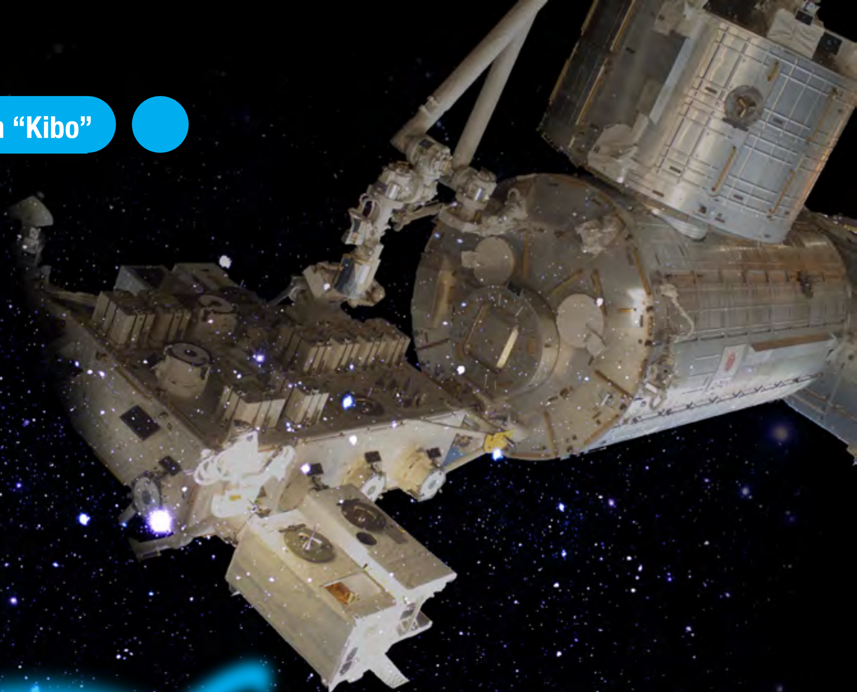
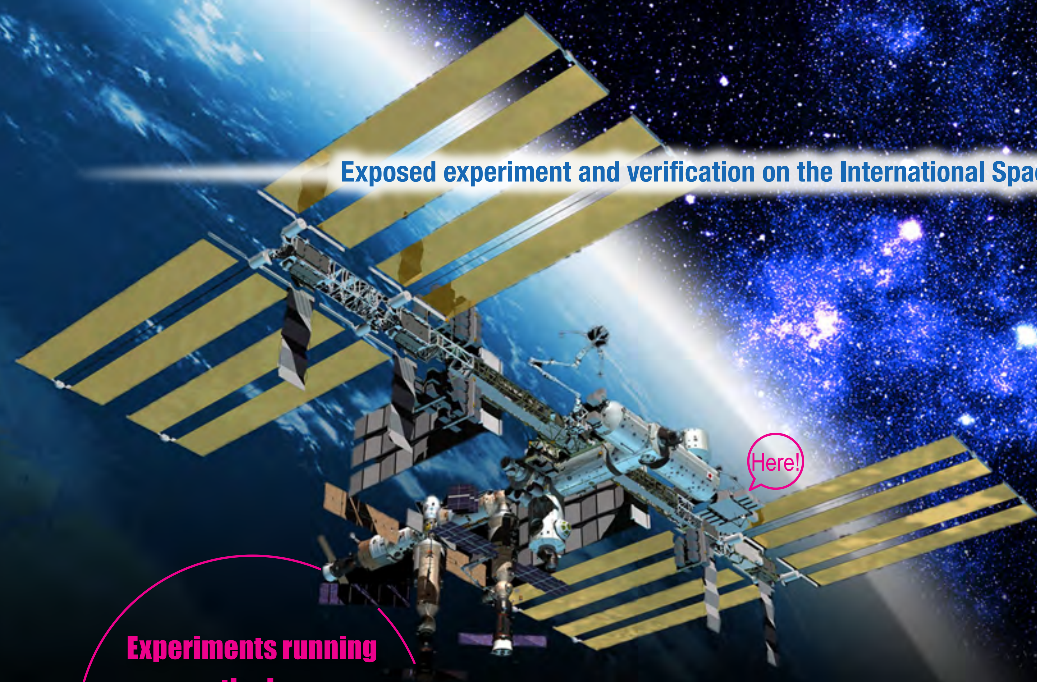


Bringing Space Utilization Opportunity Closer

Space Is Your Laboratory

Exposed experiment and verification on the International Space Station



Experiments running now on the Japanese Experiment Module "Kibo" aboard the International Space Station!

