ASI Cameras Software Manual

. Linux & OSX Platform

Revision 1.0

Jan, 2017

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Instruction

There are several ways to control our cameras through software on OSX/Linux.
You don't need to install driver for ASI camera.

INDI:
INDI is a protocol designed to support control, automation, data acquisition, and exchange among hardware devices and software frontends. It is a particular implementation of the INDI protocol for POSIX operating systems. Currently, Linux, BSD, and OSX are supported. Currently, INDI Library supports a growing number of telescopes, CCD, focusers, filter wheels and video capture devices.
Lots of software support INDI driver: http://www.indilib.org/about/clients.html

INDIGO:
INDIGO is a proof-of-concept of next generation fork of INDI protocol based on layered architecture and software bus. It maintains full backward compatibility with INDI while adds some extensions which offer better performance and USB hot-pug. Currently, Linux, MacOSX and BSD are supported.While INDIGO is capable of using the old INDI drivers, to unveil it true potential native drivers should be used. The driver library is growing fast and it supports a number of telescopes, CCD cameras, focusers, and filter wheels.
INDIGO is available here: http://www.indigo-astronomy.org

SDK:
This is Software Development Kit for developer, user don't need to install it.
Advantages: This is the most flexible way to control our camera and it can provide the fastest speed.
Limited software supports, such like OaCapture, AstroLive USB, Nebulosity, AstroImager ,AstroGuider, Planetary-imager, Lin_guider, Open PHD Guiding, etc.

Plug-in:
Currently we provide plug-in for TheSkyX and Micro-Manager.

1. Install udev rule(Linux)

In this way you can open camera without root permission on Linux, the rule is located at 'SDK directory'/lib
Open a terminal, type:

$ lsusb

……

Bus 007 Device 006 ID 03c3:120e

……

The vendor ID of our cameras is 0x03c3, so the device of bus number 007 and device number 006 is ASI camera.

$ls /dev/bus/usb/007/006 –l (007 and 006 is bus and device number respectively)

crw-rw-r-- 1 root root 189, 773 1月 13 13:44 /dev/bus/usb/007/006

before the rule is installed, owner is root, group is root

install the rule

$sudo cp asi.rules /lib/udev/rules.d

Replug ASI camera

$ lsusb

……

Bus 006 Device 005 ID 03c3:120e

……

$ls /dev/bus/usb/006/005 –l

crw-rw-rw- 1 root users 189, 644 1 月 13 13:47 /dev/bus/usb/006/005

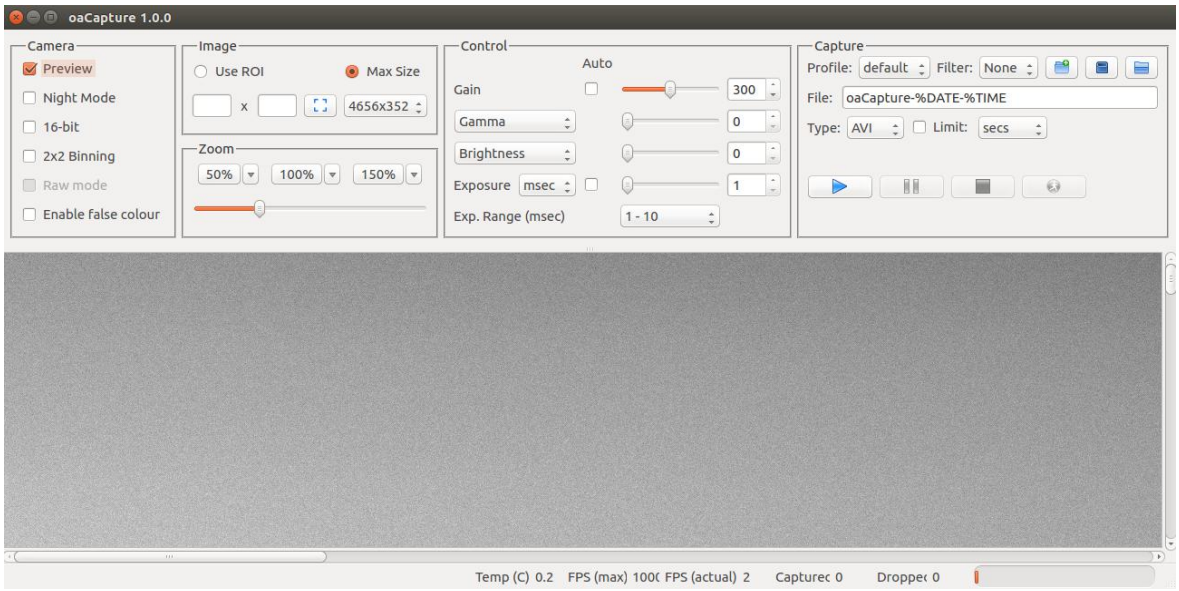
now the group is users, the rule takes effect, if not, try to install it to /etc/udev/rules.d .

2. Planetary Imaging

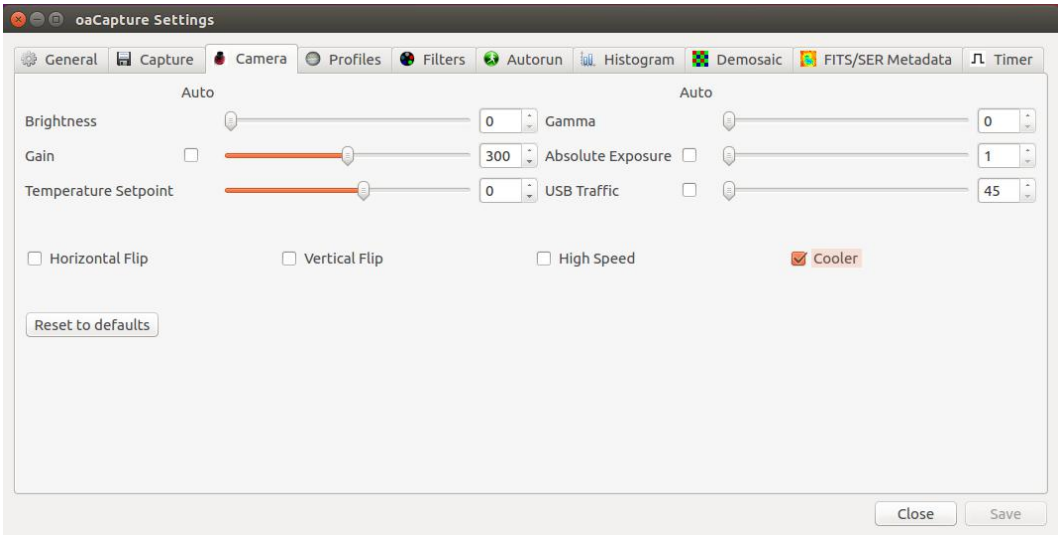
2.1 OaCapture(Linux & OSX)

OaCapture is a planetary imaging application intended mainly for Linux.
(http://www.openastroproject.org/oacapture)

Run OaCapture and press “Rescan” under “Camera” menu, and connected ASI camera should be listed under “Camera”, here ASI1600MM cool camera is connected, so I select “(ZWASI) ZWO ASI1600MM-Cool”, and the program starts to preview.
For color camera, the image is RGB as default, you can check “Raw mode” and “16-bit”.



