

# FocusMax V4 Tutorials

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# FocusMax V4 Tutorials

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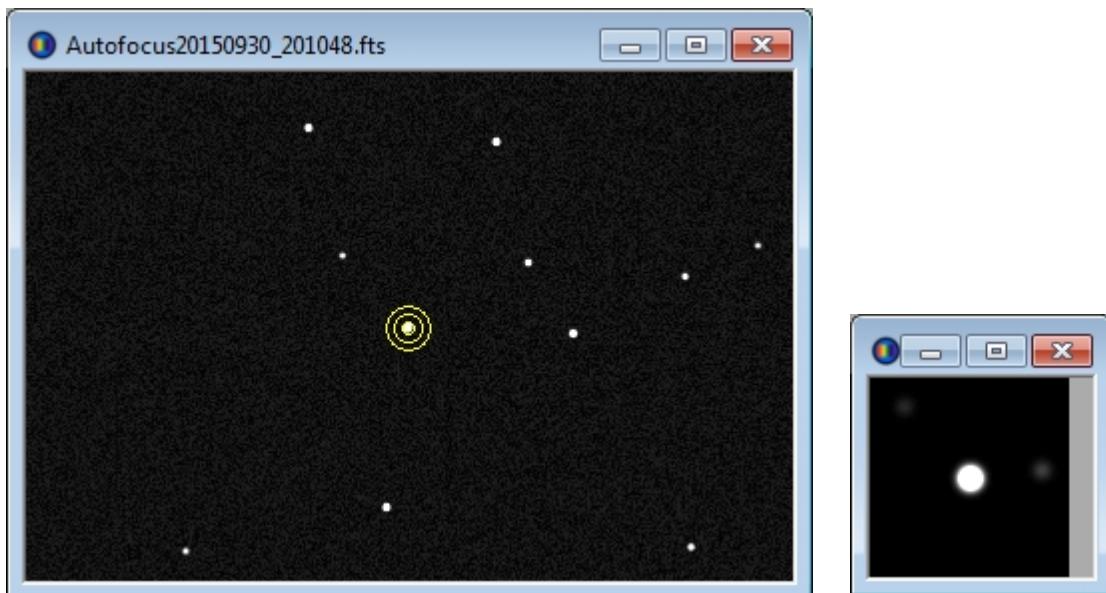
## Learning with Simulators

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### Running FocusMax With Simulators

## MaxIm

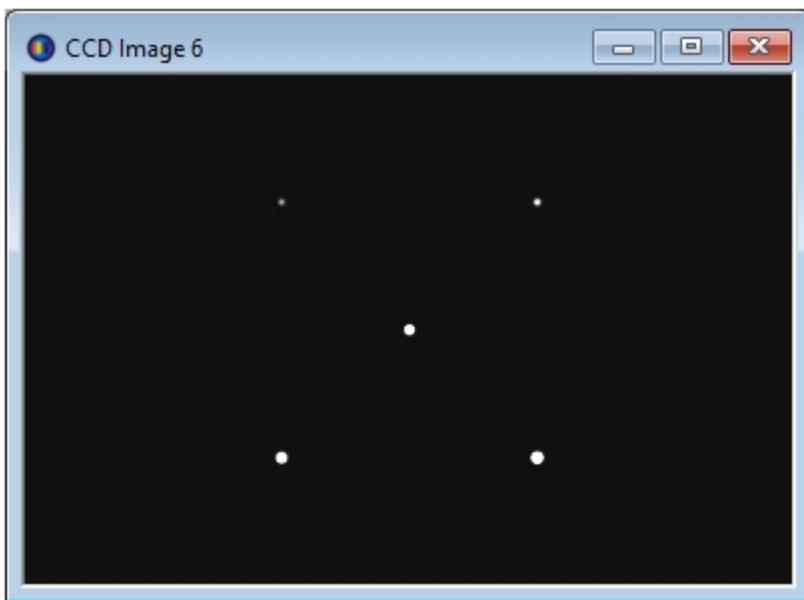
### MaxIm



## 5 Star Pattern

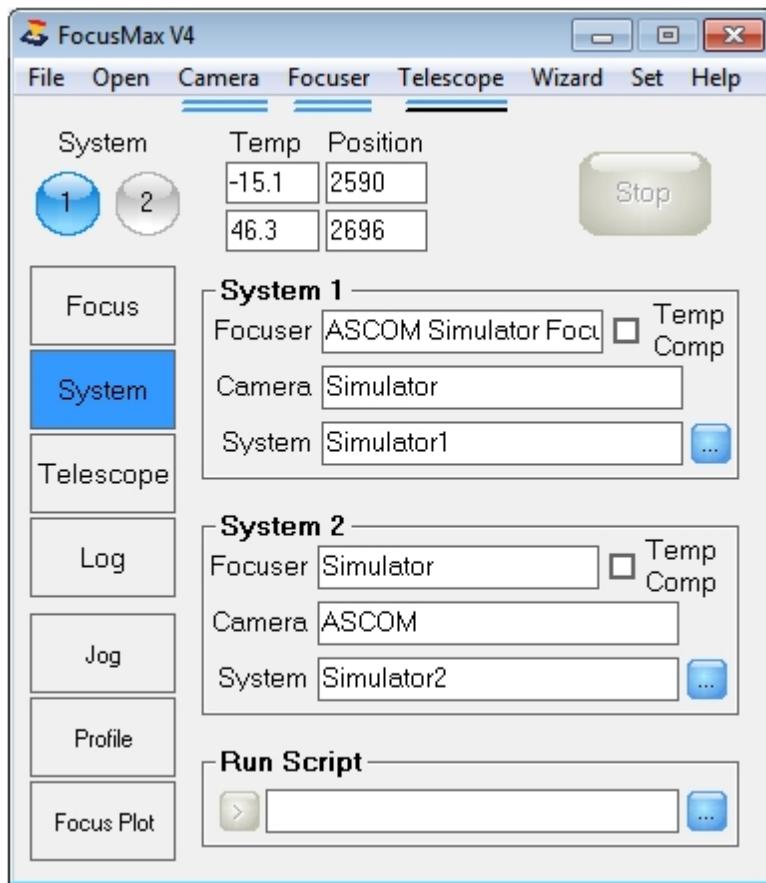
### 5 Star Pattern

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



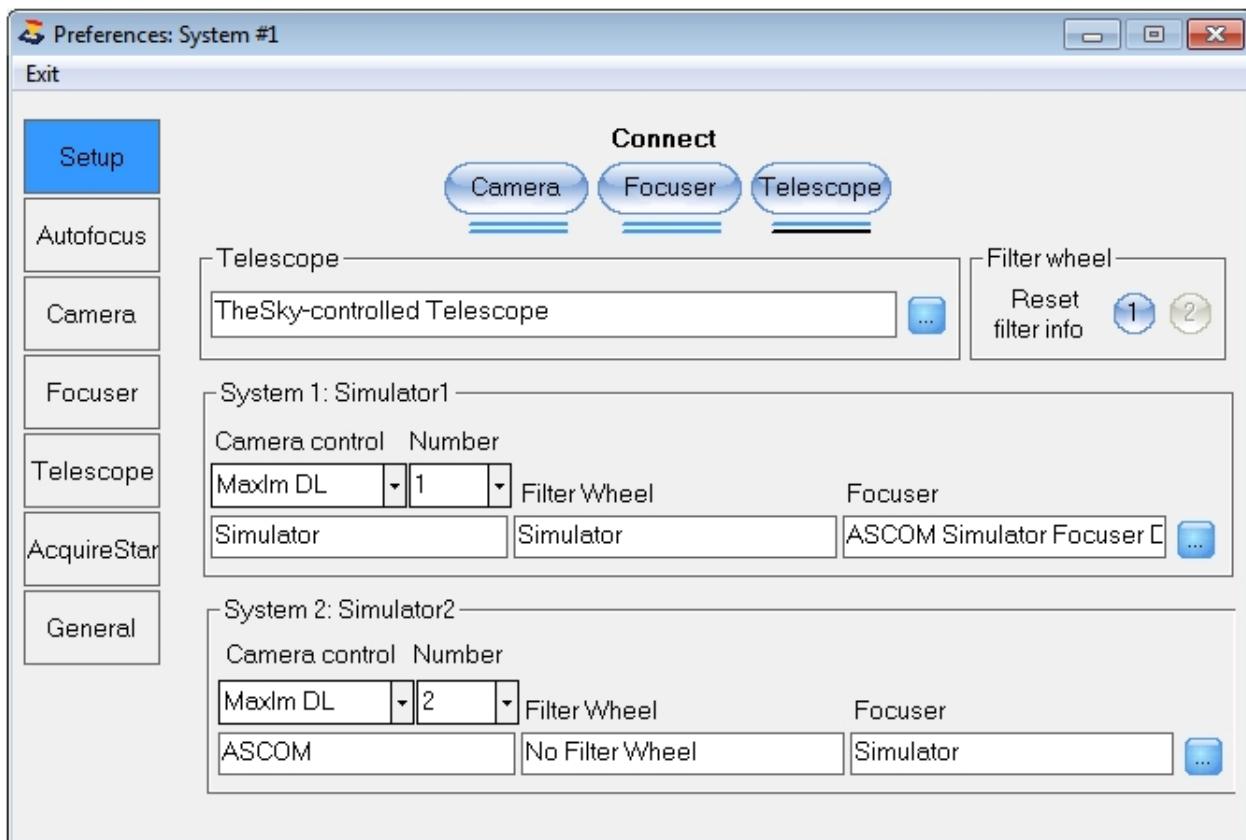
1. Open "Simulator 1" or "Simulator 2" system file on the main FocusMax System window by pressing

the small square button next to the System field



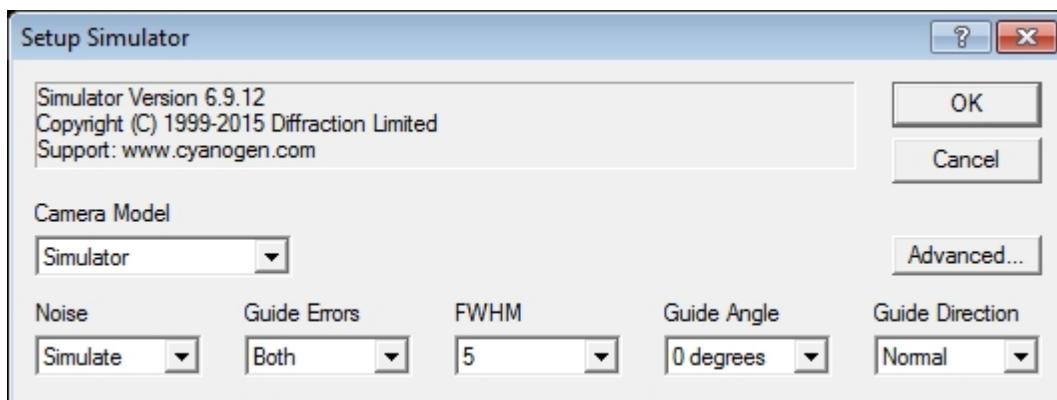
2. Open FocusMax Preferences (Menu / Open / Preferences)

- ▶ 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
- ▶ Select Simulator Focuser's for both Systems
- ▶ Press colored Connect buttons to connect to the camera(s) and focuser(s). A blue line will appear if the hardware connection was successfully established.
- ▶ There is no need to set the telescope simulator with this option.



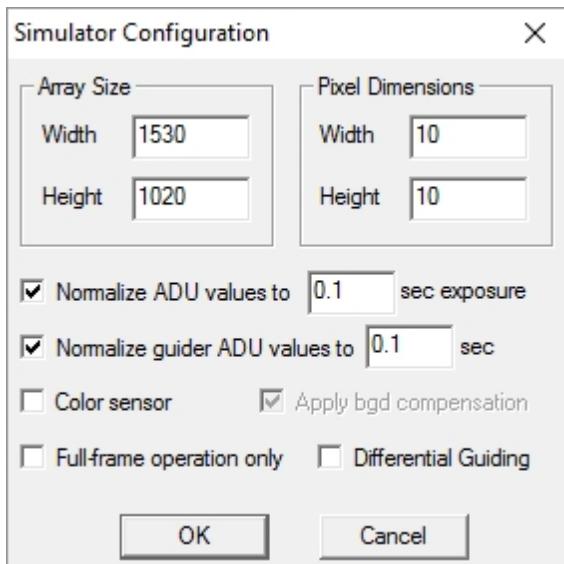
3. Configure MaxIm camera simulator

- In MaxIm, set the Camera model = Simulator
- Noise = On
- Guide errors = Both
- FWHM = 5



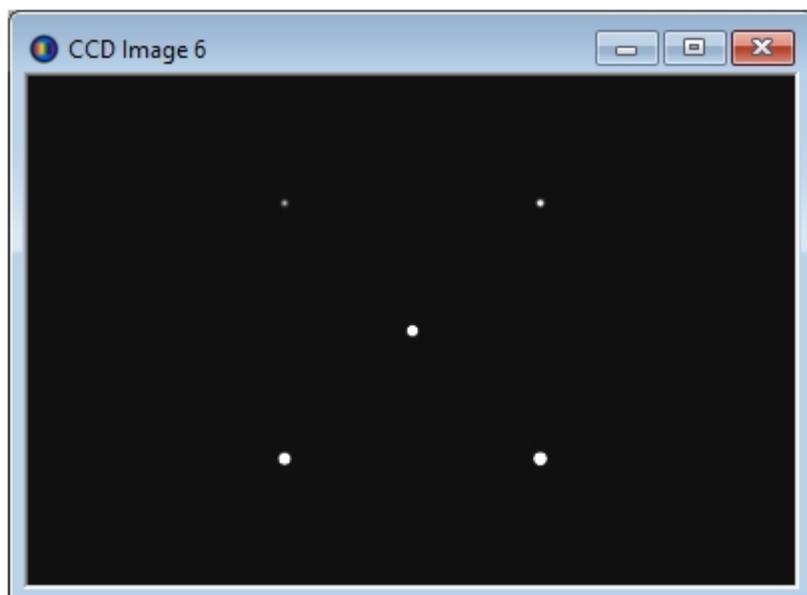
Press advanced button

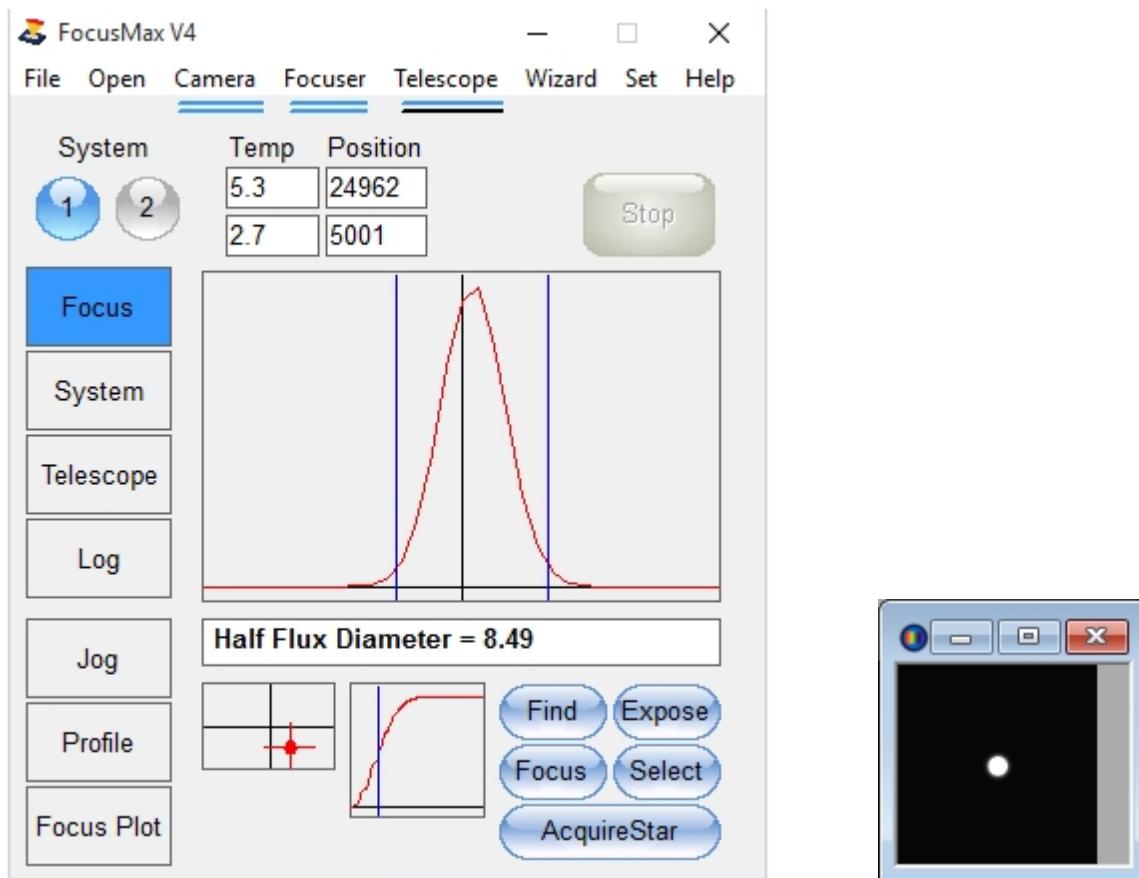
- Set the array size 768 x 511
- Normalize ADU units to 0.1 sec (guider also) which will boost the intensity of each star in the 5 star pattern by a factor of 10
- Pixel Width 10 & Height 10
- Uncheck Color and Full frame operation
- Connect to the camera



#### 4. Running FocusMax in Simulator Mode

- ▶ FocusMax should find the brightest star in the 5 'star' image when the Find button is pressed
- ▶ Run the FirstLight Wizard to generate a set of Vcurves
- ▶ Press the Focus button focus the system using simulator camera and focuser
- ▶ Press Select button to use the cursor to select a star to use for autofocus



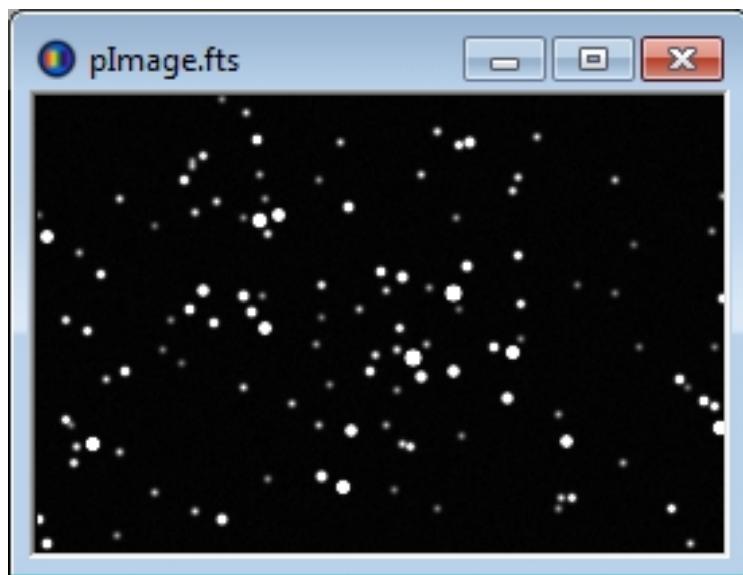


### Simulated Stars with PinPoint

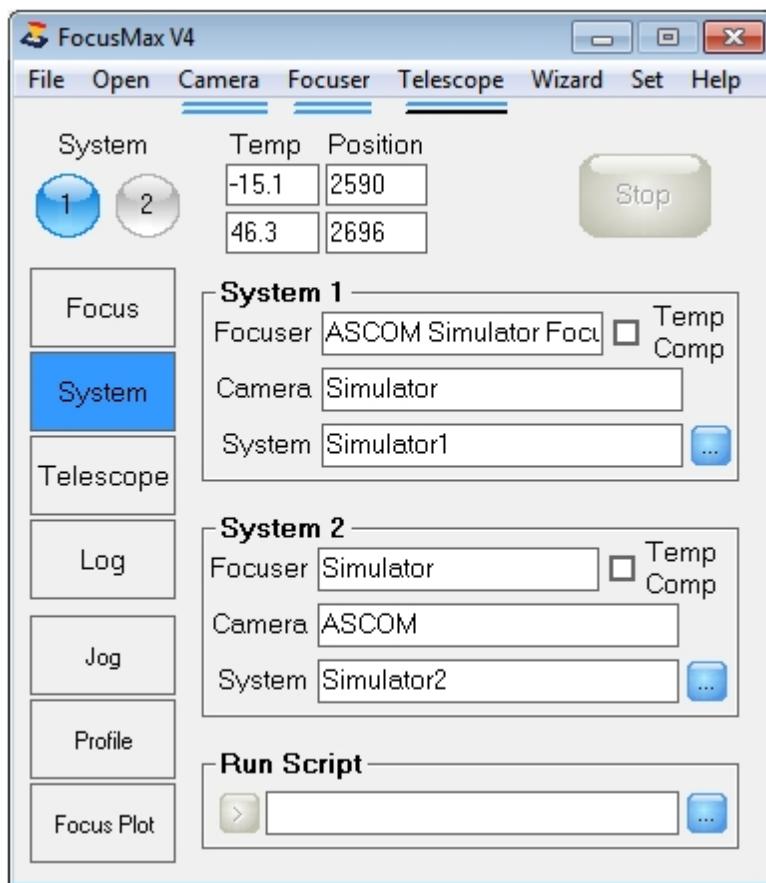
## Using PinPoint to Generate Simulated Star Field

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

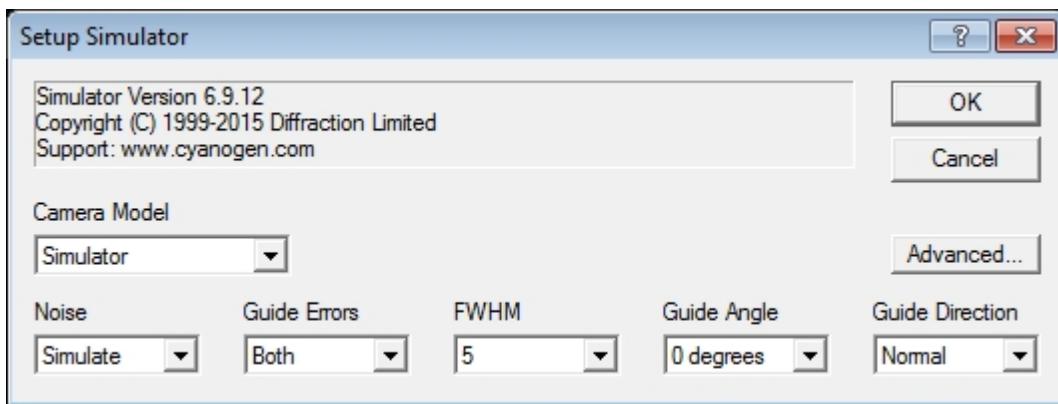
FocusMax must be setup to communicate with a simulator telescope



1. Select the "Simulator 1" or "Simulator 2".system file on the System window by pressing the small square button next to the System field

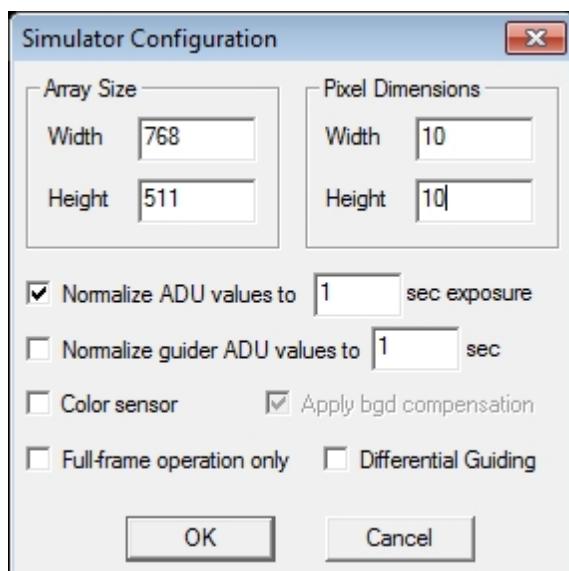


2. Configure MaxIm camera simulator
  - ▶ In MaxIm, set the Camera model = Simulator
  - ▶ Noise = On
  - ▶ Guide errors = Both
  - ▶ FWHM = 5



