30-inch Prime Focus Corrector (PFC)/LF1 Detector Basic User's Guide

This document covers basic configuration and use of the Prime Focus Corrector (PFC) and LF1 detector on the 30-inch telescope at McDonald Observatory.

Acknowledgements:
This document is a revision of the original "30-inch Basic User's Guide", authored by Brian Roman. Much of the content in this document has been lifted from Brian's original document and updated based on the changes related to the telescope and mount, as they relate to the differences between the Boller & Chivens mount and the new OMI mount.

The document assumes a rudimentary knowledge of the IRAF/ICE environment at McDonald Observatory, basic familiarity with McDonald operating procedures, including reporting, closure rules, equipment safety, and personnel safety procedures, and basic Unix/Linux operating system interface knowledge.

The McDonald Observatory 30-inch/0.8-meter telescope utilizes the prime-focus mounted PFC and associated LF1 detector as its instrument/detector in most cases. The PFC/LF1 are configured, controlled and operated via the McDonald IRAF/ICE environment, for this instrument/detector combination accessible via the workstation 'titan', located in the 30-inch / 0.8-meter control room.

The PFC/LF1 pair operate independently of the telescope control system (TCS) known as Talon, which is hosted on a workstation co-located in the 30-inch/0.8-meter control room, known as 'talon'.

Talon controls:

the telescope mount RA/HA and DEC axes
the telescope mirror cover the
dome rotation the dome shutter
operation
the dome automation system (synchronizes/slaves the dome slit to the telescope's pointing)

Talon does not control any of the PFC/LF1 functions, instead the IRAF/ICE environment controls:

The detector/camera shutter
The PFC focuser
The PFC filter wheel assembly
The dome flat lamp controller (near-term future)
The filter wheel home, and focuser reset mechanism (near-term future)

The telescope and PFC/LF1 are thus independent, and loosely coupled systems that can be powered up, down, and reset in isolation of one another.

The PFC/LF1 detector system is composed of the
LF1 CCD detector
a shutter assembly a five-position filter wheel assembly and
associated filters a temperature-compensated electromechanical
focusing system a series of optical elements
an integrating mount/canister system that houses the aforementioned
components supporting electronics, contained in an assembly near the Cassegrain focus of the telescope, with the dual use of forming part of the telescope counterweight system

Operation of the telescope mount and Talon are covered in the document "The 30-inch/0.8-meter Quick Start Guide" available by clicking the hyperlinked document title.

IRAF/ICE Configuration - Log in, set up account (if necessary):

On the workstation 'titan', at the username prompt, type in your username and hit return. At the password prompt, type in your password and hit return. If you have a new account with the default password, you should change to a new password. To do so, use the "passwd" command. It will prompt you for your old password as well as your new password. Remember that UNIX is case sensitive.

Type "cd ICE" to enter your ice directory. Type "mkiraf" to set up iraf. This command will create a file called login.cl and a subdirectory name uparm (short for user parameters).
Use 'vi' or 'emacs' to edit the login.cl file to show the following changes (substitute the text 'username' with your Unix user-id):

```
set     home =      "/home/titan/username/ICE/"
```

set imdir = "."
set uparm= "home$uparm/"
set userid= "username"

Uncomment and edit to change the defaults.
#set editor = vi
#set printer = lp
set stdimage = imt35 #set
stdimcur = stdimage
#set stdplot = laser
#set clobber = no
#set filewait = yes
#set cmbuflen = 1000000 #set
min_lenuserarea = 64000 set imtype
= "fits"

Add the following lines near the end of the login.cl file.

task noise = /home/titan/username/ice/noise.cl cd

/data2/titan/username

This completes the editing of the login.cl file.

Type “mkdir /data2/titan/username” and press the Return key. This creates a data directory.

Type “ximtool &”, or “ds9 &” and press the Return key, or use the right mouse button to open an ximtool window. This starts an image display window, running as a background process, for visualizing the FITS image data from the detector.

Type “cl” to start iraf. Type “icex” to load the parameter files needed to run the telescope. You must now edit some of the instrpars, detpars, obspars and telpars parameter files specifically for the 30-inch telescope. Change all lines highlighted in blue. Use “:wq” to save each edited parameter file.

