National Aeronautics and Space Administration

Deployable Antenna Technologies for Radar at Extreme Frequencies

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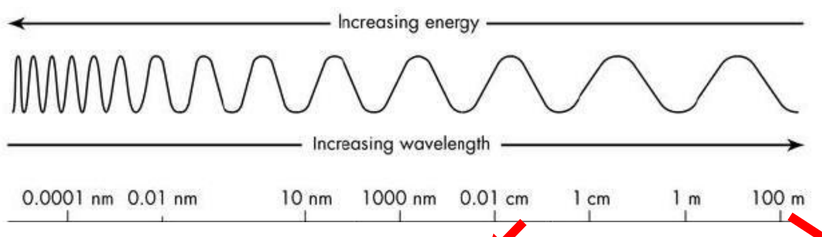
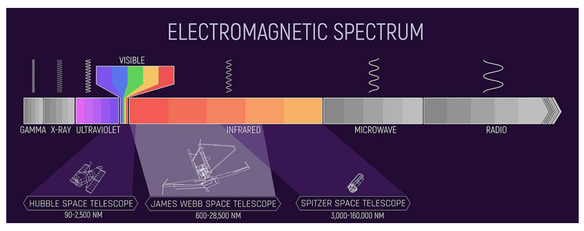
Program: FY22 Strategic Initiative
Strategic Focus Area: Radar Advances to Accelerate Earth and Planetary Missions

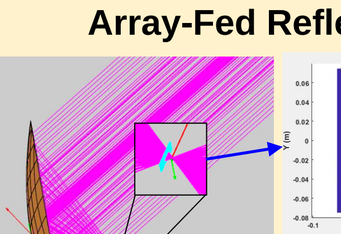
Objectives: To survey, develop, and demonstrate antennas that enable future JPL Earth Science and Planetary Science missions at both the low and high ends of the electromagnetic spectrum

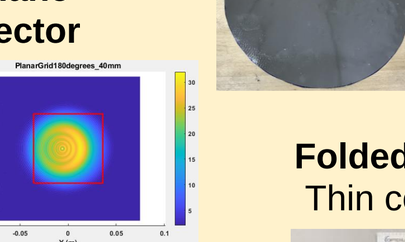


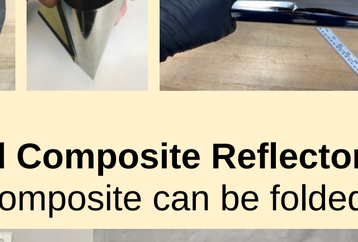


High Gain Antenna Technology for >90 GHz Earth Science Radar

Background: HGAs used for radar measurements of the Planetary Boundary Layer (PBL) as well as radiometer science missions related to climate and weather. Typically are solid reflectors (like CloudSat), have long procurement times, and aren't deployable. Need >1.6 m diameter aperture for PBL measurements.

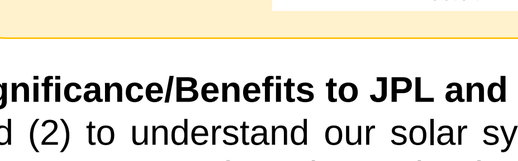


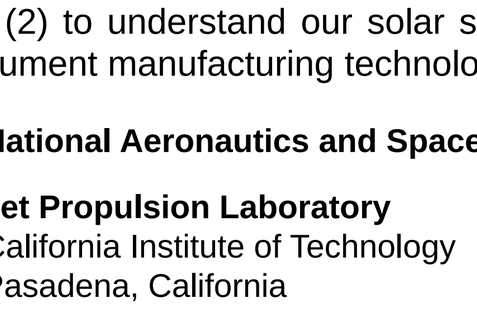




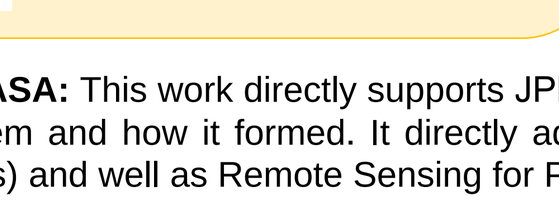
Approach and Results: We focused on identifying, studying, and prototyping a variety of innovative antenna concepts for >90 GHz deployable HGAs. We developed a trade matrix for each technology.

Petal Reflector: Flower opening reflector

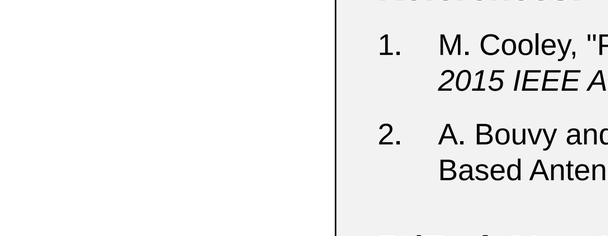




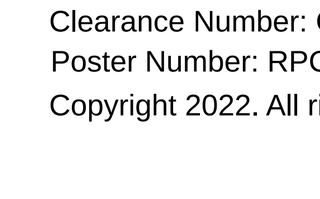
Starburst: Hexagonal sub-apertures from a compact stack

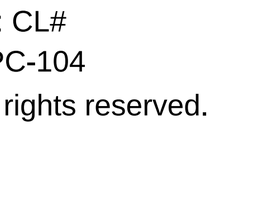


Amorphous Metal Reflector: Thin mirror that can be thermoformed like a plastic and be deployable



