An Octave-Bandwidth Dual-Function Array

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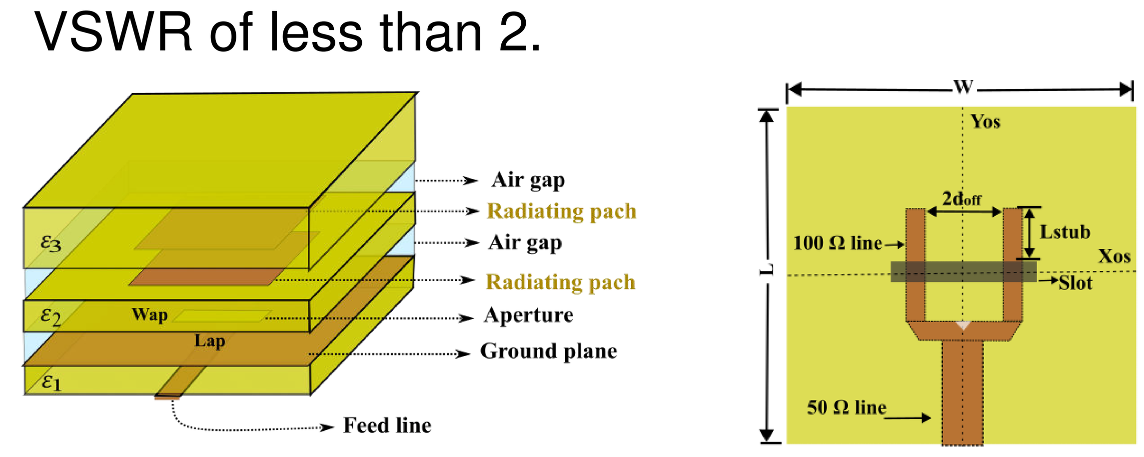
BACKGROUND

This work describes the design of **a 4x4 array** with **octave bandwidth**, using stacked microstrip patches fed by aperture coupling [1]. Its performance is improved by integrating **metal cavities** and fences to minimize **surface wave propagation** and improve the front-to-back ratio. Radiation patterns remain stable over the entire frequency range, with a gain of 17.1 dB at 4 GHz. The array operates effectively from 2 to 4 GHz, maintaining a VSWR of less than 2.



(a) Aperture-Stacked Patch Antenna (b) Dual-offset feedlines

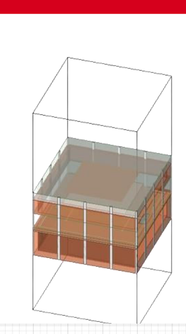
Figure 1: Design Performance

RESEARCH QUESTIONS

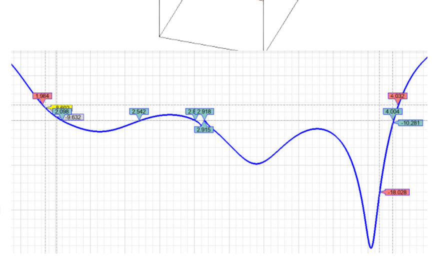
What is the most effective design for **a microstrip antenna array** that operates in the frequency range of **2 GHz to 4 GHz** and is suitable for both communication and radar applications?.

METHODS AND MATERIALS

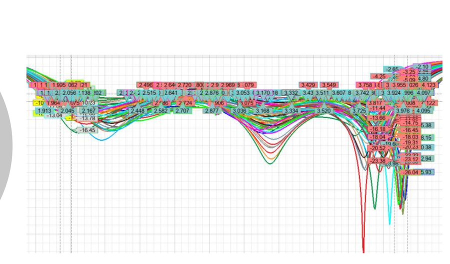
1. ASP Simulation in an Infinite Array using Ansys HFSS



