Multi-beam and High Gain Antenna Array for RF Energy Harvesting Applications in 5G Network

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ENSEA : Ecole Nationale Supérieure de l'Electronique et de ses Applications

STIC : Sciences and Technology of Information and Communication

Resume

Chemseddine Benkalfate Ph.D. student from 2018 at Quartz laboratory of ENSEA in France and STIC laboratory of University of Tlemcen in Algeria. I graduated with a master's degree in telecommunication systems in 2018. I'm working on design and realization of RF energy harvesting systems to ensure the energetic autonomy of low power consumption equipment's. I'm actually in the post of Temporary Assistant, Teaching and Research, full time at ENSEA since 09/2022.

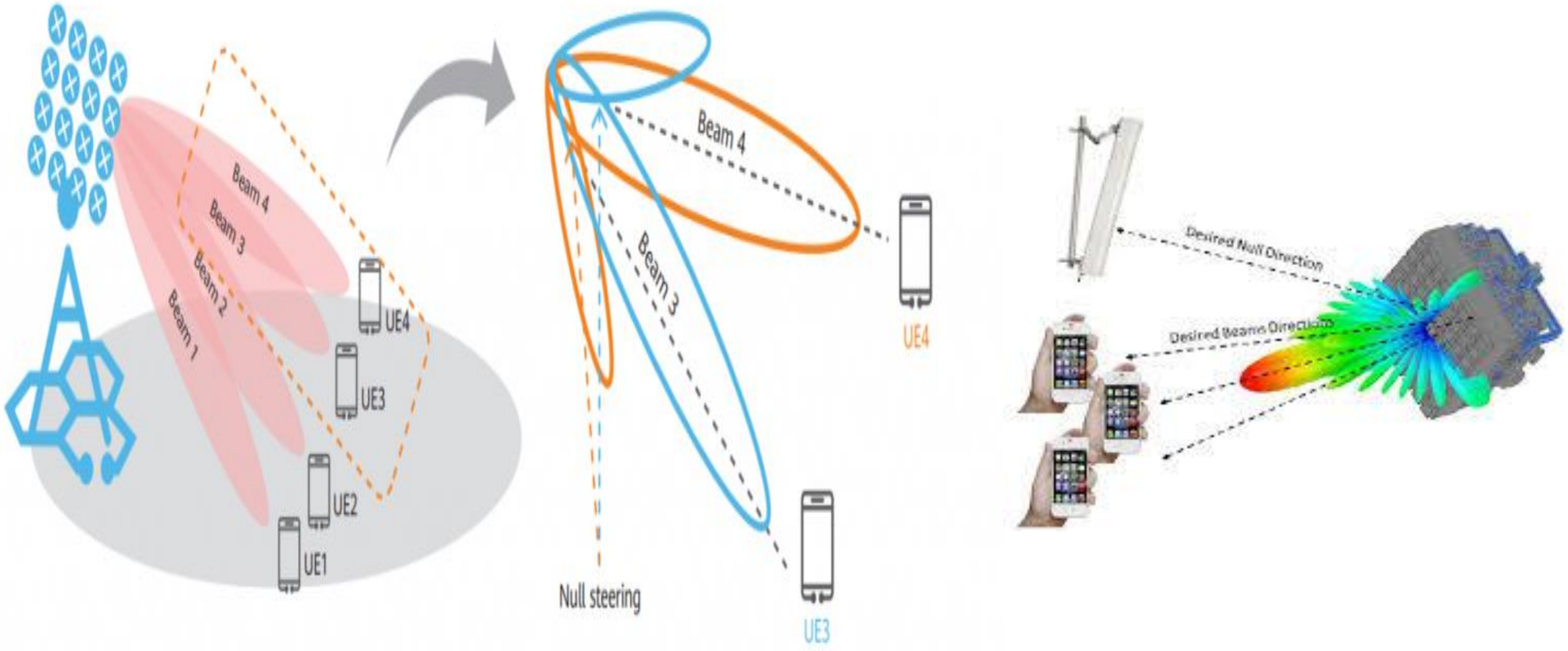
I'm working also on:

- Design and realization of antenna structures for new mobile communication generations (CST microwave software, HFSS, ADS)
- Design and realization of miniaturized micro-wave circuits (ADS, ANSYS, GENESYS)
- New physical solutions to increase optical communication rate (COMSOL, Opti-System)
- RADAR signal processing and estimation methods