ic> instrpars

I R A F

Image Reduction and Analysis Facility

PACKAGE = icex   TASK =
instrpars

```
| (instrfi=                ) filter bolt positions
  (apertur=                ) aperture
  (tvfilt =                ) tv filter
  (complam=                ) comparison lamp   (probepo=
) probe position file
  (dispers=                ) disperser
  (tiltpos=                ) tilt position
  (order  =                ) spectral order (0 = most efficient)
  (decker =                ) decker
| (instrfo=                ) instrument focus
  (posangl=                ) position angle
  (dispaxi=                ) dispersion axis
* (fts    =       U,B,V,R,I) filter translation
* (filtoff=  -700,1530,0,1400,850) filter offset values
  (polariz=                ) polarizer angle in degrees
  (instrin=                ) Optional image header info about instrument
! (instrca=  runlib$instrcap) Instrument capabilities file
! (instrna=             pfc) Instrument name
  (mode   =              ql)
  ($nargs =               0)
```

```
ic> detpars
                         I R A F
              Image Reduction and Analysis Facility

  PACKAGE = icex
     TASK = detpars

! (firstco=              1) First column of data (device coordinates)
! (lastcol=           2048) Last column of data (device coordinates)
! (firstro=              1) First row of data (device coordinates)
! (lastrow=           2048) Last row of data (device coordinates)
! (colbin =              1) Column binning factor
! (rowbin =              1) Row binning factor
  (preflas=              0) Preflash time in seconds
  (gain   =              0) Instrumental gain setting (0 for default)
  (detinfo=               ) Optional image header info about detector)
! (detcap =  runlib$detcap) Detector capabilities file
! (detname=            lf1) Detector name
  (detpix =              u) Data type of detector pix (u=16-bit l=18-bit)
  (integra=              1) Detector integrator (1=slow 2=medium 3=fast)
  (amplifi=              1) Detector amplifier
  (nframes=               ) IRDetector sum/average nframes
  (angle  =              0) Detector angle from nominal
  (mode   =             ql)
  ($nargs =              0)
```

```
ic> obspars
                    I R A F
      Image Reduction and Analysis Facility

 PACKAGE = icex      TASK =
obspars

 exposure=              1. Exposure time (seconds)   imagetyp=
object  Image type
 objectti=               Object title
* (rootnam=             username) Image root name* (sequenc=                1)
  Sequence number * (setfilt=              no) Query and set filters?
 (setfocu=              no) Query and set focus?
 (setscan=              no) Query and set nscanrows? (short scan mode)
* (filtype=        instrument) Type of filters to use
* (foctype=        instrument) Type of focus to use
* nfexpo  =               7  Number of focus exposures
* shtype  =           detector  Shift type
* focmode =              auto  Focus mode
* fstart  =           @-900  Starting focus value
* fdelta  =            +300  Focus increment
* nrvrows =              20  Number of rows to reverse shift
! (pixtype=             u) Data type of IRAF pixels
* (observe=            your initials) Observers
 (comment=                ) Comments
 (comfile=               ) Observer header comments file
 (obsinfo=               ) Optional observing info for image headers
 (observa=         MCDONALD) Observatory name
* (command=       display %s 1) Post-processing command
* (prealloc=             60) Preallocate image (0=no 1=yes N=if exptime > N)
* (prepref=          imdir$_) Preallocate image prefix* (longexp=            300.)
  Long exposure time (seconds)   (verbose=              yes) Type out image name?
 (debug  =              no)
 (mode   =              ql)
 ($nargs =               0)
```

```
ic> telpars
                              I R A F
                 Image Reduction and Analysis Facility

  PACKAGE = icex      TASK =
telpars

  (dateobs=                  ) date (dd/mm/yy) of observation
  (ut     =                  ) universal time (hh:mm:ss)
  (st     =                  ) sidereal time (hh:mm:ss)
  (ra     =                  ) right ascension (hh:mm:ss)
  (dec    =                  ) declination (dd:mm:ss)
  (epoch  =                  ) epoch of ra and dec
  (ha     =                  ) hour angle (hh:mm:ss)
  (zd     =                  ) zenith distance (dd:mm:ss)
  (airmass=                  ) airmass
  (telfocu=                  ) telescope focus
  (telfilt=                  ) filter bolt positions
  (rotangl=                  ) rotation angle
  (pressur=                  ) barometer
  (teltemp=                  ) telescope temperature
  (windspe=                  ) wind speed
  (winddir=                  ) wind direction
  (humidit=                  ) humidity
  (seeing =                  ) seeing
  (pointsr=                  ) point source info
* (pointdi=                  ) optional point source directory info
* (pointty=              mean) point type header info
* (apertur=             0.762) telescope aperture size (m)
* (focalra=             2.996) telescope focal ratio
  (telinfo=                  ) Optional image header info about telescope
! (telcap =     runlib$telcap) Telescope capabilities file
! (telname=           0.8-meter) Telescope name
  (mode   =                ql)
  ($nargs =                 0)
```

1. Filling the dewar with liquid nitrogen (optional)

The PFC/LF1 detector will have been vacuum-pumped and cooled prior to the start of your observing run. It is good practice to fill, or top-off the dewar prior to the start of your observing night. It is also good practice to top-off the dewar at the end of your observing session, prior to leaving the dome.

Make sure the telescope is in the stow position, with the fork arms at an hour angle of zero, and the telescope tube pointing due South over the telescope pier (DEC angle of -35:0:0.00). This is the standard 'stow' position. If the telescope is not at 'stow', it must be moved to this position via the use of the telescope control system (TCS) known as Talon. Refer to the Talon Quick Start Guide for details on this procedure. With the telescope in the 'stow' position, depress at least one of the hard emergency stop (e-stop) buttons; there are five e-stops, one on the east and west sides of the telescope pier, one at the north side of the dome entry door, one at the south side of the control room entry door, and one in the control room on the shelf above the consoles. Depressing an e-stop will prevent the telescope from moving under power unexpectedly, which can injure you, or damage the telescope.

There should be a 50-liter dewar on the dewar lift system, immediately behind the telescope pier on the west side. It will normally be in place, raised, and correctly positioned for use. The lift platform should be approximately level with the platform ladder's top platform, opposite the dewar lift.

Insert the filler stinger into the dewar, and thread it down finger tight, by hand – do not use any other tool to tighten the filler stinger, and use care not to cross-thread the filler stinger into the dewar. Use one hand to make sure there are no kinks in the tube, while slowly opening the Liquid nitrogen flow valve lever at the 50-liter dewar. Rotate the handle about 20 degrees at first. Allow the tubing to become cold and stiff, then slowly open the handle the rest of the way. The dewar takes about 5 to 10 minutes to completely fill, depending upon its current LN2 volume, and the pressure in the 50-liter dewar (nominal 10 psi). The dewar is full when liquid nitrogen begins to significantly spit/drip from the overflow tube. Once this happens, close the nitrogen fill valve. Allow the tubing to thaw before trying to remove the filler stinger from the dewar. Once the filler stinger has been removed, replace it in the wooden holder on the 50-liter dewar. No anti-spill tube is used with this dewar. The dewar has a maximum holding time of 24 hours after being filled. Either refill the dewar at the end of your session or note in the night log a request for the F-Duty Observing Support person to fill the dewar.

