

## **SLS-Derived Lab: Precursor to Deep Space Human Exploration**

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### **Abstract**

Plans to send humans to Mars are in work and the launch system is being built. Are we ready? Robotic missions have successfully demonstrated transportation, entry, landing and surface operations but for human missions there are significant, potentially show-stopping issues. These issues, called Strategic Knowledge Gaps (SKGs) are the unanswered questions concerning long-duration exploration beyond low-earth-orbit. The gaps represent a risk of loss of life or mission and because they require extended exposure to the weightless environment outside earth's protective geo-magnetic field they cannot be resolved on the earth or on the International Space Station (ISS). Placing a laboratory at the relatively close and stable lunar Distant Retrograde Orbit (DRO) provides an accessible location with the requisite environmental conditions for conducting SKG research and testing mitigation solutions. Configurations comprised of multiple 3 meter and 4.3 meter diameter modules have been studied but the most attractive solution uses elements of the human Mars launch vehicle or Space Launch System (SLS) for a Mars proving ground laboratory. A shortened version of an SLS hydrogen propellant tank creates a Skylab-like pressure vessel that flies fully outfitted on a single launch. This not only offers significant savings by incorporating SLS pressure vessel development costs but avoids the expensive ISS approach using many launches with substantial on-orbit assembly before becoming operational. One of the most challenging SKGs is crew radiation protection; this is why SKG laboratory research is combined with Mars transit Habitat systems development. Fundamentally, the two cannot be divorced because using the habitat systems for protection requires actual hardware geometry and material properties intended to contribute to shielding effectiveness. The SKGs are difficult problems, solutions are not obvious, and require integrated, iterative, and multi-disciplinary development. A lunar DRO lab built from the launch system elements enables an early and representative transit habitat test bed necessary for closing gaps before sending humans on a 1000 day Mars mission.