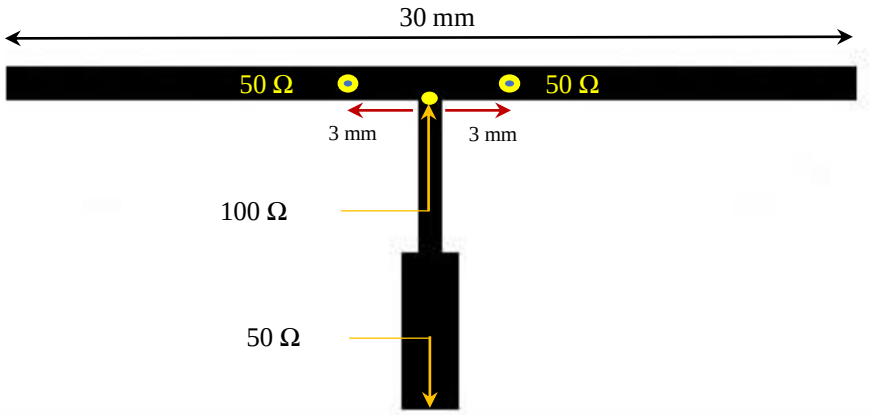
Summary

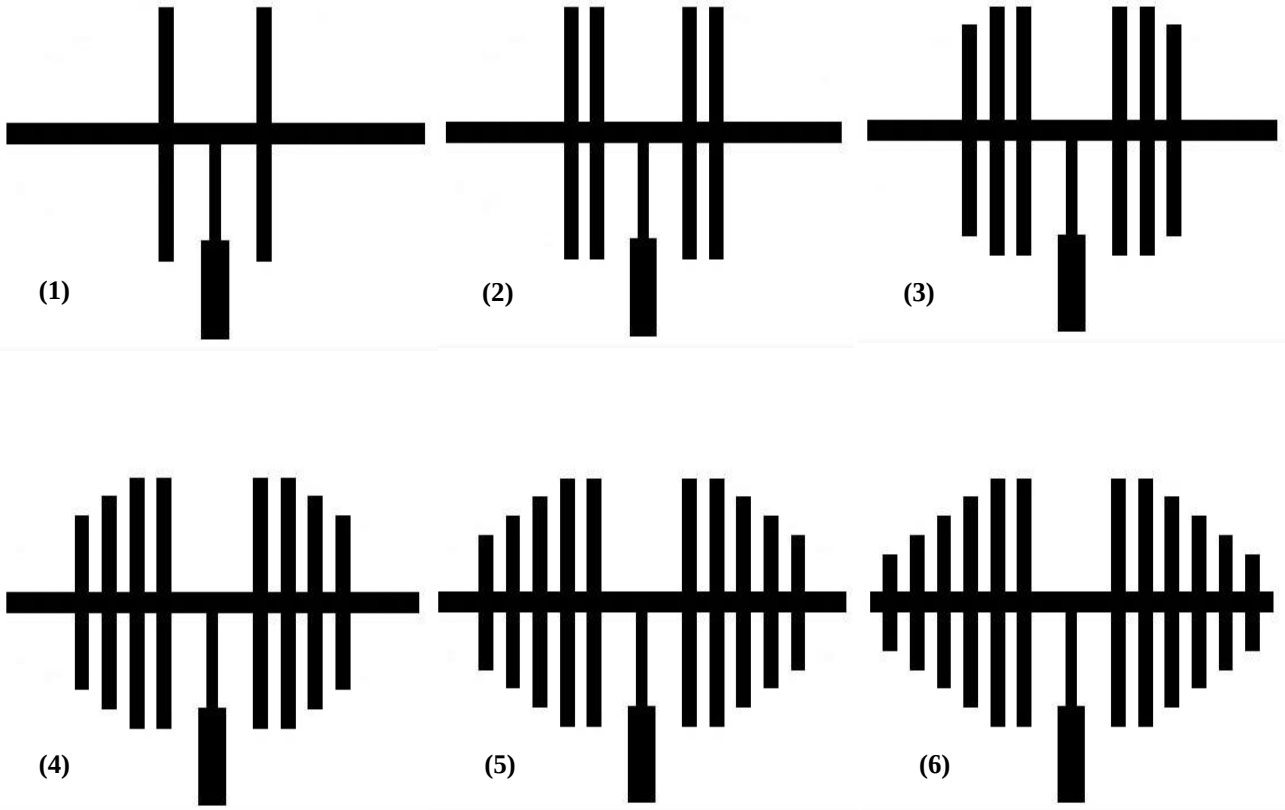
1) Introduction
2) First step of array antenna design
3) Design of 2x1 array antenna
4) Design of 2x2 array antenna
5) Simulation of scattering parameters of the array antennas
6) Simulation of radiation pattern
7) Directivity variation as a function of incident angles
8) Conclusion

