

FocusMax V5 Tutorials

Table of contents

Tutorials	3
Running FocusMax with Simulators	4
MaxIm	5
5 Star Pattern	7
Simulated Stars with PinPoint	13
ASCOM DSS Camera	23
TheSky	27
Using DSS (Deep Sky Survey)	27
Nebulosity 4	43
ASCOM DSS Camera	44
AcquireStar	48
AcquireStar Tab	50
TheSky Image Link	53
PinPoint Tab	55
Plate Solve Tab	58
AcquireStar Wizard	60
Filter Offset Wizard	66
First Light Wizard	73
Focus Convergence Wizard	82
Temperature Compensation Wizard	83
Running Vcurves	88
Image Calibration	92

FocusMax V4 Tutorials

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Author: Steve Brady <http://www.ccdware.com>

Contents

[Learning with Simulators](#)

[AcquireStar](#)

[AcquireStar Wizard](#)

[Filter Offset Wizard](#)

[First Light Wizard](#)

[Focus Convergence Wizard](#)

[Temperature Compensation Wizard](#)

[Running Vcurves](#)

[Profile Window](#)

[Image Calibration](#)

Running FocusMax with Simulators

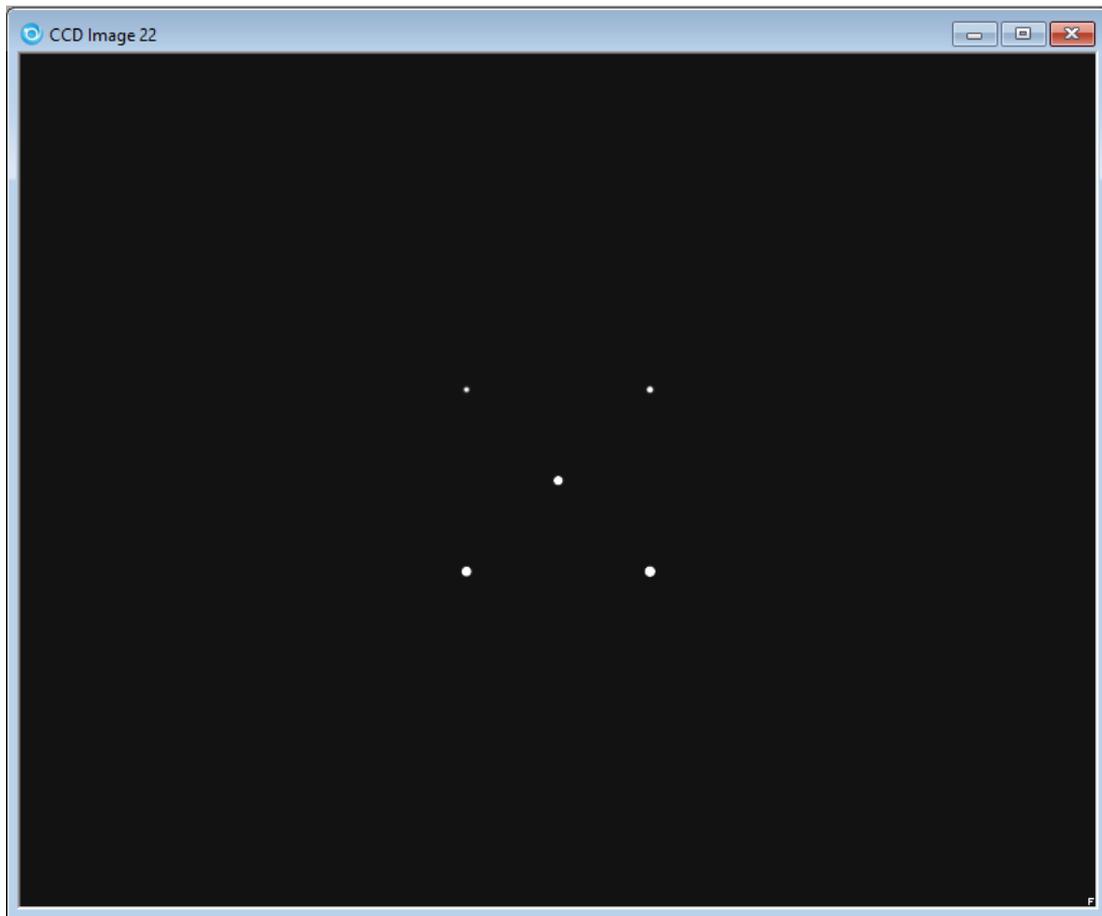
Running FocusMax With Simulators

MaxIm

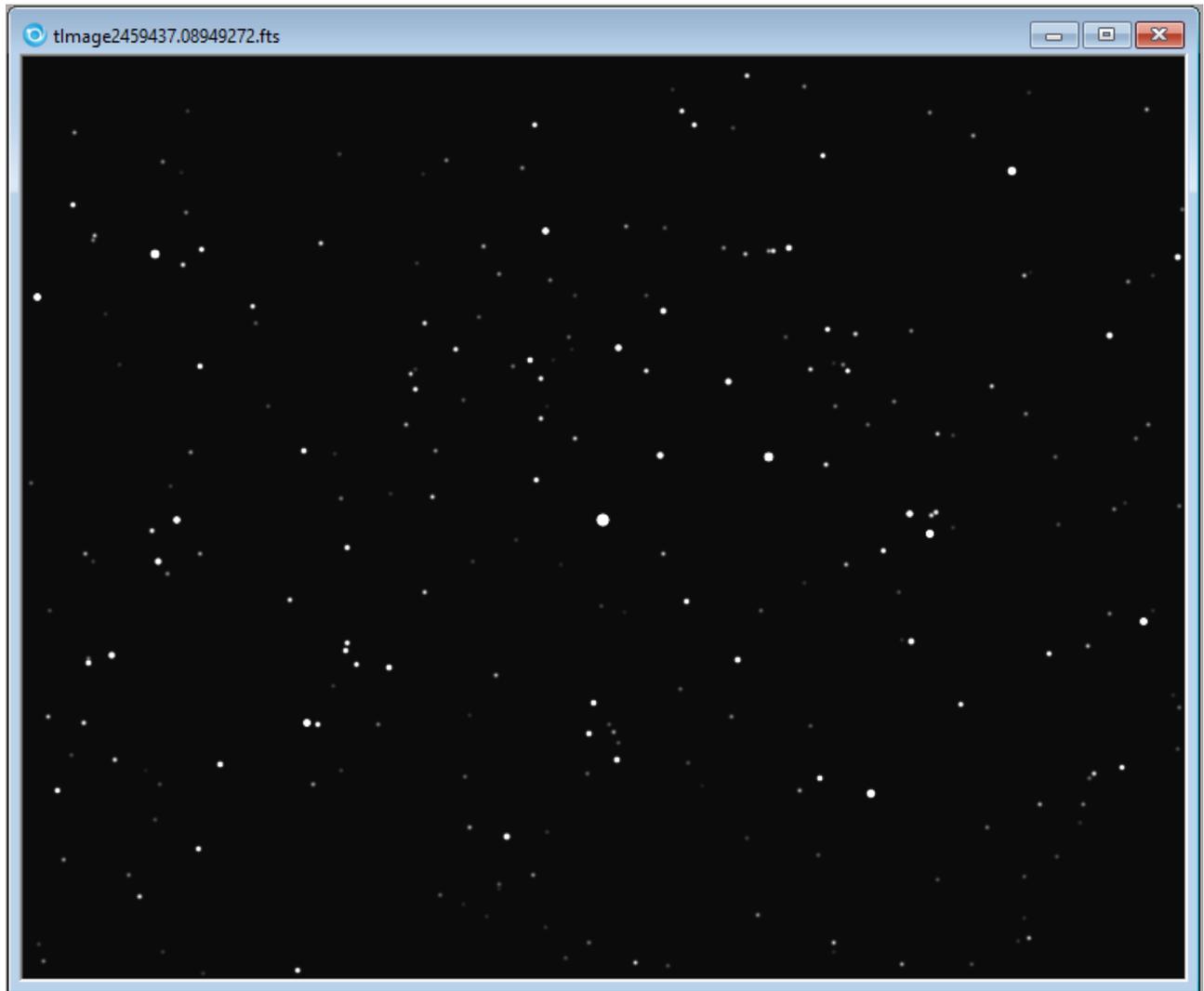
MaxIm

Options for creating simulated stars using MaxIm

1. Five star pattern
 - This option does not require a telescope connection
 - The Simulator camera must be selected in MaxIm Camera Control / Setup tab

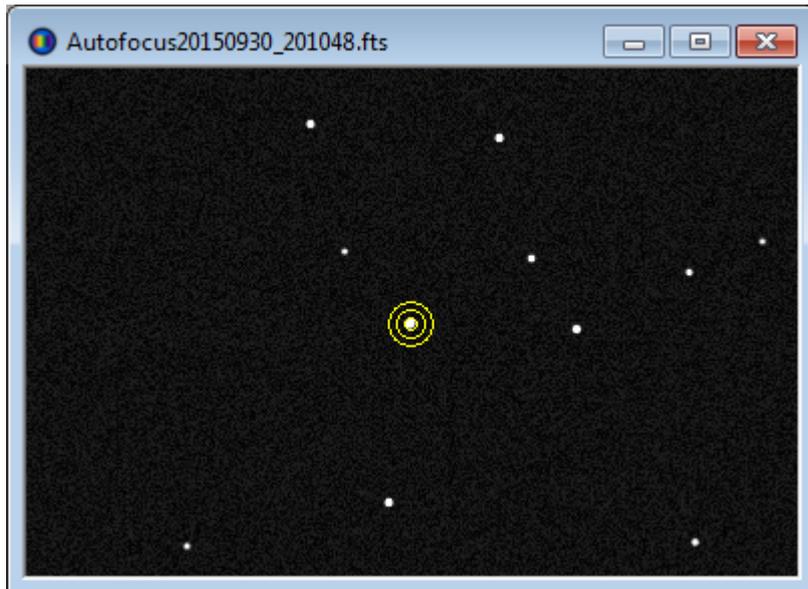


2. PinPoint
 - This option requires a Simulator telescope to be connected and tracking in order to read the telescope coordinates for PinPoint to generate the field.



3. ASCOM DSS Camera

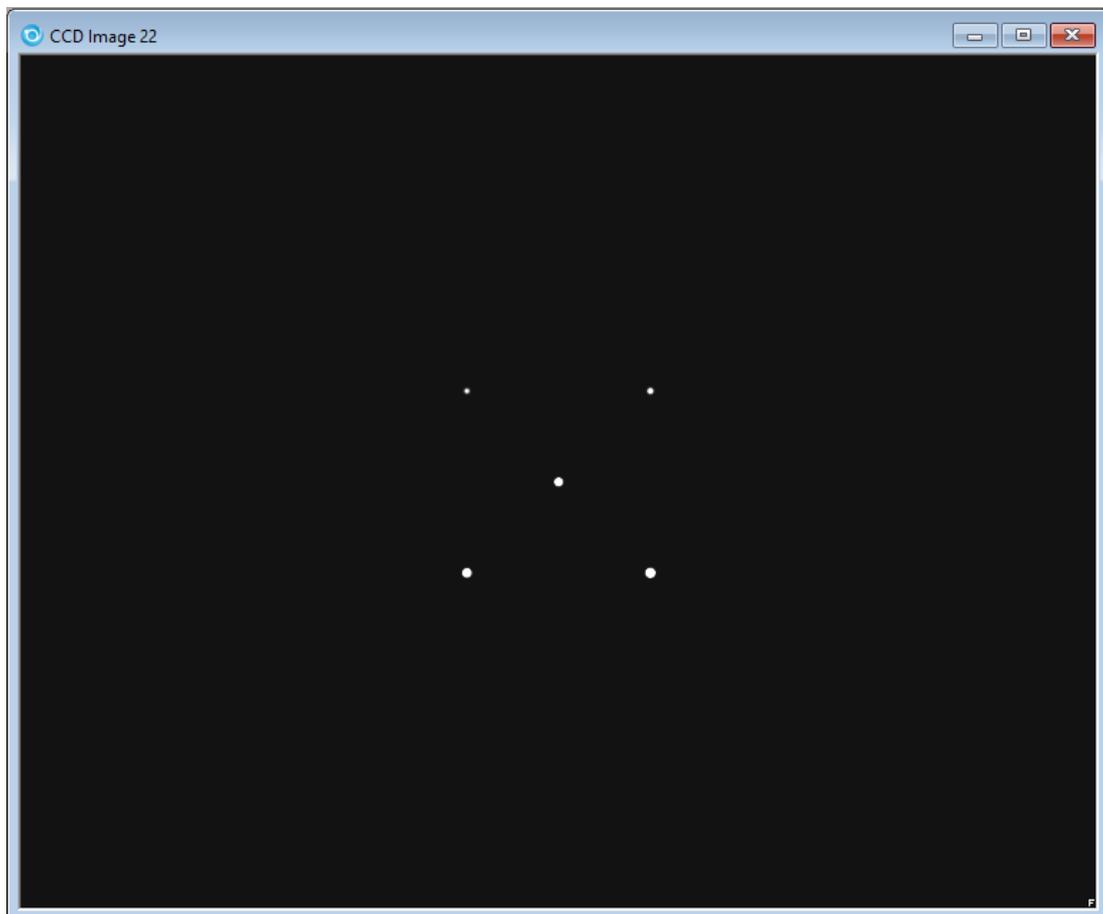
- This option requires a Simulator telescope to be connected and tracking in order to read the telescope coordinates for the driver to return DSS stars
- This requires an internet connection



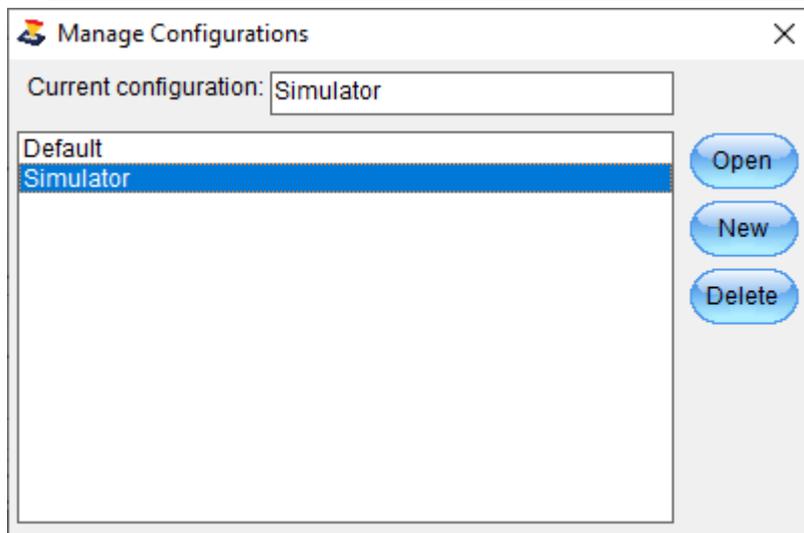
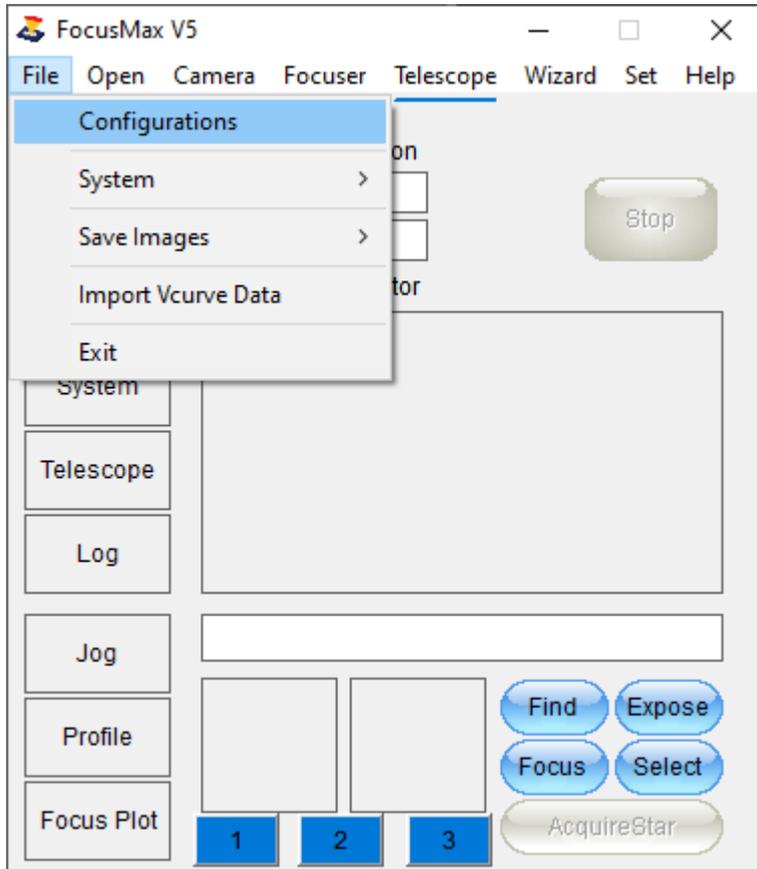
5 Star Pattern

5 Star Pattern

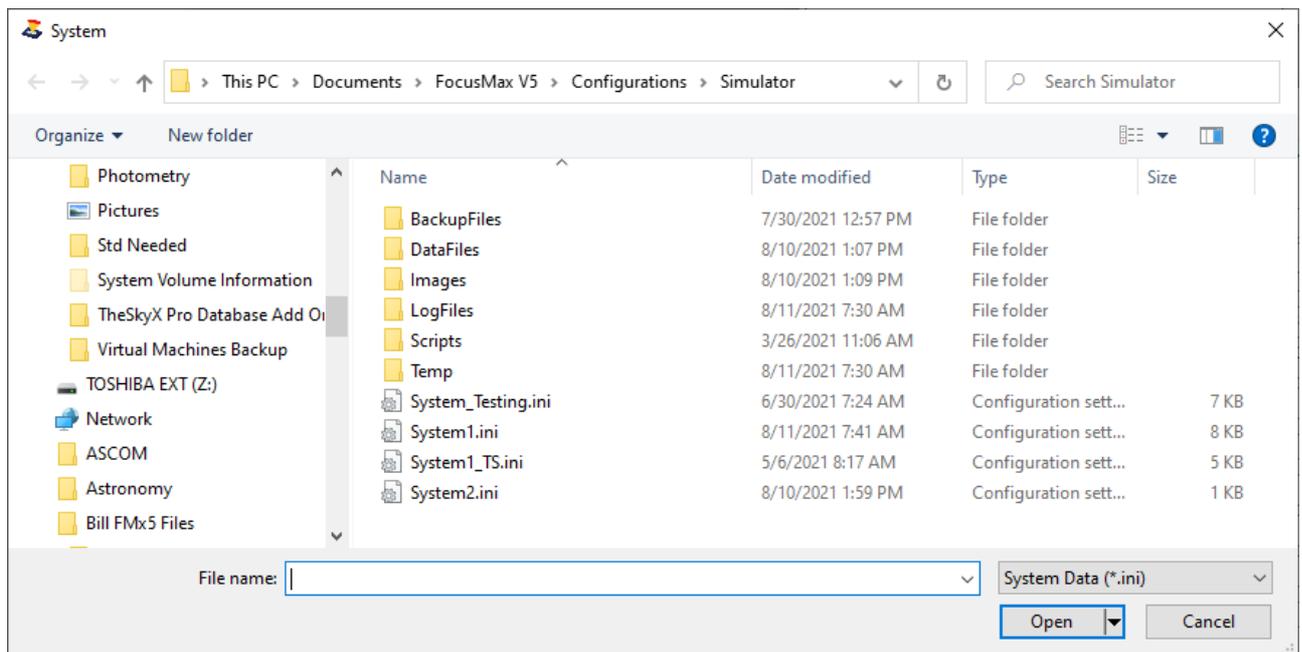
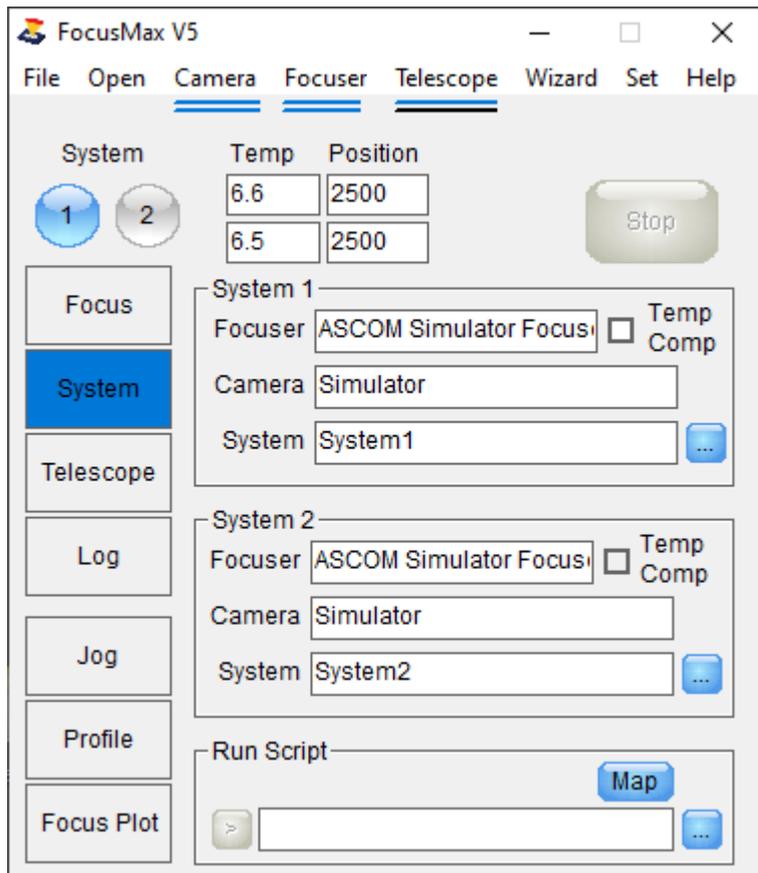
MaxIm can be setup to generate a simulator 5 artificial star pattern which can be used to learn basic FocusMax functions



1. Open menu 'File/Configurations' and select 'Simulator' then press Open

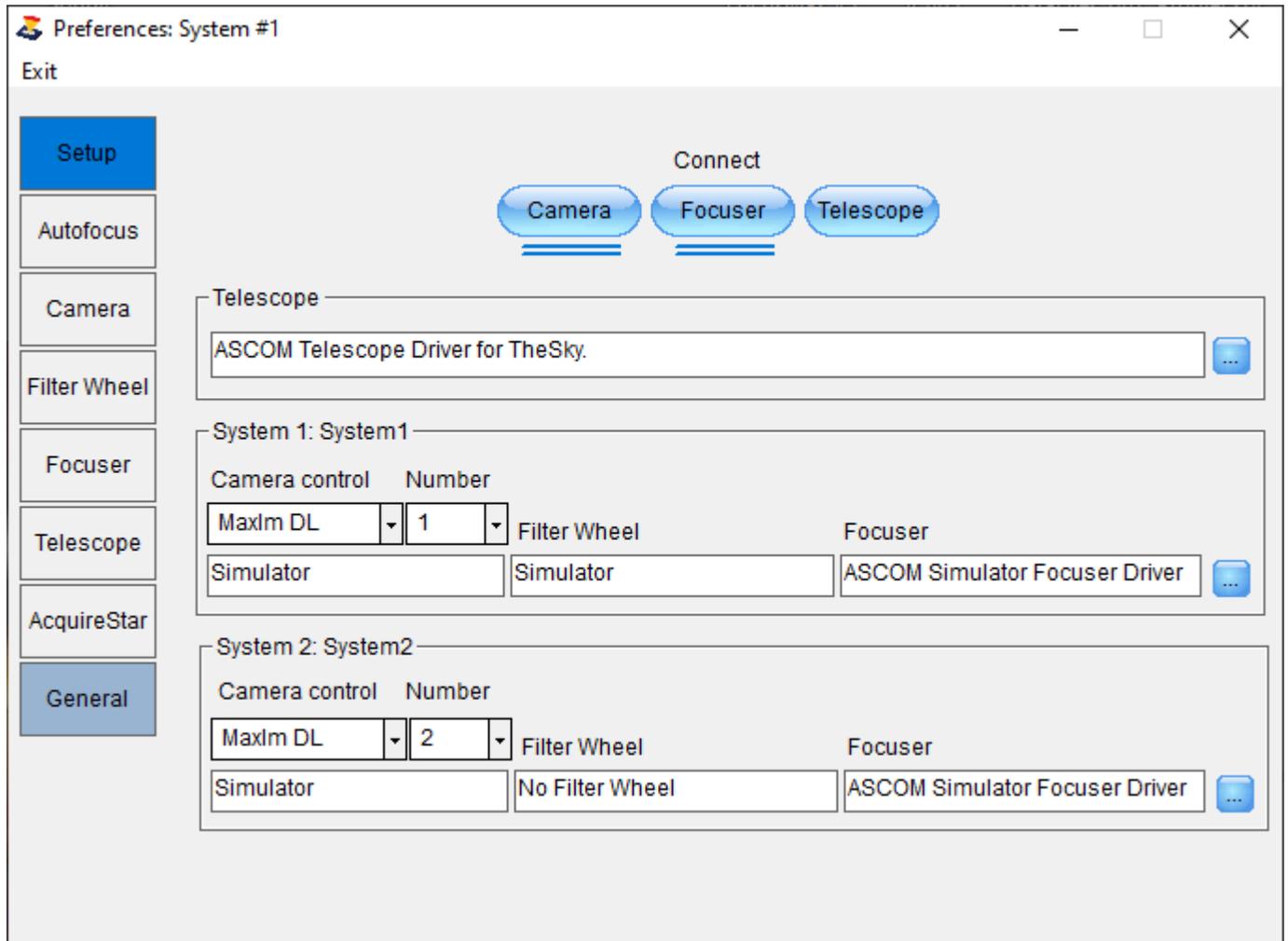


2. Press the System button then press the small square button and select "Simulator 1" or "Simulator 2" (optional) to load setup configuration

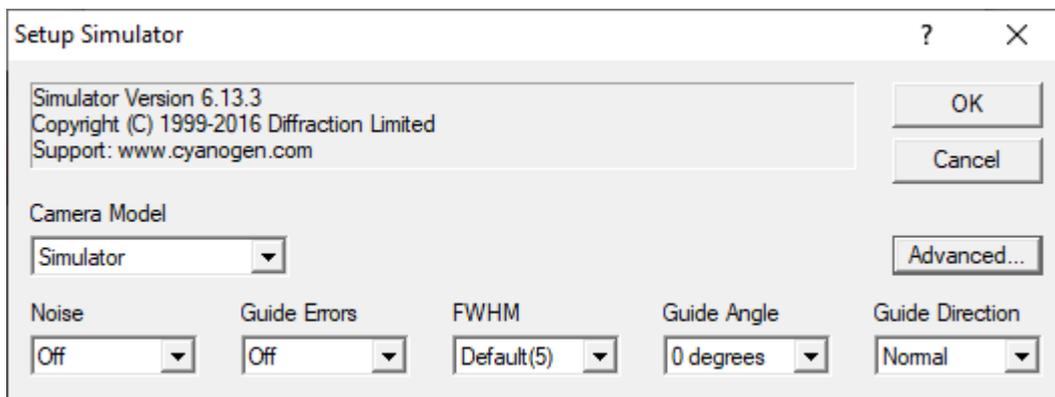


3. Open FocusMax Preferences (Menu / Open / Preferences) to configure the hardware.
 - Select MaxIm DL under 'Camera control'
 - Set camera 'Number' assignment, generally, Camera #1 is the main imaging camera and camera #2 is the second (guiding) camera
 - Select Simulator focusers for both Systems
 - Press colored 'Connect' buttons to connect to the camera(s) and focuser(s). A blue line will appear if the hardware is connection was successfully established.

- There is no need to set the telescope simulator with this option.

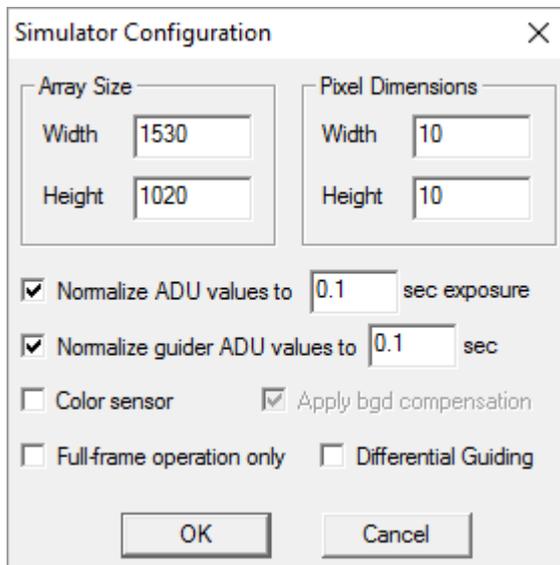


3. Configure MaxIm camera simulator
 - Set the 'Camera Model' = Simulator
 - Noise = On
 - Guide errors = Both
 - FWHM = 5

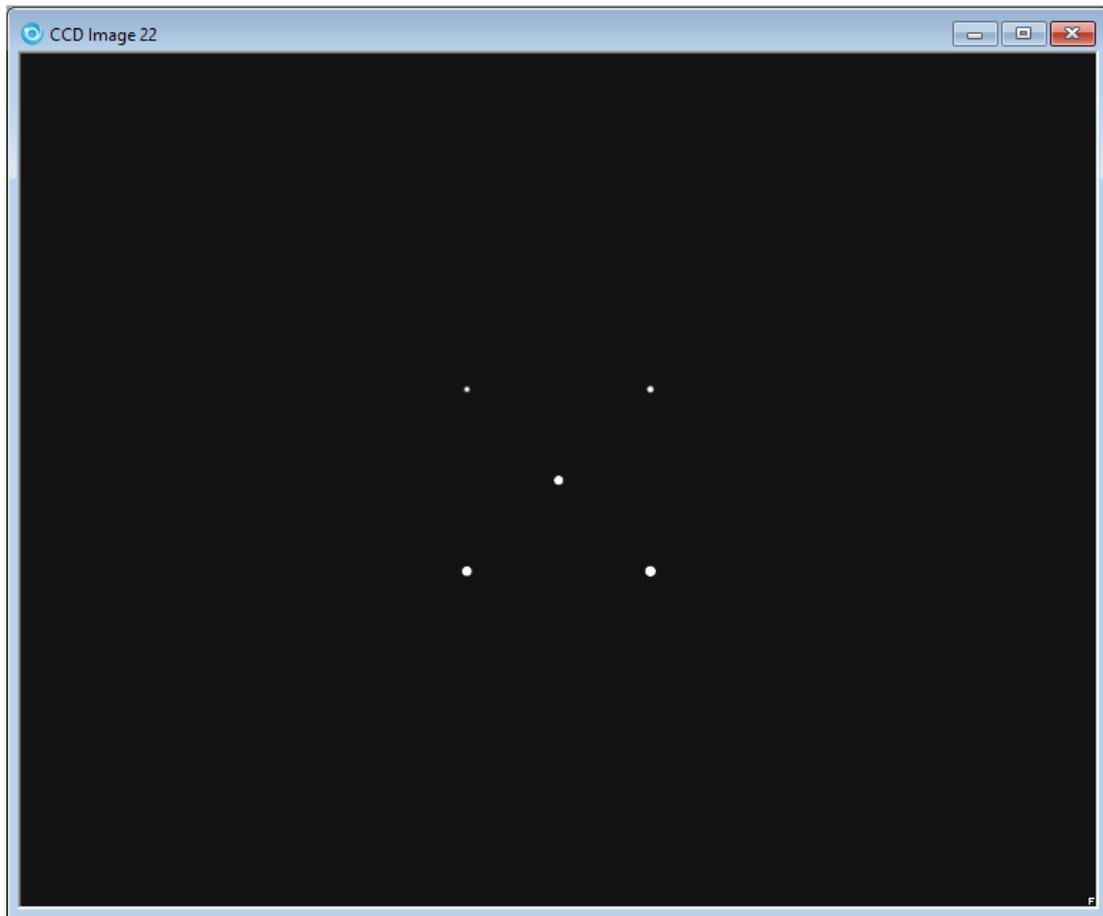


Press advanced button

- Set the array size 1530 x 1020 (default 768 x 511)
- Normalize ADU units to 0.1 sec (guider also) which will boost the intensity of each star in the 5 star pattern by a factor of 10
- Pixel Width 10 & Height 10
- Uncheck Color and Full frame operation
Connect to the camera



4. Running FocusMax in Simulator Mode
Press the FocusMax 'Find' button which should find the brightest star in the 5 'star' image.



FocusMax V5

File Open Camera Focuser Telescope Wizard Set Help

System	Temp	Position
1	6.6	2500
2	8.6	2500

Stop

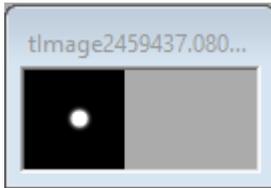
Configuration: Simulator

Half Flux Diameter = 3.89

Find Expose
Focus Select

AcquireStar

1 2 3



5. Run the FirstLight Wizard to generate a set of Vcurves - note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.

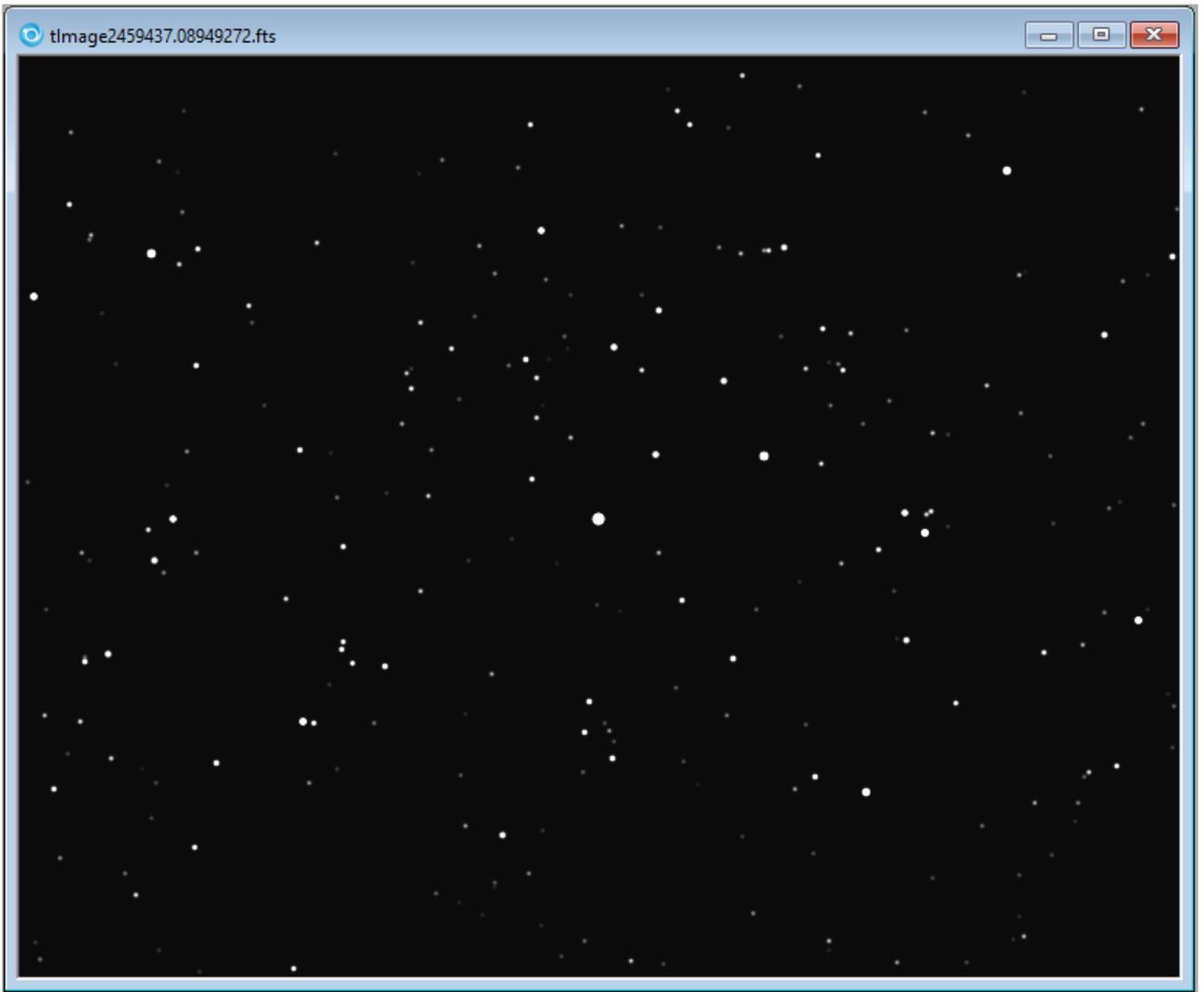
- Press the 'Focus' button to focus the system using simulator camera and focuser.
- Press 'Select' button to use the cursor to select a single star to use for autofocus.
- Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.

Simulated Stars with PinPoint

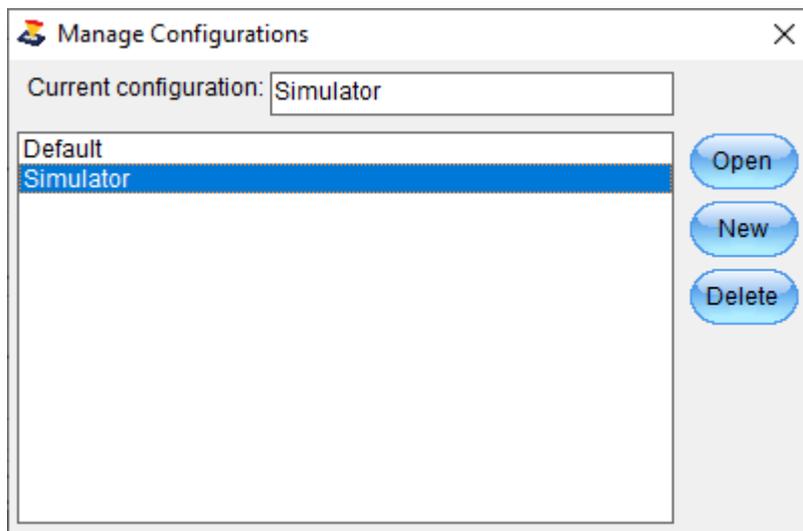
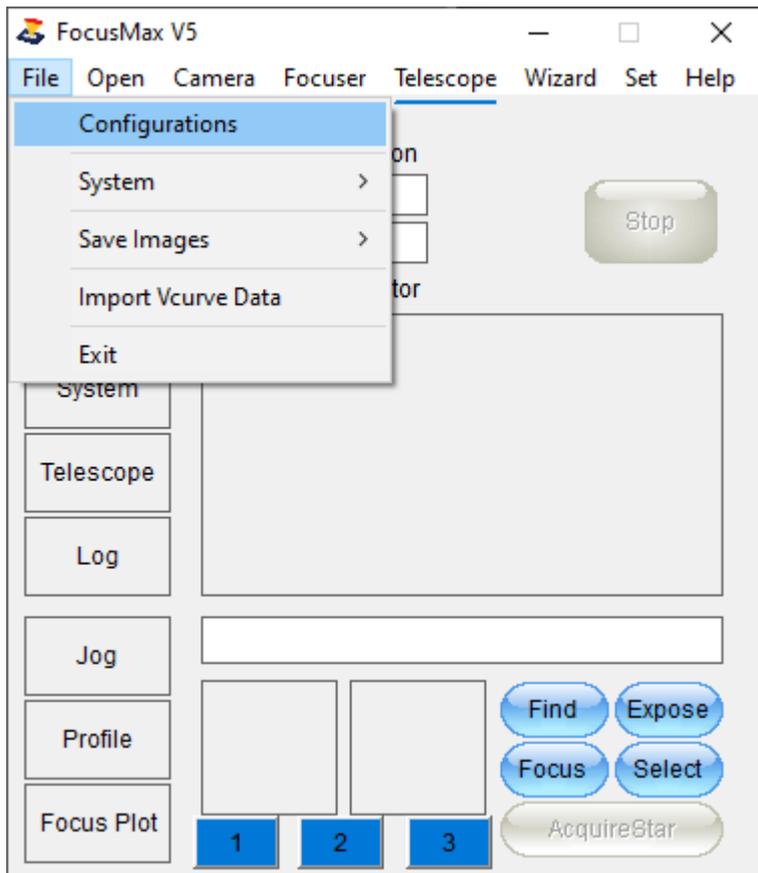
Using PinPoint to Generate Simulated Star Field

You can generate a simulated star field with MaxIm if the Full Version of PinPoint is installed.

