NASA SBIR 2015 Phase I Solicitation

H3.01 Environmental Monitoring for Spacecraft Cabins

Lead Center: JPL

Participating Center(s): GRC, JSC, KSC

Measurement of Inorganic Species in Water

There is limited capability for water quality analysis onboard current spacecraft. Several hardware failures have occurred onboard ISS which demonstrate the need for measurement of inorganic contaminants. Monitoring capability is of interest for identification and quantification of inorganic species in potable water, thermal control system cooling water, and human wastewater. Examples of inorganic species of interest and their levels in potable water are specified in Spacecraft Water Exposure Guidelines (SWEGs), released as JSC 63414 (Last revised - November 2008). Target compounds identified in the SWEGs that will be needed for exploration missions include ammonium, antimony, barium, cadmium, manganese, nickel, silver, and zinc. But there is also interest in measurement of other cations and anions including iron, copper, aluminum, chromium, calcium, magnesium, sodium, potassium, arsenic, lead, molybdenum, fluoride, bromide, boron, silicon, lithium, phosphates, sulfates, chloride, iodine, nitrate and nitrite. Detection limits should be below 0.5 mg/L where possible. The proposed analytical instrument should be compact, microgravity compatible, and have limited power and consumable requirements. Sample volumes should be minimized.

Particulate Monitor for Air

Instruments that measure indoor aerosols in spacecraft cabins to monitor air quality and for characterizing the background particle environment and major particle sources are desired. Real-time measurement instruments must be compact and low power, without volatile working fluids, intuitive for crew to operate, requiring minimal maintenance, and able to maintain calibration for years. A large measurement range is necessary in low gravity due to the absence of gravitational settling, and it is expected that more than one instrument, or a multi-sensor unit, will be required to cover the desired range from nanometer (ultrafine) to 50 microns in diameter. A major portion of aerosols on the International Space Station (ISS) are from lint and fibers, so instruments must not rely on spherical morphology for accurate measurements. High accuracy should be quantitatively demonstrated for the range of interest. Development of an instrument that covers a sub-range, as broad as possible, that optimizes the performance within that range and that can subsequently be easily expanded, or integrated with other instrumentation, to cover the full range and requirements will also be of interest. Ideally, the instrument would be portable, with a graphical user interface for crew to read directly and also with the ability to log data and offer standard data transfer interfaces for longer-term indoor air quality surveys.

Microbial Monitor

NASA continues to invest in the near- and mid-term development of highly-desirable systems and technologies that provide innovative ways to monitor microbial burden and enable to meet required cleanliness level of the closed habitat. To date, every attempt to monitor microbial communities on-board the ISS has relied on traditional, culture-based approaches. Such techniques are laborious (7 days), require a considerable amount of crew time (up to 5 hrs), sample return, and ground based analysis (1 month after sample return), and are fraught with difficulty, as different microbial species require various media or cultural conditions to grow. In current microbial quality verification protocols, which use a single medium and a single culture condition, many types of cells will go undetected.

Molecular detection of biological agents offers increased sensitivity and specificity, such that lower levels of contaminating material can be detected and unambiguous identification can be achieved. NASA is interested in an integrated molecular system that could combine all required steps such as:Â

- Sample collection/concentration/extraction.
- Amplification/enrichment.
- Detection.

The scope this solicitation is the first item, i.e., sample collection, concentration, and extraction. However, integration of any two of the above mentioned steps as a single module with a capability to develop the interface of the third step can also be proposed. Technologies that determine microbial content of the air and water environment of the crew habitat falls within acceptable limits and life support system is functioning properly and efficiently are solicited. Required technology characteristics include:Â

- 2 year shelf-life.
- Functionality in microgravity and low pressure environment (~8 psi).

Technologies that show improvements in miniaturization, reliability, life-time, self-calibration, and reduction of expendables are also of interest. The proposed integrated molecular microbial monitoring/detection system should be capable of measuring total microbial burden as well as identifying â€œproblematicâ€ microbial species on-board ISS (ISS MORD: SSP 50260; http://emits.sso.esa.int/emits-doc/ESTEC/AO6216-SoW-RD9.pdf).

For the above, research should be conducted to demonstrate technical feasibility and prototype hardware development during Phase I and show a path toward Phase II hardware and software demonstration and delivering an engineering development unit for NASA testing.Â