Asteroid Explorer, Hayabusa2 press briefing

June 29, 2022

JAXA Hayabusa2 Project

Today's topics

Changes to the structure of the Hayabusa2 Project, and the distribution of the sample from asteroid Ryugu.

1. Hayabusa2 Project results
   - Engineering Achievements
   - Science Achievements
   - Public relations, outreach, awards, and others
2. Hayabusa2 Extended Mission
   - Overview, schedule
   - Nickname, outreach
3. Ryugu sample distribution
4. Future plans

1. Results from the Hayabusa2 Project

- The Hayabusa2 Project met all the criteria for success at the JAXA review, which cited engineering achievements that included nine world firsts, and scientific results that were published in numerous papers, including major journals.

- The Project has opened up new possibilities for the future, including the Extended Mission.

Hayabusa2 Mission Success Criteria and Achievements

Success criteria initially set by the Hayabusa2 Project ▶

Minimum success：
Minimum goal reached
Full success：
All planned goals reached
Extra success：
Challenges if situation permits

The Hayabusa2 Project has achieved all set goals.（According to the JAXA internal assessment)

Mission goal	Minimum success	Full success	Extra success
【Science goal１】 Investigate the material science characteristics of C-type asteroids. In particular, clarify the interaction between minerals, water and organic matter.	Achievement ④ Provide new insights on the surface material of C-type asteroids by observations in the vicinity of the asteroid. Confirm：Initial results paper for Ryugu vicinity operations (2019/4)	Achievement ⑩ Obtain new findings on mineral-water-organic interactions from the initial analysis of the collected samples. Confirm：Phase1 curation initial results paper (2021/12)	Achievement ⑪ （in progress) Integrate astronomical & microscale information to create new scientific results regarding materials for Earth, sea and life. Confirm：Phase2 curation / sample initial analysis paper (2022/6~)
【Science goal２】 Investigate the formation process of asteroids by direct exploration of the asteroid's reaccumulation process, internal structure and subsurface material.	Achievement ⑤ Provide insights on the internal structure of the asteroid by observations in the vicinity of the asteroid. Confirm：Initial results paper for Ryugu vicinity operations (2019/4)	Achievement ⑦ Obtain new knowledge on the internal structure and subsurface material of the asteroid by observing the phenomena caused by collisions with an impacting body. Confirm：Paper on the outcome of the artificial crater experiment (2020/3)	Achievement ⑧ ・Present scientific results on asteroid formation based on new findings regarding the collision destruction & reaccumulation process. ・New scientific results from the exploration robots on the surface environment of asteroids. Confirm：results papers (2019/4, 2020/3)
【Engineering goal１】 Improve robustness, accuracy and operability of the new technology implemented in Hayabusa, and mature it as a technology.	Achievement ① Rendezvous with a target orbit using ion engines for deep space propulsion. Confirm：Ryugu arrival (2018/6)	Achievement ⑨ ・Drop the exploration robot to the asteroid surface. ・Take a sample of the asteroid surface. ・Collect the re-entry capsule on Earth. Confirm：Successful completion of MINERVA-II (2018/9), 1st touchdown (2019/2), Earth return (2020/12)	N/A
【Engineering goal２】 Demonstrate impact object colliding with a celestial body.	Achievement ② Construct a system to allow an impact device to collide with the target object and perform that collision with the asteroid. Confirm：Artificial crater experiment (2019/4)	Achievement ③ Make the impact device collide in a specified area. Confirm：Confirmation topography of artificial crater (2019/4)	Achievement ⑥ Collect a sample of asteroid subsurface material exposed during the collision. Confirm：Completion of 2nd touchdown (2019/7)

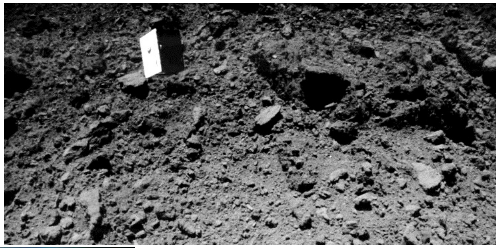
※①～⑪ indicate order achieved

（credit：JAXA）

Hayabusa2：Engineering achievements (9 world firsts)

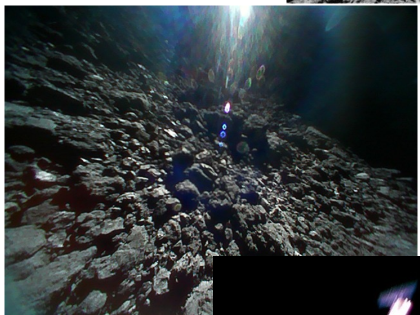
1.Exploration of the surface of a small celestial body by a small exploratory robot

2. Drop and deploy multiple robots onto a small celestial body

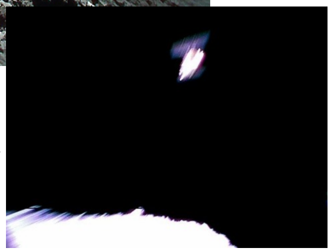


MASCOT immediately after separation from Hayabusa2, taken by the ONC-W2 camera

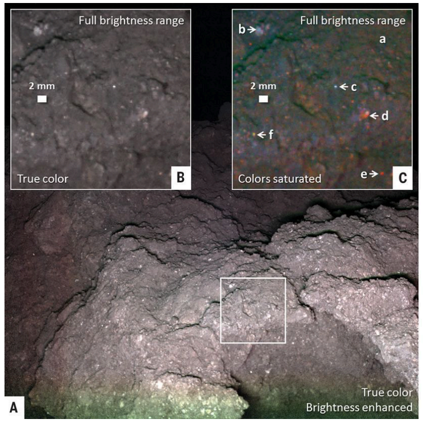
(credit: JAXA, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. Aizu, Sokendai)



Surface of asteroid Ryugu, taken by the MINERVA-II1A rover (credit: JAXA)



Hayabusa2 captured by MINERVA-II1A (credit JAXA)

