An Advanced Automated Microscope

Innovative Microscopy Research Capable of Space
Innovation and imagination are all that are required to use the Light Microscopy Module (LMM) as a laboratory microscope to perform research aboard the International Space Station (ISS). The LMM is remotely controllable, automated microscope that opens the ability to study—in real-time—the effects of the space environment on physics and biology. Spectroscopy can be utilized with the need to return the samples to Earth.

Microscope Modified for Space Research

The LMM flight unit features a modified commercial laboratory Leica RXA microscope configured to operate in an automated mode with interaction from the ground support staff. Its core capabilities include a level of confinement, within lighting and imaging possible envelope, brightness, contrast, microscopy available in 2016 to 2017, and in imaging capability from a 5-Megapixel 1300 camera.

LMM Supported in the Fluids Integrated Rack

The LMM operates in the Fluids Integrated Rack (FIR), which is located in the U.S. Destiny Laboratory of the ISS. The FIR provides the LMM with the necessary infrastructure to conduct experiments, including access to power, lighting, cameras, control panel, imaging, and biospecimen, data processing, and other resources. The FIR also provides isolation from vibrations on the station to allow for a more stable environment to obtain high-resolution images. The LMM is in cooperation with the FIR, which will help limit the risk of a failure in the space, which is ideal for long-duration development.

Critical Research Enabled by LMM

How material is organized and moves on the microscopic level profoundly affects the macroscopic world. Understanding these processes will help engineers and scientists build more efficient machines and consumer products both on Earth and in space. A suite of experiments is enabled by the LMM to allow for a planned characterization of fluids, colloids, two-phase media, and biological samples. In the future, the LMM could be used to assist in maintenance of stand-alone research, to enhance knowledge of the space on biology, and to contribute to long-term mission science exploration.

Modified Microscope

Engineers at NASA Glenn Research Center modified a Leica RXA laboratory microscope for use in the ISS environment. The modified microscope, the Light Microscopy Module (LMM), provides the ISS crew with a means to perform microscopic observations of biological samples in the Destiny Laboratory on the ISS.

Sample Modules

Biological Sample Cells

Biological samples for the LMM launched on the Space Shuttle Discovery STS-133 mission on February 24, 2011, included fixed cell samples containing yeast, bacteria, and a small fly (Drosophila). A butterfly wing, tissue section, and level, and an assemblage of the C elegans worm. The wing was from "Butterflies in Space" is a previous study that involved students from around the country that was flown into space in 2008 on STS-126. In addition, some of the worms were decontaminated that summer. The scientists on the Space Shuttle Columbia STS-103 accident. These experiments were operated using Zyla cameras and sample modules.

Physical Science Sample Cells

On-going experiments in space are conducted in the Combined Space Station (CSS). Sample modules in ground are considered "operational cell". These have numerous experiment parameters, including sample location, temperature, atmosphere, light, and environment. The isolated scientific capability cells will have a variety of sizes and locations to enable the CSS sample modules. The sample modules are designed to be reinitiated at any time without intervention by the ISS crew. In situ mixing is a feature of the microscope with powerful laser-diagnostic capabilities. These modules can be used to observe the effects of the space environment on the biological samples. The microscope is in cooperation with the CSS, which will help limit the risk of a failure in the space, which is ideal for long-duration development.

Current Data and Future Capabilities

In situ mixing of Arabidopsis thaliana (Arabidopsis) and Arabidopsis thaliana (Arabidopsis) is a feature of the microscope with powerful laser-diagnostic capabilities. The microscope is in cooperation with the CSS, which will help limit the risk of a failure in the space, which is ideal for long-duration development.

Characteristics and Features

LMM Control Box (LCB)
The LMM control box (LCB) is in cooperation with the Destiny Laboratory and provides the ISS crew with a means to perform microscopic observations of biological samples in the Destiny Laboratory on the ISS.

Imaging Camera

Two cameras can be mounted on the head of the microscope; one coaxially with the viewing axis of the microscope and one at an angle on the optic axis of the microscope. The head can be tilted to allow for a more stable environment to obtain high-resolution images. The LMM is in cooperation with the FIR, which will help limit the risk of a failure in the space, which is ideal for long-duration development.