NEWFIRM User Manual for KPNO:
Operating Procedures for Observers
With additional procedures for technical support staff

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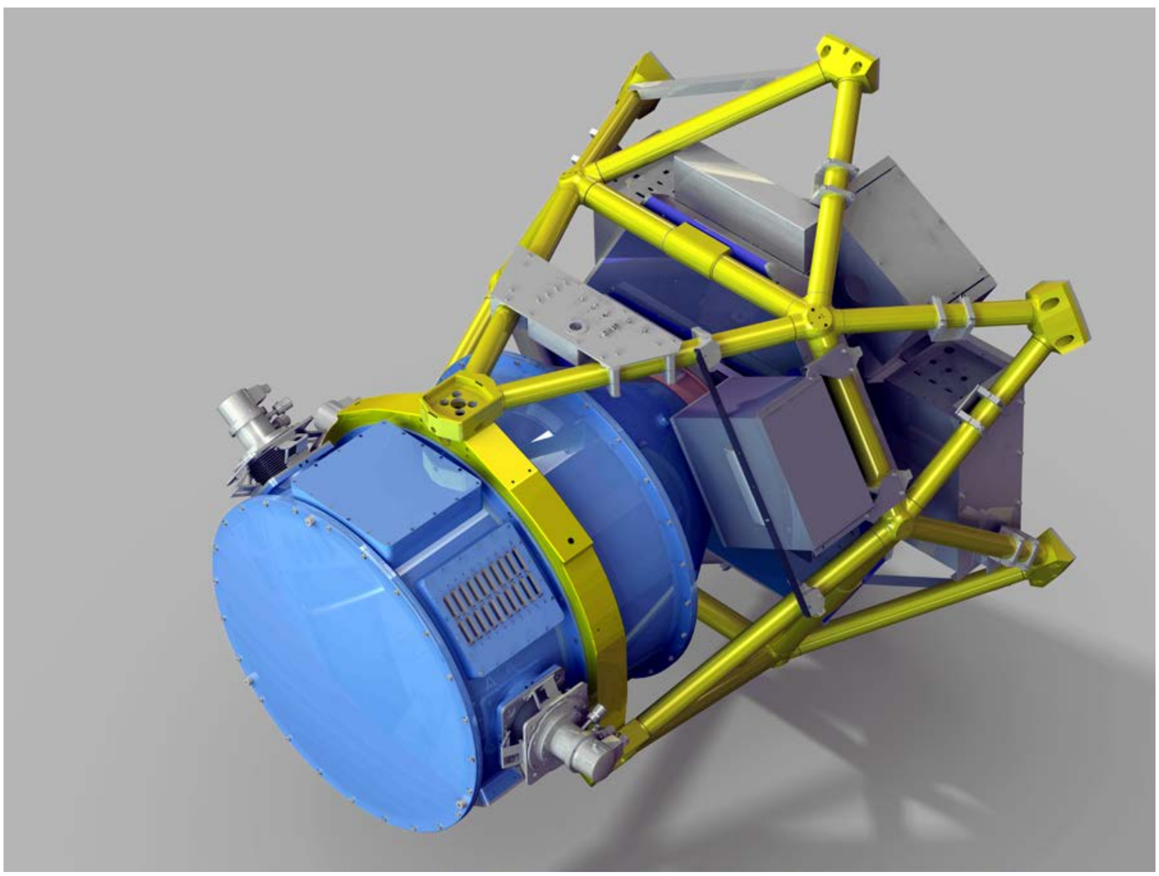
v. 7.5



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1. Introduction

This is a procedural guide to NEWFIRM observing with the NEWFIRM Observation Control System (NOCS). It covers system startup, script creation and data acquisition, daytime calibration frames, pointing and focus checks on the sky, observing tips, and data inspection. This guide supplements hands-on training at the telescope.

Recovery procedures from various error conditions are given in Appendix A.

This guide is site specific to the Mayall 4-m telescope on Kitt Peak. Users familiar with NEWFIRM will notice differences in detail for operations at the Mayall or the Blanco 4-m telescope.

Throughout this guide, look for text highlighted with a yellow background . This denotes a command string to be entered by the user, followed by the "return" key denoted as <cr>, in the command line window.

This manual also includes actions to be taken only by OAs or EM personnel. These are highlighted in bold blue font. These actions usually involve reboots with root permission, or resets of electronic hardware. Observers should not be doing this.

2. Login and Startup

The NEWFIRM observer operates the instrument from the workstation *mayall-2* near the telescope operator. This station has four monitors, which the NEWFIRM software regards as one big screen.

Log into *mayall-2* as *4meter* and open a terminal window:

Login window will be displayed on *mayall-2*
Login as *4meter*
Password is ________________________ (also posted on one of the monitors).
At *4meter@mayall-2* prompt, type

xhost + <cr> ; ignore the "disabled" message, it's not an error condition

Open a second terminal window in the lower left monitor. This window will be connected to the instrument control computer *newfirm*, and used to issue commands to it. So we refer to it as the "command line window" in what follows.

2.1 Startup from command line window

In the command line window, ssh to computer *newfirm* as user "*observer*" with

ssh –X observer@newfirm-kp <cr>

PW for "*observer*" is ________________________ .

At the prompt *observer@newfirm-kp*, type

nocs start all <cr> (three words, space between)

2.2 Startup from icon

Alternatively, on the lower left monitor, right side, click on the Newfirm icon. This will open a startup GUI in the upper left corner of this monitor. Click on the blue bar labeled "Start Newfirm".

Fig. 1. Newfirm icon (upper) and startup GUI (lower).

After a command line or GUI startup, several windows appear on all four monitors. This takes about one minute. Some windows appear briefly and are then iconized in the toolbar at the bottom of the lower left monitor.

- A VNC window to the Data Handling System will appear centered on the four-monitor system; use the mouse to move this to the lower right hand monitor.
- A long string of messages will scroll through the command line window, a preliminary to opening the next set of NEWFIRM operational windows
- Several small windows appear in the upper left hand monitor, with some being iconized.
- Several GUIs appear, stacked on top of each other, in the lower left monitor
- The startup is finished when the *observer@newfirm-kp* prompt appears again in the command line window

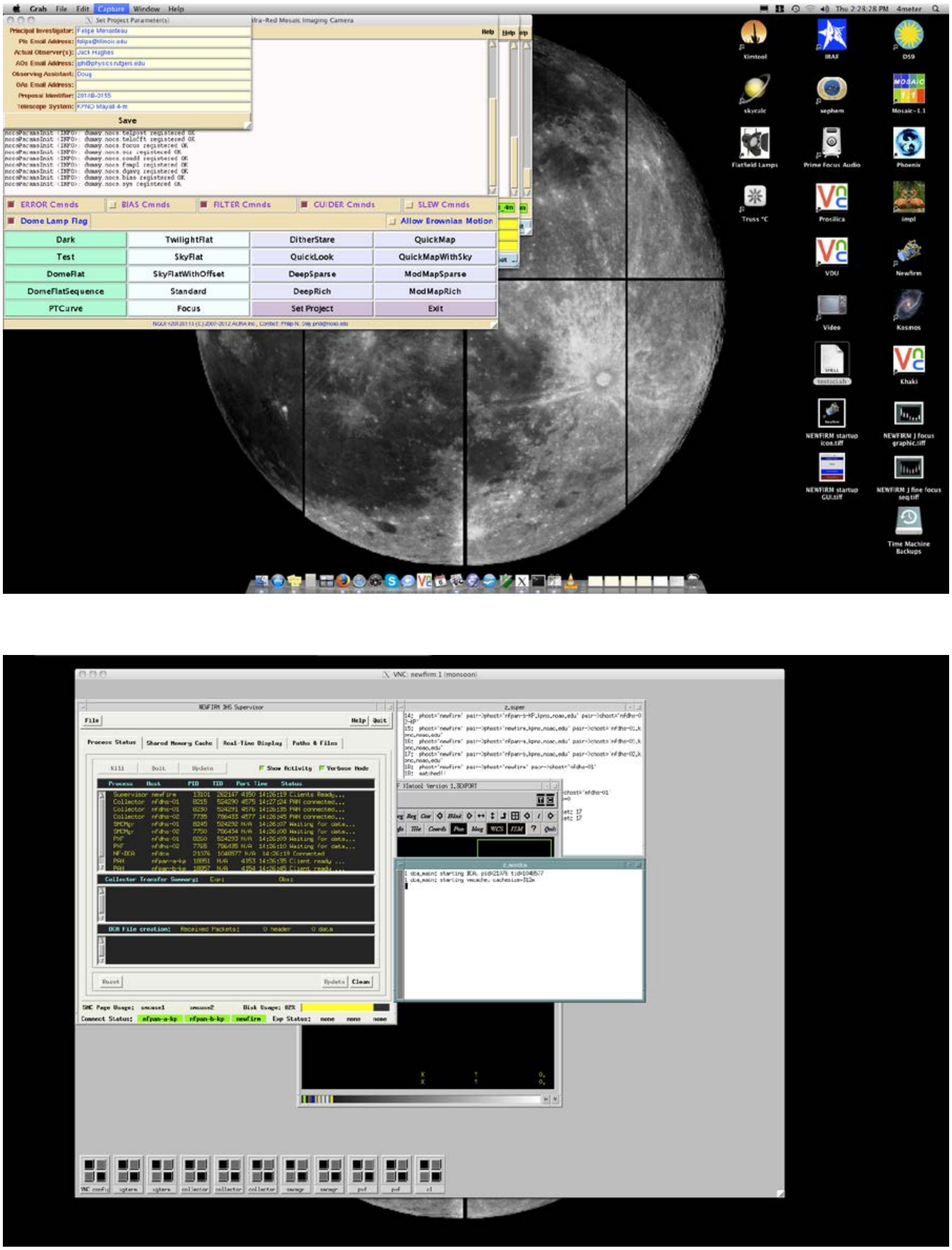

Fig. 2. Screen shots of the lower left and lower right monitors at the end of the startup sequence.

Once the startup has completed and the *observer@newfirm-kp* prompt has appeared in the command line window, bias the arrays with the command

400mvbias <cr>

This applies a 400 millivolt bias to the array detectors, making them electrically active.

There are two different errors that may occur during startup. Respond to them as follows:

Startup error condition 1:

If the windows do not appear, and you get a sequence of error messages in the command line window about "cannot connect", the host permissions need to be reset on *mayall-2*:

- Let the startup process run to completion, returning the *observer@newfirm-kp* prompt in the command line window

- Type in the command line window

  nocs stop all <cr>

  to stop all processes and close all NEWFIRM GUIs

- Alternatively, click on "Stop Newfirm" in the startup GUI.

- Type in the command line window

  exit <cr>

- At the *4meter@mayall-2* prompt, type

  xhost + <cr>

- Reconnect to computer *newfirm* as before with

  ssh –X observer@newfirm-kp <cr>

- In the command line window, type

  nocs start all <cr>

- Alternatively, click on "Start Newfirm" in the startup GUI.

Now all the windows will appear and you can proceed.

Startup error condition 2:

During the startup process, watch the GUI called “NEWFIRM Monsoon Supervisor Layer” once it appears. A string of about 14 blue **RECV** messages should appear. If you do not see any **RECV** messages, or if any red **ERROR** messages appear in the scrolling output in this GUI:

- Let the startup process run to completion, returning the *observer@newfirm-kp* prompt in the command line window

- Type in the command line window

    nmslReset <cr> (that’s en-em-ess-ell-Reset, no spaces)

The system will automatically load the Monsoon Supervisor Layer again. Watch for the blue **RECV** and red **ERROR** messages. Repeat this cycle until the load runs to completion with no red **ERROR** messages. If they appear at all, usually one or two nmslReset cycles are sufficient to get through this.

Then bias the arrays with the command

400mvbias <cr>

Summary:

log in to *mayall-2* as “*4meter*”
xhost + <cr>
ssh connection to *newfirm-kp* as “*observer*”
nocs start all <cr> or “Start Newfirm” in GUI
nmslReset <cr> in the event of red **ERROR** messages
400mvbias <cr> to activate the arrays

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3. Shutdown and logout

At the end of the night, protect the instrument by closing the warm entrance window cover, and shutting down the array controller and user software.

In the Instrument Control System GUI, close the Environmental Cover. For more about this, see Sec. 5.

This cover must be closed ***before*** the OA closes the telescope mirror covers. Be sure to coordinate with the OA.

- Use the Options button in upper left corner of the GUI to enable the button bars running across the bottom of the GUI.

- Click the bottom button bar labelled “Close”.

From the command line window in the right hand monitor, type

nocs stop all <cr>

This debiases the arrays, shuts down all processes and closes all GUIs.

Alternatively, click on “Stop Newfirm” in the Newfirm startup GUI.

After all the GUIs have closed, in the command line window type

exit <cr>

This closes the connection *observer@newfirm-kp* and takes you back to the *4meter@mayall-2* prompt.

From here you can log out of *mayall-2* if you like.

Summary:
“Close” button in Instrument Control System GUI
nocs stop all <cr> or “Stop Newfirm” in GUI
exit <cr>

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4. Setup steps after login and startup

4.1 Setup actions in the DHS VNC window

This VNC window could be moved to any of the four monitors. The lower right one is convenient for most users.

4.1.1. Start IRAF.
Locate the toolbar of icons across the bottom.

- Left-click on the "CL" icon (the one furthest to the right in the toolbar). This opens a menu.
- Click on "Restore" in this menu.

This opens an xterm with IRAF running in it, set to the *mscred* package. This is called the "IRAF cl window". This is primarily useful for image display to the DHS ximtool with *mscdisplay* and interactive image querying with *mscexamine* tools. The "msc" prefix denotes IRAF tasks that operate on multiextension FITS files, originally developed for the Mosaic optical imager.

4.1.2 Change directories to your data directory.
The startup process automatically sets the image root name, and creates a directory for raw and processed images. In the IRAF cl window just opened, the path for data directories is

/nfdata/observer

Directories have numerical names in the form year-month-day based on the local (MST) date at startup, e.g. 20120231. You'll see directories from previous nights there, as well as the one for the present MST date.

You may create and use different directory names, and/or subdirectories for raw and processed data, using the IRAF command *mkdir* in the IRAF cl window.

I recommend creating a subdirectory for processed data within your raw data directory. This will receive output from the Quick Reduction Pipeline.

Once created, set the path to your data directory in the IRAF cl window with the usual IRAF command

cd /nfdata/observer/[directory name] <cr>

4.1.3. Rearrange the window layout to your liking.

The Figure shows one arrangement. Raw images are automatically displayed from memory in the image display. The *z.super* window shows the progress of data from memory to disk, with a highlighted message when this transfer is complete. The *mosdca* window is infrequently needed and can be positioned partially behind one of the others.

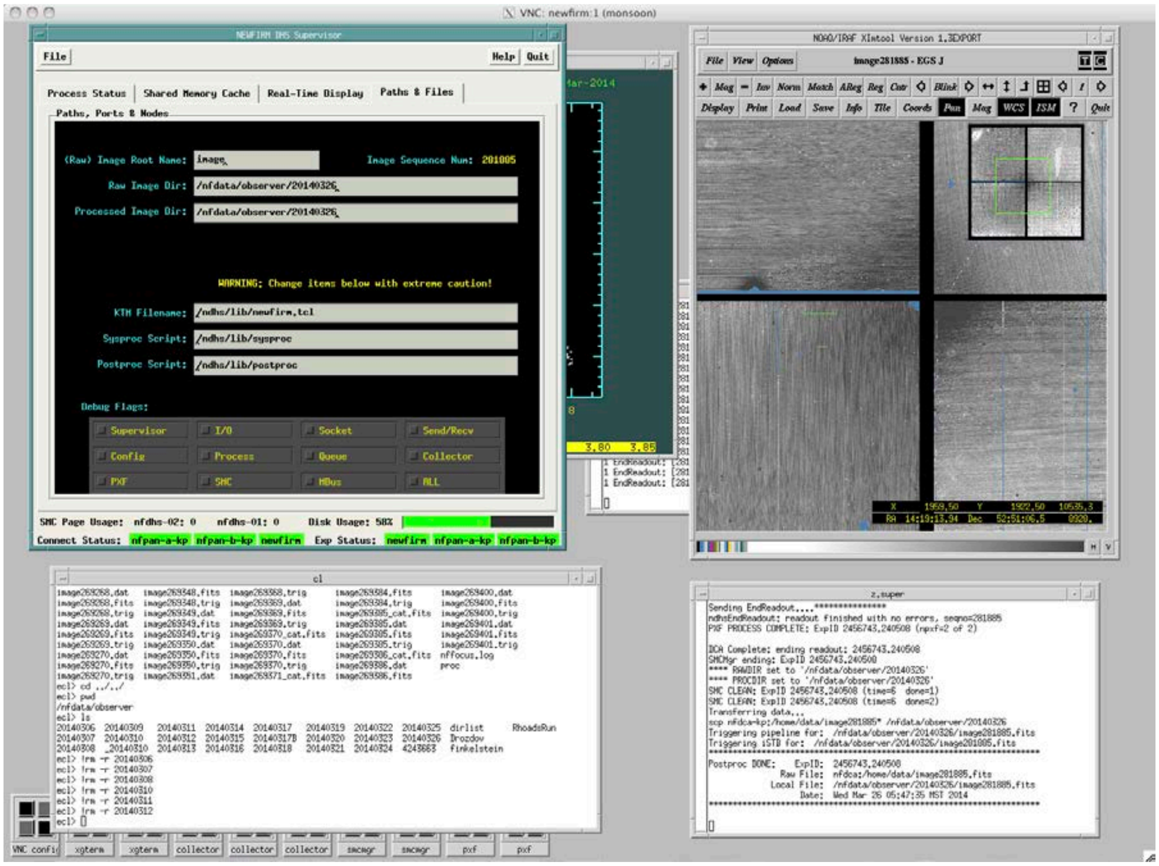

Fig. 3. VNC window to Data Handling System, rearranged by the observer. Raw and Processed image directories have been set. The z.super window shows the acknowledgement messages.

4.1.4. Set the image root image name and the data directories in the Supervisor window. You need to enter the desired name or directory path in this window, and check the z.super window for an acknowledgement message.

- Click on the NEWFIRM DHS Supervisor window to foreground it.
- Click on the “Paths and Files” tab.
- Find the root filename and image directories in the boxes near the top of the page.
- Set the raw image directory path, and hit “enter”.
- Check the z.super window for an acknowledgement message.
- Repeat for the processed image directory path.
- To reset the root name, delete the default, type in your preference, and hit “enter”.
- Image root name changes do **not** generate an acknowledgement in z.super window

You can change the image root name at any time, for example different root names for different targets. The appended six digit number just keeps incrementing, so you can't accidentally overwrite data.

4.1.5. Start automatic flushing of the DHS memory

- In the DHS Supervisor window, click on the Shared Memory Cache tab.
- Click the " Continuous Polling" box at page bottom to activate this feature.

This helps to keep data flowing smoothly from memory to disk.

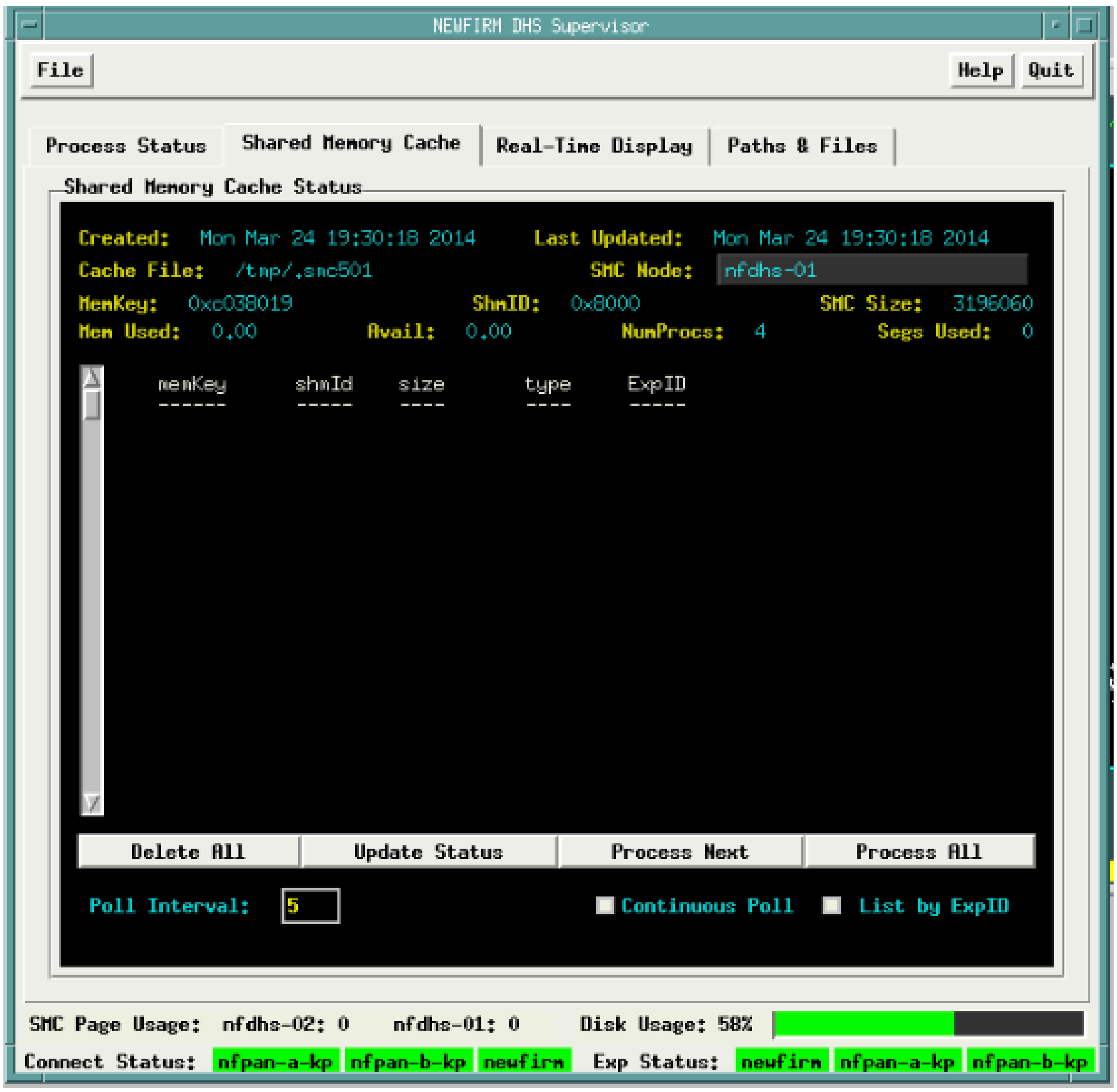

Fig. 4. DHS Supervisor window, Shared Memory Cache tab, with Continuous Polling box at bottom center.

Summary:

- Open IRAF window from the row of icons at bottom of display
- Arrange desktop to your liking
- Go to NEWFIRM DHS Supervisor -> Paths and Files
- Create root image name, hit "enter"
- Click on raw image directory path, hit "enter", verify path in z.super window
- Click on processed image directory path, hit "enter", verify path
- Switch to NEWFIRM DHS Supervisor -> Shared Memory Cache
- Click "Continuous Polling" box at page bottom to activate this feature

4.2 Setup actions in other monitors

The lower left monitor has the terminal window (=command line window) and a large number of GUIs stacked up (Fig. 2). These need to be rearranged for more convenient access.

4.2.1 Set and save Project Parameters

Locate the small "Set Project Parameters" GUI. Fill out the entries in this GUI and click Save. The GUI will close.

This information is used for data archiving, including access permission for the astronomer(s) on the proposal. "Actual Observer" means the astronomer who is at the telescope doing the observing; this is not always the PI. "Proposal Identifier" is your proposal number, e.g. 2008A-0035. This can be found on the online telescope schedule at http://www.noao.edu/kpno/forms/tel_sched/ .

VERY IMPORTANT: After filling out and saving the Project Parameters GUI, type in the command line window

nocs set project <cr>

This command uses the information entered in the Project Parameters GUI to actually set access permission, and synchronize what the NEWFIRM system is producing with what the NOAO Science Archive is expecting (from the telescope schedule).

The Project Parameters GUI can be reopened from the script generating GUI (Sec. 6.1) to make changes; for example, if two different programs are splitting a night.

4.2.2 Reposition other GUIs

Look at the larger GUIs on the lower left monitor. These are stacked or overlapping and need to be positioned for better access. They are:

- NOAO Extremely Wide Field Infra-Red Mosaic Imaging Camera (called NGUI for short). This is the script generating GUI. Its use is discussed later in this document.

- NEWFIRM Telescope Control System. Allows user control of telescope offsets. Other capabilities are disabled.

- NEWFIRM Instrument Control System. Allows user positioning of filters and warm dust cover.

- NEWFIRM Monsoon Supervisor Layer. Shows progress of integration and readout

- NEWFIRM Observation Header System. Tracks images and header information as they are assembled into FITS files on disk.

