UNIVERSITY OF PITTSBURGH

STEPUP Observing Guidelines

Allegheny Observatory

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Contents

Chapter 1

Opening Checklist

Chapters 1 and 2 provide instructions on the complete observing process for STEPUP purposes. The following instructions do not require any knowledge of physics or astronomy. Therefore, anyone who can read and follow instructions can observe. If you are an experienced observer, please go to Chapter 2 for an abridged opening checklist. Please refer to Chapter 4 for troubleshooting information.

1.1 Checking the Conditions

- Use the website forecast.io to check cloud coverage at the address 159 Riverview Ave, Pittsburgh, PA 15214.

- Use Pittsburgh Clear Sky Chart (http://cleardarksky.com/c/PittsburghPAkey.html) during the days before to check the possibility of observing that night.

- The day of, check NOAA's IR maps (http://www.goes.noaa.gov/ECIR4.html) to look at cloud cover in addition to Pittsburgh Clear Dark Sky.

- At 7:15pm you can start checking the All Sky Camera on Allegheny Observatory's website (http://www.pitt.edu/∼aobsvtry/All-Sky.html) to directly verify the cloud coverage at the observatory. Looking out the window yourself has also shown to be a good way of checking for clouds.

1.2 Preliminary Setup

- In Allen 302, log on to the Ptolemy computer and open up the terminal.

- Type the command **cd Desktop** and then **python stepup_full.py**. When it prompts you, enter the target name (case-sensitive) and the date of observation in YYYY-MM-DD format. Once you have completed this, you will have a directory for the night of observation and an observing report to begin filling out. If this Python file is not available to you, complete the following steps instead:

    - Create a directory for the target you are observing in the raw folder (/home/depot/STEPUP/raw) if one does not exist already. Within this newly created directory, make a directory for the data you will take that day in the format of year-month-day. For example, if you are observing the target HAT-P-13 on November 12, 2013 and a directory already exists for

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that target within raw, you should type **mkdir /home/depot/STEPUP/raw/HAT-P-13/2013-11-12**.

– Copy the template for the observing report into the directory that you just created by typing the command **cp /home/depot/STEPUP/obsreport_date.txt** (type a space) **/home/depot/STEPUP/raw/*target*/*date*.** In your target directory, you should add the date to the filename using the **mv** command and edit the file (using the **gedit** command and log your observation throughout the night. See the appendix for a sample observing report.

1.3   General Startup

1. On the Ptolemy computer, open the terminal and type: **vncviewer ao-keeler.phyast.pitt.edu**. A prompt will ask you for a password, which is **foo**. If the computer is not logged on, you will have to log on with the password: **group1**. The username should be defaulted as *group1*, but if it isn't, change the username to *group1*. The username and password are the same.

2. Open the **Logitech QuickCam** on the desktop. When a window pops up, click on the first icon in that window. Use this to monitor the movement of the telescope and dome.

3. Open the **Keeler Power Controller 1.1** on the desktop. You will see a series of on and off buttons. Turn the telescope on first (an automated one minute waiting period follows) followed by the rest of the controls. After you have turned on the **Lens Cap Power**, click on the *Open* button under **Lens Cap**. View the webcam to make sure the lens cap is opening.

4. Open the **Digital Dome Works** on the desktop. Two windows should pop up: *Digital DomeWorks v5.2* and *RCX Control*. **WARNING: DO NOT MOVE THE RCX WINDOW. IT MUST REMAIN IN THE SAME POSITON! (You may minimize it.)** If the RCX window even briefly edges over to right side of screen, call Lou.

5. Open the **MaxIM DL** on the desktop. When the MaxIM window pops up, click on the **Toggle CCD Control** button in the row near the top of the window. When the MaxIM CCD window opens, you should be in the *Setup* tab. Click on the *Connect* button followed by the *Cooler On* button.

