JAXA TODAY

Japan Aerospace Exploration Agency

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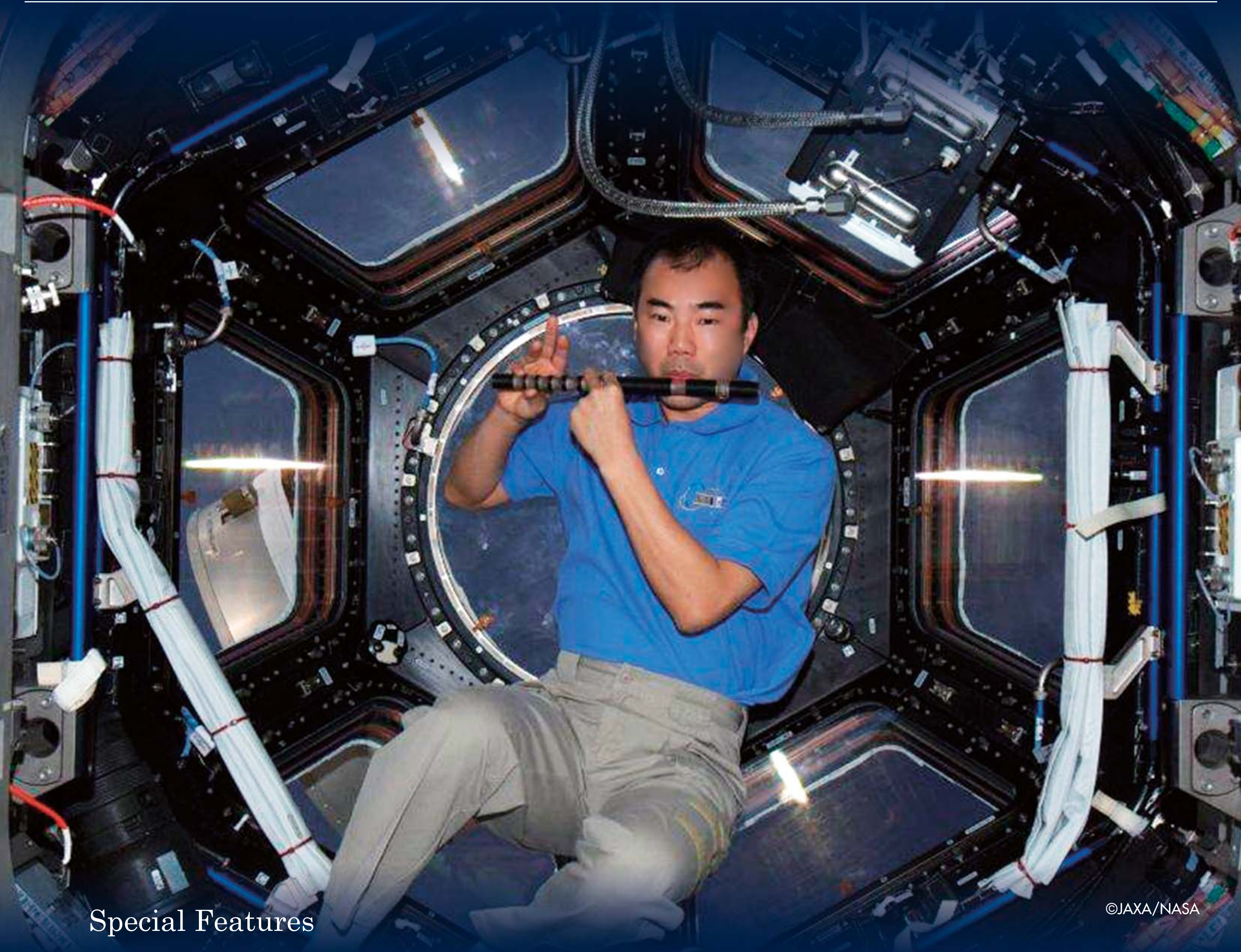

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Special Features

JAXA Astronaut Soichi Noguchi:
Discussing JAXA's future role and his message to children

H-II Transfer Vehicle:
Bolstering the ISS program by transporting both pressurized and unpressurized payloads

Japan Aerospace Exploration Agency

Contents

Welcome to JAXA TODAY

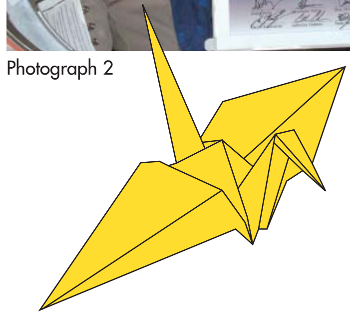
The Japan Aerospace Exploration Agency (JAXA) works to realize its vision of contributing to a safe and prosperous society through the pursuit of research and development in the aerospace field to deepen humankind's understanding of the universe. JAXA's activities cover a broad spectrum of the space and aeronautical fields, including satellite development and operation, astronomical observation, planetary exploration, participation in the International Space Station (ISS) project and the development of new rockets and next-generation aeronautical technology.

With the aim of disseminating information about JAXA's activities and recent news relating to Japan's space development programs to as wide an audience as possible, we launched JAXA TODAY in January 2010. In issue No. 04, we feature an interview with JAXA Astronaut Soichi Noguchi, who served a long-endurance mission on the ISS, look at the background behind the development of Japan's H-II Transfer Vehicle (HTV) and its track record to date, and provide details on JAXA's response to the recent devastating earthquake in Japan.

Origami Cranes Fly Over Regions Affected by the Great East Japan Earthquake

The Great East Japan Earthquake, which occurred on March 11, 2011, caused significant damage to JAXA's Tsukuba Space Center (TKSC), which includes the HTV Mission Control Room (HTV MCR). Consequently, mission control functions for H-II Transfer Vehicle 2 (HTV2), which at the time was docked to the ISS, were temporarily transferred to NASA's Johnson Space Center (JSC) in Houston, Texas. After operations were restored at TKSC, flight controllers began to make origami paper cranes to symbolize their hopes for a rapid recovery in disaster-affected areas. After hearing about this, staff at NASA, the European Space Agency (ESA) and even the crew aboard the ISS also began to fold paper cranes to show their support for those affected by the earthquake. At NASA's Mission Control Center (MCC-H) at JSC, staff displayed origami cranes next to a miniature replica of the HTV (photograph 1). The three astronauts aboard the ISS placed origami cranes inside HTV2 (photograph 2). Early on the morning of March 30, HTV2, together with the paper cranes, passed over the disaster region, sending prayers of support from space.

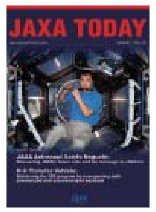
Photograph 2



Photograph 1

Cover Story

JAXA Astronaut Soichi Noguchi plays a dragon flute, which is used in "Gagaku" (ancient Japanese court music), while inside the ISS Cupola Module (observation dome). This photograph was during Astronaut Noguchi's long-endurance mission on the ISS.



Interview with
Soichi Noguchi

Photo by Hiro Arakawa

Dialogue between JAXA Astronaut Soichi Noguchi and Midori Nishiura, Executive Advisor for JAXA Public Affairs & International Relations

JAXA Astronaut Soichi Noguchi has performed extra-vehicular activity (EVA) on three occasions and has also served on a long-endurance mission on the International Space Station (ISS). Backed by this impressive record of achievements, Astronaut Noguchi discusses his views on the future of space development and the role of JAXA, his dream as an astronaut, and also offers a message for children.

This conversation with Midori Nishiura focuses on four themes that elucidate the drive and motivation underpinning Astronaut Noguchi's career in space development.

Photo by Hiro Arakawa

Profiles

Photo by Hiro Arakawa

Soichi Noguchi
JAXA Astronaut
Soichi Noguchi was born in Kanagawa, Japan, in 1965. In July 2005, he was a member of mission crew STS-114 on the Space Shuttle Discovery. He also spent approximately five-and-a-half months aboard the ISS from December 2009. During that mission, he conducted a large number of scientific experiments and medical-related research in the Japanese Experiment Module (JEM) Kibo and was also involved in carrying out system operations, maintenance and management of the ISS.

Midori Nishiura
Midori Nishiura, an opinion leader, is president of consulting firm Amadeus Inc., JAXA's Executive Advisor for Public Affairs & International Relations, and Visiting Professor of International Relations & Communications at Yamaguchi University. Among many other important roles, Ms. Nishiura has served on the Advisory Board of various major companies and also sits on committees organized by government ministries and agencies. The author of many books as well as articles in leading publications, Ms. Nishiura has had her own television interview programs and is often called upon to commentate on the news.

Theme 1 | Looking Out for the Safety of the Earth from Space

Nishiura: On March 11, Japan was struck by the Great East Japan Earthquake. When a major disaster occurs, it is crucial to quickly gain an accurate picture of the damage. JAXA used its Advanced Land Observing Satellite (ALOS) to survey the disaster-affected areas. The International Charter* was activated, too.

Noguchi: Yes, there are several robust international frameworks in the area of disaster monitoring. ALOS, which unfortunately was retired in May this year, also made a significant international contribution to disaster monitoring.

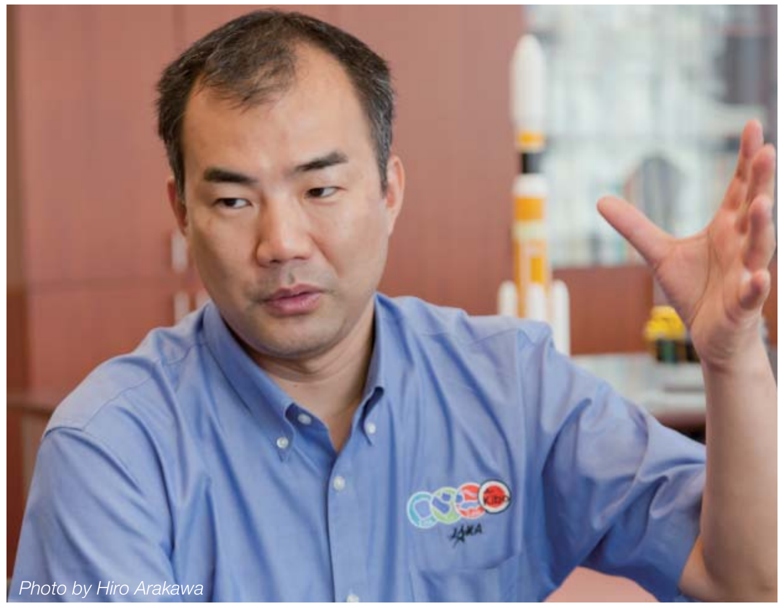
Nishiura: Indeed. Until recently, ALOS provided satellite images of disasters around the world through disaster-response organizations. Even though ALOS has completed its mission, the enormous amount of data it has accumulated so far will continue to be used extensively by many organizations and researchers.

*This refers to the Charter On Cooperation To Achieve The Coordinated Use Of Space Facilities In The Event Of Natural Or Technological Disasters.

Noguchi: Development of the successor to ALOS is already well in progress.

Nishiura: That is ALOS2, isn't it? I am really looking forward to the significant role it is certain to play. Another important role during times of disaster is the provision of means of communication. JAXA has used its Wideband InterNetworking engineering test and Demonstration Satellite (WINDS) and Engineering Test Satellite VIII (ETS-VIII) to provide communications circuits in disaster-affected regions. I find it marvelous that people in such areas have been able to use communications circuits provided by JAXA for receiving information and holding video conferences.

Noguchi: Yes, Midori-san, we as astronauts need to ask ourselves what we can do from space to help promote the development of a safe and sustainable society. I think it is important for us to be conscious of these issues during our work.



Soma City, Fukushima Prefecture area

The Soyuz spacecraft TMA-17 mission (21S) crew at Baikonur Cosmodrome
©NASA/Victor Zelentsov

Launch of the Soyuz TMA-17 spacecraft
©JAXA/NASA/Bill Ingalls

Entering the International Space Station (ISS) from the hatch on the Soyuz TMA-17 spacecraft (21S)
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Theme 2 | JAXA's Role from a Global Perspective

Nishiura: At the moment, JAXA Astronaut Satoshi Furukawa is fulfilling a long-endurance mission on the ISS. In July 2011, Japan moved into third place among all countries for the cumulative number of days spent in space by its astronauts, behind Russia (including the Soviet Union) and the United States.

