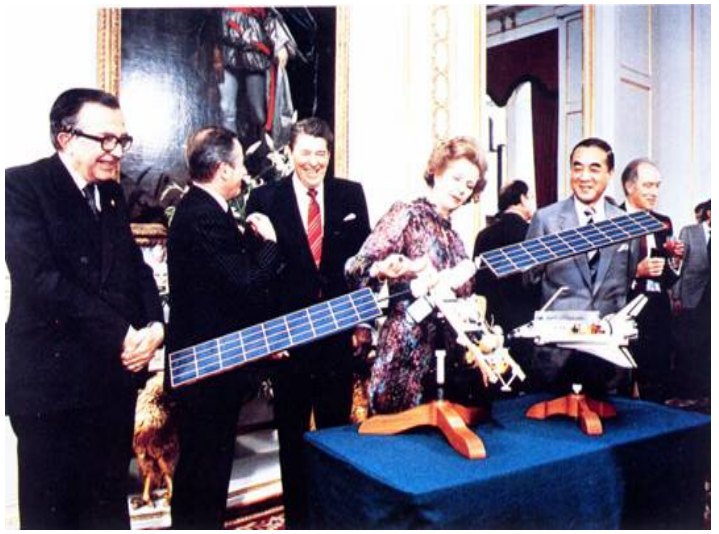
International Cooperation among ISS Partners and Japan's Contribution and Activities

13 June, 2012
Shigeki KAMIGAICHI,
Space Environment Utilization Center
JAXA

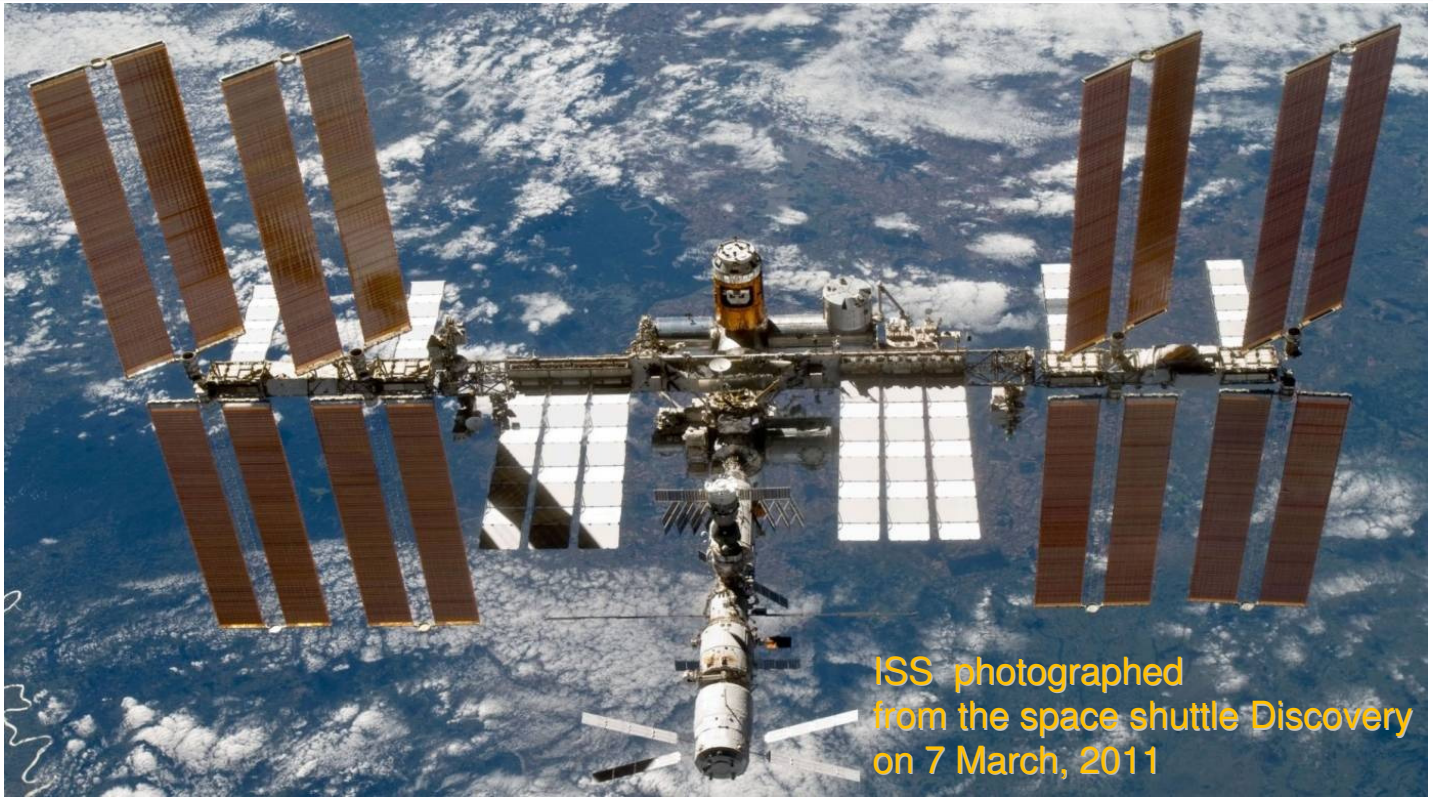
History of the International Space Station Program

