- Sample Images

AstroBin ITOD Perseus molecular cloud

by Steed Yu, QHY268C

https://www.astrobin.com/fiyi3z/?nc=user

- User's Review

YOUTUBE.COM

Hands on with the QHY268M Astro Camera - First Light Testing!

I get one shot, one opportunity to use the new QHY268M astronomy camera as the ski...

https://www.youtube.com/watch?v=Tp_sbKfOnbs

YOUTUBE.COM

QHY268M - First Impressions, Unboxing, Gear Explanation of new APS-C Mono Astrophotography Camera

https://www.youtube.com/watch?v=V-9dFr0cBfc&t=703s

YOUTUBE.COM

Adventures in QHY268M: FIRST LIGHT!

This is the third episode in a short series of my adventures in QHY land ...

https://youtu.be/AShHDwFgvoI

YOUTUBE.COM

QHY268C Review | Best Color Astrophotography Camera I've Ever Used!

https://youtu.be/R_OzxIFd698

https://youtu.be/xaboi-lhnJ0

[User interview The First Interview of QHY268M Users]

[User Interview Aaron Dalton, an astrophotographer from Alaska]

[User Interview Nico Carver's Astrophotography Story]

- Overview

With the advantage of low readout noise and high-speed readout, CMOS technology has revolutionized astronomical imaging. A monochrome, back-illuminated, high-sensitivity, astronomical imaging camera is the ideal choice for astro-imagers.

The QHY268M/C is a new generation of back-illuminated CMOS cameras with true 16-bit A/D and 3.76um pixels. This new Sony sensor is an ideal CMOS sensor exhibiting no amplifer glow. 16-bit A/D gives high resolution sampling of the whole full well range. Digitizing 0-65535 levels yields a smooth image with continuous gradation of greyscale levels. The QHY268M/C is a cooled, back-illuminated, CMOS camera based on the Sony IMX571 sensor with native 16-bit A/D and 3.76um pixels.

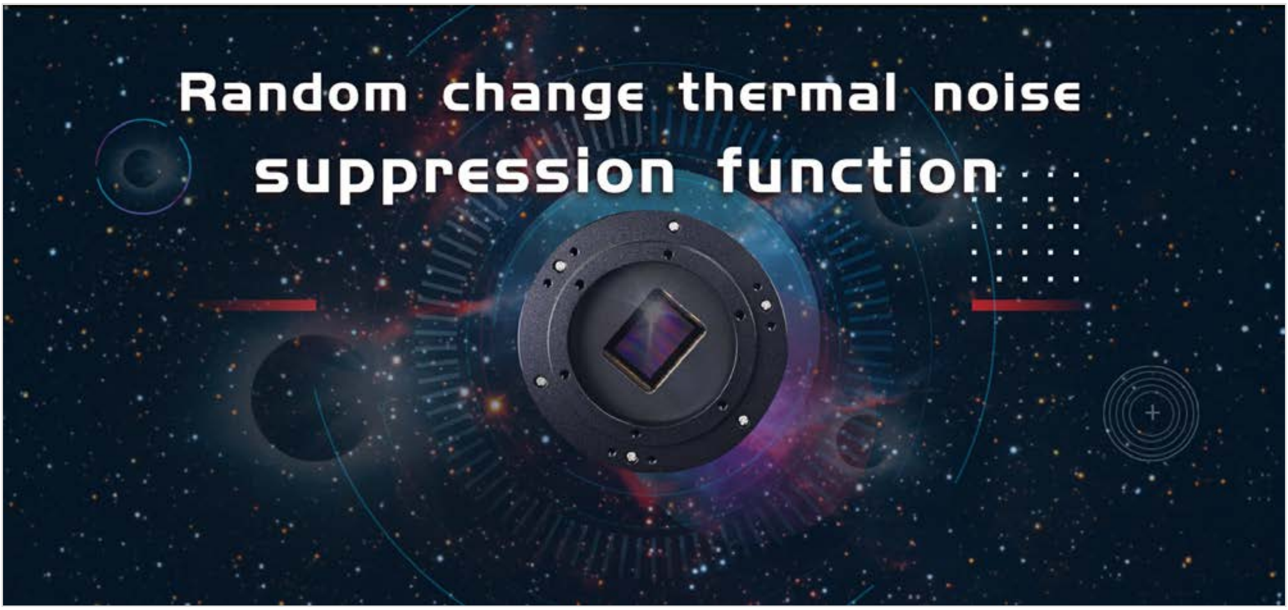
- Features

1GB DDR3 image buffer

In order to provide smooth uninterrupted data transfer of the entire 26MP sensor at high speed, the QHY268 has 1GB DDR3 image buffer. The pixel count of the latest generation of CMOS sensors is very high resulting in greater memory requirements for temporary and permanent storage. The QHY268 has adopted a large-capacity memory of up to 1GB. Data throughput is doubled. This large image buffer meets the needs of high-speed image acquisition and transmission of the new generation of CMOS, making shooting of multiple frames smoother and less stuttered, further reducing the pressure on the computer CPU.

USB Re-connection by 12V Power on/off

The 268 camera's USB interface to the computer can be connected or disconnected by turning on and off the camera's 12V power, without the need to plug and unplug the USB cable. This technology enhances the controllability of the camera when used in a remote station. You only need to remotely control the 12V power supply of the camera, or the power of the camera AC adapter, to achieve remote USB connecting and reconnecting of the camera.



Random change thermal noise suppression function

You may find some types of thermal noise can change with time in some back-illuminated CMOS cameras. This thermal noises has the characteristic of the fixed position of typical thermal noise, but the value is not related to the exposure time. Instead, each frame appears to have its own characteristics. The QHY600 / 268C uses an innovative suppression technology that can significantly reduce the apparent level of such noise.

Extended Full Well Capacity and Multiple Read Modes

With a pixel size of 3.76um, these sensors already have an impressive full well capacity of 51ke. Nevertheless, QHYCCD has implemented a unique approach to achieve a full well capacity higher than 51ke- through innovative user controllable read mode settings. In extended full well readout mode, the QHY600 can achieve an extremely large full-well charge value of nearly 80ke- and the QHY268C can achieve nearly 75ke-. Greater full-well capacity provides greater dynamic range and large variations in magnitude of brightness are less likely to saturate. The QHY600 / 268C have three readout modes with different characteristics.

Native 16 bit A/D

The new Sony sensor has native 16-bit A/D on-chip. The output is real 16-bits with **65536 levels**. Compared to 12-bit and 14-bit A/D, a 16-bit A/D yields higher sample resolution and the system gain will be less than 1e-/ADU with no sample error noise and very low read noise.

BSI

One benefit of the back-illuminated CMOS structure is improved full well capacity. This is particularly helpful for sensors with small pixels.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.

Zero Amplify Glow

This is also a zero amplifer glow camera.

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	QHY268M	QHY268C
COMS Sensor	SONY IMX571 M	SONY IMX571 C
Mono/Color	Mono	Color
FSI/BSI	BSI	
Pixel Size	3.76um x 3.76um	
Effective Pixel Area	6280*4210 (includes the optically black area and overscan area)	
Effective Pixels	26MP	
Sensor Size	APS-C	
A/D Sample Depth	Native 16-bit (0-65535 greyscale) A/D	
Full Well Capacity (1×1, 2×2, 3×3)	51ke- 75ke- or above in extended full well mode	
Full Frame Rate	USB3.0 Port: Full Resolution 6.8FPS @8BIT 6FPS @16BIT 2048lines 13.6FPS @8BIT 11.5FPS@16BIT 1080lines 25.4FPS @8BIT 19.5FPS@16BIT 768lines 35FPS @8BIT 25FPS@16BIT 480lines 50FPS @8BIT 34FPS@16BIT	
Readout Noise	1.1e- High Gain, 3.5e- Low Gain (5.3e- to 7.4e- in extended full well mode)	
Dark Current	-20C 0.0005e /pixel/sec -10C 0.001e /pixel/sec	

Exposure Time Range	30us-3600sec	
Unity Gain*	0 PH Mode 30 Extended Full Well Mode *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.	
Amp Control	Zero Amplifer Glow	
Firmware/FPGA remote Upgrade	Fully support via Camera USB port	
Shutter Type	Electronic Shutter	
Computer Interface	USB3.0	
Built-in Image Buffer	1Gbyte DDR3 Memory	
Cooling System	Two-stage TEC cooler Less than 1S lower than ambient temperature -30C in continuous mode More than 1S continuous mode or lower than ambient temperature -35C in single frame mode	
Optic Window Type	AR+AR High Quality Multi-Layer Anti-Reflection Coating	
Anti-Dew Heater	Yes	
Humidity Sensor*	Yes	No
Telescope Interface	Support M54 and M48 (with standard adapters)	M54/0.75 with CAA and M48 (with standard adapter)
Back Focal Length	QHY268M: 12.5mm (with CAA) If used with the QHY filter wheel, the actual calculated intercept is 12.5mm.The actual BFL (the intercept from the CMOS chip to the top of the camera) is 14.5mm. Since most uses will match CFW with monochrome cams, please take 12.5mm as major reference. Check the mechanical drawing below for details. Note 14.5mm rear intercept does not include adapter thread, which must be used with adapters of various sizes through the top 6 screw holes.	QHY268C: 17.5mm (without CAA) This intercept does not include CAA. If CAA is used, it increases by 6mm (23.5mm total). Please check the mechanical drawing below for details.
Weigth	855g	780g

Readout Modes and Curves

Multiple Readout Modes is a new function for newer QHY Cameras. Different readout modes have different driver timing, etc., and result in different performance. The QHY268 currently has four readout modes, and more modes will be added in the future. These readout modes are currently supported in the QHY ASCOM Camera Driver, SharpCAP software and the N.I.N.A software.

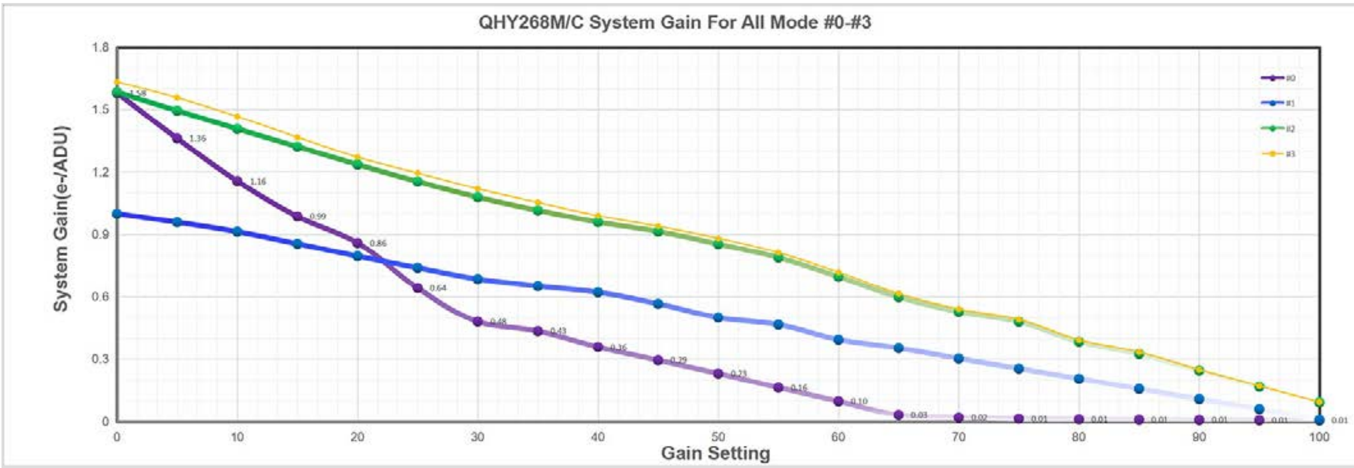
Readout Mode #0 (Photographic Mode). In this mode there is a drop in the noise between Gain 25 and Gain 26. We recommend setting the Gain to 26 to begin. At this setting the full well is 27ke- and readout noise is 2.7e-. For every long exposures you can lower the gain from this point to increase the full well capacity.

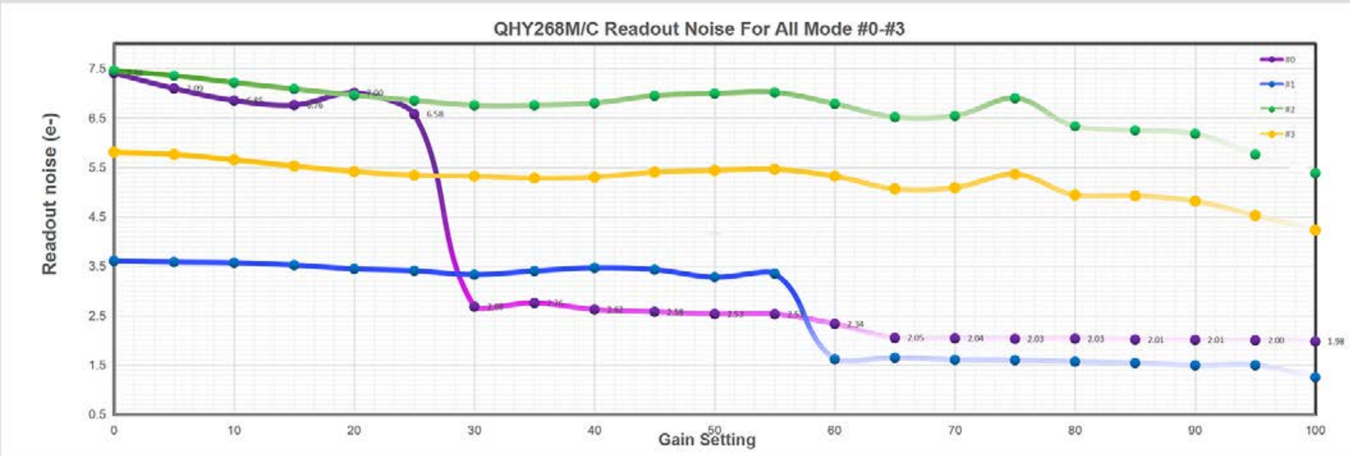
Readout Mode #1 (High Gain Mode). Please note there is a HGC/LGC switch point at gain55 to gain56. Gain0-55 uses LGC and Gain55-100 uses HGC.

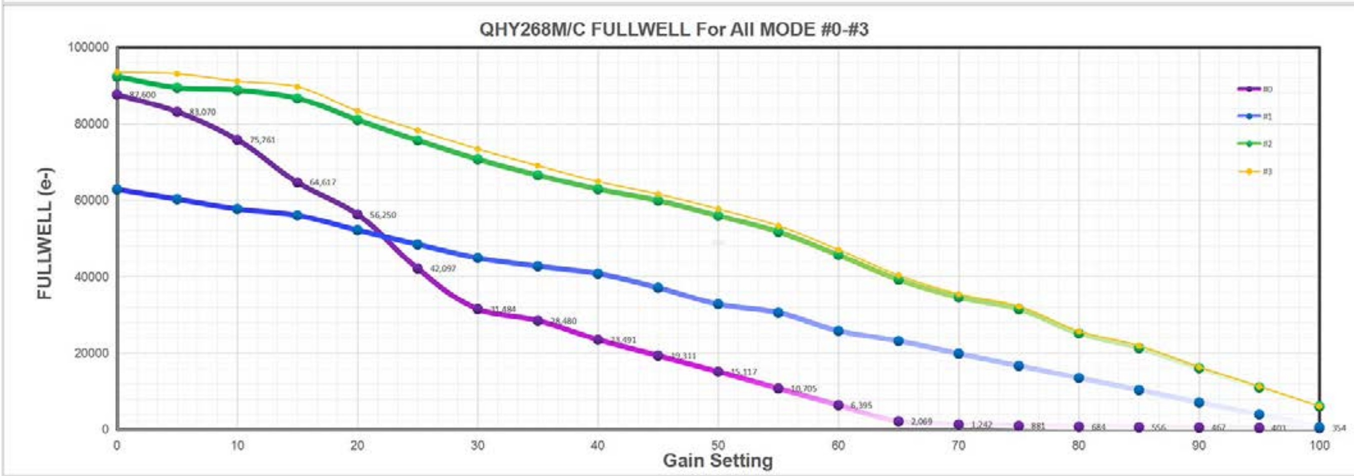
Readout Mode #2 (Extended Full Well Mode).

