NASA SBIR 2020 Phase I Solicitation

S1.07 In Situ Instruments/Technologies for Lunar and Planetary Science

Lead Center: JPL

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

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

Scope Description

This subtopic solicits development of advanced instrument technologies and components suitable for deployment on *in situ* 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, for both conventional missions as well as for small satellite missions. In addition, technologies that can increase instrument resolution and sensitivity or achieve new & innovative scientific measurements are solicited. For examples of NASA science missions, see https://science.nasa.gov/missions-page. For details of the specific requirements see the National Research Council report "Vision and Voyages for Planetary Science in the Decade 2013-2022" (http://solarsystem.nasa.gov/2013decadal/), hereafter referred to as the Planetary Decadal Survey). Of particular interest are technologies to support future missions under the New Frontiers and Discovery programs.

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., field programmable gate array (FPGA) and application-specfic integrated circuit (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 are sought. Improved robustness and g-force survivability for instrument components, especially for geophysical network sensors, seismometers, and advanced detectors (intensified charge-coupled devices (iCCDs), photomultiplier tube (PMT) arrays, etc.). Instruments geared towards rock/sample interrogation prior to sample return.
- 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.
- Small Bodies - Technologies that can enable sampling from asteroids and from depth in a comet nucleus,

improved *in situ* analysis of comets. 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 body resources (e.g., oxygen, water and other volatiles, hydrated minerals, carbon compounds, fuels, metals, etc.). Advancements geared towards instruments that enable elemental or mineralogy analysis (such as high-sensitivity X-ray and UV-fluorescence spectrometers, UV/fluorescence systems, scanning electron microscopy with chemical analysis capability, mass spectrometry, gas chromatography and tunable diode laser sensors, calorimetry, imaging spectroscopy, and laser-induced breakdown spectroscopy (LIBS).
- Saturn, Uranus, and Neptune - 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 topic seeks advancement of concepts and components to develop a Lunar Geophysical Network as envisioned in the Planetary Decadal Survey. Understanding the distribution and origin of both shallow and deep moonquakes will provide insights into the current dynamics of the lunar interior and its interplay with external phenomena (e.g., tidal interactions with Earth). The network is envisioned to be comprised of multiple free-standing seismic stations which would operate over many years in even the most extreme lunar temperature environments. Technologies to advance all aspects of the network including sensor emplacement, power, and communications in addition to seismic, heat flow, magnetic field and electromagnetic sounding sensors are desired.

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 mission.

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.

Expected TRL or TRL range at completion of the project: 3 to 5

Desired Deliverables of Phase II

Prototype, Analysis, Hardware, Software

Desired Deliverables Description

In-situ instruments in TRL 3 - 5 for planetary science purpose

State of the Art and Critical Gaps

In situ instruments and technologies are essential bases to achieve Science Mission Directorate's (SMD's) planetary science goals summarized in the Planetary Decadal Survey. *In situ* instruments and technologies play indispensable role for NASA's New Frontiers and Discovery missions to various planetary bodies (Mars, Venus, Small Bodies, Saturn, Uranus, Neptune, Moon, etc.).

There are currently various *in situ* instruments for diverse planetary bodies. However, there are ever increasing science and exploration requirement and challenges for diverse planetary bodies. For example, there is urgent need for exploring RSL (recurring slope lineae) on Mars, plumes from planetary bodies, as well as a growing demand for *in situ* technologies amenable to small spacecraft.

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 with lower mass, power and volume.

Relevance / Science Traceability

In situ instruments and technologies are essential bases to achieve SMD's planetary science goals summarized in the Planetary Decadal Survey. *In situ* instruments and technologies play an indispensable role for NASA’s New Frontiers and Discovery missions to various planetary bodies.

In additional to Phase III opportunities, SMD offers several instrument development programs as paths to further development and maturity. These include the Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO) Program, which invests in low-TRL technologies and funds instrument feasibility studies, concept formation, proof-of-concept instruments, and advanced component technology, and the Maturation of Instruments for Solar System Exploration (MatISSE) Program, which invests in mid-TRL technologies and enables timely and efficient infusion of technology into planetary science missions.