AGN14

MDM Reverberation Mapping Program

2014 January – 2014 July

PROCEDURES MANUAL FOR OBSERVERS

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1. Introduction

1.1 General Outline of Procedures

1. **Startup**: Carried out late afternoon, TWO HOURS BEFORE SUNSET. Bring up the control system in the control room. Start ccds, check focus of spectrograph, verify the central wavelength, and do evening calibrations.
2. **Twilight Setup**: Open dome, fill dewar, power up telescope. Initialize tracking, move to bright star to reset encoders. Focus telescope.
3. **Night-time Observing**: Towards end of twilight, begin observing (a) targets, (b) flux standard stars. See suggested program. Periodically check telescope focus, seeing, and weather conditions. Keep an electronic log.
4. **Shutdown**: Stop tracking, move telescope to stow position. Power down telescope, close dome. Fill the dewar. Take final calibrations. Fill out the observing report and any trouble report forms on the MDM webpage.

1.2 Site Safety Rules

The observer is responsible for protection of the telescope and instruments. This responsibility is exceeded only by responsibility for human safety on the site.

The telescope must not be used if any of the following conditions apply:

1. The wind speed exceeds 40 mph.
2. Humidity exceeds 80%.
3. There is condensation forming on cold metal surfaces such as railings or cars.
4. Dust/fog is visible in a flashlight beam.
5. There is a threat of rain or lightning.
6. There is snow on the dome.

In the event that lightning threatens, there is a lightning shutdown procedure that must be followed. Make sure you ask the mountain support staff to show you this procedure.

1.3 A Note on Scripts

Prospero command scripts have been provided for most of the observing tasks in order to optimize the observing process and reduce the possibility for mistakes or inhomogeneous observing practices among different observers. **You are required to use these scripts as described below**. To see what scripts are available, enter “call agnhelp” in Prospero.

The scripts are implemented as custom Prospero commands (e.g., “call agnhelp”). Type the “call” followed by the script name and then follow the prompts within the script. When the script is finished, a message will be printed to the Prospero screen, and the Prospero prompt will return. Make sure you check that you have responded to all prompts before leaving the screen.

1.4 Data Requirements

Because we will be acquiring a large amount of data for this campaign, there are a number of procedures that need to be followed every night that will greatly help with the flow of data through the spectral reduction pipeline.

File Naming Convention

All raw FITS format files will be named "**ccdsYYMMDD.####**", where #### is a sequence number that should be set to begin with 0001 at the beginning of each night (the system adds ".fits", so you don't have to). The date code **YYMMDD** is the date of the "observing day" which runs from **noon to noon in local time.** For example, on a night beginning at sunset on March 21 and ending at sunrise on March 22, the date code is "140321", and files will be named "ccds140321.0001.fits" and so forth.

Do not deviate from this file name convention. We use the filename to organize the data by the date of observation, and mine the information from the FITS headers when running the data through the pipeline.

The image sequence numbers start at **0001** with the first calibration image taken during the afternoon and increment from there. There is only ONE EXCEPTION: when focusing the spectrograph with "`focseq`", you will be instructed to change the filenames to 'focus.####'. Always change the filename back to ccdsYYMMDD.#### after you are done focusing.

AGN14 Observing Scripts

Scripts should be used whenever available (for basically everything). Here is a list of available scripts and what they do:

a. **startccds** – startup CCDS for a night's observing (also for restarts)
b. **chkfocus –** take a CCDS focus-check Xenon lamp spectrum
c. **focseq** – take CCDS collimator focus spectrum sequence
d. **docalibsbeg** – take the start-of-night calibrations
e. **docalibsend –** take the end-of-night calibrations
f. **domeflats –** takes 11 dome flats in the afternoon.
g. **objsetup**- take a comparison spectrum, and configure the telescope for taking data
h. **doagn** – take an AGN spectrum
i. **dostd –** take a standard star spectrum
j. **agnhelp** – lists these scripts and what they do

All of these scripts are implemented as custom Prospero commands, and are available on startup.

Seeing Estimates

Please make regular estimates of the seeing during the night. The preferred method for making these estimates is to use images from the CCDS Acquisition Camera as described in **Appendix, section 4**.

Observing Logs

Please keep electronic logs using Google Drive. The link is a long and nasty piece of business. Rather than typing it out, you can have the previous observer or one of the AGN14 core team members share it with you. It is also saved on mdm13ws1 in

```
/lhome/obs13m/AGN14/log_template.txt
```

Be sure to copy the template to a new spreadsheet, titled "Log_2014MMDD," where MMDD are the month and day, as before. When you are finished for the night, share it with Michael: fausnaugh@astronomy.ohio-state.edu. If Google Drive for some reason becomes inaccessible, instead use an Excel or OpenOffice spreadsheet. If there are further technical difficulties, use a written log. There is a blank log sheet on mdm13ws1. Fax them to the OSU Astronomy Department the following day at (614) 292-2928. If no blank log sheets are available, you can print copies by typing:

```
lpr -# 10 /lhome/obs13m/logsheets/agn14log.ps
```

(this will print 10 copies).

Weather Conditions

Please keep a detailed log of weather conditions in the "Notes" section of the observing logs, noting conditions like cirrus, wind buffeting, seeing, bright moonlight, poor guiding due to these conditions, etc.   You should also consult the weather station display in the control room for parameters you may think are relevant (wind speed and direction, changes in temperature, etc.). The weather station is actually located at the 2.4m. The display at the 1.3m is the small black box on the filing cabinet. You can also use the Kitt Peak Site Information website

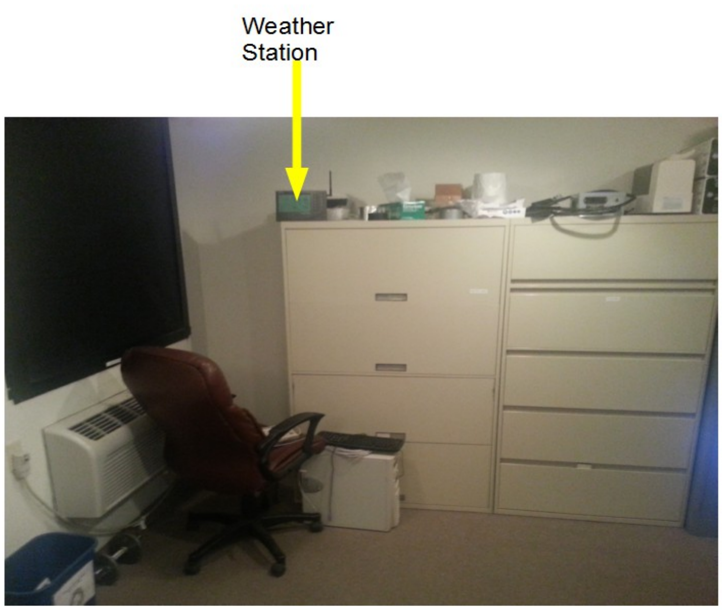
http://www-kpno.kpno.noao.edu/Info/Mtn_Weather/

to track the weather at the other ridge. Check the weather outside regularly.

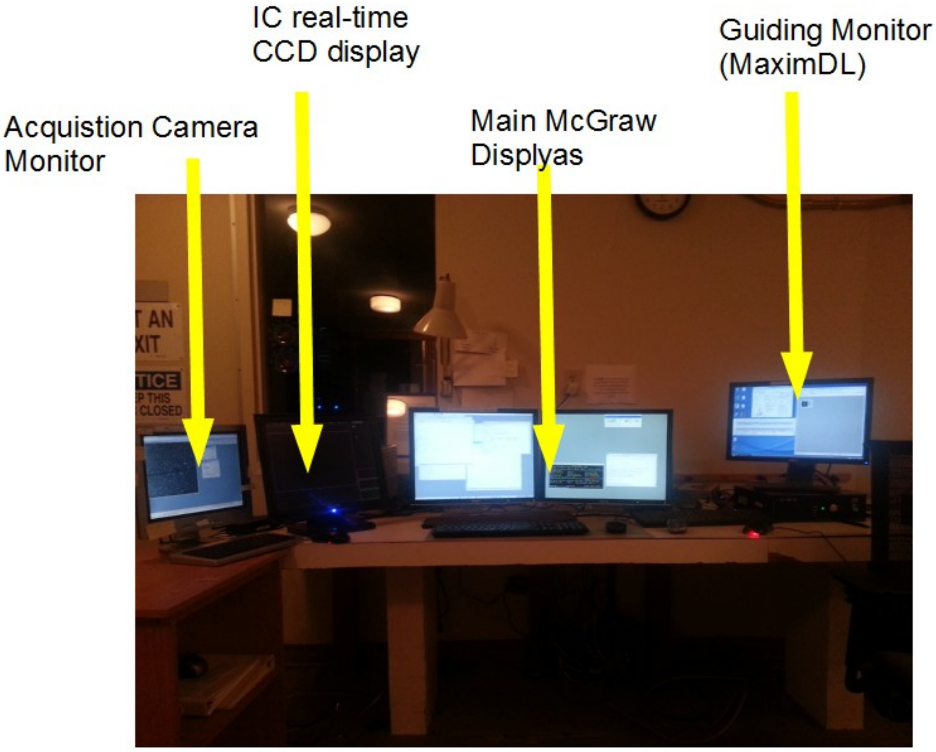
TroubleShooting

For a quick list of troubleshooting tips and other hints, check appendix 1.

