NASA SBIR 2019 Phase I Solicitation

Z8.01 Chemical Propulsion Systems for Small Satellite Missions

Lead Center: GRC

Participating Center(s): ARC, GSFC, JPL, MSFC

Technology Area: TA2 In-Space Propulsion Technologies

NASA is interested in utilizing SmallSats/CubeSats (6U-12U, < 50kg CubeSats targeted) for cislunar, interplanetary and/or deep space missions, including lunar exploration precursor missions and missions identified in recent Planetary Science Deep Space SmallSat Studies (PSDS3). To accomplish this, advances in chemical propulsion systems for these class of spacecraft are sought, to complete maneuvers such as attitude control, trans-orbit injection, orbit changes, and planetary intercept, with a minimum of transit time. Chemical propulsion systems considered here can include cold-gas, warm-gas, monopropellants and/or bi-propellant systems. These propulsion systems are preferentially envisioned as modular, add-on sub-systems to the larger SmallSat/CubeSat payloads, and would be comprised of the sum components of tank(s), valve(s), pressurant, feed system, thrusters and/or controls. Proposers should place emphasis on full propulsion systems offering long life, reliability, and minimalistic use of spacecraft resources (power, energy, volume, and mass). The use of existing component technologies to build a propulsion system is encouraged to minimize overall development, however proposers are also cautioned that experience to date has shown component technologies for larger systems do not necessarily and easily scale down to CubeSat platforms. Since the focus is on complete propulsion systems, proposals will not be considered that focus purely on individual component development (e.g., new thruster designs or propellant formulations) without addressing how the innovative component solution supports improved mission outcomes and clearly identifies how the product will be incorporated into an overall propulsion system solution. Component solutions must clearly demonstrate a willing system infusion customer and/or mission for consideration. Proposals are sought that can deliver a propulsion system hardware prototype at or greater than Technology Readiness Level (TRL) 4 (breadboard validations within a laboratory environment) within Phase II resources.

Propulsion system solutions are sought that provide as many of the following features as possible within a single propulsion system module:

- Volumetric efficient designs (> 50-60% propellant mass fraction), with tank expulsion efficiency of 95-99%. Propellant mass fraction here is defined as the usable mass of propellant divided by the total wet mass of the propulsion system.
- Maximized Delta-V capability, with target capabilities of 200-500 m/s desired. Proposers must clearly delineate how Delta-V capability is defined including anticipated payload mass/volume.
- Thrust levels from 0.2 to 1.0 N to provide rapid orbit insertions (hours vs. days/months of maneuver time)
- Operation on spacecraft bus voltage
- Systems with low/zero pre-launch pressurization needs (< 1.5 atm at launch)
- Thermal regulation of propellant (e.g., Low temp (< 0° C) storage to reduce system power requirements)
- Ability to conduct both translation and attitude control maneuvers
- Restart and pulsed operation capable, with pulse mode and impulse-bit control to meet station keeping and

pointing requirements
- Systems presenting reduced ground processing hazards, or reduced risks to primary payloads (i.e., secondary payload safe)
- Ability to tolerate > 12 mo. of loaded storage without degradation or need for servicing
- Ability to drain & flush system of propellant and/or pressurant during ground processing
- System lifetime & reliability > 2 years under flight
- Dual fault tolerance
- Optimized for the rigors of interplanetary/deep space missions (i.e., radiation tolerant > 20 krad, thermal management to minimize heat soak to remainder of spacecraft, etc.)

While electric propulsion (EP) system solutions are recognized as a key enabling advancement for small spacecraft missions, the desire in the current subtopic is to specifically bolster chemical propulsion system capabilities, where high-thrust and short duration maneuvers are required, as a compliment to the growing set of existing EP solutions. Advances in EP technologies for this class of spacecraft are of interest to NASA, and for component EP solutions for CubeSats proposers should consider submitting to STMD subtopic Z10.02 - In-Space Electric Propulsion Component Technologies or STTR subtopic T2.02 - Advanced In-Space Electric Propulsion (EP) Technologies.

This subtopic would provide technologies specifically of interest to NASA Space Technology Mission Directorate (STMD's) Small Spacecraft Technology (SST) Program and the Planetary Exploration Science Technology Office (PESTO). Technology sought would help to develop needed propulsive capabilities for SmallSats for increasingly complex science missions, such as those identified in the PSDS3 studies. Also, the Green Propulsion Working Group (GPWG) is an Agency-level working group seeking to monitor and advise on green propulsion technology development. NASA has a Green Propulsion Technology Development Roadmap, which identifies CubeSats/ SmallSats as a near-term infusion opportunity for advancing green propulsion technology. Proposers are encouraged to consider how they align to the roadmap if proposing green propulsion technologies.

References:

- Proposers are encouraged to review the STMD Small Spacecraft Technology State of the Art Report: https://www.nasa.gov/sites/default/files/atoms/files/small_spacecraft_technology_state_of_the_art_2015_tagged.pdf.
- NASA is seeking advanced propulsive capabilities for SmallSat/CubeSat spacecraft for interplanetary/deep space exploration missions, such as those described in the SIMPLEx solicitation (NNH17ZDA004O-SIMPLEX, available from NSPIRES).
- Additionally, proposers should also review recent Planetary Science mission concept studies (Planetary Science Deep Space SmallSat Studies (PSDS3) program) for sample proposed mission concepts: https://www.hou.usra.edu/meetings/smallsat2018/smallsat_program.pdf. Specifically, chemical propulsion solutions that can meet or exceed metrics identified in several of the mission studies are sought in order to provide greater propulsive capabilities to these class of missions.
- NASA/TP—2018–219861 is the 2018 NASA Green Propulsion Technology Development Roadmap, which identifies CubeSats/SmallSats as a near-term infusion opportunity for advancing green propulsion technology.