Asteroid explorer, Hayabusa2, reporter briefing

November 16, 2020

JAXA Hayabusa2 Project

Topics

Regarding Hayabusa2,

- Results of TCM-2
- Work plan after capsule collection
- Preparation status for receiving return samples

Contents

Overview of Hayabusa2

<u>Objective</u>

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.

<u>Expected results and effects</u>

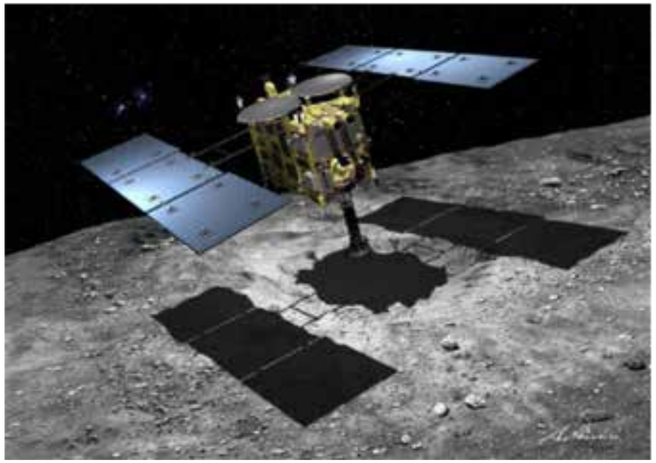
- By exploring a C-type asteroid, which is rich in water and organic materials, we will clarify interactions between the building blocks of Earth and the evolution of its oceans and life, thereby developing solar system science.
- Japan will further its worldwide lead in this field by taking on the new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

<u>Features:</u>

- 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.

<u>International positioning:</u>

- 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)

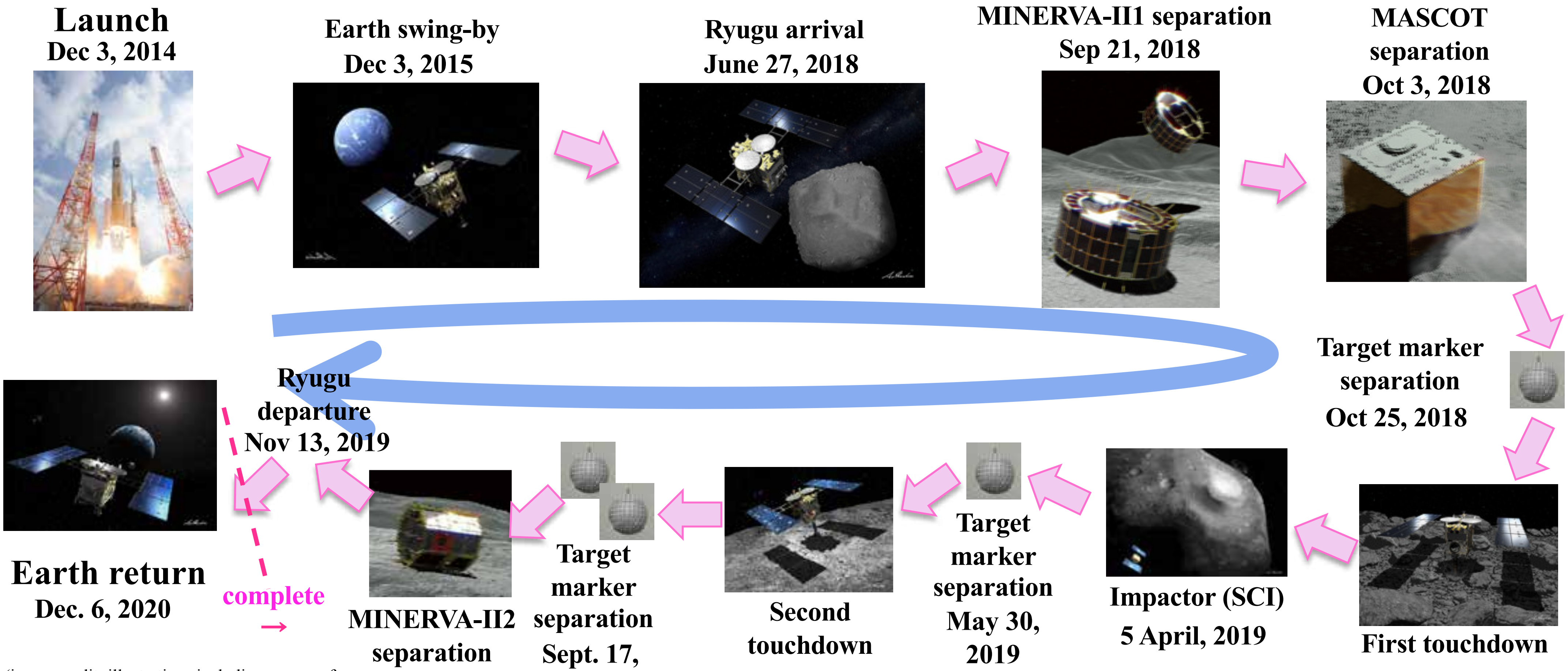
<u>Hayabusa 2 primary specifications</u>

