Martian Moons eXploration (MMX) Mission Press Kit

August 2026

Japan Aerospace Exploration Agency (JAXA)
Institute of Space and Astronautical Science (ISAS)
MMX Project Team

Greetings from Project Manager Kawakatsu Yasuhiro

I am Kawakatsu Yasuhiro, leading the Martian Moons eXploration mission. MMX is aiming to achieve the world's first sample return from Phobos, one of the moons of Mars. About ten years ago, my colleagues and I embarked on the challenge to make this mission a reality. With researchers and engineers both in Japan and overseas working together, we overcame many trials and we are now looking at the launch in fiscal year 2026.

The Martian moon Phobos is a place yet unexplored by humanity. By returning samples, we will clarify how the Martian moons were formed, explore how the Mars system evolved, and the origin of water and organic matter on our terrestrial planets. We will also develop exploration technology necessary for future human exploration. Your support through the next five years from launch to our return to Earth would mean a lot to us.

Brief biography of KAWAKATSU Yasuhiro:

Japan Aerospace Exploration Agency (JAXA)

Institute of Space and Astronautical Science (ISAS), Department of Space Flight Systems, Professor.

MMX Project Team, Project Manager

1968: born in Kyoto, Japan.

1991: Graduated from the Department of Aeronautics, Faculty of Engineering, the University of Tokyo.

1996: Completed the doctoral program at the Graduate School of Engineering, the University of Tokyo.

1997: Joined the National Space Development Agency of Japan (NASDA). Following the integration of the three space agencies in 2003 and the establishment of the Japan Aerospace Exploration Agency (JAXA), joined the Institute of Space and Astronautical Science (ISAS), and served as Professor since 2018. He is engaged in research on astrodynamics and mission and trajectory design for deep space exploration, while supervising graduate students, and has been involved in the development and operation of spacecraft that include Kaguya, Akari, Akatsuki, and PROCYON. He joined the study of the Martian Moons Exploration project that began in 2015 and has served as the Project Manager of MMX since 2020.

Contents

MMX

Martian Moons eXploration

Mass: ~ 4480kg
Mission duration: ~ 5 years
Launch vehicle: H3
Launch in JFY 2026

A world-first sample return mission from the Martian moon, Phobos

The mission will investigate the processes by which organic matter and water were transported and delivered to celestial bodies in the early Solar System by confirming the presence of these materials and uncovering the origin of the moons of Mars. Building upon the exploration technology developed in Japan, MMX will investigate the Martian moons as potential base candidates for future human exploration to Mars itself.

1. Mission Objectives

The objectives of the Martian Moons eXploration (MMX) mission

MMX Mission Objectives

The Martian Moons eXploration (MMX) mission seeks to reveal how Mars's moons formed, explore environments relevant to the origins of life and deepen our understanding of the Martian system's evolution. MMX will also develop key technologies that will serve as a foundation for future crewed missions. These objective fall into two aspects: planetary science and technology acquisition.

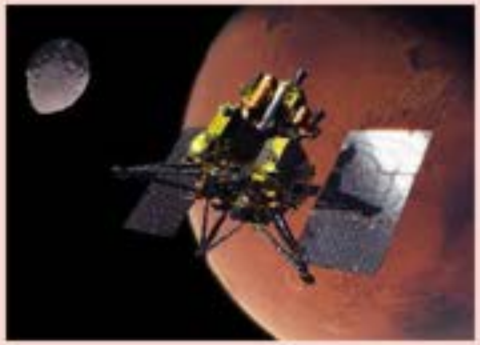
Planetary Science: exploring the Martian moons, and uncovering the origin of habitable environments in the Solar System

1. To reveal the **origin of the Martian moons** and progress our understanding of **planet formation and primordial material transport** at the border between the inner and the outer regions of the early Solar System.
2. From this new vantage point of the Martian moons, observe processes that drive changes in the Mars system and advance our understanding of Mars's surface environment transition.

Technology Acquisition for future exploration activity

To develop spacecraft technology such as,

1. **Transportation** capability to reach a planetary moon system and achieve the round trip to Martian system.
2. **Robotics** capability to reach and stay on the surface of the Martian moon and perform advanced sample retrieval.
3. **Deep space communication** capability optimized for use with the new deep-space ground station.



MMX Mission Objectives: Additional value

Beyond achieving the primary mission goals, the journey of MMX is expected to deliver valuable additional benefits. Together, these contributions will expand the mission's overall impact.

Pioneering crewed Mars exploration, Phobos as a bridgehead to Mars


Credit: NASA/JPL-Caltech, University of Arizona

MMX will explore the possibility of using **Phobos as a natural space station** by establishing the technology required for a round-trip to the Martian sphere—essential for crewed Mars exploration—and by conducting detailed observations of Phobos's surface topography, ground information, and surface and surrounding environment.

Outreach from the Martian sphere, Ultra-high-definition image of SHV


Credit: JAXA/NHK

JAXA and NHK have jointly developed the "**Super Hi-Vision Camera (SHV)**" capable of filming 4K and 8K images in space. SHV will acquire the world's first ultra-high-definition motion pictures of Mars and its moons in proximity. Through vivid and inspiring media, SHV will convey this new horizon, which has never been seen in detail, to people around the world.

Fragments of Martian meteorite on Phobos, Impurities in Phobos samples


Credit: Natural History Museum Vienna

MMX will inevitably bring back impurities in the Phobos samples. **Martian meteorites** ejected from the Mars surface during meteorite impacts, and their fragments, are expected to be sparsely deposited on the surface of the moon. The fragments may allow researchers to constrain the chemical state of the Martian surface layer and its transition over time.

MMX Mission Objectives: Mars exploration

Around the world, countries including the USA and Europe are exploring Mars itself in search of traces of life. The primary focus of these missions is the past surface environment of Mars, with mission objectives such as:

- What is the history of Mars's surface environment?
- How did Mars lose its atmosphere?
- What caused climate change?

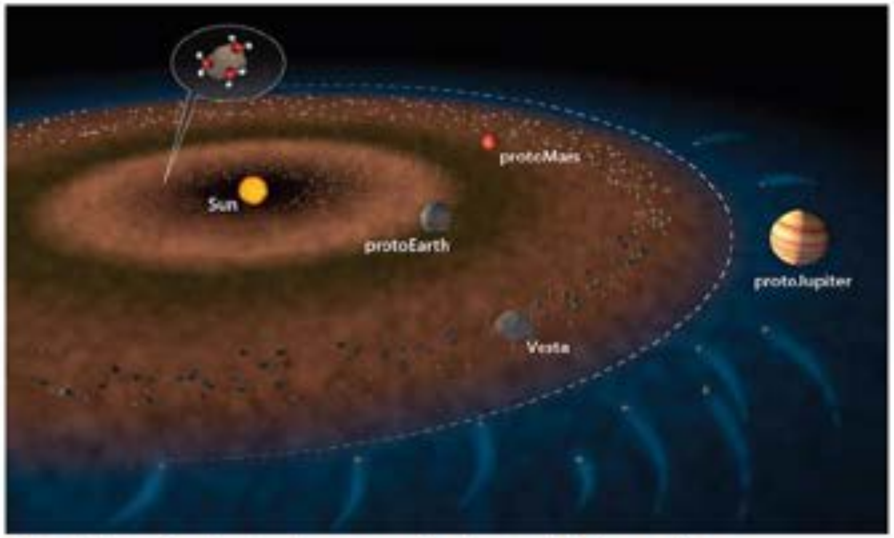
NASA Mars rover Curiosity
Credit: NASA, JPL-Caltech, MSSS, MAHLI

Ancient Mars (left) and Mars today (right)
Credit: NASA's Goddard Space Flight Center

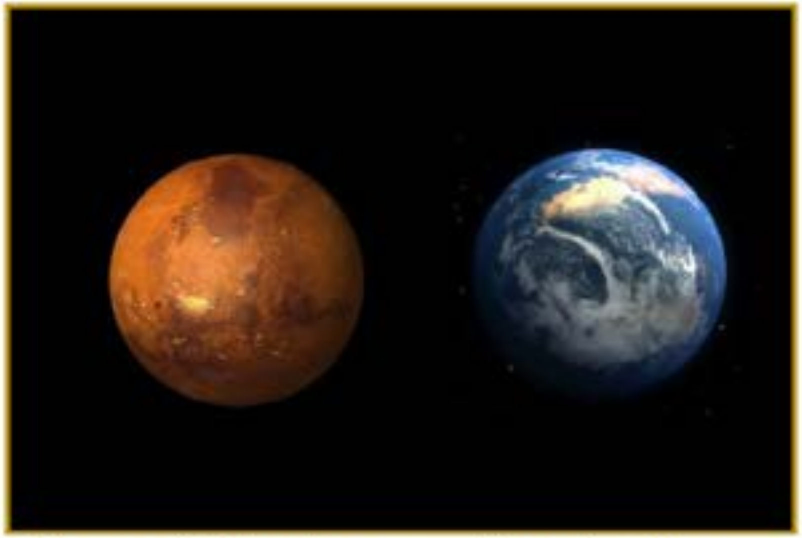
But how did Mars acquire water and an atmosphere to begin with?

MMX Mission Objectives: The origin of water on Mars

But why did Mars ever have water and an atmosphere at all?
Terrestrial planets which formed in a high-temperature region close to the Sun should have lost volatiles such as water and organic matter, and thus formed as dry worlds.