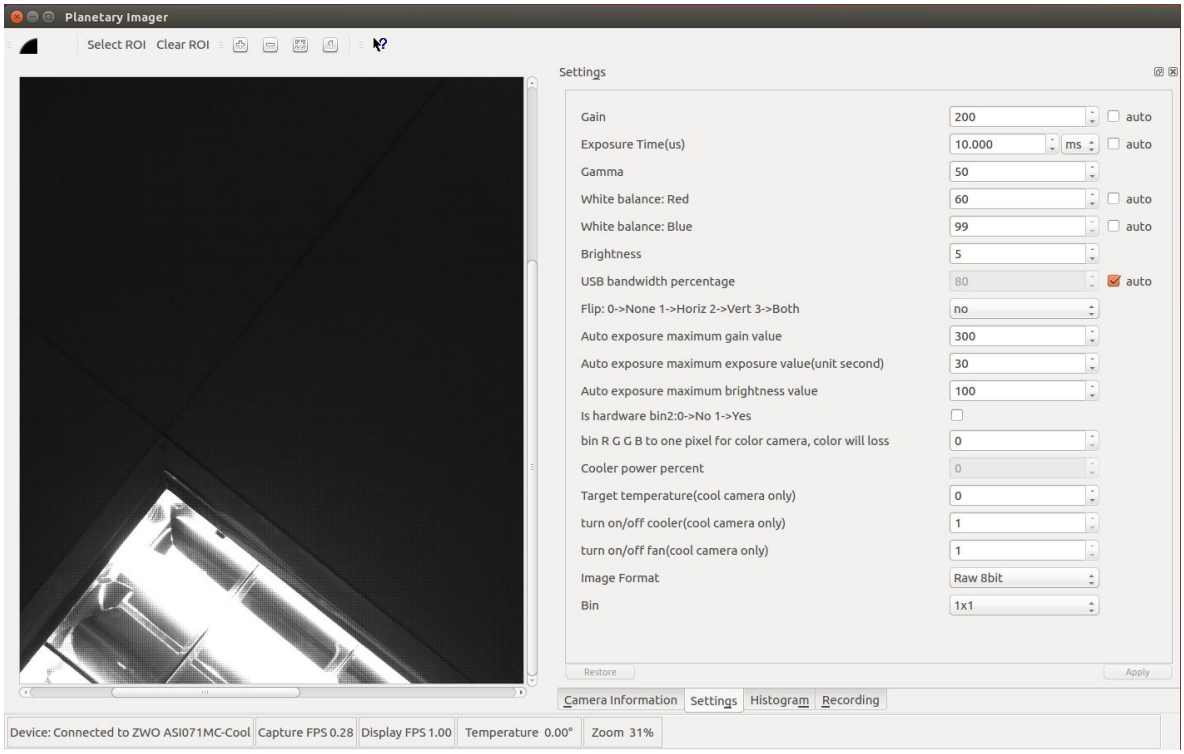
Cooling control
Click “camera” under “settings” menu, enable “Cooler” to start cooling, the temperature is shown at status bar.



2.2 Planetary Imager(Linux)

Software for planetary imaging. a simple, fast imaging software on Linux platform. (http://blog.gulinux.net/en/planetary-imager)

Camera Settings contains almost all the setting of ASI camera.



2.3 capture settings

Gamma: 50 is the default linear output data. This is the recommended setting. But you can use lower value to help focus when previewing. Always remember to return it to “50” before starting capture! Otherwise onion ring may be there after stacking and processing.

Gain: The higher the value, the more noise there will be. But it is often needed to be set high to achieve short exposures/faster frame-rates which can help to freeze seeing. Remember that faster FPS will result in more frames to stack which will dramatically reduce noise problems associated with High Gain.

Exposure: The shorter the value, the faster the fps achieved. Fps is usually calculated like this: fps = 1000 ÷ exposure time (in milliseconds, ms). For example, 20ms provides 1000 ÷ 20 = 50FPS.

But there are limits to USB bandwidth and the sensor’s capability. Usually 30-40 fps is a good choose for dim object like Saturn and you can achieve higher fps when capturing bright objects like Jupiter and Mars, Venus.

Brightness or Offset: This is an offset value added to the output data to avoid any data negative. You may need to turn it up for DSO imaging.

2.4 Get the best performance of the camera.

1. Connect the camera to USB 3.0 port.

ASI USB 3.0 cameras can run at its fastest speed when connected to USB 3.0 port. USB 3.0 has 10X faster speed than USB 2.0. So please make sure your camera is recognized as USB 3.0 device.

2. Adjust “USB Bandwidth” and “High Speed”.

80% is the default value and would be very stable for most computers. This control is called “USB Traffic”

You can try to turn it up to 100% gradually to reach the max speed. No drop frames and No bad frames, then it’s a good value.

Smaller resolution can run at the fastest speeds depending upon the exposure time you set (within certain resolution limits – you can also lower the resolution size if the image still fits in the screen window, and choose a faster fps by reducing exposure time).

High Speed: the camera will output 10bit ADC data if enable "High speed", otherwise 12bit ADC is used. The read noise of 10bit ADC is much higher than 12bit ADC, so you should NERVER check it for astronomy imaging.

*ASI120 & ASI120S cameras still use 12bit ADC when you turn on “high speed”

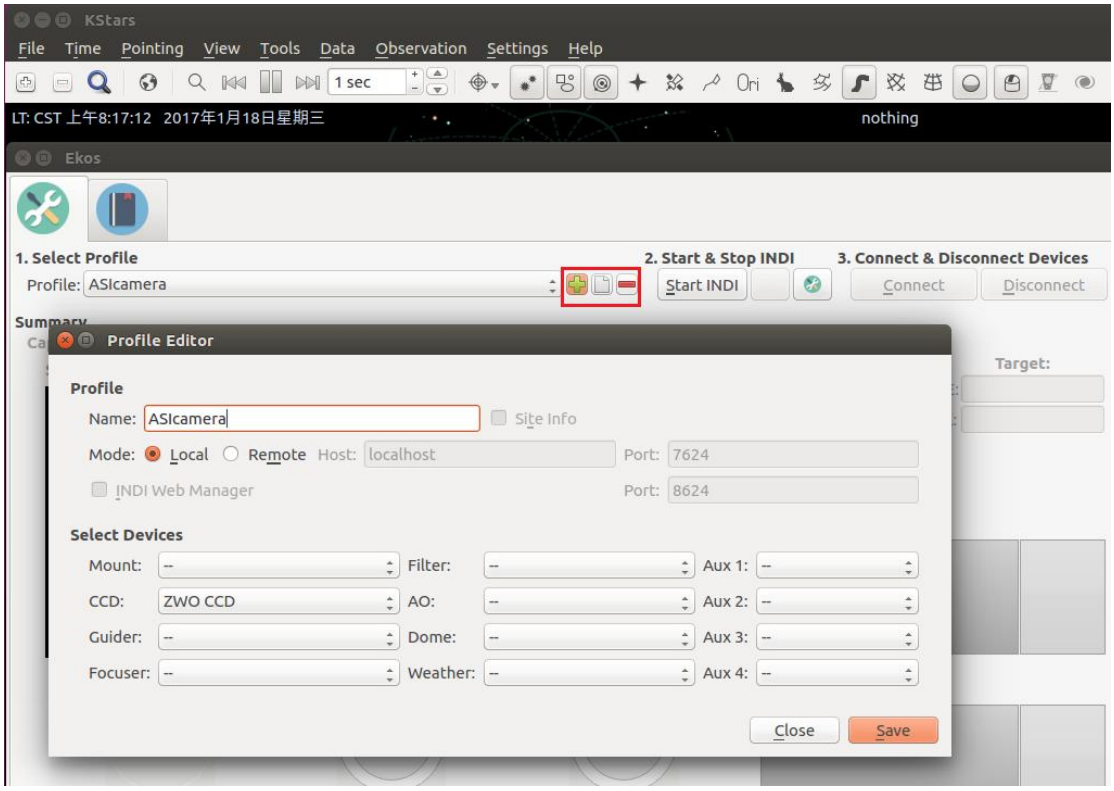
And DO NOT use any USB extension cable or USB hub which will affect the speed of fast image transfer.