The dewar will spill liquid nitrogen at Hour Angles greater than +/- 3:46:00 East or West. The worst cases for LN2 spillage exist when the tube is South of the Zenith at hour angles near the indicated limits. If you are observing low on the horizon or tracking an object that places the telescope low on the horizon, the dewar will likely begin to spill. There are two concerns if this is the case; if the dewar is spilling liquid nitrogen, do not walk under or near the PFC dewar. This can be hard to see in the dark – LN2 can produce severe skin burns, and extreme damage to eye tissue. Use caution when walking on the dome floor if the telescope is near the horizon limit. LN2 spillage also reduces the dewar holding time. If the dewar spills, it will be necessary to replenish the LN2 in the dewar sooner. You can monitor the LF1 detector temperature by viewing the temperature controller display on the PFC electronics cage – the LF1 detector temperature is displayed on the right-most card in the cage via an LCD (non-illuminated), which may require a step ladder and flashlight to view the display. It should read a nominal value of -101C. If the temperature indicator reads higher than -10C, contact a member of the Observing Support team for instructions BEFORE refilling the dewar. Do not confuse the instrument temperature display (illuminated Red LED on cage) with the LF1 detector temperature display (non-illuminated LCD display on right-most card in cage).

The PFC dewar uses activated charcoal as its getter (desiccant) mechanism. The getter is designed to outgas at temperatures above 0C. If the LF1 detector temperature reads -10C or warmer, the detector must be allowed to warm to ambient, the dewar's getter must be allowed to outgas completely, the dewar must be placed on the vacuum pump for at least 24 hours, and the dewar refilled with LN2, allowing the LF1 detector to reach -101C before observing can be re-started. Allowing the detector to warm above -10C will result in significant loss of observing time.

Once the dewar fill procedure is complete, disable the e-stop (i.e. pull out the e-stop knob to expose the yellow band) to allow the telescope's motion control system to function.

2. Dome Rotation

Using the Talon software hand-paddle, rotate the dome as required to align the open dome slit with the telescope. Avoid the use of dome-auto during pointing and initialization – there is a singularity when the telescope is near the zenith which causes the dome automation system to oscillate the dome's position.

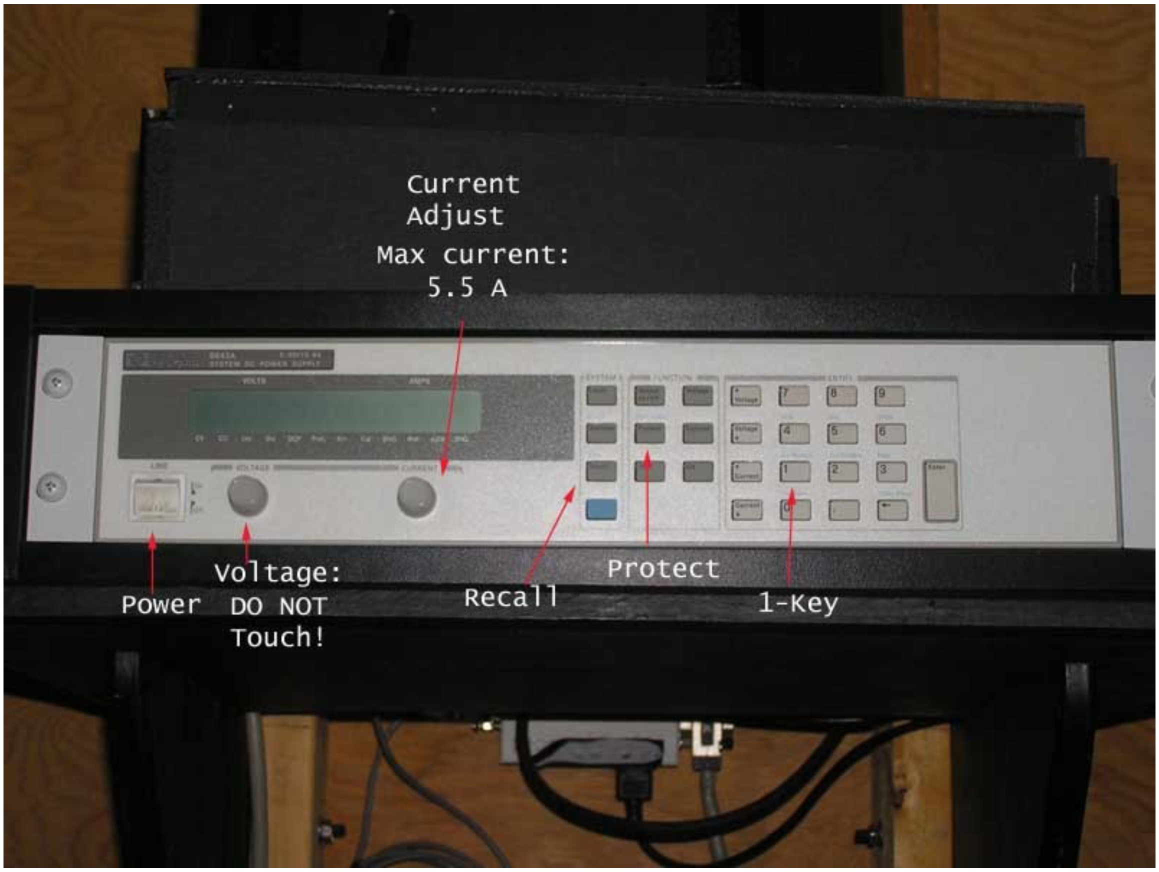
3. Open the Mirror Cover

Using the Talon software hand-paddle, select 'Cover', and click the 'Open' button on the paddle icon. This will open the primary mirror cover.

