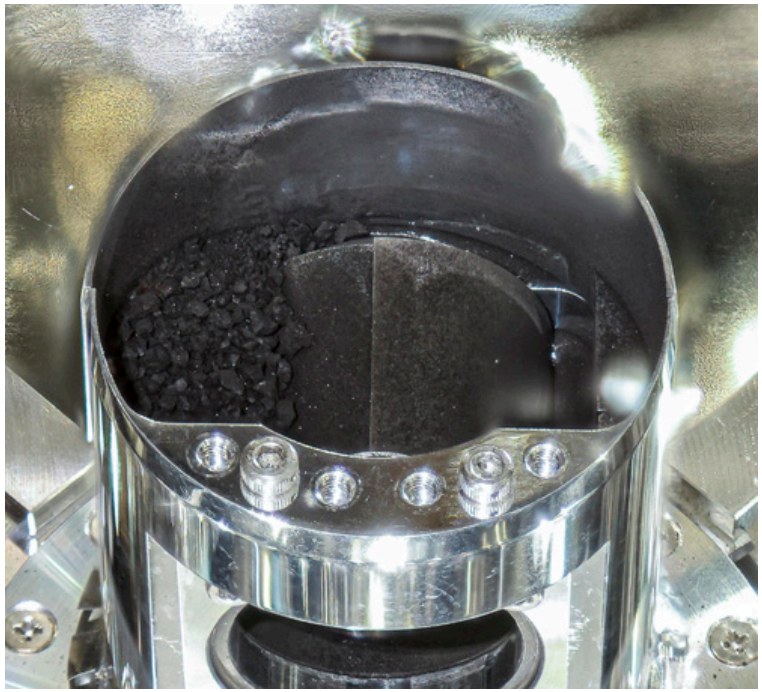
Foreign Press Center Japan（FPCJ）Press Briefings

The Mysteries of Space Revealed by the Hayabusa2

（Image credit：A. Ikeshita）



（Image credit：JAXA）

April 30, 2021 @ online

Makoto Yoshikawa (JAXA Hayabusa2 Project)

Today's contents

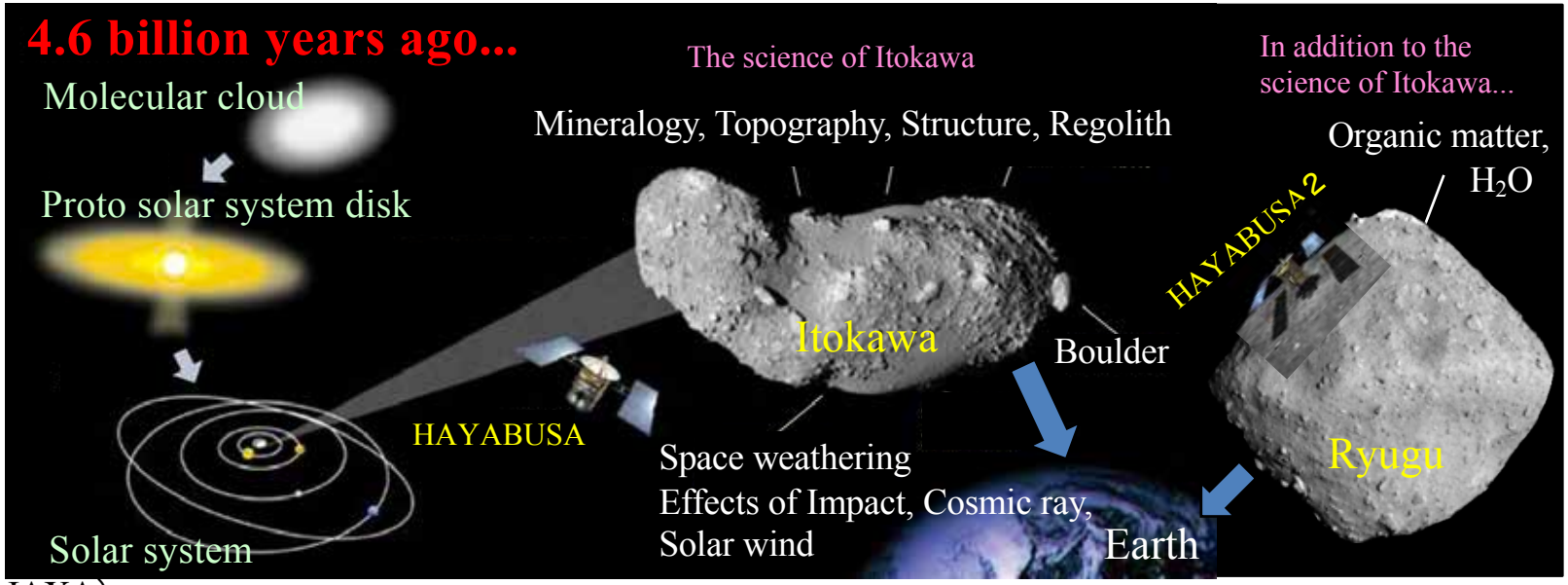
- Project Outline
- Return to Earth
- Ryugu sample
- Future progress

（Progress since November 27, 2020）

Press briefing on November 27, 2020

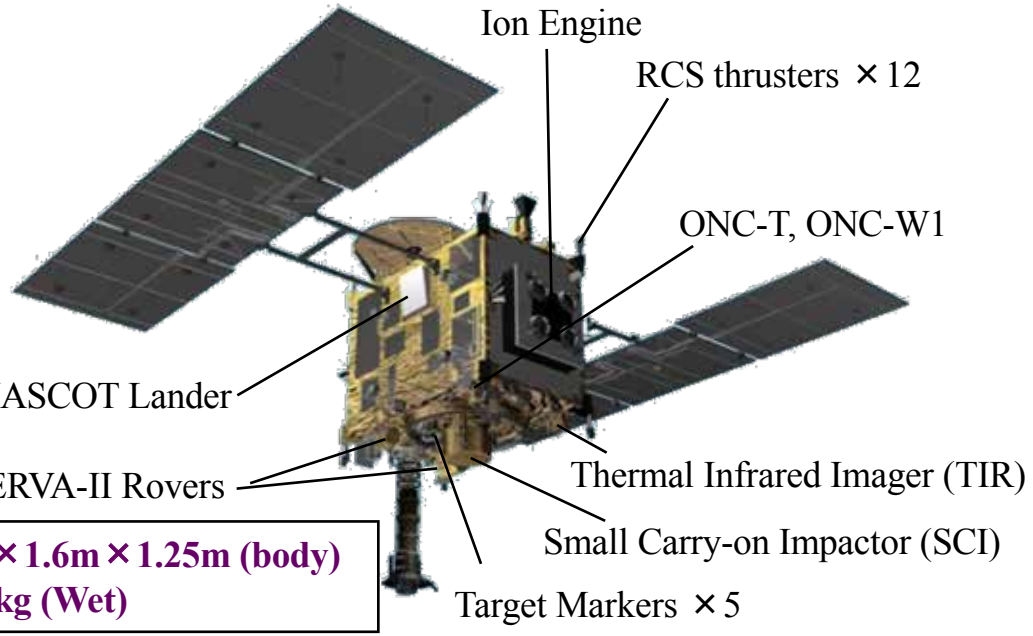
Hayabusa2 Mission

- The 2nd Asteroid sample return mission in the world (following Hayabusa)
- The target asteroid : Ryugu, C-type near earth asteroid
- Science objective : Origin and evolution of the solar system and the life, the water and the organic matter at the beginning of the solar system
- Engineering objective : Technology that perform round-trip mission reliably