3. DSO imaging softwares

The UI of some software is the same as that on Windows, so I use the screenshot on Windows.

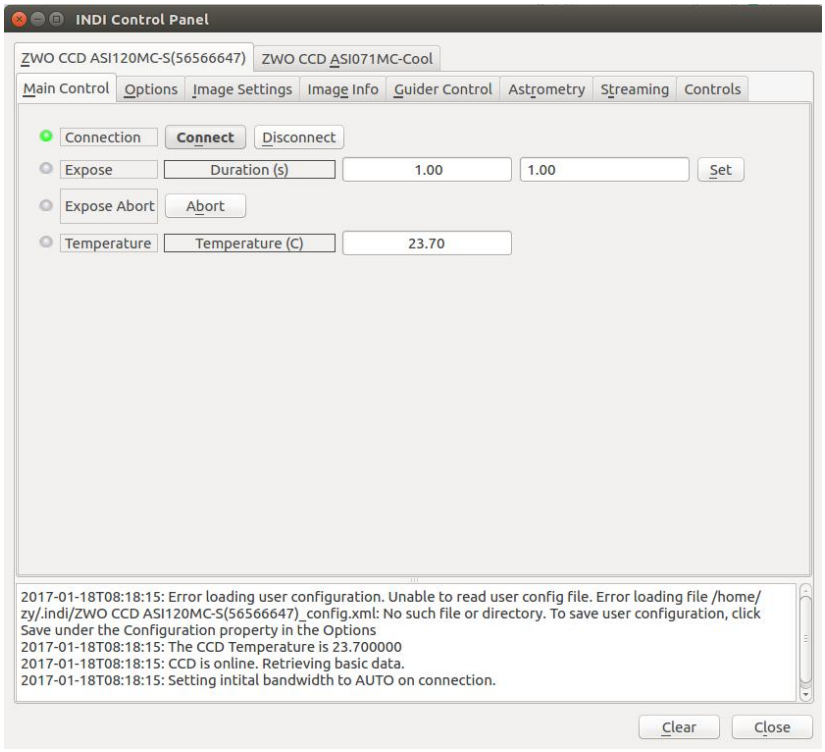
3.1 KStars(Linux /OSX)

control ASI camera through INDI Driver, here only show the base frame capture function.
Install Kstars and INDI driver as: http://www.indilib.org/download/ubuntu.html
Open Ekos panel from menu->Tools->Ekos
Edit a Profile, select “ZWO CCD” as CCD

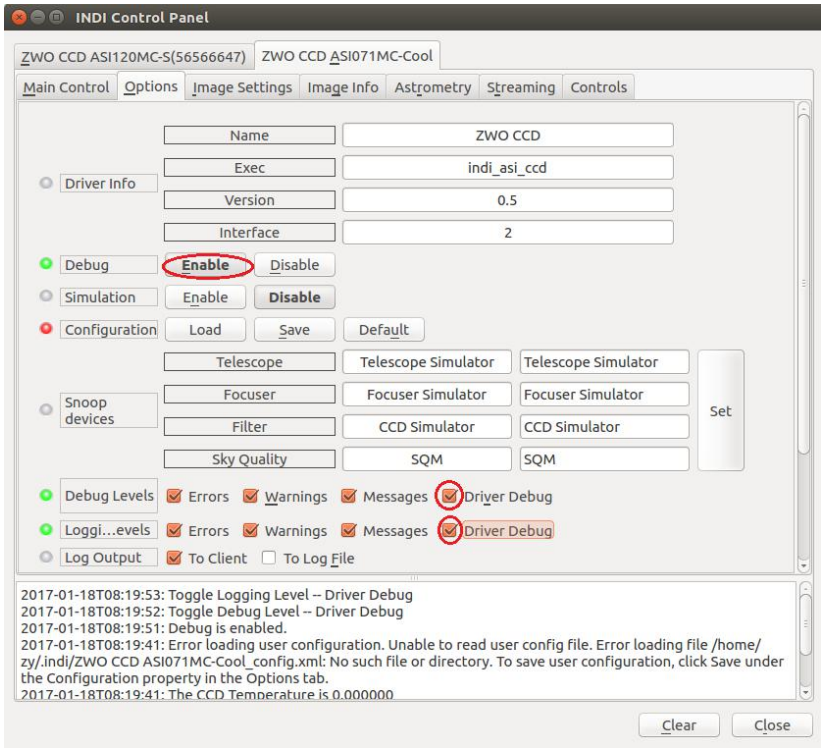


Click Start INDI and INDI Control Panel will show, afterwards you can click the right blank button to show the INDI Control Panel.

