NASA SBIR 2020 Phase I Solicitation

Z7.03 Deployable Aerodynamic Decelerator Technology

Lead Center: LaRC

Participating Center(s): ARC

Technology Area: TA9 Entry, Descent and Landing Systems

Scope Title
Deployable Aerodynamic Decelerator Technology

Scope Description

Background: NASA is advancing deployable aerodynamic decelerators to enhance and enable robotic and human space missions. Applications include Mars, Venus, Titan, as well as payload return to Earth from Low Earth Orbit. The benefit of deployable decelerators is that the entry vehicle structure and thermal protection system is not constrained by the launch vehicle shroud. It has the flexibility to more efficiently use the available shroud volume, and can be packed into a much smaller volume for Earth departure, addressing potential constraints for payloads sharing a launch vehicle. For Mars, this technology enables delivery of very large (20 metric tons or more) usable payload, which may be needed to support human exploration. The technology also allows for reduced cost access to space by enabling the recovery of launch vehicle assets. This subtopic area solicits innovative technology solutions applicable to deployable entry concepts. Specific technology development areas include:

1) Advancements in textile manufacturing technologies that can be used to simplify production, reduce the mass, or reduce the stowed volume of mechanically deployed structures, inflatable structures, or their flexible thermal protection system. Thermal protection concepts can also lead to improvements in thermal management efficiency of radiant and conductive heat transport at elevated temperatures (exceeding 1200 C). Concepts can be either passive or active dissipation approaches. For smaller scale inflatable systems, less than 1.5 meters in diameter, thin-ply or thin-film manufacturing approaches that can be used to reduce the minimum design gauge are of particular interest for inflatable structures. Focus of Phase 1 development can be subscale manufacturing demonstrations that demonstrate proof of concept and lead to Phase 2 manufacturing scale-up for applications related to Mars entry, Earth return, launch asset recovery, or the emergent small satellite community.

2) Concepts designed to augment the drag or provide guidance control for any class of entry vehicle. Concepts can be either deployable or rigid design systems that are suitable to deployable vehicle designs, including methods that modulate vehicle symmetry or adjust lift for active flight control to improve landing accuracy. Designs that decrease the ballistic coefficient by a factor of two to three times are to be considered. Of particular interest are concepts that can be used to modulate the lift or drag of a vehicle for enhanced control. Phase I proof of concept and preliminary design efforts that will lead to, or can be integrated into, flight demonstration prototypes in a Phase 2 effort are of interest.

3) High temperature capable structural elements to support mechanically deployable decelerators that surpass the performance capability of metallic ribs, joints, and struts. Anticipated systems would include composite elements or

hybrid approaches that combine metallic structures with high temperature capable interface materials to improve thermal performance. Phase 1 development can be subscale component demonstrations that lead to Phase 2 scale-up and testing in relevant environments.

References

Hughes, S. J., et al, “Hypersonic Inflatable Aerodynamic Decelerator (HIAD) Technology Development Overview,” AIAA Paper 2011-2524

Bose, D. M, et al, “The Hypersonic Inflatable Aerodynamic Decelerator (HIAD) Mission Applications Study,” AIAA Paper 2013-1389

Hollis, B. R., “Boundary-Layer Transition and Surface Heating Measurements on a Hypersonic Inflatable Aerodynamic Decelerator with Simulated Flexible TPS,” AIAA Paper 2017-3122

Cassell, A., et al, “ADEPT, A Mechanically Deployable Re-Entry Vehicle System, Enabling Interplanetary CubeSat and Small Satellite Missions,” SSC18-XII-08, 32nd Annual AIAA/USU Conference on Small Satellites

Expected TRL or TRL range at completion of the project: 1 to 4

Desired Deliverables of Phase II

Prototype, Analysis, Hardware, Software, Research

Desired Deliverables Description

Subscale manufacturing demonstration articles for Phase I that can lead to Phase II manufacturing scale up.

State of the Art and Critical Gaps

The current state of the art for deployable aerodynamic decelerators is limited due to novelty of this technology. Developing more efficient, lighter, and thinner flexible thermal protection system component materials with higher temperature capability could potentially enable more efficient designs and extend the maximum range of use of the concepts. Development of efficient guidance control and drag enhancements concepts for deployable vehicles is enabling technology. Novel and innovative high temperature structural concepts are needed for the mechanically deployed decelerator.

Relevance / Science Traceability

NASA needs advanced deployable aerodynamic decelerators to enhance and enable robotic and human space missions. Applications include Mars, Venus, Titan, as well as payload return to Earth from Low Earth Orbit. HEOMD (Human Exploration and Operations Mission Directorate), STMD (Space Technology Mission Directorate), and SMD (Science Mission Directorate) can benefit from this technology for various exploration missions.