

CURIE: UHF AND S-BAND PATCH ANTENNA DESIGN

UHF Rectangular Patch Antenna with Inset Feeding Strip added to CubeSat Structure: Rectangular patch design, with an inset feeding strip at one edge of the patch, on a 1.6mm standard FR-4 substrate with double copper layer of 50 μ m each. Patch dimensions are 6cm (length) by 7.825cm (width), and full substrate dimensions are 8.5cm (length) by 9cm (width), as previously reported. Simulation stage performed with patch antenna added to only one side of the CubeSat structure, without S-Band patch antenna, back panels or 2.5m wire antennas. Simulations performed with CST Studio Suite 2017 ©.

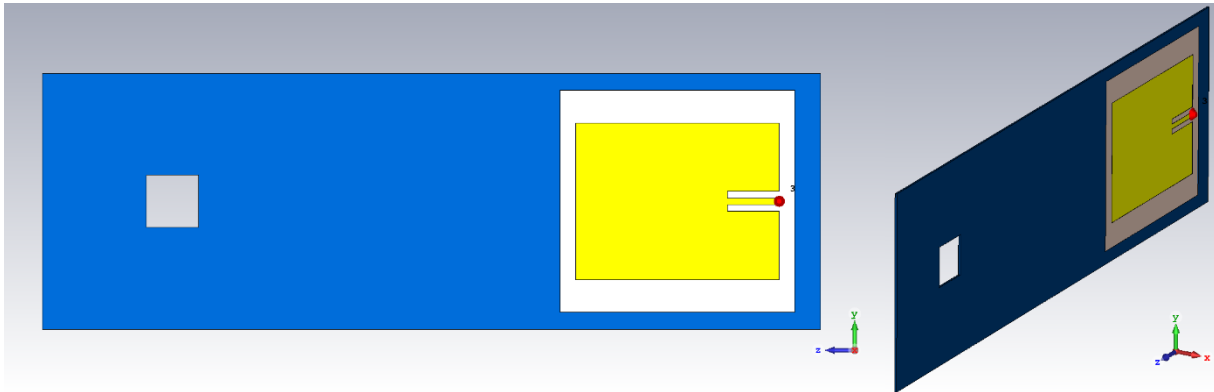


Figure 1.1. UHF Rectangular Patch Antenna on Side of CubeSat structure. Cube Side and Perspective Views.

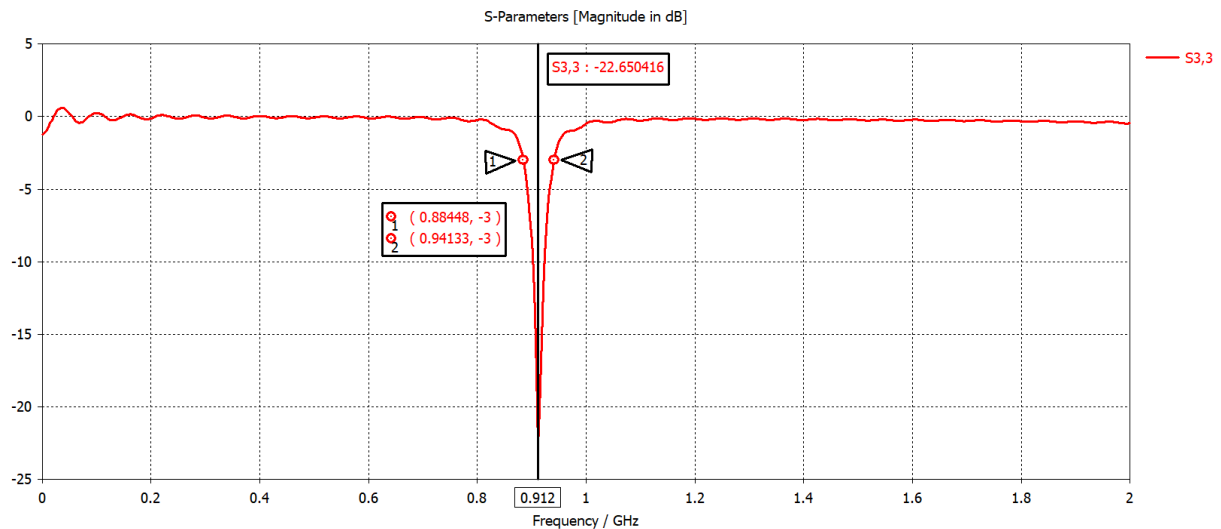


Figure 1.2. Input reflection coefficient (S11 Parameter) for UHF Rectangular Patch Antenna on Side of CubeSat structure.

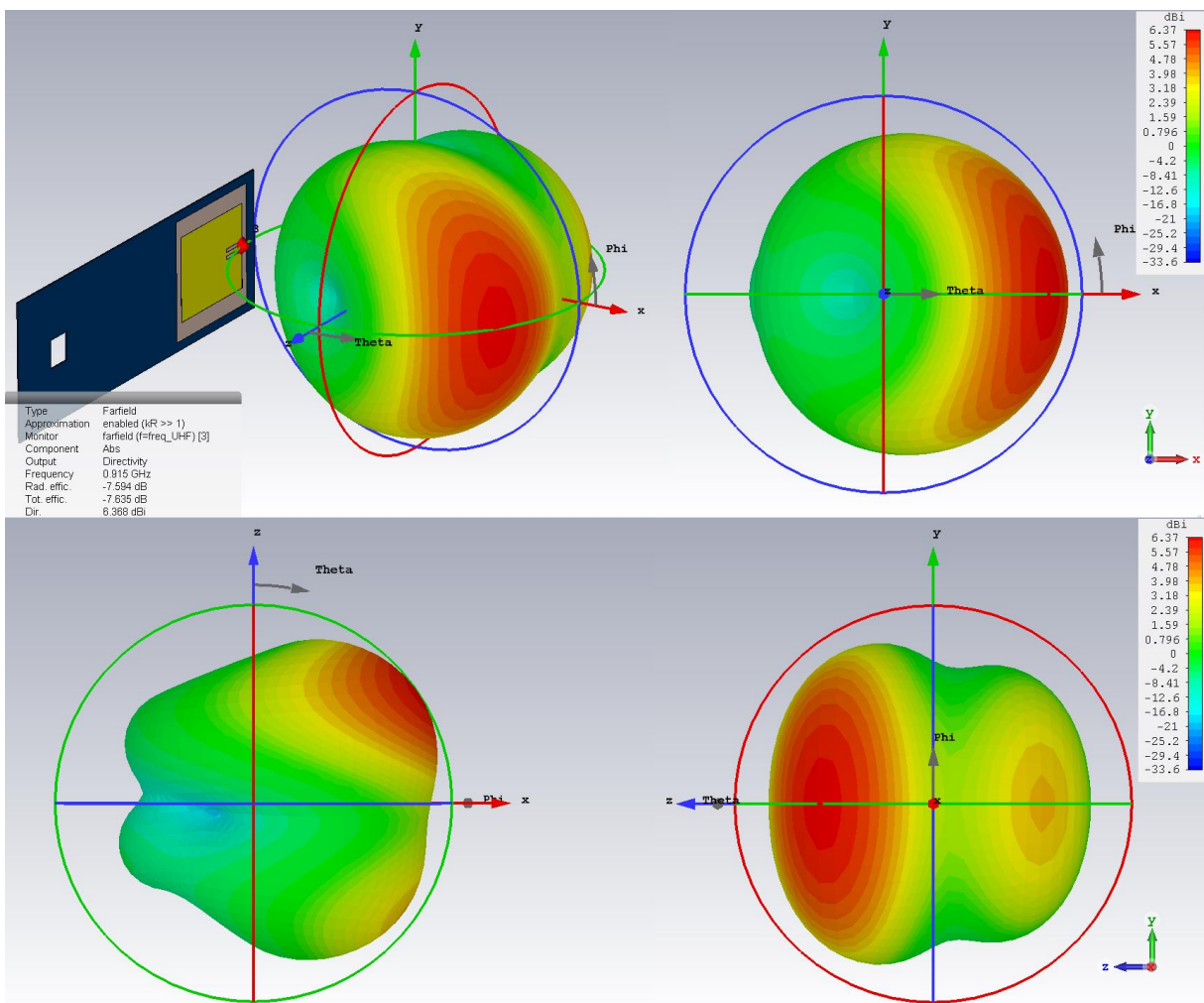


Figure 1.3. Far-field Radiation Pattern for UHF Rectangular Patch Antenna on Side of CubeSat structure. **Directivity.**

