

DEF-Guider is a free software that is automatic guide software for astrophotography. This software requires a Windows system to run. This software controls the guide camera and the telescope via ASCOM.

Web site: <https://exogalaxy.com/>

Enquiries: Contact form on my web site or e-mail to g-log@exogalaxy.com

Features:

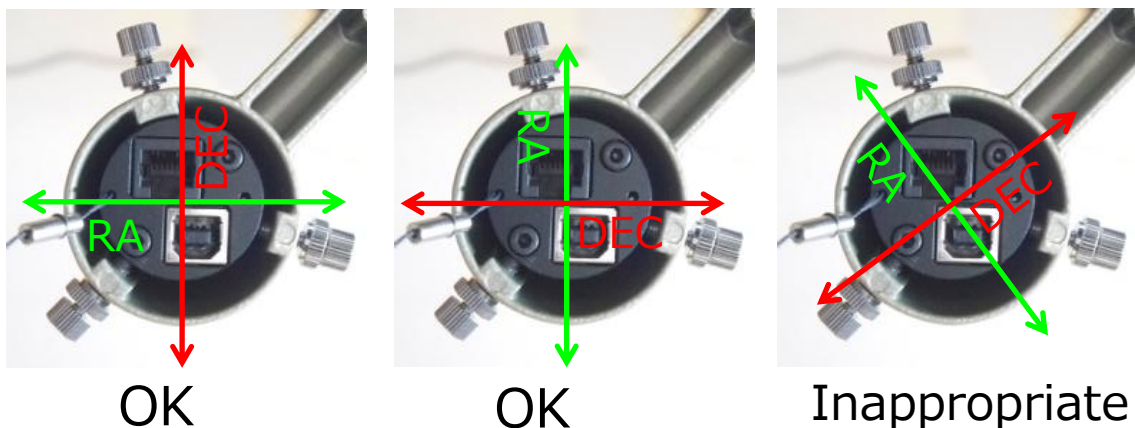
- Multi star guide using up to 16 guide stars.
- Align a telescope using All Sky Plate Solver and Astrometric Stacking Program (ASTAP).
- By sensing the RMS and mean of the guide error, the calibration value will be automatically adjusted.
- Finding the differential flexure from the star image.
- Finding the focus by the astigmatism method from the star image.

1. Installing the DEF-Guider

DEF-GuiderInstaller_x86.msi is the DEF-Guider installer program. DEF-Guider requires '.NET Framework 4.8'. Additionally, this requires ASCOM platform version 6.6 or newer. ASCOM refers to equatorial mounts as Telescope, so this book also uses the term Telescope.

2. Mounting the guiding camera

The camera must be mounted so that the horizontal and vertical lines of the camera are parallel to RA and DEC movement. If the guide camera is mounted improperly (angled), the program cannot correct the tracking errors.



3. Connecting guide camera and telescope to the PC

Please refer to the guide camera manual and the telescope manual how to connect the guide port and USB port to the PC. Guide pulse can be sent using the guide port of the guide camera or the pulse guide of telescope.