The following rearrangement has proven useful:

- Minimize the Observation Header System GUI to the toolbar across bottom of screen. Observers rarely use it.
- Move the Monsoon Supervisor Layer GUI to the upper right monitor. You will be watching the integration countdown and other activity scroll past in this window.
- Position the Telescope Control System and Instrument Control System GUIs across the top of the lower left monitor. They will overlap slightly.
- In these two Control System GUIs, activate their button functions:
    - Click on Options in the toolbar, upper left
    - Click on Enable in the menu that pops up
    - The buttons across the GUI bottom change from grey text to black text
- Position the large script-creation GUI “NGUI” in the lower left corner of this monitor.
- The command line window is already in the lower right corner. Leave it there.

The four windows that you will interact with while observing are now readily visible and accessible on the lower left monitor.

Summary:

Enter and save project parameters in the small GUI
Enter nocs set project <cr> in terminal window
Rearrange GUIs, grouping the ones you will be using in the lower left monitor.

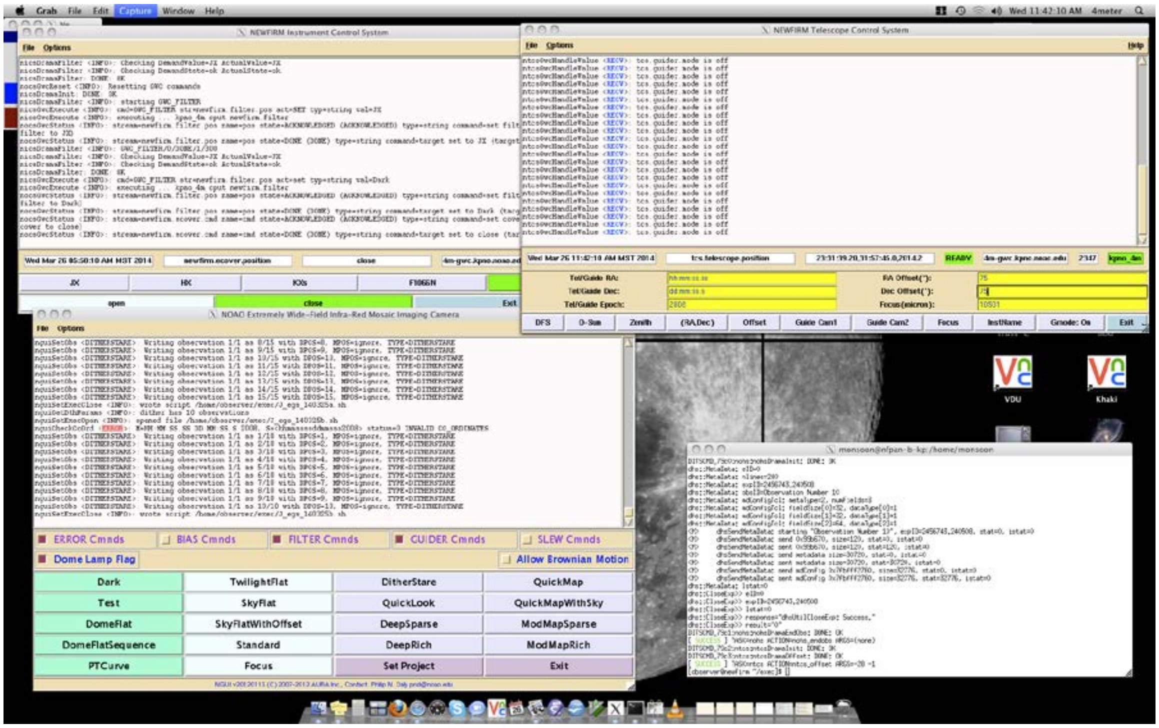

Fig. 5. Lower left monitor with GUIs and command line window positioned for observing.

Next look at the upper left monitor. It has several small windows stacked up. These are engineering status displays with scrolling text. They are only used for troubleshooting. These can be left “as is” or minimized to reduce clutter in this monitor.

4.3 Other useful tools

There are two other useful displays that are not part of the NOCS. They may already be opened on one of the four monitors. If not, start each one by double-clicking on its icon, found on the lower left monitor:

- Truss Temp: telescope temperatures GUI
- VDU (Video Display Unit): telescope and instrument status

Position these displays in the upper left and upper right monitors for quick visual checks.

The Truss Temp GUI displays telescope truss, primary mirror, and ambient temperatures. Any of these will change from green to red background if that temperature changes by more than 1 degree C since last the observer reset. This is useful for tracking temperature changes that affect telescope focus.

The VDU display shows much useful information about the telescope and instrument; see the Figure.

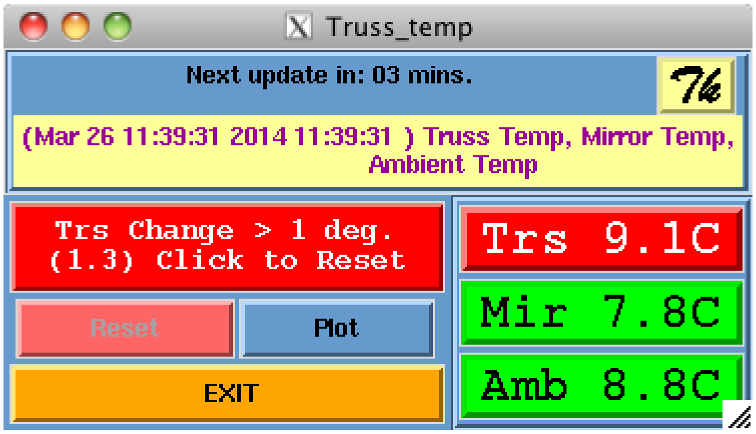

Fig. 6. Truss temperature GUI. "Trs" is the steel telescope truss, "Mir" the primary mirror, and "Amb" ambient air temperature in the dome.

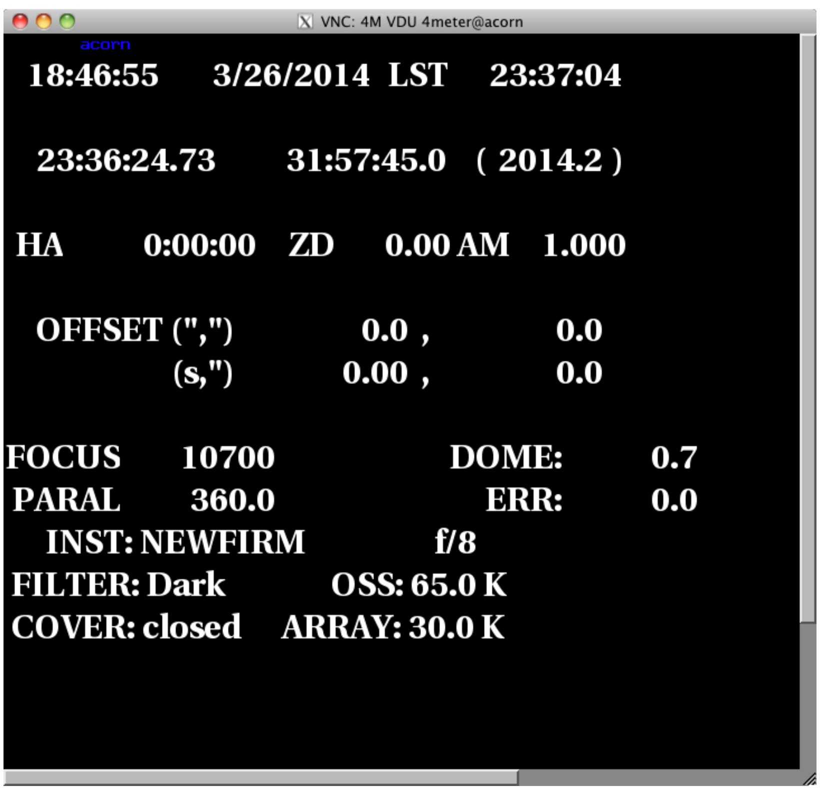

Fig. 7. VDU display of telescope and instrument status information.

Summary:

Open other tools from icons and position for easy access

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5. Instrument startup

5.1. Open the Environmental Cover (warm dust cover over Dewar window):

- Locate the Instrument Control System GUI in the lower left monitor.
- This GUI has a row of buttons across the bottom with filter names, and a second row below this one with two large buttons labeled “open” and “close”.
- Click the large button on bottom row labeled “open”. It will turn green when the Environmental Cover is open.

5.2 Select filter:
You can select a desired filter through the Instrument Control System GUI by clicking on the filter button. Since it can take up to 60 seconds to position the filter wheels, this saves some time at the start of an observing script. Filter selection is also commanded automatically from within a script, so, no harm if you forget.

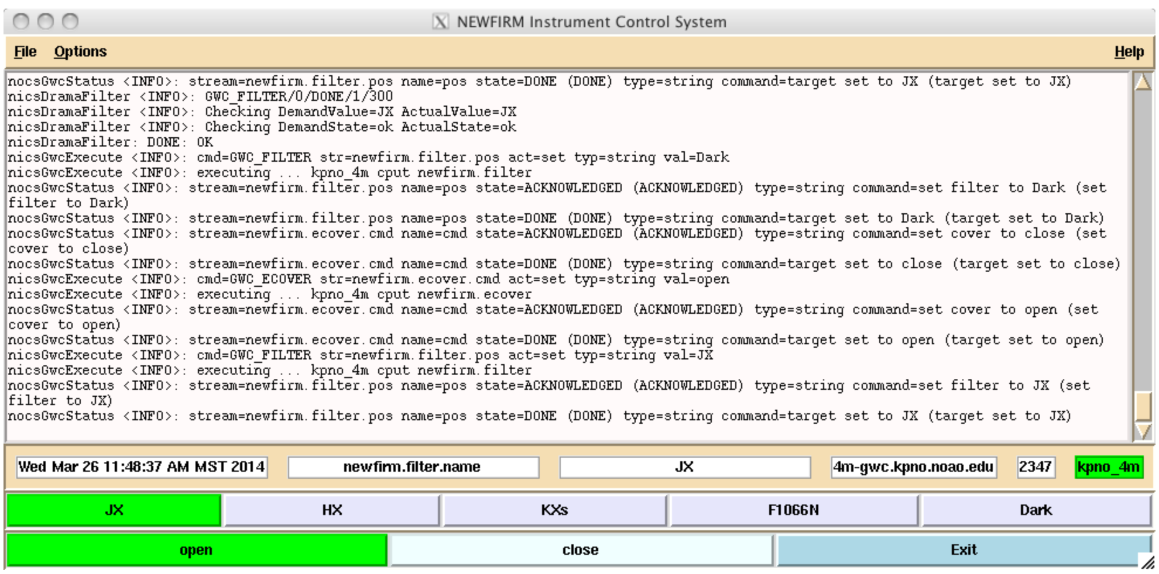

Fig. 8. Instrument Control System GUI with J filter selected and Environmental Cover open.

5.3. Check Dewar temperatures:
Look at the TCS VDU (Sec. 4.3, Figure 7). Two critical instrument temperatures are displayed at bottom right. These are the temperatures of the internal cold Optical Support Structure (OSS), and the array detectors. These should read

OSS: 65.0 K
ARRAY: 30.0 K

If either of these values does not match the above value, contact your observing support person or the Instrument Scientist before proceeding with observations.

If the array temperature is more than 0.5 K out of range, safety features in the software ***will not allow you to take data***.

Summary:

Open Environmental Cover via Instrument Control System GUI
Check critical Dewar temperatures on telescope status display

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6. Data acquisition with scripts

Sec. 6.1 [20] has information and instructions that apply to all scripts.

Secs. 6.2 [24], 6.3 [28], and 6.4 [43] describe the observing scripts, from simplest to most complex. New users are strongly urged to read through each of these descriptions and examine the associated script GUI. Each successive script description assumes knowledge gained by reading its predecessors. The Instrument Scientist or startup person can also be consulted about which scripts, and what parameter values within them, are best to use for your observations.

6.1 Creating and using scripts

All NEWFIRM images are taken by executing a script—even test exposures. Scripts are created using the script editor NGUI. For compatibility with the NEWFIRM science reduction pipeline, scripts are limited to the choices defined by buttons in NGUI. There are scripts for darks, test exposures, focus sequences, dome flats, single telescope pointings (including dithers) and multi-pointing maps. Clicking on any of the script selection buttons at the bottom of NGUI launches a script-specific GUI, divided into subsections called Configurations, with user selectable options and user-set parameters. The button “What’s This?” at the bottom of each script GUI pops up a short description of the purpose and operation of the script.

Above the script selection buttons in NGUI are two rows of options flags that enable or disable certain actions in all scripts. The default options have been chosen from observing experience and should only be changed in consultation with your support scientist. They will be referred to in the descriptions of individual scripts below.

Many scripts contain a section for Telescope Configuration, in which most of the parameters have been disabled. Relative offsets are enabled for some scripts. Absolute pointing to RA, Dec is disabled in all scripts.

Scripts are stored in /home/observer/exec.

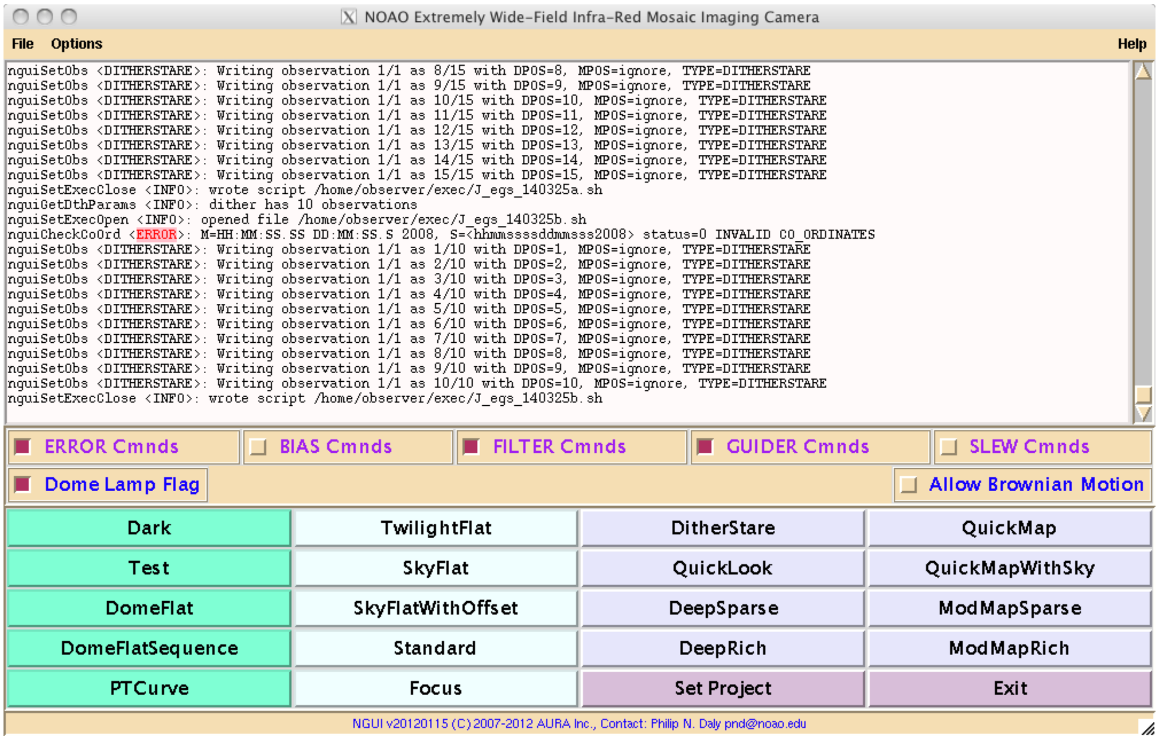

Fig. 9. Script editor NGUI with buttons for script selection.

6.1.1 To create, name, and save a script

To create a script (i.e. to set parameters in an existing script GUI), click on the appropriate script selection button at the bottom of NGUI. This will open the script-specific GUI.

In every script GUI, the Script Configuration allows you to enter an Object Name and a Script Name. The Object Name is the “title” keyword in the image FITS header. It should be short, descriptive, and meaningful to you and for that observation.

You will execute the script by typing the Script Name in the command line window. Name your script something specific and logical to you, and not too long.

To save a script, click “OK” at the bottom of the script GUI. If a script with that name already exists, you will be asked whether or not you wish to overwrite the previous version.

“What’s This?” opens a short description of the purpose and operation of the script.

If you decide not to create a script after all, click “Cancel”.

All scripts are saved in the exec directory, /home/observer/exec. The Instrument Scientist may delete scripts at this level without notification to clean up the directory from time to time. If you wish to save scripts for future use, create a subdirectory with your name (e.g. /ProbstScripts) and copy your scripts into this directory.

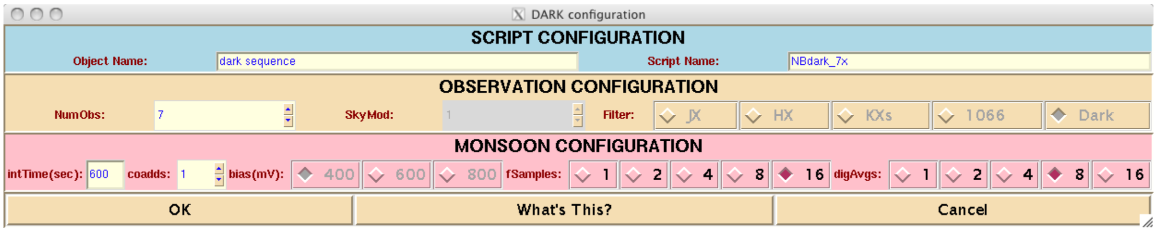

Fig. 10. Simple script GUI showing Object Name and Script Name entries (top); and "OK", "What's This?" and "Cancel" buttons (bottom).

6.1.2 To execute a script

After creating a script and clicking "OK" in the script GUI, type "rehash" in the command line window:

rehash <cr>

To execute the script, make sure that you are in the /home/observer/exec directory, and type its name as [scriptname].sh in the command line window

<scriptname>.sh <cr> (for example, Dark5s.sh <cr>)

If a script does not execute (command line window returns an error message), check to see that

- You are in the correct directory
- A script exists with that name
- The script is an executable file

6.1.3 To abort a script in progress

This has to be done carefully, or the Data Handling System will get tied up, requiring an extensive recovery process.

If the script will run to completion in a minute or two, just let it finish.

To abort, the command must be issued while an integration is in process. Examine the Monsoon Supervisor Layer GUI, upper right monitor, and verify that the integration countdown is proceeding. Then follow these steps:

i. **During integration while the countdown is proceeding**; type CNTRL-C <cr> in the command line window.

ii. The window will display instructions about how to proceed. These are the same as what is written here below.

iii. L**et the integration run to completion, until you see the message DONE in the Monsoon Supervisor Layer window.**

iv. The script will stop when integration has finished **but** it leaves the last FITS file open in the data system. This has to be closed.

v. Issue this command in the command line window to close the last FITS file:

ditscmd nohs nohs_endobs <cr>

vi. In the z.super window within the VNC DHS window, check that the last image was written to disk.

vii. You are ready to take data again.

6.1.4 To inspect or edit a script

A script can be inspected in the command line window (or in a separate xterm window logged in as *observer@newfirm-kp*) using your favorite text editor. This capability can be used to check input parameters near the start of the script. If the pattern of telescope positions on the sky is not what you expected, you can scroll through the script and check the sequence of offset commands to see how your input was translated into telescope motions.

Scripts are text files, so a text editor can also be used to change parameters without creating a new script via a GUI. However, using the GUI is likely to be faster and less prone to error, or to omissions in the repetitive metadata blocks in the script used by the reduction pipeline.

6.1.5 To create a script of scripts

GUI-created scripts can be strung together as a sequence, to make observing more efficient. You have to create a new script, which is just a line-by-line listing of existing script names. The resulting script must be in /home/observer/exec and be executable.

For example, to automatically run a set of dark scripts at various exposure times, gather the script names into a list file denominated as a shell script, e.g. “DarkSequence.sh”. Execute this script to run all the dark scripts sequentially. You can do this in the command line window using your favorite text editor. For example,

```
vi DarkSequence.sh
dark5s.sh
dark30s.sh
dark100s.sh
dark300s.sh
:wq
```

will create the script DarkSequence that runs existing scripts for 5, 30, 100, and 300 second darks in succession.

NOTE: The telescope needs to be refocused when changing filters, and this cannot be done from a script. The telescope operator does focus changes. So it's inadvisable to create a sequence of scripts in different filters.

6.1.6 To download a copy of NGUI

New NEWFIRM observers may find it useful to download NGUI to practice creating observing scripts. The latest version of NGUI may be downloaded from the NEWFIRM web site:

www.noao.edu/ets/newfirm

Scroll down the left hand table of contents to "Observing with NEWFIRM". Click on "NOCS Script Generator Tool" to retrieve a tarfile. The tarfile contents include a README file with instructions for installation on your system. While this downloadable copy of NGUI is useful for practice in making scripts, ***the resulting scripts may not work at the telescope***. NGUI uses the filter position number, not the filter name, to create scripts. The list of filters in this demonstration version of NGUI may not match the list actually installed in NEWFIRM at the time of your observations.

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6.2 Calibration and telescope setup scripts

Secs. 6.2, 6.3, and 6.4 describe all the NGUI scripts, from simplest to most complex. New users are strongly urged to read through each of these descriptions and examine the associated script GUI. Each successive script description assumes knowledge gained by reading its predecessors.

Here we describe scripts used to take dome-closed calibration data, and to get the telescope pointed and focused on sky.

NOTE: the Quick Reduce Pipeline requires appropriate Dark and Dome Flat Sequence data taken with these scripts. Be sure to do this the afternoon of your first night. See Section 8.

6.2.1 Dark

"Dark" is the simplest script, with the smallest number of user adjustable parameters. To start, click the Dark button in the script selection NGUI. This script has three Configuration sections: Script, Observation, and Monsoon Configuration.

Consult with your startup person about the instrument and telescope configuration in which to take Dark frames. If in doubt, take darks with the Environmental Cover closed, telescope mirror covers closed, and the dome darkened.

Script Configuration: user variables are *Object Name* and *Script Name*.

- *Object Name* is the "title" keyword in the image FITS header. It should be short, descriptive, and meaningful to you and that observation. Use only alphanumeric characters and the space bar.

- *Script Name* should be something short that readily identifies the script, e.g. Dark5s for a five second dark integration.

Observation Configuration: user variable is *NumObs*.

- *NumObs* is the number of images to be recorded to disk.

The Filter selection in this Configuration is fixed as Dark.

Monsoon Configuration: user variables are *intTime, coadds, fSamples*, and *digAvgs*. These define parameters for array operations in the Monsoon array controller. Since dark frames are usually taken for dark subtraction from on-sky data, the user-entered parameters under Monsoon Configuration should match the on-sky data configuration.

- *intTime* is the basic integration time—the amount of time that will be spent collecting photons before the arrays are read out.

- *coadds* is the number of integrations to take in sequence and sum into a single image which will be written to disk. A coadded image is written as a sum, not an average.

- *fSamples* is the number of Fowler samples to do in each *intTime*. *fSamples*=1 is recommended for sky background limited observations with broadband filters. Larger values of *fSamples* are for use with narrowband filters, to reduce readout noise when it is a significant noise contribution.

- *digAvgs* sets the value of a digital high frequency filter in the readout electronics. The default value of 4 is recommended for broadband and most narrowband filters. Larger values may help with noise reduction with very narrow bandpass filters.

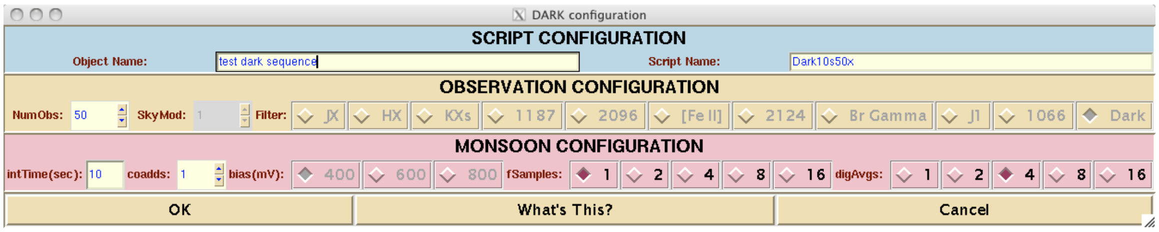

Fig. 11. DARK script GUI configured to take 50, 10 sec individual dark frames (coadds = 1). fSamples =1 and digAvgs = 4 are the default values for broadband filters.

6.2.2 Test

"Test" is a very simple script. It enables filter selection in the Observation Configuration, so external photons can be detected. "Test" is used for quick snapshots to check dome flat or sky signal levels, confirm telescope pointing, etc. The science pipeline will ignore any data taken with a Test script. Raw images are archived but not further processed.

Observation Configuration: *filter selection* is enabled. The button is to the LEFT of the filter name.