(Image credit : JAXA)

Hayabusa2 Spacecraft



Size : 1m×1.6m×1.25m (body)
Mass: 609kg (Wet)


ONC


LIDAR


NIRS3


TIR

Science Instruments

MASCOT


by DLR and CNES

MINERVA-II-1

MINERVA-II-2

II-1 : by JAXA MINERVA-II Team
II-2 : by Tohoku Univ. & MINERVA-II consortium

Small Lander and Rovers

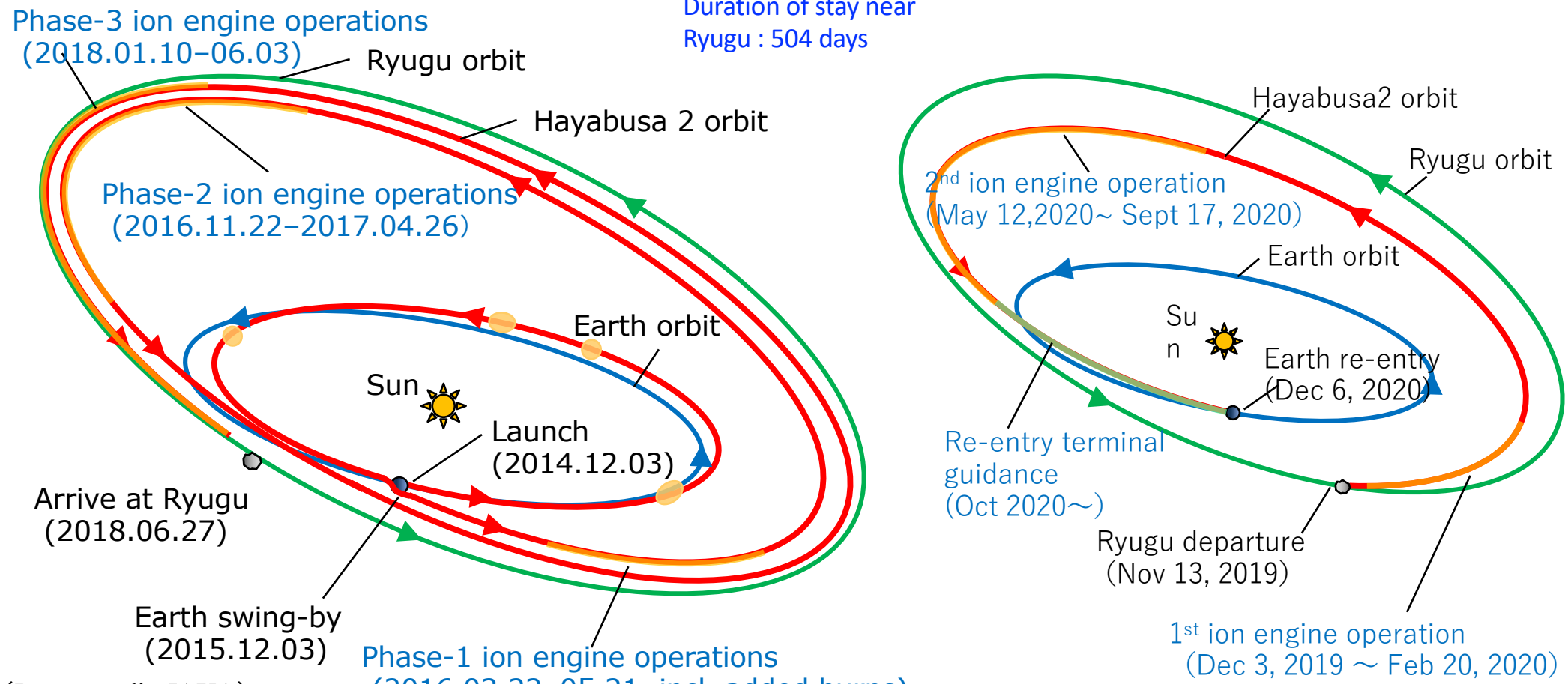
(image credit : JAXA)

From the launch to the Earth return

Launch → Ryugu arrival

Ryugu departure → Earth return

2014.12.3 ～ 2018.6.27 → Duration of stay near Ryugu : 504 days → 2019.11.13 ～ 2020.12.6



(Image credit : JAXA)

