

Asteroid explorer, Hayabusa2, reporter briefing

September 24, 2019

JAXA Hayabusa2 Project



Topics



Regarding Hayabusa2,

- Results from the target marker separation operation
- The MINERVA-II2 (Rover2) separation operation

※ Rover2 (MINERVA-II2) will also be described by Tohoku University, representing the university consortium



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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.



Hayabusa 2 primary specific information: (Illustration: Akihiro Ikeshita)

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

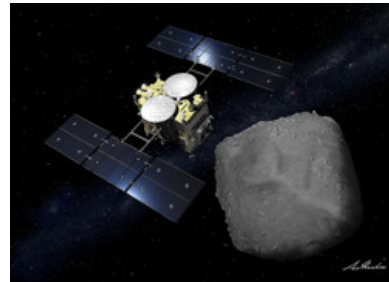
Launch
Dec 3, 2014



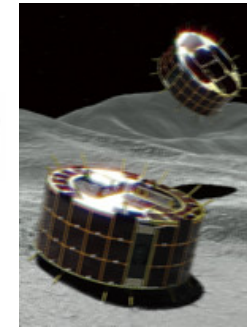
Earth swing-by
Dec 3, 2015



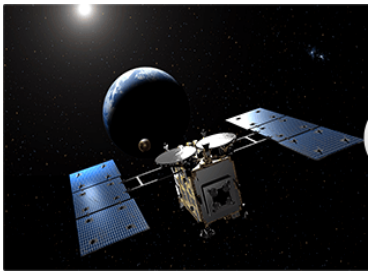
Ryugu arrival
June 27, 2018



MINERVA-II-1 separation
Sep 21, 2018



MASCOT separation
Oct 3, 2018



Ryugu departure
Nov~Dec, 2019

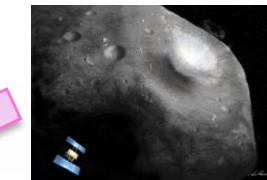
Earth return
End of 2020

completed →

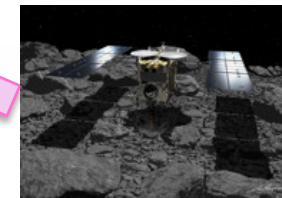
July 11, 2019



Second touchdown



Impactor (SCI)
5 April, 2019



First touchdown
Feb 22, 2019

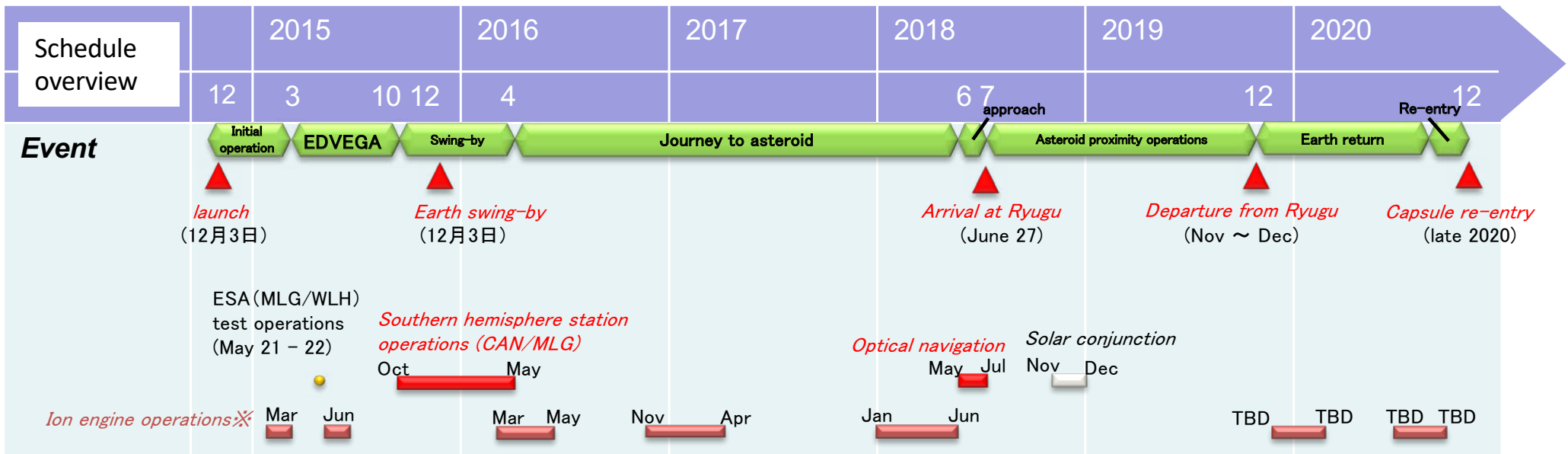
(image credit: illustrations including spacecraft by Akihiro Ikeshita, others by JAXA)



