Light Microscopy Module
International Space Station Premier Automated Microscope

**An Advanced Automated Microscope**

Innovative Microscopy Research
Quantity Time Space
Innovation and integrative solutions that are never before seen in the Light Microscopy Module (LMM) as a laboratory microscope to perform research aboard the International Space Station (ISS). The LMM is extremely controllable, automated microscope that gives scientists the ability to study—on a real-time basis—the effects of the space environment on physics and biology. Specimens can be studied without 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. Its core capabilities include a level of containment, while light imaging (available now), fluorescence, confocal microscopy (available in 2014 to 2017). and 3D imaging capability from a 3-D imaging library of 1000 samples.

**LMM Supplemented 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 laboratory infrastructure necessary to conduct research, including in-vivo bench, temperature control, power sources, imaging and data capture systems, processing, and other resources. The FIR data provides isolation from vibrations on the station to allow for a more stable environment to obtain high-resolution images. The LMM in conjunction with the FIR will keep the values of a true laboratory in space, which is ideal for low-cost, high-quality research.

**Critical Research Enabled by LMM**
How viruses are organized and used on the microlevel profoundly affects the molecular world. Understanding these processes will help scientists and engineers build more efficient machines and consumer products both on Earth and space applications. A suite of experiments is enabled by the LMM to allow for a directed characterization of viruses, colloid objects, and polymeric and biological samples. In the future, the LMM could be used to assist in maintaining all stationary research needs, to advance understanding of the effects of the space environment, and to contribute to long-term mission space exploration.

**Microfluidic Module**
Engineers at NASA Glenn Research Center modified a Leica RXA laboratory-grade microscope by adding 2 microscopes to permit remote control by scientists on the ground and to meet the demands of space flight and ground-based operations. As such, it contains all of the necessary optical components for use as a full-functional microscope. The microscope can serve many different samples corresponding to magnifications of 0.5 to 100 x., including 0.5-20 x., 5 x., 10 x., and 100 x., coupled to a 19 x., 1 x., and 10 x., auxiliary objective lenses. These microscope capabilities include high-resolution color video microscopy, confocal assembly, confocal microscopy, and optically stable wavefronts. The LMM control box contains the control system for stepper motors and 4 axes of control for servo motors. The electrical design of the LMM uses parts of the existing electronics of the Leica microscope and supplementary internal and external electronics that support enhanced automation and imaging capabilities. Motors and linear actuators have been added to the control mechanism of the Leica module. The LED provides 16 axes of control for stepper motors and 4 axes of control for stepper motors.

**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 samples of Arabidopsis (root) taken during flight and crew-tended operations. As such, it contains all of the necessary optical components for use as a full-functional microscope. The microscope can serve many different samples corresponding to magnifications of 0.5 to 100 x., including 0.5-20 x., 5 x., 10 x., and 100 x., coupled to a 19 x., 1 x., and 10 x., auxiliary objective lenses. These microscope capabilities include high-resolution color video microscopy, confocal assembly, confocal microscopy, and optically stable wavefronts.

**Physical Sample Cells**

**Polymer Micron Microscope**
Polymer microspheres are used in the Polymer Micron Microscope. The LMM has the ability to image custom made microscopic slides for biological tests and sample cells. The LMM has the ability to image custom made microscopic slides for biological tests and sample cells. The LMM has the ability to image custom made microscopic slides for biological tests and sample cells.

**Current Data and Future Capabilities**
In situ mixing allows for the observation of samples shortly after mixing and for samples to be flown into space in 2014 on STS-134. In addition, some of the samples were deposited on the Space Shuttle Columbia STS-107 accident. These experiments were performed using OptiCells™ and sample slides for biological tests and sample cells.

**Characteristics and Features**
- **Mounted Microscope**: An advanced microscope with the ability to image custom made microscopic slides for biological tests and sample cells.
- **Accessory Fluids Container**: Auxiliary fluids container for the LMM control box.
- **Etching Microscope Module**: The LMM has the ability to image custom made microscopic slides for biological tests and sample cells.
- **Test Cells**: Test cells for the LMM are available for biological tests and sample cells.
- **Equipment Transfer Module**: Equipment transfer module—Auxiliary fluids container—Pre-Advanced Colloids Experiment (PACE) LED Base—Epi-illuminated image of live C. elegans using a 10x objective lens. Present capabilities include high-resolution color video microscopy, confocal assembly, confocal microscopy, and optically stable wavefronts.

**For more information about the Light Microscopy Module, please visit**
https://ntrs.nasa.gov/search.jsp?R=20170004565 2020-01-21T18:29:40+00:00Z

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