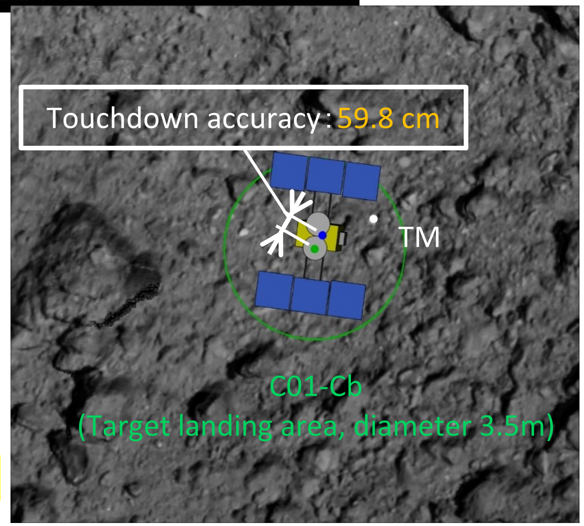


Surface of asteroid Ryugu captured by MASCOT (credit: MASCOT / DLR / JAXA)

Moment of 1st touchdown, captured by CAM-H (credit: JAXA)

2nd touchdown separation accuracy

(credit: JAXA, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. Aizu, Sokendai)

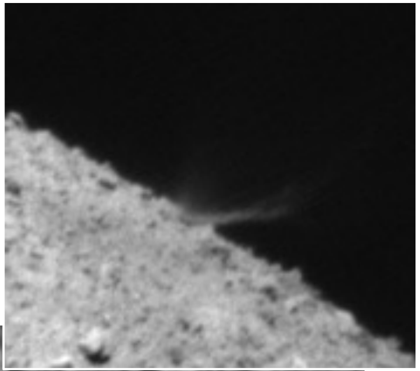


3. Generation of an artificial crater on an asteroid, and detailed observation of the process before and after

Hayabusa2：Engineering achievements (9 world firsts)

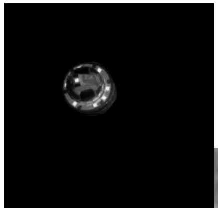
4.Achieve landing accuracy on a celestial body of 60cm

Moment of artificial crater generation captured by DCAM3

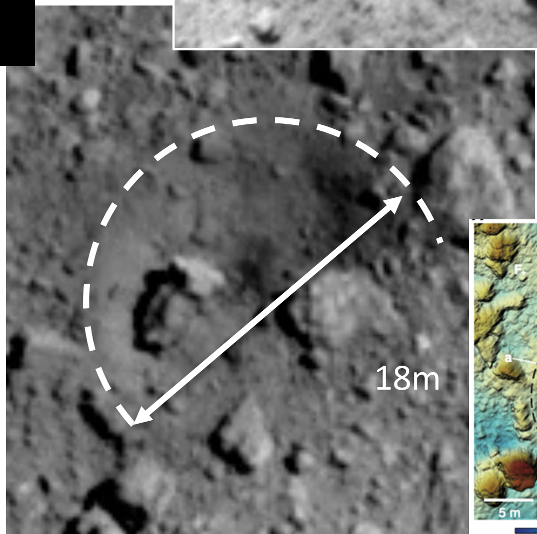


(credit: JAXA, Kobe University, Chiba Inst. Tech., Kochi U, U. Occupational and Environmental Health)

SCI (Small Carry-on Impactor) immediately after separation, captured by ONC-T



(credit: JAXA, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. Aizu, Sokendai)



(credit: JAXA, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. Aizu, Sokendai)

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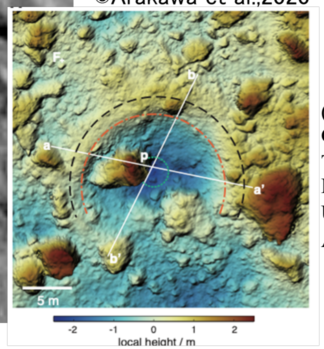
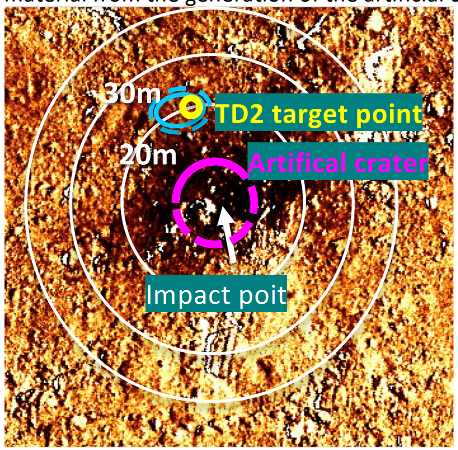


The artificial crater (left: real image, right: contour map)

5. Landing at 2 sites on the same celestial body

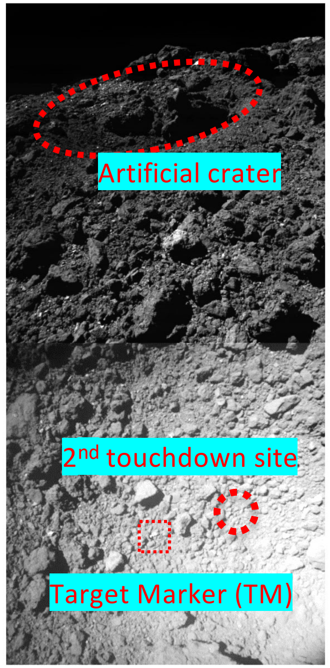
6. Access subsurface material on a celestial body beyond the geosphere

Ejected material from the generation of the artificial crater



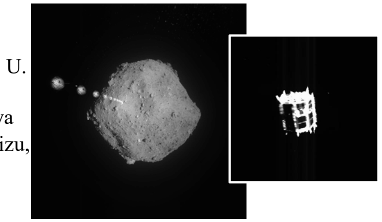
(credit: JAXA, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. Aizu, Sokendai, Kobe U)

Artificial crater captured by the ONC-W2, and the second touchdown site.