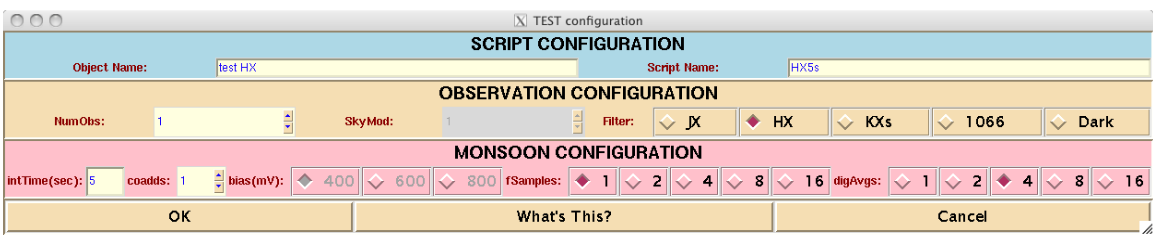

Fig. 12. TEST script GUI, configured to take one 5 sec integration in the H filter.

6.2.3 DomeFlatSequence

This script is used to take dome flats for the Quick Reduction and Science pipelines. These flats are essential to the reduction process. This is not entirely automatic. The observer must be present to turn the flatfield lamps on and off, and to set lamp levels. The script includes pauses and advisory prompts for these purposes.

You must use DomeFlatSequence for all dome flats, even if doing flats in only one filter.

Sec. 8 below has instructions for how to take dome flats, and a table of recommended lamp level and exposure time for each filter.

Observation Configuration: select the filters for which you want to take flats.

- *NumObs* is the number of images recorded to disk for each filter, typically 10

The GUI expands to allow you to set parameters for each filter selected: *intTime*, *coadds*, *fsamples*, *digAvgs*.

- *intTime* is selected to get a good exposure level, 2000-4000 ADU
- *coadds* is set to 1
- *fsamples* is set to 1 for broadband filters, higher values for narrowband filters
- *digAvgs* is set to 4 for broadband and most narrowband filters, higher values for extremely narrowband filters

The values for *fsamples* and *digAvgs* should match the values for on-sky science data taken with the same filters. Read noise reduction is an issue with narrowband filters, hence the higher values for these cases.

When the script executes, first it goes through the filter sequence, taking images, with the dome lamps off. Then it repeats with dome lamps on, prompting the user for each filter to set the lamps at the appropriate level.

Execution will stall if a filter wheel does not position properly, and the script must be aborted. Any data taken up to that point are useless to the pipelines. I recommend doing filters in batches: J H Ks first, then narrowband filters in a separate sequence.

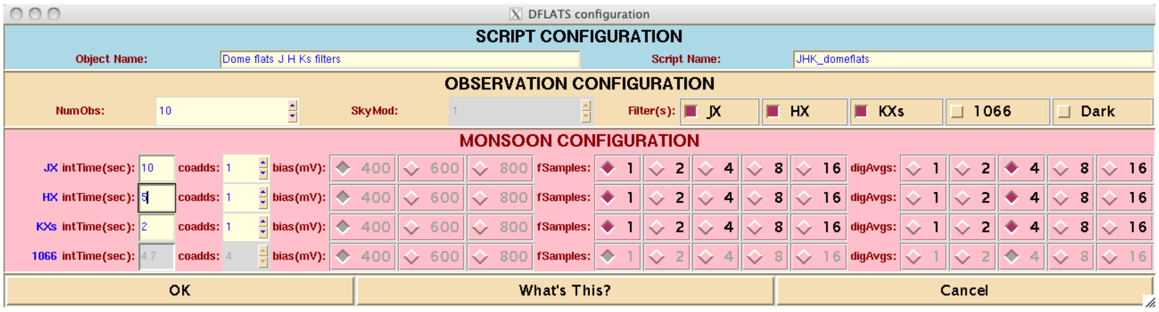

Fig. 13. Dome flats sequence script DFLATS. This script will take 10 observations in each filter J, H, Ks. The integration time is different for each filter. The dome lamp setting for each filter must be manually set by the observer as the script proceeds.

6.2.4 Focus

"Focus" takes a series of images, stepping the telescope focus in between. This script adds Telescope Configuration to the configurations. The script first offsets the telescope and acquires a "sky" frame, then offsets back to the initial position and takes an image at each focus step. These are analyzed with an IRAF routine. For more information on the focus process, see Section 9 below.

Telescope Configuration: user variables are the parameters for the focus sequence:

- RA, Dec, and Epoch are disabled. Leave these parameters "as is".

- OFFSET *RA*, *Dec* define the initial offset for the sky frame, in arcseconds. RA = 30 and Dec = 0 are reasonable choices.

- FOCUS *Start Focus*, *Step Size*, *# Focus Steps* define the focus sampling.
  - *Start Focus* is the starting value of telescope focus
  - *Step Size* is the focus increment for each step
  - *# Focus Steps* is the number of steps

  Start Focus value should be several steps less than your initial estimate of best focus. *Step Size* = 50-100 and *# Focus Steps* = 7-10 are good choices.

Output images are analyzed with the focus analysis software tools described in Section 9 below. Section 9 also describes observational procedures and rules of thumb for focusing.

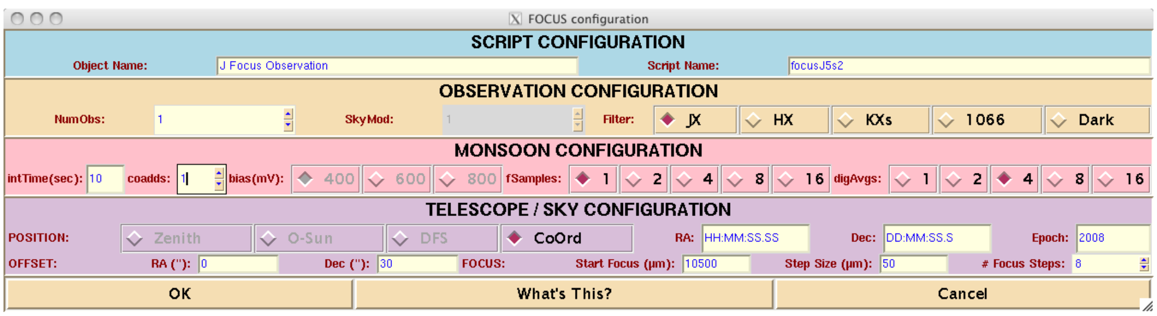

Fig. 14. FOCUS script. This example takes one 10-second observation in the J filter at each focus step. The sequence starts at telescope focus 10500, and takes 8 frames stepping by 50 units, to end at 10850. The script takes nine images in all; the first image is offset 30 arcsec in Dec and used for sky subtraction by the focus analysis routine. Note that the user-assigned Script Name is not quite right!

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6.3 Simple observing scripts; dither patterns

The two scripts described here enable observing at a single telescope pointing, including dithers (small telescope motions) and multiple integrations. These are often used for targets that do not have extensive, continuous nebulosity. The science reduction pipeline uses the image set to create a mean sky frame, with point sources suppressed by dithers, which is adequate for sky subtraction in the absence of extended sources.

The science reduction pipeline will apply linearity correction, flatfielding, sky subtraction, image registration and stacking to data taken with these and subsequent scripts, to produce science-ready images.

Pay attention to the dither geometry discussion—the same choices recur in all subsequent scripts.

If the NEWFIRM guider is used, dither patterns must remain within bounds for guide star acquisition.

6.3.1 Standard

"Standard" adds Dither Configuration for telescope dithering capability. It is used for standard stars. The data are flagged as "standard star" in the archive and are not proprietary. Other users can retrieve standard star data.

Telescope Configuration: present but inactive; inputs are ignored.

Observation Configuration: user variable is *NumObs*.

- *NumObs* is the number of observations taken at each telescope position, before the dither motion to the next position. An observation may be a single integration or a coadded sum of several integrations.

Dither Configuration: sets the dither pattern and number of repeats. The initial telescope pointing will be the center of the dither pattern. The telescope returns to this position when done.

This Configuration appears in all subsequent scripts, and the same rules apply.

- *RA* and *Dec* set offsets or bounding box sizes for dithered offsets. ***The meanings of these parameters depend on which dither geometry is chosen.***

- *Iterations* sets the number of times to repeat the dither pattern.

- *Settle*, in seconds, is an open-loop wait time after a telescope offset and before the start of the integration. This allows telescope vibrations to damp out.

6.3.2 DitherStare

This script has the same configurations and parameters as "Standard", but the data are not flagged as "standard star" in the archive. Use it when observing science targets with a single telescope pointing plus a simple dither pattern.

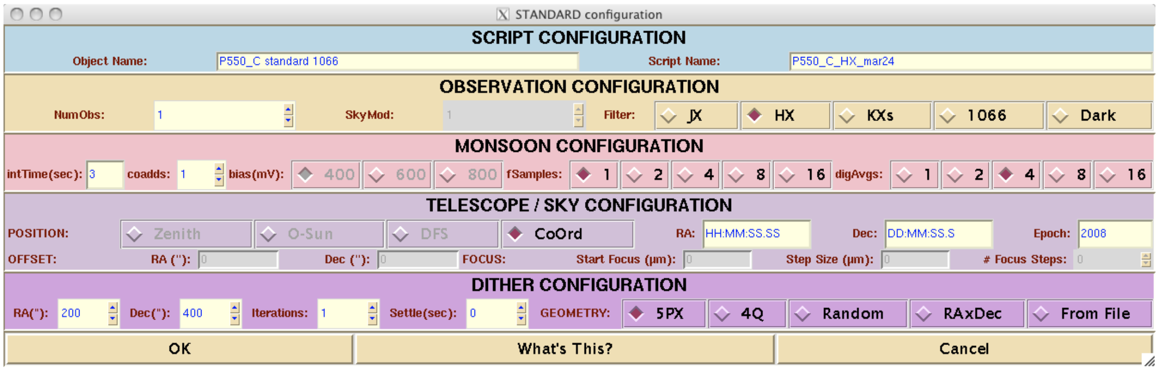

Fig. 15. STANDARD script GUI. Settle time set to 0 reduces overhead, at the expense of some image blurring from telescope shake following a move. See Fig. 17 below for more information on the 5PX dither configuration.

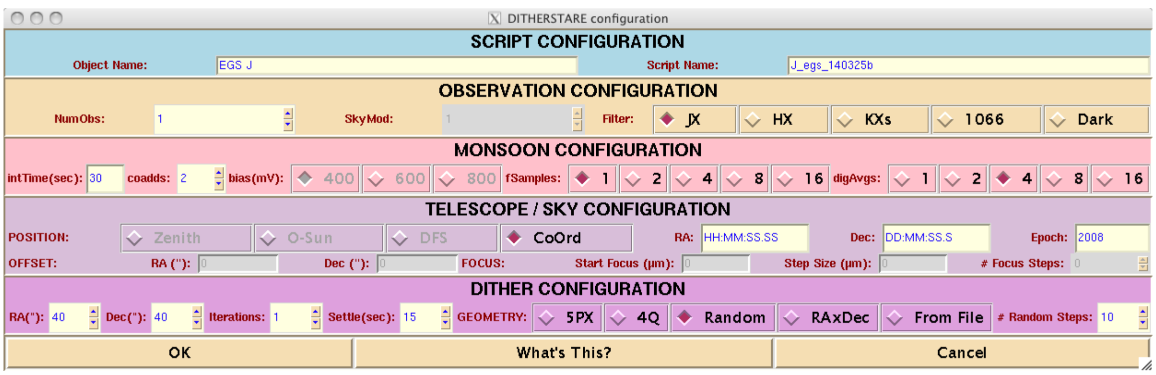

Fig. 16. DITHERSTARE script GUI. Settle time set to 15 sec is very conservative. See Fig. 20 below for more information on the Random dither configuration.

6.3.3 Dither patterns

The dither geometry choices in Dither Configuration define the pattern of motion. Dither pattern size is set by *RA* and *Dec* parameters, which have variable meanings. All patterns are centered on the initial telescope pointing, and return the telescope there at the end.

- *5PX* is an "X" pattern with integrations at each corner, and in the center
    - o *RA* and *Dec* offsets are the distances from center to corner, not corner to corner

- *RA x Dec* is a rectangular pattern. An *m* x *n* grid pattern is stepped through in successive pointings, beginning in the southeast corner and offsetting north and west.

  - *RA* and *Dec* offsets are the distances between successive points

  Setting *m* = 1 and *n* = 1 will result in no dithering—one telescope position only, at the initial telescope pointing.

- *4Q* moves the target to the center of each quadrant of the mosaic, in succession. This is a fixed, and very large, dither pattern.
  - *RA* and *Dec* offsets do not apply to this geometry.
  - Quadrant to quadrant motions exceed bounds for guiding.

- *Random* generates a bounded irregular pattern. At each successive step, an RA and a Dec motion are chosen randomly with a value between zero and +/- the *RA* and *Dec* parameters.
  - *RA* and *Dec* also set the boundaries within which the telescope is randomly pointed, ±*RA* and ±*Dec* from the initial telescope pointing.
  - Selecting "Allow Brownian motion" in the NGUI options will choose an unbounded random walk pattern. This is **not** recommended.

- *From File* moves the telescope using a user-created list of successive relative offset positions. Consult with the Instrument Scientist or observer startup assistant for use of this option.
  - *RA* and *Dec* offsets do not apply to this geometry.

Setting *Iterations* > 1 will repeat the pattern. If using the guider, the pattern will be fixed on the same detector pixels pretty closely, which may not be desirable. If not guiding, telescope-tracking drift will offset the pattern on the detector from cycle to cycle by a slight amount. To introduce deliberate offsets, use a mapping script such as DeepSparse.

The total number of coadded integrations taken of the standard star will be

NumObs x (number of positions in dither pattern) x *Iterations*

Figures 17 – 21 below illustrate these dither geometries. Each figure shows the STANDARD script GUI with appropriate entries for a chosen geometry, and a drawing of the pattern traced out by the standard star on the NEWFIRM focal plane.

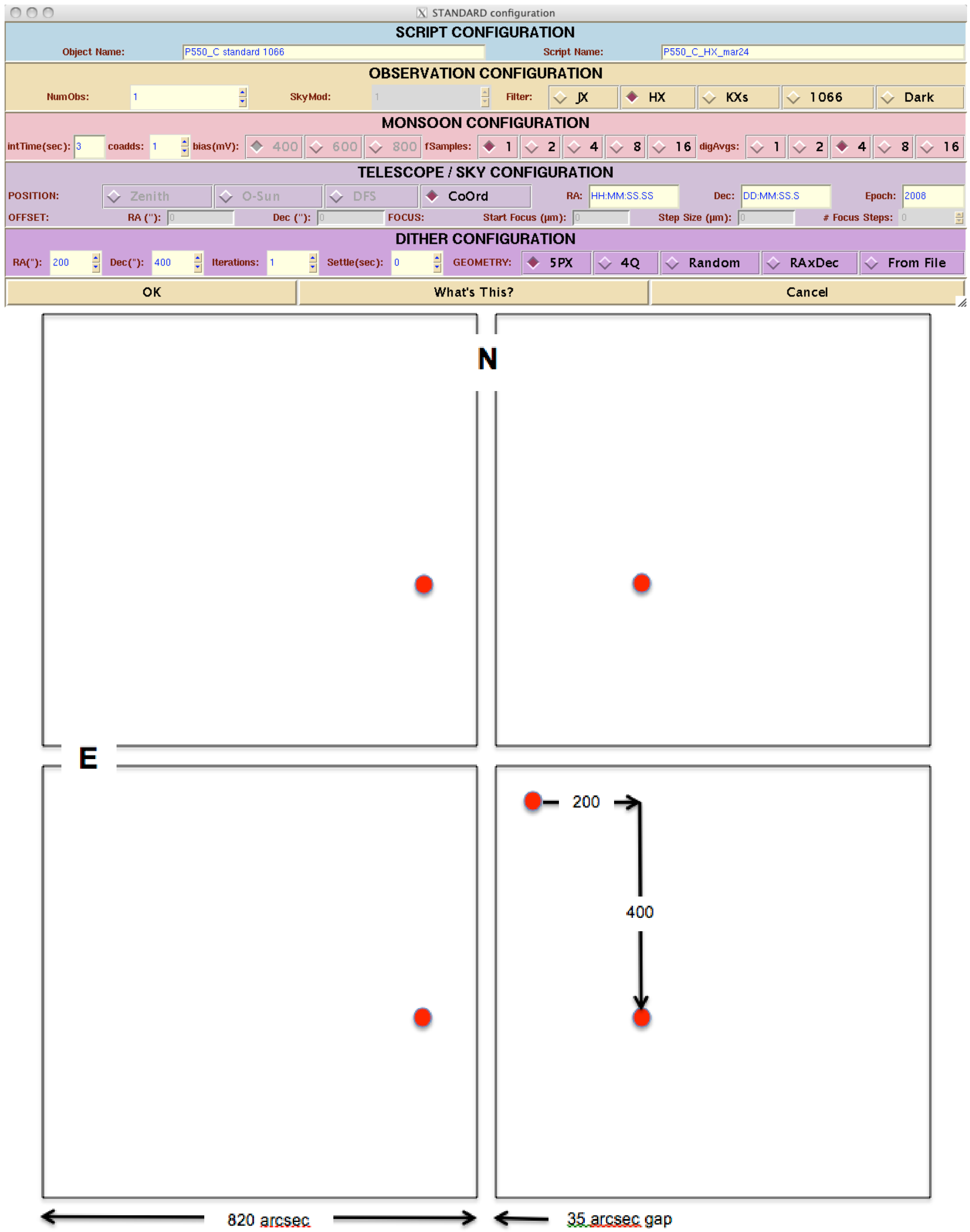

Fig. 17. STANDARD script GUI with 5PX dither geometry. Four, 3 second observations at the corners of a box 400 arcsec (RA) x 800 arcsec (Dec), plus a fifth observation at box center = starting telescope position. Settle time = 0 reduces overhead at the expense of some image blur from telescope shake. The on-sky pattern shown assumes a manual telescope offset NE from the initial telescope pointing, before starting the script, so the box-center position doesn't fall into the gap between arrays.

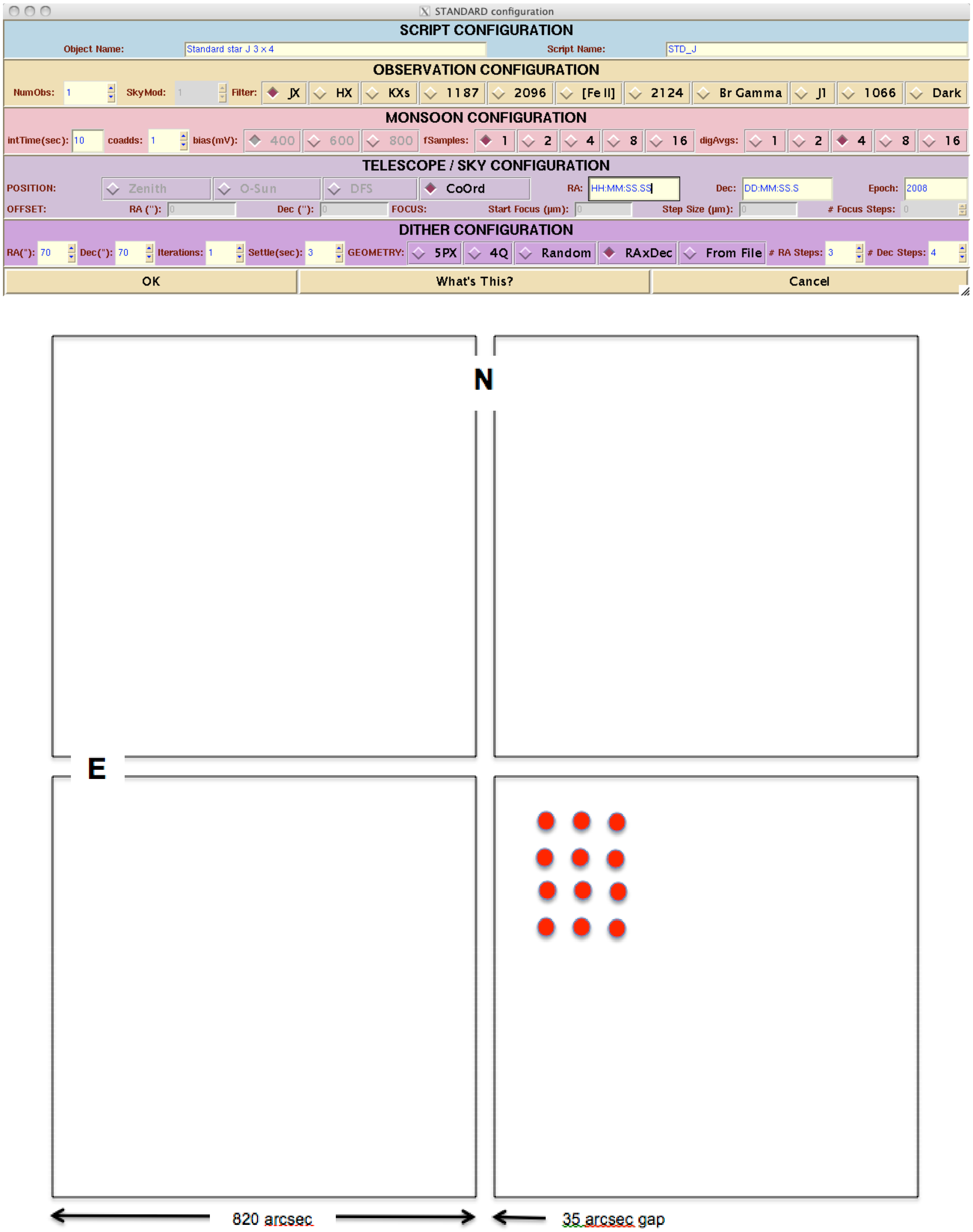

Fig. 18. STANDARD script GUI with RA x Dec dither geometry. With 70 arcsec spacing between points, the 3 x 4 dither pattern defines a 140 x 210 arcsec box. The telescope has been manually offset NE from the initial telescope pointing so all dither positions lie in one quadrant (one detector) of the focal plane.

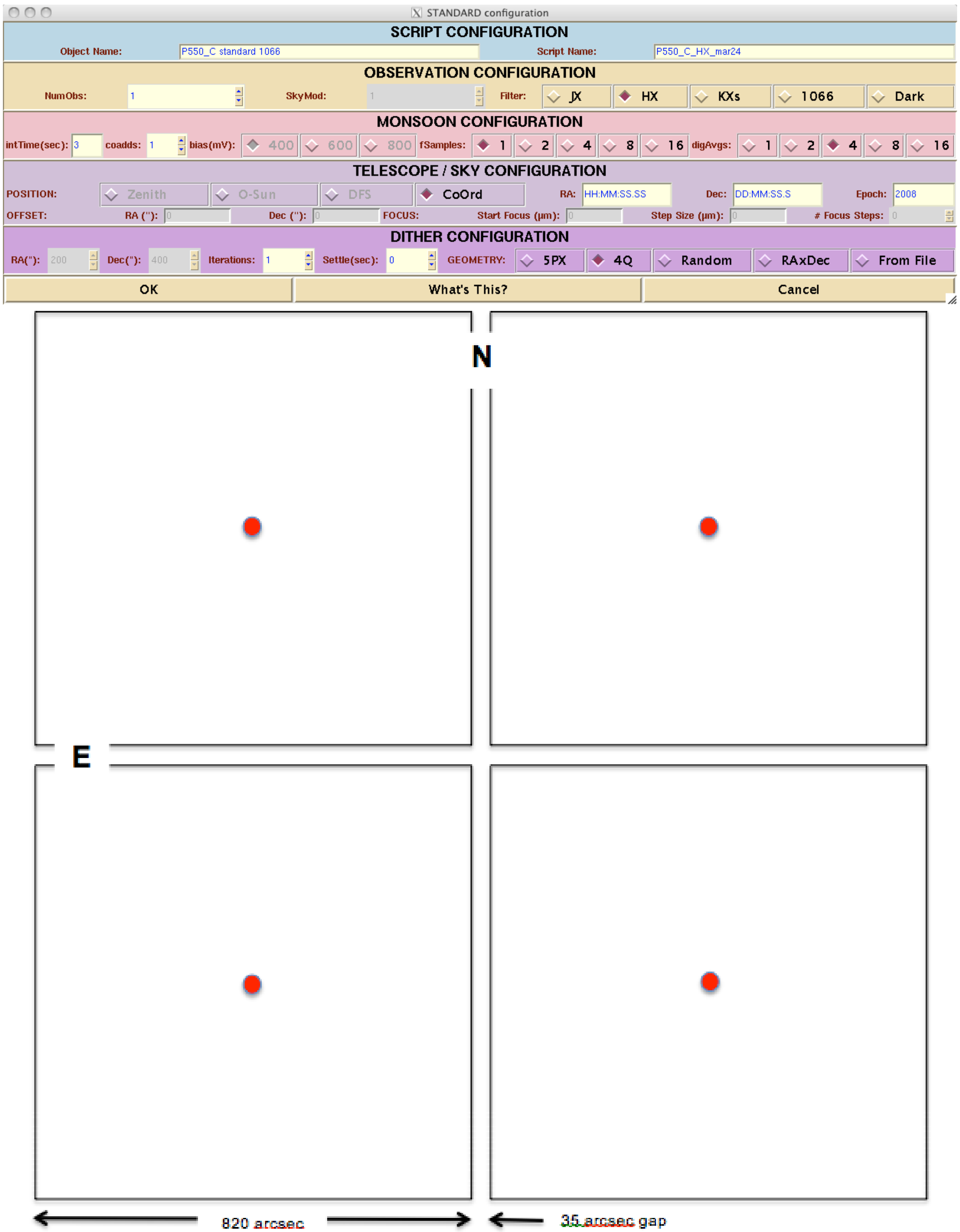

Fig. 19. STANDARD script GUI with 4Q dither geometry. Predetermined offsets put the star in the center of each quadrant of the focal plane mosaic in succession.

