JAXA's Achievements and Future Scenario for Space Exploration

Mar. 10, 2016

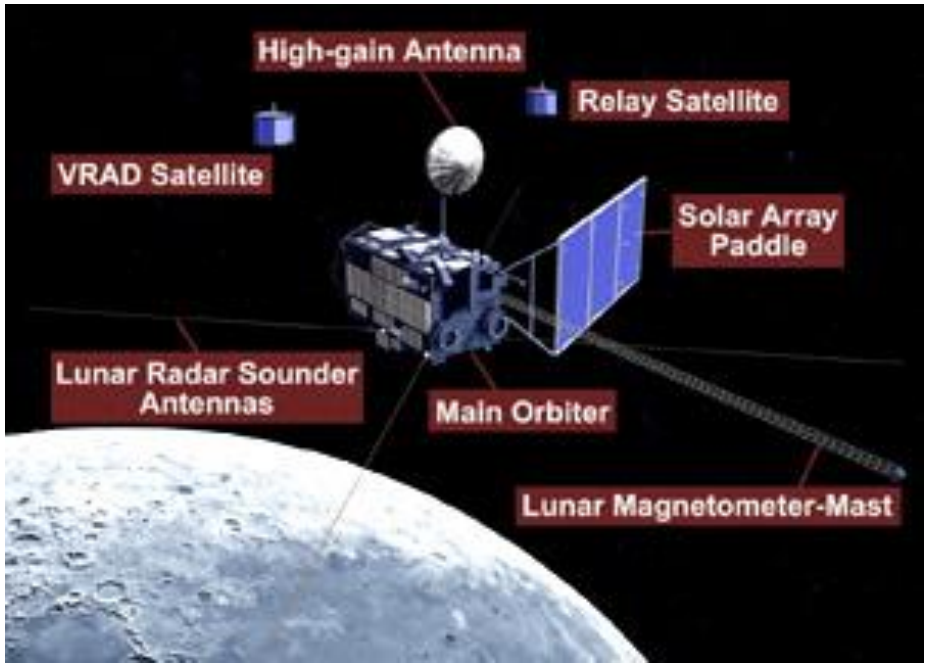
International Space Exploration Promotion Team
JAXA

JAXA's Recent Achievements for Space Exploration

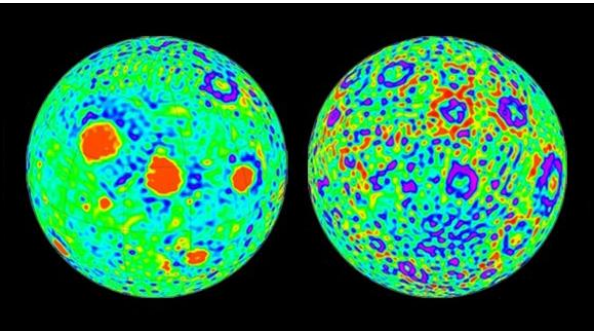
SELENE (KAGUYA)

Mission Profile:

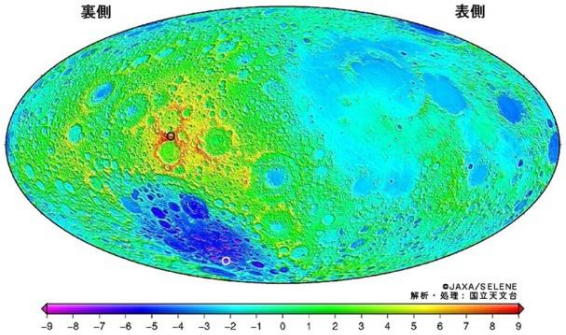
Launch: Sep. 2007
LOI to 100km: Oct. 2007
Landing (Hard): Jun. 2009



