



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





NASA is returning to the Moon with the Artemis Program

CAPSTONE is a pathfinder mission supporting Artemis



CAPSTONE

- **Cislunar Autonomous Positioning System**
- **Technology**
 - Rapid Small Spacecraft Mission
- **Operations**
 - Ballistic Lunar Transfer
 - NHRO Operations
- **Navigation**
 - Demonstrate CAPS and Lunar Navigation
- **Experiment**
 - Learn the entire time



Rapid & Meaningful Lunar Flight Demo

- Target launch of a CubeSat class orbiter in early 2021
- Risk reduction and demonstration of key exploration operations
 - Accessibility of NRHO and experience to benefit future system operations.
 - Efficient ballistic transfer experience and demonstration of small launch system delivery options for Gateway.
 - Lunar operations and automation for NASA and non-NASA missions.
- Collaboration between NASA and Advanced Space enables future commercial services for sustainable lunar exploration.



Advanced Space

- Based in Boulder CO
- Founded in 2011 to enable the sustainable exploration, development, and settlement of space
- Our core business is delivering solutions that support and improve mission planning and operations.



Key Attributes

- ✧ Cross domain knowledge
- ✧ Integrated subject matter expertise
- ✧ Dynamic, flexible, and agile team
- ✧ Diverse experience

Core Technical Areas

- ✧ Dynamics
- ✧ Estimation
- ✧ Control

Enabling Expertise

- ✧ Systems engineering
- ✧ Mission planning and operations
- ✧ Software development and maintenance
- ✧ Data science and state-of-the-art computing
- ✧ Software-firmware-hardware interfaces and requirements

