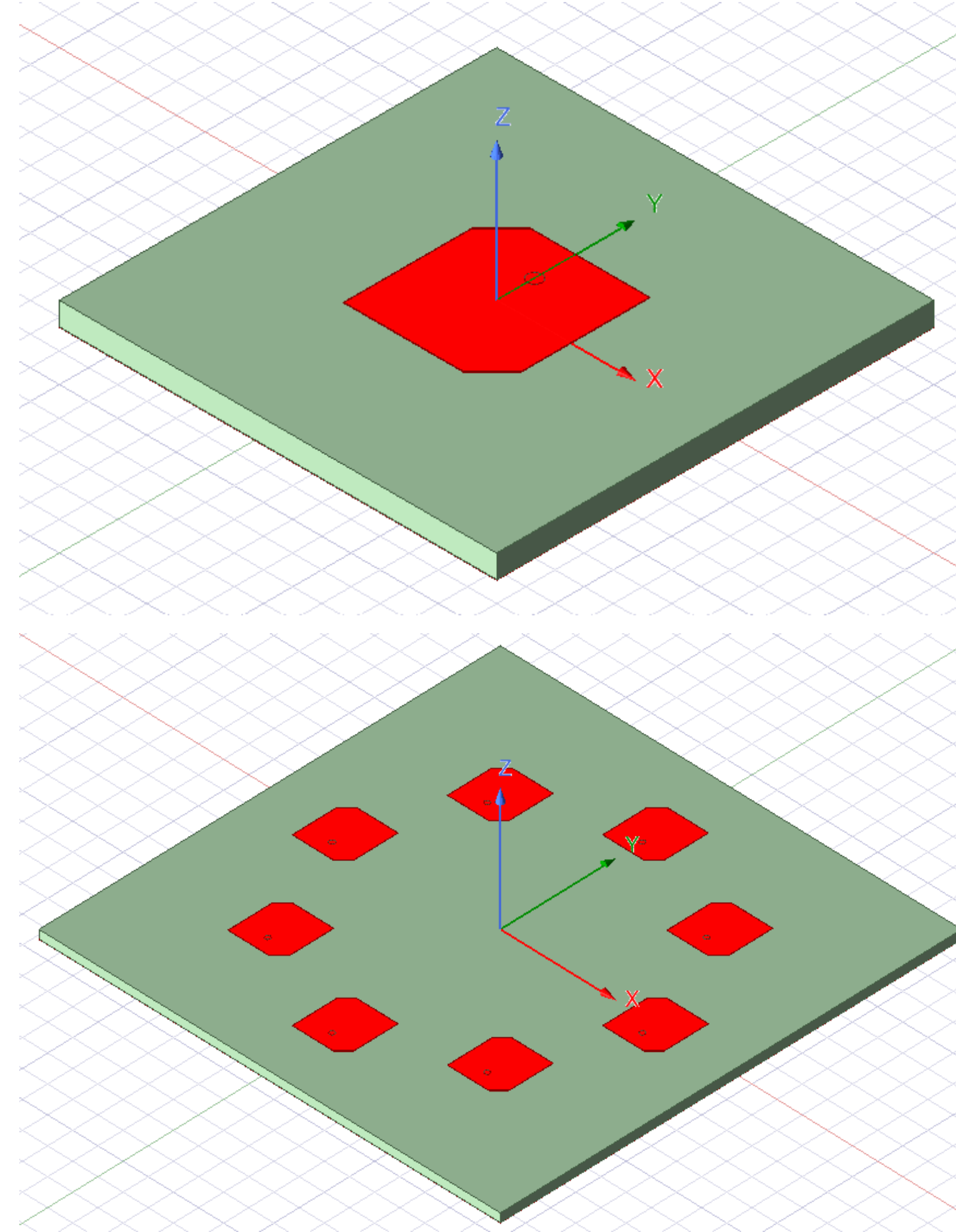


Design Of Circularly Polarized Antenna Element For Phased Array Antenna System

Introduction

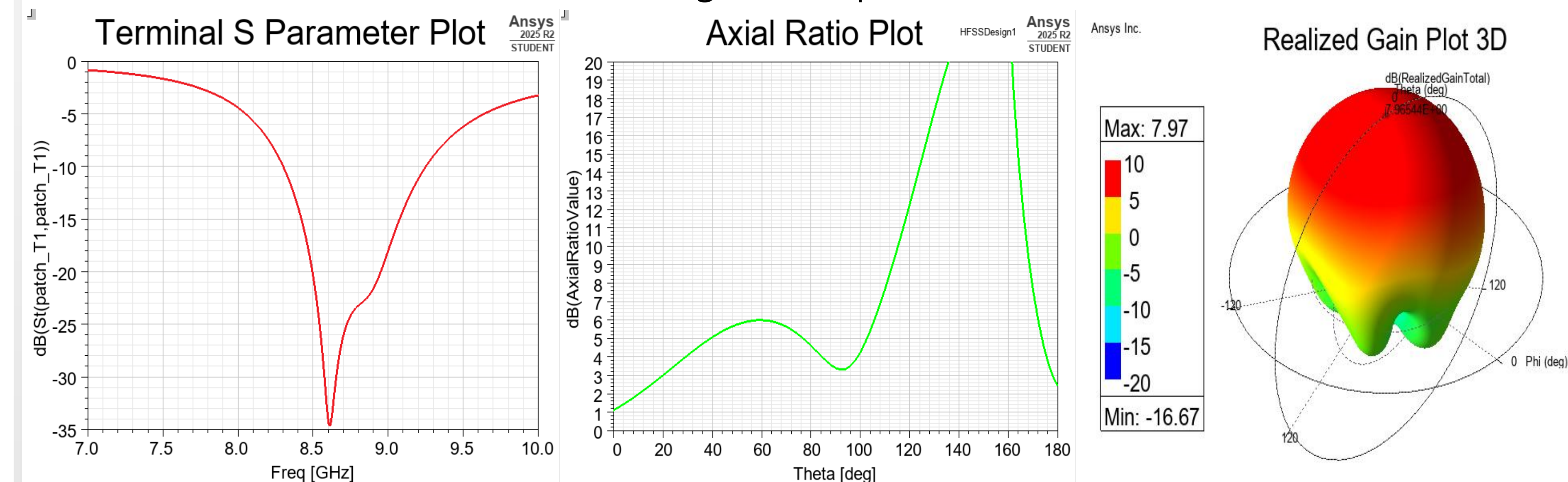
- High gain circularly polarized patch antenna array operating in the 8.5-9GHz range is developed to demonstrate key functionalities for phased array systems
- Probe fed microstrip patch antenna with truncated corners to enable circular polarization
- Circular polarization enhances the ability for the antenna to have reliable communication under different orientations between the transmitting and receiving antenna
- Study demonstrates controlled beamforming through altering the phase shift of individual antenna elements in the array
- Offers a scalable approach towards advanced wireless communication and radar systems



