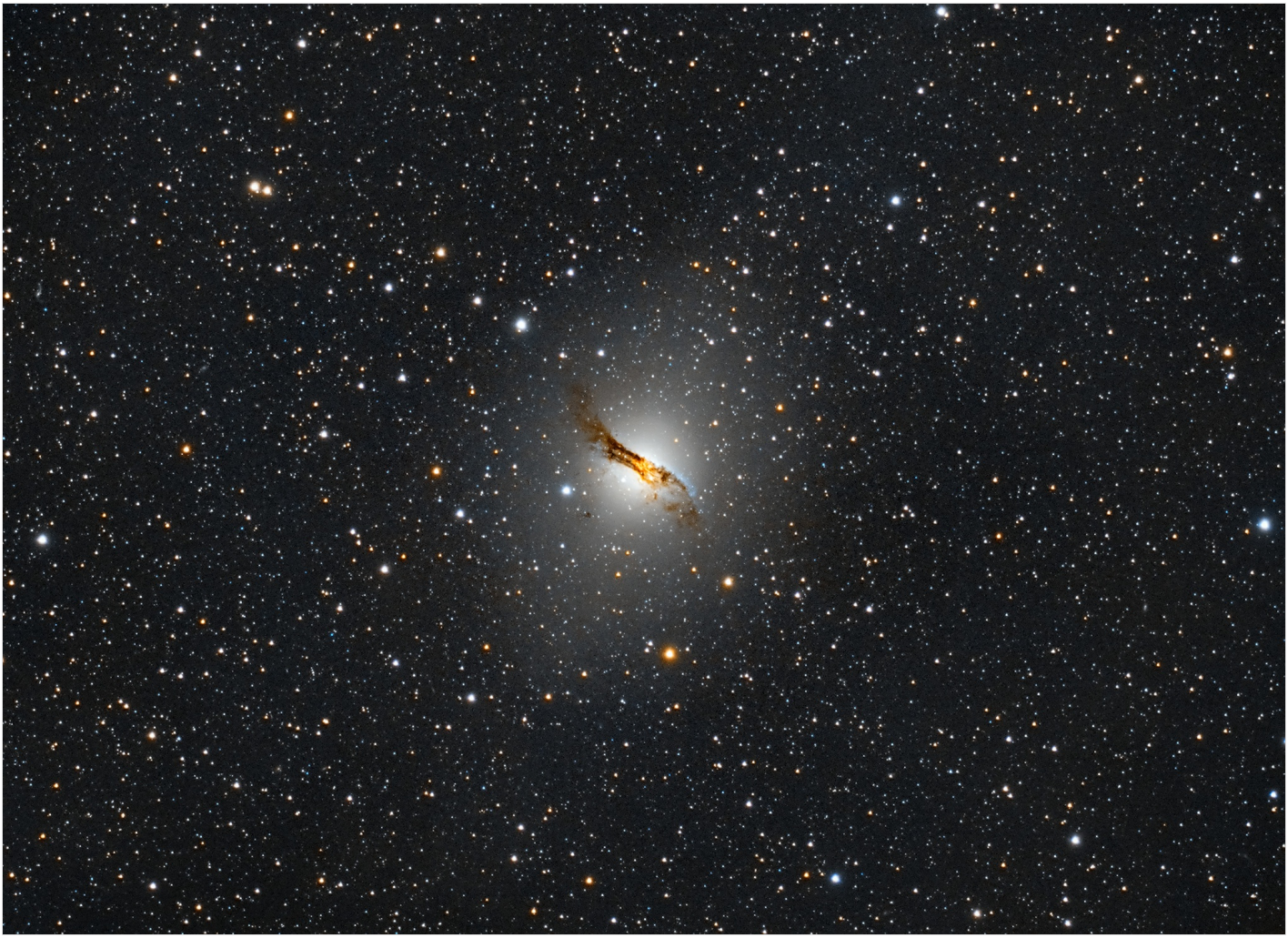
Sample Images



Centaurus A

By Amit Ashok Kamble, QHY294M Pro

Overview

The new QHY294 Pro is a 4/3-inch back-illuminated camera, equipped with Sony IMX294 (Color) and IMX 492 (Mono) sensor. The 294 Pro has 11.7 MP at 4.63um, 14-bits A/D. The IMX294 and IMX492 chips have 46.8 million 2.315um pixels, which Sony 2×2 bins on-chip to create the sensor's advertised 11.7 million 4.63um pixel array. The QHY294 Pro series camera is capable of locking and unlocking the on-chip binning to provide two readout modes. The first mode reads the sensor "locked" mode to produce 11.6mp images with 4.63um pixel size and 14 bits per pixel. The second read mode unlocks the binning to produce 46.8mp images with 2.315um pixel size at 12 bits per pixel.

The QHY294 Pro CMOS sensor has a dual gain mode, HGC (high gain) and LGC (Low gain). The QHY294 Pro will switch the two modes automatically when the gain is set to 1600 you will get the benefits of the ultra low read noise (1e- to 1.6e-) of the HGC mode and a full well capacity of about 14.5ke- at the switch point setting.

BSI

One benefit of the back-illuminated CMOS structure is improved full well capacity. In a typical front-illuminated sensor, photons from the target entering the photosensitive layer of the sensor must first pass through the metal wiring that is embedded just above the photosensitive layer. The wiring structure reflects some of the photons and reduces the efficiency of the sensor.

In the back- illuminated sensor the light is allowed to enter the photosensitive surface from the reverse side. In this case the sensor's embedded wiring structure is below the photosensitive layer. As a result, more incoming photons strike the photosensitive layer and more electrons are generated and captured in the pixel well. This ratio of photon to electron

production is called quantum efficiency. The higher the quantum efficiency the more efficient the sensor is at converting photons to electrons and hence the more sensitive the sensor is to capturing an image of something dim.

TRUE RAW Data

In the DSLR implementation there is a RAW image output, but typically it is not completely RAW. Some evidence of noise reduction and hot pixel removal is still visible on close inspection. This can have a negative effect on the image for astronomy such as the "star eater" effect. However, QHY Cameras offer TRUE RAW IMAGE OUTPUT and produces an image comprised of the original signal only, thereby maintaining the maximum flexibility for post-acquisition astronomical image processing programs and other scientific imaging applications.

Anti-Dew Technology

Based on almost 20-year cooled camera design experience, The QHY cooled camera has implemented the fully dew control solutions. The optic window has built-in dew heater and the chamber is protected from internal humidity condensation. An electric heating board for the chamber window can prevent the formation of dew and the sensor itself is kept dry with our silicon gel tube socket design for control of humidity within the sensor chamber.

Cooling

In addition to dual stage TE cooling, QHYCCD implements proprietary technology in hardware to control the dark current noise.

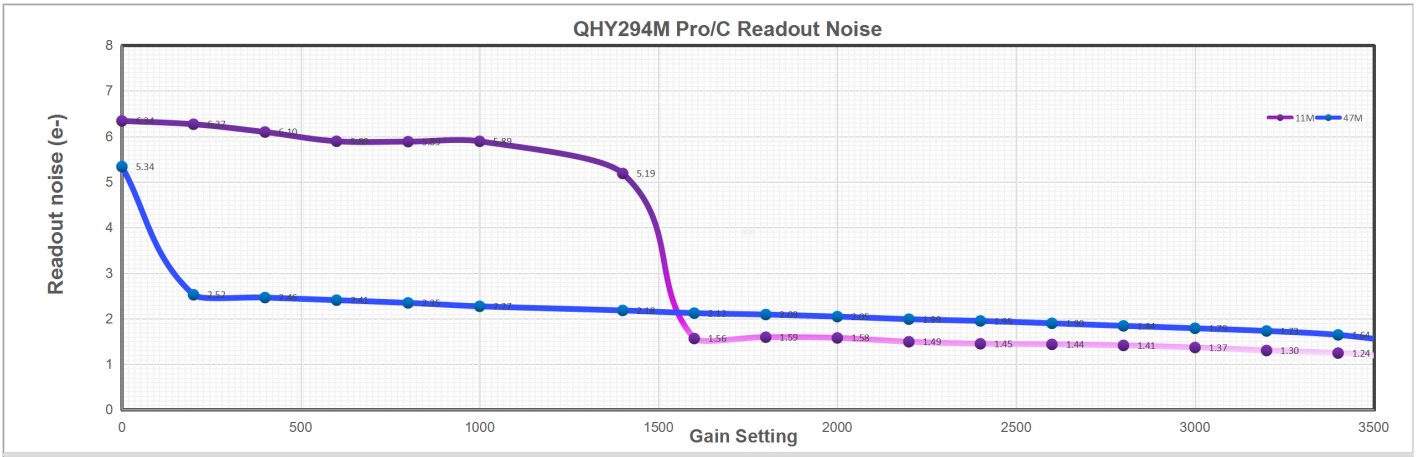
Specifications

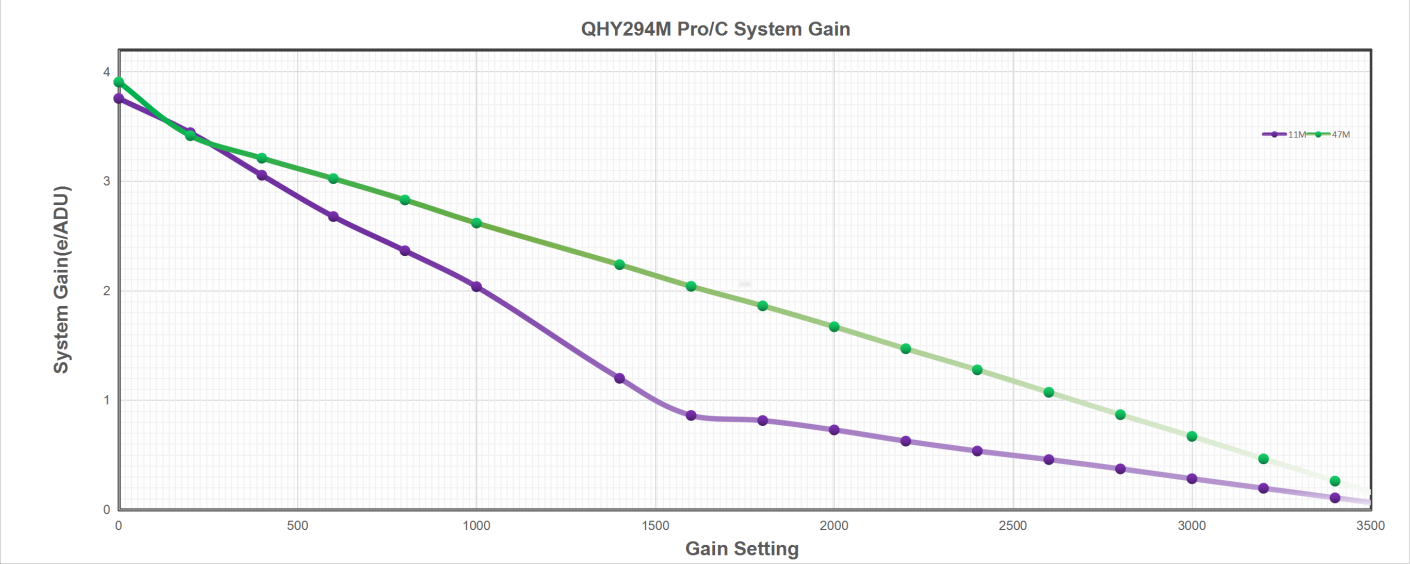
Model	**QHY294M Pro** **QHY294C Pro**
COMS Sensor	SONY IMX492 MONO SONY IMX294 COLOR
Mono/Color	Both
FSI/BSI	BSI
Pixel Size	4.63um*4.63um
Effective Pixel Area	4164*2796
Effective Pixels	11.7MP 46.8MP Extended Pixel Mode
Sensor Size	4/3 inch 19.28mm*12.95mm