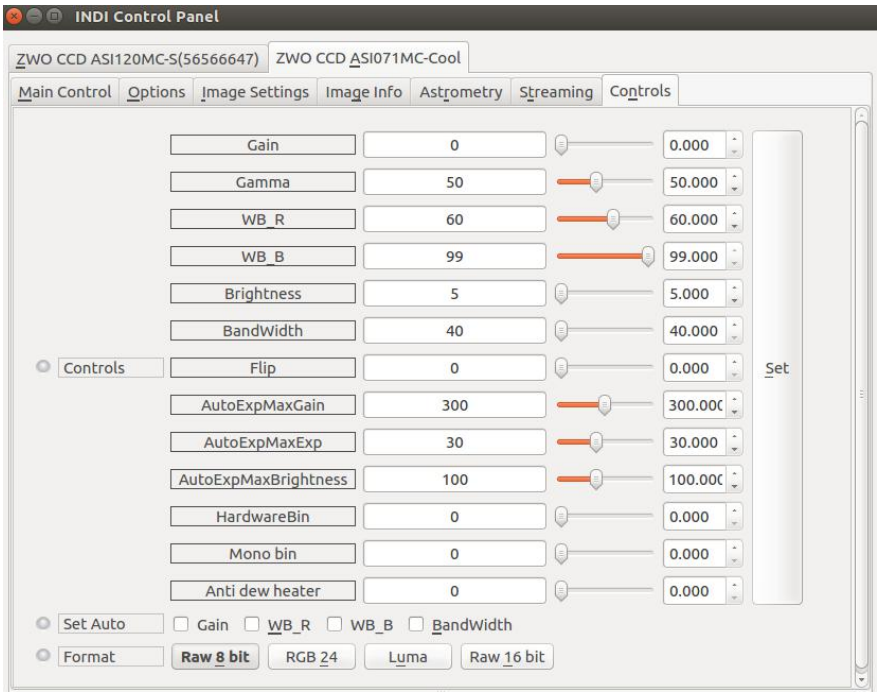
Connect camera



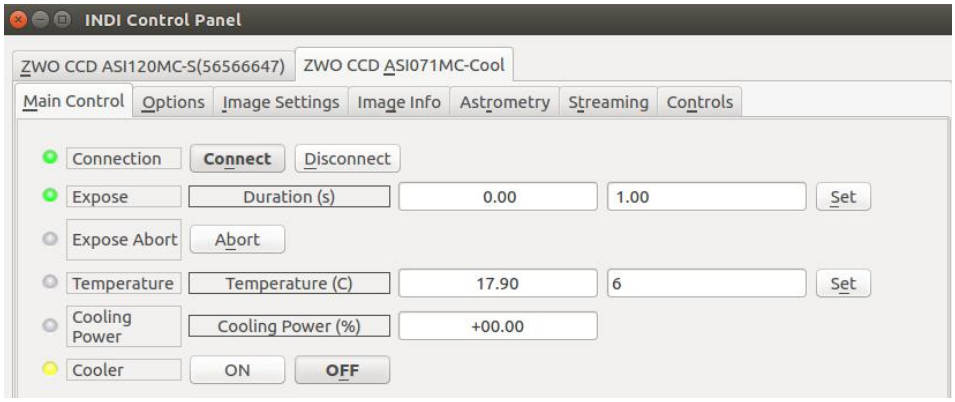
Enable debug, it can help to find bug



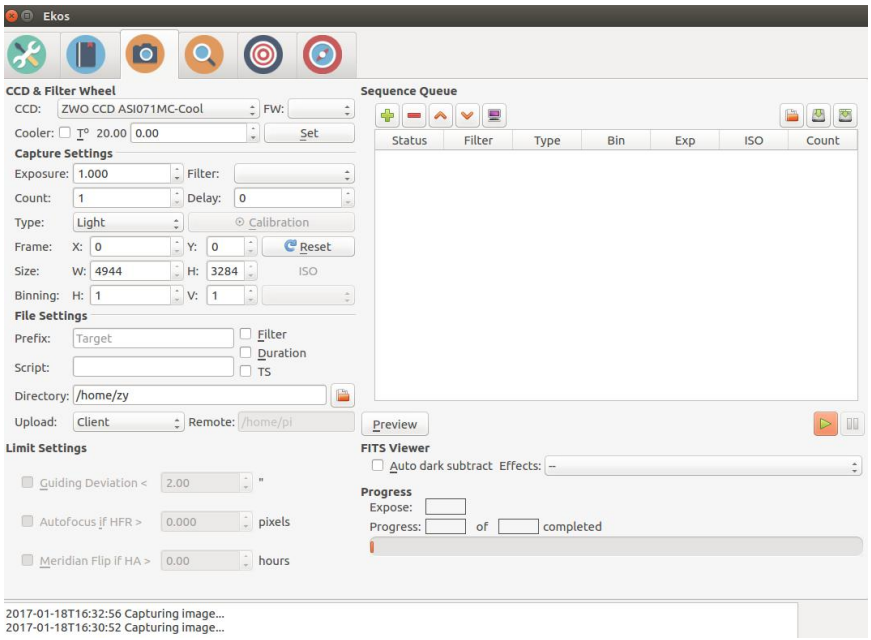
Camera controls page



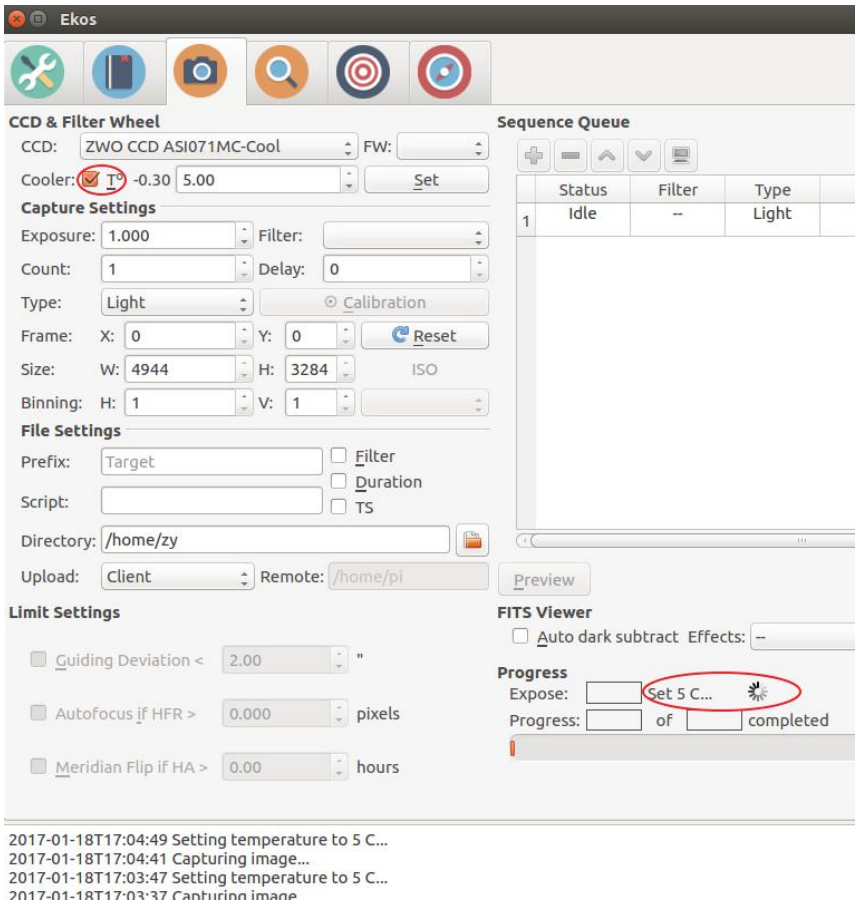
Cooling control is located in Main Control page



Open CCD page, click Preview to start a exposure.



If check the check box in “Cooler”, exposure will start only if sensor temperature reaches the set point.



You can also use INDIGO driver with ASI Camera and ZWO EFW (Linux and Mac OSX):

1. To install INDIGO see: http://www.indigo-astronomy.org/?for-users

2. Start the INDIGO server on the computer where the camera / filter wheel is connected

```
$ indigo_server indigo_ccd_asi indigo_wheel_asi
```

This should print some output and report the connected devices like this.

18:01:39.946533 indigo_server: INDIGO server 2.0-29 built on Wed Jan 18 01:19:26 2017

18:01:39.950404 indigo_server: Driver indigo_ccd_asi 2.0.0.1 loaded.

18:01:39.950460 indigo_server: Driver indigo_wheel_asi 2.0.0.2 loaded.

18:01:39.950468 indigo_server: Resource /ctrl (4349, text/html) added

18:01:39.969053 indigo_server: indigo_ccd_asi: 'ZWO ASI071MC-Cool #0' attached.

18:01:39.969706 indigo_server: XML Parser: parser finished

18:01:39.969715 indigo_server: Server home-desktop (7624) attached

18:01:39.969730 indigo_server: Server started on 7624

2. Use your favorite INDI client (Kstars, Astro Telescope, Astro Imager, Astro Guider, etc.) to connect to the INDIGO server. INDIGO shares the same port as INDI - 7624. You can also use a web browser (port 7624) to control the indigo server. See Figure X.

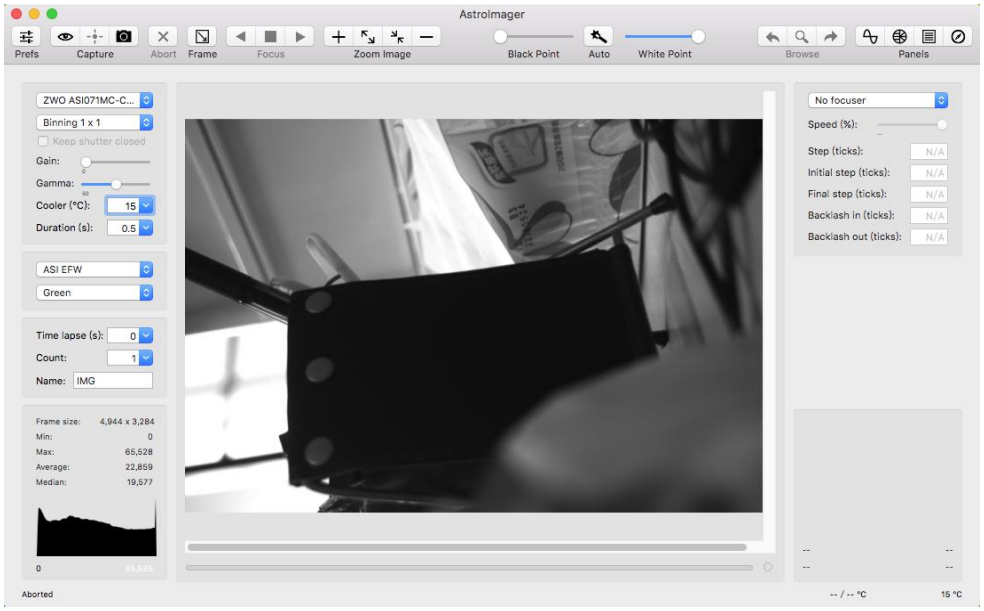
3.2 AstroImager (OSX)

AstroImager is a powerful, but easy to use image capture application for the astrophotography.

