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Implantable Antennas for Wireless Biomedical Devices

Name of Students

Name of Guide

Mr. Rajiv Nehra

(Bhartiya vidyapeeth college of
engineering)

**Abhishek Chaturvedi
(0055120281)**

**Mayur Gupta
(02151202818)**

**Aryan Joshi
(35351202818)**

**Mohd Wali
(4281202818)**

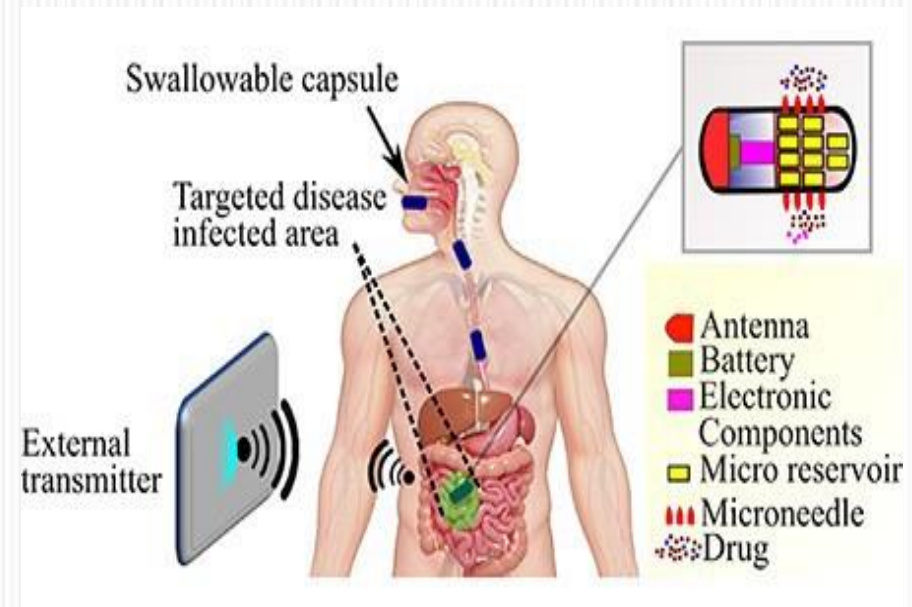
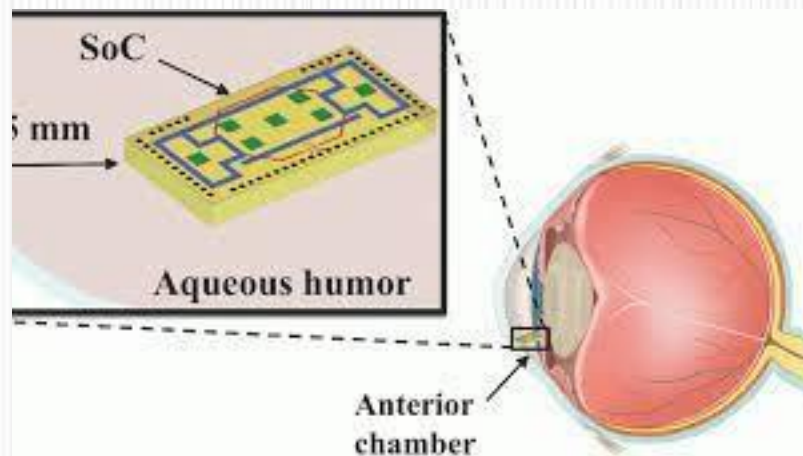


Why do we need an implantable antennas ?

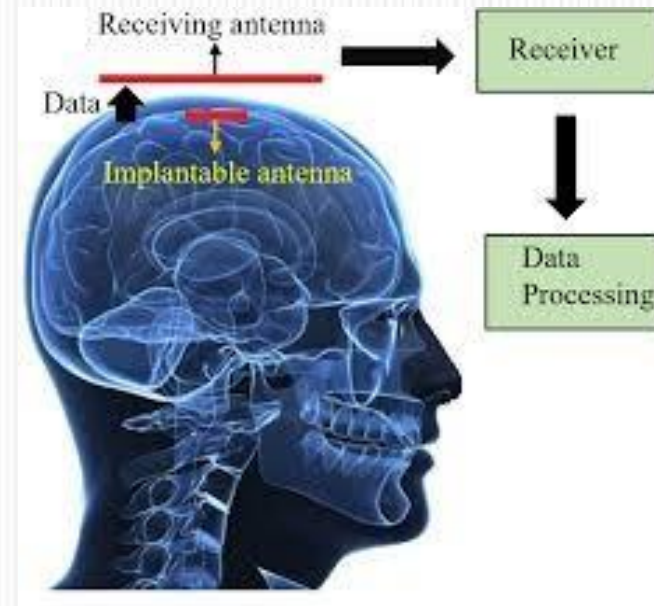
- ❖ Supplement medical research and enhance testing of the human body implantable antenna are a solution.
- ❖ Also helps In detection of diseases that aren't detectable in their early stages such as –kidney stone and many more.
- ❖ Early detection and cure of cancer has been enabled through use of implantable antennas.
- ❖ Malfunction or diseases such as heart attack can be predicted and avoided by use of implantable antennas.