1. Current project status & schedule overview

Current status :

- The target marker separation operation was conducted from September 12 ~ 17. On September 17 at 01:17 and 01:24 JST, we were able to separate two target markers as scheduled.
- After target marker separation, the spacecraft ascended to image the target marker as it orbited from an altitude of about 20km. We have confirmed that the imaging was successful. In the future, the trajectory will be analyzed.
- An operation plan for the separation of Rover2 (MINERA-II2) has been created.





2. Temporary postponement of the target marker separation



- As a rehearsal for Rover2 (MINERVA-II2) separation operation, the target marker separation operation scheduled for September 5 was postponed until September 16.
- This was due to the spacecraft being in the Safe-Hold (※) state.
 - ※ When any abnormality is detected in the spacecraft, the solar cell panel is directed towards the Sun and the level of power generation is held constant. The spacecraft is placed into a spin (rotation) state that stabilizes the posture and only the minimum necessary devices are operational, such as that for communication. This prioritises the spacecraft's safety. For Hayabusa2, the spacecraft accelerates away from Ryugu to avoid a collision with the asteroid.

■ Reason for Safe-Hold:

- An abnormal reading was detected during the testing of the spare reaction wheel.
- Hayabusa2 is equipped with four reaction wheels for attitude control, and usually three of them are used. The remaining wheel is a reserve.
- On August 29, an operation test for the reserved reaction wheel was scheduled before the return to Earth. An abnormal value (increased torque) was detected, so the spacecraft autonomously entered the Safe-Hold state. The cause of the increased torque is currently being investigated.
- Entering the Safe-Hold state indicates that the functions designed to keep the spacecraft safe are operating normally.

