Asteroid explorer, Hayabusa2, reporter briefing

May 22, 2019

JAXA Hayabusa2 Project

Topics

Regarding Hayabusa2,

- Results from the low altitude descent observation operation (PPTD-TM1)
- Future operations

Contents

0. Hayabusa2 and mission flow outline
1. Current status and overall schedule of the project
2. Low altitude descent observation operation (PPTD-TM1) results
3. Future operation plans
4. Upcoming events

・Reference material

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

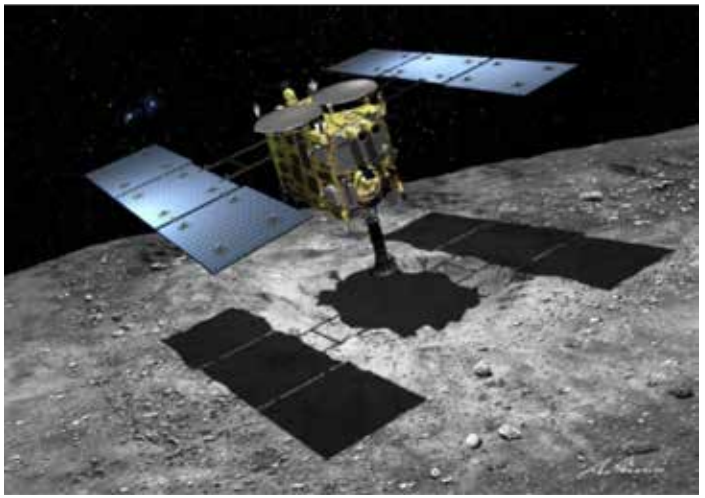
- By exploring a C-type asteroid, which is rich in water and organic materials, we will clarify interactions between the building blocks of Earth and the evolution of its oceans and life, thereby developing solar system science.
- Japan will further its worldwide lead in this field by taking on the new 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

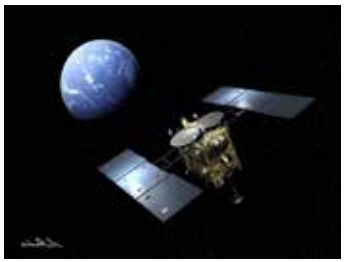
Primary instruments

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

Mission flow

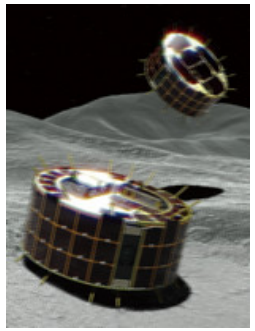
Launch
Dec 3, 2014

Earth swing-by
Dec 3, 2015

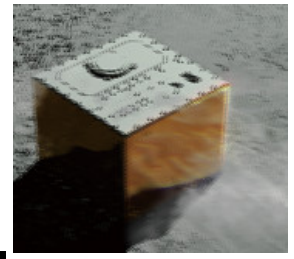


Ryugu arrival
June 27, 2018

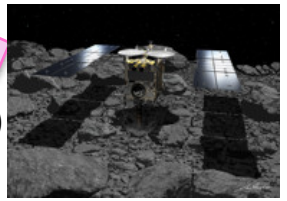
MINERVA-II-1 separation
Sep 21, 2018



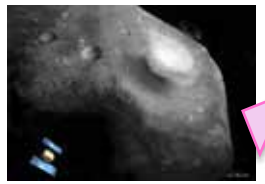
MASCOT separation
March 10, 2018



Feb 22, 2019

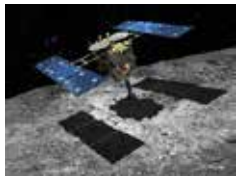


First touchdown



Impactor (SCI)
5 April, 2019

completed →



After confirming safety,
touchdown at or near crater area
to collect subsurface material.

