Asteroid explorer, Hayabusa2, reporter briefing

November 30, 2020

JAXA Hayabusa2 Project

Topics

Regarding Hayabusa2

- Results from TCM-3
- Details of capsule separation and re-entry
- Preparation status for capsule collection

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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

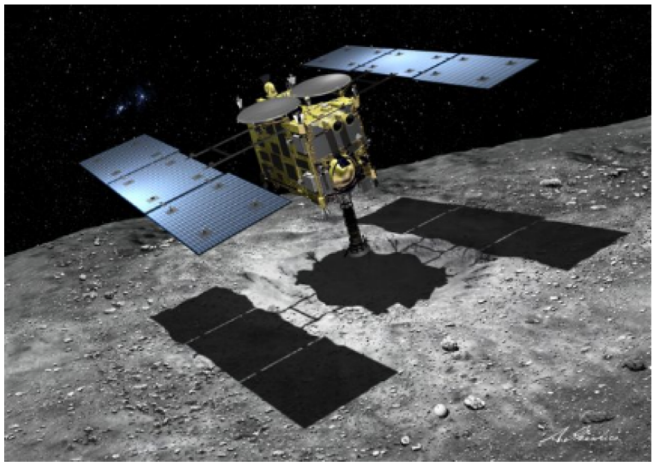
- By exploring a C-type asteroid, which is rich in water and organic materials, we will clarify interactions between the building blocks of Earth and the evolution of its oceans and life, thereby developing solar system science.
- Japan will further its worldwide lead in this field by taking on the new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

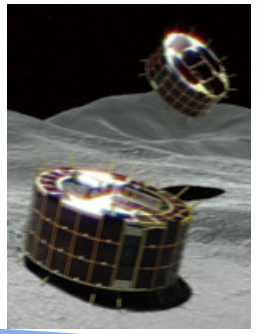
Mission flow

Launch
Dec 3, 2014

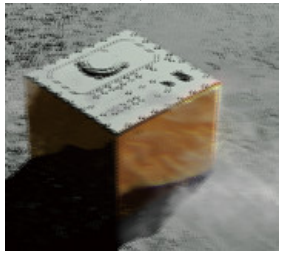
Earth swing-by
Dec 3, 2015

Ryugu arrival
June 27, 2018

MINERVA-II1 separation
Sep 21, 2018

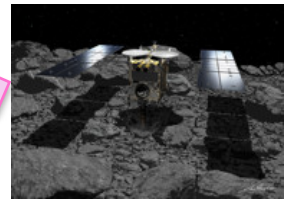


MASCOT separation
Oct 3, 2018

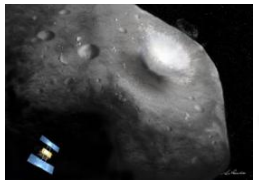


Target marker separation
Oct 25, 2018

First touchdown
Feb 22, 2019



Impactor (SCI)
5 April, 2019

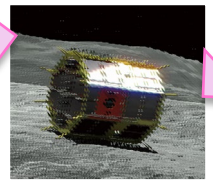


Target marker separation
May 30, 2019

Second touchdown
July 11, 2019

Target marker separation
Sept. 17, 2019

MINERVA-II2 separation
Oct. 3, 2019



Ryugu departure
Nov 13, 2019

complete →

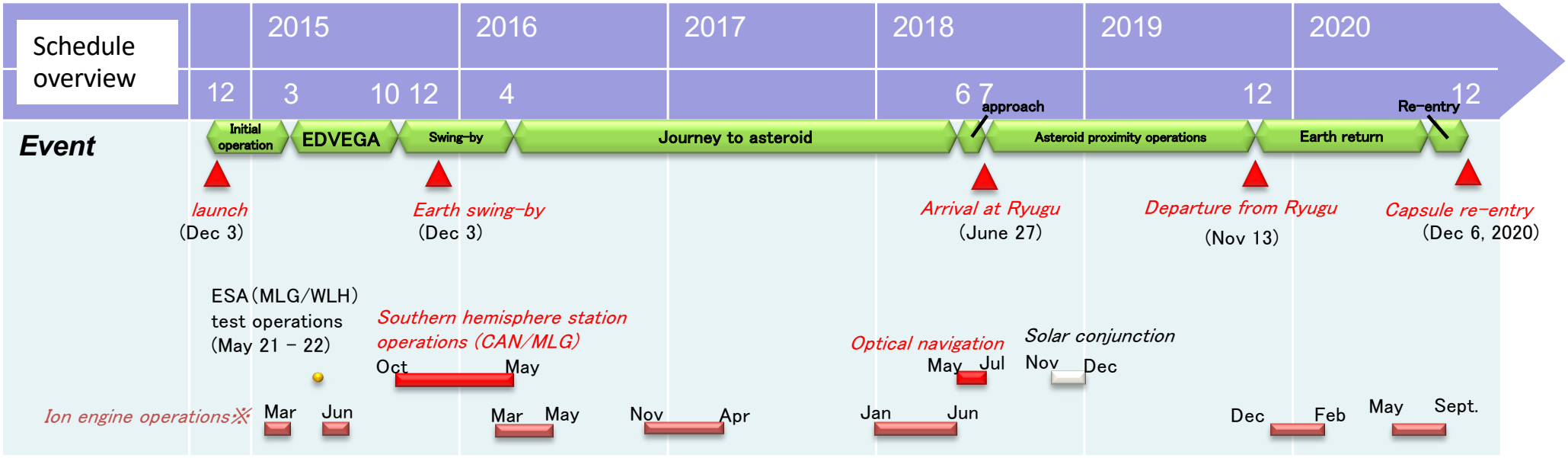
Earth return
Dec. 6, 2020

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

1. Current project status & schedule overview

Current status:

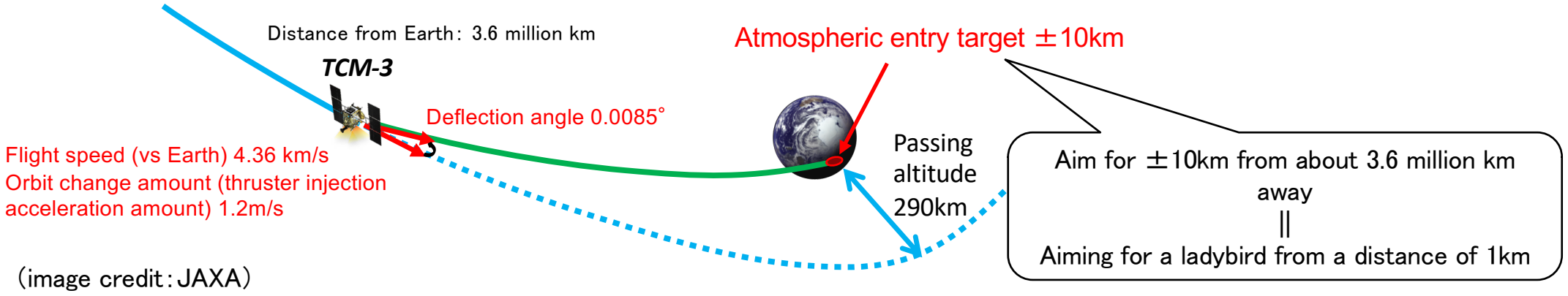
- On November 25, we obtained permission from Australia to transition to the re-entry orbit.
- TCM-3 was conducted on November 26, and the control maneuver to place the spacecraft into the atmospheric entry orbit towards Woomera, Australia was completed.
- After precisely estimating the resultant orbit, it was determined that it was unnecessary to correct the TCM-3 orbit itself, and it was decided to move onto the next TCM-4.
- In Woomera, the preparations underway for re-entry capsule recovery.



(image credit: JAXA)

2. Results from TCM-3

- On November 25, we obtained permission from the Commonwealth Return Safety Officer (CRSO) to transition Hayabusa2 onto the re-entry trajectory to the Woomera Prohibited Area (WPA) in Australia.（Judgement found no problem with navigation, guidance, planning, spacecraft or ground system)
- On November 26, TCM-3, the third precision orbit control using the chemical engines (RCS) was performed, and the orbit correction was achieved as planned（TCM: Trajectory Correction Maneuver）.
- The main control for TCM-3 was performed around 16:00 JST and the controlled correction (trim) around 17:00. The orbit control amount was about 1.2 m/s.

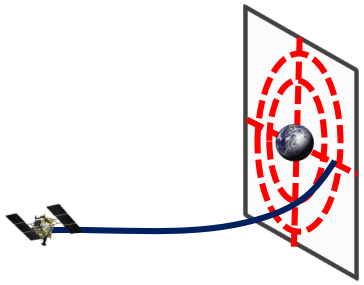


（image credit：JAXA）

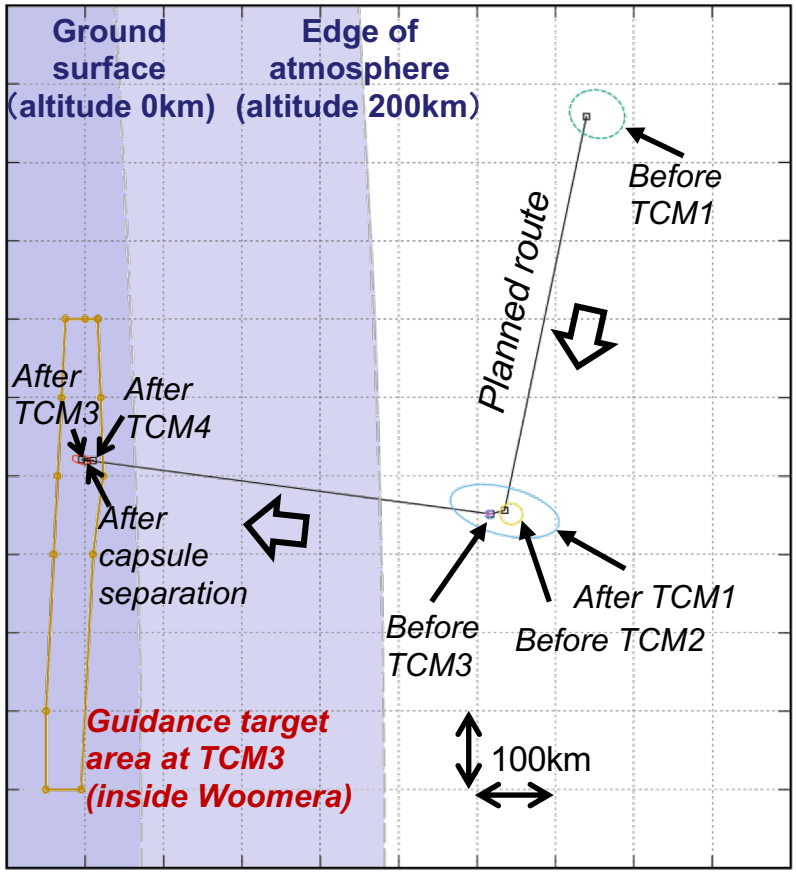
2. Results from TCM-3

Orbit guidance by TCM

※For each TCM, there are 2 cycles of practice/production



In precision guidance, a virtual target is set around the Earth and orbit control is performed to aim for a specific point on that target.



