National Aeronautics and Space Administration

NASA earth

Sachidananda Babu
ESTO/Technology Validation Program Manager
NASA Earth Science Division

small SATELLITE

National Aeronautics and Space Administration

EARTH FLEET

Key

- International Partners
- U.S. Partner
- ISS Instrument
- JPSS Instrument
- Cubesat
- Launch Date TBD
- Earth System Observatory Mission
- (Pre) Formulation
- Implementation
- Operating
- Extended

Invest/CubeSats

- MURI-FD 2023
- SNOOPI 2024
- ARGOS* 2024
- ARCSTONE* 2025
- GRITSS* 2025
- GRATTIS* 2026

JPSS Instruments

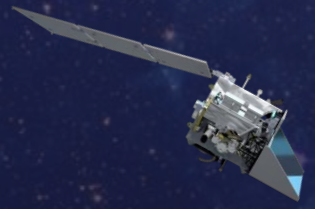
- OMPS-LIMB 2022
- LIBERA 2027
- OMPS-LIMB 2027
- OMPS-LIMB 2032

NASA earth

07.11.2024

Recent and Upcoming Earth Science Launches

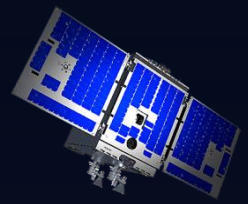
*Agency LRD Aug 2024
**Launch Date NET Oct 2024
***Agency LRD Oct 2024



PACE

PREFIRE

NISAR***



TSIS-2

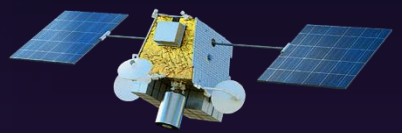
FEBRUARY | MARCH | MAY | JUNE | OCTOBER | MAY

2024

SNOOPI

HyTI

ARGOS**



2025

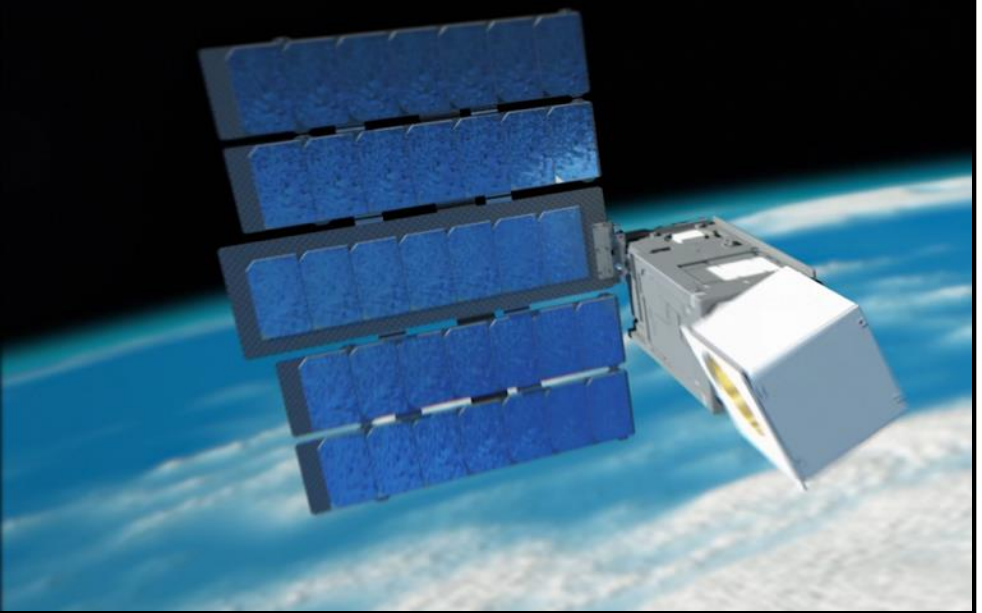
NASA earth

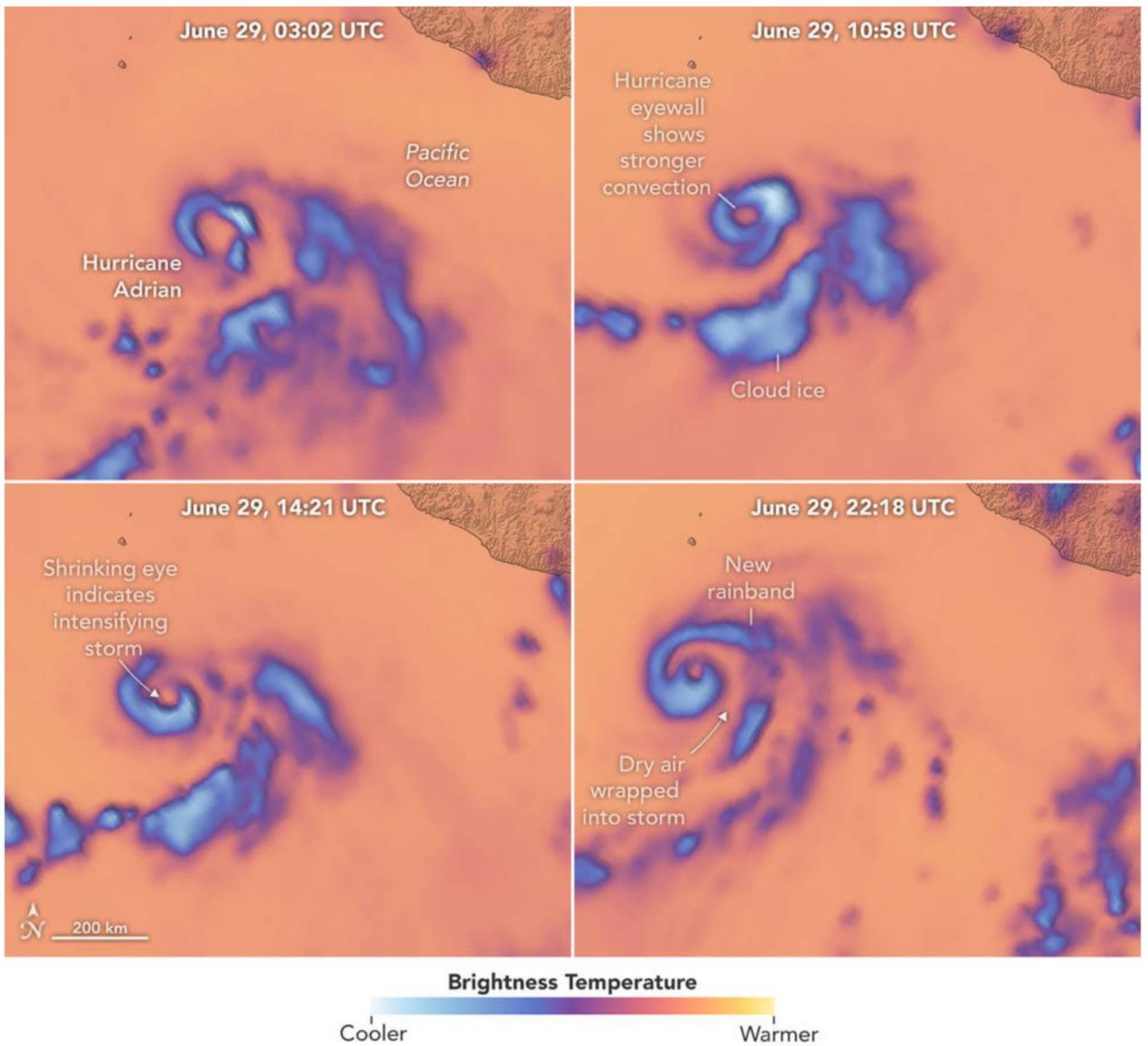
06.14.2024

NASA TROPICS

CubeSat Constellation Mission Releases First-Light Data

Four 3U CubeSats, 30° inclination, 550 km
12-channel microwave sounder payload
60-min-revisit tropical cyclone obs