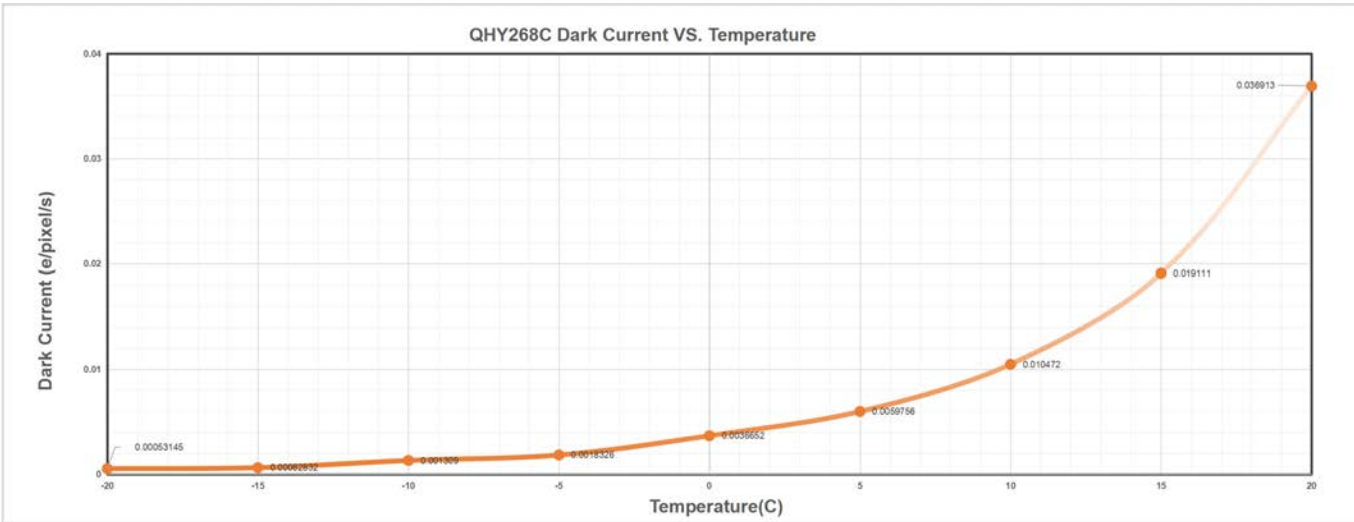
Now QHY268 adds **#3 mode Extend Full Well 2CMSIT (yellow curve).** The advantage of this mode is that it has the same full well value and system gain as the #2 mode Extend Fullwell, but the read noise is reduced by about 1.3 times.

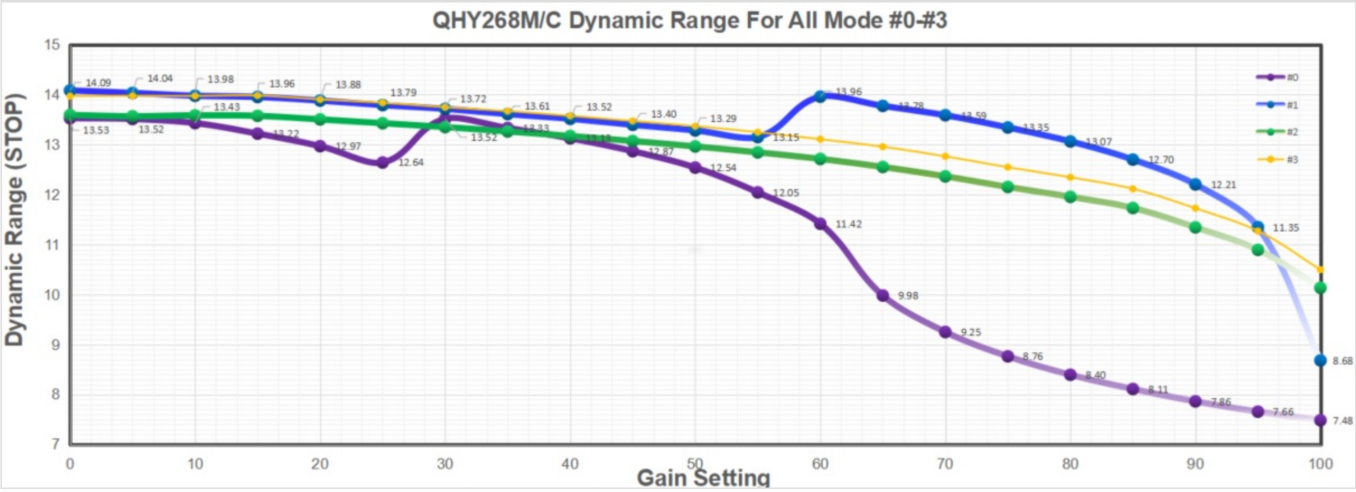
This function needs to be used with 2020.6.26 or newer SDK. If your software cannot display this mode, please download the QHYAllInOne installation package to update the SDK in the software.



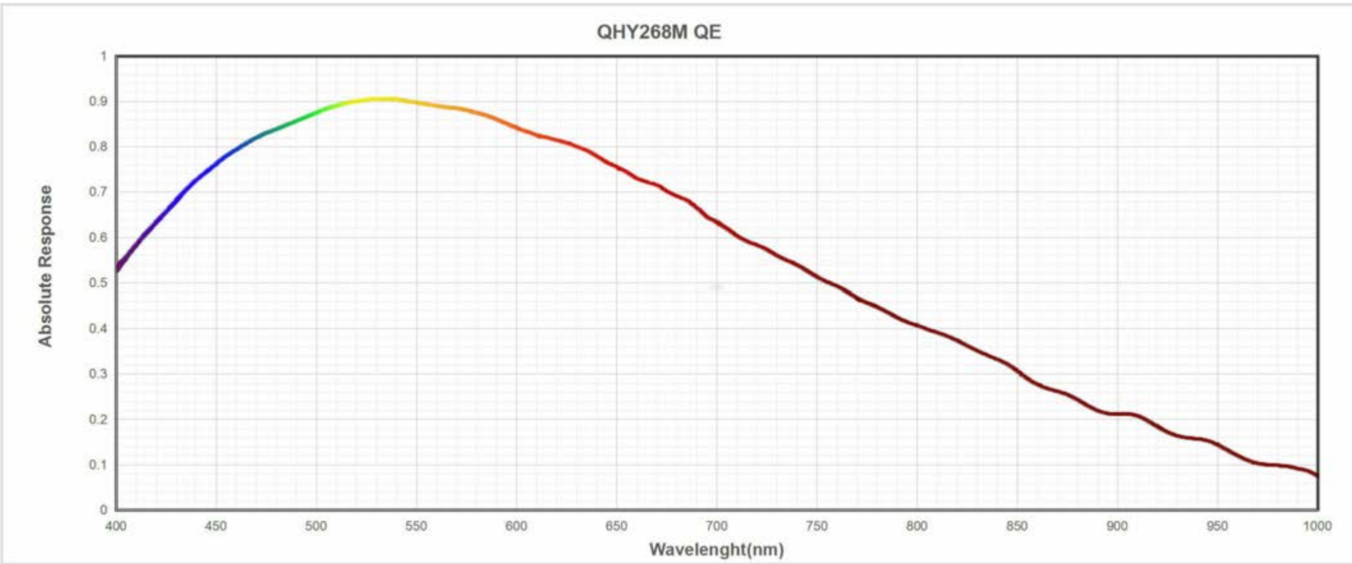




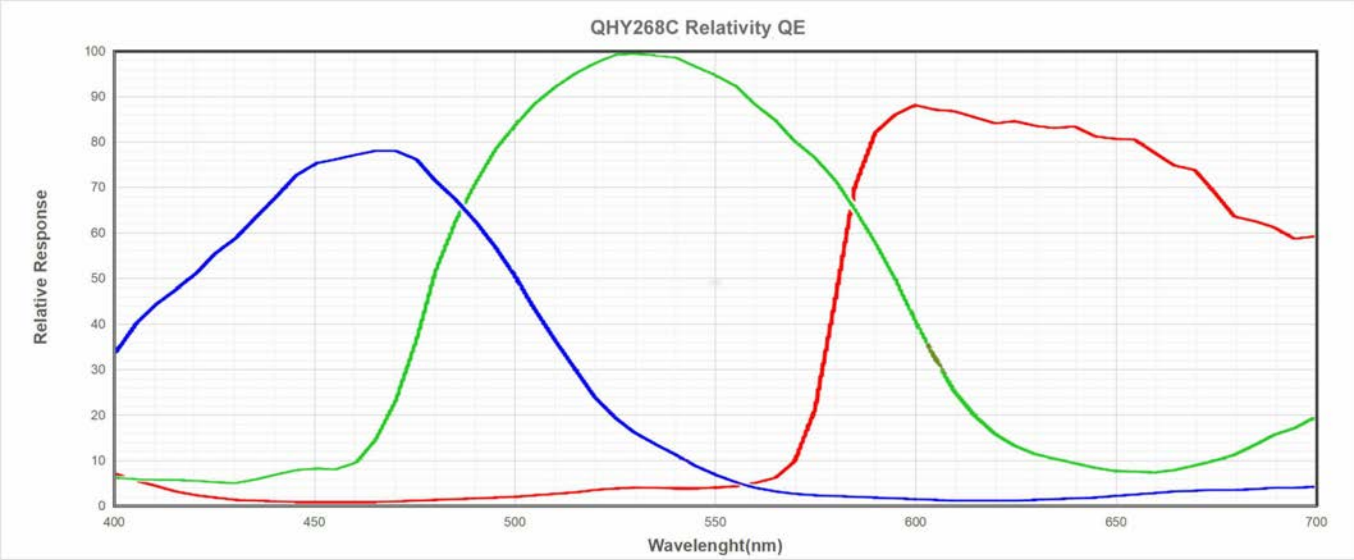




Absolute QE

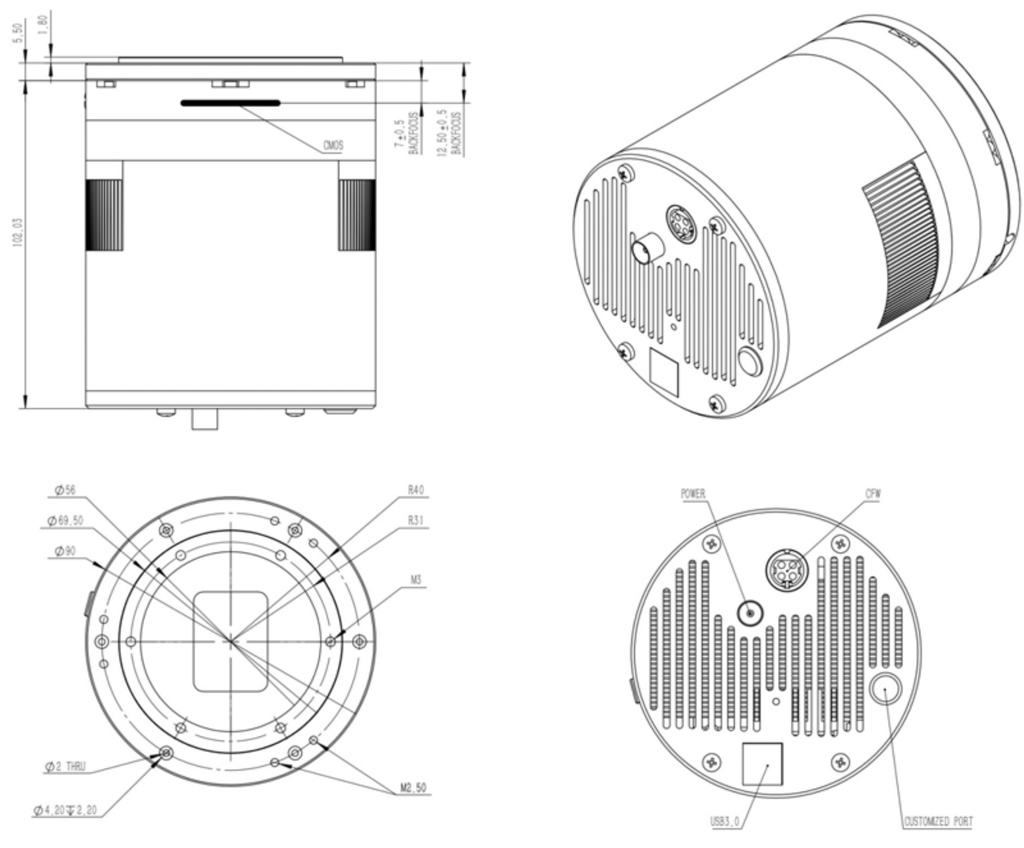


Relative QE

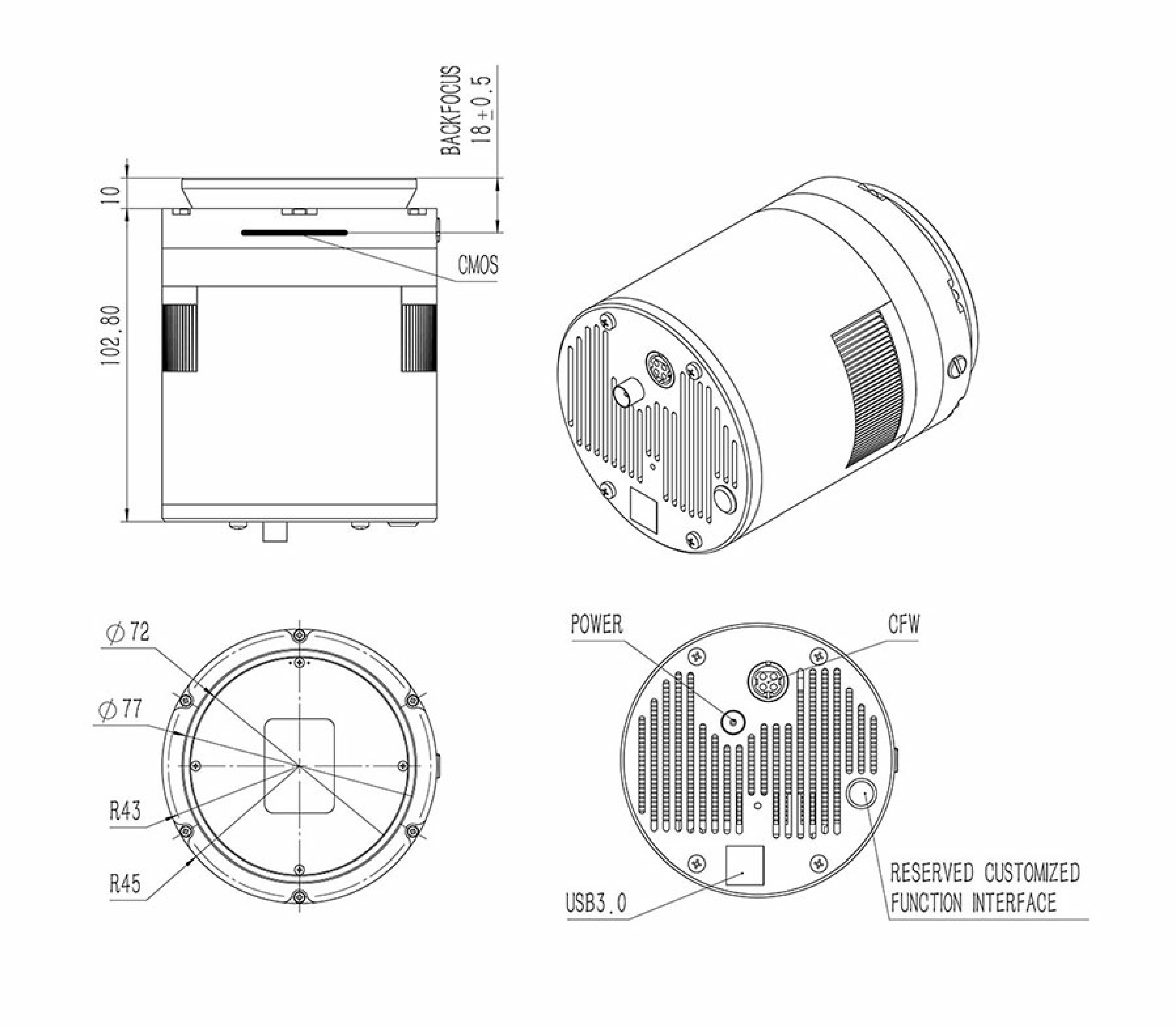


- Mechanical Dimensions

QHY268M



QHY268C



- Accessories and Match

- Combos and Adapters

Now we only have one APS-C Mono model—QHY268M.First there's no doubt that 2-inch filters are large enough to cover the whole sensor area, but they're not cheap enough. With a rough estimate, we think 36mm filter can be matched with scopes whose focal ratio are smaller than f/5 (f/4 worth a try, too). However, if your scope has a large focal ratio like f/2.8, we suggest you think carefully before using 36mm filters.

