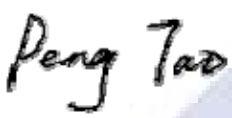
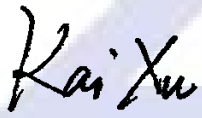
OTA TEST REPORT

Applicant	Espressif Systems (Shanghai) Co.,Ltd.
Product	ESP-WROOM-02D
Model	ESP-WROOM-02D
Report No.	Y1910A1153 -T1
Issue Date	November 12, 2019



Performed by: Peng Tao



Reviewed by: Kai Xu

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1. Test Laboratory

1.1. Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA technology (shanghai) co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein .Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2. Testing Location

Company:	TA Technology (Shanghai) Co., Ltd.
Address:	No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China
City:	Shanghai
Post code:	201201
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2. General Description of Equipment under Test

2.1. Applicant and Manufacture Information

Applicant	Espressif Systems (Shanghai) Co.,Ltd.
Applicant address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China
Manufacturer	Espressif Systems (Shanghai) Co.,Ltd.
Manufacturer address	Suite 204, Block 2, 690 Bibo Road, Zhang Jiang Hi-Tech Park, Shanghai, China

2.2. General Information

Product Name	ESP-WROOM-02D		
Model Name	ESP-WROOM-02D		
Peak gain:	2.0 dBi		
Antenna Type:	PCB Antenna		
Frequency Range(s):	Mode	Tx (MHz)	Rx (MHz)
	WIFI 2.4G:	2400 ~ 2483.5	2400 ~ 2483.5
Modulation:	WLAN 802.11b: DSSS WLAN 802.11g/n: OFDM		

2.3. Test Date

The test is performed from October 29, 2019 to November 9, 2019.

2.4. Test area environmental conditions

Temperature	Min：19℃，Max：25℃	
Relative Humidity	Min：40%，Max：72%	
Anechoic Chamber	7.40m(L)×3.66m(W)×3.66m(H)	
shielding effectiveness	0.7-6GHz	> 100dB
The impedance of the system	<0.5Ω	

3. Physical Layout and Site Description

3.1. Wireless Mobile Device Test Laboratory

Tests were performed in Company TA's state-of-the-art Wireless Mobile Device Test Laboratory consisting of a rectangular anechoic chamber equipped with a multi-axis positioning system (MAPS), two dual polarized quad-ridge waveguide horns, and one EMCO-3102 circularly polarized communication antennas. A base station simulator is used to establish communication with the EUT and place it in the proper mode and a spectrum analyzer and RF switch combination is used for measuring the signal from the EUT at each position and polarization. TA Polairs Measurement Software is used for data acquisition, post-processing, and generation of the required output.

3.2. Anechoic Chamber

The anechoic chamber is a rectangular anechoic chamber designed and built by ETS-Lindgren in July 2006 with the following nominal dimensions

Length:	7.40 m (24 ft)
Width:	3.66 m (12 ft)
Height:	3.66 m (12 ft)

The anechoic chamber consists of a shielded enclosure constructed of rigid, steel-clad, wood core modular panels with steel framing. The chamber is treated with ETS-Lindgren's microwave absorber, utilizing both pyramidal and wedge shaped absorber. Lighting in the chamber is RF-filtered and consists of two (2) incandescent lamps mounted in recessed waveguide vents in the chamber ceiling. The chamber is forced air ventilated to maintain it at the same ambient as the surrounding facility. A single leaf swing type shielded door is provided for equipment and personnel access into the chamber. The Anechoic Chamber is capable of meeting RF attenuation levels of over 100 dB throughout the frequency range of 30 MHz to 18 GHz, so that testing performed within the chamber does not interfere with other testing activities at the facility, and vice-versa. Power is supplied on separate circuits to the chamber and control area. All power filters provide a minimum of 100 dB attenuation over a frequency range of 14 kHz to 18 GHz when tested per MIL STD 220A.

3.3. Multi Axis Positioning System (MAPS™)

The MAPS™ positioning system is capable of rotating the article under test (AUT) on both theta and phi axes with full 360 degree angular range on each axis, while keeping the AUT on the center of both rotation axes. Under normal conditions it provides 0.1 degree positioning accuracy. In conjunction with the TA Polairs Pattern Measurement Software, it can perform positioning for data acquisition in both continuous and stepped movement modes.
The MAPS™ utilizes different support structures for the second axis based on the required load. A stronger medium-duty support is used for the free-space and SAM phantom head testing. During the SAM head test, the support structure is largely shadowed by the phantom so that its effects are negligible. The electrically driven MAPS™ does not introduce conducted or radiated electrical noise above the ambient levels existing with the chamber. MAPS™ rotation is controlled by an EMCO Model 2090 Multi-device Controller with IEEE-488 data/control for automation.

3.4. Quiet Zone

The phi-axis ripple test covers a quiet zone cylinder 300 mm in diameter and 300 mm long and the Theta-axis ripple test covers a quiet zone sphere 300 mm in diameter. The quiet zone volume was qualified for each axis of the MAPS and polarization of the receive antenna per an internal test plan that encompasses the requirements of the Cellular Telecommunications & Internet Association (CTIA) Method of Measurement for Over-The-Air Radiated RF Power and Receiver Performance.

3.5. EMCO Model 3164-04 Diagonal Dual-Polarized Horn

The apex of the anechoic chamber is equipped with an EMCO Model 3164-04 Diagonal Dual Polarized Quad-Ridge Waveguide Horn Antenna. This antenna is designed for wireless test applications and covers all currently known wireless service frequencies. The antenna has two orthogonally placed input feeds that permit simultaneous measurements for dual polarizations. The antenna can be used for both linearly and circularly polarized waves (with the addition of a quadrature hybrid coupler) over a very broad frequency range.

3.6. EMCO-3102 Circularly Polarized Communication Antennas

To the top of the MAPS is fitted with a broadband circularly polarized communication antenna (EMCO Model 3102 Conical Log Spiral) to provide a relatively low loss link to the base station simulator in any position. A 60-dB limited amplifier is installed to stabilize the uplink radio signal to CMW500 port. This feature provides a very robust radio-link between the mobile phone and the Radio Communication Tester. Therefore, the TRP/TIS measurement can be conducted without dropping the links. There is another Communication antenna (EMCO Model 3102L Conical Log Spiral) on the floor using for desence test.

3.7. EMQuest V1.0.9 Software

ETS-Lindgren's EMQuest V1.0.9 proprietary pattern measurement software is used to automate the data acquisition process and provides all post-processing calculations and data output required by the CTIA. Its parameterized test configuration system and conscientiously validated design helps to insure repeatable and correct results. Safeguards prevent data tampering and insure that the original "raw" measured data is always available for review.

4. General Test Set Up

In order to get as reproducible results as possible, an antenna fully anechoic room (AFAR) shall be used. Basically Vodafone accept the use of a set up according to CTIA or 3GPP.

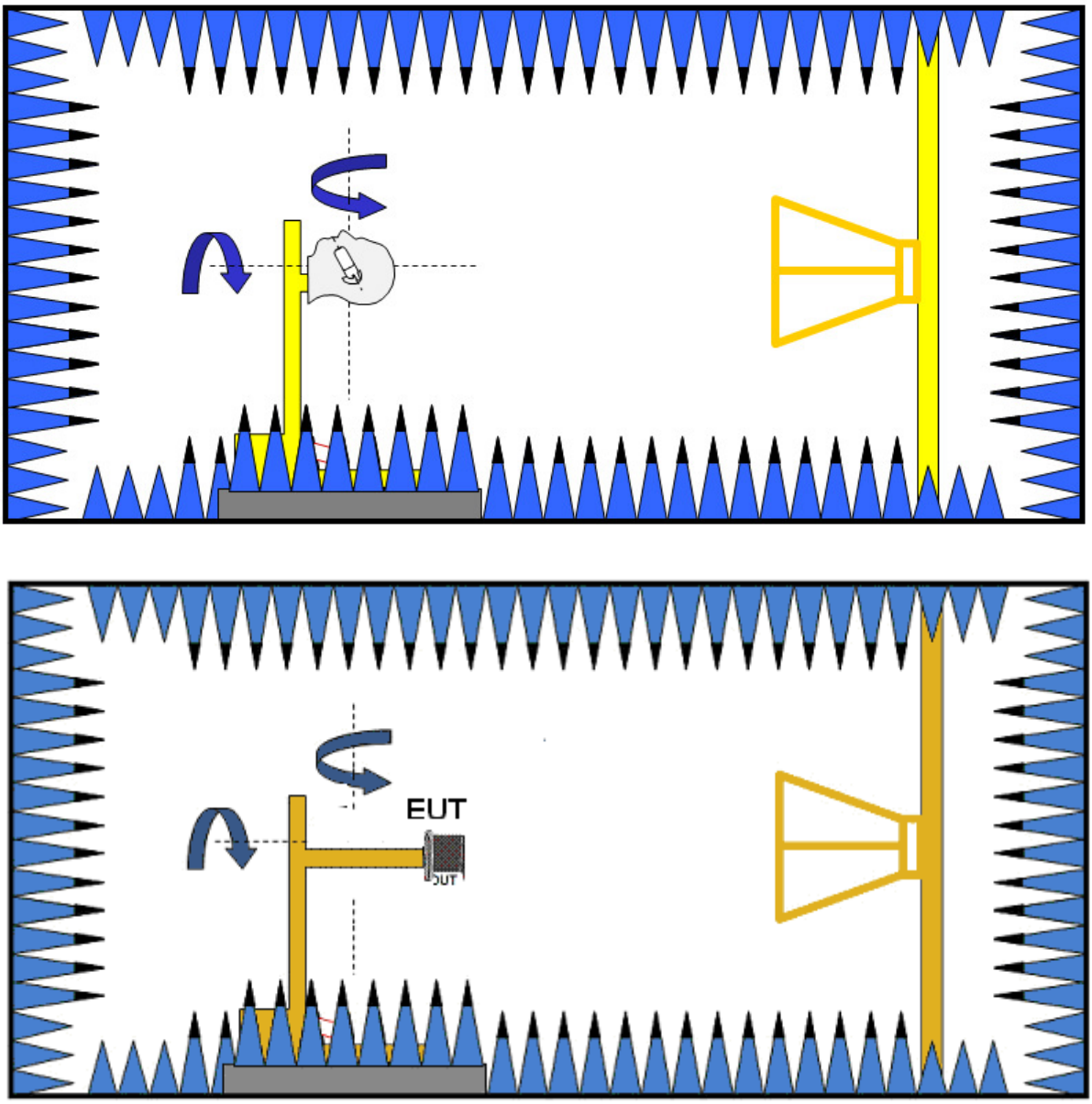


Figure 1 Set up using a two-axis controller and one measurement antenna.

The distance between measurement antennas and the equipment under test (EUT) is 5 m. The EUT is being rotated around two axis and one measurement antenna is used. The figure 1 is the test setup and the hand is omitted in the diagrams for clarity but an appropriate CTIA hand must be used for measurements.

5. Measurement Procedure

5.1. Frequencies tests

Tab. 1: Frequencies and channel numbers to be used for TRP and TIS measurements

Frequency	2.4 GHz	
Low	1	2412 MHz
Middle	7	2442 MHz
High	13	2472 MHz

Power and sensitivity shall be measured at least at three channels representing the start, mid area and end of the appropriate frequency band.

5.2. Wi-Fi Total Radiated Measurements (TRP/TIS)

Test Setup

Typical system schematics for both TRP and TIS measurements are shown in the following figures. The configurations shown are only representative examples of test systems configuration.

The figure below shows a simplified block diagram showing a configuration for TRP measurement. The uplink communication is transmitted through the measurement antenna and the downlink is transmitted through the link antenna. This configuration supports amplification of both signal paths if necessary.

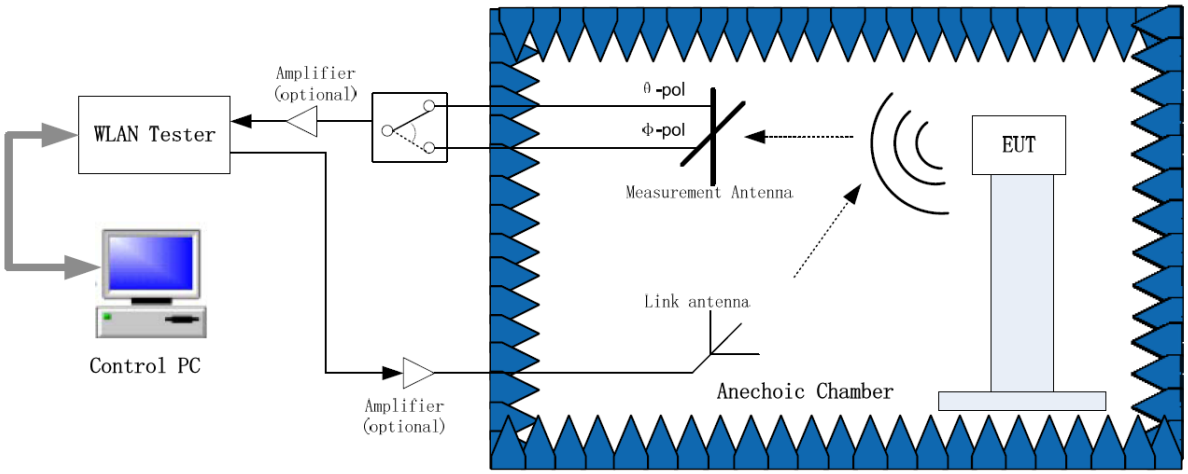


Figure 5- 1 Simplified block diagram showing a configuration for TRP measurement

The figure below shows a simplified block diagram showing a configuration for TIS measurement. The downlink communication is transmitted through the measurement antenna and the uplink is transmitted through the link antenna. This configuration supports amplification of both signal paths if necessary.

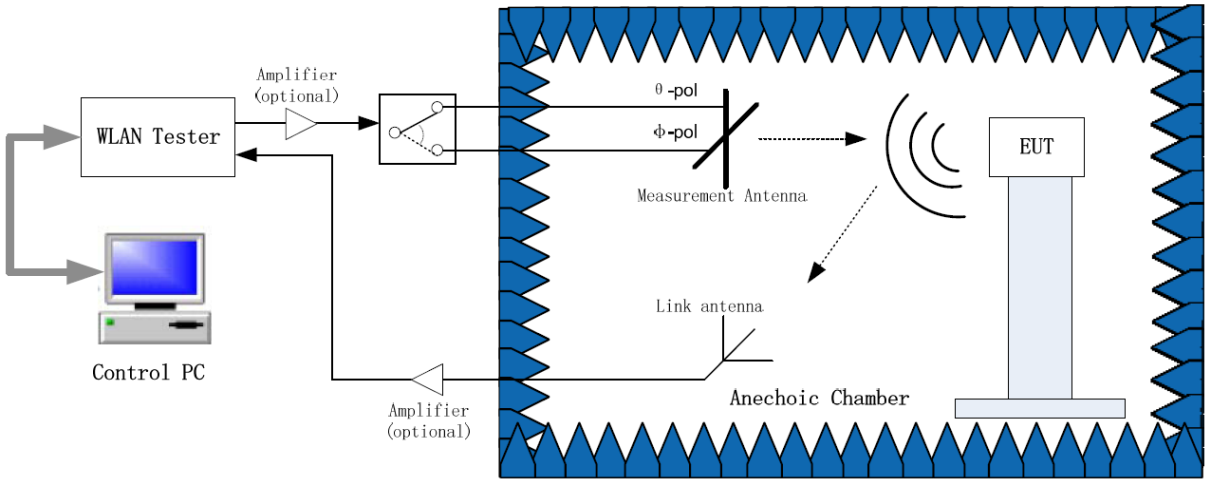


Figure 5- 2 Simplified block diagram showing a configuration for TIS measurement

6. Test Results

6.1. TRP Test

Test Item	Test State	Band	Data Rates	Channel	Result (dBm)	EIRP (dBm)	Note
TRP	FS	B	1	1	17.09	20.37	15°
			1	7	16.79	20.35	
			1	13	16.94	20.36	
			11	1	17.24	20.56	
			11	7	16.99	20.53	
			11	13	17.11	20.51	
		G	6	1	17.20	20.51	
			6	7	16.92	20.43	
			6	13	17.13	20.53	
			54	1	12.65	16.85	ICMP/15°
			54	7	13.01	17.11	
			54	13	13.50	17.92	
		N HT20	MCS0	1	16.08	21.39	ICMP/15°
			MCS0	7	16.20	20.67	
			MCS0	13	16.11	20.41	
			MCS7	1	11.49	16.56	ICMP/15°
			MCS7	7	11.14	15.14	
			MCS7	13	12.05	16.16	

6.2. TIS Test

Test Item	Test State	Band	Data Rates	Channel	Result (dBm)	Note
TIS	FS	B	1	1	-91.46	30°
			1	7	-94.56	
			1	13	-94.82	
			11	1	-87.02	
			11	7	-86.90	
			11	13	-86.87	
		G	6	1	-89.80	
			6	7	-89.75	
			6	13	-89.51	
			54	1	-72.73	
			54	7	-71.94	
			54	13	-72.26	
		N HT20	MCS0	1	-87.89	
			MCS0	7	-88.35	
			MCS0	13	-88.12	
			MCS7	1	-68.18	
			MCS7	7	-67.84	
			MCS7	13	-68.00	

7. Measurement Uncertainty

The expanded measurement uncertainties (k = 2) for the TRP results reported above have been determined to be as follows:

Band	Mode	Value (dB)
WLAN 2450MHz	Free Space	1.47

The expanded measurement uncertainties (k = 2) for the TIS results reported above have been determined to be as follows:

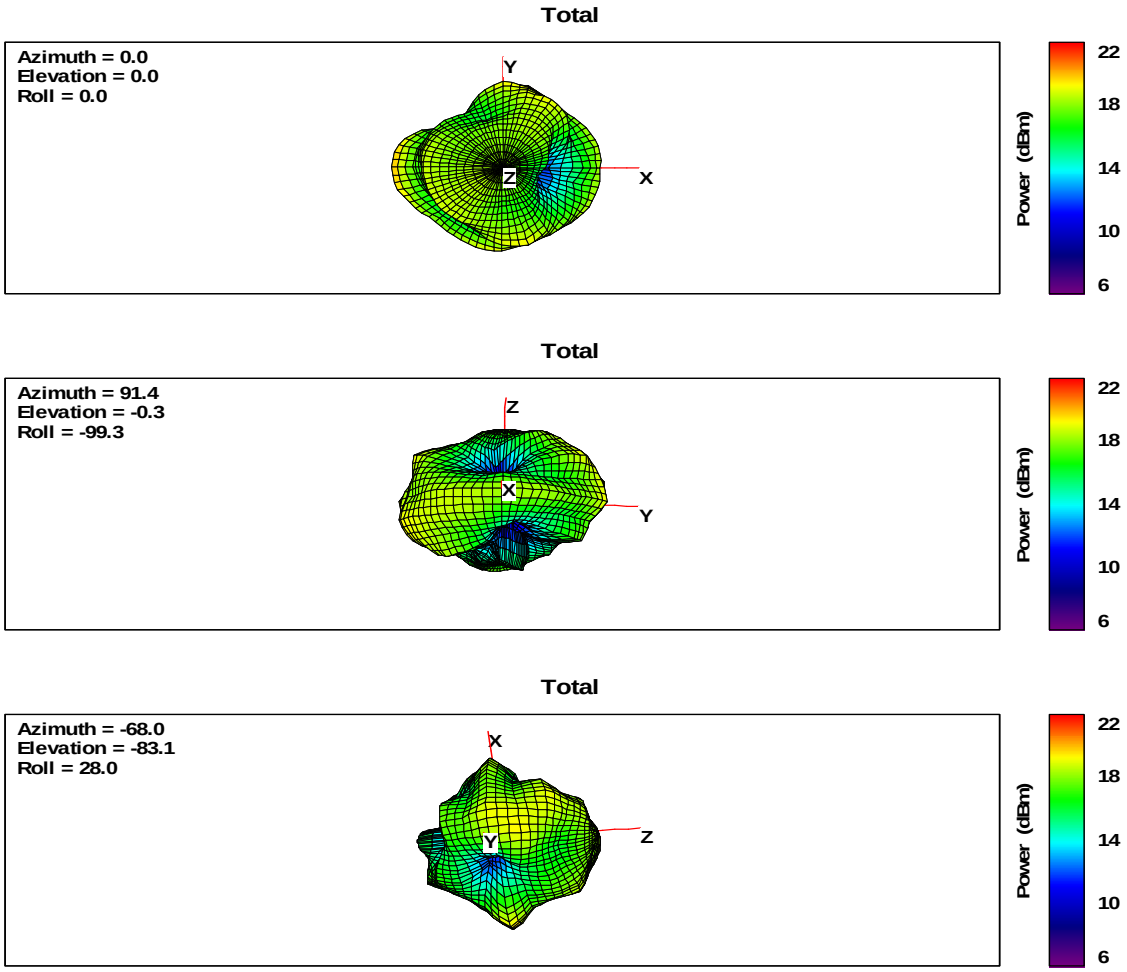
Band	Mode	Value (dB)
WLAN 2450MHz	Free Space	1.60

8. Equipment List

Type of Equipment	Manufacture	Model Number	S/N	Calibration Date	Expiration Time
Anechoic Chamber	ETS	AMS-8500	CT-001157-1219	N/A	N/A
Test Software	ETS	EMQuest™	REV 1.0.9	N/A	N/A
Wideband radio communication tester	R&S	CMW 500	146734	2019-05-19	2020-05-18
EMCenter_Switch Control System	ETS	7006/7001	00059957 /MY42001152	2019-05-19	2020-05-18
Diagonal Dual Polarized Horn	ETS	ETS 3164-04	00062743	2019-05-19	2020-05-18
Communication TX/RX Antenna on floor	ETS	3102l	00154559	2019-05-19	2020-05-18
Dynamic Range Extender	ETS	DRE	00201678	2019-05-19	2020-05-18

ANNEX A：3D-Polt Results

A.1 TRP 3D-Polt



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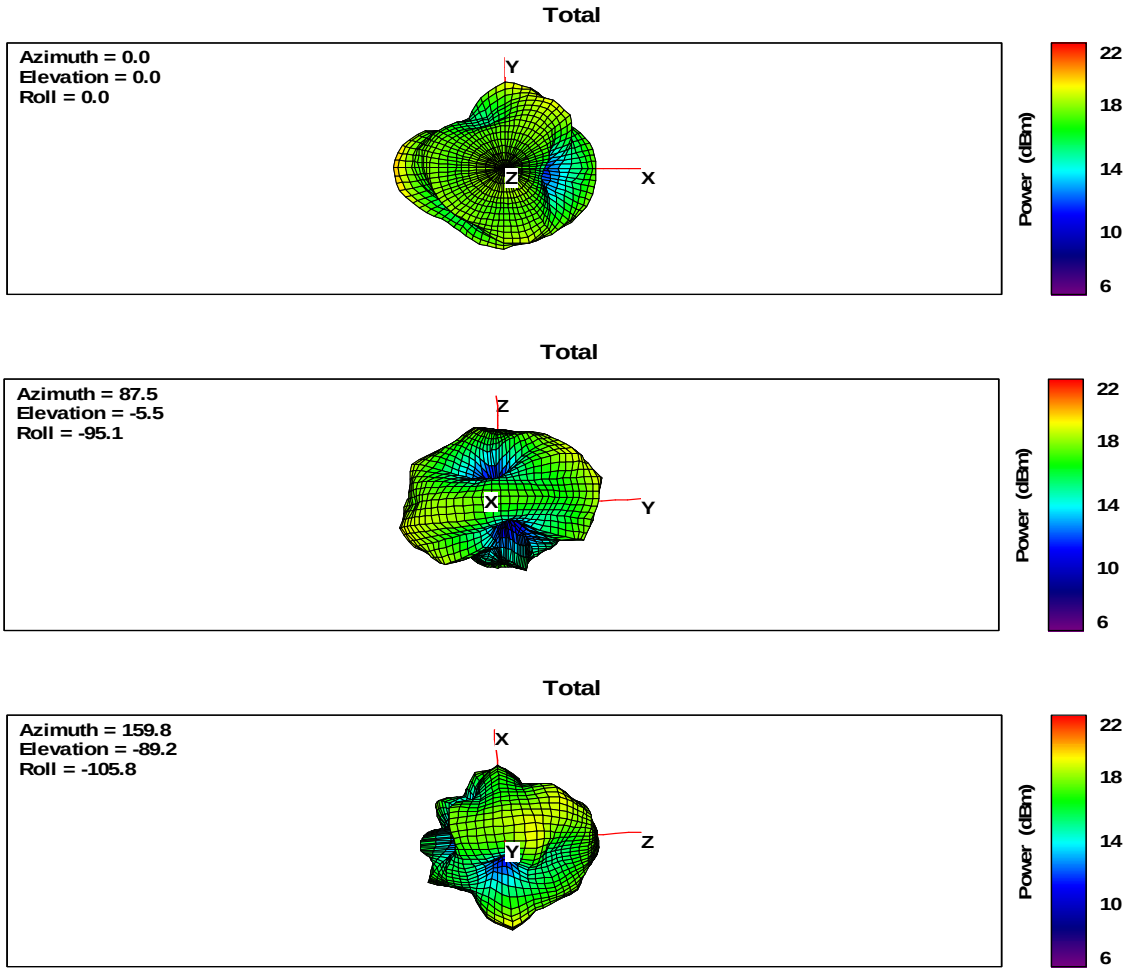

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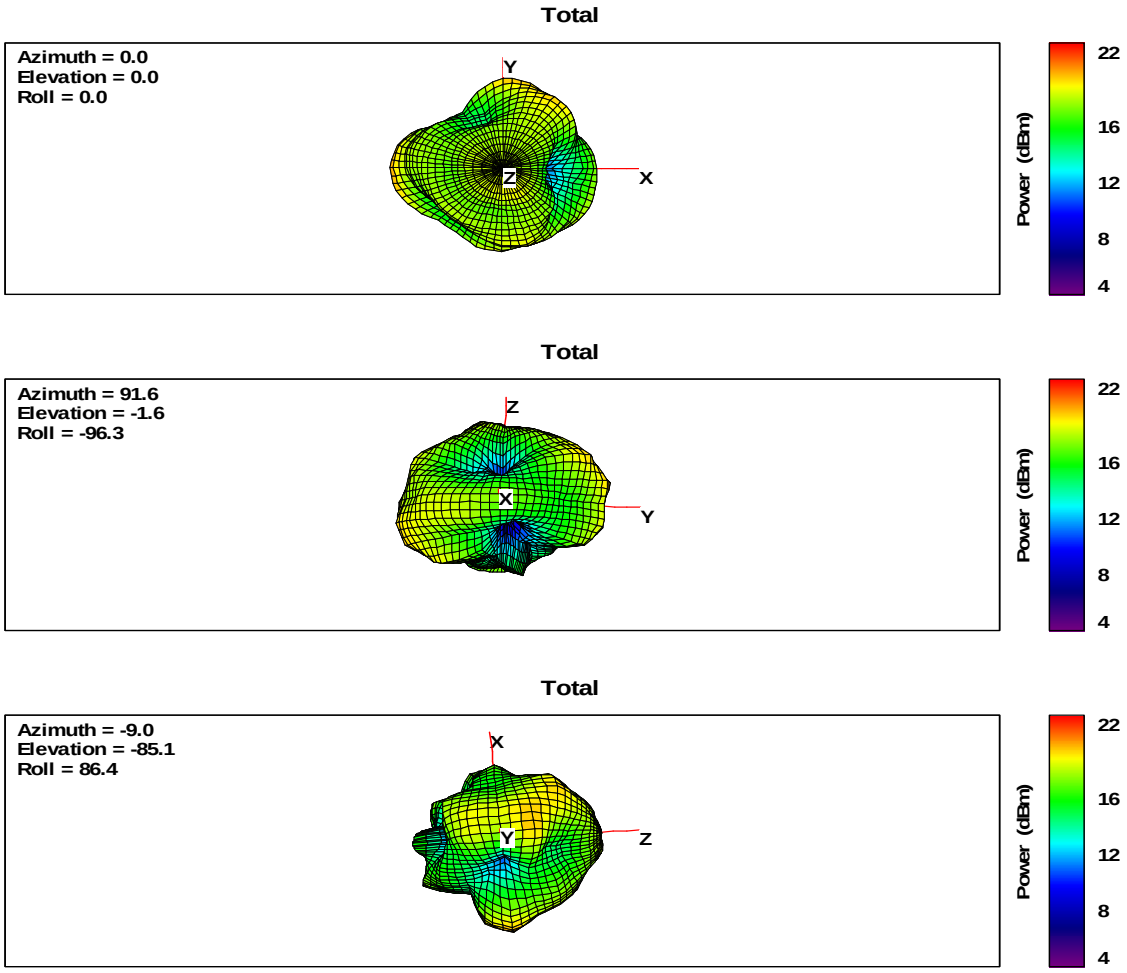

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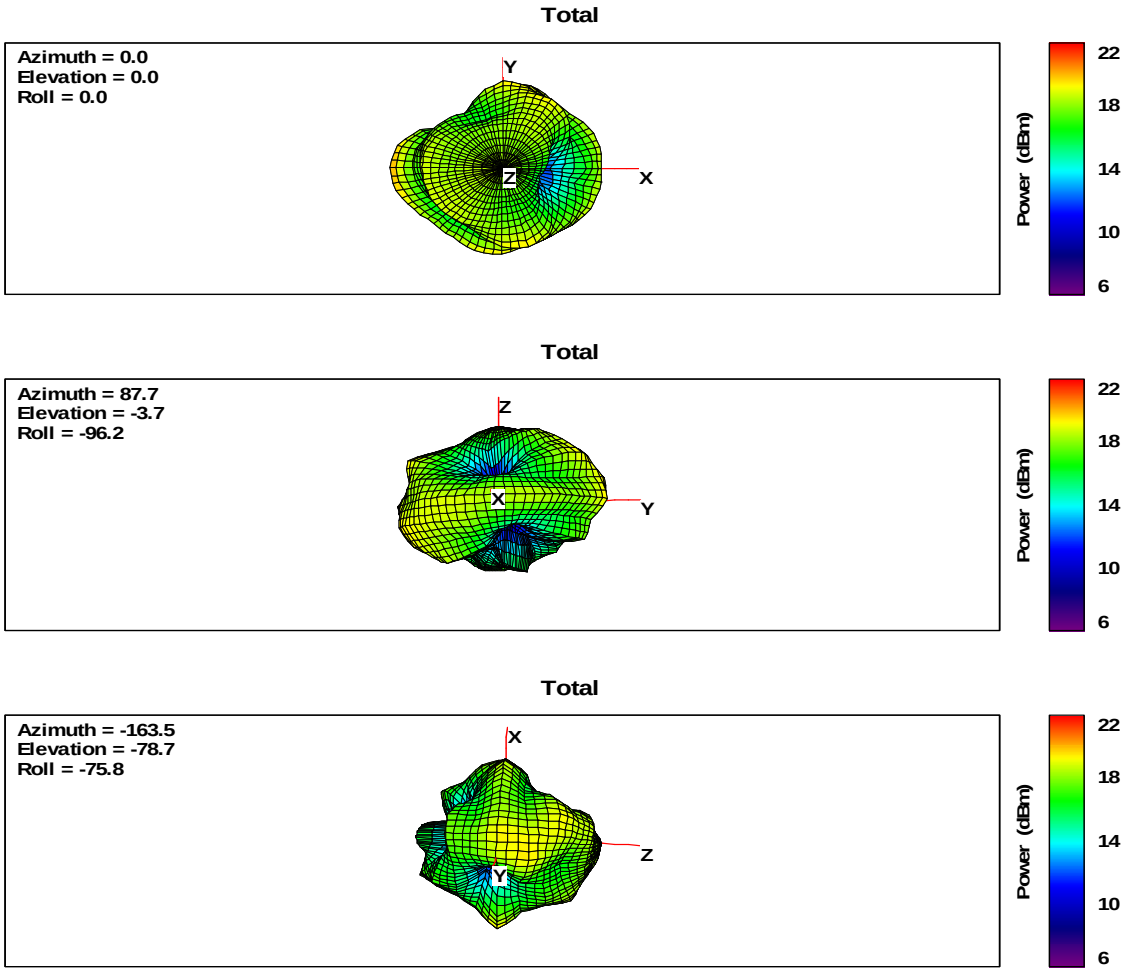

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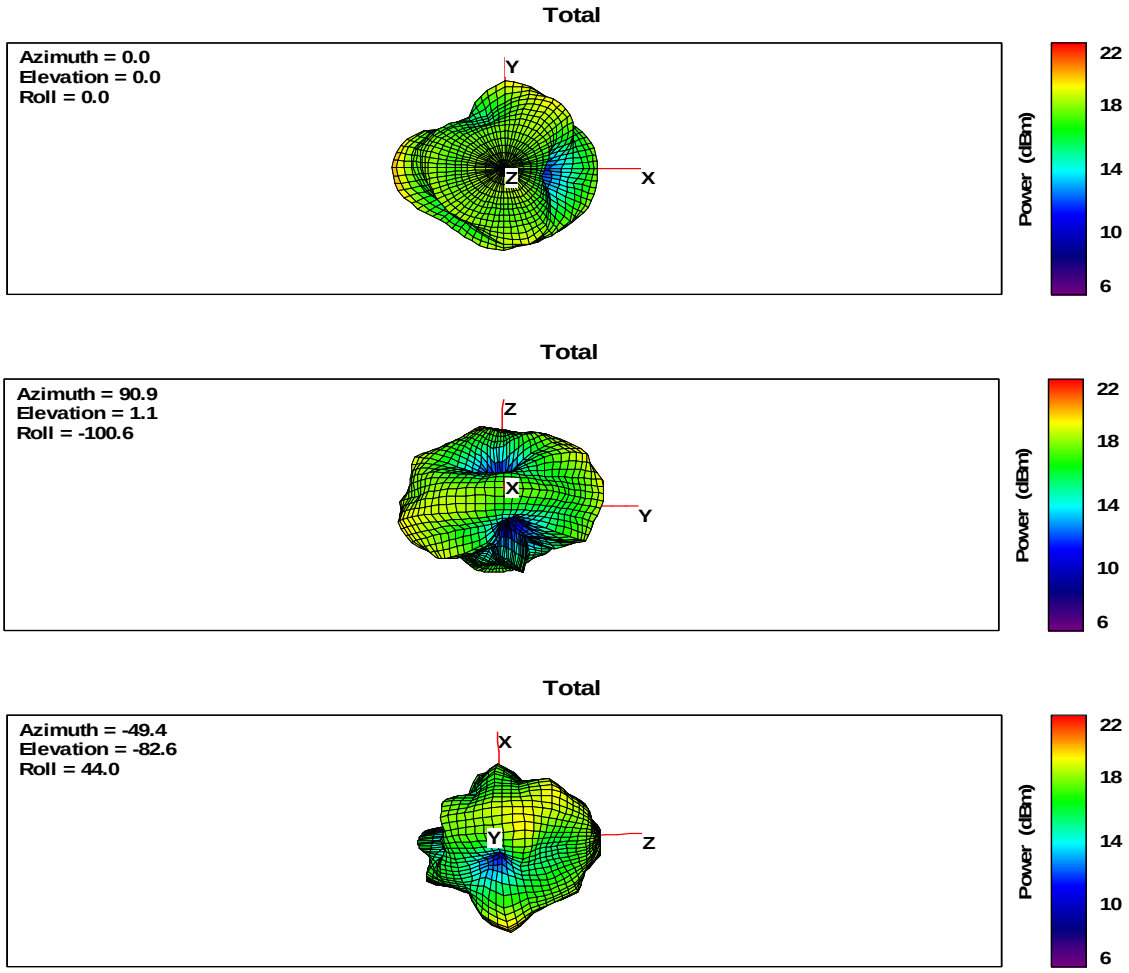

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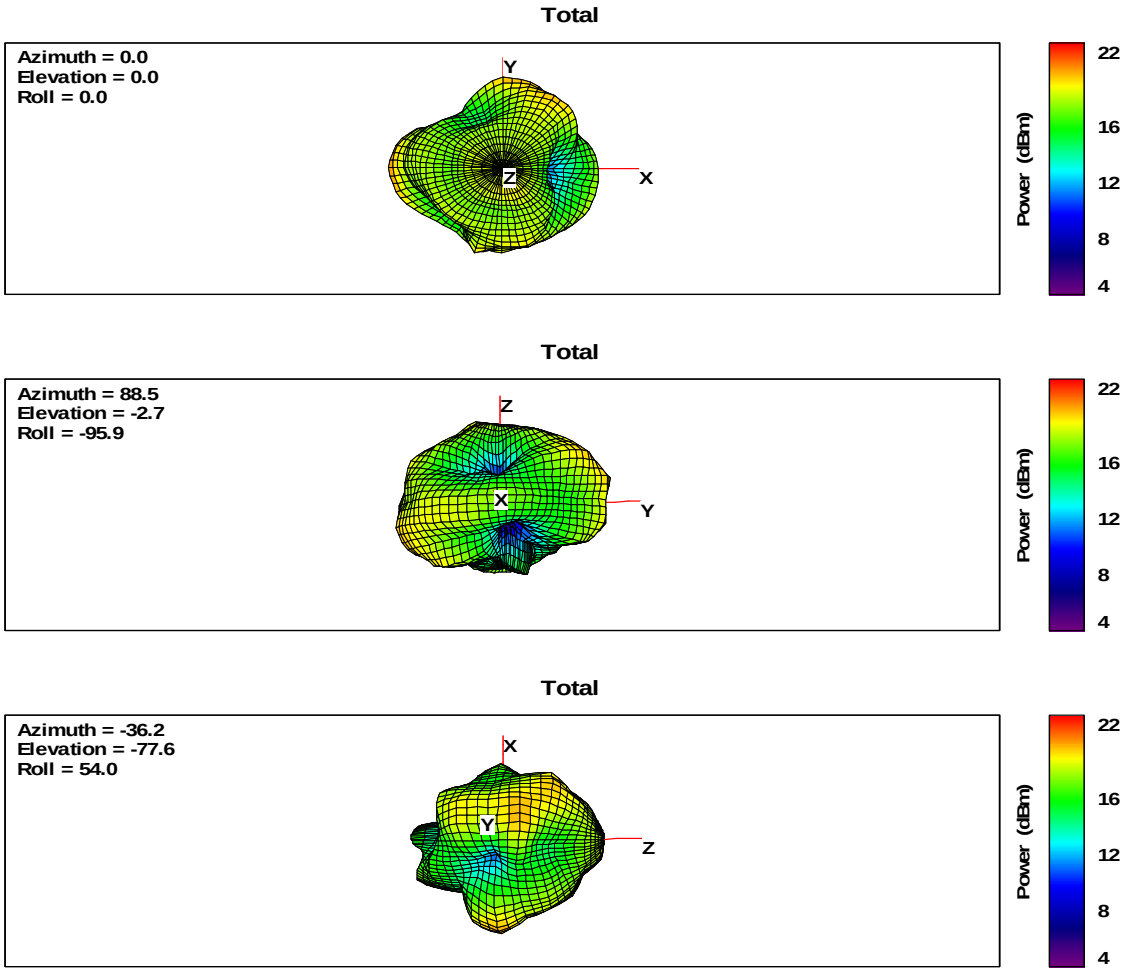

