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MARTIAN MOONS EXPLORATION (MMX) MISSION

SCIENCE MANAGEMENT PLAN FOR

ALL INSTRUMENTS

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1. SUMMARY AND SCOPE

This document, MMX Science Management Plan (MMX-SciMP-ALL), deals with the scheme that will be implemented up to and including the post operational phase, to ensure the fulfilment of the scientific objectives of the MMX mission and to optimize its scientific return, with special emphasis on science operation and data management.

Described in this document are what make a secure development of the mission and what make the mission scientifically most successful. JAXA thinks that there should not be firewalls among the PIs. Embedded in the body where science members discuss matters from science-oriented perspectives (Science Working Team: SWT) is Science Board (MMX-SB). At MMX-SB, PIs (and some more members) make strategic planning for the largest success that the mission deserves. All the relevant data will be required to be submitted to MMX-SB for the planning purpose, that is, the notion of exclusive data period does not apply to this process. Given the nature of science expected of MMX, multi-instrument studies matter most. It is this idea that made JAXA decide to set up a framework where all information are focused at MMX-SB which consists of members who are equipped with suitable capabilities so that the best strategy and planning will be formulated. Description of this document will be more detailed through the discussion and decision made by the MMX-PI/MMX-SB as SWT and finally approved by the MMX-PM as MMX project.

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2. PROGRAMME PARTICIPATION

2.1. Payload Configuration and PI-Responsible Instruments

The MMX model payload has been selected to fulfil the MMX science requirements by the efforts of the teams of international scientists in collaboration with the JAXA/MMX Project Team (see MMX-SciRD-ALL). The teams of international scientists include science instrument teams. Each instrument development team is led by a Principal Investigator (PI).

Although the definitive configuration will be determined after a detailed system study is completed, the baseline idea is that scientific instruments will share some common units (such as a payload control unit, a power supply unit, and a data processor unit) in order to maximize science return within limited resources. The common hardware will be procured under the responsibility of the JAXA/MMX Project Team, while the instrument front ends are to be developed under the responsibility of instrument development teams led by Principal Investigators (PIs). The PI-responsible software to be executed in the common units should be developed in cooperation by the JAXA/MMX Project Team and PI teams.

Each instrument team led by a single person, designated as the Principal Investigator (PI), has members who shall participate in the MMX Project as Co-Investigators (Co-Is). Co-Principal Investigators (Co-PI) may be appointed if a major development is carried outside the country/institution of the PI. Even when a Co-PI is present, PI is the formal interface to the JAXA/MMX Project Team.

It is the role of a PI to exert adequate control over all aspects of the team activity. A management plan by a PI of his/her team shall be communicated to the JAXA/MMX Project Team. Any change shall be agreed between the PI (and, if necessary, the Lead Funding Agency) and the JAXA/MMX Project Team.

2.2. Modes of Participation

The possible modes of participation to the MMX program are:

- (1) Principal Investigator (PI), leading an instrument team providing a PI-responsible instrument (see 2.2.1.);
- (2) Co-Principal Investigator (Co-PI) may be appointed if a major development is carried outside the country/institution of a PI (see 2.2.2.);
- (3) Co-Investigator (Co-I), a member of an instrument team providing a PI-responsible instrument (see 2.2.3.);
- (4) Interdisciplinary Scientist (IDS), an expert in specific science themes that need multi-instrument approaches and need to be investigated in order to obtain maximum scientific return of MMX (see 2.2.4.);

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2.2.1. Principal Investigator

The PI will have the following responsibilities:

(1) Project Management

- (i) Nominate an instrument system manager who manages the instrument development project under the guidance of PI. The Manager needs appropriate hardware, software and procurement expertise, and a PI must establish with the Manager an efficient and effective managerial scheme, which will be used for all aspects and through all phases of her/his instrument program, in cooperation with the JAXA/MMX Project Team.
- (ii) Organize the efforts, assign tasks and guide other members of the instrument team.
- (iii) Ensure that plans are established, implemented and analysed such that the status reporting complies with the requirements issued by the JAXA/MMX Project Team.
- (iv) Provide the formal managerial and technical interface of the instrument to the JAXA/MMX Project Team.
- (v) Support JAXA/MMX management requirements (e.g. investigation progress reviews, program reviews, change procedures, product assurance, etc.) outlined in the MMX Instrument Requirement Document (MMX-I-IRD).

