

IAF SPACE EXPLORATION SYMPOSIUM (A3)  
Small Bodies Missions and Technologies (Part 1) (4A)

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## RAX: THE RAMAN SPECTROMETER FOR THE MMX PHOBOS ROVER

### Abstract

We present the Raman Spectrometer onboard JAXA's Martian Moons Exploration (MMX) mission. As part of the MMX Rover, the RAX instrument is built to measure and identify the surface mineralogy of Phobos. This is realized by acquiring Raman spectra in-situ, surveying the geology beneath the Rover body. The RAX data supports the MMX top-level science by providing ground truth information of Phobos, complementary to the samples returned to Earth by the MMX spacecraft.

RAX is a very lightweight and highly compact Raman spectrometer with a mass of 1.5 kg and a volume of less than 1 dm. The spectrometer is equipped with a miniaturized and highly sensitive optical assembly, that allows for measuring rather weak Raman signals and enables the identification of water-bearing minerals. The Raman excitation ( $\lambda = 532$  nm) is realized via a separate laser module based on the Raman Laser Spectrometer (RLS) laser developed for the ExoMars2022 mission. In order to focus the laser onto the Phobos ground below the Rover, the spectrometer includes an autofocus mechanism. The RAX instrument covers a spectral range of 535 to 680 nm, corresponding to a Raman shift of approximately  $4000\text{ cm}^{-1}$ . The spectral resolution over the whole spectral range is approximately  $10\text{ cm}^{-1}$ .

This paper presents the design and development of the RAX instrument from initial concept to flight model manufacture. The optical performance of the spectrometer is demonstrated using Raman spectra recorded on the physical hardware models.

The delivery of the RAX flight model to the MMX Phobos Rover is currently scheduled for Summer 2022. The MMX mission is to be launched in 2024. First RAX data obtained from Phobos are expected in 2027.

The RAX instrument is a joint contribution by the German Aerospace Center (DLR), Instituto Nacional de Técnica Aeroespacial (INTA) and JAXA.