Cislunar Autonomous Positioning System Technology, Operations, and Navigation Experiment (CAPSTONE)

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CAPSTONE
Mission Objectives

1. Validate and demonstrate NRHO / highly dynamic Earth-Moon Operations
2. Inform future lunar exploration requirements and operations
3. Demonstrate and accelerate the infusion of the Cislunar Autonomous Positioning System (CAPS)

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CAPSTONE
Hardware

- CAPSTONE is a 12U CubeSat designed and built by Tyvak Nano-Satellite Systems
- Non-payload hardware includes:
  - a color commercial CMOS imager (resolution 4096x3000)
  - two low gain X-Band for transmitting and receiving
  - two high gain X-Band for transmitting
  - an S-Band patch array antenna

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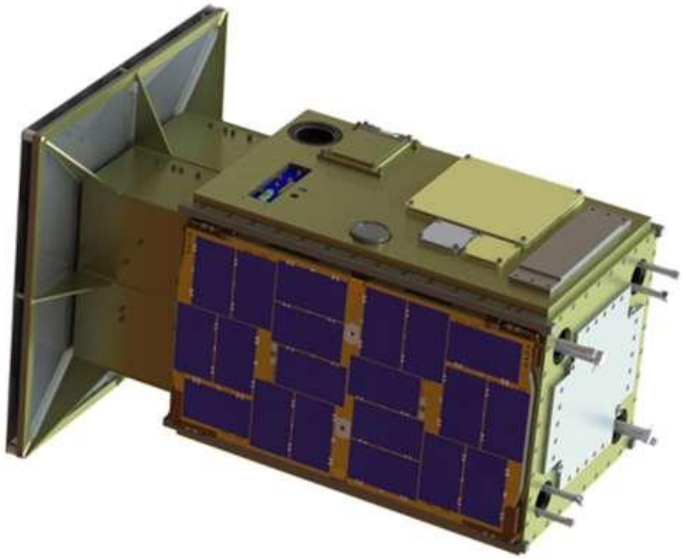
CAPSTONE
Propulsion System

- Propulsion system is designed and built by Stellar Exploration, Inc
- System Overview:
  - monopropellant hydrazine fuel
  - 200 m/s of total delta-V
  - Eight 0.25-Newton thrusters
  - Four thrusters for translational maneuvers and attitude control
  - Four thrusters for attitude control and momentum desaturation



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CAPSTONE
Payloads

1) CAPS navigation software
   - Hosted on separate flight computer, distinct from primary board
2) Chip Scale Atomic Clock (CSAC)
   - Used for generating additional navigation data

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CAPSTONE
Mission Overview

Launch

- Vehicle: three-stage Electron, developed by Rocket Lab

Ballistic Lunar Transfer (BLT)

- A type of low-energy transfer in which a spacecraft utilizes the Sun's gravity to modify orbital perigee and inclination
- Three to four months of travel until insertion to the NRHO

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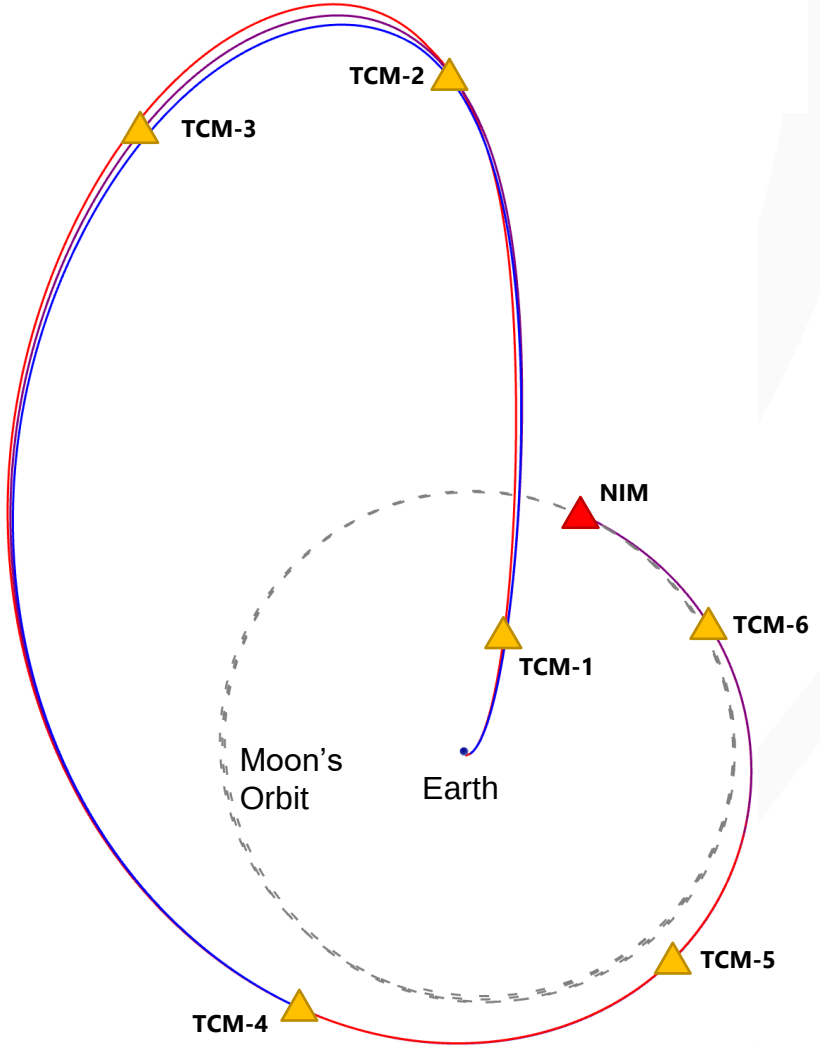
CAPSTONE
Mission Overview

