National Aeronautics and Space Administration

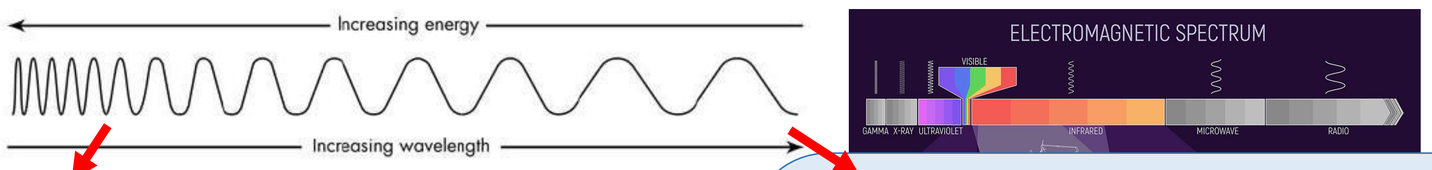
FY23 Strategic Initiatives Research and Technology Development (SRTD)

Deployable Antenna Technologies for Radars at Extreme Frequencies

Principal Investigator: Richard Hodges (3370)**; Co-Investigators:** Jonathan Sauder (355Z), Neil Chamberlain (337K), Mark Haynes (334C), Kenneth Cooper (386H), Raquel Rodriguez Monje (334G), Manan Arya (Stanford University)

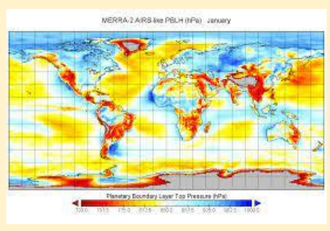
Strategic Focus Area: Radar Advances to Accelerate Earth and Planetary Missions | **Strategic Initiative Leader:** Darmindra D Arumugam

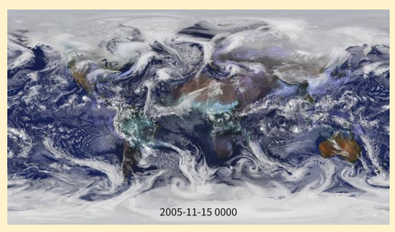
Objectives: To survey, develop, and demonstrate antennas that enable future JPL Earth Science and Planetary Science missions at both the low and high ends of the electromagnetic spectrum



High Gain Antenna Technology for >90 GHz Earth Science Radar

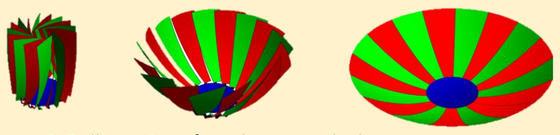
Background: HGAs used for radar measurements of the Planetary Boundary Layer (PBL) as well as radiometer science missions related to climate and weather. Typically are solid reflectors (like CloudSat), have long procurement times, and aren't deployable. Need >1.6 m diameter aperture for PBL measurements.



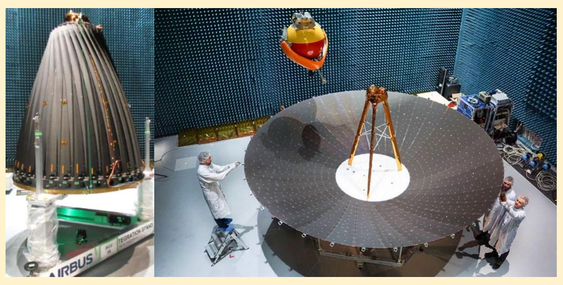


Approach and Results: We focused on developing the Petal Antenna concept that was selected in the first year of this project.