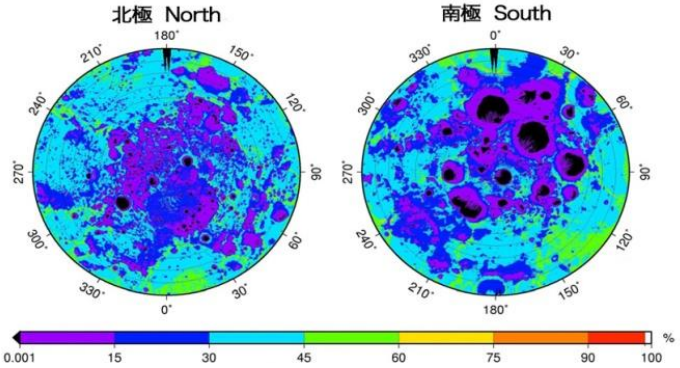
High Definition TV image



Global gravity distribution



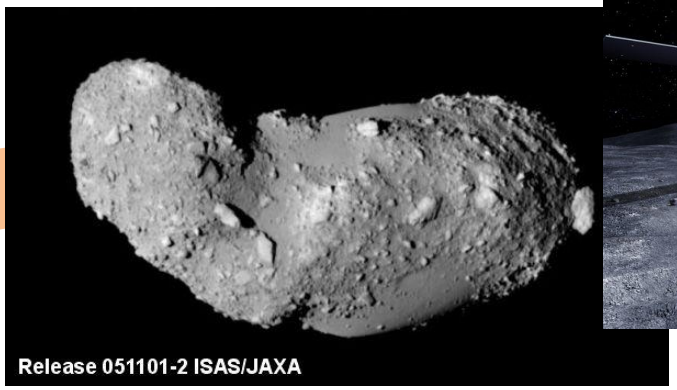
Global terrain map

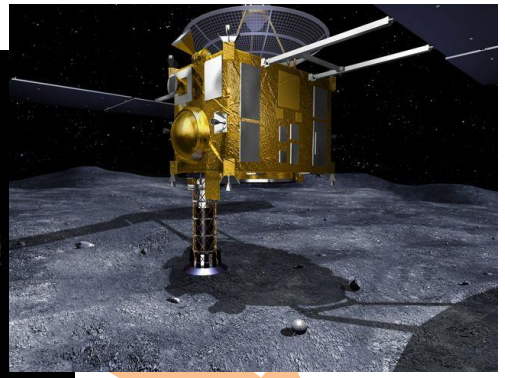


Global illumination map

HAYABUSA

- World 1st Sample Return from Asteroid -





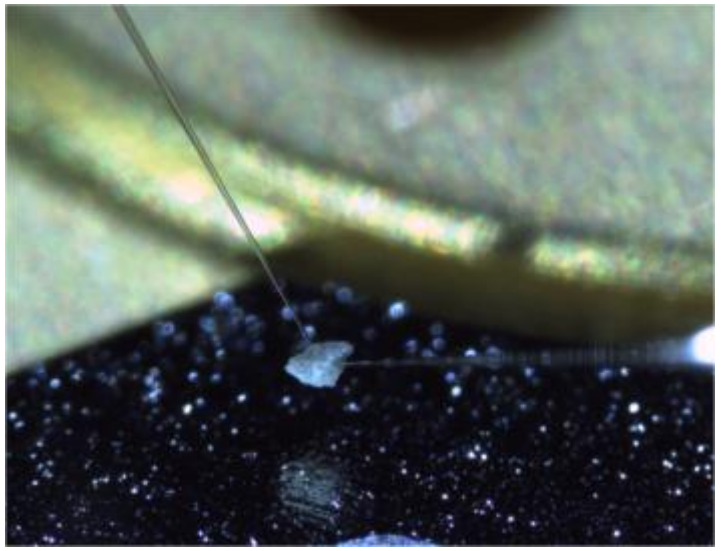
Arrival in 2005

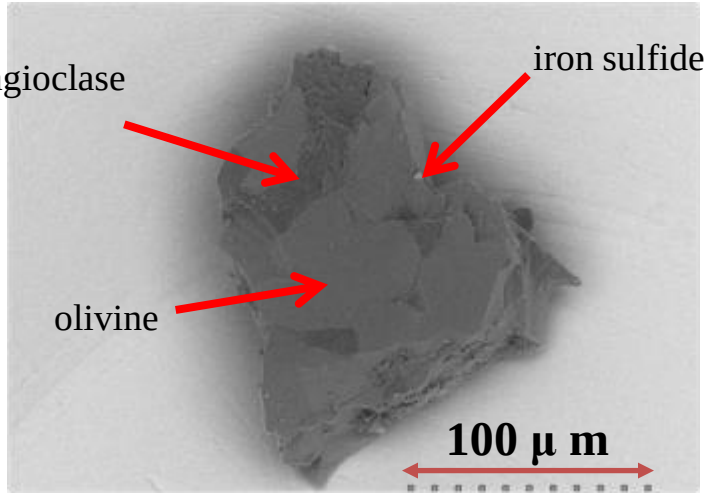
Launch in 2003

Return to Earth in 2010

HAYABUSA
- Current status of curation activity -

- Samples were collected by a special spatula in the Curation Facility in Sagamihara.
- Scanning Electron Microscope (SEM) observations and analyses (up to Nov. 2010)





- About 1,500 grains were identified as rocky particles.
- Most of them were judged to be of extraterrestrial origin (Asteroid Itokawa).

HAYABUSA 2

Launch

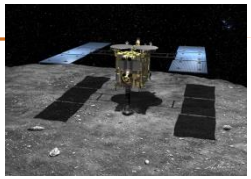
03 Dec. 2014

03 Dec. 2015

Earth swing-by

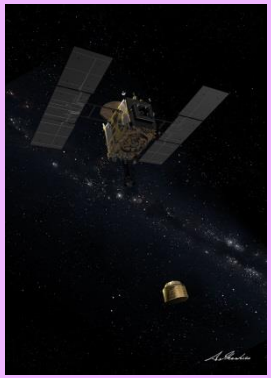
Arrival at Ryugu

June-July 2018



The spacecraft observes the asteroid, releases the small rovers and the lander, and executes multiple samplings.

2019



New Experiment

The impactor collides to the surface of the asteroid.

The sample will be obtained from the newly created crater.