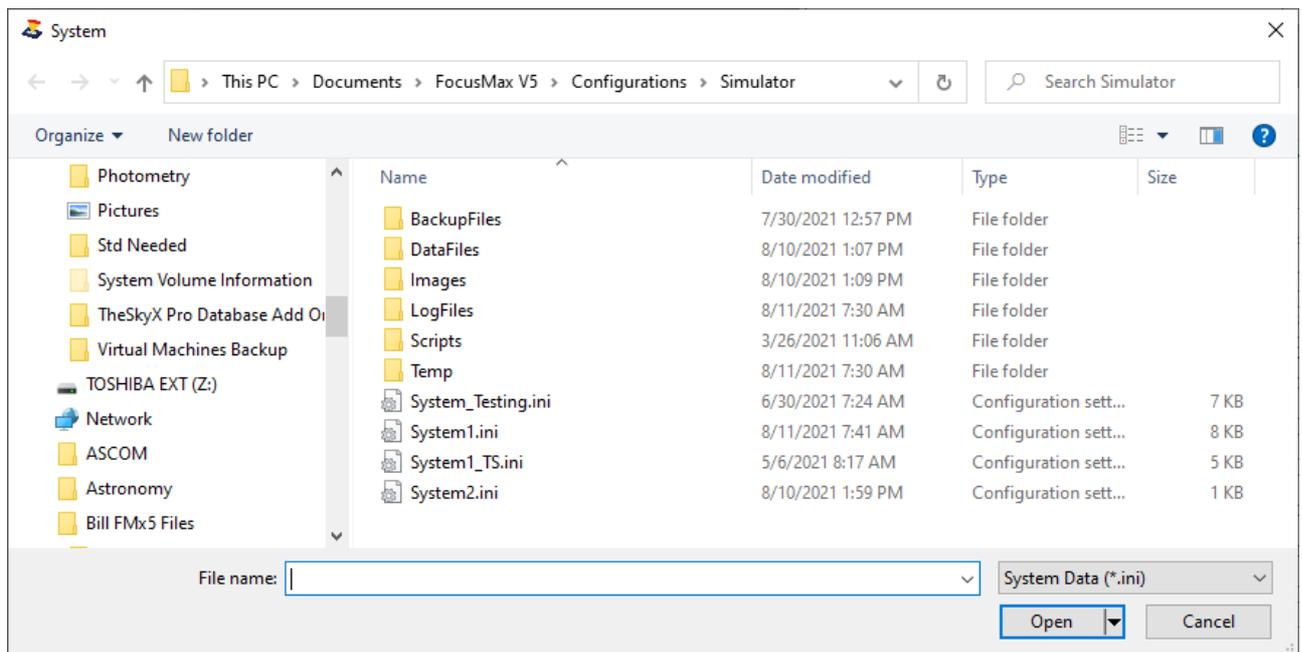
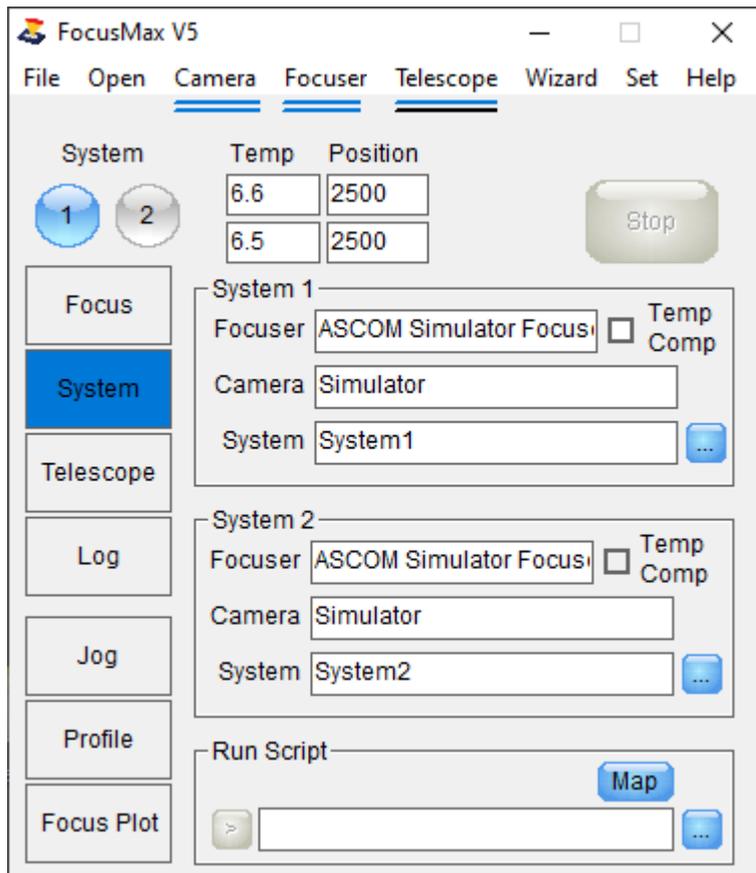
FocusMax must have a connection to the (simulator) telescope and the telescope must be tracking in order to generate a simulated star field.



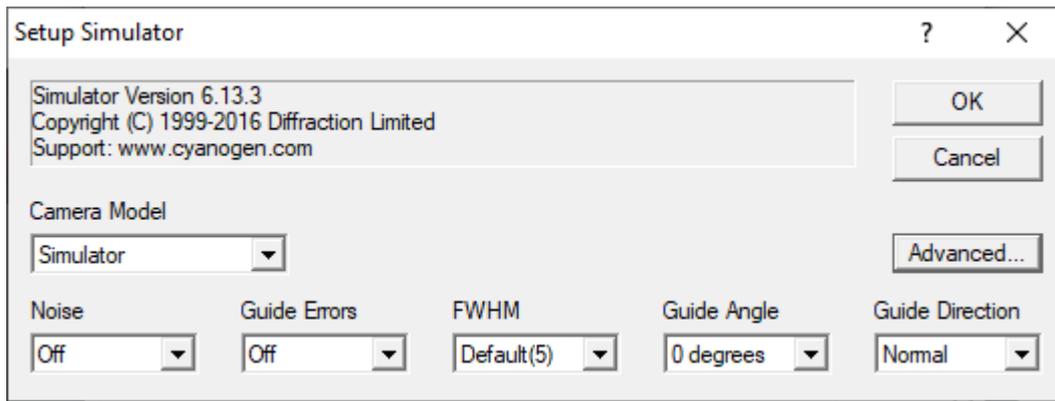
1. Open menu 'File/Configurations' and select 'Simulator' then press Open



1. Press the System button then press the small square button and select "Simulator 1" or "Simulator 2" (optional) to load setup configuration

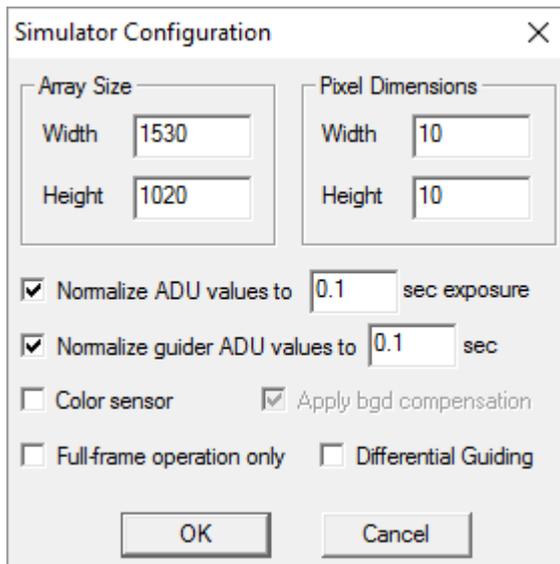


2. Configure MaxIm camera simulator
 - Select the 'Camera Model' = Simulator
 - Noise = On
 - Guide errors = Both
 - FWHM = 5



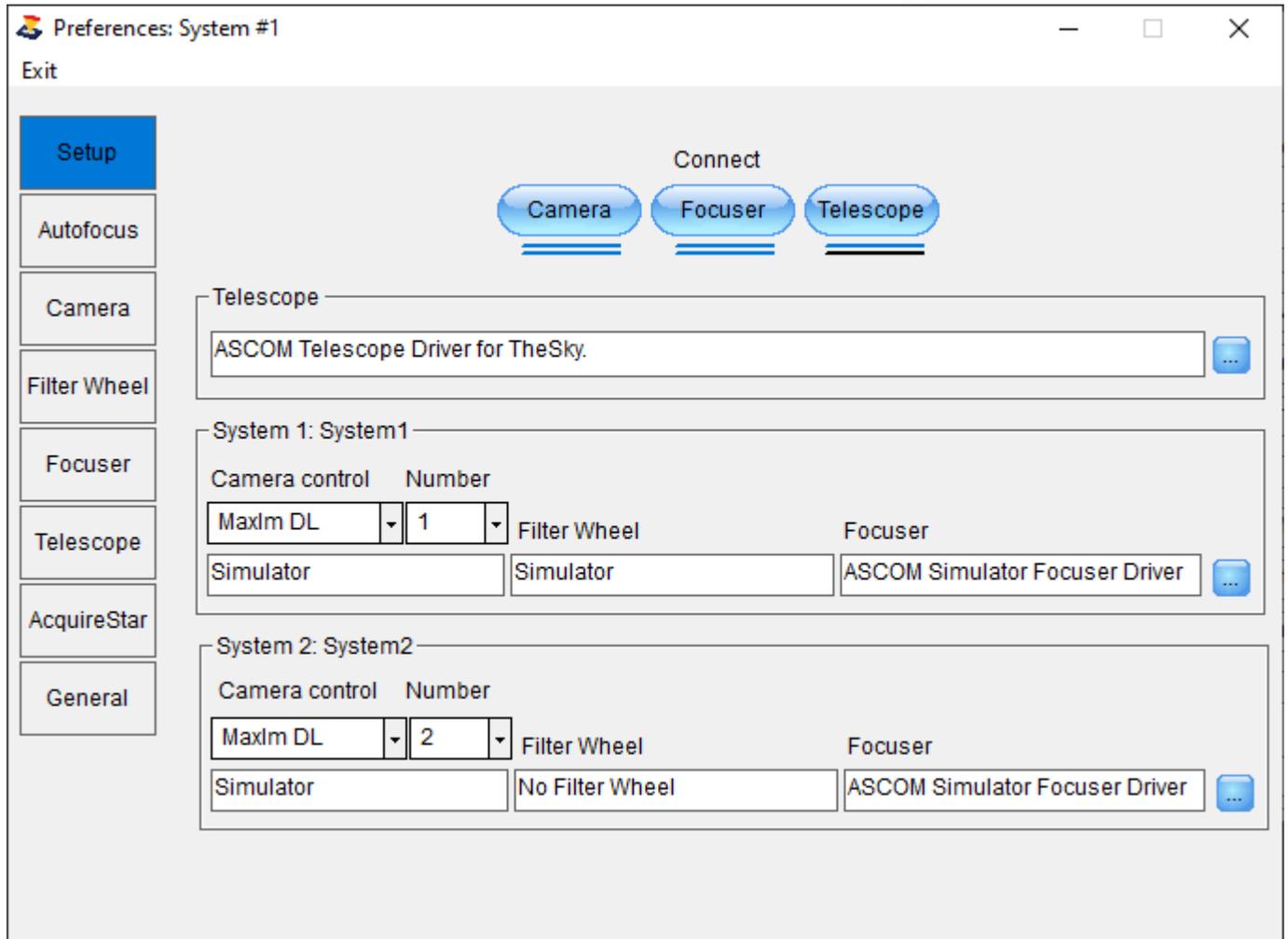
Press advanced button

- Set the array size 1530 x 1020 (default 768 x 511)
- Normalize ADU units to 0.1 sec (guider also)
- Pixel Width 10 & Height 10
- Uncheck Color and Full frame operation
- Connect to the camera



3. Open FocusMax Preferences (Menu / Open / Preferences)

- Select MaxIm DL under 'Camera control'.
- Set camera Number assignment, generally, Camera #1 is the main imaging camera and camera #2 is the second (guiding) camera which is not required.
- Select Simulator focusers for both System1 and System2 (optional)
- Select the simulator telescope connection such as TheSky Controlled Telescope and set the telescope to simulator in the planetarium software.
- Press colored 'Connect' buttons to connect to your hardware. A blue line will appear if the hardware is connection was successfully established. A black line will appear if the telescope is tracking which is required for simulated stars to be generated.



- Open Preferences/Autofocus and set FocusMax focus process to Single-Star.

Preferences: System #1

Exit

Setup

Autofocus

Camera

Filter Wheel

Focuser

Telescope

AcquireStar

General

Autofocus

Process: Single-Star

Method: Advanced

Filter: Current filter

Near Focus

HFD: 5.3 Samples: 6

Final Focus

Images: 5

Focus offset: 0

Run AcquireStar on failure

Enable A. I.

Slot	Filter	Tgt Bin	Focus Bin	Base exp	Max exp	Tgt Flux x1000
1	E	2	1	1.00	10.00	300
2	C	2	1	1.00	10.00	300
3	U	1	2	10.00	30.00	200
4	B	1	1	2.00	10.00	200
5	V	2	1	2.00	10.00	200
6	R	2	1	1.00	10.00	200
7	I	2	1	10.00	10.00	200

Move

In

Out

Settle time: 0 sec

Convergence

Enable

Steps: 0 Samples: 5

Max number exposures: 25

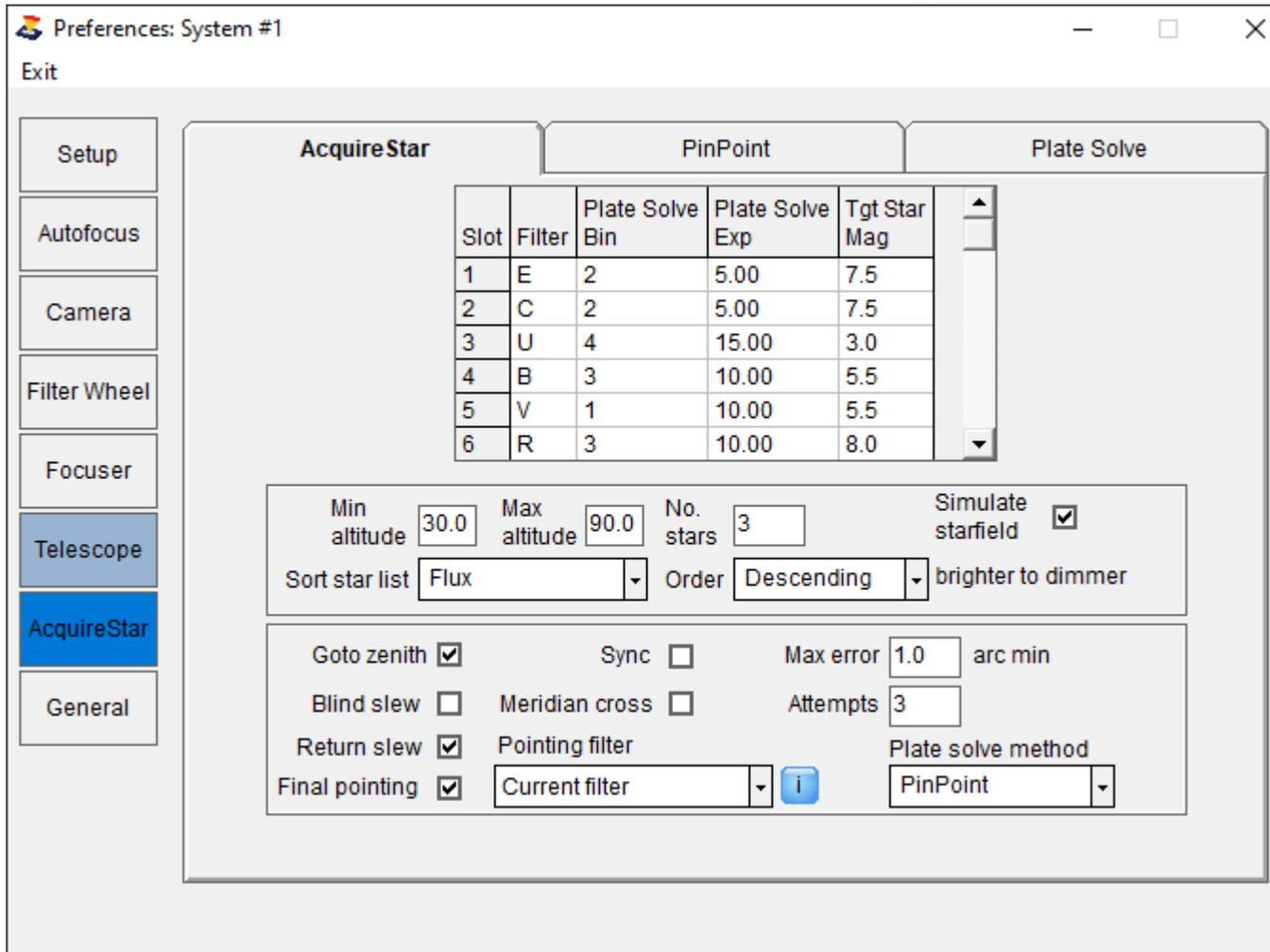
Return Start Position

Enable

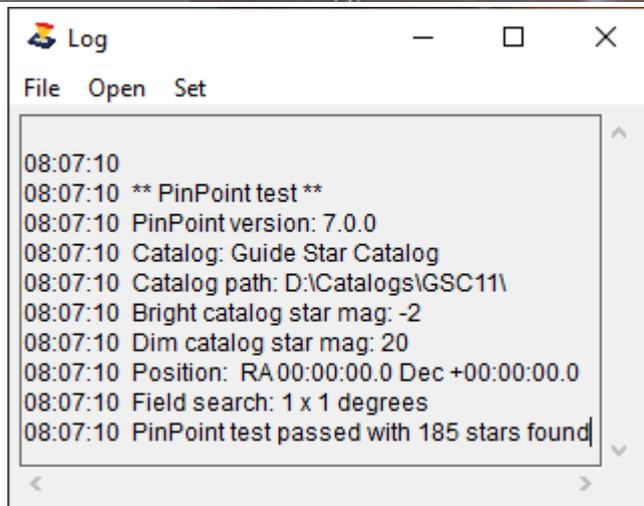
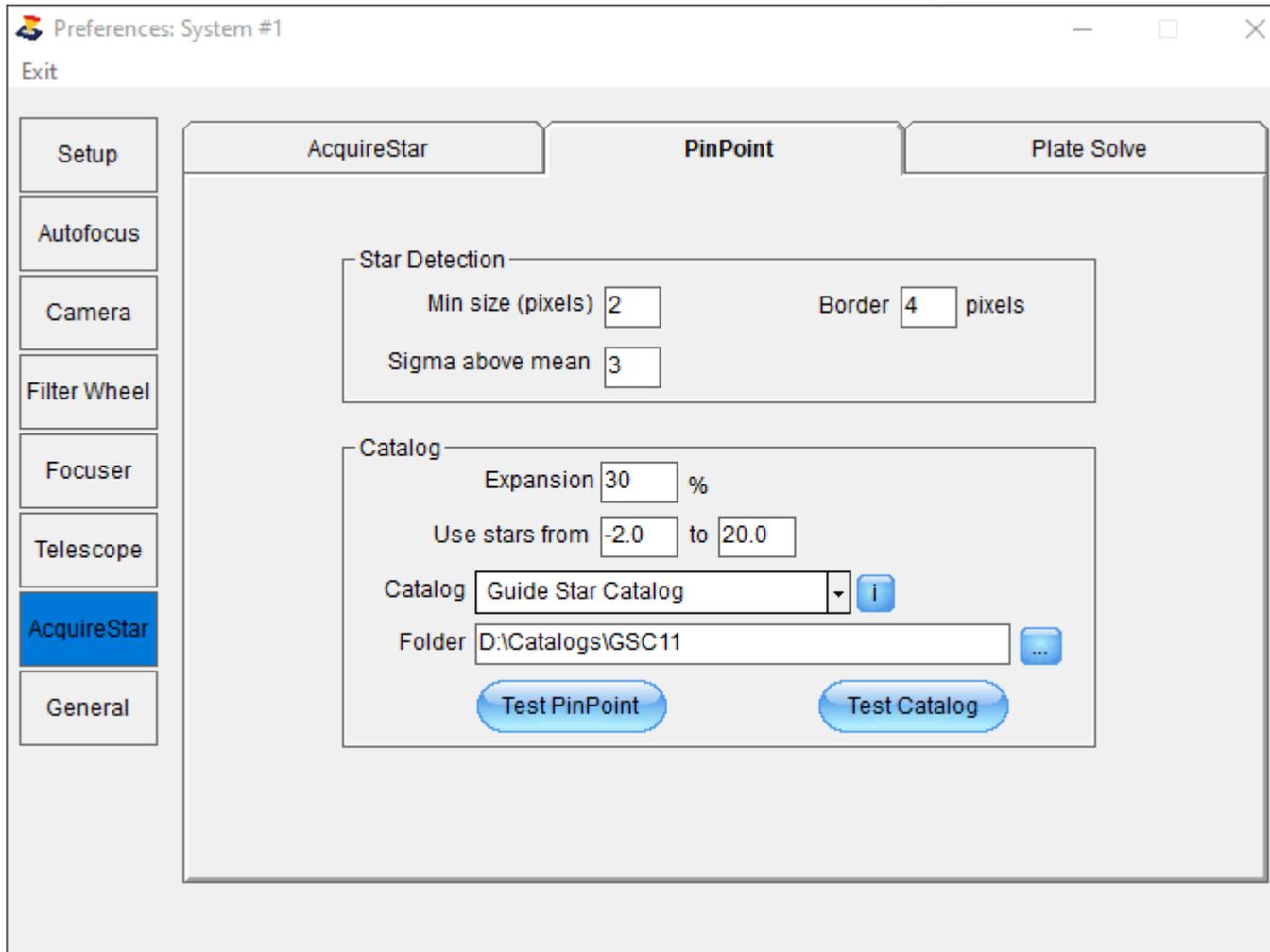
Max HFD: 6

5. Setup PinPoint

- Open the AcquireStar window and select PinPoint as the 'Plate solve method'.
- Enable 'Simulate starfield' (requires the telescope to be connected and tracking).

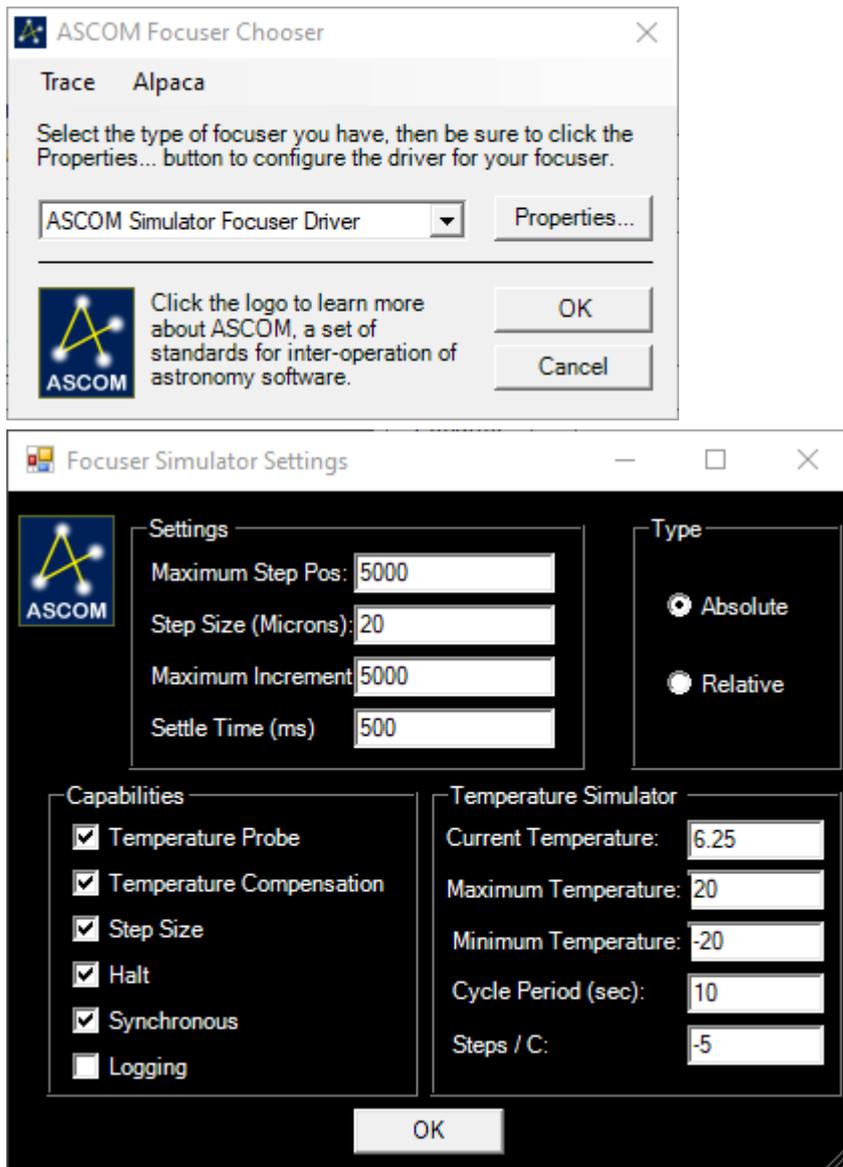


- Select the PinPoint Tab and set the path to your star 'Catalog' - the best catalog choice is the Guide Star Catalog.
- Press the 'Test PinPoint' button to verify that you have a Full PinPoint license installed and not PinPoint LE.
- Press the 'Test Catalog' button to lookup stars in the selected star catalog, the results will be displayed in the Log.

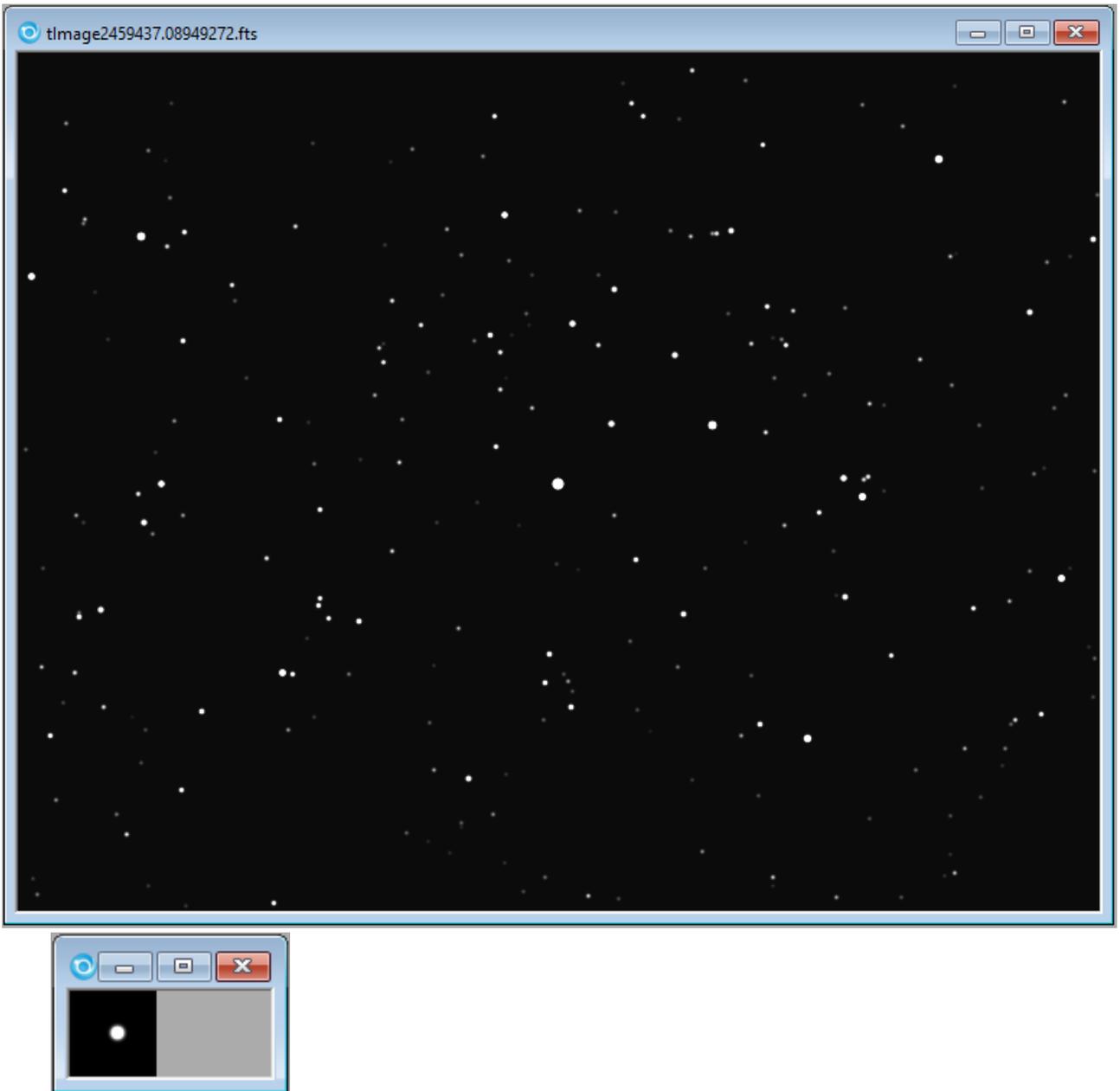


6. Running FocusMax in Simulator Mode

- Move the focuser to the mid-point of the focuser travel. This can be determined by opening Preferences / Setup then pressing the small (chooser) focuser button to open the driver then press the Properties button. The mid-point of the focuser travel will be $0.5 \times$ Maximum Position. (2500 in the screen example below). The simulated stars generated by PinPoint will increase in size as the focuser moves away from the focuser mid-point.



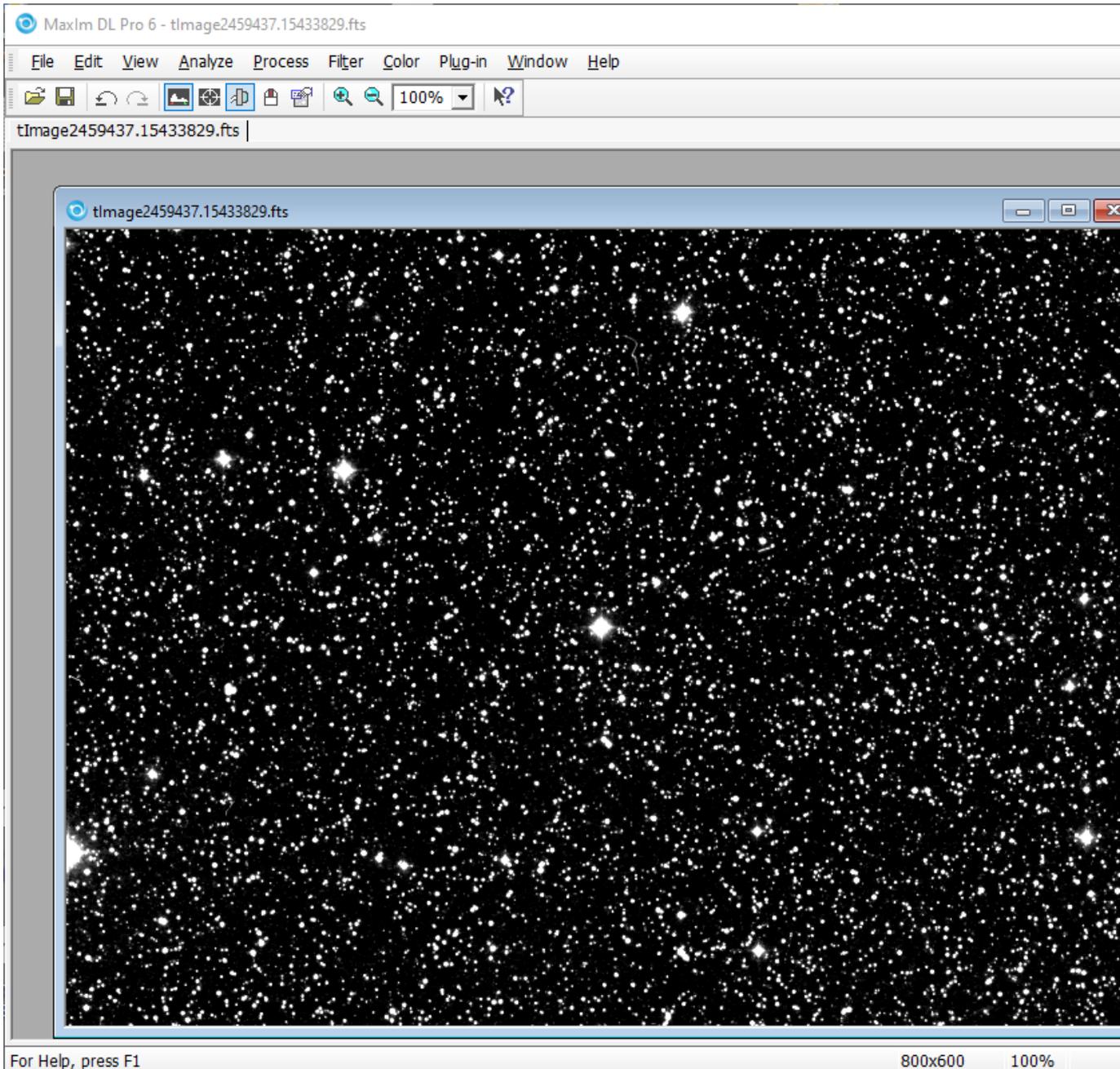
- Find and slew the simulator telescope to a star that is 6th mag or fainter - the star should be somewhat isolated from other nearby stars.
- Press the 'Find' button and FocusMax will proceed to:
 - take an image
 - create a simulated star field
 - find the brightest star in the field
 - subframe the star



- Run the FirstLight Wizard to generate a set of Vcurves - note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.
- Press the Focus button to focus the system using simulator camera and focuser.
- Press Select button to use the cursor to select a single star to use for autofocus.
- Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.
- Run AcquireStar Wizard to determine the optimum star magnitude for a given filter
- Run AcquireStar to automatically select a star for autofocus.

ASCOM DSS Camera

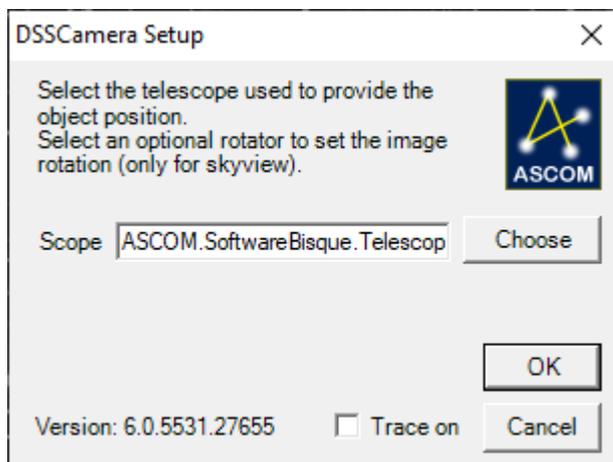
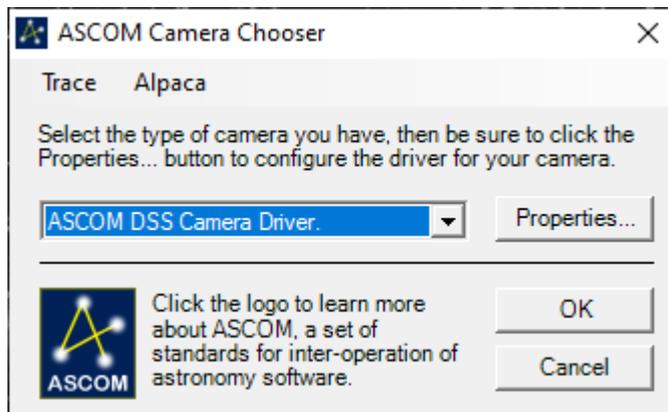
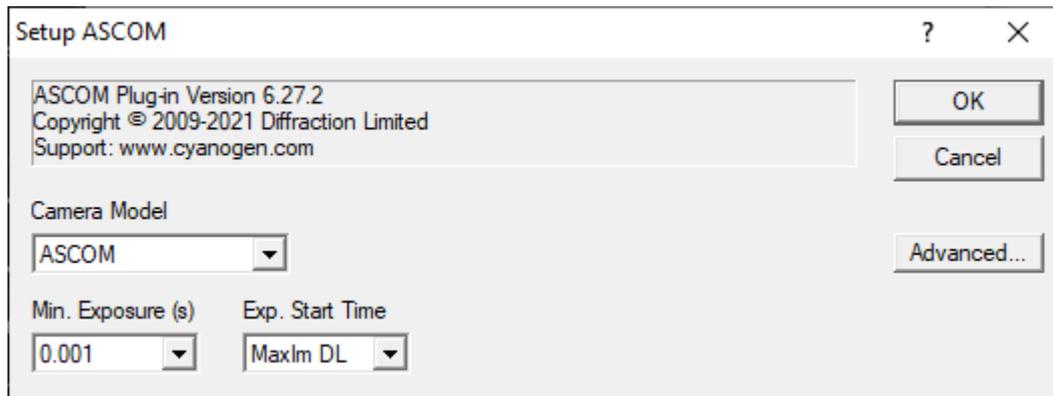
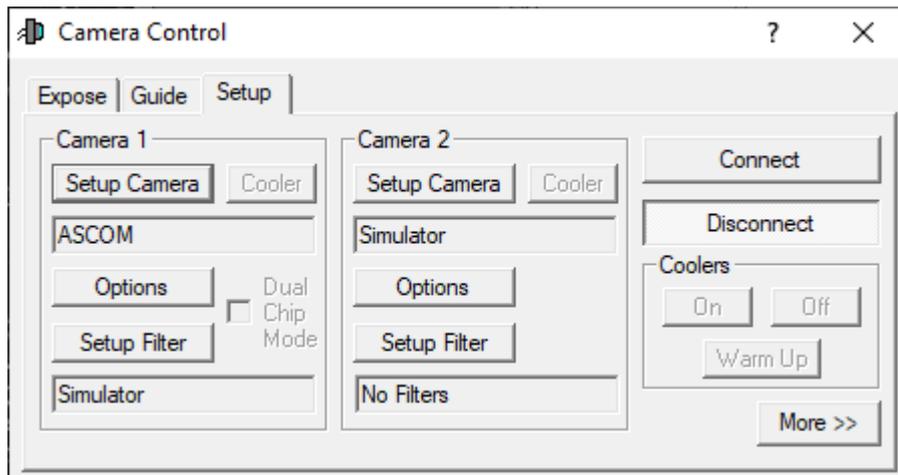
Using ASCOM DSS Camera to Generate Simulated Star Field



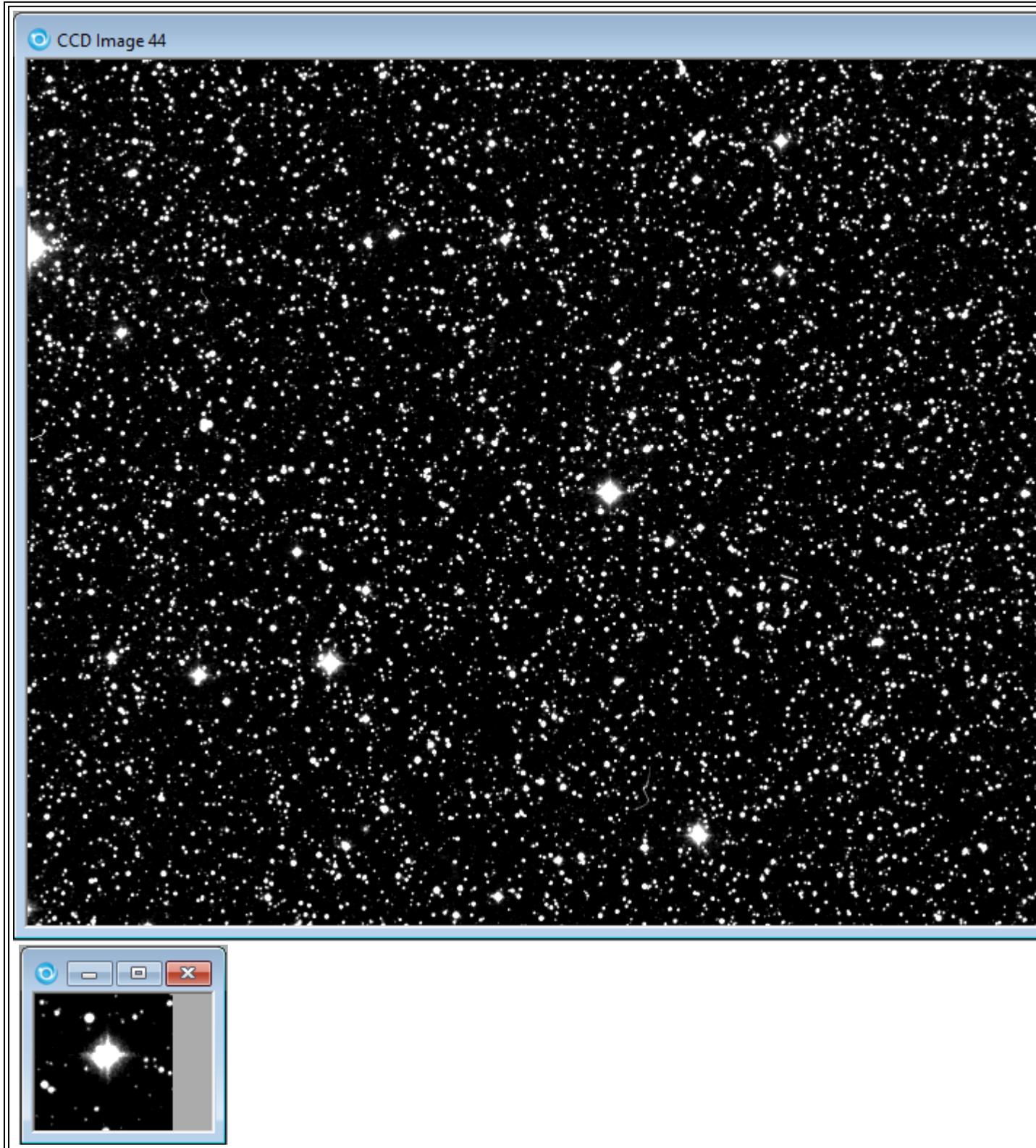
1. Install the Deep Sky Survey (DSS) ASCOM driver from <https://sourceforge.net/projects/sky-simulator/>. This camera driver will download a DSS image from the internet based on the telescope position.