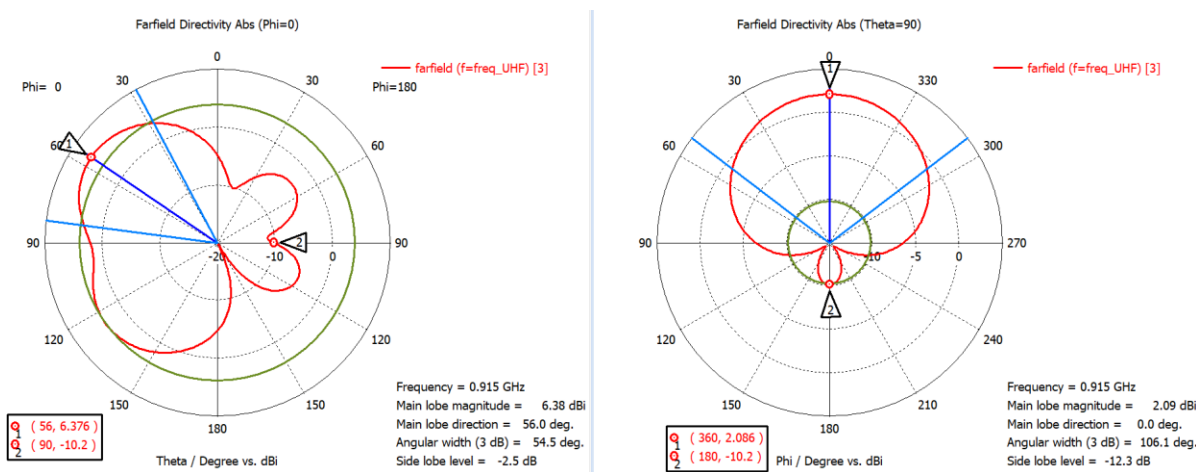


Figure 1.4. Far-field Radiation Pattern for UHF Rectangular Patch Antenna on Side of CubeSat structure. **Directivity (Polar View)**

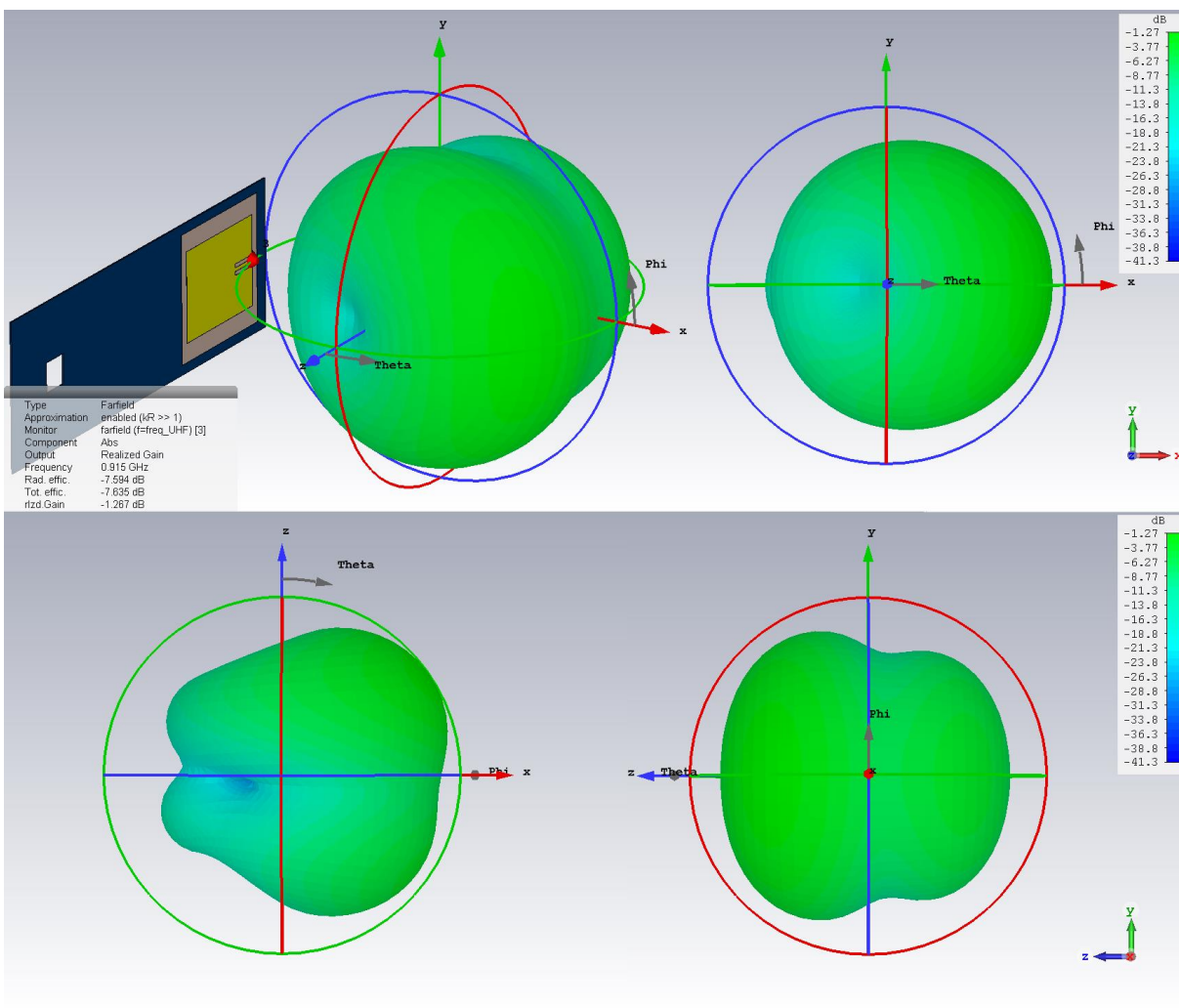


Figure 1. 5. Far-field Radiation Pattern for UHF Rectangular Patch Antenna on Side of CubeSat structure. **Realized Gain.**

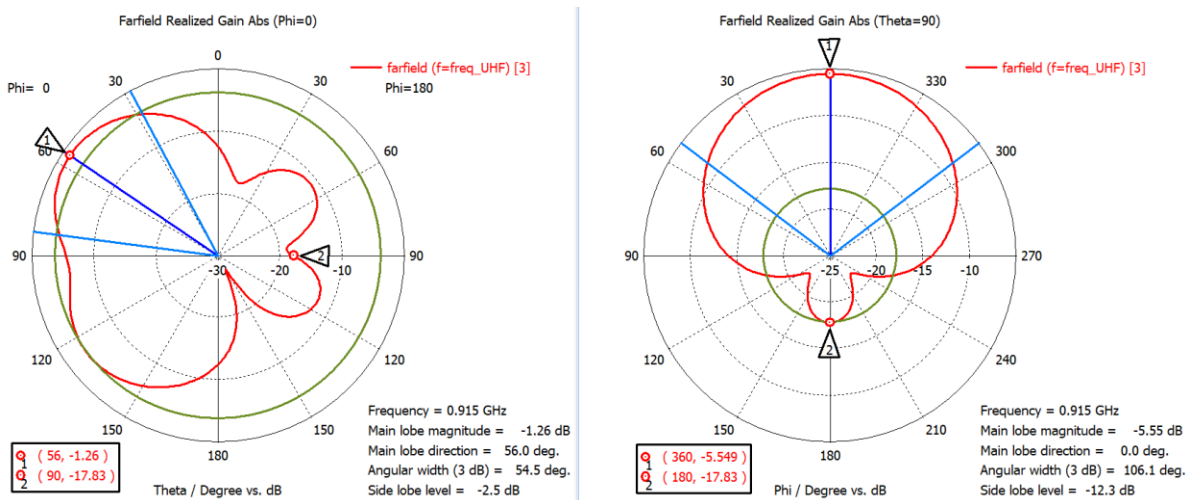


Figure 1. 6. Far-field Radiation Pattern for UHF Rectangular Patch Antenna on Side of CubeSat structure. **Realized Gain (Polar View).**

S-Band Patch Antenna: From the previously reported single S-Band rectangular patch antenna that was already fabricated and tested, we enlarge the dimensions of the FR-4 substrate, considering enough space for the screws to secure the antenna to the CubeSat structure. New substrate dimensions are 4.5cm (width) by 5cm (length). Simulations performed with CST Studio Suite 2017 ©.