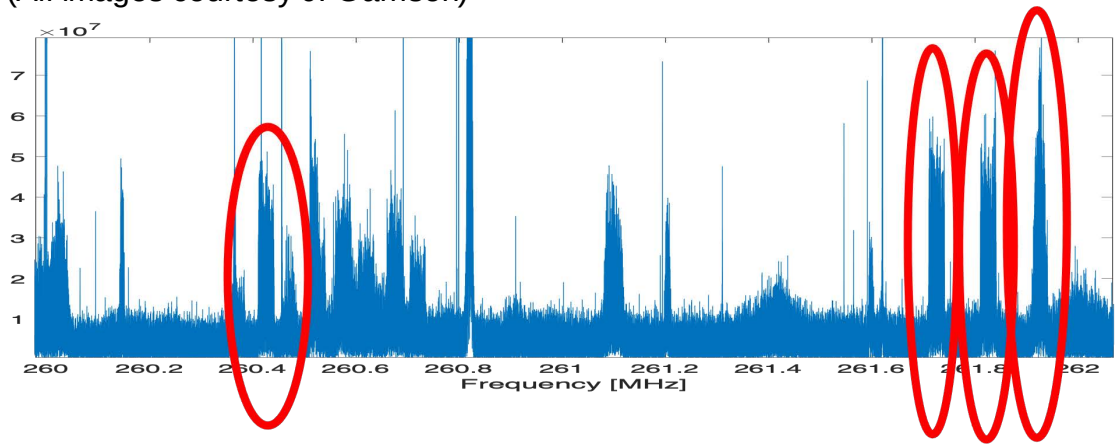
First Data Returns from SNOOPI CubeSat

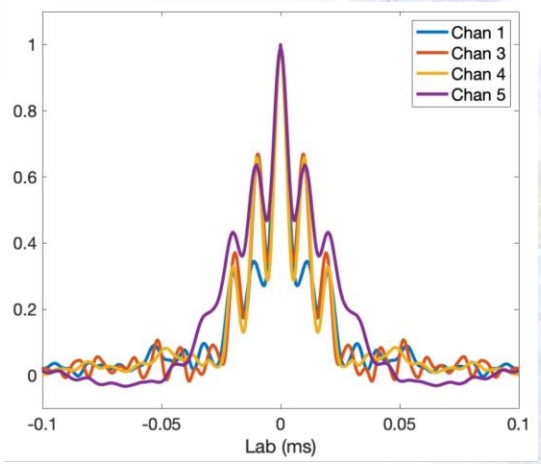
Currently on orbit, the Signals of Opportunity P-band Investigation (SNOOPI) tech demo is using P-band ***signals of opportunity*** to demonstrate measurements of root zone soil moisture (RZSM) and snow water equivalent (SWE). SNOOPI leverages signals from existing telecommunications satellites and therefore does not require a transmitter, making this technology very cost effective.

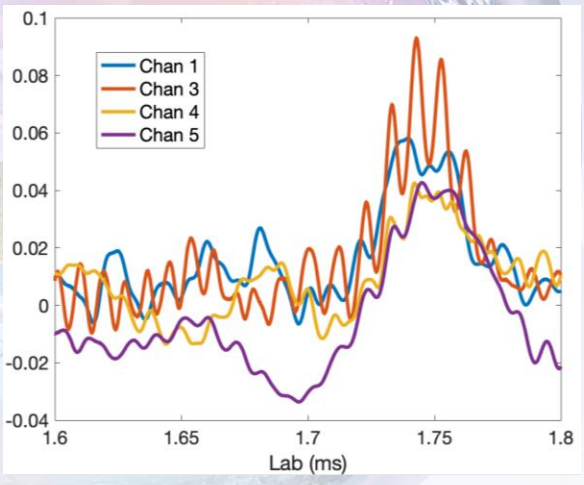
The 6U CubeSat was launched on March 21 onboard NASA's SpaceX 30th Commercial Resupply Services mission to the ISS, and subsequently deployed in mid-April. In late May and June, SNOOPI took its first data in both bands: low band (240-270 MHz) and high band (360-380 MHz). The team continues work filtering RFI and conducting data quality analysis.

SNOOPI deployment from ISS

Low band retrievals from June 6 (a confirmed reflected signal capture)
Below, the red ellipses show the data channels transmitted in the low-band, each tracked independently to produce the lines shown on the autocorrelations at right. (All images courtesy J. Garrison)