(2) Science Management

- (i) Provide the formal scientific interface of the instrument team with the JAXA/MMX Project Team.
- (ii) Attend meetings of the Science Working Team as appropriate; report on instrument development, and take a full and active part in their work.
- (iii) Monitor the compliance of the instrument design to fulfil the scientific requirements.
- (iv) Ensure adequate calibration of all parts of the instrument, both on the ground and in space. This includes the provision of all required calibration data along with a full instrument science and technical user manual.
- (v) Participate in the effort led by the JAXA/MMX Project Team to define the science operation and data handling plan. This includes provision of data products necessary for the landing/sampling site selection processes.
- (vi) Exploit the scientific results of the mission and assure their diffusion as widely as possible. This includes provision of data products to the Science Board members (see 3.3.) for promoting science themes having an overarching nature.
- (vii) Provide (by him/herself, or by assigning a dedicated Archivist) the scientific data (raw data, calibrated data, and higher level data), including relevant calibration products, to the MMX archive in a format that will be agreed by relevant parties for use by the general science community.

(3) Hardware Development

- (i) Define the functional requirements of the instrument and auxiliary test equipment (e.g. MGSE, EGSE, CGSE, etc.).

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- (ii) Ensure the development, construction, testing and delivery of the instrument.
- (iii) Ensure that the instrument meets the standard that is appropriate to the objectives and lifetime of the mission, and to the environmental and interface constraints under which it must operate.
- (iv) Deliver adequate instrument verification models (EM, STM, etc.) of the instrument to the JAXA/MMX Project Team, as required to verify system interfaces. The envelope of this delivery is ruled by the MMX-I-IRD, in accordance with technical program needs.
- (v) Deliver an instrument Flight Model in accordance with the technical requirements defined in the MMX-I-IRD, together with the relevant Ground Support Equipment. Flight spares must be prepared for critical elements.
- (vi) Support the system level integration and test activities related to and involving the instrument.
- (vii) Provide the necessary equipment to process their data as agreed with the JAXA/MMX Project Team and specified in the MMX-I-IRD.
- (viii) Provide the overall documentation during the project, as defined in the MMX-I-IRD.

(4) Software Development

- (i) Ensure the development, testing and documenting of all software necessary for the controlling, monitoring and testing of the instrument. The on-board software to be executed in the common units should be developed in cooperation with the JAXA/MMX Project Team.
- (ii) Specify and then support the development, testing and documenting of all software necessary for the testing, operation and data reduction/analysis.
- (iii) Ensure the delivery to the JAXA/MMX Project Team of any instrument specific software which is required for testing or operations, in accordance with JAXA/MMX Project guidelines, procedures and schedules.
- (iv) Maintain and update all PI-responsible instrument software and its documentation until the end of the mission.

(5) Product Assurance

Provide product assurance functions in compliance with MMX-I-IRD.

(6) Operations

Provide support for preparation and implementation of the mission and science operations up to the end of the mission including delivery of a user manual and data base inputs in accordance to the MMX-I-IRD requirements.

2.2.2. Co-Principal Investigators

A Co-Principal Investigator (Co-PI) may be appointed if a major development is carried outside

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the country/institution of a PI. Note that the single point interface to the JAXA/MMX Project Team will remain the PI.

Co-PIs are responsible for their own funding which is guaranteed via their funding agencies and must be underwritten by formal interagency agreements with the Lead Funding Agency, representing the PI and which holds overall fiscal responsibility with respect to the instrument development and delivery to the JAXA/MMX Project Team.

2.2.3. Co-Investigators

Members of each PI-led instrument team would involve Co-Investigators (Co-Is). Each Co-I should have a well-defined role either with regard to hardware/software delivery or with regard to scientific support of the investigations to be pursued by the instrument. The PI-led instrument team may review the status of its members regularly and implement changes to the charges of its members if required.

Funding for Co-I activities are to be arranged within an instrument team led by a PI. In case a Co-I is to be supported by his/her own funding agency different from the corresponding Lead Funding Agency which holds overall fiscal responsibility with respect to the instrument team, it must be underwritten by formal interagency agreements.