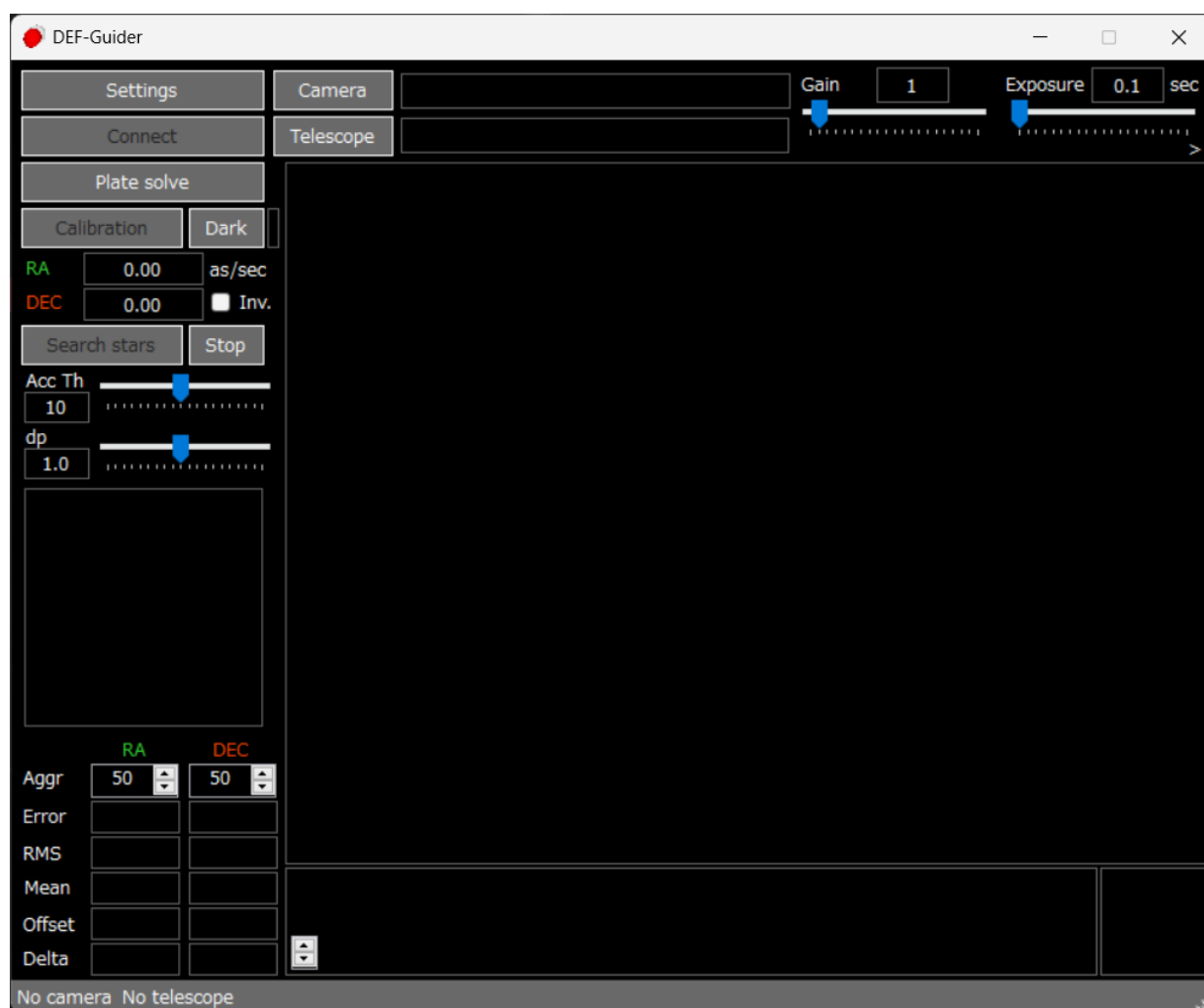
4. Autoguiding procedure

Here is a brief procedure of setting up the autoguiding. For the detailed explanations, please refer to the chapter 5 and 6.

- 1) Connect the guide camera and equatorial mount to your PC.
- 2) Launch the DEF-Guider.
- 3) Chose guide camera and telescope.
- 4) Click the Connect button of DEF-Guider.
- 5) Slew your telescope to the desired imaging area and then perform the calibration.
- 6) Adjust and determine the imaging frame (Main camera) and then start autoguiding.

5. Explanation of the main window

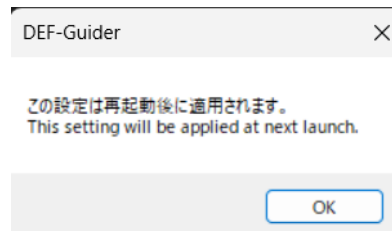
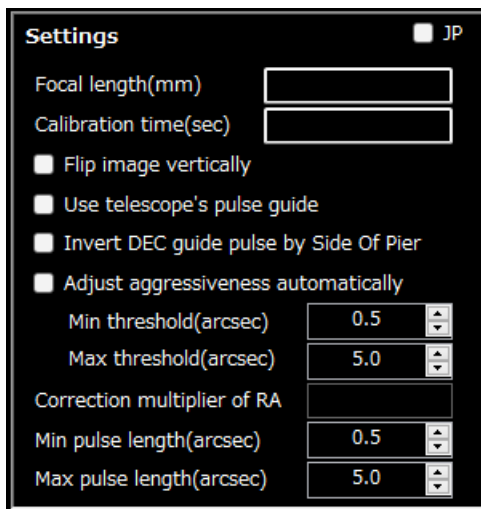
When the DEF Guider program is launched, the following window should appear.



5.1 Language settings

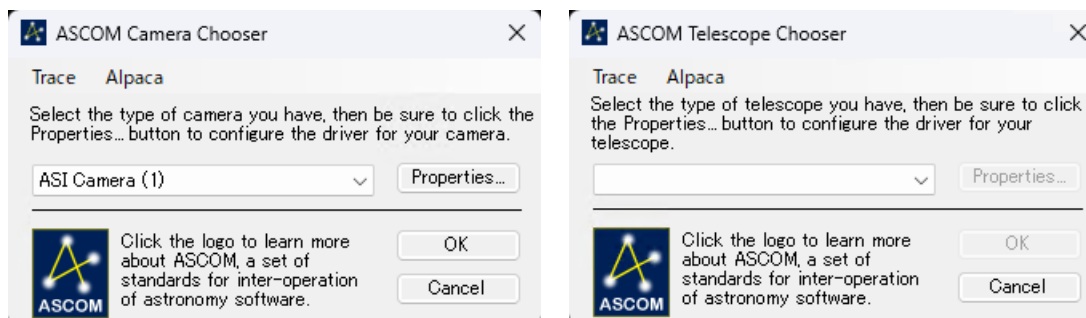
Turn on JP in Settings screen, close DEF-Guider, and restart it to change to Japanese. This screen can be closed by clicking the Settings button again or by clicking the part of the screen labeled

Settings.