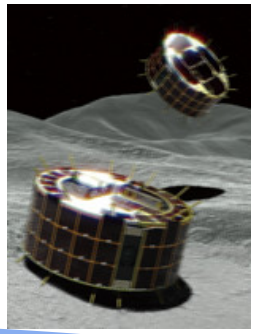
Hayabusa2 : Mission scenario

Launch
Dec 3, 2014

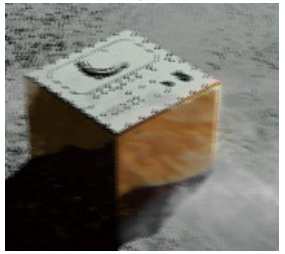
Earth swing-by
Dec 3, 2015

Ryugu arrival
June 27, 2018

MINERVA-II-1 separation
Sep 21, 2018

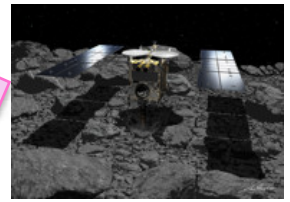


MASCOT separation
Oct 3, 2018

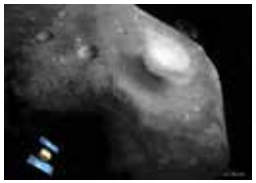


Target marker separation
Oct 25, 2018

First touchdown
Feb 22, 2019

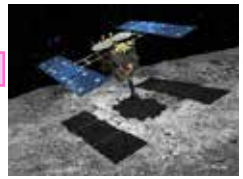


Impactor (SCI)
5 April, 2019

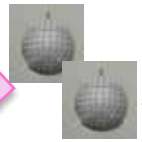


Target marker separation
May 30, 2019

Second touchdown
July 11, 2019



Target marker separation
Sept. 17, 2019



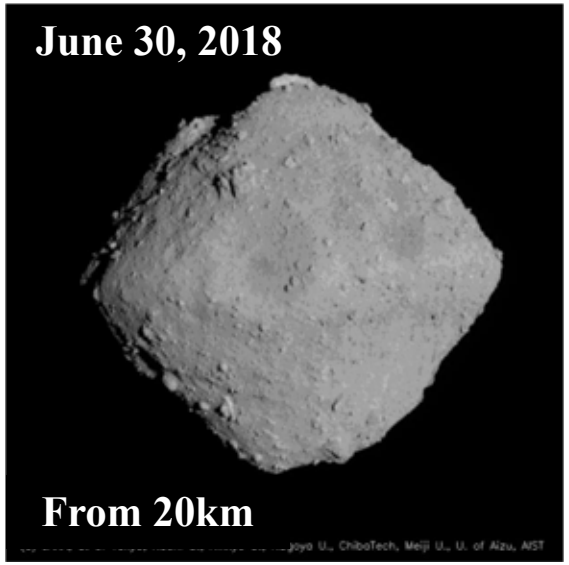
MINERVA-II2 separation
Oct. 3, 2019

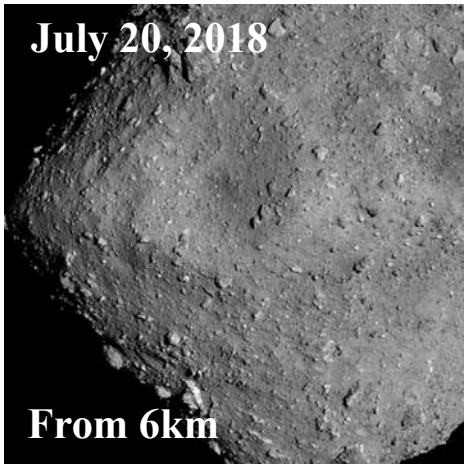
Ryugu departure
Nov 13, 2019

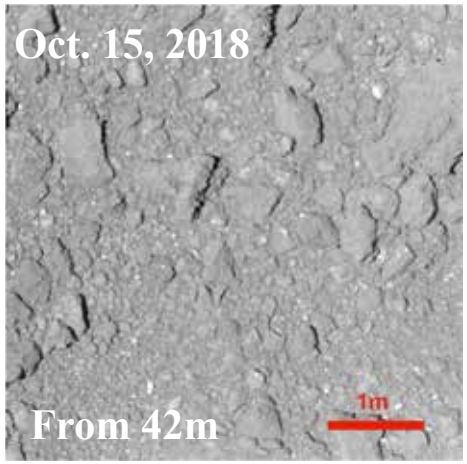
Earth return
Dec. 6, 2020

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

Asteroid Ryugu







©Arakawa et al., Science 2020

（Image credit：JAXA et al.）

What we have known from the observations by the spacecraft

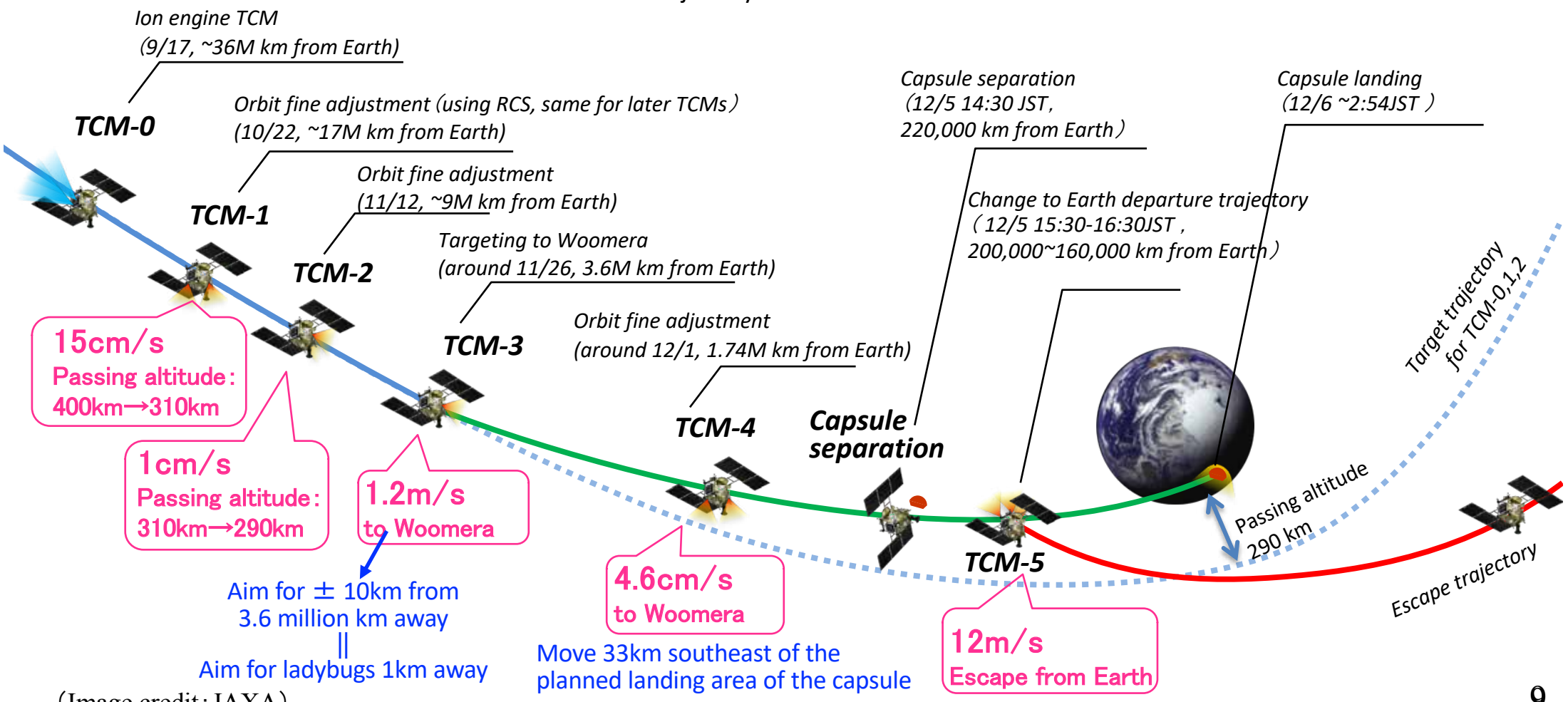
- Low density (1.19g/cm^3) → Ryugu is a rubble pile object.（porosity is more than50%)
- Top shape → The spin period was probably about 3.5h in the past. (now 7.6h)
- Small absorption at 2.72μm → hydrated mineral
- Black color (low albedo) → carbon rich
- Large artificial crater → small surface strength
- Easy to warm and cool → highly porous
- Surface reddening → approached the sun closely

（credit：ONC team）

changed from Morota et al. (2020)（©Univ. of Tokyo, JAXA）

Operation for re-entry terminal guidance

※TCM: Trajectory Correction Maneuver



(Image credit: JAXA)