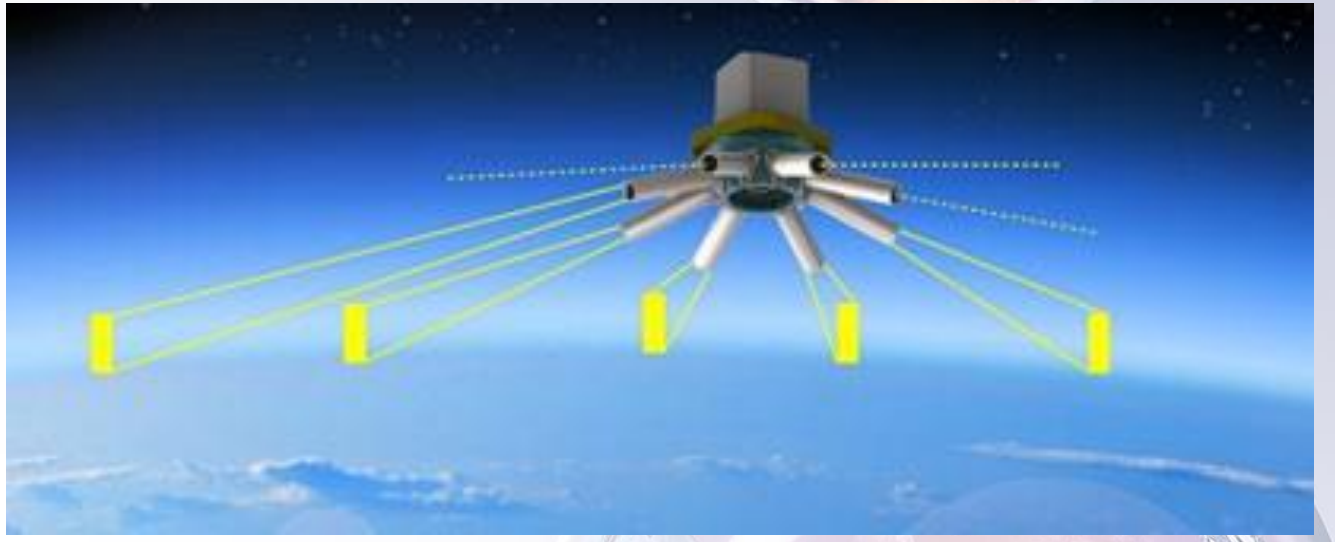




PI: James Garrison, Purdue University

ARGOS Instrument Overview

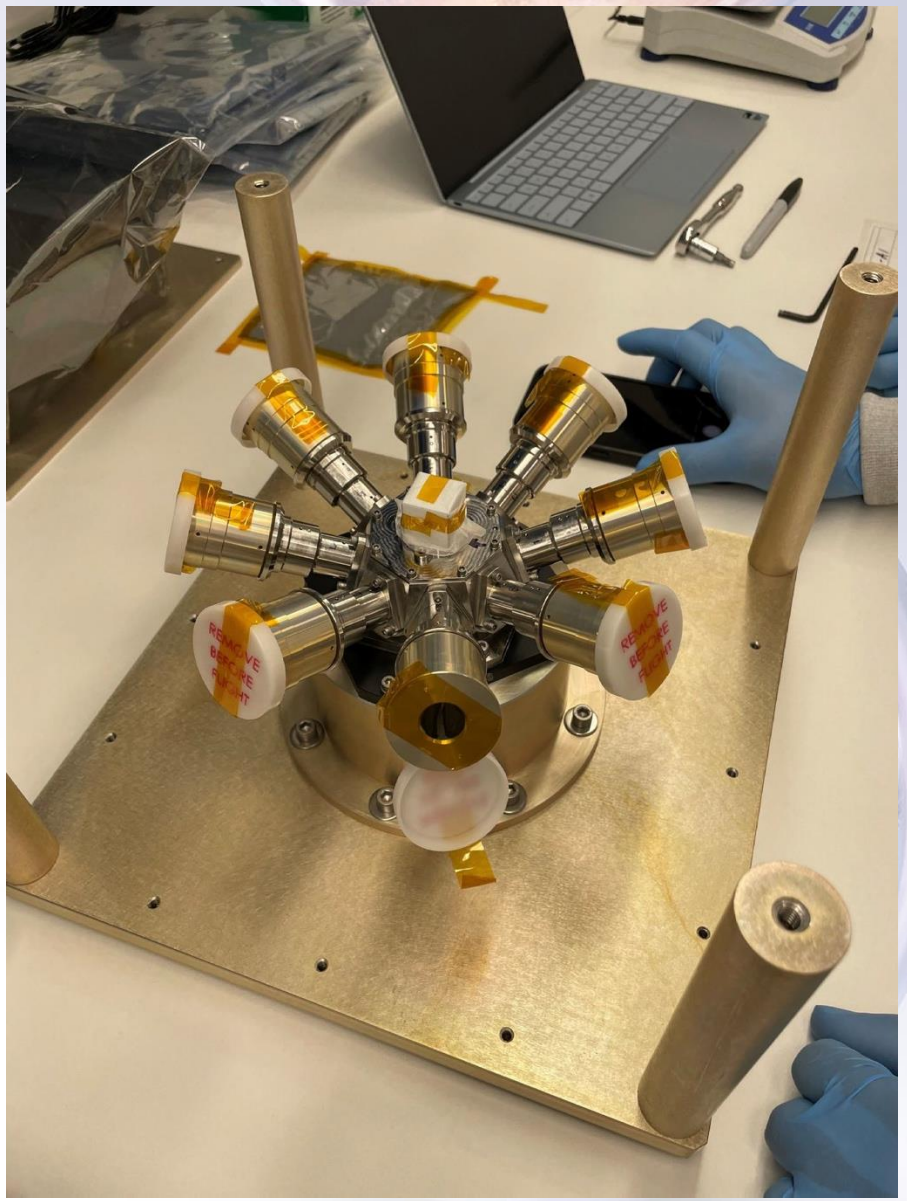
- Eight simultaneous viewing directions to atmospheric limb
  - Forward and backward along orbit track
  - Perpendicular to orbit
  - 45° azimuth between each of these directions
- Each viewing direction measures simultaneous radiance profiles at 870 nm and 1550 nm
- All measurements captured on single focal plane
- No moving parts



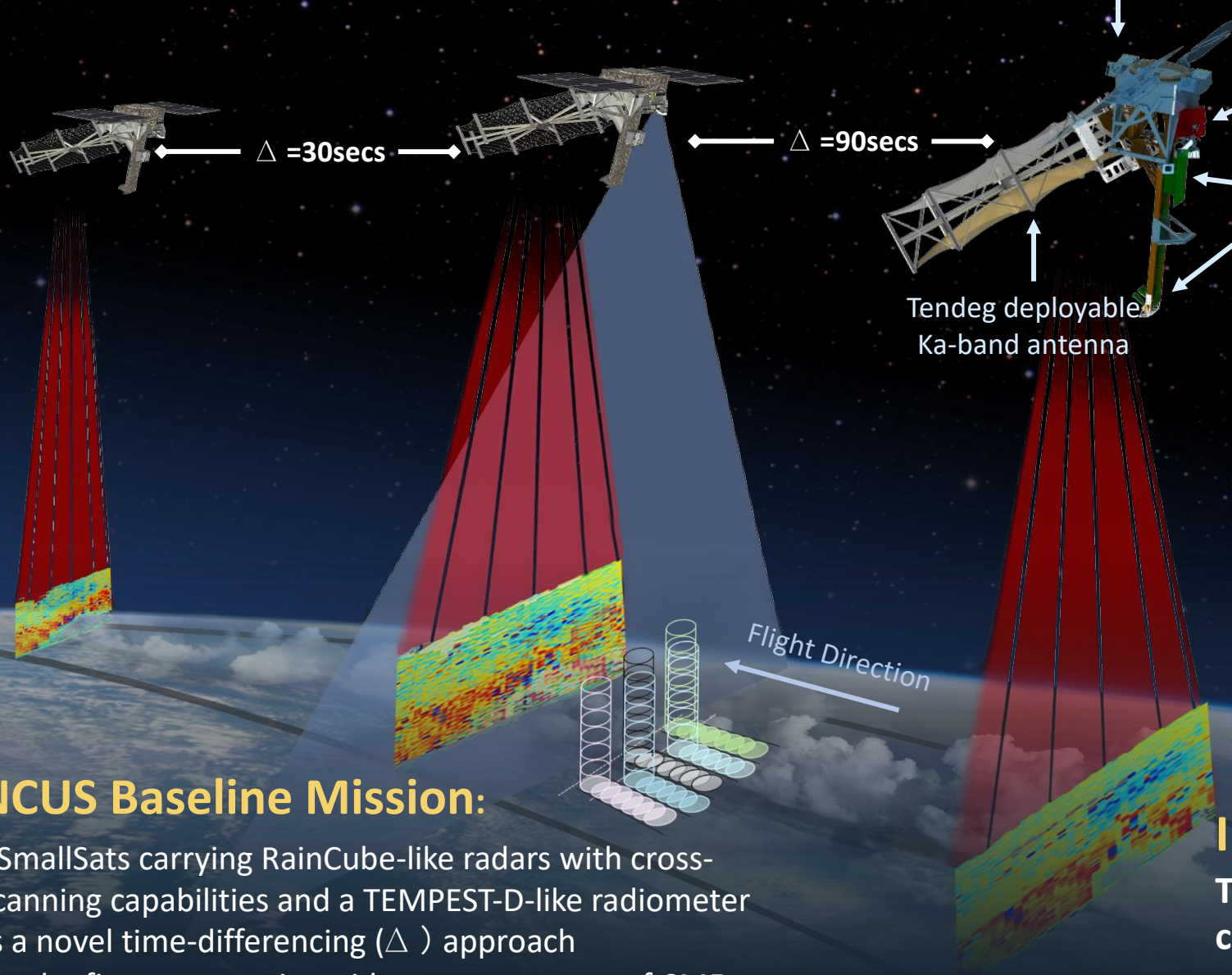
- 550 km altitude, Sun-synchronous orbit
- Vertical slits cover 0-60 km altitude at Earth limb with 0.5 km sampling
- Collect short individual images (< 25 msec) to prevent saturation due to clouds
- Nominal along-track profile sampling is 45 km (6 second averaging)

