/5-7.125GHz). The 5G/4G antennas are wide band 600MHz to 6GHz to cover the full spectrum of 5G frequencies. The Wi-Fi® antenna includes Wi-Fi® 6 and 7 capabilities to ensure your design is future proof for the next generation of Router connectivity.

Combining Multi-band GNSS, 5G/4G, Wi-Fi® 6, and an incredibly compact PC enclosure with a fully IP67 rated waterproof, The Synergy X MA1558 is the right powerful, compact combination antenna for your application.

Typical Applications Include:

- Autonomous Driving
- Precision Positioning for Robotics
- Precision Agriculture
- Inventory Management & Container tracking
- Telematics & Asset Tracking
- Timing Accuracy Synchronization

The Synergy X MA1559 is the latest external addition to an ongoing product roadmap of high precision antennas by Taoglas. For RTK applications when used on the base and/or the rover, the MA1559 can achieve genuine cm-level accuracy.

Cable and connectors are customizable. The Synergy MA1558 is supplied with low loss TGC-200 cable extensions for longer cable. Please contact your regional Taoglas customer support team for further information.

The diagram illustrates the frequency spectrum for GPS, GLONASS, Galileo, and BeiDou signals, divided into Lower Bands and Upper Bands. The frequency axis ranges from 1164 MHz to 1610 MHz. The legend identifies the systems: GPS (purple), GLONASS (green), Galileo (yellow-green), and BeiDou (dark blue). The Lower Bands section includes signals from 1164 MHz to 1300 MHz, while the Upper Bands section includes signals from 1559 MHz to 1610 MHz. A dashed vertical line separates the two sections at 1559 MHz.

Frequency (MHz)	Signal Label	System
1164		GPS
1166		GPS
1176.45	L5	GPS
1186		GPS
1189		GPS
1189	E5a	Galileo
1207.14	B2a	BeiDou
1212		GPS
1217		GPS
1217	E5b	Galileo
1217	G3/L3OC	GLONASS
1227.6	L2C	GPS
1227.6	L2	GPS
1238		GPS
1241		GPS
1248.06	G2/L2OC	GLONASS
1255		GPS
1258		GPS
1268.52	B3	BeiDou
1278.75	E6	Galileo
1280		GPS
1300		GPS
1300	L6/LEX	GPS
1559		GPS
1559	L	GPS
1561	B1C	BeiDou
1561	B1I	BeiDou
1563		GPS
1565		GPS
1575.42	E1	Galileo
1575.42	L1	GPS
1586		GPS
1588		GPS
1588	L1	GPS
1592		GPS
1592	G1/L1OC	GLONASS
1592		GPS
1596		GPS
1600.995		GPS
1610		GPS

3

GNSS Electrical						
Frequency (MHz)	1176.45	1227.6	1278.75	1561	1575.42	1602
VSWR (max.)	2:1	2:1	2:1	2:1	2:1	2:1
Efficiency (%)	48	53	46	44	48	50
Peak Gain (dBi)	2.65	0.20	3.16	3.45	4.03	3.96
Average Gain (dB)	-3.16	-2.70	-3.36	-3.58	-3.16	-3.03
Axial Ratio (dB)	1.12	0.89	1.18	2.34	2.27	2.48
Group Delay Mean (ns)	12.15	5.99	11.11	34.35	26.89	30.67
Polarization	RHCP					
Impedance	50 Ω					
Cable	RG-174 (see ME drawing)					
Connector	SMA(M)					
Passive GNSS results shown are in Free space						

LNA and Filter Electrical Properties						
Frequency (MHz)	L5 1176.45	GAL E5b 1207	GPS L2 1227	L6/E6 1278.75	B1 1561	L1 1575.42
Gain (typical)	25 dB	26 dB	25 dB	22 dB	27 dB	28 dB
Noise Figure (typical)	4.0 dB	3.7 dB	3.8 dB	4.5 dB	3.1 dB	2.6 dB
Current Draw (typical)	< 20 mA					
Input Voltage	+1.8 to +5.0 VDC					
Out-Of-Band Attenuation (dB)	100 - 900 MHz			> 50		
	900 - 1000 MHz			> 30		
	1350 - 1520 MHz			> 25		
	1700 - 2000 MHz			> 35		
	2000 - 6000 MHz			> 45		

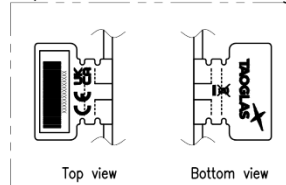
Cellular Electrical										
Band	Frequency (MHz)	MIMO	Measurement	Efficiency (%)	Average Gain (dB)	Peak Gain (dBi)	Impedance	Polarization	Radiation Pattern	Max. input power
5G NR/4G Band71	617-698	MIMO 1	Free Space	48.7	-3.13	1.49	50 Ω	Linear	Omni directional	10W
			Ground Plane	21.2	-6.73	-0.15				
		MIMO 2	Free Space	45.1	-3.46	0.53				
			Ground Plane	18.6	-7.31	-0.47				
		MIMO 3	Free Space	48.4	-3.15	1.32				
			Ground Plane	20.2	-6.96	0.23				
		MIMO 4	Free Space	48.3	-3.16	1.39				
			Ground Plane	18.6	-7.30	-0.03				
4G/3G Band 12,13,14,17,28,29	698-806	MIMO 1	Free Space	47.0	-3.28	1.45				
			Ground Plane	30.0	-5.23	-0.22				
		MIMO 2	Free Space	45.9	-3.39	0.74				
			Ground Plane	28.5	-5.45	-1.24				
		MIMO 3	Free Space	46.8	-3.30	1.17				
			Ground Plane	29.8	-5.26	-0.06				
		MIMO 4	Free Space	47.4	-3.24	1.50				
			Ground Plane	30.5	-5.15	-0.03				
4G/3G/NB-IoT/Cat M Band 5,8,18,19,20,26,27	824-960	MIMO 1	Free Space	52.4	-2.80	1.51				
			Ground Plane	42.5	-3.72	2.85				
		MIMO 2	Free Space	51.6	-2.88	1.29				
			Ground Plane	42.1	-3.76	3.34				
		MIMO 3	Free Space	52.7	-2.78	1.50				
			Ground Plane	43.3	-3.63	3.98				
		MIMO 4	Free Space	53.7	-2.70	1.88				
			Ground Plane	42.0	-3.77	2.96				
5G NR/4G Band 21,32,74,75,76	1427-1518	MIMO 1	Free Space	58.6	-2.32	2.79				
			Ground Plane	53.6	-2.71	3.00				
		MIMO 2	Free Space	56.3	-2.50	1.74				
			Ground Plane	54.0	-2.68	3.18				
		MIMO 3	Free Space	59.4	-2.26	3.02				
			Ground Plane	55.0	-2.60	2.91				
		MIMO 4	Free Space	55.2	-2.58	2.53				
			Ground Plane	53.0	-2.76	3.15				
4G/3G Band 1,2,3,4,9,23,25,35,39,66	1710-2200	MIMO 1	Free Space	50.8	-2.94	2.72				
			Ground Plane	50.5	-2.96	4.54				
		MIMO 2	Free Space	47.6	-3.23	1.19				
			Ground Plane	48.2	-3.17	3.54				
		MIMO 3	Free Space	48.6	-3.13	1.88				
			Ground Plane	51.3	-2.90	3.92				
		MIMO 4	Free Space	48.2	-3.17	2.57				
			Ground Plane	47.7	-3.22	3.15				
4G/3G Band 7,30,38,40,41	2300-2690	MIMO 1	Free Space	64.7	-1.89	4.20				
			Ground Plane	68.0	-1.67	5.65				
		MIMO 2	Free Space	64.2	-1.93	4.13				
			Ground Plane	67.0	-1.74	4.94				
		MIMO 3	Free Space	63.5	-1.97	4.16				
			Ground Plane	65.0	-1.87	5.30				
		MIMO 4	Free Space	65.4	-1.85	4.00				
			Ground Plane	66.2	-1.79	4.90				
5G NR/4G Band 22,42,48,77,78,79	3300-5000	MIMO 1	Free Space	53.4	-2.73	6.00				
			Ground Plane	52.1	-2.83	6.98				
		MIMO 2	Free Space	61.1	-2.14	5.44				
			Ground Plane	62.6	-2.03	8.11				
		MIMO 3	Free Space	52.0	-2.84	6.31				
			Ground Plane	51.3	-2.90	7.12				
		MIMO 4	Free Space	59.4	-2.26	6.34				
			Ground Plane	59.4	-2.26	8.32				
LTE5200/Wi-Fi5800	5150-5925	MIMO 1	Free Space	64.8	-1.89	7.32				
			Ground Plane	62.3	-2.05	9.29				
		MIMO 2	Free Space	41.5	-3.82	4.82				
			Ground Plane	50.5	-2.97	8.16				
		MIMO 3	Free Space	63.3	-1.98	7.72				
			Ground Plane	61.2	-2.13	9.35				
		MIMO 4	Free Space	47.8	-3.20	5.39				
			Ground Plane	47.8	-3.21	7.80				
*Tested with Staggered cables 150-350mm										

Wi-Fi Electrical										
Band	Frequency (MHz)	MIMO	Measurement	Efficiency (%)	Average Gain (dB)	Peak Gain (dBi)	Impedance	Polarization	Radiation Pattern	Max. input power
Wi-Fi - 2GHz	2400-2500	MIMO 1	Free Space	54.4	-2.65	2.34	50 Ω	Linear	Omni directional	10W
			Gound Plane	50.6	-2.96	3.67				
		MIMO 2	Free Space	50.5	-2.96	2.06				
			Gound Plane	50.5	-2.97	4.14				
		MIMO 3	Free Space	53.4	-2.73	1.65				
			Gound Plane	49.0	-3.10	3.52				
Wi-Fi - 5GHz	5150-5850	MIMO 1	Free Space	54.3	-2.65	4.78				
			Gound Plane	51.0	-2.93	7.46				
		MIMO 2	Free Space	52.3	-2.82	4.25				
			Gound Plane	48.6	-3.13	6.88				
		MIMO 3	Free Space	49.8	-3.03	4.35				
			Gound Plane	51.1	-2.92	6.84				
Wi-Fi - 6GHz	5925-7125	MIMO 1	Free Space	47.6	-3.22	5.95				
			Gound Plane	58.4	-2.34	9.01				
		MIMO 2	Free Space	47.1	-3.27	6.14				
			Gound Plane	40.3	-3.94	7.50				
		MIMO 3	Free Space	38.1	-4.19	5.04				
			Gound Plane	58.6	-2.32	8.80				
*Tested with Staggered cables 150-350mm										

Mechanical	
Dimensions	Ø161.3mm * 67mm
Weight	2.55 ±3% Kg
Material	PC
Connector	SMA (M) & RP SMA(M)
Cable	TGC-200 (see ME drawing)
Environmental	
Protection	IP67
Temperature Range	-40°C to 85°C
Humidity	Non-condensing 65°C 95% RH
RoHS Compliant	Yes
REACH Compliant	Yes

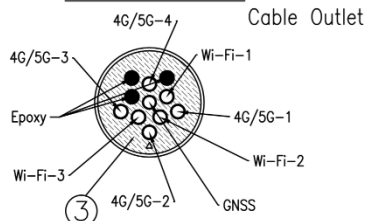
3. Mechanical Drawing

CE, WEEE and UKCA mark logo Label

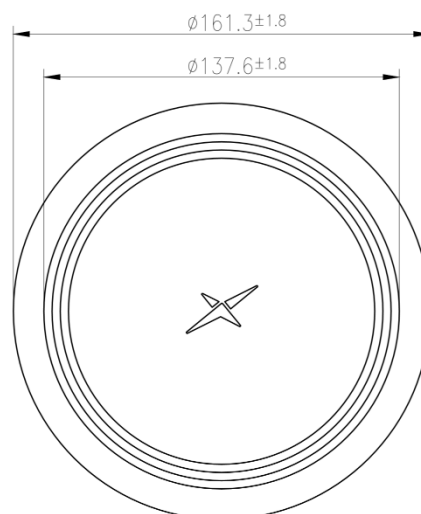


Detail A
Scale: 1.25:1

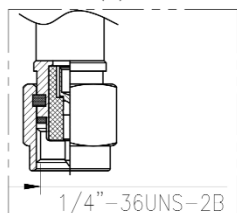
Bottom Thread View



Cable Outlet

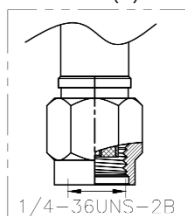


SMA(M)ST



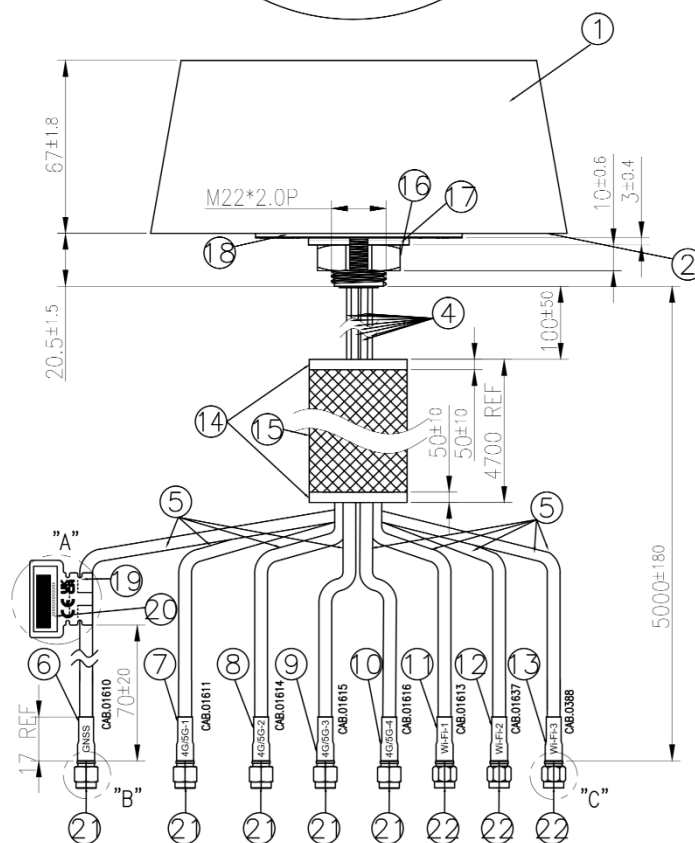
Detail B
Scale: 4:1

RP-SMA(M)ST



Detail C
Scale: 4:1

	Name	Material	Finish	QTY
1	Top Plastic Shell	PC/SABIC EXL1414	White	1
2	Bottom Plastic	PC/SABIC EXL1414	White	1
3	Cable Rubber	Silicone Rubber	Black	1
4	RG174 Coaxial Cable	PVC	Black	8
5	TGC-200 Coaxial Cable	PE	Black	8
6	Heat Shrink Tube (GNSS)	PE	Blue Tube/White Text	1
7	Heat Shrink Tube (4G/5G-1)	PE	Red Tube/White Text	1
8	Heat Shrink Tube (4G/5G-2)	PE	Red Tube/White Text	1
9	Heat Shrink Tube (4G/5G-3)	PE	Red Tube/White Text	1
10	Heat Shrink Tube (4G/5G-4)	PE	Red Tube/White Text	1
11	Heat Shrink Tube (Wi-Fi-1)	PE	Yellow Tube/Black Text	1
12	Heat Shrink Tube (Wi-Fi-2)	PE	Yellow Tube/Black Text	1
13	Heat Shrink Tube (Wi-Fi-3)	PE	Yellow Tube/Black Text	1
14	Heat Shrink Tube	PE With Glue	Black	2
15	Centenary Braid	BSPET	Black	1
16	Nut Steel M22xP2.0xH10 Cut	Steel/S45C	Zn-Ni Plated	1
17	Washer_Cut	Steel/S45C	Zn-Ni Plated	1
18	Double sided adhesive	E4382 +3M 9448HK 2.5t	Black Foam/White Liner	1
19	CE, WEEE and UKCA mark logo Label	PEPA	White	1
20	Date code label	PET	White	1
21	SMA(M)ST	Brass	Au Plated	5
22	RP-SMA(M)ST	Brass	Au Plated	3



4. Installation Instructions

A Introduction

The Taoglas Synergy X is an external permanent mount, combination antenna that can be provided with combinations of one active GNSS, four 5G/4G and 4 dual-band Wi-Fi antennas. The Synergy is available with an M22 threaded boss for surface mounting, along with 3M adhesive for added sealing. The Synergy X is ideal for vehicle panels of up to 6mm (0.23") thick with a threaded boss length of 20.5mm (0.81"). The Synergy X is IP67 rated and also includes an foam gasket to seal from any water ingress on the mounting surface.



Electrical Safety

The Synergy contains an active GPS/GNSS antenna.

Rated voltage: 3-5VDC Rated current: 20mA maximum

The supply to this device must be provided with overcurrent protection of 1A maximum.

Power consumption@1.8V (mA) 8.7 mA | Power consumption@3.0V (mA) 9.0 mA | Power consumption@5.5V (mA) 11 mA

B Mounting & Location

For prime performance, the Synergy X is recommended to be fitted on a metal panel. Optimum ground plane size is 300mm x 300mm (11.8" x 11.8"). When mounting on a vehicle roof panel ensure to mount on a flat surface, and measure for a central position. Care should be taken to mount the Synergy antenna as far as possible from other roof-mounted features such as the aircon unit, light bar etc.



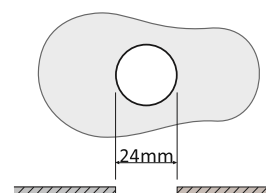
Sealing

In order to ensure that the installation is properly sealed against the mounting surface care must be taken regarding curvature of the mounting panel. It is highly recommended to install the antenna on a clean, flat and level surface. After installation the compression of the foam gasket and adhesive against the mounting panel should be checked and a small bead of neutral cure silicone sealant can be applied around the periphery of the enclosure if required.

C Surface Preparation

When preparing to drill the hole, mask the area around the hole position to protect the surface. Drill a pilot hole and increase the hole size to $\varnothing 24\text{mm}$ ($\frac{7}{8}"$). Ensure the drill bit does not contact the headliner. Deburr and clean the area around the hole carefully removing all waste.

Remove paint and primer from under panel surface to ensure adequate earth contact by washer and nut. Apply petroleum jelly or paint around cut edge of the hole to prevent corrosion



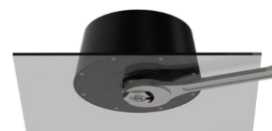
D Adhesive Patch

On the underside of the antenna there is a 3M adhesive foam gasket. Peel away the 3M adhesive protection and feed the cables through the hole. Position the antenna over the hole and press down onto the panel with pressure. This adhesion will make ensure will be securely mounted and will also allow for extremely minimal curvature on the roof of a vehicle.



E Securing the Mount

A split nut is used to easily fit onto the thread through the cables. The nut is attached from the underside of the panel, it should easily twist onto the thread and then secured in place with a final tighten with a spanner. After tightening, double check the antenna to make sure that it is properly secured.



Torque Values	kgf-cm	N-m
Plastic Nut	85 ±5	8.3 ±0.5
Metal Nut	180 ±5	17.6 ±0.5

F Cable Routing and Connection

The pigtail cables supplied are RG-174 for all feeds. The heatshrink will denote which cable is which for ease of installation. Connect each individual connector to the correct port of the router, if any cable is unused please fit a 50Ω terminator to the individual connection.



G Notices



Caution

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to provide a separation distance of at least 20 cm from all persons to satisfy RF exposure compliance.



Warning

Do not operate the equipment in an explosive atmosphere.



European Waste Electronic Equipment Directive 2012/19/EU

Please ensure that your old Waste Electricals and Electronics are recycled do not throw them away into standard waste.



Hazardous Substances Directive (RoHS) 2011/65/EU / 2015/863/EU Directive 2014/53/EU Radio Equipment Directive (RED)

View CE Certificate online:

<https://www.taoglas.com/wp-content/uploads/pdf/CE-Declaration-of-Conformity-RED-RoHS-MA15XX-Synergy-Series.pdf>

Harmonised Standards and References:

EN 301 489-1 (V2.2.1): ElectroMagnetic Compatibility (EMC) standard for radio equipment and services;
Part 1: Common technical requirements. Referencing CENELEC EN 55032 Class B.

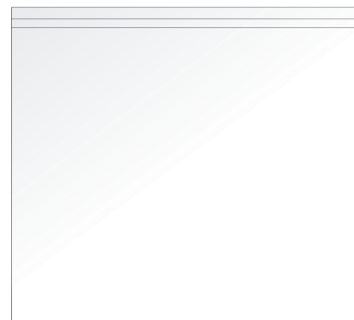
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5. Packaging



1pc MA1558 per PE Bag
Weight (Kg): 2.55 ±3%



4pcs MA1558 per Carton
Carton Dimensions: 740 x 370 x 300 mm
Weight (Kg): 11.2 ±3%



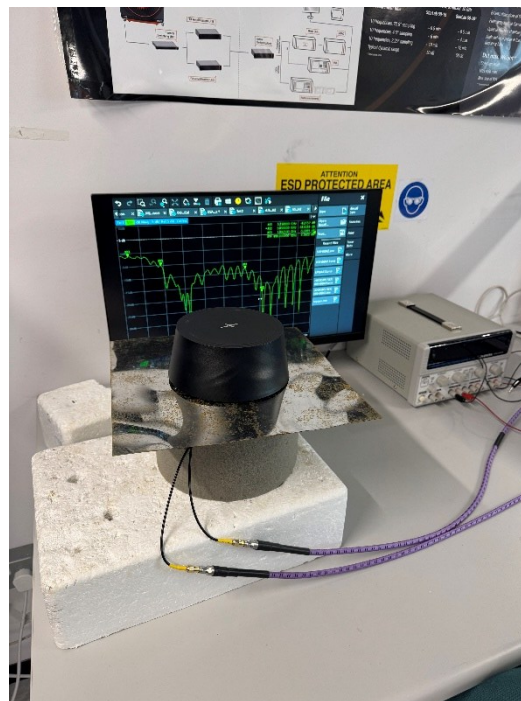
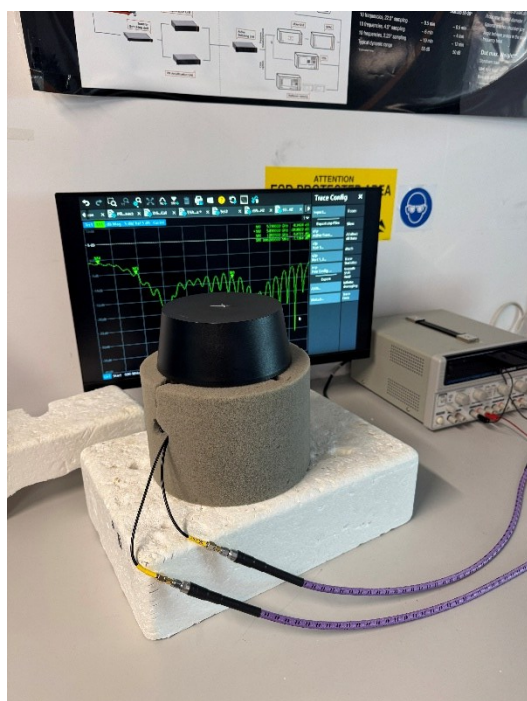
6. Antenna Characteristics

6.1 Test Setup

AUT

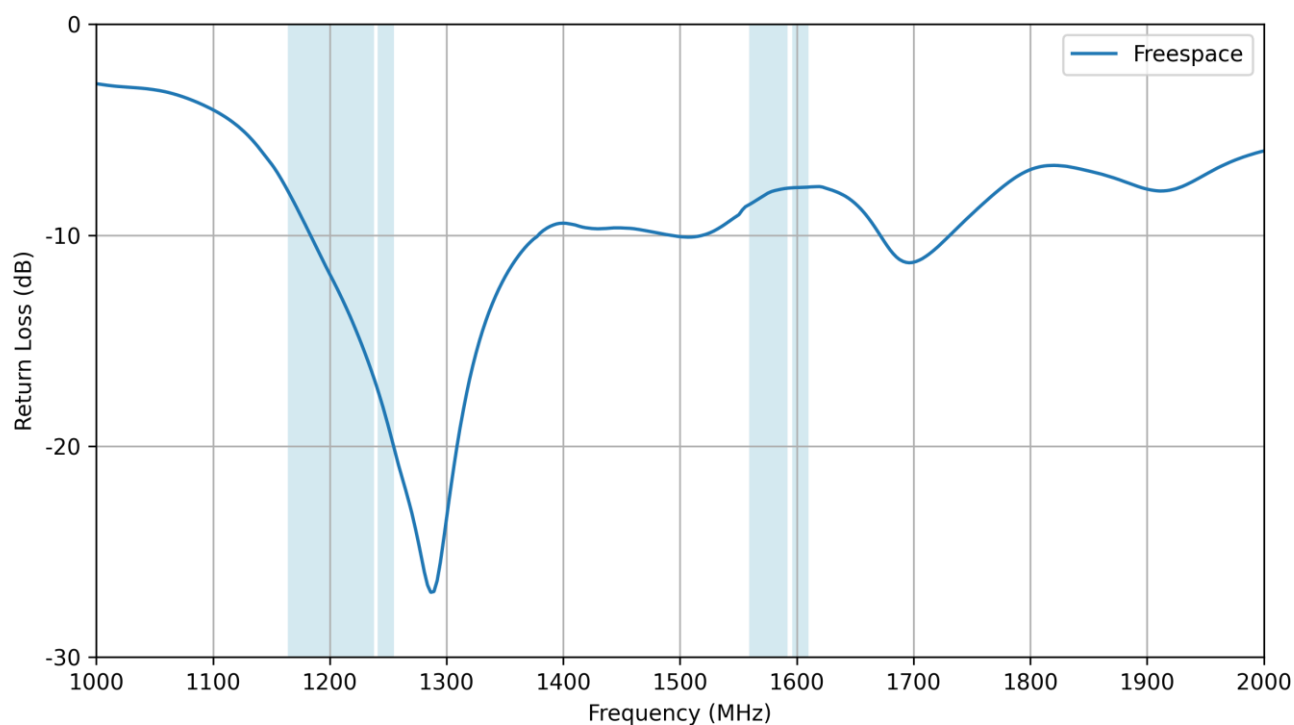


Vector Network Analyzer

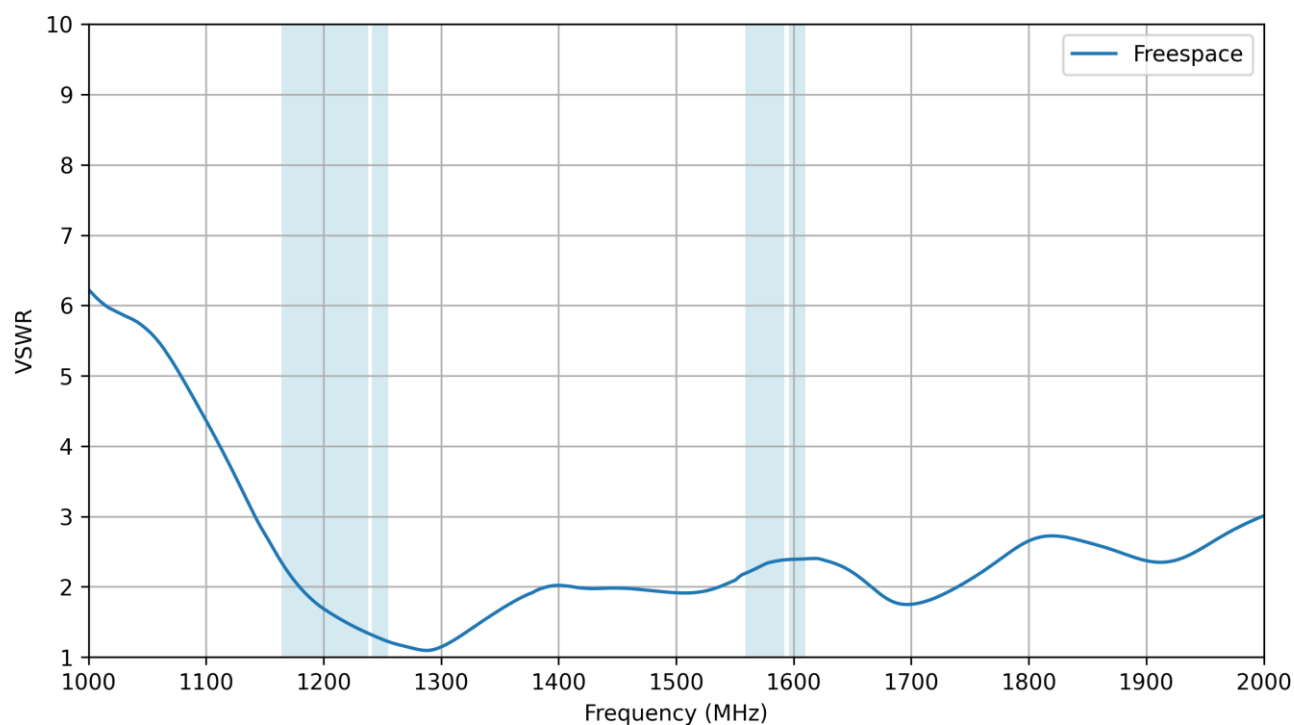


VNA Test Set-Up in Free Space and on a 30x30cm Ground Plane

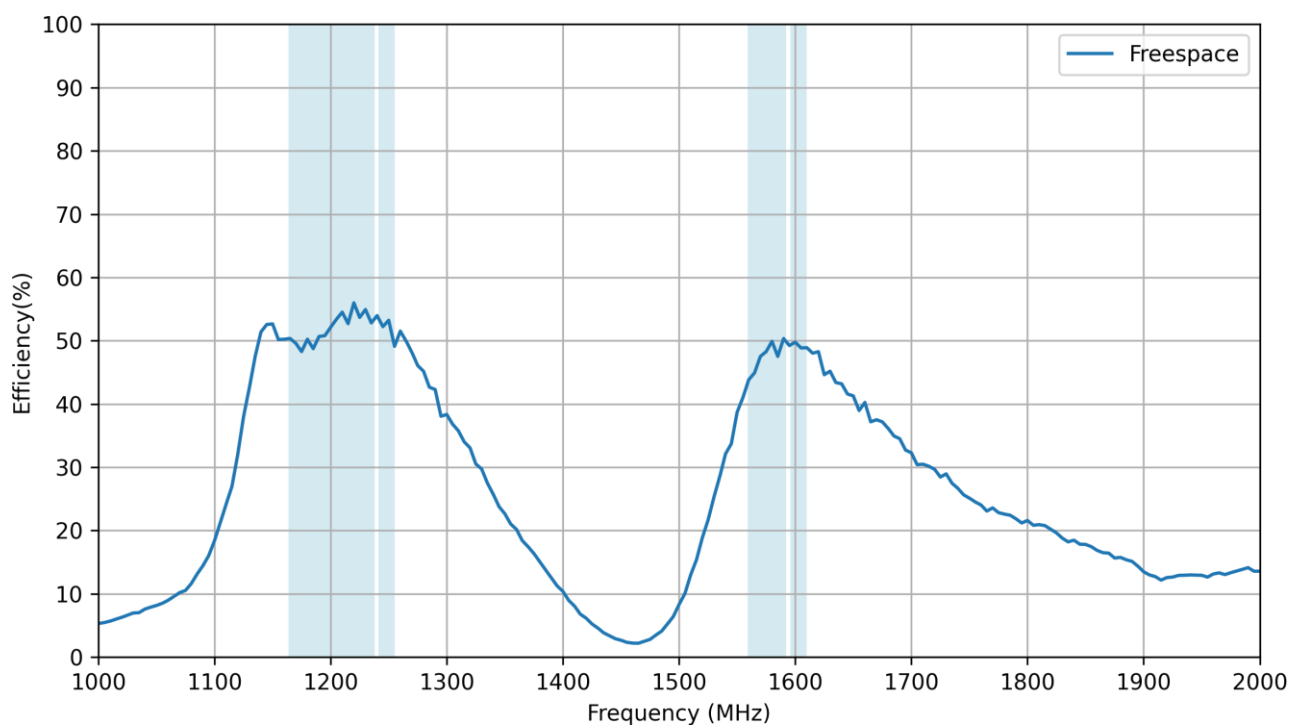
6.2 GNSS - Return Loss



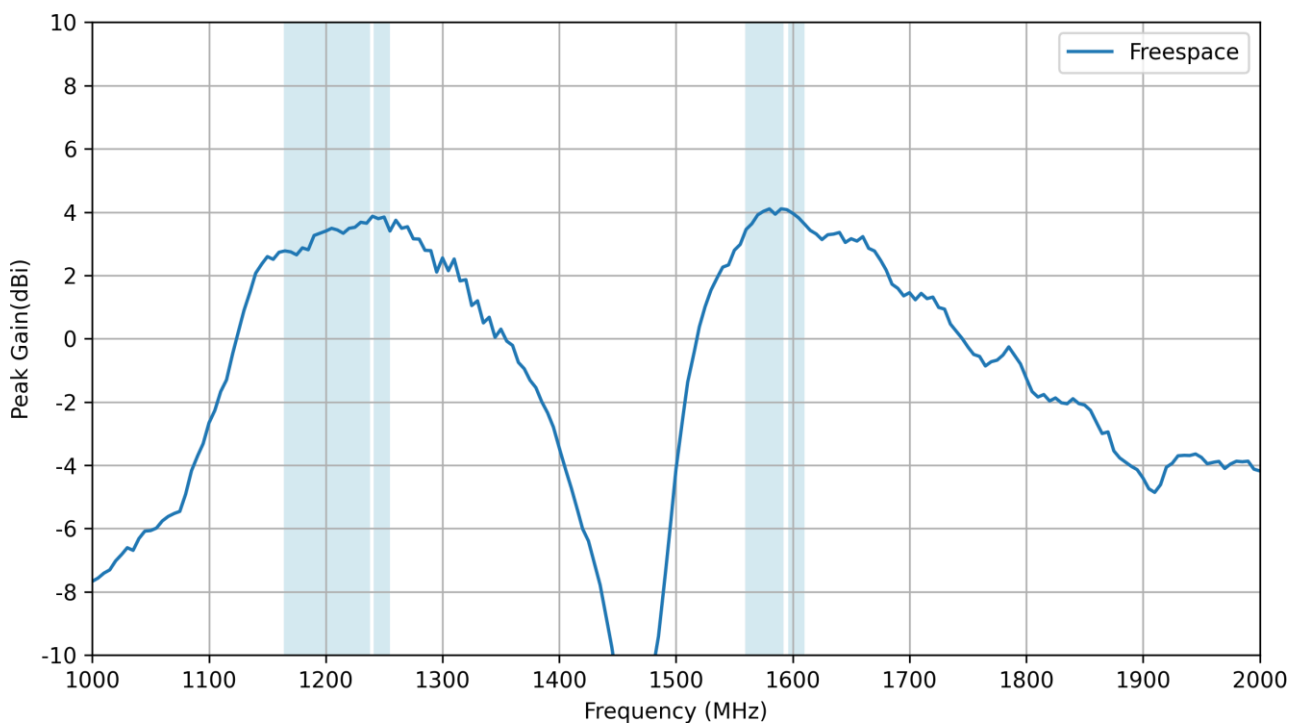
6.3 GNSS - VSWR



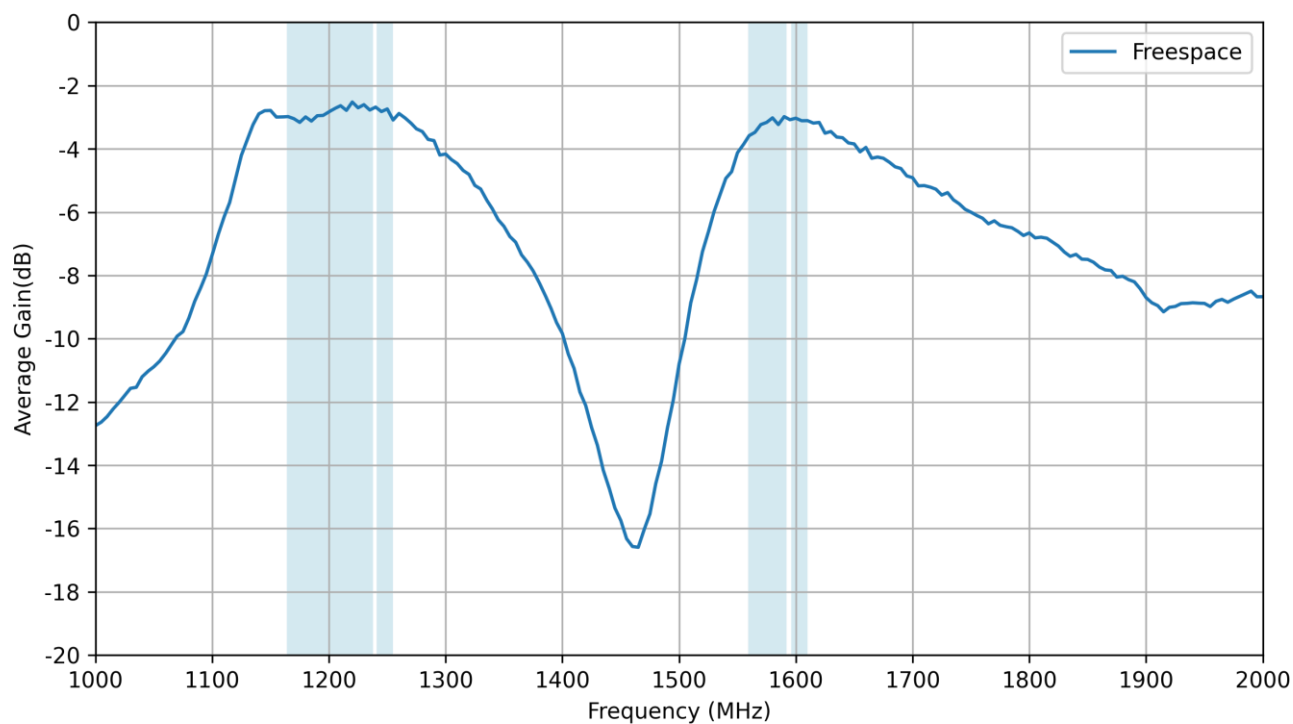
6.4 GNSS - Efficiency



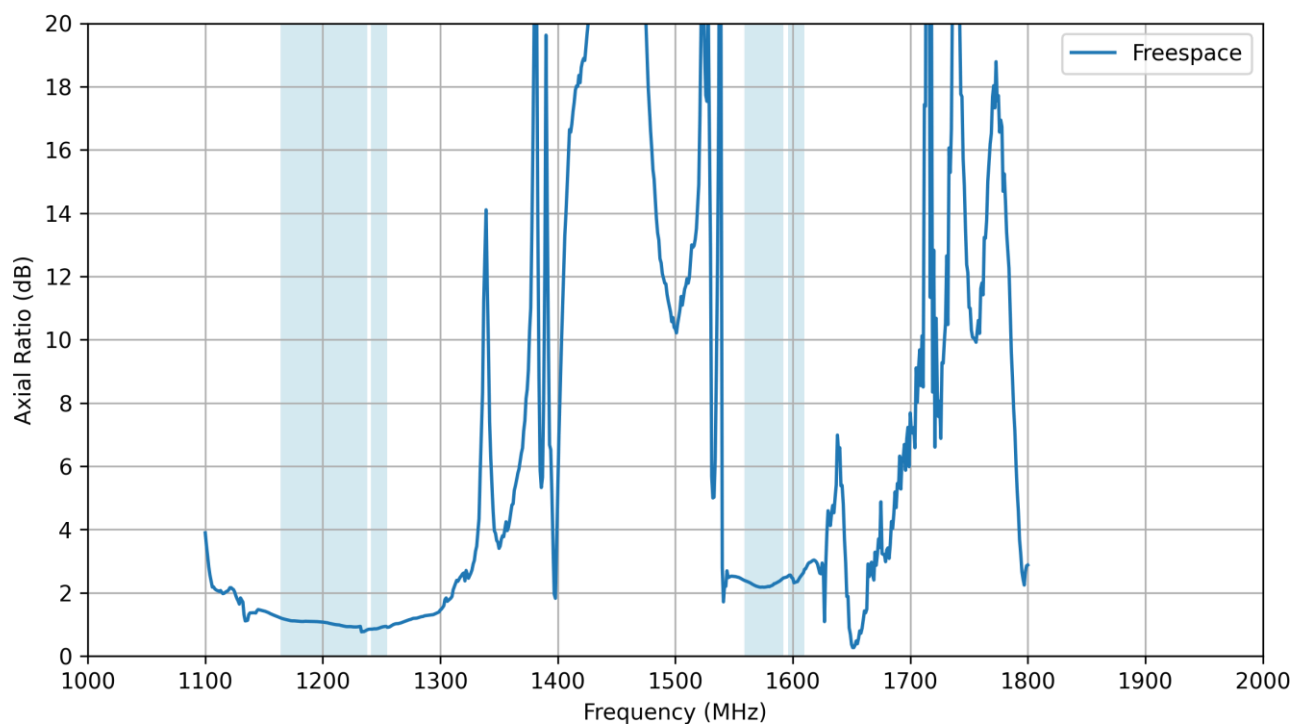
6.5 GNSS – Peak Gain



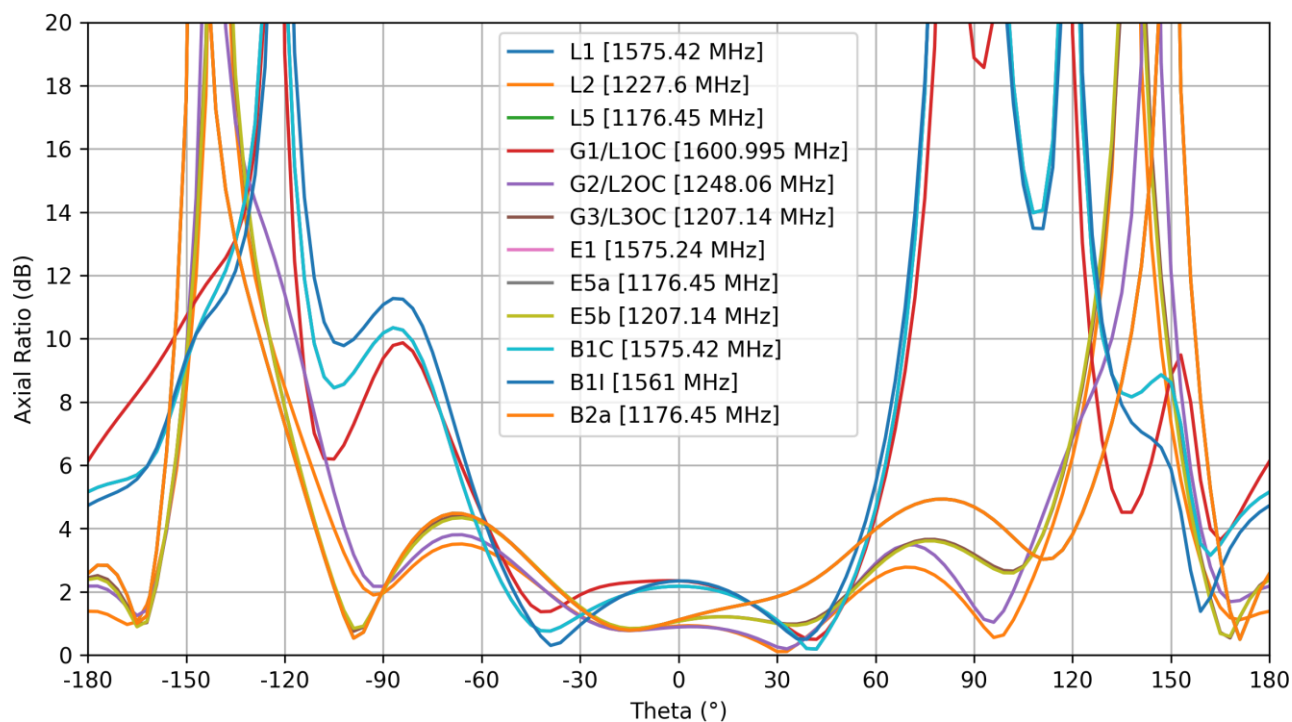
6.6 GNSS – Average Gain



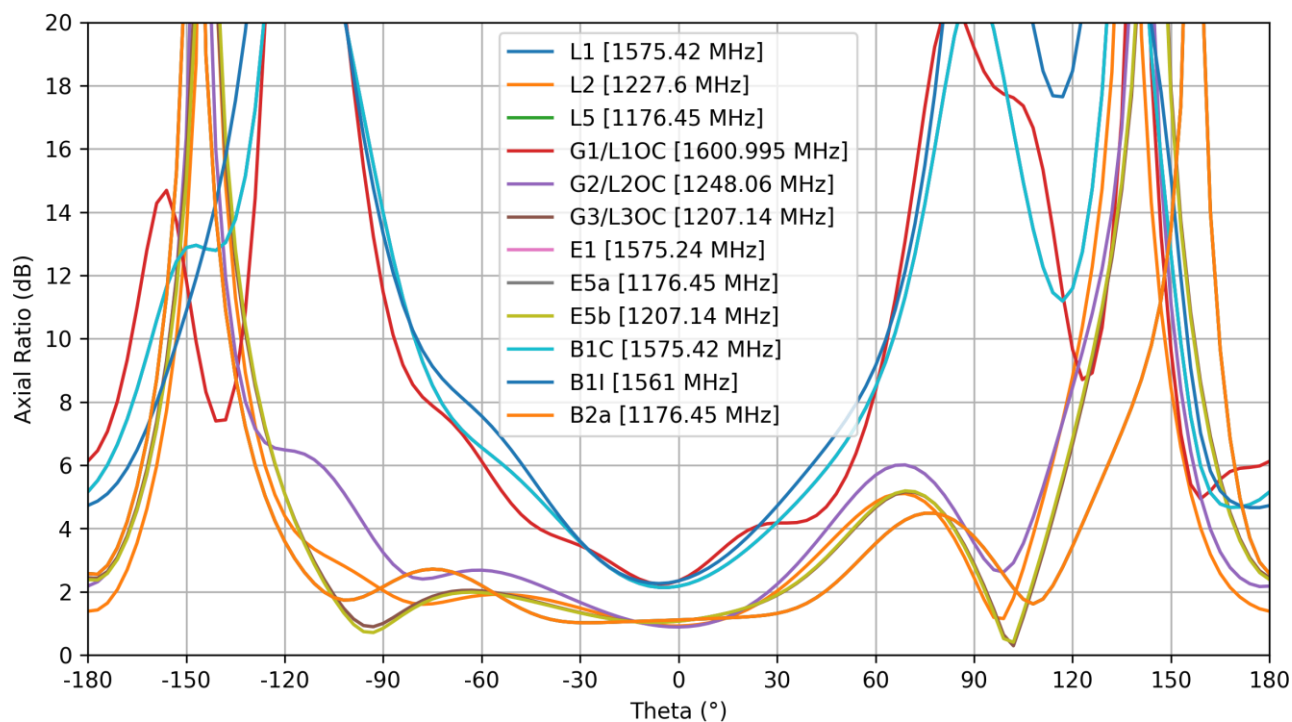
6.7 GNSS - Axial Ratio



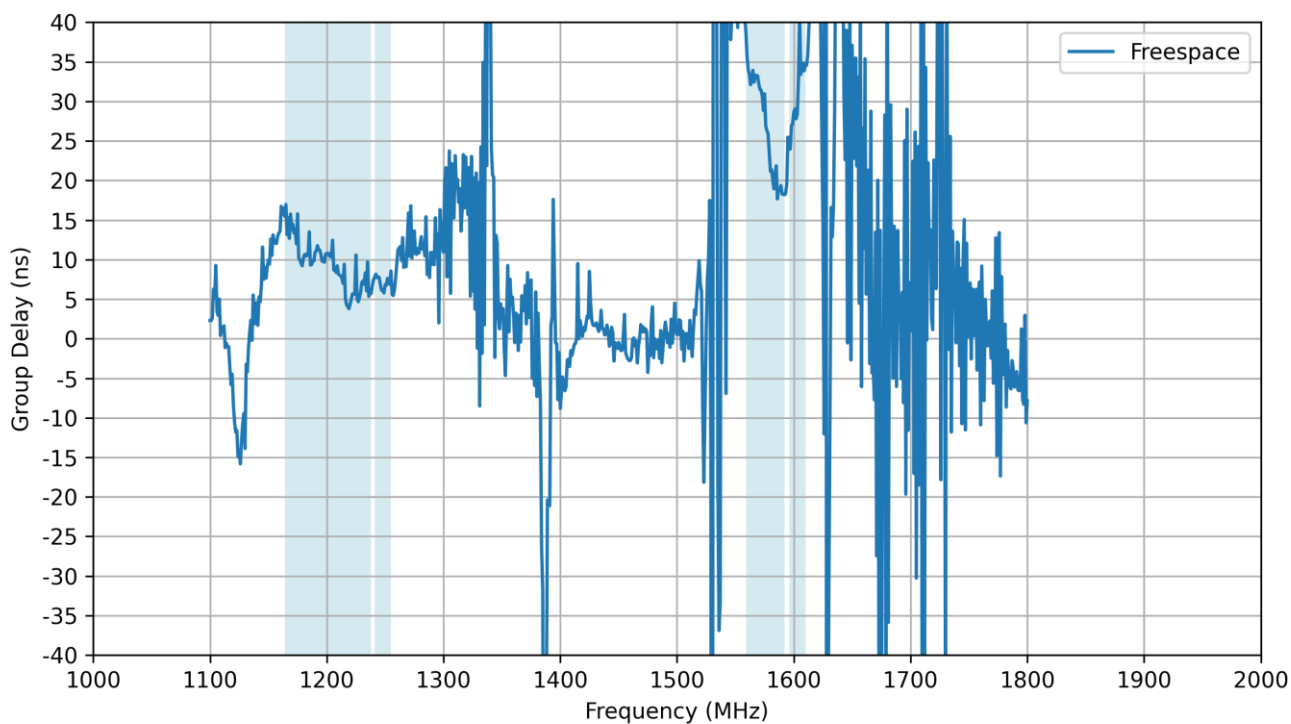
6.8 GNSS - Axial Ratio vs Angle for Phi=0



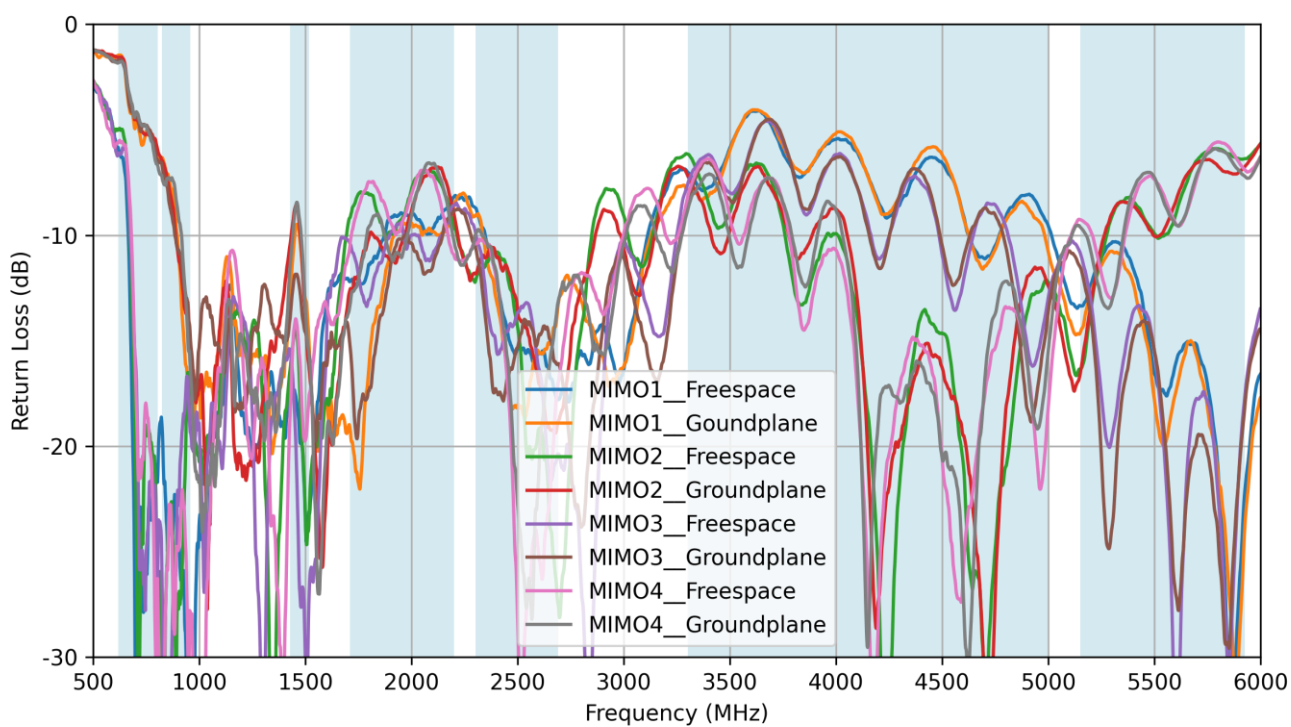
6.9 GNSS - Axial Ratio vs Angle for Phi=90



