NASA SBIR 2021 Phase I Solicitation

Z7.03 Entry and Descent System Technologies

Lead Center: LaRC

Participating Center(s): ARC

Scope Title:

Entry and Descent System Technologies

Scope Description:

Background: NASA is advancing deployable aerodynamic decelerators to enhance and enable robotic and human space missions. Applications include Mars, Venus, and Titan, as well as payload return to EarthÂ from low Earth orbit. The benefit of deployable decelerators is that the entry vehicle structure and thermal protection system are not constrained by the launch vehicle shroud. They haveÂ 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 payloadsÂ sharing a launch vehicle. For Mars, this technology alsoÂ enables delivery of very large (20 metric tons or more) usable payload, which will likelyÂ 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 1,200 Â°C). Concepts can be either passive or active dissipation approaches. For smaller scale inflatable systems for small-spacecraft/satellite applications, less than 5 m 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.Â

2. 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. Minimum-massÂ approaches that address volumetric/packing efficienciesÂ at small-scale (approx. 1 to 2 m) implementations are of interest for small-satellite applications.
3. Development of gas-generator technologies used as inflation systems that result in improved mass efficiency and system complexity over both current pressurized cold gas systems and present state-of-the-art gas generators for inflatable structures. Inflation gas technologies can include warm or hot gas generators, sublimating powder systems, or hybrid systems; however, the final delivery gas temperature must not exceed 200 Â°C. Lightweight, high-efficiency gas inflation technologies capable of delivering gas at 250 to 10,000 standard liters per minute (SLPM) are sought. This range spans a number of potential applications. Thus, a given response need not address the entire range. Additionally, the final delivery gas and its byproducts must not harm aeroshell materials, such as the fluoropolymer liner of the inflatable structure. Minimal solid particulate is acceptable as a final byproduct.Â Water vapor as a final byproduct is also acceptable for lower flow (250 to 4,000 SLPM) and shorter duration missions, but it is undesirable for higher flow (8,000 to 10,000 SLPM) and longer duration missions. Chillers and/or filters can be included in a proposed solution, but they will be included in assessing the overall system mass versus amount of gas generated.

Expected TRL or TRL Range at completion of the Project:Â 1 to 4Â
Primary Technology Taxonomy:Â
Level 1: TX 09 Entry, Descent, and LandingÂ
Level 2: TX 09.1 Aeroassist and Atmospheric Entry**Â**
Desired Deliverables of Phase I and Phase II:

- Research
- Analysis
- Prototype
- Hardware
- Software

Desired Deliverables Description:

Reports documenting analysis and development results, including description of any hardware or prototypes developed. Focus for Phase I development should be material coupon up to subscale manufacturing demonstration articles that demonstrate proof of concept, and lead to Phase II manufacturing scaleup and testing in relevant environments for applications related to Mars entry, Earth return, launch asset recovery, or the emergent small-scale satellite community. Â

State of the Art and Critical Gaps:

The current state of the art for deployable aerodynamic decelerators is limited due to the 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. Novel and innovative high-temperature structural concepts are needed for the mechanically deployed decelerator. Development of gas generator technologies that improve mass efficiency over current pressurized cold gas systems for inflatable structures is needed.Â

Relevance / Science Traceability:

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

References:

- Hughes, S. J., et al., â€œHypersonic Inflatable Aerodynamic Decelerator (HIAD) Technology Development Overview,â€ AIAA Paper 2011-2524.
- Bose, D. M, et al., â€œThe Hypersonic Inflatable Aerodynamic Decelerator (HIAD) Mission Applications Study,â€ AIAA Paper 2013-1389.
- Olds, A. D., et al., â€œIRVE-3 Post-Flight Reconstruction,â€ AIAA Paper 2013-1390.
- Cassell, A., et al., â€œADEPT, A Mechanically Deployable Re-Entry Vehicle System, Enabling Interplanetary CubeSat and Small Satellite Missions,â€ SSC18-XII-08, 32nd Annual AIAA/USU Conference on Small Satellites.
- Cassell, A., et al., "ADEPT Sounding Rocket One Flight Test Overview," AIAA Paper 2019-2896.

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