Asteroid explorer, Hayabusa2, reporter briefing

August 22, 2019

JAXA Hayabusa2 Project

Topics

Regarding Hayabusa2,

- Capsule collection
- MINERVA-II
- Place names related to the artificial crater

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Overview of Hayabusa2

Objective

We will explore and sample the C-type asteroid Ryugu, which is a more primitive type than the S-type asteroid Itokawa that Hayabusa explored, and elucidate interactions between minerals, water, and organic matter in the primitive solar system. By doing so, we will learn about the origin and evolution of Earth, the oceans, and life, and maintain and develop the technologies for deep-space return exploration (as demonstrated with Hayabusa), a field in which Japan leads the world.

Expected results and effects

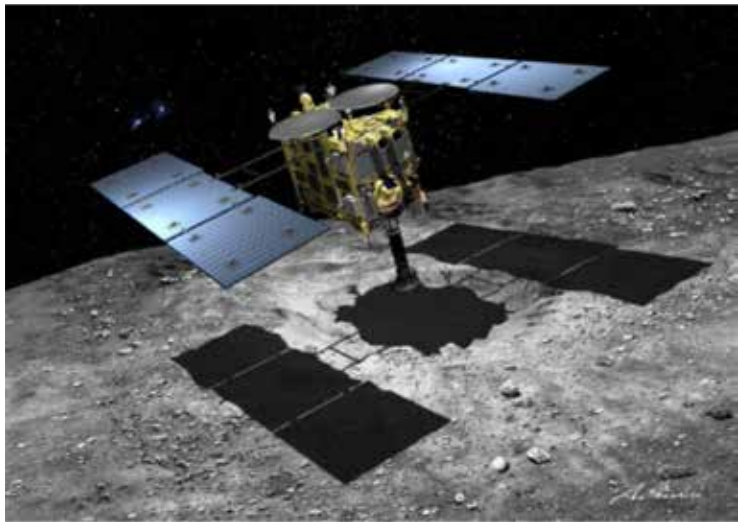
- By exploring a C-type asteroid, which is rich in water and organic materials, we will clarify interactions between the building blocks of Earth and the evolution of its oceans and life, thereby developing solar system science.
- Japan will further its worldwide lead in this field by taking on the new challenge of obtaining samples from a crater produced by an impacting device.
- We will establish stable technologies for return exploration of solar-system bodies.

Features:

- World's first sample return mission to a C-type asteroid.
- World's first attempt at a rendezvous with an asteroid and performance of observation before and after projectile impact from an impactor.
- Comparison with results from Hayabusa will allow deeper understanding of the distribution, origins, and evolution of materials in the solar system.

International positioning:

- Japan is a leader in the field of primitive body exploration, and visiting a type-C asteroid marks a new accomplishment.
- This mission builds on the originality and successes of the Hayabusa mission. In addition to developing planetary science and solar system exploration technologies in Japan, this mission develops new frontiers in exploration of primitive heavenly bodies.
- NASA too is conducting an asteroid sample return mission, OSIRIS-REx (launch: 2016; asteroid arrival: 2018; Earth return: 2023). We will exchange samples and otherwise promote scientific exchange, and expect further scientific findings through comparison and investigation of the results from both missions.



(Illustration: Akihiro Ikeshita)

Hayabusa 2 primary specifications

Mass	Approx. 609 kg
Launch	3 Dec 2014
Mission	Asteroid return
Arrival	27 June 2018
Earth return	2020
Stay at asteroid	Approx. 18 months
Target body	Near-Earth asteroid Ryugu

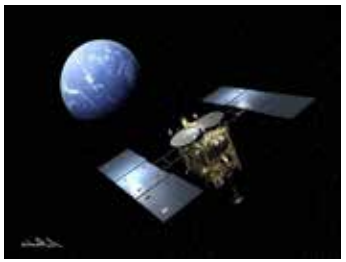
Primary instruments

Sampling mechanism, re-entry capsule, optical cameras, laser range-finder, scientific observation equipment (near-infrared, thermal infrared), impactor, miniature rovers.

