

# OBSERVING AT THE CTIO 1.0m QUICK GUIDE

James L. Clem ([jclem@phys.lsu.edu](mailto:jclem@phys.lsu.edu))

EDITED: 03 November 2011 (J. Subasavage; [jsubasavage@ctio.noao.edu](mailto:jsubasavage@ctio.noao.edu))

Welcome to the CTIO 1.0m telescope. I decided to write this guide to help new (or repeat) observers familiarize (or refamiliarize) themselves with the steps in operating the telescope and Y4KCam CCD. I would like to say, however, that despite my attempts to make this guide as comprehensive as possible, there will, undoubtedly, be some things I might have omitted by mistake. In addition, parts of this guide may become obsolete as operational procedures are changed or revised. For these reasons, I would recommend working closely with CTIO observer support staff during your run to make sure you are aware of any current information regarding the telescope, instruments, or operations.

I would also *highly* recommend that you to read the “Prospero Observer's Manual” written by R. Pogge to familiarize yourself with the Y4KCam instrument control software due to the simple fact this guide assumes, in many ways, that you have already read it. The troubleshooting section (Chapter 7) is particularly useful to avoid excessive down time if one encounters any of the described problems.

Finally, I welcome any comments regarding this manual, positive or negative. If you find there is something I left out that you feel needs to be in this manual, please let me know. Otherwise, I hope you find this guide useful and I wish you the best of luck during your observing run on the 1.0m. Clear skies!

## 1. YOUR FIRST DAY OF OBSERVING

When you arrive at the CTIO 1.0m to begin your observing run it might be helpful to acquaint yourself with the equipment both in the control room and on the telescope platform. While at some point in the future I plan to include pictures in this guide pointing out the various buttons/knobs/switches that control the telescope, at the moment I recommend asking the CTIO observer support staff to help familiarize you with where things are in the control room and upstairs in the dome.

## 2. AFTERNOON STARTUP AND CALIBRATIONS

Note that the steps in preparing the telescope to take calibration frames are usually performed by the CTIO support staff while you sleep. If you arrive at the dome in the afternoon and find the telescope is not ready for calibrations, then the steps below should get you up and running:

- Prepare the telescope (downstairs in control room).
  - 1) power up the telescope drives
    - a) turn on the master power switch (silver toggle) on the back right of the drive box
    - b) turn on all drive switches from **LEFT TO RIGHT** on the drive box
  - 2) Move the telescope to the flat screen by selecting the TCS menu option [Move To] → [Flat Screen] and pressing the RETURN key
- Prepare the dome (upstairs in the dome).
  - 1) switch the dome power ON and flip the control to MANUAL mode

- 2) rotate the dome until the arrow marked “FLAT” on the dome lines up with the red “E” on the wall
- 3) open the dark slide on the telescope by pulling the black handle at the base of the instrument outward until it locks into place
- 4) turn off dome lights

The next step is to prepare the Y4KCam instrument to begin taking observations/calibrations. A detailed outline of the startup procedures that need to be followed before you can start taking data with the instrument is given in Section 2.3 of the “Prospero Observer's Guide.” If this is your first time observing on the CTIO 1.0m, it would be wise to acquaint yourself with steps in the software startup/shutdown process. Otherwise, this guide proceeds by assuming that the Prospero program is up, running, and ready to start taking calibration frames:

- A Little Housekeeping
  - 1) Remove \*.proc files from previous night’s data by typing **cd /rawdata/y4kcam** in a terminal window (NOT Prospero) to change directory. Then check for files with **ls**. Finally, type **rm -f \*.proc** to empty the directory.
  - 2) Move data from previous night to its own directory. In /home/data/observer/, type **mkdir yYYMMDD**, where YYMMDD is the date at the start of observing. Then transfer the fits files to this directory by typing **mv yYYMMDD.\*.fits yYYMMDD**.
- Initialize Prospero for a new day's worth of data.
  - 1) Type **runinit** at the prompt in the Prospero window.
  - 2) Answer the questions while taking note that the SMARTS convention for root filenames is yYYMMDD where YYMMDD is the current date.
- Begin taking bias (zero) images.
  - 1) Ensure the CCD binning is appropriate for your program and change if needed.
  - 2) Type **dobias #**, where # is the number of bias frames, at the prompt in the Prospero window.
  - 3) The automatically generated log of observations can be viewed by opening a terminal window and typing **tail -f YYMMDD.log**. If the previous night’s log is still open, it can be exited by typing **Ctrl-c**.
  - 4) DO NOT USE THE **observe** COMMAND IN PROSPERO TO TAKE BIAS FRAMES!
- Begin taking dome flat fields.
  - 1) Familiarize yourself with the locations of the filters in the filter wheel by typing **print filter** at the prompt in the Prospero window.
  - 2) Turn on the Variac (located above the TCS computer) by flipping the silver toggle.
  - 3) Adjust the voltage appropriate for the specific filter by turning the dial – note that the intensity of the lamps do not increase considerably beyond ~70V.
  - 4) The intention is to integrate for at least 30 seconds (to mitigate shutter effects) so adjust the Variac so that a 30 second exposure will result in ~20-25k counts.
  - 5) Begin taking flat field exposures with Variac settings you just determined. A representative set of values is given in the table below (as of Feb. 15, 2010) but can change (depending on the mirror washing schedule).
  - 6) Alternatively, you can use one of the automated scripts (e.g., *domebvri.pro*) that will prompt you for the appropriate Variac settings and take dome flats according to the chart below – *however, exposure times and variac settings must be confirmed and the script must be edited as necessary.*