Model	BFL Consumed	Filters Supported
QHY268M	12.5mm	
CFW3M-US	17.5mm	7 position 36mm unmounted
CFW3L	21.5mm	7 position 2inch mounted/50mm unmounted
OAGM	10mm	

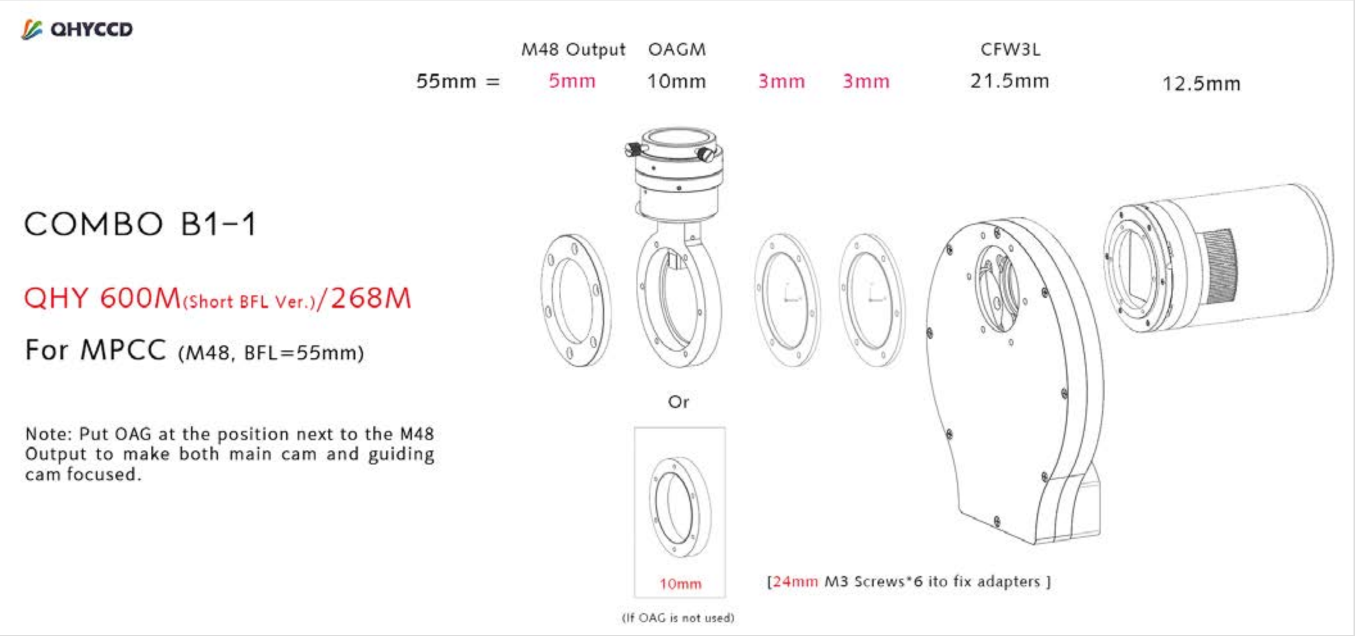
Generally speaking, there's no need for an OSC (one shot colored) camera to match filter wheel. If there's any special needs, please refer to mono cam combos and choose the corresponding filter wheel. All OSC cams use OAG M if needed.

Model	BFL Consumed
QHY268C	17.5mm+6mm (CAA)

Note: Adapter Kits B1 is provided FOR FREE with each QHY268M model. B1,B2,B3,are suited for QHY268M; Adapter Kits D1 is provided FOR FREE with each QHY268C model. D1,D2,D3,are suited for QHY268C.

- B1-1

B1: Connecting MPCC that requires 55mm BFL and M48 interface to Camera with CFWL and OAG

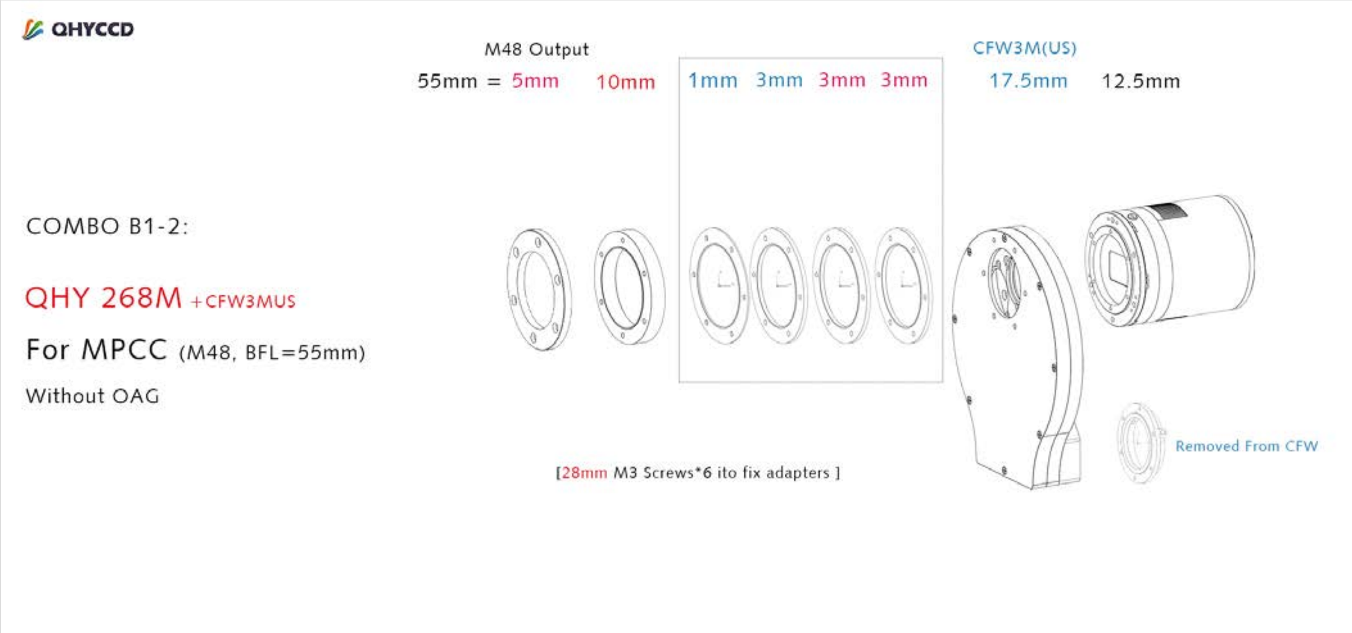


Note:

1. 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.
2. 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.
3. Put OAG at the position next to the M48 Output to make both main cam and guiding cam focused.

- B1-2

B1: Connecting MPCC that requires 55mm BFL and M48 interface to Camera with CFW3M-US Only



B1-3

B1: Connecting MPCC that requires 55mm BFL and M48 interface to Camera with CFWM-US and OAG

B2

B2: Connect Canon EF lens to Camera with filter Wheel

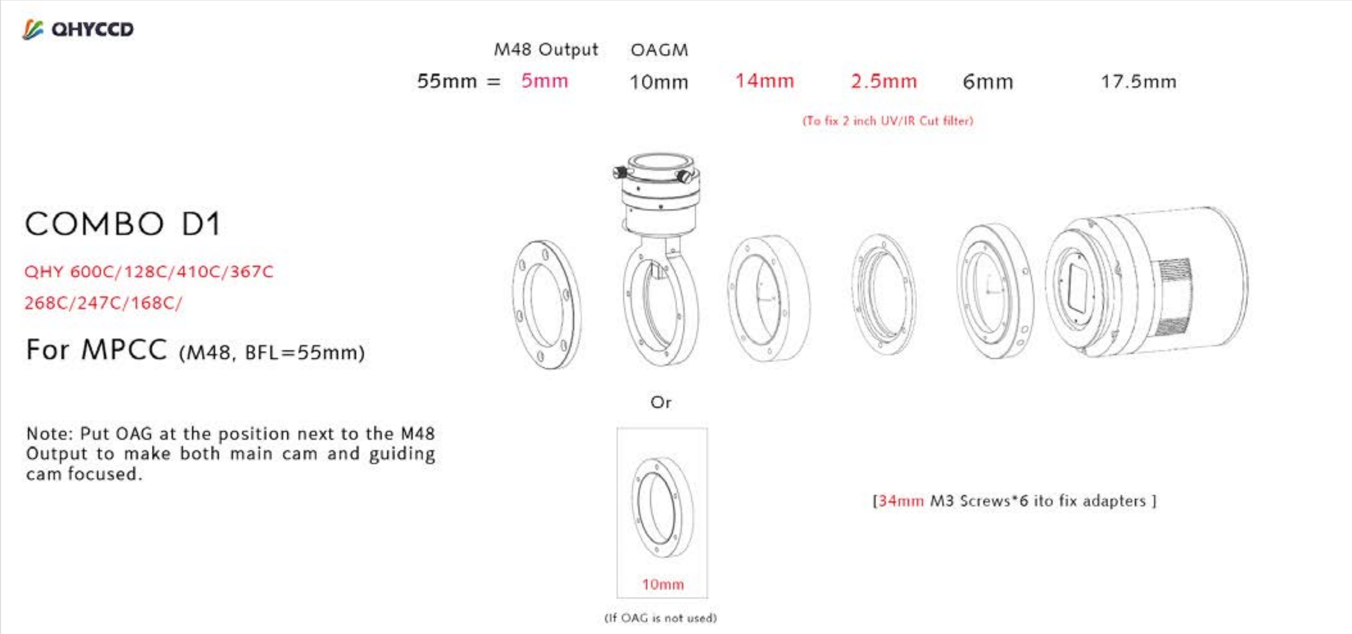
- B3

B3: Connect Nikon F Lens to Camera with Filter Wheel

Note: The current Nikon adapter used here is different from the 10mm adapter we used to provide. Now it has a back focal length increment of 12mm.

- D1

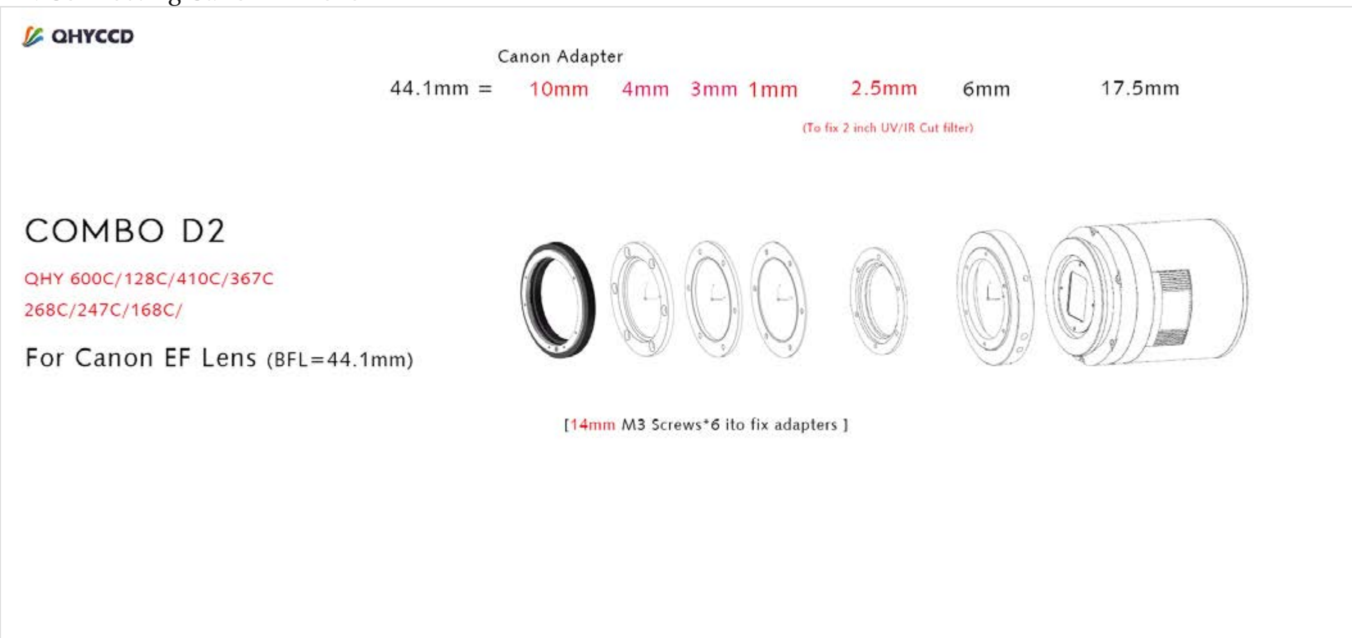
D1: Connecting MPCC with 55mm BFL and M48 interface



If you don’t use an OAG, please use 10mm adapter in the adapter kits to fill the original position of OAG.

