MIRSI Call for Proposals 2022B

What is Offered

Discrete Filters: The discrete filters in the discrete filter wheel are available for use. The ZnSe window preclude using the filters at wavelengths > 18 microns on anything but exceptionally bright targets (i.e. we saw the Moon, but Jupiter was undetected).

Discrete Filter Wheel						
Position	**Center wavelength (microns)**	**Bandwidth (%)**	**Transmission (%)**	**Short Wavelength (microns)**	**Long Wavelength (microns)**	**Comment**
0 (home)	8.9	8.9	80	8.5	9.3	
1	BaF blocker					
2	CaF blocker					
3	4.9	20.9	70	4.45	5.45	M-band
4	7.9	9.0	65	7.6	8.3	
5	9.8	9.4	58	9.3	10.25	
6	11.9	9.9	60	11.3	12.5	
7	12.3	9.4	65	11.95	13.1	
8	10.6	45.8	65	8.5	13.0	N-band
9	12.28	1.5	65	12.17	12.36	
10	18.4	1.9	19	17.8	18.15	
11	20.6	37.4	55	16.8	>25	Q-band
12	2.2	18.2	70	2.0	2.4	K-band
13	17.5	2.3	25	17.3	17.7	
14	16.8	2.1	34	16.7	17.05	
Transmission: Peak transmission based on FTS scan in 2018						
Short and Long wavelengths: 50% of peak transmission, based on FTS scan in 2018						

MOC (MIRSI Optical Camera): MOC will be available for 2022B. MOC is a clone of MORIS that is co-mounted on MIRSI. It is fed by a dichroic, so that the IR beam is reflected into MIRSI while the visible beam is transmitted to MOC. Thus, MIRSI and MOC can be used simultaneously. MOC is intended to be used as a visible light guider for MIRSI, and also for visible light photometry.

MOC enables **'blind' image stacking of MIRSI** images (where the target is too faint to be seen in individual MIRSI images). "Blind' stacking of MIRSI images using MOC has been successfully demonstrated, and has been used for science several times. Since MOC is a clone of MORIS, the sensitivity is similar.

Scheduling: MIRSI can be used at any time during the semester, day or night. MIRSI can be swapped for SpeX or iSHELL within a half-hour during the night. Observing time on MIRSI can be requested in blocks as short as 1 hour.

What Is Not Being Offered

Chopping: Chopping is not offered with MIRSI, and MIRSI will be used with the non-chopping 'hexapod' secondary mirror.

Spectroscopy: We have not yet tested the grisms in MIRSI, and so spectroscopy is not offered in 2022A.

CVF: We have not yet tested the CVF in MIRSI, and so the CVF is not offered in 2022A.

Sensitivity

Most of the measurements mentioned here were done during science observations and engineering time during semester 2022A, mostly on Alpha Tau.

Filter	Jy/ADU	Coadds	ITIME	per pixel 1 sigma 10 min (mJy)	point source (1 sigma 10 min, mJy)
2.2	0.63925	100	0.005	42.1	214
4.9	0.19871	100	0.005	20.6	107
7.7	0.20587	50	0.007	89.2	556
8.7	0.1381	50	0.005	33.2	222
9.8	0.09425	50	0.007	31.0	224
10.57	0.02542	100	0.005	4.6	35
11.7	0.03363	50	0.015	10.1	84
12.28	0.26359	100	0.01	28.2	242
12.5	0.0352	50	0.015	16.2	141
Q0	0.87503	500	0.06	473.0	5310
Q1	0.64478	500	0.06	376.0	4385
Q2	0.88396	500	0.06	558.9	6637
20.7	0.77818	200	0.005	98.4	1331

Table 2: Sensitivity and S/N compiled by Joe Hora. The 1 sigma pixel and point source sensitivities (last two columns) are for 10 minutes clock time, and include all readout and telescope offset overheads.

Targets should be visible in a single A-B pair to enable alignment and stacking, thus this sets a limiting flux for MIRSI targets. As a rule of thumb, the faintest star that we have been able to detect in a single A-B pair is about 1 Jy. On 109 Virginis (1.3 Jy), 1000 coadds of 10 ms exposures yields S/N~4. **Figure 1** shows that the sky noise decreases more slowly than sqrt(coadds), but rather the sky noise decreases as coadds^-0.35.

