

# Reflectarray antenna design for X-band applications using flexible substrates

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## Introduction

- ❖ Antennas are one of the fundamental devices of communication systems that allow us to send and to receive electromagnetic waves.
- ❖ Reflectarray antennas have been a subject of interest due to their easy production with the printed circuit method and high gain with multiple unit cells. The production cost of reflectarray antennas is low and they are very effective antenna types since they do not require a transmission line.
- ❖ The main purpose of this project is to design a reflectarray antenna on flexible substrate for X band frequencies(8-12GHz).

## Specifications and Design Requirements

- ❖ 20X20 array element
- ❖ Square patch as unit cell geometry
- ❖ Silicon as flexible substrate
- ❖ X band as operating frequency

## Methodology

- ❖ Reflectarray antenna consists of unit cells, dielectric substrate and ground plane. The unit cells reflect the rays coming from the feed antenna. In order to the signal to be directed to the desired beam the unit cells must reflect the incoming rays in phase.

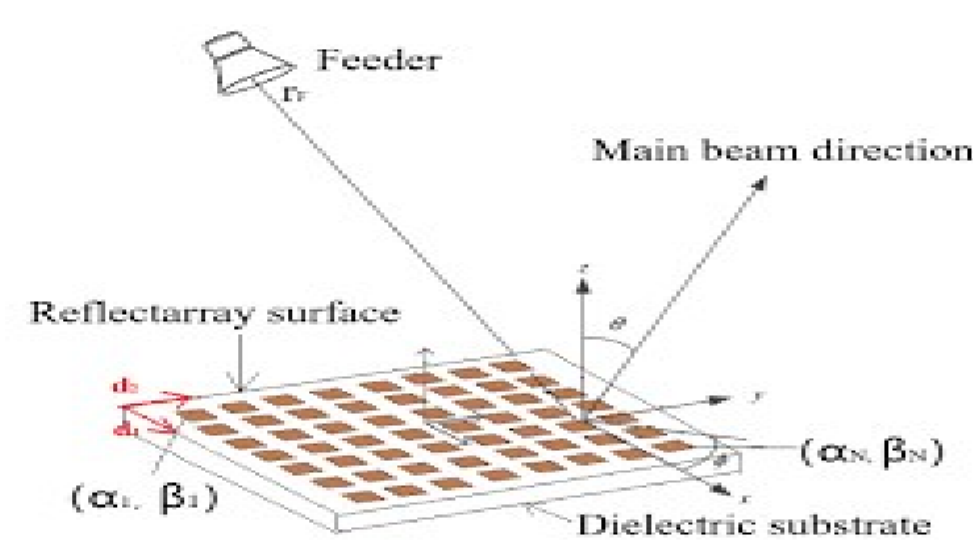


Figure1:General view of reflectarrays

- ❖ As first stage, the phase requirement of each unit cell at desired frequency must be calculated theoretically.

- ❖ As second stage, the phase characteristic of the unit cell should be obtained according to the patch geometry using EM simulation and analysis softwares.

