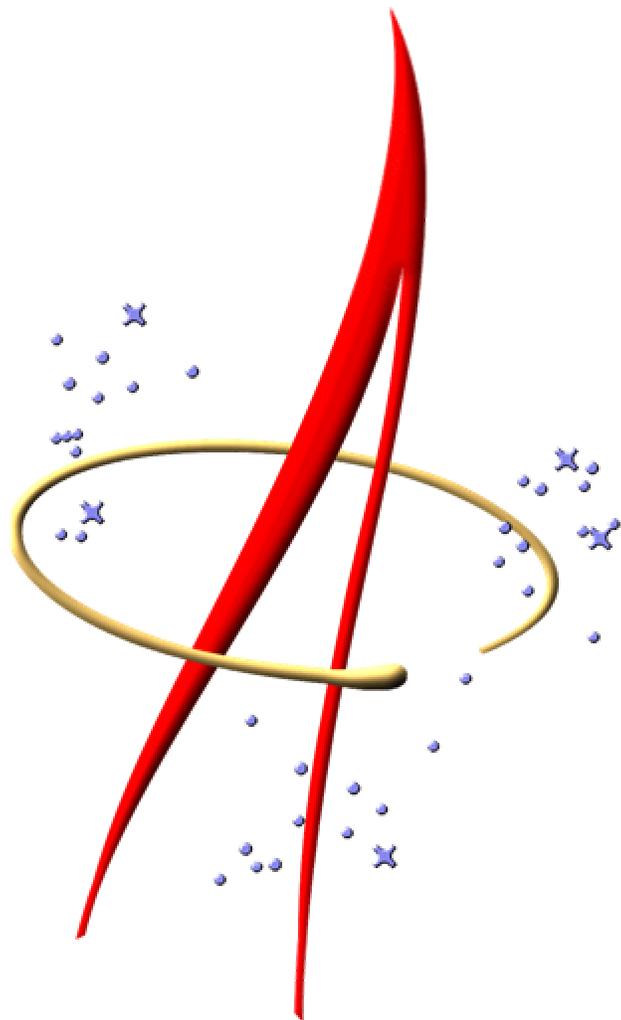


Multi-tuned Active/Passive Antenna Element Characterization

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Abstract

The goals of this project are (1) to test and characterize a current micro-strip patch array design and (2) to design a single patch which resonates at two specific frequencies. The current design consists of an 8x10 array optimized for operation at 1.26 GHz. This array will ultimately be configured as a synthetically thinned array for active radar operation. It will be used alongside a radiometer to prove the feasibility of combining radar and radiometry to obtain detailed mappings of hydrological phenomena. The dual frequency RadSTAR design will serve the purpose of combining the two systems using the same antenna for both operations, greatly reducing the size, complexity, and cost of the antenna array used.

Introduction

The 1.26 GHz array will be used to test the feasibility of combining a radar system with a radiometer in order to make concurrent measurements of radar cross-section and radiometric brightness temperature from a common target. The instruments will be tested aboard a NASA P-3 aircraft in order to prove their feasibility and usefulness. Once proven operational, the dual frequency patch will be used to combine the two systems utilizing a single micro-strip array. This technology will improve the accuracy of the remote sensing data system as a whole. The final space-borne RadSTAR design will be used to measure sea ice thickness, permafrost, soil moisture, and ocean salinity at a higher spatial resolution than achievable using two separate antennas.

Test Array

- Manufactured by ProSensing in Amherst Maryland
- 3x3 array utilizing stub tuned dual-feed micro-strip patch elements
- Elements designed for operation at 1.26 GHz
- Shown as mounted in the tapered test range inside the anechoic chamber

Test Results: Radiation Pattern

- Illustration on left: Predicted pattern obtained using Micro-Stripes simulation
- Illustration on right: Actual pattern results from range tests
 - Both E and H plane cuts performed in cross and co-polarized configuration
 - Scanned from -180 to 180 degrees off nadir
- Simulation results compared to real-world values

