

FINAL YEAR PROJECT PRESENTATION

Low-Profile Dual-Band Implantable Antenna

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Low-Profile Dual-Band Implantable Antenna

- Bio-telemetry antenna for 0.91 GHz and 2.45 GHz.
- Uses meandered line resonators and square-slotted ground plane.
- Ensures low SAR values and omni-directional radiation.

About Project

- **Objective:** Develop a compact, dual-band antenna for implantable biomedical devices operating at 0.91 GHz and 2.45 GHz for bio-telemetry.
- **Design:** Utilizes a meandered line resonator and square-slotted ground plane for miniaturization.
- **Medical Use:** Enables wireless monitoring of health data in applications like capsule endoscopy, pacemakers, neural recording, and glucose monitoring.
- **Simulation:** HFSS simulations assess antenna performance, radiation patterns, and SAR values for safety in human tissues.

Antenna Components and Design

Antenna Structure

Meandered resonator with square-slotted ground plane.

Materials

Copper, FR4 substrate, protective superstrate layer.

Simulation

HFSS for electromagnetic modeling and optimization.

System Architecture for IBD

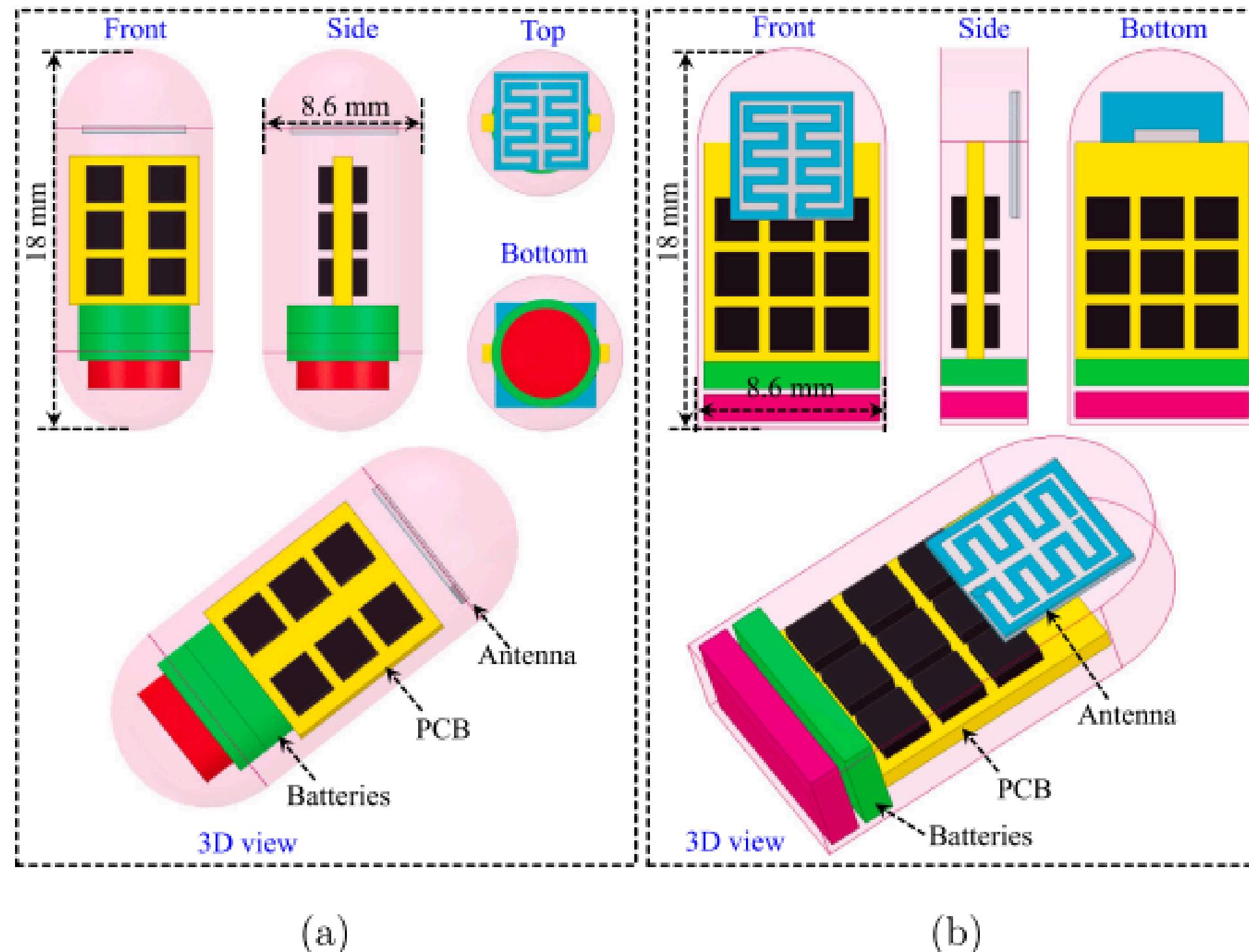
Capsule IBD for deep tissue implantation

- Designed for **deep tissue** placement (e.g., organs, muscles), requiring **lower frequencies (0.91 GHz)** to penetrate dense tissues.
- Antennas must be miniaturized and optimized for **signal attenuation** and safety (low SAR) in deep biological environments.