(image credit: JAXA)

Team movement at TCM-4

11/30 1-12 JST
Orbit determination: measure and calculate the flight position of the spacecraft.（JAXA, Fujitsu, JPL）

↓

11/30 13-14 JST
Orbit evaluation: evaluate calculation results of the flight position and chose one from 3 solutions (JAXA, Fujitsu, JPL, NEC)

↓

11/30 14-19 JST
Trajectory plan: create trajectory correction plan（JAXA, NEC）

↓

11/30 17-22 JST
Attitude plan: attitude plan for injection, create thruster injection plan (JAXA)

↓

11/30 night 22-23 JST
Confirm plan: Final confirmation meeting (TCM Go/No Go)
※ The Australian permit was obtained after TCM3

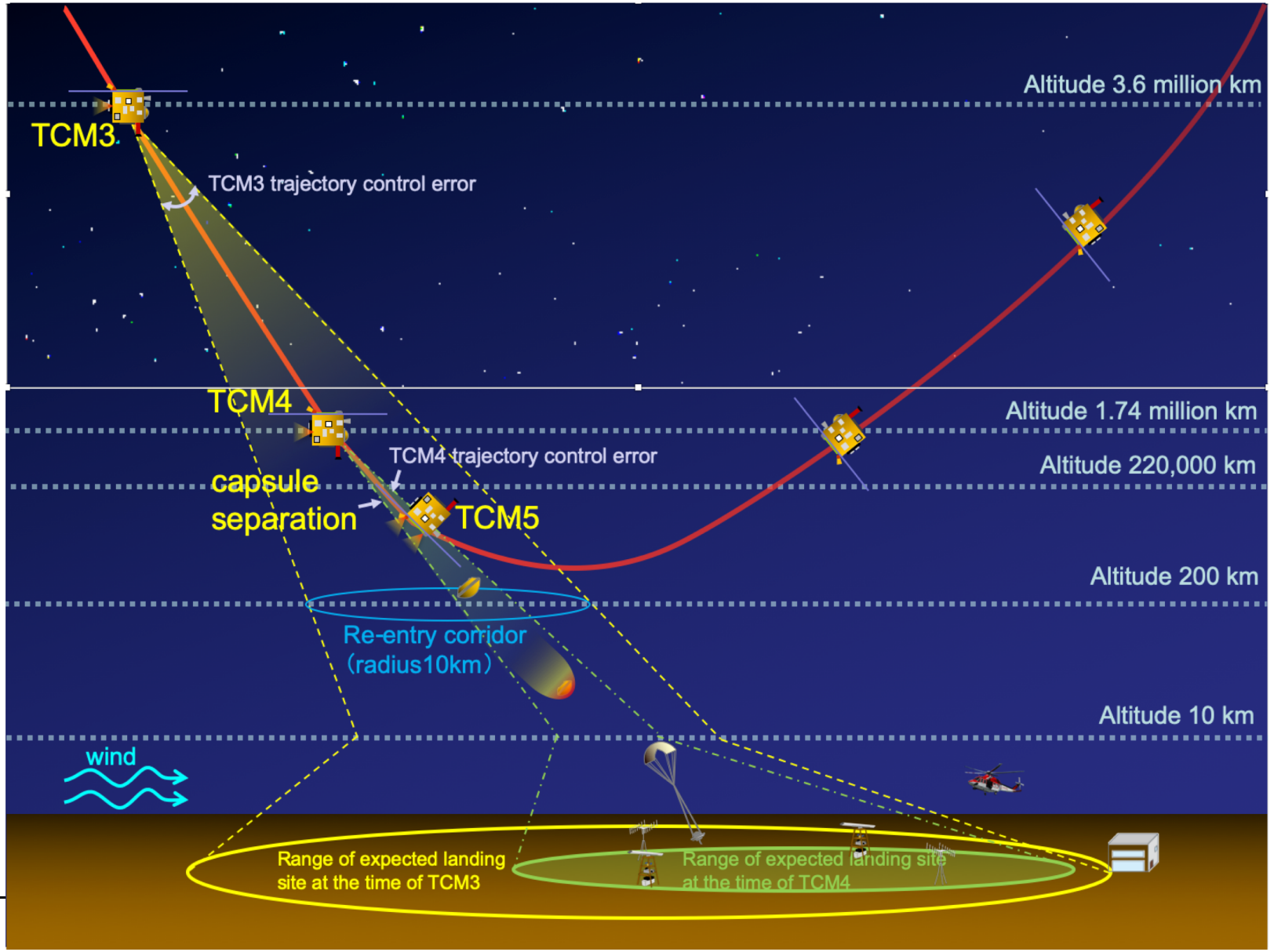
↓

12/1 all day
Actual operation

2. Results from TCM-3

TCM3、TCM4 concept

- ✓ TCM3 adjusts the course to one that enters the atmosphere over Woomera.
- ✓ TCM4 modifies this trajectory to land closer and more accurately to the area where the recovery team awaits.