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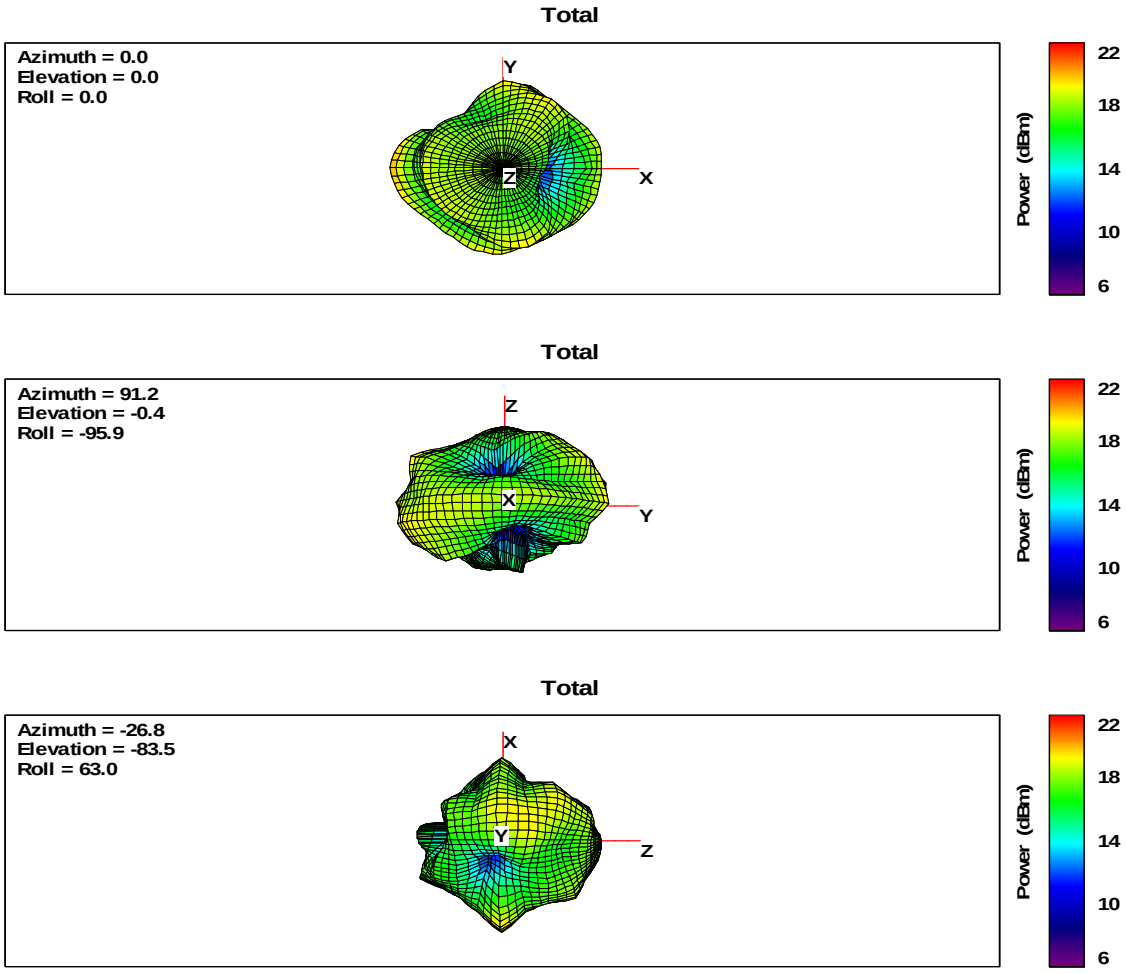

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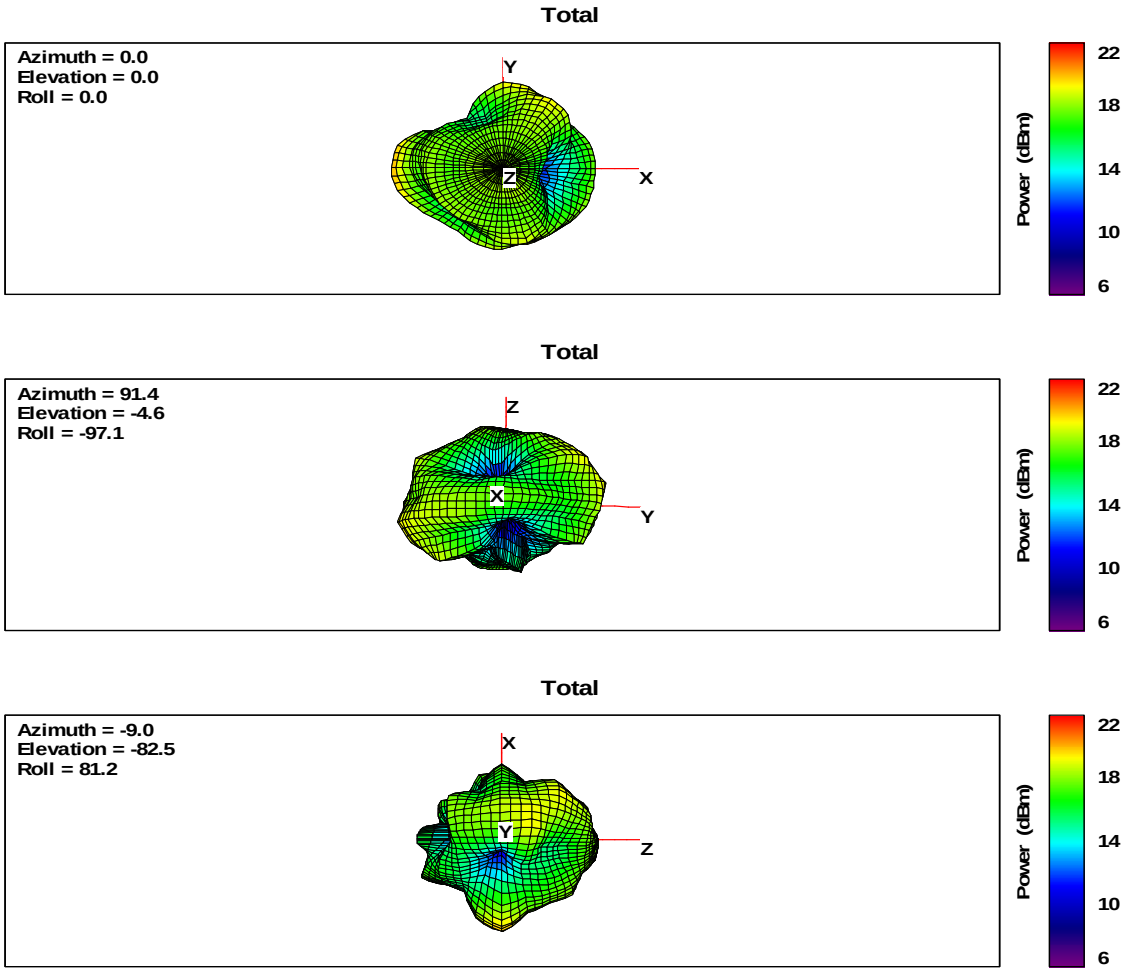

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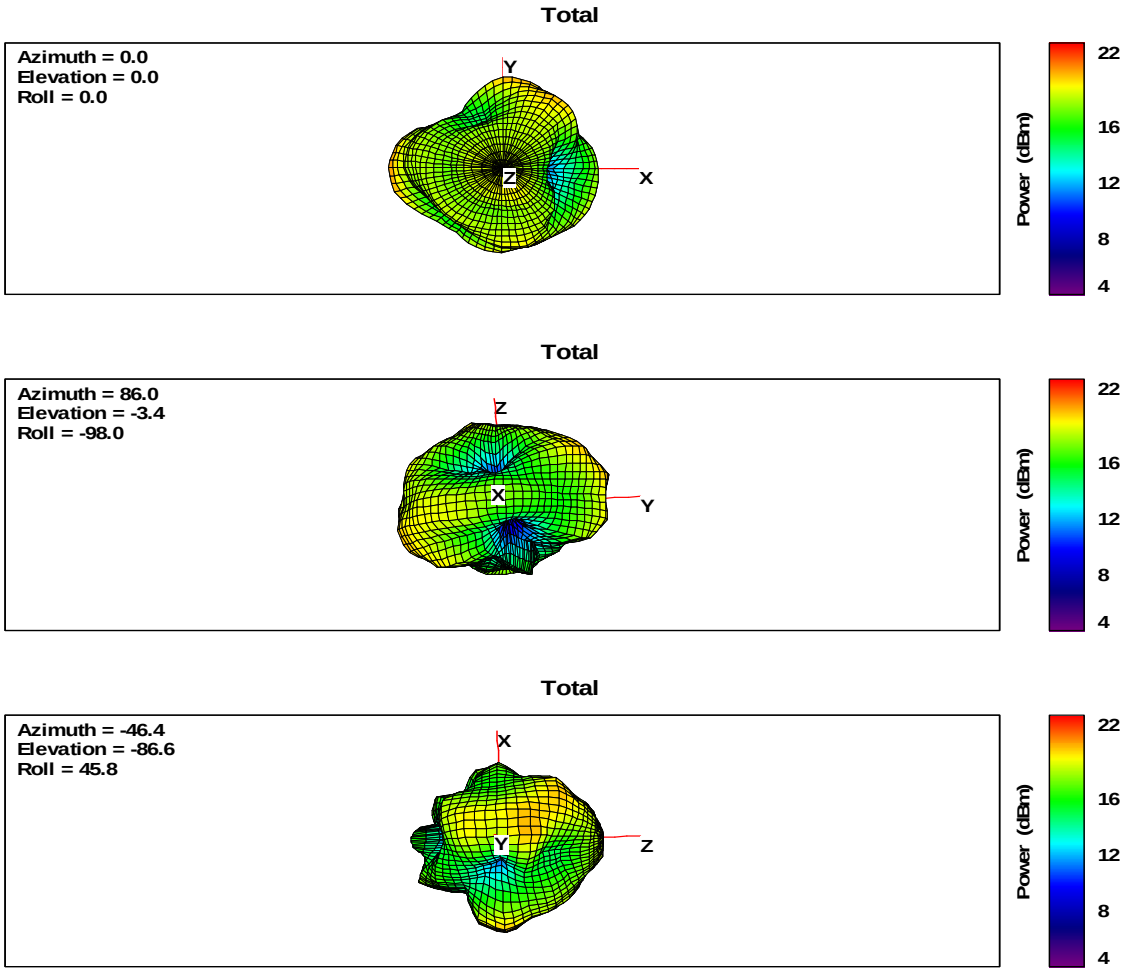

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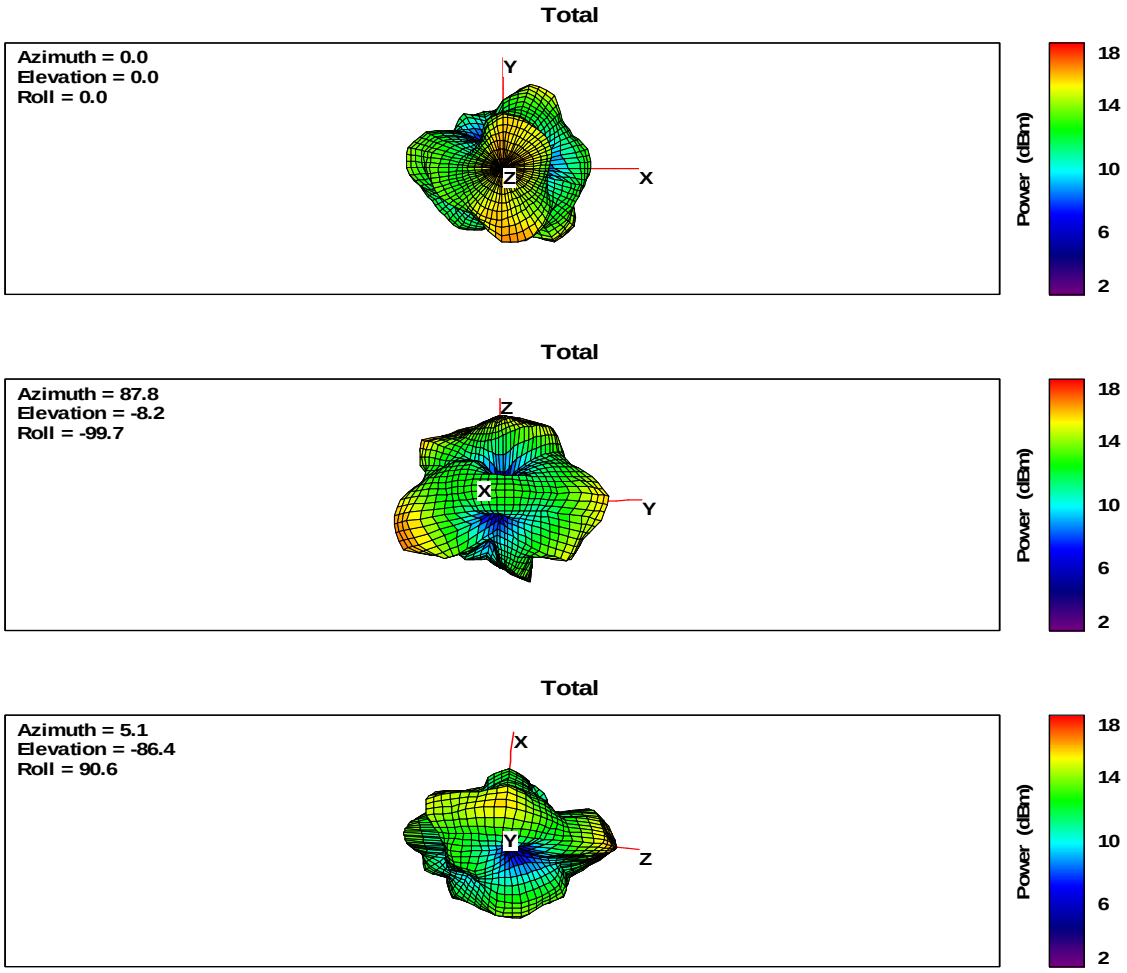

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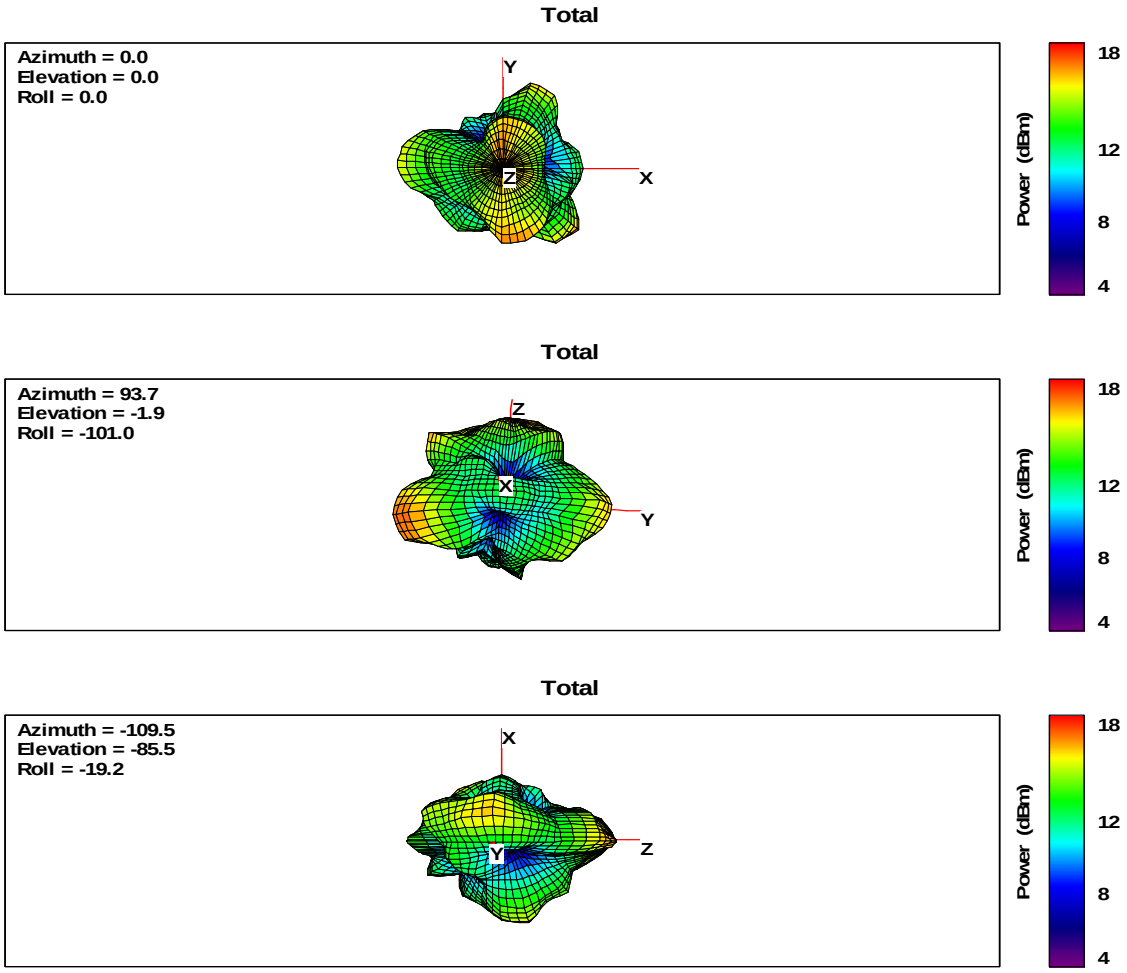