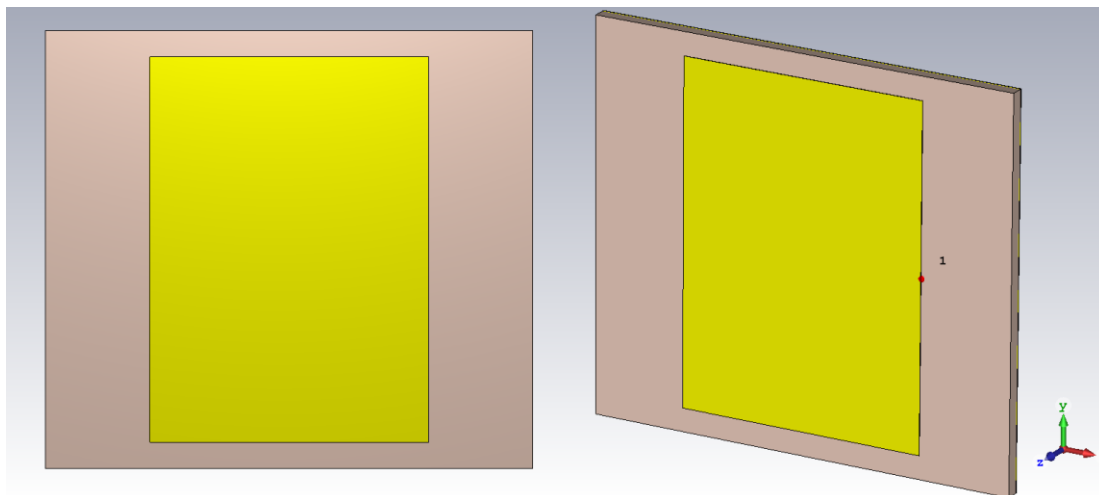


Figure 2.1. S-Band Rectangular Patch Antenna design. Cube Side and Perspective Views.

Parameter List					
<enter filter>					
	Name	Expression	Value	Description	Type
	f	= 2.4	2.4	Frequency [GHz]	Frequency
	Lambda	= 125	125	Wavelength [mm]	Length
	LambdaG	= 62.523	62.523	Guided Wavelength [mm]	Length
	Lpatch	= 28.579	28.579	Patch Length (X Axis) [mm]	Length
	Lsubs	= 45 + 5	50	Substrate Length (X Axis) [mm]	Length
	Tpatch	= 0.05	0.05	Patch Thickness (Z Axis) [mm]	Length
	Tsubs	= 1.6	1.6	Substrate Thickness (Z Axis) [mm]	Length
	Wpatch	= 39.593	39.593	Patch Width (Y Axis) [mm]	Length
	Wsubs	= 45	45	Substrate Width (Y Axis) [mm]	Length

Figure 2.2. Parameter list for Structure design.

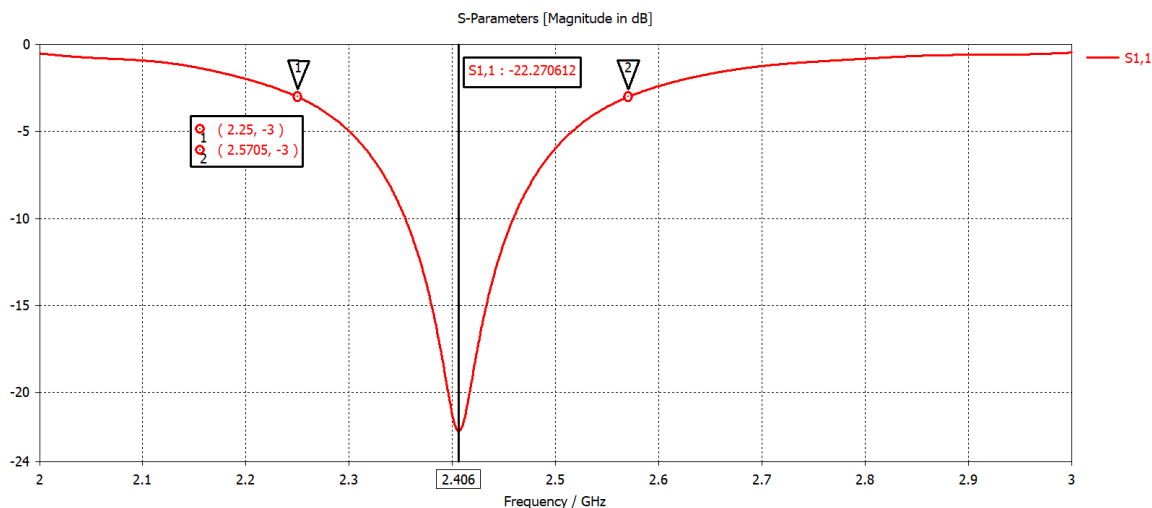


Figure 2.3. Input reflection coefficient (S11 Parameter) for S-Band Rectangular Patch Antenna.

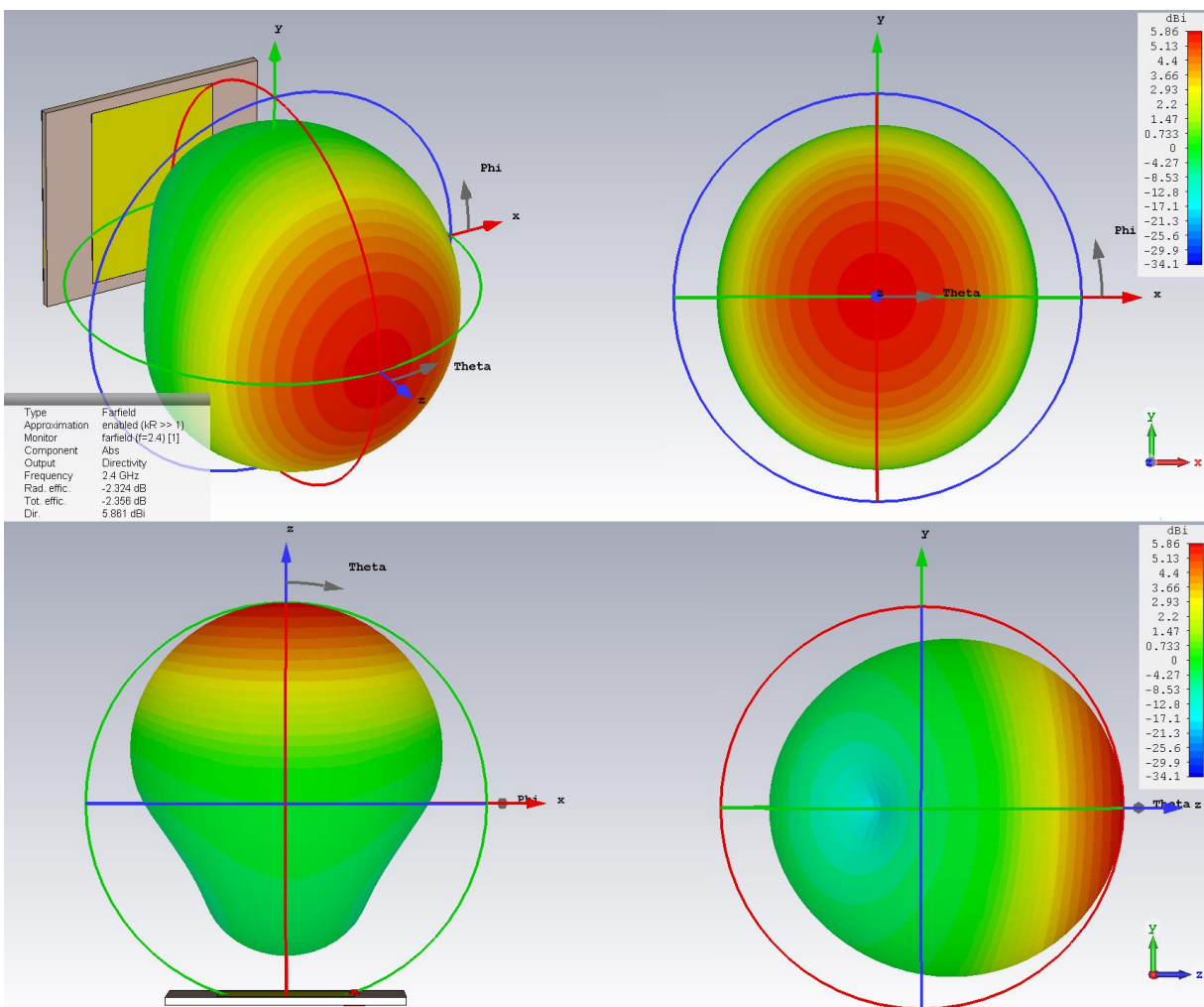


Figure 2.4. Far-field Radiation Pattern for S-Band Rectangular Patch Antenna. **Directivity**.

