NASA SBIR 2017 Phase I Solicitation

H3.02 Environmental Monitoring for Spacecraft Cabins

Lead Center: JPL

Participating Center(s): ARC, JSC, MSFC

Technology Area: TA6 Human Health, Life Support and Habitation Systems

Environmental Monitoring is comprised of the following four monitoring disciplines: air, water, microbial and acoustics. ISS has employed a wide variety of analytical instruments to deal with critical items. These functional needs are required to address identified risks to crew health during Exploration-class missions. The current approach onboard ISS, if any, will serve as the logical starting point to meeting the functional needs. However, the following limitations were found common to all the current approaches on-board ISS for any missions beyond low-Earth orbit (LEO): reliance on return sample and ground analysis, require too much crew time, constraints on size, mass, and power, lack of portability, and insufficient calibration life. Hence a concerted effort is underway to address these gaps and mature those solutions to ground and flight technology demonstrations. Technologies that show improvements in miniaturization, reliability, life-time, self-calibration, and reduction of expendables are of interest.

In-Line Silver Monitoring Technologies

NASA is interested in sensing technologies for the in-line measurement of ionic silver in spacecraft potable water systems. Overall, the sensing technology should offer small, robust, lightweight, low-power, compatible design solutions capable of stable, continuous, and autonomous measurements of silver for extended periods of time. Sensors of particular interest would provide: Continuous in-line measurement of ionic silver at concentrations between 0 and, at least, 1000 parts per billion (ppb); A minimum detection limit of 10 ppb or less; Measurement accuracies of at least 2.5% full scale (1000 ppb); Stable measurements in flows up to 0.5 L/min and pipe diameters up to ¾ inch; High sampling frequency, e.g., up to 1 measurement per minute; Stable calibration, greater than 3 years preferred; Minimal and/or no maintenance requirements; Operation at ambient temperature, system pressures up to 30 PSIG, and a solution pH between 4.5 - 9.0; A volumetric footprint less than 2000 cubic centimeters; Input/output signal(s) capable of interfacing with small embedded controllers, e.g., 4-20 mA or 0 – 5 V. In addition, the sensing technology should have a little to no impact on the overall volume, portability and concentration of silver being maintained within the spacecraft water system.

Sample Processing Module for the ISS Microbial Monitors

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, developing sample collection module and sample detection PCR systems such as RAZOR, Wet-lab 2 systems are planned for surface, water, and air. The sample collection and sample concentration modules are being developed but biomolecule (DNA, protein, etc.) processing and subsequent sample transfer modules that could deliver biological materials to the sample detection systems (PCR, microarray, sequencers, etc.) are not matured. More importantly, the future sample processing/transfer module should be compatible with existing NASA sample detection PCR systems. NASA is interested in an integrated sample collection/concentration/extraction system that could feed samples to conventional or molecular microbial monitoring techniques.

The scope of this solicitation is the sample processing and sample transfer systems. Furthermore, integration of sample collection, concentration steps and a sample delivery to the molecular instruments (such as PCR) as a single module is solicited.

Required technology characteristics include: 2-year shelf-life and 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 sample collection/concentration/extraction delivery system for molecular microbial monitoring detection should be capable of collecting all kinds of microorganisms as well as identifying “problematic” microbial species on-board ISS (ISS MORD: SSP 50260; http://emits.sso.esa.int/emits-doc/ESTEC/AO6216-SoW-RD9.pdf). Existing PCR systems are: Biofire’s Razor (http://biofiredefense.com/razorex/) and Cephied’s Smart Cycler (http://www.cepheid.com/us/cepheid-solutions/systems/smartcycler).

Hydrazine Measurement Technology

NASA currently has hydrazine measurement technology that is sensitive, selective, and reliable – but the time to make the measurement is relatively slow. It takes 15 minutes to collect and analyze a sample. This is operationally acceptable for the current operational environment, but future missions will likely need a hydrazine measurement capability that responds more quickly. The primary use of the Hydrazine Monitor is for measurements of spacecraft cabin atmosphere. NASA is especially interested in systems with the following performance parameters:

- Hydrazine lower detection limit of 1 ppm when measured in STP conditions.
- Ammonia / hydrazine selectivity ratio of 25:1 or better (e.g., background concentrations of 50ppm ammonia will measure as no more than 2 ppm hydrazine).
- Response time (T90) or 30 seconds or faster.
- Measurement range of 1 ppm to 1000 ppm.
- Instrument size smaller than 2500 cubic centimeters.