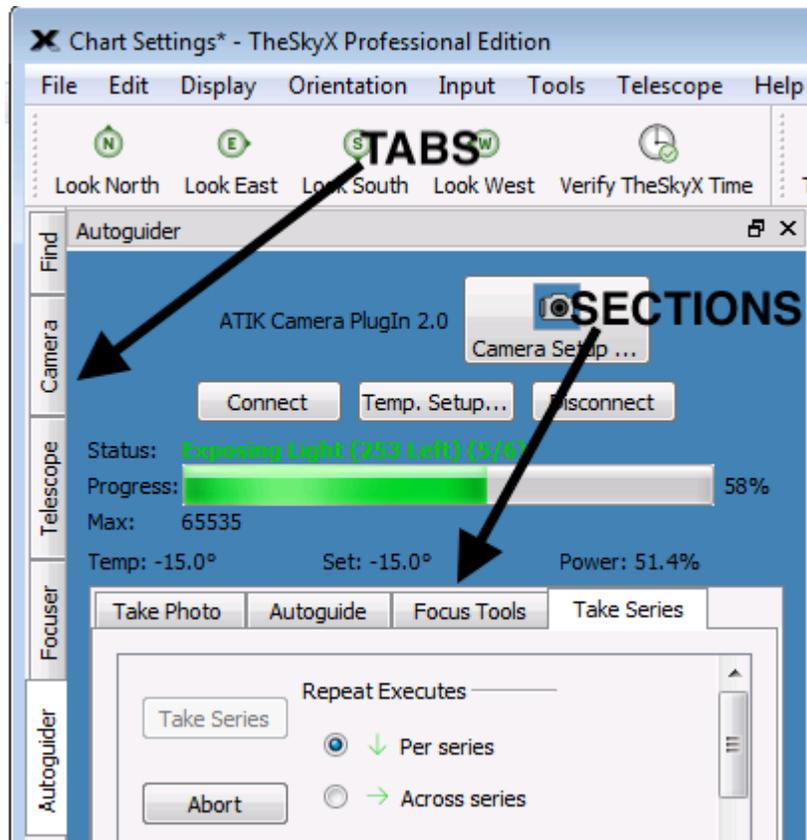


# TheSkyX User Manual

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For clarity, we will refer to the buttons on the left side as TABS and the buttons within each tab as SECTIONS.

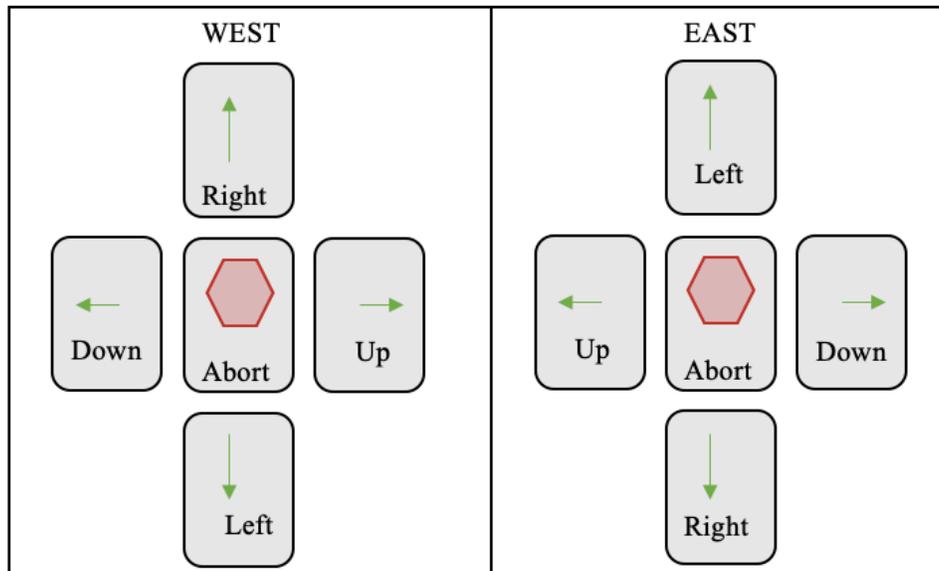


## 1) Finding a Focus star

- a) In *Find tab* type in target star, slew to that star and click center button. Zoom in until you can pick a focus star
- b) Pick a star somewhat close to the target and slew to this star. A star with magnitude between 4 and 6 is easy to work with.
- c) In the *Camera tab* under Focus section set exposure to around 0.1 seconds. Click @Focus2 button, then click Graph button. This will display three graphs, we are looking at the HFD vs Position graph
  - i) This desired graph should resemble a symmetric V shape of points on graph
  - ii) If error message appears and it cannot focus, go to the *Focuser tab* and manually change position. If points form a positively sloped line, the telescope needs to be position further left at a higher number. If points form a negatively sloped line, then telescope needs to be moved more to the right (decreased) at a lower number.