Ryugu departure
Nov～Dec, 2019

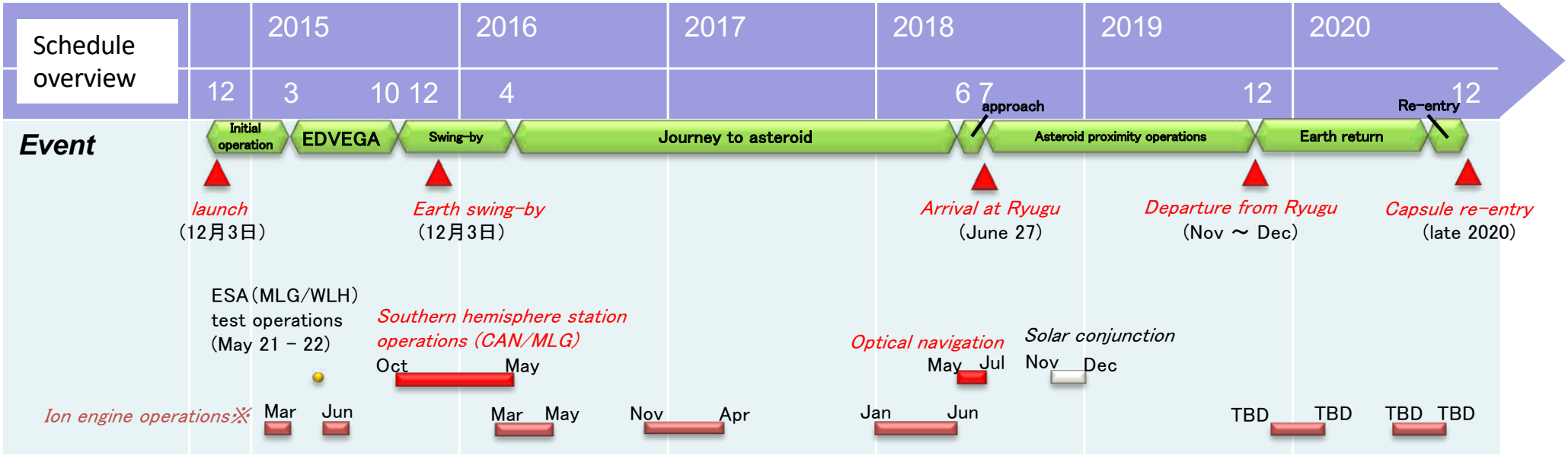
Earth return
End of 2020

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

1. Current project status & schedule overview

Current status:

- From May 14 ~ 16, the low altitude descent observation operation (PPTM-TM1) was performed. At an altitude of about 50m, the spacecraft autonomously aborted (and ascended).
- The spacecraft return to the home position on May 17.
- Results from PPTD-TM1 are being analyzed and future operations considered.

