

Thank you for downloading the DEF Guider. This is a stand-alone autoguide program to correct the tracking errors of your equatorial mount when you are imaging astronomical objects in the sky. The Windows operating systems is required to run this program.

Supporting cameras: QHY5LII, QHY5II, QHY5PII, QHY5RII, QHY5TII

Starlight Xpress Lodestar, Lodestar X2, Superstar

ZWO ASI120, ASI034, ASI174, ASI178, ASI185, ASI224

Please note. The underlined cameras are not tested; because of I don't have these cameras. You can use the color version of QHY5 family and ASI family. But this software doesn't have Bayer RGB conversion.

Supporting OS: Windows

Home Page: <https://exogalaxy.com> (Japanese and English)

Enquiries: From the above home page or email to g-log@exogalaxy.com

Features:

- A maximum of 16 guide stars can be tracked simultaneously.
- The guide stars within the appropriate luminance range are automatically selected.
- If all of the guide stars are lost while autoguiding, the program automatically searches another guide star.
- Just click "Start" button to perform the calibration.
- By sensing the guide errors while tracking, the calibration value will be automatically examined and adjusted by the DEF Guider program.
- The dark images can be stored in advance and they can be reused for the next time.

1. Installing/ Uninstalling the DEF Guider program

When the Zip file is extracted, the following files are created.

def-guider.exe

DEF-Guider_Manual_JPN.pdf

DEF-Guider_Manual_ENG.pdf (This file)

df_Lang_ENG.txt

df_Lang_JPN.txt

ASICamera2.dll **Version 1.13.1.12**

hspcv.dll

hspext.dll

pssdk.dll Version 4.2.0.444

qhycdd.dll **Version 17.12.21.0**

SXUSB.dll

tbb.dll
SXUSB.dll

Version 4.1.2012.1003

There is no installation program. The registry is not used at all. Just store all the above files in a single folder. The instruction manual (PDF files) does not have to be in the same folder to launch the program. You can store the above files in any folder **but do not put a space character within the folder name**. Just double click "def-guider.exe" to launch the program. When the DEF Guider program is executed for the first time, the configuration file, "def-guider.ini" is automatically created in the same folder. When the dark images are captured, BMP formatted dark files are automatically created. The camera drivers must be installed as instructed in the manual in advance. To uninstall the DEF Guider program, just delete all the above files in the folder.

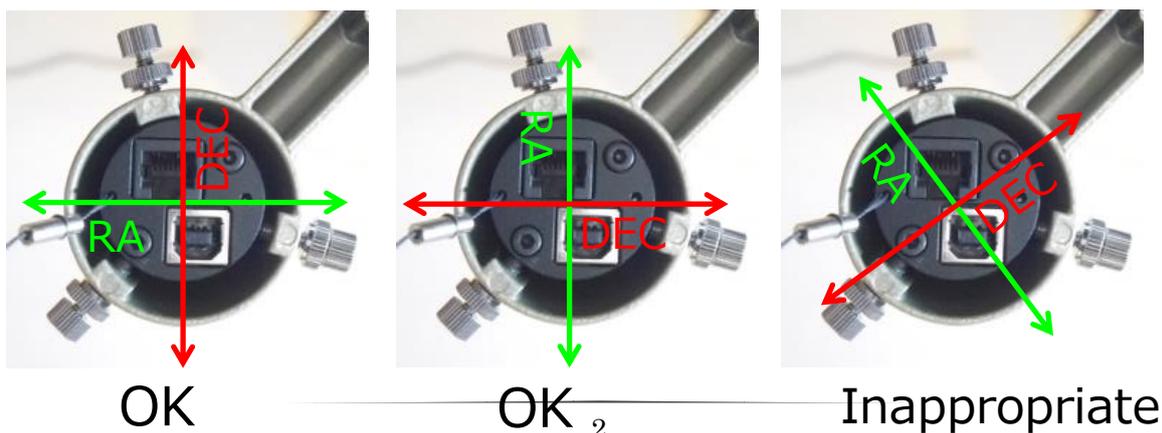
2. Recommended focal length of guide scope

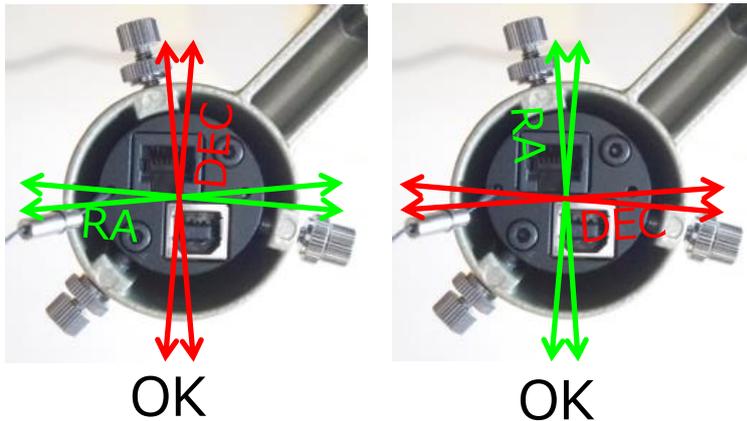
The following table is a recommended focal length of guide scope which is depends on the focal length of imaging scope and the type of guide camera. If the pixel size of your imaging camera is smaller than 5um, longer focal length of guide scope should be good for guiding.

Imaging scope	Guide scope		
	QHY5LII, QHY5TII, QHY5PII, Superstar ASI120, ASI178, ASI185, ASI224	QHY5II, QHY5RII, ASI034, ASI174	Lodestar
~1000mm	25~50mm	35~75mm	50~100mm
1000~1500mm	35~75mm	50~100mm	75~150mm
1500~2000mm	50~100mm	75~150mm	100~200mm

3. 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. It does not have to be very accurate but it should be more or less within 5 degrees range. See the pictures below for mounting the guide camera.