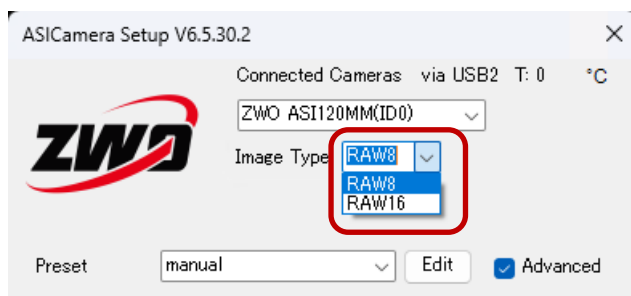


5.2 Equipment selection and settings

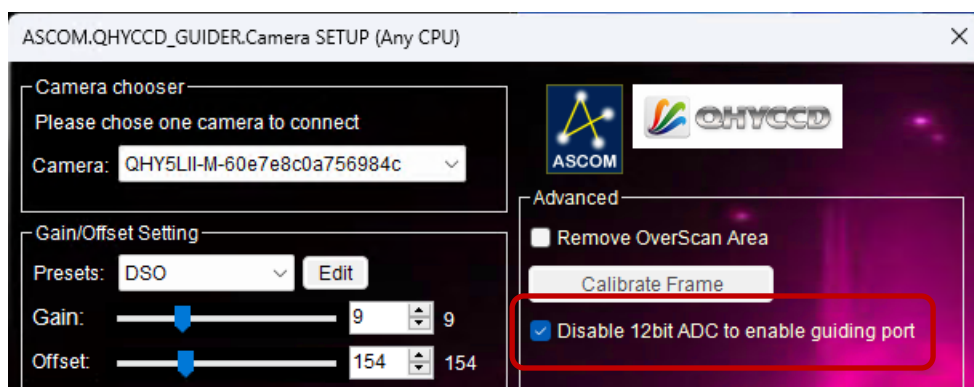
Select your guide camera and equatorial mount. Click the Camera button or Telescope button to open the ASCOM Camera Chooser or ASCOM Telescope Chooser.



If this is your first time using the ASCOM driver for your device, open Properties and check the settings. You may not be able to open Properties if the device is not connected to the PC. Click OK on Chooser and the selected equipment will be displayed in DEF-Guider. You can return to the unselected state by clicking Cancel on Chooser.



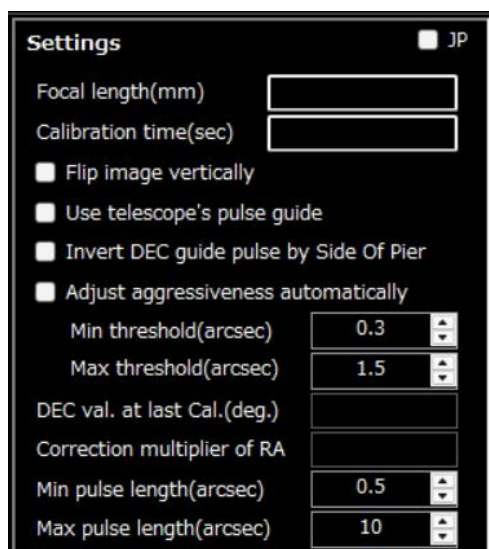
If the guiding camera allows you to select the bit depth of the AD converter, such as 8bit or 16bit, please set it to 8bit.



There is a problem that the guiding port on QHY5L-II is not work with ASCOM driver.

5.3 Settings of DEF-Guider

Click the settings button to display the following screen.



Be sure to set the focal length and calibration time.

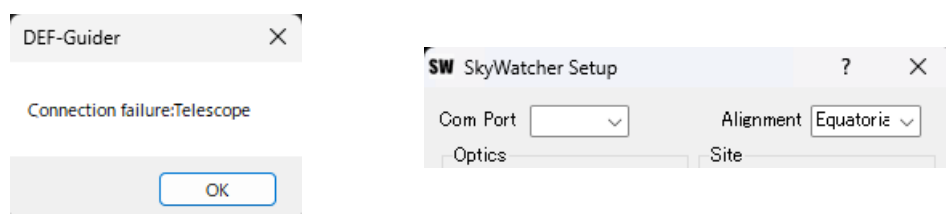
Setting Items	Setting details
JP	Japanese display on/off
Focal length(mm)	Focal length of guide scope
Calibration time(sec)	Length of guide pulse output when performing calibration
Flip image vertically	Display the guide camera image upside down
Use telescope's pulse guide	Send the guide pulse to the ASCOM port of the telescope. If it is off, it will send to the guiding camera.
Invert DEC guide pulse by Side of Pier	When the meridian flip, the DEC guide pulse is automatically inverted.
Adjust aggressiveness automatically	Automatically adjusts aggressiveness by determining over-correction or under-correction from RMS and absolute values of Mean of guide error

Min threshold(arcsec)	If both RMS and Mean are greater than the maximum threshold, it is under-correction, if RMS is greater than the maximum threshold and Mean is less than the minimum threshold, it is over-correction.
Max threshold(arcsec)	
DEC val. at last Cal.(deg.)	DEC value at the time of last calibration
Correction multiplier of RA	A multiplier that adjusts the RA guide pulse length from the difference between the DEC at calibration and the current DEC.
Min pulse length(arcsec)	Guide pulses shorter than this value will not be sent.
Max pulse length(arcsec)	Guide pulses longer than this value will not be sent.

5.4 Connecting the devices

Click the connect button to connect to the guide camera and telescope.

If you cannot connect to the telescope, check the COM port in the properties.



The image from the guide camera is displayed reduced to fit within the screen. Clicking on this image will crop the center part and display it without reducing it. Mainly used for focus adjustment.

5.5 Plate solving

Before running plate solve from DEF-Guider, please configure and check the operation of the Plate Solver. Click the Plate solving button to display the following screen. This screen can be closed by clicking the Plate solving button again or by clicking the part of the screen labeled Plate solving.