(credit: JAXA, Chiba Inst. Tech, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Meiji U, U. Aizu, AIST)

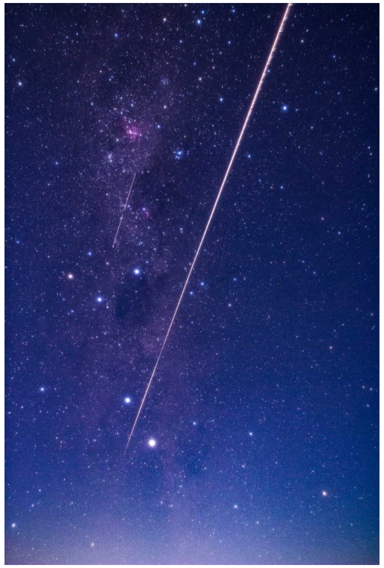
(credit: JAXA, Chiba Inst. Tech, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Meiji U, U. Aizu, AIST)



(credit: JAXA, Tohoku U, Yamagata U, Osaka U, Tokyo Denki U, Tokyo U of Sci., Kyushu Inst. Tech, Chiba Inst. Tech, AIST, Rikkyo U, U. Tokyo, Kochi U, Nagoya U, Meiji U, U. of Aizu)

7. Realisation of the smallest and multiple artificial satellites to orbit a small celestial body

Hayabusa2：Engineering achievements (9 world firsts)



Fireball of the sample capsule entering the atmosphere, taken from Coober Pedy, a town north of the Woomera Desert in Australia.

8. Sample of gaseous material returned from outside the geosphere

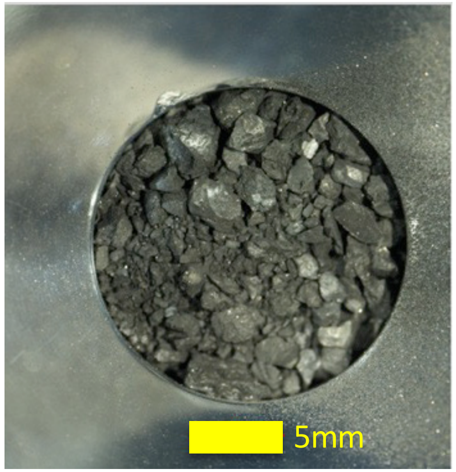
Earth return capsule landing in the Woomera Desert, Australia.

After the sample capsule was separated, the main body of the Hayabusa2 spacecraft escaped from the geosphere and transitioned onto the orbit for the Extended Mission. The Earth imaged by ONC-T while leaving Earth.

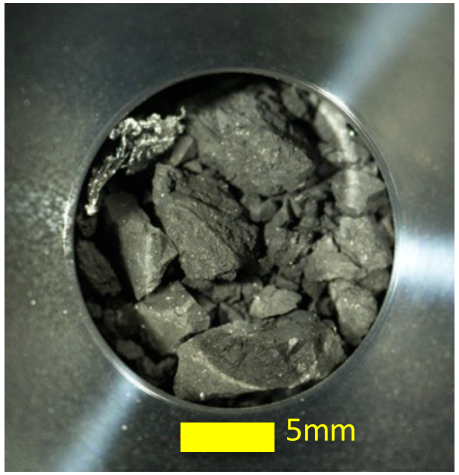
（credit: JAXA, AIST, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. of Aizu）

Sampling the gas at the temporary analysis facility in Woomera (6 hours after atmosphere re-entry).

9. Sample return of C-type asteroid material



Ryugu sample in the sample catcher chamber A (collected during the 1st touchdown).



Ryugu sample in the sample catcher chamber C (collected during the 2nd touchdown).

(credit: JAXA)

Hayabusa2 : Engineering achievements

■The “9 world firsts” in engineering by Hayabusa2

1) Mobile exploration of the surface of a small celestial body using a small exploration robot.

2) Dropping and deploying multiple exploration robots onto a small celestial body.

3) Generation of an artificial crater on an asteroid, and detailed observation of the process before and after.

4) Achieve landing accuracy on a celestial body of 60cm.

5) Landing at 2 sites on the same celestial body.

6) Access subsurface material on a celestial body beyond the Earth’s geosphere

7) Realisation of the smallest and multiple artificial satellites to orbit a small celestial body.

8) Sample of gaseous material returned from outside the geosphere.

9) Sample return of C-type asteroid material.

Further more, the realisation of “interplanetary round-trip navigation, including take-off and landing” was the second in human history, after Hayabusa.

■ Inheritance and development of “4 major demonstration items” from Hayabusa

1) Interplanetary navigation using ion engines as the main propulsion engine.

Completed round-trip navigation with all engines in good health. Inherited and developed the interplanetary navigation technology based on lessons learned with Hayabusa.

2) Autonomously approach and land on a celestial body using optical information

Overcame the “homework” left by Hayabusa in the arrival, descent and landing on an asteroid. Established pinpoint landing technology on an asteroid, which had not been available with Hayabusa.

3) Collect a sample from the surface of a celestial body in microgravity

Successfully collect samples from two sites, a gas sample, and subsurface material. Fully accomplished after setting a goal to exceed that of Hayabusa.

4) Direct atmospheric entry from interplanetary space

Returning to Earth from interplanetary space, in the second time for Japan. Inheritance and development of atmospheric entry technology.

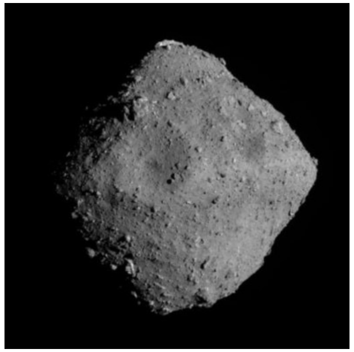
Additionally, deep space navigation provided a valuable opportunity to obtain many experimental engineering results, new operational technology, and scientific results beyond that of asteroid science.

Hayabusa2 : science achievements: summary

- The world's first C-type asteroid rendezvous observation/in-situ measurement has demonstrated for the first time that the parent body (planetesimal) of asteroid Ryugu was an icy celestial body, and that this planetesimal underwent a major migration from the outer to the inner Solar System. Ryugu formed by the reaccumulation of fragments of the parent body, and took on its current shape during high-speed rotation.

