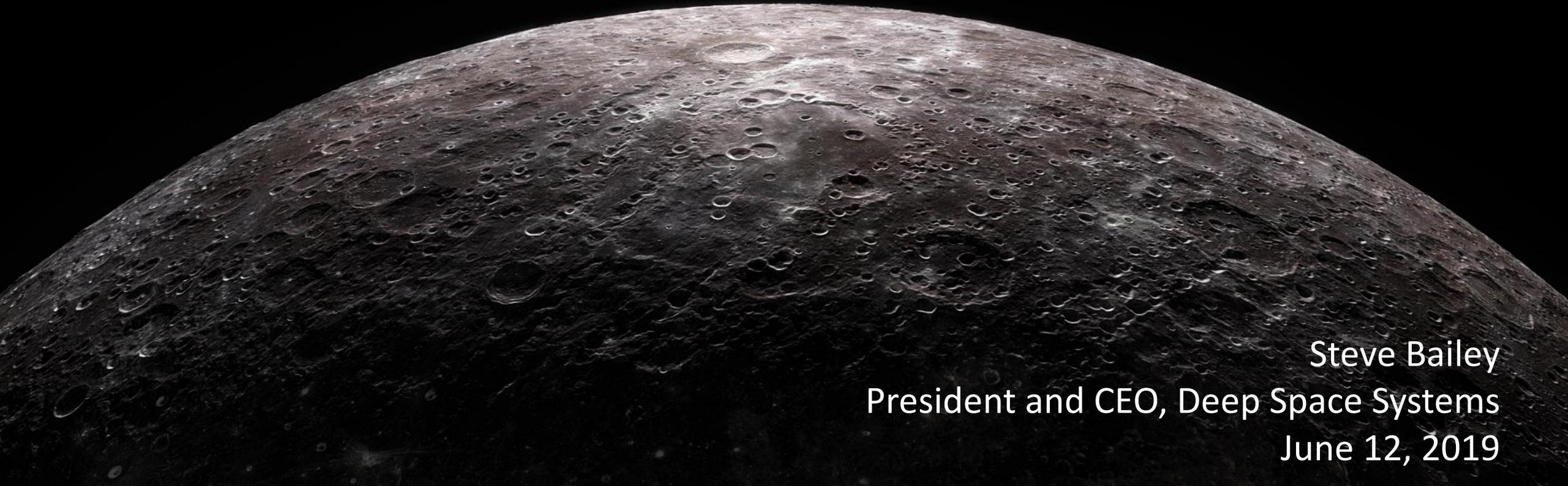


## Commercial Lunar Payload Services Overview

Space Resources Roundtable and Planetary and Terrestrial  
Mining Sciences Symposium, Colorado School of Mines



Steve Bailey  
President and CEO, Deep Space Systems  
June 12, 2019

# DSS Founder, President and CEO



Steve Bailey

- Founded Deep Space Systems in 2001
- Guided company from 1 person to 65 employees
- Expanded to include spacecraft flight hardware in 2016



➔  
**MARS**



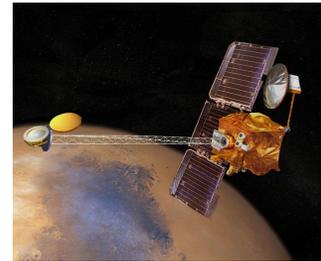
1996  
Mars Pathfinder  
Jet Propulsion Lab



1998  
Lander Design Lead  
Mars Polar Lander



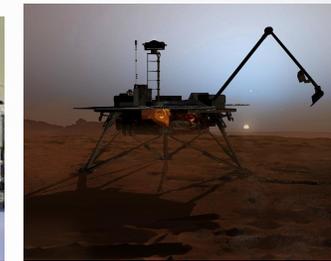
1998  
Mars Polar Lander



2001  
Mars Odyssey



2005  
Orbiter Design Lead  
MRO

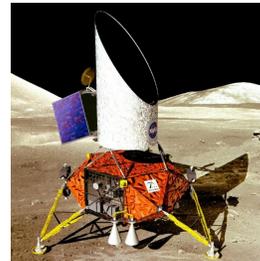


2008  
Mars Phoenix

➔  
**MARS**  
Missions



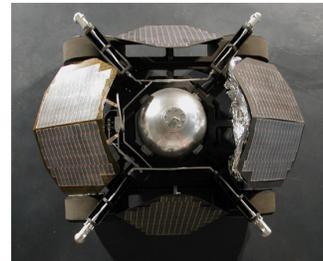
➔  
**MOON**



1991  
Program Manager JSC  
Artemis Lunar Lander



1994  
Clementine II  
Jet Propulsion Lab



1999  
Lander Design Lead  
Blastoff! (Idealab)



2003 / 2005  
Lander Design Lead  
MoonRise (New Frontiers)