Plate solving

Focal length(mm)	50
Pixel size(μm)	3.75
Current RA(Hours)	16:34:52
Current DEC(Deg)	36°39'17"

☒ Slew to target after plate solve

Run plate solver ☒ Guiding camera ☐ Imaging camera

Result

Solver folder All Sky Plate Solver(ASPS)

C:\Program Files (x86)\PlateSolver

The focal length will display the value entered on the setting screen. The pixel size is obtained from the guide camera, and RA and DEC are obtained from the telescope.

If you check Slew to target after plate solve, the telescope will slew to target set on it, when plate solve is successful. If the target is not set it, the current RA and DEC before plate solve will be set as the target. For safety reasons, if the target is more than 15 degrees away from RA and DEC measured by plate solver, the slew will not be performed.

Select the image to be used for plate solve the guide camera or Imaging camera radio buttons. To use the latter, settings for offset guides are also required. See Chapter 6 for these settings.

Duration 49 seconds
 RA = 16:40:15
 DEC = 36°17'40"
 Image rotation = -177.38°
 Focal length = 50mm
 Slew completed

Clicking the Run plate solver button will send a command to the plate solver. If the plate solve is successful, the results will be displayed as shown on the left. Image Rotation is CROTA2 of world coordinate system. Only RA and DEC will be display if Astrometric Stacking Program is selected.

Plate solve cannot be executed while calibration or autoguiding is in progress. If the plate solver is installed in a folder other than the default, specify that folder.

Solver folder All Sky Plate Solver(ASPS)

C:\Program Files (x86)\PlateSolver

5.6 Calibration

Click the calibration button to automatically calibrate. When calibration is completed, the measured value will be displayed. The unit is arcsec/second. The Invert checkbox on this screen manually inverts the DEC's guide pulses when the Invert DEC's guide pulses by Side of Pier setting is off.

Calibration Dark

RA 0.48 as/sec

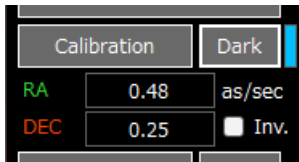
DEC 0.25 ☐ Inv.

If a telescope is connected to DEF-Guider, the current DEC is obtained from the telescope and the RA guide pulse length is adjusted based on the difference between the current DEC and the calibrated DEC. Therefore, auto-guiding can be performed without having to calibrate

each time you change the object.

5.7 Get the dark frame image

Clicking the Dark button saves the currently displayed image to a file as a dark frame. Therefore, the lens cap the guide scope before clicking this button. When performing dark frame subtraction, a blue square will be displayed to the right of the dark button.