Introduction


Beam 4
Beam 3
Beam 2
Beam 1
UE4
UE3
UE2
UE1
Beam 4
Beam 3
UE4
Null steering
UE3
Desired Null Direction
Desired Beams Direction

First step of array antenna design


30 mm
50 Ω
50 Ω
3 mm
3 mm
100 Ω
50 Ω


(1)
(2)
(3)
(4)
(5)
(6)

Design of 2x1 array antenna

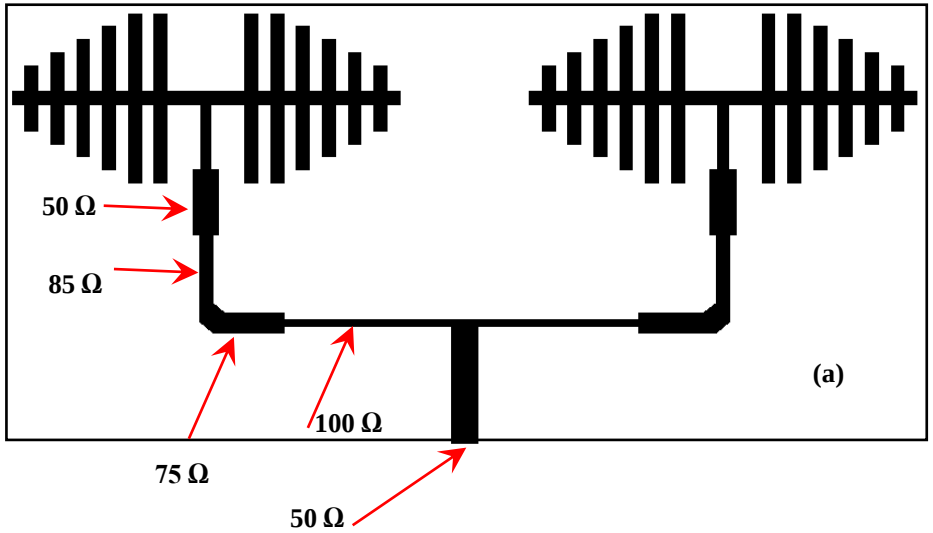
(a) : Top Side

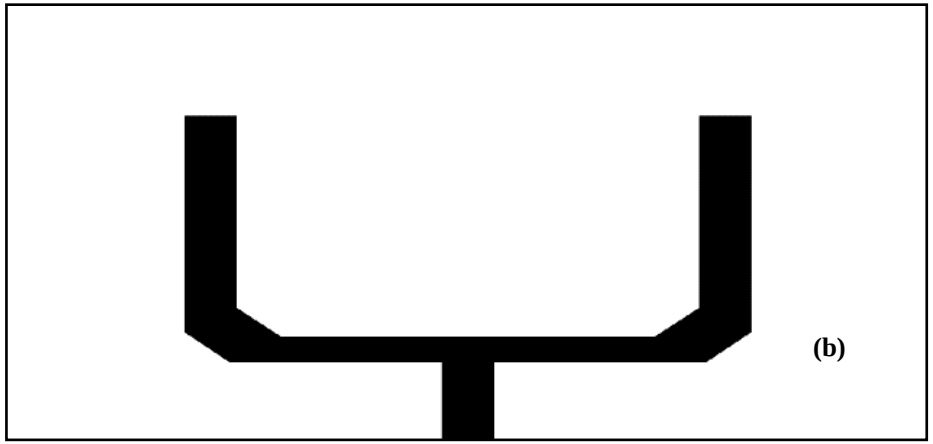
(b) : Bottom Side

- The total dimension of 65x40 mm²
- Realized on Teflon glass substrate

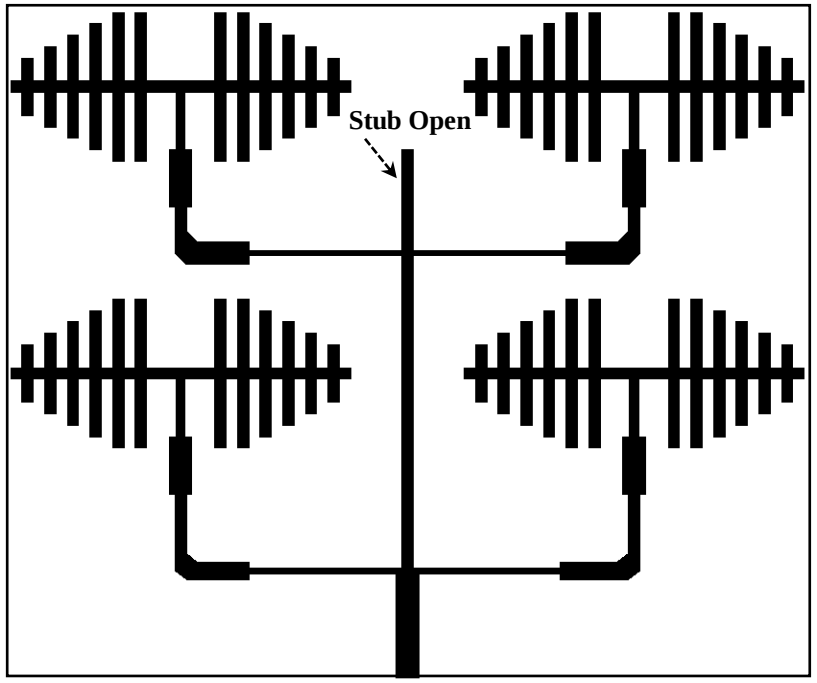
($\varepsilon r = 2,1$)

