CURIE: ANTENNA DESIGN

1. *Dipole at 438MHz:* Design of 45° angle UHF Dipole Antenna. Dipole element length of 14.9232cm for operation at 438MHz (λ=68.49cm). Simulated bandwidth (-3 dB) of 142.15 MHz and Realized Gain of 1.713 dB (Directivity of 1.845 dBi).

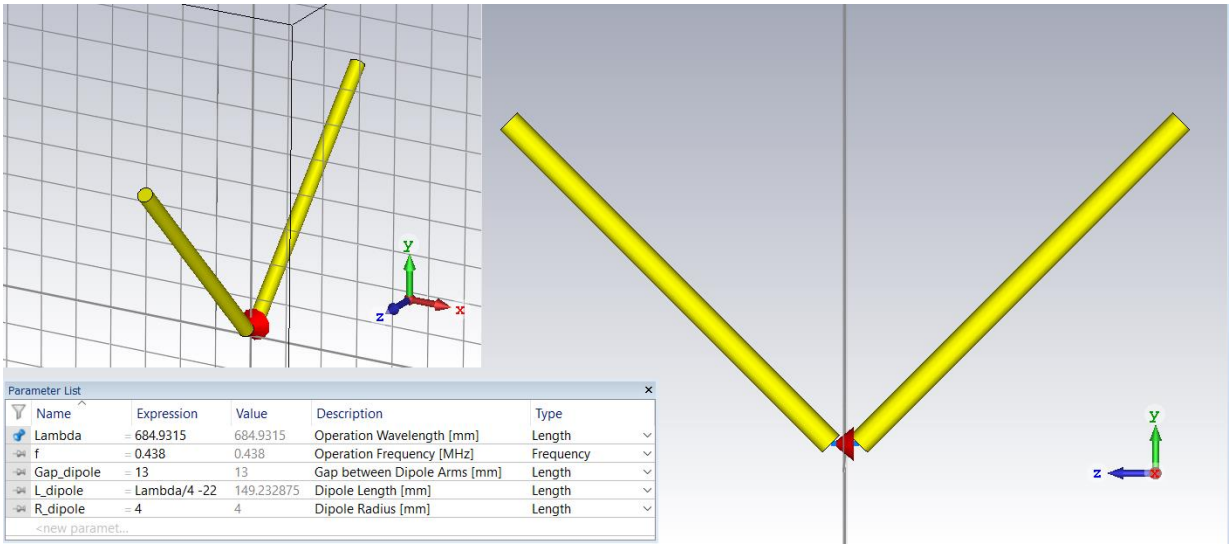

Figure 1.1. 45° Dipole Antenna. Design and Simulation performed with CST Studio Suite 2017 ©.

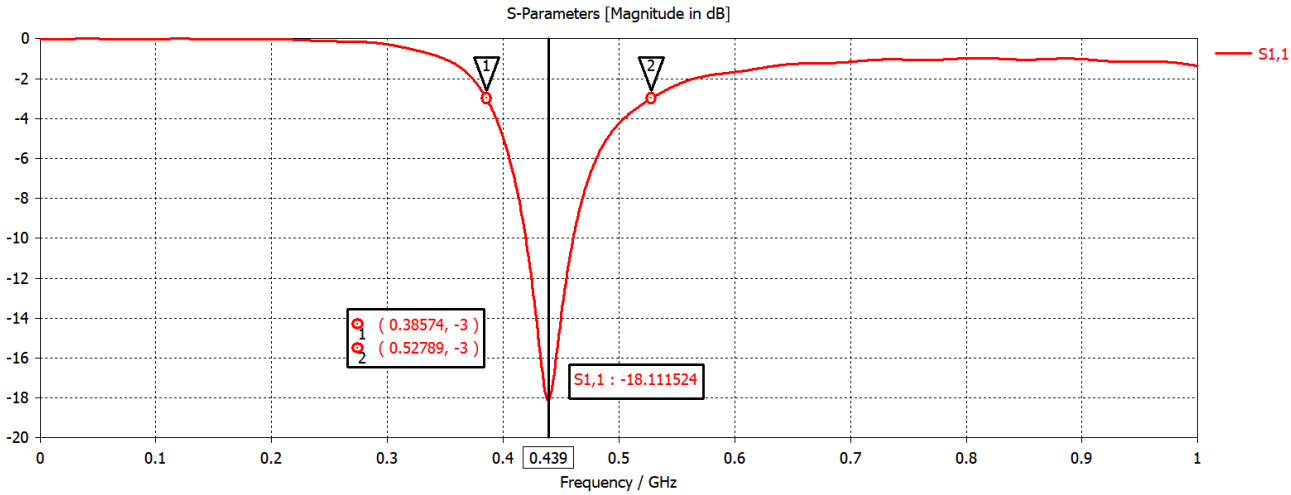

Figure 1.2. Input Reflection Coefficient for 45° Dipole Antenna. Design and Simulation performed with CST Studio Suite 2017 ©.

