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LMM Capability Overview

Light Microscopy Module
Fluids Integrated Rack
Fluids and Combustion Facility

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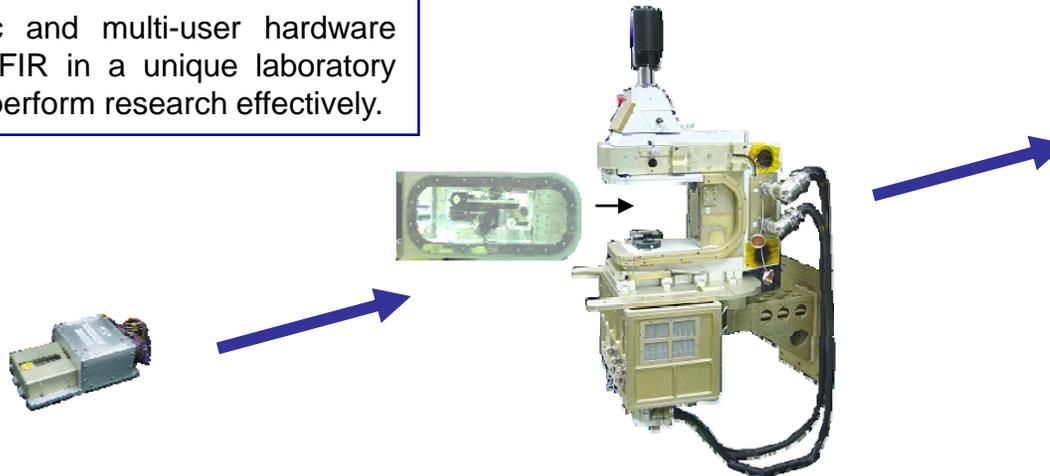


Payloads in the Fluids Integrated Rack

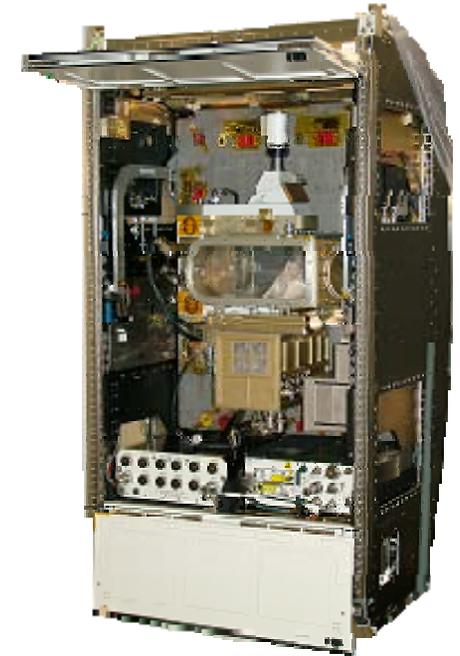
Payload Specific Hardware FIR First Increment

The FCF FIR includes support subsystems and laboratory style diagnostics common to the specific researchers and supplements the laboratory with unique science hardware developed for each Payload.

Payload specific and multi-user hardware customizes the FIR in a unique laboratory configuration to perform research effectively.



Light Microscopy Module



Payload Specific Hardware

- Sample Cell with universal Sample Tray
- Specific Diagnostics
- Specific Imaging
- Fluid Containment

Multi-Use Payload Apparatus

- Test Specific Module
- Infrastructure that uniquely meets the needs of PI experiments
- Unique Diagnostics
- Specialized Imaging
- Fluid Containment

FCF Fluids Integrated Rack

- Power Supply
- Avionics/Control
- Common Illumination
- PI Integration Optics Bench
- Imaging and Frame Capture
- Diagnostics
- Environmental Control
- Data Processing/Storage
- Light Containment
- Active Rack Isolation System (ARIS)