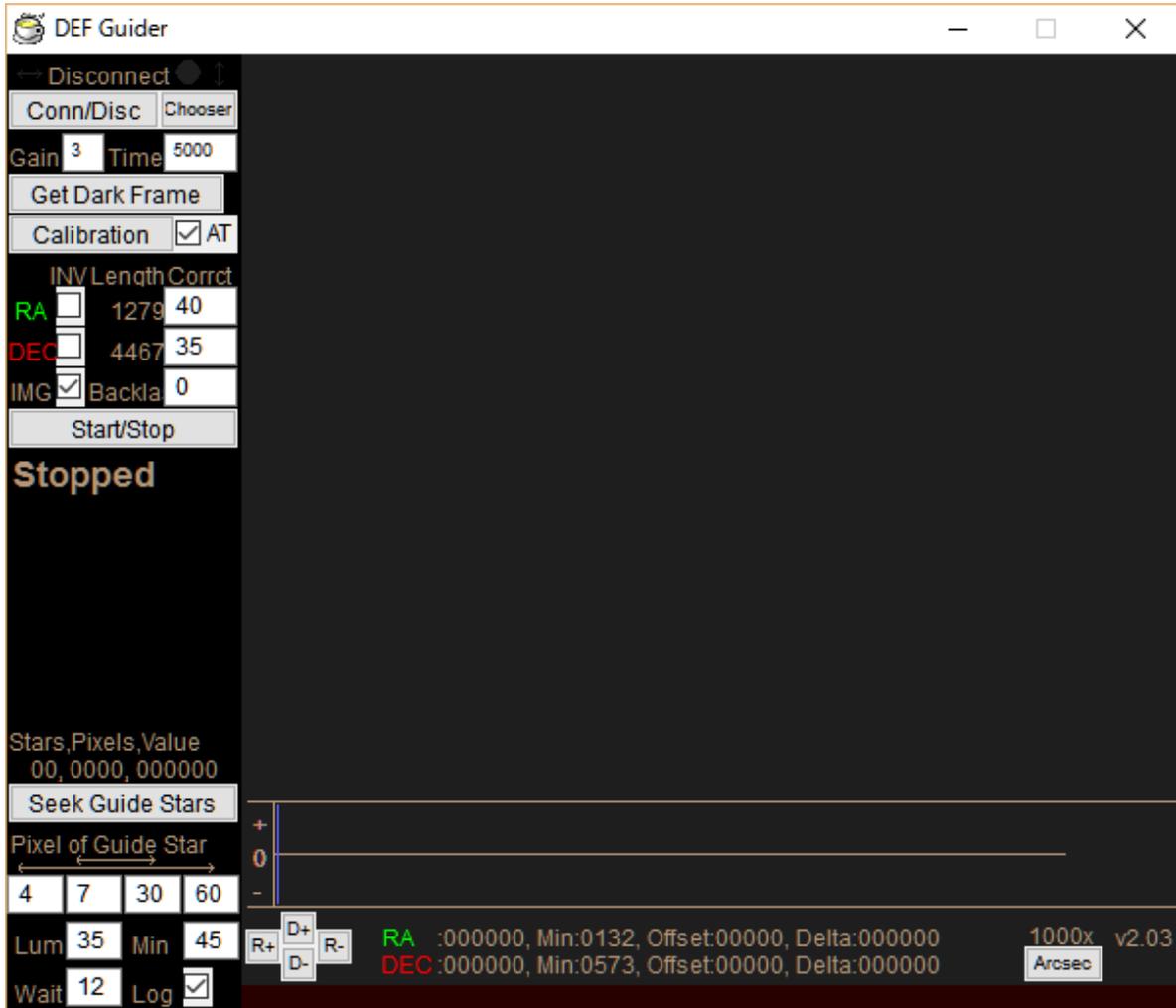




4. Connecting guide camera to a USB port on your PC
Do not use a USB hub to connect the guide camera to your PC. The guide camera and a USB port on your PC must be connected directly, using a USB cable.
5. Connecting guide camera to the guide port of your equatorial mount
Please refer to the guide camera manual and the equatorial mount manual how to connect the guide camera to your equatorial mount guide port.
6. Autoguiding procedure
Here is a brief procedure of setting up the autoguiding camera.
For the detailed explanations, please refer to the chapter 7 and 8.
 - 1) Connect the guide camera to your PC.
 - 2) Launch the DEF Guider program.
 - 3) Chose guide camera type. It is automatically saved.
 - 4) Configure "Gain" and "Time".
 - 5) Click the 'Conn/Disc' button of DEF Guider program.
 - 6) Put the lens cap to capture the dark frames. It is automatically saved.
 - 7) Slew your telescope to the desired imaging area and then perform the calibration. It is automatically saved.
 - 8) Adjust and determine the imaging frame (Main camera) and then start autoguiding.

7. Explanation of the main window

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



The configuration value of the underlined items will be stored to the configuration file when you exit the program. For your convenience, the DEF Guider program will load the default values if "def-guider.ini" file cannot be found.

Connected/Disconnect The camera status will appear here, such as the camera model name, guiding pulse status, the exposure status and more.

<- RA+ -> RA-

↑ DEC+ ↓ DEC-

● Guide camera is being exposed.

● Getting image from guide camera.*1

● Image processing.*1

*1 The program is busy and the window frame may not be dragged or moved.

The connection/disconnection status of guide camera. If the program cannot

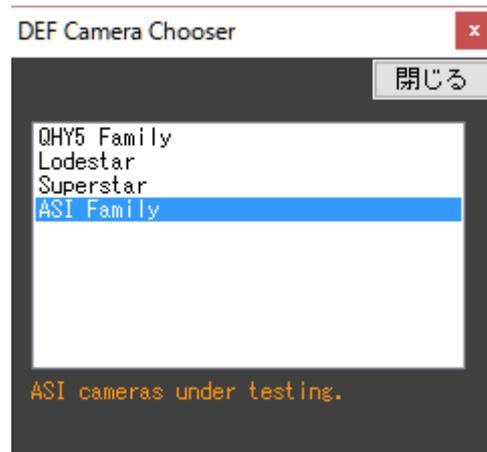
find the selected camera on one of the USB port of your PC, or the connection error occurs, "Disconnect" appears.