（image credit：JAXA）

2020/11/30

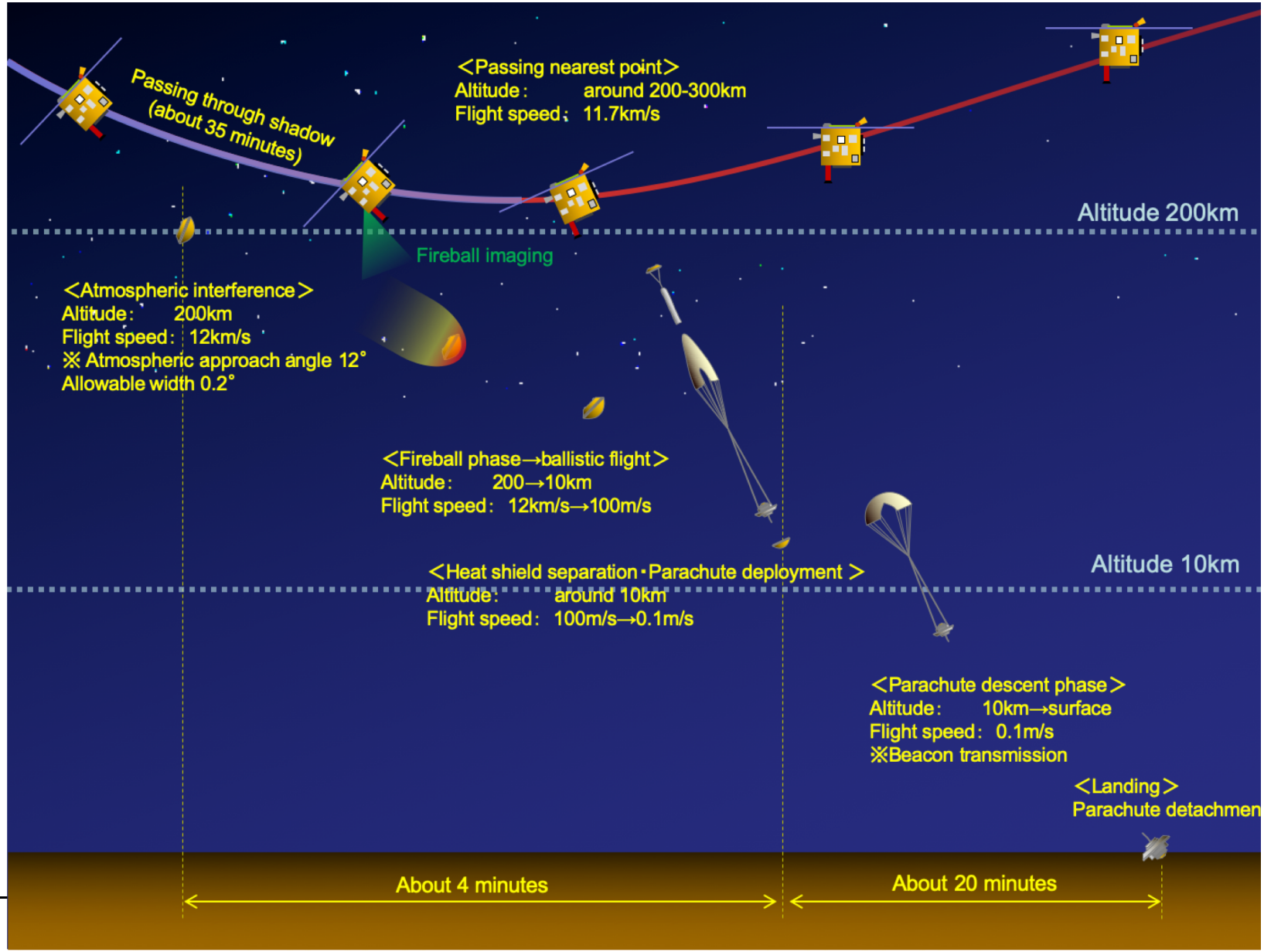
3. Details of capsule separation & re-entry

Schedule

Event	Time (JST)	Earth distance (altitude)
TCM-4（orbit control correction）	12/1 Around 16:00	1.74 million km
Capsule separation	12/5 14:30	220,000 km
TCM-5（orbit control correction to depart from the Earth's sphere）	12/5 15:30～18:00	200,000 – 160,000 km (spacecraft)
Spacecraft enters shadowed area	12/6 1:57	12,000km (spacecraft)
Capsule imaging	12/6 2:28～30	700km～300km (spacecraft)
Capsule atmospheric entry	12/6 2:28～29	120km (capsule)
Spacecraft exits shadow	12/6 2:31	350km (spacecraft)
Parachute deployment	12/6 2:31～33	11～7km (capsule)
Capsule landing	12/6 2:47～57	0km (capsule)