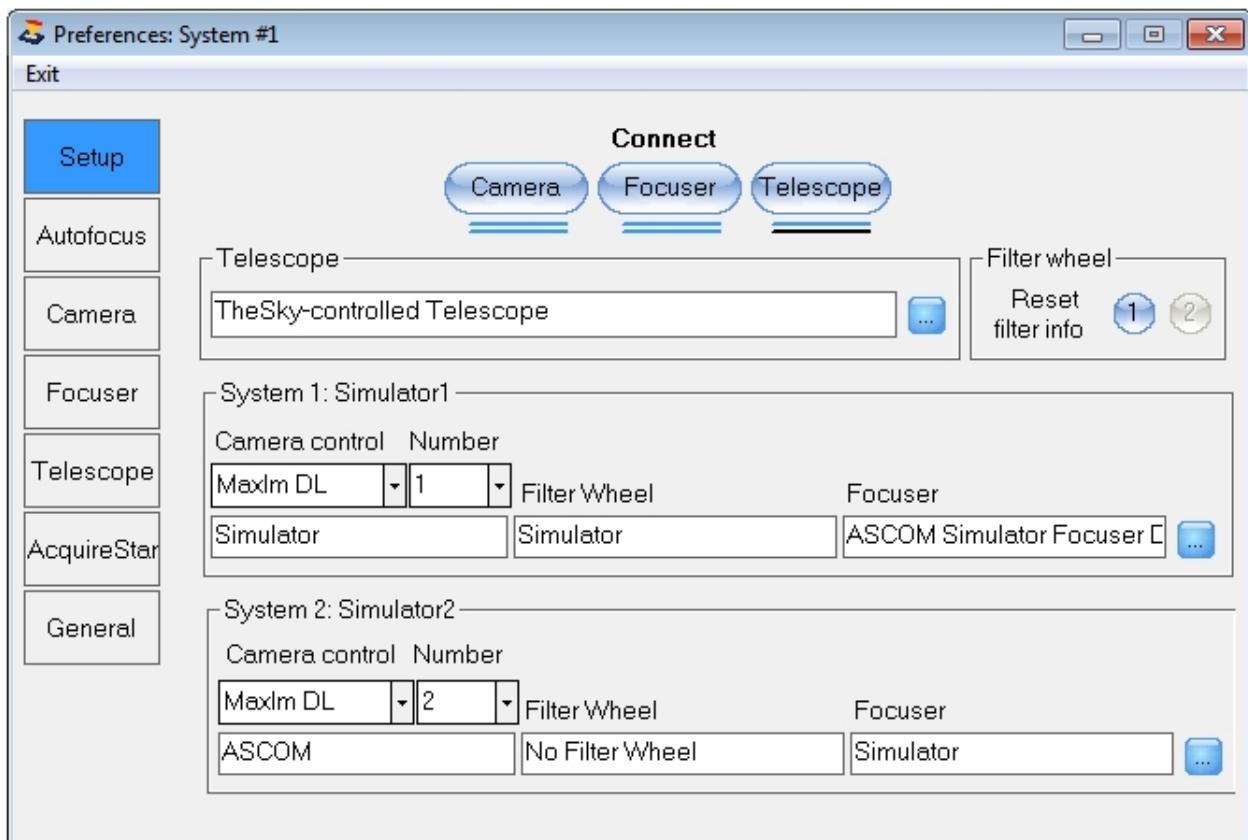
Press advanced button

- ▶ Set the array size 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



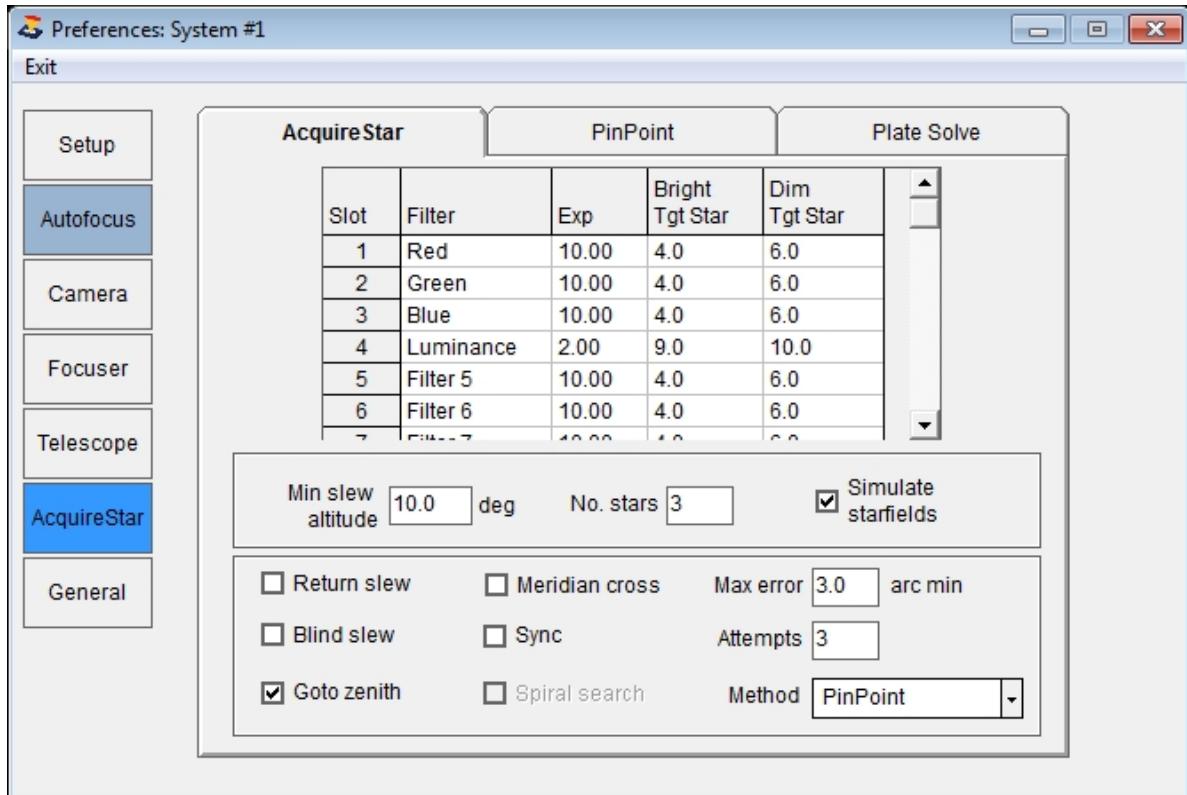
### 3. Open FocusMax Preferences (Menu / Open / Preferences)

- ▶ 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
- ▶ Select Simulator Focuser's for both Systems
- ▶ 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 connection was successfully established. A black line will appear if the telescope is tracking which is required for simulated stars to be generated.

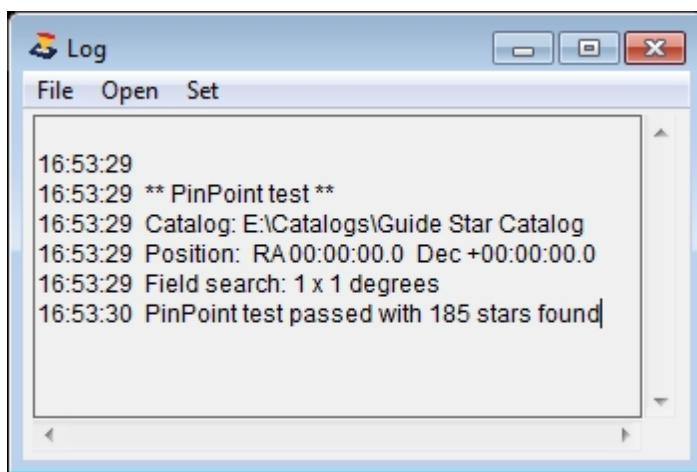
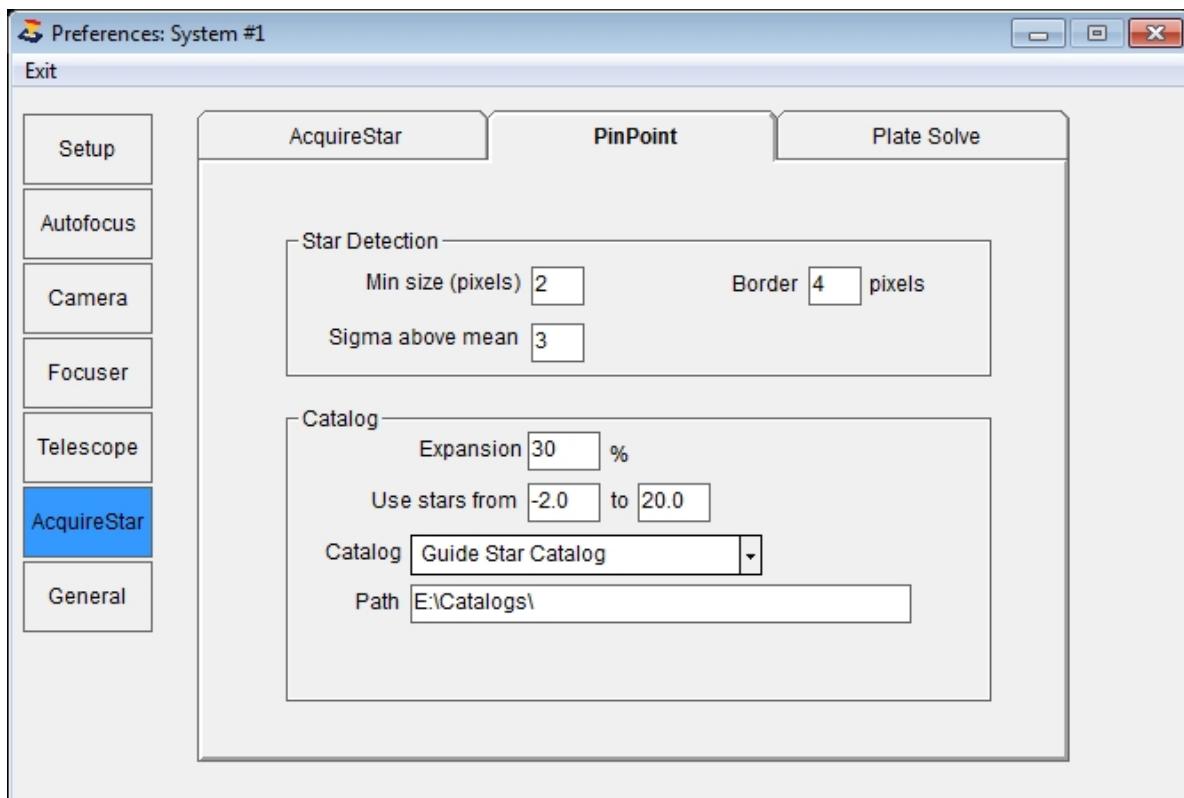


#### 4. Setup PinPoint

- ▶ Open the AcquireStar window and select PinPoint as the Plate Solve Method. Enable Simulate starfields

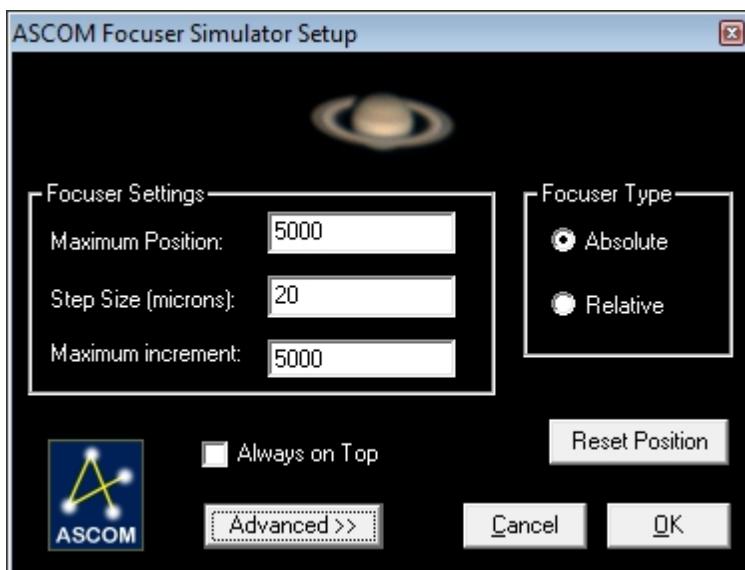
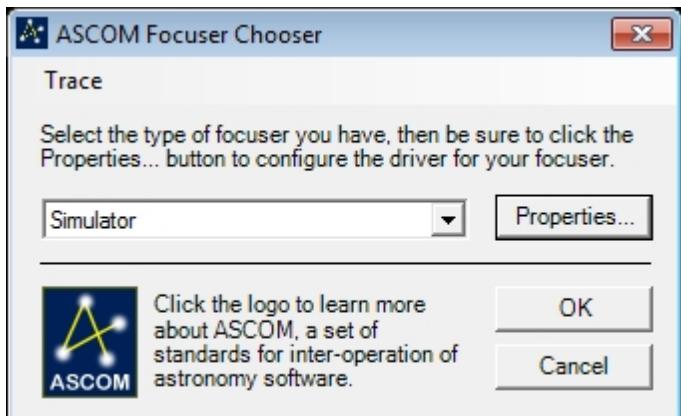


- ▶ Select the PinPoint Tab and set the path to your catalog. The best choice is the Guide Star Catalog.
- ▶ Press the Test PinPoint button to verify that you have a full PinPoint license
- ▶ Press the Test Catalog button to lookup stars in the selected star catalog. The results will be displayed in the Log

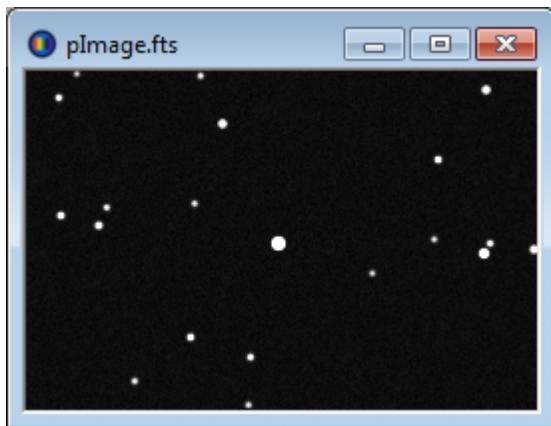


##### 5. Running FocusMax in Simulator Mode

- ▶ 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\*Maximum Position. (2500 in the screen example below).



- ▶ 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

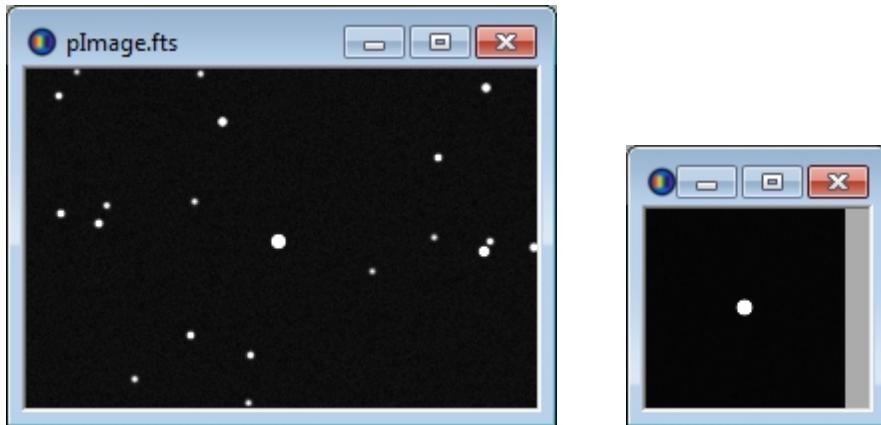


Star coordinates

J2000: 02h 43m 02.875s +55° 06' 21.334" J2000

Topocentric: 02h 44m 13.432s +55° 10' 10.380"

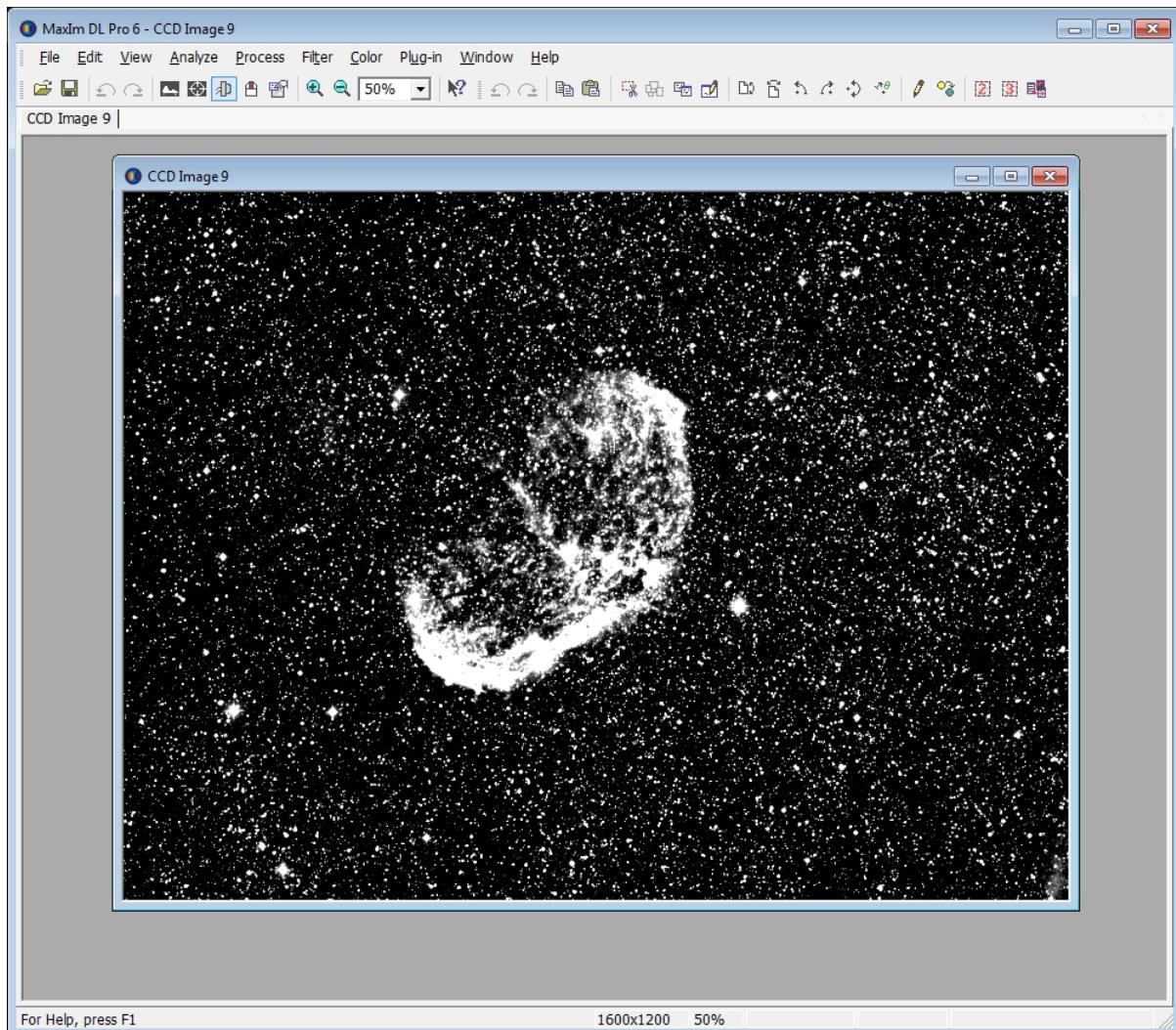
- ▶ Press Find and FocusMax will proceed take an image, create a simulated star field, find the brightest star in the field and subframe the star.



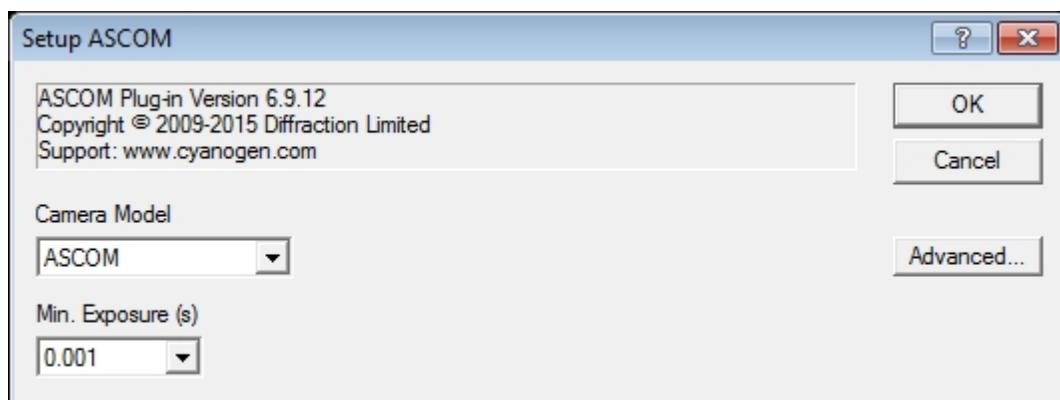
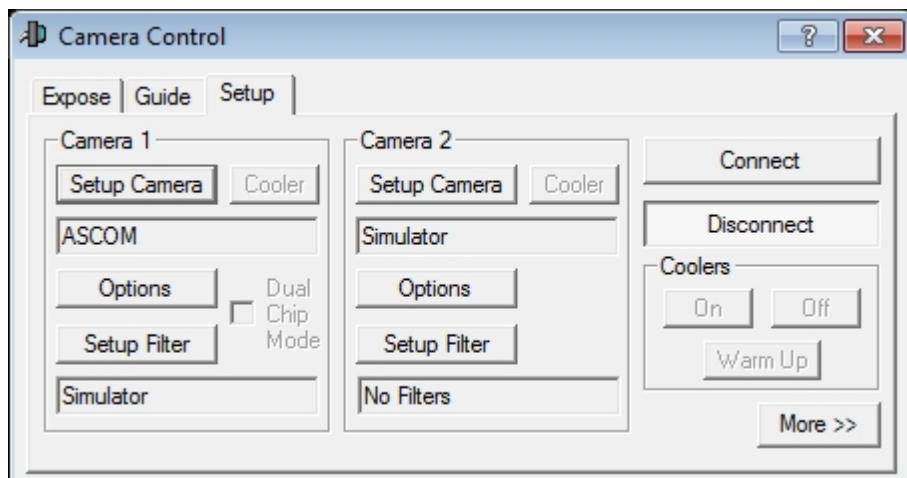
- ▶ Run the FirstLight Wizard to generate a set of Vcurves - note that the star diameter will increase as the focuser moves further away from the mid-point of the focus travel
- ▶ Press the Focus button focus the system using simulator camera and focuser
- ▶ Press Select button to use the cursor to select a star to use for autofocus
- ▶ Setup AcquireStar to automatically select a star for autofocus

#### ASCOM DSS Camera

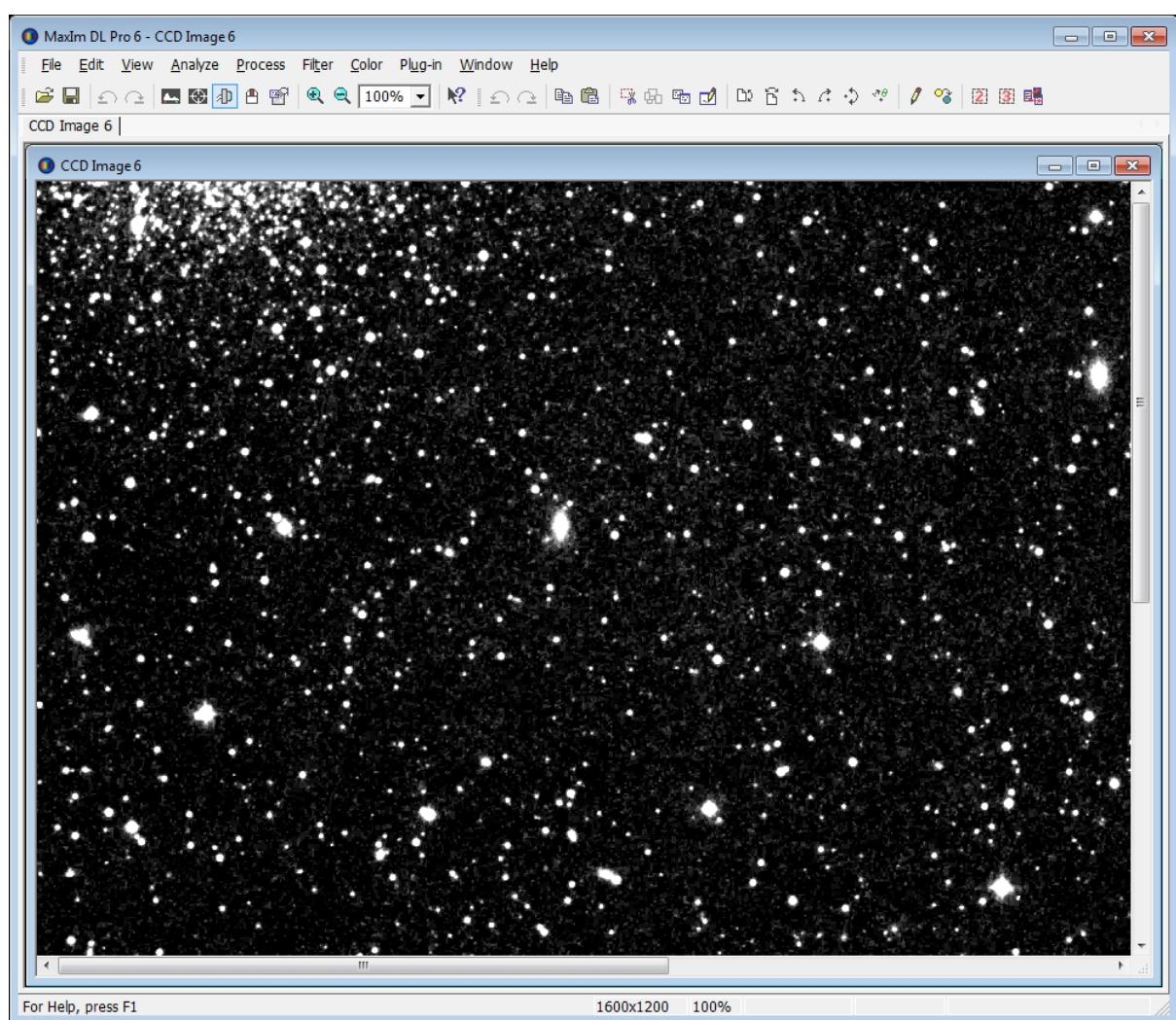
### Using ASCOM DSS Camera to Generate Simulated Star Field

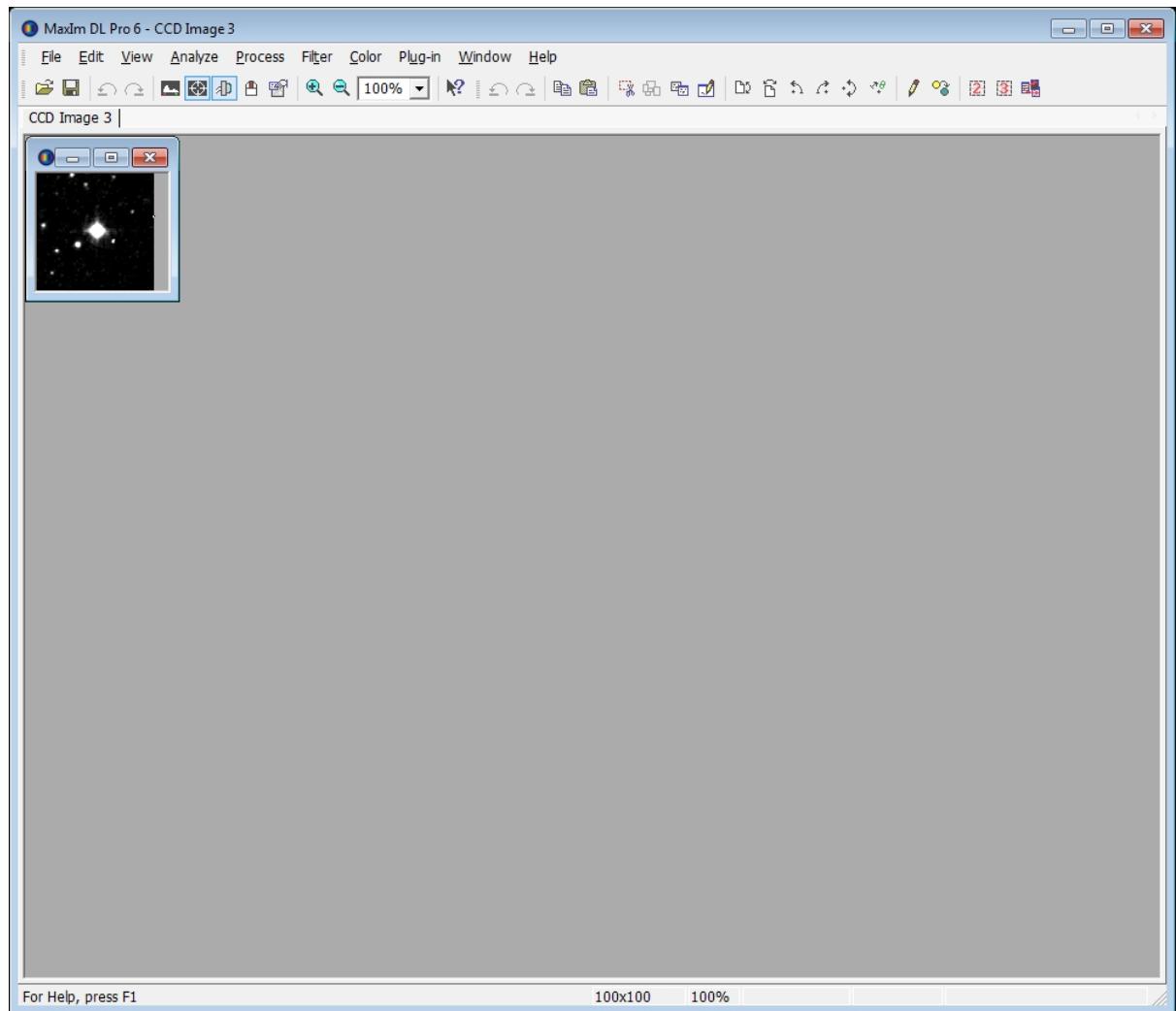


1. A Deep Sky Survey (DSS) ASCOM driver can be installed from <https://groups.yahoo.com/neo/groups/ASCOM-Talk/files/Chris%20Rowland/>. This camera driver will download a DSS image from the internet and which may be used by FocusMax. Once installed:
  - ▶ Press Setup Camera button
  - ▶ Select the ASCOM camera
  - ▶ Press Advanced button to select the telescope connection which will provide the RA & Dec coordinates.