Where is ARGOS

- ARGOS instrument delivered to Loft Orbital facility in Colorado on April 18
- Upcoming key dates:
  - Integration to spacecraft hub: August 2024
  - Spacecraft-level vibration testing: early December 2024
  - Spacecraft delivery to SpaceX: early January 2025
- Target launch date: February 1, 2025
- Hope for 2-4 week commissioning period to get first data
- Adapt OMPS LP retrieval algorithm to derive aerosol products



INCUS Investigation of Convective Updrafts



Blue Canyon Technologies X-SAT Venus commercial bus

JPL cross-track scanning microwave radiometer (middle spacecraft only) (TEMPEST-D heritage)

JPL Ka-band radar with 5 beams (RainCube heritage)

Tendeg deployable Ka-band antenna

PI: Susan van den Heever, CSU
Deputy PI: Ziad Haddad, JPL
Project Scientist: Simone Tanelli, JPL

Mission Management & Participating Organizations
CSU: PI Org, Science Data Processing
JPL: Instruments & Mission Management
Tendeg: Deployable Antennas
BCT: Spacecraft, Mission Ops
CCNY, GSFC, MSFC, NOAA, SBU, TAMU: Science Co-Is

Colorado State University
NASA Jet Propulsion Laboratory California Institute of Technology

The INCUS Baseline Mission:

§ Flies 3 SmallSats carrying RainCube-like radars with cross-track scanning capabilities and a TEMPEST-D-like radiometer
§ Applies a novel time-differencing (△) approach
§ Provides the first ever tropics-wide measurements of CMF

INCUS Goal

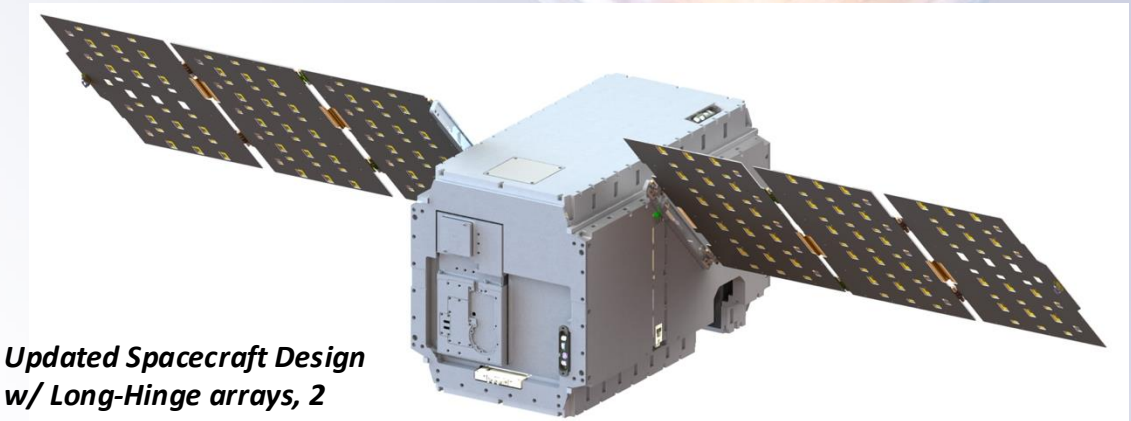
To understand why, when, where tropical convective storms form, and why only some storms produce extreme weather.

POLARIZED SUBMILLIMETER ICE-CLOUD RADIOMETER (PolSIR)

Project Overview and Update

Significant Accomplishments

- Project PDR Set for 9/10-9/12/2024; KDP-C set for 10/29/2024
- Updated Spacecraft design to get a power-positive power budget
- PDR Data Product generation underway
- First pre-PDR EPR held with VDI and TK. Other subsystem EPRs scheduled and to be complete by the end of July.
- Significant progress on budget and schedule updates to prepare for PDR, with projected improvement in reserves since PPBE26
- Updated contract documents for BCT. RFP will be issued soon with award planned for Fall 2024.



Updated Spacecraft Design w/ Long-Hinge arrays, 2 SADAs, 16U size

Key Project Information

- PI-Led Earth Venture Instrument Mission
- Data products: IWP, Deff
- Two 16U CubeSats to launch separately
- RAAN separation: ~6h
- Orbit inclination: ~51°
- Orbit altitude: ~550 km

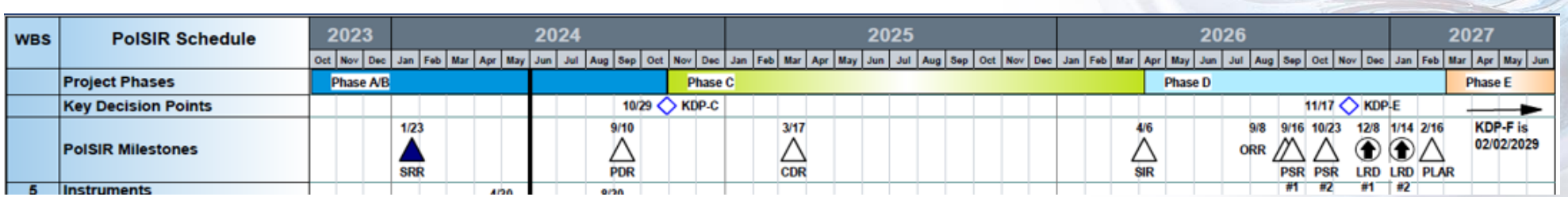
Mission Phase: Phase A/B (10/2023 -)
Launch Date: 12/2026 / 1/2027
Mission Life: 2-yr coincident science
Category: 3
Class: D
Launch Vehicle: TBD
Program Office: ESSP
Technical Authority: GSFC

Instrument Development

- GSFC: IFAs, IECS, and Instrument I&T
- Newton Engineering (contract awarded 4/2024): Payload mechanical
- VDI and TKI (contract awarded 2/2024): Optical Assemblies and SWAs

Spacecraft and Ground System

- Spacecraft Bus: BCT
- Mission Operations Center (MOC) and Ground Station:
  BCT with KSAT S-band services
- Science Data Center: University of Wisconsin
- Science Instrument Team: GSFC



PolSIR (EVI-6) Science

Science Objectives

- Constrain seasonally influenced diurnal cycle of tropical ice water path (IWP) and particle diameter (Deff)
- Determine the diurnal variability of ice clouds in the convective outflow areas
- Determine the relationship between shortwave and longwave radiative fluxes and the diurnal variability of ice clouds