Trajectory Correction Maneuvers (TCMs)

- All maneuvers conducted by spacecraft
- clean up launch vehicle errors
- correct for navigation and maneuver execution errors
- target the insertion maneuver timing to achieve an Earth-eclipse free NRHO

Insertion to Near Rectilinear Halo Orbit (NRHO)

- NRHO Insertion Maneuver (NIM) is on the order of 20 m/s



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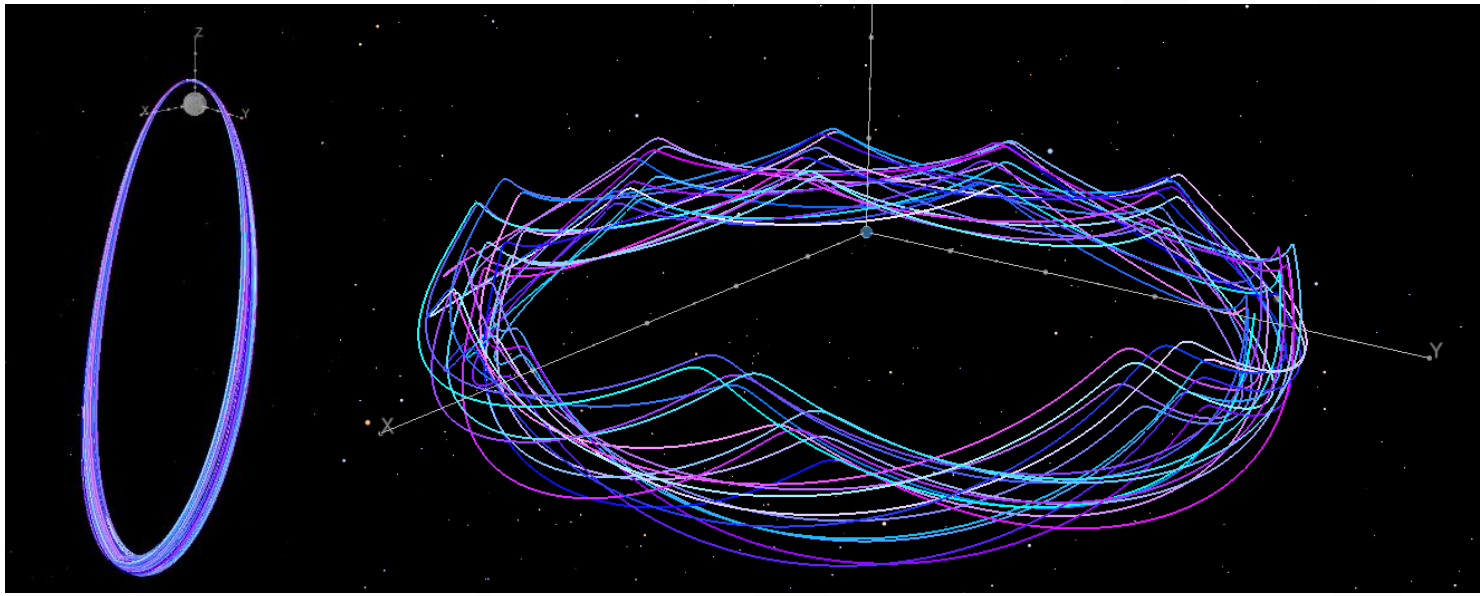
CAPSTONE
Mission Overview

CAPSTONE will operate in the same sized orbit targeted by Gateway: a 9:2 resonant, southern L2 NRHO.

NRHO Reference Orbit (NRO) is designed to avoid Earth eclipses for the duration of the primary and enhanced mission (18 months)

NRHO Reference Orbit in the Earth-Moon Rotating (left) and Sun-Earth Rotating (right) Frames



CAPS Overview

- From 2017 to 2021 CAPS development has been supported via NASA SBIR through Goddard Space Flight Center.
- CAPS starts with the algorithms and logic of automated navigation layered on top of an innovative approach to absolute orbit determination.
- Continued funding is expanding the data types ingestible by CAPS, widening its navigation capabilities in the cislunar environment.

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CAPSTONE
Crosslink Demonstration

- To demonstrate and accelerate the infusion of CAPS, CAPSTONE will perform several crosslinks with the Lunar Reconnaissance Orbiter (LRO).
- These crosslink tracking passes will provide two-way, coherent range and Doppler measurements.
- Flight software will demonstrate CAPS in flight, while also downlinking the CAPSTONE-LRO crosslink data to the ground for further refinement and development.

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Current CAPSTONE Status

- Propulsion system has been delivered for integration into the spacecraft.
- NTIA approval has been received
- Hardware integration and testing is underway.
- FAA license to fly at the Moon has been approved
- No current roadblocks

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Acknowledgements

CAPSTONE is supported by NASA's Space Technology Mission Directorate through the Small Spacecraft Technology program and by the Human Exploration and Operations Mission Directorate through the Advanced Exploration Systems program. CAPS is supported by NASA's Small Business Innovation Research (SBIR) program. The team would like to thank Christopher Baker, Elwood Agasid, and Roger Hunter at NASA for their support.

More Info

Visit our site for more details about CAPSTONE, and sign up to receive updates about the mission leading up to launch!

AdvancedSpace.com/missions/CAPSTONE