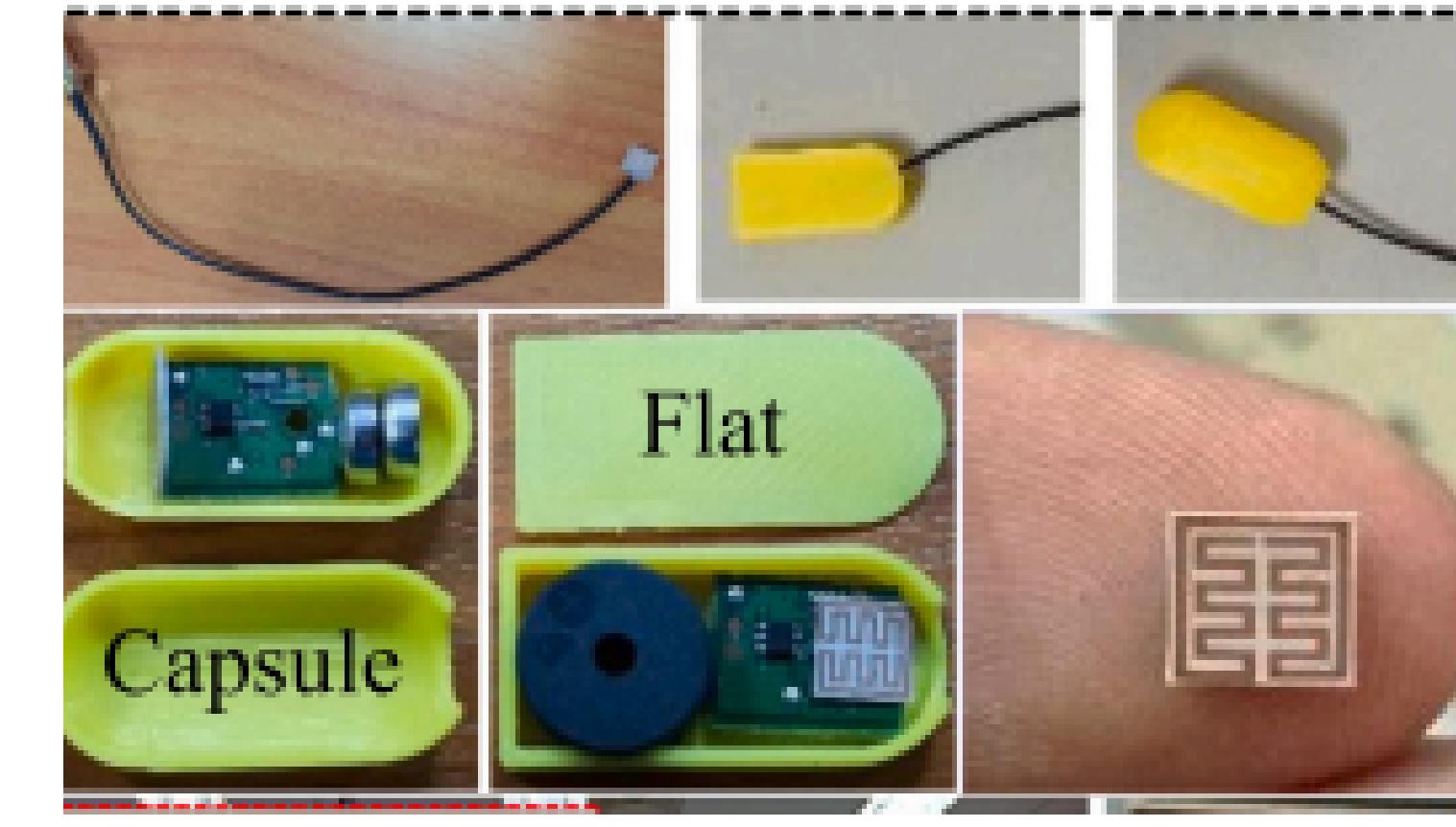
FLAT IBD for skin tissue implantation

- Placed **near the skin surface**, using **higher frequencies (2.45 GHz)** for better wireless communication with minimal tissue interference.
- Antennas are compact, flexible, and optimized for **comfort and efficient transmission** with low SAR to prevent skin heating.

Architecture:

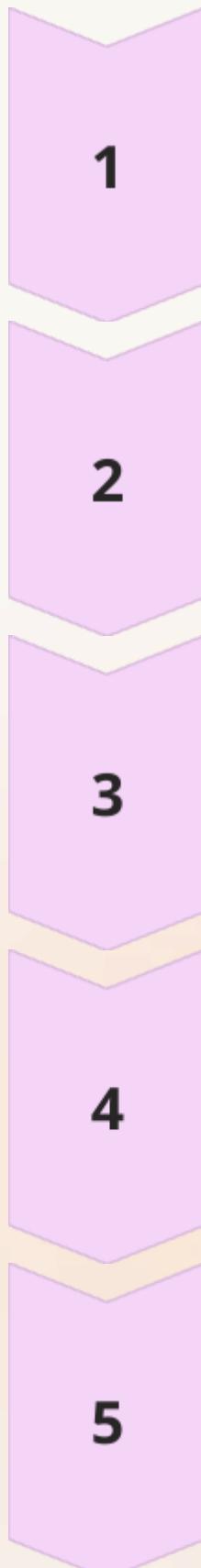


(a).Capsule IBD for deep tissue implantation, (b) Flat IBD for skin tissue implantation



Fabricated Prototype

Project Workflow



Design

Antenna conceptualization and initial modeling.

Simulation

HFSS analysis of radiation characteristics.

Fabrication

Prototype manufacturing using PCB technology.

Testing

Measurements in pork meat and saline solution.

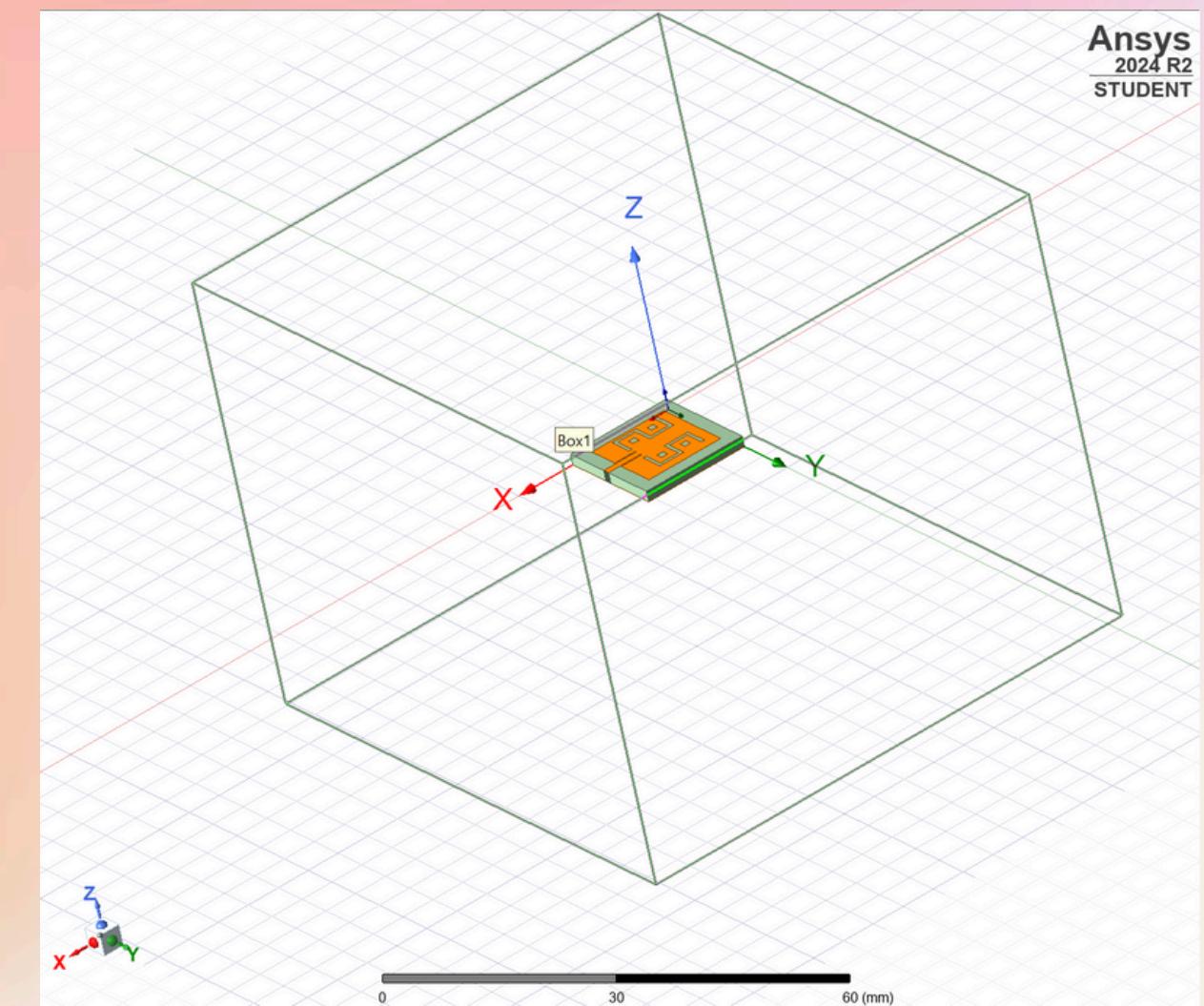
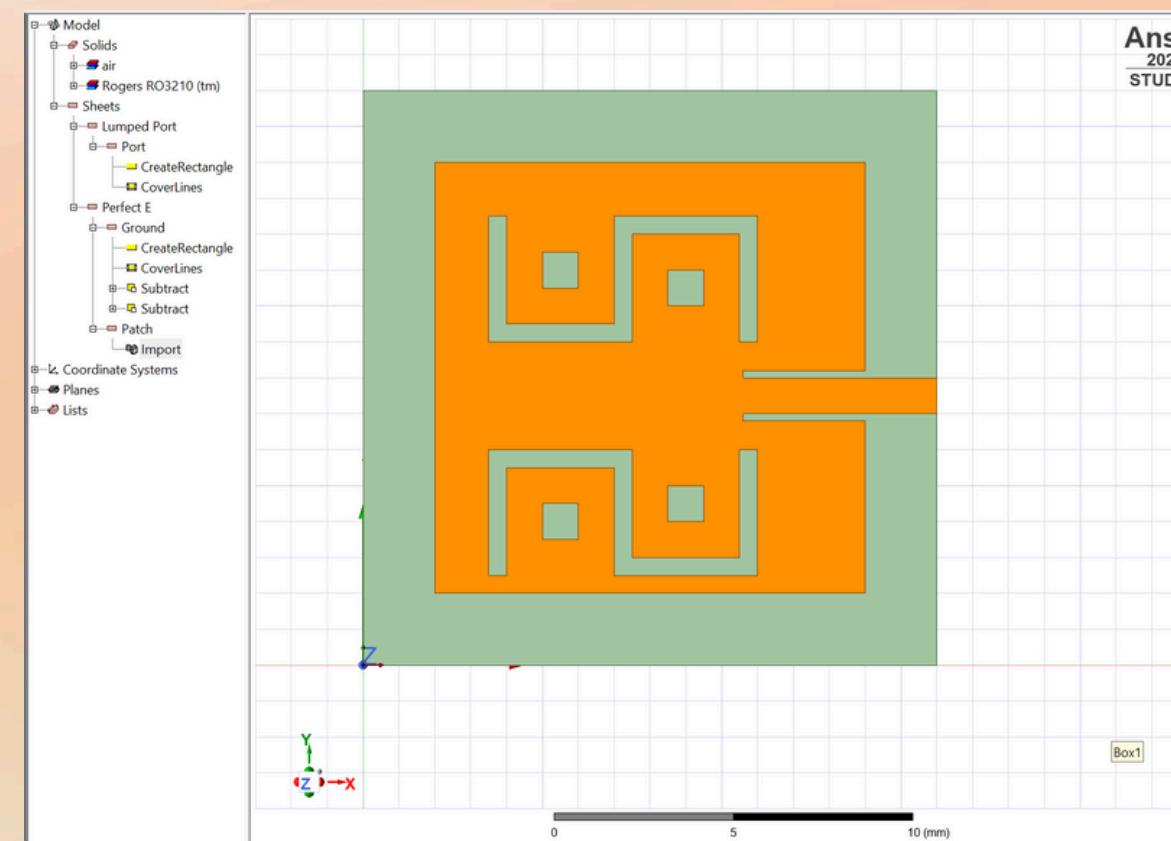
Evaluation

