Mochi Portable Spectroscopic Electron Microscope on ISS: Progress Toward Flight

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Mochii: new ISS Microgravity research facility for the benefit of mankind

Science: Mochi will enable novel research on board ISS, including EM visualization of samples prepared in microgravity, characterization of new and existing materials, and in the longer term tissue and cell architecture.

Engineering: Mochi will enable mission-critical engineering on board ISS, such as characterizing debris in life support and mechanical systems to reduce crew and vehicle risk.

Future missions: Mochi will serve as a development platform for future missions, including deep space manned and robotic exploration by enabling actionable analysis when sample return to Earth-based labs is not possible.

Applications

Your EM samples analyzed in-situ on ISS

Electron microscopy (EM) and energy-dispersive spectroscopy (EDS) are powerful tools for research and engineering. EM offers strong optical scattering, high native resolution, large depth of focus, and multiple available signals including X-rays for chemical ID.

Mochii: a new ISS platform for microgravity research.

EMSA routinely uses ground-based EM's to:
- Understand the origin and evolution of the solar system, esp. rocky bodies
- Visualize architecture of tissues and cells
- Characterize particulate debris in air/water and other environments, study fibers, and characteize micro-structures
- Guide critical adaptive mission planning via forensic imaging and microanalysis for life support and mechanical systems

Coauthors are working together in partnership with the ISS program to bring this powerful capability to ISS. Vixa is entering into an agreement with CASIS to make EM analysis available to terrestrial users as a National Laboratory facility after its initial demonstration mission. This facility supports in-situ engineering analysis and microgravity science benefiting mankind.

Out of the lab and into the field:

EM is traditionally a high-end large facility lab tool:
- Complex to operate and maintain, needs vacuum and stable environment
- Training, long queues, and geography limit access, speed to result, and the extent to which many analyses can be executed.
- Field samples must be sent back to a facility, despite potential chemical or morphological changes over time and/or damage in transit.

Vixa has developed Mochii, the world's first truly field-portable nano-imaging platform to address limitations bringing EM out of the lab.

Mochii is tiny and versatile and suitable for space use:
- Ultra-portable: 260 mm tall, < 12 kg, < 80 W
- Low accelerating potential (50 kV) provides capable imaging
- Wireless tablet interface: multi-user collaboration
- Chemical ID via energy-dispersive X-ray spectroscopy (EDS) enabled in Mochii's 5" model
- Easy sample preparation using integrated metal coater
- Low initial procurement, operating, and maintenance costs

Mochii's unique balance of features enables it to perform analyses in extreme field environments, such as outdoors under battery power, on moving vehicles such as ocean vessels, and in the most extreme of environments: space.

We report on preparing Mochii's 5" for manned space flight, the first instrument of its kind in this frontier.

www.projectvixa.com

Please share with us your microgravity experiment ideas utilizing Mochii on ISS!

Vixa may serve as your implementation partner for novel microgravity research on ISS

Flight verification testing

Mochii payload is flying as commercial off-the-shelf (COTS) hardware subject to ISS engineering integration and crew/vehicle safety verification requirements.

To reach technology readiness level (TRL) 9 and to achieve flight readiness, Mochii is undergoing rigorous testing. Tests that simulate the spaceflight environment increase safety to crew and vehicle, and reduces risk of failures on orbit. Included are EM, thermal, command & data handling, and power quality. Vibration and acoustic testing examples are to the right.

In tandem, we are performing science verifications with our research partners to prepare the Mochii for National Laboratory service.

Science verification testing

Good standards are key to accurate spectroscopic chemical ID on-station. We are providing new standards for Mochii EDS for semi-quantitative EDS alloy identification.

ISS Topology

Mochii will be aisle-deployed in the Japanese Experiment Module (JEM) and will be powered by ISOWAC Inverter (950th percentile male shown, see also center image in banner above).

Mochii is accessed wirelessly by crew, and accessed by ground National Lab users using iPads over JSPLink through Huntsville Operations and Vixa servers. Multiple users are supported.

Basic research: Extraterrestrial Samples

Mochii is an excellent analytical tool for the morphological, textural, and chemical characterization of extraterrestrial samples and is part of a suite of tools developed for the space environment. Of particular note are the hands-free sample preparation methods necessary for supporting life in other worlds and in the study of planetary geological processes.

Industrial science: Microgravity Crystallization

The ISS platform supports industrial microgravity science experiments catalyzing technology development in Earth. The example demonstrates a high value for Mochii as a technology demonstrator, allowing the demonstration of a simple but valuable microgravity science experiment. The image of a crystallizing sample in microgravity is coupled with a microgravity science experiment.

Crew safety: Water leak build-up in EMU 3011

On a routine maintenance extravehicular activity (EVA) in 9/2022, crewmember Luca Parmitano detected a water leak through its extravehicular mobility unit (EMU) helmet. ESA was informed and a replacement helmet was returned to ground, however, the issue was not resolved. Subsequently, Luca Parmitano was injured. Mochii will address this concern, which is to drain water separately into the EMU's helmet.