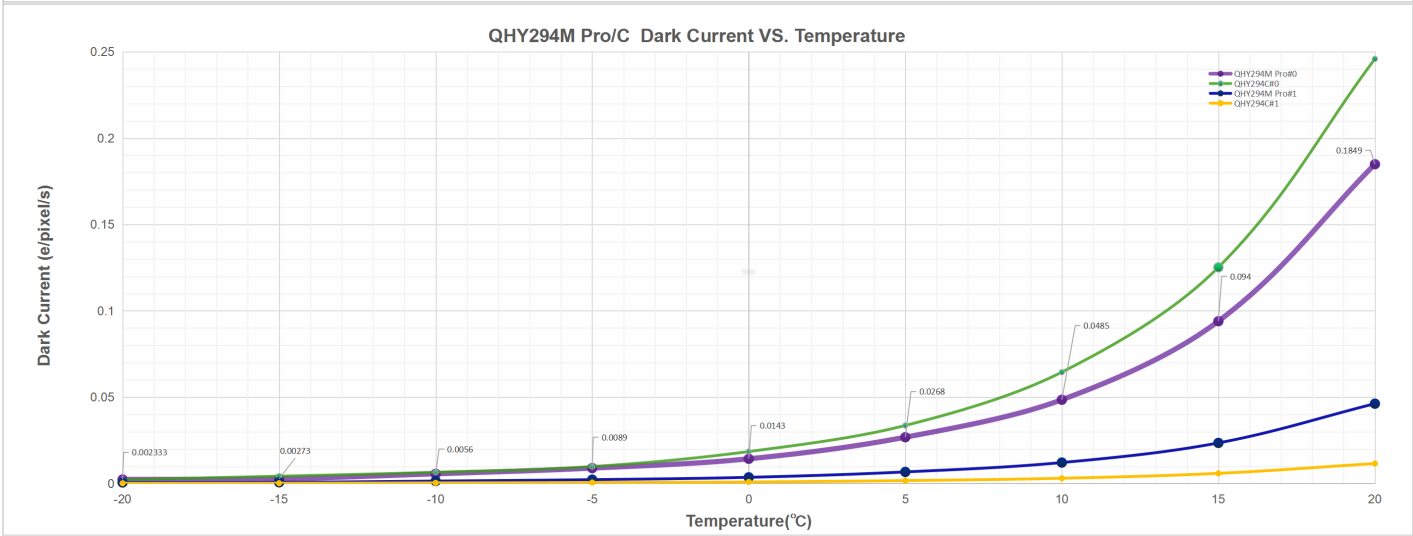
AD Sample Depth	14bit
Fullwell	65ke-
Full Frame Rate	Standard 11.6mega pixel mode 4164*2796 16.5FPS@14BIT 2160lines(eg.4164*2160,4096*2160) 21FPS 1080lines(eg.4164*2160,1920*2160) 41FPS 960lines(eg.4164*960,1280*960) 46FPS 768lines(eg.4164*768,1024*768) 56FPS 480lines(eg.4164*480,640*480) 87FPS 240lines(eg.4164*240,320*240) 156FPS 100lines(eg.4164*100,240*100) 290FPS “Unlock” 47mega pixel mode 8340*5644 4FPS@14BIT and 8BIT *Note QHYCCD has optimized the cmos drive freqency and limit the max frame rate. The CMOS sensor may not work under the maxium frequency to ensure the better noise performance. If you need the customized higher frame rate version please contact QHYCCD.
Readout Noise	1.6-1.2e- High gain mode 6.9-5.2e- Low gain mode
Dark Current	0.002e/pixel/sec @-20C 0.005e/pixel/sec @-10C
Exposure Time Range	60us-3600sec
Unity Gain	1600 (11MP Mode) 2600 (47MP Mode)
Hardware Anti-Glow Reduction	Yes. Can reduce the amp glow of the sensor in long exposure.
Shutter Type	Electric Rolling Shutter
Computer Interface	USB3.0
Built-in Image Buffer	256MByte DDR3 Memory
Cooling System	Dual Stage TEC cooler about -35C below ambient (Test temperature +20°)
Optic Window Type	AR+AR High Quality Multi-Layer Anti-Reflection Coating (For color camera user need to add a UV/IR filter in the light path)

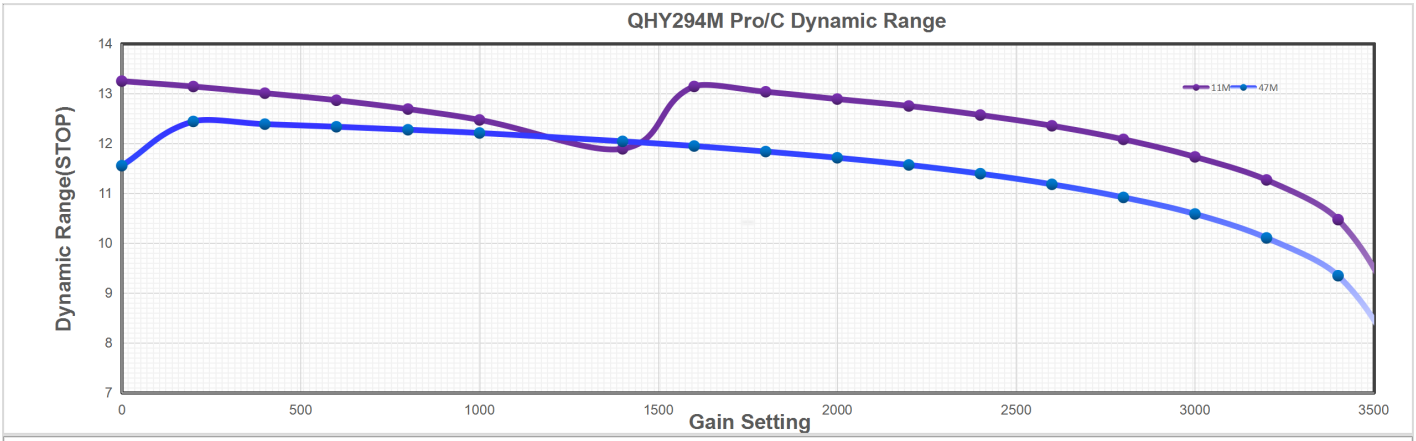
Anti-Dew Heater	Yes
Telescope Interface	M42/0.75
Back Focal Length	17.5mm
Weigth	650g