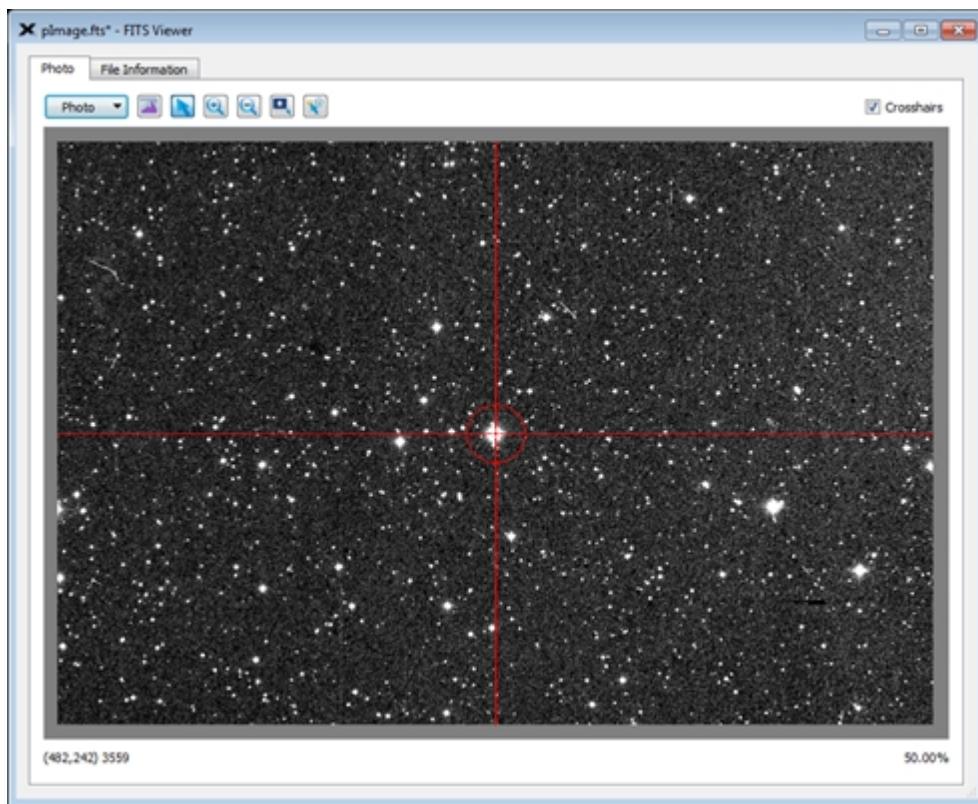
2. If you are using AcquireStar then set the Min / Max magnitude for the current filter to 10 / 11 due to the deep images and overexposed stars in the field of view.





## TheSkyX

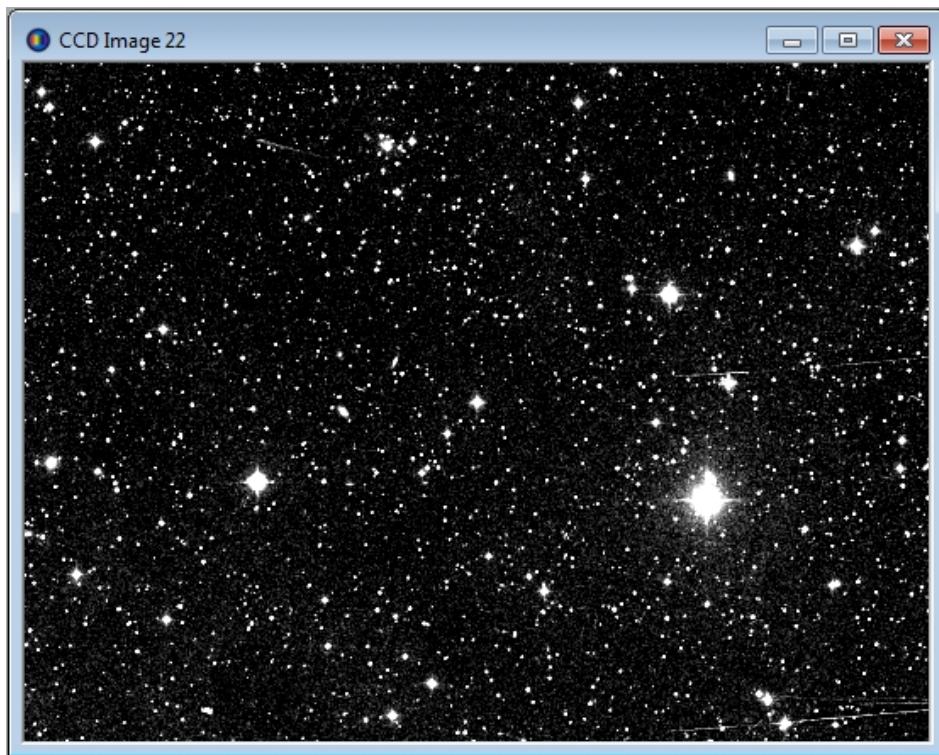
TheSkyX



## Using DSS (Deep Sky Survey)

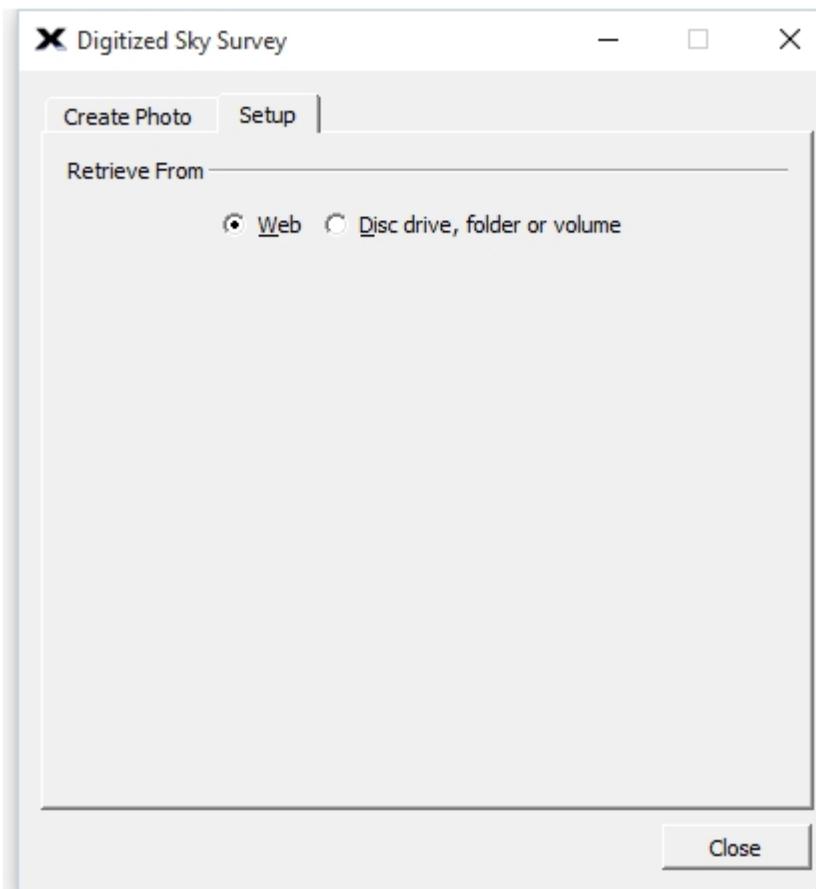
### Images From Deep Sky Survey

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



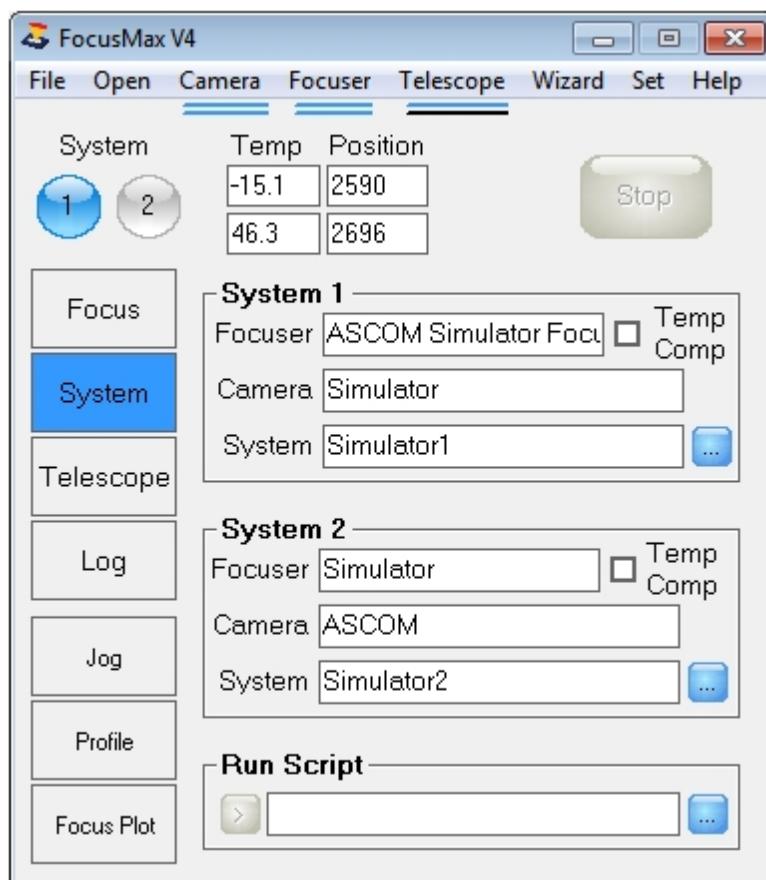
1. Setting up DSS on TheSkyX

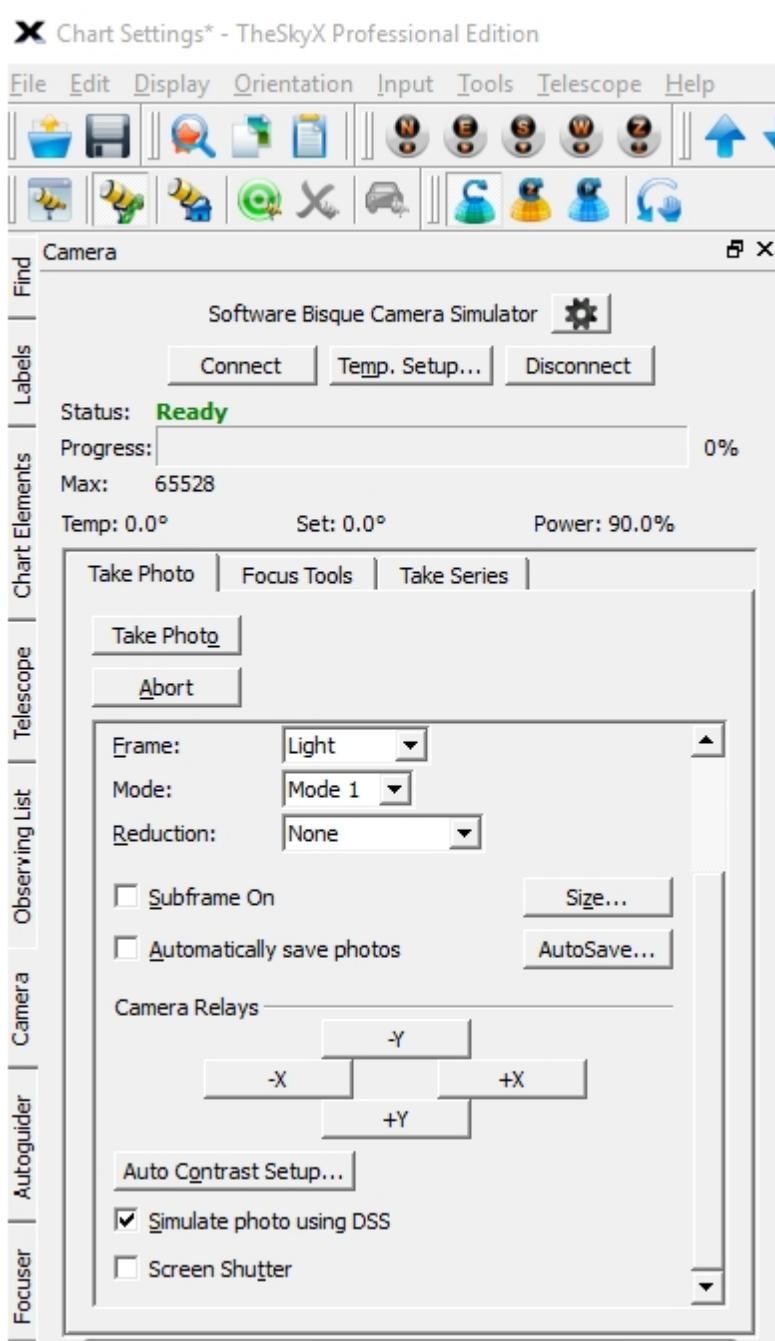
- Open TheSkyX and Menu / Tools / Digital Sky Survey / Setup Tab. Select Web unless you own a copy of the DSS disk

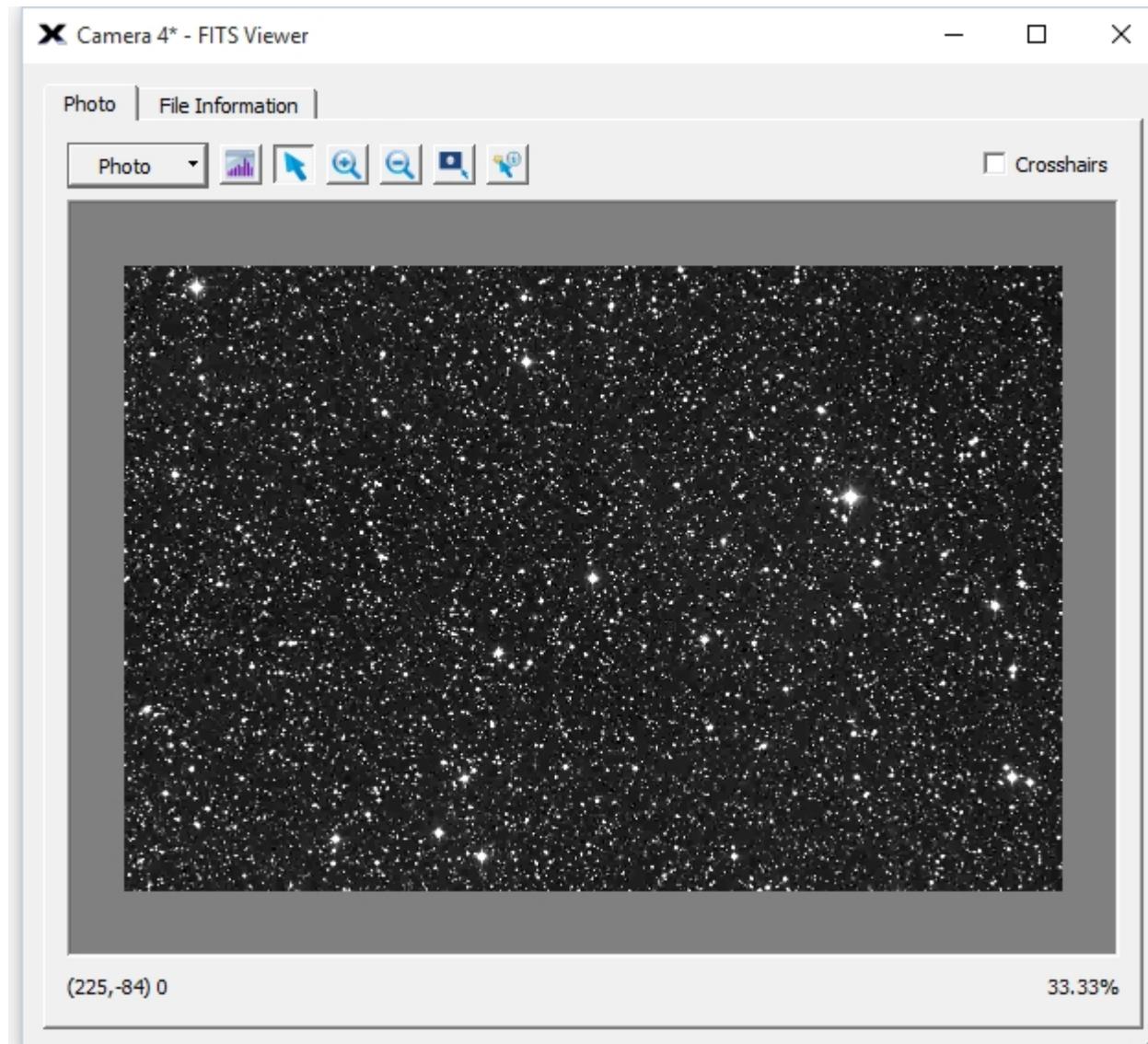


- ▶ Setup the simulator camera in TheSkyX
- ▶ Enable Simulate photo using DSS and take a photo

- ▶ Open "Simulator 1" or "Simulator 2" file on the main FocusMax System window by pressing the small square button next to the System field.



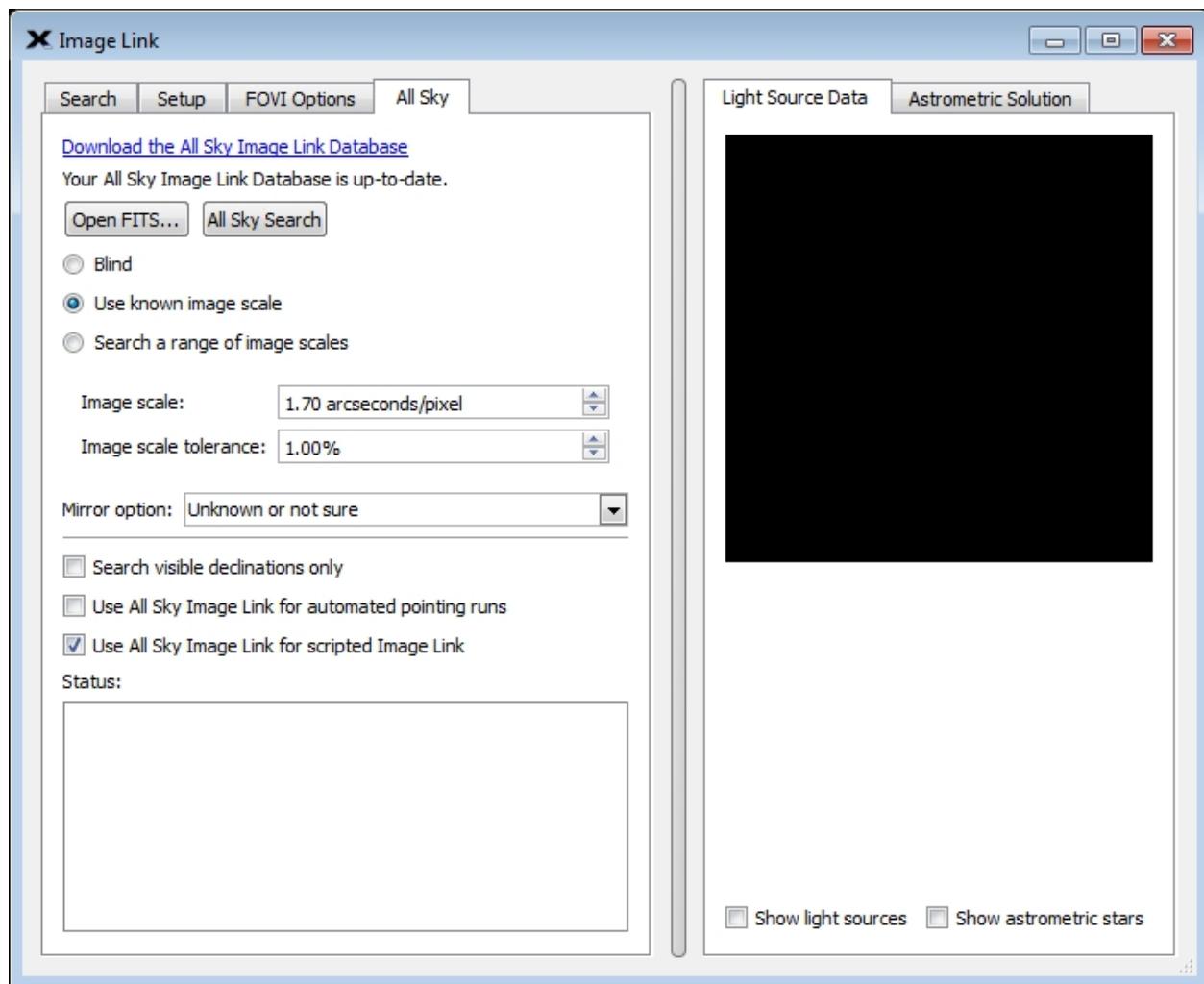




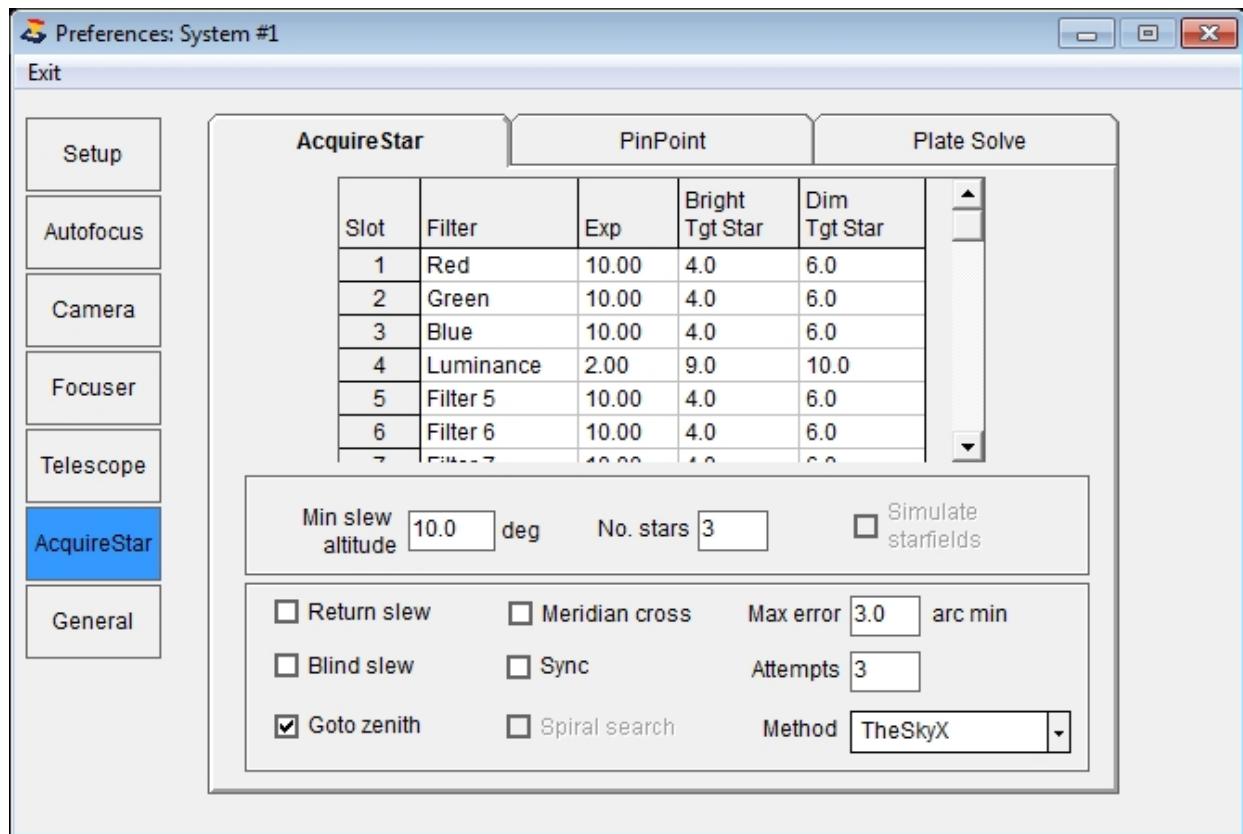
2. Plate solving images with TheSkyX Image Link:

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

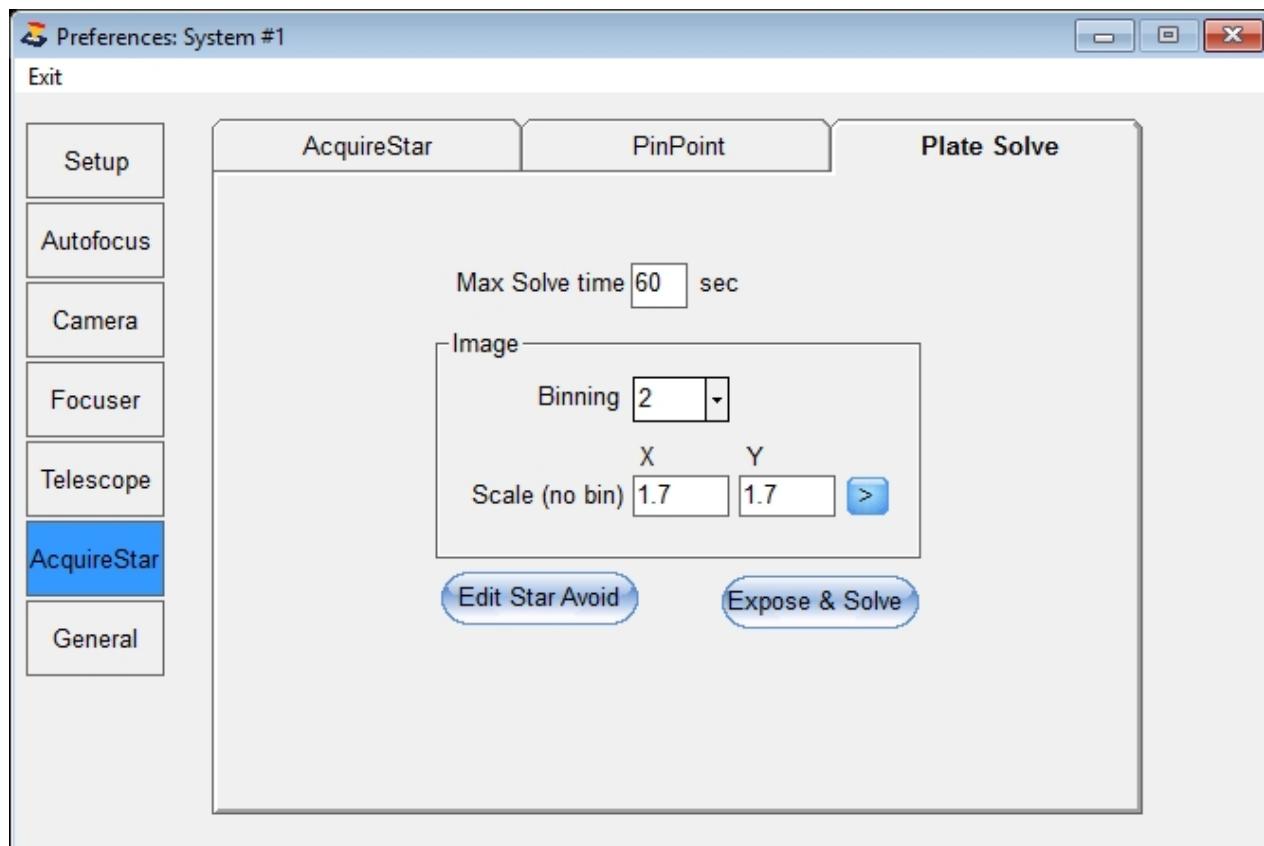
- ▶ Open TheSkyX / Menu / Tools / Image Link
- ▶ Click on All Sky tab to verify that you have the latest file installed (as shown below). If it is not up to date, then press the link to sign in to the Software Bisque site and download 1.7 gigabyte file.



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

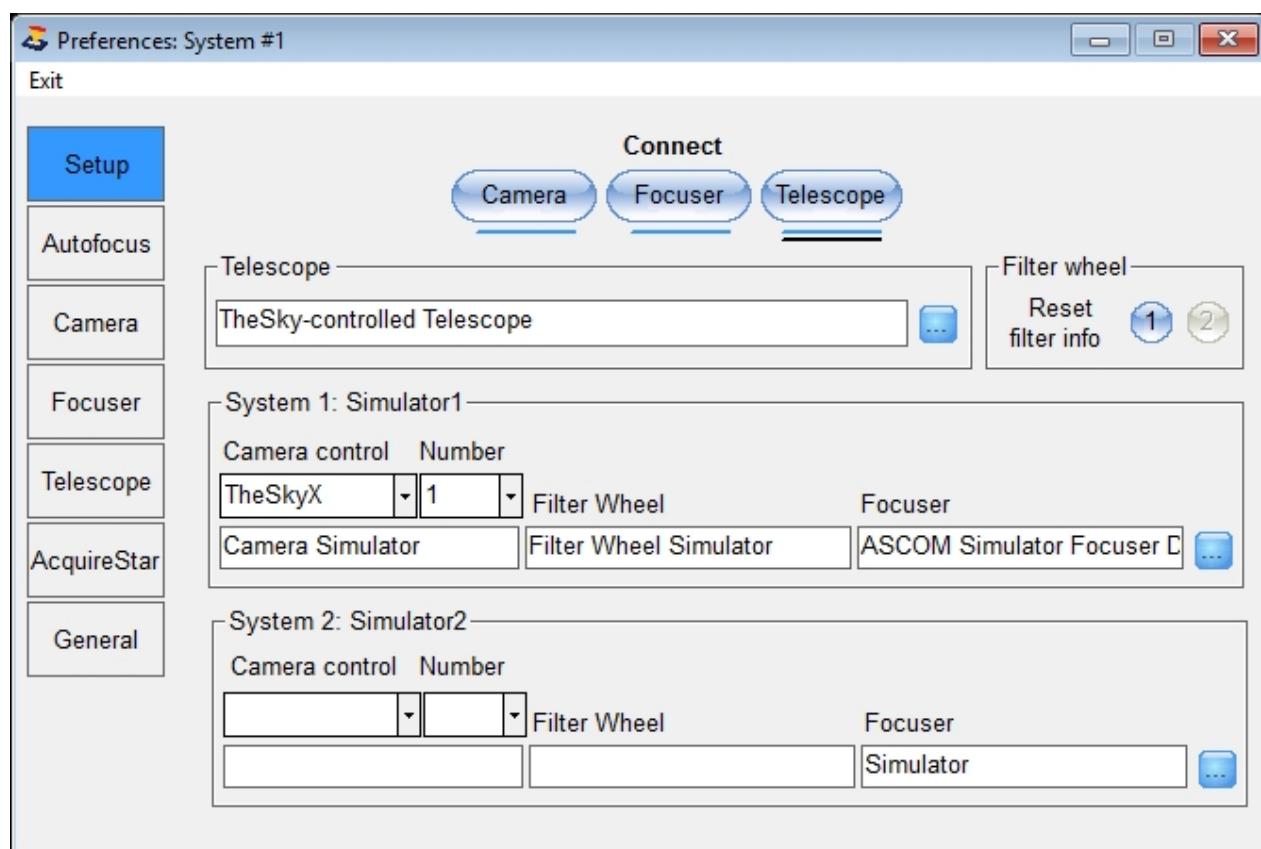


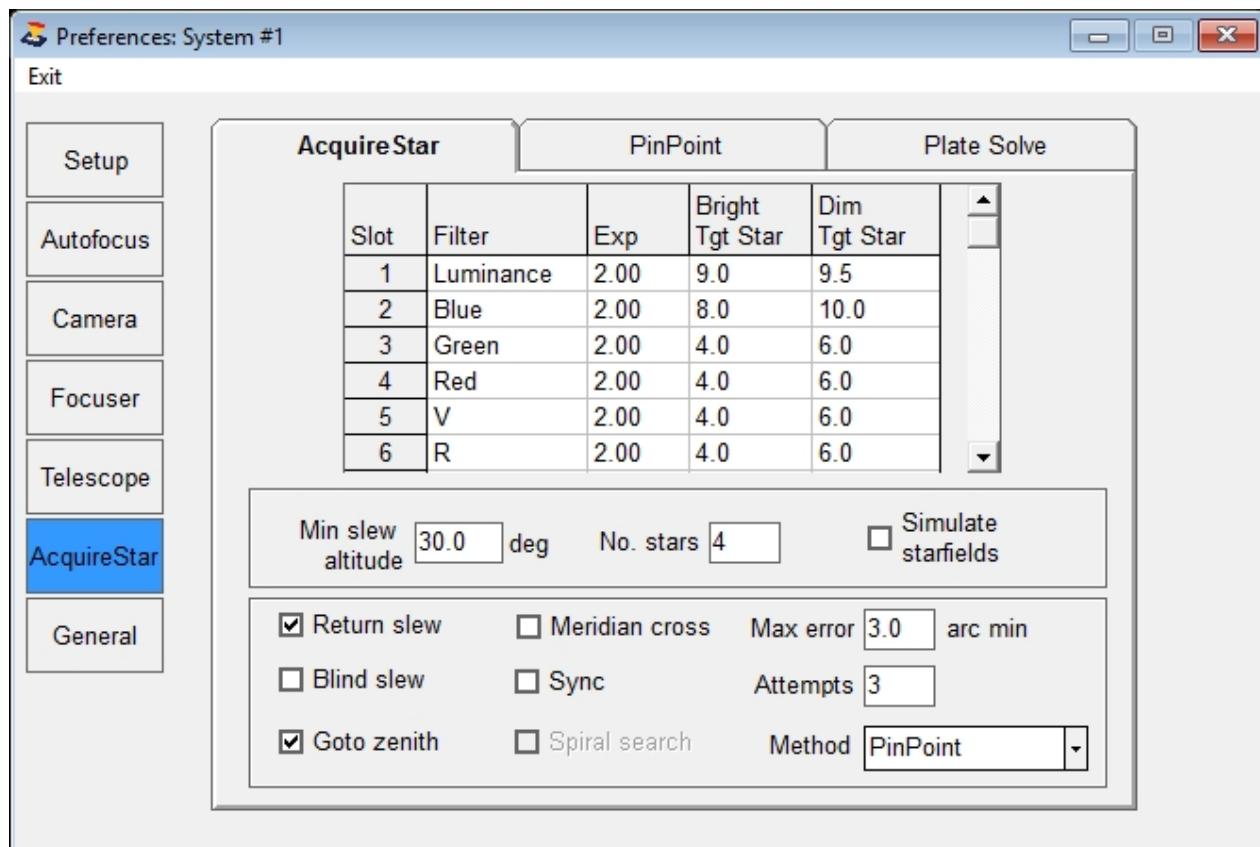
- ▶ You may test the setup by clicking Plate Solve tab and pressing Expose and Solve to take an image and attempt to plate solve.



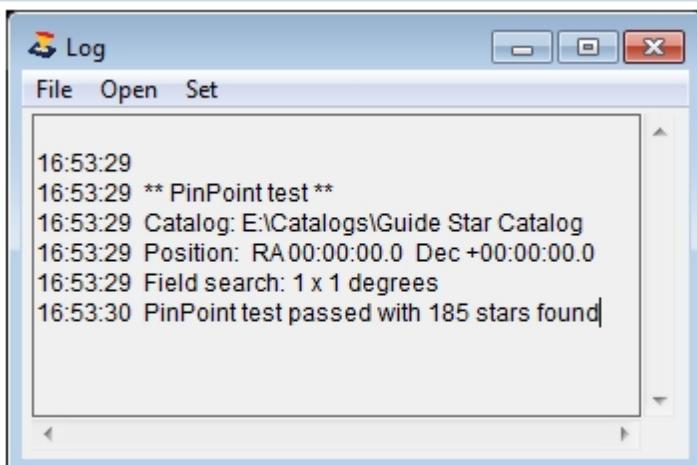
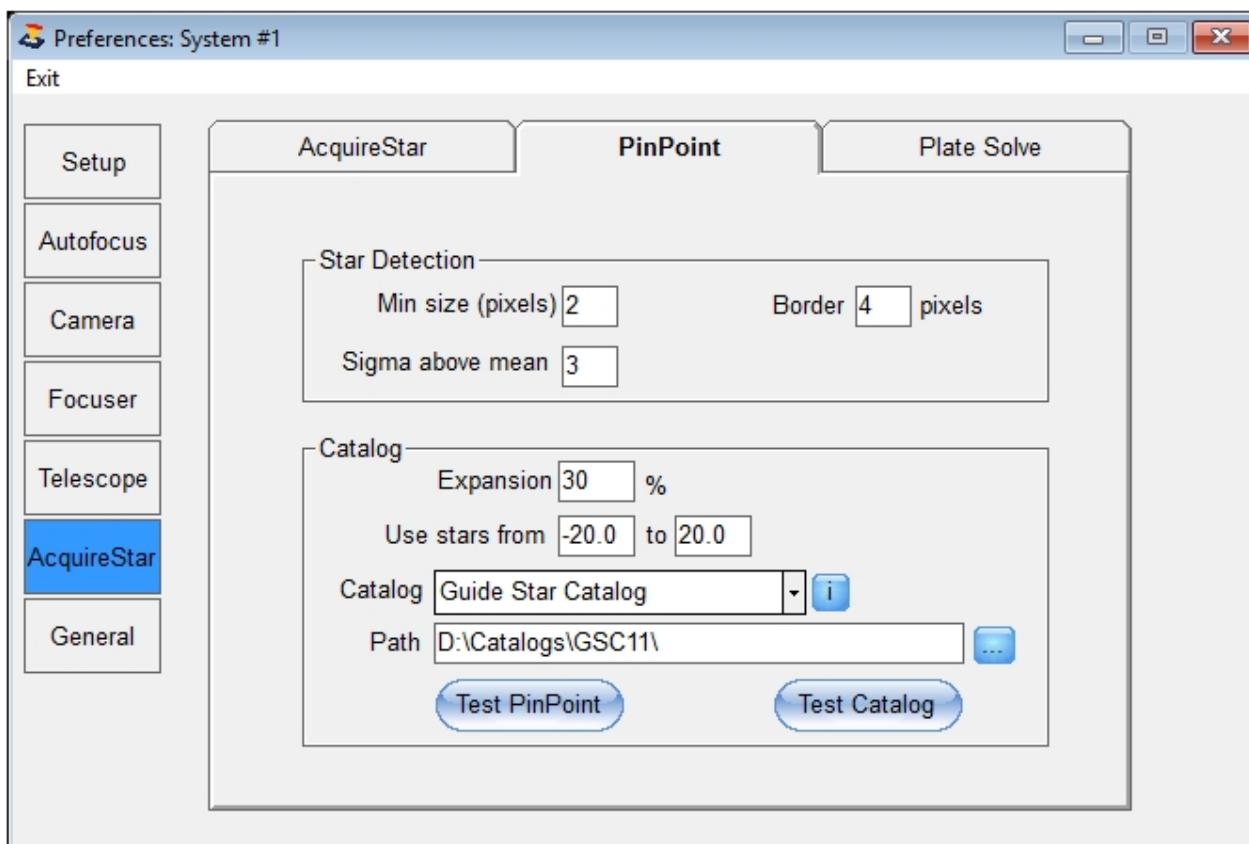
### 3. Plate solving images with PinPoint:

- Setup FocusMax to use TheSkyX camera control and AcquireStar plate solve method to TheSkyX.

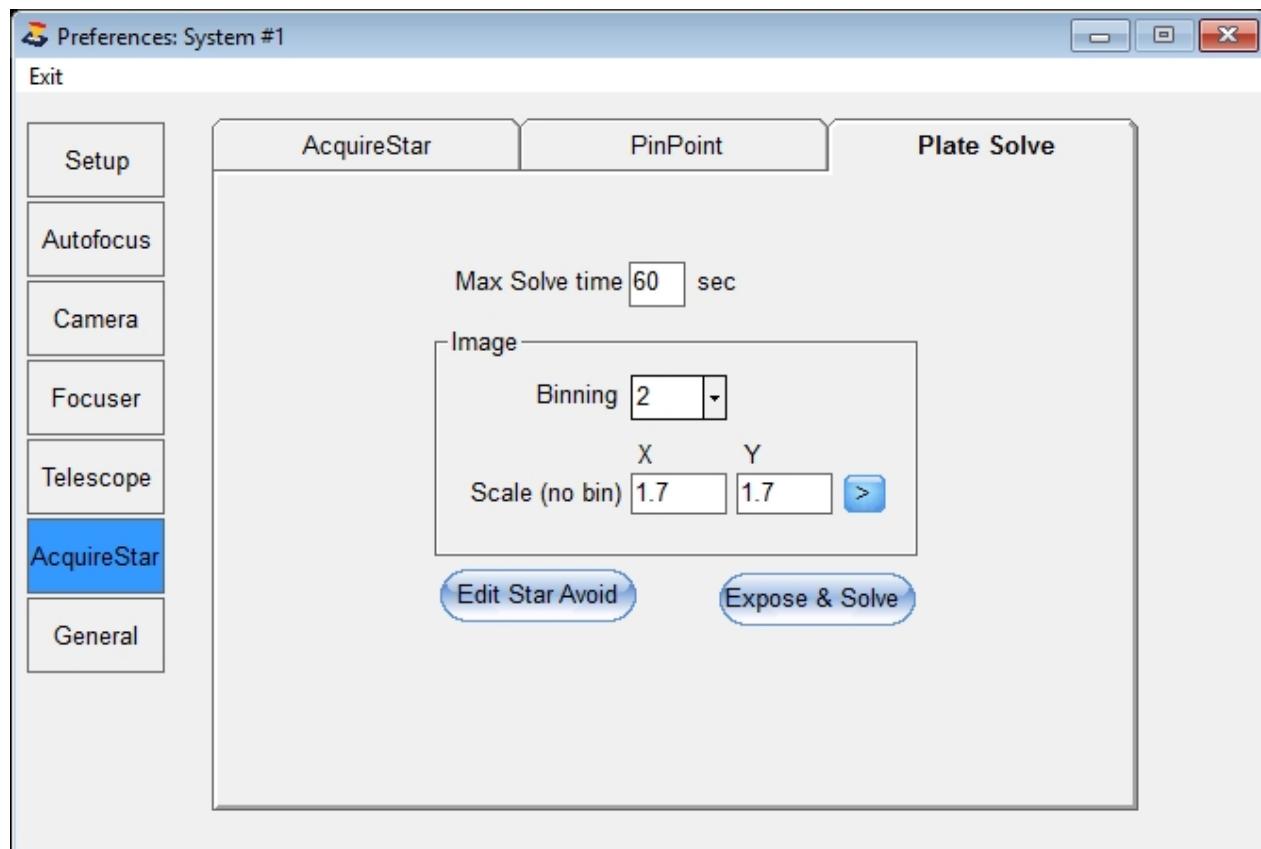


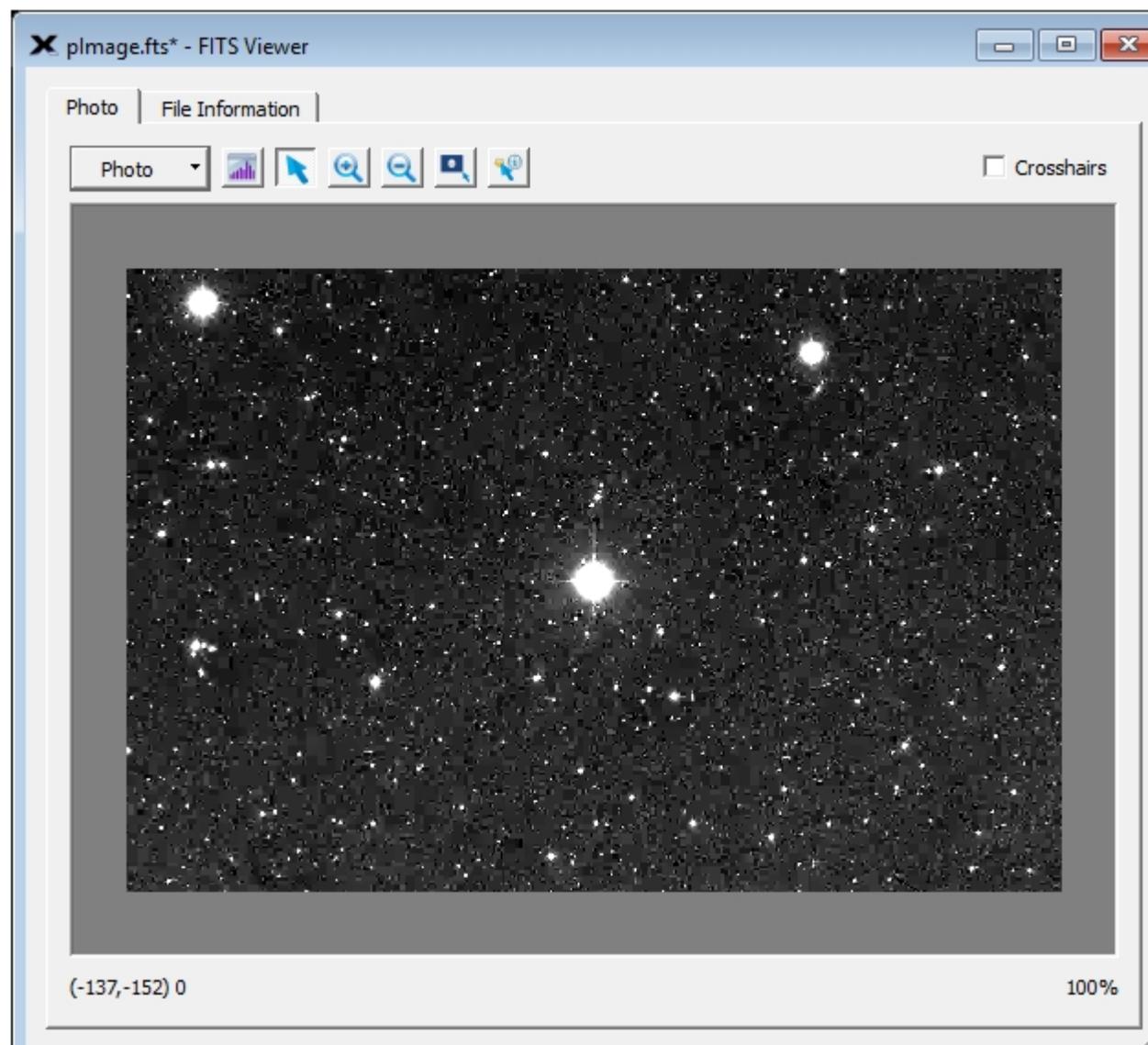


- ▶ Select PinPoint catalog and set the path to the folder containing the star catalog.
  - ▶ Press the Test PinPoint button to verify that the Full version of PinPoint is installed.
  - ▶ Press the Test Catalog button to verify that PinPoint can read successfully locate stars in the catalog.



- ▶ On the Plate Solve Tab, set Binning and image plate scale to 1.7 arc-sec/pixel for the DSS images.
  - ▶ Verify that the simulator Camera, Focuser and Telescope are connected
  - ▶ Press the Expose and Solve button to take a simulated image and plate solve using PinPoint.

