NASA SBIR 2020 Phase I Solicitation

S1.06 Particles and Fields Sensors & Instrument Enabling Technologies

Lead Center: GSFC

Participating Center(s): JPL, MSFC

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

Scope Description:

The 2013 National Research Council's, Solar and Space Physics: A Science for a Technological Society (http://nap.edu/13060) motivates this subtopic: "Deliberate 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." 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 and 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 subtopic solicits instrument development that provides significant advances in the following areas:

- Mini scalar-only temperature insensitive absolute magnetometer for CubeSats
- Magnetically clean >2 meter compact deployable booms for CubeSats
- Complementary metal-oxide-semiconductor (CMOS) active pixel type or charge-coupled device (CCD) type electron detectors in the energy range ~0.1-20KeV
- Fast visible light CMOS or CCD imaging detectors for high sensitivity (10 photons per pixel) read out of scintillator crystal light tracks caused by incident neutrons or protons
- Wide energy fast particle detectors resistant to very high radiation of >100Mrads, for instance diamond detectors.
- Grids, collimators and other components that enable the rejection of stray UV or visible light
- Innovative high efficiency neutral particle ionizers based on thermionic, cold electron emission or UV ionization
- Direct neutral particle detectors to energies <1eV

- High-resolution and high-efficiency UV-blind ENA detectors
- High voltage space qualified optocoupler components for >20KV power supplies
- Innovative miniature nested electrostatic analyzers for scan-less energy analysis
- Detectors/sensors for interplanetary/interstellar dust detection
    - Electronics technologies (e.g., field programmable gate array (FPGA) and application-specific integrated circuit (ASIC) implementations, advanced array readouts, miniature high voltage power supplies)

NASA has plans to purchase services for delivery of payloads to the Moon through the Commercial Lunar Payload Services (CLPS) contract. Under this subtopic, proposals may include efforts to develop payloads for flight demonstration of relevant technologies in the lunar environment. The CLPS payload accommodations will vary depending on the particular service provider and mission characteristics. Additional information on the CLPS program and providers can be found at this link: https://www.nasa.gov/content/commercial-lunar-payload-services. CLPS missions will typically carry multiple payloads for multiple customers. 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. Commercial payload delivery services may begin as early as 2020 and flight opportunities are expected to continue well into the future. In future years it is expected that larger and more complex payloads will be accommodated. Selection for award under this solicitation will not guarantee selection for a lunar flight opportunity.

References:

For example missions, see http://science.nasa.gov/missions. (E.g. NASA Magnetospheric Multiscale (MMS) mission, Fast Plasma Instrument)
For details of the specific requirements see the National Research Council's, Solar and Space Physics: A Science for a Technological Society (http://nap.edu/13060).

Expected TRL or TRL range at completion of the project: 3-6

Desired Deliverables of Phase II (Check all that apply):

Prototype, Hardware

Desired Deliverables Description:

A prototype component that can be tested in engineering model instruments.

State of the Art and Critical Gaps:

In situ particles and fields instruments and technologies are essential bases to achieve the Science Mission Directorate's (SMD) Heliophysics goals summarized in the National Research Council's, Solar and Space Physics: A Science for a Technological Society. These technologies play indispensable roles for NASA'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 instrumentation amenable to CubeSats and SmallSats. To narrow the critical gaps between the current state of art and the technology needed for the ever-increasing science/exploration requirements, in-situ technologies are being sought to achieve much higher resolution and sensitivity with significant improvements over existing capabilities, and at the same time with lower mass, power and volume.

Relevance / Science Traceability:

Particles and fields instruments and technologies are essential bases to achieve SMD's Heliophysics goals summarized in the National Research Council's, Solar and Space Physics: A Science for a Technological Society. In situ instruments and technologies play indispensable roles for NASA'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

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.