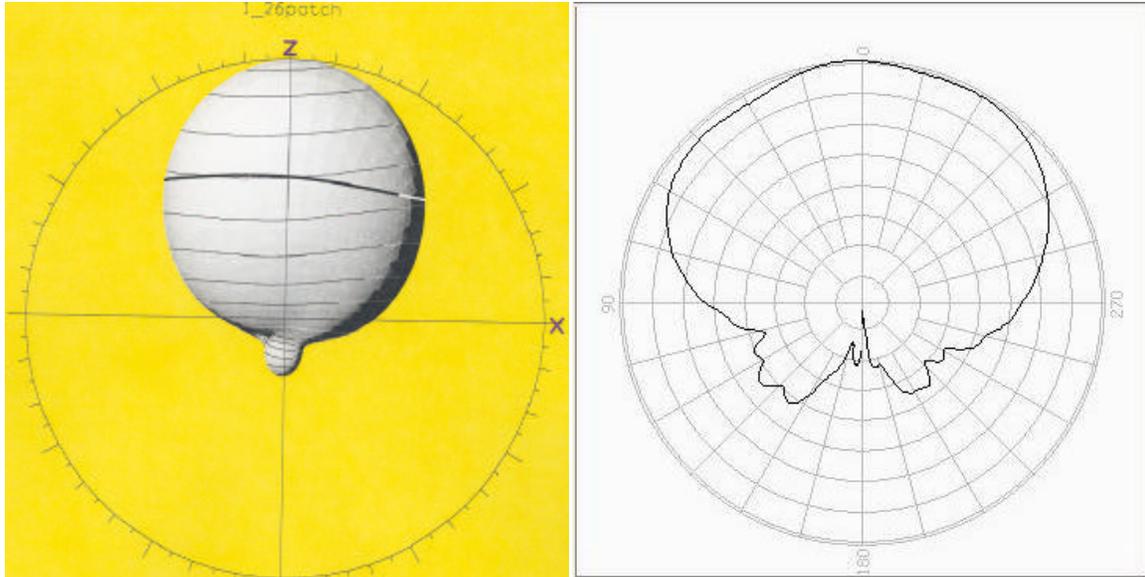


Figure 1: Simulated radiation pattern (left) vs. actual range output (right).

8x10 Micro-strip Array Layout

- Two outer sub – arrays terminated to create a more uniform boundary condition at edge
- Array will be operated in three modes
 - Simultaneous transmit and receive on all sub-arrays
 - Central sub-array transmit, simultaneous receive on all sub-arrays
 - Sequential transmit and receive on individual arrays
- Synthetic thinning used to reduce need for large amounts of hardware