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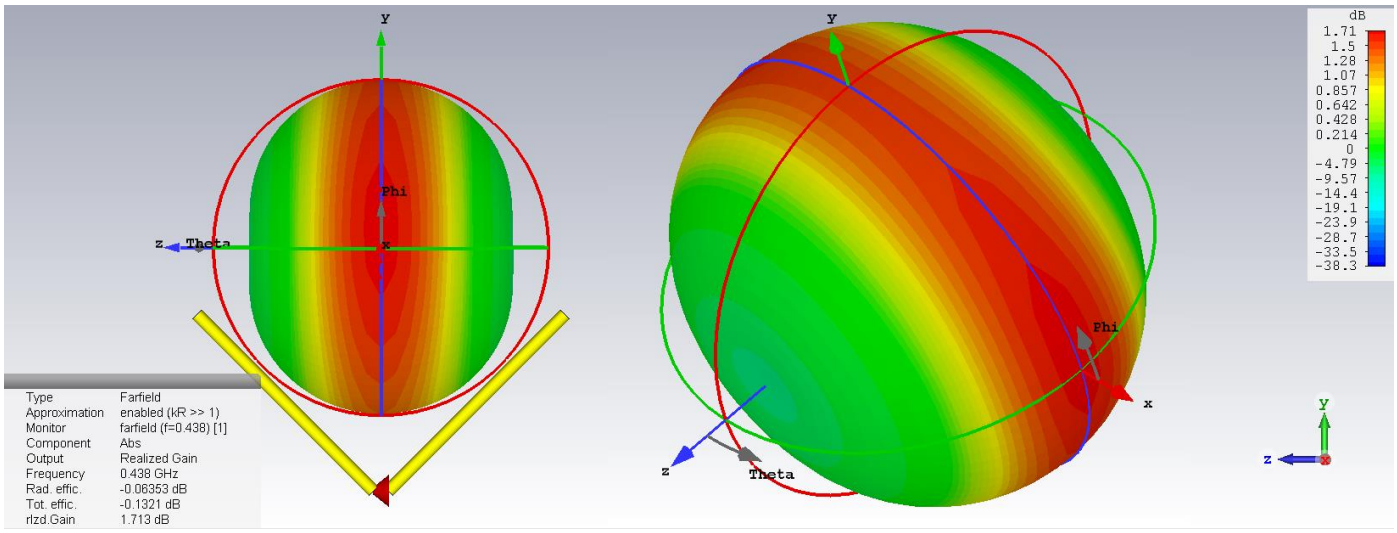

Figure 1.3. Farfield Radiation Pattern for 45° Dipole Antenna. Design and Simulation performed with CST Studio Suite 2017 ©.

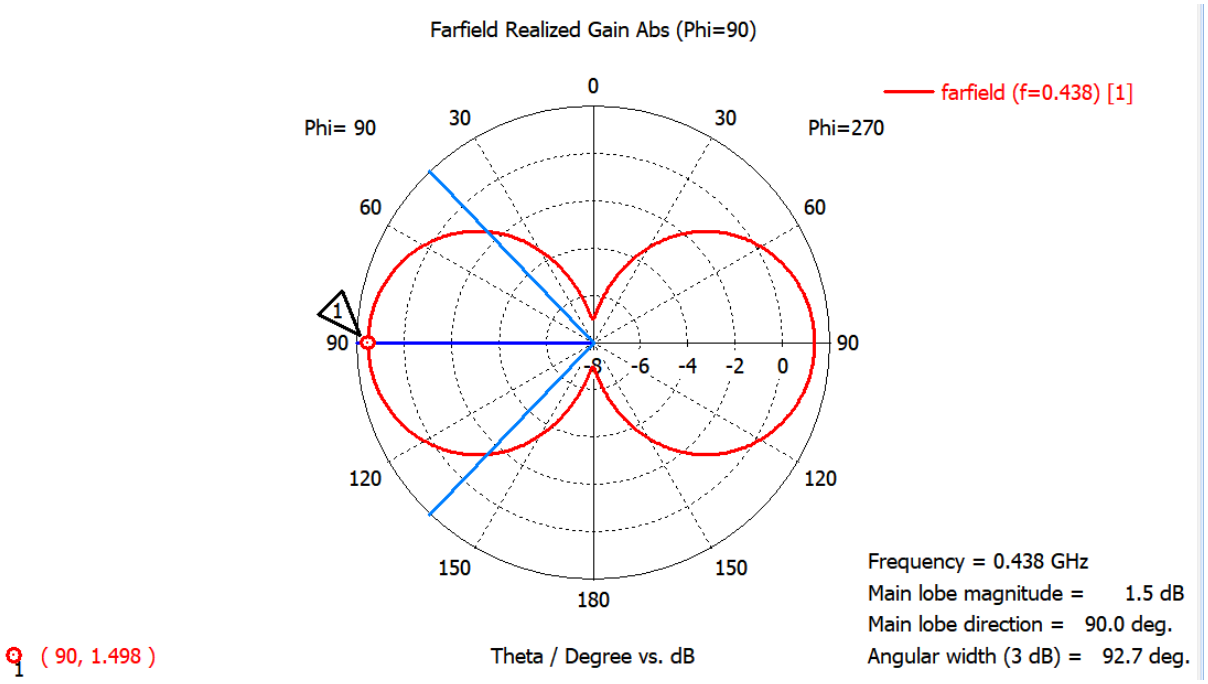

Figure 1.4. Farfield Radiation Pattern for 45° Dipole Antenna – Polar Plot. Design and Simulation performed with CST Studio Suite 2017 ©.

When adding the 45° angle Dipole Antenna to the back of CubeSat structure, with an additional 45° inclination with respect to the back side of the Cube, antenna behavior is altered. There is no resonance below -3dB level, hence there is no optimal operation at any frequency in the range considered between 0 and 1 GHz. In consequence the dipole antenna has no applicable gain. Simulation performed without 2.4m Wire Antennas at the opposite (front) side of CubeSat structure.