SAR assessment and performance verification.

First proposed Design:

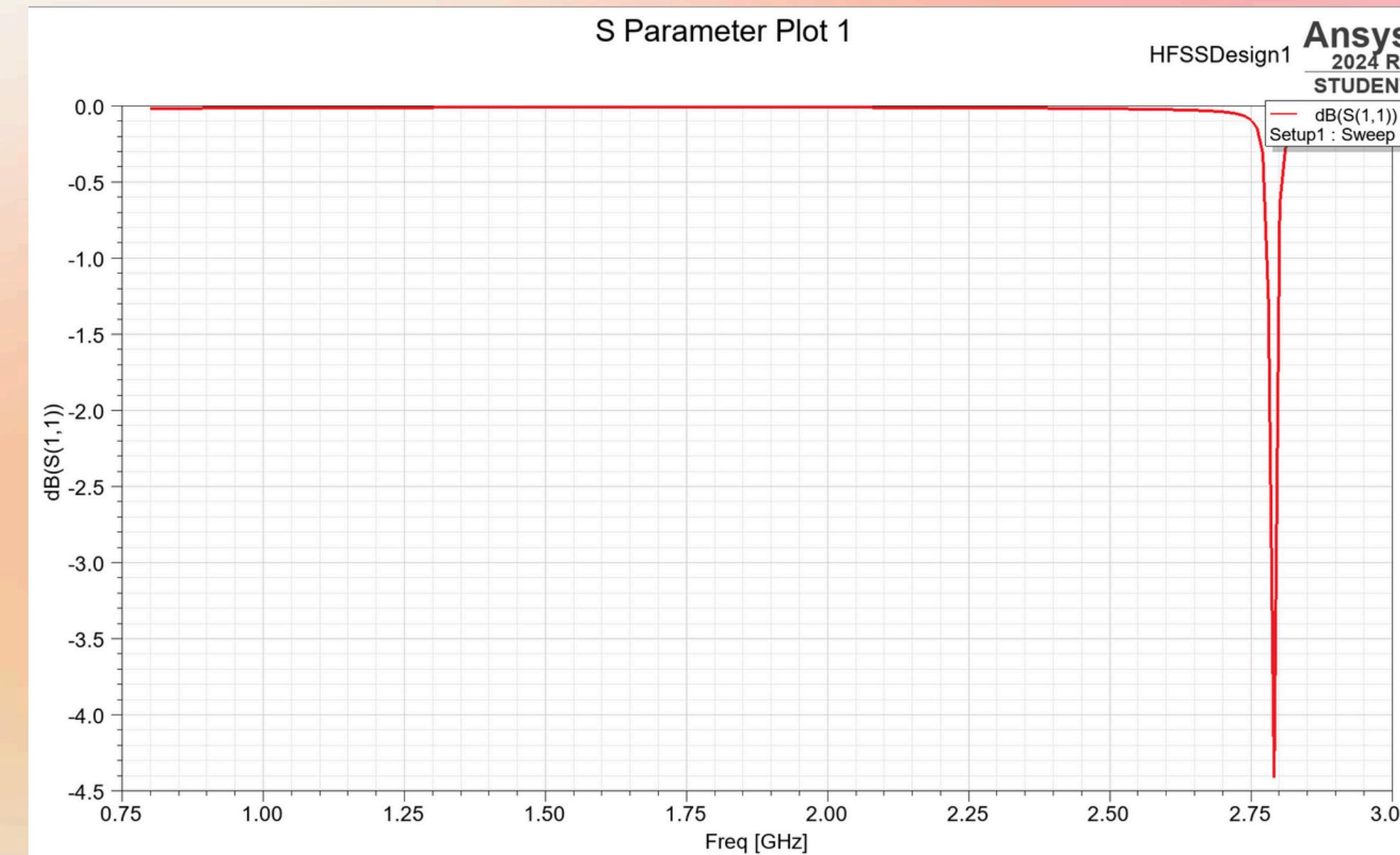
Microstrip Patch Antenna with Meandered Lines:

- **Patch Size: 12 x 12 mm, Ground Size: 16 x 16 mm.**
- **Substrate Height: 1.6 mm, compact design with meandered lines(width: 0.5 mm).**
- **Dual-band operation (0.9 GHz & 2.45 GHz), ideal for biomedical use.**



Return Loss and Its Plot

- Return Loss: Measures signal reflection; indicates antenna performance.
- Low return loss at resonant frequencies (0.9 GHz and 2.45 GHz).
- Plot:



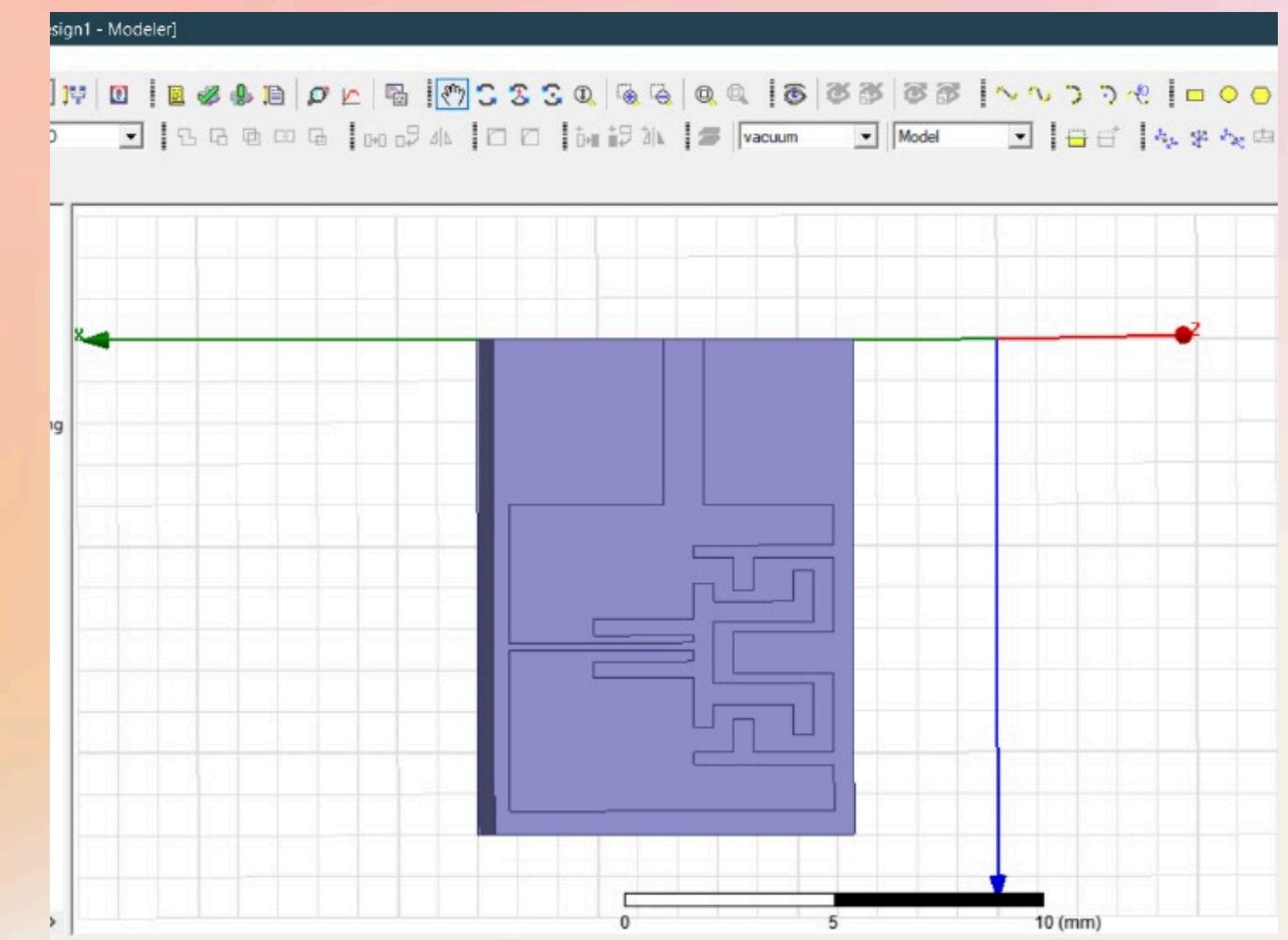
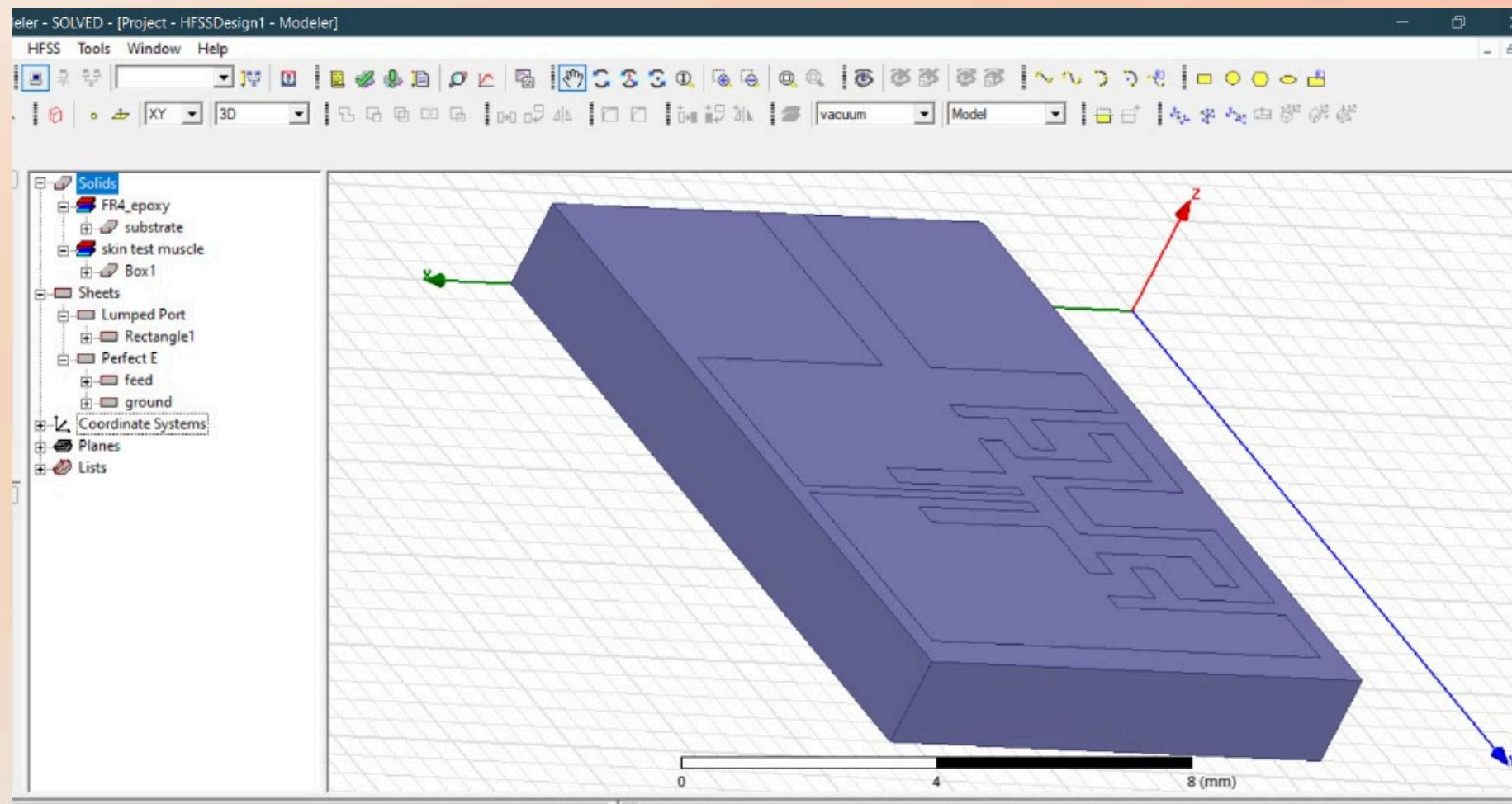
Why First Design Was Not Chosen

- Return Loss: -4 dB, should be < -10 dB for better performance.
- No Dual-Band: Does not operate at both 0.9 GHz and 2.45 GHz.
- Frequency Dip: Significant dip at 2.7 GHz, affecting performance.

