National Aeronautics and Space Administration

A Researcher's Guide to:

INTERNATIONAL SPACE STATION

Human Research

This International Space Station (ISS) Researcher's Guide is published by the NASA ISS Program Science Office.

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Cover and back cover:

a. Expedition 32 Flight Engineer Sunita Williams exercises on the Combined Operational Load Bearing External Resistance Treadmill/T2 in the Node 3/Tranquility.

b. European Space Agency Andre Kuipers prepares to insert biological samples in the Minus Eighty Laboratory Freezer for ISS for long-term storage prior to return to Earth for analysis during Expedition 30.

c. Expedition 32 Flight Engineer Akihiko Hoshide is pictured after undergoing a generic blood draw in the European Laboratory/Columbus Orbital Facility.

The Lab is Open

Orbiting the Earth at almost 5 miles per second, a structure exists that is nearly the size of a football field and weighs almost a million pounds. The International Space Station (ISS) is a testament to international cooperation and significant achievements in engineering. The ISS is critically important to NASA's future exploration missions.

Within the NASA Human Research Program (HRP), the International Space Station Medical Projects (ISSMP) element provides flight implementation services to HRP-sponsored research involving human research subjects allowing investigators to address the human risks of spaceflight enabling the safe exploration of space. For non-HRP-sponsored studies, the ISSMP supports the overall coordination of the flight studies into efficient science complements for each crew member and the scheduling of data collection sessions.

The ISS is a truly unique research platform. The possibilities of what can be discovered by conducting research on the ISS are endless and have the potential to contribute to the greater good of life on Earth and inspire generations of researchers to come.

As we increase utilization of ISS, now is the time for investigators to propose new research and to make discoveries unveiling novel responses that could not be defined using traditional approaches on Earth.

European Space Agency astronaut Luca Parmitano and astronaut Chris Cassidy perform an Ocular Health Fundoscope Exam in the Destiny Laboratory of the International Space Station.

Table of Contents

International Space Station Medical Projects Overview

The International Space Station (ISS) provides an exclusive opportunity for advancing research into the effects of the unique spaceflight environment on humans and the development of space resources. The International Space Station Medical Projects (ISSMP) provides planning, integration, and implementation services for the National Aeronautics and Space Administration (NASA) Human Research Program (HRP) research tasks.

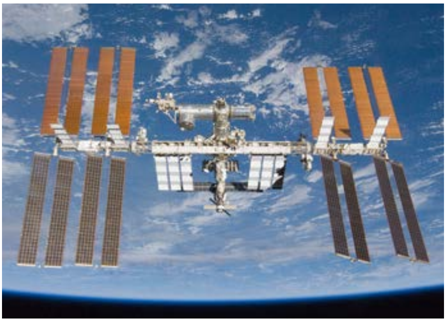

Figure 1. Flyaround view of the International Space Station taken from STS-132 Space Shuttle Atlantis *after separation.*

The goals and objectives of the ISSMP are to:

- Maximize the utilization of the ISS to assess the effects of long-duration spaceflight on human systems and to develop and verify strategies to ensure optimal crew performance.
- Enable development and validation of a suite of integrated physical, pharmacologic and/or nutritional countermeasures against the deleterious effects of spaceflight that may impact mission success or crew health.
- Support preflight, in-flight and postflight activities.
- Offer end-to-end, flight-experiment definition, development, documentation, integration, procedure development and validation, and hardware development and certification.

The ISSMP supports research investigators by defining science protocols as a set of implementable functional requirements, designing operational scenarios and developing as well as certifying hardware and software. Services provided by ISSMP include developing and validating in-flight crew procedures, providing ISS crew-member and ground-controller training, monitoring real-time, in-orbit experiment and hardware operations and facilitating data transfer to the principal investigators (PIs). The ISSMP maintains an expert team of professionals with the knowledge and experience to guide science protocols through the flight-development process.

Figure 2. ISS Expedition 30 Commander Dan Burbank prepares the Ultrasound 2 instrument developed and flight certified by the International Space Station Medical Projects.

The ISSMP coordinates with the ISS International Partners (IPs) to develop integrated mission-specific science complements for human research investigations and to negotiate inter-agency schedules, usage agreements and international crew member subject participation. Support is provided for the human Institutional Review Boards (IRBs) approval process and scheduling the Informed Consent Briefings (ICBs) for potential crew member participation in the flight studies. The ISSMP offers investigators logistics support during all phases of the mission and also maintains a facility at NASA's Johnson Space Center (JSC) for preflight and postflight collection of medical and scientific data for flight studies.

The ISSMP hardware and software teams provide design, fabrication and testing services for both ground and flight hardware and software systems. The application of unique knowledge of safety controls in human systems enables the reduction of risk in all flight-operational activities. Streamlined operational scenarios and optimized crew procedures for research and facility protocols are utilized to maximize science return within available resources, including end-to-end testing from experiment systems to data display and transmission in order to verify science data flow. The team provides complete integration support including pre-turnover testing and hardware turnover for multiple flight vehicles to the ISS including the Russian Soyuz and Progress vehicles, European Ariane Transport Vehicle, Japanese H-II Transfer Vehicle and commercial launch vehicles.