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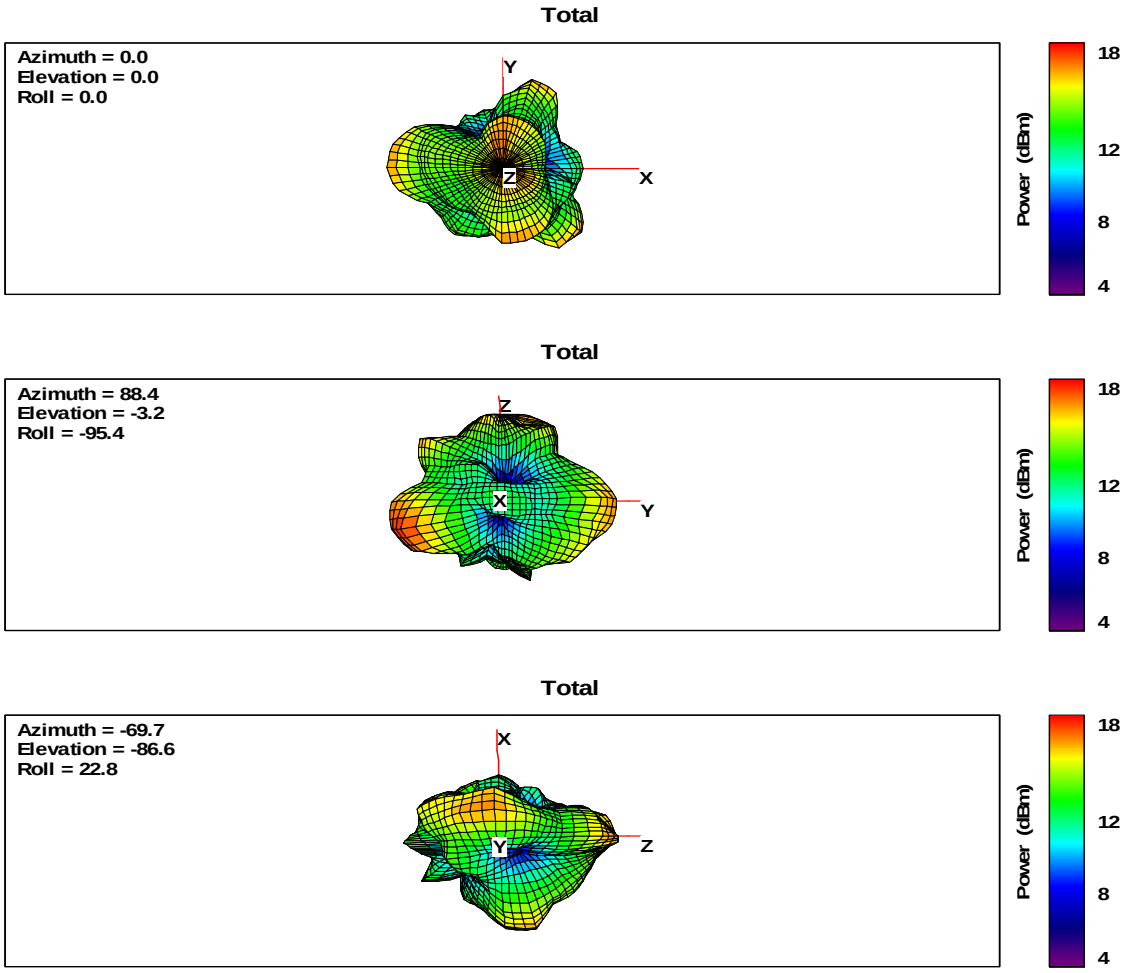

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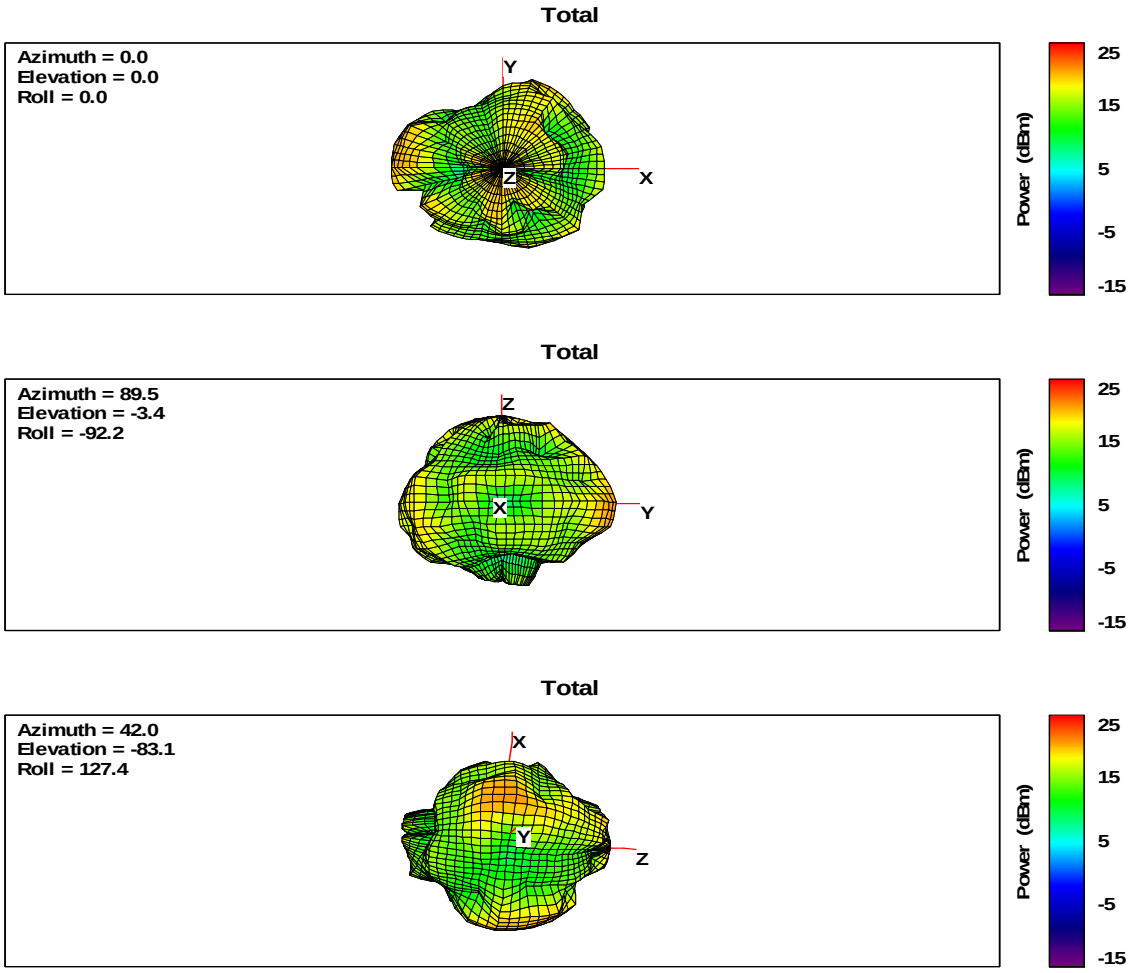

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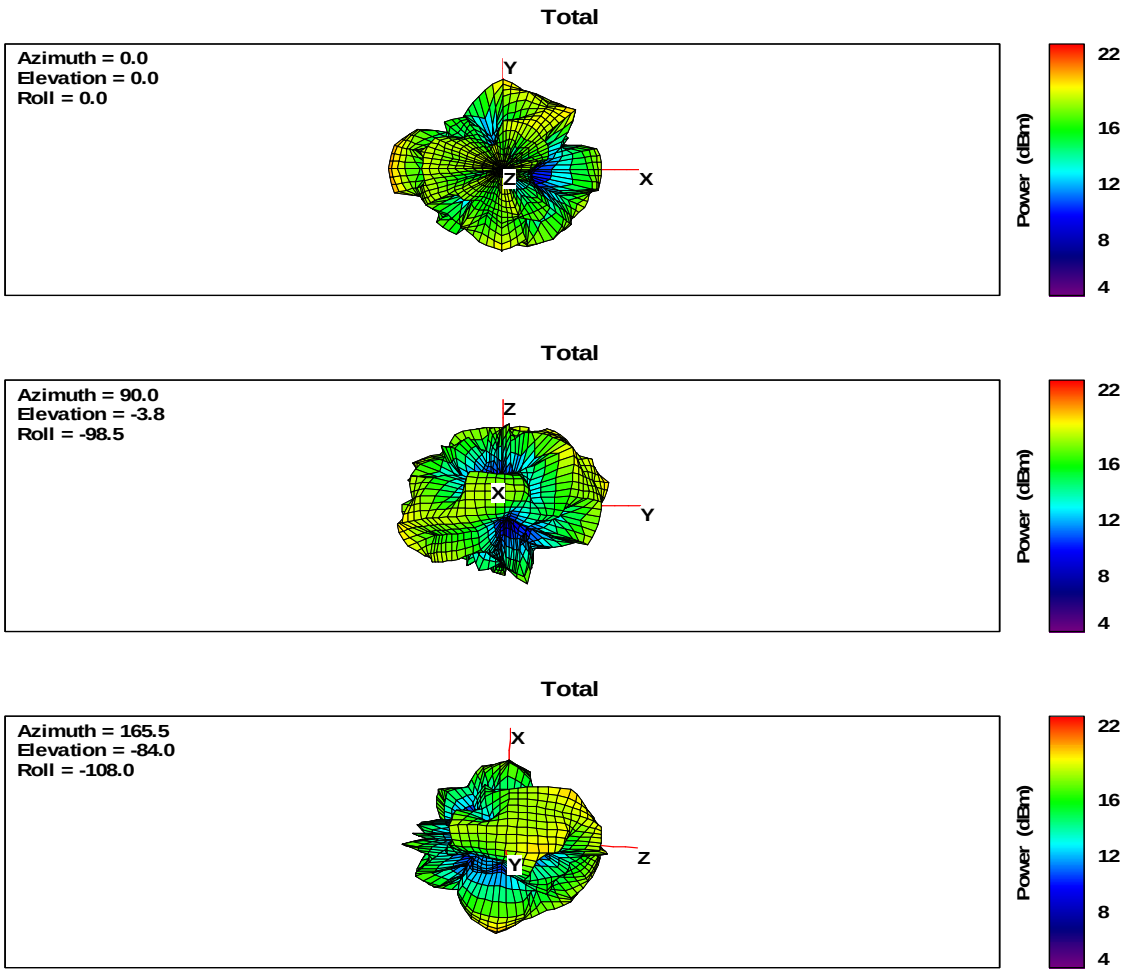

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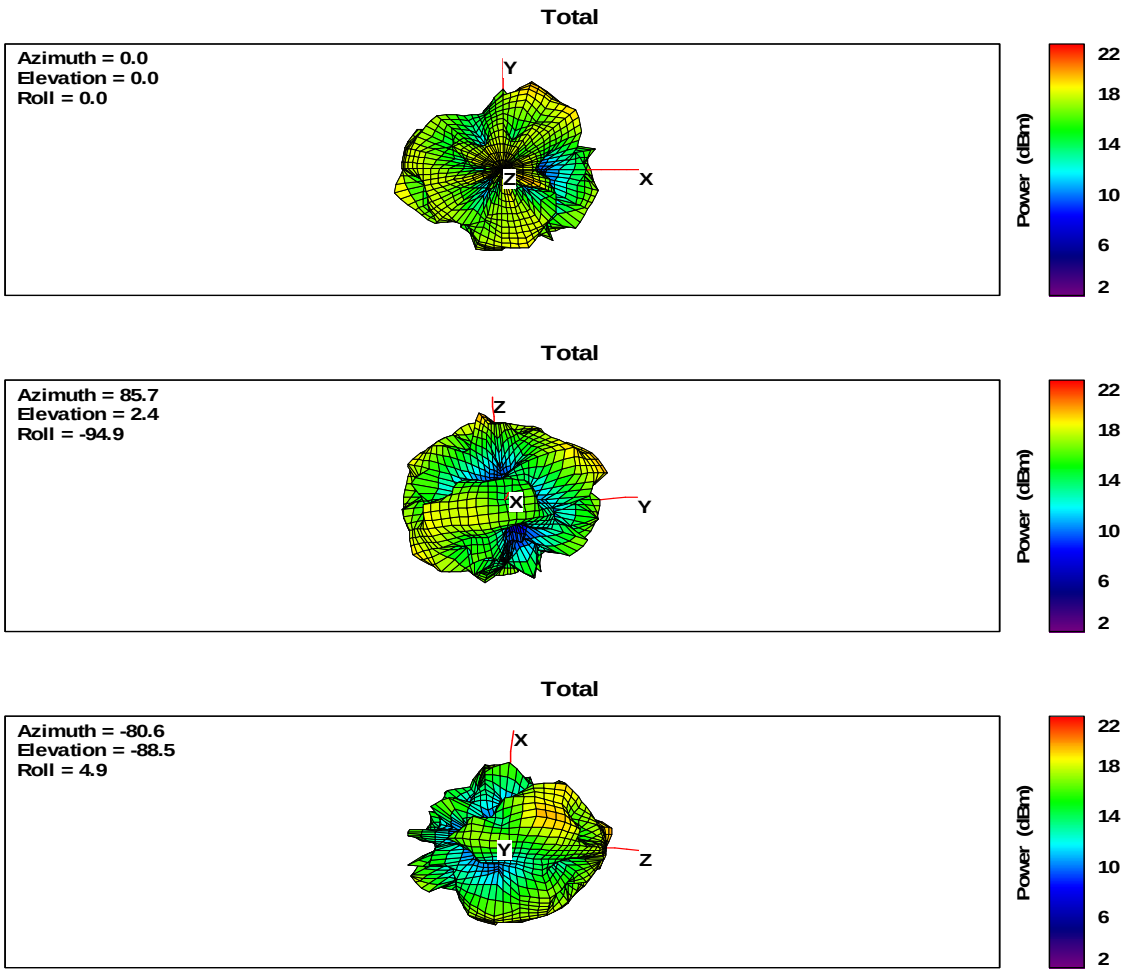

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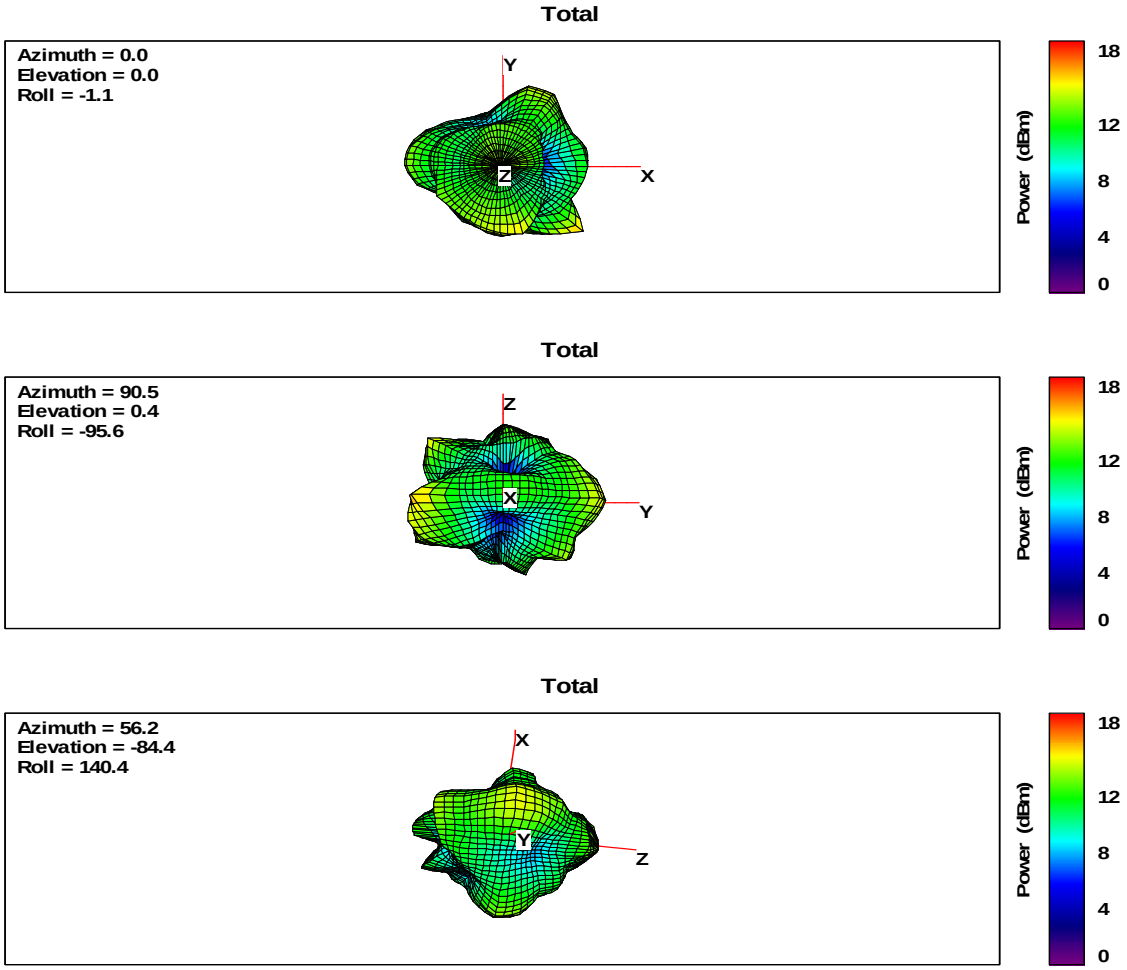