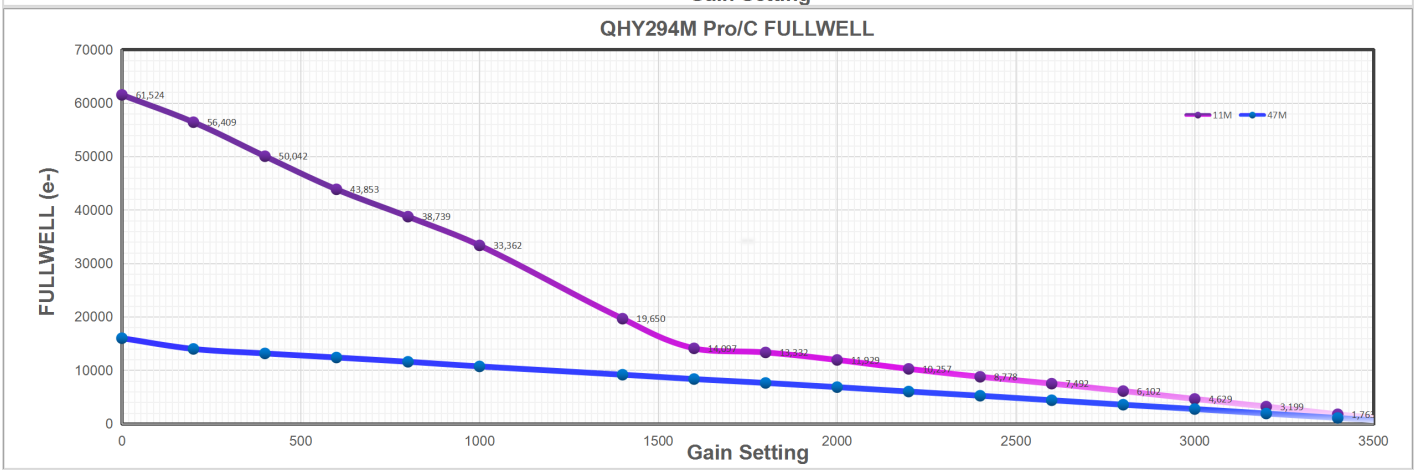
Curves



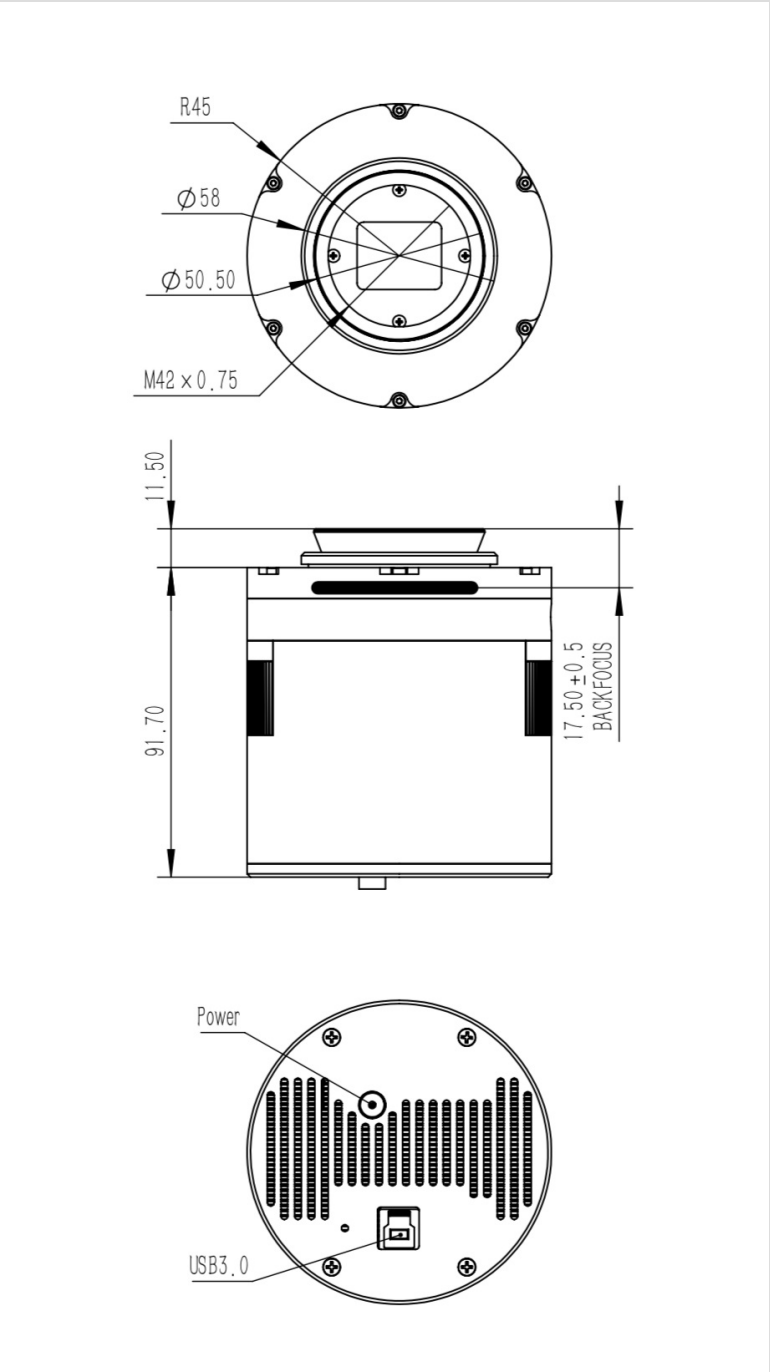








Mechanical dimensions



User Interview

User Interview Justin P's Astrophotography Story

User Interview Amit Kamble's Astrophotography Story

Accessories, Combos and Adapters

Combos and Adapters

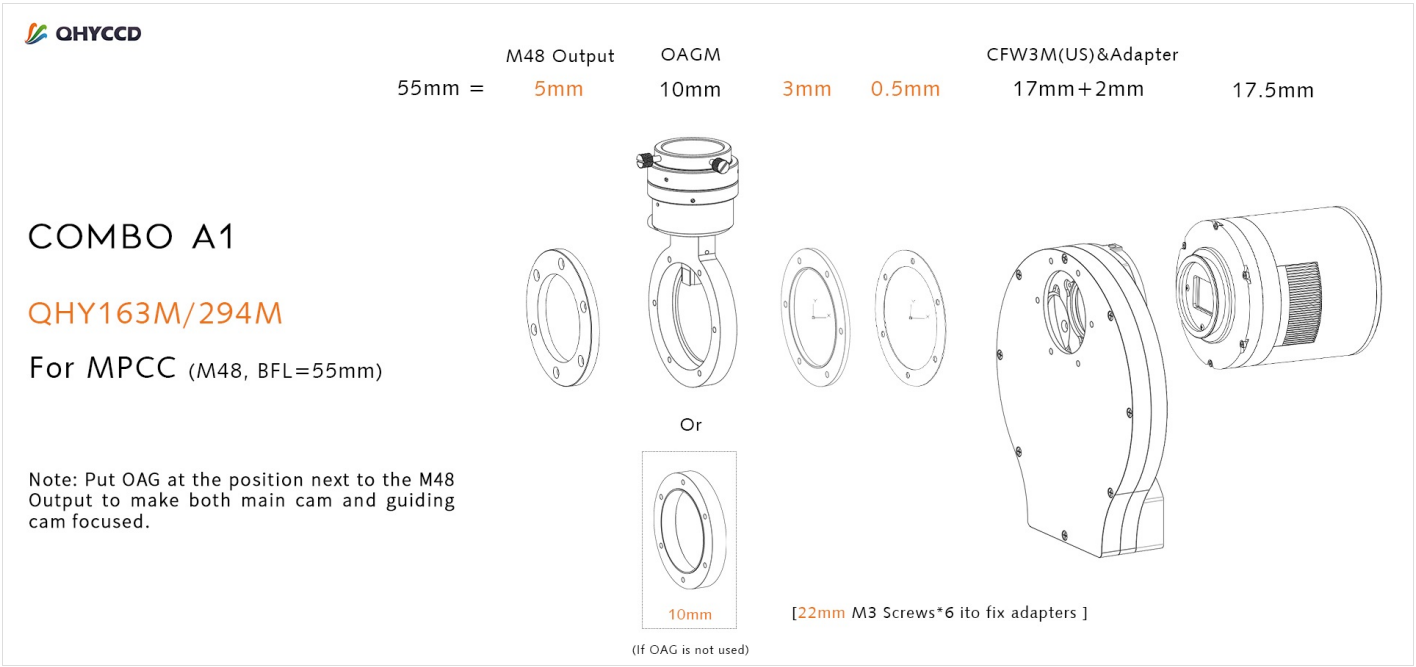
For cameras with a sensor larger than 1-inch and smaller than APS-C (QHY163m/294m) we recommend a combination of CFW3M (US) + OAGM (optional);

Model	BFL Consumed	Filters Supported
QHY163M/294M	17.5mm	7 position 36mm unmounted
CFW3M-US	17.5mm	
OAGM	10mm	

Back Focal Length (BFL), in the commercial camera field, refers to the design distance from the center of the rear lens element to the surface of the sensor. Generally, the lens will only focus correctly at infinity if the camera's back focal length meets the standard requirements provided by the lens manufacturer. This is also true for many Multi-Purpose Coma Correctors designed to be used on telescopes before the camera.

Optical system	Back focal length required
Typical Multi-Purpose Coma Corrector	55mm – 57.5mm
Canon 35mm lens	44.1mm
Nikon 35mm lens	46.5mm

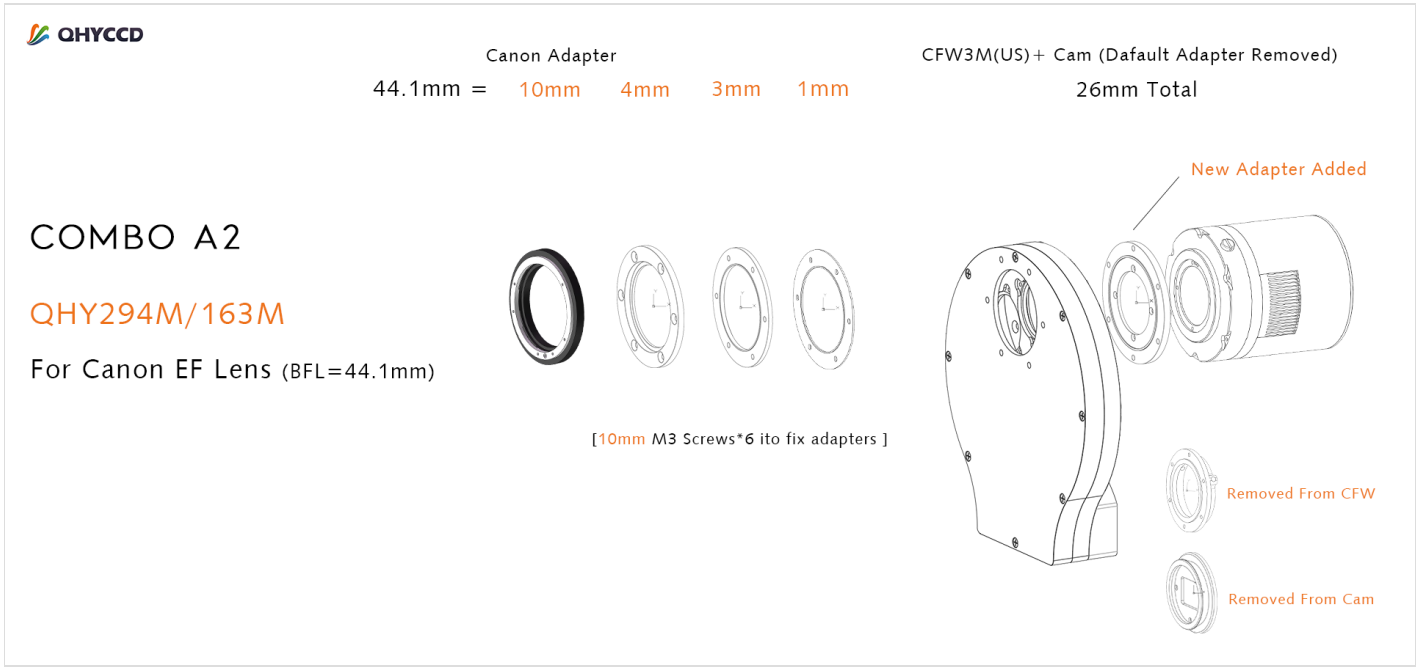
A1: Connecting MPCC that requires 55mm BFL and M48 interface to Camera with Filter Wheel and OAG



Note:

1. If you only own CFW3M-SR whose BFL is 20.5mm rather than 17.5mm, this adapter combination can still be used, just remove the 3mm and 0.5mm adapters.
2. If your MPCC requires a BFL different from 55mm, this adjustment can be made by selecting the appropriate spacer between the MPCC and the OAG. For example, an MPCC that requires 57.5mm can be used instead by adding a spacer ring or rings that add 2.5mm of BFL. to the diagram above.
3. If you don't use an OAG, you can use a 10mm spacer adapter in the adapter kits to replace the original position of OAG.
4. Put OAG at the position next to the M48 Output to make both main cam and guiding cam focused.

A2: Connect Canon lens with filter Wheel



Note: You need to remove the filter wheel and the original connection interface of the camera and replace it with a new adapter.

A3: Connect Nikon F Lens to Camera with Filter Wheel

User Guide: Start the Camera

Before Start: Install "All-In-One" Pack

All-In-One Pack Driver, SDK and Software) for WINDOWS supports all QHYCCD USB3.0 devices only except PoleMaster and some discontinued CCD cameras. Please go to https://www.qhyccd.com/download/ and install it.

Note:

- Since most of the contents of All-in-one package are plug-ins that support third-party software, **the third-party capturing software that you want to use must be installed before the All-in-one package.** Otherwise the program will report an error.
- **ALL-IN-ONE Pack contains:**
  - **System Driver,** which is necessary for camera operation and must be installed.
  - **WDM Broadcast Driver**, which can provide a live signal to Obs and other live software, you can install it if you have such needs like opeing a live show.
  - **EZCAP_QT** , which is developed by QHYCCD and can be used in QHY devices tests, and management of updates. So even if you won't use EZCAP_QT for capturing, we suggest you install it.

    - **Ascom driver** needs to be sync with the ascom platform version you installed (the latest version of Ascom is 6.5)
    - **The two sorts of Ascom CFW Drivers** correspond to two methods of controling the filter wheel: USB control and camera serial control. It is recommended that both drivers should be installed if you have a filter wheel.
    - **CP210X_VCP** is a serial driver. Some computers come with the driver, but the computer without the driver may be failed of controling the filter wheel.
    - **SDKs for Third-party Software**: Just pick and install the corresponding SDK according to the software you want to use. Don't forget to check whether the software you are using is 32-bit or 64-bit and select the right SDKs.
    - **SHARPCAP** is also included in the pack, you can choose 32-bit or 64-bit to install. This is authorized by SHARPCAP.
    - **QT LIB** is a plug-in to ensure that 64-bit software can exeuate normally on some computers with poor compatibility.
- **Difference between Stable version and Beta Version:** Beta version is the latest version, which gives priority to support for the latest products (the stable version may not be compatible with those yet), and has some of the latest optimized ,but experimental features. The stable version is older than the beta version but more stable, so it is recommended for beginners who are not using the latest products.
- **Don't let the camera connect to the computer during the All-in-one pack installation process**, connect it to the computer after all the installation is complete.

Input Voltage Requirements

The camera requires an input voltage between 11V and 13.8V. If the input voltage is too low the camera will stop functioning or it may reboot when the TEC power percent is high, causing a drain on the power. Therefore, please make sure the input voltage arrived to the camera is adequate. 12V is the best but please note that a 12V cable that is very long or a cable with small conductor wire may exhibit enough resistance to cause a voltage drop between the power supply and the camera. The formular is: V(drop) = I * R (cable). It is advised that a very long 12V power cable not be used. It is better to place the 12V AC adapter closer to the camera.