The ISSMP provides services that result in the successful completion of a wide variety of multidisciplinary, human physiology research studies enabling the safe exploration of space and allowing for the future of exploration class missions.

Preparing for Exploration Class Missions

Figure 3. View of the moon over the Earth horizon taken by the Expedition 23 crew aboard the International Space Station.

NASA's history has proven that humans are able to live safely and work in space. The ISS serves as a platform to extend and sustain human activities in preparation for long-duration, exploration-class missions. NASA uses the ISS for scientific, technological and educational purposes supporting future objectives in human space exploration. These objectives include protecting crews from the space environment, ensuring crew health through countermeasure development, testing research and technology developments, and developing and validating operational procedures for long-duration missions.

The ISS is an orbiting research laboratory providing opportunities to address critical medical questions about astronaut health through multidisciplinary research operations to advance our understanding and capabilities for space exploration.

Human Response to Living in Space

The HRP-sponsored, multi-disciplinary biomedical research currently underway on the ISS include studies addressing behavioral health and performance, bone and muscle physiology, exercise countermeasures, cardiovascular physiology, nutrition, and immunology. These life sciences research studies aim to provide a thorough understanding of the many physiologic changes that occur in a microgravity environment. Among the many physiological changes that occur in the human body include susceptibility to fainting after landing, vision changes potentially because of the harmful effects of microgravity on the eye and optic nerve, changes in blood volume, reduction in heart size and capacity, alterations in posture and locomotion, decreases in aerobic capacity and muscle tone, difficulty sleeping, increased risk for renal stone formation, and weakened bones.

The research focuses on astronaut health and performance and the development of countermeasures that will protect crew members from the space environment during long-duration voyages, evaluate new technologies to meet the needs of future exploration missions and develop and validate operational procedures for long-duration space missions.

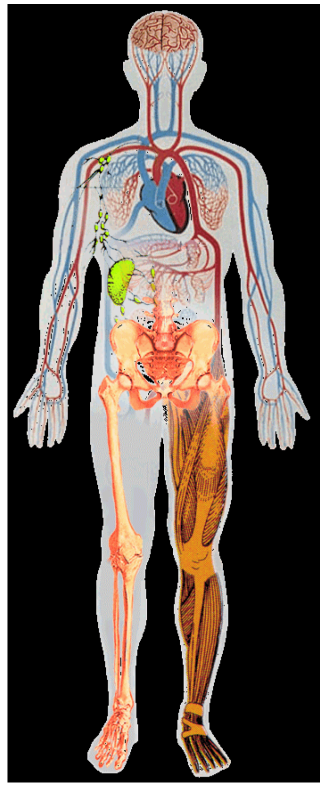

Figure 4. Human research on the ISS allows researchers to investigate the physiological and psychological effects of long duration spaceflight.

Flight Investigations

Following the selection and assignment of a research investigation to an ISS mission, the ISSMP provides the end-to-end integration, coordination and operational support to meet successfully the science requirements and objectives of the study. Among others, the current multi-disciplinary research areas in progress during ISS missions include functional performance testing through an integrated suite of functional and physiological tests before and after long-duration spaceflight. This study identifies critical mission tasks that may be impacted, maps physiological changes to alterations in physical performance and aids in the design

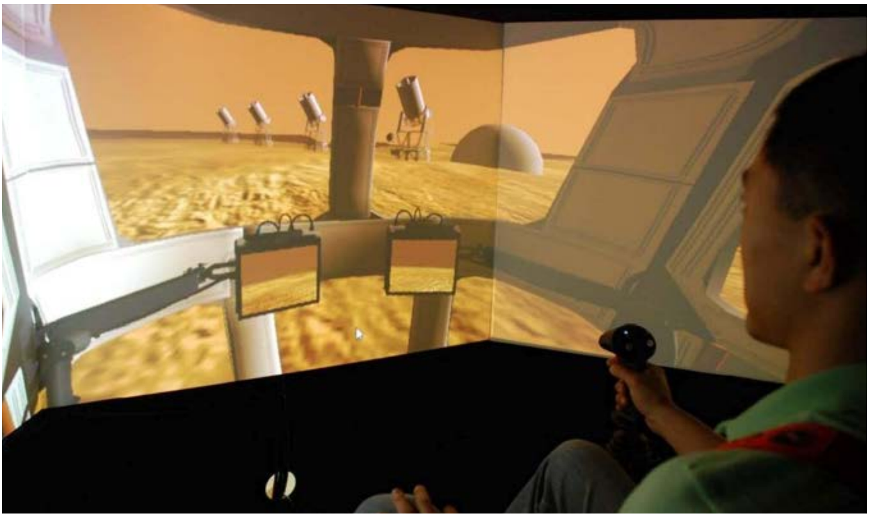

Figure 5. Subject uses a joystick to control navigation and docking during the rover simulation.

of countermeasures that target specifically the physiologic systems responsible for impaired functional performance.