2.2.4. Inter-Disciplinary Scientists

To ensure a solid top-level oversight of the mission science, and in order to ensure multi-instrument approaches that maximize science output from the MMX mission, a number of international scientists will be selected as Inter-Disciplinary Scientists (IDS). Each IDS should not reflect instrument specific domains but would cover specific science themes that need data from multiple instruments. An IDS may also wish to undertake tasks in areas such as modelling, mission and science operation planning, hazard assessment and similar activities that may be required during the course of the mission. IDSs will play a key role in Science Working Team meetings (3.3.).

An IDS will be selected based on a proposal that describes clearly their scientific cases, relevance of their contributions to maximizing the mission science return and the instrument data sets needed to pursue their research goals. IDSs are expected to provide adequate support to the communications and public relations activities. JAXA and Lead Funding Agencies that support PIs will handle the IDS selection process. Financial support required for an IDS will be provided by the corresponding funding agency.

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3. SCIENCE AND PROJECT MANAGEMENT

3.1. The JAXA/MMX Project Team

JAXA, via the JAXA/MMX Project Manager (MMX-PM), will retain overall responsibility for the MMX mission through all phases. The JAXA/MMX Project Team is led by the Project Manager (MMX-PM) and will fulfil its function until the completion of the MMX mission operations.

The MMX-PM will periodically (nominally a few times per year) call Project Reviews, which will include all aspects of the MMX mission, and discussion relevant to the development of the mission will be carried out at MMX Design Meetings hosted by JAXA.

JAXA nominates the MMX Principal Investigator (MMX-PI) who is the interface of JAXA with the PIs, Co-PIs, Co-Is and IDs for scientific matters. The MMX-PI will chair the MMX Science Board and MMX Science Working Team meeting (see 3.3.) and coordinate its activities.

During all phases of the MMX mission, the MMX-PI will be responsible for all scientific issues within the JAXA/MMX Project, including the strategy for maximizing the scientific output. The MMX-PI will advise the MMX-PM on technical matters affecting scientific performance, and will monitor the state of implementation and readiness of the MMX instrument operations and data processing infrastructure. The MMX-PI will also have overall responsibility for coordination of the MMX science operations as approved within assigned constraints. The MMX-PI will coordinate the production of the MMX scientific products, their archiving and distribution to the scientific community.

3.2. The MMX Mission Scenario

Inspection of the MMX mission scenario shows that there are points where recommendations from a science point of view are crucial and need to be made in a timely manner.

- Detailed characterization of Phobos will be made from quasi-satellite orbits. Given the resource limitation, full resolution remote sensing data may not cover the whole surface but the high quality observations need to focus on the parts that are of prime science interest. Here the role of the MMX scientists is to issue proper recommendations to the MMX Project for an optimized operation.

- One of the key items to consider in selecting a landing-sampling site is the expected nature of samples to be acquired from the selected site. In other words, for the science value map of Phobos to be submitted to the landing site selection process is crucial. Here the role of the MMX scientists is to construct the map in a timely manner.

The MMX Science Working Team is so designed that the team can perform the work that it is expected of.

3.3. Science Working Team

The MMX Science Working Team (SWT) is where all the MMX science matters are discussed.

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SWT will consist of all PI's/Co-PIs, Co-Is and IDSs. The MMX-PI is the Chairperson of the SWT and is also the interface to the MMX-PM who makes the final decisions as the project on any matters related to the mission. Internal to SWT will be the MMX Science Board (MMX-SB) that consists of PIs and selected IDSs. After discussion by the SWT members, when necessary, it is MMX-SB that makes the final decision as SWT. There will also be subgroups that are assigned with tasks related to specific topics.

The SWT will monitor and advise JAXA on all aspects of the MMX mission that will affect its scientific performance. It will assist the MMX-PI in maximizing the overall scientific return of the mission within the established boundary conditions. The SWT meetings may take place at different times and venues, in order to improve flexibility and minimize travel costs.

In order to account for the broad scientific aspects that the MMX mission involves, the SWT may delegate tasks to scientific subgroups. These subgroups will focus on specific topics of research and on issues related to spacecraft elements. In most cases, the delegated tasks will have a certain deadline before when a report to the SWT is expected.