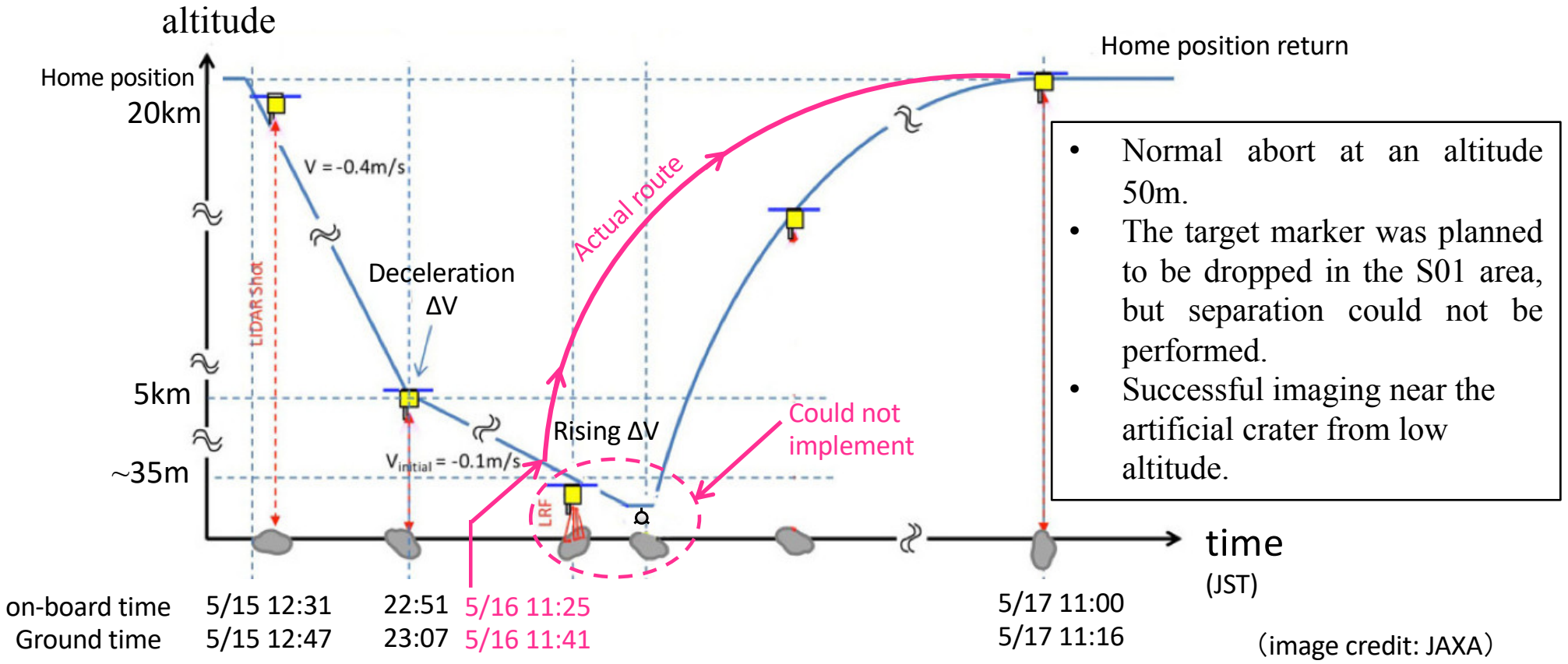


2. Low altitude descent observation operation （PPTD-TM1）results

- The low altitude descent observation operation (Pinpoint Touchdown – Target Marker 1: PPTD-TM1) was performed between May 14 ～16.
- Preparations were made for the descent (May 14) which began on May 15, 12:31 JST (on-board time) and continued to an altitude of about 50m.
- On May 16 at 11:25 JST, when the altitude was about 50m, the descent was stopped by autonomous judgement of the spacecraft and the spacecraft began to rise (normal abort procedure).
- On May 15 at 11:00 JST, the spacecraft returned to the home position. The spacecraft has no abnormalities.
- The cause of the normal abort turned out to be due to an issue with the LIDAR measurement.
- Although it was not possible to drop the target marker, low altitude imaging near the artificial crater site was successful.

2. Low altitude descent observation operation （PPTD-TM1）results

PPTD-TM1 operation



- Normal abort at an altitude 50m.
- The target marker was planned to be dropped in the S01 area, but separation could not be performed.
- Successful imaging near the artificial crater from low altitude.

（image credit: JAXA）

2. Low altitude descent observation operation （PPTD-TM1）results

The normal abort

■Event

- The spacecraft detected an anomaly in the altitude value received from LIDAR and autonomously transitioned to the normal abort state (stopped the descent and began to rise).
  - The ‘normal abort’ is a mode that is triggered when a minor abnormality occurs (e.g. sensor output abnormality etc).

■Cause of altitude anomaly

- The received sensitivity of LIDAR light can be adjusted according to the altitude. In this operation, the received sensitivity was adjusted during an automatic sequence when the spacecraft passed 50m altitude. Due to noise data being mixed in at that time, the LIDAR output returned an unusually high altitude value.
  - This is the first time that the received sensitivity change has been performed at low altitude. As the descent accuracy of Hayabusa2 was higher than originally expected, this measure was introduced to prevent the LIDAR from going crazy with a strong reflection, even when the LIDAR light hit the target marker.
  - It was difficult to predict in advance how the noise data would affect the signal, as is changes on a case-by-case basis according to the environment of Ryugu and the situation of Hayabusa2.

■ Future measures

- After this event occurred, we found a adjustment method that could reliably prevent noise mixing. This will be adopted from now on.

2. Low altitude descent observation operation （PPTD-TM1）results

Imaging during the spacecraft ascent

- Spacecraft operation was set to image the surface of the asteroid, even if the spacecraft ascended due to an abort.
- The region of the surface imaged depended on the abort situation, but fortunately we were able to image near the artificial crater.
- The acquired data is valid for the assessing the possibility of a future touchdown.
- Although the target marker could not be dropped due to the abort, as the vicinity of the artificial crater was imaged, there will be no delay in the future operation plans.

