ARCSAT User Guide

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Contents

1. INTRODUCTION

This manual is intended as a resource for operation of the ARCSAT telescope. There is a great deal of information presented. It is necessary for new users to read through the manual before beginning operations on the telescope. While becoming familiar with observing a new user should complete some simple tasks during the day before observing. Start by logging into the ACP web interface through tunneling and proceed to take a set of flats. Look through the different menus and familiarize yourself with the operations. If you are successful at a taking a set of flats, getting setup on sky will be much easier, and less frustrating than trying to learn the software during the first night of operations.

Recent Changes in the manual:

- Added Table Of Contents
- Reorganized sections for better flow

2. LOGGING-IN

Chrome is the browser recommended by the ACP software company. Chrome has been tested with no problems but a few problems have cropped up with FireFox. If you are using FireFox make sure it is updated to the most current version (26.0 at the time of writing this). If you select an imaging option and the widget box shows only html code then something is wrong. First, check for add blocking extensions; try to disable them and restart the browser. If the problem still occurs then contact the observatory staff to restart the ACP server.

The ARCSAT-TCS is protected behind the APO firewall so a little work is required to access the web server. There are two methods of accessing the ARCSAT web interface.

1. The first method is to send your IP address to the APO IT staff and have them add it to the allowed list through the firewall. This request must be made at least two days in advance (preferably more). If this is done then no tunneling is necessary.
2. The second method, described below for various operating systems, is through SSH tunneling using arc-gateway.apo.nmsu.edu. Only one user can be logged onto a single port. If an error message occurs after the ssh then try increase the port from 1234 to 1235 (or anything greater than 1024).

2.1 SSH Tunneling - Unix

For Unix based operating systems (including Mac) the method for tunneling is simple.

1. open Terminal
2. type: ssh -L 1234:arcsat-tcs.apo.nmsu.edu:80 [account]@arc-gateway.apo.nmsu.edu
3. open web browser
4. go to http://localhost:1234

2.2 SSH Tunneling - Windows

Windows tunneling is accomplished through PuTTY (search and download the windows installer version).

1. Setup SSH session on arc-gateway.apo.nmsu.edu and Save, figure 1(a)
2. Setup tunneling, figure 1(b)
3. Login to arc-gateway after pressing Open, figure 1(c)
4. Open Web browser and enter http://localhost:1234 in the url
5. Login using ARCSAT login information and start web interface, figure 1(d)

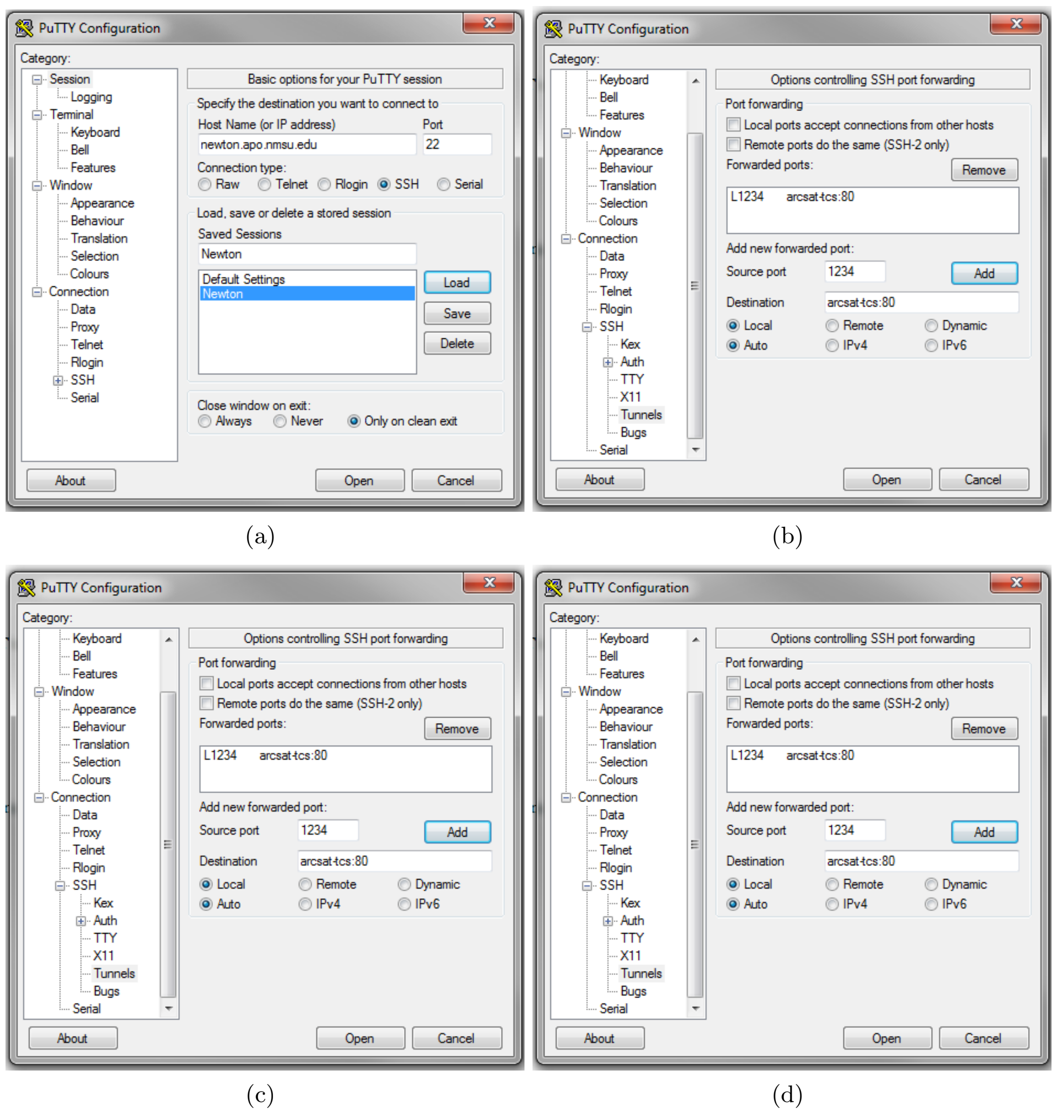
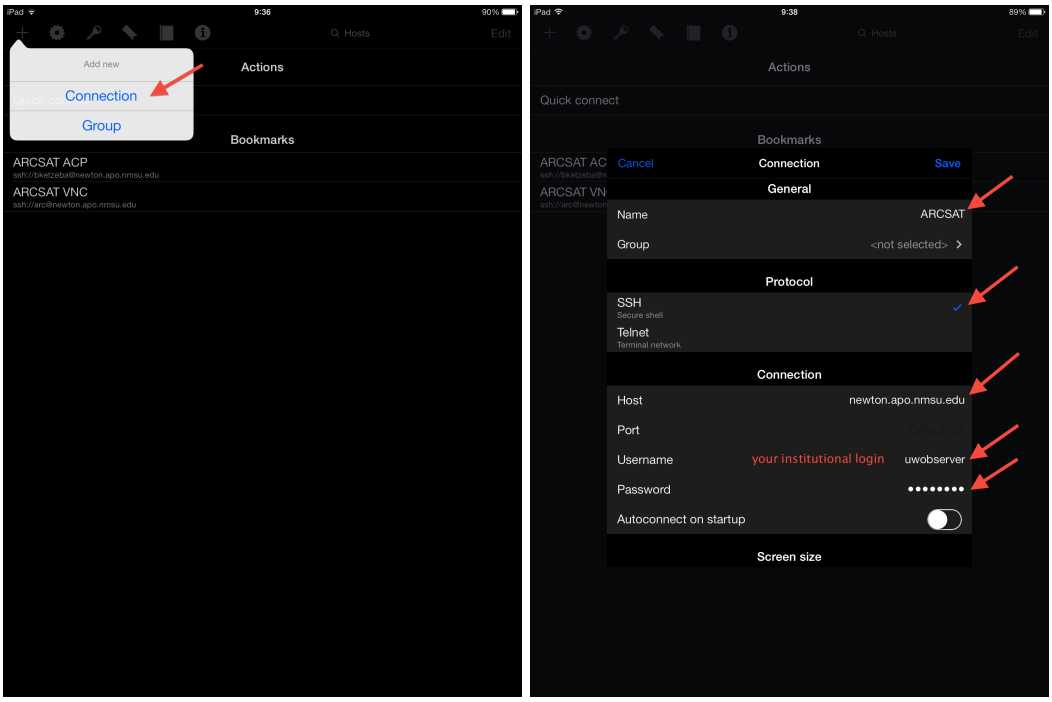


Figure 1. Windows Tunneling Setup

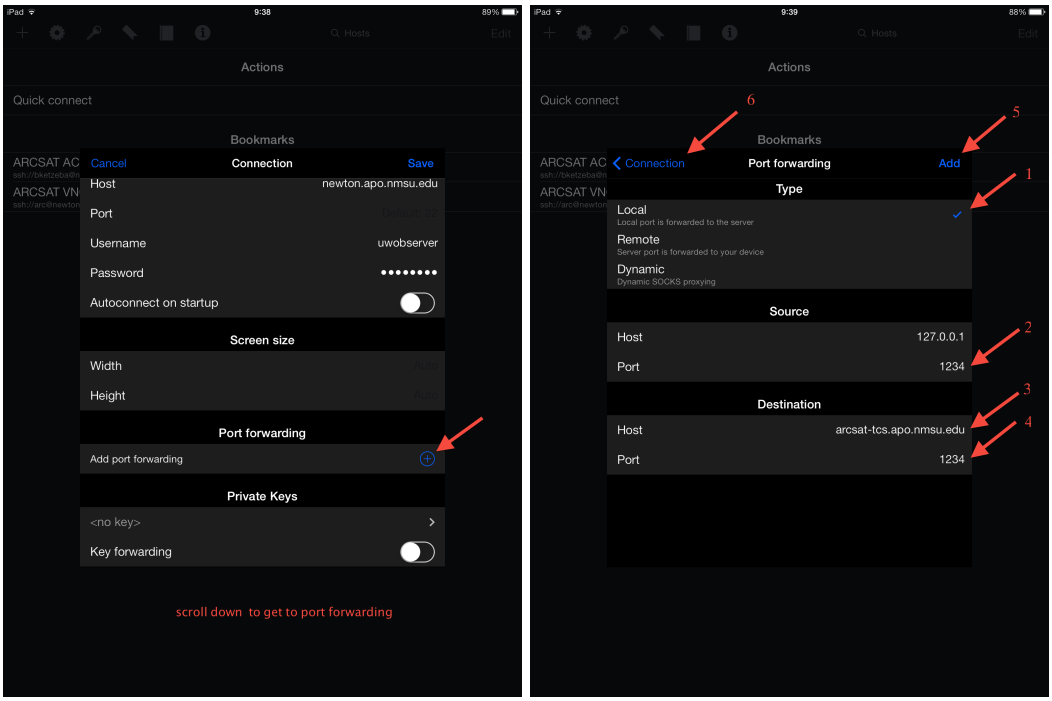
2.3 SSH Tunneling - iPad & iPhone

Tunneling on iPad is possible with vSSH (it may also be done on the iPhone with iSSH but that has not been tested).