Once installed setup MaxIm with the DSS driver:

- Open MaxIm 'Camera Control' Window and select the 'Setup' tab
- Press 'Setup Camera' button and select the ASCOM camera.
- Press 'Advanced' button to select the ASCOM DSS Camera Driver.
- Press 'Properties' to set the telescope connection which will provide the RA & Dec coordinates for the image.



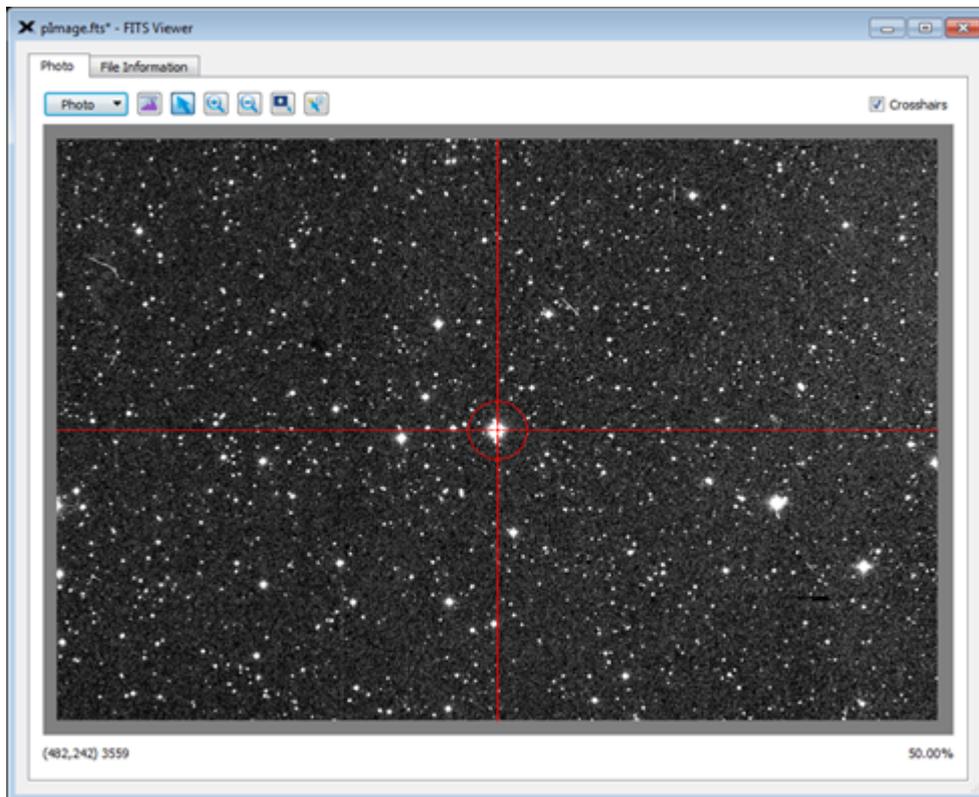
2. Find a star in the 8 - 10 mag range with your planetarium app and slew the simulator telescope to center the star.
 - Press the 'Find' button to take an in image - note that the time to download will take some time as the image is being transferred via the internet.
 - Once the image is downloaded, FocusMax will search the image for the brightest stars (default 20) then subframe the brightest star provided the exposure time can be adjusted to meet the user defined Total Flux setting for the filter in use. If it is too bright, the the next dimmer star in the list will be tested.



3. Run the FirstLight Wizard to generate a set of Vcurves - note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.
 - Press the 'Focus' button to focus the system using simulator camera and focuser.
 - Press 'Select' button to use the cursor to select a single star to use for autofocus.
 - Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.
 - Run AcquireStar Wizard to determine the optimum star magnitude for a given filter
 - Run AcquireStar to automatically select a star for autofocus.

TheSky

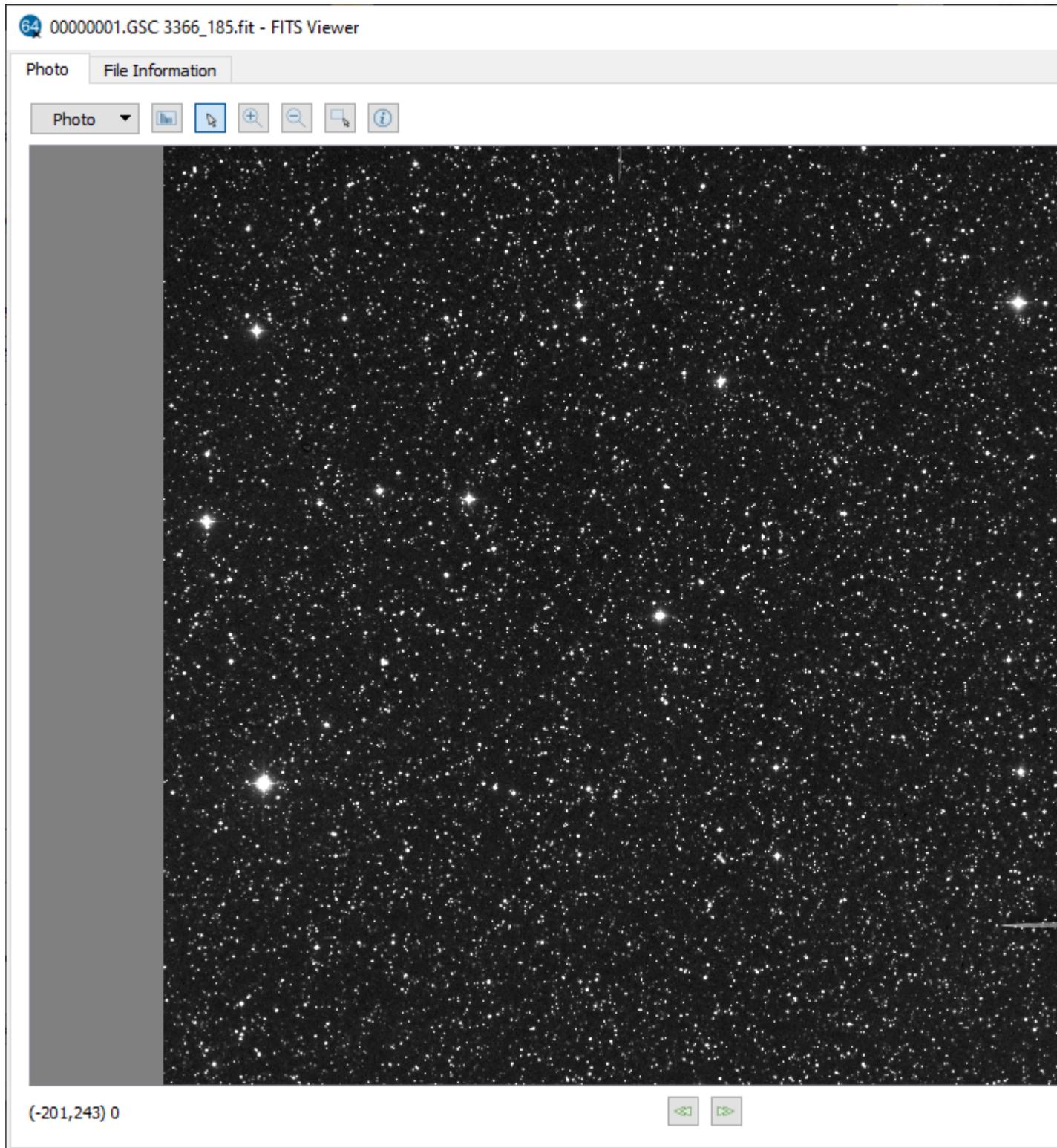
TheSky



Using DSS (Deep Sky Survey)

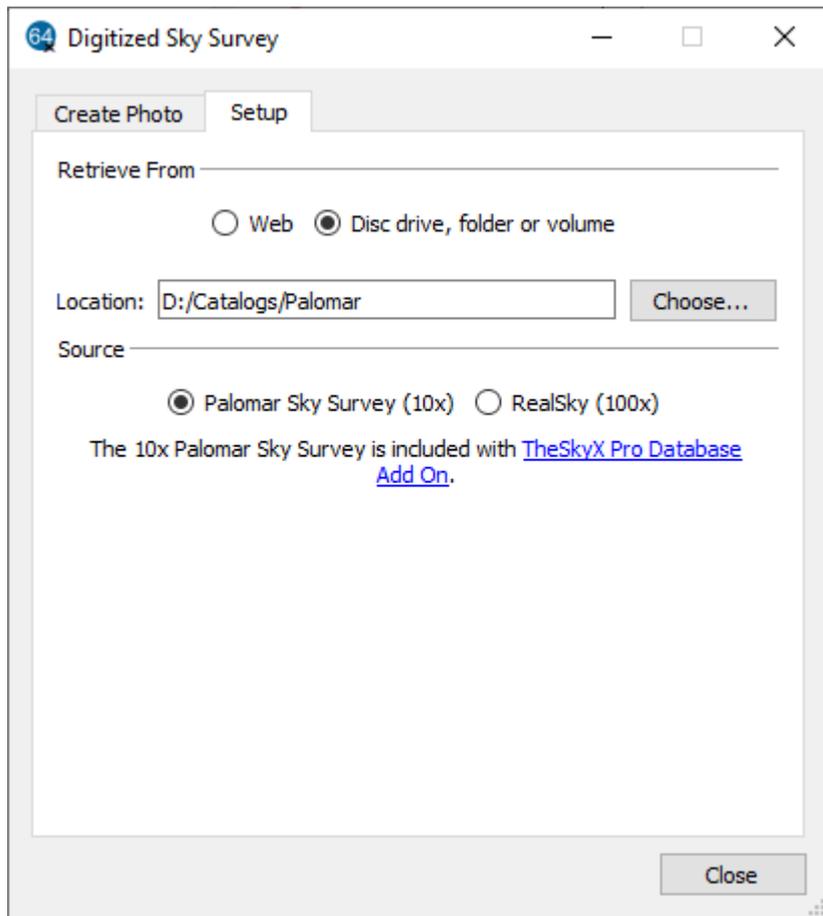
Images From Deep Sky Survey

TheSky is able to download and display Deep Sky Survey (DSS) images which can be plate solved with PinPoint or TheSky Image Link. This requires a license for TheSky Camera Add-on.

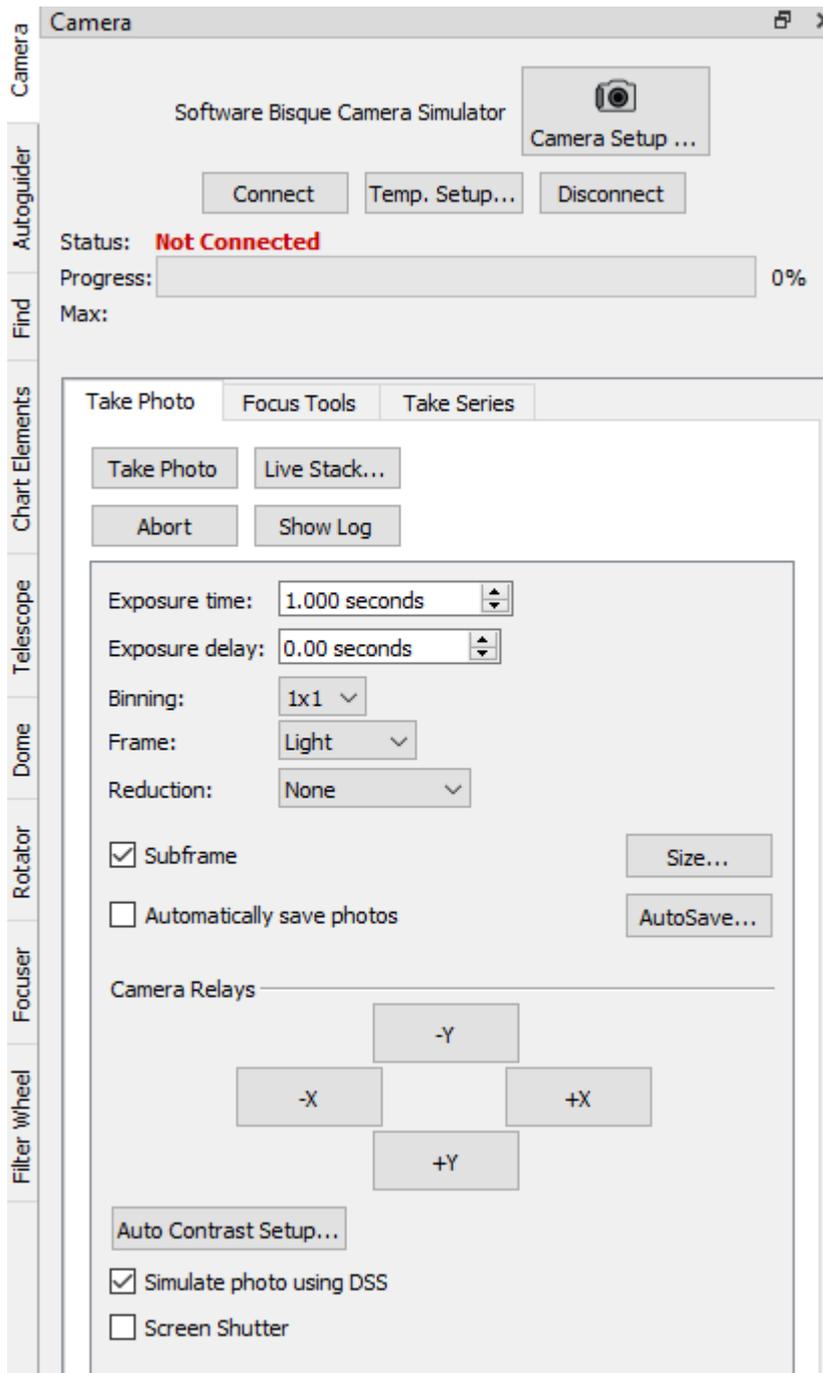


1. Setting up DSS on TheSky

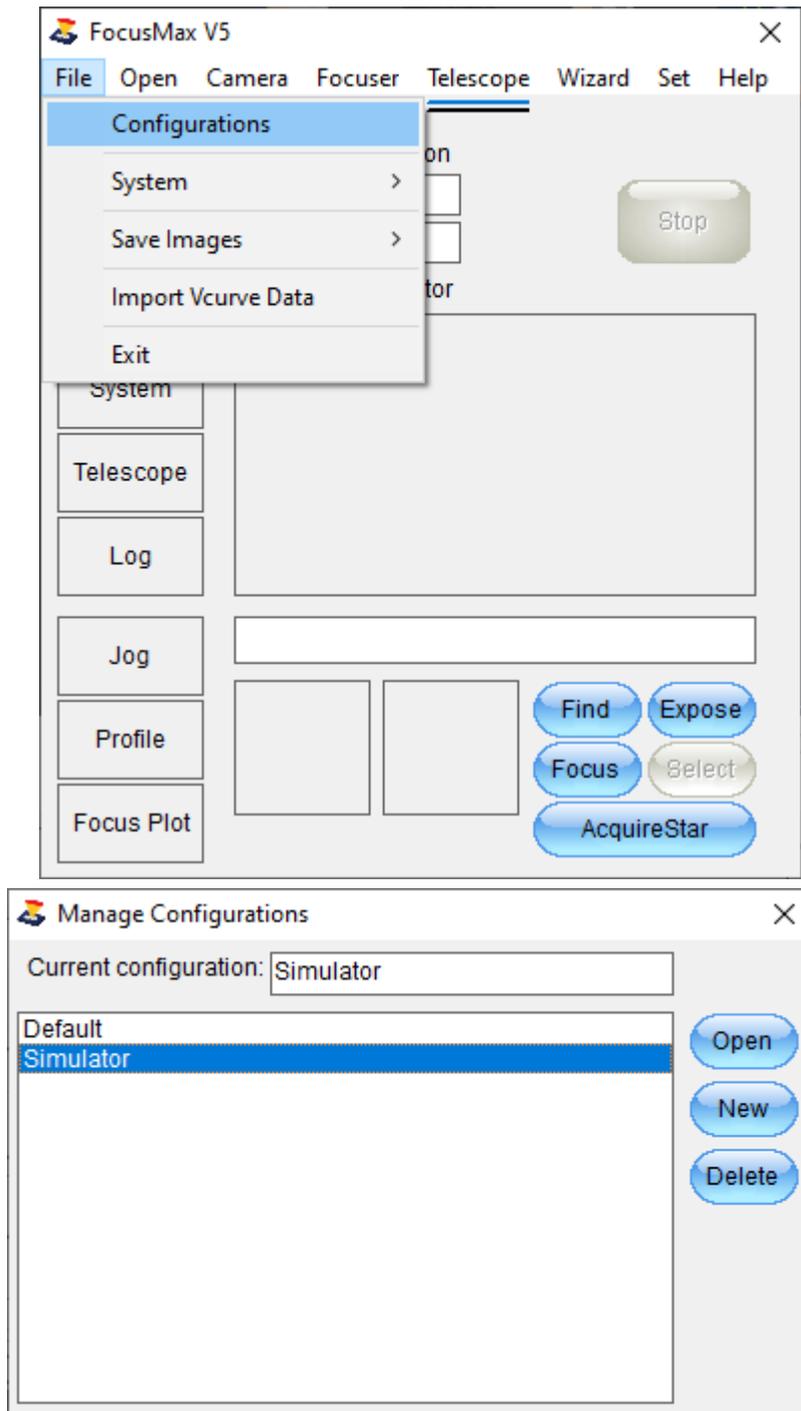
- Open TheSkyX or TheSky64 Menu / Tools / Digital Sky Survey / Setup Tab. Select Web unless you own a copy of the DSS disk



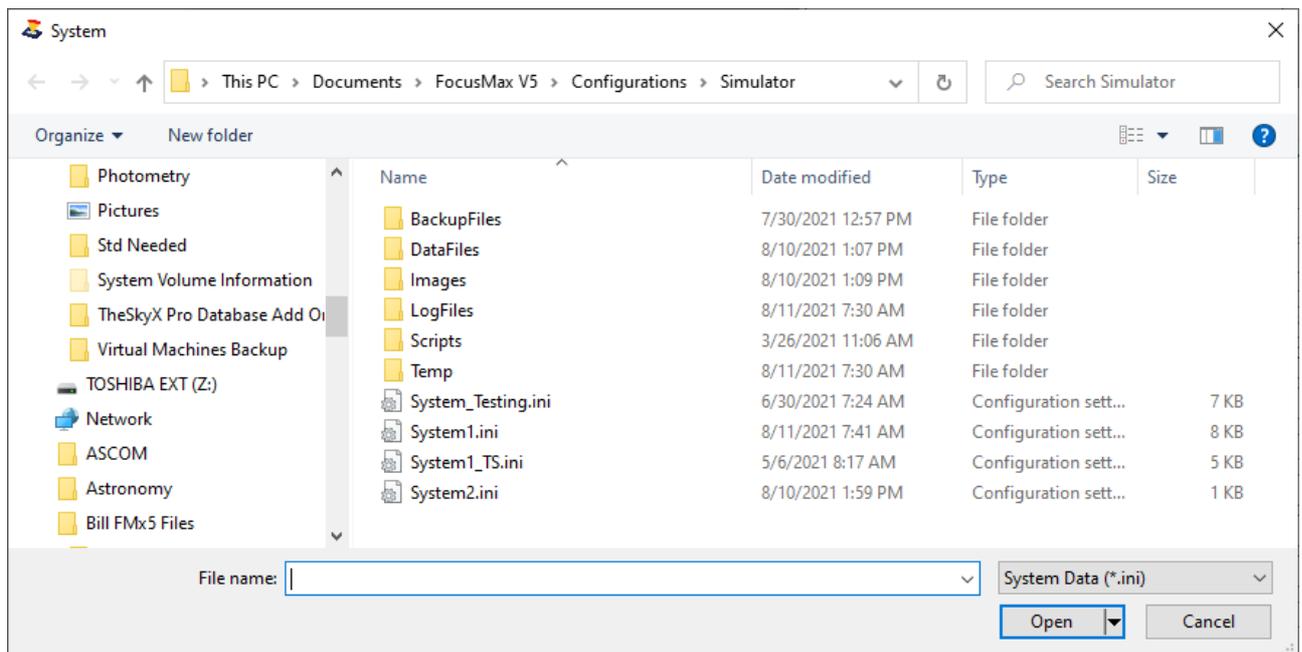
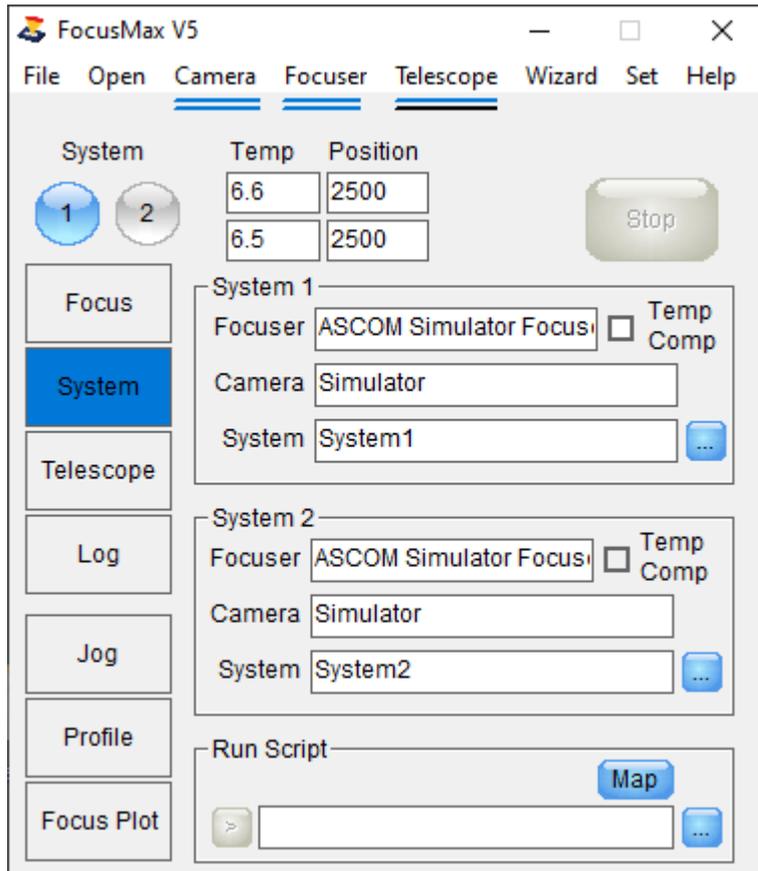
- Setup the Simulator camera in TheSky
- Enable Simulate photo using DSS



2. Open menu FocusMax 'File/Configurations' and select 'Simulator' then press Open

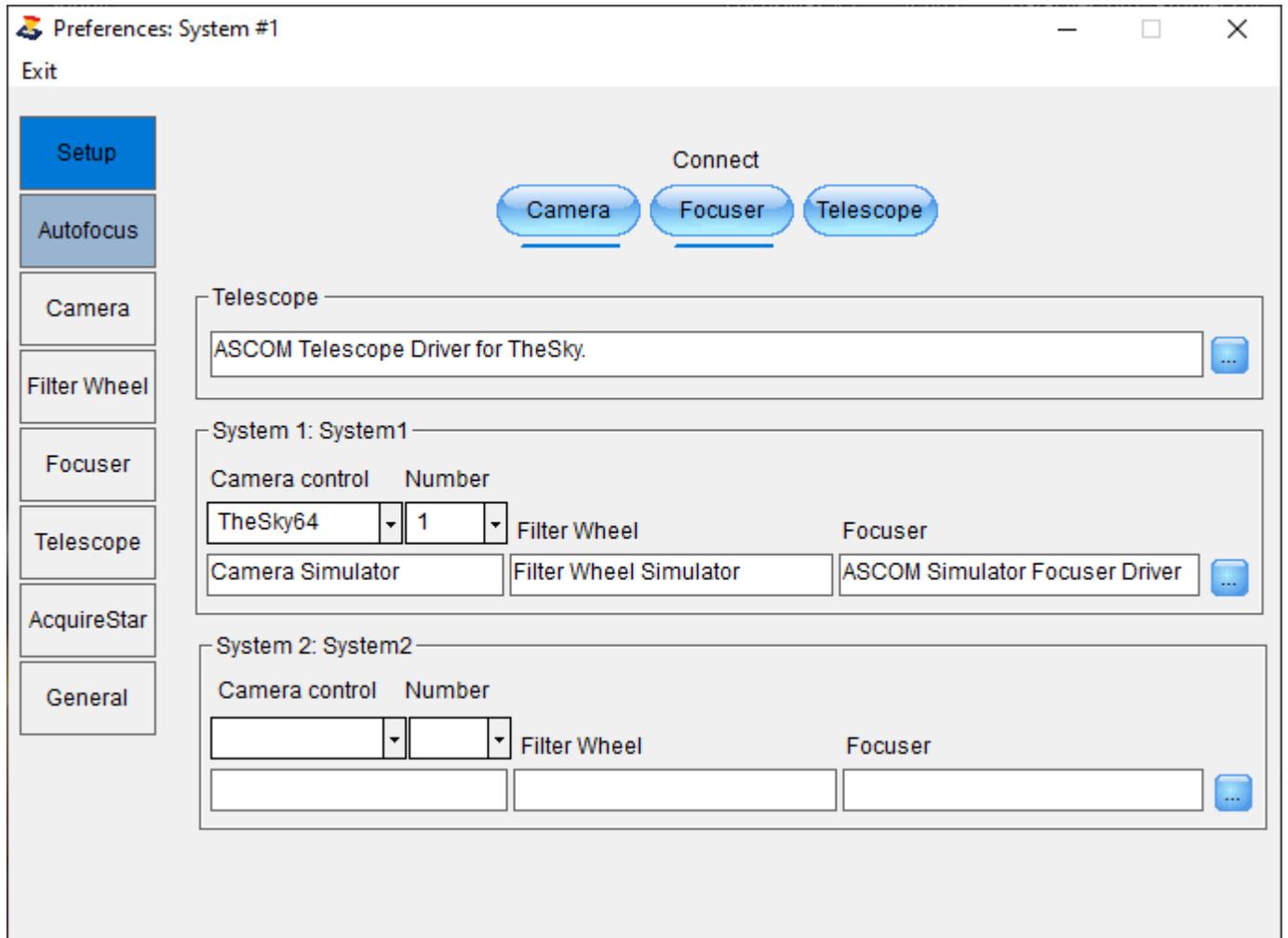


3. Press the System button then press the small square button and select "Simulator 1" or "Simulator 2" (optional) to load setup configuration

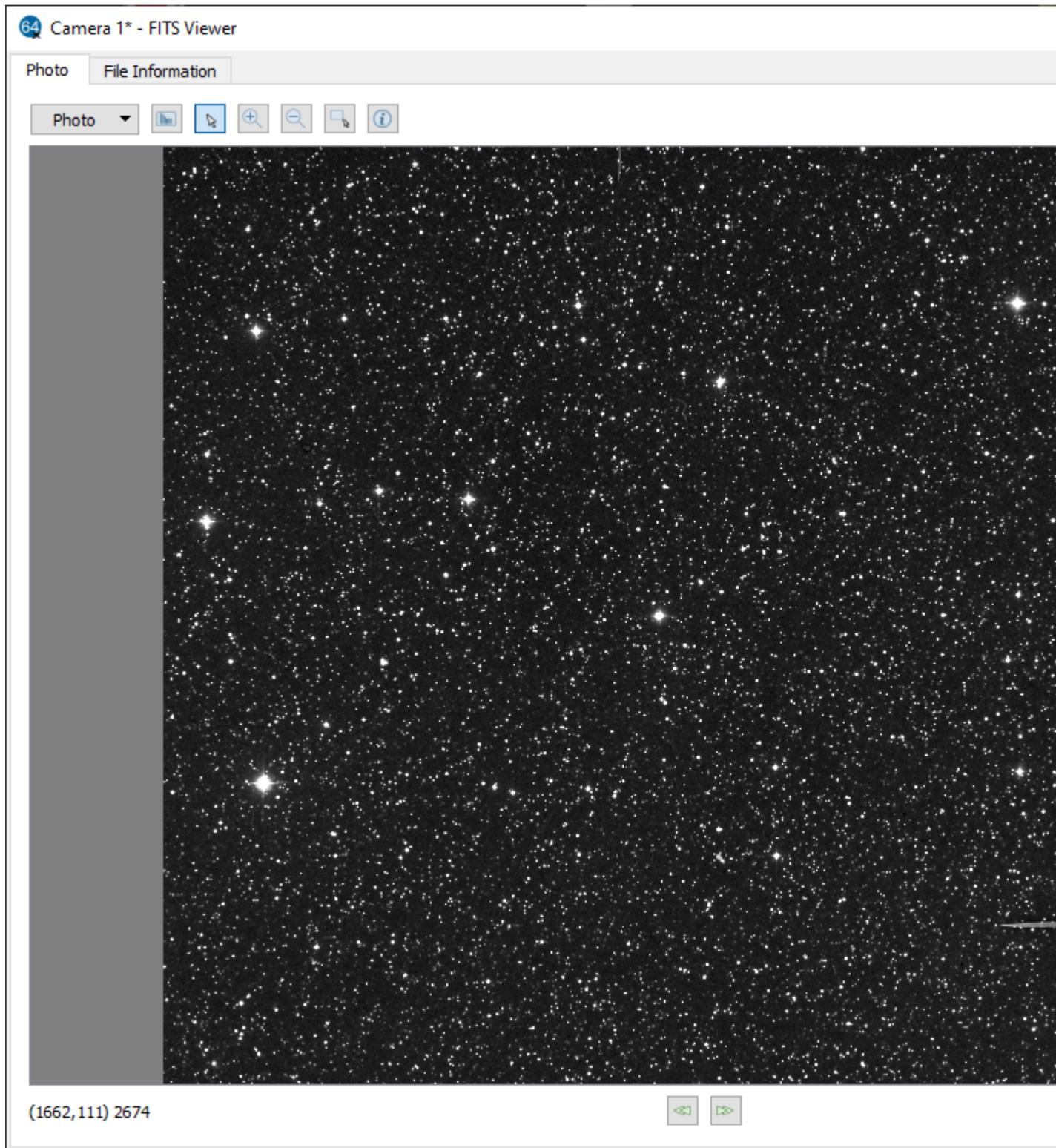


4. Open FocusMax Preferences (Menu / Open / Preferences) to configure the hardware.
 - Select TheSkyX or TheSky64 under 'Camera control'
 - Set camera 'Number' assignment, generally, Camera #1 is the main imaging camera and camera #2 is the second (guiding) camera which is not required.
 - Select Simulator focusers for System1 and System2 (optional)
 - Select the 'Telescope' driver
 - Press colored 'Connect' buttons to connect to the camera(s), focuser(s) and telescope. A blue

line will appear if the hardware is connection was successfully established with a black line if the telescope is tracking. If the telescope is not racking then set tracking will be needed to create the DSS image.



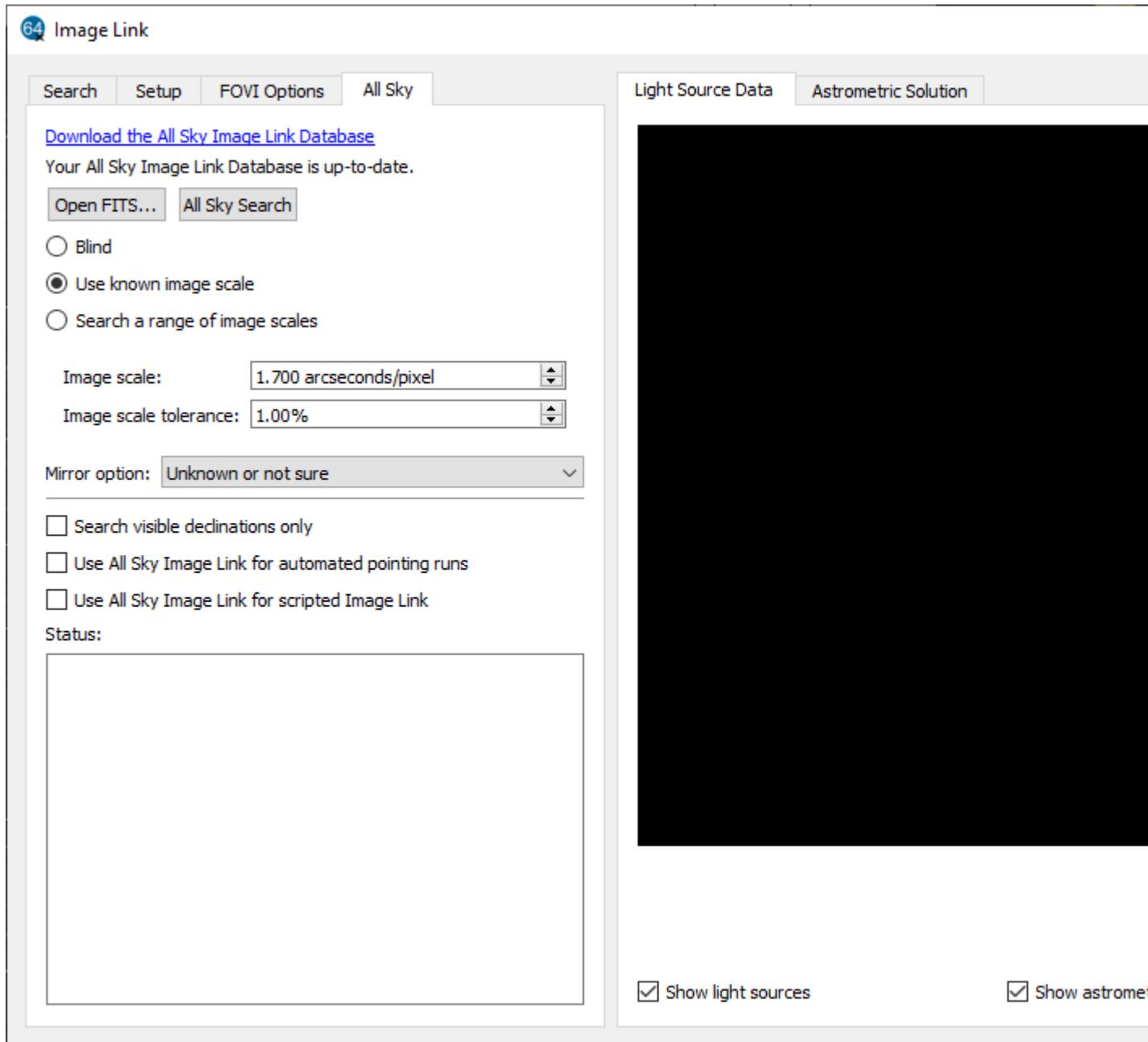
- Press the FocusMax 'Find' button and verify that a DSS image is presented in TheSky.



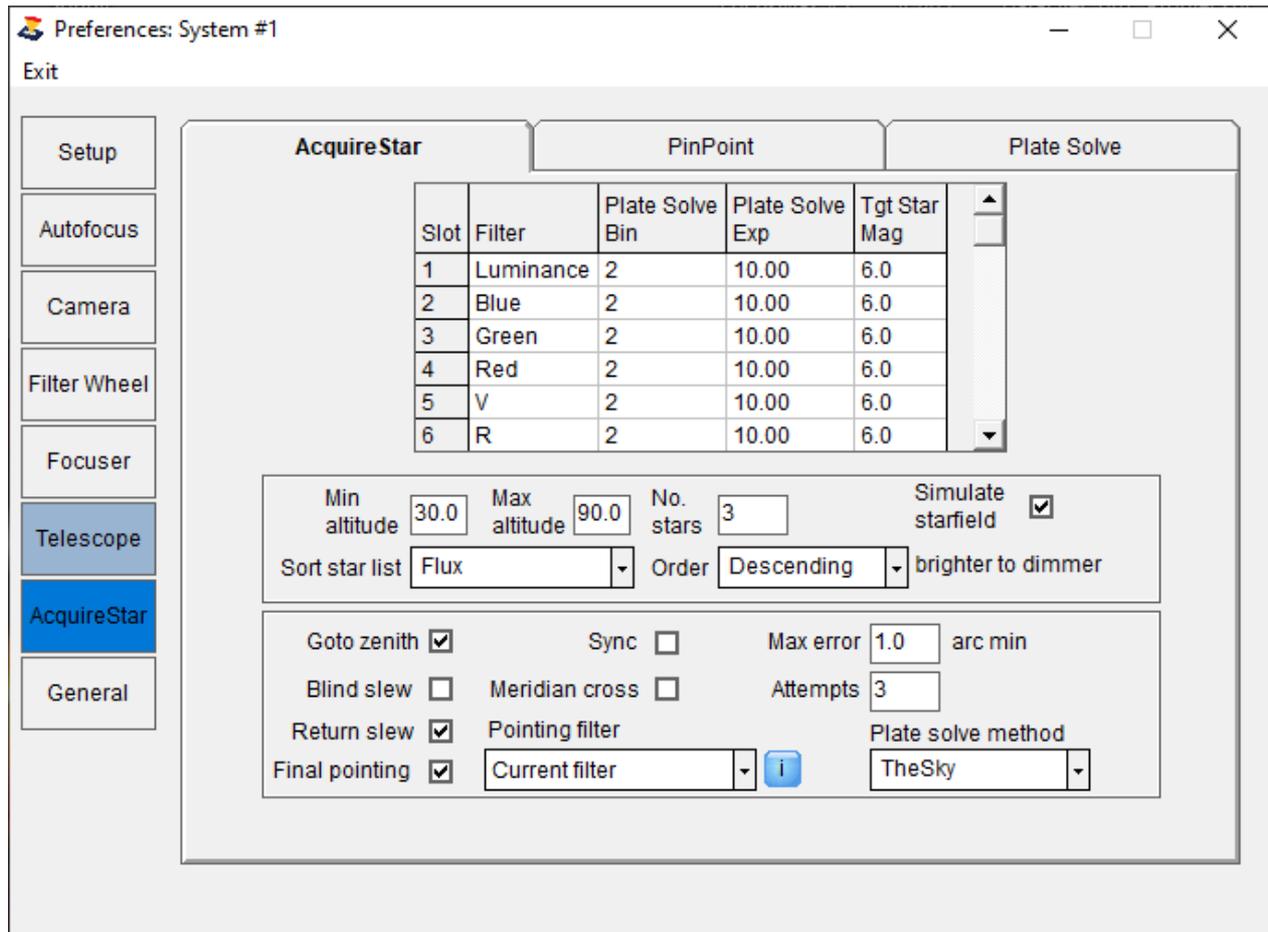
5. Plate solving images with TheSky Image Link

It is important to verify that you have the latest TheSky Image Link file is installed on your computer.

