PI: Carey M. Johnson\550

Starting TRL: __2_ , Ending TRL: _3___



Millimeter Wave Airborne Radar System for Earth Science Applications

Additional Team Members: Tasneem Khan(555);Jared Lucey(555);Lihua Li(550); Adrian Loftus(612); Lisa Billingsley(543)

Motivation / Problem Statement:

The use of Monolithic Microwave Integrate Circuit (MMIC)technology has the potential to improve flight instrument systems by reducing size, weight and power (SWaP) footprints. MMIC radars are currently being tested in SWaP limited applications. This new IRAD builds on the findings of the previous IRADs that developed W Band antennas, identified and tested a W Band COTS radar, and designed a W Band circuit board probe. This current IRAD plans to develop and integrate Commercial-Off-The-Shelf (COTS) MMIC radar, W Band Antenna, and Data Processing Unit into a standalone radar system. This miniature standalone radar system has the potential use for Earth and Planetary Science Applications.

Project Summary:

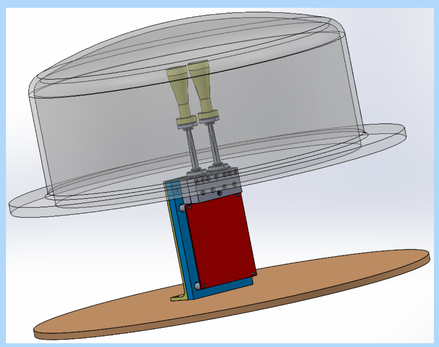
The 2021 IRAD demonstrated the functionality of using MMIC Radars in detecting various forms of precipitation. The IRAD developed and procured a narrow-band, low sidelobe W Band Antenna. We will perform laboratory and field test the integrated system to assess the optimal radar performance and firmware parameters for sensing atmospheric particulates. The innovative element of this IRAD will be the merging inexpensive components into a design that yields a SWaP-C (i.e., size, weight, power, and/or cost) system suitable to be mounted on unmanned aerial vehicles (UAVs) or be integrated with larger ground-based radars to provide intermediate atmospheric sensing.

Project Objectives:

- Design and procure a low loss narrow band W band antenna-waveguide transition
- Design and procure a low loss circuit board-to-waveguide probe
- Integrate and tune W band Antenna, on hand, to the waveguide probe
- Procure Mechanical a RF enclosure for the Radar System
- Field test the Millimeter Wave Airborne Radar System

Process / Materials / Methodology:

- *We were able to design and model a circuit board probe that resonates at the desire center frequency. We were also able to realize the waveguide housing for the probe which integrated to the horn antennas*
- *The system was tested in an outdoor environment*



Results:

- *SWaP: Electrical system is under 1kg with a power requirement under 3W.*

Device	Mass (g)	Total (g)
Horn Antenna	38	76
Waveguide Transition	28	56
Waveguide Block	85	85
Radar Circuit Board	35	35
Total		**252**
DC Power		5V/2.5A [3.3V/1.5A]

Conclusions:

- *The system is undergoing integration and test.*

Challenges Encountered / Lessons Learned:

- Design, manufacturing, and procurement timelines are short and sequential. Any disruption will delay the development. Additionally, the integration of the circuit board to waveguide requires very tight tolerances
- Lesson Learned:
  - Devote more schedule to integration and test
  - Have backup personnel at the ready

Future Plans / Next Steps:

For airborne or spaceborne radars for Earth Science applications, the Advanced Component Technologies (ACT) call would be a starting point for developing other enabling technology to move to a higher TRL 4 or higher level. This technology is entering at a TRL level of 2. Therefore, the most likely will be the Instrument Incubator Program (IIP) vehicle. I have been in discussions with a Minority Serving Institute on the development and deployment of similar radar systems. ROSES and MUREP proposals are being discussed.