Mass	Approx. 609 kg
Launch	3 Dec 2014
Mission	Asteroid return
Arrival	27 June 2018
Deoarture	13 Mov 2019
Earth return	6 Dec 2020 (plan)
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

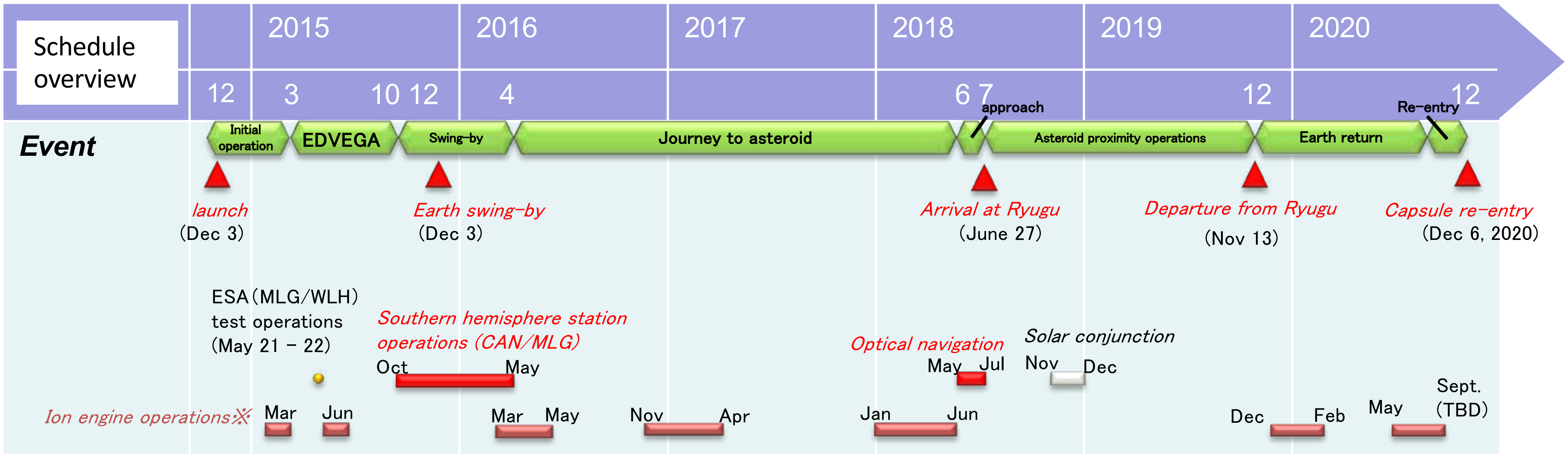


(image credit: illustrations including spacecraft by Akihiro Ikeshita, others by JAXA)

1. Current project status & schedule overview

Current status :

- TCM-2 was performed on November 12, and the orbit was corrected as planned.
- The preliminary capsule recovery team entered Australia on November 1 and moved to Woomera on November 16. The main team entered Australia on November 9 and are currently quarantining in Adelaide.



(image credit : JAXA)

2. TCM-2 results

- TCM-2, the second precision orbit control using the chemical thrusters (RCS), was performed on November 12. The orbit correction was achieved as planned. (TCM: Trajectory Correction Maneuver).
- The orbit correction was performed around 15:44 JST and 16:45 JST (trim = small correction).
- The orbit control amount is about 1 cm/s and the closest approach to the Earth has been changed from about 310 km (※) to about 290 km.
- Spacecraft condition is normal.