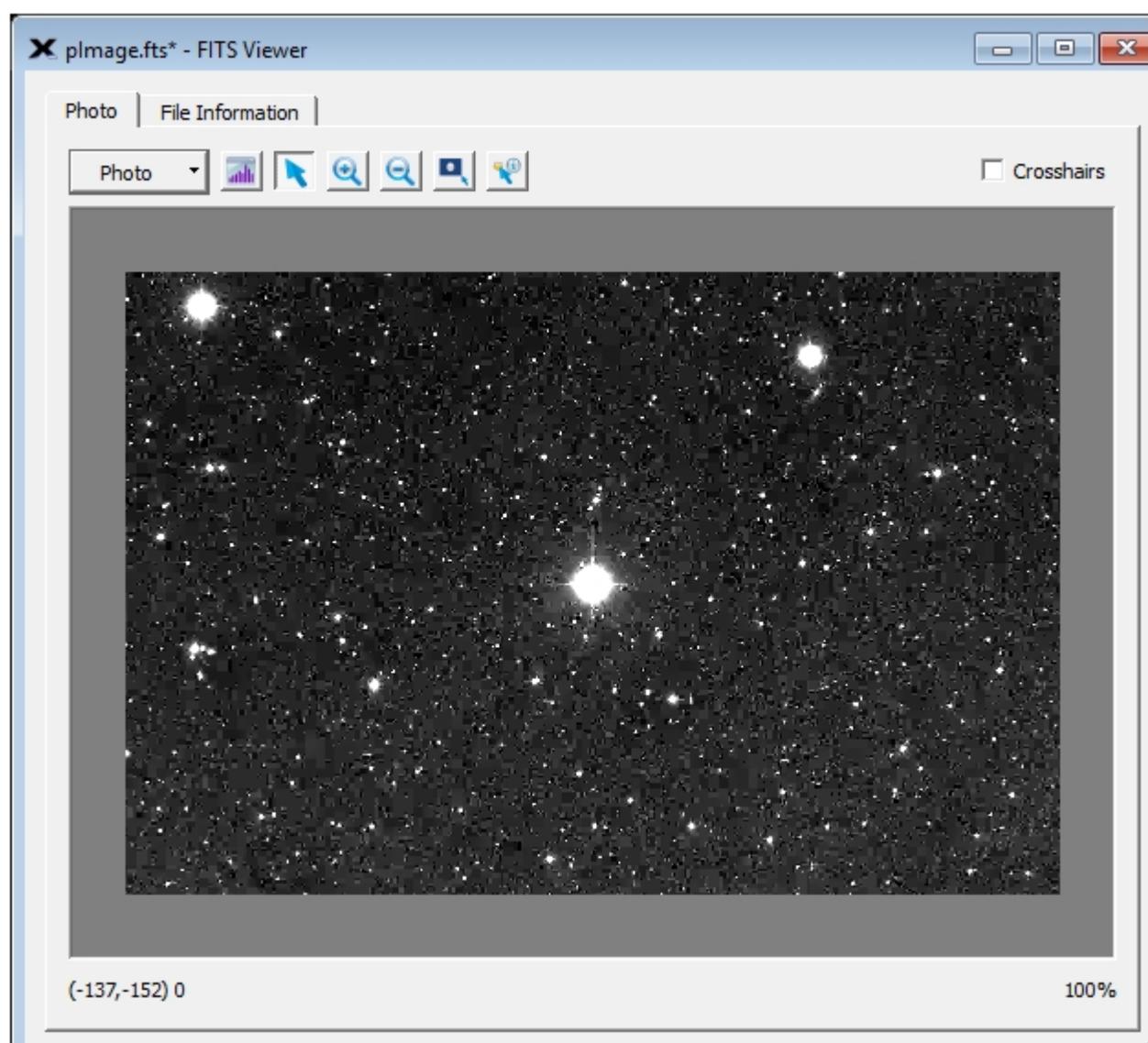


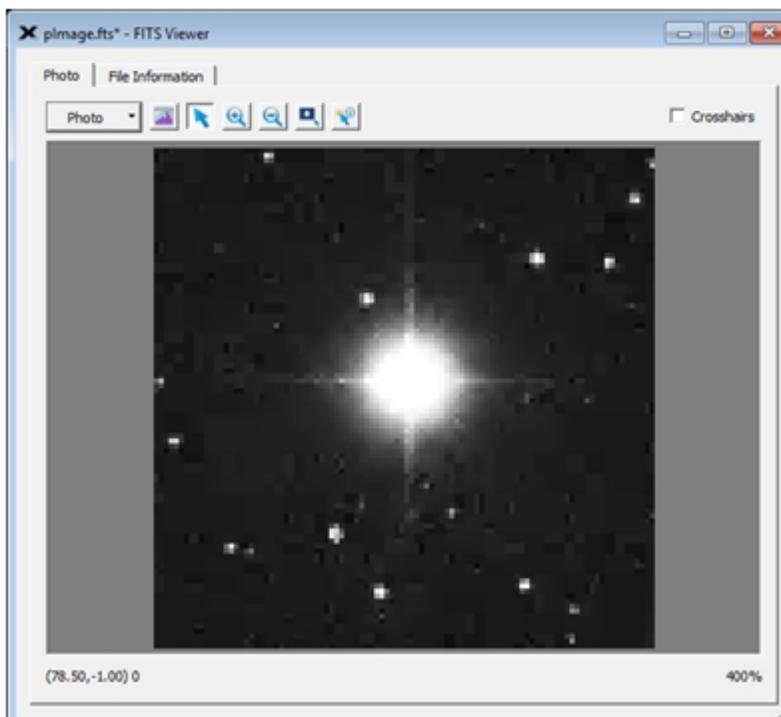
A screenshot of the FocusMax V4 Log window. The title bar reads "Log". The menu bar includes "File", "Open", and "Set". The main area is a scrollable text box containing the following log entries:

```
21:50:36 Taking pointing exposure
21:50:36 ...Binning: 2
21:50:36 ...Exposure: 2.00 sec
21:50:36 ...CCD central region: 100%
21:50:39 535 catalog stars found
21:50:39 3429 plate image stars found
21:50:39 Plate solved
21:50:39 Roll angle = -1.49 Plate scale = -3.4V -3.4H
21:50:40 Alt = 69.36 Az = 274.66
21:50:40 Plate(Topo) RA: 19:44:23.0 Dec: +41:03:37.8
21:50:40 Plate(J2000) RA: 19:43:50.3 Dec: +41:00:53.8
21:50:40 Image X,Y: 384, 255
21:50:40 Full frame (1x1 bin) X,Y: 768, 510
21:50:40 ** Plate solve was successful **
```

#### 4. Using the DSS

- ▶ Find and slew the simulator telescope to a star that is 11th mag or fainter - the star should be somewhat isolated from other nearby stars.
- ▶ You may need to adjust theTarget flux value or the Max Exposure time on the Autofocus window.
- ▶ Press Find to take an image - FocsuMax should identify the brightest star int he field then subframe the target star

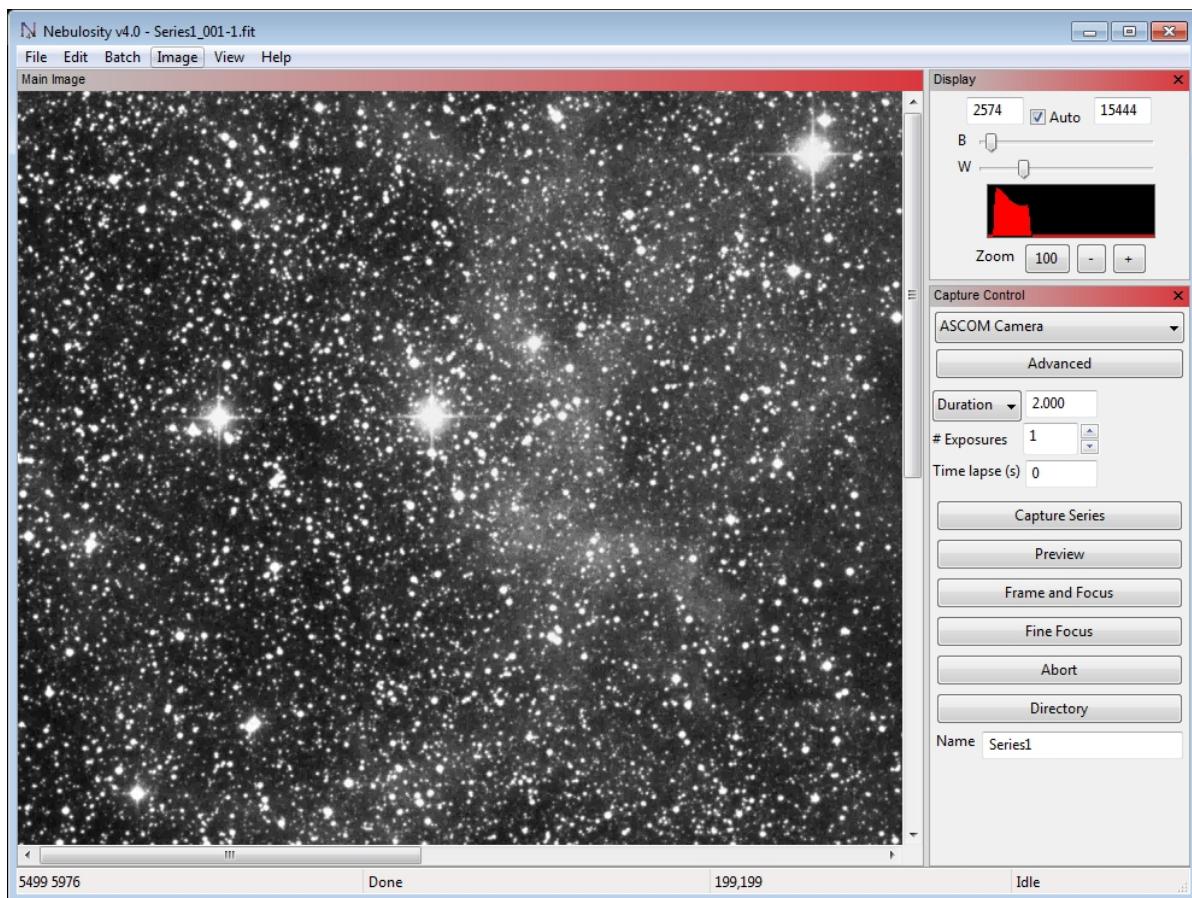




- ▶ Run the FirstLight Wizard generate a set of Vcurves.
- ▶ Once you have TheSkyX successfully taking simulator DSS images and PinPoint can solve the images, then continue to setup AcquireStar so that a star in the desired magnitude range can be located and used for autofocus.

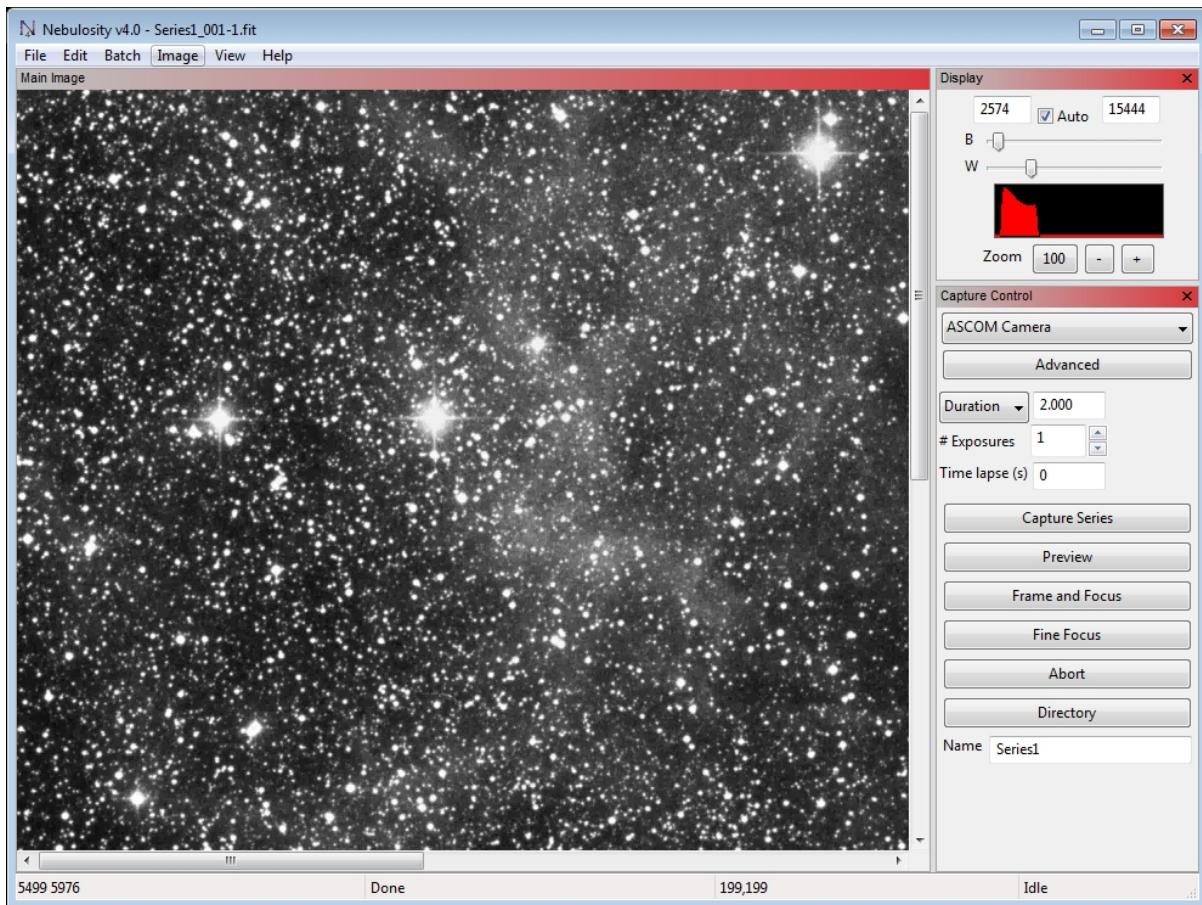
## Nebulosity 4

### Nebulosity 4

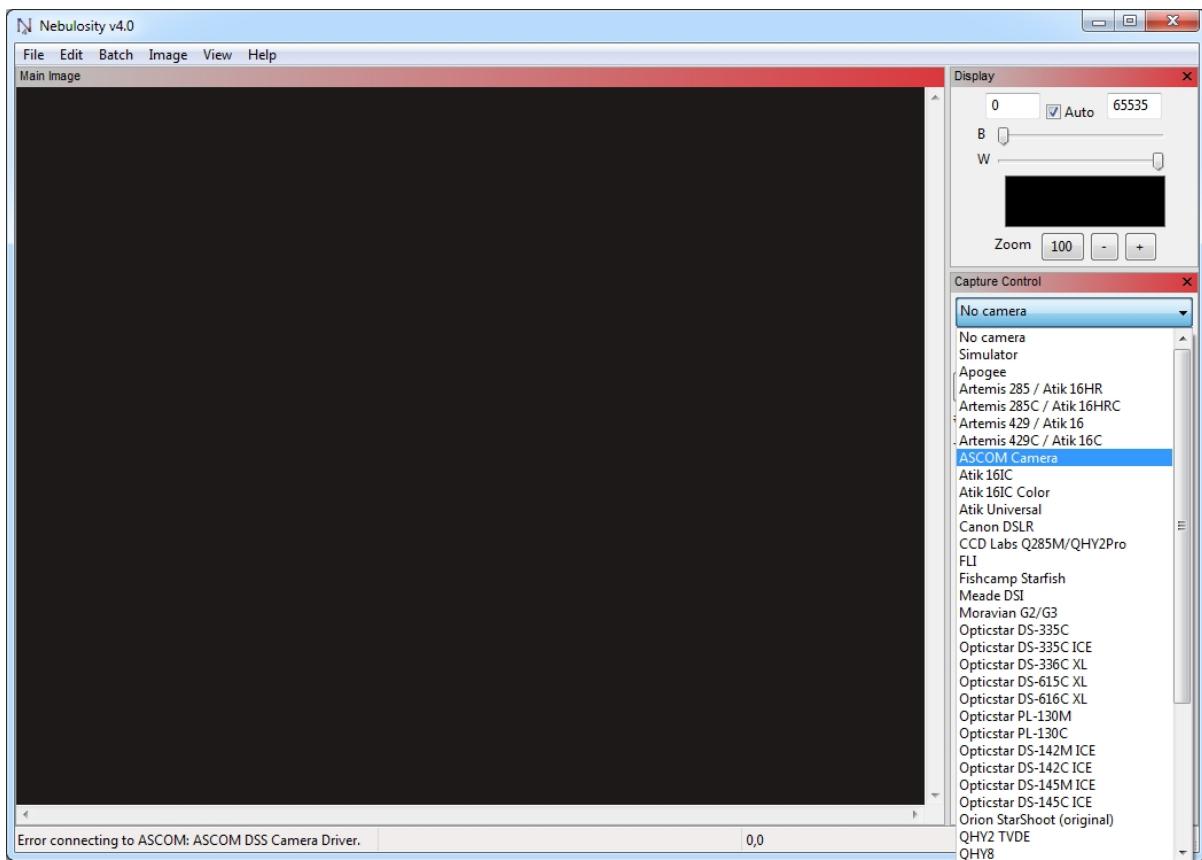


### ASCOM DSS Camera

**Using ASCOM DSS Camera to Generate Simulated Star Field**

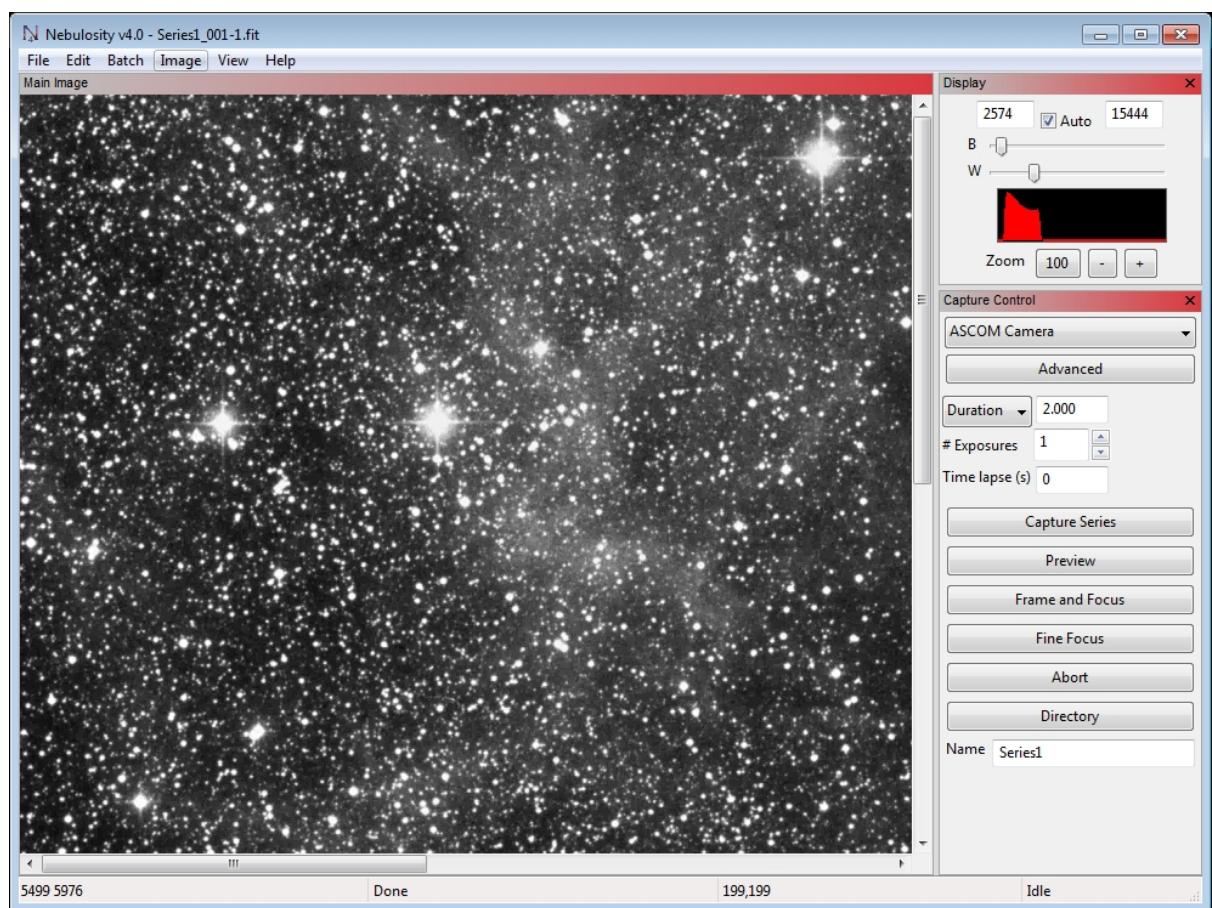


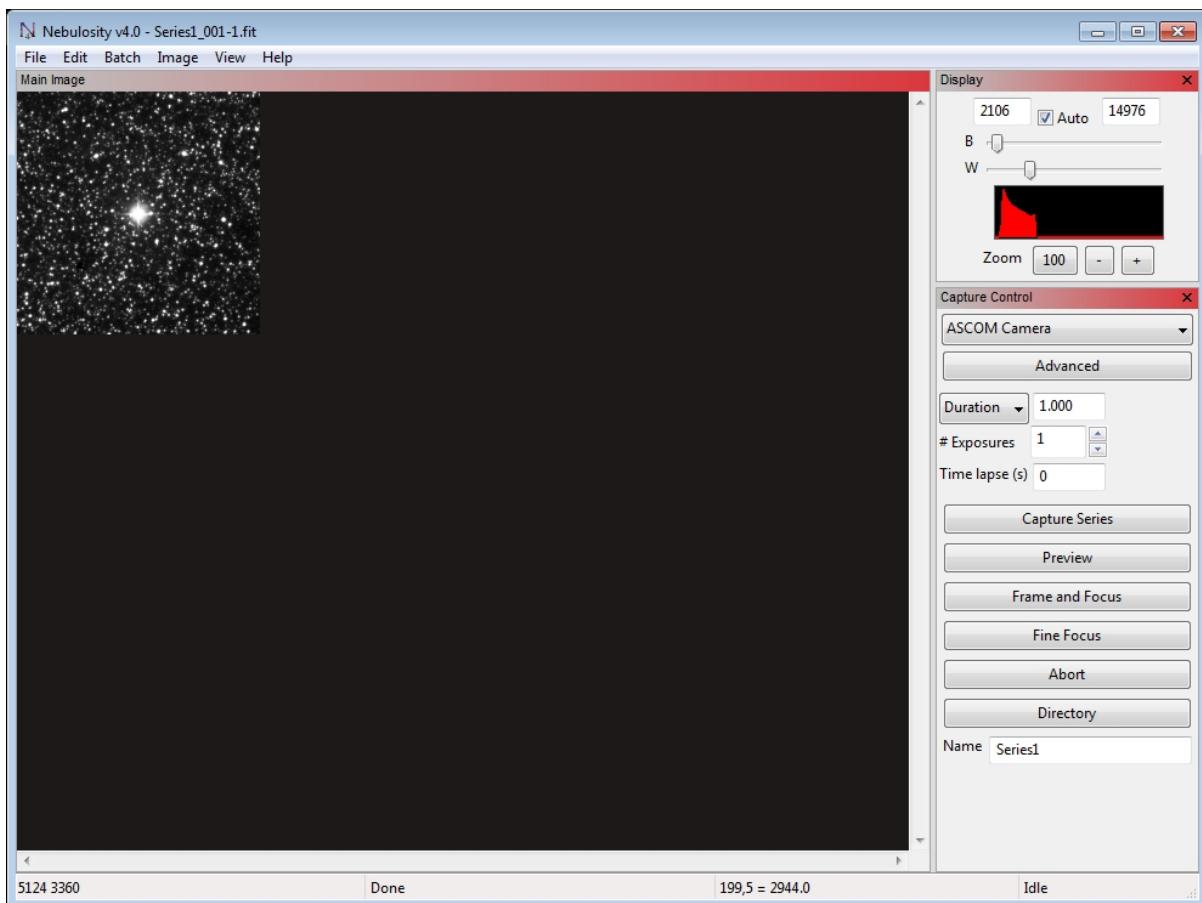
1. A Deep Sky Survey (DSS) ASCOM driver can be installed from <https://groups.yahoo.com/neo/groups/ASCOM-Talk/files/Chris%20Rowland/>. This camera driver will download a DSS image from the internet and which may be used by FocusMax. Once installed:
  - ▶ Press button to select the camera
  - ▶ Select the ASCOM camera
  - ▶ Press Advanced button to select the telescope connection which will provide the RA & Dec coordinates.



2. If you are using AcquireStar then set the Min / Max magnitude for the current filter to 10 / 11 due to the

deep images and overexposed stars in the field of view.