Earth Return

Nov.-Dec. 2020

Nov.-Dec. 2019 : Departure

Sample analysis

(162173) Ryugu

Size : 900 m

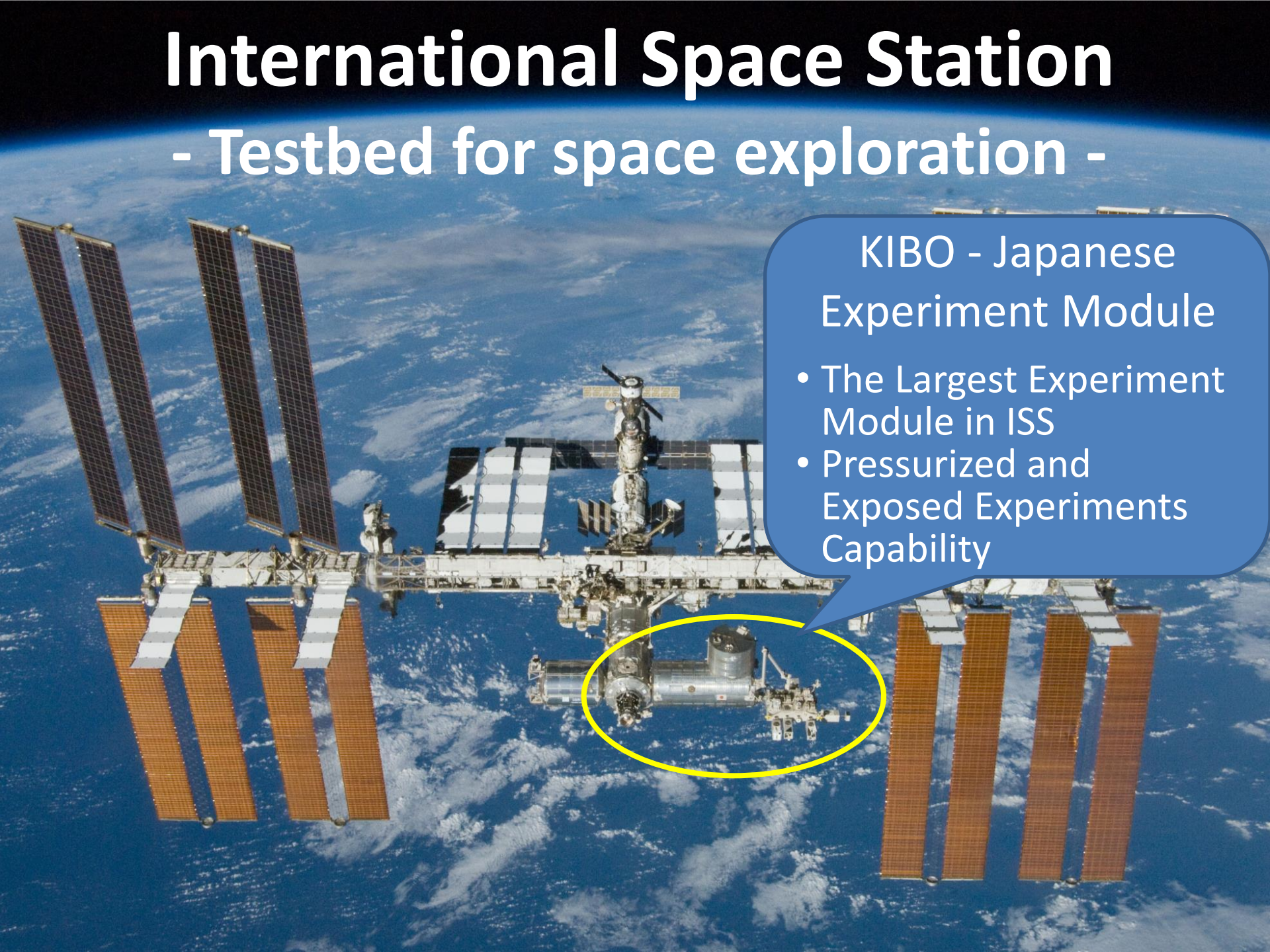
Rotation period: 7.6 h

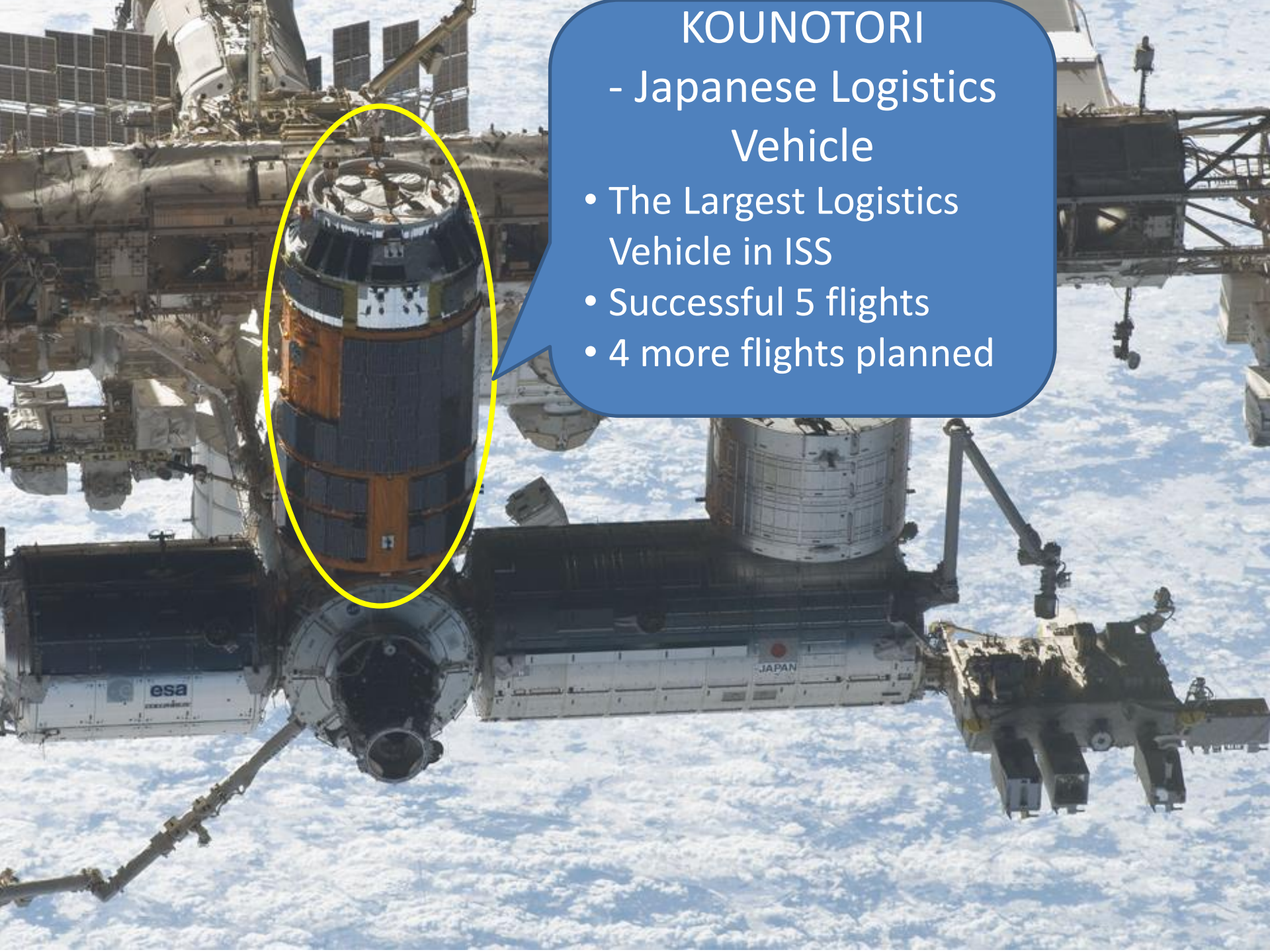
Albedo : 0.05

Type : C

International Space Station

- Testbed for space exploration -




KOUNOTORI
- Japanese Logistics Vehicle
• The Largest Logistics Vehicle in ISS
• Successful 5 flights
• 4 more flights planned
esa
JAPAN

Japan's ISS Flight Overview

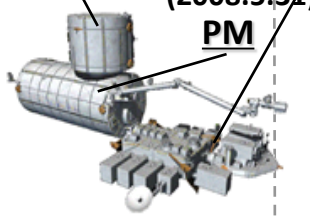
2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017～20 | 2021～

Kibo Assembly

1st launch (2008.3.11) ELM-PS