2004  
Lander Design Lead  
Copernicus (Discovery)



2013  
Lander Design Lead  
Moon Express



➔  
**MOON**  
Missions

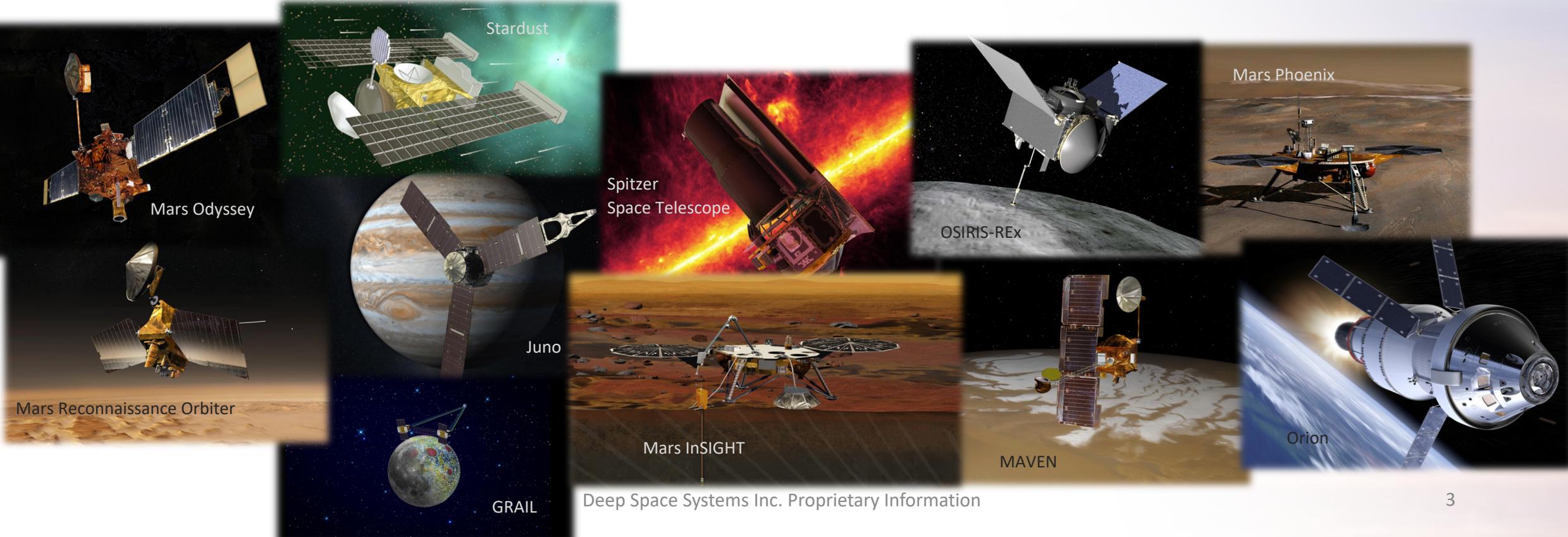
# DSS Engineering Bench Strength

15 DSS space system contracts (including all the missions illustrated below)

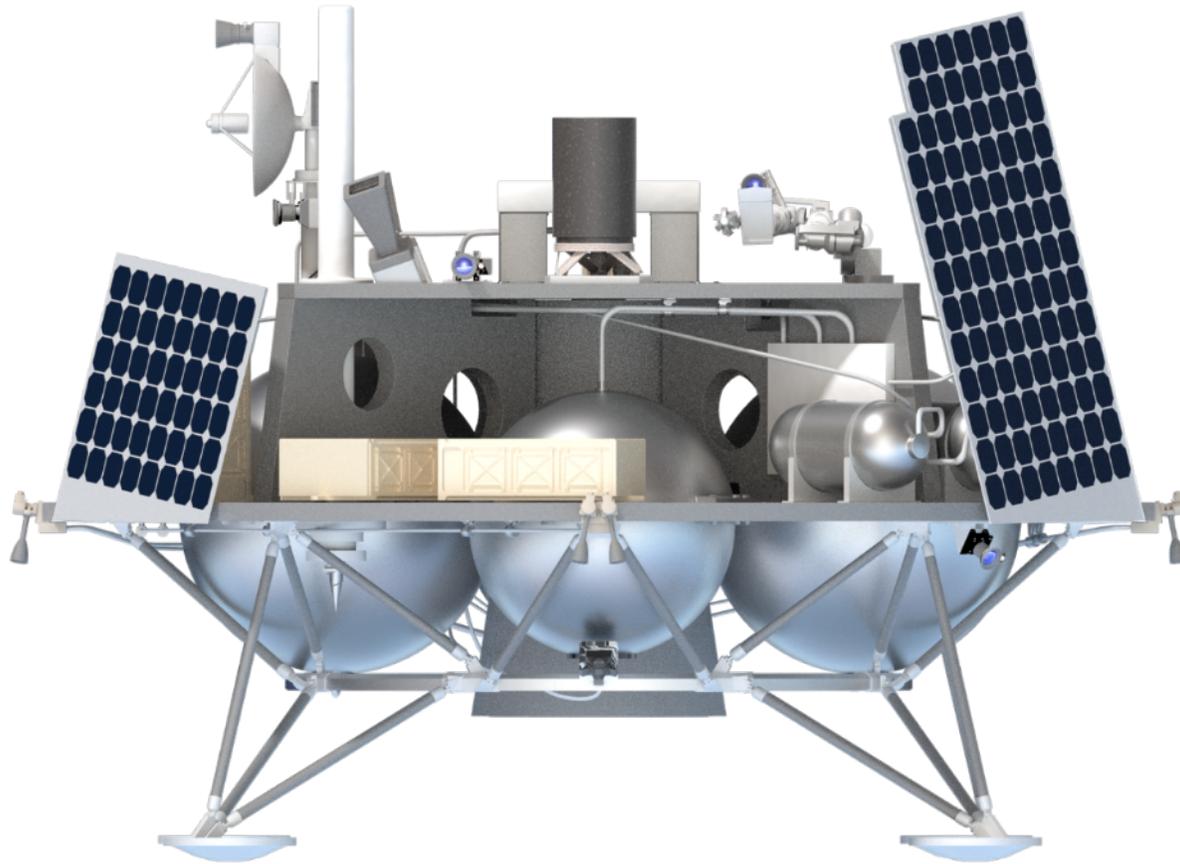
DSS Team Members have worked on 25+ other space flight programs

Experience on human, robotic, government and commercial programs

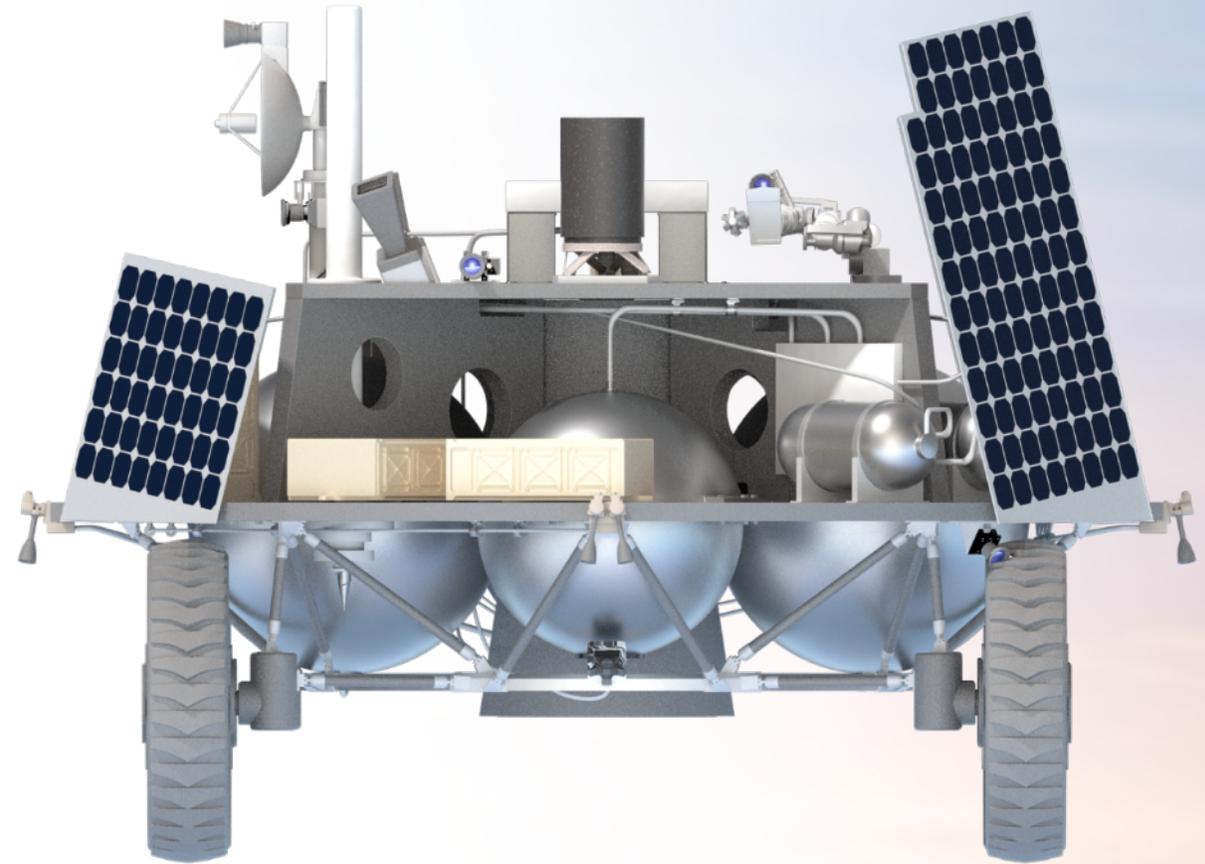
+700 years of spacecraft formulation, development, build, test and operations



# The DSS Accommodates Cubesat Deployment from High and Low Orbit and Features a Rotary Percussive Drill and Sample Acquisition System as Standard Equipment



Fixed Base Lander



With Mobility System

# DSS Midsize Lander

## Payload Summary

**Mass:** up to 100 kg

**Volume:** 3.36 m<sup>3</sup>

**Power:** 400 W (all mission phases)

**Comm:** 1-10 Mbps downlink

**Destination:** High Latitude Sites

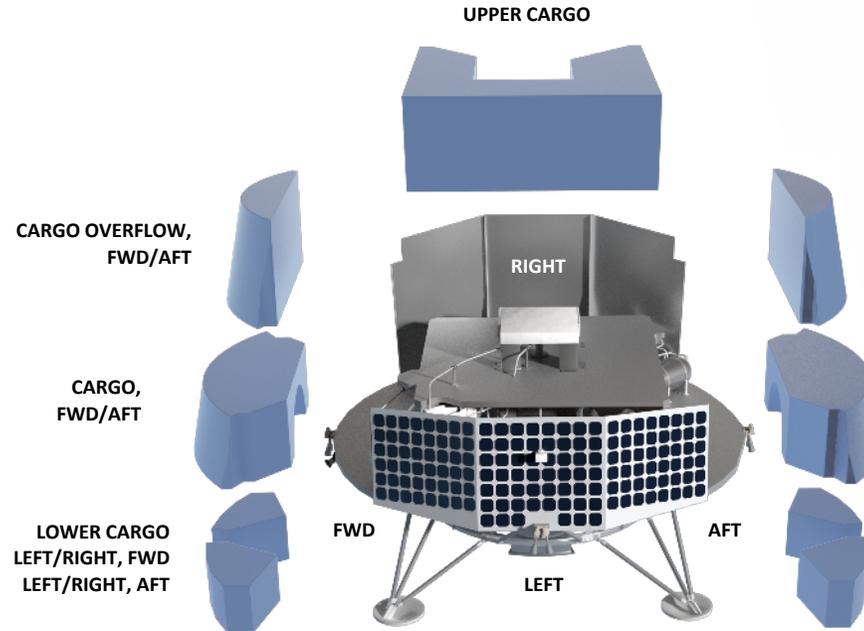
**Landing:** DSS Midsize Lander

## Payload Volumes

- Upper Cargo: 0.9 m<sup>3</sup>
- 2X Cargo Overflow: 0.26 m<sup>3</sup>
- 2X Cargo: 0.85 m<sup>3</sup>
- 4X Lower Cargo: 0.06 m<sup>3</sup>

