ANTENNA ENGINEERING LABORATORY

DESIGN AND SIMULATION OF A DUAL-BAND MICROSTRIP PATCH ANTENNA RESONANCE FREQUENCY OF 4 & 6 GHZ

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PROJECT OUTLINE

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INTRODUCTION

- The 4–6 GHz frequency range, part of the C-band, is widely utilized for satellite communication, radar systems, and 5G applications.
- A dual-band patch antenna within this range offers enhanced functionality by operating on two distinct frequency bands.
- Its compact size, ease of fabrication, and seamless circuit integration make the microstrip patch antenna ideal for modern communication systems.
- This design ensures reliable, high-performance communication across diverse applications while maintaining cost-effectiveness and scalability.

MOTIVATION

1. Mobile technology is the future of wireless communication, with 5G being a key player.5G operates below 6 GHz, offering benefits like faster speeds, better coverage, and resilience in wet conditions.

2. Microstrip patch antennas are a popular choice for 5G due to their advantages:

3. These frequencies offer potential benefits in terms of bandwidth and latency, enabling applications in areas like IoT, aerospace, and defense.

OBJECTIVES

- Design and simulate a dual-band microstrip patch antenna resonating at 4 GHz and 6 GHz.
- Optimize key performance metrics: bandwidth, gain, directivity, and impedance matching.
- Evaluate performance using critical parameters: return loss, VSWR, and radiation patterns.