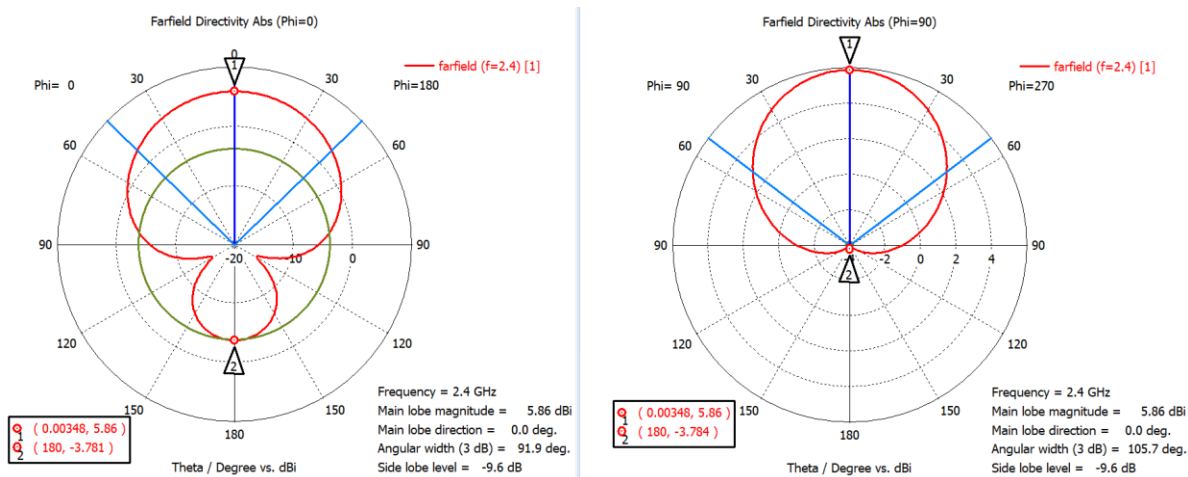


Figure 2.5. Far-field Radiation Pattern for S-Band Rectangular Patch Antenna. **Directivity (Polar View)**.

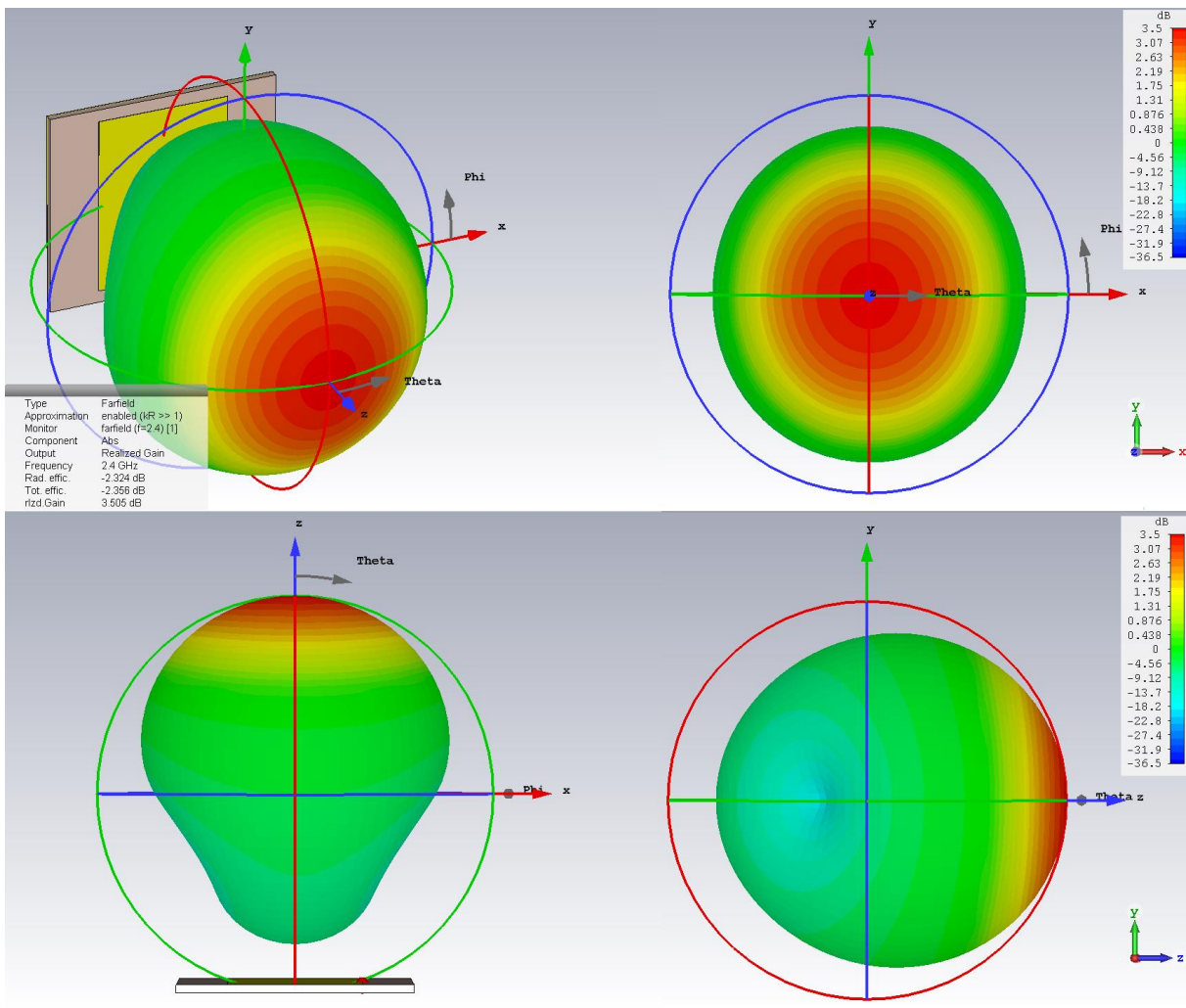


Figure 2.6. Far-field Radiation Pattern for S-Band Rectangular Patch Antenna. **Realized Gain.**

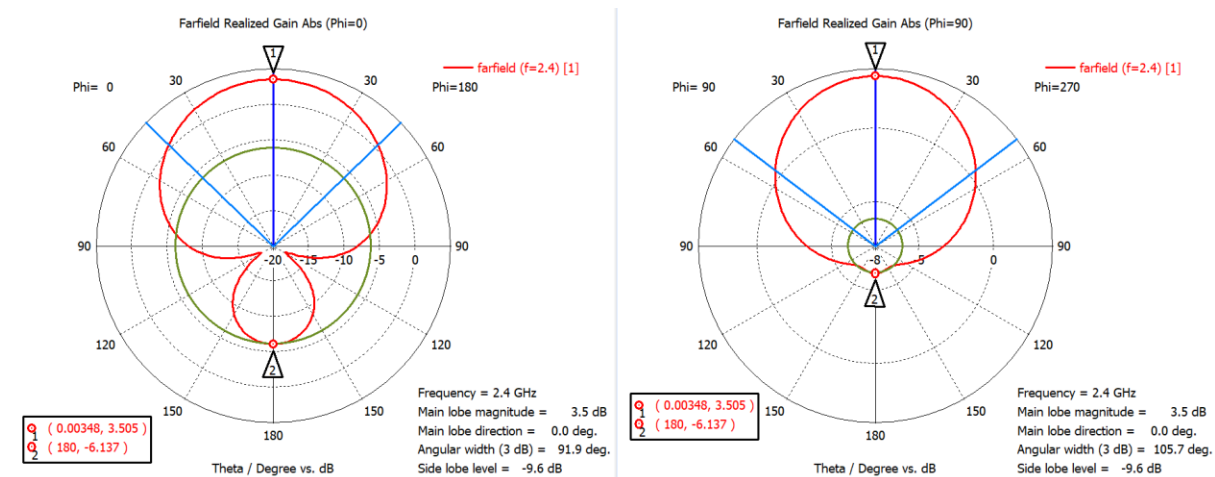


Figure 2.7. Far-field Radiation Pattern for S-Band Rectangular Patch Antenna. **Realized Gain (Polar View).**

UHF Patch added to Structure – Including S-Band Patch Antenna: S-Band patch antenna added to the side of CubeSat structure, and slightly shifted towards the front side of the Cube. Simulations performed with CST Studio Suite 2017 ©.

