First Light for MIRSI

Mid-InfraRed Spectrometer and Imager

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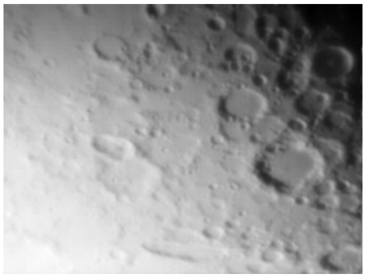
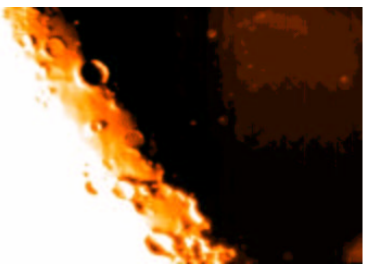
http://mirador.bu.edu/mirsi/mirsi.html



Images of the day side lunar surface (top), and the terminator at lunar sunset (bottom) were taken at 11.6 µm. Thermal emission can be seen from lingering "hot spots" on the "night" side. The FOV of both images is 7 x 5 arcmin, and the effective resolution is 3.4" at the MLOF.



First Light Observations

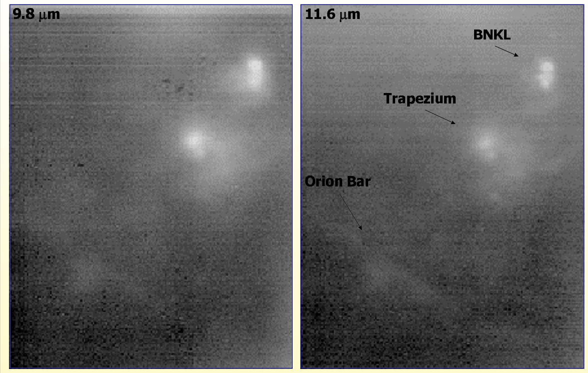
On December 5, 2001, MIRSI detected first light from astronomical sources at the 60-inch telescope at the Mt. Lemmon Observing Facility (MLOF), operated by the University of Minnesota and Steward Observatory in Tucson, AZ. Narrow band images of galactic, extragalactic, and solar system bodies were acquired over five nights.

MIRSI's total field of view at the MLOF 60-inch is about 7x5 arcmin, with a pixel scale of 1.3 arcsec/pixel. MIRSI is optimized for the IRTF's optics; the MLOF 60-inch has a smaller f-ratio than the IRTF, which results in a diffraction-limited PSF with a FWHM of 3.4 arcsec at 10 µm. At the IRTF, MIRSI will have a scale of 0.3 arcsec/pixel, with a diffraction-limited PSF FWHM of 0.8 arcsec at 10 µm.

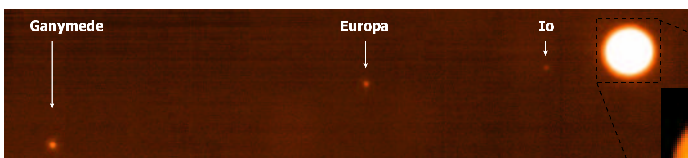
Images of Jupiter, Saturn, the Orion Nebula, Comet WM1 Linear, and the galaxy NGC1068 were acquired using an *engineering grade detector* from Raytheon/SBRC. The engineering grade array was installed only for MIRSI's inaugural test. All future observations will be made using the science grade detector.

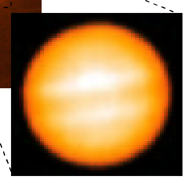
Images of the infrared standards β Gem, β Peg, and α Tau are used as calibrators. To obtain images for thermal background subtraction of the telescope and sky, the telescope was nodded a few arcmin east after each short individual on-source exposure.

ORION NEBULA



The 3.4 x 4.3 arcmin fields presented above of active star forming regions in the Orion Nebula contain many deeply embedded high and low mass YSOs. Emission from the BNKL region, Trapezium, and the Orion Bar are present. These images show only half the FOV obtained with MIRSI on the MLOF because we nodded onto the array. The effective resolution is 3.4" at the MLOF.





In the 11.6 µm image above, Jupiter has been burned out in order to show three of its relatively fainter moons. The above image is a mosaic with a total size of 11x2.5 arcmin. At right, an enlarged section of the mosaic shows the major bands found in Jupiter's atmosphere. The effective resolution is 3.4" at the MLOF.