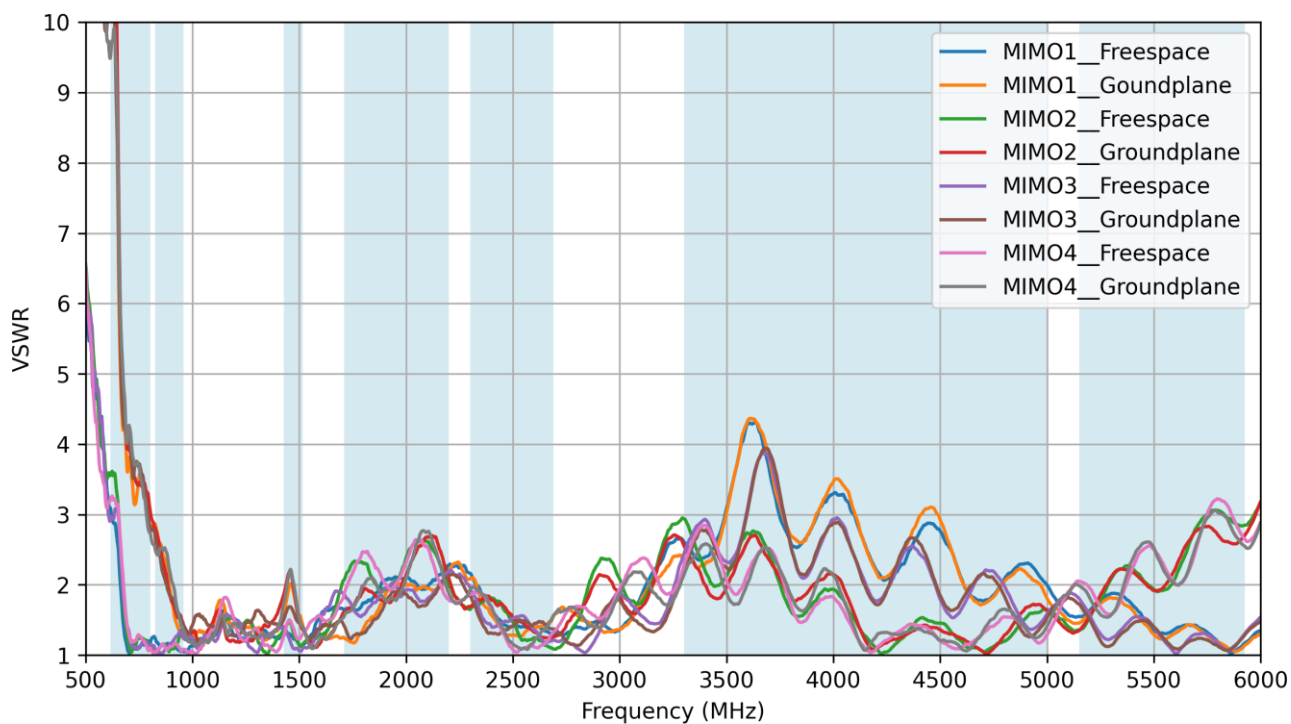
6.10 GNSS - Group Delay



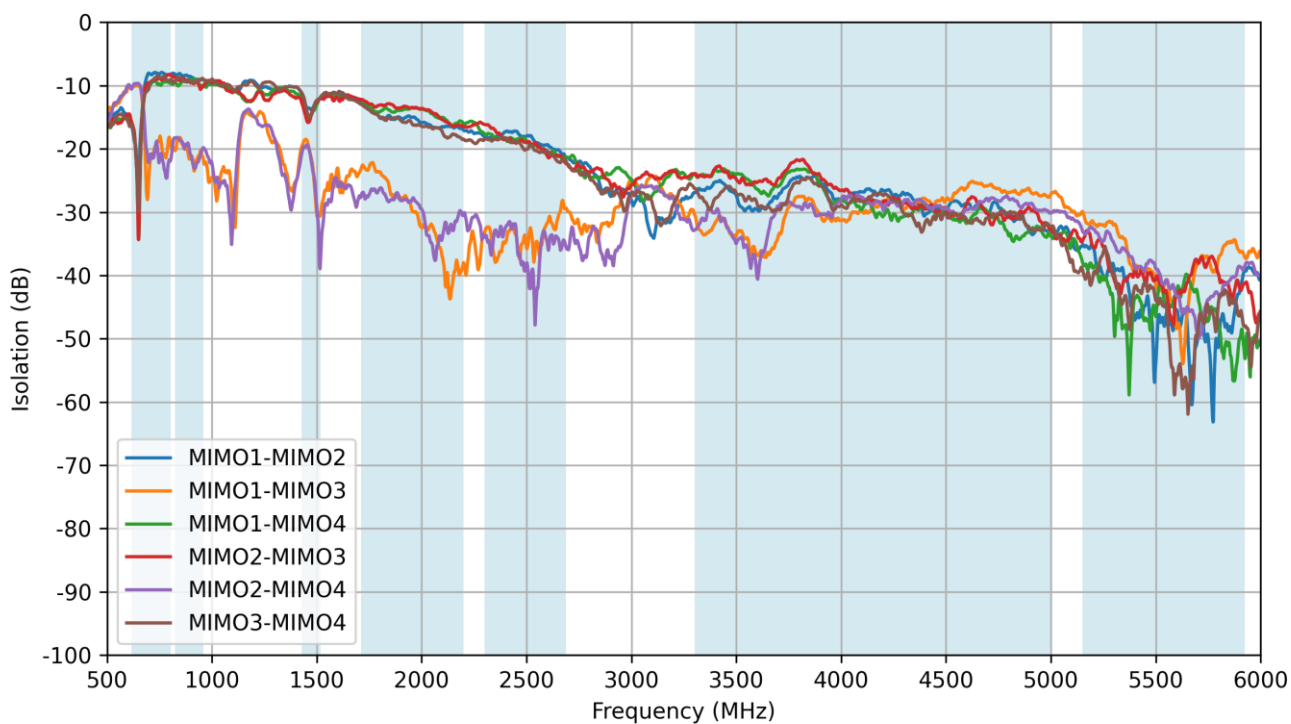
6.11 Cellular - Return Loss



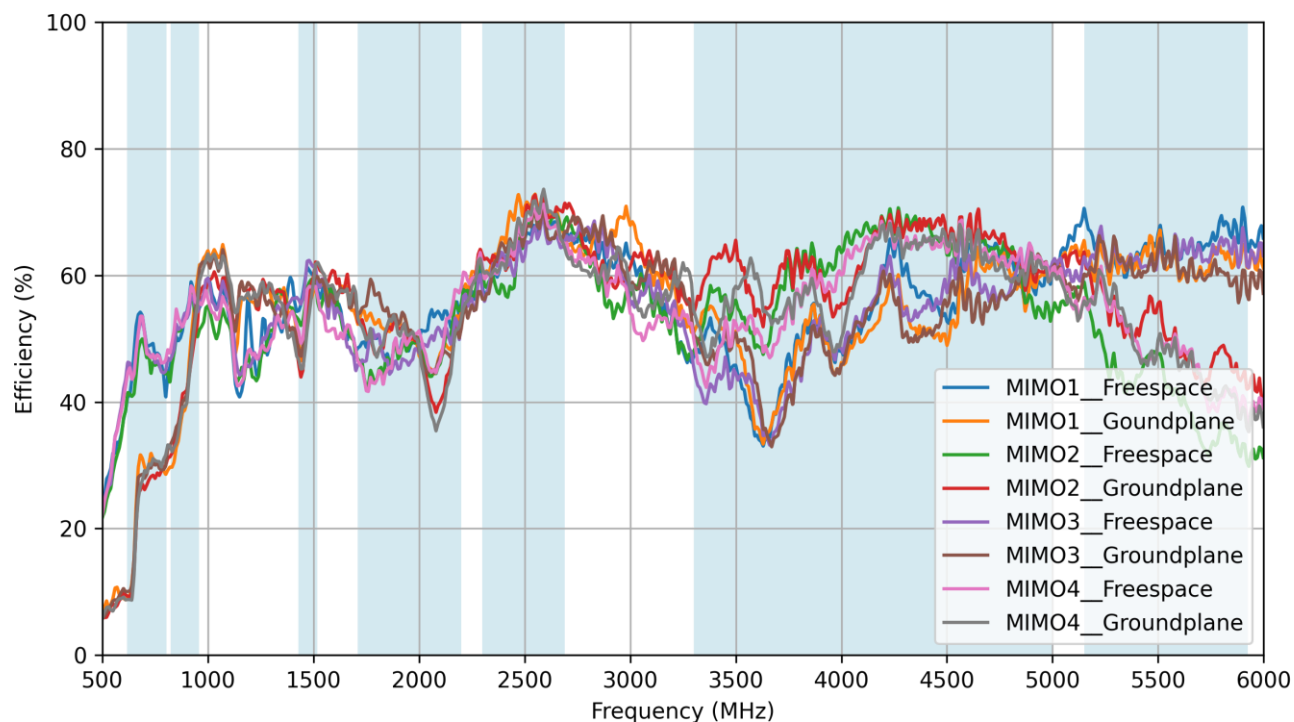
6.12 Cellular - VSWR



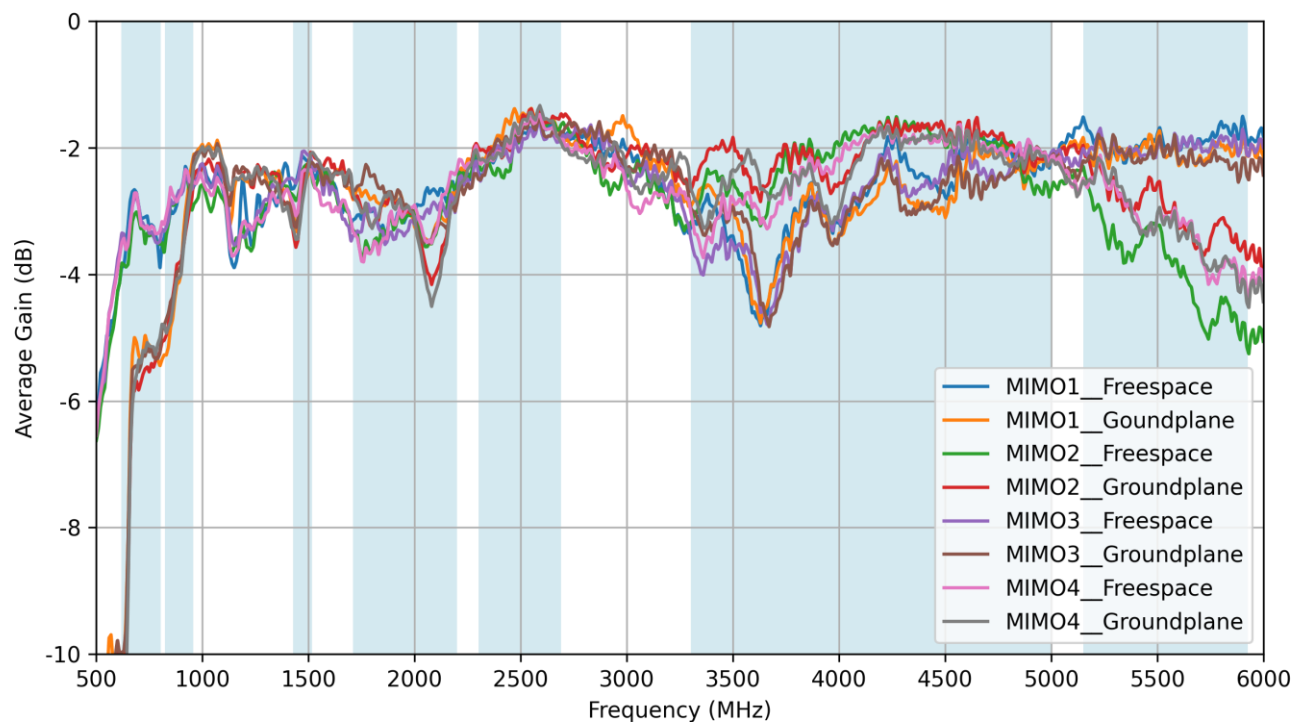
6.13 Cellular - Isolation



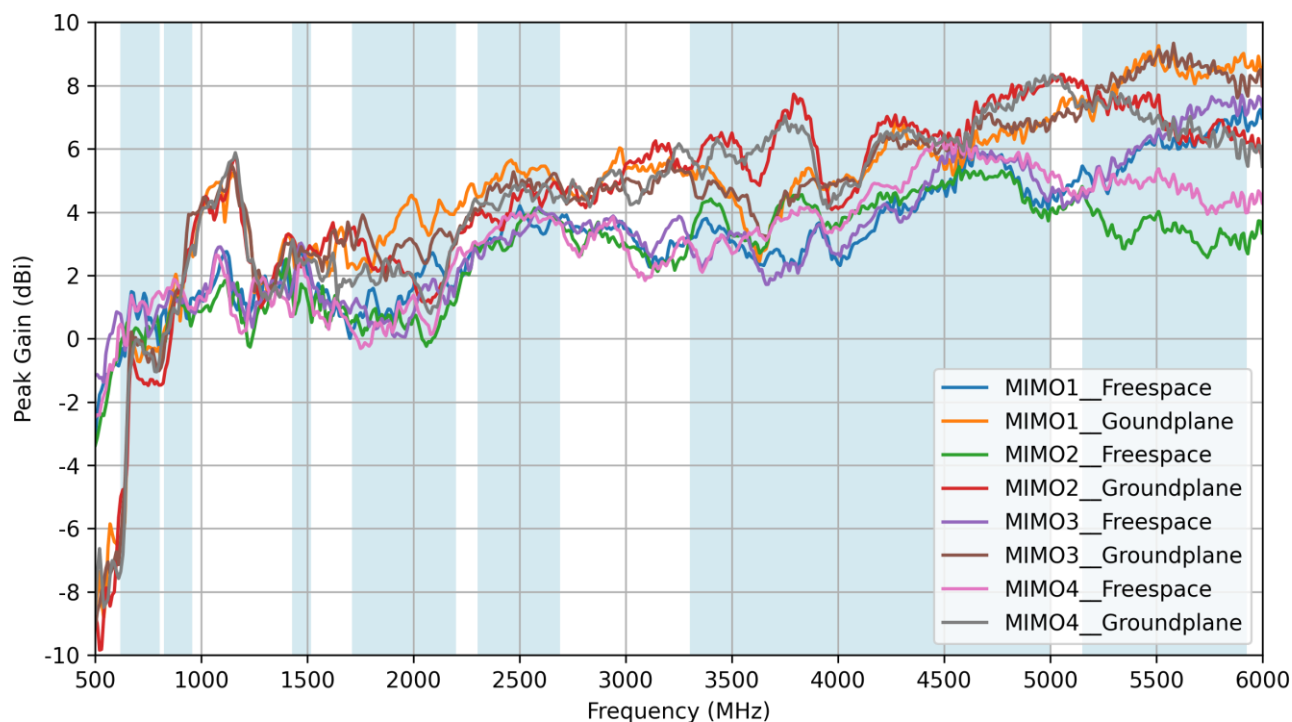
6.14 Cellular - Efficiency



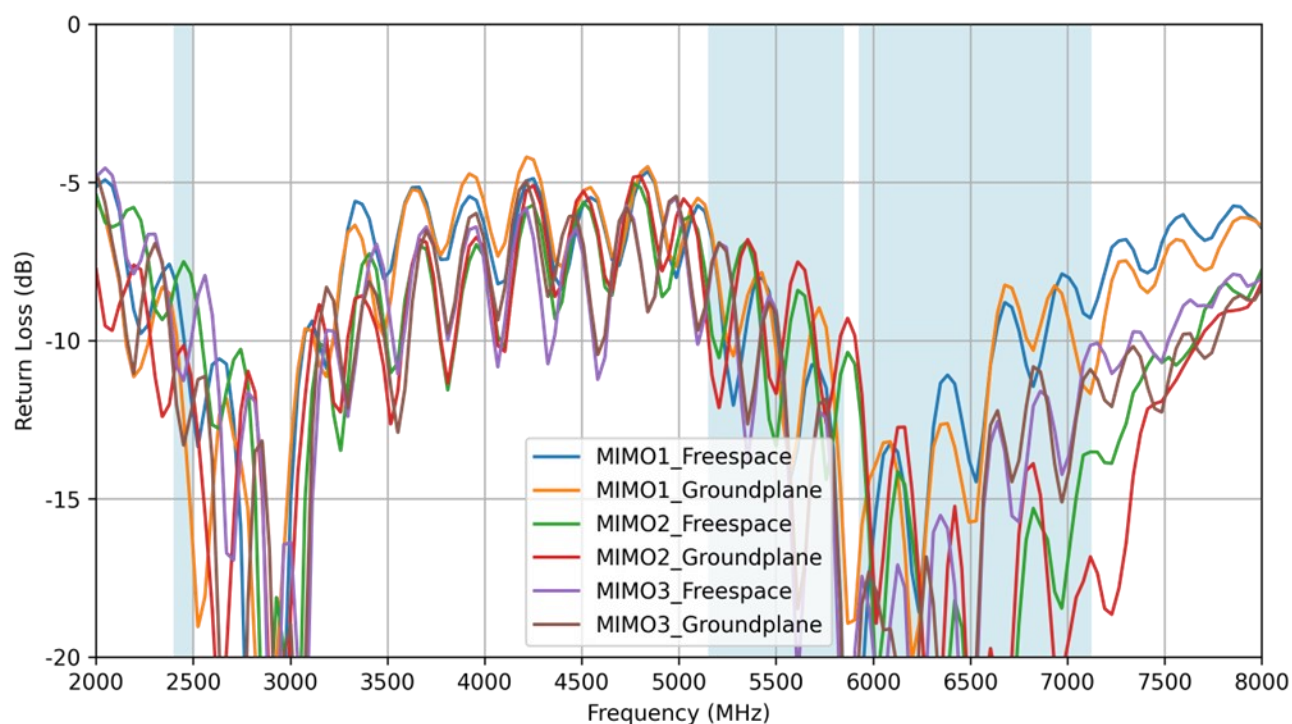
6.15 Cellular - Average Gain



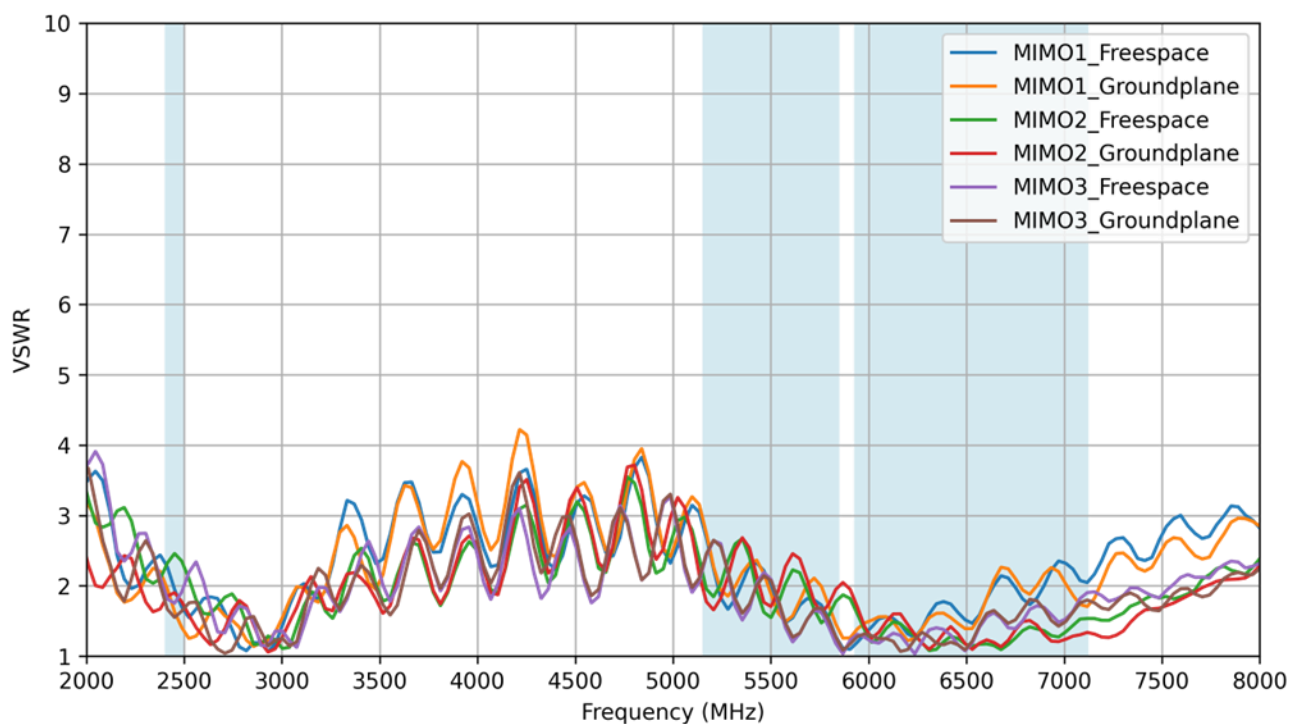
6.16 Cellular - Peak Gain



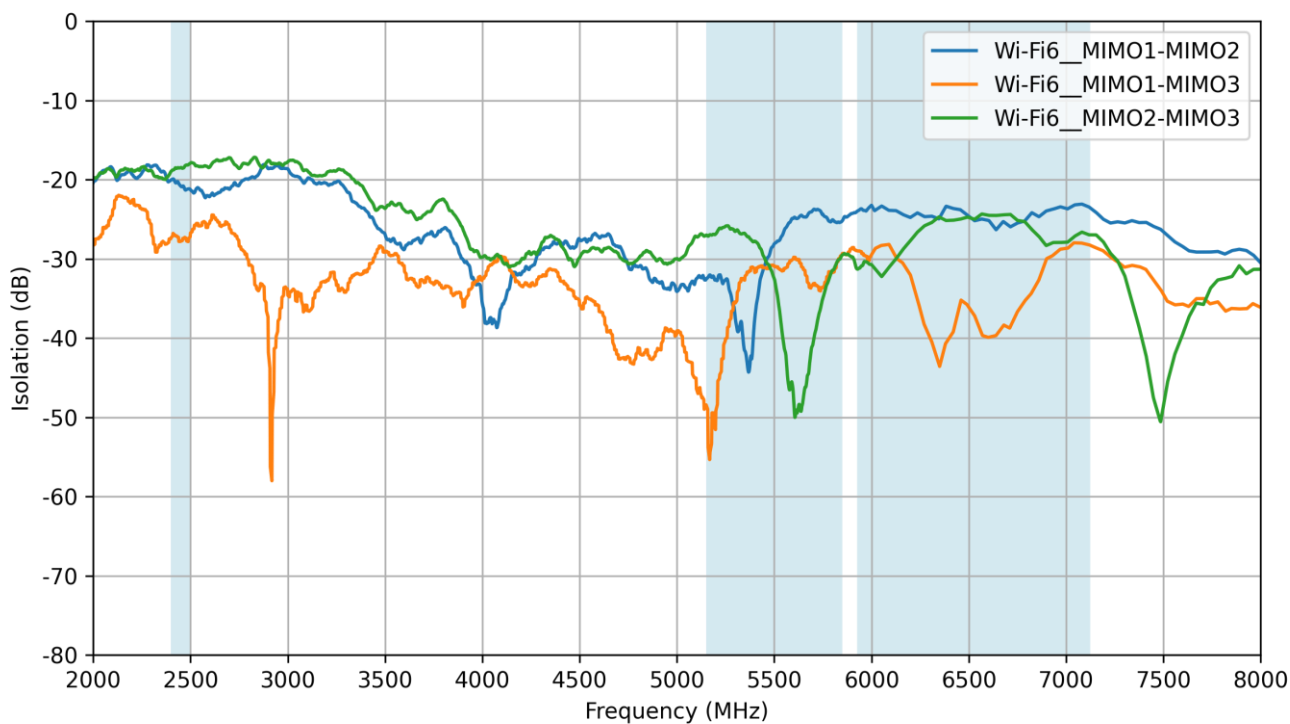
6.17 Wi-Fi - Return Loss



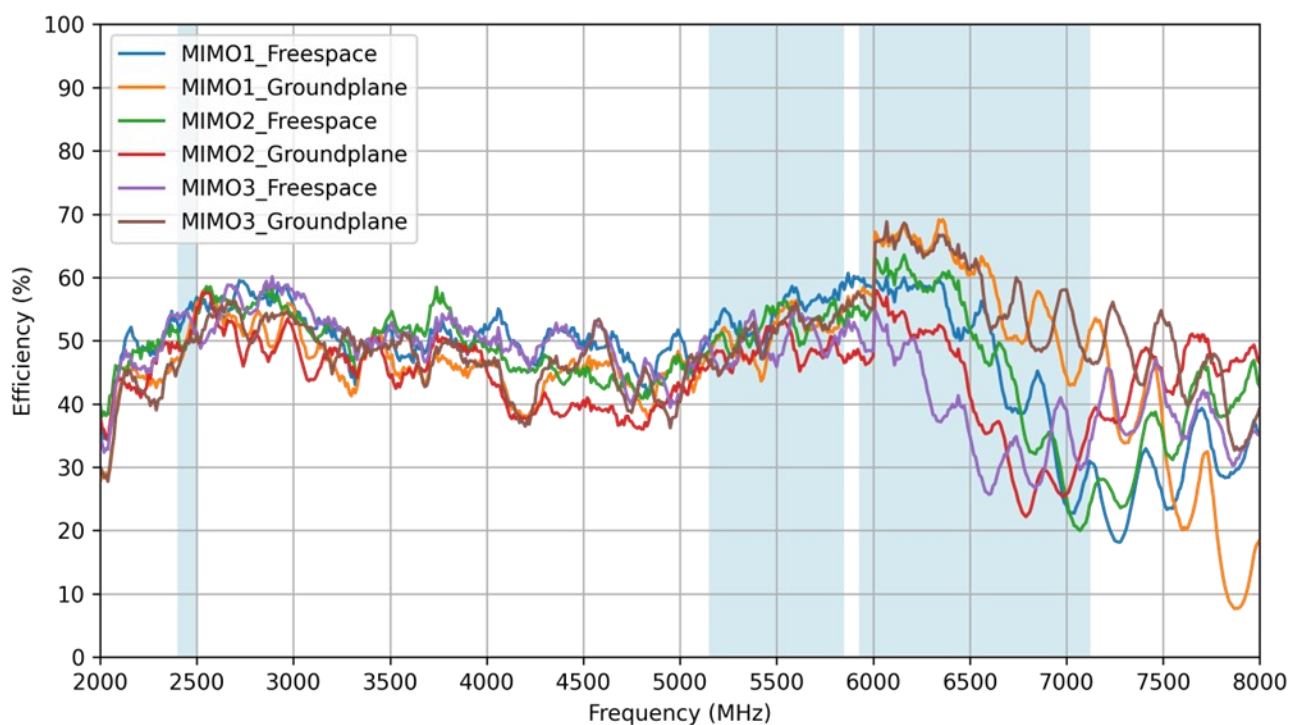
6.18 Wi-Fi - VSWR



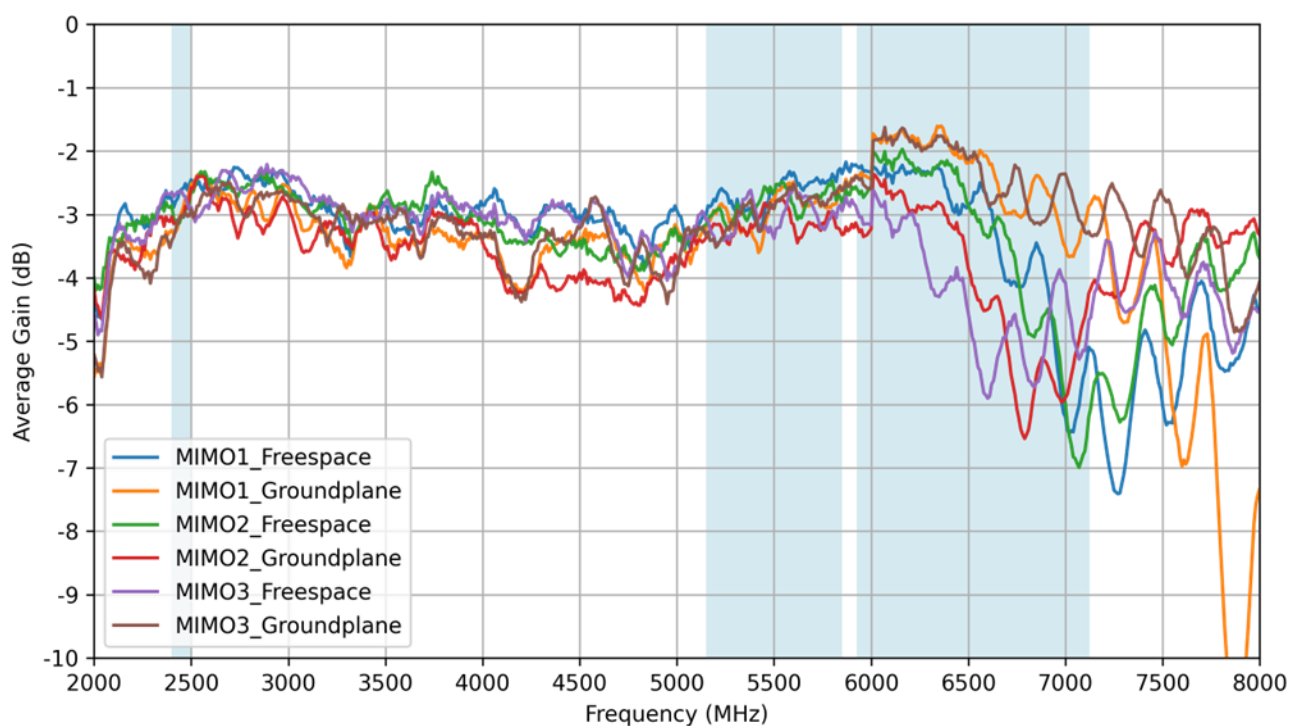
6.19 Wi-Fi - Isolation



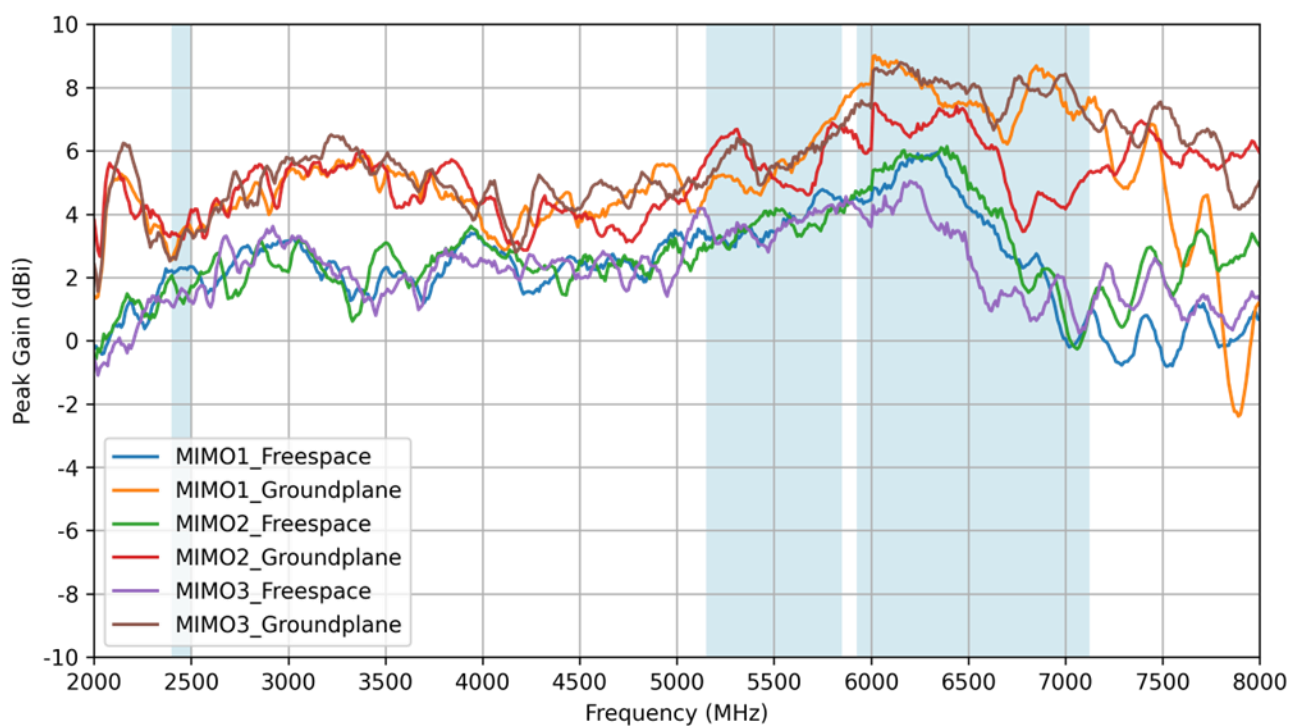
6.20 Wi-Fi - Efficiency



6.21 Wi-Fi - Average Gain

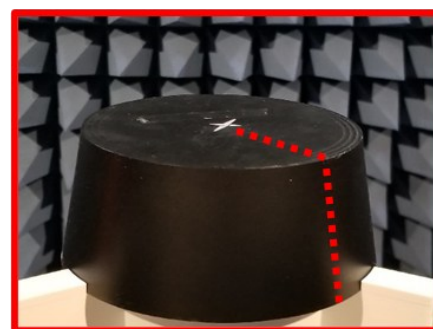
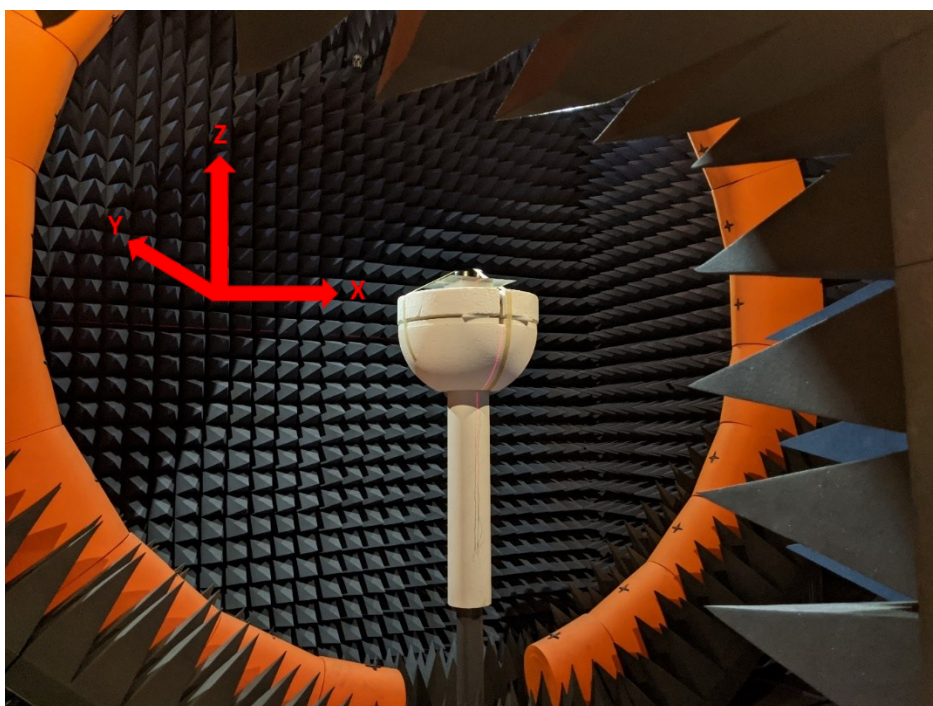
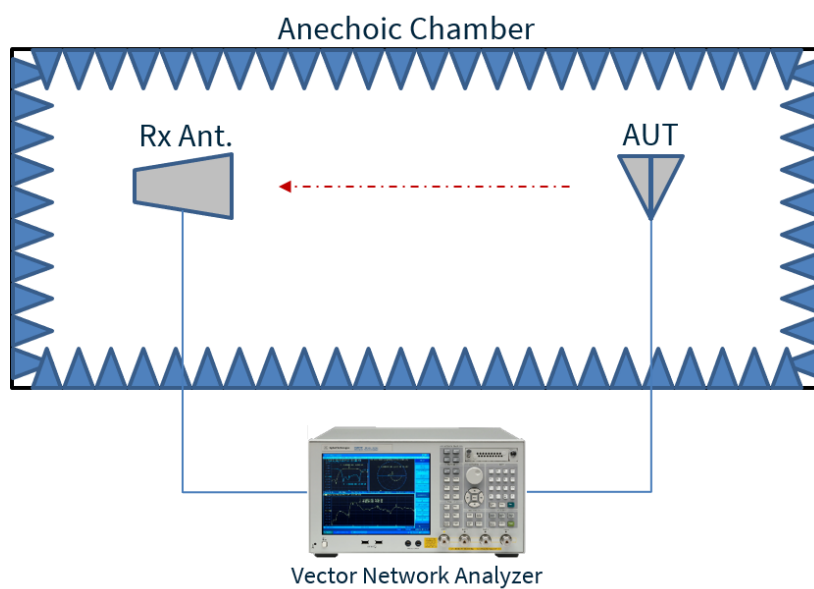


6.22 Wi-Fi - Peak Gain



7. Radiation Patterns

7.1 Test Setup



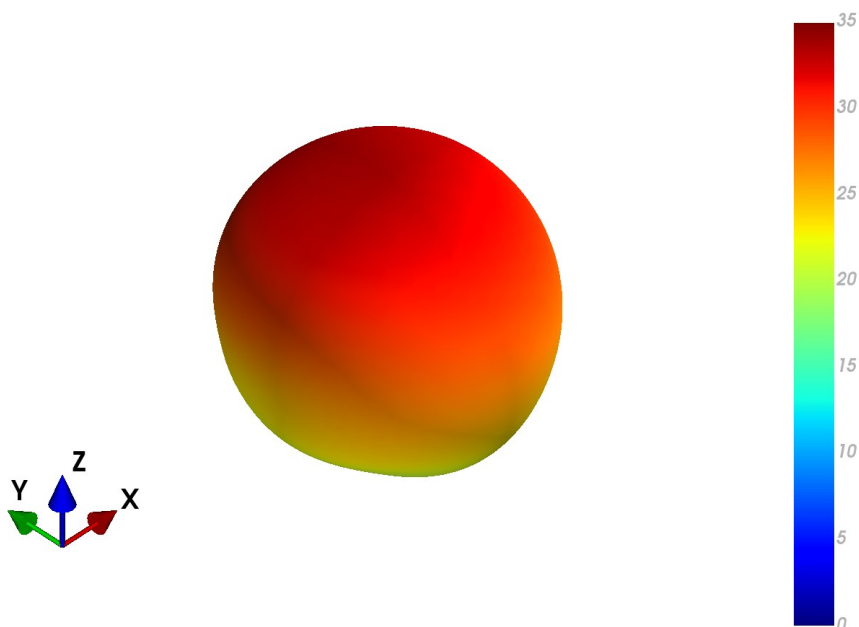
Y-Axis Location.



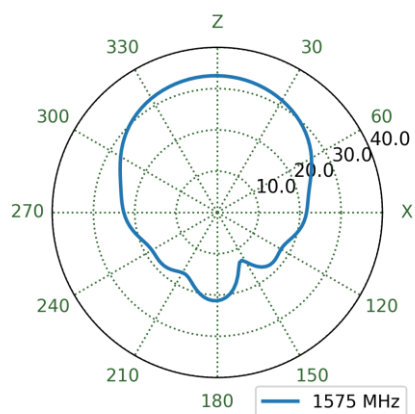
Underside-notch.

Antenna tested with underside-notch/logo centered along Y-Axis.

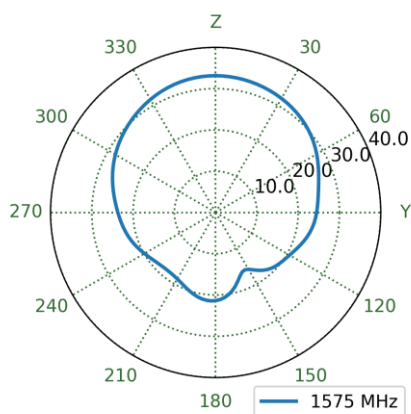
7.2 GNSS Free Space Patterns at 1575 MHz



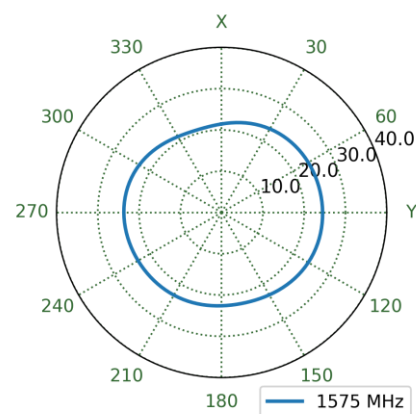
XZ Plane



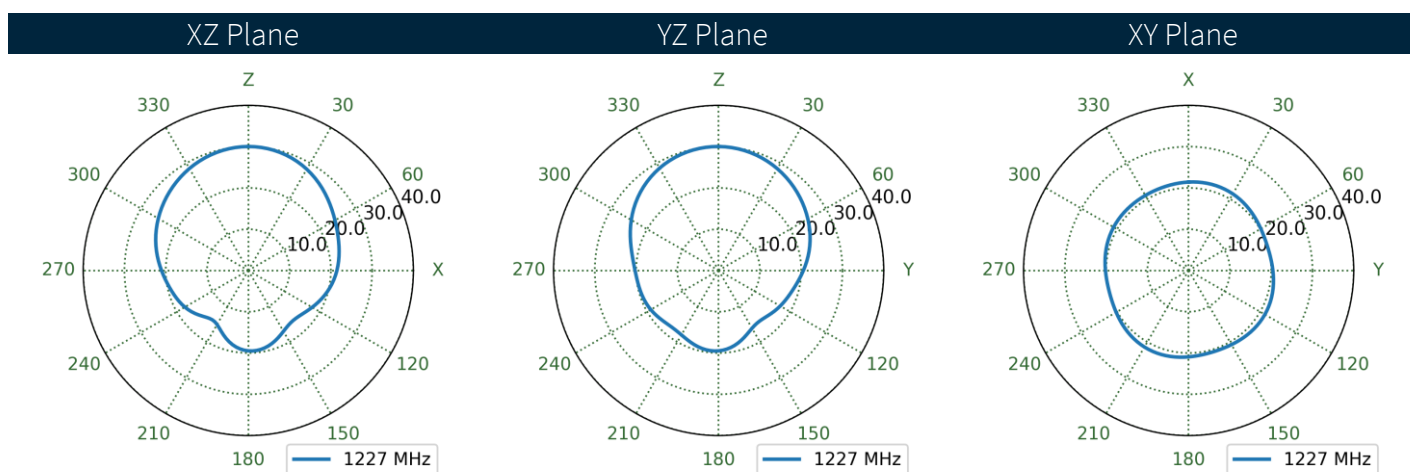
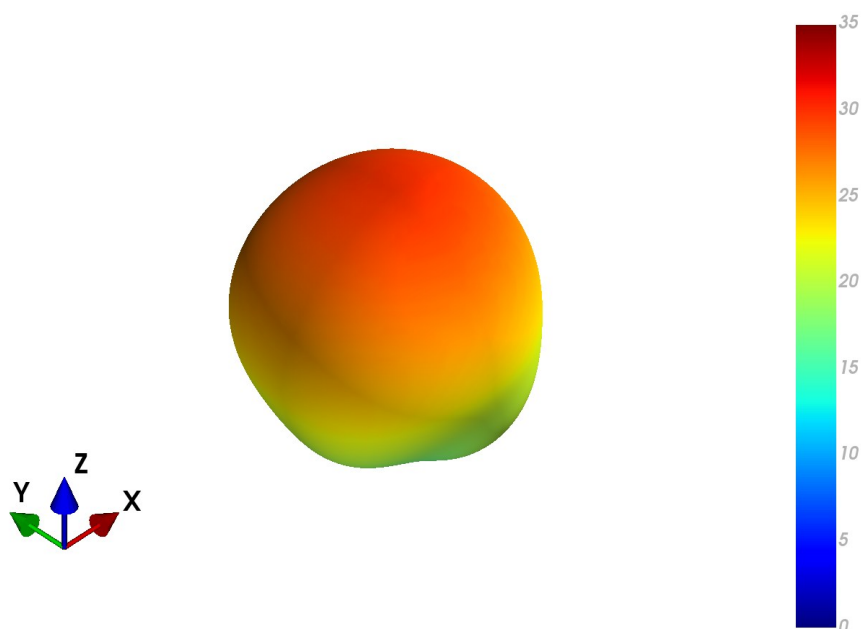
YZ Plane



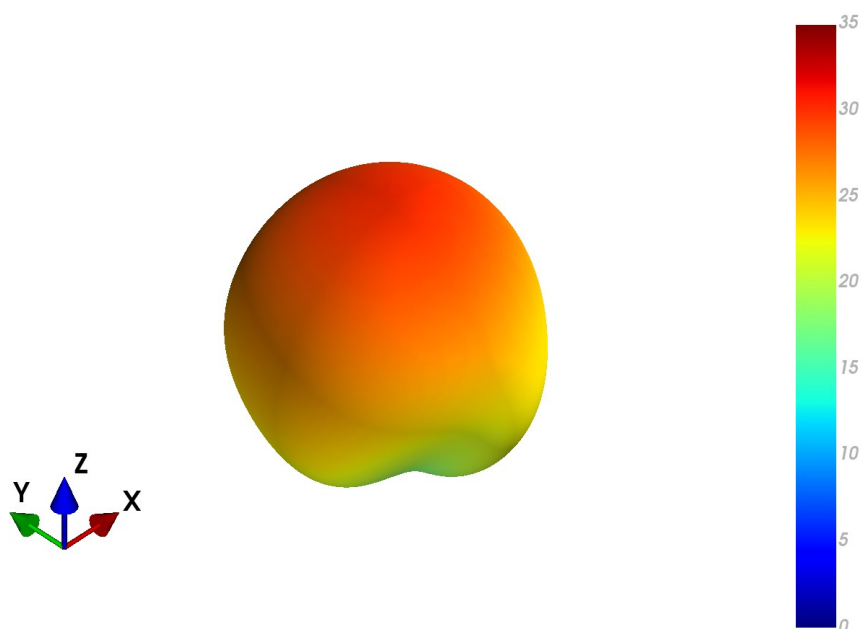
XY Plane



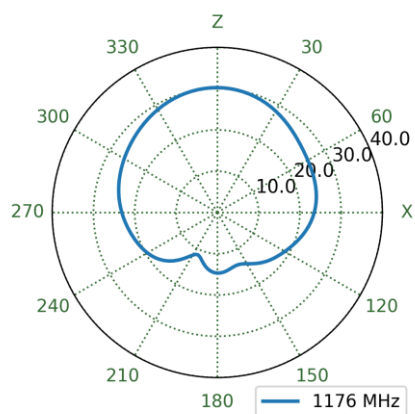
7.3 GNSS Free Space Patterns at 1227 MHz



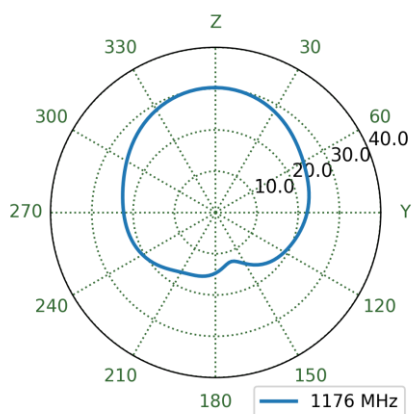
7.4 GNSS Free Space Patterns at 1176 MHz



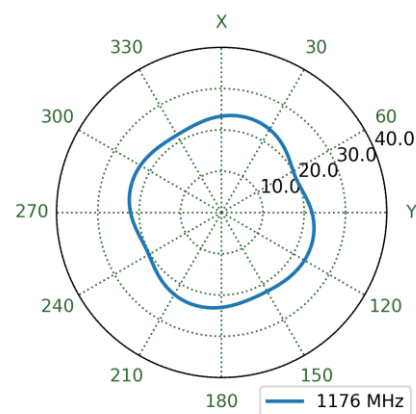
XZ Plane



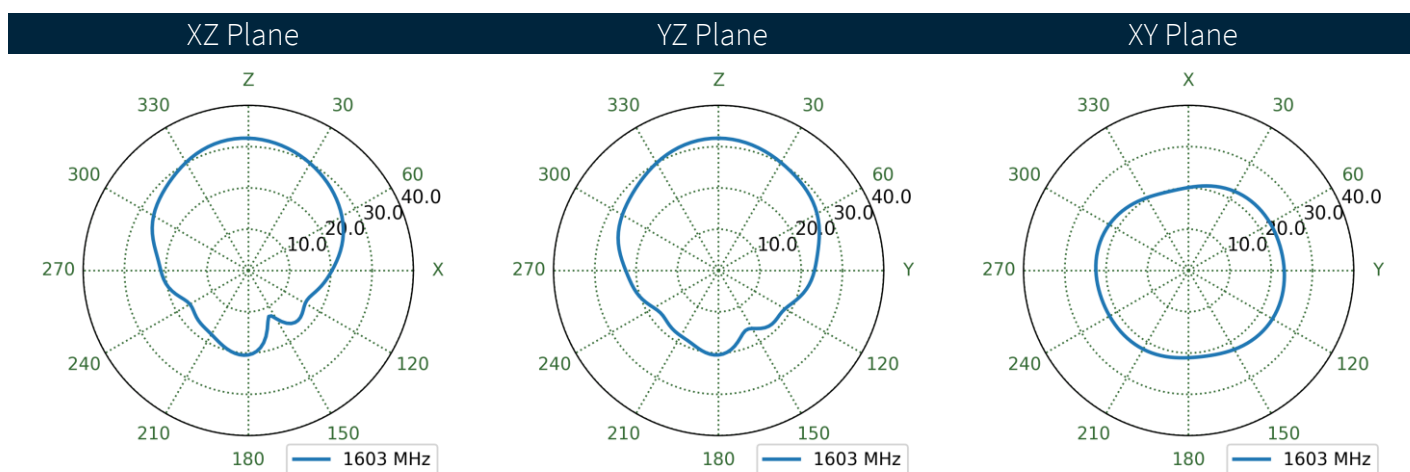
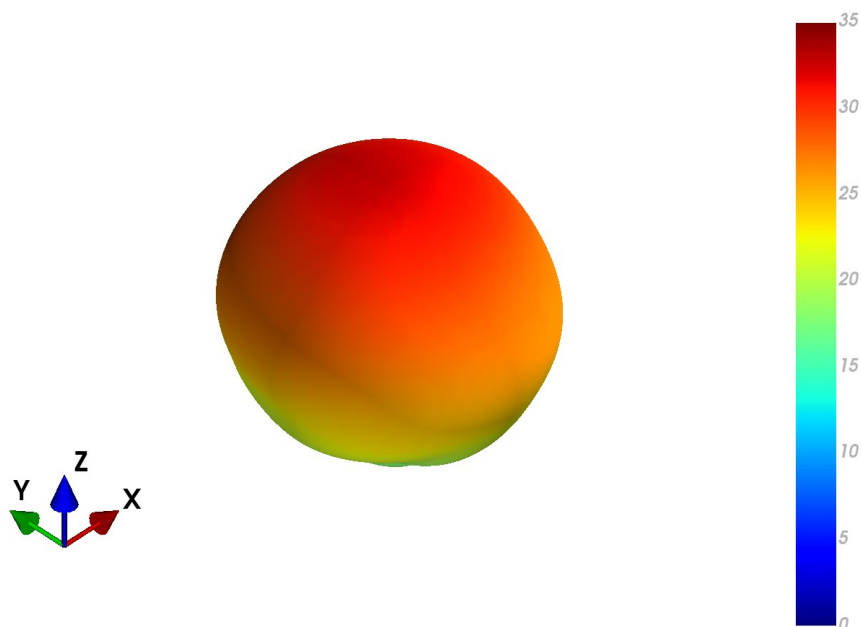
YZ Plane



