NASA SBIR 2009 Phase I Solicitation

S1.06 Particles and Field Sensors and Instrument Enabling Technologies

Lead Center: GSFC

Participating Center(s): ARC, JPL, MSFC

Advanced sensors and instrument enabling technologies for the measurement of the physical properties of space plasmas and energetic charged particles, mesospheric - thermospheric neutral species, energetic neutral atoms created at high altitudes by charge exchange, and electric and magnetic fields in space are needed to achieve NASA's transformational science advancements in Heliophysics. The Heliophysics discipline (http://sec.gsfc.nasa.gov/) has as its primary strategic goal the understanding of the physical coupling between the sun's outer corona, the solar wind, the trapped radiation in Earth's and other planetary magnetic fields, and the upper atmospheres of the planets and their moons. This understanding is of national importance not only because of its intrinsic scientific worth, but also because it is the necessary first step toward developing the ability to measure and forecast the "space weather" that affects all human crewed and robotic space assets. Improvements in particles and fields sensors and associated instrument technologies will enable further scientific advancement for upcoming NASA missions such as Solar Probe (http://solarprobe.gsfc.nasa.gov/), Solar Sentinels (http://lws.gsfc.nasa.gov/missions/sentinels/sentinels.htm), GEC (http://stp.gsfc.nasa.gov/missions/gec/gec.htm), Magnetospheric Constellation (http://stp.gsfc.nasa.gov/missions/mc/mc.htm), IT-SP and planetary exploration missions. Technology developments that result in expanded measurement capabilities and a reduction in size, mass, power, and cost are necessary in order for some of these missions to proceed. Of special interest are fast high voltage stepping power supplies for charged particle analyzers, electric field booms, self calibrating vector magnetometers, and other supporting sensor electronics.

Specific areas of interest include:

- Low cost, low power, low current, high voltage power supplies which allow ultra-fast stepping (t
- Strong, lightweight, thin, compactly-stowed electric field booms possibly using composite materials that deploy sensors to distances of 10m or more and/or long wire boom (> 50 m) deployment systems for the deployment of very lightweight tethers or antennae on spinning spacecraft.

- Self-calibrating scalar-vector magnetometer for future Earth and space science missions. Performance goals are dynamic range: +/-100,000 nT, accuracy with self-calibration: 1 nT, sensitivity: 5 pT / sqrtHz,Max, max sensor unit size: 6 x 6 x 12 cm, max sensor mass: 0.6 kg, max electronics unit size: 8 x 13 x 5 cm, max electronics mass: 1 kg, and max power: 5 W operation, 0.5 W standby, including, but not limited to "sensors on a chip".

- Low-power cathode for detection of neutral atoms and molecules ionosphere-thermosphere and planetary investigations. Performance goals are thermionic cathodes capable of emitting 1 mA electron current with heater power less than 0.1 W. The largest dimension of the electron emitter surface should not exceed 1 mm; the entire cathode assembly should be small enough so it may be mounted in a shallow channel shaped to match the largest cathode dimension. The assembly should include robust connection leads for heater and cathode surface. Uniformity across the electron beam is not critical.

- A compact electronics box to enable the operation of one Wind Temperature Spectrometer (WTS), one Ion-Drift Spectrometer (IDS), one Neutral Mass Spectrometer (NMS) and one Ion Mass Spectrometer (IMS), all based on the new generation charged-particle spectrometer SDEA. The electronics should be housed in a volume with dimensions not exceeding 3.2x3.2x3.2 inches with power requirement not exceeding 1.1 W. The EB must provide: (a) electronics for MCP detector pulse handling, (b) minimum of 64 detector pulse channels for WTS and IDS, (c) 2 channels devoted to TOF pulse processing with 2 ns time resolution or faster for NMS and IMS, (d) two ion source power supplies (1V/0.1A cathode supply floating at -100VDC) for WTS and NMS, (e) two energy scan supplies (0 to 5 V) for WTS and IMS, (f) two rectangular-wave supplies (0 to 1 V with 1 microsec rise time) for NMS and IMS, (g) ion accelerator optics voltage supplies (3 outputs @ 200 VDC max) for NMS and IMS, (h) MCP voltage supply (one lead/2700VDC max @ 50 microAmp max), and (i) micro-controller with buffer memory and telemetry link.

Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program.