The Light Microscopy Module

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Core Microscope

- Leica RXA adapted for spaceflight

Augmentation

- Automated operation and crew usable
- Ground commanding

Capabilities---all in epi mode

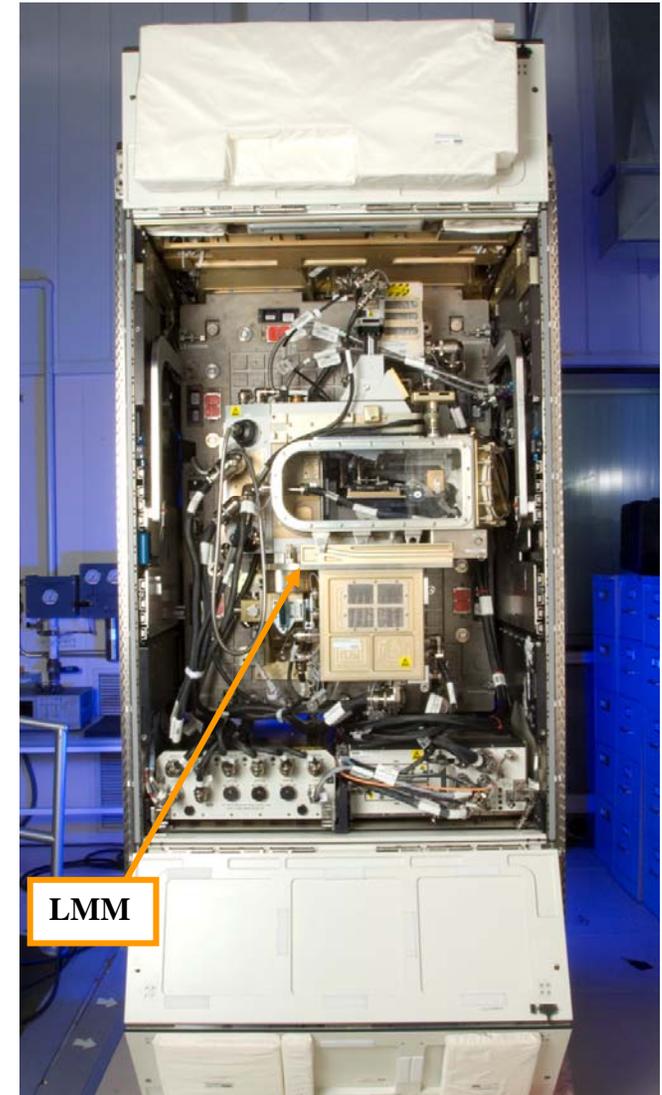
- White light imaging
- Fluorescence
- Köhler Illumination
- Linear illuminating wave plate

Camera

- Q-Imaging Retiga 1300
 - ✓ 1280 x 1024; 1/3 inch CCD
 - ✓ 12 bits
 - ✓ Binning: 1x1 to 4x4
 - ✓ Shutter: 0.0001 to 15 seconds

Location

- Fluids Integrated Rack, U.S. Module





Light Microscopy Module

Current Hardware

- **Automated:**
 - Objective turret, fluorescence turret and IC prism turret, field diaphragm, and aperture diaphragm
- **Tube lenses:**
 - 1.0x, 1.25x, and 1.6x
- **Fluorescence cubes:**
 - DAPI, FITC, AND Chroma: red, blue, and green
- **Epi Illumination Filters**, singly or in combination:
 - ND 0.4, 1.6, 436 nm, and 546 nm
- **Stage Positioning:**
 - XY: 100 x 46; 2.5 micron resolution
 - Z: 20 mm; 100 nm resolution
- **Objectives:**
 - 0.5x (Bertrand Lens)
 - 10x, N.A. 0.3
 - 20x, N.A. 0.7, PH 2
 - 40x, N.A. 0.75
 - 50x, N.A. 0.5, 7.1 mm working distance
 - 63x, N.A. 0.7, PH 2
 - 100x, N.A. 1.40, PH 3
- Containment for shatterable material
- 236 GB image storage (FIR)

Possible Future Capabilities

- Polarization Analyzer (LMM)
- 3 Chip Color VGA Imaging (FIR)
- Nipkow disc confocal with 532 nm sample excitation (LMM)
- Bio flow chamber developed by TechShot
- Droplet immersion oil dispensed by an astronaut
- Trans-illumination XY stage with a condenser
- Automated imaging modes: Phase Contrast, DIC, Darkfield
- Dynamic Light Scattering



Combined FIR / LMM Capabilities

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Core Leica Microscope

The LMM is a script driven, on-orbit microscope facility, that coupled with FIR capabilities provides optical diagnostics for PI experiments.

The imaging techniques of high resolution color video microscopy, bright field, dark field, phase contrast, differential interference contrast (DIC), fluorescence, and confocal microscopy are combined in a single configuration.

Bertrand 10x, 50x, 63x, 100x objectives



Auxiliary Fluids Container

Main work area for processing and containment.

