

FLAMINGOS at the MMT

A User's Guide

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I. FLAMINGOS+MMT Overview

FLAMINGOS is the *FLorida Multi-object Imaging Near-ir Grism Observational Spectrometer*. This manual attempts to provide the user with a good portion of the tools needed to successfully take data with FLAMINGOS at the MMT. A knowledge of basic unix commands is assumed.

FLAMINGOS is comprised of 2 cryogenic dewars. The Mos dewar, closest to the telescope backplane contains a wheel which can position one of 11 different slit plates into the cassegrain focal plane. The Camera dewar, immediately following the Mos dewar contains all of the powered optics, filters, stops, grisms, and the detector array.

Array: Hawaii II 2048x2048 HgCdTe science grade array, divided into four quadrants with 8 amplifiers each (32 amplifiers for the whole array).

Linearity: Using a bias voltage of 1.0V, the array is
 0.5% non-linear at 25,000 counts
 2% non-linear at 35,000 counts
 >3% non-linear at 40,000 counts

Plate Scale and Field of View:

0.169"/pixel
 5.76 arcminute FOV

Detector Characteristics:

Bias Voltage (Volts)	1.0	0.75
Full Well (ADU)	~50,000	~38,000
Target Count level (ADU)	25,000 – 35,000	25,000 – 30,000
Read Noise (e)	50	50.0
Gain (e / ADU)	~4.9	~4.5

Filters: J, H, K, Ks, JH, and HK bandpass filters.

Grisms: JH, and HK bandpass coverage. The HK-grism may be used with the HK-filter to obtain H and K band spectra in first order, or it may be used with the JH-filter to obtain H-band in first order, and J-band in second order.

Long Slits: 2, 3, 6, 9, 12, and 20-pixel slits are available; the 3 and 6 pixel slits cover much of the chip. All of the long slits are located on the Mos wheel.

Resolving Powers for 3 pixel slit:		
<i>Filter Combination</i>	<i>Band</i>	<i>R</i>
JH-bandpass + JH-grism	J	960
	H	1250
HK-bandpass + HK-grism	H	650
	K	865

Mos Plates: 11 positions are available for Mos plates; at present 1 position is occupied by a Mos-plate shaped single long slit with width of 3 pixels.

Mechanisms: The Mos dewar contains the Decker and Mos wheels; the Decker wheel contains an imaging hole, a pseudo dark, and aperture masks to baffle stray light for long slit and mos plates on the Mos wheel. The Camera dewar contains the filter, lyot, and grism wheel; the lyot wheel contains lyot stops for the KPNO 2.1-m and 4-m telescopes, and stops for the MMT and Gemini South; the grism wheel contains the two grisms, and imaging hole, and the only truly dark cold stop in the system.

Instrument Control: The MMT has two computers that the astronomer uses: *packrat* and *cfaguidr*. FLAMINGOS is operated via an rsh connection from *packrat* to *flamingos1b*, which is the FLAMINGOS control computer (*flamingos1b* is mounted on the right-hand electronics rack). All data taking commands are run from *flamingos1b*; the data taking commands are all perl scripts (.pl extension). *cfaguidr's* monitor is used for displaying several windows important for monitoring FLAMINGOS; these windows are started from *packrat*, via the xwindows sharing program X2X.

Data Storage: While you are taking data, all data will be located on *flamingos1b*.

Flamingos' data storage area is /data0/mmtguest/<UTDATE>/.

Packrat's data storage area is /packrat1/scratch/flam/<UTDATE>/.

Data Transport: Brian McLeod and I will setup *flamingos1b* such that data can be copied directly to *packrat* as it is taken; from there it may be transferred to your home institution via ftp, or written to tape. *Packrat* has a dds4 tape drive; the MMT web page claims that a DVD-RAM is available, too. Last year a DLT drive was also available.

Image Size: Each Flamingos frame is 16 MB in size! During a single night of imaging, it is possible to take 8 – 16 GB of data (500 to 1,000 images). Pay attention to disk usage, and bring many tapes for data archiving.

Unix Tips: Many of the command names are quite long. However, if you type a portion of the command and then hit the TAB key, you will be offered a list of possible completions to the command name. Similarly, the up arrow key will allow you to go up through the history stack of commands entered on the command line.

Halting A Script: Never type Ctrl-C. It is much safer to suspend a job with **Ctrl-Z**. Then you can kill a job by typing jobs, and kill -9 %<job number>. If you are moving a wheel, please just wait for the wheel to finish motion, and the script to complete, and then try again. If you are taking an image or a sequence of images, wait until the script starts counting the number of seconds elapsed in the exposure before suspending

the script. Then run `ufstop.pl -clean -stop`, and start over. Never type `Ctrl-C` before the exposure time counter has begun.