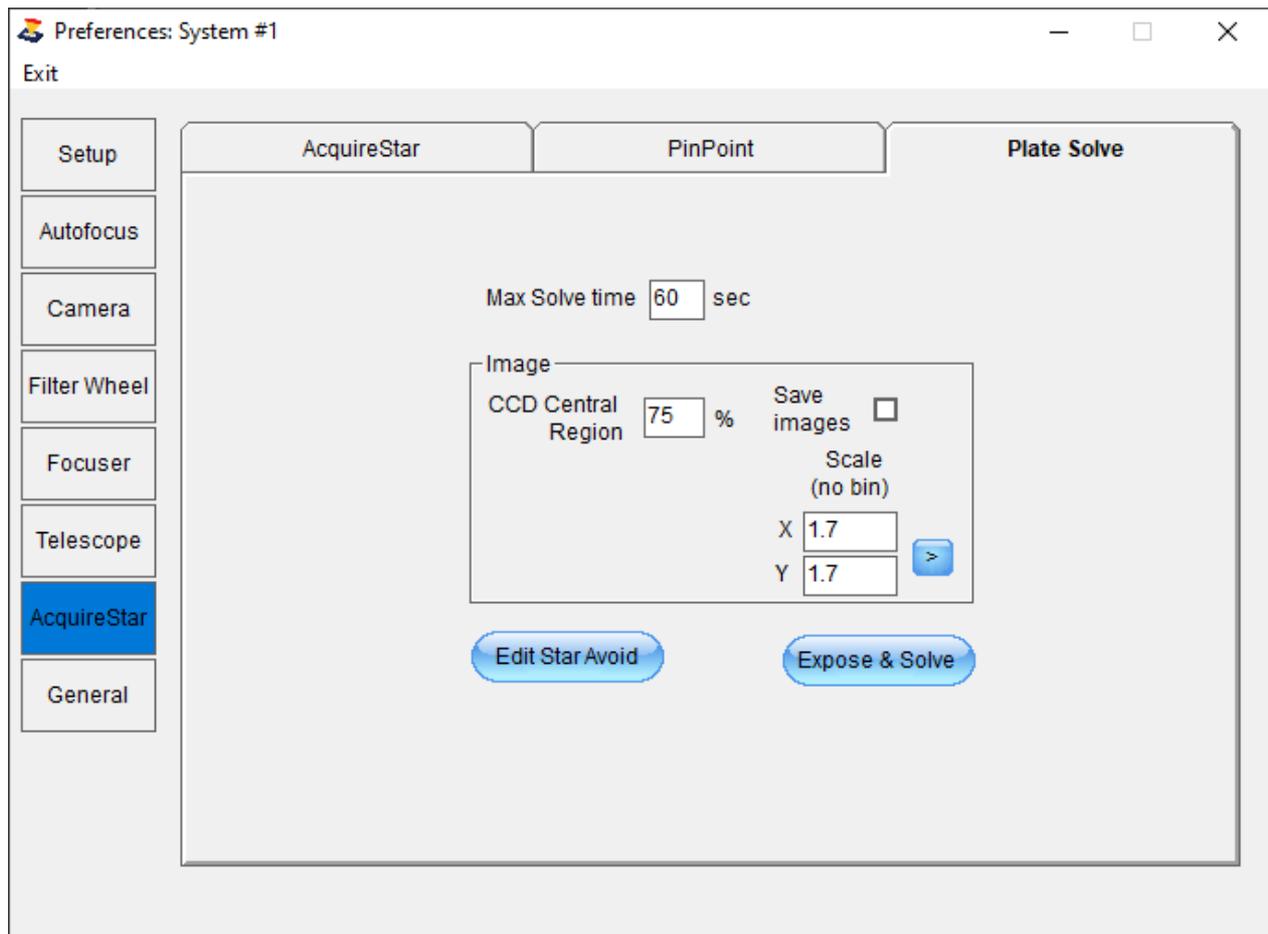
- Open TheSkyX or TheSky64 Menu / Tools / Image Link
- Click on All Sky tab to verify that you have the latest file installed (as shown below). If it is not up to date, then press the link to sign in to the Software Bisque site and download 1.7 gigabyte file.



- Once installed you have the option to use 'Image Link All Sky for scripted operations Image Link' - see above screen shot
- Enable 'Use Set the Image scale for your system or enable 'Blind' or 'Search a range of image scales'
- Open FocusMax / Preferences / AcquireStar and select TheSky method.

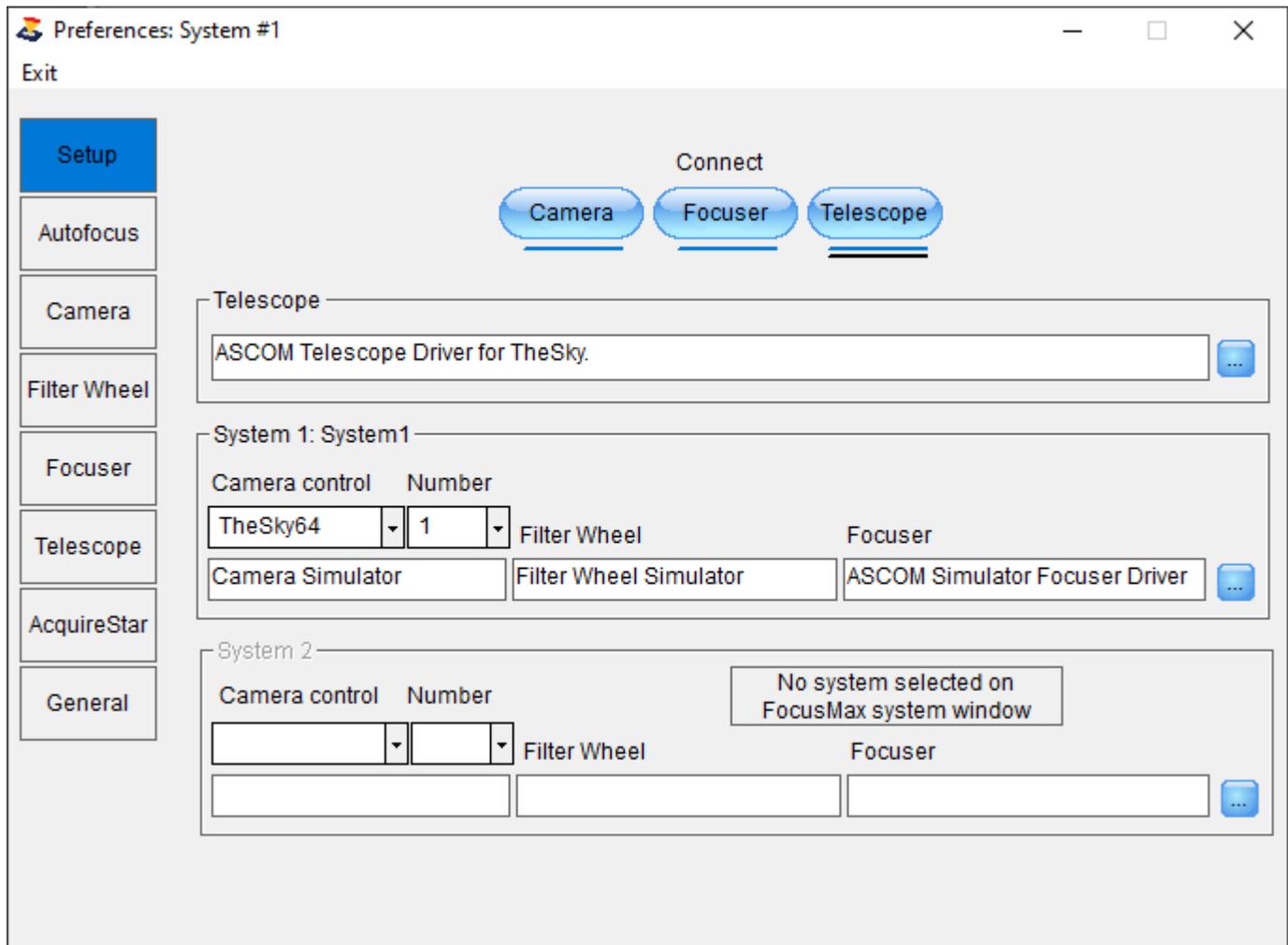


- You may test the setup by opening the AcquireStar, clicking on Plate Solve tab and pressing 'Expose and Solve' to take an image based on the current telescope coordinates. Note - The 'Expose & Solve' button will be disabled if the telescope is not connected and tracking.

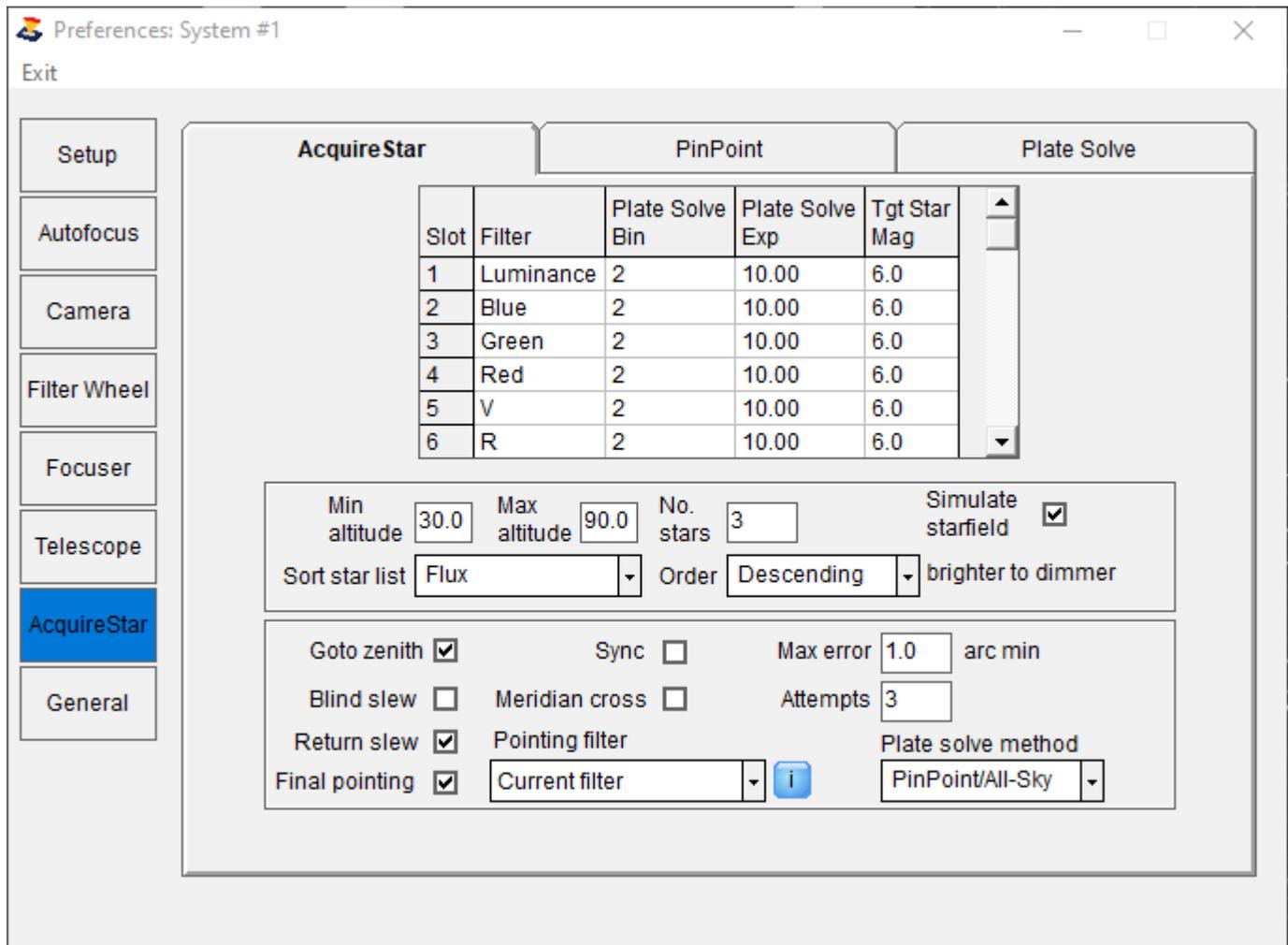


3. Plate solving images with PinPoint

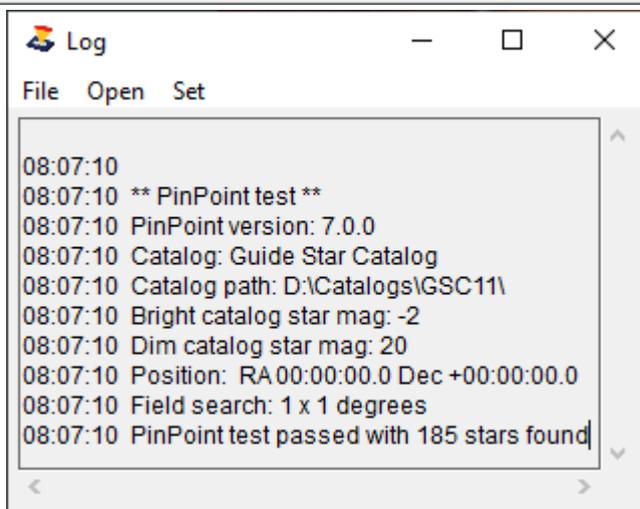
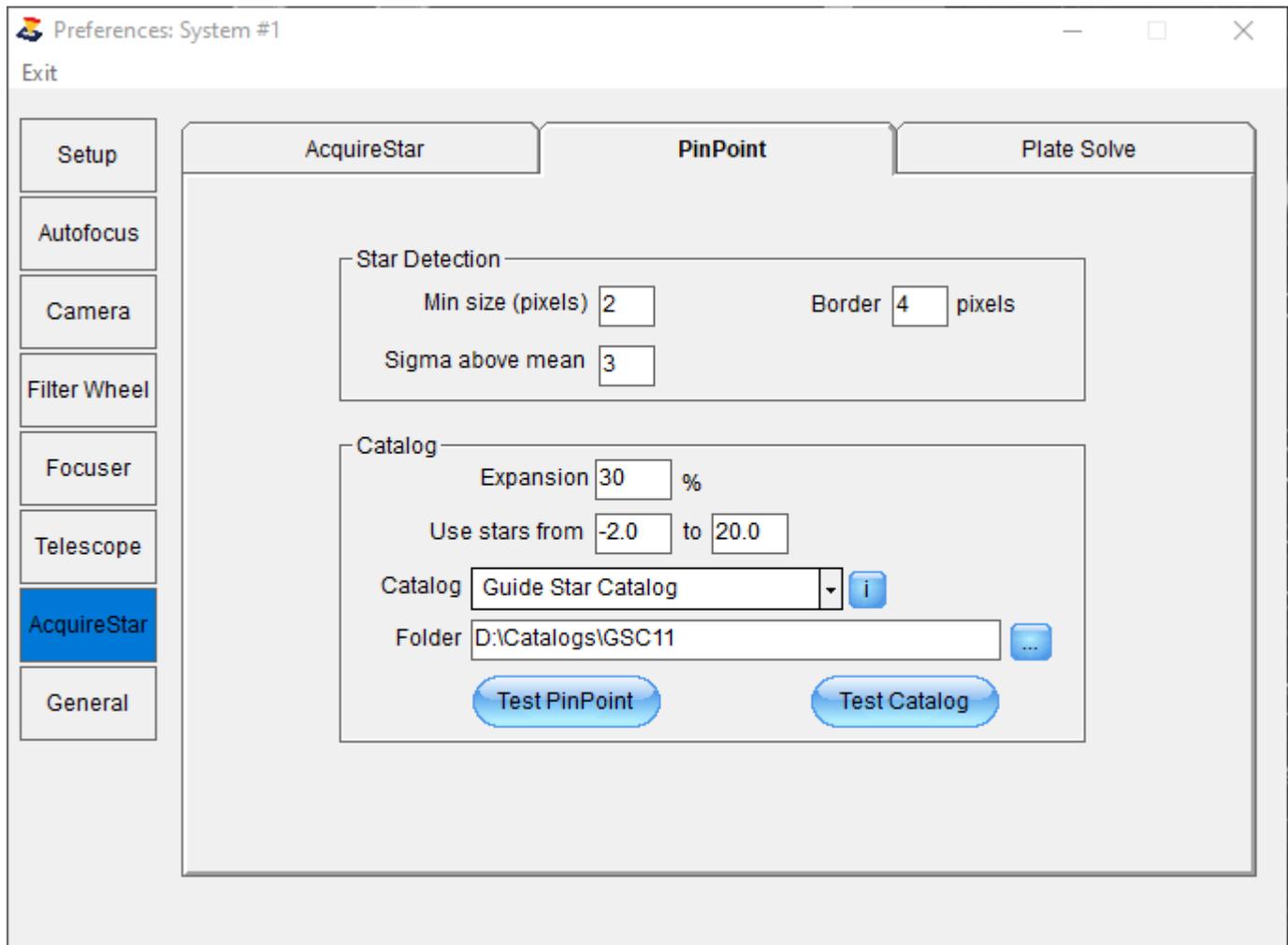
- Setup FocusMax to use TheSkyX or TheSky64 camera control



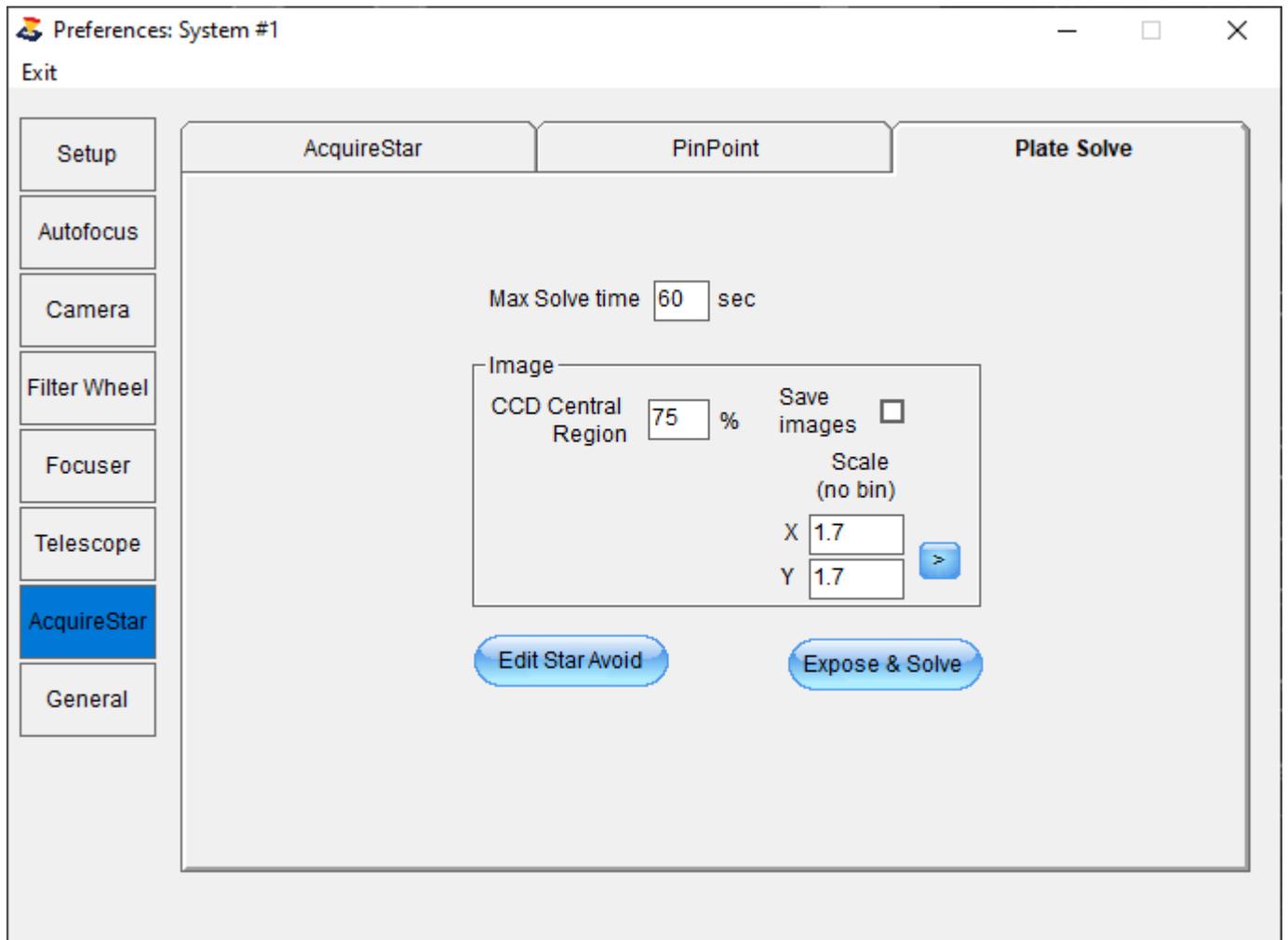
- Verify that the simulator Camera, Focuser and Telescope are connected
- Set AcquireStar 'Plate solve method' to PinPoint or PinPoint All-Sky.
- Enable 'Simulate starfield'.

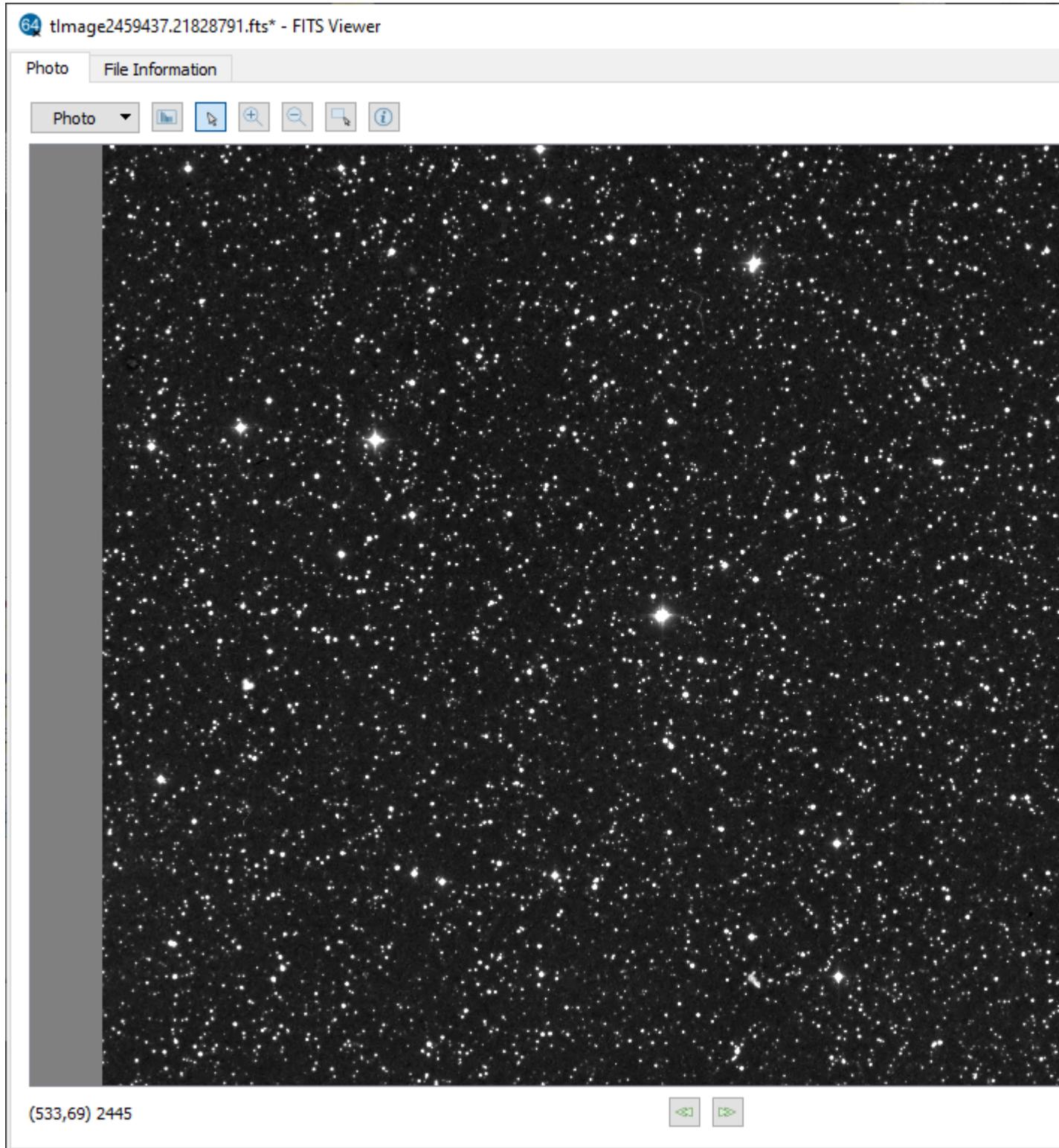


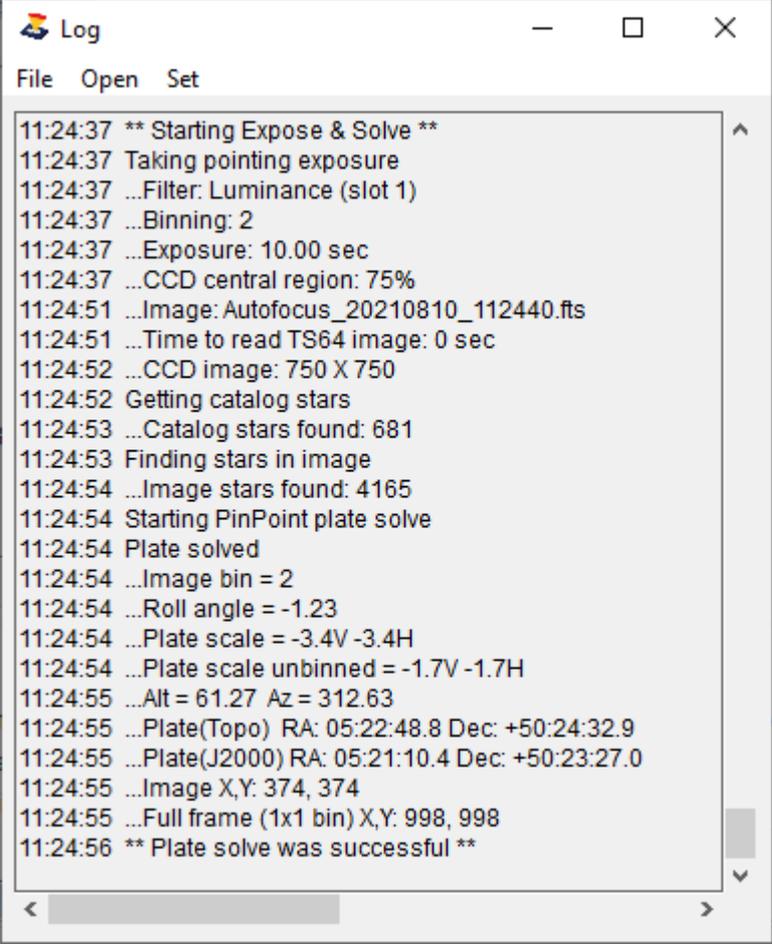
- On the PinPoint tab, select the desired PinPoint catalog and set the path to the folder containing the star catalog.
- Press the Test PinPoint button to verify that the Full version of PinPoint is installed.
- Press the Test Catalog button to verify that PinPoint can read successfully locate stars into the catalog.



- On the Plate Solve Tab, set image plate scale to 1.7 arc-sec/pixel for the DSS images.
- Press the Expose and Solve button to take a simulated image and plate solve using PinPoint.







```

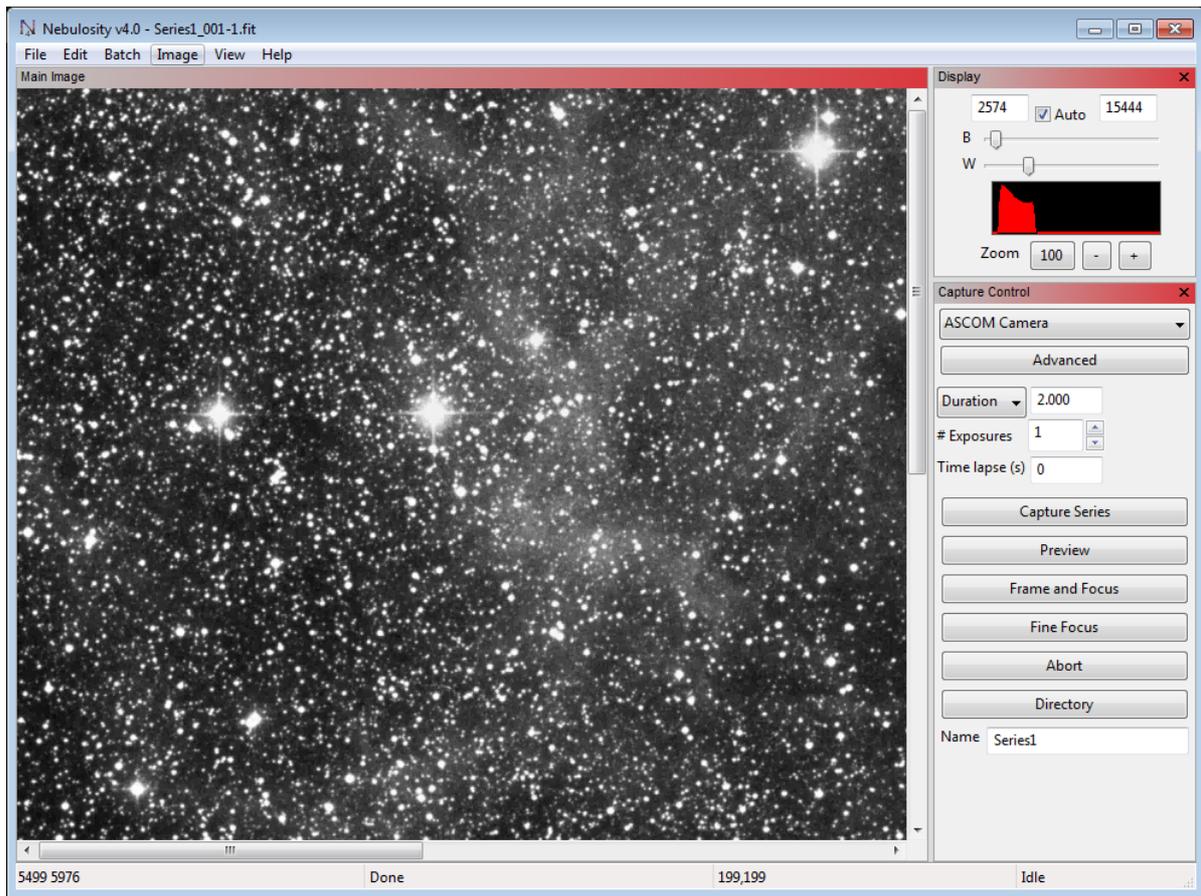
11:24:37 ** Starting Expose & Solve **
11:24:37 Taking pointing exposure
11:24:37 ...Filter: Luminance (slot 1)
11:24:37 ...Binning: 2
11:24:37 ...Exposure: 10.00 sec
11:24:37 ...CCD central region: 75%
11:24:51 ...Image: Autofocus_20210810_112440.fits
11:24:51 ...Time to read TS64 image: 0 sec
11:24:52 ...CCD image: 750 X 750
11:24:52 Getting catalog stars
11:24:53 ...Catalog stars found: 681
11:24:53 Finding stars in image
11:24:54 ...Image stars found: 4165
11:24:54 Starting PinPoint plate solve
11:24:54 Plate solved
11:24:54 ...Image bin = 2
11:24:54 ...Roll angle = -1.23
11:24:54 ...Plate scale = -3.4V -3.4H
11:24:54 ...Plate scale unbinned = -1.7V -1.7H
11:24:55 ...Alt = 61.27 Az = 312.63
11:24:55 ...Plate(Topo) RA: 05:22:48.8 Dec: +50:24:32.9
11:24:55 ...Plate(J2000) RA: 05:21:10.4 Dec: +50:23:27.0
11:24:55 ...Image X,Y: 374, 374
11:24:55 ...Full frame (1x1 bin) X,Y: 998, 998
11:24:56 ** Plate solve was successful **

```

- Run the FirstLight Wizard to generate a set of Vcurves - note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel.
- Press the Focus button to focus the system using simulator camera and focuser.
- Press Select button to use the cursor to select a single star to use for autofocus.
- Open Preferences/Autofocus and set the Focus process to 'Multi-Star', press the Focus button.
- Run AcquireStar Wizard to determine the optimum star magnitude for a given filter
- Run AcquireStar to automatically select a star for autofocus.

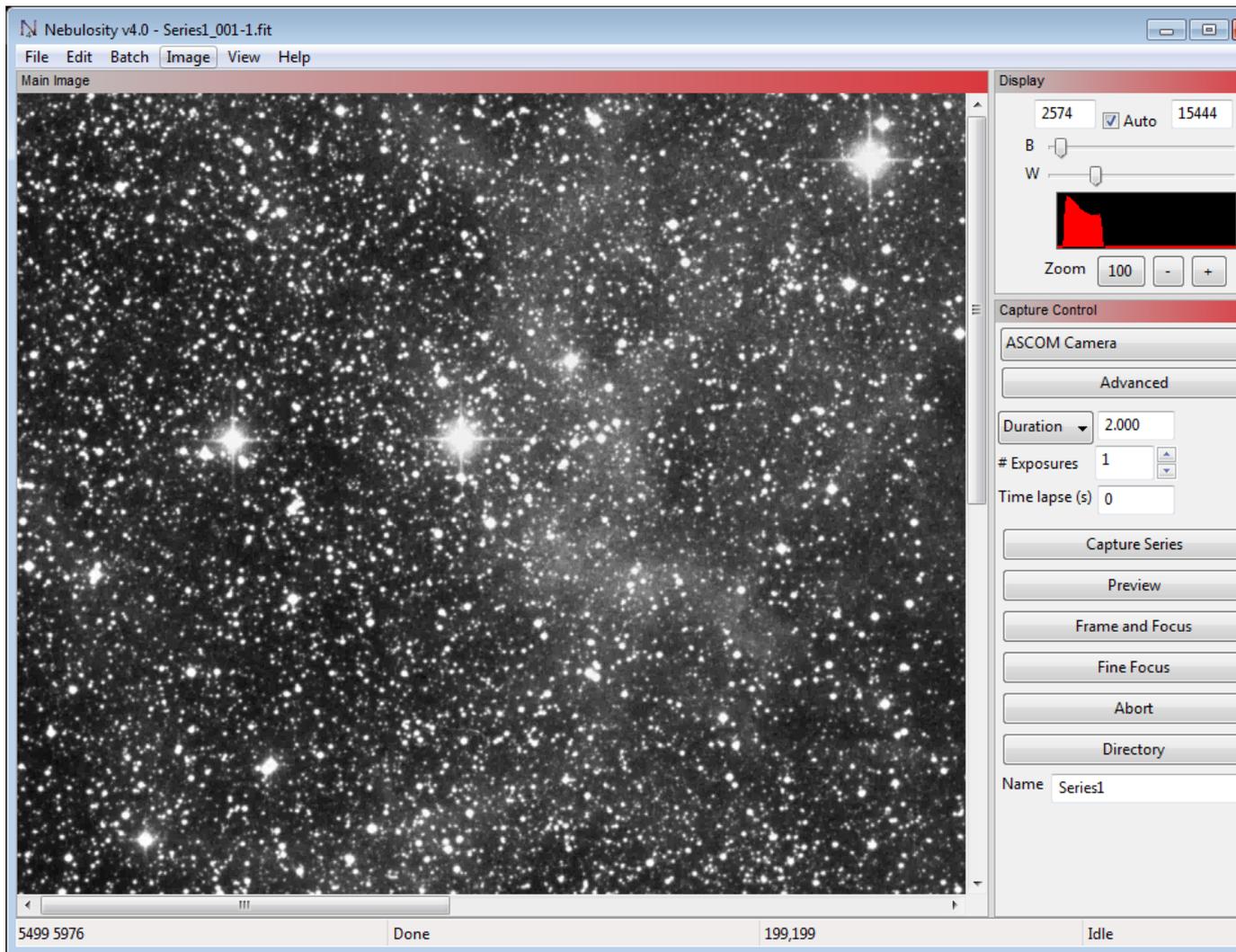
Nebulosity 4

Nebulosity 4

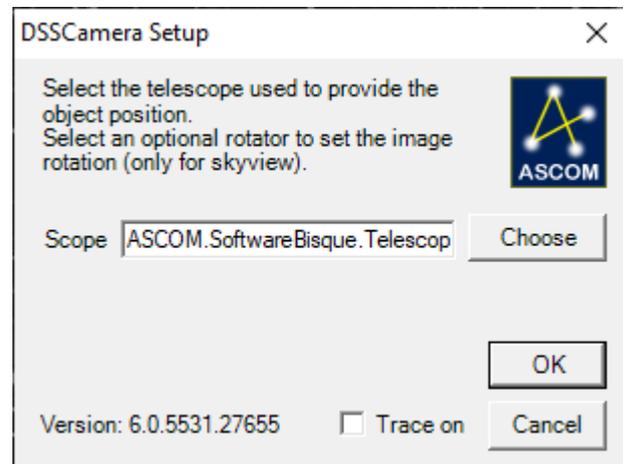
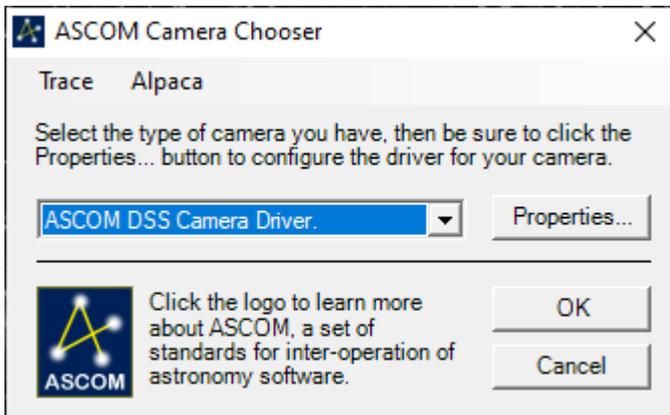
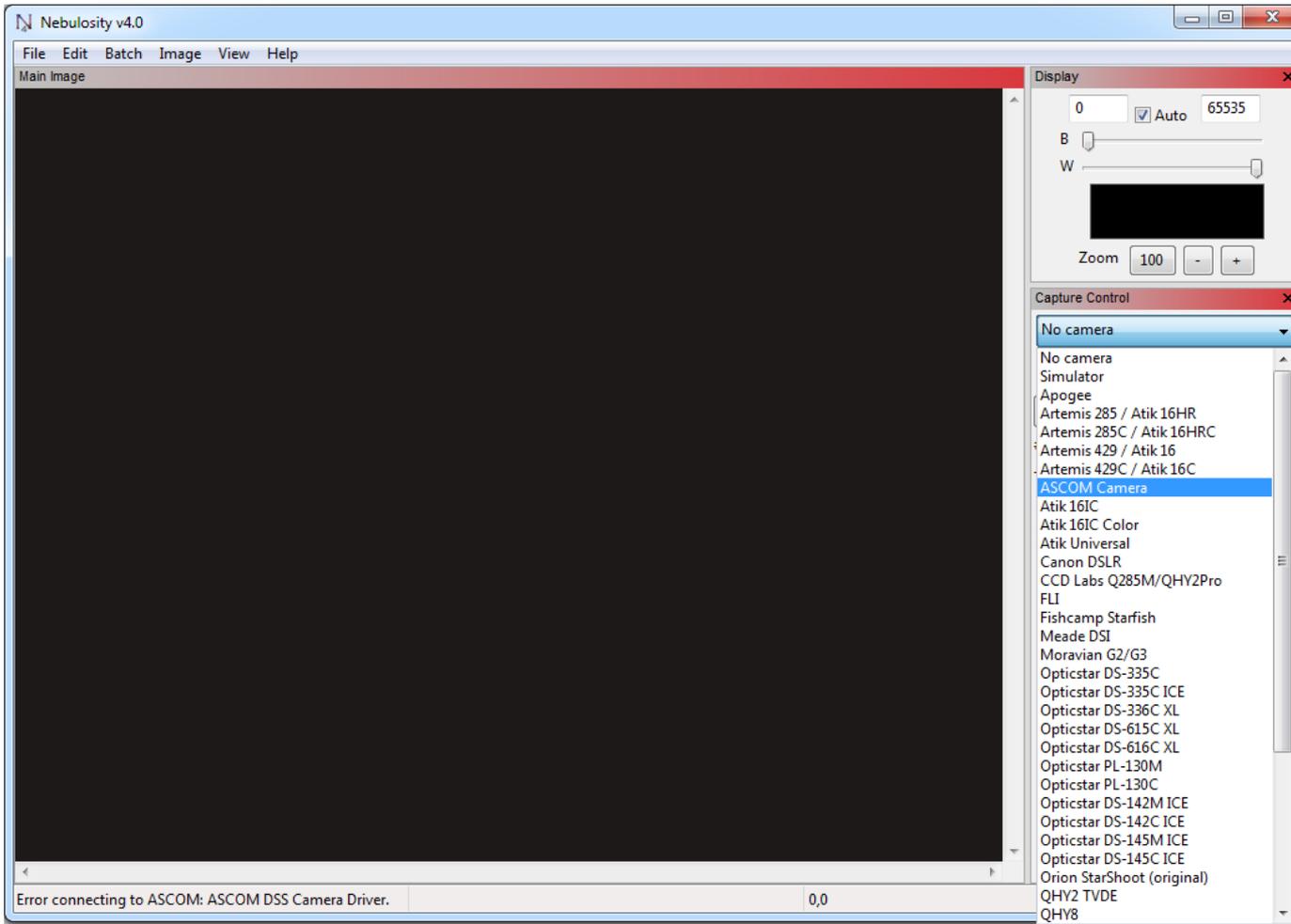