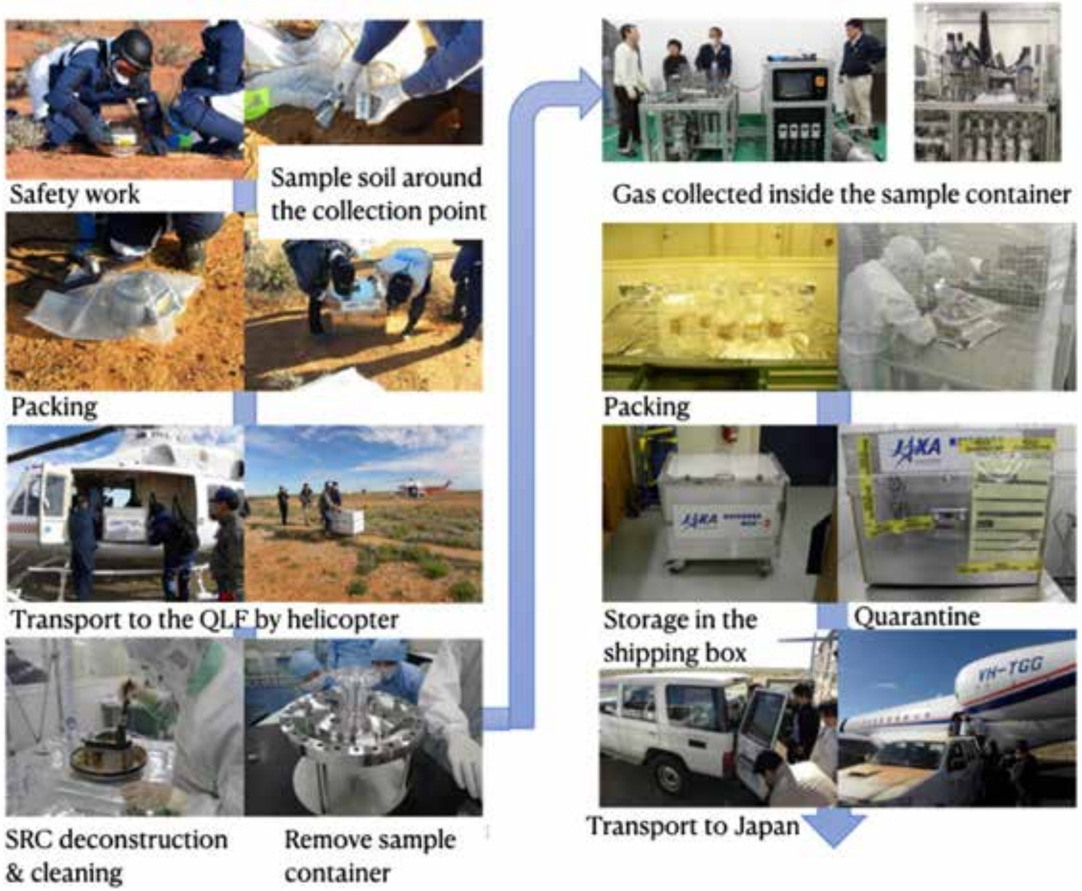
※ In the press briefing material on October 29, the closest altitude to the Earth was reported to be 330km after TCM-1, but the correct value was 310 km.

3. Work plan after capsule collection

～From capsule collection to airlifting to Japan～

Work flow after discovery (nominal case)

1. Of the capsule-related equipment found, the highest priority will be to collect the instrument module (I/M), which is the main body.
2. After the I/M safety processing at the collection site, transport will progress to the Quick Look Facility (QLF) by helicopter.
3. At the QLF, the I/M will be disassembled and the sealed sample container holding the Ryugu sample will be removed.
4. The gas sampling device will be connected to perform a simple analysis by extracting the gas that is thought to have been released from the Ryugu sample into the sample container. (This is newly developed for Hayabusa2)
5. Storage in a dedicated sealed transport box and airlifted to Japan.



（Image credit：JAXA）

Work flow after discovering the capsule (partly from the photos from Hayabusa)

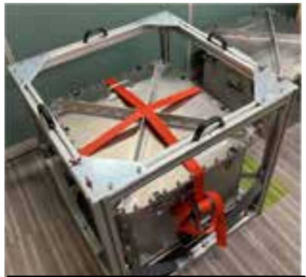
3. Work plan after capsule collection

～Until sample reaches the curation chamber～

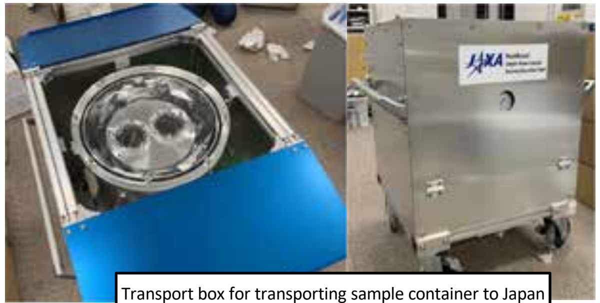
(image credit：JAXA)

Work flow after discovery cont. (nominal case)

6. Operate from Haneda Airport to ISAS by land, bring into the clean room of the curation facility.
7. Perform some disassembly work, such as removal of the ablator.
8. Attach the “sample container opening mechanism”, perform disassembly work to connect to the clean chamber while maintaining the seal.
9. Connect to Room 3-1 (CC3-1) of the clean chamber and create a vacuum environment.
10. Take out the sample catcher from the sample container in a vacuum environment and remove the lid.
11. Pick up part of the Ryugu sample and store this in a vacuum environment. ※ Refer to curtain work for details after CC3-1.

