SUSTAINED LOW ALTITUDE LUNAR ORBIT MISSION to MAP RESOURCES (SLALOM MAPR).

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Introduction: The Sustained Low Altitude Lunar Orbit Mission to Map Resource (SLALOM MapR) brings sensors closer to the lunar surface, enhancing the potential for resource prospecting and scientific monitoring of the lunar environment. Under the auspices and funding of a NASA-funded Small Business Innovative Research (SBIR) Phase II contract, Advanced Space has developed a mission system design and full technical approach to better understand the surface and subsurface resource composition on the Moon (e.g., water ice formations). The SLALOM MapR system is designed to enable nearly autonomous, continuous orbits at ~5km above the lunar surface. **Figure 1**, below, shows the visualization of the spacecraft's trajectory with consideration of the Moon's surface topography.

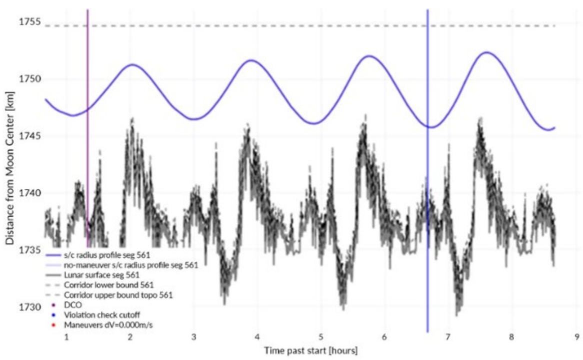

Figure 1: Demonstration of the enabling technology for SLALOM (blue orbit, black surface).

Technical Details: One sensor suite for the initial mission concept is being matured by JPL; the eventual ESPA-class spacecraft for this mission will be optimized around the finalized sensor suite and its associated support hardware. As demonstrated by multiple vendors, the terrain-relative LIDAR sensors are maturing alongside controllers and propulsion systems for maneuver execution modeling. The SLALOM MapR algorithms and GNC flight software developed and demonstrated by Advanced Space through the completed Phase II SBIR have already been deployed and demonstrated on flight system representative flight computers.

State-Of-The-Art (SOA): The current SOA for low altitude remote sensing configures an orbit with a low periapse and a high apoapse so the sensor passes within a close range of the surface for a limited time. In contrast, the Lunar Reconnaissance Orbiter (LRO) currently maintains an orbit of approximately 100 km and collects surface and topographical images with a 100m per pixel resolution. SLALOM MapR provides the ability to map any region of interest nearly continuously from 5-15km and offers the opportunity to collect data, park in a higher orbit, and re-sample as needed. Since the Lunar topography exhibits altitude variations of more than 15km between its lowlands and more elevated regions, a fixed orbit is insufficient to achieve a 10km altitude target. Instead, an active stationkeeping methodology is required to avoid the Lunar surface. Our current stationkeeping algorithm achieves 95% continuous duration below 15km and 36% below 10km, with 15-minute percentiles (time with less than 15 minute periods above a given altitude) of 99% and 89% for 15km and 10km, respectively, at an average ΔV cost of 140m/s per Lunar sidereal month. **Figure 2** compares the operational altitudes for prior lunar missions and the proposed SLALOM MapR technology.

Implication for Science and Exploration: SLALOM MapR provides a new capability for sampling the lunar exosphere and mapping the lunar surface. High-resolution lunar maps developed utilizing this capability will inform the targeting of future lunar landing systems reducing the negative impacts on the lunar environment. Using SLALOM MapR to monitor the lunar exosphere will elucidate important environmental effects caused by landings and payload operations on the Moon. Establishing an environmental baseline and continuously monitoring the lunar exosphere will improve the sustainability of surface exploration while also providing insights into the lunar surface sampled from low orbit.

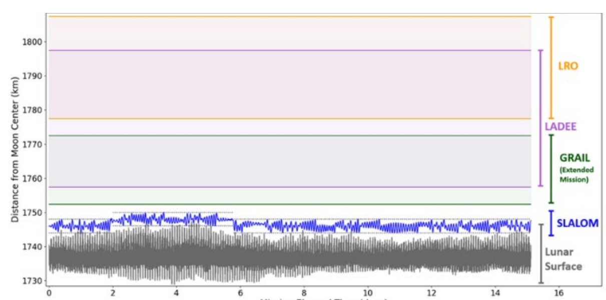

Figure 2: Distance from the Moon center as a function of mission elapsed time for different spacecraft sensor technologies for prior Lunar missions.

Next Steps: Advanced Space and its current mission partners are moving forward in maturing the technologies developed in the Phase II SBIR and working toward a Mission Concept Review with NASA in the 2024 timeframe. We seek additional science and exploration-related partners to fully leverage this technology to further the exploration and development of the resources in the lunar environment.