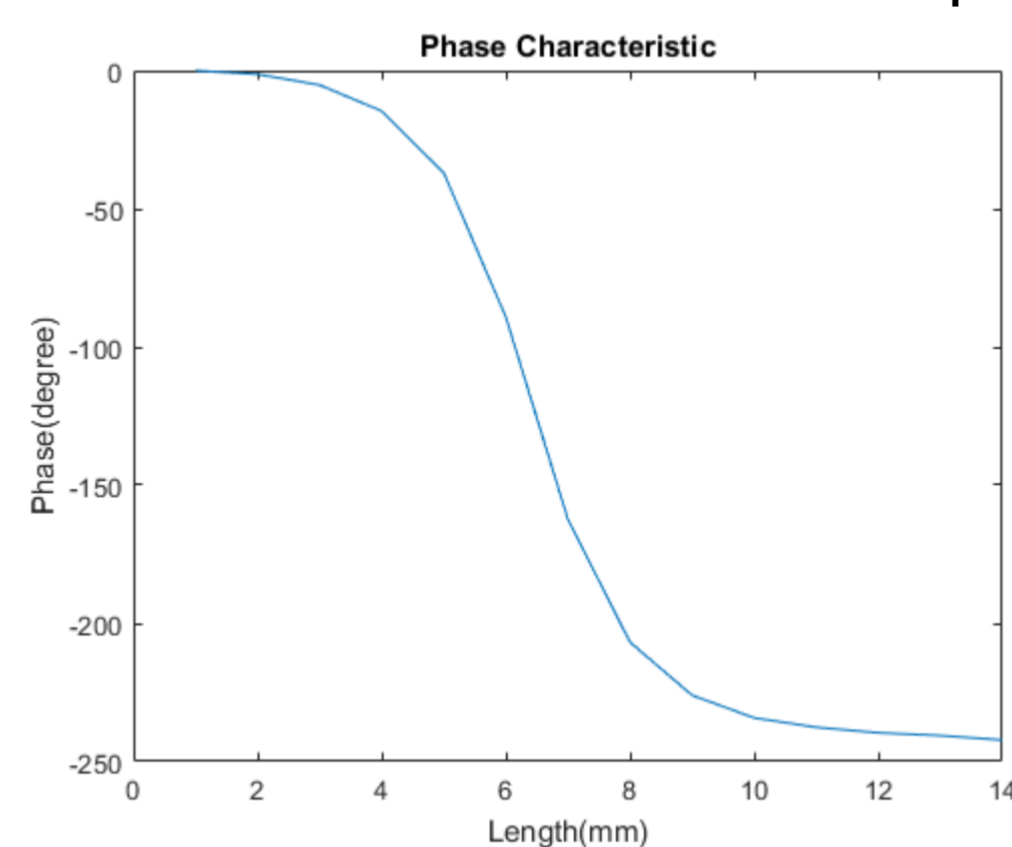


Figure2:Phase characteristic of unit cell

- ❖ At any region on the reflectarray antenna, unit cells that can meet the phase requirement in that region should be placed.

- ❖ In the project we produced three different types of unit cells given in Figure3.