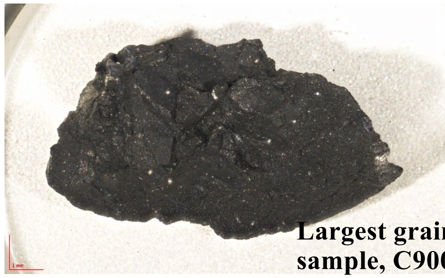
- The world's first asteroid impact experiment produced a larger than expected crater, indicating that Ryugu consists of a loose collection of fragments from its parent body, with a young surface age, and extremely weak adherence between the constituent particles, and fragile boulders. This constrains the transport process of water and organic matter to the Earth.

- The returned sample is composed primarily of minerals that have experienced alteration by water, and contain a variety of organic matter. It is the most primitive cosmic sample yet obtained by humankind, and is expected to provide new standard data on the abundance and isotopic composition of Solar System elements, and to provide a basis in material science for the theory of planetary formation.



Asteroid Ryugu
(credit: JAXA, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. of Aizu, AIST)

SCI crater
(credit: JAXA, U. Tokyo, Kochi U, Rikkyo U, Nagoya U, Chiba Inst. Tech, Meiji U, U. of Aizu, Sokendai)



Largest grain in the Ryugu sample, C9000 (credit: JAXA)

Hayabusa2: science achievements: vicinity observation

- Ryugu is a "rubble" object with many voids: formed by the accumulation of debris (boulders) after the destruction of its parent body.
- The asteroid was spinning at high-speed in the past, and took on a spinning-top shape due to a landslide on the surface.
- Low reflectance and little regional difference in spectra (but colour difference between north and south) ⇒ Parent body was relatively homogenous and undifferentiated.
- Infrared absorption of structural water (OH group) can be seen over the entire surface ⇒ Suggests that the main components are hydrous minerals.
- Majority of the boulders have low thermal conductivity and high porosity ⇒ Suggests ice evaporated to form microscopic voids.
- The adhesive strength of the surface layer is extremely weak, but there is a layer with slightly stronger strength at a depth of 1~ 2m (the key to the spinning top shape).
- Surface reddening correlated with solar irradiation

  ⇒ Suggests space weathering.
- Spectral analysis suggests a likely origin is an asteroid family with a dark surface in the inner asteroid belt.
- Several bright boulders were found that may have originated from S-type asteroids.
- Asteroid Bennu visited by NASA'S OSIRIS-Rex has similarities (shape, density, hydrous minerals, etc) and differences (water absorption, topology, direction of colour change due to space weathering etc).

Hayabusa2: science achievements: sample analysis

- Close resemblance in composition and isotopic rations to the most primitive CI chondrites, which retain the elemental abundances at the time of the formation of the Solar System.
  - Some differences suggest terrestrial contamination and weathering of CI chondrites.
- Aqueous alteration occurred at several tens of degrees Celsius millions of years after the formation of the Solar System.
- The main component is hydrous silicate, with the majority of the secondary minerals formed in the presence of water, such as magnate, sulphides, and carbonates.
- A variety of organic matter is present in multiple forms, indicating that organic matter was formed in the parent body and subsequently retained without being destroyed even on the asteroid surface.
- Ground-based analysis found that the grain porosity was about 40%, and the porosity between grains constituting Ryugu can be estimated at about 20%.
- Ground-based analysis suggests that Ryugu's parent body is likely to have been formed outside the orbit of Jupiter and, combined with the results from vicinity observations, it is likely that the asteroid was subsequently brought into the asteroid belt. In other words, C-type asteroids rich in volatiles could be a strong candidate for delivering oceans and materials for life to the Earth.
- We plan to hold another press briefing to provide an overall picture of the analysis results of the Ryugu sample once the initial results are completed.
- For the ground-based analysis, the comparative study with the Bennu sample will also be important in the future.

C0002 grain

（credit：JAXA）

Hayabusa2: science achievements: Ryugu history

Earth | Mars | Asteroid belt | Jupiter, Saturn | Solar distance | Presolar grains

Solar System formation

CAI/chondrule poor

Formation of parent cestial body

^{26}Al *decay heat*

Millions of years after formation

Aqueous alteration

Synthesis of organics

Gravitational scattering due to giant planet migration

Comets

Water and organics supplied to Earth

Move to inner asteroid belt (major migration of parent body)

1 billion years ago

Destruction of parent body (weak impact alteration)

Ice evaporation

High porosity

Re-accumulation: Ryugu formed

Weak cohesion

100 million years ago

CI chondrites

Sun-ward movement + Jupiter, Saturn gravity

High speed rotation (YORP)*

10 million years ago

Near-Earth Asteroids

Spinning top shape formed

Crater formation / surface disturbance

Atmospheric destruction

Space weathering†

Interplanetary dust

Primitive with minimum thermal alteration

Time

Hayabusa2 exploration

***YORP effect**: Change in axis and rotation period due to heat radiation.

† Space weathering: Deterioration of celestial body surface material due to cosmic rays and micrometeoroids.

（credit：JAXA）

Hayabusa2: public relations / outreach

Public relations / outreach policy

- The goal is not only to deepen understanding of the Project, but also promote interest in all space exploration activities, and a broad interest in science.
- Communicate as much information as quickly and widely as possible.
- Communicate not only results and achievements, but also plans, schedules, and the challenges and risks involved.
- Provide a wide range of people with the opportunity to enjoy different aspects of the project.

Major public relations / outreach activities

Press briefings (60+), press conferences, and interviews
Web、Twitter（3 accounts）, JAXA publications, books
Real-time coverage (at major events)
Campaigns (10), lectures (more than 40)
Goods, illustrations, CG, videos and models
Mascot characters, Ryugu place names
Capsule and sample public release

⇨

Impact

・Numerous news reports, articles (newspaper, TV, magazines etc) and programs
・Citations in books, textbooks etc
・ Documentaries（3 films）
・Twitter followers: 234,000 + 69,000 + 31,000
・Events sponsored by science museums etc.
・Activities by schools and the general public
・Local community contribution (Sagamihara City)

Hayabusa2：publications & awards

As of April 2022:

- Hayabusa2 science and engineering papers (peer reviewed)
  298 papers（1,079 abstracts）
  - Including science, engineering, joint science and engineering, and papers from outside the team (253 papers from the team)
  - Comparable result to NASA’s OSIRIS-Rex, which has 3 times the budget and dedicated paper writing team (301 papers, 10,091 abstracts)