Benefits

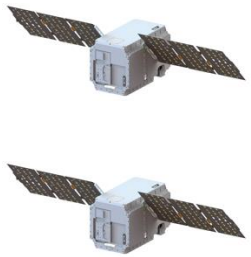
- Enable development of better cloud parameterizations
- Reduce uncertainty in 10-40 year climate model predictions

Team

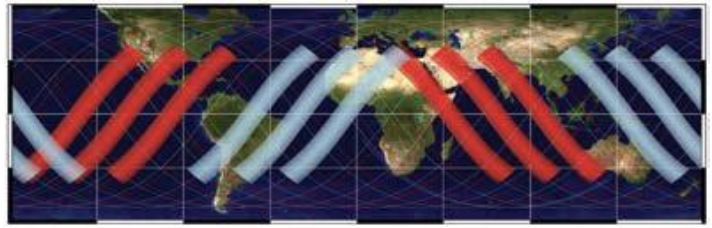
- **PI:** Ralf Bennartz (Vanderbilt U)
- **D-PI:** Dong Wu (GSFC)
- **PM:** Greg Dell (GSFC)
- **D-PM:** Charles Bacon (GSFC)
- **Science Team:**

Adams,	Ian	NASA-GSFC
Barahona,	Donifan	NASA-GSFC
Berndt,	Emily	NASA-MSFC
Brogniez,	Helene	U Paris Saclay
Braun,	Jessica	UW-Madison
Ehsan,	Negar	NASA-GSFC
Elsaesser,	Greg	GISS/Columbia U
Gong,	Jie	NASA-GSFC
Johnson,	Ben	UCAR
Karpowicz,	Bryan	NASA GMAO
Kroodsma,	Rachael	NASA-GSFC
Loveless,	Daniel	Indiana Univ
Merrelli,	Aronne	U-Michigan
Pettersen,	Claire	U-Michigan
Rapp,	Anita D.	Texas A&M
Vanags,	Chris	Vanderbilt

Mission Overview



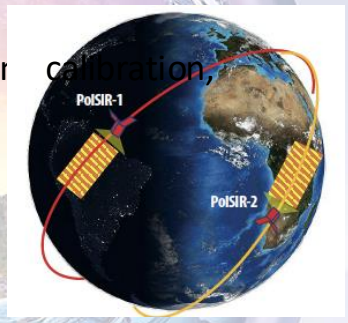
- $37M (FY24) Class-D mission selected in 2023
- Two CubeSats: Each has two radiometers:
  - 683-GHz (QV & QH)
  - 325/9.5-GHz (QV & QH)
  - 325/1.5-GHz (QV)
  - 325/3.5-GHz (QV)
  - ✓ Dual-Pol, Dual-Band
  - ✓ Cross-Track Scan
- Circular precessing low Earth orbit (LEO) for full diurnal sampling at 35°S-35°N latitudes



Ground tracks for PolSIR-1 (red) and PolSIR-2 (blue) for one full day. The blue and red semi transparent areas show the swath coverage for three consecutive orbits.

Mission Roles, Partnerships, Contributions

- Vanderbilt U: Mission science, cloud ice retrieval
- GSFC: Mission management, instrument development, calibration, data distribution
- U Wisconsin: Science data processing
- Blue Canyon Technologies (BCT): Spacecraft
- Virginia Diodes Inc (VDI): Submm-wave receivers
- NOAA: Operational enhancement options (TBD)
- U Paris Saclay (Franch Contribution): cloud retrievals

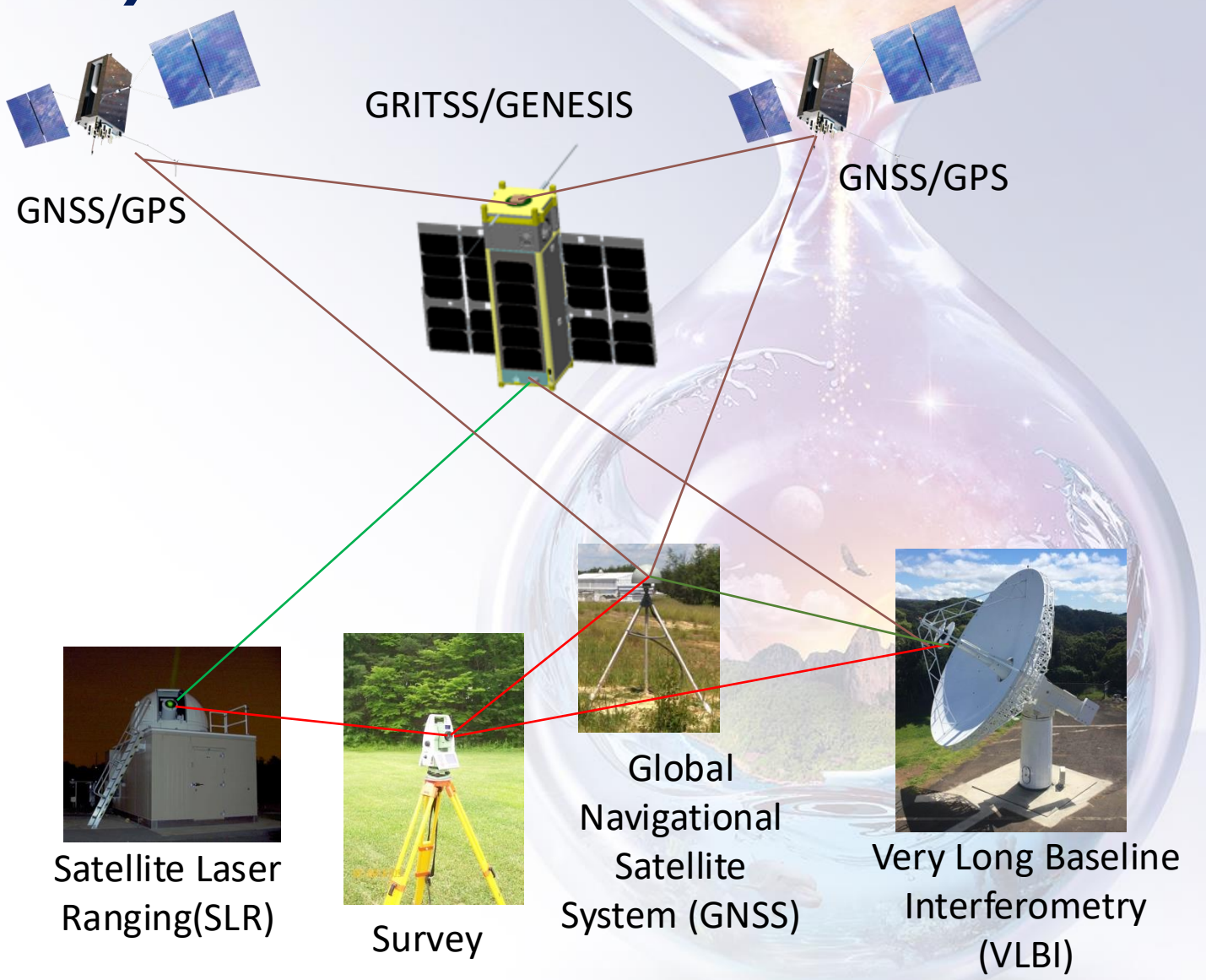


Science Enhancement Options

- GSFC, Columbia U, UCAR/JCSDA, GMAO, UMich, TAMU

Geodetic Reference Instrument Transponder for Small Satellites (GRITSS)

