



IDEFIX - The MMX Phobos Rover: One year before launch

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Introduction

The Martian Moon eXploration (MMX) mission by the Japan Aerospace Exploration Agency, JAXA, is going to explore the martian moons Phobos and Deimos. Both moons will be investigated remotely from the mother spacecraft, that will also collect samples from the surface of Phobos. There will also be a small rover, IDEFIX, which will be delivered to Phobos' surface and make in-situ investigations.

The Rover carries a scientific payload of four instruments: RAX, a Raman spectrometer, NavCam, a stereo pair of cameras looking ahead to image the terrain and also support navigation, miniRAD, a radiometer, and two WheelCams looking at the wheel-surface interface, and thus investigating the properties and dynamics of the regolith. The camera pairs will serve for both, technological and scientific needs [1,2].

The Rover is a contribution by the Centre National d'Etudes Spatiales (CNES) and the German Aerospace Center (DLR) with additional contributions from INTA and Univ. Valladolid (Spain) and Univ. Tokyo and JAXA.

IDEFIX design and payload

The rover with an allocated mass of 29.1 kg, (including the mechanical support system (MECSS) and communications system, which will stay on the main spacecraft) is based on a carbon fiber structure, a locomotion system with four individually controlled wheels and a power system with a solar generator and re-chargeable batteries.

The ground segments are established at CNES in Toulouse as well as at DLR in Cologne, Germany. All communications between the rover ground segment and the flight segment are linked via the MMX spacecraft and the JAXA ground segment and ground stations.

IDEFIX is accommodating four scientific instruments:

Navigation cameras **NavCams**, looking in front of the rover with a resolution of ~ 1 mm at 1 m distance. Besides of the scientific use, they are key for navigation and analysis of the rover location, attitude and locomotion.

Two **WheelCams** placed on the underside of the rover each aim at a different rover wheel. The WheelCam images of the surface will be used to characterize the regolith particles (e.g., size distribution, morphological characteristics).

The Raman spectrometer **RAX** is able to analyse the mineralogy on a spot about 8 cm underneath the rover chassis. Heterogeneity of surface grains can be determined and the mineralogy of the material, measured in-situ will complement orbital spectroscopic data and will be important for putting in context the samples which will be returned to Earth.

The radiometer **miniRAD** will investigate the surface temperature and surface thermo-physical properties of Phobos by measuring the radiative flux emitted in the thermal infrared wavelength range. The measurements will also constrain porosity, surface roughness, and emissivity of the surface material.

Figure 1 shows the rover design, fully deployed in the on-Phobos configuration. Figure 2 shows the Flight model before integration to the main spacecraft.

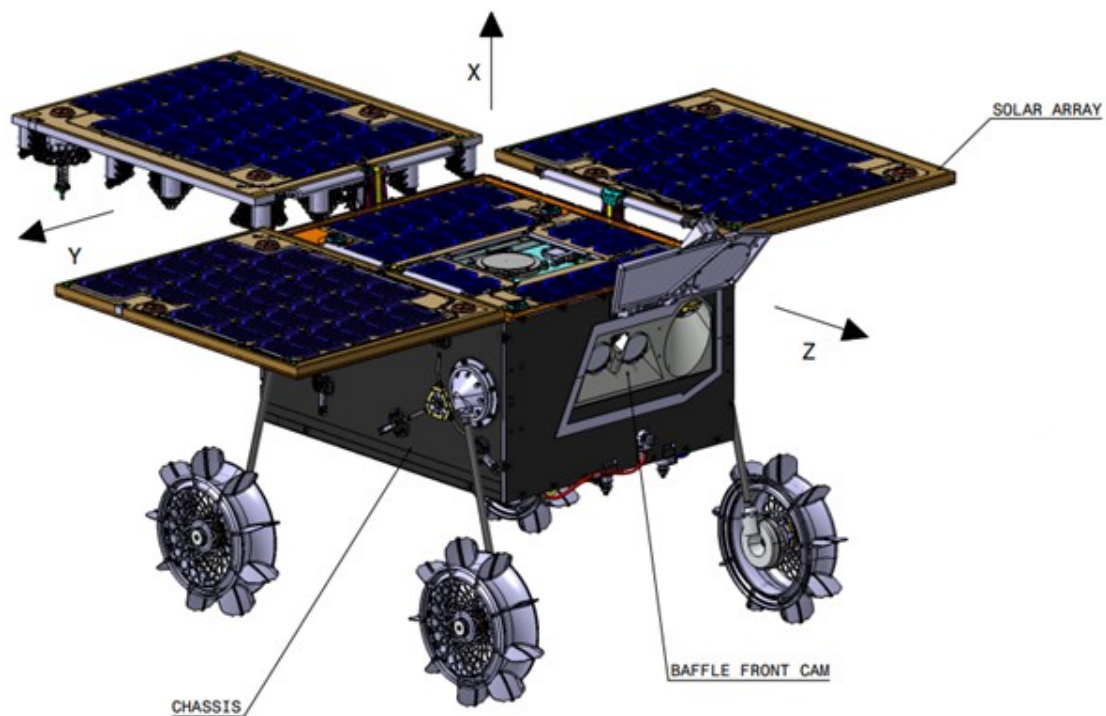


Fig. 1. IDEX in on-Phobos configuration with deployed solar generator (image: CNES)



Fig. 2. IDEFIX Flight model shortly before integration to the main spacecraft

IDEFIX project status, one year before launch

The IDEFIX rover was delivered to JAXA in February 2024, after undergoing its environmental test program in Europe. It is now attached to the main spacecraft, where tests of the complete MMX system are performed at MELCO in Kamakura. Thermal Vacuum tests have been finalized in spring 2025. The overall test program for IDEFIX is performed both, with the flight model, attached to the MMX spacecraft, but also for operational and planning preparation with a representative "flat rover" at CNES in Toulouse.

The launch of MMX is now foreseen for October 2026, arrival at the martian system in 2027 and landing of the rover in late 2028 or early in 2029, after a landing site selection exercise. IDEFIX will be released from an altitude of about 40 m, fall to the surface, upright itself and drive and carry out scientific investigations for about 100 days.

References: [1] Michel, P. et al., *Earth, Planets and Space*, 74:2, 2022; [2] Ulamec, S. et al., *Acta Astron.*, Vol. 210, pp. 95-101, 2023