Another study addresses the lack of gravity, which causes sensorimotor deficits post-landing and may impact piloted landings and early surface operations. ISSMP support for this study will aid in determining the underlying decrements in postflight operator proficiency.

In the area of cardiovascular research, there is a study aimed at quantifying the extent, time course and clinical significance of cardiac atrophy associated with long-duration spaceflight and to identify the mechanisms of this atrophy and the functional consequences for crew members that spend extended periods of time in space.

Crew members often experience back pain during spaceflight. The goal of another study is to use state-of-the-art imaging technologies to comprehensively characterize and quantify spaceflight-induced changes in disc morphology, biochemistry, metabolism and kinematics. The data collected will be analyzed to establish pain and disc damage mechanisms that will serve as a basis for future countermeasure development.

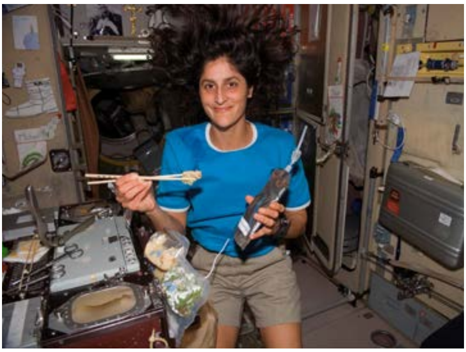

Figure 6. Expedition 14 Flight Engineer Sunita Williams poses with chopsticks and a drink pack while eating a meal in the Zvezda Service module. Nutrition plays an important role both in physiological and psychological well-being.

Nutrition is a critical component to maintain crew health and performance successfully. A current study includes measures of bone metabolism, oxidative damage, and chemistry and hormonal changes as well as assessments of nutritional status. The results will have an impact on the definition of nutritional requirements and development of food systems for future exploration missions. Bone and muscle are affected significantly during spaceflight. The ISSMP supports a flight study evaluating the use of high-intensity, low-volume exercise training to minimize loss of muscle, bone, and cardiovascular function in ISS crew members during long-duration missions. Investigators expect to provide an integrated resistance and aerobic exercise training protocol capable of maintaining muscle, bone and cardiovascular health while reducing total exercise time. The results will provide valuable information in protecting human fitness for even longer space-exploration missions.

Figure 7. Canadian Space Agency astronaut Robert Thirsk, Expedition 20/21 flight engineer, uses the Advanced Resistive Exercise Device in the Node 1 module.

Upon completion of these experiments, a number of important risks will be identified, their impacts to long-duration space missions will be evaluated, and the need, if any, for countermeasures can be determined. In support of these research investigations, the ISSMP provides flight-hardware development, crew training, flight-crew procedures, and monitoring of real-time, in-orbit operations.

Flight Investigation Activities

Preflight Operations

Figure 8. Canadian Space Agency astronaut Chris Hadfield, Expedition 34 flight engineer and Expedition 35 commander, participates in a training session in an International Space Station mock-up/trainer in the Space Vehicle Mock-up Facility at NASA's Johnson Space Center. Photo credit: NASA

Once assigned to a mission, research investigations proceed through a number of milestones. The ISSMP partners with the investigators to ensure the following: science requirements are met; human institutional review approvals are obtained; crew training is scheduled; flight procedures are developed; and preflight baseline data collection (BDC) sessions are completed. Preflight data are collected for comparison with subsequent research findings to determine how spaceflight has affected a particular measurement and what effect the return to a 1-g environment may have. The ISSMP also leads the ICBs, enabling the participation of ISS crew members in each investigation and coordinates the integration of NASA and IP life sciences research experiments.

The availability of ISS crew members prior to launch for training and BDC is extremely limited because of a heavy training schedule requiring a great deal of international travel to Russia, Europe and Japan. All U.S. training and BDC (including vehicle and ISS system training as well as all NASA payloads) must be scheduled during the periods of time preflight when crew members are at JSC. Crew members depart for Russia approximately two months before launch (L-60 days). While it is possible to perform some simple testing in Russia between L-60 and L-30 (i.e., minimal sampling, simple ambulatory monitoring, questionnaires), it is more difficult to schedule and will require strong justification for implementation.

There are no longer unique NASA facilities available for performing BDC in Russia; the only resources currently available are a freezer and centrifuge. In the L-30 to L-15 day timeframe, crew members' schedules are very busy with required simulations, vehicle tests, and commissioning activities as well as time with their families, so scheduling research testing of any kind is usually not possible. The crew travels to the launch site at around L-15 days where there are no BDC facilities available for investigator use. The only feasible activities during this time are those that require passive monitoring (i.e., Actigraphy) or simple computer or pen/paper entries. There is no freezer or any other equipment available at the launch site and retrieval of data and equipment must be arranged with crew surgeons (no investigator travel to launch site).