Noguchi: I think we can be proud that Japan's experience in manned space flight has come so far. We have acquired a vast amount of knowledge through our space development programs, including a wide range of data from scientific experiments and data relating to human biology. We should utilize this knowledge to help drive space development forward in Asia. Furthermore, Japan has engaged in an array of unique activities on the ISS in humanities-related fields—including art—and has promoted programs that engage with children through communicating directly from space.

Nishiura: The ISS' JEM Kibo has received the Good Design Award in Japan. From a functional point of view, it was also highly acclaimed internationally. Having actually used JEM Kibo, what did you think of it?

Noguchi: JEM Kibo is extremely well built. It fits a huge array of facilities into a very compact space. It comprises such facilities as the Pressurized Module (PM), where the air pressure is kept at 1 atmosphere (1 atm), and the Exposed Facility (EF), where experiments may be conducted that require samples to be exposed to the space environment. The Japanese Experiment Module Remote Manipulator System (JEMRMS)—the robotic arm—is also a key feature of the module. JEM Kibo is not only used for experiments by Japanese researchers but also NASA, the European Space Agency (ESA) and others. Researchers from many countries in Asia have applied to use JEM Kibo, which JAXA is actively promoting internationally.

Nishiura: Isn't it marvelous that this superb Japanese facility is playing such a crucial role in bringing the world valuable research results. South Korea, Thailand, Vietnam, Indonesia, Malaysia and other Asian countries are very enthusiastic about space development. At the Asia-Pacific Regional Space Agency Forum (APRSAF), a Japan-led initiative, there is an extremely lively exchange of views. JAXA's space utilization and satellite utilization teams are leading the way for Asian countries pursuing space development and use, and I hope that this provides momentum for space-related activities across the whole of Asia.

Cleaning inside JEM Kibo
©JAXA/NASA

Assembling the robotic arm's Small Fine Arm inside JEM Kibo
©JAXA/NASA

Writing the first calligraphy of the New Year, a traditional Japanese event, is carried out onboard the ISS. The individual characters mean "dream" (left) and "peace," while the three characters on the right are read as "kibo" (hope), the name of the Japanese Experiment Module section of the ISS.
©JAXA/NASA

Theme 3 | Astronaut Noguchi's Dream

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Computer graphic of H-II Transfer Vehicle-R

Photo by Hiro Arakawa

Nishiura: Noguchi-san, you became an astronaut and performed a long-endurance mission on the ISS, so with such great achievements behind you, you have most certainly fulfilled your dreams. I do hope that you will carry on to add many more feathers in your cap so to speak. Now, do let us hear of your dreams for the future.

Noguchi: Well, Midori-san, given the opportunity, I would definitely like to go to space again. Therefore, I intend to continue with my training with that goal in mind. In JAXA's next-generation project, I feel the need to be involved while making full use of my experience as an astronaut. JAXA is looking to advance its project to develop the H-II Transfer Vehicle (HTV)—a resupply spacecraft for the ISS—into a recoverable spacecraft. Maximizing my experience from working on the ISS, I hope to contribute advice in various areas to this project.

Nishiura: That is tremendous. I must ask you, until now, six months or so has been the average length of a long-endurance mission in space. Is there a possibility of this period extending?

Noguchi: On the ISS, changing crews every six months or so seems about right. Though if we were talking about going to the moon or Mars, then there is the possibility of missions lasting three years or even longer. Japan will definitely have to be ready and prepared for such times.

Nishiura: Speaking of new missions, in July JAXA announced that it had selected three new astronauts, who will be following in your footsteps.

Noguchi: Yes, the new astronauts have just successfully completed the very tough NASA astronaut candidate (ASCAN) training in Houston. I'm sure they feel very relieved. From here on, I expect to see them step up another gear or two as they work toward their first space flights. I'm really looking forward to working with them.

Nishiura: One of the new astronauts is an experienced pilot, another a medical doctor. No doubt, they will contribute hugely as their predecessors have. I am looking forward to the three new astronauts' numerous achievements in the future.

Theme 4 | A Message for Children

Nishiura: Your message to children has always been consistent, "Let's go to space!" What are the reasons behind your great dedication to space-related education, and to delivering this message constantly to children?

Noguchi: When I was a child, the idea of becoming an astronaut—making space a career—seemed like just a fantasy, a pipe dream. But for children today, by the time they are adults the concept of working in space is, I think, likely to become much more accessible. This gives me even more reason to try to let children know what it is actually like to "go to space." Rather than limiting their own potential to what they can achieve on Earth, I want children to know that fulfilling their own potential can include space as well.

Nishiura: Yes, absolutely. If astronauts like you can help to inspire children to dream about space, and more children think, "I want to go to space!", then it will not only contribute to reversing the current worrying trend of fewer students wanting to specialize in science and engineering subjects, but it could also help to open children's eyes to the infinite possibilities that science can unlock. It might give children a greater awareness of how aerospace technology can play a valuable role in the survival and development of the human race.

Noguchi: Yes, definitely. I hope we can make it happen.

Nishiura: JAXA, as you know, puts significant energy into children's education. The creation of the Space Education Center—an initiative of JAXA President Dr. Keiji Tachikawa—is one tangible outcome of these efforts. Also, JAXA has programs to support the educational sphere, including a program that operates in collaboration with elementary, junior high and high school teachers to provide classroom teaching materials that focus on space. JAXA also provides opportunities for children in Asian countries to gain firsthand experience of space-related technology

through holding such experiments as water-rocket demonstrations as well as other events and programs.

Noguchi: I believe that utilizing space in the educational field is extremely effective. I often give lectures and presentations to public audiences, and it is so rewarding to see the sparkle in children's eyes as they listen.

Nishiura: By the way, you have carried out EVA on several occasions, I understand. What were the things that left a remarkable, lasting impression on you? Did these EVA change you personally, or your outlook on life?

Noguchi: The thing that I found most inspiring was—as one might expect—the sensation of floating in space while looking down at the Earth. There is nothing between you and the Earth. You get an overwhelming sense of the Earth's existence right there in front of your eyes. It truly is an amazing experience. And in the next moment, what I felt was this—the Earth's resources are not inexhaustible. This planet before your eyes is everything. Every kind of resource is limited, and we must share all of it with every living thing. That means we must care for the Earth, and protect it.

Nishiura: Yes, I agree with you completely. Thank you so much, Noguchi-san, for giving me your ardent thoughts on the future of aerospace developments.

Photographing the Earth from the Cupola window
©JAXA/NASA

Undergoing training in the operation of JEMRMS
©JAXA/NASA

Working out using the Advanced Resistive Exercise Device (ARED)
©JAXA/NASA

Members of both crews of the STS-131 and expedition 23 on the ISS, including Noguchi and Naoko Yamazaki, photographed in JEM Kibo
©JAXA/NASA

The Soyuz spacecraft TMA-17 mission (21S) touches down in Kazakhstan
©JAXA/NASA/Bill Ingalls

Astronaut Noguchi immediately after landing back on Earth
©JAXA/NASA/Bill Ingalls

H-II Transfer Vehicle:
Playing a Vital Role in the ISS Program

A major feature of the H-II Transfer Vehicle (HTV)—developed by Japan as a resupply spacecraft for the International Space Station (ISS)—is its capabilities for transporting both pressurized payloads for internal space station use and unpressurized payloads for use on JEM Kibo's Exposed Facility (EF)—including large-scale experiment equipment. Launches of the HTV are planned to take place once a year on average, thereby supporting the ISS program based on an advanced level of technology.

HTV: An Essential Part of the ISS Program

The HTV is an unmanned resupply spacecraft developed by Japan as a mode of transportation for carrying materials and equipment to the ISS. The first HTV Demonstration Flight lifted off on September 11, 2009. This was followed on January 22, 2011, by the launch of HTV2. Both spacecraft were carried into orbit aboard an HII-B launch vehicle, and each successfully completed their full mission schedule.

From HTV2 onward, the HTV has been nicknamed "Kounotori" ("white stork") in Japanese. This name was chosen following a campaign run by JAXA in which members of the public were invited to submit their ideas for a nickname. According to ancient lore, the white stork is the carrier of important things, including babies and other things of joy or well-being. Hence, many people expressed the opinion that "white stork" would be a suitable name for the HTV, which carries essential supplies and equipment to the ISS.

The HTV carries a maximum payload of approximately six tons to the ISS, including foodstuffs, water and daily necessities for ISS crew, experiment apparatus and equipment necessary for the maintenance of the ISS. After delivering its payload from the ground, the HTV is loaded with used experiment materials, used clothing and other unwanted items, which burn up along with the HTV during its reentry into the Earth's atmosphere.

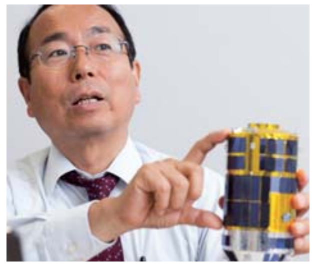
Apart from the HTV, other modes of transportation used for resupplying the ISS include NASA's Space Shuttle, the Russian Federal Space Agency (FSA)'s Progress resupply spacecraft and the European Space Agency (ESA)'s Automated Transfer Vehicle (ATV). However, since the Space Shuttle was retired from service following its final mission in July 2011, the HTV becomes the only resupply spacecraft currently operating that is capable of delivering large equipment payloads. This unique role further increases the importance of the HTV to the ISS program.

To provide an overview of the HTV's systems and mission, on pages 8 and 9 former project manager Yoshihiko Torano of the HTV Project Team discusses the HTV Demonstration Flight, and function manager Dai Aso—also from the same team—provides information on HTV2.

The ISS robotic arm (Space Station Remote Manipulator System or SSRMS) closes in to capture the HTV1 unmanned cargo transfer vehicle.

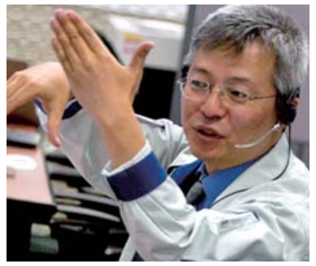
HTV flight director Koji Yamanaka seen in the HTV Mission Control Room (HTV MCR) at Tsukuba Space Center (TKSC) during the launch of HTV1.

HTV1 about to be berthed on the ISS.



Yoshihiko Torano

Former Project Manager
HTV Project Team
Human Space Systems and Utilization Mission Directorate



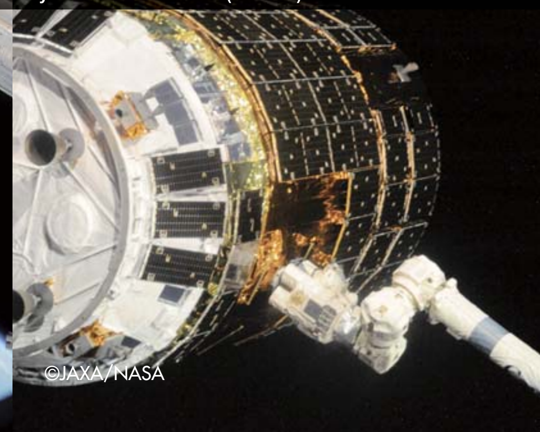
Dai Aso

Function Manager
HTV Project Team
Human Space Systems and Utilization Mission Directorate

HTV1 (KOUNOTORI1)

"Kounotori1" (HTV1) approaches the ISS.

The space station H-II Transfer Vehicle "Kounotori1" (HTV1) Technical Demonstration Vehicle is captured by the ISS robotic arm (SSRMS).



Ecstatic HTV flight directors Koji Yamanaka (left) and Dai Aso (center) hug each other after HTV1's success capture by the station's robotic arm (SSRMS).

HTV Demonstration Flight (HTV1)'s Success Underpinned by more than 100 Training Drills

Basic Structure of the HTV

The HTV has a total length of approximately 10 meters and a diameter of approximately 4.4 meters. Excluding payload, the HTV has a mass of approximately 10.5 tons, and can carry a payload to the ISS of up to 6.0 tons. The payload section of the spacecraft comprises a Pressurized Carrier, which transports payloads at an air pressure of 1 atmosphere (1 atm), and an Unpressurizied Carrier, which transports cargo while exposed to the vacuum conditions of space. The aperture on the docking section of the HTV is large—a 1.2 by 1.2 meter square hatch. The Progress and ATV resupply spacecraft have round docking hatches of approximately 0.8 meters in diameter. Hence, the HTV is able to carry large payloads that are unable to be transported by the Progress and ATV spacecraft.