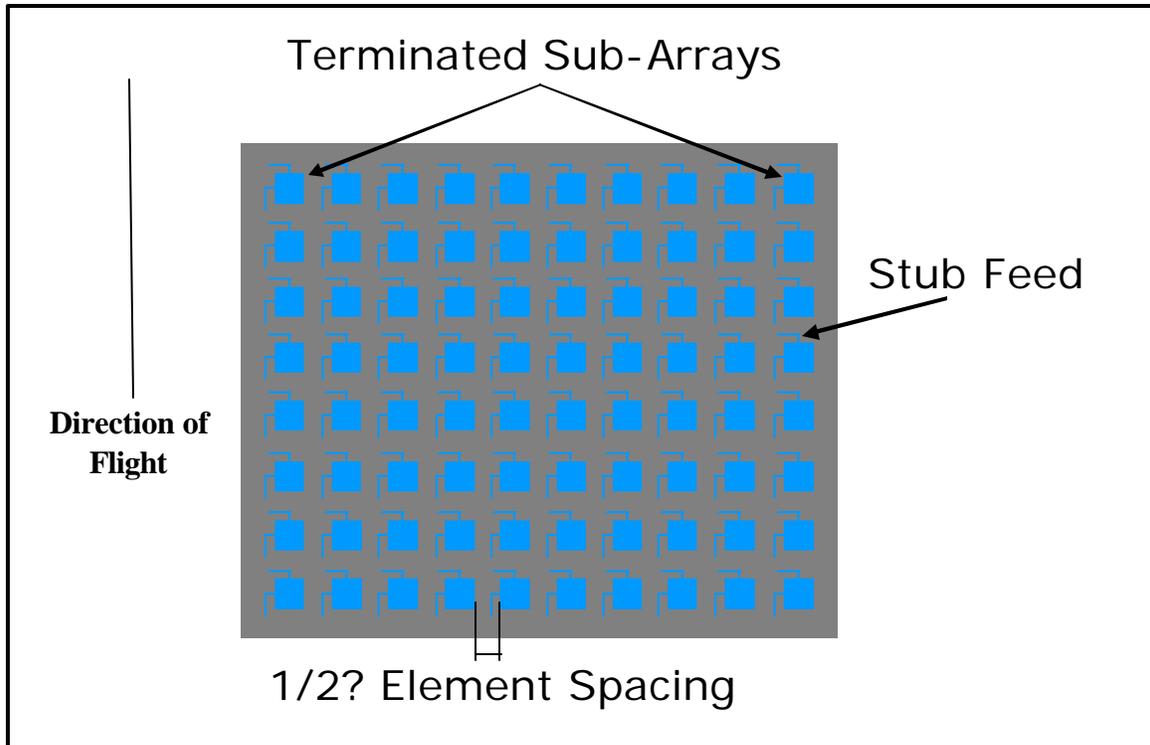


Figure 2: Illustration of 8x10 radar array.

Dual Tuned Design

By creating a microstrip patch antenna which resonates at two specific frequencies, a combined active/passive system can be designed for use in earth science applications. The lower of the two resonances will reside at 1.26 GHz, and will be used in active radar mode for the purpose of illuminating surface features. The upper resonance will reside at 1.413 GHz for use in the passive radiometer mode. The data from each system will be combined to create detailed mappings of soil moisture and ice characteristics. Scientists at JPL are experimenting with a current multi-tuned patch which uses a stacked patch design. The advantage of creating a single patch design lies in the reduction in overall complexity and cost to the end user. Two of the initial designs tested are discussed below.

Annular Ring Design: Coaxial Feed

- Broadband in nature compared to typical rectangular patch
- Annular ring produces less surface waves than rectangular designs
- Large number of resonances makes the patch useful in various applications
- Extra resonant points also couple un-needed energy into other bands
- Optimum design would exhibit two deep resonances at the frequencies needed

