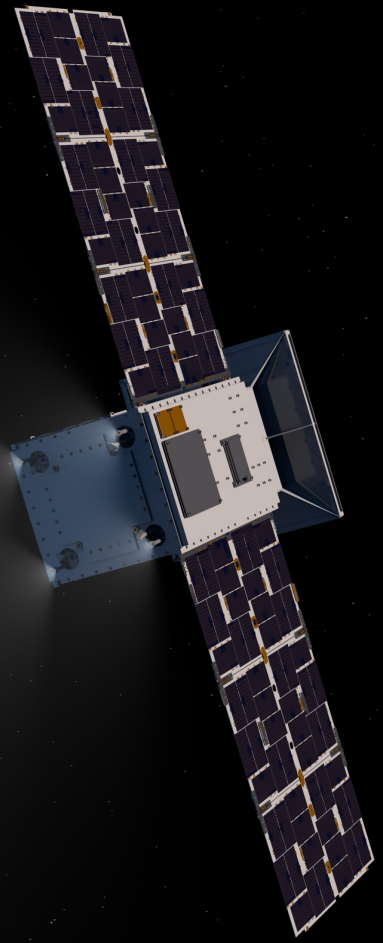


National Aeronautics and Space Administration

NASA Small Spacecraft Technology Program

Roger C. Hunter
Program Manager

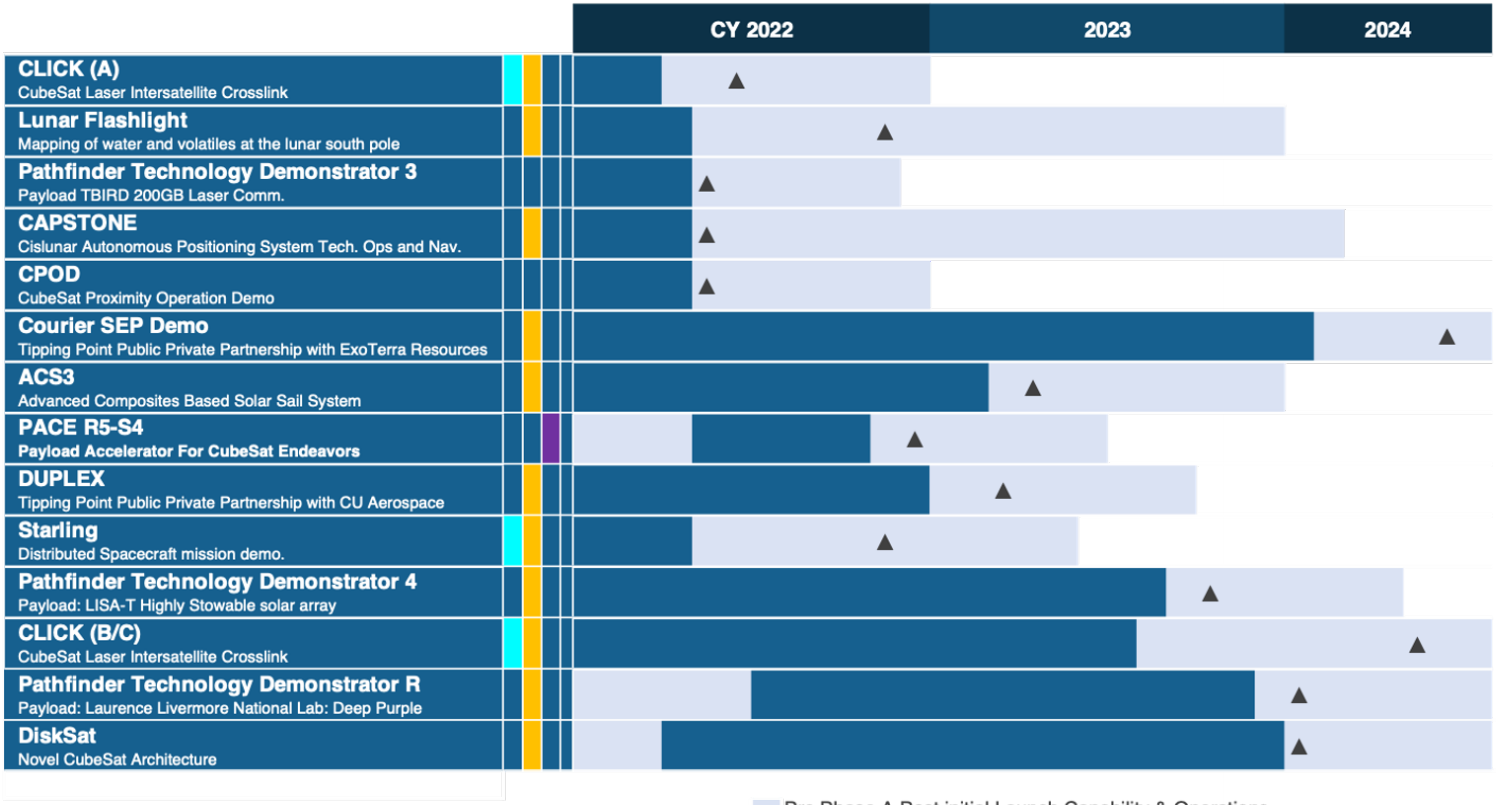
EUROVIA Napoli “Umberto Nobile” ✦ December 22, 2022

NASA Small Spacecraft Technology Objectives

The Small Spacecraft Technology program **expands U.S. capability to execute unique missions through rapid development and demonstration** of capabilities for small spacecraft applicable to exploration, science and the commercial space sector.

- Enable execution of missions at much **lower cost** than previously possible.
- Substantially **reduce time** required for development of spacecraft.
- Enable and demonstrate **new mission architectures**.
- Expand the capability of small spacecraft to execute missions at **new destinations** and in challenging new environments.
- Enable the **augmentation of existing assets and future missions** with supporting small spacecraft.