INTRODUCTION

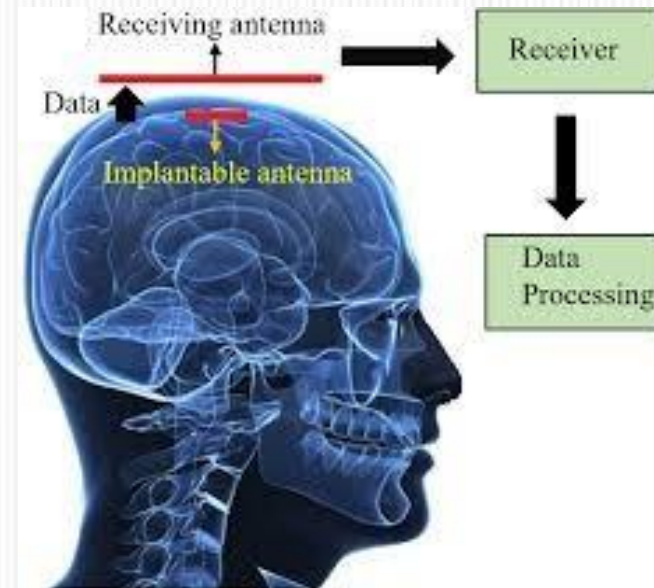
- ❖ Implanted biomedical devices are witnessing great attention in finding solutions to complex medical conditions. Many challenges face the design of implantable biomedical devices including designing and implanting antennas within hostile environment due to the surrounding tissues of human body.



- ❖ Human tissues are conductive, and would short-Circuit the implantable antenna if they were allowed to be in direct contact with its metallization. Biocompatibility and prevention of undesirable short-circuits are especially crucial in The case of antennas that are intended for long-term implantation.
- ❖ Biomedical/medical devices are instruments, machines, implants, in vitro reagents, software, materials, or other related articles that are purposed for the safe and effective prevention, diagnosis, treatment, and rehabilitation of illness and disease for human beings.



What is an implantable antenna ??