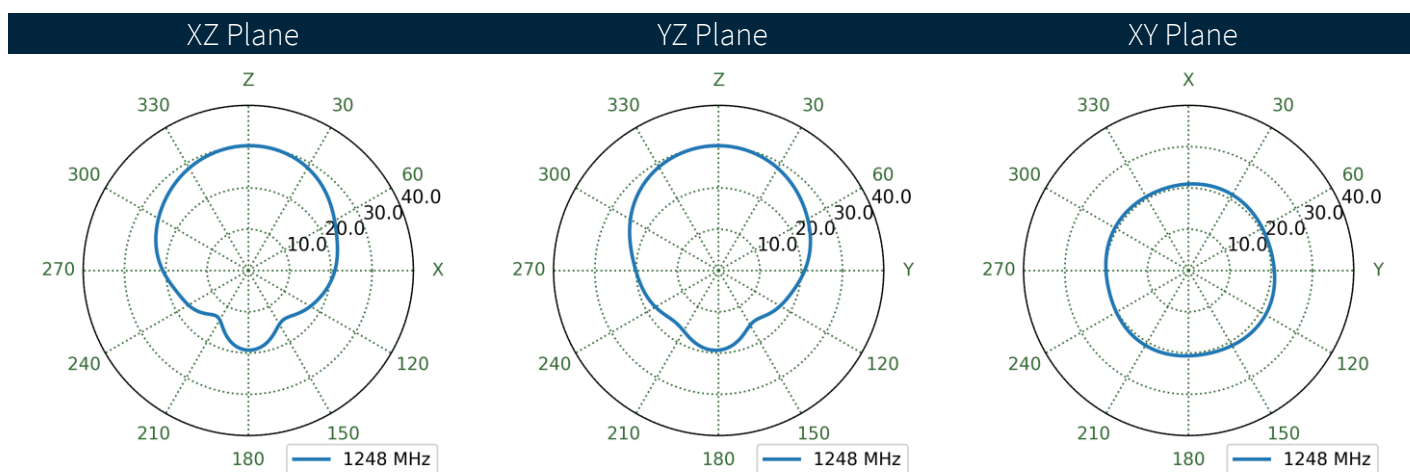
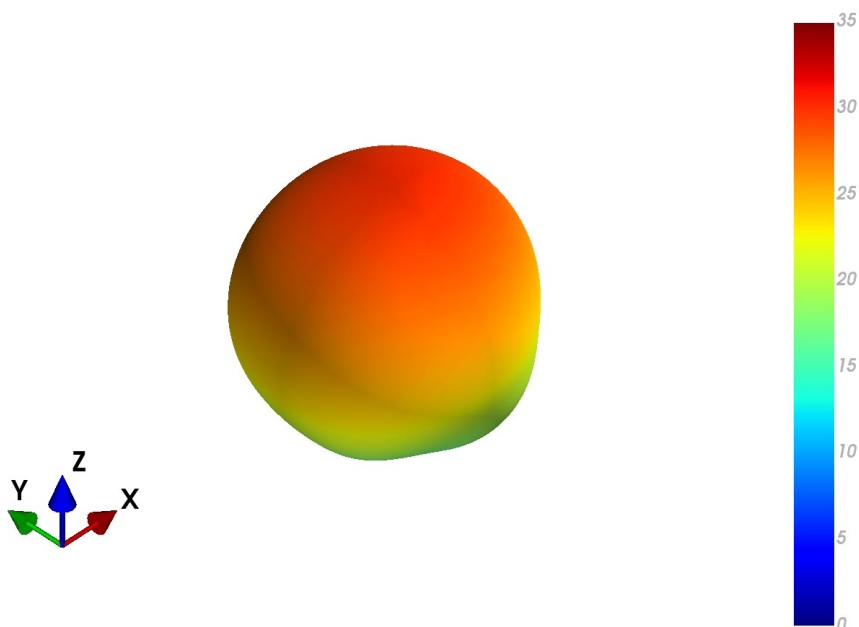
XY Plane



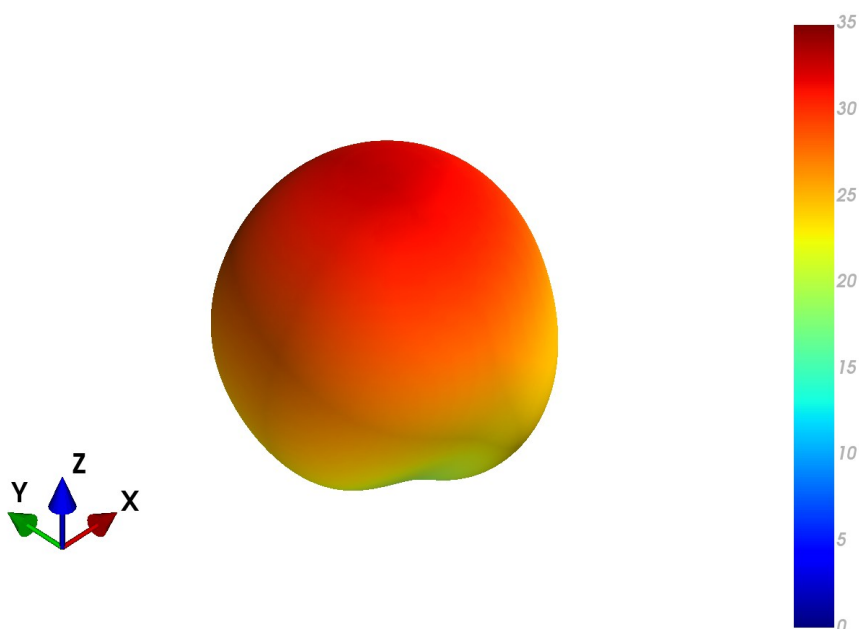
7.5 GNSS Free Space Patterns at 1603 MHz



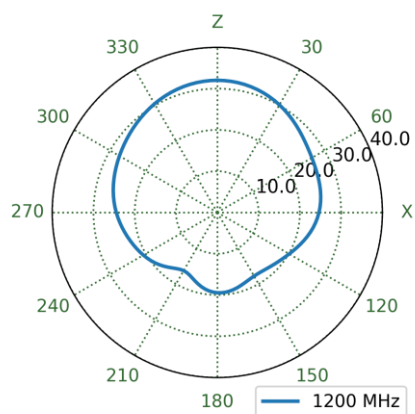
7.6 GNSS Free Space Patterns at 1248 MHz



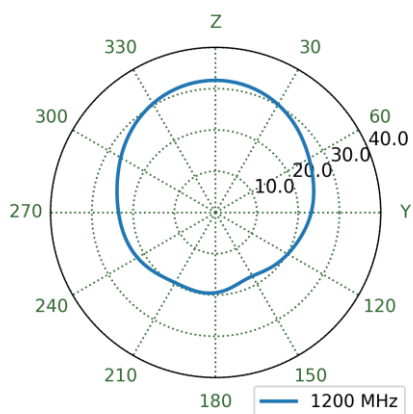
7.7 GNSS Free Space Patterns at 1200 MHz



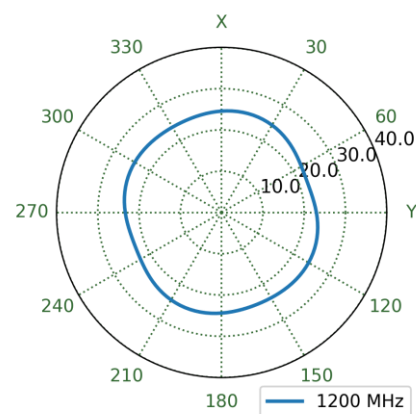
XZ Plane



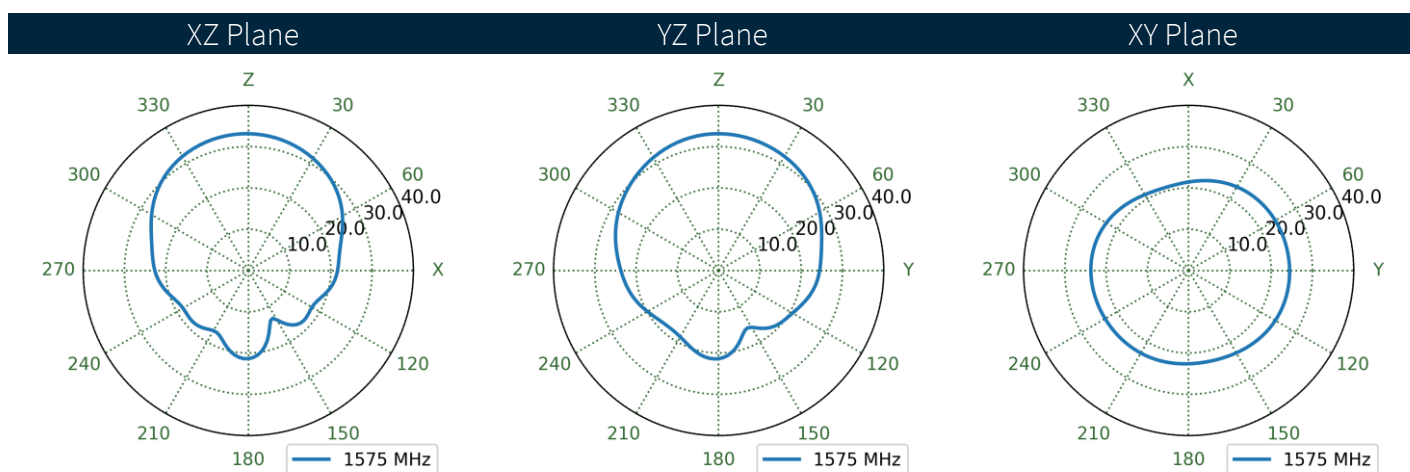
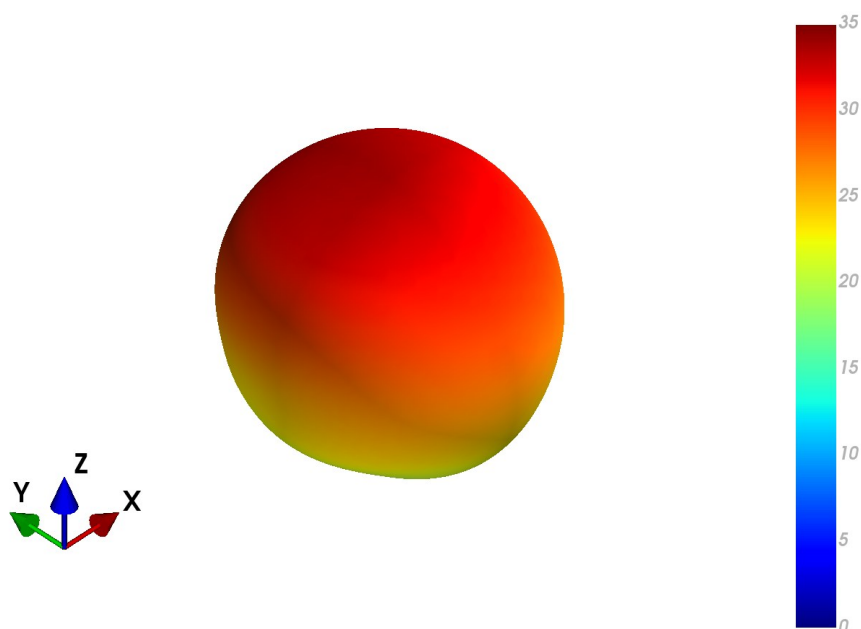
YZ Plane



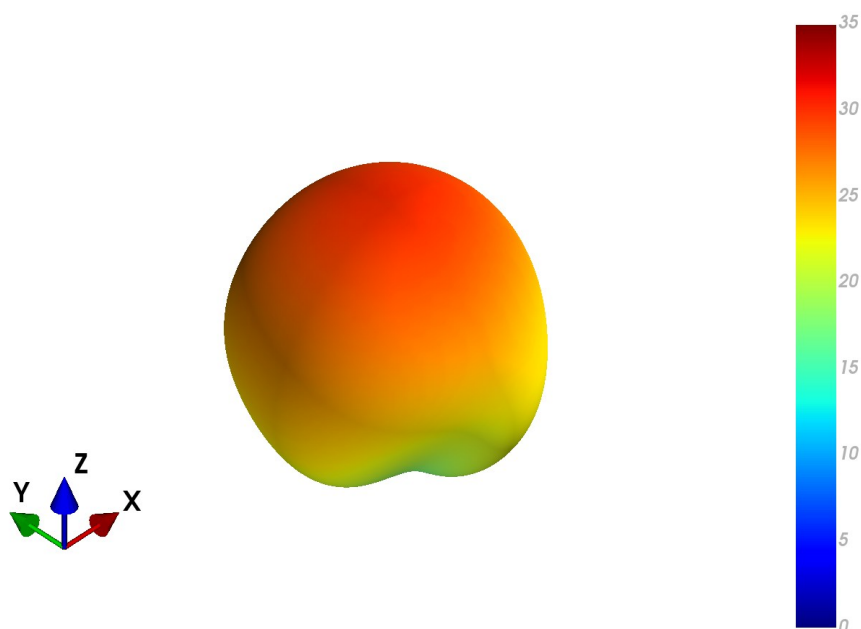
XY Plane



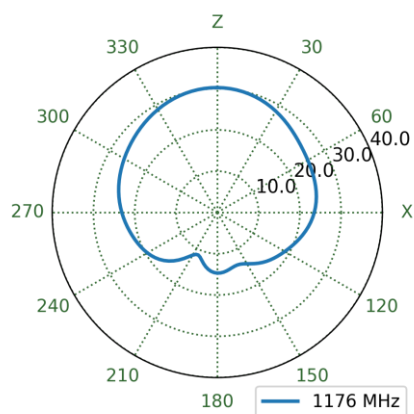
7.8 GNSS Free Space Patterns at 1575 MHz



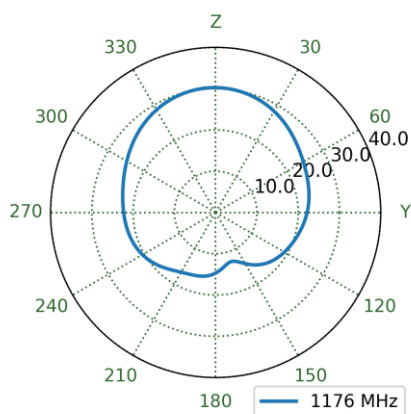
7.9 GNSS Free Space Patterns at 1176 MHz



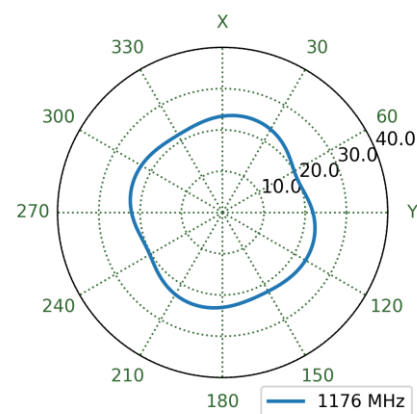
XZ Plane



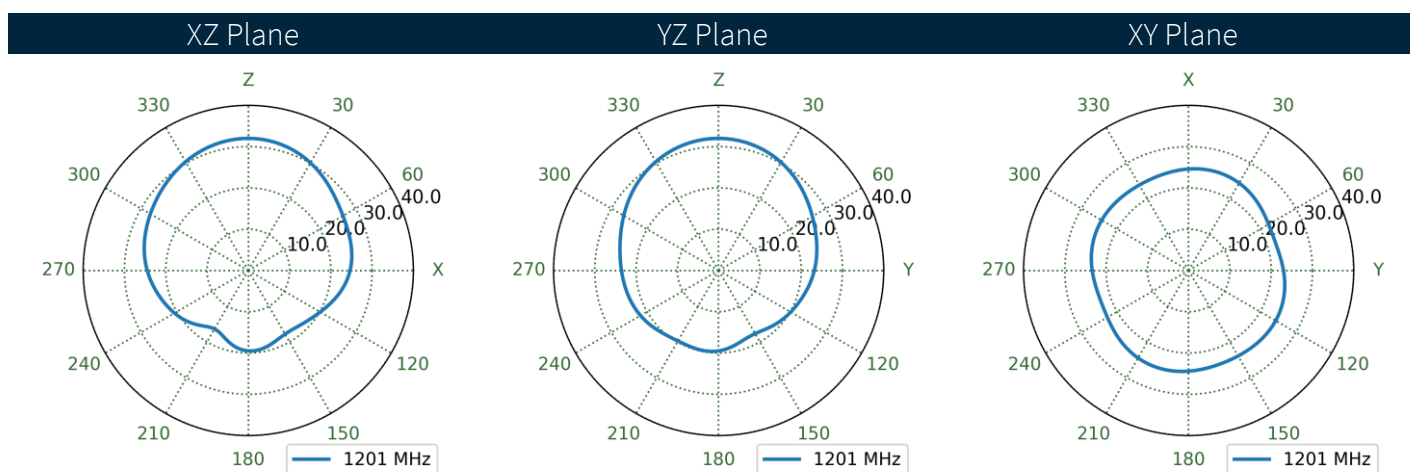
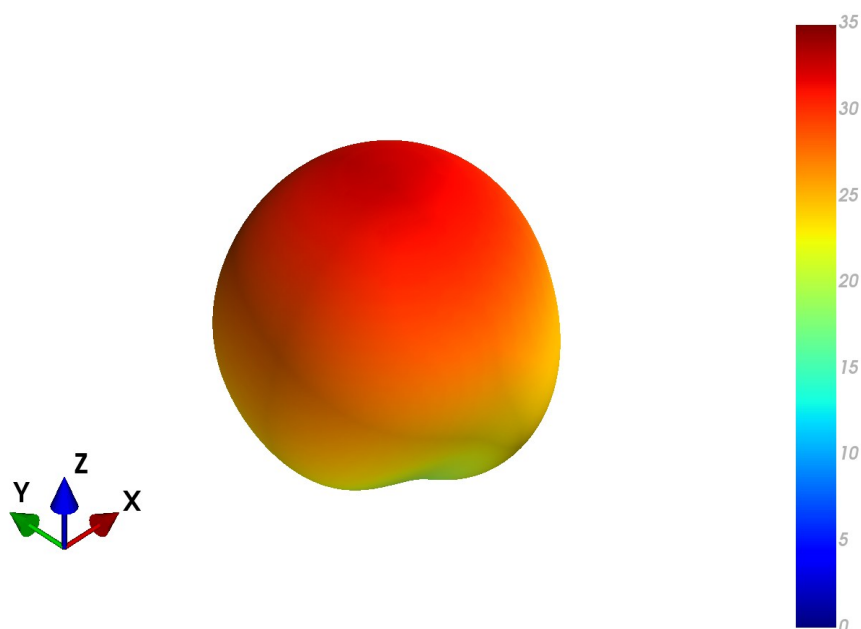
YZ Plane



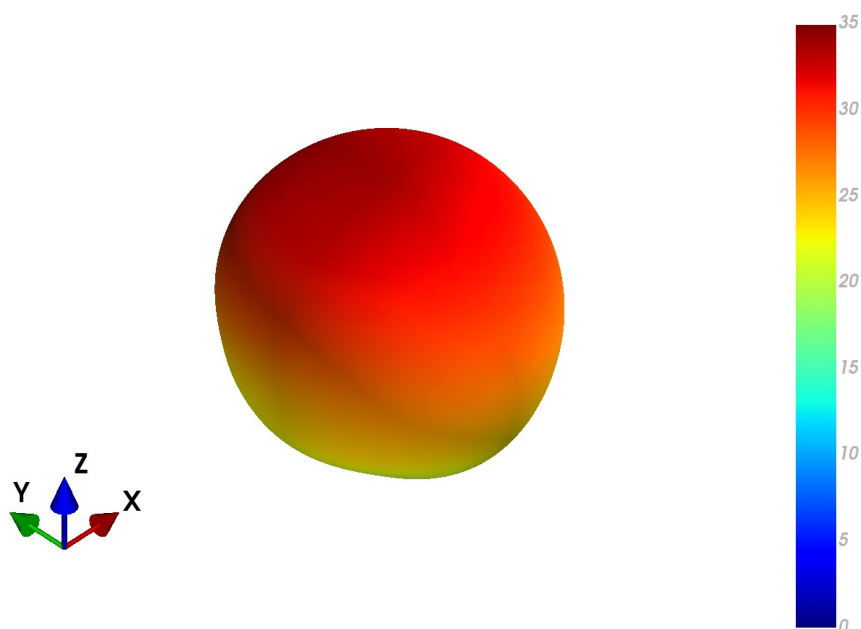
XY Plane



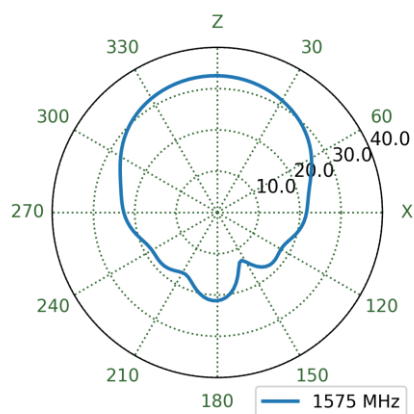
7.10 GNSS Free Space Patterns at 1201 MHz



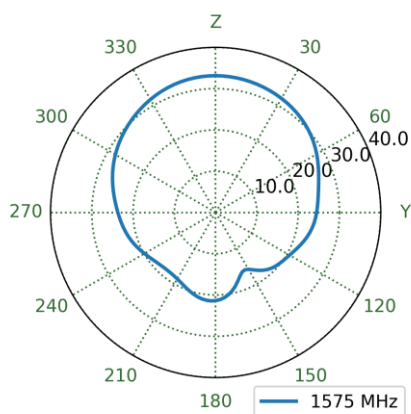
7.11 GNSS Free Space Patterns at 1575 MHz



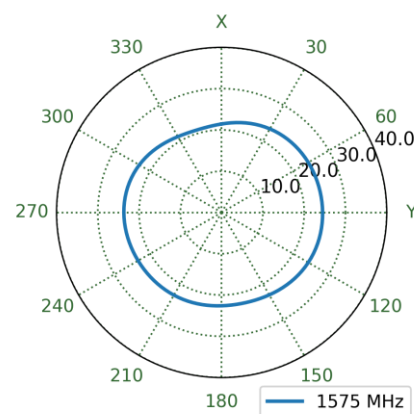
XZ Plane



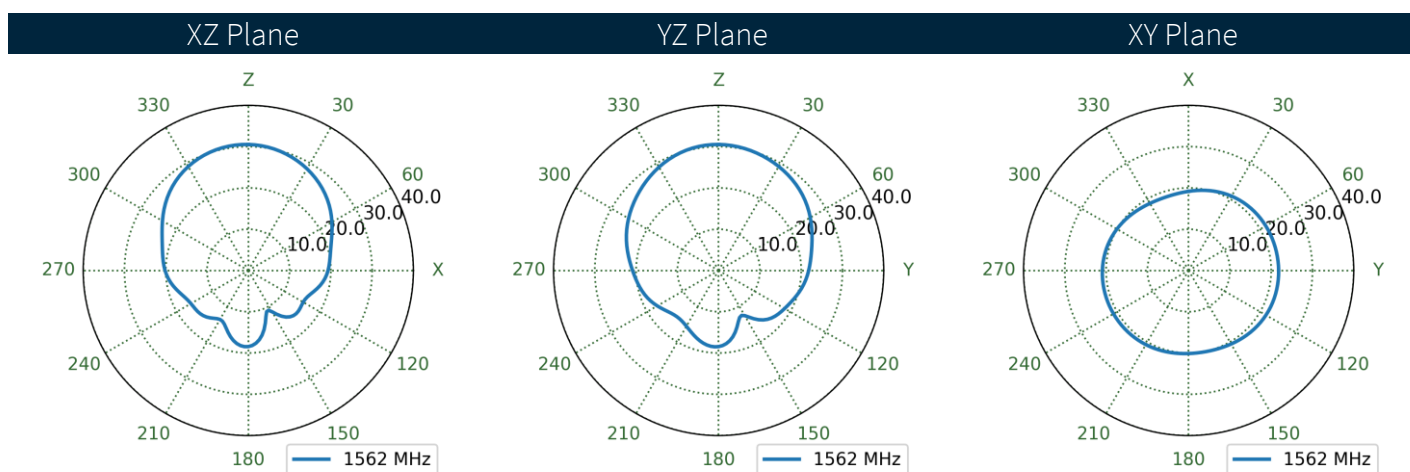
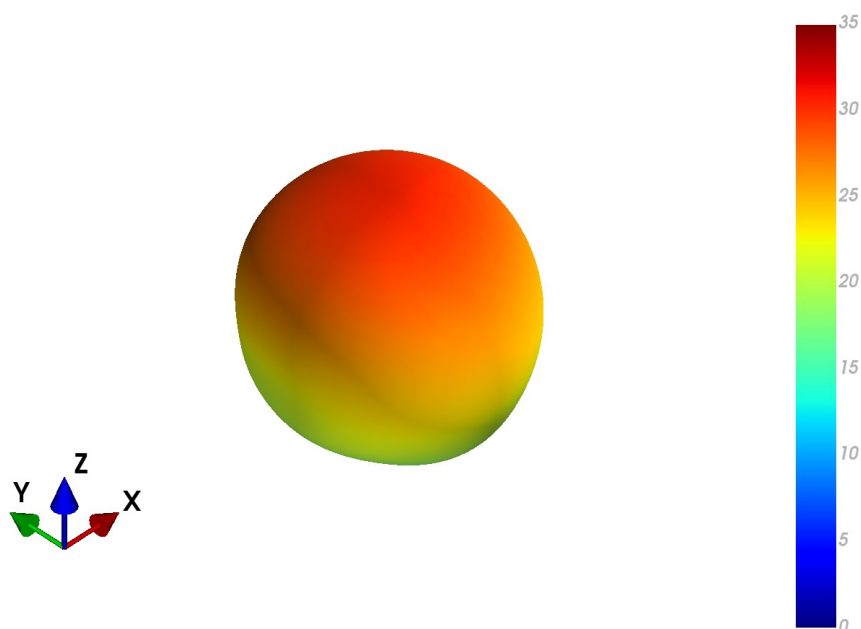
YZ Plane



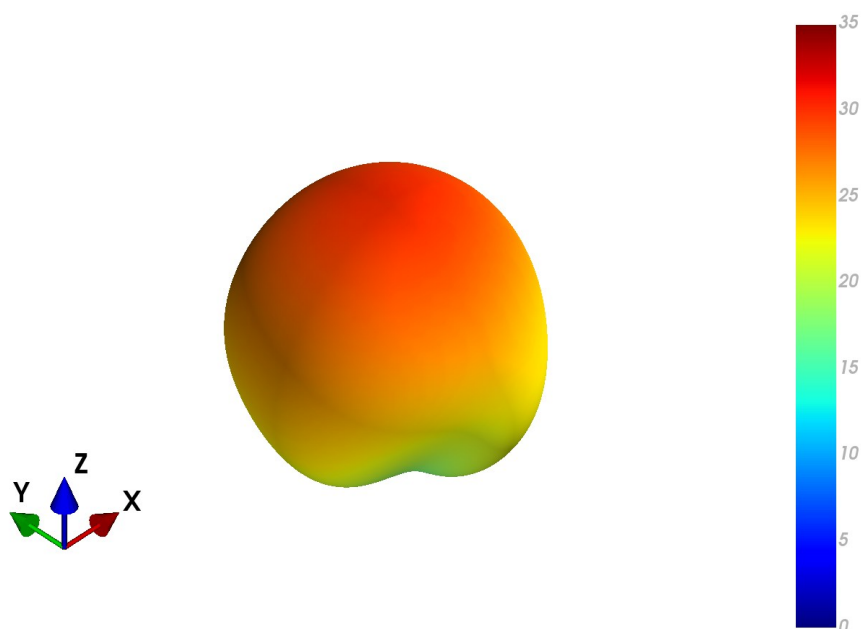
XY Plane



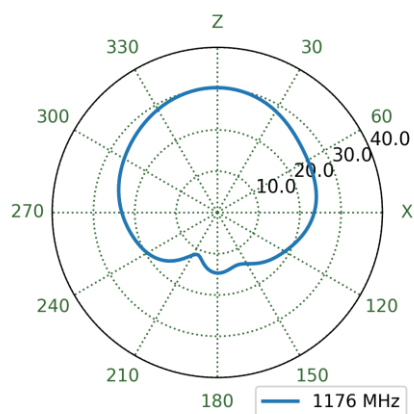
7.12 GNSS Free Space Patterns at 1562 MHz



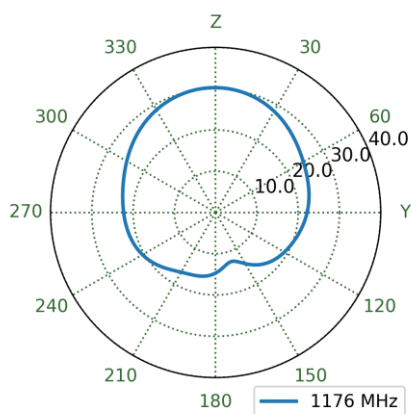
7.13 GNSS Free Space Patterns at 1176 MHz



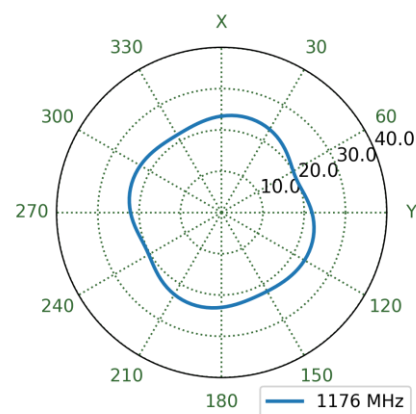
XZ Plane



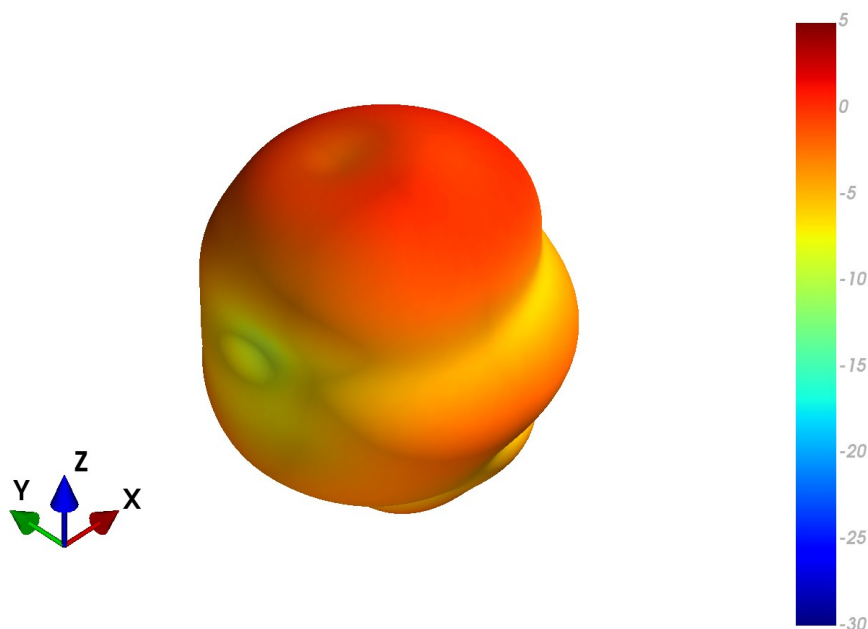
YZ Plane



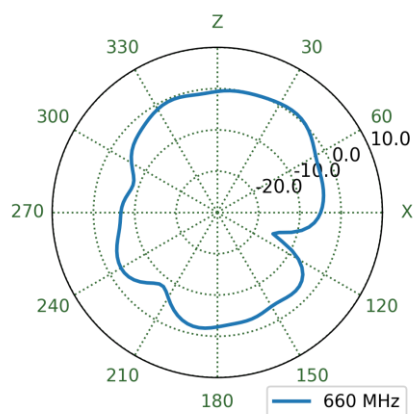
XY Plane



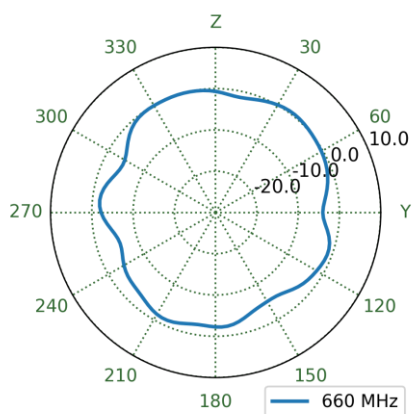
7.14 MIMO1 Cellular Free Space Patterns at 660 MHz



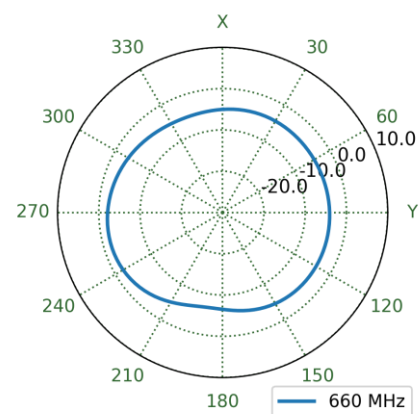
XZ Plane



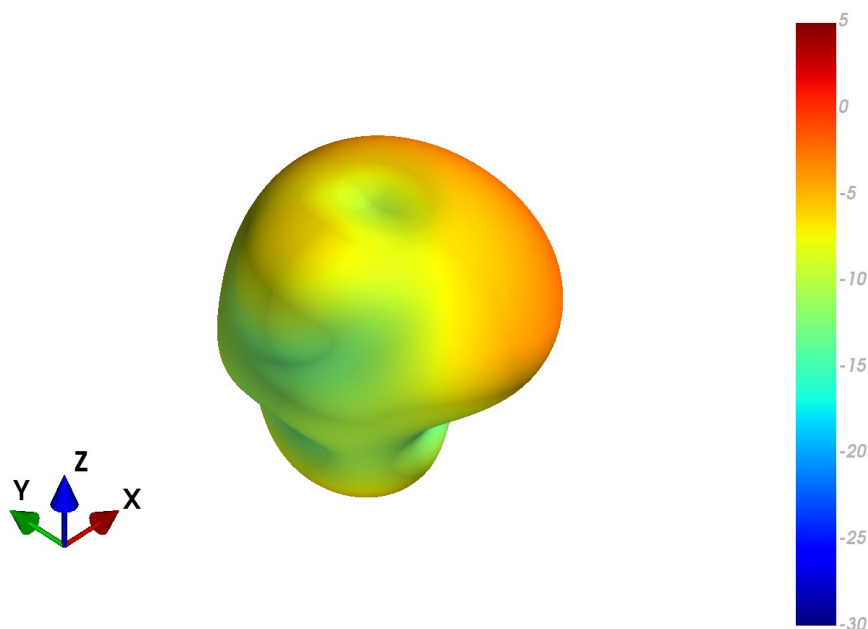
YZ Plane



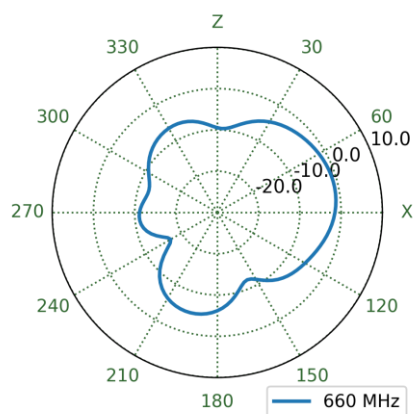
XY Plane



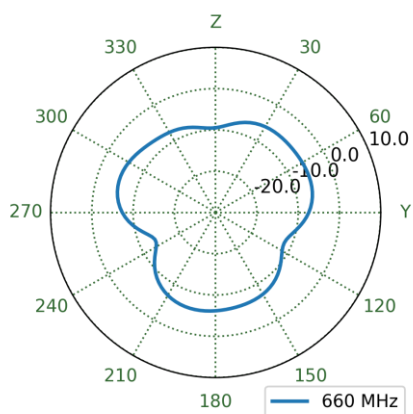
7.15 MIMO1 Cellular Ground Plane Patterns at 660 MHz



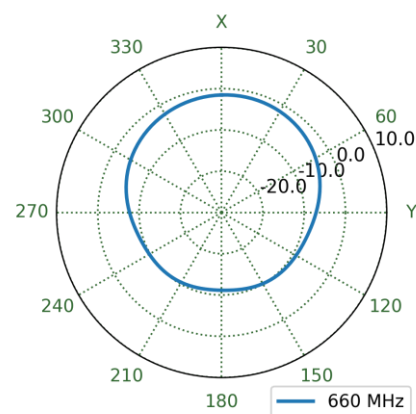
XZ Plane



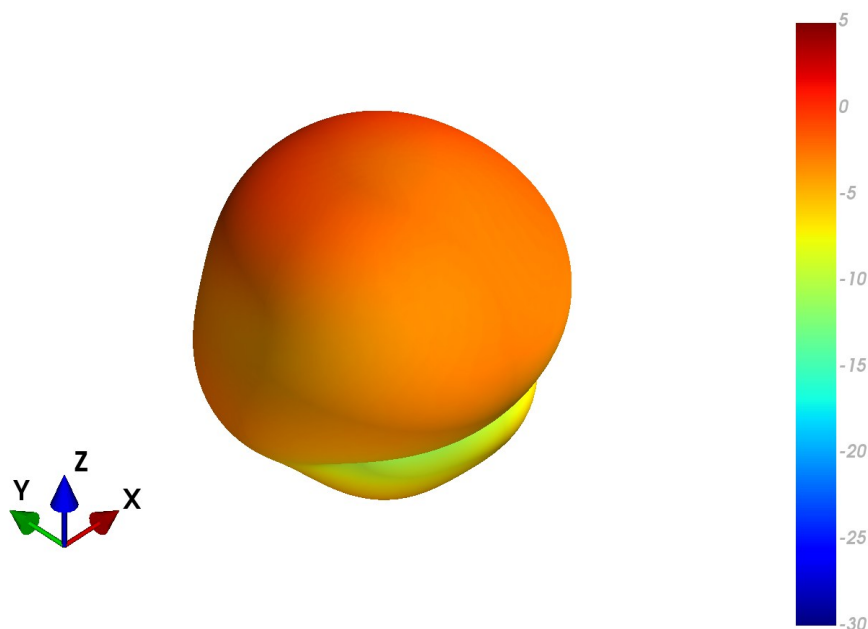
YZ Plane



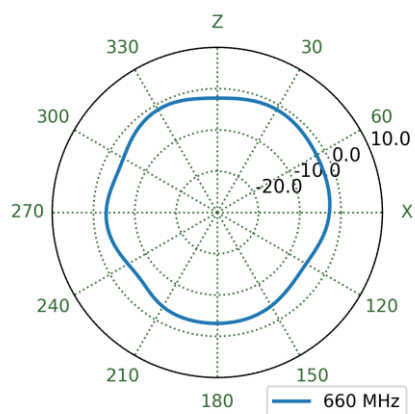
XY Plane



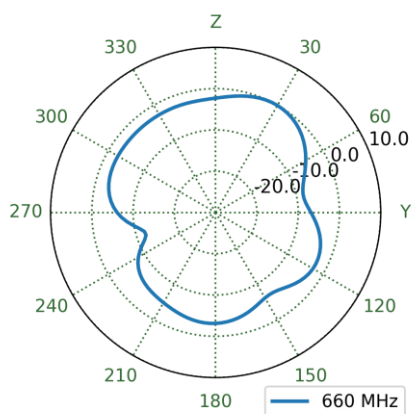
7.16 MIMO2 Cellular Free Space Patterns at 660 MHz



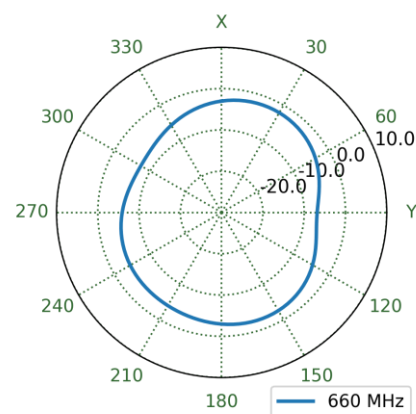
XZ Plane



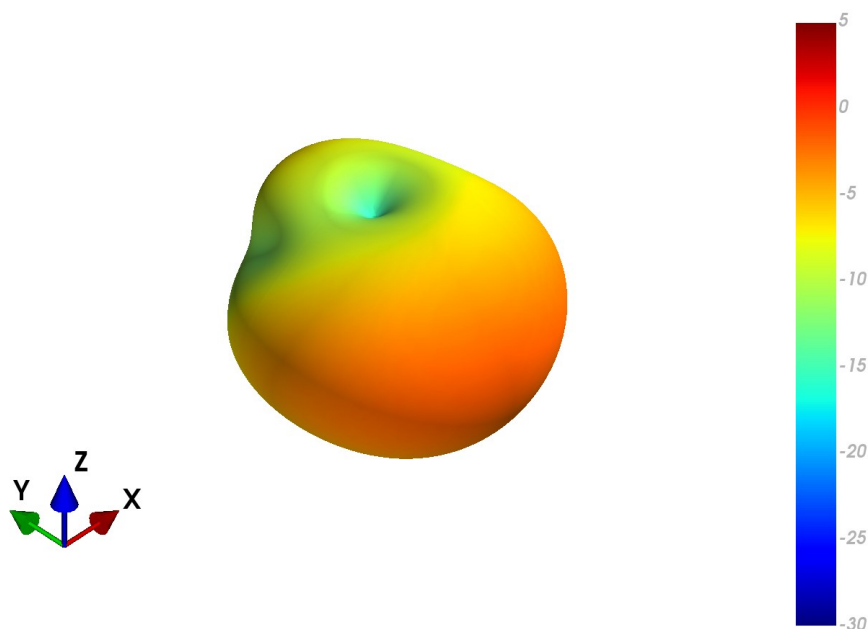
YZ Plane



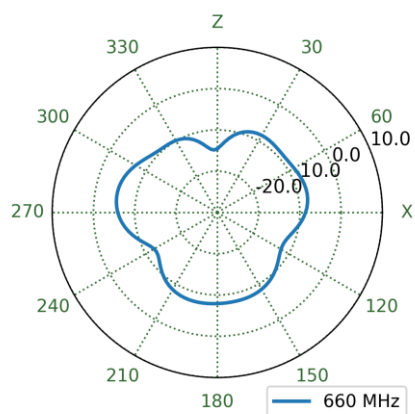
XY Plane



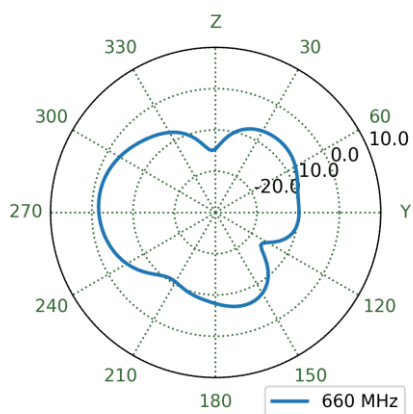
7.17 MIMO2 Cellular Ground Plane Patterns at 660 MHz



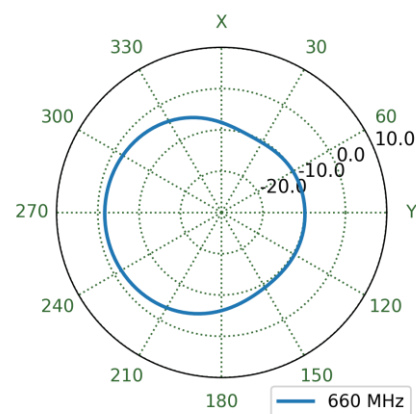
XZ Plane



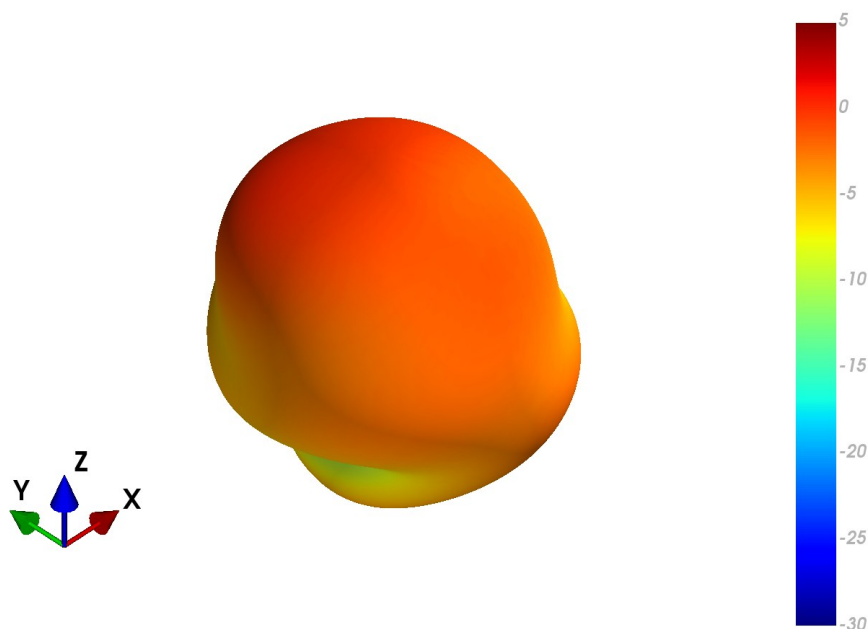
YZ Plane



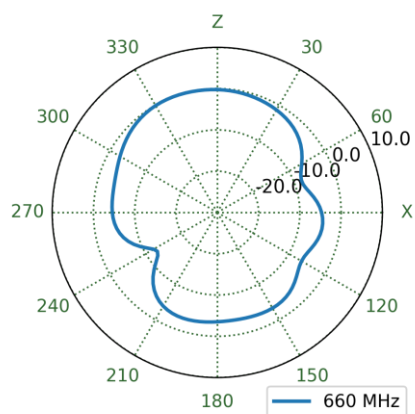
XY Plane



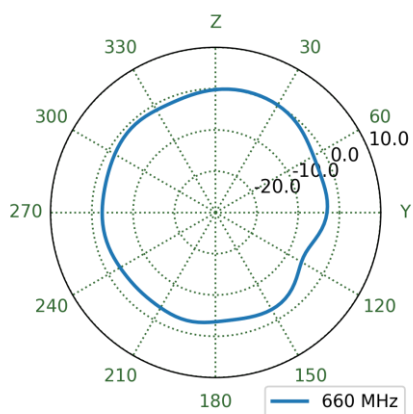
7.18 MIMO3 Cellular Free Space Patterns at 660 MHz



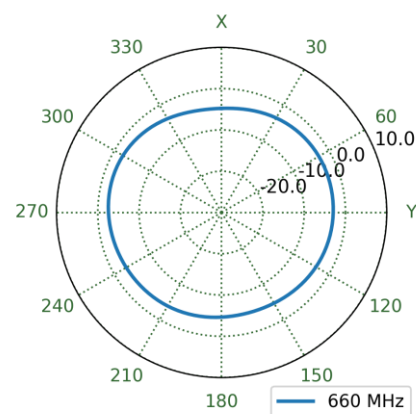
XZ Plane



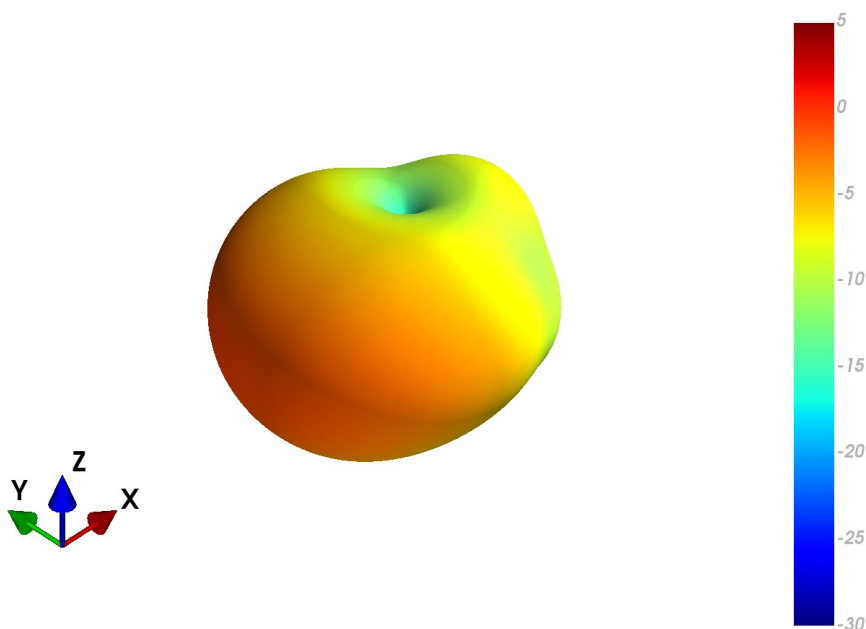
YZ Plane



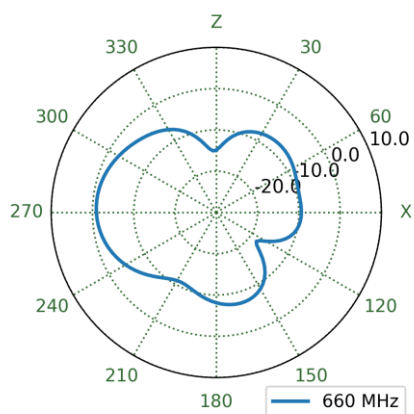
XY Plane



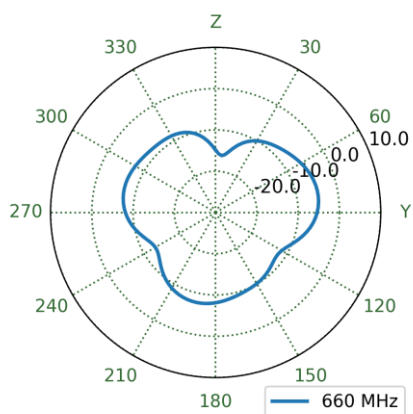
7.19 MIMO3 Cellular Ground Plane Patterns at 660 MHz



