NASA SBIR 2015 Phase I Solicitation

H14 International Space Station (ISS) Demonstration and Development of Improved Exploration Technologies and Increased ISS Utilization

Lead Center: JSC

The Human Exploration and Operations Mission Directorate (HEOMD) is chartered with the development of the core transportation elements, key systems, and enabling technologies required for beyond-Low Earth Orbit (LEO) human exploration that will provide the foundation for the next half-century of American leadership in space exploration. This new deep space exploration era starts with increasingly challenging test missions in cis-lunar space, including flights to the Lagrange points, followed by human missions to near-Earth asteroids (NEAs), Earthâ€™s moon, the moons of Mars, and Mars itself as part of a sustained journey of exploration in the inner solar system. HEOMD was formed in 2011 by combining the Space Operations Mission Directorate (SOMD) and the Exploration Systems Mission Directorate (ESMD) to optimize the elements, systems, and technologies of the precursor Directorates to the maximum extent possible. HEOMD accomplishes its mission through the following goals:Â

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- Development and use of launch systems and in-space transport capabilities permitting exploration of various regions of space.
- Development of space habitats that permit the processing and operation of physical and life science experiments in the space environment.
- Development of means to return data and explorers to Earth from these in-space operations.

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HEOMD encapsulates several key technology areas, including Space Transportation, Space Communications and Navigation, Human Research and Health Maintenance, Radiation Protection, Life Support and Habitation, High Efficiency Space Power Systems, and Ground Processing/ISS Utilization. These areas of focus, along with enabling technologies and capabilities, will continue to evolve synergistically as the directorate guides their development and enhancement to meet future needs. In addition, operational capacity will continue to grow by including these enhancements as other NASA programs develop new mission capabilities and requirements. To generate new capabilities and contribute to the knowledge required for humans to explore in-space destinations, HEOMD is responsible for:Â

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- Conducting technology development and demonstrations to reduce cost and prove required capabilities for future human exploration.
- Developing exploration precursor robotic missions to multiple destinations to cost-effectively scout human

exploration targets.
- Increasing investments in Human Operations and research to prepare for long-duration missions in deep space.
- Enabling U.S. commercial human spaceflight capabilities.
- Developing communication and navigation technologies.
- Maximizing ISS utilization.

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HEOMD looks forward to incorporating SBIR-developed technologies into current and future systems to contribute to the expansion of humanity across the solar system while providing continued cost effective space access and operations for its customers, with a high standard of safety, reliability, and affordability.Â Â Â

Subtopics

H14.01 International Space Station (ISS) Utilization

Lead Center: JSC

Participating Center(s): ARC, GRC, JPL, KSC, MSFC

NASA continues to invest in the near- and mid-term development of highly-desirable systems and technologies that provide innovative ways to leverage existing ISS facilities for new scientific payloads and to provide on orbit analysis to enhance capabilities. Utilization of the ISS is limited by available up-mass, down-mass, and crew time as well as by the capabilities of the interfaces and hardware already developed and in use. Innovative interfaces between existing hardware and systems, which are common to ground research, could facilitate both increased and faster payload development and subsequent utilization. Technologies that are portable and that can be matured rapidly for flight demonstration on the International Space Station are of particular interest.

Desired capabilities that will continue to enhance improvements to existing ISS research and support hardware include, but are not limited to, the below examples:Â

- Providing additional on-orbit analytical tools. Development of instruments for on-orbit analysis of plants, cells, small mammals and model organisms including Drosophila, C. elegans, and yeast. Instruments to support studies of bone and muscle loss, multi-generational species studies and cell and plant tissue are desired. Providing flight qualified hardware that is similar to commonly used tools in biological and material science laboratories could allow for an increased capacity of on-orbit analysis thereby reducing the number of samples which must be returned to Earth.
- Development of instruments and software for reconstructing 3-D tomographic images that provides a non-intrusive measurement of the spatial phase distribution in gas-liquid flows. Instruments must be capable of a high temporal acquisition (200 Hz or greater) with resolution between phase boundaries within the measured region on the order of 2-3 millimeters or better. The fluids are typically air-water systems. Providing flight qualified hardware with these capabilities will allow for real-time measurements of phase distribution for a number of life support and biology technologies such as reactor beds, separators, and plant habitats.
- Devices that provide rapid or snap freezing of samples are sought due to their capability to provide for the preservation of samples that support a broad range of space research in the plant, microbiology, cell biology and animal biology subject areas.
- Increased use of the Light Microscopy Module (LMM). Several additions to the module continue to be solicited, such as: laser tweezers, dynamic light scattering, stage stabilization (or sample position encoding) for reconstructing better 3-D confocal images.
- Instruments that can be used as infrared inspection tools for locating and diagnosing material defects, leaks of fluids and gases, and abnormal heating or electrical circuits. The technology should be suitable for handheld portable use. Battery powered wireless operation is desirable. Specific issues to be addressed include: pitting from micrometeoroid impacts, stress fractures, leaking of cooling gases and liquids and detection of abnormal hot spots in power electronics and circuit boards.