3. Details of capsule separation & re-entry

Re-entry explanatory diagram ▶

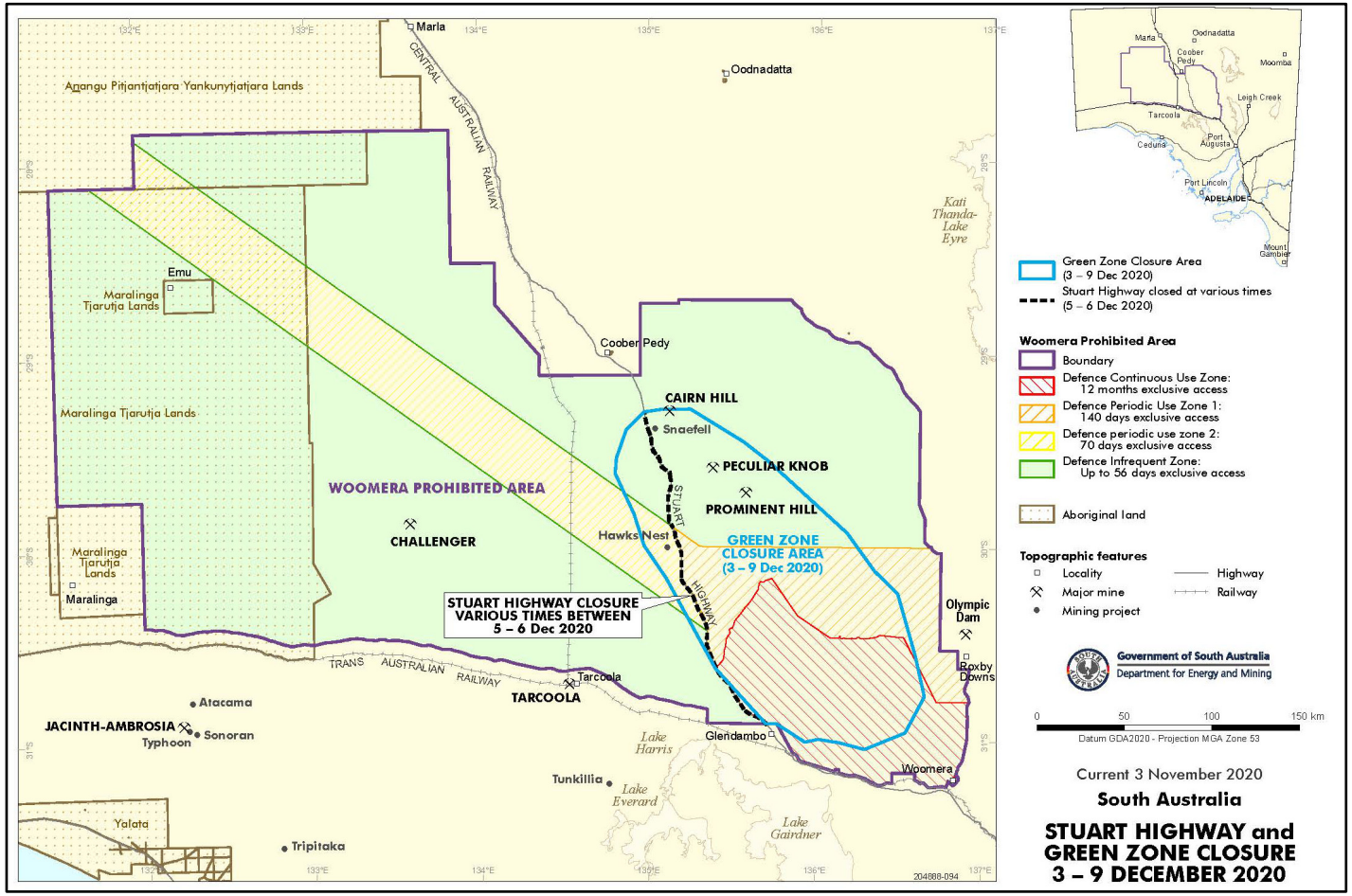


(image credit: JAXA)

2020/11/30

3. Details of capsule separation & re-entry

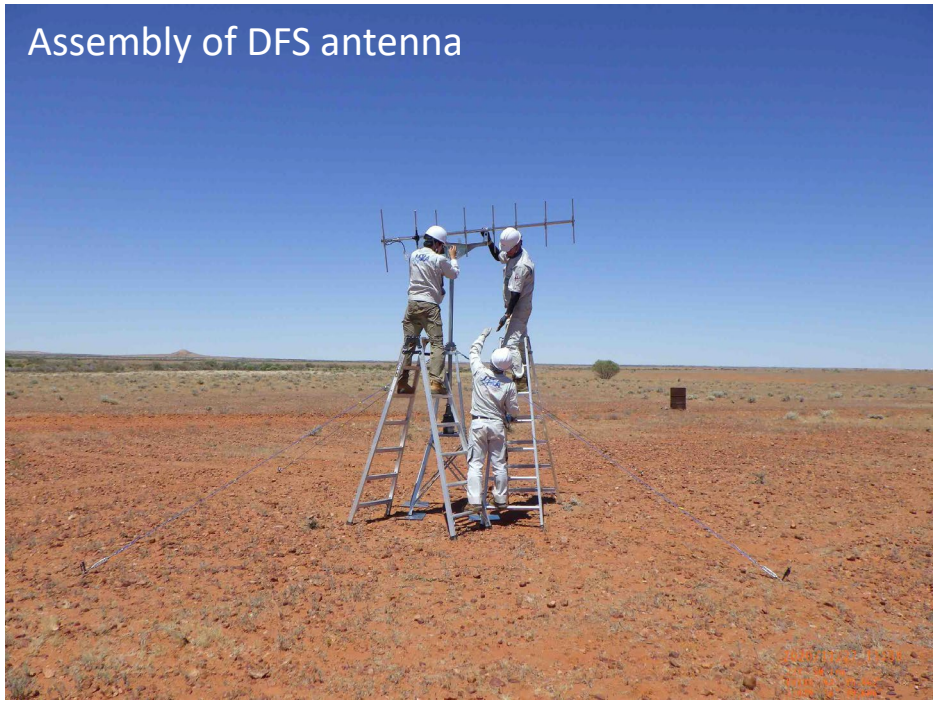
Closed off area published by the Australian Air Force