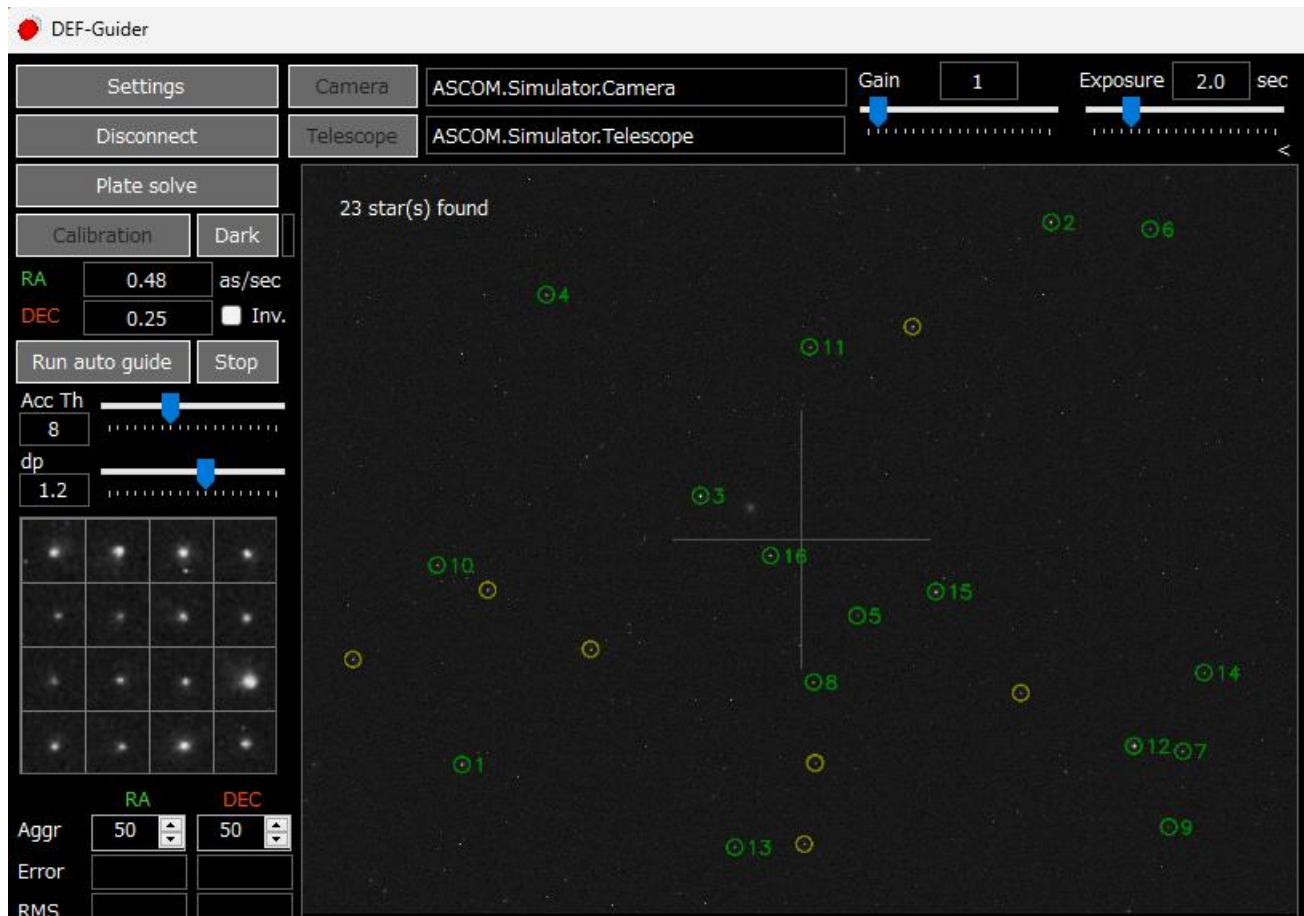


If you click the Dark button when the camera is not connected, the saved dark frame file will be deleted. The folder name and file name of the dark frame file are as follows.

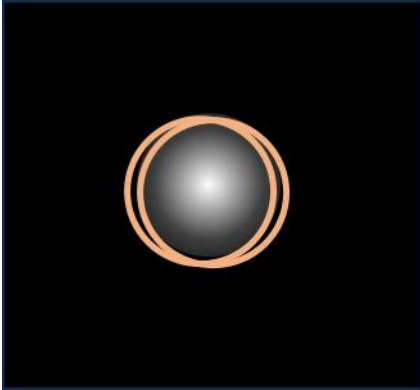
C:\Users\<username>\AppData\Local\VisualStore\Program Files (x86)\DEF-Guider\DEF-GuiderDark.png

5.8 Search stars

Click the Search stars button to display guide stars. The stars marked in green are the guide star. If more than 16 stars are found, the 17th and subsequent stars will not be used as a guide star and will be displayed in yellow. The button name changes to Run auto guide.



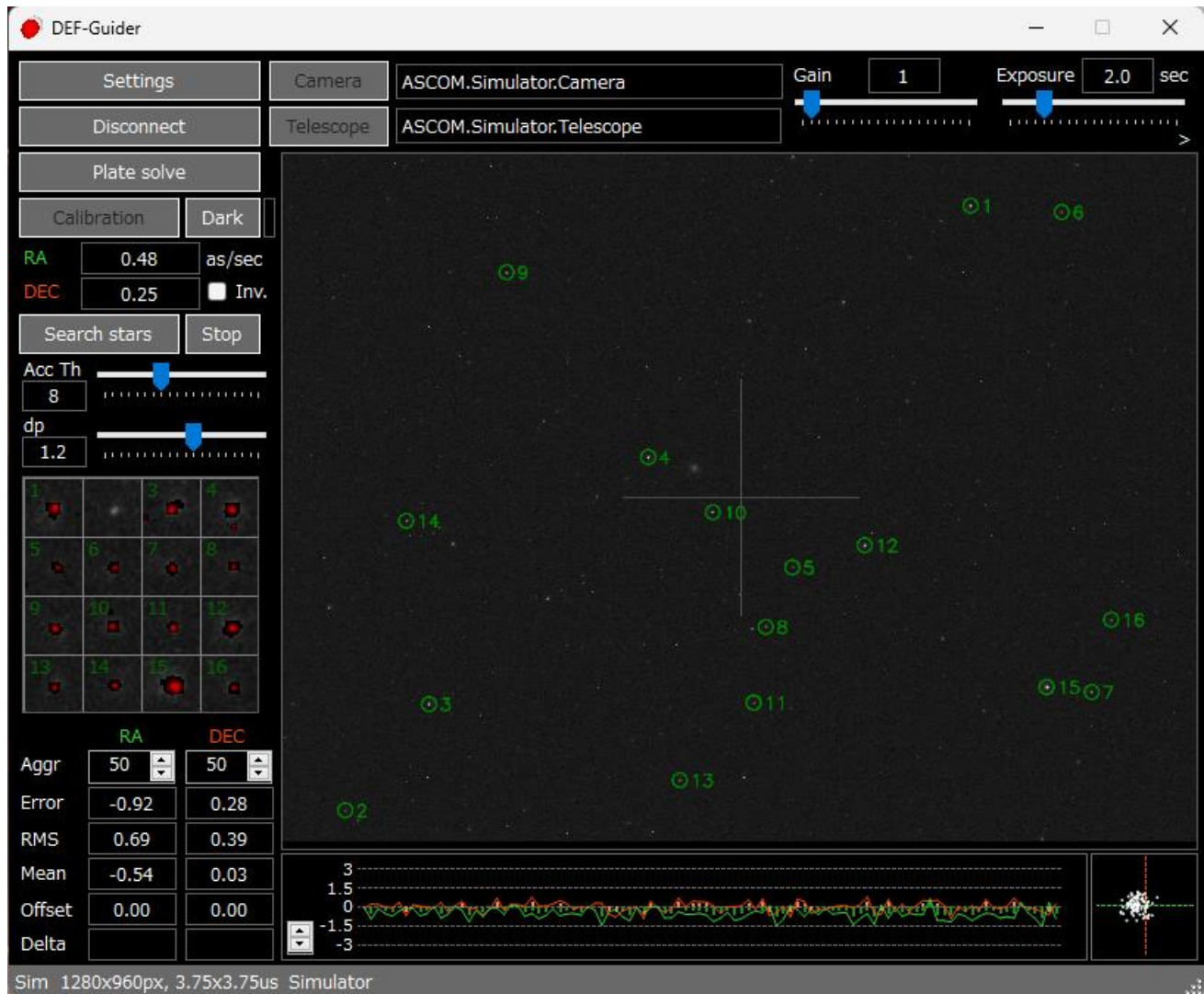
Acc Th and dp are thresholds for determining guide stars. DEF-Guider is detecting circles. Acc Th is the threshold of the number of votes for the detector, and if you reduce this value, it will be judged as a circle even with a small number of votes, so the number of detections will increase, but the number of false positives will also increase. dp is the reciprocal of the detector resolution; increasing this value lowers the resolution and increases the number of detections. If you can see stars on the screen but the number of stars detected is small, adjust Acc Th a little smaller or dp a little larger.



