NASA SBIR 2021 Phase I Solicitation

S1.06 Particles and Fields Sensors and Instrument Enabling Technologies

Lead Center: GSFC

Participating Center(s): JPL, MSFC

Scope Title:

Particles and Fields Sensors and Instrument Enabling Technologies

Scope Description:

The 2013 National Research Councilâ€™s "Solar and Space Physics: A Science for a Technological Society"Â motivates this subtopic: â€œDeliberate investment in new instrument concepts is necessary to acquire the data needed to further solar and space physics science goals, reduce mission risk, and maintain an active and innovative hardware development community.â€ This subtopic solicits development of advanced in-situ instrument technologies and components suitable for deployment on heliophysics missions. Advanced sensors for the detection of elementary particles (atoms, molecules, and their ions) and electric and magnetic fields in space along withÂ associated instrument technologies are often critical for enabling transformational science from the study of the Sun's outer corona, to the solar wind, to the trapped radiation in Earth's and other planetary magnetic fields, and to the atmospheric composition of the planets and their moons. These technologies must be capable of withstanding operation in space environments, including the expected pressures, radiation levels, launch and impact stresses, and range of survival and operational temperatures. Technology developments that result in a reduction of mass, power, volume, and data rates for instruments and instrument components without loss of scientific capability are of particular importance. In addition, technologies that can increase instrument resolution and sensitivity or achieve new and innovative scientific measurements are solicited.

Improvements in particles and fields sensors and associated instrument technologies enable further scientific advancement for upcoming NASA missions such as CubeSats, Explorers, Solar Terrestrial Probe (STP), Living With a Star (LWS), and planetary exploration missions. Specifically, this yearÂ the subtopic solicits instrument development that provides significant advances in the following areas:

- Faraday cup:Â 2-kHz alternating-current (AC) power supply with direct-current (DC) offset up to 40 kV and ACÂ peak-to-peak at 10% of DC offset,Â operating temperature range -35Â to +55 ÂºC, and radiation hardness >1 ~ 200 krad.
- Magnetically clean >2 mÂ compact deployable booms for CubeSats.
- Innovative high-efficiency neutral particle ionizers based on thermionic, cold electron emission, or ultraviolet (UV) ionization.
- Direct neutral particle detectors to energies <1 eV.

Smaller, simpler, and more self-sufficient payloads are more easily accommodated and would be more likely to be considered for a NASA-sponsored flight opportunity.

Expected TRL or TRL Range at completion of the Project:Â 3 to 5Â
Primary Technology Taxonomy:Â
Level 1: TX 08 Sensors and InstrumentsÂ
Level 2: TX 08.X Other Sensors and InstrumentsÂ
Desired Deliverables of Phase I and Phase II:

- Prototype
- Hardware

Desired Deliverables Description:

Phase I deliverables:Â Concept study report, preliminary design, and test results.

Phase IIÂ deliverables:Â Detailed design, prototype test results, and a prototype deliverable with guidelines for in-house integration and test (I&T).

State of the Art and Critical Gaps:

High-Voltage Power Supplies DC and AC:

Low-energy particle instruments often require significant high-voltage DC power supplies up to 40 kV. Some applications such as Faraday cups require sine wave power supplies with a DC offset 0 to 40 kV and AC peak-to-peak at 10% of DC offset at oscillating frequency of 2 kHz,Â an operating temperature range from -35Â to +55 Â°C, and radiation hardness >1 ~ 200 krad.Â

Importance: Â â€“ Critical need for next-generation Faraday cups in order to extendÂ the upper limit of solar wind speed measurement to >2,500 km/sec. Current Faraday cup high-voltage (HV) power supplies support maximum solar wind speeds of up to 1,500 km/sec. Very important for future space weather missions.

Existing direct neutral particle detectors are not capable of detecting, without ionization, neutral particles with energy <1 eV.

There is a need for nonthermionic ionizers to reduce power dissipation.

There is a need for magnetically clean, small booms for CubeSat magnetometers.

Relevance / Science Traceability:

Particles and fields instruments and technologies are essential bases to achieve SMD's Heliophysics goals summarized in the National Research Councilâ€™s, Solar and Space Physics: A Science for a Technological Society. In situ instruments and technologies play indispensable roles for NASAâ€™s LWS and STP mission programs, as well as a host of smaller spacecraft in the Explorers Program. In addition, there is growing demand for particles and fields technologies amenable to CubeSats and SmallSats. NASA SMD has two excellent programs to bring this subtopic technologies to higher level: Heliophysics Instrument Development for Science (H-TIDeS) and Heliophysics Flight Opportunities for Research and Technology (H-FORT). H-TIDeS seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions. This is done through incubating innovative concepts and development of prototype technologies. It is intended that Page 2 of 3 technologies developed through H-TIDeS would then be proposed to H-FORT to mature by demonstration in a relevant environment. The H-TIDES and H-FORT programs are in addition to Phase III opportunities. Further opportunities through SMD include Explorer Missions, New Frontiers Missions, and the upcoming Geospace Dynamic Constellation.

References:

- For example missions, see:Â http://science.nasa.gov/missionsÂ (e.g., NASA Magnetospheric Multiscale (MMS) mission, Fast Plasma Instrument).
- For details of the specific requirements, see the National Research Councilâ€™sÂ Solar and Space Physics: A Science for a Technological Society,Â http://nap.edu/13060

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