- Input impedance of 50 Ω

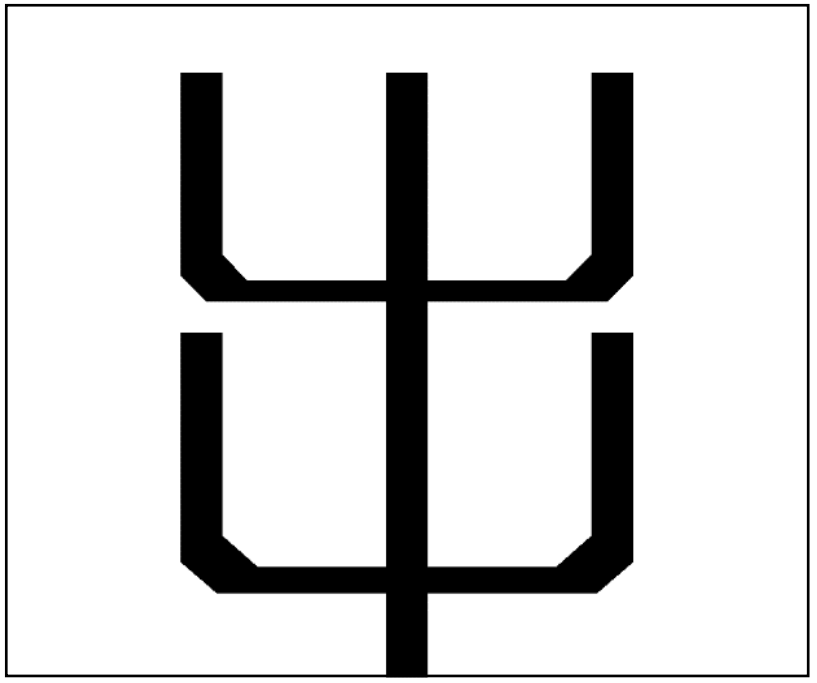




Design of 2x2 array antenna

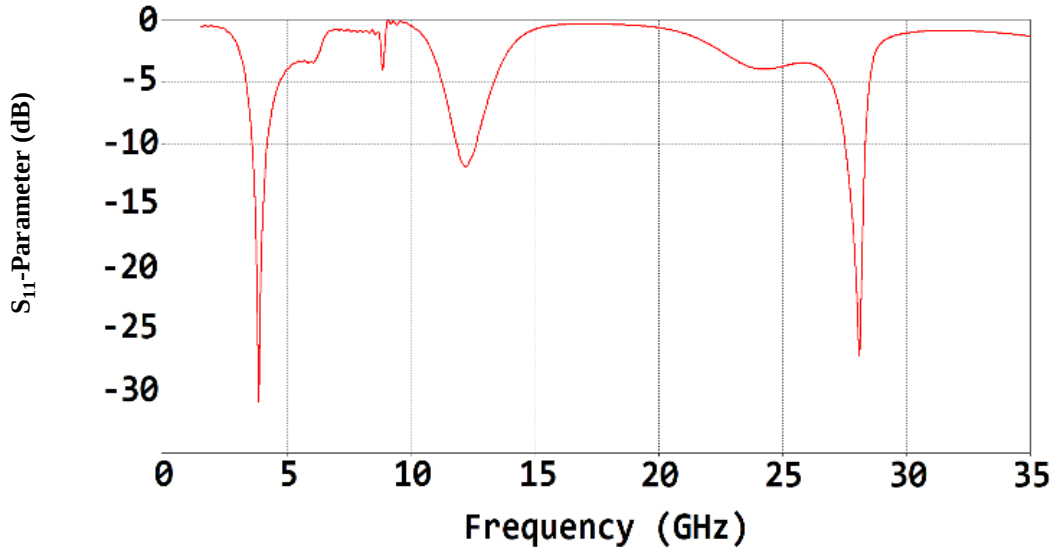


Top side