2022-2024 Schedule



Schedule as of the beginning Q4 CY 2022

KEY

- Pre-Phase A and Post Initial Launch Capability & Ops
- ATP to ILC
- ▲ Launch
- ● Suborbital

Smallsat Technology Partnership (STP) follow on flight or contains STP Technology

Payload Accelerator for CubeSat Endeavors (PACE) team led or supported

SBIR / STTR Phase III or contains SBIR Technology

U-Class Exploration Mission Status

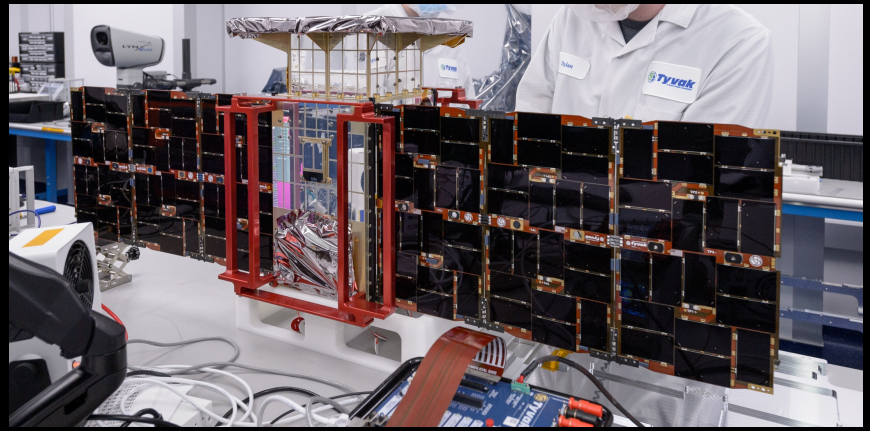


Image Credit: NASA

CAPSTONE

Launched: June 28, 2022
Status: In orbit around the Moon, CAPSTONE to LRO communications to be begin

Objective: Demonstrate how to enter and function in a near rectilinear halo orbit around the Moon; demonstrate spacecraft-to-spacecraft navigation

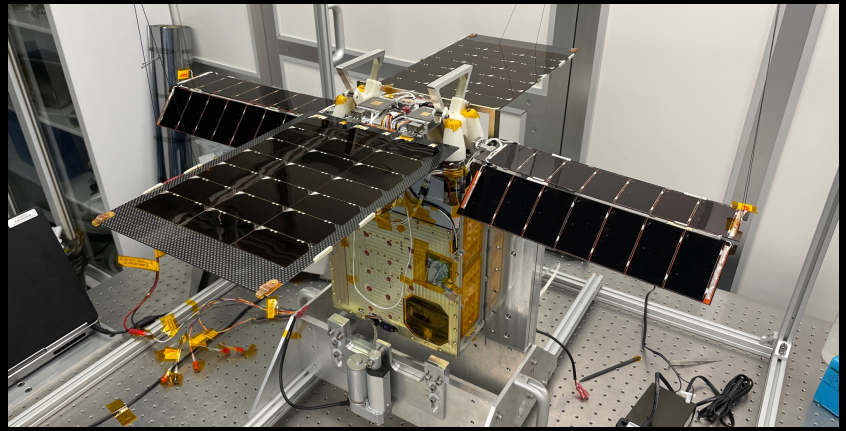


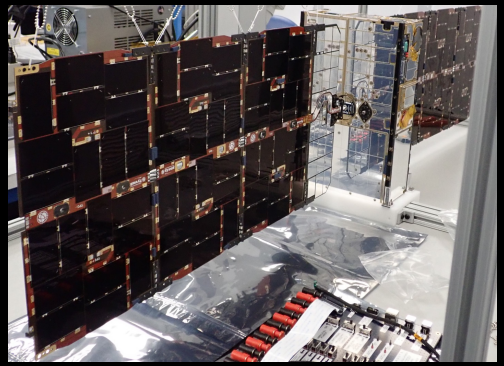
Image Credit: NASA/JPL-Caltech

Lunar Flashlight

Launched: December 11, 2022
Status: En route to the Moon

Objective: Characterize lunar *in-situ* resource utilization potential.[4] Measure quantity and distribution of surface ice deposits in lunar South Pole cold traps with a compact laser spectrometer

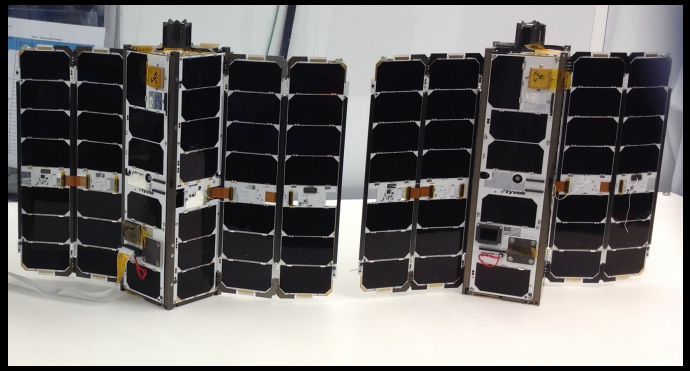
On-Orbit U-Class Technology Demonstration Missions – 2022



Pathfinder Technology Demonstrator (PTD-3) / TeraByte InfraRed Delivery (TBIRD)
Launched: May 25, 2022

Status: To date, demonstrated 100 Gbps data downlink rate and 1.4 terabyte data download to an optical ground station during a single 10-minute pass. 200 Gbps data downlink planned.