- 1984: President Ronald Reagan was committed to the United States in developing a permanently-occupied space station and, along with NASA, invited other countries to join the program.
- 1988: Governments of Canada, ESA member countries, US and Japan signed the Intergovernmental Agreement (IGA) on the cooperation in designing, building, operating and utilizing the space station.
- 1993: Revised the plan as Russia joined the program
- 1998: Beginning of on-orbit station assembly
- 2000: Beginning of continuous stay of the astronauts
- 2011: Completion of station assembly
- Present: In the utilization phase



Photographed on 14, April, 2010

Profile of the International Space Station Program



- The largest space station ever built; the largest structure ever assembled in space; one of the most complex international projects in history.
- **The largest international program** in history, with the participation of **15 countries, for about 25 years**.
- Manned orbital facility for cutting-edge research and development, **only for peaceful purposes.**

Framework of the ISS Program (IGA/MOU)

ISS Program Heads of Agencies

(yr. 2010, Tokyo, Japan)

Intergovernmental Agreement (IGA)

Russia
Government of Russian Federation

Canada
Government of Canada

Europe
Government of participating nations

Japan
Government of Japan

U.S.A.
Government of the United States

Cooperating Agency:
FSA

Cooperating Agency:
CSA

Cooperating Agency:
ESA

Cooperating Agency:
NASA

Cooperating Agency:
MEXT

Supporting MEXT for execution of MOU etc.:
JAXA

Memorandum of Understanding

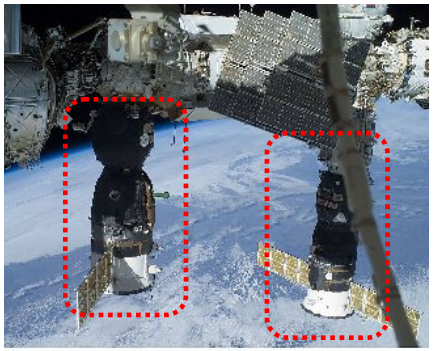
Participating nations of Europe (11 nations) :
Belgium, Denmark, Spain, France, Germany, Italy, Nether lands, Norway, Sweden, Switzer land, Britain

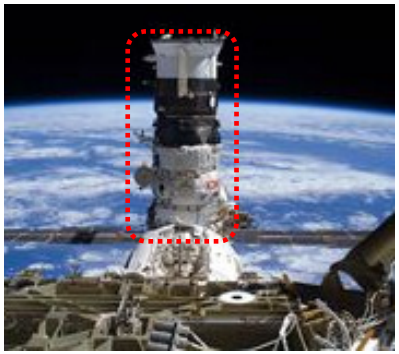
NASA : National Aeronautics and Space Administration
FSA : Russian Federal Space Agency
ESA : European Space Agency
CSA : Canadian Space Agency
MEXT : Ministry of Education, Culture, Sports, Science and Technology
JAXA : Japan Aerospace Exploration Agency

Contributions of each agency on the ISS

US (Space Shuttle, Dragon, etc.)

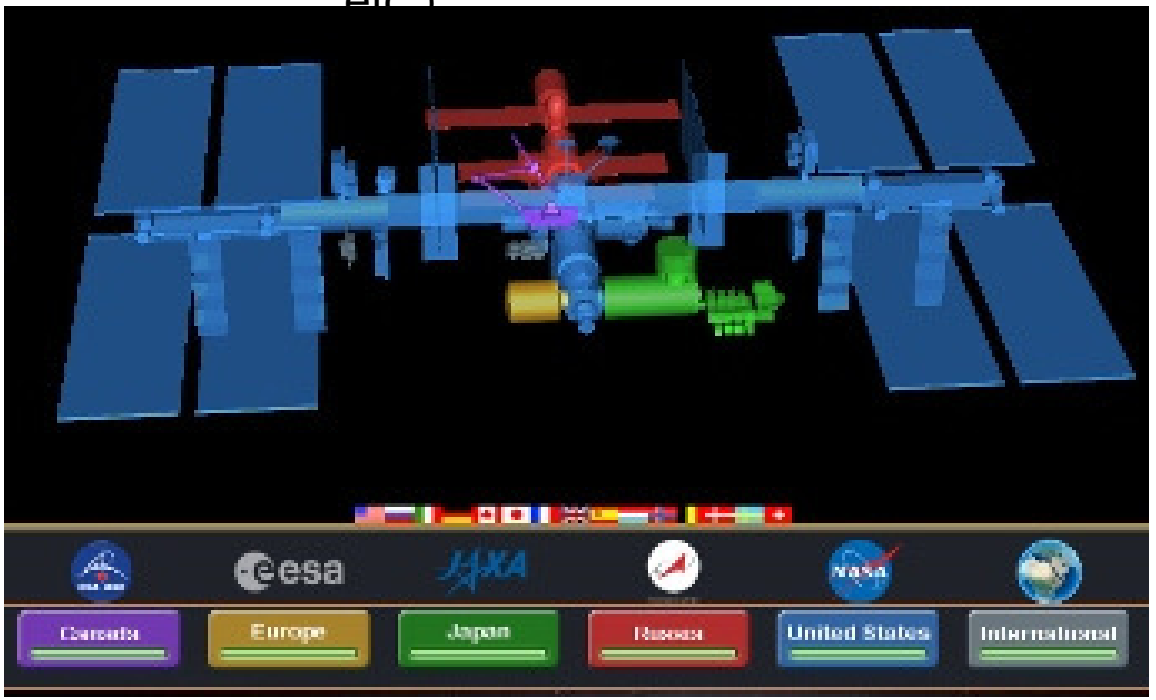
Europe (ATV, etc.)





Russia (Progress, Soyuz, etc.)