2nd launch (2008.5.31) PM

3rd launch (2009.7.15) EF



HTV1 2009.9.11

HTV2 2011.1.22

HTV3 2012.7.21

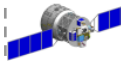
HTV4 2013.8.4

HTV5 2015.8.16

HTV6 (TBD)

HTV7、8、9

HTV-X1



HTV Flights (Since 2009 to Estimated 2020)

Kibo Utilization and Operation

"Doi" (1J/A) (Nov. 1997)

"Hoshide" (1J) (June 2008)

"Wakata" (2J/A) (Mar. 2009 ～July 2009)

"Noguchi" (Ex.22/23) (Dec. 2009 ～June 2010)

"Furukawa" (Ex.28/29) (June 2011 ～Nov. 2011)

"Hoshide" (Ex. 32,33) July 2012 ～Nov. 2012)

"Wakata" (Ex.38/39) Nov. 2013 ～May 2014)

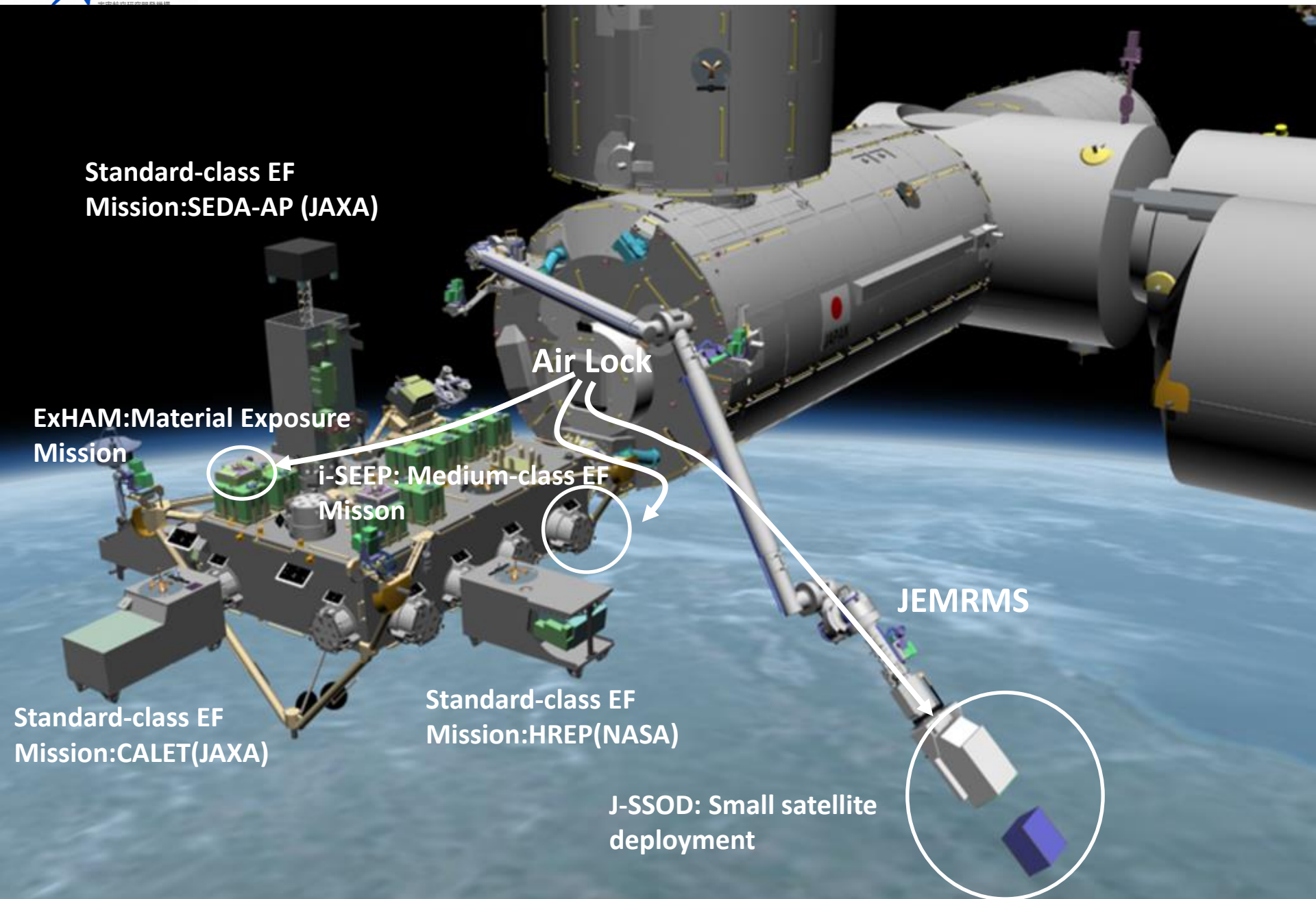
"Yui" (Ex.44/45) (July 2015 ～Dec. 2015)