Mission flow

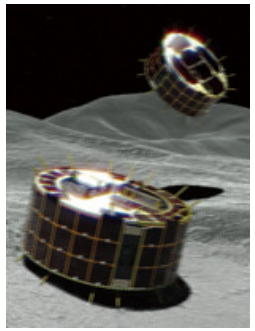
Launch
Dec 3, 2014

Earth swing-by
Dec 3, 2015

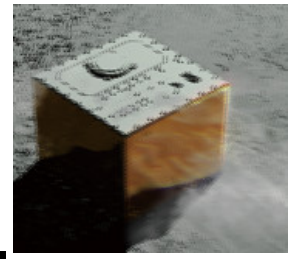


Ryugu arrival
June 27, 2018

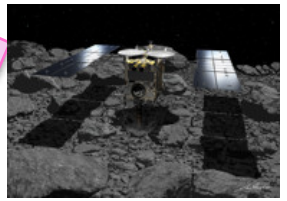
MINERVA-II-1 separation
Sep 21, 2018



MASCOT separation
March 10, 2018

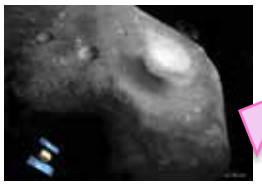


Feb 22, 2019



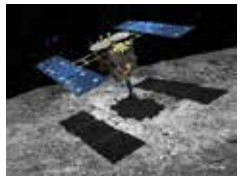
First touchdown

Impactor (SCI)
5 April, 2019



completed →

July 11, 2019



Second touchdown

Ryugu departure
Nov～Dec, 2019

Earth return
End of 2020

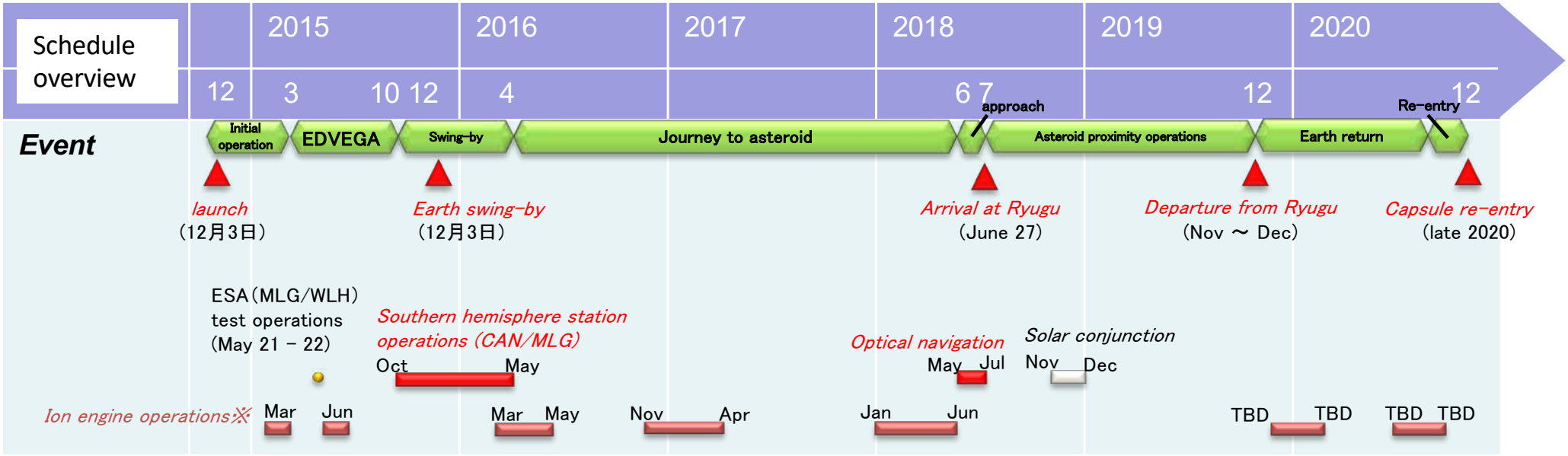
(image credit: illustrations including spacecraft by Akihiro Ikeshita, others by JAXA)

1. Current project status & schedule overview

Current status:

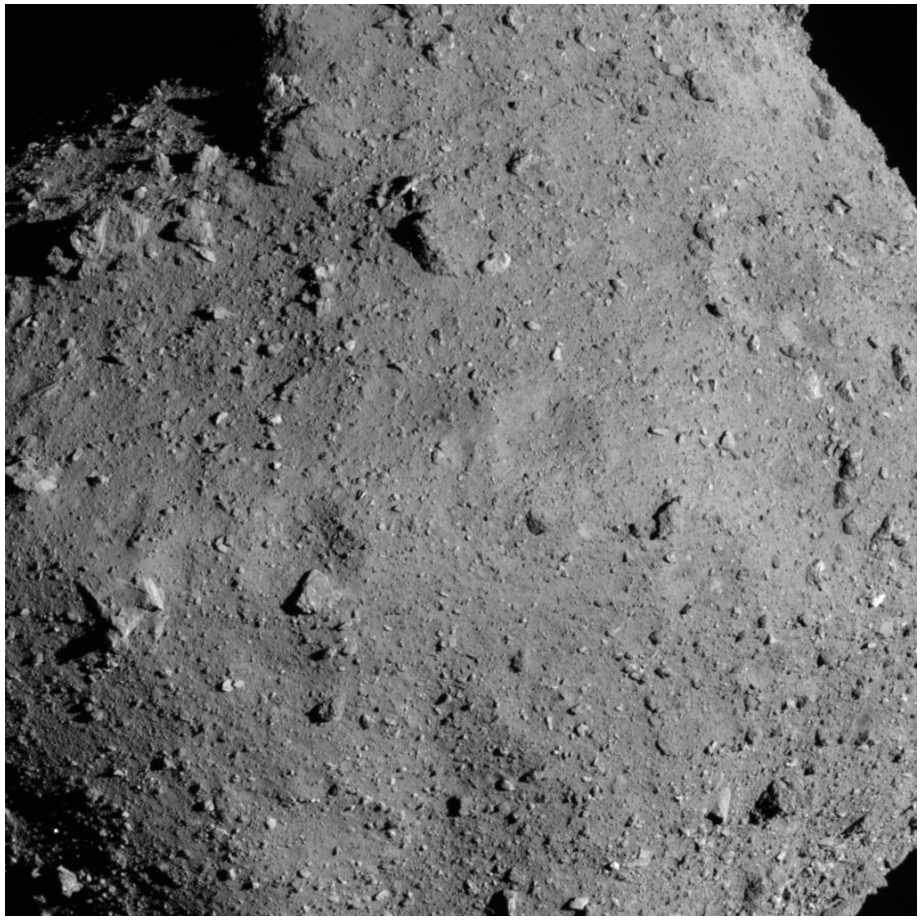
- A BOX-C operation was conducted from July 21 ~ 31. The lowest altitude reached was about 5km (7 / 25 ~ 27) above Ryugu.
- BOX-B operation is is currently underway, operating from August 8 to 27.