Wireless Implantable Antennas

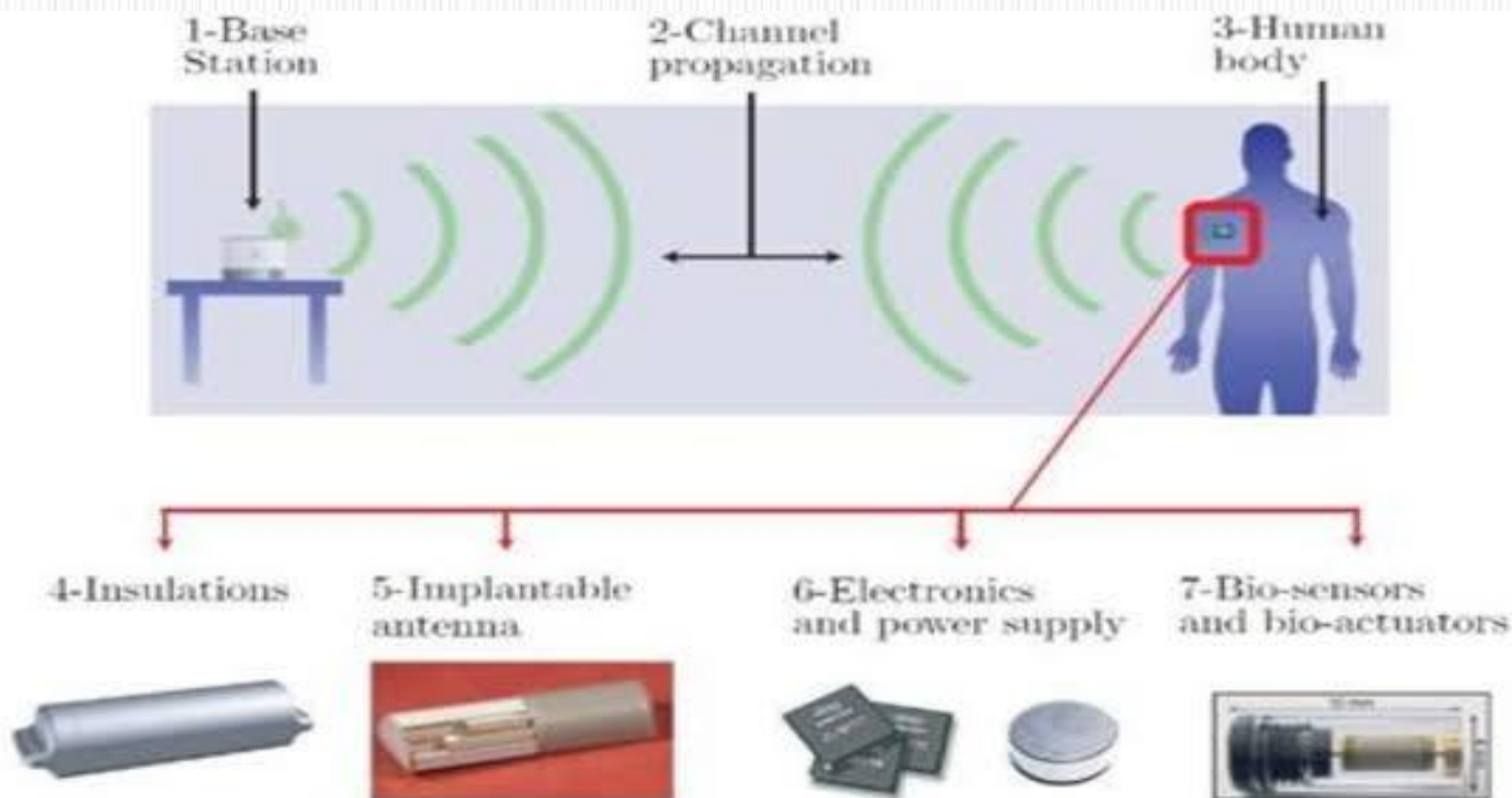


Figure 1. Wireless implantable system [7]



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LITERATURE SURVEY

We studied a lot of research papers but ones relevant to our project are

A Review of Implantable Antennas for Wireless Biomedical Devices

Changrong Liu^(1, 3), Yong-Xin Guo^(1, 3) and Shaoqiu Xiao⁽²⁾

The purpose of this paper Firstly, the overview of the requirements related to the implantable antenna design was explained. Then simulation and test methods for implantable antenna design are examined. Different antenna types, operating frequency bands and design environments are reviewed. Finally recent research topics on implantable antennas are introduced.



A Review of Implantable Patch Antennas for Biomedical Telemetry: Challenges and Solutions

Asimina Kiourti and Konstantina S. Nikita

Biomedical telemetry permits the transmission (telemetering) of physiological signals at a distance. One of its latest developments is in the field of implantable medical devices (IMDs). Patch antennas currently are receiving significant scientific interest for integration into the implantable medical devices and radio-frequency (RF)-enabled biotelemetry.