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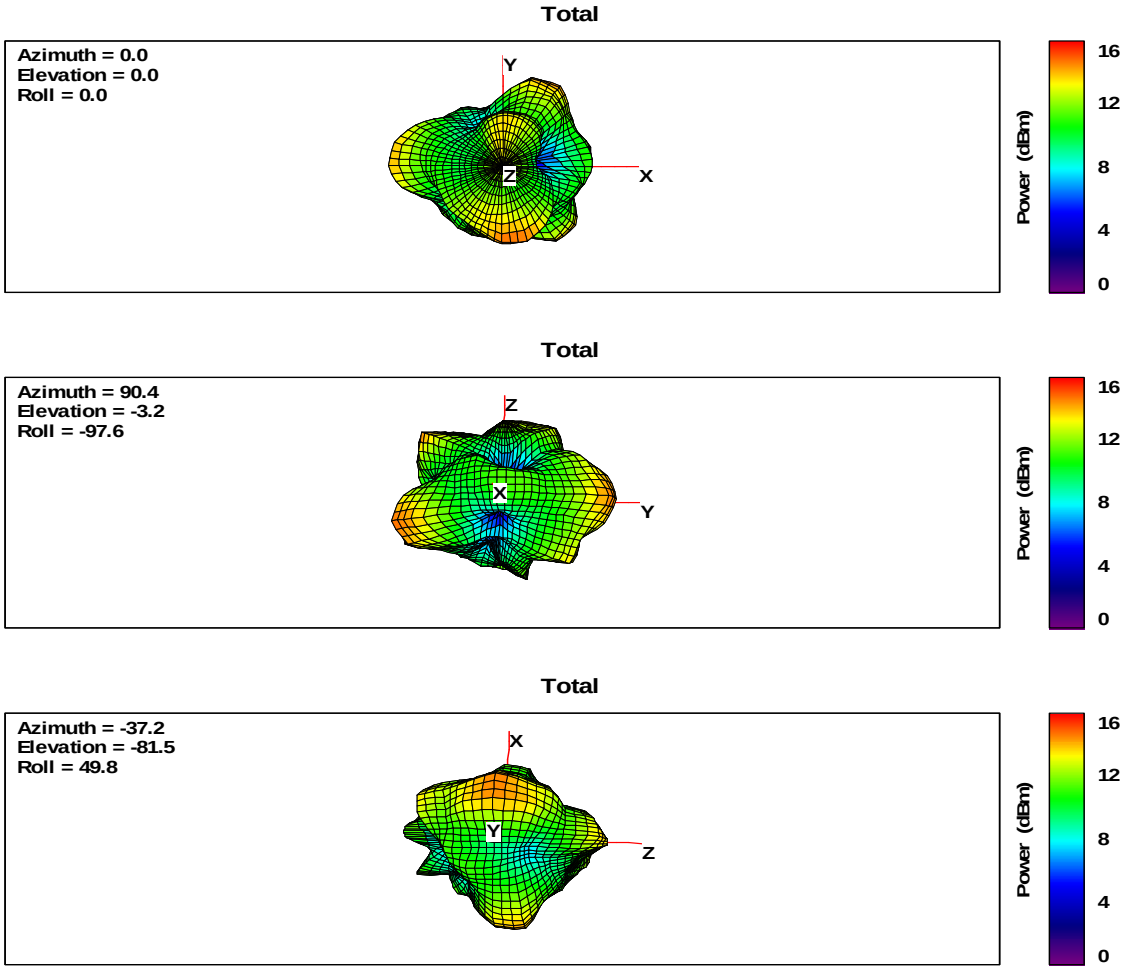

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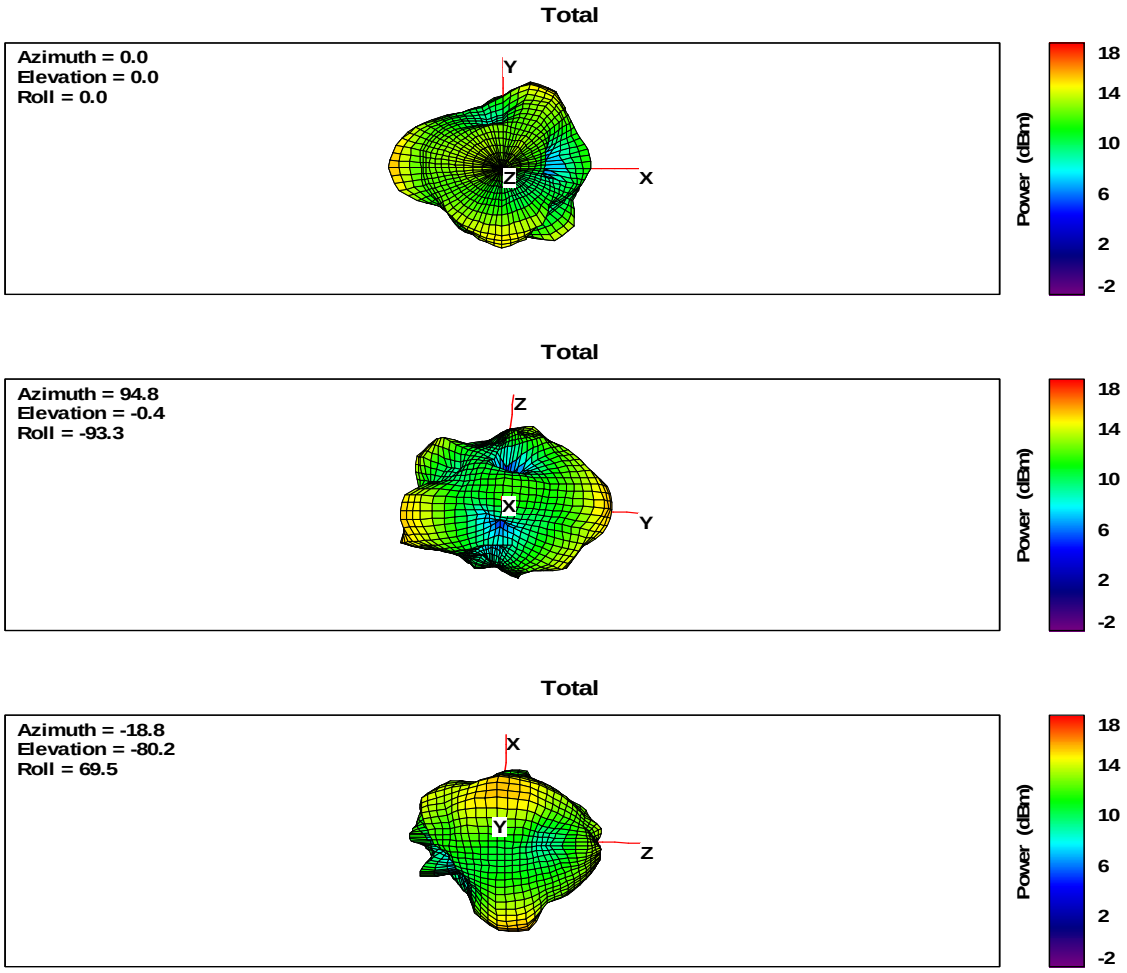

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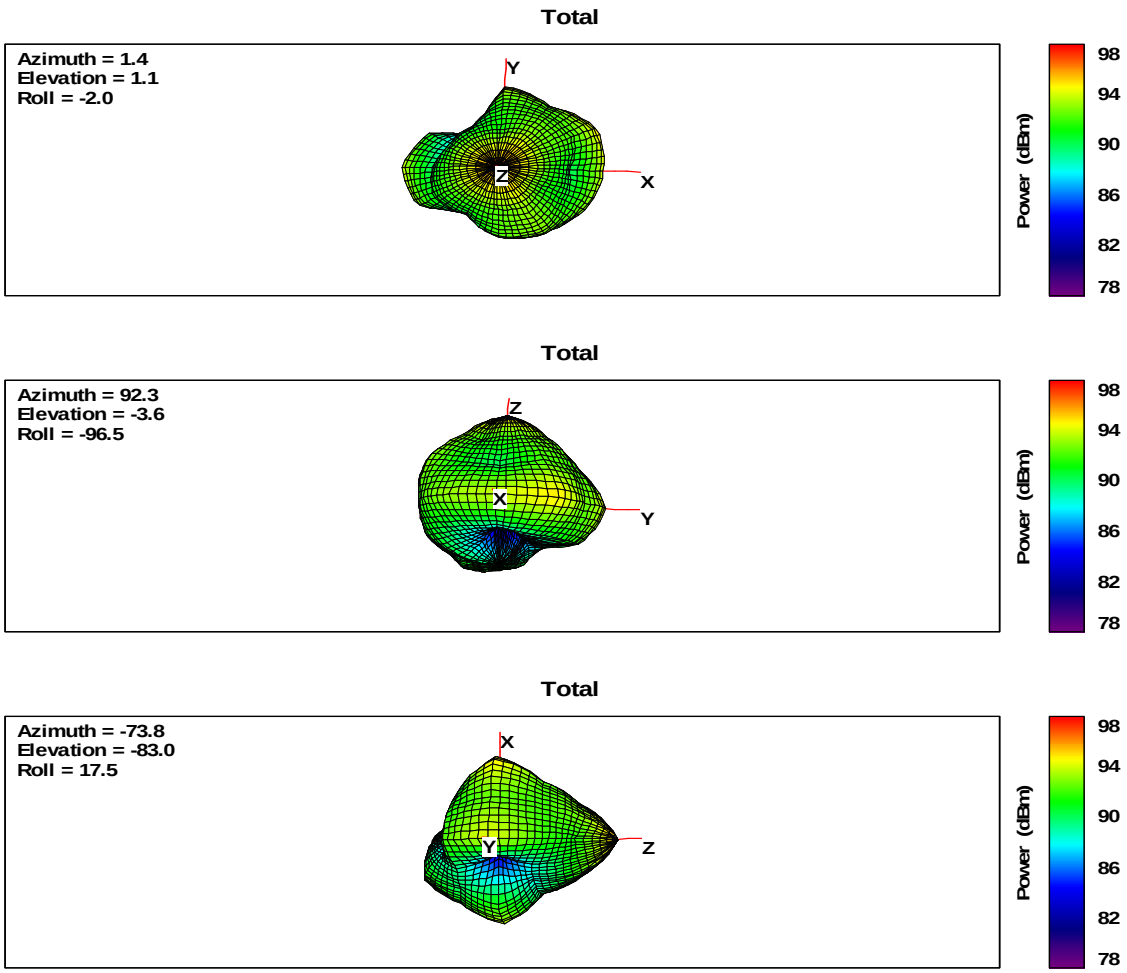
A.2 TIS 3D-Polt



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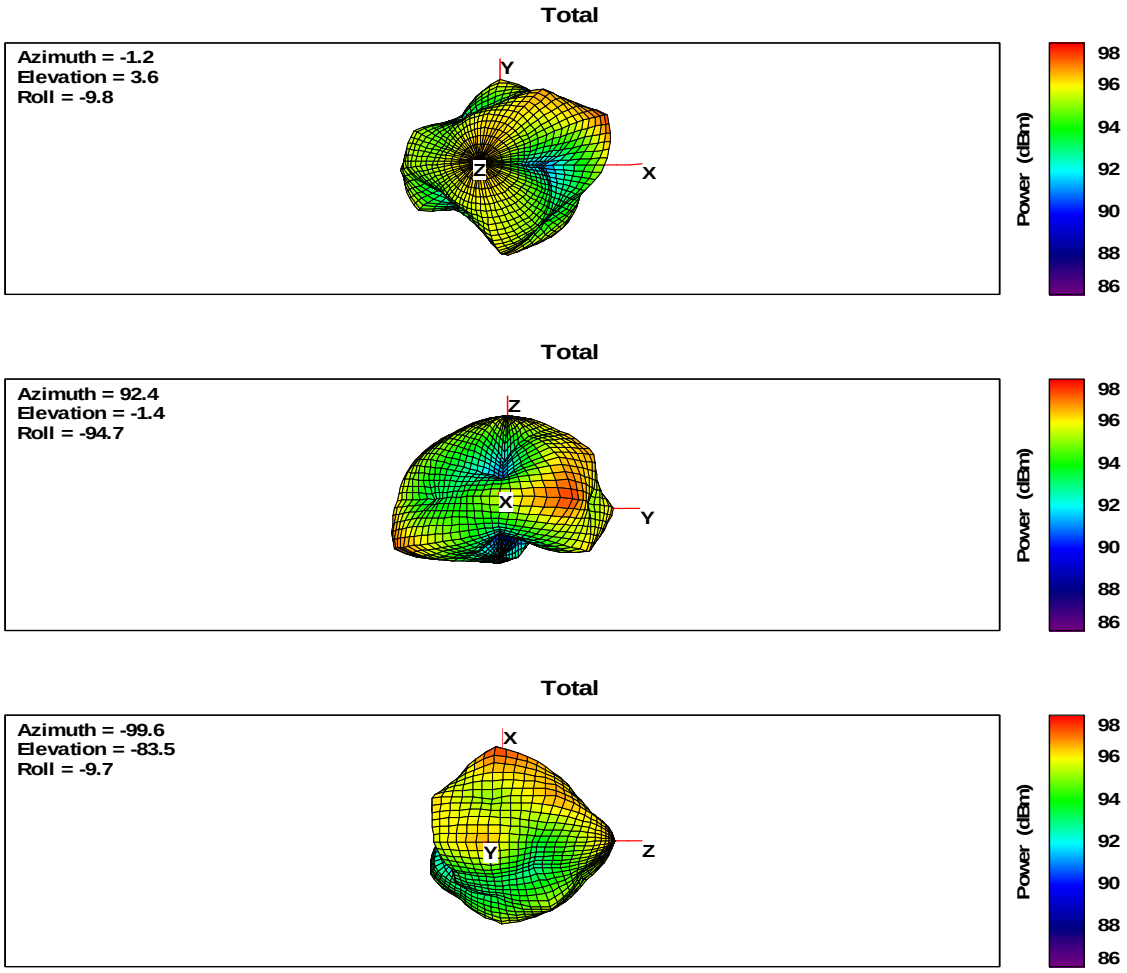

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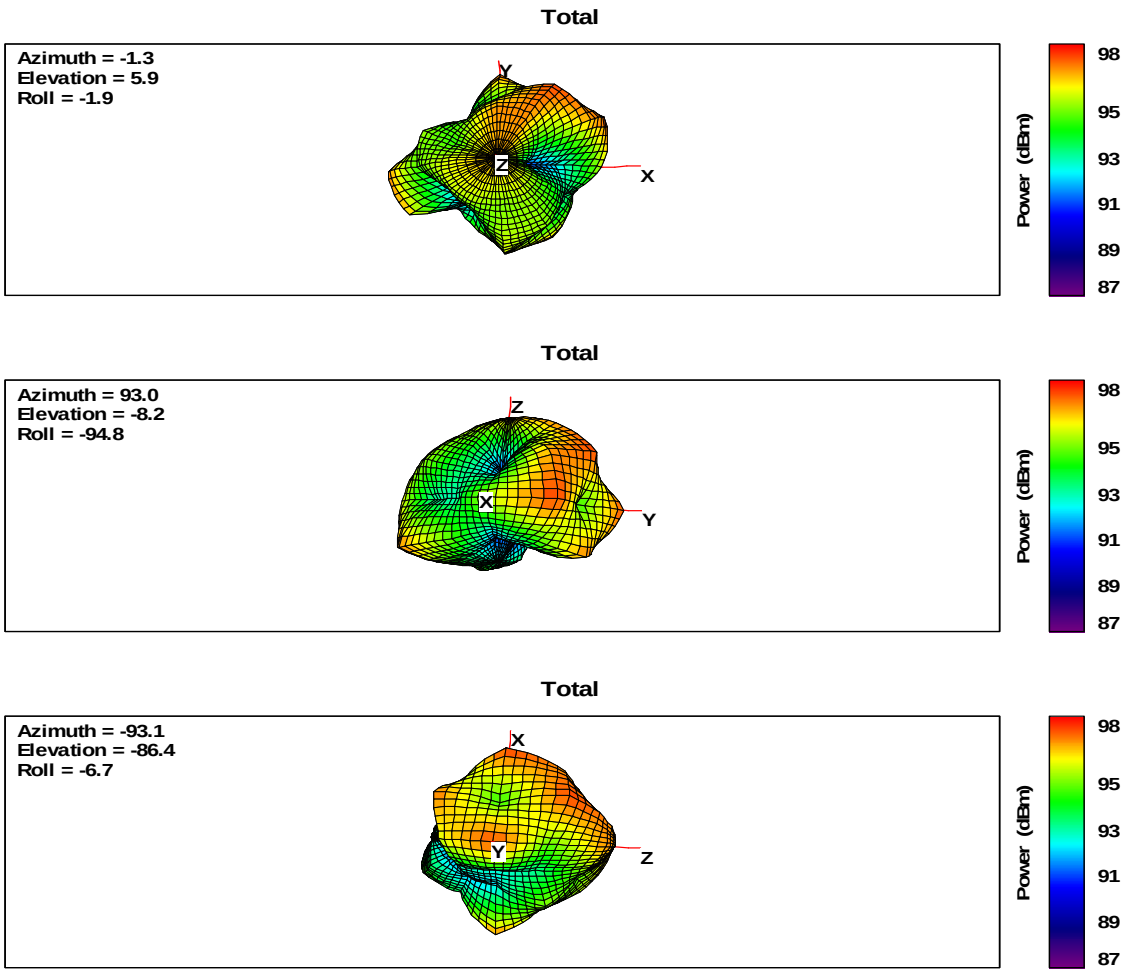

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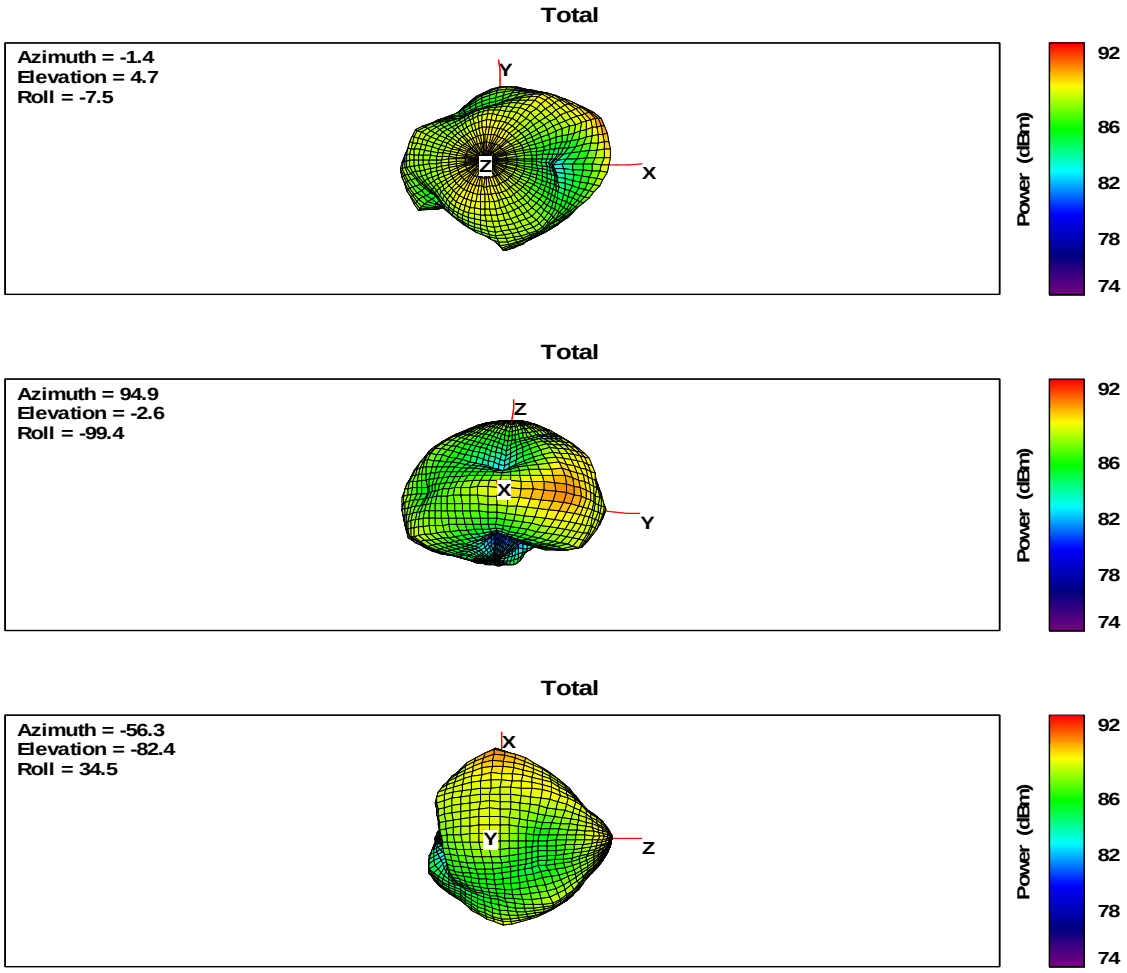