4. Flat Fielding

A series of flat field images should be taken for each filter to be used during observing. Move the telescope to the stow position of 0:00 HA and -35:00:00.0 Declination – conveniently, this is the same as the stow position, which can be commanded via a single button in the Talon Xobs interface via 'Telescope->Stow'. Rotate the dome so that the calibration screen is in line with the telescope field of view. Use the Talon software hand-paddle to set the dome azimuth to 359:47:13, which aligns the dome flat with the front of the telescope at 'stow' position.

The flat lamp is on the north dome wall. At the flat lamp amplifier, turn the power to “On” and wait about ten seconds. Press the “Recall” button, then the “1” (number one) button, then the “Enter” button. The lamp should come on with an initial current of 4.5 amps.



You should take between 9 and 10 flat field exposures for each filter you plan to use during your observing run. There is a chart on the control room bulletin board with suggested flat lamp power settings and integration times for each filter. The ideal detector ADU count is approximately 50,000 ADU or slightly higher.

If the chart is absent, this table reflects suggested starting points for flat frames:

Filter	Lamp Current	Integration Time
U	5.00	200
B	5.00	75
V	4.30	27
R	3.55	13
I	2.50	20 *

*This is a very low lamp current, and combined with the filter low throughput and must be done at dusk or dark.

Dome flats are much easier to process than sky flats, although either may be used. Within a limit, more flats are better than fewer flats.

It is also useful to create your bias frames during set-up. The standard practice is to create one bias set of 9 – 10 frames. The bias frames are 'zero second' integrations. For example, if you plan to use the full UBVRI filter set, ideally you would create a total of 50 flat frames with appropriate integration times (10 for each filter) and 10 bias frames. Keep in mind that the approximate total time required per frame is the integration time PLUS the detector read time; for this example, a single frame requires approximately 3 minutes and thirty seconds. A complete set of flats and biases would thus require approximately 205 minutes (three- and one-half hours) to acquire.

Dome flats and biases can be acquired the afternoon of, or the day after your observing run, and the time can be split across multiple days of your run. There is no requirement to complete the flat and bias integrations in a single session in sequence.

5. Open the Dome Shutters

Once the dome flats are complete, and you are in or near civil twilight, it is time to open the dome shutters.

The first step to take in preparing to open the dome shutters is that of turning off the dome floor HVAC. Located on the northwest wall of the dome, adjacent to the control room entry way you will find a thermostat control. Move the right-hand lever/switch from either cool, or heat to the 'Off'
(central) position. , then open the dome shutters using the Talon TCS. After Talon has been initialized (dome, telescope 'homed'), the dome shutters may be opened by executing the Talon GUI command Roof->Open. It takes approximately two minutes to complete the dome shutter open cycle. Do not interrupt the open cycle with any other Talon commands

6. Start Point

Running 'point' prints out the coordinates which will be used to populate the FITS image header during each exposure.

NOTE: *unlike the prior implementation of the 30-inch/0.8-meter telescope and IRAF, 'cosmo'/Point do not model the telescope and mount flexure. Currently, the flexed coordinates returned by 'cosmo'/Point are based on the decommissioned telescope mount. The current OMI mount/telescope internally model the mount* *flexure, precession, and atmospheric refraction based on a point-grid model that is "internal" to Talon, the TCS. Use of 'cosmo'/Point is a historical anachronism that simply writes the target object coordinates into a file (pointlast.dat), which in turn is used by IRAF/ICE to populate the FITS header.*

Type 'cosmo' in a 'titan' terminal window and press the Return key. It should return with something like:

titan% cosmo

Model FLEX_08M_RAW.dat selected

titan%

The 'cosmo' utility can provide pointing information for a variety of objects, including planets, NGC, IC, FK5, and Messier objects. This is a synopsis of the 'cosmo' pointing command formats.

POINT COMMANDS:

p - Display point parameters
p a hh mm ss.s - dd mm ss.s [epoch [ra-pm [dec-pm]]] - Airmass only p b nnnn - Yale Bright Star nnnn p c - Give scope coordinates (same as 'p') p h - This help message p i nnnn - IC object nnnn p k nnnn - FK5 star nnnn p l - Point again to the last object p m nnnn - Messier object nnnn p n nnnn - NGC object nnnn
p r - Record point residuals (mount modeling) p t [zd [mag]] - Find FK5 stars near zenith p w - Point on an entire worklist file p z - Re-zero point's coordinates (82" only) p z d - Restore default zeros p z r - Restore previous zeros p z 0 - Set P Zeros to zero
p z x y - Set P Zeros to x asec RA and y asec Dec p z p 'coords' - Set P Zeros based on 'coords' rather than the default p 'object' - Find 'object', e.g. 'p alpha hya', 'p castor', or 'p mars'. p 'ephemeris' - Find position in file 'ephemeris', e.g. 'p ceres' p nnnn - Object nnnn in worklist.dat
p ["star name"] hh mm ss.s -dd mm ss.s [epoch [ra-pm [dec-pm]]]- Point to RA and Dec

zhist - Shows the history of the zeros (P Z 0) commands fhist - Shows the history of the set focus (teldef) commands