The Solar System at an early stage of formation
Credit: Illustration by Jack Cook, Woods Hole Oceanographic Institution



Early mars (left) and a water-rich ancient Mars
Credit: Right image credit: NASA's Goddard Space Flight Center

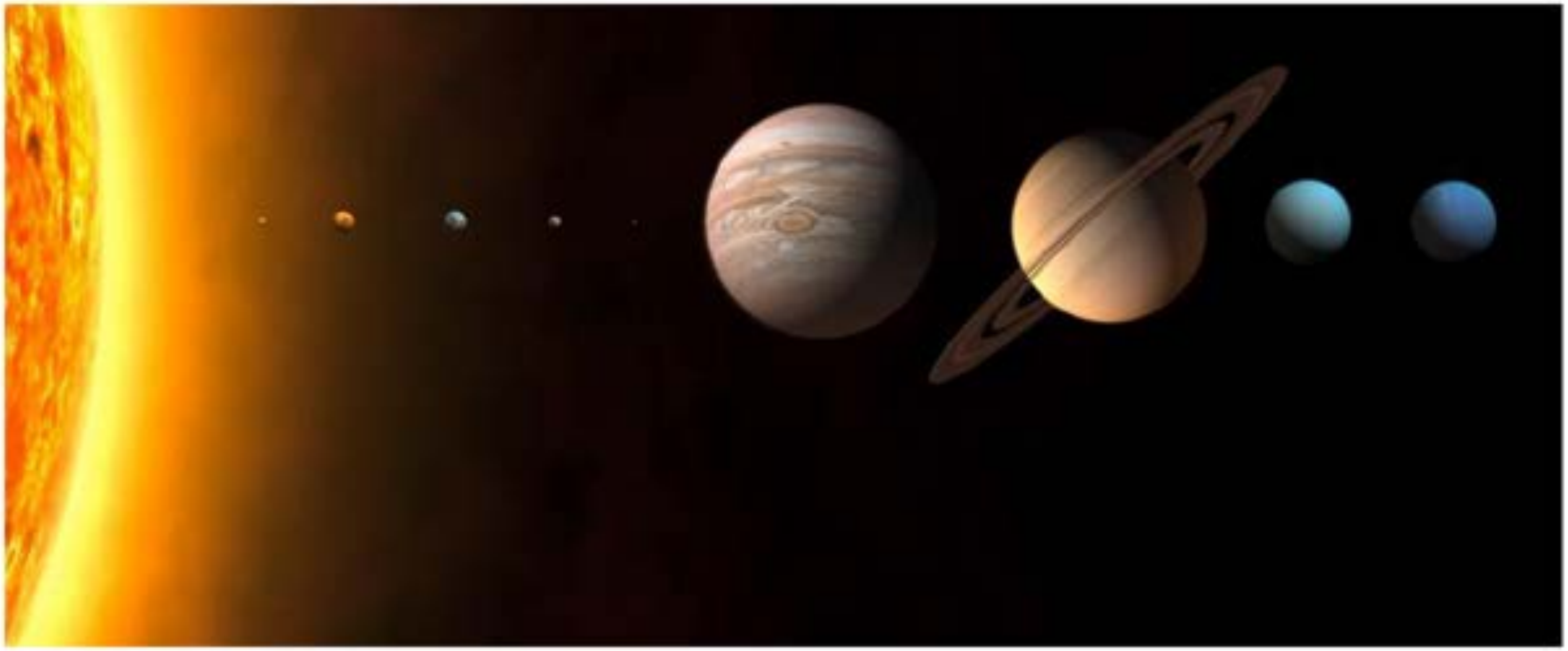
This suggests water was transported to Mars after formation

How was water delivered to the terrestrial planets, creating environments capable of supporting life?

MMX Mission Objectives: Transport of water within the Solar System

Water and volatiles including organic materials may have been transported inwards from beyond the snow line (where water vapour can freeze to become ice) and transformed the terrestrial planet region to produce environments capable of supporting life. These materials are thought to have been delivered by asteroids, comets, and dust.

Evidence for this process might be held in the small bodies near the snow line



So to verify this transportation process, where should we go?

MMX Mission Objectives: The Martian moons – small celestial bodies orbiting Mars

Situated near the snow line at the gateway to the terrestrial planet region, Mars should have witnessed the transportation of materials between the inner and outer Solar System. Mars itself has geologically evolved over time, but it is orbited by two small bodies: the moons, Phobos (diameter 23km) and Deimos (diameter 12 km). If they did not orbit Mars, we would likely consider them just asteroids.

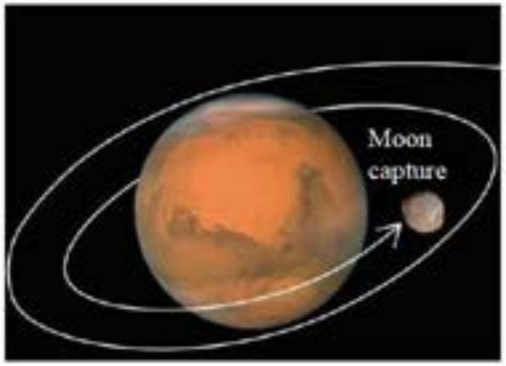
Credit:
NASA/JPL-Caltech
University of Arizona

Could the Martian moons be examples of the capsules that carried water through the Solar System?

MMX Mission Objectives: The origin of the Martian moons Capsules for water transport?

The origin of the Martian moons is unknown. There are two hypotheses, the "captured asteroid hypothesis" and the "giant impact hypothesis" but theoretically, we cannot say which is preferred.

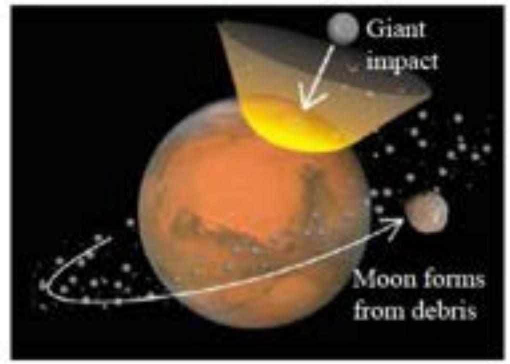
Captured asteroid hypothesis



Images from Earth-Life Science Institute, Institute of Science Tokyo, Kurokawa Hiroyuki

An asteroid that formed far away in the Solar System was scattered towards Mars by a collision with another celestial body or similar event and was captured by Mars's gravity.

Giant impact hypothesis



A large-scale celestial collision occurred on Mars, and the resulting debris was scattered into Martian orbit where it later reaccumulated to form the moons.

The sample returned by MMX will settle the debate over the origin of the Martian moons

Obtain a sample from a water-transport capsule prior to planet delivery

Explore the transport of material through the Solar System and delivery to the terrestrial worlds

Obtain a mixed sample from a water-transport capsule and from early Mars

Explore transport of material and the properties of a young Mars.

2. Positioning of MMX

How does MMX fit into Japan's space science and exploration program?

Positioning: Small body exploration and international space exploration

Following Hayabusa2, the Martian Moons eXploration (MMX) mission is the core of JAXA's small body exploration program and within international space exploration, the mission is Japan's leading initiative in Mars exploration

Small body exploration

MMX is a world-first mission to collect a sample from the Martian moon, Phobos. To investigate how organic matter and water moved through the early Solar System and were delivered to celestial bodies, MMX will analyse hydrated minerals, water, organic matter and other materials contained in the Martian moons, clarifying the presence of these materials as well as the origin of the moons themselves.

Credit: JAXA

International space exploration

MMX is Japan's first major initiative in Mars exploration. Through MMX, Japan will lead a major international collaborative mission to the Martian system—a key target of international space exploration, a shared value of humankind–leveraging Japan's unique and mature small-body exploration technology. MMX will carry forward the exploration technology that Japan has cultivated and contribute to its future development.

Credit: JAXA

Positioning: ISAS small body exploration strategy

The JAXA ISAS small body exploration strategy involves periodic sample return missions, returning celestial material for detailed analysis in laboratories in Japan and around the world to explore how water, organics and other volatiles made their way to the terrestrial planet region. With Hayabusa, Hayabusa2, and MMX, Japan is a global leader in the distribution and analysis of celestial samples.

Return: 2010 **Hayabusa** S-type asteroid	→	Return: 2020 **Hayabusa2** C-type asteroid	→	Return: 2031 **MMX** Phobos (D-type?)	→	Return 20xx **Next Generation Sample Return (NGSR)** comet

Positioning: ISAS small body exploration strategy

Building on Japan's world-leading small body exploration and sample return technology developed through Hayabusa and Hayabusa2, MMX takes on the challenge of the Martian moons, described as the most important unexplored peak in the Solar System.

Hayabusa2 asteroid touchdown (Artist impression)

Asteroid Ryugu
© JAXA, U. Tokyo and collaborators

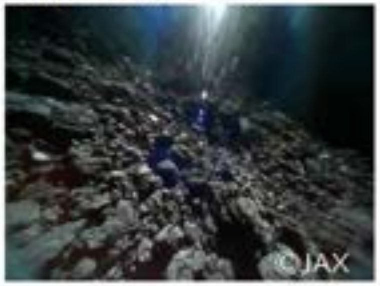


Image from Ryugu's surface captured by the MINERVA-II1 small rover.

Hayabusa, which achieved the world's first sample return from an asteroid, and the currently operating Hayabusa2 established Japan as a world leader in small body exploration.

Moons of Mars: Phobos and Deimos
Credit: NASA/JPL-Caltech, University of Arizona

The two moons of Mars, Phobos and Deimos, are small celestial bodies approximately 10 – 20 km in diameter. Although discovered in the 19th century, the moons have never been directly explored and remain the most important unexplored peak in the Solar System.

Collecting samples on Phobos (artist impression)

The round-trip to the Martian moons, including the sample return, travelling deep within Mars's gravitatonal well, is far more challenging that a mission to an asteroid in our Solar System, and requires a large rocket and spacecraft.

The MMX spacecraft will land on the surface of the Martian moon and remain there for several hours. Using advanced sampling equipment with a manipulator and corer, the spacecraft aims to collect more than 10g of sample from a depth of at least 2cm (Hayabusa2 aimed to collect 0.1g, and succeeded in gathering 5.4g).