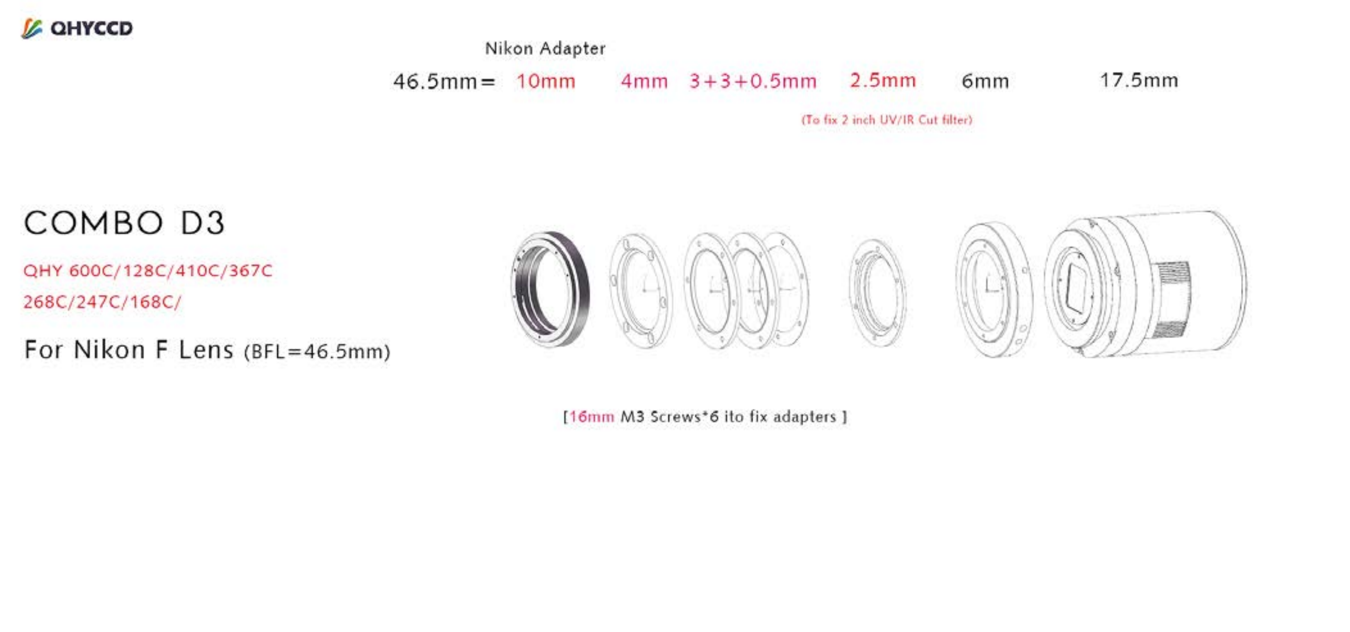
- D2

D2: Connecting Canon EF Lens



- D3

D3: Connecting Nikon F Lens



+ User Guide 1: Start the Camera

- 1. Before Start: 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.

- 2. Install "All-In-One" System Pack

All-in-one Pack (Windows) is for all QHYCCD USB3.0 devices, including all Cooling CMOS cameras, QHY5III and QHY 5II series, QHYCFW3. We recommend you choose "Stable Version" as usual.

In this pack there are:

1. System driver. It must be installed to make devices work.

2. EZCAP_QT: it's developed by QHYCCD which could be used in QHY devices tests, simple capture tasks, and above all, the management of updates. So even if you won't use EZCAP_QT as your main capture software, we suggest you install it to get the latest information of QHY drivers/SDK updates.

3. Ascom driver: Ascom Platform is supported by most astronomy devices which connect to Windows.

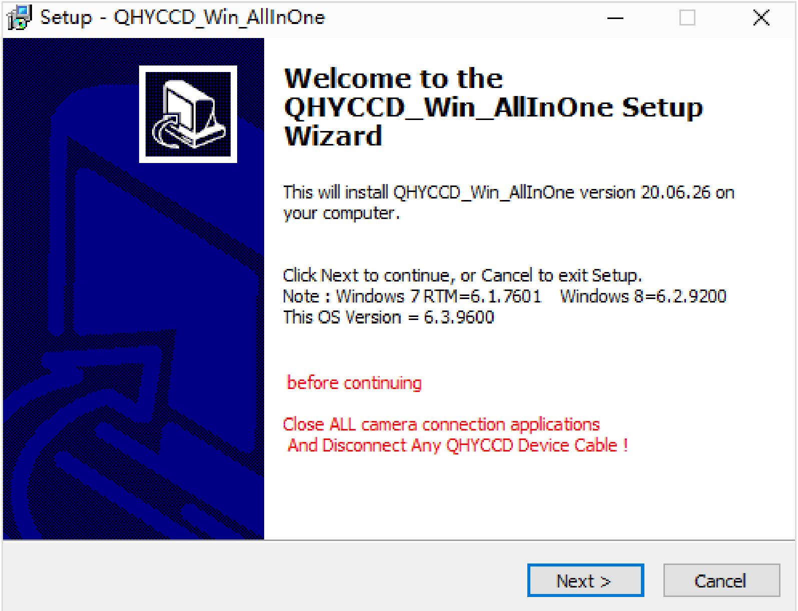
4. SDK: SDK is the file of ".dll" format. With this the device can be identified in other capture software.

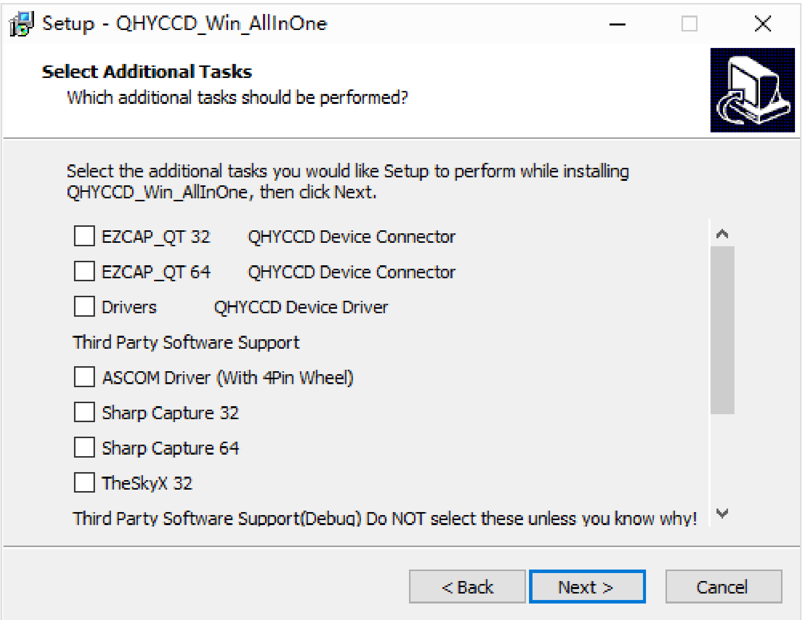
5. SkyX Plugin: special support for SkyX.

6. QHYCCD BroadCast WDM Driver: It 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.

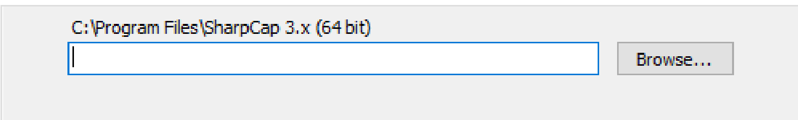
How to install it?

Take SharpCap (x64) for example:
Before the installation, make sure you've already installed SharpCap (X64) on your PC;





Then click "Third Party Software Support" – "SharpCap 64", the pack will detect the location of SharpCap files and install automatically; if not, please manually select root directory of SharpCap where you installed it, like: C:\Program Files\SharpCap 3.2 (64 bit)



3. Connect with Software

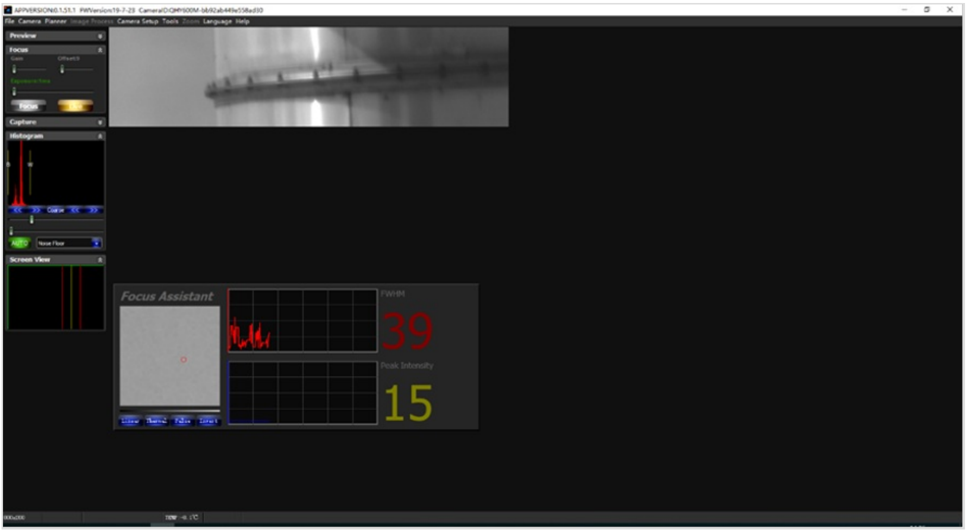
Before using software, make sure you have connected the cooling camera to the 12V power supply and connected it to the computer with a USB3.0 data cable. If it's a planetary/guiding camera, 12V power is not needed.

Note: We recommend 64-bit Software when you're using cameras with a large sensor, such as QHY600. A full resolution image from the QHY600 is 120MBytes. It takes a significant amount of processing power and memory to capture, buffer, display and process. We therefore suggest using 64-bit software with the QHY600, for example, SharpCAP x64 , N.I.N.A x64. etc. Although the camera has 4GB of internal memory, 32-bit software will run within this memory area and the remaining memory may be not sufficient for normal operation.

3.1 EZCAP_QT

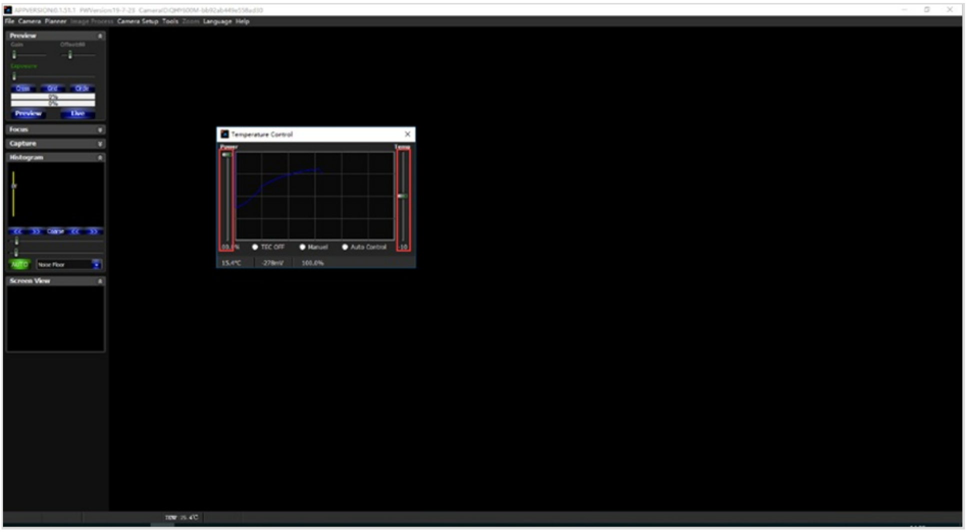
EZCAP_QT is software developed by QHYCCD. This software has basic capture functions for QHYCCD deep sky cameras.

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.



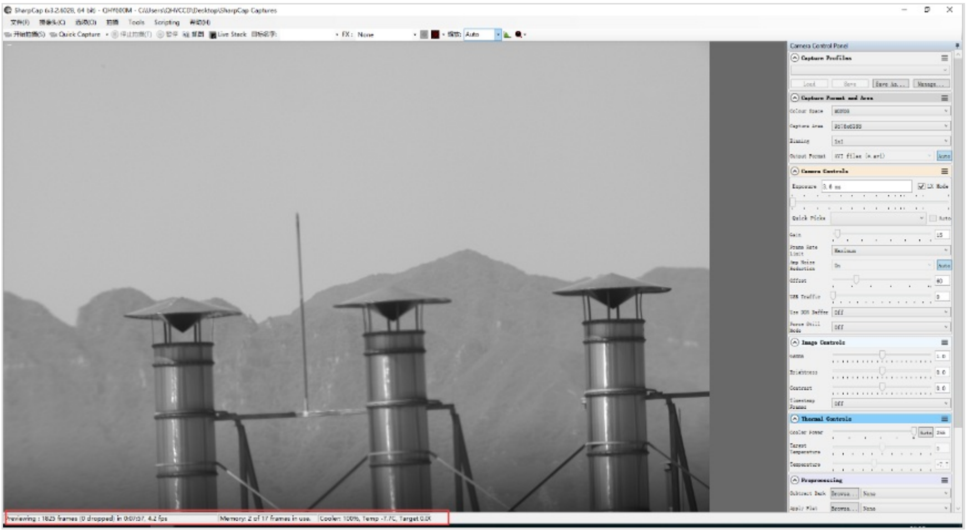
Click “Temperature Control” in “Camera Settings” to set the temperature of the CMOS sensor. You can turn on “Auto” to set the target temperature. For example, here we set the target temperature to -10C. The temperature of the CMOS sensor will drop quickly to this temperature (approximately 2-3 minutes). 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.



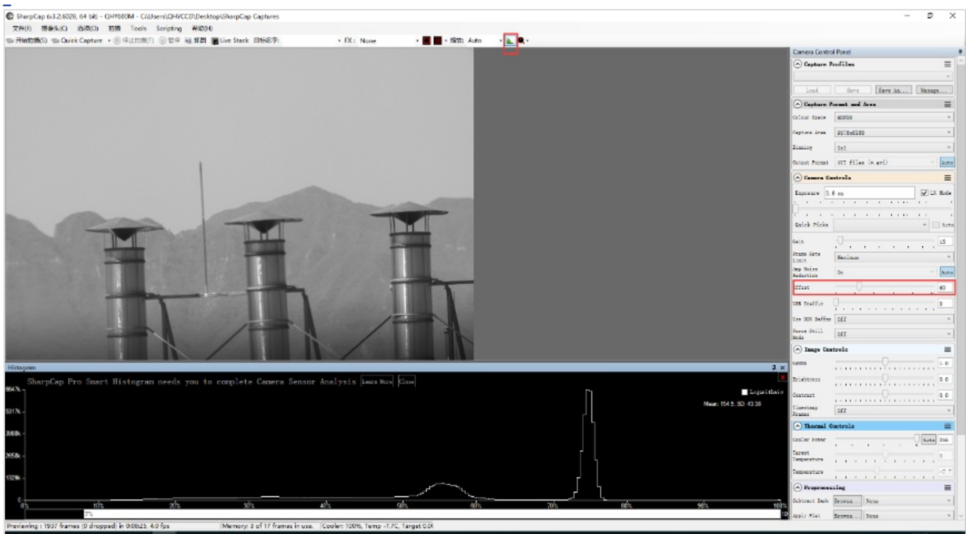
3.2 SharpCap

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.

