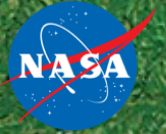


National Aeronautics and  
Space Administration



# EXPLORE EARTH TECH

## Earth Science Technology Office Update 2021



2021 NASA Town Hall

**Sachidananda Babu** Technology Program Manager  
**Pamela Millar** ESTO, Program Director  
**Robert Bauer** ESTO, Deputy Program Director

# Earth Science Division: SmallSat Missions & Investment, 2010-2021

EXPLORE

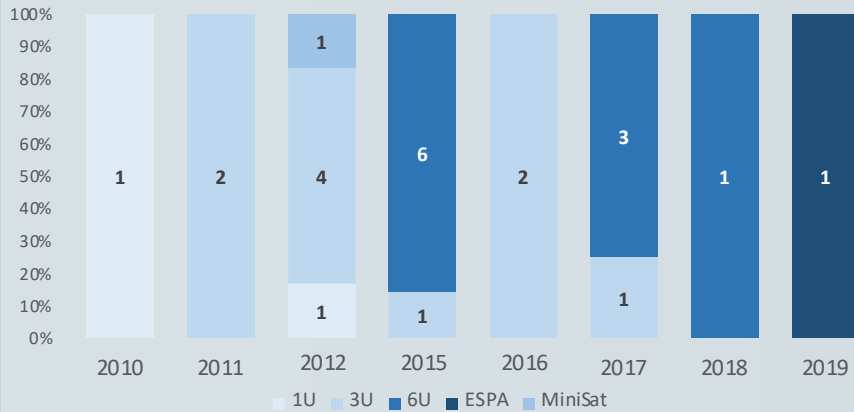


**25**  
TOTAL MISSIONS  
*Over 11 Years*

**8** COMPLETED  
**9** IN IMPLEMENTATION  
**5** OPERATION  
**3** CANCELLED/FAILED

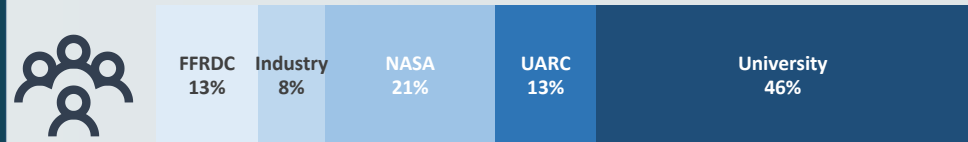
**\$442M**  
TOTAL INVESTMENT  
*Over 11 Years*

**Earth Science Missions: Trended Mission Size**



*Hosted payloads are not included in data shown.*

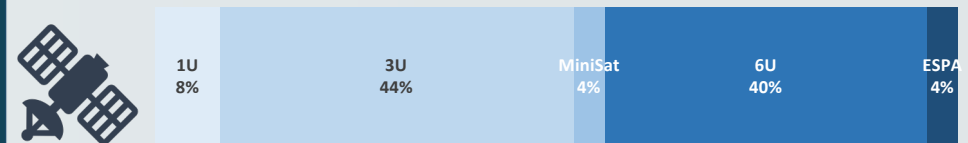
## Sponsoring Organization



## Mission Theme



## Spacecraft Size

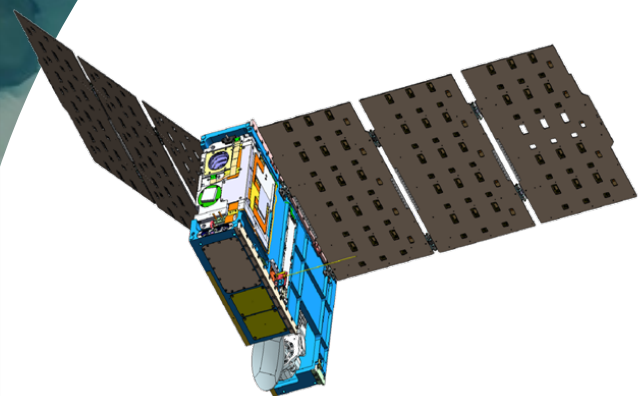
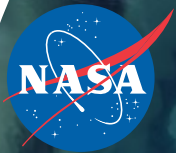