ASCOM DSS Camera

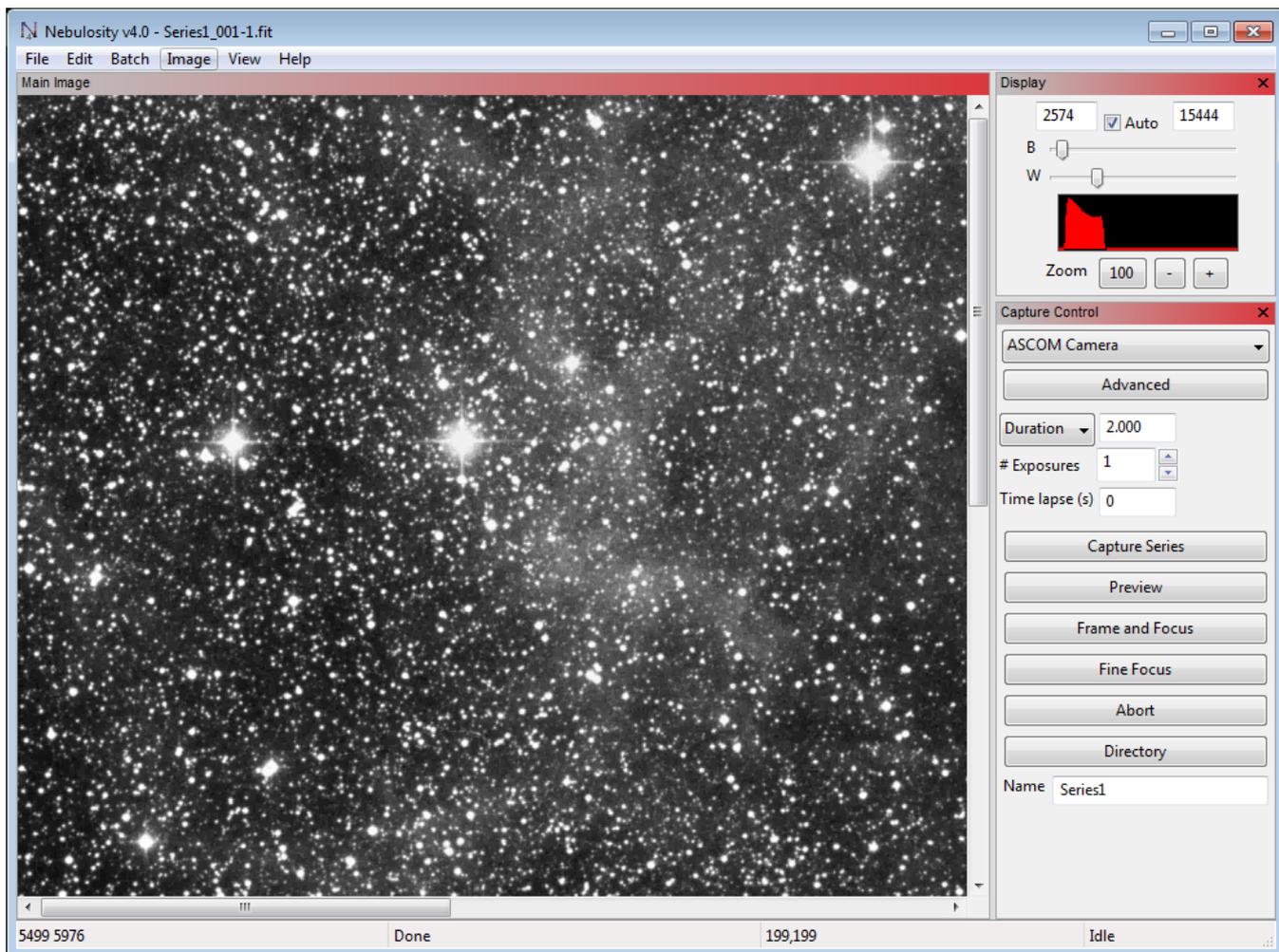
Using ASCOM DSS Camera to Generate Simulated Star Field

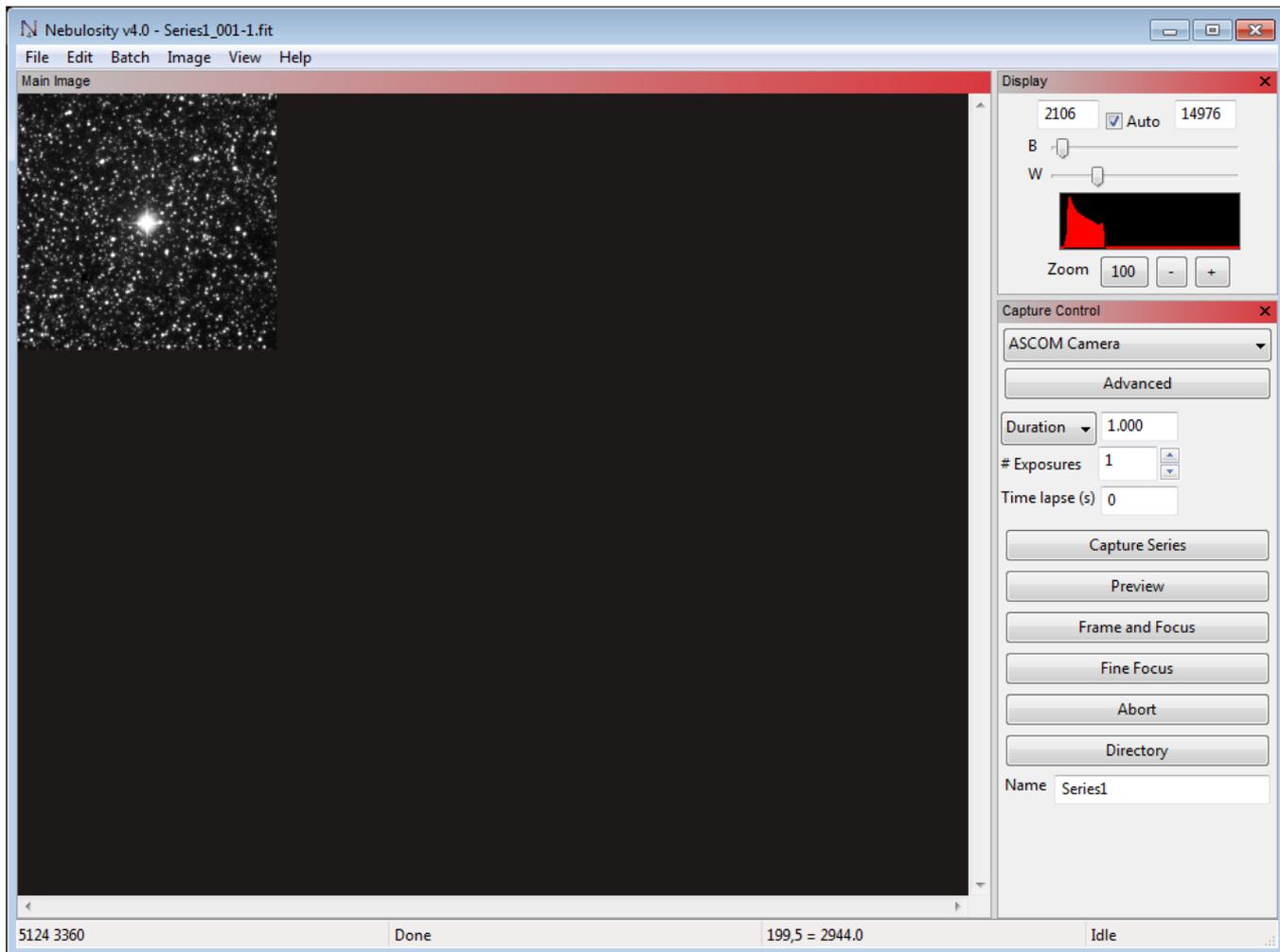


1. Install the Deep Sky Survey (DSS) ASCOM driver from <https://sourceforge.net/projects/sky-simulator/> . This camera driver will download a DSS image from the internet based on the telescope position. Once installed:
 - o Select the ASCOM camera in 'Camera Control'
 - o Press Advanced button to select the telescope connection which will provide the RA & Dec coordinates.



2. Find a star in the 8 - 10 magnitude range using your planetarium app.
 - o Press the FocusMax 'Find' button to take an image and find the brightest star in the field.

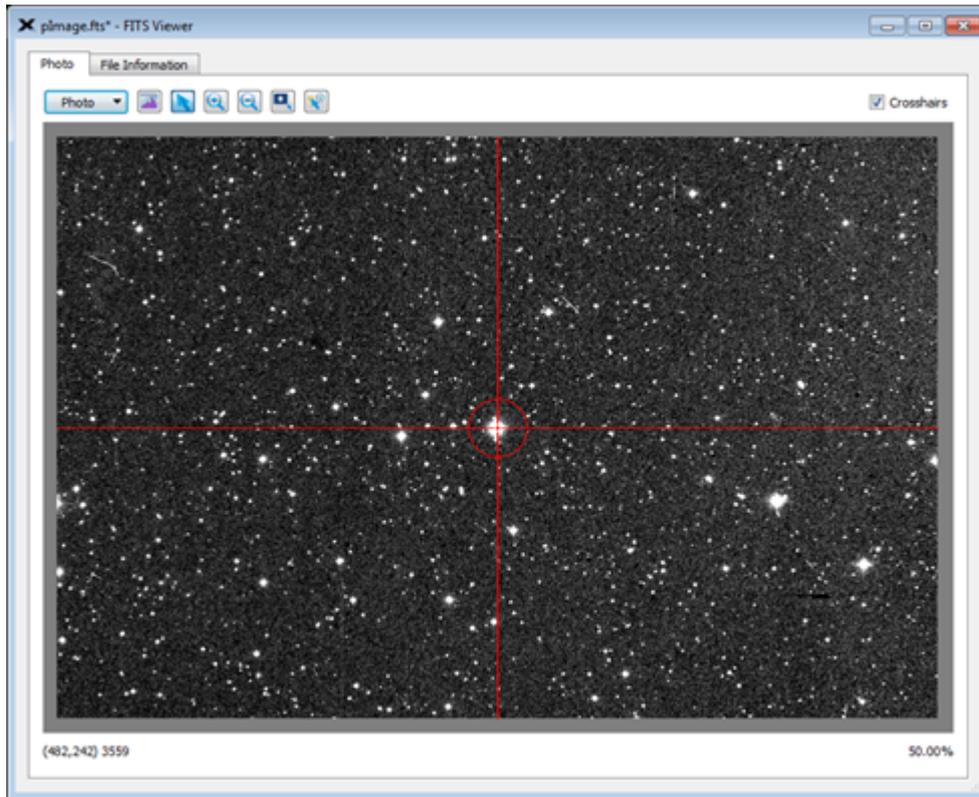




AcquireStar

Setting up AcquireStar

Astronomers are using AcquireStar with automated telescopes to perform a periodic focus update to assure that images acquired during the night are perfectly focused. AcquireStar can be operated manually by a push of a button or through automation within a script.



AcquireStar will identify and acquire a target star for autofocus that falls within the user defined requirements.

This feature requires TheSky ImageLink or the full version of PinPoint. AcquireStar will not work with the current version of PinPoint LE bundled with MaxIm V3 or higher.

At the push of a button or from a script, AcquireStar will (depending on user settings):

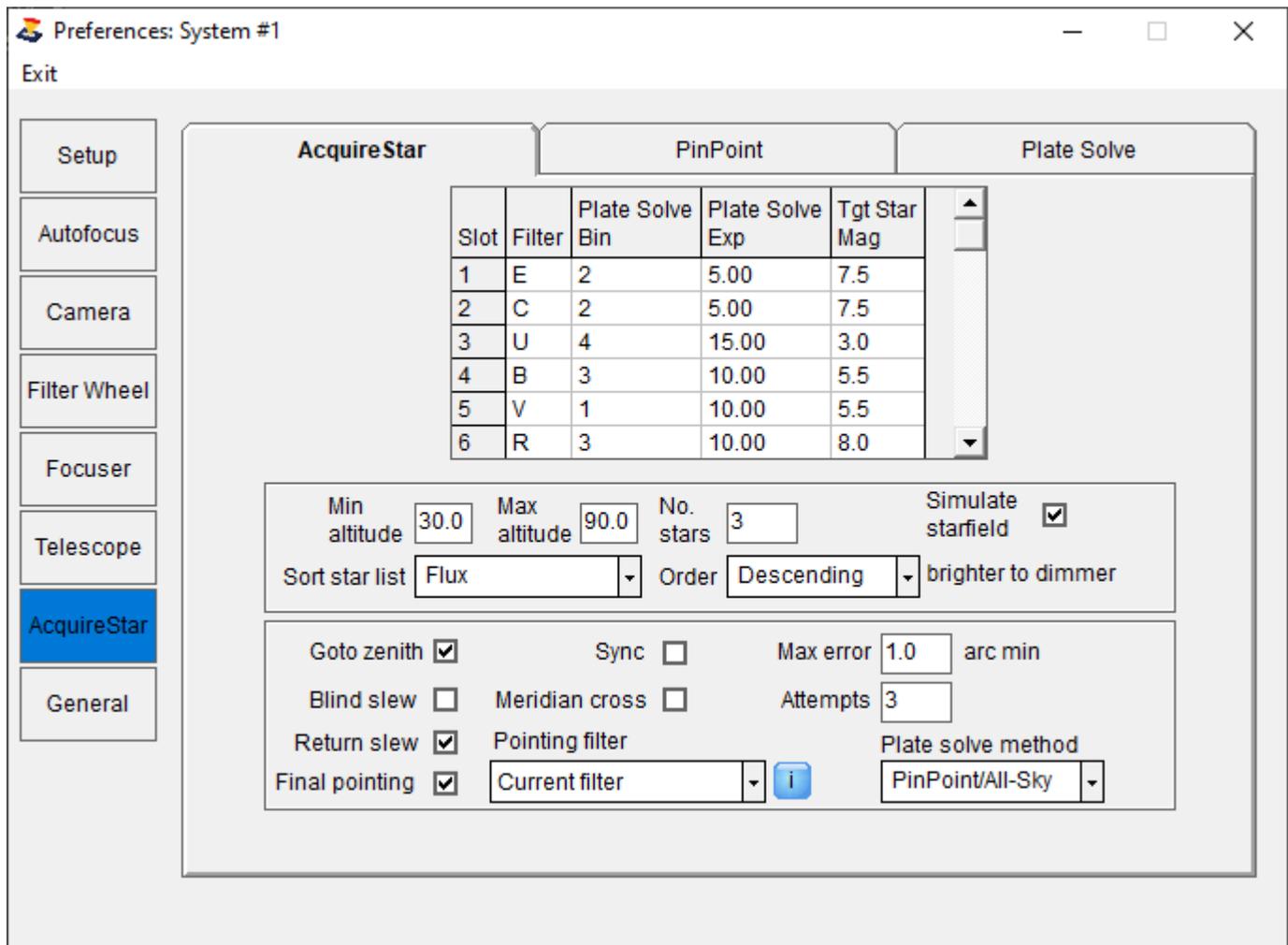
- take short exposure and plate solve current telescope position using PinPoint or TheSky Image Link.
- initiate a search in a star catalog to identify stars that meet the user defined magnitude range
- identified stars will be screened for min slew altitude, side of meridian to prevent telescope flip
- slew the telescope to the first target star in the list
- take a short exposure and plate solve current telescope position
- tweak telescope pointing to center target star
- initiate autofocus routine
- perform a return slew to original position
- take a short exposure and plate solve current telescope position
- tweak telescope pointing to meet user defined allowable pointing error

AcquireStar Tab

AcquireStar Setup Tab

The AcquireStar Tab shows the exposure and target magnitude that will be used for selecting a star from the catalog.

The bottom portion of the window is used to define the process that AcquireStar will use in selecting and slewing the telescope to the selected stars found in the catalog.



Settings for each filter (data grid):

- 'Plate Solve Bin' - set the binning that will be used for plate solve. Note: consider using 3x3 or 4x4 for restrictive filters
- 'Plate Solve Exposure' - set the exposure that will be used for plate solve current telescope position for each filter
- 'Target star magnitude' - define the target star magnitude that will be selected from the catalog. Note - a default of +1 magnitude will be used to set the dimmer star magnitude limit. This may be changed in the file FWi_XXX.cfg - for example:
 Filter1=E|2|5.00|30.00|200|2|10.00|7.0|1.0 ==> (Target = 7.0, Upper mag limit = 7.0 + 1.0 = 8.0)
 Filter2=C|2|5.00|15.00|200|4|5.00|10.0|2.0 ==> (Target = 10.0, Upper mag limit = 10.0

+ 2.0 = 12.0)

Click in the cell you wish to update then double click to change the value, press Return or leave the cell to save the changes.

Min Slew Altitude

The minimum allowed telescope slew altitude.

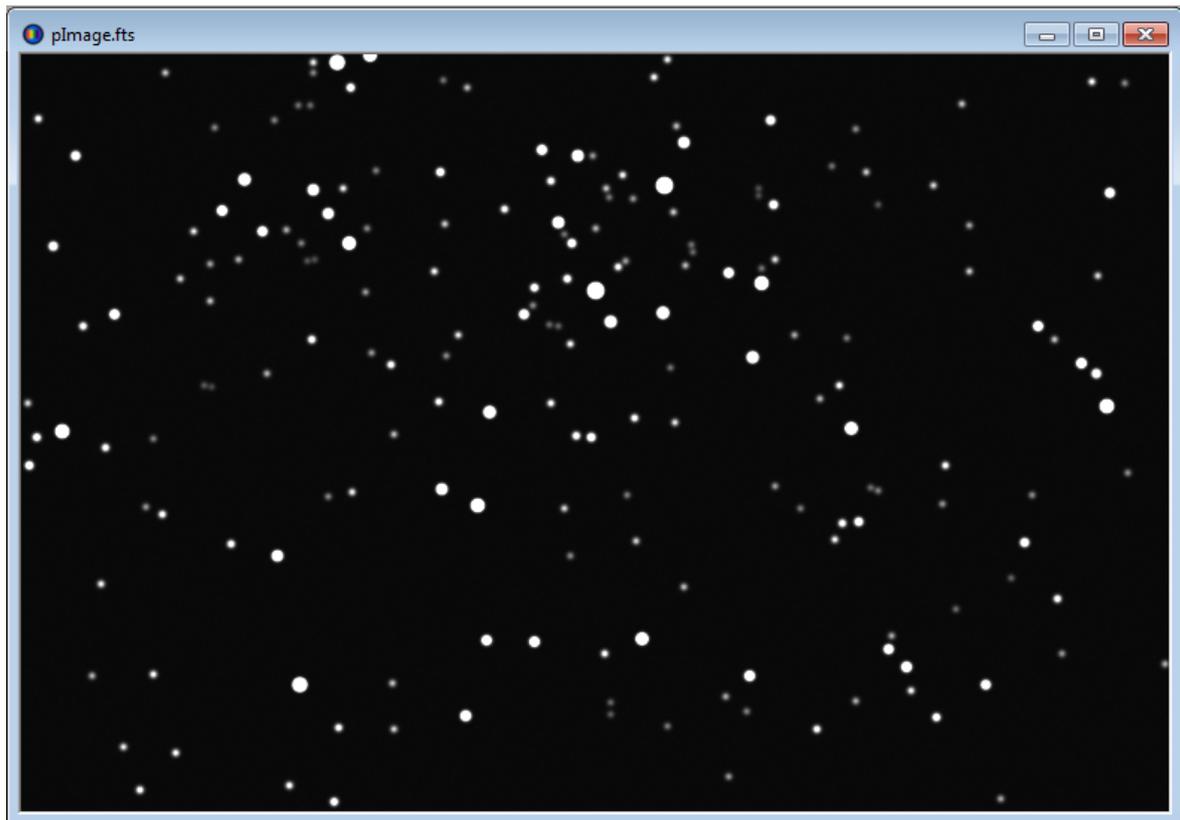
Number of Stars

The minimum number of stars that will be selected from the star catalog that meet the user defined parameters, default = 3.

Simulate starfields

A simulated starfield can be generated for testing and learning about the many FocusMax features.

- PinPoint or PinPoint All-Sky must be selected as the plate solve method (requires Full PinPoint not LE) or TheSky Image Link
- System 'Simulator1' or 'Simulator2' must be selected on the main FocusMax 'System' window. These files can be found in '//Configurations/Simulator'.
- Camera Simulator must be selected and connected in the camera control app.
- Focuser (Simulator or real) must be selected and connected.
- Telescope (Simulator or real) must be connected and tracking.



Return slew

Enable to set the telescope to perform a return slew after acquiring the target star and performing the autofocus routine.

Blind slew

Enable for the telescope to perform slews blind without using astrometric plate solving to determine the precise telescope position.

Goto Zenith

AcquireStar will begin the target star selection process at the zenith and expand in 2x2 degree increments until a suitable stars are found.

Meridian Cross

AcquireStar will allow target star from being selected on the other side of the meridian. Enable this feature if you are using a mount **that does not flip**, such as an equatorial fork mount.

Sync

Allow the telescope to sync to current position following a successful astrometric plate solution of the current telescope position.

Max error

The maximum allowable telescope position error following a telescope slew that the user will accept before AcquireStar will attempt to fine tune the telescope position by taking another image and plate solving, default = 1 arc-min.

Attempts

The number of plate solve attempts to achieve required telescope pointing, default = 3

Plate Solve Method

- [PinPoint](#) to plate solve the telescope pointing
- [PinPoint/All-Sky](#) requires an internet connection to send information to Astrometry.net plate solving service or the All-Sky may be copied to a local drive which will speed the process.
- [TheSky](#) Image Link to plate solve the telescope pointing. The user may enable utilize All Sky Image Link in TheSky if the appropriate catalogs have been installed

Notes

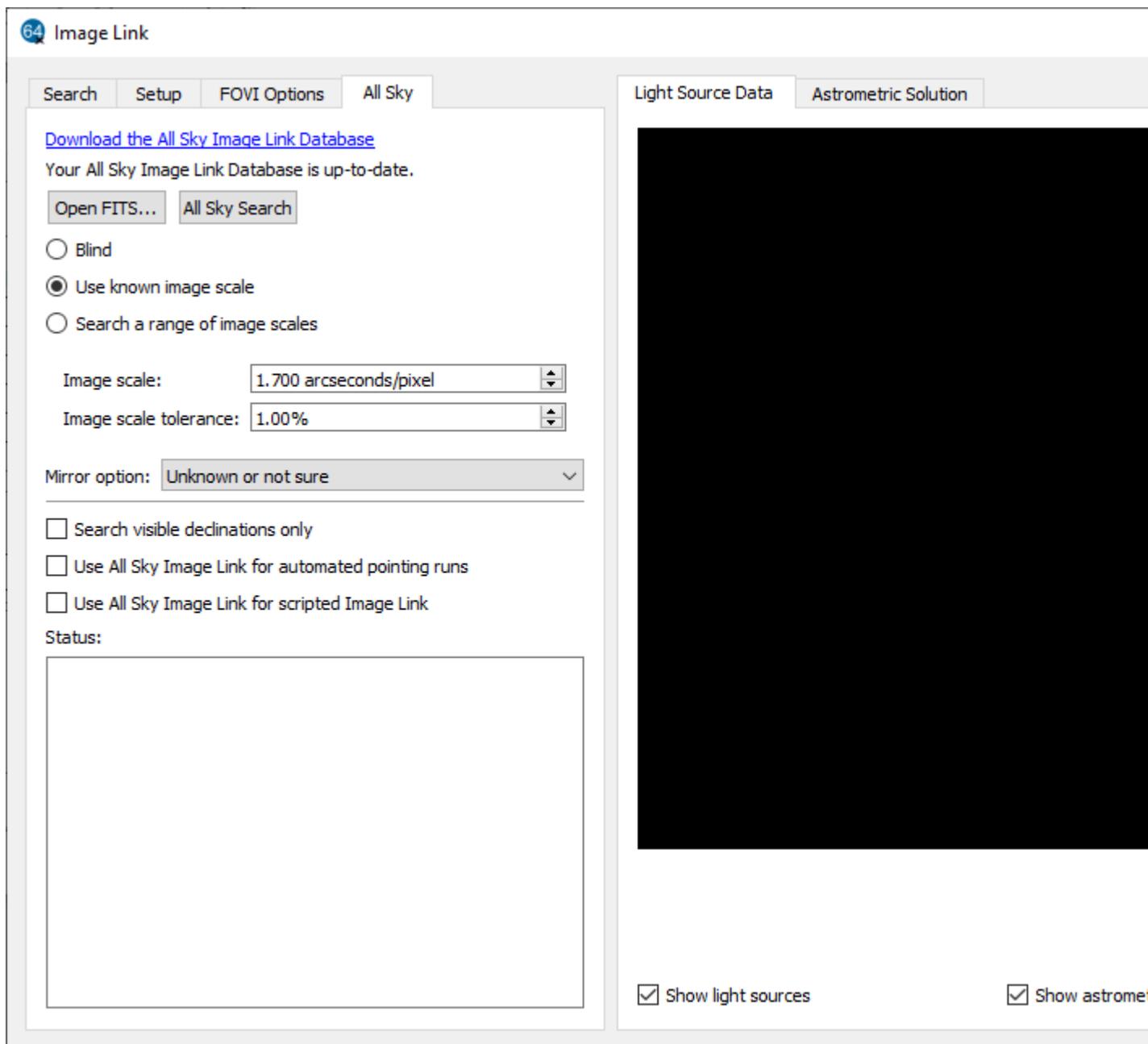
- Do not select a target star magnitude that will saturate the camera sensor for any given filter.
- The user can specify the number of stars (default = 3) to select from the star catalog before the telescope slew is initiated. If the autofocus run fails, then the second star in the list is used, followed by the 3rd, etc.

TheSky Image Link

Setting up TheSky Image Link

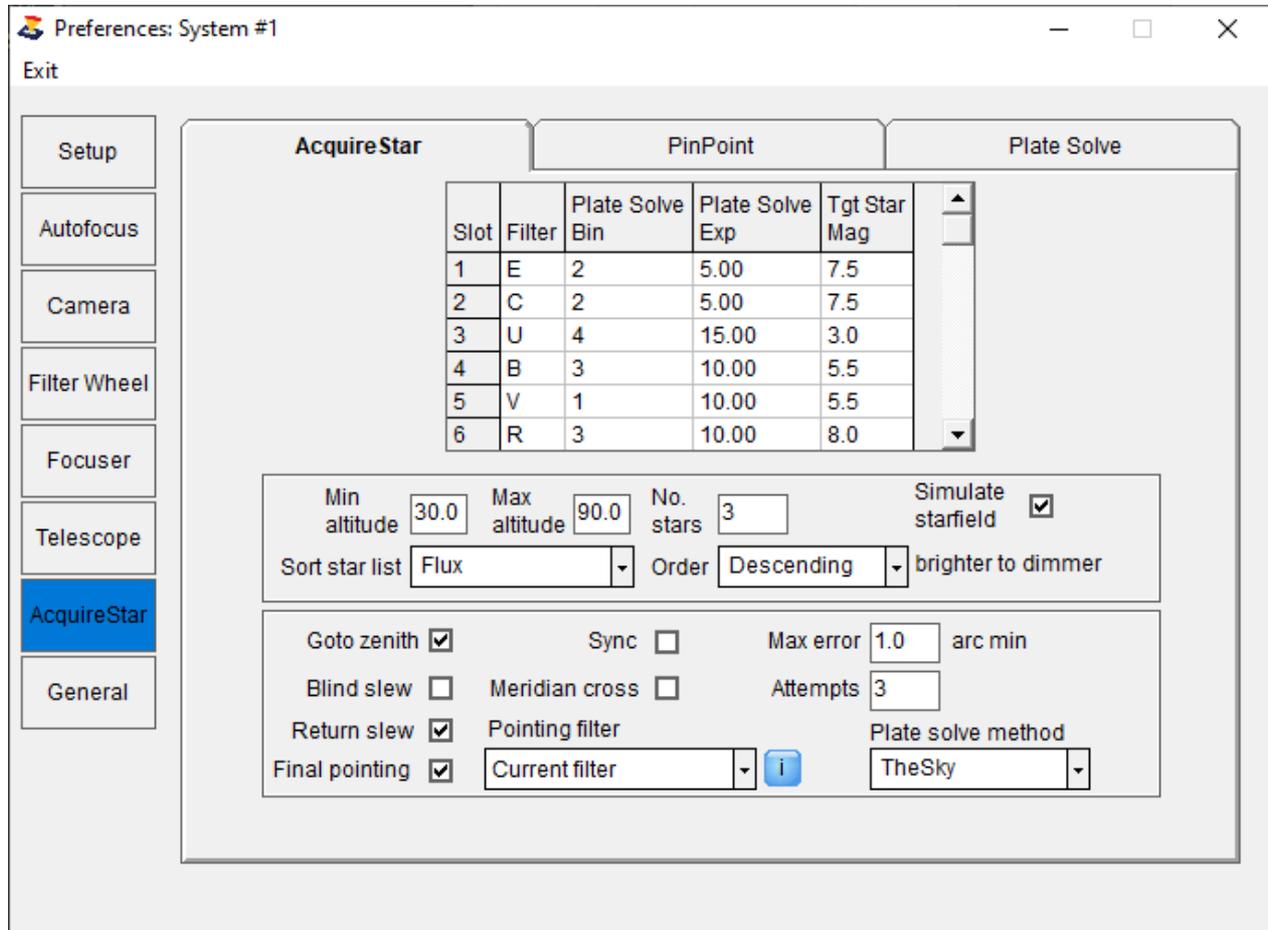
Images taken with TheSky Camera Add-on, MaxIm, or Nebulosity 4 may be plate solved using TheSky Image Link method.

1. **It is important to verify that you have the latest TheSky Image Link file is installed on your computer.**
 - o Open TheSky / Menu / Tools / Image Link
 - o Click on All Sky tab to verify that you have the latest file installed (as shown below). If it is not up to date, then press the link to sign in to the Software Bisque site and download 1.7 gigabyte file.

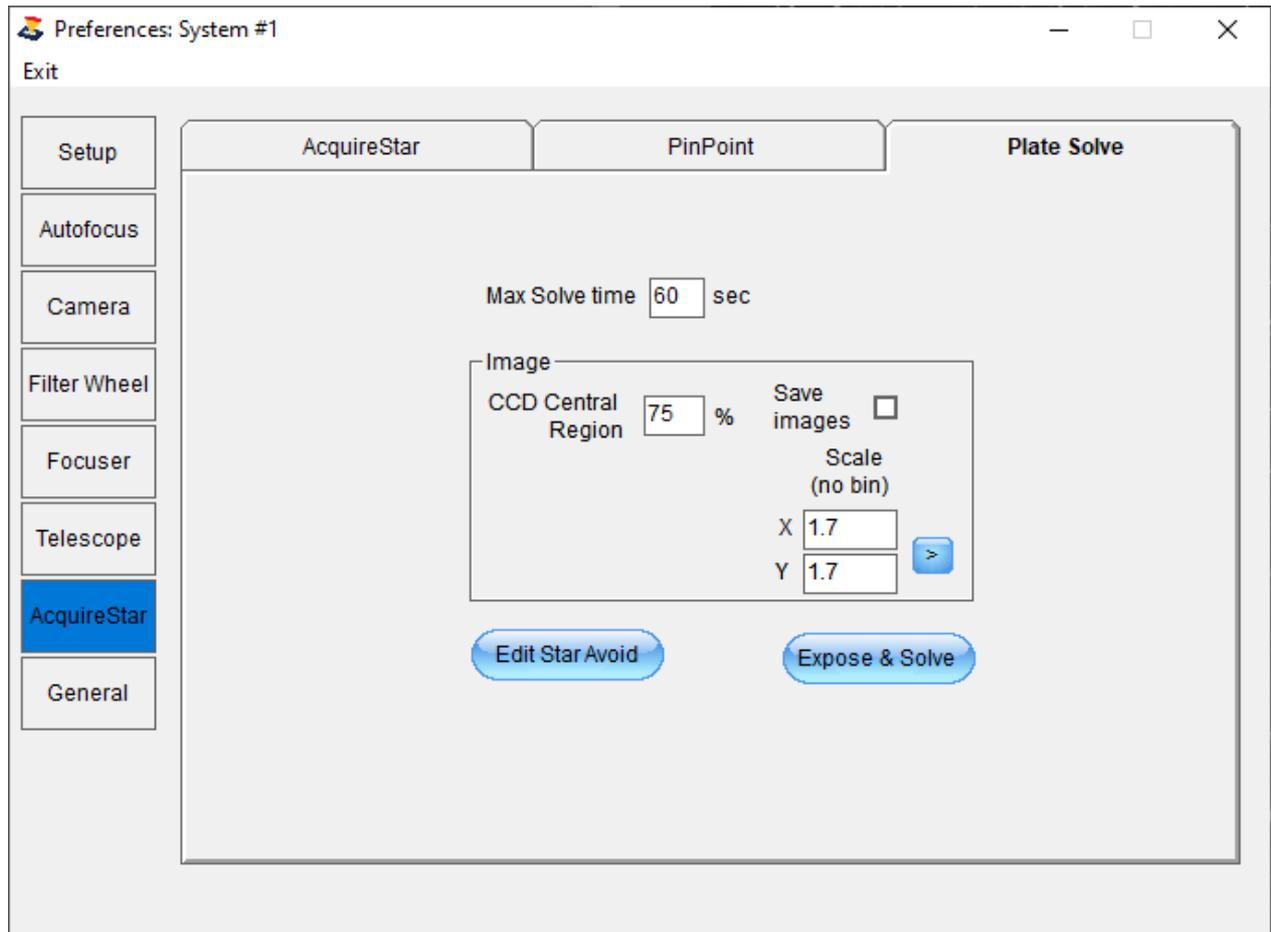


- Once installed you have the option to use 'Image Link All Sky for scripted operations Image Link' - see above screen shot
- Enable 'Use Set the Image scale for your system or enable 'Blind' or 'Search a range of image scales'

2. Open FocusMax / Preferences / AcquireStar and select TheSky method.



3. You may test the setup by opening the 'Plate Solve' tab and pressing 'Expose and Solve' to take an image to plate solve.

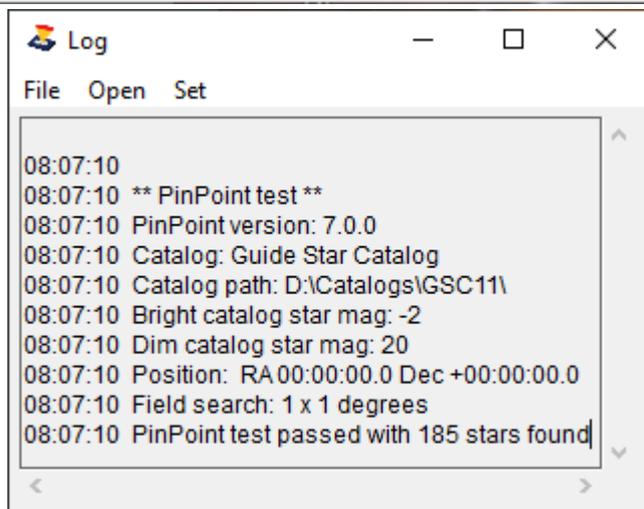
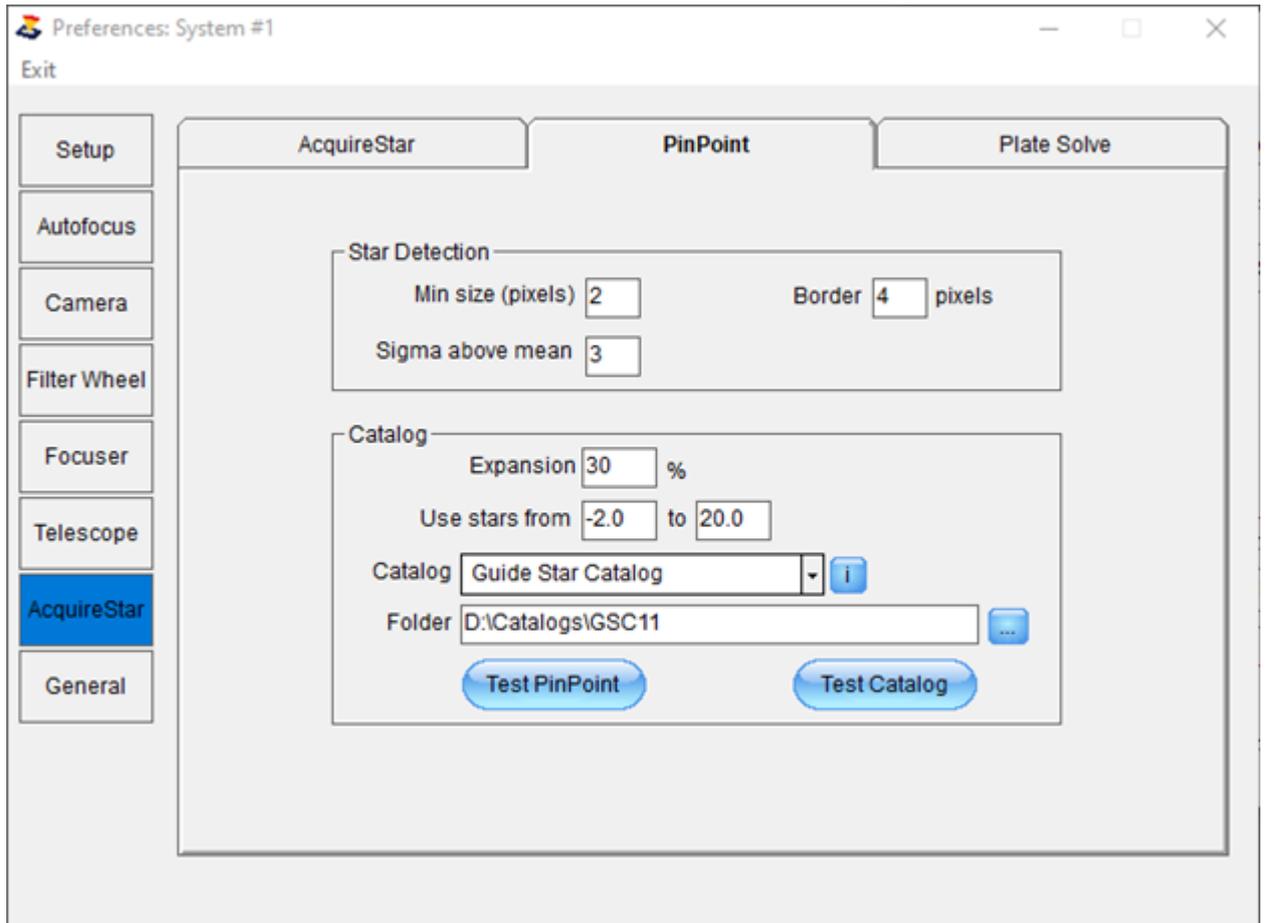


PinPoint Tab

Setting up PinPoint

This PinPoint tab is used to set the Star detection parameters (if needed) and specify the star catalog to be used.