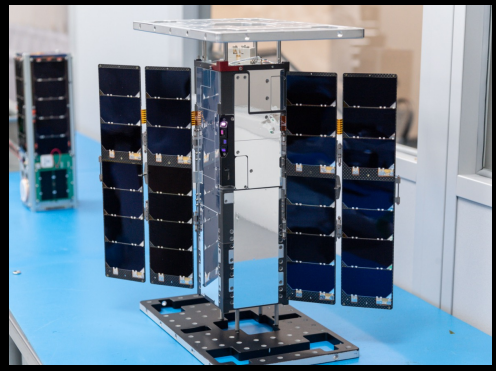
Image Credit: Terran Orbital Corporation



CubeSat Proximity Operations Demonstration (CPOD)
Launched: May 25, 2022

Status: Demonstration of rendezvous, proximity operations and docking using two 3U CubeSats is pending

Image Credit: Terran Orbital Corporation

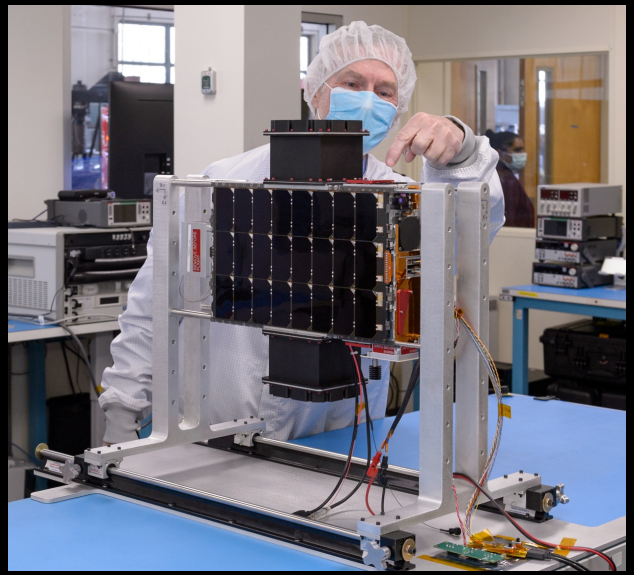


CubeSat Laser Infrared CrossLinK (CLICK-A)
Launched: July 14, 2022
Deployed: Sept 6, 2022

Status: Demonstrated precision pointing of the spacecraft's fine steering mirror control system. Risk reduction mission for CLICK B/C.

Image Credit: NASA

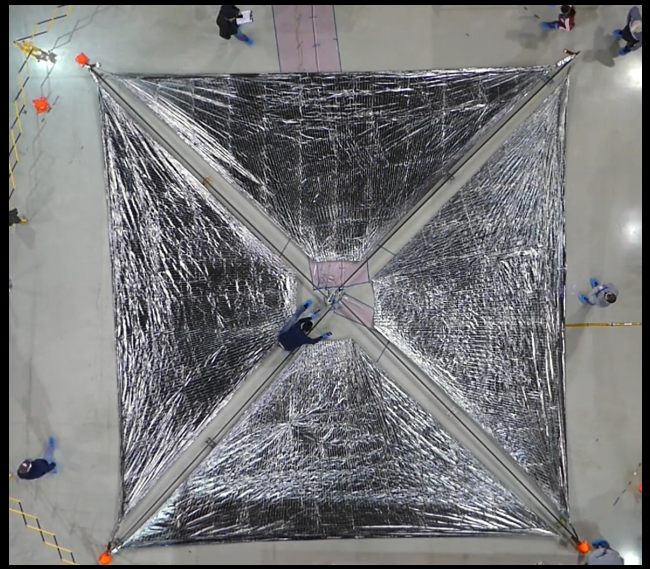
Upcoming U-Class Technology Demonstration Missions – 2023



Starling
Launch: Mid 2023

Demonstrate swarm maneuver planning and execution, communications networking, relative navigation, and autonomous coordination between a swarm of four 6U CubeSats

Image Credit: NASA

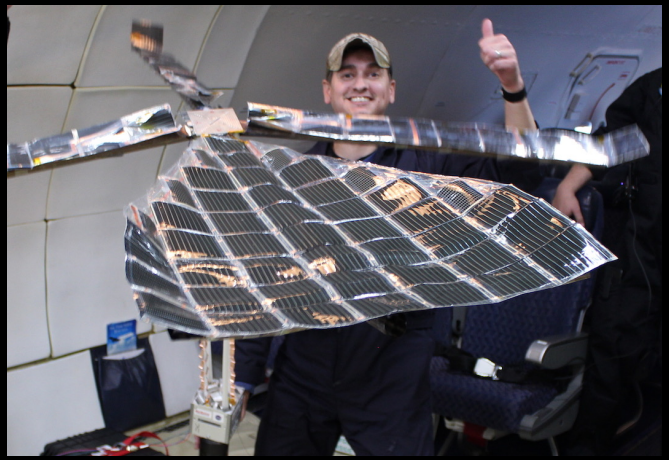


Advanced Composite Solar Sail System (ACS3)
Launch: Second Half of 2023

Demonstrate deployment of the composite boom solar sail in low-Earth orbit. The unfurled solar sail will measure approximately 84 m^2

Image Credit: NASA

Upcoming U-Class Technology Demonstration Missions – 2023 / 2024



Pathfinder Technology Demonstrator (PTD-4)
Launch: Late 2023

Demonstrate Lightweight Integrated Solar Array and anTenna (LISA-T), a high-power, low-volume deployable solar array with an integrated antenna

Image Credits: NASA

CubeSat Laser Infrared CrosslinK (CLICK B/C)
Launch: Mid 2024

Demonstrate optical crosslink and precision ranging between two 3U CubeSats at a data rate of 20 Mbps and range up to 580 km

Image Credits: NASA (illustration) and Blue Canyon Technologies (photograph)

