IRMOS Performance Summary – Preliminary

Author: John W. MacKenty
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Abstract: This document describes the measured performance of IRMOS at the KPNO 4 meter telescope as of the "Last Revised" date. It also provides some basic capabilities parameters (e.g. filter and grating set). Clearly, the internal backgrounds are higher than desired and we are working to lower these. Also, there is some room for optimization of the detector operating temperature that may change the zero points.

1. Instrument Zero Point (in DN/S for a zero magnitude A0 star)
   J = 3.86E8, H = 4.90E8, K=4.49E8

   Notes: (a) gain value is between 5.5 and 6.0 electrons per DN.
   (b) Star measured was UKIRT FS123
   (c) The IRMOS PSF has significant wings, using 0.5 of this value for a "core" flux is probably appropriate.

2. Observed Backgrounds (in DN/S/pixel on blank sky)

	J	H	K1	K
DMD ON	11	45	44	142.7
DMD OFF	3	3.1	5.2	31.2
Sky Mag/sq arc second	15.7	14.2	14.2	13.0

There is a diffuse background (worse on the East side but a fix for that is understood) of approximately 3 DN/S/pixel. In the K band, we also see thermal emission directly from the DMD and are planning experiments to validate operating the DMD at a somewhat lower temperature. At the North and South sides of the DMD (i.e. along the dispersion direction), the background appears to be about 2 to 3 DN/s. This level is equivalent to the background observed in J 1000 spectroscopic mode.

We are taking steps to improve this situation and hope to reduce the backgrounds to at least < 1 DN/s/pixel in the near term and to demonstrate this during the upcoming April T&E run.

Note that the sky magnitudes compare favorably to the FLAMINGOS values at the 4m telescope (J=15.7, H=13.9, Ks=13.1, K=12.9). Admittedly, our K1 is significantly narrower than the FLAMINGOS Ks filter.

3. Detector Noise

The readnoise appears to be in the neighborhood of 3 DN (corresponding to ~15-18 electrons) for a CDS (Fowler 1) measurement.

4. Image Parameters

The plate scale is 0.2 arc seconds per pixel at the 4 meter (f/15 beam). Typically good seeing FWHM appears to be 4-5 pixels. The PSF has significant wings. Approximately 50% of the energy is in a 5 pixel diameter circle. The image quality between the DMD and the Detector (slit image) is <4 pixels for a 3 mirror wide slit.

The 848x600 micro-mirror array (DMD) provides a 170 x 120 arc second field of view on the KPNO 4 meter telescope. The detector and DMD have some geometric distortion but have the same plate scale to <10%.

5. Available Filters

IRMOS provides filters for Z, J, H, and K with half-band filters also available for JHK to support the R~3000 spectroscopy (otherwise the spectra are too long to fit on the detector). In band transmissions of are typically 90-100% except between 2200 and 2270 nm where they lie between 80 and 90%. Filter half-power points are:

Filter	Blue 50% Point	Red 50% Point
Z	847 nm	1142 nm
J	1131	1339
J blue	1125	1258
J red	1216	1348
H	1431	1803
H blue	1457	1609
H red	1589	1823
K	1909	2456
K blue	1909	2200
K red	2119	2460

6. Available Gratings

Dispersions are based on the assumption of a 3 mirror wide (0.6 arc second) slit. Under less favorable seeing conditions, the slit widths may be increased to improve throughput at the expense of spectral resolution.

Band	Dispersion ($\lambda/d\lambda$)	Spectrum Length
J 300	188	
H 300	246	
K 300	327	
Z 1000	1063	

J 1000	1035	
H 1000	1047	
K 1000	1183	
J 3000 blue	3145	
J 3000 red	3456	
H 3000 blue	2631	
H 3000 red	2992	
K 3000 blue	3315	
K 3000 red	3090	

Note: the R~3000 grating produce spectra too long to fit on the detector over a significant part of the DMD (i.e. the full 3x2 arc minute field of view does not provide full spectral coverage at the highest resolution). Approximately 3x1 arc minutes are available if spectral features of interest lie at the ends of the bandpasses.

7. DMD Point Source Contrast

As noted in section 2, the background suppression is currently limited by internal stray light and, at the longer wavelengths, by thermal emission from the DMD.

Contrast measurements of point sources demonstrate that the DMD meets or exceeds our expectations. We obtain an ON versus OFF contrast of ~400.

We have had good success with an observing strategy of alternating exposures between the slit mask and the DMD mirrors in the ALL_OFF configuration. Although this increases the observing time, it is quite effective in removing the instrumental backgrounds and the residual "print through" of any very bright sources in the field.

8. Observing Modes

IRMOS presently supports a "point and click" observing mode. An image of the field of interest is obtained (in any filter) and the observer selects objects for spectroscopy with the computer mouse. The dimensions of the slit are fully definable. Tools to edit the resulting slit mask and to image it (normally inverted) on the target field are provided. We have been able to define, edit, and check alignment of masks with 10-20 slits in typically less than 10 minutes.

We are also experimenting with an integral field mode using Hadamard transforms. Field of 170" x (30-60") are available with synthetic slit widths of 5-7 pixels. Tools to reduce such data are in a very experimental stage but the facilities to automate the data acquisition are operational.

A general scripting capability to automate sequences of IRMOS observations is under development and should ease the effort of obtaining calibrations. Extension of this capability to include telescope offsets is planned for Fall 2006 but not assured.