High-precision Control Crucial for Docking with the ISS

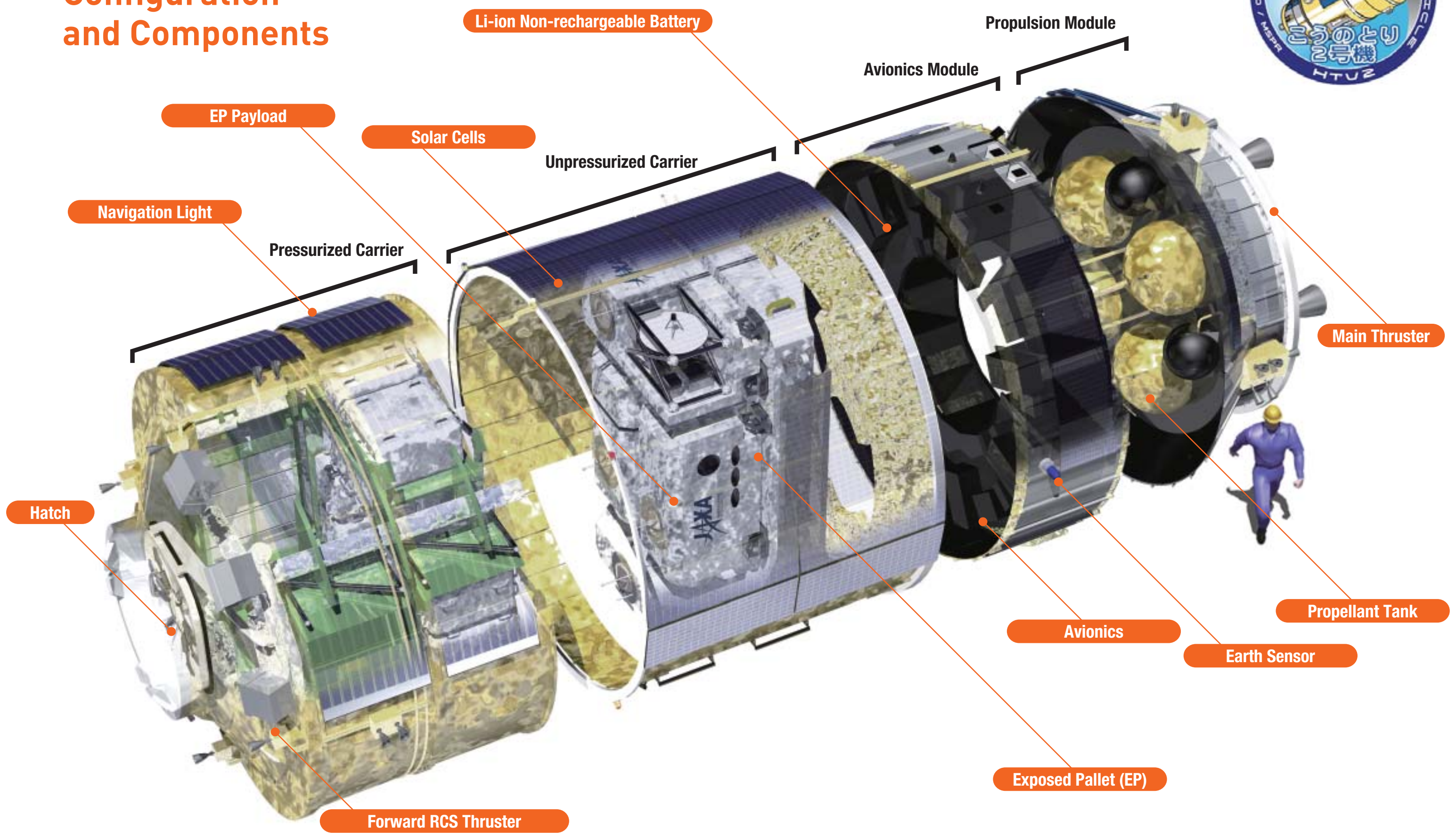
The ISS orbits the earth at a velocity of approximately 7.7 kilometer per second. The most challenging aspect of HTV operation is the docking procedure. When docking, the HTV must be stationary in relation to the ISS. In other words, the HTV must be traveling at precisely the same speed and in the same direction as the ISS, so that one appears stationary when viewed from the other. For this reason, the HTV requires high-precision control systems backed by an enormous volume of data.

Since the HTV Demonstration Flight was the very first mission for the HTV, we conducted more than 100 training drills, including joint training exercises with NASA in the United States. These drills included launch, docking and operation procedures for the HTV.

HTV Paves the Way for Future Manned Space Flight by Japan

Since the HTV's Pressurized Carrier maintains 1 atm air pressure, it is a suitable environment for human respiration. Hence, if we added life support systems to this compartment, the HTV could become a manned spacecraft. In other words, we are now ready to build a manned space flight system. Moreover, by enhancing the HTV's propulsion system, we would be able to undertake lunar missions. Thus, the HTV's significance is not limited to carrying cargo safely to the ISS, but also puts Japan's space development efforts within reach of manned space flight.

HTV's Configuration and Components



HTV2: Enhanced Payload Capacity

Differences between the HTV Demonstration Flight and HTV2

The key difference between HTV2 and the HTV Demonstration Flight lies in the Pressurized Carrier. HTV2 gained increased load capacity compared with the HTV Demonstration Flight by leaving out such items as spare batteries and fuel tanks. The HTV Demonstration Flight had a cargo capacity of 4.5 tons, but this was increased to 6.0 tons for HTV2. In terms of operation, there were no major differences between the HTV Demonstration Flight and HTV2, however, a number of minor changes were implemented. For example, when docking, for the HTV Demonstration Flight we positioned the spacecraft 300 meters directly below the ISS, whereas for HTV2 this was modified to 250 meters. This slight change reduced the workload on the thrusters.

Subdivision of Project Team Training

Although there were fewer training drills for HTV2, we still carried out around 60 exercises. From HTV2, 22 new members joined the project team, and we felt that full-team exercises alone were insufficient. For this reason, we implemented individual training for each position, formulated detailed operation manuals and conducted training based on these while making ongoing modifications. At the Tanegashima Space Center (TSC), our team was present for operational testing as much as possible, and we stayed up to date with developments across the overall system.

Looking Ahead to Continuing HTV Launches and Beyond

Based on the data we have acquired through the HTV Demonstration Flight and the HTV2 mission, we plan to make further improvements while working toward a schedule of around one launch per year. In the resupply of materials and equipment to the ISS, we aim to contribute as a highly safe and reliable mode of transportation. At the same time, through the HTV project, we intend to accumulate an array of technologies necessary for future manned space flight programs.

HTV2 (KOUNOTORI2)

H-II Transfer Vehicle No.2 (HTV2), "Kounotori2," is unveiled to the media at the Tanegashima Space Center.

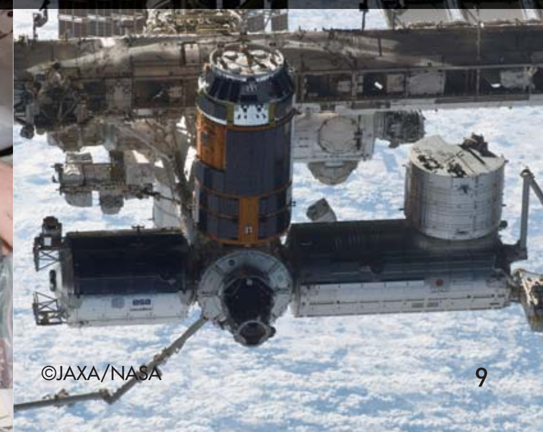
In the Cupola astronauts Paolo Nespoli (left) and Catherine Coleman prepare to capture "Kounotori2" (HTV2), which can be seen through the window above them.

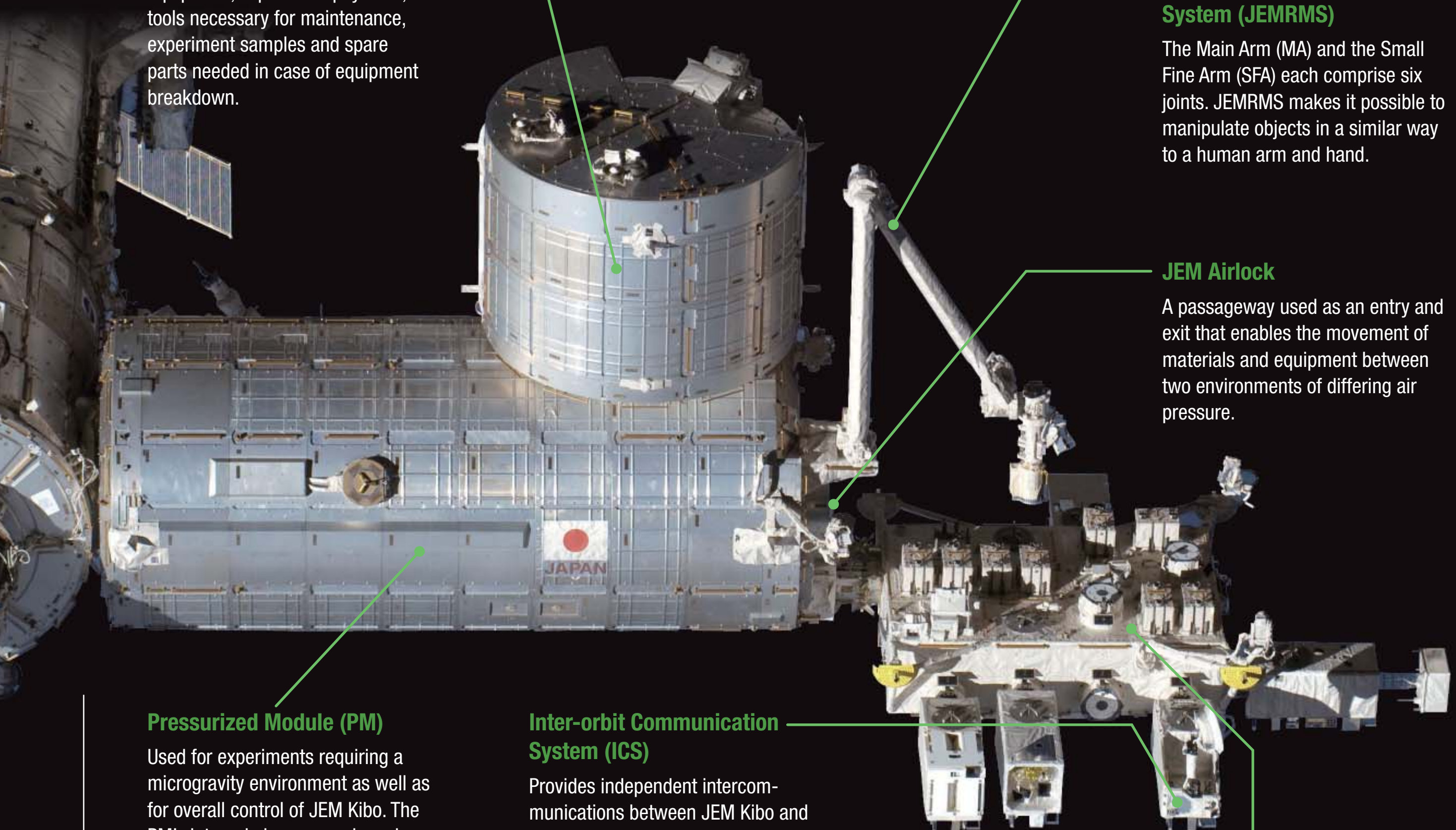
The ISS robotic arm (SSRMS) has "Konoutori2" (HTV2) safely in its grasp.

Members of the HTV operations management team at TKSC show their delight at the SSRMS' successful capture of "Kounotori2" (HTV2).

Having opened the hatch, astronaut Scott Kelly enters the pressurized section of the "Kounotori2" (HTV2) cargo transporter to check the status of supplies.

"Kounotori2" (HTV2) photographed from the Space Shuttle Discovery after undocking.