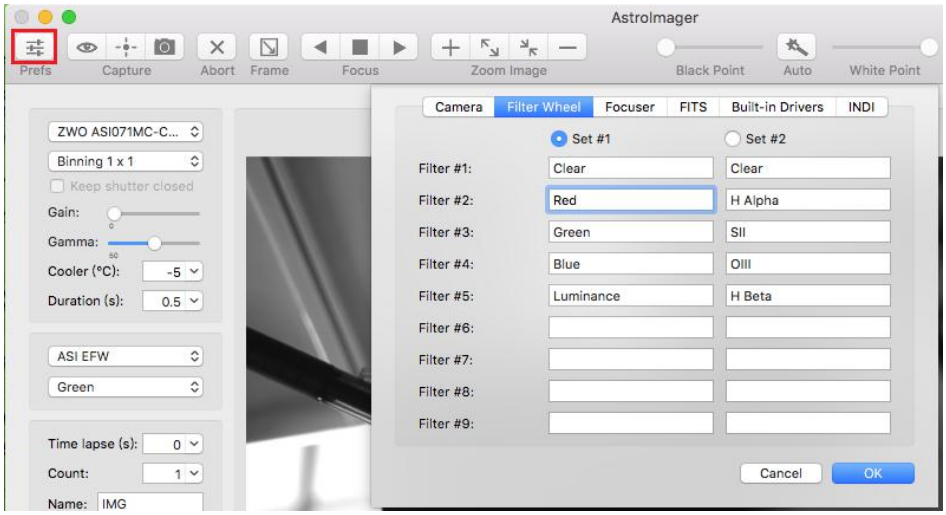
The built-in drivers support ASI USB 3.0 camera, EFW filter wheel, it can be used as a client to any remote or local INDI or INDIGO server with any supported CCD, filter wheel or focuser as well.(

http://www.cloudmakers.eu/astroimager/)

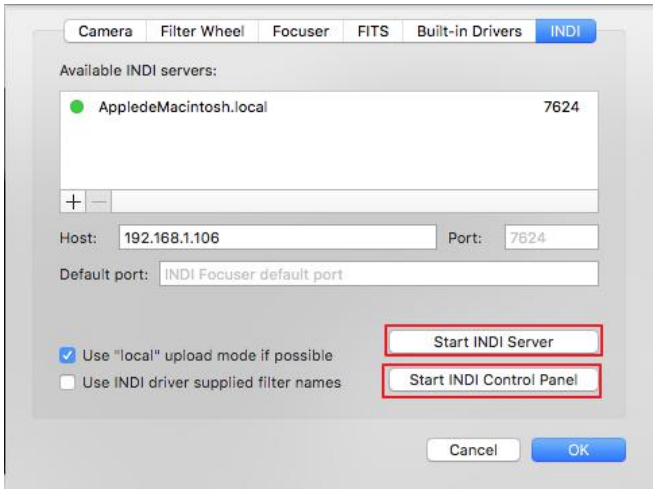
In below screen shot I select ASI camera and EFW filter wheel with build-in driver.



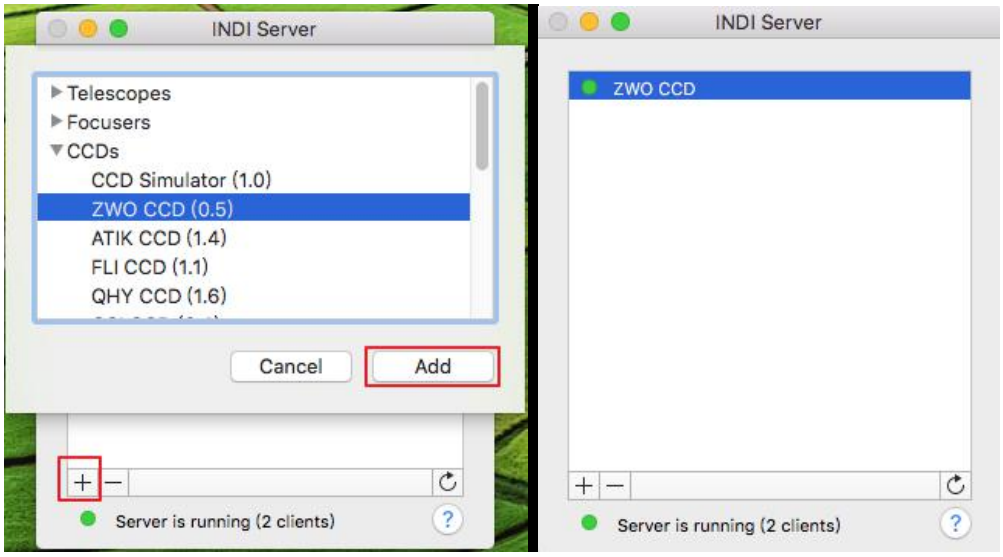
Edit filter wheel name in Preference dialog



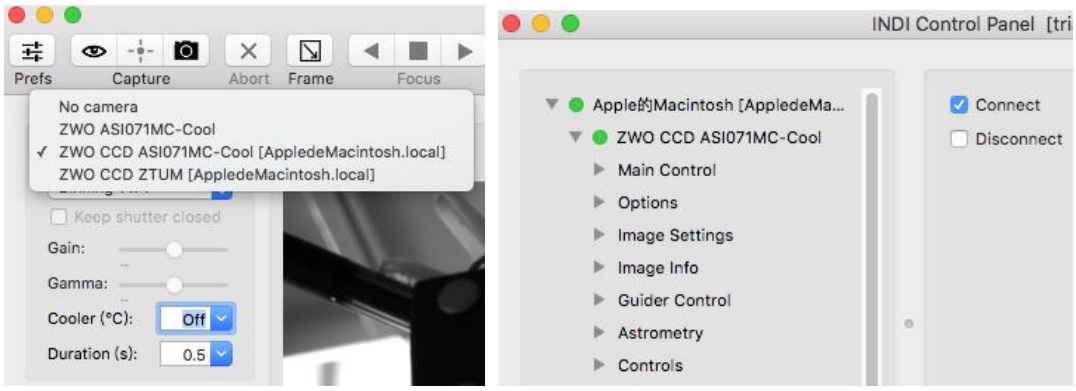
Now switch to connect ASI camera through INDI driver
Click Start INDI Server and Start INDI Control Panel (need Install INDI server & INDI Control panel)