Figure 1: Weather station location



South Wall of Control Room



Workstation 1

Figure 2: Main Observing Workstation Monitors.

2. Startup Procedures

If no windows are up, open the menu in the uper left hand corner of the left workstation monitor. Open things in order: Telescope Control (TCS and xmis, both of which have "initialize" buttons), and four items under data acquisition ISIS, Caliban, MDMTCS Agent, and Prospero, all in the order that they appear.

In MDMTCS you type "tcinit" and then "tcstatus" after it has initialized. Caliban and Prospero just go. In Prospero you type "startup"

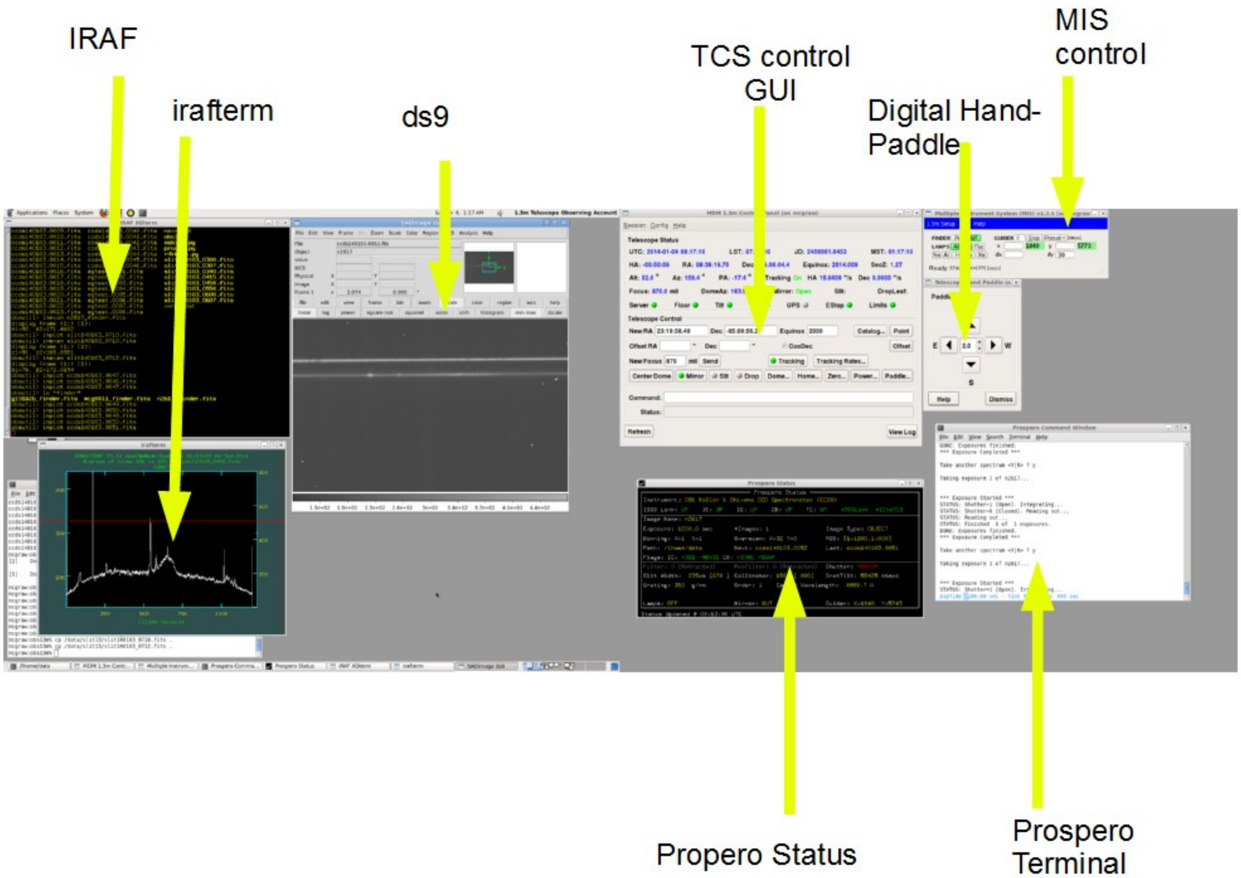


Figure 3: Mcgraw workstation screen.

2.1 Inside the Control Room

1. Make sure that you have located all manuals/binders and that they are easy to find during the night. (1.3 Telescope manuals, acquisition and auto-guiding, and AGN14 campaign). Electronic versions are also available on the MDM website: http://mdm.kpno.noao.edu/.
2. Make sure that the Instrument Computer (IC) (in the computer room) is functioning and that the CCDS is working. See the CCDS manual ("CCDS and TIFKAM Data Taking Startup Procedure inside the front cover of the 1.3m Observer's Handbook binder) for info on how to start the data-taking system if needed.
3. Make sure that the data-taking system (Prospero and all its friends) are running on the Linux workstation (mcgraw), and connected to the CCDS.
4. Turn on monitor for guide camera (see Fig. 3). Everything else should already be turned on and

Maxim DL should be set up and running. If it is not, start it up using the procedures in the "Acquisition and Guiding" manual.

5. The data should have been stored and remotely transferred to OSU during the day. If the previous night's data are still in /data/mcgraw/, store the data in a new subdirectory (in order to get them out of the way). Type "mkdir AGN14_14MMDD" where MMDD is the month and day of the previous night's data. Then type "**mv ccds14MMDD*.fits AGN14_14MMDD**". Also move any slit images from the previous night into this directory.

6. Initialize the observing session by entering "call startccds" in the Prospero command window. You will be prompted with several questions and should respond as below (text in boldface):
   `Initialize Session <y|n>?` Answer: **y**
   `Image Directory Path?` Answer: **/lhome/data** (note: letter before home is lower-case 'el')
   `Root file name for image?` Answer: **ccdsYYMMDD**, where YYMMDD is the current date (local time noon-to-noon) as described in Section 1.4 above. For example, on the night beginning with sunset on 2014 March 21 and ending at sunrise on March 22, type "ccds140321".
   `Starting image number?` Answer: **1** (unless you are restarting, then it should be number for the NEXT image to be acquired).
   `Observer names?` Answer: **[last names]** (e.g., Smith and Jones)

   `Save setup <y|n>?` Answer: y

7. We use the 350 l/mm grating in first order. These will be set by the "startccds" command, but you should see confirmation of this in the Prospero command window and in the Prospero status window. **NOTE:** If you have to restart the data-taking system for any reason during the course of a night (e.g., restarting after a lightning shutdown or recovering from a system crash), you will need to run the "startccds" script again, but this time take extra care to answer "Starting image number" with the number of the NEXT image to be written in sequence. For example, if after restarting the system the last image written to disk is /lhome/data/ccds140321.0069.fits, then answer "70" for "starting image number" above.

8. In addition, there are several other helpful tools/programs to run. You have 4 virtual desktops available, and it is suggested to use them liberally. This will avoid cluttering your virtual workspace.
   a. On the same virtual desktop as Prospero et al., it is helpful to watch the autolog, a continuous log of all images taken by the instrument that runs in the background. You can view the autolog by opening an xterm and typing

      ```
      tail -f /lhome/data/Logs/YYMMDD.log
      ```

   In particular, be alert for any sign that data are not being written to disk correctly, or for signs that the telescope information is corrupted. Both conditions are rare, but this is your best way to catch them early.

   b. In a second virtual desktop, or the second monitor, you will want to be running IRAF and the ds9 image display to use for examination of the data as they are taken. On the second virtual desktop, launch an IRAF xgterm by clicking on the IRAF icon (the red box with the white star inside) on the top toolbar. Launch ds9 by clicking on the SAO sunburst icon next to the IRAF icon. Make sure there is not another IRAF or ds9 running—IRAF does not like to share the ds9 window with others, and it can be very confusing when this happens.

c. If you have your own laptop, we suggest that you fill out the nightly observing logs there (in your favorite web browser), rather than trying to use yet another virtual desktop window. However, if you do not have a laptop, you can open Firefox and any other tools you need on the third virtual desktop.