"All Japan" Ingenuity Creates the "Ultimate Laboratory"

As one of the International Space Station (ISS)'s constituent modules, the Japanese Experiment Module (JEM) Kibo is Japan's first manned facility enabling astronauts to undertake long-term missions in space. In this article, we provide an overview of the design and construction of the "ultimate laboratory"—which represents the combined efforts of more than 600 Japanese companies—as well as some of the experiment results yielded by JEM Kibo's Exposed Facility (EF).

Kuniaki Shiraki
Technical Counselor
Former Executive Director for Human Space Systems and Utilization Mission Directorate
Japan Aerospace Exploration Agency (JAXA)

JEM Kibo Assembly Mission

March 2008: ELM-PS Attached to ISS
On Mission 1J/A (STS-123), the first launch in the delivery of JEM Kibo, ELM-PS was attached to the ISS. This photograph shows Space Shuttle Endeavour making its docking approach to the ISS. The ELM-PS can be seen inside the Endeavour's payload bay.

Development under an "All Japan" Framework Involving over 600 Companies

The ISS project began in 1984 when then U.S. President Ronald Reagan invited Japan, Europe and Canada to participate in the program. At the time, Japan was aiming to develop the H-II—a rocket that would be fully designed and manufactured in Japan. However, there was also interest in Japan in developing manned space systems, hence the decision was made to participate in the project. In the preliminary design phase, scientists in Japan voiced the need for a facility that would enable experiments to be conducted in both a pressurized environment and an exposed space environment. This consideration led to a structure comprising a pressurized module (PM) and an exposed facility (EF). In addition, with the future development of technologies necessary for manned space systems in mind, the concept for the present-day JEM Kibo was finalized after inclusion of the robotic arm (JEMRMS), the Experiment Logistics Module, Pressurized Section (ELM-PS) and the JEM Airlock.

Subsequently, participation of companies was solicited based on an "All Japan" development framework for the country's first manned space facility. Over 600 companies in total were involved in the project, including four of Japan's leading heavy manufacturing groups—Mitsubishi Heavy Industries, Ltd., Ishikawajima-Harima Heavy Industries Co., Ltd. (currently IHI Corporation), Kawasaki Heavy Industries, Ltd., and Nissan Motor Co., Ltd.—and four top electrical equipment manufacturers—Mitsubishi Electric Corporation, NEC Corporation, Toshiba Corporation and Hitachi, Ltd.

Original Technology Developed for JEM Kibo to be Utilized in Future Projects

JEM Kibo's major components include the PM, EF, ELM-PS, JEMRMS, JEM Airlock and ICS, with each of these components comprising numerous innovations that are based on the ingenuity and resourcefulness of the participating companies.

June 2008: PM and JEMRMS Attached to ISS
On Mission 1J (STS-124), the second assembly mission for JEM Kibo, the PM was berthed to the ISS and JEMRMS was attached. This photograph shows the PM being gripped by the Space Station Remote Manipulator System (SSRMS)—the ISS' main robotic arm, also known as Canadarm2.

For example, JEMRMS—the robotic arm—has the Small Fine Arm (SFA) to support maintenance of the experiment apparatus and system equipment. To ensure that the SFA functions properly in the space environment, original technology related to lubrication under vacuum conditions was developed as part of the project. The JEM Airlock is used for transferring materials between the PM and EF, and operates with a two-hatch system to prevent air from leaking out. When the outer hatch connecting to the EF is opened, a vacuum pump is used to recover air, hence eliminating wastage. On the EF, it is possible to attach experiment equipment that requires a large amount of electricity, and there is a thermal control system for removing heat from experiment apparatus.

NASA's design requirements for the internal environment of the PM were very demanding in relation to such parameters as temperature, humidity, air conditioning, noise and lighting. To fulfill these requirements, we applied ourselves strenuously with a typically Japanese degree of earnestness. Later, when JAXA Astronaut Koichi Wakata first entered the JEM Kibo PM, he commented, "It's very neatly designed. Right down to the minute details, a lot of work has gone into it. Inside it's very quiet too." NASA engineers as well as cosmonauts and astronauts from other countries have also praised JEM Kibo.

The original technologies cultivated during the manufacture of JEM Kibo have since been applied broadly across Japan's space development efforts. On the H-II Transfer Vehicle (HTV)—a spacecraft developed by JAXA to resupply the ISS— the structure of the Pressurized Logistics Carrier (PLC) is almost the same as that of the JEM Kibo ELM-PS, and the Exposed Pallet (EP) carried in the Unpressurized Logistics Carrier (ULC) utilizes technology from JEM Kibo's EF.

In addition to meeting NASA's stringent requirements, the results of the JEM Kibo project are particularly pleasing from the perspective of the level of compactness that we achieved. This will be a key asset for JAXA as we pursue new projects in the future, and we intend to fully leverage this success.

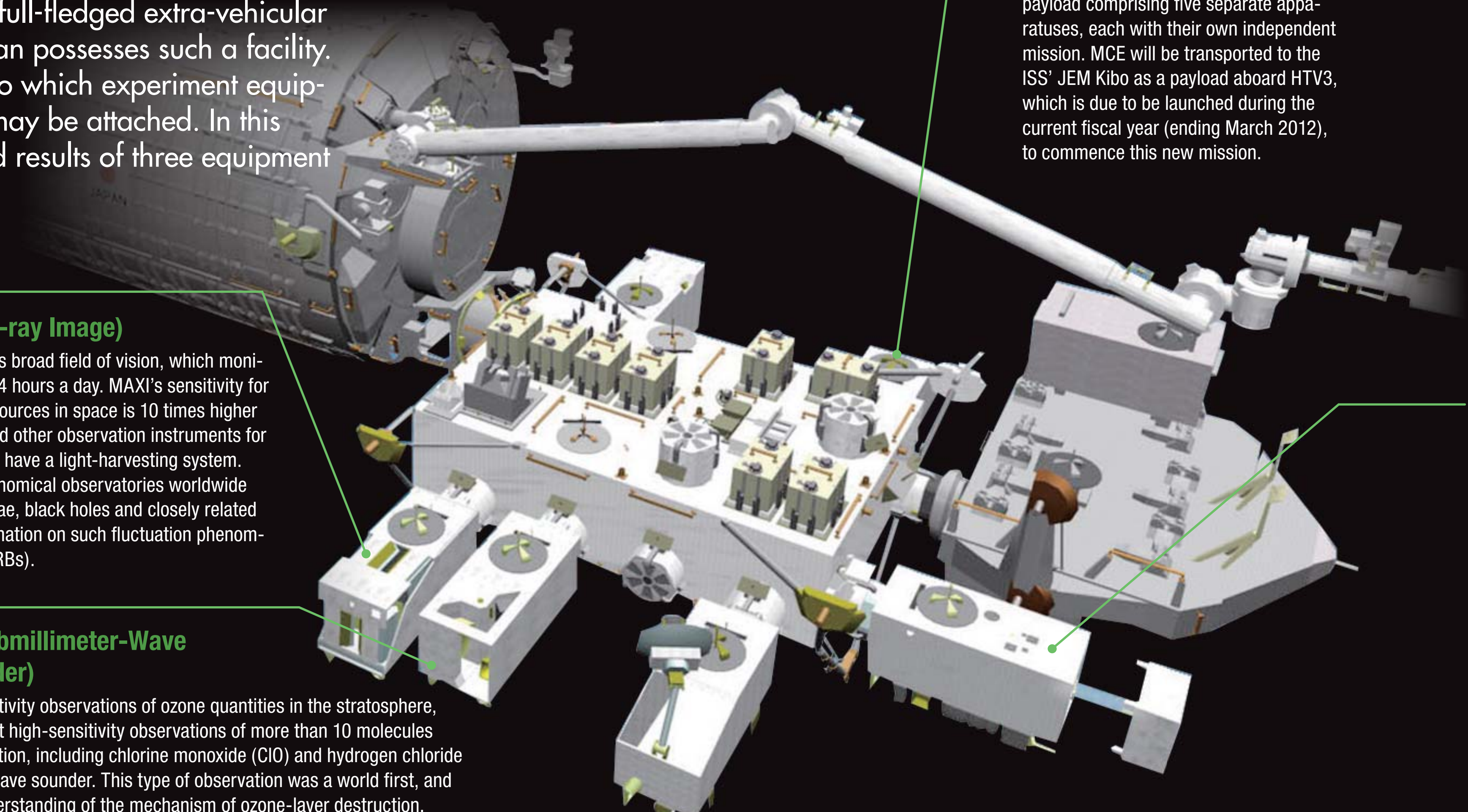
July 2009: EF and EP Attached to ISS
On the third assembly mission, 2J/A (STS-127), the EF and an EP were attached to the ISS. The photograph shows the Monitor of All-sky X-ray Image (MAXI) unit—to be attached to the EF—being manipulated by JAXA Astronaut Koichi Wakata who is operating the JEMRMS robotic arm. The empty EP was returned to ground aboard the Endeavour.

The International Space Station Bustles with Activity

This photograph of the ISS was taken from the Space Shuttle Discovery after undocking from the space station. At the top-center of the photograph is JAXA's gleaming, gold-colored H-II Transfer Vehicle 2 (HTV2; nicknamed "Kounotori2" ("white stork") in Japanese). At the bottom-center of the photograph is the European Space Agency (ESA)'s Automated Transfer Vehicle (ATV), a resupply spacecraft, with its distinctive array of four solar wings. Just above the ATV are two Russian Federal Space Agency (FSA) Soyuz spacecraft and the Progress resupply spacecraft, also belonging to the FSA. The photograph was taken on March 7, 2011.

Experiment Results from JEM Kibo's Exposed Facility (EF)

JEM Kibo's EF provides a platform for carrying out full-fledged extra-vehicular experiments and observation. On the ISS, only Japan possesses such a facility. The EF has 10 Exposed Facility Unit (EFU) ports onto which experiment equipment for conducting various types of observations may be attached. In this article, we provide an overview of the functions and results of three equipment payloads that have been attached to the EF to date.



Shigeki Kamigaichi

Deputy Director,
Space Environment Utilization Center
Human Space Systems
and Utilization Mission Directorate
JAXA

Shortly after the EF was attached to JEM Kibo's PM in July 2009, two experiment instruments—Monitor of All-sky X-ray Image (MAXI) and Space Environment Data Acquisition equipment-Attached Payload (SEDA-AP)—were installed on the EF. Subsequently, in September 2009, Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) was transported to the ISS as a payload aboard HTV2 and began observations after being installed on the EF. In the near future, JAXA plans to add Multi-mission Consolidated Equipment (MCE) as a new experiment payload on the EF.

JAXA has appealed to countries participating in the ISS program to utilize the ISS—including JEM Kibo—more extensively for Earth-observation purposes. For example, if an infrared camera were installed on the EF, it could be used for such purposes as monitoring forest fires. Furthermore, using the JEM Airlock, it is possible to launch small satellites after transporting them to the ISS as payloads from the ground. In such cases, a satellite would be released using the robotic arm JEMRMS. At present, three satellites chosen for launch from JEM Kibo are in their design phase. In striving to further expand space development, JAXA will promote a diverse range of uses for JEM Kibo, including its EF.

MAXI
(Monitor of All-sky X-ray Image)

A unique feature of MAXI is its broad field of vision, which monitors X-ray sources in space 24 hours a day. MAXI's sensitivity for detecting X-rays emitted by sources in space is 10 times higher compared with telescopes and other observation instruments for all-sky monitoring that do not have a light-harvesting system. MAXI provides alerts to astronomical observatories worldwide and researchers on supernovae, black holes and closely related X-ray novae, as well as information on such fluctuation phenomena as gamma-ray bursts (GRBs).

SMILES
(Superconducting Submillimeter-Wave Limb-Emission Sounder)

SMILES conducted high-sensitivity observations of ozone quantities in the stratosphere, and simultaneously carried out high-sensitivity observations of more than 10 molecules related to ozone-layer destruction, including chlorine monoxide (ClO) and hydrogen chloride (HCl), using a submillimeter-wave sounder. This type of observation was a world first, and was expected to advance understanding of the mechanism of ozone-layer destruction. Unfortunately, approximately six months into the experiment an equipment failure meant that the mission was terminated in January 2011. However, in the future we plan to utilize archive data already acquired during the experiment.