Observation of the re-entry capsule fireball

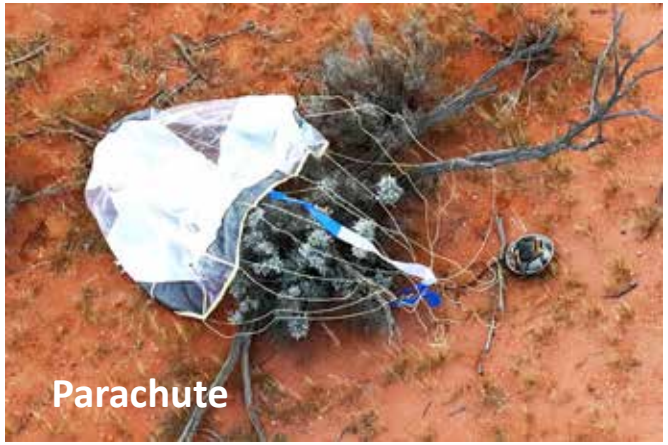
December 6, 2020

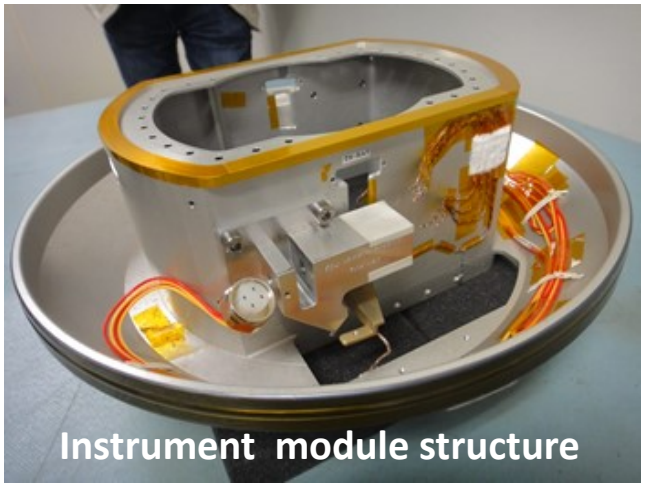
(movie)