First connect the 12V power supply, then connect the camera to your computer via the USB3.0 cable. Make sure the camera is plugged in before connecting the camera to the computer, otherwise the camera will not be recognized. When you connect the camera for the first time, the system discovers the new device and looks for drivers for it. You can skip the online search step by clicking "Skip obtaining the driver software from Windows Update" and the computer will automatically find the driver locally and install it. If we take the 5IIISeries driver as an example (shown below), after the driver software is successfully installed, you will see QHY5IIISeries_IO in the device manager.

Please note that the input voltage cannot be lower than 11.5v, otherwise the device will be unable to work normally.

Connect Software

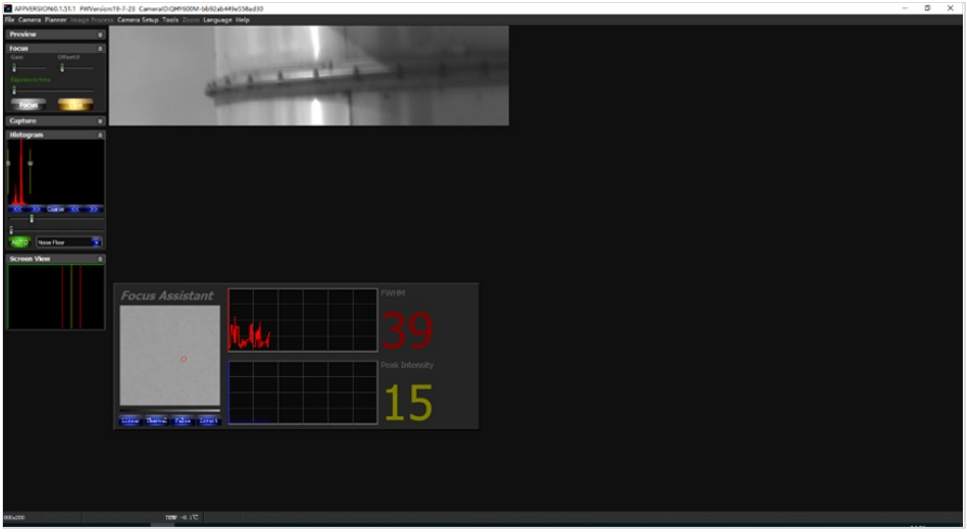
Before using software, make sure you have connected the cooling camera to the 12V power supply and connected it to the computer with a USB3.0 data cable. If it's a planetary/guiding camera, 12V power is not needed.

Note: We recommend 64-bit Software if possible, like SharpCAP x64 , N.I.N.A x64. etc., especially when you're using 16bit cameras like QHY600.

EZCAP_QT

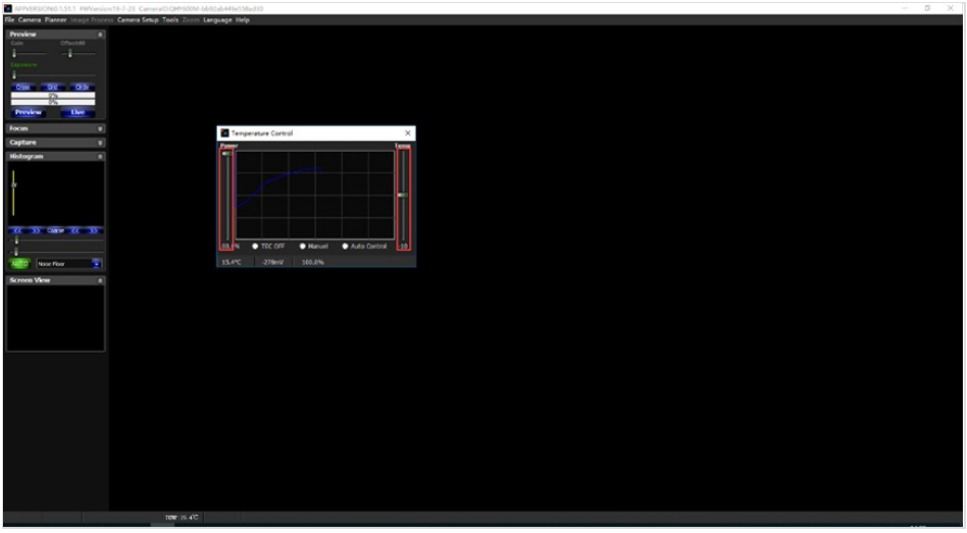
EZCAP_QT is software developed by QHYCCD. This software has basic capture functions for QHYCCD deep sky cameras.

Run EZCAP_QT. Click "Connect" in Menu -> Camera. If the camera is successfully connected, the title line of EZCAP_QT will display the camera firmware version and the camera ID as shown below.



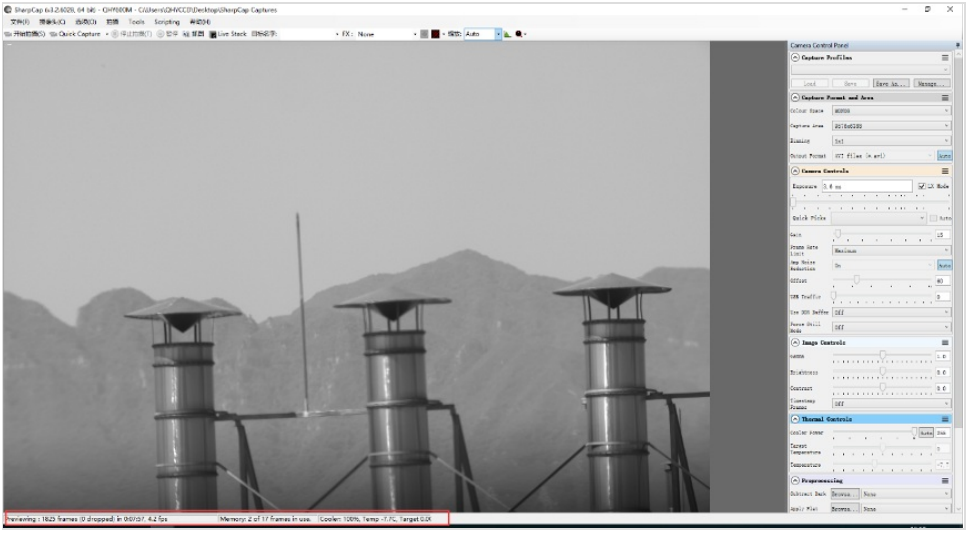
Click “Temperature Control” in “Camera Settings” to set the temperature of the CMOS sensor. You can turn on “Auto” to set the target temperature. For example, here we set the target temperature to -10C. The temperature of the CMOS sensor will drop quickly to this temperature (approximately 2-3 minutes). If you want to turn off cooling, you can choose Stop. If you just want to set the TEC power but not the temperature. You can select “Manual” and then set the percentage of the TEC power.

You can use the “preview tab” to preview and use the focus tool to focus. Then use the “capture tab” to capture the image.



SharpCap

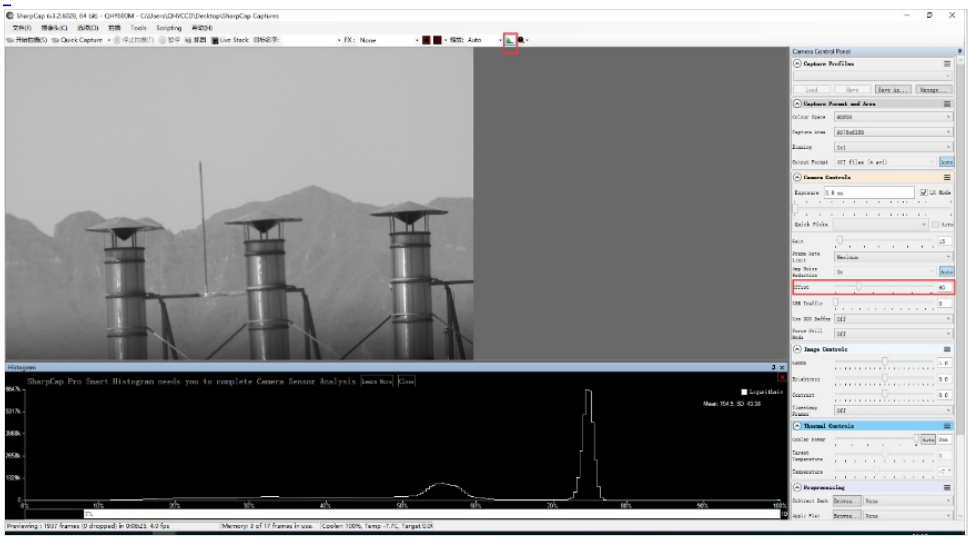
Launch SharpCap. If the software and drivers mentioned above are installed successfully, the video image will appear automatically about 3 seconds after the software loads. You will also see the frame rate in the lower left corner of the software window as shown below.



If you have already started the SharpCap software before connecting the camera, in order to open the camera, click on the

“camera” in the menu bar and then select the device.

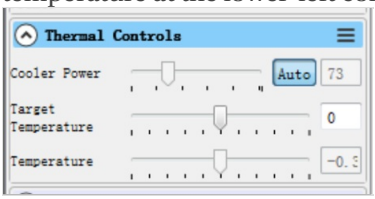
Offset adjustment. When you completely block the camera (i.e., like taking a dark frame) you may find that the image is not really zero. Sometimes this will reduce the quality of the image contrast. You can get a better dark field by adjusting the offset. You can confirm this by opening the histogram as indicated in the figure below.



If you want to enter the 16-bit image mode, select the “RAW16” mode.

By selecting the “LX” mode you can expand the exposure setting range and take long exposures.

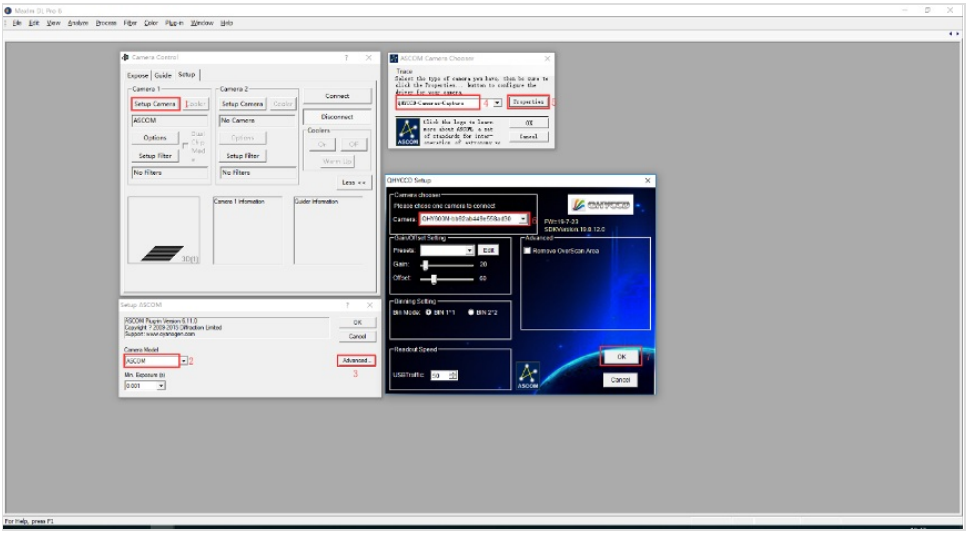
After cooling devices connected to the 12V power supply, the temperature control circuit will be activated. You can control the CMOS temperature by adjusting the settings in the figure below. Basically, you can control the temperature of CMOS by either adjusting “Cooler Power” or clicking “Auto” and setting “Target Temperature”. You can also see the CMOS temperature at the lower-left corner of the software window.