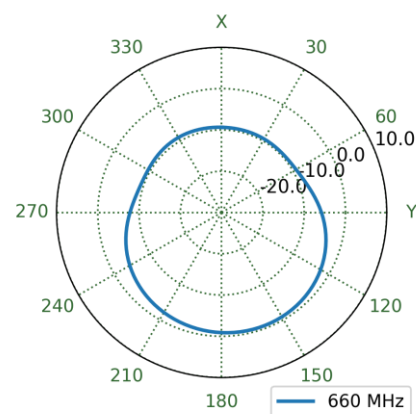
XZ Plane



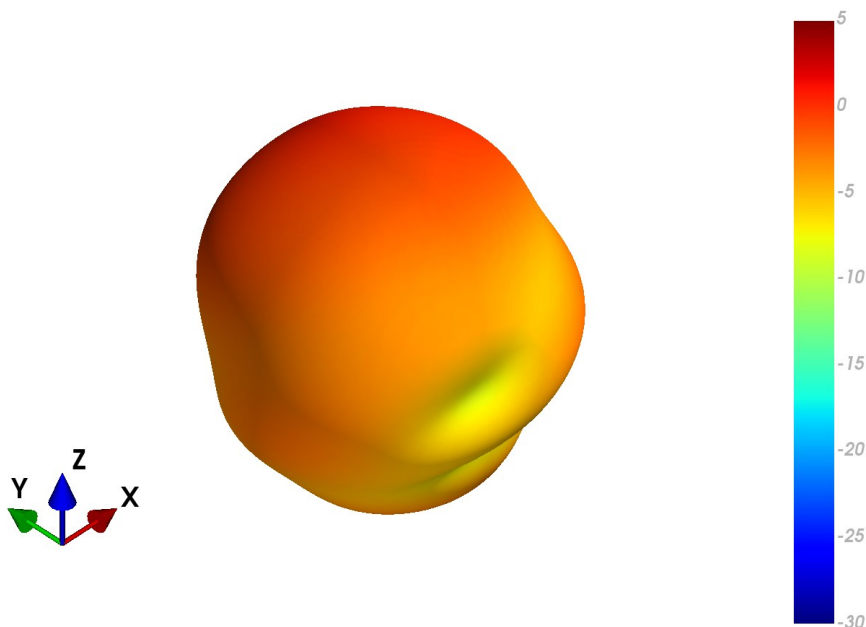
YZ Plane



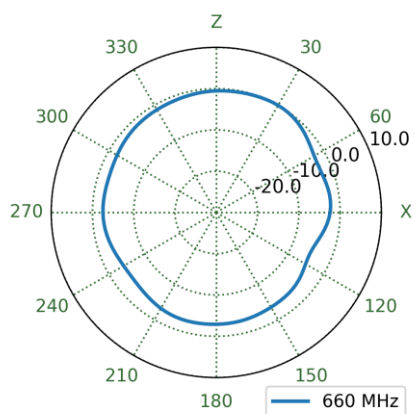
XY Plane



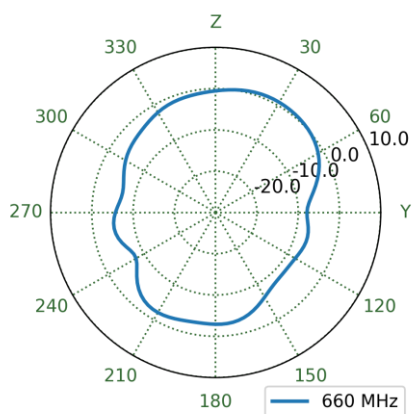
7.20 MIMO4 Cellular Free Space Patterns at 660 MHz



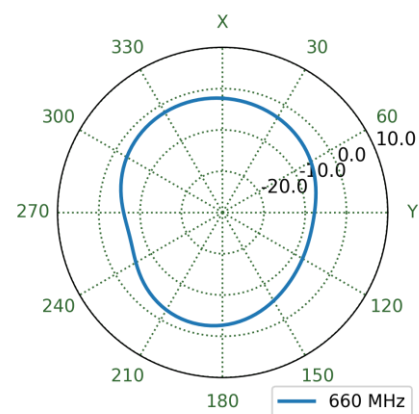
XZ Plane



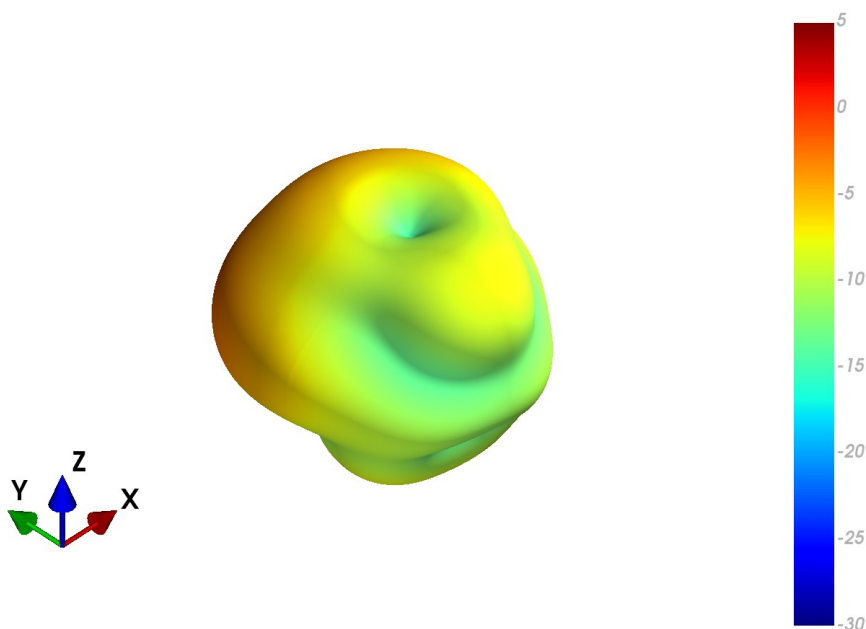
YZ Plane



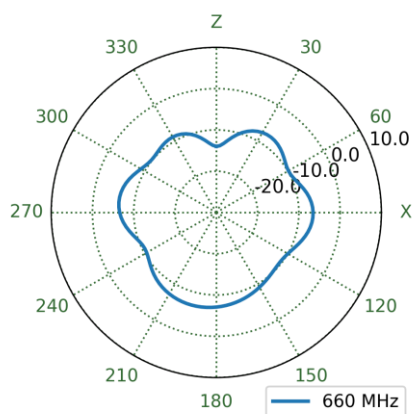
XY Plane



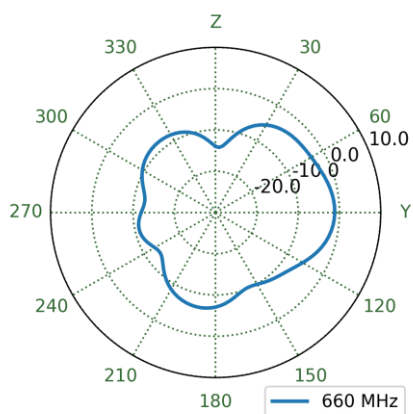
7.21 MIMO4 Cellular Ground Plane Patterns at 660 MHz



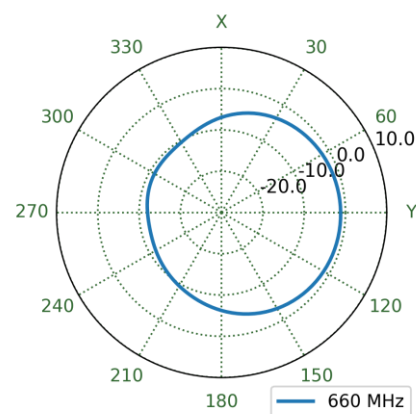
XZ Plane



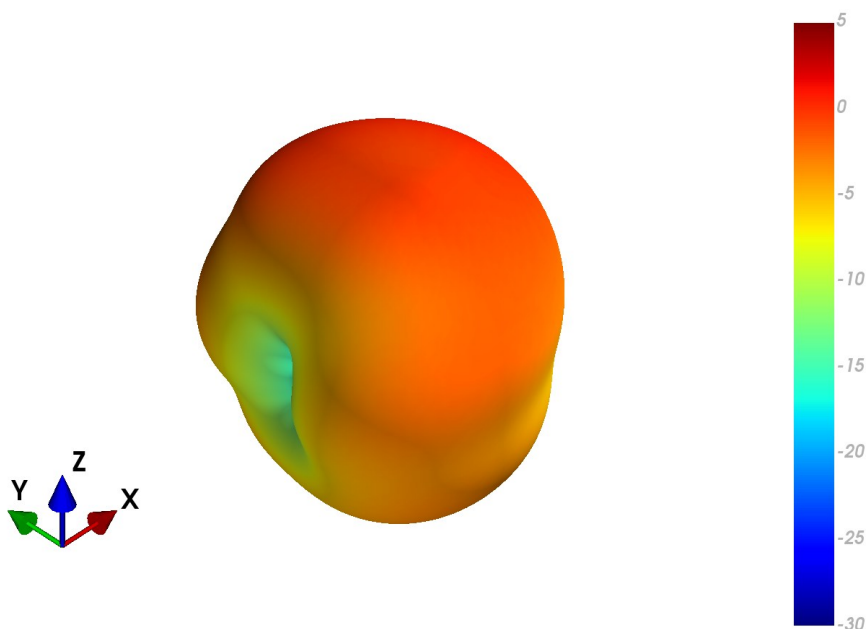
YZ Plane



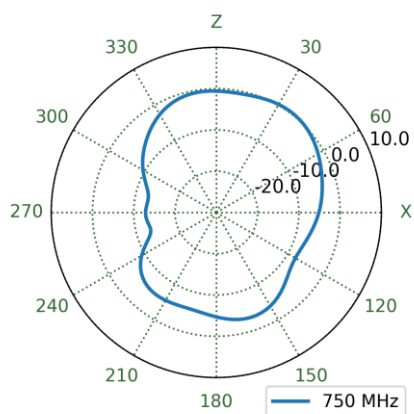
XY Plane



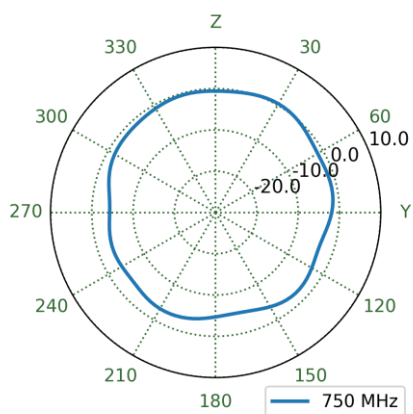
7.22 MIMO1 Cellular Free Space Patterns at 750 MHz



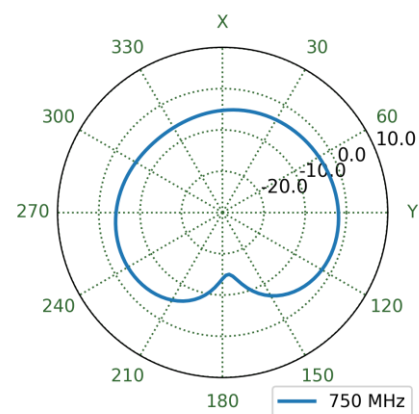
XZ Plane



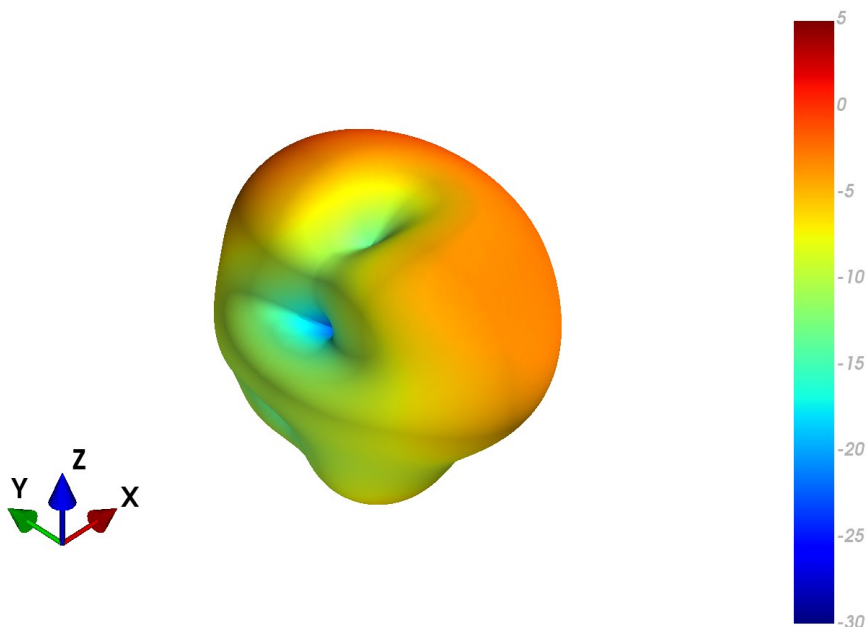
YZ Plane



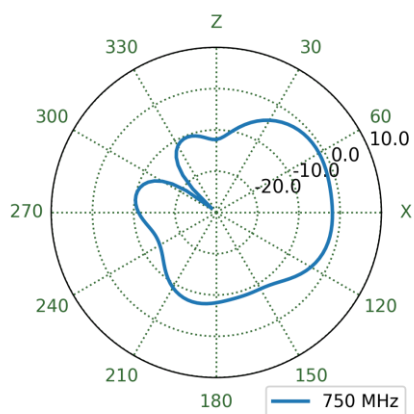
XY Plane



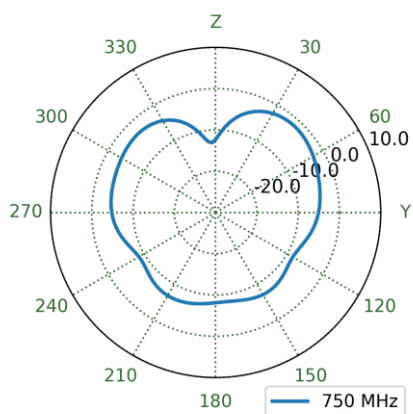
7.23 MIMO1 Cellular Ground Plane Patterns at 750 MHz



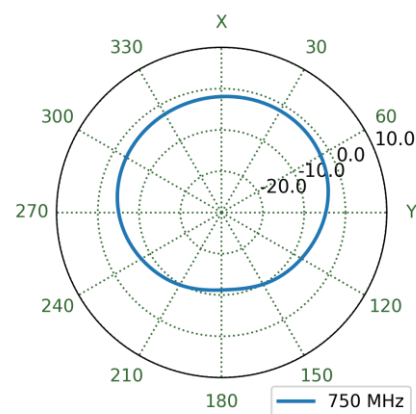
XZ Plane



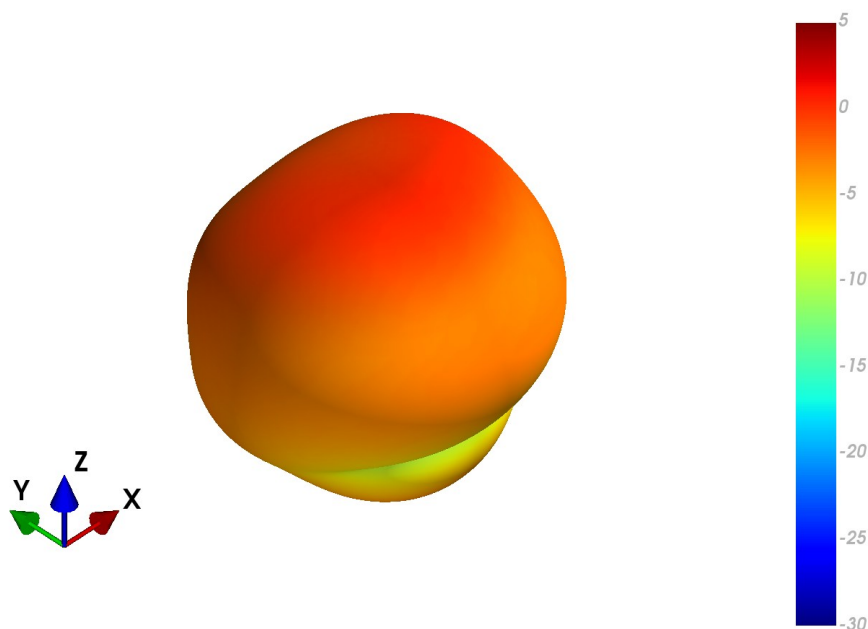
YZ Plane



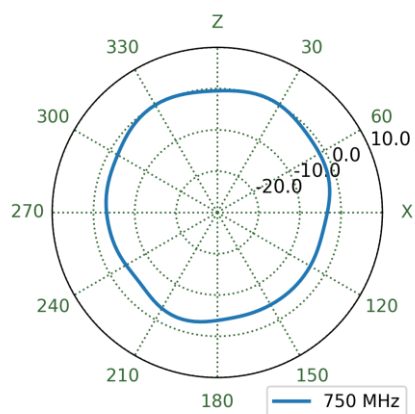
XY Plane



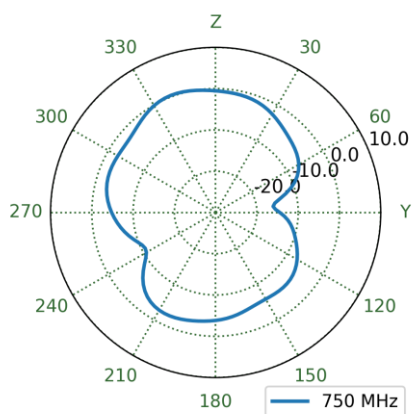
7.24 MIMO2 Cellular Free Space Patterns at 750 MHz



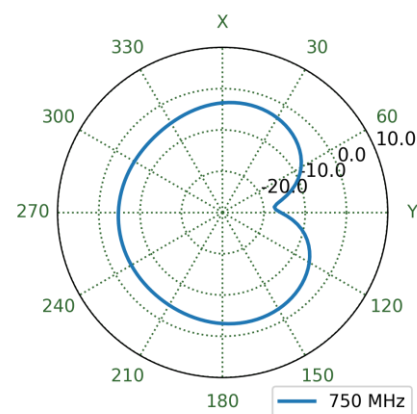
XZ Plane



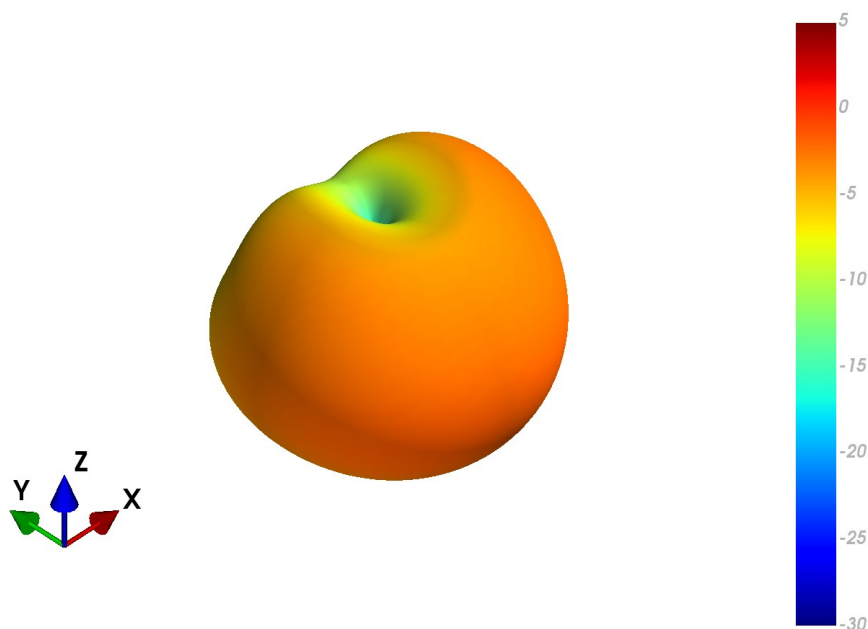
YZ Plane



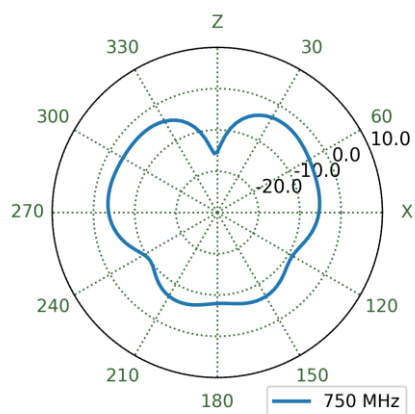
XY Plane



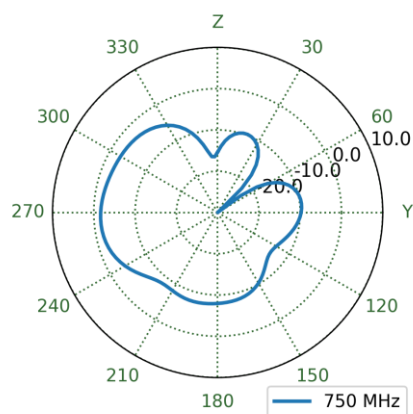
7.25 MIMO2 Cellular Ground Plane Patterns at 750 MHz



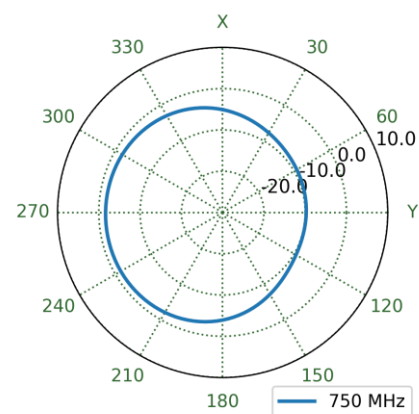
XZ Plane



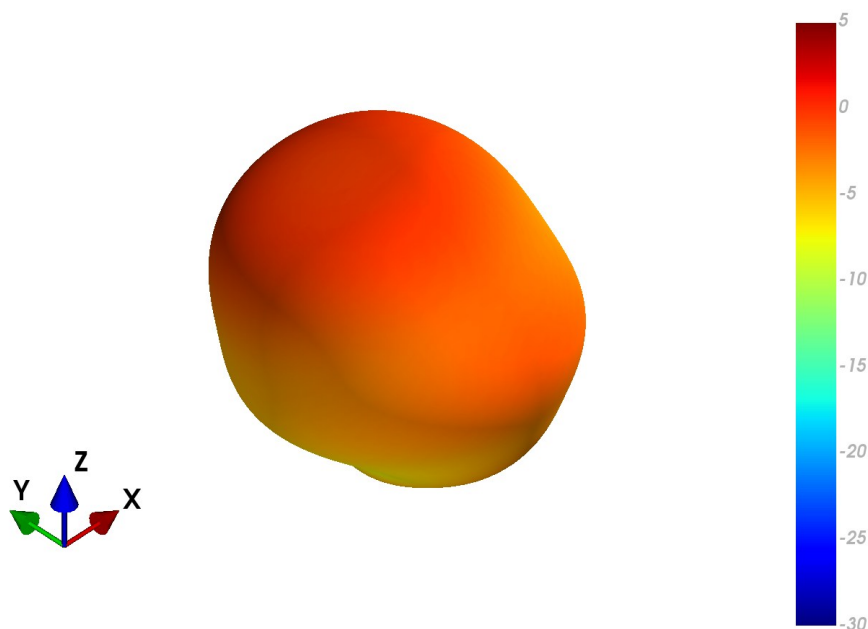
YZ Plane



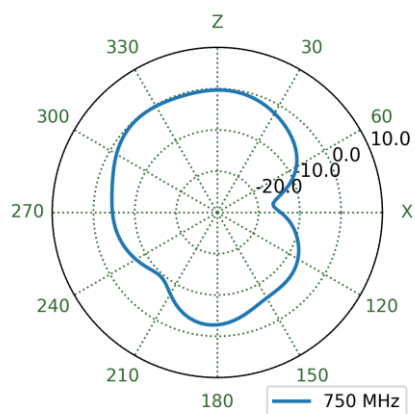
XY Plane



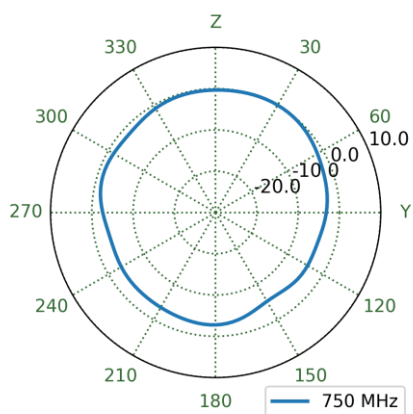
7.26 MIMO3 Cellular Free Space Patterns at 750 MHz



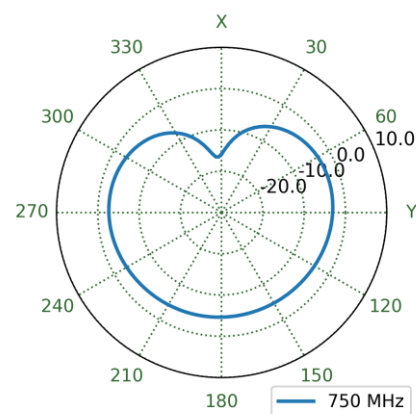
XZ Plane



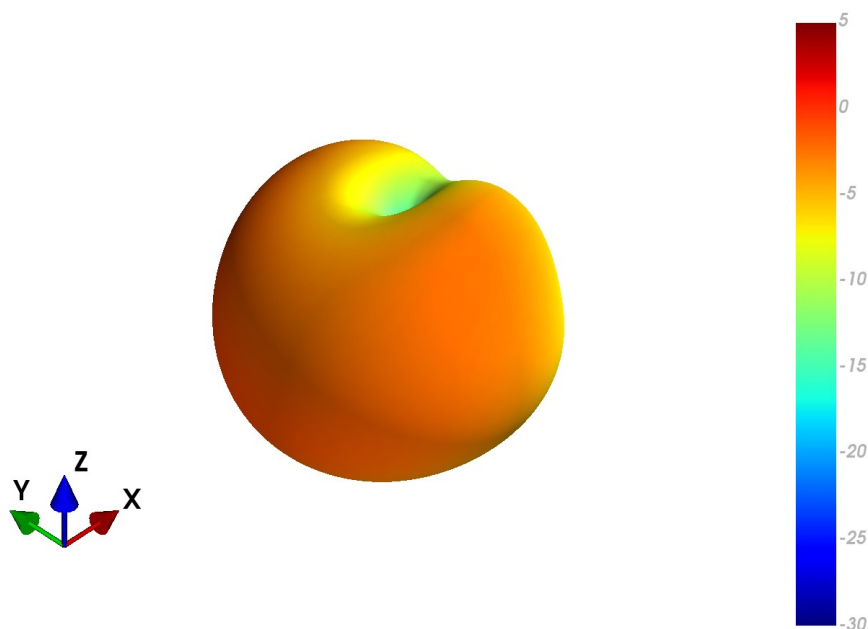
YZ Plane



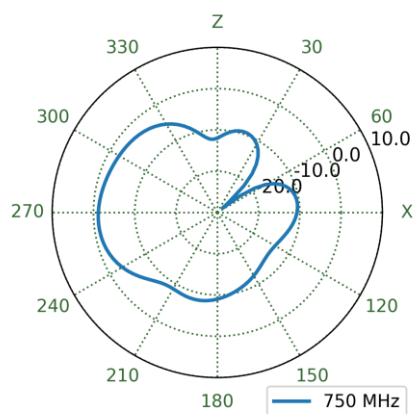
XY Plane



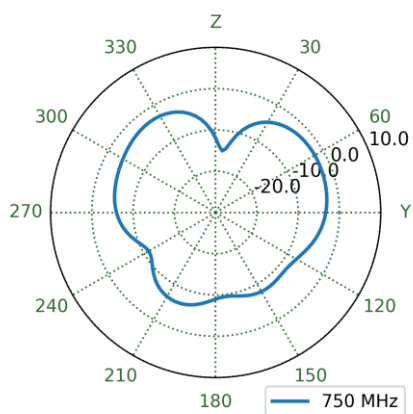
7.27 MIMO3 Cellular Ground Plane Patterns at 750 MHz



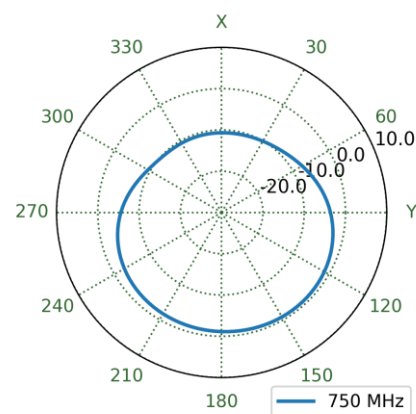
XZ Plane



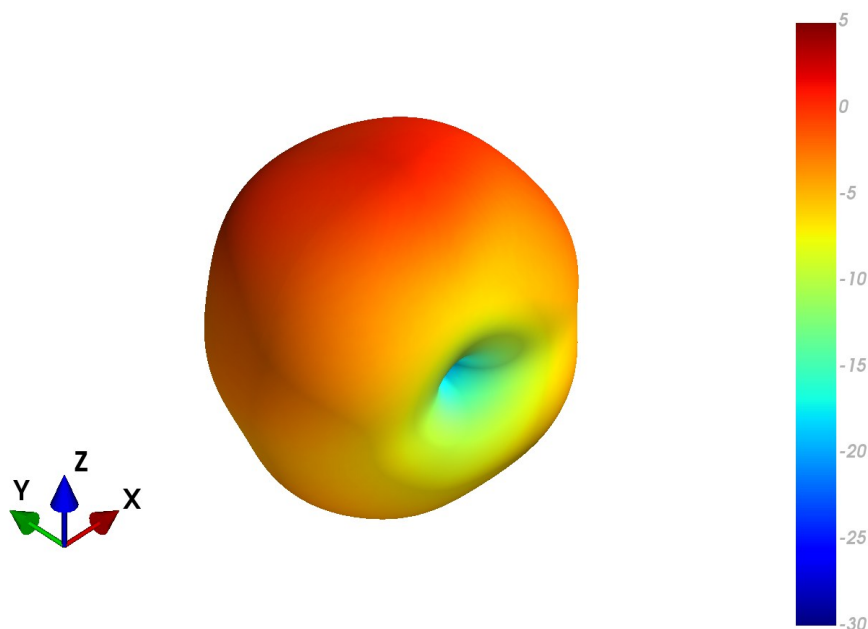
YZ Plane



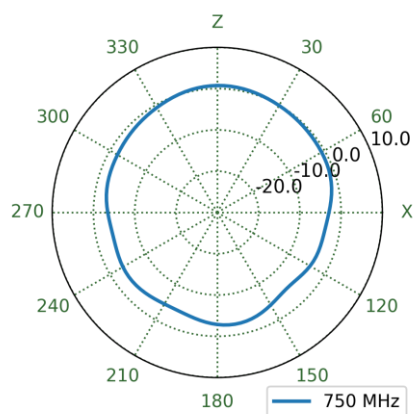
XY Plane



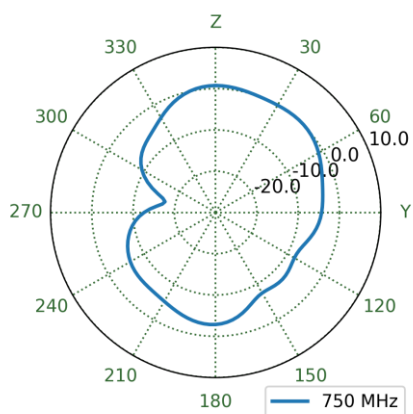
7.28 MIMO4 Cellular Free Space Patterns at 750 MHz



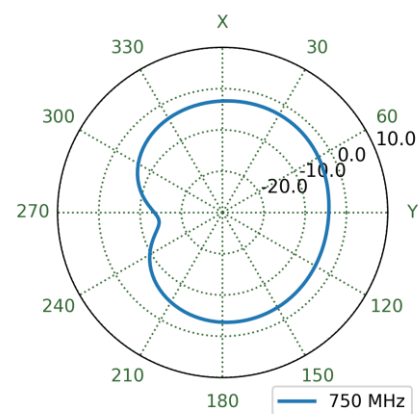
XZ Plane



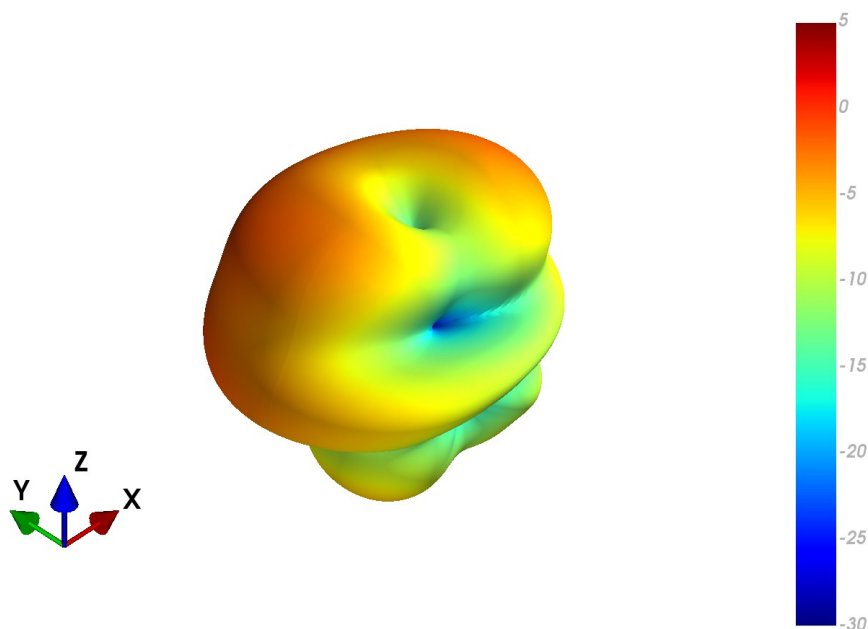
YZ Plane



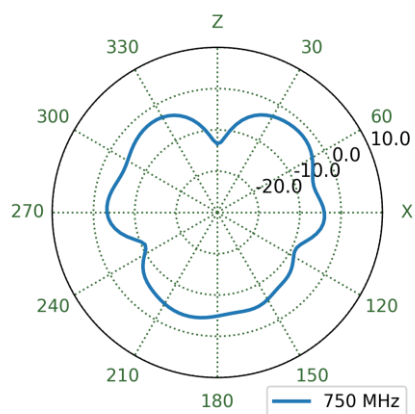
XY Plane



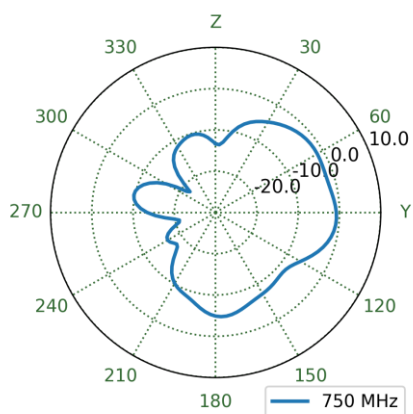
7.29 MIMO4 Cellular Ground Plane Patterns at 750 MHz



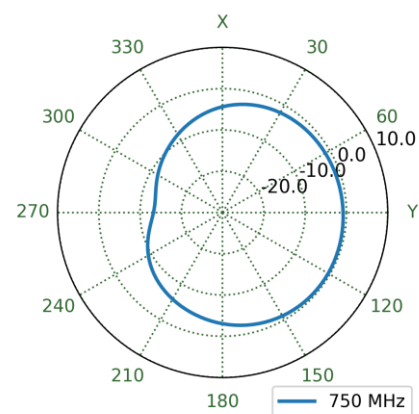
XZ Plane



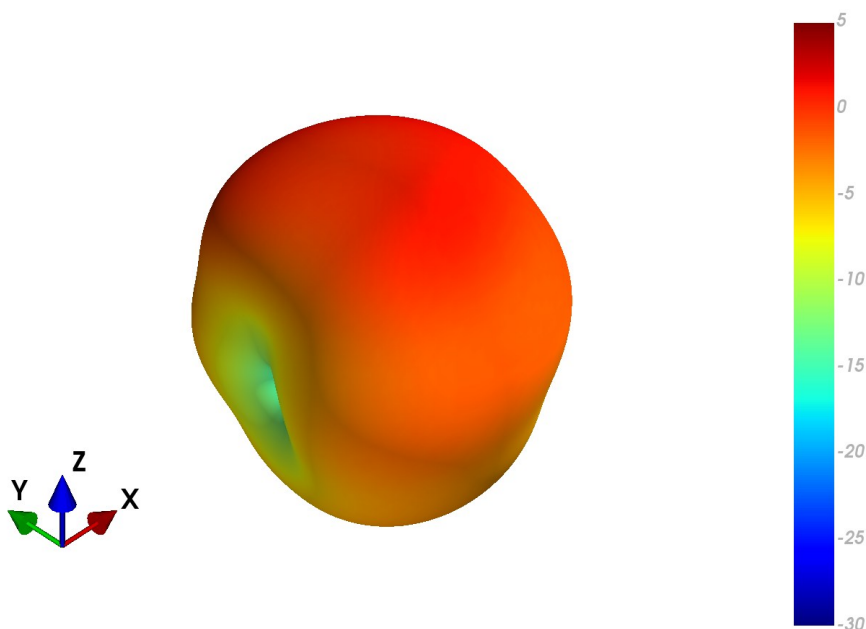
YZ Plane



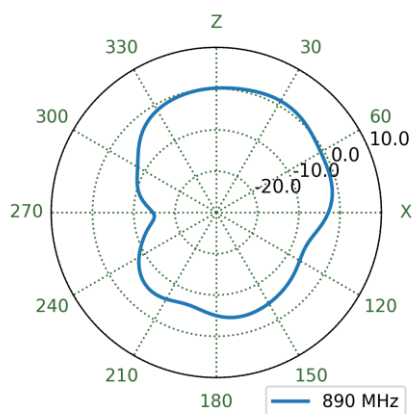
XY Plane



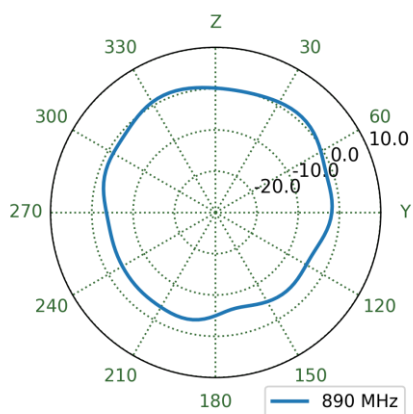
7.30 MIMO1 Cellular Free Space Patterns at 890 MHz



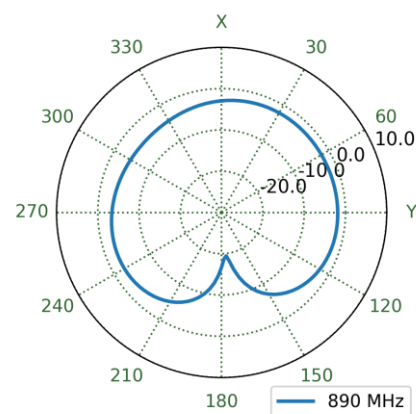
XZ Plane



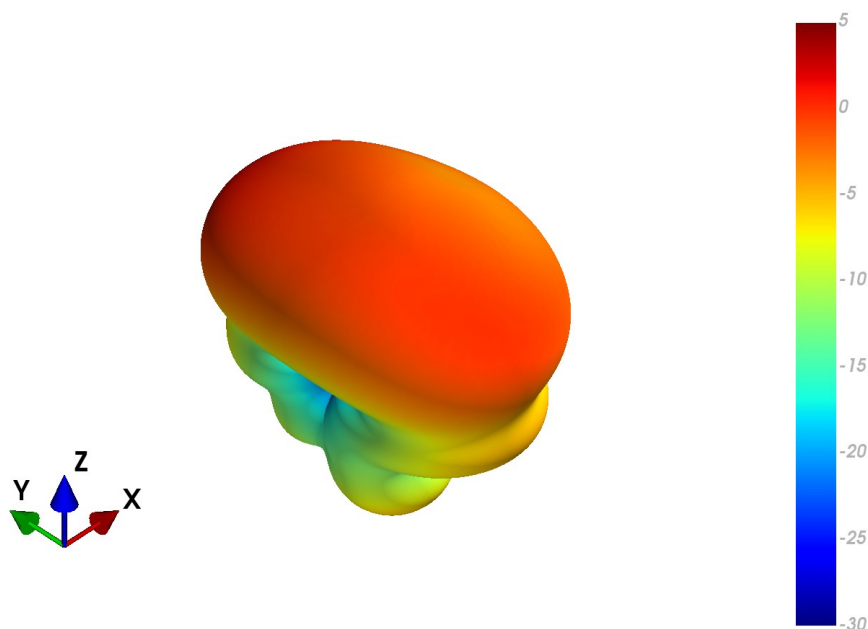
YZ Plane



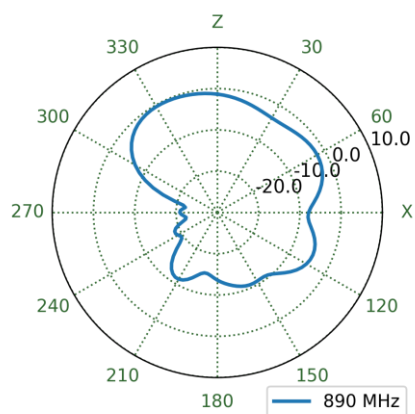
XY Plane



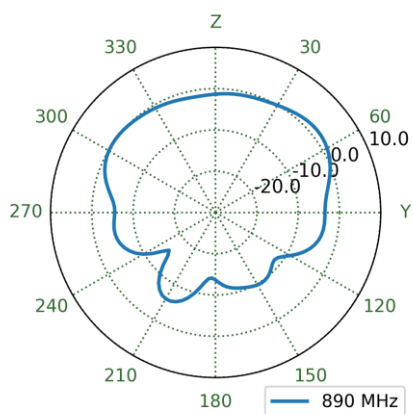
7.31 MIMO1 Cellular Ground Plane Patterns at 890 MHz



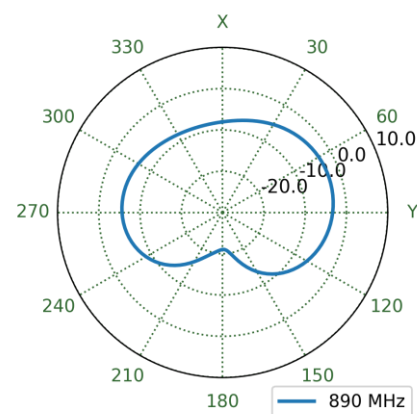
XZ Plane



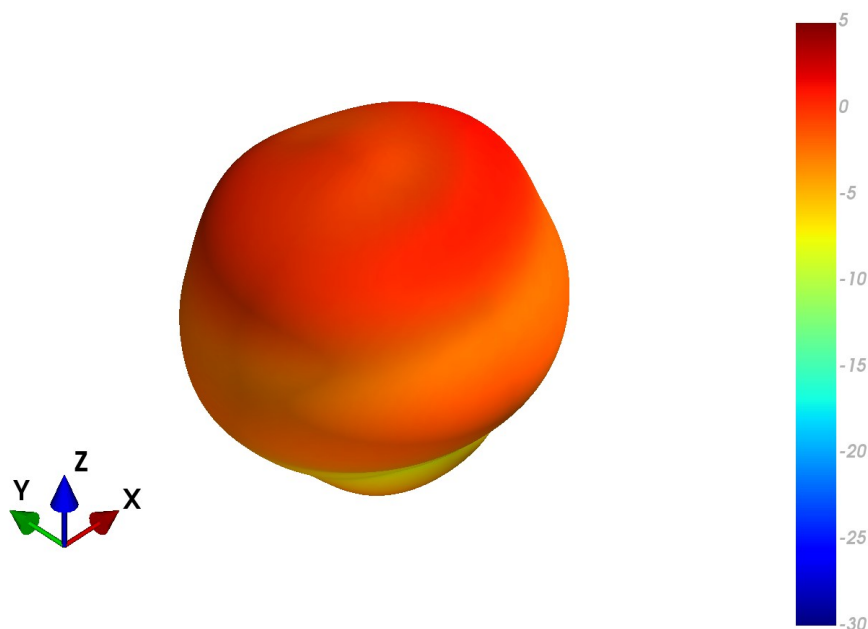
YZ Plane



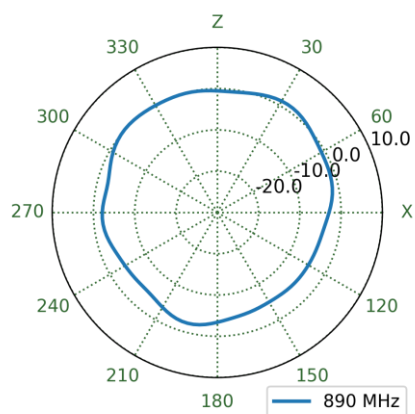
XY Plane



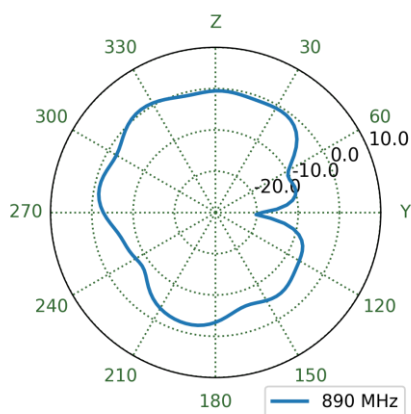
7.32 MIMO2 Cellular Free Space Patterns at 890 MHz



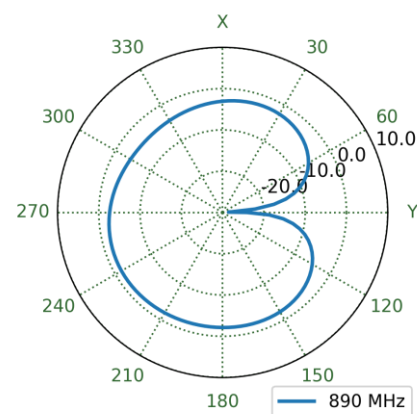
XZ Plane



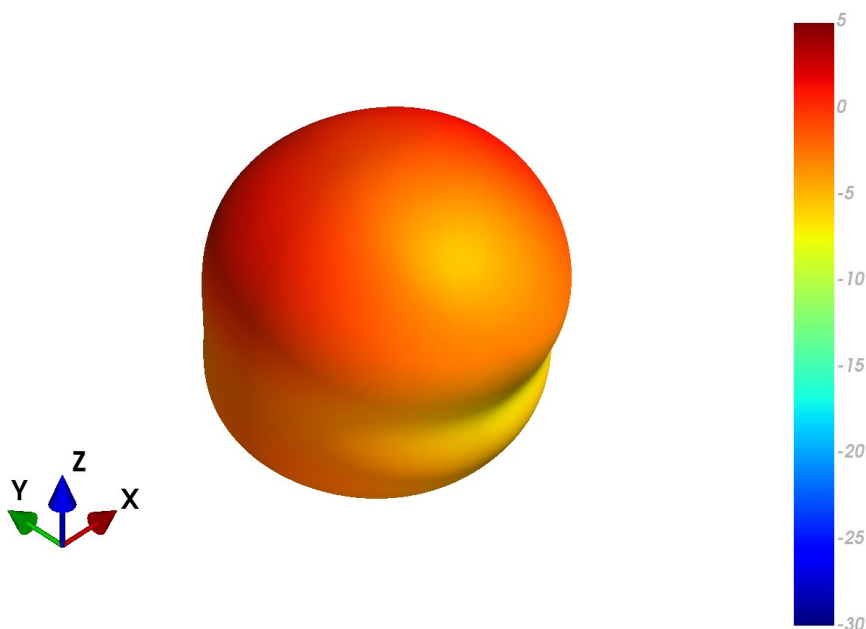
YZ Plane



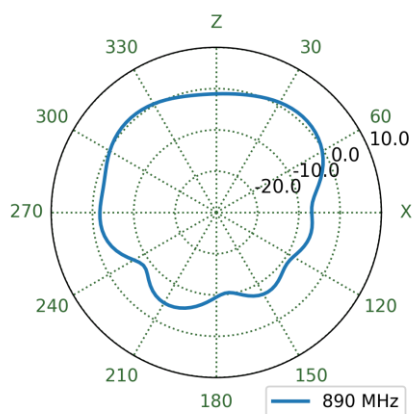
XY Plane



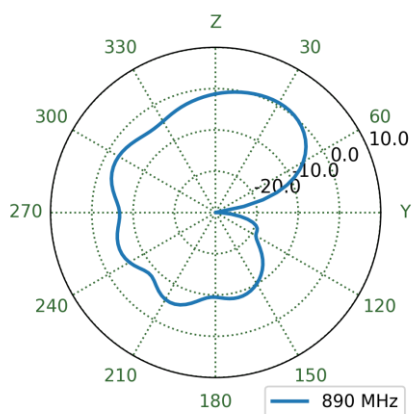
7.33 MIMO2 Cellular Ground Plane Patterns at 890 MHz



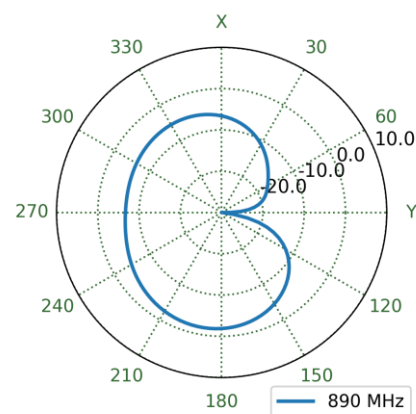
XZ Plane



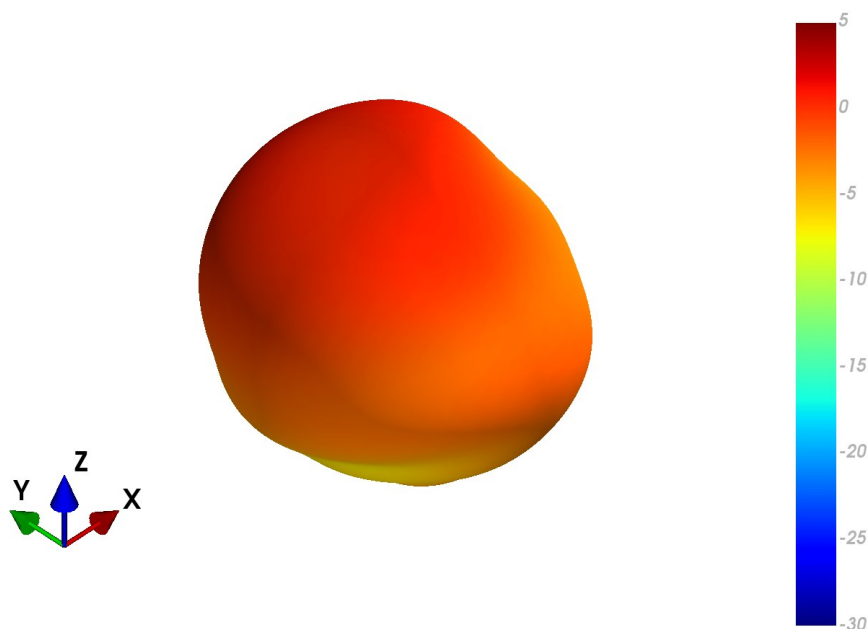
YZ Plane



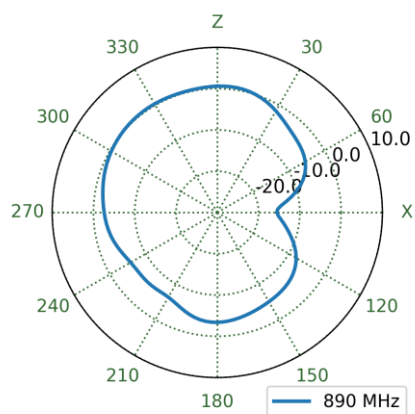
XY Plane



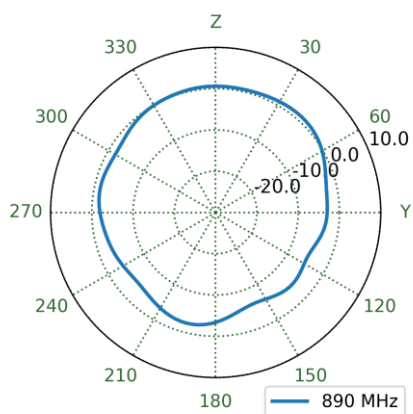
7.34 MIMO3 Cellular Free Space Patterns at 890 MHz