Conn/Disc Cam

Click this button to toggle the "Connect" and "Disconnect" the camera to your PC.

Chooser

Pop up the Camera Chooser window. You can select the camera models. Then click the "Close" button. Please do NOT click the  button of this window. It will close this program.



Gain

Adjust the sensitivity of the camera. The value "1" to "10" can be configured. It is recommended to set the value to have the background value of 30 or less. If this value is changed, the dark frames must be recaptured.

Time

It is Exposure time. "1" to "10000" can be configured. The unit is in millisecond. If this value is changed, the dark frames must be recaptured.

Get Dark ■

This is used to capture the dark frames. Put the lens cover and wait until the imaging frame is darkened. Then, click to start capturing the dark frames. When the camera is disconnected, the dark frames cannot be captured. When the dark frames are captured, they will be stored as "BMP" format files so that you do not have to recapture the dark frames every time you launch the program. The file name of the dark frame changes according to the seasons of a year. From January to March, it will be "dfDark123.bmp", from April to June and October to December, it will be "dfDark456.bmp" and from July to September, it will be "dfDark789.bmp". The DEF Guider program searches and detects these dark frames when the program is launched in order to subtract the dark frame from the light frame. So, you must capture, at least, 3 times in a year to capture the dark frames. If the value of "Gain" or "Time" is changed, the stored dark frames will not be erased. However, if you recapture the dark frames, the dark frames will be overwritten. While the dark frame subtraction is performed, right side of

the dark frame indicator will light up in green but it lights up in red while the dark frame subtraction is not performed.

Calibration

The Calibration window appears. While guide camera is disconnected, the calibration cannot be performed. The program stops autoguiding, If this button is clicked while autoguiding. Please refer to Chapter 8 for the details.

AT

When it is checked, the program will study the excess corrections or insufficient corrections and then it tries to adjust the Correct values. After the calibration is performed near the celestial equator but the imaging would be performed near the polar star, the declination of the equatorial mount position is also changed. In this case, it may take up to 15 to 20 minutes to adjust the value. If the telescope passed meridian line and the telescope is flipped to the other side (Pointing to West), click the RA INV checkbox. The program cannot detect whether the telescope is flipped.

It also corrects the backlash value of DEC axis.

RA INV

To reverses the guide pulse of RA correction. If the calibration is performed in the east sky but you would like to continue to guide a star when the telescope is flipped after passing the meridian, click this checkbox. In this way, you do not have to re-calibrate the autoguider. In opposite case, such as you calibrate the autoguider in the west sky but you would like to autoguide a star in the east sky, click this check box. **But remember that you must uncheck this checkbox when you calibrate the autoguider.**

DEC INV

To reverses the guide pulse of DEC correction. **When you calibrate the autoguider, you must uncheck this checkbox.**

IMG INV

Display the captured image upside down.

Length RA/DEC

The result of calibration value. It shows the travel distance in pixel per 1-second long guide pulse. The unit will be 100 times of ARCSEC/second.

Corrct RA/DEC

This value represents the guiding correction aggressiveness in percent. The unit is in percent. Normally, the value of 20 to 40 is used. If you would enter "0", no guiding correction is performed. RA=0 use for polar alignment by drift method. DEC=0 use for one axis guiding such as portable mount.

Backlash

The duration of DEC backlash is configured here. The unit is in millisecond. Usually, it is recommended entering a large value, such as "3000" to start out with. Then, decrease the value until the hunting correction does not occur. **While adjusting this value, uncheck the AUTO correction checkbox. After adjusting this value, please do the calibration again.**

Start/Stop

Click this button to toggle the autoguiding on and off. The guide stars are automatically selected by the program. You cannot manually select the guide stars. You cannot start the autoguide while the camera is

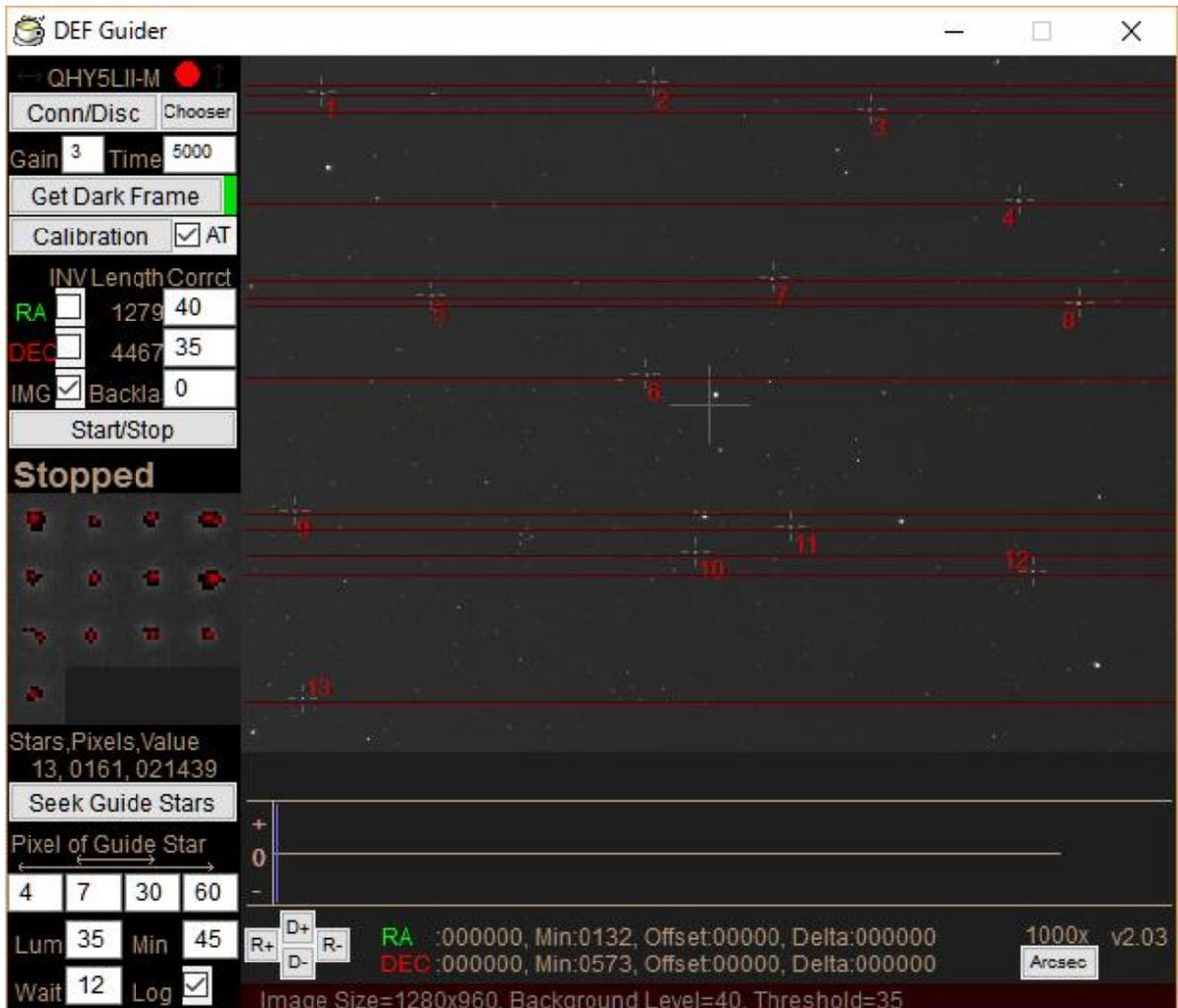
disconnected.