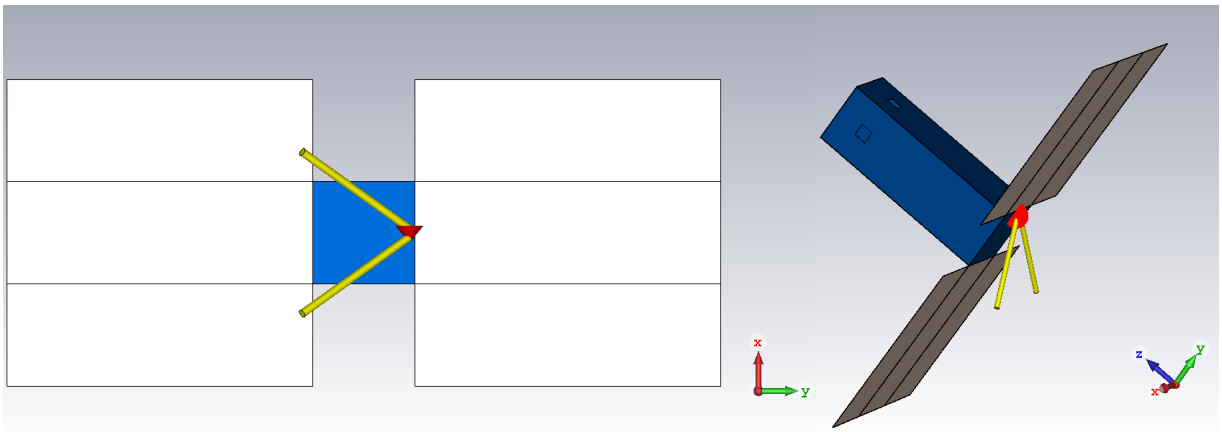

Figure 1.5. 45° Dipole Antenna on Backside of CubeSat structure. Design and Simulation performed with CST Studio Suite 2017 ©.

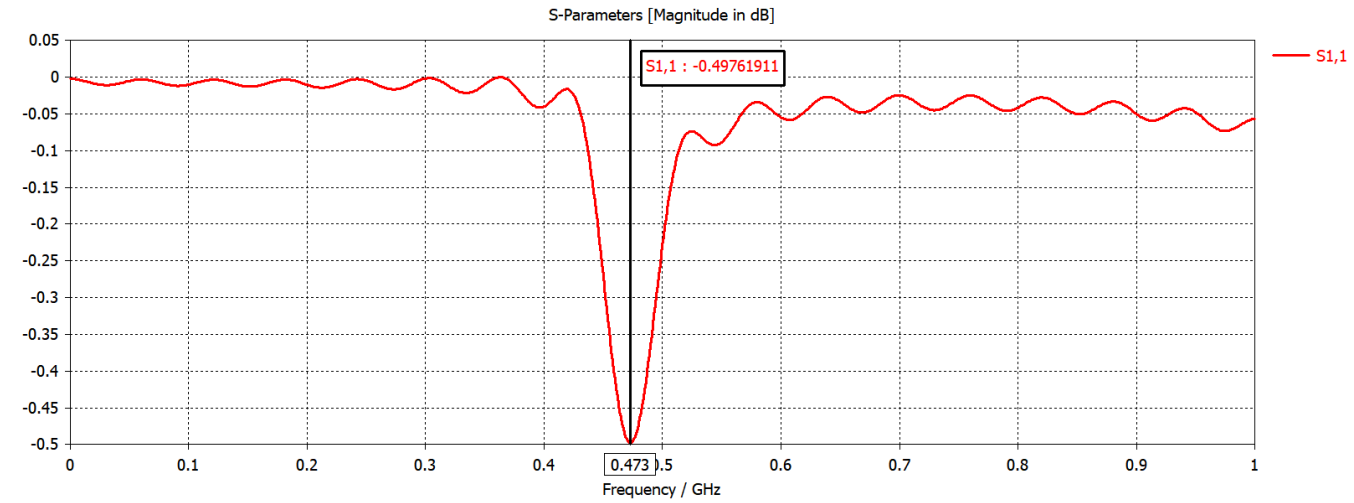

Figure 1.6. Input Reflection Coefficient for 45° Dipole Antenna on Backside of CubeSat structure. Design and Simulation performed with CST Studio Suite 2017 ©.

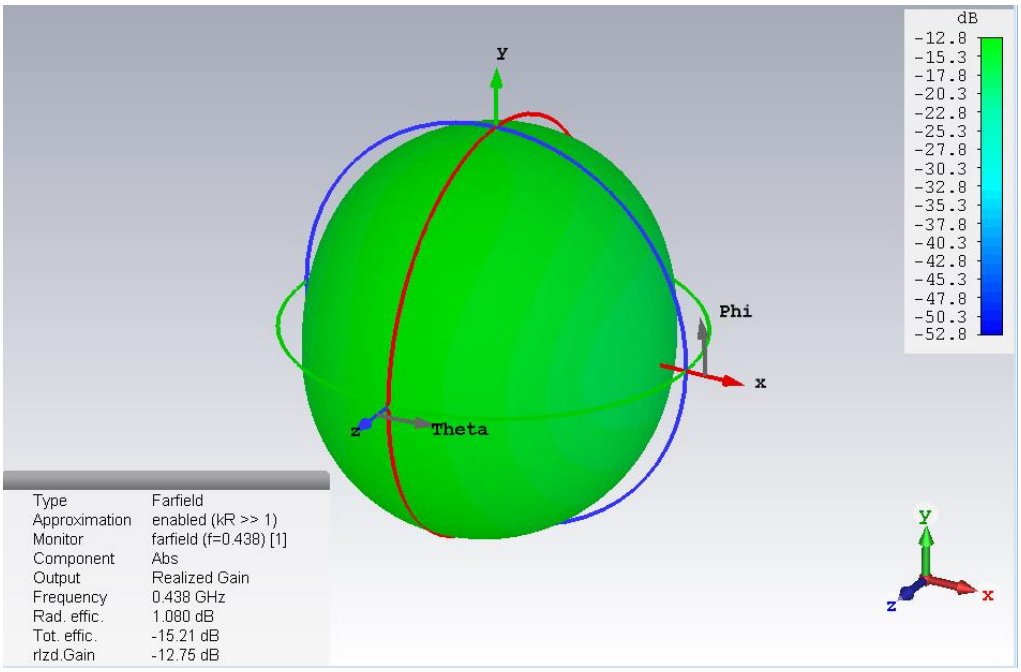

Figure 1.7. Farfield Radiation Pattern for 45° Dipole Antenna on Backside of CubeSat structure. Design and Simulation performed with CST Studio Suite 2017 ©.