2.2 Check the Spectrograph Focus

Before you take any calibration data you need to check the spectrograph focus as follows:

1. Note the current collimator focus displayed in the Prospero Status Window. The collimator dial units are given in square brackets (e.g., [805]).
2. Run the script ‘chkfocus’ and follow the instructions. This will take a single Xenon lamp exposure. Note the filename (e.g., ccds140321.0052.fits). The script takes care of selecting the lamp, slit width, etc.
3. When chkfocus is finished, go into the IRAF xgterm window (or open IRAF if it is not yet running), and examine this exposure using the “implot filename.####" command, where ‘filename.####’ is the name of the image taken by chkfocus.
4. In the IRAF graphics window, enter “`: a 20`” and “`: l 455`” (letter ‘el’) to display the average of 20 rows around row 455 (the sweet-spot on the CCD).
5. Measure the line widths of the comparison lines using ‘`p`’ key: place the cursor at the base of the blue (right) wing of the line, press ‘`p`’ and place cursor at the base of the red (left) line wing and press ‘`p`’ again. The line width and center will be displayed at the bottom of the IRAF graphics window.
6. Repeat this for other lines—do some at both ends and in the middle of the wavelength range, taking note of the line widths. Try to choose lines that are unblended and isolated.
7. Good focus is defined as a line width of about 2.3-2.5 pixels. If the lines are broader, you will have to refocus the spectrograph (go to Appendix Section 2 at the end of this manual). If the spectrograph focus is correct, you can move on. If not, see appendix 2 for instructions on how to focus the spectrograph.

2.3 Verify the Correct Central Wavelength

When “startccds” is run, we need to measure the central wavelength and update this in prospero before we begin every night. Verify the central wavelength as follows:

1. Plot a well-focused Xenon comparison lamp using “implot” as described above (use 20 rows centered on row 455 of the CCD).
2. Using the Xenon spectral line atlas in the CCDS manual for the range from 4000Å to 6000Å (see Figure 4 below), identify two unblended spectral lines at either end of the CCD. Good lines to use are the λ4501Å and 5028Å lines, located approximately at pixels 980 and 580, respectively. Note that the red end is to the left when the spectra are read out from CCDS.

3. Using the key ‘`p`’ as before (in task “implot”), measure the centroids of two lines (e.g., the 4501Å and 5823Å lines) and write them down. The units are pixels.
4. In Prospero, type ‘xwave’ and at the prompts enter pixel centers and the catalog wavelengths (the central pixel is 600). XWAVE will return the approximate central wavelength and the approximate linear dispersion. Note: the central wavelength is only accurate to within a few Angstroms, but that is all the accuracy we need for this step.
5. Update the central wavelength value in the Prospero status window with command ‘`newcenter cenlam`’ where ‘`cenlam`’ is the central wavelength estimate just returned by XWAVE.
6. If the central wavelength is more than ±20Å different than 5000Å, contact the on call AGN team member for permission to change the central wavelength. The command for this is “center XXXX” in Prospero, where XXXX is the new central wavelength. However, due to hysteresis in the travel, it is necessary to always approach the central wavelength from smaller values. Therefore, you must first enter a central wavelength ~2000Å *lower* than the target value (i.e. first move to 3000Å, then back to 5000Å).
7. Record the central wavelength each afternoon on your daily log sheet.

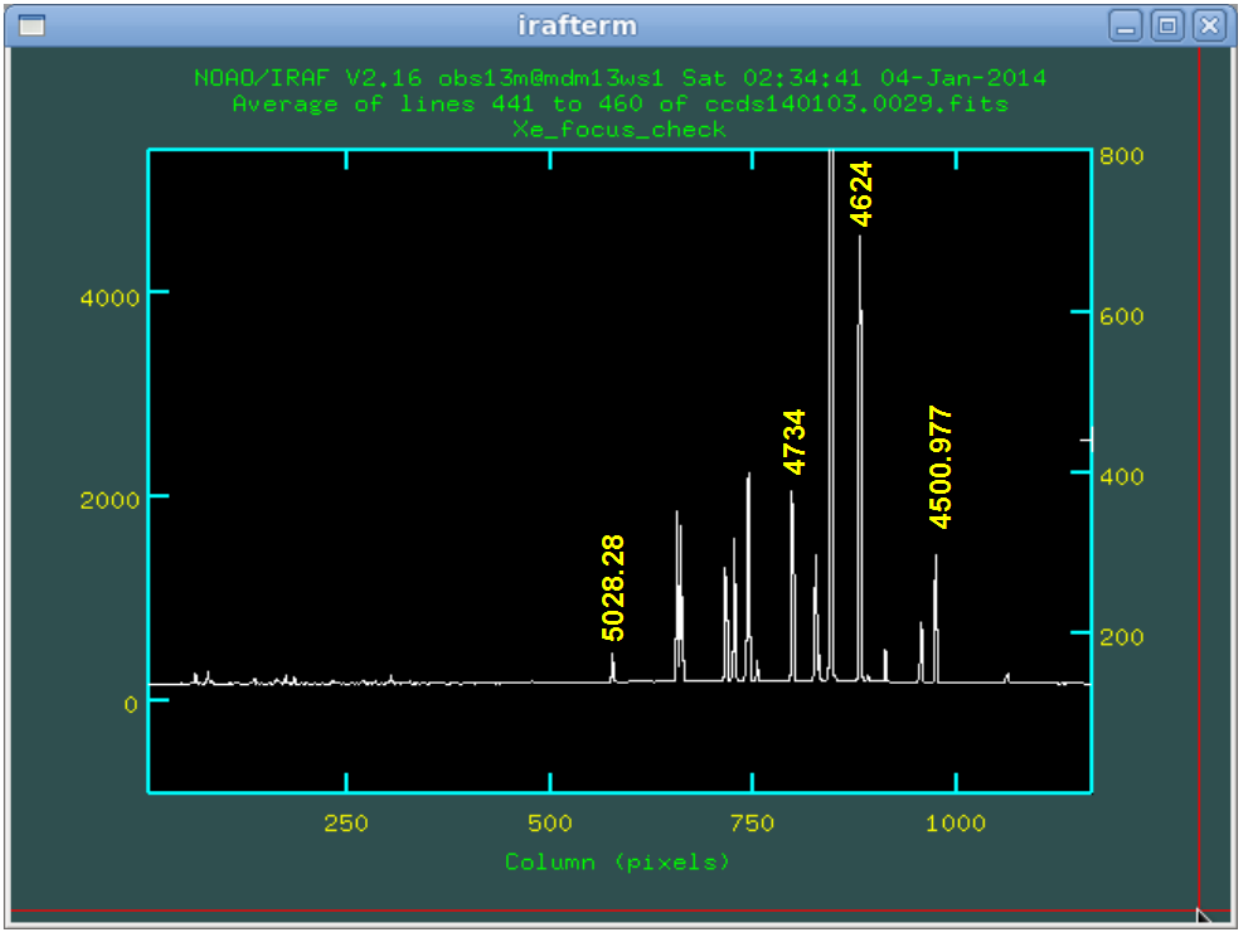


Figure 4: Xenon spectrum with central wavelength of 5000Å. Several particularly useful comparison lines of Xenon are identified.

2.4 Take Starting Calibration Data [docalibsbeg and domeflats]

There are a number of calibration images that need to be taken at the beginning of each night: (a) long Xenon and Argon lamp spectra that will be used for wavelength calibration, (b) Bias frames, and (c) Dome flat-field images. These can all be taken in the afternoon or early evening, but should be done before it is dark enough to observe. Give yourself plenty of time to run these scripts.

1. Before beginning calibrations, make sure that the next image filename has a rootname like "ccdsYYMMDD" (this should have been set using "startccds"). If it isn't, change it by typing "filename ccdsYYMMDD" (see Section 1.4). Also make sure that dome lights are off and all doors to the dome are closed. Note that calibration data may not be the very first image of the "ccdsYYMMDD" sequence if you took focus check or test exposures as part of startup. Be sure to mark the start of calibrations in your logsheet.
2. In Prospero type "**call docalibsbeg**" and follow the instructions. The script will take 1 xenon lamp, 1 argon lamp, and 12 bias frames. You must be present for the first bit, since it asks you

to verify that the data are ok. This procedure ensures we don't take bad calibration data. Once you have verified the lamps, it will take all 12 biases on its own—this will take about 15 minutes.