Guiding/Stopped Displays whether the program is autoguiding or not.

Enlarged Guide Star Display The initial position of the selected guide star appears in white. The current position of the guide star appears in red and also enlarged in 200%. The number overlaid from 1 to 16 in camera image window represents the numbers in the following square boxes.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Seek Guide Stars The captured camera image is divided into 16 square areas and the program searches one guide star in every box. The program may pick up a different guide star if you seek a guide stars again. If you would seek a guide stars again while imaging, the guiding error may occur.



When you click this button in guide stopped state, you can see the red line nearby guide star. Then push the RA+ or RA- button of your equatorial mount controller. This can easy to check the camera angle.

Star, Pixel, Value

This is the sum of the following values that are the number of stars, the number of Pixel, the value of the luminance. Greater number of star and pixel, better autoguiding can be performed. But too many bright stars may degrade the autoguiding accuracy. This is because the image of bright stars are often saturated in wide area of autoguiding imaging chip and then the autoguiding correction cannot be performed accurately. In this case, adjust the value of Pixel of Guide Star.

Pixel of Guide Star

These are threshold values to select the guide stars that are not too bright but not so dim. The program counts the number of pixel that is brighter (higher) than the value of luminance threshold value. Greater number is, brighter the star is. The value in the center boxes are used to search the guide stars. As for the example below, the program searches the guide stars within the range of 7 to 40 pixels. If you click the Seek Guide Stars button after you enter the new values, the program searches new guide stars based on the new values. As for the value on the right and left box, they are a minimum threshold value and maximum threshold value that allow the autoguiding. These values are used for the clouds or transparency change.

4	7	40	70
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The value in the most left and right square boxes limits out the guide star if the transparency of the sky changes or clouds pass over the guide star and then the guide star luminance changes. For the example below, if the pixel count of the guide star is less than 4 or 70 or more, the star is not used for autoguiding. When the star is rejected for autoguiding, it does not appear in red color. If the guide star comes back within the configured range, the program restarts autoguiding.

4	7	40	70
---	---	----	----

Note: These values must be increased from left to right. (The right side must be a greater value.) $A < B < C < D$

A	B	C	D
---	---	---	---

Lum

The value of luminance that is used for guide stars. "0" to "255" can be configured. For example, if the background level is 30 and the value of 35 is configured here, a star that is more than or equal to 65 luminance level is selected for a guide star.

Min

The minimum duration of guide pulse. The unit is in millisecond.

Wait

Stabilizer counter for the guide stars and the value of "1" to "16" can be configured. If a guide star is lost while autoguiding, the program waits for the relative period to restart autoguiding. The unit is the number of guide

stars. If the guide stars are found more than this value, and also the program tries to expose the guide stars the number of times specified here before restarting the autoguide. If the "Seek Guide Stars" button is clicked while waiting for restarting the autoguide, the program immediately restarts the autoguide.

Note: If you configure the value more than the number of guide stars, the program may not be able to restart autoguiding after the cloud passes by the guide stars.

Log

When this checkbox is checked, the log file will be recorded. The file name will be "def-guider.csv" and it cannot be changed. It is a text file that the recorded values are separated by a comma. If the file already exists, the file will be overwritten. The log file is recorded until you terminate the DEF Guider program and the new records are appended to the previous records even if you start or stop autoguiding. The log format is as follows. Date, Time, Status, RA error, RA Offset, RA guide pulse, DEC error, Dec Offset, DEC guide pulse.

Graph

The graph of Guide errors. The vertical axis is the amount of the guide error and the RA error is shown in green and the DEC error is shown in red. As the focal length of the guide scope changes, a maximum value of vertical axis scale changes as follows.

Less than 50 mm +/- 0.2 pixels
 51 mm to 100 mm +/- 0.4 pixels
 More than 101 mm +/- 1.0 pixels

The horizontal axis have the space for 400 exposures. If the guide error graph reaches to the most right position, the graph drawing returns to the most left position to overwrite the old graph. The line in purple indicates the current position of the graph. While the guide stars are lost, the color of the graph will be in yellow. If 3-second exposure is configured, the graph can show the guide error graph for approximately 30 minutes.

R+, R-, D+, D-

Click these buttons to generate guide pulse manually. If you click these buttons once, the program generates a guide pulse for 1 second long.

A number appears on the right side of the R- button

Guide error value: The unit is in x1000 pixel. For example, "100" means 0.1 pixel.

Min: If the guide error is less than this value, the program does not correct the guide error.