7) Turn off the Variac when you are finished taking dome flats.

<b>FILTER</b>	<b>NUMBER</b>	<b>EXP. TIME</b>	<b>VOLTAGE</b>	<b>COUNTS</b>
U+CuSO <sub>4</sub>	6	700	70	~11k
B	2	60	65	~22k
V	3	30	50	~22k
R	4	30	42	~22k
I	5	30	40	~22k
SDSS u'	12	250	70	
SDSS g'	8	60		
SDSS r'	9	30		
SDSS i'	10	30		
SDSS z'	11	30		
Stromgren u	7			
Stromgren v	8	300	90	~16k
Stromgren b	9	60	75	~18k
Stromgren y	10	30	70	~22k
Stromgren Ca	11	900	90	~7k

### 3. EVENING STARTUP

As with the afternoon startup, preparation of the telescope for the night is usually performed by the CTIO support staff around dinnertime. Again, if for any reason the staff is unable to perform these steps, here is what you need to do.

- Prepare the dome (upstairs in dome).
  - 1) open the dome shutter and windscreen by using the black toggles on lower-right of the old telescope control panel
  - 2) ensure the dome power mode is switched to MANUAL before turning the dome power to ON
  - 3) rotate the dome until the slit is pointed due east ensuring to align the “Z DOME” with the red “E” on the wall
  - 4) flip the dome control to AUTO mode
  - 5) open the dark slide
  - 6) turn of dome lights
- Prepare the telescope (downstairs in control room).
  - 1) power up telescope drives
    - a) turn on the master power switch (silver toggle) on the back right of the drive box
    - b) turn on all drive switches from **LEFT TO RIGHT** on the drive box front
  - 2) move the telescope to zenith by selecting [Move To] → [Stow] on the TCS
  - 3) initialize the dome position in the TCS by selecting [Declare As] → [Dome Initial]
  - 4) set the dome to auto mode in the TCS by selecting [Motion] → [auto Dome] (or alt-D)
  - 5) synchronize the TCS time with the UT clock by typing **tesynch** in the Prospero window
  - 6) turn on telescope tracking in the TCS by selecting [Motion] → [Tracking] (or alt-T)
- Other miscellaneous steps.
  - 1) turn on the large ventilation fan at the base of the stairs leading up to the telescope
  - 2) (optional) turn on the mirror fans on the gray box above the telescope drive box

3) ensure the Prospero software is operating and ready to start taking exposures (see Section 2.3 in the “Prospero Observer’s Guide”)

## 4. OBSERVING

### 4.1 Evening Sky Flats

The task of taking sky flats on the CTIO 1.0m can be somewhat difficult. Please bear in mind the following when you are performing sky flat observations:

- the total readout/processing time for each image is approximately 70 seconds in 1x1 binning mode
- the Y4KCam CCD deviates from linearity >45k counts
- the slow camera shutter means that shutter corrections are recommended for exposures <30 seconds (required for exposure times less than ~5-10 seconds).

All of these can conspire to make taking a sufficient number of sky flats in multiple filters a challenge. For instance, if your program requires a full set of observations in all five UBVRI filters, then it is highly unlikely you will be able to obtain more than 3 “good” sky flats in each filter during evening twilight. If, on the other hand, you only need observations in BV or BVI or VI or whatever, then you will probably find it easier to get 4-5 “good” flats in each filter during the evening.

Good luck and remember to turn tracking on and move the telescope between each flat field exposure!

### 4.2 Moving to an Object

The following steps will allow you to enter the coordinates of your program object into the TCS and subsequently move the telescope to that object:

- Select TCS menu option [Position] → [Next] (or Ctrl-n) and enter the Epoch, R.A., and Dec. of your object’s coordinates (note that the coordinates listed on the TCS screen in the “Next:” row have now changed to what you just entered).
- Select TCS menu option [Move To] → [Next] (or Alt-n) to command the telescope to move to your object (note that the coordinates on the TCS screen in the “Commanded:” row have now changed to what you entered).