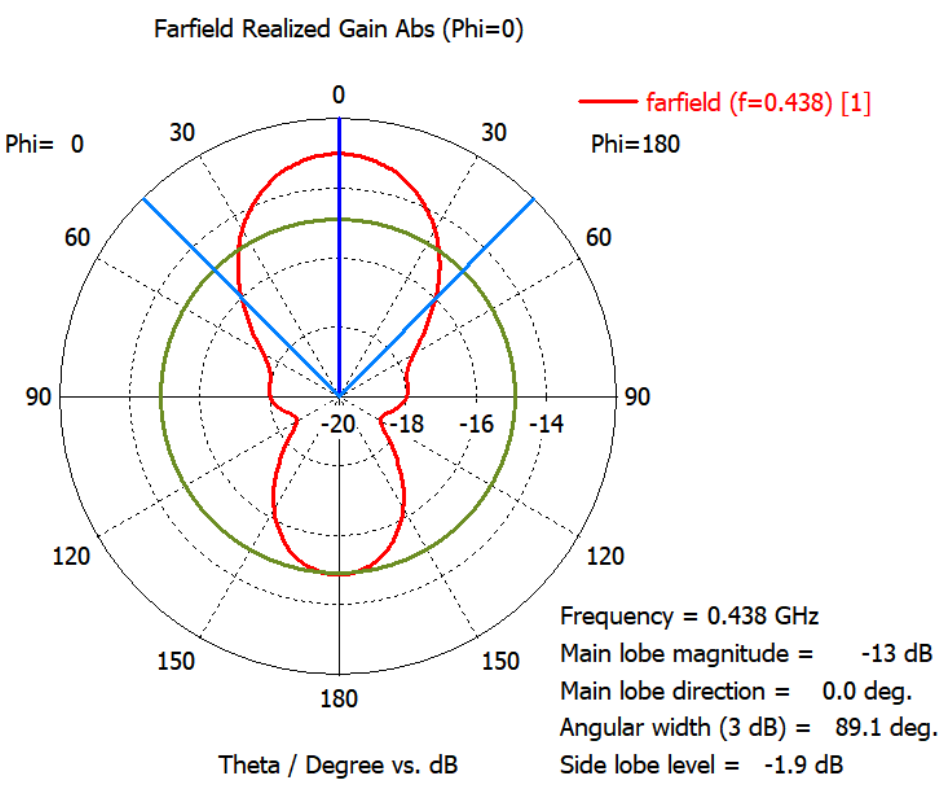

Figure 1.8. Farfield Radiation Pattern for 45° Dipole Antenna on Backside of CubeSat structure – Polar Plot. Design and Simulation performed with CST Studio Suite 2017 ©.

2. *2.4GHz Patch Array*: Design of 2x1 patch antenna array for operation at 2.4GHz (λ=12.5cm). Simulated bandwidth (-3 dB) of 171.8 MHz and Realized Gain of 2.862 dB (Directivity of 6.892 dBi) and Front-to-Back ratio of 7.197.

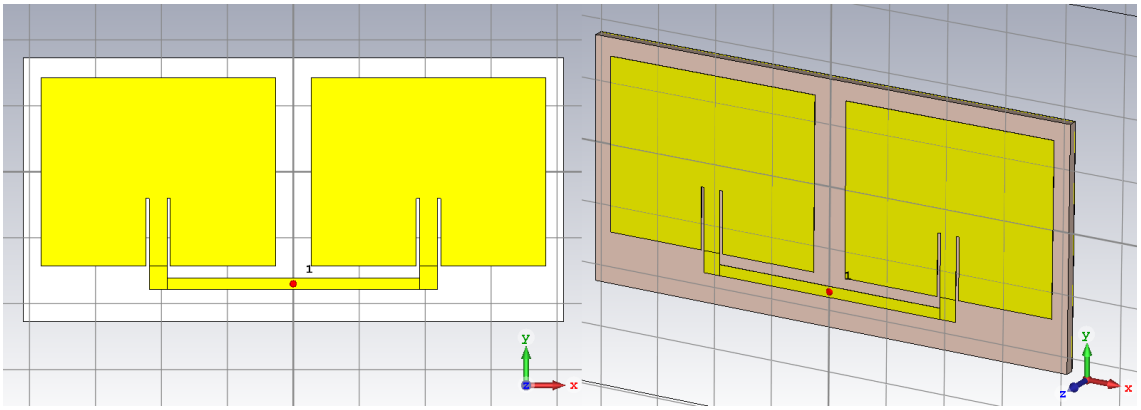

Figure 2.1. Patch Antenna – 2x2 Array. Design and Simulation performed with CST Studio Suite 2017 ©.

Parameter List

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	= 40	40	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	= 35.593	35.593	Patch Width (Y Axis) [mm]	Length
Wsubs	= 2*(2*Wstrip + Wpatch)	81.986	Substrate Width (Y Axis) [mm]	Length
Lconn	= y0	10.25	Length - Connector Strip between Patches [mm]	Undefined
Lstrip	= 6	6	Feed Strip Length (Y Axis) [mm]	Length
Wconn	= 2*Wstrip/3	1.8	Width - Connector Strip between Patches [mm]	Undefined
Wstrip	= 2.7	2.7	Feed Strip Width (X Axis) [mm]	Length
x0	= 0.5	0.5	Space between Patch & Feed Strip (X Axis) [mm]	Length
y0	= 10.25	10.25	Space between Patch & Feed Strip End (Y Axis) [mm]	Length

Figure 2.2. Parameters for Patch Antenna – 2x2 Array. Design and Simulation performed with CST Studio Suite 2017 ©.

