Asteroid explorer, Hayabusa2, reporter briefing

March 19, 2021

JAXA Hayabusa2 Project

Topics

An overview of the sample curation and initial analysis and introduction to the team.

Contents

1. Overview of the current project status
2. Curation overview / team introduction
3. Summary of the initial analysis
4. Introduction to the initial analysis team
5. Future plans

1. Overview of the current project status

■Spacecraft operation

- Regular operation is ongoing. The current solar distance (distance from the spacecraft to the Sun) is the shortest for the mission so far (about 120 million km on March 13). The temperature of the spacecraft has risen, but careful operation has ensured no problems have occurred. The spacecraft is in good condition.

■Curation work

- We are continuing with high-definition optical microscope imaging and weight measurements of the particles / bulk aggregate samples returned from Ryugu.

2. Curation overview / team introduction

Curation：Returned sample characterizations・secure storage・allocation management・sample distribution to world-wide community＋research and development

＊JAXA is undertaking curatorial activities in cooperation with other institutes.

Phase-1@ISAS

Sample recovery・initial description（optical image, weight, size, shape etc.）・distribution

Initial detailed description, catalogue creation・Technology / R&D including storage . distribution

sample

Phase-2 lead：Eizo Nakamura

Okayama University, Institute for Planetary Materials

higher-order detailed description data / provision of curation technology

- Establish analysis method based on the Comprehensive Analytical System for Terrestrial and Extraterrestrial Materials (CASTEM)
- Development and technology licensing of the Depository for References of Earth and Analytical Materials (DERAM).
- Provision of multi-element / isotope analysis and age data.

sample

Phase-2 lead：Motoo Ito

JAMSTEC Kochi Institute for Core Sample Research

R&D for future and current curatorial work, Detailed characterizations of the samples

- R&D of universal sample holders for multi-analytical instruments under a none air exposure system.
- To acquire the detailed characteristics of the Ryugu samples without terrestrial contaminations.
- R&D of a linkage analysis (microbeam and bulk chemical) with multi-institute (NIPR, UVSOR, JASRI/SPring-8 etc.)

Initial detailed description, catalogue creation・Technology / R&D including storage . distribution

Reference：Sample distribution schedule (plan)

