National Aeronautics and Space Administration

International Space Station Facilities

Research in Space 2013 and Beyond

CSA ASC esa JAXA ROSCOSMOS

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Welcome to ISS

The International Space Station (ISS) is an unprecedented human achievement from conception to construction, to operation and long term utilization of a research platform on the frontier of space.

Fully-assembled and continuously-inhabited by all Partners, this orbiting laboratory provides a unique environment in which to conduct multidisciplinary research and technology development that drives space exploration, basic discovery, and Earth benefits.

The ISS is uniquely capable of unraveling the mysteries of our universe; from the evolution of our planet and life on Earth to technology advancements and understanding the effects of spaceflight on the human body. Through continued habitation and experience this outpost also serves to facilitate human exploration beyond low Earth orbit to other destinations in our solar system.

This orbiting laboratory is our species largest foothold in space. Exploration, research and discovery, bound with international cooperation and commercial development serve to highlight the best that we can be.

We look forward to sharing this brochure which outlines and highlights our ISS research capabilities and potential as we continue to push the bounds of on-orbit research.


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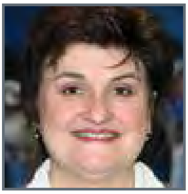

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Research Goals of Many Nations

It is the unique blend of unified and diversified goals among the world's space agencies that will lead to improvements in life on Earth for all people of all nations. While the various space agency partners may emphasize different aspects of research to achieve their goals in the use of ISS, they are unified in several important overarching goals.

All of the agencies recognize the importance of leveraging ISS as an education platform to encourage, inspire and ultimately motivate today's youth to pursue careers in math, science and engineering: **educating the children of today to be the leaders and space explorers of tomorrow.**

Advancing our knowledge in the areas of human physiology, biology, material and physical sciences and translating that knowledge to health, socio-economic and environmental benefits on Earth is another common goal of the agencies: **returning the knowledge gained in space research for the benefit of society.**

Finally, all the agencies are unified in their goals to apply knowledge gained through ISS research in human physiology, radiation, materials science and engineering to enable future space exploration missions: **preparing for the human exploration of destinations beyond low Earth orbit.**


INTERNATIONAL SPACE STATION

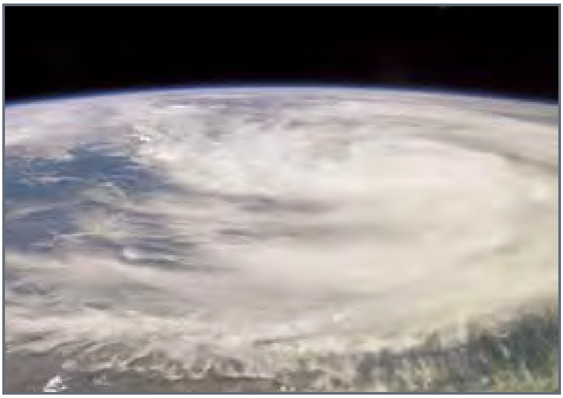
An Orbiting Laboratory Complex

The laboratories and operational components of the International Space Station (ISS) have been assembled and are up and running. As all ISS partner nations expand their research programs, international collaboration and interaction among scientists worldwide is growing rapidly.

Joining the U.S. Destiny laboratory on orbit, 2008 saw the greatest expansion of research capabilities with the addition of the European Space Agency Columbus and Japan Aerospace Exploration Agency Kibo laboratories as well as several external platforms. Over the final years of assembly from 2009-2010, many initial experiments were completed in the newest racks and the crew complement onboard ISS doubled to accommodate six rotating crewmembers; thus our transition from "early utilization" to "full utilization" of ISS became reality. The ISS, now complete, serves as the worlds preeminent microgravity research facility.

Early science on ISS has taught us much about what to expect as additional research facilities become operational. Across the scientific spectrum, many hypotheses about what will happen without gravity are being challenged. Data from ISS experiments is causing scientists to rethink existing models, and propose different lines of research, as they seek to understand new data from orbit. Rather than waiting years for the next flight opportunity, ISS discoveries generate new hypotheses that can often be tested in a short period of time—in the same way that scientists would follow a compelling result in a laboratory on Earth. We are able to push the bounds of previous research and extend the duration of experiments over many months and even years. We do not yet know what will be the most important knowledge or benefit gained from ISS, but through dedicated persistence, we do know that some amazing discoveries are yet on their way!

Knowledge and Benefits for all Humankind



NASA Image ISS017E005600 The Expedition 17 crew captured this image of the Tropical Cyclone Nargis in the Bay of Bengal prior to landfall in Burma on May 2, 2008.

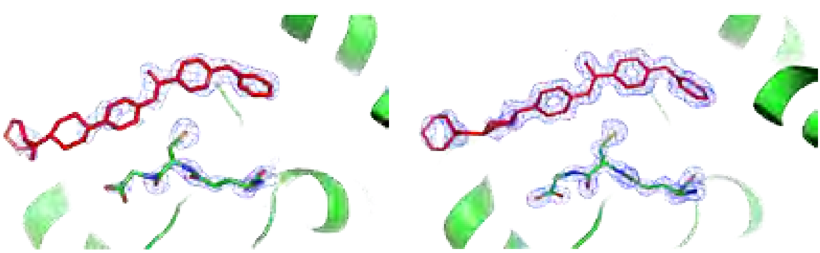
ISS research benefits humankind in areas ranging from human health to advanced product development to environmental study and monitoring. Ongoing development of patents and partnerships have directly demonstrated benefits to our lives on Earth as a result of the public's and world's investment in ISS research.

NASA Image ISS012E13692 A 25-kilometer long smoke plume from a fire in the Upper Ouachita National Wildlife Refuge in northeastern Louisiana.

Knowledge and Benefits for all Humankind

New Treatment Options for Duchenne Muscular Dystrophy: Collaborative High Quality Protein Crystal Growth – This JAXA and Russian FSA-sponsored investigation was a unique collaboration between these and other ISS International Partners. The inhibitor for human hematopoietic prostaglandin D synthase (H-PGDS) is a candidate treatment in inhibiting the effects of Duchenne muscular dystrophy. Investigators used the microgravity environment of the ISS to grow larger crystals and more accurately determine the 3-dimensional structures of H-PGDS inhibitor complex. The findings led to the development of a more potent form of the inhibitor, which is important for the development of novel treatments for Duchenne muscular dystrophy.

Crystals of H-PGDS grown on Earth (left) and in space (right) showing better defined crystal structures produced within the microgravity environment.



Electro density maps of the inhibitor crystals grown in space (resolution of 1.1 Angstroms by X-ray diffraction, right) show a clearer and more detailed density as compared to the inhibitor crystals grown on Earth (resolution of 1.8 Angstroms, left).

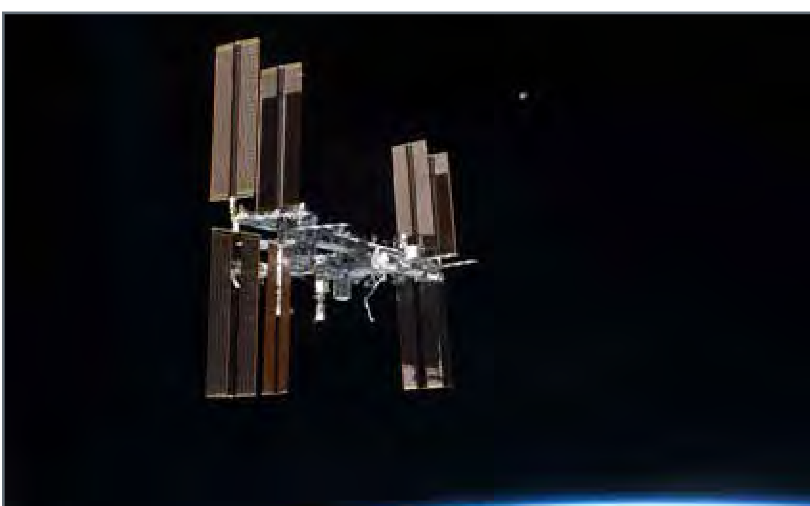
Knowledge and Benefits for all Humankind

Microbial Vaccine Development – Scientific findings resulting from International Space Station research have uniquely shown increased virulence in Salmonella bacteria flown in space, and identified the controlling gene responsible. AstroGenetix, Inc. has funded their own follow-on studies on ISS and are now pursuing approval of a vaccine as an Investigational New Drug (IND) with the FDA. They are now applying a similar development approach to methycillin-resistant Staph aureus (MRSA).

An ISS investigator recently patented the **Microparticle Analysis System and Method**, an invention for a device that detects and analyzes microparticles. This technology supports the chemical and pharmaceutical industries, and is one of a sequence of inventions related to technology development for experiments on the ISS, including the MEPS (Microencapsulation Electrostatic Processing System) experiment that demonstrated microencapsulation processing of drugs, a new and powerful method for delivering drugs to targeted locations.

Knowledge and Benefits for all Humankind

By allowing us to continuously explore and seek out answers to each question presented by our marvelous universe, the ISS laboratory provides a unique setting for discovering untold benefits for all Humanity. Possibly the greatest and most lasting benefit will be its unique ability to inspire and motivate youth and adults alike to learn and grow, and to bring together all who inhabit our tiny world. Such a unique vantage point and environment teaches us to look at questions and problems from ever new and unique perspectives, all the while paving the way for our next great leaps towards the stars.



What is an ISS Facility?

Let's begin our tour by defining exactly what a Facility is on the ISS:

ISS Research Facilities enable scientific investigations and are defined as 1) available onboard or as a sortie to ISS for long periods of time (i.e., more than a single increment) AND 2) can be scheduled for use by investigators OR provide an interface for connecting investigations to the ISS/environment, by other than the hardware's original developer/owner.

NASA Image: ISS018E026974 - Astronaut Sandra Magnus works with the Smoke Point In Co-flow Experiment (SPICE) using the Microgravity Sciences Glovebox (MSG) during Expedition 18.

Keeping this definition in mind, the remainder of this brochure outlines and highlights the capabilities of the Facilities already or soon to be in use onboard the ISS as of the date of this publication.

Since the list of all Facilities onboard ISS periodically changes, please be sure to contact the Program Science Office (PSO) in case of questions at jsc-iss-research-helpline@mail.nasa.gov, or check the latest Facility information, availability and research results at http://www.nasa.gov/mission_pages/station/research/facilities_category.html.

ISS Research History and Status

The International Space Station (ISS) was first inhabited just before the turn of the millennium. This laboratory in space has continuously grown and supports ongoing research into how the microgravity environment impacts fields of research from the physical sciences to biology to human physiology, and as such much of the knowledge gained crosses over and directly impacts many aspects of our daily lives.

In 2009 a significant space exploration goal was established, the number of astronauts capable of living onboard the ISS increased from 3 to 6, and in 2010 the assembly of the ISS was completed. Since then the time spent on-orbit performing ISS research has continuously grown. ISS laboratories now accommodate an unprecedented amount of space-based research with new and exciting capabilities being continuously proposed and developed.

This Earth orbiting laboratory and living facility houses astronauts who continuously conduct science across a wide variety of fields including human life sciences, biological science, human physiology, physical and materials science, and earth and space science. Over 1250 unique experiments have been conducted on the ISS over 13 years of continuous research.

Current International Space Station utilization statistics, including a cumulative history of research completed is continuously being tracked and updated and can be found here:

http://www.nasa.gov/pdf/695701main_Current_ISS_Utilization_Statistics.pdf.

For up to date information regarding ISS activities, research and accomplishments, please visit the following link:

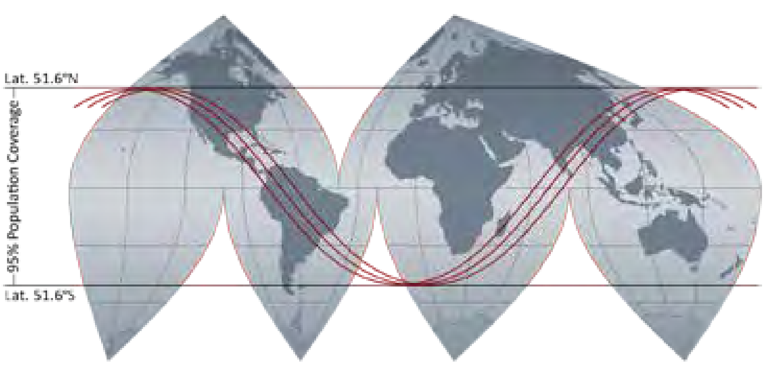
http://www.nasa.gov/mission_pages/station/main/index.html

ISS Topology “Where things are!”

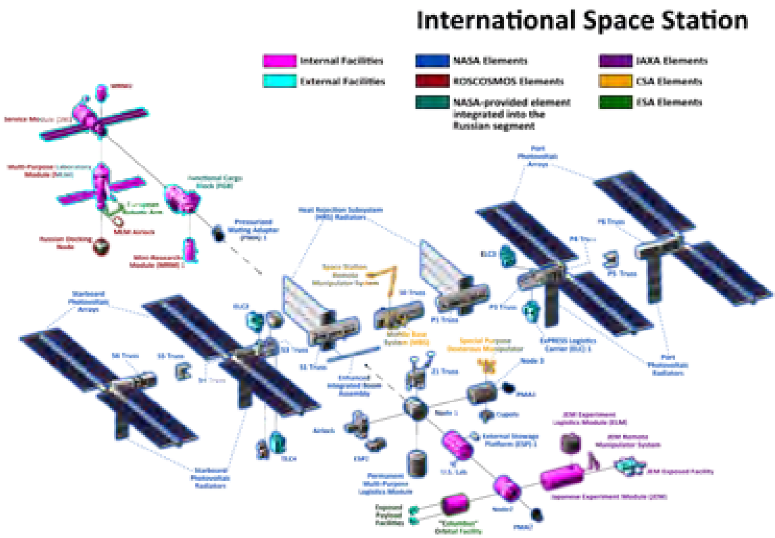
This section provides an overview of the completed ISS, its structures, and the locations that house and supply all of the individual ISS research facilities. All labels and locations depict the onboard layout at the time of this publication, though upgrades are planned and in work.