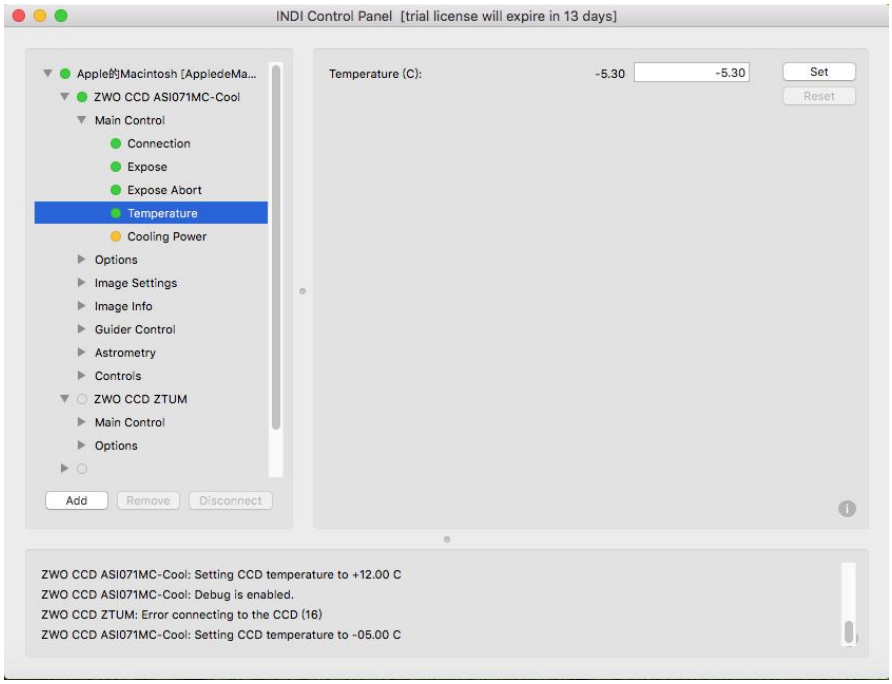
Add ZWO CCD driver



Select camera through INDI driver and the camera is connected



Now you can control camera



3.3 Nebulosity(OSX)

(http://www.stark-labs.com/nebulosity.html)
Using method please refer to manual for Windows

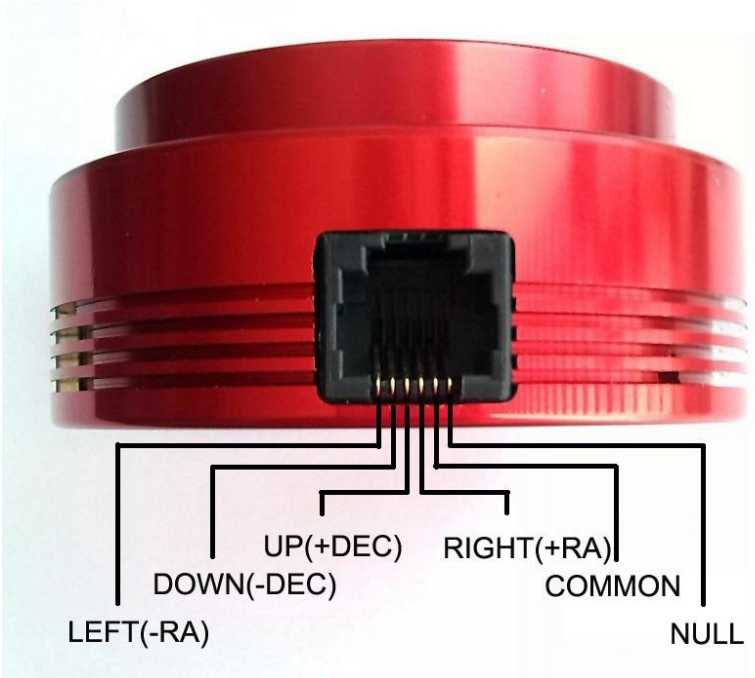
3.4 TheSkyX(Linux and OSX)

(http://www.bisque.com/sc/pages/TheSkyX-Professional-Edition.aspx)
Install TheSkyX :
TheSkyX Professional Edition for Linux, TheSkyX Professional Edition for Raspberry Pi is released newly.

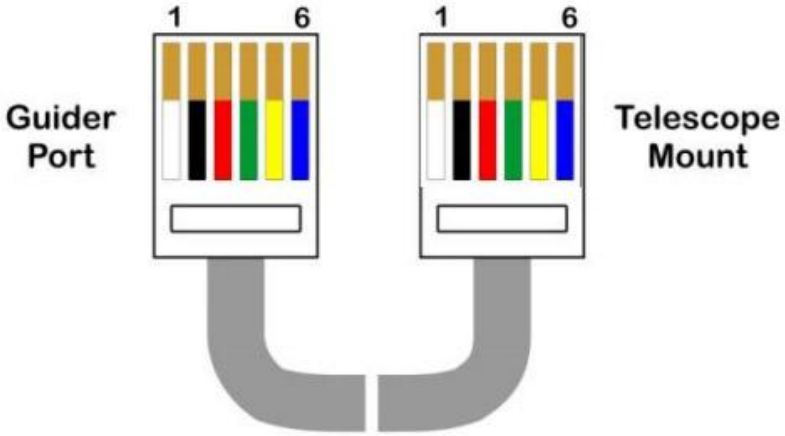
Install plug-in driver: download TheSkyX_ZWO_ASICamera.tar.gz from our website and extract, run “install.bin”, the plug-in installer suits for Linux and OSX.
Using method please refer to manual for Windows.

4. Auto Guider

ASI cameras which have a Guider Control Port can be used in conjunction with PHD or MaxIm DL to guide your mount for long time exposure imaging.
The image below summarizes how the Guider Port defines.



The connecting cable is a 6P6C telephone-style directly connecting cable.



4.1 Open PHD Guiding(Linux & OSX)

(http://openphdguiding.org/)
Using method please refer to manual for Windows

4.2 Lin_guider(Linux)

(https://sourceforge.net/projects/linguider/)
1. Video hardware setup

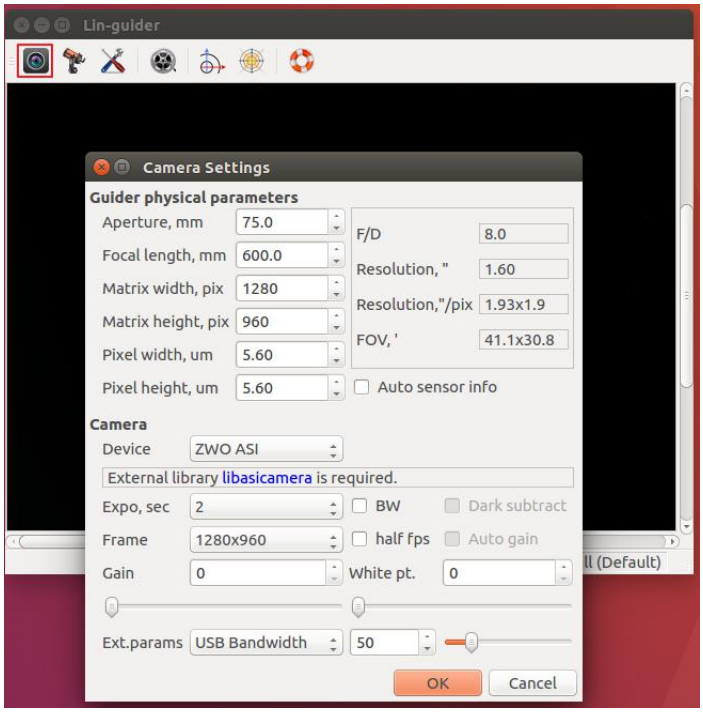
Open the dialogue box 'Camera Settings' in the toolbar.
Set the physical parameters of the guider telescope. It is advised to check "Auto sensor info" this will get the sensor parameters from the camera driver.
Then it is necessary to specify the video device you will work with. To do this, you should select device in dropdown list 'Device' and restart the program in order to establish the connection to the selected device.

The image from the video device must appear after the restart. In this case, you can proceed with the setup of the guider actuator.
If the device initialization was not successful and the error window was displayed, you should check the console log for more detailed information.

You may also need to specify the exposure time and the size of the captured image. You can also set parameters such as 'Gain', 'White point' (if they are available).

You can switch the 'Dark subtract' parameter on, if you are planning to calibrate guiding frames with a dark frame.