Examples:

p mars
p alpha boo or p alp boo or p arcturus p 02 03 38.3 20 31 13 1950 p 02 03 38.3 20 31 13 (default epoch 2000) p b number points to star from Bright Star Catalog number = HR#
p m number points to Messier object by number p n number points to NGC object by number p t yields list of FK5 stars near zenith p k number use FK5 number from above p l point last. Repoints to the previous object

7. Check Focus

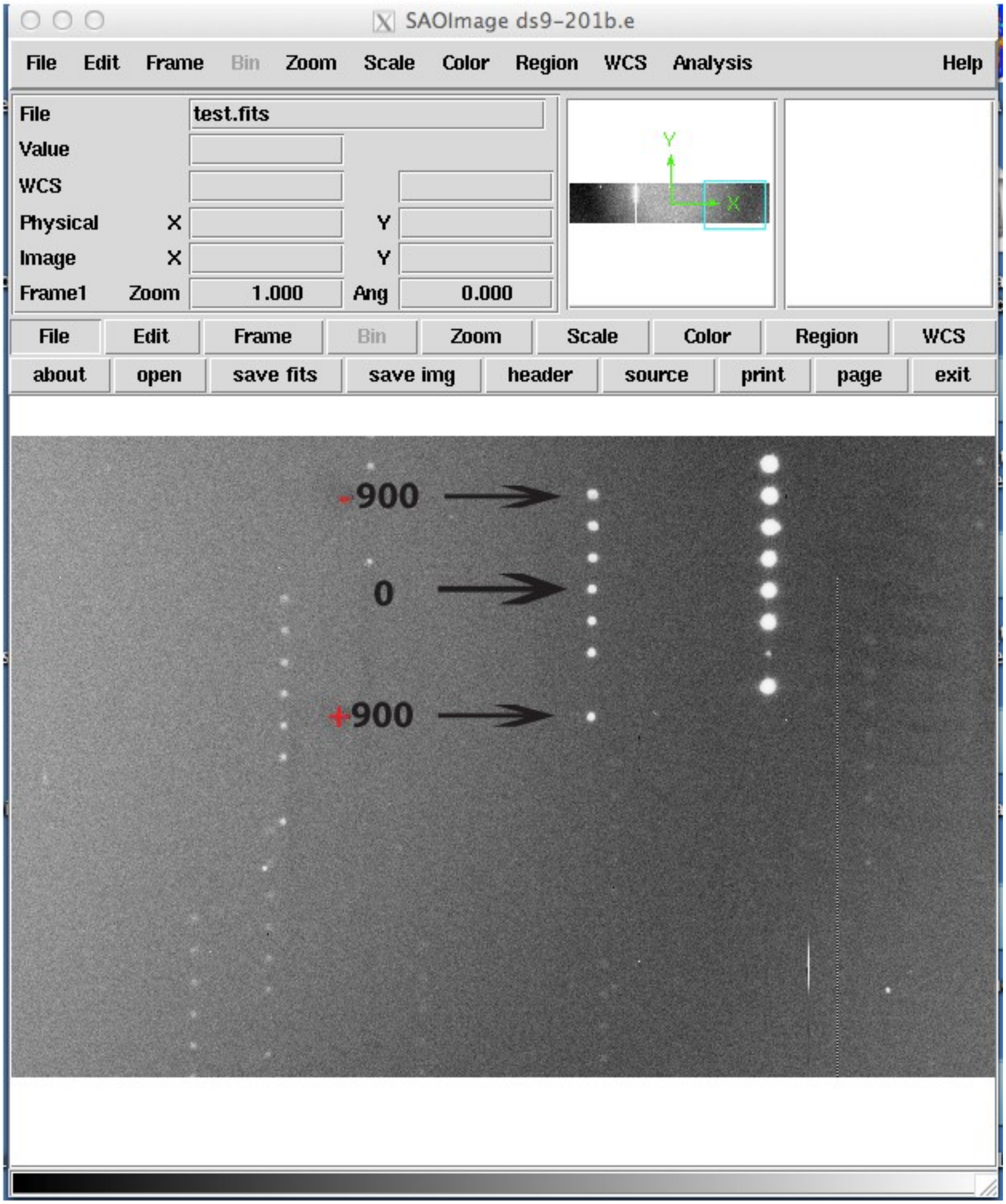
If you have not already done so, constrain the detector read area by the following procedure:

With the cursor in the ICEX window type "detp" and enter "800" in the "firstro=" parameter line and "1200" in the "lastrow=" parameter line. Save the detector parameters.
This will reduce the time required to read out the detector during the focusing procedure.

To start the focus procedure, in the 'icex' window type "instrp" and enter "h" in the "instrfo=" parameter line to home (zero) the focus offset and start the focus servo system. Save the parameters with Ctrl-d, then type "instru". Note that all focus adjustments are made in a relative sense, hence this first step sets a zero position at the start of the focus sequence.

Type "test" and select the focus option. A 10 second integration is usually sufficient for focusing. The focus routine generates seven separate images for each star. The usual focus offset values are set to -900, -600, -300, 0, 300, 600, 900. This is accomplished in obspars with values of nfexpo=7, fstart = "@-900", fdelta = "+300". In the resulting focus image in the 'ximtool' or 'ds9' window, the last star image (for +900) is separated from the rest of the sequence.