※BOX-C operation: Operation that vertically extends the hovering area to enable observation at low altitude.
BOX-B operation: Operation that shifts the position of the spacecraft from the line connecting the Earth and asteroid while maintaining an altitude of approximately 20km. (Neither operation is critical.)



2nd touchdown point seen from an altitude of 5km

First release



Around the 2nd touchdown point, 'Uchide-no-Kozuchi', captured with the ONC-T at an altitude of about 5km. Image was taken on July 25 at 17:01 JST (onboard time). As the photograph was taken under conditions with a large solar phase angle (angle between the Sun, asteroid and Hayabusa2), the appearance of boulder shadows and the depression of the artificial crater stand out.

(Image credit: JAXA, University of Tokyo, Kochi University, Rikkyo University, Nagoya University, Chiba Institute of Technology, Meiji University, University of Aizu, AIST)

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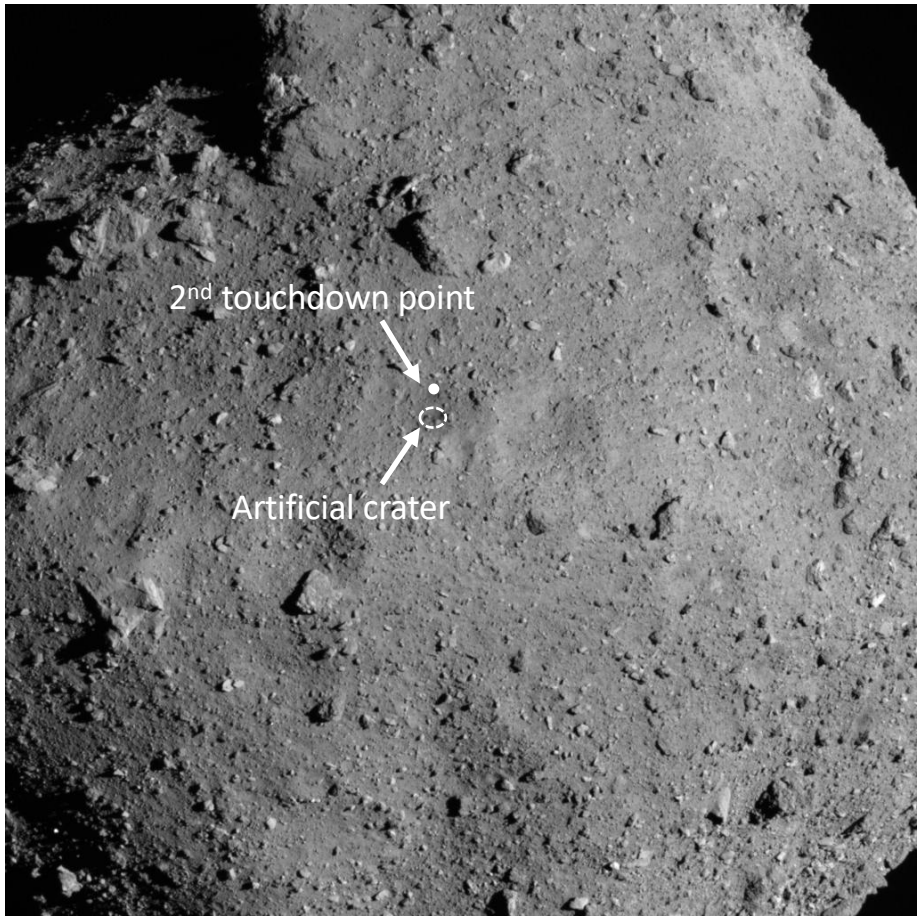