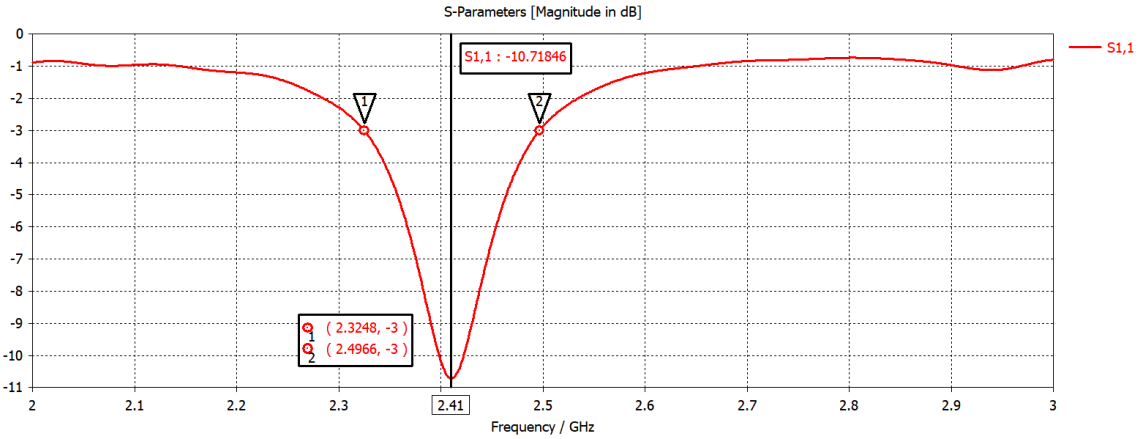

Figure 2.3. Input Reflection Coefficient for Patch Antenna – 2x2 Array. Design and Simulation performed with CST Studio Suite 2017 ©.

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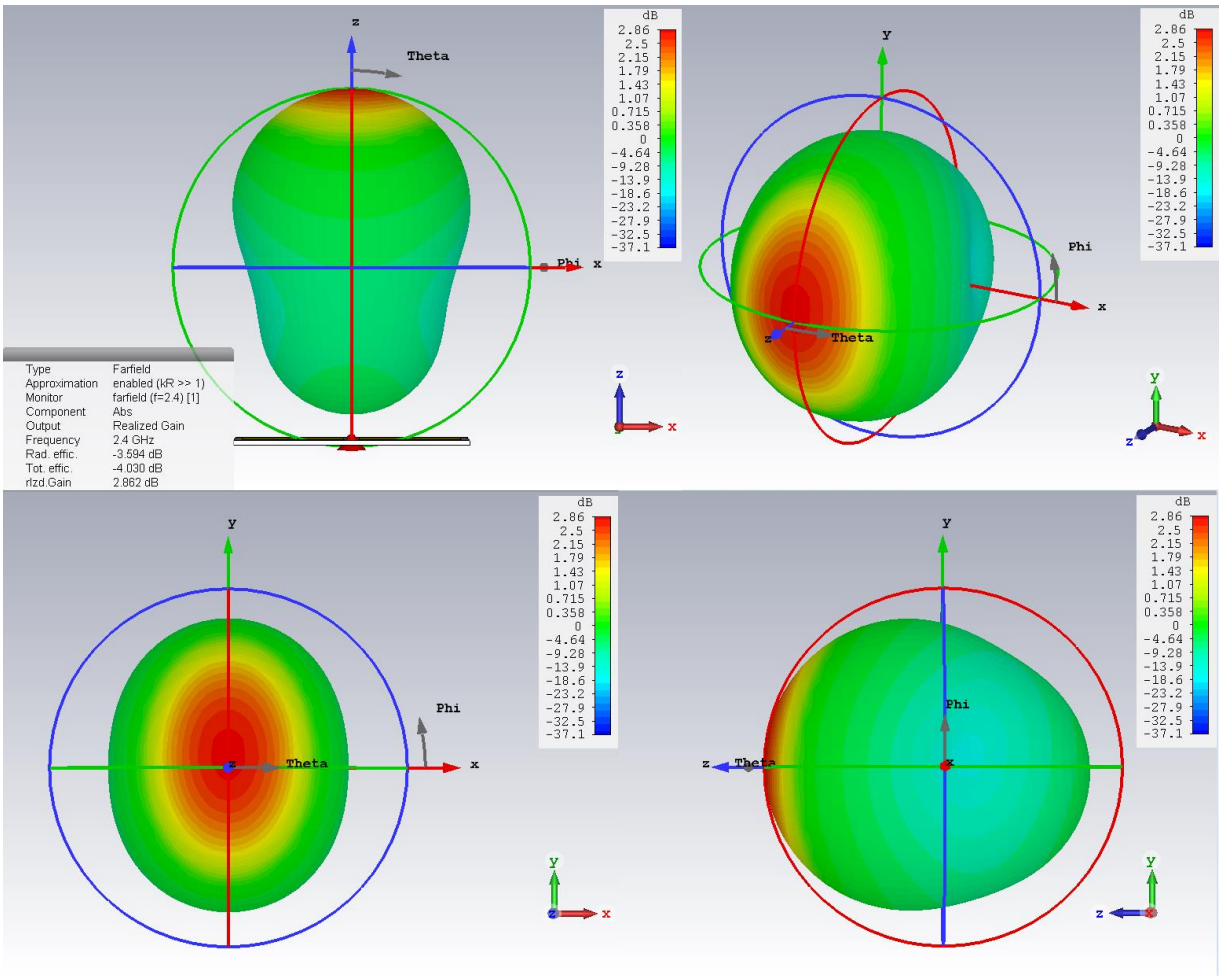

Figure 2.4. Farfield Radiation Pattern for Patch Antenna – 2x2 Array. Design and Simulation performed with CST Studio Suite 2017 ©.