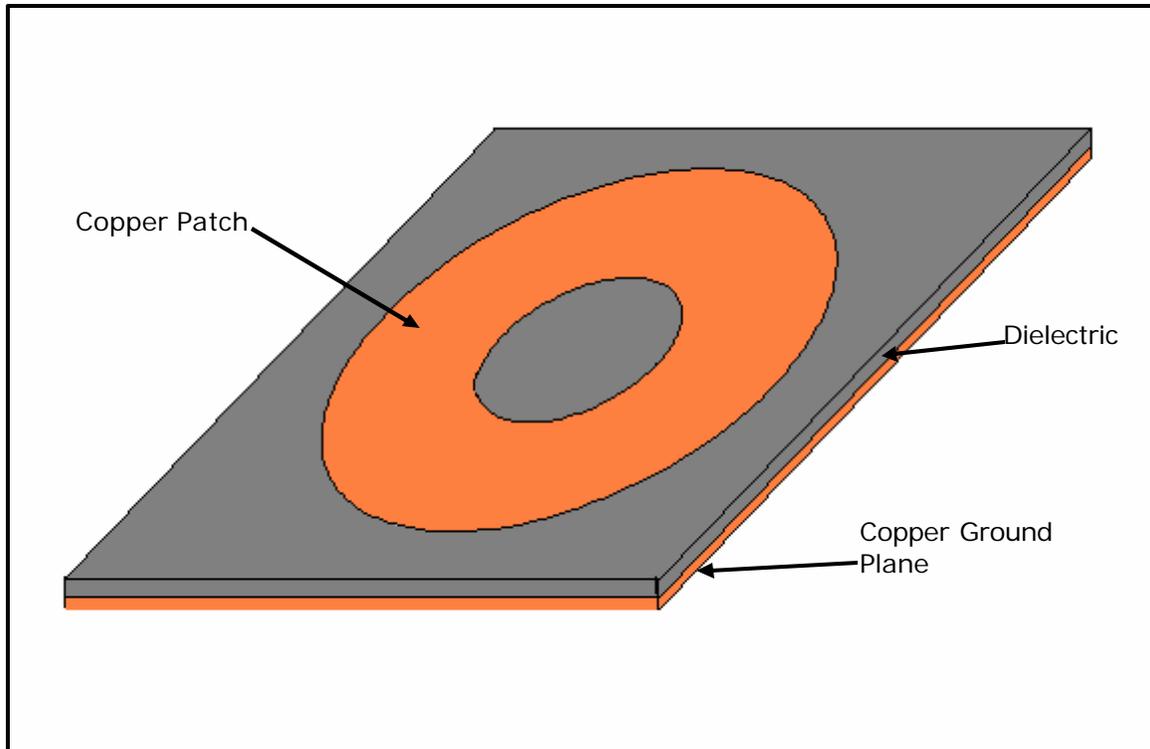


Figure 3: Illustration of annular ring design.

Annular Ring Simulation Data: Magnetic Properties

- Low, medium and high magnetic currents represented by blue, green and yellows respectively
- Segments around perimeter exhibit high magnetic currents predictive of radiation pattern
- Segmented patterns suggest dual feeding to fill in nulls in radiation pattern
- Only small amount of energy present at edge of cutout predicts null in forward direction
- Optimized size and feed location being researched to enhance performance