By aligning and adding dithered images, we were able to further decrease the sky noise. When aligning and adding dithered images, the sky noise seems to go down with the square root of the number of images added.

Overheads

From the observations of a faint standard star (109 Virginis mentioned above), we estimate that the observing efficiency is about 25%. It took 22 minutes to collect 6 minutes of integration time, using dithering, A-B nodding, a 10 ms exposure time and 1000 coadds. All dither/nod positions were with the star on chip. If a program requires off-chip nodding, then the observing efficiency will be proportionally lower. Observing with different filters, and using different integration times, will also impact efficiency. Although the specific details of individual programs will affect the observing efficiency, at this time assuming 25% efficiency is a reasonable starting value. Observers can reasonably expect to need 4x more clock time than integration time to carry out an observation.

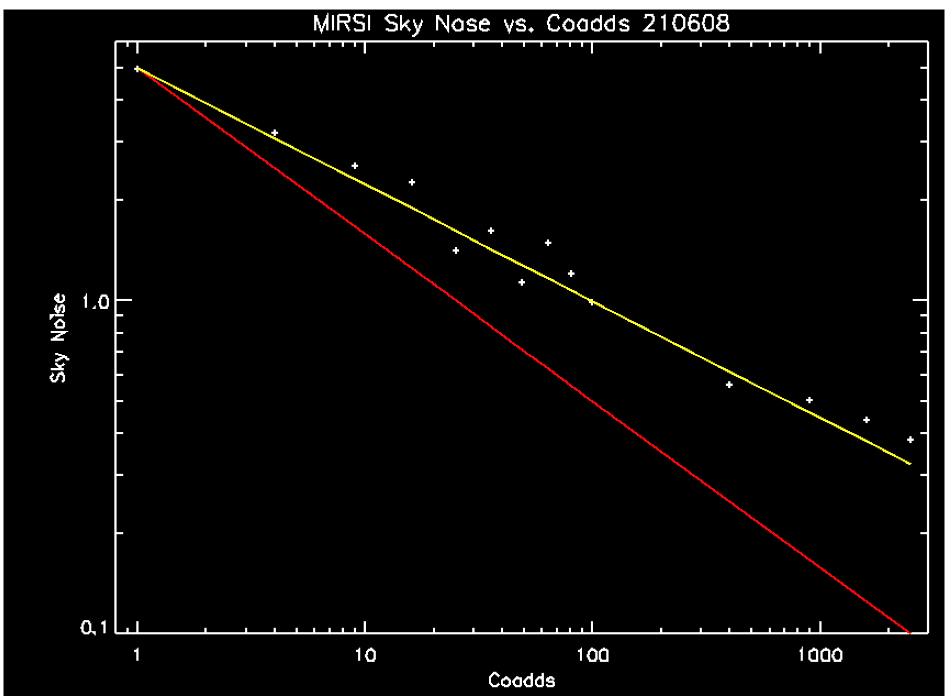

Figure 1: The sky noise decreases with coadds to -0.35 power (yellow), rather than with the square root of coadds (red).

Blind Stacking

If the MIRSI observes a target fainter than about 1 Jy, then the science target is unlikely to be detected in a single A-B pair. In this case, the observer should expect to need to blindly stack their MIRSI images. In the past, the telescope offsetting was not precise enough to allow the images to be aligned. However, with MOC guiding MIRSI, this is no longer the case. Since MOC is guiding in each of the telescope offset locations, the offsets of the images in MIRSI will be precise. Knowing your dither pattern, and the image scale of MIRSI, you can calculate the offsets to align and stack the images.

What to Do:

1. Point IRTF to your target. If it is a Solar System object, the telescope will track at the non-sidereal rate.
2. See the target in MOC, and start guiding with MOC.
3. While taking images with MIRSI and doing a dither pattern, make sure that the MOC guide box follows the telescope offsets and is guiding in each offset location.