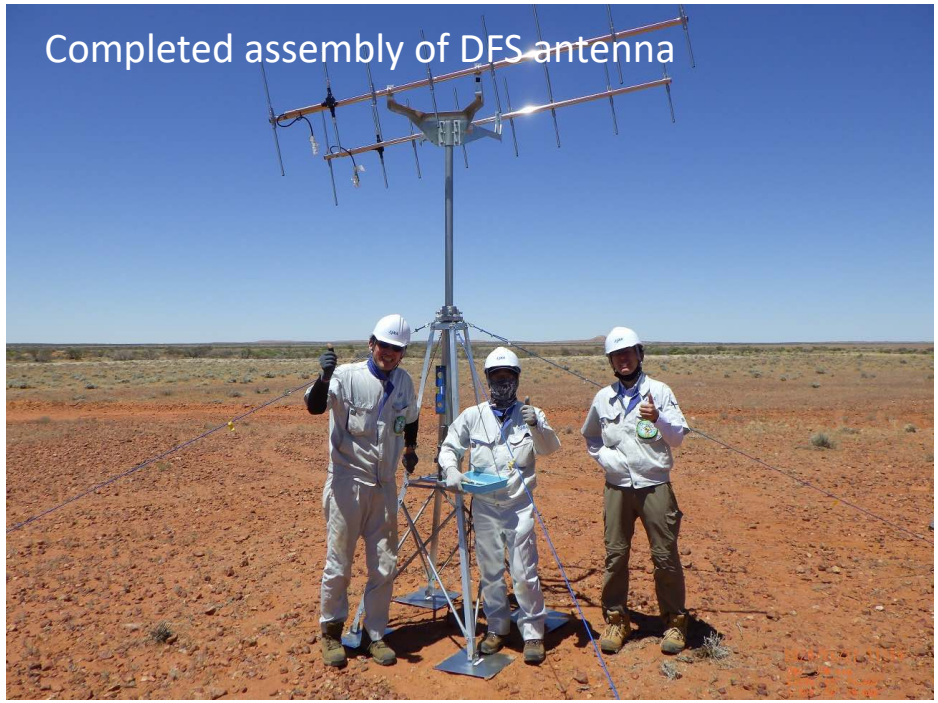


Source:
https://www.airforce.gov.au/sites/default/files/attachment_a_-_map_-_access_zones_plus_stuart_highway_and_partial_green_zone_exclusion3-9_december_2020.pdf?utm_source=miragenews&utm_medium=miragenews&utm_campaign=news

4. Preparation status for capsule collection

- The main team arrived at Woomera on 11/24 and began settling up antennas, etc.
- The temperature at the time of installation was over 40℃. Work was under the scorching sun while trying to prevent heat stroke.





（image credit：JAXA）

4. Preparation status for capsule collection

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- The temperature at the time of installation was over 40℃. Work was under the scorching sun while trying to prevent heat stroke.

MRS antenna assembly complete

MRS antenna assembly complete

（image credit：JAXA）

4. Preparation status for capsule collection

- The QLF clean booth has been set up and is being tested.

（image credit：JAXA）

5. Outreach

Ryugu & Hayabusa2 return observation campaign

- Number of registered campaigns : 135
- Many reports (28 as of November 26) have already been made of observations of Ryugu.
- For observations of Hayabusa2 just before re-entry, data for the observation will be provided to registrants.
- A special observation team (nicknamed “Hayabusan2”) was formed among the registered observers and if the observation is successful, the position and luminosity will be measured. Also, attempts will be made to try and observe the separated capsule. (24 teams as of November 26)

※ The Subaru Telescope succeeded in imaging Hayabusa2 on November 20 (Hawaii time)

- Organisers: Hayabusa2 Project, Japan Public Observatories Society (JAPOS), The Planetary Society of Japan (TPSJ)
- Campaign URLs:

  JAPOS https://www.city.himeji.lg.jp/atom/planet/info/campaign/haya2return/index.html