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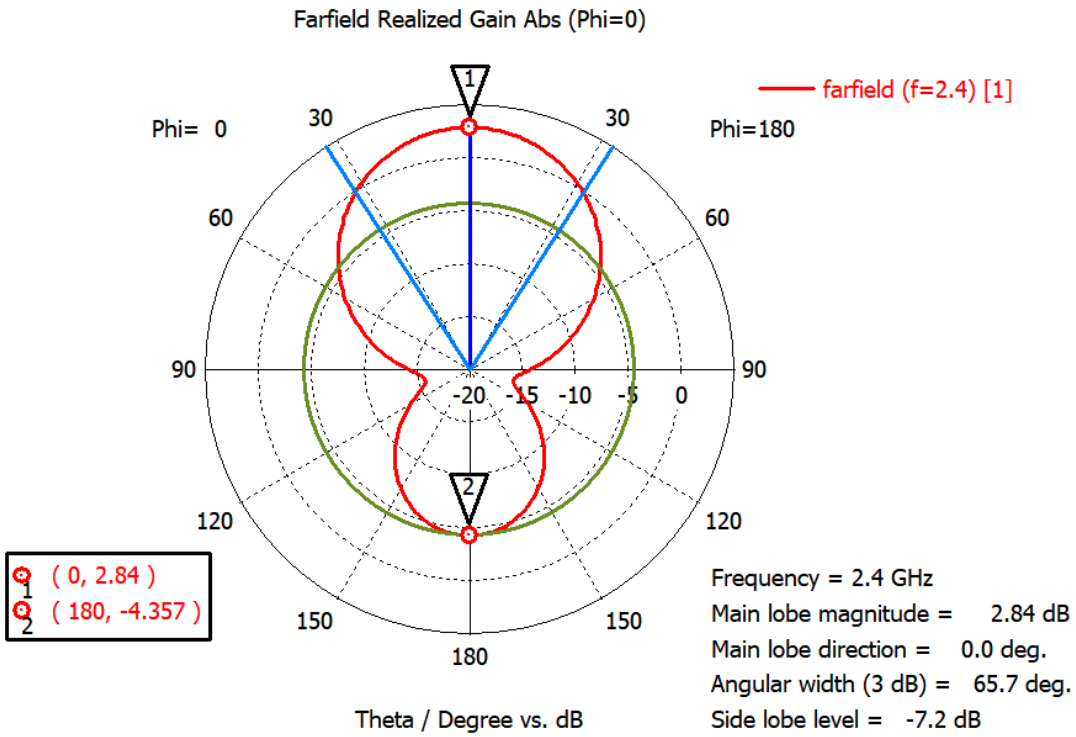

Figure 2.5. Farfield Radiation Pattern for Patch Antenna – 2x2 Array – Polar Plot. Design and Simulation performed with CST Studio Suite 2017 ©.

When adding the 2x2 Patch Array to each side of the CubeSat structure, antenna bandwidth is reduced to 112.8MHz, with a shift in frequency of 41MHz (up to 2.451GHz). Antenna gain also decreases to 1.2 dB, in comparison to directivity, which is enhanced to 8.329 dBi. Simulation performed without 2.4m Wire Antennas at the opposite (front) side of CubeSat structure.

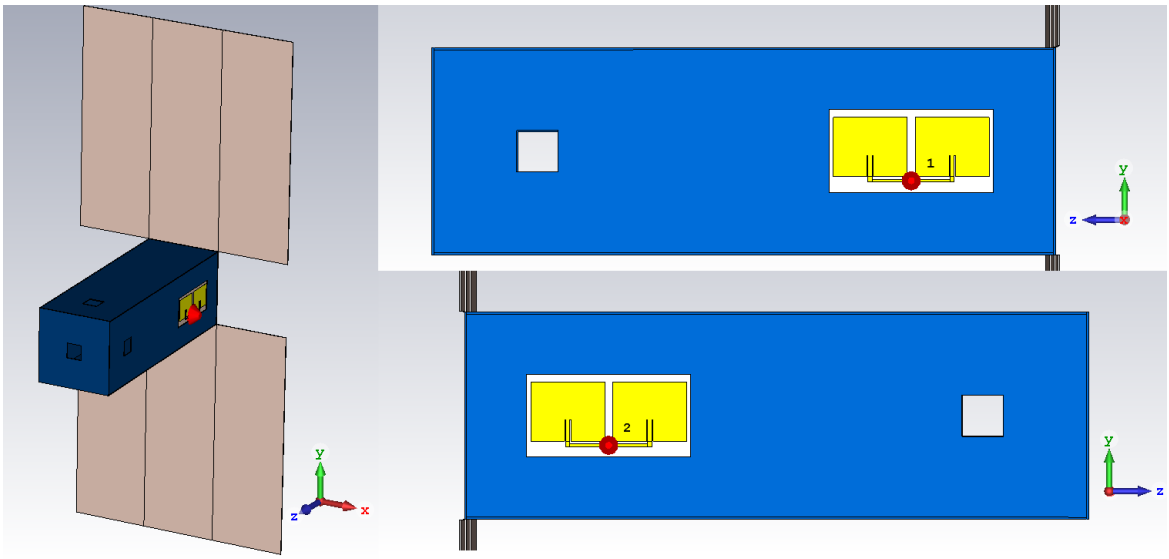

Figure 2.6. Patch Antenna arrays added to each side of CubeSat structure. Design and Simulation performed with CST Studio Suite 2017 ©.