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(Image credit: JAXA, University of Tokyo, Kochi University, Rikkyo University, Nagoya University, Chiba Institute of Technology, Meiji University, University of Aizu, AIST)

2. Recovery plan for the Hayabusa2 capsule

- Hayabusa2 plans to return to Earth at the end of 2020 and separate the SRC capsule.
- As with the recovery from the first Hayabusa in 2010, JAXA is currently working with the Australian Government to facilitate the recovery of the Hayabusa2 re-entry capsule in 2020 at the Woomera Prohibited Area (WPA) located in the outback desert of South Australia. The Australian Department of Defence will provide support and access to the area for the safe return of the capsule, and the Defence Science and Technology Group will conduct cooperative scientific activities with JAXA.

Image of the recovery candidate site (photographed in December 2018)

(Image credit: JAXA)

2. Recovery plan for the Hayabusa2 capsule

<Chronology and plan>

- **Nov. 2018**
  Hayabusa2 Project team and the Australian Government signed an agreement to carry-out preparatory work for the capsule recovery at WPA, with JAXA and the Defence Science and Technology Group conducting cooperative scientific activities during the return of Hayabusa2.
- **Dec. 2018**
  A field survey of the proposed recovery site in the WPA was conducted. This preparatory work confirmed the suitability of both the proposed recovery site and the candidate site for the antenna station that will search for the capsule.
- **July 2019**
  JAXA is preparing to submit an application (AROLSO*) detailing the recovery and safety plan to the Australian Government.

<Australian Association>

- **Australian Space Agency (ASA)**
  Supporting to submit an application and the discussion with the Australian ministry.
- **Department of Defence (DOD)**
  Facilitating access to the WPA and supporting the recovery operation with cooperative scientific activities.

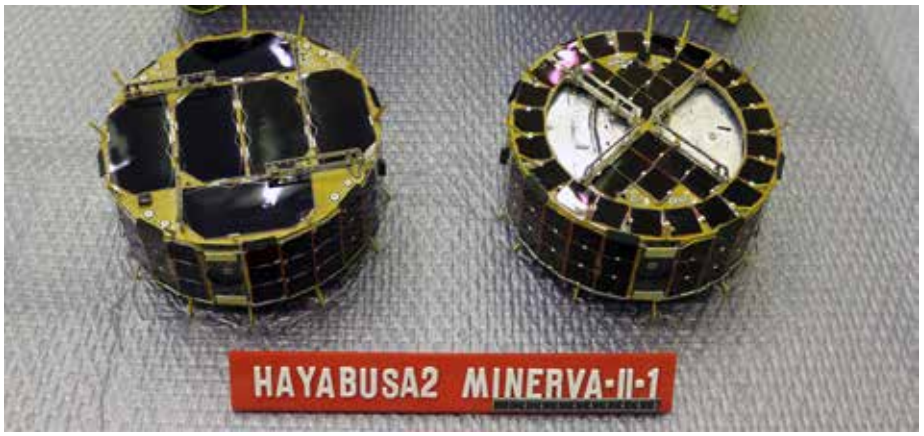
*AROLSO : Authorisation of Return of an Overseas Launched Space Object

3. Status of MINERVA-II1

- Telemetry data were acquired from OWL from 13:15 to 13:25 JST on August 2, 2019.
- As Ryugu approached the Sun, the rovers woke from hibernation.
- The operation plan is currently being considered.

HIBOU
(From the French for owl)

Rover-1A



OWL

Rover-1B

(Image credit : JAXA)

4. About MINERVA-II2

- In order to obtain meaningful results using Rover-2 (university consortium development), separation from a relatively high altitude (about 1km) is planned, with the descent to the asteroid surface over time used to estimate the asteroid's gravitational field by monitoring the descending orbit.
- Details of this operation will be explained at the press briefing on September 24 (planned).