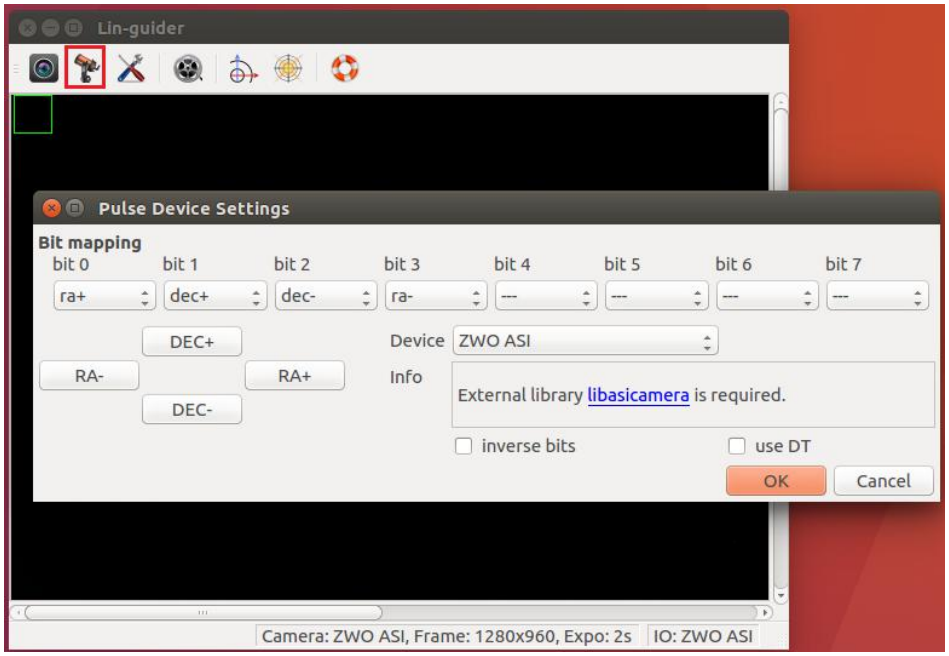
Note: You may need to install libASIcamera by following the link given in the info field.



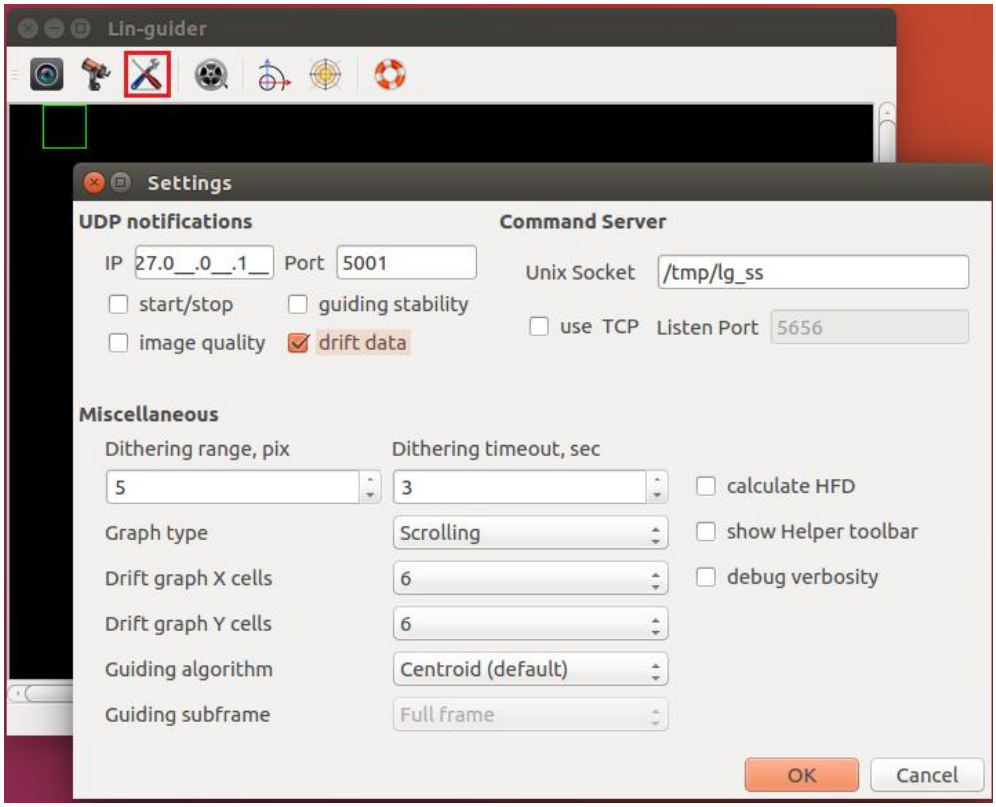
2. Guider setup

Open the dialogue box 'Pulse Device Settings' in the toolbar then choose the device to work with from the dropdown list.
Then you should restart the program in order to connect to the selected device.
If all went right, the program would start without pulse driver error messages.
If the box with the pulse driver initialization error message appeared, you should check the console log for more details.

If the launch is successful, open the dialogue box 'Pulse Device Settings' and check that the guiding device functions properly. By pressing test buttons RA+-, DEC+- in the dialogue box to your mount should react accordingly. In case the mount does not react as expected you can remap the signals in this window.



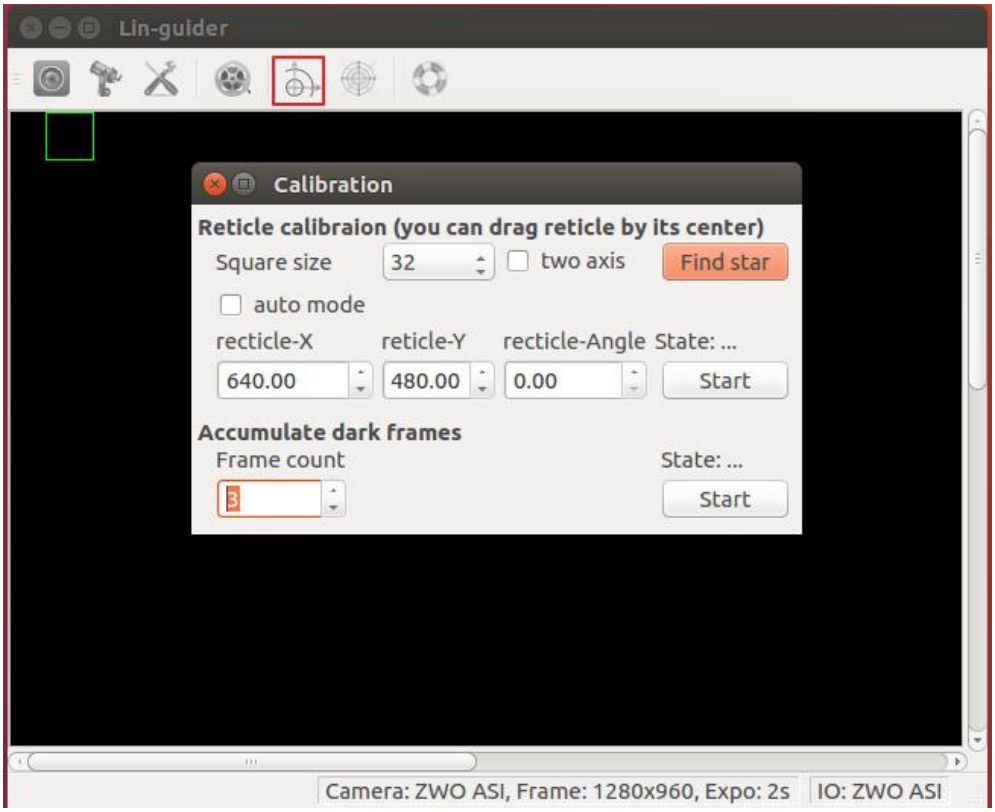
Make sure "Drift data" is opened, otherwise you can't see any curve. Dithering range, usually 5 pixels is enough.