Before we begin discussing the layout, we should review a little about the unique location this laboratory inhabits high above our heads. The ISS resides in a 51.6 degree inclined low-earth orbit that repeatedly provides a view of the majority of the populated surface of the Earth. Perpetually free-falling, the microgravity environment on the ISS provides a unique location for conducting unparalleled biological, physical, Earth and space science research. From an average altitude of 400 km, surface details in such features as glaciers, agricultural fields, cities and coral reefs can be clearly observed from the ISS. Coordinated with ground observations, ISS provides the most flexible, repeatable and efficient sources of space-based data available.

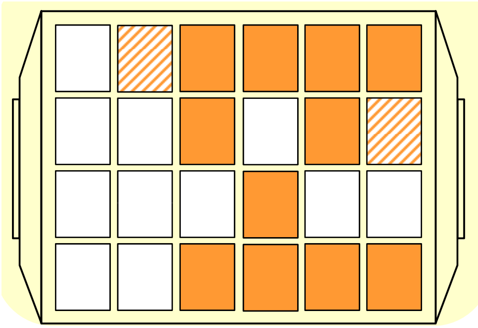
Orbiting once every 90 minutes, the ISS passes over 90 percent of the Earth’s habitable land mass.



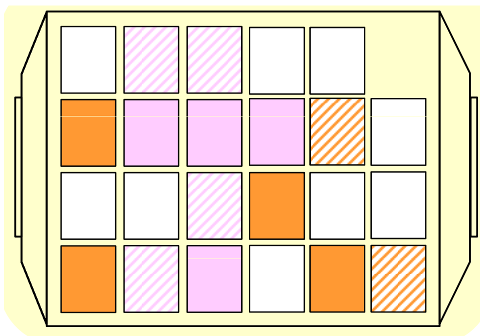
This graphical breakout shows the major ISS elements and components with regards to their current locations. Highlights show international partnerships as well as locations housing, both internal and external ISS research facilities.



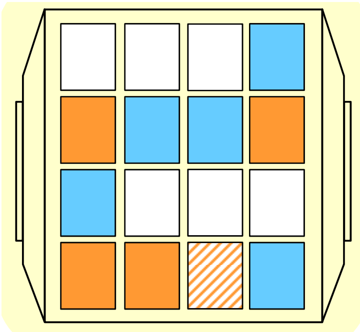
USOS Laboratory Research Rack Locations at Assembly Complete



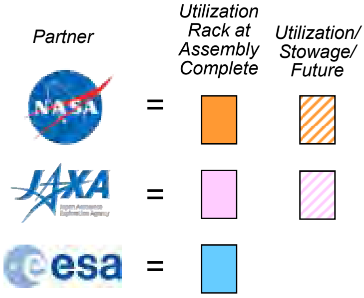
Destiny



Kibo

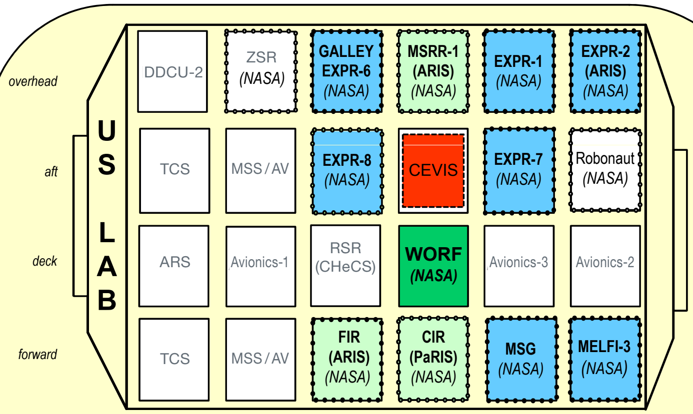


Columbus



ISS "Destiny" Laboratory Internal Facility Locations

Configuration for Increment 31/32



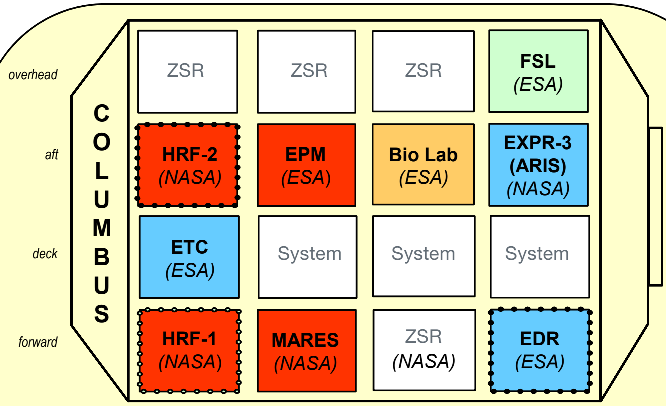
CEVIS = Cycle Ergometer with Vibration Isolation System
CIR (PaRIS) = Combustion Integration Rack (Passive Rack Isolation System)
EXPR-# = EXPRESS Rack Number
FIR (ARIS) = Fluids Integration Rack (Active Rack Isolation System)
MELFI-# = Minus Eighty Degrees Laboratory Freezer for ISS
MSG = Microgravity Science Glovebox
MSRR-# (ARIS) = Materials Science Research Rack (Active Rack Isolation System)
WORF = Window Observational Research Facility
ZSR = Zero-Gravity Stowage Rack

11 NASA Utilization Racks

- Physical Sciences and Materials Research
- Earth Science
- Human Research
- Multipurpose
- Systems and Stowage
- ARIS/PaRIS Capable

ISS "Columbus" Laboratory Internal Facility Locations

Configuration for Increment 31/32



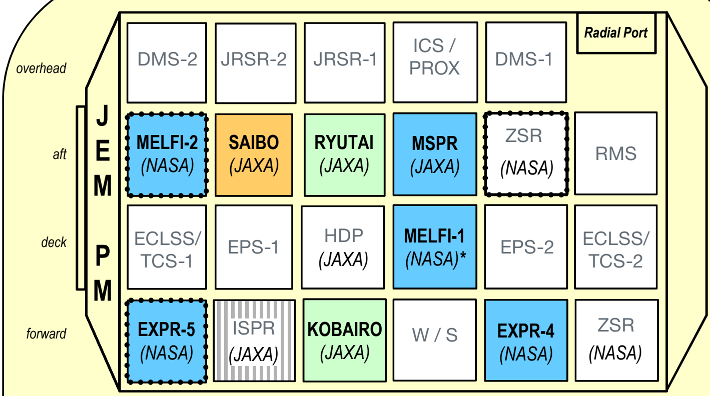
Bio Lab = ESA Biolab Facility
EDR = European Drawer Rack
EPM = European Physiology Module
ETC = European Transport Carrier
EXPR-# (ARIS) = EXPRESS Rack Number (Active Rack Isolation System)
FSL = Fluid Science Laboratory
HRF-# = Human Research Facility-Number
MARES = Muscle Atrophy Resistive Exercise System
ZSR = Zero-Gravity Stowage Rack

4 NASA Utilization Racks
5 ESA Utilization Racks

Biological Sciences
Human Research
Physical Sciences and Materials Research
Multipurpose
Systems and Stowage
ARIS/PaRIS Capable

ISS “Kibo” Laboratory Internal Facility Locations

Configuration for Increment 31/32



EXPR-# = EXPRESS Rack Number
ISPR = International Standard Payload Rack
HDP = Hard Dummy Panel
JRSR-# = Japanese Resupply Stowage Rack
KOBAIRO = Material Science
MELFI-# = Minus Eighty-Degree Laboratory Freezer for ISS (MELFI-1 is 85% NASA, 15% JAXA)

4 JAXA Utilization Racks
4 NASA Utilization Racks

MSPR = Multi-purpose Small Payload Rack
RMS = Remote Manipulator System
RYUTAI = Fluid Science
SAIBO = Cell Science
ZSR = Zero-Gravity Stowage Rack

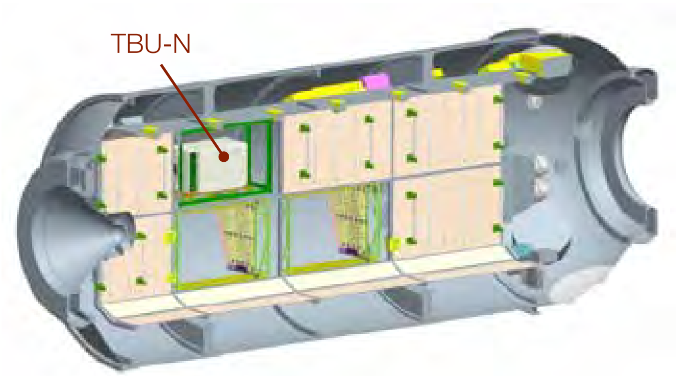
- Biological Sciences
- Physical Sciences and Materials Research
- Multipurpose
- Systems and Stowage
- Future JAXA Utilization Rack Location
- ARIS/PaRIS Capable

ISS Russian Segment Laboratory Internal Research Locations

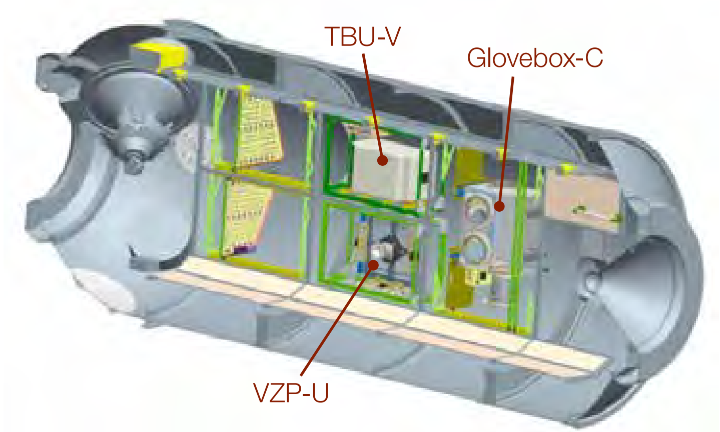
The Russian Segment (RS) has 5 modules used to support on orbit research: the Service Module (SM) Zvezda, the Mini Research Modules (MRM) Rassvet (MRM1) and Poisk (MRM2), the Docking Compartment-1 (DC1) Pirs, and one US sponsored module – the FGB Zarya. Additional modules are planned for the future.

One of these modules, MRM1 is further described below. This module contains eight internal workstations equipped with facilities including a glovebox, two incubators (TBU-V and TBU-N) to accommodate high- and low temperature experiments, and a Multipurpose Vibroprotective Platform (VZP-U).

MRM1 - Port side



MRM1 - Starboard side

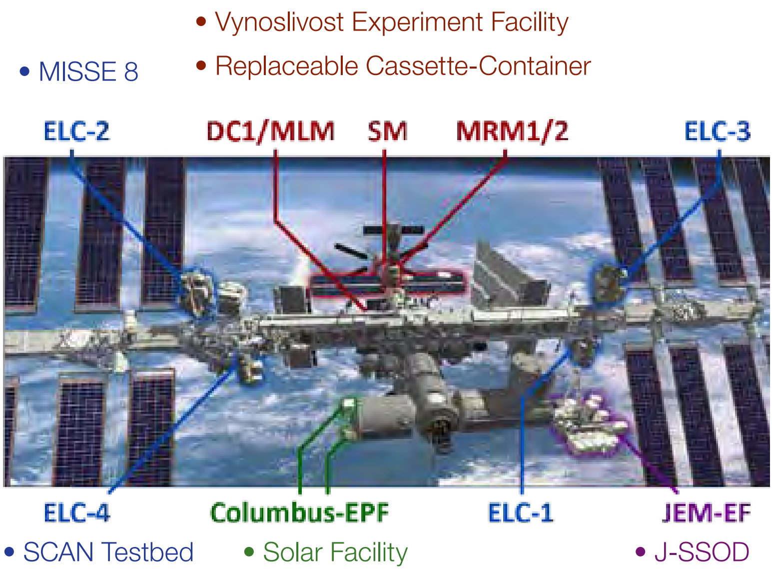


Graphics courtesy of and © RSC Energia, 2011

ISS Topology

ISS External Facility Locations

This graphical representation of the ISS flying towards the viewer highlights the primary locations where external facility interface infrastructure and hardware is located, including a subset of current ISS facilities housed at those locations.



Multipurpose Laboratory Facilities

Multipurpose ISS facilities represent a wide array of internal and external structures and devices designed to support a variety of investigations. These facilities often provide attachment locations for individual investigations or provide an assortment of research equipment that can be used by different research teams in furthering their own experiments.

This section is divided into two areas to highlight those facilities that are available inside the habitable volume of the ISS as well as those that are external and open to the space environment. Additions and changes to the makeup of these facilities occurs over time and the remainder of this section provides an overview of current capabilities and locations:

Internal Facilities:

- European Drawer Rack (EDR) [ESA]
- Expedite the Processing of Experiments to Space Station (EXPRESS) Racks [NASA]
- General Laboratory Active Cryogenic ISS Equipment Refrigerator (GLACIER) [NASA]
- Light Microscopy Module (LMM) [NASA]
- Microgravity Experiment Research Locker/Incubator (MERLIN) [NASA]
- Microgravity Science Glovebox (MSG) [ESA, NASA]
- Minus Eighty-Degree Laboratory Freezer for ISS (MELFI) [ESA, NASA]
- Multi-purpose Small Payload Rack (MSPR) [JAXA]
- Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) [NASA]

External Facilities:

- Columbus-External Payload Facility (Columbus-EPF) [ESA]
- Expedite the Processing of Experiments to the Space Station (EXPRESS) Logistics Carrier (ELC) [NASA]
- JEM External Facility (JEM-EF) [JAXA]
- JEM Small Satellite Orbital Deployer (J-SSOD) [JAXA]
- URM-D multipurpose workstations , Biaxial pointing platforms, Magnetomechanical anchors/locks and Portable working platform [Roscosmos]

Multipurpose Laboratory Facilities

ISS Internal Accommodations

The following section provides an overview of existing Internal Facilities that are multidisciplinary in nature - providing access to the microgravity environment as well as ISS resources and crewmembers.