6. Still in the MaxIM DL window, click on the **Toggle Telescope Control** button in the same row near the top of the window. When the Telescope Control window opens, you should be in the *Setup* tab. Click *Connect* for both the telescope and focuser.
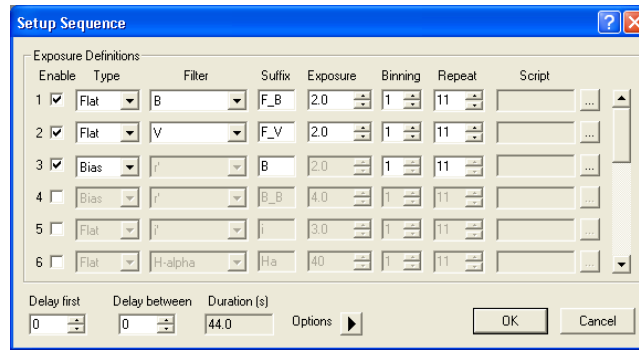
1.4   Calibration

You should be taking calibrations each night that you observe. However, if you have time constraints (For example, if a transit starts at 9pm, but you just started setting up at 8:15pm.), you can skip this section and save it for the end of the night.

1. In the Digital DomeWorks window, click on *Go To* and enter 270 when it prompts you to. The dome will likely stop shy of 270 degrees, so you will need to over shoot and click *STOP* a few degrees before it reaches 270. You may have to play with it a few times before the dome is positioned correctly. Use the webcam to verify the dome is moving.

2. In the RCX Control window, turn tracking off by clicking on the green button that says *Tracking* near the top. If there is a red button labeled *Not Tracking*, then it is already set. Regardless, the final setting should be *Not Tracking*.

3. In the RCX Control window, note the *ALT* and *AZ* values in the top right corner of the window. You want to set these to **ALT: 10 degrees** and **AZ: 180 degrees**. Within one degree is close enough. To do this, you will use the buttons in the *Motion Control* box in the center of the RCX Control window. Use 'N' and 'S' buttons to adjust the ALT value larger and smaller respectively. Use the 'W' and 'E' to adjust the AZ value larger and smaller respectively. The radio buttons below labeled *Guide, Center, Find, Slew* represent the magnitude of the response with *Slew* being the greatest and *Guide* the smallest. For example, if the ALT is at 40 deg, you will want to use *Slew*, but if it is at 11 deg, you will want to use *Guide*. If the direction arrows do not work, select *Guide* first and try. This will wake the program up if frozen.

4. You will now create a folder to store the nights images. Click on the Start menu → My Computer → group 1 on 'aoserver1\data'(Z:) → STEPUPDataFiles. In this folder, create a new folder in the format of YYYY-MM-DD for the night of observation.

5. In the MaxIM CCD sub-window within the MaxIM DL window, click on the *Sequence* tab. Click on *Options* and select *Set Destination Path...* Select the folder you just created.

6. Click on *Options* again and select the *Setup Sequence* choice. Enable the two boxes Flat and Bias, setting the suffix as F and B respectively. Make sure the *Binning* is set to 1 and *Repeat* is set to 11 for each. No other settings should be enabled at this point. **IMPORTANT:** The bias images are instantaneous. This should be on default so the *Exposure* cannot be changed. The flat images have different exposure times, depending on what filters you are observing in. They are as follows:

   (a) B = 50 s
   (b) V = 20 s
   (c) R = 10 s
   (d) g' = 15 s
   (e) r' = 7 s
   (f) i' = 60 s
   (g) Hα = 90 s

   Biases will not have a filter, however, you should be sure to set the filter for the flat sequence to be the same as the filter you plan to take target images with. Indicate these filters in the suffix box. Your setup should look like the screenshot below. If you plan to take target images in several filters, you will need to, for each filter, set up a separate flat sequence with the same specifications as above in each different filter. Typically, for observing exoplanet transits, you can use the r filter. For variable stars, use B and V filters. For example, if you were observing a variable star your *Setup Sequence* window will look like the below image.

7. Still in the *Sequence* tab, enter the name of the star in the *Autosave Filename* box. Make sure that "1" is selected in the *Start at* box.

8. Start taking the calibration images by clicking *Start.* As the images begin to download, open the folder you created. Make sure the calibration images are saving to that folder. You also want to make sure that the flat field lights are on.

   Side-note: We also take 30 minute dark calibration images, but this only needs to be done once a month and is usually not done on an observing night due to the fact that it takes over 1.5 hours. To take the 30 min darks the telescope and dome can be left where they are. In the Sequence tab instead of selecting Flat and Bias select Dark and put the exposure time at 1800 seconds (30 min). Other than that, the procedure is the same.