MCE
(Multi-mission Consolidated Equipment)

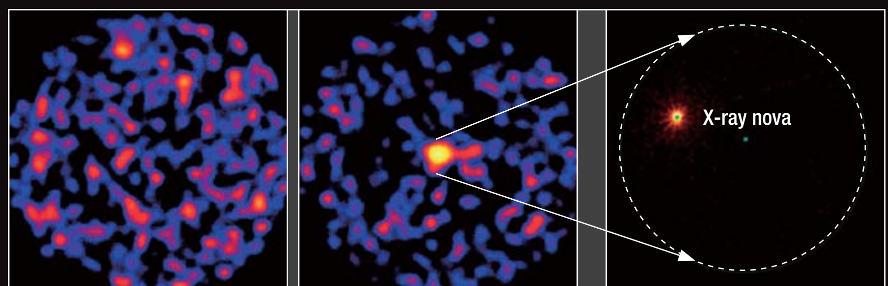
MCE, which is currently under development, is a single experiment-equipment EF payload comprising five separate apparatuses, each with their own independent mission. MCE will be transported to the ISS' JEM Kibo as a payload aboard HTV3, which is due to be launched during the current fiscal year (ending March 2012), to commence this new mission.

SEDA-AP
(Space Environment Data Acquisition equipment-Attached Payload)

SEDA-AP conducts quantitative measurements of the space environment in the ISS' orbit (neutrons, heavy ions, plasma, high-energy light particles, atomic oxygen, etc.) as well as materials exposure experiments and electronic component evaluation experiments. The purpose of these measurements and experiments is to investigate the impact of the space environment on spacecraft—including satellites and space stations—and the health of astronauts.

MAXI Discovers X-ray Nova

On January 11, 2011, MAXI discovered an X-ray nova that occurred in the constellation Columba. An X-ray nova is a star that suddenly produces an X-ray outburst and begins to emit visible light. Most X-ray nova are black hole binaries within our galaxy.



a: Prior to the appearance of the nova observed by MAXI (January 7, 2011)

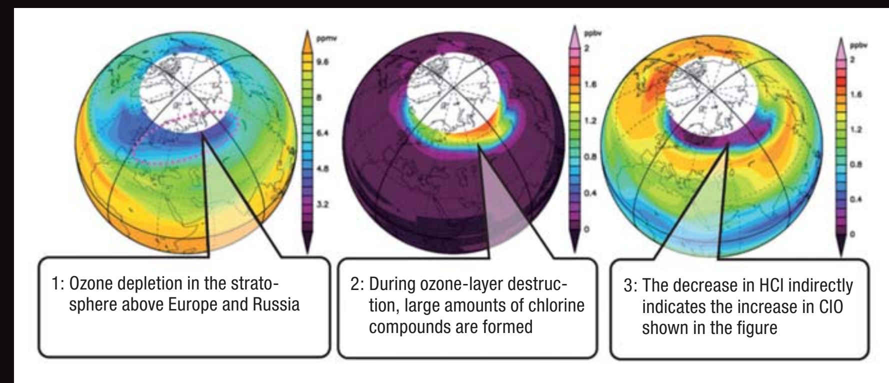
b: Subsequent to the appearance of the nova (January 11, 2011)

c: NASA's Swift space-based observatory—which is dedicated to the study of GRBs—captured this tracking-observation image using its small X-ray telescope (XRT) after receiving an alert from MAXI regarding the X-ray nova.

SMILES Observes Ozone-layer Destruction

On January 23, 2010, SMILES observed destruction of the ozone layer at an altitude of 22 kilometers. Utilizing its high sensitivity, SMILES not only observes ozone depletion (shown in figure 1) but also captures changes in chlorine compound levels over a single day (the increase shown in figure 2 and the decrease shown in figure 3).

*Owing to the particular orbit of the ISS, the area near the North Pole is excluded from the SMILES observation area, and hence no data is shown for that region.



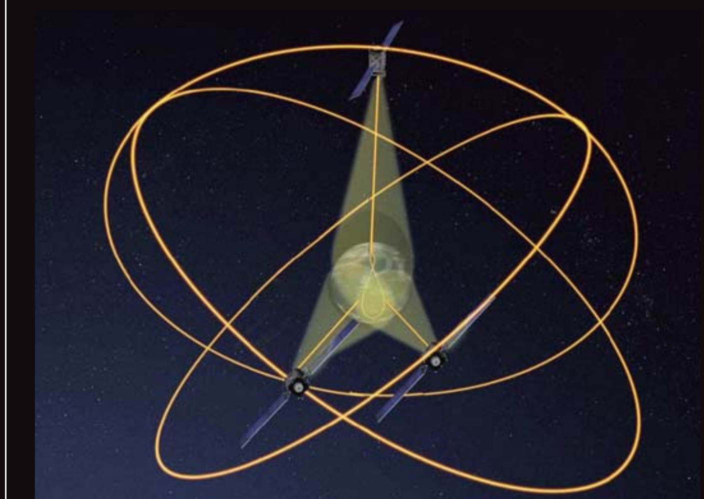
1: Ozone depletion in the stratosphere above Europe and Russia

2: During ozone-layer destruction, large amounts of chlorine compounds are formed

3: The decrease in HCl indirectly indicates the increase in ClO shown in the figure

MICHIBIKI's Unlimited Potential

Global Positioning System (GPS)—owned by the U.S. government—is a familiar and widely used global navigation satellite system (GNSS) that provides location and time information. The Quasi-Zenith Satellite System (QZSS) is set to play a key role in further bolstering the usability and precision of GPS. Quasi-Zenith Satellite-1, which is more commonly known by its Japanese nickname "MICHIBIKI" (meaning "guiding light"), was launched from Tanegashima Space Center (TSC) on September 11, 2010, aboard H-IIA Launch Vehicle No. 18 as the first satellite in the QZSS. In this article, the former QZSS project manager Koji Terada and Satellite Applications and Promotions Center associate senior engineer Satoshi Kogure discuss the QZSS, which holds significant potential for contributing to the creation of a safer, more convenient society.



A computer graphic illustrating the three satellites comprising the QZSS

Koji Terada

Director
Public Affairs Department
Former Project Manager
Quasi-Zenith Satellite System Project Team

Satoshi Kogure

Associate Senior Engineer
Satellite Applications and Promotions Center / Quasi-Zenith Satellite System Project Team

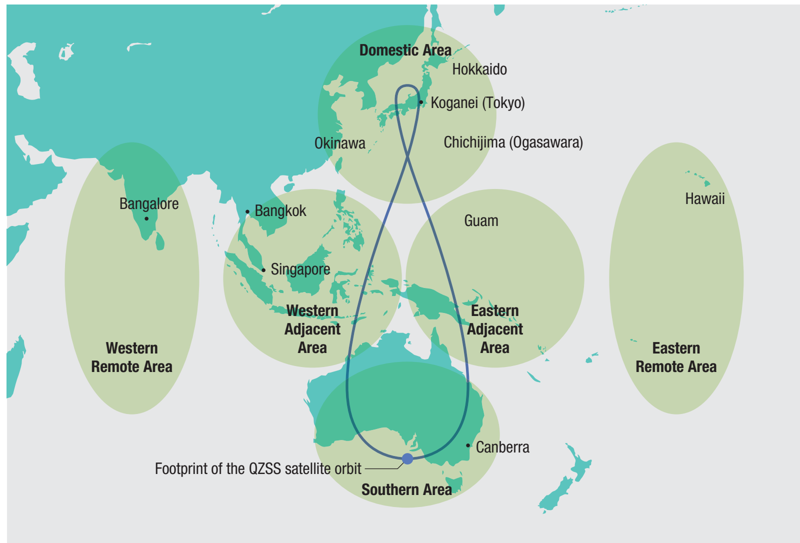
1. Overview of MICHIBIKI (Quasi-Zenith Satellite-1)

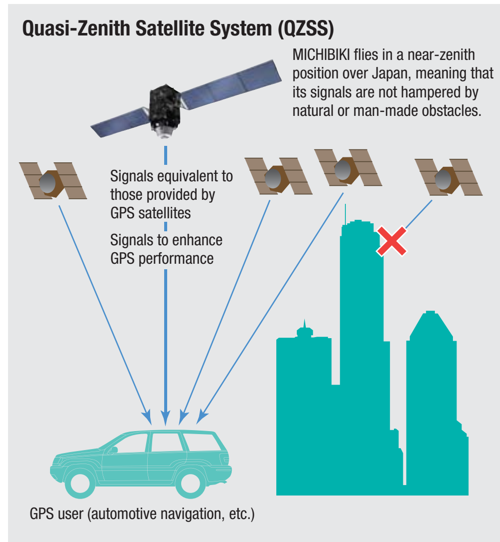
Resolving Weaknesses in GPS

Through the widespread popularization of such products as automotive navigation systems and GPS-equipped mobile phones, positioning information utilizing GPS satellites has become an essential part of the daily lives of many people. However, in Japan's urban environment, signals from GPS satellites may be hampered by the presence of tall buildings, which can sometimes lead to the loss of positioning data or the degradation of positioning accuracy. In urban situations, significant disadvantages can arise if positioning-information accuracy is degraded. For example, it may cause automotive navigation system users to become disoriented. However, the QZSS resolves such weaknesses. The QZSS is a joint national project led by four Japanese government ministries—the Ministry of Internal Affairs and Communications (MIC), Ministry of Education, Culture, Sports, Science and Technology (MEXT), Ministry of Economy, Trade and Industry (METI), and Ministry of Land, Infrastructure, Transport and Tourism (MLIT). JAXA's role is to utilize MICHIBIKI—the first QZSS satellite—to conduct technical verification, as well as maintain and operate the overall system.

Future Plans Call for a Three-satellite Constellation

The QZSS uses a constellation of satellites placed in multiple orbital planes, which keep them in a near-zenith (quasi-zenith) position over Japan for a significant part of each day, meaning that line-of-sight with at least one satellite is maintained continuously. The satellites have the same orbital period as a traditional equatorial geostationary orbit, however, they have a large orbital inclination and therefore move with respect to the Earth. The QZSS' orbits are also elliptical owing to a slight eccentricity, enabling them to pass slowly through the zenith over Japan. The QZSS' orbit follows an asymmetric figure-8 footprint above the Earth's surface. Although each satellite is visible at or near the zenith over Japan for eight hours each day, unfortunately, during the remaining 16 hours, each satellite moves outside of Japan's zenith. By deploying a three-satellite constellation, after each eight-hour period the next satellite approaches, providing Japan with zenith satellite visibility 24 hours a day. This system eliminates shadows created by mountainous topography and buildings, enabling the provision of high-precision positioning services with almost 100% coverage for all of Japan.





To use the QZSS, the user terminal must obtain accurate data at all times indicating the exact position of the QZSS satellite flying overhead. To ensure this information is available, it is necessary to have monitoring stations on the ground receive positioning signals from the satellite. Since monitoring from several directions simultaneously increases the accuracy of positioning calculations, the QZSS not only utilizes monitoring stations in Japan but also overseas—in Hawaii, Guam, Australia, Singapore, Thailand and India.

2. Technical Verification of MICHIBIKI Progressing Steadily

Three Missions of the QZSS

MICHIBIKI was inserted into an orbit passing through the near-zenith over Japan on September 27, 2010, and then underwent a three-month initial functional verification period. Subsequently, from December 15, 2010, we commenced the full-fledged technical and application verification phase, which is the first stage of development of the QZSS. During this period, JAXA will collaborate with MEXT, MIC, METI, MLIT and other organizations involved in the project while carrying out technical and application verification. For the first developmental phase of the QZSS, MICHIBIKI has been given three missions as summarized below. Through the technical and application verification process, we are working to verify the functions and performance of each of these missions.

GPS Availability Enhancement

MICHIBIKI will transmit signals almost identical to the signals currently used by the U.S.' GPS as well as the signals that are planned to be used by GPS in the future. GPS users will be able to utilize signals from MICHIBIKI as an "extra GPS signal." Hence, even for times or places in which GPS satellite coverage is insufficient for positioning, by using signals from MICHIBIKI, accurate positioning and time information can be obtained. This system complements the GPS service and facilitates the provision of more advanced positioning services.

