

## THE SAMPLE ANALYSIS LABORATORY AT DLR AND ITS EXTENSION TO CURATION FACILITY FOR MMX

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**Introduction:** Laboratory measurements of extraterrestrial materials like meteorites and ultimately materials from sample return missions can significantly enhance the scientific return of the global remote sensing data. This motivates the ongoing addition of a dedicated Sample Analysis Laboratory (SAL) to complement the work of well-established facilities like the Planetary Spectroscopy Laboratory (PSL) and the Astrobiology Laboratories within the Department of Planetary Laboratories at DLR, Berlin. SAL is being developed in preparation to receive samples from sample return missions such as JAXA Hayabusa 2 and MMX missions, the Chinese Chang-E 5 and 6 missions as well as the NASA Osiris-REX mission. The main focus of SAL will be on spectroscopic, geochemical, mineralogical analyses at microscopic level with the ultimate aim to derive information on the formation and evolution of planetary bodies and surfaces, search for traces of organic materials and presence of water.

**Sample Analysis Laboratory:** SAL is being set up at the Institute for Planetary Research at the DLR location in Berlin-Adlershof (Germany). The cleanroom environment will be on the ground floor with a room for support infrastructure in the basement below. The rooms are currently being setup with a planned completion date by autumn 2023. Procurement of the instruments is ongoing and first instruments are already been delivered. SAL will be equipped with a vis-IR-microscope (Bruker Hyperion 2000), a Malvern Panalytical Empyrean X-ray diffraction (XRD) system with Bragg-Brentano geometry which can be switched to parallel beam geometry, equipped with a Cu K $\alpha$  source, 1Der detector and automated incident beam optics, a Field Emission – scanning electron microscope (FE-SEM), a JEOL iHP200F Field Emission – electron microprobe analyzer (FE-EMPA), petrographic and stereo microscopes, Keyence VHX-7000 3D microscope and a glovebox. The X-ray diffraction system has been delivered in December 2022 and is currently in storage and will be setup as soon as the cleanrooms are ready. The JEOL iHP200F is currently setup at JEOL GmbH in Freising (Germany) for calibration, testing and training and is planned to be transferred to DLR in autumn 2023. SEM procurement will be kicked off within the next weeks. The Bruker Hyperion 2000 is already in use at PSL as well as the Keyence VHX-7000 which already have been used for our study on Ryugu sample A112 [1]. All samples will be stored under nitrogen gas and dedicated nitrogen filled shuttles will be used for transporting samples between the instruments to avoid them to enter in contact with the external environment.

**Curation preparation:** In collaboration with the Natural History Museum (MfN) in Berlin, SAL will also have the expertise and facilities for carrying out curation of sample return material which will be made available for the whole European scientific community. DLR is already curating a 0.45 mg of Lunar regolith collected from the Luna 24 Soviet mission and the first analyses of the material are being planned. Currently, the curatorial expertise is being developed on the existing expertise from the Meteorite Collection based at the MfN and in collaboration with the JAXA curation facilities. Current curators, together with the younger generation are being trained and working on skillset exchange.

**Preparation for MMX curation:** In 2024 the Martian Moons eXploration (MMX) mission [2] from JAXA will be launched to the Martian Moons Phobos and Deimos to investigate their nature and improve our understanding about their formation. In 2029 samples from Phobos will be returned back to Earth as MMX is the latest JAXA's sample return mission. Samples returned to Earth by the MMX mission will be retrieved by JAXA and transferred to the JAXA ISAS Sample receiving laboratory for initial description, followed by initial proprietary analyses performed by the MMX Science Sub-Teams (SSTs), which will include a number of ESA-appointed MMX participating scientists from ESA Member States. The duration of these activities is determined by the MMX Sample Allocation Committee (SAC), and is estimated to last approximately 1 year.

It is planned that JAXA will thereafter transfer an allocation of samples to ESA for use by scientists and laboratories in the ESA Member States. Sample Curation Facilities (hereafter SCFs) at DLR and CNES will host and handle the MMX Samples provided to the ESA Science Programme. After transfer to the SCFs the samples will be catalogued (if not done by JAXA) in preparation for an ESA Announcements of Opportunity (AOs) to allocate the Samples to scientists and laboratories in the ESA Member States.

Within the analytical facility it will be possible to carry out the basic characterization of the samples in controlled environmental conditions, for then being able to move on to more specialized facilities for more in depth examination.

**References:** [1] Maturilli A. et al. (2023) *LPSC LIV*, Abstract #1632. [2] Kuramoto K. et al (2022) *Earth, Planets and Space* 74: 1.