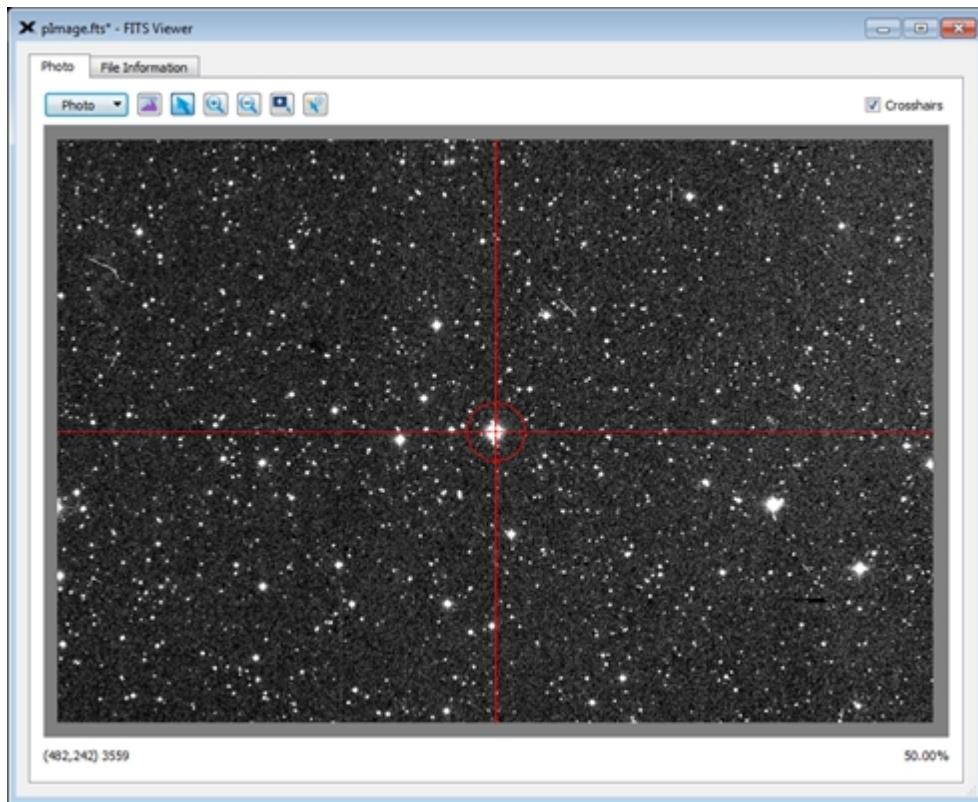




## AcquireStar

### 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 TheSkyX 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):

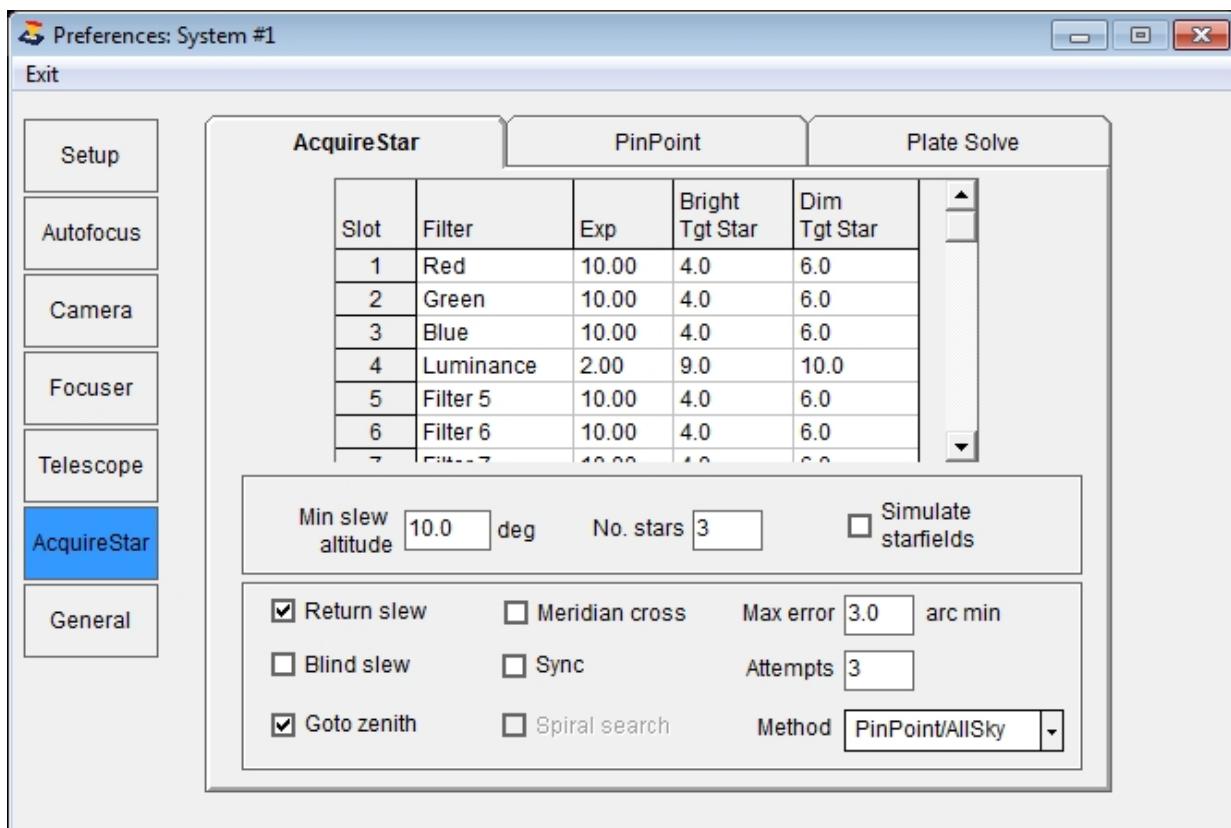
- ▶ take short exposure and plate solve current telescope position using PinPoint or TheSkyX Image Link.
- ▶ initiate a search in a star catalog to identify stars that meet the user defined magnitude range
- ▶ identified stars will be screened for min slew altitude, side of meridian to prevent telescope 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 met user defined allowable pointing error

## AcquireStar Tab

### AcquireStar Setup Tab

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

The bottom portion of the window is used up the process that AcquirStar will use in selecting and slewing the telescope to the stars found in the star catalog.



#### Target Star:

Target star selection from the star catalog are specified for each filter.

- ▶ Brightest magnitude to be selected from the catalog
  - ▶ Dimmest magnitude to be selected from the catalog
  - ▶ Exposure to be used to plate solve current telescope position
- Click in the cell to change a value and press Return or leave the cell to save the changes.

#### Min Slew Altitude

The minimum telescope slew altitude allowed.

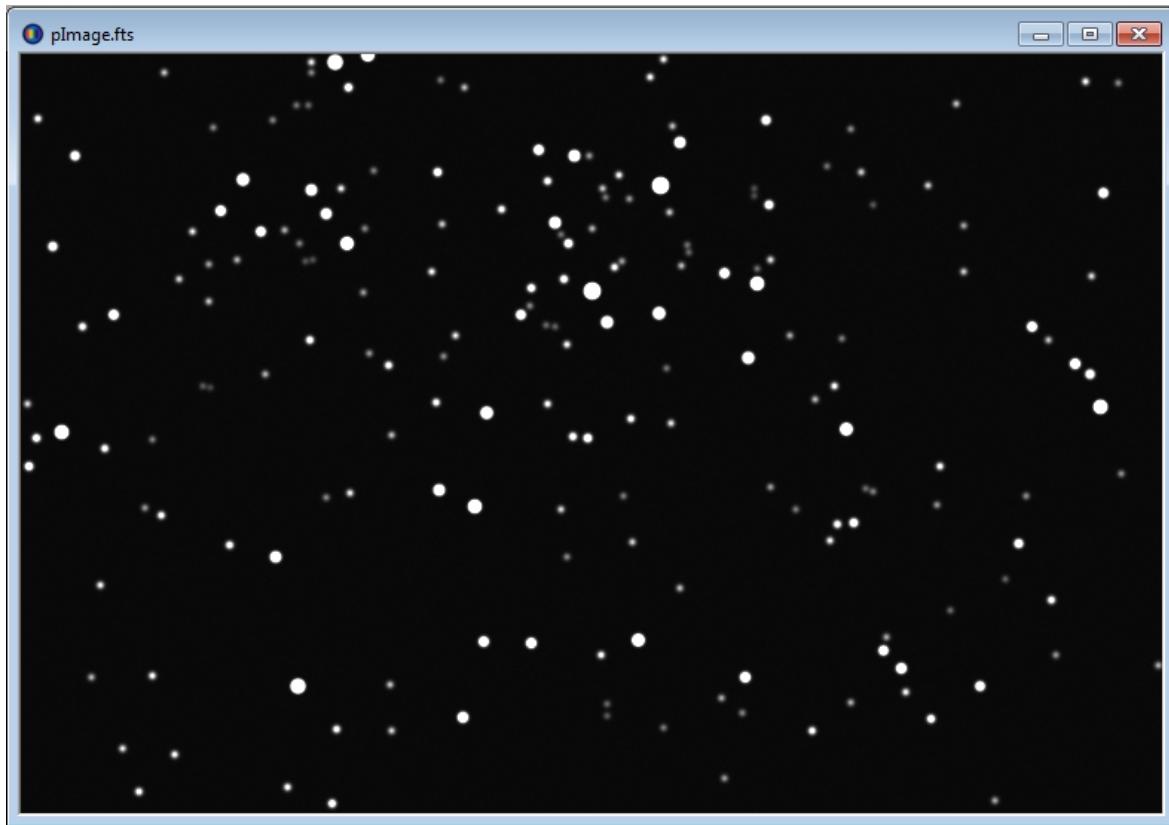
#### Number of Stars

The minimum number of stars 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 the many FocusMax features

- ▶ PinPoint or PinPoint/AllSky must be selected as the plate solve method (requires PinPoint Full not LE)
- ▶ Simulator system must be selected on the main FocusMax System window
- ▶ Camera must be selected and connected
- ▶ Telescope must be connected and tracking - telescope may be a real or setup as Simulator



## 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 to allow the telescope to perform all slews blind without using astrometric plate solving to determine telescope position.

Disable this option if your telescope is able to slew and bring the target star close to the center of the CCD image.

## 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.

## Spiral Search

Allow PinPoint to search adjacent catalog positions in an attempt to plate solve the current telescope position.

## Max error

The maximum telescope position error (arc-minutes) following a telescope slew that 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.

Example:

Setting Max Error = 0.0833 arc-min (5 arc-sec)

With the authors 16 f/4.5, 70" FL telescope (1.05 "/pixel), Paramount ME and a fresh TPoint model, the final return slew position is within a few arc-seconds after one, sometimes two 2 pointing updates

## Attempts

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

## Method

- ▶ [PinPoint](#) to plate solve the telescope pointing
- ▶ [PinPoint/AllSky](#) requires an internet connection to send information to Astrometry.net plate solving service.
- ▶ [TheSKyX](#) Image Link to plate solve the telescope pointing. The user may enable utilize All Sky Image Link in TheSkyX if the appropriate catalogs have been installed

## Notes

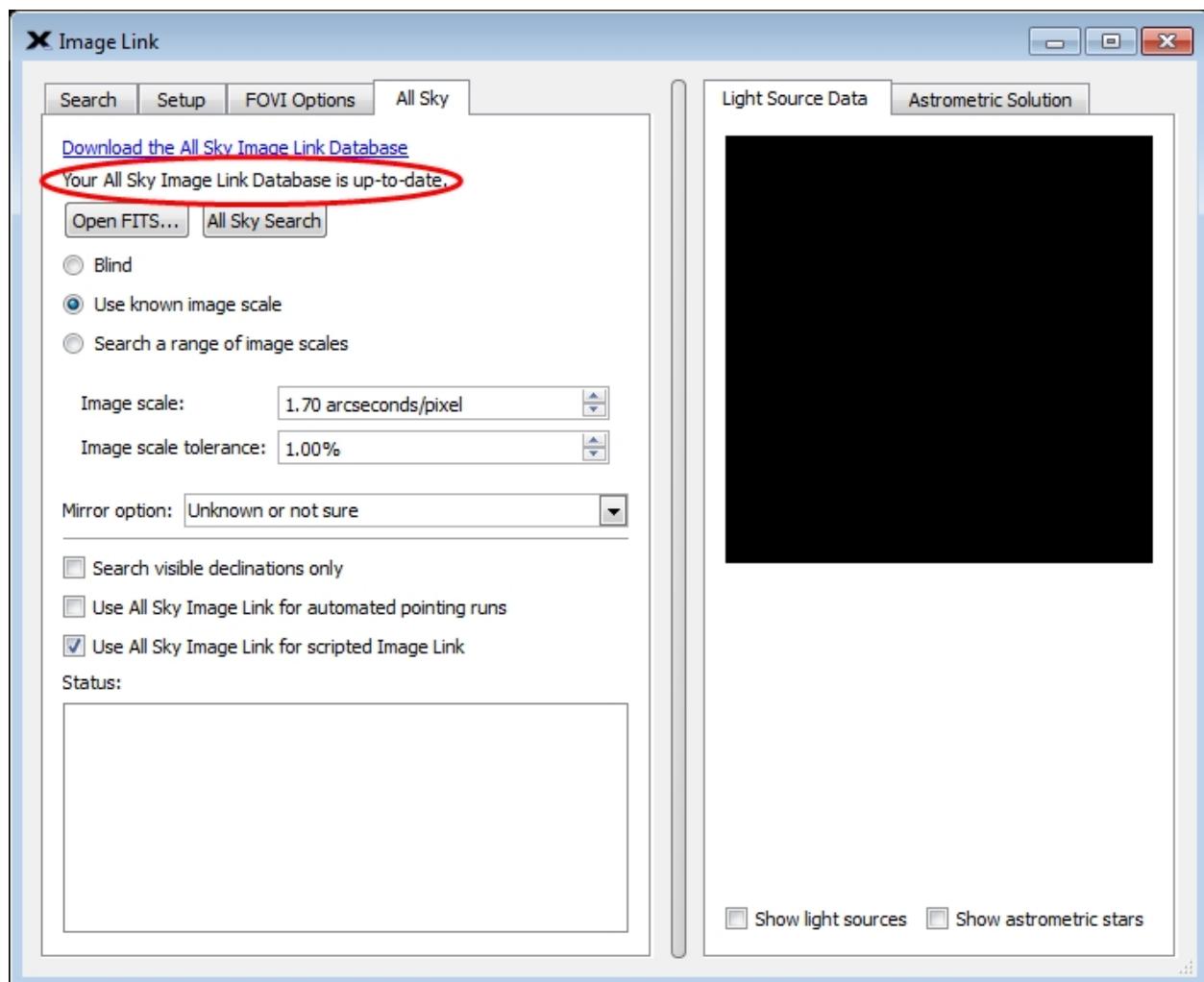
- ▶ Do not select a target star magnitude that will saturate the camera sensor for any given filter.
- ▶ The user can specify the number of stars (default = 3) to select from the star catalog before the telescope slew is initiated. If the autofocus run fails, then the second star in the list is used,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

## TheSkyX Image Link

# Setting up TheSkyX Image Link

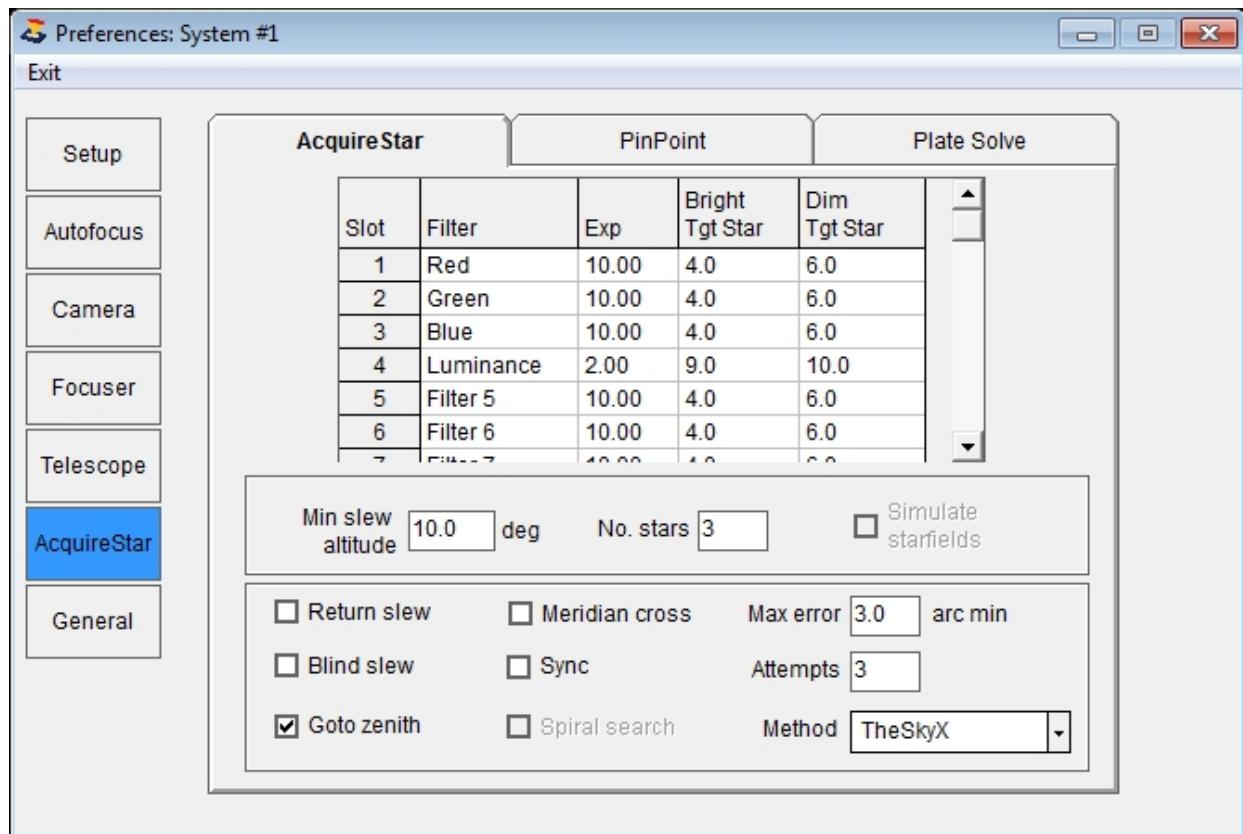
Images taken with TheSkyX Camera Add-on, MaxIm, or Nebulosity 4 may be plate solved using TheSkyX Image Link method.

1. It is important to verify that you have the latest TheSkyX Image Link file is installed on your computer.
  - ▶ Open TheSkyX / 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.

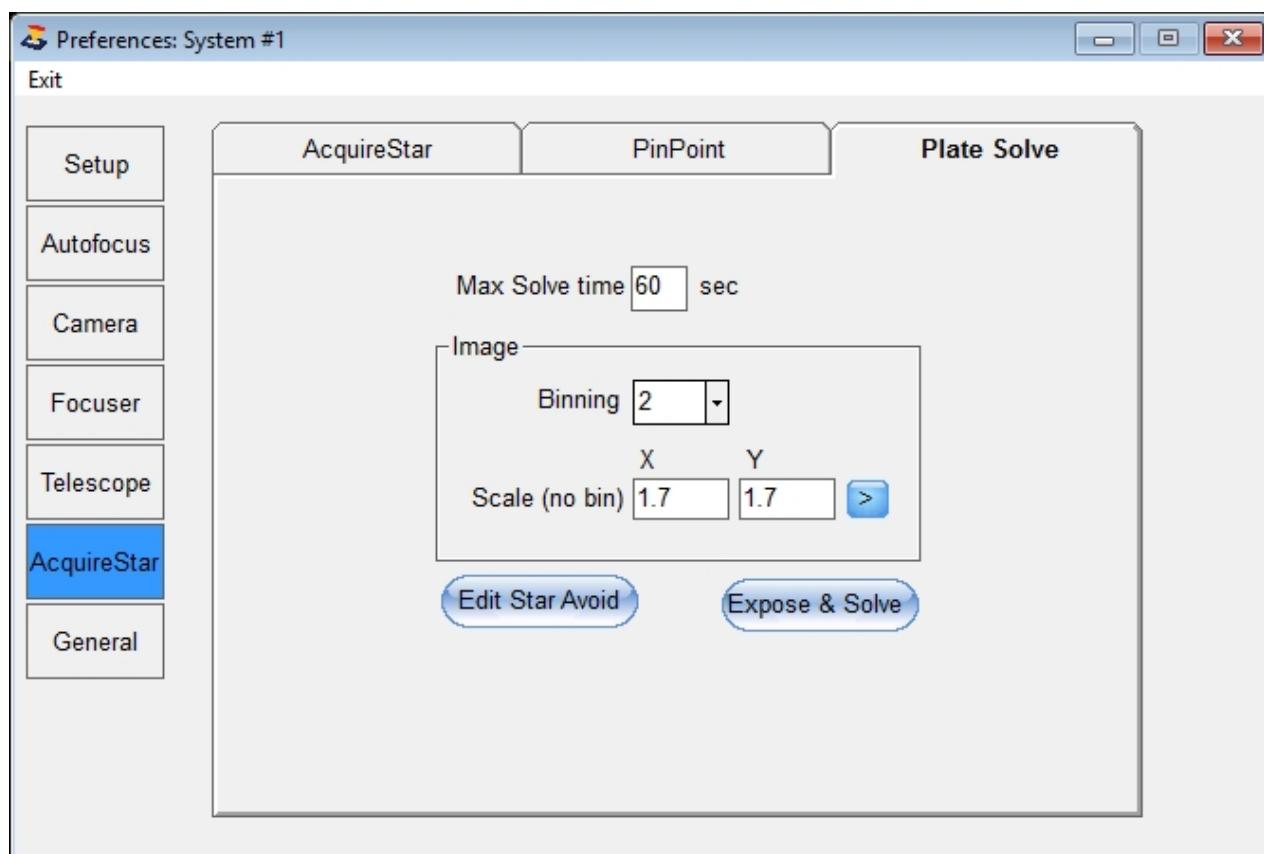


2. Once installed you have the option to use 'Image Link All Sky for scripted operations Image Link' - see above screen shot
3. Enable 'Use Set the Image scale for your system or enable 'Blind' or 'Search a range of image scales'

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



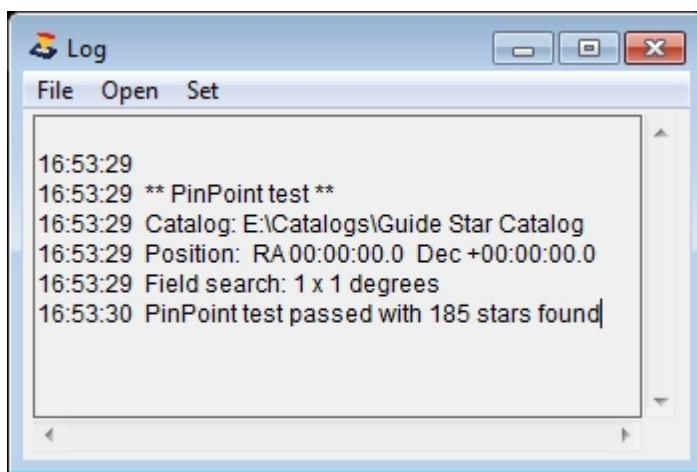
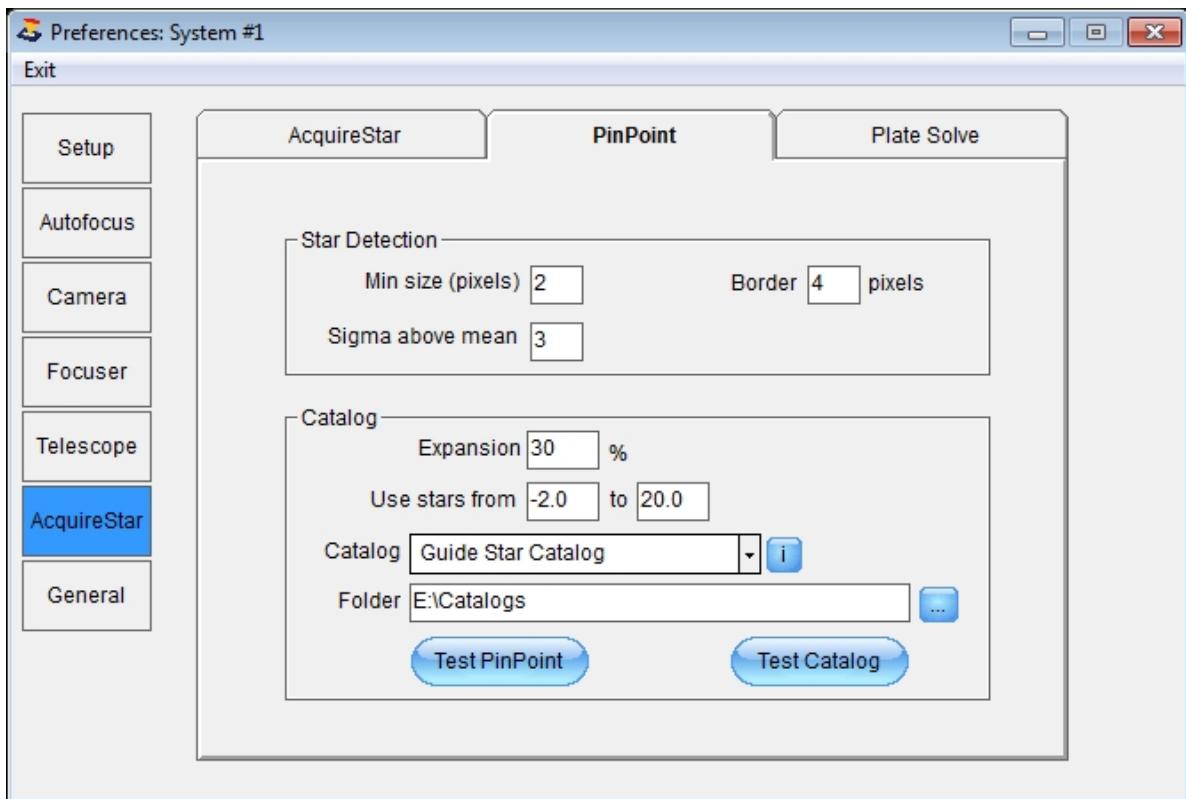
3. You may test the setup by clicking Plate Solve tab and pressing Expose and Solve to take an image and attempt to plate solve.