- Observations of a common space-based reference has the potential International Terrestrial Reference Frame.
- The NASA GRITSS flight demonstration will have lessons learned and applications for ESA's GENESIS mission
- GRITSS uses a novel approach that upconverts GPS signals as a VLBI source
- Targeting launch Fall 2025



(ACMES) Overview

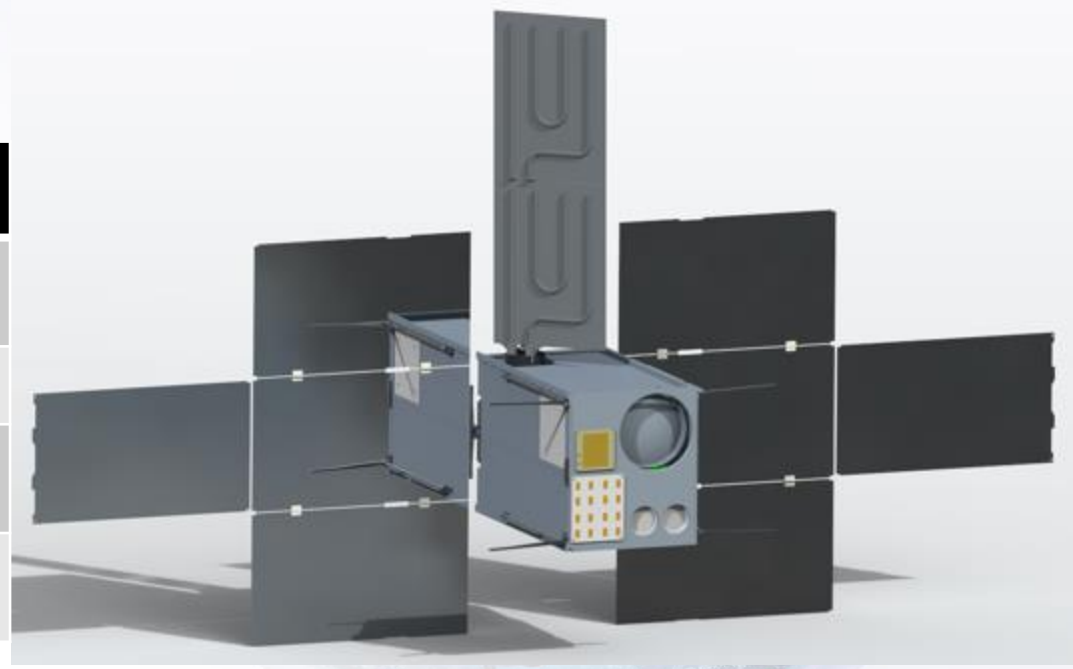
Principle Investigator: Charles Swenson

Partners: Center for Space Engineering at Utah State University, Hawaii Space Flight Laboratory, Orion Space Solutions.

Funding: NASA Earth Science Technology Office under an In-Space Validation of Earth Science (InVEST) grant

Key Parameters (current best estimate)

Form Factor	# Spacecrafts	Orbit	Altitude	Inclination	Launch Date
+16U	1	SSO	550 km	>85°	2025
Launch Interface	**Mission Duration**	**Onboard Processing**	**Active Thermal Control**	**Power (Peak)**	**Telemetry**
ISI M3S	1 to 4 years	Unibap IX10	+100 W MPFL	~230 W	+180 GB/day

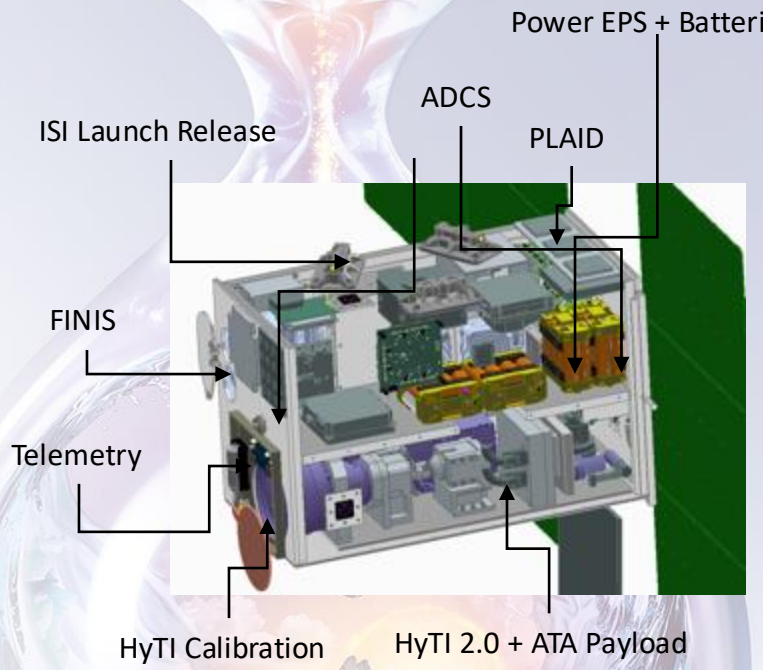


ACMES Scientific Objectives

ACMES is a two-part mission

A 1-year technology demonstration followed by up to 4 years of scientific return

- **HyTI 2.0**
  - LandSAT quality TIRS imaging from a CubeSat platform.
  - LWIR ground mapping for geology/mineralogy, Vulcanic activity, surface moisture, and hydrology
- **FINIS**
  - Low SWAP Methane detection
  - CH_4 Total Column abundance, point leak detection, and plum geometry
- **PLAID**
  - Planar-style space weather plasma probe
  - Electron temperature, density, and potential



ECE 5230 Space Mission Design

Nicholas Wallace, Joseph Dewsnup, Nathan Brinkerhoff, Travis Blaylock, Kelly Burch, Andrew Nelson, Dalton Yerke, Grable Hart, Tyler Rose, Weston Seegmiller, Charles Swenson

Zachary Hall, David Allen, Zachary Clarke, Michael Kirk, Jason Powell, Rowan Antonuccio, Benjamin Lewis, Oliver Parkinson, Nathan Dickson, Alessa Love, Bruno Mattos

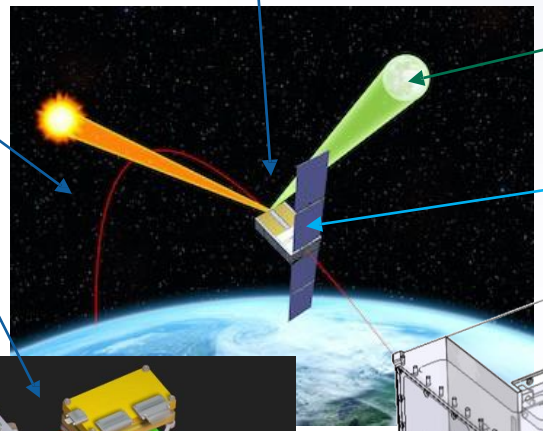
Not Pictured: Aubrey Hjorth, David Pipkin, Isaiah Olsen