Positioning: Inheritance and advancement of exploration technology through MMX

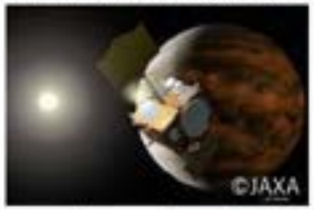
MMX builds on the technologies established through previous space exploration missions. The technologies demonstrated and acquired through MMX will, in turn, be carried forward to the technologies for future international space exploration.

Previous missions


Lunar explorer, Kaguya

Asteroid explorer, Hayabusa

Smart Lander for Investigating Moon (SLIM)



Venus climate explorer, Akatsuki

Exploration technology being developed for MMX

Advanced deep-space navigation capabilities
(1) Deep-space round-trip navigation technology
(2) Navigation technology for accessing planetary moons
(3) Navigation technology for accessing the surface of low-gravity celestial moons

Advanced surface operations and sampling on celestial bodies
(1) Landing guidance technology
(2) Sampling technology
(3) Surface exploration system technology

Advanced deep space communication capability
(1) Optimise for reliable communication operations with ground stations during deep space exploration

Operability improvement & outreach technology
(1) High-definition imaging and mission visualisation technology (*)

Radiation environment assessment capability
(1) Technology to evaluate the radiation dose a human crew might receive from high-energy solar particles

Technology required for international space exploration

Deep space resupply technology
Rendezvous, high-precision proximity approach and departure technology for non-cooperative bodies in long-range, highly perturbed environments within another planetary system.

Surface exploration of a celestial body
System design that enables prolonged presence on the surface of celestial bodies (particularly thermal control and power supply), alongside advanced operational techniques on the surface of celestial bodies (manipulation and sampling).

Landing technology for celestial bodies with gravity
Bridging the technology gap between landing and takeoff operations on microgravity celestial bodies such as asteroid Itokawa, and gravitational bodies such as the Moon.

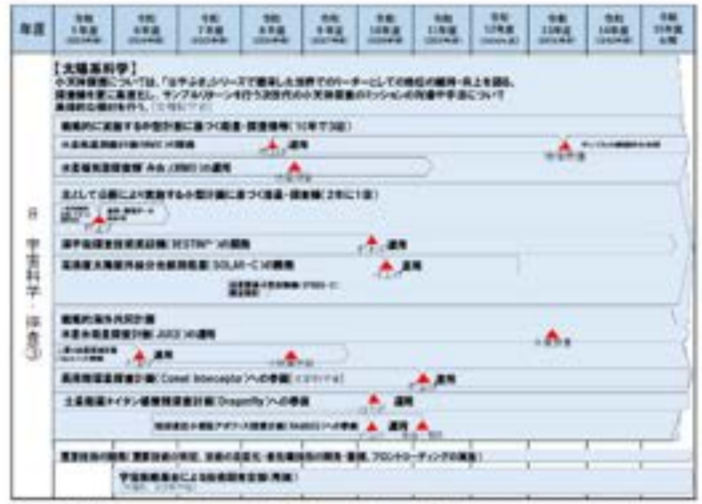
Crewed space habitation technology
Closing the knowledge gap for human Mars exploration.

(*) Onboard instrument contributions for the purpose of developing exploration technology

MMX Positioning: Space Policy and MMX

The Japanese Government Space Policy Timeline revised in December 2025 states that the **launch of MMX will be carried out in FY2026**, positioning the mission as a **priority initiative** to be addressed at the meeting for the Space Development Stategic Headquarters held in May 2026.

Japan Prime Minister Takaichi summerising the meeting (2026.6.12, Space Development Stategic Headquarters)



Basic Plan on Space Policy Timeline (2025.12.23 decided by the Space Development Stategic Headquarters)

Key points on the basic plan for the Space Policy Timeline (FY2024 revision)

3. Creation of new knowledge through space science and exploration (excerpt)

<Key points of Timeline revision>

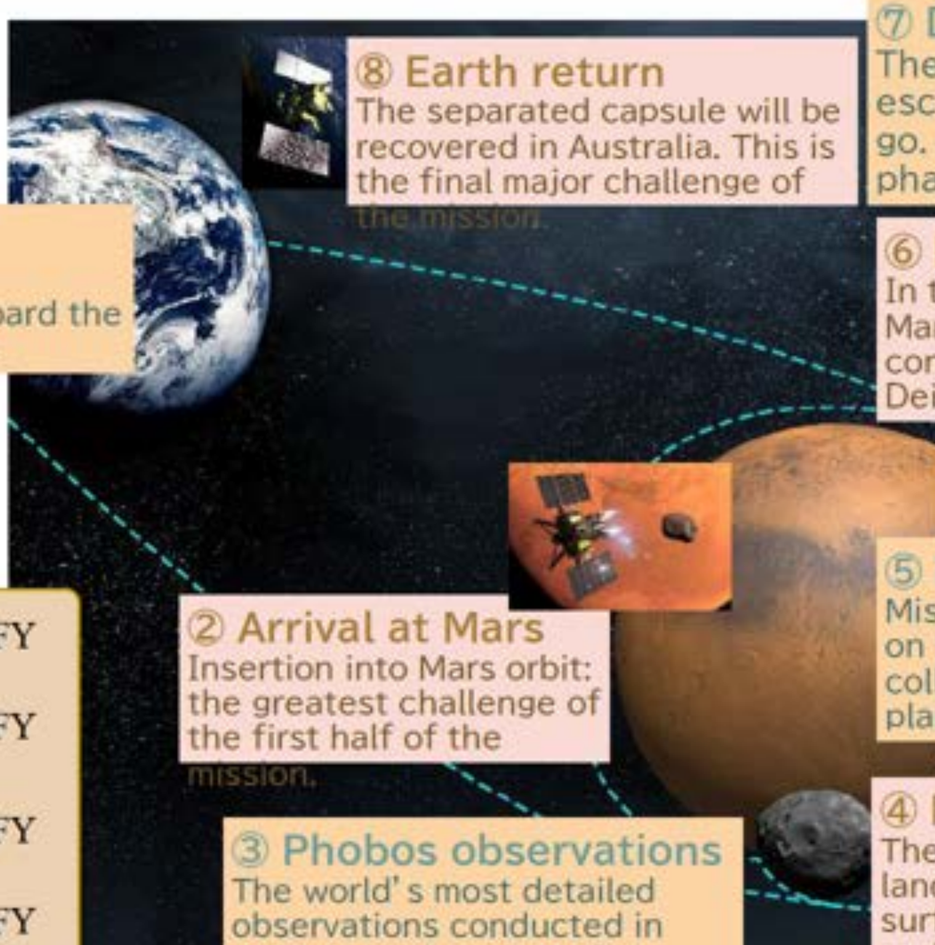
To achieve humanity's first sample return from the Martian system in FY2031, the spacecraft for the Martian Moons Exploration (MMX) mission will be launched in FY2026, and after launch, once the spacecraft's functions have been confirmed, cruise operations toward Mars will be conducted.

3. Mission Profile

Outline of the mission milestones

MMX Mission Profile

The interplanetary flight duration (one way) is just under one year for both the outbound and return journeys. Including the observation and operation period in the vicinity of the Martian moons, the total mission duration is planned at approximately five years. This five-year mission period begins with the JFY 2026 launch, continuing with this keystone events:



① Launch
JPY 2026 from Tanegashima onboard the H3 launch vehicle

② Arrival at Mars
Insertion into Mars orbit: the greatest challenge of the first half of the mission.

③ Phobos observations
The world's most detailed observations conducted in orbit around a moon of another planet.

④ Rover deployment
The IDEFIX rover will be the first to land on Phobos. It will measure the surface properties and environment and contribute to the spacecraft's safe landing.

⑤ Phobos landing
Mission climax: a soft landing on Phobos and sample collection. Two landings are planned.

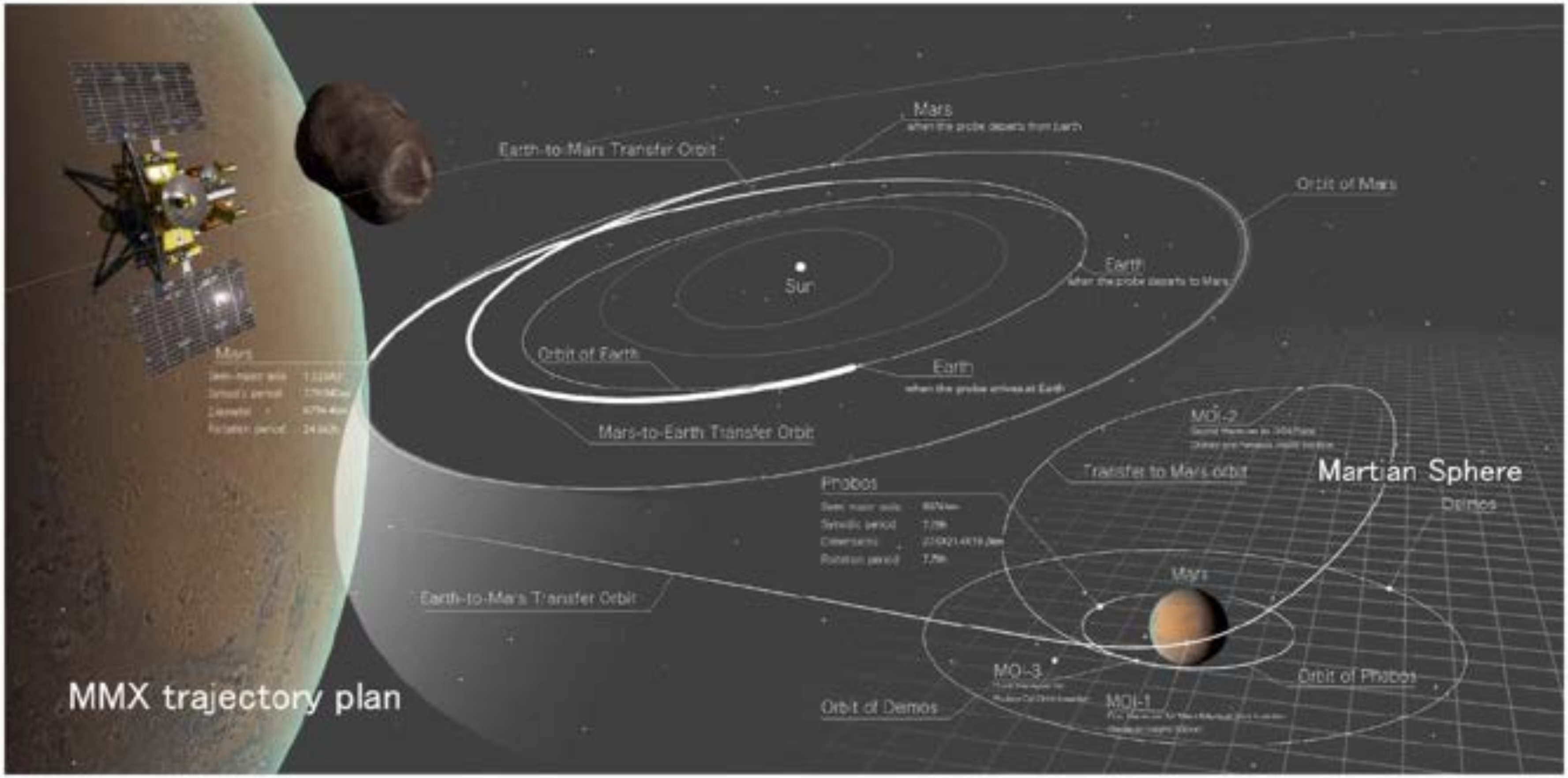
⑥ Deimos observation
In the final stage of the stay in the Martian sphere, the spacecraft will conduct flyby observations of Deimos, the second moon of Mars.