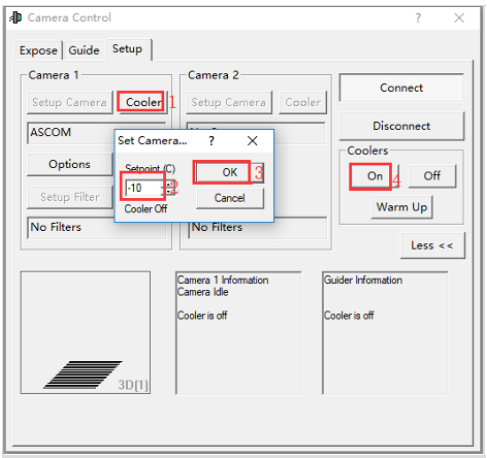


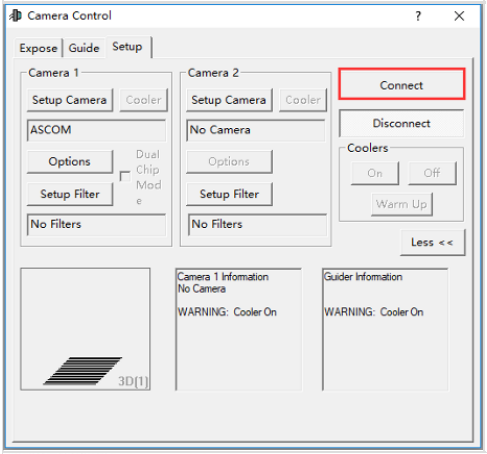
ASCOM supported software (e.g. MDL)

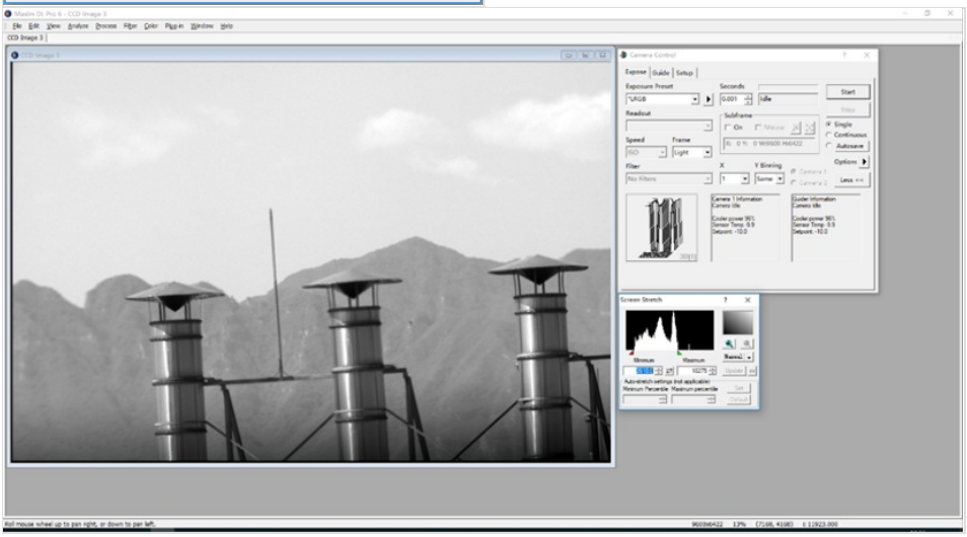
With ASCOM drivers, you can use the device with many software packages that support the ASCOM standard. We will use **Maxim DL** below as an example, but a similar procedure is used for The SkyX and other software packages supporting ASCOM.

First make sure you have not only loaded the ASCOM drivers but that you have also downloaded and installed the ASCOM platform from ASCOM. After both the drivers and platform are installed, start MAXIMDL. Follow the instructions shown below to finish the setup. Then Click Connect in and enter the software.





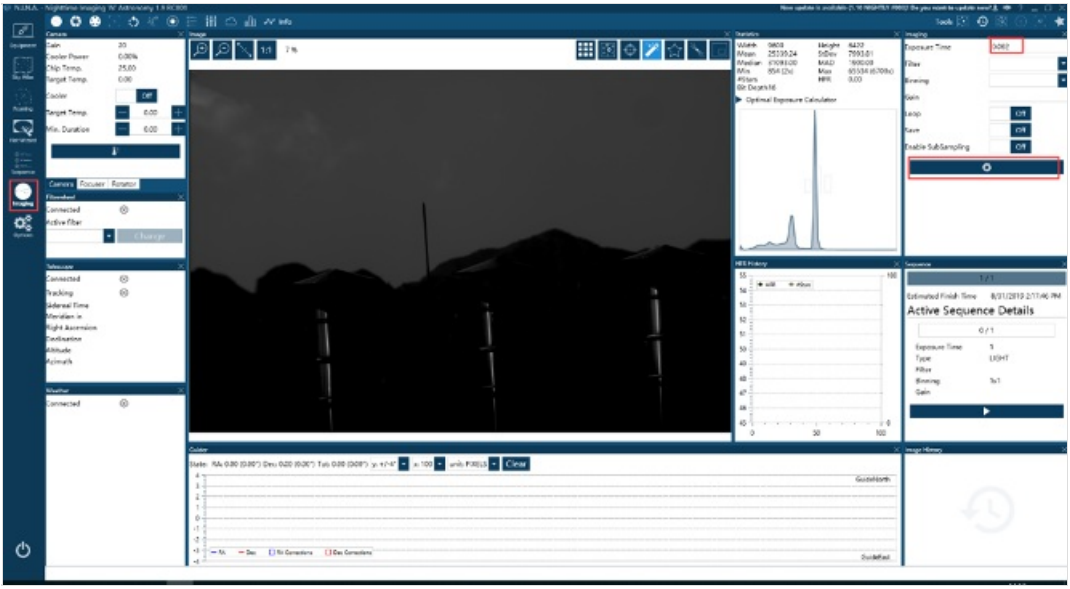




N.I.N.A

Open N.I.N.A. – Nighttime Imaging ‘N’ Astronomy. Drive connections via ASCOM.

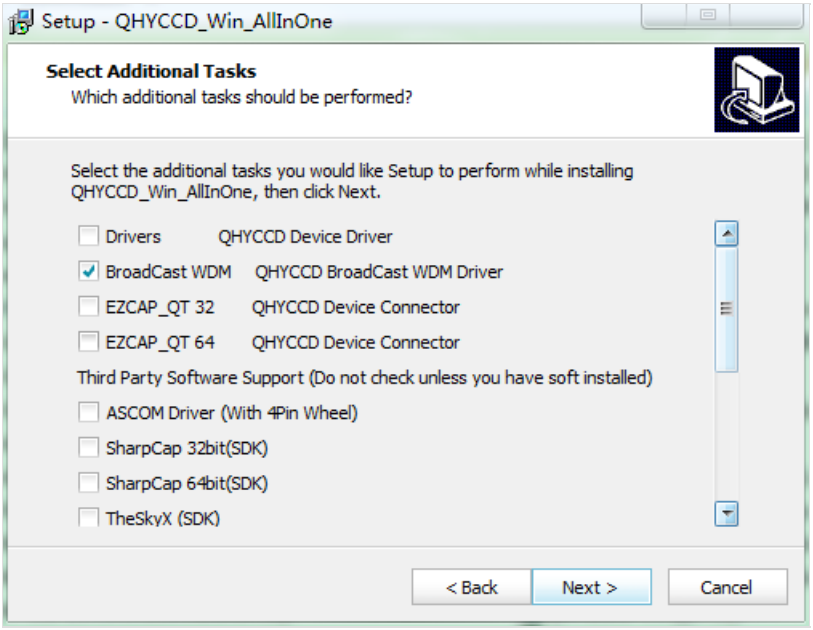
Turn on the TE cooler to set temperature. Then set the exposure time to capture the image.



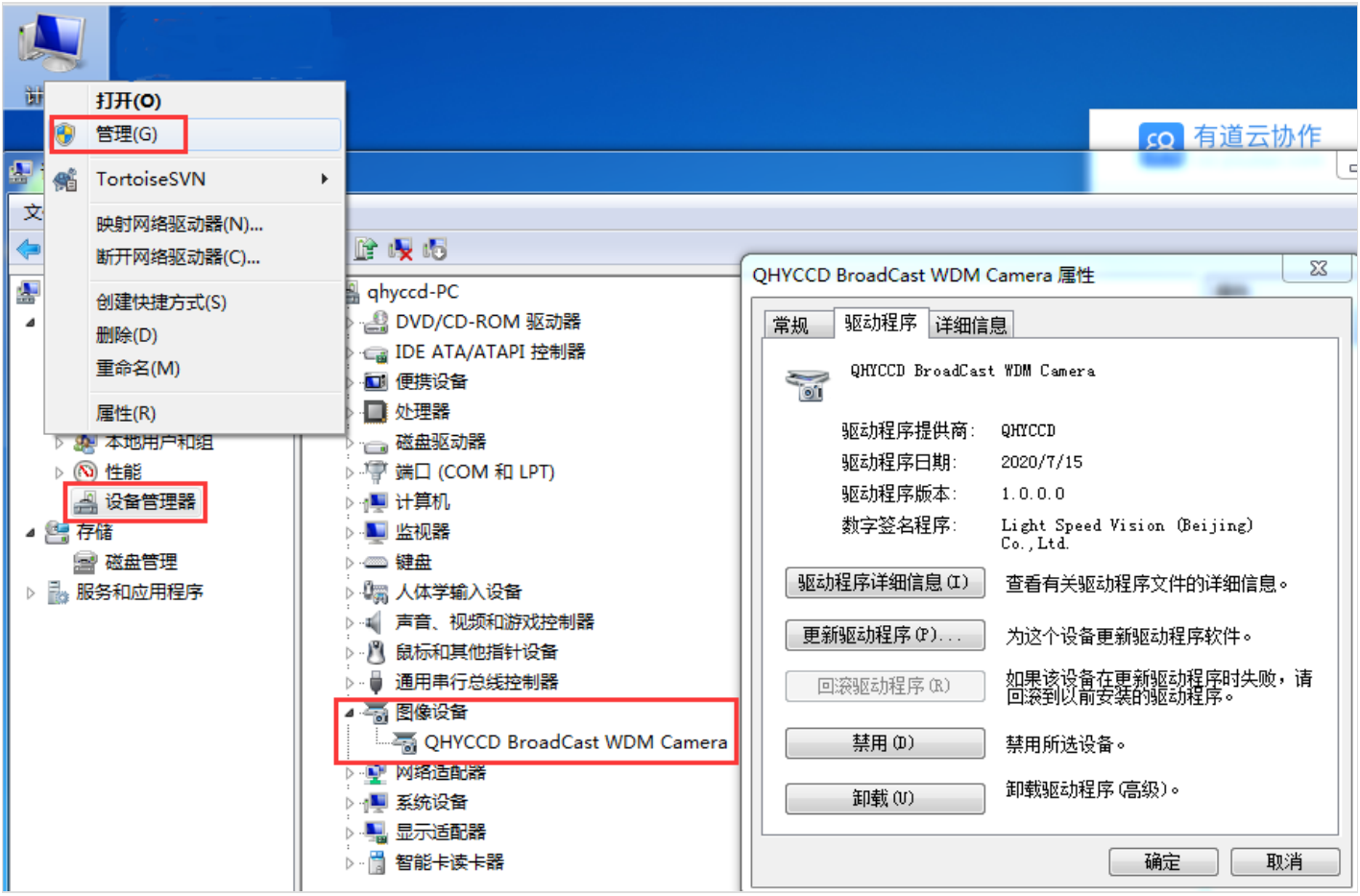
BroadCast WDM Camera Driver

QHYCCD BroadCast WDM Camera is a broadcast driver that supports QHYCCD cameras with video broadcast function, which can meet the needs of customers to send video images to other target software. For example, use sharpcap to connect a WDM-enabled camera, and the sharpcap display video image can be sent to other WDM-supported software for display, which is suitable for video online broadcast applications.