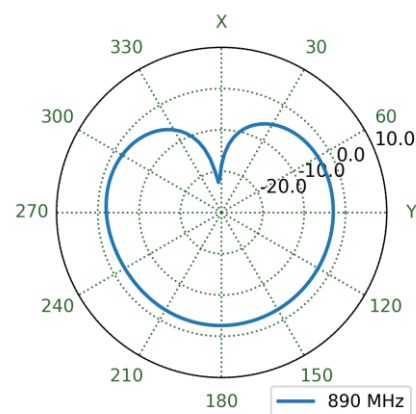
XZ Plane



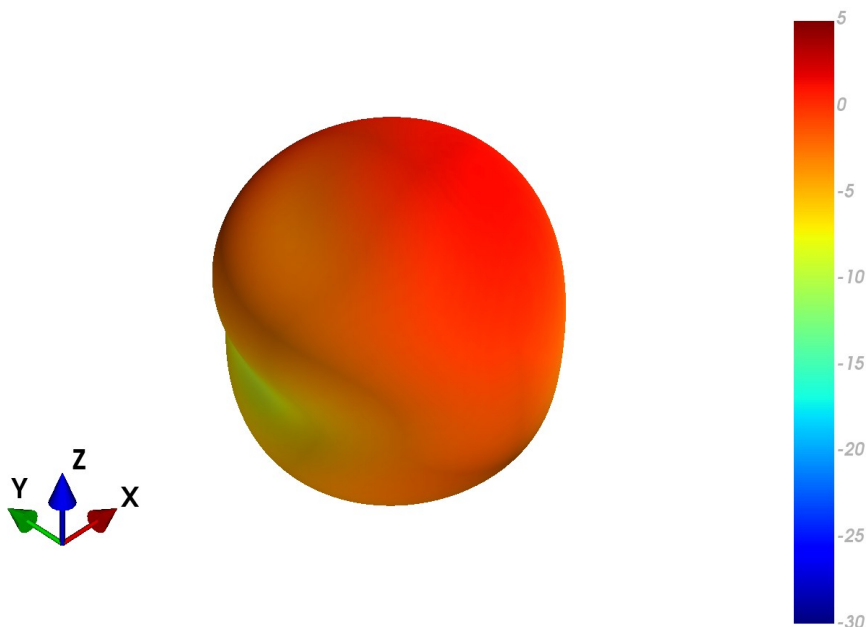
YZ Plane



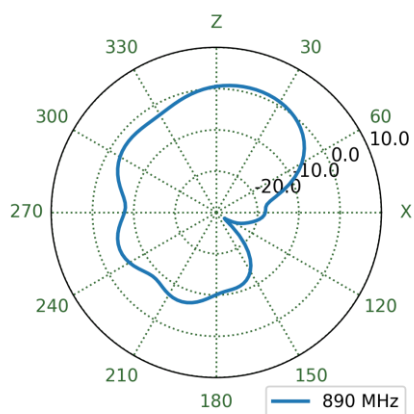
XY Plane



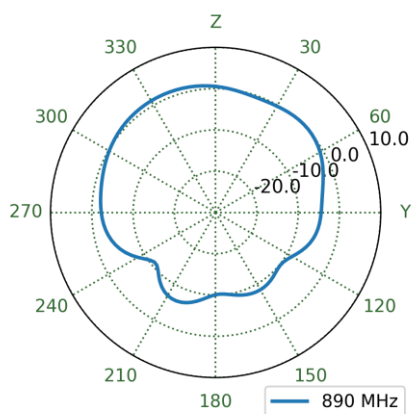
7.35 MIMO3 Cellular Ground Plane Patterns at 890 MHz



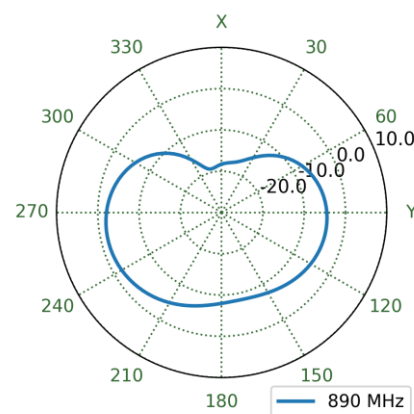
XZ Plane



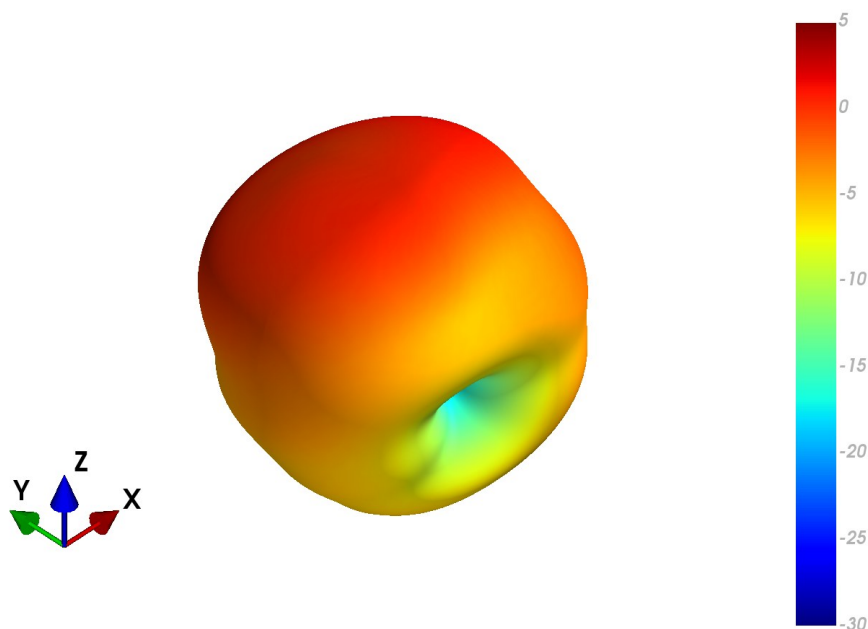
YZ Plane



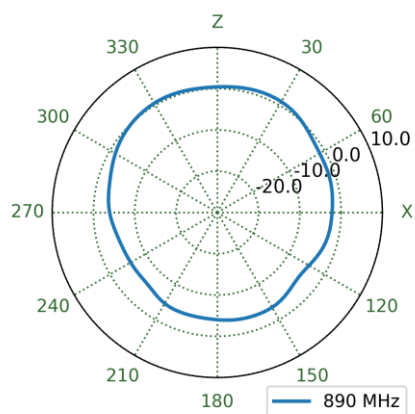
XY Plane



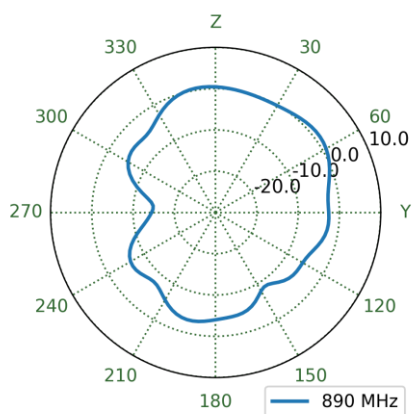
7.36 MIMO4 Cellular Free Space Patterns at 890 MHz



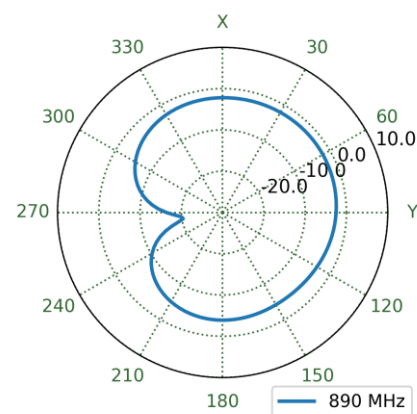
XZ Plane



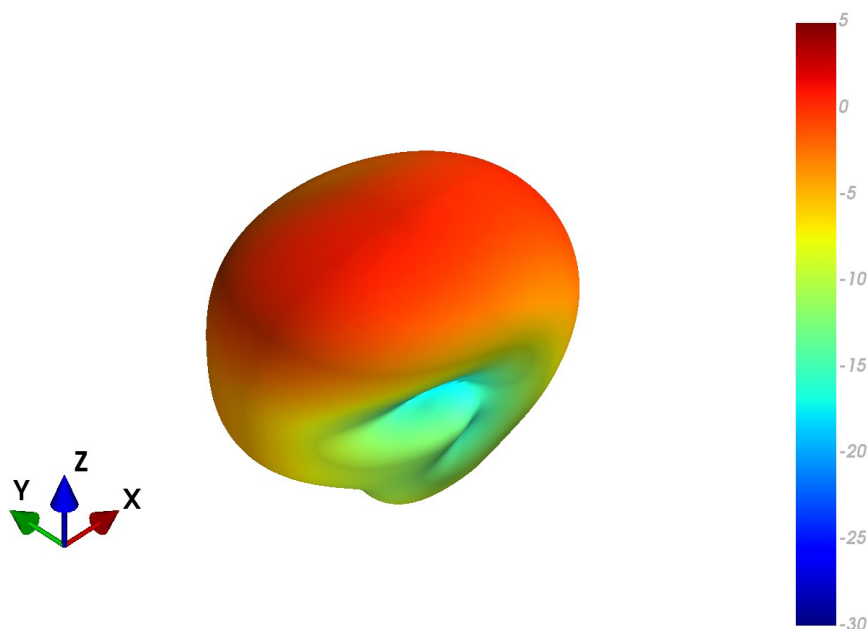
YZ Plane



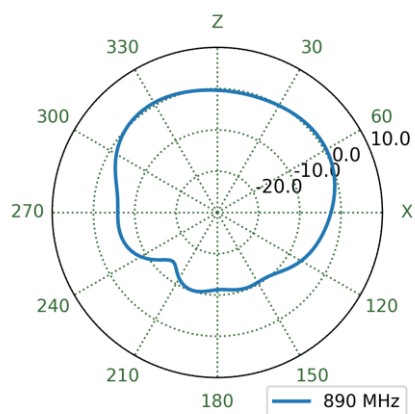
XY Plane



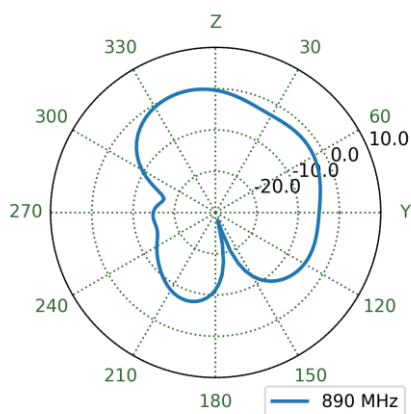
7.37 MIMO4 Cellular Ground Plane Patterns at 890 MHz



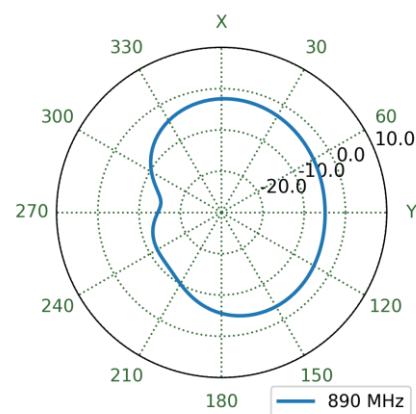
XZ Plane



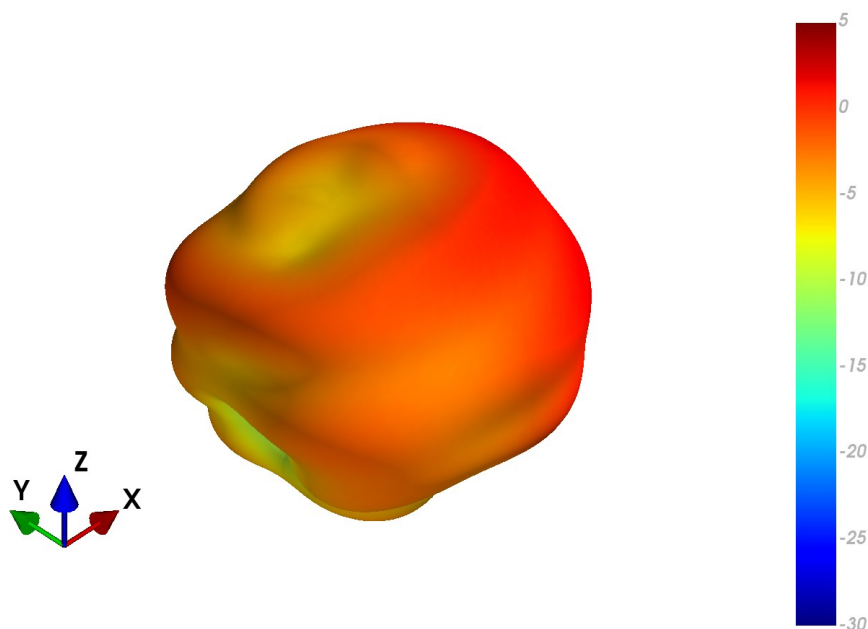
YZ Plane



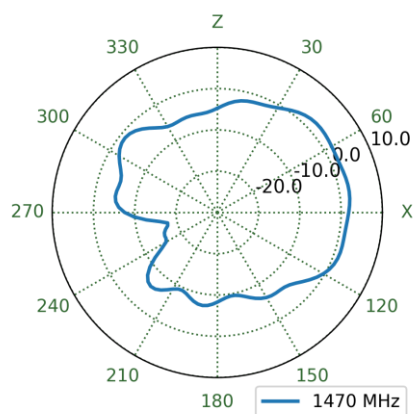
XY Plane



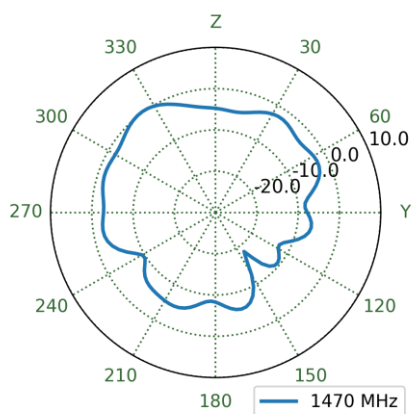
7.38 MIMO1 Cellular Free Space Patterns at 1470 MHz



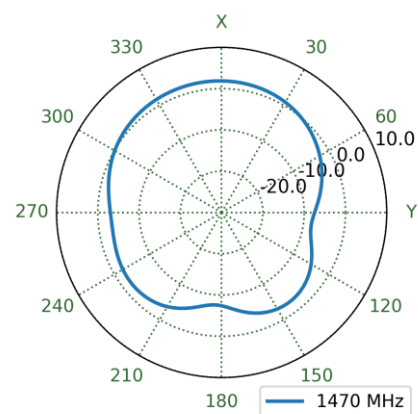
XZ Plane



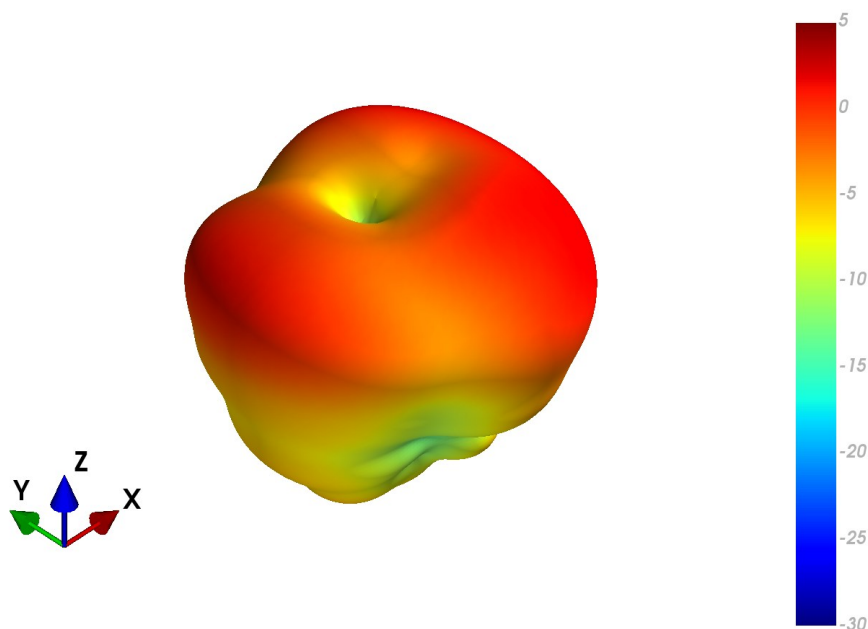
YZ Plane



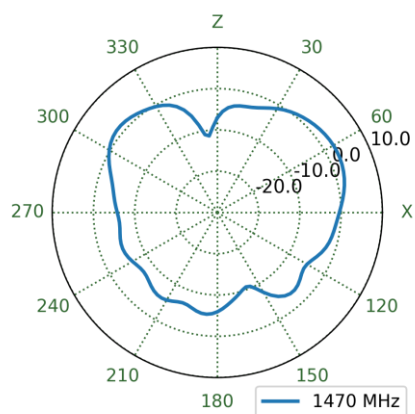
XY Plane



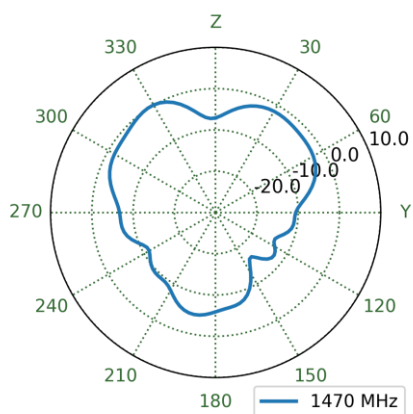
7.39 MIMO1 Cellular Ground Plane Patterns at 1470 MHz



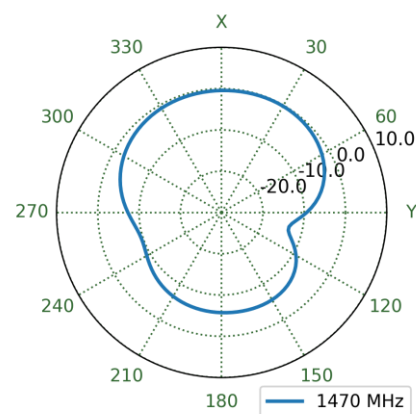
XZ Plane



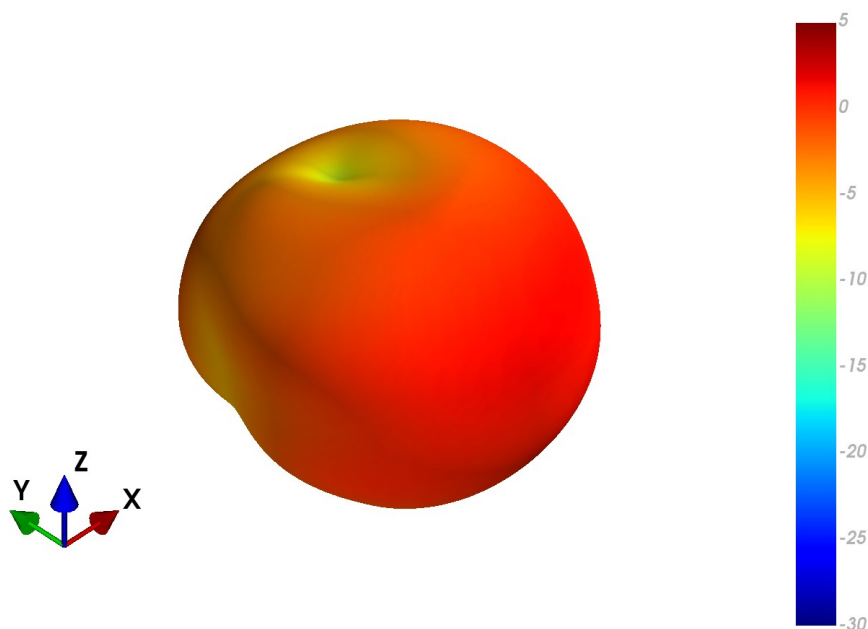
YZ Plane



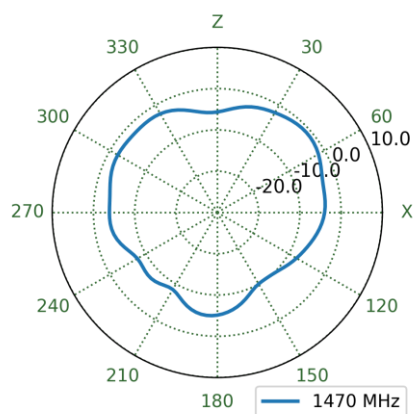
XY Plane



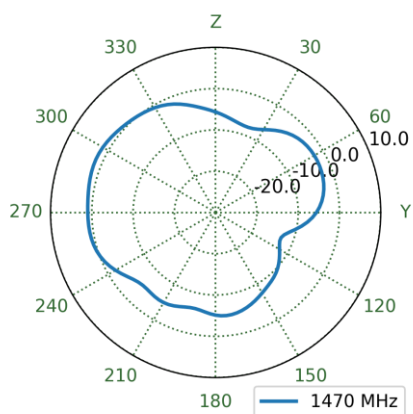
7.40 MIMO2 Cellular Free Space Patterns at 1470 MHz



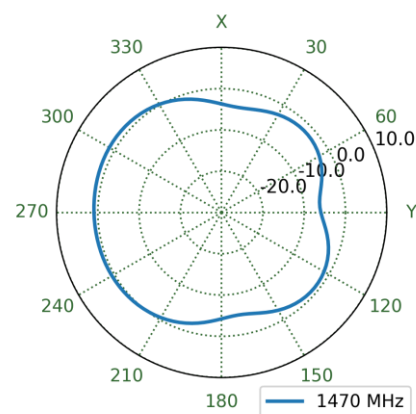
XZ Plane



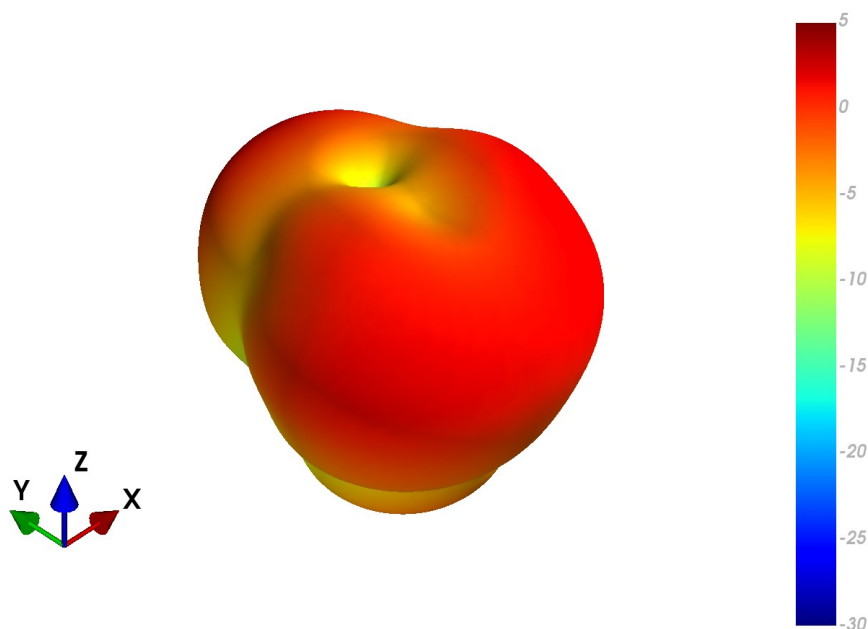
YZ Plane



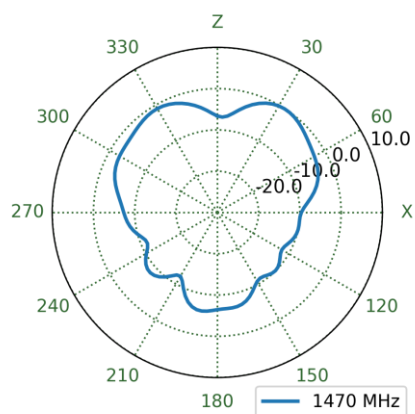
XY Plane



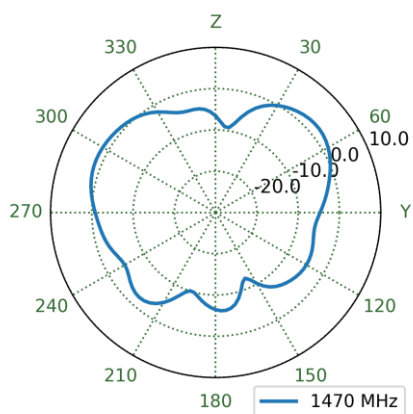
7.41 MIMO2 Cellular Ground Plane Patterns at 1470 MHz



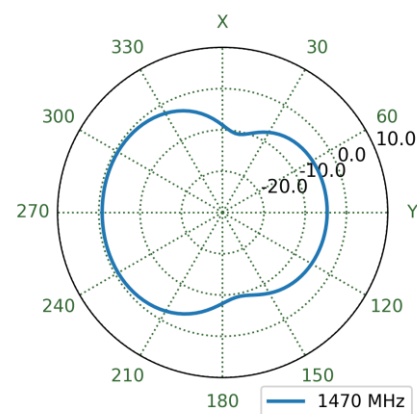
XZ Plane



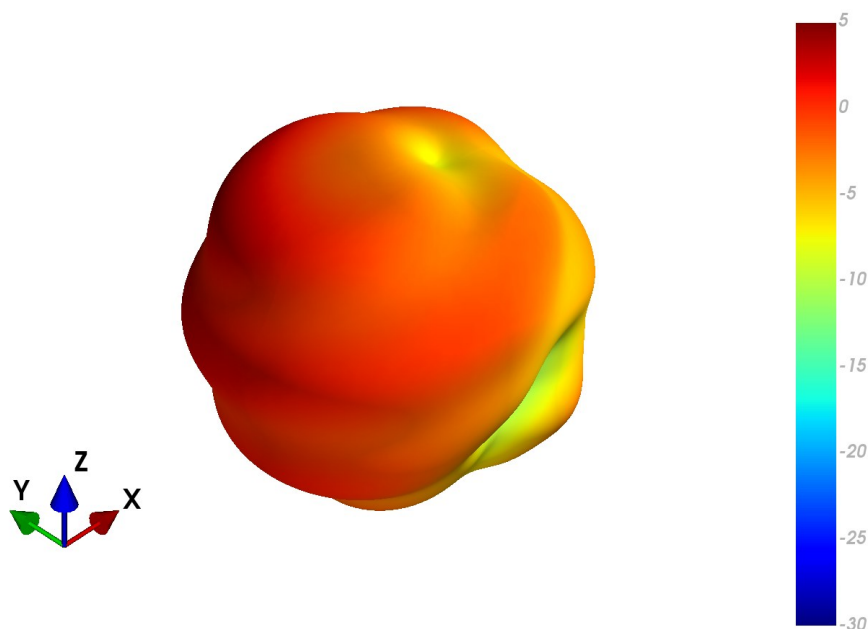
YZ Plane



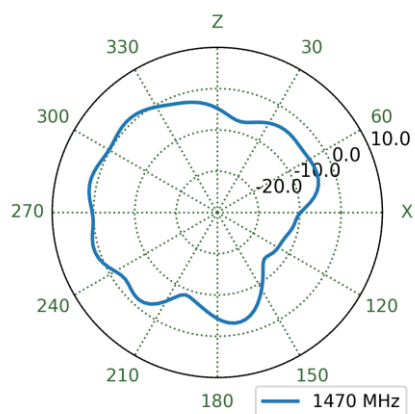
XY Plane



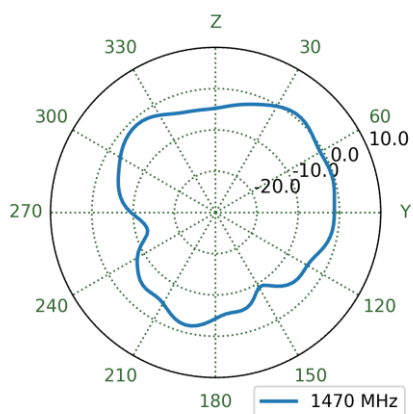
7.42 MIMO3 Cellular Free Space Patterns at 1470 MHz



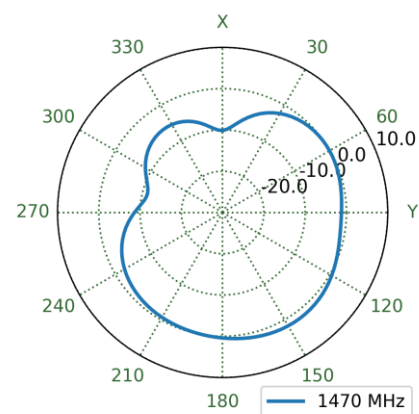
XZ Plane



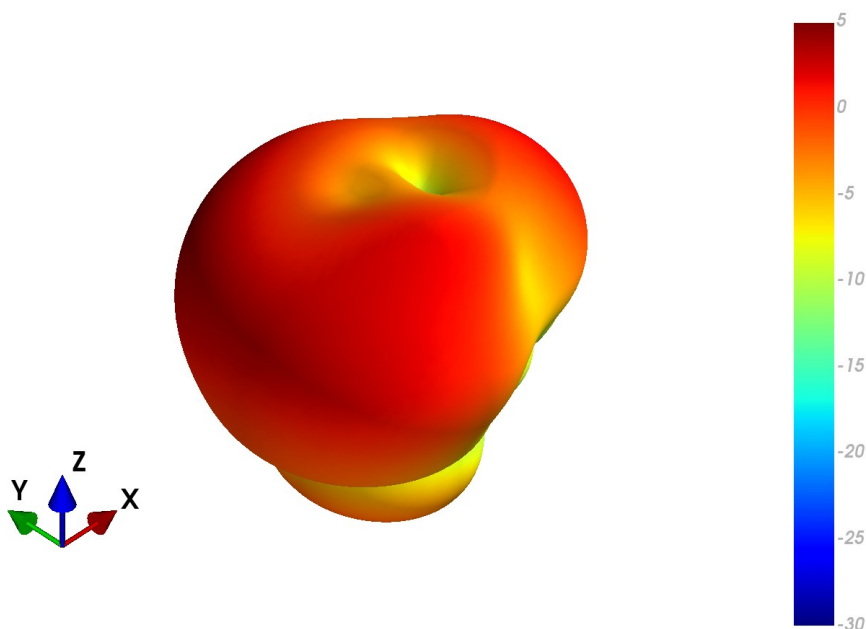
YZ Plane



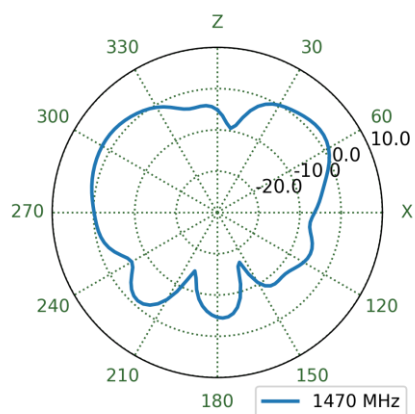
XY Plane



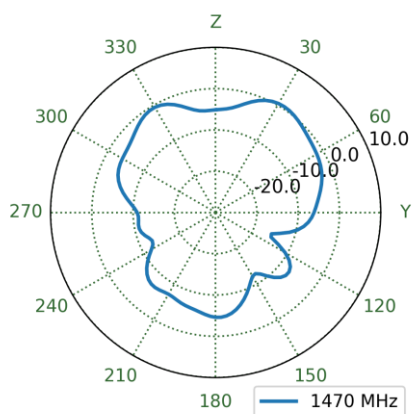
7.43 MIMO3 Cellular Ground Plane Patterns at 1470 MHz



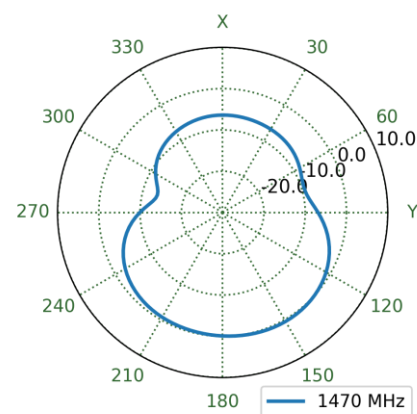
XZ Plane



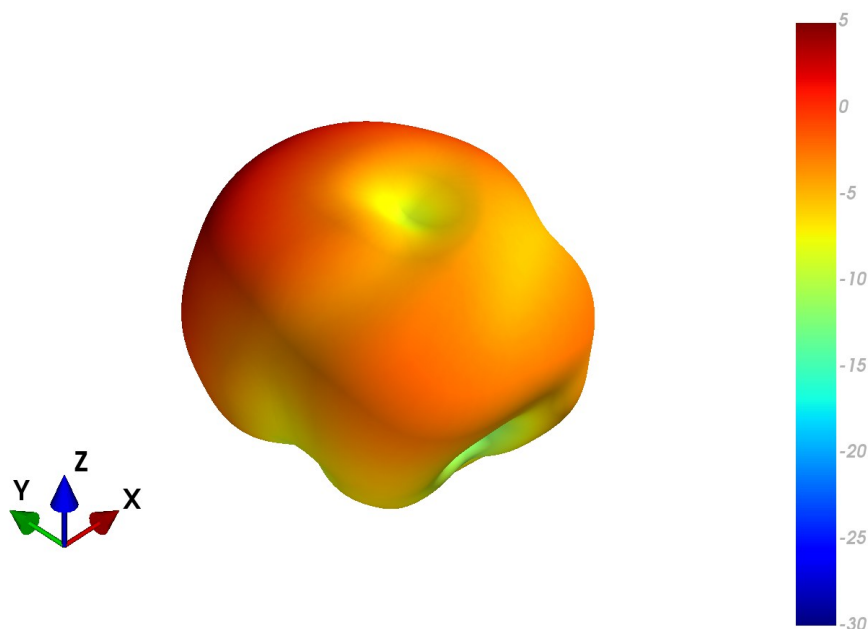
YZ Plane



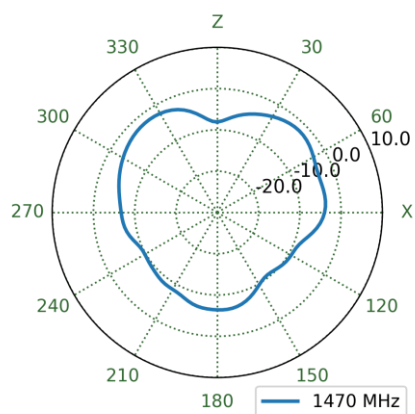
XY Plane



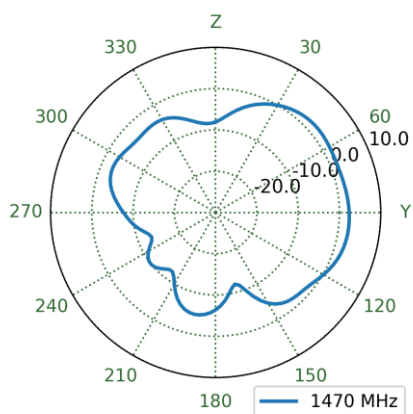
7.44 MIMO4 Cellular Free Space Patterns at 1470 MHz



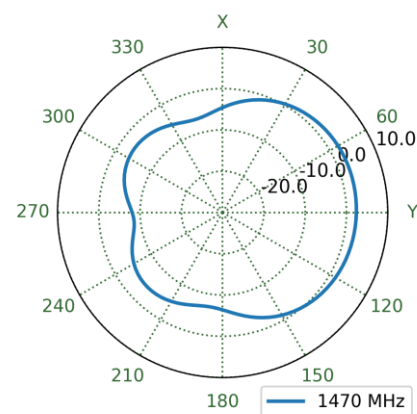
XZ Plane



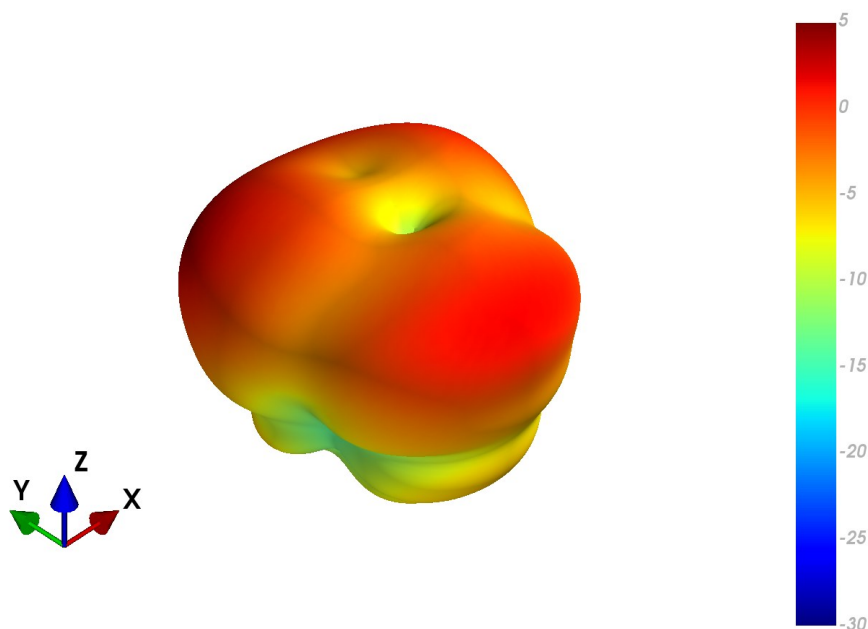
YZ Plane



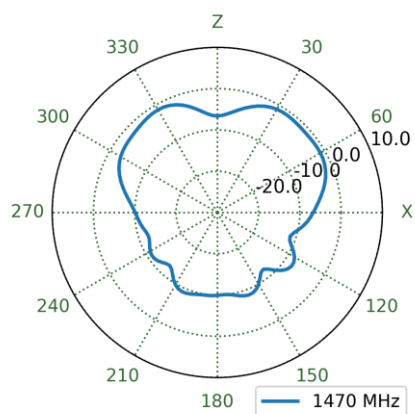
XY Plane



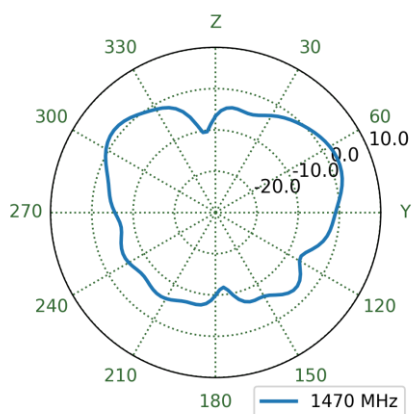
7.45 MIMO4 Cellular Ground Plane Patterns at 1470 MHz



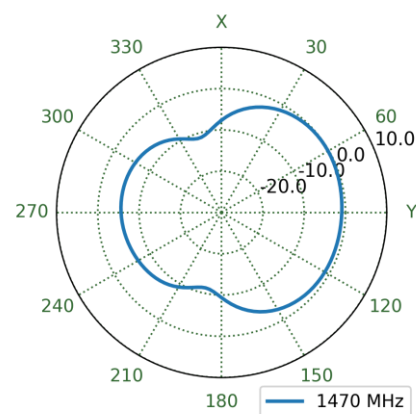
XZ Plane



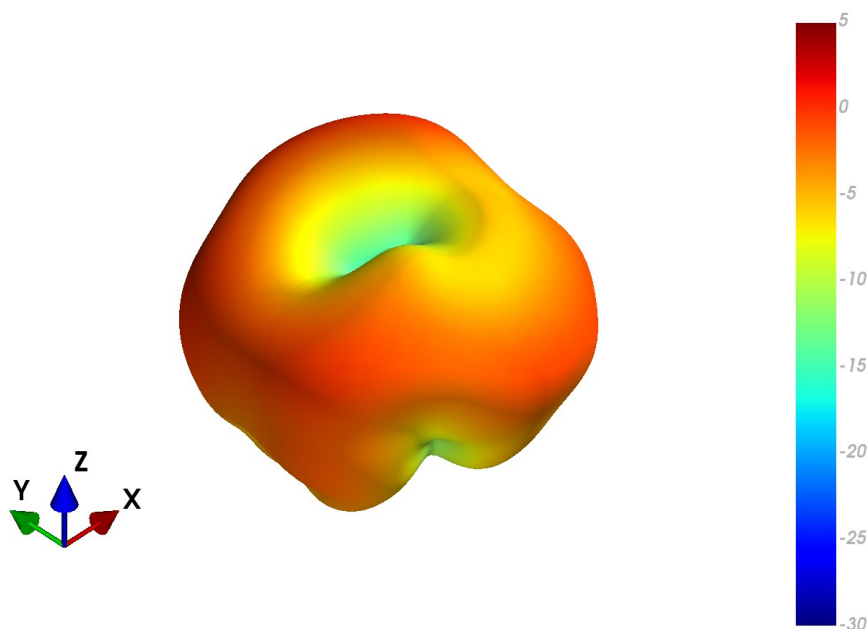
YZ Plane



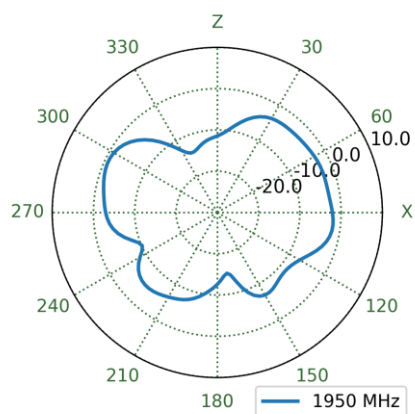
XY Plane



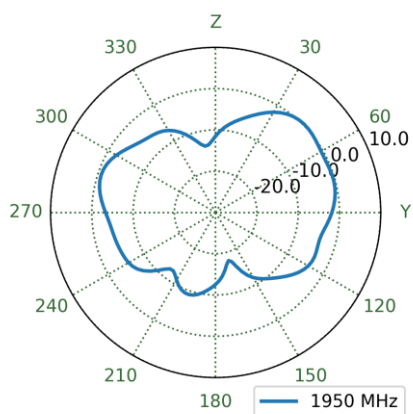
7.46 MIMO1 Cellular Free Space Patterns at 1950 MHz



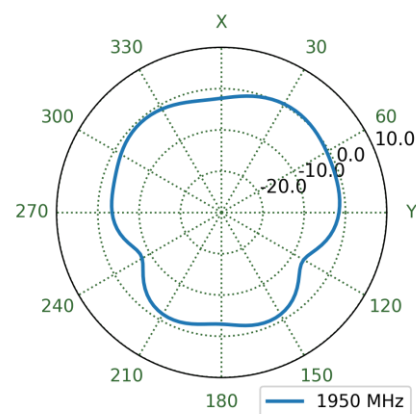
XZ Plane



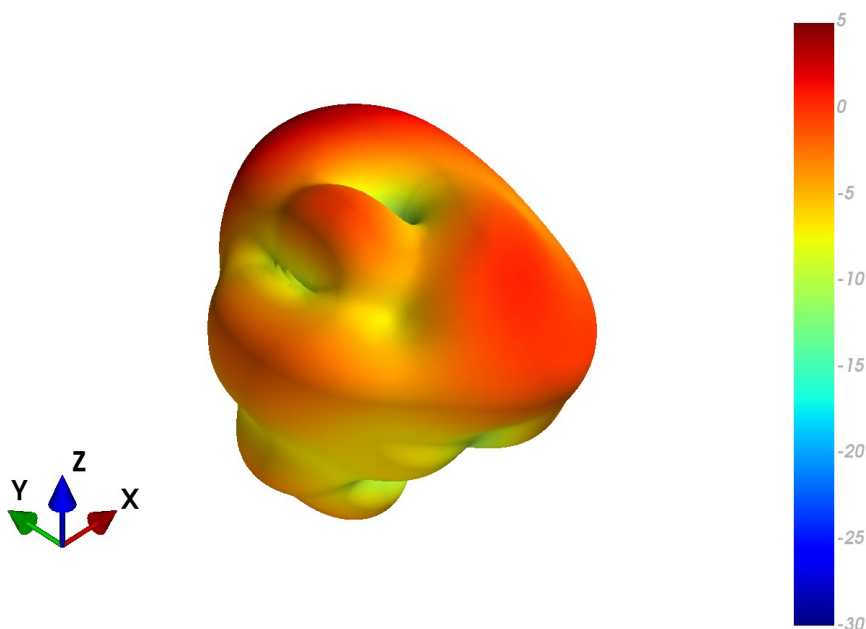
YZ Plane



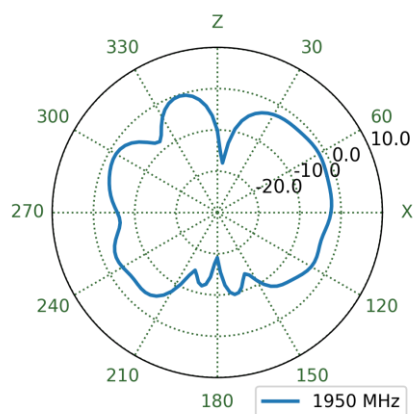
XY Plane



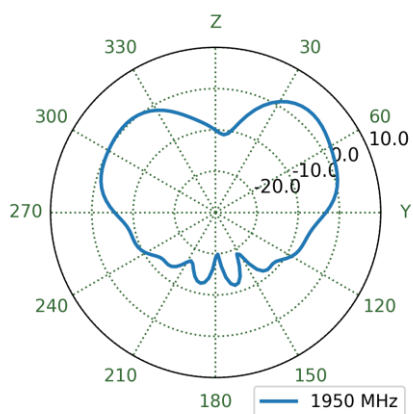
7.47 MIMO1 Cellular Ground Plane Patterns at 1950 MHz



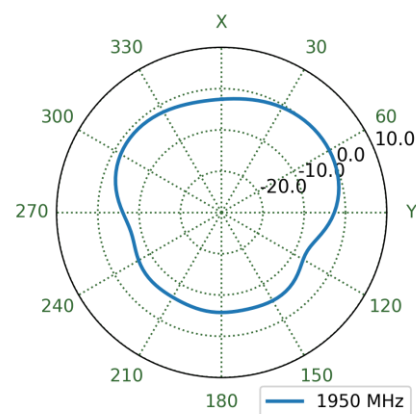
XZ Plane



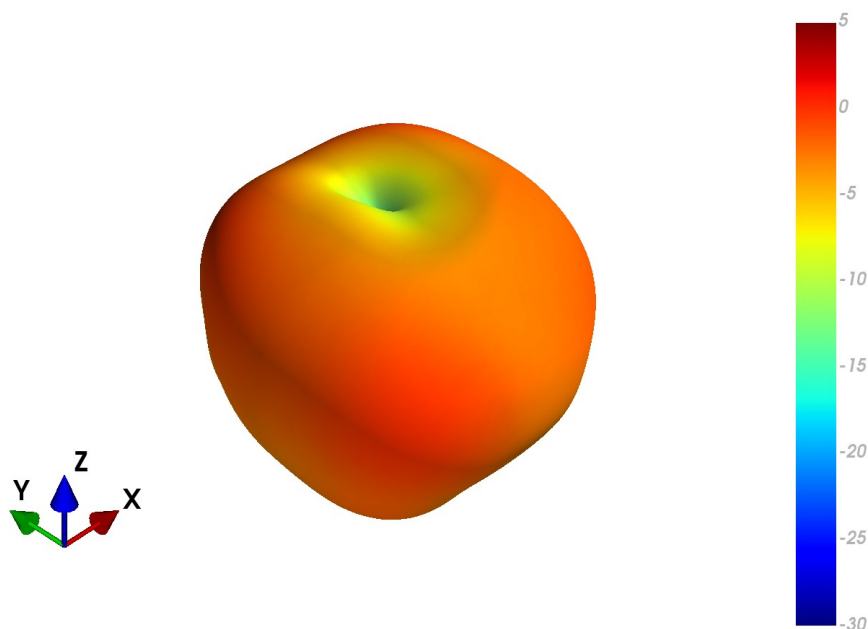
YZ Plane



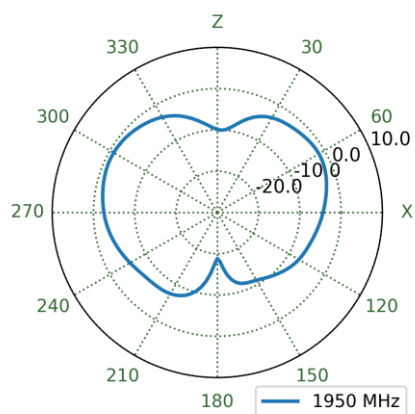
XY Plane



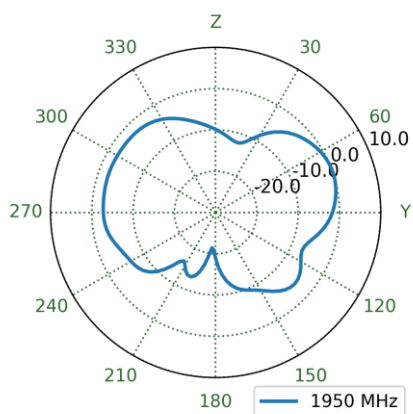
7.48 MIMO2 Cellular Free Space Patterns at 1950 MHz



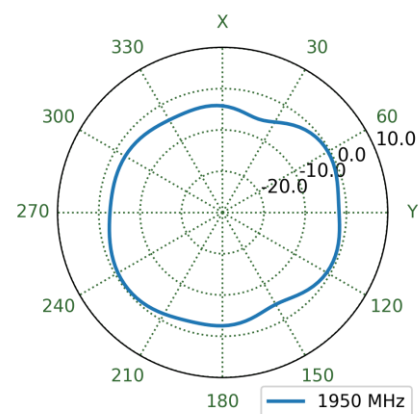
XZ Plane



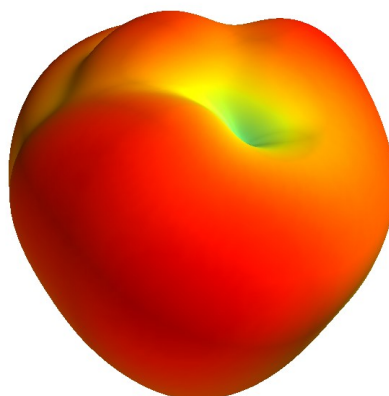
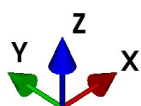
YZ Plane



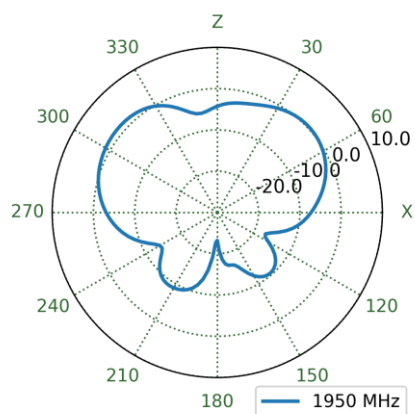
XY Plane



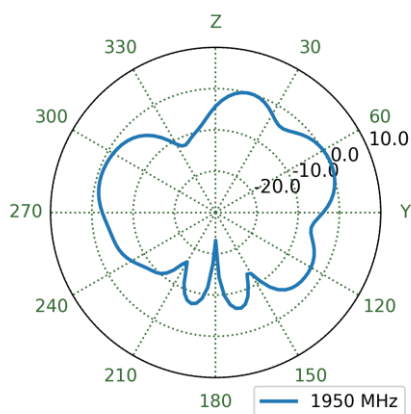
7.49 MIMO2 Cellular Ground Plane Patterns at 1950 MHz