II. Getting Started....

...at the beginning of your run (or in case of crashes):

When you arrive at the telescope, you will have to bring up the FLAMINGOS windows and initialize the system. This is a procedure that will hopefully only need to be done once at the beginning of your run, however, you may need to repeat this process during the course of your observing time if the system crashes. Taking it from the top, the startup procedure is as follows:

1. Log onto *cfaguid* and *packrat* - the login and password are usually written on a piece of paper taped inside of the desk drawer on the right, where the astronomer sits.
 - The *cfaguid* login should automatically start a program called *mountdisplay*, which starts a window titled *MMTO Status*; this shows where the telescope is presently pointed. Another window titled *Paddle* should start as well; this may be used for offsetting the telescope, however *flamingos1b* has a set of scripts for doing this.
 - The *packrat* login should start an *xgterm* titled *Flamingos Control*. It should also start *x2x* to *cfaguid* and set *xhost* to allow display connections from *flamingos1b*. If for some reason you cannot access the *cfaguid* monitor using the *packrat* mouse, use the *packrat* desktop pulldown titled *Restart X2X*.
2. From the *Flamingos Control* *xgterm*, *rsh* into *flamingos1b*, as *mmtguest*. The password is in the same location as for logging into *packrat*. The command is

```
flamingos packrat 1> rsh -l mmtguest flamingos1b
```

3. Open a *ds9* and an *xgterm*, and start *iraf* and start *iraf*:

```
mmtguest@flamingos1b{1} iraf.start.mmt.sh
```

ds9 should start on the right-hand monitor, and an *xgterm* labeled *flamingos_iraf* should appear on the central monitor; in this *xgterm* type *cl* to start *iraf*.

4. You are now ready to initialize FLAMINGOS! This is done by running the command *mmt.initflam.pl*. This will initialize several software agents and start the following windows on *cfaguid*'s monitor (the left-hand monitor):

Temperature Daemon - This daemon reads temperatures from 5 different sensors in FLAMINGOS with the following output written to the screen:

```
UFLakeShore208Agent::ancillary
>new reading:(2002:170:05:24:06.920436) 1,75.67 2,82.05 4,76.04
5,76.67 6,82.73
```

You should always keep an eye on the array temperature (~76 K, in the example above where it says 1, 75.67) and the MOS dewar temperature (~83 K, where it says 6, 82.73 in the example above). The array

temperature should never vary by more than ~ 0.5 K and the MOS dewar temperature must remain below 200.0 for successful imaging. If you are taking spectra, the Mos dewar must be at ~ 83 K. Mechanisms inside of the Mos dewar should not be moved for about 4 hours from the time it is first cooled down from room temperature.

Record Temps window - This window logs all five temperatures every 10 minutes. It is sometimes easier to monitor the array and MOS dewar temperatures from here.

Motor Daemon - This daemon controls the motors which move all of the wheels.

MCE4 Daemon - This daemon runs the array controller, referred to as MCE4.

UFSTATUS GUI - This window displays the temperatures, the bias voltage on the array, and the positions of all of the wheels. Note that it is *NOT* updated automatically. Rather you must click the update button in the middle of the gui for the most recent values and positions. *DO NOT* press the update button while any of the wheels are moving.

During `mmt.initflam.pl` execution, you will be asked at multiple points whether you wish to continue. In general, if the correct windows are present and the daemon windows say `listening on port`, startup has been successful and you should answer *yes*. (Sometimes `initflam` will complain that agents are stalled, however, if you see the daemon in question functioning normally just answer *yes* anyway.)

Finally, you do not need to run `mmt.initflam.pl` every night; only in the case of a reboot or if one of the daemons crashes or is missing.

II. Getting Started....

...at the beginning of each night:

Unless some of the daemons have crashed or hung, it is not necessary to run `mmt.initflam.pl` every night. The following is a list of things you do need to do prior to each night's observing:

1. Fill Both Dewars. The telescope operator should be in charge of filling the dewars with liquid nitrogen. Although the telescope operator is in charge of this at the MMT, guest observers do this at the KPNO 2.1-m. The instructions from the 2.1-m manul are presented here for completeness:

Both the main dewar (the big one on the bottom) and the MOS dewar (the little one on the top) need to be filled with liquid nitrogen at the start of the night before you can observe. *The MOS dewar needs to be filled at the end of the night, too.* Fill the main dewar first and then the MOS dewar using the following procedure:

- a) Check the pressure and fill gauges on the big storage dewar. The pressure should be ~20 psi and the tank should be more than 1/3 full. If this is not the case, have someone refill the tank before it gets too low. Also, note that you should give the tank a shake prior to reading the fill level as the gauges can get stuck.
- b) Un-velcro or pull out the fill line of your desired dewar and connect it to the storage dewar so that it is "finger tight".
- c) Open the valve on the storage dewar SLIGHTLY and let the line cool. At this point, you should hear a "whooshing" from the dewar you are filling and see some initial boil-off.
- d) When the "whooshing" stops and/or the line freezes, open the valve the rest of the way and let the dewar fill. The dewar is full when liquid is vigorously pouring out of the vent (a few drops does not a full dewar make!).

CAUTION: The vent of the Mos dewar is about face-level in height. Do not stand close enough to the vent such that liquid nitrogen can splash you in the face!

- e) Using the polar gloves on the work table (and a crescent wrench if necessary) unscrew the fill line from the tank and tie it back down in between the dewars and the electronics rack. NEVER unscrew the fill lines from FLAMINGOS. ALWAYS leave them attached and securely tied down.