Offset Focal Plane Array-Fed Reflector

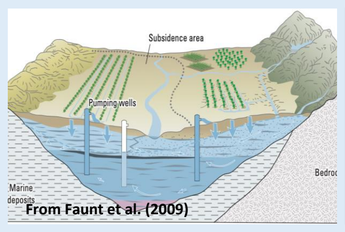


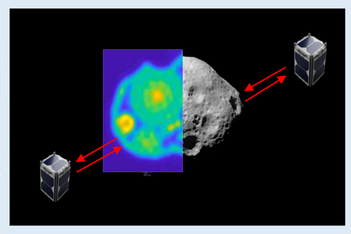


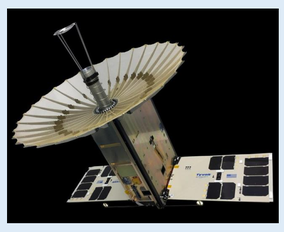
Folded Composite Reflector: Thin composite can be folded

Low Gain Antenna Technology for HF Radar Antennas (3-30 MHz)

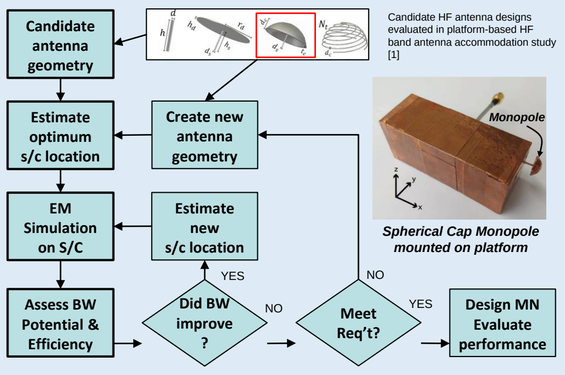
Background: Includes sounders to characterize Earth ice sheets and aquifers, as well as tomographic measurements to reveal the interior structure of small bodies such as asteroids. Usually composed of SmallSats with an HF antenna. Typical issues include mass, stowage, environmental, impact on spacecraft attitude determination. Need smaller antennas that can achieve required bandwidth with efficiency.







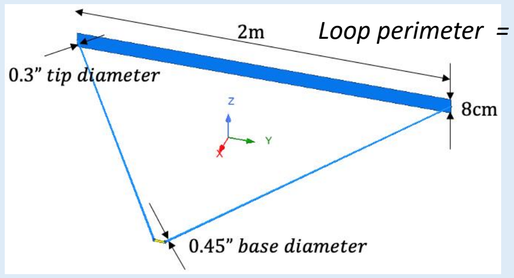
Approach and Results: We developed a new low frequency antenna design capability and then designed a triangle loop antenna with the broad bandwidth and transient response needed to enable a tomographic radar that reveal the interior structure of an asteroid.



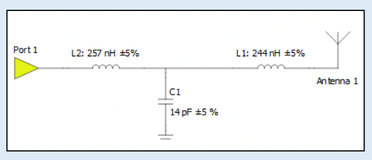
Candidate HF antenna designs evaluated in platform-based HF band antenna accommodation study [1]

Spherical Cap Monopole mounted on platform

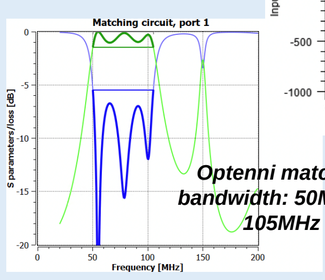
Design Methodology



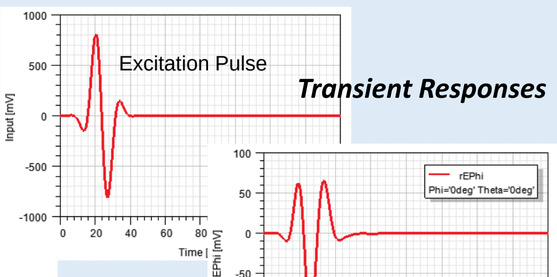
Triangular Loop Antenna



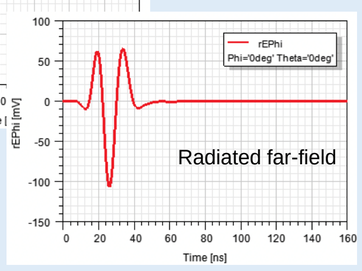
Matching Network Circuit

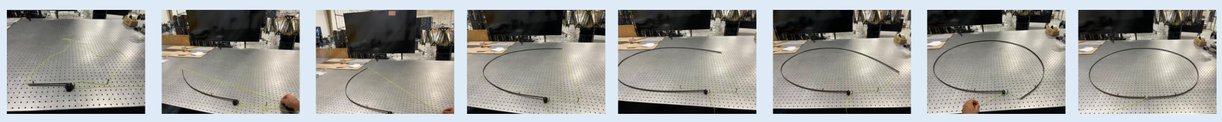


Optenni matched bandwidth: 50MHz to 105MHz



Transient Responses





Demonstration test of a composite tape deployer used to deploy a circular tape

Significance/Benefits to JPL and NASA: This work directly supports JPL's Quests to (1) understand how Earth works as a system and how it is changing and (2) to understand our solar system and how it formed. It directly addressed ESD's technology roadmap for Earth Science (SmallSat technologies, instrument manufacturing technologies) and well as Remote Sensing for Planetary Science. The work enables designated Earth decadal survey science

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New Technology

1. Neil Chamberlain, et. al., NTR 52515 is titled, "Wideband low-frequency deployable triangle antenna".

References:

1. M. Cooley, "Phased Array Fed Reflector (PAFR) antenna architectures for space-based sensors," *2015 IEEE Aerospace Conference*, 2015, pp. 1-11, doi: 10.1109/AERO.2015.7118963
2. A. Bouvy and N. Behdad, "A Heuristic Study of the Bandwidth Potential of Electrically Small, Platform-Based Antennas at the HF Band," *IEEE Trans. Antennas and Propagat.*, Feb. 2021.

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