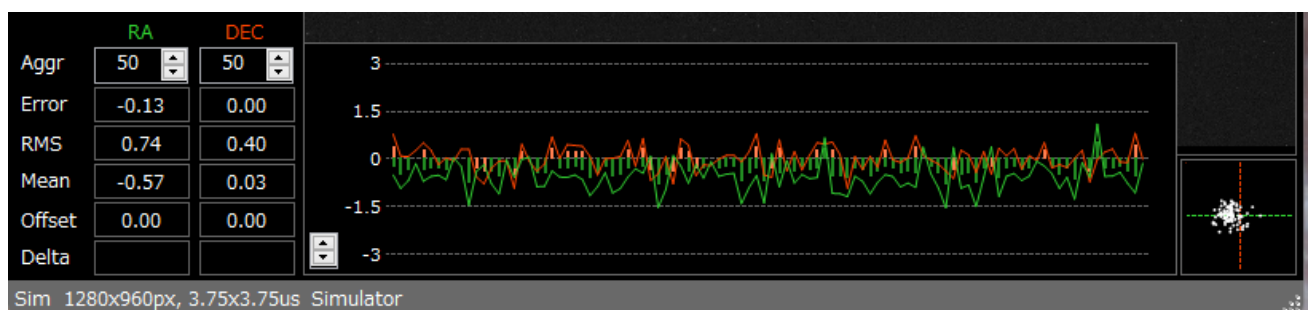
Explain the concept of thresholds. When the detector detects two circles whose center is slightly shifted as shown in the figure on the left, if the resolution is high (dp is small), it will determine that they are separate circles, so two circles with a vote count of 1 will be detected. If the resolution is low (dp is large), it will be determined that they are the same circle, so one circle with a vote count of 2 will be detected.

5.9 Run auto guide

Click the Run auto guide button to start the guide. The button name changes to Search stars.



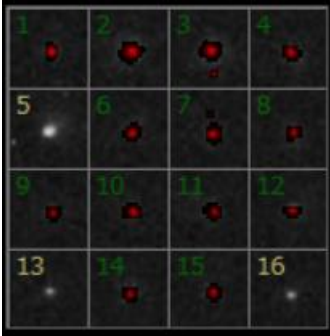
The line graph is the guide error magnitude, and the bar graph is the guide pulse length. RMS and Mean are calculated using the values in the range (100 times) displayed on the graph. All units are arcsec.



Click on the graph to enlarge it twice vertically. Click again to return to the original size. You can change the graph scale in the range of 1 to 10 arcsec using the up/down buttons at the bottom right of the graph. The dispersion diagram on the right is a 2D representation of the magnitude

of the error.

If you click the guide star search button again while guiding, the guide will be interrupted and the guide star search will resume. Use this if you want to change the current guide stars. In this case, the graph will not be cleared. Click the Stop button to stop the guide and clear the graph.



When DEF-Guider loses the guide star while guiding, the number of that guide star will be displayed in yellow. Also, by clicking squares 1 to 16, you can explicitly stop using that guide star as auto guide. This may increase the stability of the auto guide when the guide star is frequently lost or a double star is selected.

6. Offset guiding

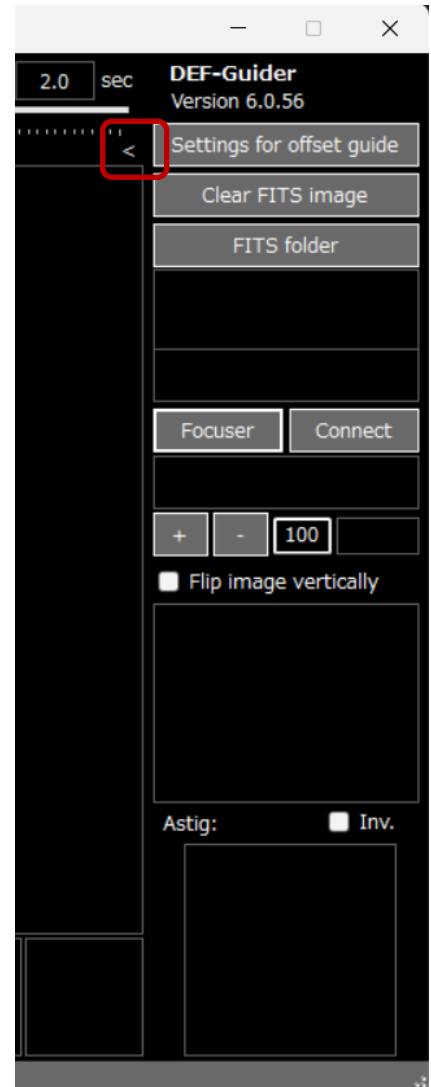
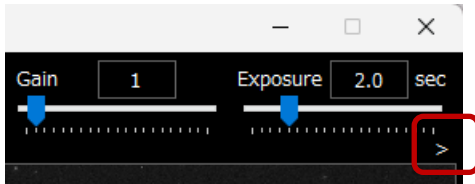
In astrophotography, even if the auto guide is accurate, the star image may gradually shift due to the deflection of the telescope.