2. Low altitude descent observation operation （PPTD-TM1）results

Today's release

Imaging during the spacecraft ascent

From about 0.5 km altitude

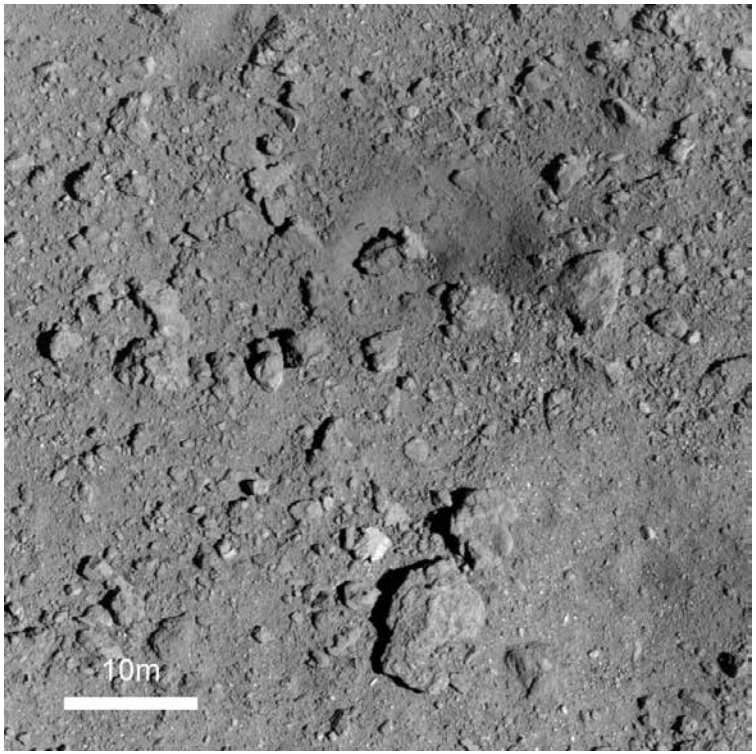


Image time：May 16, 2019, 11:36 JST（on-board time）

From about 0.6 km altitude

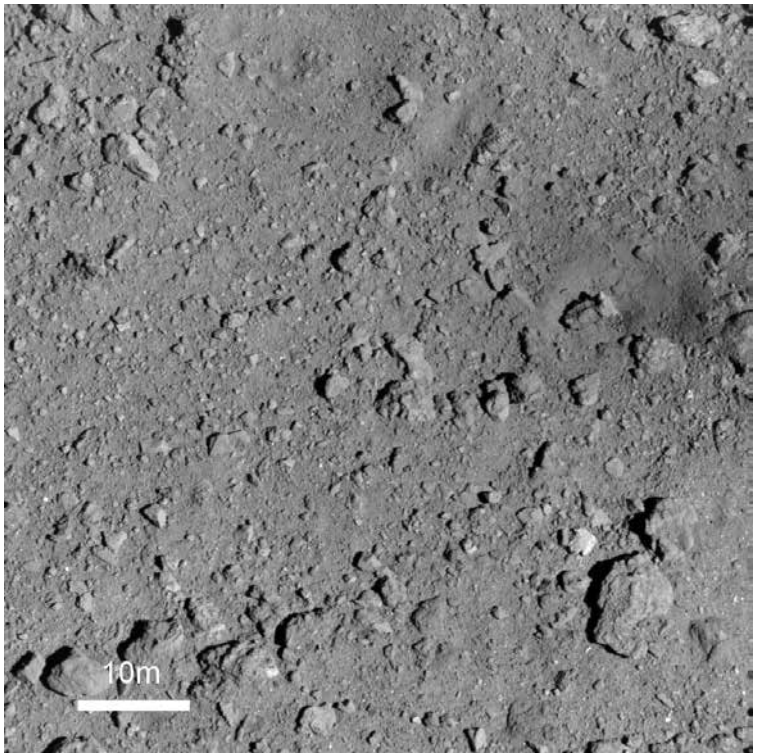


Image time： May 16, 2019 2019, 11:39 JST（on-board time）

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

2. Low altitude descent observation operation （PPTD-TM1）results

Imaging during the spacecraft ascent

labelled

From about 0.5 km altitude

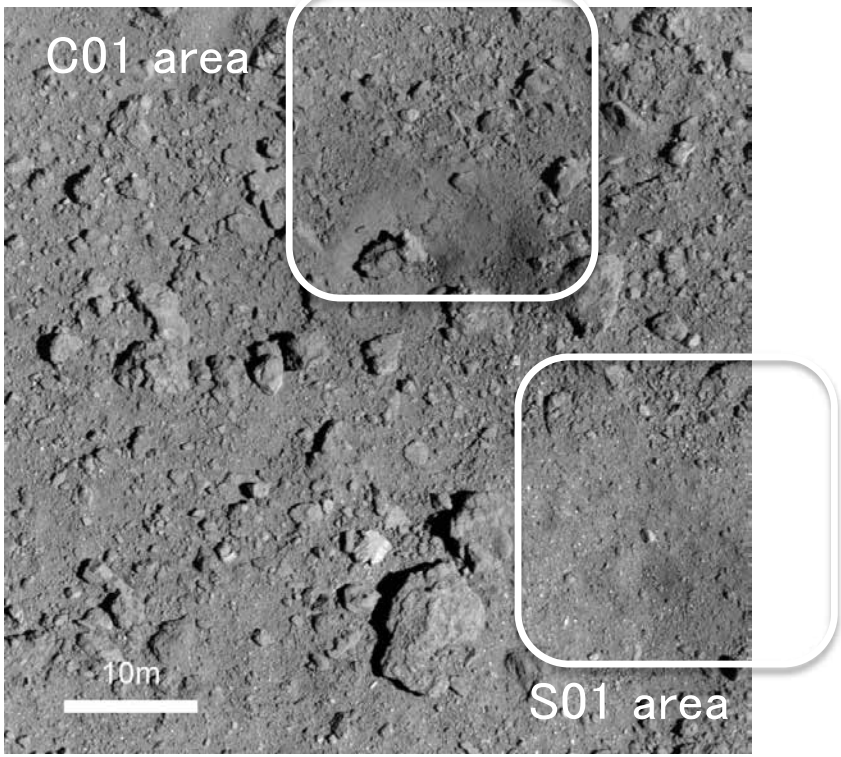


Image time：May 16, 2019, 11:36 JST（on-board time）

From about 0.6 km altitude

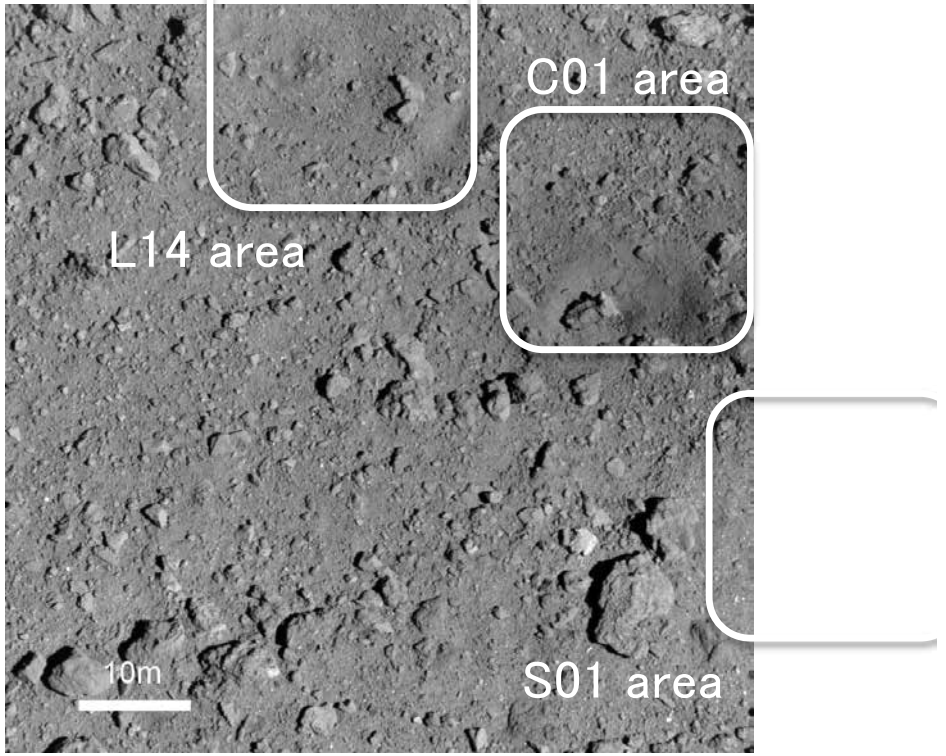


Image time： May 16, 2019 2019, 11:39 JST（on-board time）

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

3. Future operation plans

■ Operation plan concept from May ~ July

- Currently, Ryugu is approaching the Sun (perihelion in September). It will only be possible to land on Ryugu until the end of July, after which the asteroid temperature will rise.
- By the middle of June, the crater and state of the spacecraft will have been examined and it will then be decided if a second touchdown operation will be performed between the end of June and start of July.
  - Target point: Area where there is ejected material from the artificial crater.
  - Operation name: “Pinpoint touchdown” (PPTD).
- 2 or 3 low altitude descent observations will be performed in May and June before the PPTD operation. While performing detailed topographical observations of the landing point candidates, a target marker will be dropped as a guide for landing in this region.
  - 1st: 5/14～5/16 Operation name: PPTD-TM1 → target marker could not be dropped
  - 2nd: 5/28～5/30 Operation name: PPTD-TM1A
  - 3rd: week of 6/10 Operation name: PPTD-TM1B (provisional)
- During PPTD-TM1A, a target marker will be dropped at one of the candidate landing points. At this time, C01 is thought to be the best area among those shown in the detailed image obtained during the last operation.

