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Research Objectives for Human Missions in the Proving Ground of Cis-Lunar Space

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Introduction: This talk will introduce the preliminary findings in support of NASA's Future Capabilities Team. In support of the ongoing studies conducted by NASA's Future Capabilities Team, we are tasked with collecting research objectives for the Proving Ground activities. The objectives could include but are certainly not limited to: demonstrating crew well being and performance over long duration missions, characterizing lunar volatiles, Earth monitoring, near Earth object search and identification, support of a far-side radio telescope, and measuring impact of deep space environment on biological systems.

Beginning in as early as 2023, crewed missions beyond low Earth orbit will begin enabled by the new capabilities of the SLS and Orion vehicles. This will initiate the "Proving Ground" phase of human exploration with Mars as an ultimate destination. The primary goal of the Proving Ground is to demonstrate the capability of suitably long duration spaceflight without need of continuous support from Earth, i.e. become Earth Independent.

A major component of the Proving Ground phase is to conduct research activities aimed at accomplishing major objectives selected from a wide variety of disciplines including but not limited to: Astronomy, Heliophysics, Fundamental Physics, Planetary Science, Earth Science, Human Systems, Fundamental Space Biology, Microgravity, and In Situ Resource Utilization. Mapping and prioritizing the most important objectives from these disciplines will provide a strong foundation for establishing the architecture to be utilized in the Proving Ground.

Possible Architectures: Activities and objectives will be accomplished during the Proving Ground phase using a deep space habitat. This habitat will potentially be accompanied by a power/propulsion bus capable of moving the habitat to accomplish different objectives within cis-lunar space. This architecture can also potentially support staging of robotic and tele-robotic assets as well as sample-return.

As mission durations increase from 20 days to 300 days, increasingly ambitious objectives may be undertaken including rendezvous with an asteroid or other near-Earth object.

Research activities can occur inside the habitat, outside the habitat, via externally mounted instruments, or using free flying satellites/landers.

Research Objectives: Primary mission objectives are listed below. In order to help define details of the mission architecture, including the means by which the architecture can be supported, more specific research objectives are needed.

Title/Objective

- Crew Transportation/Provide ability to transport at least four crew to cislunar space
- Heavy Launch Capability/Provide beyond LEO launch capabilities to include crew, co-manisfested payloads, and large cargo
- In-Space Propulsion/Provide in-sapce propulsion capabilities to send crew and cargo on Mars-class mission durations and distances
- Deep Space Navigation and Communication/Provide and validate cislunar and Mars system navigation and communication
- Science/Enable science community objectives

- Deep Space Operations/Provide deep-space operation capabilities: EVA, Staging, Logistics, Human-robotic integration, Autonomous operations
- In-Situ Resource Utilization/Understand the nature and distribution of volatiles and extraction techniques, and decide on their potential use in the human exploration architecture
- Deep Space Habitation/Provide beyond LEO habitation systems sufficient to support at least four crew on Mars-class mission durations and dormancy
- Crew Health/Validate crew health, performance, and mitigation protocols for Mars-class missions

Reference: .NASA, NASA's Journey to Mars: Pioneering Next Steps in Space Exploration. 34 (October 8, 2015).