The AFC provides one level of containment. Two sealed glove ports, elect pass through. 1/2" thick Lexan® windows with Viton seals

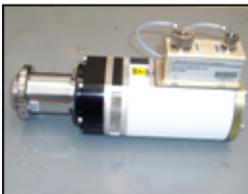
Working volume = 0.054 cu. Meters



LMM Control Box

Conditions Power for LMM

Provides 16 axis of control for stepper motor and 4 axis of control for servo motors



QImaging Camera

High resolution imaging

QImaging Retiga 1300C

1280 × 1024 pixels

12 bit monochrome

6.7 μm × 6.7 μm pixel size

Dark Current 0.15e-/pix/s cooled
Selectable Region of Interest (ROI)



Surveillance Camera

Low resolution observation

Point Grey Firefly™ Monochrome Camera IEEE-1394 digital

1/3 CCD Sony, VGA 640x480 format - 3.75, 7.5, 15 and 30 FPS

Focal lengths of 4mm, 6mm, or 8mm



FCF Fluids Integrated Rack

Volume: 0.7 m³ (1100mm x 895mm x 495mm on the front of the OB)

Mass: 300kg

Power: Nominal 672 W/1600W max at 28Vdc; 1450 W at 120Vdc

Thermal Cooling: 3 kW water (MTL); 1300 W air (provided at 20-30°C)

FIR Optics Bench: Provides structural mounting platform for experiment hardware. Provides PI interfaces for power, control and data acquisition. Overall dimensions - 896 mm x 1194 mm



Electrical Power Control Unit

28VDC and 120VDC.

Power management and control functions, as well as fault protection.



Input/Output Processor

Main FIR controller and data acquisition system.

Video - 16x8 video switch, Ethernet Switch, Sync Bus

Fluids Science Avionics Package

Serves as the control and data acquisition system for the payload: RS-422, 2 channels, A/D, D/A, DIO, Motion control, Analog video, CAN bus control of diagnostics and PI Hardware

Two 36 G B hard drives

P3-500mhz-RAM



Image Processing and Storage Unit

Stores digital image data from a camera

Image analysis, processing and reduction

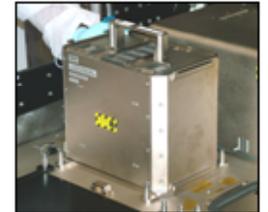
Control signals to camera and Illumination pkgs

IEEE 1394, FireWire Interface

Analog video, RS-170A, input/output

Two 36 G B hard drives

P3-500mhz-RAM



White Light Package

Provides uniform, broad band lighting

Two independent light engines

Easy replacement of light engine

Adjustable intensity

Fiber Optic Quick disconnects

Mounted to rear of bench, quick connect/disconnect of fiber bundles



Nd:YAG Laser

Provides a laser source for various diagnostic techniques such as Particle Image Velocimetry

532 nm, 150mw Output power

Analog control of laser functions

Bench mounted rear, fiber coupled to front

Laser output power monitoring



Color Camera Package

24 Bit, 3 chip CCD

1/3 inch array, 768 X 404 pixel

RS 170C output (30 FPS)

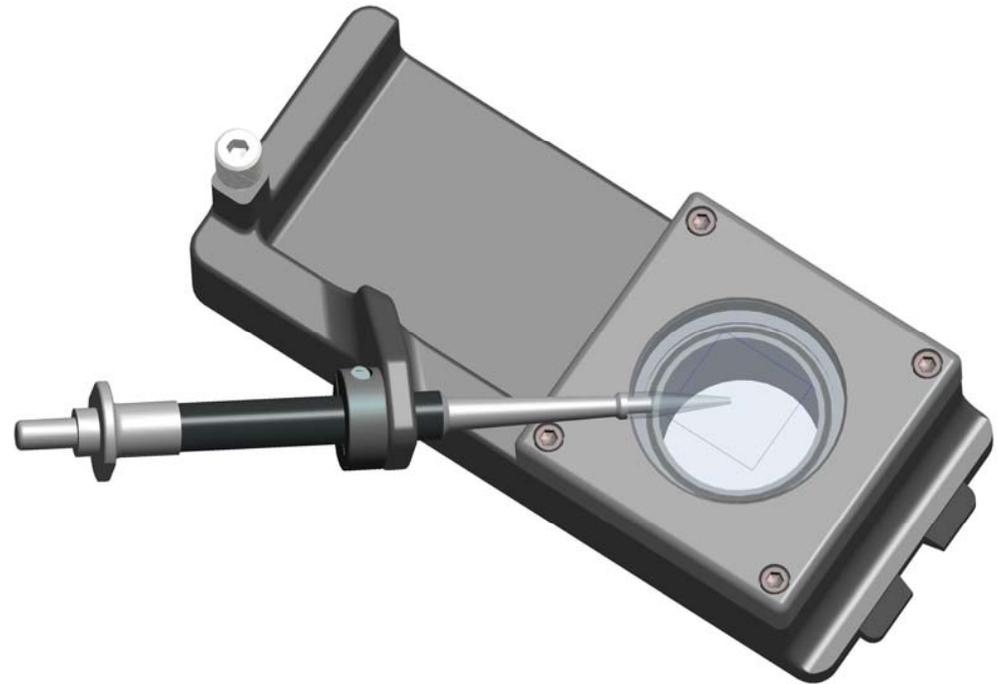
Remote and interchangeable head allowing for in-situ calibration with controller