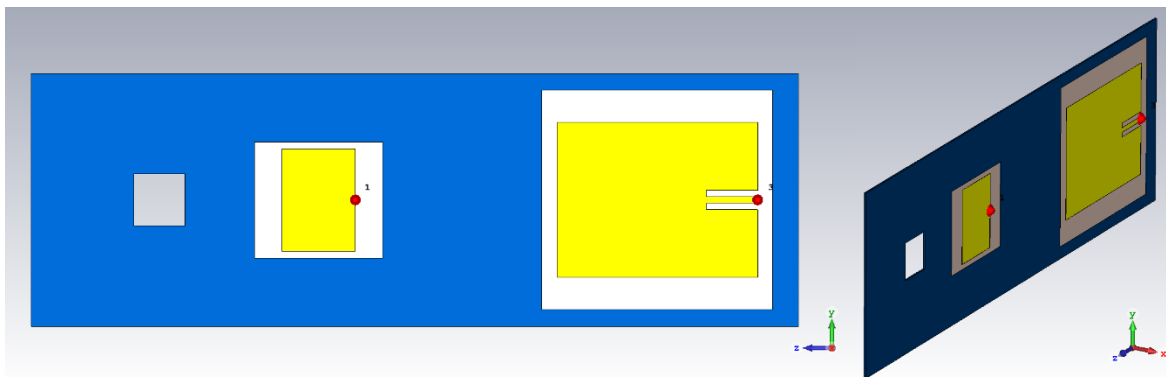


Figure 3. 1. UHF Patch Antenna and S-Band Patch Antenna added to side of CubeSat structure. Cube Side and Perspective Views.

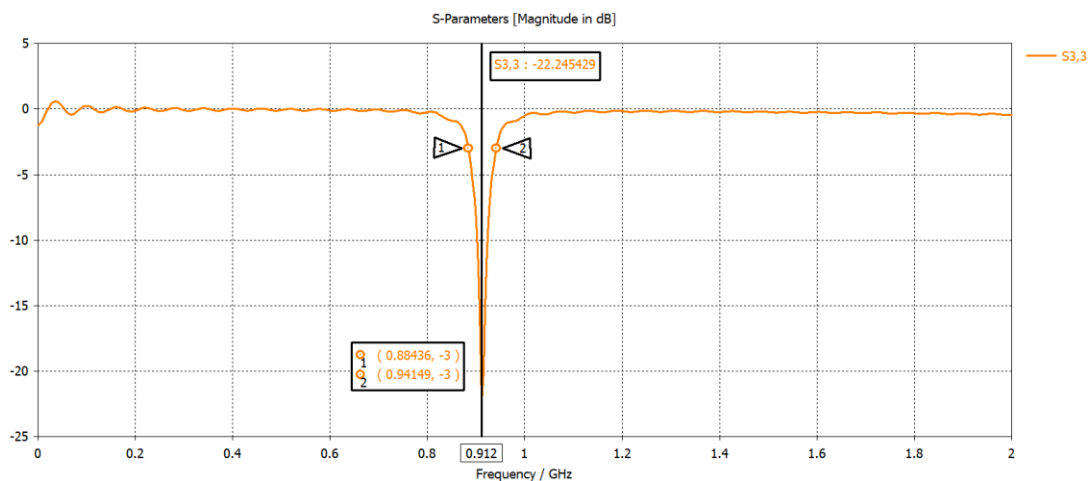


Figure 3. 2. Input reflection coefficient (S11 Parameter) for UHF Patch Antenna added to side of CubeSat structure

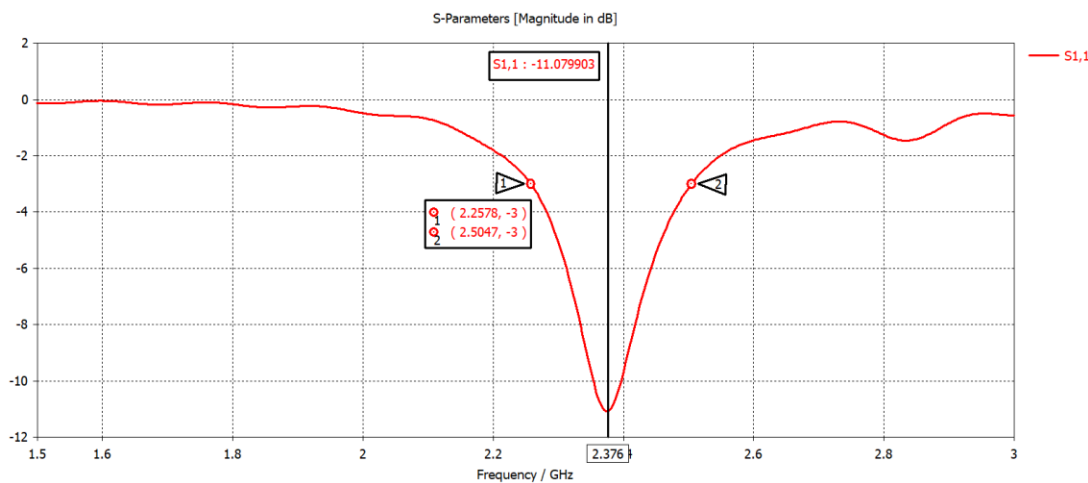


Figure 3. 3. Input reflection coefficient (S11 Parameter) for S-Band Patch Antenna added to side of CubeSat structure