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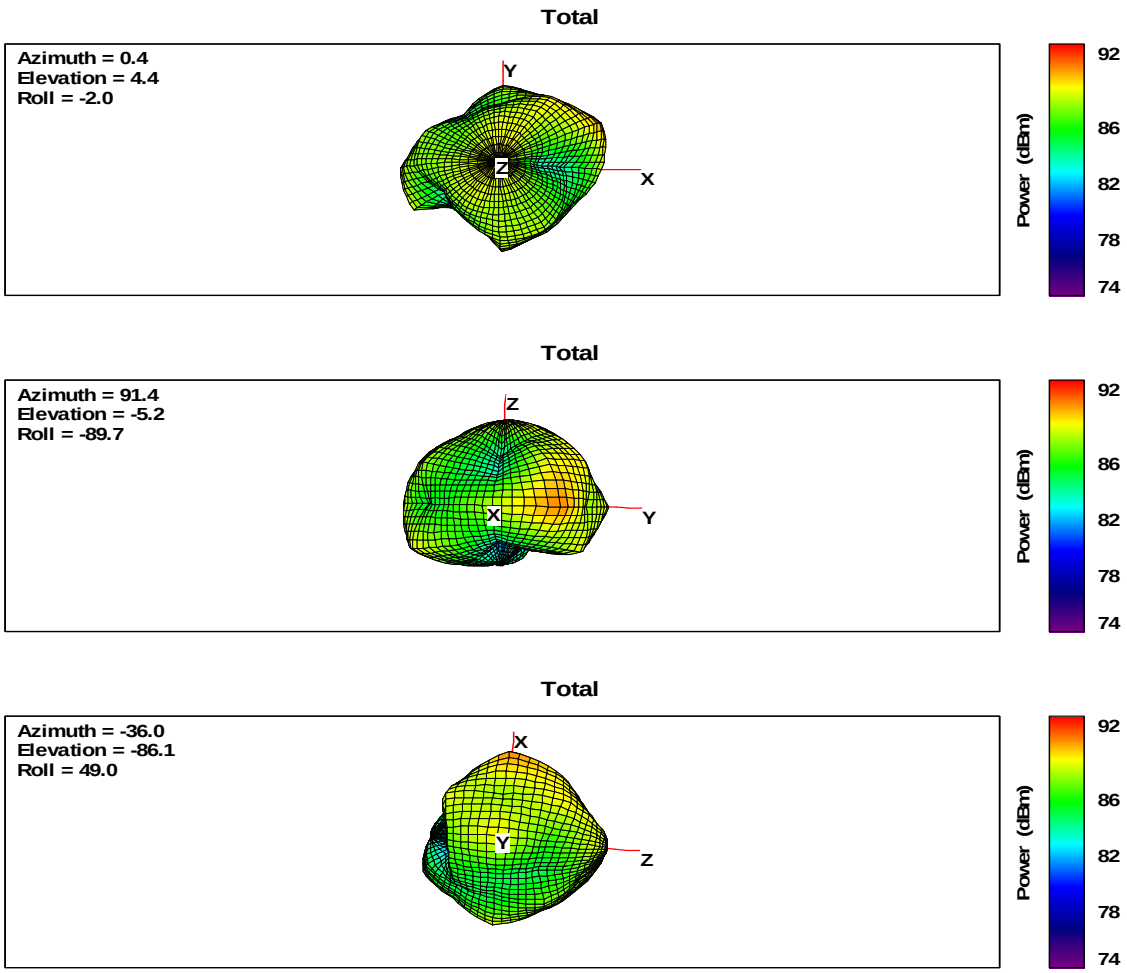

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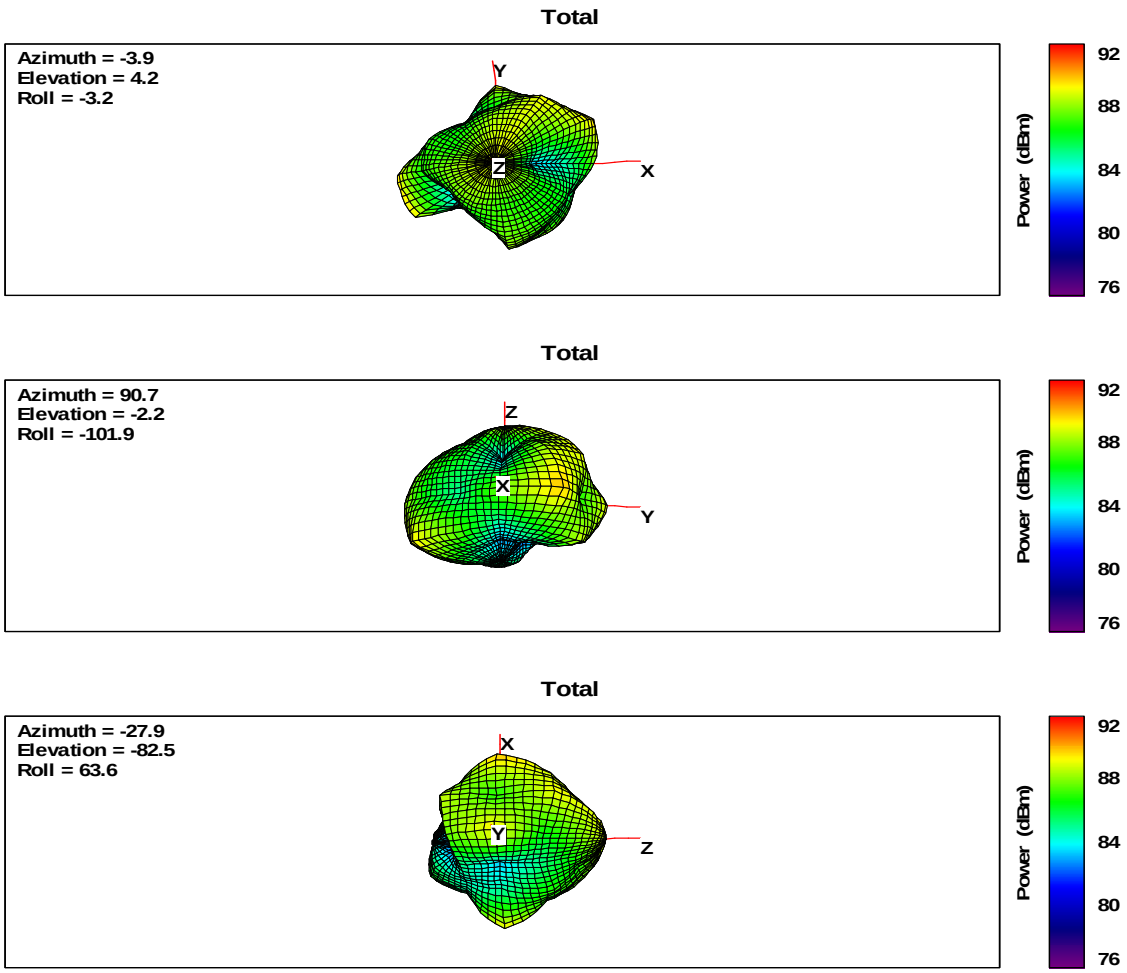

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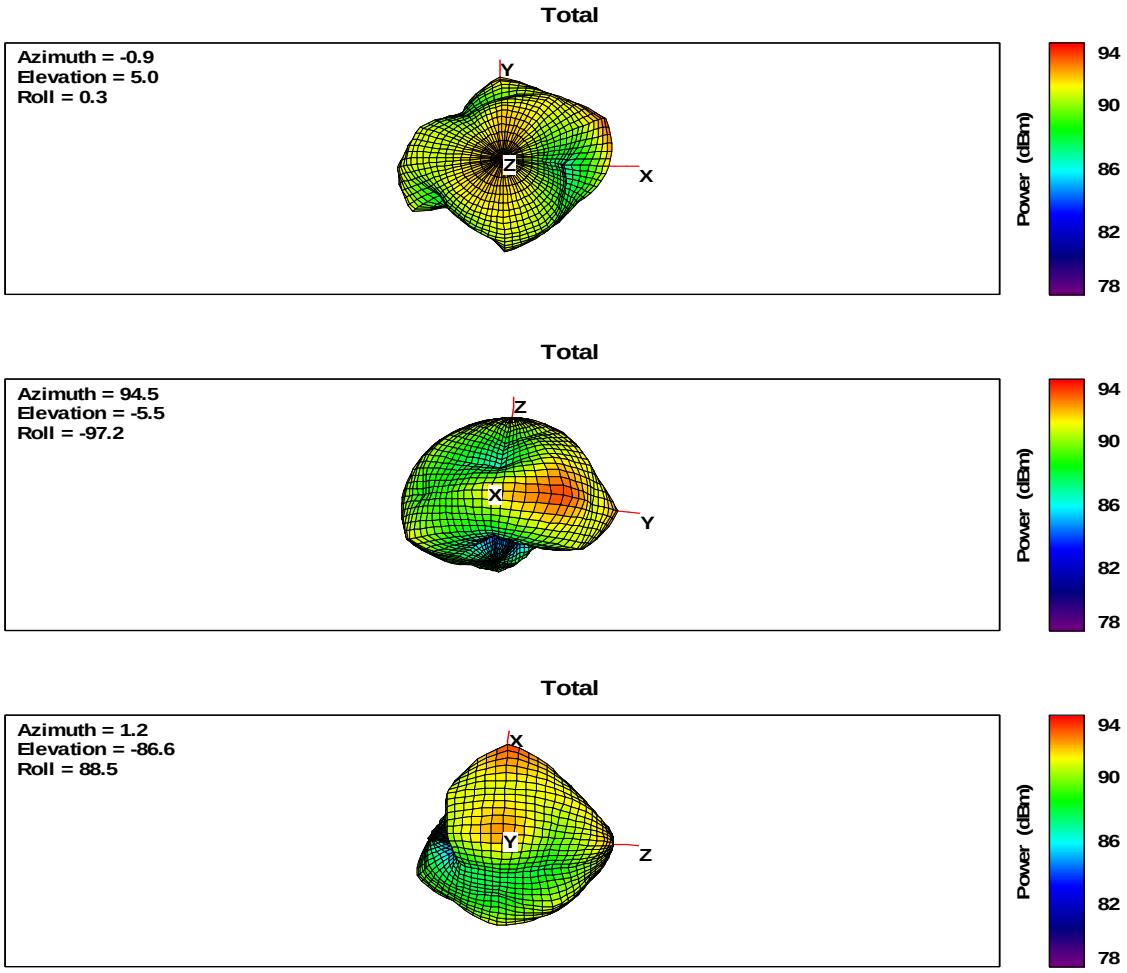

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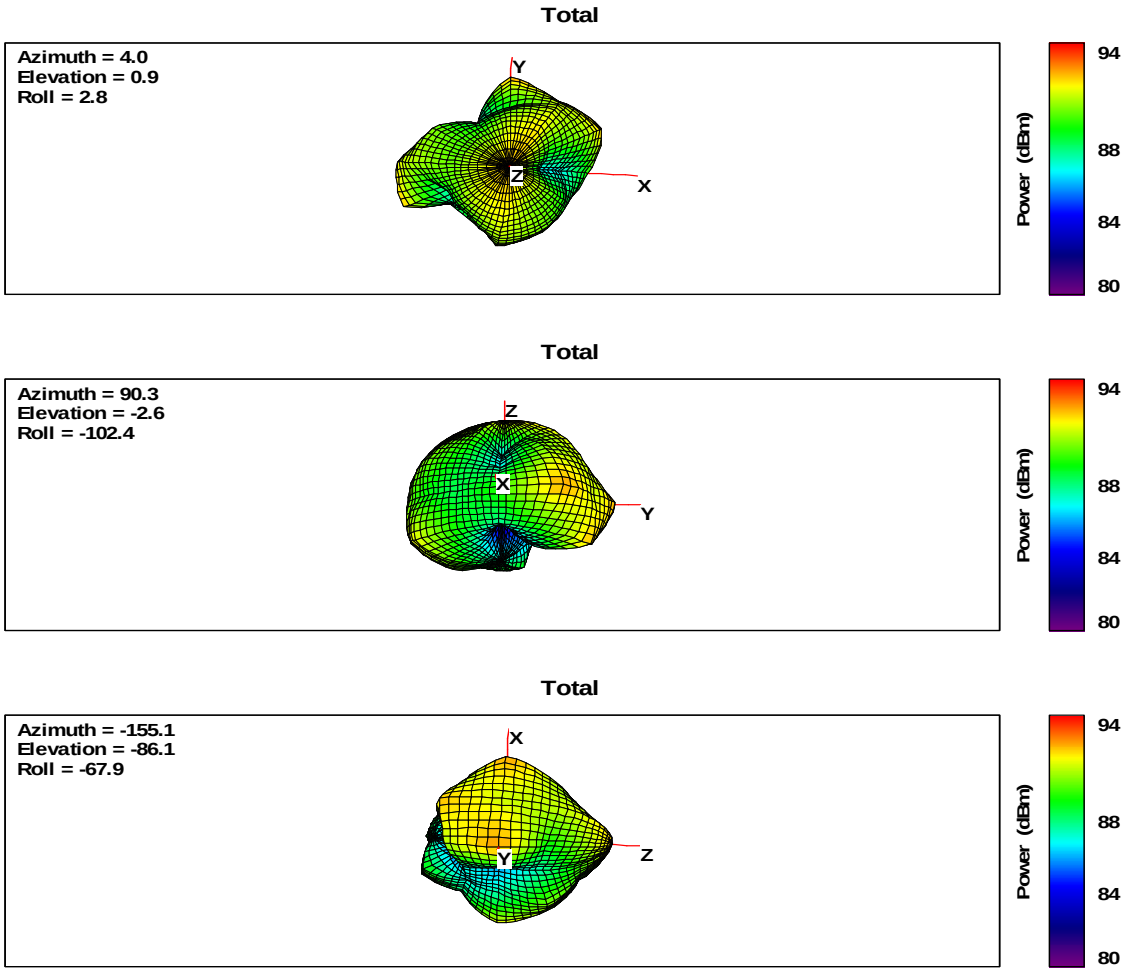

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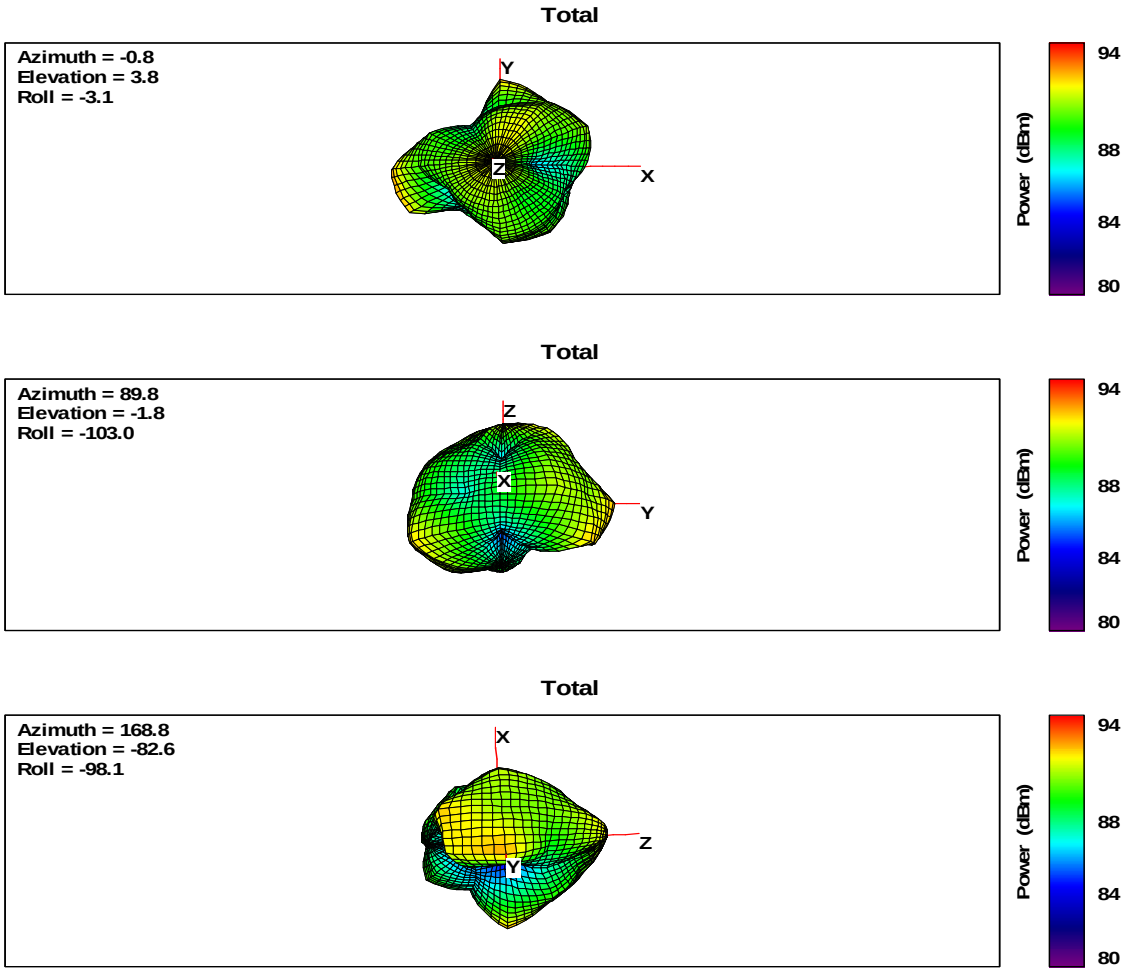