International Standard Payload Rack (ISPR) Utilities and Capabilities

Power

- 3, 6 or 12 KW, 114.5-126 VDC

Vacuum

- Venting: 10^{-3} torr in less than 2 hours
- Vacuum Resource: 10^{-3} torr

Gases

- Nitrogen
  - Flow = 0.1 kg/minute min
  - 517-827 kPa nominal, 1379 kPa max.
- Argon, Carbon Dioxide, Helium
  - 517-768 kPa nominal
  - 1379 kPa maximum

Cooling Loops

- Moderate Temperature: 16.1C - 18.3C
- Flow rate: 0-45.36 kg/hr
- Low Temperature: 3.3 C - 5.6C
- Flow rate: 233 kg/hr

Data

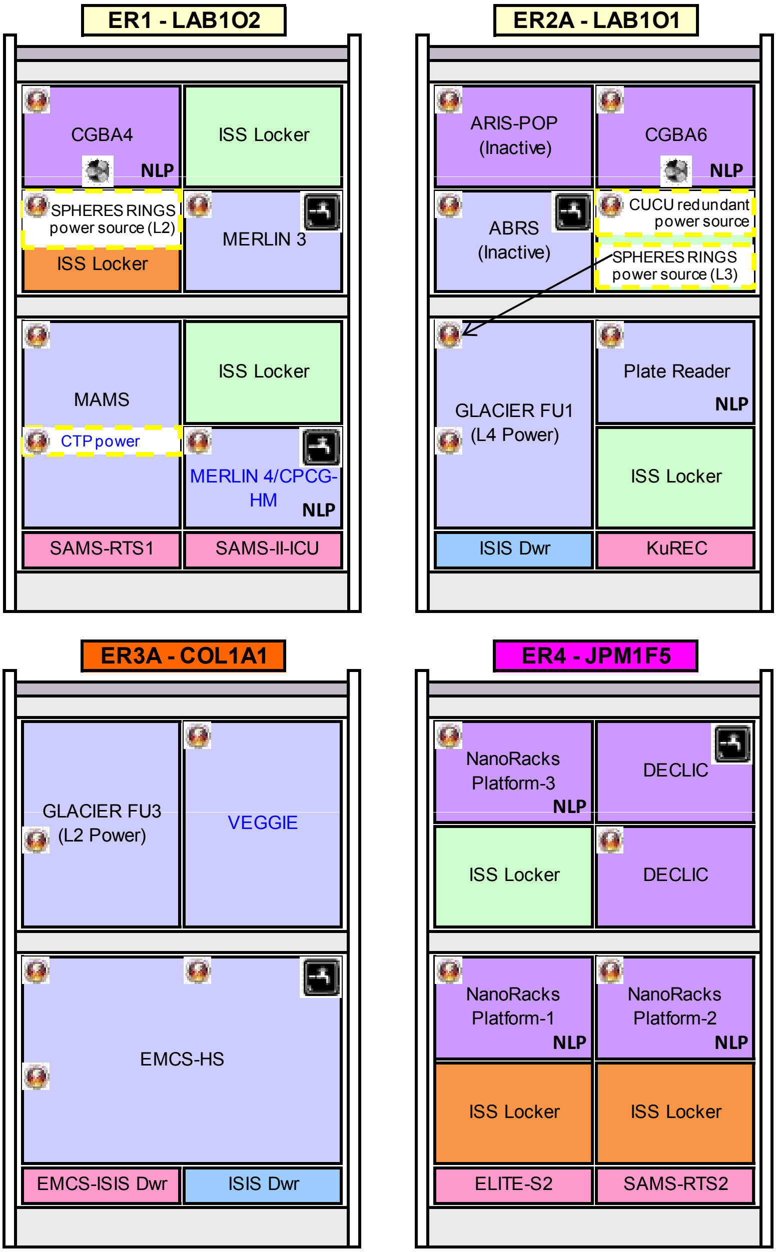
- Lo Rate: MIL-STD- 1553 bus 1Mbps
- High Rate: 100 Mbps
- Ethernet: 10 Mbps
- Video: NTSC

Expedite the Processing of Experiments to Space Station (EXPRESS) Racks [NASA] are modular multipurpose payload racks designed to store and support experiments aboard ISS. Each rack provides structural interfaces, power, data, cooling, water and other items needed to operate science experiments on the ISS. Experiments are exchanged in and out of EXPRESS Racks as needed; some smaller multi-user facilities will remain in EXPRESS for the life of ISS, others are used for only a short period of time.

Express Racks are one of the primary means of accommodating scientific hardware in the habitable volume of the ISS. Express Racks are the most flexible modular research facility available on ISS, and are used by NASA, JAXA and ESA.

EXPRESS Rack Configuration

Layout of all ISS Express Racks as planned through the SpaceX-3 mission docked operations timeframe. See legend (page 29) for more details.



EXPRESS Rack Configuration

See legend (page 29) for more details.

EXPRESS Rack Configuration Key

ISS Locker	- Stowage Locker
ISS Locker	- Location reserved for Lean Payloads
Payload	- Payload Insert (Payload inserted into ISS Locker or ISIS Drawer)
Payload	- Locker Replacement Payload
ISIS Dwr	- ISIS Drawer
Payload	- Drawer Replacement Payload
	- requires water (TCS)
	- requires EXPRESS Rack provided power
	- Front Breather payload
	- deployed payload
	- power resource utilized
NLP	- National Lab Payload

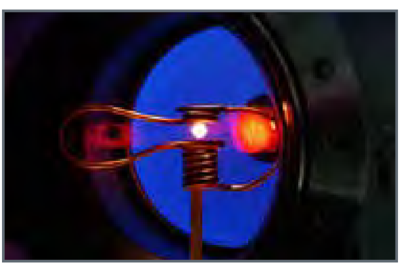
Gloveboxes provide containment for experiments, insuring that small or hazardous materials do not escape or float about the cabin. The **MSG** has been the most heavily used facility during ISS construction. This glovebox is continuously used for experiments ranging from combustion science, to the study of complex fluids, to the harvesting of plants.

Microgravity Science Glovebox (MSG) [ESA, NASA] provides a safe environment for research involving liquids, combustion and hazardous materials on board ISS. Crewmembers access the work area through ports equipped with rugged, sealed gloves. A video system and data downlink ability allows for the control of enclosed experiments from the ground. Built by ESA and operated by NASA, MSG is the largest glovebox ever flown in space.

European Drawer Rack (EDR) [ESA] is a highly felxible, multidisciplinary facility that supports up to seven modular experiment modules. Each payload has its own cooling, power, data communications, vacuum, venting and nitrogen supply. EDR facilitates autonomous operations of subrack types of experiments in a wide variety of scientific disciplines. The EDR also provides a data downlink capability for an ESA high definition 3D video camera.

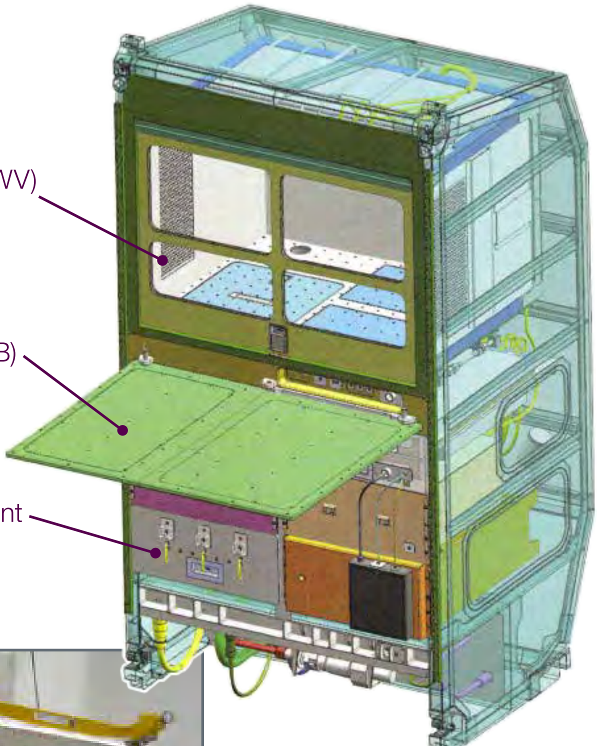
With the installation of a special drawer inside EDR, the facility is able to accommodate one of ESA's KUBIK incubator facilities, providing the ability to undertake a range of experiments. Investigations to date have included protein crystal growth studies that attempt to understand how crystals grow in purely diffusive conditions, and cell biology experiments, using the KUBIK Incubator, have studied the activation of T cells that play an important role in the immune system.

EDR capabilities will soon be expanded with ESA's Facility for Adsorption and Surface Tension (FASTER) addition, which provides an ability to study the links between emulsion stability and physico-chemical characteristics of droplet interfaces. The Electro-Magnetic Levitator (EML) will also soon be added to investigate microgravity thermophysical properties of metal alloys, supporting both basic and industrial research and development needs.



The Protein Crystallization Diagnostics and Facility (PCDF) was the first experiment performed with the EDR rack. Its main science objectives is to study protein crystal growth conditions by way of non-intrusive optical techniques like Dynamic Light Scattering (DLS), Mach-Zehnder Interferometry (MZI) and classical microscopy. Understanding how crystals grow in purely diffusive conditions help define the best conditions needed to make crystals as perfect as possible.

Multi-purpose Small Payload Rack (MSPR) is a multi-user facility that has a Work Volume (WV) that can hold research hardware (roughly 350L in volume) and a Workbench (WB), and a Small Experiment Area (SEA). The rack also provides general interfaces, such as power, N2 gas supply and exhaust, heat rejection, smoke detection, sound suppression, communications and video. The MSPR can be used for wide range of fields in the space environment, including science and educational missions. More information available at http://iss.jaxa.jp/en/kiboexp/pm/mspr/mspr.pdf.



JAXA Image:
The MSPR is shown during ground processing prior to launch.

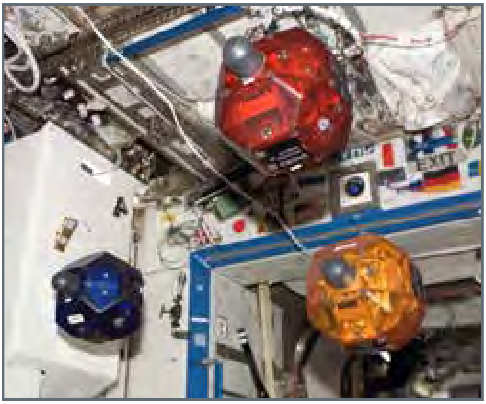
Freezers allow for cold storage and transportation of science samples collected on ISS for later return to Earth; often times relating to the biological and life sciences. Three MELFI freezers are on orbit to support physiology and biology research by all of the ISS partners.

General Laboratory Active Cryogenic ISS Equipment Refrigerator (GLACIER) [NASA] serves as an on-orbit ultra-cold freezer (as low as -165 °C).

Minus Eighty-Degree Laboratory Freezer for ISS (MELFI) [ESA, NASA] are ESA-built and NASA-operated freezers that store samples at temperatures as low as –80 °C.

Microgravity Experiment Research Locker/Incubator (MERLIN) [NASA] can be used as either a freezer, refrigerator, or incubator (between -20.0 °C to + 48.5 °C).

Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) [NASA] is a suite of free-flying satellites used to perform preprogrammed coordinated flight demonstrations and is capable of supporting multiple attachments to perform investigations from fluid physics to technology demonstration. SPHERES have been used for numerous investigations to date and including educational outreach and student competitions.



NASA Image ISS017E017377 - Above, Astronaut Greg Chamitoff, Expedition 17, programs the SPHERES satellites to perform a coordinated flight task.

ISS External Accommodations

This section gives an overview of existing External Facilities that are multi-disciplinary in nature - providing access to multiple sites that are exposed to the space environment and which include structural attachment points and utility interfaces.