3. Once the biases are complete, in Prospero type “**call domeflats**”. This program will guide you through the steps necessary to take dome flats. Follow the instructions and answer the prompts as asked—once you are ready, the program will take 11 45-second dome flats. This will take about 10-15 minutes to run.
4. While the dome flats are running, inspect the morning calibration frames from the previous “night.” Use implot and check the line widths and max counts. Do the same for the evening calibrations when you have time during the night. Check of the visual inspection box in the log.

3. Twilight Set-Up

3.1 Fill the CCD Dewar

Fill the camera dewar on the observing floor (see Figure 5, below):

Figure 5. Proper dewar filling procedures. Insert the fill tube into the fill port of the camera dewar, gently pushing it in as far as it will go (upper left). Turn the fill valve (upper right) on the liquid nitrogen tank to the fully open position. The camera dewar is full when liquid N_2 will pour copiously onto floor. Turn off fill valve. Do not attempt to move the liquid nitrogen tank until the fill tube has

completely thawed or else it will shatter. The fill tube will fall out when it has thawed out. Move the liquid nitrogen tank away from the telescope to its stowed position on platform near the telescope control panel. Please record the fill time on dry erase board in the control room (lower left). If the liquid nitrogen supply tank is getting low, please inform the support staff immediately so they can get you another tank. Especially check in on a Thursday afternoon, as it is not possible to get a fresh tank on the weekend except in emergencies.

3.2 Opening the Dome

1. Make sure that the dome in the stow position at Azimuth 51°. The shutter can only be opened/closed while in the stow position. If it is necessary to manually move the dome, twist the left or right dome direction switch.
2. Refer to Figure 6t (below). Turn on the telescope drive power, which is the red knob labeled "emergency stop" on the side of the dome control box. Turn the knob clockwise until it releases and the red light goes off.
3. Set the main shutter switch to **Open,** and press the main shutter control button.
4. Once the main shutter has opened a bit, press and hold the dropout shutter control button until the dropout is completely open. It will make horrid screeching sounds when it is completely open.

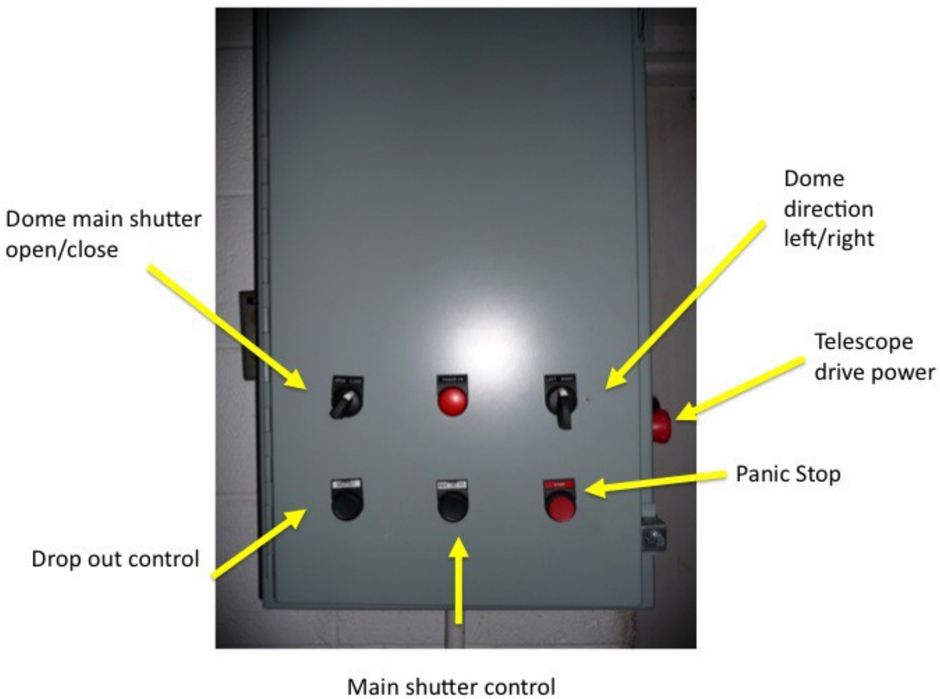


Figure 6. Dome Controls for rotating and opening/closing the shutters. Open the main shutter first, then lower the dropout shutter.

3.3 Opening the Mirror Cover and MIS Hatch Cover

The dome must be completely open before the mirror cover may be opened (this prevents debris from the dome doors from falling onto the mirror).

1. Make sure the telescope is pointed at the zenith (it should already be there).

2. Open the mirror cover by pressing the "Mirror" Button on the TCS display. This will take a couple of minutes; go out into the dome and watch the sides of the mirror cover open to make sure it opens properly.
3. Inside the dome, open the MIS hatch cover, accessible from the east side of the telescope (see Figure 7). Open and closed positions are clearly marked. You will need to pull it outward first, then move it to its new position.

Figure 7. Open the MIS box hatch cover using the lever. Pull it out and then move it to the "open" position.

3.4 Power-up the Telescope

1. Before doing anything, make sure that there is nothing on the platform that can collide with the telescope – in particular, move the liquid nitrogen tank to the northeast corner of the platform. Make sure that the platform is all the way **down.** There is no reason it should not already be down, but it's always good to double-check.
2. Turn off the dome Air Conditioning system and prop open all of the doors to the dome to help temperature regulation.
3. Assuming everything is working properly, step 2 is the last thing you need to do inside the dome until morning. Make sure the dome lights are off and the door to the dome is shut tight.

3.5 Verify Telescope position, begin tracking, and set up CCDS.

1. Click "Refresh" on the TCS interface. Note the Hour Angle (HA) on the TCS GUI. It should say that the HA is 00:00:00. If it is considerably off, you will need to re-home the telescope using the procedure in the 1.3m manual.

2. Note the tilt sensors in the computer room. They should both read somewhere close to zero. Again, if these are off, you may need to re-home the telescope.
3. If the telescope is properly homed, the RA should read the same as the LST and the DEC should be 31:57:12.
4. Turn on the tracking by clicking the "Tracking" Button on the TCS interface. When tracking has begun, the indicator will turn green on the TCS interface.
5. Click on the "Dome" button in the TCS interface and select "Center Dome" and "Auto Center". Click "Apply". The dome will now track with the telescope. If you do not select "Auto Center", the dome will center itself but will not track, so make sure you select both options.
6. On the CCDS acquisition monitor, go to "setup" in the CCDOPS toolbar. Set "Temperature regulation to "active" and set the set point to about 20 degrees below the ambient temperature. To see if this is working, check the menu bar at the lower right of the monitor—this gives the % activity that the temperature regulator is working at. This should stay around 60% all night, although it will initially work at 100%.

3.6 Check the Telescope Pointing:

Check the pointing of the telescope on a bright star during twilight while it is still too bright to observe. This procedure should be followed at any time during the night when you cannot find your target because the pointing is off.

1. If Jskycalc is not running, ssh into Hill by typing "ssh hill" in a terminal shell.
2. Start jskycalc by typing "./runjskgs" in this terminal. A skycalc GUI will open, along with 3 other windows. See Figure 8 for reference.
3. Click on "Read Telescope" in the 1.3m Telescope Interface panel. This reads the current position of the telescope from McGraw. The RA/DEC in jskycalc will show up in equinox 2000.0 coordinates, so they will differ slightly from the RA/DEC that show up in the TCS panel.
4. In the Sky Display, the red circle represents the position of the telescope and the green square represents the coordinates that are currently loaded into skycalc.
5. Select "Nearest Bright Star" to provide the coordinates of the nearest bright star—this will provide the name and coordinates of the nearest star to the current telescope position.
6. Click "Slew Telescope" on the 1.3m telescope interface window to move the telescope to the position of the nearest bright star. When it has finished slewing, there will be a green indicator that says "Slew completed" directly underneath the "Slew Telescope" button. The red circle and the green square should now line up in the Sky Display.
7. At the CCDS Acquisition monitor, click on "Focus" and set the exposure time to 0.5 seconds. Hit "OK" to begin the acquisition loop. You will see the acquisition camera view as it loops. The star you are using will be extremely bright and should be extremely obvious. If you cannot see a star, raise the exposure time to 1 second, but all of these stars should be bright enough to find with a very short exposure time.
8. Go to the MDM TCS panel and hit the "Paddle" button, which brings up a small window called "Telescope Hand Paddle" which does the same thing as the hand paddle, but is easier to control. The units are in arcseconds, and you cannot enter a number above 60 arcseconds. The acquisition camera has a 3.5' x 5' FOV. Note: Whichever way you move the telescope, the star will move the opposite direction in the guider window, so if your star is below the slit, you will need to move the telescope east, and the star will appear to move west on the screen.