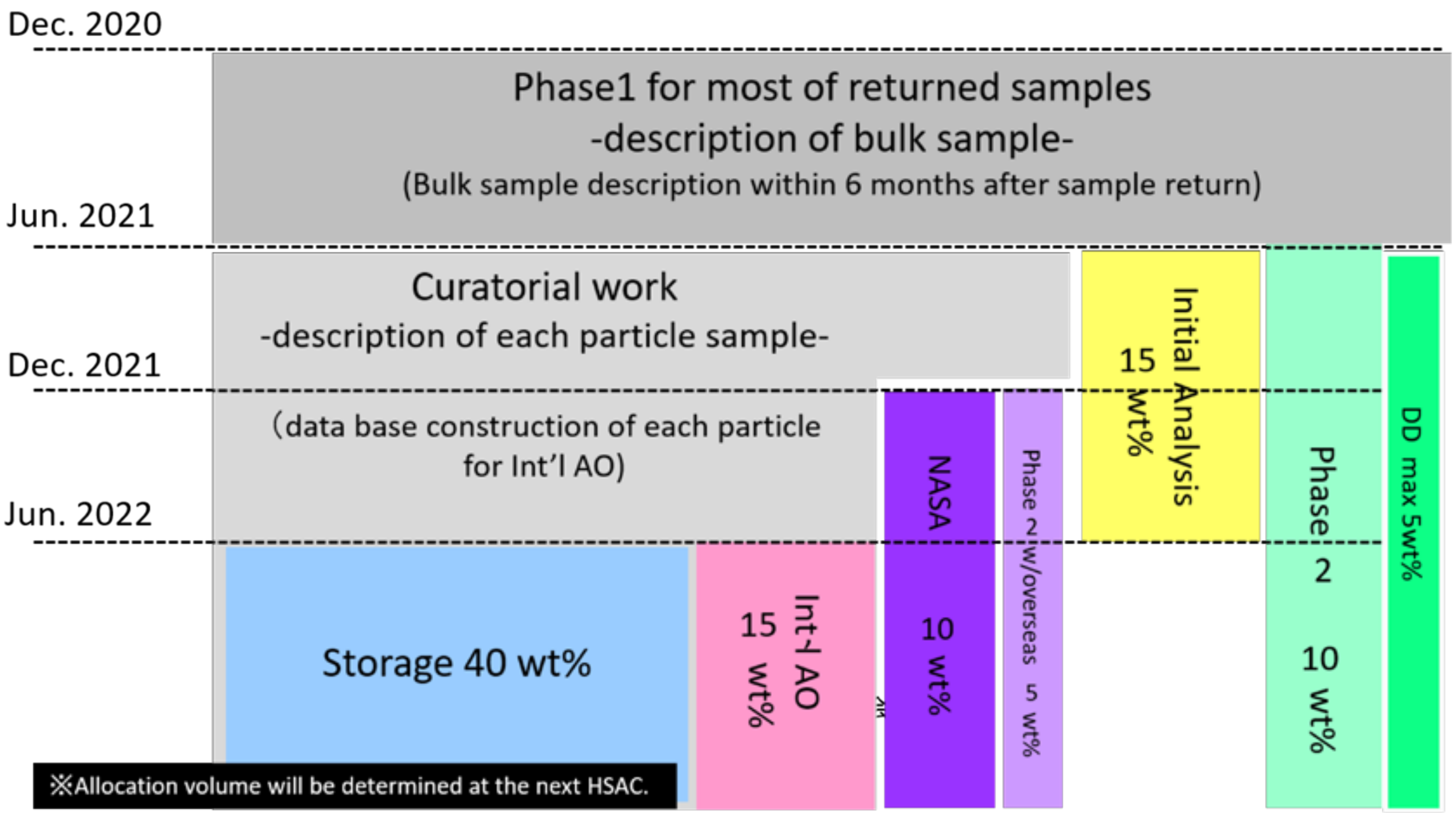
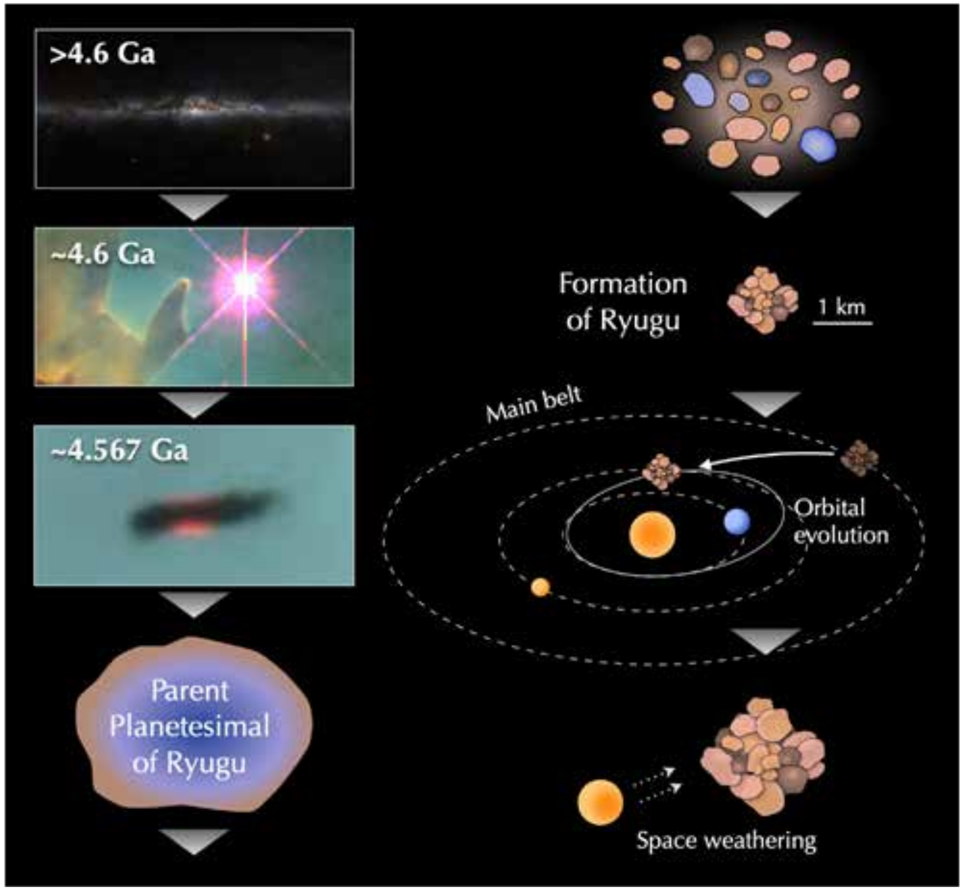