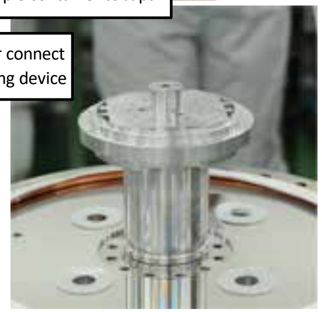


Shipping box for transporting 1/M by helicopter

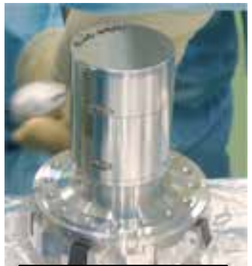


Transport box for transporting sample container to Japan

The gas sampling device



Sample container connect to the gas sampling device



the sample catcher

Connection to container opening mechanism and CC3-1 (rehearsal)

4. Preparation for receiving return samples

Curation view point

- Curation here is the acceptance and initial description of the Hayabusa2 sample, the allocation to later detailed analysis and storage work for the future.
- The curation work begins once the sample container is connected to the clean chamber. Until then, the sample is under the jurisdiction of the sampler team.
- The work during the 6 months after receiving the return sample is the primary curation work where the work listed below is performed.
  - Connection of the sample container to the clean chamber.
  - Removal and storage of part of the sample from the sample catcher (vacuum environment).
  - Extraction of the bulk sample from each room of the sample catcher and initial description (nitrogen environment).
  - Pick-up individual samples and sort aggregate samples.
  - Selection and proposal of samples to be distributed to the initial analysis team and Phase 2 team.
  - Individual initial descriptions of the distributed samples and packing and distribution (shipping) of the distribution (transport) containers.

4. Preparation for receiving return samples

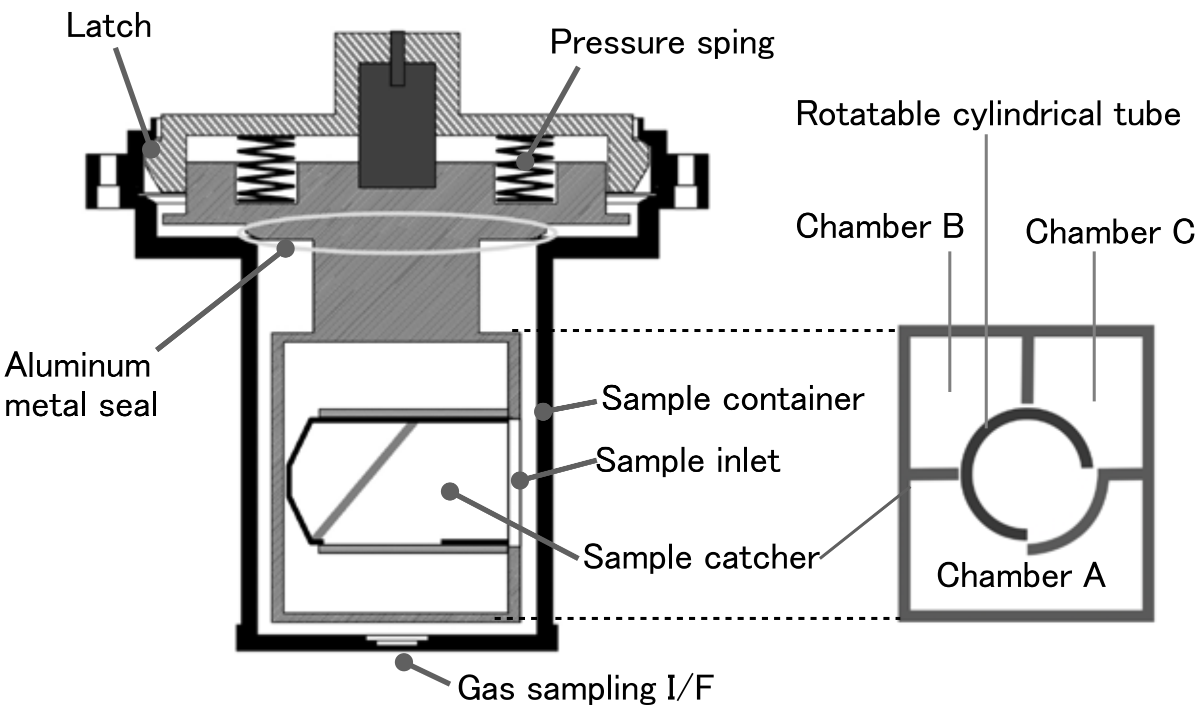
Curation policy

- During the primary curation work, the initial description is made with the following constraints:
  - Sample is not exposed to the global atmospheric environment.
  - Sample is not intentionally destroyed (damaged).
  - Sample is not lost.
- Initial description items have the following content:
  - Optical observation (optical microscope observation)
  - Weight measurement
  - Spectral observation（with FTIR and MicrOmega（※)）
- The initial description is used to archive the data, in addition to being used to select samples for distribution and sample maintenance for later sample distribution and international open research.