As crew time is very constrained during their time at JSC, the number, length and timing of BDC sessions should be optimized as much as possible. Training sessions are limited to skills-based sessions as opposed to lecture-style overview sessions. The ISSMP team works with HRP investigators to develop an appropriate training plan for each investigation that is selected for flight.

In-Flight Operations

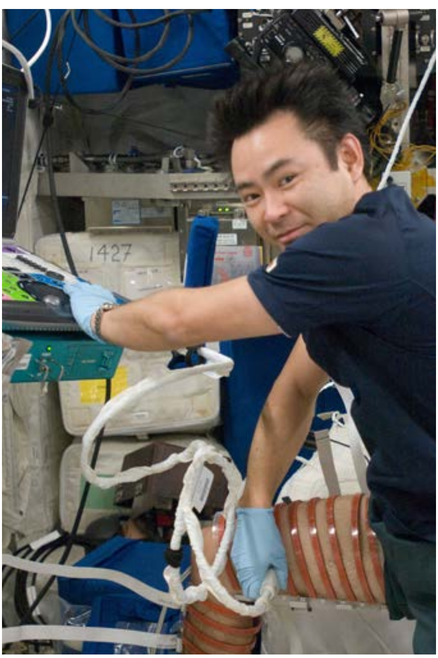

Figure 9. Japan Aerospace Exploration Agency (JAXA) astronaut Akihiko Hoshide, Expedition 33 flight engineer, performing an ultrasound scan supporting a skeletal muscle investigation. (Image Credit: NASA)

All ISS crew members are currently launched on the Russian Soyuz spacecraft. The Soyuz is very space constrained, and it is not feasible to perform any in-flight operations before docking with the ISS. After docking with ISS, crew members are typically busy with handover activities, and crew time for scientific activities is extremely limited for the first two weeks. Crew time is also limited during periods when other vehicles dock or undock because of required preparation activities and around extra vehicular activities (EVAs). Weekends are protected as time off for crew members, and science is only performed if it is a crew preference or as part of voluntary science.

In-flight crew time constraints require investigators to build flexibility into their scheduling requirements. In addition to the constraints mentioned above, many investigations often have similar in-flight timing requirements, and they cannot all be scheduled during the same week. Investigators should clearly state the reasoning for specific timing requirements and explain how flexible the timing is (plus or minus number of days).

Experiment implementation is more difficult to achieve under the following conditions:

- Complicated in-flight sessions before the second week in-flight (e.g., requires set-up of multiple pieces of equipment, followed by testing session of more than an hour; sessions that require privatized voice or video).
- More than five complicated in-flight sessions involving multiple pieces of equipment (e.g., requires set-up of multiple pieces of equipment, followed by testing of more than two to three hours, requires extensive privatized resources).
- A single session with one crew member requiring four or more hours in one day.
- Crew activity that must be performed daily or more than once a week.
- Very precise/inflexible timing requirements for sessions (e.g., plus or minus window for testing of less than one week, multiple, timed blood draws, sessions that are linked to other crew activities like meals, EVAs, etc.). Note that occasional fasting data collections upon crew wake up are not difficult to implement.
- Extended, continuous activities over multiple days that could interfere with other operations.

Postflight Operations

The postflight priority is to rehabilitate the crew from the flight and return them to safe terrestrial function. All crew members are currently returned from the ISS via the Soyuz spacecraft after landing in Kazakhstan. United States Operation Segment (USOS) crew members (includes participants from IP agencies of Europe, Canada, and Japan) are returned directly to JSC within approximately 24 hours after landing via a NASA plane. Crew members may have significant circadian disruption. Investigators should not expect to have access to crew members until they have returned to JSC, and only limited testing is possible during their

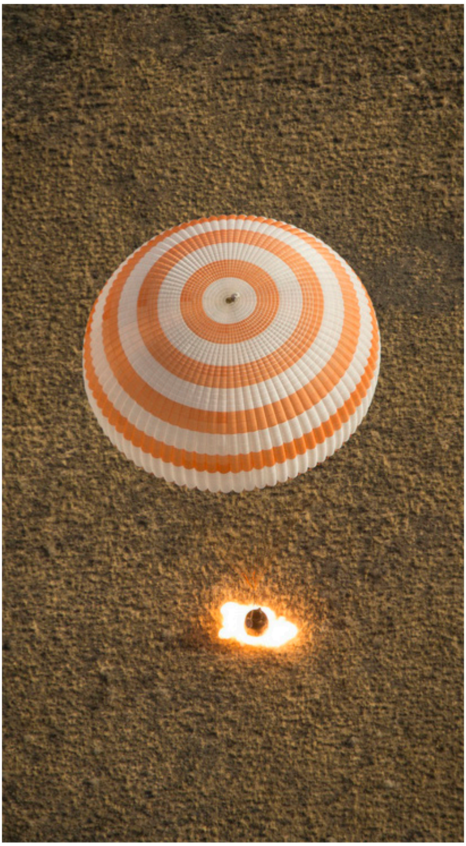

Figure 10. The Soyuz TMA-08M spacecraft with Expedition 36 Commander Pavel Vinogradov of the Russian Federal Space Agency (Roscosmos), Flight Engineer Alexander Misurkin of Roscosmos and Flight Engineer Chris Cassidy of NASA aboard, lands in a remote area near the town of Zhezkazgan, Kazakhstan, on Wednesday, Sept. 11, 2013. (Credit: NASA/ Bill Ingalls.)

return flight (i.e., Actigraphy, urine and saliva sampling). There is some opportunity for limited, passive testing upon immediate crew return to JSC (blood draws, ultrasound scans), but extensive or lengthy testing is not possible. The time period from crew landing to crew sleep after return to JSC is considered landing day or "R+0." The start of R+1 begins after crew wake up the day after their return to JSC.