Explore to Realize

National Research and Development Agency
Japan Aerospace Exploration Agency
Human Spaceflight Technology Directorate

IVA-replaceable Small Exposed Experiment Platform (i-SEEP)
https://humans-in-space.jaxa.jp/en/biz-lab/experiment/facility/ef/i-seep/

JEM Small Satellite Orbital Deployer (J-SSOD)
https://humans-in-space.jaxa.jp/en/biz-lab/experiment/facility/ef/jssod/

Explore to Realize

リサイクル適性Ⓐ
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Printed March, 2023

Do Space Experiments Seem Beyond Your Grasp? “Kibo” Allows Easier Access to Space for Your Experiments.

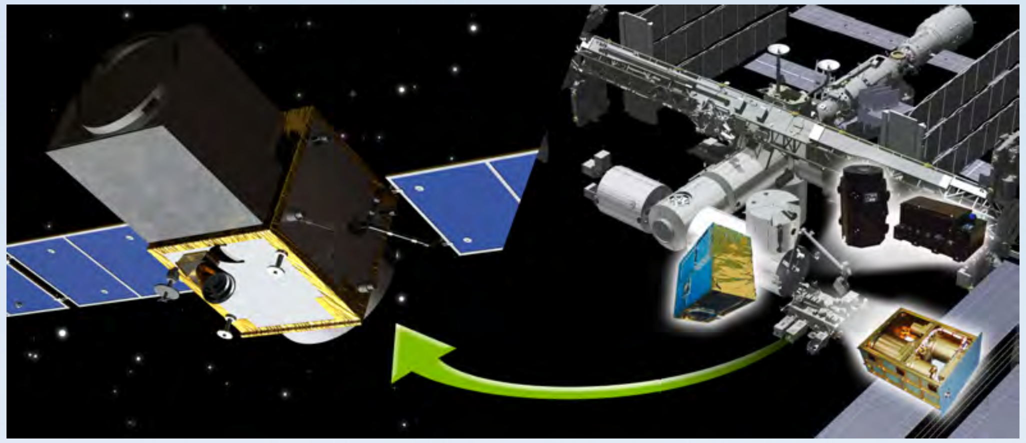
Most researchers likely consider space to be out of reach for their experiments. However, the Exposed Facility of the Japanese Experiment Module (JEM) “Kibo” on the International Space Station (ISS) provides various opportunities for experiments, components, parts verification, and other activities.

1 Using space as your laboratory opens up amazing possibilities

What can we do on the ISS?

The ISS allows for many new possibilities. The space environment at an altitude of 400 km is harsh—a vacuum with nearly no gravitational effects, filled with radiation and temperatures ranging from positive to negative 150 °C.
This enables testing of devices, components, and materials in the toughest environments. For example, this is the perfect place to test advanced observation sensors before launching them in a satellite.

Verification testing in space of a component planned for mounting on a small satellite



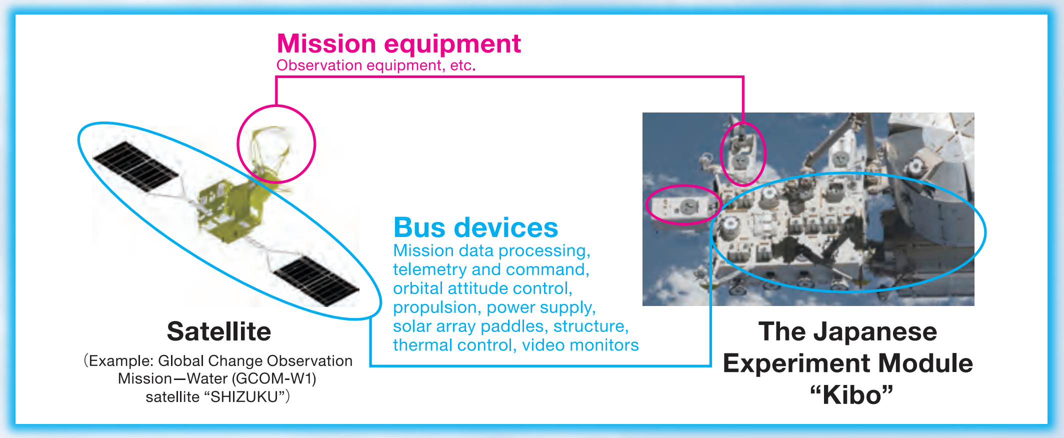
The ISS completes an orbit of Earth in about 90 minutes with a wide field of view. This makes it an effective platform for space-based Earth observation.