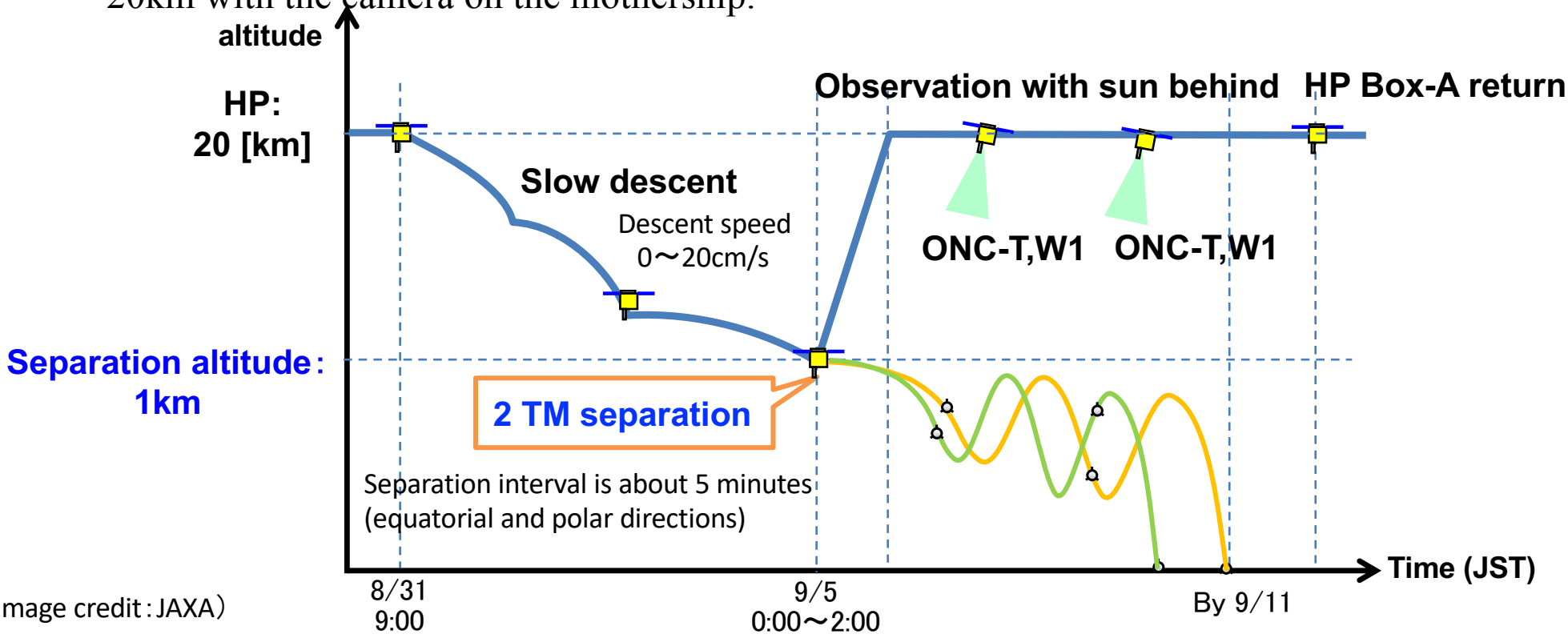
※Target marker separation operation

- A rehearsal is scheduled for September 5, ahead of the separation operation for Rover-2. Two target markers onboard Hayabusa2 will represented Rover-2 and be separated.
- The two target markers will be separated at an altitude of about 1km.

4. About MINERVA-II2

Overview of target marker separation operation

- After separating the two target markers (TM), the spacecraft will rise to an altitude of 20km.
- The trajectory of the TMs descending while orbiting will be optically observed at an altitude of 20km with the camera on the mothership.



（Image credit：JAXA）

5. Place names related to the artificial crater

The following nicknames are being used for the area around the artificial crater:

■Artificial crater

Omusubi-Kororin Crater

（SCI Crater）

■Moved rock

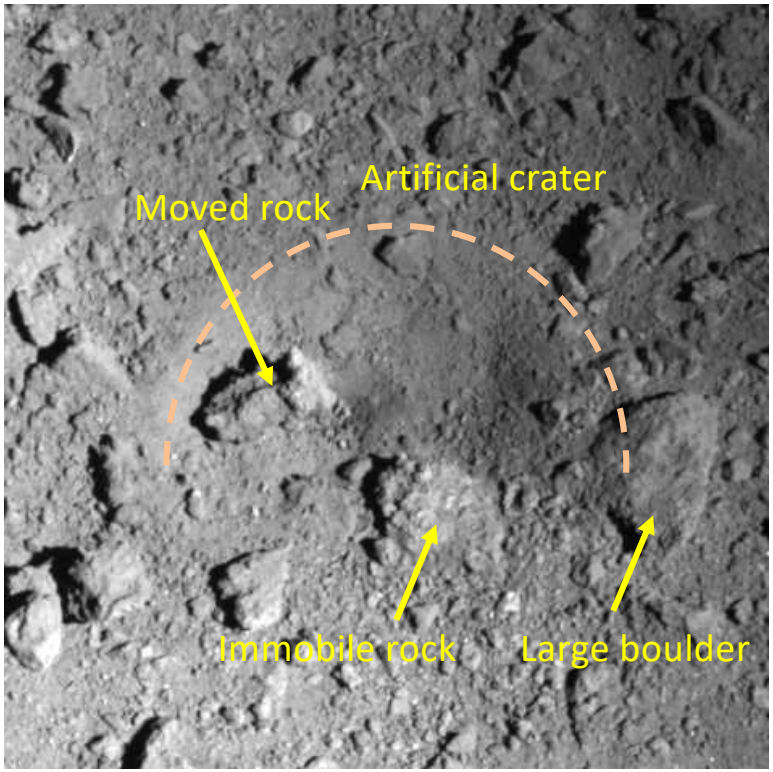
Iijima Boulder

■Immobile rock

Okamoto Boulder

■Large boulder

Onigiri Boulder



Note：The range of the artificial crater is currently under study, and the line shown in the figure is the approximate range.