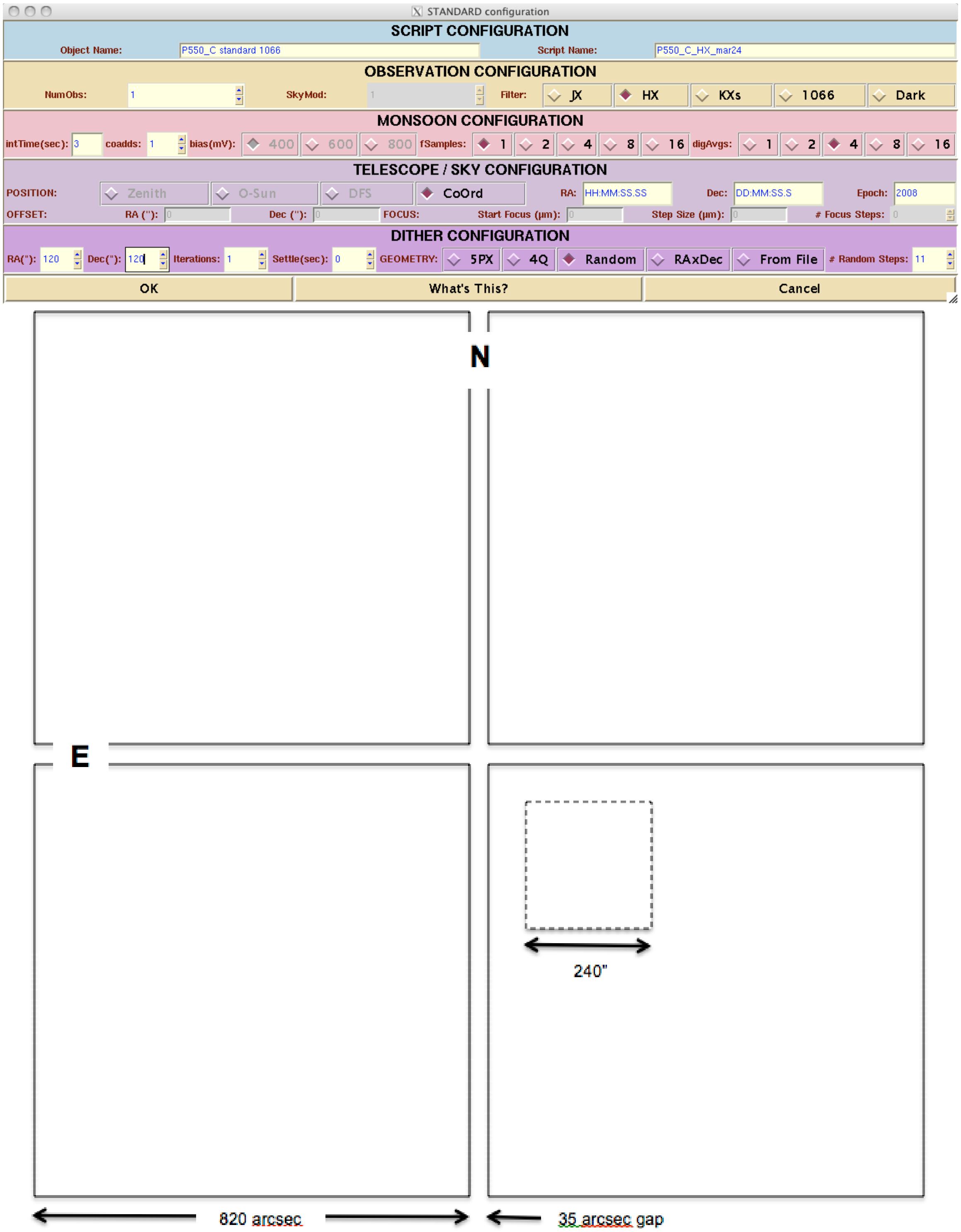

Fig. 20(a). STANDARD script GUI with Random dither geometry. With RA = Dec = 120 arcsec, the specified 11 steps will lie within a 240 x 240 arcsec box. The telescope has been manually offset NE from the initial telescope pointing so this box will be in one quadrant (one detector) of the focal plane.

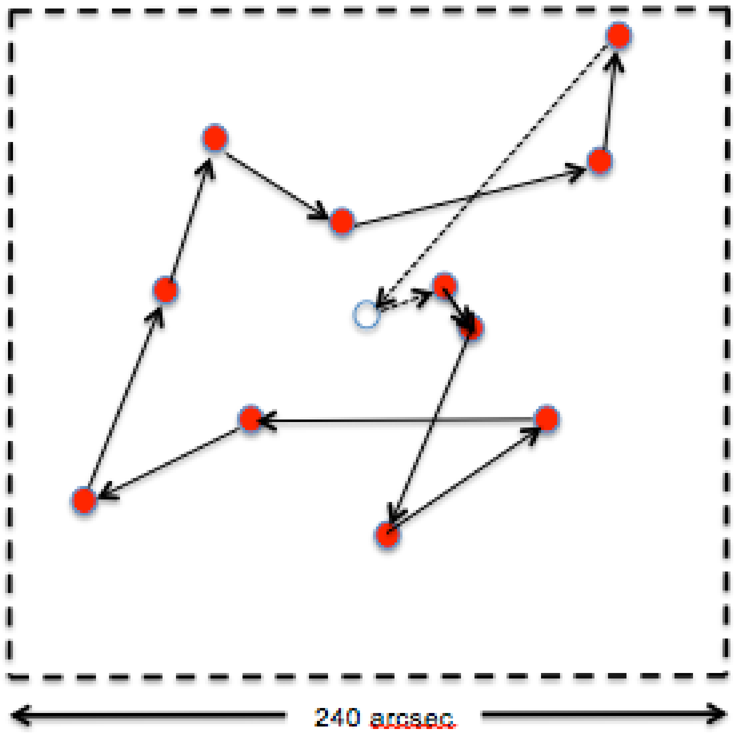

Fig. 20(b). Enlargement of the sequence of telescope positions generated by the Random script generator. The open circle marks the starting point after manual telescope offset, which is also the center of the pattern. Integrations are taken at the red positions. The first and last dither moves, dotted lines, are from and then returning to the pattern center.

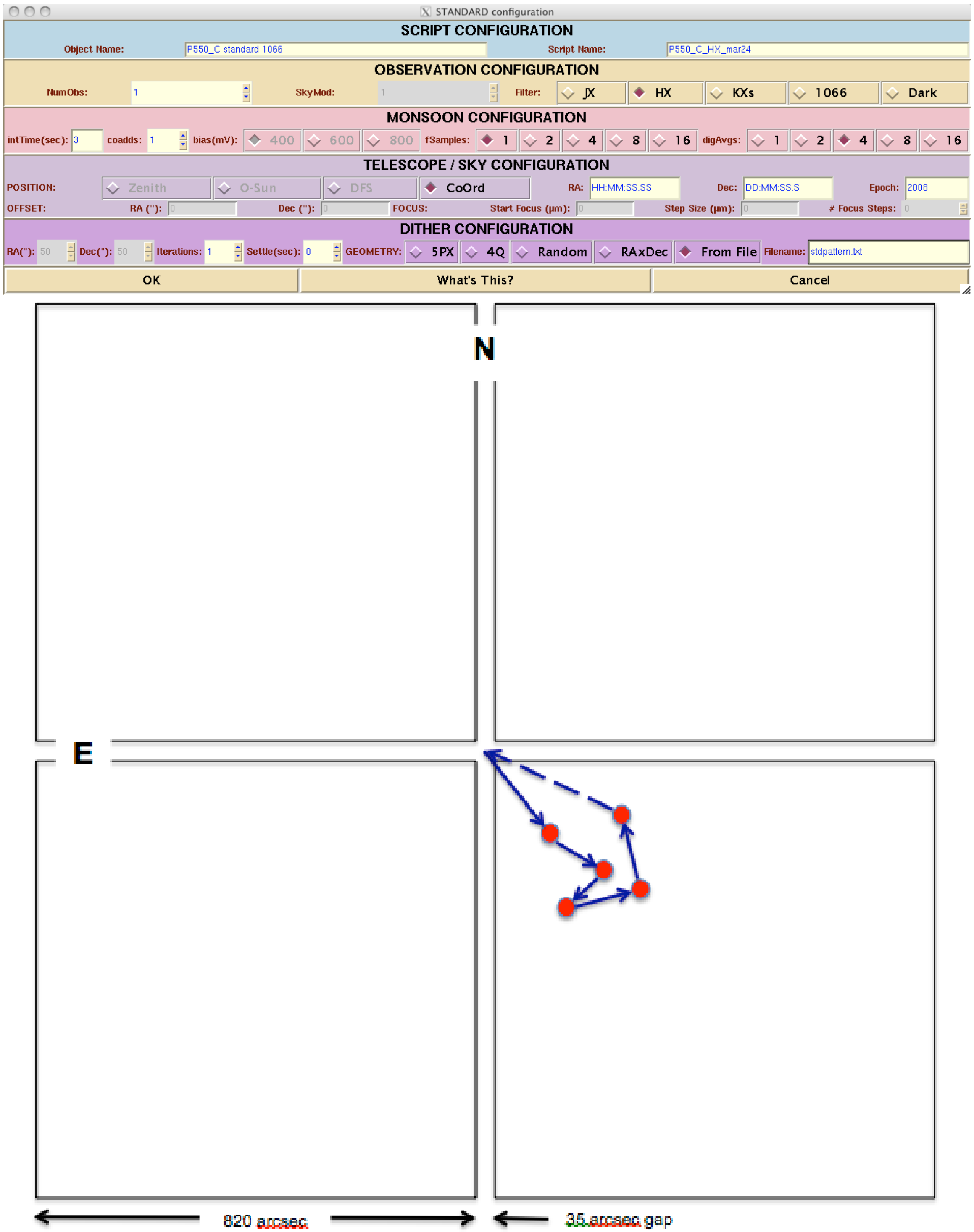

Fig. 21(a). STANDARD script GUI with dither pattern "From File". The first telescope motion moves the star out of the central gap between arrays. The last motion recenters it. The pattern has been defined so that the star position does not repeat any row or column, and the separation between images adjacent in time is many tens of arcsec.

File stdpattern.txt

123.	158.
105.	70.
-70.	70.
140.	-35.
-35.	-140.
-263.	-123.

Fig. 21(b). The file of telescope motions that generates the pattern shown in Fig. 21(a).

The figures used above to illustrate dither patterns show these from the point of view of the detector: where on the focal plane mosaic does a single point in the sky (in the examples, a standard star) lie at any point in the pattern? For science targets, which may be extended sources or a defined area of sky with many small sources, it is useful to ask what the coverage looks like on the sky—how is a given area of sky being sampled?

First consider an extended source of moderate size observed with a 4Q pattern. Fig. 22 shows this from the detector point of view—the source moves from quadrant to quadrant.

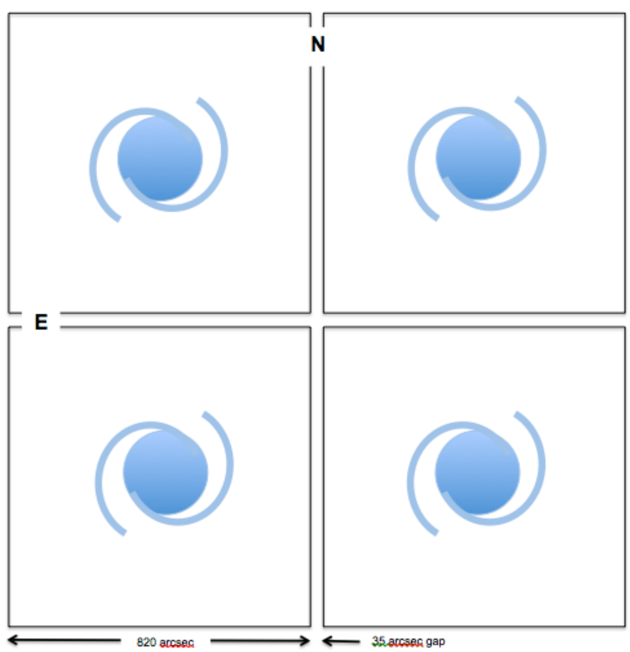

Fig. 22. Integrations on an extended source with a 4Q dither pattern, from the detector point of view. The source moves around the 2x2 mosaic of individual detector arrays.

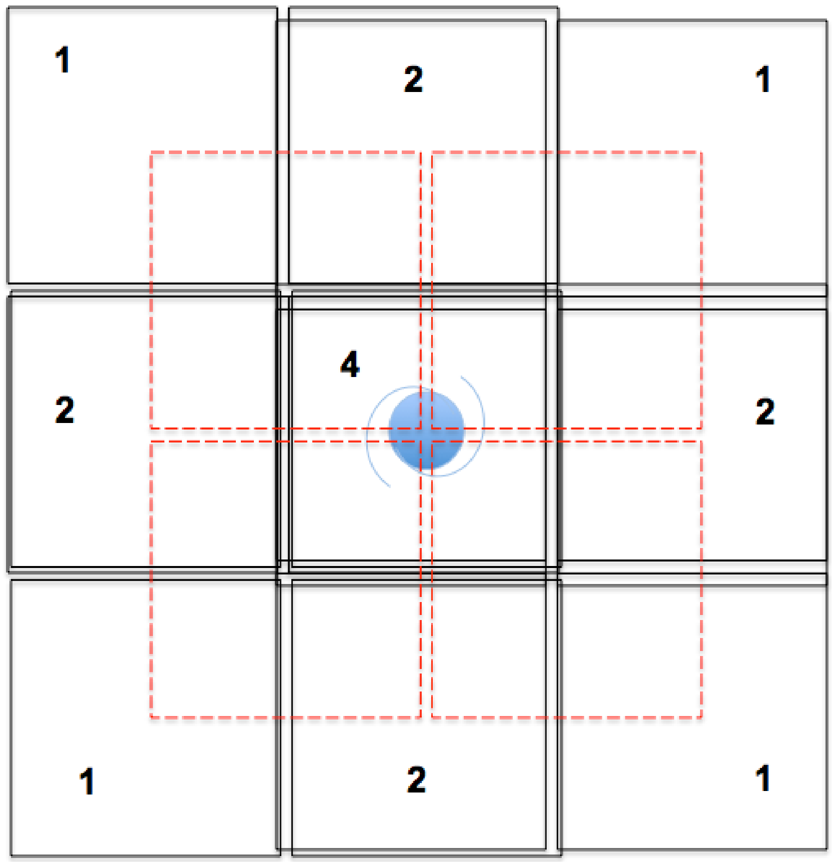

Fig. 23. Integrations on an extended source with a 4Q dither patter in terms of sampling on sky. Red dashed lines show the actual 2x2 detector mosaic. The pattern on the sky is 3x3, with quadrant-sized pieces of sky observed 1, 2, or 4 times as indicated. The fixed offsets of the 4Q pattern are defined so that the gaps between arrays are filled in the final composite image.

Fig. 23 shows the sky coverage of this pattern. Total sky coverage is ~2X the single-pointing FOV by area, but the time spent at any given point on the sky, and resulting SNR, have pronounced spatial variations. The advantages of 4Q for this source are (i) 100% efficiency integrating on the source and (ii) the sky is well sampled by each array in the 2x2 detector mosaic for good sky subtraction on the source.

Next consider an area of sky with dispersed small sources, observed with an RA x Dec pattern. Fig. 24 shows the DITHERSTARE script GUI that defines the observations. Fig. 25 shows the detector point of view: how the field center of the initial telescope pointing moves around the focal plane. Notice that the offsets between dither pointings are larger than the gap between detectors.

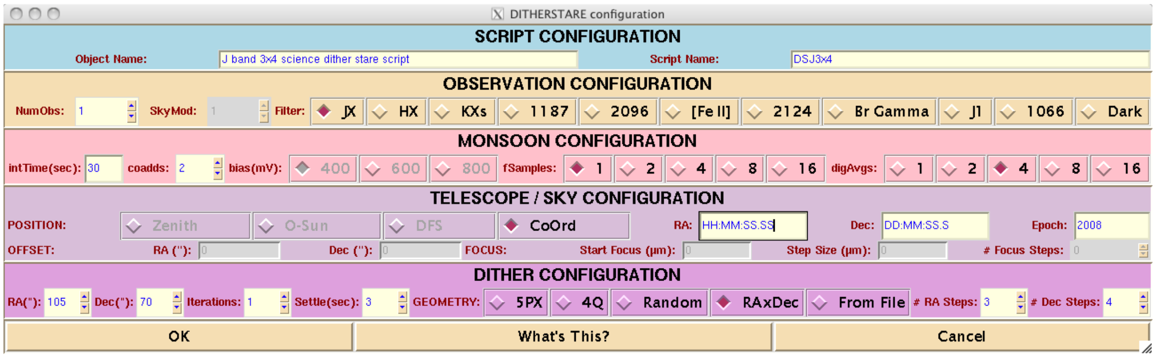

Fig. 24. Script defining the dither pattern shown in Figs. 25 - 27. This RA x Dec pattern uses 3 x 4 positions, with different offsets in RA and in Dec.

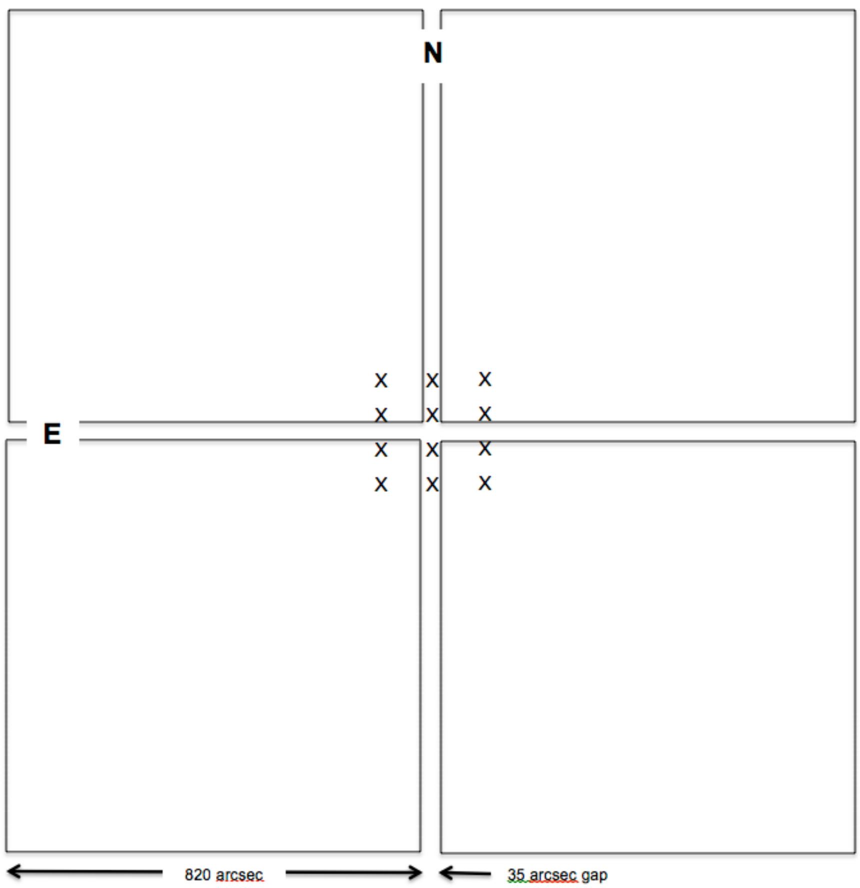

Fig. 25. Observation with an RA x Dec pattern: detector point of view. The X's indicate how the field center of the initial pointing moves around the focal plane. This is a 3 x 4 pattern with spacings of 105 arcsec in RA and 70 arcsec in Dec.

The next two figures show how the sky is sampled, and compares this to a single pointing. The area of maximum source time-on-pixel is ***smaller*** than the single-pointing FOV. Over most of this area, source time-on-pixel is uniform and equal to the total integration time of the dither pattern. The gap between arrays introduces stripes of reduced time-on-pixel across field center. But, since the dither offsets are larger than the gap, spatial coverage is still continuous.

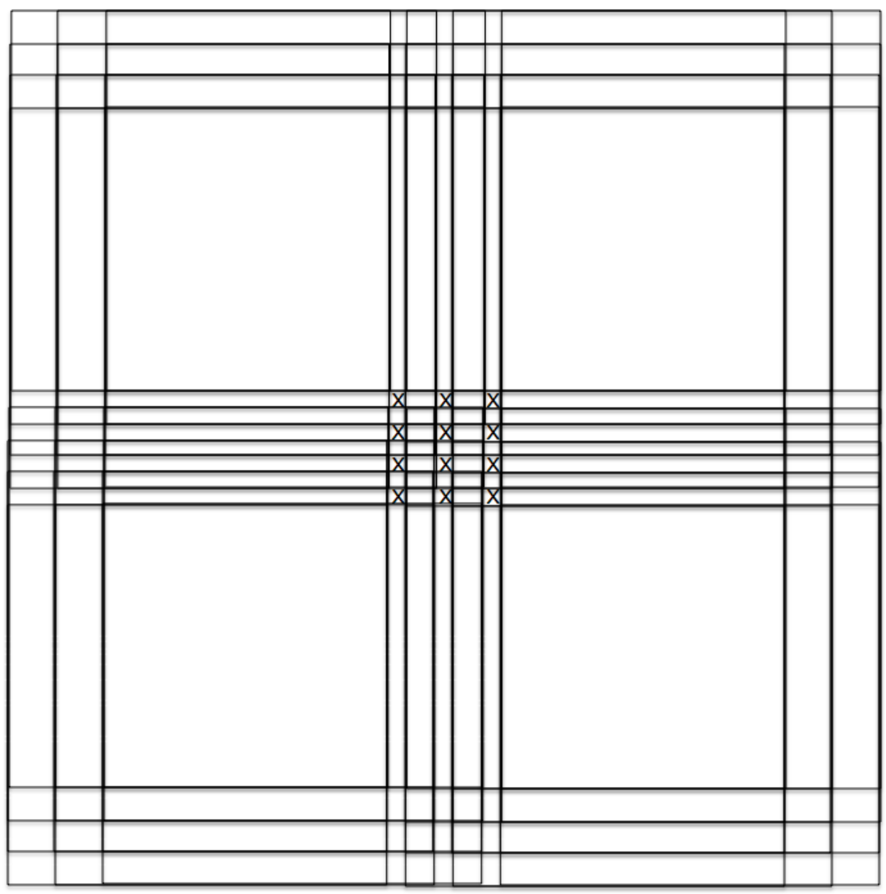

Fig. 26. Sky coverage of the RA x Dec pattern of Figs. 24 and 25. The sky is sampled with twelve overlapping telescope pointings.

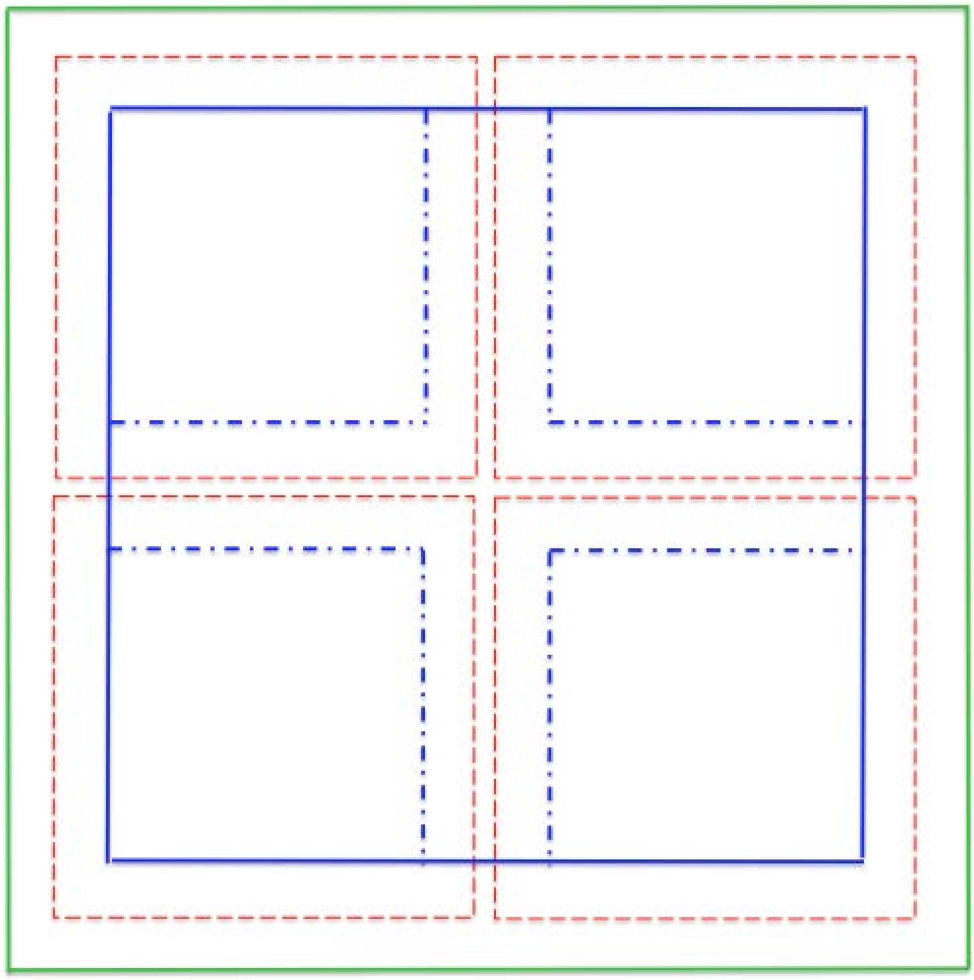

Fig. 27. Observation with an RA x Dec pattern: time on source. The single-pointing FOV is shown in red. An area of sky within this (blue) is sampled at every pointing for maximum time on source, except for the cross-shaped region where the array gaps produce stripes of lower integration time and SNR. The total sky coverage is outlined in green. Integration time and SNR taper stepwise to lower values in the frame defined by the blue and green outlines.