## Standard Payload Features:

- Multiple Data Interfaces
  - < 1 Mbps: UART serial over RS-422, RS-485, LVDS
  - >= 1 Mbps: 10/100/1000 Ethernet, SPI over LVDS
  - Available: SPI, I2C, USB, Spacewire, MIPI CSI, Quad-SPI, I2S, 1553, Wi-Fi, CAN, low-voltage discretes, high-voltage discretes, and RS-422 differential discretes, heater control
- Multiple Power Interfaces:
  - Preferred: 28V
  - Available: 12V, 5V, or selectable voltage above/below 28V
- Data Storage: 1000 GB (1 TB)
- Payload Survival Heaters (two wire system)
- HiRes Camera Package (6 VisCams)
- Orbital/Surface Cubesat Deployment (1U up to 27U)



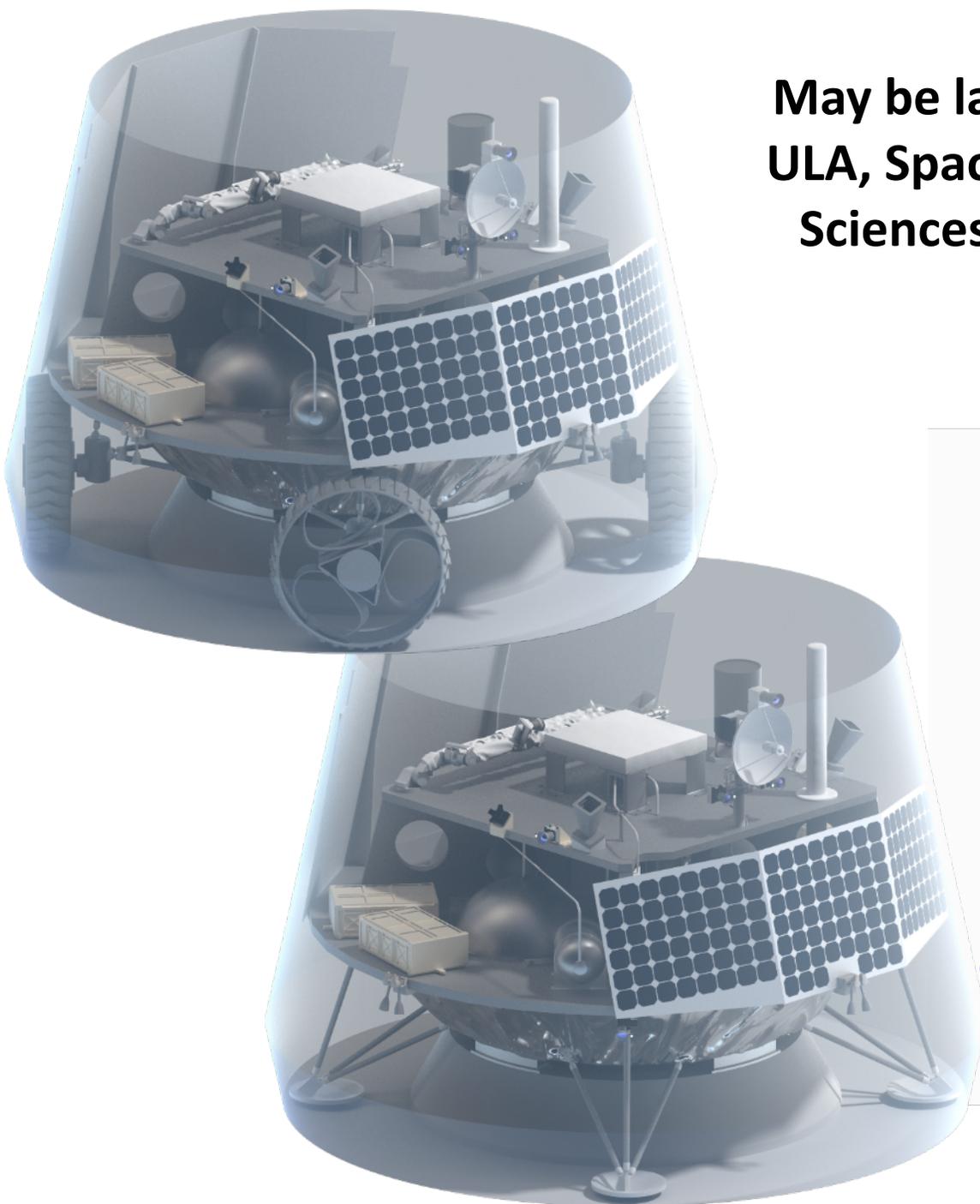
## Special Lunar Science Features:

- Surface Roving Operations (up to 3 km/hr)
- 1 m Rotary Percussive Drill
  - Sample Delivery to Payloads
- Propulsive Hop Mobility (up to 4 km)
- Lunar Night Survivability
- Easy Access to Surface

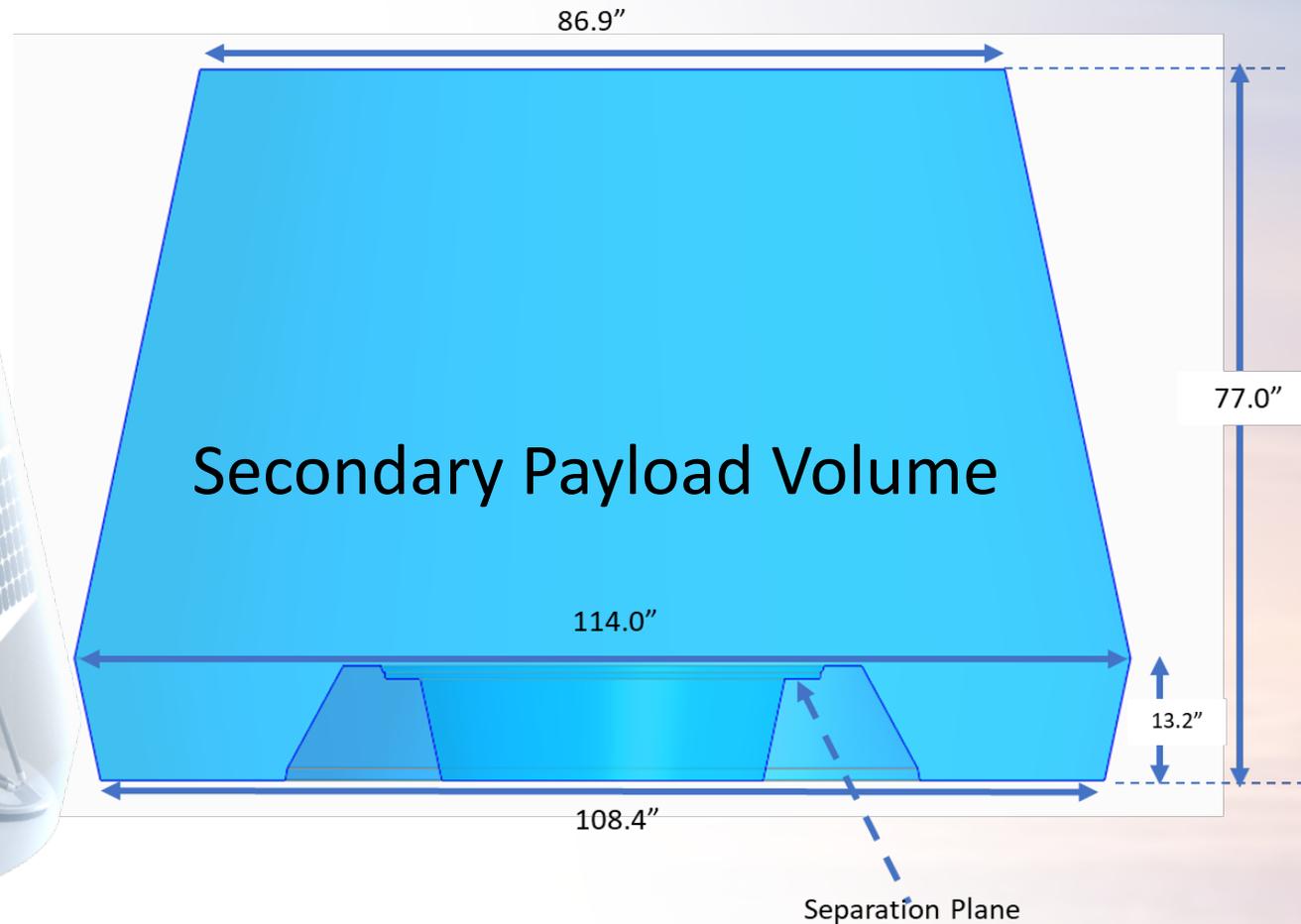
## More Options and Services:

- 6 DOF Robotic Arm and Appendages
- Mast Mounted Payloads
- Auxiliary Solar Panels
- High Capacity Battery (60 Ahr)
- Up to 6 TB of Data Storage
- UHF Data Relay to Orbit (>128 Kbps 2 way)
- Payload Dedicated i5 Computer
- WiFi and/or WiGig Surface Radio Systems
- Custom Camera System
- Complete Payload Design, Development, Test and Integration Service
- Surface Cubesat Deployment (1U to 16U)

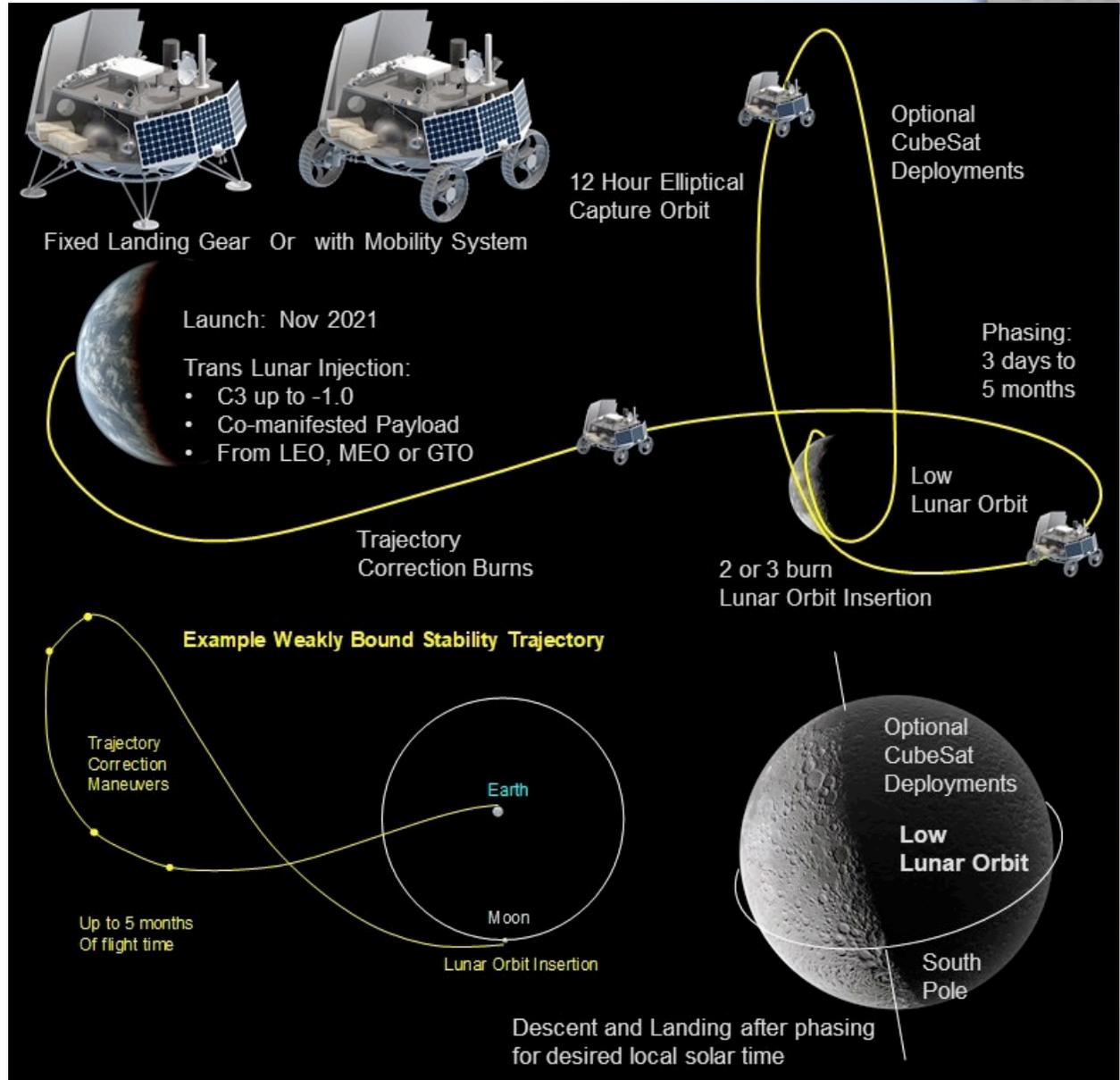
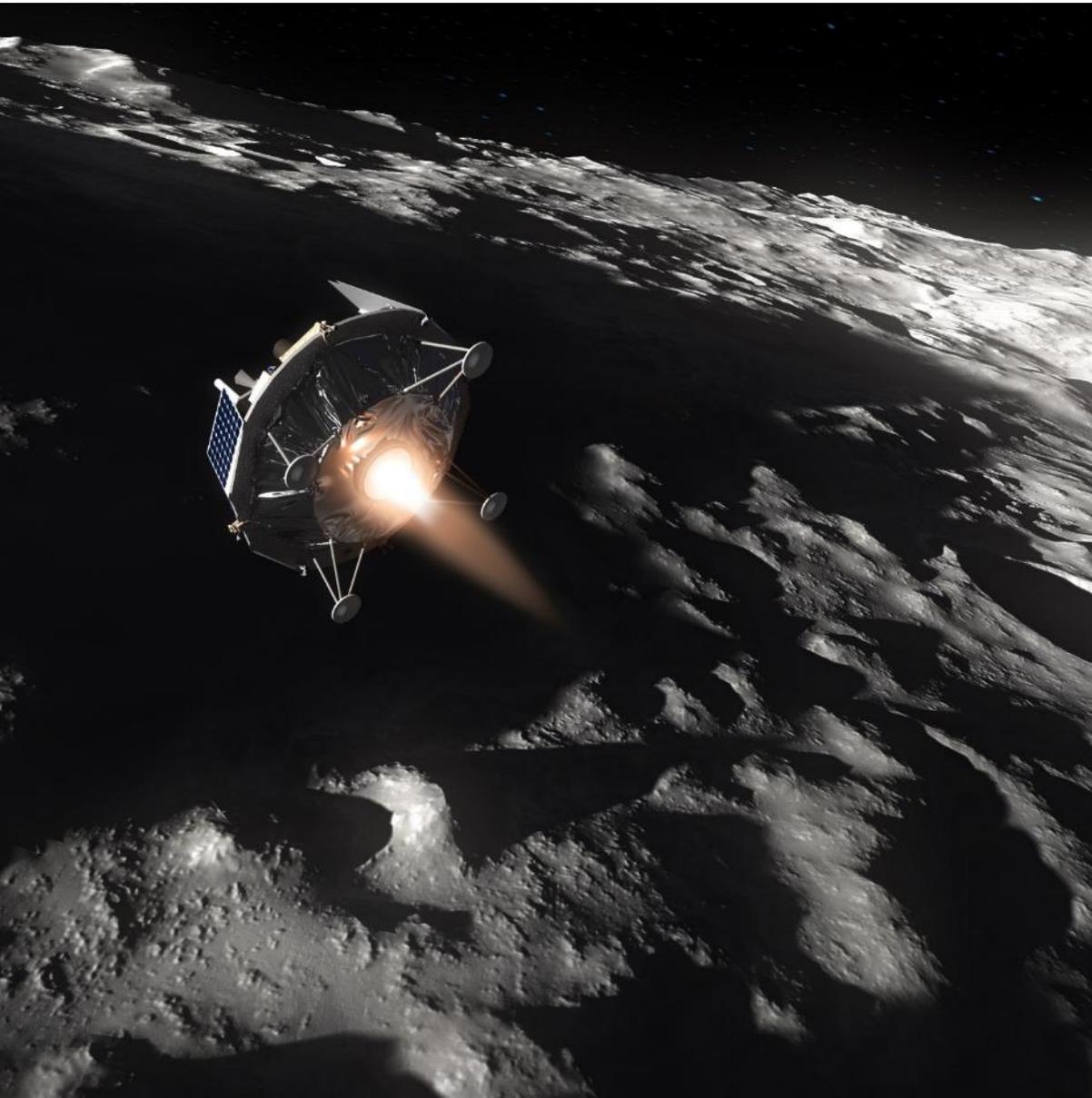
May be launched as a secondary payload on ULA, SpaceX, Blue Origin, Arienne, or Orbital Sciences Launch Vehicle from LEO or GTO.