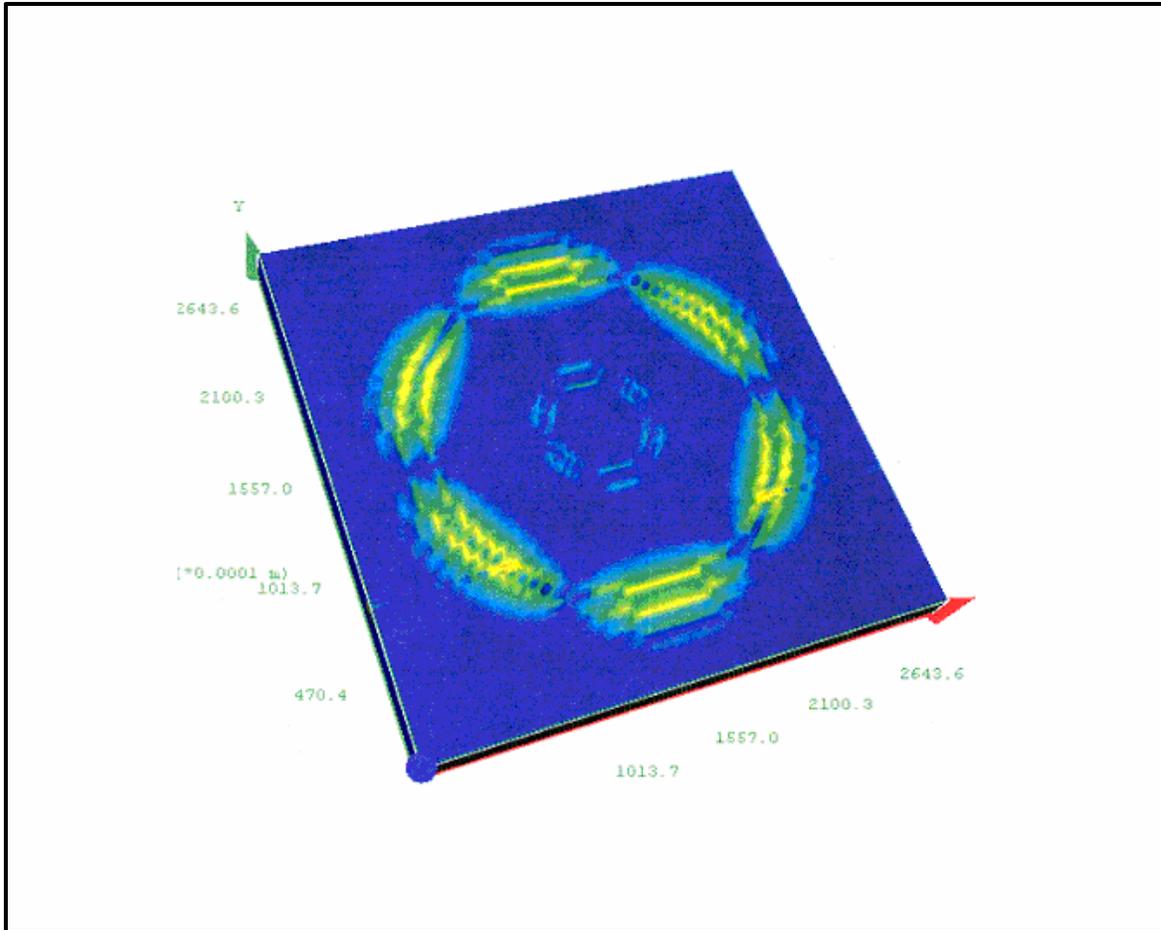


Figure 4: Magnetic current output of annular ring simulation.

U-Slot Patch Design: Coaxial Feed

- Original model created at Flomerics was modified and simulated
- Resonant points proven to be more focused than those exhibited by annular ring
- Width of cutout and overall width of U display the strongest effects on resonance
- Overall dimensions can be adjusted to optimize for 1.26 and 1.413 GHz
- Dual feeding more difficult due to asymmetrical design of patch

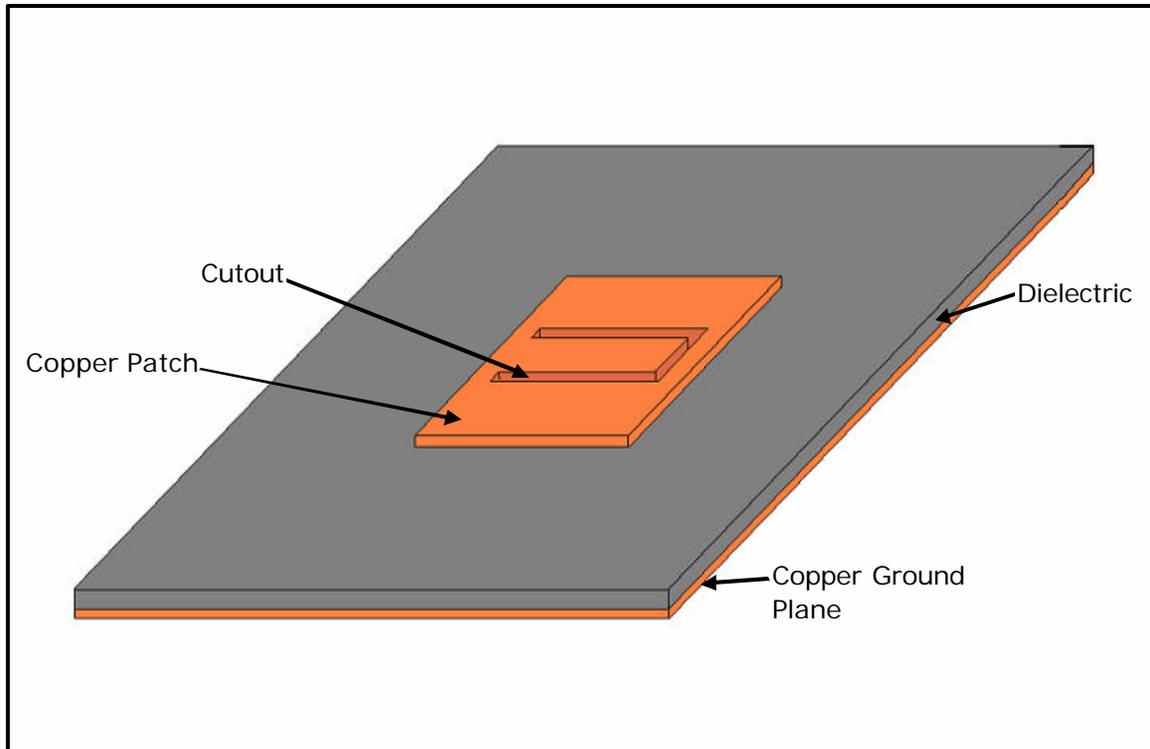


Figure 5: Illustration of U-slot design.