The MMX-PI is also the Chairperson of the MMX-Science Board. At the top level, the members of the MMX-SB are expected to give strategic thinking in a timely manner to the ways to maximize science output from the MMX mission. To be more specific, the roles of the MMX Science Board are as follows;

- To make decisions related to mission and science operations at the SWT level from a science-oriented standpoint. This will be forwarded by the MMX-PI to the MMX-PM as a recommendation; Note that the final decision as the mission will be given by the MMX-PM. In other words, the MMX-SB members are the voting members of the SWT. While discussion will be deployed widely and openly by the SWT members, when voting becomes necessary, it will be left to the MMX-SB members.
- To judge if the SWT is working in a proper way, and if not, assist the MMX-PI to perform counter-measures. This includes setting up of a subgroup internal to the SWT.
- To promote publication of multi-instrument studies as a major component of the MMX science output. Given the nature of the science objectives of the MMX mission, it is clear that multi-instrument studies are crucial. The MMX-SB is the body that ensures the SWT to follow the direction in the pursuit of its excellence.
- To select topics for highlight papers, so that the whole set of which would reflect most adequately the output from the MMX mission. The set of highlight papers would very likely include multi-instrument papers and the MMX-SB involving not only PIs but also IDSs are needed to make the most adequate selection.
- To make agreement on the authorships of the highlight papers, especially of those that have multi-instrument aspects.
- To make decisions related to sample analysis work that is initiated after the return of the samples. This includes the formation of a body that consists of cosmo-chemistry experts which would control the curatorial works and initial analysis of the samples (e.g., Sample Allocation Committee).

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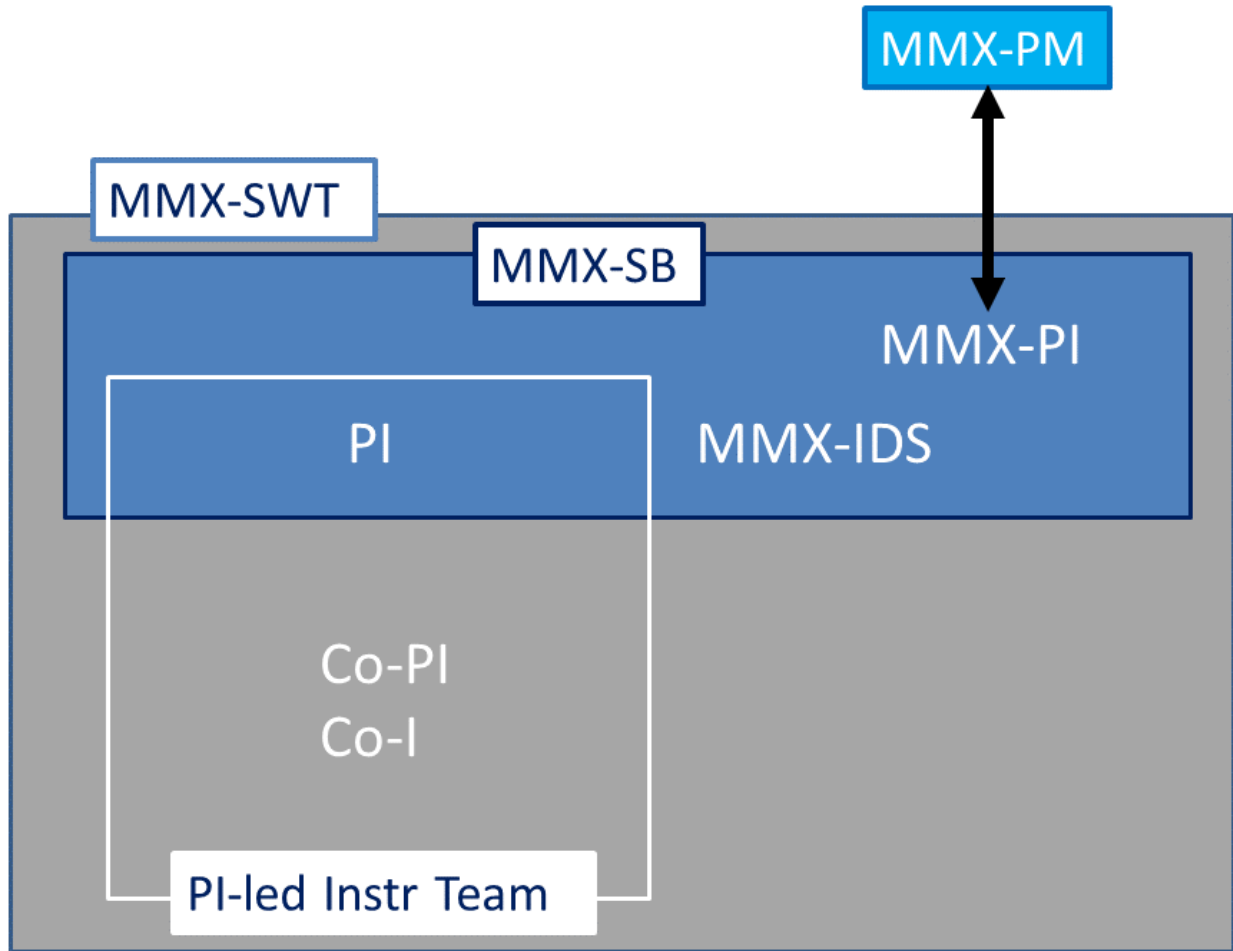


