

Press Release

Japanese Space Mission Collects Rock Samples On-Site and Brings a Sample Back to Earth for the First Time

Mini Laser from Jena to explore Mars' Moon Phobos

Jena / Tanegashima (Japan) | On October 20, the Japanese space agency JAXA plans to launch its MMX probe to Mars. Its mission is to retrieve a rock sample from Mars' moon Phobos and bring it back to Earth. On board is a miniaturized laser built at the Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena. Originally developed for the European ExoMars mission—whose 2022 launch had to be canceled—the technology is now being used in the Japanese mission to Mars' moon.

The “Martian Moons eXploration” mission, or MMX for short, is currently one of the most ambitious projects in space exploration. The Japanese space agency JAXA plans to send a probe to Mars' moon Phobos, land there, and then return a sample to Earth. The mission is scheduled to launch on October 20, 2026, aboard an H3 rocket from the Tanegashima Space Center in Japan. About a year later, it will study the Martian moon Phobos up close, and a rover is scheduled to land there in 2029.

This Will Be the First Time Samples from a Martian Moon Are Brought Back to Earth

To this day, it remains unclear where the two Martian moons, Phobos and Deimos, came from. Were they formed by a massive impact on Mars? Or were they originally asteroids captured by the planet's gravity? MMX is designed to answer questions like these by not only studying Phobos from orbit but also collecting at least ten grams of material from its surface. The plan is for the probe to return to Earth and drop the collected sample over Australia in 2031. It would be the world's first return of samples from the Martian region.

International partners are also involved in the Japanese-led mission, including the U.S. space agency NASA, the European Space Agency (ESA), the French space agency CNES, the German Aerospace Center (DLR), and the Spanish Institute of Aerospace Technology (INTA).

Laser Light as a Geological Fingerprint

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The mission is not limited to sample collection alone. It is also designed to analyze the rock in situ. To do this, the surface of the Martian moon will be illuminated with a small but powerful laser. The characteristic radiation emitted by the rock is then measured using a special Raman spectrometer. This allows researchers on Earth to investigate the composition of the lunar surface from millions of kilometers away.

A team from Fraunhofer IOF in Jena built the laser for this spectrometer. It emits green light with a wavelength of 532 nanometers and an output of more than 100 milliwatts—about 100 times stronger than a laser pointer—while weighing only about 50 grams.

Special Soldering Technique for Extreme Durability

However, the challenge in developing and building such a mini-laser lies not only in making it particularly lightweight. The optical components must withstand strong vibrations during rocket launch as well as radiation and extreme temperature fluctuations. The system was designed for temperatures ranging from minus 130 to plus 24 degrees Celsius.

A special key technology from Fraunhofer IOF makes this possible, as Fraunhofer researcher Marta Gilaberte Basset explains: “Instead of bonding the sensitive optical components using conventional methods, we secured elements of the laser resonator and the secondary optics using a laser-based brazing technique,” she says. She played a key role in developing the alignment and integration concept for the laser, first in Spain and later at Fraunhofer IOF. “We cannot readjust the optics for a Mars mission after launch. When brazed, the components maintain their position with high precision for years.” Furthermore, the brazing technique prevents potential problems in the instrument that could arise from adhesives outgassing in a vacuum.

A Second Chance for Technology from Jena

For a long time, it was by no means certain that the technology would actually make its way to Mars. The laser system was originally developed for the “ExoMars” mission, which had once been planned as a European-Russian partnership. Following Russia’s invasion of Ukraine, the ESA suspended its cooperation with the Russian space agency Roscosmos in 2022. The launch that had been scheduled at the time did not take place.

However, the technology developed at Fraunhofer IOF found a new application. Through the Spanish space agency INTA, which had already been involved in developing the measurement technology for the ExoMars rover and has now provided the chance to fly an identical laser unit on the MMX mission, the expertise from Jena was incorporated into the instrument for the Japanese MMX mission. As a result, a technology that had already been qualified for use on Mars is getting a second chance in space.

Dr. Erik Beckert, head of the Department of Opto-Mechatronic Components and Systems at Fraunhofer IOF, sums it up: “For us, it is of course something special that a technology into which many years of work have gone is now actually flying to Mars. At the same time, MMX demonstrates how important long-term international cooperation is for space projects.”

Following the MMX mission, the ExoMars mission is back on the agenda, though without the participation of Russian partners. The launch is currently scheduled for 2028. Laser technology from Fraunhofer IOF will once again be part of that mission.

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Further Information

You can find the JAXA mission page here: www.mmx.jaxa.jp/en/

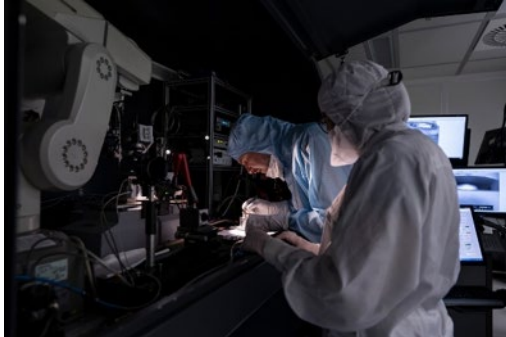
About Fraunhofer IOF

The Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena conducts applied research in the field of photonics and develops innovative optical systems for controlling light—from its generation and manipulation to its application. The institute's range of services covers the entire photonic process chain, from opto-mechanical and opto-electronic system design to the manufacture of custom solutions and prototypes. At Fraunhofer IOF, approximately 500 employees generate an annual research budget of 40 million euros.

For more information, visit: www.iof.fraunhofer.de



Fig.1 The laser module built in Jena combines a compact size with maximum robustness. It is now on its way to Mars' moon Phobos. © Fraunhofer IOF



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Fig. 2 Researchers at Fraunhofer IOF prepare the laser's tiny components for the specialized soldering process. © Fraunhofer IOF

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