DESIGN

GEOMETRY

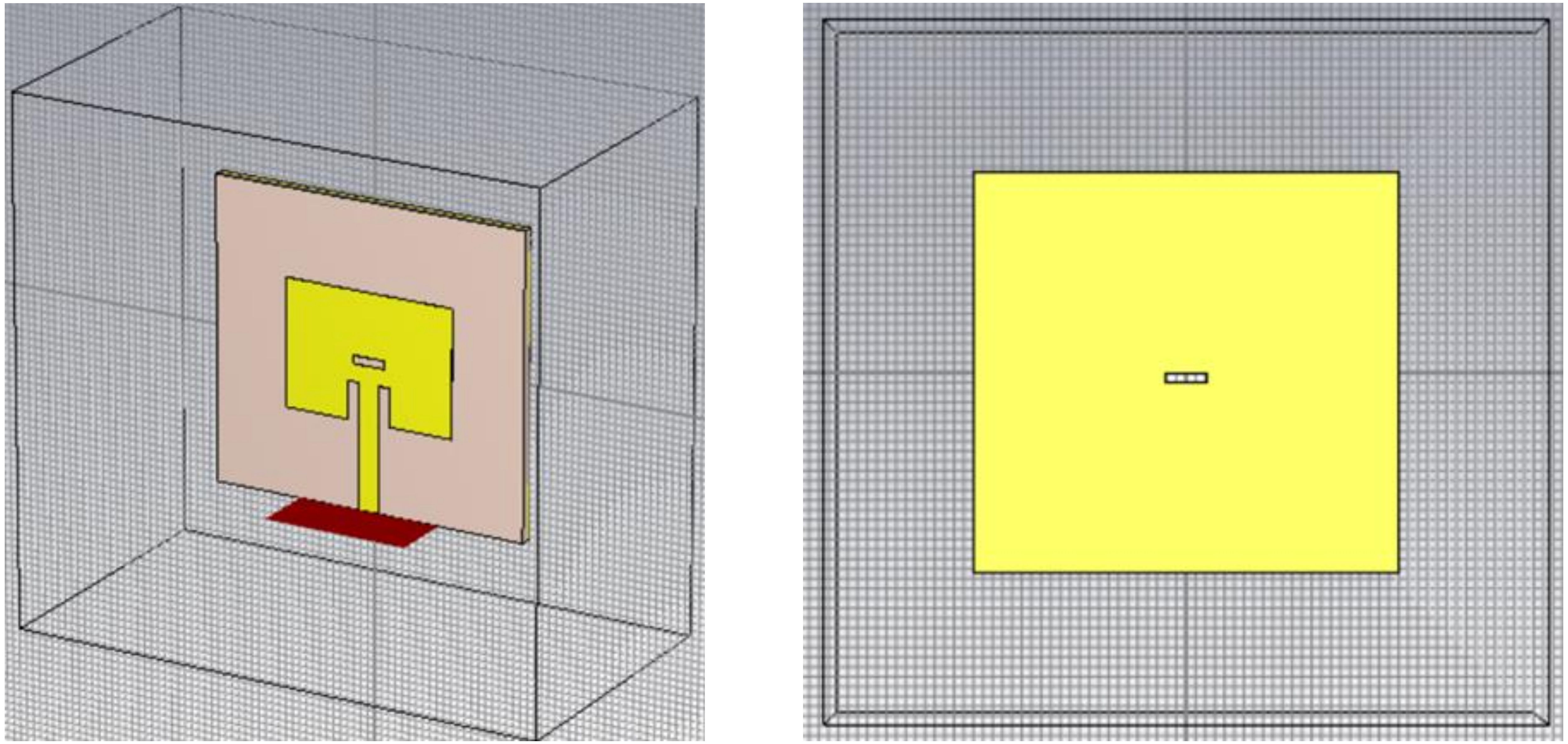


FIG 1: GEOMETRY DESIGN OF PATCH ANTENNA

Parameter List:

Name	Expression	Description
subw	= 44	substrate width
subl	= 41	substrate length
subd	= 1.5	substrate depth
antw	= 23.75	antenna width
antl	= 17.25	antenna length
txw	= 2.94	transmission line width
insw	= 1.5	inset width
insl	= 5.16	inset length
varl	= 2.2	slot2 length
varw	= 1.1	slot2 width
varl1	= 2.2	slot1 length
var1w	= 1.1	slot1 width

RESULT & ANALYSIS

- The simulated return loss is shown in Fig. 2, with bandwidths determined by |S11| > 10 dB and VSWR < 2.
- First band: 3.995 GHz, return loss -23.72 dB, bandwidth 200 MHz.
- Second band: 5.999 GHz, return loss -18.27 dB, bandwidth 250 MHz.