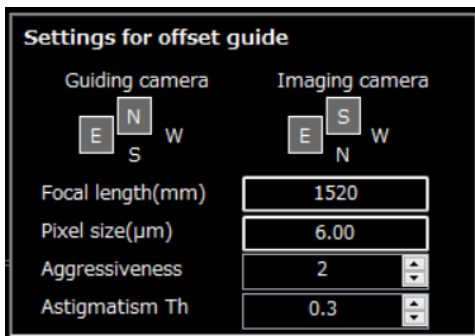
The offset guide detects the magnitude and direction of misalignment. Then offsets the center of gravity of the auto guide in the direction to cancel it. Assuming that the third star image is also shifted in the same way as the difference between the first and second images, it will be gradually offset over the time interval between shots. This reduces the phenomenon in which the star image is deformed into an elliptical shape due to deflection, etc.

6.1 Settings for offset guide

Click the '>' mark at the top right of the window to show the offset guide function. Click the '<' mark to hide them. Even if you hide the offset guide function, the offset guide will continue to run.



Click the Settings for Offset Guide button to display the following screen.



Please set the direction of the Guiding camera and the Imaging camera to the east, west, north and south. Clicking the button to the left of the direction of the camera (button E in the diagram) changes the display to north, south, east, and west. This adjusts the horizontal direction. Next, click the upper button (button N in the diagram) to change the top and bottom. This adjusts vertical direction. Note that offset guide cannot work if the camera direction is not horizontal or vertical to RA and DEC.

For the focal length, enter the value of the imaging telescope. If you are using reducer or some type of lens, please enter the corrected focal length. For the pixel size, enter the value of the imaging camera. This setting is also used for plate solving with FITS files. Aggressiveness can be set from 0 to 6 using the offset guide correction rate. At first, set it to 1, and adjust while checking the effectiveness of the offset. If set it to 0, offset guide will be disabled.

6.2 Performs offset guide

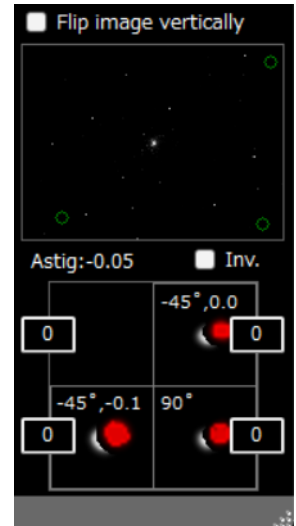
To read images from the imaging camera, click the FITS folder button and specify the folder where the capture software will save the images. Image files only support 16bit 1-plane FITS format. Note that images from color cameras are also used as is without Bayer RGB conversion. You can clear the specified folder by clicking the Cancel button in this folder selection popup window. Offset guide will not be performed in this state.

When the capture software saves the image file, DEF-Guider automatically reads the latest image and detects the star images in the four corners. The position of the detected star is shown in green circle.

	RA	DEC
Aggr	50	50
Error		
RMS		
Mean		
Offset		
Delta	-3.37	1.60

No camera No telescope

From the second image onward, the deviation from the first star image will be displayed in the Delta column at the bottom left of the screen. From now on, the offset will be applied gradually and the current value will be displayed in the Offset column. The unit is arcsec.

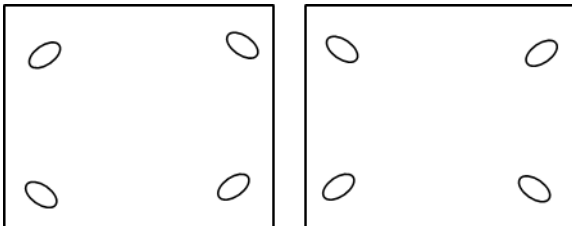


If DEF-Guider accidentally detect something that is not a star as a star, click the Clear FITS Image button to initialize the offset guide. When capture software saved next image, DEF-Guider may be able to successfully detect stars.

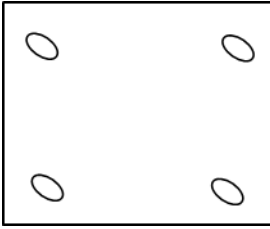
Images read here can also be used for plate solving. When using Plate Solver, take an image with the capture software and save it. Once DEF-Guider has read the image, select the Imaging camera of the radio button on the plate solve screen, and then click the Run plate solver button.

7. Automatic focusing

DEF-Guider can autofocus using the astigmatism method. If astigmatism remains in the optical system, and the focus is slightly off, the star images at the four corners will become elliptical, pointing in the circumferential or vertical direction, as shown in the figure below. DEF-Guider detects them and performs autofocus by clicking the forward or reverse button on the electric focuser software.