Once the telescope starts to move you should begin to hear the dome rotating to align itself with the new position (if the new position is at least a few degrees away from the old). If the telescope is moving and you do not hear the dome, then you may have forgotten to set the dome to AUTO mode either upstairs or on the TCS. Consult the evening startup list given above if this is the case.

A useful feature of the TCS is its ability to store a list of coordinates that might be used multiple times during a night or observing run. For instance, let’s say you have a good standard star field that you want to observe over and over again during your run. Rather than typing in its coordinates each time you want to move the telescope, you can store its position in the TCS:

- The first time you observe this field manually enter its coordinates and move the telescope using the steps above.

- Once the telescope has stopped moving you can save its current position in the TCS selecting the menu option [Position → save]
- Select an open entry (or overwrite a preexisting one) using the up/down arrows and hitting the RETURN key
- The current position of the telescope will be inserted into the list and you can type a nickname for your field in the third column.
- To reuse this field at a later time select [Position] → [Recall] and scroll down the list to your object. Insert the object's position and nickname into the “Next” row by hitting RETURN.
- Move to your target using [Move To] → [Next] (or Alt-n).

You can store up to 30 different coordinates in the list. Keep in mind that you cannot delete individual entries in the saved list, only overwrite them. If you need to completely delete the entire saved list (either a list saved by a previous observer, or you just don't need those coordinates anymore) select [Position] → [Purge File].

### 4.3 Check the Pointing

It is generally a good idea to check the pointing of the telescope at the beginning of each night you observe. This can be done by either using a bright object of known RA/Dec, or using one of your own program objects. I will outline a procedure for the former since I have no knowledge of what you plan to observe. However, the steps listed below can be easily applied to your own program object you wish to center.

- Find a nice bright object of known RA/Dec. I suggest using the stars in the *Yale Bright Star Catalog* (<http://www-kpno.kpno.nao.edu/Caches/Catalogs/BSC5/catalog5.html>).
- Locate a star that is near zenith and move the telescope to that star using the steps listed above in Section 4.2.
- Take a short test exposure of the field using Prospero.
- Once the readout is finish and the image displayed, check to see if the bright star is positioned close enough to the center of the field to your liking. If so, you can be assured the pointing is fairly accurate and continue your observing program. If not, then continue reading...
- Use the IRAF script *offset.cl* to help center the star:
  - 1) in the IRAF XGterm window type `offset <filename>` where `<filename>` is the name of your test exposure (e.g., y100214.0080.fits)
  - 2) wait for the image to load into DS9 window – once completed, the IRAF task *imexamine* will execute and you can use all of its functions
  - 3) type `q` in the DS9 window to quit *imexamine* and you will be prompted to “place cursor on desired object, hit any key” at which point you should place the cursor over the bright star and hit any key
  - 4) you will be prompted for “desired x position on CCD” – to center the star horizontally at the exact center of the chip and type 2048
  - 5) you will be prompted for “desired y position on CCD” – to center the star vertically at the exact center of the chip and again type 2048
  - 6) the result of this is the offset that need to be applied to the telescope to reposition the star at the center of the CCD
  - 7) select the TCS menu option [Position] → [Offset] → [Direct] and enter the values for the “RA OFFSET Vector” and “DEC OFFSET Vector”, respectively

- 8) select the TCS menu option [Move To] → [cur+Offset] to move the telescope and recenter the star
- 9) once the telescope has finished slewing, take another test exposure to ensure the star is centered to your liking
- 10) to reinitialize the telescope pointing, select the TCS menu option [deClare] → [Init Next] and answer *yes*

The telescope pointing should now be reasonably accurate to within 1-2 arcminutes depending where it is pointed (more accurate near zenith, less accurate near the horizons). Note that the IRAF *offset* task can also be used to position the telescope appropriately for a science field (e.g., to place a program object in the center of quadrant 4 by simply changing the values for “desired x position on CCD” and “desired y position on CCD” to 3072 and 3072, respectively. Just be aware that if you decide to reinitialize the telescope pointing to place your object in the 4th quadrant, then subsequent objects will be centered there as well.