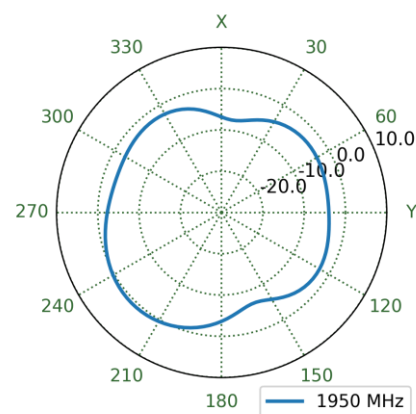
XZ Plane



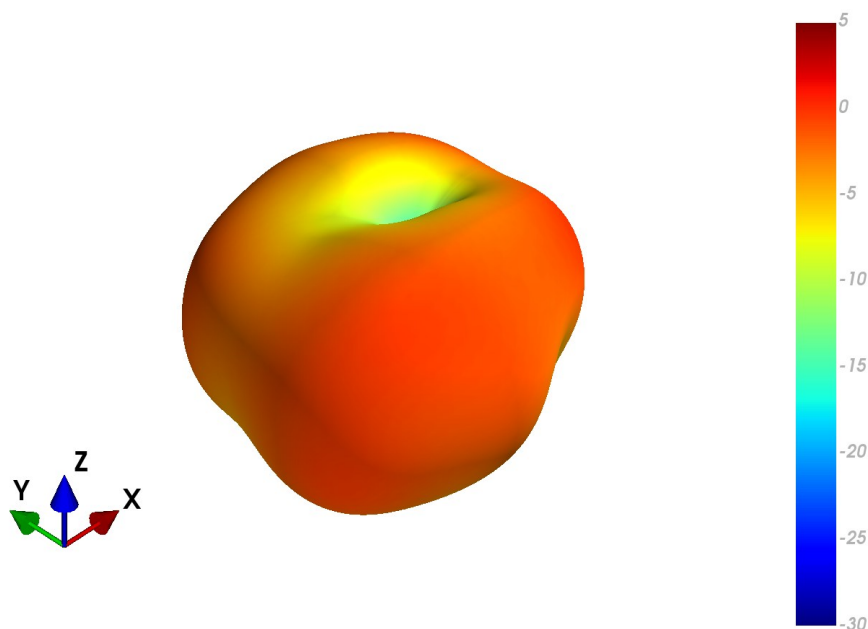
YZ Plane



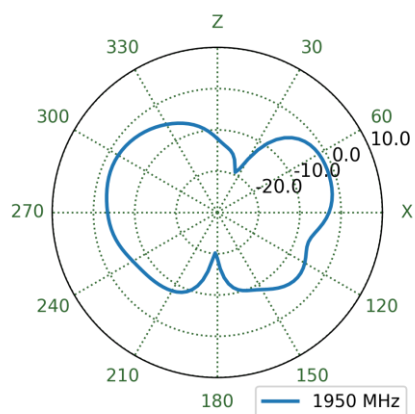
XY Plane



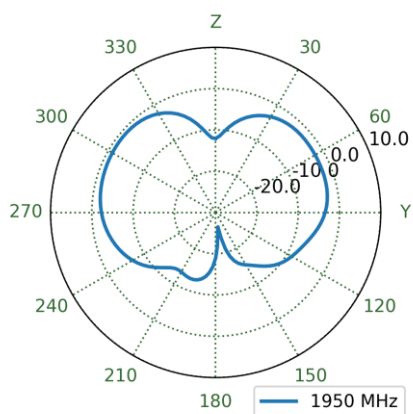
7.50 MIMO3 Cellular Free Space Patterns at 1950 MHz



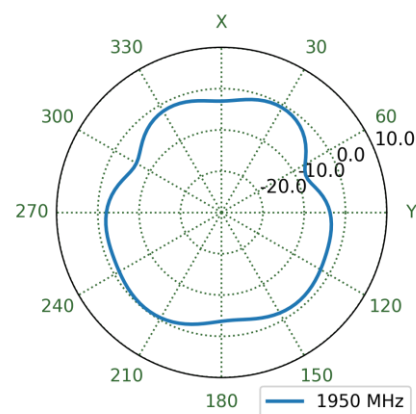
XZ Plane



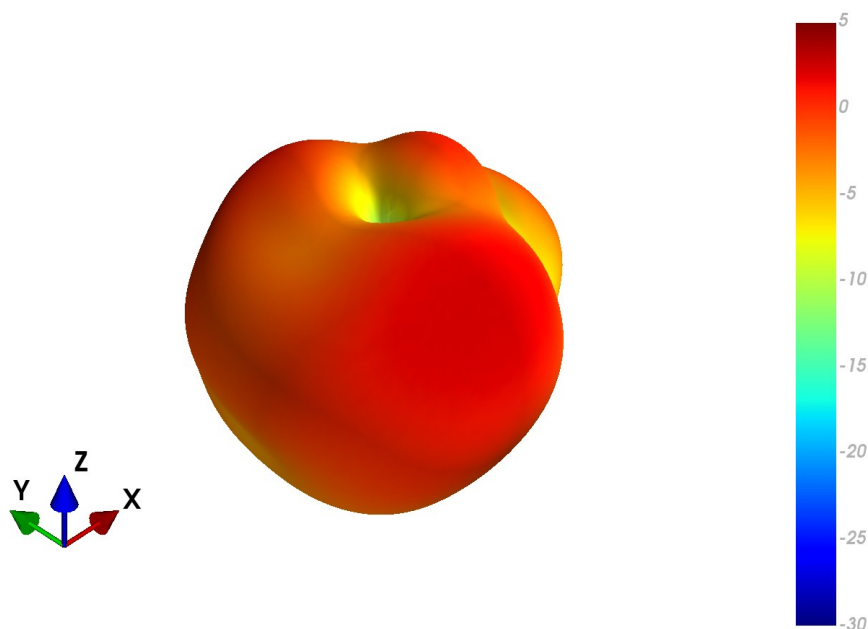
YZ Plane



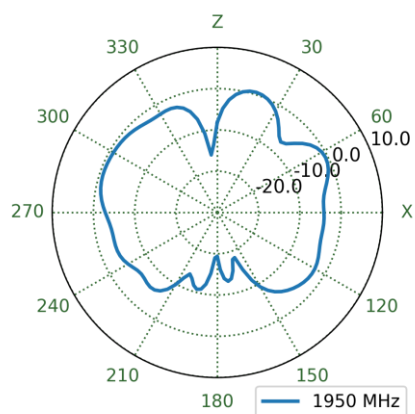
XY Plane



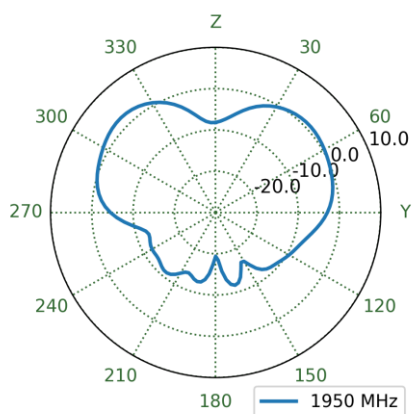
7.51 MIMO3 Cellular Ground Plane Patterns at 1950 MHz



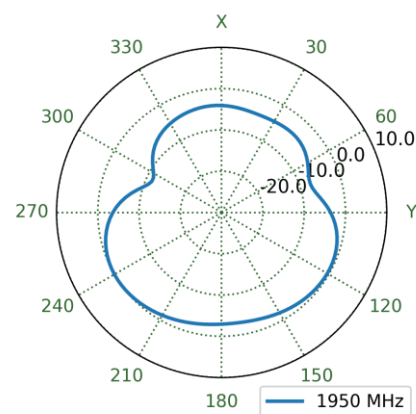
XZ Plane



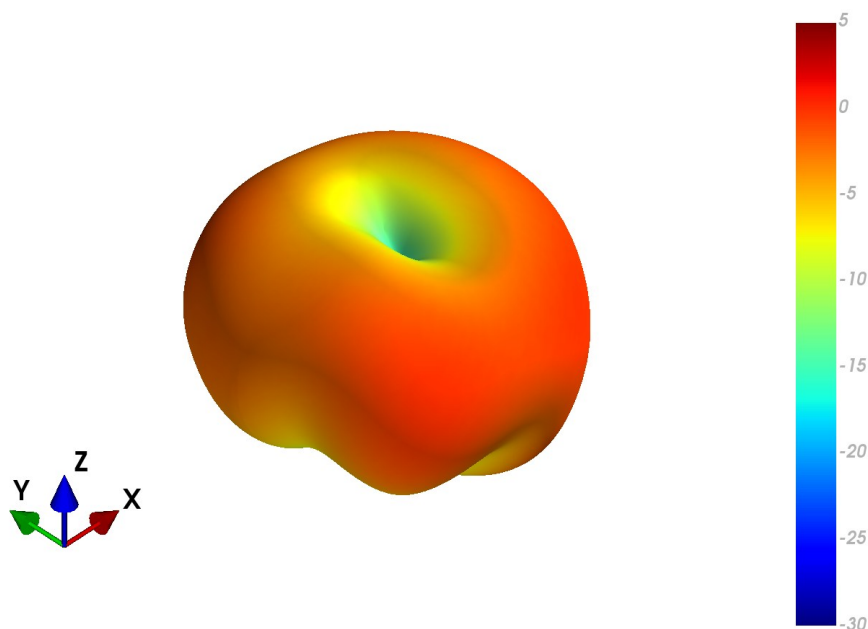
YZ Plane



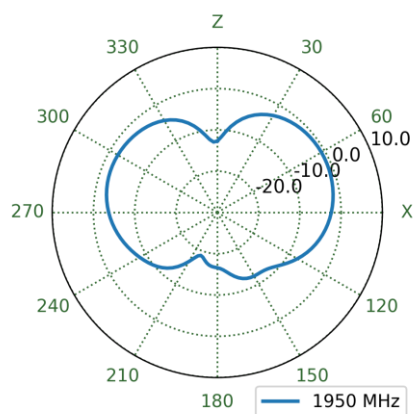
XY Plane



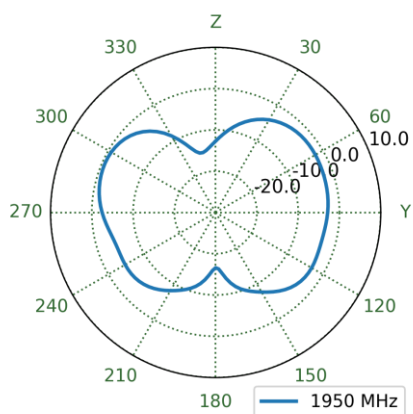
7.52 MIMO4 Cellular Free Space Patterns at 1950 MHz



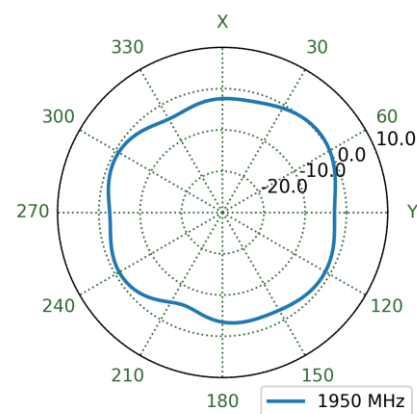
XZ Plane



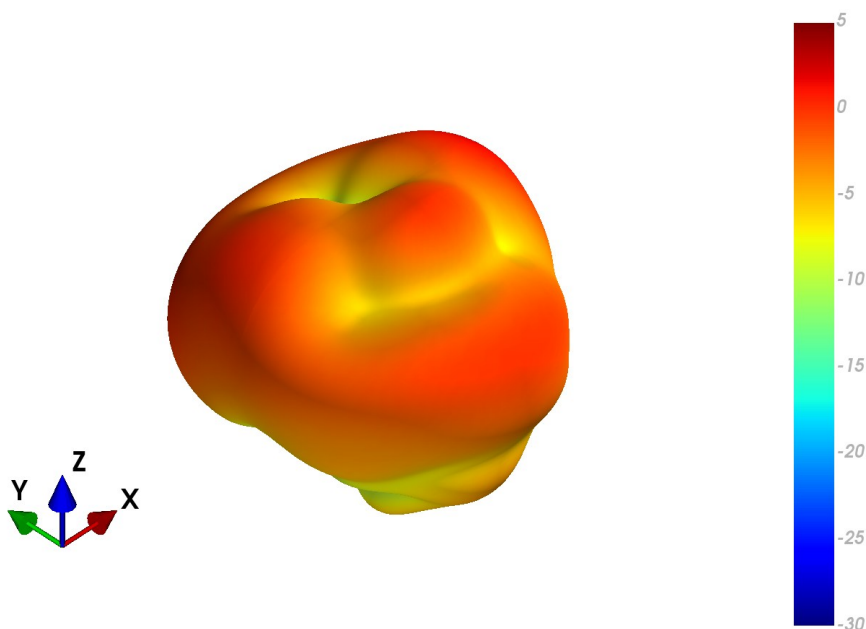
YZ Plane



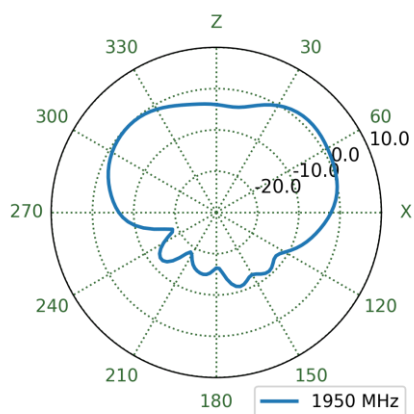
XY Plane



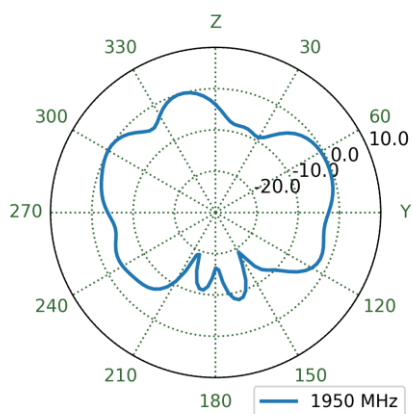
7.53 MIMO4 Cellular Ground Plane Patterns at 1950 MHz



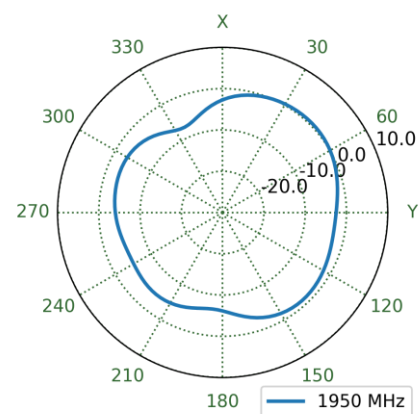
XZ Plane



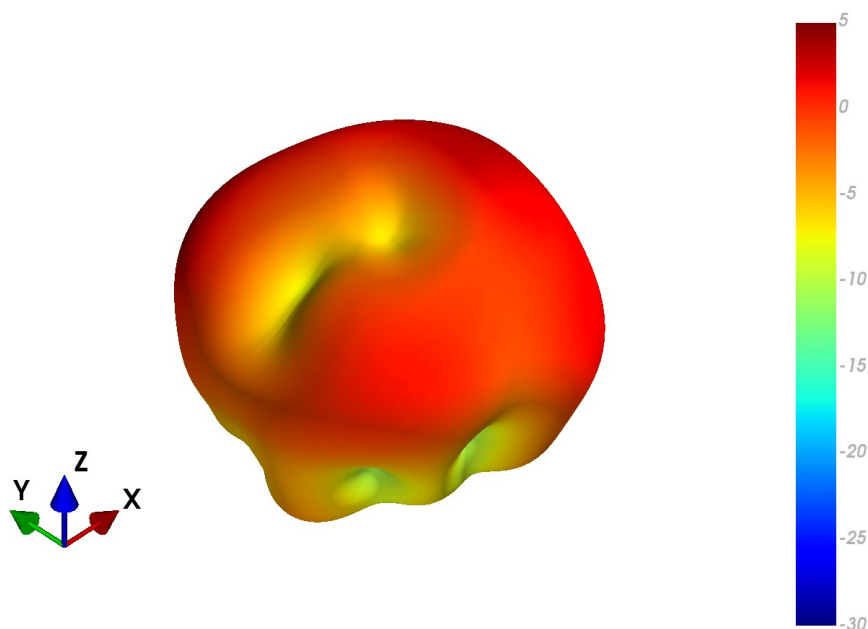
YZ Plane



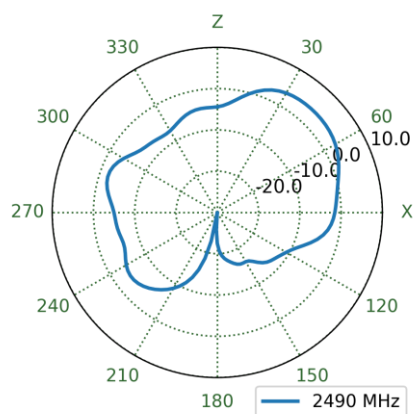
XY Plane



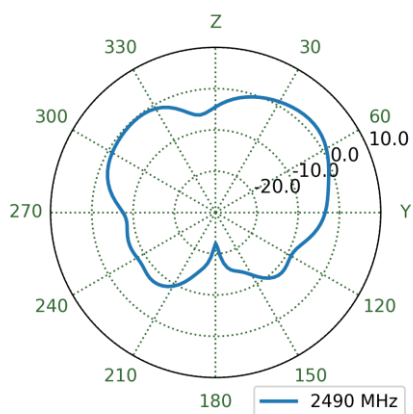
7.54 MIMO1 Cellular Free Space Patterns at 2490 MHz



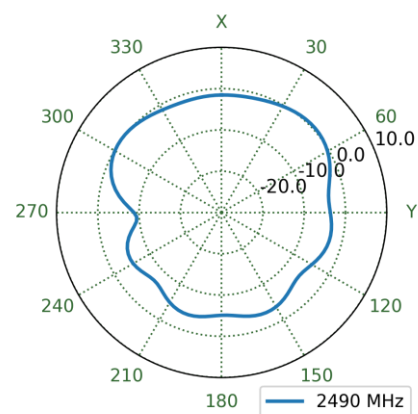
XZ Plane



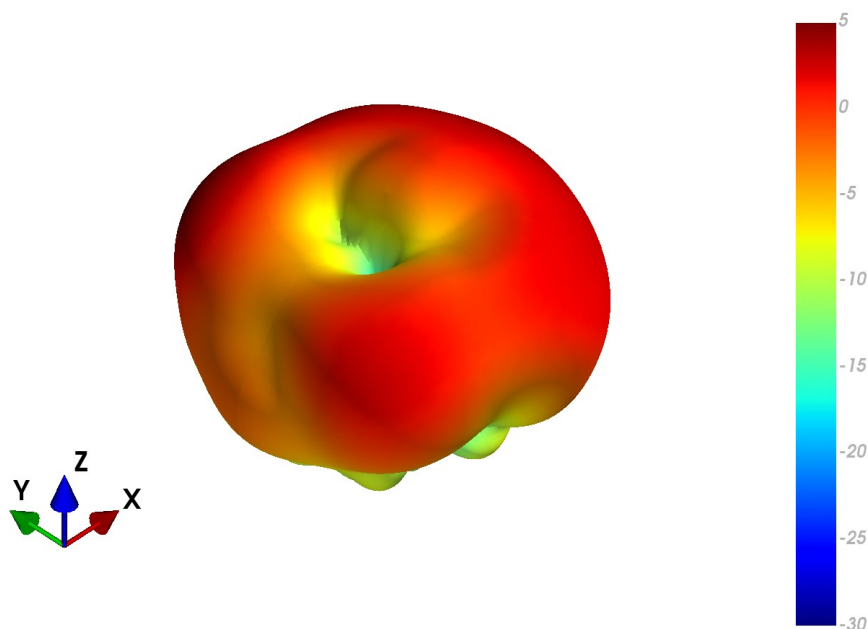
YZ Plane



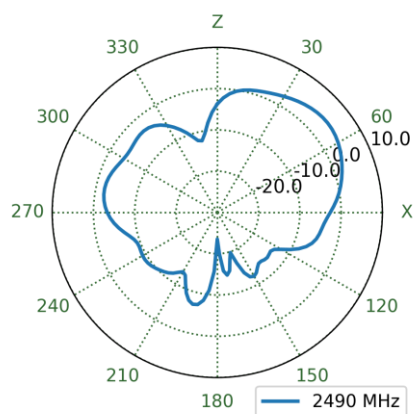
XY Plane



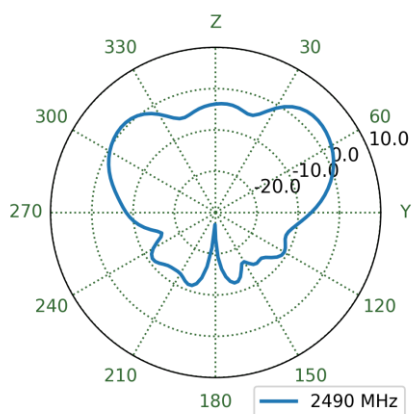
7.55 MIMO1 Cellular Ground Plane Patterns at 2490 MHz



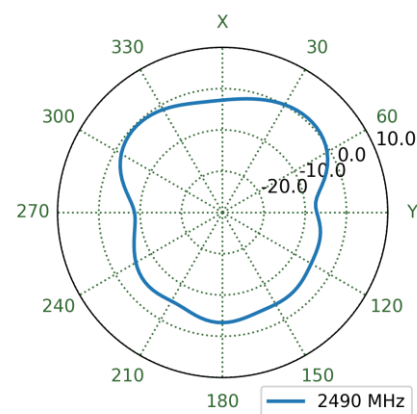
XZ Plane



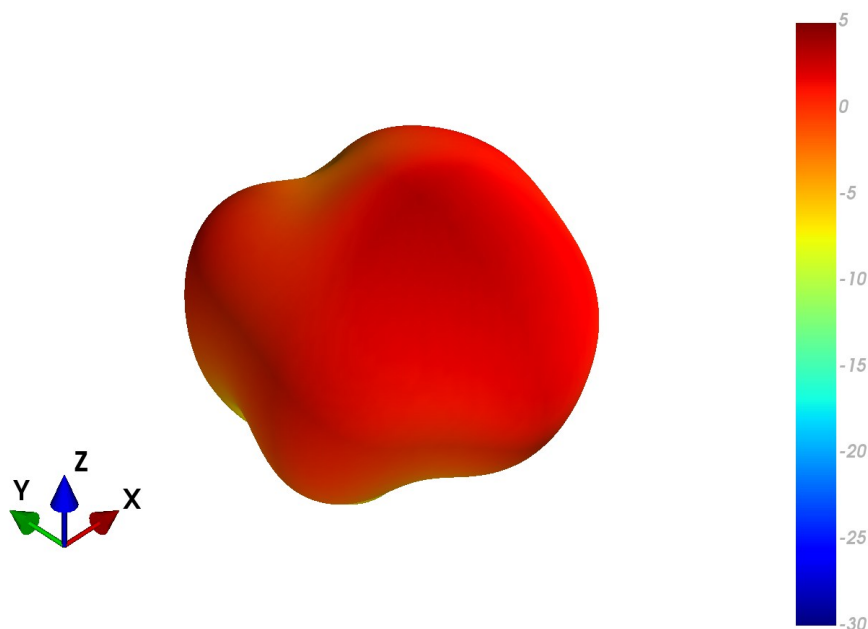
YZ Plane



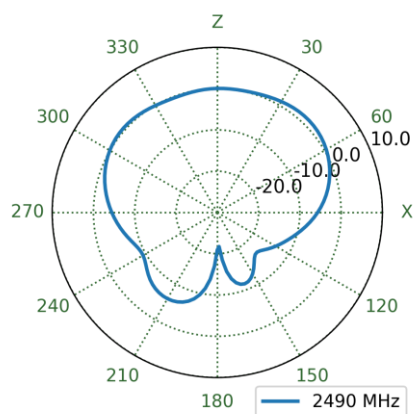
XY Plane



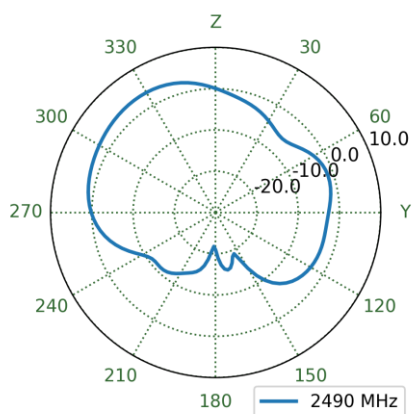
7.56 MIMO2 Cellular Free Space Patterns at 2490 MHz



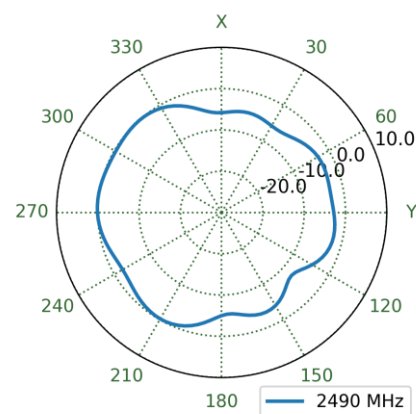
XZ Plane



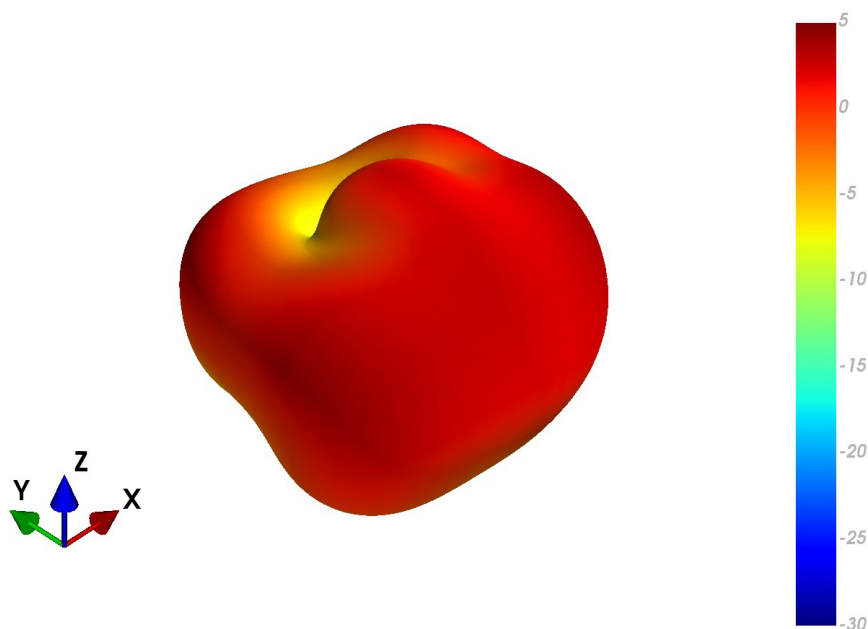
YZ Plane



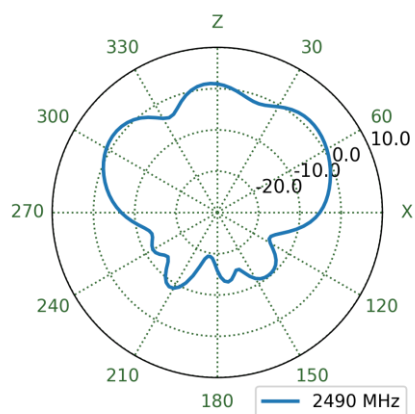
XY Plane



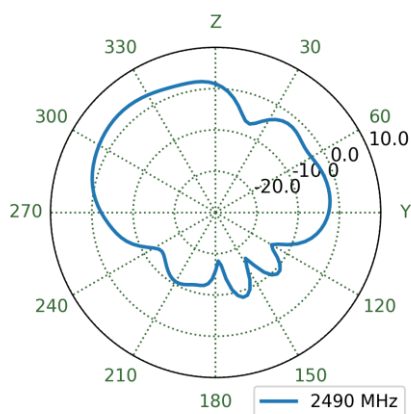
7.57 MIMO2 Cellular Ground Plane Patterns at 2490 MHz



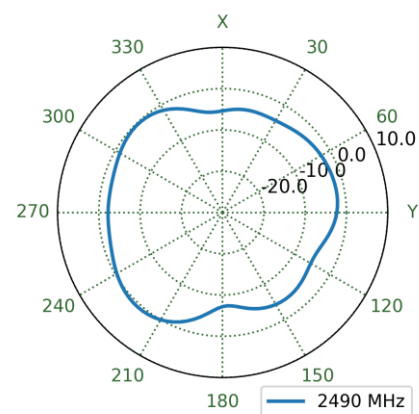
XZ Plane



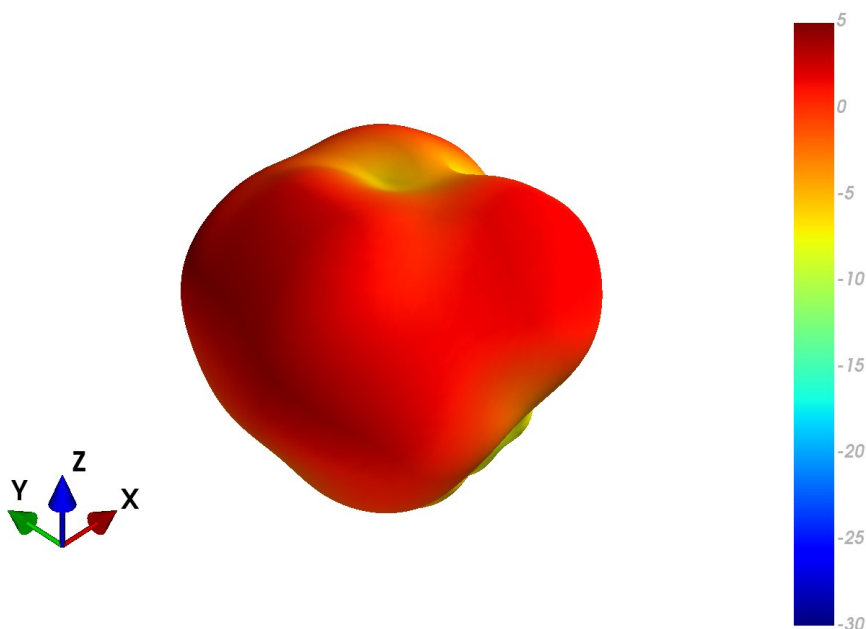
YZ Plane



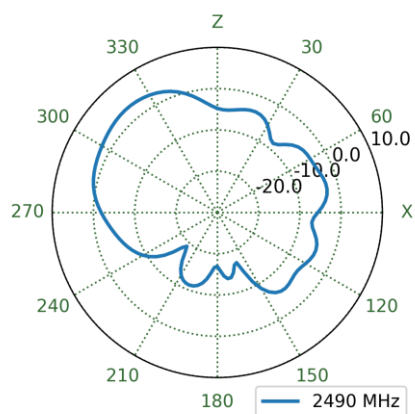
XY Plane



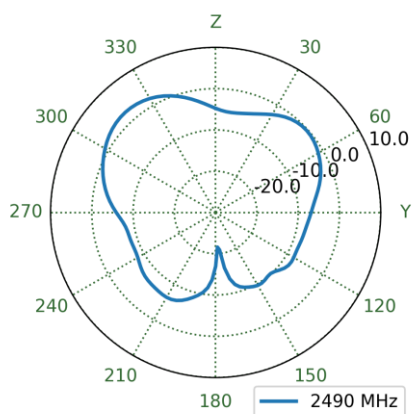
7.58 MIMO3 Cellular Free Space Patterns at 2490 MHz



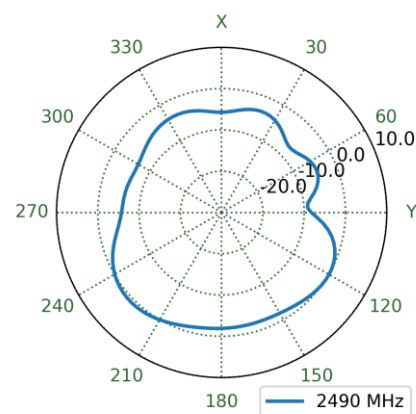
XZ Plane



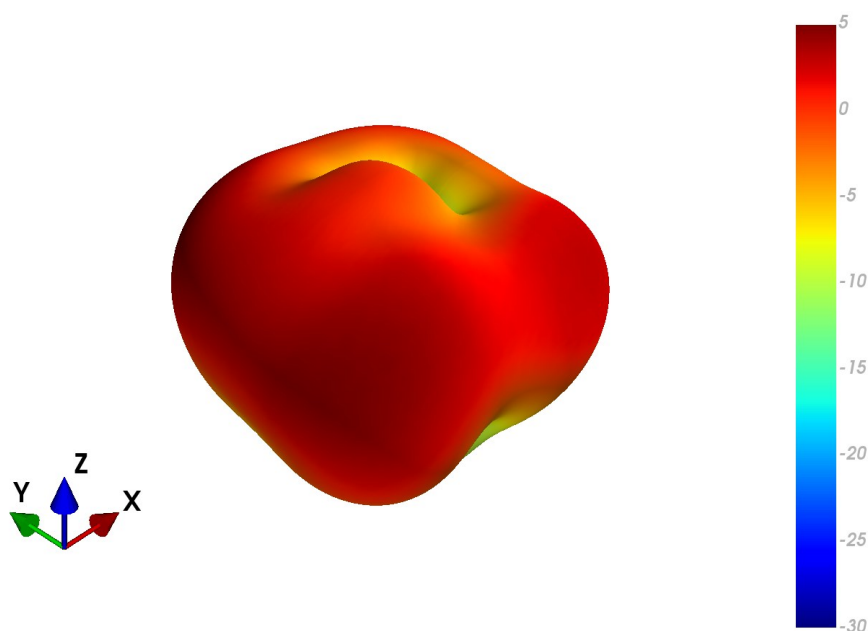
YZ Plane



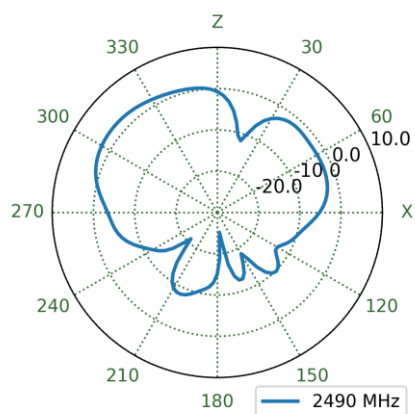
XY Plane



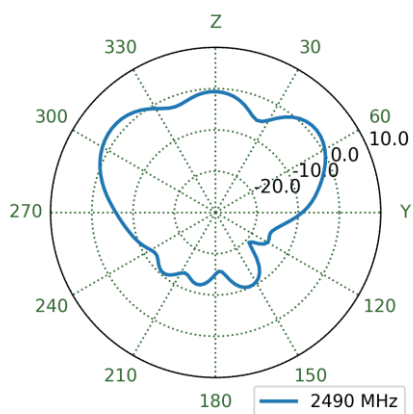
7.59 MIMO3 Cellular Ground Plane Patterns at 2490 MHz



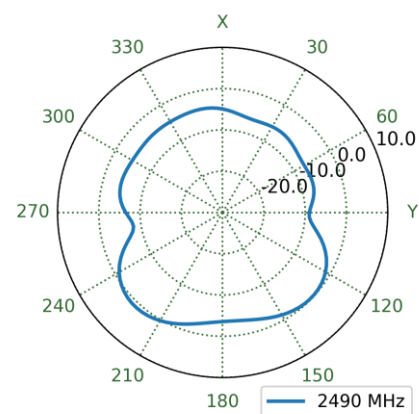
XZ Plane



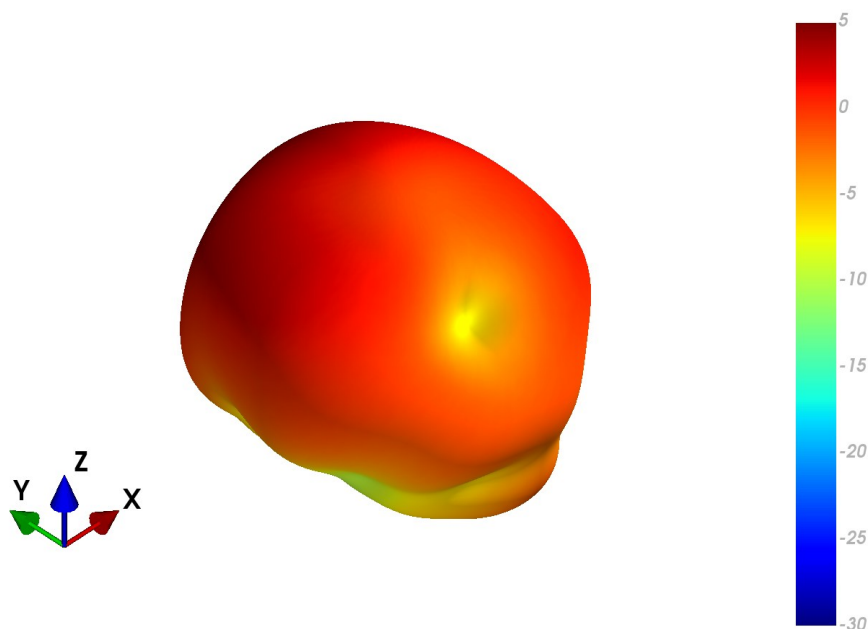
YZ Plane



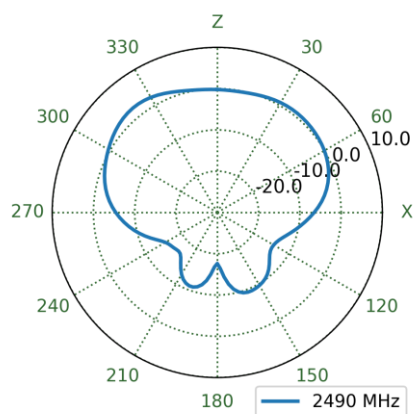
XY Plane



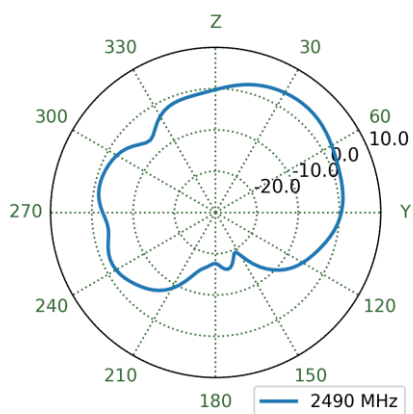
7.60 MIMO4 Cellular Free Space Patterns at 2490 MHz



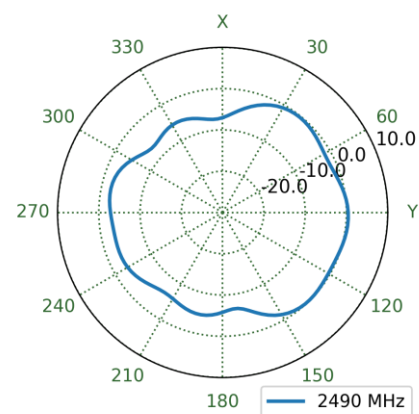
XZ Plane



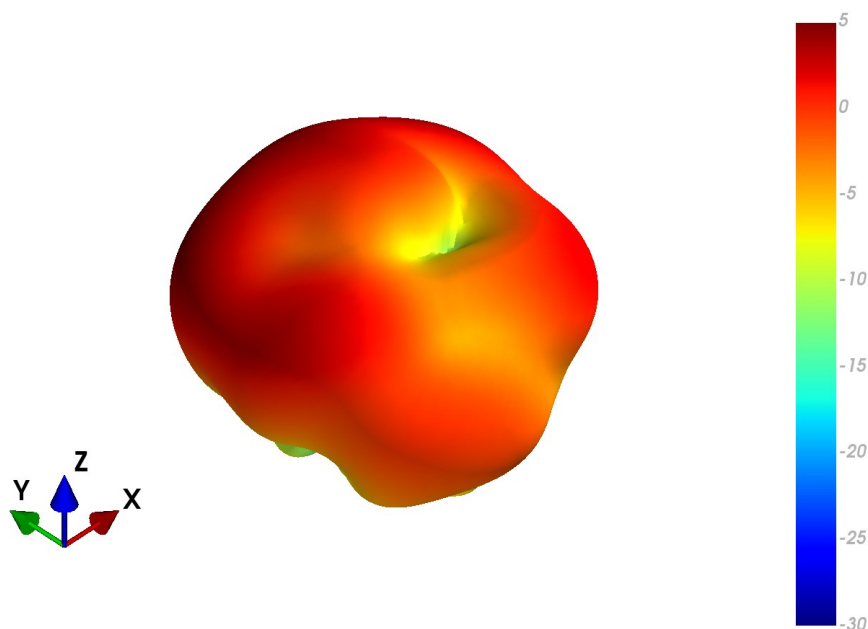
YZ Plane



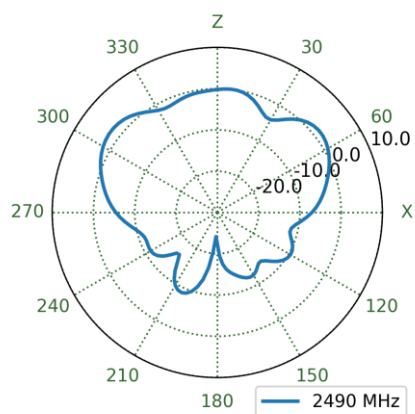
XY Plane



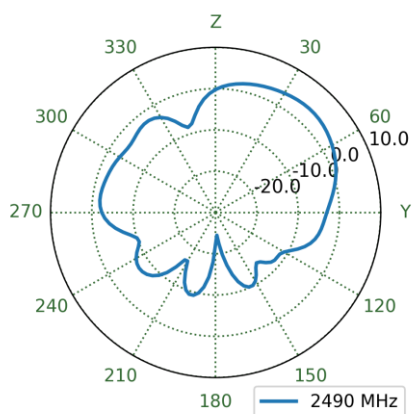
7.61 MIMO4 Cellular Ground Plane Patterns at 2490 MHz



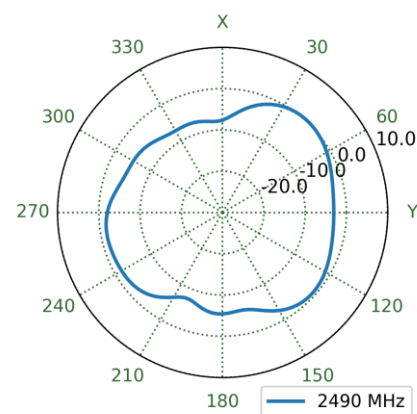
XZ Plane



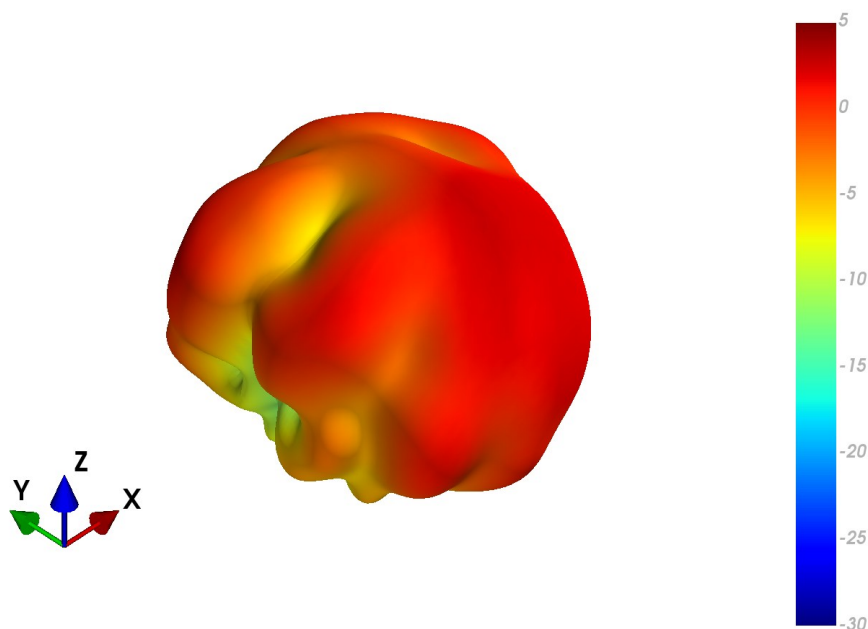
YZ Plane



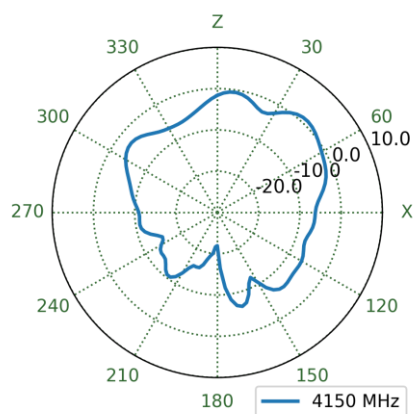
XY Plane



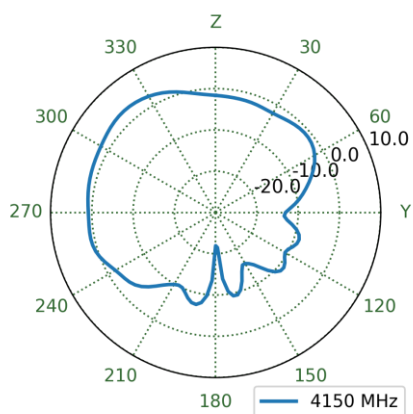
7.62 MIMO1 Cellular Free Space Patterns at 4150 MHz



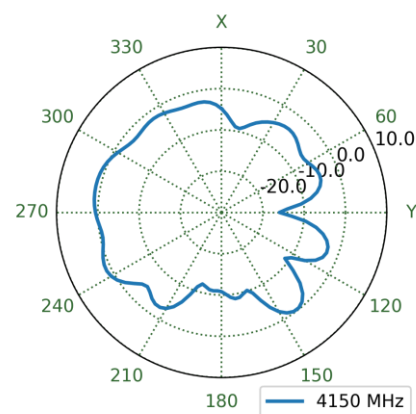
XZ Plane



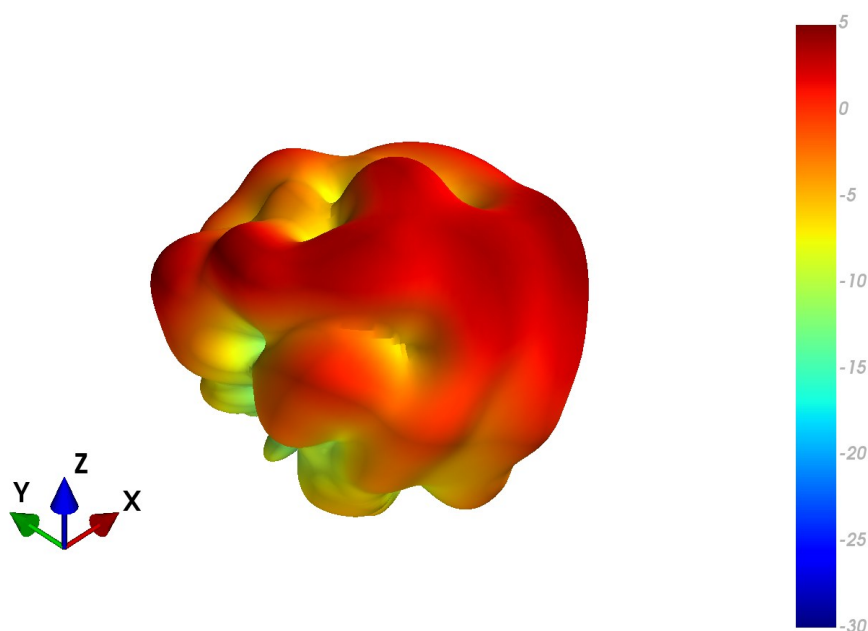
YZ Plane



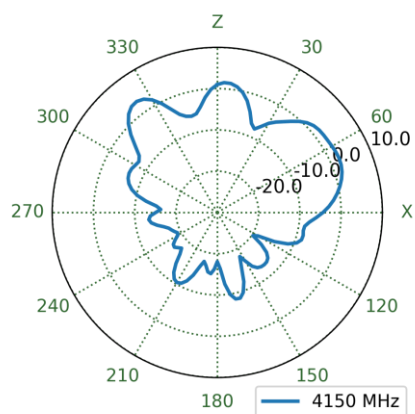
XY Plane



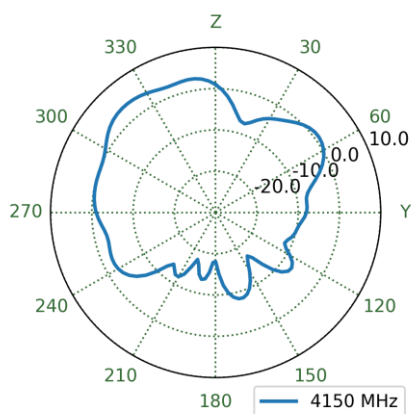
7.63 MIMO1 Cellular Ground Plane Patterns at 4150 MHz



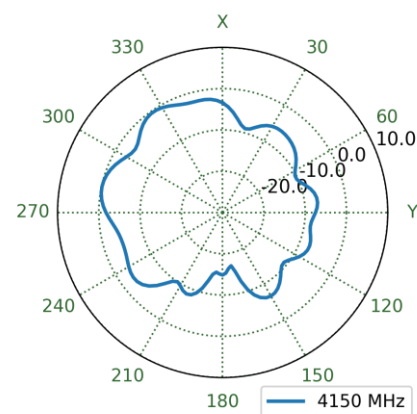
XZ Plane



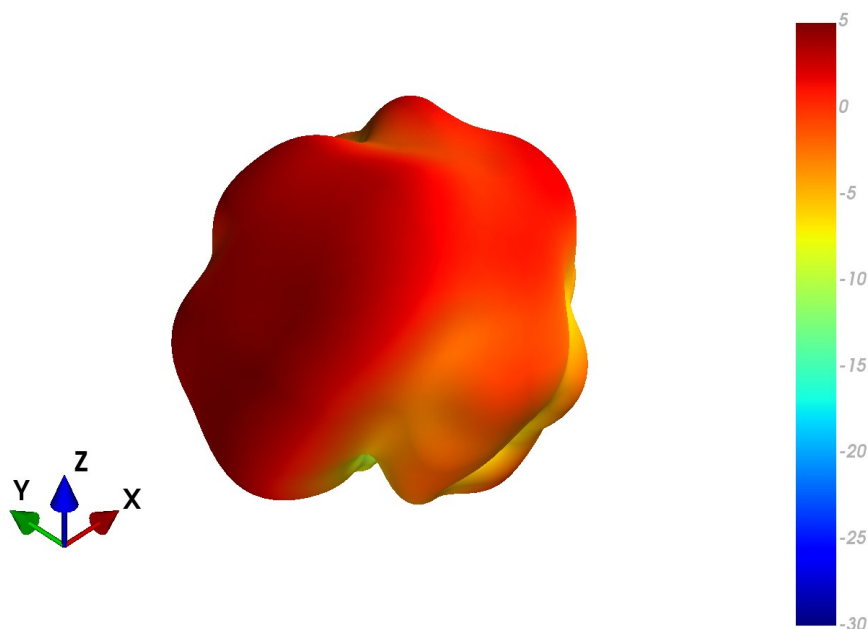
YZ Plane



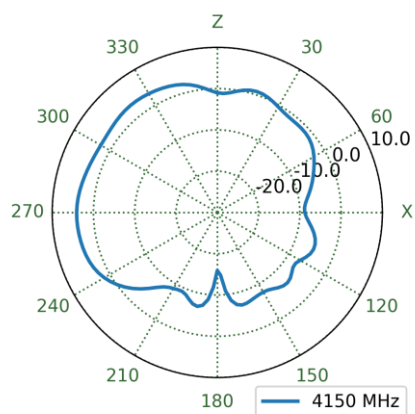
XY Plane



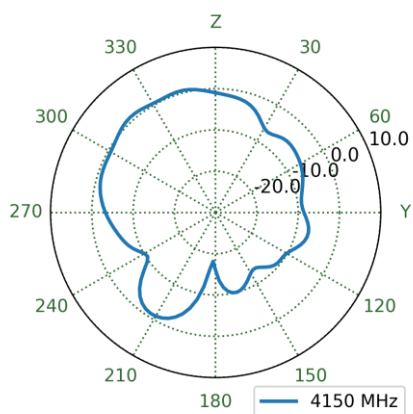
7.64 MIMO2 Cellular Free Space Patterns at 4150 MHz