Petal Reflector: Flower opening reflector

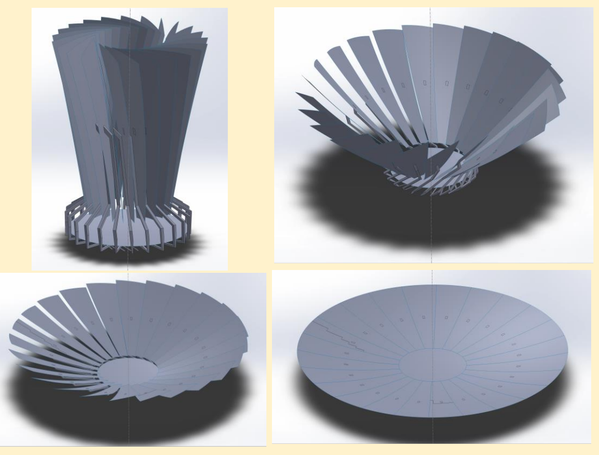


CAD Illustration of petal antenna deployment process

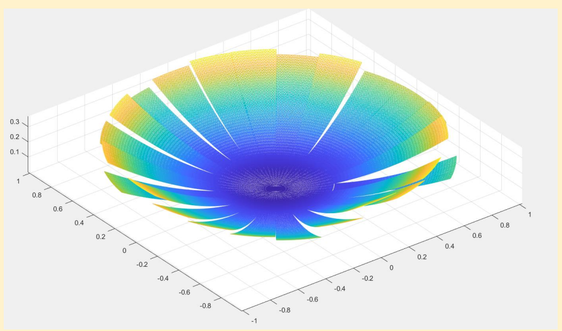


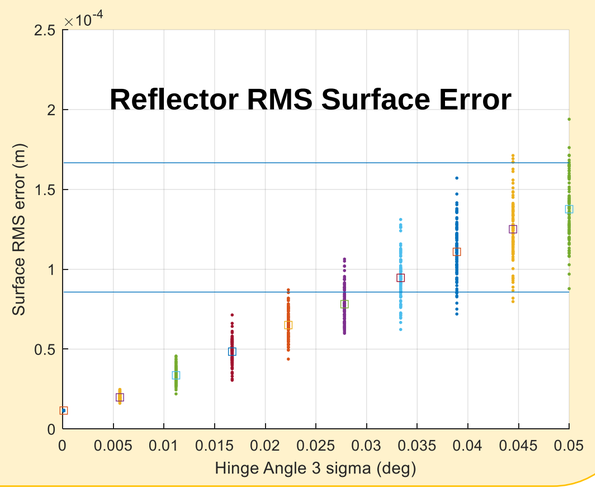
5 m diameter Airbus protoflight model (scheduled launch ~2023)

Petal Reflector CAD Model



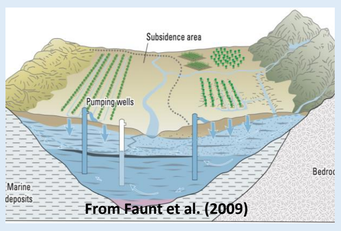
Petal antenna hinge error effect on Surface RMS

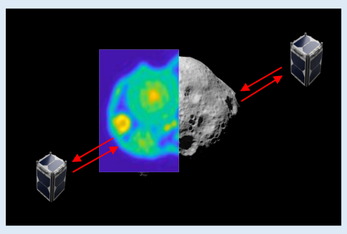




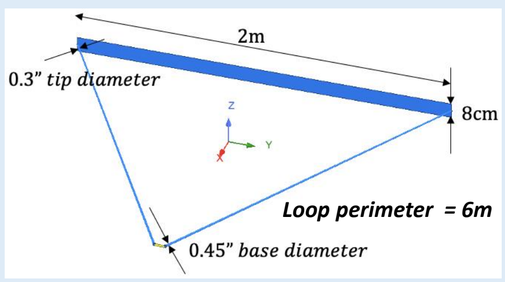
Low Gain Antenna Technology for HF Radar Antennas (3-100 MHz)

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.



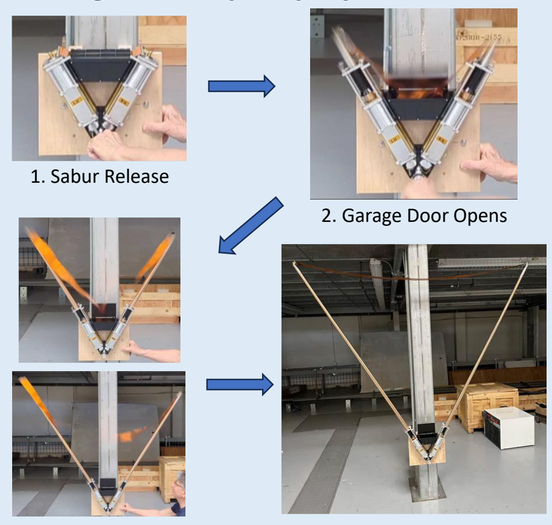


Approach and Results: We developed a new low frequency antenna design capability and then designed a triangle loop antenna with the broad bandwidth and transient response needed to enable a tomographic radar that reveal the interior structure of an asteroid.

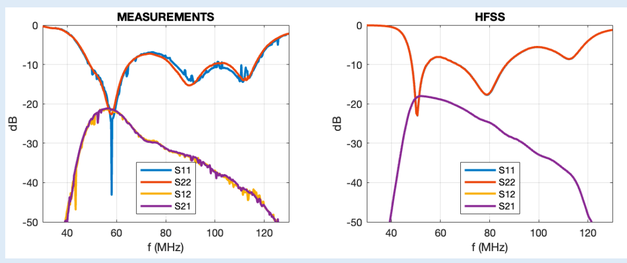


Triangular Loop Antenna

Triangular Loop Deployment Test



RF Test on MESA Antenna Range



Calculated vs. Measured Test Results

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

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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New Technology

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

References:

1. 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.

PI/Task Mgr. Contact Information:

Email: Richard.e.Hodges@jpl.nasa.gov