NEVER let nitrogen drip on any of the cables on the electronics racks!

The end of the hose where it attaches to the Mos dewar may need to be tightened-do so very carefully by hand, until it is just snug so that it does not drip liquid nitrogen when filling the dewar.

2. Create a data directory for the night. Each night's data should be stored in a separate directory. In any *flamingos1b* window, `cd` into `/data0/mmtguest/`. Create a directory with the UT date in the format `YYYYMMDD` (e.g. `2002dec12`). Note that you should always check the disk space using the `df -k`

command and check the usage of `/export/home0/`; if it is getting full, start taping!

4. Set up header information, data location, file names: Once you have created a data directory, you need to tell the computer where it is.

```
mmtguest@flam-4m-1b{17} config.exposure.pl
```

The script will then prompt you for the desired information. Make sure you change the date, data directory, and file name! Weather info is usually a good thing as well.

You are now ready to start observing!

III. Imaging with FLAMINGOS

FLAMINGOS is set up so that all data taking is run from the command line of `flamingos1b` using a set of perl scripts¹. In the following sections, the scripts useful for taking imaging data are discussed.

A. Wheel set-up for Imaging:

FLAMINGOS has five wheels in its optical path, each containing various filters, pupil masks, and spectroscopic slits. In imaging mode the following configuration should be in place:

Decker Wheel (motor a) should be set to *imaging*
 MOS Wheel (motor b) should be set to *imaging*
 Filter Wheel (motor c) should be set to one of the following bandpass filters: *J, H, K, Ks, JH, HK*.
 Lyot Wheel (motor d) should be set to *mmt*²
 Grism Wheel (motor e) should be set to *open1*

For general purposes, observers can ignore the lyot wheel as it should already have been configured during engineering time. However, during the first pointing check on a very bright star ($V = 2$) of the evening, it is advisable to take an image of the star way out of focus, to verify that the stop has not moved, and that the mirror covers and dome are open and positioned properly. You should see a bright donut, with shadows for the secondary and the spider vanes.

The remaining wheels positions will need to be adjusted. This is done using the wheel configuration commands:

`config.mos.wheel.pl` - Allows selection of the MOS wheel position.
`config.filter.grism.decker.wheels.pl` - Allows selection of the position of the decker, filter, and grism wheels. Note if you are unsure where the wheels are, you can hit update on the UFSTATUS GUI and it will tell you.

B. Configuring an Exposure:

In order to set up an exposure, run the `config.exposure.pl` command. This allows you to set up the following observing parameters³:

OBS_TYPE - Type of observation being taken (e.g. object, standard, flat, dark, etc.).
 OBJECT - Name of object being observed.
 FILEBASE - Prefix of image file. Naming convention is `<filebase>####.fits` where the numbers are automatically incremented by the data taking script.
 ORIG_DIR - Absolute pathname of the directory to which you wish to write data.
 Make sure you include the trailing `/` on the pathname.

1 Located in `/usr/local/flamingos/`, in the directories `perl_all_tel/`, `perl_mmt/`, `flamingos.headers.lut/`, and `flamingos_modules/`.

2 If the power to the motor controller has been cycled, the gui will claim that the lyot wheel is at Hartmann1. The lyot wheel should have been set during the first engineering night of Flamignos' run, and should not need to be adjusted.

3 There are several other parameters that should not be changed: `USE_MST = 1` and `MSTBREAK = 60`.

DATE_OBS - UT date at the end of the night (YYYY-MM-DD)
 EXP_TIME - Exposure time for integration. Must be an integer ≥ 3 seconds.
 NREADS - Number of non-destructive reads per endpoint (currently must equal 1)

 WEATHER - Sky conditions (1=photometric, 2=thin cirrus, 3=broken clouds,
 4=overcast, 5=snowing, 6=fog).
 WIND - Wind conditions (1=calm, 2=low, 3=moderate, 4=high, 5=closed).

In addition, after prompting you for all of these parameters, `config.exposure.pl` will ask if you want to change the bias. In imaging mode, the bias should always be set to 1.0 V!

If you wish to change just the exposure time, or just the filename and don't want to run through the entire list of parameters, you can use the following commands:

`set.exposuretime.pl` - Allows adjustment of integration time and number of reads.
`set.filename.pl` - Allows adjustment of the filebase and directory only.
`set.bias.pl` - Allows adjustment of the bias only. Type `i` for imaging, `s` for spectroscopy.

C. Taking Images at a Single Pointing

`singleimage.pl` - Take a single image at the current pointing, with the current configuration.
`more.singleimages.pl <n>` - Take `n` images at the current pointing, with the current configuration, and stepping the image number. This comes in very handy when taking darks!

