



NASA SBIR 2011 Phase I Solicitation

03.02 ISS Utilization

Lead Center: JSC

Participating Center(s): ARC, GRC, KSC

NASA is investigating the near- and mid-term development of highly-desirable systems and technologies that provide innovative ways either to leverage existing ISS facilities for new scientific payloads or, to provide on orbit analysis to enhance capabilities and reduce sample return requirements.

Current utilization of the ISS is limited by available upmass, downmass, and crew time as well as by the capabilities of the interfaces and hardware already developed. Innovative interfaces between existing hardware and systems, which are common to ground research, could facilitate both increased, and faster, payload development.

Desired capabilities include, but are not limited to, the below examples:

- Enabling additional cell and molecular biology culture techniques. Providing innovative hardware to allow for safe, contained transfer of cells from container to container within the Microgravity Sciences Glove Box (MSG) would permit new types of studies on ISS. On orbit analysis techniques that would reduce or remove the need for downmass - such as a system for gene array tests, or kits for DNA extractions for long term storage - are also examples of hardware possibilities that would extend and enable additional research.
- Providing compact Dynamic Light Scattering (DLS) hardware. Development of a compact robust DLS instrument based on diode lasers and photo detectors capable of providing significant power and weight savings now make it possible to measure the diffusion coefficient of experimental systems using the Light Microscopy Module (LMM) on the International Space Station (ISS). The light scattering instrument (laser, detector, optics) to be mounted on a Leica DM/RXA microscope camera port should be about the size of a 40mm diameter tube around 60mm long) with associated support electronics (including the correlator) being able to fit into a volume of about 30mm x 100mm x 100mm, or less. The intensity dynamic range should be able to cover between 10^{-10} to 10^{-7} Watts. The relaxation time range should be capable to spanning 200nsec to 50sec. This peer-reviewed science was considered a decade ago but not developed due to technology limitations. It is now possible to meet the required performance criteria (with the above size and power requirements) to measure diffusion coefficients. From the measured diffusion coefficient, particle size can be extracted, or the temperature determined for the location being viewed (e.g., in a capillary cell with a

temperature gradient along it) can be deduced (for known particles and solvents) using the Stokes-Einstein equation.

- Providing compact laser tweezers and supporting software. Development of a compact robust Holographic Laser Tweezers (LT) instrument and associated control scripts for use with a microscope on the International Space Station (ISS) based on the recent developments of holographic techniques. This could expand the types of experiments conducted on orbit. The laser tweezers that would mount on a Leica DM/RXA microscope should be less than ~100mm on a side and the associated control electronics should be less than ~150mm on a side. This technology should now be robust since it is solid-state and no longer requires gimbaled mirrors. This peer-reviewed science was previously considered but not developed because of the size and technology limitations of a decade ago. LT holds open the possibility of performing scientific experiments that manipulate groups of particles that evolve uniquely in space when gravitational sedimentation and jamming no longer exist. Any new LT and its corresponding control software should allow for tracking of particle positions to better than one micron in 3D (before the concentration becomes too high) and impart rotational forces. Being able to accurately track the position of particles while measuring the forces on them is important for laying the foundations of colloidal engineering. Because of its use on space station, the instrument should be self-calibrating. The instrument would need to meet the size and volume limitations of the Light Microscopy Module (LMM).
- Providing additional on-orbit analytical tools. 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. Examples of tools that will reduce downmass or expand on-orbit analysis include: sample handling tools; mass measurement devices; a (micro) plate reader; a mass spectrometer; an atomic force microscope (for biological and material science samples), non-cryogenic sample preservation systems; autonomous in-situ bioanalytical technologies; centrifuges for analysis and for providing fractional-g environments; microbial and cell detection and identification systems; and fluidics and microfluidics systems to allow autonomous on-orbit experimentation and high throughput screening.
- Providing Nanorack compatible inserts to enable additional life science payloads. Development of 1, 2 and/or 4 cube design biological payload hardware for use with the ISS Nanorack platform would decrease the need for development of multiple control racks and reduce development time of future payload experiments.
- Enabling additional payloads. Innovative methods for further subdividing payloads lockers would allow for numerous pico-payloads. Developing multi-generational or multi-use habitats would reduce the upmass and downmass required to conduct biological experiments on ISS.

The existing hardware suite and interfaces available on ISS may be found at:
http://www.nasa.gov/mission_pages/station/research/experiments_category.html.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path toward Phase II hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase II contract.

Phase I Deliverables: Written report detailing evidence of demonstrated technology (TRL 5 or 6) in the laboratory or in a relevant environment and stating the future path toward hardware and software demonstration on orbit.

Phase II Deliverables: Hardware and/or software prototype that can be demonstrated on orbit (TRL 7).