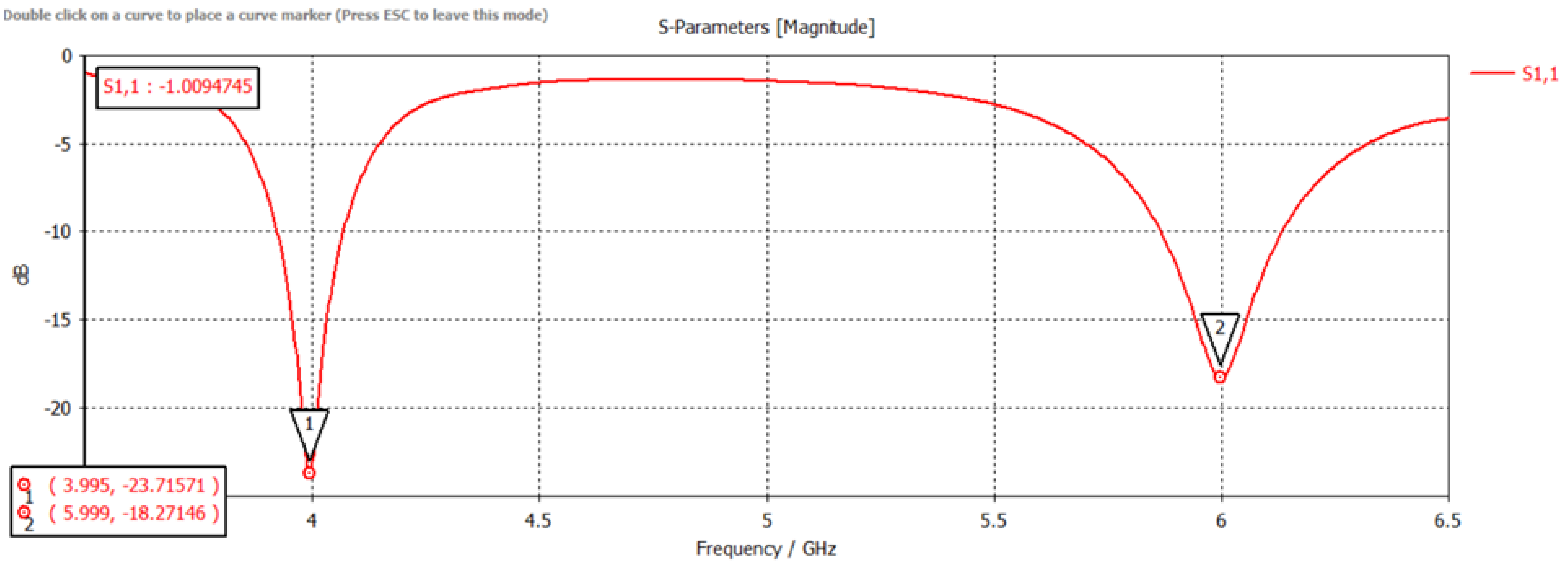


FIG 2: S- PARAMETER.

Fig. 3 shows simulated VSWR values: 1.139 at 4 GHz and 1.277 at 6 GHz, indicating excellent transmission.

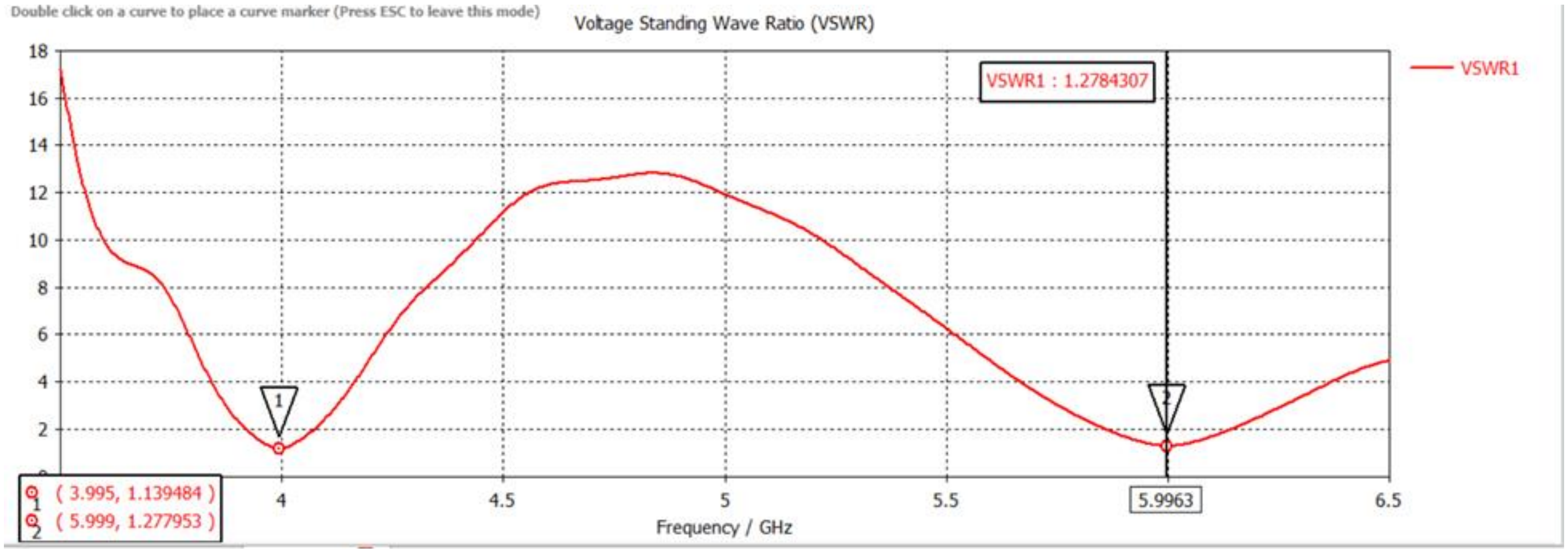


Fig. 3: VSWR of the proposed dual-band microstrip patch antenna

Fig. 4 shows simulated Gain values: 2.86 at 4 GHz and 2.67 at 6 GHz, indicating excellent transmission.