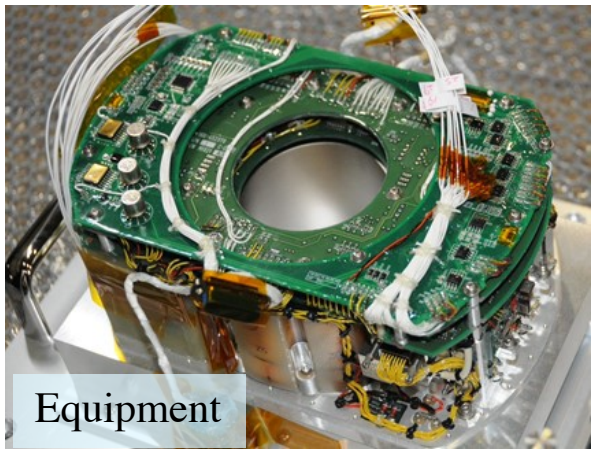
Fireball observed in Coober Pedy

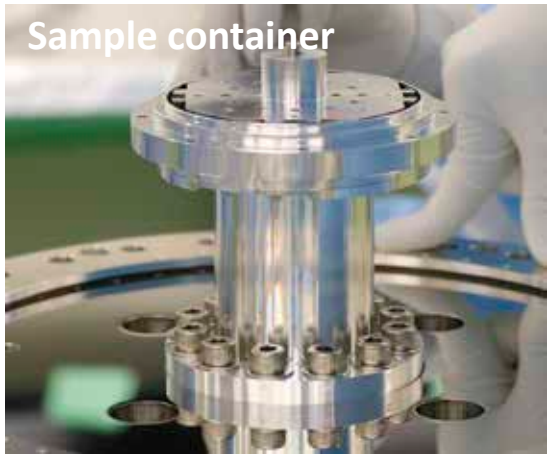
（Image credit：JAXA）

Re-entry Capsule



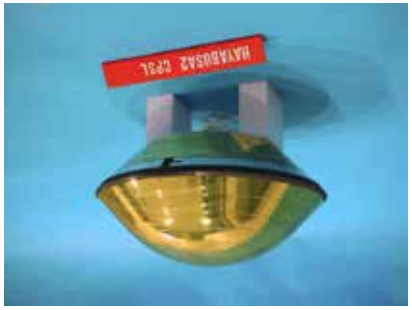


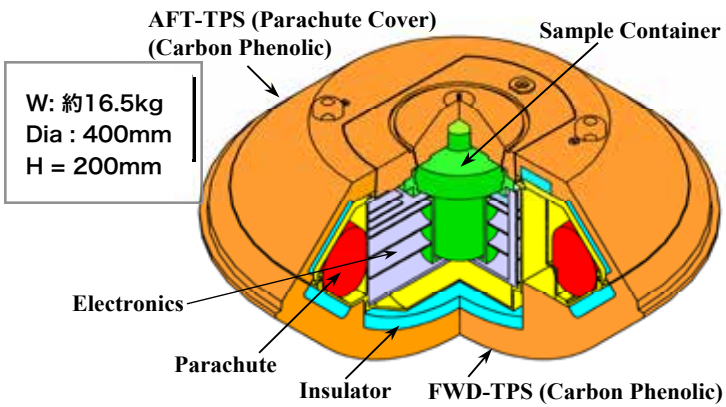


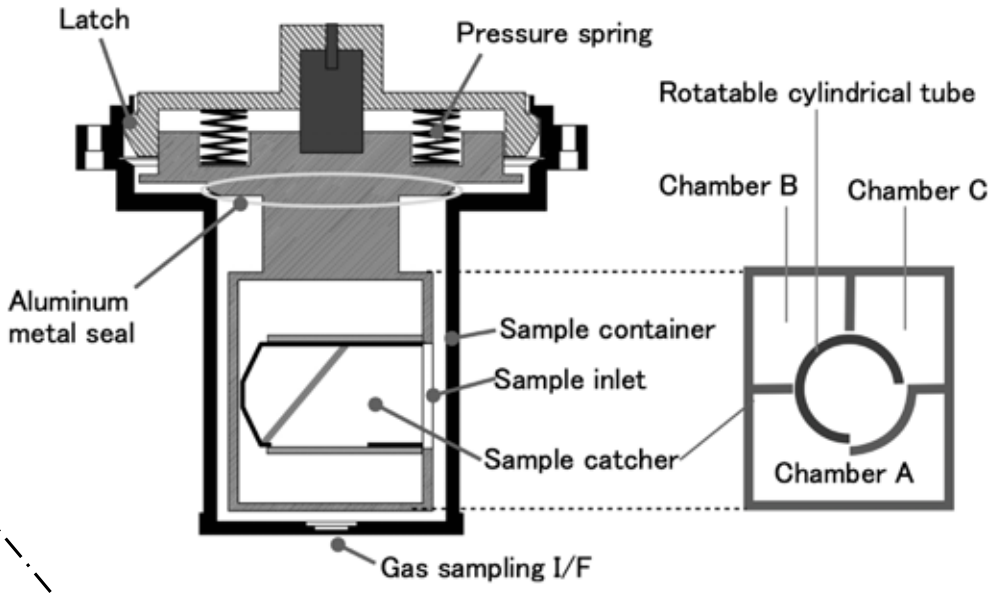


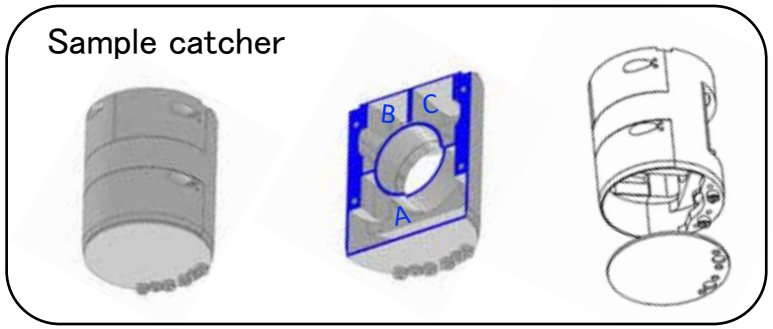
（Image credit：JAXA）

Structure of re-entry capsule



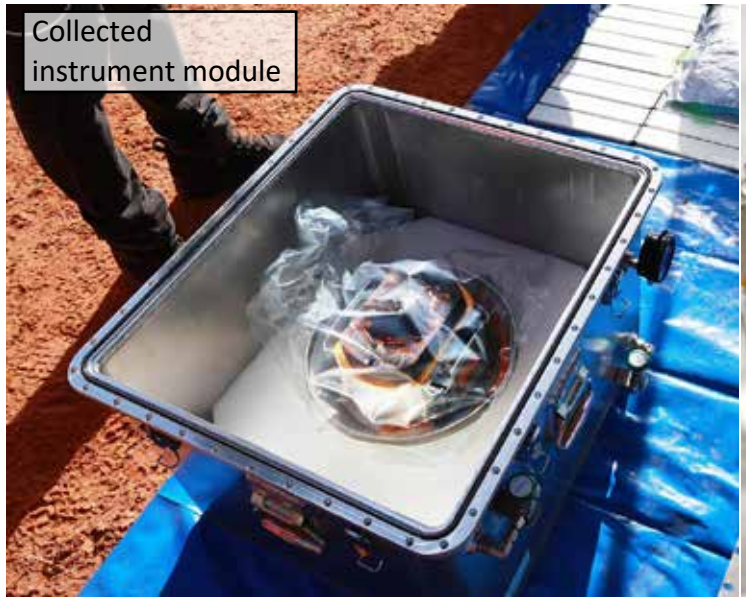


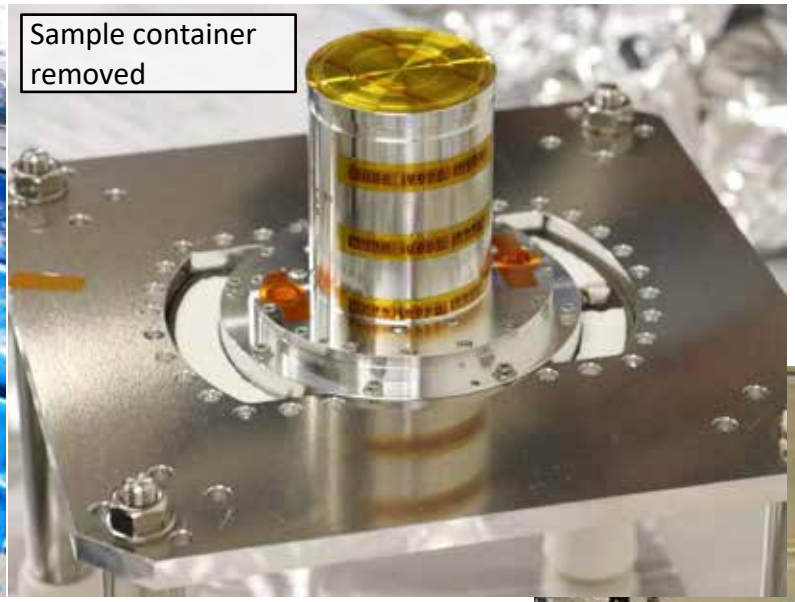




（Image credit：JAXA）

Gas sampling





- The collected instrument module (I/M) is transported to the QLF (Quick Look Facility) and disassembled after safety checks.
- Remove the sample container and connect it to the gas sampling equipment.
- Collect gas from the sample container and perform mass spectrometry.

（credit：collected instrument module: JAXA
Sample container removed, collecting the gas：JAXA/University of Tokyo/Kyushu University/JAMSTEC）

Successful sample acquisition from Ryugu

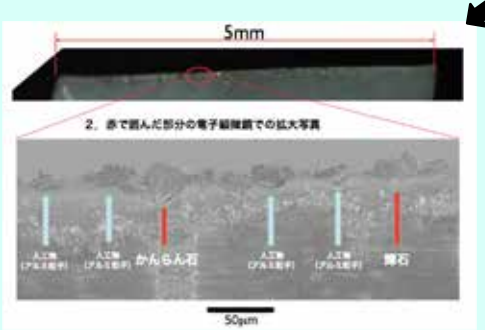
5.4g!

Photos of the inside of the chamber A in the sample catcher
Dec. 15, 2020

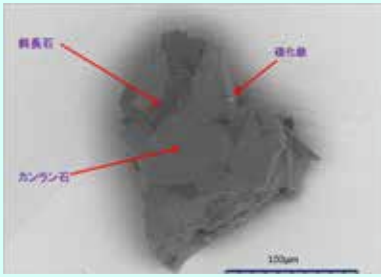
(Image credit：JAXA)

At the time of Hayabusa (2010) ...

Inside of the sample catcher

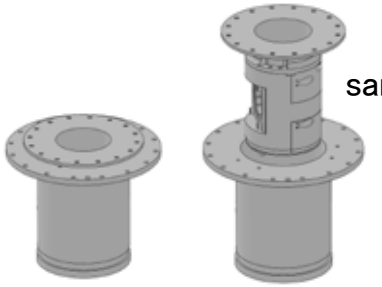


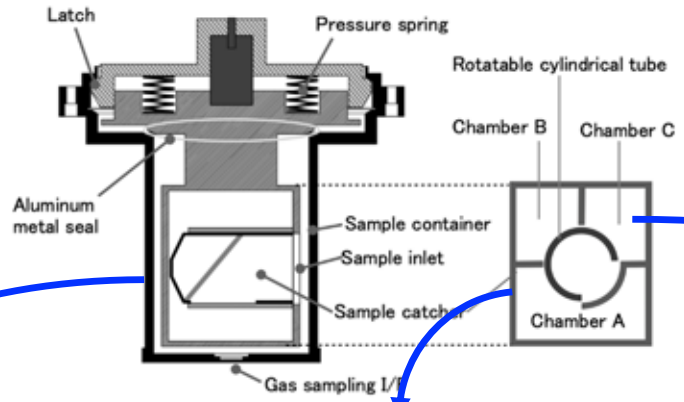
Confirmation of Itokawa materials
(Nov. 16, 2010)



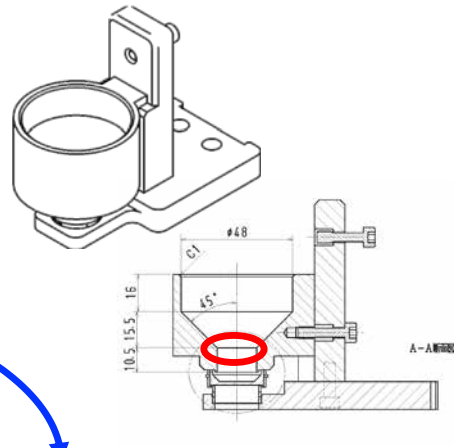
Reported at LPSC (42nd) held in the United States
(March 11, 2011)