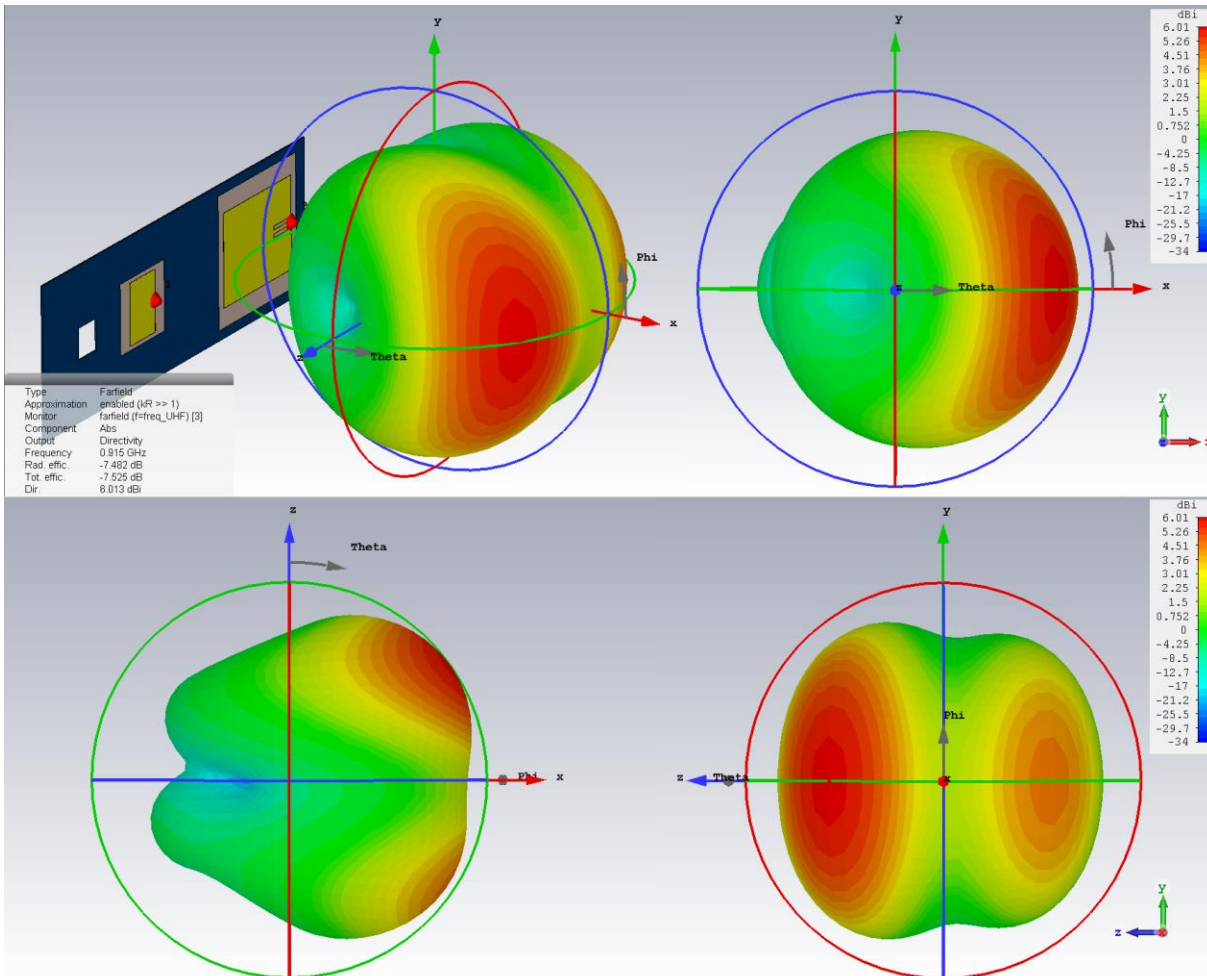


Figure 3.4. Far-field Radiation Pattern for UHF Patch Antenna added to side of CubeSat structure. **Directivity.**

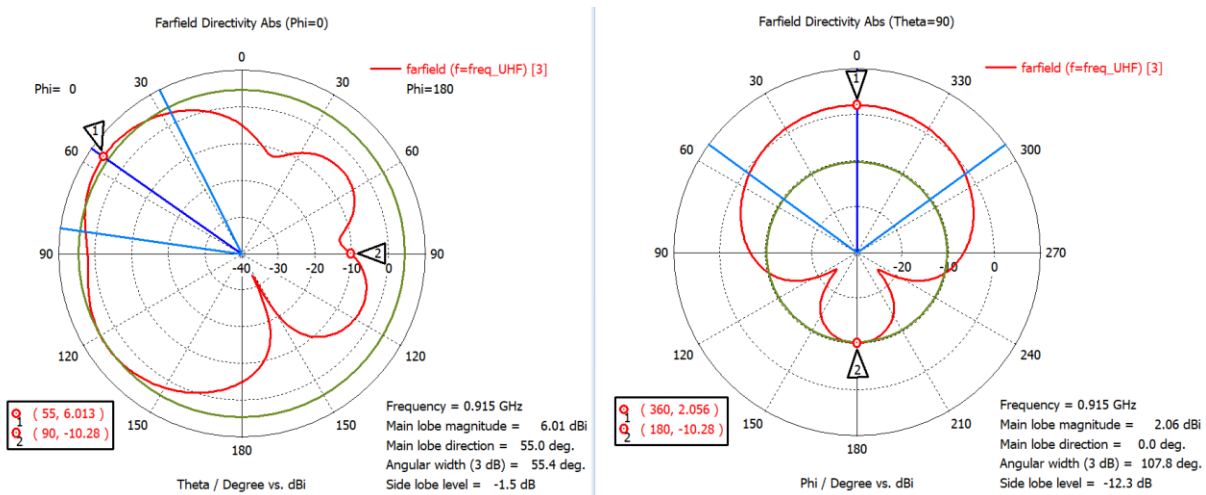


Figure 3.5. Far-field Radiation Pattern for UHF Patch Antenna added to side of CubeSat structure. **Directivity (Polar View).**

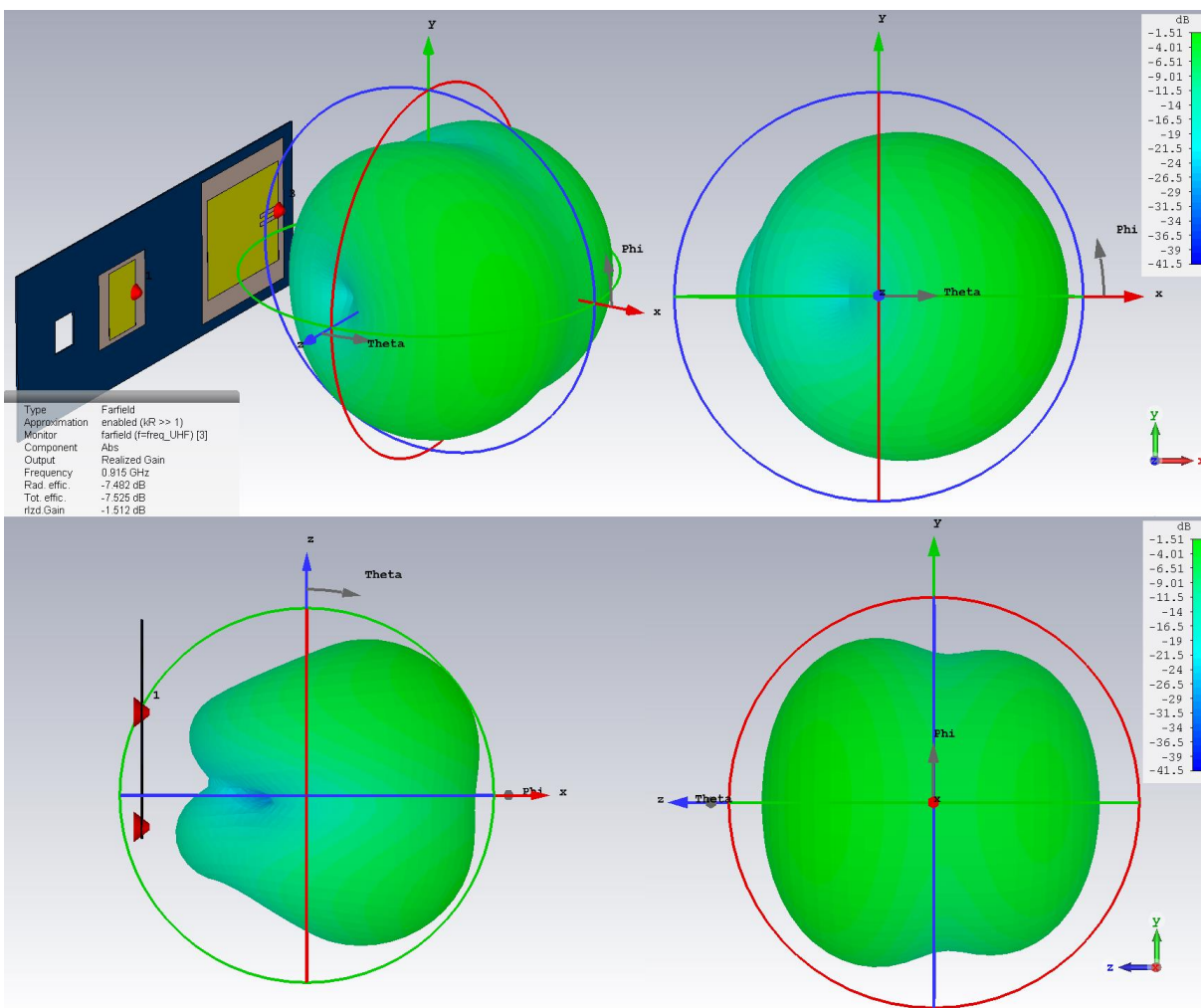


Figure 3.6. Far-field Radiation Pattern for UHF Patch Antenna added to side of CubeSat structure. **Realized Gain.**