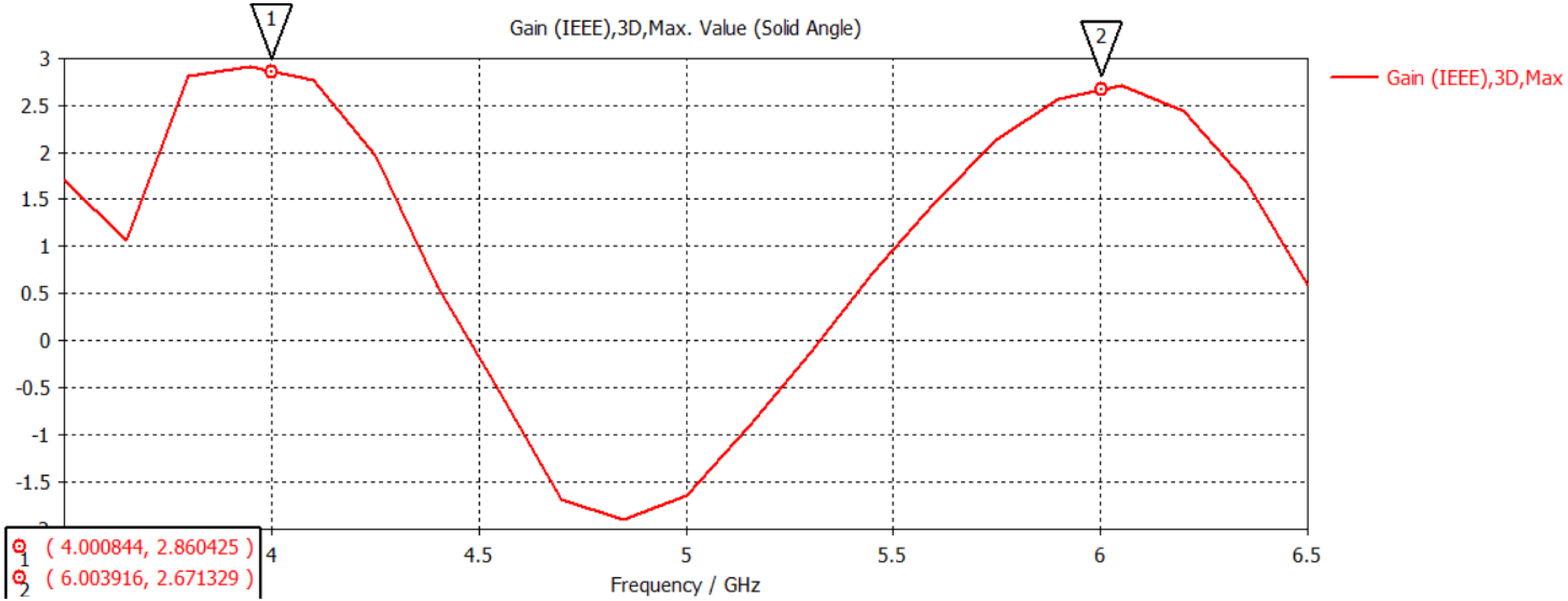