## Primary Payload

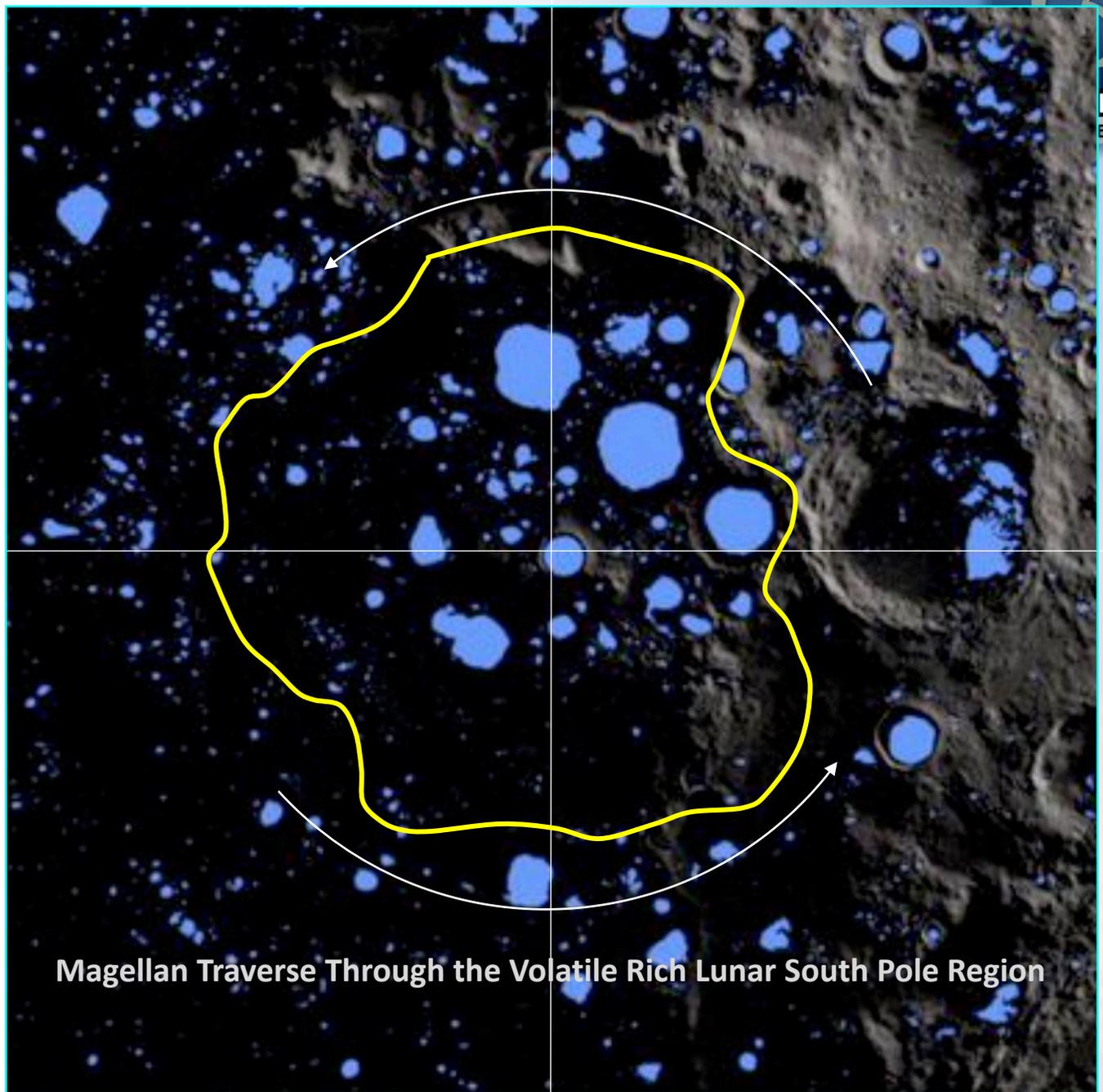
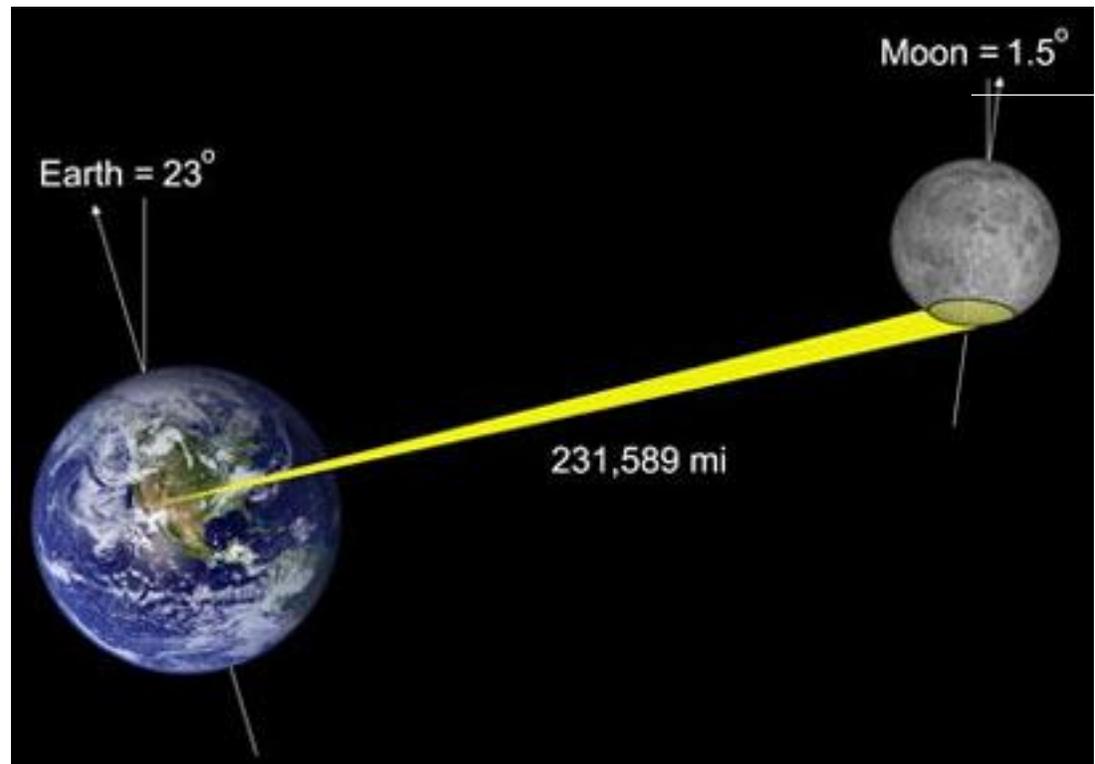


# Deep Space Systems Awarded NASA Commercial Lunar Payload Services (CLPS) Contract Nov 29, 2018



We plan to move and drill, move and drill, move and drill, always seeking the most abundant, pure, accessible and favorably situated sources of water ice.