Second proposed Design:

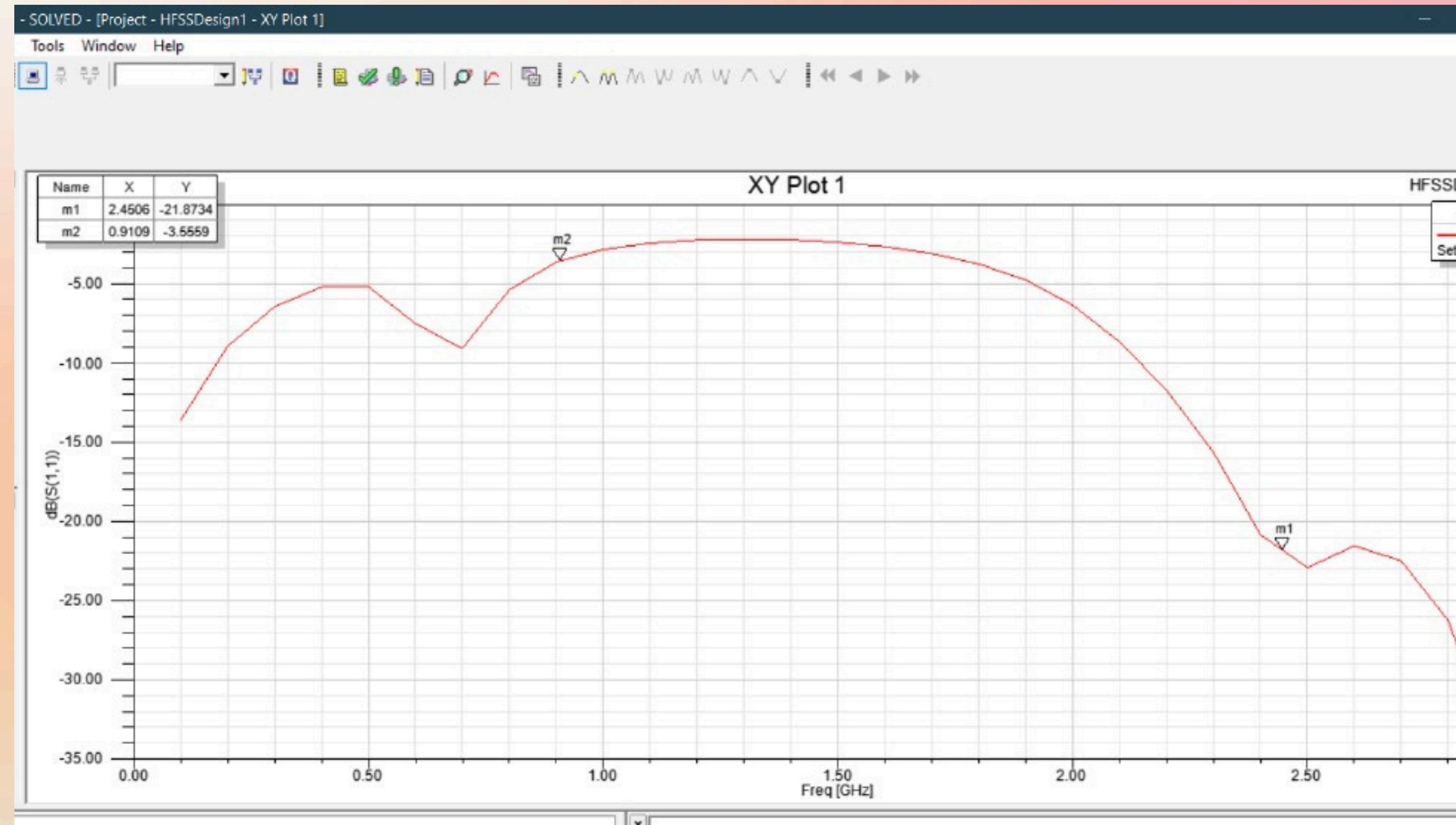
Microstrip Patch Antenna with Meandered Lines:

- **Patch Size: 12 x 9 mm, Substrate Height: 1.6 mm.**
- **Meandered Line: Includes line feed for dual-band operation.**
- **Successfully operates at 0.9 GHz and 2.45 GHz for optimal performance.**