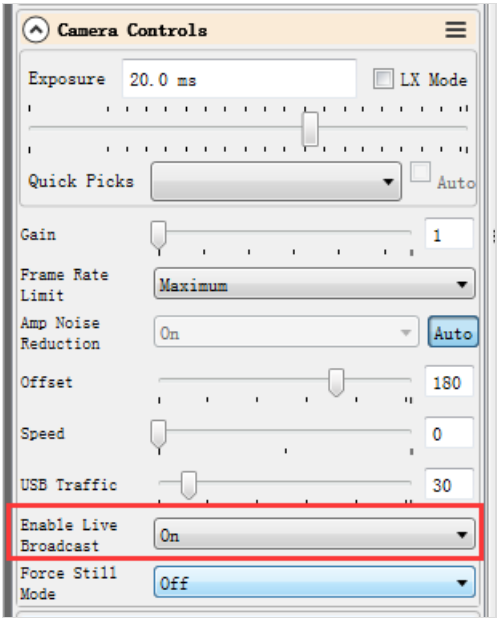
Installation:
Perform the AllInOne installation and check the BroadCast WDM Camera option.



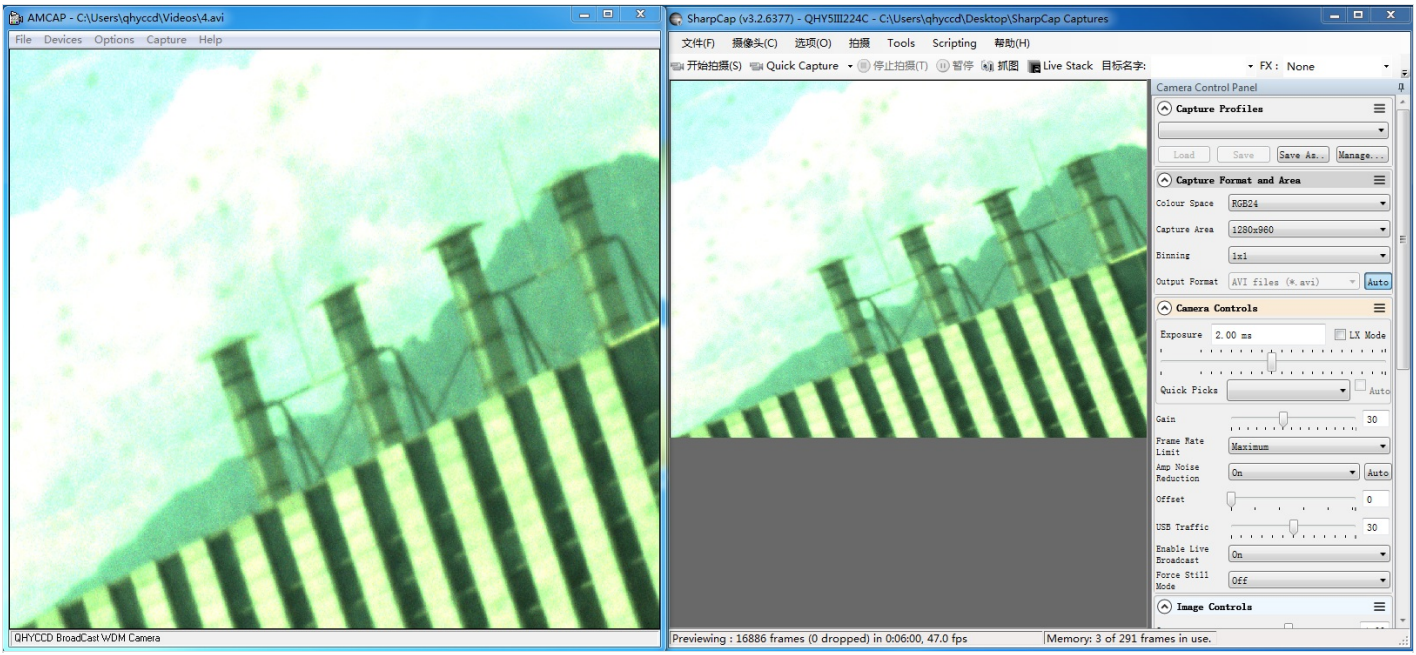
The installation process is over, right-click the computer to find the device manager, and check that the image device name is QHYCCD BroadCast WDM Camera, which means the installation is successful.



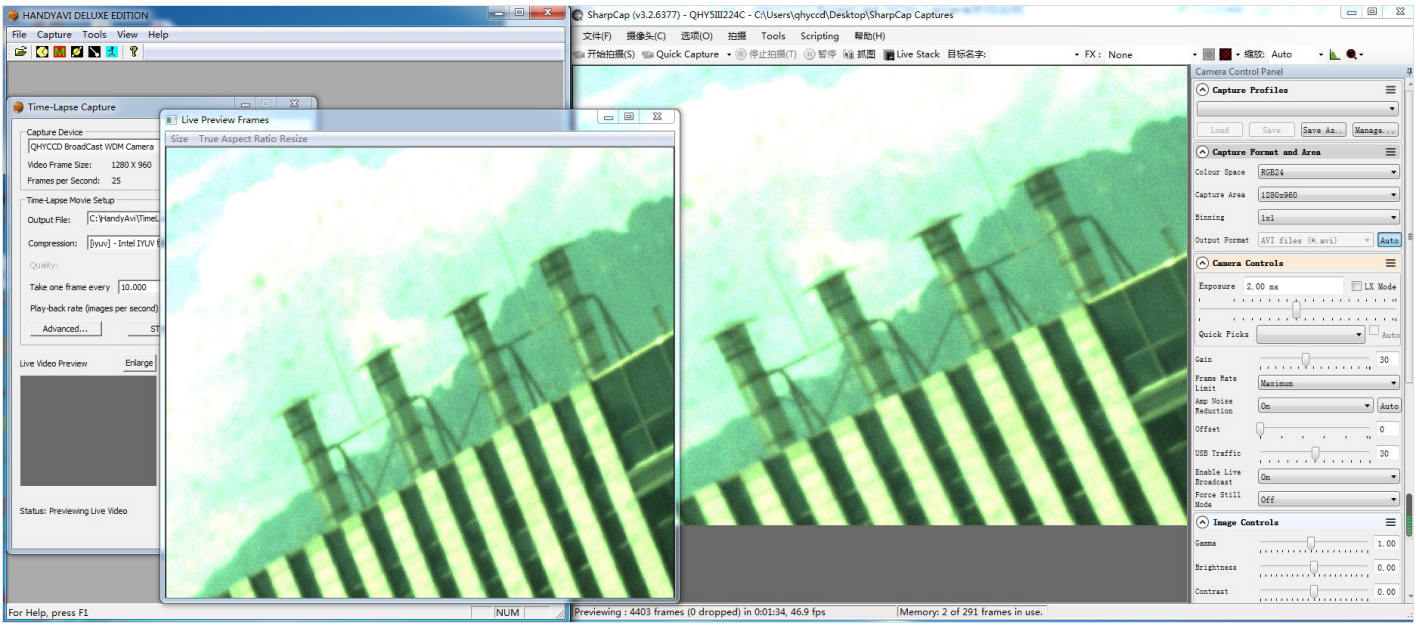
Activate the function:
Usually sharpcap is used to connect the camera as the broadcasting terminal. After connecting the camera, you need to turn on the Enable Live Broadcast switch to broadcast.



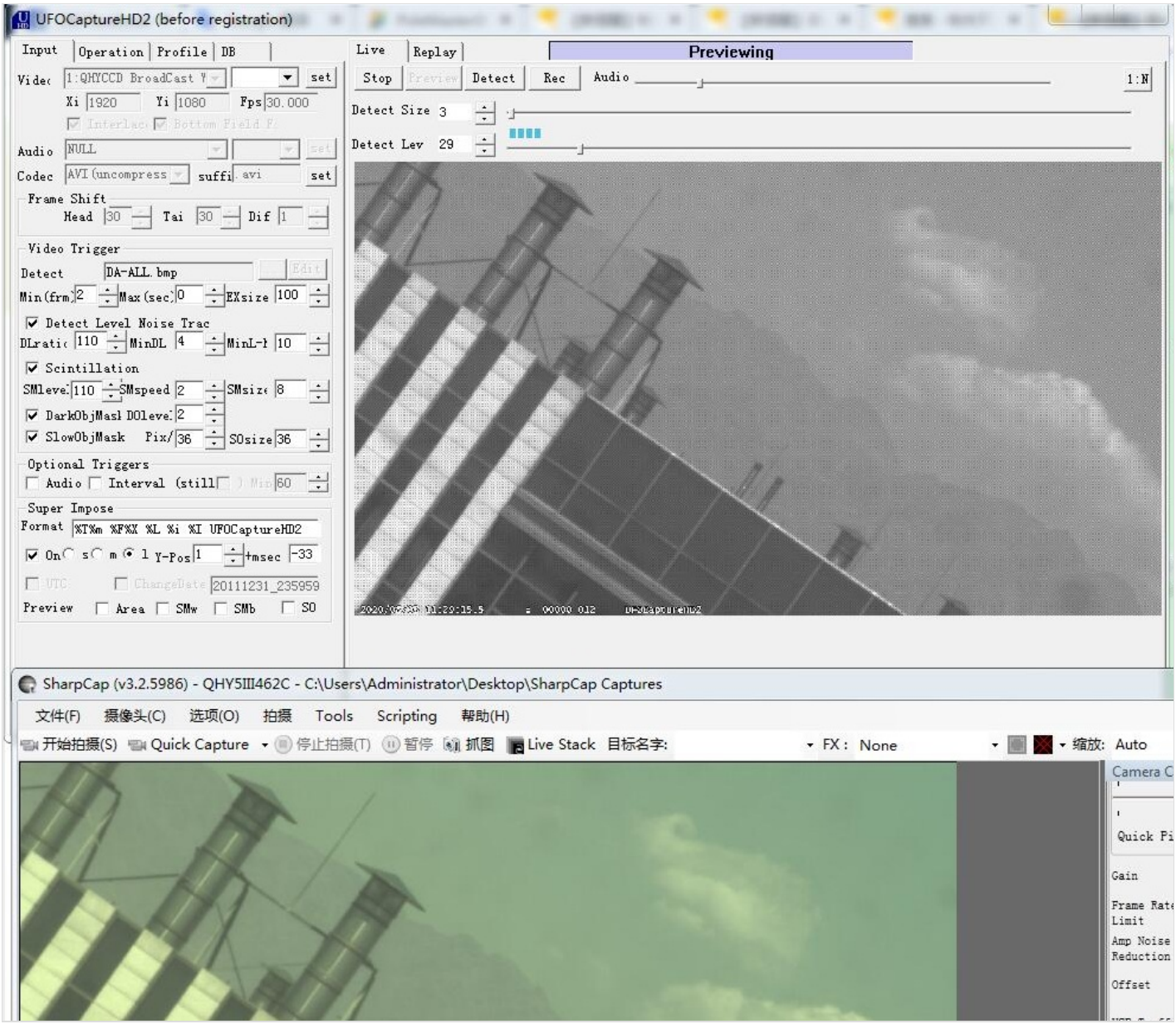
Common supporting software (ie, broadcast receiver) includes: UFOCAPTURE, HANDYAVI, QQ video functions, etc.
AMcap test effect chart:



HANDYAVI test effect chart:



UFOCAPTURE test renderings:



Precautions:
Currently only supports Windows system.
Currently, the SDK does not support 16 bits for the time being.
RGB24 mode must be selected for color images, otherwise the image will appear gridded.