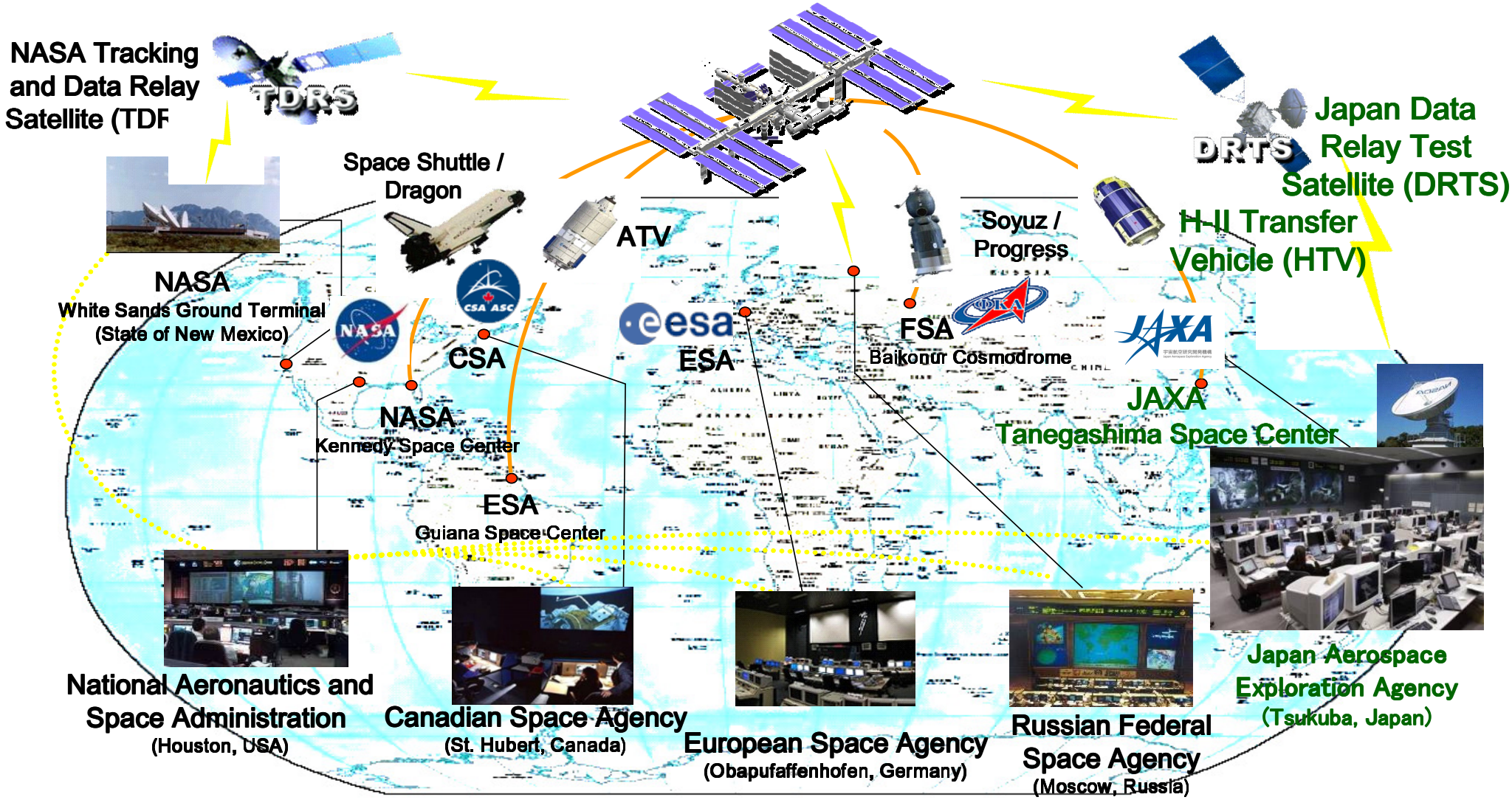
Canada
(Dexter, etc.)



from NASA's website.

Japan
(HTV, JEM, etc.)

Worldwide ISS Operations



Each of the space agencies operates their own ISS elements and space crafts from their own control centers.

Japan's Contribution to the ISS Program : Japanese Experiment Module "Kibo"

Pressurized Module

- The largest pressurized module on ISS
- 10 payload racks can be installed
- Various resources provided