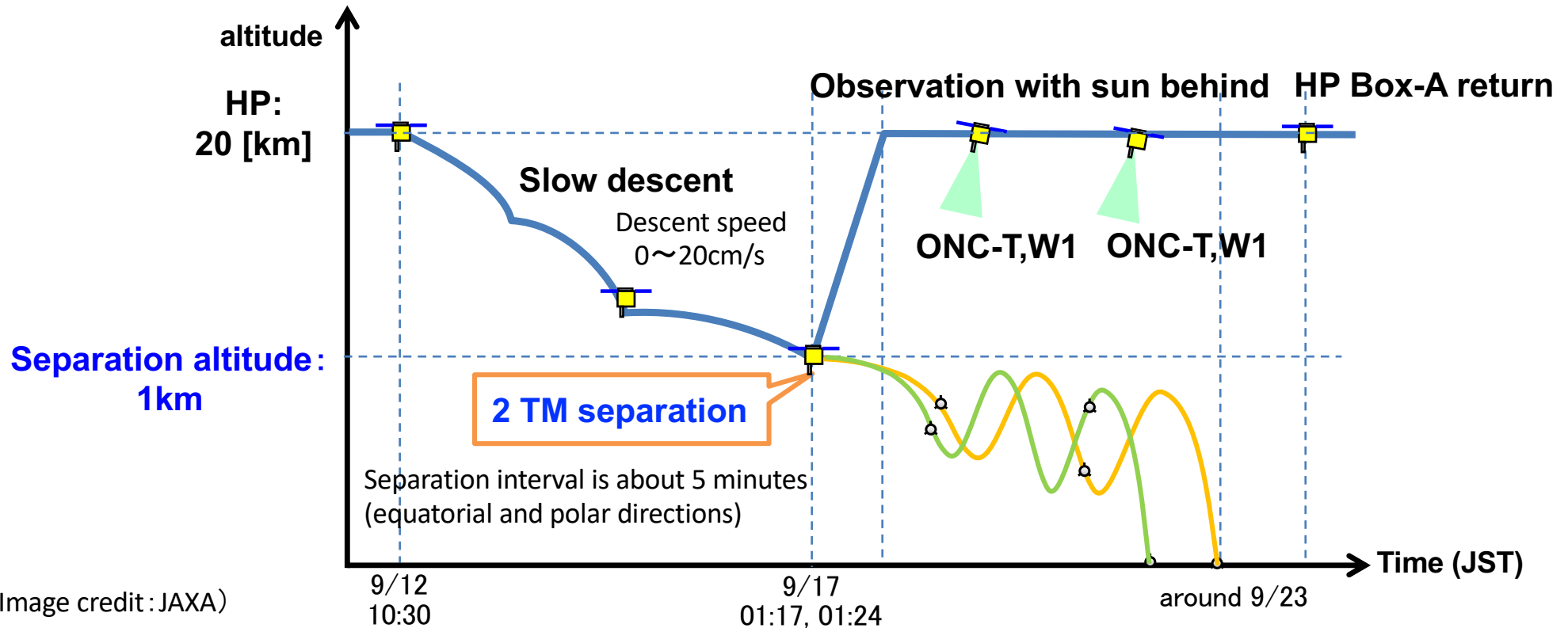


3. Target marker separation operation results



Overview of target marker separation operation

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



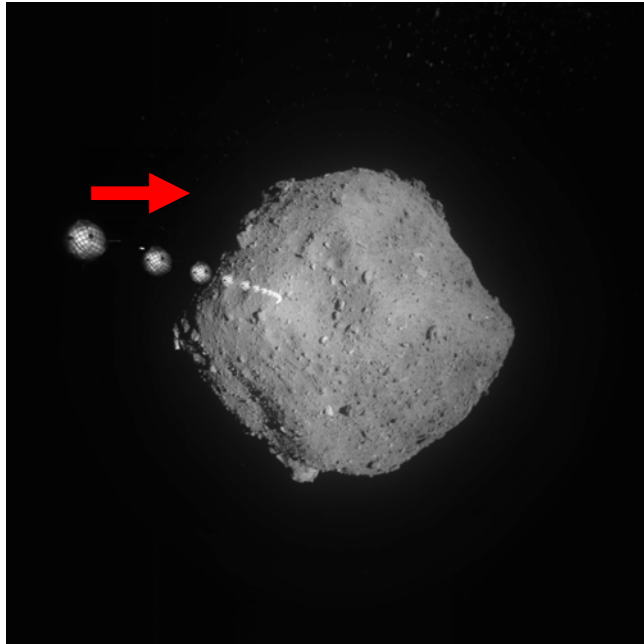
(Image credit : JAXA)



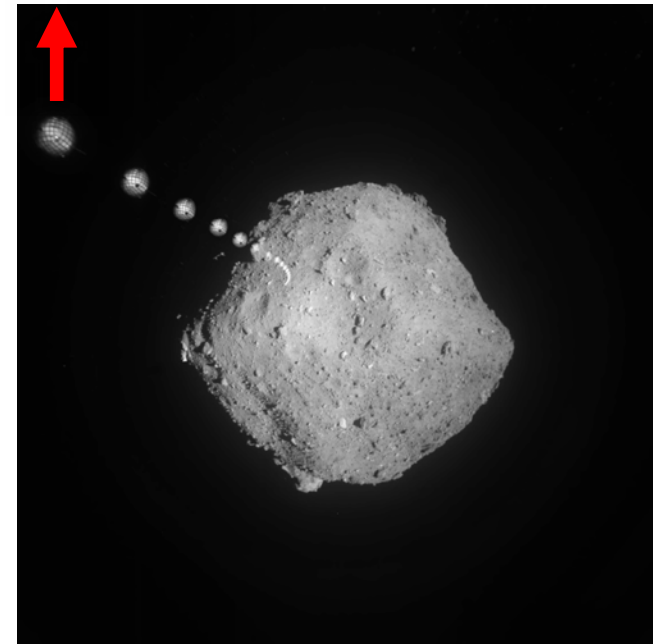
3. Target marker separation operation results