EXPRESS Logistics Carrier (ELC)Adapter

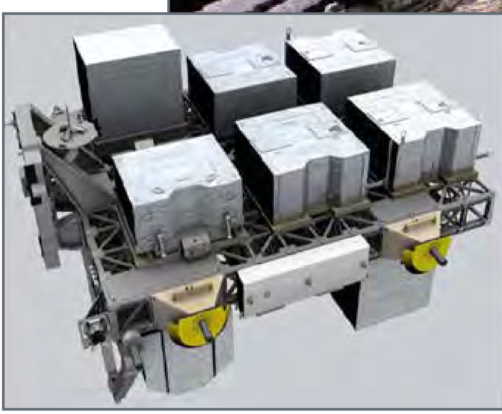
- Mass: 227 kg (8 sites across 4 ELCs; not including adaptor plate)
- Volume: 1.2 m^3
- Size: 0.8m x 1.2m x 1.2m
- Power: 750 W, 113-126 VDC; 500 W, 28 VDC
- Data: Low Rate: 1 Mbps
  MIL-STD-1553
  Medium Rate: 6 Mbps (shared)

JEM External Facility (EF)

- Mass: 500 kg (10 Standard Sites, mass includes PIU adaptor); 2500 kg (3 Heavy Sites, mass includes PIU adaptor)
- Volume: 1.5 m^3
- Size: 1.85m x 1m x 0.8m
- Power: 3 kW/6 kW, 113-126 VDC
- Thermal: 3 kW/6 kW cooling
- Data: Low Rate: 1 Mbps
  MIL-STD-1553
  High Rate: 43 Mbps (shared)
  Ethernet: 100Base-TX

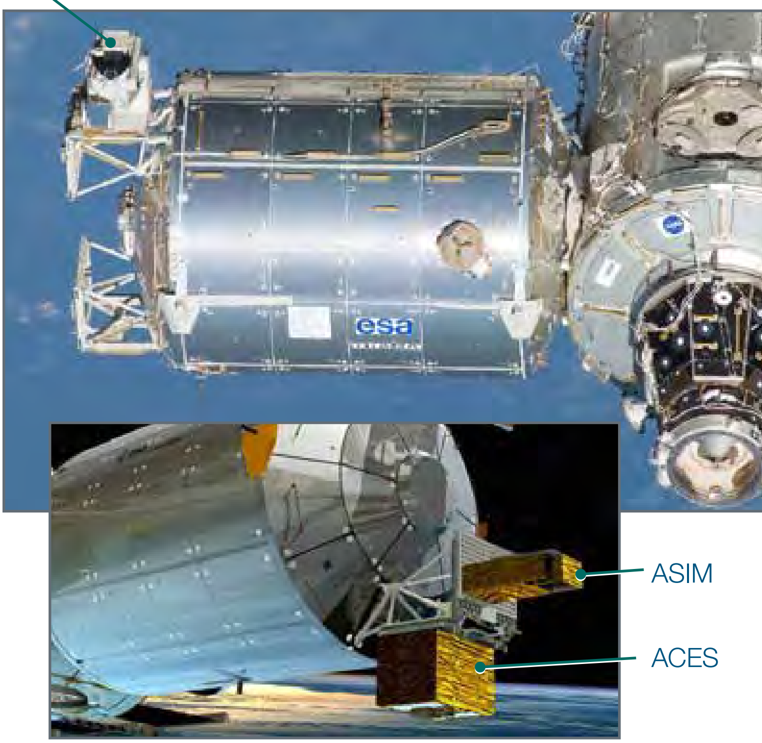
Columbus External Payload Facility (EPF)

- Mass: 230 kg per site (4 sites; uses Columbus External Payload Adapter (CEPA)
- Volume: 1.2 m^3
- Size: 0.8m x 1.2m x 1.2m
- Power: 1250 W, 120 VDC (shared)
- Data: Low Rate: 1 Mbps
  MIL-STD-1553
  Medium Rate: 2 Mbps (shared)
  Ethernet: 10 Mbps

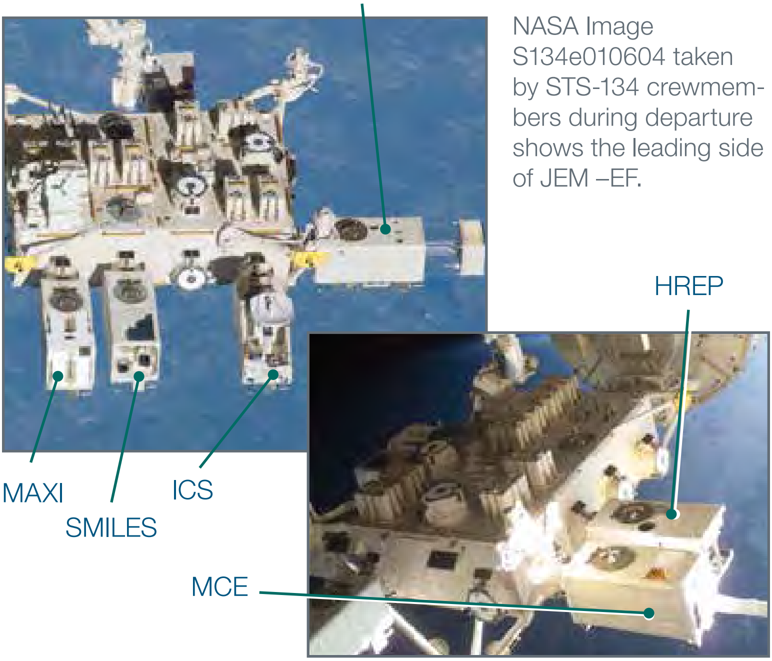


Expedite the Processing of Experiments to the Space Station (EXPRESS) Logistics Carrier (ELC) [NASA] is a pallet designed to support external research hardware and store external spares (called Orbital Replacement Units, ORUs) needed over the life of ISS. Currently, 4 ELCs are mounted to ISS trusses providing unique vantage points for space, technology and Earth observation investigations. Two ELCs are attached to the starboard truss 3 (ITS-S3) and two ELCs to the port truss 3 (ITS-P3). By attaching at the S3/P3 sites, a variety of views such as zenith (deep space) or nadir (Earthward) direction with a combination of ram (forward) or wake (aft) pointing allows for many possible viewing opportunities.

Columbus-External Payload Facility (Columbus-EPF) [ESA] provides four powered external attachment site locations for scientific payloads or facilities, and has to date been used by ESA and NASA. Each of the four attachment sites may hold a mass of up to 290 kg, and are provided utility connections for power and data. Included with Columbus at launch, the **Solar Facility** was one of the first two European investigations supported by the Columbus-EPF. In the future the Atomic Clocks Ensemble in Space (ACES) investigation holding two high precision atomic clocks and the Atmosphere Space Interaction Monitor (ASIM) will be installed on the lower, Earth-facing external attachment sites.



JEM External Facility (JEM-EF) [JAXA] is an un-pressurized multipurpose pallet structure attached to the Japanese Experiment Module (JEM) or "Kibo" (meaning Hope). This external platform is used for research in areas such as communications, space science, engineering, technology demonstration, materials processing, and Earth observation. Accessible from the internal pressurized volume of ISS via the JEM Airlock, articles interfacing with this structure are grappled and moved using the JEM Remote Manipulator System (JEMRMS). This entire platform is roughly 5.6m x 5m x 4m, weighing approximately 4000 kg, and includes utilities at each of the nine attachment sites.



NASA Image S134e010604 taken by STS-134 crewmembers during departure shows the leading side of JEM –EF.

Current users of the JEM-EF include SEDA-AP (Space Environment Data Acquisition equipment-Attached Payload) that measures the space environment around the ISS, MAXI (Monitor of All-sky X-ray Image) is a space X-ray observatory, ICS-EF (Inter-Orbit Communication System-EF) is used to transfer data between ISS and Earth, SMILES (Superconducting Submillimeter-wave Limb-emission Sounder) observes global trace gases in the stratosphere, HREP (HICO and RAIDS Experiment Payload) consists of two Earth observation devices, and MCE (Multi-mission Consolidated Equipment), which supports five science experiments including earth observations.

The **JEM Small Satellite Orbital Deployer (J-SSOD) [JAXA]** provides a novel, safe, small satellite launching capability to the International Space Station (ISS). The J-SSOD is a unique satellite launcher handled by the Japanese Experiment Module Remote Manipulator System (JEMRMS) that provides containment and deployment mechanisms for several individual small satellites. Once the J-SSOD including satellite install cases with small satellites are installed on the Multi-Purpose Experiment Platform (MPEP) by crewmembers, it is passed through the JEM airlock for retrieval, positioning and deployment by the JEMRMS.

NASA Image: iss033e006452 - Astronaut Akihiko Hoshide posing with J-SSOD before it enters the JEM airlock for its initial CubeSat deployment operations during Expedition 32.

Examples of some J-SSOD users include TechEdSat, NanoRacksCubeSat-1/F-1, FITSAT-1, RAIKO and WE-WISH.

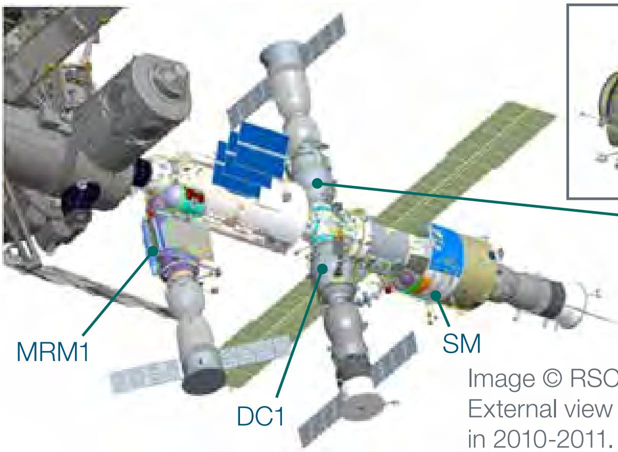


Image © RSC Energia: External view of the ISS RS in 2010-2011.

Image © RSC Energia

Russian Segment External Facilities [Roscosmos] consists of a whole host of multi-user external Facility interface locations and support structures. The following list outlines, by element, the primary locations, types and nomenclature for these sites.

Image © Roscosmos: URM-D multipurpose workstation with integrated Photon-Gamma experiment taken during Increment 26 EVA-28.

Service Module (SM) or Zvezda:

- URM-D multipurpose workstations
- Biaxial pointing platforms
- Handrail clamp locations

Docking Compartment-1 (DC1) or Pirs:

- Magnetomechanical anchors/locks
- Handrail clamp locations

Mini Research Modules (MRM2) or Poisk:

- URM-D multipurpose workstations
- Magnetomechanical anchors/locks

Multipurpose Laboratory Module (MLM) - scheduled for launch in late 2013:

- Magnetomechanical anchors/locks
- Handrail clamp locations
- URM-D multipurpose workstations

URM-D stands for “universal workstation with capabilities for re-equipping.”

Biological Research

In our ongoing quest to understand biological processes, protect biological systems and engineer ever more efficient and effective means of cultivating biological products, the microgravity environment of the ISS has opened a whole new frontier for long duration study and experimentation. Provisioned with a multitude of advanced facilities and coupled with an interdisciplinary focus, the ISS supports an array of scientific investigations in the field of biological research. Akin to any biological research laboratory here on Earth, the ISS is outfitted with all the instrumentation and tools needed to conduct modern biological investigations including: incubators, centrifuges, animal and plant habitat systems, glove boxes, freezers and coolers, spectrometers and microscopes.

This section provides an overview of the current and growing capabilities afforded by the ISS in the fields of animal, plant, cellular and microbial research:

Internal Facilities:

- Advanced Biological Research System (ABRS) [NASA]
- Aquatic Habitat (AQH) [JAXA, Roscosmos]
- BioLab [ESA]
- Biomass Production System (BPS) [NASA]
- Biorisk [Roscosmos]
- Biotechnology Specimen Temperature Controller (BSTC) [NASA]
- Cell Biology Experiment Facility (CBEF) [JAXA]
- Clean Bench (CB) [JAXA]
- Commercial Generic Bioprocessing Apparatus (CGBA) [NASA]
- EOSTEO Bone Culture System [CSA]
- European Modular Cultivation System (EMCS) [ESA, NASA]
- Kriogem-3M [Roscosmos]
- KUBIK (KUBIK) - European Space Agency (ESA)
- LADA [Roscosmos]
- Mouse Drawer System (MDS) [ASI]
- Rodent Habitat (RH) [NASA]
- Saibo Rack (Saibo) [JAXA]
- TBU-N Low-temperature incubator [Roscosmos]
- TBU-V High-temperature incubator [Roscosmos]
- VEGGIE (VEGGIE) [NASA]

External Facilities:

- Expose Experiment (Expose) [ESA]

The first experiments in ABRS include the first trees flown in space (Willows for a Canadian study of cambium formation) and an American study will use green fluorescent proteins as indicators of environmental stress.

Advanced Biological Research System (ABRS) [NASA] is a single locker system providing two growth chambers. Each growth chamber is a closed system capable of independently controlling temperature, illumination, and atmospheric composition to grow a variety of biological organisms including plants, microorganisms, and small arthropods (insects and spiders).

BioLab [ESA] can be used to perform space biology experiments on microorganisms, cells, tissue cultures, small plants and small invertebrates. Such studies provide a better understanding of the effects of microgravity and space radiation on biological organisms. Biolab includes an incubator, microscope, spectro¬photometer, glovebox, freezer units, and two centrifuges to simulate the effects of gravity.

Kriogem-3M [Roscosmos] is a refrigerator-incubator used for the stowage of biological samples or medical kits and for the culture and incubation of bioreactors such as Recomb-K, Lutch-2.

Incubators and bioreactors are specialized environmentally controlled hardware used for growing cells, tissues, and microorganisms.

TBU-V High-temperature incubator [Roscosmos] enables a variety of experiments in human life sciences, biology, and biotechnology at elevated temperatures.

TBU-N Low-temperature incubator [Roscosmos] provides a refrigerated environment for carrying out a variety of experiments in human life sciences, biology, and biotechnology.

Biotechnology Specimen Temperature Controller (BSTC) [NASA] includes a refrigerator, incubator and cryo-drawer, as well as environmental and atmospheric controls to grow and maintain mammalian cell cultures in microgravity.

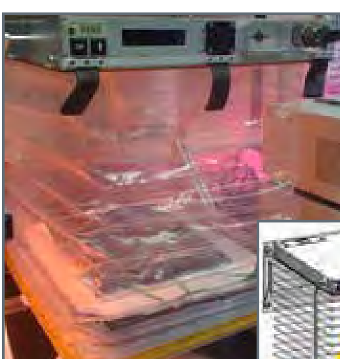
Commercial Generic Bioprocessing Apparatus (CGBA) [NASA] provides programmable, accurate temperature control—from cold stowage to a customizable incubator—for experiments that examine the biophysical and biochemical actions of microorganisms in microgravity. CGBA can be used in a wide variety of biological studies, such as protein crystal growth, small insect habitats, plant development, antibiotic-producing bacteria and cell culture studies.

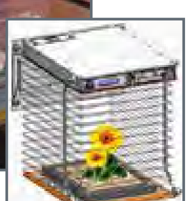
CGBA, operated by Bioserve Space Technologies is a key facility being used by investigators as part of the ISS National Laboratory initiative.

KUBIK [ESA] are portable incubators with microgravity and centrifuge accommodations which were originally designed to be flown to ISS via Soyuz spacecraft. KUBIK can function as an incubator or cooler (+6C to +38C temperature range) for undertaking self-contained automatic biological experiments. One of the KUBIK incubator facilities is accommodated within the **European Drawer Rack (EDR)** facility. Standalone KUBIK incubators have also been used to house numerous experiments on the ISS. An example in the field of immunology is the ROALD-2 (ROle of Apoptosis in Lymphocyte Depression 2) investigation, December 2011, which studied the role of the lipid, Anandamide, with regards to the regulation of immune processes in human lymphocytes and in the cell cycle under weightless conditions.