Image credit：JAXA

3. Initial analysis summary



(image credit Shogo Tachibana)

・Supervisor	Shogo Tachibana (U. Tokyo)
・Chemical analysis team	Hisayoshi Yurimoto (Hokkaido U.)
・Stoney material analysis team	Tomoki Nakamura (Tohoku U.)
・Sandy material analysis team	Takaaki Noguchi (Kyoto U. / Kyushu U.)
・Volatile analysis team	Ryuji Okazaki (Kyushu U.)
・Solid organics analysis team	Hikaru Yabuta (Hiroshima U.)
・Soluble organics analysis team	Hiroshi Naraoka (Kyushu U.)

109 universities and research institutes in 14 countries, 269 people.

4. Initial analysis team introduction

Chemical analysis team

Investigation of the chemical characteristics of the sample from Ryugu. For this, the bulk elemental and isotopic compositions are determined. Additionally, variations in the isotopic composition and the formation age of components within the sample are analyzed.

These results will allow clarification of the relationship between asteroid Ryugu and the types of meteorites that fall to Earth, and probe the formation and origin of Ryugu itself.

Fluorescent X-ray spectrometer for chemical composition analysis (©Rigaku, Horiba)

Thermal ionization mass spectrometer for isotope analysis and dating (© Tokyo Institute of Technology)