（Image credit: JAXA, University of Tokyo, Kochi University, Rikkyo University, Nagoya University, Chiba Institute of Technology, Meiji University, University of Aizu, AIST）

5. Place names related to the artificial crater

Origin of the names:

Omusubi-Kororin crater (SCI crater)

From the folktale of the “rolling rice ball”. This was chosen as the boulders in this vicinity are shaped like Japanese rice balls and may roll down into the crater. The crater will also continue to be referred to as the “SCI crater”, depending on the situation.

Iijima boulder

In memory of Yuichi Iijima. Dr Iijima worked to gain the cooperation from universities outside JAXA during the start-up of the Hayabusa2 Project and so laid the foundation for Project’s success. In particular, in order to maximise the scientific results from the impact experiment, he worked hard across different fields and focussed on the proposal and development for the digital deployable camera for scientific observation (DCAM3). Dr Iijima passed away on December 7, 2012.

Okamoto boulder

In memory of Chisato Okamoto. Dr Okamoto was one of the core members of the Hayabusa2 sampler development team and energetically repeated laboratory experiments in preparation for collecting samples on Ryugu. She was also a member of the impact experiment team and played a central role in the simulation of the asteroid surface conditions used for the impact experiment in Kamioka. Dr Okamoto passed away on July 25, 2018.

Onigiri boulder

An onigiri is a Japanese rice ball (sometimes the shape is triangular) and resembles this boulder. (Both omusubi and onigiri mean rice ball.)

6. Future outreach plans

■Discussion meeting on outreach and educational activities for Hayabusa2: Part 2.

- Purpose:

  Discuss what can be done in the future for education and outreach with Hayabusa2.

- Location, date & time:

  Sagamihara City Museum（8/25、10:00～）

  Osaka City Science Museum（9/29、10:00～）

- Information (Japanese): http://www.hayabusa2.jaxa.jp/topics/20190807_Outreach/

6. Future outreach plans

■Hayabusa2 Talk Live Extra

- Sagamihara City Museum（8/25、14:00～） ※ Fully booked
  http://sagamiharacitymuseum.jp/blog/event/201908haya2talk-bangai/
- Osaka City Science Museum（9/28、17:30～）
- Itami City Children's Science Museum（9/29、14:30～）

■Hayabusa2 Talk Live Season 2

- The second series of Talk Live will be held from January to October 2020 during the Return to Earth Phase.（※ The first series was 14 talks that ran from February 2016 to April 2016, held at the Sagamihara City Museum)
- Nationwide：Looking for venues
- Details (Japanese)： http://www.hayabusa2.jaxa.jp/topics/20190807_TalkLive/

7. Other topics

Seiun Award

- Hayabusa2 received the 5-th Seiun Award in the “Free Category” at the 58th Japan SF Convention.
- The Free Category allows nominations for both works of science fiction and scientific achievements (in the past, both the H-IIA rocket and Hayabusa have received nominations and won).
- Reason for Award：“Landing on Ryugu and movement and exploration of the asteroid by MINERVA-II1”
- Award ceremony：2019/7/27
- "Seiun" means nebula in Japanese.