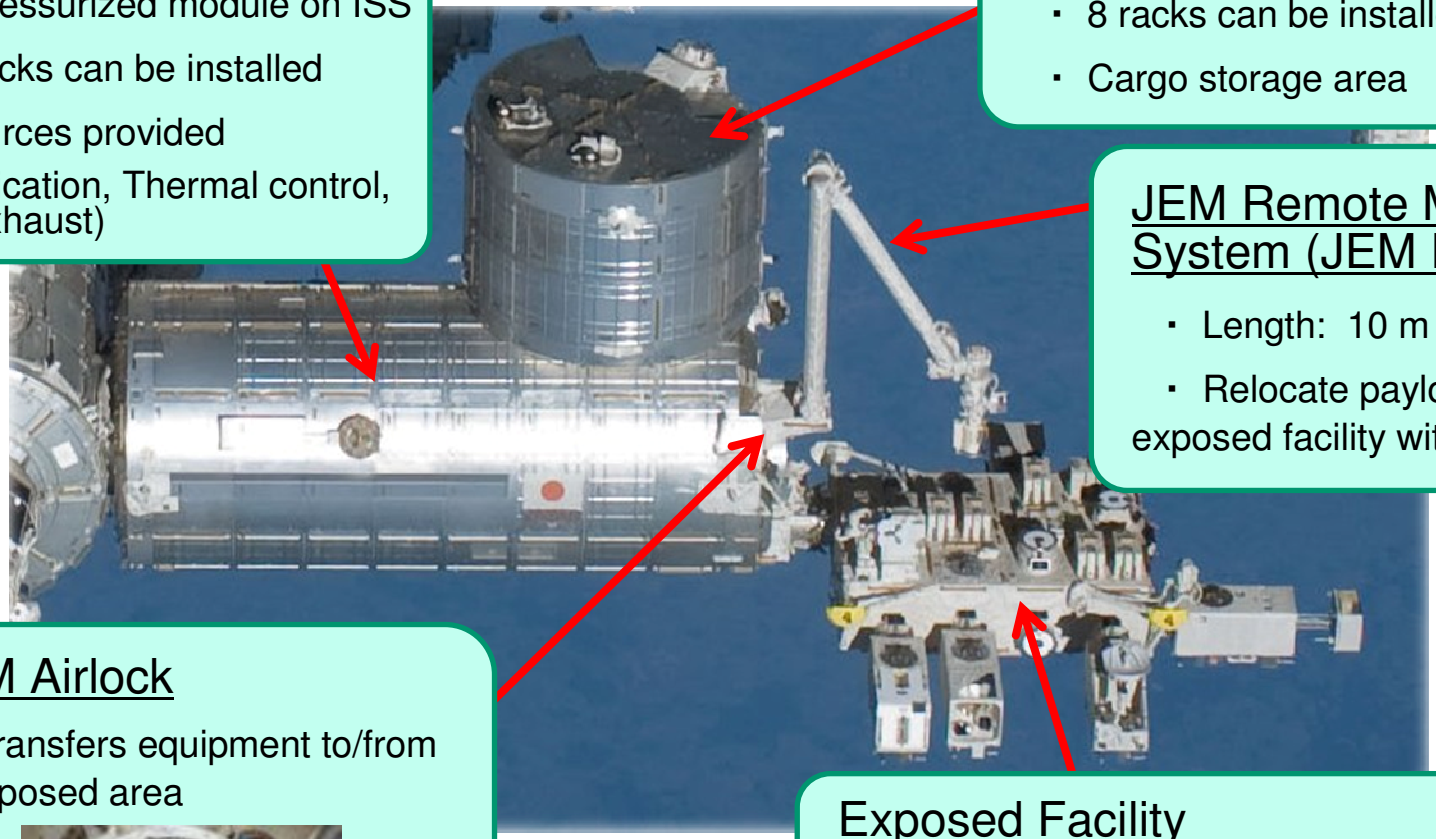
(Power, Communication, Thermal control, Gas supply and exhaust)

Experiment Logistic Module

- 8 racks can be installed
- Cargo storage area

JEM Remote Manipulator System (JEM RMS)

- Length: 10 m
- Relocate payloads on the exposed facility without EVA



JEM Airlock

- Transfers equipment to/from exposed area

Exposed Facility

- Only full-scale external experiment area on ISS
- 10 attachment ports for experiment payloads
- Various resources provided

(Power, Communication and Thermal control)

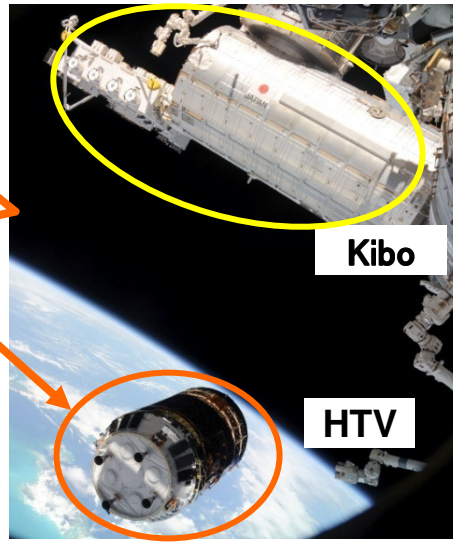
Japan's Contribution to the ISS Program : H-II Transfer Vehicle (HTV)

① The first Japanese unmanned supplying spaceship to the ISS

② An essential vehicle for the ISS operation after the Space Shuttle retirement in 2011; which is the sole transportation vehicle that can transfer large unpressurized cargo and pressurized experiment rack to the ISS.

③ Delivered total 6 tons of pressurized and unpressurized cargo to the ISS.

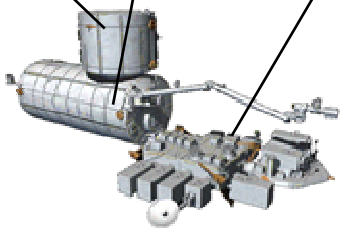
④ 7 HTVs launched in total (2 have been launched).