1. Open vSSH
2. Click the plus sign in the upper left and select connection
3. Enter the arc-gateway configuration information as is seen in figure 2(b). (note that newton has been replaced by arc-gateway).
4. Under the port forwarding subject header click the plus sign to add port forwarding, figure 2(c)
5. Configure port forwarding as is shown in figure 2(d). Note that the Source Port may need to be incremented if multiple users are port forwarding using that same account.
6. Save the configuration settings
7. Click Done in the upper right corner
8. To start the port forwarding click on the newly created setting under Bookmarks
9. The ssh should now be connected to arc-gateway, figure 3(a)
10. To break the connect click the back arrow next to Hosts and the X next to active, figure 3(c).
11. Confirm the disconnect

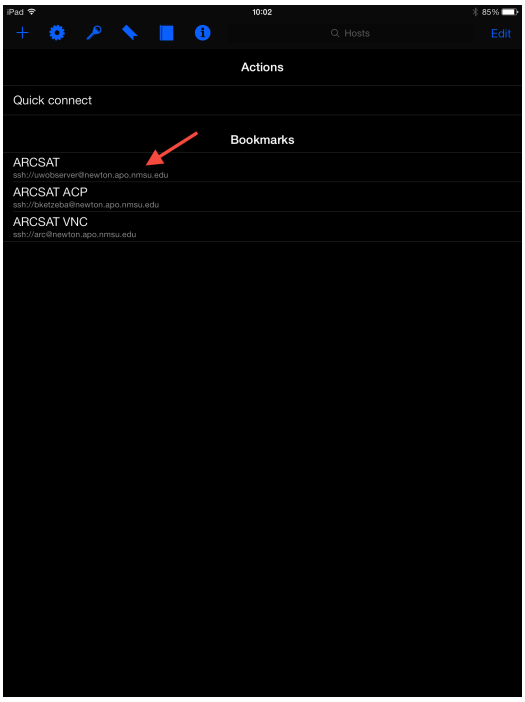


(a) (b)

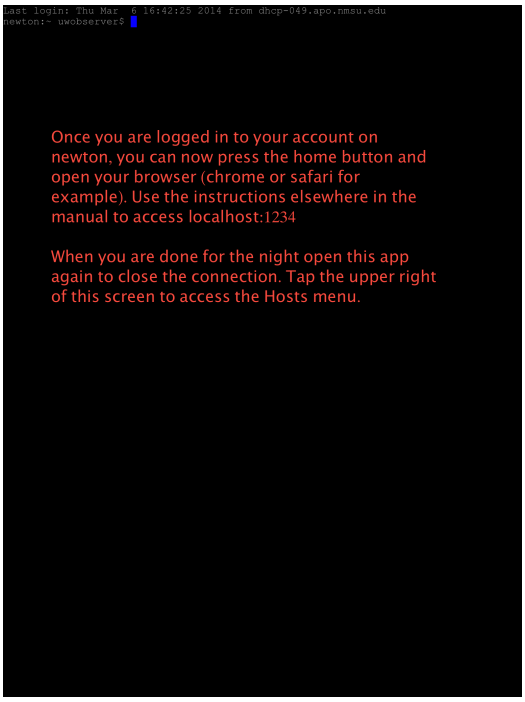


(c) (d)

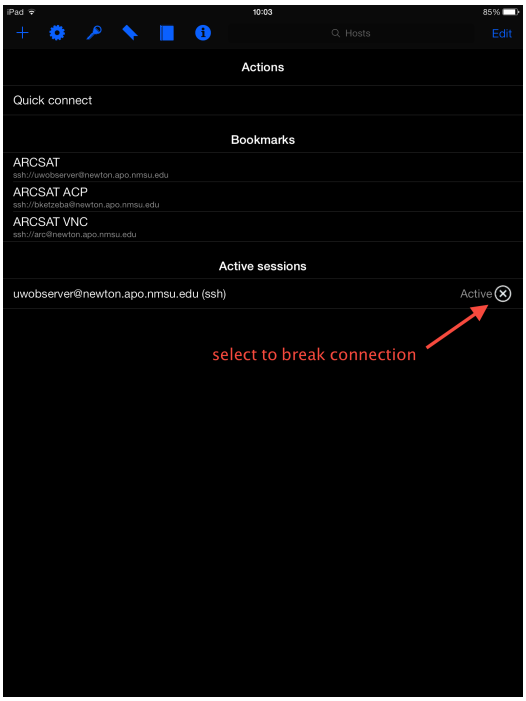
Figure 2. iPad Tunneling Setup



(a)



(b)



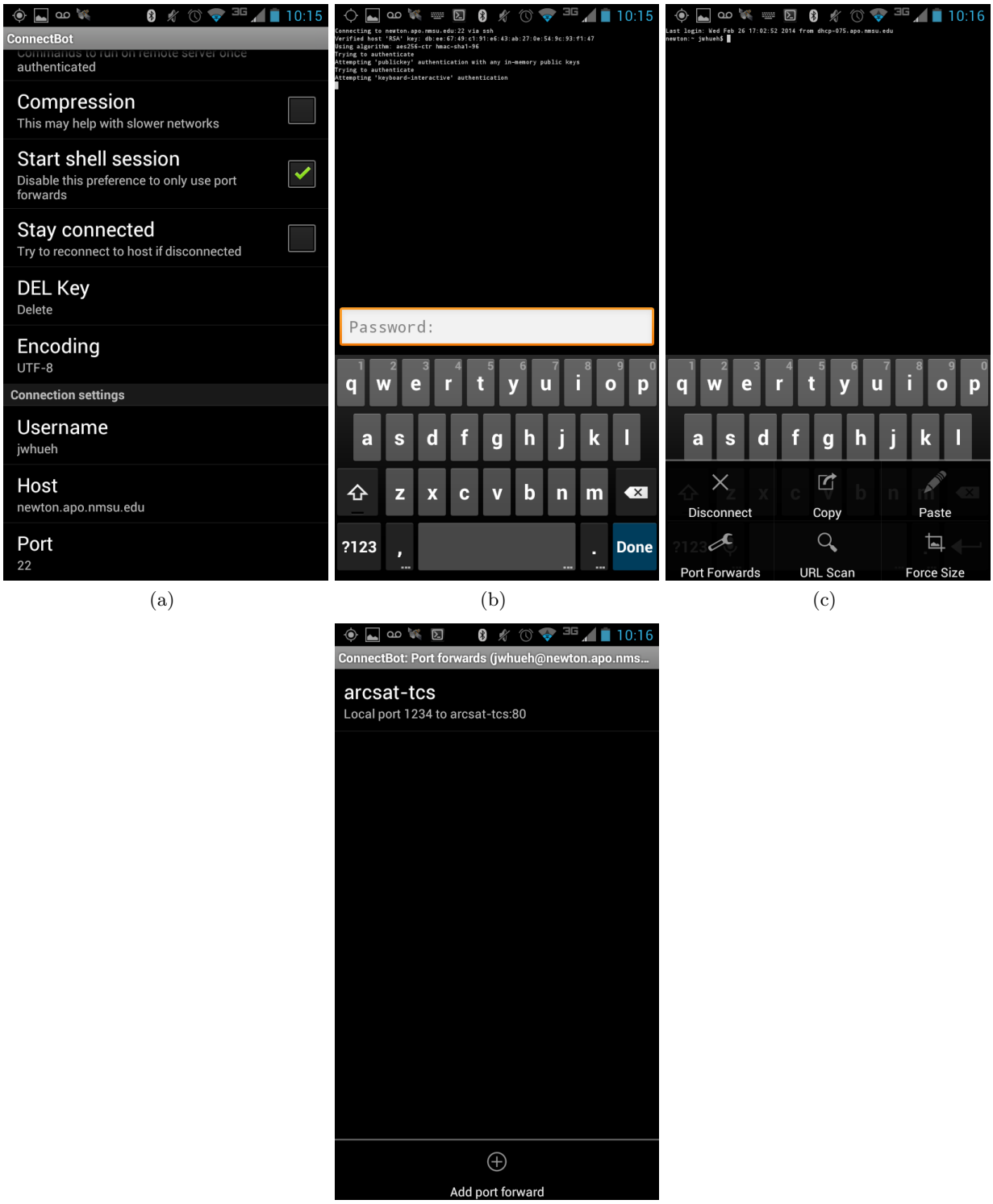
(c)

Figure 3. iPad Tunneling Setup

2.4 SSH Tunneling - Android Phone & Tablet

Tunneling through Android is achieved by using the ConnectBot program available on Google Play.

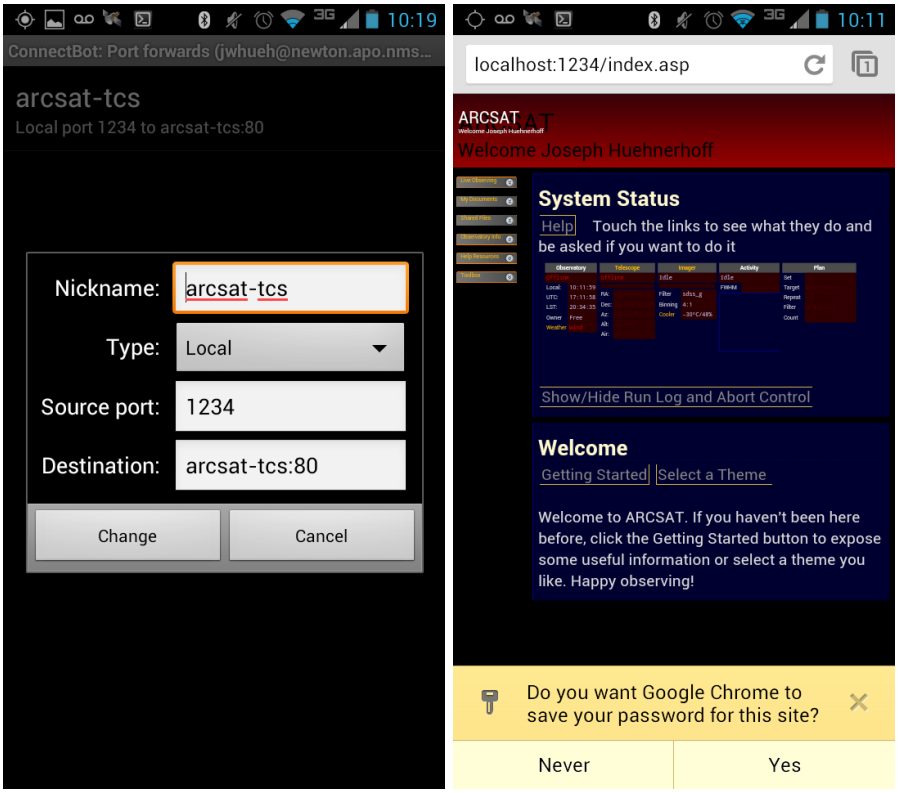
1. Setup ConnectBot to login in to arc-gateway, see figure 4(a). (note that newton has been replaced with arc-gateway).
2. After logging into arc-gateway (figure 4(b)) press the Android phone Menu button (typically lower left on phone face) and click on Port Forwards, figure 4(c)
3. Press the menu button again and click Add port forward, figure 4(d)
4. Configure the port forward as shown in figure 5(a) and click Create port forward
5. Use the back button to go to the arc-gateway SSH terminal opened in the first step and press the Android home button
6. A little ssh icon should appear in the status bar
7. Open the Chrome for Android browser
8. Type: localhost:1234 in the url and click enter
9. **Authentication Required** window should now appear
10. After entering login information the web interface should appear, figure 5(b)



(a) (b) (c)

(d)

Figure 4. Android Tunneling Setup



(a) (b)

Figure 5. Android Tunneling Setup

3. WEATHERTAP ACCOUNT

1. ARCSAT WeatherTap Account - Used for monitoring localized weather information.
2. The WeatherTap website is located at: www.weathertap.com. The username is **apo05m** with the password **darksky**.
3. Radar View 1:
   (a) Click **Radar** along the top and go to **Radar Home**.
   (b) On the second view of the US, find the Holloman AFB radar station.
   (c) Radar will provide a good idea of precipitation in the area.
   (d) **Animate Image** provides a nice view of directionality.
   (e) There is a radar blind spot to the East of APO, that is why there is minimal radar returns. This does not mean there is no perception.
   (f) The small scattered radar returns often seen to the east of Holloman is scatter off the Sacramento Mountains. It is not active radar returns. Instead focus on the higher signal returns.
4. Radar View 2:
   (a) Click on **Radar** → **US Regional Radar** → **Southwest**.
   (b) Click on New Mexico.
   (c) Otero County is the L shaped county bordering the tip of Texas.
5. IR View:
   (a) Go to **Satellite** tab along the top and then **Satellite Home**.
   (b) On the bottom view of the US click New Mexico.
   (c) This view will show cloud coverage over the state.

4. OBSERVING

4.1 User Interface

The user interface is a browser based system utilizing an interactive front end to connect to the various telescope components. The program, called ACP, allows the user to interact with the telescope while providing a layer of safety necessary in remote operations. ACP can handle both single object science as well as scripted observing plans (how to write these plans is detailed in another section below).

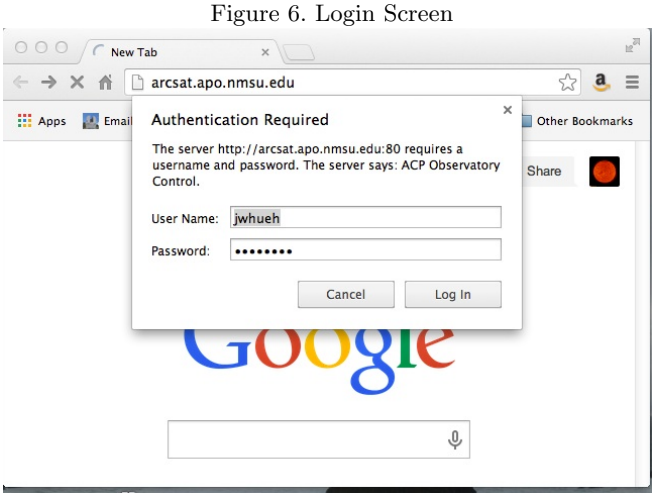
4.2 ACP Login

After tunneling into the APO network, section 2, the web browser should prompt for a username and password. At the log-in screen, shown in figure 6, enter the username and password for your program. Observatory username and password will be created and supplied by your institutional scheduler or Users Committee Representative. A typical program username would be AS01, a two-digit abbreviation of the telescope followed by a sequential program id.

