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

High Definition TV image

Global gravity distribution

Global terrain map

Global illumination map
HAYABUSA
- World 1st Sample Return from Asteroid -

Launch in 2003

Arrival in 2005

Return to Earth in 2010
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).
The impactor collides to the surface of the asteroid.

The sample will be obtained from the newly created crater.

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

**HAYABUSA 2**

- **Launch**: 03 Dec. 2014
- **Arrival at Ryugu**: June-July 2018
- **Earth swing-by**: 03 Dec. 2015
- **New Experiment**: 2019
- **Earth Return**: Nov.-Dec. 2020
- **Sample analysis**: Nov.-Dec. 2019 : Departure

**Ryugu**
- Size: 900 m
- Rotation period: 7.6 h
- Albedo: 0.05
- Type: C

**Timeline**
- 03 Dec. 2014: Launch
- 03 Dec. 2015: Earth swing-by
- June-July 2018: Arrival at Ryugu
International Space Station
- Testbed for space exploration -

KIBO - Japanese Experiment Module
- The Largest Experiment Module in ISS
- Pressurized and Exposed Experiments Capability
KOUNOTORI
- Japanese Logistics Vehicle
  • The Largest Logistics Vehicle in ISS
  • Successful 5 flights
  • 4 more flights planned
Japan’s ISS Flight Overview

Kibo Assembly

1st launch (2008.3.11)

ELM-PS

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

PM

2nd launch (2008.5.31)

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

- Standard-class EF Mission: SEDA-AP (JAXA)
- ExHAM: Material Exposure Mission
  - Air Lock
- i-SEEP: Medium-class EF Mission
- Standard-class EF Mission: CALET (JAXA)
- Standard-class EF Mission: HREP (NASA)
- J-SSOD: Small satellite deployment
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
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

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

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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

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Science Roadmap (Moon) - on-going discussion -

Science Goals

- Understand the solar system evolution
  - Understand chemical stratification of the crust, mantle, and core
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Science Roadmap

- In-situ analysis
  - In-situ geological analysis of crust

- Sample Return
  - Geological analysis of the sample from Mantle (SPA)
  - Dating of the sample from the youngest lava flow area
  - Dating of the sample from various igneous area
  - Dating of the sample of old crater around 3.9Ga
  - Dating of the sample of various 3.9 Ga area

- Human Exploration
  - Core observation using seismometer
  - Search the sample from the Earth in Hadean eon

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# Knowledge Gap and Criticality for Habitation

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

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

Criticality:
- Low
- Mid
- High
Example of Human Geological Exploration

Far Side of the Moon

South Pole Aitken Basin

(a) Traversing by Pressurized Rover

(b) Sampling

(c) Selection of sample

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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

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

**Propulsion Module**

Launch vehicle selection depends on the payloads.

Launch configuration
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.

In what shape will our Mars mission be?
- Lead sample return from small bodies that memorize the history of the solar system
- Leveraging through modest participation to large-scale missions led by foreign agencies
- Incubation of key technologies

Launch in 2022
Return in 2025
Launch Mass : 3000kg

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

Phobos & Deimos

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.