  TPSJ http://planetary.jp/Haya2-Special/projects/hayabusa2-serv.html

6. Future plans

■ Operation schedule

2020/12/1　TCM-4

2020/12/5　TCM-5

2020/12/6　Re-entry

■Press and media briefings

2020/12/4　16:00～　Press conference @JAXA Sagamihara Campus

2020/12/6　16:30～　Press conference @JAXA Sagamihara Campus

■Internet live broadcast

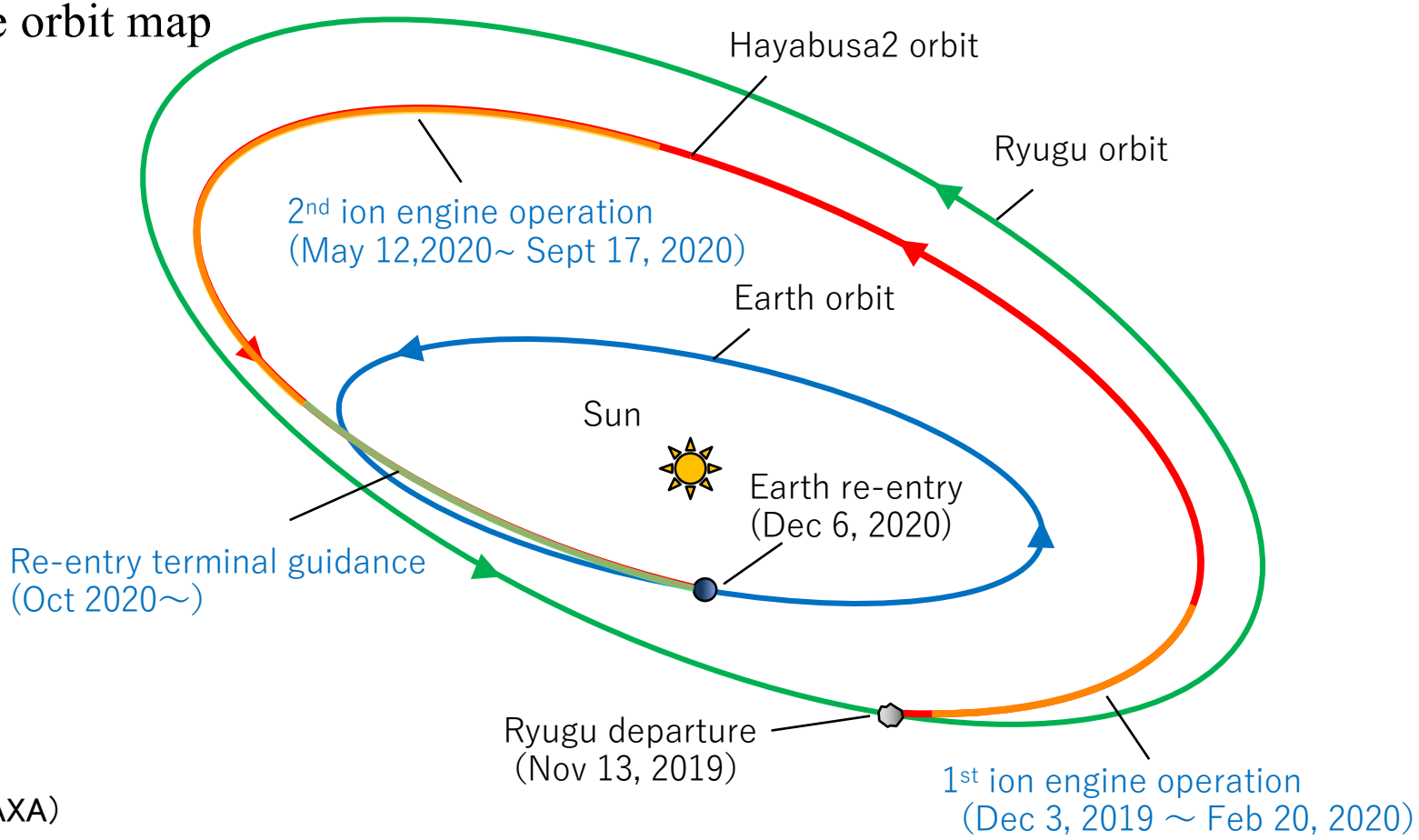
2020/12/5　13:30～16:40 (until 17:30)　Capsule separation