（Image credit：JAXA）

8. Future plans

■Operation schedule

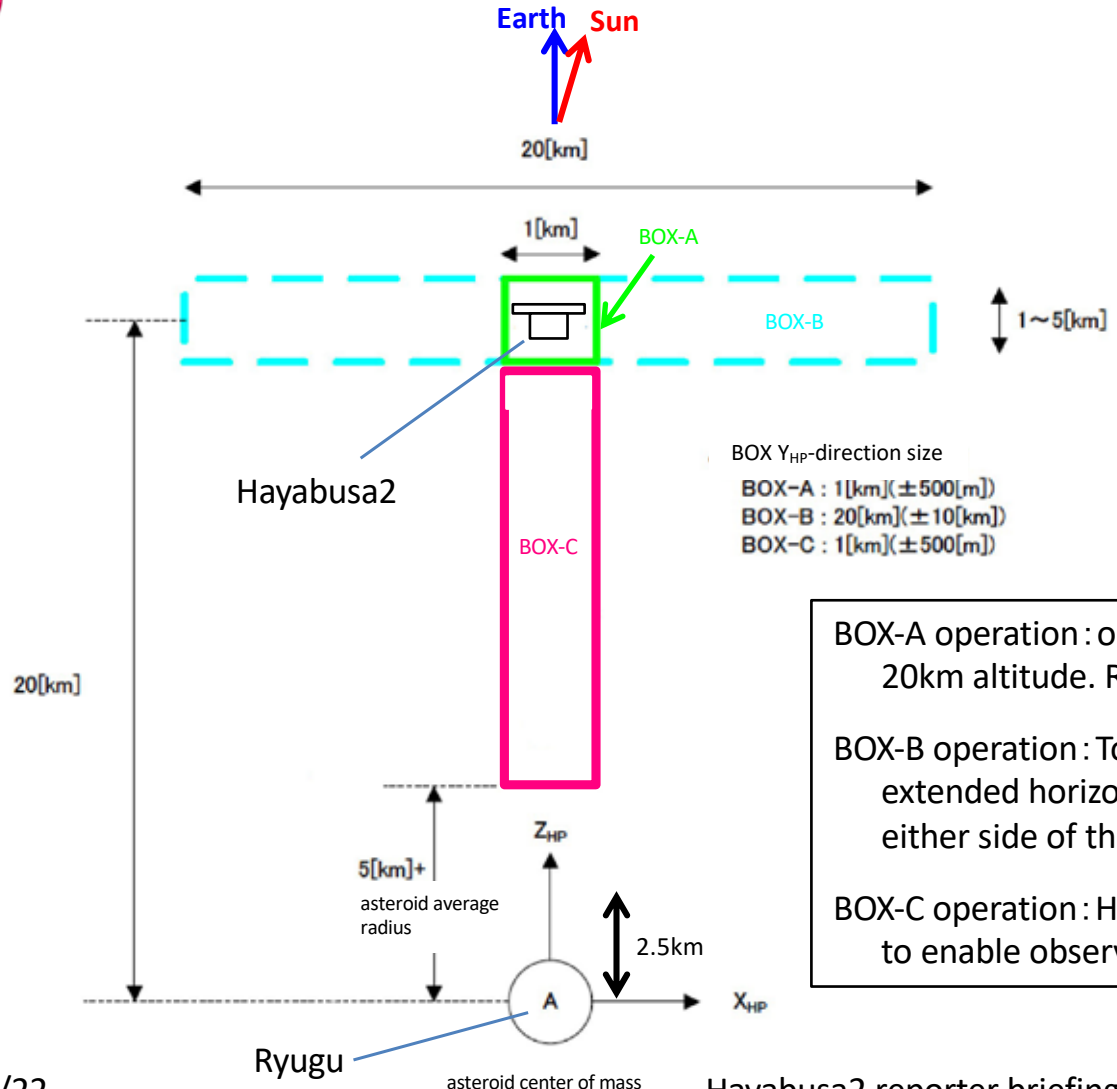
- On September 5, the target marker separation operation will be performed as a rehearsal for MINERVA-II2 separation.

■Press and media briefing

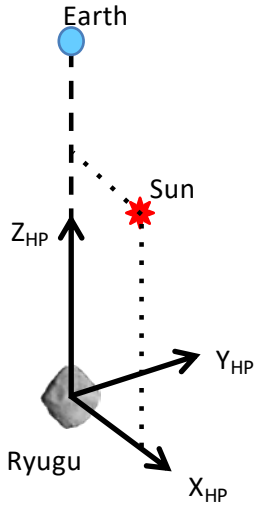
- September 24（Tuesday）（planned） Regular press briefing @ Tokyo office

Reference material

BOX definition



Home position coordinate system (X_{HP}, Y_{HP}, Z_{HP})



BOX-A operation : operations while hovering at 20km altitude. Regular operation standard.

BOX-B operation : Tour observation. Hovering area extended horizontally to enable observations to either side of the asteroid.

BOX-C operation : Hovering area extended vertically to enable observations at low altitude.

（Image credit : JAXA）

Capsule collection site requirements

- Southern Hemisphere location
  - The near point of the Earth return orbit for Hayabusa2 is in the southern hemisphere.
- Low population density area
  - An elliptical area of land with a low population density with a length of about 150 km or more.
  - Sufficient and appropriate measures (access restriction, evacuation etc) related to ensuring safety must be feasible.
- Other
  - Topology (flat), accessibility, vegetation, etc.
  - From the viewpoint of ensuring safety, there should be no political unrest or other series risk factors.