Biomass Production System (BPS) [NASA] provides a complete growing environment for plants in microgravity. Several large chambers are designed to support plant growth during long duration space flight in order to assess viability and examine the impacts of microgravity on growing and developing plants. Four independent chambers provide lighting, temperature, humidity, carbon dioxide level, and nutrient/water delivery control.

The initial BPS mission provided the most extensive microgravity data set for plant growth and development to date. Apogee wheat plants, shown above, were grown in the BPS during the Photosynthesis Experiment and System Testing Operation (PESTO) investigation portion of this initial Technology Validation Test.





VEGGIE (VEGGIE) [NASA] is an ISS biology research facility that will soon be onboard, allowing researchers to analyze and grow large plants in the habitable volume of a spacecraft. This hardware is housed in an Express rack, provides light and uniquely relies on the ISS cabin Environmental Control and Life Support System (ECLSS) cabin air flow for temperature, humidity, and CO_2 maintenance.

European Modular Cultivation System (EMCS) [ESA, NASA] allows for cultivation, stimulation and crew-assisted operation of biological experiments under well-controlled conditions (e.g. temperature, atmospheric composition, water supply and illumination). It is being used for multi-generation experiments and studies of the gravitational effects on early development and growth in plants and other small organisms.

The EMCS has two centrifuges that can spin at 0 to 2x Earth's gravity. Different experiment containers can hold a variety of organisms, such as worms and fruit flies, as well as seeds and plants. The EMCS has already supported a number of plant growth experiments operated by ESA, NASA, and JAXA.

LADA [Roscosmos] is a space greenhouse launched in 2002, and it has been in almost continuous use for growing plants in the Russian Service Module. It has supported a series of experiments on fundamental plant biology and space farming, growing multiple generations of sweet peas, wheat, tomatoes, and lettuce.

NASA Image: ISS014E15479 – Above, Cosmonaut Mikhail Tyurin performs inspection of the BIO-5 Rasteniya-2 (Plants-2) experiment in the Russian LADA greenhouse during Expedition 14.

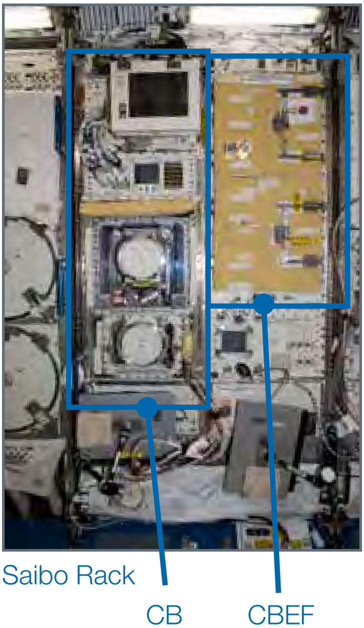
NASA and Roscosmos have used the LADA greenhouse in cooperative tests to determine the best ways to keep roots moist in space. Bioregenerative life support from photosynthesis may be an important component of future spacecraft systems.

EOSTEO Bone Culture System [CSA] provides the controlled environmental conditions needed to grow bone cells in microgravity. This culture system has been used successfully on previous U.S. and Russian recoverable orbital flights, and is available for use to study bone cell cultures on ISS.

Understanding the changes in bone cells in microgravity could be key for understanding the bone loss that occurs in astronauts while they are in space or during the aging process on at home on Earth.

Mouse Drawer System (MDS) [ASI] is hardware provided by the Italian Space Agency that uses a validated mouse model to investigate the genetic mechanisms underlying bone mass loss in microgravity. MDS is a multifunctional and multi-user system that allows experiments in various disciplines of biomedicine, from research on organ function to the study of the embryonic development of small mammals under microgravity conditions. Research conducted with the MDS is an analogue to the human research program, which has the objective of safely extending the human presence beyond low Earth orbit.

The **Saibo Rack (SAIBO) [JAXA]** is a multi-purpose rack consisting of two main parts, the **Clean Bench [CB] [JAXA]** and **Cell Biology Experiment Facility [CBEF] [JAXA]**. The CB is a sterilized glove box equipped with a phase contrast microscope, and the CBEF is an incubator that has a micro-G compartment and a 1G compartment equipped with small centrifuge. The primary purpose of the Saibo Rack is to support cell or plant culture experiments across a range of life and biological sciences.

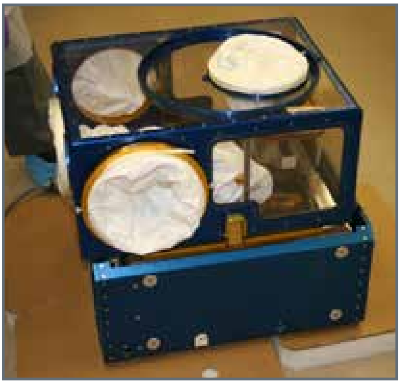


Biological Research

Saibo (細胞) means "Cell" in Japanese. This rack consists of the CBEF and CB which supports various cell culture experiments, and its first use included studies on the effects of space radiation.

Aquatic Habitat (AQH) [JAXA, Roscosmos], located in the **Multi-purpose Small Payload Rack (MSPR)** facility, is designed for breeding small fresh-water Medaka or Zebrafish for up to 90 days in the microgravity environment in the ISS. Such fish provide many advantages as model animals for microgravity research of biological processes and systems. The AQH is composed of two aquariums that contain automatic feeding systems, day/night cycle LED lighting, Charge-coupled device (CCD) cameras and a bacteria based water quality control system. Multiple lines of biological research are planned for AQH including bone degradation, muscle atrophy and radiation impacts.

AAU



AEM-X

Rodent Habitat (RH) [NASA] will provide containment systems for rodents within an ISS ExPRESS rack in support of mammalian biological studies. This hardware contains a complex assortment of ancillary equipment and Hardware Support Kits, all designed to safely and comfortably transport and house animal subjects and provide basic analytical capabilities on-board. This includes the Animal Transport System (ATS), which has two subcomponents that provide environmental control (AEM-E) and housing (AEM-T) during transportation to the ISS, and the Animal Access Unit (AAU) and Animal Enclosure Module-X (AEM-X) which provide on-orbit access and housing.

Expose Experiment (Expose) [ESA] is a multi-user facility accommodating experiments in the following disciplines: photo processing, photobiology and exobiology. Expose allows short- and long-term exposure of experiments to space conditions and solar UV radiation reaching the ISS. The Expose facility is installed outside of the ISS where the appropriate resources are available (power, data, etc) and to date has been installed on the external surfaces of the Russian Zvezda service module (**Expose-R**) and the European Columbus laboratory (**Expose-E**). Expose-E was returned from orbit in 2009 as part of the **European Technology Exposure Facility (EuTEF)**. The Expose-R facility is still on orbit awaiting the next batch of experiment samples as part of the follow up project called **Expose-R2**.

NASA Image: ISS018E014431- Cosmonaut Yury Lonchakov, Expedition 18 flight engineer, working with the EXPOSE-R and its connectors .

Biorisk [Roscosmos] is a suite of hardware used to measure the impacts of the space environment on biological activity. Two internal components, the **Biorisk-MSV** container and **Biorisk-KM** case, and one external **Biorisk-MSN** container, allow researchers to obtain new information about limits of an organisms (phenotypical) adaptation and its associated response or genotypical changes. The focus with this hardware is on bacteria and fungi that form conventional colonies of microorganisms living on structural materials used in space technology. **Biorisk-MSN**, on the other hand, is designed to support long-term exposure for monitoring the resting stages of organisms on the external surface of the ISS Russian modules.

Together, these experiments provided evidence that bacterial and fungal spores as well as dormant forms of organisms that have reached higher levels of evolutionary development (for instance, dehydrated embryos of lower crustaceans in the state of deep diapauses) have the capability to survive a long-term exposure to the harsh outer space environment. This observation suggests that such organisms can be transferred on external surfaces of spacecraft during interplanetary missions and therefore may drive future requirements with regards to planetary protection.

Inside, pressurized environment compartment monitors:

Biorisk-MSV container

Biorisk-KM case

The **Biorisk-MSN** containers expose samples to the long term, external space environment.

Human Physiology Research

ISS Facilities support an array of scientific investigations concerning human physiology, adaptation and the health of crewmembers. All facilities in this section support investigations that directly employ human subjects as the focus of the experiment. Much of the hardware serves the dual purpose of maintaining or assessing crewmembers health as well as equipment capable of supporting scientific research.

This section provides overviews and highlights with regards to facilities that can support research into human physiology and space adaptation presently available onboard the ISS:

Internal Facilities:

- Advanced Resistive Exercise Device (ARED) [NASA]
- Anomalous Long Term Effects in Astronaut's Central Nervous System (ALTEA) [ESA, NASA, ASI]
- Combined Operational Load Bearing External Resistive Exercise Treadmill (COLBERT) [NASA]
- Cycle Ergometer with Vibration Isolation System (CEVIS) [NASA]
- European Physiology Module (EPM) [ESA]
- Hand Posture Analyser (HPA) [ASI]
- Human Life Research Complex [Roscosmos]
- Human Research Facility (HRF-1 and HRF-2) [NASA]
- Human Research Hardware [CSA]
- Human Research Hardware [JAXA]
- Intra-Vehicular Tissue Equivalent Proportional Counter (IV-TEPC) [NASA]
- Measuring Radiation Hazards in Space (Matryoshka) [Roscosmos]
- Muscle Atrophy Research Exercise System (MARES) [ESA]
- Onboard Diagnostic Kit (ODK) [JAXA]
- PAssive Dosimeter for Lifescience Experiments in Space (PADLES) [JAXA]
- Percutaneous Electrical Muscle Stimulator (PEMS) [ESA]
- Pulmonary Function System (PFS) [ESA, NASA]
- Space Linear Acceleration Mass Measurement Device (SLAMMD) [NASA]
- Ultrasound 2 [NASA]

Muscle Atrophy Research Exercise System (MARES) [ESA] is used for research on musculoskeletal, biomechanical, and neuromuscular human physiology to better understand the effects of microgravity on the these related systems. This instrument is capable of assessing the strength of isolated muscle groups around joints by controlling and measuring relationships between position/velocity and torque/force as a function of time.

European Physiology Modules (EPM) [ESA] facility is designed for investigating the effects of microgravity on short-term and long-duration space flights on the human body and includes equipment for studies in neuroscience, cardiovascular, bone and muscle physiology as well as investigations of metabolic processes.

The EPM Cardiolab instrument was provided by the French national space agency (CNES) and German Aerospace Center (DLR).

NASA Image ISS025E008371 - Above, Doug Wheelock, Expedition 25 commander, performing PASSAGES experiment.

NASA Image ISS030E177225 - Left, Astronaut Dan Burbank, Expedition 30, performing PASSAGES experiment.

Human Research Facility (HRF-1 and HRF-2) [NASA] enables human life science researchers to study and evaluate the physiological, behavioral, and chemical changes induced by long duration space flight. HRF-1 houses medical hardware including devices for measuring blood pressure and heart function, and a refrigerated centrifuge for processing blood samples. Two more pieces of hardware that are in themselves facilities are Ultrasound 2 [NASA], and the Space Linear Acceleration Mass Measurement Device (SLAMMD) [NASA] for measuring on-orbit crewmember mass, The equipment is being used to study the effects of long-duration spaceflight on the human body. Researchers will use ISS to understand the physiology and to test countermeasures that will prevent negative effects, and enable humans to travel beyond Earth orbit.

SLAMMD

Refrigerated Centrifuge

Ultrasound 2

Techniques developed for using ultrasound technology on ISS are now being used in trauma facilities to more rapidly assess serious patient injuries.

Pulmonary Function System (PFS) [ESA, NASA] is hardware developed collaboratively by ESA and NASA. It includes four components that are needed to make sophisticated studies of lung function by measuring respired gases in astronaut subjects. It includes two complimentary analyzers to measure the gas composition of breath, the capability to make numerous different measurements of lung capacity and breath volume, and a system to deliver special gas mixtures that allow astronauts to perform special tests of lung performance. ESA also operates a small portable version of the system (Portable PFS) that can be used in the various laboratory modules on ISS. PFS and Portable-PFS are instruments used in the field of respiratory physiology, comprising gas analysis and delivery modules with the goal of enhancing our capabilities in pulmonary research and operational medicine.

Portable PFS

SLAMDD and PFS are used by flight surgeons during periodic medical exams on ISS. Understanding the gradual deconditioning of astronauts and cosmonauts during their stay on ISS is critical for developing better exercise capabilities for exploration beyond Earth orbit.

Human Research Hardware [CSA] developed by Canada, is used co-operatively with other international hardware in order to better assess and understand human physiological responses to space flight. The hardware includes radiation dosimeters (EVARM), hardware and software for studying hand-eye coordination and visual perception (PMDIS, BISE), and neurophysiology (H-Reflex).

H-Reflex

EVARM

BISE

PMDIS

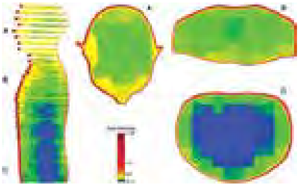
Advanced Resistive Exercise Device (ARED) [NASA] provides resistive exercise capabilities to crewmembers on the ISS. The ARED also collects data regarding the parameters (loads, repetitions, stroke, etc) associated with crew exercise, and transmits it to the ground.

Cycle Ergometer with Vibration Isolation System (CEVIS) [NASA] The CEVIS is a structurally isolated aerobic exercise cycle that serves as a countermeasure to cardiovascular deconditioning on-orbit.

Combined Operational Load Bearing External Resistive Exercise Treadmill (COLBERT) [NASA] is an exercise treadmill that can be used to collect data such as body loading, duration of session, and speed for each crewmember.