GPS Performance Enhancement

MICHIBIKI will transmit a precise correction signal to improve the accuracy of GPS. As a result, GPS users will be able to receive this signal to obtain more accurate positioning information. This system holds the promise of delivering high-precision positioning anywhere in Japan.

Development of Underlying Technology for Next-generation GNSS

To acquire fundamental technology for next-generation systems, MICHIBIKI will be utilized for experiments that aim to improve positioning accuracy. This will include frequent transmissions of such information as experimental signals, which will provide more precise information about orbit, time discrepancies and other parameters.

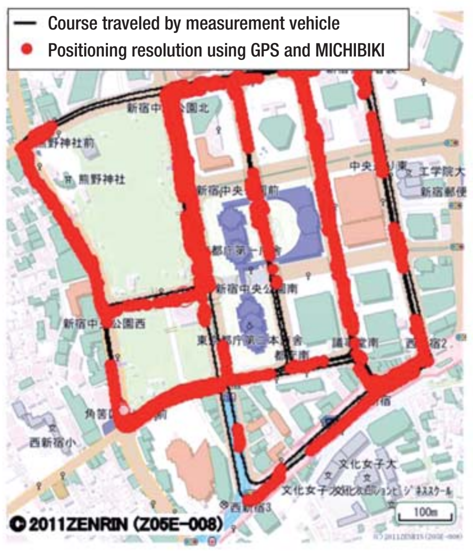
JAXA is responsible for GPS availability enhancement and the development of underlying technology for next-generation GNSS. Utilizing MICHIBIKI, we are conducting ongoing experiments to improve the accuracy of positioning signals and system stability, as well as to verify the performance of the QZSS. By July 2011, we were able to verify our ability to provide four GPS supplementary signals, which stably satisfied the QZSS user interface specifications (IS-QZSS) for performance and accuracy. Consequently, we lifted the "alert flag," which had until that point rendered the positioning signals from MICHIBIKI unusable for general users. By doing so, GPS receivers that are compliant with MICHIBIKI signals may now use these signals for positioning. Based on an evaluation of technical and usage verification test results, the Japanese government will make a decision on whether to advance to the second phase of development in which system verification will be conducted using three quasi-zenith satellites.

MICHIBIKI Improves Urban Positioning Service Availability

Positioning-Signal Availability Improvement in Shinjuku, Tokyo, from Using MICHIBIKI

Positioning-signal availability when using GPS alone

Positioning-signal availability when using GPS and MICHIBIKI



To obtain observation data in urban areas and mountainous regions throughout Japan, JAXA is currently collaborating with a large number of organizations to conduct experiments that compare and assess the difference between positioning using only GPS satellites and positioning using GPS satellites in conjunction with MICHIBIKI. Below is a summary of the results of one such experiment conducted jointly with Mitsubishi Electric Corporation.

From January 18 to March 31, 2011, we conducted a positioning experiment in an urban environment where GPS signals can be hampered by the large number of buildings and structures. This experiment used positioning signals from MICHIBIKI, which was located in a near-zenith position. In two parts of Tokyo—Shinjuku's skyscraper district and Ginza's clustered backstreets—by combining MICHIBIKI with GPS satellites, we were able to verify a substantial increase in signal availability.

3. The Future Society that MICHIBIKI Will Create

New Services Made Possible by the QZSS

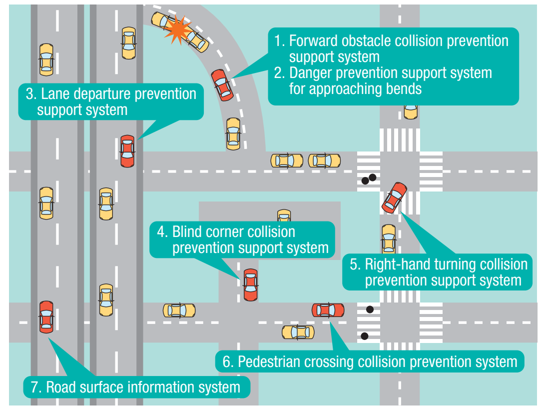
In addition to automotive navigation, the application of satellite positioning systems continues to expand across an ever-wider sphere, leading to demand for enhanced accuracy and reliability. Fields in which satellite positioning is used include surveying essential for cartography and construction, automated control of agricultural machinery, seismic and volcanic monitoring, detection of changes in the Earth's crust, and estimation of water vapor content in the atmosphere to improve weather forecasting accuracy.

If further improvements in positioning accuracy can be achieved through the practical application of the QZSS, the potential will be opened up for the development of completely new services. Below, we introduce three services that are expected to be offered in the near future.

Contributing to Traffic Safety: Enhancement of Traffic Information Services

In urban areas, the accuracy of positioning based on GPS signals varies from between several meters to over 10 meters. However, by utilizing MICHIBIKI's supplementary signals, positioning accuracy improves to approximately one meter. By developing a driving support service that utilizes precise location information, we anticipate such benefits as accident prevention, congestion avoidance and route optimization. Such systems may also lead to reductions in fuel consumption and CO_2 emissions.

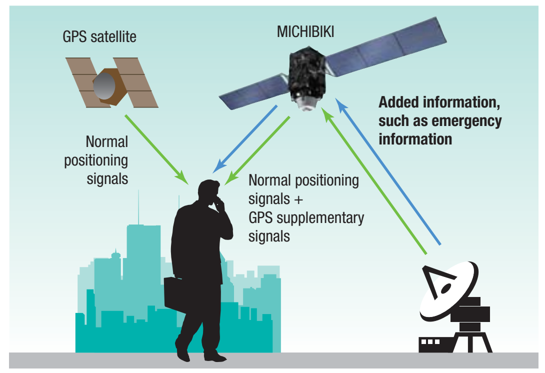
Example of Driver Support Using Precise Positioning Data in an Urban Area



Contribution to Disaster Prevention: Provision of Emergency Information during Disasters

When major disasters occur, having access to accurate information is vital for obtaining a clear picture of the damage situation and preventing secondary disasters. Using current GPS technology, only location and time information can be supplied, but MICHIBIKI is able to simultaneously transmit disaster information and other emergency data along with positioning and supplementary signals. Mobile phones and other devices compatible with GPS and MICHIBIKI data will be able to receive emergency information.

Concept Diagram for Emergency Information Delivery Using MICHIBIKI



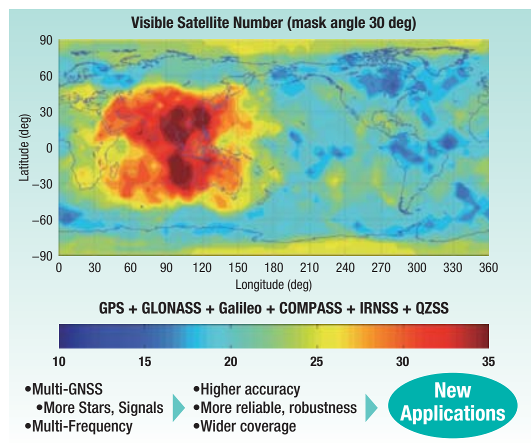
Leisure-Related Applications: Expansion of Coverage Area

By developing sightseeing services utilizing the GPS functions of mobile phones, not only can tourists effectively use the limited time they have available to visit several famous spots in an area, but tourist regions can use such services for promotion purposes and hence revitalize their area. Furthermore, although signal coverage from GPS satellites alone is often insufficient in mountainous regions and urban areas that have many tall buildings, under the QZSS, if MICHIBIKI constantly flies in a near-zenith position over Japan, even in such environments accurate location information is always close at hand.

4. Multi-GNSS

The Multi-GNSS Demonstration Campaign aims to encourage and promote the adoption and utilization of satellite positioning, navigation and timing services in the Asia-Pacific region through programs to assist with the integration of GNSS services into national infrastructures. The Asia-Pacific region is unique as the number of usable, modernized navigation satellites will increase here much faster than in any other area of the world. We anticipate significant improvements in Position, Navigation and Timing (PNT) capabilities and hence there is a great opportunity to test and validate new receiver hardware, algorithms and applications in order to address user requirements. The Multi-GNSS Demonstration Campaign will encourage GNSS signal and service providers as well as users in the Asia-Pacific region to develop new applications and to carry out joint experiments and demonstrations.

Multi-GNSS Asia-Pacific Showcase

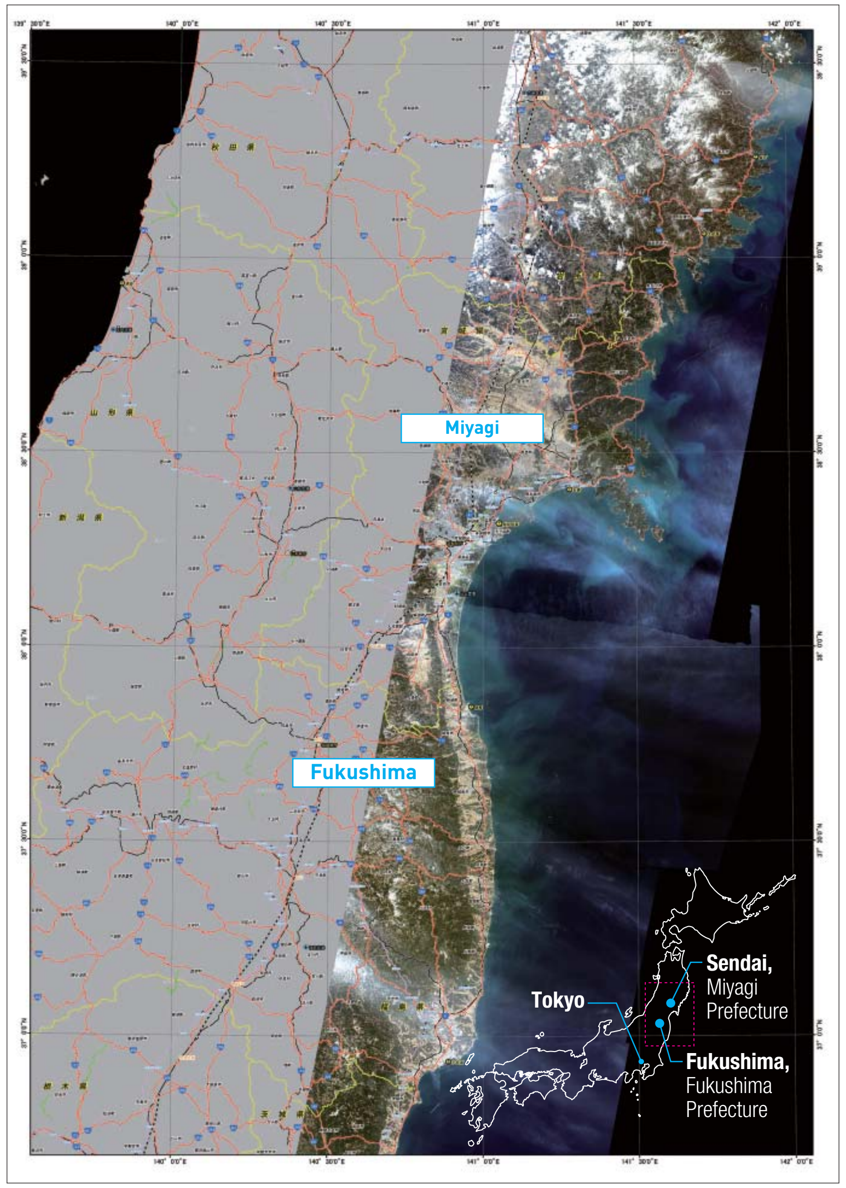


People in the Asia–Pacific region will be able to access multi-GNSS signals earlier than any other region in the world.

JAXA's Response to the Great East Japan Earthquake

On March 11, 2011, the Great East Japan Earthquake caused enormous damage to areas centering on the Tohoku region. JAXA immediately responded by using one of its satellites to carry out an emergency survey of the disaster-affected areas, and provided these satellite images through various government agencies.