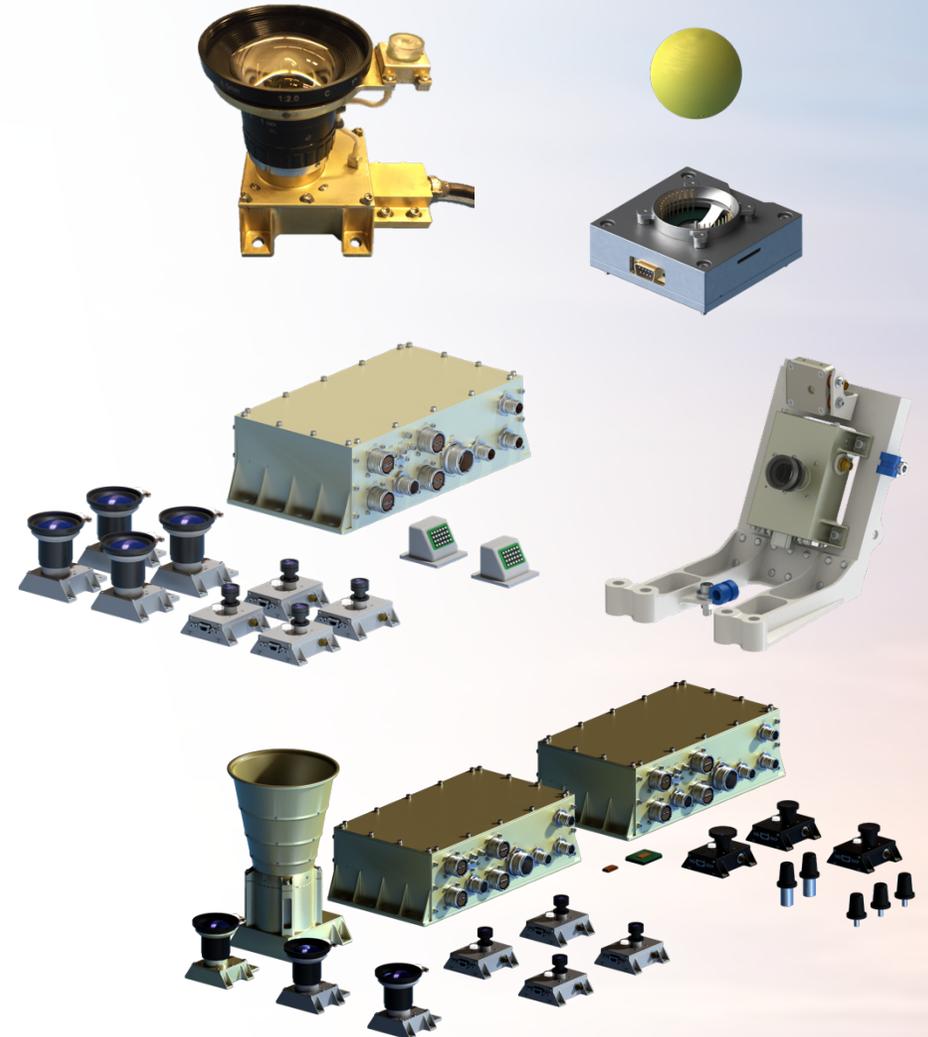
The Mobility System allows us to circumnavigate the volatile rich polar region, racing, at 1 km/hr, to stay ahead of sunset.



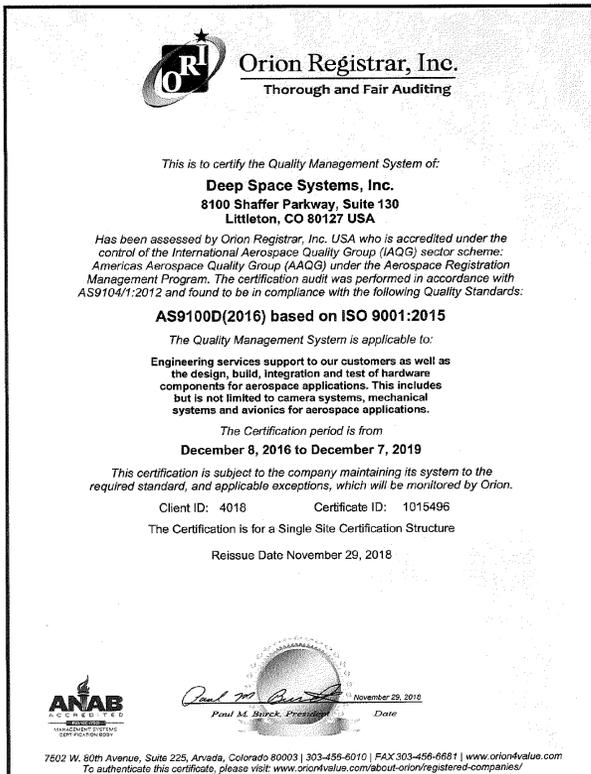
Magellan Traverse Through the Volatile Rich Lunar South Pole Region

# DSS Space Hardware

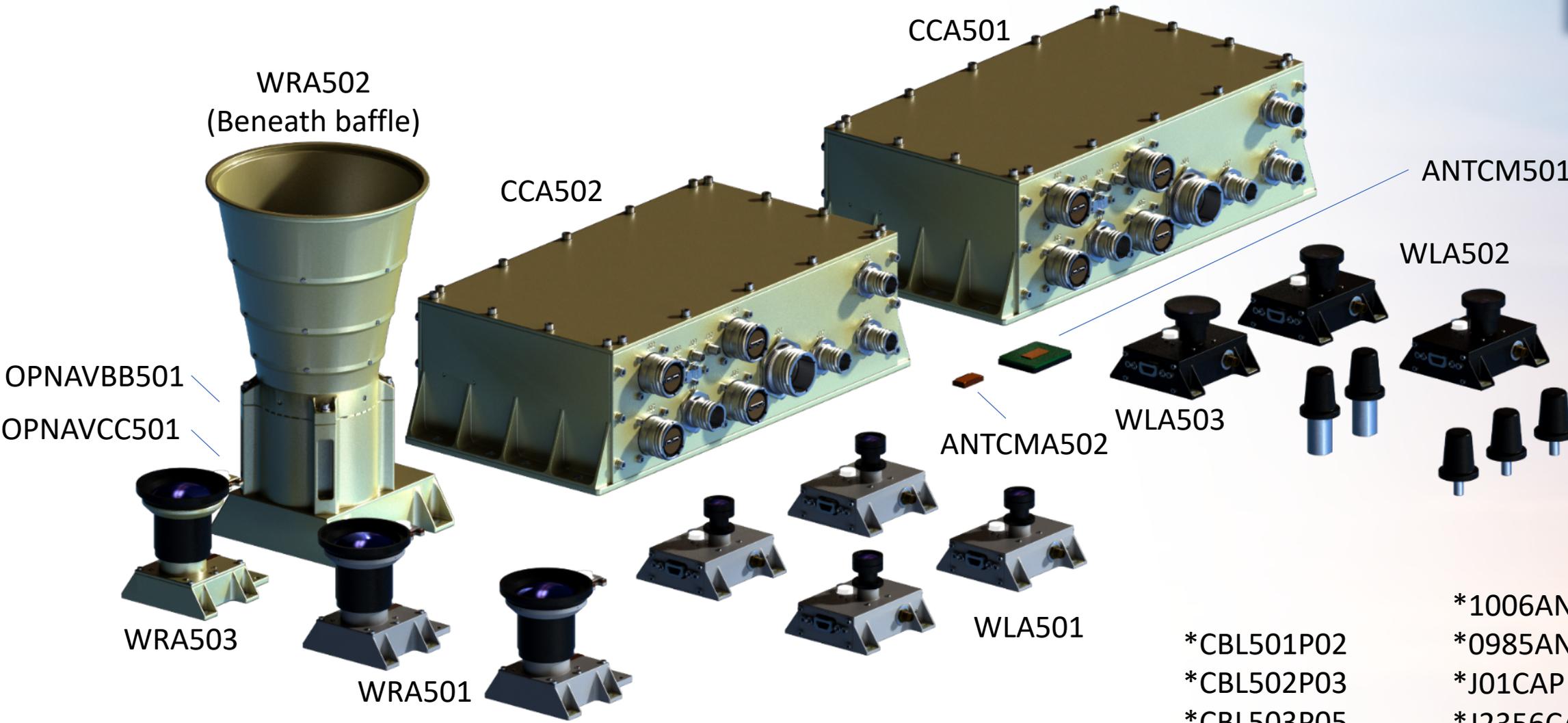
- Space-Hardened Cameras
- Spacecraft Avionics
- Data Acquisition and Recovery Systems
- Flight Computers
- Class D/Crit 3 to Crit-1S (Human Space Flight Rating)