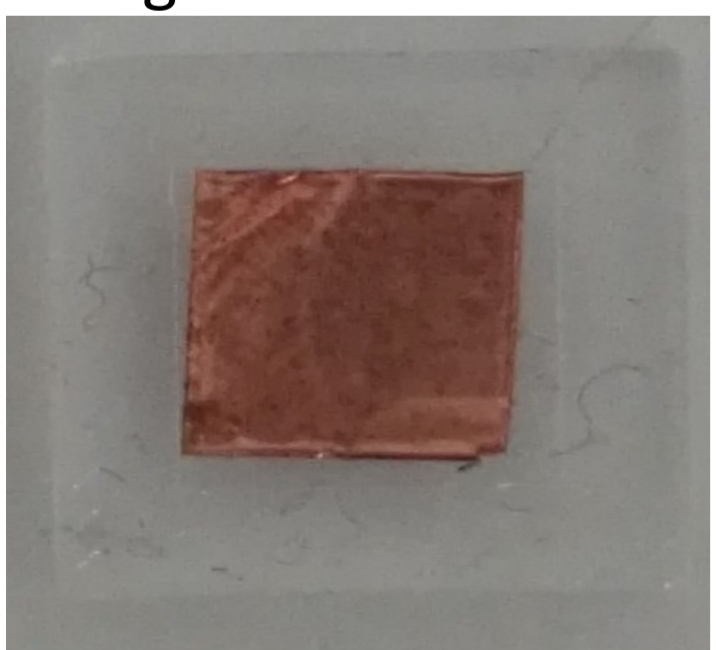


Figure 3a:Unit cell with copper patch

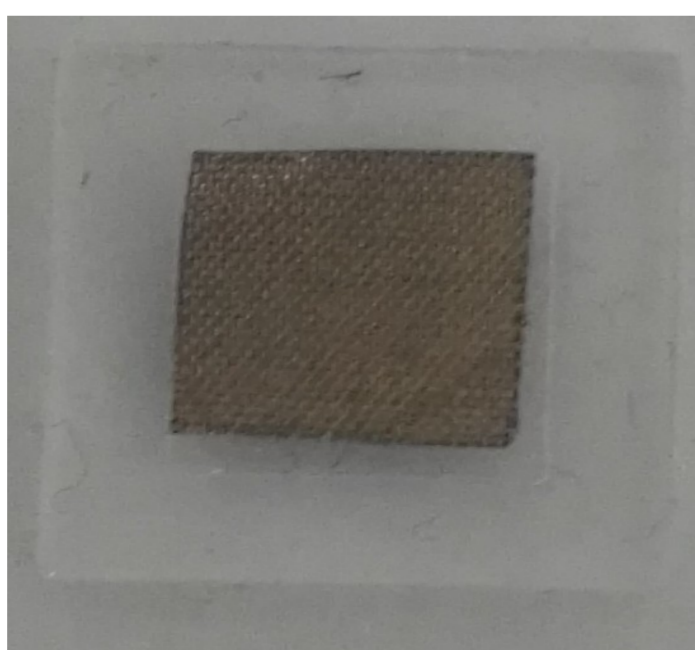