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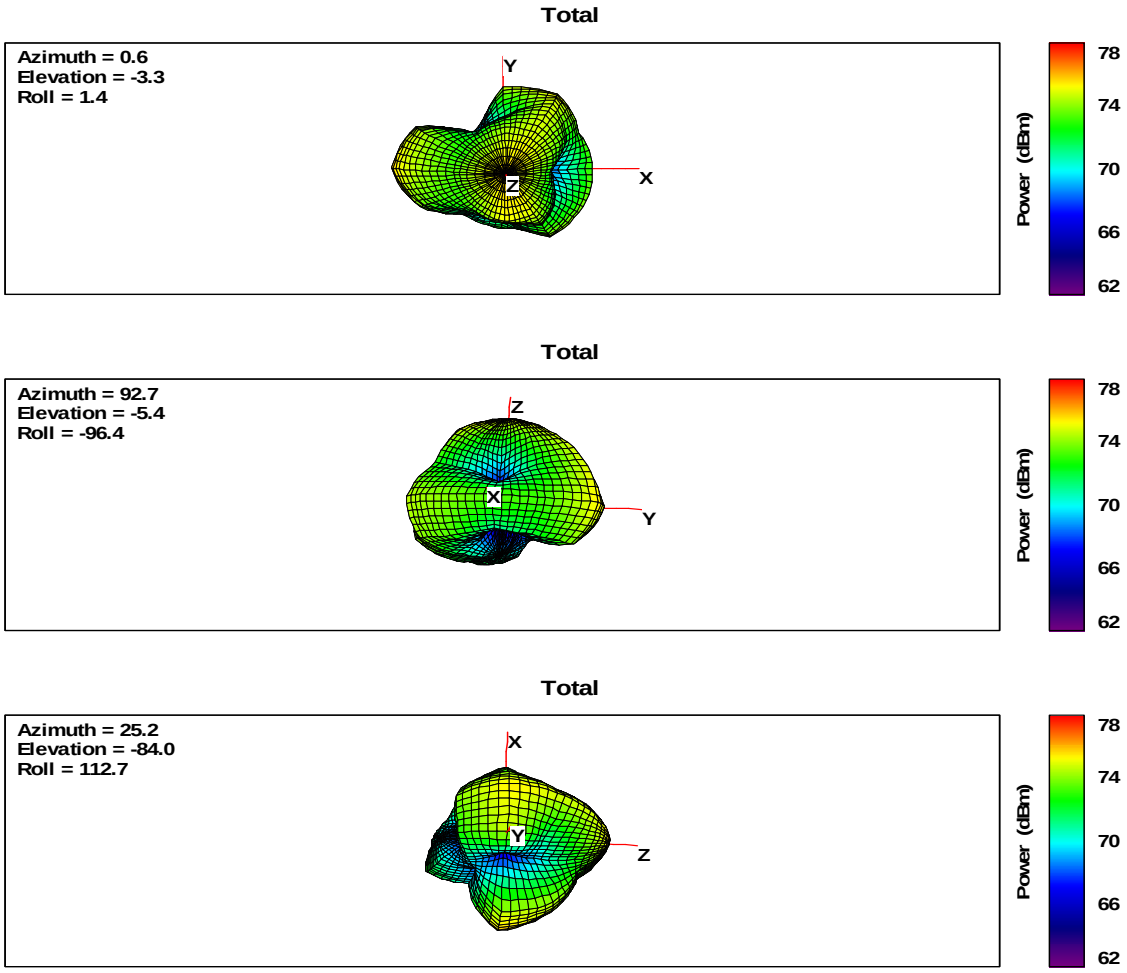

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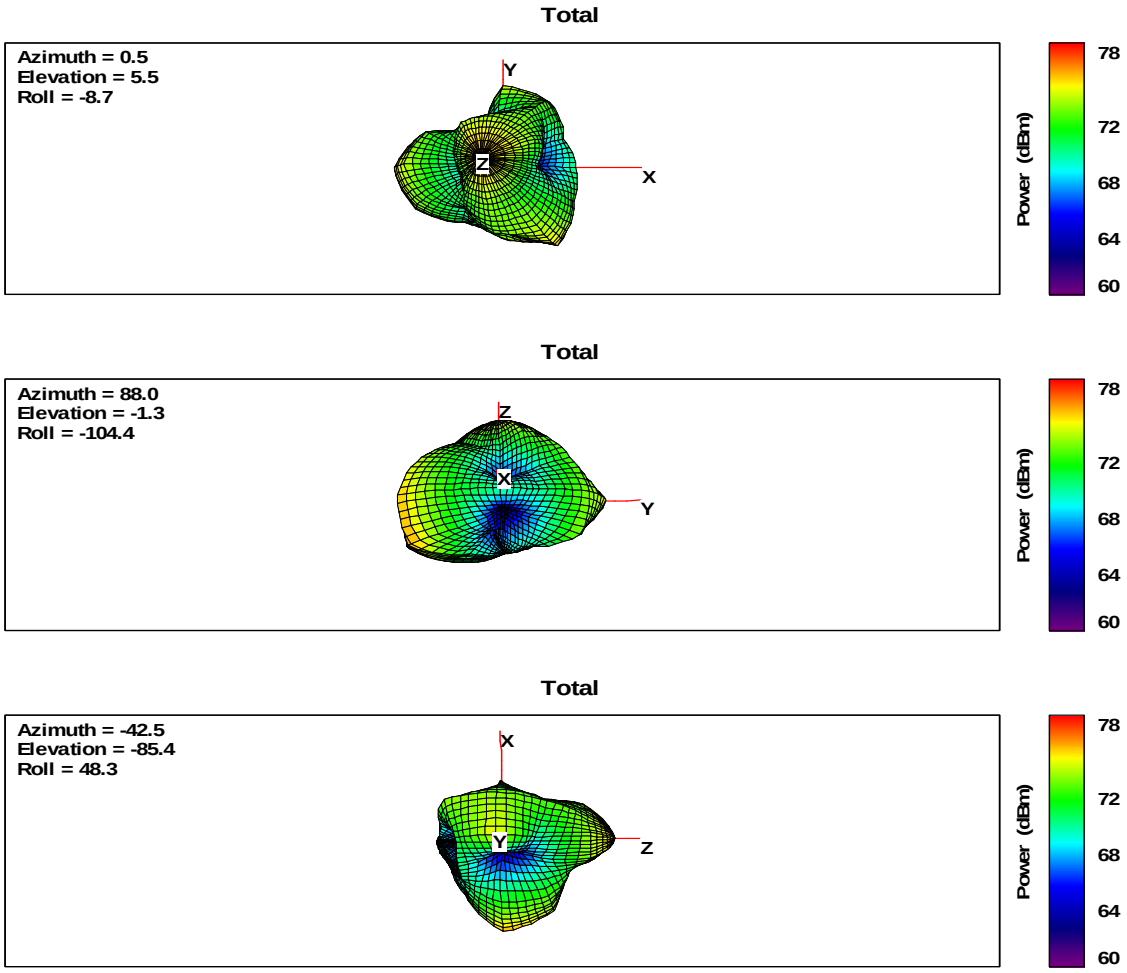
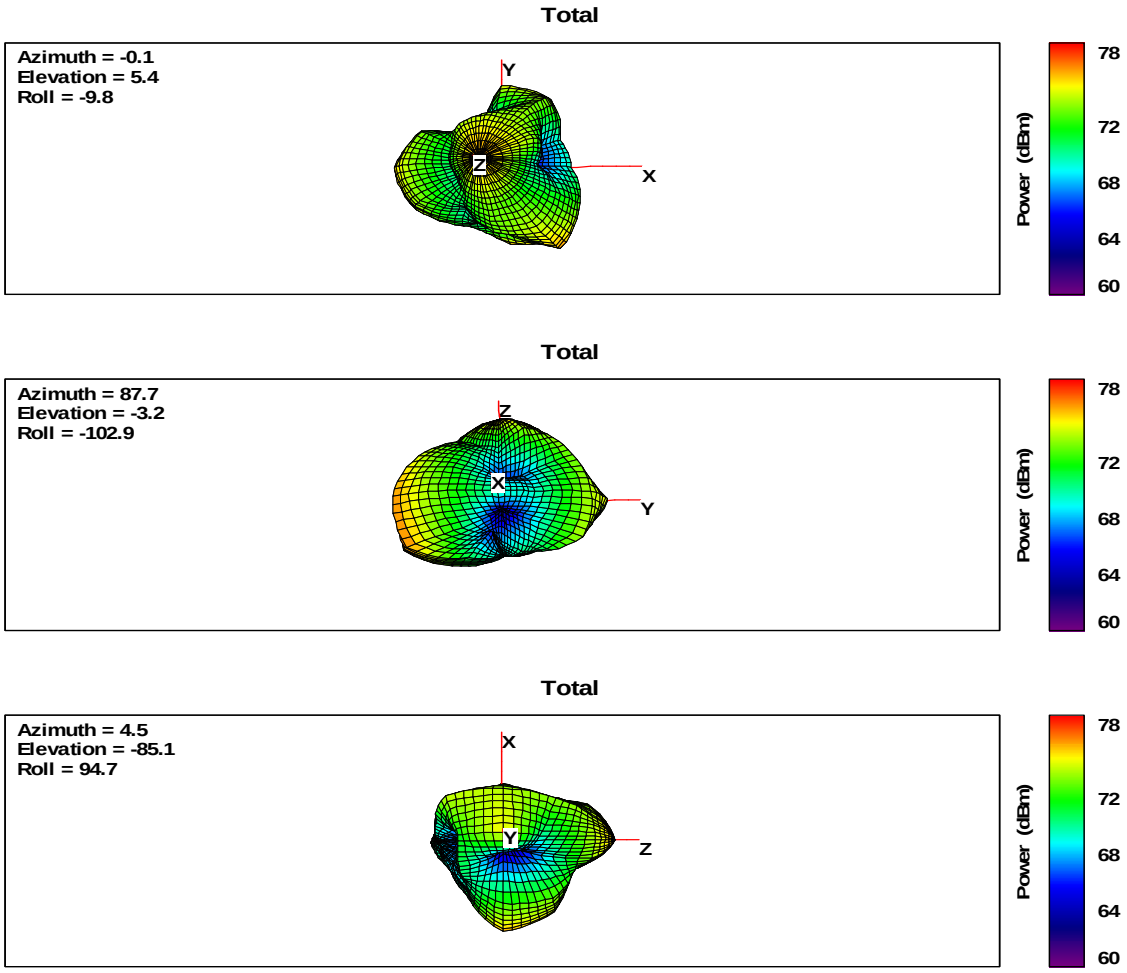


WIFI G CH7 54M TIS



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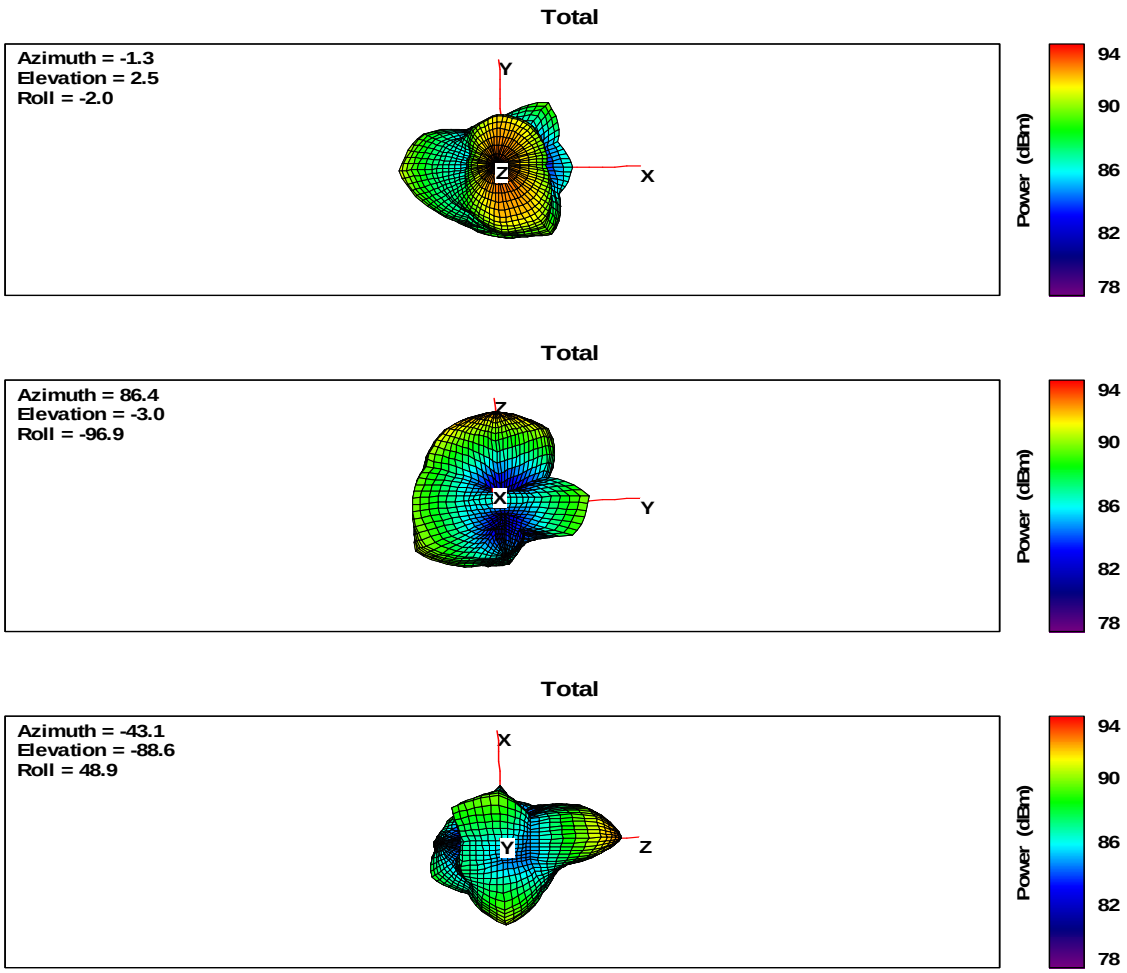

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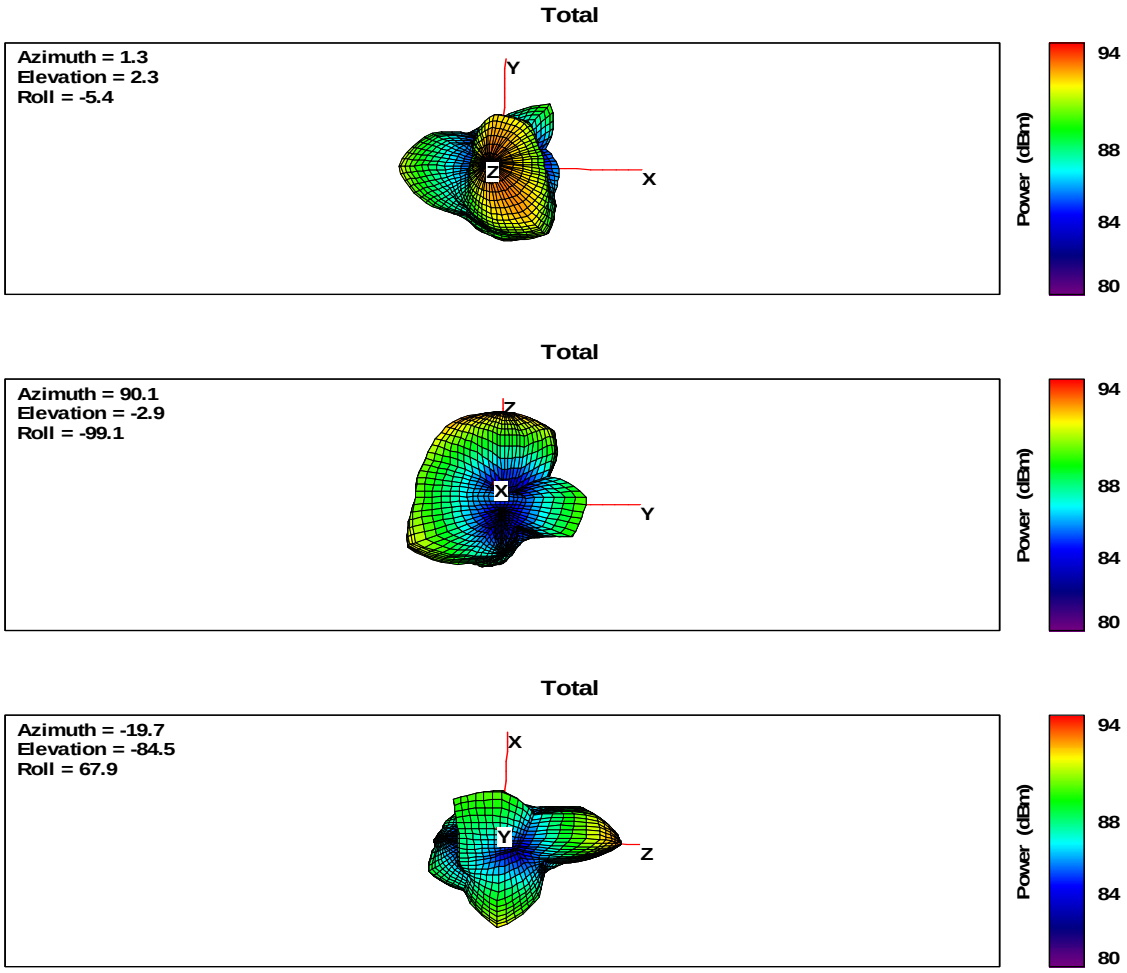

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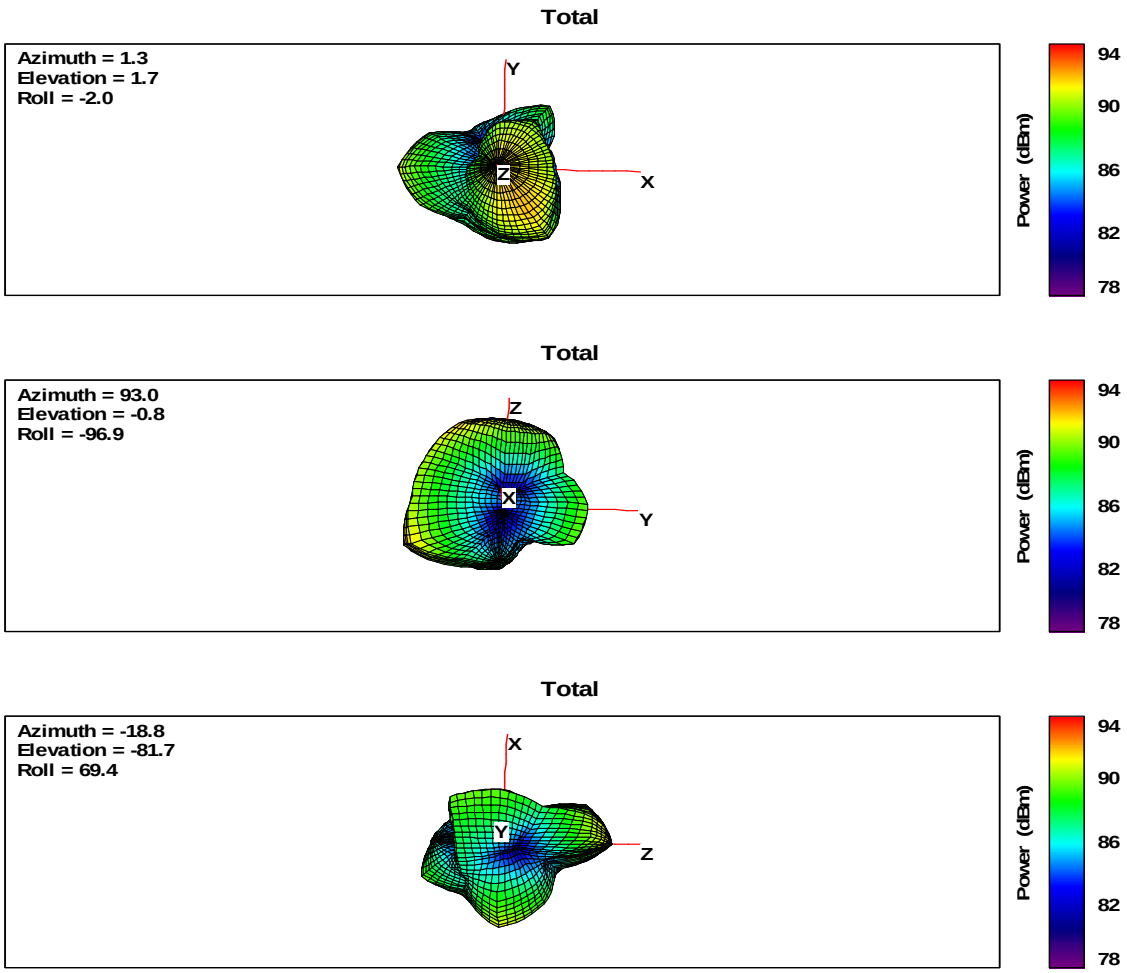