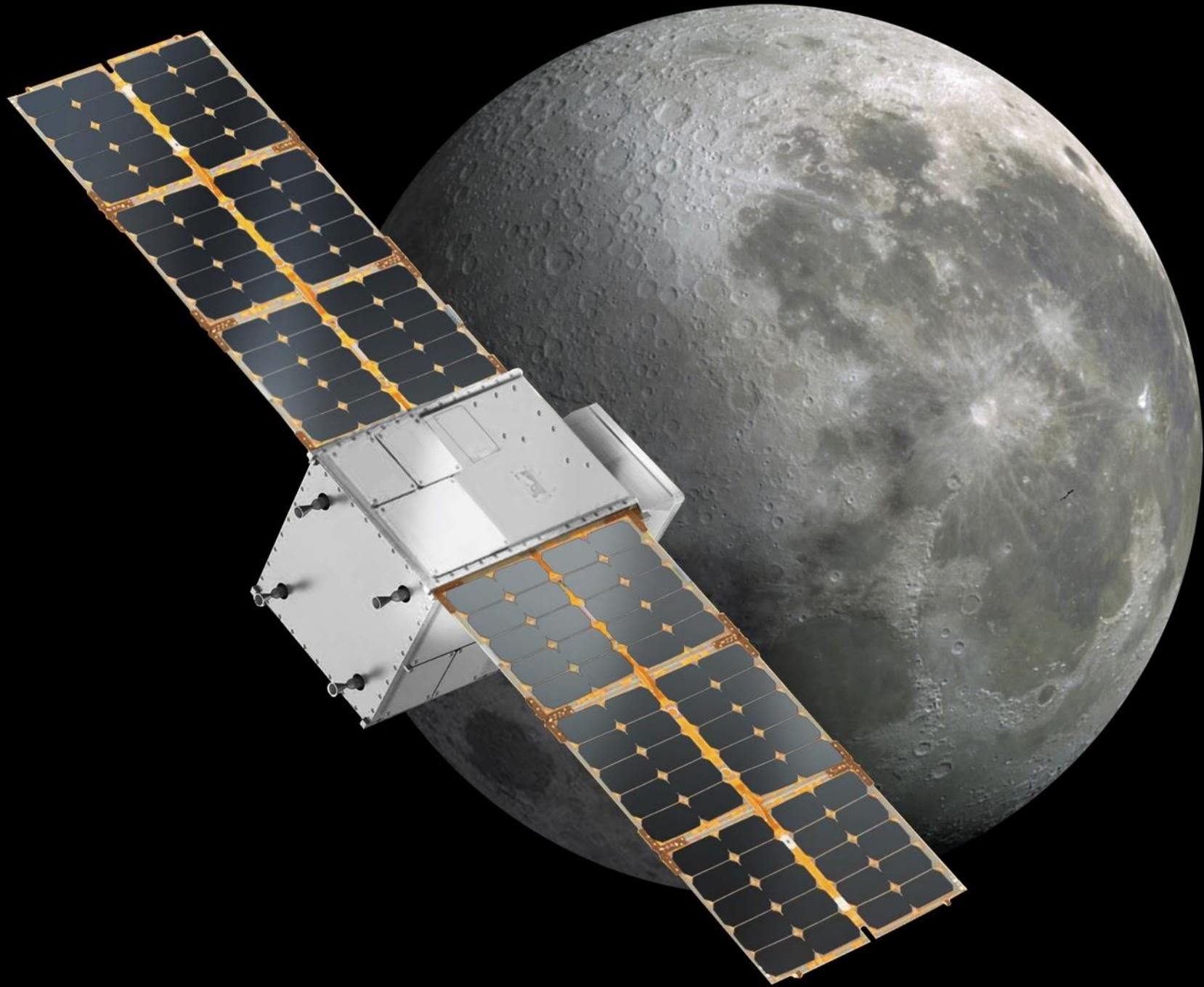


Image credit: NASA



Dedicated Launch – Early 2021

Launch by Rocket Lab from Wallops Flight Facility



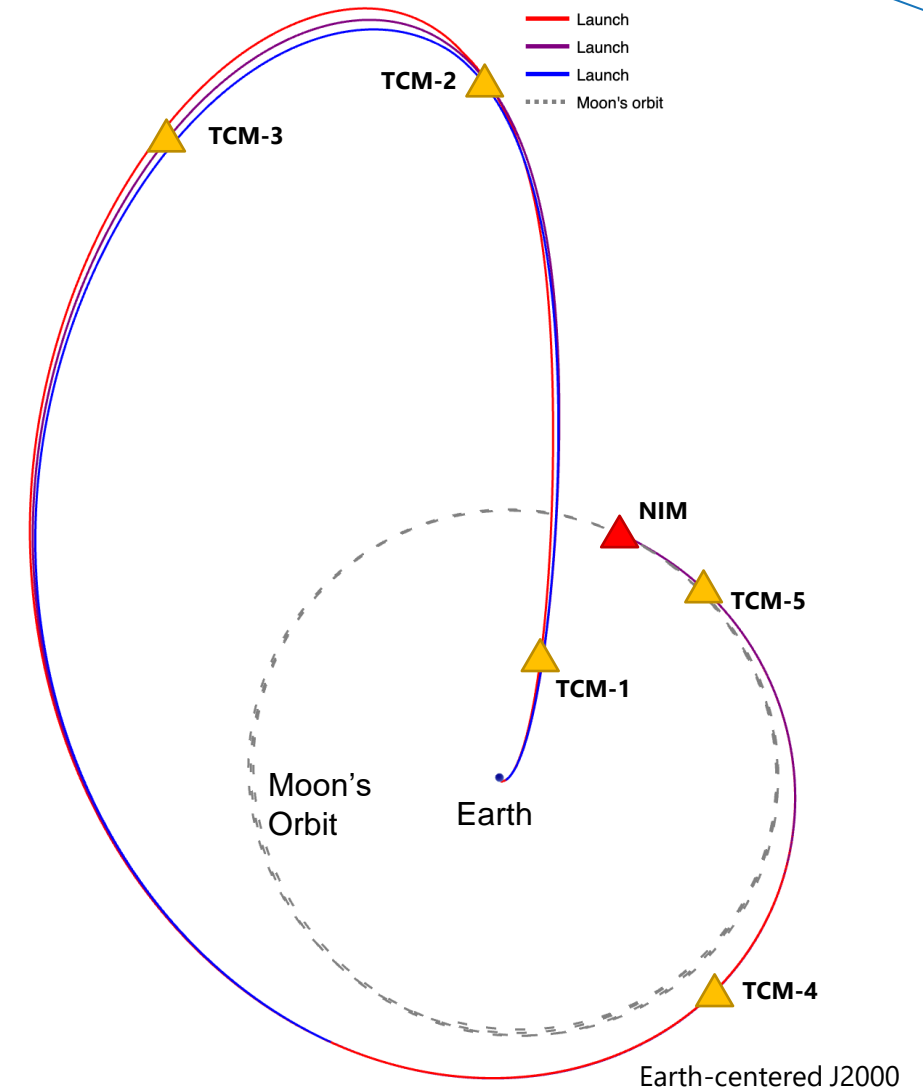
Image credit: Rocket Lab



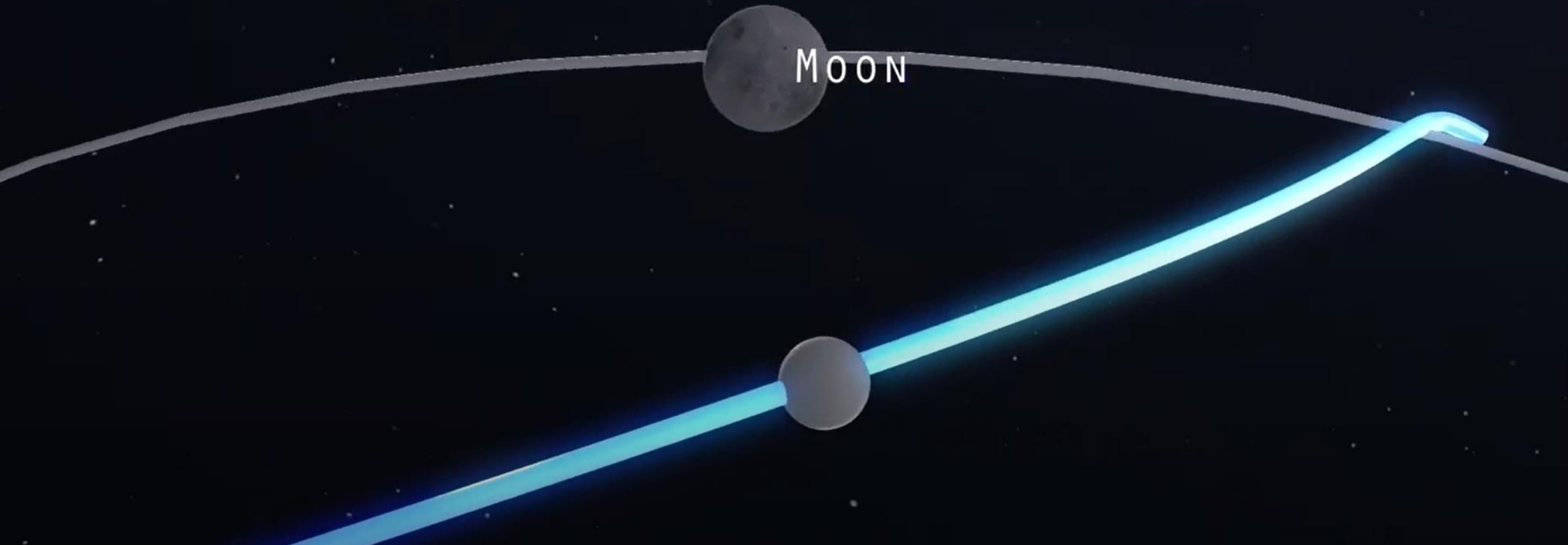
Enabled by Efficient Lunar Transfer

- TCM = Trajectory Correction Maneuver
- NIM = NRHO Insertion Maneuver

Maneuver	Purpose	Notional Timing
TCM-1	Clean up launch errors	24 hours after deployment
TCM-2	Expand launch period	30 days after deployment
TCM-3	Clean up sensitive TCM-2	50 days before NIM
TCM-4	Target NRHO insertion	10 days before NIM
TCM-5	Target NRHO Insertion	1 day before NIM