1. Setting up PinPoint



Star Detection

- 'Min size' - minimum size in pixels for star detection (default = 2)
- 'Sigma above mean' - minimum standard deviation of the signal (star) above the background noise for star detection (default = 3)
- 'Border' - the number of pixels to ignore around the perimeter of the image when plate solving (default = 4)

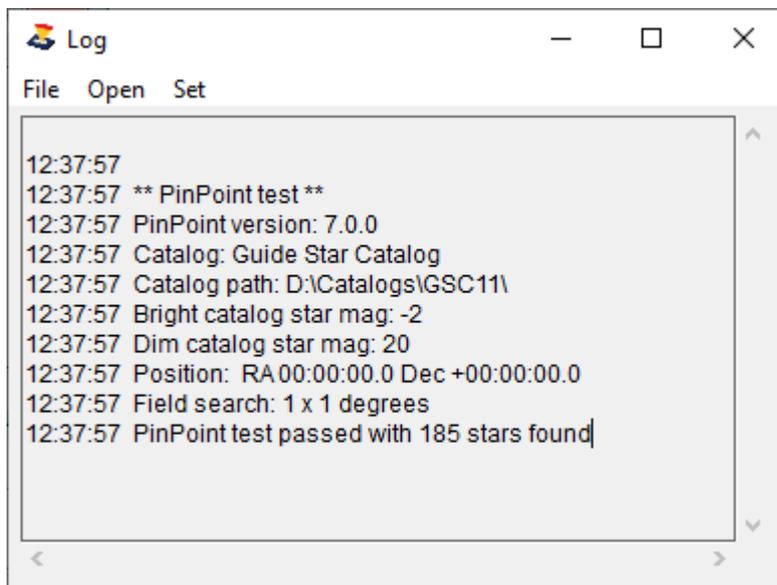
Catalog

- 'Expansion' setting will read additional stars from the catalog to aid in plate solving (default 30%)

- 'Use stars from' will extract stars in the defined magnitude range for plate solving (default -2.0 to 20.0)
- 'Catalog' lists the current catalogs that are available to be used by PinPoint. Pressing the small information button will open a text file that lists information about some of the available star catalogs. In general, the GSC is an excellent choice for most users. The ATLAS or USNO is useful if faint stars are required for narrow field of view.
- 'Folder' is the path to the chosen catalog

Buttons

- 'Test PinPoint' is used to verify that the full version of PinPoint has been installed on the PC. Unfortunately, PinPoint LE which ships with MaxIm does not provide COM plate solving capabilities.
- 'Test Catalog' will verify that AcquireStar can access, read and count the number of stars in a 1.0x1.0 degree field centered on RA 00:00:00, Dec 0:00:00 from the chosen star catalog. The results will be displayed in the Log



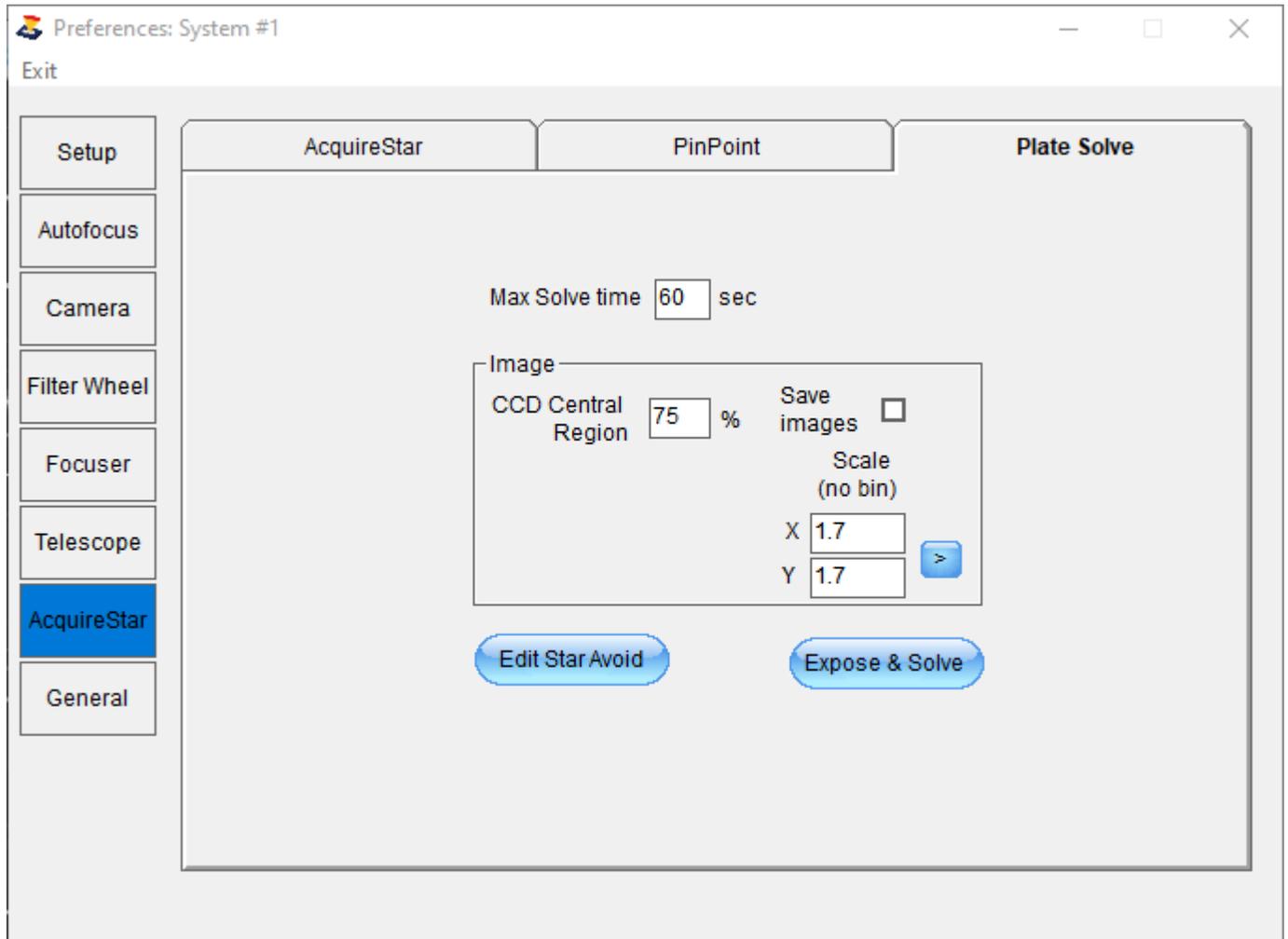
The screenshot shows a window titled 'Log' with a menu bar containing 'File', 'Open', and 'Set'. The main area of the window contains the following text:

```
12:37:57
12:37:57 ** PinPoint test **
12:37:57 PinPoint version: 7.0.0
12:37:57 Catalog: Guide Star Catalog
12:37:57 Catalog path: D:\Catalogs\GSC11\
12:37:57 Bright catalog star mag: -2
12:37:57 Dim catalog star mag: 20
12:37:57 Position: RA 00:00:00.0 Dec +00:00:00.0
12:37:57 Field search: 1 x 1 degrees
12:37:57 PinPoint test passed with 185 stars found
```

Plate Solve Tab

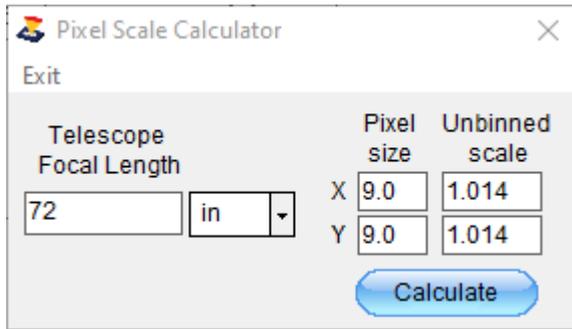
Plate Solve Tab

The Plate Solve tab is used to set the desired binning and the image scale of your system and test to verify that a plate solve can be successfully performed.



Image

- 'CCD Central Region' will set the size of the image. If you have a large chip then consider setting this to 50% or less.
- 'X/Y scale' is the camera unbinned scale in arc-sec / pixel.
- Press the small button to open the Scale calculator



Max Solve Time

Set the maximum time in seconds to plate solve an image, default = 60 sec (PinPoint only).

Buttons:

- Occasionally AcquireStar may locate a star in the star catalog that appears to FocusMax as double star which will result in poor or failed autofocus run.
- 'Edit Star Avoid' will open a text file that contain a list of stars that will be ignored by AcquireStar.

The file contains Star ID, Ra and Dec and magnitude delimited by '|'

'ID |RA |Dec |Mag ==> Any line starting with ' will be ignored. Do not delete this line

'GSC 3097-0115|17:52:09.2|+42:51:25.8|7.11 ==> sample - you may delete this line

SAO 49603 |20:25:26 |+42:36:18 |6.9

.

Simply add the known problem star to the list and AcquireStar will ignore it.

- 'Expose & Solve' will take an image and attempt to plate solve the current telescope position using the plate solve method selected on the AcquireStar Setup tab.

AcquireStar Wizard

AcquireStar Wizard

The AcquireStar Wizard will find the optimum focus star magnitude for a selected filter. The minimum focus exposure time will be set to 1.00 second to provide head-space for exposure adjustment depending on the magnitude of the star selected. Instructions for each step are provided in the left hand text box.

1. AcquireStar will automate the focus process by:
 - a) Take an image and plate solve the current telescope position (if desired)
 - b) Identifying focus stars from a star catalog that meet your magnitude requirements by filter
 - c) Slew the telescope to the target star
 - d) Center the star on the CCD
 - e) Initiate an autofocus run
 - f) Perform a return slew (if desired)

AcquireStar Wizard

File

AcquireStar will automate the focus process by:

- 1) Plate solve current telescope position (if desired)
- 2) Identifying focus stars from a star catalog that meet your magnitude requirements by filter
- 3) Slew the telescope to the target star
- 4) Center the star
- 5) Initiate an autofocus run
- 6) Perform a return slew (if desired)

This wizard will find the optimum focus star magnitude for a given filter.

Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag
1	E	2	5.00	7.5
2	C	2	5.00	7.5
3	U	4	15.00	3.0
4	B	3	10.00	5.5
5	V	1	10.00	5.5
6	R	3	10.00	6.0
7	I	4	10.00	3.0

Reference filter: C Pointing filter: C

Buttons: Back, Next, Run, Filter offset

2. Filter off sets will be used for plate solving the telescope position. Pressing the 'Filter offset' button will open a Window which will allow you to enter the offsets. The filter off sets values do not need to be precise but should be close enough to prevent large out of focus donuts when an image is taken after a filter change. To estimate the offsets:

- a) Set the filter that provides the brightest image (typically Luminance) as the 'Reference' filter
- b) Focus the telescope with the chosen Reference filter and record the focuser position and HFD
- c) Set the next filter in place
- d) Center a star on the CCD that is appropriate for the filter

- e) Focus the telescope and note the HFD of the star
- f) Enter the offset in the data-grid as: $\text{Offset} = \text{Target filter position} - \text{Reference filter position}$

AcquireStar Wizard

File

Filter offsets will be used with AcquireStar for plate solving telescope position.

At this time the filter offsets do not need to be precise, the images taken must be close to focus and not large donuts which may prevent the image from being successfully plate solved.

Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag
1	E	2	5.00	7.5
2	C	2	5.00	7.5
3	U	4	15.00	3.0
4	B	3	10.00	5.5
5	V	1	10.00	5.5
6	R	3	10.00	6.0
7	I	4	10.00	3.0

Reference filter: C Pointing filter: C

Back Next Run Filter offset

AcquireStar Wizard

File

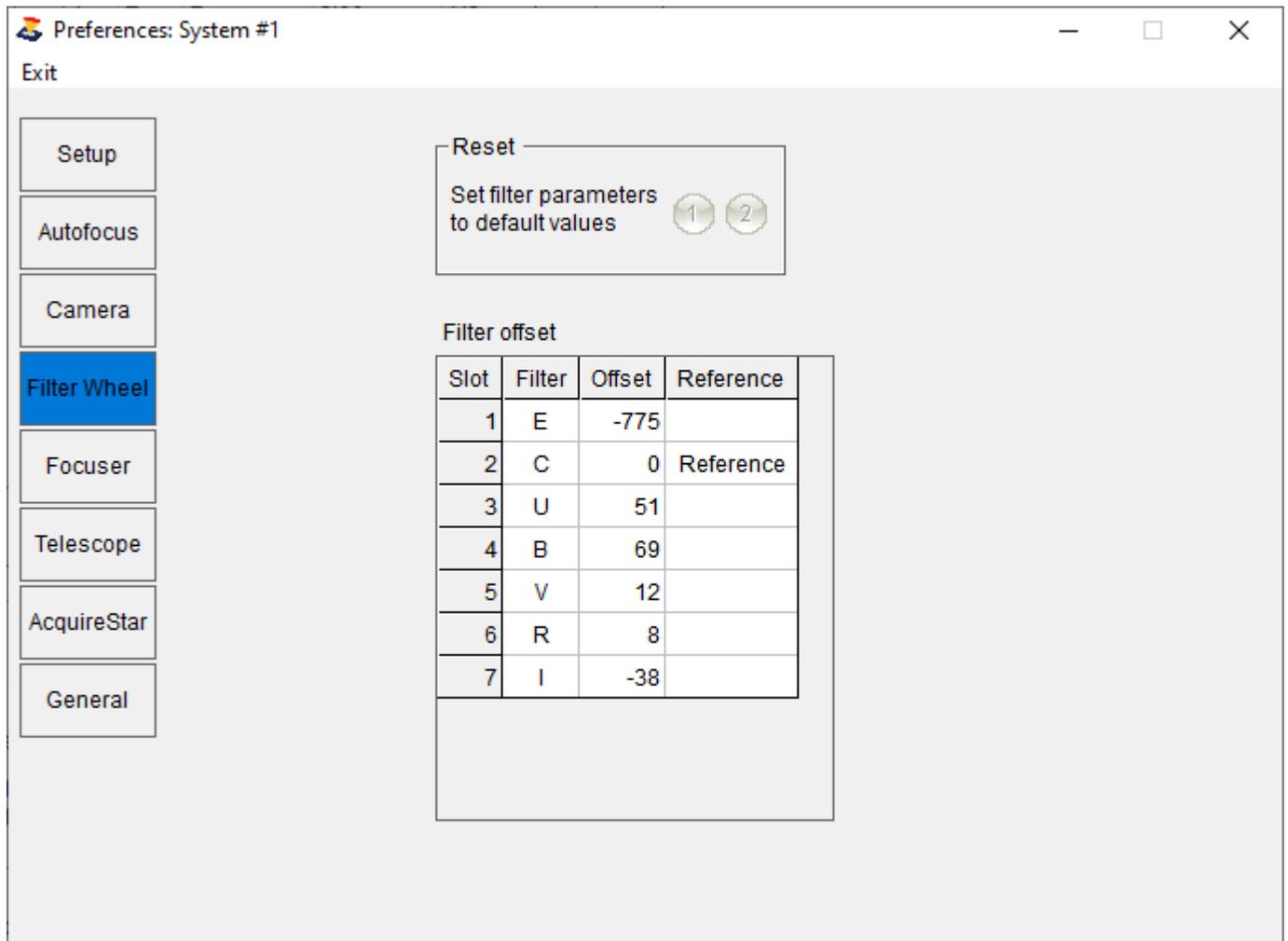
Reference filter C (slot 2) has been defined in file: FW1_Simulator.cfg

You may edit filter offsets by pressing the Filter Offset button.

Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag
1	E	2	5.00	7.5
2	C	2	5.00	7.5
3	U	4	15.00	3.0
4	B	3	10.00	5.5
5	V	1	10.00	5.5
6	R	3	10.00	6.0
7	I	4	10.00	3.0

Reference filter: C Pointing filter: C

Back Next Run Filter offset



3. Select the filter to be used for plate solving the telescope position - typically the filter that provides the brightest image such as Luminance.

AcquireStar Wizard

File

Please select the filter to be used for plate solving. Selecting 'Current filter' will use the current active filter.

Typically, the reference filter is also used for pointing updates.

Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag
1	E	2	5.00	7.5
2	C	2	5.00	7.5
3	U	4	15.00	3.0
4	B	3	10.00	5.5
5	V	1	10.00	5.5
6	R	3	10.00	6.0
7	I	4	10.00	3.0

Reference filter: C Pointing filter: C

Buttons: Back, Next, Run, Filter offset

4. You may edit the AcquireStar settings for each filter
- Plate solve binning
 - Plate solve exposure
 - Focus target star magnitude

Click the cell then double click change the entry.

AcquireStar Wizard

File

You may edit the the following AcquireStar parameters for each filter:
 ...Plate solve exposure
 ...Plate solve binning
 ...Focus target star magnitude

Slot	Filter	Plate Solve Bin	Plate Solve Exp	Tgt Star Mag
1	E	2	5.00	7.5
2	C	2	5.00	7.5
3	U	4	15.00	3.0
4	B	3	10.00	5.5
5	V	1	10.00	5.5
6	R	3	10.00	6.0
7	I	4	10.00	3.0

Reference filter: C Pointing filter: C

Buttons: Back, Next, Run, Filter offset

5. You may edit the autofocus parameters:
- Target star binning
 - Focus binning
 - Base exposure
 - Max exposure
 - Target star flux

AcquireStar Wizard

File

To focus with narrow band filters consider:
 ...Setting Flux target to 150
 ...Use longer base exposure
 ...Select a brighter target star
 ...Try 3x3 or 4x4 binning

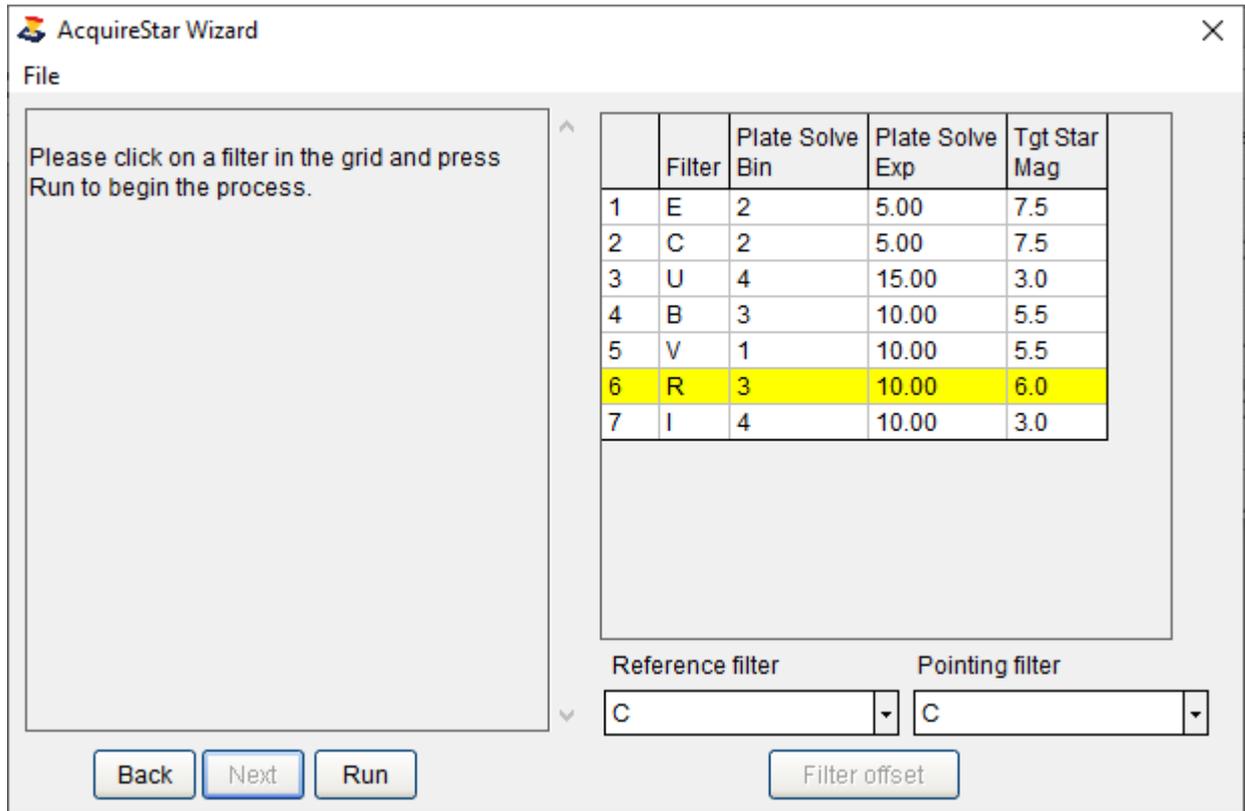
You may edit the the following Autofocus parameters for each filter:
 ...Target star binning
 ...Focus binning
 ...Base exposure
 ...Max exposure
 ...Target star flux

Slot	Filter	Tgt Bin	Focus Bin	Base exp	Max exp	Tgt Flux x1000
1	E	2	1	1.00	10.00	300
2	C	2	1	1.00	10.00	300
3	U	1	2	10.00	30.00	200
4	B	1	1	2.00	10.00	200
5	V	2	1	2.00	10.00	200
6	R	2	1	1.00	10.00	200
7	I	2	1	10.00	10.00	200

Reference filter: C Pointing filter: C

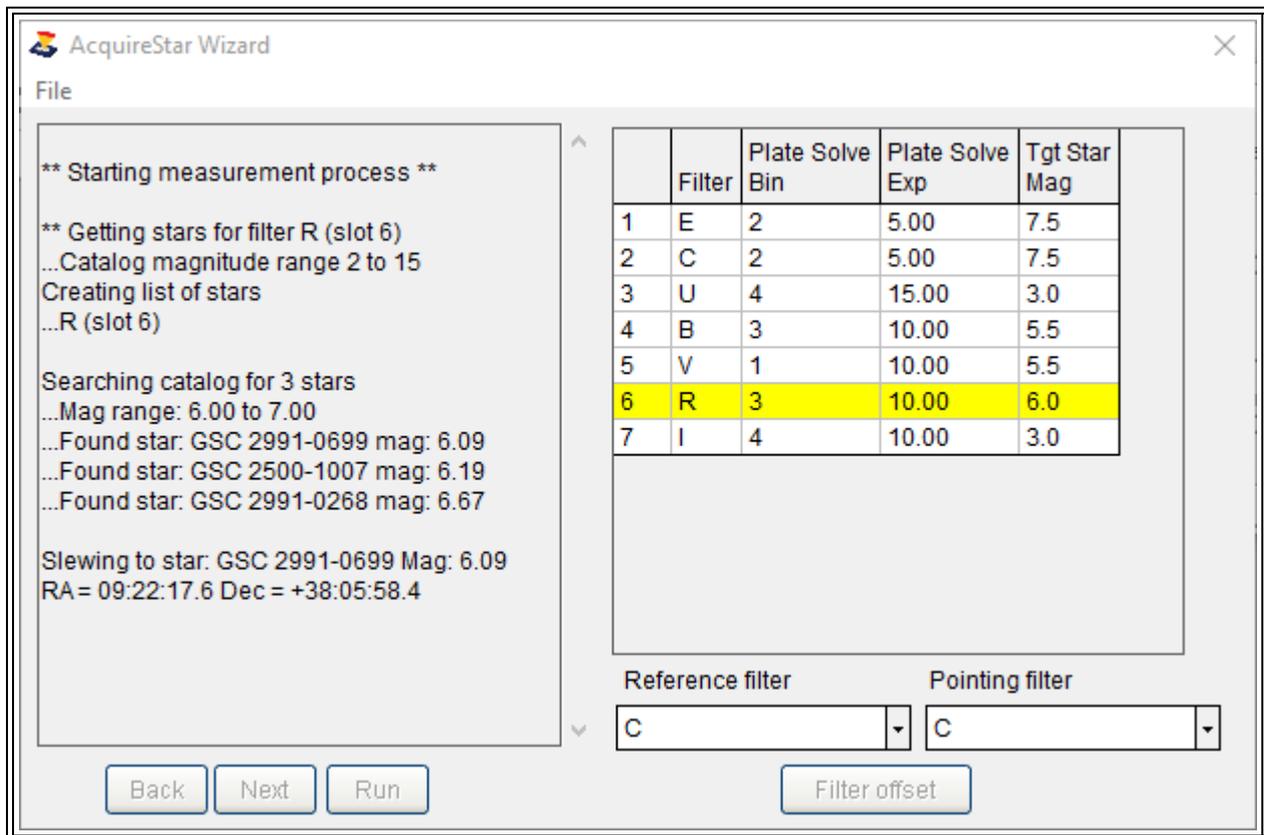
Back Next Run Filter offset

6. Select a filter in the grid then press run to begin the measurement process.



7. The AcquireStar Wizard process:

- a) Identify multiple stars starting at the defined target magnitude (range: +1 magnitude)
- b) The telescope will slew to the first star in the list, plate solve using the 'Pointing filter'
- c) Set target filter and apply 'focus offset'
- d) Test if the star can be used as a focus star
- e) If the star is too bright, then a new star list is created of dimmer stars
- f) If the star is too dim, then a new star list is created of brighter stars
- g) A focus run is initiated once the star magnitude has been identified
- h) The AcquireStar setting is updated with the new mag setting



Filter Offset Wizard

Filter Offset Wizard

Filter Offset

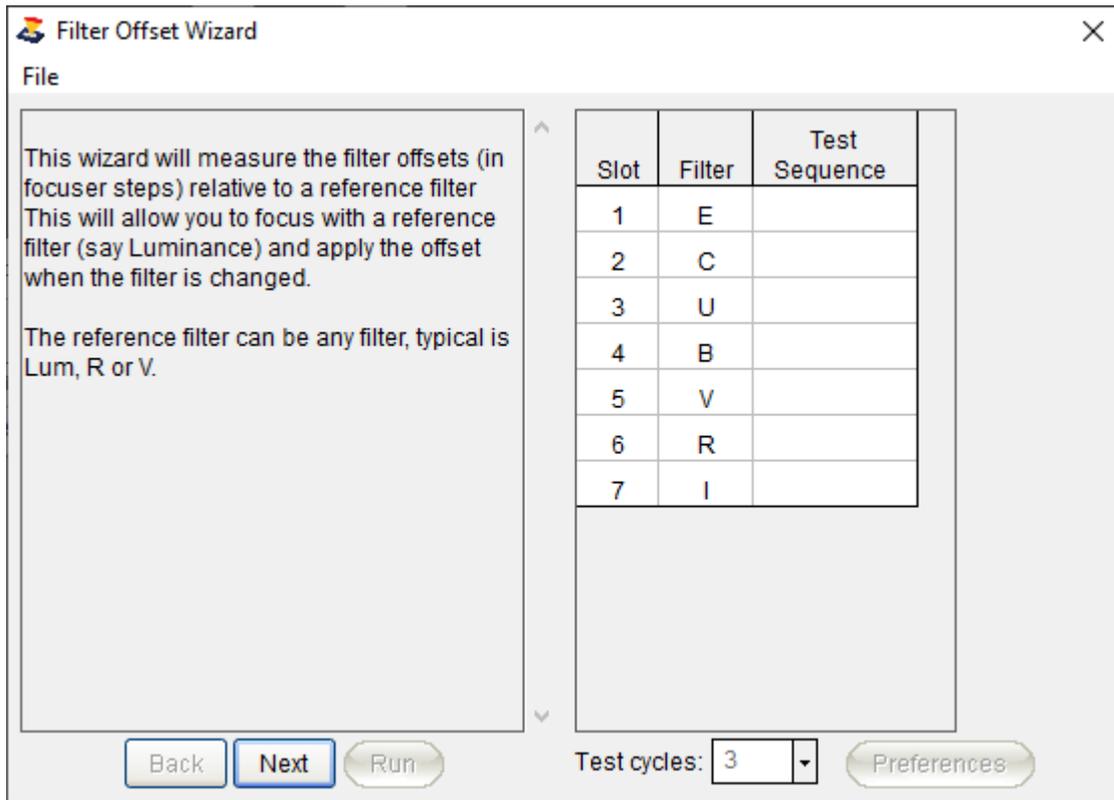
Filter offset is a measurement of the difference in focuser steps between a given filter and a reference filter. Once this 'offset' is known you may use the reference filter to focus the telescope with a filter that provides a bright image (typically Luminance) then apply the offset steps to bring the system into focus for the target filter.

1. The reference filter is typically the filter that yields the brightest image in the filter wheel such as the slot containing Clear / Luminance filter.
2. Focusing with the reference filter will save precious observing time as the focus process will be significantly shorter than with a filter that yields a fainter image such as a narrow band filter.
3. The reference filter will provide more stars in the field for focus candidates than other filters.
4. Focus error will be introduced if the offset steps between the target filter and reference filter is not well established and statistically significant. Determining the offset will require running multiple (many) runs comparing the focus point with both filters then evaluating the runs to identify potential data outliers and determine if the data is statistically sound. Most apps that offer filter offset measurements will run one or several focus iterations for setting the offset; FocusMax V5 will allow you to build a significant database of measurements so that the offset step relationship can be statistically determined.

Filter Offset Wizard

1. The Filter Offset Wizard is designed to walk through the process of collecting data on the number of steps between a target filter and a reference filter.
2. The Wizard will store the current focus process, method and settings then set the autofocus 'Process' to Single-Star and 'Method' to Advanced.

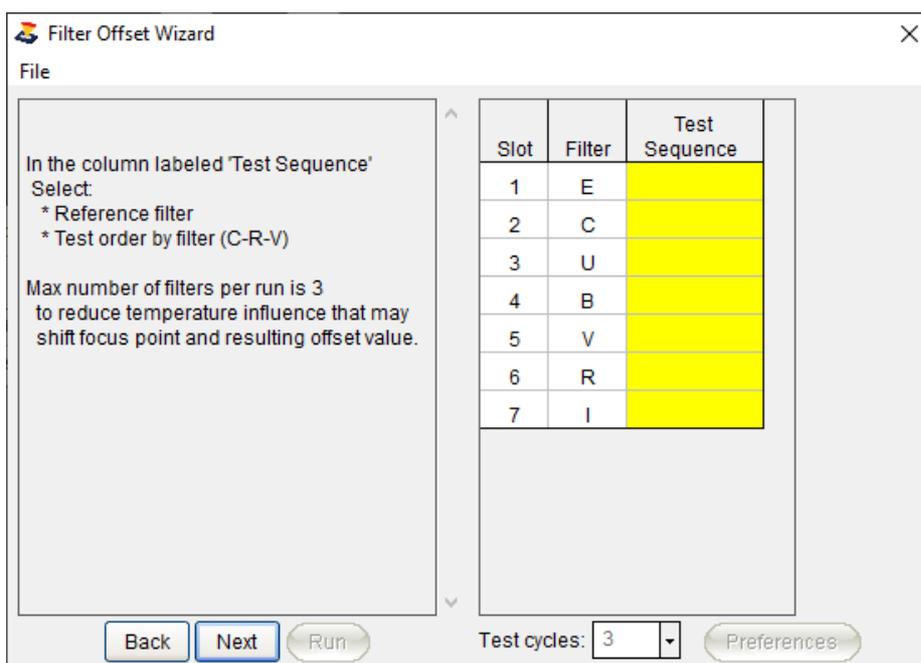
Shown is the filter contained in the active filter wheel by slot number.

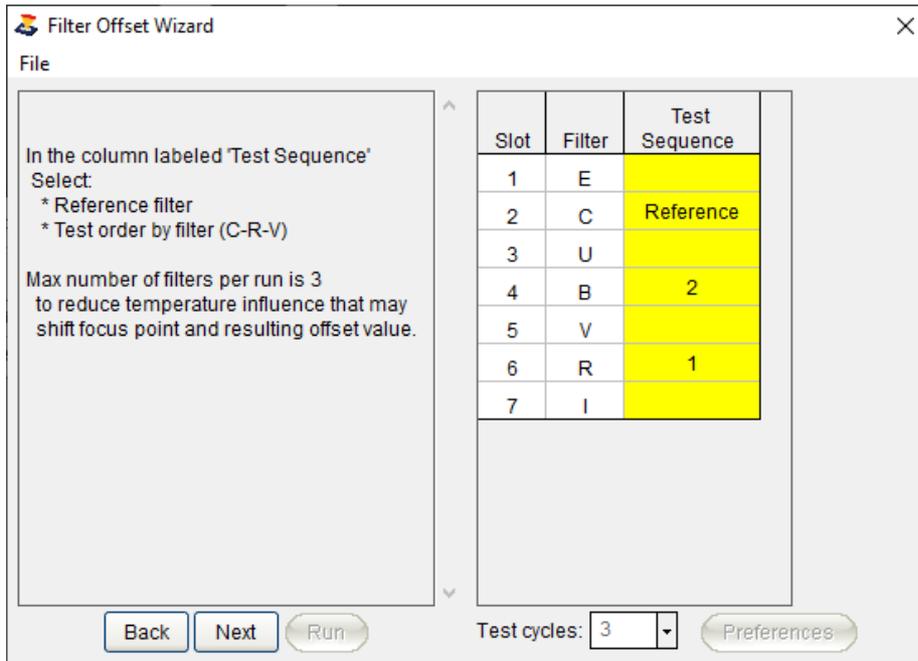


- Click in the yellow column to identify the 'Reference' filter and set the order to measure one or two target filters.

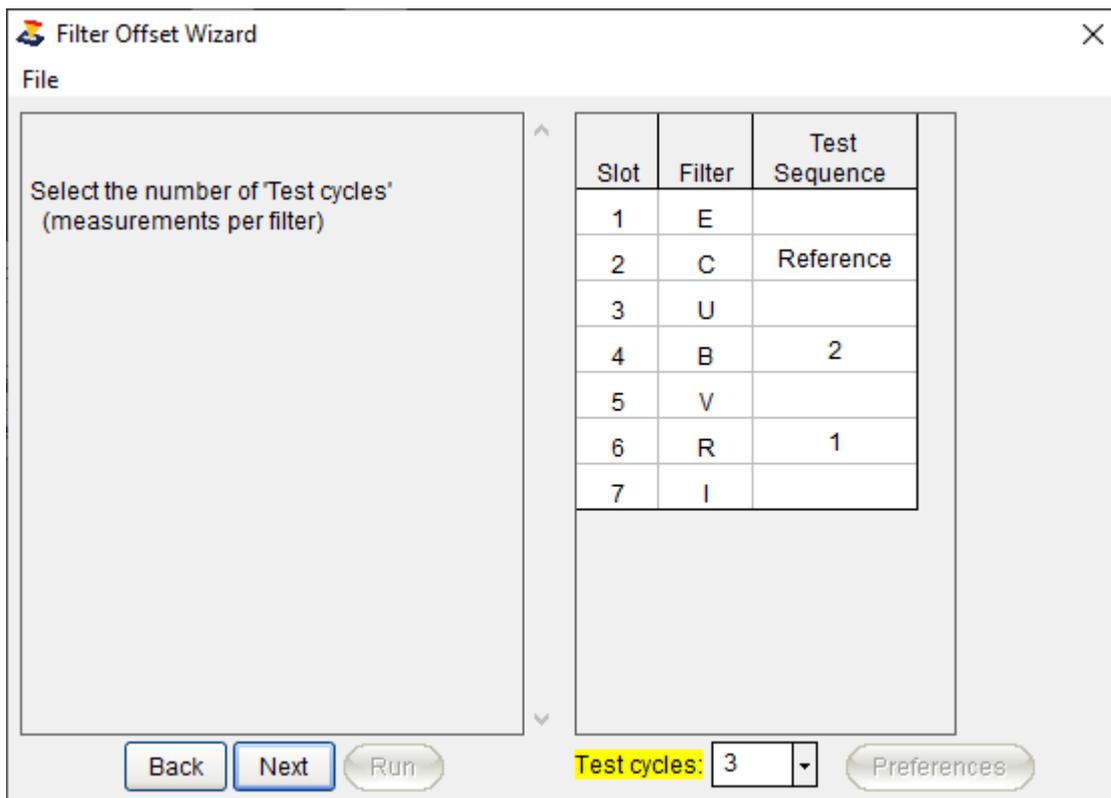
You may choose up to 2 different target filters for each run. **If this is not the first filter offset run then the Reference filter must not be changed.**

If temperature change during the measurement process is a concern, then it is suggested that you run only one target filter or plan to run when the temperature has stabilized.

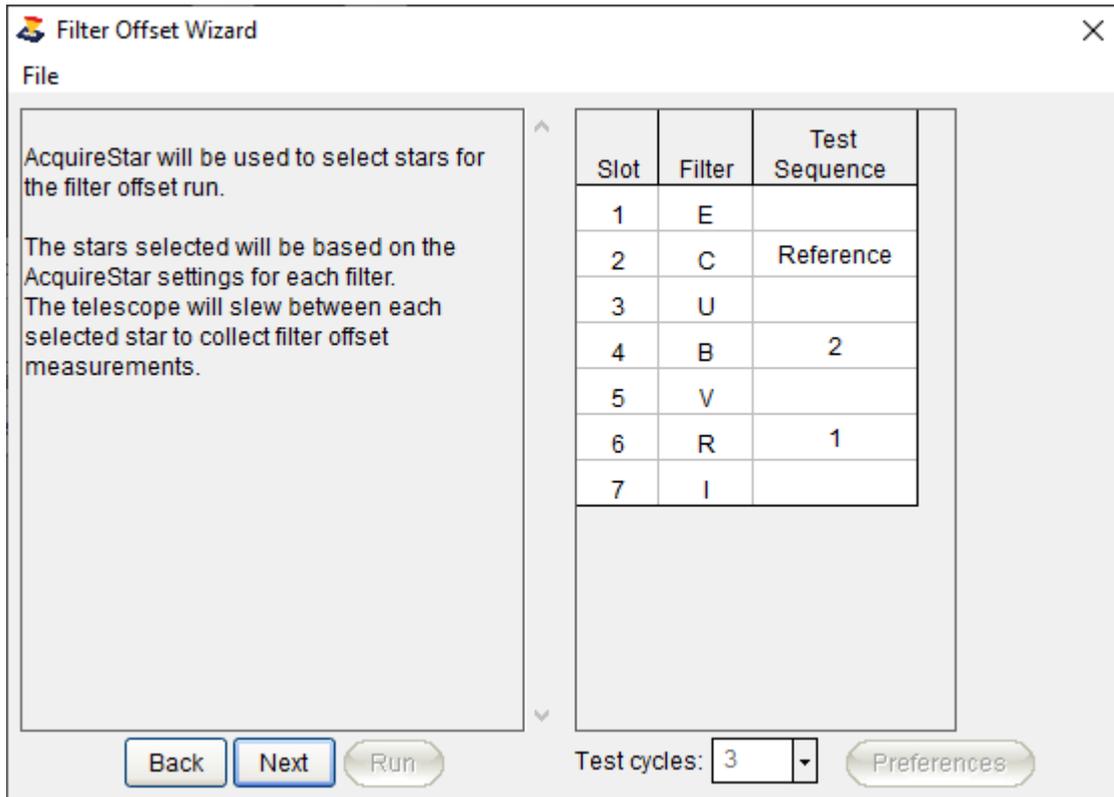




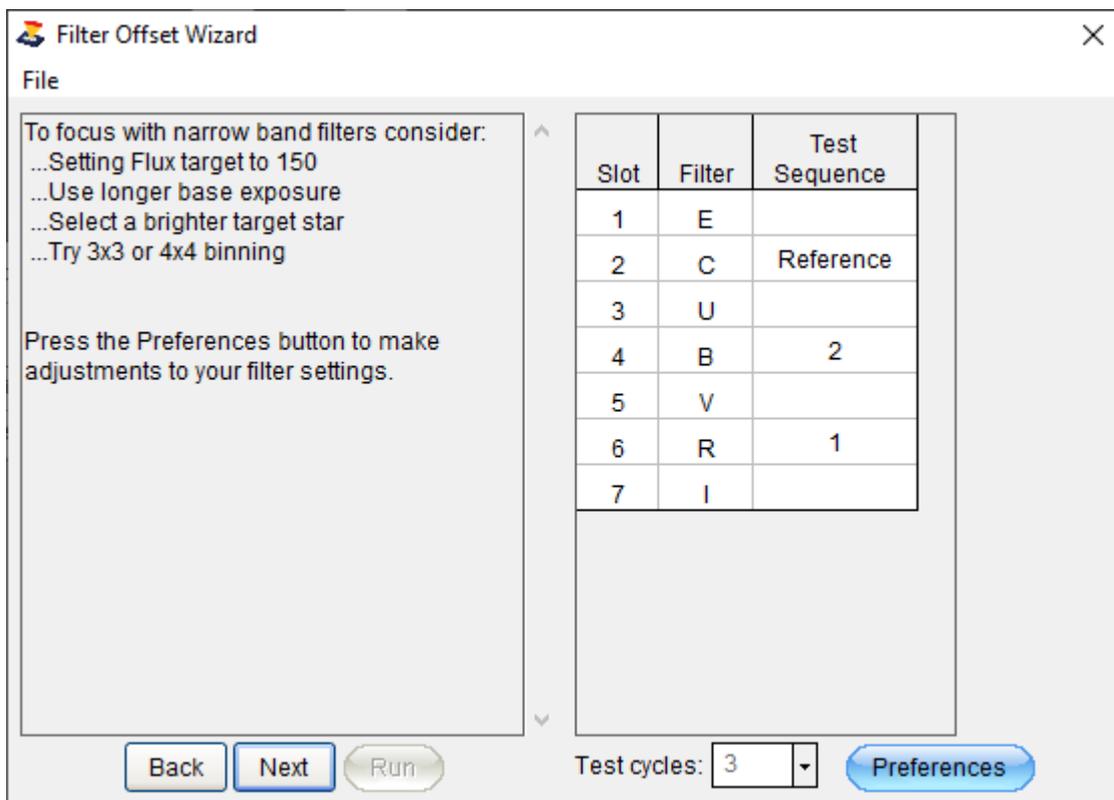
3. Select the number of test cycles (measurement iterations) that will be run.