- In 2020-2021 especially, Hayabusa2 papers alone account for 10% of the world’s asteroid papers.
  - “asteroid” (1,432 papers) vs “Hayabusa2 or Ryugu” (144 papers)

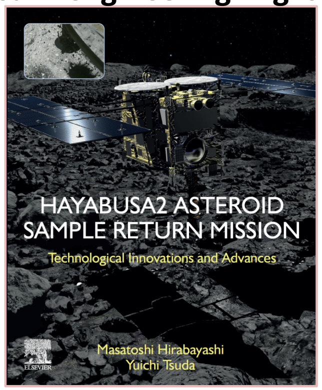
- Awards（scientific and social recognition）:57
  - International Awards: （IAF World Space Award, etc）
  - Domestic awards: （Prime Minister‘s commendation, etc）
  - Individual (young) awards: （Society awards, best paper awards, etc)
  - Joint commendation with companies: (Japan Industrial Technology Awards, etc)

Vicinity phase initial results papers

Science magazine April 19, 2019 issue

Nature magazine March 26, 2020 issue

"Hayabusa2" engineering English book



Hayabusa2：summary video & pamphlet

- Video and pamphlet summarising the Hayabusa2 mission have been released

Hayabusa2 –A 2195 day odyssey-

CG movie of the mission, from launch (December 3, 2014) to Earth return (December 6, 2020) with narration and live-action footage at the beginning and end. Run time about 14 minutes 30 seconds.

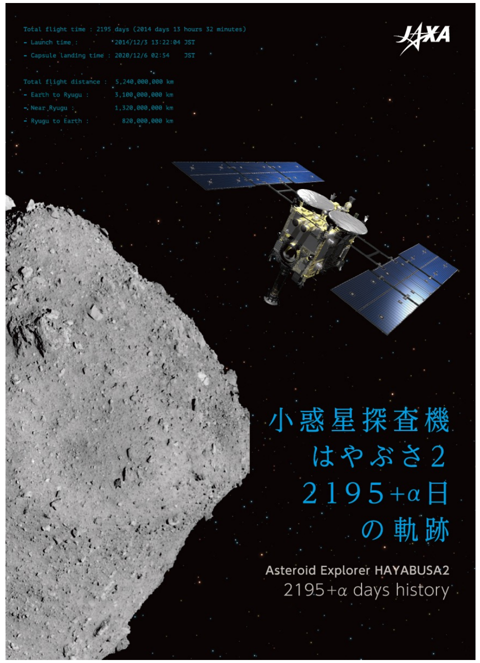
YouTube： https://youtu.be/imUy11NiPH4

- Simultaneous release：Hayabusa summary video

Asteroid explorer Hayabusa –Looking back on a journey of 6 billion km -

Video summary of the Hayabusa mission with live-action and CG with narration (Japanese only). Run time about 8 minutes.

YouTube：https://youtu.be/U_C2yDCSFtE



Pamphlet summarising the mission

（credit：JAXA）

Hayabusa2: utilization and development of results

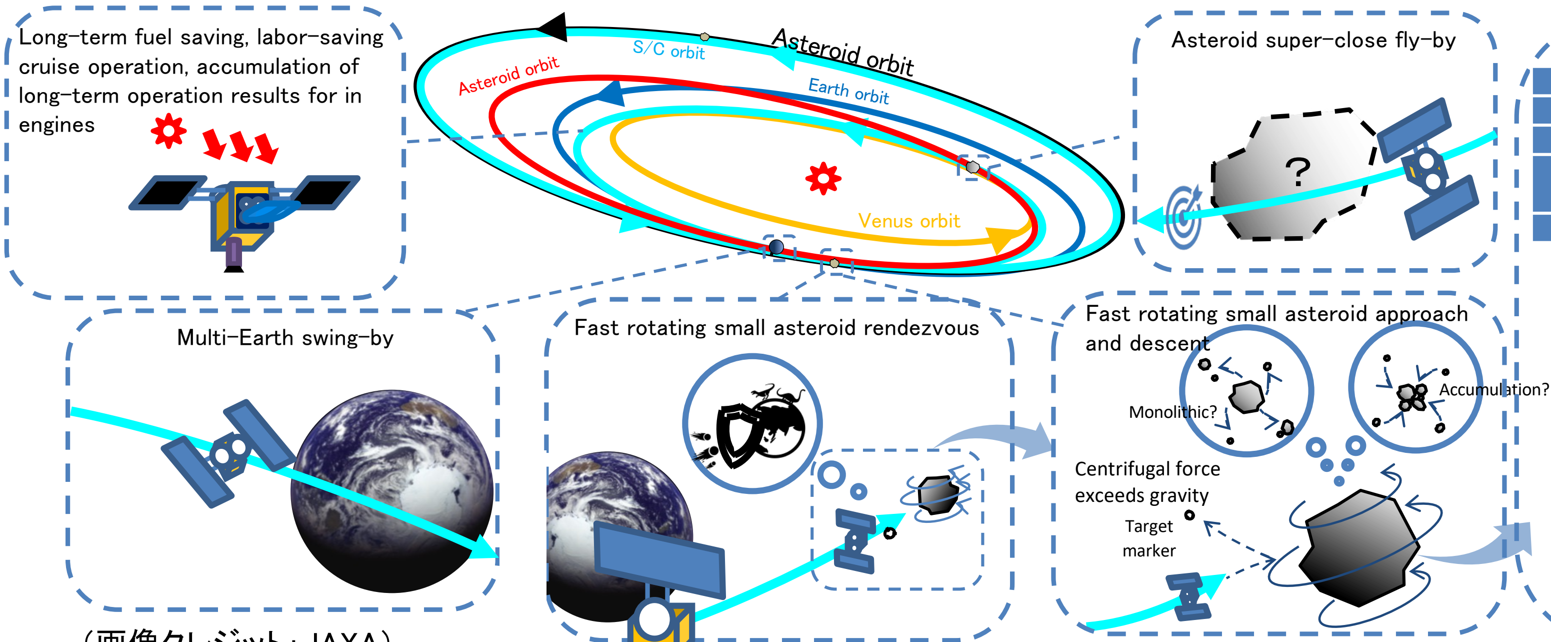
- Future exploration revealed from the results of Hayabusa2
  - **Science: With the clarification of the identity of C-type asteroids, the importance of understanding the diversity of primordial objects has become clearer.**
    → The understanding of one primitive type revealed by Hayabusa2, the scientific power of sample return exploration can be used to elucidate diverse primordial bodies such as D-type, E-type, and comets.
  - **Technology: NEO round-trip technology and flexible exploration opens the challenge of distant and larger celestial body exploration.**
    → Hayabusa2's interplanetary round-trip and flexible exploration makes it possible to consider challenges of sample return from small bodies beyond Mars, and advanced one-way exploration of more distant objects.
  - **Exploration: Demonstrated the potential for activities that respond to social needs and issues beyond science and technology.**
    → With the technology for astronomical round-trip navigation, flight and landing near small celestial bodies, surface movement on small bodies, and high speed collisions and evacuation, how will Japan tackle issues such as planetary defence, space resources, and international space exploration?
  - **Contribute to Japan's Solar System exploration projects**
    → Contribute to the creation and advancement of recent projects (SLIM, MMX, DESTINY+, Hera, etc) and R&D activities for future missions