Target marker E separation
(separation time: 2019/9/17 01:17 JST)



Target marker C separation
(separation time: 2019/9/17 01:24 JST)



Separation at an altitude of about 1 km. Continuous image sequence (for about 1 minute) captured every 4 seconds. Images taken while the spacecraft is ascending at 11cm/s. Target markers separated at about 12 cm/s in the horizontal direction (approximate direction of separation is indicated by the red arrow). Although the descent speed is almost zero, the target marker appears to get smaller as the spacecraft is rising.

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



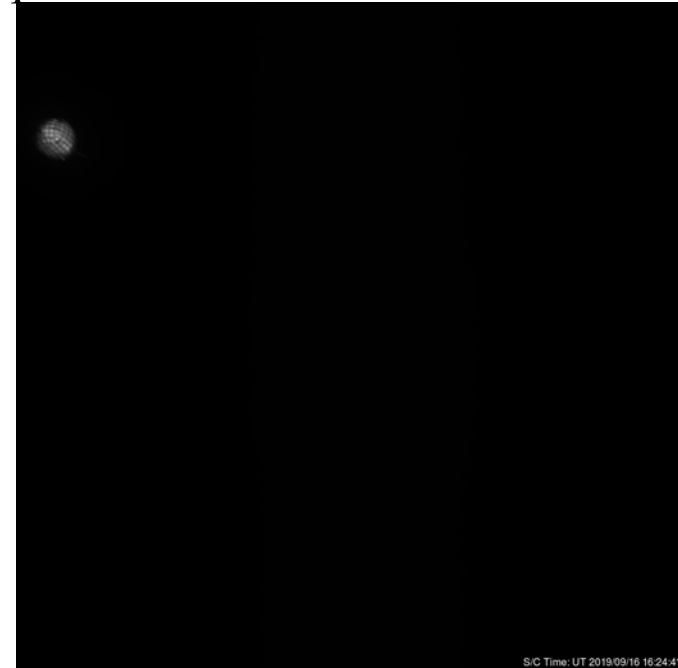
3. Target marker separation operation results



Target marker E separation
(separation time: 2019/9/17 01:17 JST)

Target marker C separation
(separation time: 2019/9/17 01:24 JST)

(animation)



Animation of the target markers taken from the spacecraft. Images captured at 4s intervals. In the first image, the distance to the target marker is about 1m, and in the final image is about 9m (the target marker is not dropping, but the spacecraft moves away from the target marker.)