"Onishi" (Ex.48/49) (June 2016～)

"Kanai" (Ex.54/55) (Nov. 2017～)

"Yamazaki" STS-131 (Apr. 2010)

JEMRMS's Work on the ISS

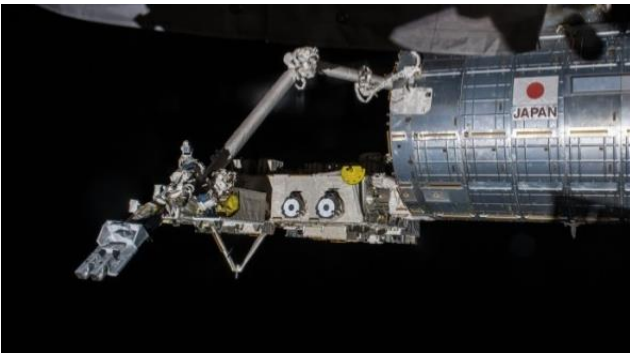


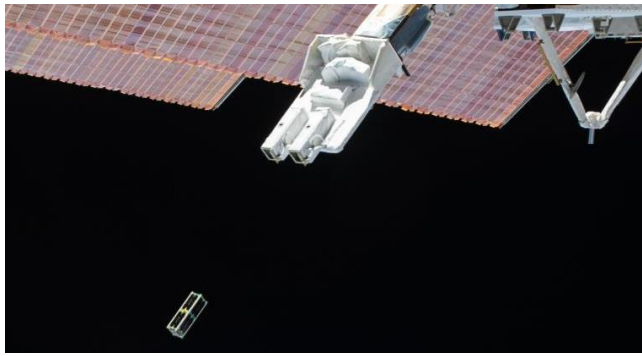
UNOOSA-JAXA Cooperation

KiboCUBE

Collaboration between UNOOSA and JAXA to offer small satellite deployment opportunities from Kibo in order to facilitate improvement of space technologies in developing countries.
(CubeSat (1U)/ once a year from 2017-2019)

Applications Deadline: 31 March 2016 Contact: hsti-kibocube@unoosa.org





UNITED NATIONS
Office for Outer Space Affairs

Japan Aerospace Exploration Agency

Future Scenario

These are the current status of technical study at JAXA as a reference.

Habitation Goals

Lunar Vicinity Mission (＜15 years)

Demonstrate the long travel to Mars in deep space

Stay(0G)： Crew of 4, 300 days

Human Mars Exploration (25 years later)

Just for technical reference derived from ISECG

LEO

Stay(0G): Crew of 6, Permanent

Technology demonstration for space exploration

Human Lunar Exploration(15 years alter)

Demonstrate habitation capability and surface exploration at low gravity for human Mars mission

Stay(1/6G)： Crew of 4, 500 days

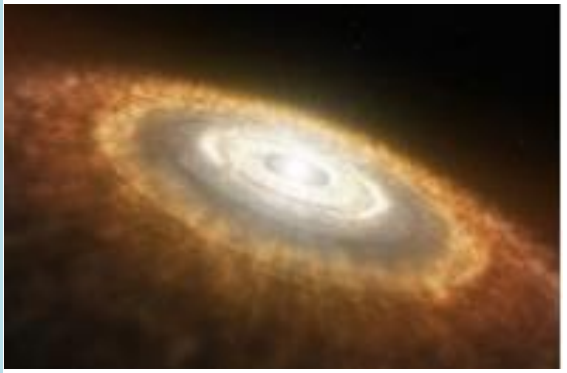
Utilization：Demo of Fuel Production

These are the current status of technical study at JAXA as a reference.

Science Goals

Goals for Solar System Science

- Understand how the terrestrial bodies of solar system were formulated
- Understand how the environment of solar system enable the evolution, and produce the life
- Understand its universality and particularity



Science Goals related the Moon

- Understand the solar system evolution
  - Understand chemical stratification of the crust, mantle, and core
  - Discover the sample from the Earth in Hadeon eon
  - Understand diversity and age of igneous activity
  - Understand of the origin of water and volatiles at the poles
- Establishment of crater chronology

These are the current status of technical study at JAXA as a reference.

Science Roadmap (Moon)
- on-going discussion -

Science Goals

- Understand the solar system evolution
  - Understand chemical stratification of the crust, mantle, and core
  - Discover the sample from the Earth in Hadean eon
  - Understand diversity and age of igneous activity
  - Understand of the origin of water and volatiles at the poles
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Science Roadmap

In-situ analysis	Sample Return	Human Exploration
In-situ geological analysis of crust	Geological analysis of the sample from Mantle (SPA)	Core observation using seismometer
		Search the sample from the Earth in Hadean eon
	Dating of the sample from the youngest lava flow area	Dating of the sample from various igneous area
In-situ isotope analysis of water and volatiles		
Dating of the sample of young crater	Dating of the sample of old crater around 3.9Ga	Dating of the sample of various 3.9 Ga area

These are the current status of technical study at JAXA as a reference.