D. Taking Dithered Images

FLAMINGOS also has the ability to take a sequence of images using a set of pre-determined dither patterns. In order to configure the dither pattern, run `config.dither.mmt.pl`. This allows you to change the following parameters:

DPATTERN The desired dither pattern. Your choices are 2x2, 3x3, 4x4, 5x5, 5point+, 5pointx
 D_SCALE Additional scale factor for the offsets. The default of `D_SCALE = 1` will add a border to your images of 10 arcseconds, or a total width of 20 arcseconds to the total field of view of the final stacked image.
 D_RPTPOS Number of times to repeat each dither position.
 D_RTPAT Number of times to repeat the entire dither pattern.
 STARTPOS Starting position in the dither pattern (0=first position). This is very useful if the system crashes or hangs mid-sequence.
 USENUDGE Nudge pointing center on pattern repeats.
 NUDGESIZE Radial size of nudge, randomly chosen in one of the cardinal directions.
 THROW Radial length to other nod beam, for on-source / off-source imaging.
 THROW_PA PA of other beam for nodding.

E. Offsetting the Telescope from Flamingos1b

At certain times (such as pointing checks or adjusting the position of your sources on the detector) you may wish to offset the telescope directly from *flamingos1b* rather than having your operator do it. In this case, the following commands may prove to be useful:

`absolute.offset.mmt.pl <Dx> <Dy>` - Allows manual *absolute* offsets (e.g., an fixed offset with respect to the present target's catalog coordinates) of the telescope by the observer. Repeating this command will not move the telescope.

`relative.offset.mmt.pl <Dx> <Dy>` - Allows manual offsets of the telescope by the observer relative to wherever the telescope presently is pointed.

Notes:

- 1) The offsets for each of these commands is in arcseconds.
- 2) Both of these commands offset the telescope in *instrument* coordinates, *i.e.*, along the detector's x and y axes, and not in α , δ .
- 3) These commands are only used if you are ***not guiding***. There are different commands which are used for spectroscopy when guiding.

IV. Taking Spectra with FLAMINGOS

Flamingos may be used for obtaining long slit or multi-object slit spectra; please see the overview section for resolving powers within selected passbands. This section sketches out the sequence of commands required to align a long slit or mos plate, and describes some of the calibration data typically taken. The following list of commands is used for alignment of both long slits and mos plates:

On the flamingos command line:

<code>config.exposure.pl</code>	Setup the filename and exposure time.
<code>config.filter.grism.decker.wheels.pl</code>	Use to insert filter and grism and appropriate baffle.
<code>config.mos.wheel.pl</code>	Use to insert long slit or mos plate
<code>config.mos.dither.mmt.pl</code>	Setup the spectroscopy ABBA parameters
<code>dither.mos.mmt.pl</code>	Take the spectroscopy ABBA data
<code>guided.relative.offset.mmt.pl</code>	Use for offsetting the telescope while guiding.
<code>set.bias.pl</code>	Use to change bias for imaging or spectroscopy.
<code>tweak.decker.pl</code>	Allows adjustments to the decker wheel position.
<code>tweak.mos.pl</code>	Allows adjustments to the mos wheel position.

At the iraf cl prompt:

<code>imexam</code>	Measure slit profiles and stellar centers (keys: <i>a</i> , <i>x</i> , <i>g</i> , <i>i</i>)
<code>xbox</code>	Use to align a mosplate (keys: <i>q</i> , <i>f</i> , <i>g</i>)

A. Long slit Alignment

1. Acquire target on Flamingos. If necessary, adjust telescope pointing with `relative.offset.mmt.pl` until target is positioned at the center of the array.
2. Have the telescope operator acquire a guide star, and begin guiding.
3. Have the telescope operator adjust focus; the guide camera should be confocal with Flamingos and should give a good starting focus. Take another image with Flamingos, to see if the focus still needs a tweak.
4. Measure the object's centroid with `imexam`.
5. Insert decker long-slit baffle using `config.filter.grism.decker.wheels.pl`.
 - Verify slit is straight along the chip (small *dx* for a large *dy*). Use `imexam` and *j* to fit a gaussian to a cross-cut through the slit at two different *y*-values. You may need to `epar jimexam`, and modify the fitted sigma, since this slit is very wide.
 - If necessary, straighten the decker slit using `tweak.decker.pl`.
6. Now insert slit using `config.mos.wheel.pl`.
 - Verify slit is straight; don't forget to reset `jimexam` if you modified any parameters earlier when inserting the decker.
 - Measure x-location of slit.
7. Use `guided.relative.offset.mmt.pl` to move the star onto the slit. You may need to iterate with this step, and peak up the flux from the object through the slit.
8. Once aligned, insert filter and grism combination with `config.filter.grism.decker.wheels.pl`.
9. Verify bias is set to 0.75 V for spectroscopy.
10. Configure filename and exposure time.