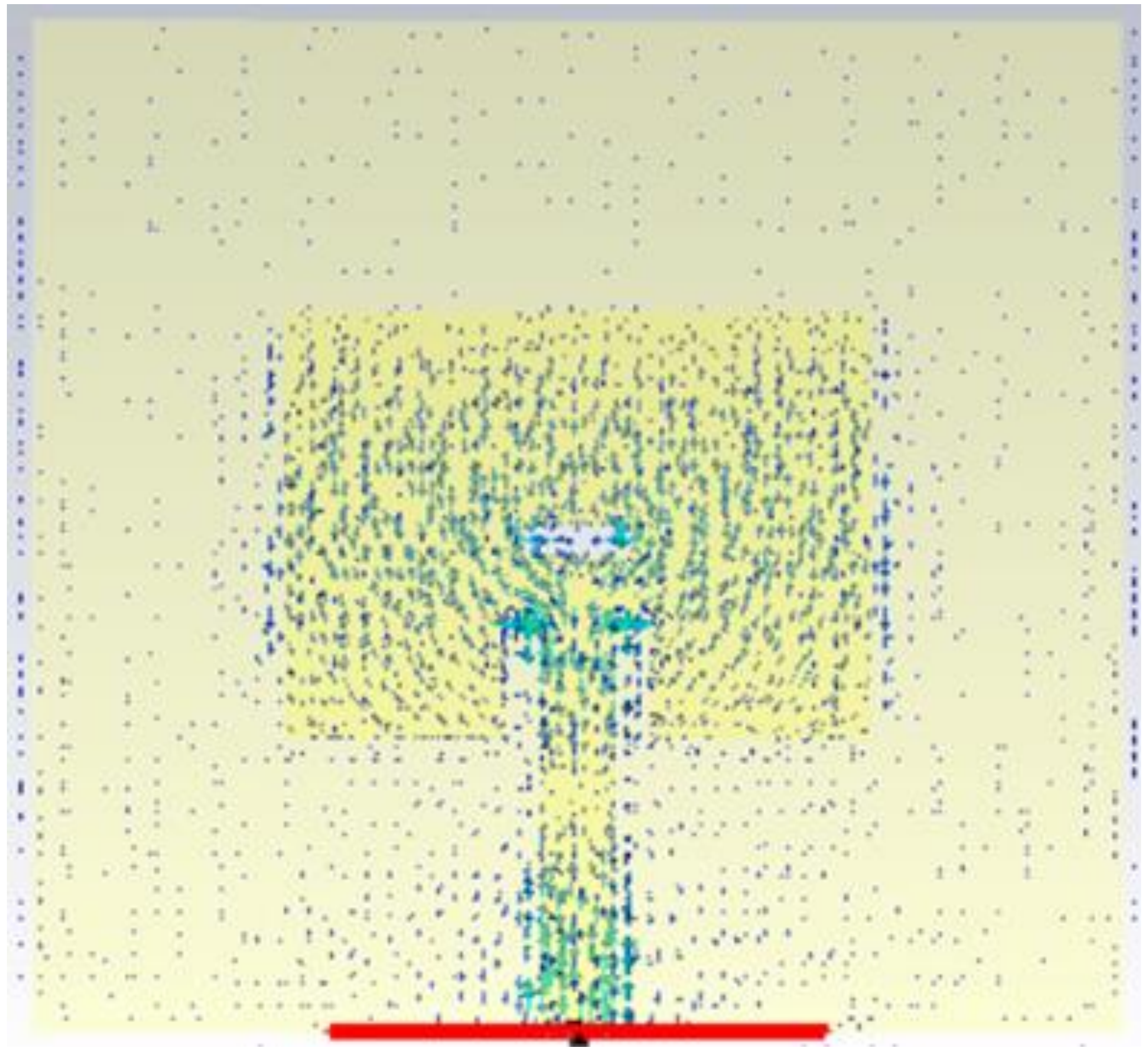