The total amount of time available for science BDC in the first week postflight (R+0 - R+7) is only 11.5 hours, and this scarce resource must be shared with multiple investigations. Therefore, investigators should only request BDC during this timeframe if it is required. In addition, scheduling flexibilities should be noted so that the postflight schedule can be optimized for maximum scientific data return. If testing requires use of a facility not located at JSC, travel time to and from the facility must be included in the session time.

Because of these implementation constraints, the ISSMP must assess and integrate all postflight testing requirements early in the complement development process. These restrictions have a significant impact on the types and number of experiments that can be performed simultaneously.

Spaceflight Research

Flight Support Capabilities

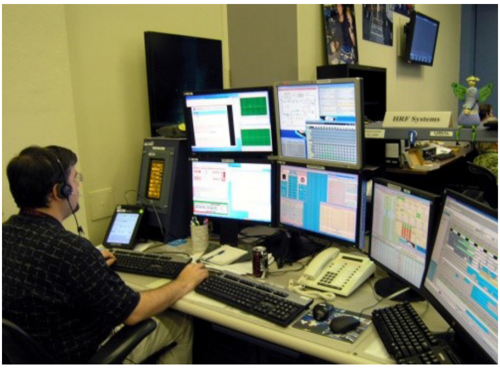

Figure 11. Real-time science monitoring services are provided through the Telescience Support Center.

The ISSMP services include the management, maintenance, operations, and use of the Telescience Support Center (TSC) located at JSC providing a focal point for real-time ISSMP operations and a distribution point for remote investigators to monitor their experiments and acquire telemetry data. The TSC interfaces with the Payload Operations Intergration Center at NASA's Marshall Space Flight Center. The TSC provides investigators and ground teams with ISS Space-to-Ground audio capabilities allowing the relaying of commands and software uplinks to ISSMP facility systems. This facility serves as a gateway to distribute ISS digital data and video over virtual private networks to support the ISSMP science and engineering communities. Real-time system and experiment-data displays are available over a secure network between the ISS and remote investigator data facilities.

In-Orbit Research Hardware

The ISSMP provides the Human Research Facility (HRF), which is comprised of a suite of hardware that provides core capabilities to enable research on human subjects. These research tools are available to HRP-sponsored investigators who wish to conduct human physiological research on the ISS. Most flight hardware must be specially built or modified to suit the space environment. The ISSMP provides flight hardware development processes designed to meet rigorous requirements for safety, mass, operation, human factors, electrical power usage, computer interfaces, and thermal properties. All flight hardware must be tested to verify that it can withstand the mechanical and acoustic vibrations encountered during launch, the acceleration forces during ascent into orbit, and the microgravity conditions in orbit.

The HRF consists of items mounted on two racks located in the Columbus module, as well as separate portable equipment kept in stowage locations and brought out as needed. The Human Research Facility enables human life science researchers to study and evaluate the physiological, behavioral, and biochemical changes induced by long-duration spaceflight. HRF Rack 1 (HRF-1) houses a Clinical Ultrasound, and the Space Linear Acceleration Mass Measurement Device for measuring in-orbit, crew-member mass. HRF Rack 2 (HRF-2) houses the Pulmonary Function System, the result of a collaboration between NASA and the European Space Agency (ESA) to develop pulmonary physiology instrumentation, and a centrifuge for processing blood samples. HRF Racks 1 and 2 are currently in orbit and are regularly used for data collection and downlink of experiment data.

Figure 12. Ultra-low cold storage is available with the in-orbit Minus Eighty-Degree Laboratory Freezer for ISS. Expedition 39 flight engineers Steve Swanson and Rick Mastracchio work to transfer samples from the MELFI-1 to a Double Cold Bag.

Supplies for collection of human biological samples, including blood, urine and saliva are available for investigators who require them. Standardization of this type of hardware both reduces costs and provides a familiar interface for crew members regardless of which investigation(s) they may be performing.

More information on the HRF hardware is available at: http://www.nasa.gov/mission_pages/station/research/experiments/facilities_hardware.html.

Investigators should not assume that hardware previously flown but not listed on this website is available for their use. Potential investigators should check with the appropriate facility managers for current hardware functionality and availability.

ESA has also launched several hardware facilities designed for use in human life sciences experiments. Information about these facilities can be found at: http://www.nasa.gov/mission_pages/station/research/experiments/facilities_by_partner_agency.html. Investigators should be aware that while these ESA facilities will be aboard the ISS, use of them by NASA investigators will have to be negotiated.