Patch antennas have gained considerable attention for dealing with issues related to biocompatibility, miniaturization, patient safety, improved quality of communication with exterior monitoring/control equipment, and insensitivity to detuning



Methodology

We have made a patch antenna in HFSS to simulate with real world scenarios

HFSS is high frequency structure simulator it is high performance full wave electromagnetic field simulator 3D volumetric passive device modelling that takes advantages of familiar Microsoft Windows graphical user interface .it integrates simulation, visualization, solid modelling and automaton in easy to learn environment.

What is HFSS ?

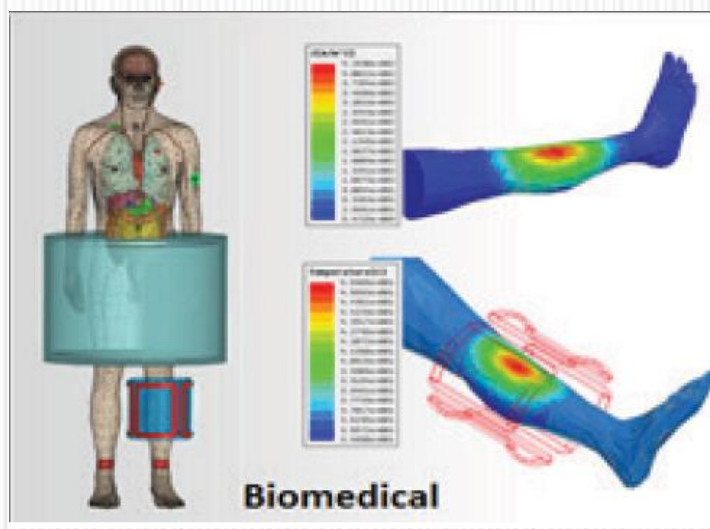
- HFSS - High frequency structure simulator
- HFSS is an industry-standard simulation tool for 3D full-wave electromagnetic field simulation.
- It is essential for the design of high-frequency and high-speed component design



We have used this software to design and test our implantable antenna in such a way that it can operate at very low frequency, typically at medical implant communications service (MICS) band also so it can have high operating frequency near about 1400Mhz and has short wavelength and suitably lower resonating frequency.