ARRIVAL INTO THE NEAR RECTILINEAR HALO ORBIT (NRHO) MUST BE PRECISELY EXECUTED





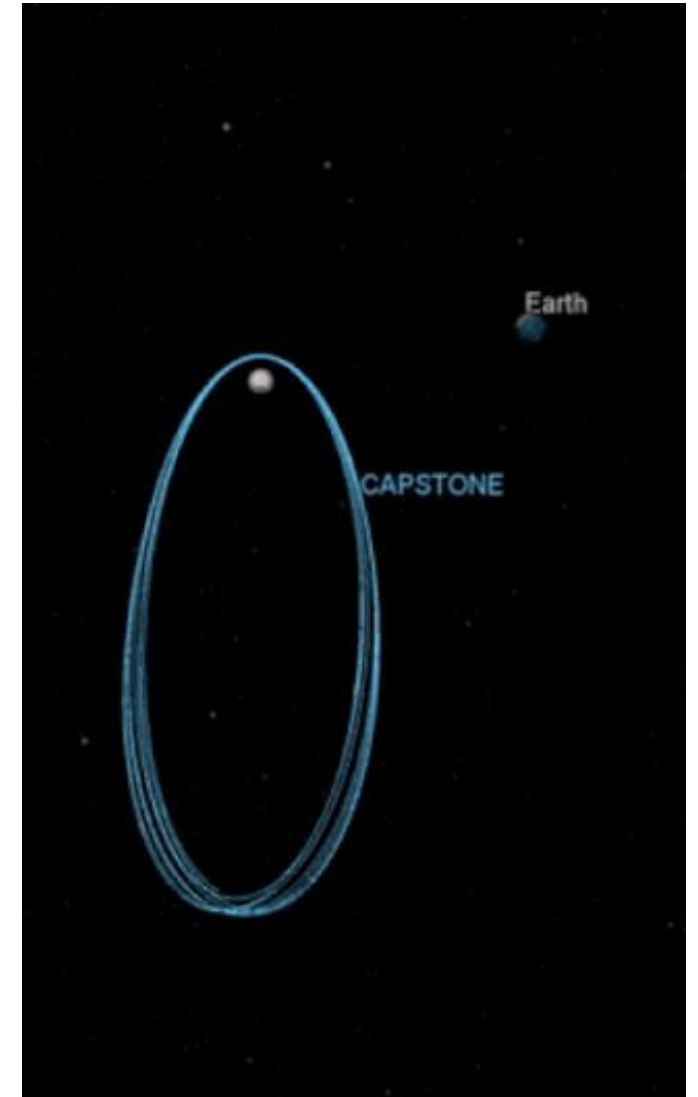
Why this orbit?


- NASA's Lunar Gateway will operate in an NRHO
- These orbits
 - ▶ always have an unobstructed view of Earth
 - ▶ can be designed to avoid eclipses
 - ▶ are efficiently accessible
 - ▶ have communications coverage of polar regions



While in the NRHO

- CAPSTONE will demonstrate CAPS
 - Enabled by a crosslink with the Lunar Reconnaissance Orbiter (LRO)
- CAPSTONE will demonstrate and validate stationkeeping and operations
- CAPSTONE will take pictures





Cislunar Autonomous Positioning System



AdvancedSpace.com



Credits and Acknowledgements

The CAPSTONE mission is a rapid and low-cost small spacecraft pathfinder for the Artemis program that will also demonstrate the CAPS technology.

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.



What's next

- CAPSTONE spacecraft has completed Critical Design Review
 - Hardware is being acquired, integrated, and tested
 - Software is maturing and undergoing integrated testing
 - Launch vehicle is under contract and proceeding
 - Regulatory licensing is underway
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- We are working hard and plan to be on our way to the Moon next year!