Figure 3b:Unit cell with textile patch

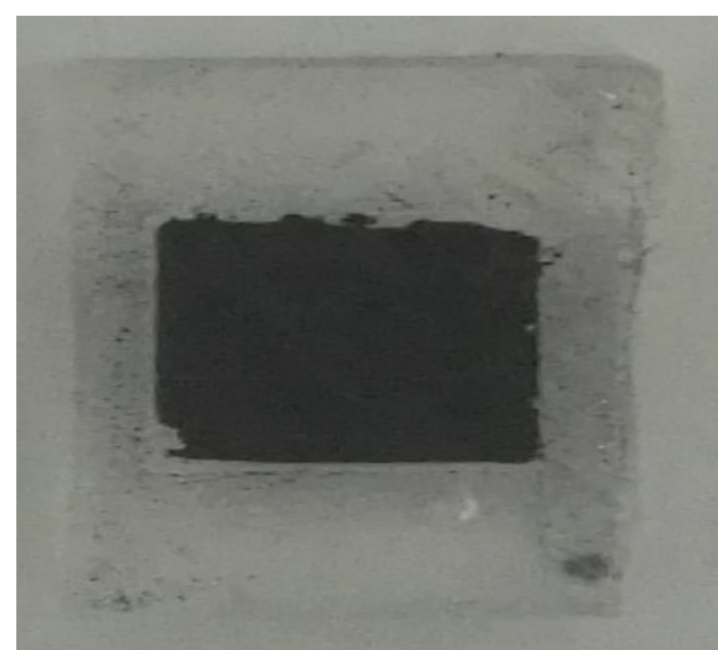


Figure 3c:Unit cell with ink patch