※MicrOmega is an observation instrument provided by the IAS under the CNES/JAXA agreement.
https://global.jaxa.jp/news/2019/

4. Preparation for receiving return samples

Sample container structure



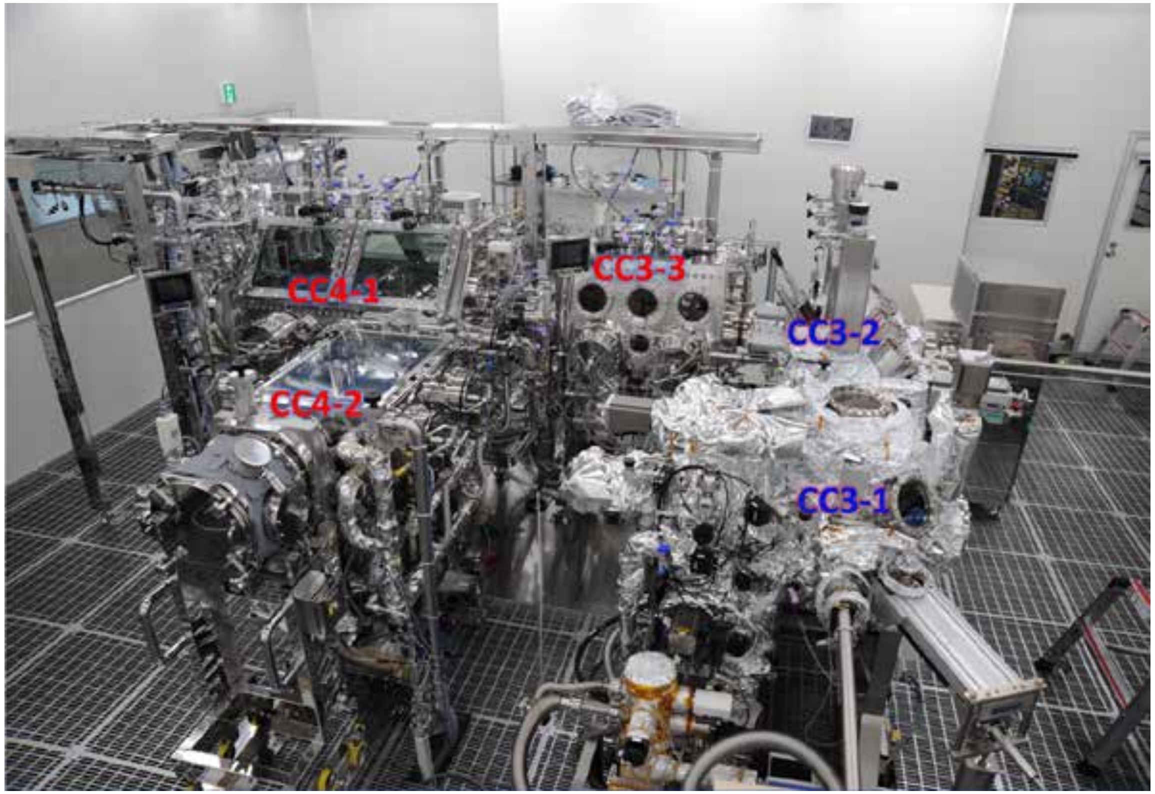
(image credit：JAXA)

Features of the sample container

- A metal seal structure maintains the seal.
- Interface for collecting gas from the sample container.
- 3 sample storage chambers. The sample from TD1 is in chamber A, the sample from TD2 is in chamber C.

4. Preparation for receiving return samples

Clean chamber configuration



(image credit : JAXA)

CC3-1 : Opening of the sample container (vacuum environment)

CC3-2 : Opening of the sample catcher and removal of part of the sample (vacuum environment)

CC3-3 : Replacement of vacuum environment with nitrogen environment.

CC4-1 : Deconstruction of the sample catcher and bulk sample recovery (nitrogen environment)

CC4-2 : Individual sample collection and initial description (nitrogen environment)

(blue : vacuum environment Red : nitrogen environment)

4. Preparation for receiving return samples

Work flow until sample collection

- Connection of sample container to CC3-1
- Sample container opened
- Transport of sample catcher to CC3-2
- Sample catcher chamber A lid opened
- Partial sample collection and storage from chamber A
- Transport of sample catcher to CC3-3
- Catcher handling jig installed
- Transport of sample catcher to CC4-1
- Sample catcher disintegration and bulk sample collection

4. Preparation for receiving return samples

Work flow after sample collection

- Transport of bulk sample to CC4-2
- Weigh bulk sample
- Optical observation of bulk sample
- FTIR observation of bulk sample
- Transport of bulk sample to CC3-3
- MicOmega（※) observation of bulk sample (※ instrument provided by the IAS under international cooperation)
- Transport of bulk sample to CC4-2
- Pick-up of individual samples
- Initial description of individual samples (optical observation, weighting, FTIR observation, MicOmega observation)
- Selection of distribution sample
- Packing and shipping of distribution samples in shipping containers.