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 or software package for NASA testing at the completion of the Phase II contract that could be turned into a proof-of-concept system which can be demonstrated in flight.

Phase I Deliverables - Written report detailing evidence of demonstrated prototype technology in the laboratory or in a relevant environment and stating the future path toward hardware and software demonstration on orbit. Bench or lab-level demonstrations are desirable. The technology concept at the end of Phase I should be at a TRL of 3-6.

Phase II Deliverables - Emphasis should be placed on developing and demonstrating hardware and/or software prototype that can be demonstrated on orbit (TRL 8), or in some cases under simulated flight conditions. The proposal shall outline a path showing how the technology could be developed into space-worthy systems. The contract should deliver an engineering development unit for functional and environmental testing at the completion of the Phase II contract. The technology at the end of Phase II should be at a TRL of 6-7.Â

H14.02 International Space Station (ISS) Demonstration of Improved Exploration Technologies

Lead Center: JSC

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NASA is investing in technologies and techniques geared towards advancing the state of the art of spacecraft systems through the utilization of the ISS as a technology test bed. Successful submissions will describe requisite testing on ISS. Proposals that do not require testing at the ISS should respond to other subtopic solicitations in appropriate technical areas. If submitted to this subtopic they will be considered non-responsive.

NASA encourages submissions that increase the Technology Readiness Level of space exploration and pioneering technologies in areas that include but are not limited to the following:Â

- Ambient temperature catalyst replacement for the ISS Water Processing Assembly.
- High pressure oxygen generation applicable to both ISS and future human space flight vehicles, demonstrated on ISS.

For all proposed technologies, research should at a minimum 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 flight unit or software package for ISS testing.

Phase I Deliverables - Research to identify and evaluate candidate technologies applications to demonstrate the technical feasibility and show a path towards a hardware/software demonstration. Bench or lab-level demonstrations are desirable. The technology concept at the end of Phase I should be at a TRL of 3-6.

Phase II Deliverables - Emphasis should be placed on developing and demonstrating hardware and/or software prototypes that can be demonstrated on orbit (TRL 8). The contract should deliver unit for functional and environmental testing at the completion of the Phase II contract. The technology at the end of Phase II should be at a TRL of 6-7.

Proposals should be generated to assume costs that are limited to the deliverables and the ISS Program, if chosen for flight, would provide safety, upmass and other integration costs.

Potential NASA Customers include:Â

- International Space Station Program (http://www.nasa.gov/mission_pages/station/main/index.html).
- Orion Multipurpose Crew Vehicle (http://www.nasa.gov/exploration/systems/mpcv/index.html).Â

H14.03 Recycling/Reclamation of 3-D Printer Plastic Including Transformation of Launch Package

Solutions into 3-D Printed Parts

Lead Center: MSFC

Participating Center(s): ARC, JSC, KSC

The National Aeronautics and Space Administration (NASA) has a long-term strategy to fabricate components and equipment on-demand for crew exploration missions. The greater the distance from Earth and the longer the mission duration, the more difficult resupply becomes; thus requiring a significant change from the current space travel supply chain model. The ISS is an ideal platform to begin testing and transitioning from the current model for resupply and repair to one that is more suitable for exploration missions. 3-D Printing, more formally known as Additive Manufacturing, is the method of building parts/objects/tools layer-by-layer. 3-D Printers on-board ISS will use extrusion-based additive manufacturing, which involves building an object out of plastic deposited by a wire-feed via an extruder head. While this process does provide on-demand capability for printing parts, to truly develop a self-sustaining, closed-loop on-orbit manufacturing process that will result in meaningfully less mass to launch and enabling space exploration, a means of recycling/reclaiming readily available materials will ultimately be required.