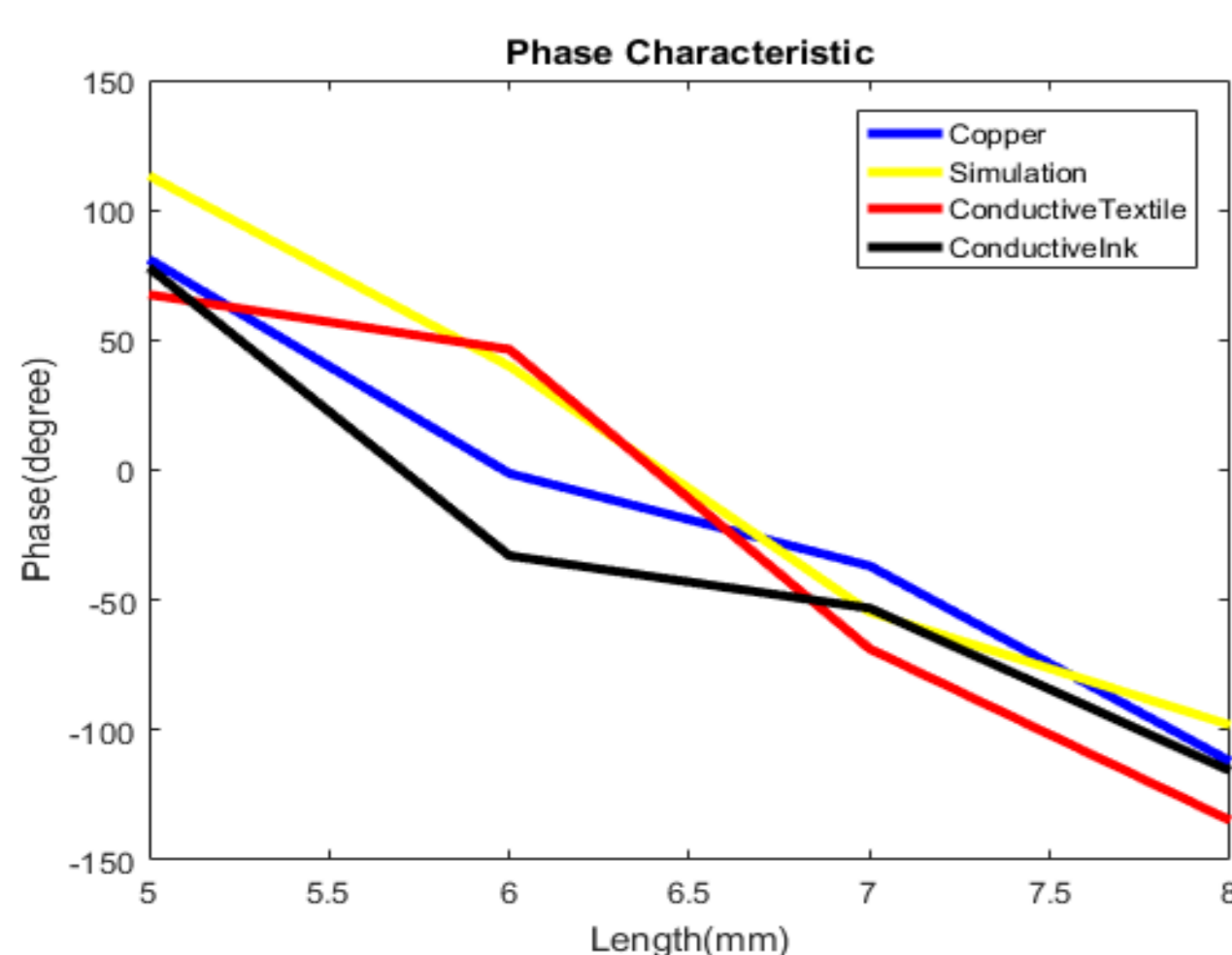


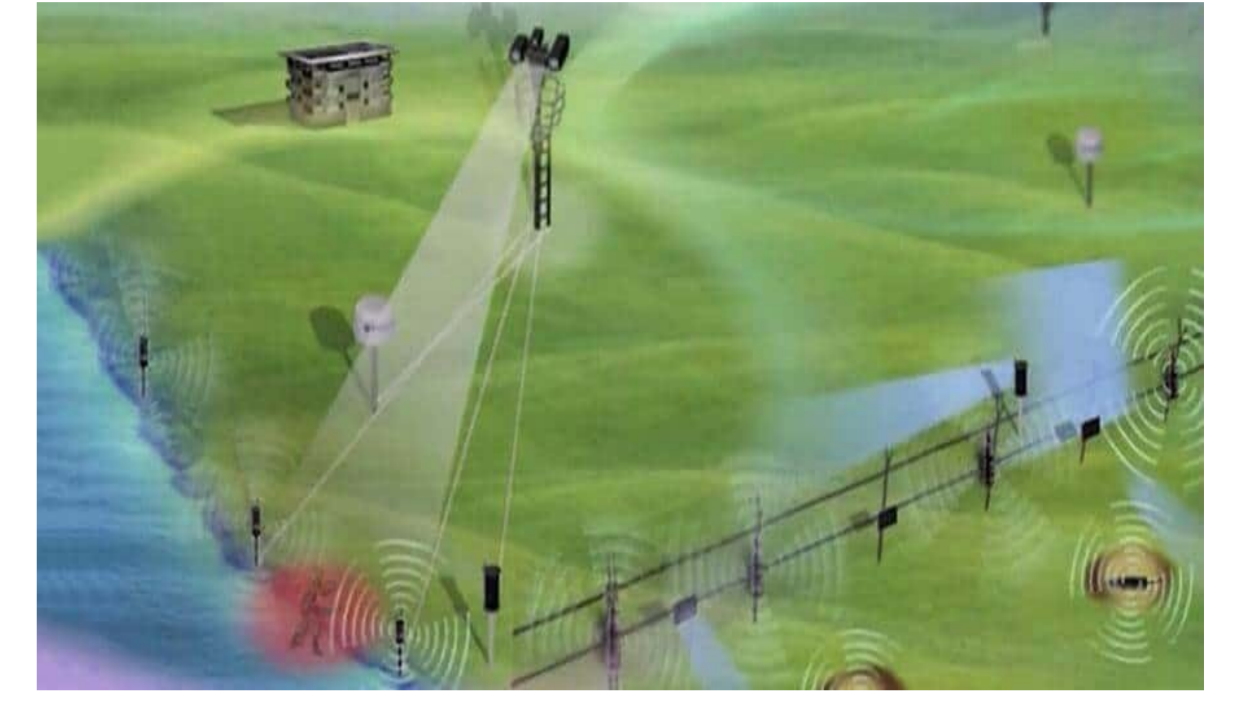
Figure4:Comparison of fabricated unit cells and simulation results