- Offset: Fluctuation value (The DEF Shifter program is required.)
- Delta: Error value of imaging camera (The DEF Shifter program is required.)
- vX.XX: Version number of DEF Guider

A number appears at the bottom

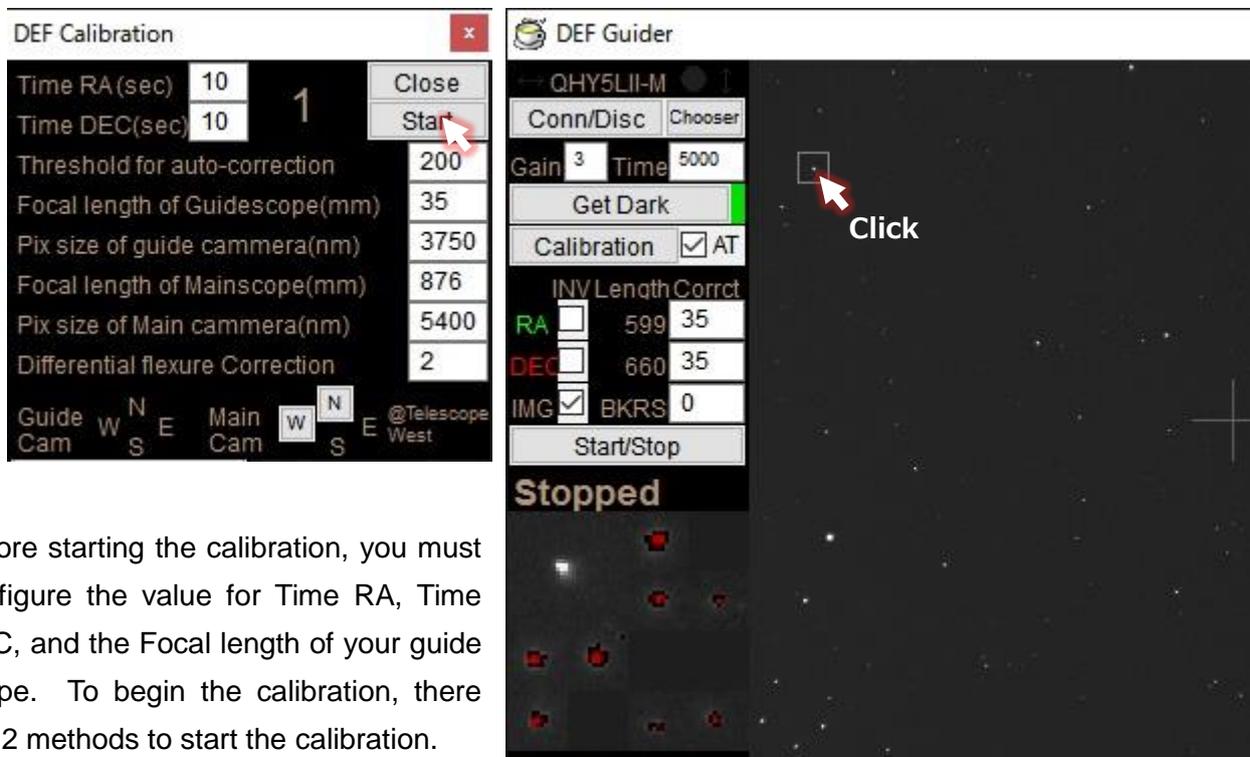
- Image Size: The resolution of guide camera
- Background Level: The background brightness (Counted value)
- Threshold: The threshold value that is specified in the luminance.

1000xArcsec

You can select the unit of Length and guide error value. These are ARCSEC and PIXEL.

8. Explanation of the Calibration window

When you click the Calibration button, the windows in left side will appear.



Before starting the calibration, you must configure the value for Time RA, Time DEC, and the Focal length of your guide scope. To begin the calibration, there are 2 methods to start the calibration.

- Method 1: Click the Start button in the DEF Guider Calibration window. <--- Try this method first.
- Method 2: Click a guide star in the DEF Guider main window. <--- If the program does not start calibrating.

The enlarged target guide star appears on left top of the guide stars area during the calibration. The calibration of DEF Guider is performed only RA+ direction and DEC+ direction. After the calibration is ended, this window closes automatically.

*The detailed instructions of Calibration procedure

Method #1: When you click the "Start" button

1. Uncheck the RA INV, DEC INV, and AT checkboxes.
2. Click the "Start" button in the Calibration window.
 - The program searches a target guide star automatically for the calibration and a square box will appear for the target star to be used for the calibration. Then, the calibration starts.
 - If there would be more than 2 stars in the square box, the calibration cannot be performed correctly. In this case, perform the calibration again or try another method described in #2 below.
 - While calibrating, a large number will appear as "1" -> "3" -> "4" -> "5" -> "6" in order on upper left window. If the number goes back to "1" while calibrating, the calibration is incomplete. In this case, try the followings.
 - Click the "Start" button again. The program may select another star that is used for the calibration. Let it calibrate again to see whether the calibration can be done.
 - Decrease the time in "Time RA (sec)" and "Time DEC (sec)" from 5 seconds (default) to 4 seconds or less. (If the focal length of the guide telescope is long, adjust the duration so that the target star does not move out from the square box.) Or increase the time 6 seconds or more (If the focal length of the guide telescope is short and the target star does not move enough.)
 - Adjust the guide star detection pixel values from 4, 7, 40, 70 (default) to 4, 8, 40, 80 so that the threshold value difference can be expanded.
 - Select another star for the calibration manually as described in method #2.
3. After "1" to "6" appears using this method and the calibration is successful, Click the "Guide Start/Stop" button to start autoguiding.