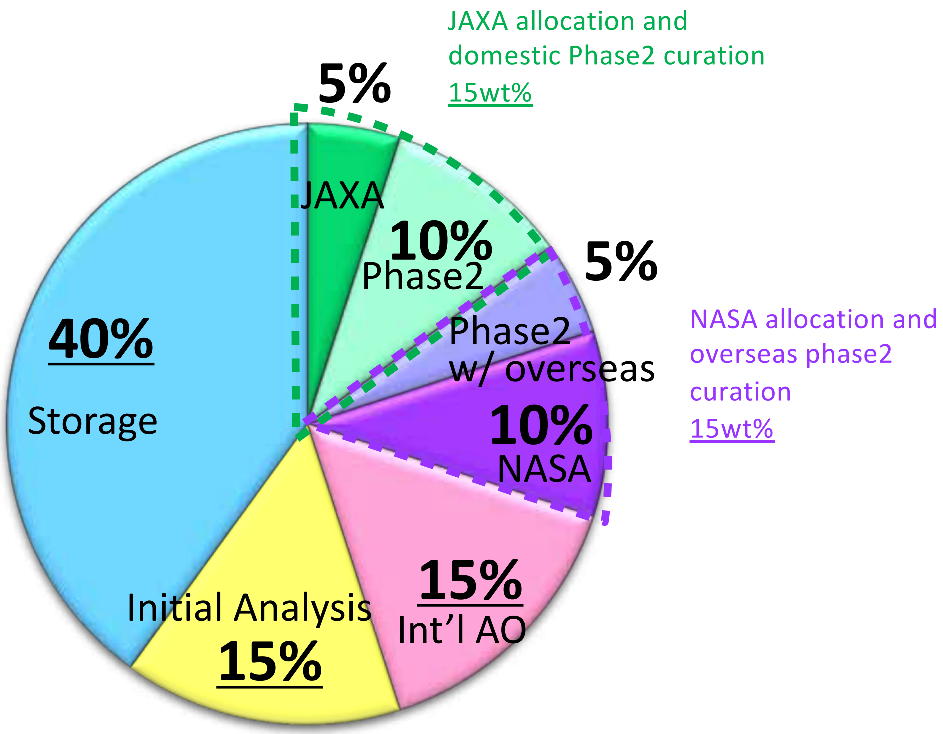
4. Preparation for receiving return samples

Work schedule (planned)

- Early December: Return capsule arrives at Sagamihara
- Mid-December： Sample container clean chamber connected.
- Late-December～： Bulk sample removal, initial description begins.
- Mid-January～： Individual sample pick-up begins

4. Preparation for receiving return samples

Sample distribution policy



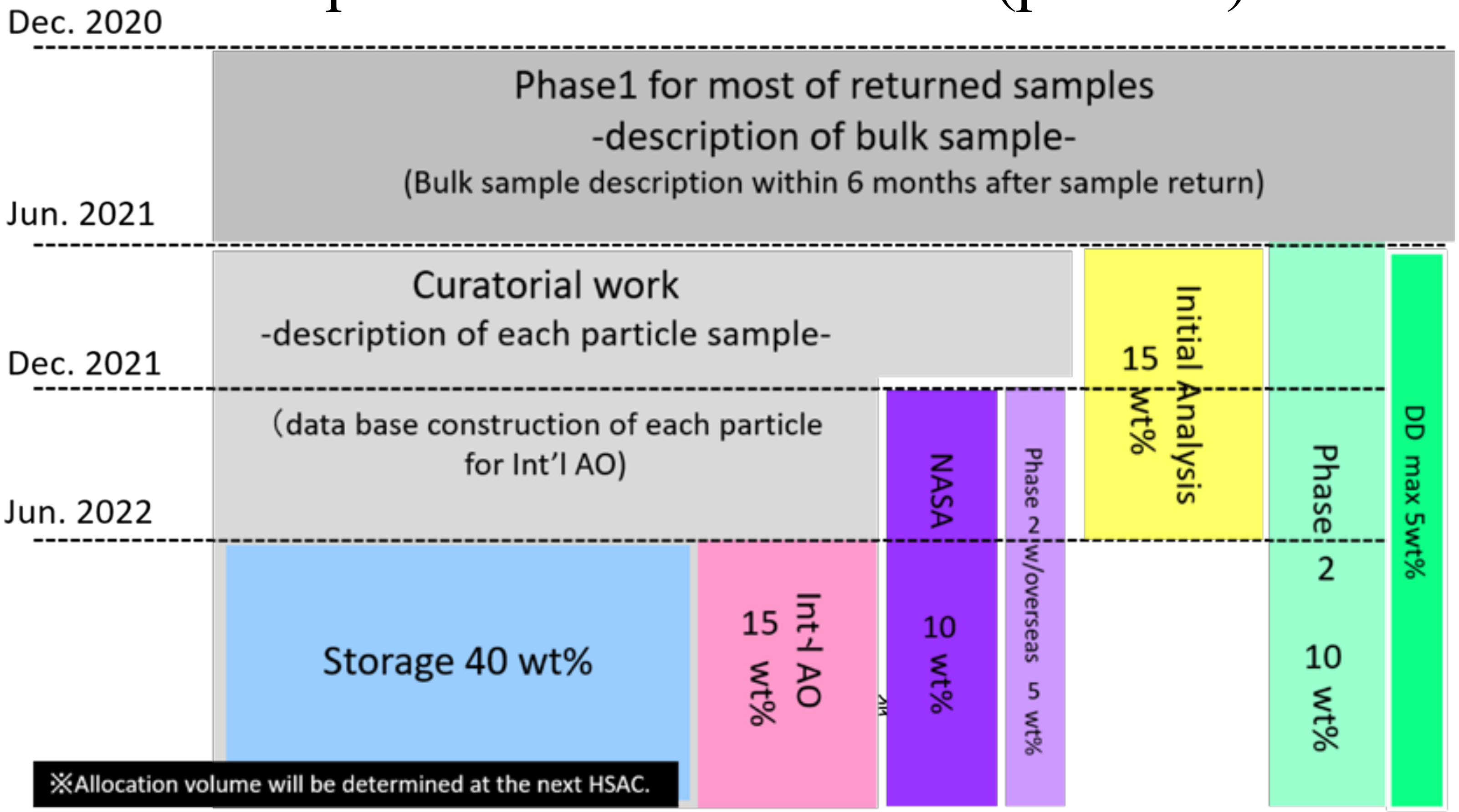
(image credit：JAXA)