2. Hayabusa2 Extended Mission

- On June 30, the Hayabusa2 Project is formally dissolved and completely transferred to the Hayabusa2 Extended Mission Project.
- While the original project was under direct control of JAXA, the new project is under the Institute of Space and Astronautical Science (ISAS).
- In the Hayabusa2 Extended Mission Project, we will continue to operate the spacecraft as we head towards a new asteroid with the aim of promoting and developing the scientific results gained so far.
- The team leader of the Hayabusa2 Extended Mission Project will continue to be the Project Manager of Hayabusa2, Yuichi Tsuda.

Hayabusa2 Extended Mission：Overview

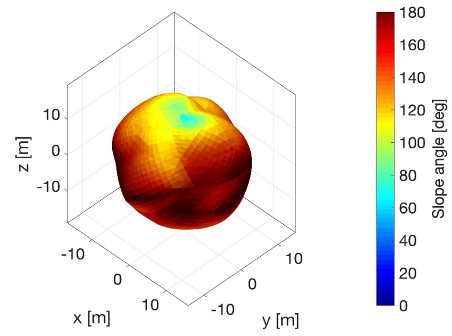
Aim	Overview
New celestial body exploration	Acquire technical and scientific knowledge that till contribute to deep space long-term navigation technology and planetary defence, and ultimately rendezvous with a rapidly spinning asteroid.
Promotion and development of the academic value of the Hayabusa2 results	・ Expansion of join scientific analysis activities for Hayabusa2 / OSIRIS-Rex samples ・ Establish facility to receive the OSIRIS-Rex sample ・ Enhance the international visibility of the Hayabusa2 science results



（画像クレジット：JAXA）

＜1998 KY26 properties＞

Shape	Spherical (from radar obs.)
Av. Diameter	About 30 m
Spin period	10.7 min (0.178hr)
Tumbling motion	No short-term variability detected
Spectral type	Possible carbonaceous asteroid



（credit：Auburn University, JAXA）

Hayabusa2 Extended Mission: Major Events

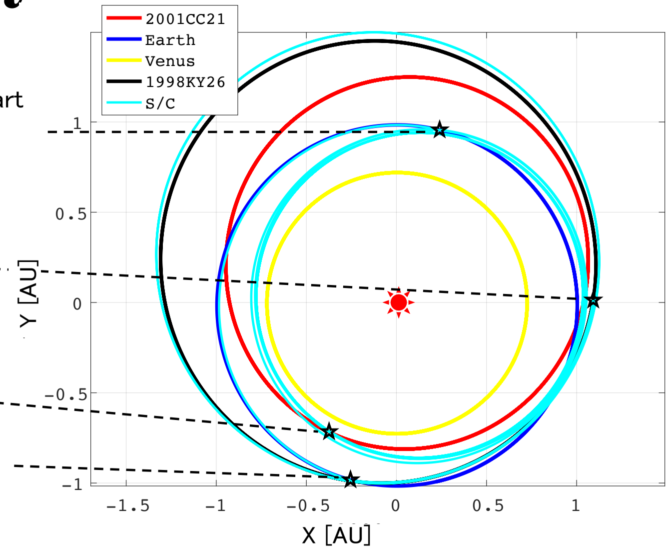
2020/12
Extended mission start
2027/12
Earth swing-by

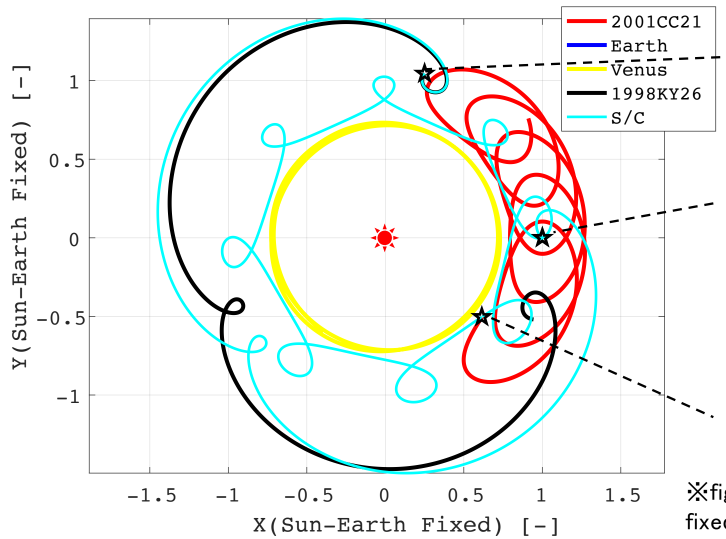
2031/7
1998 KY26
rendezvous

2026/7 2001CC21
Fly-by

2028/6
Earth swing-by

(credit：JAXA)





2031/7 1998 KY26
rendezvous

2020/12
Extended mission start
2027/12
Earth swing-by
2028/6
Earth swing-by

2026/7 2001 CC21
Fly-by

※figure where Sun and Earth are fixed at the origin and at (1,0)