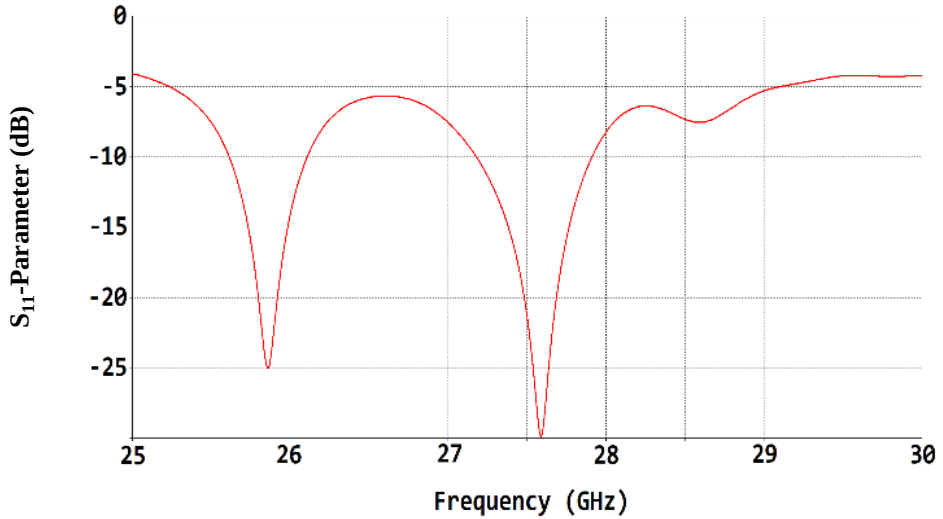


Bottom side

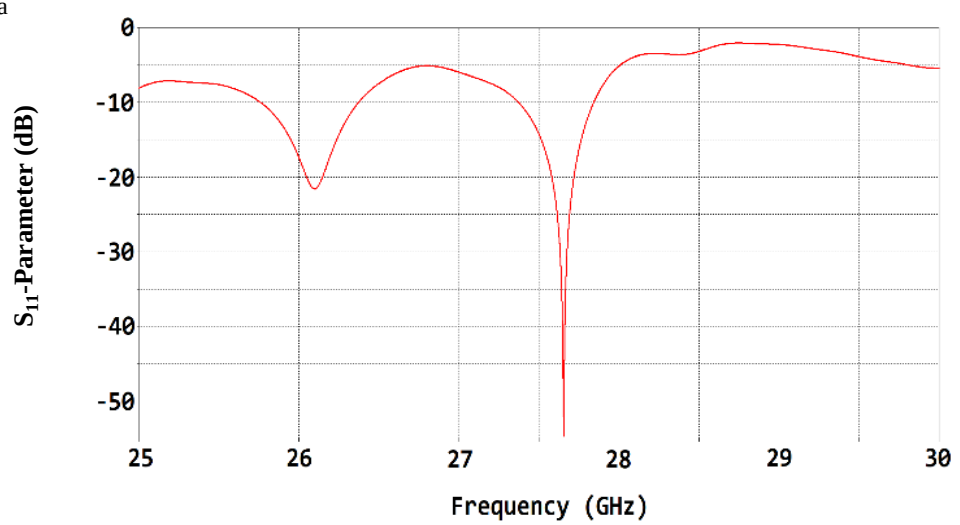
Simulation of scattering parameters of the array antennas