Crew Health Care hardware used for daily exercise onboard ISS collects information on protocols and forces that are used as supplemental data for physiological studies including muscle and bone loss and cardiovascular health during long duration spaceflight.

Measuring Radiation Hazards in Space (Matryoshka) [Roscosmos, ESA, JAXA] is composed of a torso (Matryoshka-E) and a spherical phantom (Matryoshka-R) that are used to measure radiation doses experienced by astronauts at various locations both outside and inside the ISS. The torso mannequin is made of materials equivalent to human tissues therefore simulating the different muscles and organs of the body, including a lower density material for the lungs. The torso is equipped with dozens of radiation sensors that are placed in strategic locations throughout its surface and interior to measure how susceptible different organs and tissue may be to radiation damage in space. Matryoshka-R also represents a human body radiation equivalent and is filled with water and a series of passive radiation detectors which measure radiation entering the spherical phantom. Research institutes from around the world have collaborated and shared data from the project, and the results will allow researchers to better correlate between skin and organ dose and therefore provide better risk assessments for future long duration space flight.



Spherical phantom shown stowed aboard ISS.

Participants from 10 countries provided dosimeters and other components of Matryoshka, making it one of the most interesting collaborative investigations on the ISS. This program started in 2004 and will incrementally continue under Russian leadership for some years after undergoing refurbishment on ground.

Human Life Research Complex [Roscosmos] includes a variety of devices and systems designed to study human life in space. Components include the Cardiovascular System Research Rack, Weightlessness Adaptation Study Kit, Immune System Study Kit, and Locomotor System Study Facility.

Cardiovascular Research System

Locomotor System

Weightless Adaptation

The **PAssive Dosimeter for Lifescience Experiments in Space (PADLES) [JAXA]** contains the following set of hardware for assessing the space radiation environment: Area PADLES are used to monitor radiation at prescribed locations inside the Kibo module, Bio PADLES assesses the biological effects of radiation exposure and Crew PADLES measures the personal dose acquired by an individual astronaut. These small, portable devices measure absorbed doses (Gy) and dose equivalent (Sv). Dose records are used to asses astronaut radiation exposure limits in low Earth orbit and help researchers better understand human exploration beyond LEO.

Human physiology research is coordinated by an internal working group in order to efficiently schedule experiments and share data. An astronaut or cosmonaut can participate in as many as 20 physiology experiments on orbit in during an increment.

Anomalous Long Term Effects in Astronaut's Central Nervous System (ALTEA) [ESA, NASA, ASI], originally an experiment developed by the ISS partner and ESA member agency, the Italian Space Agency (ASI), ALTEA is a helmet-shaped device that holds 6 silicon particle detectors that used to measure the exposure of crewmembers to cosmic radiation and its relation to brain activity and visual perception; including astronauts' perceptions of light flashes when their eyes are closed due to the passing of radiation through the eye. Because of this equipments ability to be operated without a crewmember, it is also being used as a portable dosimeter to provide quantitative data on high energy radiation particles passing into ISS.

Hand Posture Analyser (HPA) [ASI] is composed of the Hand-grip Dynamometer / Pinch Force Dynamometer (HGD/PFD), the Posture Acquisition Glove (PAG) and the Inertial Tracking System (ITS) for the measurement of fingers position and upper limb kinematics. The HPA examines the way hand and arm muscles are used differently during grasping and reaching tasks in weightlessness.

The **Onboard Diagnostic Kit (ODK) [JAXA]** is a non-invasive, health-monitoring system capable of measuring, storing, and analyzing crewmember medical data while onboard the ISS. The medical data collected onboard can be sent to the ground immediately, whereby doctors can quickly diagnose crewmember health. For example, one component of this system is the Digital Holter ECG recorder which records a 24-hour electrocardiogram that can be used to monitor astronauts cardiovascular and autonomic functions.

One component of the ODK is the Digital Holter ECG recorder, a portable 24-hour electrocardiogram recording device used to monitor astronauts’ cardiovascular and autonomic functions.

Intra-Vehicular Tissue Equivalent Proportional Counter (IV-TEPC) [NASA] is a portable, active ionizing radiation monitor that measures the internal radiation environment in near real time using a simulated tissue site device. Some of the information generated by this instrument is used to make operational radiation protection decisions and make risk assessments by estimating the physiological consequences to crewmembers from radiation exposure during space flight. As a portable unit, it may be used to characterize the radiation environment in different locations within the ISS and assess varying impacts related to humans during long duration space flight.

Percutaneous Electrical Muscle Stimulator (PEMS) [ESA] is a portable, self-contained neuromuscular research device that may be used standalone or in conjunction with other physiological instruments. The purpose of this device is to deliver electrical pulse stimulation to non-thoracic muscle groups of a human test subject, thereby creating contractile responses from the muscles. It is capable of providing single, variable amplitude pulses or pulse trains according to a pre-adjusted program.

Physical Science Research

Scientific investigations concerning the physical sciences and materials research are supported by an array of onboard ISS Facilities. Today researchers are examining fundamental scientific questions from how fluids behave and crystals develop to how things burn and smoke moves through the environment; and these are just a small example of the contributions being made in the physical sciences onboard the ISS. Additionally, by exposing and understanding how various materials perform and change in the microgravity and space environments allows future designers the ability to more wisely build spacecraft, systems and long lived components.

This section provides highlights of the current physical and material science platforms available onboard the ISS. An overview of each of the following is provided within this section:

Internal Facilities:

- Chamber for Combustion Experiment (CCE) [JAXA]
- Combustion Integrated Rack (CIR) [NASA]
- Device for the study of Critical Liquids and Crystallization (DECLIC) [ESA, NASA]
- Fluid Science Laboratory (FSL) [ESA]
- Fluid Physics Experiment Facility (FPEF) [JAXA]
- Fluids Integrated Rack (FIR) [NASA]
- Gradient Heating Furnace (GHF) [JAXA]
- Kobairo Rack (Kobairo) [JAXA]
- Light Microscopy Module (LMM) [NASA]
- Materials Science Laboratory (MSL) [ESA, NASA]
- Materials Science Research Rack (MSRR-1) [ESA, NASA]
- Plasma Crystal 3 Plus (PK-3 Plus) [Roscosmos, ESA]
- Ryutai Rack (Ryutai) [JAXA]
- Solution Crystallization Observation Facility (SCOF) [JAXA]
- Protein Crystallization Research Facility (PCRF) [JAXA]
- Space Dynamically Responding Ultrasonic Matrix System (Space-DRUMS) [NASA]

External Facilities:

- Materials International Space Station Experiment (MISSE) [NASA]
- Replaceable Cassette-Container (SKK or CKK) [Roscosmos]
- Vynoslivost Experiment Facility (Endurance) [Roscosmos]

Combustion Integrated Rack (CIR) [NASA] is used to perform sustained, systematic combustion experiments in microgravity. It consists of an optics bench, a combustion chamber, a fuel and oxidizer management system, environmental management systems, interfaces for science diagnostics and experiment specific equipment, as well as five different cameras to observe the patterns of combustion in microgravity for a wide variety of gasses and materials.

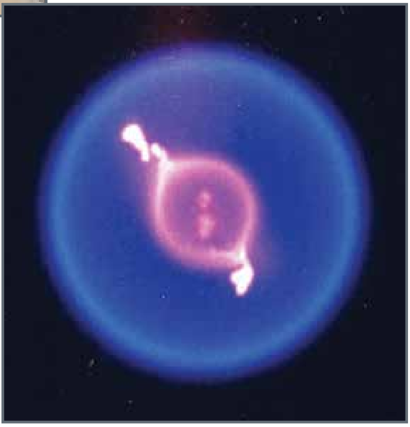
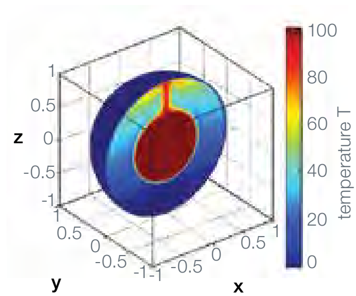
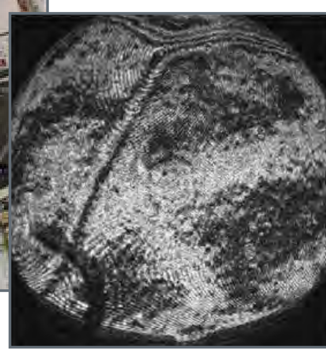


Image: Glenn Research Center - Burning droplet from the MDCA-FLEX investigation.

The Multi-User Droplet Combustion Apparatus - Flame Extinguishment Experiment (MDCA-FLEX) and The Flame Extinguishment - 2 (FLEX-2) have produced and positioned droplets of fuel that ignite while suspended in the CIR containment chamber.

Fluid Science Laboratory (FSL) [ESA] is a multi-user facility for conducting fluid physics research in microgravity conditions. The FSL provides a central location to perform fluid physics experiments on board the ISS that gives insight into the physics of fluids in space and on Earth, covering areas such as foam and emulsion stability, geophysical fluid flow, and thermodiffusion. An enhanced understanding of how fluids behave in space and on earth will help researchers improve mathematical models of fluids and geophysical processes and may lead to improvements in many industrial processes involving fluid systems.





Geoflow Interferogram Image

The first experiment processed in the FSL, GEOFLOW, examined an experimental model of a planet in order to improve knowledge of geophysical fluid flow. The more complex follow-up experiment, GEOFLOW-2 has also been completed and both have provided a wealth of fundamental data. Another series of investigations, known as FASES, will study emulsion properties using advanced optical diagnostics which could enhance processes in the oil extraction, chemical and food industries.

Fluids Integrated Rack (FIR) [NASA] is a multi-user fluid physics research facility designed to accommodate and image a wide variety of microgravity fluid experiments. FIR features a large user-configurable volume for experiments. The FIR provides data acquisition and control, sensor interfaces, laser and white light sources, advanced imaging capabilities, power, cooling, and other resources. The FIR will host fluid physics investigations into areas such as complex fluids (colloids, gels), instabilities (bubbles), interfacial phenomena (wetting and capillary action) and phase changes (boiling and cooling). Fluids under microgravity conditions perform differently than those on Earth and by understanding how fluids react in these conditions will lead to improved designs on fuel tanks, water systems and other fluid based systems. An additional component, that is itself considered facility is the **Light Microscopy Module (LMM) [NASA]** - a remotely controllable, automated microscope, that allows flexible imaging (bright field, dark field, phase contrast, etc.) for physical and biological experiments. .

NASA Image: ISS21E033218 - Astronaut Bob Thirsk assembling LMM components in the FIR during Increment 21.

NASA Image: ISS026E032518 - Astronaut Paolo Nespoli, below, loading a sample of live c.elegans for imaging in the Preliminary Advanced Colloids Experiment - Light Microscopy Module: Biological Samples (PACE-LMM-Bio) investigation during Increment 26.

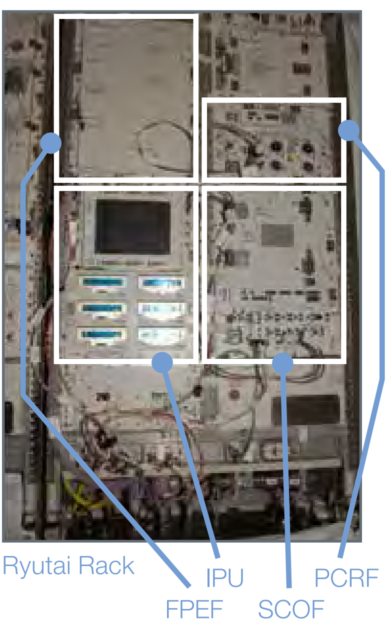
Materials Science Research Rack (MSRR-1) [ESA, NASA] is a powerful, multi-user facility that enables researchers by providing hardware to control the thermal, environmental, and vacuum conditions of experiments, as well as monitor experiments using video, and supply power and data handling for experiment instrumentation.

Materials Science Laboratory (MSL) [ESA, NASA] is a facility housed inside MSRR-1 that can accommodate microgravity studies over a wide range of different types of materials and experimental conditions. The ability to exchange dedicated furnace inserts in the MSL processing chamber also provides a wider range of processing conditions for different samples.

Experiment modules that contain metals, alloys, polymers, semiconductors, ceramics, crystals, and glasses, can be studied to discover new applications for existing materials as well as the development of new or improved materials (e.g., crystal growth, longer polymer chains, and purer alloys).

Experiments in the MSL are coordinated by international teams, sharing different parts of the samples. Columnar-to-Equiaxed Transition in Solidification Processing (CETSOL) and Microstructure Formation in Casting of Technical Alloys under Diffusive and Magnetically Controlled Convective Conditions (MICAST) were the first two investigations in the MSL supporting research into metallurgical solidification, semiconductor crystal growth, and measurement of thermo-physical properties of materials.

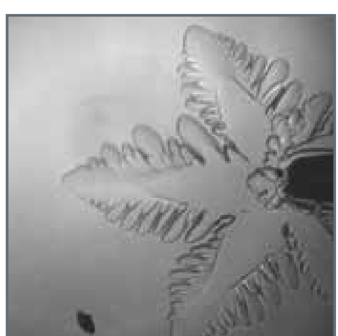
Ryutai Rack (Ryutai) [JAXA] is a multipurpose, multi-user rack system that supports various fluid physics experiments. Ryutai consists of four sub-racks of which three are themselves considered facilities: **Fluid Physics Experiment Facility (FPEF) [JAXA]; Solution Crystallization Observation Facility (SCOF) [JAXA]; Protein Crystallization Research Facility (PCRF) [JAXA]**. The fourth subrack holds the Image Processing Unit (IPU) that supports the entire rack with regards to image data handling. Ryutai enables teleoperations of experiments while providing the electrical power, ground command and telemetry monitoring, water cooling, and gas supply needed by those sub-rack facilities.