The page that appears after login is the user interface with the System Status window already open. Other windows can be accessed from the tabs to the left.

Closing the browser logs your user, and only your user, out of the system. To change user it is the same process. Close browser and log back into the web interface.

Figure 6. Login Screen



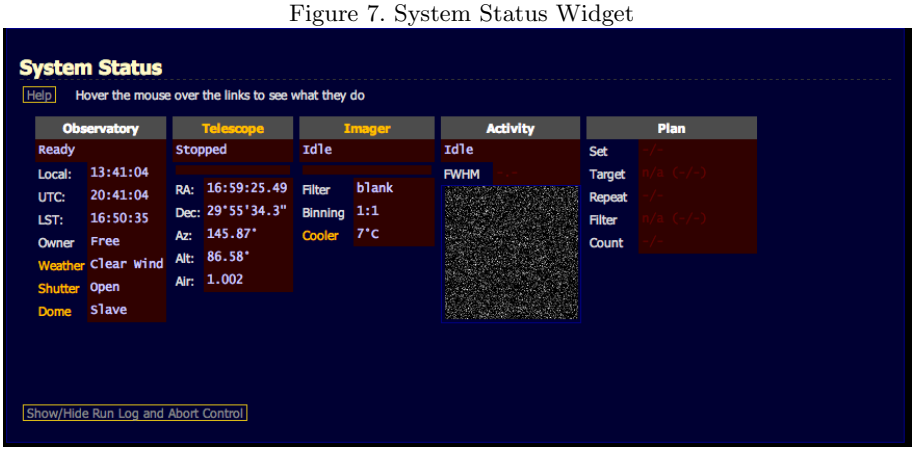
4.3 Observing Specialist Connection

It is recommended that the ARCSAT user login using the 3.5m TUI*. Close all other windows except for the Message window for keeping up to date on weather status. This is important for knowing why the telescope may be closed under what seem like good conditions. The ARCSAT user should only use TUI for determining site conditions and asking the Observing Specialist for help if the telescope is not working.

4.4 System Status Window

The System Status window will be the most used and most informative of the entire interface. This window displays where the telescope is pointing, if it is moving, if another user is making observations, as well as the current status of the imager and any planned activity.

Figure 7. System Status Widget



1. **Observatory**
   (a) **Status**
      i. Ready - displayed if both the telescope and imager are both properly connected and the dome is open.
      ii. Ready (closed) - If the telescope and imager are connected but the dome is closed.
      iii. Offline - shown if either the telescope is disconnected or the weather does not permit opening.

*http://www.apo.nmsu.edu/35m_operations/TUI-images/

(b) **Owner** will display the user actively controlling the telescope. If the telescope is slewing, taking an image, or running a planned observation. If the telescope is not currently active is will show Free.

(c) **Weather** will show the current weather status using data from the weather window. The weather window is found by going to Observatory Info → Weather.

(d) Shutter Operation

i. Clicking **Shutter** will open and close the dome shutter.

ii. While the command is being executed, the status will flash opening or closing for the corresponding action.

iii. The dome can only be opened 12 degrees prior to sunset (and if the 3.5m or 2.5m are open).

iv. The dome will also automatically close if rain is felt by the rain sensor or the 3.5m and 2.5m are closed.

(e) **Dome** selecting the **Dome** text will either Home or Slave the dome

2. **Telescope**

(a) **Status**

i. Offline - is displayed when the telescope is disconnected.

ii. Stopped - is displayed when the telescope is connected and waiting for commands but is not currently moving.

iii. Slewing - is displayed when the telescope is in motion

3. **Imager**

(a) The Idle status, displayed below the Imager header is an indicator that the camera is connected but is not currently active. This status will change to Offline when the camera is disconnected or will show an integration counter if an integration is underway.

(b) Observing Protocol

i. During observations the camera should be cooled no more than 75% of the TEC load. This number is presented to the right of **Cooler** under the **Imager** heading.

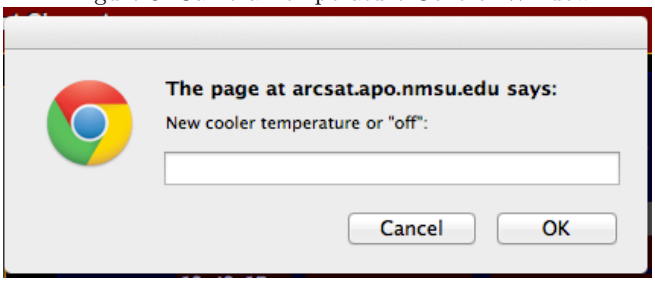
A. SurveyCam should be cooled to -35C (-40C if ambient temperature is below freezing). This is not always possible if the ambient temperature is above 20C. If the camera is having trouble cooling make sure that the louvres are open (the 3.5m Observing Specialist has control of louvres). If the camera cannot cool to -35C then change the set point to -30C but make sure to take darks.

B. FlareCam should be cooled to -25C (-30C if ambient is below freezing)

ii. To change the CCD temperature click on the Cooler text. The window, seen in figure 8, will appear. Enter the new temperature and click ok.

iii. If the cooler is off, clicking Cooler will turn it on.

Figure 8. Camera Temperature Control Window



4. **Activity**

(a) The first keyword under **Activity** will either be **Idle** or **observing**. This is an indicator if any activity currently being performed with the telescope.

(b) FWHM does report values when image series are being taken and the final plate solve is successful. Final plate solve is most successful with well populated fields.

(c) The box at the bottom displays a preview after a science image is taken.

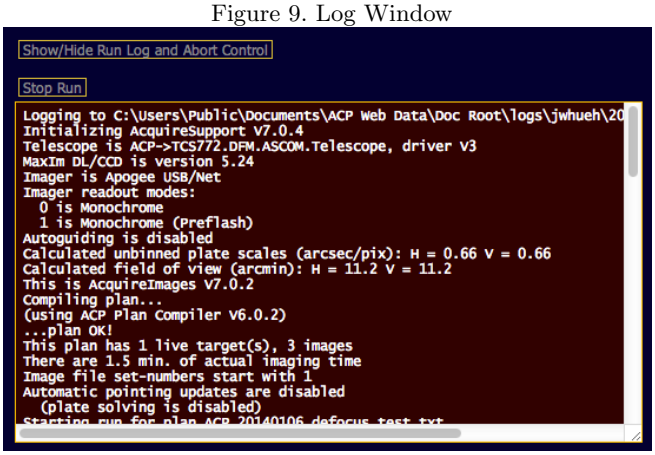
5. **Log Window**

(a) Clicking the **Show/Hide Run Log and Abort Control** text button at the bottom of the **System Status Window** opens a running text window.

(b) This window will show all current telescope activity, regardless of login.

(c) If the **System Status** window is not open, it can be accessed by going to **Observatory Info** → **System Status Disp**.

Figure 9. Log Window



4.5 Opening

1. Check the weather status.

(a) Although this telescope has safety's built into the software the observer should also check the weather before opening the dome.

(b) Use http://weather.apo.nmsu.edu/ as a rough idea of cloud cover.

(c) Look at: http://irsc.apo.nmsu.edu/ for current cloud cover over site.

(d) Keep an eye on other telescope status and temperatures at: http://weather.apo.nmsu.edu/cgi-bin/weather.py

(e) The 3.5m or 2.5m must be open in order for ARCSAT to open. Current large telescope enclosure status is shown on the weather page within the web interface. It is located by going to **Observatory Info** → **Weather**. The web interface will report a green **Open** if either the 2.5m or 3.5m telescope are open. Large telescope enclosure status can be bypassed with special permission and intervention from the observing specialist. A config file on the ARCSAT TCS must be changed to allow for bypassed operation.

(f) In the **Weather** window the 2.5m/3.5m dome status will be shown. Any item in red will cause the ARCSAT dome to close.

2. Safety's

(a) ARCSAT E-Stops are released. The current state of the stop buttons can be found by going to **Observatory Info** → **Motor Status**, see figure 10(a).

(b) The telescope can only be opened if the 3.5m or 2.5m are open. This can be bypassed upon request to the 3.5m Observing Specialist. The current state of the bypass can be viewed by going to **Observatory Info** → **Bypass Status**, see figure 10(b).

(c) The rain sensor outside the dome shutter does not detect rain. If rain is detected it will automatically close the dome.

3. **Observatory** status should read **Ready (closed)**. Click **Shutter** to open the dome shutter, which will change the status to **Ready**.

(a)

(b)

Figure 10.

4.6 Closing

1. Manual shutting down telescope

   (a) After observations are done click the **Close Dome** link in the **System Status** window.

   (b) The camera set point should remain cool after observations are complete. Keep the camera set point at the observation temperature.

2. Scripted closing

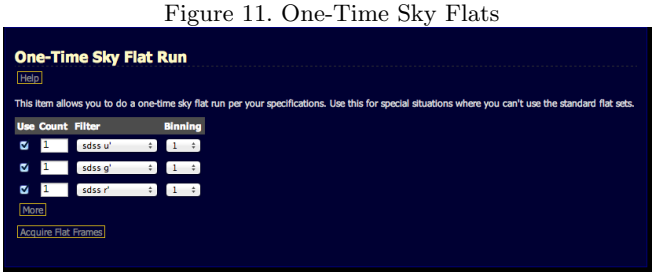
   (a) To close using a script make sure to use the following commands at the end of the script, typically after dawn flats.

   (b) #DOMECLOSE

4.7 Flats

1. Flat Type Selection
   (a) Two types of flats can be taken with this telescope, dome flats or sky flats.
   (b) The type is selected through the **Live Observing** → **Setup Sky Flats** window. Note: this software does not actively distinguish in window headers if the flat is a dome or sky flat.
   (c) Before starting the flat sequence click one either **Use Dome Flat Config** or **Use Sky Flat Config**.
   (d) Note: The dome must be opened for sky flats. It will not automatically open and if closed it will try to take sky flats in the dome.
2. Sky Flats (Auto & Manual)
   (a) The sky flat boxes can be accessed under the **Live Observing** tab to the left.
   (b) One-Time Sky Flats

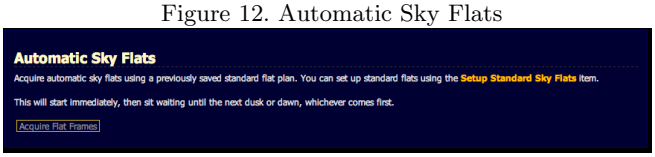
Figure 11. One-Time Sky Flats



   i. Enter the specifications for the count, filter and binning on each line.
   ii. Clicking **More** will create an additional line for the run.
   iii. When the entire plan is filled in, click **Acquire Flat Frames** to run it.
   iv. After running, a pop up box will appear notifying the completion of the flats, figure 13.
   v. Information from the flats can be accessed from the run log in the **System Status box**, figure 9.

   (c) Standard Sky Flats
   i. Click **Setup Standard Sky Flats** to create a plan for sky flats.
   ii. Click The button at the bottom **Use Sky Flat Config** (a line should appear below the buttons with the text "Sky Flat Config File Set").
   iii. Next, choose the filter, quantity, and binning for the dome flats.
   iv. Click **Save Flat Plan** (the script for the flat plan should appear below the buttons).
   v. Once setup and saved, the plan can be run by going to **Live Observing** → **Standard Sky Flats** and clicking **Acquire Flat Frames**.

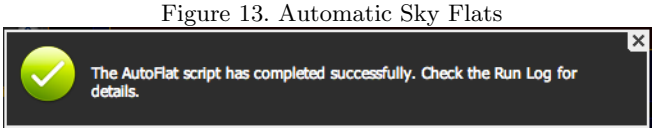
Figure 12. Automatic Sky Flats



   vi. After running, a pop up box will appear notifying the completion of the flats.
   vii. Information from the flats can be accessed from the run log in the **System Status** box (Figure 9).

3. Dome Flats

Figure 13. Automatic Sky Flats



(a) Dome flats follow the same forms and process as sky flats.

(b) Dome flats can be taken when the Observatory status is shown as **Offline**, the telescope and dome will automatically slew to the proper position.

(c) Go to **Live Observing** → **Setup Sky Flats**.

(d) Click The button at the bottom **Use Dome Flat Config** (a line should appear below the buttons with the text "Dome Flat Config File Set").

(e) Next, choose the filter, quantity, and binning for the dome flats.

(f) Click **Save Flat Plan** (the script for the flat plan should appear below the buttons).

(g) Go to **Live Observing** → **Standard Sky Flats** and click **Acquire Flat Frames**.