DiskSat - A New Circular Small Spacecraft Design

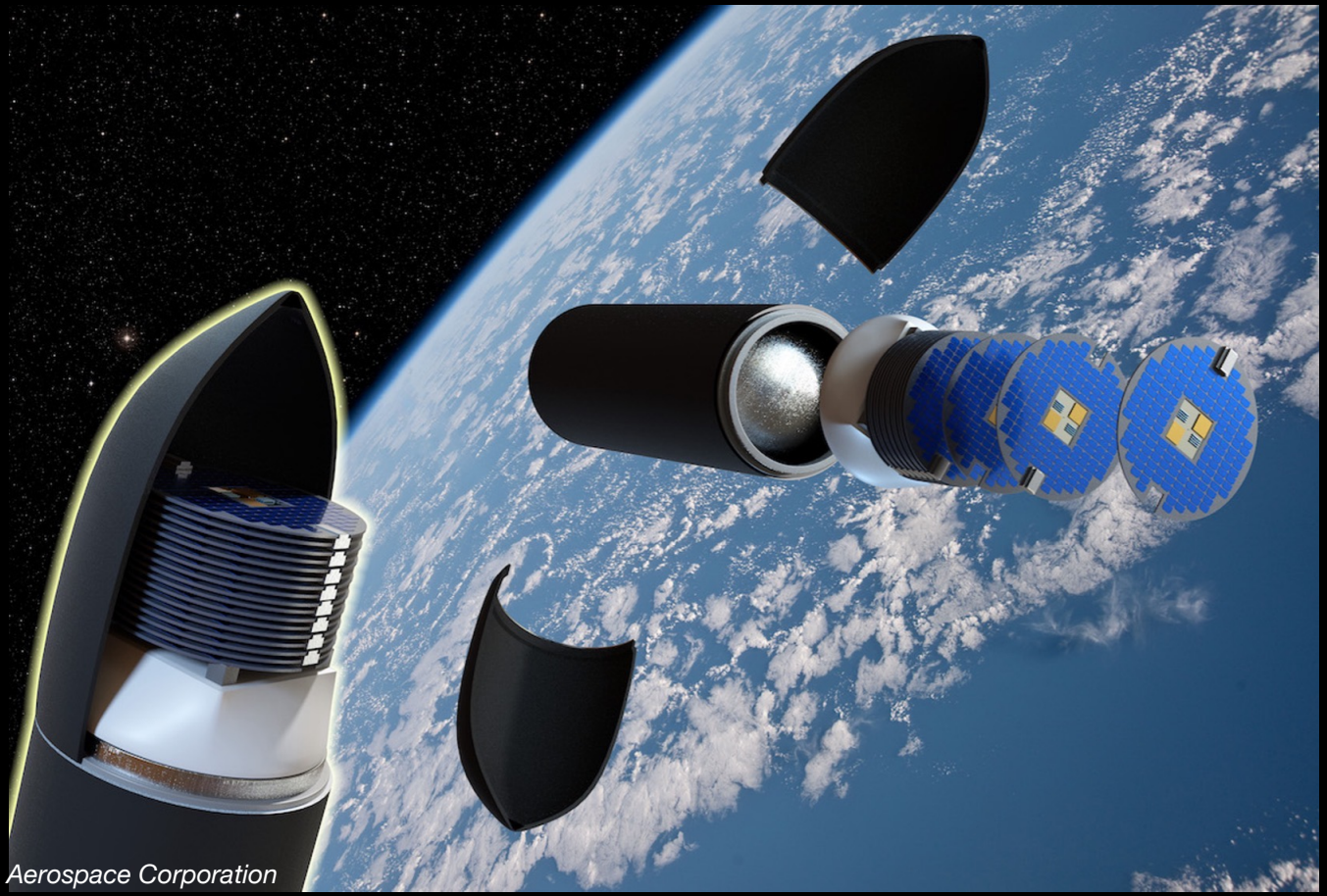


Image Credits: The Aerospace Corporation

SmallSat Technology Partnerships Overview

Overview:
- U.S.-based university and NASA center, PI-lead cooperative agreements
- Competitive solicitations
- Specific technology topics vary
- Grants for max duration of two years
- Year-2 option after first annual review
- 5 “classes” to-date: 2013, 2015, 2016, 2018, 2020

Investments:
- Over $26,468,000 awarded
- 8 of 10 NASA Centers partnered
- 30 Universities in 18 states
- 46 partnerships in 5 class years

Results:
- 1 Intersatellite Network Planning/ Routing tool software open-sourced
- 4 New Technology Reports / Patents
- 13 flight demonstrations planned
- 27+ Conference presentations
- 46+ Papers published
- 100+ Students involved + Many TRLs raised

30 Universities in 18 States

8 NASA Centers (including JPL FFRDC)

2013 $6,500,000 17 awards; 13 Y2 option
2015 $3,590,150 8 awards; 8 Y2 option
2016 $4,676,693 8 awards; 8 Y2 option
2018 $5,802,500 8 awards; 8 Y2 option
2020 $5,900,000 9 awards: (assumes 2 yrs)

Announcement of Collaboration Opportunity Projects – 2018

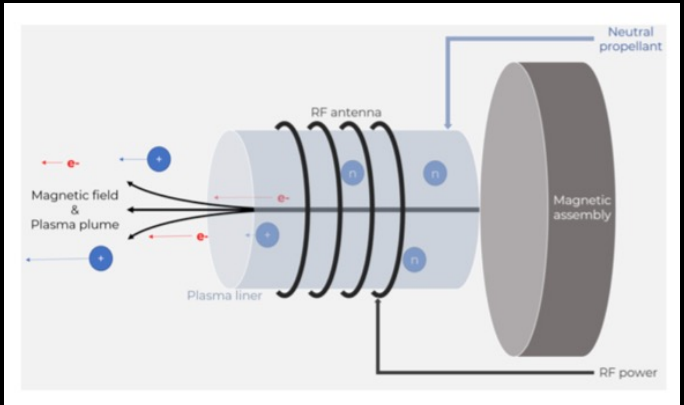
Diagram of the concept of operations for the Cislunar Autonomous Position System (CAPS). CAPS is an innovative spacecraft-to-spacecraft navigation solution to be demonstrated on the CAPSTONE mission currently in orbit around the Moon. CAPS is anticipated to allow future spacecraft the ability to determine their location relative to the Moon without relying exclusively on tracking from Earth.
Image Credits: Advanced Space, LLC

A public-private partnership with NASA's Goddard Space Flight Center

The Vulcan Wireless CubeSat radio, NSR-SDR-S/S. This CubeSat radio is a fully integrated, full-duplex, software-defined radio transponder. The radio transponder is being tested for compatibility with NASA's Space Network.
Image Credits: Vulcan Wireless, Inc.