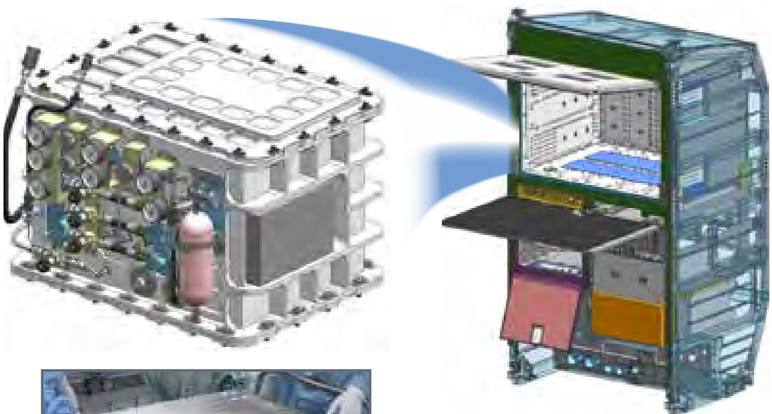
Ryutai Rack

Ryutai (流体) means "Fluid Dynamics" in Japanese. Using this rack, the JAXA experiment Pattern Formation during Ice Crystal Growth (Ice Crystal) examines the formation of unique patterns in ice crystals in microgravity.

JAXA Image: One of six PCRF protein Cell Unit sample enclosures is shown during ground processing.



Chamber for Combustion Experiment (CCE) [JAXA] is located in the **Multi-purpose Small Payload Rack (MSPR)** facility and enables researchers to conduct controlled combustion experiments aboard the ISS.



JAXA Image:
The CCE is shown during ground processing prior to launch.

Space Dynamically Respoding Ultrasonic Matrix System (SpaceDRUMS) [NASA] provides a suite of hardware capable of facilitating containerless advanced materials science, including combustion synthesis and fluid physics. SpaceDRUMS uses ultrasound to completely suspend a baseball-sized solid or liquid sample during combustion without the materials ever contacting the container walls. Potential outcomes could be in advanced ceramics production which may have applications in new spacecraft or extraterrestrial outposts, such as bases on the Moon.

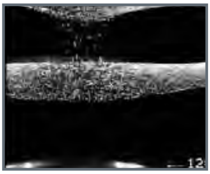
The **Kobairo Rack (Kobairo) [JAXA]** contains the **Gradient Heating Furnace (GHF) [JAXA],** which provides all utility interfaces for this material science furnace. The GHF is a vacuum furnace that contains three heating blocks, and is used mainly to conduct high quality crystal growth experiments using unidirectional solidification. The three heater-units can generate the high temperature gradients needed to produce large scale pure crystals.

NASA Images showing GHF with door removed (left) and one of the heating elements (below).

Kobairo, which is short for ondo-kobairo (温度勾配炉), means "temperature gradient furnace." The JAXA experiment, Growth of Homogeneous SiGe Crystals in Microgravity by the TLZ Method (Hicari), examines crystal-growth by using the Travelling Liquidous Zone method in microgravity.

Device for the study of Critical Liquids and Crystallization (DECLIC) [ESA, NASA] is a multi-user facility developed by the ESA-member agency Centre National d'Etudes Spatiales (French Space Agency, CNES) and flown in collaboration with NASA. It is designed to support experiments in the fields of fluid physics and materials science. Special inserts allow researchers to study both ambient temperature critical point fluids and high temperature super-critical fluids. Another class of insert will study the dynamics and morphology of the fronts that form as a liquid material solidifies.

Materials International Space Station Experiment (MISSE) [NASA] consists of a series of external exchangeable test beds located on ESA's Columbus-External Payload Facility (Columbus-EPF) for studying the durability and degradation of materials in the space environment. This has included materials such as optical components, sensors, electronics, communications devices, coatings and structural materials. To date, more than seven versions of the MISSE experiment have been attached to the outside of the ISS and evaluated for the effects of atomic oxygen, vacuum, solar radiation, micrometeorites, direct sunlight, and extremes of heat and cold. This experiment allows the development and testing of new materials to better withstand the rigors of space environments. Results are providing a better understanding of the durability of various materials when they are exposed to such an extreme environment. Many of the materials may have applications in the design and protection of future spacecraft and satellites.



Dusty plasma as observed in microgravity

Plasma Crystal 3 Plus (PK-3 Plus) [Roscosmos, ESA] consists provides a facility for studying the crystallization and melting of dusty plasma in microgravity. Located in the Russian Segment, it includes a tenzor unit, turbo pump and two TEAC video tape recorders which form the core of this telescience equipment. Video recordings of the plasma crystal formation processes and phenomena, along with parameters such as gas pressure and the size of dust particles are down linked to Earth for analysis.

Expedition 31 Cosmonaut G. Padalka working with the Plasma Crystal facility.

PK-3 Plus facility

Results from MISSE tests have led to changes in materials used in dozens of spacecraft built over the last several years.

Physical Science Research

Replaceable Cassette-Container (SKK or CKK) [Roscosmos] is a materials test facility mounted on the outside of ISS to provide directly exposure to the harsh environment of space. **CKK** are detachable cassette containers that measure the level and composition of contamination as well as monitor the change in operating characteristics for samples of materials from the outside surfaces of the ISS Russian segment.

Vynoslivost Experiment Facility (Endurance) [Roscosmos] is materials science facility designed to investigate the impact of the space environment with regards to material deformation, strength, and fatigue of present space technologies and structural materials. Long-term exposure of loaded and unloaded samples of structural materials is carried out on the external surface of MRM2 module. The data obtained will be used to more accurately assess the durability of ISS RS modules structural elements, and for providing recommendations for the selection of more efficient and reliable structural materials for use in future designs and structural elements.

Both the **Replaceable Cassette-Container** and **Vynoslivost Experiment Facility** consist of two-flap structures and consist of a casings and spool holders that contain sample cassettes of materials of the outside surfaces of the ISS Russian segment modules.

Earth and Space Science Research

Circling the Earth every 90 minutes in a low-earth orbit, covering over 90 percent of the planets habitable land mass, the ISS provides a unique vantage point for collecting Earth and space science data. From an average altitude of about 400 km, detailed data regarding the space environment, land features, environmental changes and land use taken from the ISS can be layered with other sources of data, such as orbiting satellites and aerial photogrammetry, to compile the most comprehensive information available.

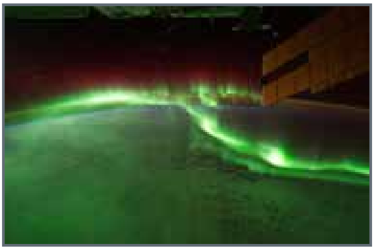
Facilities in this section show some of the current and growing capabilities afforded by the ISS in the following fields of research: glaciers, agriculture, urban development, natural disaster monitoring, atmospheric observations and space radiation:

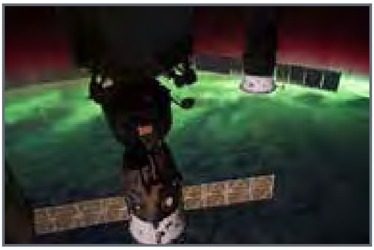
Internal Facilities:

- Earth Resources Sensing and Geophysics Instruments [Roscosmos]
- ISS SERVIR Environmental Research and Visualization System (ISERV) [NASA]
- Window Observational Research Facility (WORF) [NASA]

External Facilities:

- Cosmic Ray Detectors and Ionosphere Probes [Roscosmos]
- Seiner [Roscosmos]
- Solar Facility



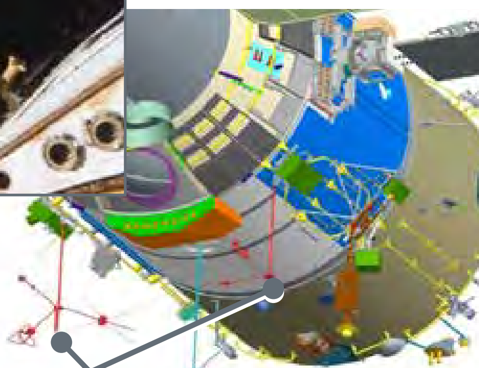


NASA Video - Aurora Australis.

External Earth and space science hardware platforms are located at various places inside and outside of the ISS. Locations inside include the Window Observational Research Facility (WORF) whereas outside includes the COL-EPF (Columbus External Payload Facility), JEM-EF (JEM-External Facility, ITS S3 (ISS Truss Site Starboard 3), and ITS P3 (ISS Truss Site Port 3).

Cosmic Ray Detectors and Ionosphere Probes [Roscosmos] are important for ongoing studies of cosmic rays and the low Earth Orbit environment. Several external investigations and instrument packages are available including **Platan** (cosmic ray detector), **BTN-Neutron** (neutron flux detector), and **Vsplesk** (gamma ray and high energy charged particle detector). **Obstanovka** is another suite of detectors used to measure several ionosphere parameters and plasma-wave characteristics.

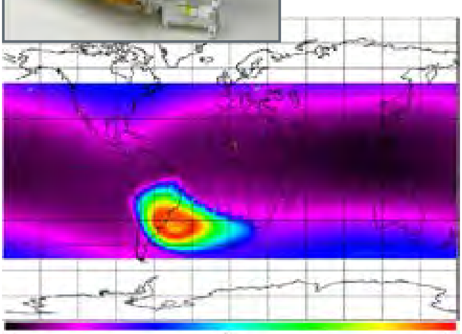
Vsplesk shown installed externally on the SM during Expedition 33



Obstanovka plasma-wave detector antennae

BTN-Neutron

Platan



Example of the fast neutrons counting rate results within the energy range of 400 keV to 10 MeV using the BTN-Neutron scintillation detector.

Earth Resources Sensing and Geophysics Instruments [Roscosmos] are a suite of instruments used in the study of geophysics, natural resources, ecology and natural disaster monitoring. **Fialka** is an ultraviolet imager and spectrometer used to study radiation emitted by reactions between atomic oxygen in space and the propulsion system exhaust products from ISS, Progress and Soyuz thrusters. It is also used to study the spatial distribution and emission spectra of atmospheric phenomena such as airglow. **Rusalka** is a infrared (IR) spectrometer used to collect detailed information on spectral radiance in the near IR waveband used to measure greenhouse gas concentrations in the Earth atmosphere. **Photospectrometric System (FSS)** is used for monitoring natural disasters (**Uragan**), investigating bioproductive water areas in the worlds oceans (**Seiner** - see page 81), and ecological monitoring (**Econ** uses a spectral range of 350-1050 nm and resolution of better than 3 nm). In all, this suit of instruments practically and efficiently increases the ability to perform scientific and Earth observation experiments from the ISS.


Fialka


Rusalka


FSS

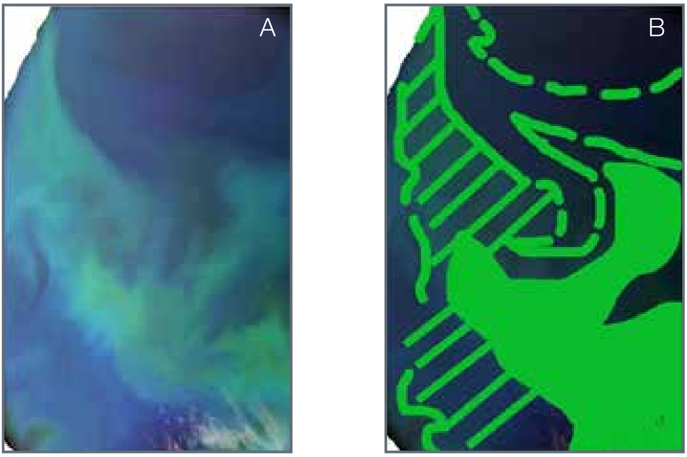

Roscosmos Image showing Cosmonaut Fyodor Yurchikhin working with the FSS.

Window Observational Research Facility (WORF) [NASA] provides a unique International Space Station facility for conducting crew tended or automatic Earth observation and scientific research using the Destiny modules, large optical-quality window. WORF is a multi-purpose facility that provides structural support hardware, avionics, thermal conditioning and optical quality protection in support of a wide variety of remote sensing instruments and scientific investigations.

Destiny features an Earth observation window with the highest-quality optics ever flown on a human occupied spacecraft. The first remote sensing instrument to be used in WORF was ISSAC (ISS Agricultural Camera); a multi-spectral, visible and infrared, camera that imaged crops to aid in land use management practices for farmers, as well as collecting imagery in support of natural disaster response and recovery.

ISS SERVIR Environmental Research and Visualization System (ISERV) [NASA] is an observatory mounted within the WORF rack onboard the International Space Station (ISS). This facility provides Earth observation data and is unique, both in terms of orbital characteristics and available human and infrastructure support that makes it a highly useful platform from which to acquire rapid and changing Earth observational data. Initial versions of this hardware provide the necessary experience in automated system tasking, data acquisition, and data transfer. Ultimately, this kind of observational system has the capability to support environmental decision-making, and to assess and monitor the impact of disasters and other significant events of the surface of our planet.

Seiner (Seiner) [Roscosmos] uses components of the P**hotospectrometric System** (**FSS**; see page 79) to allow multiple researchers the ability to observe and study ocean bio-productivity. Researchers are able to monitor fish-rich ocean regions and communicate resource data to fishing fleets.



Seiner contrast-color images of the formation of phytoplankton fields interacting between the Falkland current and Falkland Islands shelf water zones: A) image of South-West Atlantic made by the ISS crewmembers on January 10, 2010; B) decoded fields of phytoplankton.

Earth and Space Science

Earth and Space Science

Solar Facility [ESA] is a multi-user facility currently occupying the zenith external attachment site of the Columbus-EPF (See page 37). This triple spectrometer observatory has been measuring solar spectral irradiance since 2008. Knowledge of the solar energy irradiance entering the Earth's atmosphere and its variations is of great importance for atmospheric modeling, atmospheric chemistry, and climatology.