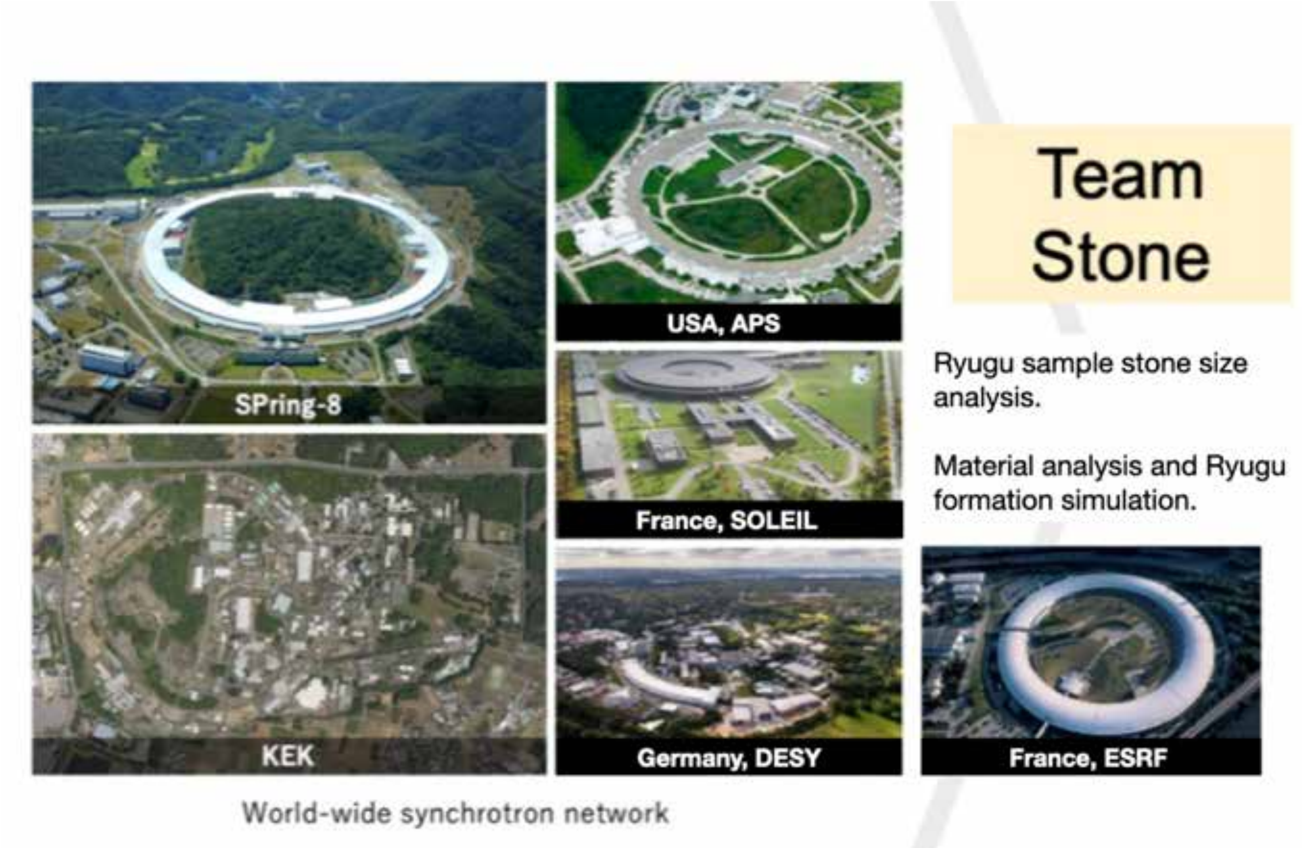
Isotope microscope for observing element and isotope distribution (© Hokkaido U)

4. Initial analysis team introduction

Stony material analysis team

Obtain the light reflection spectra of the coarse-grains recovered from the sample, and estimate the material distribution over the surface of asteroid Ryugu. Perform non-destructive material analysis using the synchrotron radiation high-energy beam and obtain the 3D internal structure and element distribution of the recovered sample. Observe the sample's microstructure using a high-resolution electron microscope. Physical properties such as thermal conductivity are also measured.

Integrate all data to model the formation process of asteroid Ryugu.



(image credit is from each institution)

4. Initial analysis team introduction

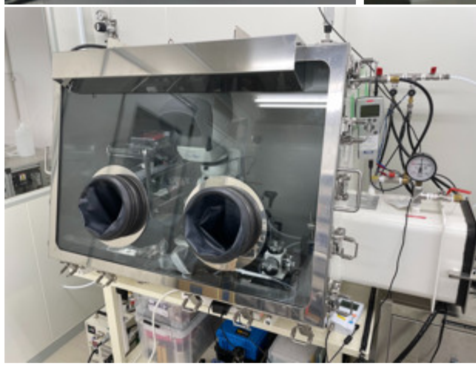
Sandy material analysis team

The surface of celestial bodies without atmospheres is directly exposed to outer space. The surface of Ryugu is therefore continuously exposed to the flow of plasma known as the solar wind that is constantly streaming from the Sun. Additionally, very small meteorites collide with the surface at speeds much faster than from rifles.

The sand material analysis team focuses on how the surface material on Ryugu changes when exposed to this harsh environment.

Sample processing will take place at Kyushu University and Kyoto University, where the sample will be observed with a transmission electron microscope, and the samples distributed to researchers in Japan and overseas to proceed with research.