DSS Quality Management Systems are certified to AS9100-D standards



# Orion Camera System



- \*1006ANTU501
- \*0985ANTG501
- \*J01CAP
- \*J2356CAP
- \*CBLWLA501P02
- \*CBL501P02
- \*CBL502P03
- \*CBL503P05
- \*CBL504P06

\*DSS Provided Flight Harness and Coax not shown

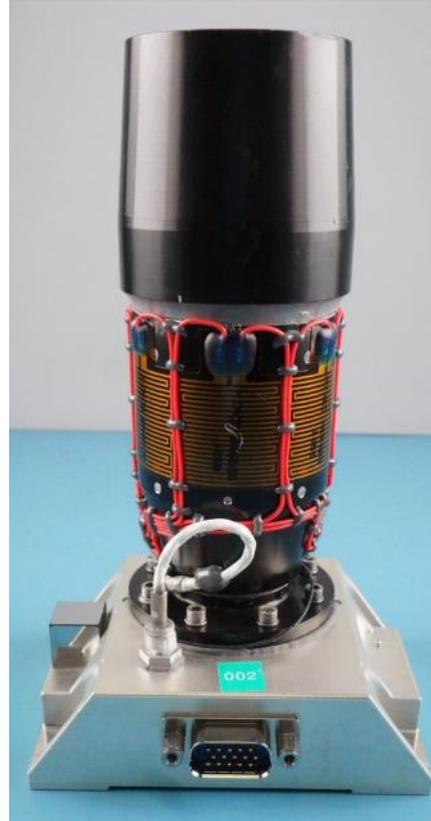
# Jasper Camera System Shipset



02-01-CAM-00-502



02-01-CAM-00-501



02-01-CB-00-501

\*02-01-CBL-00-501

\*02-01-CBL-00-502

\*DSS Provided Flight Harnesses not shown

# Dream Chaser Video/Camera System Shipset



\*03-01-USBC-00-501

\*03-01-WLAC-00-501

\*03-01-P05C-00-501

\*DSS Provided Flight Harnesses not shown



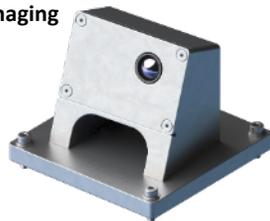
ACE  
MS

# DARS – Data Acquisition and Recovery System

# DSS MicroCapsule – Potential Applications



DARS Visible Imaging Video Camera AKA VisCams



DARS Visible Imaging LED Flood Light AKA Floodlights

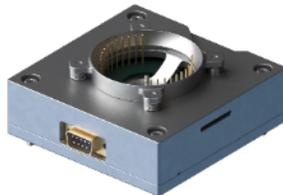
Data Return Capsule (DRC)



Data Acquisition and Recovery System

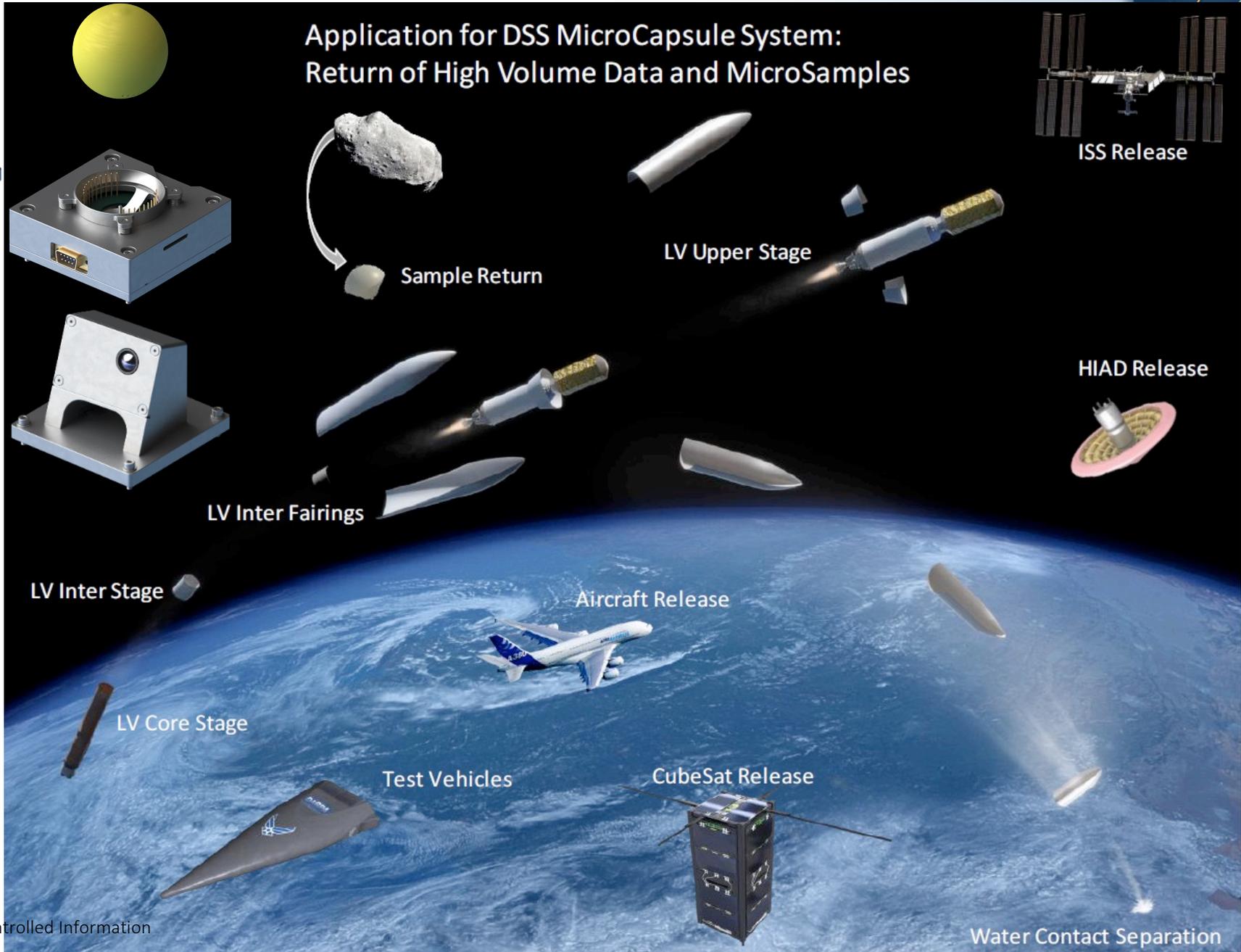


DARS Retention and Release System AKA Power and Data Controller (PDC)