Method #2: Selecting a target star for the calibration in the main window

1. Uncheck the RA INV, DEC INV, and AT checkboxes.
2. Click (Single click) a star once that is relatively dark. (It barely shows as a white dot on the screen.)
 - A red square box will appear and then the calibration starts automatically.
 - While calibrating, a large progress number appears on left top window. The number increases in order, such as "1" -> "2" -> "3" -> "4" -> "5" -> "6". If the number returns to "1" before reaching "6", the calibration is incomplete. Select another star which is relatively dark to calibrate again. Adjust the time in "Time RA (sec)" and "Time DEC (sec)" or the guide star detection pixel values as described in the Method #1.
3. After the progress number reaches "6" and the calibration is successful, click the "Start/Stop" button to start autoguiding.

The explanation of the Calibration window display and configuration items:

The configuration value of the underlined items will be stored to the file.

For your information, the program recovers all default values when the file, "def-guider.ini" is deleted.

Time RA (sec)

The calibration time for the RA direction. The unit is in second. Adjust this value so that a target star moves several pixels when the guide telescope is pointing around the celestial equator. If the focal length of the guide scope is long, the target guide star may travel a long distance. In this case, decrease the guide speed of your equatorial mount to X 0.25 or less.

Time DEC (sec)

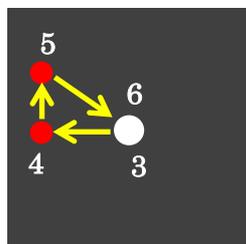
The calibration time for the DEC direction. The unit is in second. Adjust this value so that a target star moves several pixels.

A large number "1"

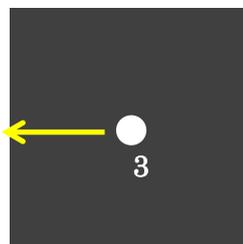
This is the calibration progress indicator.

- 1: Ready to start the calibration
- 2: Clicked a guide star – Only show when using Method #2
- 3: Found the guide star
- 4: Calibrating RA side
- 5: Calibrating DEC side
- 6: Finished calibration

Note: This indicator will back to 1 when you lost the guide star while calibration.



Example of calibration was successful.



Case you have lost the guide star. Guide star goes out of measurement area.

Close

Click to close the Calibration window. If you click "X" in this window, the main window also closes and the DEF Guider program ends. So, please remember this in your mind before you click "X" in this window.

Start

Click to start the calibration. A target calibration star is also automatically selected.

Threshold for auto-correction

Adjust this value to configure the ratio of the correction compensation sensitivity. The unit is in percent (%). The program accumulates 30 guide error values in the past and if these value exceeds this threshold value (%), it corrects the mount movement. So, less this

value is, more sensitive the mount movement is to correct the mount movement. Adjust this value as you are actually guiding a star with the automatic correction. If the program is too aggressive to correct the mount movement, uncheck the Automatic correction and then perform the calibration again.

Focal length of Guidescope (mm) Specify the focal length of your guide telescope in millimeter. More than 1 must be specified.

Pix size of guide camera (nm) Specify the pixel pitch value in nanometer. The pixel size of QHY5L-II is 3750nm (3.75um).

The parameters below are flax ration correction that is used in conjunction with the DEF Shifter program. These parameters are not used for the DEF Guider autoguiding program.

Focal length of Mainscope (mm) Specify the focal length of your main scope in millimeter. More than 1 must be specified.

Pix size of Main camera (nm) Imaging Camera Pixel pitch (nm) Specify the value in nanometer.

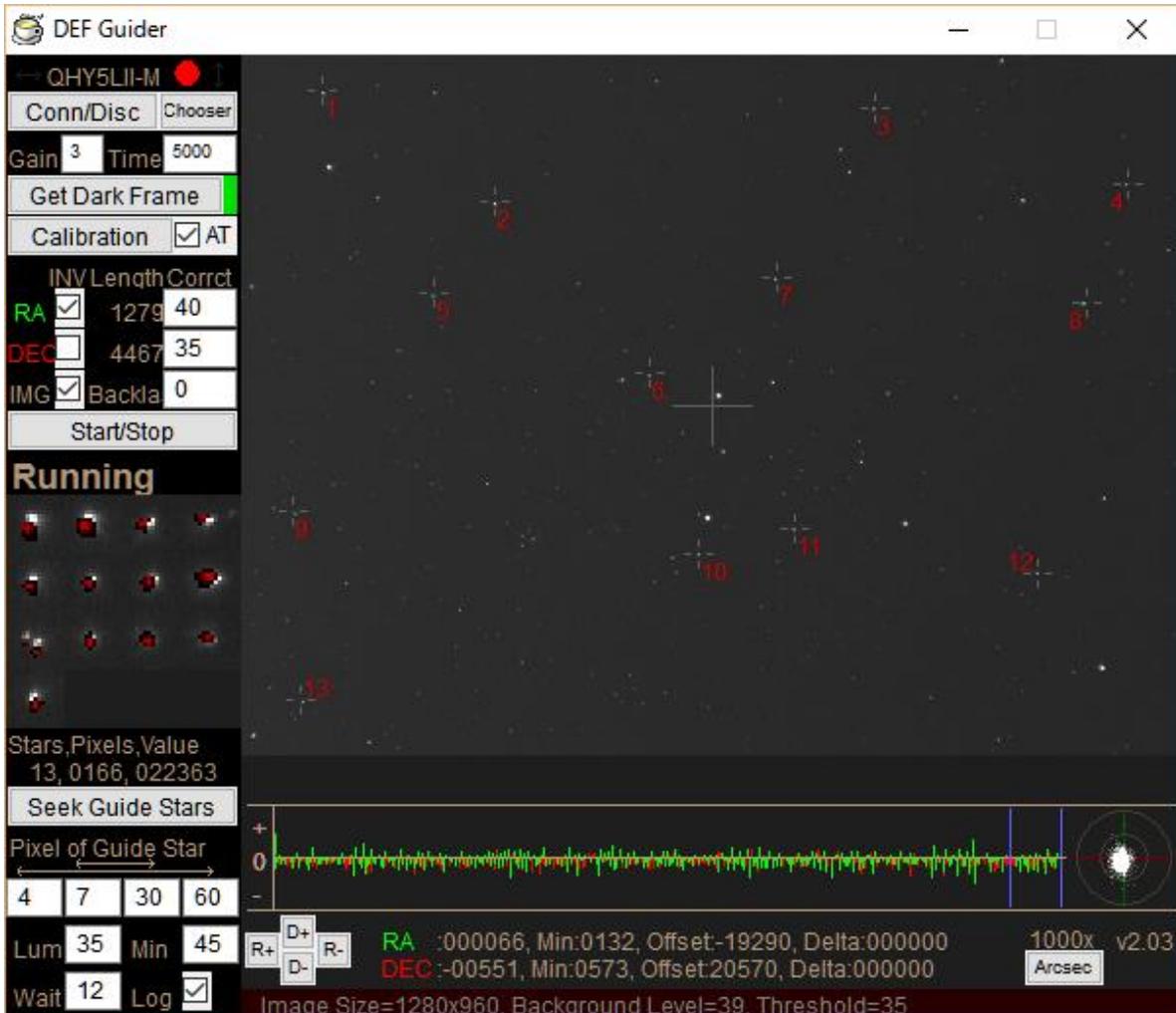
Differential flexure Correction The numbers of pixel to correct per correction. The unit is in 1/1000 pixel. The default value is 2. If the excessive correction is performed, set this value to 1. If the loose correction is performed, set this value to 3.