Oil Immersion Objective Development

- A sample holder supporting oil immersion objectives is in development.
- The sample holder design supports trans-illumination using the existing stage.
- The sample holder will become a resource for future users to utilize.
- The oil injection syringe can be retrofitted to place biological samples on a test slide for direct measurement using an immersion objective.





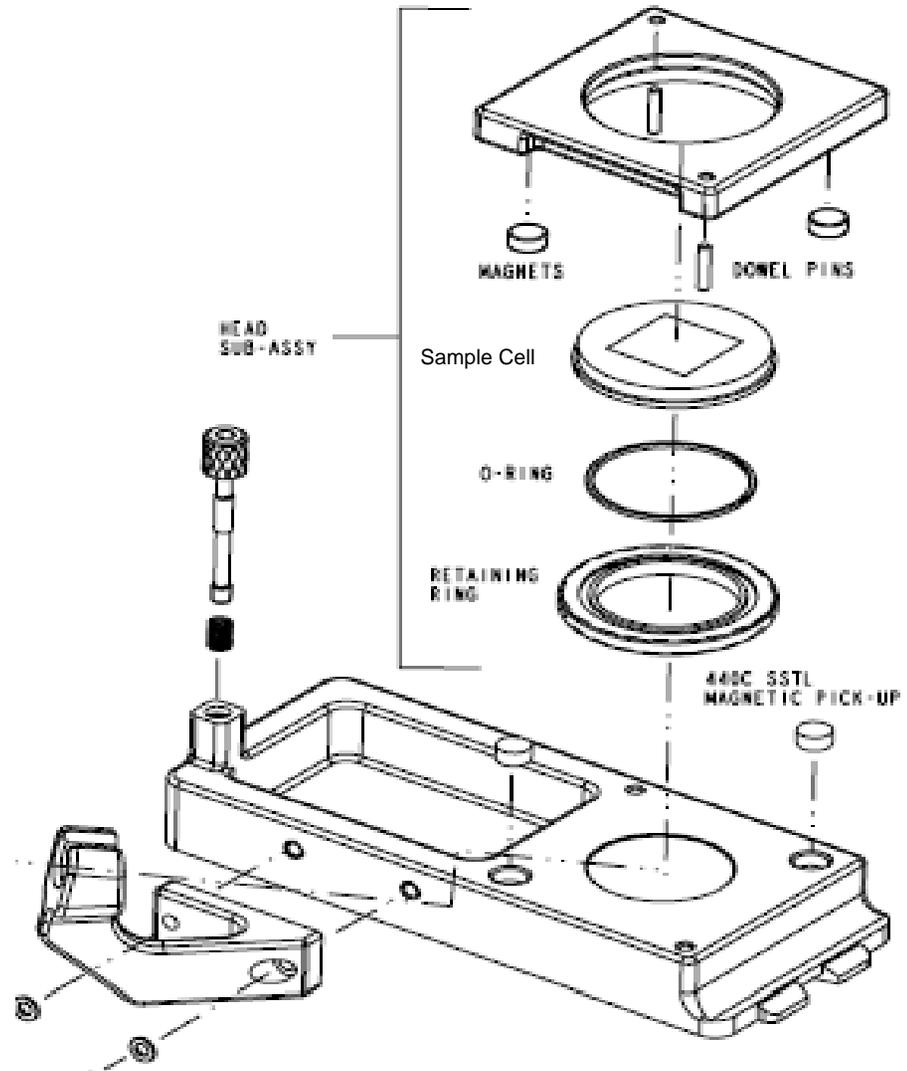
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BACKUP