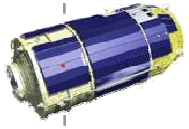
HTV Launch Schedule & JAXA Astronaut Activities

2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 ～

2008.3 2008.6 2009.7 JEM Assembly ɛtion



2009.9 2011.1 2012.7

HTV1 HTV2 HTV3 HTV4 HTV5 HTV6 HTV7

JEM Operation & Utilization

"Doi"
STS-123 Crew
(2008.3)

"Wakata"
Exp. 18,19,20 Crew
(2009.3～7)
First Japanese long duration stay on ISS

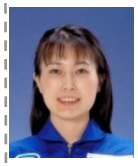
"Noguchi"
Exp. 22,23 Crew
(2009.12～2010.6)

"Furukawa"
Exp. 28,29 Crew
(2011.6 ～11)

"Hoshide"
Exp. 32,33 Crew
(2012.7～)

"Wakata"
Exp. 38,39 Crew

"Hoshide"
STS-124 Crew
(2008.6)



"Yamazaki"
STS-131 Crew
(2010.4)

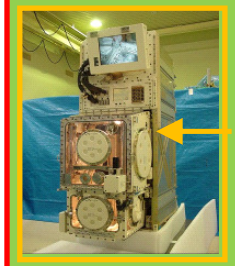
as the Commander of the ISS crew



"Yui" "Onishi" "Kanai"

Under training aiming at future ISS mission

SAIBO Rack



CB (Clean Bench)

CBEF (Cell Biology Experiment Facility)

High Definition TV System

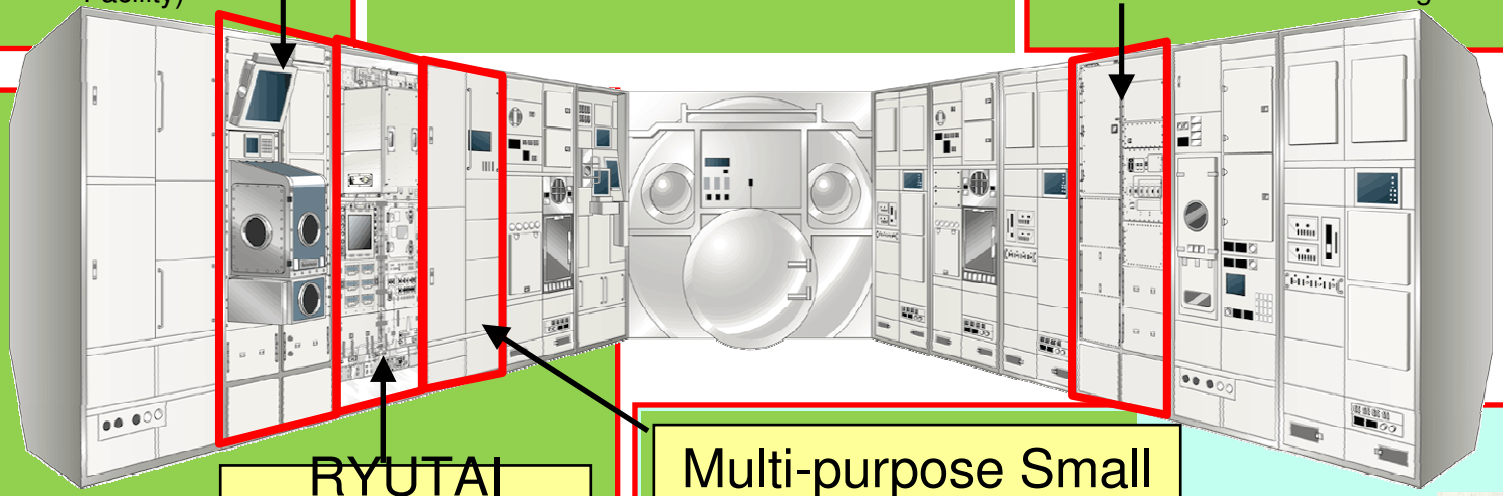
HDV CAM

Multi Protocol Converter

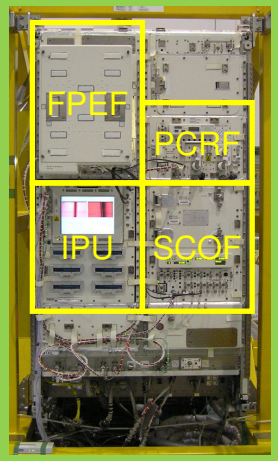
Super Sensitive HDV CAM

KOBAIRO Rack

GHF (Gradient Heating Furnace)

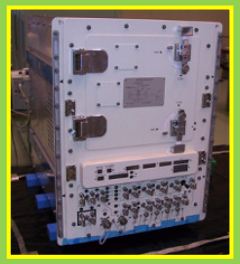


RYUTAI Rack



FPEF (Fluid Physics Experiment Facility)

IPU (Image Processing Unit)



SCOF (Solution Crystallization Observation Facility)

PCRF (Protein Crystallization Research Facility)

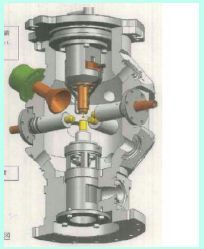
Multi-purpose Small Payload Rack

MSPR

CCE (Chamber for Combustion Experiment)

AQH (AQuatic Habitat)

to be operational from 2012



ELF (Electrostatic Levitation Furnace)

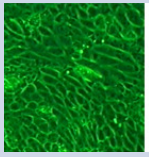
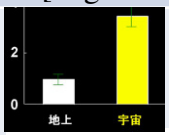
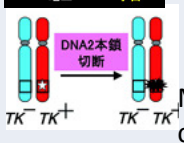
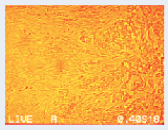
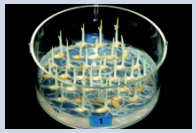
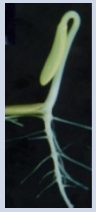
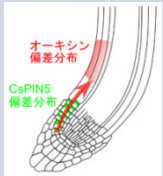
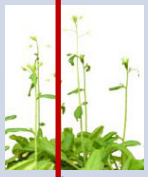
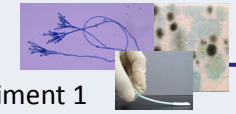
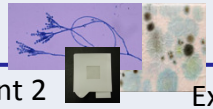
to be operational from 2014

Status of Life Science Experiments on Kibo

Life science experiments on Kibo began (in Feb. 2009).

