NASA SBIR 2017 Phase I Solicitation

S1.12 Sample Processing For Life Detection Investigations for Ocean Worlds

Lead Center: GSFC

Participating Center(s): ARC, JPL

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

This solicitation is for development of innovative sample processing technologies (methodologies and hardware) for the purposes of improving the resolution and sensitivity of life detection measurements and supporting habitability assessment of environmental samples from Ocean Worlds (e.g., Europa, Enceladus, Titan, etc.). Samples are expected to contain water, minerals, salts, etc. that may complicate measurements or interfere with interpretations. Thus, samples are expected to require separation of components as a preparatory step to analysis. Analytes of interest (e.g., organic molecules including biomolecules, cells, and inorganic solutes and particulates) in samples may also be too dilute and could escape detection unless concentration technologies are applied as a preparatory step. These technologies must be capable of operation under space and planetary conditions, including the extreme pressures, temperatures, radiation levels, stress from launch and impact. Technologies should be of low mass, power, volume; capable of radiation-hardening and sterilization; and require low data rates. Technologies that support minimal biological and analytical contamination of the full technological component and sample stream in order to meet planetary protection requirements and maintain sample integrity for mission-science investigations as well as those that support integration of contamination and/or analyte monitoring are solicited. For synergistic NASA technology solicitation, see ROSES 2016/C.20 Concepts for Ocean worlds Life Detection Technology (COLDtech) call: https://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={5C43865B-0C93-6ECA-BCD2-A3783CB1AAC8}&path=init.

Specifically, this subtopic solicits instrument technologies and components that provide significant advances in the following areas, broken out by planetary body:

- *Europa, Enceladus, and other Ocean Worlds with liquid water and ice* - Technologies and components relevant to sample processing of water and ice samples from plumes, surface ice, subsurface ice, or sub-ice waters. Examples of such technologies include, but are not limited to: sonic processing; subcritical and critical solvent extraction; solid-phase extraction; cell isolation, concentration, and lysing; filtering, separation by osmosis and dialysis; chemical hydrolysis and derivatization; novel substrates or adaptives to enhance sensitivity or selectivity of target analytes; total organic carbon, pressure, temperature, pH, eH, dissolved ion monitoring and regulation components; miniaturized components such as microfluidic valves and pumps; and other fluid and solid handling systems following separation and concentration processing components).

- *Titan* – Sample-processing approaches optimized for particulate, inorganic chemicals, and organic molecules of possible biological origin in aerosols and surface materials. Mechanical and electrical components and subsystems that work in cryogenic (95K) and hydrocarbon-rich environments; sample

extraction from liquid methane/ethane and/or hydrogen cyanide, sampling from organic 'dunes' at 95K and robust sample preparation and handling mechanisms that feed into spectral and mass analyzers, as well as X-ray detection devices are solicited.

Proposers are strongly encouraged to relate their proposed development to:

- NASA's future Ocean Worlds exploration goals.
- 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.

Development of these technologies may support environmental, laboratory, military and medical fields that require low mass, power and volume sample processing.

The Technologies for Detection of Extant Life subtopic seeks instruments and component technologies that will enable unambiguous determination of whether extant life is present in target environments on other solar system bodies. Because there is no single measureable signature of life, this will require advances in a variety of areas, from those involving sample processing to the detailed components of chemical and optical instruments. Searches for extant life can take place in a variety of environments, including ocean depths, ice sheets, dry deserts, seasonal flows, or even dense atmospheres; technologies are required for handling samples obtained from any or all of these environments. Preprocessing technologies required for those samples may include separation, concentration, dilution, drying, staining, mixing, and many other common processes for laboratory analysis, but which must be done in a remote, autonomous environment. Tests of whether a given sample contains or indicates the presence of extant life include the full range of microbiological and chemical techniques, but those that do not require the addition of potential biomarkers (e.g., complex organics) as part of the test are preferred. Technologies that support or enable the use of multiple techniques to investigate a single sample are of particular interest, both because of small sample sizes in planetary missions and the need to apply multiple independent tests to identify extant life. Proposed technologies should support miniaturization and design for low power and use in harsh environments.