The antenna must also be matching the safety limits as defined by SAR (specific absorption ratio) and SA (specific absorption) standards and does not raise the body temperature more than 1-2 degree Celsius.

We have used simulations in HFSS for designing are antennas



Specifications on implantable antennas

- ❖ The antenna is fabricated on FR4 substrate with relative permittivity 4.4 and thickness 1.6 mm. Table-I shows the optimized dimensions of the antenna. Table II lists the conductivity and permittivity values of human tissues at 433.92 MHz used in simulation.

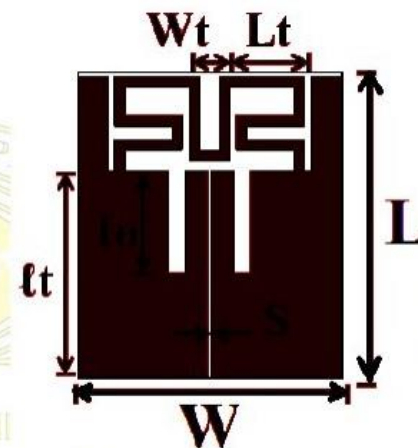
TABLE I
PARAMETER VALUES OF PROPOSED ANTENNA

| Parameter | Value (mm) |
|-----------|------------|
| L | 8.615 |
| W | 7.43 |
| ℓ_t | 6 |
| ℓ_0 | 3.615 |
| L_1 | 2.5 |
| S | 0.11 |
| W_1 | 0.5 |

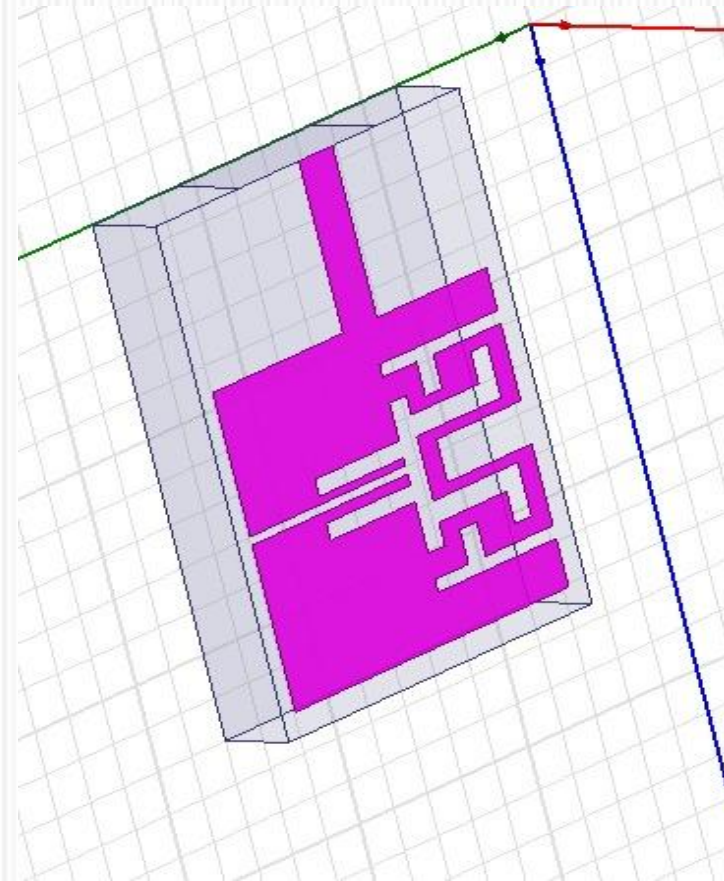
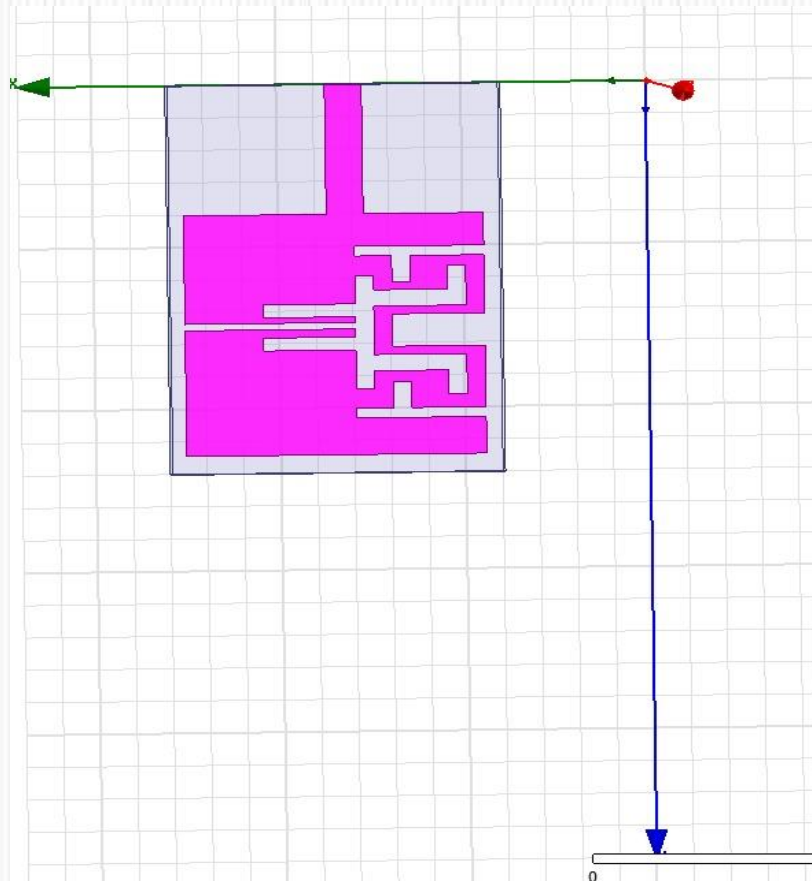
TABLE II
THE DIELECTRIC & CONDUCTIVE PROPERTIES OF HUMAN
TISSUES AT 433.92 MHz