⑦ Departure from Mars
The main engine is fired to escape the Martian sphere in one go. A tense event in the final phase of the mission.

⑧ Earth return
The separated capsule will be recovered in Australia. This is the final major challenge of the mission.

Launch:	2026 JFY
Arrival at Martian sphere:	2027 JFY
Departure from Martian sphere:	2030 JFY
Return to Earth:	2031 JFY

Trajectory plan for MMX, showing the location of the Earth and Mars during the interplanetary journey, and the trajectory maneuvers that will bring the spacecraft into a co-orbit around Mars with Phobos upon reaching the Martian sphere.



MMX Profile: Quasi Satellite Orbit

MMX will follow Phobos around Mars, adopting an orbit that has not been previously used for scientific observations. If observed from Mars, the spacecraft will appear to follow the moon. But an observer on Phobos would see the spacecraft "look around" the moon's surface and think that MMX was in orbit. This is known as a Quasi-Satellite Orbit (QSO)

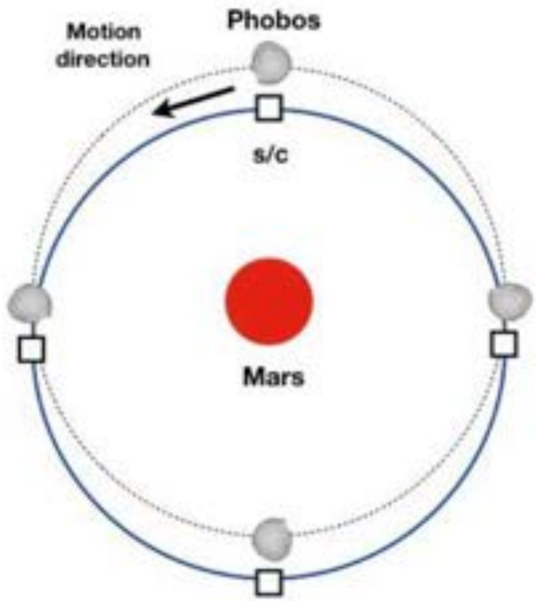


Fig.1(a) Mars-centered inertial coordinate system

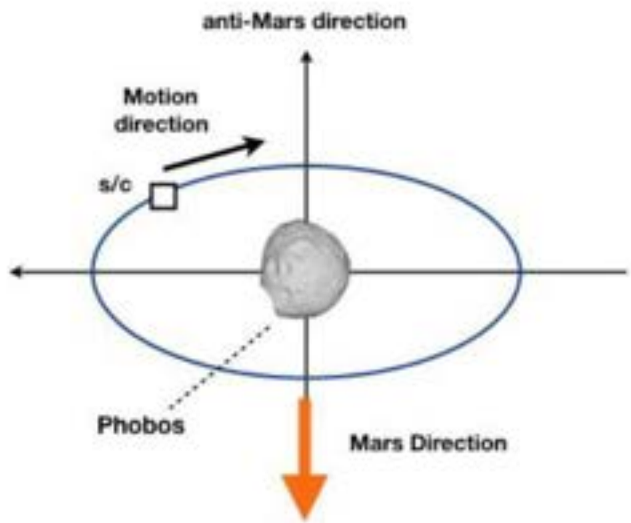


Fig.1(b) Phobos-centered rotating coordinate system (Mars-Phobos line fixed)

Operations around Phobos must be planned around periodic interruptions due to the geometry of the Phobos, Mars, Earth system.

For example, communication will be interrupted during a solar conjunction and occultation by Mars. An eclipse caused by Mars and Phobos will also prevent power generation.

The landing operations will therefore be timed during the phase when the distance to Earth is at its shortest, minimizing eclipses or occultations.

4. Spacecraft System

Overview of the design of MMX

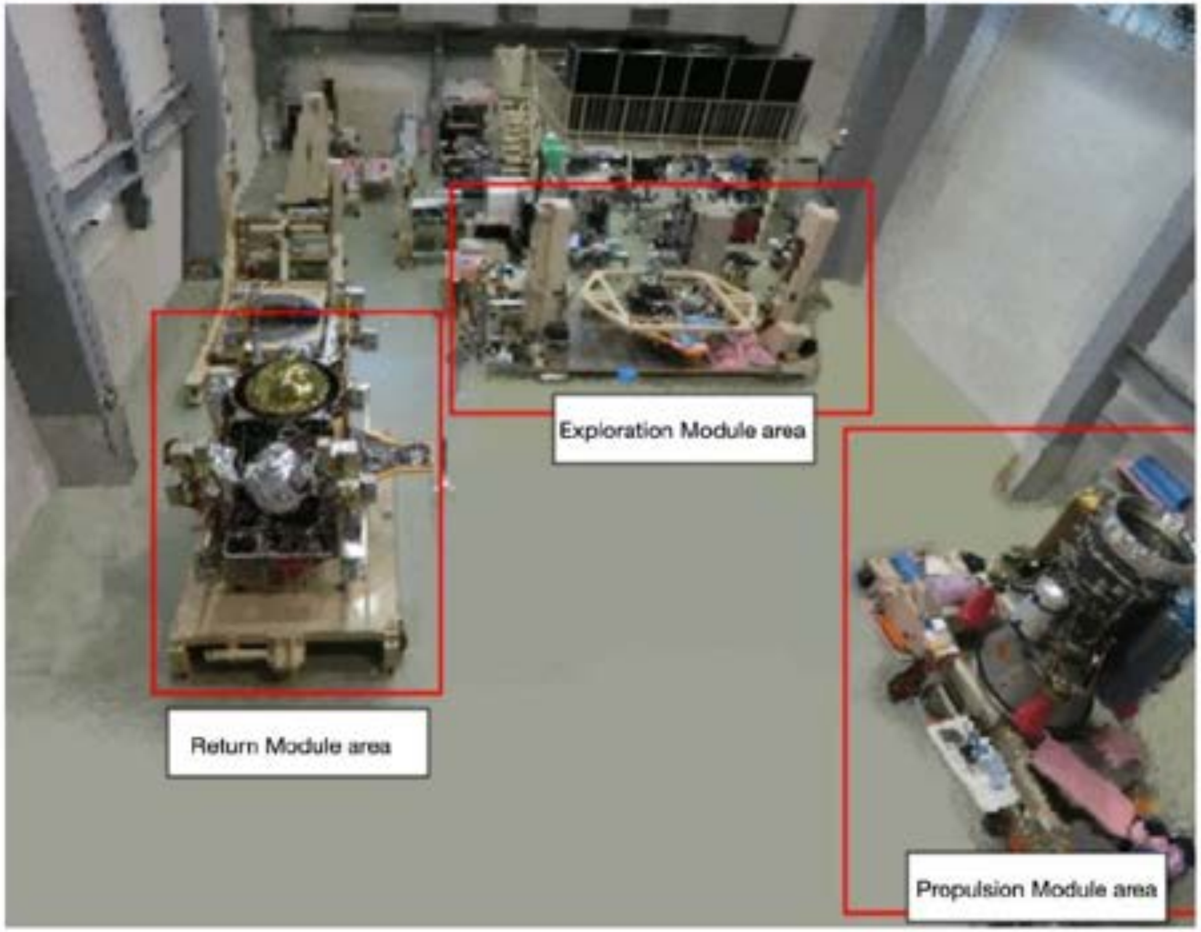
Spacecraft system: Overall configuration

The spacecraft was developed by Mitsubishi Electric Corporation.
This is a large spacecraft, with a launch mass of 4,480 kg with a chemical propulsion system for primary propulsion. A three-stage configuration is adopted to efficiently achieve high orbital speeds.