B. Mosplate Alignment

1. Load the mask design image and region file into buffer 3 of *ds9*. Flip and rotate until the image's WCS matches that of a raw Flamingos frame. Turn on tiling, with a vertical orientation.
2. Acquire target on Flamingos and attempt to visually pick out the alignment targets (stars or galaxies). If necessary, adjust telescope pointing with *relative.offset.mmt.pl* until the targets are within the central region of the array. If targets are faint, may need to offset a small amount and work on a difference image.
3. Have the telescope operator acquire a guide star and start guiding.
4. Have the telescope operator adjust focus on the guide camera, then check focus on Flamingos and tweak if necessary.
5. Insert the decker mos baffle using *config.filter.grism.decker.wheels.pl*.
6. Verify the decker is straight (see the section on aligning a long slit); use *tweak.decker.pl* if necessary.
7. Measure the star centroids and write them to a stars file for *xbox*:
 - `imexam logf=stars keep+`
 - Type `a` on each star
8. Insert mosplate using *config.mos.wheel.pl*
9. Check the plate is straight on the array with by stretching the display to see the plate frames. If necessary, use *tweak.mos.pl*.
10. Measure the box centers and write them to a box file for *xbox*: Measure the boxes in the same order as you measured the stars.
 - `imexam logf=box1 keep+`
 - type `e` to generate a contour map
 - type `g` to get the graphics cursor
 - center the cursor on the box and type `x`
 - type `i` to return the image, and repeat this process for the other boxes.
 - If you cannot see the box well in the contour plot, consider starting over after setting the upper contour limit threshold to $\sim 5,000$ ADU (*epar eimexam*).
10. *epar xbox*, and run it on the mask image; set the box and star file parameters to your imexam filenames, then type *go*.
11. Type `q` to step through each of the boxes in the graphics window. If the box center is not clearly detected, use the `f` key to force the center, and `g` to force the signal threshold.
12. After the last box it will tell you how much to rotate the mos wheel and offset the telescope.
 - Use *guided.relative.offset.mmt.pl* to offset in instrument coordinates.
 - Have the telescope operator increment the instrument position angle by the suggested rotational motion; do not tweak the mos unless *xbox* is using the mos wheel's center of rotation for calculations.
13. Take another image. At this point you should have stars in boxes.
14. If you have rotated the mos wheel with respect to the detector, remeasure the boxes with imexam and make a new box file.
15. Run *xbox* on the latest image, with **no** star file. After several iterations of offsetting and rotating the telescope and taking images the mos plate should be aligned.

Note: if the alignment stars are faint, you may need to run *xbox* on images with some of the sky flux subtracted. To do this take an image with no stars in boxes; scale this image by 0.8 (use *imarith*) and then subtract the scaled image from the newest image; run *xbox* on the difference image.

C. Calibrations

There are two types of calibrations required for long slit and mos spectra: wavelength calibration and flat fields. These measurements need to be made after the instrument is fully configured, and before you change the configuration (do not move any wheels until you've taken these data!). If the telescope stays focused and collimated for several hours, then it's probably good to take flat field images at the start and the end of acquiring an object's spectrum; wavelength calibrations can be taken at the start or end of the observation, but only need to be measured once per object.

- To take calibrations, guiding must be suspended while the lamps are on.
- The observer selects what lamps are on using an interface box on the table next to packrat.
- After setting the filename and exposure time, use *more.single.images.pl* to take 3 to 5 images.
- When you have finished with the calibrations and are back to guiding on the sky, take a junk image with the same exposure time that you want to use on your object. You should do this because the first image taken in low-flux conditions after being in high-flux conditions has lower counts than normal. For example, the calibrations might be taken at 30 seconds and the object taken at 300 seconds, so you need to take a junk image at 300 seconds before taking any real data.

D. Taking spectra

There are two common techniques for taking spectra: walking up the slit, and nodding the telescope back and forth between two beams *A* and *B* in a *ABBA* pattern.

Walking up the slit:

- Use *singleimage.pl* to take an image at every location.
- Use *guided.relative.offset.mmt.pl* to move the star up and down the slit while continuing to guide.

Nodding between A & B beams:

- Use *config.mos.dither.mmt.pl* to set up the distance in *arcseconds* between beams and the number of times to repeat the *ABBA* pattern. If you want, you can nudge the entire *ABBA* pattern up and down the slit by a small amount (in *arcseconds*; typically the size of one or two pixels). I think this nudging works, but we'll have to test it.
- Use *dither.mos.mmt.pl* to execute the actual dither pattern.

V. Shutting Down at the End of the Night

At the end of a long and productive (we hope!) night of observing, there is a small sequence of things that need to be done. In order, they are:

1. Move the wheels to their resting positions - Using the scripts `config.mos.wheel.pl` and `config.filter.grism.decker.wheels.pl` send the MOS wheel to *imaging*, the decker wheel to *imaging*, the filter wheel to *J*, and the grism wheel to *true_dark*.
2. Take any necessary dark frames - Now that the grism is in the dark position, you will be able to take dark frames. We recommend 10-20 darks per exposure time. Use the `set.exposuretime.pl`, `set.filename.pl`, and the `more.singleimages.pl` scripts to complete this task.
3. Fill the MOS Dewar (as long as no one is changing MOS PLATES) - Use the same procedure as you used at the beginning of the night. If someone is changing Mos plates, turn on the heater; note you should not take darks while the heater is on.
4. Begin ftping data to *packrat* if it has not already been copying in the background as you took data, and write the transferred data to tape.

VI. Troubleshooting

1) Problem: The image looks funny. You can see all 32 amplifiers, and the signal level is ~58,000 ADU.