(h) The run log should now show the telescope and dome moving to the proper position followed by the image sequence. When the telescope is pointed at the flat field screen the altitude will be 38 degrees and the azimuth will be 287 degrees.

(i) The image sequence will start by taking a 120 second test exposure. From that exposure it will determine the integration time necessary for the flat to have an optimal 20,000 counts. A minimum of 8,000 counts is considered acceptable.

(j) Note: To save time, start the flat sequence with redder filters and end with bluer filters (SDSS u' and/or narrow band pass filters).

(k) Note: Expected exposure times in table 1 & 2

Table 1. SurveyCam Dome Flat Typical Exposure Times

Filter	1x1	2x2
SDSS u'	NA	120
SDSS g'	25.1	6.2
SDSS r'	14.8	3.7
SDSS i'	29.9	7.6
6563nm - 50nm	NA	111
6450nm - 50nm	NA	106

Table 2. FlareCam Dome Flat Typical Exposure Times

Filter	1x1	2x2
SDSS u'	120	55
SDSS g'		2
SDSS r'		
SDSS i'		
6563nm - 50nm	29.8	188

4. Auto-Calibration is currently untested. When further testing and proven functionality becomes available the manual will be updated.

4.8 Single Image Acquisition

1. Go to **Live Observing** → **Single Image**, figure 14.

2. Enter the target name, coordinates, duration, filter, and binning in the appropriate fields.

3. Selecting Auto focus before imaging will focus the telescope before taking any science images. Autofocusing takes between 90 and 180 seconds and is only necessary if it is at the beginning of the night or during variable seeing. More autofocus and manual focus discussion in section 4.13.

4. Auto calibrate will use darks and flats to process the final image

5. Images taken can be accessed by clicking **Acquired Images** under **My Documents** tab to the left.

6. Note: A Single image cannot be taken before twilight. If images are needed before twilight it is recommended to use a script. Figure 15 is an example of what might be seen while attempting to take a science image during sunset. The solution is to create a custom script, copy all the lines except for the #waituntil, see figure 16. Then upload the script and run through **Multiple Objects (Plan)** window.

Figure 14. Acquire Single Image

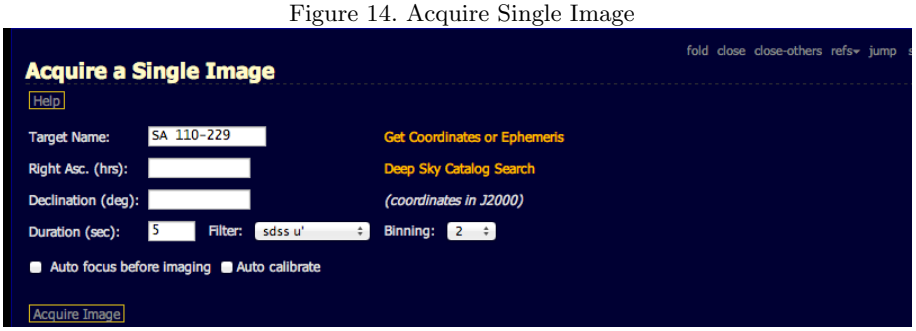


Figure 15. Sun Elevation < -12

```
;
; Single target color series plan by Joseph Huehnerhoff, created Tue, 11 Mar 2014 17:29:25 UTC
;
; Wait until it's dark enough (sun < -12 deg elevation)
#waituntil 1,12 Mar 2014 02:00:35   ; It's still too light
#count 1
#interval 1
#binning 1
#filter sdss_g
test    17.197777777777776      32
```

Figure 16. Sun Elevation < -12 Bypass

```
#startsetnum 1 ; Persistent set numbering added by ACP
#completionstate 0,0,0,0,0 ; Plan completion status added by ACP
#count 1
#interval 1
#binning 1
#filter sdss_g
test    17.197777777777776      32
```

4.9 Color Series

1. go to **Live Observing** → **Color Series**, figure 17.

2. **Color Series** is the same setup as **Single Image** but allows for multiple filters.

3. enter Target Name, RA, and DEC.

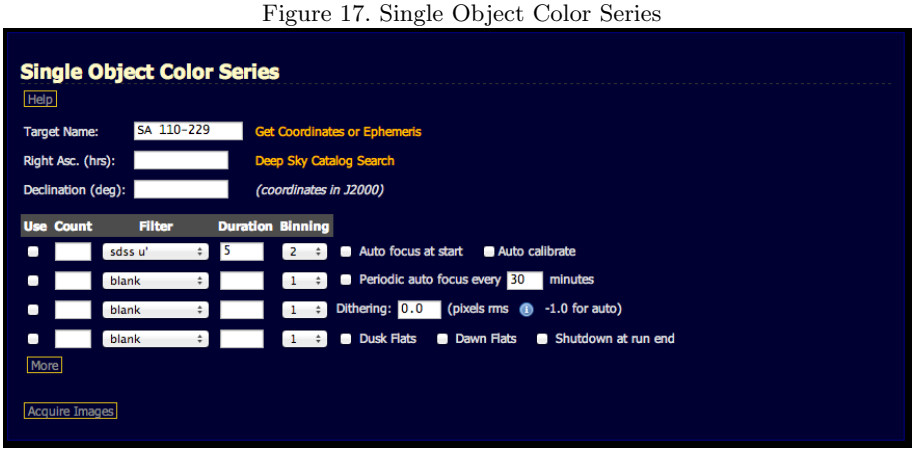
4. check **Use** to include in image sequence.

5. input the number of images for that filter to be taken under the **Counts** heading.

6. select the filter from the drop down menu.

7. enter integration time under **Duration**.
8. select square binning mode.
9. several other features are available in the check or input boxes right of the sequence fields.
10. click **Acquire Images** to start the sequence.

Figure 17. Single Object Color Series



4.10 Image Download

1. Images taken can be accessed by clicking **Acquired Images**, figure 18, under **My Documents**

Figure 18. AcquiredImages

2. ARC Gateway
   (a) Images will by sync'd to the /export/arcsat disk and can be scp'd
   (b) If the directory is unknown then ssh into arc-gateway.apo.nmsu.edu using the given institutional username and password (the password changes quarterly and if it is not known then contact your institutional scheduler or Users Committee Representative).
   (c) cd /export/arcsat/
   (d) cd into the ARCSAT institutional account that was used for image collection
   (e) cd in the desired nights date
   (f) use scp with the determined directory.
      i. file: scp uwobserver@arc-gateway.apo.nmsu.edu:/export/arcsat/AS01/140108/test.fits .
      ii. directory: scp -r uwobserver@arc-gateway.apo.nmsu.edu:/export/arcsat/AS01/140108/ .

4.11 Telescope/Detector Information

1. This information can be accessed by going to **Observatory Info** → **Instruments & Equipment**.
2. Use this information to determine field of view, plate scale, and filter organization.
3. The plate scale is shown for 1x1 binning and should be used to determine the focus for the input into the night log.
4. Filter allocation shows the filter position and filter name for use in scripting.
5. SurveyCam
   (a) Readout time in 1x1 binning is 22 seconds with readout time in 2x2 binning is 11 seconds.
6. FlareCam
   (a) Readout time in 1x1 binning is sub-second with readout time in 2x2 binning being about a second.
7. Observing Restrictions
   (a) Lower observing limit (current): 27 degrees above horizon (Air Mass=2.2).
   (b) Some vignetting of the field may occur at Air Mass > 2.1 from the lower dome shutter door. Tracking into the lower altitude limit is discouraged.

4.12 Dawn/Dusk Times

1. Under the **Observatory Info** tab is **Dawn-Dusk Times**
2. This is useful when remote observing and determining the sun and twilight times
3. An alternate form can be found: http://www.apo.nmsu.edu/Planning/obs.calendar/obs.calendar.html and then navigating to the given night.

4.13 Focusing

1. Auto Focus
   (a) Autofocus Interval (#AFINTERVAL, see section 5 for more information on scripting) - is used to systematically focus the telescope every x minutes. When adaptive autofocus is enable this option is not. With the current setup this feature is not available.
   (b) Single Autofocus (#AUTOFOCUS, see section 5 for more information on scripting) - will only focus at the beginning of an image. This is most effective at the beginning of the night or if the focus is highly variable throughout the night.
   (c) The autofocus routine takes 90 - 180 seconds. During this time you will see a pointing update followed by the start of the focus routine. No focusing updates will be sent to the run log due to increased instability in communications. During the focus routing the telescope will slew to a nearby 6th magnitude star then perform the focus routine. The system computes the current HFD (Half Flux Diameter) then use a calibrated convergence to compute the best focus. It will then slew back to the target star and check the pointing again before taking science images.
   (d) If there is concern that the program has become unresponsive there are several items to check
      i. If the Local time (in the **System Status** window) is updating then the web server is still responsive.
      ii. If you can refresh your browser window and it brings back the ARCSAT web interface then the web server is still responsive. If refreshing brings up an html error then the server has crashed and the 3.5m observing specialist should be notified.

iii. If the system is responsive per the previous two tests then wait up to 5 minutes, the focus routine may be looking through clouds and have trouble converging.

iv. After waiting 5 minutes contact the 3.5m observing specialist, it may be possible that the focus routine is in an infinite loop state.

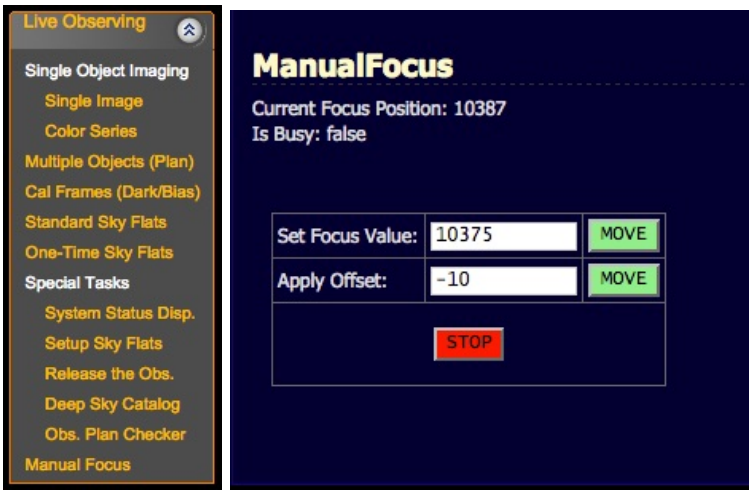
2. Manual Focus

   (a) Manual focus mode is used by going to **Live Observing** → **ManualFocus**, figure 19(a).

   (b) An absolute focus value can be entered in the **Set Focus Value** text field, figure 19(b). Clicking **MOVE** will initiate the move to the desired focus value.

   (c) A relative focus offset can be entered in the **Apply Offset** window, figure 19(b). Clicking **MOVE** will initiate the move to the desired focus value.

   (d) The focus move can be aborted, mid-move, by clicking **STOP**. The focus value will be moved to the previous value.



(a) (b)

Figure 19. Using manual focus mode

4.14 Nightly Operations Plan Outline

1. Several hours before sunset
   (a) set camera temperature
   (b) take biases, darks, and dome flats
2. Open dome at sunset
3. Take sky flats
4. Start imaging
   (a) autofocus
   (b) if during twilight then upload script to image
   (c) if after twilight then use web interface for imaging or scripts
5. autofocus sparingly, typically only if seeing changes or it has been several hours
6. close dome when done imaging
7. verify Telescope is Stopped

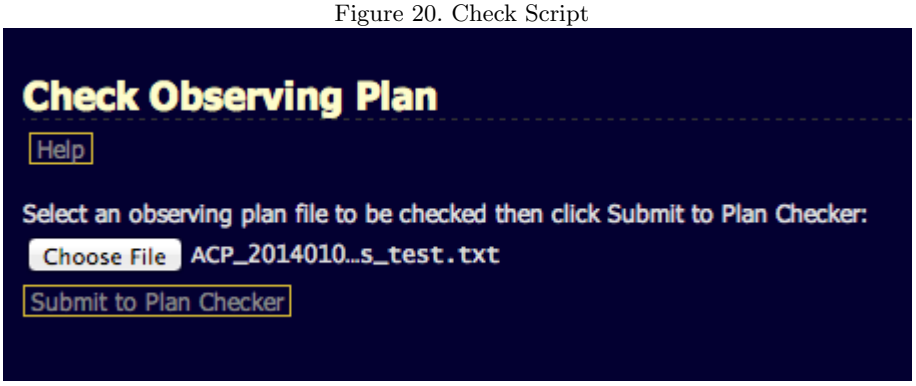
5. SCRIPTING

The scripting environment in the web interface is one of the most powerful tools available. This section will introduce the reader to script usage, the commands available, and some sample scripts.