3. Future operation plans

※No change from the explanation in the May 9 press briefing session

■Outlook for future touchdown operations

The decision to perform a touchdown operation will be based on consideration of the following points:

（1）Scientific & engineering value of the 2nd touchdown

- Is the risk during the touchdown operation small enough and the expected value of the second touchdown high enough?
- Is It highly likely that artificial crater ejecta can be collected?

（2）Feasibility of the touchdown operation

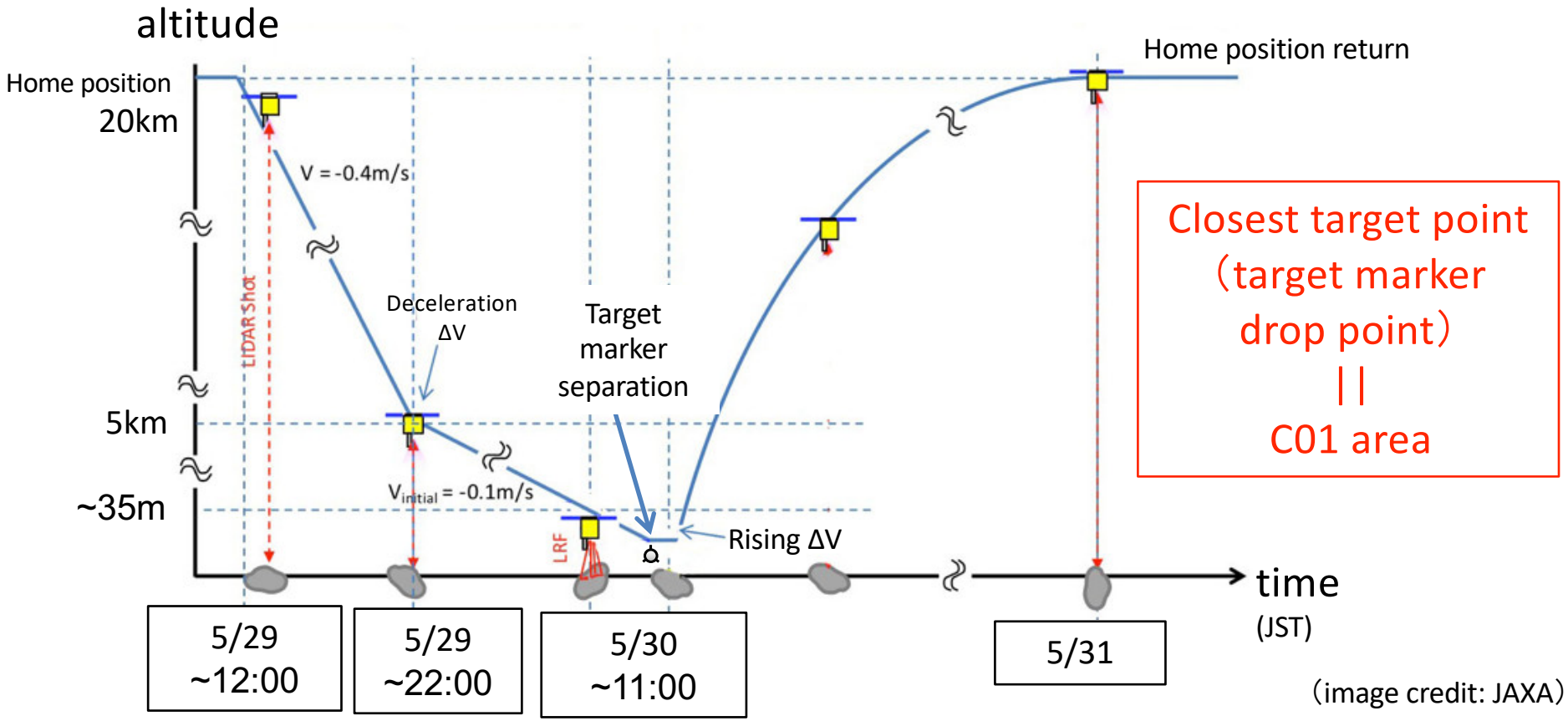
- Can the terrain information necessary for touchdown be obtained and a sufficiently safe touchdown sequence be designed?
- Can the target marker be dropped close to the touchdown target point?