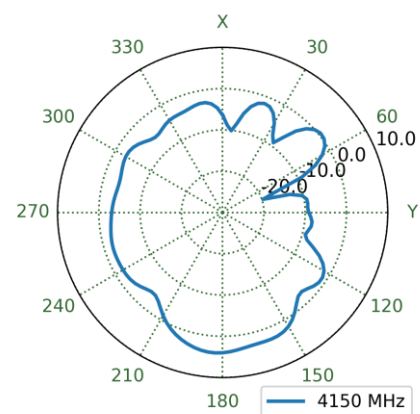
XZ Plane



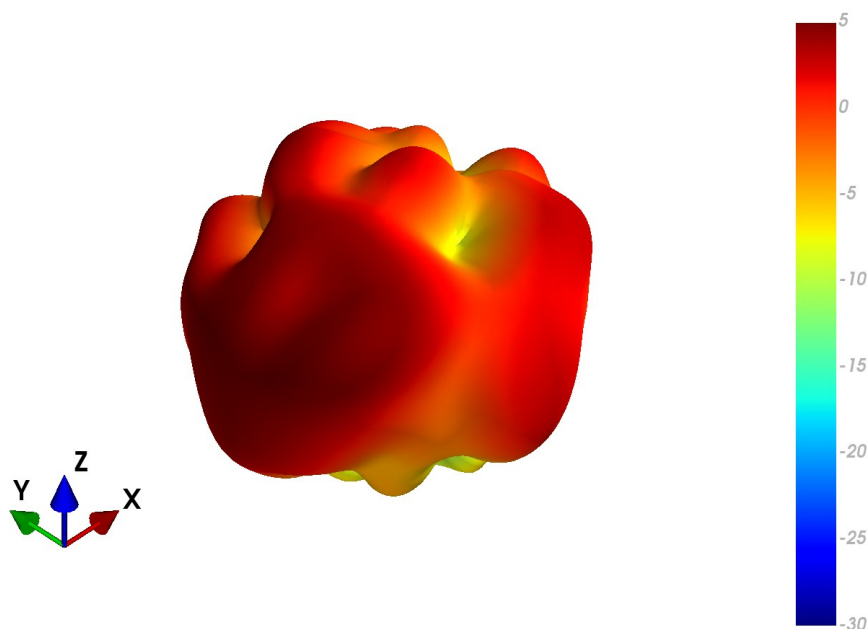
YZ Plane



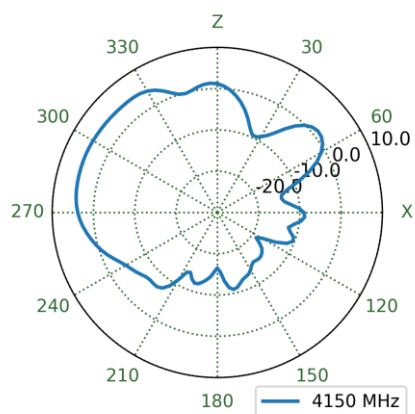
XY Plane



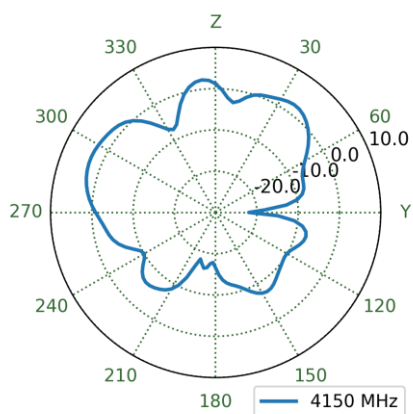
7.65 MIMO2 Cellular Ground Plane Patterns at 4150 MHz



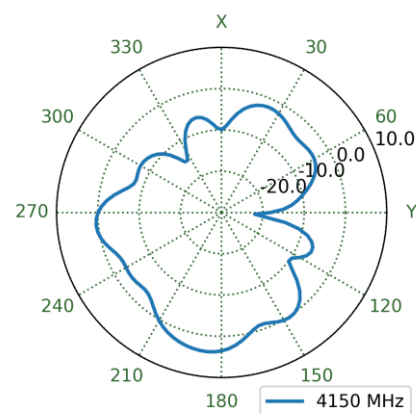
XZ Plane



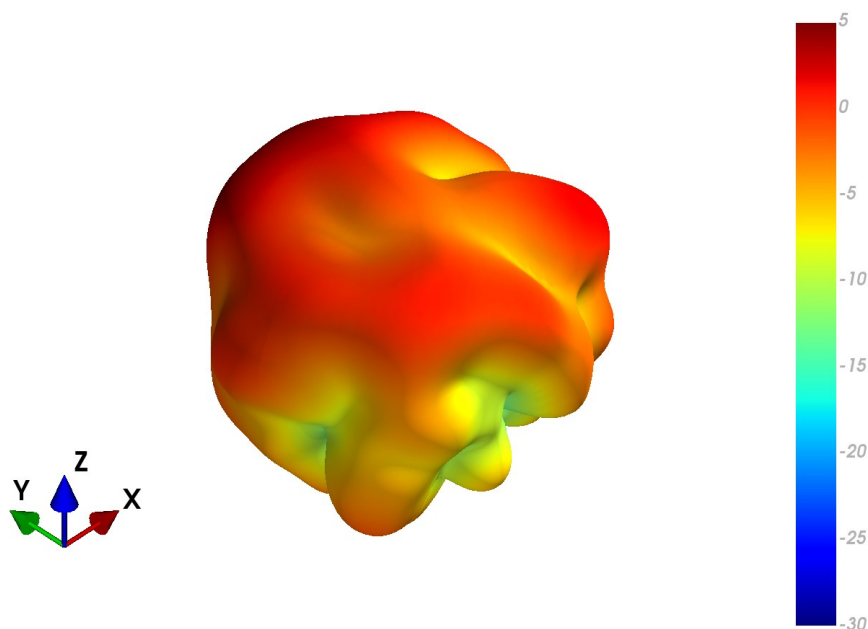
YZ Plane



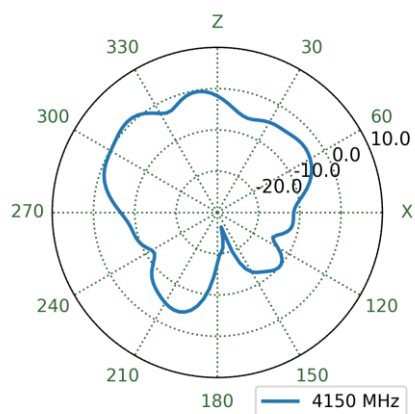
XY Plane



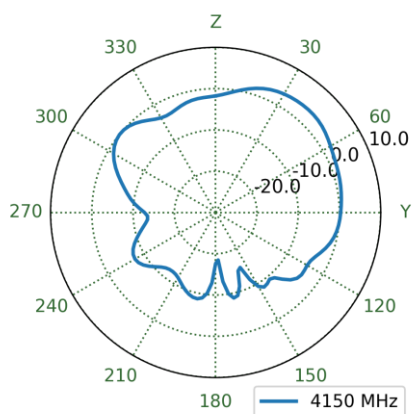
7.66 MIMO3 Cellular Free Space Patterns at 4150 MHz



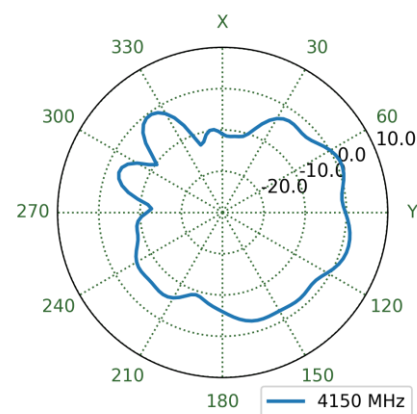
XZ Plane



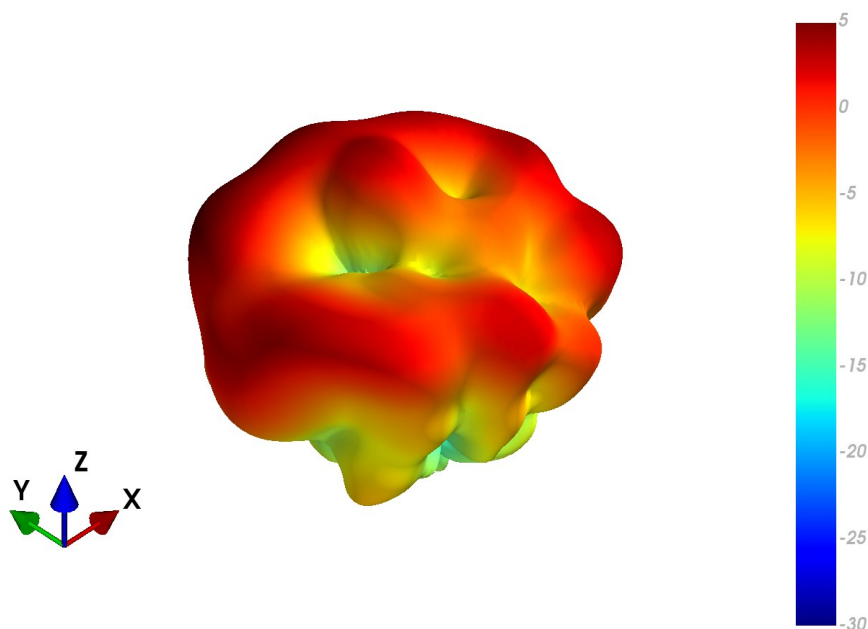
YZ Plane



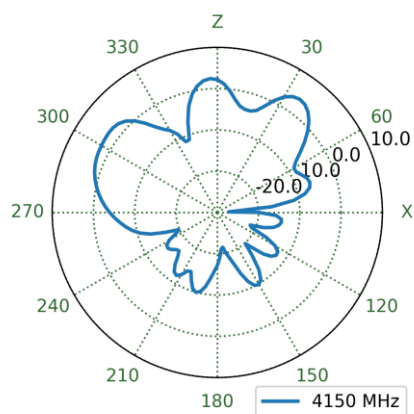
XY Plane



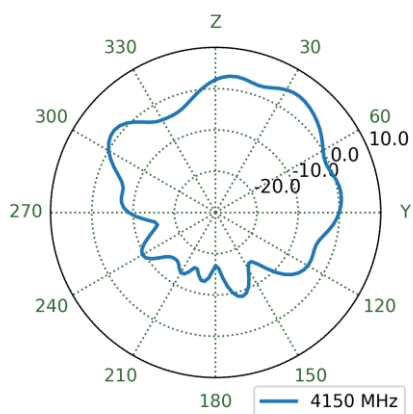
7.67 MIMO3 Cellular Ground Plane Patterns at 4150 MHz



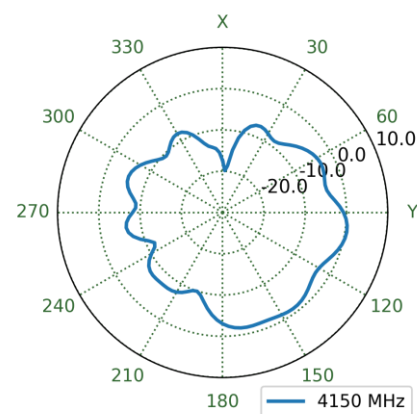
XZ Plane



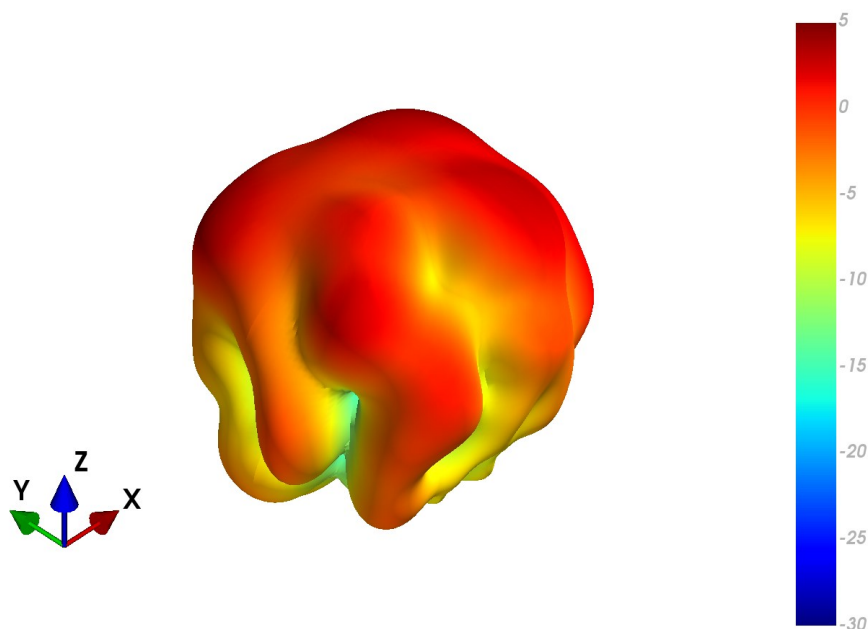
YZ Plane



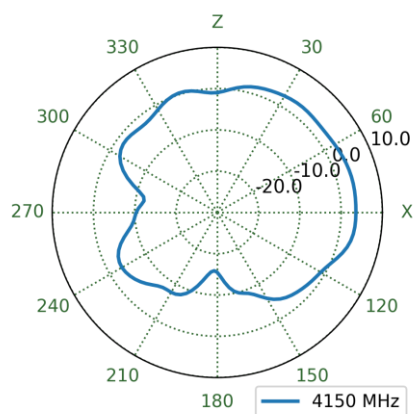
XY Plane



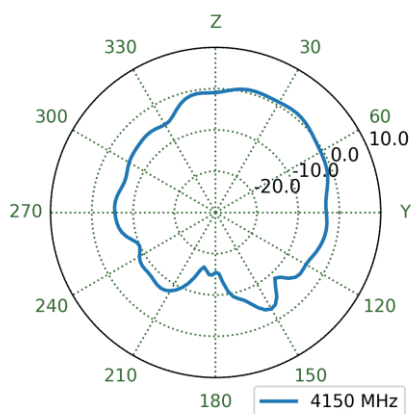
7.68 MIMO4 Cellular Free Space Patterns at 4150 MHz



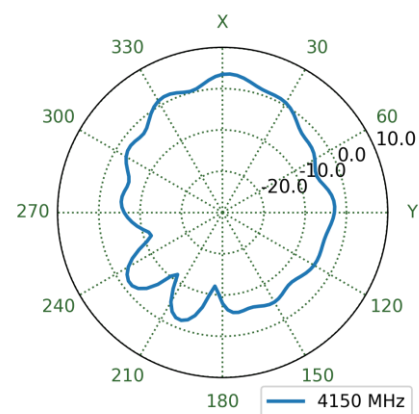
XZ Plane



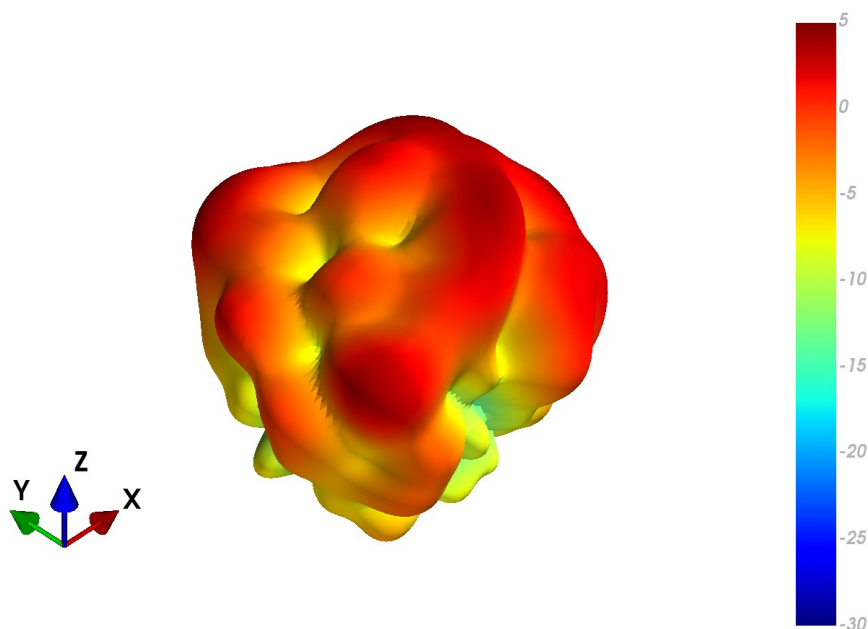
YZ Plane



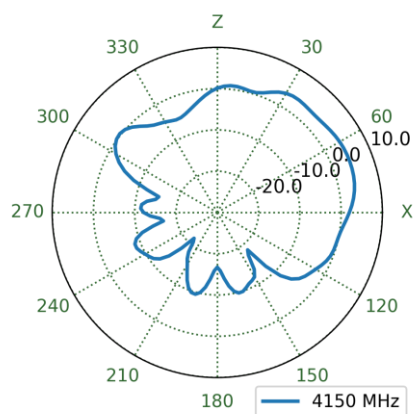
XY Plane



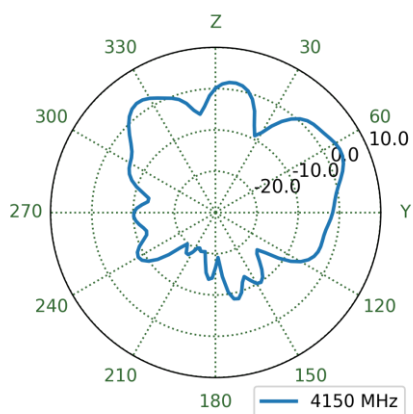
7.69 MIMO4 Cellular Ground Plane Patterns at 4150 MHz



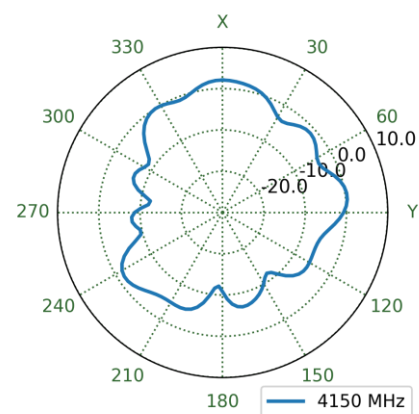
XZ Plane



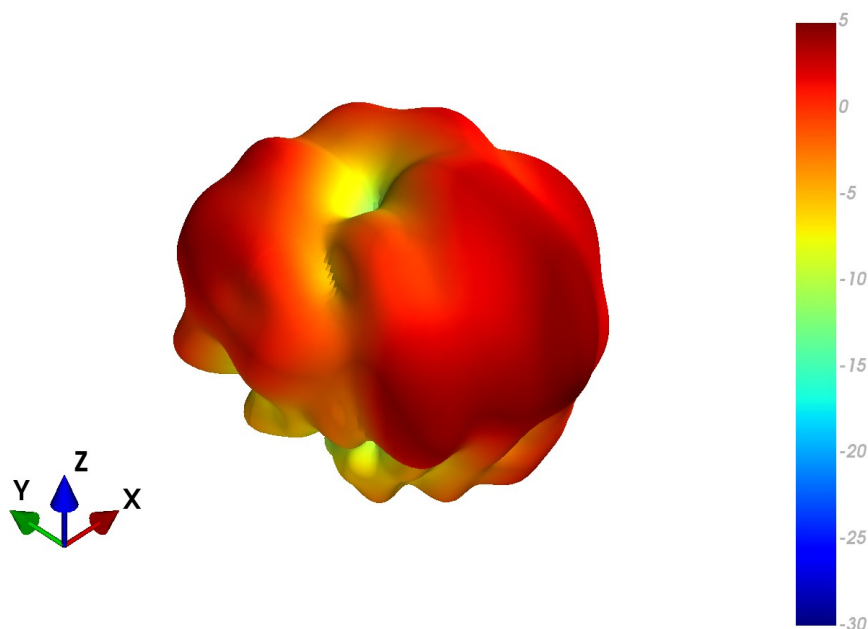
YZ Plane



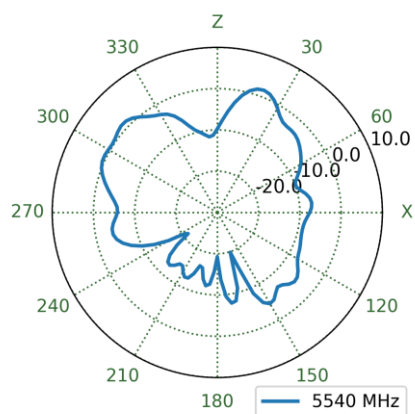
XY Plane



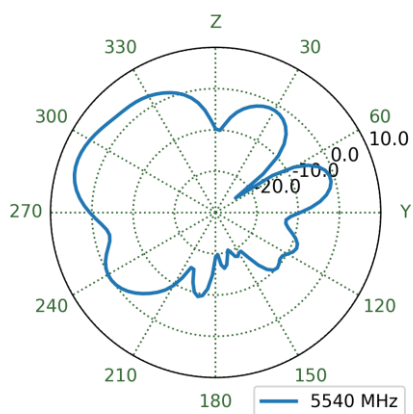
7.70 MIMO1 Cellular Free Space Patterns at 5540 MHz



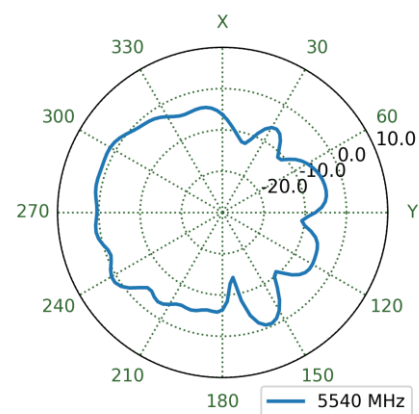
XZ Plane



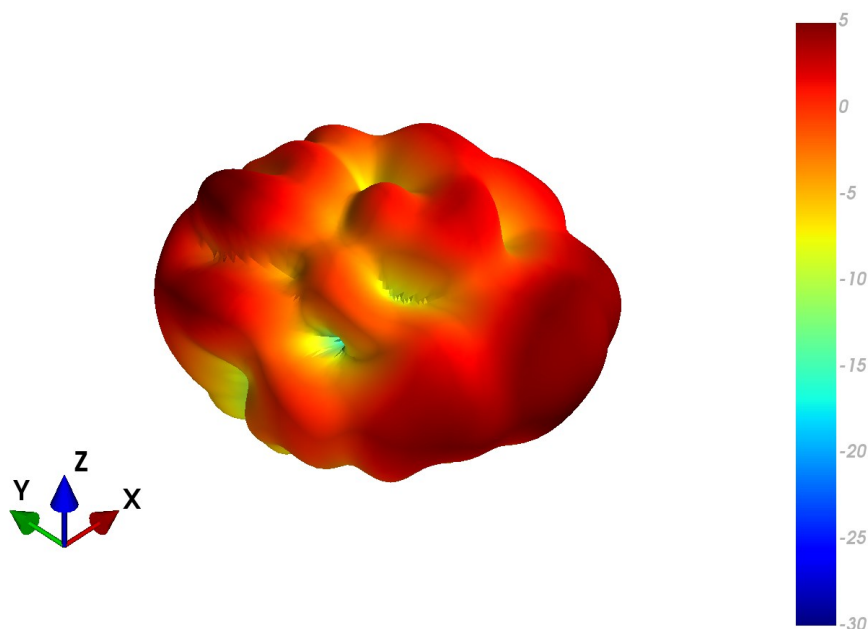
YZ Plane



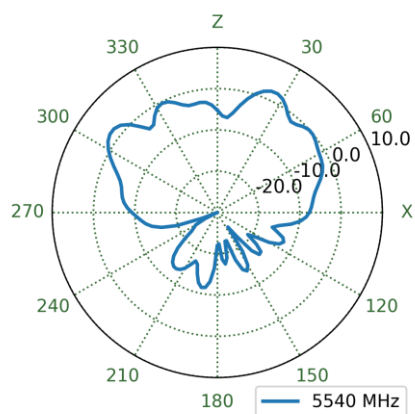
XY Plane



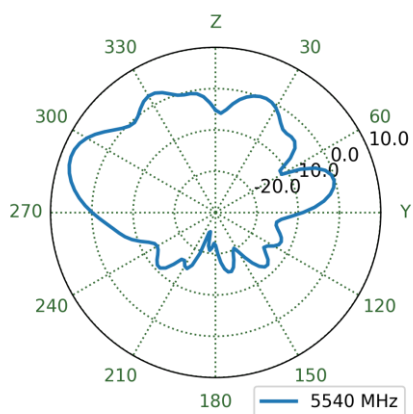
7.71 MIMO1 Cellular Ground Plane Patterns at 5540 MHz



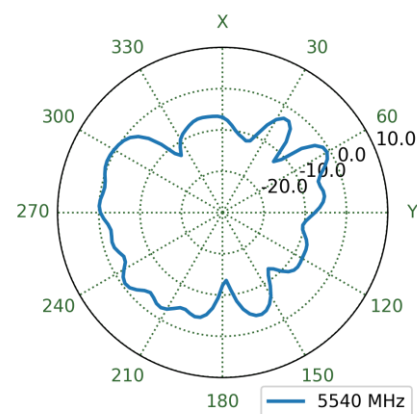
XZ Plane



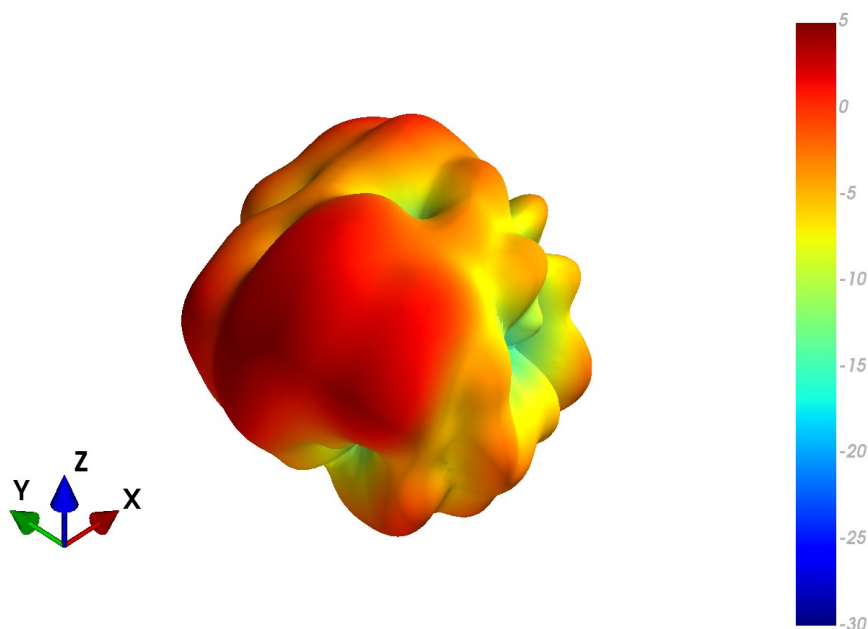
YZ Plane



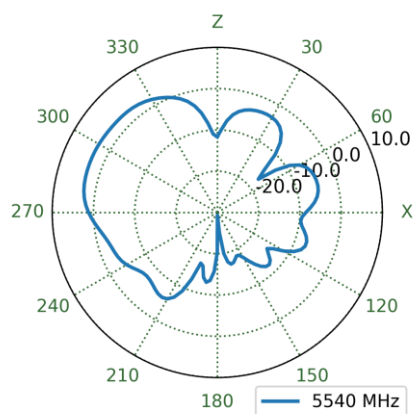
XY Plane



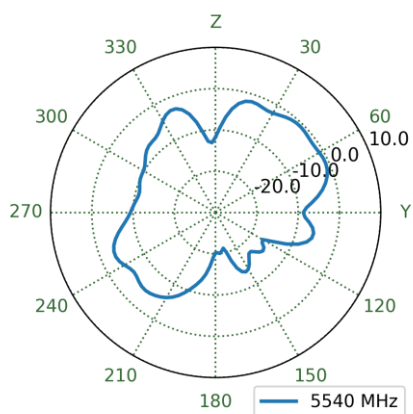
7.72 MIMO2 Cellular Free Space Patterns at 5540 MHz



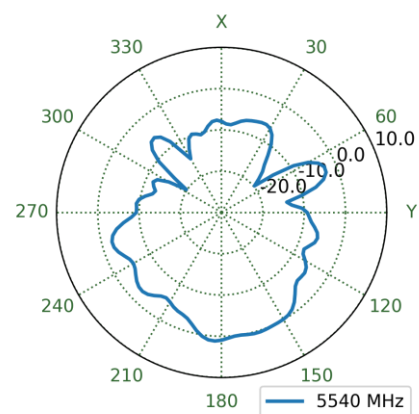
XZ Plane



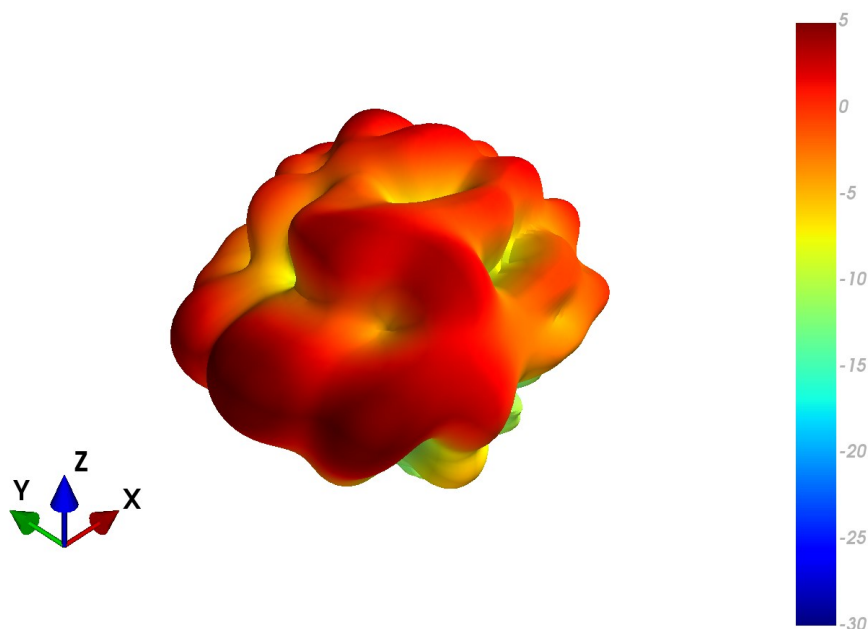
YZ Plane



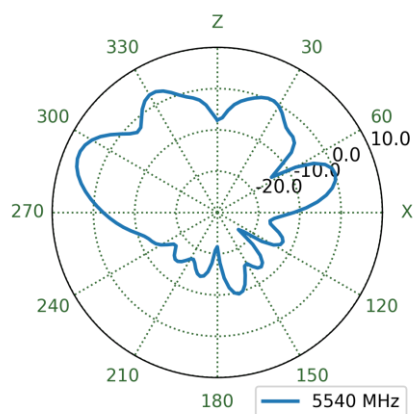
XY Plane



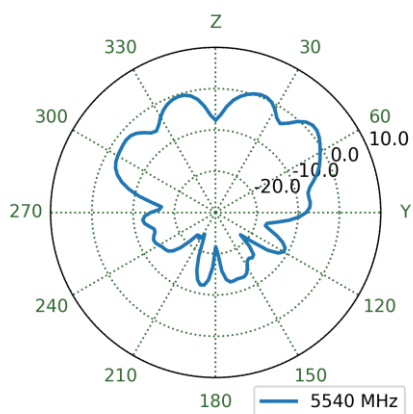
7.73 MIMO2 Cellular Ground Plane Patterns at 5540 MHz



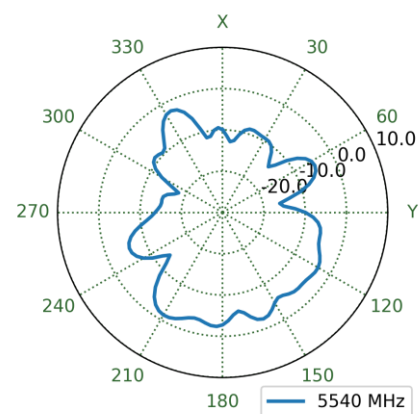
XZ Plane



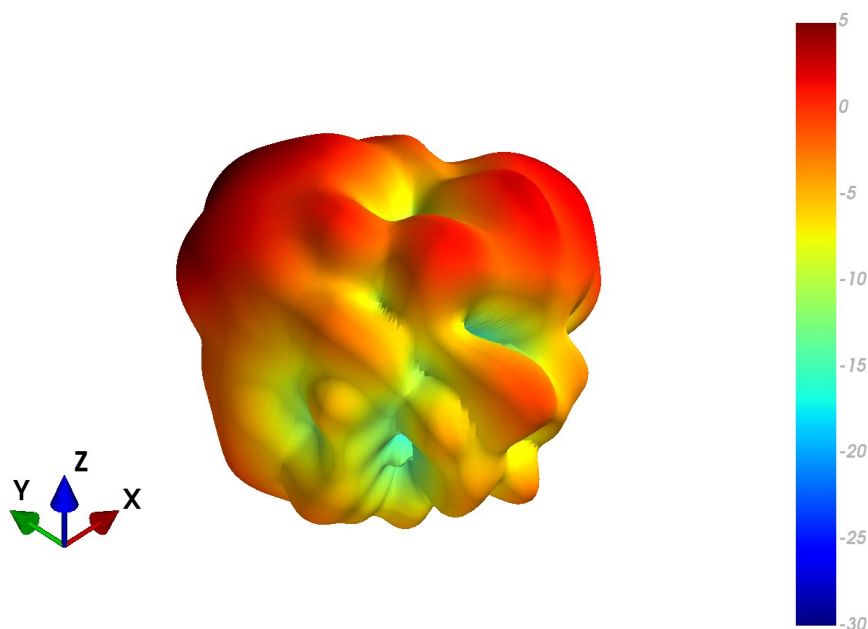
YZ Plane



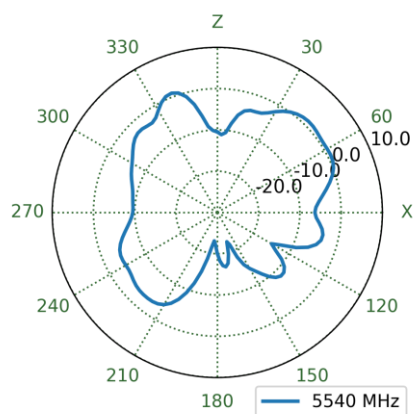
XY Plane



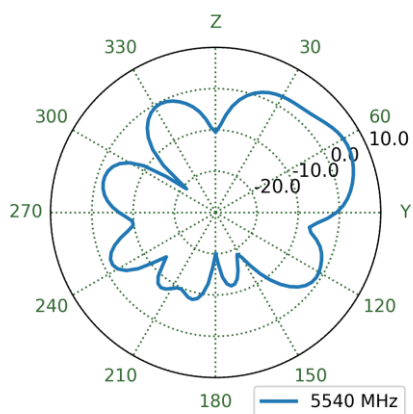
7.74 MIMO3 Cellular Free Space Patterns at 5540 MHz



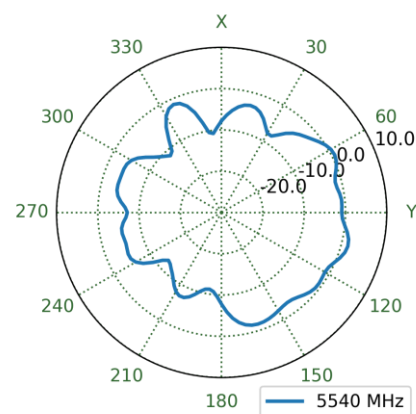
XZ Plane



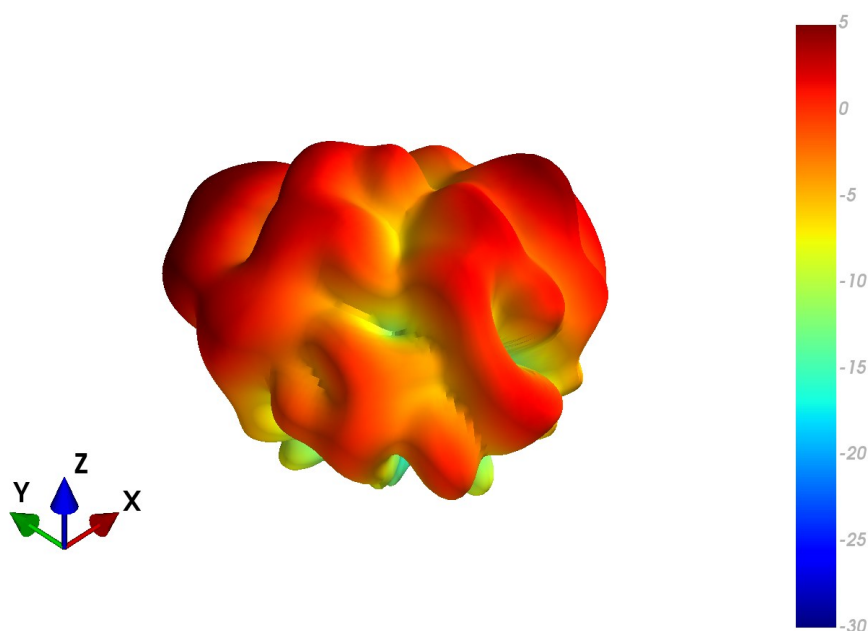
YZ Plane



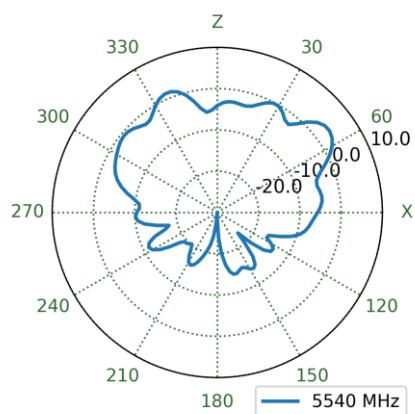
XY Plane



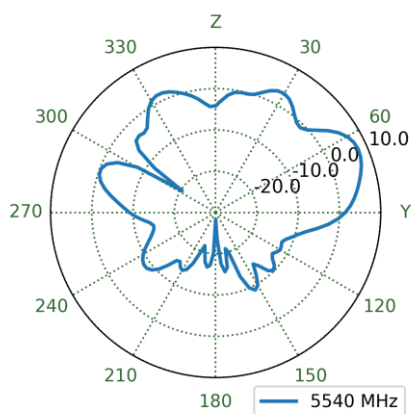
7.75 MIMO3 Cellular Ground Plane Patterns at 5540 MHz



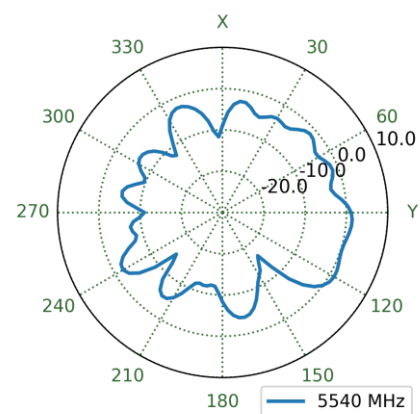
XZ Plane



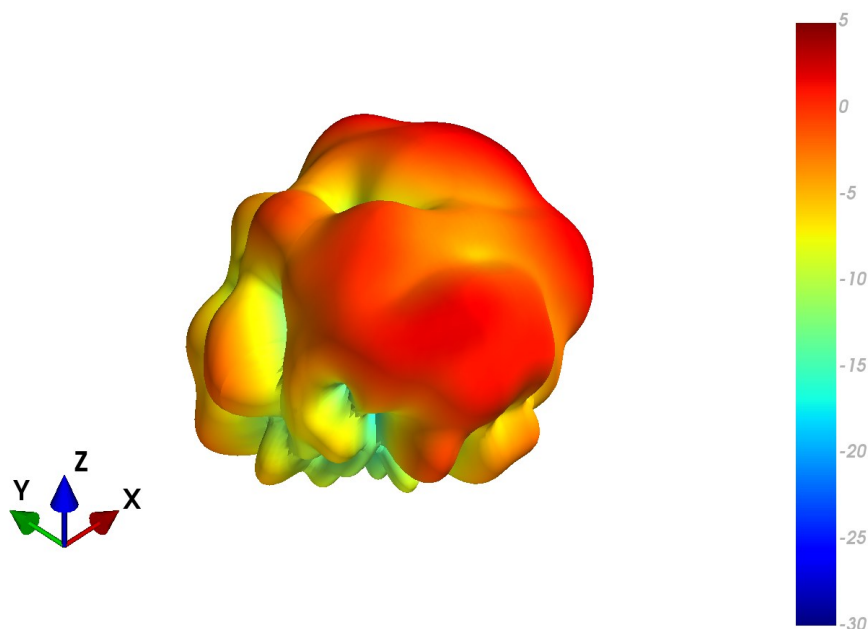
YZ Plane



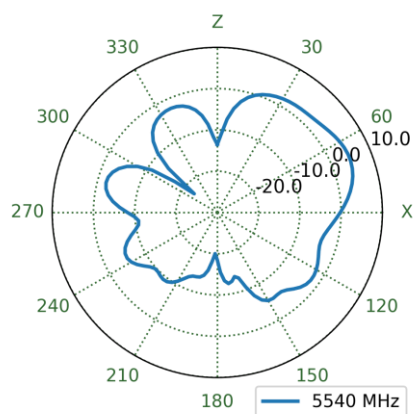
XY Plane



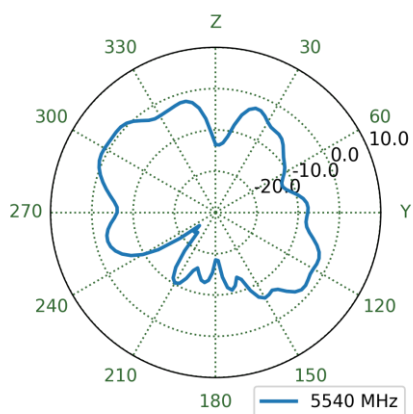
7.76 MIMO4 Cellular Free Space Patterns at 5540 MHz



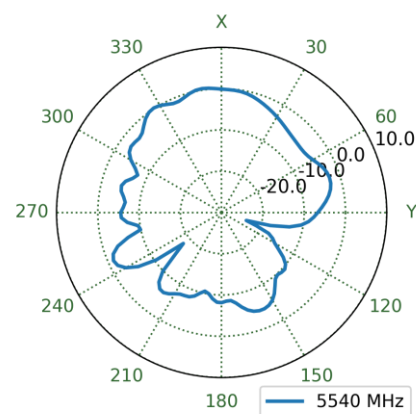
XZ Plane



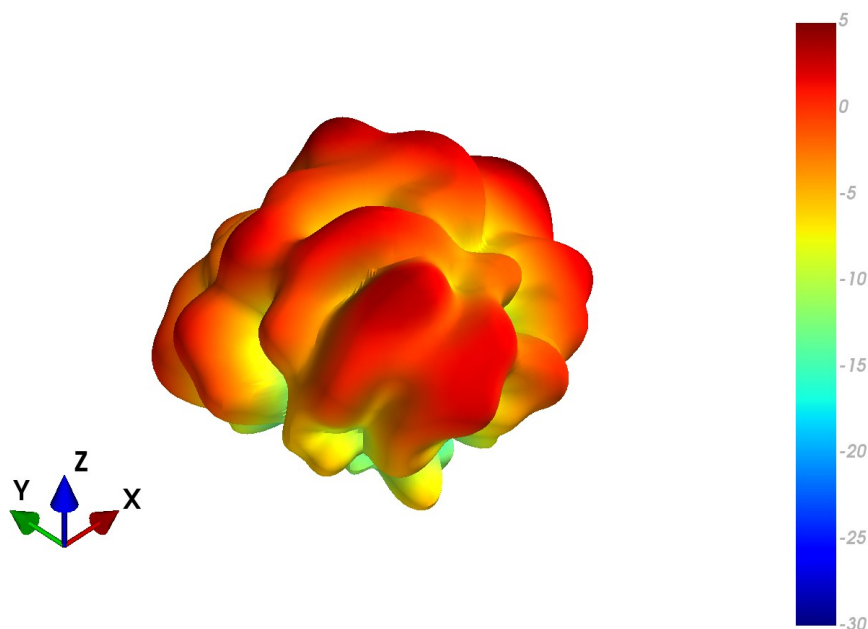
YZ Plane



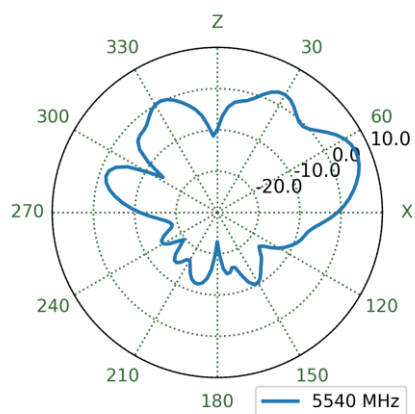
XY Plane



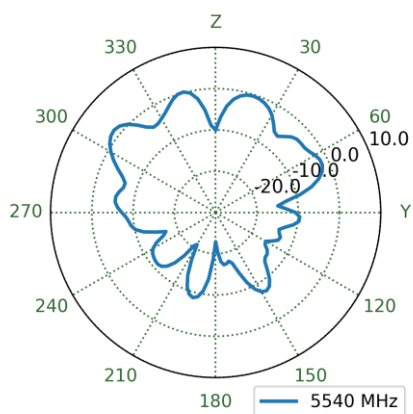
7.77 MIMO4 Cellular Ground Plane Patterns at 5540 MHz



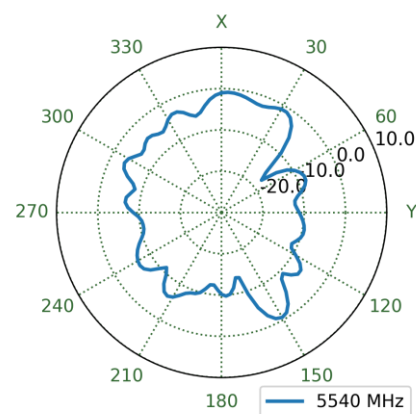
XZ Plane



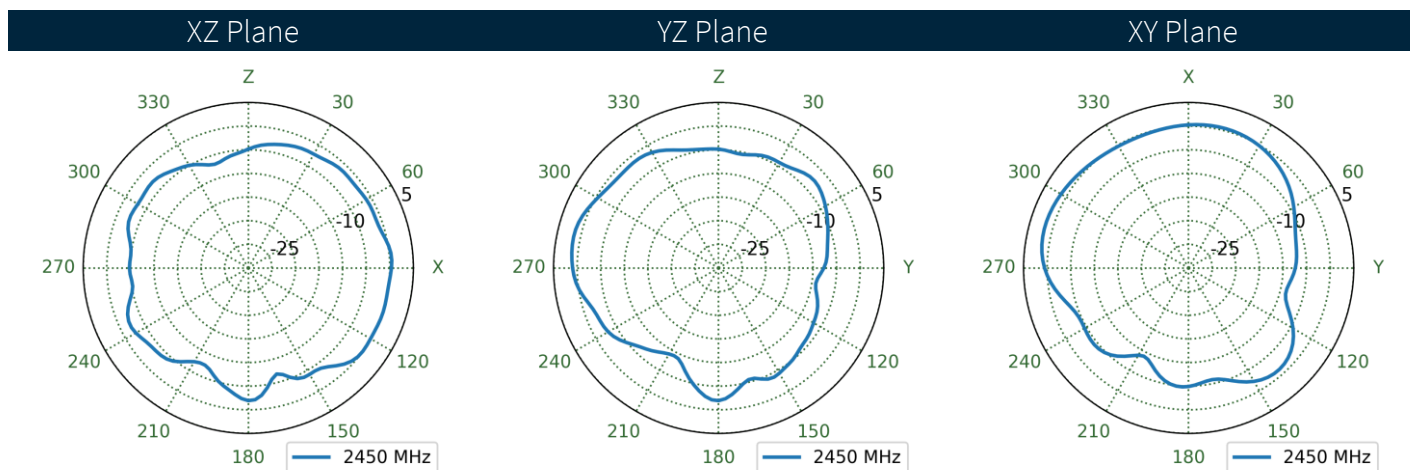
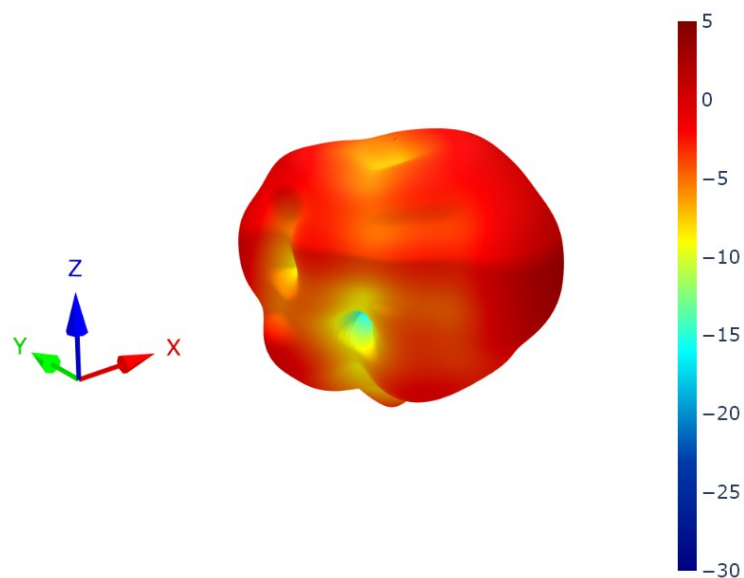
YZ Plane



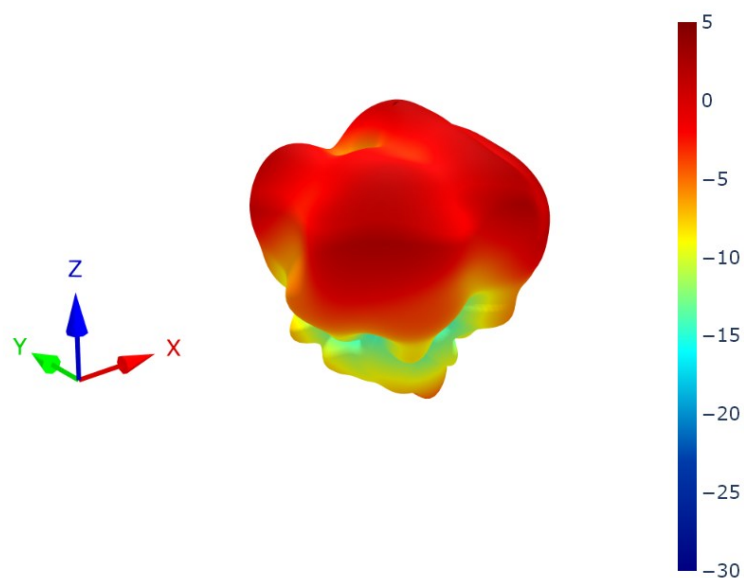
XY Plane



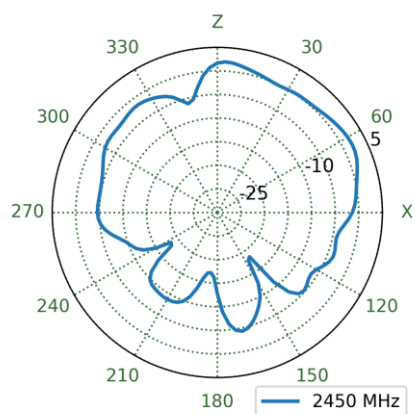
7.78 MIMO1 Wi-Fi Free Space Patterns at 2450 MHz



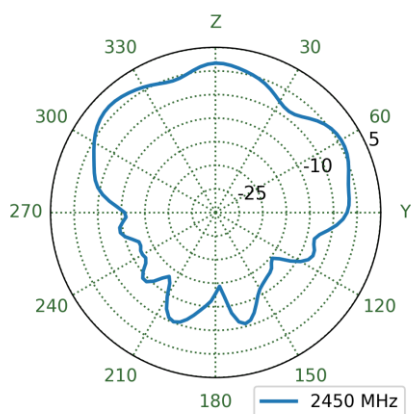
7.79 MIMO1 Wi-Fi Ground Plane Patterns at 2450 MHz