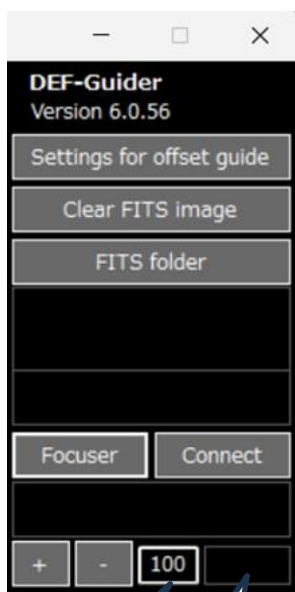


Cases where autofocus does not work:



If the star images at the four corners are deformed in the same direction as shown in the image on the left, there may be a factor other than out-of-focus. If DEF-Guider detects only two stars in the upper left and lower right, or only two stars in the lower left and upper right, determine whether the deformation of the star image is due to out-of-focus or other factors. autofocus may not work properly. Also, if the focus is significantly out of focus, it may not be possible to detect the out of focus.

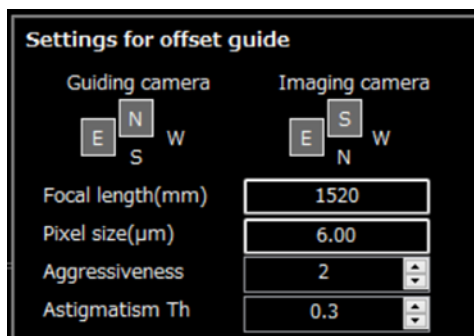
7.1 Settings for autofocus



Click the Focuser button to open the ASCOM Focuser Chooser. If this is your first time using the ASCOM driver for your device, open Properties and check the settings. You may not be able to open Properties if the device is not connected to the PC. Click OK on Chooser and the selected driver will be displayed in DEF-Guider. You can return to the unselected state by clicking Cancel on Chooser.

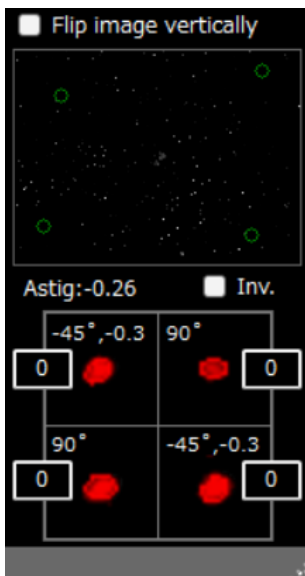
The current position will display after clicking the connect button.

Step size is the number of steps the focuser moves when you click the plus or minus button. DEF Guider's autofocus will click the plus or minus button once if the focus is off after each shot. This action is intended to correct an image that was in focus but has become slightly out of focus due to the telescope's temperature acclimation or changes in temperature. Therefore, set the step size so that the focuser moves a small amount with each click.

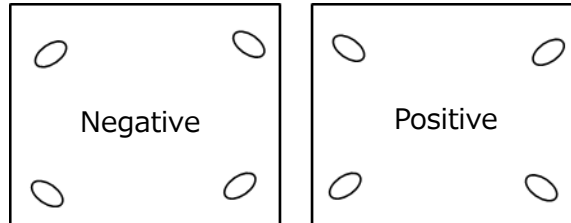


The astigmatism threshold is the value that determines whether autofocus is performed. If the absolute value of the average flattening of star images is greater than this value, autofocus will be performed. This value can be set between 0.0 and 0.6. If set it to 0.0, autofocus will not be performed.

7.2 Performs autofocus



The image used for autofocus is the same as the one for the offset guide. When the second or subsequent image is read, the inclination and flattening of the star image are displayed. The flattening is 0 when the star image is a perfect circle. 'Astig:' is the average flattening. These numbers are displayed as negative values if the star image is deformed in the circumferential direction, as shown in the figure below, and as positive values when the deformation is in the vertical direction.



If the inclination is close to horizontal or vertical, or if the flattening is more than 0.66, it is assumed that the flattened is due to factors other than astigmatism, and the flattening will not be displayed and will not be used for autofocus.

The 'Inv.' checkbox sets whether to click the forward or reverse button. If the check is Off, click the forward button when the value is positive, and click the reverse button when the value is negative. If checked, this will be inverted.

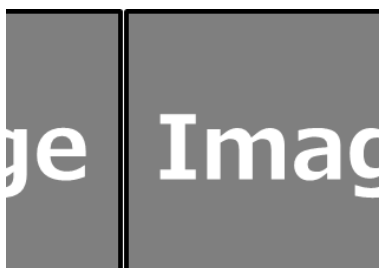


If you know that star images on the periphery of the screen become flattened because of field curvature, tilt problem etc. when the center of the screen is in focus, you can correct the focus judgment by inputting an offset value. For the offset value, input the flattening value when the image is in focus.

8. Unresolved issues and workarounds

1. Issue: The guide camera image may appear shifted left or right.

Workaround: Disconnect and then connect it again.



2. Issue: Guide pulse dose not sent from the guide port on the QHY5L-II camera.

Workaround: No workaround now. Please use the pulse guide of your telescope.

DEF-Guider release information:

V6.1.1 Sep. 20, 2026 First edition release

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