9. Using the hand paddle window, move the telescope until the star is positioned on the slit very close to the center of the acquisition camera. When you use the paddle, you will see a confirmation of the command in the "status" window in the TCS control panel that tells you when it it slewing and when the slewing is complete.
10. Once the star is directly positioned where you want it, go to the jskycalc "Telescope Interface" window and click on "Reset tel. coords", which tells the telescope where it is actually pointed. YOU MUST HAVE THE TELESCOPE POINTED CORRECTLY WITH THE STAR POSITIONED OVER THE SLIT BEFORE HITTING THIS BUTTON! Again, remember that the RA/DEC in jskycalc will be in J2000.0 coordinates, while the RA/DEC in the TCS panel are in current-day coordinates, so they will differ.

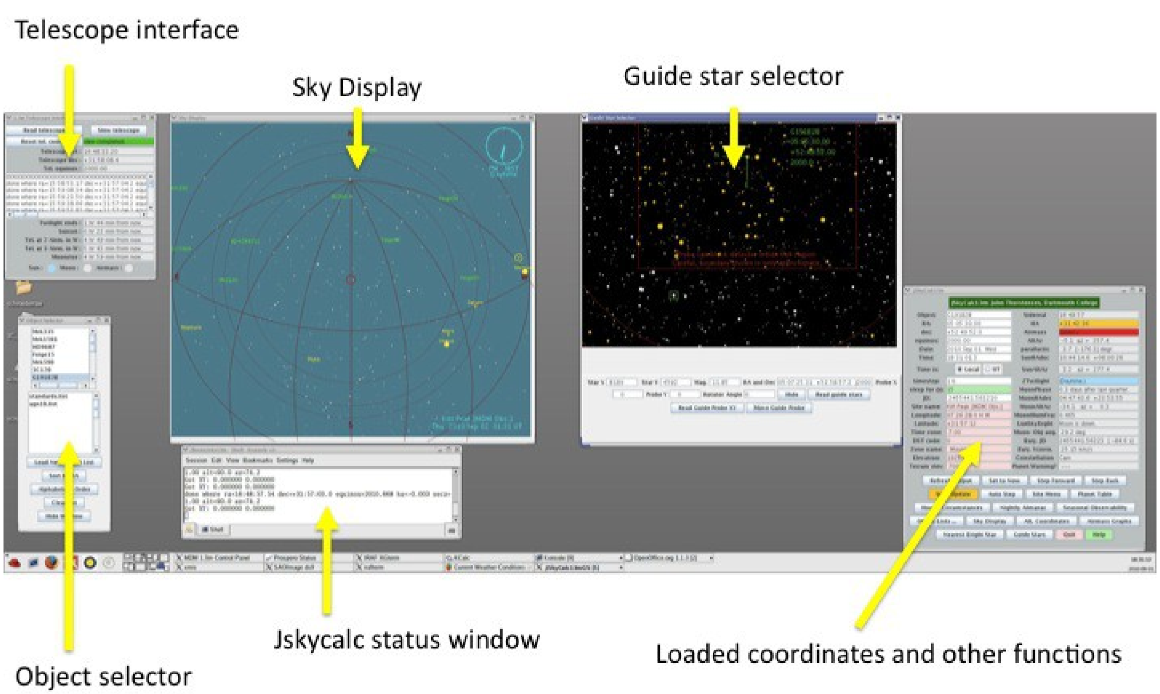


Figure 8. The jskycalc setup and interface.

3.7 Focus the Telescope

1. Move to the first standard star/target of the night (see section 4 on how to slew).
2. Start a short exposure on the Slit-Viewer/Acquisition Monitor as follows:
   a. Click on "Focus" on the CCDOps Toolbar.
   b. Choose an exposure time of 1-2 seconds for a bright star. If the star falls on the slit, move it off of the slit using the hand paddle.
3. Record the current telescope focus.
4. Begin by subtracting 40 from the current focus, type this value for the focus in the "New Focus" box on the TCS control panel and hit "Send". This will put the telescope far out of

focus, but is necessary because of hysteresis in the focus travel.

5. Raise the focus value by 30, so that you begin reviewing focus values at 10 units below where you started.
6. Move the focus towards larger numbers (by increments of 5) and note where the focus is optimal (i.e. star is round and as small as possible). Run through the focus to higher numbers until the image becomes a doughnut again.
7. Change the focus to a value much **lower** than the optimal focus, and then move to the optimal focus from lower numbers. Record the focus and temperature on your observing log.
8. Check the focus throughout the night—for example, when observing flux standards. The focus will change as the temperature drops, so that focus decreases by about 1.5-2.0 units per ºF, so keep an eye on it.

4. A Routine Observation

1. Keep a record of all observations in the observing log for the night
2. In Prospero, type "call objsetup". You will be prompted for the object name, and then prompted to slew the telescope to that object.
3. Slew to an object:
   a. On the Telescope Control Panel GUI, click on the "Catalog..." button. If you haven't loaded a target catalog yet for the night, you will need to click on the "File..." button. This will open a file selector dialog, go to the /lhome/obs13m/Catalogs directory, and select the AGN14.cat file. Press Open to load it. Once you load a catalog, it stays loaded in the Telescope Control Panel GUI until you load another or clear the catalog. This is the list of objects for the night.
   b. In the Target Catalog dialog, click once on the target you want to observe. The "Apply" button will turn yellow. Click on the yellow Apply button to send the target coordinates to the control panel. You should see the target coordinates appear on the TCS GUI. If you press the "Dismiss" button on the Target Catalog dialog, it will hide the catalog from view. Click on the "Catalog..." button again to bring the catalog back.
   c. When you are ready to point, click on the "Point" button to slew the telescope to the selected target.
4. Once you have started slewing, return to the Prospero terminal and press enter. Follow the instructions of the additional prompts. We want to take a comparison spectrum (Xe lamp) before each object in order to quantify the effects of flexure in CCDS. This script will reconfigure the telescope, take a Xe lamp, and return the telescope to its previous state for observing. To reduce overhead, we want to reconfigure for calibration while slewing.
5. After the objsetup script finishes, type "call doagn" in Prospero (or "call dostd" if observing a standard star), and follow the instructions. The appropriate IDs for each target are written on the finding charts. Note that both doagn and dostd will set the guide probe for the preset guide star for this target, so there is no need to hunt for a guide star.
6. Increase the exposure time on the CCDS Acquisition camera by clicking on "Focus" and entering in the desired exposure time, which is provided for each object with the finding charts. At this point, you should be able to see your target. Using the hand paddle, move your object **onto the slit**, as well as within the grease pencil box drawn on the monitor. You will be able to make fine adjustments after you start guiding, so you do not need to get it perfectly positioned

here.

7. On the guider monitor in Maxim DL, make sure you are on the “Guide” tab. Select the “Expose” Button and press “Start”. Maxim DL will take one exposure. There should be at least 1 bright star visible in the field. Click on the “Track” button and “Start” again. This will begin guiding. If there is no bright star, or guiding in some way fails, call the on-call AGN14 team member.
8. If you need to make any small adjustments to the object's position on the slit, you can enter them on the 'dx' and 'dy' boxes on the MIS control. Follow the directions taped to the acquisition monitor for the sense of direction for dx and dy offsets. 10 units are approximately 1 arcsecond.
9. Watch the images on the CCDS Acquisition Camera monitor for several cycles to make sure that the guider works and the object stays on the slit. **NOTE:** There is an issue with the telescope “nodding” in the N-S direction, with an amplitude of 1-10 arcseconds. This is a known but sporadic issue. If it happens to you, you will see objects in the acquisition camera smeared out in the N-S direction. The guiding system will keep track of the average dispersion —note the rms value in the log, which can be found in the tracking error graph on the Maxim DL monitor.
10. Once you are guiding and the object is stable and well-placed on the slit, you can continue responding to the prompts in Prospero when running “doagn” or “dostd”.
11. Once an observation is complete, watch the CCD display monitor as the image is read out. Do 3 exposures for each target (see target list and exposures). Dostd automatically takes 2 spectra of each standard star. Check also that the data are written to disk, and remember to keep updating your observing log and checking the weather.
12. As the image is read out, check the data quality. Specifically, make sure that there is a spectrum, and, if it is an AGN, make sure that it has emission lines. An example of the raw data for one AGN is in figure 9. You may need to open the image in ds9 and adjust the scale—it is recommended to use “log” and “minmax.” You can also examine the spectrum with IRAF—use implot, and type “:a 2\0”, then “l 455”, just as with the calibration frames.
13. Once you are finished with an object, rerun “call objsetup.”