Beautiful images captured from space are being used for education and disaster monitoring.

2 Benefits of experiments on “Kibo”

Benefit 1: The ISS provides power, communication functions and heat dissipation.

Functions equivalent to bus devices on a satellite (power supply to experimental devices, coolant circulation for device cooling, communications functions for data acquisition, etc.) can be provided from the ISS and JEM-EF, so technology verifications and experiments can be achieved by focusing on only mission equipment development.



Benefit 2: Flexible launch scheduling

4–5 launch opportunities per year using Japanese and U.S vehicles. The period from equipment handover to JAXA until launch can be as short as several months.

Benefit 3: Reduced vibration level

Equipment is packed in a soft cushion bag that reduces vibration to about the same level as truck transport. So, there is less need for concern regarding anti-vibration measures.

Equipment is launched in cushion bags.

Benefit 4: Equipment can be returned after completion of the experiment

After experiments, samples and equipment can be returned to Earth for analysis and evaluation, as needed.

JEM Exposed Facility

❶ JEM Exposed Facility (JEM-EF)

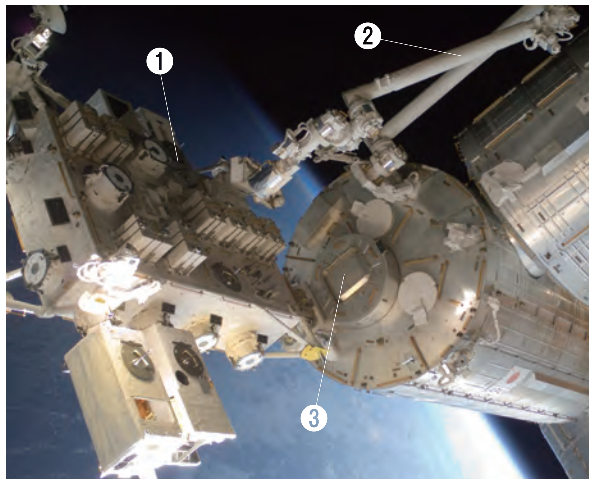
Experimental equipment can be exposed into space to perform experiments, like the intravehicular activity (IVA)-replaceable Small Exposed Experiment Platform (i-SEEP) (details on p. 3-4).

❷ JEM Remote Manipulator System (JEMRMS)

