# CAPSTONE: A Unique CubeSat Platform for a Navigation Demonstration in Cislunar Space

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With the number of NASA, commercial, and international missions to the Moon growing rapidly, the need to make these future endeavors as efficient as possible is a challenge that is being solved now. Advanced Space is aiming to mitigate the existing Earth based tracking and communications resource limitations by enabling spacecraft in the cislunar environment to navigate autonomously and reduce the need for oversubscribed ground assets for navigation and maneuver planning.

Launching in May 2022 and with upcoming operations in a unique cislunar orbit, the Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment (CAPSTONE) mission is utilizing a highly capable 12U CubeSat to demonstrate the Cislunar Autonomous Positioning System (CAPS) software as well as a validation of the mission design and operations of the Near Rectilinear Halo Orbit (NRHO) that NASA has baselined for the Artemis Lunar Gateway architecture. The CAPS software enables cislunar missions to manage their navigation functions themselves and reduces the reliance on Earth based systems.

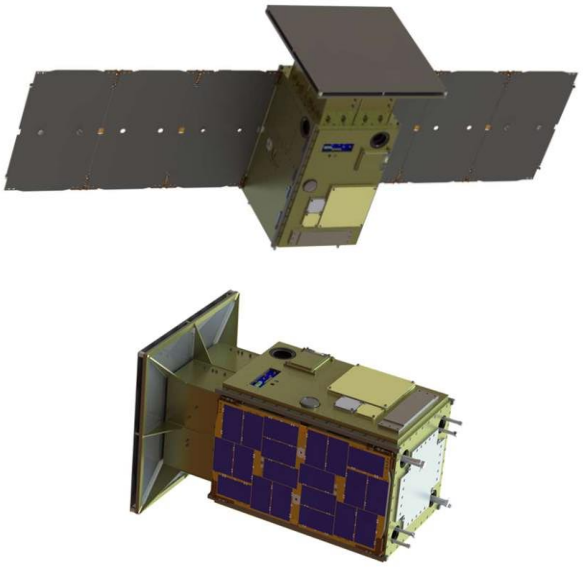

**Fig. 1 CAPSTONE spacecraft in a deployed (top) and stowed (bottom) configuration.**

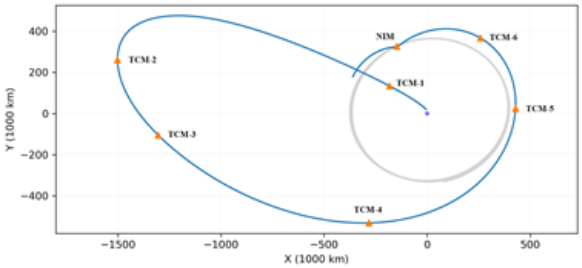


**Fig. 2 TCM Placement in the Earth-Centered EME2000 Frame.**

Upon arrival in the NRHO, the CAPSTONE spacecraft will initiate its navigation demonstration mission in collaboration with the Lunar Reconnaissance Orbiter (LRO) team at NASA's Goddard Space Flight Center to demonstrate the CAPS autonomous navigation system. Success criteria for CAPSTONE in this demonstration are defined as 1) semi-autonomous operations and orbital maintenance of a spacecraft in an NRHO, 2) collection of inter-spacecraft ranging data in support of the autonomous navigation process, and 3) execution of the CAPS navigation software in an autonomous mode on-board the CAPSTONE spacecraft. Additionally, CAPSTONE will demonstrate an innovative one-way ranging navigation approach utilizing a Chip Scale Atomic Clock (CSAC) and additional autonomous navigation algorithms.

Advanced Space, along with our partners at NASA, the Jet Propulsion Lab (JPL), Terran Orbital and Rocket Lab, have developed and implemented the CAPSTONE mission to support both NASA's upcoming Gateway operations development and the expanding commercial cislunar economy. This high value mission will demonstrate an efficient low energy orbital transfer and NRHO insertion as well as full-scale operations in this unique orbit. Over the next 21 months, CAPSTONE will validate these key operations and navigation technologies required for the success of NASA's lunar exploration plans. This presentation will include an overview of the current mission status, development lessons learned, an overview of transfer, and insertion into the NRHO, an overview of NRHO operations, and plans for the CAPS demonstration in support of lunar exploration and scientific objectives.