| Tissues | ϵ_r | σ (S/m) |
|-----------------|--------------|----------------|
| Stomach | 67.2 | 1.01 |
| Colon | 62.0 | 0.87 |
| Small Intestine | 65.2 | 1.92 |
| Muscle | 56.9 | 0.8 |

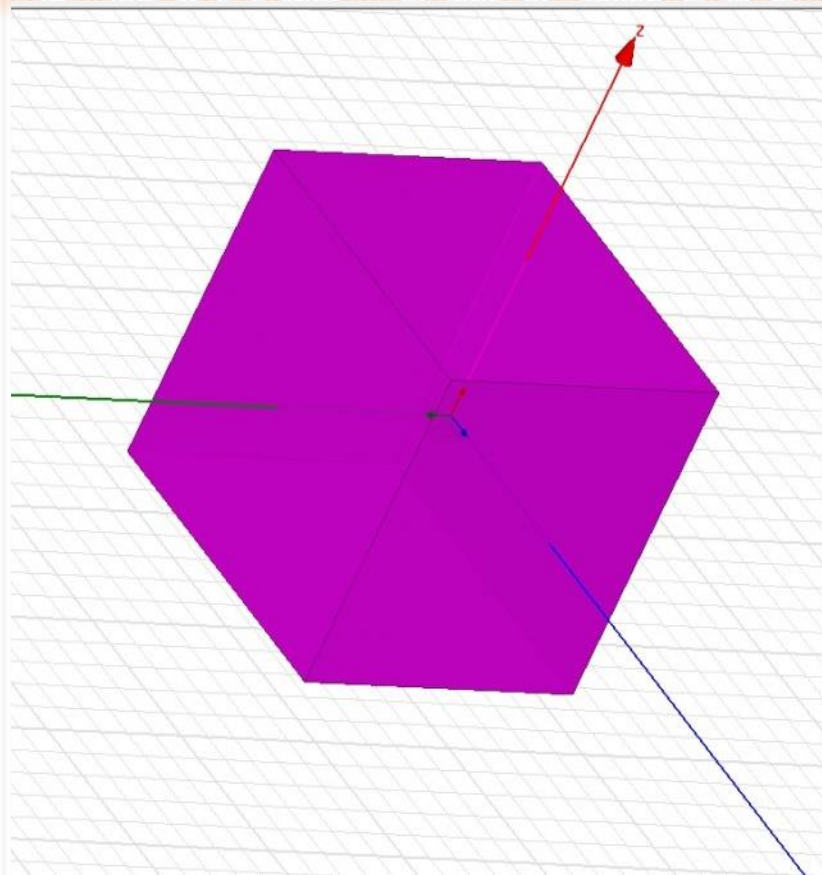
FIG I
Modified Patch Antenna



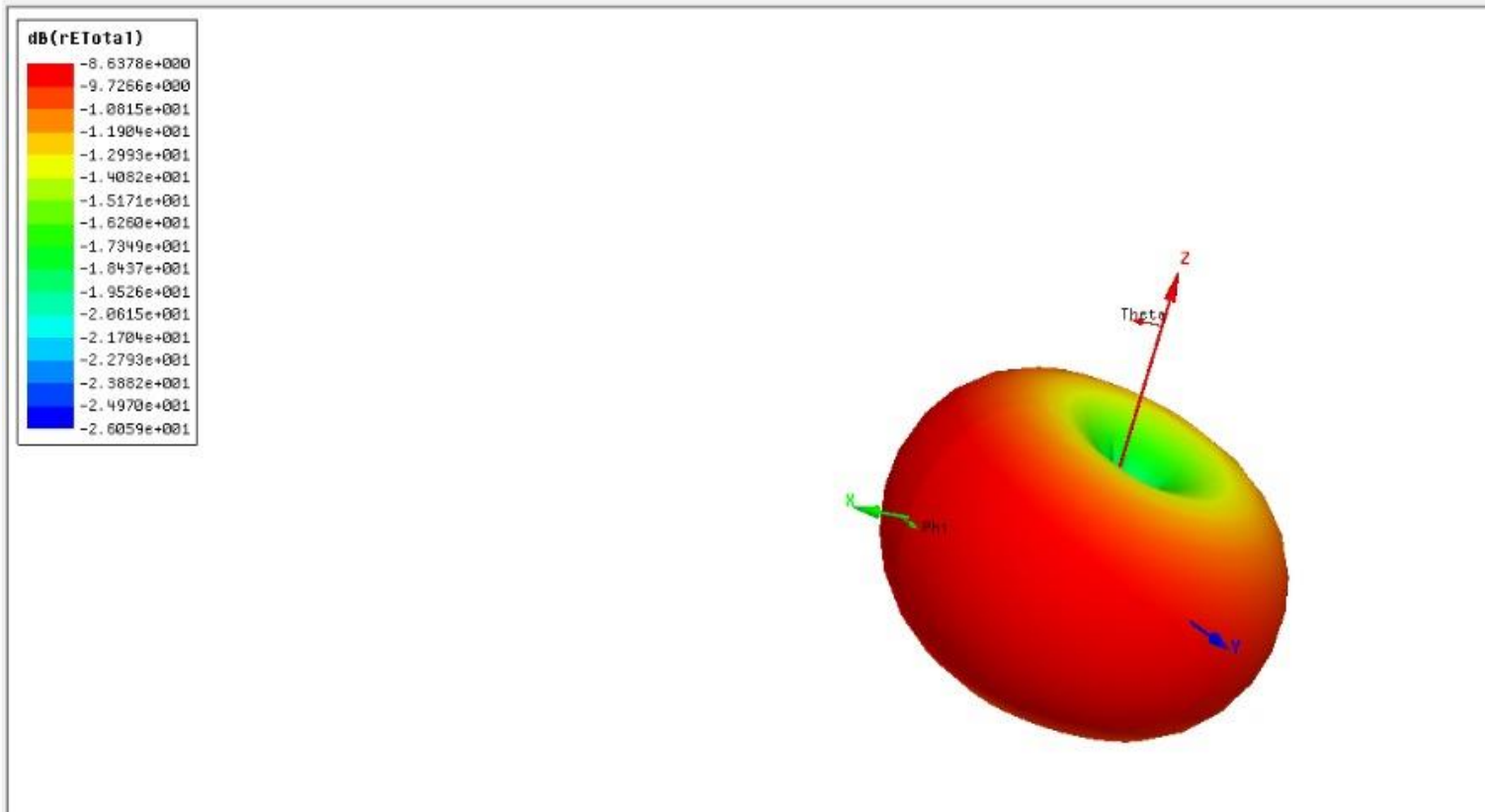
DESIGNED OUTPUT OF ANTENNA

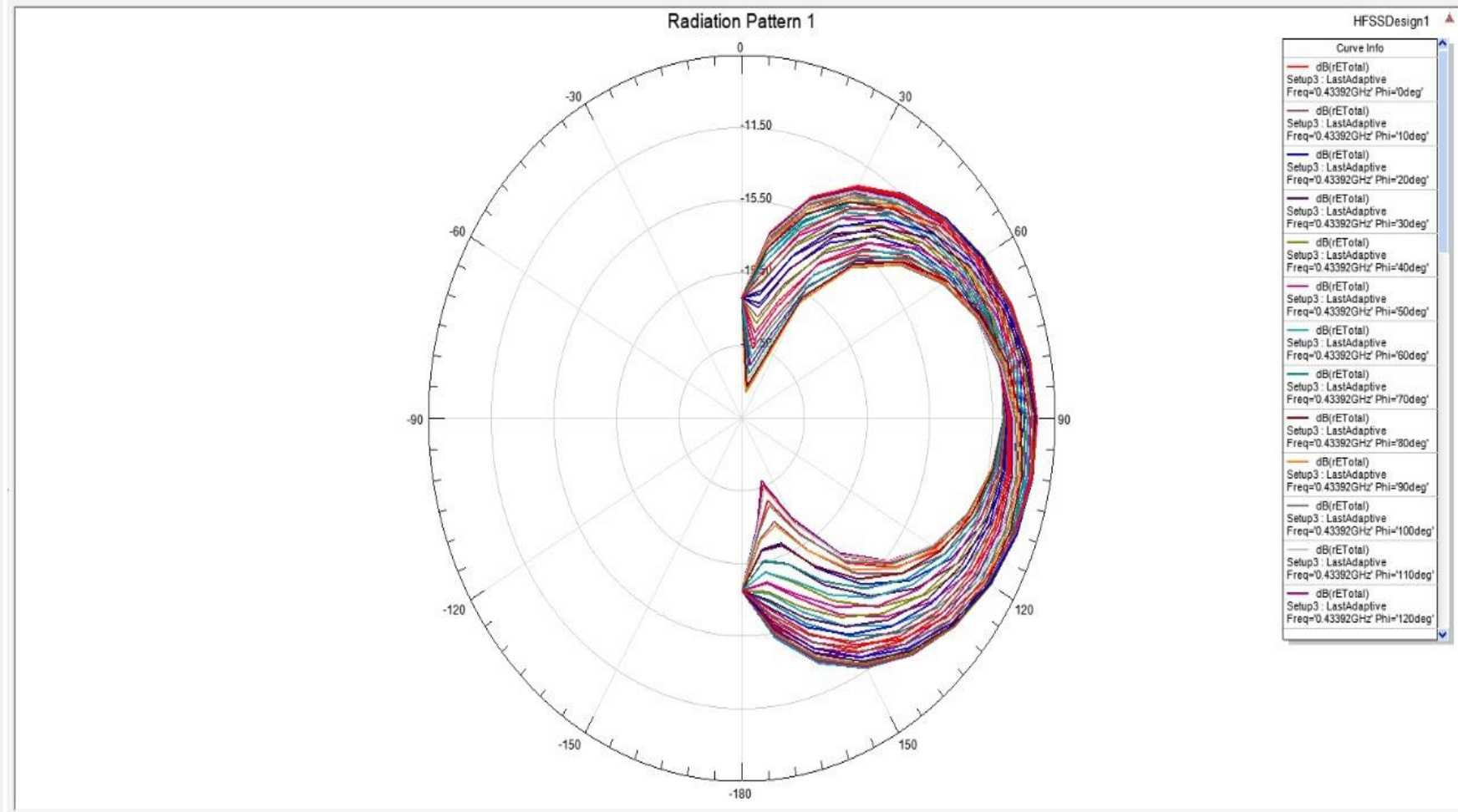


SKIN BOX VIEW



RADIATION PATTERN







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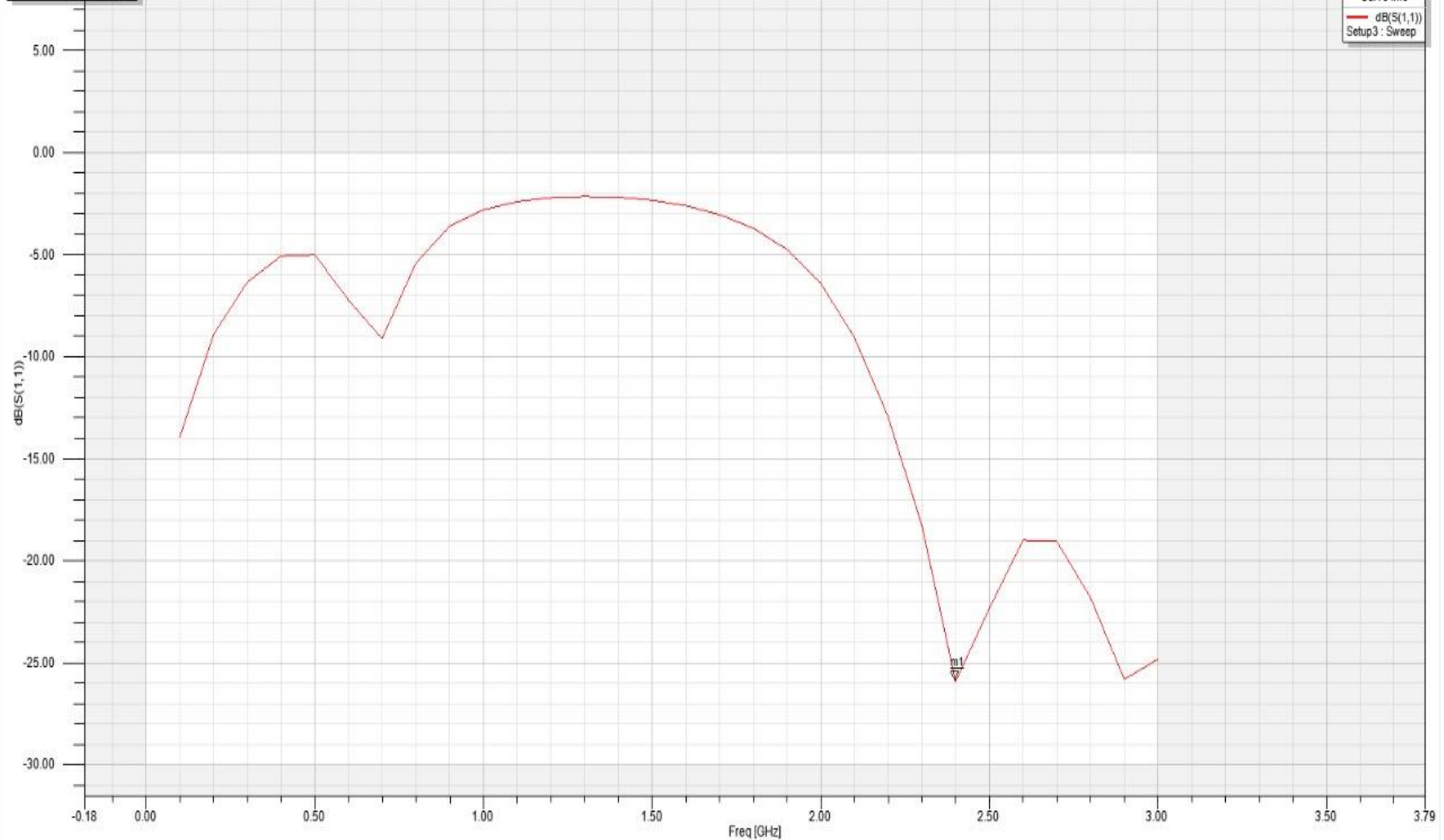


| Name | X | Y |
|------|--------|----------|
| m1 | 2.4000 | -25.9253 |

XY Plot 1

HFSSDesign1

Curve Info
dB(S(1,1))
Setup3: Sweep





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FUTURE SCOPE