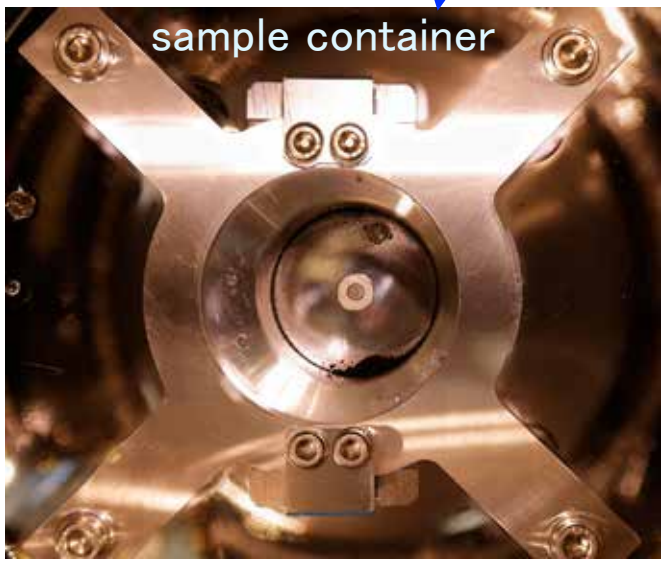
Samples of Ryugu

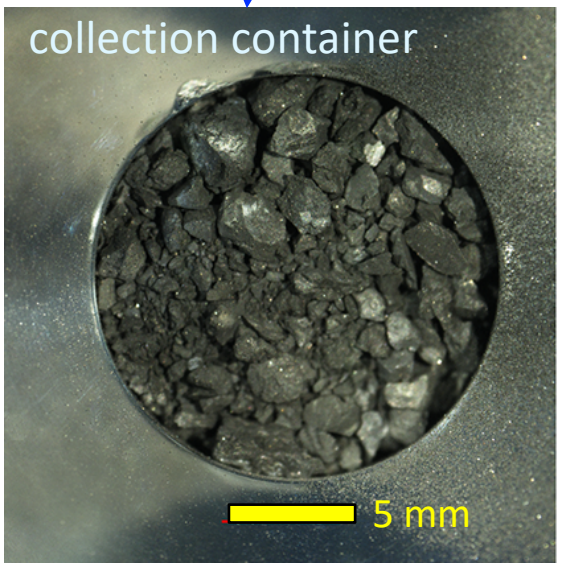


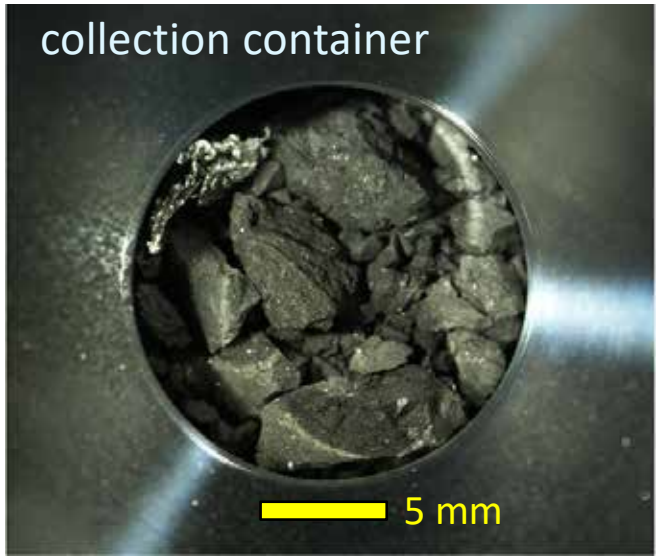


collection container









(Image credit : JAXA)

Samples of Ryugu in the observation containers

Chamber A
(1st touchdown)

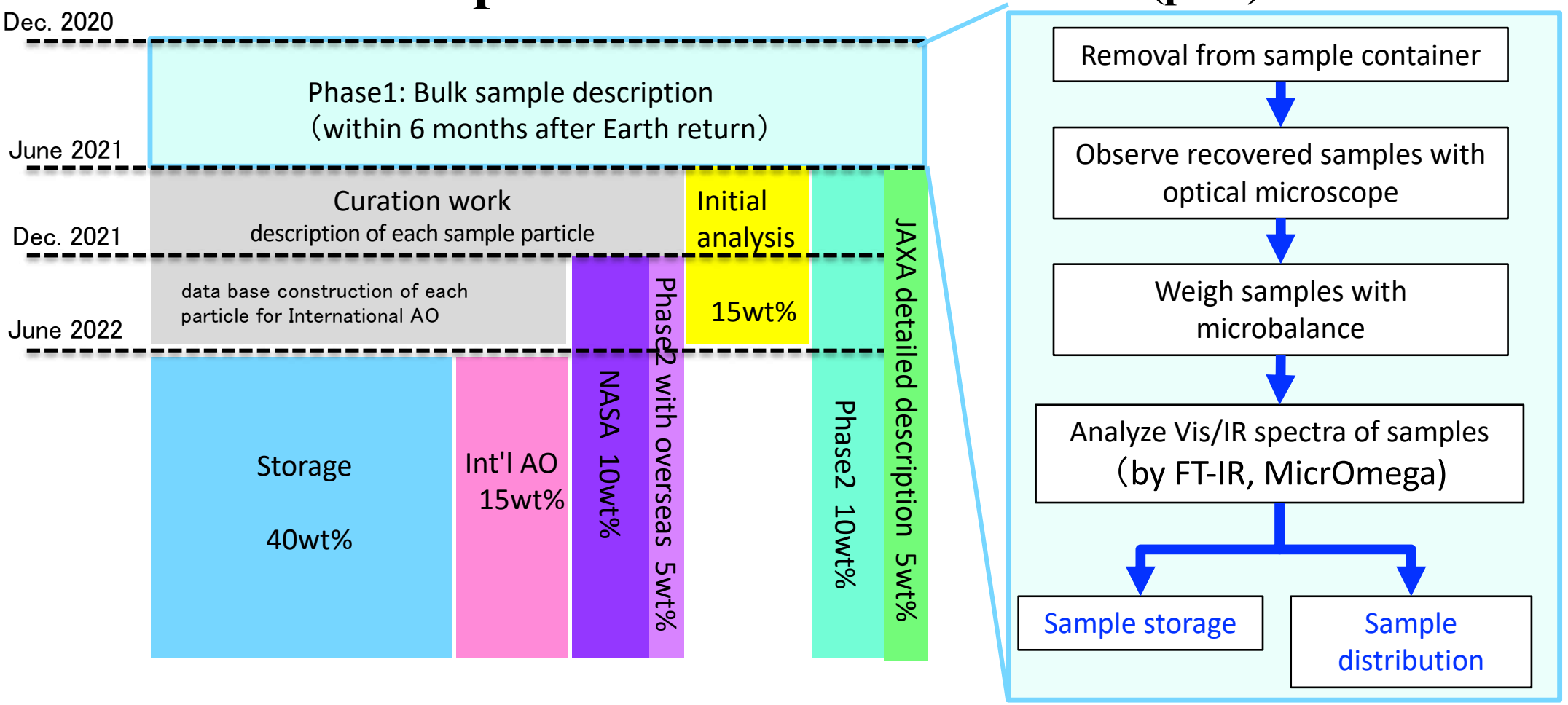
Camber C
(2nd touchdown)

Container inner diameter is 21 mm

(image credit：JAXA)

* Weight is the weight of the sample in each observation container. The weight of the separated pieces is not included.