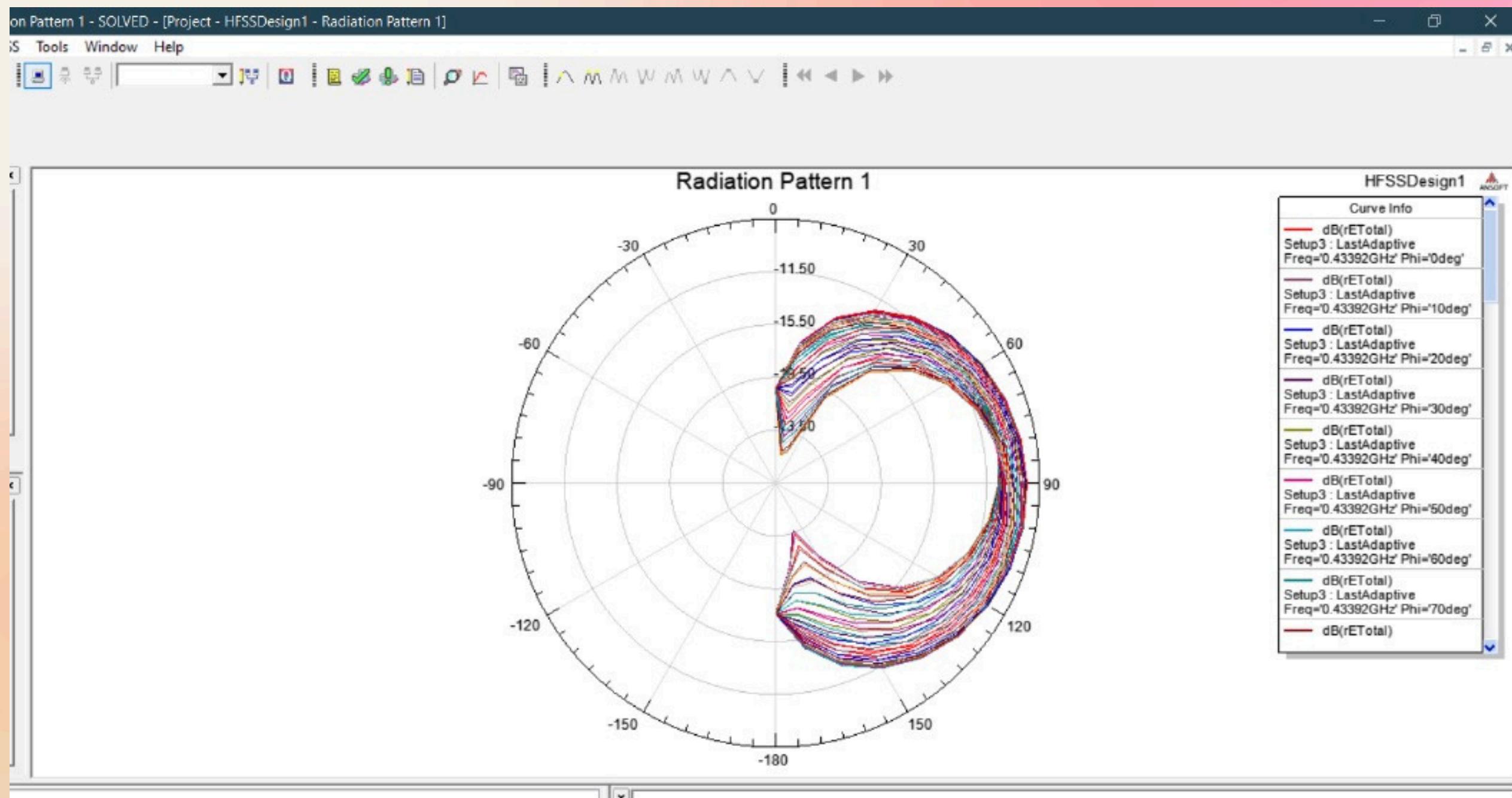


Return Loss and Its Plot

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- Plot:

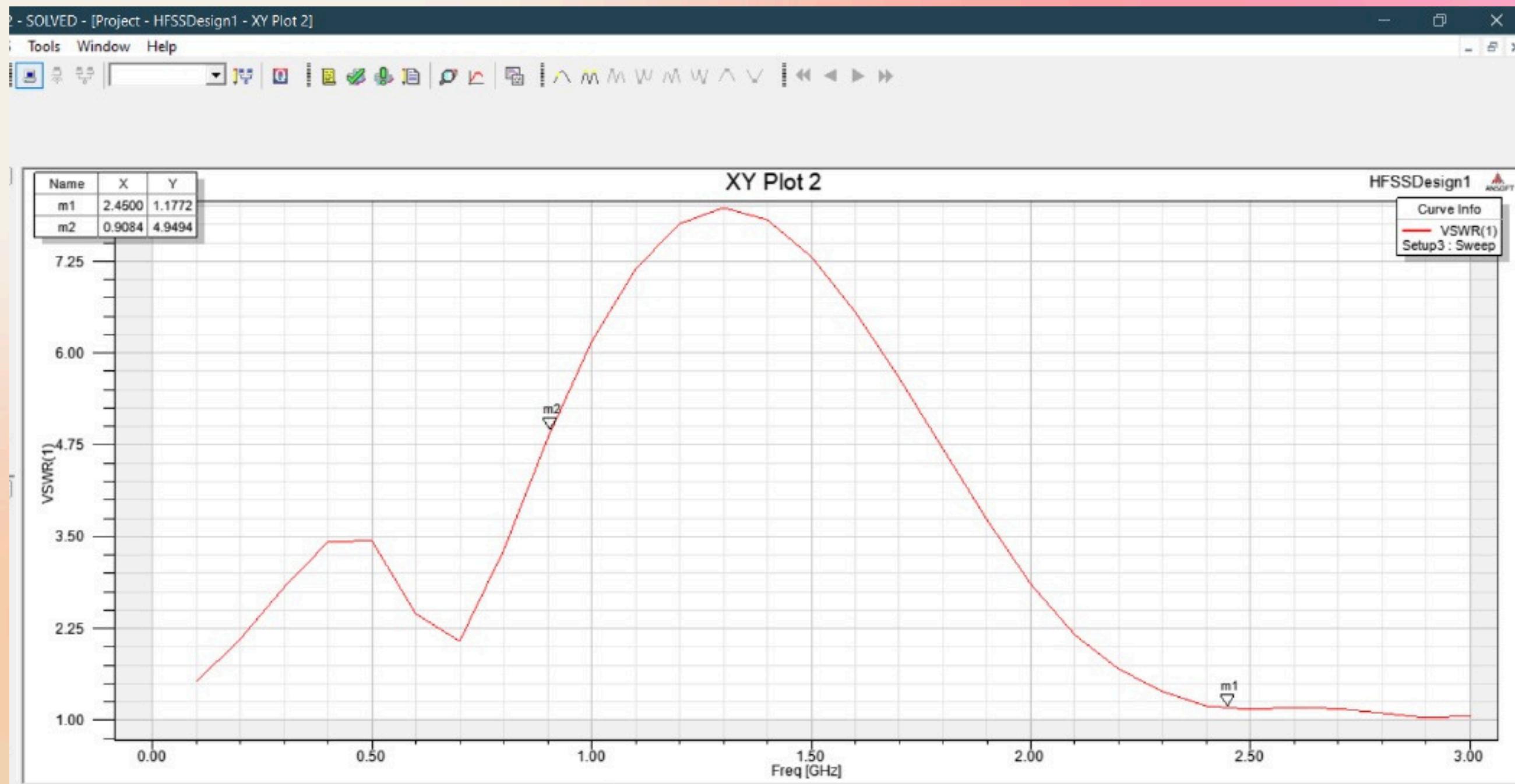


Other Plots:



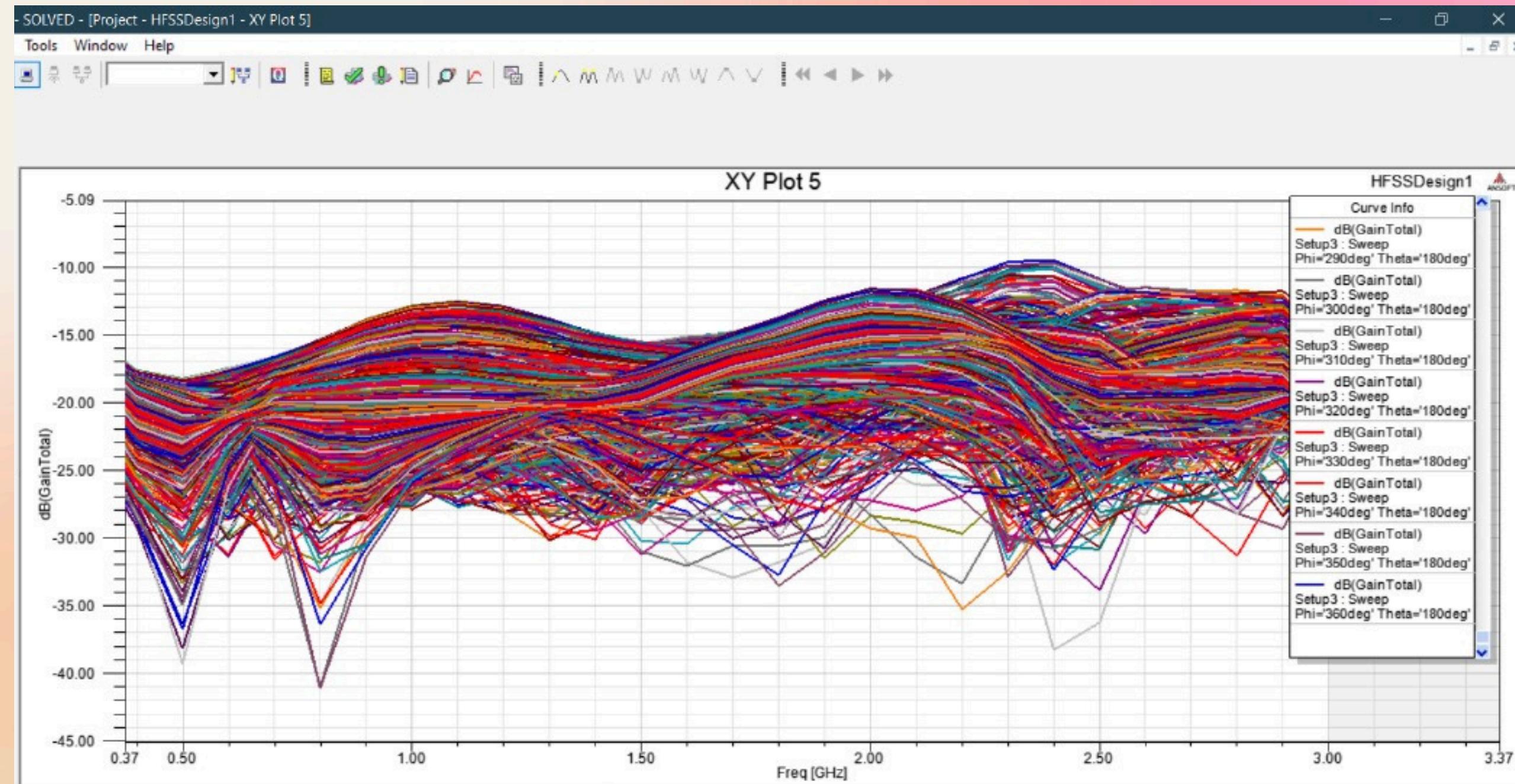
Electric field distribution pattern.

