# Kibo Utilization Strategy (Overview)
# - Agenda 2020 toward maximized "Kibo" utilization outcomes -

Oct. 2016
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## What is Kibo Utilization Strategy?

The Kibo Utilization Strategy is devised as a guideline for expanding and promoting "Kibo" utilization, covering the priority of research areas, promotion activities, requests for hardware development, and research solicitation, so as to promote "Kibo" utilization strategically toward maximized outcomes. The strategy will be reviewed as needed according to changes in its situation and progress.

## 1. Circumstances

### (1) Government policies

- Maximize Japan's R&D outcomes by transforming the administrative agency into national R&D agencies.
- Create scientific outcomes meeting the investment budget and expound the adequacy of public funding.

### (2) Overseas activities

- The US offers utilization opportunities to its national agencies and private companies, aiming to establish a private-company-led low-Earth orbit (LEO) platform.
- Russia and Germany are under consideration for the nation-led LEO platform technology.

### (3) JAXA's activities

- Based on the output strategy, prioritize utilization in national strategic R&D and promote fee-based utilization in private-company-led R&D.

## 2.1 Our goal

Make "Kibo" a valuable R&D basis for science & technology innovation by 2020, and commercialize part of "Kibo" utilization services by 2024. After the end of the ISS, run a public-private joint business for microgravity experiments in LEO (according to JAXA Management & Action Policies 2016).

## 2.2 Our philosophy

- Contribute to national R&D and industrial activities through "Kibo" utilization in order to fulfill JAXA's mission to "maximize Japan's R&D outcomes."
- Demonstrate the social values of "Kibo" utilization by offering experiment opportunities to various users, and make it a critical existence as an innovation-creating basis in Japan.

## 2.3 Five objectives to be achieved by 2020

### (1) Contribute to national research promoted by the government

Offer the microgravity environment of "Kibo" to help solve issues in research being strategically promoted by the government, and enhance the value of related research results.

### (2) Demonstrate certain social values of "Kibo" through utilization by private companies

Promote "Kibo" utilization by private companies and contribute their R&D, industrial applications, and product development. Recognize that investment in "Kibo" utilization is valuable to private companies.

### (3) Promote R&D of technologies for longer duration manned stays and exploration in space

Lead global space development by promoting the R&D of internationally competitive technologies that employ Japan's original technology, such as those for a manned stay longer than six months and exploration to the Moon, Mars, and beyond.

### (4) Contribute to enhancement in technology through academic studies

Contribute to the enhancement of Japan's technology by promoting "Kibo" utilization based on cutting-edge original ideas. Lead to the expanded utilization of microgravity in LEO in the future.

### (5) Contribute to Japan's growing presence in the world

Contribute to Japan's growing presence in the world by promoting "Kibo" utilization from strategic and diplomatic aspects.

## 2.4 Basic policies to achieve the objectives

### 1) Prioritization toward maximized outcomes

Identify and prioritize prospective utilization areas as "platforms," and make them available to various users.

#### a. Four platforms of the moment

**<Pressurized Module (PM)>**

**i. Drug-design supporting platform**

- More than a decade of experience in protein crystal growth experiments
- Contribution to promote national research for "Health & Longevity" (Objective 1) and contribution to private company businesses (Objective 2)
- Needs for bio-ventures that have led to onerous utilization contracts for a set of space experiment opportunities

**ii. Aging research supporting platform**

- Years of experience in research on the mechanisms of gravireception, bone metabolism, muscle atrophy, aging, and environmental adaptation
- Contribution to promote national research for "Health & Longevity" (Objective 1)
- Scientific research proposals related to aging including bone loss, muscle atrophy, and a weakened immune system are constantly applied to research solicitations for "Kibo" utilization themes.

**<Exposed Facility (EF)>**

**iii. Cube satellite (CubeSat) deployment platform**

- CubeSat deployment from the ISS is only feasible from "Kibo" (which has deployed more than 130 CubeSats to date).
- Contribution to private company businesses (Objective 2) and Japan's growing presence in the world (Objective 5)
- Increase fee-based utilization, such as a university cooperating with an overseas organization.

**iv. Exposed Facility (EF) port utilization platform**

- "Kibo's" Exposed Facility (EF) has contributed to all-sky X-ray observations of space and observations of Earth using large-scale equipment.
- Contribution to "natural disasters" and "earth's environmental information" (Objective 1)
- Currently used is the IVA-replaceable Small Exposed Experiment Platform (i-SEEP), a small- and mid-sized experimental device that allows for frequent launches in a gentle launch environment.
- Needs for demonstrating space technologies that use specific elements unique to "Kibo" and not realizable by other spacecraft (mainly in JAXA)

#### b. Our efforts for future platforms

In addition to the platforms described in a. above, new platforms expected to present the values of utilizing "Kibo" or continue "Kibo" utilization can be undertaken.

### 2) Improvement in experiment technology from aspects of quality, quantity, and variety

Strengthen the main capability related to experimental technology from the three aspects of quality, quantity, and variety (e.g. reduce experiment periods, increase experiment samples and frequency, enhance sophistication, automation and diversification of experiment facilities and equipment).

Further enhance "Kibo" utilization by developing technologies such as robotics technology and exploration technology for realizing a longer duration manned stay in space, conducting academic research by regularly inviting themes, and engaging in diplomatically valuable international cooperation.

# 3. Our approach 1) Prioritization toward maximized outcomes

## a. Four platforms of the moment

Based on the achievements and results in space experiments, prioritize utilization areas that have strong needs and can produce values only aboard "Kibo," and which are expected to help realize Japan's science & technology policies and R&D by private companies.