Solution: This is a hardware problem related to electrical noise causing an early readout of the detector. In imaging mode, MCE4 reads the array once, and then lets it integrate before reading it again. The final image written to disk is the difference of these two images. This problem occurs when MCE4 spits out the image before making the second read and difference. There is nothing you can do to resolve the problem. Typically, we get bad reads for about 2-5% of the images taken. If you are getting a much higher failure rate you should call for help. You should be cautious with the image immediately following a bad read frame, because the ADU level in the image is frequently lower than it should be.

2) Problem: Excess Background

Possible solutions:

a) Image a very bright star ($V \sim 2$) at Ks-band, with the telescope way out of focus, say 2000 units lower. You should see a donut with a central obscuration and spider vanes. If it's not circular, then you could have something obscuring the beam---e.g., the dome, the mirror covers, or a mispositioned filter, lyot stop, or grism wheel.

b) Check that the ion gauge on the Granville-Phillips pressure monitor is off. When left on it casts a large amount of warm illumination on the lower right hand corner of the array.

c) Check that the Mos dewar temperature is lower than 200 K. If the temperature is not between 80 – 85 K, did you forget to fill the dewar with LN2? What about the camera dewar?

3) Various Problems related to image readout, wheel motion and iocomm communication.

The three daemons started by *initflam.pl* (temperature, motor, and MCE4) work by issuing commands to particular hardware addresses on a networked device called the *iocomm*. This device is like a multiplexer. We have three devices (the temperature monitor, the motor controller, and the array controller, MCE4) which accept commands via serial ports. The *iocomm* has one serial port connection for each device. Commands from the software daemons running on *flamingos1b* are received by the *iocomm* via an ethernet connection, and then passed to correct device.

Troubleshooting several types of problems involves deciding if the problem is intrinsic to the device, or to the communication via the *iocomm* itself.

a) Problem: The image has not read out. The exposure time counter never appears.

This is our most common failure mode. Sometimes the array controller crashes before the image acquisition script issues the START command to MCE4. For example, a successfully started image acquisition should show:

```
/usr/local/uf/bin/ufdc -host flamingos1b -port 52008 -acq "start -
timeout 9 -cnt 1 -lut /usr/
local/flamingos/flamingos.headers.lut/Flamingos.lut -fits
```

```
/usr/local/flamingos/flamingos.headers.lut/Flamingos.fitsheader -file /data0/mmtguest/Test/test -index 2"
```

If it hangs here for more than ~6 seconds, type `ufdc -q status` in another `flmn-2m-1b` window

```
ufdc> greeting: UFGemMCE4Agent -- accepted client: ufdc@flmn-2m-1b@2002:350:03:40:49.170980
2002:350:03:40:49.170980
2002:350:03:40:50.440745ufdc@flmn-2m-1b
START
```

```
GATIR *Flamingos Beta* 2.00_f.07 >>
```

```
>>>>.....TAKING AN IMAGE OR APPLYING LUT.....
(Exposure time + number of reads = 3 + 1)
Have slept 3 seconds out of an exposure time of 4 seconds
```

If you do not see the `START` command and the exposure time counter above, then MCE4 has crashed. The statement in the output above that saying to type `ufdc -q status` is a red herring, doing so will not change anything.

Solution: Reboot MCE4 and reinitialize it with `initflam.pl`. To reboot MCE4 telnet to *baytech* from *flamingos1b* with userid *mce4pow* and password *16Mb,img*. Type `reboot 1`, and wait for the prompt to return. Then type `logout`. Example output from this procedure follows:

```
mmtguest@flamingos1b{2001}telnet baytech
Trying 140.252.53.86...
Connected to baytech.
Escape character is '^]'.

```

```
RPC-3 Telnet Host
Revision F 4.20a, (C) 1999
Bay Technical Associates
Unit ID: flamingos1b
```

```
Enter username>mce4pow
Enter password>16Mb,img
Option(s) installed:
True RMS Current
Internal Temperature
```

```
True RMS current: 1.6 Amps
Maximum Detected: 1.7 Amps
```

```
Internal Temperature: 18.5 C
```

```
Circuit Breaker: On
```

Selection Number	Outlet Name	Outlet Number	Power Status
1	mce4	4	On

```
Type "Help" for a list of commands
```

```
RPC-3>reboot 1
```

```
(Now it counts down for 10 seconds before applying the power).
..RPC-3>logout
```

Now run *initflam.pl* at the *flamingos1b* prompt. You do not need to close any of the daemons to rerun *initflam.pl* for this problem. At the start *initflam.pl* will complain that the motor and mce4 daemons are not up and listening, and ask if you want to continue. You do want to continue, as the daemons were working properly before the crash of MCE4. MCE4 must be reinitialized, in order to set the proper clocking of the array. You need to set the bias for imaging or for spectroscopy (enter *i* for imaging, or *s* for spectroscopy when it prompts you). After it has successfully initialized the EDT frame grabber (where it says do you see 10 lines of text between a line saying *opening pdv unit 0* and a line saying *done*), it will ask if you want to continue. You can type *n* at this point (typing *y* will just launch another array temperature gui).