#### 4.4 Focusing

Adjusting the focus of the telescope is accomplished by using the using the small silver box situated next to the TCS keyboard with the current focus displayed in the black box above the TCS monitor. It is important to note that you should always approach a nominal focus value from ABOVE. For example, let's say you have determined a good focus value is 12500, but your current focus is 12300. If you start to increase the focus and stop near 12500 you will likely notice that the readout will stop but immediately drop down by 50-100 units. This is due to the backlash in the gears that move the secondary mirror against gravity. Hence, it is best to increase the focus to a value that is 100-200 units above nominal, then decrease the focus to 12500. If, on the other hand, nominal focus is 12300 and you are currently at 12500, then simply decrease the focus.

There are a couple of techniques you can use to determine a nominal focus value. The first of these is the Prospero script **dofocus** whose implementation is described in detail in Section 4.2 in the “Prosper Observer's Manual.” Hence, I will instead describe the second method to obtain a nominal focus value by using the IRAF task *imexamine*. It is important to note that you should only use this method if you are already near nominal focus (i.e, <100 units or so), otherwise I suggest using **dofocus** first, then use the steps below to fine-tune the focus:

- Take a short test exposure of any particular field, preferably near zenith and preferably in the V filter
- Display the test image in DS9 using IRAF
- Start *imexamine* and use the following keystrokes when the cursor is placed over a star
  - a – printout of the centroid and FWHM of the star
  - r – a radial profile plot
  - e – a contour plot
  - j – a plot of horizontal counts and FWHM
  - k – a plot of vertical counts and FWHM
- At nominal focus the radial profile should show little scatter among the points along the fit line and the contour plot of the star should look round and not elongated. If not, then.....
- Using the FWHM estimates from hitting the **j/k** keys (located in the lower-right of the plot window), use the following rule to improve the focus:

- if  $j > k$ , then decrease the focus
- if  $j < k$ , then increase the focus

- Generally, adjust the focus in 50 unit increments until you get a nice round star image and the horizontal and vertical FWHMs are roughly equal.

The reason for determining a nominal focus value in the V filter is because other filters in the wheel will not necessarily have the same focus. For instance, while the BVRI filters are all parfocal (to within +/- 25 units), the nominal focus for the U filter is +125 units above that for the V filter. If you are using any other filter set like the SDSS or Stromgren filters, then it is advisable to determine your own nominal foci and focus offsets appropriate for your program.

## 4.5 Guiding

Fine guiding/tracking of the telescope is performed in the monitor to the left of the TCS. In this display you will see an image of the current field from the guider camera (constantly updated) along with a few of the guider control parameters. It might be useful to know that the guide camera is pointing approximately 17 arcminutes NORTH of the telescope. To begin guiding:

- Use the keyboard arrow keys to move the white box over the top of a bright star in the guide field. If the box seems to be moving too slowly, change the **Incremental** value in the PC Guider Control window from 1 to 10.
- Change the **Guide Box Size** to a value that totally includes the star.
- Press F3 to begin guiding.
- Press F1 to stop guiding.

It is important to remember two things when guiding. First, turn off the guiding when slewing to a new field. Second, the guider camera is usually focused to coincide with the telescope's nominal focus. If you need to change the telescope focus for an exposure in a particular filter (e.g., U or SDSS u'), then you will likely find the stars in the guide field are no longer in focus. This can cause problems if you are using a filter set that has focus values drastically different than UBVRI. In this case, it would be advisable to contact the CTIO support staff and ask them to help you to refocus the guider to better accommodate your program.

## 5. MORNING SHUTDOWN

Hopefully, your night was clear and you had no major problems with the telescope or equipment. Before heading down to bed, remember to follow these steps before leaving the dome:

- Turn off the guider by pressing F3.
- Move the telescope to the flat screen position by selecting the TCS menu option [Move] → [Flat Screen].
- Head upstairs
- Close the dome shutter and raise the wind screen using the toggle switches on the lower-right of the old telescope control panel.
- Close the CCD dark slide by pushing it in until it locks into place.

- Turn the dome to MANUAL mode and fine tune its alignment by rotating it until the arrow marked “FLAT” is aligned with the red “E” on the wall.
- Turn off the dome power.
- Turn off dome lights and head downstairs turning off the ventilation fan on the way back to the control room.
- Switch off the telescope drives:
  - a) turn off all drive switches from **RIGHT TO LEFT** on the drive box front
  - b) turn off the master power switch (silver toggle) on the back right of the drive box
- Leave the TCS computer, guider computer, and Y4KCam computers up and running
- Fill out the 1.0m night observing report located at:

<http://www.ctio.noao.edu/new/Tools/Forms/EON/Form.php?telescope=YALO>

- If this is the final night of your observing run, fill out the CTIO End-of-run report at:

<http://www.ctio.noao.edu/new/Tools/Forms/EOR/Form.php?telescope=YALO>

- Fill out the observing record in the blue binder.
- Turn off control room overhead lights.