HFSS Simulation Results

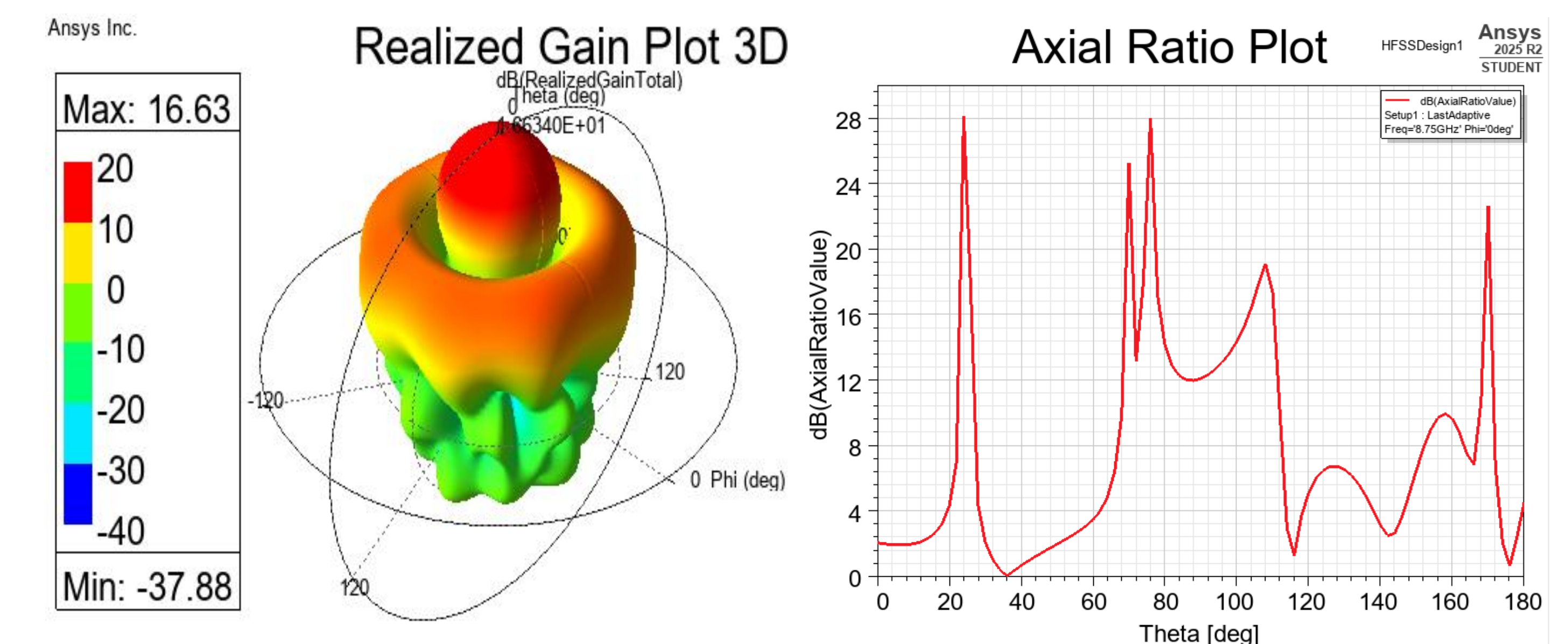
Individual Patch Antenna Results:

- Operational frequency range of 8.305-9.243GHz with S11 of -24.2dB at my main testing frequency of 8.75GHz
- Axial ratio of 1.13dB and realized gain of up to 8dB at 8.75GHz