Next, you need to take two junk frames with short exposure time (e.g. 3 seconds). The first frame after repowering and initializing MCE4 is not good, and taking a second frame makes sure that it looks normal.

b) Problem: The image acquisition counts past the exposure time without reading out an image.

Solution: This problem rarely happens anymore. With our previous slower version of *flamingos1b*, it would sometimes take an extra 5 to 10 seconds to finish reordering the pixels, i.e., applying the look up table, or LUT, before it writes the image to disk. In the MCE4 daemon window you could see string of dots being printed out during the apply lut phase:

```
UFEdtDMA::applyLut> . . . . .
```

You should watch for several seconds to see if this line is present, and that it is printing additional dots. When it finishes, it should also print something similar to:

```
UFEdtDMA::takeAndStore> close mmap file:
/data0/mmtguest/Test/test.0002.fits
UFEdtDMA:::> completed: 1 -- /data0/mmtguest/Test/test.0002.fits
ufgtake> acquired frames: 1
UFEdtDMA::takeAndStore> close mmap file:
/data0/mmtguest/Test/test.0002.fits
UFEdtDMA:::> completed: 1 -- /data0/mmtguest/Test/test.0002.fits
ufgtake> acquired frames: 1
```

If this never appears, try typing *ufstop.pl -stop -clean* at a *flamingos1b* prompt. Then try taking another image; if that fails see if *ping iocomm* returns with the message that the *iocomm* is alive. If the *iocomm* is alive, try rebooting MCE4 and reinitializing. If that completely fails, call for help.

c) Problem: A large number of error messages are printed out either when trying to move a wheel (e.g., with *config.filter.grism.decker.wheels.pl*), or during the first part of an image acquisition, where it sends commands to MCE4.

Solution: It's possible that the *iocomm* has crashed, or is very confused. Try *ping iocomm* from *flamingos1b*; if there is no response, it needs rebooting. Even if there is a response, it may be advisable to

reboot it. To do this `telnet baytech`, `userid iocompow` (note there's only one *m* in this userid) password `16Mb,img`. At the prompt type `reboot 1`, and then type `logout` when the prompt returns (e.g., see the example output in 3a, above). Now you must close all three daemons (Temperature, Motor, and MCE4) and the `record_temperatures` window and run `initflam.pl`.

4) Problems when running `config.filter.grism.decker.wheels.pl` or `config.mos.wheel.pl`. The script ends by saying that the time for the wheel's motion to complete has expired.

The default algorithm for motion of the wheels is that they first go to the home position, tell the controller to zero the position, and then move to the demanded position. We refer to this as a *home-type* of *limit*, or *limit switch*. We usually run the Mos wheel in an alternative mode referred to as a *home-type* of *near-home*. In this mode the wheel moves from the present position back to somewhere close to home, and then to the demanded position.

There are two modes of failure for each wheel.

- (1) The limit switch fails to engage. If the wheel operates with a limit-switch home type, then the wheel can spin endlessly, and the perl script will just give up after some time limit. If you can stop the wheel and determine the location of the mechanism, it is possible to recover from such a failure and then use the *near-home* motion algorithm for the wheel.
- (2) The wheel binds, and a grinding noise is audible if you stand next to the dewar. If this happens there usually is no quick recovery after you have stopped the motor.

Solutions:

- A) First, you must stop the wheel that is either spinning endlessly, or is jammed.
 1. Type `ctrl-Z`, type `jobs`, `kill -9 %<jobnumber>` if the perl script has not yet finished and you already know that there is a problem.
 2. Type `ufmotor -host flamingos1b -port 52004`
 - a) At the motor prompt, type `<motor_name>@`, where `<motor_name>` is one of letters *a*, *b*, *c*, *d*, or *e*, where motor *a* = *decker*, *b* = *mos*, *c* = *filter*, *d* = *lyot*, and *e* = *grism*. This should do a *soft-stop* of the motor.
 - b) Type `exit` to quit `ufmotor`.
 3. Type `turn.off.motor.hold.current.pl` (or, alternatively, you can do this through the engineering pulldown on `ufstatus_gui`).

If this does not stop the motion of the wheel (e.g., you can hear it spinning, or grinding), the last recourse is to turn off the motor controller itself. **Note: any wheels that use near-home type and are not at home will be lost when the motor controller is powered up again. You should call for assistance if this happens.** To do cycle the power on the controller, `telnet baytech` as `motorpow`, password `16Mb,img`, and then `reboot 1`, and `logout` to exit.

B) If the failure was of the limit switch, you need to recenter the mechanism in question, and redetermine the home point. The best way to do this is to image a very bright star with the telescope out of focus by about 3000 units. The wheel probably is not well centered, so use one of the tweak scripts to adjust it. Then step the wheel by discrete positions, and measure the background. With some help you should be able to determine where you are, and use the `ufmotor` command to rezero everything.

