NASA SBIR 2019 Phase I Solicitation

S4.03 Spacecraft Technology for Sample Return Missions

Lead Center: JPL

Participating Center(s): GRC, GSFC

Technology Area: TA2 In-Space Propulsion Technologies

Sample Return Missions that require landing on an extraterrestrial body are the most mass critical missions in NASA's portfolio. The feasibility of scientific missions depends to a very large extent on the mass criticality dictated by the orbital mechanics of the mission design. The least mass critical mission is a single fly-by (e.g., New Horizons), followed by an orbiter or multiple fly-by (e.g., Juno), followed by a lander or rover (e.g., Mars Science Lab), and followed by a sample return (e.g., Mars Sample Return). The mass ratio of the orbit-injected spacecraft mass to the science payload (or return sample) mass varies by several orders of magnitude over these missions. Thus a one-kilogram sample returned from Mars requires three launches of the most powerful launch vehicles available. Therefore, early investments in technologies that could significantly reduce the mass requirements and improve the propulsion efficiency of spacecraft for sample return missions have particularly high payoff potential.

NASA plans to perform sample return missions from a variety of scientifically important targets including Mars, small bodies such as asteroids and comets, and outer planet moons. These types of targets present a variety of spacecraft technology challenges. Some targets, such as Mars and some moons, have relatively large gravity wells and will require ascent chemical propulsion. Propellant possibilities include those that are transported from Earth or propellants that can be generated using local resources. Other targets are small bodies with very complex geography and very little gravity, which present difficult navigational and maneuvering challenges. In addition, the spacecraft will be subject to extreme environmental conditions including low temperatures (-270Â° C), dust, and ice particles. Reducing the mass associated with these complex design issues (e.g., thermal and power subsystems) is of similar importance.

Technology innovations should either enhance vehicle capabilities (e.g., increase performance, decrease risk, and improve environmental operational margins) or facilitate sample return mission implementation (e.g., reduce size, mass, power, cost). Current and future NASA projects that could use this technology include Mars Sample Return (MSR) and Comet Nucleus Sample Return (CNSR).Â The drastic mass reductions and propulsion efficiency improvements sought in this subtopic could enable these projects, or significantly enhance their feasibility, as, for example, by reducing the number of launches or the size of the launch vehicles required. An ideal Phase II deliverable would be a successful demonstration of an appropriate-TRL (expected TRL range at completion of this project is 4 to 6) performance test, such as at representative scale and environment, along with all the supporting analyses, design, and hardware specifications.

Â **References:**

Â Mass-Efficient Sample Return Technologies - Vision and Voyages for Planetary Science in the Decade 2013-2022:

Â https://www.nap.edu/catalog/13117/vision-and-voyages-for-planetary-science-in-the-decade-2013-2022

Â MSR Mission:

Â http://mars.jpl.nasa.gov:80/missions/samplereturns.html

- http://www.pioneerastro.com/Team/RZubrin/A_Comparison_of_Methods_for_the_Mars_Sample_Return_Mission.pdf

Â CNSRÂ Mission:

Â https://ntrs.nasa.gov/search.jsp?R=20180002990