Left: The latest plasma FIB sample processing observation device. Observe, analyze and process asteroids samples.
Right: A scanning transmission electron microscope used to investigate the kind of substances Ryugu is made from.
Both devices allow samples to be taken in and out without coming into contact with the atmosphere.



Glove box for handling samples without exposure to the atmosphere. This is filled with purified nitrogen gas before use.

4. Initial analysis team introduction

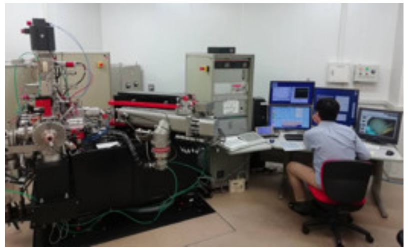
Volatile component analysis team

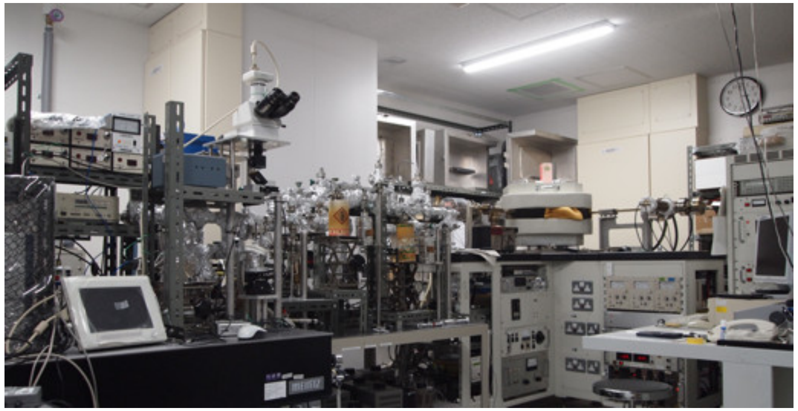
Analysis of the elemental and isotopic compositions of the volatile substances enclosed within the Hayabusa2 sample catcher and the volatiles within the Ryugu solid sample. Through analyzing the various volatile substances such as hydrogen, nitrogen, oxygen, and noble gases, we will obtain information on the origin and geological age of the parental materials of Ryugu.

The Ryugu solid samples will be analyzed without exposure to the atmosphere at domestic and overseas research institutes, with the aim of obtaining 'raw' information about Ryugu. Additionally, neutron irradiation at Kyoto University Research Reactor Institute for Nuclear Science allows trace element analysis, such as iridium, and Ar-Ar age. Through these combined analyses, we will obtain a variety of material science information from these valuable samples at the same time.

Neutron irradiation / trace element analysis
（©Kyoto U. / Research Reactor Institute)

Light element isotope analysis
（©U. Tokyo, Atmosphere and Ocean Research Institute)





Rare gas isotope analysis
（©Kyushu U. ）

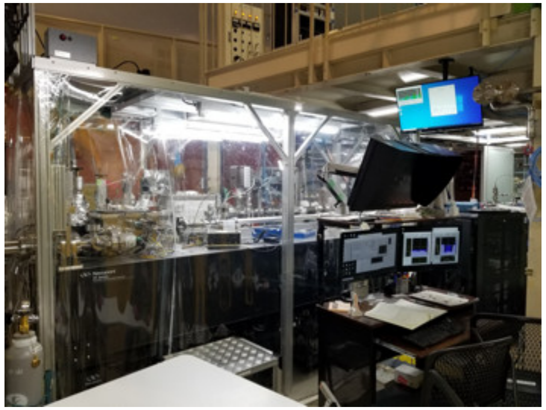
4. Initial analysis team introduction

Organic macromolecule analysis team

In order to understand the formation process of the the life's building blocks in the early Solar System, the molecular and isotopic compositions and the distributions of the organic macromolecules in the asteroid Ryugu samples will be investigated through combining a variety of microspectroscopy techniques (infrared, Raman, synchrotron soft X-ray), electron microscopy and isotope microscope.