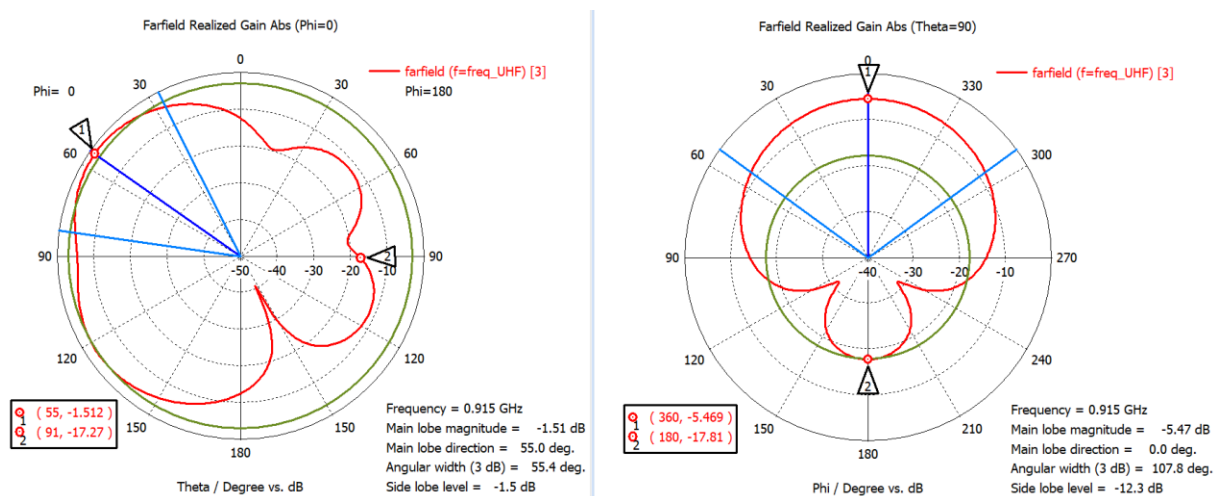


Figure 3.7. Far-field Radiation Pattern for UHF Patch Antenna added to side of CubeSat structure. **Realized Gain (Polar View).**

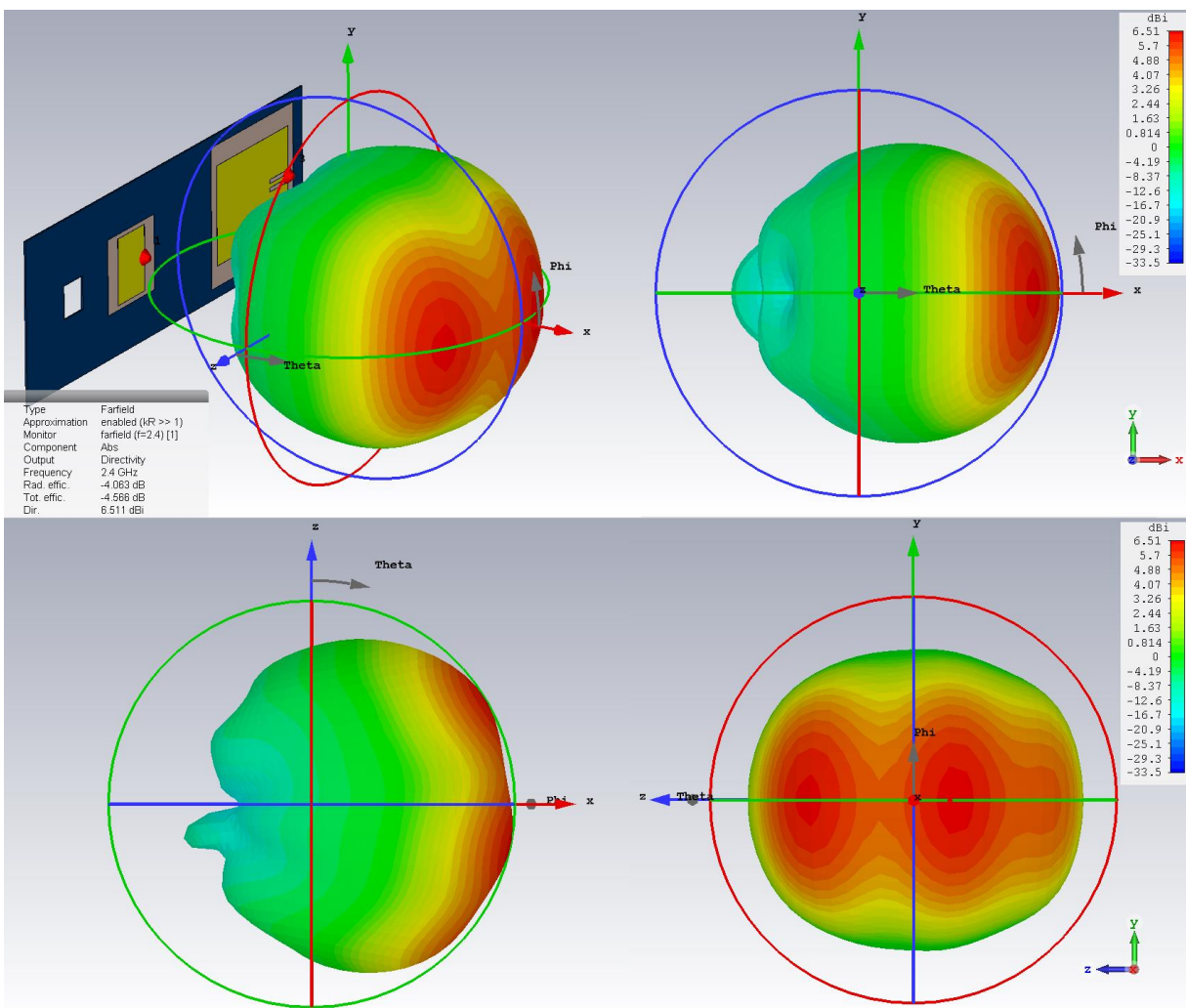


Figure 3.8. Far-field Radiation Pattern for S-Band Patch Antenna added to side of CubeSat structure. **Directivity.**

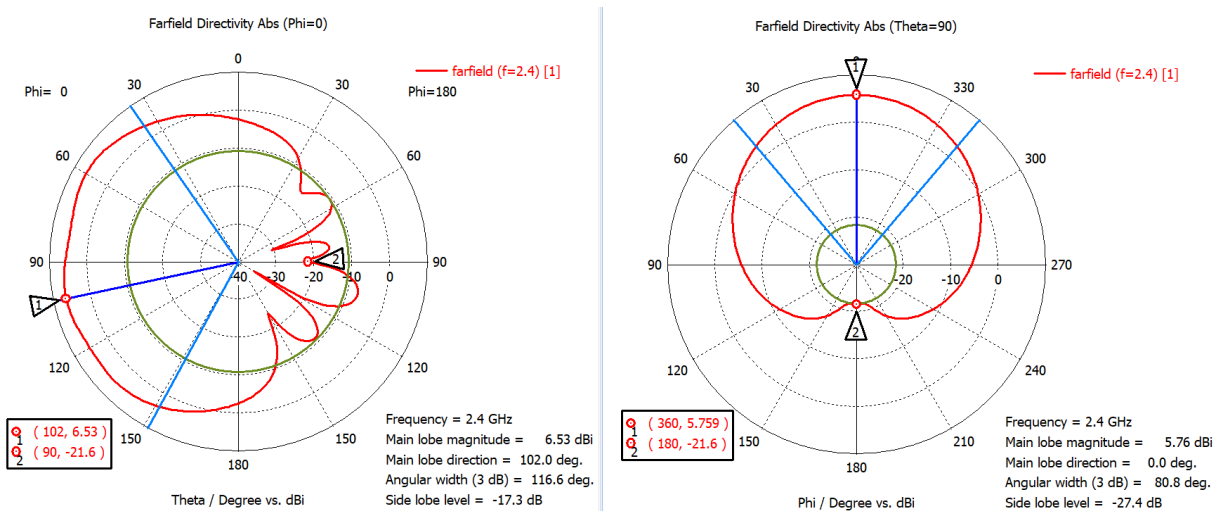


Figure 3.9. Far-field Radiation Pattern S-Band Patch Antenna added to side of CubeSat structure. **Directivity (Polar View).**