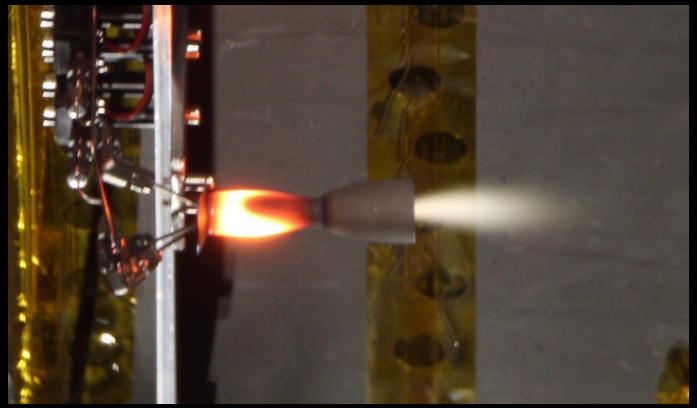
A public-private partnership with NASA's Goddard Space Flight Center

Announcement of Collaboration Opportunity Projects - 2020



The Phase Four RF plasma thruster operates by using RF to heat propellant into ionized plasma that is then ejected away from a spacecraft by a permanent magnet, creating thrust.
Image Credits: Phase Four

A public-private partnership with NASA's Glenn Research Center



A prototype bipropellant thruster is shown in ambient pressure testing. The key technology being tested is the propellant pump - an enabling technology for launch safety approval (no stored gas) and system performance (lightweight tanks). Testing includes a propulsion system composed of monopropellant and bipropellant systems.
Image Credits: Stellar Exploration, Inc.

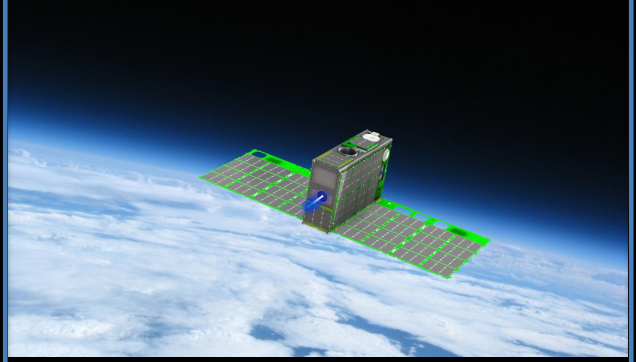
A public-private partnership with NASA's Ames Research Center

Tipping Point Projects – 2019

The 12U Courier CubeSat contains a compact, high impulse solar electric propulsion module. The mission will demonstrate a Halo Hall Effect Thruster which operates between 85-175 watts.
Image Credits: ExoTerra Resource, LLC.

Accion's Tiled Ionic Liquid Electrospray 3. The compact, modular electric system uses a non-volatile ionic salt propellant.

Image Credits: Accion Systems, Inc.



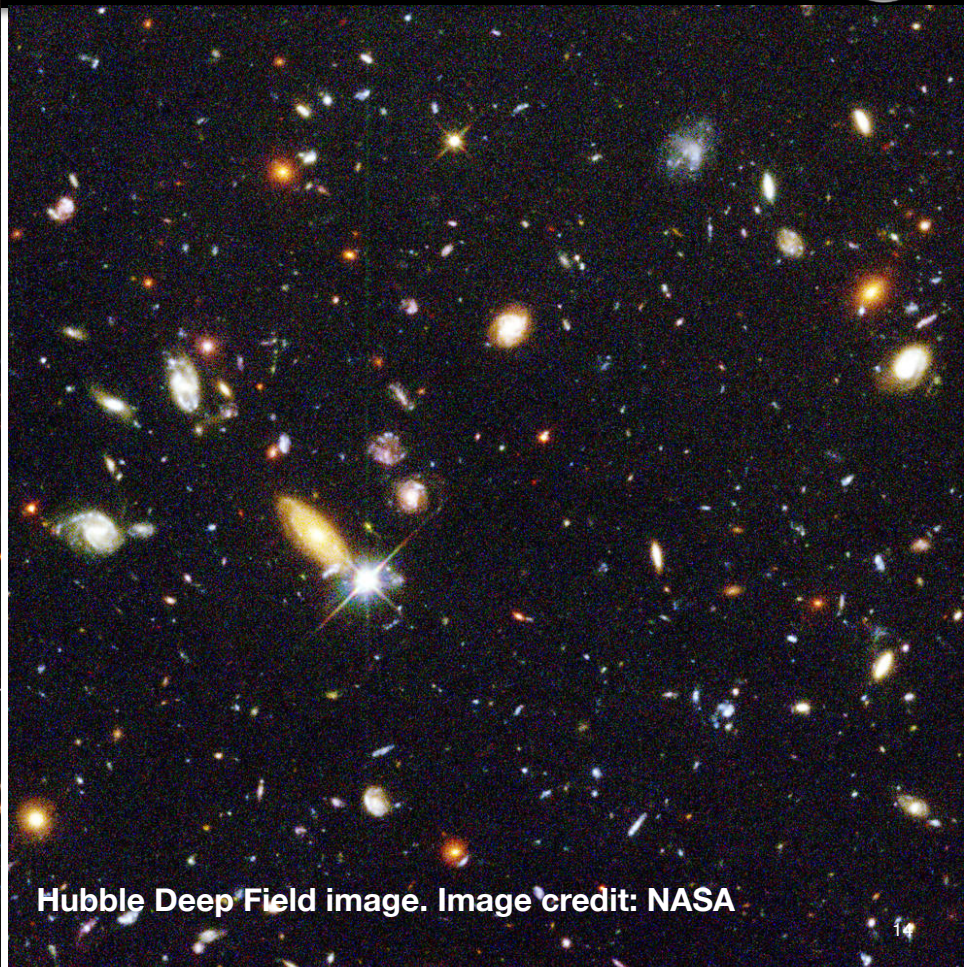
A 6U Dual Propulsion Experiment CubeSat. Both propulsion systems, the Fiber-fed Pulsed Plasma Thruster and Monofilament Vaporization Propulsion, were developed with NASA SBIR funding.