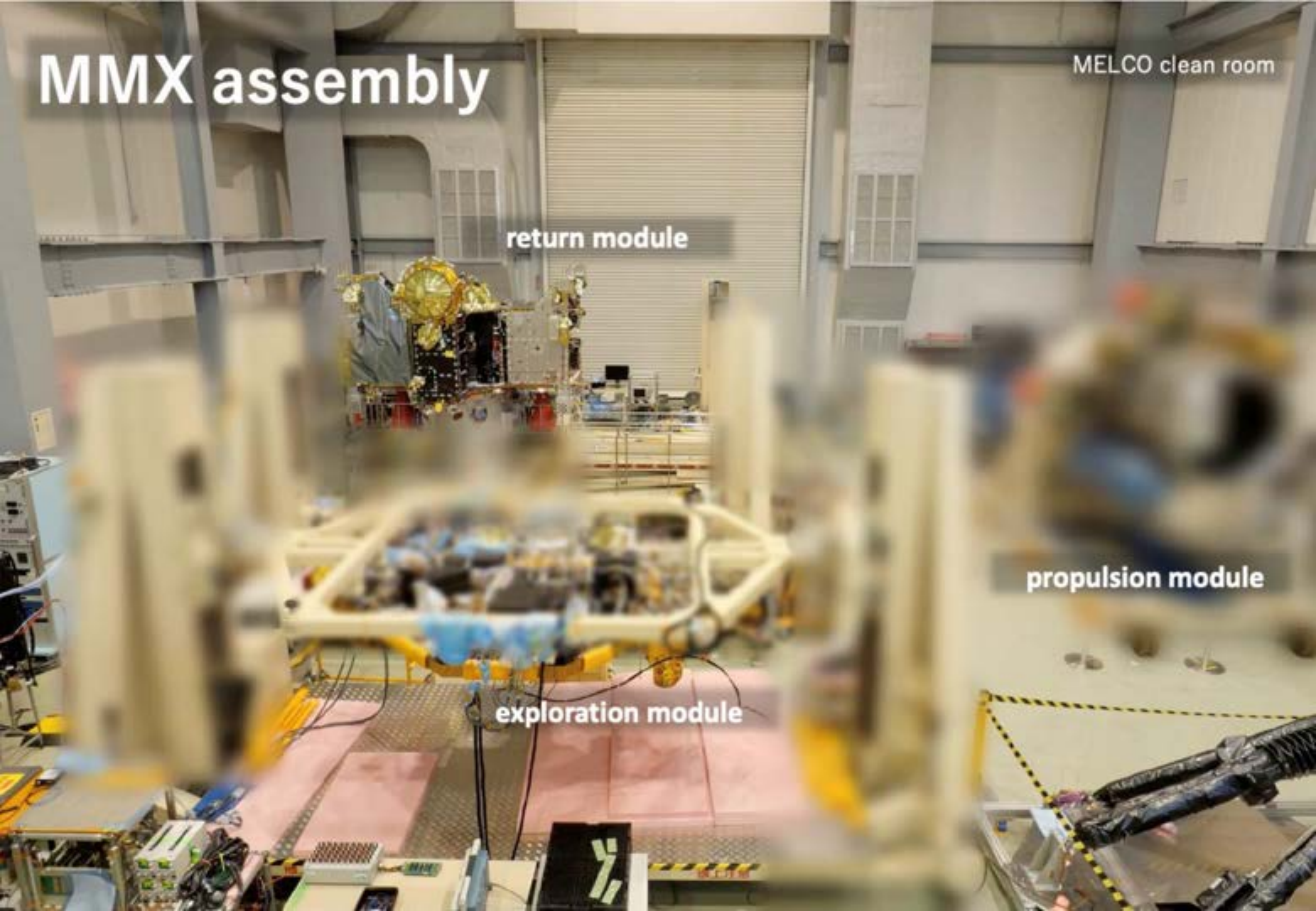
Item	Function & performance
Design	Three-module configuration for the outbound journey, exploration, and return journey
Launch	H3-24L launch vehicle
Launch year	2026 JFY
Mission duration	5 years
Launch mass	4480kg
Propellant mass	Propusion Module: 1840kg Return Module: 1190kg
Communications (Telemetry transmission rate, delay time)	X-band 32kbps/Ka-band 128kbps (furthest point: Earth distance 2.5 au, approximately 40 minute round trip)
Power	High-efficiency thin-filmed solar cells
Landing navigation	Image matching navigation Technology demonstrated by SLIM

Spacecraft system assembly

Manufacturing and testing the flight models for the onboard instruments is complete, and integration into the spacecraft system and verification of the electrical interface is completed.



Scene of the spacecraft assembly at Mitsubishi Electric Kamakura Works (May 2024)


MMX assembly
MELCO clean room
return module
propulsion module
exploration module

Spacecraft system integrated testing

System proto-flight testing (PFT) is intended to demonstrate that the onboard instruments (bus and mission), system design and manufacturing all satisfy the requirements for flight quality.

Items to be performed in the system proto-flight test (system PFT)

Item	Summary of activities / results
Initial electrical tests	Confirmed that no anomalies had occurred in the electrical functions/performance of the test items manufactured for the PFM (proto-flight model). In addition, tests were conducted on the items required for the integrated operational tests of the bus and mission equipment/system. The results were satisfactory, and measures such as HW/SW (hardware/software) modifications were taken in response to the issues that arose before proceeding to the next process.
Thermal vacuum tests	Thermal balance testing confirmed that the functions/performance of the thermal design and thermal control were valid. No anomalies in the electrical performance of the test article under the thermal vacuum test environment were found. The test results were favorable, and after taking measures such as HW/SW modifications in response to the issues that arose, the project proceeded to the next phase.
Mechanical environment tests	Alignment verification, electrical tests before and after the mechanical environment, sine vibration test, acoustic test, and MGA/SAP retention and release shock test
End-to-End tests	Verification that, with the ground-station-side functions interconnected, operation of each system and operational mode can be carried out. Also verifies the Spacecraft Operations Procedure manual (SOP) using the actual spacecraft.
Sampling mission test	Verified end-to-end that the series of operations unique to the MMX mission, from sample collection to capsule stowage, can be carried out without interference.
Final electrical tests	Confirm that no anomalies have occurred in the electrical functions/performance of the test items and that, even after the completion of the series of system PFTs, the electrical condition of the test article remains the same as at the start of the PFT.

Spacecraft system integrated testing

System proto-flight testing (PFT) is intended to demonstrate that the onboard instruments (bus and mission), system design and manufacturing all satisfy the requirements for flight quality.

View of the spacecraft testing at Mitsubishi Electric Kamakura Works (March 2025)

Completed successfully
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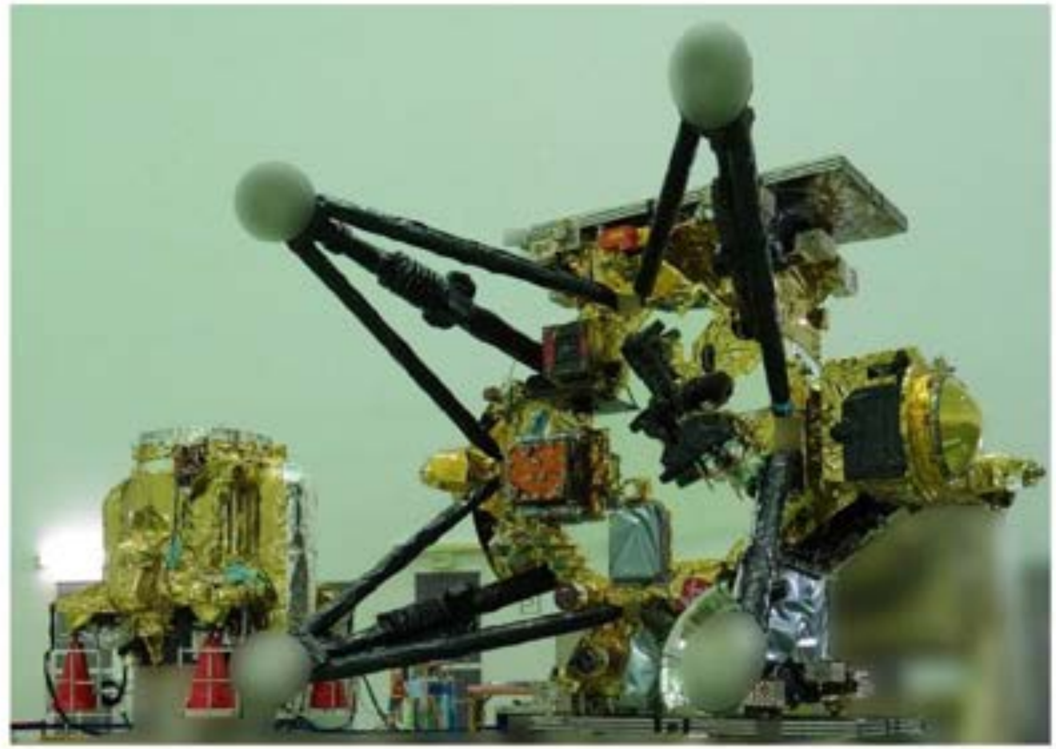
Spacecraft system launch site operations

At the end of March 2026, the spacecraft was transported to Tanegashima Space Center (TNSC). Preparations for the propellant loading and other tasks are currently underway.

Transport of the spacecraft to the Tanegashima Space Center and unpacking at the launch site (April 2026)

Spacecraft system launch site operations

At the end of March 2026, the spacecraft was transported to Tanegashima Space Center (TNSC). Preparations for the propellant loading and other tasks are currently underway.



View of the launch site operations for the spacecraft at Tanegashima Space Center (TNSC), May 2026

5. Mission Instruments

Overview of the 13 onboard instruments

5. Onboard mission instruments

MMX is equipped with 11 scientific instruments to achieve the mission objectives. To ensure that MMX is a world-class mission, four of the instruments have been developed by our overseas partners. Two additional instruments are designed for the acquisition of exploration technology.