## PinPoint Tab

### Setting up PinPoint

#### 1. Setting up PinPoint



#### Star Detection

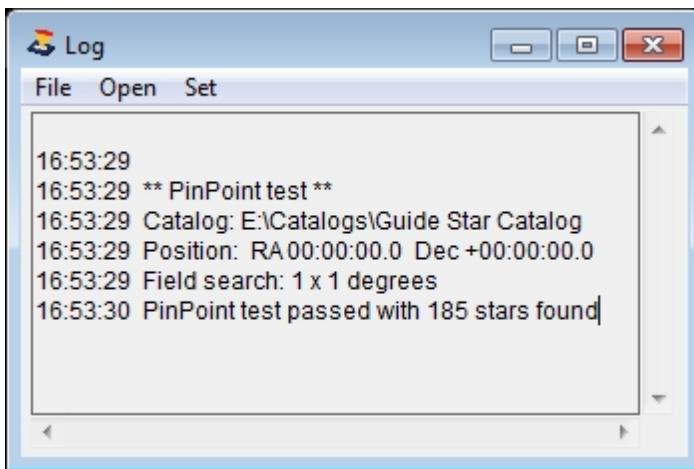
- ▶ Min size - minimum size in pixels for star detection (default = 2)
- ▶ Sigma above mean - minimum standard deviation of the signal (star) above the background noise for star detection
- ▶ Border - the number of pixels to ignore around the perimeter of the image when plate solving (default = 4)

## 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 from plate solving (default -2.0 to 20.0)
- ▶ 'Catalog' combo 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 USNO is useful if faint stars are required
- ▶ Folder is the path to the chosen catalog

## Buttons

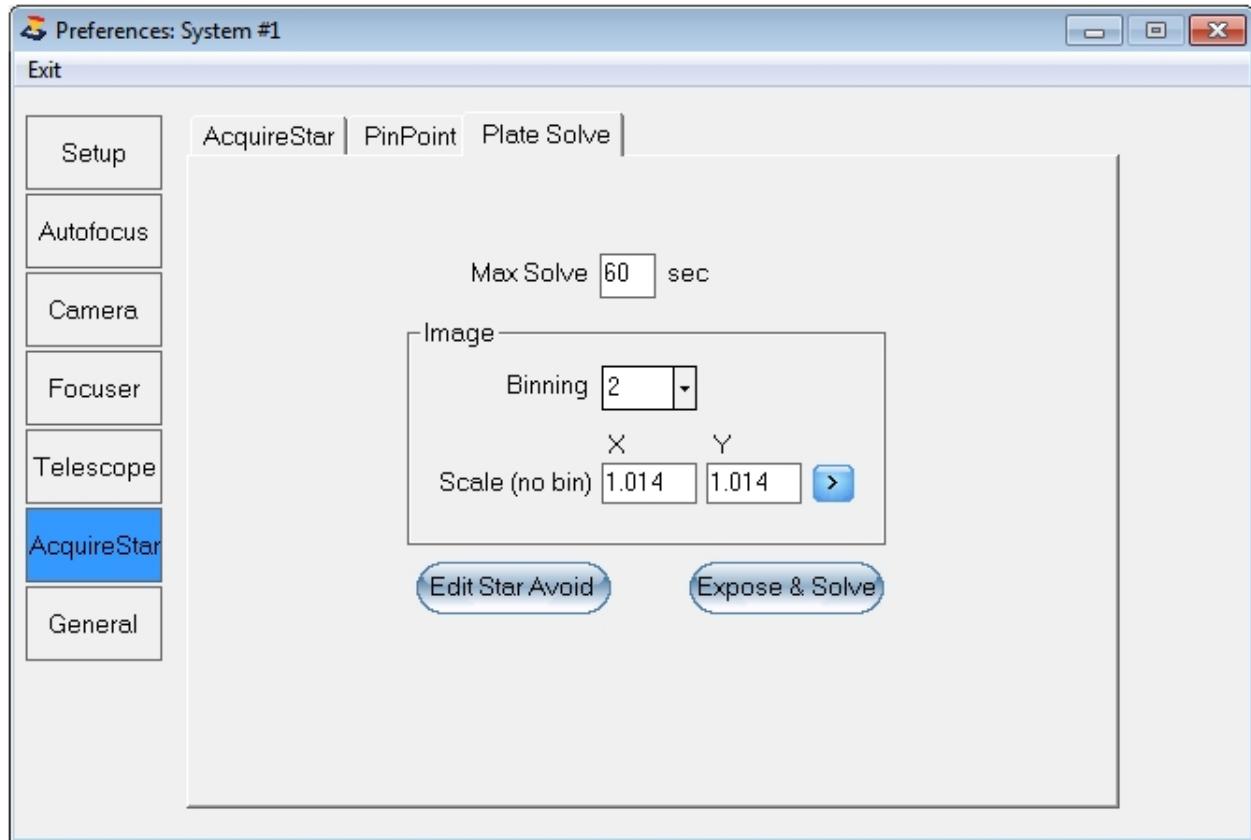
- ▶ 'Test PinPoint' is used to verify that the full version of PonPont has been installed on the PC. Unfortunately, PinPoint LE which ships with MaxIm does not provide plate solving capabilities.
- ▶ 'Test Catalog' will verify that AcquireStar can access, read and count the number of stars in a 1.0x1.0 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



## Plate Solve Tab

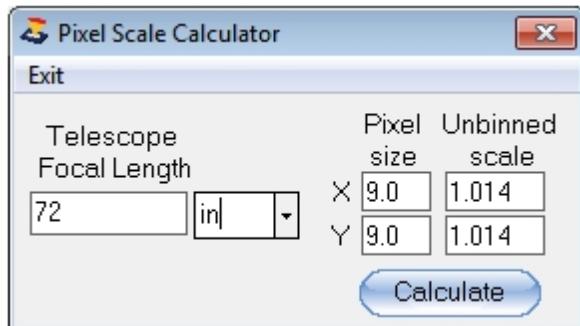
### Plate Solve Tab

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

- ▶ Binning defines the camera binning that will be used for determining telescope pointing. It is recommended that you use 2+ to improve S/N and reduce image download time
- ▶ 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:

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

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.

## FirstLight Wizard

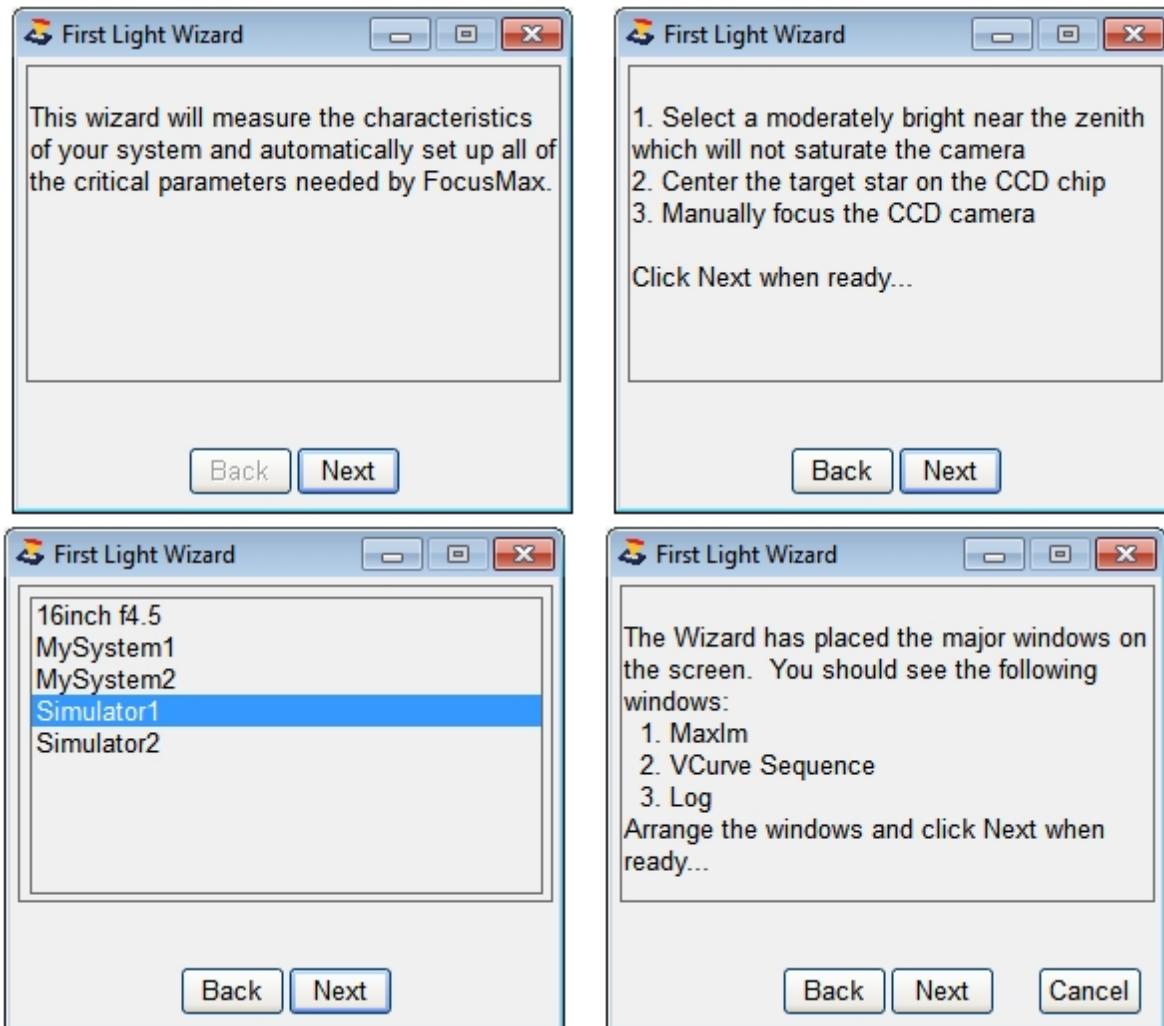
### FirstLight Wizard

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.

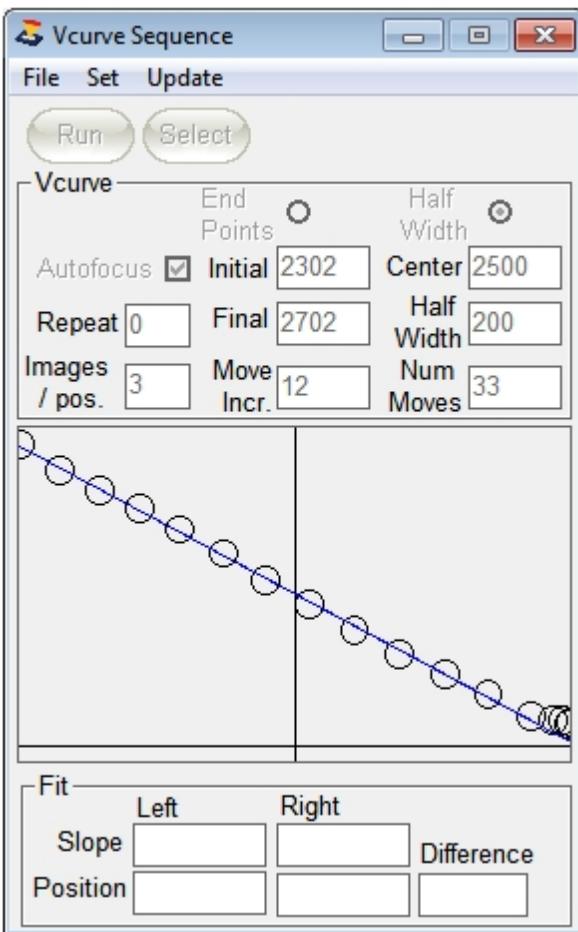
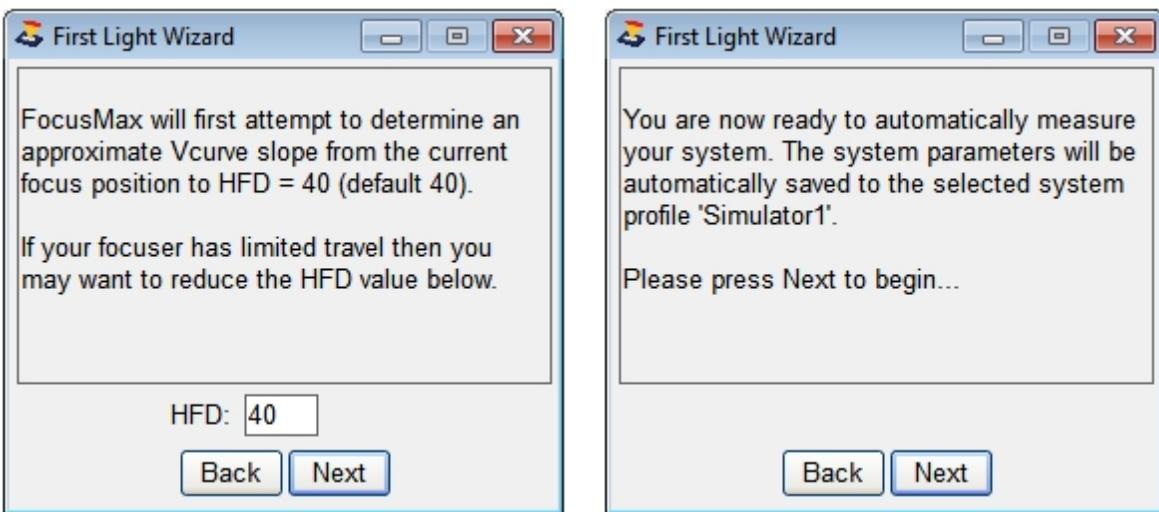
#### Running the First Light Wizard:

1. Manually focus the telescope – the focus does not have to be exact, just close.
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.

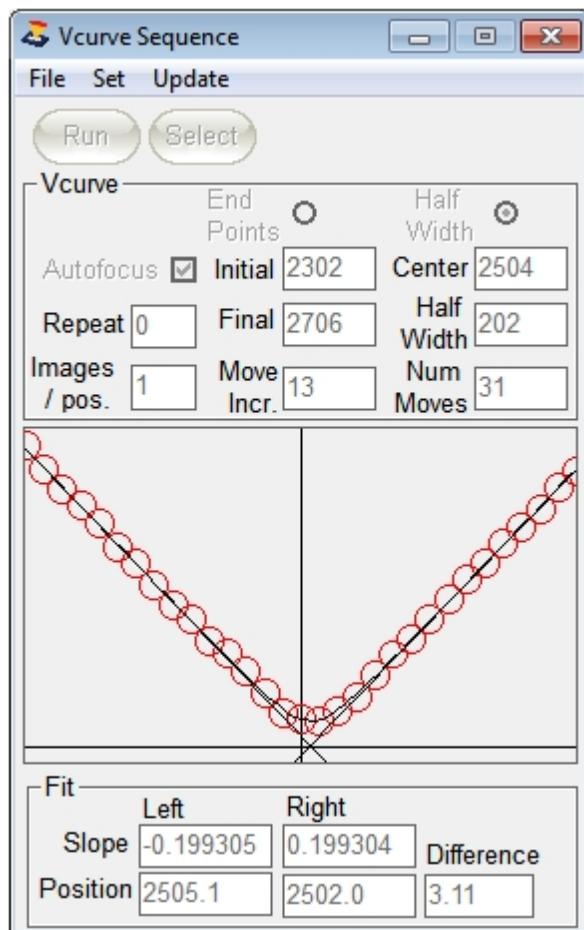


6. The First Light Wizard will start by moving the focuser in small then larger increments away from the focus point as it attempts to estimate the slope of one side f the 'Vcurve . The wizard will continue to

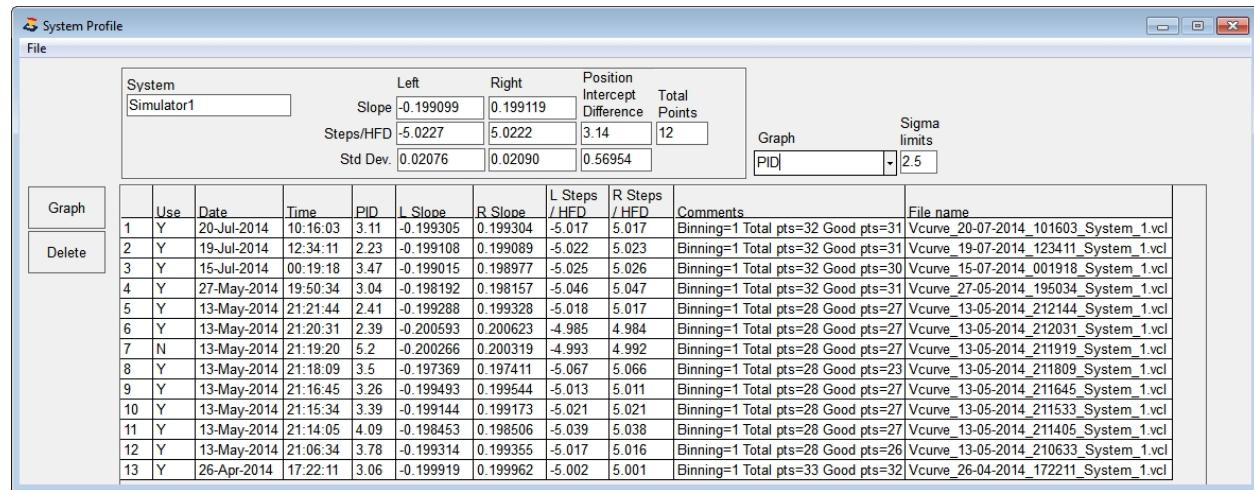
move the focuser until it achieves the HFD setting (default = 40). If your focuser cannot reach this HFD setting then Stop and re-run the First Light Wizard and reduce the HFD value to a smaller value when prompted. This is not uncommon if the focuser is not centered in the travel range of the focuser (as per step 2 above) or the focuser has limited travel.



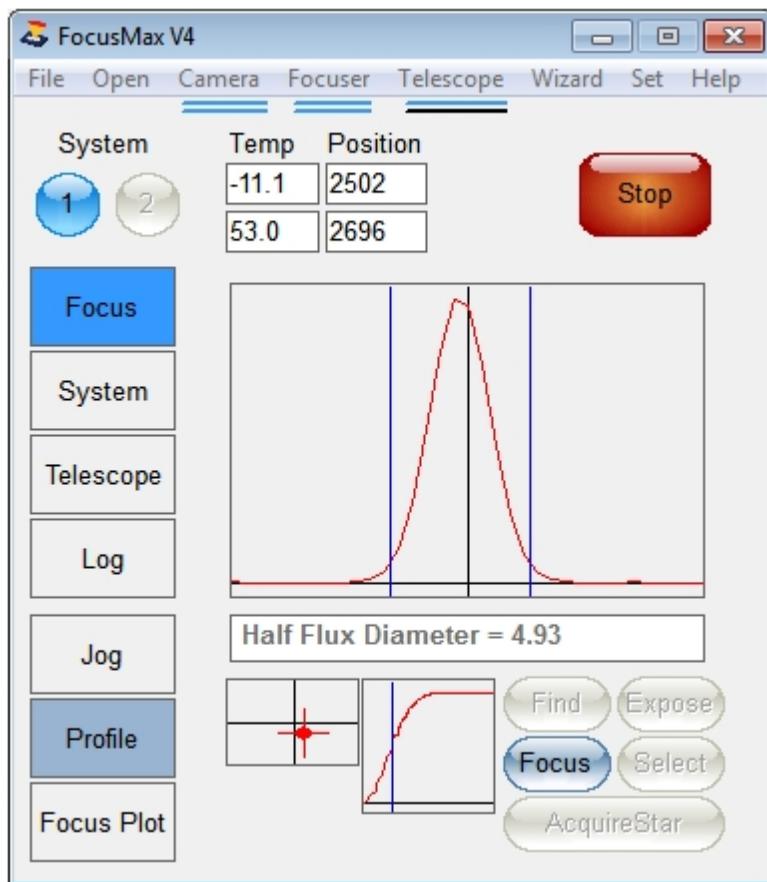
7. Now that the First Light Wizard has estimated the Vcurve slope, it will proceed to take a series of subframe images from outside of focus, through focus to the other side of focus.
8. Open the Log if closed and watch the HFD change as the focuser is moved, an image taken and measured by FocusMax.



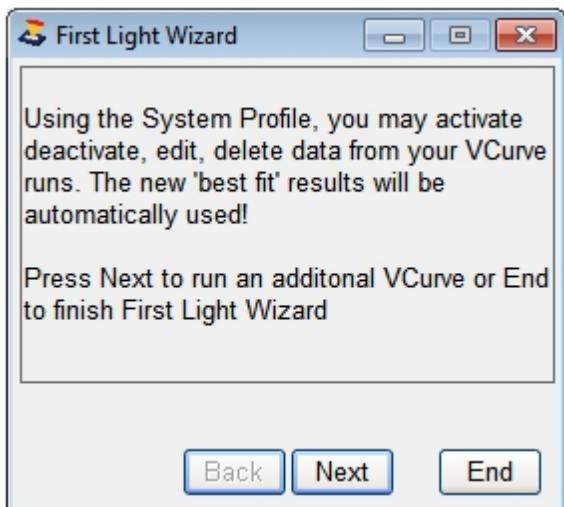
9. The slope of the lines for both left and right Vcurve lines and the Position Intercept Difference (PID) will be calculated and saved in your system Profile that is active.



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

**Notes:**

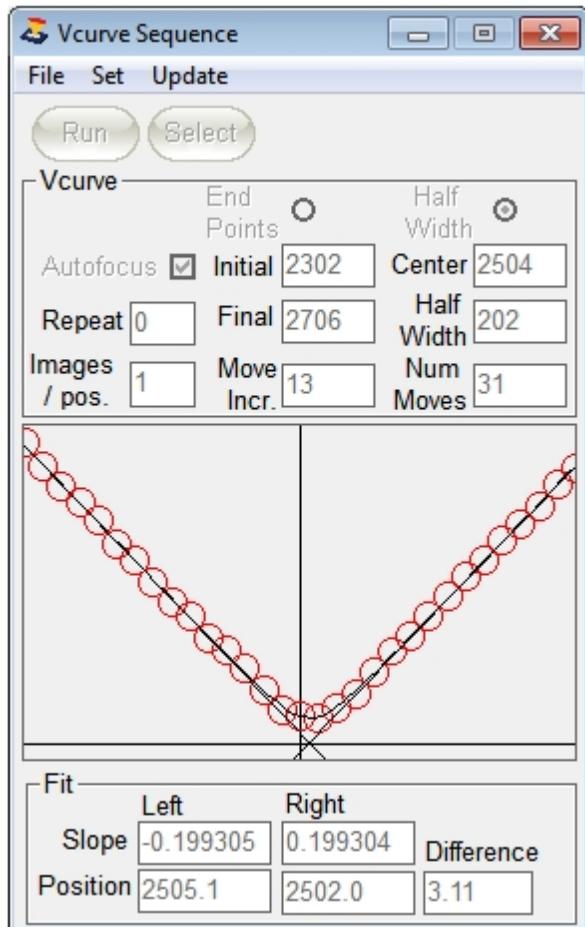
- ▶ Set the Target Star and Focus binning to 2 if you are using a DSLR camera.
- ▶ Verify that the focus position is approximately centered in the focuser travel range (step 2). This is particularly important if the focuser has limited travel and may not be able to move the focuser to achieve the max 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.

## 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 4th-5th-6th 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:

- ▶ Half Width is the movement in steps away from the Center in both directions
- ▶ End Points are the Initial and Final focuser positions.

- ▶ Step Increment sets the number of steps the focuser will move at one time
- ▶ Steps is the resulting 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.
- ▶ 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 drifting rapidly then it may negatively impact the overall accuracy of the Vcurve. A setting of 3 under stable conditions is recommended for many users.

### 3. Method #1 - Determining 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 20+ (30 - 40 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. Method #2 - Determining End Points

- ▶ Press the End Points button on the Vcurve window
- ▶ Press the Jog button and move the focuser 100 units 'Out' then press the Find button
- ▶ Continue to move the focuser until you achieve an HFD of 20+ (30 - 40 is better)
- ▶ Enter the focuser position in the Initial position
- ▶ Move the focuser In 200 units 'In' then press the Find button
- ▶ Continue to move the focuser until you find the position approximately equal to the HFD value above
- ▶ Enter the focuser position in the Final position
- ▶ Bring the focuser back to the focus position

**Example:**

- ▶ Focus position is 3,500
- ▶ 'Out' position = 4,000 to achieve 30 HFD
- ▶ 'In' position = 3,000 to achieve 30 HFD
- ▶ Adjust the Step Increment value until you see 30 - 40 'Steps' displayed

5. Press the Run button and 'enjoy the show' as FocusMax characterizes your system by creating a Vcurve
6. Watch the 'V' plot while running a V-Curve cycle.
  - ▶ As the points on the 'V' near the bottom watch the FMx Log's HFD value for each point on the 'V'
  - ▶ When the HFD reaches its lowest value and starts increasing note the lowest HFD's focuser Position. That position will be the (approximate) point of best focus.
7. Upon completion of the V-Curve cycle change the "Center" field before running another V-Curve cycle. {the 'Initial' and 'Final' fields should automatically adjust} This also helps center the apex of the 'V' on the center line of the V-Curve plot.
8. 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 of the line. The larger transition from max 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](#)

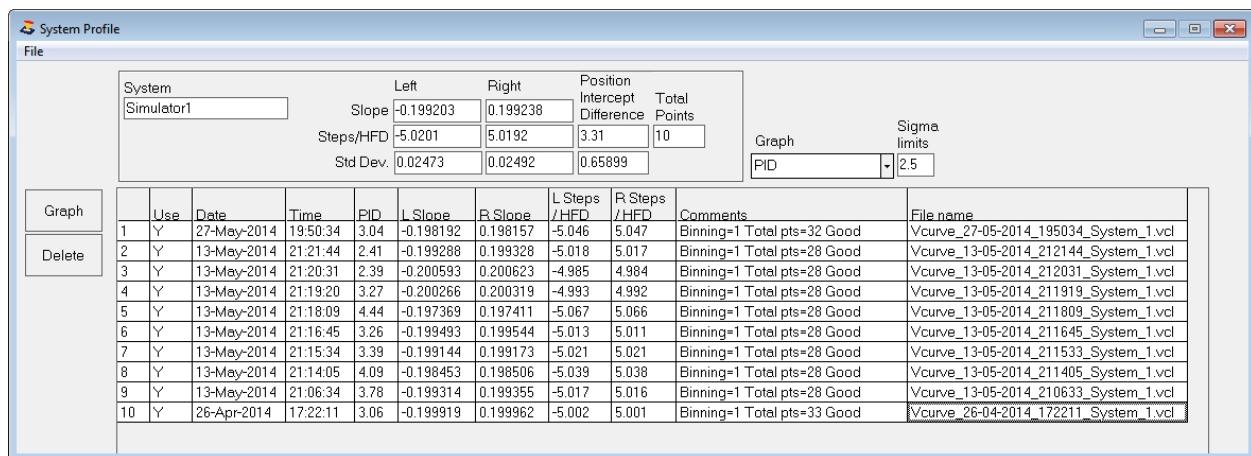
## Profile Window

### Profile window

This window contains the results of the Vcurve runs that characterize your system.

These parameters are the heart of the FocusMax algorithm and are unique for each system configuration.

If you change a camera, focuser, add a device such as filter wheel or rotator, then a new Profile should be created with a unique name so that the system parameters may be saved and loaded when you wish to focus the telescope.



1. Vcurve data is stored in the system ini file and can be viewed by opening the Profile window.

- ▶ The system name
- ▶ Average Left and Right slopes
- ▶ Average Position Intercept Difference (PID)
- ▶ Standard deviation
- ▶ Total number of points are used to calculate the mean values.