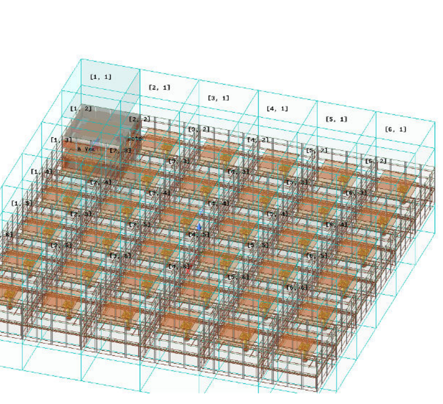
2. Parametric Study Analysis of an Infinite Array



3. Improved infinite array response.



4. Finite array simulation 4x4 using Ansys HFSS

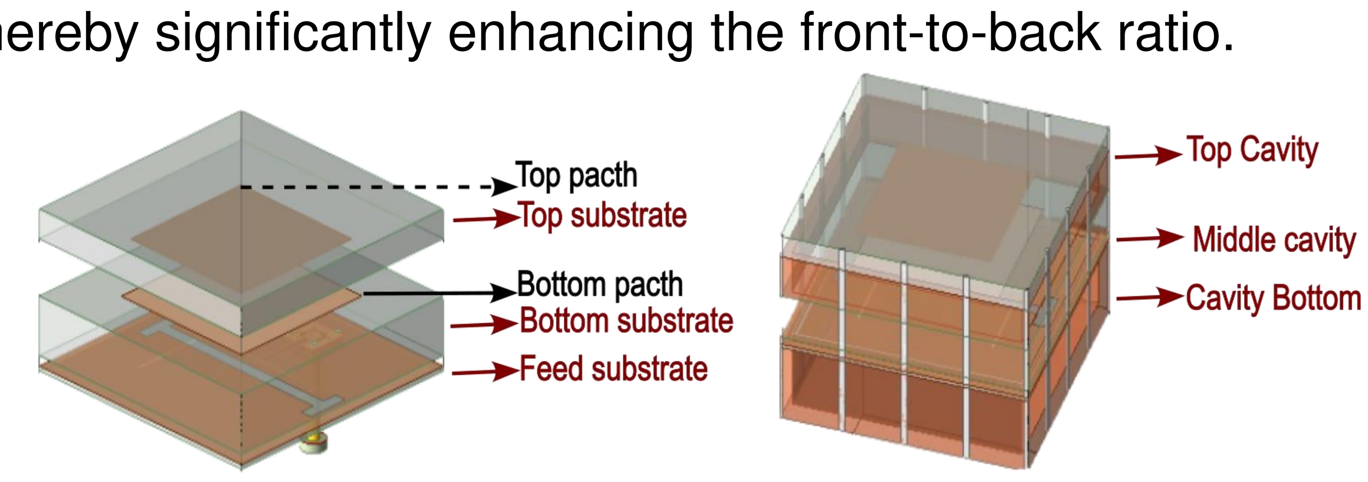


5. Implementation of Strategies for Enhancing Mutual Coupling in 4x4 Arrays

6. Manufacture

RESULTS

The parametric study conducted in a simulation environment of an infinite array enabled the proposal of incorporating metallic cavities into the ASP antenna. This modification led to an improvement in the response, thereby significantly enhancing the front-to-back ratio.



(a) ASP without cavities (b) ASP with cavities

Figure 2: Antenna element architecture

The behavior of the 4x4 array is depicted in the following graphs:

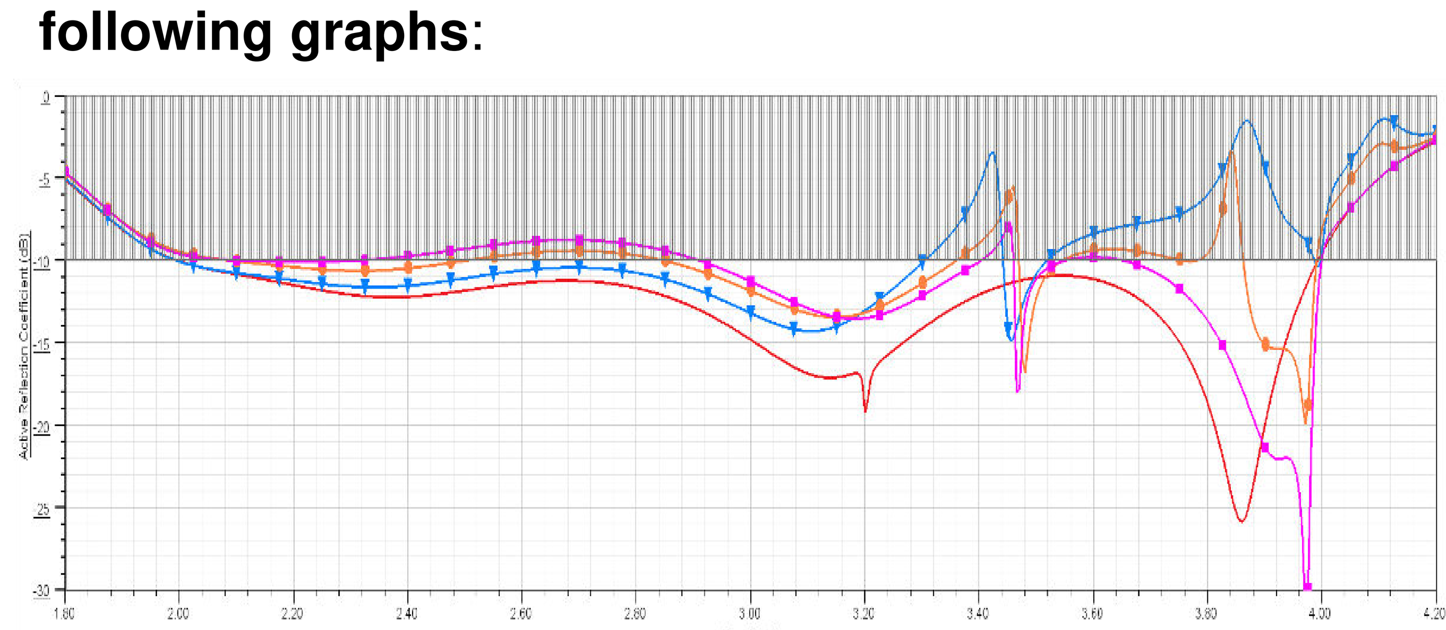


Figure 3: Active reflection coefficient for the element in the array environment at broadside (red, plain), θ=30, φ=30 (blue, triangle), θ =30, φ =60 (orange, circle) and θ =30, φ =90 (pink, square).

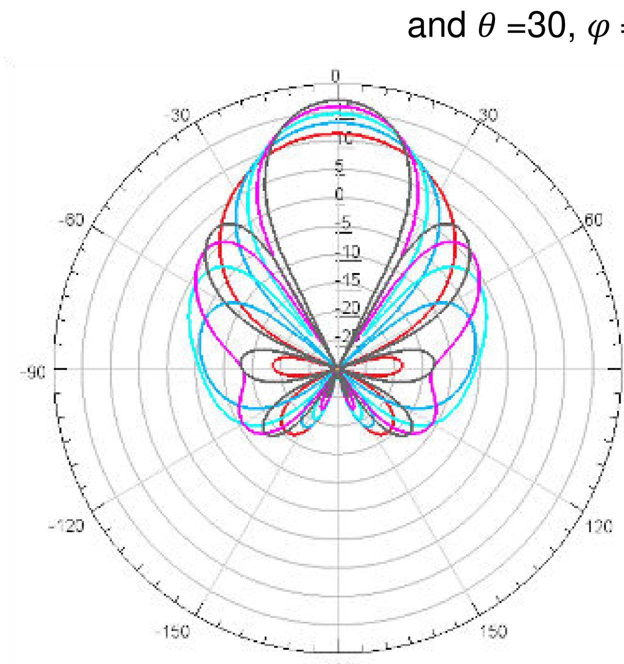


Figure 4. Gain pattern in dB for a 4x4 array pointing at broadside, at 2.0, 2.5, 3.0, 3.5 and 4.0 GHz. Only the E-plane pattern is shown since H-plane pattern is below -35 dB.