U-Slot Simulation Data: Magnetic Properties

- Low, medium and high magnetic currents represented by blue, green and yellows respectively
- High current locations representative of radiation patterns output from simulations
- Current magnitudes higher over lower portion of cutout supporting importance of cutout width respective to cutout length
- Pattern displays less dramatic null region in forward direction relative to annular ring for initial design

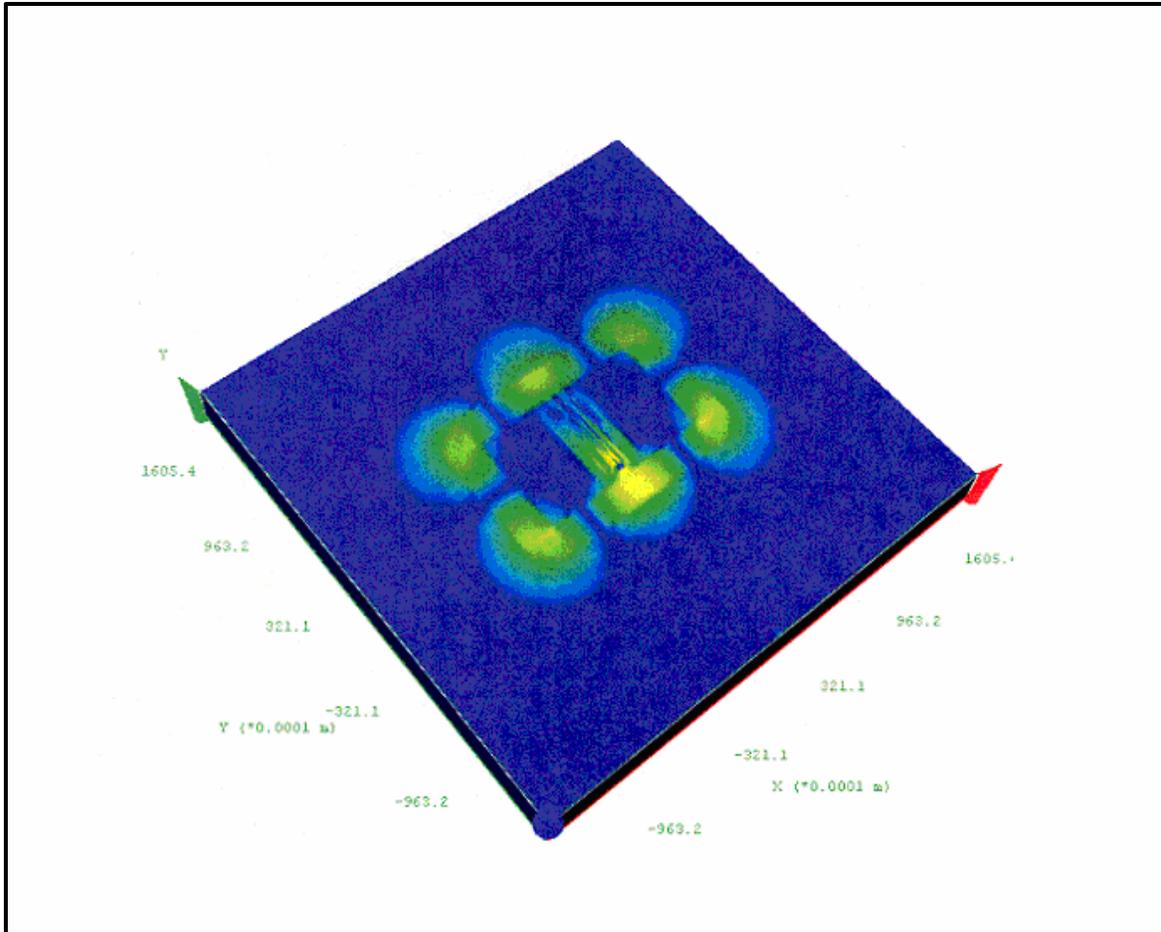


Figure 6: Magnetic current output of U-slot simulation.

Short Term Goals

- Performed range testing of 3x3 array
- Created and simulated patch designs using Micro-Stripes
- Compared test data output by Micro-Stripes with test data from range
- Scheduled to perform range testing of 8x10 array in late July

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