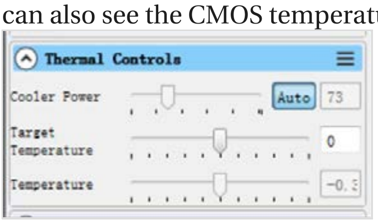
Offset adjustment. When you completely block the camera (i.e., like taking a dark frame) you may find that the image is not really zero. Sometimes this will reduce the quality of the image contrast. You can get a better dark field by adjusting the offset. You can confirm this by opening the histogram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

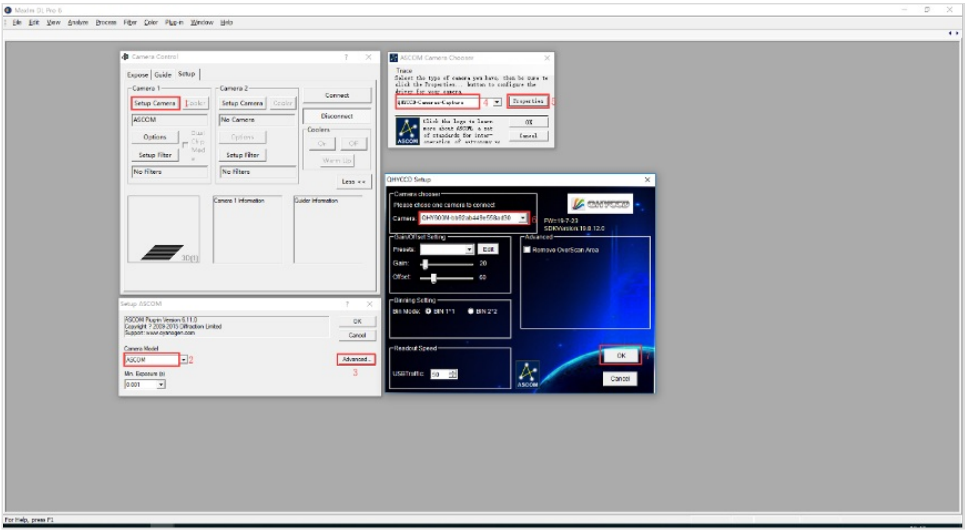
After cooling devices connected to the 12V power supply, the temperature control circuit will be activated. You can control the CMOS temperature by adjusting the settings in the figure below. Basically, you can control the temperature of CMOS by either adjusting “Cooler Power” or clicking “Auto” and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

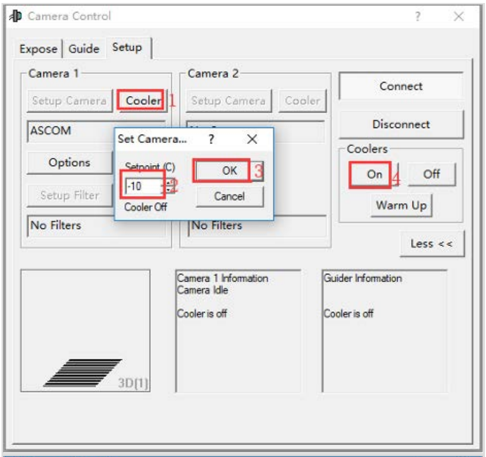


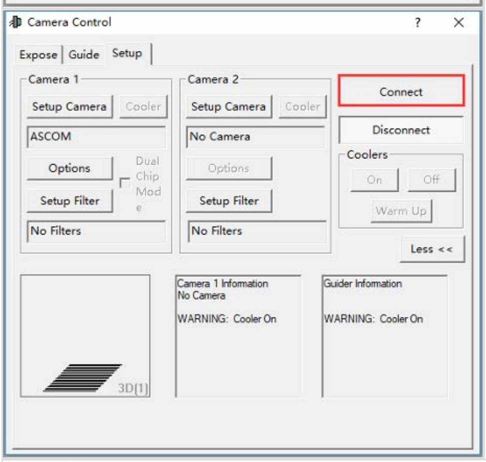
3.3 ASCOM supported software (e.g. MDL)

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.




Camera Control
Expose
Guide
Setup
Camera 1
Camera 2
Setup Camera
Cooler
Connect
Disconnect
ASCOM
Set Camera...
Setpoint (C)
-10
OK
Cancel
Cooler Off
Coolers
On
Off
Warm Up
Options
Setup Filter
No Filters
Less <<
Camera 1 Information
Camera Idle
Cooler is off
Guider Information
Cooler is off
3D[1]


Camera Control
Expose
Guide
Setup
Camera 1
Camera 2
Setup Camera
Cooler
Connect
Disconnect
ASCOM
No Camera
Coolers
Options
Dual Chip Mode
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Setup Filter
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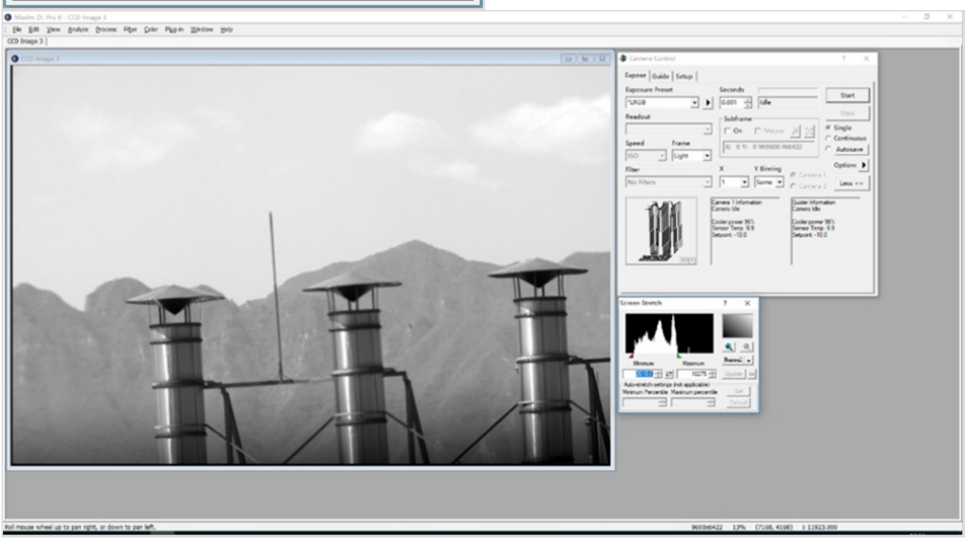
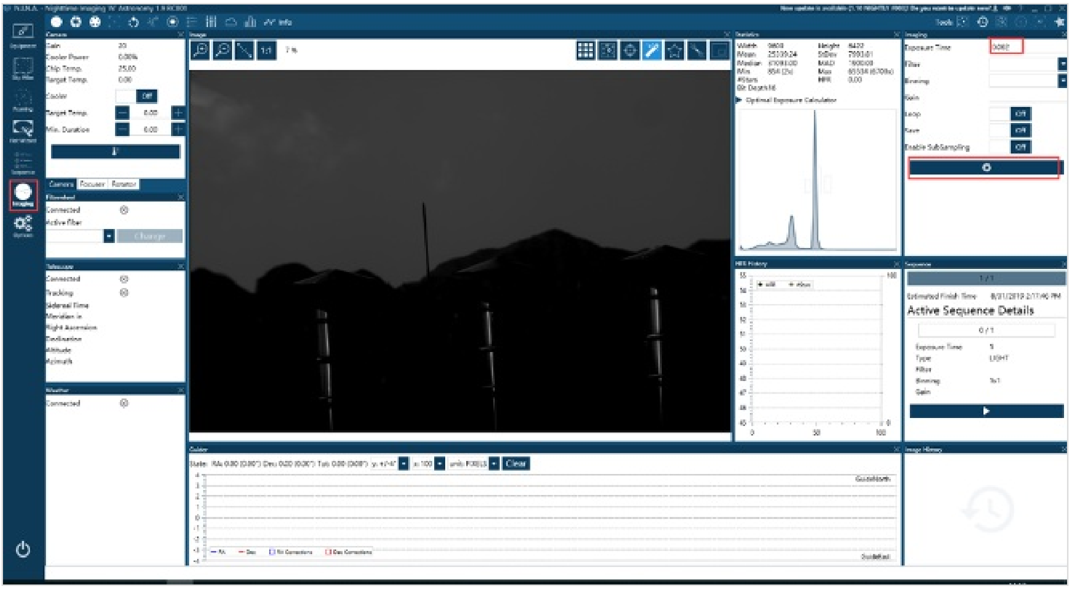
WARNING: Cooler On
3D[1]



3.4 N.I.N.A

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

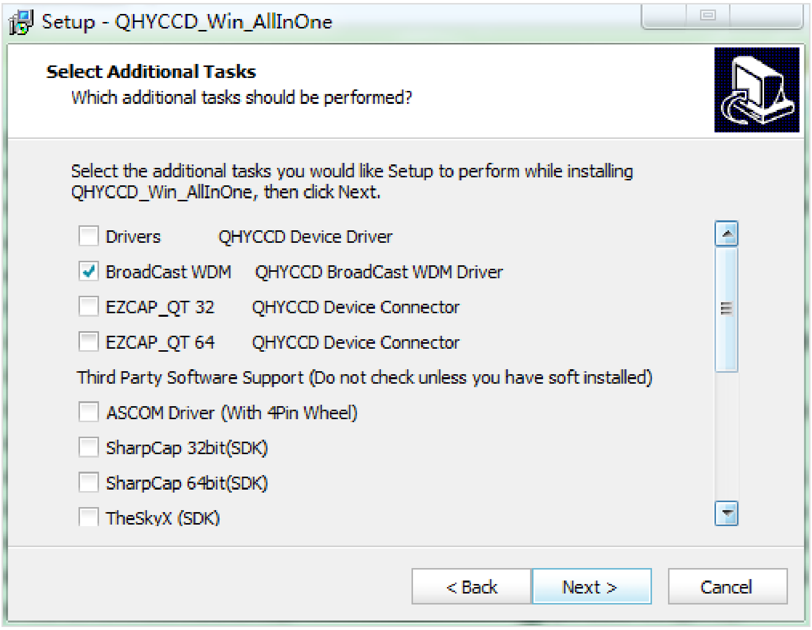
Turn on the TE cooler to set temperature. Then set the exposure time to capture the image.



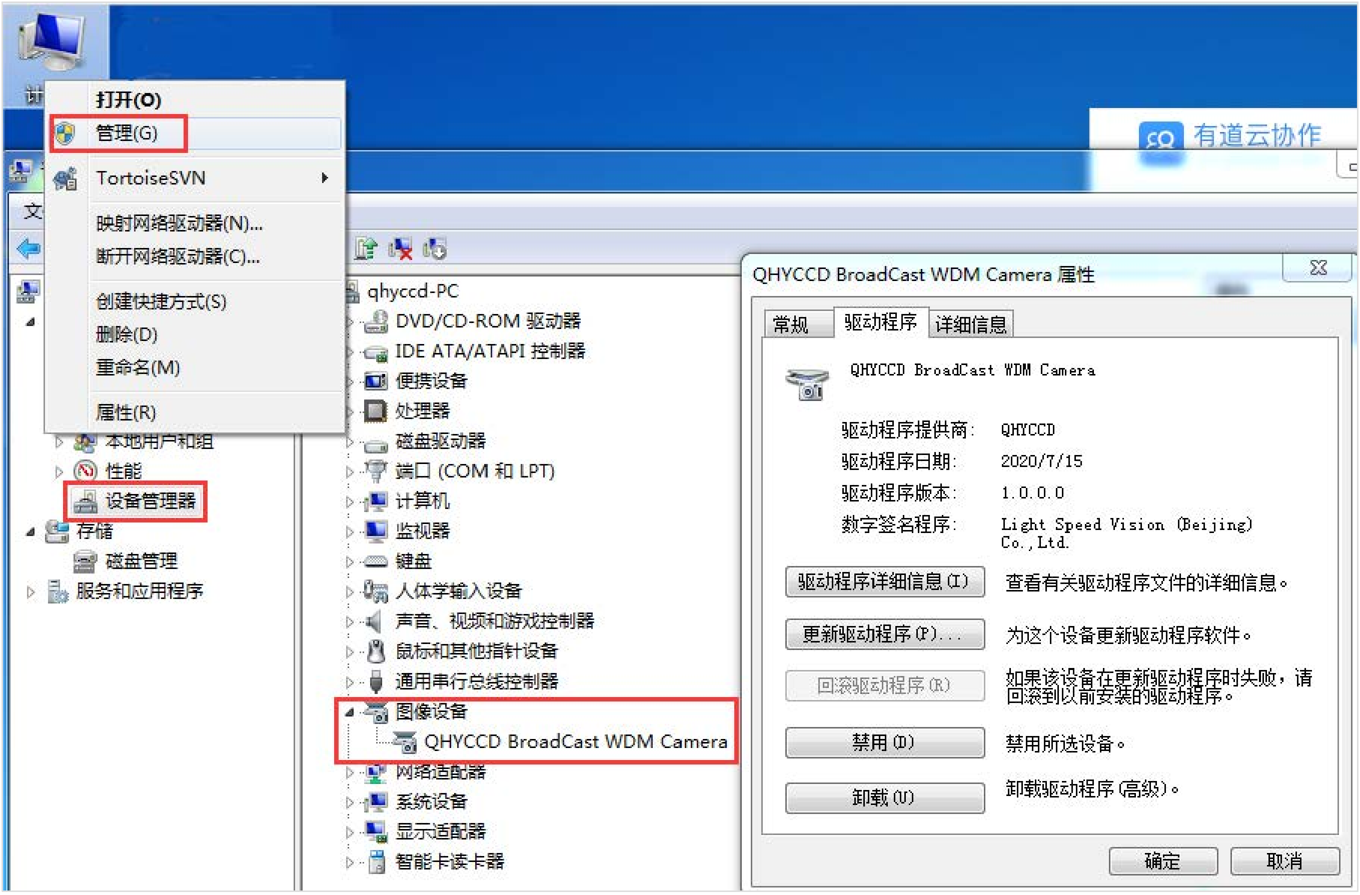
- 4. BroadCast WDM Camera Driver

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.

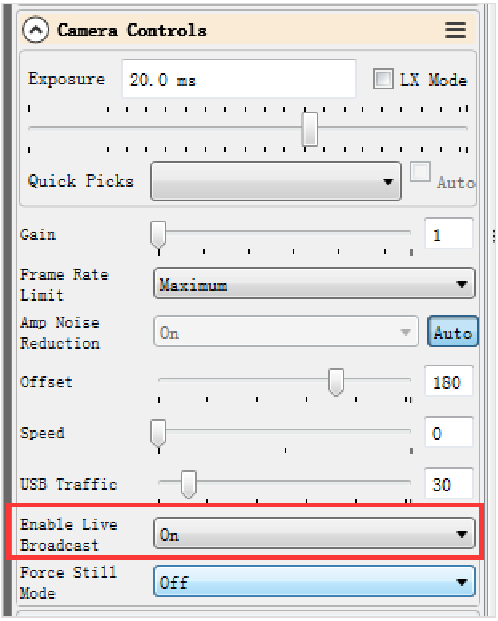


The installation process is over, right-click the computer to find the device manager, and check that the image device name is QHYCCD BroadCast WDM Camera, which means the installation is successful.