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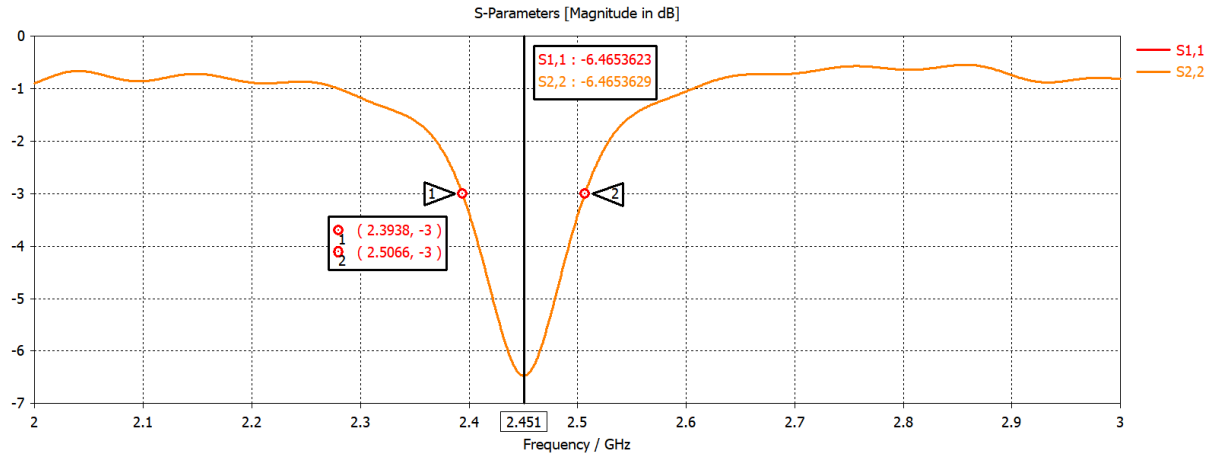

Figure 2.7. Input Reflection Coefficient for Patch Antenna arrays added to each side of CubeSat structure. Design and Simulation performed with CST Studio Suite 2017 ©.

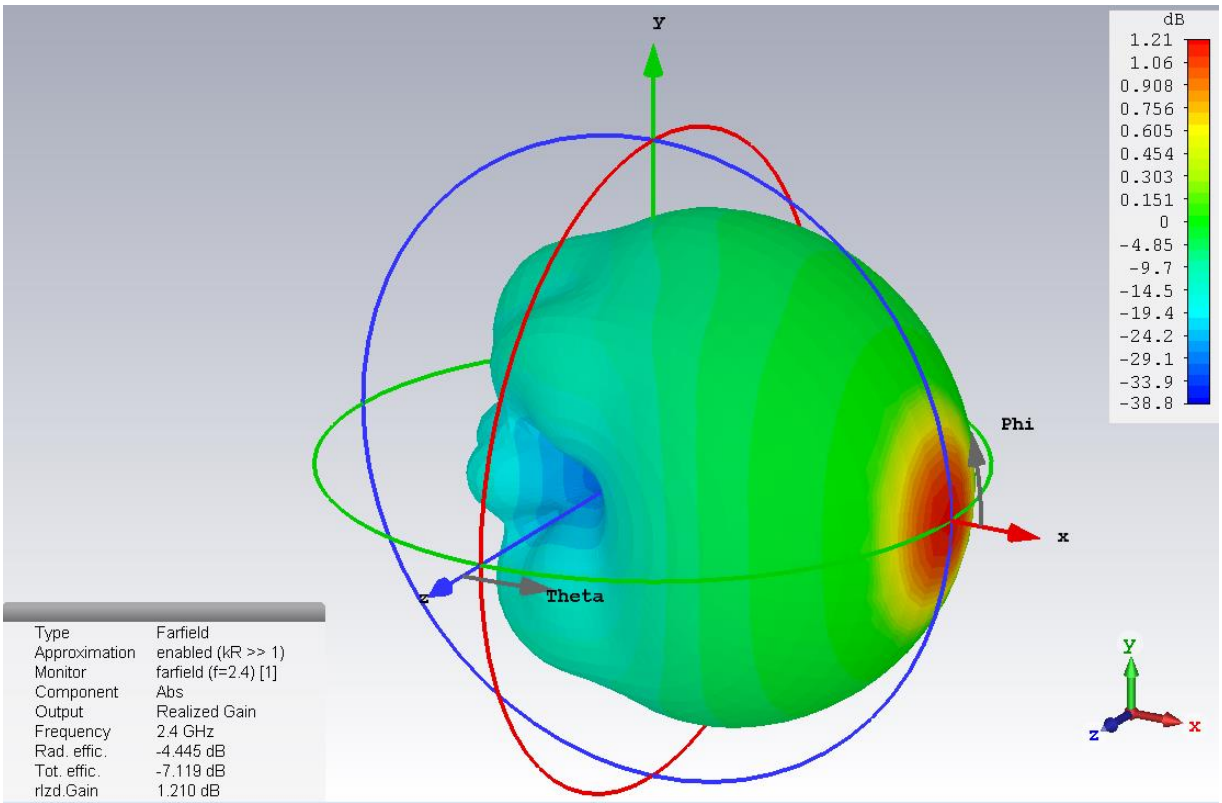

Figure 2.8. Farfield Radiation Pattern for Patch Antenna arrays added to each side of CubeSat structure. Design and Simulation performed with CST Studio Suite 2017 ©.

