NASA STTR 2019 Phase I Solicitation

T2.02 Advanced Technologies for In-Space Electric Propulsion (EP)

Lead Center: GRC

Participating Center(s): JPL

Technology Area: TA15 Aeronautics

Advanced EP Technologies for Small Spacecraft

NASA seeks new technologies that can be rapidly fielded to drastically decrease mission cost. Small spacecraft (<500 kg) launched as secondary payloads provide such an opportunity; however, sub-kilowatt in-space electric propulsion (EP) systems with high propellant-throughput capability remain immature. Future small spacecraft and constellations of small spacecraft will have high-performance electric propulsion requirements, usually in volume-, mass-, and power-limited envelopes. Furthermore, the cost of electric propulsion systems need to decrease to remain commensurate with the total mission cost of small spacecraft. Toward these ends, proposals must address one of the following specific areas of interest applicable to sub-kilowatt Hall-effect and/or gridded-ion thrusters. Proposers are expected to show an in-depth understanding of the current state-of-the-art (SOA) and quantitatively (not qualitatively) describe improvements over relevant SOA technologies that substantiate investment in the new technology. Proposers must also quantitatively explain the operational benefit of the new technology from the perspective of improving or enabling mission potential. Proposals outside of the scope described below shall not be considered:

- Lower-cost, more compact, heated cathode assemblies, which demonstrate the capability to achieve 10,000 hours of operation and 10,000 cycles with performance and reliability comparable to state-of-the-art flight-heritage cathode assemblies.
- Compact heaterless cathode assemblies capable of reliable ignition below 500 V, and greater than 10,000 hours of operation and 10,000 cycles.
- Innovative high-temperature discharge channel materials and/or designs that permit fabrication of thinner walls, yet still capable of surviving the rigors of launch and repeated thermal cycling.
- Innovative, lower-cost, and reliable xenon flow control systems capable of delivering well-regulated flow rates between 0 and 5 mg/s for Hall-effect or gridded-ion systems. Scale and fault-tolerance are to be consistent with reasonable small spacecraft requirements for a NASA class-D mission.

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. Mission priorities are outlined in the decadal surveys for each of the SMD Divisions (https://science.nasa.gov/about-us/science-strategy/decadal-surveys). Future spacecraft and constellations of spacecraft will have high-precision propulsion requirements, usually in volume-, mass-, and power-limited envelopes.

This subtopic seeks innovations to meet future SMD propulsion requirements in electric propulsion systems related to missions to the moon, Mars, and small bodies (like asteroids, comets, and Near-Earth Objects). Additional electric propulsion technology innovations are also sought to enable low-cost systems for small spacecraft missions. The roadmap for in space propulsion technologies is covered under the NASA Technology Area- TA-02 In Space Propulsion.

The expected TRL of this project is 4 to 5.

Advanced Diagnostics for Electric Propulsion (EP) Testing Facilities

Advancements in electric propulsion and growing demand for long-life and highly reliable electric propulsion systems necessitates new or improved diagnostic tools for ground test facilities. Diagnostics are generally desirable that increase functionality, improve accuracy, increase reliability, accelerate collection time, require fewer resources to implement, lower cost, are non-intrusive, and/or are compatible with novel propellants such as iodine.
Toward these ends, proposers must address one of the following areas of interest. Proposers are expected to show an in-depth understanding of the current state-of-the-art (SOA) and quantitatively (not qualitatively) describe improvements over relevant SOA technologies that substantiate investment in the new technology. Proposals outside of the scope described below shall not be considered:

- Species spectrometers for characterizing plasma with charged species that have overlapping energy distribution, such as that of a charge-exchange plasma generated by a Hall thruster. Magnetically-shielded Hall thrusters tend to have a greater fraction of multiply-charged species than traditional Hall thrusters and the distribution function of the multiply-charged species tend to overlap (Hofer, AIAA-2012-3788; Huang, IEPC-2013-057). There are regions in the plume of a magnetically-shielded Hall thruster where the traditional approaches to measuring fractions of multiply-charged species are inadequate.
- An iodine compatible diagnostics package. Iodine properties make it an interesting alternative to xenon propellant; however, iodine is highly corrosive, and damages most modern plasma diagnostics employed in electric propulsion technology development. An innovative diagnostics package is desired that can be demonstrated immune to iodine both under vacuum and in ambient laboratory conditions where the diagnostic might remain contaminated with small amounts of iodine post-test. Proposers should include a development plan that includes both theoretical and experimental evidence that the probes will remain immune from long-term degradation, providing consistent reliable data.

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The expected TRL of this project is 4 to 6.