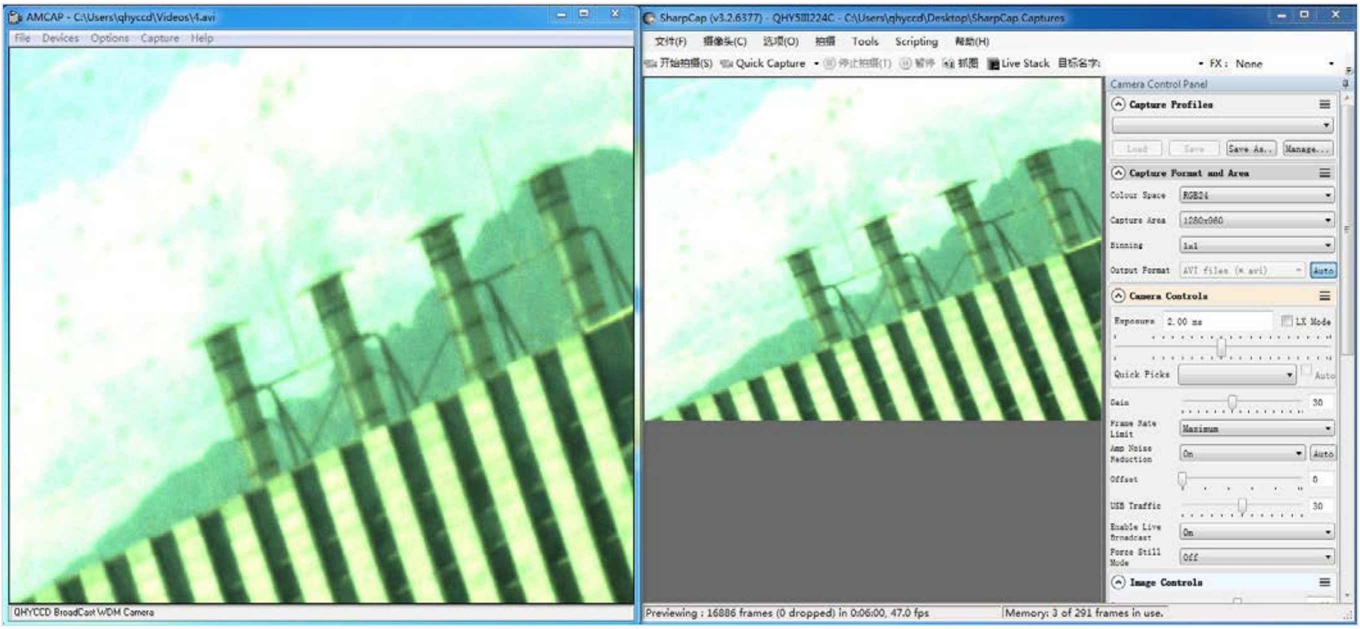


Activate the function:

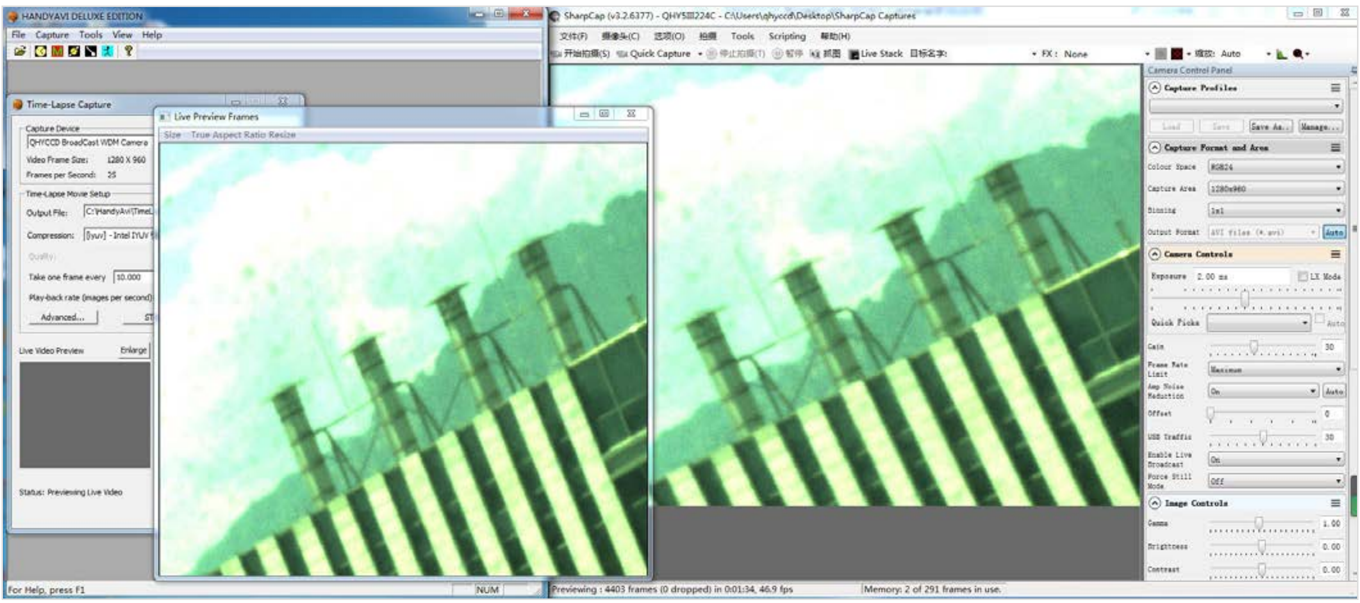
Usually sharpcap is used to connect the camera as the broadcasting terminal. After connecting the camera, you need to turn on the Enable Live Broadcast switch to broadcast.



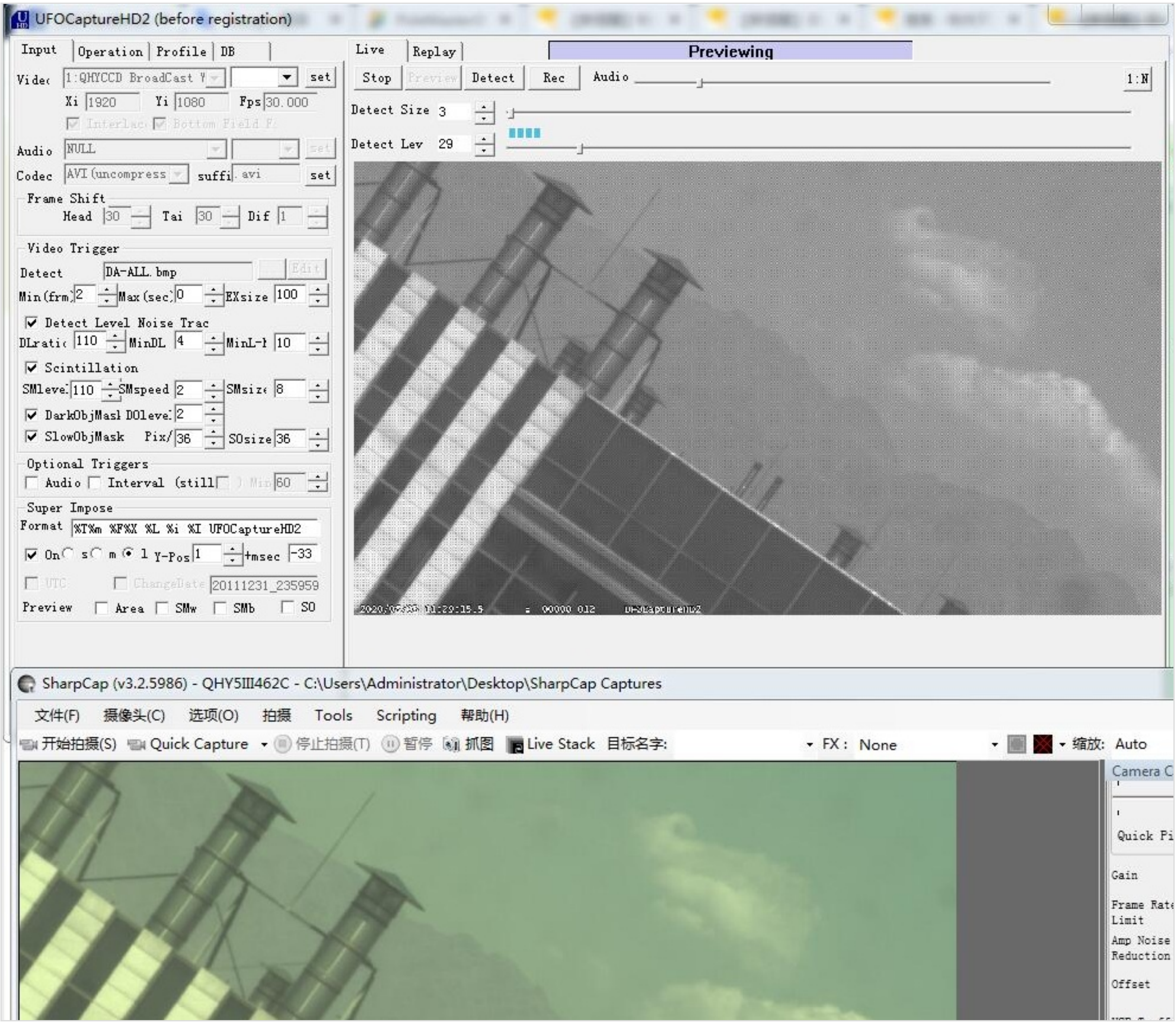
Common supporting software (ie, broadcast receiver) includes: UFOCAPTURE, HANDYAVI, QQ video functions, etc. AMcap test effect chart:



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.

+ User Guide 2: Make Better Use of the Camera

- 1.Reboot the camera by power off and on

The QHY600/268 is designed to use the +12V to reboot the camera without disconnecting and reconnecting the USB interface. This means that you can reboot the camera simply by shutting down the +12V and then powering it back on. This feature is very handy for remote controlling the camera in an observatory. You can use a remotely controlled power supply to reboot the camera. There is no need to consider how to reconnect the USB in the case of remote control.

- 2.Image Area Layout

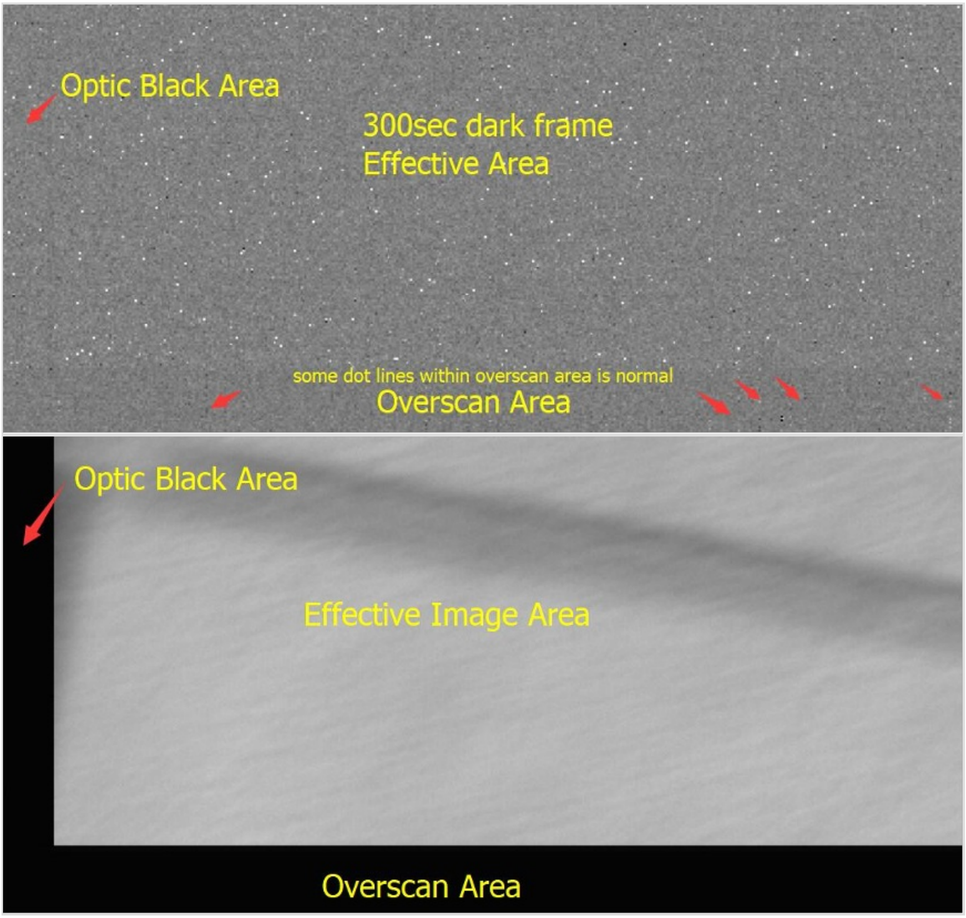
The QHY600 can output the whole active area of the sensor, including the optically black pixels and the overscan area. The total image size including the optically black area area is 9600 x 6422 pixels. The optically black area is on the left of the image and the overscan area is on bottom of the image.

The difference of optically black area and overscan area is that the optically black area includes the dark current during a long exposure while the overscan area does not include the dark current during an exposure.

Neither the optically black area nor the overscan area respond to light, so they are regarded as the “non-effective” area of the sensor.

In the bottom of the overscan area you may find some vertical series of dots in single frame that can become vertical lines after stacking. One of the reasons for this is that the FPN calibration results represented in the overscan area can't be found in the effective image area.

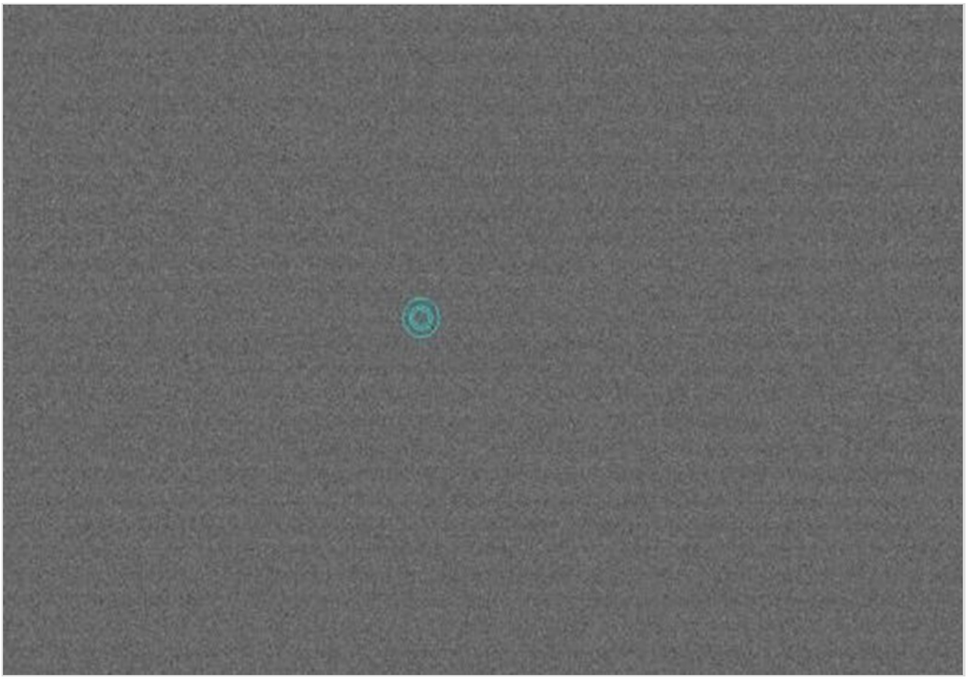
The following picture is the left bottom corner of a 300 second dark image. You can see these dots in the overscan area. The optically black level area and overscan area are usually used for precise calibration of an image and for calibration of an image without using a bias frame or dark frame, or for some scientific applications. Because the optically black and overscan areas are not part of the effective image area, QHYCCD does not guarantee the signal quality in these areas. If you do not use these areas, you can select the option "Ignore overscan area" in the ASCOM driver or select a ROI of effective area in SharpCAP.



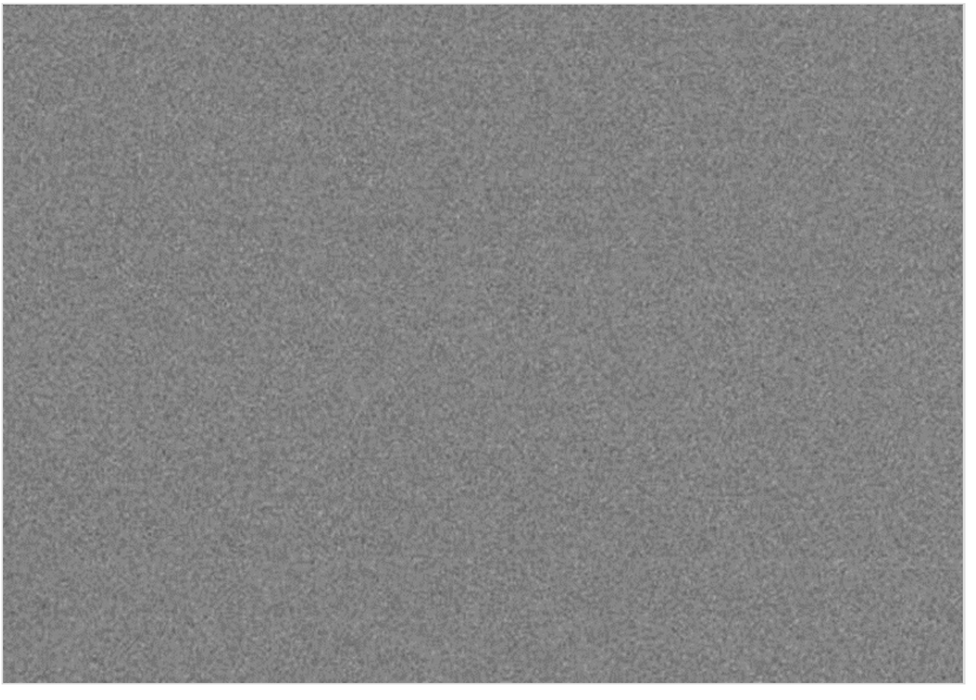
3.Optimizing USB Traffic to Minimize Horizontal Banding

It is common behavior for a CMOS sensor to contain some horizontal banding. Normally, random horizontal banding can be removed with multiple frame stacking so it does not affect the final image. However, periodic horizontal banding is not removed with stacking so it may appear in the final image. For QHY600, by adjust the USB traffic in Single Frame mode or Live Frame mode, you can adjust the frequency of the CMOS sensor driver and it can optimize the horizontal banding appeared on the image. This optimized is very effective to remove the periodic banding in some conditions.