Oil Immersion Objective Development

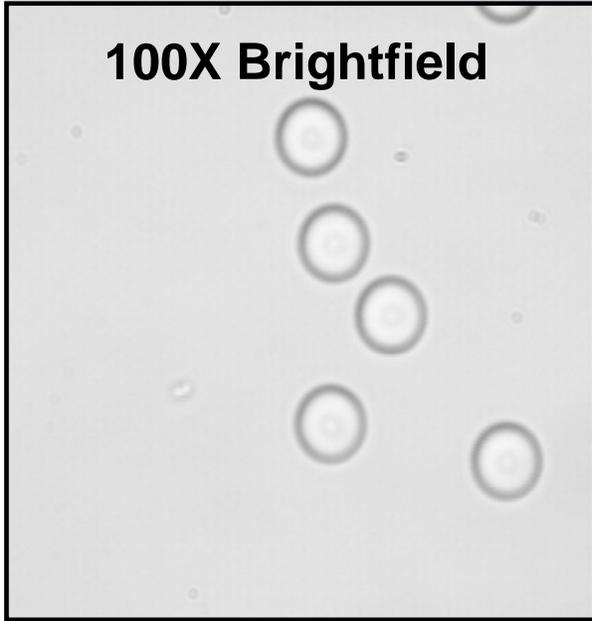
- The sample holder allows for easy replacement of the sample cell by the ISS crew.
- The sample cell can be instrumented to measure temperature, pressure, etc
- The sample cell can be filled on-orbit or on the ground prior to launch pending safety review.
- This design development is a simple example of the flexibility available to support biological applications.





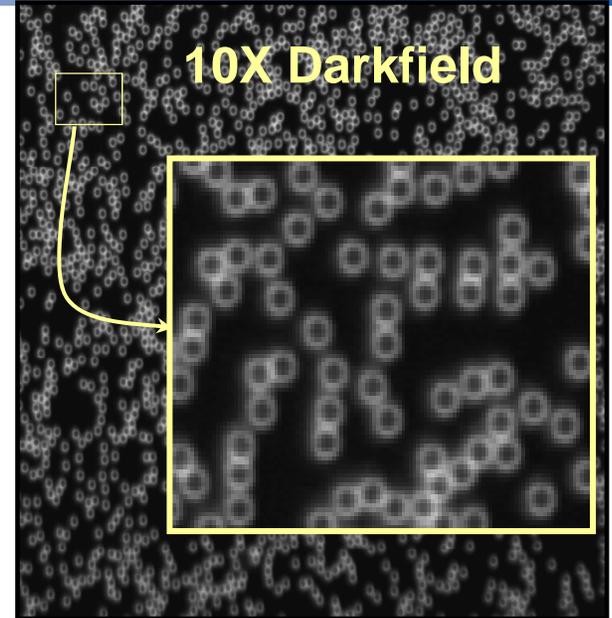
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100X Brightfield

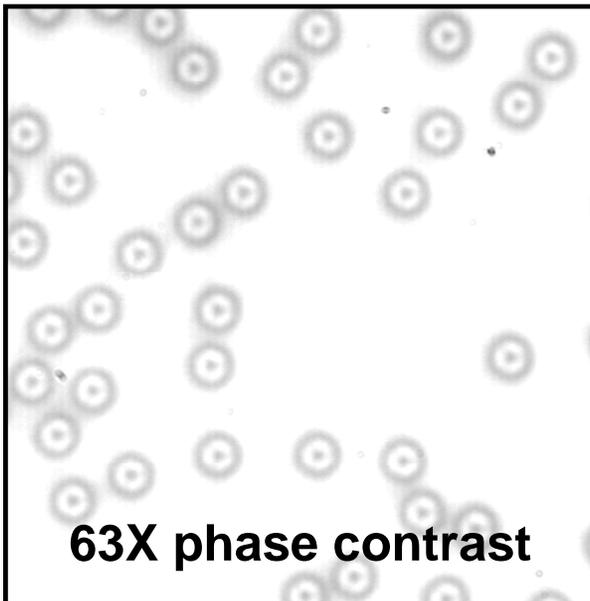


**Imaging
Modes of the
LMM
Microscope**

10X Darkfield



63X phase contrast



Sample: 5 μm polystyrene spheres in water.

100X DIC