（3）Spacecraft condition

- During the 1st touchdown, the optical system became cloudy due to dust. Can we confirm that a second touchdown can be performed without any problems given this situation?

3. Future operation plans

PPTD-TM1A operation ※Sequence is the same as for PPTD-TM1

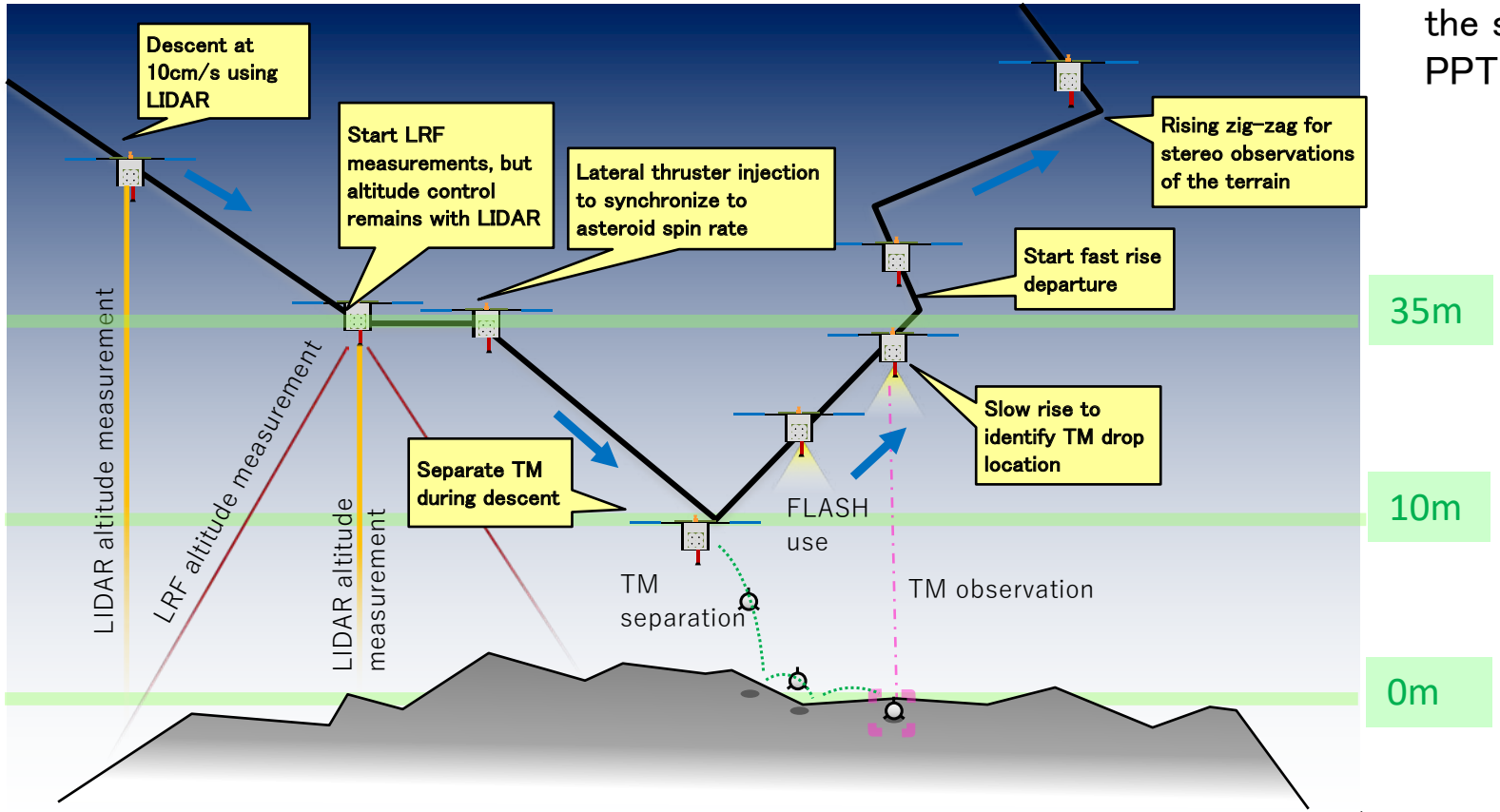


(image credit: JAXA)

3. Future operation plans

Low altitude sequence during PPTD-TM1A operation

※Sequence is the same as for PPTD-TM1



(image credit: JAXA)