Image Credits: CU Aerospace, LLC.


NASA

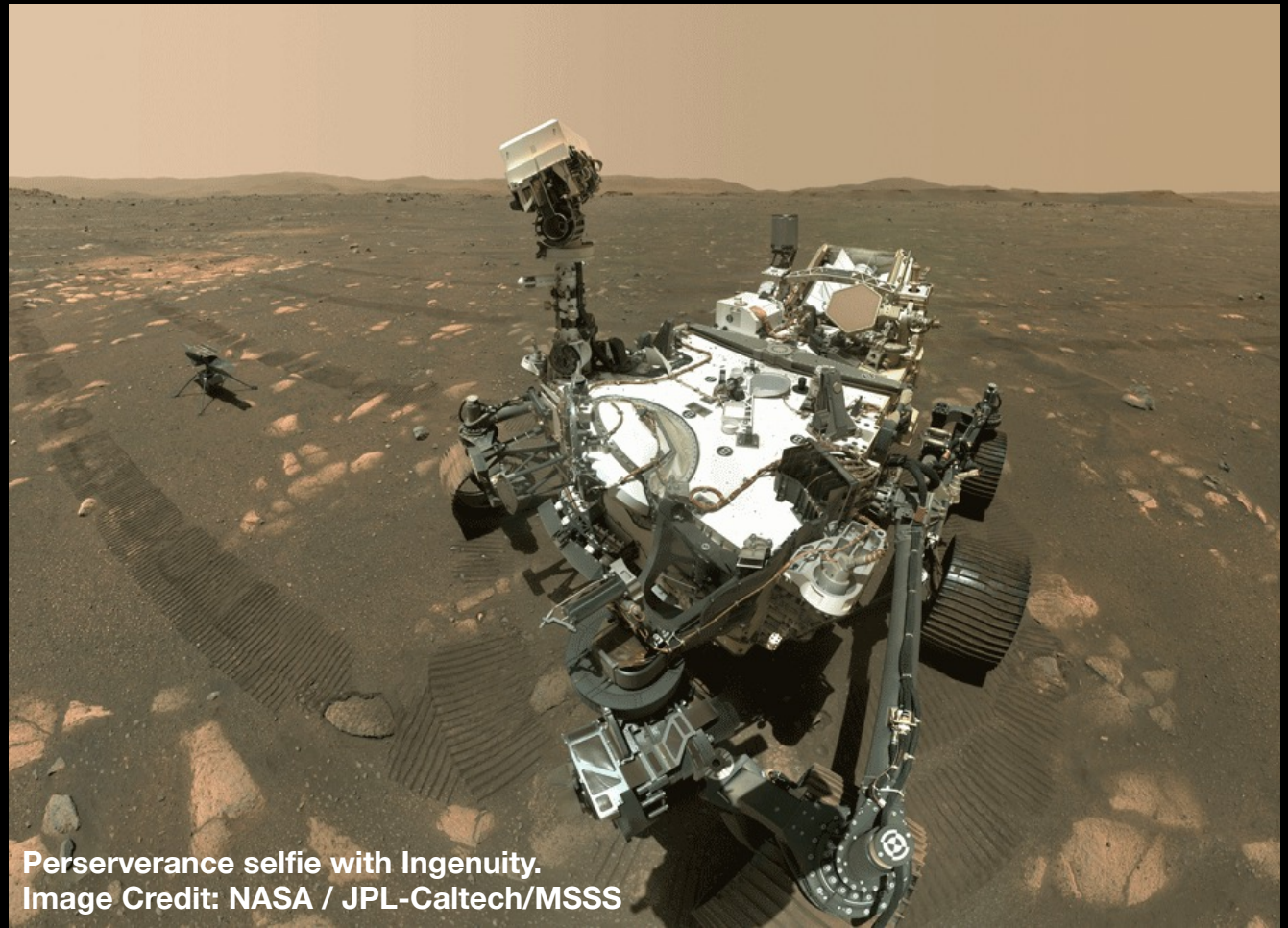
NASA James Webb Space Telescope

Webb's First Deep Field image. Image credit: NASA, ESA, CSA, and STScI



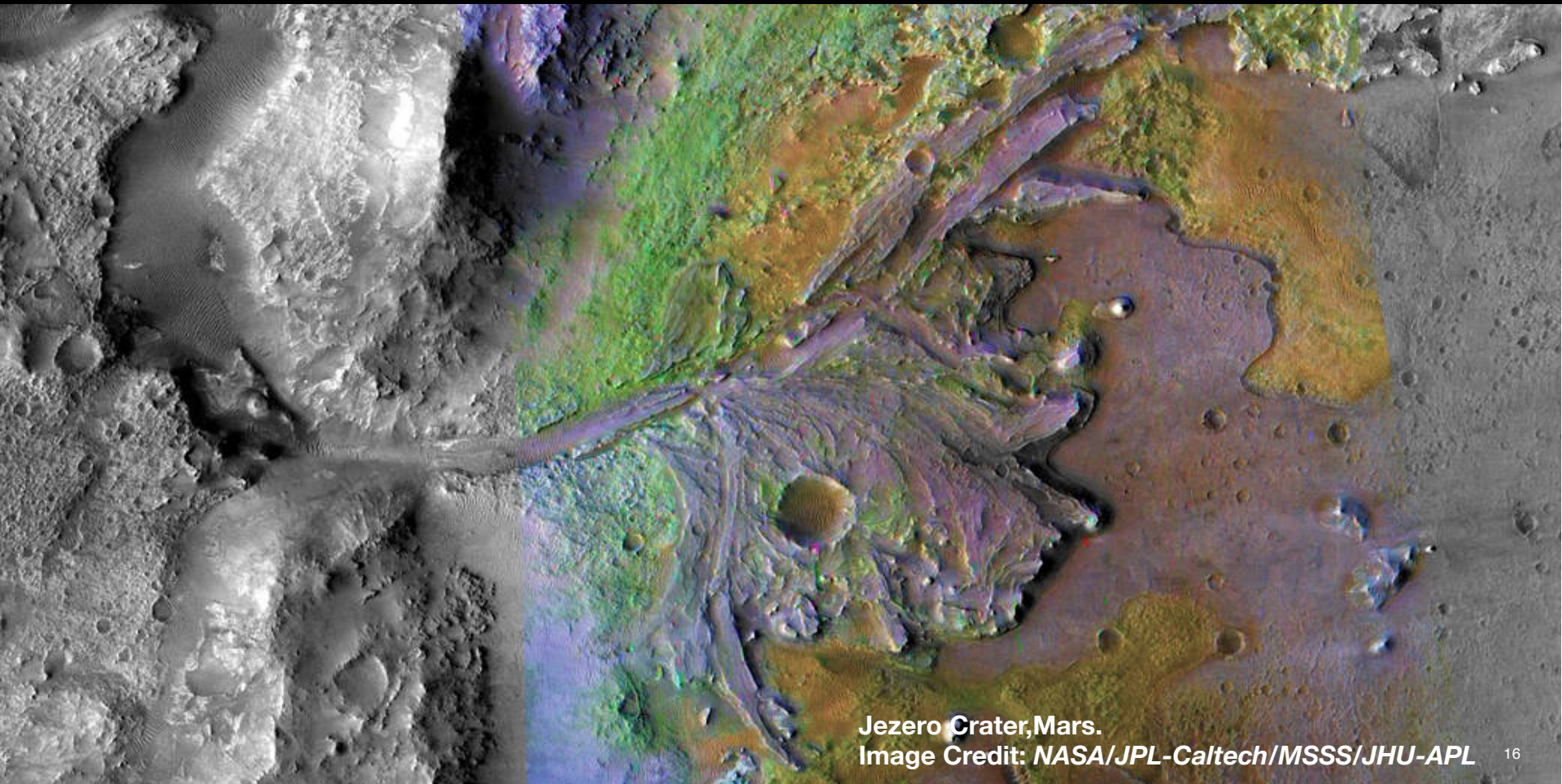