In the graph on the left, it is seen that the measurement results and the simulation results are in good agreement.

## Application Areas



a.Long distance communication systems



b.Radar systems

## Designed Antenna Simulation Results and Discussion

- ❖ The designed reflectarray antenna is shown in Figure 5. The radiation pattern of the reflectarray antenna is given Figure 6 and 7.

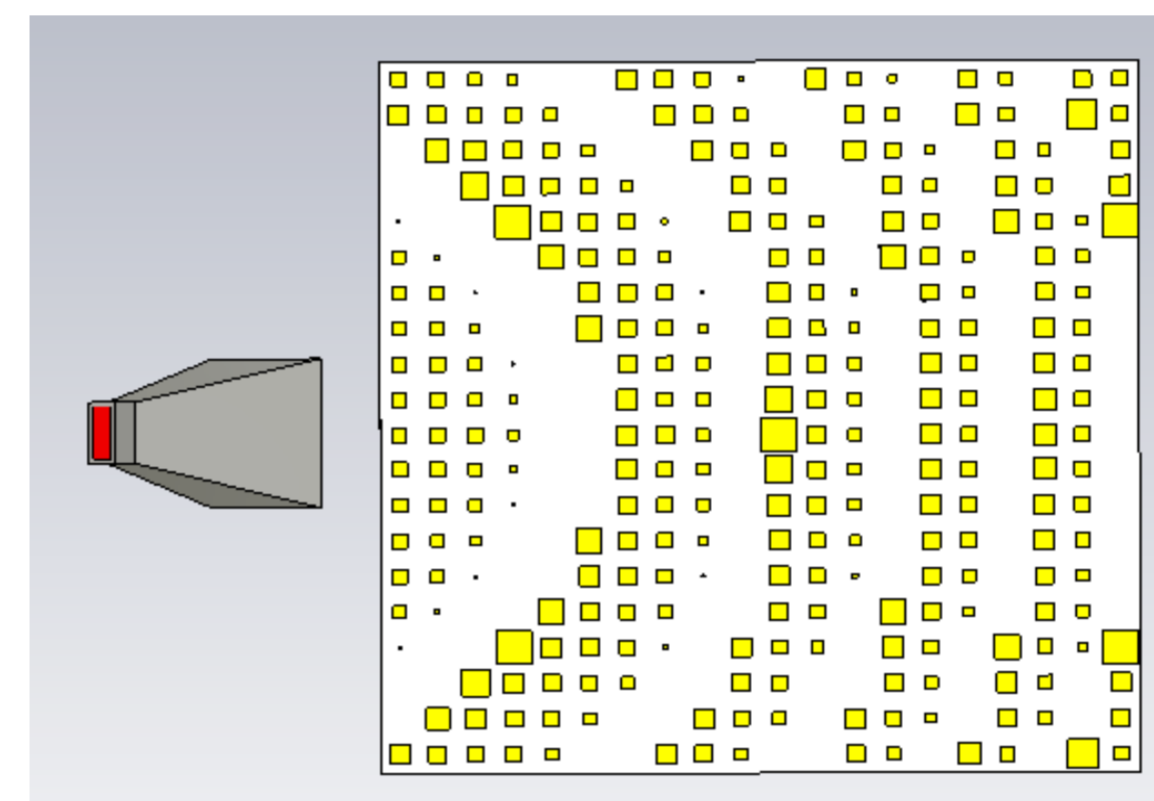


Figure 5:Designed reflectarray

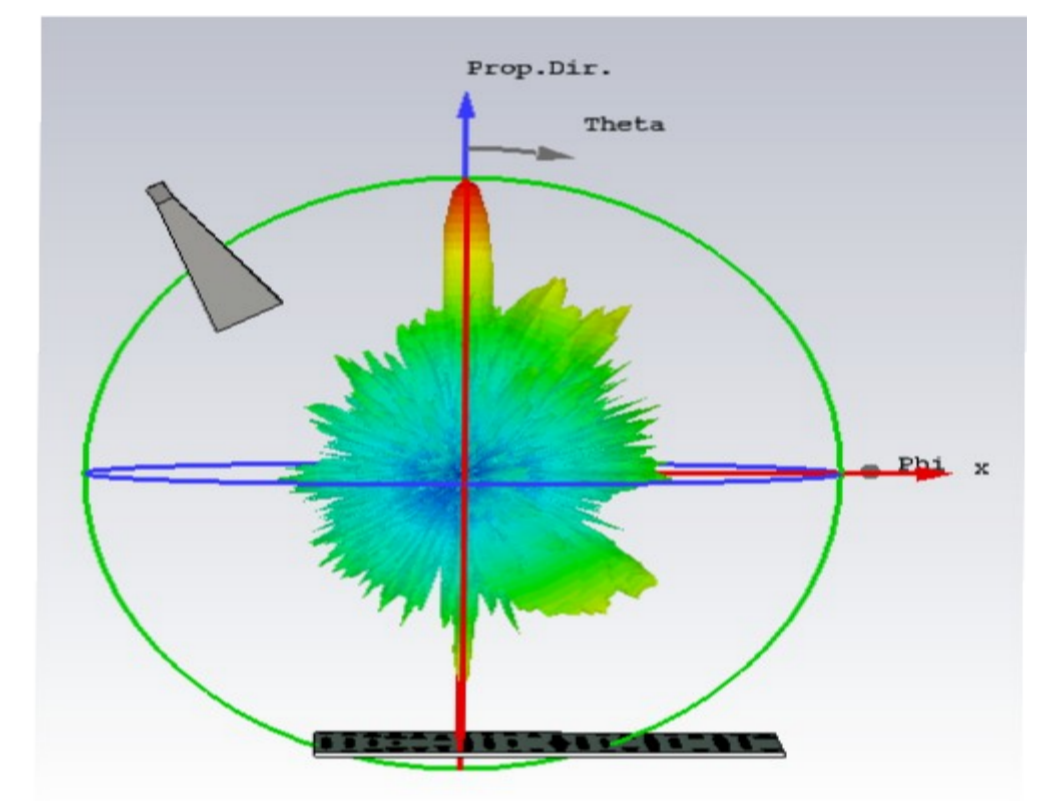


Figure 6:3D Radiation pattern

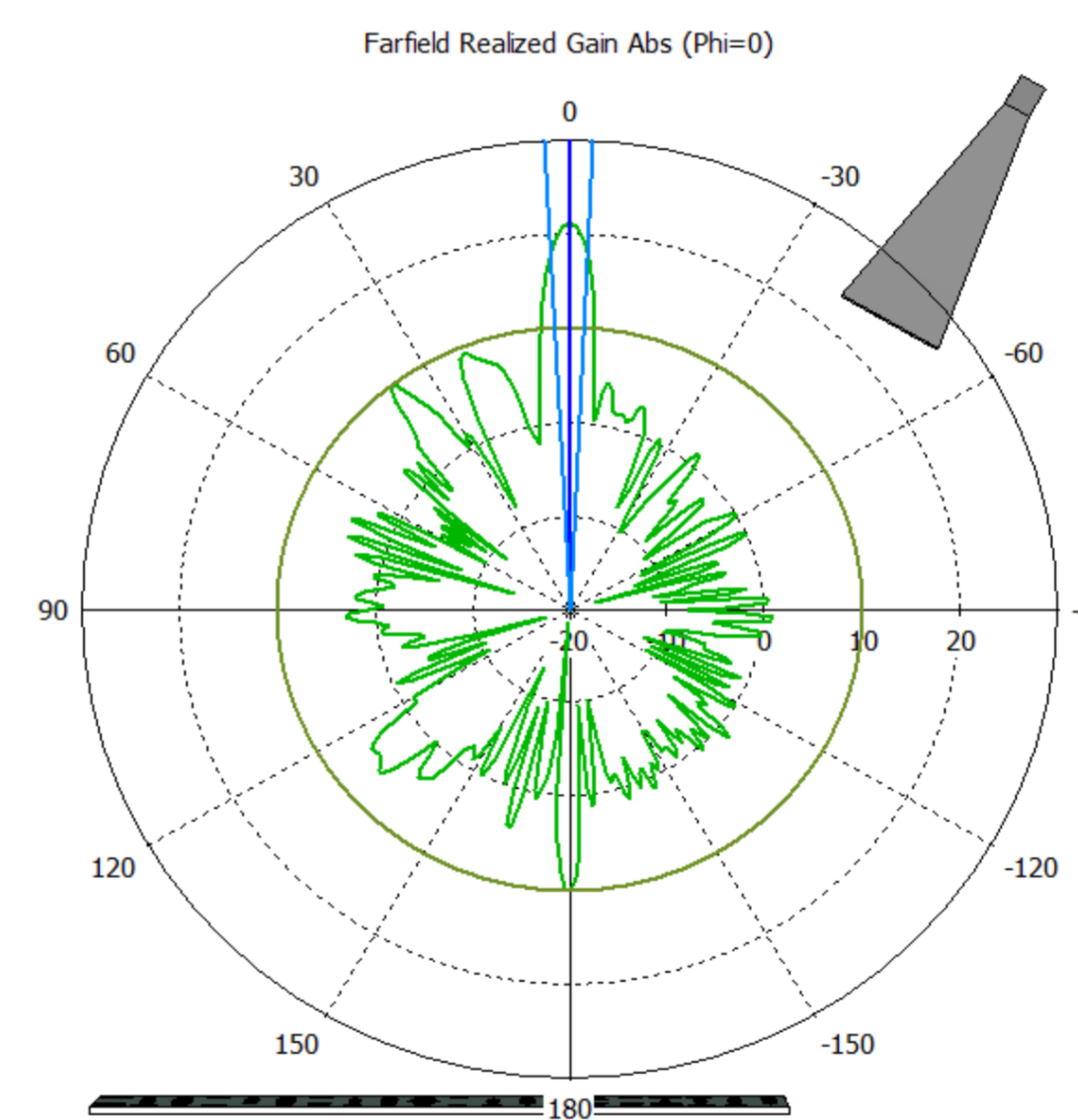


Figure 7:Radiation Pattern in polar graph

The reflectarray antenna has a gain of 21dB at 10GHz. Side lobe levels are below -10dB. With this design, a high gain antenna that can be used in X band applications has been Obtained. Despite the high gain, since the designed antenna is a microstrip antenna, its bandwidth will be narrow. There are studies in the literature to increase the bandwidth of reflectarray Antennas. For the development of this project, these studies in the literature should be followed and implemented.

## References

- [1] P. Nayeri, "Advanced Design Methodologies and Novel Applications of Reflectarray Antennas",2012
- [2] J. Huang and J. A. Encinar, "Reflectarray Antennas," 2007.

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