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



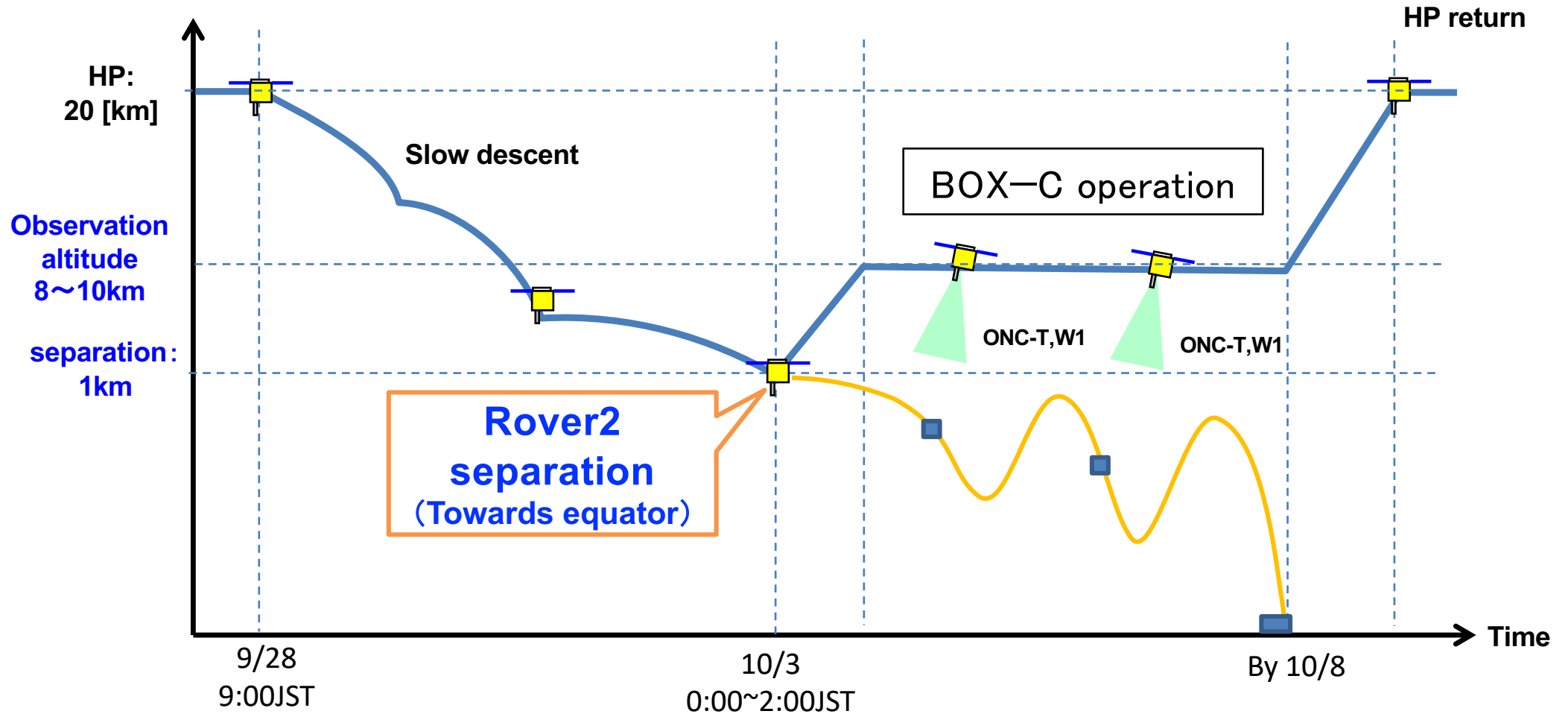
4. MINERVA-II2 (Rover2) separation operation



- At the press briefing on 2018/11/8, Tohoku University announced the status of the MINERVA-II2: “Study with JAXA to acquire meaningful results”.
- Study meetings were held involving the Hayabusa2 Project, Tohoku University, Kyushu Institute of Technology and Colorado University, USA.
- Consortium plan:
 - “Landing on the asteroid surface: Acquire useful scientific results while descending to the surface of the asteroid”
 - Expected outcomes:
 - Scientific results: Contribution to higher accuracy estimations of Ryugu’s gravitational field.
 - Engineering results: Separation and landing of a small space probe from high altitude, flight trajectory analysis.
 - Operation plan (in agreement with Tohoku University)
 - Separate Rover2 at high altitude (~1km) in an equatorial orbit.
 - From information from Tohoku University, the separation device will give a separation speed between 13 cm/s ~ 17 cm/s.
 - The separation sequence has been assembled under these conditions, and the separated Rover2 will be tracked as much as possible through optical observations by Hayabusa2



4. MINERVA-II2 (Rover2) separation operation





5. Outreach



- Exchange of opinions meeting on outreach and educational activities with Hayabusa2 Part 2.
 - Held on August 25 at the Sagamihara City Museum. About 30 people outside the project participated.
 - Various opinions were exchanged regarding data released from the project and future activities.
 - The next meeting will be held on September 29 at the Osaka City Science Museum.



5. Outreach

■ Hayabusa2 Talk Live Extra

- Sagami-hara City Museum (8/25、14:00～) ← Finished (~170 participants)
- Osaka City Science Museum (9/28、17:30～) ← First event outside Sagami-hara City Museum
<http://www.sci-museum.jp/>
- Itami City Children's Science Museum (9/29、14:30～)
<http://business4.plala.or.jp/kodomo/>

■ 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 Sagami-hara City Museum)
- Nationwide: Looking for venues
- Details (Japanese): http://www.hayabusa2.jaxa.jp/topics/20190807_TalkLive/



6. International conference report



■ EPSC-DPS Joint Meeting 2019

- EPSC (European Planetary Science Congress)
- DPS (AAS Division for Planetary Science)
- Sept. 15-20, 2019, Geneva International Convention Center
- Hayabusa2 and OSIRIS-REx joint session was held on September 17 (16 oral presentations related to Hayabusa2)
- A press briefing for Hayabusa2 was held on September 17. About 10 people from the media participated.