Hubble Deep Field image. Image credit: NASA

NASA Mars 2020 – Perseverance Rover with Ingenuity Mars Helicopter



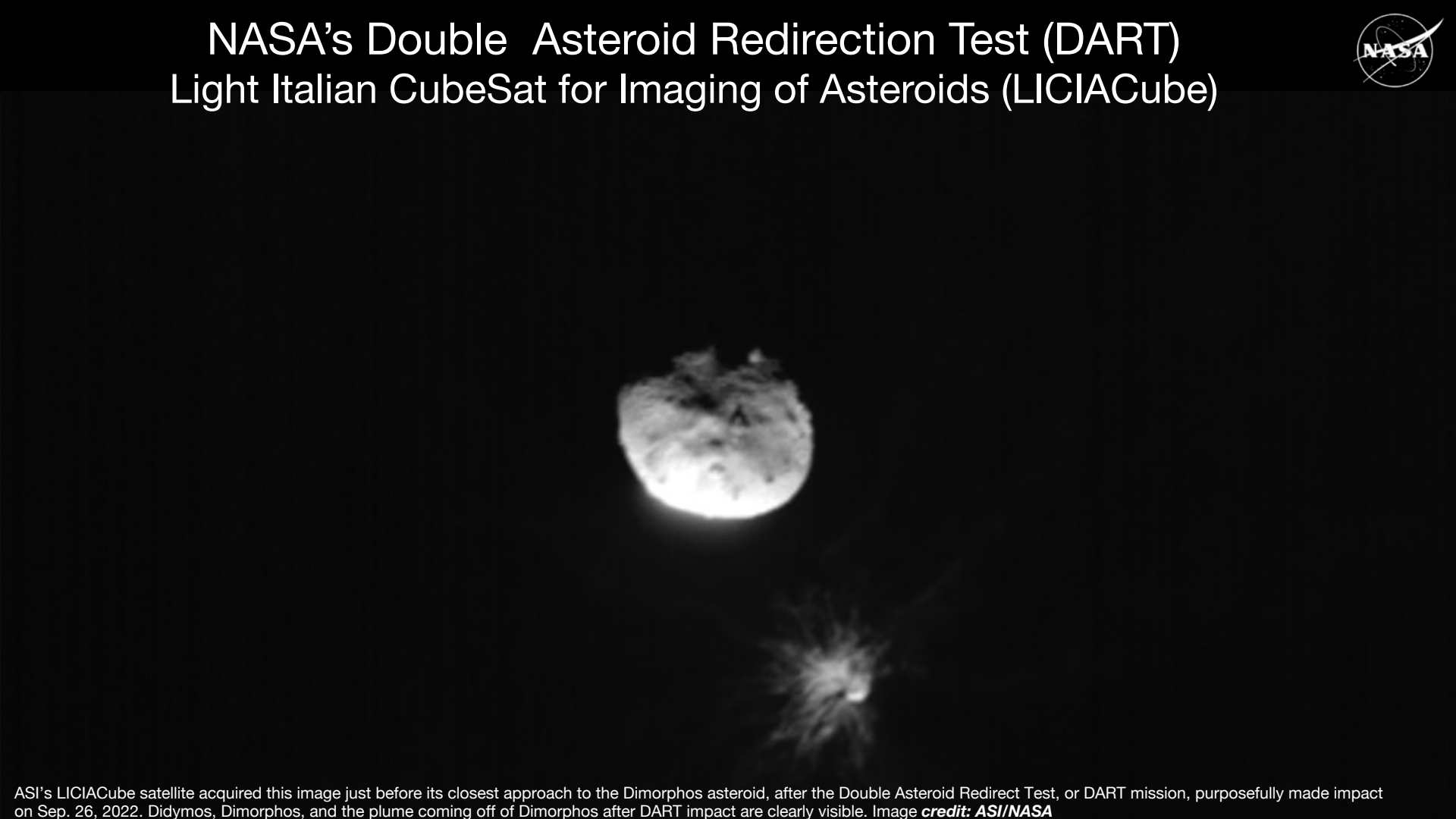
Perserverance selfie with Ingenuity.
Image Credit: NASA / JPL-Caltech/MSSS