S_{11} parameter of elementary antenna

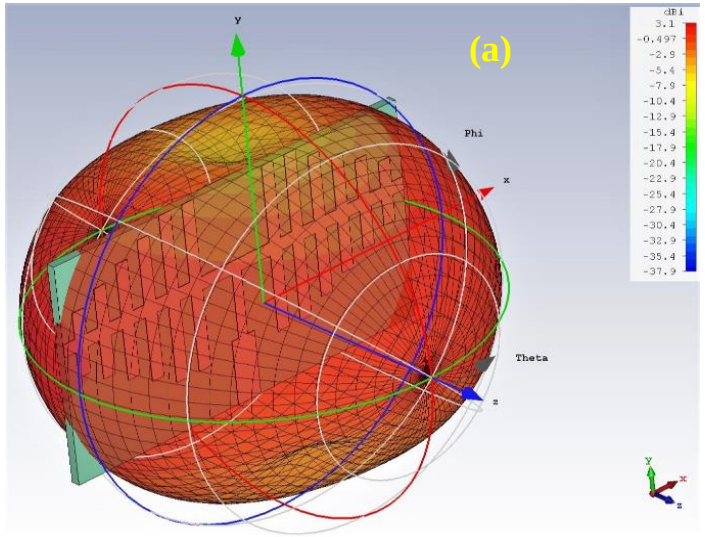


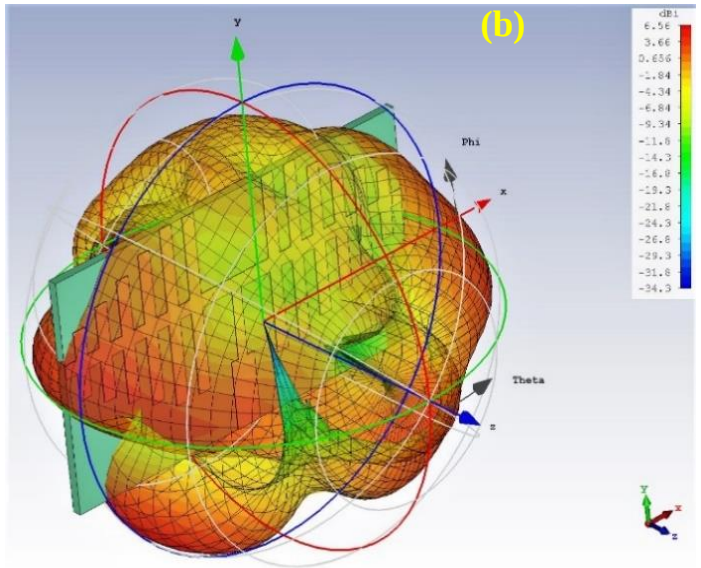
S_{11} parameter of the proposed (2 x 1) antenna array.



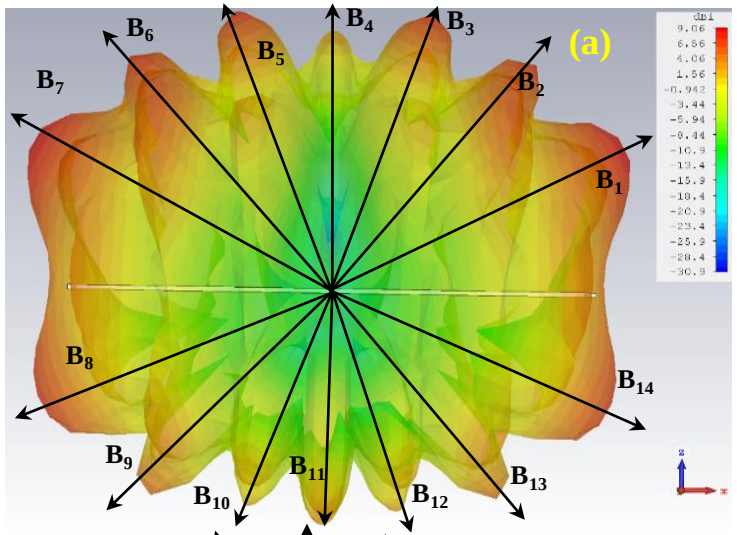
S_{11} parameter of the proposed (2 x 2) antenna array.