5.1 Running a Script

1. After a script has been made it can be checked for errors at anytime (a good time for this is during the day before the observing run).
   (a) To access the script checking widget find the **Toolbox** tab on the left and click on **Obs. Plan Checker**.
   (b) Click on **Choose File** and navigate to the directory of the script to be checked.
   (c) Once the file name is shown in the space to the right of **Choose File**, click the **Submit of Plan Checker**.
   (d) An output box will appear and let the user know of any problems.

Figure 20. Check Script



2. Upload the script to the server
   (a) Under the **My Documents** tab on the left, click **Observing Plans**
   (b) Click **Choose File**
   (c) Navigate and open the observing script
   (d) Click **Upload File**

3. Run Script
   (a) Go to **Live Observing** → **Multiple Objects (Plan)**
   (b) Use the drop down to select the previously uploaded file
   (c) Click **Acquire Images**

5.2 Creating a Script

A script supported by the web interface is a combination of selected commands to accomplish a task. An example of the scripting language is seen in the text below an acquire image. These widgets send the same scripting commands to the user as a custom script. If a command sequence is ever unknown then taking a color series or using the acquire images button in any widget is a good method of determining the correct command sequence.

Each script command begins with a # while ; is used for commenting.

Figure 21. Upload Script

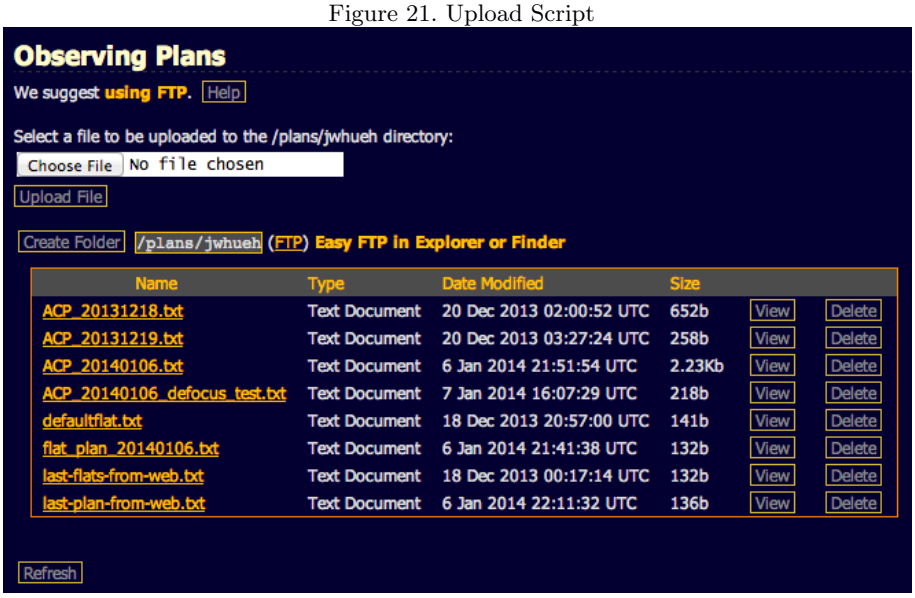


Figure 22. Run Script

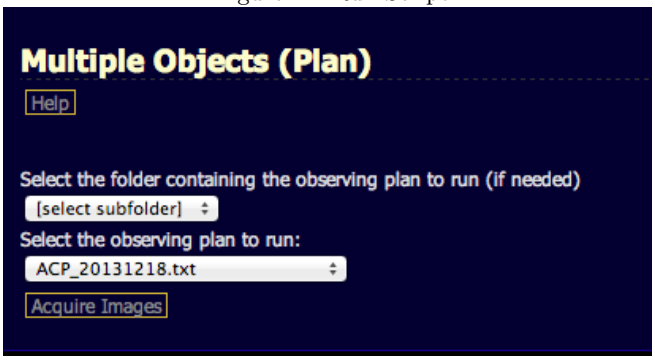


Figure 23. Example Script 1

```
#DUSKFLATS

;====HR645=====
#REPEAT 20
#FILTER sdss_g,sdss_r
#COUNT 1,1
#INTERVAL 10,10
#BINNING 2,2
TYC484901       02:54:16.3      +00:19:16.9

#SHUTDOWN
```

Figure 23 is a simple script that will take a set of dusk flats (using the save flat plan), take some images, then shut the telescope down. The format for taking images will be the most used. #REPEAT is used to take 20 of the following image types. There are multiple levels of continuous imaging with the most common commands being #REPEAT and #SETS. #SETS is the same idea of #REPEAT but for many objects, example below. Next is the filter selection command, #FILTER. In this example there will be two filters used. This can range from a single filter to the whole set of filters. The code sequence is also seen in color series exposures, and is the same concept. The following line will use #COUNT to set the number of exposures for each filter. #INTERVAL

will then set the exposure integration time. The final image config line will set the binning using #BINNING. In figure 23 the binning is set to 2x2 for each filter. The horizontal and vertical binning cannot be set independently so any binning is for a square.

The scripting language is very picky about spaces, specifically with the target fields. These fields are tab delimited. In programs like emacs it may add a space after the tab. If this happens it will fail the script check.

To check a script before uploading, go to **Toolbox → Obs Plan Checker**, see figure 20.

Several sample scripts can be found at: http://users.apo.nmsu.edu/ jwhueh/arcsat/userdoc/.

5.3 Timed Series Observations

There are a couple helpful tips for time series observations. Often it is necessary to defocus the science images. This is possible to using #DEFOCUS. A value between 10-60 would be typical. This would be about a 30% widening of the PSF.

For timed series observations it is important to have no interruptions in data. It is recommended to not only use scripts for image acquisition but to also add two commands at the beginning. The first command is #NOSOLVE, this will prevent the software from taking time to compute image statistics. The second command is #NOPOINTING. This command will prevent a pointing update image from being taken at the start of a sequence. In a time critical event this could cause delays at the start of a sequence.

5.4 Complete Command Sets

Command definitions taken from ACP manual.

- #REPEAT - Tells script to take the given number of filter groups of the next target or dark/bias frame (#DARK) in a row. #REPEAT may be combined with #SETS. For example: #REPEAT 5
- #CALIBRATE - Forces calibration of the images for this target, even if ACP's auto-calibration preference is turned off (it is redundant if ACP's auto-calibration is turned on). This will not cause calibration of pointing exposures, only the final images. For example: #CALIBRATE
- #STACK - Combines repeated images within one filter group without aligning into a single image. Individual images used in the stack are preserved. File names will have -STACK in place of the repeat number. This is most useful when doing orbital tracking. See #TRACKON. The stacked image is saved in IEEE floating-point FITS format to preserve the dynamic range. For example: #STACK
- #STACKALIGN - Combines repeated images within one filter group and aligns images into a single image. Individual images used in the stack are preserved. File names will have STACK in place of the repeat number. Use this for all stare-mode image sets. The stacked image is saved in IEEE floating-point FITS format to preserve the dynamic range. For example: #STACKALIGN
- #AUTOFOCUS - Automatically refocus the optical system before each filter group in the filter group for this target. In order to preserve compatibility with the old target-per-filter plan format, this is modified if there is only one filter group. In this case, the autofocus is done once for the target, even if #repeat is greater than one. This requires that FocusMax 3.4.1 or later be installed and autofocus be enabled in ACP's preferences. For example: #AUTOFOCUS
- #POINTING - Schedule a pointing update prior to the target. This will work even if auto-center is disabled in Preferences. Thus, you can use #POINTING as a means to manually control when pointing updates occur in a plan. For example: #POINTING
- #NOPOINTING - Prevent the pointing update prior to the target. Harmless if auto-center is disabled in Preferences. For example: #NOPOINTING
- #NOSOLVE - Prevent final/data image plate solving for all of the images of the current target. Harmless if final/data image solving is disabled in Preferences. For example: #NOSOLVE

- #WAITFOR - Pause for the given number of seconds before processing the next target. For example: #WAITFOR 30

- #WAITUNTIL - Pause during a specific set (see #SETS) until the given UTC date/time or (only) time. The first parameter is the set number for the pause, the second is the date/time at which to resume. The set number may range from 0 through the number of sets given by the #SETS directive. If there is no #SETS directive on the plan, the set number must be 1. If the set number is 0, it means "wait on all sets". This is useful, when only a time is given, for plans that are stopped before completion then resumed on subsequent nights. If a complete date/time is given, and has passed, the directive is ignored. If only a time is given, it will wait for up to 12 hours. If the time is less than 12 hours in the past, it will not wait. The idea is that the time is relative to that observing night, and may be re-used on the next night. See the note below. For example:

  #WAITUNTIL 1, 21-Apr-2011 08:02:00

  Wait until 08:02 UTC only if set #1 and only if 21-Apr-2011

- #WAITINLIMITS - Pause until the target is within the observatory limits: minimum elevation, horizon, and any tilt-up limit. If target will never meet the criteria, it Is immediately skipped. A maximum time to wait (minutes) must be included. For Example:

  #WAITINLIMITS 60

  This will wait for the target to rise above the observatory limits for up to 60 minutes.

- #WAITZENDIST - Pause until the target is within the given zenith distance (deg) for up to the given time (min). If the target will never get within the given zenith distance, or won't get there within the time limit, it is skipped. A maximum time to wait (minutes) must be included. For Example:

  #WAITZENDIST 40, 30

  This will wait until the target is within 40 degrees of the zenith for up to 30 minutes.

- #WAITAIRMASS - Pause until the target is at or below the given air mass. If the target will never get within the given air mass, or won't Get there within the time limit, it is skipped. A maximum time to wait (minutes) must be included. For example:

  #WAITAIRMASS 2.5, 30

  This will wait until the target is at or below 2.5 air masses for up to 30 minutes.

- #TAG - Adds a named tag to the target. This directive does not affect the image acquisition process; it simply attaches the tag name and value to the target. You can specify as many of these as you want (each with different names) for any target. The tag name(s) and value(s) will be echoed to the run log, but this is most useful when you have custom actions defined for TargetStart and TargetEnd. These custom actions are passed a Target object as a parameter. Within the custom action, you can refer to tags by their name (as you defined them) with the syntax Target.Tags.name. Thus, you can use tags to alter the action of TargetStart and TargetEnd based on the tags' value(s). This is an expert feature and allows powerful custom logic to be implemented. The syntax is #TAG name=value. There must be an '=' in the #TAG directive. For example:

  #TAG type=reference star

  This will attach a tag "type" with the value "reference star" to the target.

- #COUNT - Used only when specifying a filter group. For example: #Count 5,10,5,15

- #INTERVAL - Set the final target exposure interval(s) for subsequent targets (sec.). For example:

  #INTERVAL 31.5

  #INTERVAL 180,240,180,180

- #FILTER - Set the filter(s) for subsequent targets. If the filter name is not recognized, an error is logged at plan start, and the plan will not run. For example:

  #FILTER Blue

  #FILTER Red,Clear,Green,Blue

- #BINNING - Sets the binning factor(s) for subsequent targets. Note that some detectors don't support arbitrary binning values. Consult the documentation for your detector for specifics. Note: for auto-calibration, of the binned size must be available in MaxIm's calibration groups. For example:

  #BINNING 4

  #BINNING 2,1,2,2

- #SUBFRAME - Sets the fraction of the chip to be used for subsequent images. Legal values are 0.1 to 1.0 (full frame). For example, if the chip is 1K by 1K (1024 by 1024), a SUBFRAME of 0.5 will result in using the center 512 by 512 pixels of the chip. For example: #SUBFRAME 0.5

- #DITHER - Offset each image in a repeat-set by some small amount away from the original target location. Works for both guided and unguided images. If no parameter is given, ACP uses a value of 5 main imager pixels for dithering (see below). Normally, this value will be appropriate for achieving the noise reduction effect of dithering. Dithering is done by generating two uniform random numbers ranging from minus to plus the "amount". One is applied in the X direction, the other in the Y direction. Note that you must supply a value for the guider's plate scale in order for ACP to calculate main imager pixels for guided dithering. If you fail to do this, a warning message will appear in your run log and dithering will be in guider pixels.