- d) In the *Focuser tab*, type in new position into Move To in order to keep track of change in position. The focuser automatically adjusts to this new number it calculated but it is nice to keep track of the previous place it was.
  - e) Repeat steps c. through d. until symmetrical V shape appears on graph
- 2) **Go to target and confirm that it is correct.**
- a) In *Find tab* find target star. Slew to this star.
  - b) Press Closed Loop Slew button. This will take a photo of target star and then center star in frame. Zoom in far enough to see the star pattern (white box) surrounding the target star. This will allow you to confirm that this is the target star.
  - c) You can identify that this is your star visually with your eyes or get SkyX to do the work for you: On the photo of star, check the crosshairs box to see the center of the frame. Then on the photo, press the photo drop down button. Click image link. On the separate image link tab, press the Astronomic Solution button. Your star field will shift to match the perspective of the photo. Now you can match the objects in the photo to the star field and confirm target.
- 3) **Slit alignment**
- a) In the *Camera tab*, under the Focus Tools section
  - b) Check the Take Photos Continuously box and set Exposure Time to 1-3 seconds and Exposure Delay to 0.
  - c) Take a photo. If slit is hard to see, increase exposure time.
  - d) The star needs to be centered on the slit and vertical crosshair line. The slit will appear to be a darker line above the crosshairs. Go to the *Telescope tab* under Jog section
  - e) Change distance to 5 arcseconds. The picture is 10 arcminutes wide so adjust distance as necessary to center. Depending on the orientation of the star (East or West of the midline), the movement will correspond to the keys below:

**Imaging in the Northern Hemisphere**



- 4) **Calibration and Flats**

- a) If you do not have a calibration and flat light controller, turn on the calibration and flat lights manually.
- b) For this manual, we are using an Arduino based controller.

Arduino Command window:  
COM7 (Arduino/Genuino Uno)

Arduino Command	Function
c	Turns on the calibration light
d	Turns off the calibration light
f	Turns on the flat light
g	Turns off the flat light

- c) For Calibration:
  - i) In the Arduino, type 'c' into the command prompt or manually turn on the calibration light. Your photo should turn white.
  - ii) In the *Autoguider tab*, under the take photo section change the exposure time to 0.1 seconds, check the 'Automatically save photos' box and click Autosave.
  - iii) In the new window that pops up, change the title to cal, sequence to 1, and for location, create a new folder (month-day-year-target).
  - iv) Take 2 calibration photos by clicking Take Photo
  - v) In the Arduino, type 'd' or manually turn off the calibration light. Wait for the photo to return to normal.
- d) For Flats:
  - i) In the Arduino, type 'f' to turn on the flat light or manually turn on your flat light. Once again, your photo should be white.
  - ii) In the *Autoguider tab*, under the take photo section, change the exposure time to 10 seconds and click Autosave.
  - iii) In the new window, change the title to flats, sequence to 1. Location should be the same folder you selected for the calibration.
  - iv) Take one flat photo and hover your mouse over the middle of the flat rectangle that appears when the flat is taken. We are looking for ADU in the range of 30,000 to 40,000.
  - v) If these are the values you are seeing, continue and take 4 more flats, for 5 total.
  - vi) In the Arduino, type 'g' or manually turn off the flat light.

**5) Check slit position again**

- a) Go back to *Telescope tab* and center star once more
- b) Abort the continuous imaging in the *Camera Tab*, under the Focus Tools section.

**6) Set up the Autoguider**

- a) In the *Camera Tab*, under the Autoguider section, take a 0.1-1 second Exposure Time with no Delay Exposure. The first time will be a test for this saturation. Take a picture and look at the maximum brightness as well as the center pixels of the star picture. If brightness is 65,536 AUD, then lower Exposure Time. If the brightness is saturated (at 65,536 AUD), decrease the exposure time.

- b) Clear the guide star from the previous choice. Double click on the target star in the picture you just created. A box should pop up around it and its coordinates should be in the boxes where you just cleared.
  - c) Set Exposure Delay to 3-5 seconds so you are not chasing the seeing.
  - d) Take Photo and press Graph button to see the error graph on the right.
  - e) If the error graph points are saturated (red squares), click Abort button. Decrease the exposure time, repeat steps c) through d). Decrease the exposure time and repeats steps until error graph points are no longer saturated.
- 7) **Getting the fits/data**
- a) Go to Autoguider tab, under the take series section.
  - b) Set the exposure time to:
    - i) Exposure time 600s
    - ii) Binning 2x2
    - iii) Frame: Light
    - iv) Repeat: 6 (1 hour of data)
  - f) Click AutoSave, and make sure the target name is correct and the sequence number starts at 1.
- 8) **Wait for an hour...**
- a) If the signal-to-noise ratio is too low, then you may want to extend the series by changing the repeat in the series section to 3 and changing the sequence number in the Autosave section to 7. Typically, you won't need more than 1.5 hours of data.
  - b) Final Calibration
    - i) In the Arduino, type 'c' or manually turn on the calibration light.
    - ii) In the Autoguider tab, under the take photo section change the exposure time to 0.1 seconds, check the 'Automatically save photos' box and click Autosave.
    - iii) In the new window that pops up, change the title to cal, and the sequence to 1+ the total number of calibrations you took earlier.
    - iv) Click Take Photo and in the Arduino, type 'd' or manually turn off the calibration light.

## Appendix I

**Find tab** helps you locate your target stars, constellations, and orient using the sky midline

**Camera tab** shows you the star field and mirror slit

**Telescope tab** controls the telescope

**Focuser tab** helps focus on the target star

**Autoguider tab** takes the spectra, flats, and calibration images

**Arduino** is a calibration and flat light controller