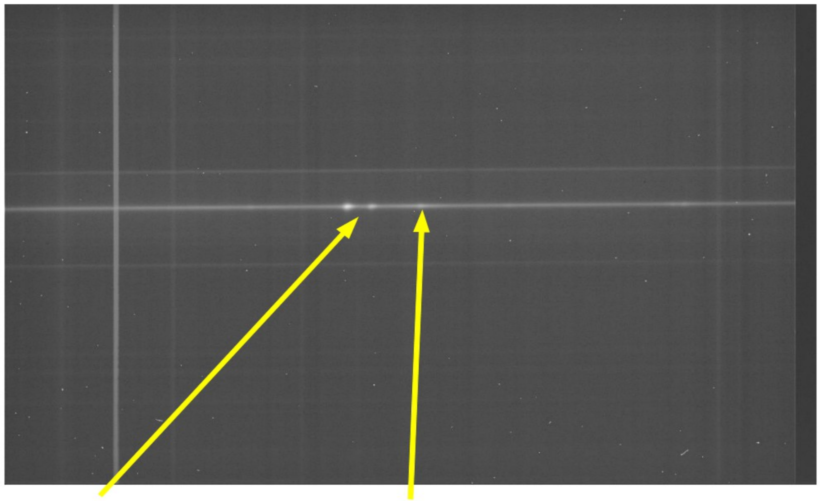


Figure 9: Example of emission lines. This object is raw data for MCG-08-11-011. The ds9 scale parameters used are "log" and "minmax."

5. A Typical Night of Observing

This is the typical sequence of observations during a night. Names of scripts that will do these tasks are listed in square brackets. On a good night, you should be able to observe 7 or 8 targets, in addition to 3 standard stars. If the weather is patchy, just get as many objects as you can. The objects with stars ("*") are priorities (they have short lags, and therefore require better time coverage). NGC 5548 is especially important, and should be observed every night. Objects must be observed at airmass 2.0 or lower (higher elevation) for the length of the observations.

1. Afternoon calibrations **[scripts: docalibsbeg, domeflats]**
2. Standard Star (G191B2B or other) **[scripts: objsetup, dostd]**
3. MCG 08-11-011* **[scripts: objsetup, doagn]**
4. Akn 120 **[scripts: objsetup, doagn]**
5. Mrk 374 **[scripts: objsetup, doagn]**
6. CBS 74 **[scripts: objsetup, doagn]**
7. Standard Star (Feige 34 or other) **[scripts: objsetup, dostd]**
8. NGC 2617* **[scripts: objsetup, doagn]**
9. NGC 4051* **[scripts: objsetup, doagn]**
10. PG 1244+026 **[scripts: objsetup, doagn]**
11. NGC 5548** **[scripts: objsetup, doagn]**
12. Standard Star (Hz44 or other) **[scripts: objsetup, dostd]**
13. End-of-Night calibrations after closing up **[script: docalibsend]**

Some objects are special, and will make specific demands on your nightly program. For example, we suspect that NGC 4051 has very rapid variations, and we will eventually wish to observe it twice per night. This is only possible in the spring, and will require special planning. You will be alerted of similar special instructions before your run, by the previous observer, or by email.

6. Shutdown Procedures

1. Stop guiding. Turn off the guide camera monitor. Stop the CCDS Acquisition Camera focus loop by closing the window labeled "focus."
2. Bring the telescope to zenith using the following two steps:
   a) Turn off the telescope tracking by clicking the "Tracking" button. The indicator light should turn gray.

   b) In the command box of the TCS control panel, type 'point ha=0 dec=31:57:12 nodome' and hit enter. This will bring the telescope to zenith. Note that the command box history can be accessed with the keyboard up arrow, so that you don't have to type this every time.

   c) Verify that the tilt sensors in the computer room read close to zero.
3. Go into the dome and close the MIS hatch cover.
4. Close the Mirror Cover by clicking on the "Mirror" button in the TCS control panel.
5. Rotate the dome to the stow position at Azimuth 51° by clicking on the "Dome" button in the TCS control panel and selecting "Home Dome", and clicking "Apply". This will send the dome to its starting position. While the dome is slewing, you may proceed to the next step.
6. Click on the Setup icon on the Toolbar in the CCDS Acquisition Camera and switch the temperature regulation from "Active" to "Off".
7. Close the dome shutters with the following steps:
   a) Turn the dome main shutter switch to **close** (Figure 5 above).
   b) Press and hold the dropout shutter button till the dropout shutter is completely closed.
   c) Press the main shutter button to close the main shutter.
8. Go back into the dome and turn **Off** the telescope power by depressing the "Emergency Stop" knob. The red light inside the knob will turn on.
9. Turn on the dome air conditioner system (if necessary).
10. Fill the CCD dewar and record the time it was filled on the dry erase board in the control room. DO NOT leave the dewar unattended during fill process.
11. Close all of the doors to the dome and turn off the lights.
12. With dome lights off, take the end-of-night calibration observations. [script **call docalibsend**]. Once again, you must be present for the lamp exposures. Note: you do NOT need to take dome flats this time—just the lamps and biases are sufficient. The only difference between docalibsend and docalibsbeg is the number of biases.
13. Share the log with fausnaugh@astronomy.ohio-state.edu . If you are not using Google Drive, email the log spread sheet to this address (or fax a copy to OSU).
14. **Submit an observing report**. Open the web browser and go to the MDM website (mdm.kpno.noao.edu), click on "Submit a Nightly Observer's Report" and fill in the form. Remember to report ANY problems you have by mentioning them in the observing report and then filling out an additional Trouble Report with the detailed description of the problem(s) encountered.
15. Make sure that all the lights are out on the observing floor and in the control room, that the monitors shut off, and that the LN2 has been stored on the northeast corner of the platform..

8. Appendix

A1. Miscellaneous Hints and Pointers/Troubleshooting

Prospero Status: If this window shows red, it means one or more parameters are in error. In particular pay attention to the row of flags 2nd from the top (ISIS Link: et al.) and the "Flags" line at the bottom of the second box (the IC and CB flags). Red means something is wrong with one or more data-taking system states, and any data you attempt to take could be compromised in one way or another (either it won't take data at all, or it will take data just fine, but telescope or other info will be missing from the FITS headers).

On the second line, all the various data-taking subsystems should read UP in green. If any are down, try doing STARTUP in Prospero. This should resynch the system. If not, you will get error messages as part of the STARTUP procedure. Pay attention to these, as they suggest corrective measures. Until all the flags in this line show GREEN, you cannot start taking data.

Some examples:

> **IC or IE are down**: See if the IC is running and responsive to keyboard commands (keyboard in the computer room—for example, press enter and see if the command line returns). If so, type STARTUP and see if you can do a warm restart. If not, reboot the IC, wait for the CCDS% prompt, and then type STARTUP in Prospero when it comes back. If this fails, exit out of all data-taking programs on mcgraw (in order: Prospero, Caliban, MCMTCS Agent, and ISIS), then reboot the IC and follow the cold restart procedure below from the step where the IC is up and ready and xtcs and xmis are up and running. You do not need to kill the xtcs or xmis, they don't play a role in this process, but they do have to be running.
>
> **You see –TCSLink in red** (sometimes along with TC: Down in red): Make sure that the MDMTCS agent is running, and that it returns useful information in response to a "tcstatus" command. If it claims the link is down, type "tcinit" then "tcstatus". This usually recovers the TCS link, though in rare circumstances you may have to restart the MDMTCS agent. Then type STARTUP in Prospero and it should set the flag green. It is also a good idea to make sure that the xtcs program is running and initialized (a simple mistake to make).
>
> **You see –TCStoIC in red**: If +TCSLink is green, this means that the TCS interface is up, but the IC doesn't know this. To correct, go to the computer room and on the IC keyboard type "tcinit". After a brief pause you should see correct TCS info returned. Then in Prospero type "STARTUP" and it should clear things up. This usually happens after a cold restart of the system, as the IC is slow to see the TCS interface on startup. Sometimes, just typing STARTUP again in Prospero clears it, but this fix is more explicit.

The second set of status flags is in the instrument status box (2nd from the top) along the bottom of the box where its says "Flags:". There are two sets of status data for CCDS, one for IC and one for CB.

