NASA SBIR 2014 Phase I Solicitation

S3.02 Propulsion Systems for Robotic Science Missions

Lead Center: GRC

Participating Center(s): JPL, MSFC

The Science Mission Directorate (SMD) needs spacecraft with more demanding propulsive performance and flexibility for more ambitious missions requiring high duty cycles, more challenging environmental conditions, and extended operation. Planetary spacecraft need the ability to rendezvous with, orbit, and conduct in situ exploration of planets, moons, and other small bodies in the solar system (http://solarsystem.nasa.gov/multimedia/download-detail.cfm?DL_ID=742). Future spacecraft and constellations of spacecraft will have high-precision propulsion requirements, usually in volume- and power-limited envelopes.

This subtopic seeks innovations to meet SMD propulsion requirements, which are reflected in the goals of NASA's In-Space Propulsion Technology program to reduce the travel time, mass, and cost of SMD spacecraft. Advancements in chemical and electric propulsion systems related to sample return missions to Mars, small bodies (like asteroids, comets, and Near-Earth Objects), outer planet moons, and Venus are desired. Additional electric propulsion technology innovations are also sought to enable low cost systems for Discovery class missions, and eventually to enable radioisotope electric propulsion (REP) type and low-power, nuclear electric propulsion (NEP) missions. Roadmaps for propulsion technologies can be found from the National Research Council (http://www.nap.edu/openbook.php?record_id=13354&page=168) and NASA’s Office of the Chief Technologist (http://www.nasa.gov/pdf/501329main_TA02-InSpaceProp-DRAFT-Nov2010-A.pdf).

The focus of this solicitation is for next generation propulsion systems and components, including micropropulsion rocket technologies, and low cost/low mass electric propulsion technologies. Propulsion technologies related specifically to Power Processing Units will be sought under S3.03 Power Electronics and Management, and Energy Storage and should not be submitted to this subtopic.

Proposals should show an understanding of the state of the art, how their technology is superior, and of one or more relevant science needs. The proposals should provide a feasible plan to fully develop a technology and infuse it into a NASA program.

Electric Propulsion Systems

This subtopic also seeks proposals that explore uses of technologies that will provide superior performance in high specific impulse/low mass electric propulsion systems at low cost. These technologies include:

- Long-life thrusters and related system components with efficiencies > 55% and up to 1 kW of input power that operate with a specific impulse between 1600 to 3500 seconds to enable radioisotope electric propulsion.
- Any long-life, electric propulsion technology between 1 to 10 kW/thruster that would enable a low-power nuclear electric propulsion system based on a kilopower nuclear reactor.

Mini-satellite Propulsion Systems

This subtopic also seeks proposals that address the propulsion for spacecraft 180-1000 kg. It is desired that the capability of plane-changing or de-orbiting in a timely manner be achieved. These system or component technologies would likely be:

- Low mass and low volume fractions.
- Wide range of delta-V capability to provide 100-1000s of m/s.
- Wide range of specific impulses up to 1000s of seconds.
- Precise thrust vectoring and low vibration for precision maneuvering.
- Efficient use of onboard resources (i.e., high power efficiency and simplified thermal and propellant management).
- Affordability.
- Safety for users and primary payloads.

Small Satellite/CubeSat Propulsion

The small satellite (<180kg) market shows significant promise to enable low cost science missions. Launch vehicle providers, like SLS, are considering a large number of secondary payload opportunities. The majority of small satellite missions flown are often selected for concept or component demonstration activities as the primary objectives. Opportunities are anticipated to select future small satellite missions based on application goals (i.e., science return). However, several technology limitations prevent high value science from low-cost small spacecraft, such as post deployment propulsion capabilities. Additionally, propulsion systems often place constraints on handling, storage, operations, etc., that may limit secondary payload consideration.

Specifically, proposals are sought for propulsion systems capable of full scale flight demonstration on 12U CubeSats or smaller; to enable science through secondary payloads carried by SLS or other launch vehicles. Mission applications can be extended up to ESPA based or up to 180kg spacecraft.

Proposals are sought that can deliver hardware products and proof-of-concept demonstrations in Phase I. Proposals are sought that can deliver hardware at or greater than TRL 6 suitable for flight demonstration within the Phase II resources provided. Propulsion systems requiring Phase II-E or II-X funding will be considered if justified through enabling mission capabilities.

Specific propulsion technologies of interest to interplanetary small satellites include:

- Moderate to high specific impulse propulsion systems.
- High specific impulse - density solutions.
- Systems that require no pressurization prior to operations.
- Systems that place no demanding storage requirements prior to launch.
- Systems than can remain quiescent under ambient conditions for extended durations (>6 months) prior to launch.

In addressing technology requirements, proposers should identify potential mission applications and quantify the expected advancement over state-of-the-art alternatives.

Note to Proposer: Topic H2 under the Human Exploration and Operations Directorate also addresses advanced propulsion. Proposals more aligned with exploration mission requirements should be proposed in H2.