### i. Drug-design supporting platform

**○Objective**
- Establish and promote a platform providing X-ray diffraction structural data useful for new drug design by multiplying experiment opportunities (4-6 times) and shortening the duration of experimental cycles (decrease by 40%).
- Newly develop large-protein crystal growth technology for neutron diffraction and cooperate with the Japan Proton Accelerator Research Complex (J-PARC).

**○Required experimental technology**
- Opportunities for 4˚C crystallization experiments must be provided (in the second half of 2016). Large-protein crystallization technology must be developed for neutron diffraction. The in-space applicability of membrane protein crystallization technology must be demonstrated and a related feasibility study conducted.
- A crystallization method must be developed that allows the crystallization conditions of the vaper diffusion method to be applied in space without the effect of Marangoni convection on orbit (possibly in FY2017).

**○Measures for promoting utilization**
- Strengthen activities with the National Institute of Advanced Industrial Science and Technology (AIST), set as a strategic partner. Actively work on bio-ventures with pharmaceutical manufacturers and enzyme-related chemical companies (FY2016 – 2017).

### ii. Aging research supporting platform

**○Objective**
- Aim to contribute to elucidating the mechanism of biotransformation associated with human aging and developing related-disease control by using a centrifuge, which allows comparisons to be made in investigating gravitational effects on mice.

**○Required experimental technology**
- A larger centrifuge for the Mouse Habitat Unit must be developed to increase the number of mice onboard (by FY2018).
- Sophisticated experimental technologies must be developed, including an optical marker behavior monitoring system for genes in the body, and technology for sequentially acquiring and analyzing a very small amount of a sample in orbit (by FY2020).

**○Measures for promoting utilization**
- Research solicitation to invite experiments contributing to the world's cutting-edge medical care and surviving incurable diseases.
- Aim for cooperation with public research institutions that could be strategic partners (FY2016 – 2017).

### iii. CubeSat deployment platform

**○Objective**
- Establish Japan's original service (business model), such as transporting a satellite into orbit higher than that of the ISS aboard the Free Flyer that departs and arrives on "Kibo's" Exposed Facility (EF).
- Establish an agent system for overseas users (in FY2016).

**○Required experimental technology**
- The stages of functions of the JEM Small Satellite Orbital Deployer (J-SSOD) must be enhanced to increase its satellite deployment capability for allowing a maximum of 48-U satellites, or eight times larger than the current capability (by FY2019).
- The deployment mechanism must be examined for satellites not using satellite install cases.

**○Measures for promoting utilization**
- Promote cooperation with service supplier candidates including universities, consortiums, and dealers selling satellite kits (FY2016).

### iv. Exposed Facility (EF) port utilization platform

**○Objective**
- Contribute to Japan's future space technology development by demonstrating future innovative space technology, including the Earth observation sensor.

**○Required experimental technology**
- The functions of the IVA-replaceable Small Exposed Experiment Platform (i-SEEP) must be enhanced in terms of quantity and quality.

**○Measures for promoting utilization**
- Focus on demonstrating the space technology from JAXA projects while promoting fee-based utilization by the private sector (e.g. sensor development, provision of images), universities, and overseas space agencies (FY2016- 2017).
- Promote i-SEEP utilization while considering missions enabled only by large-scale equipment.

## b. Our efforts for future platforms

### i. Material research using container-less processing technology (Electrostatic Levitation Furnace: ELF)
- Obtain thermophyisical property data on high-melting point materials with strong commercial needs, including oxides and ceramics, and explore advanced functional materials.
- Build a strategic partnership with public research institutions in charge of material research, and strengthen the relationship.

### ii. Demonstration of the effectiveness of 3D culture technology
- Develop 3D culture technology under the microgravity environment and demonstrate the effectiveness of that environment for 3D culture.

### iii. Demonstration of new materials in space (Exposed Experiment Handrail Attachment Mechanism: ExHAM)
- Contribute to the improved quality and reliability of space materials at companies, universities, and JAXA.
- Examine the development of devices enabling exposed experiments with a power supply, communication resources, and expanded functions, including multiplied experiment opportunities.

### iv. Fostering of experiment platforms mainly for industrial applications
- New research solicitation for experiments focused on the views of commercialization and industrialization proposed by an industry-academia joint team.
- Create new experiments leading to expanded commercial applications in cooperation with industry-academia-government projects or consortiums.

## 2) Acquisition of technologies for longer duration manned stays and exploration in space
- Establish a new robotic system to automate tasks by crew inside and outside "Kibo."
- Develop technologies for complete recycling environmental control, life support, and radiation measurement and protection.
- Formulate a R&D plan soon (in FY2016).
- Develop health management technology for astronauts.

## 3) Promotion of scientific research
- Invite research themes regularly. Select scientific themes with prospects and visions of creating and applying results.

## 4) Promotion of international cooperation
- Expand areas of NASA-JAXA cooperation under the Japan-US Open Platform Partnership Program.
- Prioritize "Kibo" utilization that has been valued and promoted by Asian countries. Contribute to Japan's growing presence in the world through cooperation with other governments and the UN.
- Devise a utilization tactical plan for Asian countries soon (in FY 2016).

## 5) Strengthening of core technology for space experiments
- Promote the development of support equipment such as microscopes, an automatic analysis system, and an imaging system for samples. Realize cutting-edge research on Earth in space.
- Automate experimental facilities by examining the use of artificial intelligence (AI) and other tools with an eye toward future LEO platforms.