Hardware is available aboard the ISS for investigations that require conditioned storage of samples. Information about these facilities can be found under the "Refrigerator or Freezer" heading at: http://www.nasa.gov/mission_pages/station/research/experiments/facilities_hardware.html.

Information on all ISS facilities can be found at: http://www.nasa.gov/mission_pages/station/research/facilities_category.html and http://www.nasa.gov/mission_pages/station/research/news/new_facilities_brochure.html.

Executing flight experiments necessitates different constraints than is usually found in ground-based research. With the retirement of the space shuttle, all hardware is now launched to ISS using an IP resupply vehicle or a U.S. commercial vehicle. At this time, return of hardware and samples from the ISS is only possible using U.S. commercial vehicles, with a very limited capability on the Soyuz.

Experiment-Unique Equipment

Some investigators may need to develop their own special experiment hardware to work in conjunction with the facilities and functional capabilities of existing hardware. Development of Experiment-Unique Equipment can be costly and extend the preparation time for an experiment in order to design, build and test the hardware to meet spaceflight requirements. Commercially available hardware is often more feasible to prepare for flight than custom-made hardware, but it will still require additional resources and certification in order to meet the requirements levied on all hardware flying to the ISS. It should not be assumed that any device can fly "as is" off the shelf.

Investigators should keep in mind the following implementation issues when designing flight experiments. These are factors that ISSMP will assess when determining the feasibility of HRP flight projects:

- Is new flight hardware required? The extent of how difficult this development will be is dependent on how much design and development is required for custom-made equipment and how off-the-shelf equipment will have to be modified. Resources such as up-mass and volume could constrain launch opportunities.
- Does the hardware need to be returned to the ground for refurbishment or data retrieval? Down mass resources will be protected for critical science samples, data should be planned to be downlinked, and hardware no longer being used will likely be discarded.
- Is conditioned stowage required in orbit or for return? The ISS has freezers and refrigerators aboard the ISS. Conditioned down-mass volume is limited. Requirements for cold stowage should not exceed the capabilities of the equipment identified on the cold stowage website.

Data and Sample Sharing

Some experiments collect identical or similar data as standard medical tests or other concurrently scheduled investigations. Duplication may be avoided via data sharing. A Data Sharing Plan is implemented for each mission to minimize crew time and inconvenience. The plan would also allow individual investigators to enhance their studies through interpretation of their data within the context of the many physiologic adjustments provoked by spaceflight. The correlation and comparison of all experiment results will, in turn, produce a more coherent and comprehensive understanding of human physiologic adaptation to spaceflight.

In addition, data produced from NASA-funded life sciences research must be archived in the Life Sciences Data Archive (LSDA) for the benefit of the greater research and operational spaceflight community. Archival data products may include but are not limited to low-level (raw) data, high-level (processed) data, and data products such as calibration data, documentation, related software, and other tools or parameters that are necessary to interpret the data. To protect the right of first publication, funded investigator(s) are generally allowed a period of one year after final data collection before making the data available to other investigators through release from the LSDA. This archive, as well as other NASA data repositories, allows investigators to implement research by enabling analysis of existing astronaut experiment, medical and/or performance data.

Sample sharing also may be available to investigators depending on the type and quantity of sample requested. Similar to the Data Sharing Plan, sample sharing minimizes valuable crew time and inconvenience and decreases up and down mass.

Research Involving Human Subjects

Currently, the maximum number of crew members aboard the ISS at any given time is six; this includes three Russian crew members and three USOS crew members. In-orbit durations are approximately six months, and the crew rotations are staggered, so there may be periods when only three crew members are aboard ISS. Currently, NASA-sponsored investigations may only seek participation from USOS crew members; therefore, the maximum number of subjects available per year for any one experiment is six. For planning purposes, four subjects per year is the average that should be assumed for any experiment since other constraints and crew consent may limit participation. All flight investigations involving USOS crew members must receive approval by the NASA/JSC IRB and the Human Research Multilateral Review Board. Approval by the ESA Medical Board and Japanese Aerospace Exploration Agency IRB are also needed if participation of crew members representing those agencies will be recruited. Crew members are given an ICB on all proposed human research for their mission at approximately one year before launch. A large number of human life sciences investigations are being performed such that it is not possible for one crew member to participate in all of them, even if that crew member is willing. This is due to resource limitations described in this document as well as science conflicts between investigations. Based on crew members' interest and program priorities, a specific complement of research is developed that can be performed within the flight resource constraints.

With a small subject pool and a large number of investigations requiring human subjects, the number of subjects required to complete an investigation becomes an important aspect of technical feasibility for all flight proposals. In addition to taking a long time to complete, studies that require large subject numbers limit the throughput for overall human spaceflight research. An investigation that has multiple constraints, and that will effectively reduce the number of other investigations in which a subject can participate, will be more difficult to implement. Investigators should note that one crew member can participate in up to 20 human life sciences investigations, depending on complexity, across all USOS partners.