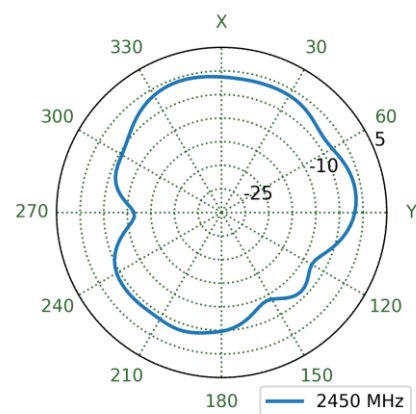
XZ Plane



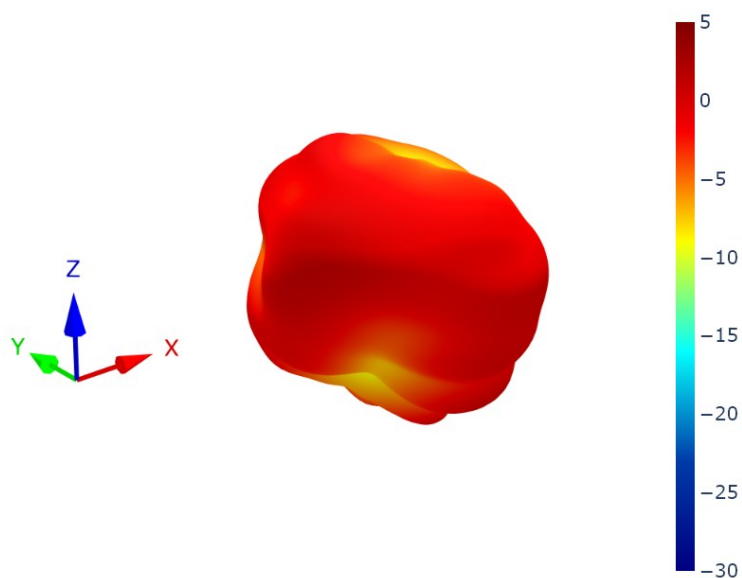
YZ Plane



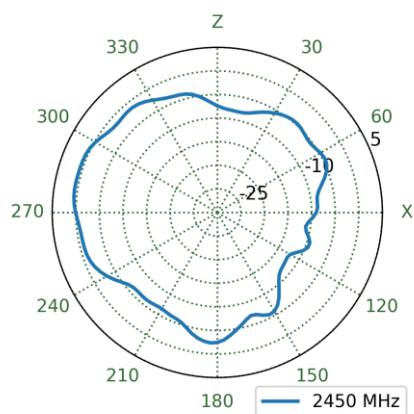
XY Plane



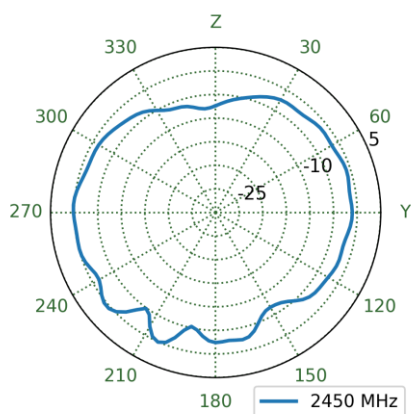
7.80 MIMO2 Wi-Fi Free Space Patterns at 2450 MHz



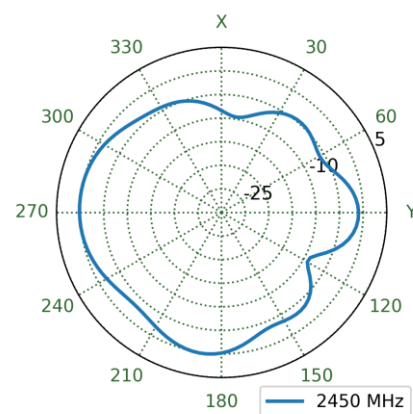
XZ Plane



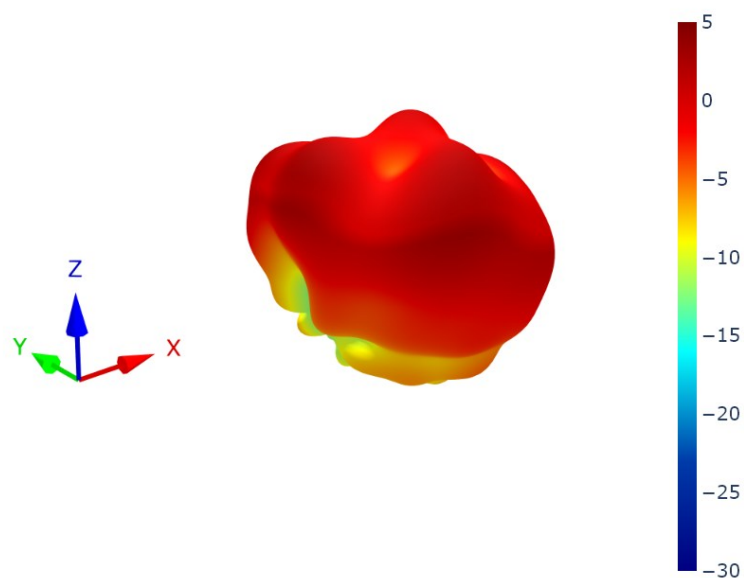
YZ Plane



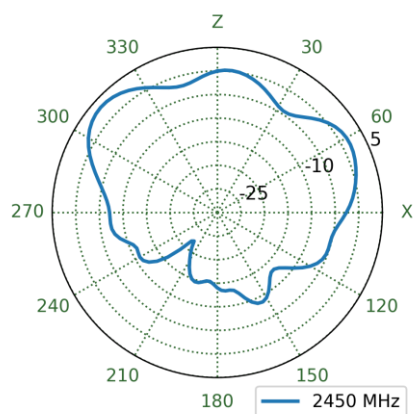
XY Plane



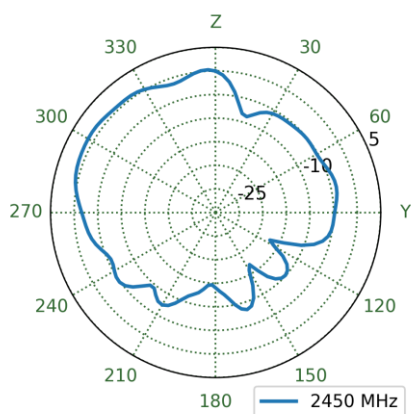
7.81 MIMO2 Wi-Fi Ground Plane Patterns at 2450 MHz



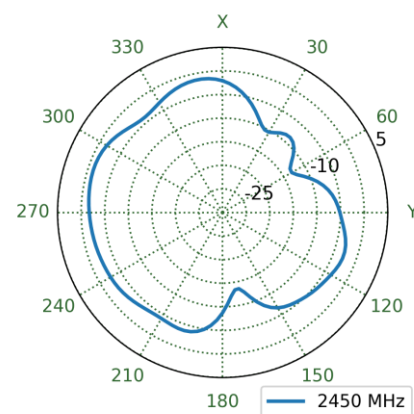
XZ Plane



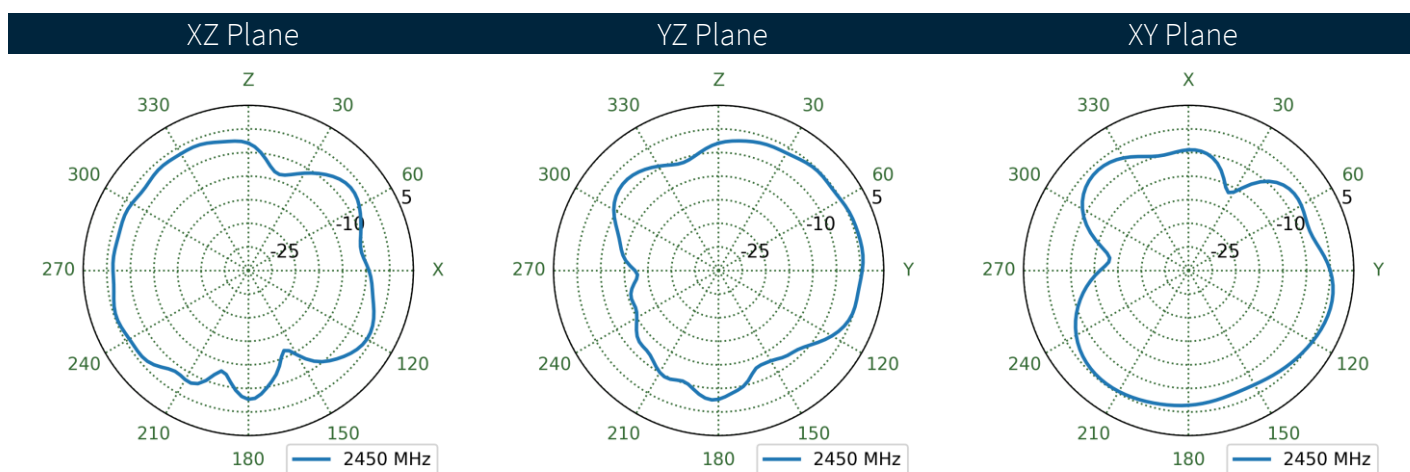
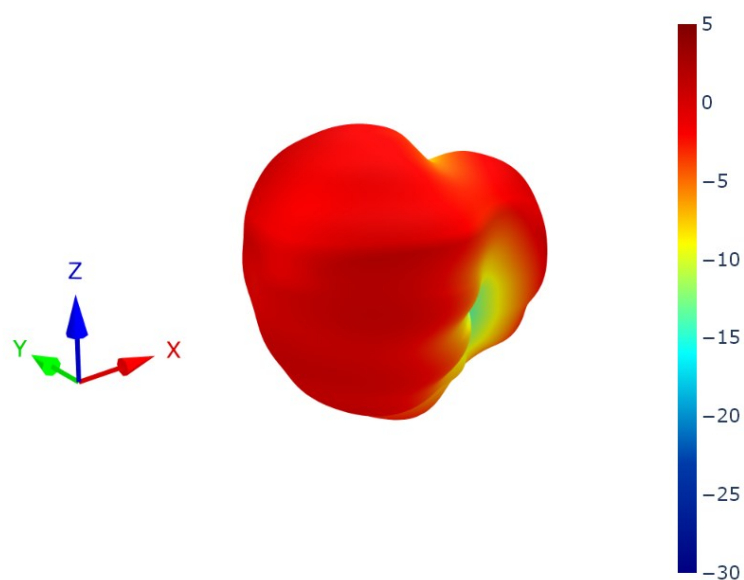
YZ Plane



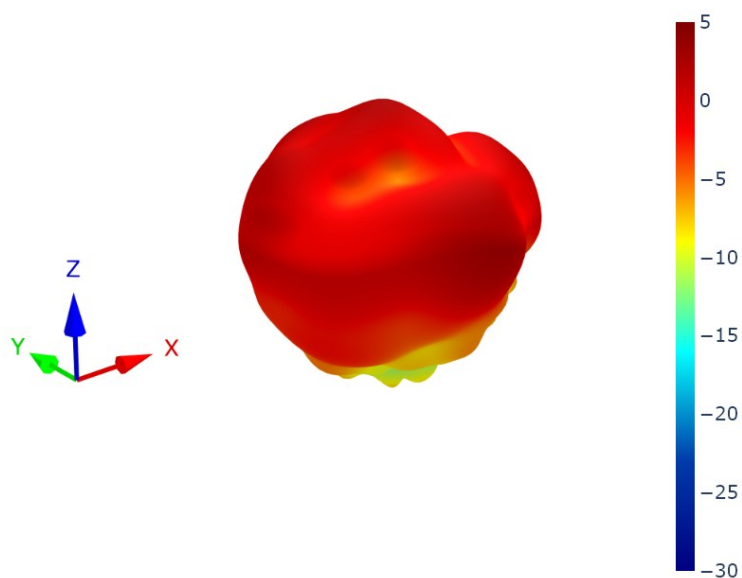
XY Plane



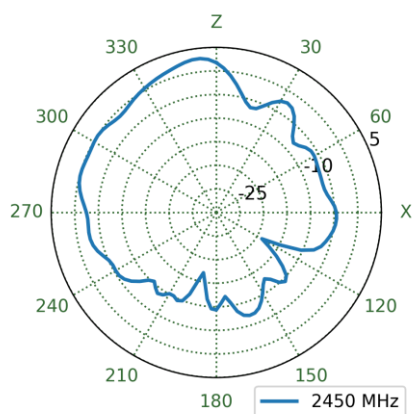
7.82 MIMO3 Wi-Fi Free Space Patterns at 2450 MHz



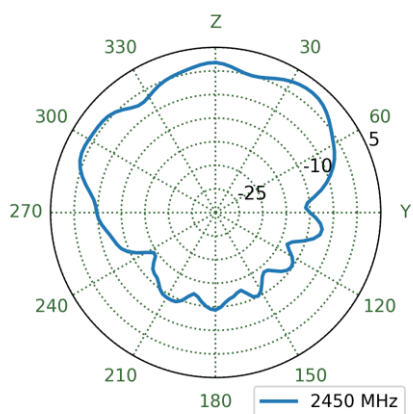
7.83 MIMO3 Wi-Fi Ground Plane Patterns at 2450 MHz



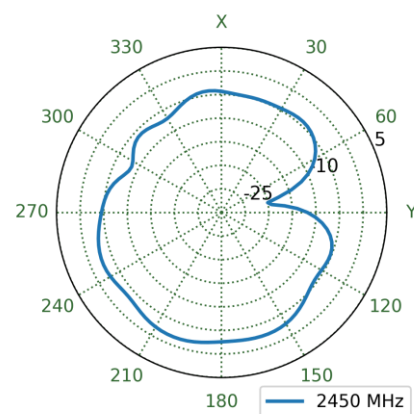
XZ Plane



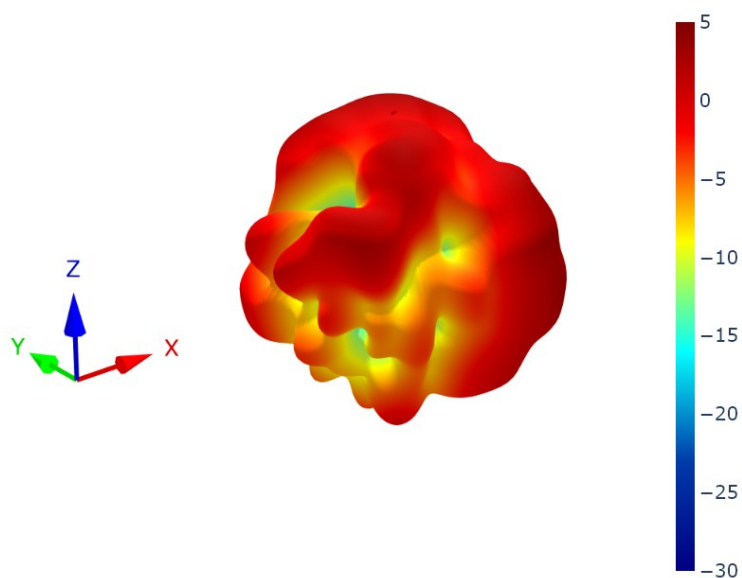
YZ Plane



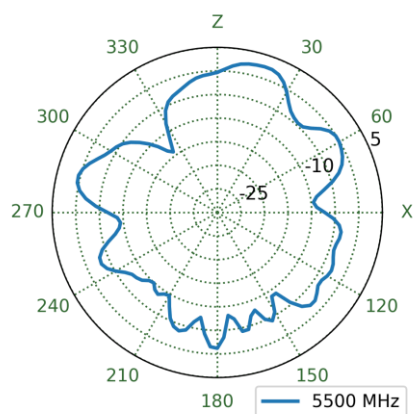
XY Plane



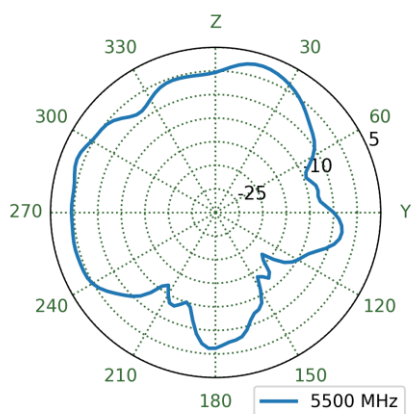
7.84 MIMO1 Wi-Fi Free Space Patterns at 5500 MHz



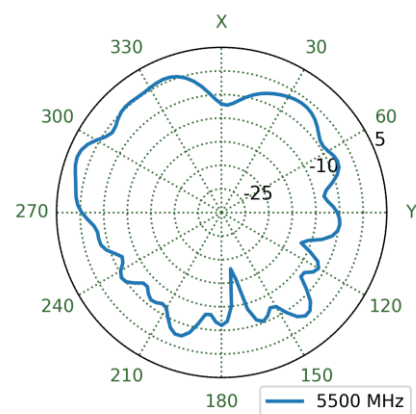
XZ Plane



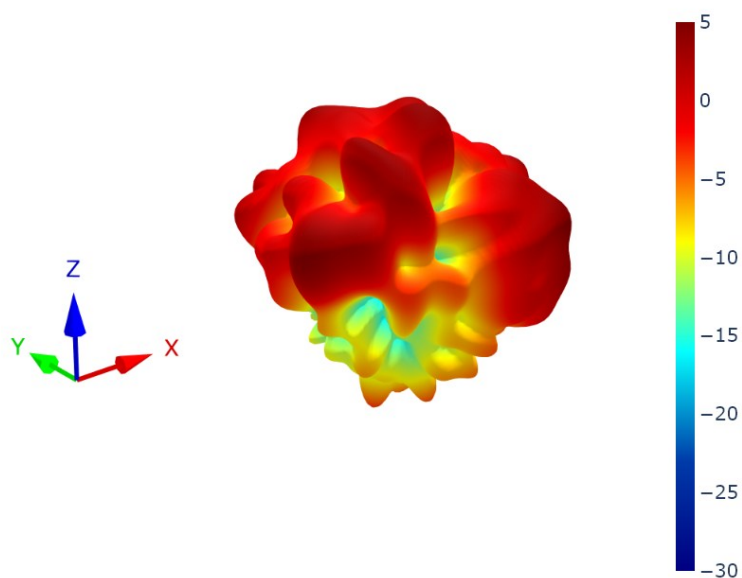
YZ Plane



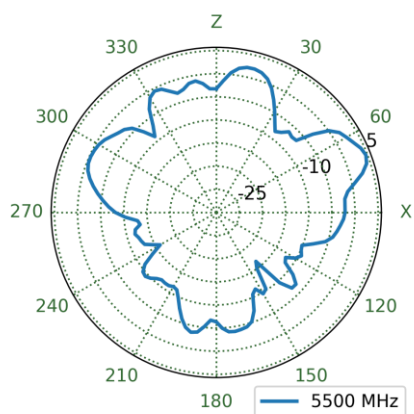
XY Plane



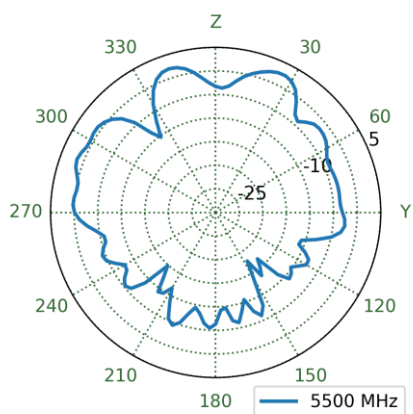
7.85 MIMO1 Wi-Fi Ground Plane Patterns at 5500 MHz



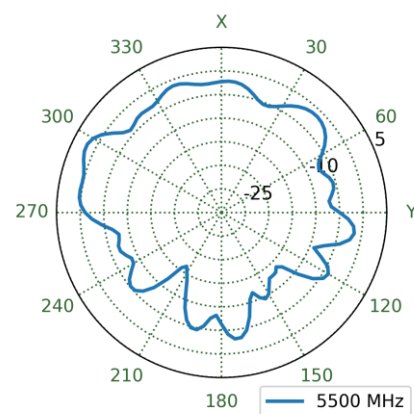
XZ Plane



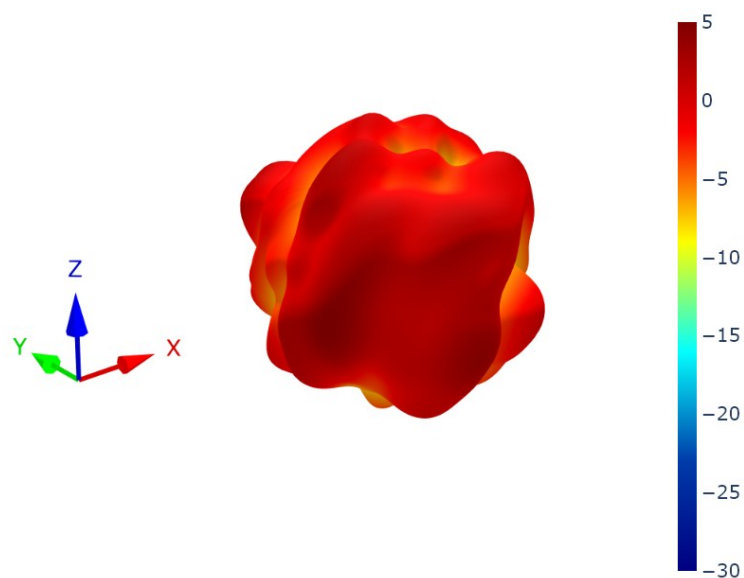
YZ Plane



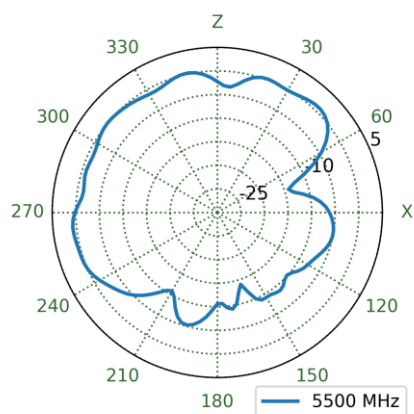
XY Plane



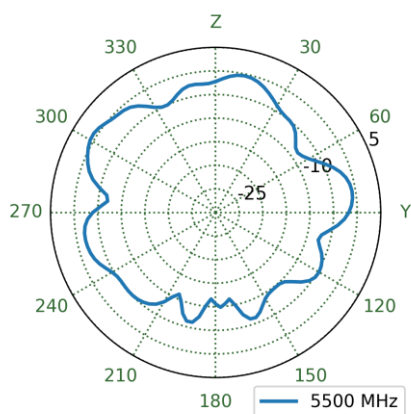
7.86 MIMO2 Wi-Fi Free Space Patterns at 5500 MHz



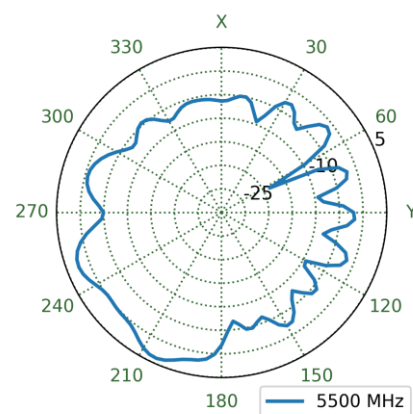
XZ Plane



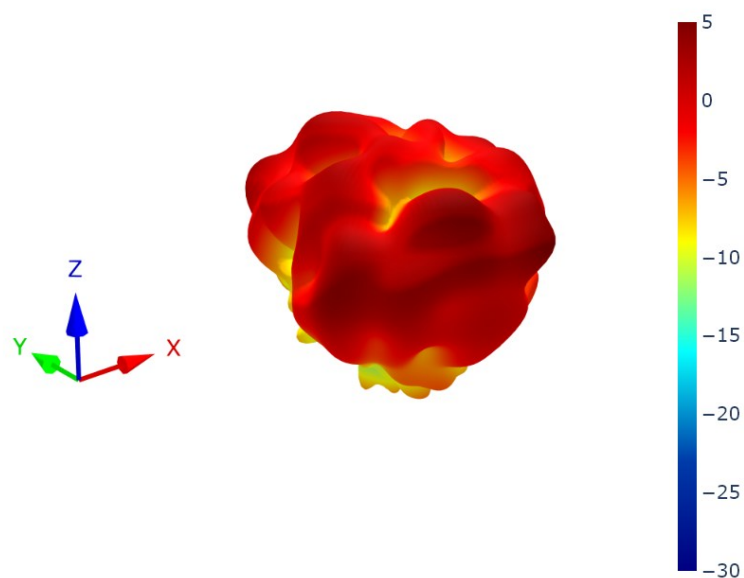
YZ Plane



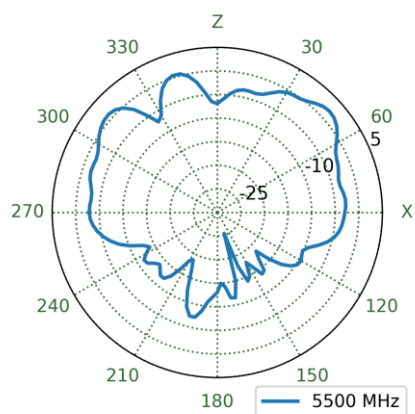
XY Plane



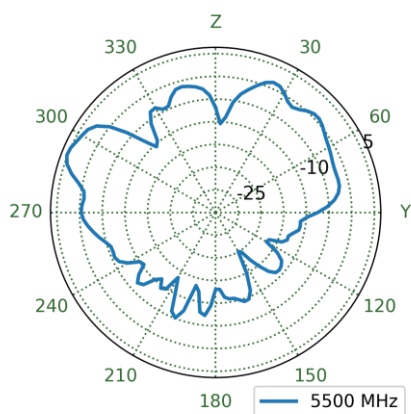
7.87 MIMO2 Wi-Fi Ground Plane Patterns at 5500 MHz



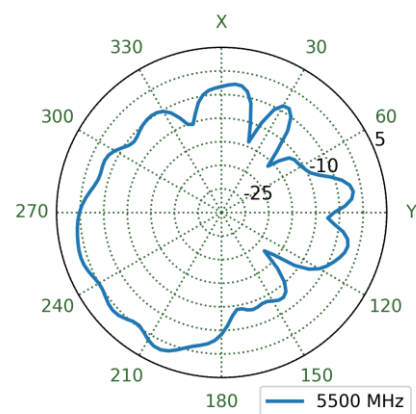
XZ Plane



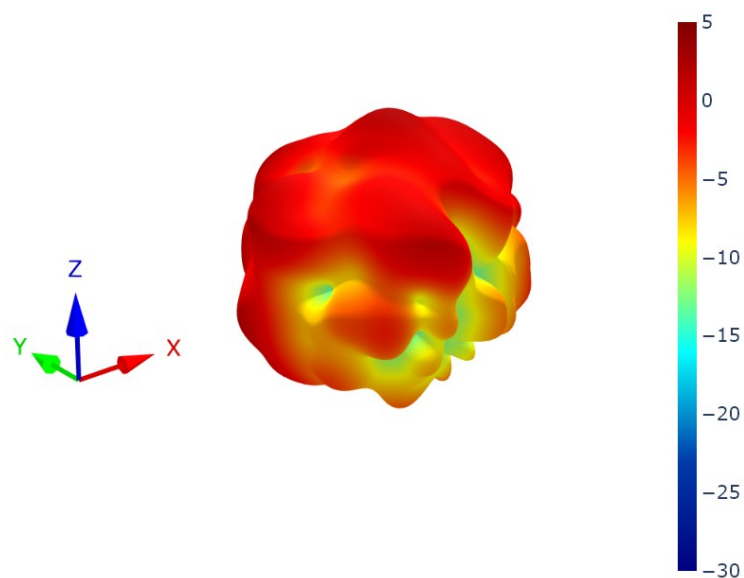
YZ Plane



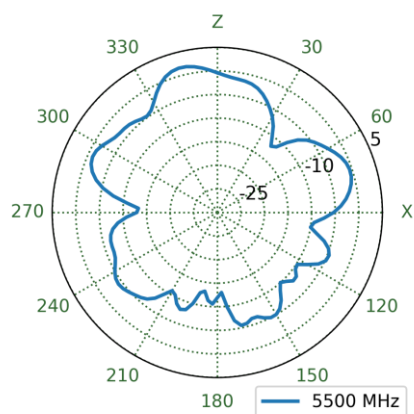
XY Plane



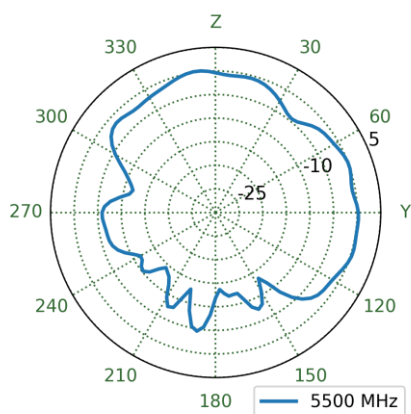
7.88 MIMO3 Wi-Fi Free Space Patterns at 5500 MHz



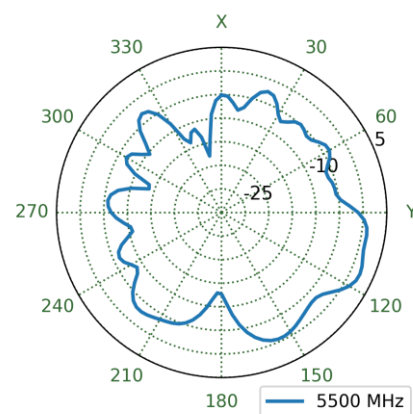
XZ Plane



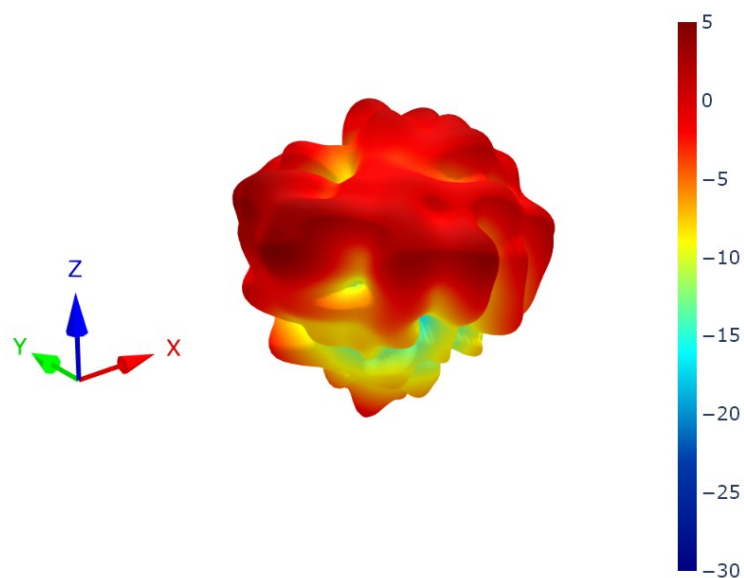
YZ Plane



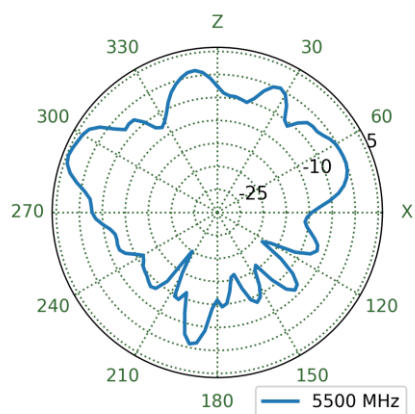
XY Plane



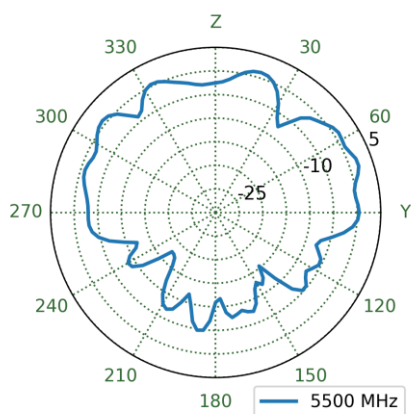
7.89 MIMO3 Wi-Fi Ground Plane Patterns at 5500 MHz



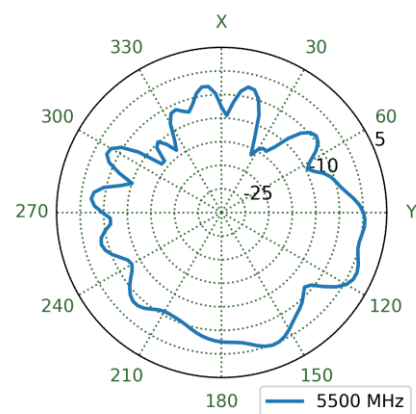
XZ Plane



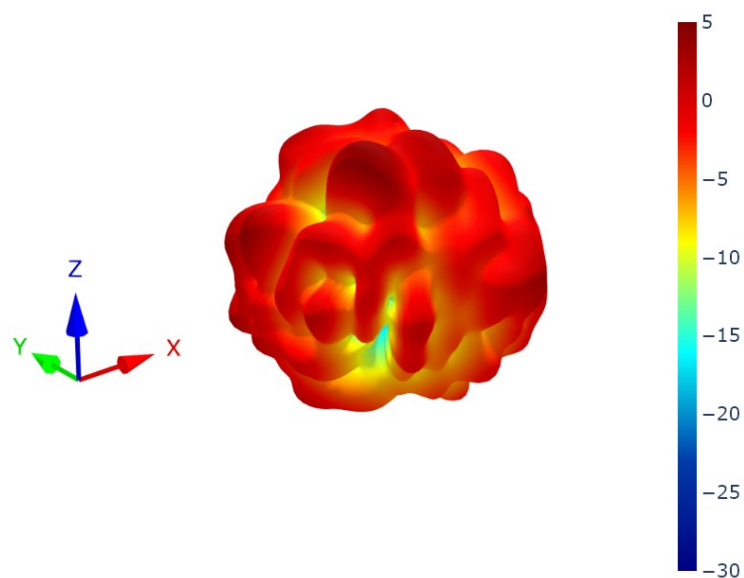
YZ Plane



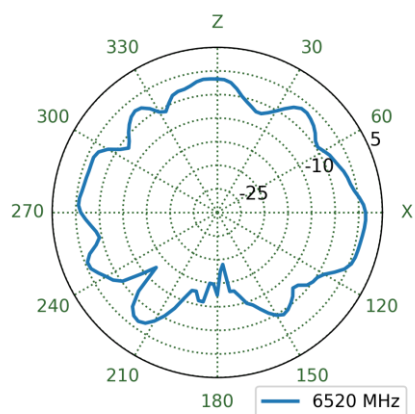
XY Plane



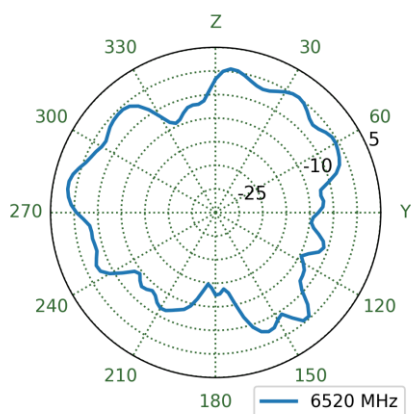
7.90 MIMO1 Wi-Fi Free Space Patterns at 6520 MHz



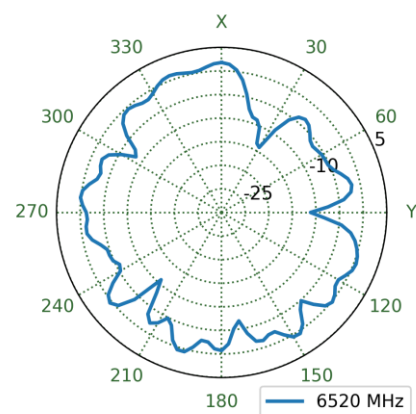
XZ Plane



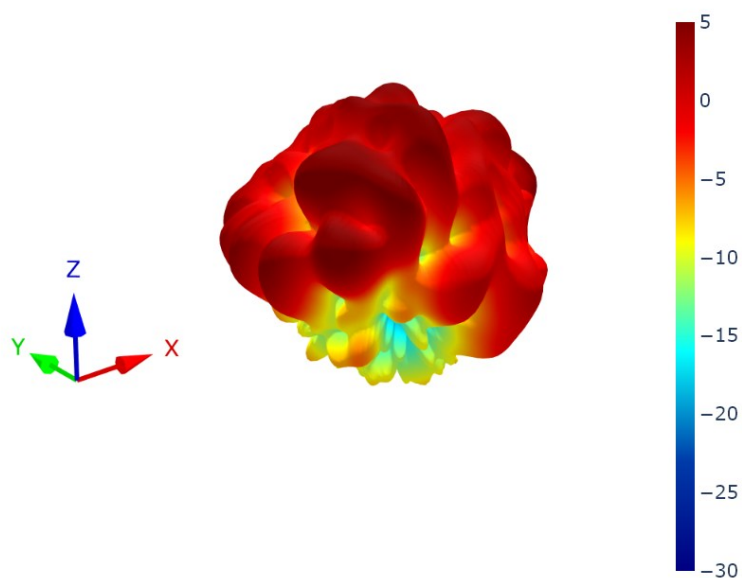
YZ Plane



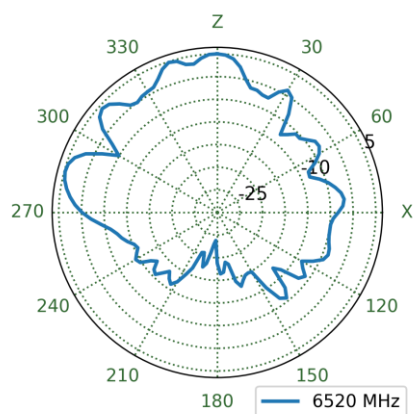
XY Plane



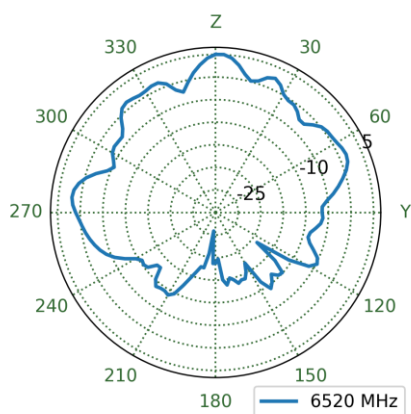
7.91 MIMO1 Wi-Fi Ground Plane Patterns at 6520 MHz



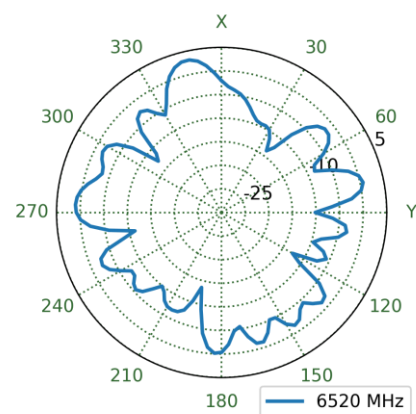
XZ Plane



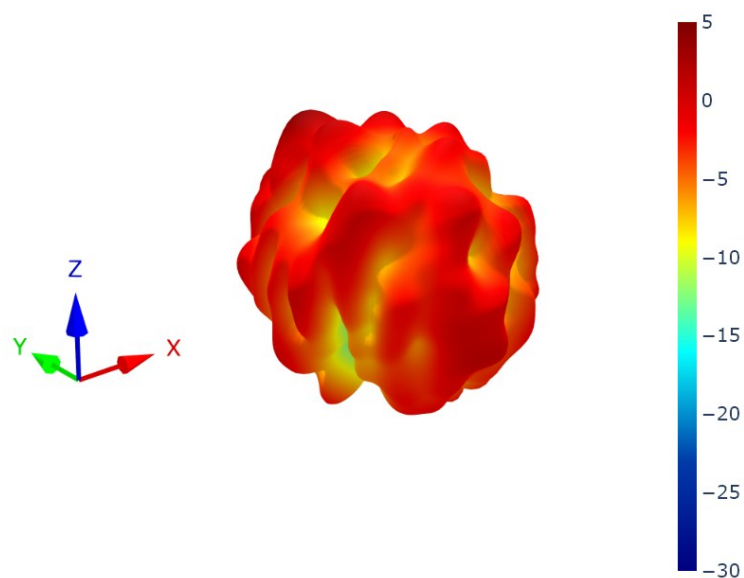
YZ Plane



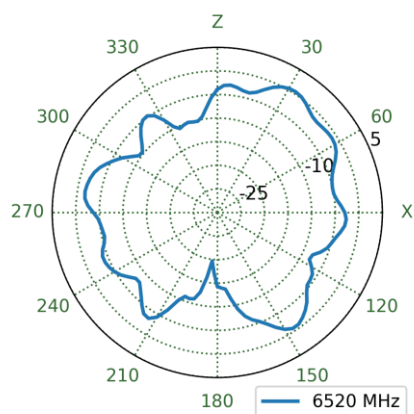
XY Plane



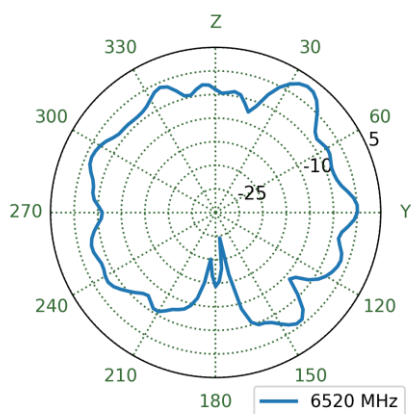
7.92 MIMO2 Wi-Fi Free Space Patterns at 6520 MHz



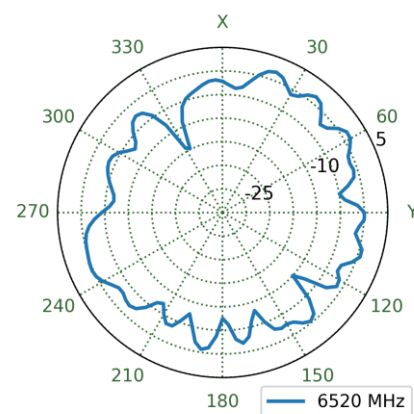
XZ Plane



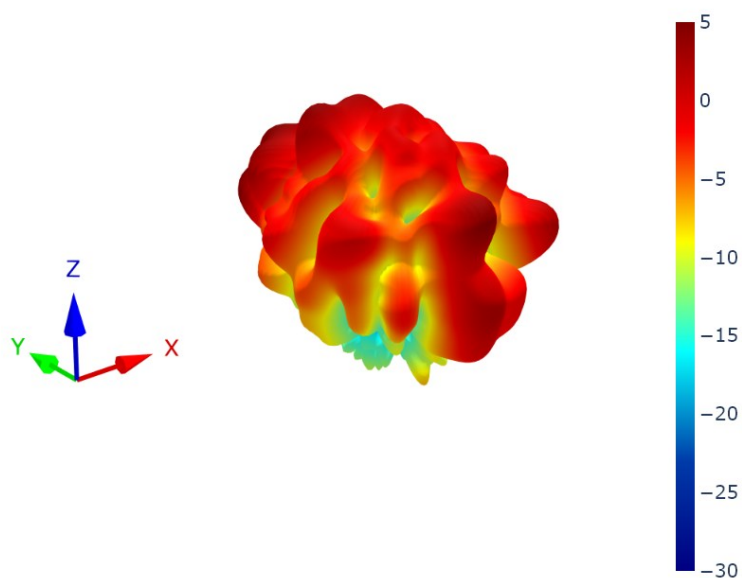
YZ Plane



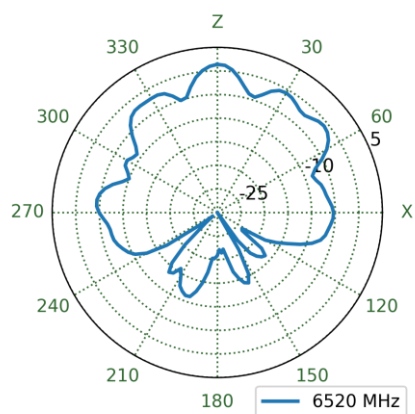
XY Plane



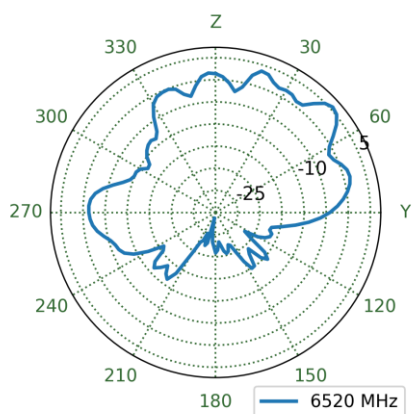
7.93 MIMO2 Wi-Fi Ground Plane Patterns at 6520 MHz



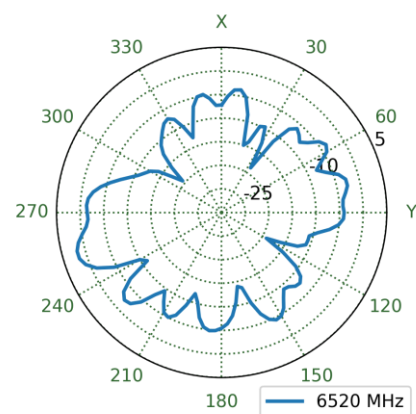
XZ Plane



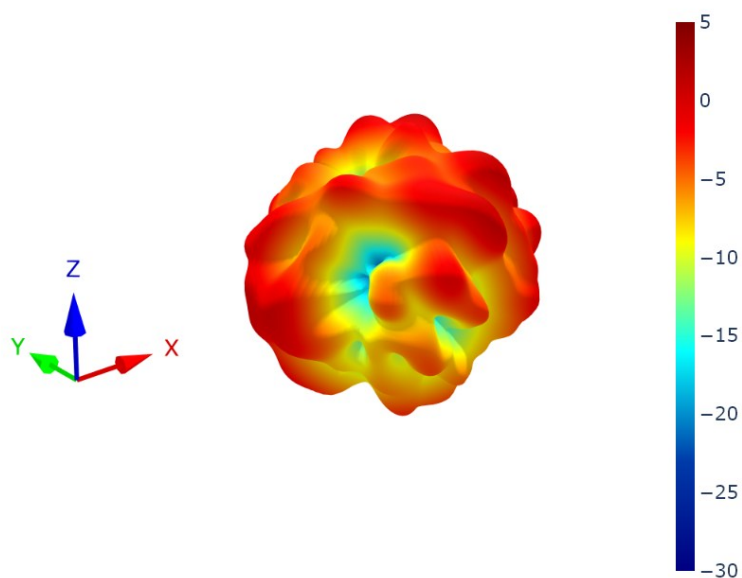
YZ Plane



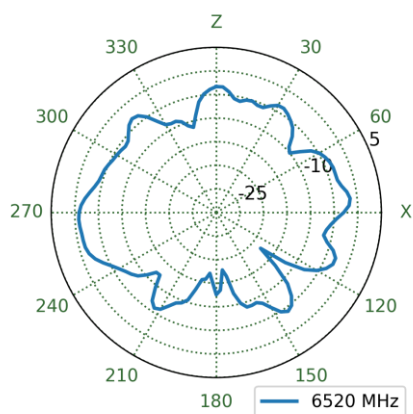
XY Plane



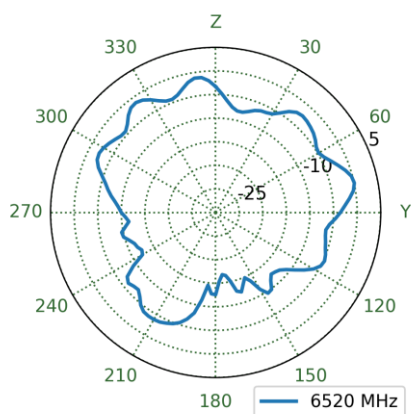
7.94 MIMO3 Wi-Fi Free Space Patterns at 6520 MHz



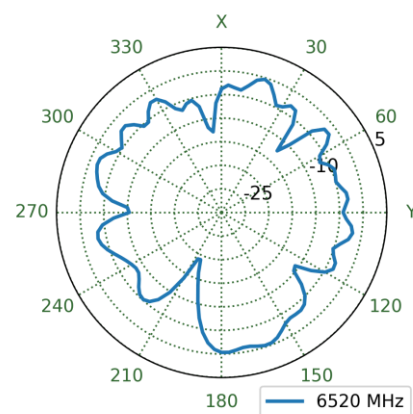
XZ Plane



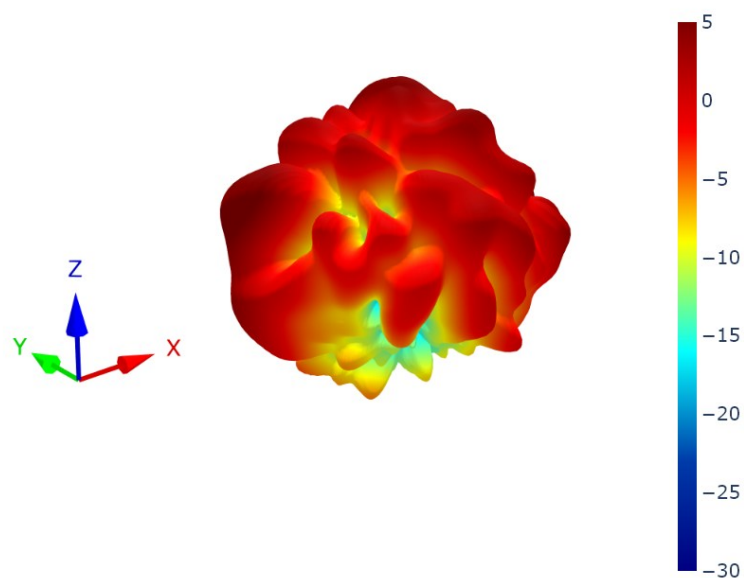
YZ Plane



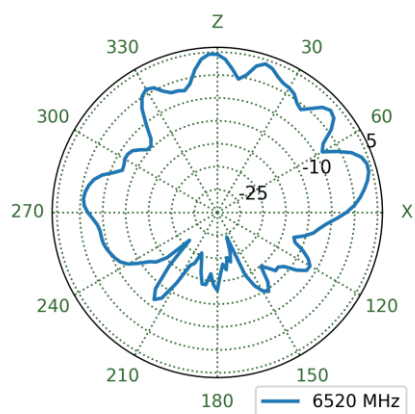
XY Plane



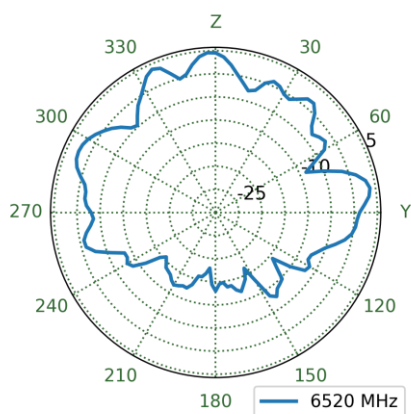
7.95 MIMO3 Wi-Fi Ground Plane Patterns at 6520 MHz



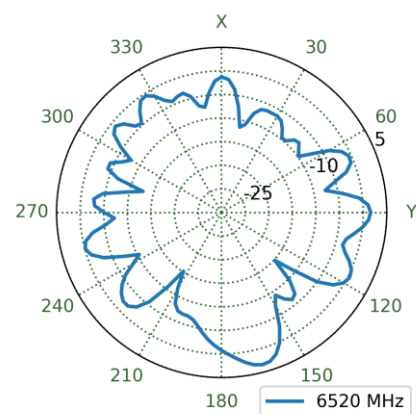
XZ Plane



YZ Plane



XY Plane



Changelog for the datasheet

SPE-25-8-292 - MA1558.W.AK.001

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Author:	Gary West

Previous Revisions



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