In general, any dither pattern that is bounded by a box will produce an area of maximum sensitivity that is the single-pointing FOV less a "frame" of half the box width on all sides.

The regular pattern of RA, Dec offsets used for Figs. 24-27 emphasizes the stripes of lower integration time across field center, by precisely overlaying the row and column array gaps multiple times. This reinforcement can be reduced by using a Random pattern, or by creating a file of offset positions chosen so that the array gaps do not overlap on sky between any telescope pointings. This will produce spatially smoother SNR in the final registered and stacked composite image.

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6.4 Scripts with complex telescope motions

Previous scripts have enabled a pattern of telescope motions around the initial pointing with the Dither Configuration. Now we introduce a second level of telescope pointings via the Map Configuration. "Dither" motions and "Map" motions are nested. Starting from the initial telescope position, the telescope goes to the first pointing specified by the map parameters. It executes a dither pattern around that pointing, as specified by dither parameters, ending back at the first map pointing. Then the telescope moves to the second map position and executes a dither pattern; and so on.

In some scripts below, Telescope Configuration is used to introduce a third level of motions, for observing "blank sky" positions free of extended emission. Yes, this is getting complicated!

Scripts with both Dither Configuration and Map Configuration are used to (i) observe large contiguous areas, and (ii) to subsequently treat the image set as a whole in the science reduction pipeline. There are two types of usage:

- Efficient observation of large areas containing only point (or very compact) sources, also yielding a well-defined mean sky image for sky subtraction.
- Observation of extended sources. The Map Configuration is used together with Telescope Configuration to define "sky" pointings chosen to be free of extended nebulosity, to observe them intermixed with target pointings, and to flag them for definition of background mean sky image in the pipeline reductions.

Map Configuration patterns and parameters are the same as for Dither Configuration. The same rules apply as to location of starting point, how the telescope walks through a Map pattern, and what RA, Dec offsets mean depending on the chosen Map pattern.

Large (~1600 arcsec) Map offsets displace the telescope by nearly a full NEWFIRM field of view (with a little overlap for registration). The fixed half-field offsets (~800 arcsec) of the 4Q pattern can be used to position a moderately extended target on each quadrant of the array mosaic in succession (and then dither it using the Dither Configuration).

A large Map motion (>2 arcmin) will place a selected guide star out of range of the guide probe. The Guider Wait option will pause data taking to allow acquisition of a new guide star at each Map position. This will impact observing efficiency.

One generally thinks of Map motions as "large" and Dither motions as "small". However, Map offsets can be any size. Small Map offsets (few arcsec) can be used to quasi-randomize the pixel sampling of the sky in an iterated dither pattern, while guiding. This is useful for very deep imaging of fields containing only pointlike sources.

6.4.1 DeepSparse

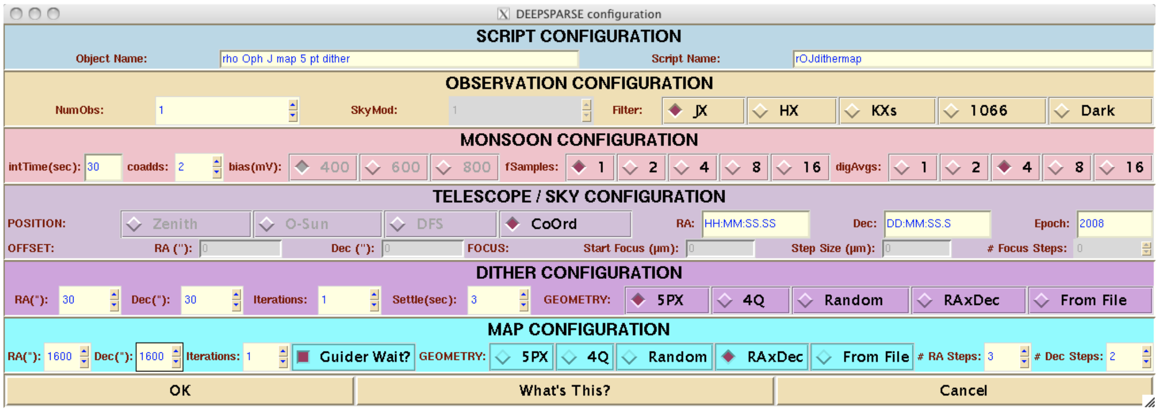
This script adds Map Configuration. Map patterns and parameters are the same as for Dither Configuration. The same rules apply as to the location of the starting point, how the telescope walks through a Map pattern, and what RA, Dec offsets mean depending on the chosen Map pattern.

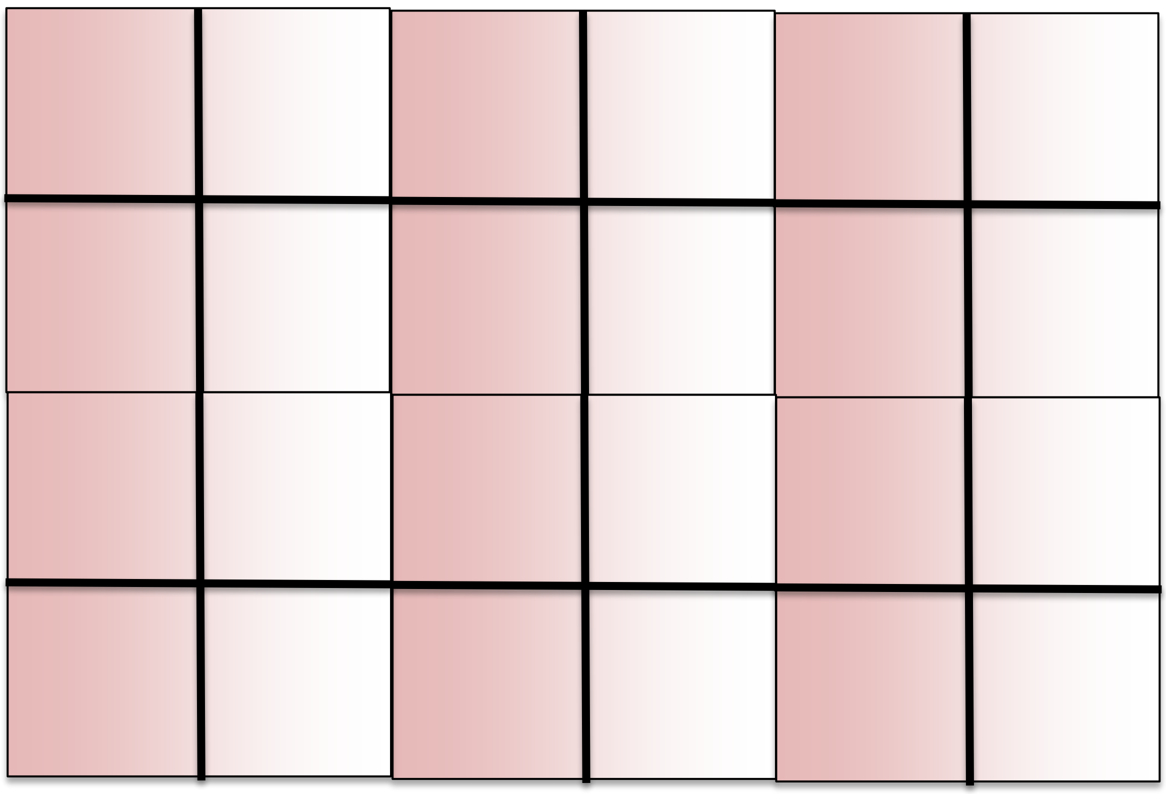
Telescope Configuration is present but inactive; inputs are ignored.

This script is used for efficient observation of large areas containing only point (or very compact) sources. It also produces a well-defined mean sky image for sky subtraction.

Map parameters are typically set to offset the telescope by large amounts, to cover the desired total area. Dither parameters are set to do a dither pattern at each map pointing. The pipeline reduction uses all images together to define a mean sky image for sky subtraction.

Figure 28 is an example of a DeepSparse script. The map is a rectangular pattern, 3 x 2 positions in RA x Dec. At each map position, a 5 PX dither is executed. E-W shading is used to denote the individual Map pointings. Heavier lines are the array gaps. The 1600 arcsec map offsets allow ~70 arcsec of overlap between positions, for registration into a composite image using stars in common. This overlap is also slightly larger than the 60 x 60 arcsec box covered by the dither patterns. This dither pattern, in turn, is chosen to fill in the 35 arcsec wide array gaps.





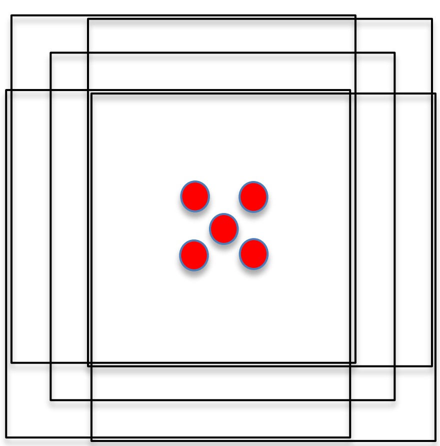


Fig. 28. Example DeepSparse script:

Top: Script GUI entries
Middle: Large scale Map pattern
Bottom: Small scale Dither pattern at each Map pointing

6.4.2 DeepRich

Like DeepSparse, this allows two levels of telescope motion, Dither and Map, which can be used in the same ways. Telescope Configuration is now active and allows a third level of motion with the Offset parameters in RA and Dec.

Telescope Configuration: user variables are *RA Offset* and *Dec Offset*.

- *RA Offset* (in arcsec) specifies how far to move the telescope in RA, from the current map position, to take sky frames; + east, - west.

- *Dec Offset* does the same in Declination; + north, - south.

The offsets are applied between Map positions during the dither-map cycle to move off of an extended target for sky frames. This produces a dithered sky frame set for every Map position. Note that this is not the same sky pointing every time. The offsets to sky mimic the Map pattern, offset in RA and Dec. The routine begins and ends with a sky position.

This has proven to be a time-inefficient script when used “full up” for dithering plus mapping plus sky. The repeated telescope offsets to sky are time-consuming. For many purposes, they also result in far more sky frames than are necessary.

DeepRich can be useful for observing an extended source that fits within a single NEWFIRM field of view. In this case, choose “RA x Dec” as the Map option and set m = n = 1 to get a single Map position. Point the telescope to the target. The telescope will then offset to the sky position specified in Telescope Configuration; execute a dither pattern there; offset back to the target and execute a dither pattern there; and then repeat the sky observations. The reduction pipeline will use only the sky position images to define and subtract the sky background from the extended source images.

Figure 29 is an example of a DeepRich script. The map on source (pink) is a 3 x 2 pattern in RA x Dec, as in Fig. 28. Each source map pointing is accompanied by a pointing on sky (blue). The sky pointings build up a similar pattern. The map offsets are 1600 arcsec in Dec x 2 Dec positions. The offset to sky from each source pointing is 3200 N in Dec. As a result, the pattern on sky is contiguous to the pattern on source in this example.

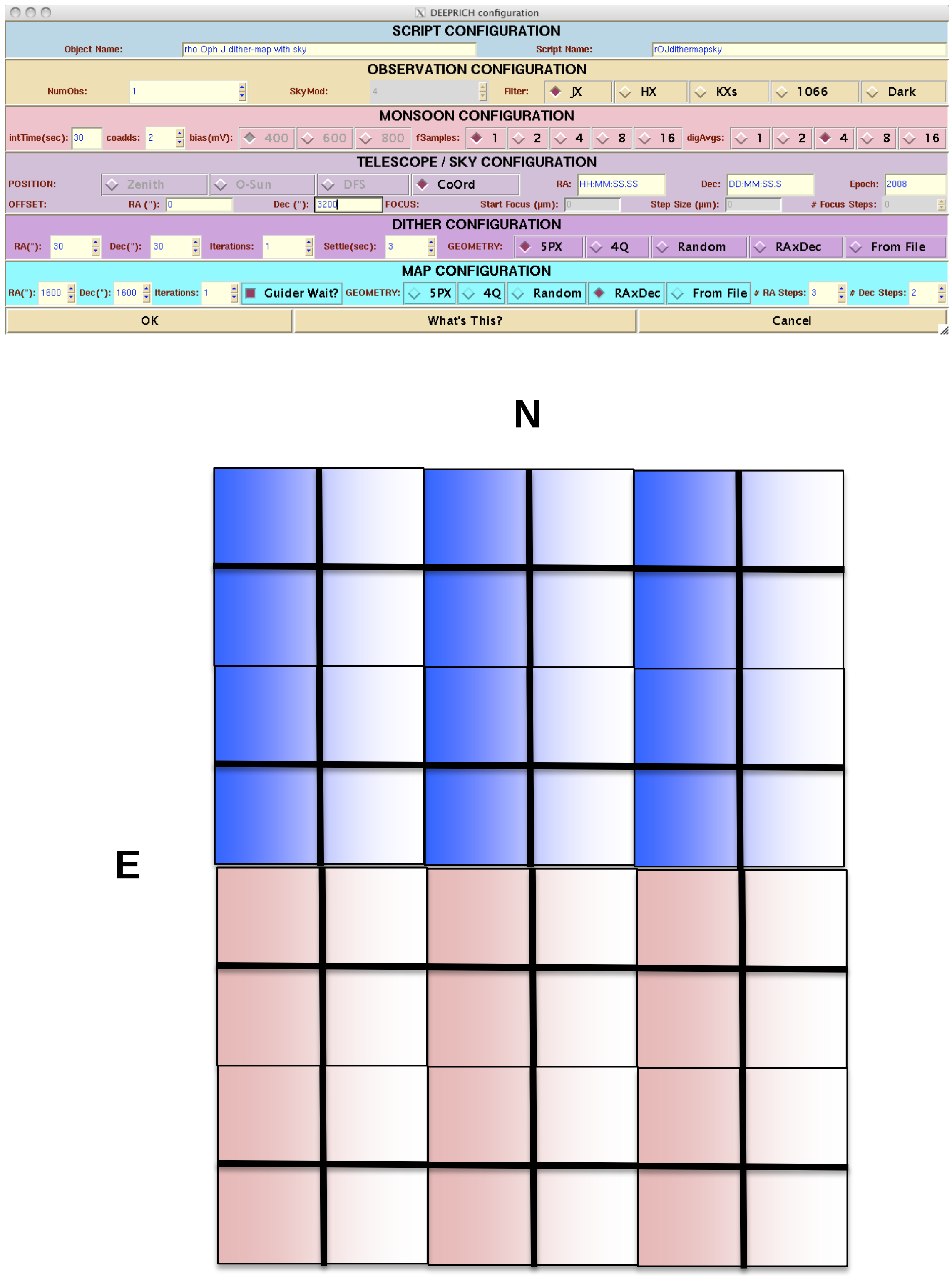


Fig. 29. Example DeepRich script. GUI (top) and resulting sky positions (bottom). Pink is the map on source, blue is the map on sky.

6.4.3 ModMapRich

Like DeepRich, this allows three levels of telescope motion: dithering, mapping, and offset to a blank sky position. However, it takes fewer blank sky positions.

Telescope Configuration: new user variable is *SkyMod.*

- *SkyMod* sets the frequency of offsets to sky while executing the Map.

This is best illustrated by examples:

- For a 2 x 2 raster Map and *SkyMod* = 4, ModMapRich will do a dither pattern at the blank sky offset position; all four Map positions; and another sky set.

- For a 3 x 3 raster Map and *SkyMod* = 3, ModMapRich will do a blank sky set; the first three Map pointings; another blank sky set; the middle three Map pointings; a sky set; the last three Map pointings; and a sky set to end the script.

This results in less clock time spent on large telescope motions, and a more optimal number of sky frames for definition and subtraction of a mean sky frame, compared to DeepRich.

Consult with the Instrument Scientist or startup support person for setting the parameters of this rather complex script.

Figure 30 is an example of a ModMapRich script. The map on source (pink) is a 3 x 2 pattern in RA x Dec, as in Figs. 28 and 29. With parameter SkyMod = 3, the script takes an offset sky frame at the start (sky 1), executes the three position southern row of the source map in RA, takes another offset sky (sky 2), executes the second, northern row of the source map, and finishes with a final offset sky position (sky 3). Since the Map offset = 1600 and the Sky offset = 3600 in Dec, there is a 400 arcsec gap in Dec between the source pattern and the southerly sky pointings. The script also executes a 5-point dither pattern at each source and sky pointing.

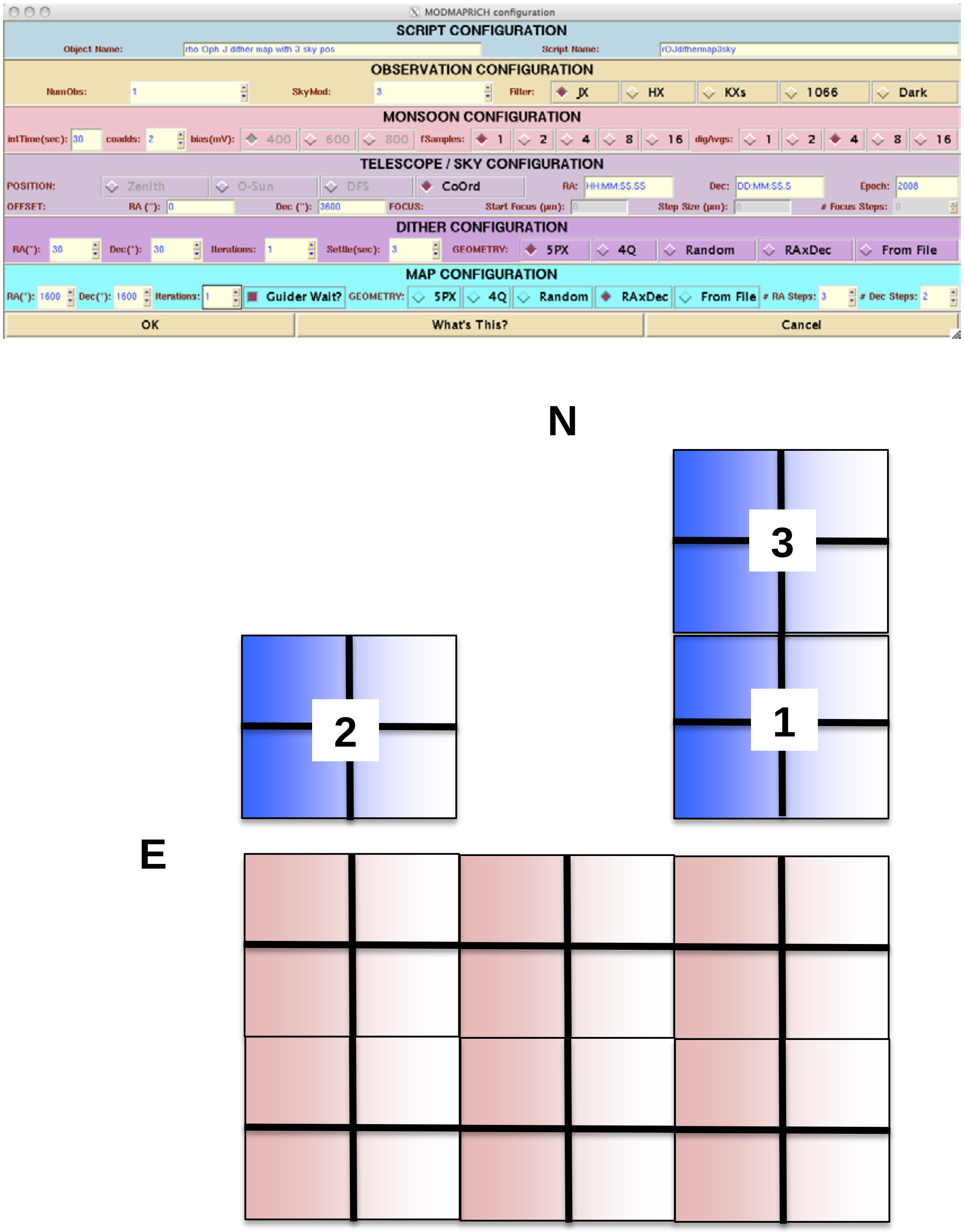


Fig. 30. Example ModMapRich script. GUI (top) and resulting sky positions (bottom). Pink is the map on source, blue is the map on sky.

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7. Using the DHS windows while observing

Two functions of this set of windows are to display and interact with raw images, and to be sure that the image writing to disk is proceeding normally.

7.1 Image display and interactions

Ximtool image display features:

- o Image display shows the raw incoming pixel frame, autoscaled to sky level.
- o Orientation is North up, East left.
- o Click on the T and C boxes in the toolbar to open up two more toolbars.
- o Click on Pan, WCS, and ISM to get an image panner; X, Y coordinate display; and pixel value display.
- o Mag +/- will change the size of the panner box.
- o Hold down the right mouse key and pan around the image to change image brightness and contrast.
- o Click on Display to bring up a GUI with these and other capabilities.

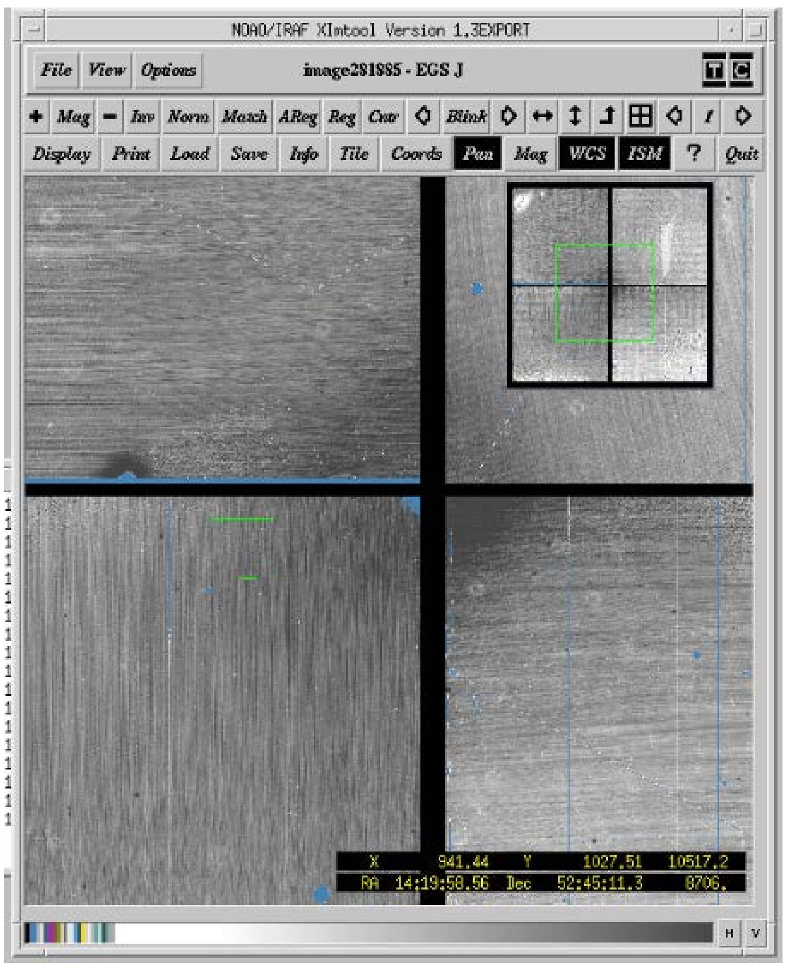

Fig. 31. Ximtool image display with toolbars, Pan, WCS and ISM selected.

Images on the disc can be displayed to the Ximtool with IRAF using *mscdisplay* in the mscred package. *mscexamine* or other tools can interact with the displayed image. However, if you are taking data, the next raw frame to be read out will overwrite an image displayed from disc. Imexam etc. tools will not work on the autodisplayed raw frame since it was not retrieved from the disk.