Remote sensing / in-situ observations

TENGOO (telescopic camera)

OROCHI (wide-angle spectroscopic camera)

MIRS (near-infrared spectrometer)

MEGANE (gamma-ray and neutron spectrometer)

LIDAR (Laser altimeter)

CMDM (Circum-Martian orbit dust monitor)

MSA (ion energy mass spectrometer)

IDEFIX (rover)

Sample collection and retrieval

C-SMP (coring sampler)

P-SMP (pneumatic sampler)

SRC (sample return capsule)

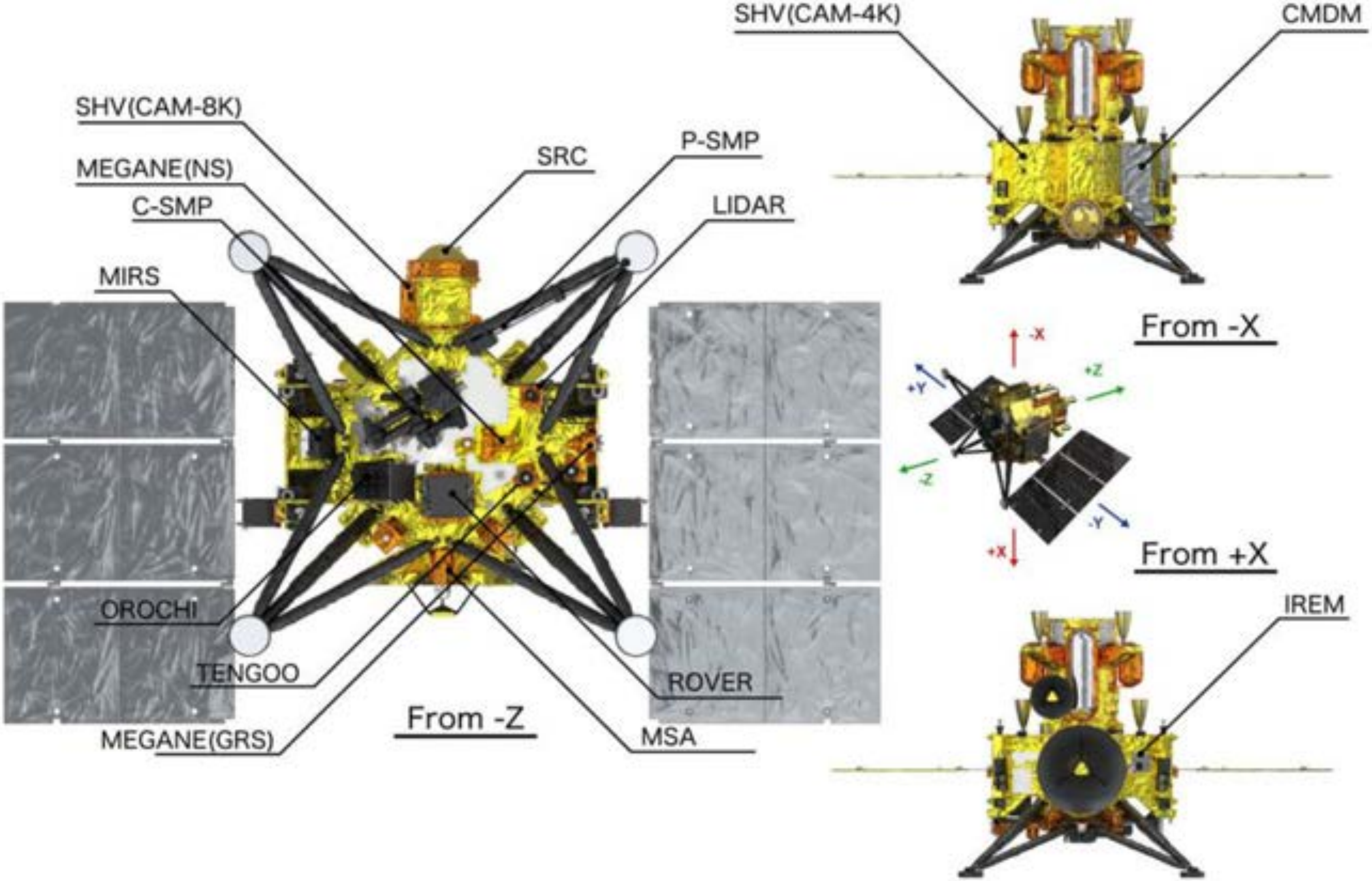
Acquisition of exploration technology

IREM (interplanetary radiation environment monitor)

SHV (Super Hi-Vision cameras)

Red indicates instruments provided by overseas institutions / domestic partner institutions.

5. Onboard mission instruments: Configuration



5. Onboard mission instruments: Scientific roles

*In addition to the 10 instruments mentioned below, three instruments will perform sample collection and recovery.

<table>
<tr><th>Instrument name</th><th colspan="3">Roles</th></tr>
<tr><td>MEGANE
Mars moons Exploration with GAmma rays and NEutrons</td><td rowspan="4"></td><td rowspan="7">Landing site selection and characterization (safety, prestine-ness)</td><td></td></tr>
<tr><td>OROCHI
Optical RadiOmeter composed of CHromatic Imagers</td><td rowspan="4">Mars atmosphere, circulation and escape</td></tr>
<tr><td>MIRS
MMX InfraRed Spectrometer</td></tr>
<tr><td>MSA
Mass Spectrum Analyzer</td></tr>
<tr><td>TENGOO
TElescopic Nadir imager for GeOmOrphology</td><td rowspan="2">Geodesy, geology, internal structure</td></tr>
<tr><td>LIDAR
LIght Detection And Ranging</td><td></td></tr>
<tr><td>IDEFIX Rover
Radiometer, cams, Raman spectrometer</td><td>Regolith composition and physical properties</td><td></td></tr>
<tr><td>CMDM
Circum-Martian Dust Monitor</td><td colspan="3">Dust ring, space weathering</td></tr>
<tr><td>IREM Interplanetary Radition Environment Monitor</td><td colspan="3">Environment data for future crewed space exploration</td></tr>
<tr><td>SHV Super Hi-Vision cameras</td><td colspan="3">Outreach</td></tr>
</table>

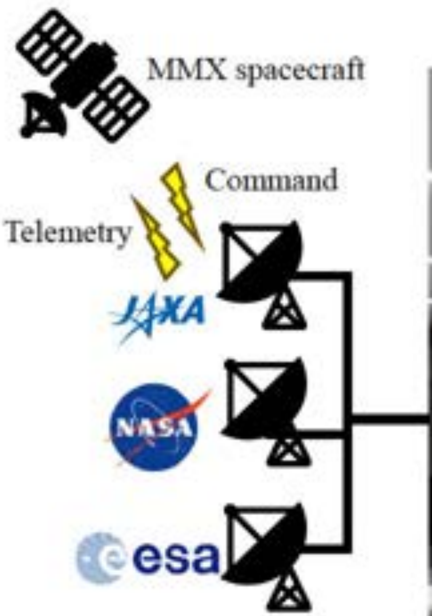
6. Ground System

For the command and operation

of the spacecraft from Earth

6. Ground Systems: MMX control room

Spacecraft command and control operations will be conducted from the JAXA Institute of Space and Astronautical Science (ISAS) on the Sagamihara campus. The three domestic ground stations, MDSS54 (the new Misasa Deep Space Station with a 54m antenna), UDSC64 (Usuda Deep Space Center 64 m antenna), and USC34 (Uchinoura Space Center 34 m antenna) and overseas tracking station networks will allow monitoring of the spacecraft status from the control room. The control room has been used for pre-launch training since mid-2025 and will continue to be used for during the five years mission after launch in JFY 2026.



Ground tracking stations:
Domestic stations (Misasa, Usuda, Uchionoura), NASA DSN, ESA ESTRACK

To keep the spacecraft operating, we need to repeatedly exchange commands and reports (telemetry) between the spacecraft and ground. This happens in the control room, a newly developed facility exclusively for MMX in response to the increase in ISAS missions that require prolonged control room access.

Ground Systems: Deep space tracking stations

For MMX tracking and control, JAXA's deep space tracking stations (MDSS: Misasa 54m and UDSC: Usuda 64 m) will serve as the primary stations, with support from the overseas deep space tracking networks, NASA/JPL DSN and ESA ESTRACK.

JAXA deep space tracking stations, MDSS and UDSC

The Misasa Deep Space Station is the successor to UDSC and supports the higher frequency Ka-band adopted since Hayabusa2 in order to reliably support current and future deep space exploration missions. In addition to deep space exploration, MDSS is designed with the scalability to support future lunar and Lagrange point missions. The antenna is a 54m diameter reflector and was completed in March 2021. Communications with spacecraft are conducted in the Ka-band (32 GHz) and X-band (8 GHz).

The Usuda Deep Space Center was constructed to transmit operational commands and receive data from deep-space spacecraft that approach and observe celestial bodies such as comets, planets, and asteroids. To receive the faint signals from spacecraft at extremely great distances, this site was chosen for its low level of interfering radio waves, such as from urban noise, and has been in operation since October 1984. UDSC's core large parabolic antenna has a reflector with a diameter of 64m and a total weight of approximately 2,000 tons. Communication is carried out in the S-band (2 GHz) and X-band (8 GHz).