NASA seeks launch packing solutions that can be composed of materials suitable for recyclable processing into 1.75mm filament and subsequently 3-D printed parts. This capability will significantly decrease current waste and substantially increase sustainability. The solution may be obtained using a variety of approaches, such as:Â

- Converting commonly used 3-D printing feedstocks into packing solutions, including but not limited foam or bags.
- Transforming traditional packing materials into 3-D Printing feedstock.
- Developing a technology that utilizes a novel approach to identify compatible materials for both packing solutions and 3-D Printing. For example, this could include such materials as netting, fabrics, structures, containers, etc.

Examples of traditional packing materials currently used for ISS, as well as commonly used feedstocks and types of 3-D Printed parts are provided below. These are intended to serve as examples rather than requirements. The proposal does not have to be limited to these materials:Â

- Foams currently used on ISS:
    - Plastazote (LD24FR & LD45FR).
    - Polyethylene.
    - Polyurethane.
    - PVDF.
    - PTFE film (for bubble wrap).
- Bagging materials currently used on ISS:
    - Pink Poly (not pink and white).
    - Llumaloy (good for ESD compatibility).
    - Tedlar (particularly for containment).
    - Kynar (positive flammability ratings).
- Common Feedstock Materials:
    - ABS.
    - PTFE.
    - PEAK.
    - Ultem.
- Examples of 3-D Printed Parts:
    - Common hand tools.
    - Handles, containers.
    - Clips.
    - Personal items such as grooming tools.
    - â€˜Seat trackâ€™ strips.
    - Corresponding studs.

Phase I Deliverable is a Technical Feasibility Study and should provide:Â

- Demonstration of a close-looped system that provides launch packing solutions that can be recycled into 1.75mm filament for creating 3-D Printed parts without requiring any additional mass other than the shared packing/printing materials and process. The 3-D Printed part(s) must be able to be printed using 1.75mm filament feedstock via a Fused Deposition Melting (FDM) process.
- A materials assessment, which addresses such things as materials composition, flammability, toxicity, off-gassing, etc.
- Technology Readiness Level (TRL) rating from 2-5.
- A Systems Engineering and Proposed Design path for developing an ISS locker-sized hardware demonstration for functional testing at the completion of the Phase II contract.

The ultimate objective is to evolve this technology into a Phase II SBIR ISS Technology Demonstration payload.Â

H14.04 Optical Components, Sensors, and Systems for ISS Utilization

Lead Center: LaRC

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The International Space Station (ISS) is an on-orbit research platform that provides a superior environment for human health and exploration, technology testing for enabling future exploration, research in basic life and physical science, and earth and space science as enunciated in the NASA Authorization ACT of 2010. This subtopic would focus on the utilization of ISS as a foremost test bed for test, operation, and validation of the functionality of advanced optical components, sensors and systems for enabling future exploration. The goal of this subtopic research is to satisfy the mission of the International Space Station (ISS) Program by advancing science and technology research and there by significantly contributing to expand human knowledge, inspire and educate the next generation, foster the commercial development of space and demonstrate capabilities to enable future exploration missions beyond low Earth orbit (LEO) as discussed in the International Space Station (ISS) Researcherâ€™s Guide is published by the NASA ISS Program Science Office. Under this subtopic, innovative research topics compatible to ISS test environment would address HEOMD core issues related to radiation protection, deep space habitat elements and analog missions.

This subtopic would take advantage of revolutionary and rapid advances that are taking place in optics, materials and processing disciplines. Development of sensors and systems using innovative sources, detectors, materials, components and configurations for accomplishing new and/or improved performance, increased reliability and ruggedness, reduction in size, weight and power consumption (SWaP), and cost would advance HEOMD missions.

Topics of interest include but not limited to optical materials, optical components such high temperature and broadband windows and elements, active and passive sensing architectures, smart sensors and sensor suites including multifunctional aspects, monolithic or hybrid high operating temperature detectors and focal plane arrays, ISS compatible miniature remote sensing systems for characterization of hard targets, terrain mapping, deep space imaging (3-D and hyper spectral) sensors and systems, and precision, navigation, and timing systems.Â Â Â