Present

Conducting proposed themes and fixing plans based on Kibo utilization scenario

Year	2009	2010	2011	2012	2013 -
Cell & Life	 Frog kidney cell (dome formation) [Asashima]  Nematode (RNA interference) [Higashitani]	 Muscle atrophy (ubiquitin) [Nikawa]  Goldfish scale (bone metabolism) [Suzuki]		 Medaka bone metabolism [Kudo]	Cells: gravity response,muscle atrophy, bone marrow cell: osteogenesis Nematodes: gene effects through aging and alternation of generations in space Aquatic organisms: effects across generations (breeding across 3 generations), muscle atrophy, reproductive function, and stress evaluation
Technology for measuring the effects of radiation	 Human cell p53 influence [Ohnishi] Silkworm egg [Furusawa]  Mutant human cell [Yatagai]   Nerve cell (Mitochondria apoptosis) [Majima]		  Mouse's frozen and dried sperm [Wakayama] Frozen ES cells [Morita]	Effects on life by long-term radiation exposure (max. 3 years), evaluation of effects on reproduction, growth and multiple generations Development of real-time radiation measuring technology
Plants	Arabidopsis thaliana cultivated (long term till 60th day) [Kamisaka] 	 Oryza sativa cell wall (ferulic acid) [Wakabayashi]  Root hydro-tropism (auxin) [Takahashi]	 Auxin dynamics [Takahashi]	 Plant's gravity response system [Hoson]	Systems of graviperception and posture control Effective plant production, utilization technology, and life support
Microorganism	 Experiment 1	Monitoring microorganism in the Kibo module [Makimura & Nasu]	 Experiment 2	 Experiment 3	In-orbit analysis and adaptation to monitoring and environment

Status of Space Medicine Research on Kibo

Health Monitoring System

Study on bone loss prevention with bisphosphonate

- Prevent bone loss and urinary calculi.
- Analyze live body rhythm.
- Analyze effects of space radiation.
- Monitor hair and fungi.
- Health monitoring system

Phase 1 (2008-2011): Completed

Initial Utilization of JEM:
Verify KIBO's utility

Artificial Gravity

- Measures for muscle atrophy and artificial gravity
- Adjustment of dynamic changes of cerebral circulation
- Adjustment of vestibular and blood pressure reactions
- Identification of lives of microbes and analysis of contamination
- Biological studies using killifish

Phase 2 (2012-2015): Being considered

Medium-term utilization of JEM: High-level achievements from research, reducing risks, and identifying mechanisms

Verification of biological mechanisms in model living organisms

- Preparation for future space exploration.
- Space medicine supporting Japanese human space activities
- Identify adaptability of living organisms to space environment

Phase 3: Being considered

Late ISS utilization: Sophisticated research and preparation for future space activities

Status of Materials Science Experiments on Kibo

Start of materials science experiments on KIBO（Aug. 2008）

Present

To be scheduled

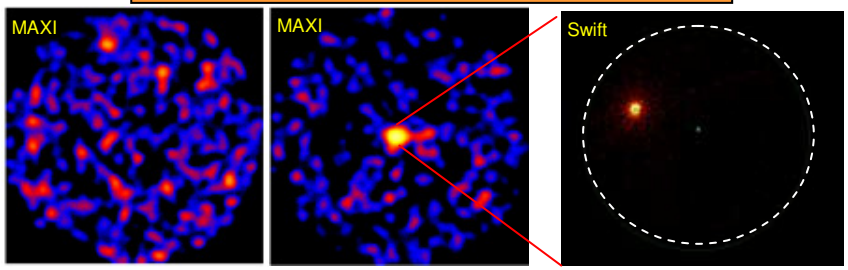
年	2008	2009	2010	2011	2012	2013 -
Fluid	1st series	2nd series	1st series / 2nd series / 3rd series	4th series	5th series	Atomization Theory verification Exp. [Umemura]; Boiling/Two Phase Flow Exp.[Ohta]
Com-bustion				Droplet Combustion Exp.[Mikami]		Gaseous Combustion Exp. [Maruta]; Solid Combustion Exp. [Fujita]
Crystal Growth	Ice Exp.[Furukawa]	Solidification/Crystallization Exp.. [Inatomi]			Protein Crystal Observation Exp. [Tsukamoto]; Single Crystal Semiconductor Exp. [Kinoshita]	Antifreeze Protein Crystal Observation Exp. [Furukawa]; Semiconductor Growth Exp.[Inatomi]; Electrostatic Levitation Furnace [TBD]
Soft matter	Protein Crystallization Exp.	Nano-skelton Exp.[Abe]	Nano-template Exp.[Kinoshita]			Colloid Crystal Observation Exp. [Sogami]
Funda-mental physics			Plasma Exp. in collaboration with DLR (Germany)			

Status of Observation through Exposed Payloads on Kibo

24-Hour Monitoring of Space and the Earth with Various 'Eyes'

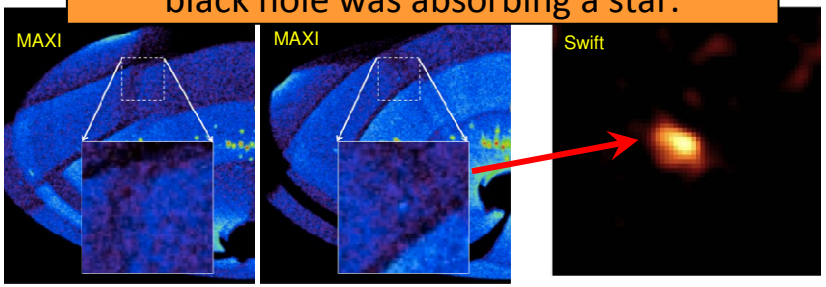
MAXI

Discovery of new X-ray stars



New X-ray star of Columba (MAXI J0556-332) Jan. 11, 2011

Observation of the moment when a huge black hole was absorbing a star.