NASA/JPL DSN(Deep Space Network) and ESA ESTRACK(European Space Tracking)

Location of deep space stations:
Goldstone (USA),
Canberra (Australia),
Madrid (Spain)

Location of deep space stations:
Cebreros (Spain),
Malargüe (Argentina),
New Norcia (Australia)

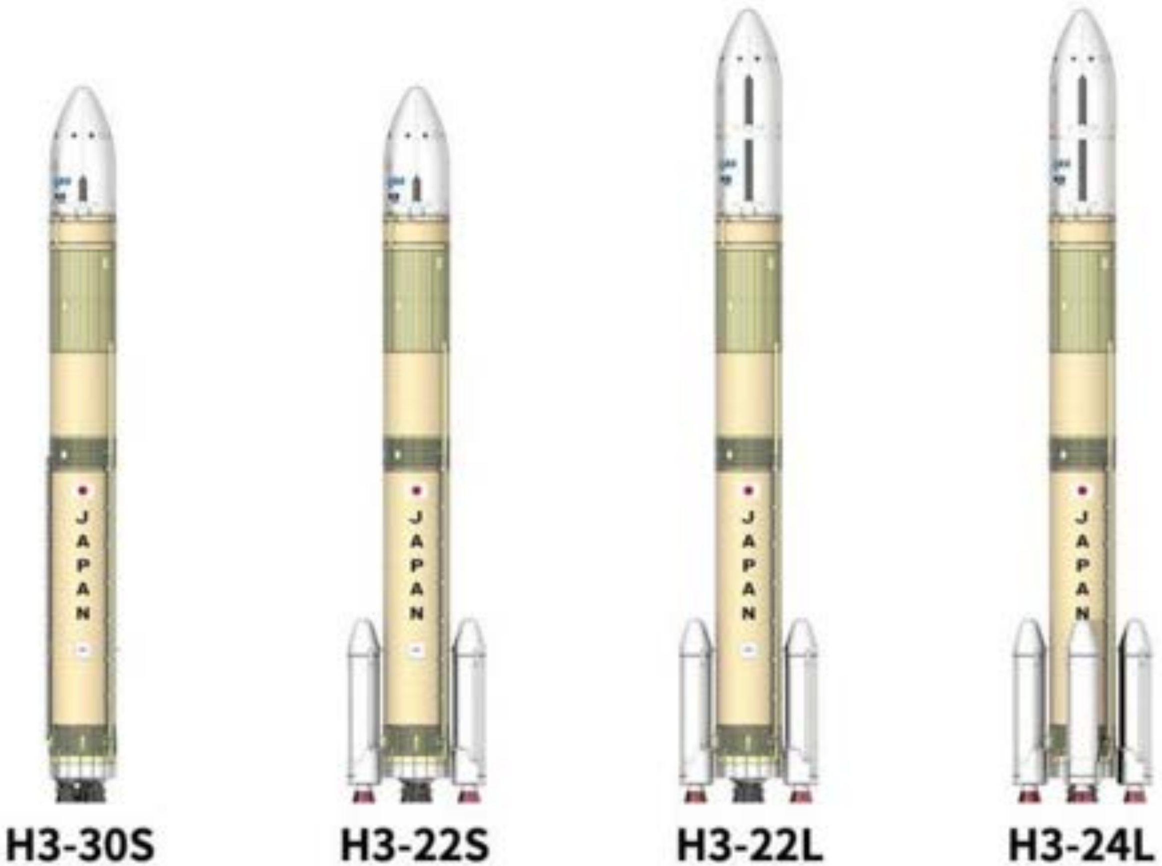
7. Launch Vehicle

The MMX spacecraft will be

launched on the H3 rocket

The H3 launch vehicle

The H3 is Japan's newest launch vehicle. The H3 has two types of possible fairings, two or three units for the first-stage engines (LE-9) and zero, two or four solid rocket boosters (SRB-3) which allow for various payload sizes and orbits. MMX will launch on the H3-24L configuration: the most powerful configuration.



Launch configurations for the H3

The H3-24L has a length of 63m and a mass (without payload) of 574 tons.

8. Project Plan

Project implementation structure,

schedule, and budget

Project implementation structure

MMX will be Japan's largest exploration project. A broad framework for cooperation and promotion has been established with overseas space agencies, industry and the science community to develop the spacecraft system, mission instruments, advance the scientific program and make MMX a success.

Space Agencies

JAXA
NASA
DLR German Aerospace Center
cnes
esa
Australian Space Agency (under coordination)

Industry

MITSUBISHI ELECTRIC Changes for the Better
Kawasaki Powering your potential
MEISEI
NEC
三菱重工 (Launch service)
住友重機械
IHI AeroSpace
FUJITSU
WEL
Nitsuki
AES
Fujikura
JAMSS

(Companies assigned a role.)

Science community (institutes of the affiliated science board members)

JAXA
HOKKAIDO UNIVERSITY
IAS
JOHNS HOPKINS UNIVERSITY
NAGOYA UNIVERSITY
千葉工業大学
RIKKYO UNIVERSITY
東京大学
東京工業大学
THE UNIVERSITY OF AIZU
DLR German Aerospace Center
NAOJ
大阪大学 OSAKA UNIVERSITY
TOHOKU

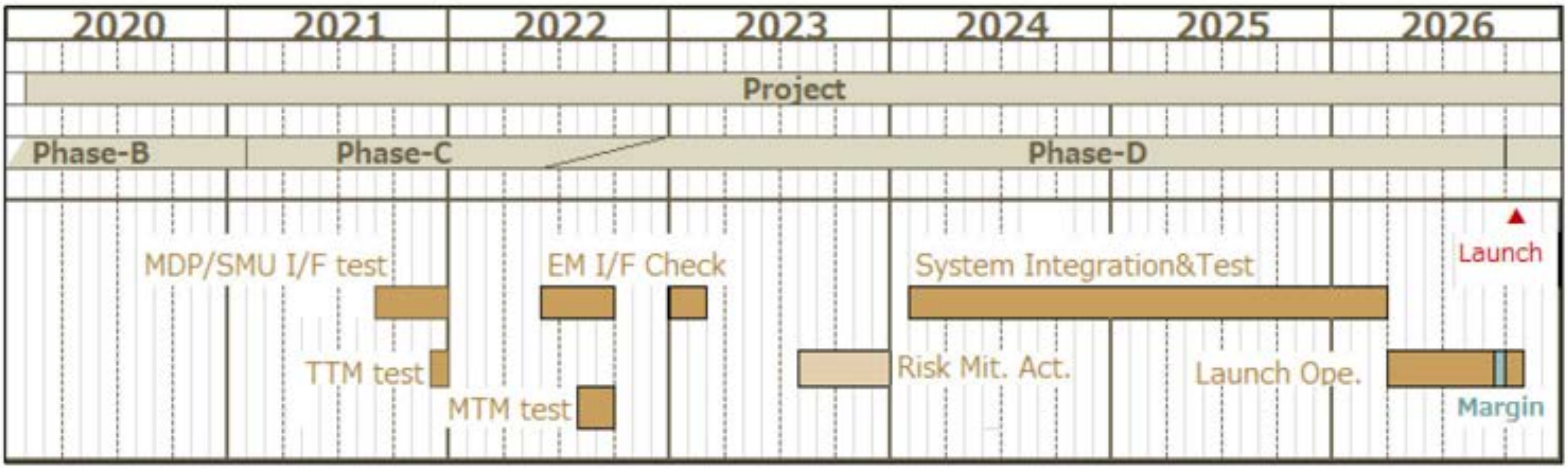
Total Development Cost and Schedule

The total development cost for MMX is 55.3 billion yen.

* In May 2024, a proposal to revise the development plan—accounting for a change in the launch schedule and the impact of recent price surges—was reviewed. Based on the results, the development plan and total development cost were revised (from 46.4 billion yen to 55.3 billion yen).

Schedule (Up to Launch)

Following the MMX Project's transition from the JAXA Pre-Project phase to JAXA Project (Phase B) in February 2020, the team conducted various tests using test models during the preliminary and detailed design phases, followed by the manufacturing and comprehensive testing of the Flight Model (FM). Operations at the launch site began in April 2026, and work is currently underway targeting a launch in JFY 2026.



EMX-265036

Reference material

Selection of target body for exploration: Phobos

During the mission definition phase, Phobos was assessed as the more desirable target of the two moons from the standpoint of planetary science. Following a variety studies during the system definition phase, the technical feasibility was confirmed and the target body for exploration was finalised as Phobos.

Basis for considering Phobos more desirable from the standpoint of planetary science

1. Significantly greater observational data exists of Phobos compared to Deimos, and information is available to place the essential prior constraints on the sample size.
2. Regions with different reflected spectra ("red" and "blue") are present on the surface of Phobos, while only red regions extend across the surface of Deimos. A Deimos sample along cannot identify the material corresponding to the blue regions, making it difficult to determine the origin of Phobos.
3. Estimates suggest that the concentration of material that could have arrived from Mars after the formation of the moons (Martian transfer material) is more than two orders of magnitude greater on Phobos, which has the closer orbit, compared to the more distant Deimos (*1)

(*1) In one example is Hyodo et al. (2019) presents a theoretical study on the quantity and quality of Martian material contained in the regolith of the Martian moons.

Principal points confirming technical feasibility

1. A round-trip to Phobos, which orbits closer to Mars, requires a greater amount of prooellant. However, it was confirmed that the spacecraft design (mass) was feasible.
2. An international agreement(*2) was reached to conduct the sample return mission from the Martian moons (Phobos and Deimos) under a planetary protection policy at the same level as that of Hayabusa2.

(*2) For details, please refer to the JAXA press release (2019.9.6): Contributing to the International Planetary Protection Policy for Martian Moon Exploration

Mission requirements (planetary science)

The objectives for planetary science focus on understanding the origin of the Martian moons, constraining planetary formation processes and material transport, and acquiring new insights into the evolutionary histroy of the Martian sphere. This goals identified Phobos as the primary exploration target from which samples would be collected.

Table: Planetary science objectives

Primary Objective 1: Clarify the origin of the Martian moons and place constraints on the planetary formation processes and material transport at the inner – outer Solar System gateway.	
	1.1 Determine if the origin of Phobos is asteroid capture or giant impact.
	1.2a Asteroid caputure sceanario: Clarify the composition of primordial material supplied to the terrestrial-planet region and the transport processes, and constrain the initial conditions of the Martian surface layer.
	1.2b Giant impact sceanario: Investigate giant impacts and the process of moon formation in the terrestrial planet region, and assess the effect on the early evolution processes of Mars.
	1.3 Place new constrains on the origin of Deimos.
Primary Objective 2: From the perspective of the Martian moons, eludicate the driving mechanisms behind changes in the Martian sphere and provide new insights into its evolutionary history.	
	2.1 Obtain a fundamental picture of the elementary processes governing the surface evolution of the moons in e Martian sphere.
	2.2 Provide new insights and constraints on the history of changes to the Martian surface.
	2.3 Constaint the mechanisms for Mars atmospheric material circulation related to changes ito the Martian climate.

See also Reference 3 for a breakdown of the established mission requirements.