Period	Event	Engineering goals	Science goals
2021/1～2026/7	Long term navigation	Acquisition of long-term fuel-saving / labour saving cruise operation technology	・ Understand dust spatial distribution from zodiacal light observations ・Search for exoplanets
2026/7	2001 CC21 Fly-by	・ Acquisition of Japan's first asteroid ultra-proximity high-speed fly-by technology. ・Acquisition of technology that contributes to Planetary Defense	Constrain characteristics of L-type asteroids in fly-by observations
2027/12	Earth swing-by	・Multi (3rd time) Earth swing-by technology	N/A
2028/6	Earth swing-by	・Multi (4th time) Earth swing-by technology	Long-term performance evaluation of onboard scientific instruments during cruising & passing celestial bodies.
2031/7	1998 KY26 rendezvous	・Acquisition of high-speed rotation small asteroid exploration technology ・Accumulation of technology that contributes to Planetary Defense	・Elucidate the formation & evolution of high-speed rotating asteroids ・Acquisition of science for Planetary Defense

Current status of spacecraft operation

- Ion engine operation will start from 2022/6/28 (scheduled until around October)
  （Ion engine operation time for the Extended mission so far: about 5,000 hours)
- Upon completion of ion engine operation for this time, the quota of the initial mission phase of the Extended mission will be achieved. Operation will then be paused until around 2025.
- Current（6/29） information

Sun distance：　~156,600,000 km
Earth distance：～216,800,000 km
Total flight distance：~6,818,000,000 km
（flight distance since 2020/12/6：
~1,541,000,000 km）

REF：Speed increase from ion engines up to the approach of 2001 CC21

Period	Acceleration	(sum)
2020/12/6～2022/06/27	~500 m/s	~500 m/s
2022/6/28～2022/10	~100 m/s	~600 m/s
2025 ～2001 CC21 approach	~200 m/s	~800 m/s
2001 CC21 approach ～1998 KY26 arrival	~500m/s	~1300m/s

Hayabusa2 Extended Mission：Name

- Official name

  はやぶさ2拡張ミッション、Hayabusa2 extended mission

- Spacecraft name

  小惑星探査機「はやぶさ2」、Asteroid Explorer “Hayabusa2”

- Team name

  はやぶさ2拡張ミッションチーム、Hayabusa2 Extended mission team

- Mission nickname

  はやぶさ2#、Hayabusa2# （Read：Hayabusa2 sharp）

  ➤#（SHARP）＝Small Hazardous Asteroid Reconnaissance Probe
  （A spacecraft that investigates small but dangerous asteroids that may collide with the Earth)

Hayabusa2 Extended Mission: Outreach

Let's meet the Little Prince: Million Campaign 2#

- Send your message to the Hayabusa2 spacecraft that will be written in the spacecraft's memory.
- Messages will be accepted through the web interface, and an "Extended Mission Ticket" will be issued upon receiving your message.
- Application period: scheduled for 2022/7/11～12/6
- Reference: Before the launch of Hayabusa2, the "Million Campaign 2" was held to add names and messages to the target markers and re-entry capsule. For Hayabusa, the "Million Campaign" added names to the target markers.

3. Distribution of the Ryugu sample

- 1st Ryugu sample research open call
  - Background
    - 2021/12/17: 1st international AO was issued.
    - 2022/3/25: Deadline to submit application “Notice of Intent”. Received 105 applications (from 19 countries).
    - 2022/4/22: Deadline for the open recruitment. Received 57 research proposals (12 countries).
  - Results
    - After deliberation by the Ryugu Sample Research Announcement of Opportunity Committee (AO Panel), 40 out of 57 proposals (9 countries, 74 samples, total of about 230mg) was selected. On June 13, 2022, this was approved by the Hayabusa2 Sample Allocation Committee (HSAC).
  - Future schedule
    - Distribution of Ryugu samples will begin at the end of June.
    - A total of four international AOs are planned, one every six months.

Ryugu sample distribution

- 2nd Ryugu sample research open call
  - Schedule
    - 2022/6/29: 2nd International AO issued. Published guidelines. Published list of first awardees (including research themes).
    - Early 2022/8: Call for Notice of Intent opens. Samples for research open to the public.
    - 2022/10: Deadline for Notice of Intent applications.
    - 2022/11: Deadline for research proposal applications.
    - 2023/1: Results for the open call to be announced. Sample distribution started.
  - Samples available for research in open call
    - Individual grains (same as 1st International AO, stony sample).
    - Aggregate sample (sand sample).
    - Gas sample.
    - Samples retuned after the initial analysis.

4. Future plans

■ Spacecraft operation schedule

2022/6/28 ～2022/10　Ion engine operation

As required　Observations (zodiacal light, exoplanet)

■ Press and media briefing

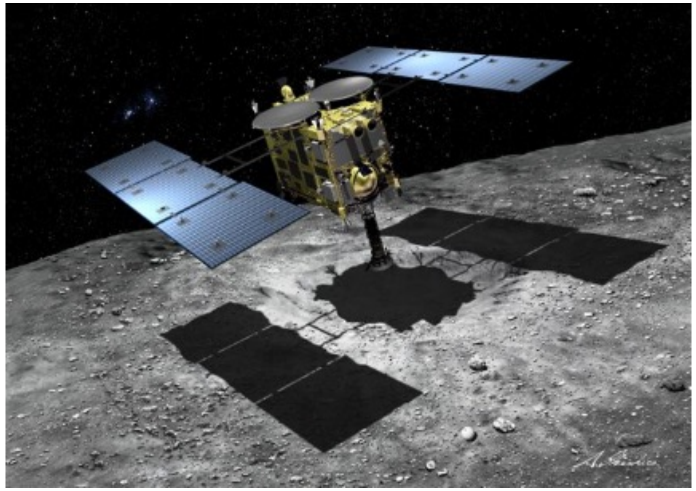
2022　TBD　Announcement of sample analysis papers (many)

Summary of science

Reference

Overview of Hayabusa2

(Illustration: Akihiro Ikeshita)



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.