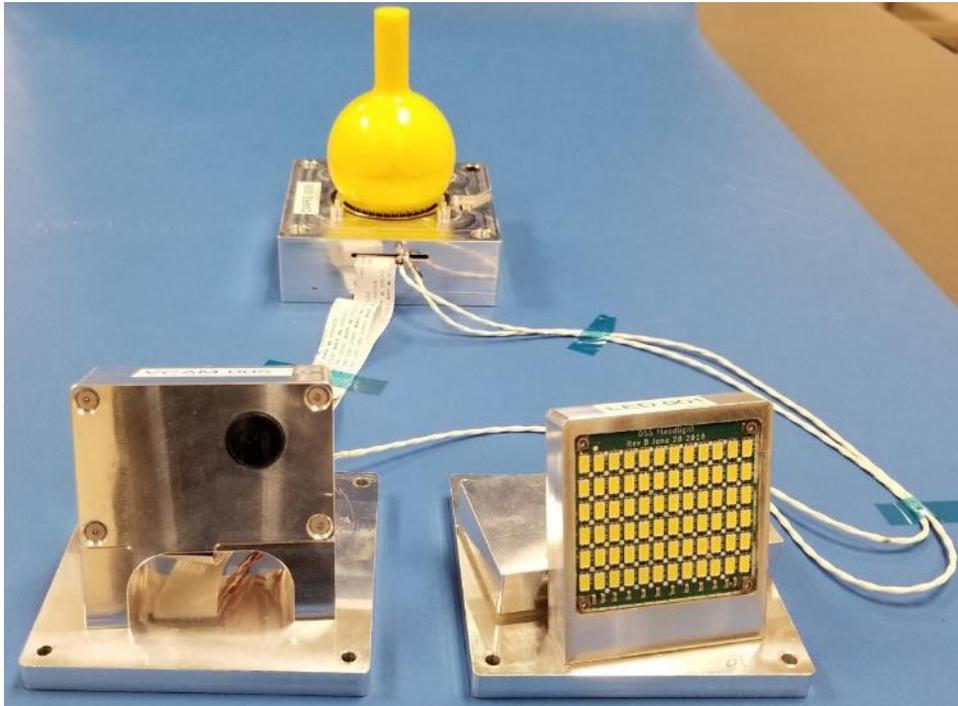
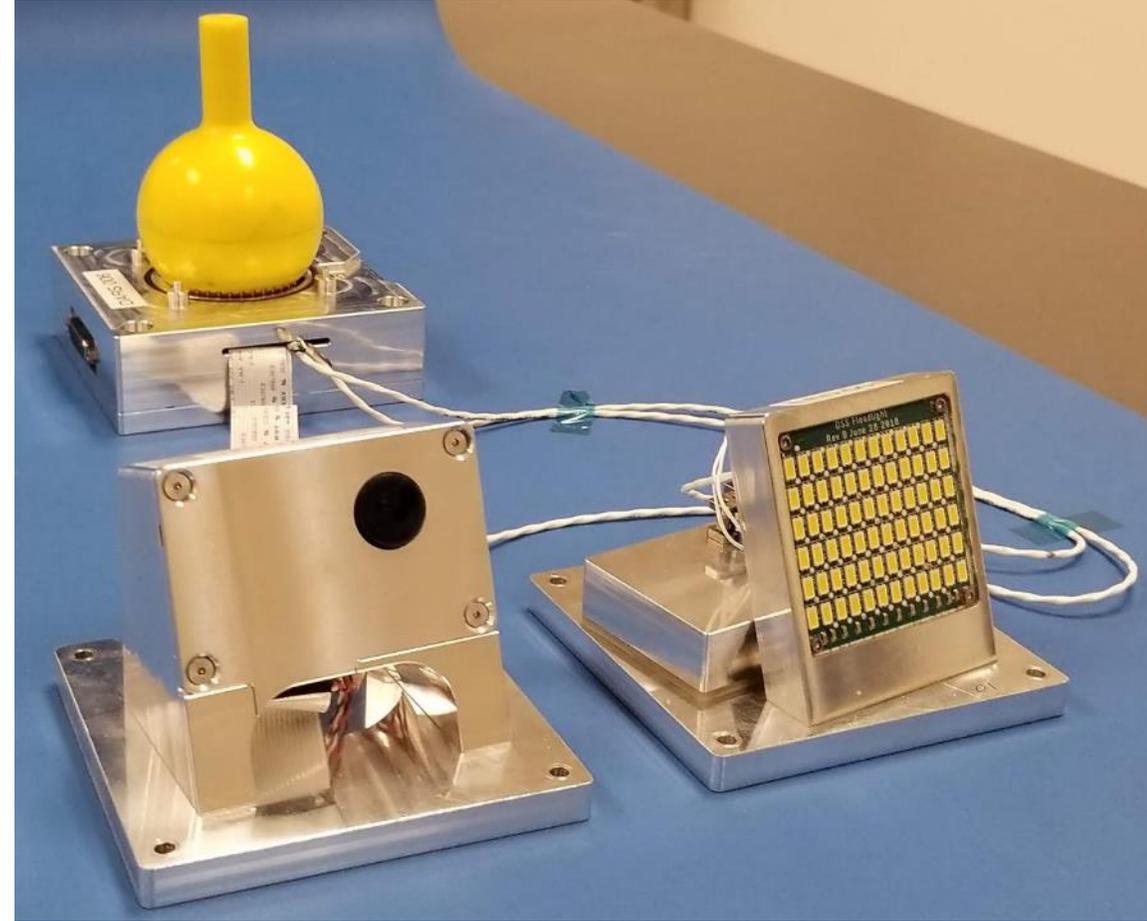
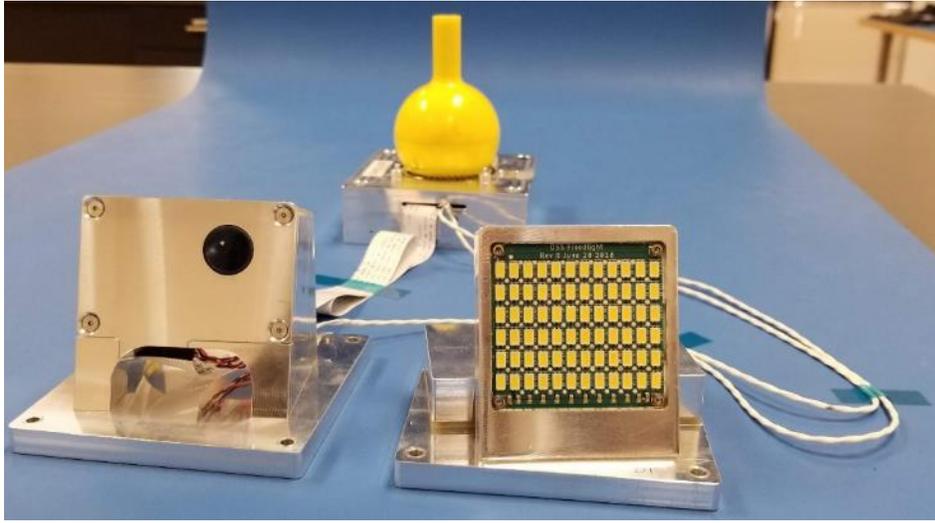


DARS LoRa Mobile Ground Station

Contains Export Controlled Information



# DARS, Camera and Floodlight Qualification Hardware





# DSS In-House Test Capabilities Include: Vibe, Shock, Thermal Vacuum, Calibration and RF Performance

Shock & Vibration Testing  
(Up to 45 GRMS for Cameras)

Thermal Vacuum and  
Thermal Cycle Testing  
Chamber 2 and 3





# DSS Flight Hardware Production Facilities



# DSS Customers