Mission requirements (acquistion of exploration technology)

Solar System exploration is in the developmental phase, making it important to strategically advance technologies developed during each mission and pass these technology onto the next mission.

Table: Acquiistion of exploration technology objectives

Primary Objective 3: Acquire technology for future space exploration
3.1 Develop round-trip transportation technology to the Martian sphere and the capabilities to reach a planetary moon system.
3.2 Develop robotic capabilities for reaching and conducting prolonged operations on the surface of a Martian moon, and perform advanced sampling technology on the surface of celestial bodies.
3.3 Optimise communication technology for use with new deep-space ground stations.

See also Reference 3

Success criteria and outcome goals

The success criteria (divided into the main-objective level; minimum/full success level) and outcome goals corresponding to the mission requirements.

Primary Objective	Outcome goals	Output goals	
		Minimum success	Full success
Scientific Objective 1: Determine whether the Martian moons are captured asteroids or were formed by the accretion of debris generated by a giant impact on Mars, thereby obtaining a new picture of the formation process of Mars and the terrestrial planets.	Area: Planetary Science Goal: Advancement of planetary science through the construction of a terrestrial planet formation model based on data identifying the origin of the Martian moons.	Through close-up observation, clarify the material distribution on the moon's surface and infer the moon's origin.	By analyzing samples collected from the surface of Phobos, in addition to conducting close-range observations, the origin of the moon will be determined. In addition, new insights will be gained into the initial materials that formed Mars and the processes of moon formation, depending on that origin of the moons.
Scientific Objective 2: The mechanisms that have driven the evolution of the Martian moons and Mars will be explored, adding new insights to the evolutionary history of the Martian sphere, including the two moons of Mars.	Area: Planetary Science and Astrobiology Objective: To advance planetary science and astrobiology by obtaining a new picture of the evolutionary processes of the Martian sphere and by investigating the conditions which allow liquid water to be retained on the surfaces of terrestrial planets.	Through close-range observation, we will clarify the degree of weathering alteration and heterogeneity of the moon surface layer and obtain new insights into the surface evolution processes unique to moons.	In addition to close-proximity and landing observations of the moon, analysis of samples collected from the surface of Phobos will provide new insights into the state and mechanisms of space weathering and other processes affecting the moon surface layer. Furthermore, by searching the returned samples for material transported from Mars and by observing Mars' s escaping atmosphere and meteorology, we will obtain new insights into the material transport processes and evolutionary history within the Martian sphere.
Objective for acquiring exploration technology: To acquire technology that will develop space exploration.	Area: Deep Space Exploration Engineering Objective: to create advanced and highly flexible missions by acquiring more sophisticated deep-space navigation and exploration technology.	Reach the vicinity of the Martian moons and land on the surface of a Martian moon. Also enhance the deep-space communication capabilities of spacecraft.	Collect samples from a Martian moon and recover these on Earth. This will also enhance the spacecraft's deep-space communication capability to more than twice the conventional level.

* "Outcome" refers to the ultimate objective that a project aims to achieve, and denotes the effects and benefits ultimately brought to the target field through items such as products and services under a framework of cooperation with partners both inside and outside JAXA, by the project's activities themselves and deliverables. See also reference 4.

Acromyms

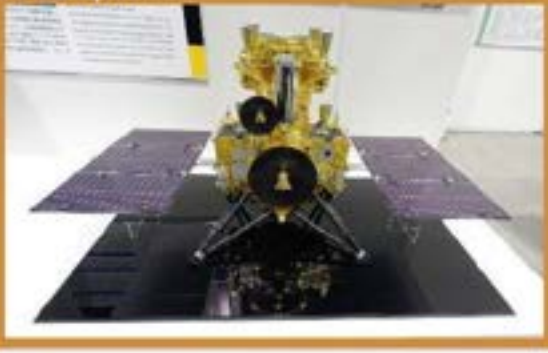
略称	名称（英語）	名称（日本語）
	(1)　全体	
JAXA	Japan Aerospace Exproration Agency	国立研究開発法人宇宙航空研究開発機構
MMX	Martian Moons eXploration	火星衛星探査計画
SMP	Sampler	サンプリング装置（別称：CSMP、C-SMP）
SRC	Sample Return Capsule	サンプルリターンカプセル（別称：SRC-SUB）
TENGOO	TElescopic Nadir imager for GeOmOrphology	望遠カメラ
OROCHI	Optical RadiOmeter composed of CHromatic Imagers	広角多波長カメラ
LIDAR	Light Detection And Ranging	レーザー高度計
CMDM	Circum-Martian Dust Monitor	火星周回ダストモニタ
MSA	Mars moon mass Spectron Analyzer	イオンエネルギー質量分析器
MEGANE	Mars-moon Exploration with Gamma Rays and Neutrons	ガンマ線・中性子線分光計
MIRS	MMX InfraRed Spectrometer	近赤外分光装置
P-SMP	Pneumatic Sampler	ニューマティックサンプラ
Rover	MMX Rover	MMXローバ
KaCOM	Ka-band Communication system	Ka帯通信機器
SHV	Super Hi-Vision camera	スーパーハイビジョンカメラ
IREM	Interplanetary Radiation Environment Monitor	惑星空間放射線環境モニタ
RAX/AFS	RAman spectrometer / Auto Focus System	ローバ用ラマン分光装置／自動焦点調整機構
RDR	Retrive Data Recorder	回収型データレコーダ

略称	名称（英語）	名称（日本語）
	(3)　一般用語	
BBM	Bread Board Model	ブレッドボードモデル
EM	Engineering Model	エンジニアリングモデル
PFM	Proto Flight Model	プロトフライトモデル
FM	Flight Model	フライトモデル
ICS	Interface Control Specification	インタフェース管理仕様書
IRD	Interface Requiremet Document	インタフェース要求書
ICD	Interface Control Document	インタフェース管理図面
PDR	Preliminary Design Review	基本設計審査
CDR	Critical Design Review	詳細設計審査
PQR	Post Qualification Review	認定試験後審査
PSR	Pre Shipment Review	出荷前審査
FDIR	Fault Detection, Isolation, Recovery	故障検出，分離及び復旧
FMEA	Failure Mode and Effects Analysis	故障モード及び影響解析
FTA	Fault Tree Analysis	故障の木解析
	(4)　運用準備・運用支援関係	
SOOH	Spacecraft Orbital Operation Handbook	衛星運用説明書
SOP	Spacecraft Operations Procedure	衛星運用手順書
SOCP	Spacecraft Orbital Checkout Procedure	衛星チェックアウト手順書
ITU-R	International Telecommunication Union Radiocommunication Sector	国際電気通信連合 無線通信部門
SFCG	Space Frequency Coordination Group	宇宙用周波数調整会議
IFRB	International Frequency Registration Board	国際周波数登録委員会
GSE	Ground System Equipment	地上支援装置（専用治工具含む）
QL	Quick Look	クイックルック
GSTOS	Generic Spacecraft Test and Operations Software	汎用衛星運用試験ソフトウェア
SIB	Spacecraft Information Base	衛星情報ベース
ORLG	Operation Request Language for GSTOS	GSTOS 運用要求等記述言語
CMDI	Command Interface file	コマンド計画インタフェースファイル
SIRIUS	Scientific Satellite Telemetry Database System	科学衛星テレメトリデータベースシステム
EDISON	Engineering Database for ISAS Spacecraft Operation Needs	衛星運用工学データベースシステム

Public relations

Models of spacecraft are on display at the Communication Hall on the JAXA Sagamihara Campus. The MMX project also maintains a website and social media accounts.

Models of spacecraft on display at the Communication Hall on the JAXA Sagamihara Campus.



MMX homepage
https://www.mmx.jaxa.jp/en/

Sharing the latest updates and behind-the-scenes stories on SNS.
@mmx_jaxa_en

	Website	
MMX Project	https://www.mmx.jaxa.jp/en/	
MMX News	https://mmx-news.isas.jaxa.jp/	
MMX SNS	X	x.com/mmx_jaxa_en
	Instagram	instagram.com/mmx_jaxa
	Threads	threads.com/@mmx_jaxa
JAXA Digital Archives (images)	https://jda.jaxa.jp/	
JAXA / ISAS	https://www.isas.jaxa.jp/en/	
JAXA	https://global.jaxa.jp/	

The MMX mission mark

Our mission mark was created through a public competition and will be used on the surface of the launch vehicle, in illustrations for websites and printed material, for publicity goods such as posters, and in presentations.

Concept statement:

The design focusses on Mars and the MMX spacecraft.
From there, the circle expands outwards.

We see the rings of the orbits of Phobos and Deimos, followed by a segmented blue ring for the Earth that represents the five international organisations. The final encompassing orange ring represents the MMX mission.

This is a symbol of people coming together, and making the circle bigger and bigger.

Background to the mission mark selection:

May 2023: A competition was held to solicit designs, and 47 applications submitted .
August 2023: The MMX team conducted the review and selected the grand prize winner.
April 2024: The MMX mission mark was unveiled.

MMX Public Relation Ambassadors

JAXA Astronaut YONEDA Ayu and JAXA Astronaut SUWA Makoto have joined the team as Public Relations Ambassadors for the Martian Moons eXploration (MMX) mission.

As the Martian Moons eXploration (MMX) mission aims to achieve the world's first sample return from a Martian moon, our Public Relations Ambassadors for MMX will serve as communicators connecting MMX with society by widely conveying the mission's objectives and significance in an accessible manner as the spacecraft approaches launch and begins the journey to Phobos.

Both our Public Relations Ambassadors are the most recently certified JAXA Astronauts and are scheduled to participate in a number of events related to JAXA and MMX. JAXA Astronaut Suwa Makoto is also scheduled to undertake a long-duration stay on the International Space Station (ISS) around 2027. As this will overlap with operational period for MMX, MMX and the ISS are expected to engage in mutual information dissemination during these opportunities.

Destination Phobos
The unexplored Martian moon

MMX

Martian Moons eXploration