Guide Cam From the result of calibration, it shows the direction of East, West, South and North of the vertical/horizontal screen*1. If no calibration has been performed yet, "-" appears.

Main Cam Set the direction of the imaging camera picture to East, West, South and North, which is displayed by the DEF Shifter program.*1 Every time you click the button on left side, the display changes N, E, S and W. Select the direction of the left side of the screen. Then if you click the button on top, the screen flips (upside down). Set the screen direction using these buttons. If no calibration has been performed yet, "-" appears.

*1: If you are using a German equatorial mount, this screen should be shown as Telescope West (Your telescope is pointing to East sky.) If the calibration was performed while Telescope East, the screen does not appear properly. So, to adjust the position of your guide camera and main camera, you must perform the calibration using Telescope West. After you calibrate the mount as Telescope West and then you can move the telescope to Telescope East, the screen shows properly and you do not have to re-adjust the directions of screen. If you are using a fork-type equatorial mount, the proper screen display should appear regardless of the direction.

Here is a screen shot while the DEF Guider is guiding. The guide stars have white cross markings. The numbers in red represents the position of the enlarged display boxes (Lower left. 16 boxes)



You can find the Rader chart at left end of graph. It also shows guide error in the circle.

9. Multiple Language Display capability

You can customize almost all text messages in the DEF Guider windows to any language by changing messages in the language file. 2 standard sample language files are provided. Japanese and English language files (Standard files).

df_Lang_ENG.txt

df_Lang_JPN.txt

When the DEF Guider is launched, the program picks up either of these files. The target language file can be changed by specifying the first line of the "DEF Guider.ini" file.

When the DEF Guider program is launch for the first time and the language environment of your PC is Japanese, the program automatically select the Japanese language file. If the language environment of your PC is other than Japanese, the program will show the messages in English.

If a language file that is specified in "DEF Guider.ini" cannot be found, all the messages will be in English. The English file, "df_Lang_ENG.txt" is not necessary to show the messages in English.

How to create a language file:

Place a desired message to the right of the "=" (equal) character. If no "=" (equal) character is found in the line, the line is considered as commentary line. A space character before and after the configured value will be removed automatically. In the case of MS Gothic character, there is a space between MS and Gothic but this is not removed. The following examples are all the same.

```
font=MS Gothic
```

```
font = MS Gothic
```

```
font = MS Gothic
```

If there are more than 1 of the "=" (equal) characters in a line, the parameter may not be properly configured.

As the following example shows, it will be "QHY5" and "=connection" will be ignored.

```
s_conn_cam = QHY5=connection
```

Remarks (comments) cannot be appended to the line with the configured value. The following example will be handled as MS Gothic // font configuration