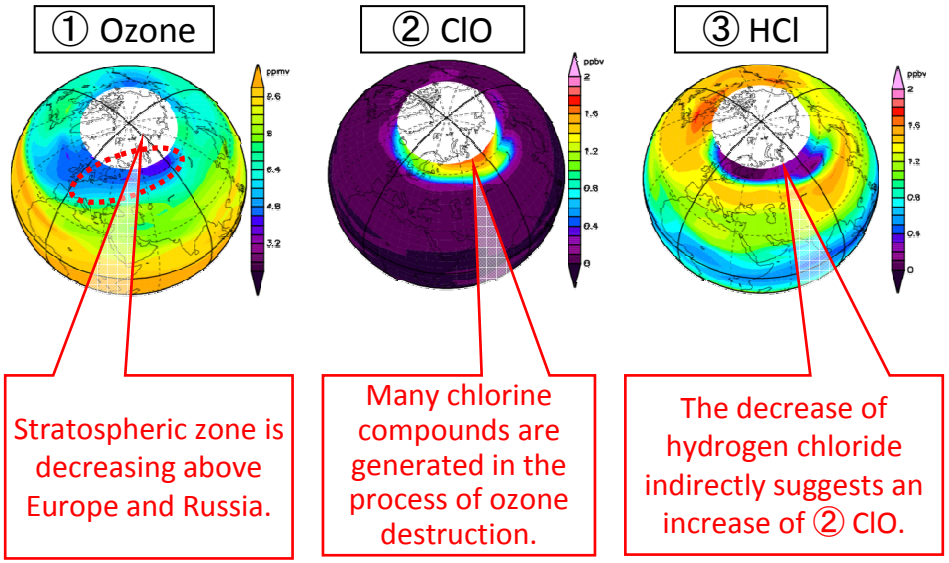


Discovered at a X-ray heavenly body in the Draco direction
(Appeared in the British science journal *Nature* on Aug. 25, 2011.)

JAXA/RIKEN/MAXI Team

SMILES

Simultaneous observation with high precision of consistent atmospheric traces (nearly 10 kinds including ozone (O3))



- Eight new X-ray stars have been discovered for 34 months since the beginning of its observation (Before MAXI, about one was discovered a year.)
- Cooperating with the U.S. satellite (Swift), Kibo had been observing new discoveries regarding a black hole. The related thesis was introduced in the "*Nature*".

- Japan has studied ozone destruction phenomena from various aspects by utilizing the world's highest standard of performance provided by Kibo.
- Further improvement of estimate precision is being targeted.

Cooperation in Asia through APRSAF

(APRSAF: Asia-Pacific Regional Space Agency Forum)

Bilateral Cooperation

ANGKASA (Malaysia) has been using a facility in Kibo (PCRF: Protein Crystallization Research Facility) 5 times in its protein crystallization experiments.

Malaysia

Protein Crystallization experiments in Kibo are implemented through the cooperation between JAXA and FSA(Russia)

KARI (Rep. of Korea) and JAXA have conducted a feasibility study toward a collaborative mission in Kibo, 2011. Further consideration is ongoing.

Rep. of Korea

LAPAN (Indonesia) and JAXA are working together on a feasibility study toward a collaborative mission in Kibo.

Indonesia

Cooperation in Asia through APRSAF

(APRSAF: Asia-Pacific Regional Space Agency Forum)

Space Seed for Asian Future 2010

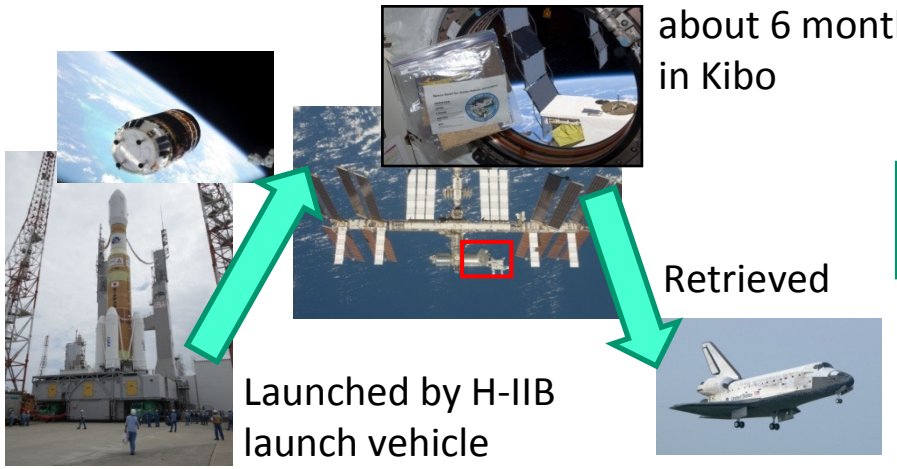
- Asian countries'(Indonesia, Malaysia, Thailand, Vietnam and Japan) collaborative mission was successfully performed.
- Seeds were retrieved to the Earth and returned to each countries July 2011.
- These seeds are being used for research and educational activity in each countries


Indonesia


Malaysia


Thailand


Vietnam



Returned and distributed


Vietnam


Malaysia


Indonesia


Thailand

Cooperation in Asia through APRSAF

(APRSAF: Asia-Pacific Regional Space Agency Forum)

Parabolic Flight Micro-G Experiment for students

- 5 Parabolic Flight Micro-G experiments for Asian students have been carried out since 2006.
- Students from Malaysia and Thailand have participated in this program.
- This program encourages students to study Micro-G science and promotes space environment utilization among young generations in Asia.
- Next flight is scheduled this December.