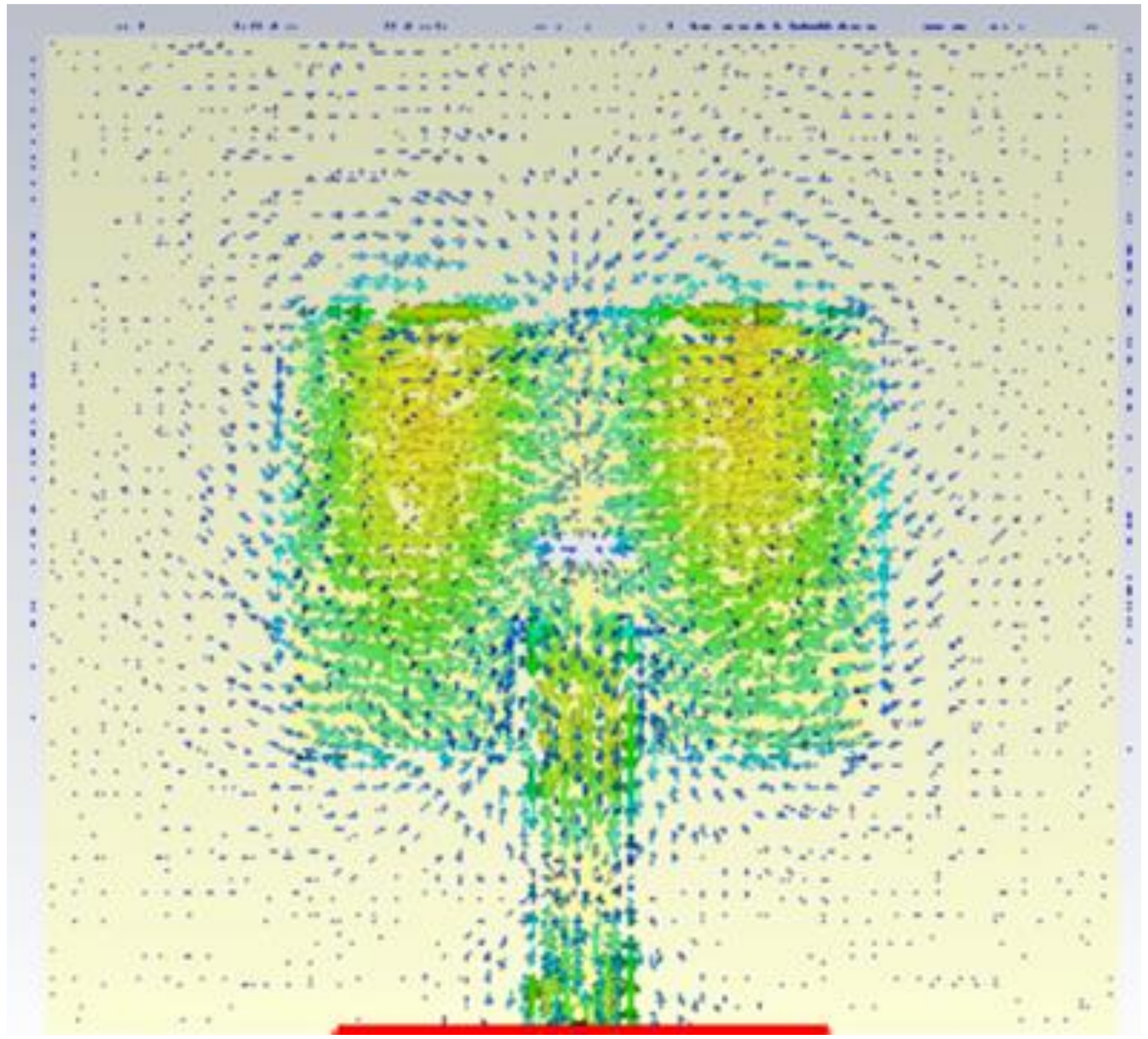