  If given, the parameter specifies the maximum amount in each axis of this offset in fractional pixels. A parameter value of 0 disables dithering. The random offsets are applied independently in X and Y and are always relative to the initial position. For example:

  #DITHER ; Automatic dithering

  #DITHER 3.0 ; 3 pixels dither on the image

  #DITHER 0 ; Disable dithering

- #DIR - Temporarily change the directory into which all subsequent images are to be stored. This can be a relative or full (with a drive letter) directory path, with multiple levels. If relative, the folder is relative to the default image folder as configured in the Local User tab of ACP Preferences (or for web users, their images folder). The folder, including all intermediate levels, is created if needed. For example:

  #DIR C:\Special\Comet Search\28-Sep-2003 (absolute)

  #DIR Photometric Standards\Landolt (relative)

  If no folder name is given, this will switch back to the default image folder as configured in the Local User tab of ACP Preferences (or for web users, their images folder) plus the usual date-based subfolder. For example:

  #DIR ; Restore default image folder

- #TRACKON - Initiates orbital tracking of solar system bodies. This remains in effect until cancelled by #TRACKOFF. Orbital tracking will not be done except for solar system bodies, so non-solar-system targets may be intermixed without harm. Autoguiding will not be done if orbital tracking is active. Note that orbital tracking requires orbital elements as the target specification (major planet targets will also be tracked). For example: #TRACKON

- #TRACKOFF - Cancels orbital tracking. This remains in effect until re-enabled with #TRACKON. For example: #TRACKOFF

- #READOUTMODE - Selects the imager's readout mode for the current target and all subsequent targets. The imager must support readout modes, and the name you give must be supported by your imager. You can see which readout modes (if any) are supported by looking on the MaxIm DL CCD control window's "Expose" tab. Pointing exposures will always use Fast or Normal, so this will not impact pointing update times. For example: #READOUTMODE 8 MPPS (RBI Flood)

- #DEFOCUS - Moves the focuser the given number of integer steps away from proper focus just before acquiring each subsequent image. The focus position is restored immediately after acquiring the image, but this directive does carry from target to target, so unless changed, the focus will be moved away from proper focus before each subsequent image. This does not affect pointing images. For example: #DEFOCUS -150

- #SETS - Repeat the entire plan a given number of times. The images are acquired in round-robin order. This directive may appear anywhere in the plan. If it appears more than once, the last value is used for the plan. The default is a single set. For example: #SETS 3

- #AFINTERVAL - Turns on periodic autofocus and forces an autofocus at the start (or resumption) of the plan. The interval is given in minutes. If an #AUTOFOCUS directive is seen, it overrides a scheduled autofocus, and the time to the next autofocus is reset to the interval. This directive may appear anywhere in the plan, and the value given in the last appearance will be used for the entire plan. For example, to start the plan with an autofocus, then do an autofocus every 30 minutes: #AFINTERVAL 30

- #ALWAYSSOLVE - Normally, when ACP fails to solve a final/data image in a series (the same target/filter/etc.), it will not try to solve again for that series. This prevents wasting time waiting for plate solves that will probably fail (again). If you want to override this behavior and force ACP to attempt solving every final/data image, include this directive anywhere in your plan. For example: #ALWAYSSOLVE

- #DUSKFLATS - The plan starts by acquiring a series of automatic sky flats at dusk via the AutoFlat.vbs script (which is run under control of AcquireImages.js). See #DAWNFLATS below, and Using Automatic Sky Flats. If no argument is supplied, there must be a default flat plan named defaultduskflat.txt or just defaultflat.txt in the Local User's default plans folder or AcquireImages will not try to start AutoFlat. This avoids AutoFlat stalling waiting for flat plan input. If an argument is supplied it can be either a full path to a flat plan, or just a flat plan file name. If just the flat plan file name is given, it is assumed to be in your default Plans folder. For example:

  #DUSKFLATS ;Need standard flat plan defaultflat.txt in user's default plans folder

  #DUSKFLATS 20060122-dusk-flats.txt ; In user's default plans folder

  #DUSKFLATS C:\MasterCalibration\LRGB-Standard-Flats.txt

- #MISETTIME - The minimum amount of time that a set is allowed to take. This can be used to limit the number of sets per unit time. For example: #MINSETTIME 00:05 will tell ACP to wait until at least 5 minutes has elapsed before starting the next set.

- #QUITAT - Set a "quitting time" at which the plan will stop acquiring images. The quitting date/time is in UTC, and is interpreted the same as for #WAITUNTIL. If you specify #DAWNFLATS, #CHAIN, or #CHAINSCRIPT, these actions will still occur after the plan ends. For example: #QUITAT 7/1/01 08:22

  If the plan completes before the quit date/time is reached, it ends as usual. If only a time is given, it will always wait until the given time, even if it was just passed (it will wait till it is that time again).

- #SHUTDOWNAT - Same as #QUITAT, except the scope is parked and the camera is shut down at the quitting time, or at normal exit. The shutdown time is in UTC, and is interpreted the same as for #WAITUNTIL. For example:

  #SHUTDOWNAT 7/1/06 08:22

  If the plan completes before the shutdown date/time is reached, it acts as though a #SHUTDOWN directive was given instead. If only a time is given, it will always wait until the given time, even if it was just passed.

- #SHUTDOWN - At the end of the run, parks the scope and shuts down the camera and cooler. If dome control is active, and if the "Automatically park or home and close AFTER the scope is parked" option is set, then the dome will be parked or homed and the shutter or roll-off roof will be closed. This may be used with #DAWNFLATS, and shutdown will occur after dawn flats have been taken. For example: #SHUTDOWN

- #STARTSETNUM - The starting set number used in naming image files. Do not include this in your plans, it is automatically inserted in all plans by AcquireImages.js. Each time the plan runs to completion, this number is incremented by the number of sets specified in #SETS or by 1. Its main use is to prevent overwriting of images when the same plan is run multiple times. For example: #STARTSETNUM 6

- #COMPLETIONSTATE - The number of sets, targets in the current set, repeats in the current target, filter groups in the current repeat, and images in the current filter group, that have been completed. Do not include this in your plans, it is automatically inserted in all plans by AcquireImages.js each time a target is completed, then removed if and when the plan runs to completion (at which time #STARTSETNUM is adjusted as described above). Its main use is to allow an interrupted plan to resume at the point where the interruption occurred. For example: #COMPLETIONSTATE 2,4,1,3,1

- #DARK - Acquire a dark or bias frame using the current target exposure interval. If you set #INTERVAL to 0 before using #DARK, ACP will acquire a bias frame, and the file naming will be adjusted. It is recommended, however, to use the #BIAS directive described below. You can use the #REPEAT directive to acquire multiple darks or biases. Multiple darks/biases will be sequence numbered as well as carrying the current #SET number, similar to file naming for light images (except no filter name is included of course). For example: #DARK

- #BIAS - Acquire a bias frame using the current target exposure interval. You can use the #REPEAT directive to acquire multiple biases. Multiple biases will be sequence numbered as well as carrying the current #SET number, similar to file naming for light images (except no filter name is included of course). For example: #BIAS

- #MANUAL - Acquire an image at the current telescope location. No pointing updates or slews will be done. This is actually a type of target, so don't include a target line. Include an object name. For example: #MANUAL MyImage

  If you don't include an object name, the current date/Time will be used. For example: #MANUAL

- #CHILL - If needed, turns on the imager's cooler and waits for 5 seconds. In any case, the imager's temperature setpoint is changed to the given temperature (deg. C). After the change, #chill waits for up to 15 minutes for the cooler to reach a temperature within the given tolerance (or 2 degrees, default) of the setpoint. This is actually a type of target, so you can wait before it, have the imager cooled, then wait again so that imaging starts later. If the cooler does not reach the given temperature and tolerance, the plan fails with an error. For example:

  #CHILL -35.0

  #CHILL -32.5, 0.2

- #DOMEOPEN - Opens the shutter or roll-off roof, and waits until the shutter or roof is actually open. Will un-home or un-park the dome if needed. Effective only during the first or only set-loop of the plan. This is actually a type of target, so you can wait before it, have the shutter or roof opened, then wait again so that imaging starts later. For example: #DOMEOPEN

- #DOMECLOSE - Closes the shutter or roll-off roof, and waits until the shutter or roof is actually closed. Effective only during the last or only set-loop of the plan. For example: #DOMECLOSE

- #DAWNFLATS - When encfountered during the last (or only) set, immediately stops reading image acquisition lines from the current observing plan file, terminates AcquireImages.js, and starts ACP's automatic sky-flat script AutoFlat.vbs. If AcquireImages fails or is aborted, the auto-flats will not occur.

See #DUSKFLATS above, and Using Automatic Sky Flats. If no argument is supplied, there must be a default flat plan named defaultdawnflat.txt or just defaultflat.txt in the Local User's default plans folder or AcquireImages will not try to start AutoFlat. This avoids AutoFlat stalling waiting for flat plan input. If an argument is supplied it can be either a full path to a flat plan, or just a flat plan file name. If just the flat plan file name is given, it is assumed to be in your default Plans folder. For example:

#DAWNFLATS ;Need standard flat plan defaultflat.txt in user's default plans folder

#DAWNFLATS 20060122-dawn-flats.txt ; In user's default plans folder

#DAWNFLATS C:\MasterCalibration\LRGB-Standard-Flats.txt

6. TROUBLESHOOTING

1. Initial Plate Solve Fails
   (a) The Log window will report a message that the RA/DEC centering is off, this is typically NOT the case.
   (b) Causes
      i. Clouds - check to see if the telescope is looking at clouds using the APO IRSC webpage.
      ii. In rare circumstances the telescope may be lost.
   (c) Solutions
      i. Try slewing to a standard field with many stars.
      ii. Use a script that images a 5th or brighter star making sure to include the commands #NOPOINTING, #NOSOLVE and do not autofocus.
      iii. Check with the 3.5m Observing Specialist about more in-depth troubleshooting. Observing Specialist see Section 8.8.11.
2. Final Plate Solve Fails
   (a) Too few stars in field - this is often seen on FlareCam due to the narrower field.
   (b) This error will not affect observations and can be ignored.
   (c) In scripting mode this can be bypassed by using #NOSOLVE.
3. Autofocus taking a long time
   (a) The autofocus should take 60-90 seconds to run. It could take up to 3 minutes.
   (b) If after 5 minutes the system is not responding check to make sure the web server is still active. To do this hit the refresh button on your browser. If ACP comes back then the telescope is still working.
   (c) If after 8 minutes there is still no solution. Contact the 3.5m Observing Specialist so they can look at the current telescope activity on the TCS. Observing Specialist see Section 8.8.11.
4. Dome Troubleshooting
   (a) If the dome reports an un-availability failure, a common correction is to slew to a different position. This is typically caused by a temporary loss of communications between the controller on the fixed portion of the dome and the controller on the rotation portion of the dome.
   (b) If there is a dome failure report the azimuth position in the night log.

7. NIGHT LOG

A night log should be sent after the end of each observing run. The night log is an internet form that can be found by the following three methods: navigating through the ARCSAT section of the main APO web page, using the link found in ACP under **My Documents** → **Create Night Log**, or at the following address, http://www.apo.nmsu.edu/Telescopes/ARCSAT/ObservingAids/index.html.

1. Enter your program ID, this will typically be some such as AS01 or AS06.
2. Enter the UTC time that the dome is opened (and closed at the end of the night).
3. Enter the PI Name that is listed on the proposal.
4. Enter email address.
5. Enter the names of all involved in taking observations.
6. Fill in the drop downs and text input for the night of observations. The day should be the same date as the afternoon that observations start.
7. Select the camera in use from the instrument drop down.
8. The activity log is the free form section for adding any comments about thats night observations. It should include an overview of observing that night as well as a detailed description of any problems.
9. Fill out the focus log throughout the night
   (a) Instabilities in communications prevent the focus log from being printed in the run log of the web interface.
   (b) Focus information should be taken from the pointing update immediately after the autofocus routine.
   (c) Figure 24 is an example of the information needed.
   (d) Make sure that "FocusMax auto-focus successful!".
   (e) Start by entering the **Time** across from the successful autofocus text. In the case of figure 24 this would be 03:17:52.
   (f) Next enter the focus position. In figure 24 this would be 10322.
   (g) Look in the ACP window, below **Telescope** for the **RA**, **DEC**, and **airmass** (AM). This information can be obtained during the focus routine.
   (h) Use the **Weather** window and record the **Temperature**.
   (i) Enter the filter used for focusing. This will typically be SDSS g.
   (j) Enter the FWHM from the pointing information in the log window. In figure 24 this would be 4.1 (as found on the line at time 03:18:45).
10. The final text box is weather information. Go the the provided link (at the beginning of the night) and use a time interval of 60 minutes. Copy and paste the weather information into the Night Log text box.
11. When done observing click **Email nightlog**. That will automatically email the form to the 05m-obs@apo.nmsu.edu email list. If you would like to be subscribed to this list go to the main APO web page then to **Mailing lists (Maintained by APO)**. Click on 05m-obs and fill out the form.
12. To view previous night logs without subscribing, go to the subscription page and instead of filling out the form go to **05m-obs Archives** (lowers the top of the page).