FAQs

How to avoid the camera hanging?

If your camera hangs (stops downloading images and does not respond to commands) it may be caused by a number of things. Check the following:
1. In some computers with a VIA chipset and some types of motherboards, running the camera with SharpCap will not produce an image. But in ASCOM it works well. In this case, you need enable the DDR buffer of the camera.

2. Is there a leak for your mount or computer? If so, the leaking current may be transferred from computer to the camera via the GND. This may affect the USB transfer and cause data packet loss, hanging the camera. In this case you need to make sure that the computer and mount are well grounded.

3. Is the USB port voltage sufficient? The voltage of some computers' USB ports is sometimes less than +5V. This may cause the camera to hang. In this case you can use a powered USB 3.0 HUB to connect camera, which will ensure that the camera gets +5V power.

4. Is your CPU utilization is too high? If your computer's CPU utilization is too high, it will cause many frames to be lost and may cause the camera to hang. You can change the USB
traffic value to reduce the FPS and get more stable video transfer.

5. Is the USB cable connection is secure enough? Sometimes a connection issue with the USB cable to camera or USB

cable to computer will cause some signal loss and may cause the camera to hang, particularly when you move the cables. In this case you can try to add a little silicon oil into the USB connector and socket. This can make the connection more stable.

6. Avoid the static electricity. Static electricity from the human body can cause the camera to hang. To ground yourself, touch the external metal case of the computer to discharge any static electricity before touching the camera.

7. Are you using the front USB port on your computer? The USB port on the front of some computers is not adequate for high-speed transfer because it is connected to mainboard by a cable which weakens the signal integrity. If you find that the camera always hangs when using the front USB port, try using a USB port on the rear panel of the computer instead. This will connect the camera to the chipset on the mainboard directly.

8. When the USB selective pause function is enabled in the system, it may cause the camera to hang during long hours of work. Follow the steps below to turn off this option. Windows power setting steps: 1. Click “Start button” and click “Settings”. 2. Click “Power and Sleep”, and click “Other Power Settings”. 3. Click “Change Power Plan”. 4. Click “Change advanced power settings”. 5. By default, the “USB Selective Suspend” function is enabled. (This may cause the image to freeze, the frame rate too become low, the video to become unsmooth, the image fail to refresh, and so on.) 6. Disable this function.

9. When you encounter a situation where the camera cannot output the usual frame rate after updating Sharpcap software, please download the All-In-One installation package and select the Sharpcap option during installation. The installation package will automatically update the QHY SDK in Sharpcap. Restart the sharpcap software after completion.

Image misalignment due to USB data transmission errors

What is happening here can be caused by USB communication problems or external interference problems. The data of the USB image packet being transmitted is wrong and cannot pass the CRC check, so the SDK judges it as a USB transmission error. The SDK will repair communication errors to avoid crashes, but this packet of data will also be lost. To trouble shoot this type of issue, note the following:

(1) Communication quality problems caused by USB cable damage or poor USB contact: The solution is to replace the USB cable, and check the connection of the USB cable to the computer and whether the connection between the USB cable and the camera is too loose.

(2) Some HUBs with mismatched signals may cause such problems. Connect directly or replace to another type of HUB. (It is recommended to use active HUB)

(3) The communication is experiencing interference problem caused by noise or voltage leakage of the AC adapter. Check whether the AC adapter of each device in the system is well grounded.

(4) You may be using an SDK and firmware that do not match. Download the latest installation package (All-In-One package), or request QHYCCD technology Support for remote assistance.

Camera grounding precautions

To avoid the problem of unreliable USB connection or port damage

Some computers or 220V to 12V adapters have leakage currents. If they are not well grounded, a high voltage is formed between the ground (metal case) of the USB interface and the ground (metal case) of the power supply line. If the USB and power supply wires are in good contact with the camera, the device can operate normally due to the formation of a common ground at the camera.

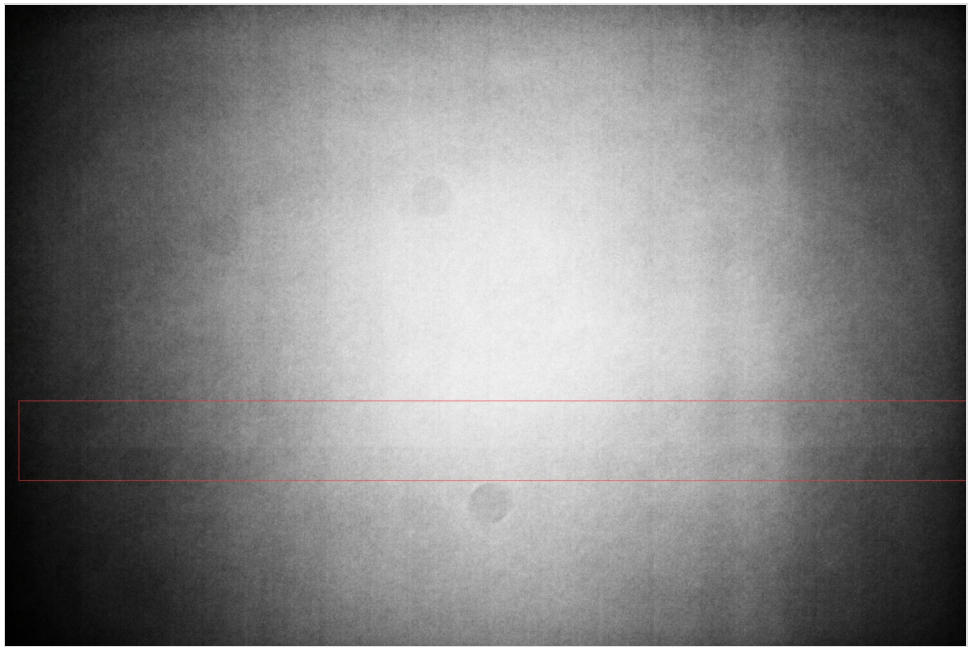
However, the common ground formed at the camera is very dangerous. On the one hand, it is easy to cause the USB connection to be unreliable, and the USB connection is often lost during use, and on the other hand, there is a risk of potentially damaging the port. Therefore, make sure the computer and adapter are well grounded before putting the device into service.

You can use the multimeter's AC voltage file to detect if there is any leakage between the computer and the adapter. The method is not to connect the camera first, one meter is connected to the metal case of the USB plug, and the other meter is connected to the negative pole of the DC output plug of the power adapter (generally inside and outside negative). If the voltage between the two is small, there is no leakage or a good ground has been achieved through the ground of the power plug. If there is a voltage of several V to several tens of V, there is leakage and there is no good grounding. Need to check if the 220V power plug can provide a good ground.

Another way is to use a test pencil. Test the negative pole of each power adapter, the metal part of the computer, and the metal part of the equatorial mount for leakage.

If there is no way to avoid it, you need to use a separate wire to connect the ground of the computer (usually connected to the metal case) and the negative pole of the 220V to 12V adapter to achieve common ground.

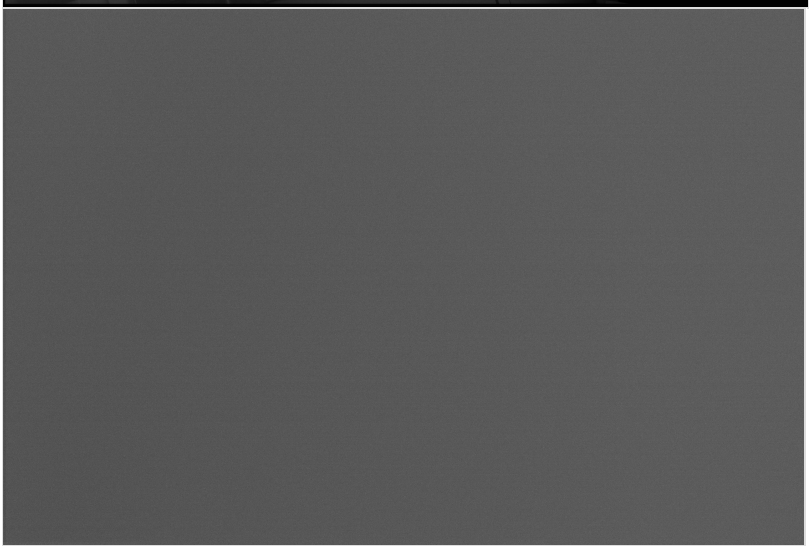
Commonly because the computer or power adapter leaks to cause USB instability or port damage:
A camera with a 9-pin socket and a USB socket is common at the camera.
A camera with a USB socket and a metal case. After connecting the telescope to the equatorial mount, the ground of the equatorial mount and the ground of the computer are at the camera.
After the QHY9 is connected to the color wheel through the camera's color wheel interface, it is common at the color wheel interface.
The above may cause the USB connection to be unstable, the connection is often lost, the USB port is burned, the color wheel interface is burned, etc.



Shooting flat field is the difference between light and dark above and below the image FAQ:
This situation is caused by the rolling shutter effect, which is easy to encounter when shooting short exposures. Increasing the exposure time can avoid this difference. It is recommended to use an exposure time greater than 1 second for flat-field frame shooting.

What is RBI?

Residual Bulk Image (RBI) effect behaves like when you take a normal image (P1), some data will be residual on your next frame. This will affect your calibration work. P2 shows the dark frame captured right after P1 without any RBI control.
But don't worry, almost all QHY cameras have RBI removing function. Compared with P2, P3 is the dark frame when the RBI removing function is on. This function is defaulted open unless you change the ".ini" file to keep it off. (which we don't suggset)



Maintenance

CMOS Maintenance

Drying the camera CMOS chamber

The CMOS sensor is located in the CMOS chamber. There is a hole in the side of the camera near the front plate that is normally plugged by a screw with an o-ring. If there is moisture in the CMOS chamber that causes the sensor glass to fog, you can connect the silica gel tube to this hole for drying the chamber.

Place an effective silica gel desiccant in the silica tube make sure there is some cotton inside to prevent the silica gel from entering the CMOS chamber.

Cleaning the CMOS sensor and optical window

If you find dust on the CMOS sensor, you can first unscrew the front plate of the cam and then clean the CMOS sensor with a cleaning kit for SLR camera sensors. Because the CMOS sensor has an AR (or AR/IR) coating, you need to be careful when cleaning. This coating can scratch easily so you should not use excessive force when cleaning dust from its surface.