> IC should show **+SEQ** and **–MOVIE** in green. If you see –SEQ in red, this means the CCD controller "sequencer" is not correctly initialized. In this case, go into the computer room and on the IC keyboard type "seqinit". This should start the sequencer. If successful, in Prospero type STARTUP and it should clear the fault. If the sequencer does not initialize correctly, try stopping and power cycling the IC, and repeat the cold restart procedure from the point where xtcs/xmis are running (you will need to quit out of Prospero/Caliban/MDMTCS and ISIS in

order).

CB should show **+SYNC** and **+SWAP**. The most common problem is –SYNC appearing in red. This means that Caliban and the IC have not synchronized the transfer disks. One way to correct this is to open the Caliban window and type ">IC PING". This should be followed by a lot of chatter as the disks synchronize. If this fails, leave Caliban running and then restart the IC (cold restart) and follow the usual warm restart procedures.

If you cannot get a particular process working after following the suggestions in startup and above, you may have a real problem that requires external help. Before doing that, quit out of and power off the IC and do a cold restart EXCEPT for rebooting mcgraw (you almost never have to reboot the Linux workstation). If this fails at long last, call for help.

Image looks funny (i.e. something is wrong): Although we can't address every possible problem that may go wrong with your observations, there are a couple of problems which seem to reoccur with some frequency. We will address these here, in the hopes of curbing your frustrations should one such problem occur.

a. You only see the top half of your image, and it fades (i.e. there's not a sharp cutoff) to black on the bottom, or fades out in the middle, though the top and bottom of your image look normal: Most likely, this has happened because the finder mirror got stuck halfway between 'in' and 'out.' If this happens, move it back to its previous position (e.g., it was 'out' and you moved it 'in' to take a calibration spectrum and it got stuck, so move it back 'out'), wait about 30 seconds, and then try again to move it to your desired position. Then repeat your previous observation. This should fix the problem. If it continues to get stuck or just doesn't seem to move anywhere, you should call one of the people on the emergency list for assistance.

b. When your image is reading out, the pixels shift sideways so that your image appears to slowly jump to the left as you go down columns, where the breaks are sharp cuts at a certain row: this means that CCDS has started to hate you, like it does me, or, if you'd really like a more technical explanation, there has been a readout error where the charge is not transferred correctly across the CCD chip as it reads out. In this case, just try taking another image, it could have been a single, freak, readout failure. However, if it is followed by errors in Prospero and/or it keeps happening, type "seqinit" on the IC keyboard, then if successful type STARTUP in Prospero. Try to take a test image of a xenon lamp (chkfocus), and see if it looks better – if not, call for help.

Guide stars: If for some reason the guide stars provided do not work for a particular position on the sky (e.g., too close to the moon), you may need to search for a new guide star. Jskycalc displays a window titled "Guide Star Selector," which displays the field of view of the telescope, and a square showing the approximate field visible to the detector. The guide probe can be moved anywhere within this field—click on a star, preferably brighter than 13th magnitude and at a respectable distance from the detector box. Also try to avoid high y values (>10,000). Then click "move guide probe" in the panel below the display. After the guide probe is done moving (yellow disappears on the MIS control), switch to the MaximDL monitor. In the Guide tab, click Expose, and then Track, just as before. More information is about guiding system is available online: http://mdm.kpno.noao.edu/Manuals/guiderdoc/autoguiding.html.

Guider Monitor: Just as a sanity check, if for some reason you think everything is correct, but you can't see any stars on the Guider Monitor, check the following: Is the finder mirror 'out'? Are the guide probe coordinates near a star? Is the telescope looking out of the shutter? Is the sky clear of clouds? If you answered 'no' to any of these questions – there's your problem.

Guider Focus: Sometimes the guider camera itself gets out of focus; this is no big deal, you just need to find the guider focus and move it until the stars on the guider camera are more well-defined. The guider focus is a silver box, next to the MaximDL monitor. Since the probe is generally off-axis, you won't get perfect circles. But you will be able to get rid of fuzzy donuts.

Slit Viewer/Acquisition Monitor: Just like the Guider Monitor, if for some reason you think that you have everything set up correctly, but you can't see any stars in these CCD images, check the following: Is the finder mirror 'out'? Is the guider probe OUT of the center (i.e. somewhere with Y < 13,000)? Is your exposure time long enough (1-2 seconds for stars; 5-10 seconds for target galaxies)? Again, if you answered 'no' to any of these questions, now you know what to fix.

A2. Focusing the Spectrograph

The best spectrograph (collimator) focus value is typically around 805. To check that the current setting holds (this can change with temperature changes) run through a focus sequence as follows. This should only be done by experienced CCDS observers if you suspect the focus has changed substantially. If you are a first-time CCDS user, or have never done a focus sequence before, you should consult with personnel at OSU before proceeding.

1. In an xterm, cd to /lhome/data and delete any focus.####.fits files you find there.
2. In Prospero, run the "focseq" script and follow the instructions. This will take about 15 minutes to run. When the sequence is done, you will have 10 images named focus.0001.fits through focus.00010.fits in /lhome/data and the spectrograph focus will be changed to the lowest starting value of 700 so that we can approach the optimal focus from below.
3. Open an IRAF xgterm (if you haven't already got one open), and issue the following commands at the IRAF prompt:
   ```
   cd /lhome/data
   nmisc
   epar specfocus
   ```
   Once inside the parameter file edits, change the parameters to the following values:
   ```
   images = "focus.00??.fits"
   (focus = "760x10")
   (corwidth = 10)
   (level = 0.5)
   (shifts = yes)
   (dispaxis = 1)
   (nspectra = 1)
   (slit1 = 340)
   (slit2 = 360)
   (logfile = "logfile")
   ```
   Save the parameters and quit with ":wq"
4. Run the specfocus task to compute the best spectrograph focus by typing "specfoc". You will be shown a graph that should be a parabola with a minimum line width at the best spectrograph focus and several smaller diagrams with line profiles for each spectrograph collimator setting and with the average line width of that image labeled. The title will say which setting gives the best average focus setting (for these images and parameter settings) and what the best average line width is. You can print the plot by entering "=" with the cursor in the graphics window. Put the cursor on the plot and hit "q" to exit.
5. If you think this focus looks good (it is usually around 800 or 805), in Prospero type
   ```
   setfocus xxx
   ```
   where "xxx" is the best focus value returned by specfocus. Also remember to record this focus value in the nightly log.
6. After having completed the spectrograph focusing, change the filename back to the one to use for that nights observing (ccdsYYMMDD.####.fits). For example, if it is observing day 140321, and the last image with this name is "ccds140321.0001.fits" in /lhome/data/, in Prospero you would type:
   ```
   filename ccds140321
   newext 02
   ```

Since the NEXT image to be written is ccds140321.0002.fits. You must be very careful not to overwrite existing data. In fact, if the system tries, it will instead use an UNIQNAME, something awful with numbers and letters. If you see such files in the /lhome/data directory, check the headers, they might be some "missing" files you or someone else was looking for. The data-taking system will print warnings, but most people don't notice these.

Specfocus can be fooled, especially if the focus settings used are way off, if one or more of the images were contaminated by light in the dome or somehow corrupted, or even if all the spectral lines are in one half of the spectrum. Therefore it is a good idea to check the image which the "specfocus" program selects as being the best focus image. Check the image by entering "implot filename.####". This will allow you to examine graphically the image. With the cursor in the graphics window type (no quotes) ":a 20" and then ":l 450" (letter 'el'). This will plot the average of 20 lines centered around line 450 (where the targets are positioned on the chip). You'll see a comparison lamp spectrum with the various emission lines. Measure the line widths of the lines from the blue (left) to the red (right) by placing cursor at the very base of the line on the blue side of the profile and hit 'p'; repeat for the red side. The measured line width and center will appear at the bottom of the graphics window. Especially check the stronger lines to ensure that there is NOT a large spread in the line widths or a systematic increase or decrease in the line widths. With a 1 arcsecond slit and a good focus the line widths should be around 2.3 - 2.5 pixels (1 pixel is approximately 1.3366Å).