Figure 24. Focus Information from Log

```
03:16:17   Starting Autofocus...
03:17:52   FocusMax auto-focus successful!
03:17:52     HFD = 8.43
03:17:52     Focus position = 10322
03:17:52   Slewing back to original position...
03:17:52   Start slew to AF return...
03:18:03   Autofocus finished.
03:18:08   (no slew, scope already within max error of target)
03:18:08   (doing post-focus pointing update...)
03:18:08   Updating pointing...
03:18:08   Switching from sdss_r to sdss_g filter for pointing exposure
03:18:08   No focus change required
03:18:12   (taking 10 sec. exposure, sdss_g filter, binning = 4)
03:18:12   (using Monochrome readout mode)
03:18:12   (starting exposure)
03:18:40   (exposure complete and image downloaded)
03:18:41   Image finished
03:18:42   Plate-solve pointing image.
03:18:42   242 image stars found
03:18:42   283 catalog stars found
03:18:43   Solved! 83 stars matched.
03:18:43   Average residual is 0.4 arcsec.
03:18:43   Pointing error is 5.925 arcmin @ angle 293.39
03:18:43   True focal length is 4007.0 mm.
03:18:43   True binned plate scales (arcsec/pix): H = 1.85 V = 1.85
03:18:43   True image center (J2000): 08h 46m 24.6s   06° 27' 28.72"
03:18:45   Imager sky position angle is 359.8 deg.
03:18:45   Image FWHM is 4.1 arcsec (2.22 pixels)
03:18:45   [sync] pointing model updated
03:18:45   Re-slew to target.
```

8. ENGINEERING

8.1 Computer Restart

The startup sequence of the system is very specific but not difficult.

1. Disconnect Telescope and Camera in ACP Console (it may complain about ASCOM objects being connected, click ok)
2. Close down arcsatExtras.py python management script by pressing the X in the upper right of the windows shell
3. Close down FocusMax (it may complain about ASCOM objects being connected, click ok)
4. Close down MaximDL (it may complain about ASCOM objects being connected, click ok)
5. Close down ACP
6. Close down TCS (it may complain about ASCOM objects being connected, click ok)
7. Restart the computer by going to the Windows Start button in the lower left then click on the arrow next to shutdown (do not click shutdown) and click restart
8. Wait about two minutes for the computer to restart
9. Reconnect with VNC
10. Log into Windows 7 with the DFM Engineering account
11. A window will popup asking for a password to add to the PuTTY Agent.
12. Start the arcsatExtras.py python management script by double clicking on arcsatExtras.py, located on the desktop.
13. Double Click on the DFMTCS icon on the desktop and wait till the autofocus initialization is complete (about one minute). In the lower right of the DFMTCS window is an **Activity Message** section. While the focus is home it will display **Finding Focus Fiducial**. When complete it will display **Focus Initialization is Done**.
14. Double click on the MaximDL icon on the Desktop
    (a) go to View → Camera Control Window
    (b) in the Camera Control Window go to the Setup tab
    (c) click Connect
    (d) under Camera 1 turn on the cooler and set the temperature to -30C
15. Double click the FocusMax icon on the Desktop
16. If ACP does not automatically open then double click the ACP icon on the Desktop
17. Start the python ancillary scripts. Icons are located on the left hand side of the desktop.
18. Double click **telPos4irsc** to start the IRSC position reporting program.
19. Double click **domeShutter** to start the weather page dome status reporting program.
20. Using the web interface take a dome flat to verify basic operations

8.2 Verify Pointing

1. The best method for verifying pointing is to slew to a bright star near zenith.
2. Go to http://www.apo.nmsu.edu/arc35m/StandardStars_ARC35m.html and find a bright star near the current LST. Verify the coordinates for J2000.0 using Simbad.
3. VNC into ARCSAT-TCS and use the ACP console to slew to the coordinates. Tracking should automatically start after the slew.
4. Manually take an image in MaximDL using the Camera Control Window.
5. These stars only need 0.5 second exposures and are very useful when centering up the pointing, see the following section.
6. If the star falls on the center of the CCD then pointing is good.
7. If the star falls on a center 1/3 of the chip it is ok and should be up to the users discretion if they want to correct.
8. If the star is not on the CCD then try a 10 second exposure. If you can see the glow from the star then use the ACP console to nudge the telescope towards the star.
9. If no star can be found then proceed to section 8.8.3.

8.3 Set Zenith Position

1. Make sure the Track switch on the MDC is off but the Halt Motors button is out
2. Using the set and slew buttons, located on the hand paddle, center the bubble in the middle of the level. There are two bubble levels located on the back of the PMS. One bubble level is for E-W level the other is for N-S level. Use the slew button to get the telescope close, then use the set button to get the bubbles as close to center as possible. The bubbles have a long settle time (near 30 seconds when close to level).
3. In the TCS window go to Telescope → Initialization and click on the Telescope Position tab
4. Declination should be 32:46:49
5. Right Ascension should be synced with the current LST
6. To sync the RA set the value to something 10 seconds ahead of the current LST, when that LST is reached click Apply in the Initialization window.
7. Close the Initialization window
8. Chances are it should be checked on-sky
   (a) setup SurveyCam on the telescope so that the field is large enough to easily find position (remember to set CCD orientation)
   (b) slew to known field (Bright Star Catalog + Simbad + Aladin are your friends)
   (c) VNC into ARCSAT TCS
   (d) use the ACP nudge window and Maxim DL interface to center star
   (e) set position to star coordinates in TCS window (Telescope → Initialization → Telescope Position)

8.4 FocusMax Usage

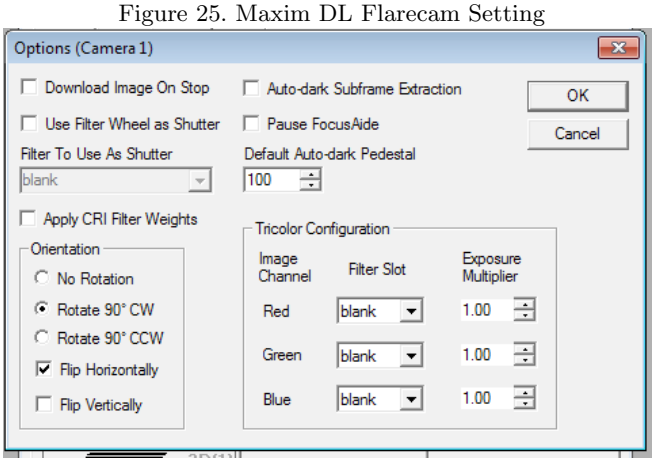
1. V Curve - Calibrating focus solution
   (a) If something drastic changes to the system then the focus convergence parameters may need to be re-calibrated.
   (b) Use the TCS to slew to standard star.
   (c) In FocusMax go to the Vcurve tab.
   (d) Enter realistic parameters, figure 29(a).
   (e) Click run.
   (f) Repeat on several different fields.

8.5 Maxim DL Settings

1. SurveyCam
   (a) Set CCD orientation
      i. Open Camera Control Window by going to View → Camera Control Window or using the keyboard shortcut, Ctrl+W.
      ii. In the Camera Control Window go to the Setup tab.
      iii. under Camera 1 sub window go to Options
      iv. under orientation set Rotate 90° CCW making sure Flip Horizontally and Flip Vertically are unchecked.

2. FlareCam
   (a) The camera should be mounted such that the usb and power ports are facing south when the telescope is at zenith
   (b) In this camera orientation the CCD is flipped 180 degrees from SurveyCam
   (c) Set CCD orientation, figure 25
      i. Open Camera Control Window by going to View → Camera Control Window or using the keyboard shortcut, Ctrl+W.
      ii. In the Camera Control Window go to the Setup tab.
      iii. under Camera 1 sub window go to Options
      iv. under orientation set Rotate 90° CW and check Flip Horizontally

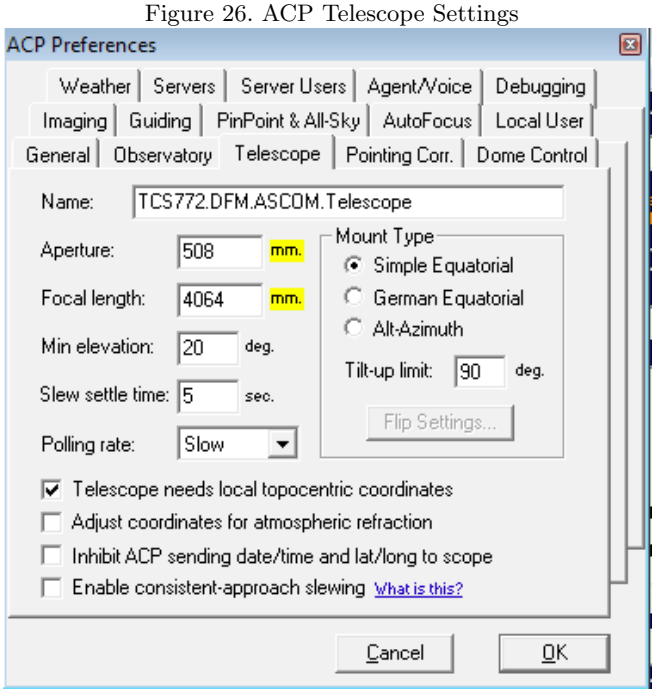
Figure 25. Maxim DL Flarecam Setting



8.6 ACP Settings

1. ACP preference → Telescope tab checked Telescope needs local topocentric coordinates and display epoch needs to be current
2. Telescope configuration should be set to an aperture of 504mm and a focal length of 4010mm.
3. Config Files
   (a) Most configuration files are located at C:\Users\Public\Documents\ACP Config\ or C:\ProgramFiles\ACP Obs Control\
   (b) files in the ACP Config folder include: AutoFlatConfig.txt and FilterInfo.txt
   (c) files in the ACP Obs Control folder are: weather safety script, ACP-Weather.vbs and when created the a shutdown and/or startup script.

Figure 26. ACP Telescope Settings

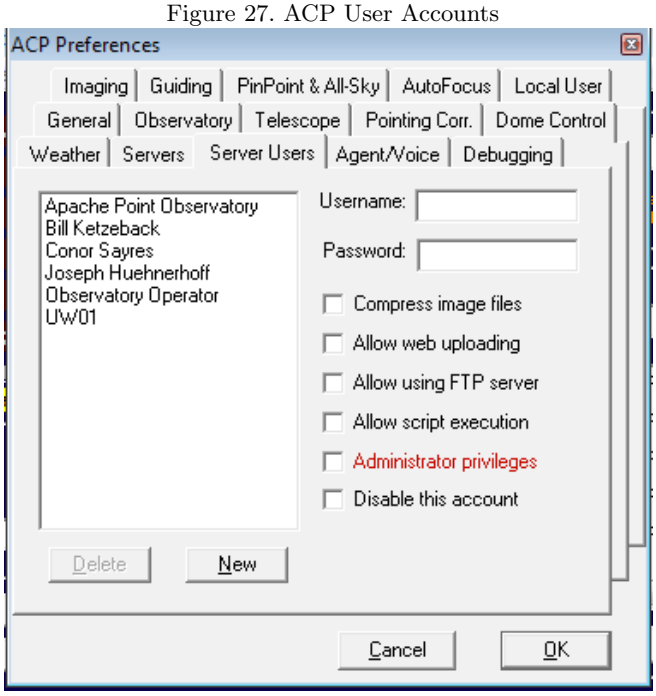


4. User Accounts
   (a) Go to ACP → Preferences... → Server Users (figure 27)
   (b) To edit a current user account, click on the user name and change the desired field to the right
   (c) To add a user click new and enter the information in the popup window
   (d) Admin users have rights that allow them to disconnect and reconnect devices, regular users cannot

8.7 Python Scripts

(a) Located on ARCSAT-TCS
   i. Scripts are located in C:\Users\Public\Documents\ACP Web Data\Doc Root\file\
   ii. Webcam Polling (webcamPoll.py)
      A. The webcams are polled every 10 seconds and placed into a folder C:\Users\Public\Documents\ACP Web Data\Doc Root\webcam\

Figure 27. ACP User Accounts



B. To start the program double-click on the program name. A windows command shell will open and start reporting the time stamp for when the image was taken.

iii. Weather Polling (weather.py)

A. The weather script polls the wxhost for current site weather information.

B. This information is edited then written to a file, weather.txt, in the Boltwood Weather Station format.

C. Cloud condition is determined based off the IRSC sigma value. If sigma is less than 15 then it is clear, less than 75 and it is 50% cloudy, greater than 75 and it is 100% cloudy.

D. A config.dat file is used to tell the weather system if the 2.5m should be bypassed or if it should look at the 2.5m

E. commented lines are start with ;

F. The first uncommented line is the bypass line. Changing the second parameter to yes will bypass the 3.5m status and show the 3.5m as open in the ACP software. Leaving the second parameter as no will cause ARCSAT to follow the 3.5m enclosure status.

G. The second uncommented line which telescope to look at for status. This can be either 25m or 35m with the default being 35m.

H. To start the program double-click on the program name. A windows command terminal will open and displays the output being sent to the weather.log file.