Work of Initial Description and sample distribution Schedule (plan)

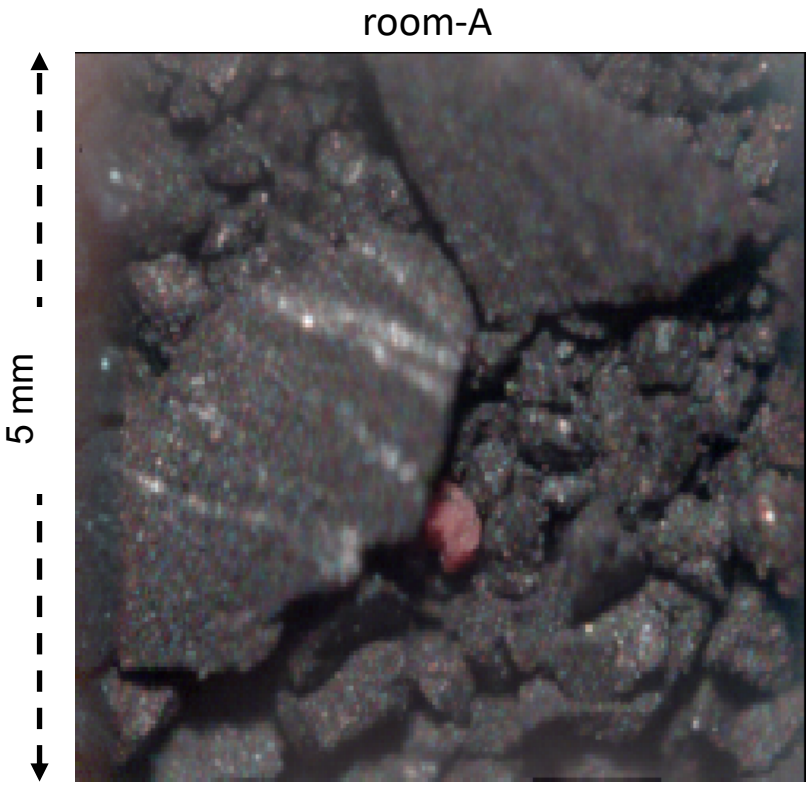


（Image credit：JAXA）

Spectral Profiles of Ryugu Return Sample

- Spectroscopy of bulk return sample has started as an initial description under non-destructive and non-contaminated conditions since January 2021
- Performed with FTIR (NIR continuous spectroscopy) and MicrOmega (NIR hyperspectral microscopy).
- The same features are found in both spectral profiles
  - 2.7μm absorption, related to water (-OH), the similar feature observed in NIRS3 spectrum
  - 3.4 μm absorption, related to organics (-CH) and/or carbonate ($-CO_3$)
- These features are the evidence that the return sample is originated from Ryugu.
- Indicating primitive sample in the solar system, containing water or carbon related materials

(waiting for in-depth analyses with higher accuracy and resolution)



Wavelength-selected image enhance (few) grains with specific composition, within bulk material.
[Red] : OH-enriched grain

Spectral Profiles of Ryugu Return Sample

3D movie by MicrOmega

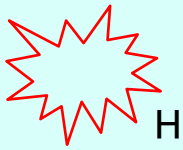
- Observation down to sub-mm scale structures
- Identification of different compositional materials

3D image emphasizing the presence of few grains with specific composition:
[Red] A largely OH-enriched grain

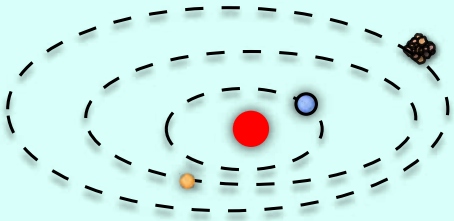
What we want to find out by sample analysis

History of the universe

13.8 billion years ago → (9.2 billion years) → **4.6 billion years ago** → **Now**



Birth of the universe
"Big Bang"



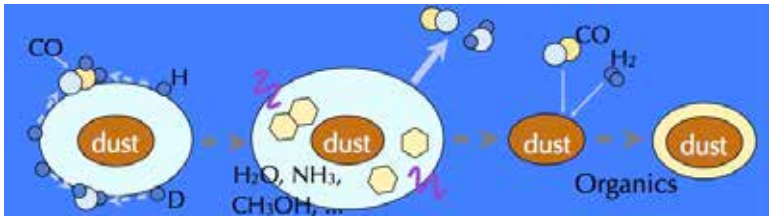
Birth of the solar system

Planetesimal

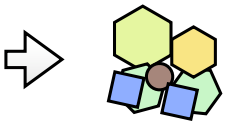
Collision, disruption, accumulation

Material changes

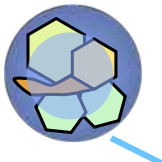
molecular cloud → protoplanetary disk → planetesimals → asteroids