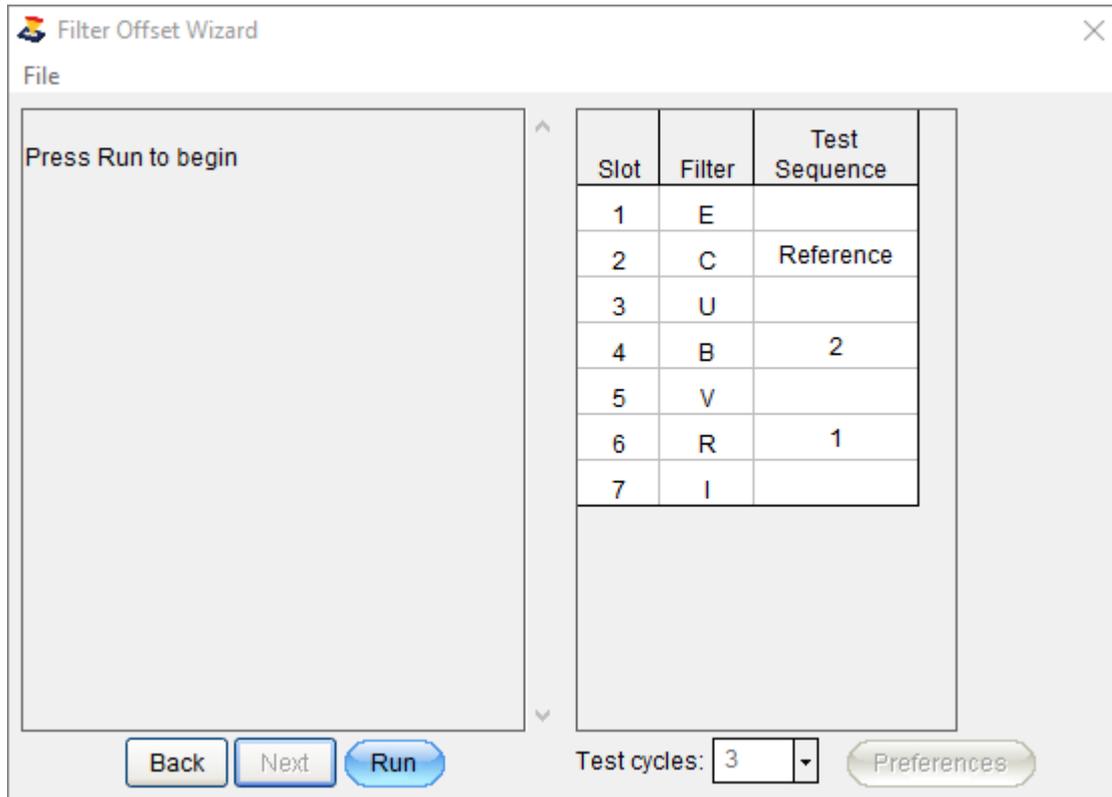
4. AcquireStar must be setup for each filter so that the telescope may slew to an appropriate star and initiate a focus process. If AcquireStar has not been setup, you may use the AcquireStar Wizard for the filters you wish to measure.



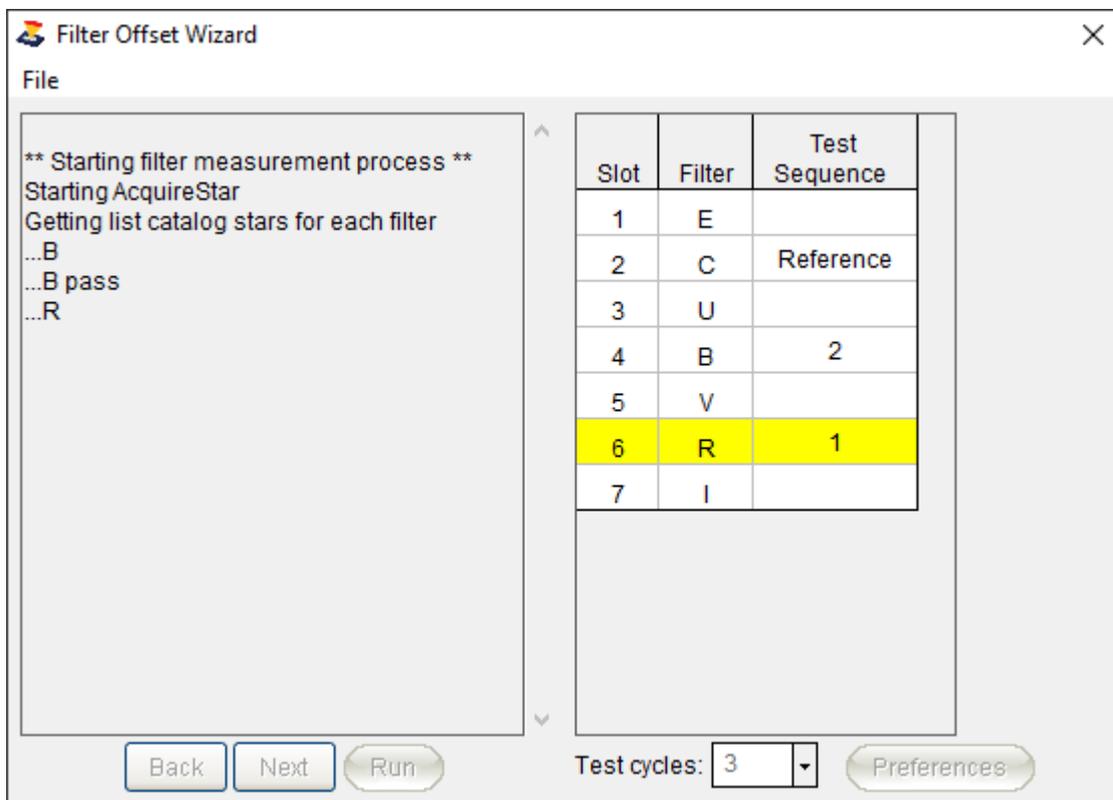
5. You may press the Preferences button to review the autofocus and AcquireStar settings.



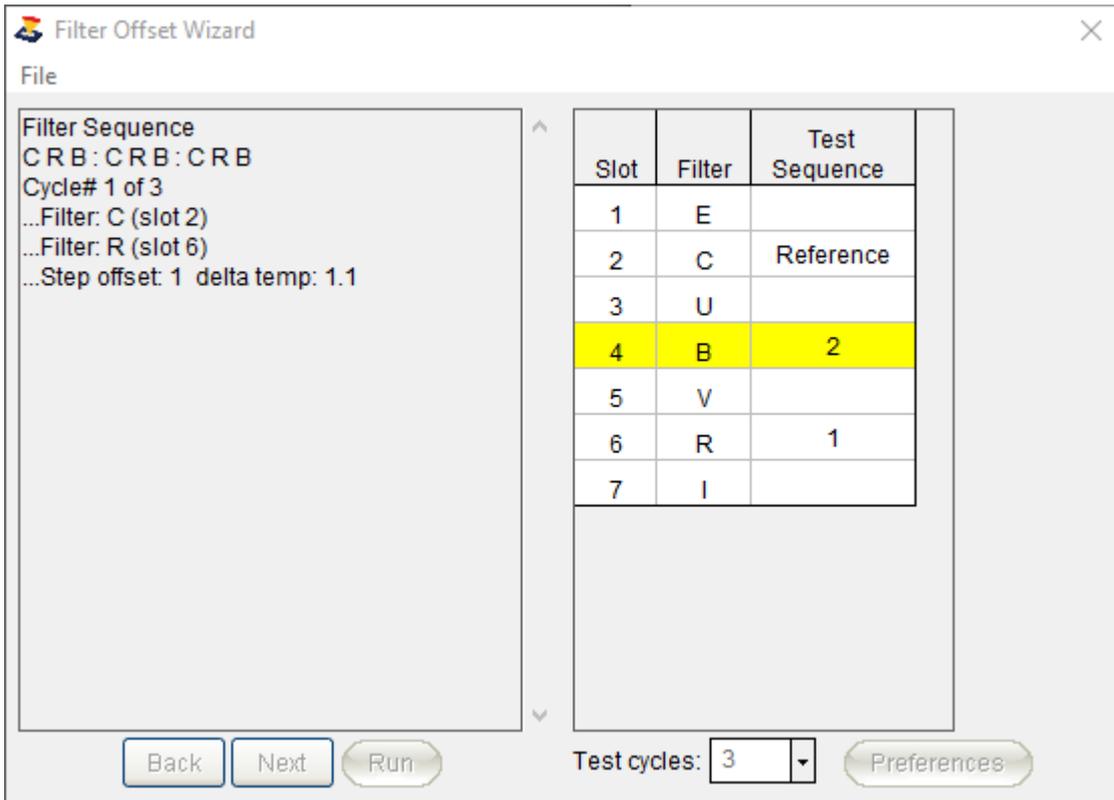
6. Press Run to begin the measurement process.



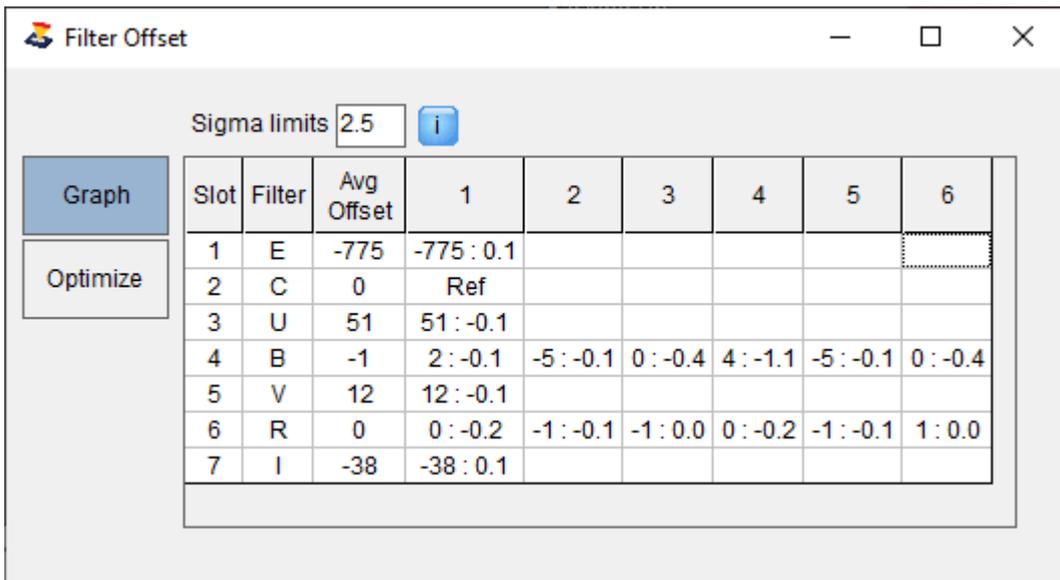
- The Wizard will identify a list of potential target stars for each filter, slew the telescope to the first star in the list and verify that it may be used for the focus run.



- The filter sequence (C R B : C R B : C R B) is shown and results of each filter sequence.



9. At the conclusion of the run, the Filter Offset Window will be opened showing all of the offset measurements:
- Average offset steps.
 - Individual offset and temperature difference
 - Reference filter identification (Clear)



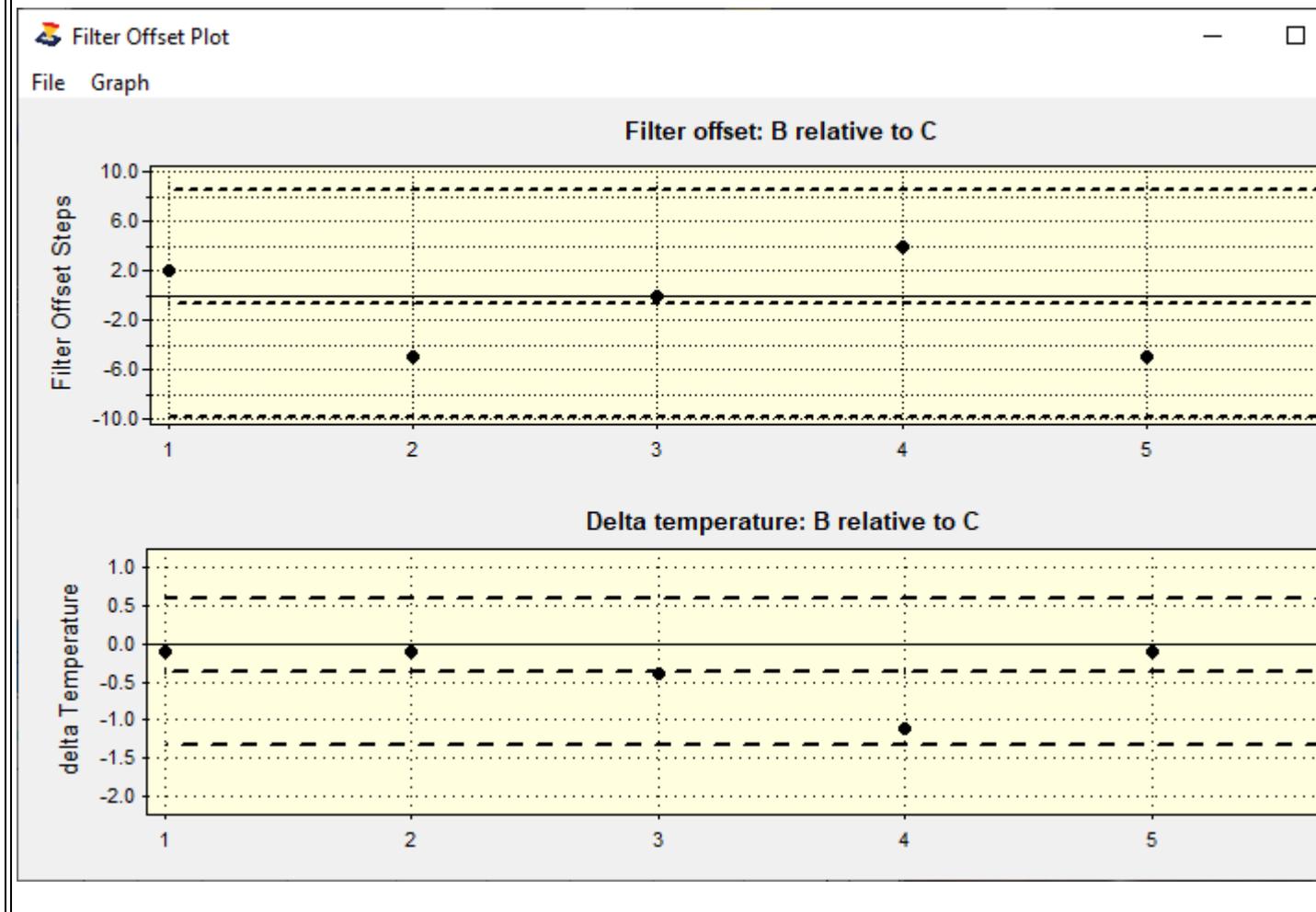
10. You may select a filter and press the 'Graph' button to show the plotted results for the filter offset and observed temperature change. The upper and lower dotted lines represent the +/- sigma limits (+/- 2.5

sigma) and the middle dotted line is the mean. Any point that is close or exceeds the upper or lower sigma lines may be considered suspect which is shown in the illustration below for point # 4 Delta Temperature.

Filter Offset

Sigma limits

Graph	Slot	Filter	Avg Offset	1	2	3	4	5	6
Optimize	1	E	-775	-775 : 0.1					
	2	C	0	Ref					
	3	U	51	51 : -0.1					
	4	B	-1	2 : -0.1	-5 : -0.1	0 : -0.4	4 : -1.1	-5 : -0.1	0 : -0.4
	5	V	12	12 : -0.1					
	6	R	0	0 : -0.2	-1 : -0.1	-1 : 0.0	0 : -0.2	-1 : -0.1	1 : 0.0
	7	I	-38	-38 : 0.1					



- The 'Optimize' function can be run if the a filter contains 6 or more data entries which will identify potential filter offset outliers for offset and temperature change. Suspect offset data is identified by Red

highlight and temperature change by Yellow. If suspect data is found, pressing 'OK' button will delete the entry from the data set.

Filter Offset

Sigma limits ⓘ

Graph	Slot	Filter	Avg Offset	1	2	3	4	5	6
Optimize	1	E	-775	-775 : 0.1					
	2	C	0	Ref					
	3	U	51	51 : -0.1					
	4	B	-1	2 : -0.1	-5 : -0.1	0 : -0.4	4 : -1.1	-5 : -0.1	0 : -0.4
	5	V	12	12 : -0.1					
	6	R	0	0 : -0.2	-1 : -0.1	-1 : 0.0	0 : -0.2	-1 : -0.1	1 : 0.0
	7	I	-38	-38 : 0.1					

FocusMax

Suspect data detected!

Red: suspect filter offset
Yellow: suspect delta temperature

Cell format: |Offset data : Delta temperature|

Double click cell to delete entry

OK

First Light Wizard

First Light Wizard

The First Light Wizard will identify the settings needed to assure that an acceptable Vcurve can be run based on your equipment.

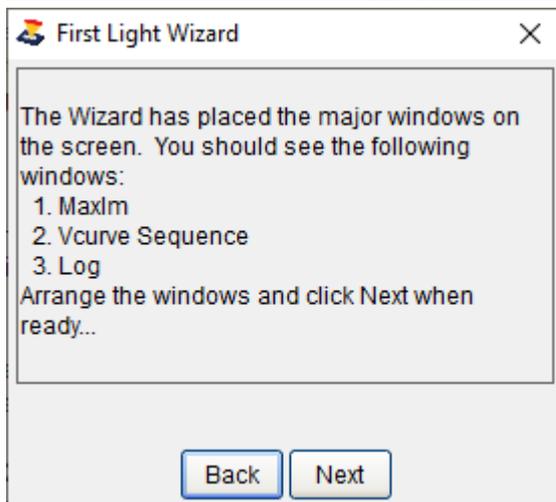
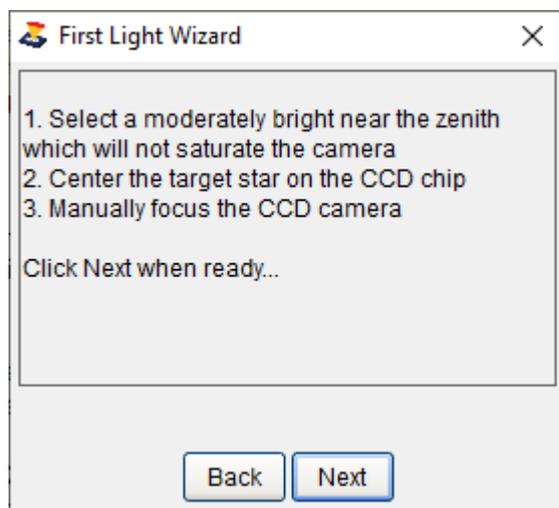
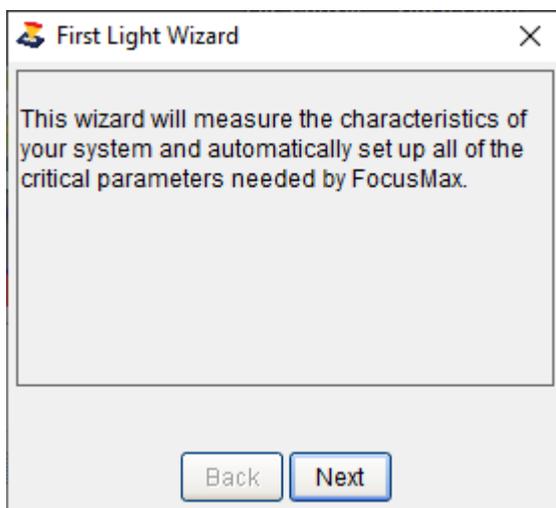
The First Light Wizard is designed to assist the new user in setting up the parameters for running a Vcurve for the first time.

Once the Vcurve has been created and the data is saved then FocusMax is will able to autofocus your telescope.

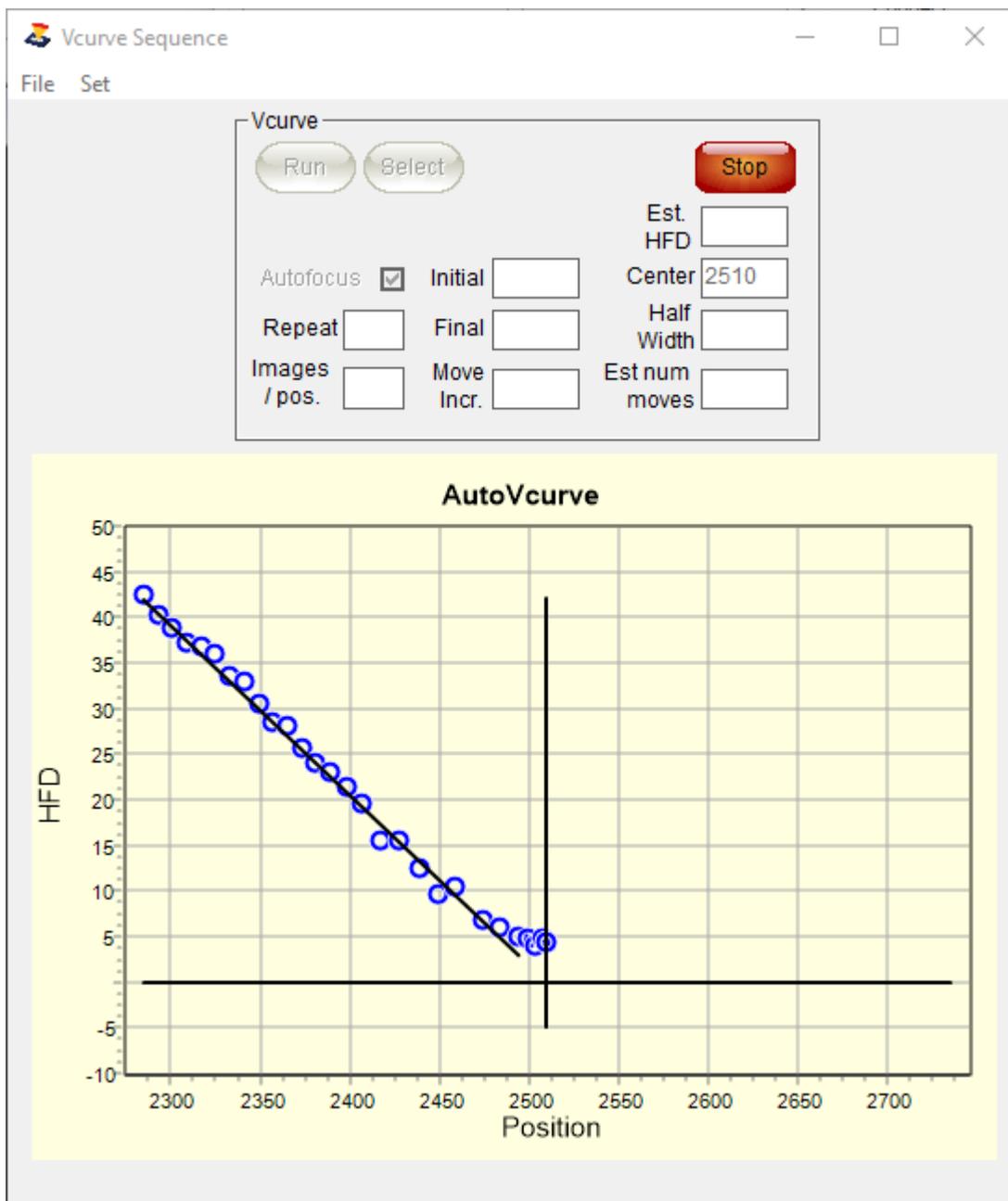
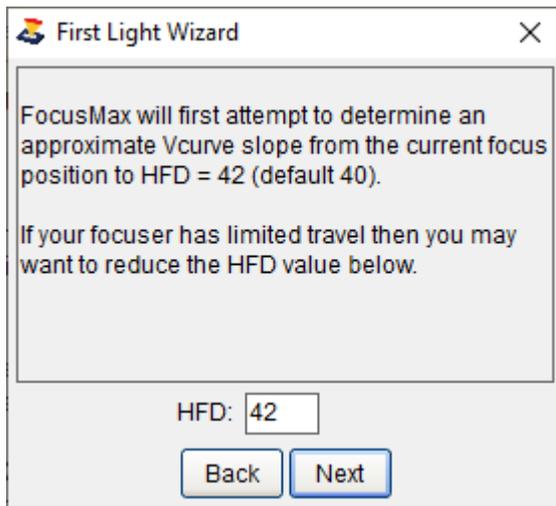
Running the First Light Wizard:

1. Manually focus the telescope – the focus does not have to be exact, just close.
If you have loaded FocusMax 'Simulator1' or Simulator2' on the Setup Tab and selected a 'Simulator' focuser in Preferences the midpoint of the focuser travel can be found by:
 - o opening Preferences/Setup, press the small Chooser button next to the focuser text field then

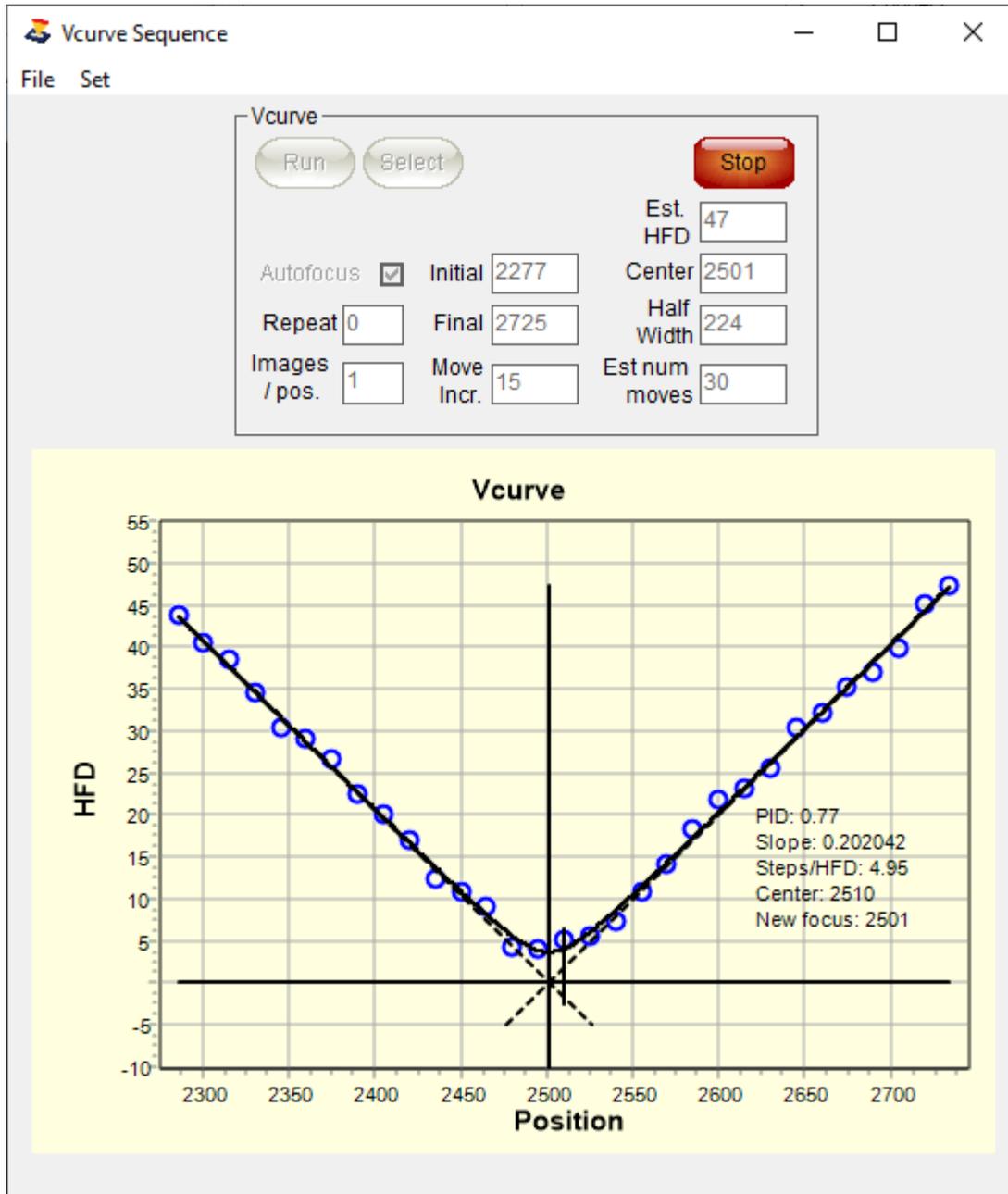
- select Properties.
 - The focus position will be 1/2 the 'Maximum Step Position'.
 - For example: if the Maximum Step Pos. is 5000 then the focus position while using simulators will be 2500.
 - Using the Jog button, move the focuser to the midpoint 2500
- 2. It is best if you can adjust the draw tube or move the primary mirror (SCT) so that the focus position is mid-way in the in and out travel of the focuser. This is important as FocusMax will require sufficient travel range inside and outside of focus in order to develop the full Vcurve.
- 3. Select a star near the zenith, press the Find button and verify in the Log that the resulting min/max flux falls within the boundary on the Setup tab and verify that the star is not saturated.
- 4. Select the First Light Wizard from the Wizard menu.
- 5. The wizard will prompt you at each step of the process.



- 6. The First Light Wizard will start by moving the focuser in small then larger increments away from the focus point as it attempts to estimate the slope of one side of the 'Vcurve'. The wizard will continue to move the focuser until it achieves the HFD setting (default = 40). If your focuser cannot reach this HFD setting then Stop and re-run the First Light Wizard and reduce the HFD value to a smaller value when prompted. This is not uncommon if the focuser is not centered in the travel range of the focuser (as per step 2 above) or the focuser has limited travel.



7. Now that the First Light Wizard has estimated the Vcurve slope, it will proceed to take a series of subframe images from outside of focus, through focus to the other side of focus.
8. Open the Log if closed and watch the HFD change as the focuser is moved, an image taken and measured by FocusMax.
9. Open the Vcurve Graph from the menu to view the Vcurve in detail
 - The graph may be resized as needed
 - Data values may be displayed when you roll the mouse over the data points
 - The best fit hyperbola to the data is shown through the points
 - The vertical line is the 'Center' when the Vcurve was created
 - The Left & Right tangent lines to the hyperbola are displayed
 - The Left & Right slopes and PID are shown at the bottom of the window
 - The V 'Center' and 'Focus position' are shown. Note:
 - The V 'Center' = 2510 is offset from the 'Focus position' = 2501 in the graph which indicates that the telescope was not in perfect focus when the Vcurve was started.
 - The end points of the 'V' the same with the left tip at are not the same with the Left = 44 HFD and the Right = 47. This difference will increase the further the 'Center' is from the true focus position and the Vcurve may fail if this difference is too large. It is important that you begin the Vcurve run as close to focus as possible.



9. The slope of the tangent line and the Position Intercept Difference (PID) will be calculated and saved in your system Profile that is active.

System Profile

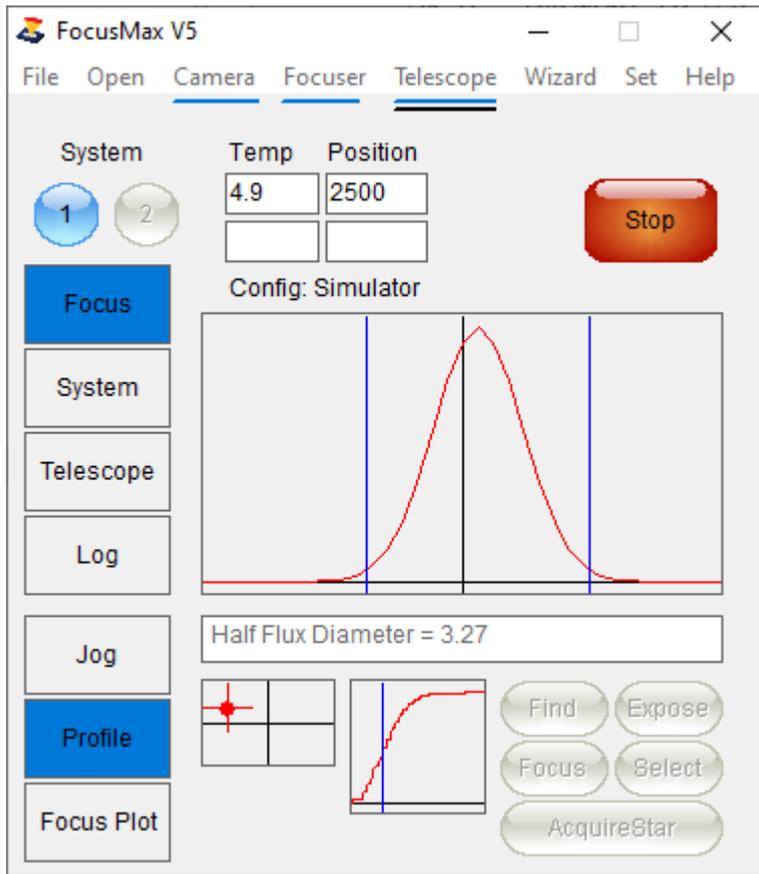
File

System System1	Steps/HFD <input style="width: 80%;" type="text" value="5.0397"/>	Position Intercept Difference <input style="width: 80%;" type="text" value="3.66"/>	Total Points <input style="width: 80%;" type="text" value="10"/>	Sigma limit <input style="width: 80%;" type="text" value="2.5"/>
	Slope <input style="width: 80%;" type="text" value="0.198492"/>	3.60300		Graph <input style="width: 80%;" type="text" value="PID + Slope"/>
	Std Dev. <input style="width: 80%;" type="text" value="0.00376"/>			

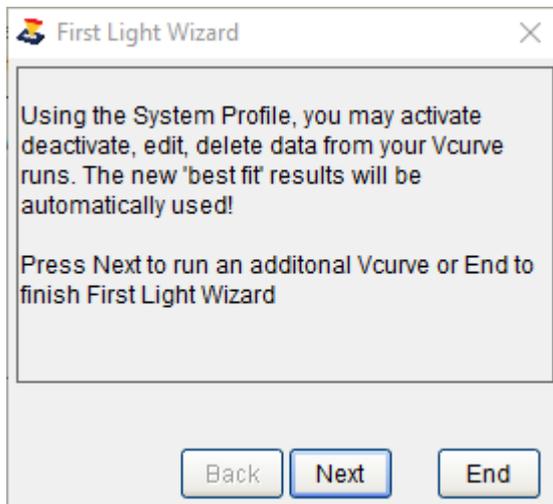
	Use	Date	Time	PID	Slope	Steps /HFD	Fit			Comments
1	Y	2021-07-30	11:48:33	1.93	0.200211	4.9947	16.93073 3.38971 2500.31028 0.05299 0.27684			Binning=1, Tot
2	Y	2021-07-29	12:57:13	11.34	0.188937	5.2928	12.55093 2.37134 2499.34923 0.92203 0.26654			Binning=1, Tot
3	Y	2021-07-25	15:27:40	-1.41	0.202954	4.9272	19.95721 4.05039 2500.93102 -0.54357 0.85311			Binning=1, Tot
4	N	2021-07-25	15:11:34	-3.08	0.210496	4.7507	20.78625 4.37543 2499.45885 -0.76313 0.87047			Binning=1, Tot
5	N	2021-06-14	12:50:17	0.76	0.195443	5.1166	21.40689 4.18382 2498.60966 -0.38007 0.65188			Binning=1, Tot
6	N	2021-06-14	12:42:49	16.44	0.185406	5.3936	5.13814 0.95264 2499.15425 1.49933 0.58408			Binning=1, Tot
7	Y	2021-06-04	11:28:11	1.52	0.200307	4.9923	15.14862 3.03437 2500.7348 0.03612 0.85833			Binning=1, Tot
8	Y	2021-06-04	11:16:54	6.81	0.196887	5.0791	11.65434 2.29459 2500.46486 0.60252 0.92466			Binning=1, Tot
9	N	2021-06-04	11:09:03	5.49	0.194201	5.1493	13.84228 2.68818 2500.05911 0.43877 0.75241			Binning=1, Tot
10	Y	2021-06-04	10:45:03	3.42	0.199051	5.0238	13.6731 2.72165 2500.89846 0.24647 0.8486			Binning=1, Tot
11	Y	2021-06-04	10:38:21	5.95	0.197282	5.0689	14.16422 2.79434 2499.24258 0.48685 0.83534			Binning=1, Tot
12	Y	2021-06-04	10:27:27	3.98	0.199294	5.0177	19.69805 3.92571 2499.77547 0.20219 0.79486			Binning=1, Tot
13	N	2021-06-04	10:19:31	-3.06	0.204397	4.8924	23.24795 4.75182 2500.35648 -0.59058 0.90134			Binning=1, Tot
14	Y	2021-03-27	12:55:51	1.47	0.2	5.0000	17.50705 3.50141 2500 0 0			Binning=1, Tot
15	Y	2021-03-27	12:00:55	1.55	0.2	5.0000	17.50704 3.50141 2500 0 0			Binning=1, Tot

Graph	
Optimize	
Delete	

10. FocusMax will then use the results to perform an autofocus run



11. You have the option to rerun the Vcurve or exit. It is suggested that you collect multiple Vcurves



12. Pressing the Focus button on the Focus Tab which should result in a perfectly focused star.

13. **Profile:**

- If there are 6 or more data points in the Profile, then you may press the Optimize button which will scan the Slope and PID data and identify data entries that may be suspicious and will be flagged with yellow highlight. You will note that the 'Use' column changed the 'Y' to 'N' to exclude the data row.