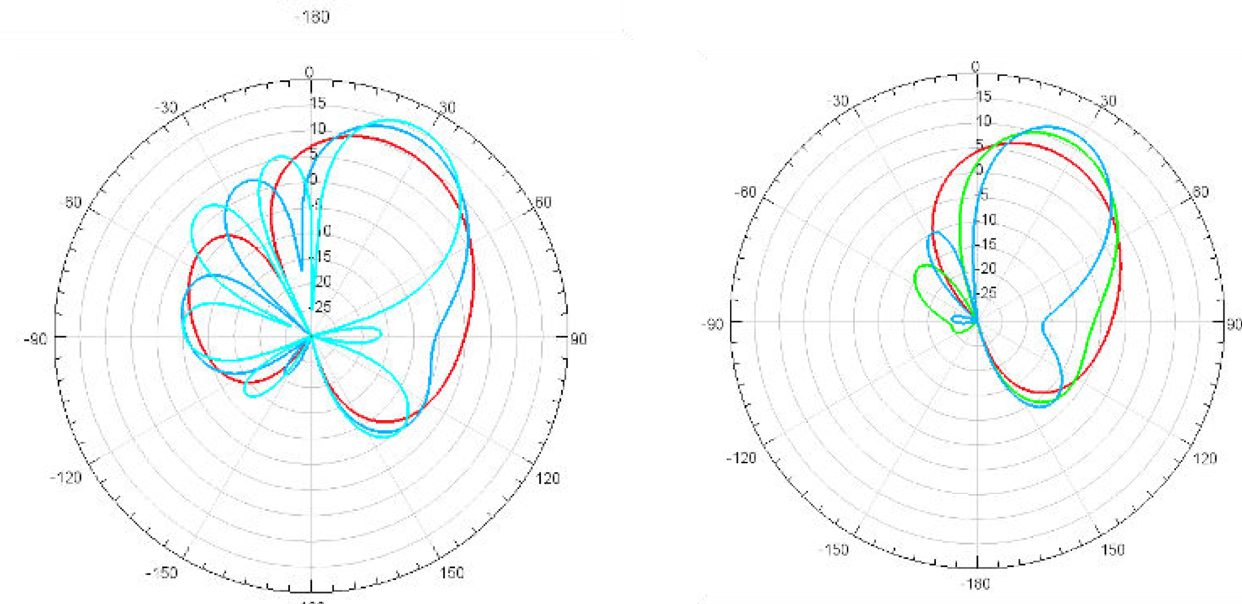


Figure 5: E-plain gain pattern in dB for a 4x4 array pointing at q=30, f=0, (left) and q=30, f=45, (right) at 2.0, 3.0 and 4.0 GHz.

The In the case of the 4x4 rectangular finite array, parasitic antennas were placed around to mitigate the effects of mutual coupling. However, the results reveal active S-parameter plots where the curves with higher reflection correspond to the corner components, indicating areas where mutual coupling has the most significant impact.