Here is a screen shot of the resulting focus test image in the 'ds9' visualization tool:



The focus test produces these seven superimposed images, where each shiftstep in the image frame represents a relative move of 300 focus steps – as the image depicts, the first image line is a relative position of -900 steps, while the seventh (separated by one row), last image line is a relative position of -+900 steps.

The 'ds9' window has a view pane, as shown in the top-right, inside box of the 'ds9' window. The view pane contains a pannable frame, outlined in blue which allows you to view the selected subset of the LF1 detector by “dragging” the pan cursor window around in the pane. You should select a non-saturated set of stars in the 'ds9' view – the example depicts the best choice for this particular focus test image.

After you display the focus frame, type "imexamine" in the IRAF window to bring up image examine routine.

There will now be a circular cursor in the 'ximtool', or 'ds9' window. Place that cursor on each star of a series and type "a" each time to get the FWHM of the image. For each "a" typed you will get a line with image statistics, seven lines for each series.

Typing "?" with the cursor in the 'ximtool' or 'ds9 'window will produce a menu of the other 'imexa' functions. With the cursor still in the 'ximtool' or 'ds9' window type "q" to quit. Determine which position produces the minimum FWHM value. Having established this value (for example, focus = -300) we need to reset the focus to that position. With the cursor in the ICEX window edit "instrp" and enter your estimate of the new focus position by typing "@[n]" on the "instrfo=" parameter line (e.g. @-300). Save the instrument parameters with Ctrl-d. Type "instru" for it to take effect.

A VERY IMPORTANT LAST STEP: edit "instrp" again, enter "h" in the "instrfo=" parameter line. This last step is very important, since it is "telling" ICE where the current best focus position is. All subsequent moves performed by ice, whether from filter change or temperature change, are made relative to this position.

Very Important Summary of this Procesdure:

The following command sequence illustrates the iterative process for focusing the instrument/detector:

intrp->instrfocus->h instrument
instrp->instrfocus->@[+/-]nsteps
instrument instrp->instrfocus->h
instrument

instrp->instrfocus->@[+/-]nsteps
instrument instrp->instrfocus->h
instrument
…

The autofocus mechanism must be turned 'on' (the initial instrp->instrfocus>h + instrument command);

The focus mechanism gets moved in the indicated direction (+ or – nsteps), (the instrp->instrfocus->@[+/-]nsteps + instrument command);

Then the focus mechanism is 're-homed' at the new position (the instrp>instrfocus->h + instrument command).

The summary illustrates the iterative sequence of turning 'on' the autofocus mechanism, moving the focus mechanism some number of steps, and 'homing' the focus mechanism after each move. This sequence is important, as missing or skipping a step leaves the autofocus mechanism in an indeterminate state, which will result in a dramatic, and difficult-to-correct out-of-focus condition.

Generally, you will repeat this sequence several times. Type "test" to take another focus frame, and repeat until you are satisfied with the focus. (The best attainable focus with the PFC is 1.5 pixels.)

If for any reason ICE stopped running (power outage, or hitting ^C), you need to log into ICE again and reinitialize the PFC. The filter is where it was before, you just have to tell it using instrp. You can also recover the focus by typing "l" in the instfo parameter line, use instru to implement it, then go again to instrp, type "h" on the instfo line, execute instru for starting autofocusing.
When finished with the calibration, focus and pointing exposures edit the detpar file to restore the default 1st and last row values for the detector.

8. Observe Target(s)

Use point to determine pointing coordinates for your target. Type “observe” and fill in your desired parameters to begin a science target image. In order for the header information to be current, you should rerun Point (the 'p' command enabled by 'cosmo') prior to each exposure.

9. End of Night and Various Notes

In a terminal window on 'titan', enter 'dr' at the shell prompt, and press the Return key. The night report should come up.

Make sure the report fields are completed, including dome open/close times, cloud cover estimates, seeing, along with any other operational notes you wish to communicate to the mountain staff. All fields with Red description labels are mandatory.

IMPORTANT! The following end-of-night procedure benefits you, and the next observer. Reset/home the filter wheel to the 'U' filter position: In the IRAF-ICE window on 'titan', type “instrp”. Use the arrow keys to move to the ‘instrfi=’ line. Enter @U, where U indicates the desired U-band filter, or 'home' position. Type Control-d to exit and save your request. Type “instru” to move the filter wheel to the requested position. You should be able to hear the filter wheel move through the dome audio system.

In the bottom section of the report, note if, and when you last filled the dewar. The hold time for the PFC dewar is approximately 24 hours. Ideally you should refill the PFC dewar at the end of the night. If you need the dewar filled during the day, make a note in the night report. Also note the position of the filter wheel.

Use Talon to close the mirror cover, stow the telescope, close the dome shutters, and 'quit' the Talon application. While there is no formally defined 'home' position for the dome, it is a good practice to use the Talon software hand-paddle to move the dome counterclockwise (CCW), West of North off of the shutter power contacts. This saves wear and tear on the hydraulic motors and positions the dome conveniently for the next Talon 'home' operation. A good parking location for the dome and visual cue is to align the dome shutters with the East dome entry door.

At the end of your session, in a terminal window on 'talon' type the command 'killTel' at a shell prompt, then press the Return key. This will shut down the telescope and leave it in a safe mode.
Once the telescope is shutdown, and IRAF-ICE are closed, check that your night report entries are complete and correct, then click the “quit” button on the night report application, and log off from 'titan'.

Other Useful Tips regarding the PFC/LF1:

The orientation of PFC images is north down and east is to the right. This typically requires that you turn finder charts upside down to locate targets.