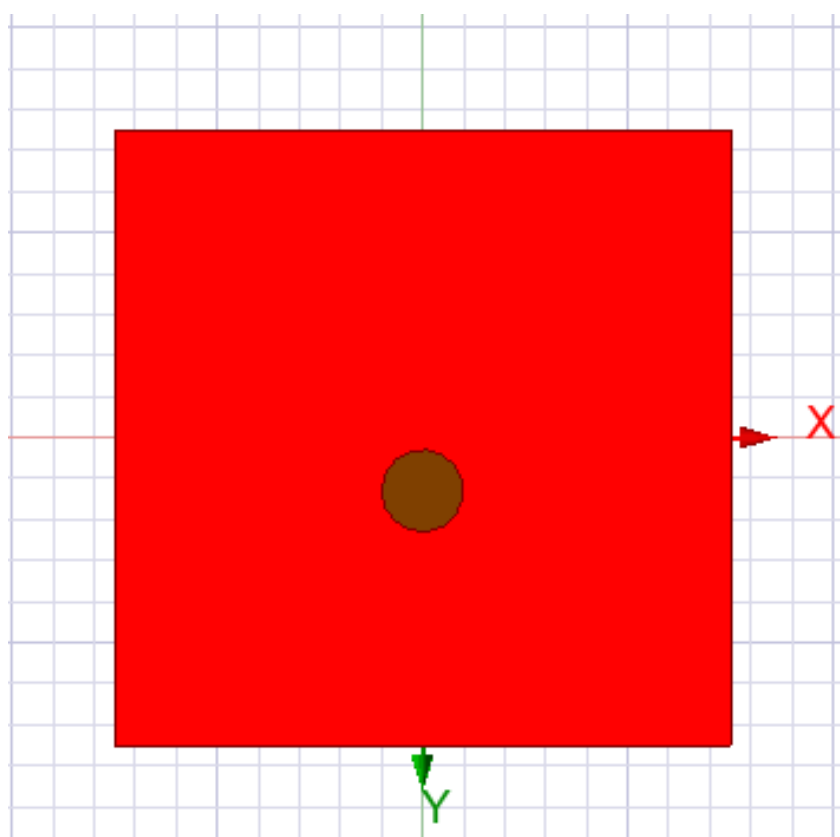
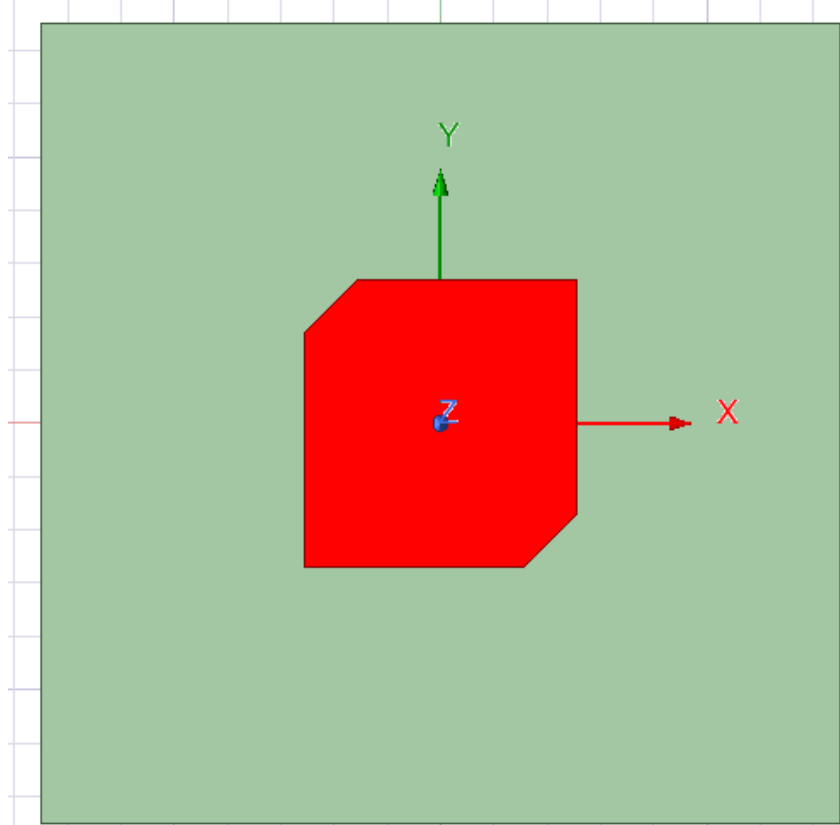
Antenna Array Results:

- Retains circular polarization and operational frequency range of at least 8.5-9GHz while reaching a realized gain up to 16.63dB



Design Of Patch Antenna

- Obtained initial dimensions of the patch antenna from an online calculator that calculates patch dimensions and feed position based on resonant frequency and substrate properties
- Tuned the antenna using HFSS until I got S parameter results below -10dB in the intended operating frequency range of 8.5-9GHz and axial ratio of below 3dB in the broadside direction
- Truncated corners shorten the path current travels for one of the orthogonal E field components, causing resonant frequency to be lower for one direction. This creates a phase difference between the E fields in orthogonal directions, causing the E field pattern over time to be circular



Objectives

- Design and simulate a probe fed patch antenna with circular polarization that operates from 8.5-9GHz
- Simulate a circular array of 8 of these antenna elements in HFSS and CEMS
- Print out the patch antenna and antenna array onto a Rogers 5880 board using a milling machine
- Obtain a solid understanding on how circular polarization and phased arrays work

References

- [1] Vinoth Kumar Sundaramoorthy, "Microstrip Patch Antenna Calculator," *Vinoth.org*, 2016. <https://www.vinoth.org/rf-calculators/microstrip-patch-antenna-calculator> (accessed Apr. 14, 2026).
- [2] ANSYS HFSS. (2025). Ansys, Canonsburg, PA. [Online]. Available: <https://www.ansys.com/products/electronics/ansys-hfss>
- [3] Veysel Demir and Atef Elsherbeni, *Computational Electromagnetics Simulator (CEMS)*. (Aug. 2020). [Online]. Available: [Available from: veysdemir@gmail.com](mailto:veysdemir@gmail.com),