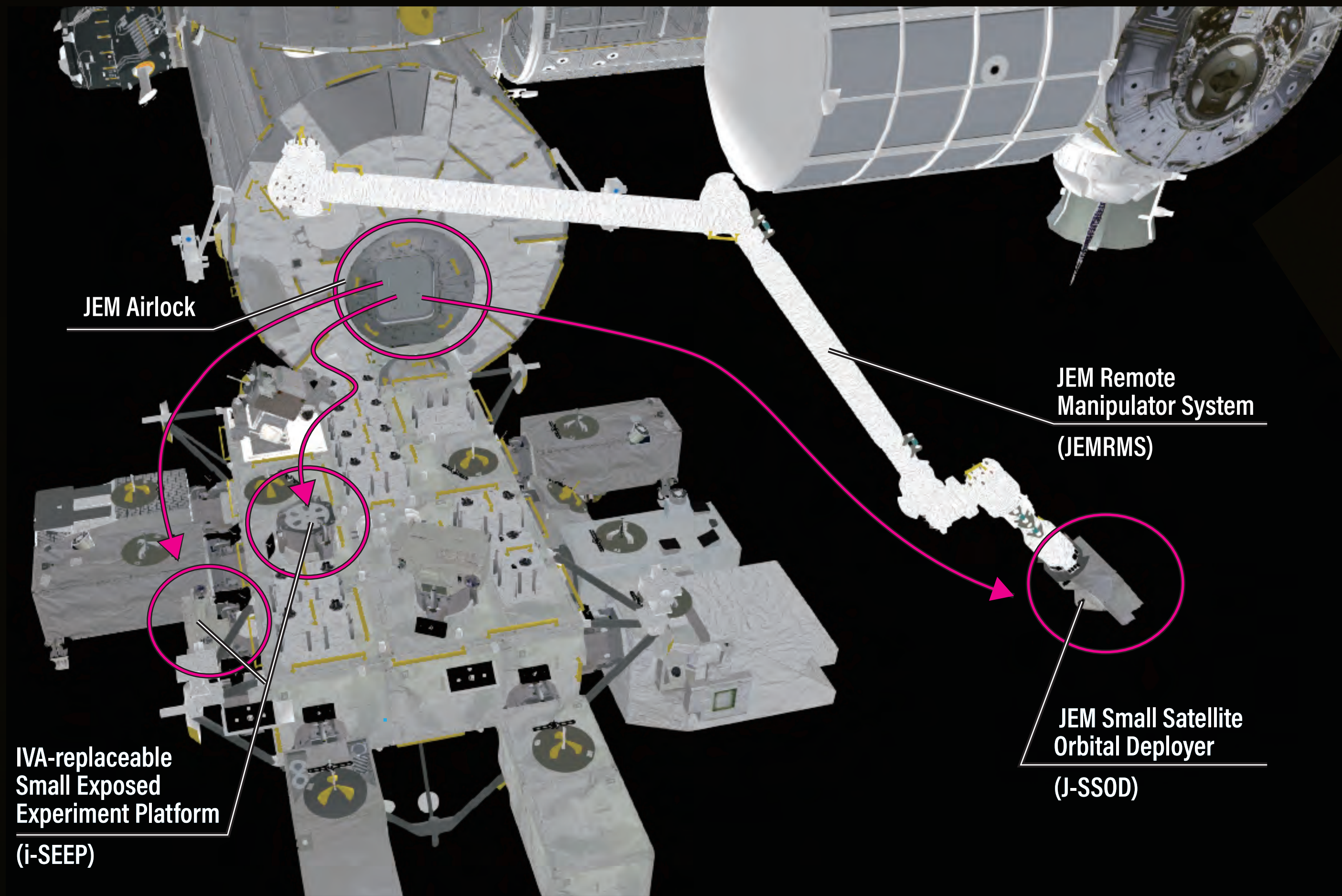
JEMRMS is a robotic arm used to exchange experimental equipments and deploy small satellites.

❸ JEM Airlock

This airlock is used to transfer equipment between a pressurized module and Exposed Facility.



Main Experimental and Verification Methods aboard JEM-EF on "Kibo"



JEM Airlock and JEM RMS enable unique functions, providing opportunities to realize frequent, easy, and varied space experiments aboard the JEM Exposed Facility (JEM-EF).

The IVA-replaceable Small Exposed Experiment Platform (i-SEEP) provides power and communications resources, so only mission equipment needs to be developed. This allows for easier technology verifications and Earth and astronomical observations.

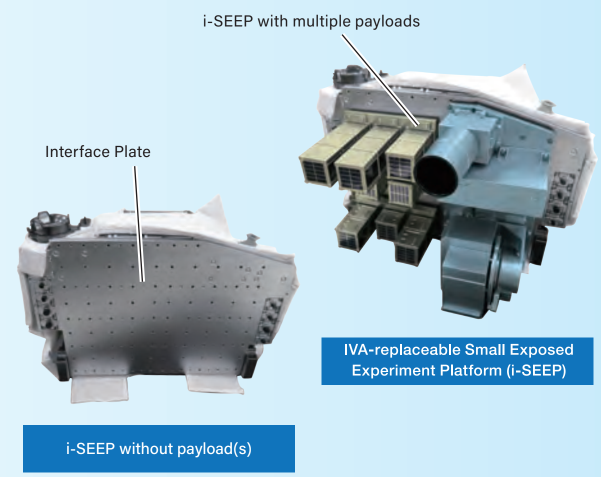
Two payloads can be mounted on i-SEEP, but even more small experimental devices can be mounted by using the Small Payload Support Equipment (SPySE).

The JEM Small Satellite Orbital Deployer (J-SSOD) enables the deployment of small satellites from "Kibo", which has deployed domestic and international satellites for such diverse purposes as communications, Earth observation, and technology verification.