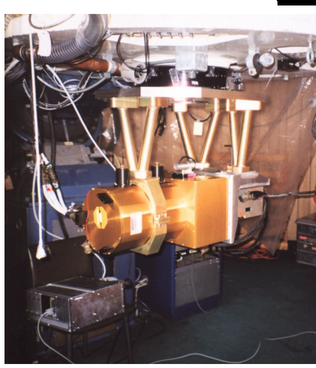
Equipped with wide-field imaging and low resolution spectroscopic modes, MIRSI is uniquely suited to studies of:

- Planetary and Protoplanetary Nebulae
- Young Stellar Objects
- HII Region/Molecular Cloud Complexes
- Starburst and Active Galaxies
- Vega-like Stars & Origins of Solar Systems
- Solar System Objects

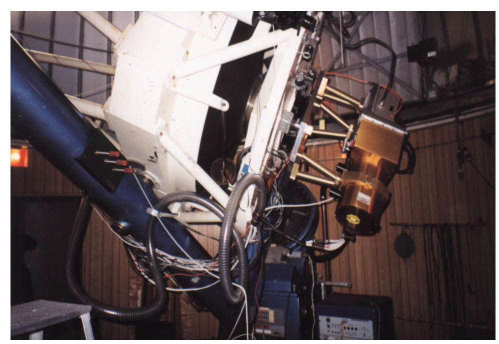
MIRSI is a mid-infrared camera system recently completed at Boston University. This system offers the unique ability to acquire both spectra and high-spatial resolution, multi-wavelength images of an astrophysical source.

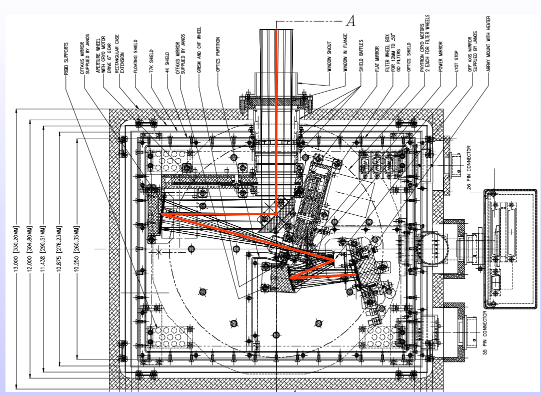
Camera Characteristics	
Spectral Range	2 - 28 µm
Pixel Scale (at IRTF)	0.3 arcsec/pixel
Field of View (at IRTF)	96 x 72 arcsec
Spectroscopic Resolution	100-200
Estimated NEFD at 10 µm	3.4×10^{-3} Jy/Hz$^{1/2}$
Estimated NEFD at 20 µm	7.5×10^{-3} Jy/Hz$^{1/2}$
Optics	Reflective
Detector	Si:As IBC
Number of pixels	320 x 240
Well depth	>= 3×10^{7} e-
Peak QE	> 40%
Readout Channels	16
Readout Time	15 msec

- **Large field of view: 1.6x1.2 arcmin at the IRTF**
- **Diffraction limited imaging: 0.8" at 10 µm at the IRTF**
- **Spectral coverage from 2-26 µm**
- **Detect spectral features using 10 and 20 µm grisms with resolutions of 200 and 100**
- **Discrete filters to map spectral features**
- **High sensitivity: expected 1-sigma sensitivities of 5 and 20 mJy at 10 and 20 µm, respectively, for 30s on-source at the IRTF**
- **Efficient, high throughput optics**
- **Quick selection of observing modes**
- **Real-time data reduction and quick-look capability**
- **Accessible to the community**



MIRSI attaches directly to the telescope at the Cassegrain focus in order to eliminate intermediate, warm optics from the optical path. The photo at left shows MIRSI mounted on the 60-inch MLOF. During MIRSI's first light, the 60-inch MLOF was tipped 60 degrees from zenith while taking sky flats (right)





Top view of MIRSI's optical design. The red line traces a beam in the optical path.

Optical Design

MIRSI has an upward-looking dewar. An entrance aperture wheel is used to select between spectroscopic and imaging mode. After passing through the KRS-5 window and aperture wheel, the beam reflects off a folding flat and an off-axis parabolic collimator mirror and is directed toward the pupil stop. The filter wheel nearest to the pupil holds the CVF and grisms, while the other holds discrete filters. After passing through the filter wheels, the beam is reflected from the two off-axis aspheric camera mirrors and on to the detector. The all reflective design leads to a system that is achromatic over the full 2-28 µm range of the detector sensitivity.

Filters	
λ	Δλ/λ
7.9-14.5 µm CVF	~5%
4.9 µm	20%
7.8 µm	10%
8.7 µm	10%
9.8 µm	10%
10.3 µm	10%
N-band 10.4 µm	47%
11.6 µm	10%
12.28 µm H_2	1%
12.28 µm H_2-cont.	1%
12.5 µm	10%
18.5 µm	7%
19.0 µm	26%
20.9 µm	42%
24.5 µm	5%

Grisms		
λ	λ/Δλ	slit width
8-14 µm	200	0.6"
17-26 µm	100	1.2"

Acknowledgements: Funding for MIRSI is provided by the NSF and Boston University. We would also like to thank the MLOF and the University of Minnesota for use of the 60-inch telescope with special thanks to Dr. Terry Jones and Jim Lyke of UMN.

9 January 2002