1.5 Focusing

1. In Digital DomeWorks, move the dome back to 180 degrees using the *Go To* setting. When it nears 180 degrees, click *Home.* It should say that "Dome is Home" and "DSR closed". If not, continue to click *Home* until it says "Dome is Home".

2. Still in Digital DomeWorks, click the *Open* button. This will open the dome shutters. Use the webcam to visually verify that the shutters of the dome are in fact opening.

   - *Note:* You should never open the dome shutters unless you are sure there is no chance of precipitation in the area of the observatory. As a rule of thumb, do not open the shutters if it is mostly cloudy/overcast.
   - To check this, use the environmental computer. Click the VNCViewer icon on the desktop and select the automatically-highlighted IP address. The password is *foo.*
   - At the bottom of this window, there is a current and time-lapse display of the skies above the observatory. Use the current display to ensure that it is not overcast. Once you are done, exit out of the environmental computer.

3. Open **Starry Night College 6** on the desktop (If it asks for updates, do not update. If it asks for downloads, do not download). When the window opens click on the *Telescope* tab on the left side of the screen. Then click *Connect.* Minimize the *Telescope* tab. Do not use these tabs again until closing.

4. In Digital DomeWorks, check the *Slave to Telescope* box in the lower left corner.

5. In Starry Night College 6, click on the *Options* tab on the top menu bar. Go to *Orientation* and select *Equatorial.* Go to the *Edit* tab on the top menu bar and select *Centre On...* Enter

the target coordinates. Make sure that you are entering them in the *Equatorial J2000* tab! An example of a coordinate entry in this box can be seen below.
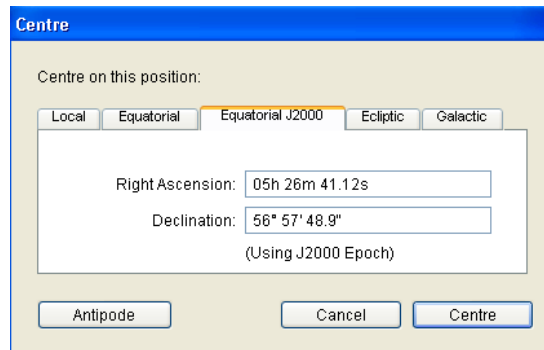
6. Zoom in to the small rectangular box that should be labeled "Meade RCX-400..." The zoom controls are in the upper right corner of the window. Find a 6-8 magnitude star nearby that is not a binary star system by moving your cursor over the stars. Right click on the star and select *slew to 'starname'*. You should see a red cross hair cursor move to that point. This cursor indicates where the telescope is pointing.

7. Visually check on the webcam monitor that the telescope is pointing through the opening in the dome. Turn off flat field lights in the Keeler Power Controller 1.1. Also, close the webcam so that the computer can run faster.

8. In MaxIM CCD window, go to the *Expose* tab. Ensure that the filter selected in the drop-down box is the filter that you wish to observe in.

9. Go to the *Focus* tab. Click on the *CCD* radio button. **Make sure binning is set to 3 when CCD radio button is selected!** Set the exposure time between 1-5 seconds depending on quality of image. *Delay* should be set at 0. Click *Start Focus*. A window of the field of view will open. Click *Stop*. Find the focus star in that image, right click on it and select *point telescope here*.

10. Go back to Starry Night College 6. The red cursor may or may not have shifted a bit. Right click on the focus star and select *sync on 'starname'*.

11. Open **FocusMax**, which should be in the taskbar (It opened automatically when you connected the focuser). Click *Focus*. Record the **HFD** that FocusMax returns in the observing report. Also, under the *Inspect* tab of MaxIM CCD, record both the **FWHM** and **HFD** values.

1.6   Guiding

1. In Starry Night College 6, re-enter the target coordinates by going to *Edit → Centre On...* Zoom into Meade RCX-400 box. Find a 6-8 magnitude star in the field to be your guide star. This star does not need to be the same as the focus star, and the focus star does not need to be in the Meade RCX-400 box when guiding. Move the box around until the guide star is located in the guide star box (the smaller box above) **AND** the target star is still within the

Meade RCX-400 box. Do not rotate the guide star box. Ideally, we do not want the target star too far from the center. Right click on the center of the Meade RCX-400 box (not the target!) and select *slew to this location.*

2. In the MaxIM CCD *Focus* tab, click the *Guider* radio button and set the exposure time to 3 seconds. Click *Start Focus.* The guide star should show up in the image that pops up. Click *Stop.* **Note: If the guide star does not show up, see Chapter 4: Troubleshooting*

3. Still in MaxIM CCD, go to the *Guide* tab and select the *Expose* radio button. Make sure the exposure time is set to 3 seconds and binning is set to 3. Click *Start.* An image with the guide star should pop up. Click on the guide star in the image. Back in the *Guide* tab, select the *Track* radio button and click *Start.* A very small image window with the guide star should show up. Monitor this window occasionally to ensure the guide star is still present and appears in focus.

