NASA SBIR 2008 Phase I Solicitation

X14 Inflight Biological Sample Preservation and Analysis

Flight resources such as the International Space Station and the Lunar outpost are essential assets for the Human Research Program goals of quantifying the human health and performance risks for crews during exploration missions. However, the resources for carrying supplies and returning biological samples to/from these assets are limited. Thus the Human Research Program must identify a means for inflight sample analysis or unique sample processing techniques that minimize the need to return conditioned human samples for analysis. The Inflight Biological Sample Preservation and Analysis topic is seeking innovative technologies or techniques to: provide an On Orbit Cell Counting and Analysis capability; and On Orbit Ambient Biological Sample Preservation Techniques.

Subtopics

X14.01 On Orbit Ambient Biological Sample Preservation Techniques

Lead Center: JSC

Measurement of blood and urine analytes is a common clinical medicine practice used for differential disease diagnosis and determination of the therapeutic response to treatment. Accurate biochemical results depend on maintaining the integrity of blood and urine samples until analyses can be completed. Improper sample collection, handling, or preservation may lead to critical errors in diagnostic interpretation of analytical results. Traditional methods have been developed that include the use of sample component separation by means of centrifugation, refrigeration, freezing or the addition of preservatives to maintain the integrity of biological samples. While such techniques are easily achieved in a routine clinical setting, the spaceflight environment presents unique challenges to sample processing and stowage. Diagnosis, treatment and research of health-related issues in human crewmembers during their confinement in the remote spaceflight environment depend on the ability to maintain the analytical integrity of biological samples. Thus, novel on-orbit methods for the ambient preservation of biological samples are critical for scientific research, monitoring of crew health and evaluation of countermeasure efficacy. The Dried Chemistry Technology developed at NASA/JSC represents one approach to the collection and preservation of in-flight blood and urine samples. Briefly, whole blood collected by venipuncture into flight-certified tubes is applied either directly to special filter cards, or alternatively, serum or plasma separated from the red cells by means of the ISS refrigerated centrifuge is applied to the filter cards. Urine samples can also be applied directly to the filter cards. The whole blood, plasma, serum, or urine filter cards are then dried and stored at ambient temperature pending analyses which may require that they be returned to Earth. Many analytes in blood and urine samples prepared and stored by means of the NASA/JSC Dried Chemistry Technology are stable for several months. The development of alternative innovative techniques with advantages over currently used methods for processing and preserving biological samples at ambient temperatures during spaceflight that provide a high level of reliability in maintaining a wide array of both blood and urine analytes over a long period of ambient stowage is

highly desirable.

Phase 1 Requirements: Phase 1 expectations include at a minimum a fully developed concept with feasibility analyses and top-level drawings. A breadboard or prototype is highly desirable.

X14.02 On Orbit Cell Counting and Analysis Capability

Lead Center: JSC

Cell counting and analysis within the clinical hematology/immunology area generally refers to identification and enumeration of various populations of white blood cells in the peripheral blood. This capability has direct clinical relevance, as peripheral cell populations may expand (proliferation in response to pathogen, hematological malignancy) or contract (sequestered at localized site of inflammation) related to specific disease states. In medicine, the complete blood count, white blood count and CD4+ T cell counts are examples of routinely used cell counting assays. Instrumentation typically used for automated analysis includes hematology analyzers and flow cytometers. Hematology instruments generally accept unstained cells for analysis and differentiate the subpopulations based on scatter properties alone. Flow cytometers require pre-staining of specific cell surface proteins with fluorescent dyes, the emission of which will be optically detected by the cytometer upon excitation with an onboard laser. Flow cytometers may range from large, multi-laser/multi-color instruments with sorting capability, to miniaturized bench top instruments with diode lasers and less capability. NASA is interested in developing a microgravity-compatible instrument capable of on-orbit cell counting. This instrument could support medical testing of crewmembers as well as various research activities. The instrument technology is not constrained, and might range from typical cytometer fluidics, a micro fluidics approach, or some other novel method for resolving and counting cells. It is generally believed that typical sheath-fluid based cell focusing, used in standard flow cytometers, is not desirable due to microgravity incompatibility and operational constraints (fluid volume, mass and waste constraints). Extremely miniaturized and lightweight instrumentation, without high-energy lasers, and requiring minimal sample volume or exogenous (sheath) fluid to operate, and generating minimal biohazardous waste would have the greatest chance for success. An associated sample processing system may be required, that would stain, lyse or otherwise process the whole blood or cell sample is anticipated. The instrument should be capable of deriving absolute counts, in addition to the relevant percentage of various cell subpopulations.

Phase 1 Requirements: Phase 1 expectations would be at a minimum a fully developed concept, complete with feasibility analyses and top-level drawings. A breadboard or prototype is highly desired.