3. Calibration

It is necessary to calibrate lin_guider before the start of the guiding. To do this

you have to complete at least one procedure - determination of the orientation of the celestial reference frame in the image, taken from the camera. In addition, it is advisable to perform camera calibration with the dark frame.



3.1. Determination of the orientation of the celestial reference frame

Direct your guide to the star you'd like to use for guiding. Make sure that the star isn't near the image edge. Focus the image. Make sure that all mountings are tightened and the wires do not hang freely. Open the dialogue box 'Calibration'. Use the 'Two axes' parameter to choose the two-axes or one-axis calibration. If the polar axis is well aligned, it is recommended to use the automatic mode of calibration - parameter 'auto mode'.

3.1.1. Automatic calibration

Set time in seconds during which the drift along axes will be performed. Grab the green square by the mouse pointer and drag it over the guiding star. Make sure that the square follows the star. Press the button 'Start'. The program will start to move the star along one or two axes. The result will be shown at the end of calibration. 'Status: DONE' will be shown in the case of successful completion and the axes of reference will be in the newly calculated position. In case of an error, a window with an error message will be shown. If the polar axis is poorly aligned, the automatic calibration may be terminated with an error.

3.1.2. Manual calibration

If the automatic calibration doesn't suit for any reason or terminates with an error, you can perform manual calibration. To do this, grab the green square by the mouse pointer and drag it over the guiding star. Make sure that the square follows the star. Press the button 'Start'. Then use the mount control panel to shift the star position in RA+ direction and press 'Stop'. If the two-axes mode is engaged, use the control panel to shift the star in the DEC+ direction and press 'Stop' right after the end of the drift along RA. It is important to understand that the bigger the move is, the more precise the determination of the celestial coordinates' axes will be. It is recommended, that the square, following the star, doesn't touch the image edges during the calibration.

3.2. Dark frame calibration.

In order to calibrate the camera with a dark frame, select the number of frames to accumulate in the field 'Frame count'. Cover the guide objective to prevent light from penetrating the camera and press the 'Start' button. At the end of the process a master frame will be formed, that will be subtracted from every new frame, taken from the camera, if the 'Dark subtract' parameter is chosen in the Camera setup.

4. Guiding

You can start guiding after the celestial orientation is determined (see. Calibration). Open the 'Guiding' window and set the proper value in the "Guiding rate" field.
For centroid Guiding Set the appropriate size of the square, following the star - 'Square size'. The square area shouldn't be too small or too large, compared to the visible size of the star.
Choose the threshold algorithm, used to calculate the star position, 'Threshold alg.' The 'Smart' is recommended. Next you have to specify parameters in the 'Control' block. All parameters are defined separately for each axis RA and DEC. These parameters are:

1. Enable directions - enables or disables the use of calculated axis corrections. All is enabled by default.
2. Accumulate frames - enables the averaging of the coordinate values, using N frames, and the transfer of corrections at the end of the averaging. Set to 1 by default.
3. Proportional gain - is the coefficient of the proportional term in the PID control. May be precalculated in the 'Info' block by default.
4. Integral gain - is the coefficient of the integral term in the PID control. Set to 0 by default.
5. Derivative gain - is the coefficient of the differential term in the PID control.

Set to 0 by default. (disabled in this version)

6. Maximum pulse - the maximum duration of the correction pulse. Limited by the specific type of the actuator. Set to 5000 ms by default.

7. Minimum pulse - the minimum duration of the correction pulse. Set to 100 ms by default.

8. Avg.frm. - disabled.

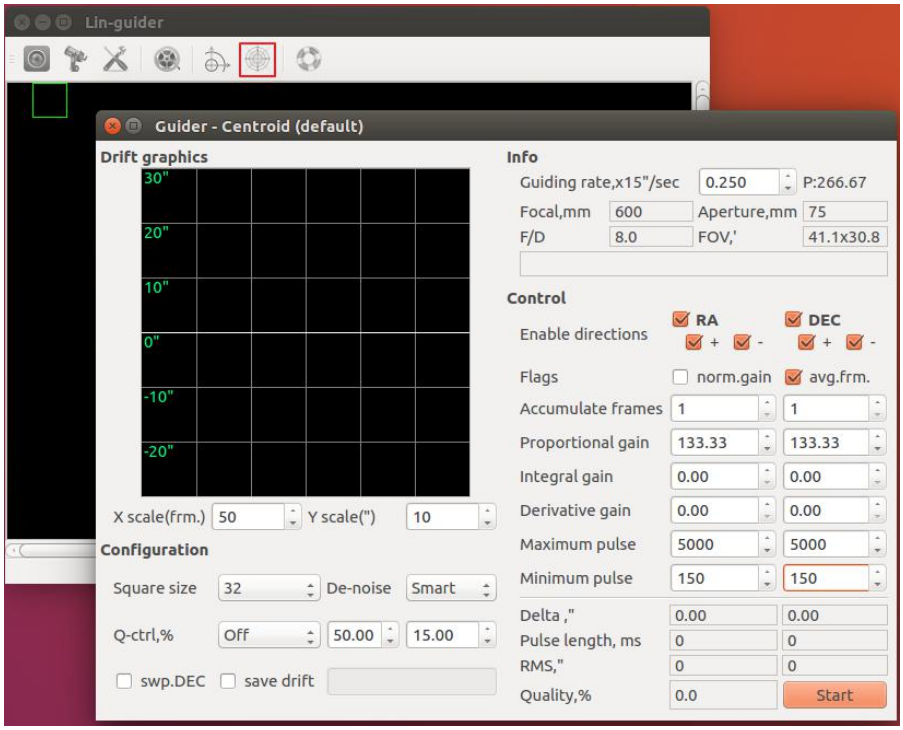
The PID control coefficients adjustment should by performed empirically, using the specific equipment at full load. The idea of the adjustment is to find coefficients that don't lead to 'under-guiding' (corrections are too slow) or 'over-guiding' (oscillations around the target). It is advised to check "Normalize gains". In this case PID coefficient of 1 means full correction. In most cases Integral and Differential gains can be kept 0.

If the polar axis is well aligned, then the DEC axis guiding can be performed rarely, every 2-4 frames. This will avoid excessive movement of the axis and unnecessary vibrations. It is also recommended to introduce small imbalance (overweight) against the tracking on the RA axis in order to have a small amount of constant tension to avid the backlash.

The value of 'Maximum pulse' is usually chosen more or less equal to the period of the working cycle (time between two successive camera data captures). Usually there is no need to change this value. The 'Minimum pulse' value is of more importance. This parameter defines the threshold of the correction duration. If the calculated correction is more or equal to 'Minimum pulse', it is transfered to the mount, otherwise the correction is discarded. If the threshold is too large, then the non-adjustable band of deviations around the zero value will be too wide and the quality of guiding will be too low. If the threshold is too small, then the amount of corrections around the zero value will be very large, leading to constant axis twitching in opposite directions and, as a consequence, badly controlled oscillations. This is particularly important for high load setups with low mechanical stiffness.

You can also save guiding logs in text files with the aid of the guiding dialogue box. To do this, you have to set the check box 'save drift' to checked and specify the file name in the 'Configuration block'. The file format is a plain text with two columns with numbers - deviations along RA and DEC.

Lin_guider has two guiding algorithms selectable in the Settings window. 'Centrod' - used for guiding on a single star and 'Donuts' - capable of guiding on full frame using many stars. DONUTS works well in high turbulence effectively dampening the scintillation and is capable of guiding on defocussed stellar images.



4.3 AstroGuider(OSX)

(http://www.cloudmakers.eu/astroguider/)
Using method please refer to its manual

5. Live Stack Software

5.1 AstroLive USB(OSX)

http://astrolive.io/astroliveusb.html