VII. Contacts

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Appendix 1: FLAMINGOS Command Listing and Partial Description of Function

A. Basic Instrument Configuration Commands

config.exposure.pl	Sets object, filebase, orig_dir, exp_time.
config.filter.grism.decker.wheels.pl	
config.mos.wheel.pl	
initflam.pl	Starts daemons, and setup MCE4 (array controller).
set.bias.pl	Imaging use bias = 1.0 V; Spectroscopy use bias = 0.75 V.
set.exposuretime.pl	Exposure time is in integer seconds; 3 seconds is the shortest.
set.filename.pl	Set image's rootname and directory.

B. Basic Imaging Configuration and Acquisition Commands

config.dither.mmt.pl	Select dither pattern and number of repeats.
dither.source.mmt.pl	At present, only dithers on source in a square grid.
more.singleimages.pl #	Takes # of images with parameters set by config.exposure.pl.
singleimage.pl	Automatically take an image with present integration parameters.

C. Basic Spectroscopy (MOS and Long Slit) Configuration and Acquisition Commands

config.mos.dither.mmt.pl	Setup the spectroscopy ABBA parameters.
dither.mos.mmt.pl	Take the spectroscopy ABBA data.
guided.relative.offset.mmt.pl	Use for offsetting the telescope while guiding.
set.new.mos.plate.names.pl	Use when loading new Mos plates so their names are in the header.

D. Advanced Imaging and Spectroscopy Commands

config.chippa.mmt.pl	For setting the chip's PA on the sky.
config.slit.chip.pa.mmt.pl	For setting the PA of the slit wrt the chip.

E. Telescope Information and Motion Controller

absolute.offset.mmt.pl	Offset telescope wrt catalog position.
mmtops.pl -info	Request the present TCS information.
relative.offset.mmt.pl	Offset telescope wrt the present offsets.

F. Resetting the Array Controller (MCE4), the Motor Controller, and the Iocomm

- 1). Telnet baytech userid: mce4pow, motorpow, or iocompow
 password: see the cheat sheet in the drawer.
- 2). reboot 1
- 3). logout
- 4). If you rebooted the iocomm, close all daemons (the TEMPS, MOTOR, and MCE4 xterm windows), otherwise leave them open.
- 5). initflam.pl

G. Data Taping

1) *Packrat's* dds4 tape drive is /dev/rmt/0cn. Here are some common taping commands:

- flamingos packrat 28> mt -f /dev/rmt/0cn status
- flamingos packrat 29> mt -f /dev/rmt/0cn fsf #
- flamingos packrat 30> mt -f /dev/rmt/0cn rewind
- flamingos packrat 31> mt -f /dev/rmt/0cn offline
- flamingos packrat 32> tar -cvf /dev/rmt/0cn *.fits

H. Data Transfer

To use a tape device on either *packrat* you must transfer it from *flamingos1b* first. One option is to ftp the data from Flamingos to packrat. A better option is to run on *packrat* the program *autocopy* to copy each image from Flamingos to *packrat* as you take data.

1. Transfer using ftp:

- ftp flamingos1b
- Set binary mode, turn off the prompt, and grab all fits files: bin;prompt;mget *fits

2. Transfer using autocopy:

- At start of night make a data directory on flamingos and packrat with the same name, e.g.
mmtguest@flamingos1b{3} mkdir 2003feb12
flamingos packrat 33> mkdir 2003feb12
- Make the flamingos data directory world writable, e.g.
mmtguest@flamingos1b{3} chmod a+w 2003feb12
- From the flamingos home directory on packrat, run autocopy. For example:
flamingos packrat 34> cd; autocopy
At the prompt type the data directory name, e.g. 2003feb12. After you have taken a few frames, you should see the data being transferred to packrat.

I. Instrument Engineering Commands

center.of.rotation.pl	Determine the center of rotation from 3 points.
config.location.pl	Copies the correct Flamingos.fitsheader for a telescope.
engineering.config.home.type.wheels.pl	Sets Limit Switch or Near Home wheel motion.
engineering.config.output.pl	Various settings (unlock file, talk to TCS, png image, etc.).
engineering.ct10.singleimage.pl	Output the first read of a CDS read.
engineering.ct12.singleimage.pl	Output the first set in a multiple read.
engineering.set.lyot.wheel.pl	Moves Lyot wheel for each telescope.
engineering.soft.stop.mos.wheel.pl	Sends and escape character to the Mos wheel controller.
engineering.tweak.filter.wheel.pl	Allows adjustments to the filter wheel position.
engineering.tweak.grism.wheel.pl	Allows adjustments to the grism wheel position.
engineering.tweak.lyot.wheel.pl	Allows adjustments to the lyot wheel position.
readFITheader.pl -f /usr/local/flamingos.headers.lut/Flamingos.fitsheader	Prints out the present fitsheader template file for the next image.
turn.off.motor.hold.current.pl	Sends command to filter, lyot and grism wheel controllers.
tweak.decker.pl	Allows adjustments to the decker wheel position.

tweak.mos.pl
ufidle.pl
ufstop.pl -clean
 -stop

Allows adjustments to the mos wheel position.
Sets MCE4 in continuous resetting mode on the array.
Sets various semaphores in /var/tmp/
Stops the present integration.