The field of view of the PFC is 46.5 arc minutes square.

The LF1 pixel dimensions are 15um square. There are overscan regions on the LF1 detector that can be 'trimmed' by using columns 5 through 2045, and rows 4 through 2047 on the detector, specified in the 'detpars' ICE parameters as:

! (firstco= 5) First column of data (device coordinates)
! (lastcol= 2045) Last column of data (device coordinates)
! (firstro= 4) First row of data (device coordinates)
! (lastrow= 2047) Last row of data (device coordinates)

The maximum useful integration time on the LF1 detector is approximately 1800 seconds, before skyglow and local radiation conditions begin to saturate the detector.

Determine/Select Filter Wheel Position (Only If Necessary)

NOTE – *this procedure is normally not required, as Observing Support will position the filter wheel correctly, and initialize IRAF-ICE prior to the start of your observing run. This procedure is used when a power failure has occurred, if the PFC has been power-cycled during use for some reason, or if the filter wheel has malfunctioned during use, or if you are on a split observing run and the previous observer failed to reposition the filter wheel at its home location (U-band filter by default). Currently the PFC filter wheel assembly does not have an electromechanical 'home' location indicator or homing function – it must be manually homed. An upcoming release of IRAF-ICE and modifications to the PFC will support an automated filter homing routine and related hardware/electronics. If you must perform this procedure, be aware that most of the LN2 will spill from the dewar. It will need to be replenished after the procedure is complete, and you MUST verify the LF1 detector temperature is within an appropriate range to replenish the dewar without vacuum pumping (-101C to -10C).*

With the Talon TCS running and initialized, use the software hand-paddle to position the telescope at its West limit (-X) in hour angle/right ascension from 'stow' (tube south). This will place the telescope tube into a safe, and accessible position to allow the PFC shutter mechanism into an angle such that it can be viewed from the floor, or via use of the small three-step dome step-ladder.

CAUTION: Liquid nitrogen will pour from the dewar fill neck – use caution not to allow the pouring/dripping liquid nitrogen to contact your skin or eyes.

As a precaution, once the telescope is in position to examine the shutter and filter wheel, enable one of the e-stop (push in the e-stop knob) controls to disable inadvertent telescope motion.

In the IRAF window, type “test 1 o 60”. This will start a 60 second exposure, during which time the shutter will be open. The 60-second exposure will allow you enough time to get from the control room to the dome floor to examine the shutter/filter assembly. You will need to position your head/shoulders inside the PFC truss assembly, which may require standing on the three-step dome ladder. The clearance is limited, and you should exercise caution. During the exposure, use a flashlight to look inside the open shutter assembly. You will see a filter. Assuming the filter wheel is the standard UBVRI wheel, you will see either an almost opaque filter (U), a blue filter (B), a green filter (V), an orange filter (R) or a deep red filter (I).
The filters are labeled to aid in identifying which one is in the optical path. IRAF assumes that the filter is at U each time it is restarted.

At the IRAF window, type “instrp”. Use the arrows to move down to the ‘instrfi=’ line. Type “hX” on the line, where X is either the filter name (U, B, V, R or I) or the filter number (1, 2, 3, 4 or 5). The numbers correspond directly to the UBVRI scale. Type Control-d to exit instrpars and save your change. Type “instru” to make the changes take effect.

Type “instrp”. Use the arrow keys to move to the ‘instrfi=’ line. Enter @X, where X is a filter or location different from the current position. Type Control-d to exit and save your request. Type “instru” to move the filter wheel to the requested position. You should be able to hear the filter wheel move through the dome audio system.
Once you have determined and set the filter wheel position, disable the e-stop you previously enabled to allow telescope motion, then use Talon to command the telescope to the stow position by clicking Talon>Telescope->Stow, and respond 'Yes' to the confirmation prompt. You will need to refill the dewar with the telescope in stow position, and one of the hard e-stop buttons depressed during the fill operation.

Check Pointing (Only by Clearance with Obs. Support)

NOTE: *The current implementation of the 30-inch/0.8-meter telescope, PFC/LF1 and the Talon TCS are designed to use Talon's internal point-mesh model for pointing the telescope. The system is pre-configured for "best" placement of a target on the LF1 detector to avoid the column defects near the center of the CCD. It is HIGHLY recommended that observers not alter the pointing model in the telescope's TCS for a variety of reasons. The default pointing conditions will almost always place the object in the detector's field of view, and the object will be located left of center, and slightly below the detector's middle row (in the physical North-West quadrant, and lower-left quadrant of the LF1 detector view in 'ds9' or 'ximtool'). If it is necessary, the object's position can be changed by iteratively exposing an object via the PFC and IRAF/ICE, examining 'ximtool' or 'ds9' to evaluate the object's position on the detector, and using the Talon TCS software hand-paddle to 'nudge' the position as desired.*

The image orientation on the LF1 detector places North 'down', and East on the right of the image view in 'ximtool' or 'ds9'. If you are looking at a physical star chart, or image display, this will require inversion (turning the chart upside down) to orient the chart to the LF1 detector. If you are using Xephemeris for pointing, you can use the 'Flip Top/Bottom' command button toggle on the left side of the Sky View panel to invert the display to match the LF1 detector's orientation.

With the cursor in the ICEX window type "detp" and enter "800" in the "firstro=" parameter line and "1200" in the "lastrow=" parameter line. Save the detector parameters.