- Sample for detailed description by JAXA is 5wt%
- Allocation to domestic Phase2 curation is 10wt%
- Allocation to overseas Phase2 curation is 5wt%
- Allocation to NASA 10wt%
- Allocation for the 1st international analysis open call is 15wt%
- Allocation to the initial analysis team is15wt%
- The remaining 40wt% will be stored as a sample for future work and be used as a sample for the second and subsequent open call for participant analysis.

※ The sample distribution ratio will be finally decided by the Hayabusa2 Sample Allocation Committee (HSAC)

4. Preparation for receiving return samples

Sample distribution schedule (planned)



(Image credit：JAXA)

5. Future plans

■Operation schedule

November 26, 2020（planned）　TCM-3

December 6, 2020　　　　　　　Re-entry

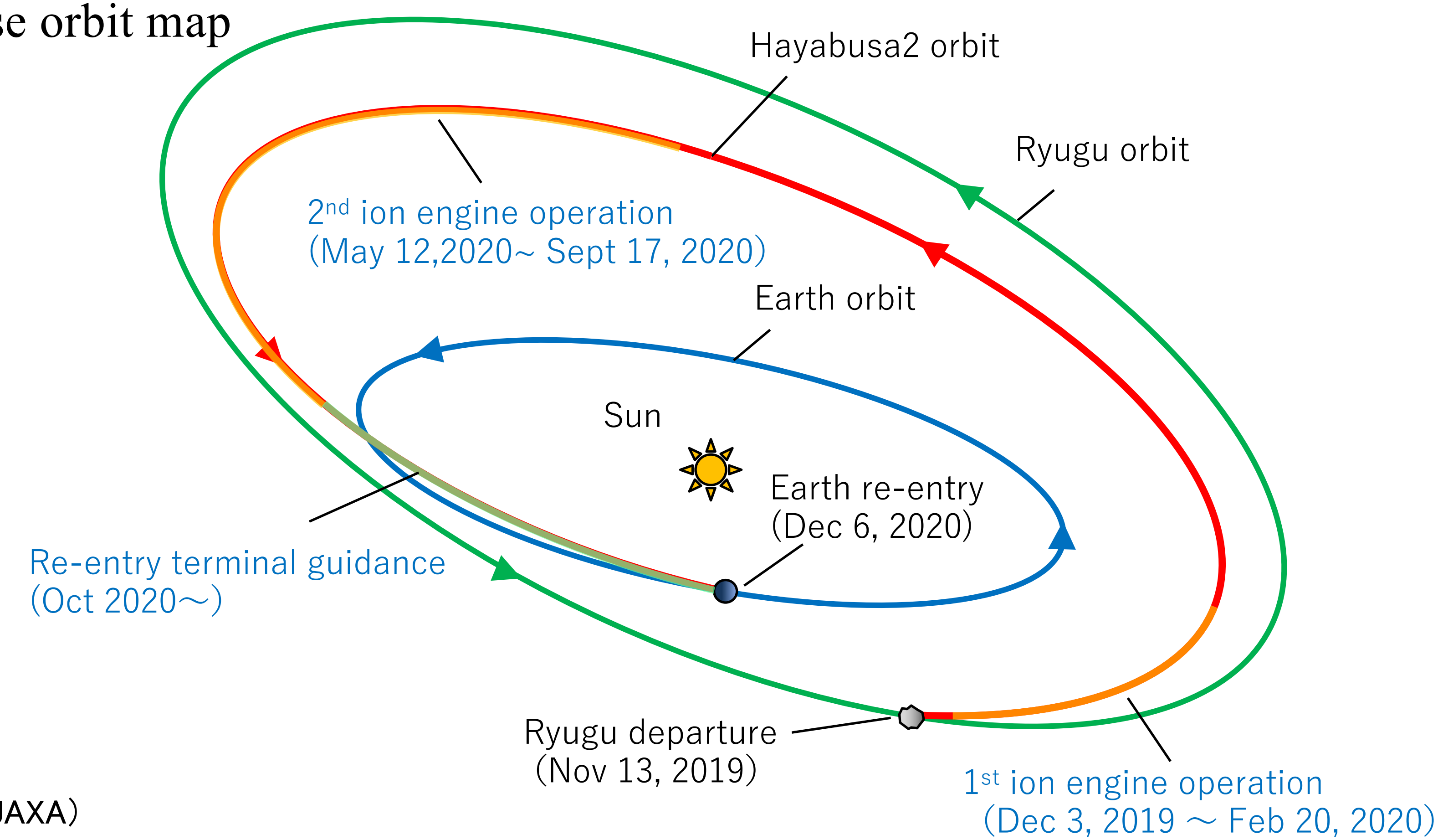
■Press and media briefings

November 2020（TBD）　　　Press briefing @ online（TBD）

Reference material

Return cruise operation plan

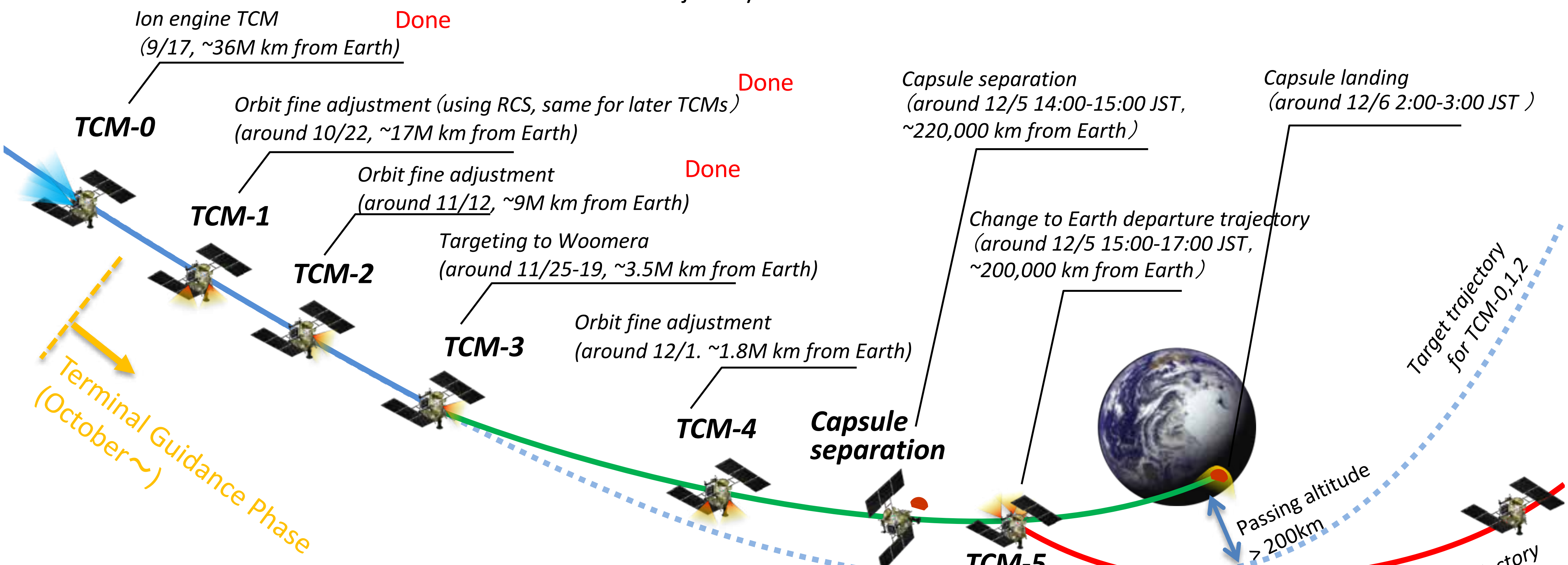
Return phase orbit map



(image credit：JAXA)

Operation plan for re-entry terminal guidance

※TCM: Trajectory Correction Maneuver



- May change depending on conditions.
- At TCM-0,1,2, the spacecraft will enter an orbit that passes more than 200 km away from the Earth.
- After capsule separation, the spacecraft will divert from the reentry trajectory by TCM-5.

(Image credit：JAXA)