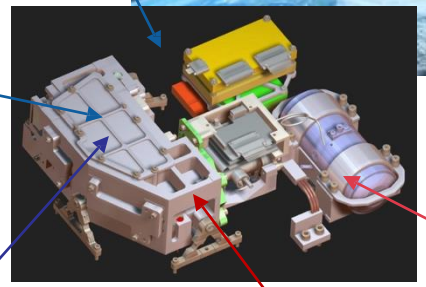
ARCSTONE InVEST Overview

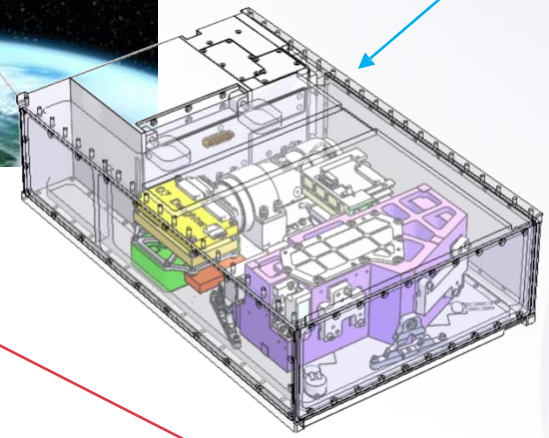
LaRC

Project management
Engineering coordination
ü Instrument electronics
Flight and ground software
Mechanical, Thermal & Structural
Instrument I&T
Science and data products
Operations
Outreach

CubeSat Launch Initiative: SpaceX/Maverick







USGS

Lunar calibration approach and validation analysis

BLUE CANYON TECHNOLOGIES

✓6U CubeSat Bus:
✓ Mechanical
✓Power/Electric ü
Electronics/Data ü
Avionics
✓Bus Storage & Maintenance
System I&T
Operations

GSFC

✓ Optical black coating

SSAI

✓ Xiphos sub-contract Management
✓ Publication

LASP

Laboratory for Atmospheric and Space Physics

✓Flight Calibration System
ü IDCA characterization
Instrument characterization
Uncertainty budget
L1 data validation

RESONON

✓Opto-mechanical design
✓Radiometric modeling ü
Instrument fabrication ü
Instrument assembly ü
Functional testing
Support for inst. modeling

quartus ENGINEERING

✓ Payload Analysis
✓ Input to payload design
✓ Flexure design

ANALYTICAL MECHANICS ASSOCIATES

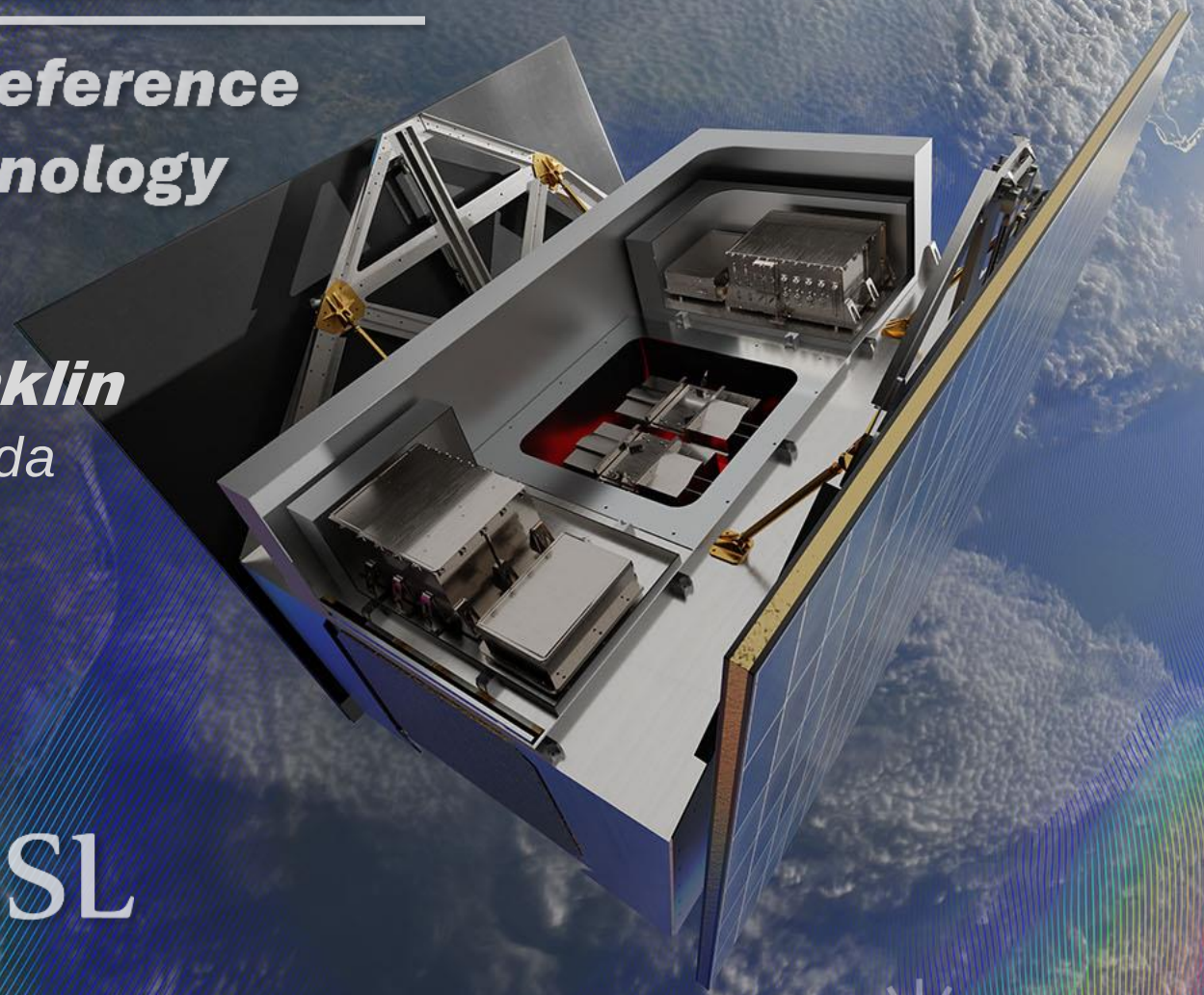
SMCE Cloud support
SPS development and Operations