On the Talon host ('talon'), start the Xempheris utility by typing 'xephem &' at the Linux shell prompt in a terminal window. This will start Xephemeris as a background process.
Once Xephermis is running, you will need to load a catalog of bright stars into the Xephemeris application. From the Xephemeris window, select 'Data->Load/Delete' with the left mouse button.

A dialog panel to load the Xephemeris database will pop up in your display window. Locate the 'Selection' entry field near the bottom of the dialog panel. Double-click the interior of the box, and enter '/usr/local/telescope/archive/catalogs/YBS.edb' and press the return/enter key. You should see the dialog panel mid-section indicate '1 Loaded Catalogs', and a button marked 'Delete', along with the text '3140 YBS.edb' should appear in the Loaded Catalogs pane. Once this is complete, select 'Control->Close' from the dialog panel menu bar to close the panel.

Next, in the main Xephmeris window, left-click 'View->Sky View'. This will open the Sky View window on your display. This pop-up window provides a view of the celestial sphere, depicting the visible planets, Moon, Sun, and stars from the Yale Bright Star (YBS) catalog of magnitude 5 and greater.

In the 'Sky View' window, select 'Telescope->Enable Telescope Marker', followed by 'Telescope->Enable Telescope Control'. These actions create a circle with a white cross in its center, and enable Xephemeris pointing control over the Talon TCS and telescope.
NOTE: *The Talon TCS must be running, the telescope axes and dome must be homed in order for this procedure to be utilized.*

Using the Talon TCS Xobs user interface, select 'Control->Calib Axes' from the main window. A dialog box will appear that contains the Axis Calibration actions.

Manually slew the dome to align the dome slit and telescope using the Talon TCS software hand-paddle ('Control->Paddle->Roof/Dome->CCW (or CW as appropriate)).

In the Xephemeris 'Sky View' window, select a bright star near the Zenith by using the left-click (or left-click equivalent, for example Comand key + click under Xwindows on a Mac OS X machine), and scroll the mouse down the dialog pop-up to 'Set Telescope'. Select this menu item and release the mouse button. The telescope marker will move to the selected object. If you are monitoring the dome camera, you should see the telescope slew to this object.

Once the telescope slew operation is complete, evaluate the dome slit alignment with the telescope, and manually align the dome slit with the telescope as necessary using the Talon TCS software hand-paddle.

In the IRAF-ICE environment, create a 10-second integration of the selected star with the ICE command 'test 1 o 10'. After the exposure and read are complete, the image will be displayed in the 'ximtool' or 'ds9' window. Evaluate the image location relative to the center of the detector.

If necessary, use the Talon TCS software hand-paddle to move the telescope in the direction necessary to center the image on the detector in the desired location. Usually the 'Fine scope' action on the hand-paddle, combined with the directional arrows will be sufficient. Recall that the image orientation in the 'ximtool' or 'ds9' window is North-down, East-right.

Integrate another image exposure in IRAF-ICE, and evaluate the new location of the object on the detector. It is useful to mark the starting point, and successive locations of the object using the 'Mark' function in 'ximtool' or 'ds9' to keep track of and help with adjustment to the object location on the detector.

Once satisfied with the location of the object on the detector field, use the Axis Calibration dialog to 'Mark' the object's position. Clicking the 'Mark' button on the panel will turn the indicator next to the Object name from grey to green.

Next, select a new object in the Xephemeris 'Sky View' window, and use the select/set telescope dialog menu to select the new object.

NOTE: you will not see the Telescope Marker move in the 'Sky View' window with subsequent object selections.

Repeat the image integration, IRAF-ICE exposure and evaluation process for the new object and once satisfied about the object location on the LF1 detector, 'Mark' the object in the Xephemeris Axis Calibration dialog panel.

A minimum of two objects will complete the model data required to generate a pointing solution; however, this will generally not result in a satisfactory solution to allow accurate pointing. Three objects, and ideally eight are the recommended number to generate an accurate pointing model solution.

Once this iterative procedure has been completed for at least three objects, use the Solver to generate an updated pointing model. Selecting 'Solve' with the left mouse button in the Axis Calibration dialog panel will use the marked stars to generate a new update for the mesh pointing model.

Once the 'Solve' button is pressed, and the Solver finishes execution, it will populate the computed offset from the original pointed location against the manual slew coordinate for each object in the object list, and populate the model fields including T-Pole, Pole Offset, and axis reference offsets, along with new 'home' positions. The model update is installed and applied using the 'Install' button on the Axis Calibration dialog panel. It is possible to 'Undo' each mark step, or 'Reset' the entire process using the appropriate panel buttons. The 'Close' button exits the axis calibration dialog.

CAUTION! *The Axis Calibration procedure requires significant skill and in-depth knowledge of the entire IRAF-ICE, Talon TCS and integration of these components, along with in-depth knowledge of the detector characteristics, the underlying point-grid mesh model in Talon, as well as significant time and patience to complete a model update. The model update that results from use of the 'Install' function is destructive to the existing mesh model, and to many of the Talon TCS configuration files. Incorrect, inept, or incomplete use of the Axis Calibration function can result in pointing and homing errors (at best), or render the telescope nonfunctional (at worst), requiring it to be completely re-initialized by Observing Support.*
DO NOT USE *the Axis Calibration function unless:*

- you have consulted with, and obtained prior approval from a member of the Observing Support staff
- You have backed up the following files and directories:
- /usr/local/telescope/archive/config/home.cfg
- /usr/local/telescope/archive/pointmesh
- /usr/local/telescope/archive/calib
- You are absolutely certain you understand the entire procedure, including use of IRAF-ICE, the Talon TCS, and Xephemeris
- You have the time required to complete the process