Geodetic Reference Instrument Transponder for Small Satellites (GRITSS)

Completed Technology Project (2018 - 2019)

Project Introduction

Background: In support of NASA's Earth Surface and Interior (ESI) focus area, the Terrestrial Reference Frame (TRF) is the foundation for virtually all airborne, space-based, and ground-based Earth observations. This frame is developed by combining the observations from Satellite Laser Ranging (SLR), Very Long Baseline Interferometry (VLBI), the Global Navigation Satellite System (GNSS), and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) stations, and is realized as an international standard through the International Terrestrial Reference Frame (ITRF). Combining the different measurement techniques is only possible with accurate knowledge of the relative measurement reference points between co-located systems, and doing so is essential to take full advantage of the strengths of each technique. Currently, the ITRF is limited in accuracy by systematic errors in tying together the contributions from the different geodetic techniques. Since standard ground-based surveys providing ties between geodetic techniques have reached the limit of their capabilities, a new approach is required that extends technique ties into space. Major goals: We propose to develop a new space flight instrument and verify a measurement concept that enables the determination of systematic errors between the VLBI, GNSS, and SLR independent measurement techniques by extending surveying techniques out to spaceflight assets. The proposed instrument, functioning as a GNSS L-to-X-band transponder, establishes frequency compatibility between VLBI and GNSS, thereby facilitating a direct space-based geodetic tie between these two radio-based techniques in post-processing. Separate laser retro-reflectors flown concurrently with GRITSS would provide additional connection to the SLR network. Because the measurement concept by which the VLBI/GNSS systematic errors will be determined only requires one VLBI station to observe the space vehicle, the space vehicle may be in Low-Earth Orbit. This is advantageous as it opens up the possibility of using inexpensive CubeSats or other small satellites, making it possible to implement a cost-effective constellation of spacecraft to provide better global coverage and further improve the accuracy of the geodetic site ties. Specific tasks: 1) Develop modified version of an existing space flight GNSS receiver to support GNSS relaying functionality Procure commercial space flight UHF (low data rate), S, and X-band (high data rate) digital data transmitters. 2) Design and fabricate a fit-form-function instrument capable of being implemented within a Cubesat/Small Satellite. 3) Bench test breadboard concept of GNSS-to-VLBI transponder with GNSS synthetic signal generators and space vehicle GNSS receivers. 4) Bench test breadboard concept of GNSS-to-VLBI transponder with GNSS synthetic signal generators and space vehicle GNSS receivers. 5) On sight ground test of GNSS-to-VLBI transponder at Goddard Geophysical Astronomical Observatory. 6) Airborne flight test evaluation of GNSS-to-VLBI transponder at Goddard Geophysical Astronomical Observatory.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

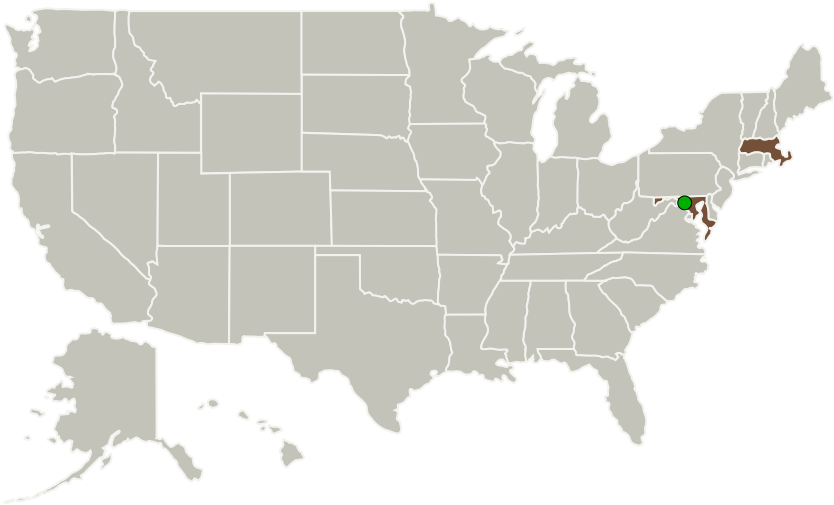
Lead Organization:

University of Massachusetts-Amherst (UMASS)

Responsible Program:

Advanced Component Technology Program

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Massachusetts-Amherst(UMASS)	Lead Organization	Academia	Amherst, Massachusetts
●Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland
University of Massachusetts-Lowell	Supporting Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	Lowell, Massachusetts

Primary U.S. Work Locations	
Maryland	Massachusetts

Project Management

Program Director:

Pamela S Millar

Program Manager:

Amber E Emory

Principal Investigator:

Christopher J Beaudoin

Co-Investigators:

Jaime Esper
Stephen M Merkowitz
Frank G Lemoine
Susan C Puryear
Jason W Mitchell

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

Target Destination

Earth