1.7   Sequencing

1. In the MaxIM CCD *Sequence* tab, click on *Options → Setup Sequence.* Uncheck any previously-selected calibration image sequences. Make sure that *Light* is selected for the image type and that the box next to it checked. Select the appropriate filter and suffix (r' is a good choice for exoplanets). Select an exposure time depending on the magnitude of the target star, normally between 30-120 seconds. Note that the exposure time can go lower than this, but you may want to add a delay between exposures to avoid bulky datasets. Also, set *Repeat* to 3000 and *Binning* to 1. Click *Ok.*

2. Back in the *Sequence* tab, make sure the image starts at 1 and the target star name is in the *Autosave Filename* box. Click *Start.*

3. After the image downloads, click on the cross hair button near the top of the MaxIM DL screen. A circular aperture now becomes your cursor, and a small window with information about the pixel counts should pop up. Move the circular cursor over the target star. If the counts are between 20,000-50,000, then you are set. Record the **FWHM, Maximum, Minimum, Bgd Avg** in the observing report. You will record this information every 30 minutes. If the counts are below 20,000, you will want to increase the exposure time. If the counts are above 50,000, you will want to decrease the exposure time.

4. If the maximum hits 65,535 this means the ccd has been maxed out. If the target star hits 65,535 in an image than we *cannot* use that image in our data analysis and the exposure time should be lowered.

5. Try to keep the exposure time below 200s so we get a decent number of images of the the transit. If you observing a star dimmer than magnitude 11.5, this may mean that the maximum counts dip to around 10,000. That's okay, as long at its remains above 7,500 the data should be analyzable, just slightly noisier.

6. Once you have recorded a few images, upload one of them to *astrometry.net*, then download the astrometrically calibrated *new-image.fits* file and open it in a FITS file viewer (such as DS9) and ensure that your target star is in the image by searching its coordinates.

7. Once you have finished recording your data, under the *Sequence* tab hit *Stop.* Then, under the *Guide* tab, ensure that the guide sequence has stopped as well.

Chapter 2

Using the Finder Camera

Using the finder camera is a relatively easy way to see what the telescope is really pointed at. For instance, sometimes Starry Night *thinks* you're looking at a certain star, but the telescope may in reality be out of sync with the program and pointed at some nearby patch of sky instead. Also, sometimes it is hard to identify why you can't see stars in your focus image (i.e. is it cloudy, are the dome shutters closed, etc.). Using the finder cam will allow you to quickly identify these issues and get you back on track.

1. Once logged onto the observatory computer, go to the *Start* button in the bottom left.

2. Now click on *Remote Desktop Connection* in the left column.

3. In the dropdown box of the window that pops up, make sure you have the IP address that ends in "105" selected. Then hit *connect*.

4. To sign in, the unsername and password are both *blah*.

5. Next, go to **CCDOps**. Establish a link on the icon bar and once you're connected at the bottom it will say *STI*.

6. Use focus mode by clicking *Focus*. A one-second exposure should be sufficient.

7. Once you are finished using the finder camera, close it without saving.

8. In the icon bar, hit *Shutdown*. You can log out or shut off to exit the remote.

Chapter 3

Abridged Opening Checklist

1. Open all controls in the **Keeler Power Controller 1.1**.

2. Open Logitech webcam.

3. Open **Digital Dome Works**. **Remember to keep RCX window on left side of the screen!!!**

4. Open **MaxIM DL**. Open **Toggle CCD Control** and click both *Connect* and *Cooler On*. Open **Toggle Telescope Control** and connect both focuser and telescope.

5. Create folder for the night in STEPUPDataFiles under the Z drive.

6. Set destination path to that folder in MaxIM CCD.

7. **Calibrations**

   (a) Move telescope to **ALT: 10 deg** and **AZ: 180 deg** in the RCX window.