For advancement in biotech field we need it's implementation for various applications like heart rate monitoring and disease monitoring. We plan to conduct lab trials next in the project, and check its commercial viability for real life use.



CONCLUSION

- The design goal of the antenna is to have a compact size and sufficient resonance and radiation characteristic at 433.92 MHz. The antenna is fabricated on FR4 substrate with relative permittivity 4.4 and thickness 1.6 mm.
- Four different locations inside the human phantoms have been targeted for the investigation purposes: Muscle, stomach, colon and small intestine.
- The solution frequency was reached 2.4GHz, which is provided by government for medical Blue-tooth transmissions.



References

- ❖ Forum for Electromagnetic Research Methods and Application Technologies (FERMAT) A Review of Implantable Antennas for Wireless Biomedical Devices Changrong Liu Yong-Xin Guo and Shaoqiu Xiao .
- ❖ Kiourti, K. A. Psathas, and K. S. Nikita, "Implantable and ingestible medical devices with wireless telemetry functionalities: A review of current status and challenges," Wiley Bioelectromagn., vol. 35, no. 1, pp. 1–15, Jan. 2014
- ❖ P.S. Hall and Y. Hao, Antennas and Propagation for Body-Centric Wireless Communications. MA: Artech House, 2006.
- ❖ K. S. Nikita, Handbook of Biomedical Telemetry. John Wiley & Sons, Inc., Hoboken, New Jersey, 2014.
- ❖ <https://www.sciencedirect.com/science/article/pii/S2215098615001433>



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Thank You!!