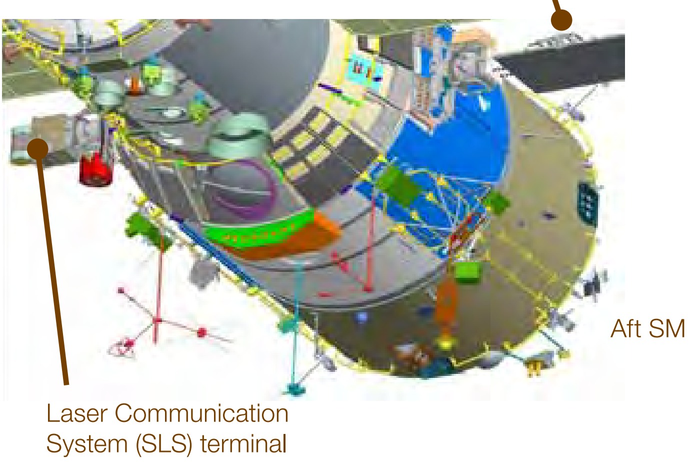
Technology Demonstration Research

A small, but growing portion of ISS Facilities directly relates to investigations that demonstrate and test new or evolving technologies for use in the space environment. Having hardware that multiple users can use to perform experiments saves researchers time and money since they do not need to develop, from scratch, the shared equipment.

External Facilities:

- Bar [Roscosmos]
- Global Transmission Services (GTS) [ESA, Roscosmos]
- Laser Communication System (SLS) [Roscosmos]
- RK-21-8 Microwave Radiometer [Roscosmos]
- Space Communications and Navigation Testbed (SCAN Testbed) [NASA]
- Vessel Identification System (VIS) [ESA]

RK-21-8 Microwave Radiometer [Roscosmos] provides information regarding radio brightness temperatures of Earth's land and ocean surfaces. Such data is used to investigate several surface and environmental conditions including monitoring soil humidity, sea water salinity levels, and assists in predicting the potential for forest fires.



Laser Communication System (SLS) [Roscosmos] provides a test bench for investigating laser beam propagation through the Earth's atmosphere by initiating a communication link between the external SLS laser and ground laser terminals. Pointing and tracking functionality and reliability as well as variable operational modes are key capabilities of this hardware. An internal control unit provides crewmembers access in order to plan and conduct laser operations.

Global Transmission Services (GTS) [ESA, Roscosmos] is a continuously operating facility within the Russian segment of the ISS, which tests the receiving conditions of time and data signals from dedicated receivers on the ground. Special coding of the time signal allows the receiver to determine the local time anywhere on the Earth. The main objective of this hardware is to verify the performance and accuracy of a time signal transmitted to the Earth's surface. This assessment includes signal quality and data rates achieved on the ground, measurement of disturbing effects such as Doppler shifts, multi-path reflections, shadowing, and elevation impacts. The GTS technology is being developed for future applications by ICARUS (International Cooperation for Animal Research Using Space), which includes the goal of developing a technological solution for the global tracking of small objects (e.g., animals).

Above, GTS avionics unit installed behind SM panel #305.

Left, graphic of GTS antenna installed on nadir side of SM

VIS Antenna shown installed on the external surface of the Columbus module.

The **Vessel Identification System (VIS) [ESA]** is a multi-user radio receiver that operates in the VHF maritime band. The orbit of the ISS provides an ideal location for space-based signal reception, and the incorporation of this system will verify the capability of tracking global maritime traffic from space. VIS is capable of receiving a multitude of ship information including: identity, position, course, speed, other ship particulars, cargo and voyage information and then communicate the data between other vessels and shore sites.

Bar [Roscosmos] uses a unique set of instruments for conducting ultrasonic probing, measuring and mapping spacecraft temperatures and pyro-endoscopic analysis of potentially dangerous locations and conditions onboard the ISS as a result of material degradation or corrosion during operations in orbit. Zones of possible formation of condensation have been revealed, and potential corrosion damage has been evaluated.

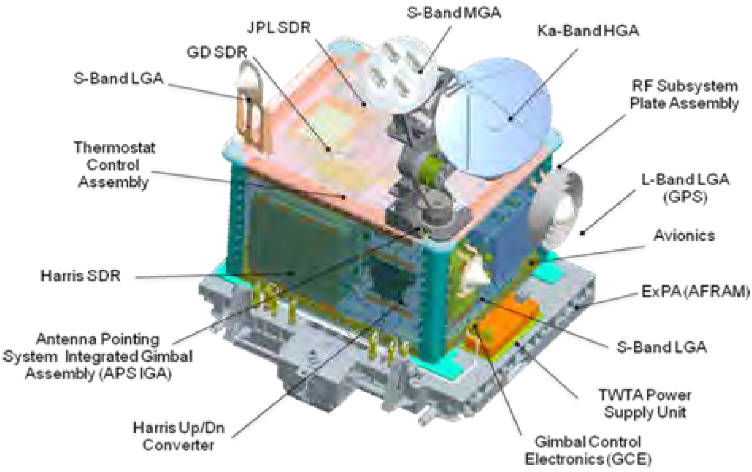
Cosmonaut Romanenko configures **Bar** hardware for use within the ISS RS.

In a related investigation, colonies of micromycets were found on the internal walls of a pressurized ISS compartment during the **Expert** experiment. Understanding and maintaining environmental integrity from structures to microbiology will ultimately allow humans to explore beyond low Earth orbit and become permanent inhabits of space.

Ulocladium: a genus of water-needing fungi or mold.

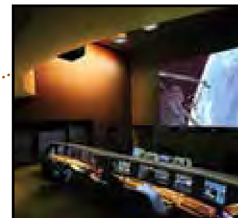
Cladosporium: a common indoor/outdoor fungus.

The Space Communications and Navigation Testbed (SCAN Testbed) [NASA] consists of a set of reconfigurable software defined radios (SDRs) which have software that can be modified on-orbit in order to allow users to test multiple radio frequency bands using the same hardware. By providing reconfigurable software to an existing radio platform, SCAN Testbed allows different radio vendors the ability to demonstrate unique radio configurations based on the common Space Telecommunications Radio System architecture standard. The goal of providing this facility is to encourage the development and advancement of SDR technologies for common, space based architectures, in hopes of reducing future developmental risks and costs. This hardware is located on ELC-4 and points Earthward (ISS nadir).

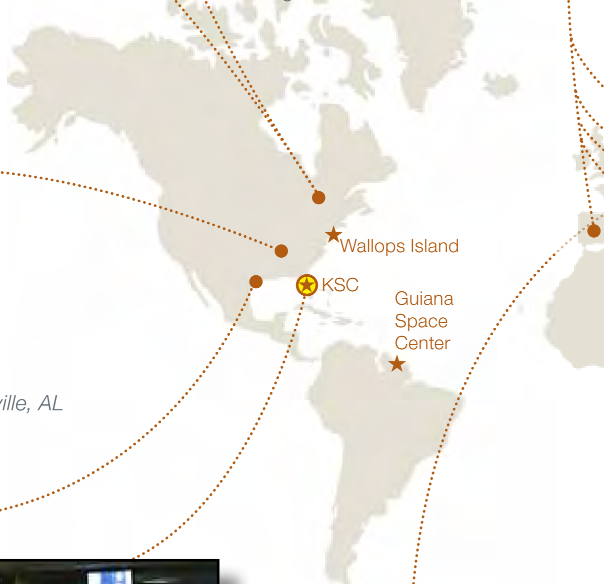


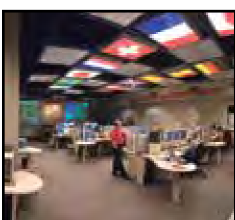
ISS Control Centers and Launch Sites

CSA-Payloads Telescience Operations Center (PTOC), St. Hubert, Quebec, Canada

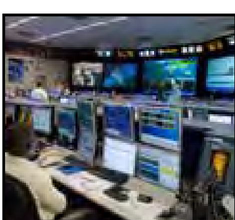


Canadian Space Agency Mission Control Center (CSA-MCC), Longueuil, Quebec, Canada

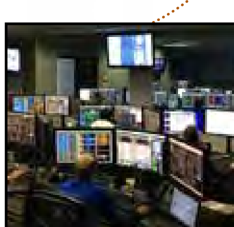




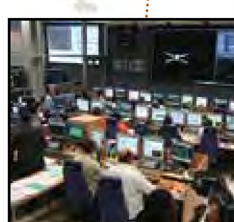
NASA - Payload Operations and Integration Center (POIC), Huntsville, AL



NASA - Mission Control Center (MCC), Houston, TX

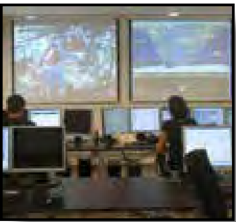


SpaceX Launch Control Cape Canaveral, FL



ESA ATV - Control Center Toulouse, France

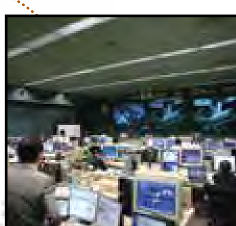
● Control Center
★ Launch Site



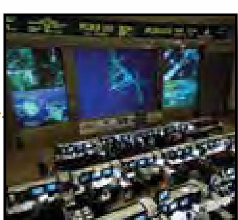
ESA-European User Support Operations Centers:
CADMOS, Toulouse, France
MARS, Naples Italy
MUSC, Cologne, Germany
B-USOC, Brussels, Belgium
E-USOC, Madrid, Spain
N-USOC, Trondheim, Norway
DAMEC, Odense, Denmark
BIOTESC, Zurich, Switzerland
ERASMUS, Noordwijk, The Netherlands

ESA - Columbus Control Center (Col-CC), Oberpfaffenhofen, Germany

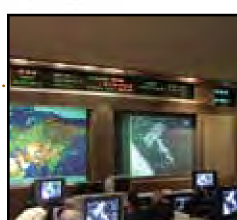
HTV Control Center (HTVCC), Tsukuba, Ibaraki, Japan



Japan Experiment Module Mission Control (JEMMC), Tsukuba, Ibaraki, Japan



Roscosmos - Mission Control Center (TsUP), Korolyov, Russia



Roscosmos - Transport Vehicle Control Room, Korolyov, Russia

Acronyms

ABRS	Advanced Biological Research System
ALTEA	Anomalous Long Term Effects in Astronaut's Central Nervous System
AQH	Aquatic Habitat
ARED	Advanced Resistive Exercise Device
BioLab	Biological Experiment Laboratory
BPS	Biomass Production System
BSTC	Biotechnology Specimen Temperature Controller
CB	Clean Bench
CBEF	Cell Biology Experiment Facility
CCE	Chamber for Combustion Experiment
CEVIS	Cycle Ergometer with Vibration Isolation System
CGBA	Commercial Generic Bioprocessing Apparatus
CIR	Combustion Integrated Rack
CNES	Centre National d'Etudes Spatiales
CKK/SKK	Replaceable Cassette-Container
COL-EPF	Columbus External Payload Facility
COLBERT	Combined Operational Load Bearing External Resistive Exercise Treadmill
DECLIC	Device for the study of Critical Liquids and Crystallization
DLR	German Aerospace Center
EDR	European Drawer Rack
ELC	EXPRESS Logistics Carrier
EMCS	European Modular Cultivation System

EOSTEO	Bone Culture System
EPM	European Physiology Module
EXPRESS	Expedite the Processing of Experiments to the Space Station
EuTEF	European Technology Exposure Facility
EVARM	Study of Radiation Doses Experienced by Astronauts in EVA
FIR	Fluids Integrated Rack
FSL	Fluid Science Laboratory
FPEF	Fluid Physics Experiment Facility
GHF	Gradient Heating Furnace
GLACIER	General Laboratory Active Cryogenic ISS Equipment Refrigerator
GTS	Global Transmission Services
HPA	Hand Posture Analyzer
HRF	Human Research Facility
ISERV	ISS SERVIR Environmental Research and Visualization System
ISPR	International Standard Payload Rack
ITS P3	ISS Truss Site Port 3
ITS S3	ISS Truss Site Starboard 3
IV-TEPC	Intra-vehicular Tissue Equivalent Proportional Counter
JEM-EF	Japanese Experiment Module-External Facility
J-SSOD	JEM-Small Satellite Orbital Deployer
LMM	Light Microscopy Module
LOCAD-PTS	Lab-on-a-Chip Application Development-Portable Test System
MARES	Muscle Atrophy Research Exercise System
MDS	Mice Drawer System
MELFI	Minus Eighty-Degree Laboratory Freezer for ISS
MERLIN	Microgravity Experiment Research Locker/Incubator
MISSE	Materials International Space Station Experiment
MSG	Microgravity Science Glovebox
MSL	Materials Science Laboratory
MSPR	Multi-purpose Small Payload Rack
MSRR	Materials Science Research Rack
ODK	Onboard Diagnostic Kit
PADLES	PAssive Dosimeter for Lifescience Experiments in Space
PCRF	Protein Crystallization Research Facility
PEMS	Percutaneous Electrical Muscle Stimulator
PFS	Pulmonary Function System
PK-3 Plus	Plasma Crystal 3 Plus
PMDIS	Perceptual Motor Deficits In Space
RH	Rodent Habitat
SCAN Testbed	Space Communication and Navigation Testbed
SCOF	Solution Crystallization Observation Facility
SLAMMD	Space Linear Acceleration Mass Measurement Device
SpaceDRUMS	Space Dynamically Responding Ultrasonic Matrix System
SPHERES	Synchronized Position Hold, Engage, Reorient, Experimental Satellites
URM-D	Universal Workstation with Capabilities for Re-equipping
VIS	Vessel Identification System
WORF	Window Observational Research Facility

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Space Station Science
http://www.nasa.gov/mission_pages/station/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

CSA- Canada
http://www.asc-csa.gc.ca/eng/sciences/default.asp

ESA- Europe
http://www.esa.int/esaHS/iss.html

JAXA- Japan
http://iss.jaxa.jp/en/

Roscosmos- Russia
http://knts.tsniimash.ru/en/site/Programm.aspx?id=1

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