The large venue where the Hayabusa2 presentations were held (Hayabusa2 Project photograph)



Press briefing (Hayabusa2 Project photograph)



7. Future plans



■ Operation schedule

9/28 (Sat.) 9:00~ Begin descent for Rover2 separation

10/3 (Thurs.) 0:00~2:00 Rover2 separation

(Separation status will be announced on the Hayabusa2 official twitter:
@haya2_jaxa/@haya2e_jaxa)

■ Press briefing

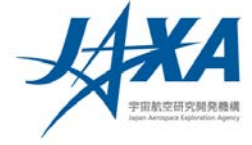
10/2 (Wed.) 14:00~ Regular press briefing @ Sagamihara Campus

(Study results from the MASCOT team, with simultaneous interpretation)

Late October (TBD) Regular press briefing @ Tokyo office



Reference



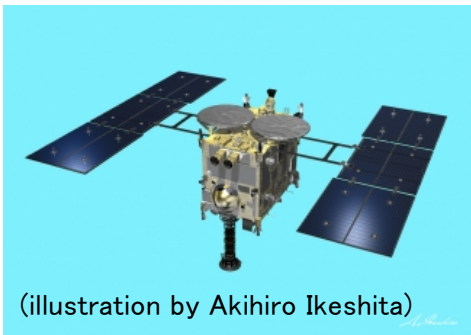
Hayabusa2 reaction wheels

The reaction wheel is a device used to control the attitude of satellites and spacecraft. It contains a metal disk that rotates at high speed.

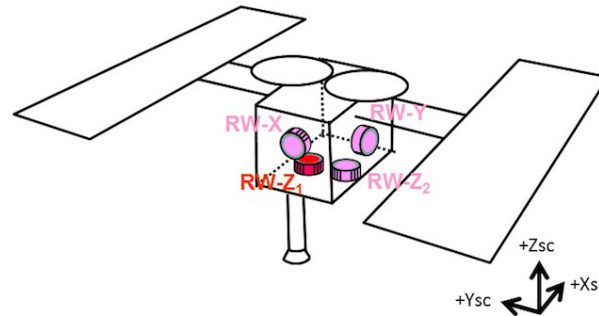
As an example, imagine playing with a toy spinning top. As it spins in the air, the top always faces the same direction. A reaction wheel takes advantage of this property so that if the disk is kept rotating in the spacecraft, the spacecraft will continue to point in the same direction. Furthermore, accelerating or decelerating the disk results in the spacecraft rotating or stopping due to the reaction force. This allows the spacecraft to take the desired attitude.



Hayabusa2 reaction wheels



(illustration by Akihiro Ikeshita)



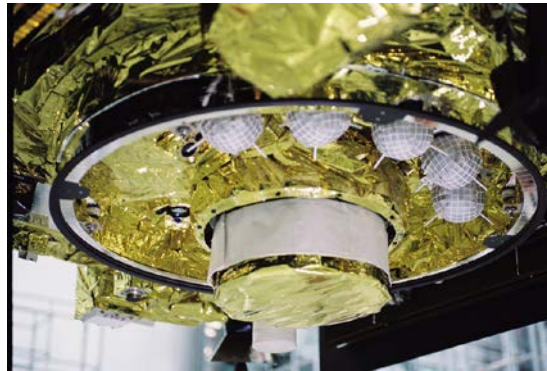
CG image of Hayabusa2 (left) and schematic diagram of reaction wheel layout (right). The spare reaction wheel that was tested this time is located in red on the right figure.

Video about the reaction wheels (JP): https://fanfun.jaxa.jp/c/jaxaclub/cgi-bin/index3857.html?MODE=NEWS_DETAIL&ID=821





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
- 2019/09/17 E and C dropped



(Image credit : JAXA)