Pathway to Flight Investigations

A proposal can be submitted for consideration to the Human Research Program in many different ways including, among others, through a NASA Research Announcement (NRA), NASA Space Act Agreement, NASA Human Research Program Directed Task and through an International Announcement of Opportunity. ISS investigators may receive funding from NASA and many other sources. These sources determine the sponsorship for access to the orbiting laboratory. Studies that involve only preflight and postflight testing of the crew members before launch and upon return from their spaceflight may also be performed. Additional information for prospective investigators can be found at: http://www.nasa.gov/mission_pages/station/research/ops/research_information.html.

Following development and submission of a research proposal to HRP, the proposal undergoes a peer-review process to evaluate the relevance of the study to NASA's goals and objectives and the scientific merit of the proposed investigation. The outcome of this review may lead to a refinement of the study followed by selection as a flight investigation. After selection of a research proposal for a flight investigation is made by the sponsoring organization, the process formally begins to define the overall research requirements, objectives and probable costs. Critical to conducting a successful study is agreement on a set of realistic mission objectives including establishing the technical, functional, and performance requirements to satisfy the objectives.

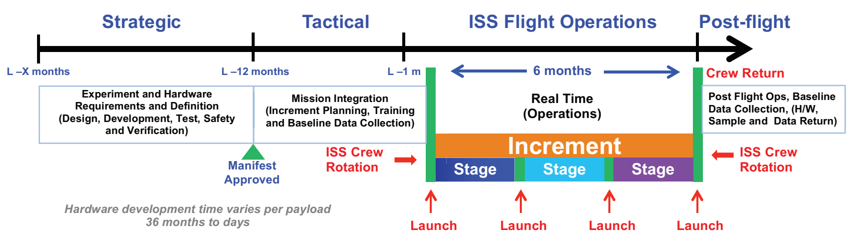

Figure 13. Example pathway following select-for-flight for a research investigation.

Subsequently, the ISSMP will conduct a feasibility evaluation of the investigation focusing on the functional requirements including the use of any experiment-unique hardware and development time and the requested number of subjects. Ground-based requirements for conducting the preflight and postflight operations necessary for conducting the flight experiment must also be defined. Included in the feasibility is an assessment of the complexity of the experiment, crew time requirements and the testing schedule.

The ISSMP team plays a critical role in conducting HRP human life sciences investigations on the ISS and provides an experienced team to each investigation to assist each investigator in defining their experiment hardware, software and operational requirements.

Funding Opportunities

What Should Principal Investigators Know About Conducting Research on ISS?

Supporting research in science and technology is an important part of NASA's overall mission. NASA solicits research through the release of NRAs, which cover a wide range of scientific disciplines. All NRA solicitations are facilitated through the Web-based NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES), http://nspires.nasaprs.com/external/. Registering with NSPIRES allows investigators to stay informed of newly released NRAs and enables submission of proposals. NSPIRES supports the entire lifecycle of NASA research solicitations and awards, from the release of new research calls through the peer review and selection process.

In planning the scope of their proposal, investigators should be aware of available resources and the general direction guiding NASA research selection. NASA places high priority on recommendations from the 2011 National Research Council's NRC Decadal Survey, which placed emphasis on hypothesis-driven spaceflight research. In addition, principal investigators should be aware that spaceflight experiments may be limited by a combination of power, crew time, or volume constraints. Launch and/or landing scrubs are not uncommon, and alternative implementation scenarios should be considered in order to reduce the risk from these scrubs. Preliminary investigations using ground-based simulators may be necessary to optimize procedures before spaceflight.

To understand previous spaceflight studies, prospective PIs should familiarize themselves with the NASA ISS Program Science Office database, which discusses research previously conducted on the ISS, including that of the International Partners. A detailed catalog of previous, current, and proposed experiments, facilities, and results, including investigator information, research summaries, operations, hardware information, and related publications is available through the NASA ISS Program Office at http://www.nasa.gov/mission_pages/station/research/index.html.

Additionally, details pertaining to research previously supported by the Space Life and Physical Sciences Research and Applications Division of NASA's Human Exploration and Operations Mission Directorate can be located in the Space Life & Physical Sciences Research and Applications Division Task Book in a searchable online database format at: https://taskbook.nasaprs.com/Publication/welcome.cfm.

NASA generally uses Broad Agency Announcements (BAA) to solicit proposals for research and technology investigations. Such BAAs may take the form of Announcements of Opportunity (AO), NRAs or, less frequently, Cooperative Agreement Notices (CAN). In addition, for specific, well-defined research end points or tests, NASA may elect to use Request for Proposals.

NASA solicits this research through the release of various research announcements in a wide range of science and technology disciplines. NASA uses a peer-review process to evaluate and select research proposals submitted in response to these research announcements.

The AO is used to solicit and competitively select research investigations characterized as having a well-defined purpose and end product; for example, science investigations with hardware responsibility for a unique spaceflight mission, a program of flight missions or unique but large-cost, non-flight programs.