   (b) Move dome to 270 deg.

   (c) Ensure flat field lights are on.

   (d) In MaxIM, setup the sequence with 11 images each of the flats and biases. Flats should be 2 seconds and biases are instantaneous. The suffixes are F and B.

   (e) Make sure image starts at 1 and the filename is the name of the star you are observing.

   (f) Click *Start*.

8. Move dome back to 180. Click *Home* and make sure DDW says it is home. Open the shutters. Click *Slave to Telescope*.

9. Open **Starry Night College 6**.

   (a) Connect the telescope.

   (b) Set orientation to *Equatorial* .

   (c) Center onto the target coordinates. Right click on the field of view and select *Point Telescope Here.*

   (d) Select a star between the magnitudes 6-8 nearby.

10. Go to MaxIM DL. In the *Focus* tab, select CCD radio button and start 1-5 second focus. **Make sure binning is set to 3 when CCD radio button is selected!** Right click on target star and select *Point telescope here.*

11. Back in Starry Night, right click on focus star and select *sync to 'starname'.*

12. **Turn off flat field lights!**

13. Go to FocusMax and click *Focus.* Record the **HFD** and **FWHM** info from both FocusMax and MaxIM.

14. Re-enter coordinates in Starry Night. Put a guide star in the guide star box. Right click on center of field of view and select *Point telescope here.*

15. In MaxIM Focus tab, select the *Guide* radio button and click *Start Focus.* Make sure the guide star is there.

16. In MaxIM Guide tab, select the *Expose* radio button and click *Start.* Click on the guide star in the image that pops up. Back in the Guide tab, select the *Track* radio button and click *Start.*

17. In MaxIM Sequence tab, setup the sequence so the light images are being taken. Make sure image starts at 1 and the *Autosave Filename* is filled in with target star name.

Chapter 4

Closing Checklist

1. Under the *Setup* tab in the MaxIM CCD window, press the *Warm Up* button. Wait about 1 minute. Click on *Cooler Off.* Click on *Disconnect.* Close the window.

2. In the MaxIM Telescope Control window, click *Disconnect* for both the telescope and focuser. Close the window.

3. Exit MaxIM DL completely.

4. In the Starry Night College 6 program, open the *Telescope* tab on the left. Disconnect the telescope. Exit Starry Night College 6, and don't click Save.

5. In the RCX Control window, click on the *Park* button. Reopen the webcam and turn on the flat field lights to ensure that the telescope is moving. Don't close the window. When you close Digital Dome Works, the RCX Control window will close.

6. In Digital DomeWorks, unslave the telescope and turn the dome to 180 degrees by clicking GoTo. If the dome happens to get stuck, try turning it in the opposite direction. When the dome stops, click *Home* and make sure the message "Dome is Home" is there. Click *Close* and make sure the message "DSR is CLOSED" is there. Visually check the webcam screen to ensure dome is in fact closed.

7. In the Keeler Power Controller 1.1, click *Close* under the lens cap. Make sure lens cap closes in the webcam view.

8. Close the Logitech webcam.

9. Close Digital Dome Works.

10. Turn off all the power switches in the Keeler Power Controller 1.1 starting from *Lens Cap Power* up to *Telescope.* Close the window.

11. Log off the computer.

Chapter 5

Troubleshooting

5.1 WinTV

WinTV shows the image that the finder camera sees. The image is not as clear, but you should be able to see a few bright stars in WinTV. Match these stars with those in the images that you take. If the the stars do not match up, the telescope is not pointed at where Starry Night says it is pointed.

- Click *start → Remote Desktop Connection*. Log onto 136.142.17.105. The password is **blah**

5.2 No stars in Image

- Did you turn off the flat field lights? Use webcam to check.

- Are the shutters of the dome opened? Use webcam to check. If DDW says it is open, but the webcam shows it is not, move the dome back to 180. Click *Home*. Click *Close*. Click *Reset*. Click *Open*. If the dome still does not open, call Lou.

- What does the All Sky Camera show? Are there thick clouds?

- Check the sequence setup. Make sure we are taking images in R or r'.

- Did the dome get stuck? If so, *See Dome*.

- Is the dome still slaved to the telescope? If not, recheck that box in DDW.