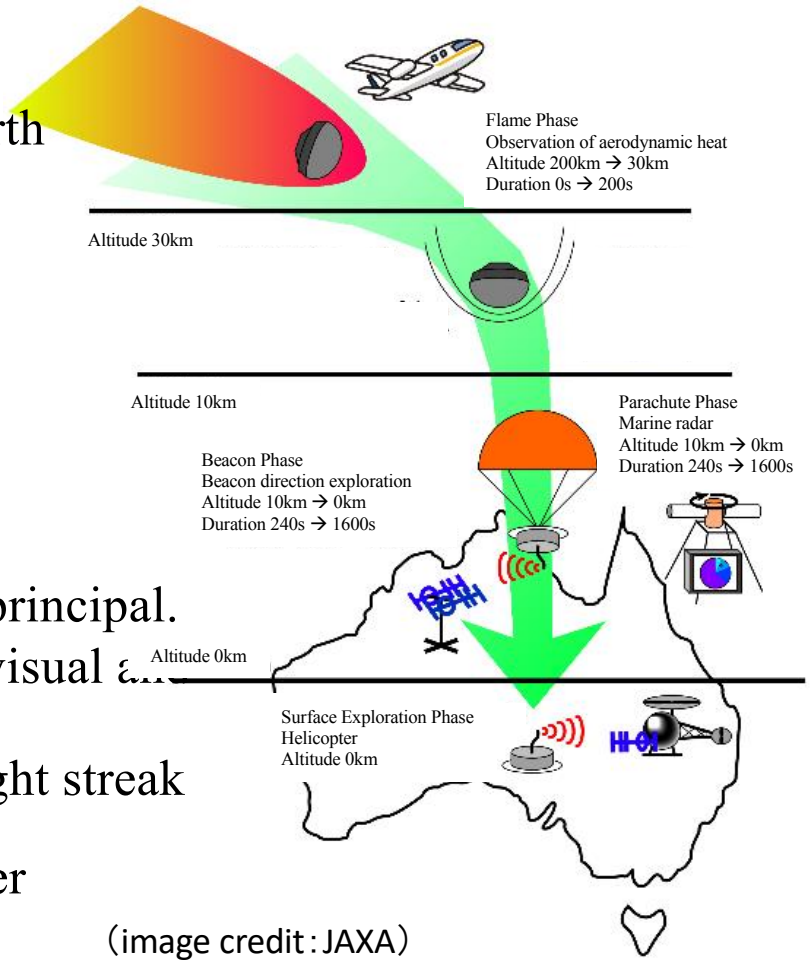
Overview of capsule collection method

＜Capsule re-entry sequence＞

- Capsule separation when the spacecraft approaches the Earth
- Light emission from aerodynamic heating at altitude 100−40km.
- Parachute open and beacon transmission at an altitude of about 10km.

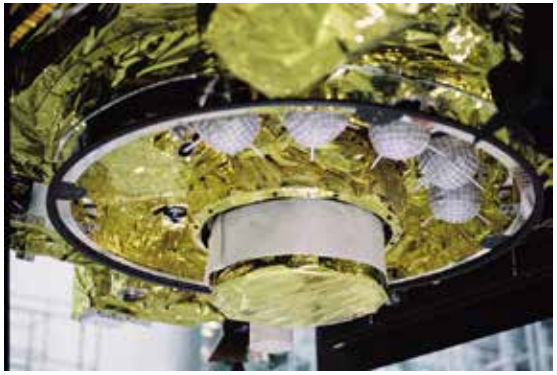
＜Recovery method＞

- Deploy direction search station (antenna station) in the landing area.
  Received descending beacon and locates by triangulation principal.
- Search for beacon after landing using helicopter antenna (visual and infrared cameras will also be used).
- Back-up if parachute does not open: triangulation of the light streak from aircraft and ground to estimate the re-entry trajectory and landing point. A search using marine radar is also under consideration.

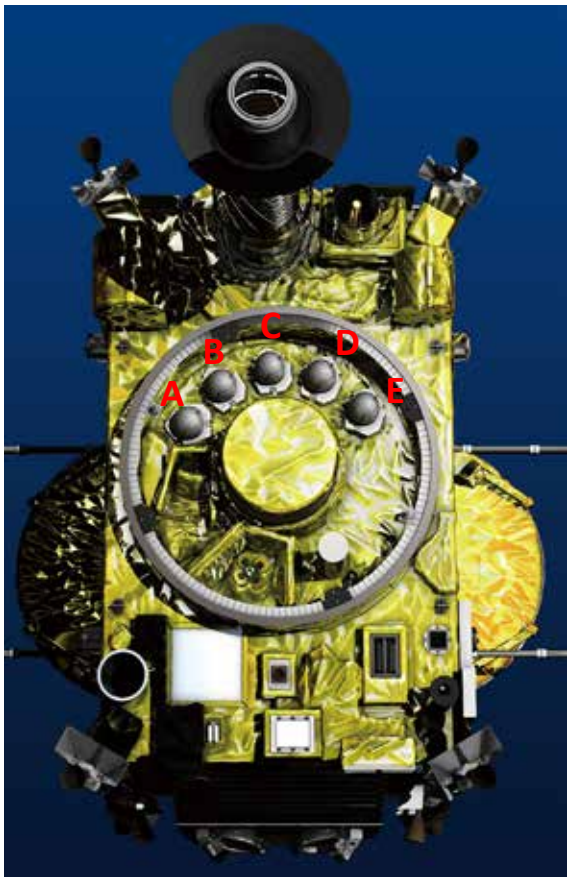


（image credit：JAXA）

Target marker



- Body (ball) size: about 10cm diameter
- Retroreflective film on the surface
- 4 bar rolling prevention
- Many polyimide small balls inside
- Separation order：B→A→E→C→D
- 2018/10/25: B dropped
- 2019/05/30: A dropped



（Image credit：JAXA）