The NRA is used to solicit research that is characterized as being a part of the HRP's ongoing approved research program under the budgetary discretion of the HRP program manager. Normally, the HRP will issue at least two NRAs annually in partnership with the National Space Biomedical Research Institute, one for research in support of the Space Radiation Element and one for the remainder of the program. In general, an NRA solicits research investigations that are characterized as being of high relevance to NASA's program interests but in which a specific end product or service is not well-defined but left to the creativity of the proposer. NRAs are typically used to solicit and competitively select proposals for ongoing programs although some may be singular in nature such as a data analysis program.

The CAN is used to solicit and competitively select proposals to support NASA program interests that require a high degree of cooperation between NASA and the selected institution. The scope of activities solicited by a CAN may be as modest as those through an NRA or as complex as those through an AO. The cooperative agreements awarded as a result of a CAN are similar to grants except that both NASA and the selected institution are required to provide resources, and both are involved in decisions related to the activities carried out by the selected institution.

NASA issues annual program solicitations that set forth a substantial number of research topics in areas consistent with stated agency needs or missions. Both the list of topics and the description of the topics and subtopics are sufficiently comprehensive to provide a wide range of opportunity for Small Business Concerns to participate in NASA research programs. Topics and subtopics emphasize the need for proposals with advanced concepts to meet specific agency needs.

The Small Business Innovation Research (SBIR) Program was established by Congress in 1982 to provide increased opportunities for small businesses to participate in research and developments to increase employment and to improve U.S. competitiveness. The program's specific objectives are to stimulate U.S. technologic innovation, use small businesses to meet federal research and development needs, increase private-sector commercialization of innovations and foster and encourage participation by socially disadvantaged businesses. Legislation enacted in 2000 extended and strengthened the SBIR program and increased its emphasis on pursuing commercial applications of SBIR project results.

The Small Business Technology Transfer (STTR) Program awards contracts to small business concerns for cooperative research and development with a non-profit research institution, such as a university. Congress's goal in establishing the STTR program is to facilitate the transfer of technology developed through the entrepreneurship of a small business and is modeled after the SBIR Program with the same basic requirements and phased funding structure. STTR is nevertheless a separate activity and is separately funded. It differs from SBIR in several important aspects including existing as a smaller program. The small company must take the research and intellectual property of the research institution and convert it into a useful product. Additional information and a current list of solicitations are available at: http://sbir.gsfc.nasa.gov/.

Points of Contact

The ISSMP provides planning, integration and implementation services for HRP, enabling the research communities as well as NASA's International Partners requiring access to space. For more information regarding the ISSMP, please visit: http://www.nasa.gov/exploration/humanresearch/elements/research_info_element-issmp.html.

Future Directions

Figure 14. The ISS is the only facility allowing researchers to evaluate the capabilities needed in preparation for missions to the moon and Mars. ((Image Credit: NASA)

The ISS is a test bed to continue validation of countermeasures, assess autonomous operations, and evaluate new technologies to acquire the knowledge, skills and capabilities to venture beyond low-Earth orbit. With assembly of the ISS complete and all laboratories in operation, scientific research has become the top priority. The ISSMP is uniquely positioned to support life science investigations to produce a biomedical research portfolio to mitigate space human health risks and to extend and sustain human activities for future human space exploration.

Acronyms

AO	Announcements of Opportunity
BAA	Broad Agency Announcements
BDC	Baseline data collection
CAN	Cooperative Agreement Notices
ESA	European Space Agency
EVA	Extra vehicular activities
HRF 1	HRF Rack 1
HRF 2	HRF Rack 2
HRF	Human Research Facility
HRP	Human Research Program
ICB	Informed Consent Briefing
IP	International Partner
IRB	Institutional Review Board
ISS	International Space Station
ISSMP	International Space Station Medical Projects
JSC	NASA's Johnson Space Center
LSDA	Life Sciences Data Archive
NASA	National Aeronautics and Space Administration
NRA	NASA Research Announcement
NSPIRES	NASA Solicitation and Proposal Integrated Review and Evaluation System
PI	Principal Investigator
SBIR	Small Business Innovation Research
STTR	Small Business Technology Transfer
TSC	Telescience Support Center
USOS	United States Operation Segment

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For more information...

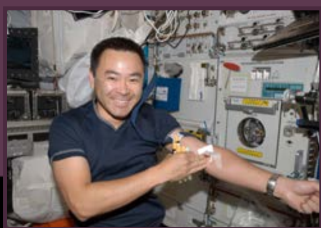
Space Station Science
http://www.nasa.gov/iss-science

Facilities
http://www.nasa.gov/mission_pages/station/research/facilities_category.html

ISS Interactive Reference Guide
http://www.nasa.gov/externalflash/ISSRG/index.htm

Researchers/Opportunities
http://www.nasa.gov/mission_pages/station/research/ops/research_information.html

ISS Research Customer Helpline
JSC-ISS-research-helpline@mail.nasa.gov
281-244-6187



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