We aim to understand the diverse origin and evolution of extraterrestrial organic matter by observation of the chemical heterogeneity of the organic macromolecules from the intact (unprocessed) asteroid samples. Analysis of the insoluble organic matter that is recovered by acid treatment of the asteroid sample will reveal the bulk composition of the organic macromolecule, which characterizes Ryugu.

Organic macromolecular solids purified by acid treatment of carbonaceous chondrites. The chemical history of the early Solar System is recorded in its complex molecular structure (photo: Yabuta).



Synchrotron-based scanning transmission X-ray microscopy（BL19A, Photon Factory, KEK, Tsukuba, Ibaraki, Japan）

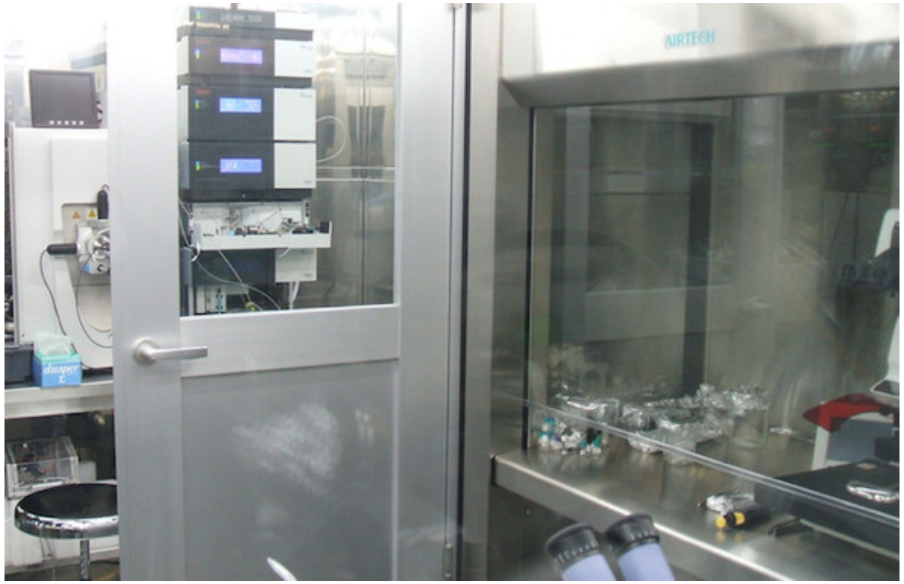
With a high spatial resolution of about 30 nm, one can reveal the functional group chemistry of the submicron-sized organic matter (Photo: Yabuta)

4. Initial analysis team introduction

Soluble organics analysis team

The kinds of organic compounds are clarified in asteroid Ryugu.

Samples are extracted with a variety of solvents, and organic molecules are identified and quantified using mass spectrometry coupled with chromatography. The main target compounds are amino acids and nitrogen-containing cyclic compounds, but all detectable molecules are comprehensibly analyzed by ultra-high resolution mass spectrometry. Additionally, the spatial distribution of soluble organic compounds and the abundance and isotope ratio analysis of carbon, nitrogen, sulfur etc., will be determined. This is conducted by an international collaborative research team in Japan, the US, Germany and France.



Kyushu University clean room and liquid chromatograph-high resolution mass spectrometer (top) and rehearsal analysis (bottom)