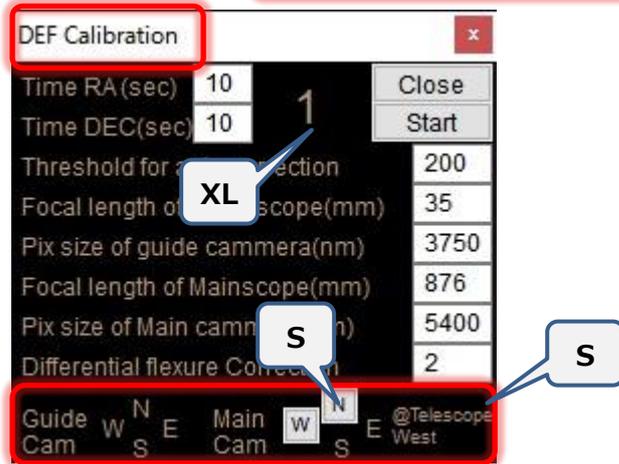
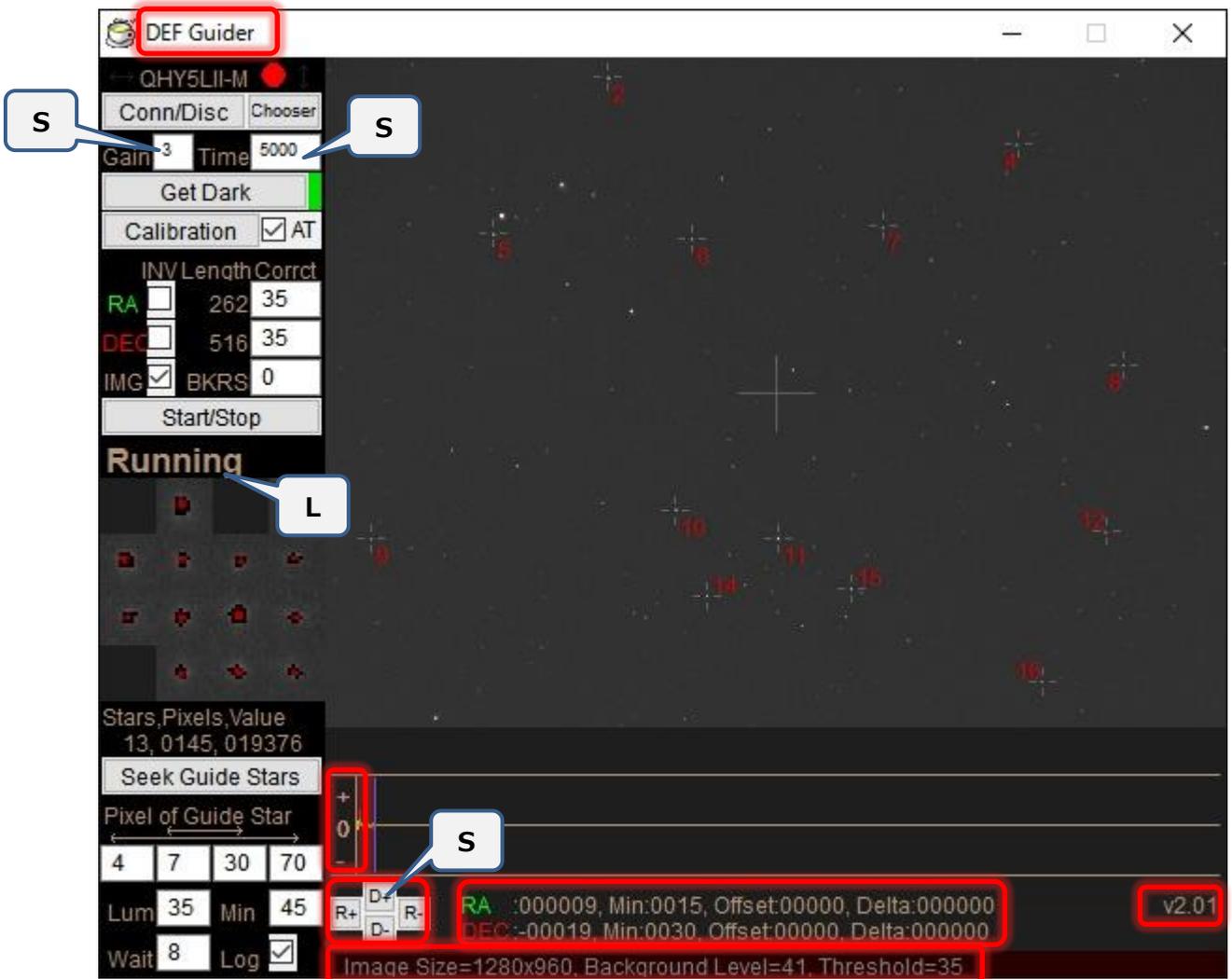
```
font=MS Gothic // font configuration
```

There are 4 different font sizes are used, S, M, L and XL. These sizes can be configured in the language file.

The following example shows S, L and XL-size characters. An M-sized character can be also configured.

Please use the following examples if you would like to change the size or font of the messages that appears in the window.

The size of the characters in red rectangular cannot be changed. (The type of font can be configured.) The font of the window title depends on the configuration of your windows control panel.



10. DEF Guider 2

Two DEF Guider can be run on one PC. If you launch the DEF Guider again when one DEF Guider is running, DEF Guider 2 will be run on your PC. A new configuration file is automatically created for DEF Guider 2 in the same folder. The file name is def-guider2.ini.

11. Known issues and these workaround

- Nothing

Acknowledgment:

I would like to thank Dyna-san, MK66-san, Mohoroba-san, Oyaji-san, Yoshi-san and HUUQ-san for improving this software and the description of the instruction manual.

DEF Guider release note:

V4.01	August xx, 2018	Change the DLL files for QHY Change the DLL files for ASI Support DEF Guider 2
v3.02	July 2, 2017	Change the model number of Superstar camera Disable AutoCAL when the guiding correction aggressiveness is zero
v3.01	March 19, 2016	Support ASI cameras
v2.03	January 09, 2016	Add the unit select button of displayed value It shows a warning message when calibration error Add the backlash correction feature Save the window position The correction rate can set to 0. At this time it not send the guide pulse
v2.02	December 1, 2015	Bug fix: Lodestar(X2) can't connect
v2.01	November 29, 2015	Support the Starlight Xpress Lodestar(X2) and Superstar Support the QHY5 family (change the DLLs for QHY cam)
v1.06	June 20, 2015	The bug fix: The mis-correction of autoguide error. The bug fix: The interval between shots may become unstable.
v1.05	March 12, 2015	The bug fix: The program may become no response when you connect or disconnect the camera
v1.04	January 22, 2015	To avoid the over correction of autoguiding error, a maximum correction is limited to a half of the graph scale. In conjunction with the release of DEF Shifter, the directions of

		East, West, South and North appears on the guide camera and main camera screen. To see a guide star more easily, the location of guide stars is shown in a red cross bar.
		Add the support not to launch 2 DEF Guider programs at the same time.
v1.03	December 9, 2014	Removed one digit from the display of calibration result. Add the support to adjust the calibration result automatically. Double the area for calibration. Add the support to select a calibration star automatically. Add the support to store and automatic recall of a dark frame. Add the support for the Multi-language capability.
v1.02	June 4, 2014	Enhance the support not to autoguide a double star. The bug that the program cannot recall some parts of the configuration values and the value returns to a default value. Correct the erroneous distribution of DLL files.
v1.01	May 12, 2014	Add the support for changing the scale factor in accordance with the focal length of guide telescope.
v1.00	May 10, 2014	Initial release.

Copyright and license notices:

The DEF Guider program is copyrighted by Tsutomu Chikazawa.

The DEF Guider program is written in Hot Soup Processor Version 3.4.

Also, the following HSP expansion plug-ins are used.

hspext.dll

hspcv.dll

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If you distribute those libraries along with the DEF Guider program and this instruction manual, this problem can be avoided.

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The following xml files are developed by Mr. Rainer Lienhart.

haarcascade_frontalface_default.xml

haarcascade_frontalface_alt.xml

haarcascade_frontalface_alt2.xml

HSPCV.DLL

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