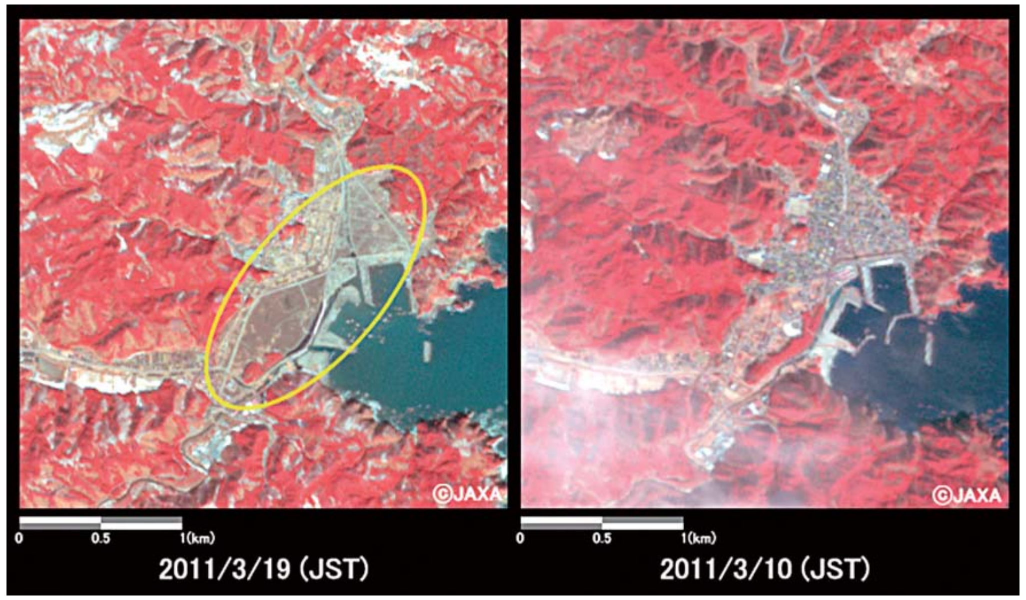
1. ALOS Mission Continued Beyond Target Operating Life



This image, taken on March 14, 2011, was captured by ALOS' Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), and includes the Tohoku region, which sustained severe damage from the earthquake and tsunami. AVNIR-2 is a visible and near infrared radiometer capable of observing four wavelength bands. It provides 10-meter spatial-resolution images of the ground over a swath width of 70 kilometers at nadir.

The Great East Japan Earthquake and the massive tsunami that immediately followed wreaked unprecedented damage over a broad area spanning the Tohoku and Kanto regions. To swiftly provide a picture of the large-scale damage situation, JAXA utilized its Advanced Land Observing Satellite (ALOS) to conduct continuous emergency observations of the disaster-affected areas beginning on March 12. ALOS captured approximately 400 satellite images during these observations, thereby contributing to efforts by the Japanese government and its various agencies to gather information on the disaster situation. One of the unique strengths of satellite technology is the ability to capture images of a very wide area in a single observation. ALOS leveraged this capability to play a valuable role in efforts to ascertain information relating to such phenomena as flooding caused by the tsunami and changes in the Earth's crust.

ALOS is an Earth-observing satellite whose mission included the collection of topographic data with accuracy sufficient for 1/25,000-scale maps of the entire globe. It also provided geological and land-use data. Topology data is also necessary for quickly comprehending the situation after the occurrence of large-scale disasters. After it was launched on January 24, 2006, ALOS continued to operate beyond both its design life of three years and JAXA's mission goal of five years. ALOS accumulated an impressive record of achievements both in Japan and abroad during its operation period, including emergency observations of the Great East Japan Earthquake and other disasters. Unfortunately, ALOS completed its mission in May 2011 owing to an electrical power anomaly.



These images, taken by ALOS' AVNIR-2 radiometer, show the Taro district of Miyako City, Iwate Prefecture. The image on the right-hand side shows the area prior to the earthquake on March 10, while the image on the left-hand side shows the same area following the earthquake on March 19. By looking at the area inside the yellow ellipse indicated on the left-hand image, one may observe the extent of the damage caused by the 10-meter high tsunami, which breached the storm-surge barrier, destroying a large number of buildings.

A Message From JAXA Astronaut Satoshi Furukawa to All the Earthquake Victims

Satoshi Furukawa
JAXA Astronaut

Video Q&A session between Astronaut Furukawa on the ISS and children, in which questions such as "How does the earthquake area look from space?" were asked

JAXA Astronaut Satoshi Furukawa delivers his message of encouragement, "Hang in there, Japan!" from JSC in Houston.

In response to the Great East Japan Earthquake, astronauts serving long-endurance missions aboard the ISS conducted emergency observations of disaster-affected parts of the Tohoku region on behalf of JAXA on March 13 and 14, 2011. JAXA also posted to its web site video and text messages (in Japanese only) from JAXA astronauts to earthquake victims. JAXA also received messages from long-endurance crew members aboard the ISS. At the time of the earthquake, JAXA Astronaut Satoshi Furukawa was undergoing training at the Johnson Space Center (JSC) in the United States. During the video message of encouragement that he made for Japan, he noted that while reading a local newspaper, The Houston Chronicle, on March 13, the article talked about how the earthquake had clearly not damaged the selflessness of Japanese people as televisions across the globe streamed images of emergency rescue teams and of the spirit of compassion shown time and time again by people who put the needs of others ahead of their own during such a time of great turmoil. From June 10, Astronaut Furukawa has been serving a long-endurance mission on the ISS as a flight engineer. He is part of the ISS Expedition 28/29 long duration missions.

On August 1, a communication event was held in Miyagi Prefecture, one of the disaster-affected areas, between Astronaut Furukawa aboard the ISS and children from the earthquake-damaged region. Astronaut Furukawa's message for the children included these words of encouragement: "Always have a dream for the future, and never forget about how you can work to make that dream come true."

2. Support Provided through the International Charter and Sentinel Asia

Image data of the Tohoku region captured at approximately 9:15 a.m. on March 12, 2011, by FORMOSAT-2, which is operated by Taiwan's National Applied Research Laboratories (NARL).

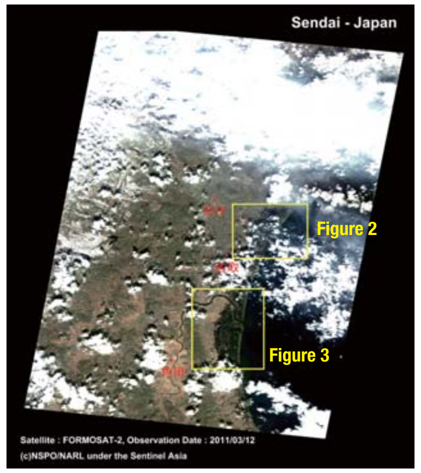


Figure 1: Sendai City and surrounding areas in Miyagi Prefecture. The areas inside the two yellow boxes are enlarged in Figures 2 and 3.

Following the Great East Japan Earthquake, Japan received approximately 5,000 satellite images taken by around 20 foreign satellites. These images were supplied through such international cooperation frameworks for dealing with disasters as the International Charter "Space and Major Disasters" and Sentinel Asia. JAXA provided satellite images to a wide range of agencies, including the Cabinet Office, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), the Ministry of Agriculture, Forestry and Fisheries (MAFF) and other government agencies with responsibilities in such areas as disaster-prevention, as well as regional and local government agencies.

The International Charter "Space and Major Disasters"

The International Charter "Space and Major Disasters" is an international cooperation framework for disaster response. As of July 31, 2011, the Charter had 15 members centering on the national space agencies of each country. At times of major disaster, each space agency provides data from their respective Earth observation satellites on a gratis basis. The Charter's objective is to contribute to the mitigation of crises arising from natural or technological disasters.

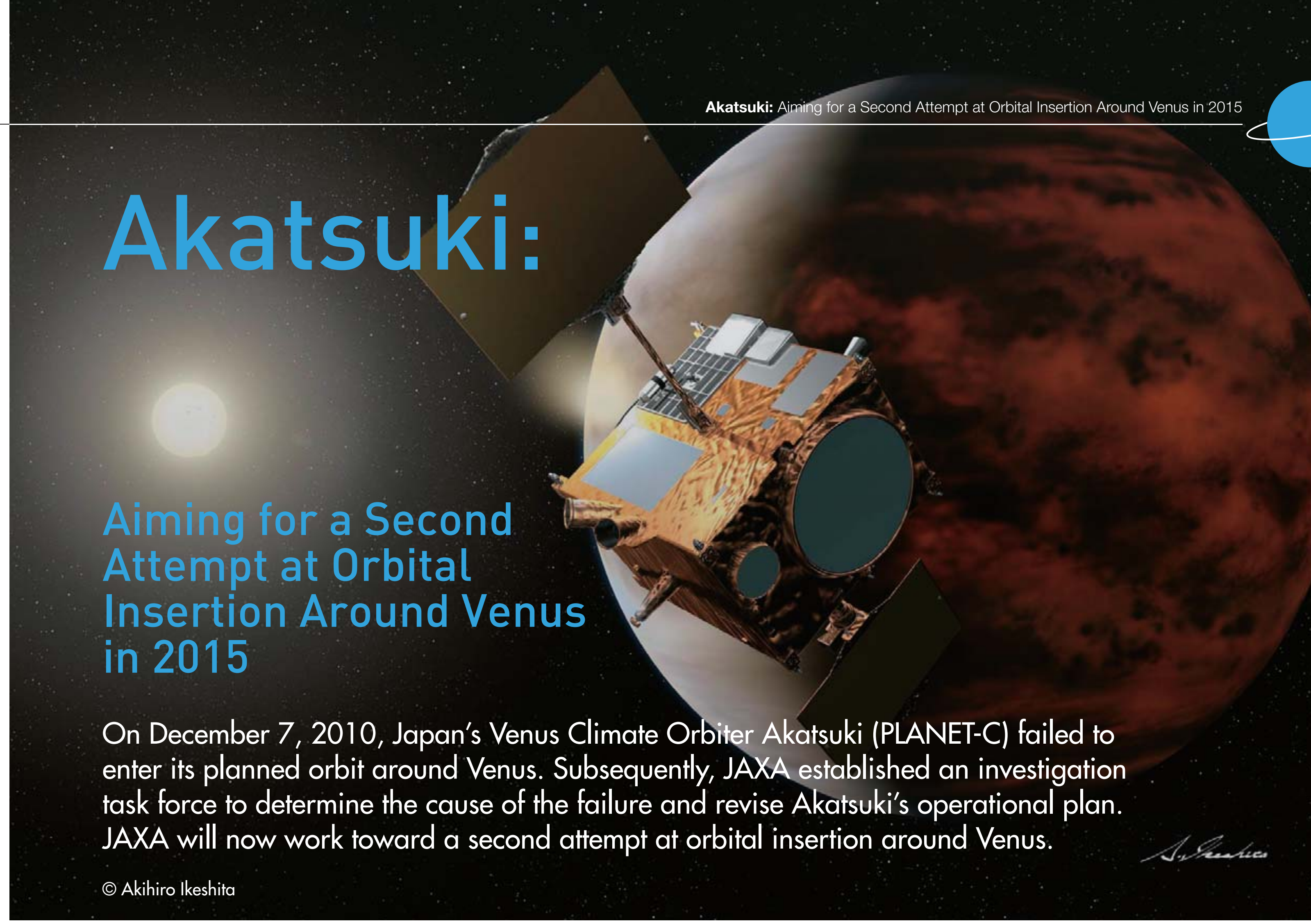
In response to the Great East Japan Earthquake, in addition to images supplied by ALOS, images provided by such satellites as Worldview-2 (United States), RADARSAT-2 (Canada), KOMPSAT-2 (South Korea), HJ (China), TerraSAR-X (Germany) and SPOT-5 (France) were utilized for such tasks as multidimensional assessment of tsunami-flooded areas and detailed analysis of specific areas. Central and local government agencies used this information to gain a better understanding of the damage situation.

Sentinel Asia

Sentinel Asia is an international cooperation initiative that developed out of a proposal by the Asia-Pacific Regional Space Agency Forum (APRSAF) with the objective of monitoring natural disasters in the Asia-Pacific region. As of July 31, 2011, Sentinel Asia participants comprised 66 organizations from 24 countries and regions, including space agencies, governmental agencies and universities, as well as 11 international organizations. Sentinel members share—via the Internet—disaster-related information acquired by Earth observation satellites and other means. The goal of these activities is to mitigate and prevent damage caused by natural disasters, including typhoons, floods, earthquakes, tsunamis, volcanic eruptions and forest fires. After the Great East Japan Earthquake, in addition to images supplied by ALOS, FORMOSAT-2 (Taiwan), THEOS (Thailand) and Cartosat-2 (India) were utilized to carry out observations in a narrow geographic range.