Micro-G experiment March, 2012


Malaysia


Thailand


Meeting before the flight


Micro-G experiment on the Airplane

Cooperation in Asia through APRSAF

(APRSAF: Asia-Pacific Regional Space Agency Forum)

Communication with Japanese Astronaut

Real-time communication between Fijian students and Astronaut Furukawa in Kibo was conducted October, 2011.

Fiji

Try Zero-G in Kibo

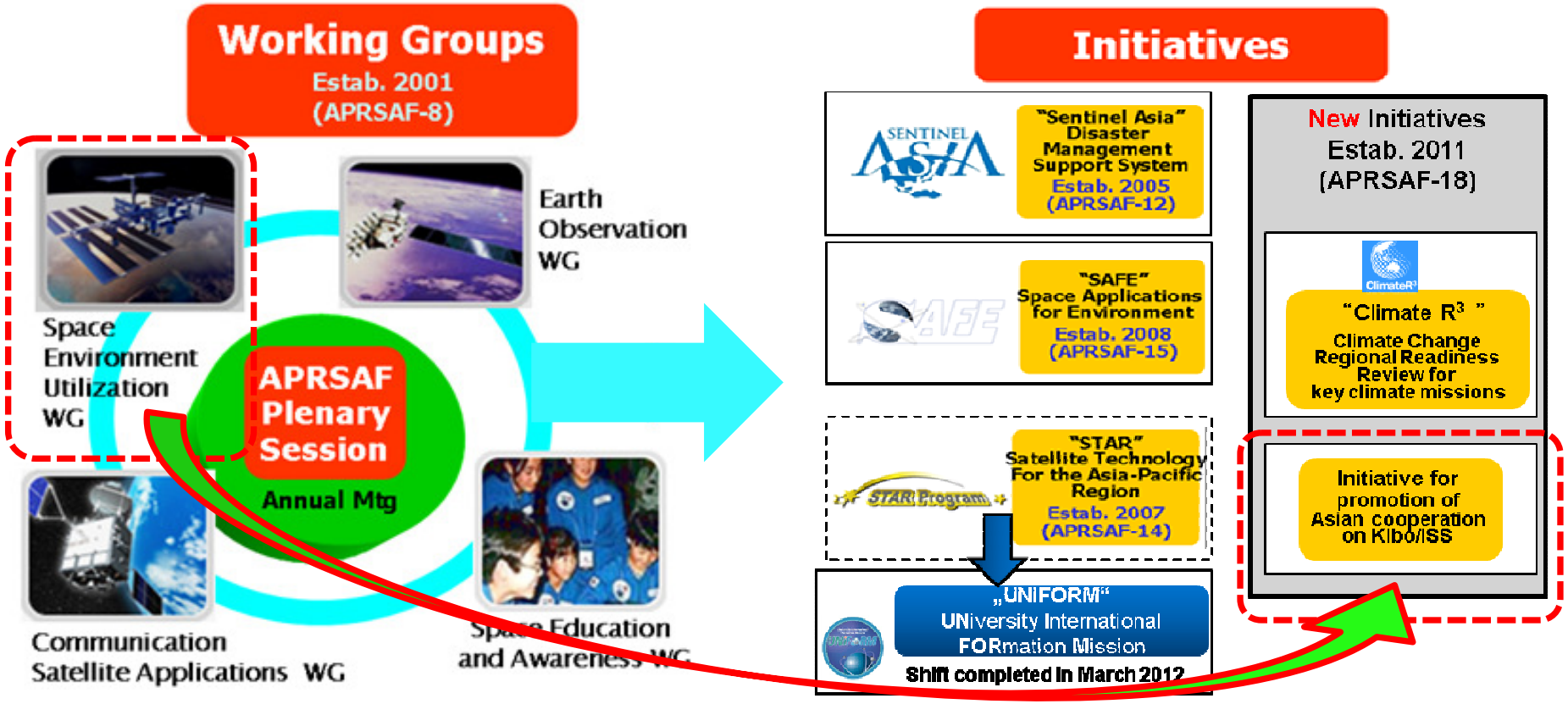
- Scientific questions proposed by children in Asia-Pacific region(Australia, Bangladesh and Malaysia) were answered by Astronaut Furukawa's experimental demonstrations(Try Zero-G program) in Kibo September, 2011.
- Next Try Zero-G is scheduled in this Summer during Astronaut Hoshide's long duration stay in the ISS.

Australia

Malaysia

Bangladesh

Cooperation in Asia through New Initiative on Kibo Utilization



- Space Environment Utilization WG agreed to launch a new initiative at APRSAF-18
- Objective of this Initiative:
  - to share the significances and values which Kibo/ISS will bring to the human beings.
  - to promote the establishment of Kibo utilization cooperation projects in Asia-Pacific region.

Thank you
for your attention!