IVA-replaceable Small Exposed Experiment Platform (i-SEEP)

i-SEEP expands possibilities for exposed experiment and verification of equipment for use in space, for payload(s) of 59 cm × 72 cm × 39 cm and 200 kg at maximum.

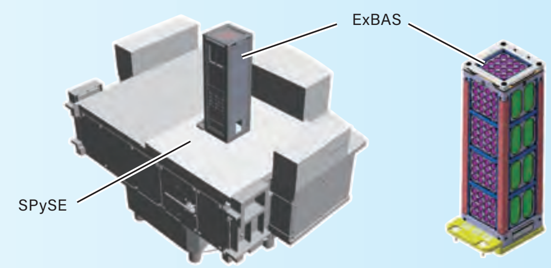
Item	Characteristics
Power	28V DC (rated) 2 ch, up to 200 W/ch
Communications	Ethernet (100BASE-TX), 2 ch Wireless LAN (IEEE 802.11n) MIL-STD-1553B, 1 ch USB 2.0, 2 ch Video (NTSC), 1 ch
Downlink	Max 60 Mbps including overall equipment data
Heat dissipation	400 W (max.) (Cold plates on the back-side of Interface Plate) Temperature of Interface Plate: 16–40 °C
Launch vibration environment	About 3 Grms in common softbag



Small Payload Support Equipment (SPySE)

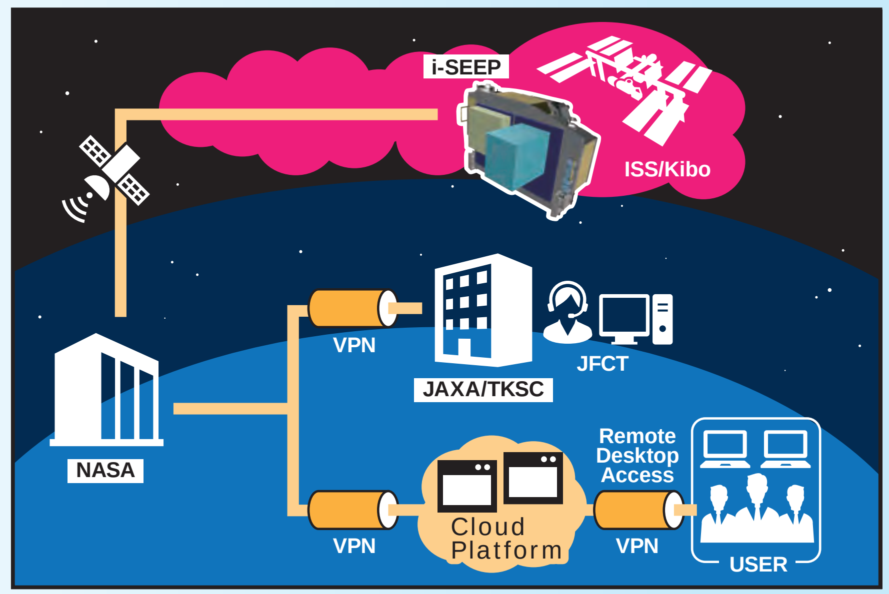
SPySE is in onboard service to accommodate CubeSat-sized payloads to be attached on i-SEEP. SPySE supplies electrical and communication resources via USB (power/data Interface device).

Specifications	5 payloads in parallel
Communication method	Ethernet
Electrical power (per unit)	voltage 5V / power 4W
Thermal Interface	Heat is dissipated to the cold plate by thermal conduction.



Remote Operation and Control Services (ROCS)

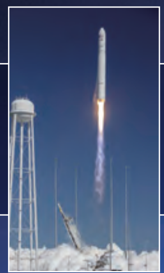
JAXA developed and introduced the ROCS via the commercial cloud platform for i-SEEP users to operate the payloads on i-SEEPs from a remotely located i-SEEP user sites.



Service Provider

JAXA selected "Space BD Inc." as the service provider for providing exposed facility utilization platform services using i-SEEP. Along with the ingenuity of the service providers, JAXA would like to provide more opportunities for potential users worldwide.

Project Flow



Launch to the ISS

Experimental payloads and samples are transported to the ISS in a packaged state (about 4 times a year).