It may be convenient to go to a separate desktop on the monitor, open another connection to *observer@newfirm-kp*, and then open a separate IRAF cl window and Ximtool for data inspection.

7.2 Monitoring data logging

This is done through the DHS Supervisor Window and the z.super window.

In the DHS Supervisor Window, click on the Shared Memory Cache tab. This displays the data presently in memory. A complete data set for a single image is five lines of text, all with the same exposure ID number at the end (ExpID column). Lines of text will appear and disappear as data are read into memory and then processed onto the disc.

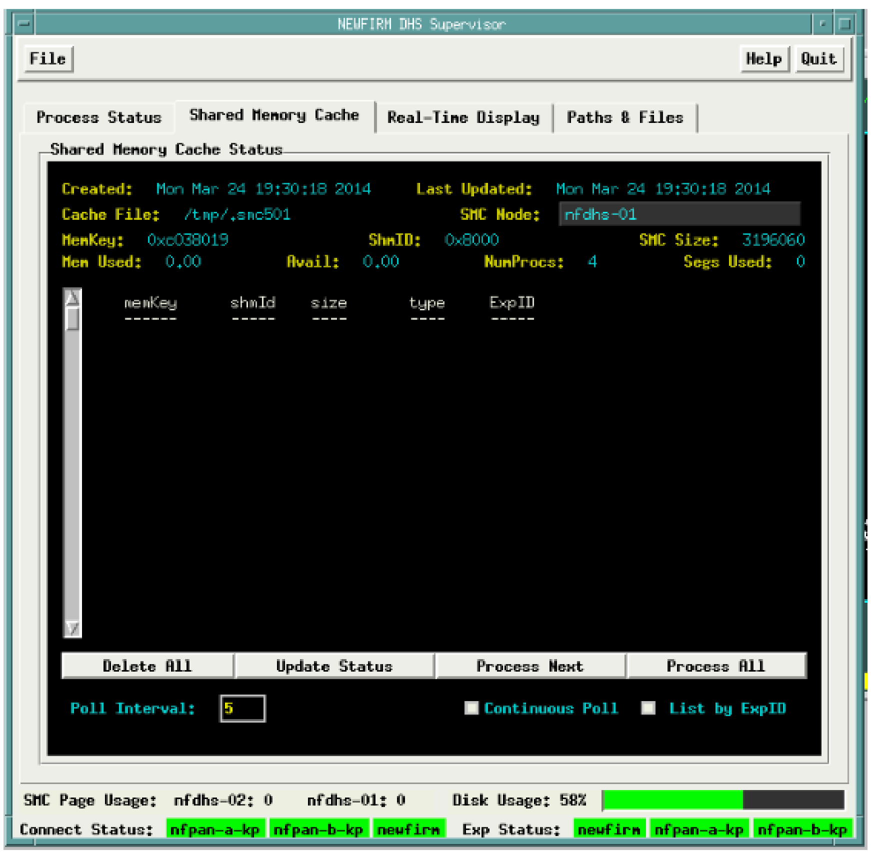

Fig. 32. DHS Supervisor Window – Shared Memory Cache display.

Processing steps are displayed in the z.super window. The main thing to look for is the highlighted box with message “Postproc DONE”, updating at regular intervals. This indicates that a raw image has been written to disk as a multiextension FITS file.

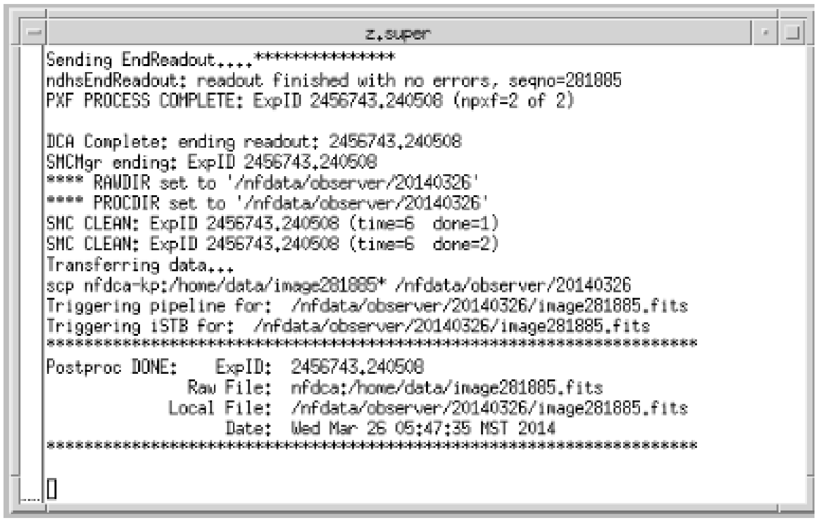

Fig. 33. z.super window with Postproc DONE message

If lines of text begin to build up in the DHS Supervisor Window without disappearing, 10 lines or more, try clicking the Update Status button at the bottom to flush data to disk. It does no harm to click this more than once, to flush multiple frames. You should see processing occur in the z.super window as text lines disappear from the DHS Supervisor Window.

If processing stops and text lines continue to build up, or if the Shared Memory Cache page turns **red**, there is a problem. Use the procedures in Appendix A.5 [96]to abort any script that’s running and then recover from the error condition with the procedures in Appendix A.2 [78].

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8. Taking dome flats and darks

Both the Quick Reduce Pipeline and the Science Pipeline require dome flats taken with the Dome Flat Sequence script to process your on-sky data. Be sure to get these during the afternoon.

Dark frames that match the science exposures are needed for the best quality Science Pipeline reduction. Provision of dark frames is critically important for exposures with low background, especially narrowband images. This requires advance planning of science exposure parameters for the first night, so that darks can be taken to match in the afternoon.

8.1 Taking dome flats

Ask the operator to request that the telescope be set up for dome flats at 4:00 p.m.

Use a DomeFlatSequence script to take these data (Sec. 6.2.3). This is necessary for the pipeline processing. This script allows you to choose which filters to use, and to set the integration time for each filter. It will take a set with “lamps off” in all filters, and then a set with “lamps on”. DomeFlatSequence will prompt you to turn the lamps on or off, and to set them to the desired brightness, at every filter change. Take at least three dome flats in every filter. The pipeline requires this. I recommend a minimum of ten in every filter for adequate photon statistics in the flatfields.

Execution will stall if a filter wheel does not position properly, and the script must be aborted. Any data taken up to that point are useless to the pipelines. I recommend doing filters in batches: J H Ks first, then narrowband filters in a separate sequence.

The DomeFlatSequence script sets the integration time in each filter. However, lamp brightness is set manually, so taking a set of dome flats is an interactive process.

Lamp control is via a group of buttons on the telescope console, below the windows to the telescope, labeled LAMPS (Fig. 34). The upper button indicates which set of dome flat lights is turned on. The middle row of three buttons select high intensity lamps, low intensity lamps, or off (no lamps). The bottom row of two buttons let you make the selected lamps brighter or dimmer. A large red display shows the brightness setting.

A toggle switch below the lamp control buttons allows the same buttons to be used to drive counterweights for balancing the telescope. Be sure this switch is set to “Flat Field Lamps”.

Figs. 35-37 show the appearance of the buttons with no lamps, high lamps, or low lamps selected.

Fig. 34. Dome flat lamp control buttons, toggle switch, and brightness display.

Fig. 35. Dome flat lamp pushbuttons with lamps off. The topmost display button does not show either high lamps or low lamps as "on".

Fig. 36. Dome flat lamp pushbuttons with high lamps selected.

Fig. 37. Dome flat lamp pushbuttons with low lamps selected.

Here are recommended lamp settings and integration times for each filter. Integration times were chosen for filters in the J and H bands to give about 3000 ADU of signal. This is 24000 electrons, or 240000 electrons total in ten frames, for a photon statistics S/N ~ 500. Integration times were chosen for filters in the K band so as not to exceed 4000-5000 ADU in the lamps-on frame (lamp plus background thermal emission). This keeps the signal in the linear regime of the detector response curve over the range of individual pixel raw values that will result. The S/N in the averaged differential frame will be lower than for the other filters.

Table 1. Recommended lamp settings and integration times for dome flats.

Filter	Lamp setting	Integration time	Signal level
J	Low @ 25	10 sec	~ 3000 ADU
H	Low @ 15	5 sec	~ 3200 ADU
Ks	Low @ 15	1 – 2 sec **	~ 3900 on, 1700 off**
1066	High @ 14	10 sec	~3200 ADU
1187			
2096			
1644	Low @ 25	20 sec	~1900 sec
2122	Low @ 20	15 sec	~ 2600 on, 500 off
2168	Low @ 20	15 sec	~ 3000 on, 1000 off
1056	High @ 22	10 sec	~2800 ADU
1063	High @ 22	10 sec	~3000 ADU
J1	Low @ 30	20 sec	~ 2800 ADU
J2	Low @ 30	10 sec	~ 3000 ADU
J3	Low @ 30	6.5 sec	~ 3000 ADU
H1	Low @ 15	10 sec	~ 3000 ADU
H2	Low @ 15	6 sec	~ 3000 ADU

** Depending on temperature in the dome. A value of 1 sec defaults to 1.24 sec, the minimum readout time. In warm weather when the dome flat screen itself is emitting a lot of thermal radiation, it may not be possible to get unsaturated Ks flats.

8.2 Taking dark frames

You need to take dark frames with the same array parameters as your on-sky science data: integration time, coadds, Fowler samples, and digital averages. The Science Pipeline uses the on-sky data and matching darks to generate source-free, scaled background sky frames for sky subtraction.

On your first afternoon you may have to estimate on-sky times for the various filters, from previous experience and/or advice of your setup person. For the broadband filters, darks taken at 10, 15, 20, 30, and 60 seconds would cover the normal range of integration times on the sky. Set coadds to match your planned science observation protocol. For example, 15 sec integration x 4 coadds to get 60 sec total exposure on source before dithering.

Close the Environmental Cover in the Instrument Control GUI to take dark frames. Consult with your Instrument Scientist about the advisability of further closing the telescope and turning off lights in the dome.

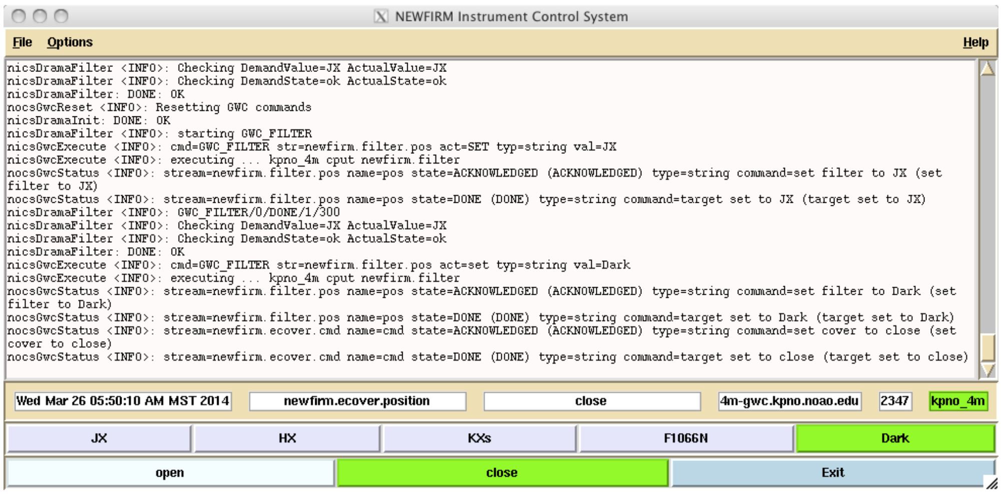

Figure 38: Instrument Control GUI showing configuration for dark frames.

Use the Dark script to take these data. Take at least three frames at each combination of integration time, coadds, Fowler samples, and digital averages that you plan to use. To automatically run a set of dark scripts at various exposure times, gather the script names into a list file denominated as a shell script, e.g. "DoDarks.sh". Execute this script to run all the dark sequences (see also Sec. 6.1.5).

8.3 A typical calibration plan

A typical calibration plan for a program doing both broadband and narrowband imaging would be this:

- Dome flats in J, H, and Ks filters; using a DomeFlatSequence script, with lamp settings and integration times from Table 1 above.

- Dome flats in 1644 (1.64 μm [FeII]), 2122 (2.12 μm H_2), and 2168 (2.17 μm Br γ) filters; using a separate DomeFlatSequence script, with lamp settings and integration times from Table 1 above.

- Dome flats done from 4-5 pm with the observer present for required manual interactions.

- A sequence of dark frames, 10 each at (5 sec x 12 coadds), (10 sec x 6 coadds), (30 sec x 2 coadds), and (180 sec x 1 coadd); using separate Dark scripts for each, bundled into a superscript (Sec. 6.1.5).

- Observing times and coadds for dark frames are chosen to match typical use; change to fit needs of your program. The sequence above provides for short integrations on brighter sources (5 sec), sky-background-limited integrations in H and Ks (10 sec) and J (30 sec) with 60 sec on source between telescope dithers, and single background-limited integrations in narrowband filters.

- Darks run for 75 minutes while everyone is having supper. Or, at the end of the night, left to run after telescope and dome are closed up, and observer and operator go to bed.

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9. How to check telescope pointing

The instrument pointing center, used to point the telescope, must be at the science field center for the guider probe positioning calculations to work. Unfortunately, the science field center has no pixels in it, due to the ~35 arcsec gap between arrays in the 2x2 mosaic. So we position the pointing check star off center, then offset the telescope by an amount calculated to put the star at field center, to initialize the pointing.

- At start of night, have Observing Assistant go to a bright star (3-6 mag).
- Take a short integration (1-2 seconds) in Test mode.
- If bright star is not seen in raw image, it may be in the gap between arrays. Offset the telescope by 100 arcsec in RA and in Dec (via the Telescope Control GUI) and take another frame.
- You should see the star now. Use the cursor to determine the offset in pixels between star position and the inside corner of the array it's on.
- Convert to arcsec at 0.40 arcsec/pixel.
- Add 17 arcsec in RA and in Dec to allow for half the gap between arrays.
- Apply this offset to the telescope to place the star at field center.
- Take a final Test frame to confirm positioning. The star should not be seen.
- Diffraction spikes on very bright stars may be seen. They should radiate from the inside corner of the active area of each array.
- Ask the Observing Assistant to " zero the telescope " at this position. This sets input coordinates for the star = current telescope position.

I recommend verifying pointing in this manner whenever you go to a new target more than 30 degrees or so from the previous pointing.

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10. How to focus

Take a focus sequence using a FOCUS script (Sec. 6.2.4). The first frame duplicates the first focus value, and is offset on the sky to get a frame for sky background subtraction.

It is easiest to focus in J, and apply a known focus offset between J and other filters. Ten seconds x 1 coadd is a good integration time for J. This will average out any rapid variations in seeing. For H and Ks use 5 sec x 2 coadds due to the higher sky backgrounds.

Focus is a function of telescope truss temperature T and wavelength. Use these formulas to get reasonably good starting values. Set up the focus sequences to be centered on these values:

J Focus ~ 12000 – { 100 x T (ºC) }

H focus = J + 100 units

K focus = J + 200 units

Or check with the previous observer or the telescope operator for best focus at the start of the previous night.

A good step size is 100 units for an initial search, followed by 50 unit steps around the best resulting focus value to refine the result. Set starting value and number of steps to bracket the estimated focus with three or four steps on each side.

The truss temperature is obtained from the Truss Temp GUI, Sec. 4.3.

After all the images in the sequence have been taken, run the IRAF focus analysis.

In IRAF cl window (Sec. 3.1.1), type

nffocus [file number] <cr>

[file number] is the running image number appended to the root filename, for any image in the focus sequence. The IRAF routine will find all the images in the sequence given any one of them.

This routine

- Subtracts the initial “sky background” frame from each focus frame.
- Generates an object catalog for each array at each focus value.
- Uses the catalog to identify round, unsaturated sources at each focus setting.
- Derives the FWHM for each of these sources.
- Displays a plot of source FWHM vs telescope focus in a graphics window.

- Displays its solution for best focus value from a fitting routine.

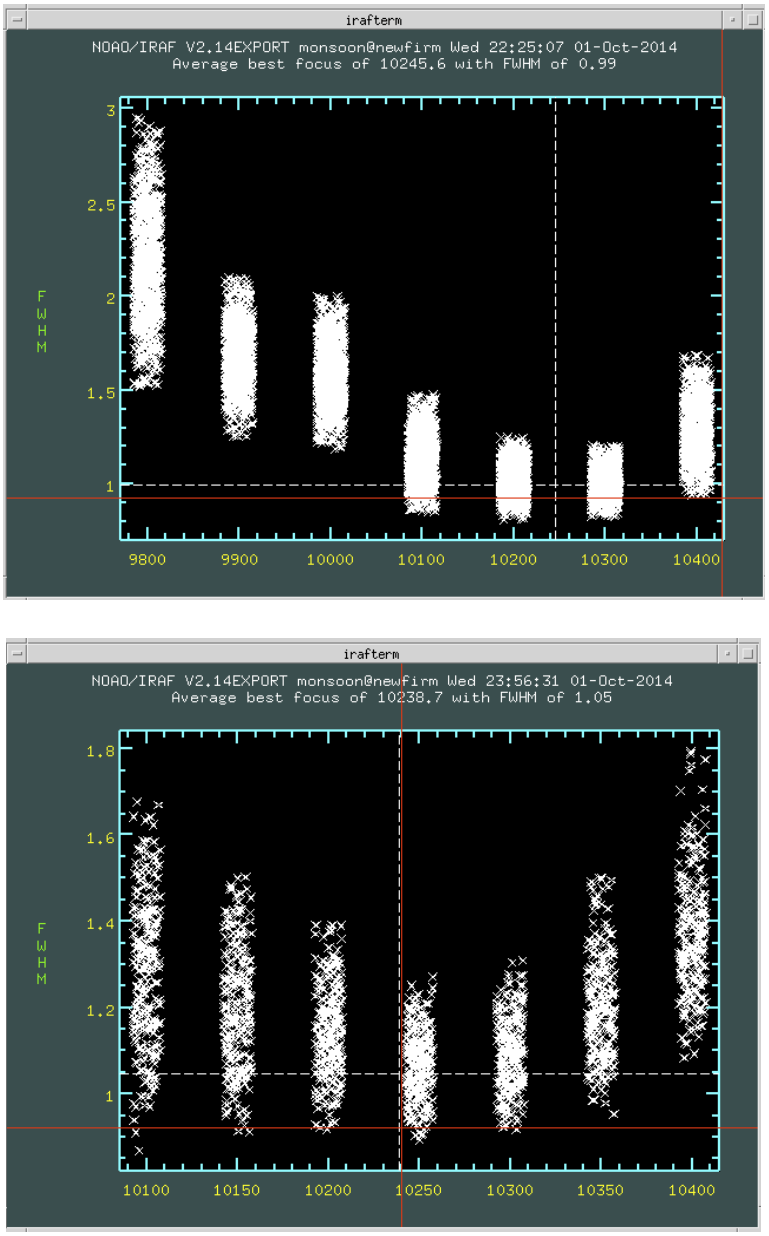

Figure 45: nffocus graphics with coarse (upper) and fine (lower) sampling.

Occasionally, for unknown reasons, the nffocus routine hangs, leaving the IRAF cl window unresponsive to mouse or keyboard. See Appendix A.2.7 [78] for recovery procedures.

Visually inspect the plot of FWHM vs. focus setting as a sanity check. Your eye may do better than the curve fitting routine at identifying the best focus.

Note the focus value ("solution" and "eyeball") then type *q* in the graphics window to quit this routine, or explore the data further with keystrokes below.

Keystrokes in the graphics window display the analysis in various ways, and can be used to delete suspect data points:

f	plots FWHM vs focus setting (default plot)
b	plots focus vs various spatial parameters
t	radial distribution of FWHM
m	magnitude distribution of FWHM
d	locate cursor over bad point, hit d to delete it
x	deletes entire data set for given focus value
u	reverses last delete action
q	exits the graphics window (may have to hold down firmly, not merely tap)

It may be useful to use the "d" (*delete*) keystroke to remove discordant data points from the FWHM data sets near the fitted best focus. If the fitted focus solution is stable, it won't change much.

If the displayed FWHM vs. focus setting doesn't have a clearly defined minimum, you probably haven't gone through the best focus position. Run the focus script again with a different START value to try to bracket the estimated telescope focus.

On nights of poor seeing the focus may have a very broad minimum or be undefined. This may also happen if you have chosen a very star-poor field for the focus test.

Focus stability can be monitored on the science frames as observing proceeds. Both changing temperature and truss flexure will change the focus. I recommend running a focus sequence if the telescope truss temperature changes by 0.5 deg C or more, or if you move across the sky to a new target by more than 30 degrees.

Here is a tabulation of the focus offset for each filter with respect to filter JX (broadband J).

Filter	**Offset**
J	0
H	+100
Ks	+200
1066	
1187	
2096	
1644	+100
2122	+185
2168	
1056	+50
1063	+50
J1	0
J2	
J3	
H1	
H2	

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11. Guiding

The NEWFIRM guider is operated by the 4-m Observing Assistant (OA) from the OA's telescope control station. The guider uses two cameras that access stars in two rectangular guide fields via X-Y stages. Each camera can access any position within its guide field. However, the guide star must stay within the field at all dither positions.

The guide field size is 26.8 arcmin (RA) by 4.4 arcmin (Dec). This constrains dithering in Declination (N-S). If the chosen guide star is near the N-S centerline of the guide field, then dithers must remain within ±2 arcmin of the starting position. If the guide star is less favorably positioned, then N-S dither motions are further constrained.

The guide star display and selection tool, at the OA station, displays the science field of view and the two guide fields, at the current telescope position, from the Digital Sky Survey. Consult with the OA to choose a suitable guide star, balancing brightness and accessibility while dithering.

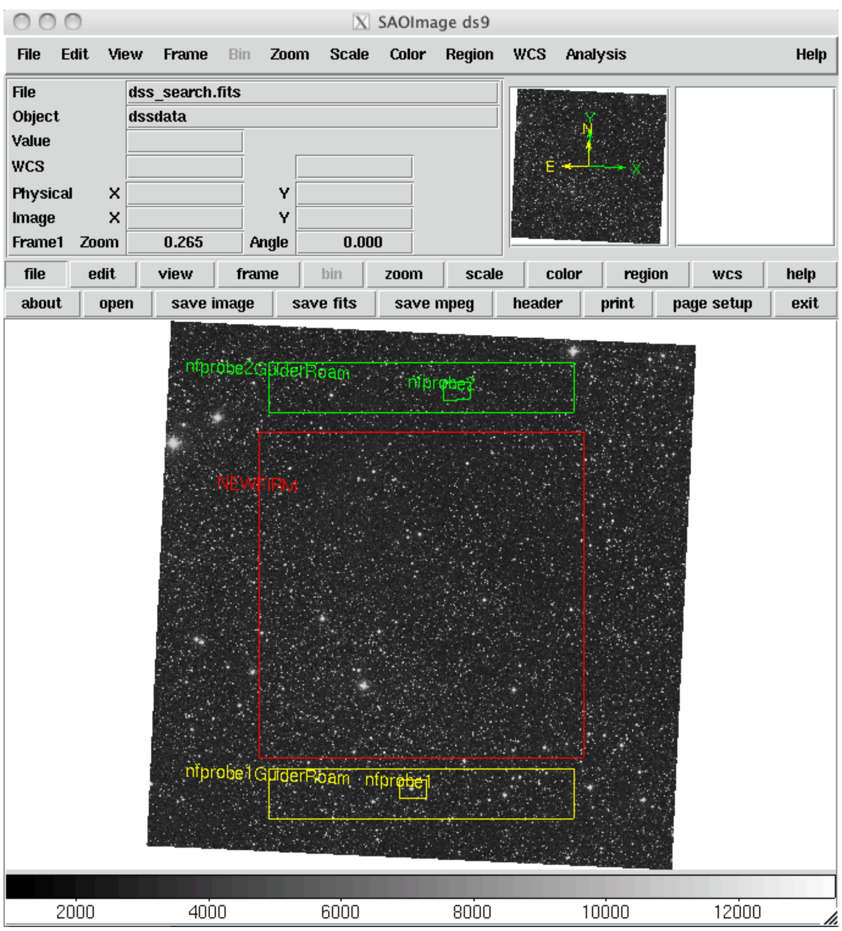

Figure 48: Guide star display and selection tool.

There are two overhead costs with guiding: time spent manually selecting and setting up on a guide star before starting an integration sequence (1-2 minutes) and time needed to automatically recover the guide star after a telescope dither (a few seconds).

Use of a script that includes Map motions (Sec. 6.4) introduces another complication. A large Map motion will move a selected guide star completely out of the guide field. The Guider Wait option will pause data taking to allow manual acquisition of a new guide star at each Map position. This further impacts observing efficiency.

The most efficient observing mode is to not use the guider. The open loop tracking of the telescope will deliver round star images for exposure times up to 60 seconds at Dec +32; longer at more northerly Declinations, and shorter near the celestial equator. For many programs using broadband filters, 60 sec or less integration time followed by a telescope dither is a good protocol. One can also select a guide star, but disable guiding, and use it only as a telescope position check at the end of a dither sequence. This is useful if observing the same field in multiple filters.