Knowledge Gap and Criticality for Habitation

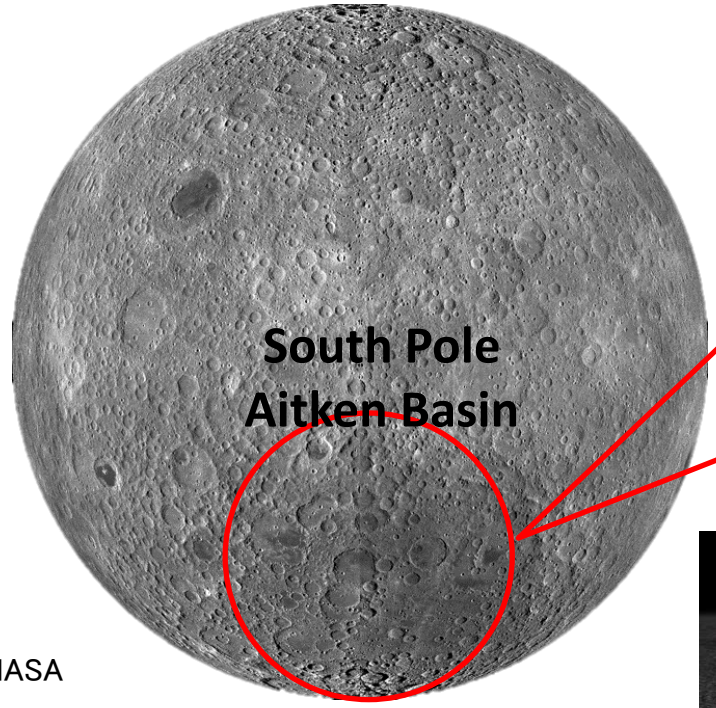
Knowledge To be obtained	Knowledge gap (Activities to do)	Criticality			
		Safety	Impact to Architecture	Urgency	Total
Water distribution	In-situ measurement of distribution				
Radiation	Flux data along LET per solar activity				
Safety of regolith	Animal testing by actual regolith				
Terra mechanics data of regolith	In-situ measurement of regolith and terra mechanics model construction using actual traction data				
Contamination of regolith	In-situ measurement of floating regolith by electric field				
Terrain data	None				
Temperature	In-situ continuous measurement at the site				
Sunlit	None				
Plasma	In-situ measurement at the site				
Micrometeoroid	In-situ measurement of micrometeoroid				
Gravity	None				

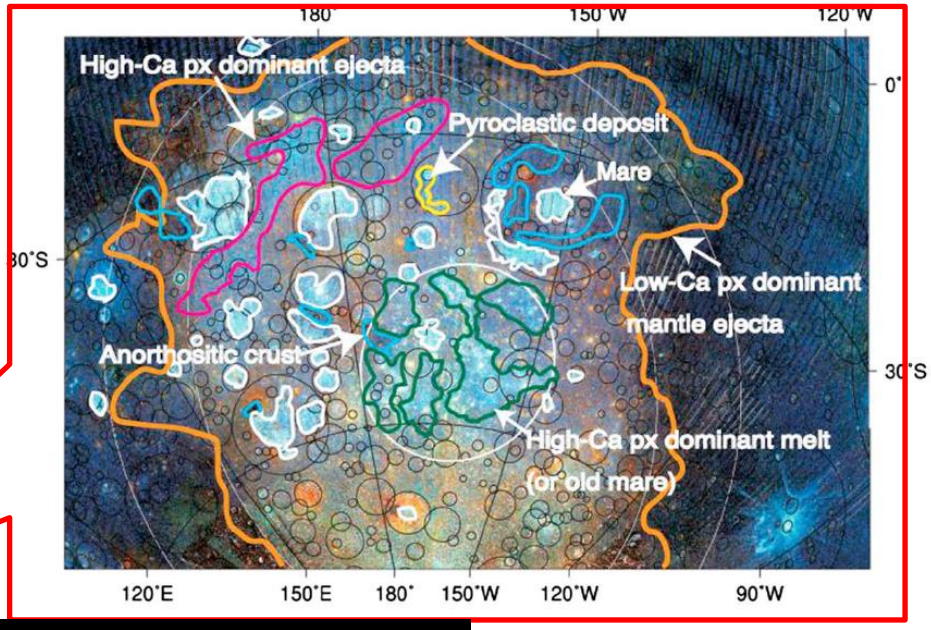
Criticality Low Mid High

These are the current status of technical study at JAXA as a reference.