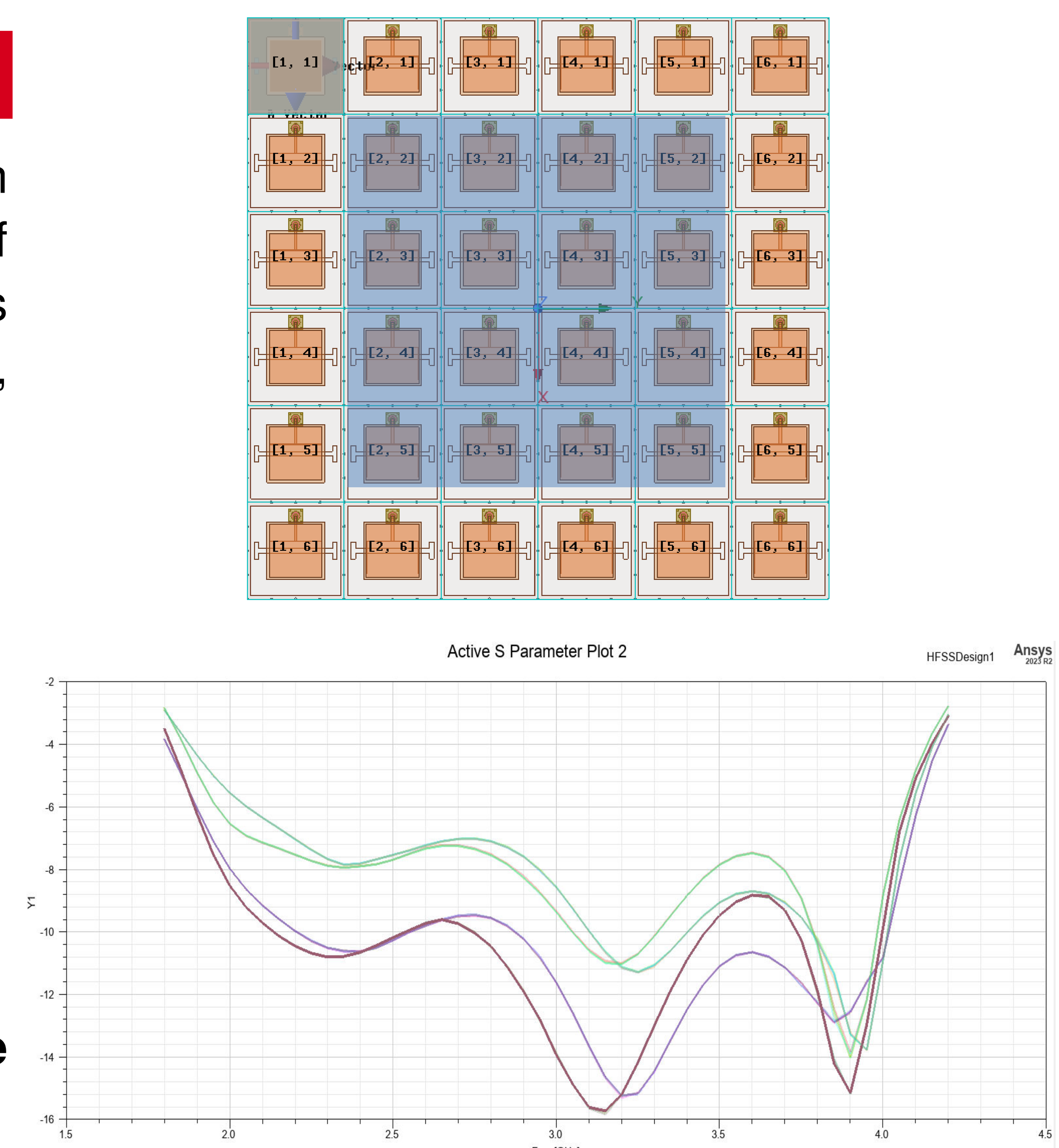


Figure 6: Active parameters S finite array 4x4

CONCLUSION

- This work introduces a pioneering design of an antenna array with a 2:1 bandwidth, utilizing stacked microstrip patches and aperture coupling.
- The results demonstrate the stability of radiation patterns across all frequencies, supporting the suitability of the design for various applications.
- The scalability of the design to higher frequencies expands its potential applications and versatility in different environments.
- The future integration with active circulators will maximize the dual capabilities of the array in radar and communication applications.

ACKNOWLEDGEMENTS

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REFERENCES

[1] S. Targonski, R. Waterhouse, and D. Pozar, “Design of wide-band aperture-stacked patch microstrip antennas,” IEEE Transactions on Antennas and Propagation, vol. 46, no. 9, pp. 1245–1251, 1998.
[2] G. Kumar and K. Ray, Broadband Microstrip Antennas. Norwood, MA: Artech House, 2003