Fig. 4: Gain of the proposed dual-band microstrip patch antenna

Current exhibits omnidirectional behavior, ensuring strong excitation across the antenna at both bands.



A) CURRENT DISTRIBUTION AT 4 GHZ



B) CURRENT DISTRIBUTION AT 6 GHZ

FIG. 5: SURFACE CURRENT DENSITY DISTRIBUTION OF THE PROPOSED DUAL-BAND MICROSTRIP PATCH ANTENNA

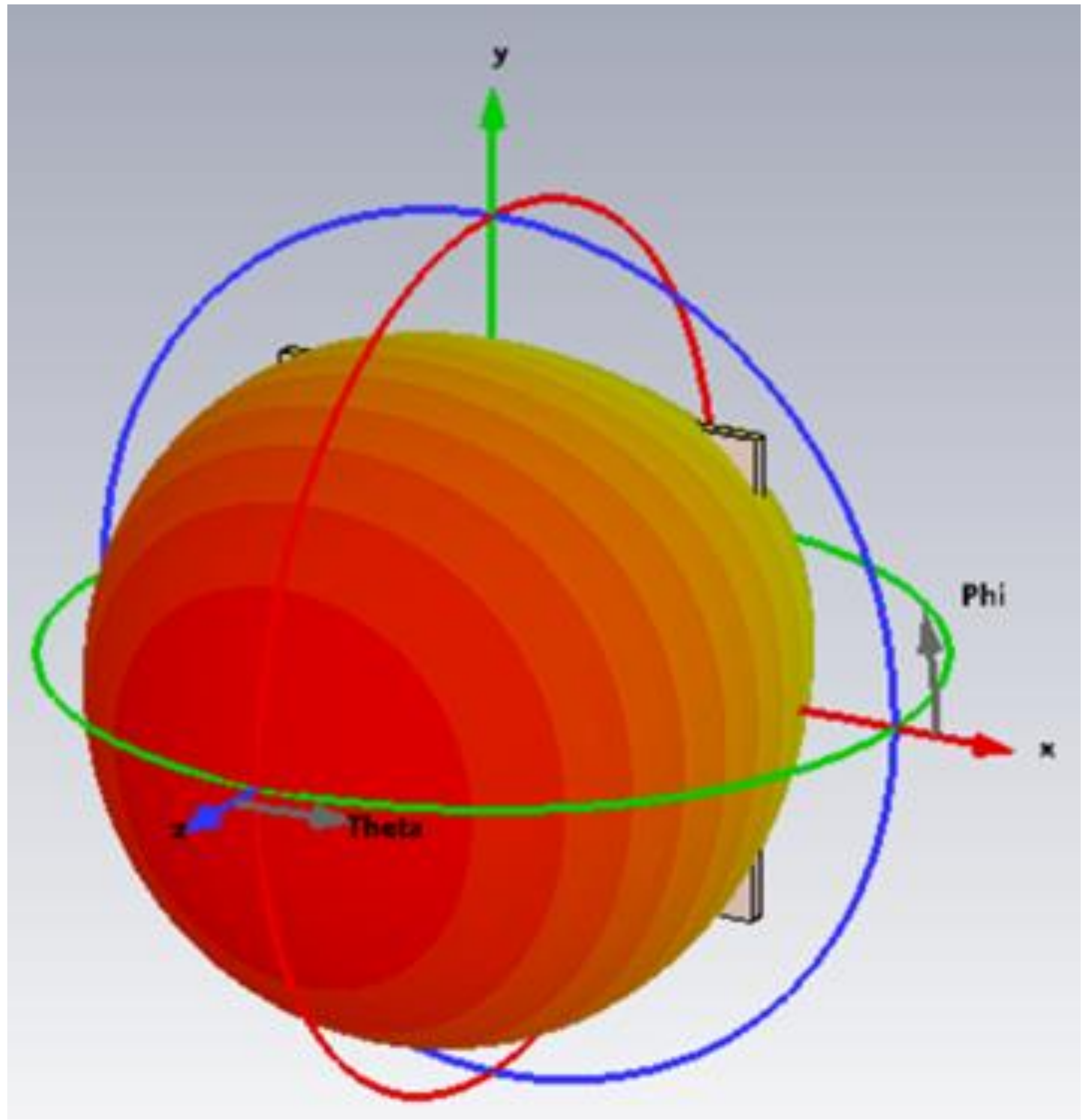
farfield (f=4) [1]

Type	Farfield
Approximation	enabled (kR >> 1)
Component	Abs
Output	Directivity
Frequency	4 GHz
Rad. Effic.	-3.684 dB
Tot. Effic.	-3.706 dB
Dir.	6.555 dBi