2020/12/6　02:00～03:10　Capsule fireball

Reference

Return cruise operation plan

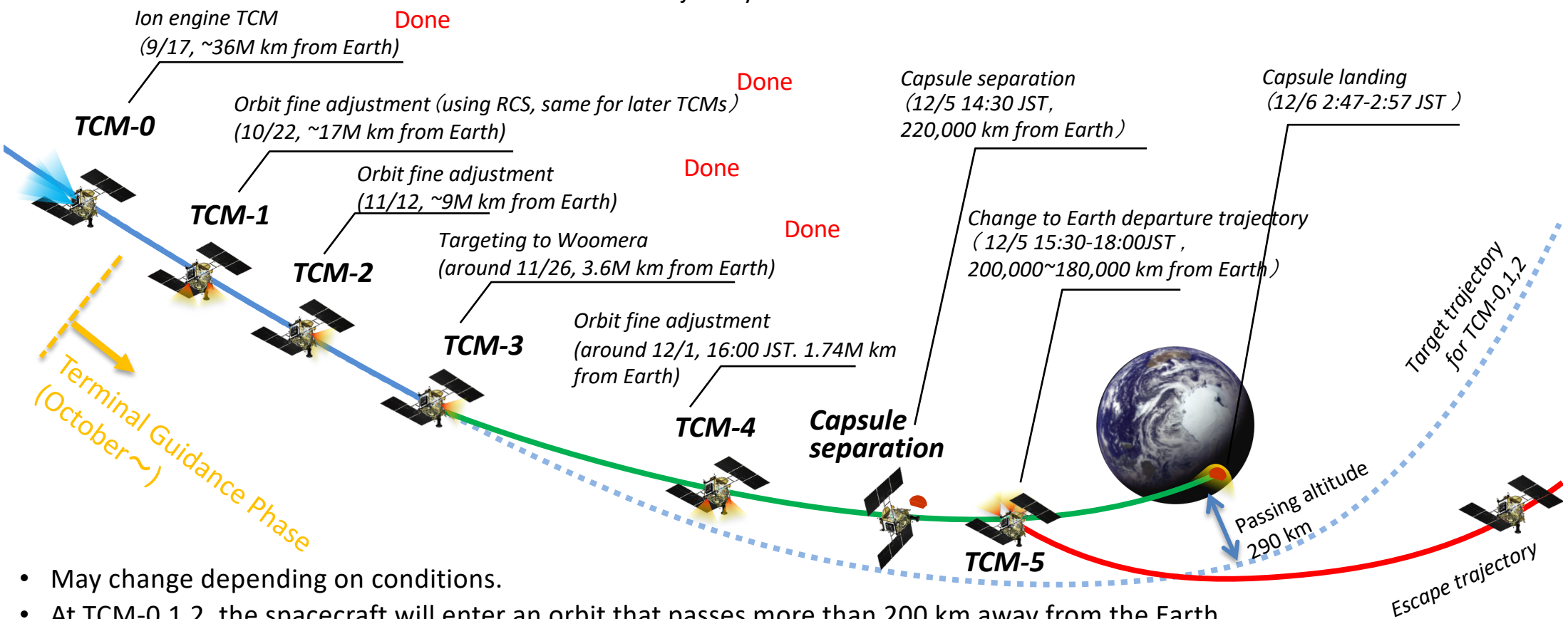
Return phase orbit map



(image credit：JAXA)

Operation plan for re-entry terminal guidance

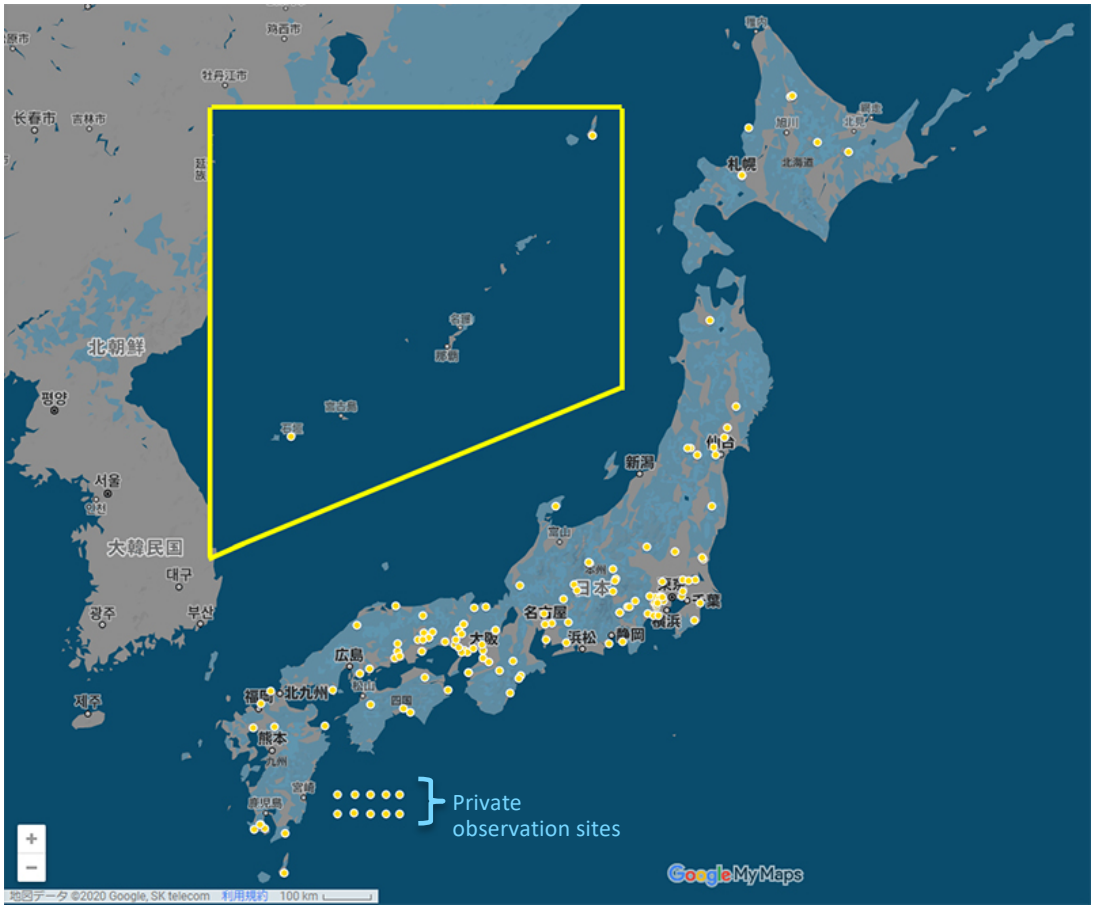
※TCM: Trajectory Correction Maneuver



- 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)

Ryugu & Hayabusa2 return observation campaign observation site



(image credit: Ryugu & Hayabusa2 Return Observation Campaign Team