Sample Images

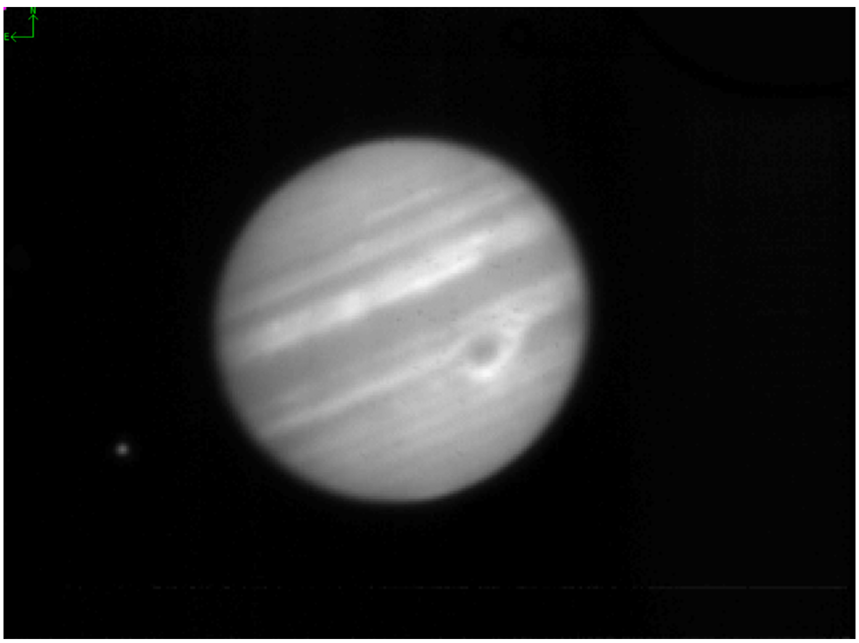

Figure 2: Stack of several images of Jupiter at N-band. Note Io to the lower left, and the GRS to the lower right.

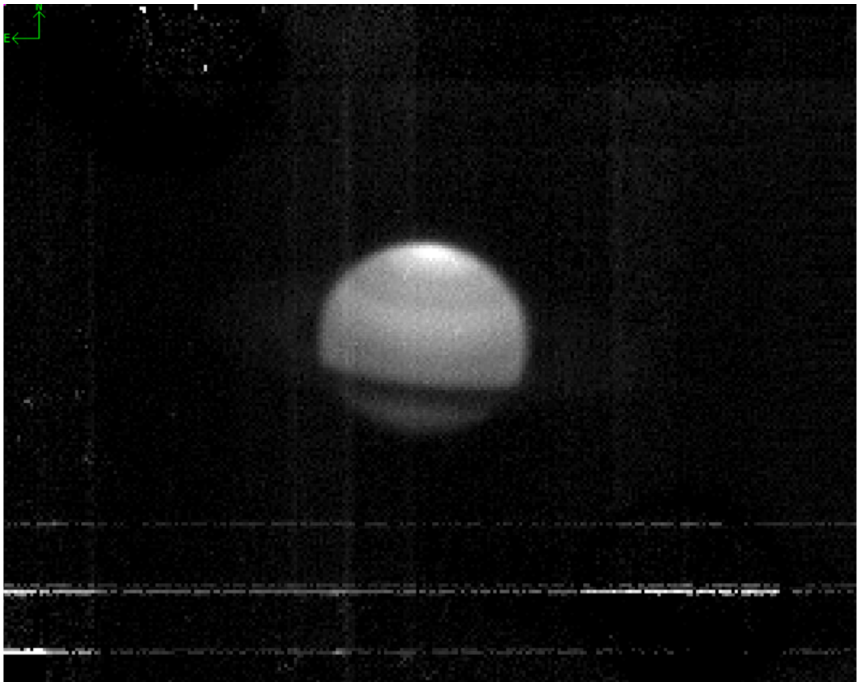

Figure 3: A stack of several images of Saturn, N-band.

Tips

1) Observe bright targets. 5 Jy sources are easily detected in an A-B pair. 1 Jy is near the limit on a clear night.
2) Dither frequently. The S/N seems to be better on the 2nd A-B pair than the first A-B pair after the array has been idle for a while. A good strategy may be to take a large set of dithered images and discard the first image or two.
3) Use enough coadds to see the object, and then align and add multiple images to further improve S/N. Increasing coadds doesn't beat down noise as fast as adding separate images, but taking separate images adds overhead for the dithering.

Questions? Please contact Mike Connelley (msc at ifa dot Hawaii dot edu)