A3. Cold Start of the Data Acquisition System

Refer to Figure 10 below for which computer is which. The IC computer is the only one with a keyboard and monitor in the computer room. If all of the computers are up and running, go directly to step 5. If you are powering up the computers from the completely powered-down state (e.g., after a lightning shutdown):

1. Turn on the CALIBAN disk enclosure. This box must be powered on **before** any of the other computers are turned on.
2. Next power up the Linux workstations mcgraw and hill by pressing the power button on the front of the computer. Monitor their progress as they boot up on the monitors in the control room. Wait for mcgraw to boot completely to the login prompt before proceeding to the next step.
3. Turn on the IC computer in the computer room. You should see it boot up on the IC monitor in the computer room, and then on the color LCD monitor in the control room. Wait for the IC to boot completely to the instrument selection prompt, which will appear on the color LCD monitor in the control room before proceeding.
4. Once the IC computer is up and asking whether to start "CCDS or TIFCAM or 4k", type 'c' on the IC keyboard in the computer room. This starts the CCDS detector control program. Wait for it to come up. It should show a blank image on the LCD monitor in the control room, and the amber monitor in the computer rack will show a command prompt and a table at the top with various status info. Watch the IC's monochrome monitor in the computer room for error messages. If there are problems with the IC reboot, they will appear here first. Wait until you see the "CCDS%" prompt on the IC's monochrome monitor in the computer room before proceeding.
5. Now startup the MDM 1.3m Telescope and MIS control interfaces (xtcs and xmis) as follows:
    a. Start the Telescope Interface by clicking "Applications" in the upper left corner of the left workstation monitor, and from the menu select '**Telescope Control**' and then '**xtcs**'. When the xtcs window appears, press the red INITIALIZE button, and wait for it to finish initializing before proceeding.
    b. Start the MIS Interface by again clicking "Applications," and from the menu select '**Telescope Control**' and then '**xmis**'. When the xmis window appears, press the red INITIALIZE button, and wait for it to finish before proceeding.
6. Now startup the Data Acquisition software. This consists of four programs that must be started in the order specified below:
    a. Return to "Applications," and from the menu select '**Data Acquisition**' and then '**ISIS**'. When the ISIS window appears, wait for it to finish its startup chatter (there will be only a little). If all goes well, you should see "PONG" responses from the IC and IE. Minimize this window by clicking the "–" button on the upper right-hand corner of its window.
    b. Return to "Applications," and from the menu select '**Data Acquisition**' and then '**Caliban**'. When the window appears, wait for it to finish its startup chatter. There will be a lot of communications with the IC while the two are synchronizing the data-transfer disks. When you get the CB% prompt, type "**info**" and look at the two entries for "Transfer Disks". Both

should read “Synched=Y”. If not, follow the transfer disk synchronization procedure described below. You should minimize this window like the others, but you may need to open it during the night if for some reason you fail to see data making it to the /lhome/data directory.

c. Return to “Applications,” and from the menu select ‘**Data Acquisition**’ and then ‘**MDMTCS Agent**’. When the window appears, wait for it to finish its startup chatter. If all goes well, you should see “PONG” responses from the IC and IE. Once this window comes up, type the commands ‘**tcinit**,’ and then ‘**tcstatus**’. Verify that the TCS info returned is the same as on the TCS monitor. You can then minimize this window as same as you did with the ISIS window.

d. Finally, return to “Applications,” and from the menu select ‘**Data Acquisition**’ and then ‘**Prospero**’. This will launch two windows: the Prospero Command Window and the Prospero Status Window. Move them around to suit you.

7. In the Prospero Command Window type “startup” at the prompt. Everything in the Prospero Status window should turn green. If it doesn’t, see troubleshooting tips in **Section A1 of the Appendix**.
8. Turn on and boot up the CCDS Acquisition Camera PC, which is located in the cabinet under the printer in the computer room. The password and any other information you need to get this started correctly is in the CCDS Acquisition Camera User’s Manual located in the control room or at http://mdm.kpno.noao.edu/Manuals/ccdsacq.pdf
9. At this point everything should be up and running and you are ready to run “startccds” in Prospero and continue and begin taking data.

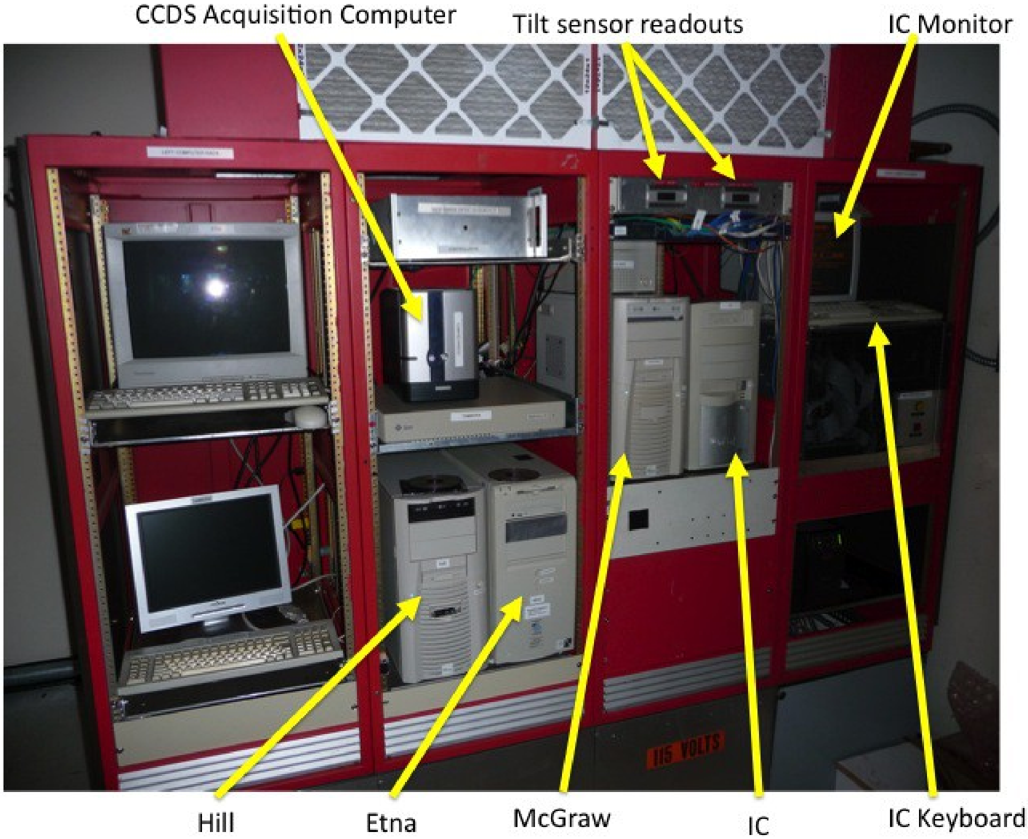


Figure 10. The data-acquisition and observing computers in the computer room and their identities.

A4. Estimating the Seeing with the CCDS Acquisition Camera

The seeing should be checked periodically throughout the night and noted in the observing log.

The best way to get a quantitative estimate of the seeing is when observing a target or standard star with visible, unsaturated stars on the slit image. In the CCDS Acquisition Camera control program (CCDOps), do the following to capture the current image of the slit with stars relatively close to the slit (the slit images degrade away from the slit).

You can save the image while exposing the spectrum. Be sure to shorten the acquisition camera exposure time (say 1sec or so) so that this star is not saturated. NGC 5548 is an exception—there are no suitable stars in the acquisition field near this galaxy. A special object, "starn5548," is in the TCS catalog, which is a field of stars near NGC 5548 that you can use to focus on and check the seeing (before taking NGC 5548's spectrum). Before calling "objsetup" for n5548, slew to this field and check the focus. Then follow the procedure below.

To save the slit image and check the seeing, do the following:

1. Pause the acquisition camera loop if running (click on the Pause button on the Focus window), and close the Focus window.
2. Click on the "Save" button on the CCDOps Toolbar
3. In the dialog box, give the image a name. Use the following format: "slitobj_YYMMDD_1.fits", where obj is the doagn ID (or dostd ID) and YYMMDD is the root name for the CCDS. If you take multiple images of the same object, increase the number 1 for each exposure. Be sure to include the ".fits" extension in the filename. Then click "Save" and another box will pop up. In this box, enter "Seeing check" in the comment section. Click 'OK.'
4. Resume Focus mode in CCDOps
5. On the Linux workstation (mcgraw), open an xterm window and cd to /lhome/data, then type

    cp /data/slit13/slitobj_YYMMDD_1.fits .

   this will copy the slit image you just took (using the example filename from step 3) to the mcgraw data disk.

6. Use IRAF to display the image in ds9 and measure star PSFs using imexamine. The pixel scale of the acquisition camera is 0.41 arcsec/pixel. Record the FWHM of the stars as an estimate of the seeing in your log, and be sure to note the image it was derived from.
7. In the log make a note of the image used to acquire the seeing estimate.
8. These slit images will become part of the data stored with the night's CCDS images, as they allow us to go back and re-measure the seeing estimates later.