Transition of carbon material on the dust surface



accumulation

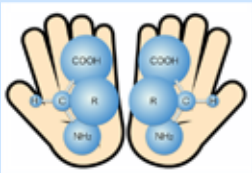


metamorphism

Earth

Clue to the origin of life

Amino acid chirality



Left-handed (L-chiral) and right-handed (D-chiral) amino acids

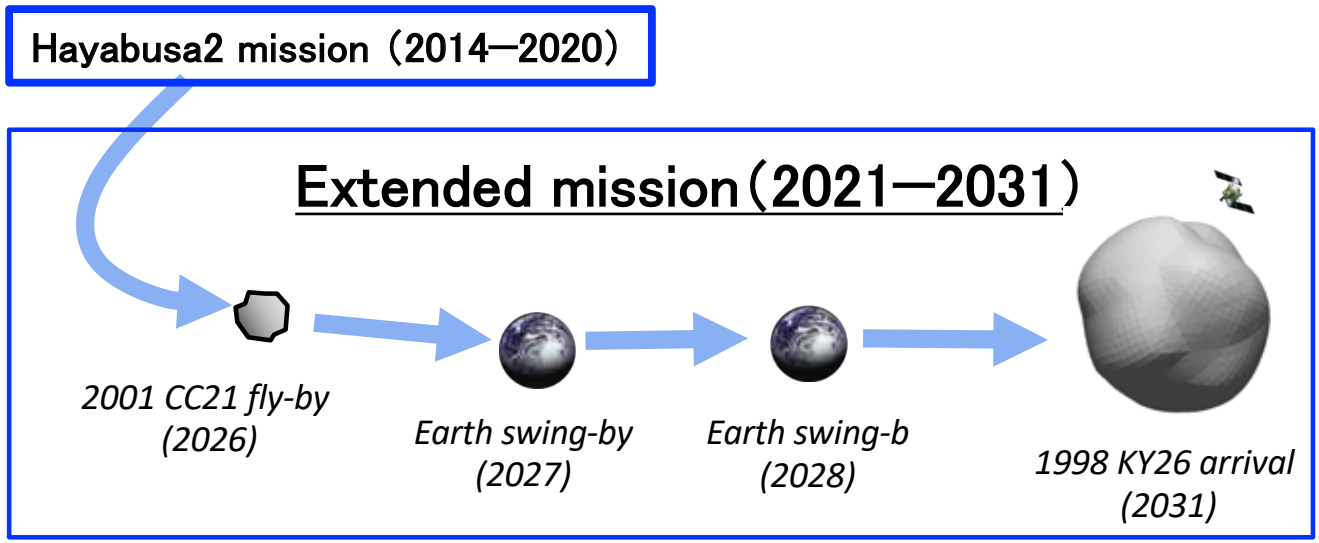
The life on Earth uses left-handed (L-chiral) amino acids.→Why？

(Image credit：JAXA)

Extended mission

- The spacecraft is still operational.
- 50% of xenon, the fuel for ion engines, remains.

To further exploration:
- The technical challenge of long-term space navigation
- A type of celestial body that has never been explored (30 m in size, 10 minutes in rotation period)
- Science and technology related to planetary defense

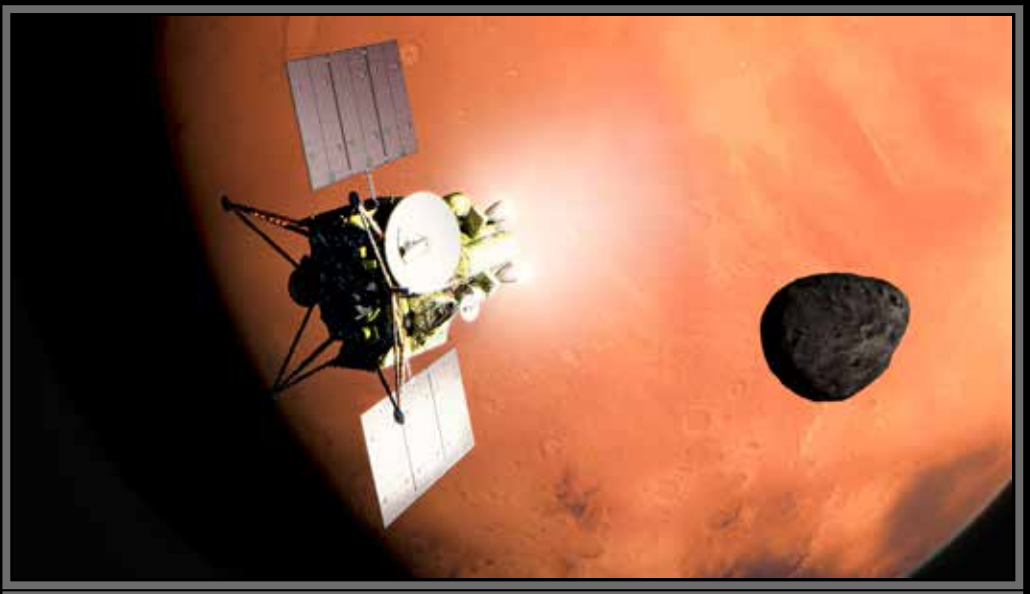


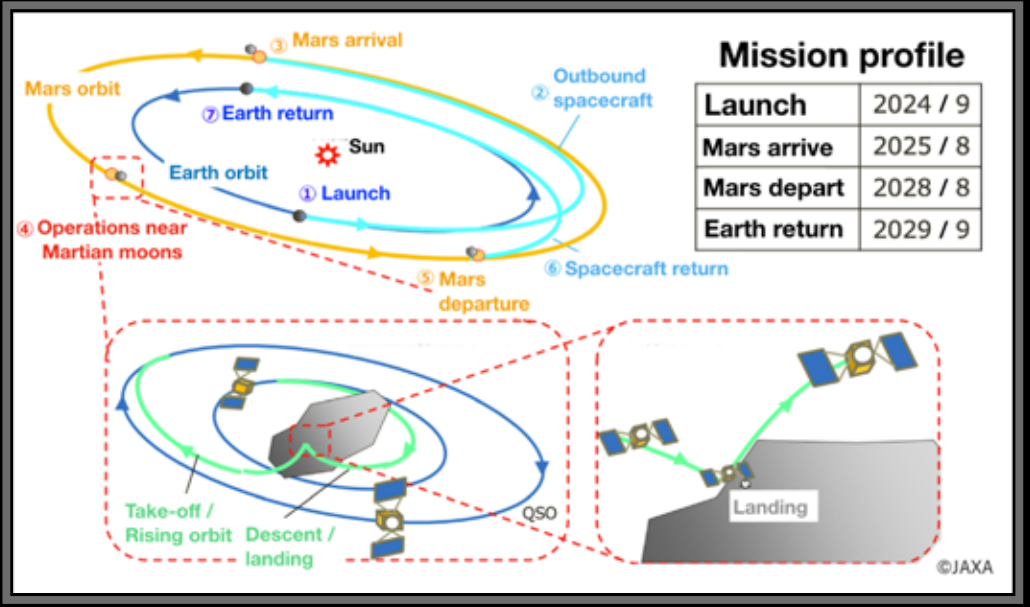
1998 KY26	
Discovery	May 28, 1998, by Spacewatch project
Shape	Spherical (from radar observation)
Av. diameter	About 30 m
Spin period	10.7 min (0.178 hr)
Spectral type	Possible carbonaceous asteroid
Semimajor axis	1.23 au
Orbital period	1.37yr（500 day）

（Image credit：JAXA）

Summary

- .The reentry capsule landed in Woomera, Australia on Dec. 6, 2020. ＝ 6-year mission completed successfully
- The amount of sample was about 5.4g. This is much higher than the planned 0.1g.
- Curation work is currently underway, and the initial analysis, which is a full-scale analysis, is scheduled to start in June of this year.
- The spacecraft is in operation for the next destination, 1998 KY26. Arrival is scheduled for 2031, 10 years later.





Mission profile

Launch	2024 / 9
Mars arrive	2025 / 8
Mars depart	2028 / 8
Earth return	2029 / 9

MMX

Martian Moons eXploration

World first Mars return mission to uncover the mystery of the Martian moons, Phobos & Deimos

3rd sample return mission, following Hayabusa2

Aim to bring home a sample from Phobos

Goals

Uncover the origin of the Martian moons and increase understanding of planetary formation, and primordial transport of material between the inner & outer Solar System.

Understand conditions in the circus-martian environment and the evolution of the surface of Mars and its moons.

News http://mmx.isas.jaxa.jp

@mmx_jaxa_en

(Image credit : JAXA)