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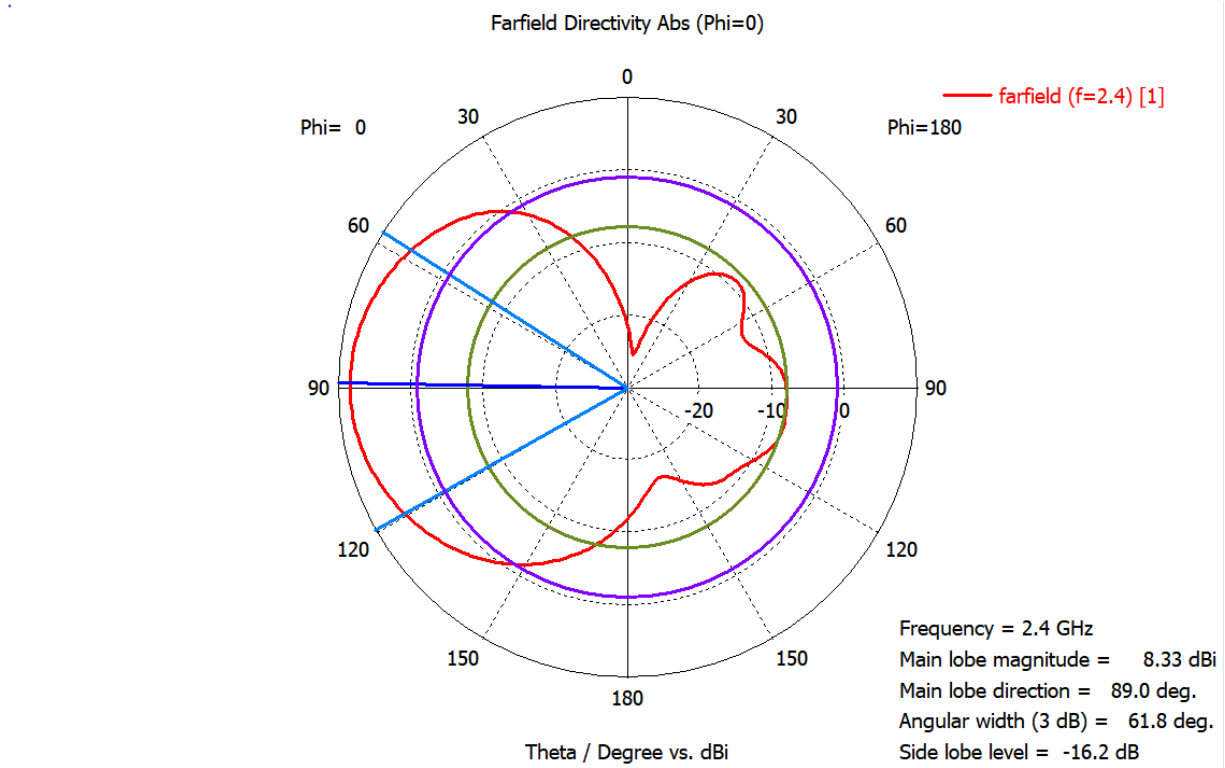

Figure 2.9. Farfield Radiation Pattern for Patch Antenna arrays added to each side of CubeSat structure – Polar Plot. Design and Simulation performed with CST Studio Suite 2017 ©.

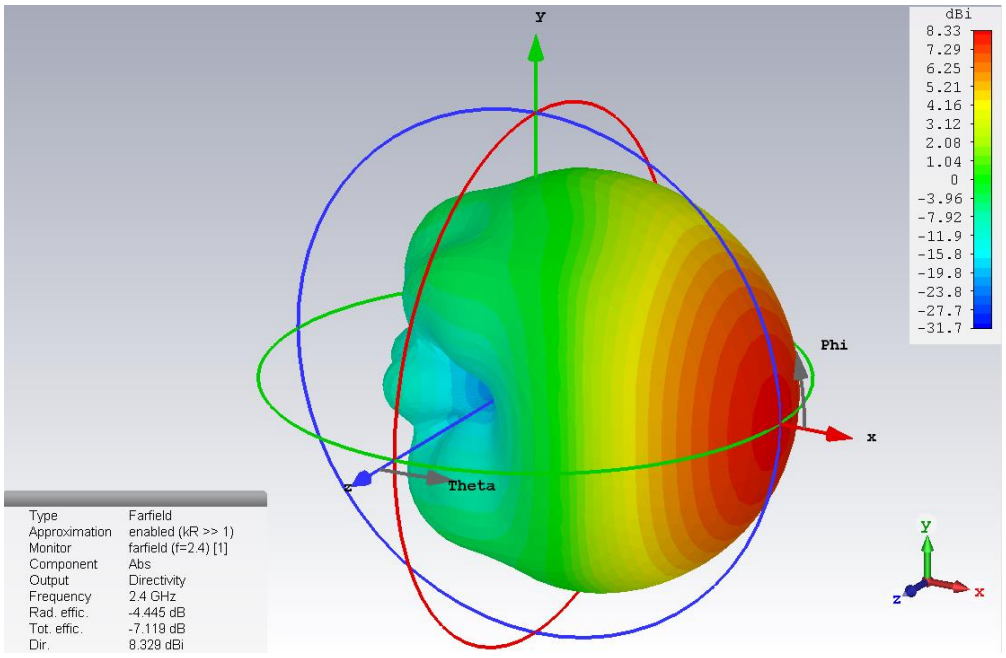

Figure 2.10. Directivity Pattern for Patch Antenna arrays added to each side of CubeSat structure. Design and Simulation performed with CST Studio Suite 2017 ©.