## Constellations



*Constellations include two or more spacecraft.*

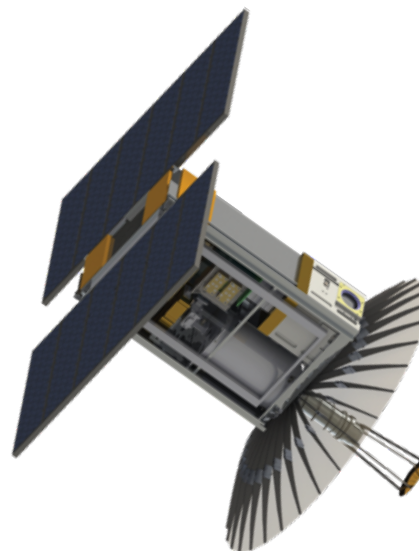
# Just Completed Missions



## **TEMPEST-D**

*Colorado State University*  
Launched June 2018  
Re-entered June 2021

**5 Frequency mm-Wave Radiometer**  
Technology demonstrator measuring the transition of clouds to precipitation

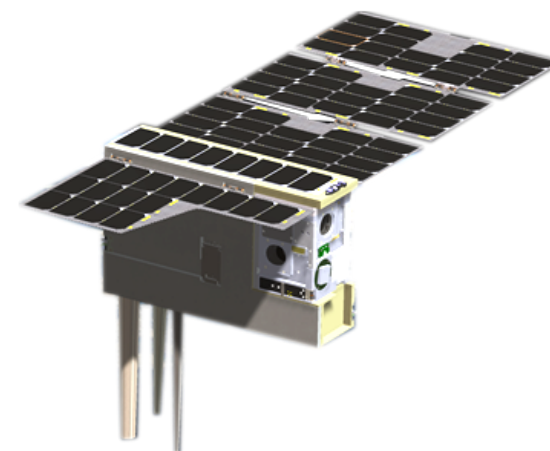


## **RainCube**

*Jet Propulsion Lab*  
Launched June 2018  
Re-entered December 2020

### **Precipitation Radar**

Validate a new architecture for Ka-band radars on CubeSat platform and an ultra-compact deployable Ka-band antenna



## **CubeRRT**

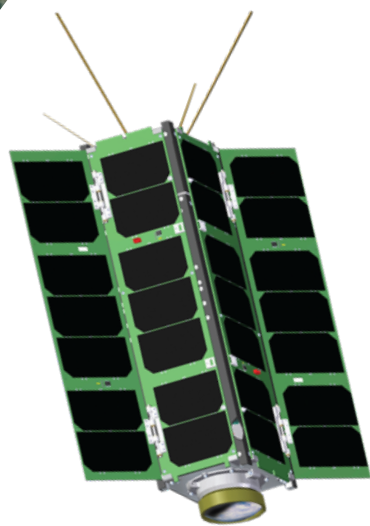
*The Ohio State University*  
Launched: June 2018  
Re-entered November 2020

### **Radiometer RFI**

Demonstrate wideband RFI mitigating backend technologies vital for future space-borne microwave radiometers



# In Operation Now

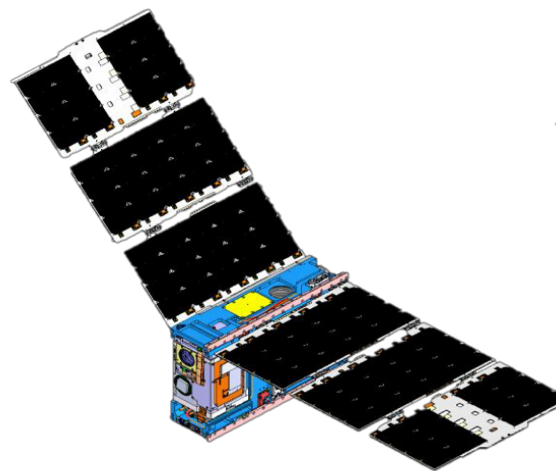


## HARP

*University of Maryland Baltimore County*  
Launch: 2019

### Wide FOV Rainbow Polarimeter

Demonstrate 2-4 km wide FOV  
hyperangular polarimeter for  
cloud & aerosol characterization