NASA Mars 2020 Mission Destination – Jezero Crater, Mars



Jezero Crater,Mars.
Image Credit: *NASA/JPL-Caltech/MSSS/JHU-APL*

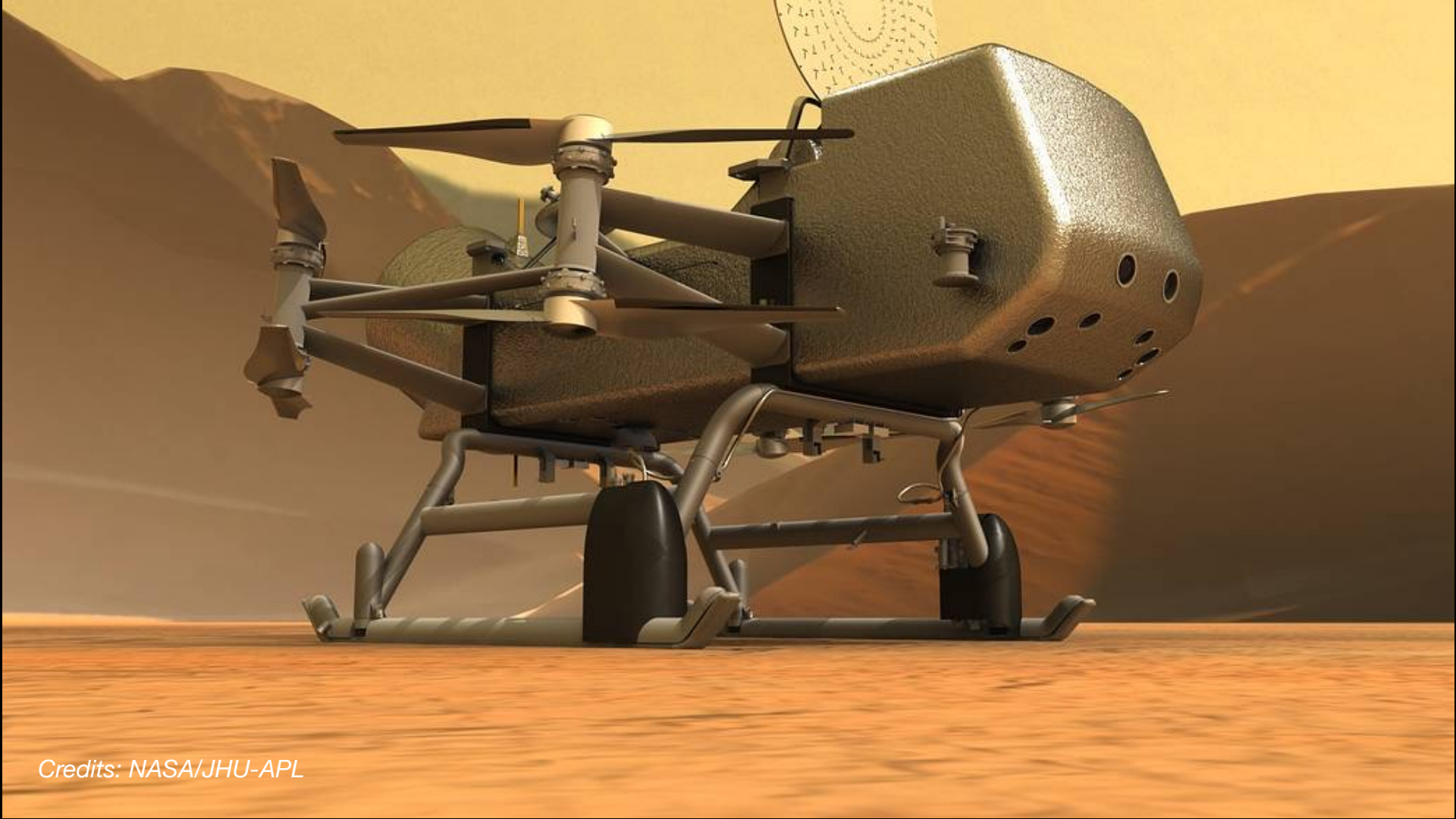
NASA's Double Asteroid Redirection Test (DART)
Light Italian CubeSat for Imaging of Asteroids (LICIACube)



ASI's LICIACube satellite acquired this image just before its closest approach to the Dimorphos asteroid, after the Double Asteroid Redirect Test, or DART mission, purposefully made impact on Sep. 26, 2022. Didymos, Dimorphos, and the plume coming off of Dimorphos after DART impact are clearly visible. Image ***credit: ASI/NASA***

NASA's Artemis Program

Orion Gazes at Moon Before Return to Earth
Image Credit: NASA



Credits: NASA/JHU-APL


NASA