ARCSTONE

GRATTIS

Gravitational Reference Advanced Technology Test In Space

PI: John W. Conklin
for University of Florida
grattis.ufl.edu



ESTO EARTH SCIENCE TECHNOLOGY OFFICE

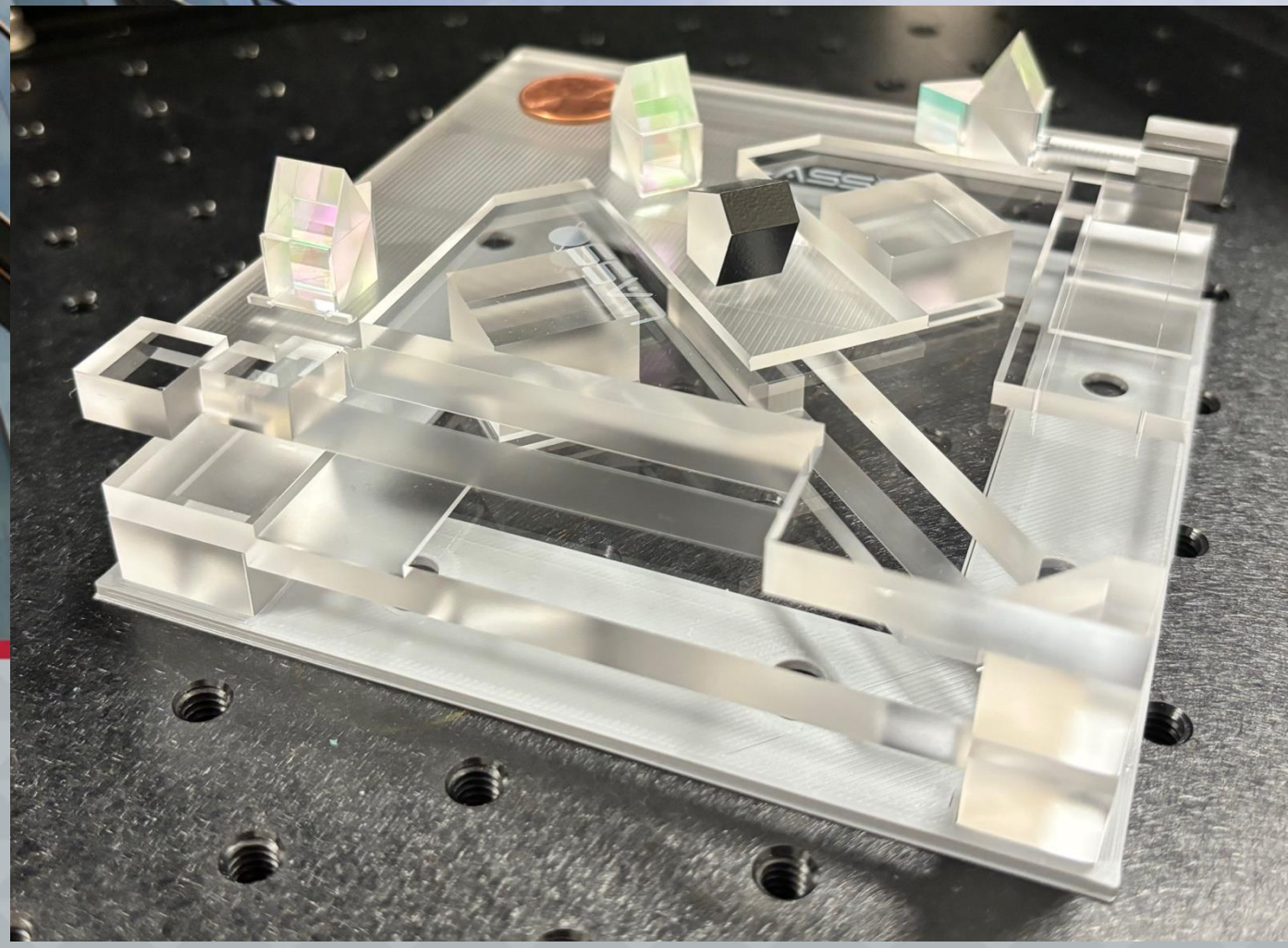
NASA

UF PSSL

TAMU EMBRY-RIDDLE Aeronautical University CROSSXTRAC BAE SYSTEMS FIBERTEK, INC. APEX SPACEX

Optomechanical accelerometers for space geodesy

THE UNIVERSITY OF ARIZONA
Wyant College of Optical Sciences



- Principal Investigator: Felipe Guzman
- Team: Jose Sanjuan, Moritz Mehmet, Andrea Nelson, Ian Harley, Lee Ann Capistran, Jackson Dahn

GRATTIS Payload: Simplified Gravitational Reference Sensors

GRATTIS will fly two Gravitational Reference Sensors (GRS) on 170 kg satellite in Earth orbit

Using LISA tech to improve to improve GRACE accelerometers

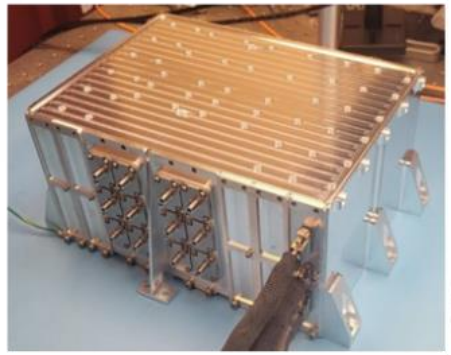
By comparing measurements from two sensors, we can determine noise floor

Under development since 2019 via NASA ESTO IIP program

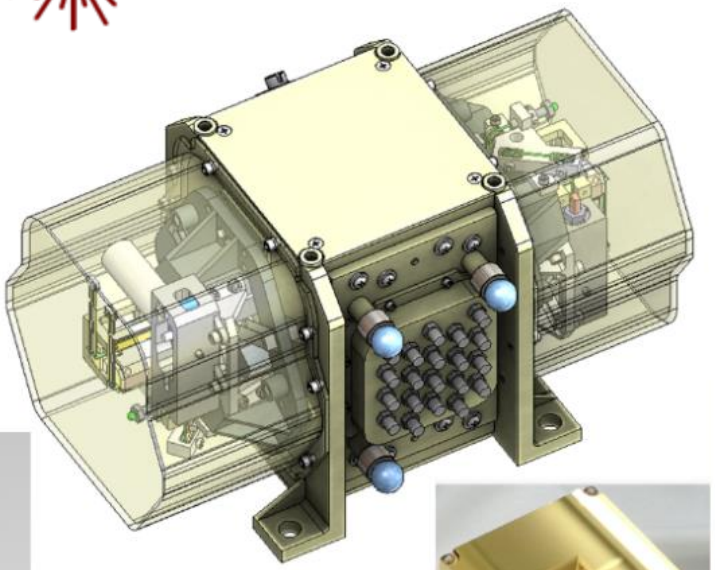
Currently in TRL 6 phase

Launch planned for early 2027

FIBERTEK, INC.

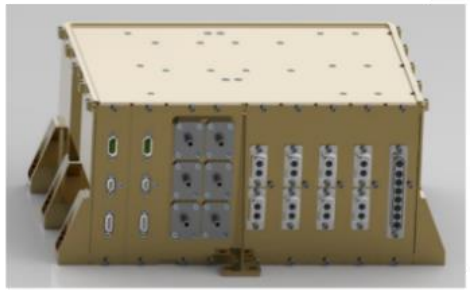


TRL 6 LISA Charge Management Device

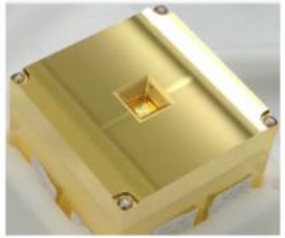


TRL 6 S-GRS Head

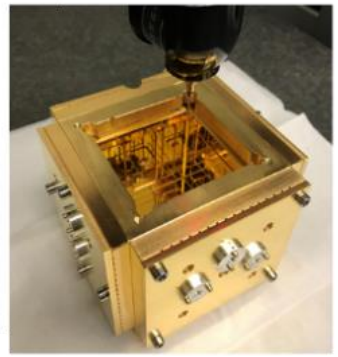
TRL 6 S-GRS Caging Mechanism



TRL 6 S-GRS Sensing, Actuation and Charge-control Unit



LISA Pathfinder flight Test Mass



UF prototype Electrode Housing

BAE SYSTEMS

CROSSXTRAC

UF PSSL

NASA

NASA earth

science.nasa.gov/earth

esto.nasa.gov