（image credit：Kyushu University）

5. Future plans

■Operation schedule

2021/3～　Continued regular operation

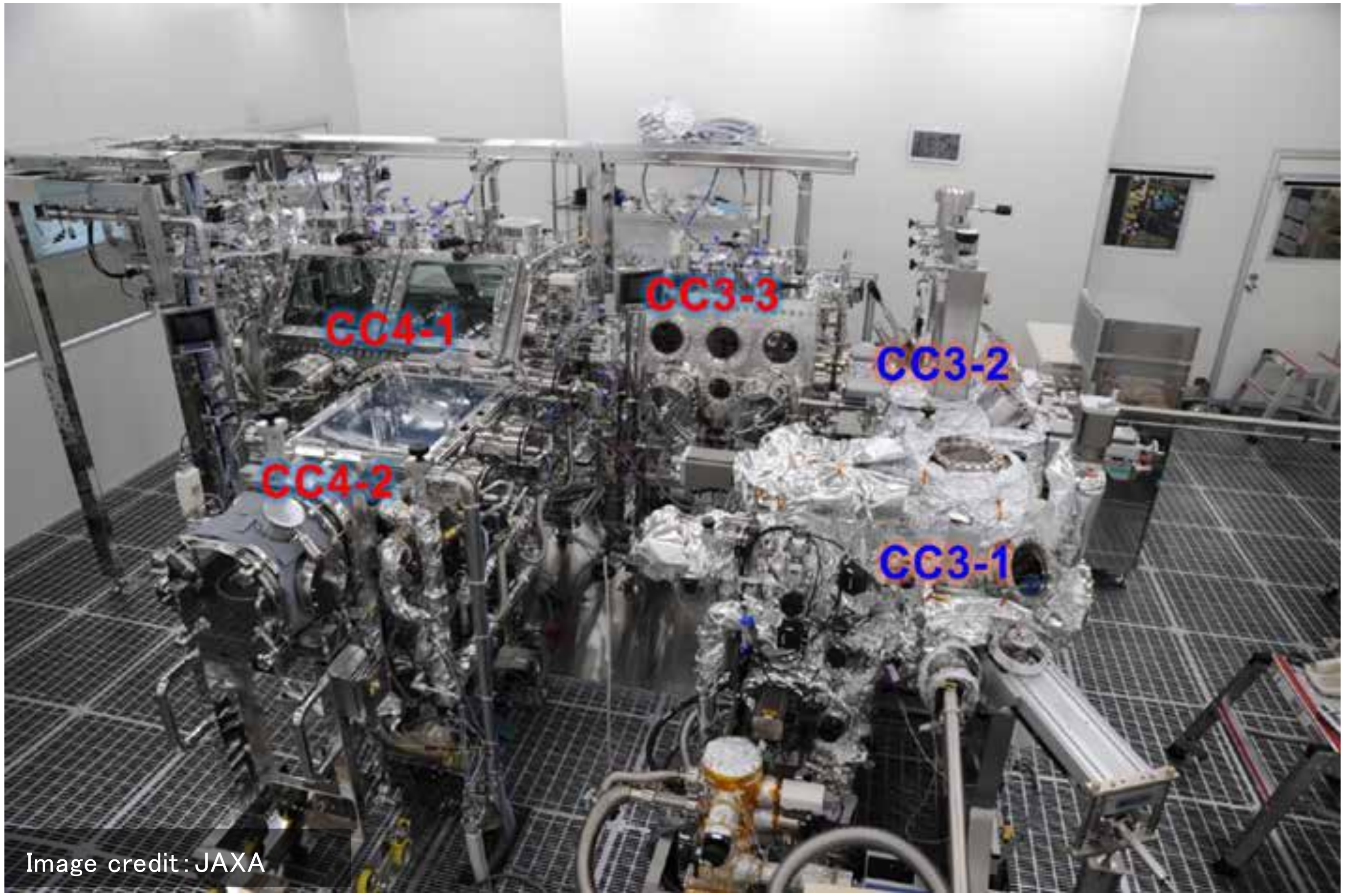
Ion engine operation scheduled to begin around the end of April

■Press and media briefings

2021/4/TBD　Press briefing

Reference

Clean chamber overview



CC3-1 :
Opening the sample container under vacuum environment

CC3-2 :
Sample collection under vacuum

CC3-3 :
Transition from vacuum to nitrogen environment

CC4-1 :
Handling of submillimeter-sized particles

CC4-2 :
Handling / observation / sorting of relatively large particles (> mm)