A typical Periodic Horizontal Noise under certain USB_TRAFFIC values.



After Adjusting the USB Traffic to avoid the periodic horizontal noise.



+ User Guide 3: FAQs

-

What if ALL-In-One Pack installation fails / installation is successful but the device still cannot be detected?
Please make sure you've already installed capture software you need before you add their plugins; check whether your software is 32bit(X86) or 64bit(X64) and select the relevant SDK.

-

What if All-in-one pack doesn't support the auto installation I'm using now?
Since the pack is still under developing, currently it doesn't support auto installation of all sorts of astrophotography software. But don't worry, we can still finish the job with manual installation.

Take Fire Capture as example. So far you cannot click "Fire Capture" in "Third Party Support" part, so just skip it. When installation is finished, it creates a short cut named "QHYCCD-SDK" on desktop, which includes all SDK. Pick up the file you need and paste it to the root directory of Fire Capture:

-

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.

-

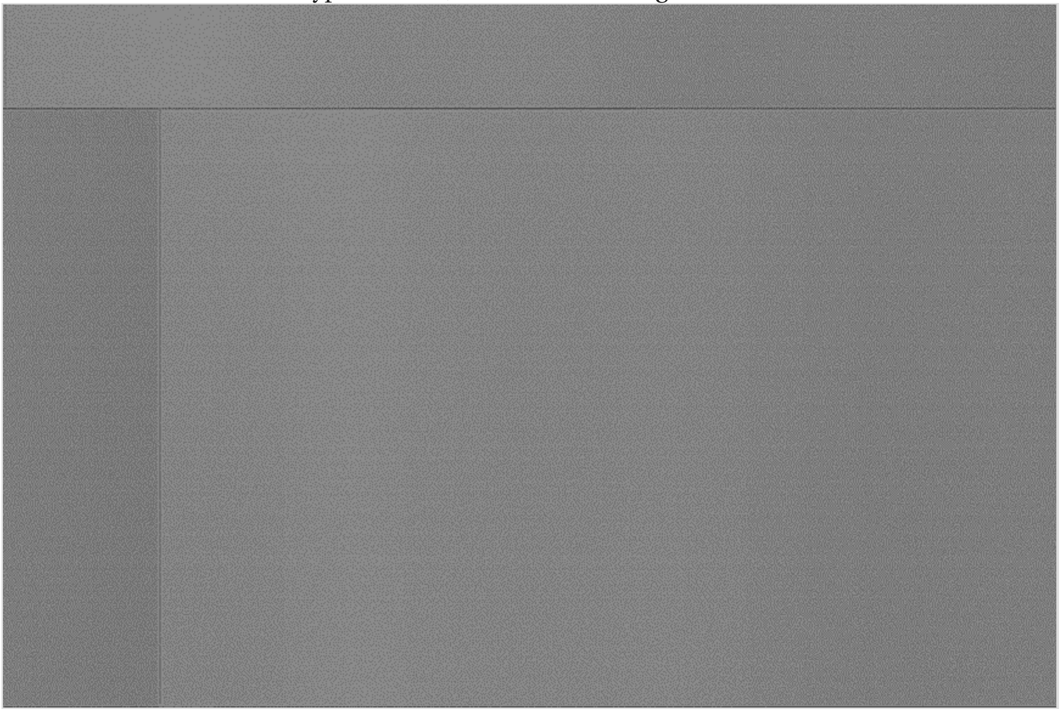
The frame rate drops to 0 after the camera restarts when DDR mode is turned on.

The large file sizes of high-resolution images and fast frame rates will tax computers that are not designed and configured for such high speed, high data rate transfers and display. Some users reported that the frame rate of their cameras with DDR modules dropped to zero after re-running on SharpCap. This problem is caused by the high output rate of the CMOS chip and the slow reception rate of the computer. If the computer suspends USB transmission too much due to the operating system, it will cause the DDR data to overflow, resulting in the continuous generation of bad frames. None of the images entering the DDR are complete, so the frame is implanted with zeros.

Solutions: The first method is to replace a better computer. For computers with poor performance, we recommend replacing them to ensure that the camera runs normally. The second method is to turn off the DDR mode in SharpCap, but for computers with poor performance, this method is not necessarily effective due to its slow data transmission speed.

-

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 (QHY recently released the All-In-One installation package, which can automatically replace the SDK with one click, you only need to check the corresponding software in the installation package), or request QHYCCD technology Support remote assistance.

+ User Guide 4: Camera Maintenance

- 1. Camera grounding precautions

To avoid the problem of unreliable USB connection or port damage caused by leakage of computer or 220V to 12V adapter

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.

- 2. 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.

- 3. 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.

- 4. 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.

- 5. Protecting the TE Cooler

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 1: 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 2: Bayer Sequences of Some Colored Cameras

-

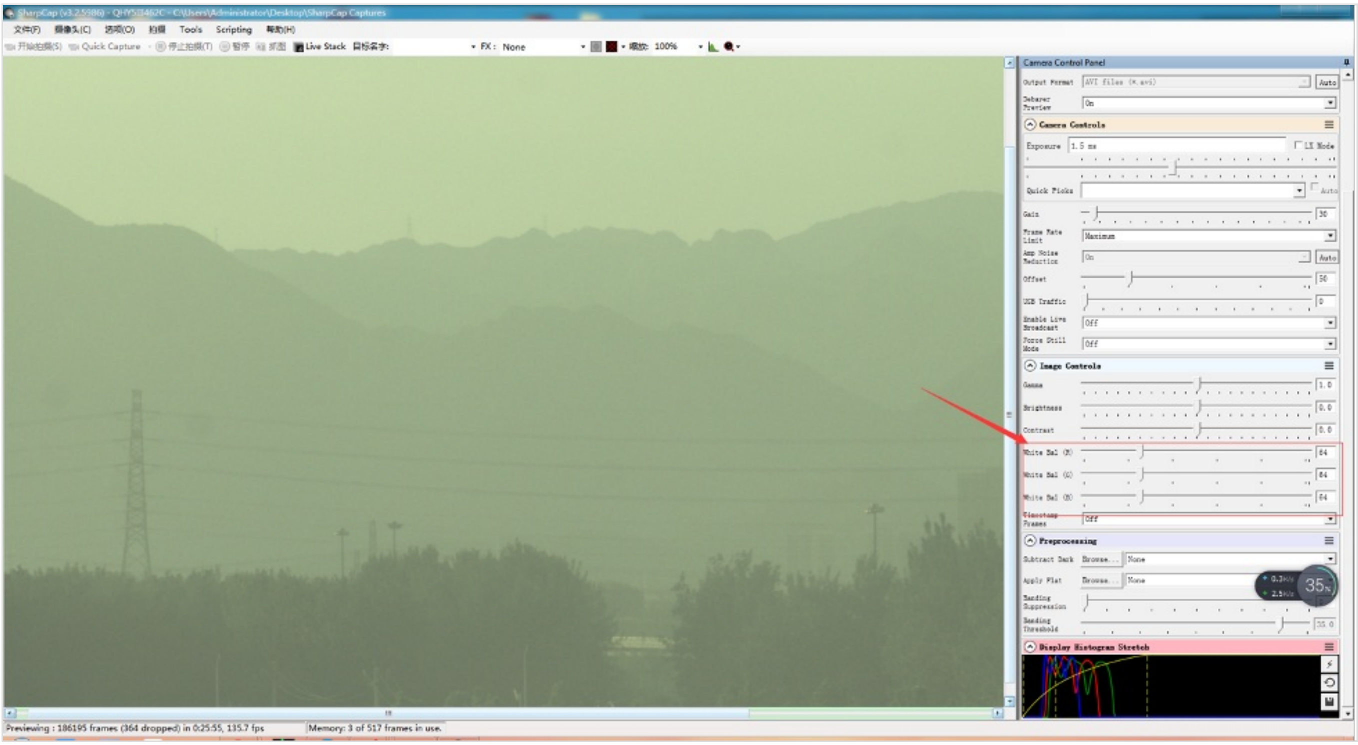
Cooled CMOS Camera	Bayer
QHY600C	RGGB
QHY268C	RGGB
QHY410C	RGGB
QHY367Pro	RGGB
QHY128Pro	RGGB
QHY294C	RGGB
QHY247C	RGGB
QHY168C	RGGB
QHY165C	RGGB
QHY163C	GRBG
QHY183C	RGGB
QHY174C	RGGB
QHY178C	GBRG
QHY290C	GBRG
QHY224C	GBRG
Planetary and Guiding	**Bayer**
QHY5III174C	RGGB
QHY5III178C	GBRG
QHY5III224C	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 3: 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.

- Appendix 4 Testing the QHY 268 Mono for science observations (by alto-observatory)

Abstract

The purpose of this paper is to conduct a series of tests, both on the bench and on real stars, to understand the behaviour of the new QHY268 Mono in the field of science observations for the amateur community. The availability of high end cameras, such as the new CMOS cameras, is now opening an entire new field of observations for the general amateur that can effectively produce useful scientific data.

In this paper the testing of the QHY268 Mono is conducted in four parts:

1. measuring the camera basic performance in terms of conversion factor (full well capacity), readout noise, dynamic range and dark current
2. measuring the linearity of the camera
3. testing the camera for recording spectra of variable stars and planetary nebulae
4. testing the camera for demanding photometry such as observing exoplanet transits

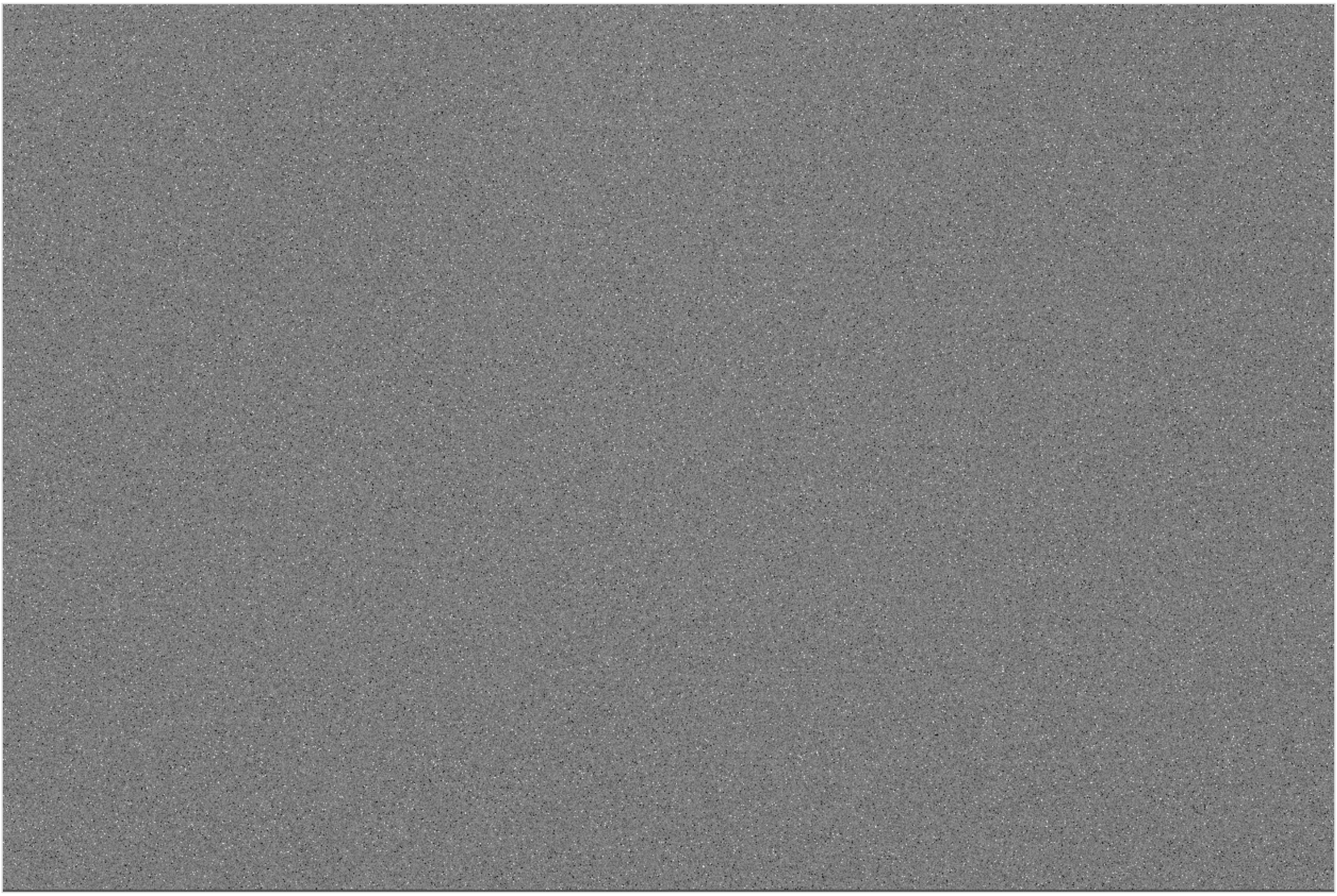
For the first two goals the camera has been evaluated on a test bench taking various calibration frames. For the other goals images of real stars are taken and measured.

1. Measuring the QHY268 Mono – basic performance

Before illustrating results of the behaviuor of the camera we would like to highlight just a couple of things. The QHY268 Mono has a really beautiful fit and finish and to avoid condensation problems it has a small hole near the top of the camera that is covered by a black cap. In case of condensation on the front glass window QHY recommends to use a supplied tube of silica. The first test we have conducted was in a humid environment. However keeping the cooler at -10C for the entire test duration resulted in no dew at all. Point to note is that in binning 1×1 the files are 50 Mb in size and even if the camera is equipped with an Usb 3.0 port it takes about 3 seconds to download images. On the other hand a CCD with similar size would take no less than 30 seconds to download a 1×1 binned frame.

The camera offers 4 operating modes, each of which delivers a different response curve in terms of readout noise and gain. After studying the curves provided by QHY we have tested mode #1 (high gain) and mode #3 (extend fullwell 2CMS) as we see no particular advantage of using the other two modes. For science obervations you want as little noise as possible but also a good dynamic range as in many star fields it is not possible to find comparison stars that have roughly the same brightness of the variable star we want to measure. For spectroscopy readout noise should be kept as low as possible because it is going to be more important than sky noise in terms of limitations.

Looking at the curves of mode #1 we can see that the best dynamic range is reached at gain 0 and 60. According to Richard Berry's book Aip4win to make the evaluation it is necessary to take and measure 2 flats, 2 bias and 1 long dark (we have chosen 600 seconds). We then have measured the parameters of the camera at gain 0 and at gain 52- 56-58-60 and 64. Temperature has been set at -10C and to avoid pixels with zero value the offset has been set at 20. Offset is basically adding a pedestal to the image and we have found that a value of 20 results in pixels with a minumum value of around 150 – 200 ADU across the frame with an average of about 326 ADU. One thing to notice is that there is no amp glow at all. The 600 second dark frame show some hot pixels. However only 86pixels appear to be saturated. Altough the number of saturated hot pixels is small, to avoid calibration problems you may want to reduce exposures to perhaps 300 seconds and stack multiple images.


