NASA SBIR 2014 Phase I Solicitation

S1.06  In Situ Sensors and Sensor Systems for Lunar and Planetary Science

Lead Center: JPL

Participating Center(s): ARC, GRC, GSFC, JSC, KSC, LaRC, MSFC

This subtopic solicits development of advanced instrument technologies and components suitable for deployment on planetary and lunar missions. These technologies must be capable of withstanding operation in space and planetary environments, including the expected pressures, radiation levels, launch and impact stresses, and range of survival and operational temperatures. Technologies that reduce 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. For example missions, see (http://science.hq.nasa.gov/missions). For details of the specific requirements see the National Research Council’s, Vision and Voyages for Planetary Science in the Decade 2013-2022 (http://solarsystem.nasa.gov/2013decadal/). Technologies that support NASA’s New Frontiers and Discovery missions to various planetary bodies are of top priority.

In situ technologies are being sought to achieve much higher resolution and sensitivity with significant improvements over existing technologies. Orbital sensors and technologies that can provide significant improvements over previous orbital missions are also sought. Specifically, this subtopic solicits instrument development that provides significant advances in the following areas, broken out by planetary body:

- Mars – Sub-systems relevant to current in situ instrument needs (e.g., lasers and other light sources from UV to microwave, X-ray and ion sources, detectors, mixers, mass analyzers, etc.) or electronics technologies (e.g., FPGA and ASIC implementations, advanced array readouts, miniature high voltage power supplies). Technologies that support high precision in situ measurements of elemental, mineralogical, and organic composition of planetary materials are sought. Conceptually simple, low risk technologies for in situ sample extraction and/or manipulation including fluid and gas storage, pumping, and chemical labeling to support analytical instrumentation. Seismometers, mass analyzers, technologies for heat flow probes, and atmospheric trace gas detectors. Improved robustness and g-force survivability for instrument components, especially for geophysical network sensors, seismometers, and advanced detectors (iCCDs, PMT arrays, etc.). Instruments geared towards rock/sample interrogation prior to sample return are desired.
- Europa & Io - Technologies for high radiation environments, e.g., radiation mitigation strategies, radiation tolerant detectors, and readout electronic components, which enable orbiting instruments to be both radiation-hard and undergo the planetary protection requirements of sterilization (or equivalent) for candidate instruments on the Europa-Jupiter System Mission (JEO) and Io Observer are sought.
- Titan - Low mass and power sensors, mechanisms and concepts for converting terrestrial instruments such as turbidimeters and echo sounders for lake measurements, weather stations, surface (lake and solid) properties packages, etc. to cryogenic environments (95K). Mechanical and electrical components and subsystems that work in cryogenic (95K) environments; sample extraction from liquid methane/ethane, sampling from organic ‘dunes’ at 95K and robust sample preparation and handling mechanisms that feed
into mass analyzers are sought. Balloon instruments, such as IR spectrometers, imagers, meteorological
instruments, radar sounders, air sampling mechanisms for mass analyzers, and aerosol detectors are also
solicited.

- **Venus** - Sensors, mechanisms, and environmental chamber technologies for operation in Venus's high
temperature, high-pressure environment with its unique atmospheric composition. Approaches that can
enable precision measurements of surface mineralogy and elemental composition and precision
measurements of trace species, noble gases and isotopes in the atmosphere are particularly desired.

- **Small Bodies** - Technologies that can enable sampling from asteroids and from depth in a comet nucleus,
improved in situ analysis of comets. Also, imagers and spectrometers that provide high performance in low
light environments dust environment measurements and particle analysis, small body resource
identification, and/or quantification of potential small bodies (e.g., oxygen, water and other
volatiles, hydrated minerals, carbon compounds, fuels, metals, etc.). Specifically, advancements geared
towards instruments that enable elemental or mineralogy analysis (such as high-sensitivity X-ray and UV-
fluorescence spectrometers, UV/fluorescence flash lamp/camera systems, scanning electron microscopy
with chemical analysis capability, time-of-flight mass spectrometry, gas chromatography and tunable diode
laser sensors, calorimetry, laser-Raman spectroscopy, imaging spectroscopy, and LIBS) are sought. These
developments should be geared towards sample interrogation, prior to possible sample return.

- **Saturn, Uranus and Neptune** - Technologies are sought for components, sample acquisition and instrument
systems that can enhance mission science return and withstand the low-temperatures/high-pressures of the
atmospheric probes during entry.

- **The Moon** - This solicitation seeks advancements in the areas of compact, light-weight, low power
instruments geared towards in situ lunar surface measurements, geophysical measurements, lunar
atmosphere and dust environment measurements and regolith analysis, lunar resource
identification, and/or quantification of potential lunar resources (e.g., oxygen, nitrogen, and other volatiles,
fuels, metals, etc.). Specifically, advancements geared towards instruments that enable elemental or
mineralogy analysis (such as high-sensitivity X-ray and UV-fluorescence spectrometers, UV/fluorescence
flash lamp/camera systems, scanning electron microscopy with chemical analysis capability, time-of-flight
mass spectrometry, gas chromatography and tunable diode laser sensors, calorimetry, laser-Raman
spectroscopy, imaging spectroscopy, and LIBS) are sought. These developments should be geared
towards sample interrogation, prior to possible sample return. Systems and subsystems for seismometers
and heat flow sensors capable of long-term continuous operation over multiple lunar day/night cycles with
improved sensitivity at lower mass and reduced power consumption are sought. Also of interest are
portable surface ground penetrating radars to characterize the thickness of the lunar regolith, as well as,
low mass, thermally stable hollow cubes and retro-reflector array assemblies for lunar surface laser ranging.
Of secondary importance are instruments that measure the micrometeoroid and lunar secondary ejecta
environment, plasma environment, surface electric field, secondary radiation at the lunar surface, and dust
concentrations and its diurnal dynamics are sought. Further, lunar regolith particle analysis techniques are
desired (e.g., optical interrogation or software development that would automate integration of suites of
multiple back scatter electron images acquired at different operating conditions, as well as permit
integration of other data such as cathodoluminescence and energy-dispersive x-ray analysis).

Proposers are strongly encouraged to relate their proposed development to NASA's future planetary exploration
goals and existing flight instrument capability, to provide a comparison metric for assessing proposed
improvements.

Proposed instrument architectures should be as simple, reliable, and low risk as possible while enabling compelling
science. Novel instrument concepts are encouraged particularly if they enable a new class of scientific discovery.
Technology developments relevant to multiple environments and platforms are also desired.

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