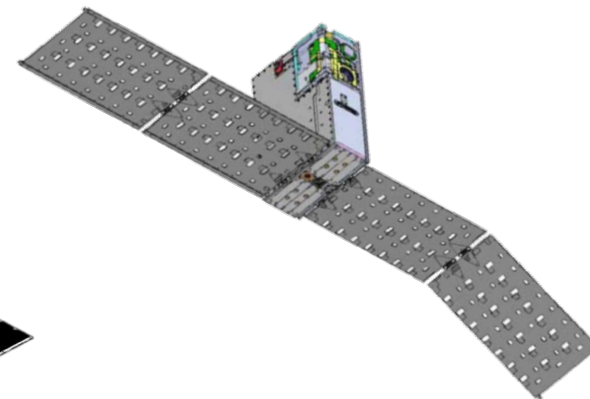


## CIRiS

*Ball Aerospace*  
Launch: 2019

### Infrared Radiometer

Validate an uncooled imaging  
infrared (7.5  $\mu\text{m}$  to 13  $\mu\text{m}$ )  
radiometer designed for high  
radiometric performance from LEO

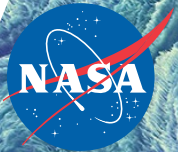


## CSIM

*LASP- University of Colorado*  
Launch: 2018

### Spectral Irradiance Monitor

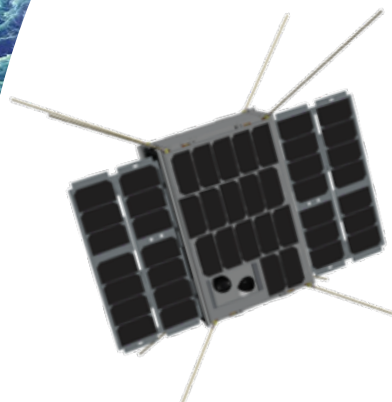
Compact SIM two channel  
instrument to measure  
spectral irradiance between  
200-2400nm



# Launching in Next Year

## SNoOPI

*Purdue University*

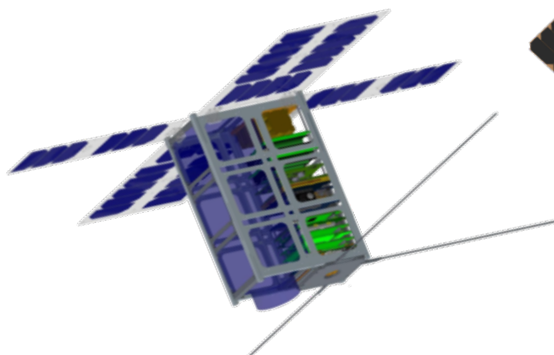


### **SigNals of Opportunity: P-band Investigation**

Demonstrate measurement of the reflection coefficient and phase of land surface reflections from P-band communication satellite signals of opportunity

## HyTI

*University Of Hawaii*

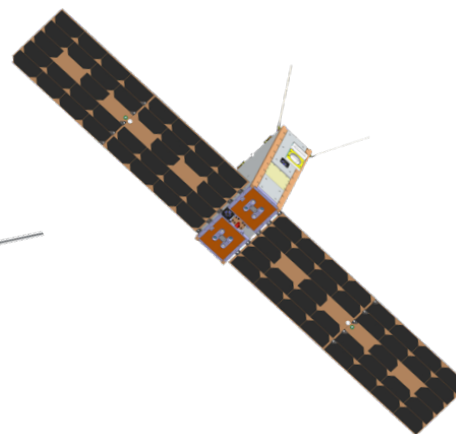


### **Hyperspectral Thermal Imager**

Demonstrate a 6U CubeSat based LEO thermal infrared (ITIR) hyperspectral imager with agile on-board processing