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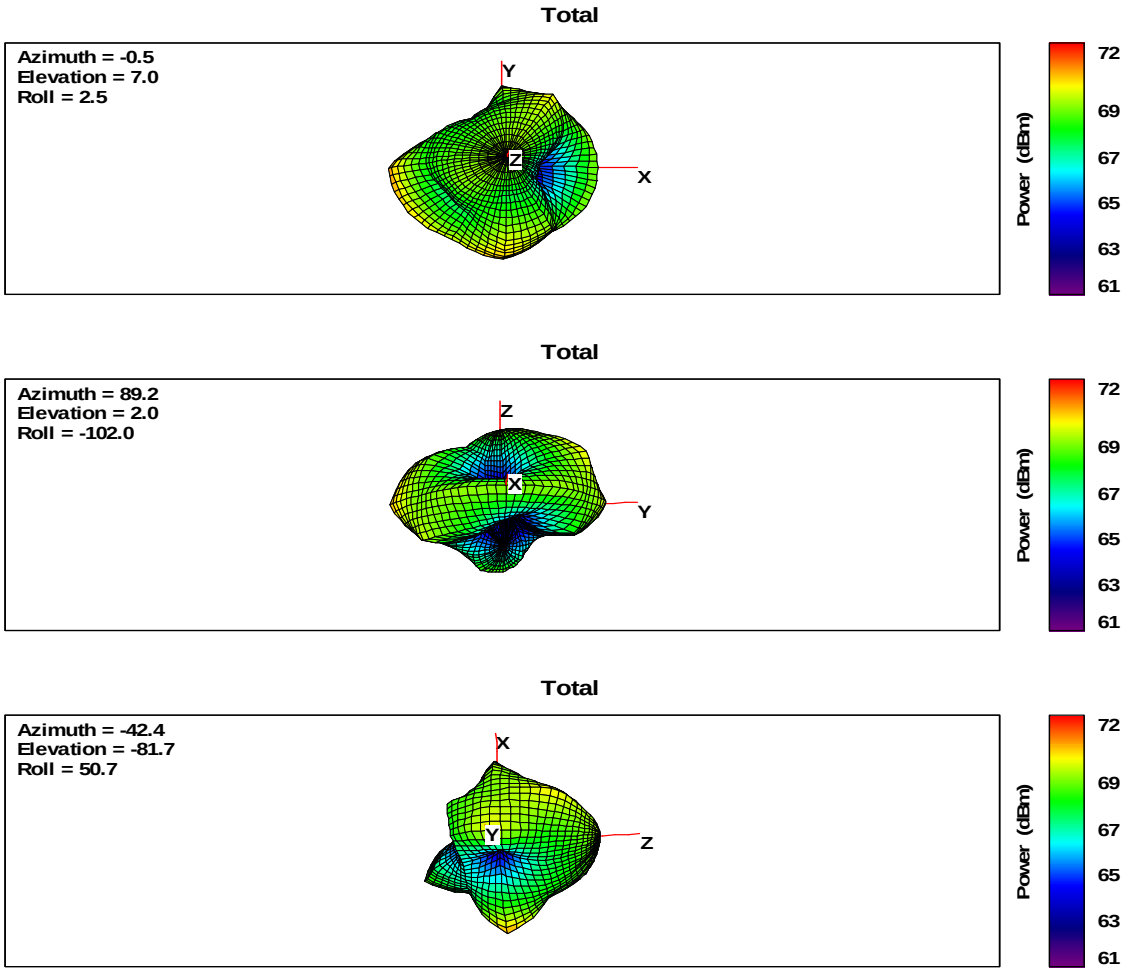

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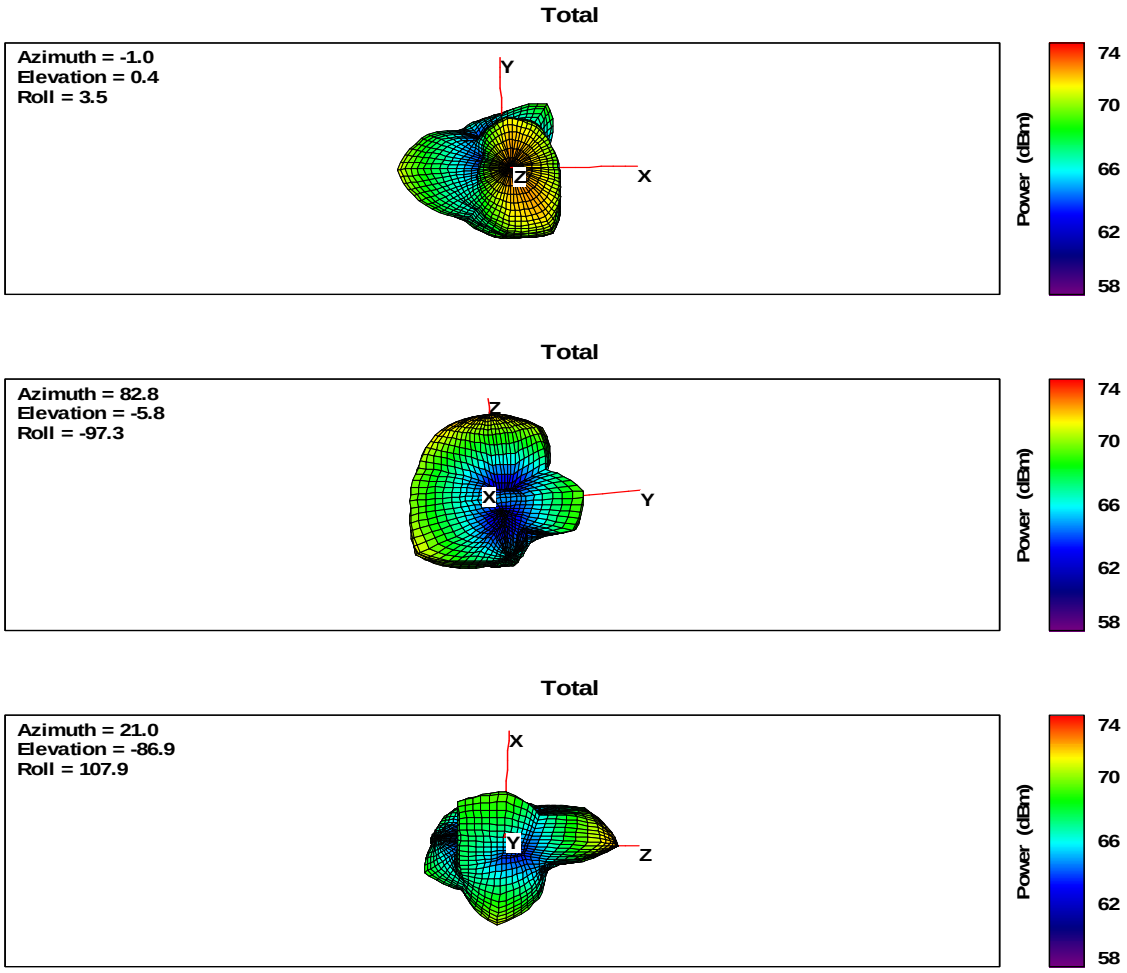

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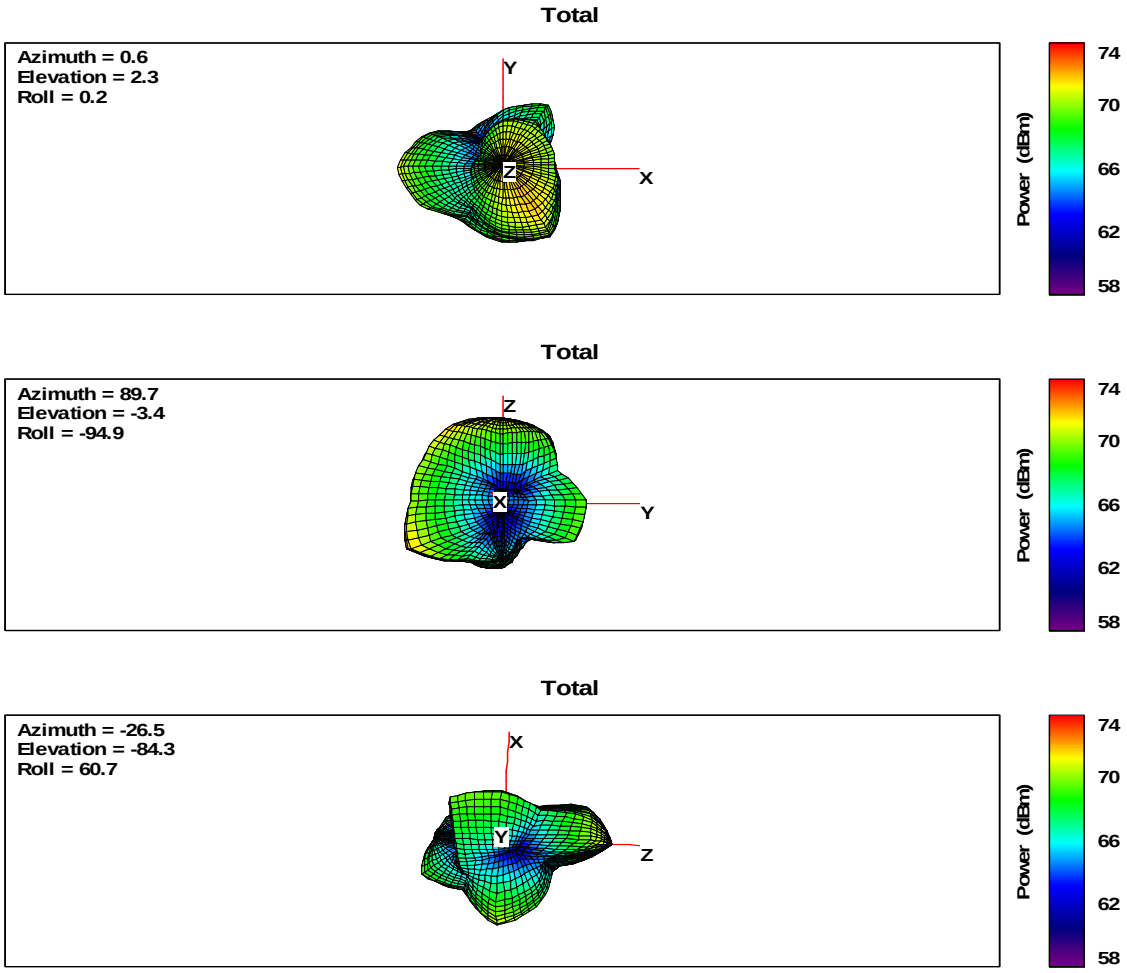
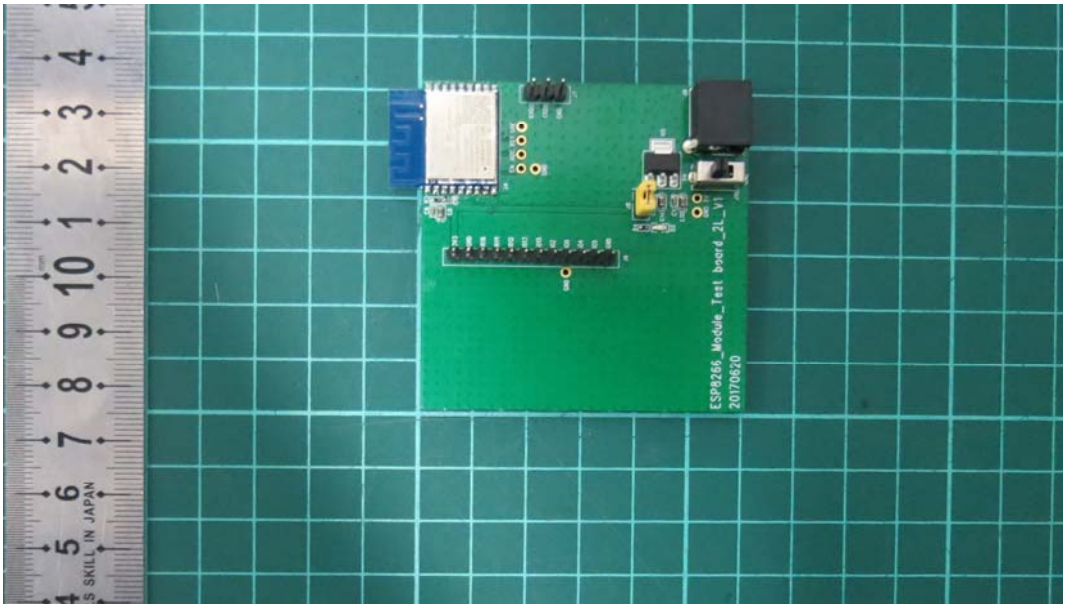
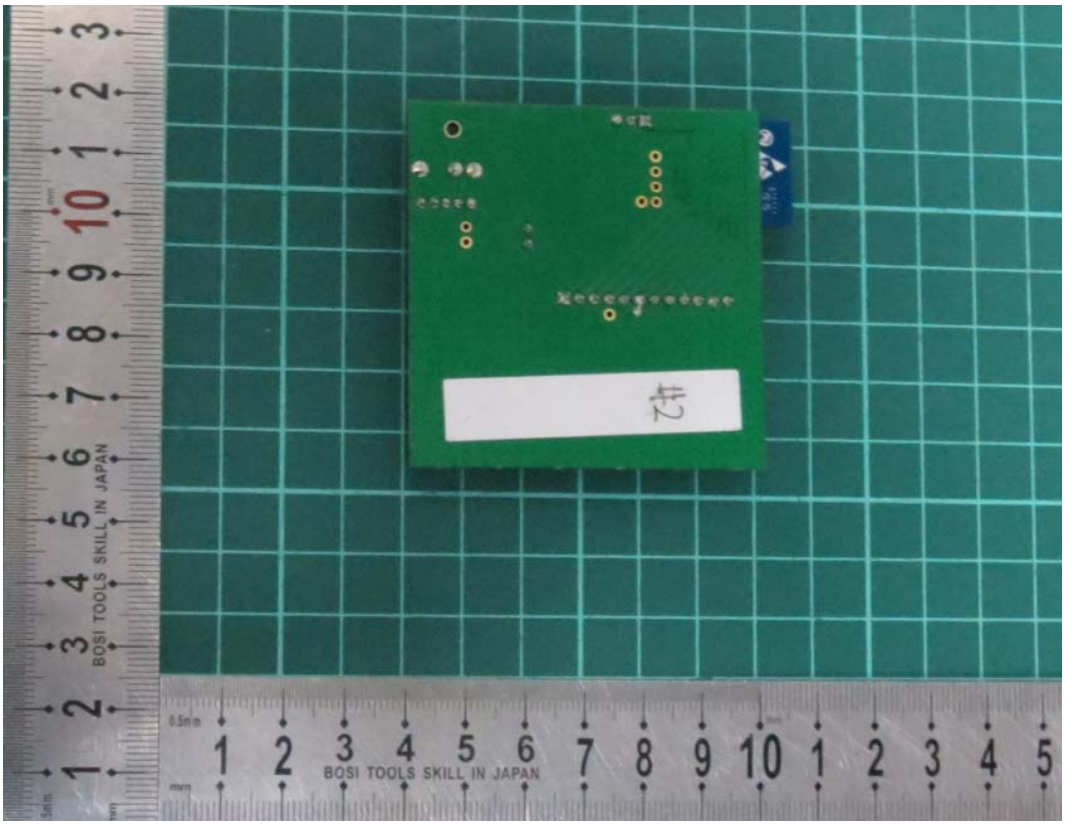


WIFI N HT20 CH13 MCS7 TIS

ANNEX B: The EUT Appearance and Test Configuration

B.1 EUT Appearance

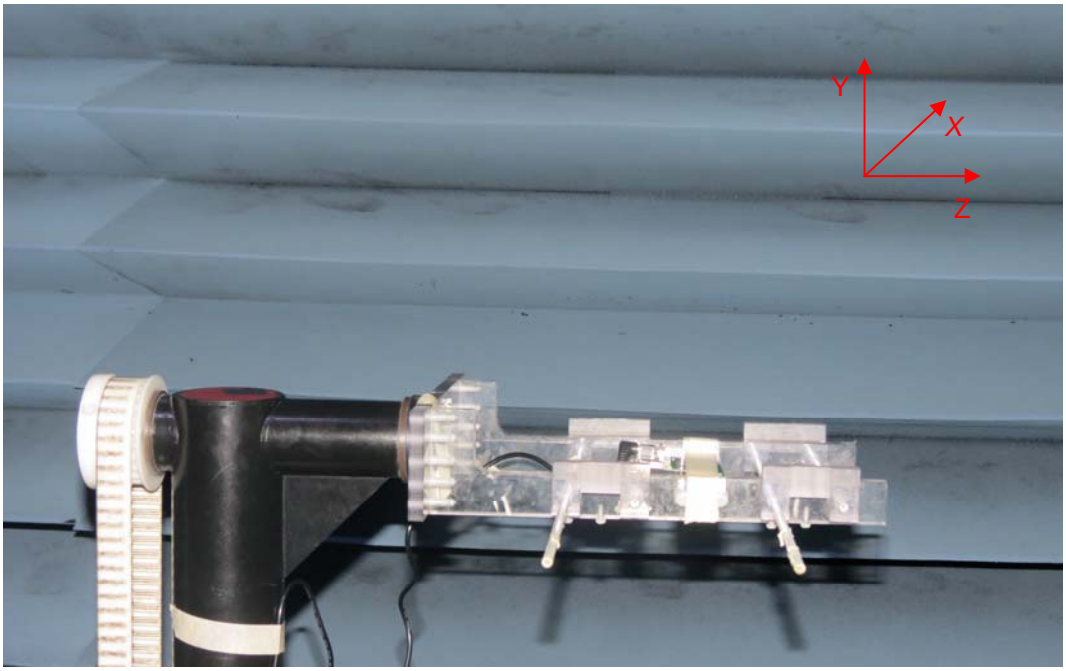




a: EUT

Picture 1: Constituents of EUT

B.2 Test Setup



Picture 2: Typical Free Space EUT Mounting