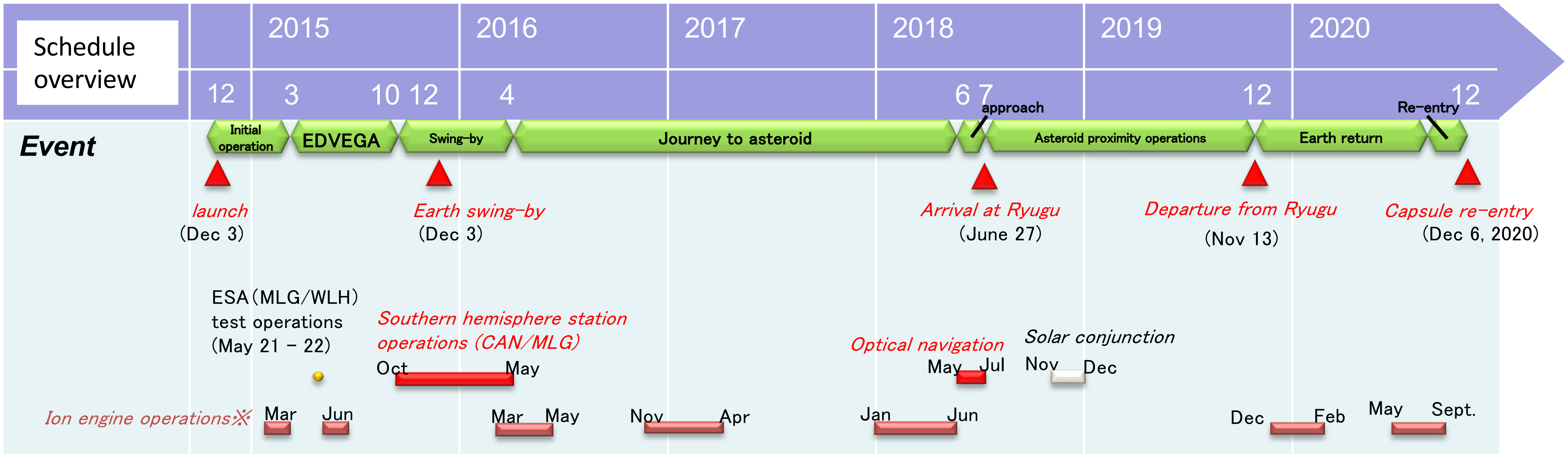
Hayabusa 2 primary specifications

Mass	Approx. 609 kg
Launch	3 Dec 2014
Mission	Asteroid sample return
Arrival	27 June 2018
Stay at asteroid	Approx. 17 months
Departure.	13 November 2019
Earth return	6 December 2020
Target body	Near-Earth asteroid Ryugu

Primary instruments

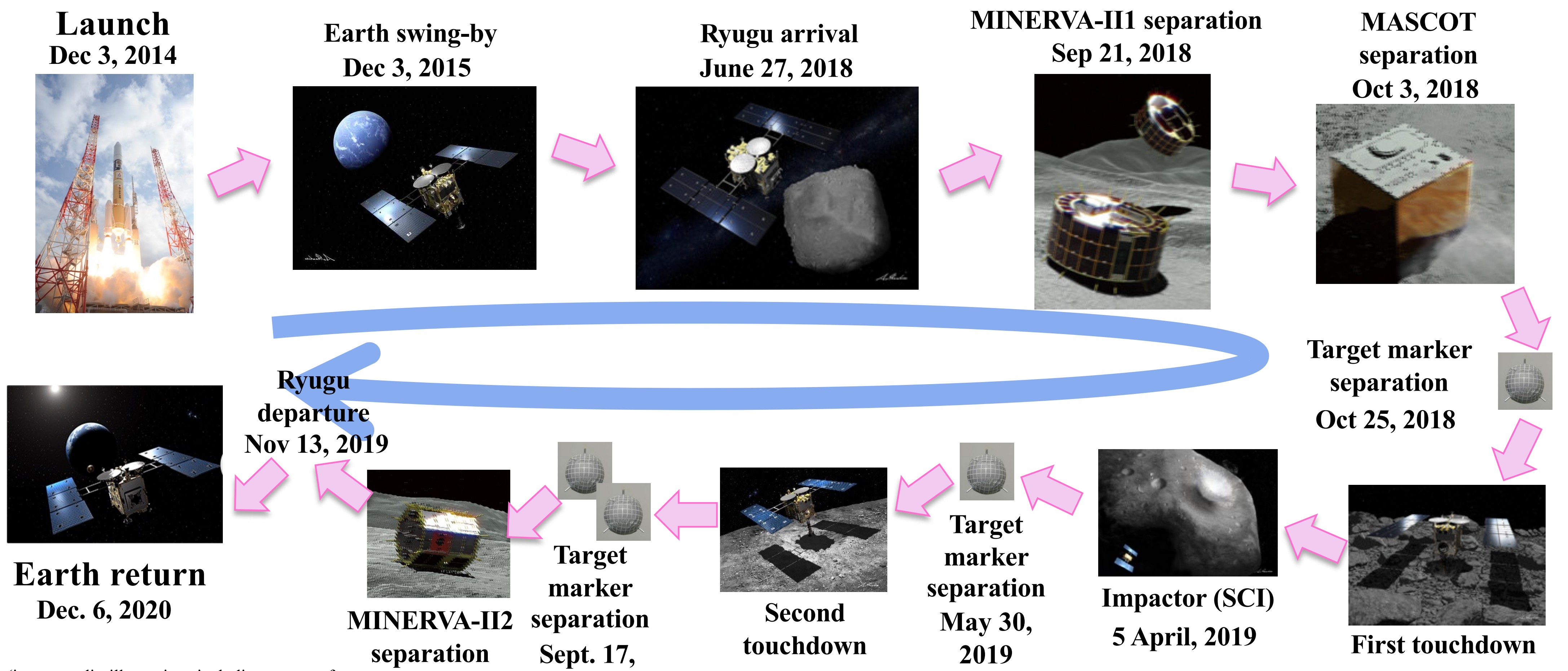
Sampling mechanism, re-entry capsule, optical cameras, laser range-finder, scientific observation equipment (near-infrared, thermal infrared), impactor, miniature rovers.

Overall project schedule



(image credit：JAXA)

Mission flow



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