Figure 3.3-1 Structure of MMX Science Working Team

3.4. Monitoring of Instrument Development

The JAXA/MMX Project Team, in close coordination with the MMX-PI, will monitor the progress of the design, development and verification of the MMX instruments. The PIs will have to demonstrate to the JAXA/MMX Project Team, in regular reports and during formal reviews, compliance with the scientific mission goals, the spacecraft system constraints, the spacecraft interfaces and the program schedule as defined in the mutually agreed MMX Instrument Interface Control Document (ICD).

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4. SCIENCE DATA RIGHTS

This section is intended to touch on the following items.

- Data sharing within the project
- Data release to the general public
- Interaction with news and other popular media
- Use of social media
- Data sharing with the science community
- Roles of the SWT in overseeing publications
- Authorship guidelines
- Presentations at scientific conferences and informal talks, etc.

While not all are described at full depth nor even touched upon at all, they will be detailed through autonomous discussion by SWT.

The MMX data sets will be made available in compliance with the decision made by the MMX-PI/MMX-SB as SWT and finally approved by the MMX-PM as MMX project. Some instrument teams may need to prioritize higher the rules concerning the data release policy set by its Lead Funding Agency. Reduction of science data is under the responsibility of PI teams. Exclusive data rights reside with the PI team for a limited period whose duration is to be agreed at the SWT (most likely less than a year). After this period, data will be made available by PIs to the scientific community at large through the JAXA science data archive.

Even during the exclusive period, PIs are required to share data products with the MMX-SB members so that (1) the science operation decision making process will be made as smooth as possible, and that (2) multi-instrument studies will be promoted to its full extent (see 3.3. for the roles of MMX-SB). Regarding data sharing within the SWT, detailed procedures will be agreed and formalized according to the autonomy of the SWT members who share the common goal of maximizing the science output from the MMX mission.

The PI teams will provide records of processed data with all relevant information on calibration and instrument properties to the JAXA science data archive. The JAXA science data archive will be the repository of all mission products (including all relevant information on calibration and instrument properties). Some instrument teams may also need to comply with the data archive schemes set by its Lead Funding Agency.

Scientific results from the missions will be published, in a timely manner, in appropriate scientific and technical journals. Proper acknowledgement of the services supplied by JAXA and other institutes/agencies shall be made.

Upon request from JAXA, PIs will provide JAXA with processed and usable data for the Science Communication purposes. The PIs will also be engaged in supporting science communication activities that will be led by JAXA and other institutes/agencies.

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5. DOCUMENTS

5.1. Applicable documents

(1) JAXA-RPR-MX16300

MMX Science Requirement Document for All Instruments (MMX-SciRD-ALL)

(2) JAXA-RPR-MX16301

MMX Instrument Interface Requirement Document (MMX-I-IRD)

5.2. Reference documents

N/A

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6. ACRONYMS

Co-I	Co-Investigator
Co-PI	Co-Principal Investigator
CGSE	Calibration Ground Support Equipment
EGSE	Electrical Ground Support Equipment
ICD	Interface Control Document
IDS	Inter-Disciplinary Scientist
JAXA	Japanese Aerospace Exploration Agency
MGSE	Mechanical Ground Support Equipment
MMX	Martian Moons Exploration
MMX-I-IRD	MMX Instrument Interface Requirement Document
MMX-PI	MMX Principal Investigator
MMX-PM	MMX Project Manager
MMX-SciRD	MMX Science Requirement Document
MMX-SB	MMX Science Board
PI	Principal Investigator
SWT	Science Working Team