## C-TIM FD

*LASP-Univ of Colorado*

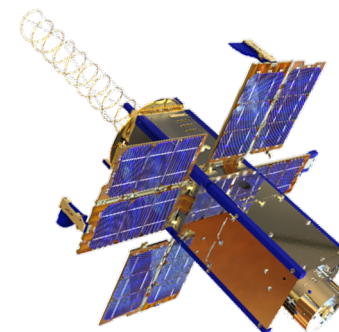


### **Infrared Radiometer**

Validate and demonstrate science performance validate 6U CubeSat system against existing TSIS instrument

## NACHOS 1 & 2

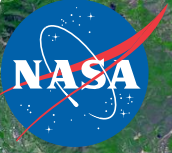
*Los Alamos National Laboratory*



### **NanoSat Atmospheric Chemistry Hyperspectral Observation System**

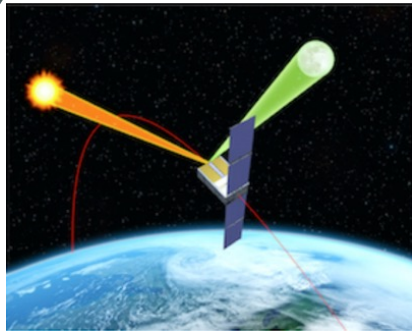
Compact high-resolution trace-gas hyperspectral imagers, with agile on-board processing

ESTO



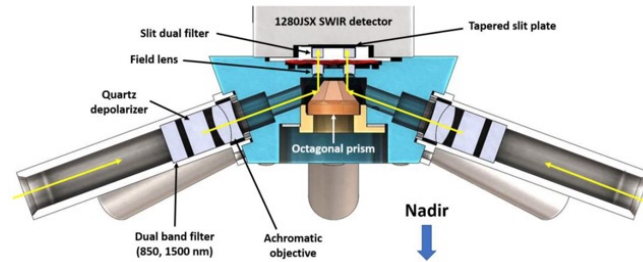
# Looking Forward

## Three New Projects Selected Under InVEST-20



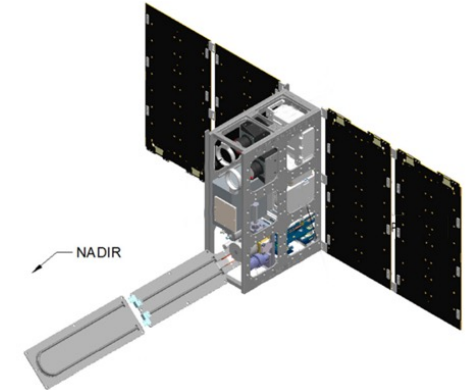
### ***ARCSTONE: Calibration of Lunar Spectral Reflectance from Space*** PI: Constantine Lukashin, NASA Langley Research Center

A hyperspectral instrument spanning the VSWIR spectral range that is designed to be integrated into a 6U CubeSat in low Earth orbit (LEO), will provide lunar spectral reflectance measurements with a target accuracy  $< 0.5\%$  ( $k=1$ ), sufficient to establish an absolute, on-orbit lunar calibration standard for current and future Earth observing sensors.



### ***The Aerosol Radiometer for Global Observation of the Stratosphere (ARGOS) Instrument*** PI: Matthew DeLand, Science Systems And Applications, Inc., in partnership with GSFC and Loft Orbital

ARGOS instrument will collect limb scattering data of atmospheric aerosols at several wavelengths in multiple viewing directions simultaneously. Such dense sampling could reduce the uncertainty in climate model calculations of post-volcanic eruption global aerosol loading by a factor of 2-3. ARGOS can be considered as a next generation OMPS limb profiler



### ***Active Cooling for Methane Earth Sensors (ACMEs)*** Charles Swenson, Utah State University

The 6U ACMEs CubeSat will demonstrate two technologies: an active architecture for thermal control of instruments on small satellites, which aims to reduce radiator size by 70% for a given application; and a filter incidence narrow-band infrared spectrometer for the detection of methane sources.

# EXPLORE EARTH TECH



More information  
@  
<https://esto.nasa.gov>

**NASA Earth Observing Satellites Since 1958**