Installation on iSEEP onboard "Kibo"

Installation of experimental payloads on i-SEEP inside "Kibo" by a crew member.

Moving to Kibo's Exposed Facility Platform

Move i-SEEP with experimental payloads into outer space through the JEM Airlock.

Connecting to the Exposed Facility Port

Attach i-SEEP to the specific port on the Kibo's Exposed facility platform by using Kibo's robotic arm.

Conducting experiments on "Kibo"

Experiments can be conducted and all data obtained can be downlinked to Earth.

Sample return to Earth and handover

Samples and equipment can be brought back to Earth if necessary. Said items are handed over to the user for analysis or verification after the on-orbit operation.

JEM Exposed Facility Accomplishments

Video acquisition via high-definition video camera

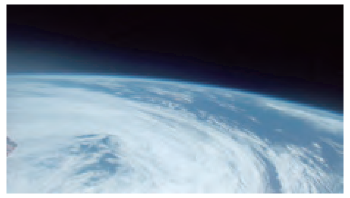
Video recording using a commercial camera, mounted on the first-generation i-SEEP. Image acquisition starts in 2016.

Goals

- **Acquisition of video images for public relations and education**
  Exposed observation of rendezvous with a transport unit and detailed images of the Earth's surface have many uses for public relations and education.
- **Disaster observation**
  Conditions related to disaster situations can be provided to relevant agencies, aiding in rescue and recovery operations.
- **Verification of a commercial product in space**
  Verification is performed of whether commercial products (such as high-definition video cameras) can be used for extended periods in space.

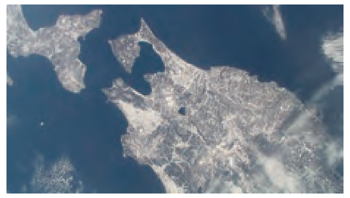
Mission started in 2017

Images from a high-definition video camera (acquired during a previous mission)



A large low-pressure vortex against the blue Earth

Flooding of the Amur River (natural disaster observation)



Winter in northern Japan and the Tsugaru Strait

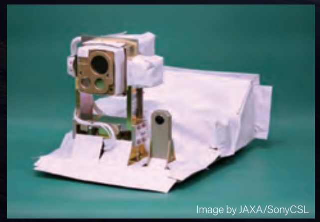
On-orbit demonstration of SOLISS

Small Optical Link for International Space Station : SOLISS
*Joint research between JAXA and Sony Computer Science Laboratories

An optical downlink with oriental control and a two-way optical communication link were established between SOLISS and the optical ground station using a 1.5-μm wavelength laser beam. HD images were also successfully received from SOLISS at the optical ground station using 100 Mbps Ethernet communication.

Goals

- **Realization of future large-capacity real-time data communication between satellites and with the ground**



Mission period 2019-2021

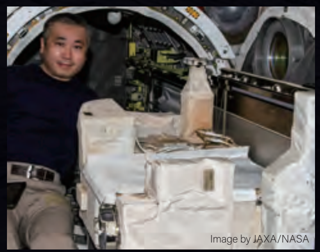
Demonstration experiment of all-solid-state lithium-ion batteries

*Joint research between JAXA and Hitachi Zosen Corporation

Developed as a new type of battery that needs no fine temperature control, all-solid-state lithium-ion batteries are expected to contribute to smaller, lighter equipment and lower power consumption for use in the space environment. Moreover, these batteries are expected to be used in lunar and Mars probes subject to an even more severe temperature environment, as well as in rovers and observation equipment that provide mobility on the lunar surface.

Goals

- **Practical use of all-solid-state lithium-ion batteries in space**



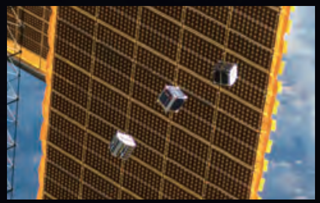
Mission started in 2022

Small satellite deployment missions

Various small satellites developed by universities and private companies worldwide have been deployed from "Kibo".

Goals

- **Technology verification for high-speed communications, meteorological data acquisition, space debris measures, etc**
- **Video image acquisition and Earth observations using a thermal infrared camera.**
- **Human resource development aiding the training of personnel for space development in Japan and other Asian countries.**



CubeSats deployed into space