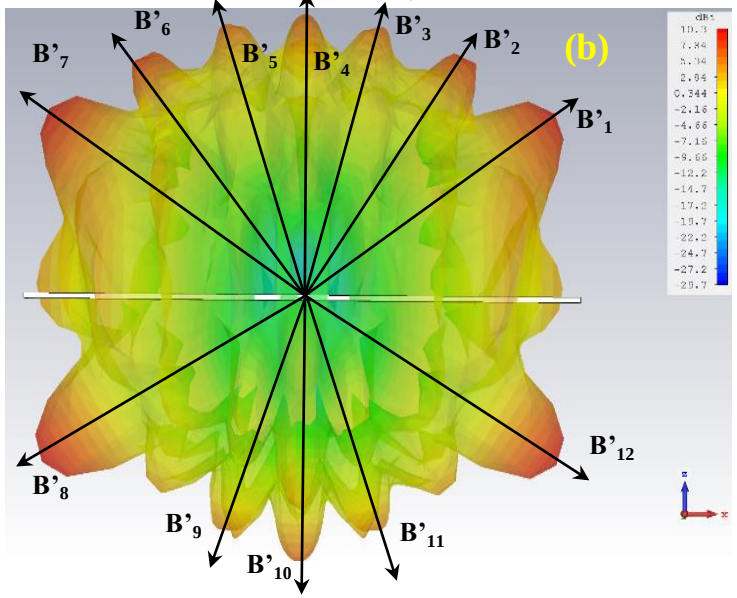
Simulation of radiation patterns



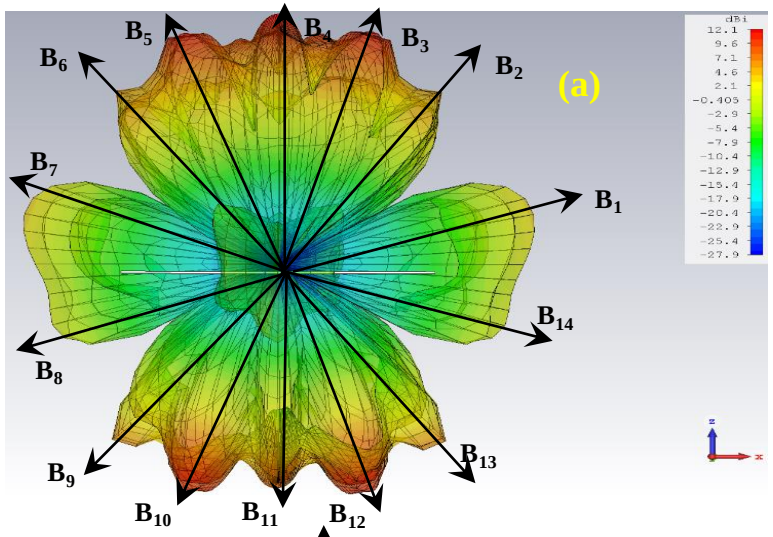


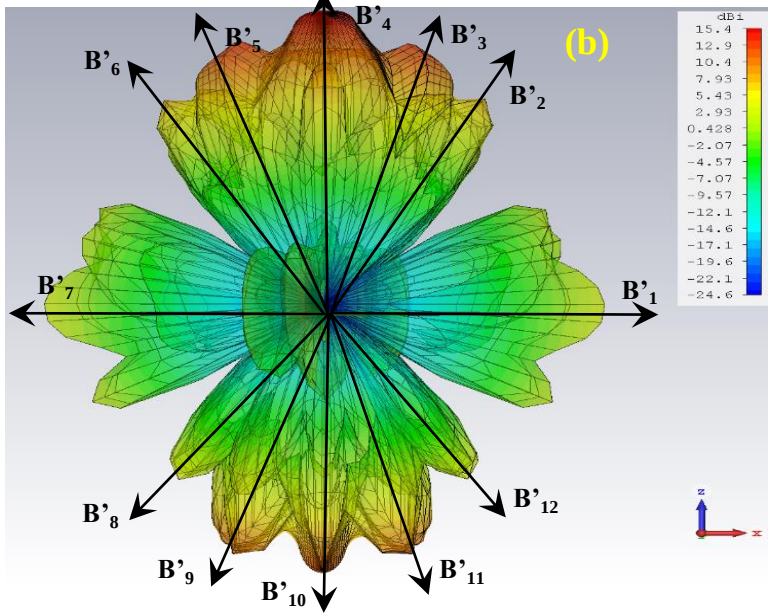
E_Plan Simulated radiation pattern of elementary antenna.
(a) : 3.5 GHz, (b) : 28 GHz.