4. Upcoming events

■Operation plans

- May 28～30：Descent and target marker separation operation （PPTD-TM1A）

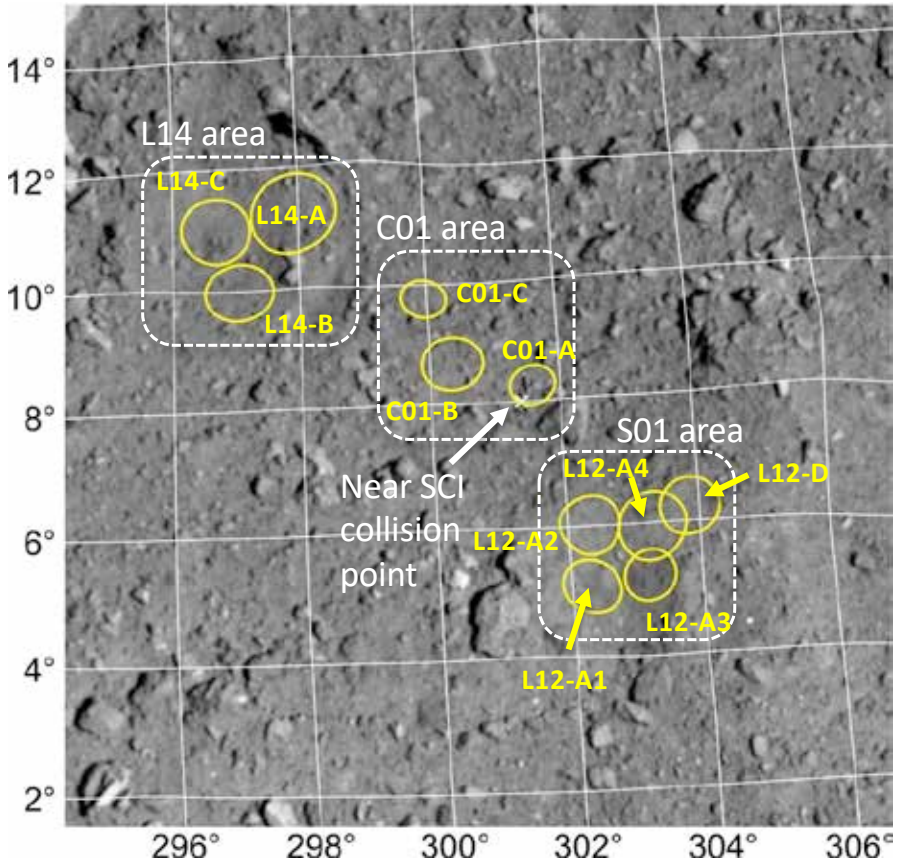
■Press and media briefings

- June 11 15:00～： Press briefing session @ Tokyo office

Reference

Low altitude descent observation operation（PPTD）

■Currently identified touchdown candidate points

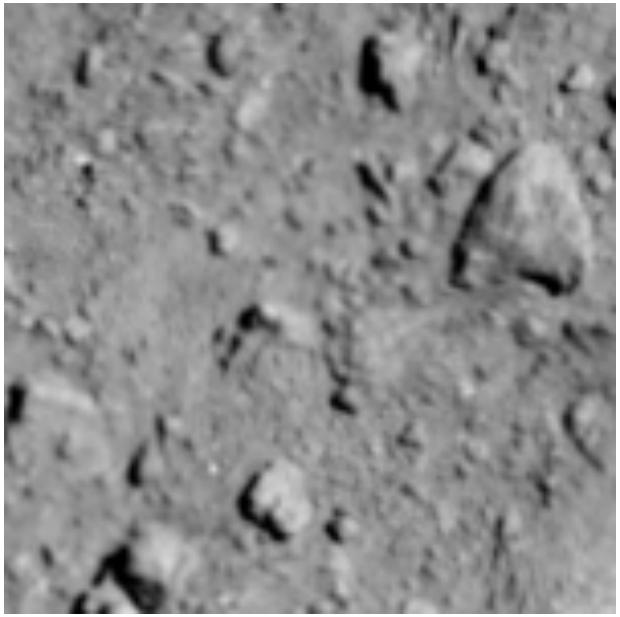


- CO1 is the area where the artificial crater was generated.
- S01 is that area that was observed in March this year as a backup candidate site for TD2.
- L14 was identified at the time of the landing point selection for the first touchdown, that was carried out in August last year.
- The yellow circles (approximate position) denote currently identified touchdown candidate points (all are 6 ~ 12 m in diameter)

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

Terrain change before and after the SCI collision

Before SCI collision 2019/03/22



After SCI collision 2019/04/25

Comparison before & after (blink image)

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