System Profile

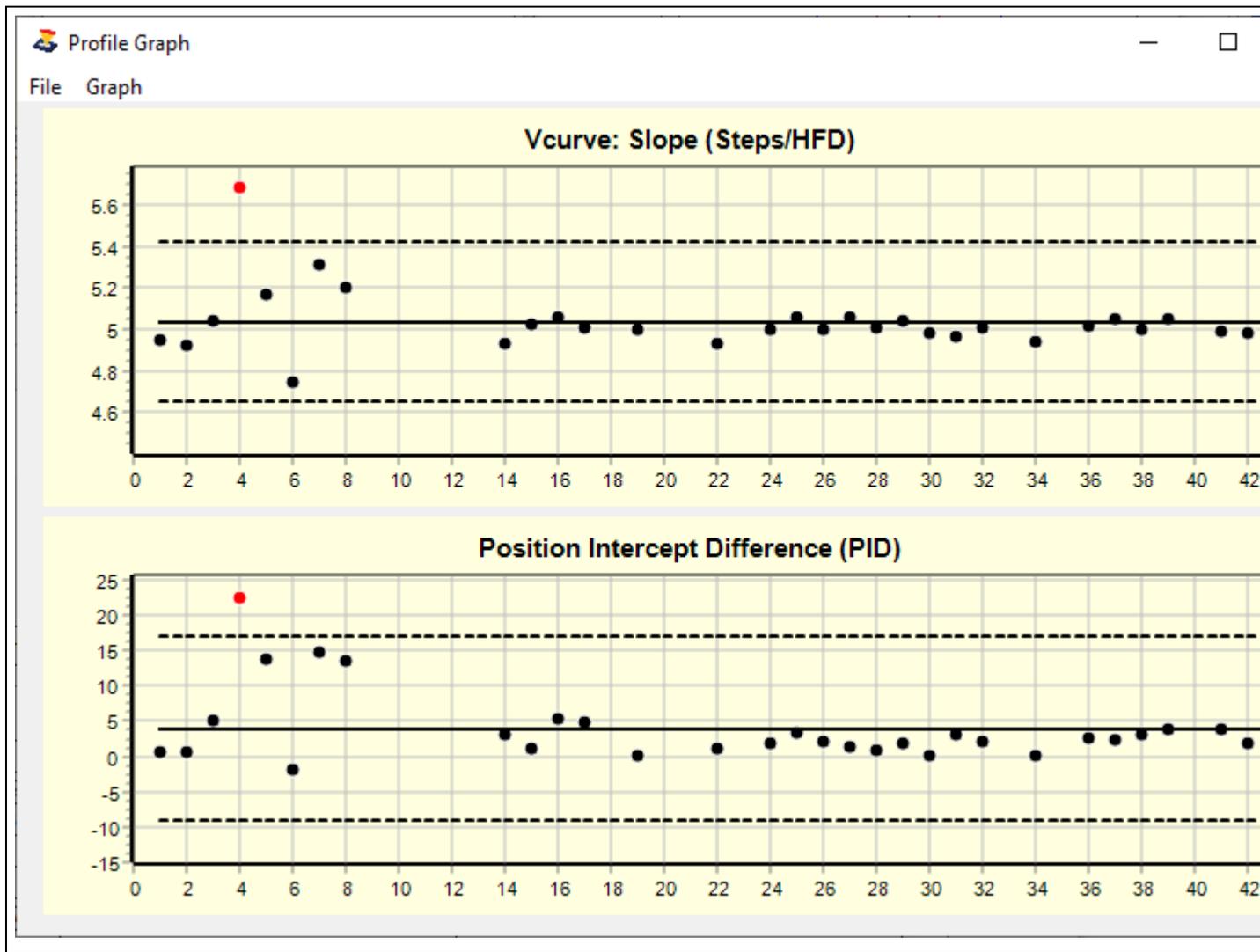
File

System System1	Steps/HFD <input style="width: 80%;" type="text" value="5.0048"/>	Position Intercept Difference <input style="width: 80%;" type="text" value="2.31"/>	Total Points <input style="width: 80%;" type="text" value="6"/>	Sigma limit <input style="width: 80%;" type="text" value="2.5"/>
	Slope <input style="width: 80%;" type="text" value="0.199811"/>	1.10206		Graph <input style="width: 80%;" type="text" value="PID + Slope"/>
	Std Dev. <input style="width: 80%;" type="text" value="0.00051"/>			

	Use	Date	Time	PID	Slope	Steps /HFD	Fit	Comm
1	Y	2021-07-30	11:48:33	1.93	0.200211	4.9947	16.93073 3.38971 2500.31028 0.05299 0.27684	Binnin
2	N	2021-07-29	12:57:13	11.34	0.188937	5.2928	12.55093 2.37134 2499.34923 0.92203 0.26654	Binnin
3	N	2021-07-25	15:27:40	-1.41	0.202954	4.9272	19.95721 4.05039 2500.93102 -0.54357 0.85311	Binnin
4	N	2021-07-25	15:11:34	-3.08	0.210496	4.7507	20.78625 4.37543 2499.45885 -0.76313 0.87047	Binnin
5	N	2021-06-14	12:50:17	0.76	0.195443	5.1166	21.40689 4.18382 2498.60966 -0.38007 0.65188	Binnin
6	N	2021-06-14	12:42:49	16.44	0.185406	5.3936	5.13814 0.95264 2499.15425 1.49933 0.58408	Binnin
7	Y	2021-06-04	11:28:11	1.52	0.200307	4.9923	15.14862 3.03437 2500.7348 0.03612 0.85833	Binnin
8	N	2021-06-04	11:16:54	6.81	0.196887	5.0791	11.65434 2.29459 2500.46486 0.60252 0.92466	Binnin
9	N	2021-06-04	11:09:03	5.49	0.194201	5.1493	13.84228 2.68818 2500.05911 0.43877 0.75241	Binnin
10	Y	2021-06-04	10:45:03	3.42	0.199051	5.0238	13.6731 2.72165 2500.89846 0.24647 0.8486	Binnin
11	N	2021-06-04	10:38:21	5.95	0.197282	5.0689	14.16422 2.79434 2499.24258 0.48685 0.83534	Binnin
12	Y	2021-06-04	10:27:27	3.98	0.199294	5.0177	19.69805 3.92571 2499.77547 0.20219 0.79486	Binnin
13	N	2021-06-04	10:19:31	-3.06	0.204397	4.8924	23.24795 4.75182 2500.35648 -0.59058 0.90134	Binnin
14	Y	2021-03-27	12:55:51	1.47	0.2	5.0000	17.50705 3.50141 2500 0 0	Binnin
15	Y	2021-03-27	12:00:55	1.55	0.2	5.0000	17.50704 3.50141 2500 0 0	Binnin

Graph	
Optimize	
Delete	

- Pressing the 'Graph' button will display the Slope and PID data with a line indicating the mean and dotted lines which represent the +/- sigma limits (in this example +/- 2.5 sigma). Any point that is on or beyond the dotted line are candidates to exclude from the data set which is done by double clicking the 'Y' changing the entry to 'N' in the 'Use' column. You may experiment by including / excluding various data rows and evaluate the changes in the graph and the header of the Profile window (looking for smaller Standard Deviation).

**Notes:**

- Set the Target Star and Focus binning to 2 if you are using a DSLR camera.
- Verify that the focus position is approximately centered in the focuser travel range (step 2). This is particularly important if the focuser has limited travel and may not be able to move the focuser to achieve the max HFD value.
- If the FistLight Wizard fails because it cannot achieve the max HFD setting (40 HFD in step 6), then reduce the max HFD value to the largest found in the Log. For example: If the default HFD setting =40 BUT the largest HFD found in Step 6 is 35 then adjust then set HFD = 35 in the text box.

Focus Convergence Wizard

Focus Convergence Wizard

The Focus Convergence Wizard is to assist in setting the number of convergence 'Steps' which will be used when the focuser has moved to the Near Focus position during the autofocus run. The 'Steps/HFD' is based on the measured Vcurve slope which is determined by $1/\text{slope}$.

The '% HFD error' is the acceptable focus error expressed as a percentage of one HFD unit.

'Samples' is the number of consecutive points that must fall within the 'Steps' setting.

Convergence Wizard

File

**** Focus Convergence Overview ****
 This calculator will help you to determine the Convergence 'Steps' when sampling at Near Focus to determine the focus position.

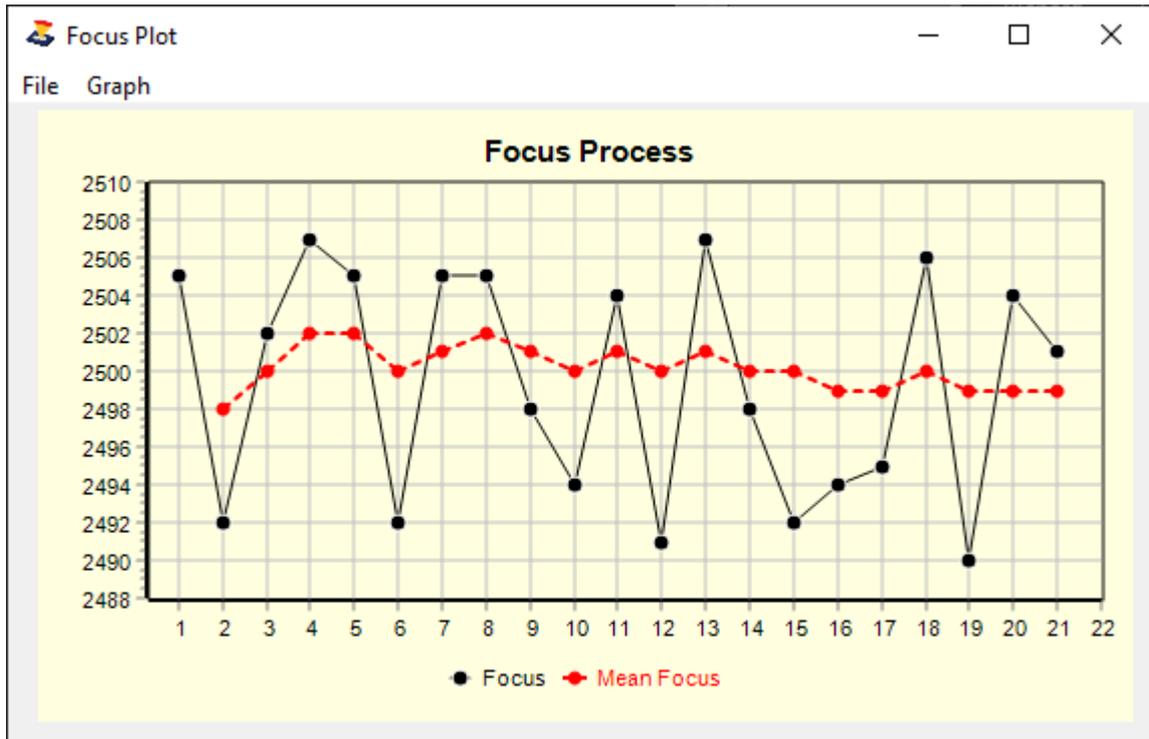
**** Set the % HFD error ****
 Your system Steps per HFD is: 5 steps.
 The allowable focus error is based on a fraction of one HFD unit, a good starting point is 10%.
 As the '% HFD error' decreases, the number of samples required during the focus run will increase and visa versa.

**** Set Samples ****
 'Samples' is the number of consecutive mean focus positions that must fall within the 'Steps' (tolerance) requirement.
 A good starting point is 3 to 5 'Samples', increasing 'Samples' will require more measurements to be taken.
 If the seeing is stable, then the focus position will converge quickly with few subframes required.
 If seeing is poor, then more samples will be required before the focus position converges.

Steps/HFD % HFD error Steps Samples Save

5 10 0 3

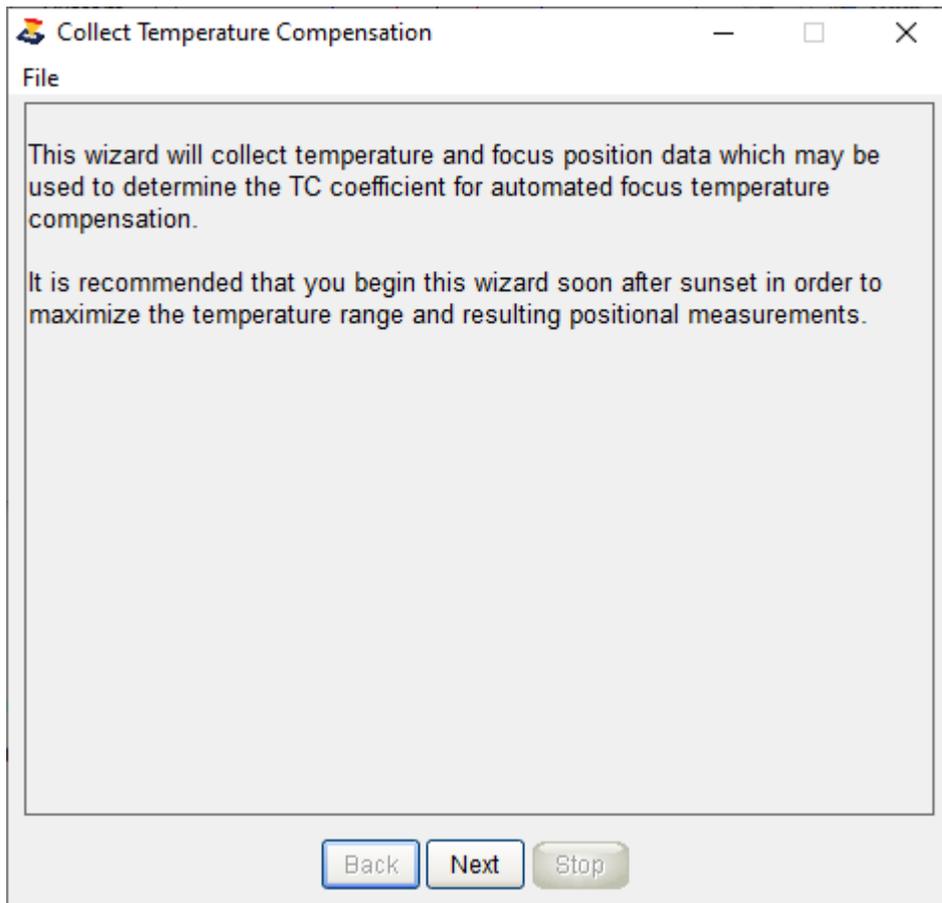
In the figure above, there are 5 steps/HFD, if the percent HFD error is set to 10% then focus will be considered converged when there are 3 consecutive data points (Samples) with a difference of 0 Steps between them. The focus plot below shows each individual calculated focus position (black) and the mean focus value (red). Note that the last three data points (red) fall within the 'Steps' of 0.



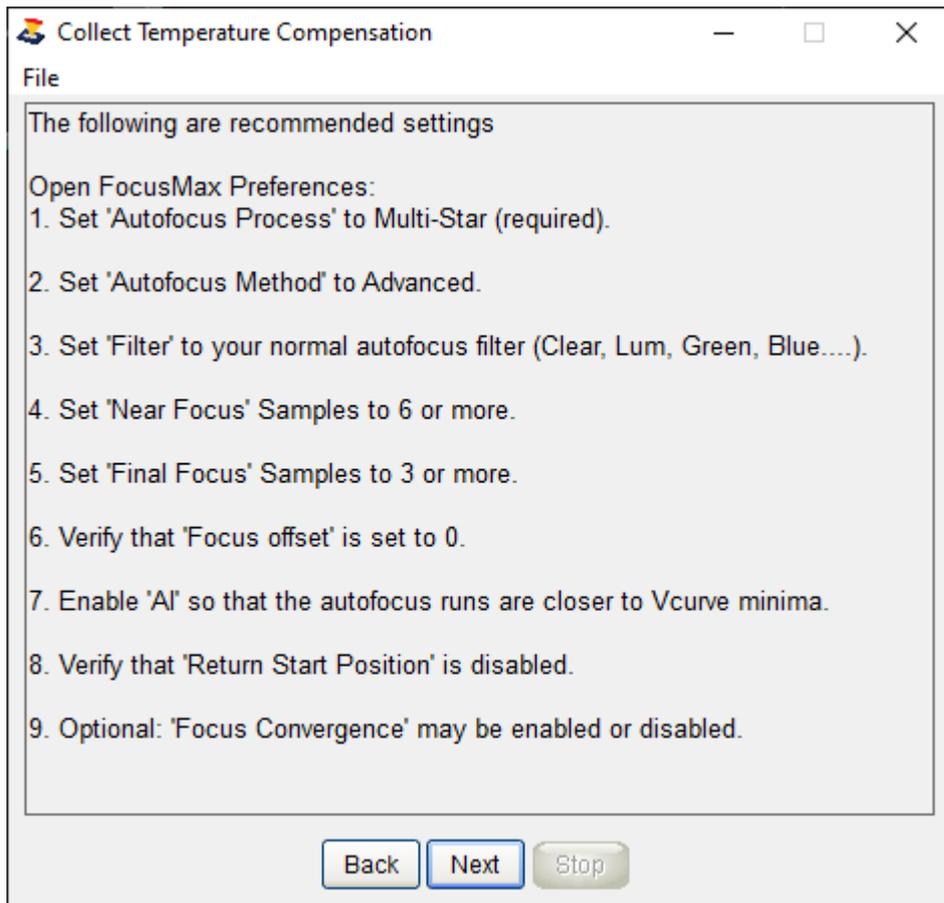
Temperature Compensation Wizard

Temperature Compensation Wizard

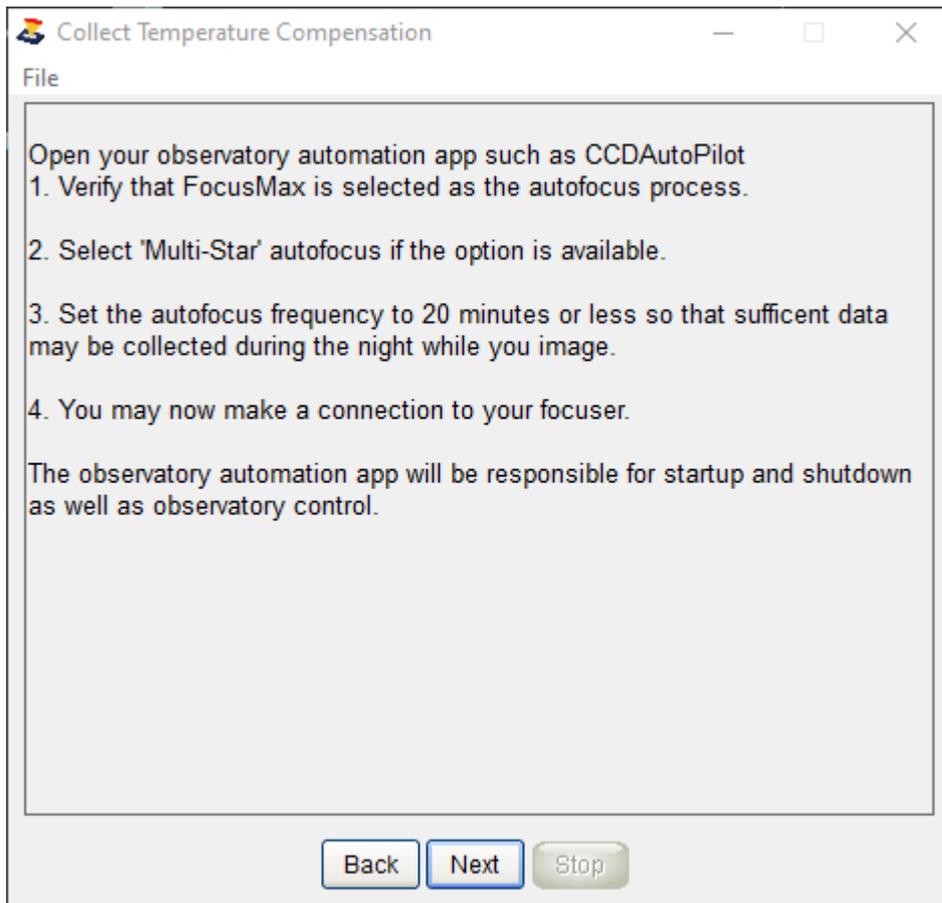
The Temperature Compensation Wizard is designed to collect position and temperature data over the course of one night. The output is a Log with temperature and positions that can be analyzed using the Temperature Compensation Window (Menu/Open/Temp Comp) to determine the temperature coefficient. The Temperature Log will be opened which will log the position and temperature from each autofocus run throughout the night.



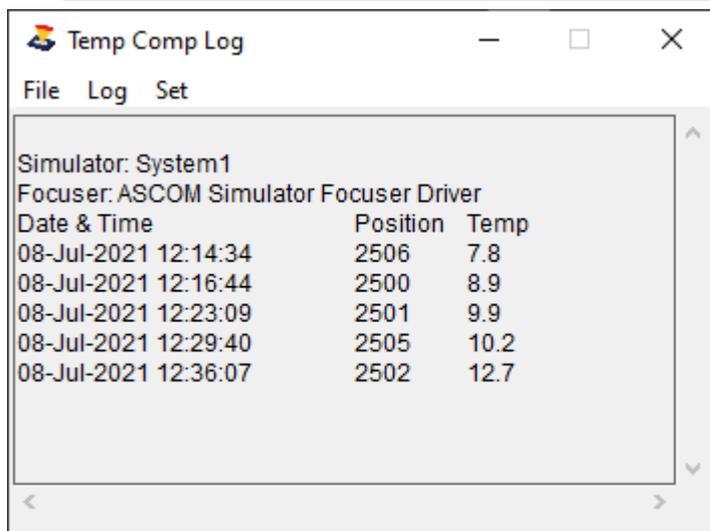
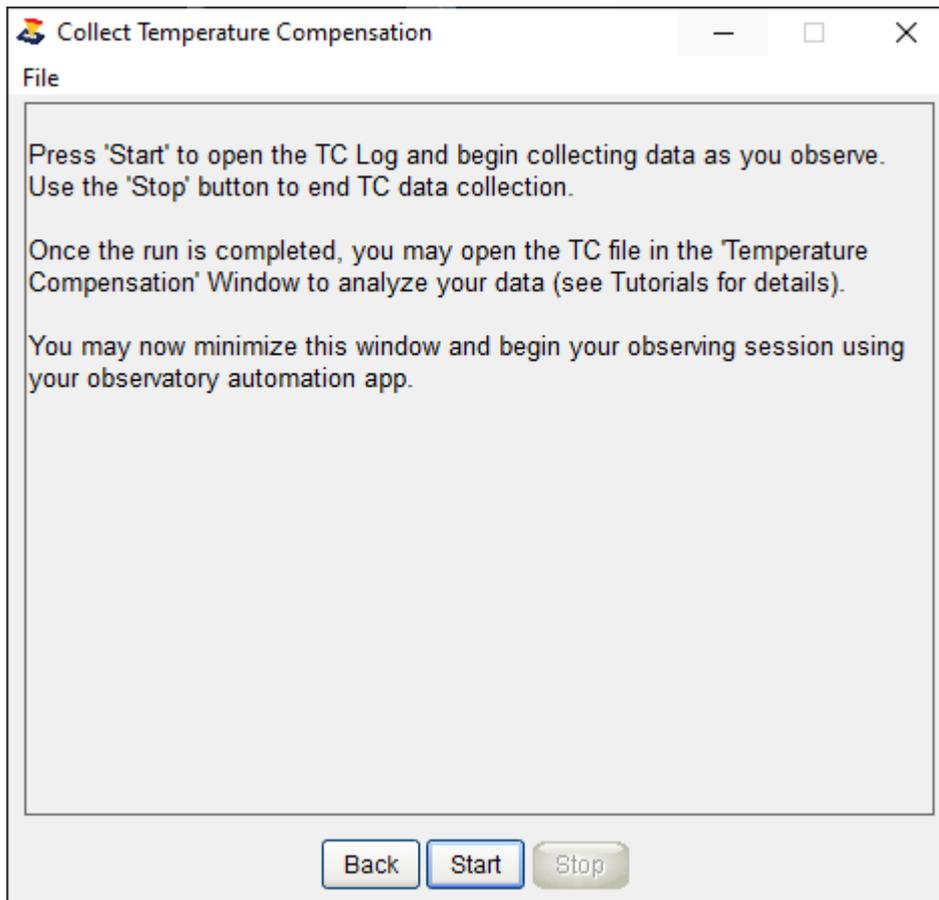
- Set the autofocus parameters as noted below in Preferences/Autofocus



- Open your observatory automation app and set the following parameters. Note that the observatory automation app will be responsible of observatory control and shut down.



- Press Start to begin collecting temperature compensation data during the observing session.

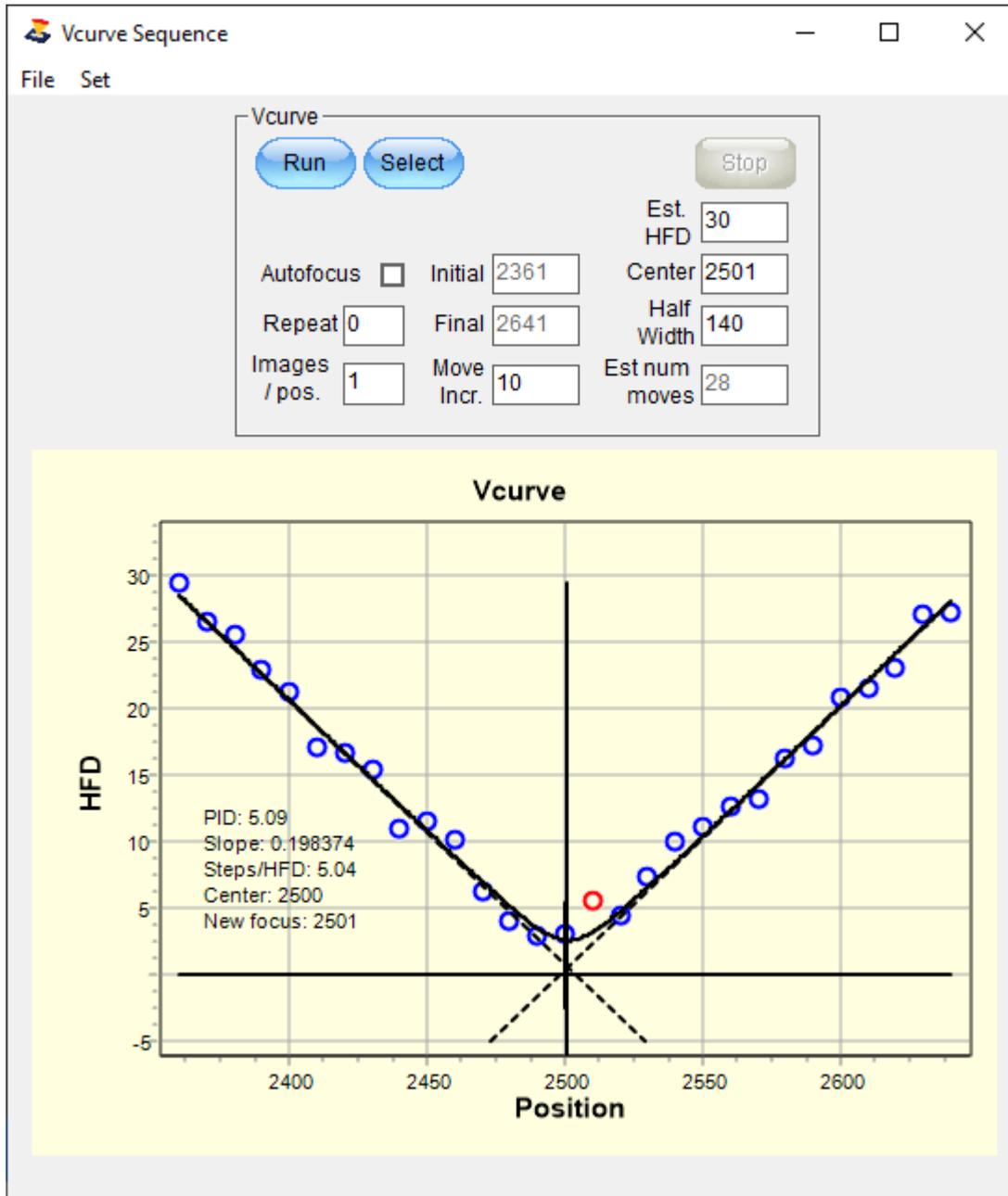


Please see [Temperature Compensation](#) for information on analysis.

Running Vcurves

Running Vcurves

Some users find that the [First Light Wizard](#) is not able to characterize their system or have a working understanding of the Vcurve generation process and prefer to save time by running manual Vcurves.



1. Focus the telescope manually
 - Adjust the focuser so that the focus position is approximately mid-way in the full range of travel on your focuser.

Example - an Optec TCF-S focuser has a total range of 7,000 steps so the focus position should be adjusted to roughly 3,500 steps by adjusting the draw tube, primary mirror (SCT), etc.
 - Verify that the focus position is approximately mid-way in the focus travel range (3,500 for the

above example).

- Select a 6 - 7th mag star (fainter for larger apertures) near the zenith and center on CCD.
- Using your imaging program, set the exposure time to a 'recommended' value of 0.5 sec and take an image. Measure the star intensity and adjust the exposure or use a brighter/fainter star until the target star intensity is mid-way in the camera's ADU range.
- Open the Vcurve window, the current focuser position will be entered in the 'Center' box.

2. Vcurve Parameter Settings:

- 'Center' is the current focuser position which is assumed to be the focus position.
- 'Half Width' is the movement in steps away from the Center in both directions.
-
- 'Step Incr.' sets the number of steps the focuser will move for each data point.
- 'Steps' is the total number of moves that will be made when generating the Vcurve.
Note that as you make adjustments in the boxes that the parameters will change once you leave the entry box or press Enter.
- The 'Initial' and 'Final' are the end point focuser positions.
- Enable 'Autofocus' If you want to perform an autofocus run after the Vcurve is completed.
- 'Repeat' setting will rerun the Vcurve using the same settings above
- 'Images/position' setting will take multiple images and average the HFD measurements at each focuser position. This feature is useful for reducing noise and will yield a more consistent Vcurve. Downside is it takes more time and if the temperature is dripping rapidly then it may negatively impact the overall accuracy of the Vcurve.

3. Determine the Half Width

- Press the Jog button and move the focuser In or Out 100 units then press the Find button
- Continue to move the focuser until you achieve an HFD of 30+ (more is better)
- Note the focuser position
- Bring the focuser back to the focus position and press the Half Width button on the Vcurve window
- Enter the difference between the focus position and the position achieved when you manually jogged the focuser

Example:

Focuser position is 3,500 and 4,000 was the position to achieve 30 HFD.

- Enter the difference of 500 into the Half Width box
- Adjust the Step Increment value until you see 30 - 40 Steps displayed
- Adjust the Step Increment until the Steps has an 'odd' number which helps sharpen the 'V' because each side of the 'V' Plot will have an even number of points.

4. Press the Run button and 'enjoy the show' as FocusMax characterizes your system by creating a Vcurve

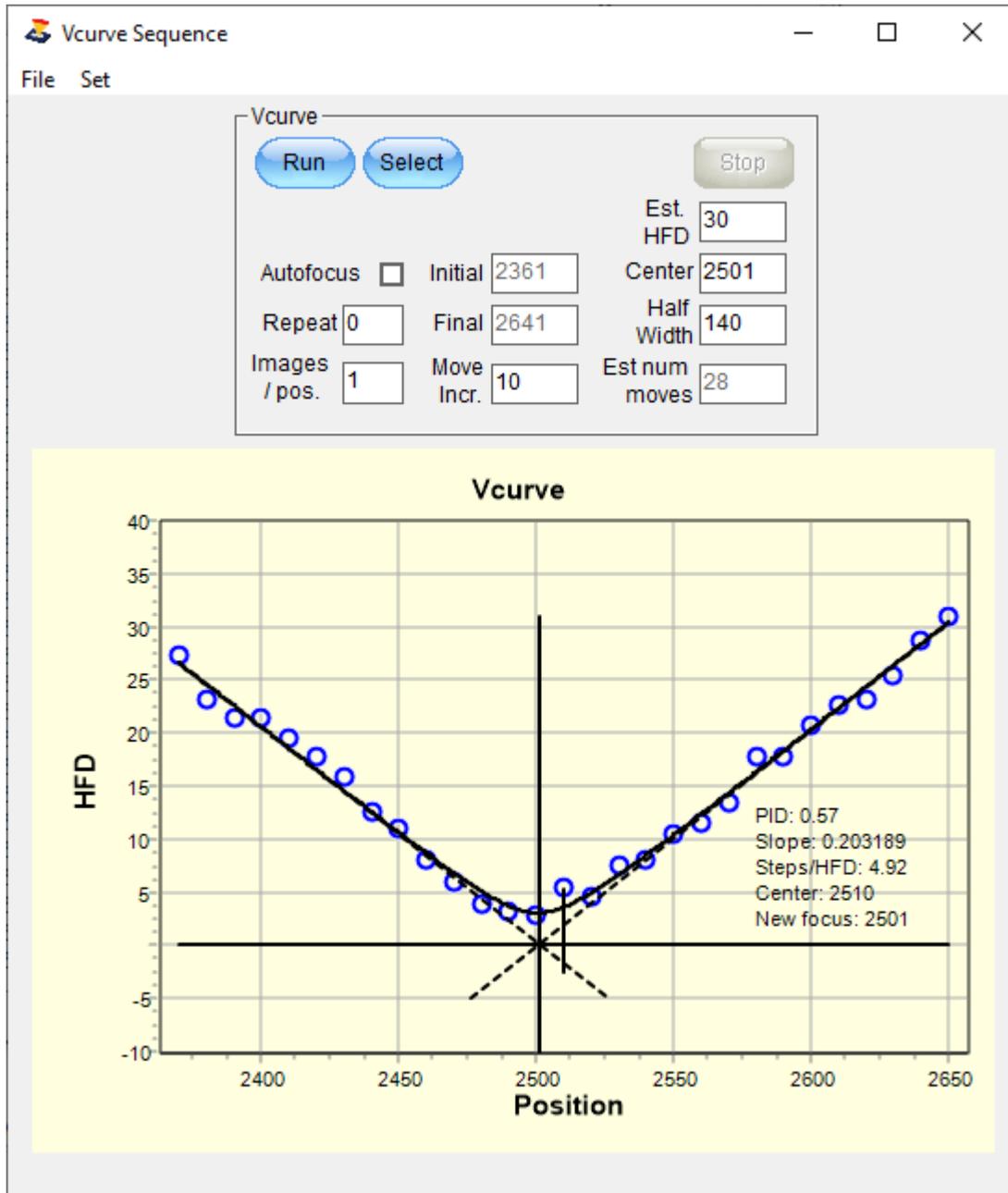
5. Watch the 'V' plot while running a V-Curve cycle.

- Watch the HFD value in the Log as the points on the 'V' near the minima
- When the HFD reaches its lowest value it will start to increase. Note: the lowest HFD position will be the approximate point of best focus.

6. Open the Vcurve Graph from the menu to view the Vcurve in detail

- The graph may be resized as needed
- Data values may be displayed when you roll the mouse over the data points
- The best fit hyperbola to the data is shown through the points
- The vertical line is the V 'Center' when the Vcurve parameters were created
- The Left & Right tangent lines to the hyperbola are displayed

- The slope and PID are shown on the Vcurve graph
- The 'Center' and 'Focus position' are shown. Note:
 - The V 'Center' = 2510 is offset from the 'Focus position' = 2501 in the graph which indicates that the telescope was not in perfect focus when the Vcurve was started.
 - The left tip of the 'V' = 27 HFD and the right tip = 31 HFD. This difference will increase the further the 'Center' moves away from the true 'Focus position' and the Vcurve may fail if this difference is too large. It is important that you begin the Vcurve run as close to focus as possible.



6. Upon completion of the V-Curve cycle jog the focuser to the 'Focus position' before running another Vcurve cycle so that the the V 'Center' is placed at the telescope focus position. This also helps center the apex of the 'V' on the center line of the V-Curve plot.
7. If the lowest HFD in the Log continually changes or the apex of the 'V' in the V-Curve plot drifts this can indicate:
 - The telescope has not reached thermal equilibrium with ambient temperature - wait until the

- telescope cools closer to air temperature.
- Temperature changed causing the focus point to drift - wait until temperature and telescope stabilize.
- Continual drift of lowest HFD in the V-Curve Log, or centering of the 'V' on the V-Curve plot can also indicate the focuser might be slipping.

Notes:

The extremes of the Vcurve should be on the order of 30 - 40 HFD. The primary reason for the large HFD values is to improve the ability for FocusMax to determine the slope. The larger transition from max (tips of the 'V') to min (focus position) the better. This may be a challenge for some telescopes with short range of travel and/or telescopes with low focal ratios which yield a shallow Vcurve.

See [Profile Window](#)

Image Calibration

Image Calibration

This feature is requested by users that may have CCD defects such as hot pixels which FocusMax may attempt to use utilize for focusing. Enable image calibration which is found on the Features tab and follow this procedure:

Preferences

Exit

Setup

Autofocus

Camera

Filter Wheel

Focuser

Telescope

AcquireStar

General

Properties

Sensor Pixel size X Y microns

Full well ADU Max Image ADU % Readout mode

Image

Software bin CCD central region % Border pixels

Mark stars Calibrate

Min Exposure

Single-Star sec Multi-Star sec

Pre-exp delay sec Flush camera

Post-exp delay sec Enable cooler Link delay sec

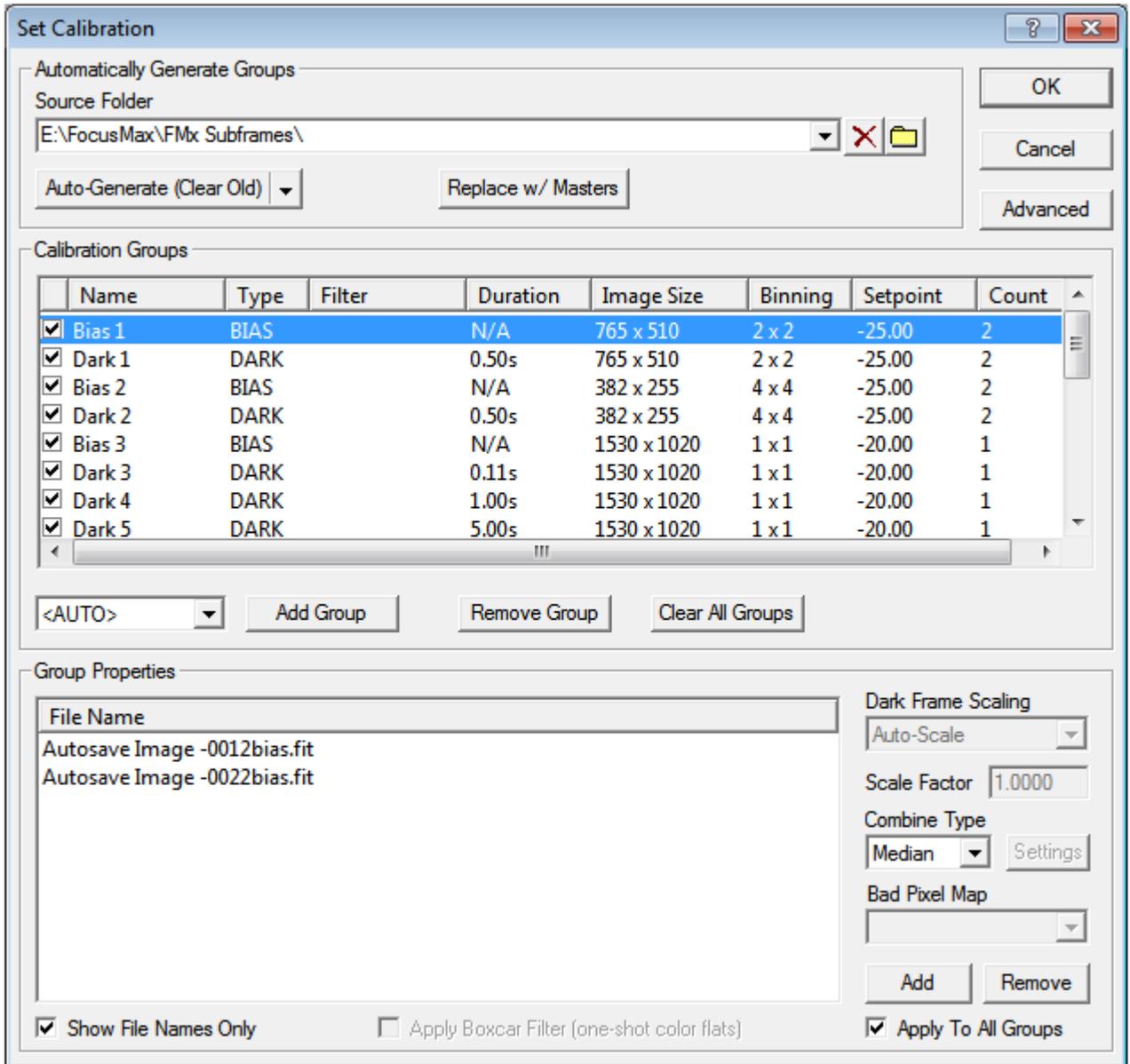
Simulator

Seeing Guide errors

MaxIm image calibration

1. Create a set of dark & bias frames at the binning used for the initial image and autofocus sub-frame images (see Target Star Bin and Focus Bin in Preferences/Autofocus).
2. The Dark frame exposures should span the range which FocusMax may use (0.1, 1, 5, 10 sec...). You may want to create a set of calibration frames from 1x1 through 4x4 just in case you decide to change bin size.
3. Save the calibration frames to a directory
4. Load the saved images into MaxIm using menu/Process/Set Calibration

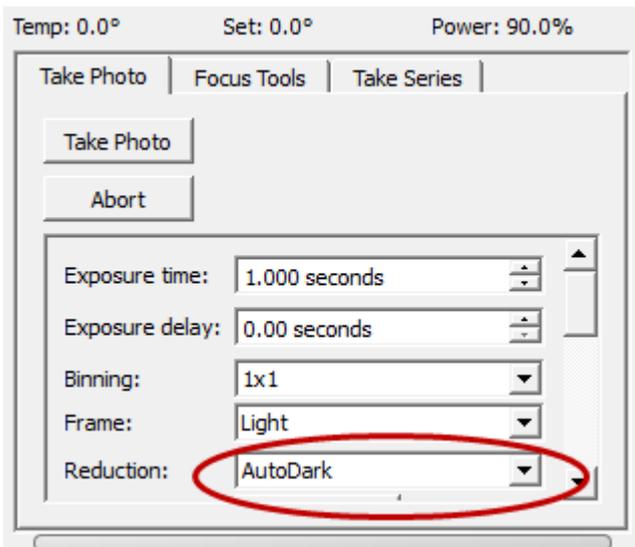
MaxIm will extract the appropriate image and position in the calibration image to calibrate the FocusMax frames for the initial target star section and autofocus sub-frame images.



TheSky Camera Add-on / CCDSoft image calibration

Image Reduction will use 'AutoDark' with each light frame is taken.

TheSky



CCDSOFT