Preventing fogging of the CMOS chamber

If the ambient humidity is very high, the optical window of the CMOS chamber may have condensation problems. The QHY600 has a built-in heating plate to heat it to prevent fogging. In most cases, it is very effective. However, If fogging still persists, try the following:
1. Avoid directing the camera towards the ground. The density of cold air is greater than the density of hot air. If the camera is facing down, cold air will be more accessible to the glass, causing it to cool down and fog.

2. Increase the temperature of the CMOS sensor. You can increase the temperature of the CMOS sensor slightly to prevent fogging of the glass.

3. Check if the heating plate is working. If the heating plate is not working, the glass will be very easy to fog. Normally, the temperature of the heating plate can reach 65-70 °C in the environment of 25 °C. If it does not reach this heat, it may be because the heating plate is damaged, you can contact us to replace the heating plate.

TE Cooler Maintenance

You should avoid thermal shock during use. Thermal shock refers to the internal stress that the TE cooler has to withstand due to the thermal expansion and contraction when the temperature of the TEC suddenly rises or falls. Thermal shock may shorten the life of the TEC or even damage it.

Therefore, when you start using the TEC to adjust the CMOS temperature, you should gradually increase the TEC power rather than turning the TEC to maximum power. If the power of the TEC is high before disconnecting the power supply, you should also gradually reduce the power of the TEC and then disconnect the power supply.

Appendix: How to set Gain and Offset

Unity Gain of Some Models

Model	Unit Gain
600M/C	25 (Extended Full Well Mode) *
268M/C	30 (Extended Full Well Mode) *
294Pro	1600 (11MP Mode) 2600 (47MP Mode)
410C	90 (Low gain) 40 (High gain)
367C	2800
247C	2200
128C	3300
168C	10
183M/C	10
163M/C	120

174GPS	17
550P	85

**With the improvement of the CMOS technology, the 16bit CMOS camera has been released, like QHY600/268/411/461. For these cameras, even in lowest gain it has beyond the requirement of unit gain (less than 1e/ADU due to sufficient samples) So you can directly set gain0 as start. Please note QHY600/268C/411/461 has extend full well mode. In this mode you still need to find out the unit gain position.*

Gain Setting

For beginner, we recommend that you set the gain to "unit-gain". Unit-gain is the gain when system gain is 1 (1e/ADU). This number is shown in the table above, like the unit-gain of QHY168C is 10. In fact, increasing or decreasing a bit doesn't make a big difference.

You could increase or decrease Gain according to the condition. For example, if your optical system is fast, like F2.2 to F5, or long exposure for more than 5 minutes without narrowband filters, then you can decrease GAIN to achieve a higher dynamic range and make better use of full well capacity. By doing so you can avoid overexposure.

If you use narrowband filter on a slow optical system like F6 to F10, or short exposure time, the amount of photons received will be less. In this case you can increase GAIN to make better use of characteristics of low read-out noise in high GAIN value.

OFFSET Setting

There is no fixed "best value" for OFFSET. To set OFFSET, you should take the bias frame and dark frame at a certain GAIN value, then check the histogram of the frames.

As you can see, the histogram distribution is a peak-like curve. By changing the OFFSET value, this curve will move left or right. We must guarantee the range of the whole curve is greater than 0, and it cannot be chopped off at the end. At the same time, we need to keep a bit of residue on the left side, just over 0 a bit. 100 to couple hundreds ADU are all okay. Don't be too huge, however.

Pay attention that under different GAIN values, the width of this peak varies. The higher the GAIN is, the wider the distribution will be. So OFFSET value st low GAIN is not suitable for high GAIN, because the curve is very likely to be chopped off.

Advanced Settings

For those CMOS less than native 16-bits, the AD sampling accuracy doesn't match perfectly with the full well capacity. At low GAIN level, the system gain will be couple electrons per ADU. The camera loses the ability to distinguish the strength of the signal because of such sampling error.

When GAIN increases, the system gain will decrease. However, increasing GAIN will limit the full charge of the well. If the system gain is 1 for a 12bit CMOS camera, the pixel will be saturated at only 4096 electrons (full well). Some bright stars will be easily saturated. This problem goes worse under fast optical system or long exposure. Over saturated objects cannot be fixed during post processing (unless you shrink stars, like in PixInsight). Also, the color saturation of the star will be affected. As result, the stars will be huge and white washed. We should decrease the gain value in this case, to gain a higher full well capacity.

Under long exposure or using fast optical system, the pixel will receive more photons. The variation of quantized noise from the photon which you can consider as natural dithering of the light intensity, will be greater than the "noise" from the sampling error. Therefore, the effect of the sampling error will diminish. By averaging multiple exposures, this will compensate the lack of depth of the picture because of the sampling error.

If the number of received photons is limited, like using narrowband filters or short exposures, we can increase the GAIN value. It is because the stars will not be easily saturated. At the same time, we limit the noise from the background cosmic radiation. Under this condition, the readout noise and quantized noise are the major factors that affect the ability to distinguish dim light or objects. By increasing the GAIN value in order to decrease the readout noise and quantized noise from sampling error, this would greatly increase the signal to noise ratio.

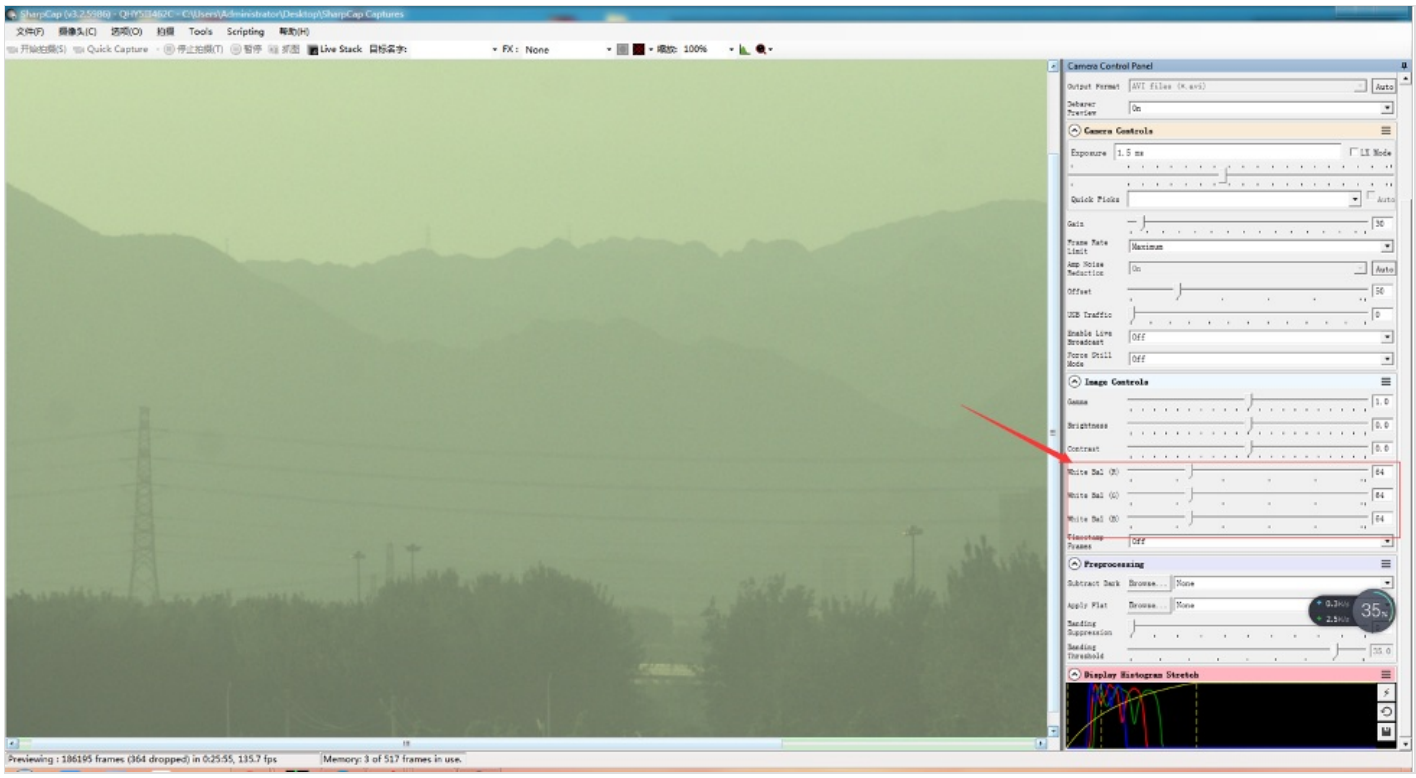
Appendix: Bayer Sequences of Some Colored Cameras

Cooled CMOS Camera	**Bayer**
QHY600C	RGGB
QHY268C	RGGB

QHY410C	RGGB
QHY367Pro	RGGB
QHY128Pro	RGGB
QHY294C	RGGB
QHY247C	RGGB
QHY168C	RGGB
QHY165C	RGGB
QHY163C	GRBG
QHY183C	RGGB
QHY174C	RGGB
QHY178C	GBRG
QHY290C	GBRG
QHY224C	GBRG
Planetary and Guiding	**Bayer**
QHY5III174C	RGGB
QHY5III178C	GBRG
QHY5III224C	GBRG
QHY5III290C	GBRG
QHY5III462C	GBRG
QHY5III485C	RGGB
QHY5L-II-C	BGGR
QHY5P-II-C	GBRG
Cooled CCD Camera	**Bayer**
QHY8L-C	GBRG
QHY10-C	RGGB
QHY12-C	BGGR

Appendix: White Balance Adjustment

When SharpCAP starts, it will use the default white balance, which is R:G:B=1:1:1. Therefore, the image you see is greenish (as shown below). Because from the light efficiency curve of the color CMOS chip, the response to green light is the highest. In order to obtain the correct white balance, you need to perform manual white balance adjustment.



For color cameras, SharpCAP will automatically open the progress bar of the white balance adjustment function, and you can make adjustments.
Since white balance is the ratio of light sensitivity between red and green, and the ratio of light sensitivity between blue and green, you can first fix the green value to 128. Then adjust the red and blue.
For example, after adjustment, blue is 255 and red is 161, and now it looks much better. If you need more blue, because the blue has reached 255 and cannot be adjusted upwards, in this case, you can reduce the green appropriately. Then adjust again. In this way, a larger proportion can be obtained.
As we said before. If you are doing planetary imaging you should set the offset value as low as possible. To make the background close to zero. Then you can easy to get correct color balance. Otherwise it will not easy to get it. The The following image shows the offset is good and you can not get good balance.
The reason is that the Color balance is a ratio of the RGB sensitivity difference. So we use a ratio to multiple the RGB value and get it done. But if there is a bias exist. The ratio will not be correct. For example, the G sensitivity is two times than R. G=2R In order to get white balance. We multiply a ratio of 2 to R
R'=2R= G so we get R=G
When a bias exist. The bias is a constant add to each pixel. So the image you see is:
R''=R+bias
G''=G+bias=2R+bias

Now the ratio R":G"=(R+bias)/(2R+bias) and it is not equ to 1:2. It shows the bias will effect the true value of the R:G. And the ratio of R:G will arious when the image light changed. It is hardly to correct with a fixed ratio.

But for DSO capture, You should keep the offset above zero and avoid the background is cut off. A background from 1000-5000 is a good value(16bit mode) for DSO imaging.