The periodic loss of the guide star when using a Map configuration can be finessed a bit. For Map positions that will *only* be used to define “blank” sky for sky subtraction, it doesn’t matter if the images are a bit elongated, so a new guide star doesn’t have to be acquired.

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12. Real time data inspection

There are two ways to inspect your data and evaluate data quality. One is to access the raw data as they come in, and perform simple image analysis with IRAF. For example, sky subtraction followed by image quality evaluation using the *imexam* task provides a running check on telescope focus.

The other way is to inspect the Quick Reduce Pipeline products. These include sky subtracted, linearized, flatfielded, shifted and added final frames from dithered observations. This permits confirmation of detection of sources plus quantitative evaluation of signal-to-noise.

Both approaches can use the workstation to the right of the NEWFIRM observer's workstation so that inspection does not interfere with data taking.

12.1 Inspection of raw data

To the right of *mayall-2* is another workstation with multiple screens, *mayall-3*, where you can set up a separate data analysis station. This is also the observer's station for the MOSAIC CCD camera.

Login as

user: mosaic
password: ____________

Let the VNC session come up (it does so automatically) then kill it. Open a shell-console window. At the mosaic prompt, open an xgterm:

```
mosaic@mayall-3%   xgterm &
```

In the xgterm window, ssh to newfirm-kp:

```
mosaic@mayall-3% ssh -X observer@newfirm-kp
password: _______________
```

Then start iraf :

```
[observer@newfirm-kp~]$ cl
```

Once in iraf, load the mscred and newfirm packages, and open up a ds9 display tool:

```
ecl> mscred
mscred> newfirm
newfirm> !ds9 &
```

Now you can cd to your data directory and access your data.

newfirm> cd /nfdata/observer/[today's_date]

12.2 Accessing the Quick Reduction Pipeline products

The NEWFIRM Quick Reduction Pipeline web pages are under the purview of Rob Swaters. At present they may be accessed at

http://www.noao.edu/staff/med/newfirm/QRP/

I especially recommend that observers read the section on “How to observe in a pipeline-friendly manner”.

Questions about the QRP, or reporting of problems with the QRP at the telescope, should be reported to **nfpipe@noao.edu**.

To access the pipeline products, I recommend using the other multiscreen workstation in the 4-m control room, *mayall-3*; or, you could work from a laptop. You need to open several windows in order to connect to or view several processes simultaneously:

- Open a web browser and point it to http://nfpipe-01-kp.kpno.noao.edu/NEWFIRM_pipeline/observer/. This is a web page showing a log of the data that the QRP has processed for your run so far. Initially, it will be empty until you take data for the QRP to process, such as dome flats, darks, or your first nighttime observing sequences. You will need to reload/refresh this web page in your browser periodically. It will be updated as new data are processed and added to the QRP review log.

- Open one xterm window and log in to the *newfirm* computer via *ssh observer@newfirm-kp*. From there, you can run the plstatus command to check that the pipeline is running properly.

- Open another xterm window and log in to the *nfpipe-01* computer via *ssh observer@nfpipe-01-kp.kpno.noao.edu*, using the same password as for *observer@newfirm-kp*. From there, you can run the dqquery command, which provides data quality information for images that the pipeline has processed recently.

- Open an xgterm window and log in to the *newfirm* computer via *ssh -X observer@newfirm-kp*. Open an image display (ximtool or ds9) in the background, and then start an IRAF session from the /home/observer/ directory by typing 'cl'. Change directories to go to the location you specified for the QRP FITS output products (Sec. 4.1.2). You can then display and otherwise analyze these images as they appear during the course of the night.

The QRP web page (first bullet above) provides access to a wealth of information and to the QRP images. You will see a log of data that the QRP has processed for your run so far, with various information about each observing sequence, including:

- image filenames
- UT at the start of the observing sequence
- observation type
- exposure times
- filter
- focus setting
- number of digital averages (DA) and Fowler samples (FS)
- airmass
- image title

In addition, this log reports the ranges spanned by some data quality parameters that are measured by the pipeline, such as:

- sky brightness (in ADU and mag per square arcsec)
- seeing FWHM
- magnitude zeropoint estimated from 2MASS stars (useful for monitoring relative transparency)
- estimated 5-sigma point source sensitivity

Clicking on the image filenames for a given sequence takes you to a pipeline review page with information about data from that sequence. There are review pages for processed, combined dark frames and dome flats, as well as for nighttime on-sky observations. For nighttime science observations, the QRP review pages provide:

- thumbnail pictures of the data
- links to images at two different higher resolutions for quick visual checks
- basic header information about each image
- links to the full FITS headers
- data quality measurements (seeing, magnitude zeropoint, depth, etc. - see above)

For dithered on-sky observing sequences, preview images are shown for each individual exposure, as well as for stacked mosaics of the observations. The stacked images are shown in the second column of thumbnail images. If, during the course of an observing sequence, the telescope motions exceed a particular hardwired tolerance (currently 8 arcmin, but this may change), the QRP will break the sequence into multiple independent stacks that will all appear in the 2nd column of thumbnail images.

FITS data products: When processing is complete for a sequence, FITS files of the combined image (the "mosaics" or "stacks") will be delivered to the directory that you specified for processed images (see Sec. 4.1.2 above). The names of the files start with NFQR (for NEWFIRM Quick Reduce). FITS files are delivered only for on-sky observations, not for dome flats or dark calibrations.

Processed image filenames are long and opaque. The key is to look for an image sequence number. This will be the first image in a data sequence (a set of dithered exposures, for example). This can help you trace a processed image file back to the raw image sequence from which it originated.

The QRP products are not archived, so if you want to save them, move them to your local hard drive or otherwise retrieve and store them before your run is over. The QRP log and associated data products will automatically reset for the next observer.

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Appendix A. Error recovery procedures

Here is a quick functional/symptomatic index to the error recovery procedures. In each section, the more common problems are presented first.

Procedures requiring OA/EM intervention are highlighted in blue. Hardware procedures are embedded in the troubleshooting instructions. Instructions for rebooting the NEWFIRM computers are given separately for each computer in Section A.7 .

If symptoms are unclear, help is unavailable, and/or a return to science readiness without diagnosis is desired, this sequence of steps will clear up many errors with data acquisition, transfer, and display.

A.3 Instrument control errors (GUI in lower left monitor, or command line window) [87]

A.3.1 **Instrument Controller GUI not seen** during instrument startup

A.3.2 **No communication with Environmental Cover or filter wheels**

A.3.3 **Filter wheel doesn't reach commanded position**

A.3.4 **Can't move filters and cannot "ssh" connect to *nicc*.**

A.4 Monsoon Supervisor Layer errors (NMSL GUI or command line window) [90]

A.4.1 **Red ERROR messages appear** during startup

A.4.2 **Red ERROR message appears** during startup about a **timeout error**

A.4.3 **Red ERROR message appears** about a **voltage out of range**

A.4.4 **Monsoon Supervisor Layer** window shows a **red ERROR message** during integration and readout cycle, **while DHS activity appears normal**

A.4.5 **NMSL task failure** error message

A.4.6 **Red ERROR message appears** during data taking about a **timeout error**

A.5 Problems with scripts (command line window) [96]

A.5.1 How to **abort a script**

A.5.2 **"Permission denied"** error message when executing a script

A.5.3 **"File not found"** error message when executing a dither or map pattern from a file (text list of offset commands)

A.6 Problems with appearance of raw images (image display in DHS window) [98]

A.6.1 **Raw image has identical count in every pixel**

A.6.2 **Raw image has negative counts and strange appearance**

A.6.3 **Raw image shows a strong center to edge gradient, or a vague shape covering the central part of the field**

A.7 Reboot instructions for NEWFIRM computers [101]

A.7.1 Reboot newfirm-kp

A.7.2 Reboot nfpan-a-kp and nfpan-b-kp
Note power-off and power-on of DHE in the cage!

A.7.3 Reboot nfdca-kp

A.7.4 Reboot nfdhs-01 and nfdhs-02

A.7.5 Reboot NEWFIRM Instrument Controller, aka NICC

A.8 Locations of rack-mounted NEWFIRM computer power buttons [105]

A.0 Kitchen sink error recovery

If symptoms are unclear, help is unavailable, and/or a return to science readiness without diagnosis is desired, this sequence of steps will clear up many errors with data acquisition, transfer, and display.

a) Halt the user interface with

   debias <cr>
   nocs stop all <cr>

b) Ask the OA to power cycle the Digital Head Electronics (DHE) also known as the Monsoon array controller. This may require moving the telescope for access to the Cass cage where these electronics reside.

c) Open another terminal window on *mayall-2*, and connect to *newfirm-kp* as user "monsoon":

   ssh –X monsoon@newfirm-kp
   pw _______________________

d) From this monsoon login on newfirm-kp, give the command

   zzkpvm <cr>

   This clears DHS setup information from all NEWFIRM computers. The next system startup will have a clean slate.

e) Exit the monsoon login and kill the second terminal window

   exit <cr> (from monsoon@newfirm-kp)

f) Restart the user interface from the existing *observer@newfirm-kp* login with

   nocs start all <cr>
   400mvbias <cr> (after restart is complete)

g) Check, and reset if necessary, the root image name and the data directories in the DHS Supervisor Window, Paths and Files.

h) Take a short test frame or two, see if all looks well.

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A.1 Global window management errors

A.1.1. The “nocs start all” process ran to completion, returning observer@newfirm-kp prompt, but **no windows or GUIs appeared**: host permissions need to be reset on *mayall-2*.

a) Type “ nocs stop all <cr> “ to stop processes
b) Type “ exit <cr> “ to return to computer *mayall-2*
c) At *4meter@mayall-2* prompt, type “ xhost + <cr> “
d) ssh to *observer@newfirm-kp* and type “ nocs start all <cr> “

Now all the windows will appear and you can proceed.

A.1.2 **All NEWFIRM windows suddenly close** leaving only the *4meter* login prompt to *mayall-2*: a high level network communications glitch closed all the connections.

We’ve seen this happen once at the Mayall telescope and never at the Blanco. The communications dropout appeared to spontaneously recover. However this left several NEWFIRM computers in a strange state.

A.1.2.1 First recovery procedure: observer restart of PAN computers

a) Exit from any other *observer@newfirm-kp* logins on *mayall-2* and *mayall-3*.
b) Ask the Observing Assistant to shut down and reboot *newfirm-kp*.
c) Log back in to *newfirm-kp* from *4meter@mayall-2*:
   ssh –X observer@newfirm-kp
   usual password
d) Ask the Observing Assistant to restart the PAN computers from the command line window.

   The commands are
   panTools nuke nfpan-a-kp <cr>
   panTools nuke nfpan-b-kp <cr>

   VERY IMPORTANT: be sure observer has issued the “nocs stop all” command first. Otherwise, “nuke” can have catastrophic consequences. If this makes you nervous, don’t do it. Move on to A.1.2.2 below.

e) Continue with a normal system start:

   nocs start all <cr>
   400mvbias <cr>

f) Reset the filename and directories in the NEWFIRM DHS Supervisor window
g) Take a short test frame with a TEST script to verify that all appears normal.

A.1.2.2 Second recovery procedure: complete shutdown and reboot of PAN computers. This takes about 15 minutes. Try if the first procedure doesn't produce normal operation.

a) Exit from any other *observer@newfirm-kp* logins on *mayall-2* and *mayall-3*.
b) Ask the Observing Assistant to turn off the Monsoon power in the Cass cage. This may require moving the telescope for access to the cage.
c) Ask the Observing Assistant to shut down and reboot PAN A and PAN B computers. This takes about ten minutes.

   See A.7.2 [101] Reboot nfpan-a and nfpan-b.
   Note requirement to turn off the Monsoon power (=DHE power) in the cage first, and turn it back on after the reboots.

d) After both have been rebooted, ask the Observing Assistant to turn on Monsoon power in the cage.
e) Ask the Observing Assistant to shut down and reboot *newfirm-kp*.

   See A.7.1 [101] Reboot newfirm-kp

f) Log back in from *4meter@mayall-2* to *newfirm-kp* and do a normal system start:

```
ssh –X observer@newfirm-kp
usual password
nocs start all
400mvbias
```

   followed by the normal setup activities in all three monitors

Take a short single image with a TEST script to see if the system is now running normally (it should be).

Return to Error Recovery Procedures list [72]

A.2 Data Handling System (DHS) errors
Error symptoms generally appear in the VNC window to the DHS. Some DHS error conditions also produce error messages in the Monsoon Supervisor Layer GUI and/or the command line window.

A.2.1 **Images don't appear in image directory**: probably you forgot to click on the directory path in the NEWFIRM DHS Supervisor window when the DHS desktop was brought up.

a) The images are in default directory /home/data .
b) Move or copy the .fits files, and associated .dat, .trig, .txt files to the desired directory.
c) Go to Supervisor Window, Paths and Files, and do mouse click <cr> on the path to set it for future images.
d) Look for confirming message in the z.super window.

A.2.2 The **IRAF cl window** in the DHS display has **disappeared.**
While the cl window appears in the DHS desktop, it is running on *newfirm-kp*, not on the *nfdhs* machines.

a) It may have been backgrounded by a stray mouse click. Check to see if it is hidden behind the DHS Supervisor window.
b) If truly gone, go down to the icons at the bottom of the DHS window and click on an xgterm icon to open an xgterm window. Alternatively, select "New Xgterm window" from the window manager menu.
c) In the xgterm window, type "cl <cr>" to start IRAF in this window.
d) Type "mscred <cr>" to go to the right task, and cd to the current data directory.
e) If this problem occurs repeatedly, halt the user interface in the command line window with

   nocs stop all <cr>

   and then ask the OA to reboot *newfirm-kp*.
f) Restart the user interface with

   nocs start all <cr>
   400mvbias <cr>

g) Check, and reset if necessary, image root name and data directory paths in DHS Supervisor Window, Paths and Files

A.2.3 The **Ximtool** in the DHS has **disappeared** or been accidentally **closed**.

a) Go down to the icons at the bottom of the DHS window and click on an xgterm icon to open an xgterm window.
b) In the xgterm window, type “ximtool & <cr>” to restart the Ximtool

Or alternatively,
Select “New Ximtool window” from the window manager menu.

A.2.4 DHS Supervisor, **Shared Memory Cache Status window** suddenly shows a **red background**: Data Collector Agent process (DCA) has crashed.

a) Check the VNC screen to verify that the z.mosdca window has disappeared (if not, something else has crashed and we have a different problem).
b) Close the pending observation file for the last frame. From the command line window, issue the command

    ditscmd nohs nohs_endobs <cr>

   This moves data to DHS memory but not onto the disk.
c) Restart the system with

    debias <cr>
    nocs stop all <cr>
    nocs start all <cr>
    400mvbias <cr>

d) In DHS Supervisor window, click on Paths and Files tab, and redefine the file root name and directory paths
e) If you want to save the data in memory, click “Update Status” in the Supervisor window to list the exposure ID’s ExpID of images in the memory. These are numeric, e.g. 2454411.609138.
f) Flush these to disk using, repetitively if necessary,

    dhsflush <ExpID>   (for example, dhsflush 2454411.609138)

g) This should save the data although the file numbers will be <previous image filenumber> + <appended letter a, b, c, etc.>
h) The file numbers will begin incrementing normally when the next script starts.
i) If you don’t care to save the data, use instead

    dhsclean <cr>

j) See A.2.5.3 below for more on dhsflush and dhsclean, if these commands don't seem to work from the command line window.

Debiasing and rebiasing the arrays may produce higher dark current or other transitory phenomena for tens of minutes. Running a set of short integration time "junk" frames may help stabilize them. It's not advisable to take low background data, e.g. narrowband filters, immediately after a debias/rebias cycle.

A.2.5 **Data are stuck in the DHS shared memory cache**, indicated by many lines of entries in the DHS Supervisor, Shared Memory Cache display, and no processing activity in the z.super window. However Shared Memory Cache has not turned red (A.2.4 above).

The goal is to flush the DHS memory, preferably saving the data. There are several procedures to try.

A.2.5.1. First recovery procedure:

a) Click on "Update Status" button on Shared Memory Cache page.
b) Watch for activity in the z.super window. This indicates data transfer.
c) Click on "Update Status" again to see if the memory is empty; if it isn't, click a couple more times to see if this procedure flushes it.
d) If no entries are seen in the Shared Memory Cache, you have succeeded.
e) If data don't entirely clear, go to next procedure A.2.5.2

A.2.5.2. Second recovery procedure:

a) Stop any data taking script that is running with CNTRL-C in the command line window. Wait for the integration to complete and return *observer@newfirm-kp* prompt. (If no script is running, go to next procedure A.2.5.3)
b) In the command line window, issue an end-of-observation command,

ditscmd nohs nohs_endobs <cr>

c) Watch for activity in the z.super window ending with a Postproc DONE message
d) Click on "Update Status" again to see if the memory is empty; if it isn't, repeat steps b-c for a couple more times to see if this procedure flushes it.
e) If no entries are seen in the Shared Memory Cache, you have succeeded.
f) If data don't entirely clear, go to next procedure

A.2.5.3. Third recovery procedure:

a) Switch to an unused desktop on *mayall-2* and open a terminal window
b) Log in to *newfirm-kp* with

ssh –X monsoon@newfirm-kp <cr>
password is ________________ .

c) Get the exposure ID number of stuck data from the field ExpID in the Shared Memory Cache window. The ExpID is numeric, e.g. 2454411.609138. There will be several lines with the same ExpID.
d) In the monsoon login window you just created, type

dhsflush <ExpID> <cr> (for example, dhsflush 2454411.609138)

e) This should save the data although the file numbers will be <previous image filenumber> + <appended letter a, b, c, etc.>
f) The file numbers will begin incrementing normally when the next script starts.
g) Watch for activity in the z.super window and the Shared Memory Cache window
h) Click on "Update Status" again to see if the memory is empty. If it isn't, repeat steps d and h a couple more times.
i) If data still don't entirely clear, from *monsoon@newfirm-kp* type

dhsclean <cr>

j) You will lose the data in memory with the "clean" procedure
k) Click on Update Status to be sure the memory has cleared. If the exposures are still shown as present, but with parameter *shmId* set to –1, it will be necessary to go through a debias – nocs stop all – nocs start all – 400mvbias cycle to get the status window to show as empty.

A.2.6 **Data aren't being written to disk as .fits files.** This probably indicates that a data disk is full. There are two disks that can produce this error. One is on *newfirm-kp*, /nfdata; the other is on the Data Capture Agent computer, *nfdca-kp*, /home2/data. You need to check both disks, and clear off old data to make room. /nfdata and /home2/data each have the capacity to hold a month's worth of broadband data, so anything that you delete has long since been archived and checked.

A.2.6.1 First recovery procedure, to clean off data disks:

a) In the NEWFIRM DHS Supervisor window, Shared Memory Cache page, check the Disk Usage Bar in bottom right corner. If it reads 100% then /nfdata is full.
b) In the IRAF window, cd to /nfdata/observer. You will likely find many nights' worth of data in subdirectories. Delete subdirectories, beginning with the oldest, while watching the Disk Usage Bar. Get it below 90%.
c) The delete command you need is

!rm –rf [subdirectory name]

d) Now go to an unused desktop and open a terminal window on *mayall-2* (prompt will be *4meter@mayall-2*).
e) Log in to the Data Capture Agent computer *nfdca* as user "monsoon" with

ssh –X monsoon@nfdca-kp
password _______________

f) Check the available space on /home2 . If it's full, you need to delete some data. From /home/monsoon, enter

df <cr>

g) cd to the data directory with

cd /home2/data <cr>

h) Do a directory listing, then delete old data with the command

_clean <cr>　　Note the leading underscore

i) This will remove any FITS image older than seven days.
j) Take a short test image to see if the data are processed and stored to disk properly. If the raw image shows all pixels having exactly the same value, go to Procedure A.6.1 .
k) Put an entry into Service, or have the OA make an entry, describing briefly what you've done. The Instrument Scientist may want to do further data deletion after checking with the Archive Scientist.

A.2.6.2 Second recovery procedure: if data disks aren't full, but data aren't being written to disk as fits files:

a) Halt the user interface and exit in the usual way:

nocs stop all <cr>
exit <cr>

This will return the *mayall-2* prompt.

b) Exit from any other *observer@newfirm-kp* logins that may be open on *mayall-2* or *mayall-3.*
c) Ask the OA to shut down and reboot the Data Capture Agent computer, *nfdca*

See A.7.3 [101] Reboot nfdca-kp

Then log back in as *observer@newfirm-kp* and restart:

nocs start all <cr>
400mvbias <cr>

A.2.7 **nffocus IRAF routine hangs** leaving the IRAF cl window unresponsive to mouse or keyboard. This occasionally happens during the catalog creation process.

Kill the process and/or the IRAF window and start a new CL session.

A.2.7.1 First recovery procedure

a) Type repeatedly in the CL window (5 or more times)

control-c <cr>

b) If it returns a prompt, type

flpr <cr>

a couple of times. Recovery is complete.

c) If instead the CL session is killed, restart it with

cl <cr>

and reset the path to your data directory.

A.2.7.2 Second recovery procedure

a) Kill the IRAF window with the window manager button: click on the left hand icon in the top bar to open a menu, and then click on “close”.
b) Open a new xgterm window from the row of icons along the bottom of the VNC window display.
c) Type

cl <cr>

to start a new CL session, and reset the path to your data directory.

This leaves the hung process running, which does no harm. If your comfort level allows, you can clean things up as follows:

d) Open another xgterm window from the row of icons.
e) Log onto machine *newfirm* with

ssh –X monsoon@newfirm-kp <cr>
pw: ______________________

f) Type

ps –x <cr>

to generate a process list. Look for an x_ecl.e process that is running, and an x_ace.e process that's defunct. "ecl" is the IRAF CL and "ace" is the stuck cataloging and analysis process.

g) Kill the stuck "ecl" process with

    kill –9 [pid] <cr>   where [pid] is the process ID number from the list

h) This will return a Unix prompt in the window with the hung CL session.
i) If you had multiple IRAF sessions running, perhaps to do some image analysis, care is needed not to kill the wrong one. But you can always just restart any that you kill by mistake.

A.2.8 **Data transfers** to the DHS processing computers **appear to freeze**: bogus lock files in the /tmp directory are confusing the processes and must be removed.

We've seen this happen very rarely. Data seem to be coming from the PANs normally, but one or both of the *nfdhs* computers fail to process it. One error condition is that only half of the image is displayed, the final file is never written to disk, and the DHS becomes unresponsive. Another error condition is that the messages in the DHS z.super window show the processing stopped at "Trigger Host", and issuing a

    ditscmd nohs nohs_endobs

command from the NOCS command line window does not produce any response in the z.super window.

First, check the data disks (A.2.6 above) to be sure this isn't a "full disk" problem.

Lock files are created in the system /tmp directory for use by the Shared Memory Cache (SMC) system to describe how to attach to the current SMC. This file is named "/tmp/.smc501". In rare cases, multiple versions of this file have been created of the form "/tmp/.smc501_1" that cause confusion about how to attach to the shared memory cache on the machine.

Recovery consists of deleting all existing lock files, then restarting the system:

a) Shut down the data taking system with

    nocs stop all <cr>

b) Open a new terminal window on *mayall-2*

c) In this window, connect to *newfirm-kp* as user "monsoon":

    ssh –X monsoon@newfirm-kp
    password _______________

d) From this monsoon login on *newfirm-kp* execute the command

/ndhs/dev/zzkpvm <cr>

This should remove all lock files.

e) From this monsoon login on *newfirm-kp*, verify that the lock files are removed with the commands

ssh nfdhs-01 ls –a /tmp/.smc*
ssh nfdhs-02 ls –a /tmp/.smc* [Note the use of \ escape before *]

Neither of these commands should list any files.

f) Restart the system normally from the existing *observer@newfirm-kp* login with

nocs start all <cr>
400mvbias <cr>

This will create a single new lock file on each of the *nfdhs* machines.

g) Repeat step (e) commands from the *monsoon@newfirm-kp* login, and verify that only one file of the form /tmp/.smc501 exists on each machine.

h) To further verify that the SMC is operating properly, from your monsoon login issue these commands

ssh nfdhs-01 smcmgr –list <cr>
ssh nfdhs-02 smcmgr –list <cr>

On each machine, only one entry of type ‘ SMCache ‘ should be listed.

i) Exit from *monsoon@newfirm-kp* and close this window.

A.2.9 **Integration times out** and “nohs nohs_endobs” returns **Broken Pipe error message**: something in the DHS Shared Memory has gotten corrupted.

This error is confusing because the first symptom appears as a timeout error in the Monsoon Supervisor Layer GUI. The integration doesn’t finish. This looks like a Monsoon error, Sec. A.4—but it isn’t.

The key symptom is that attempting to close the open .fits file with command

ditscmd nohs nohs_endobs <cr>

results in an error message “Broken pipe” in the command line window, and no activity in the DHS z.super window.

Also, the DHS Supervisor Window in the VNC window to DHS becomes unresponsive to the mouse.