8.8 Located (run from) on arc-gateway

i. run these scripts from the **arc** account on arc-gateway

ii. Louvre Control

A. The louvres can be controlled through the command line on arc-gateway.

B. **arcsatLouvres [open | close | status]**

iii. Desk Lamp Control

A. A desk lamp has been added to the ethernet AC switch in the ARCSAT dome. This lamp is for checking dome position through the telescope web camera.

B. The lamp can be controlled through the command line on arc-gateway.

C. **arcsatDeskLamp [on | off | status]**

D. This lamp can be used to provide additional light in the dome for narrowband flats. Scatter and light leaks may be a problem and have not been tested.

iv. Dome Shutter Bypass

A. The dome shutter is designed to only allow opening when one of the other telescopes are open. For special programs this safety can be bypassed through the command line on Newton.

B. Login using the **arc** account on arc-gateway

C. Usage is shown by typing **arcsatBypass**

D. **arcsatBypass state resettime**

E. example: **arcsatBypass on 90** will turn the bypass on for 90 minutes.

F. Do not close the terminal window while the program is running

G. The bypass can be manually turned off by typing **arcsatBypass off**

8.9 Camera Swap Procedure

(a) Warm up camera through ACP interface.

(b) Disconnect the Imager in the ACP interface.

(c) Close FocusMax.

(d) After camera has reached 0C, disconnect power and usb.

(e) Unbolt the camera from the back of the filter wheel box. There are 6 x 10-32 screws holding on the camera plate. After unbolting the camera pull straight down to disengage the locator pin, there will be some friction but pulling steady will separate the camera plate from the filter wheel plate.

(f) Install the desired camera by aligning the locator pin and the central axis of the plate along the optical axis. Push up until locator pin is engaged. Tighten down bolts.

(g) Plug in USB.

(h) Plug in power cable. The power plugs for FlareCam and SurveyCam are different. Verify the correct power supply is plugged into the appropriate camera (SurveyCam power supply is rated for higher current).

(i) Connect camera in MaximDl, set the orientation, and desired temperature.

(j) Connect camera through ACP software.

(k) Change camera name in ACP Preferences → Imaging tab. SurveyCam should be called **surveycam** and FlareCam should be called **flarecam**.

(l) Start FocusMax. If FocusMax is properly connected it will update the telescope position within 10 seconds.

(m) Verify camera installation by taking some dome flats. Dome flats test both the telescope and camera interface.

8.10 Filter Change Procedure

(a) The filter box is located above the camera and is the curved black aluminum piece that protrudes from the side. This is attached to the side plate through some sliders.

(b) Telescope should be at zenith.

(c) Disconnect camera from MaximDL.

(d) Disconnect the circular power connector by twisting. Un-plug the USB cable located next to the circular connector. Do not disconnect any cables on the camera.

(e) Remove the two 1/4-20 screws that hold on the side plate, using a 3/16" allen wrench. The side plate will not fall if the telescope is at zenith. Set bolts aside.

(f) Pull side plate straight away from box. It is ok to use the filter wheel housing as a pull point. The sliders have a friction release. When near end of travel pull with more force until the slide pulls from the rail. Be careful not to drop the filter wheel while performing this process.

(g) Set filter wheel on flat surface.

(h) Rotate filters by hand, or by using a small allen wrench to push on aluminum. Do not touch or push on filters. The filter wheel will only move in one direction.

(i) When the proper filter location is located remove the two allen screws holding down the retainer that presses against the filter.

(j) Tilt the filter out using a gloved finger. When possible grab filter by sides and place in filter box.

(k) Install new filter by gently sliding into filter wheel.

(l) Set retainer on top of filter.

(m) Screw down retainer. The screws do not need to bottom out. They should have tension on the retainer without the retainer bending upwards.

(n) Move the filter wheel by hand to verify that no screws are in contact with either the top or bottom surface.

(o) No filters, retainers, or screws should stick more than 1mm above the filter wheel plate.

(p) Align filter wheel slides with rails.

(q) Push filter wheel into box.

(r) Tighten down 1/4-20 screws so that plate is secure.

(s) Plug in USB.

(t) Plug in circular power cable. Listen for the detent to click as the filter wheel moves around. If it does not stop clicking after 20 then there is circuit board damage. Disconnect power and contact Bill.

(u) Go to MaximDL Camera Control Window. In the Setup tab go to **Setup Filter**. Enter the filter name in the proper location. Names should not have spaces or odd characters. These names are used in the image name and headers.

(v) Press **Connect** and start the camera cooling.

(w) As a safe measure take a dome flat sequence. If there are any problems with the filter wheel or camera this will fail.

8.11 In-Depth Troubleshooting

(a) Long focus time

  i. This is most likely due to the program not being able to detect the star.

  ii. Logon to the TCS and look at the raw images.

  iii. Are the stars donuts?

    A. Then the focus could not converge and ran away.

    B. Use **Jog** button in FocusMax to set the focus to **10400**.

    C. rerun focus on a 6th - 9th magnitude star.

  iv. Error Messages

    A. There are times when it might be a communication problem between MaximDL and FocusMax.

    B. Look at the FocusMax log window. If you see an error like figure 28 then record the error and email to Bill.

    C. After sending message to Bill try disconnecting the telescope and camera in ACP. Then close down FocusMax and MaximDL. Bring MaximDL up first, followed by FocusMax. Then reconnect the telescope and camera in ACP. Try to take a focus sequence through ACP.

    D. If this fails to work then restart the computer.

Figure 28. FocusMax Error

```
** Beginning Focus Run **
23:34:28  FocusMax Version: 3.8.0.10
23:34:28  System: MySystem
23:34:28  Camera: Apogee USB/Net
23:34:28  LS: -0.194305 RS: 0.193738 PID: 5.54
23:34:28  Min/Max flux setting = 50/700K
23:34:28  Min/Max exp. setting = 0.10/20.00
23:34:28  Flux target = 187083
23:34:28  Using arithmetic mean
23:34:28  Move direction: In
23:34:28  Filter = sdss_g (slot 3)
23:34:28  Current position = 10297
23:34:28  NearFocus HFD: 12
23:34:28  Focus Start: 10352
23:34:33  Find star binning = 1x1
23:34:33  Initial exposure = 10
23:34:33  Exposure Aborted
23:34:33  MaxIm DL 5 Error 2: Unknown Error
Module modComponents sub TakePicture
23:34:33  Halting - error in module getTargetStar
23:34:33  Could not get CCDImage
23:34:33  Can not measure HFD for this image
23:34:33  Moving to previous focus position of 10298
```

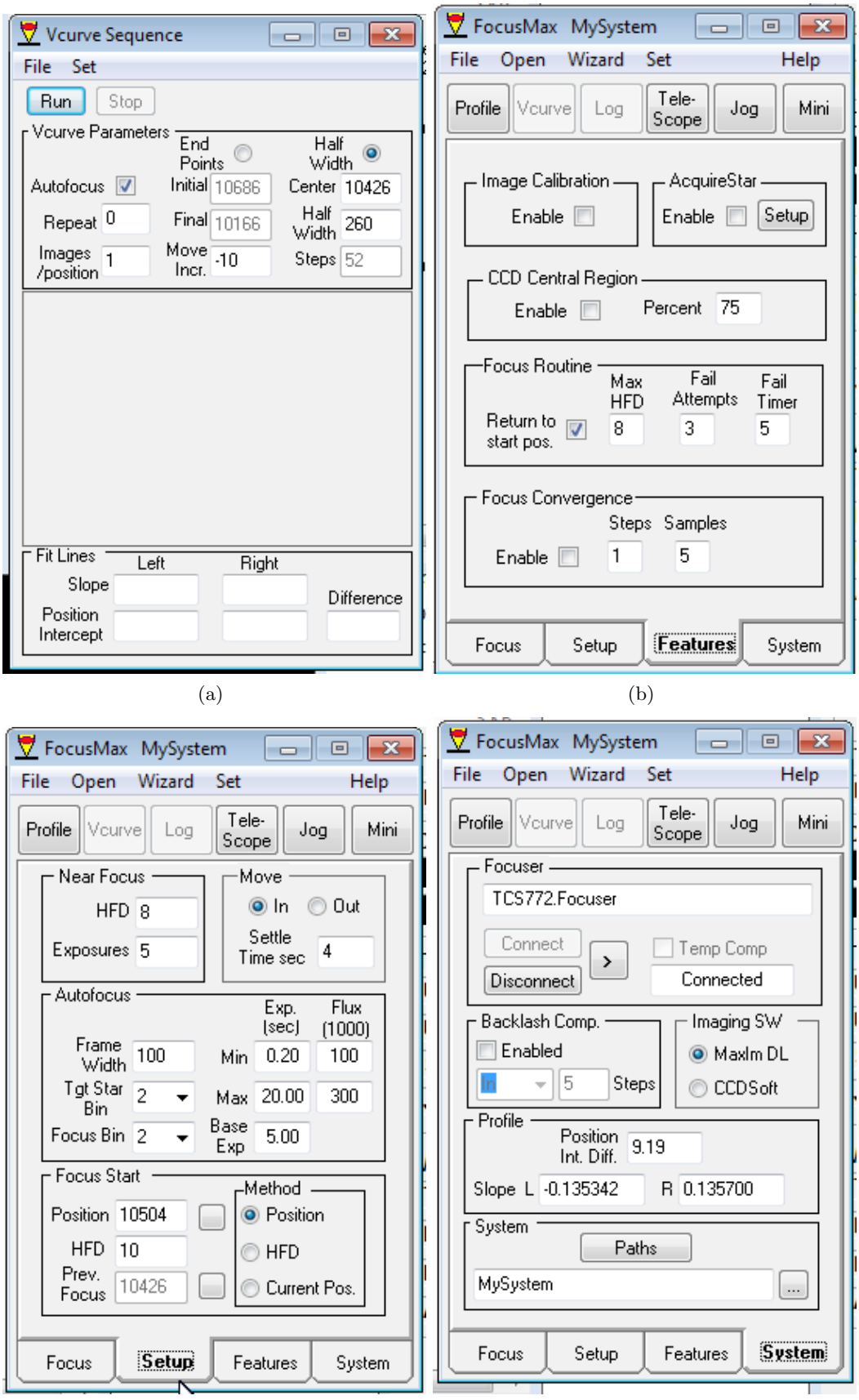
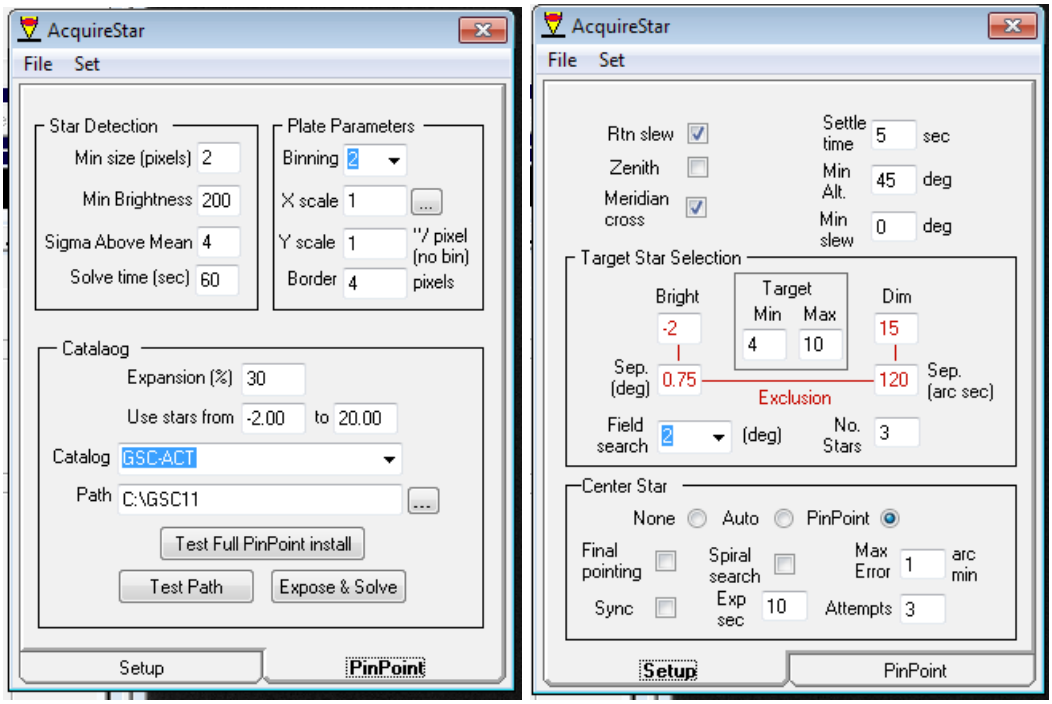


Figure 29. FocusMax Settings



(a) (b)

Figure 30. FocusMax Settings