Figure 2: These images reveal the extent of flooding in Sendai City and Natori City. The left-hand image was taken on March 12, 2011, following the earthquake, while the right-hand image was taken on January 16, 2011, prior to the earthquake. The dark area that may be seen in the upper part of the left-hand image is flooding from the tsunami.

Figure 3: This image shows the flood situation in Iwanuma City and Watari Town. The dark area is flooding from the tsunami.



Akatsuki:

Aiming for a Second Attempt at Orbital Insertion Around Venus in 2015

On December 7, 2010, Japan's Venus Climate Orbiter Akatsuki (PLANET-C) failed to enter its planned orbit around Venus. Subsequently, JAXA established an investigation task force to determine the cause of the failure and revise Akatsuki's operational plan. JAXA will now work toward a second attempt at orbital insertion around Venus.

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Akatsuki was launched from the Tanegashima Space Center on May 21, 2010, on a mission to gather data on the Venusian atmosphere. The space probe was carried into space aboard the H-IIA launch vehicle No. 17.

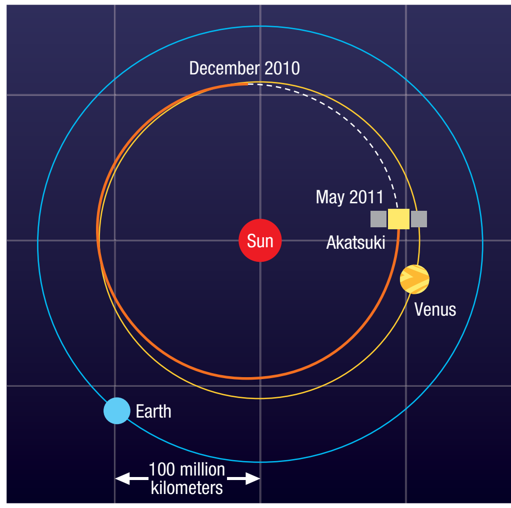
In December 2010, Akatsuki approached its rendezvous with Venus as planned. However, during the orbit injection maneuver an obstruction occurred in an engine check valve. This is likely to have caused damage to the thruster nozzle of the orbital maneuvering engine (OME), and led to the failure of the reverse thrust of the engine, which is necessary for the orbital insertion maneuver.

The check valve obstruction was probably caused by crystals inside the valve, which formed after a chemical reaction between the engine fuel and oxidizer. Although fuel and oxidizer are not meant to come into contact with each other prior to mixing in the OME thruster nozzle, for some reason oxidizer ran back up the pipe in a reverse flow from a check valve in the pipe, and appears to have come into contact with vaporized fuel.

Following the orbital insertion failure, JAXA had originally envisaged making a second attempt at placing Akatsuki into orbit around Venus in 2016. However, in July 2011 JAXA announced that it was studying the possibility of moving this schedule forward by one year. The reasons for considering this earlier schedule include the limited amount of remaining fuel and concerns over exposure to high temperatures during the spacecraft's unanticipated orbital course around the sun, which may lead to equipment deterioration (please refer to the accompanying diagram). While analyzing the status of Akatsuki's equipment from the ground, JAXA plans to conduct a test firing of the spacecraft's OME in September 2011.

Based on the results of these activities, JAXA will make a decision on whether or not to proceed with the early orbital insertion schedule.

If the earlier schedule is adopted, Akatsuki will undergo an orbital correction in November 2011 when it reaches perihelion—the point nearest to the sun—in its current orbit. Under this scenario, Akatsuki will once again approach Venus in November 2015, when a new attempt will be made to enter orbit around the planet.



At present, Akatsuki completes one orbit of the sun in approximately seven months. Although its onboard instruments are operating normally, Akatsuki's position is closer to the sun than was intended under its original plan for entering orbit around Venus. Consequently, there is concern that the spacecraft may suffer heat damage. For this reason, JAXA plans to investigate any effects of possible heat exposure.

JAXA's Frontier

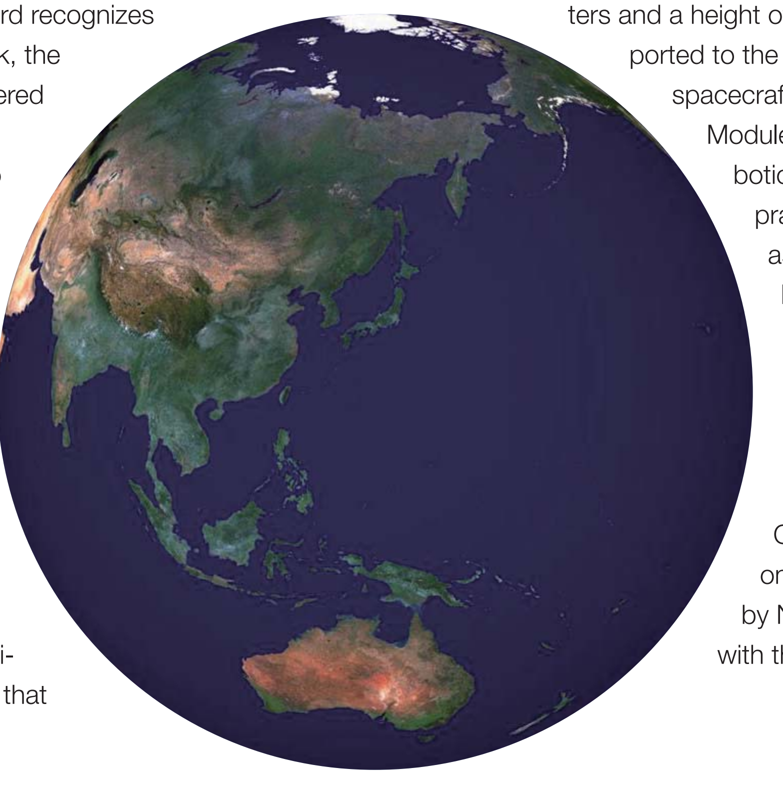
From left to right: Kuninori Uesugi, John Strickland (NSS Awards Committee Chair), Norimitsu Kamimori (Director of JAXA's Washington, D.C., Office), Jun'ichiro Kawaguchi, John Mankins (NSS) and Hiroki Matsuo

Kuninori Uesugi:
The previous Hayabusa project manager. He played a key role in the development of Japan's space exploration technology, which ultimately led to the Hayabusa project's success. His previous projects include the development of Japan's interplanetary space-flight technology during the Suisei (PLANET-A) probe to Halley's Comet, and verification of the swing-by space-navigation method during the Hiten (MUSES-A) lunar fly-by mission.

Hiroki Matsuo:
He has made a major contribution to Japan's rocket technology through such achievements as the M-V rocket. He has had a close involvement with the launches of many of Japan's space probes, including Hayabusa.

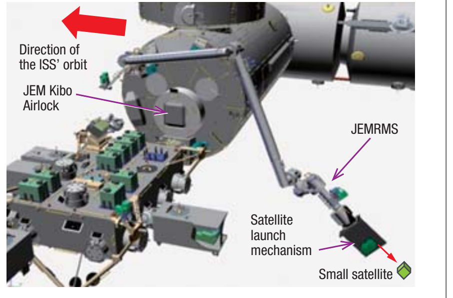
Hayabusa Project Team Receives Wernher von Braun Memorial Award

On May 20, 2011, the National Space Society (NSS) in the United States presented the Wernher von Braun Memorial Award to the Hayabusa project team at the 30th International Space Development Conference (ISDC), held at the von Braun Center in Huntsville, Alabama. The award recognizes "the first round trip to the surface of an asteroid and back, the first round trip to an extraterrestrial object using ion powered thrust, and the first return of asteroid samples from an asteroid's surface." Project manager Professor Jun'ichiro Kawaguchi commented, "This award is proof of the recognition Japan's space development and solar system exploration programs have received in the United States and around the world. Right now, Japan is dealing with a disaster of unprecedented scale and many people are being forced to overcome great hardships. I believe that this Wernher von Braun Memorial Award recognizes not only our achievements in the space development field but also shows the worldwide recognition of Japan's capabilities. I think one of the messages we can take from this is that we, the people of Japan, must apply ourselves with confidence and courage as we work toward a reconstruction that will take us toward an even higher level than before."



Three Small Satellites Chosen for Verification Mission of JEM Kibo's Satellite-Launch Function

JAXA plans to conduct a verification mission in 2012 of JEM Kibo's capability for launching small satellites from the ISS. The satellites to be released from the orbiting laboratory JEM Kibo have a length and width of up to 10 centimeters and a height of up to 30 centimeters. The satellites will be transported to the ISS inside a special case aboard the HTV resupply spacecraft, and inserted into orbit using Japanese Experiment Module Remote Manipulator (JEMRMS)—JEM Kibo's robotic arm. The plan aims not only to expand JEM Kibo's practical functions by utilizing its unique characteristics as a manned space facility, but also provide increased launch opportunities for small-satellite users in Japan and abroad. JAXA called for applications from institutions in Japan wishing to participate in the program, and the three successful proposals chosen for the verification mission were from Wakayama University, Fukuoka Institute of Technology and Meisei Electric Co., Ltd. The results of the selection were announced on May 25, 2011. An international experiment selected by NASA is also planned to be conducted in conjunction with the verification mission.



JEM Kibo's satellite-launch function

Hayabusa Officially Recognized by Guinness World Records

GUINNESS WORLD RECORDS

CERTIFICATE

On 13 June 2010 the unmanned spacecraft Hayabusa, built and operated by the Japanese space agency JAXA, landed on Earth with its precious cargo of tiny grains of material collected from the surface of the asteroid Itokawa. It was the first spacecraft to lift off from an asteroid. The sample return capsule contained around 1,500 tiny solid grains, most of which are from the asteroid Itokawa.

GUINNESS WORLD RECORDS LTD

Hayabusa's Guinness World Records Certificate

Japan's asteroid explorer Hayabusa has been officially certified by Guinness World Records as the world's first spacecraft to return to Earth with material collected from an asteroid. JAXA celebrated the first anniversary of Hayabusa's return to Earth on June 13, 2011. Hayabusa project manager Professor Jun'ichiro Kawaguchi commented, "I am extremely glad that Hayabusa has received this Guinness World Records certification because it provides an additional opportunity for the people of Japan to recognize the achievements of the Hayabusa project. I hope that this honor will serve to inspire Japanese young people and children to believe in their own ability to achieve great things if they apply themselves to a goal."

JAXA Certifies Three New ISS Onboard Astronauts

On July 25, 2011, JAXA certified three new ISS onboard astronauts. Two of the new astronauts, Kimiya Yui and Takuya Ohnishi, have been undergoing basic training necessary for certification as astronauts for the ISS for approximately two years, since April 2009. The third new astronaut, Norishige Kanai, commenced the same training in September 2009. Certification was granted to the new astronauts after their completion of all basic training requirements. The three will participate in further training to improve the knowledge and skills they will need as astronauts, principally at the Johnson Space Center (JSC) in Houston, Texas, but also in Japan and other countries.

From left to right: JAXA Astronauts Takuya Ohnishi, Kimiya Yui and Norishige Kanai attend a press conference to announce their certification as ISS onboard astronauts

The Earth Seen from Space

Tanegashima Island—

Such a Beautiful Place for a Rocket-Launch Site

Tanegashima is a small island that lies just off the southeast coast of the Kyushu mainland, at the northern end of an island chain that forms the boundary between the Pacific Ocean and the East China Sea. The island is administered as part of Kagoshima Prefecture, which is itself situated at the far southwest of the main Japanese archipelago. On this beautiful subtropical island is Japan's largest rocket-launch complex, Tanegashima Space Center. Since the complex opened in 1969, it has played a central role in the launches of a large number of satellites and space probes. Each of the four spacecraft introduced in this issue of JAXA TODAY—KOUNOTORI (HTV), MICHIBIKI (Quasi-Zenith Satellite-1), DAICHI (ALOS) and Akatsuki (Planet-C)—were launched from Tanegashima Space Center.

Photo taken by DAICHI (ALOS)/JAXA on July 25, 2007

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