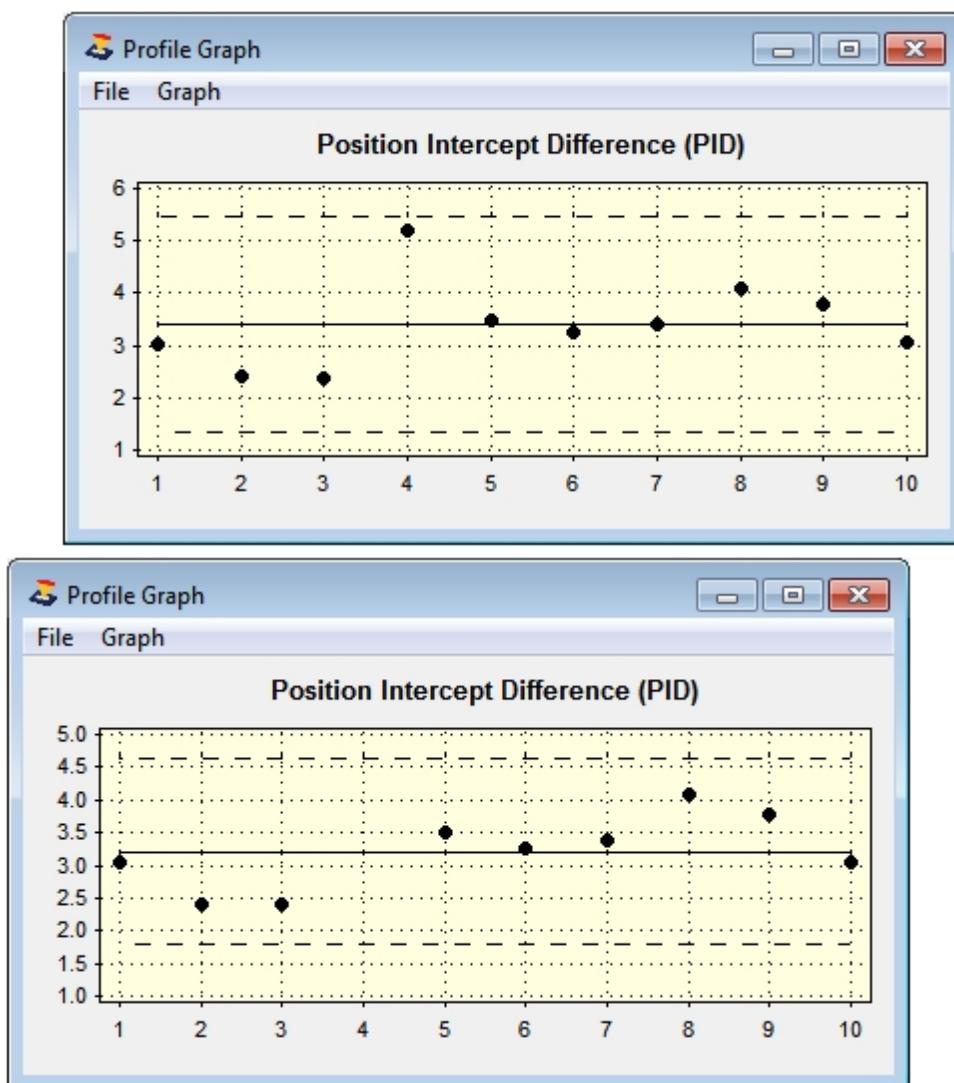
#### 2. Data grid:

- ▶ Use column will allow you to select or unselect Vcurve data to be used for calculating the averages
- ▶ Date and time of the Vcurve run
- ▶ Position Intercept Difference (PID)
- ▶ Left and Right Slopes

- ▶ Calculated Left and Right Steps per HFD (1/slope)
- ▶ Comments with camera binning, Total points used to generate the Vcurve and the number of good points used to estimate the slope of the line
- ▶ File name of the Vcurve run. Vcurve files (ending in .vcl) can be loaded into the Vcurve window and reviewed or shared with other users

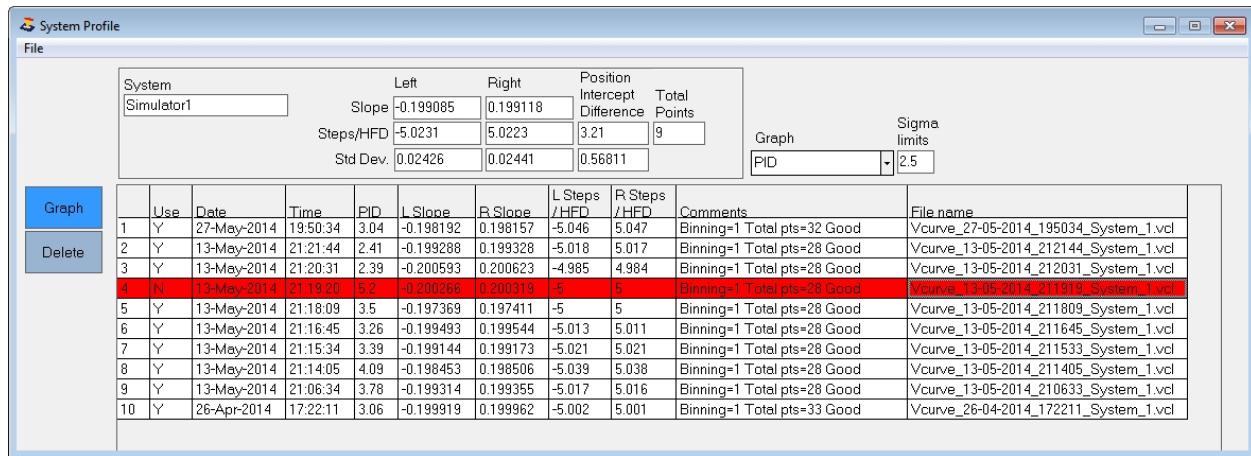
### 3. Graph:

- ▶ Graphs of the Vcurve runs can be displayed based on Left or Right Slope, Left or Right Steps/HFD or PID
- ▶ The Sigma Limits setting in the Profile Window will allow you to identify Vcurve data that is errant or suspect.
- ▶ Note in the picture below that reading number 4 is at or slightly beyond the dashed Sigma Limit lines and can be considered a suspect data point. This can easily be excluded from the analysis by double clicking the 'Y' on data point #4 in the data grid which will toggle the 'Y' to 'N' and automatically update the graph.



### 4. Delete Button:

To delete Vcurve data Click the far left row number which will highlight the row(s) to delete then press the Delete button.



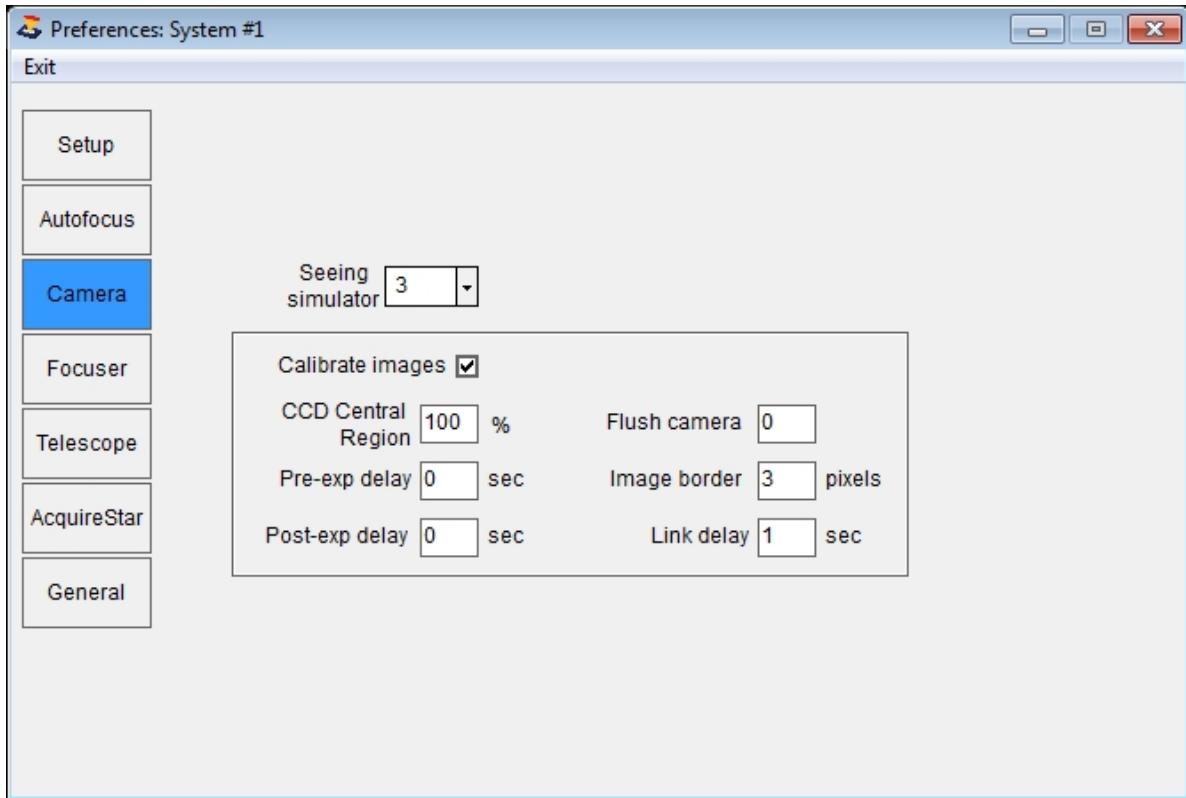
5. Review the data and look for any significant difference in the R and L Slopes, PI Difference.

- ▶ Entries that looks suspect can be excluded by clicking the 'Y' in the Use column.
- ▶ If the Comments column show many points that were excluded then you may want to consider removing the row
- ▶ You can permanently delete entries by clicking in the small box to the left of the Use column which will turn red then press the Delete Entries button.

## Image Calibration

### Image Calibration

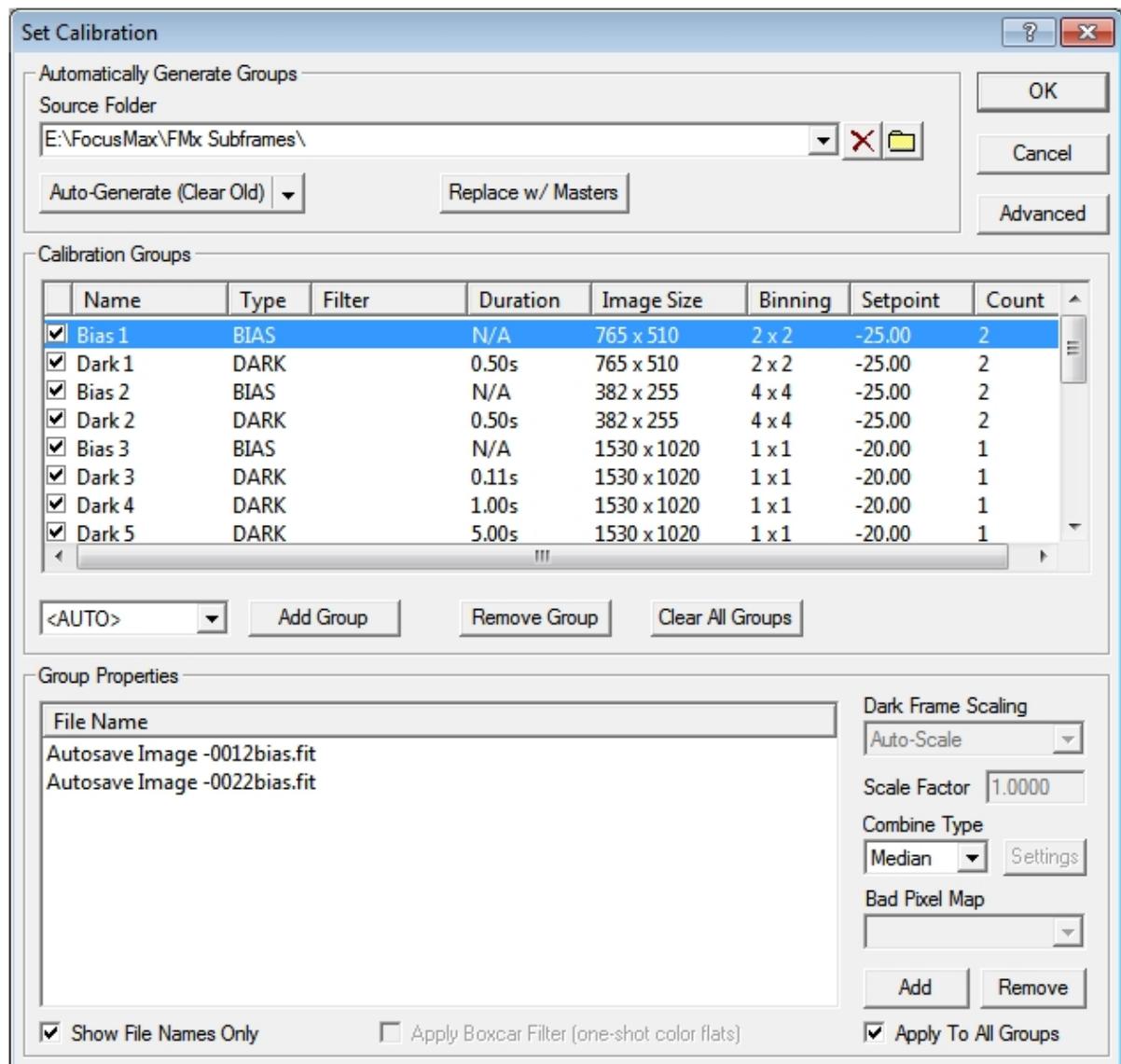
This feature is requested by users that may have CCD defects such as hot pixels which FocusMax may attempt to use utilize for focusing. Enable image calibration which is found on the Features tab and follow this procedure:



#### MaxIm image calibration

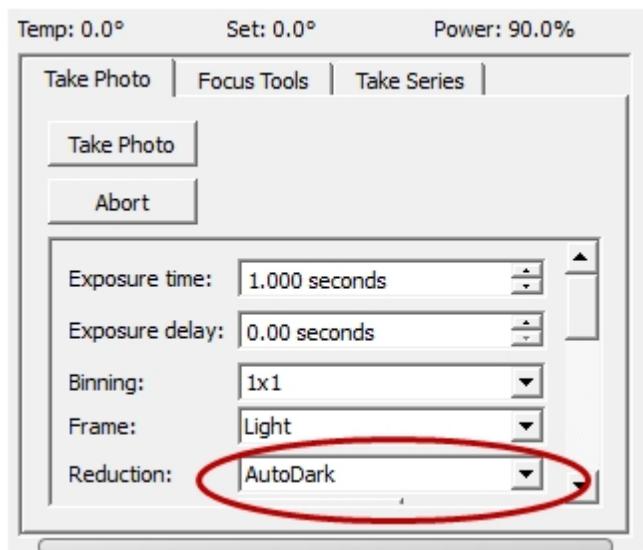
1. Create a set of dark & bias frames at the binning used for the initial image and autofocus sub-frame images (see Target Star Bin and Focus Bin in Preferences/Autofocus).
2. The Dark frame exposures should span the range which FocusMax may use (0.1, 1, 5, 10 sec...). You may want to create a set of 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.

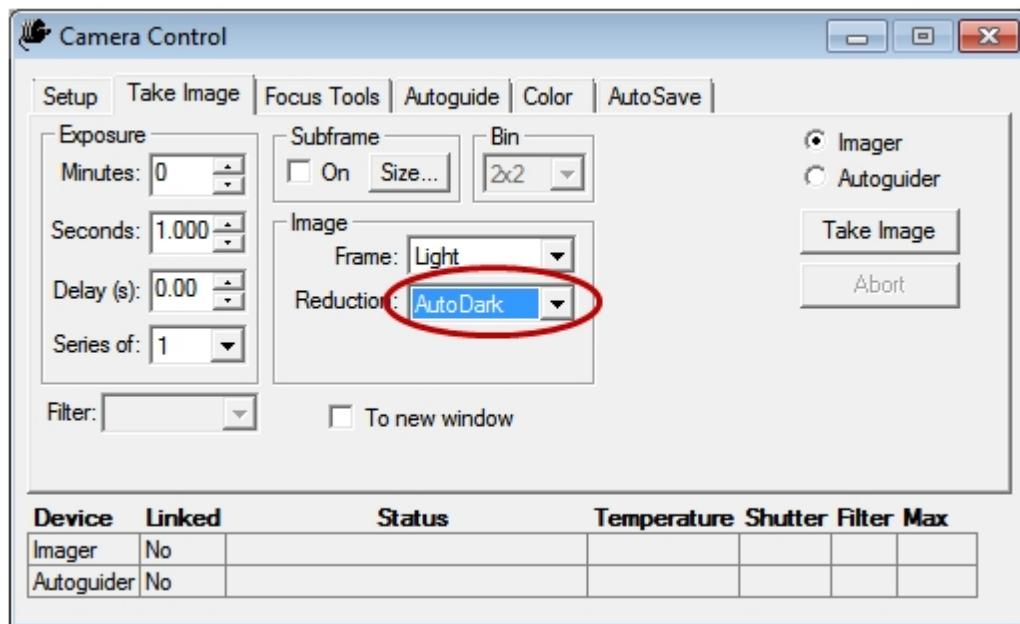


TheSkyX Camera Addon / CCDSoft image calibration  
Image Reduction will use 'AutoDark' with each light frame is taken.

**TheSkyX**



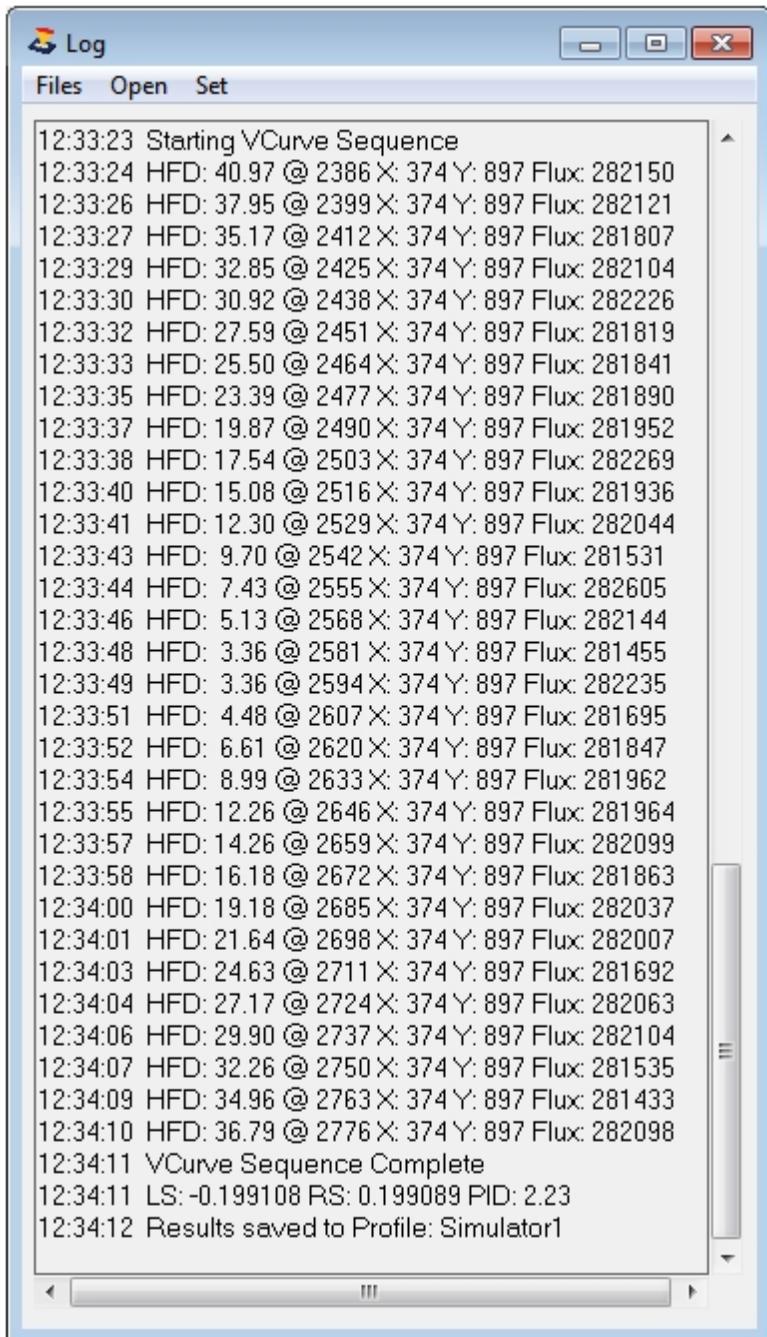
## CCDSOFT



## Near Focus HFD Setting

### Near Focus HFD Setting

1. To determine the best setting for Near Focus HFD (see Preferences / Setup )
  - ▶ Generate a Vcurve
  - ▶ Examine the Vcurve graph and identify the circle which begins to deviate from a straight line.
  - ▶ Determine the position in the Log by counting up the number of circles from the minimum HFD value (9.7 HFD below).
  - ▶ Round up the HFD value in the Log (9.7 becomes 10)
  - ▶ Add 2 - 3 HFD units to assure that the Near Focus Position is on the linear portion of the 'V' (13 in the example below).

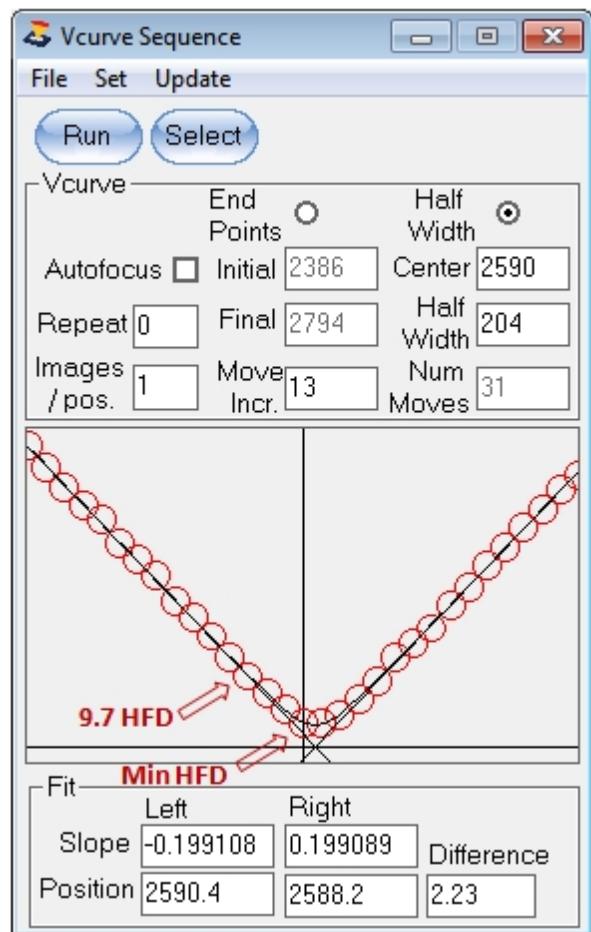


The screenshot shows a Windows-style application window titled "Log". The menu bar includes "File", "Open", and "Set". The main window displays a list of log entries in a text box. The entries show a sequence of events starting at 12:33:23, with each entry containing a timestamp, an HFD value, coordinates (X: 374 Y: 897), and a Flux value. The log ends at 12:34:12 with a message indicating the sequence is complete and results are saved to a profile named "Simulator1".

```

12:33:23 Starting VCurve Sequence
12:33:24 HFD: 40.97 @ 2386 X: 374 Y: 897 Flux: 282150
12:33:26 HFD: 37.95 @ 2399 X: 374 Y: 897 Flux: 282121
12:33:27 HFD: 35.17 @ 2412 X: 374 Y: 897 Flux: 281807
12:33:29 HFD: 32.85 @ 2425 X: 374 Y: 897 Flux: 282104
12:33:30 HFD: 30.92 @ 2438 X: 374 Y: 897 Flux: 282226
12:33:32 HFD: 27.59 @ 2451 X: 374 Y: 897 Flux: 281819
12:33:33 HFD: 25.50 @ 2464 X: 374 Y: 897 Flux: 281841
12:33:35 HFD: 23.39 @ 2477 X: 374 Y: 897 Flux: 281890
12:33:37 HFD: 19.87 @ 2490 X: 374 Y: 897 Flux: 281952
12:33:38 HFD: 17.54 @ 2503 X: 374 Y: 897 Flux: 282269
12:33:40 HFD: 15.08 @ 2516 X: 374 Y: 897 Flux: 281936
12:33:41 HFD: 12.30 @ 2529 X: 374 Y: 897 Flux: 282044
12:33:43 HFD: 9.70 @ 2542 X: 374 Y: 897 Flux: 281531
12:33:44 HFD: 7.43 @ 2555 X: 374 Y: 897 Flux: 282605
12:33:46 HFD: 5.13 @ 2568 X: 374 Y: 897 Flux: 282144
12:33:48 HFD: 3.36 @ 2581 X: 374 Y: 897 Flux: 281455
12:33:49 HFD: 3.36 @ 2594 X: 374 Y: 897 Flux: 282235
12:33:51 HFD: 4.48 @ 2607 X: 374 Y: 897 Flux: 281695
12:33:52 HFD: 6.61 @ 2620 X: 374 Y: 897 Flux: 281847
12:33:54 HFD: 8.99 @ 2633 X: 374 Y: 897 Flux: 281962
12:33:55 HFD: 12.26 @ 2646 X: 374 Y: 897 Flux: 281964
12:33:57 HFD: 14.26 @ 2659 X: 374 Y: 897 Flux: 282099
12:33:58 HFD: 16.18 @ 2672 X: 374 Y: 897 Flux: 281863
12:34:00 HFD: 19.18 @ 2685 X: 374 Y: 897 Flux: 282037
12:34:01 HFD: 21.64 @ 2698 X: 374 Y: 897 Flux: 282007
12:34:03 HFD: 24.63 @ 2711 X: 374 Y: 897 Flux: 281692
12:34:04 HFD: 27.17 @ 2724 X: 374 Y: 897 Flux: 282063
12:34:06 HFD: 29.90 @ 2737 X: 374 Y: 897 Flux: 282104
12:34:07 HFD: 32.26 @ 2750 X: 374 Y: 897 Flux: 281535
12:34:09 HFD: 34.96 @ 2763 X: 374 Y: 897 Flux: 281433
12:34:10 HFD: 36.79 @ 2776 X: 374 Y: 897 Flux: 282098
12:34:11 VCurve Sequence Complete
12:34:11 LS: -0.199108 RS: 0.199089 PID: 2.23
12:34:12 Results saved to Profile: Simulator1

```



2. Enter the value (13 HFD ) in the **Near Focus HFD** box