5.3 Wrong star field

- *See WinTV*

- Did daylight savings recently happen? If so, call Lou.

- Go to Edit → Centre On. Re-enter the target coordinates. Make sure the coordinates are correct before centering.

5.4   Dome

- If DDW shows the shutters are opened, but it is not, close the shutters in DDW. Click *reset*. Reopen the shutters. If it does not work, call Lou.

- If the dome is stuck, unslave the telescope. Move the dome in the opposite direction it was going by at least 90 degrees. Reslave the telescope. If the dome still gets stuck, more the dome in the opposite direction by at least 181 degrees. Then reslave the telescope. The dome should now reach where the telescope is from the other direction. *Note: In the winter, the dome sometimes gets stuck in the 300-360 degree range.*

5.5   Not focusing

- If you are having trouble focusing, try focusing on a magnitude 6ish star that is directly overhead (sidereal time equals star's RA) and a declination of 40 degrees.

- If you are unsure if the telescope is working (i.e. it is so out of focus you can't see anything) try pointing it at a really bright star such as Vega, Capella, Polaris or even Sirius. While you might be able to see these stars as bright blobs taking up half of the viewing window you won't be able to focus on them since they are so bright. However, they do serve as a good indicator that the telescope is working and pointing where you tell it to go.

- If MaxIm is operating very slowly, try ensuring that you are not running a focus exposure and a guide exposure at the same time.

Chapter 6

Appendix

6.1   Sample Observing Report

Success: Yes

Observers: Anja, Helena, Meghan, Cynthia

Date: 2017-07-25

Conditions
Cloud Cover: Clear
Wind: 4.1mph
Humidity: 38%
Temperature: 35.6°F

The information below can be found by googling the target. Make sure the source is reliable. It is a good idea to cross reference sources to make sure the information is consistent.

Target: WASP-65   Mag: 11.9
RA: 08h 53m 17.38s   Dec: 08° 31' 22.8"

4:45pm - Began setup.

In this space below, record times at which you:
-Checked that dome and telescope were functioning.
-Began taking dark calibrations (if applicable).
-Began taking calibration images (flats and biases).
-Began focusing the telescope.

5:00pm - Visually confirmed that the dome and telescope are working.

5:05pm - Started taking dark calibrations.
Darks: 3   Exposure Time: 1800s

7:30pm - Started taking flat and bias calibrations.

Flats: 11   Filter(s): r'
Biases: 11

8:13pm - Focused telescope.

FocusMax -   HFD: 4.79

MaxIM -   FWHM: 2.91   HFD: 4.63

8:35pm - Began guiding.

Guide Star: TYC811-2091-1   Mag: 10.12
RA: 8:53:50.3   Dec: 8:43:01

8:40pm - Began sequencing.

Filter(s): r'   Exposure Time: 120s

FWHM: 2.975   Bkgr(avg): 4543
Star(max): 20897   Star(min): 4998

8:47pm -   003r

FWHM: 3.957   Bkgr(avg): 4688
Star(max): 21438   Star(min): 4565

9:17pm -   018r

FWHM: 4.013   Bkgr(avg): 5797
Star(max): 23428   Star(min): 4786

For image 19 we lost the guider and the image was completely blank. It looked like a dark calibration image. As of 9:10pm it seems to have recovered and all of our images look normal.

9:47pm -   033r

FWHM: 8.138   Bkgr(avg): 5467
Star(max): 18964   Star(min): 3425

10:01pm -   039r

FWHM: 9.716   Bkgr(avg): 5347
Star(max): 12134   Star(min): 2426

10:31pm -   054r

FWHM: 5.444   Bkgr(avg): 5023
Star(max): 22452   Star(min): 2003

11:01pm -   069r

FWHM: 4.324   Bkgr(avg): 4897
Star(max): 23982   Star(min): 3012

11:31pm -   084r

FWHM: 6.788   Bkgr(avg): 4563
Star(max): 32094   Star(min): 2121

12:01am -   099r

FWHM: 7.323   Bkgr(avg): 5432
Star(max): 23453   Star(min): 1890

12:31am -   114r

FWHM: 7.021   Bkgr(avg): 5567
Star(max): 24221   Star(min): 2189

12:32am - Stopped sequence.
Science Images: 114   Filter(s): r'

12:33am - Begin shutdown.

12:45am - Shut down.