Recovery consists of halting the system, issuing a “DHS clear all” command, then restarting the system:

a) Halt the user interface with

    nocs stop all <cr>

b) Open a second terminal window on *mayall-2*

c) In this window, connect to *newfirm-kp* as user “monsoon”:

    ssh –X monsoon@newfirm-kp
    password _______________

d) From this monsoon login on *newfirm-kp* execute the command

    zzkpvm <cr>

   This clears DHS setup information from all NEWFIRM computers. The next system startup will have a clean slate.

e) Exit the monsoon login and close the terminal window.

f) Restart the user interface from the existing *observer@newfirm-kp* login with

    nocs start all <cr>
    400mvbias <cr>

g) Check, and reset if necessary, the root image name and the data directories in the DHS Supervisor Window, Paths and Files.
h) Take a short test frame or two, see if all looks well.

Return to Error Recovery Procedures list [72]

A.3 Instrument control errors

These manifest as error messages in the Instrument Control System GUI and in the command line window.

A.3.1 **Instrument Controller GUIs not seen** on Desktop 2 during instrument startup: need to restart the connection to *nicc*, the instrument controller computer.

a) Open an xterm window on Desktop 2.
b) Connect to *nicc* with

ssh –X nicc@nicc-kp <cr>
pw is ________________ .

c) Start GUI menu with

/usr/local/nicc/start-menu <cr>

d) Click on "Temperatures" in the menu to open the temperature display GUI

A.3.2 **No communication with Environmental Cover or filter wheels**: need to reboot the Instrument Controller. A very rare circumstance.

Ask the OA to reboot the Instrument Controller.
This requires a halt, and subsequent restart, of the OA guider software.
The data system can be left running; there is no need to stop or log out.
This may require moving the telescope to enable access to the cage.
This process takes 10-15 minutes.

See A.7.5 [101] Reboot NEWFIRM Instrument Controller, aka NICC

A.3.3 **Filter wheel doesn't reach commanded position**: One of the filter wheels failed to sense its position. If the filter positioning was part of a script, the script will halt and generate an error message. This is potentially very serious. The filter wheels are inside the Dewar and not accessible for adjustment or repair on the telescope.

A.3.3.1 First recovery procedure:
Command the filter wheels to the desired filter position from the Instrument Control System GUI. Click the button for the desired filter.

This will take a minute or two. The wheel with sensor failure goes into a recovery mode in which it creeps along slowly, repeatedly querying its position sensors, until it finds a known position and detent. Then it completes the desired motion. Numerous status messages appear in the GUI message window.

If you still get a "failed to reach filter position" error, try this procedure one more time. It may take the wheel a couple of tries to figure out where it is.

A.3.3.2 Second recovery procedure:
Command the filter wheels individually from the NICC Filter Wheel GUI on Desktop 2.

Go to Desktop 2. From the menu for NICC GUIs, click on Filter Wheels (near the top of the menu). A GUI will open that has a row of filter position buttons (J, H, K, etc.). Above them will be two rows of buttons labelled 1 through 8. These are the physical wheel detent positions for the upper filter wheel (upper row) and the lower filter wheel (lower row). Any commanded filter position corresponds to a pair of wheel positions, one in each wheel.

The filter wheel GUI will probably show a position button lit up green in one row. This indicates that it has arrived at the correct position for that wheel. It will probably show a position button lit up white in the other row, indicating that it has not arrived at the correct position for the other wheel.

Click on the next button in sequence after the one lit up in white. This wheel will move and attempt to find this position. If it succeeds, the button for this position will turn green. If it fails, an error message about failure to find position will show up in the filter wheel GUI. If this happens, try again.

If it succeeds, you now have one wheel correctly positioned for the requested filter, and the other wheel (the stuck one) in a known but likely incorrect position.

Once the stuck filter wheel has succeeded in finding a position (button lights up in green) then try commanding the desired filter position from the bottom row of buttons.

If the wheel can't figure out where it is and position itself properly after three tries, call the Instrument Scientist.

A.3.4 **Can't move filters and cannot "ssh" connect to *nicc*.** The Environmental Cover responds to open/close command buttons, but filter wheels don't move. Attempt to ssh to *nicc* (A.3.1, or OA reboot procedure in A.3.2) has connection refused. We've seen this once.

> Ask the OA to cycle AC power to the Instrument Controller.
> This requires a halt, and subsequent restart, of the OA guider software.
> The data system can be left running; there is no need to stop or log out.
> This may require moving the telescope to enable access to the cage.
> This process takes 10-15 minutes.

Instructions to OA/EM for power cycling the NEWFIRM Instrument Controller.

This is the crude way to reboot the Instrument Controller when it is refusing an ssh connection.

Guider must be powered off first, and remain powered off until instrument controller has rebooted and reconnected to the network.

1) Exit the NEWFIRM guider software in the guider VNC window (see separate NEWFIRM Guider Manual).
2) Turn off power to the guider using the guider circuit breaker on the instrument interface panel facing the Cass cage door.
3) Turn off power to the instrument controller at its circuit breaker on the instrument interface panel.
4) Wait 60 seconds.
5) Turn on power to the instrument controller.
6) Wait 5 minutes for reboot of its self-contained computer
7) Reconnect with ssh from *mayall-2* following procedure A.3.1 .
8) start GUI menu with
    i. /usr/local/nicc/start-menu <cr>
9) Click on menu items to display GUIs for Temperatures, Filters, and Environmental Cover.
10) At this point, turn on power to the guider at the instrument interface panel.
11) From the OA station in the control room, restart the guider per separate Guider Setup Instructions.

Return to Error Recovery Procedures list [72]

A.4 Monsoon Supervisor Layer (array controller) errors

A.4.1 **Red ERROR messages appear** in the Monsoon Supervisor Layer window while "nocs start all" process is running: need to run this window process again.

a) Wait for the loading process to stop and *observer@newfirm-kp* prompt to appear in shell window
b) In the command line window, type

nmslReset <cr> (that's en-em-ess-ell-Reset)

c) Process will run again in the Monsoon Supervisor Layer window.
d) Watch for red **ERROR** messages.

Repeat this cycle until the process runs to completion with no red **ERROR** messages. If they appear at all, usually one or two nmslReset cycles are sufficient to get through this.

A.4.2 **Red ERROR message appears** in the Monsoon Supervisor Layer window upon startup, about a timeout error : the NOCS may have reconnected to a "ghost" memory page and gotten confused about how many PAN computers it's talking to.

Recovery procedure is

In the command line window (terminal window), type

grep PANs /home/monsoon/log/* <cr>

A normal response would be something like:

+2454753.6885068165138364: mslSuperConfig status 0L > PANs: 2

The abnormal response is something like:

+2454751.8555645765736699: mslSuperConfig status 0L > PANs: 4

Where "4" rather than "2" indicates the confusion.

If you see an abnormal response, shut the NOCS down with

nocs stop all <cr> ← **this is very important!**

and then execute

shmUNuke 501 <cr>

then restart the system with

nocs start all <cr>
400mvbias <cr>

A.4.3 **Red ERROR message appears** about a **voltage out of range** and the array does not integrate and read out: this may be a telemetry glitch, or an actual hardware voltage error. This may occur during initial system startup, or while taking data.

If the error appeared while taking data, close the image file that's been opened in anticipation of a completed integration. This will keep the DHS from hanging up. From the command line window, issue the command

ditscmd nohs nohs_endobs <cr>

Now proceed with the recovery procedures.

A.4.3.1 First recovery procedure:

a) In the command line window, type

   nmslReset <cr>

b) A process will run in the Monsoon Supervisor Layer Window. If it completes with no red **ERROR** messages,
c) Take a short single image with a TEST script to see if the system is now running normally.
d) If you still get red **ERROR** messages, continue to the second recovery procedure.

A.4.3.2 Second recovery procedure: for an actual hardware error

a) From the row of iconized windows at the bottom of the lower left monitor, foreground the panDaemon windows for PAN-A and PAN-B.
b) Look for messages in these windows like

   ERROR: detGetState(NEWFIRM): VssExt_Ary2=4.955 volts Out of Range, requested was 2.471

c) Note down which voltage(s) on which PAN are identified as wrong, for entry into the Service log
d) From the command line window, do

   debias <cr>
   nocs stop all <cr>

e) Ask the OA to power cycle the Digital Head Electronics (DHE) also known as the Monsoon array controller. This may require moving the telescope for access to the Cass cage where these electronics reside.

Instructions to OA/EM for DHE power cycling:

1) Be sure the observer has halted the data taking system, step d above.
2) Go to the Cass cage.
3) Power off the array controller (aka Monsoon, DHE) at the circuit breaker on the instrument interface panel (attached to yellow truss, faces Cass cage door).
4) Wait 30 seconds, then power it back on.
5) Inform the observer that he/she may continue with the recovery procedure.

f) After the OA has done this, restart the system with

nocs start all <cr>
400mvbias <cr>

g) In the DHS Supervisor window, click on the Paths and Files tab and redefine the file root name and directory paths
h) Take a short single image with a TEST script to see if the system is now running normally

Debiasing and rebiasing the arrays may produce higher dark current or other transitory phenomena for tens of minutes. Running a set of short integration time "junk" frames may help stabilize them. It's not advisable to take low background data, e.g. narrowband filters, immediately after a debias/rebias error recovery.

A.4.4 **Monsoon Supervisor Layer** window shows a **red ERROR message** during integration and readout cycle, **while DHS activity appears normal**: a problem has occurred with communications to/from the array controller.

A.4.4.1 First recovery procedure:

e) In the command line window, type

nmslReset systran <cr>

f) A process will run in the Monsoon Supervisor Layer Window. If it completes with no red **ERROR** messages, [if not go to second recovery procedure]
g) Go to the DHS Supervisor Window, Shared Memory Cache, and click on Update Status.
h) Watch the z.super window to see if an image is processed to disk.
i) Click on Update Status again to see if the memory has cleared.

j) If "Update Status" still shows DATA or META files in DHS memory, go to A.2.5 procedures to clear the memory.
k) When you have succeeded with this, take a short single image to see if the system is now running normally.

A.4.4.2 Second recovery procedure:
If the Monsoon Supervisor Layer Window continues to show red **ERROR** messages at step (b) above, do a stop/start cycle:

a) Stop and restart the system with

debias <cr>
nocs stop all <cr>
nocs start all <cr>
400mvbias <cr>

b) In DHS Supervisor window, click on Paths and Files tab, and redefine the file root name and directory paths
c) Take a short single image with a TEST script to see if the system is now running normally.

Debiasing and rebiasing the arrays may produce higher dark current or other transitory phenomena for tens of minutes. Running a set of short integration time "junk" frames may help stabilize them. It's not advisable to take low background data, e.g. narrowband filters, immediately after a debias/rebias error recovery.

A.4.4.3 Third recovery procedure:
If system is still hung with red **ERROR** messages, try a hardware reset of the Master Control Boards from the keyboard (these boards are in the Digital Head Electronics box on the Dewar):

a) Issue the following command sequence from the shell window

debias <cr>
mnsnReset.sh mcbHrdReset <cr>
nmslReset <cr>
400mvbias <cr>

b) Take a short single image with a STARE script to see if the system is now running normally.

See the note about debiasing and rebiasing the arrays above at A.2.6.2.

A.4.4.4 Fourth recovery procedure
This is a reset of the Master Control Boards at the boards with a reset button.

b) From the shell window, do

debias <cr>
nocs stop all <cr>

c) Ask the Observing Assistant to perform a hardware reset on the DHE Master Control Boards. This may require moving the telescope for access to the Cass cage where these electronics reside.

Instructions to OA/EM for Master Control Boards reset:

1) Be sure the observer has halted the data taking system, steps a and b above.
2) Go to the Cass cage and open the top cover of the DHE box.
3) Identify the two Master Control Boards front panels, labelled “MCB” with a reset button.
4) Use a pen tip to firmly push the small black reset button on each panel. The button is “soft”, you may not hear or feel a “click”.
5) Various red lights should come on, on these boards and on some of the other boards in the box.
6) Securely close the top cover of the DHE box.
7) Inform the observer that he/she may continue with the recovery procedure.

d) After the OA has done this, restart the system from the shell window with

nocs start all <cr>
400mvbias <cr>

d) In DHS Supervisor window, click on Paths and Files tab, and redefine the file root name and directory paths
e) Take a short single image with a STARE script to see if the system is now running normally.

A.4.5 **NMSL task failure** error message appears in the command line window or the Monsoon Supervisor Layer GUI. There is no activity in the Monsoon Supervisor Layer GUI. The Monsoon Supervisor has lost its connection to the router.

To recover:

In the command line window, close any observation that may have been left open with

ditscmd nohs nohs_endobs <cr>

and watch the DHS windows for activity indicating data transmission. Then shut down and restart the system with the usual

nocs stop all <cr>
nocs start all <cr>
400mvbias <cr>

A.4.6 **Red ERROR message appears** during data taking about a **timeout error** *and* there are problems in the DHS z.super window: data capture process has stopped at "Trigger Host", and issuing the command

ditscmd nohs nohs_endobs

from the command line window doesn't produce a response in the z.super window.

This is the same root problem as A.2.8, bogus lock files in the /tmp directories of the nfdhs-01 and nfdhs-02 machines are confusing the processing.

See A.2.8 [78] for the recovery procedure.

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A.5 Problems with scripts

A.5.1 How to **abort a script**:
This has to be done carefully, or the Data Handling System will get tied up, requiring an extensive recovery process.

a) If the script will run to completion in a minute or two, just let it finish.

b) To abort, type CNTRL-C <cr> in the command line window

   i. **During an integration while the countdown is proceeding**; type CNTRL-C <cr>, then **let the integration run to completion, with DONE in the Monsoon Supervisor Layer window.**
   ii. The script will stop when integration has finished but leaves the last FITS file open in the data system.
   iii. Issue this command in the command line window to write the last integration to disk and close the FITS file:

      ditscmd nohs nohs_endobs <cr>

   iv. In the z.super window within the VNC DHS window, check that an image processed to disk.
   v. You are ready to take data again.

A.5.2 **"Permission denied"** error message when executing a script: for some reason, script was created as non-executable.

a) Check to see if it permissions are "rwx" (executable) or "rw—" (non-executable):

   ls –l <scriptname>.sh <cr>

b) To make it executable, enter

   chmod +x <scriptname>.sh <cr>
   rehash <cr>

Should be OK to execute now.

A.5.3 **"File not found"** error message when executing a dither or map pattern from a file (text list of offset commands): NGUI looked in the wrong place for the file when creating the script.

a) Go to the terminal window in which you created the text file, and check the path to the file.
b) Insert the full path plus filename in the GUI in the "filename" box.

The most common problem is that NGUI was started in /home/observer/ , but the file was created in the directory where the scripts are stored, /home/observer/exec/ .

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A.6 Problems with appearance of raw images

A.6.1 **Raw image has identical count in every pixel**, for example all zero's, or all 10000 ADU, or all –25000 ADU. The array control computers need to be restarted. These are the Pixel Acquisition Nodes, or PANs.

A.6.1.1 First recovery procedure: observer restart of PAN computers.

a) In the terminal window (command line window), issue this command string:

    nocs stop all <cr>

b) Ask the OA to issue the PAN computers "clean all" command

The command is issued from the observer@newfirm-kp prompt:
nocs nuke pans

VERY IMPORTANT: be sure observer has issued the "nocs stop all" command first. Otherwise, "nuke" can have catastrophic consequences. If this makes you nervous, don't do it. Move on to A.6.1.2.

c) Restart the system with the usual commands

    nocs start all <cr>
    400mvbias <cr>

d) Reset the filename and directories in the NEWFIRM DHS Supervisor window
e) Take a short test exposure using a TEST script to verify that all is well.

A.6.1.2 Second recovery procedure: complete shutdown and reboot of PAN computers. Try this if the first procedure doesn't restore normal operations. This takes ~15 minutes.

a) Exit from any other *observer@newfirm-kp* logins on *mayall-2* and *mayall-3*.
b) Ask the Observing Assistant to turn off the Monsoon power in the Cass cage. This may require moving the telescope for access to the cage.
c) Ask the Observing Assistant to shut down and reboot PAN A and PAN B computers. This takes about ten minutes.

See A.7.2 [101] Reboot nfpan-a-kp and nfpan-b-kp.

d) After both have been rebooted, ask the Observing Assistant to turn on Monsoon power in the cage.
e) Log back in to *newfirm* and do a normal system start:

ssh –X observer@newfirm-kp
usual password
nocs start all <cr>
400mvbias <cr>

followed by the normal setup activities in all monitors

f) Take a short single image with a TEST script to see if the system is now running normally (it should be).

A.6.2 **Raw image has negative counts and strange appearance**: the arrays aren't biased. Counts may be several hundred ADU negative with light on the array, and 1-2 thousand ADU negative with the dark slide in place. Appearance is "washed out" with cracks and other defects bright, not dark.

Bias the arrays with

400mvbias <cr>

A.6.3 **Raw image shows a strong center to edge gradient, or a vague shape covering the central part of the field**: condensation on the entrance window due to high local humidity. This must be removed by turning up the dry N2 gas flow, and waiting for the window to dry off.

First, verify that it is condensation. This will **reduce** the background sky level in the J band (because it is blocking incoming photons), but **increase** the background in K (because it is warm and emissive).

a) Take a 5-10 second test exposure on the sky in J. Verify that the background level increases from the FOV center to FOV edge (i.e. background is darker in the center).
b) Repeat in Ks. Verify that the background level decreases from FOV center to FOV edge (i.e. background is brighter in the center).

Then, clear the window by evaporating the condensate.

c) Ask the OA to turn up the dry N2 gas flow across the NEWFIRM entrance window. It may be necessary to move the telescope to allow access to the Cass cage to do this.

   There are two flow control valves in series. Both need to be turned up. One is at the gas flow panel mounted on the east side of the cage. The other is on a panel mounted on the yellow NEWFIRM truss on its northwest side, near the instrument controller (NICC).

d) Take a Ks frame on sky from time to time to monitor the background as the condensate is dried off the window.
e) Clearing the window may take anywhere from a few minutes to an hour or more, depending on how badly it has fogged, and the ambient relative humidity.
f) Clearing will proceed more rapidly if the Environmental Cover is closed. However, open it whenever you do step (d), then close it again.

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A.7 Reboot instructions for NEWFIRM computers

A.7.1 Reboot newfirm-kp

1) Be sure the observer has halted the data system with user commands “debias” and “nocs stop all” and done an “exit” from observer@newfirm-kp.
2) Have the observer exit any other observer@newfirm-kp accounts he may have opened
3) Open an xterm window on Desktop 3 of mayall-2. (Alternatively, use the monitor and keyboard provided in the computer room next to the NEWFIRM computer rack, selecting the desired machine with the rack-mounted switcher box.)
4) Connect to “newfirm-kp”
   i. ssh –X newfirm@newfirm-kp
   ii. pw ______________
5) Log in as root to perform a shutdown
   iii. su <cr>
   iv. PW is __________
6) From root login, give shutdown command
   /sbin/shutdown –h –t 0 now
7) Wait a couple minutes for the ssh connection to drop out.
8) Push front panel power button (see note below on power buttons) on computer “newfirm” to cycle power back on and reboot. This machine is in the NEWFIRM rack in the 4-m computer room.
9) Wait 5 minutes for reboot to finish.
10) Inform the Support Team person or observer that he/she may continue with troubleshooting or recovery procedures.

A.7.2 Reboot nfpan-a and nfpan-b

1) Be sure the observer has halted the data system with user commands “debias” and “nocs stop all” and done an “exit” from observer@newfirm-kp.
2) Have the observer exit any other observer@newfirm-kp accounts he may have opened
3) Go down to the Cass cage. Power off the array controller (aka Monsoon, DHE) at the circuit breaker on the instrument interface panel (attached to truss, faces Cass cage door)
4) Open an xterm window on Desktop 3 of mayall-2. (Alternatively, use the monitor and keyboard provided in the computer room next to the NEWFIRM computer rack, selecting the desired machine with the rack-mounted switcher box.)
5) Connect to PAN A
   i. ssh –X monsoon@nfpan-a-kp
   ii. pw _____________
6) Log in as root to perform a shutdown
   i. su <cr>
   ii. PW is __________

7) From root login, give shutdown command
   /sbin/shutdown –h –t 0 now
8) Open another xterm window and do the same shutdown for PAN B.
9) Wait a couple minutes for the ssh connections to drop out, leaving you back at newfirm.
10) Push front panel power button (see note below on power buttons) on each PAN computer to cycle power back on and reboot.
11) Wait 5 minutes for reboot to finish.
12) Turn on power to Monsoon at the circuit breaker on the instrument interface panel in the Cass cage.
13) Inform the Support Team person that he/she may continue with troubleshooting or recovery procedures.

A.7.3 Reboot nfdca-kp

1) Be sure the observer has halted the data system with user commands “debias” and “nocs stop all” and done an “exit” from observer@newfirm-kp.
2) Have the observer exit any other observer@newfirm-kp accounts he may have opened
3) Open an xterm window on Desktop 3 of mayall-2. (Alternatively, use the monitor and keyboard provided in the computer room next to the NEWFIRM computer rack, selecting the desired machine with the rack-mounted switcher box.)
4) Connect to “nfdca-kp”
   i. ssh –X newfirm@nfdca-kp
   ii. pw ______________
5) Log in as root to perform a shutdown
   iii. su <cr>
   iv. PW is __________
6) From root login, give shutdown command
   /sbin/shutdown –h –t 0 now
7) Wait a couple minutes for the ssh connection to drop out.
8) Push front panel power button (see note below on power buttons) on computer “nfdca” to cycle power back on and reboot. This machine is in the NEWFIRM rack in the 4-m computer room.
9) Wait 5 minutes for reboot to finish.
10) Inform the Support Team person or observer that he/she may continue with troubleshooting or recovery procedures.

A.7.4 Reboot nfdhs-01 and nfdhs-02

1) Be sure the observer has halted the data system with user commands “debias” and “nocs stop all” and done an “exit” from observer@newfirm-kp.

2) Have the observer exit any other observer@newfirm-kp accounts he may have opened
3) Open an xterm window on Desktop 3 of mayall-2. (Alternatively, use the monitor and keyboard provided in the computer room next to the NEWFIRM computer rack, selecting the desired machine with the rack-mounted switcher box.)
4) Connect to “nfdhs-01-kp”
    i. ssh –X newfirm@nfdhs-01-kp
    ii. pw ______________
5) Log in as root to perform a shutdown
    i. su <cr>
    ii. PW is __________
6) From root login, give shutdown command
    1. /sbin/shutdown –h –t 0 now
7) Wait a couple minutes for the ssh connection to drop out.
8) Open a second xterm window on mayall-2, and repeat steps 4-7 for nfdhs-02-kp.
9) Push front panel power button (see note below on power buttons) on each computer “nfdhs-01” and “nfdhs-02” to cycle power back on and reboot.
10) Wait 5 minutes for reboot to finish.
11) Inform the Support Team person or observer that he/she may continue with troubleshooting or recovery procedures.

A.7.5 Reboot NEWFIRM Instrument Controller, aka NICC

Guider must be powered off first, and remain powered off until instrument controller has rebooted and reconnected to the network.

1) Turn off power to the guider using the guider circuit breaker on the instrument interface panel facing the Cass cage door.
2) Go to Desktop 2 on mayall-2. If there is not already an xterm window connected to nicc@nicc-kp, connect to nicc with
    ssh –X nicc@nicc-kp <cr>
    pw is _______________
3) Log in as root and issue the shutdown command:
    su <cr>
    PW __________________
    /sbin/shutdown –h now
4) The ssh connection will be terminated when shutdown is performed.
5) Go out to the Cass cage and turn off power to the instrument controller at its circuit breaker on the instrument interface panel. The cold heads will stop.
6) Wait 60 seconds.
7) Turn on power to the instrument controller. The cold heads will start back up.
8) Wait 5 minutes for reboot of its self-contained computer.
9) Reconnect with ssh from *mayall-2* following procedure A.3.1 .
10) start GUI menu with
    /usr/local/nicc/start-menu <cr>

11) Click on menu items to display GUIs for Temperatures, Filters, and Environmental Cover.
12) At this point, turn on power to the guider at the instrument interface panel.
13) From the OA station in the control room, restart the guider per separate Guider Setup Instructions.

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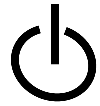
A.8 Locations of rack-mounted NEWFIRM computer power buttons

Computer power buttons are indicated by the symbol 

PAN A and PAN B (rack positions 3, 4):

> **Button is on the left hand side of the computer front panel, next to the DELL logo.**
> **Symbol is on the button. Symbol glows green when power is on.**

nfdhs-01, nfdhs-02 (rack positions 5, 6);
nfdca-kp (position 7);
newfirm-kp (position 8):

> **Button is in upper right hand corner of the computer front panel.**
> **Button is a dull red color with the symbol engraved on it.**
> **Button is slightly recessed; may need a pencil, etc. to push it.**
> **It is NOT the small button labelled "RESET".**

nfguider (rack position 9):

> **Button is a square grey button in the middle of the computer front panel.**
> **There are two square grey buttons side by side. Power is the one on the right.**
> **The power symbol is directly above the power button.**

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