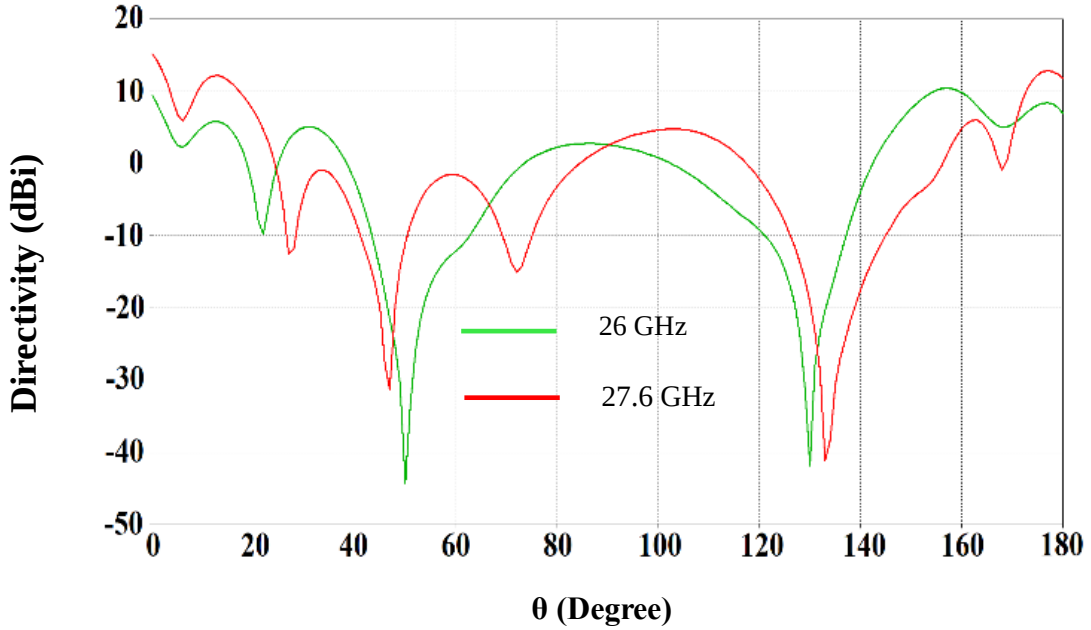
E_Plan simulated radiation pattern of (2 x 1) antenna array.
(a) : 26 GHz, (b) : 28 GHz.



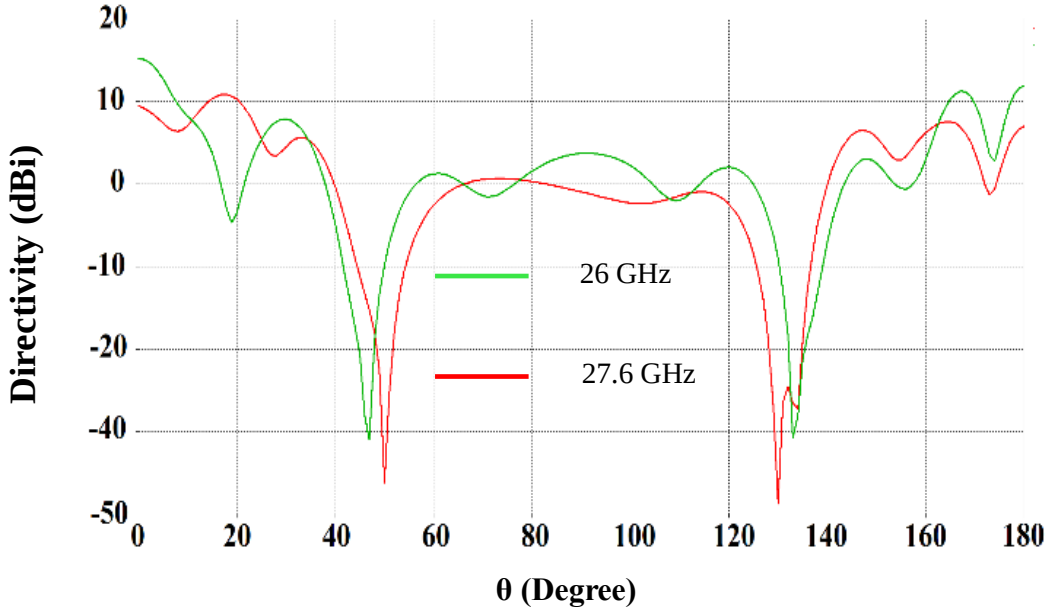


E_Plan simulated radiation pattern of (2 x 2) antenna array.
(a) : 26 GHz, (b) : 27.6 GHz.

Directivity variation as a function of incident angles in E and H Plans



Directivity variation as a function of incident angles in E_Plan



Directivity variation as a function of incident angles in H_Plan

Conclusion

A high directivity multi-beam antenna for Radio Frequency Energy harvesting in 5G network is presented. This antenna has a size of 65 x 55 mm² designed on Teflon glass substrate with a relative permittivity of 2.1 and a thickness of 0.67mm. The maximum directivity obtained is 12.1 dBi for the 26 GHz frequency and 15.4 dBi for 27.5 GHz. The multibeam property makes this antenna capable of picking up waves at both frequencies (26 and 27.5) GHz in several directions with high directivity, which largely increases the received power.

Thank you for your attention