Example of Human Geological Exploration

Far Side of the Moon



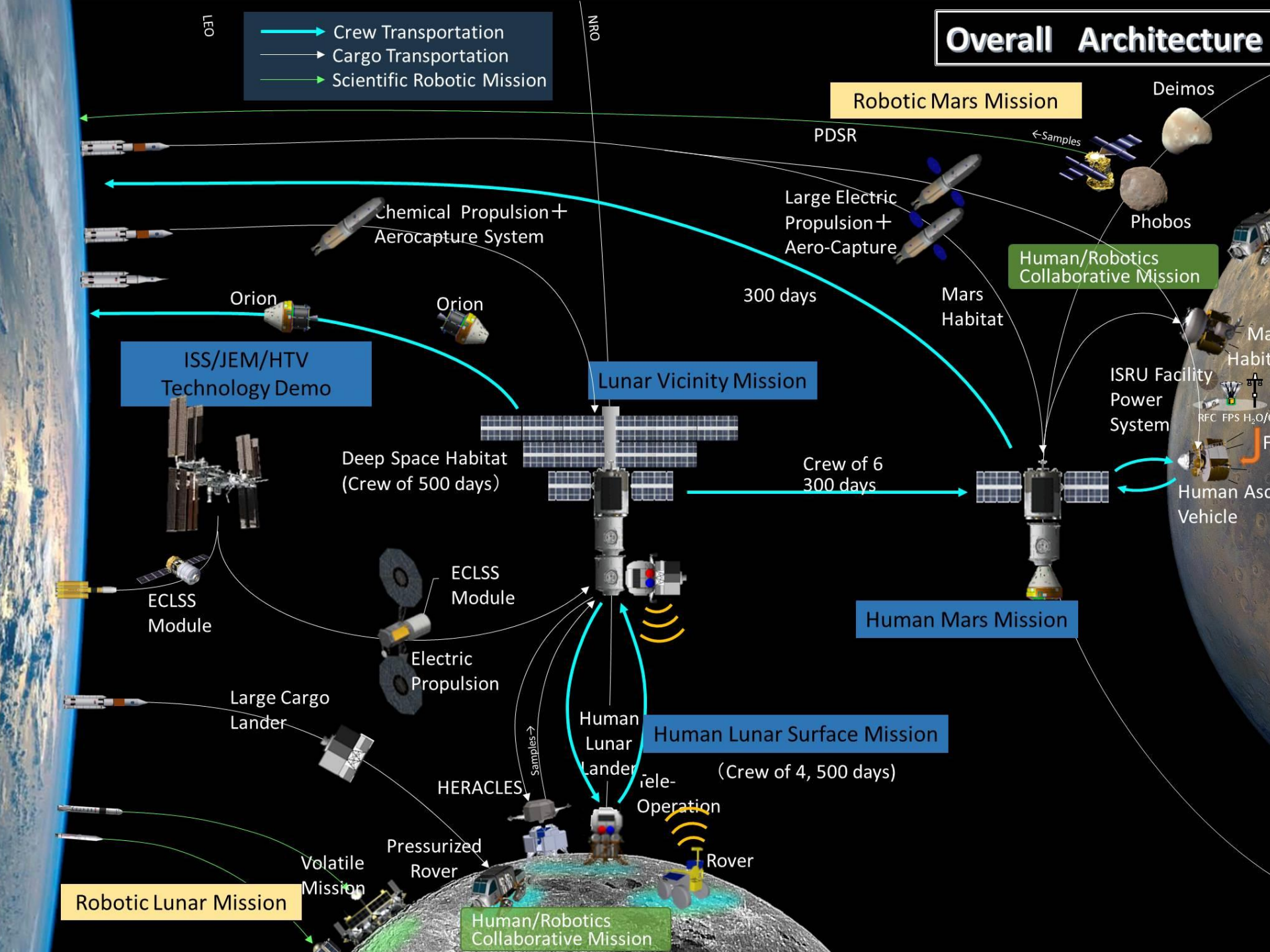


(a)Traversing by Pressurized Rover

(b)Sampling

(c)Selection of sample

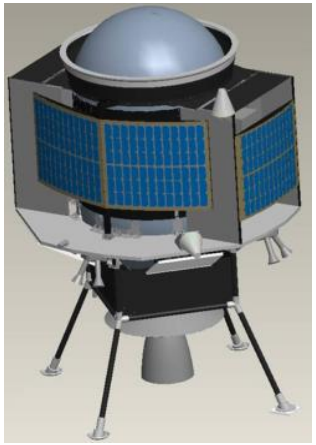
These are the current status of technical study at JAXA as a reference.


Overall Architecture
LEO
NRO
Crew Transportation
Cargo Transportation
Scientific Robotic Mission
Robotic Mars Mission
Deimos
PDSR
←Samples
Phobos
Large Electric
Propulsion＋
Aero-Capture
Chemical Propulsion＋
Aerocapture System
Human/Robotics
Collaborative Mission
300 days
Mars
Habitat
Orion
Orion
ISS/JEM/HTV
Technology Demo
Lunar Vicinity Mission
ISRU Facility
Power
System
Deep Space Habitat
(Crew of 500 days)
Crew of 6
300 days
Human Asc
Vehicle
ECLSS
Module
ECLSS
Module
Human Mars Mission
Electric
Propulsion
Large Cargo
Lander
Human
Lunar
Lander
Human Lunar Surface Mission
(Crew of 4, 500 days)
Samples→
HERACLES
Tele-
Operation
Pressurized
Rover
Volatile
Mission
Rover
Robotic Lunar Mission
Human/Robotics
Collaborative Mission

Missions in Near Term

SLIM (Smart Lander for Investigation Moon)

- SLIM is a mission to demonstrate the technology for pin-point soft landing on lunar or planetary surface.
- Planned to be launched in JFY 2019.



- Technology demonstration with Small Spacecraft:

（Landing on the point where we want to explore!)

  - Image-based Navigation utilizing Lunar Terrain
  - Autonomous Obstacle Detection
  - Robust Pin-point Guidance
  - Landing Shock Absorber
  - High-performance Propulsion
  - Exploration using Tiny Rovers (option)

- Enable frequent trials of lunar/planetary surface exploration technology
- Precursor of future full-scale lunar or planetary missions

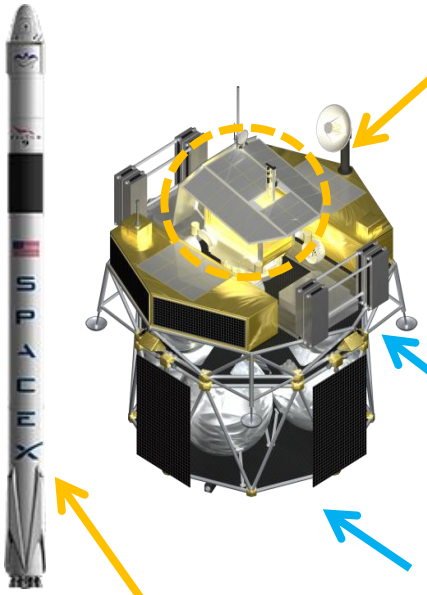
SELENE-RP (under concept study with NASA)

- Spacecraft mass : 5000 kg (Wet)
- Surface payload: 340 kg
- Launch target : 2020 (TBD)

Rover

- Near Infrared Spectrometer
- Neutron Spectrometer
- Oxygen & Volatile Extraction Node
- Lunar Advanced Volatile Analysis