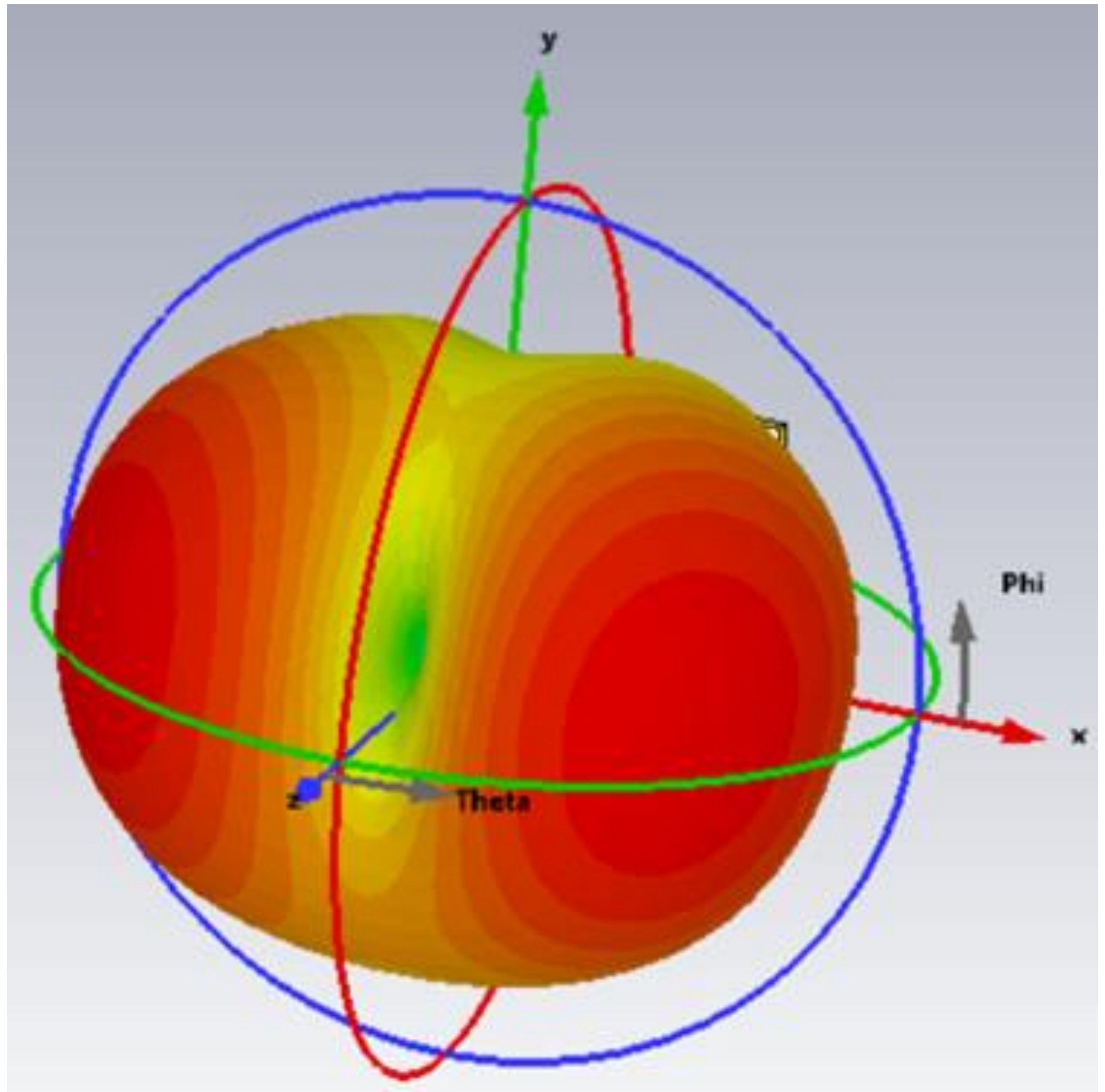
farfield (f=6) [1]

Type	Farfield
Approximation	enabled (kR >> 1)
Component	Abs
Output	Directivity
Frequency	6 GHz
Rad. Effic.	-3.638 dB
Tot. Effic.	-3.703 dB
Dir.	6.345 dBi

Fig. 6 shows the simulation results for the radiation pattern of the proposed antenna. The radiation pattern is nearly omnidirectional for both operating bands. The antenna gain is 2.86 dB



(a) Directivity at 4 GHz



(b) Directivity at 6 GHz

Fig. 7: The simulated 3D radiation pattern of the proposed dual-band microstrip patch antenna

Table 2: The summarized simulated results

Parameters	First Resonance (4GHz)	Second Resonance (6GHz)
Frequency (GHz)	4	6
S11 (dB)	-23.72	-18.27
Bandwidth (GHz)	3.9–4.1=200 MHz	5.875–6.125=250 MHz
VSWR	1.139	1.277
Directivity (dB)	6.555	6.345
Radiation Efficiency (dB)	-3.684	-3.638
Gain (dB)	2.86	2.67

Conclusion

- **Designed a rectangular microstrip patch antenna for dual-band operation at 4 GHz and 6 GHz.**
- **Achieved return losses of -23.72 dB (4 GHz) and -18.27 dB (6 GHz).**
- **VSWR values: 1.14 (4 GHz) and 1.29 (6 GHz).**
- **Bandwidths: 200 MHz (4 GHz) and 250 MHz (6 GHz).**
- **Future scope: Fabrication and real-time testing.**

Reference

- A Study on Dual-band Microstrip Rectangular Patch Antenna for Wi-Fi
- A circular microstrip patch antenna to operate in dual band for wireless communications
- Dual Band Microstrip Patch Antenna and its Gain Enhancement for X Band and Ku Band Application Using Metamaterial

THANK YOU