

Development of the Raman Spectrometer for Martian Moon Exploration (RAX) for the MMX rover

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The Raman Spectrometer for MMX (RAX) is one of the instruments on board the MMX rover. RAX will conduct Raman spectroscopy on the surface of Phobos to analyze the surface mineralogy. This instrument is composed of laser module, spectrometer module, and autofocusing subsystem (AFS). The entire RAX instrument weighs ~1.4 kg and its size is only 81 x 98 x 125 mm³, excluding the externally mounted laser module. The RAX instrument is developed through an international collaboration among Japan (Univ. Tokyo/Rikkyo Univ/JAXA), DLR from Germany, and INTA/Univ Valladolid from Spain.

The Japanese team provides the autofocusing subsystem (AFS). The aim of AFS is to focus the collimated laser beam onto the surface of Phobos and to transmit the Raman signal generated at the laser spot back to the spectrometer module in the form of collimated light. To obtain optimized Raman signals from samples of various size, the distance between the bottom end of the optics and a sample can be adjusted within a range of ± 7.5 mm from the nominal working distance of 80 mm. Because of the highly limited volume inside the rover, the volume allocated for the autofocusing subsystem is only approximately 65 x 65 x 50 mm³, giving a challenge in designing and manufacturing the system. The mass of AFS will be less than 250 g.

The AFS is composed of the objective lens, stepping motor, linear guide, lead screw, photo-interrupter, electronics, and mechanical parts that connect them. The rotations of the stepping motor are converted to the linear motion of the objective lens, with a combination of nut, lead screw, and linear guide. To protect the motor axis from any shock/vibration load, the lead-screw shaft is separated from the motor axis and connected with it by a pair of gears. The AFS has its own printed circuit board to activate the stepping motor. Although the AFS will not have an encoder, the photo-interrupter will be used as an end-stop sensor. Its end-to-end performance is being evaluated with a breadboard model, while the preliminary design of the AFS is established in the international RAX team.

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