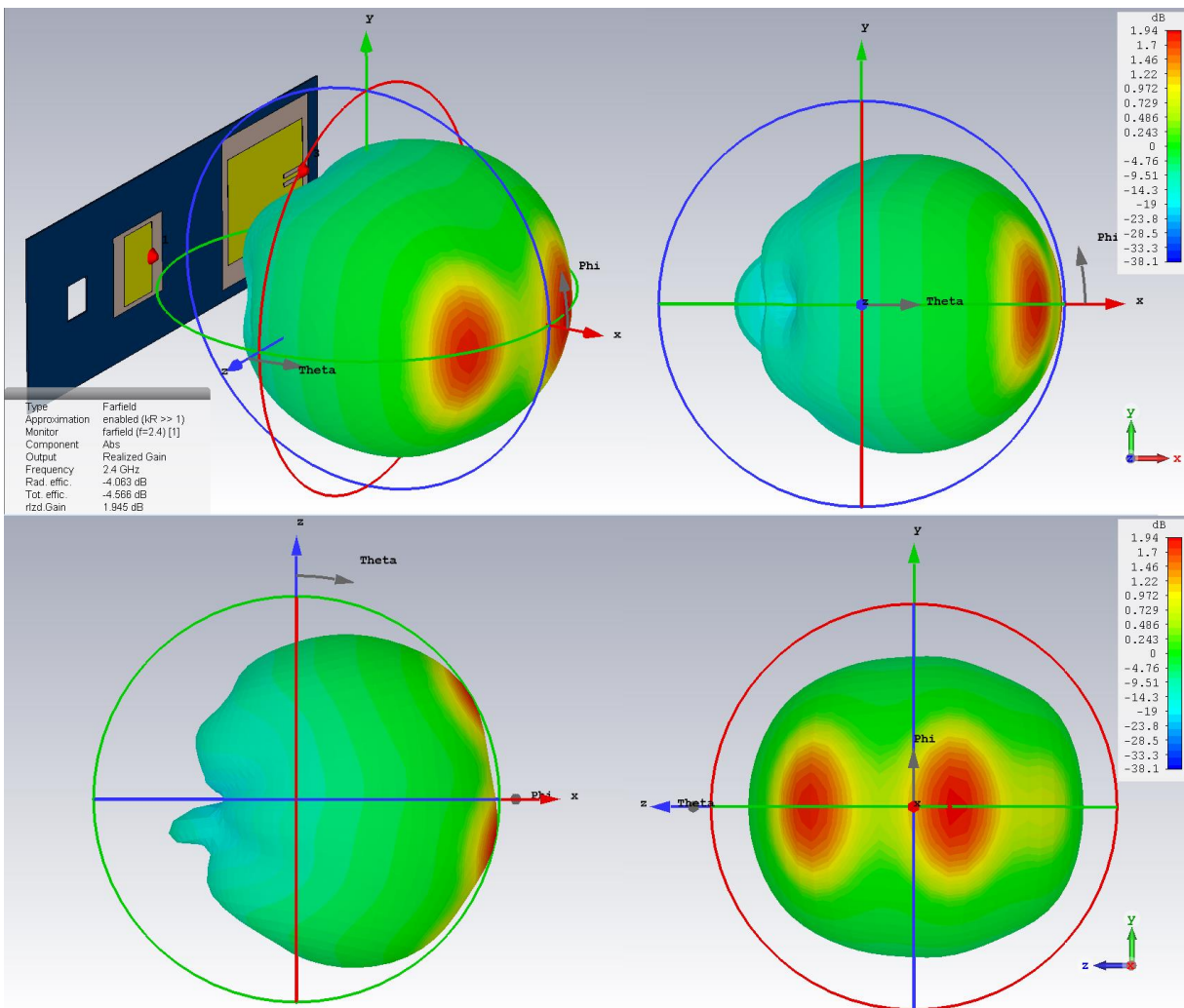


Figure 3. 10. Far-field Radiation Pattern for S-Band Patch Antenna added to side of CubeSat structure. **Realized Gain.**

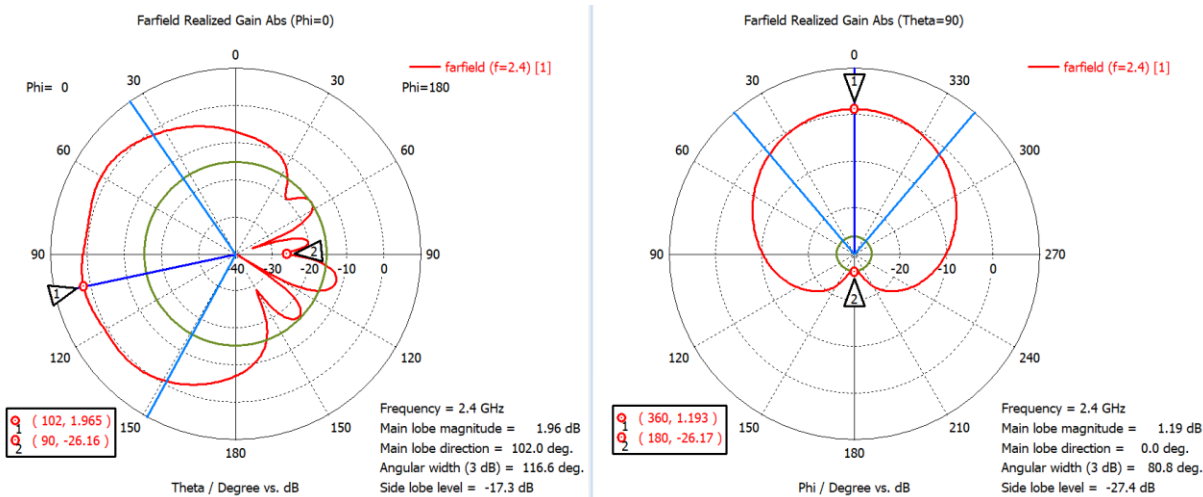


Figure 3. 11. Far-field Radiation Pattern for S-Band Patch Antenna added to side of CubeSat structure. **Realized Gain (Polar View)**

Adding the UHF patch antenna to the CubeSat structure side, shows a small enhancement in terms of UHF realized gain, with a operation frequency of 912MHz (shift down of 3MHz), however, the radiation pattern shows a small interference with the Cube metallic structure, shifting the direction of maximum radiation almost 30 degrees from the normal position of the patch antenna (See figures 1.3 to 1.6).

As previously reported, the UHF antenna has a small interference effect on the S-Band patch behavior and Radiation Pattern, possibly due to the current location of both communication antenna systems. With respect to the previous report, there's a small compromise in gain, due to both enlargement of substrate and interference with UHF antenna. (Pending verifications and a new simulation including 2.4m Wire antennas and verifying its interference on both communications antennas).

PARAMETER	UHF Rectangular Patch Antenna	S-Band Patch Antenna	UHF Patch added to CubeSat Structure (Only One Side)	UHF and S-Band Patch added to CubeSat Structure (Only One Side)	
				UHF Antenna	S-Band Antenna
Input Reflection Coefficient (S11 Parameter)	-31.696 dB (at 915 MHz)	-22.271 dB (at 2.406 GHz)	-22.650 dB (at 912 MHz)	-22.245 dB (at 912 MHz)	-11.079 dB (at 2.376 GHz)
Half-Power (-3 dB Bandwidth)	50.14 MHz	320.5 MHz	56.85 MHz	57.13 MHz	246.9 MHz
Directivity	4.550 dBi	5.861 dBi	6.368 dBi	6.013 dBi	6.511 dBi
Gain (IEEE)	-5.879 dB	3.537 dB	-1.226 dB	-1.469 dB	2.447 dB
Realized Gain	-5.882 dB	3.505 dB	-1.267 dB	-1.512 dB	1.945 dB
Half-Power Beamwidth (HPBW)	95.3 deg	91.9 deg	54.5 deg	55.4 deg	116.6 deg
Front-to-Back Ratio	3.056 dB	9.642 dB	16.57 dB	15.758 dB	28.125 dB

Table 1.1. Results Summary for UHF Patch and S-Band Patch Antennas.