Volatile observation in Polar region



- Radiation monitor
- Seismometer
- Heat flow measurement
- Spectro-microscope camera
- Active X-ray spectrometer

Other instruments candidates

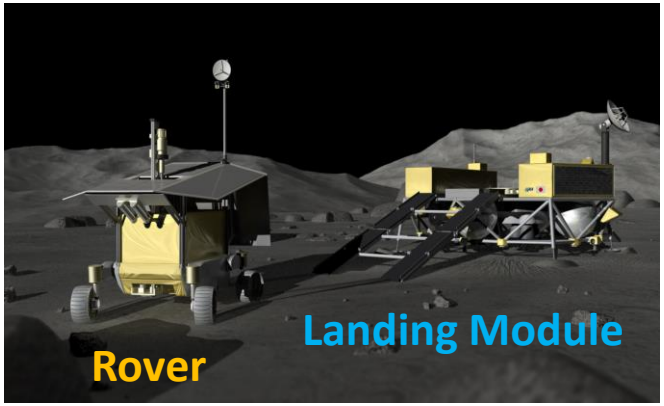
Landing Module

Propulsion Module

Launch Vehicle

Launch vehicle selection depends on the payloads.

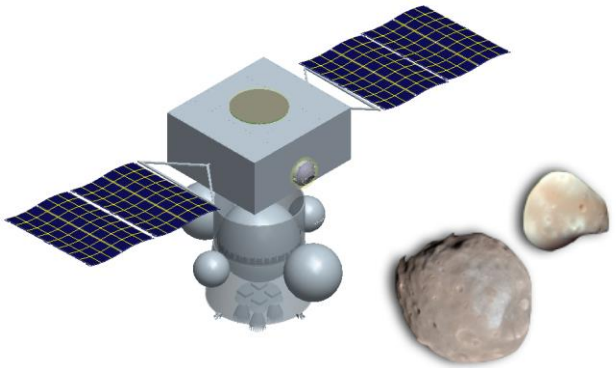
Launch configuration



Lunar surface

Martian Moons eXploration (MMX)

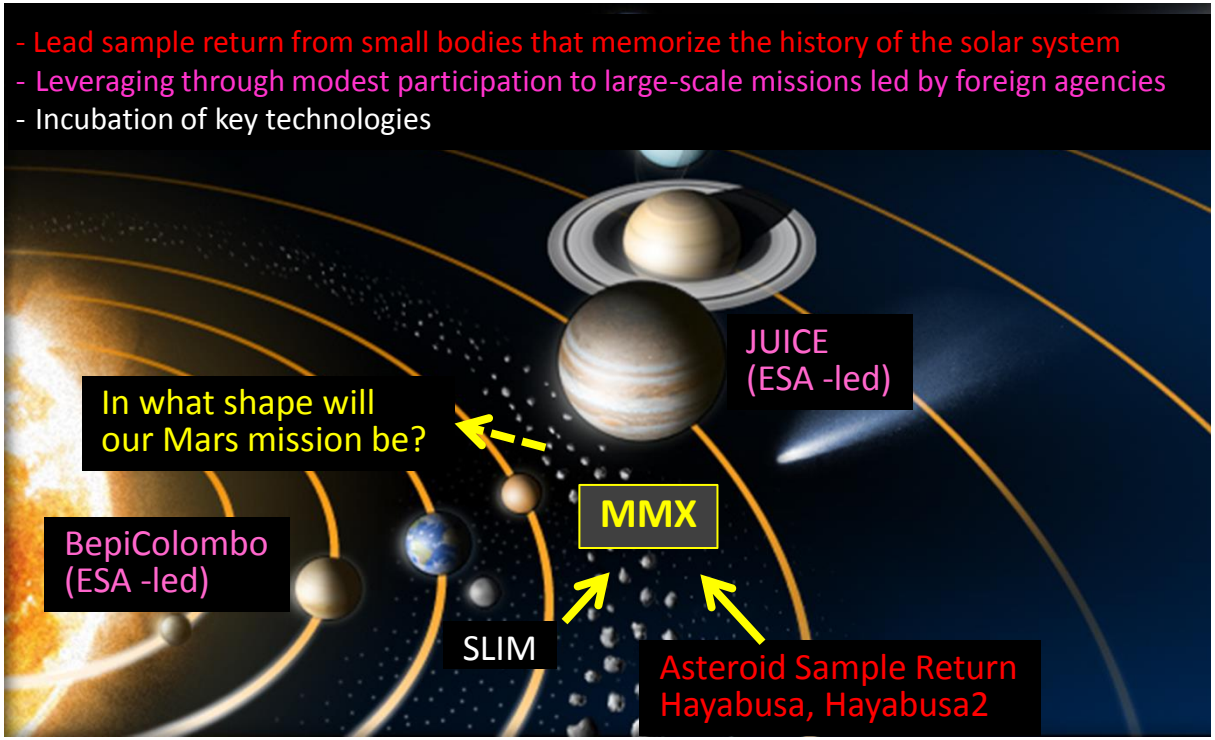
- To be the World first sample return from the Mars system.
- ISAS/JAXA plans as a middle class space science mission to be launched in early 2020s.



Phobos & Deimos

Launch in 2022
Return in 2025
Launch Mass : 3000kg

Three stage modules:
- Return module: 1050kg
- Exploration module: 150kg
- Chemical propulsion :1800kg



Martian Moon eXploration (MMX)
in our Solar System Exploration Roadmap

Forward Activities

Forward Activities

- As the key member of ISECG, JAXA is contributing to the development of the 3rd edition of Global Exploration Roadmap (GER) which will be published in 2017.
- Japan will host the 2nd International Space Exploration Forum (ISEF) in 2017 to promote the political discussion for international space exploration.
- JAXA is promoting advancement of critical technologies for space exploration so that Japan can play a key role in the international space exploration.