Other Plots:



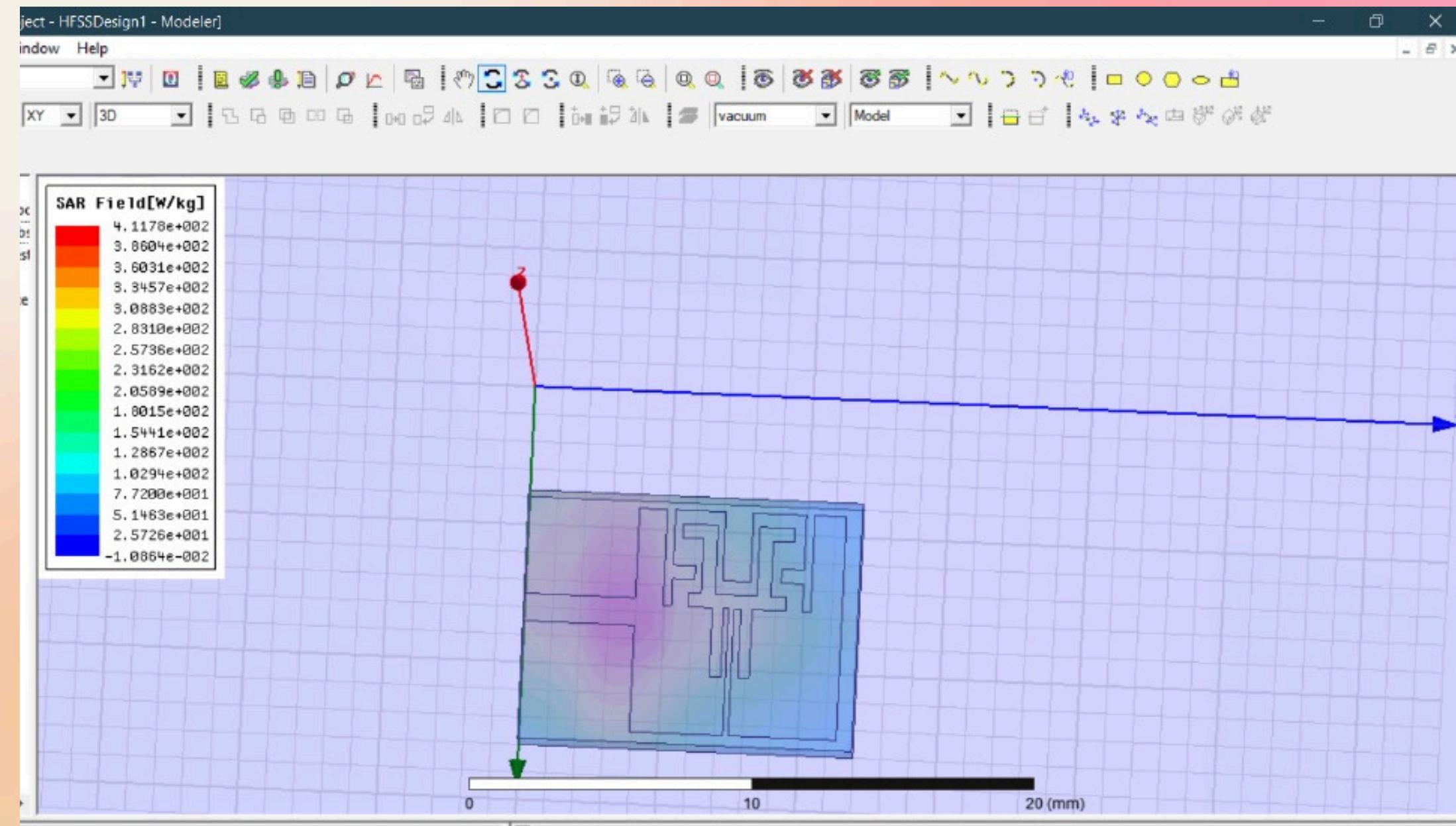
VSWR

Other Plots:



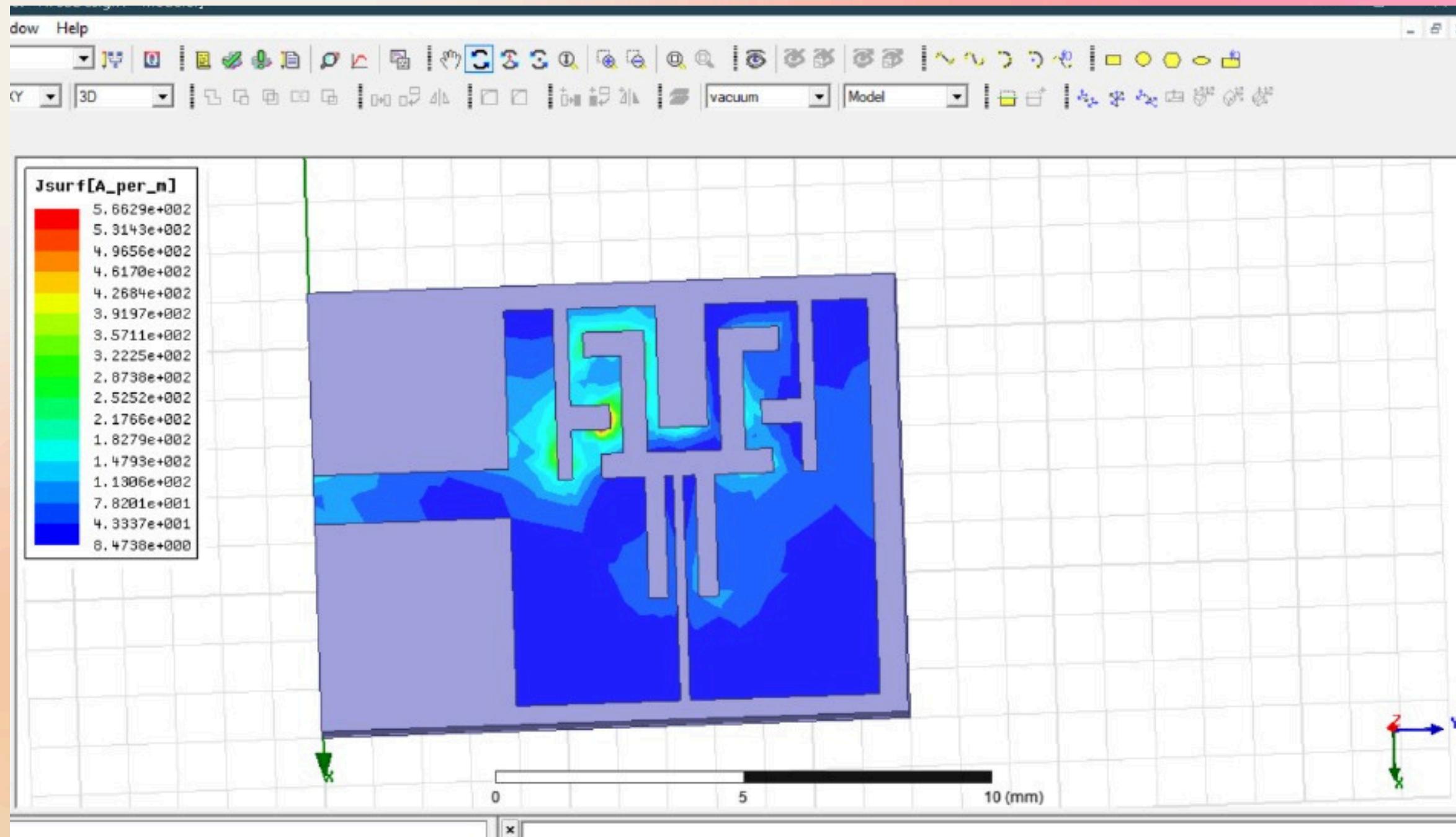
Gain Plot

Other Plots:



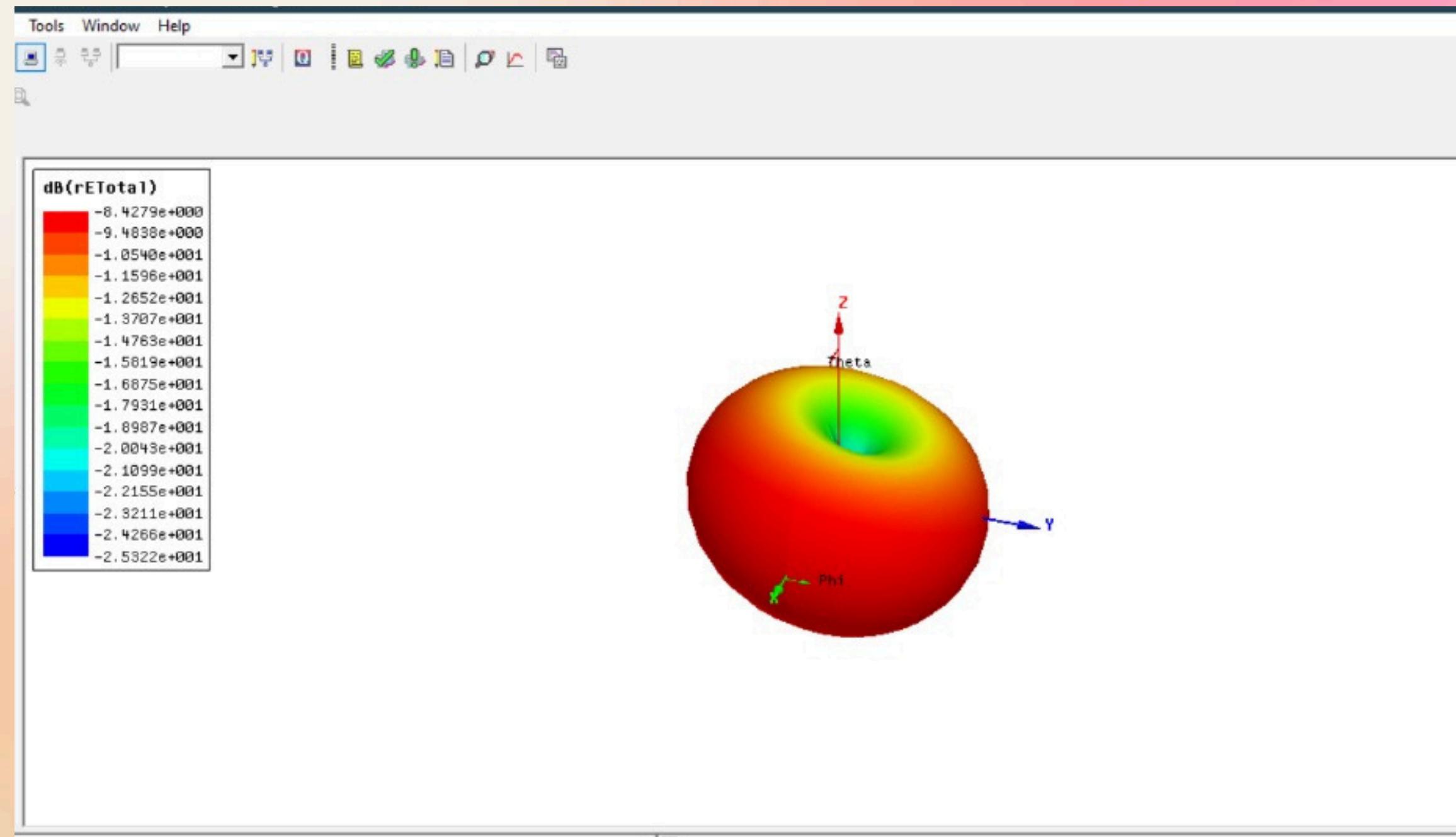
SAR Representation

Other Plots:



Current Density Distribution

Other Plots:



Electric Field Distribution

Skin Implantable Biomedical Device (IBD) and Antenna Focus

- Application: Antenna for implantable biomedical devices (IBDs) under the skin.
- Frequency: Operates at 2.45 GHz, ideal for communication with external devices.
- Devices: Examples include glucose sensors, pacemakers, and neural implants.
- Design: Flat, compact antenna for easy implantation and minimal discomfort.
- Biocompatibility: Materials chosen for long-term use in the human body.

Comparison with referenced research paper:

COMPARISON PARAMETERS	PAPER RESULT	OUR RESULT
Return Loss	-21.6 dB	-21.87 dB
% Bandwidth	45%	68.31%
SAR	481.1 W/Kg	411.78 W/Kg

References:

- [1] M. Al-Hasan, P. R. Sura, A. Iqbal, J. J. Tiang, I. B. Mabrouk, and M. Nedil, "Low-profile dual-band implantable antenna for compact implantable biomedical devices," International Journal of Electronics and Communications (AEÜ), vol. 138, p. 153896, 2021.
- [2] K. Kiourti, A. Psathas, and K. S. Nikita, "Implantable and ingestible medical devices with wireless telemetry functionalities: A review of current status and challenges," Bioelectromagnetics, vol. 35, no. 1, pp. 1–15, Jan. 2014.
- [3] P. S. Hall and Y. Hao, Antennas and Propagation for Body-Centric Wireless Communications, Norwood, MA: Artech House, 2006.
- [4] K. S. Nikita, Handbook of Biomedical Telemetry, Hoboken, NJ: John Wiley & Sons, Inc., 2014.