A highly stretched dark frame of 600 seconds taken through the QHY268 Mono showing no amp glow. The gain has been set at 64, offset 20 and temperature -10C

From the above-mentioned test we get the following results:

Mode #1 (high gain)

Gain 0	**results**	**Notes**
Conversion factor	0.77 e/ADU	
Full well	50,462	
Readout noise	3.56 e RMS	
Mean dark current	0.001558 e/px/sec at -10C	
Dynamic range	14,175 grey tones	Highest dynamic range
Gain 52		
Conversion factor	0.39 e/ADU	
Full well	25,559	
Readout noise	3.58 e RMS	
Mean dark current	0.001744 e/px/sec at -10C	
Dynamic range	7,139 grey tones	
Gain 56		
Conversion factor	0.33 e/ADU	
Full well	21,626	
Readout noise	1.66 e RMS	
Mean dark current	0.001641 e/px/sec at -10C	
Dynamic range	13,027 grey tones	

Gain 58		
Conversion factor	0.32 e/ADU	
Full well	20,971	
Readout noise	1.59 e RMS	Lowest readout noise
Mean dark current	0.001575 e/px/sec at -10C	
Dynamic range	13,189 grey lines	
Gain 60		
Conversion factor	0.31 e/ADU	
Full well	20,316	
Readout noise	1.67 e RMS	
Mean dark current	0.0016933 e/px/sec at -10C	
Dynamic range	12,165 grey tones	
Gain 64		
Conversion factor	0.28 e/ADU	
Full well	18,350	
Readout noise	1.69 e RMS	
Mean dark current	0.001594 e/px/sec at -10C	
Dynamic range	10,858 grey tones	

From the above results we can then conclude that Gain 0 and Gain 58 are likely to deliver the best results for doing spectroscopy and photometry. Gain 0 will probably be more useful under light polluted skies while Gain 58 is probably more useful for fainter objects under semi-urban and dark rural skies.

By studying the curves of the other modes we have then tested mode #3 that offers a bigger full well and a reduced readout noise compared to mode #2. Here are the results for Gain 0 and Gain 40 (offset and temperature remain the same):

Mode #3

Gain 0	results	notes
Conversion factor	1.28 e/ADU	
Full well	83,886	Highest full well
Readout noise	5.82 e/Rms	
Mean dark current	0.001429 e/px/sec at -10C	
Dynamic range	14,413 grey tones	Highest grey tones
Gain 40		
Conversion factor	0.82 e/ADU	
Full well	53,739	
Readout noise	5.54 e/Rms	
Mean dark current	0.001795 e/px/sec at -10C	

Dynamic range	9,700 gray tones	

From the above results we can see that at Gain 0 we have the highest dynamic range regardless of the bigger readout noise compared to mode #1. For photometry of bright objects this can be the best setting altough mode #1 offers the advantage of a lower readout noise. Gain 40 offers no advantages over the settings we have tested in mode #1.

Those results have been confirmed by testing another QHY268 mono unit. In that case we have used an higher sensor temperature (about -7.2C).

Here are the results:

Mode #1 (high gain)

Gain 0	**results**	**Notes**
Conversion factor	0.77 e/ADU	
Full well	50,462	
Readout noise	3.49 e RMS	
Mean dark current	0.002272 e/px/sec at -7.3C	
Dynamic range	14,459 grey tones	Highest dynamic range
Gain 58		
Conversion factor	0.32 e/ADU	
Full well	20,971	
Readout noise	1.58 e RMS	
Mean dark current	0.002595 e/px/sec at -7.2C	
Dynamic range	13,272 grey lines	
Gain 59		
Conversion factor	0.31 e/ADU	
Full well	20,316	
Readout noise	1.54 e RMS	Lowest readout noise
Mean dark current	0.002531 e/px/sec at -7.2C	
Dynamic range	13,192 grey tones	
Gain 60		
Conversion factor	0.31 e/ADU	
Full well	20,315	
Readout noise	1.69 e RMS	
Mean dark current	0.002571 e/px/sec at -7.3C	
Dynamic range	12,021 grey tones	

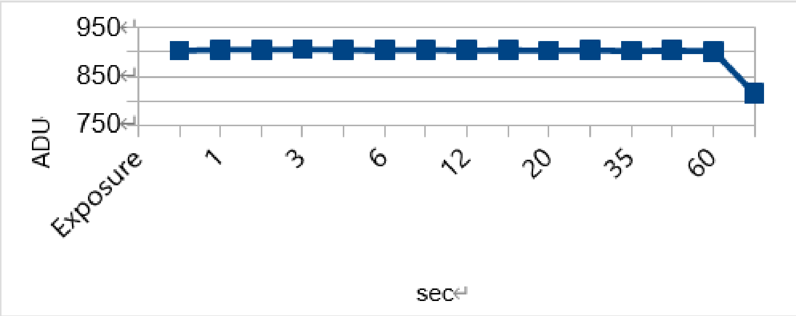
We continue to test the behaviour of the QHY268 Mono in mode #1 at Gain 0 and Gain 58-59 since we feel that overall these are the best settings for this camera. We will however use mode #3 at gain 0 for exoplanet work.

2. Measuring the linearity of the QHY268 mono

We have conducted this test, according to Aip4win book by Richard Berry, by taking a series of increasing and decreasing flats to measure the deviation in Adu with different exposures. For each exposure time 2 flats and 1 corresponding dark has been taken. As baseline we have set an exposure of 0.5 sec to be slightly above the bias level and then we have used exposures up to 80 seconds to saturate the camera. The test has been conducted in mode #1, Gain 0 and Gain 58. Offset and temperature still at 20 and -10C respectively. Here are the results:

QHY268 Mono linearity test

Gain 0

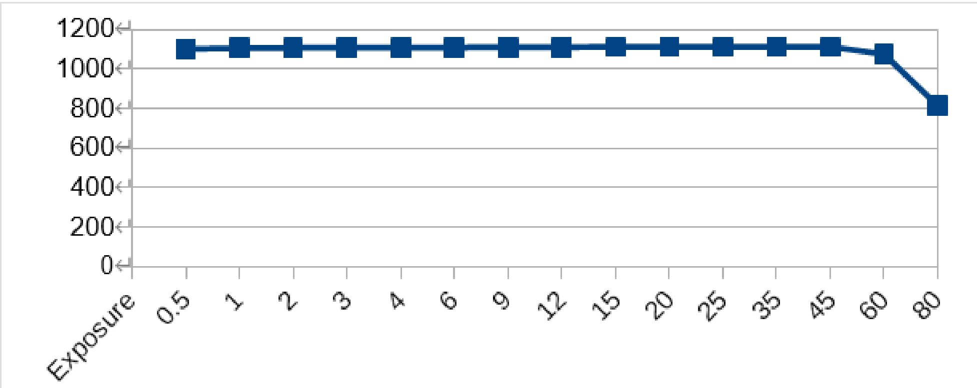


The above graph shows that the camera is very linear with a deviation of less than 0.3% from 500 ADU to 55,000 ADU. The 80 sec exposure is saturated so it cannot be taken into account for this test.

At Gain 58 results are basically the same:

QHY 268 Mono-linearity test

Gain 58



The exposures of 60 and 80 seconds are saturated so they cannot be taken into account for determining linearity.

Note that the graphs above are very sensitive as we have decided to plot the ADU per second instead of plotting the average ADU at each exopsure time so that even a minimal deviation can be clearly seen.

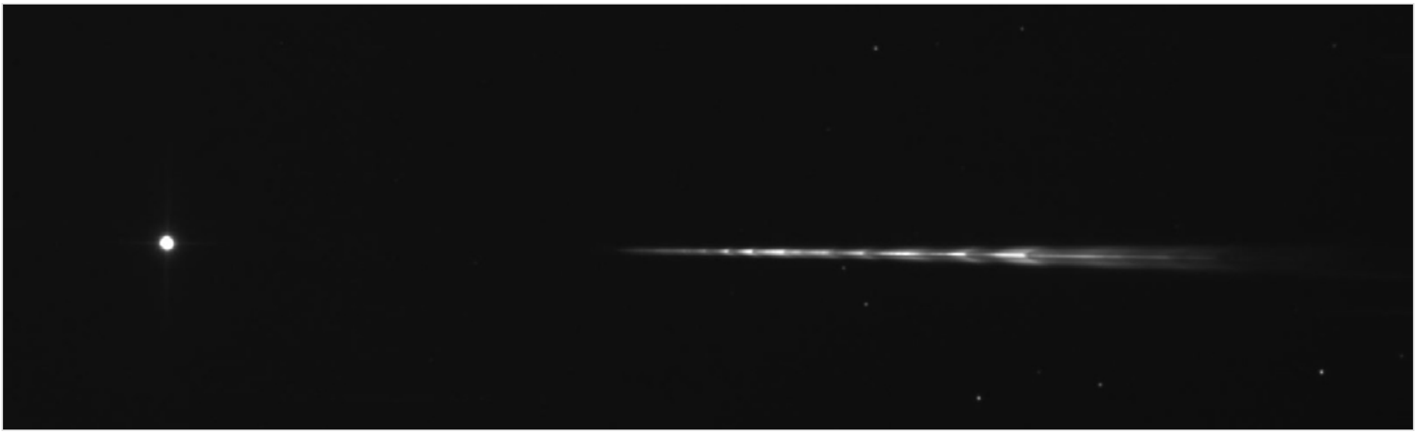
We conclude that the QHY268 is a very linear camera, much better than other CCDs we have tested in the past, many of which show a variation in the bias level and linearity as a function of exposure. The linearity range of this camera is absolutely satisfactory to be used for science observations to near saturation limit. We think a deviation of about 1% is likely to take place over the almost entire range of this camera from 500 ADU to about 60,000 ADU. In the real world this is an extreme situation that may only take place when we have to measure the brightness of red giants in the near infrared where exposures are short to avoid saturation of the variable star and comparisons stars appear very dim.

Another thing that is worth noting is that this camera has very stable electronics (the average value of dark frames is the same at any exposure time, with minimal differences in standard deviation) so we expect less scatter in scientific data compared to other consumer cameras. This may be an advantage for examples when observing transiting exoplanets.

3. Testing the QHY268 mono for recording spectra of variable stars and planetary nebulae

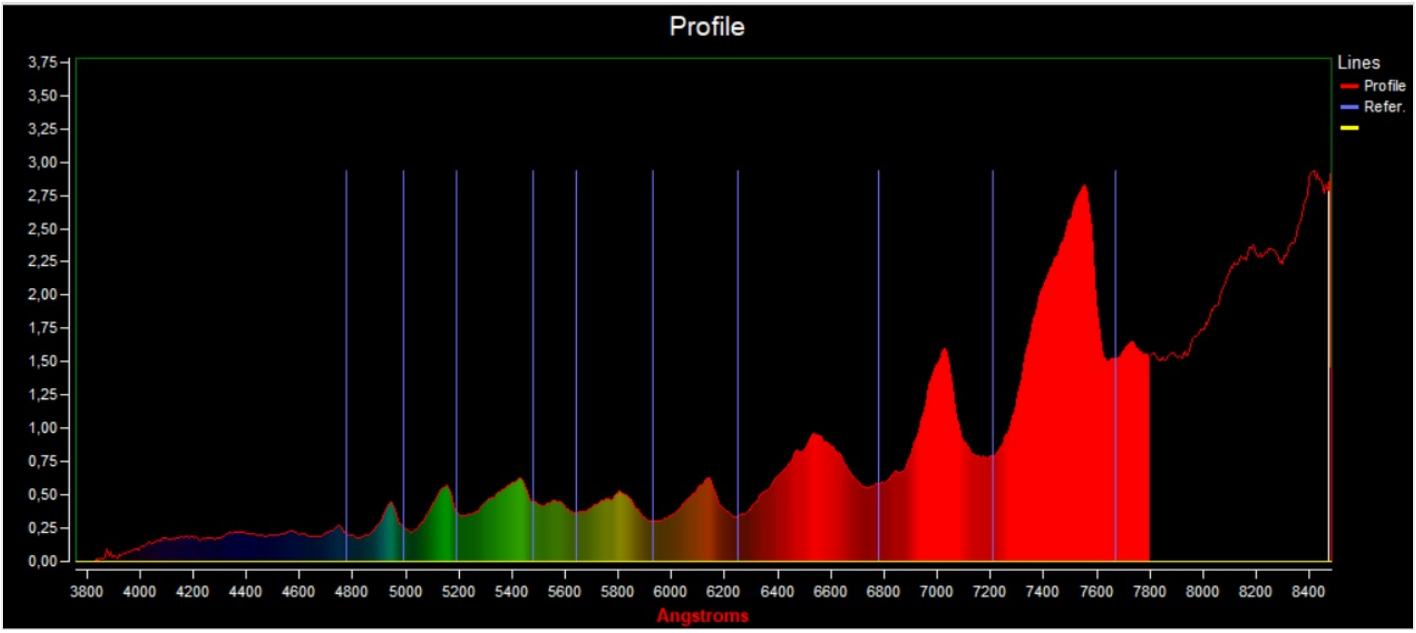
Among the field of research, spectroscopy is becoming accessible for the amateur as nowadays a simple grating put in front of the camera, for example in a filter wheel, can deliver valuable data. The study of the spectra of variable stars is of utmost importance to understand the evolution of stars.

Here is a picture of variable star V Bootis, a semi-regular red pulsating giant that oscillates between mag. 7 and 12. The image has been taken through a simple 6” Newton, a star analyser 200 and the QHY 268 Mono. It is a stack of 12 exposures of 100 seconds and it has been dark corrected.



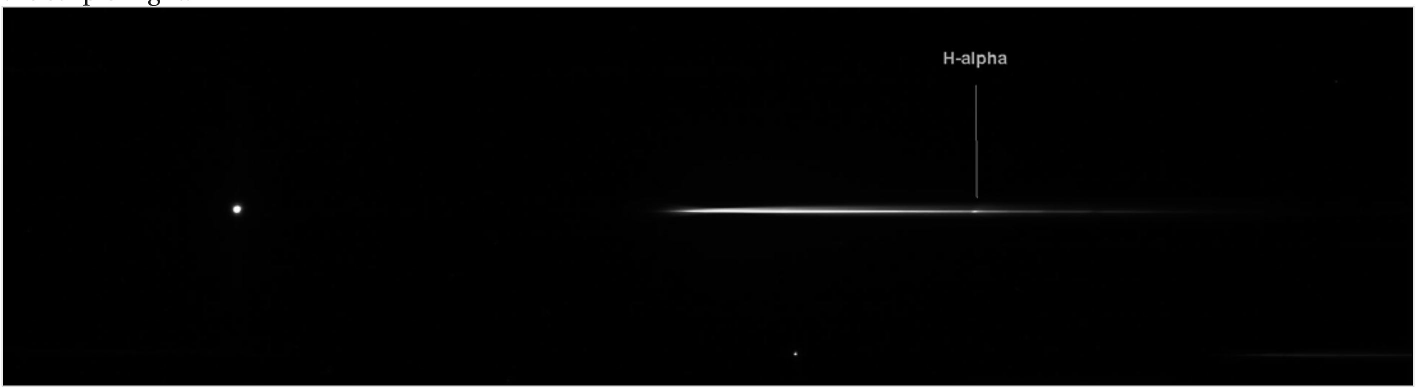
We can see that the strip of light, that it is actually the spectrum of this star, shows dark and bright bands. The dark bands are caused by the molecular band of Titanium Oxide that is typical of the atmosphere of class M giant stars. Note the image has very little noise thanks to the low readout noise of the camera (mode #1, gain 58, offset 20 temperature – 10C).

The little noise can also be confirmed from the spectrum profile of this star that shows very little scatter and a regular profile line.

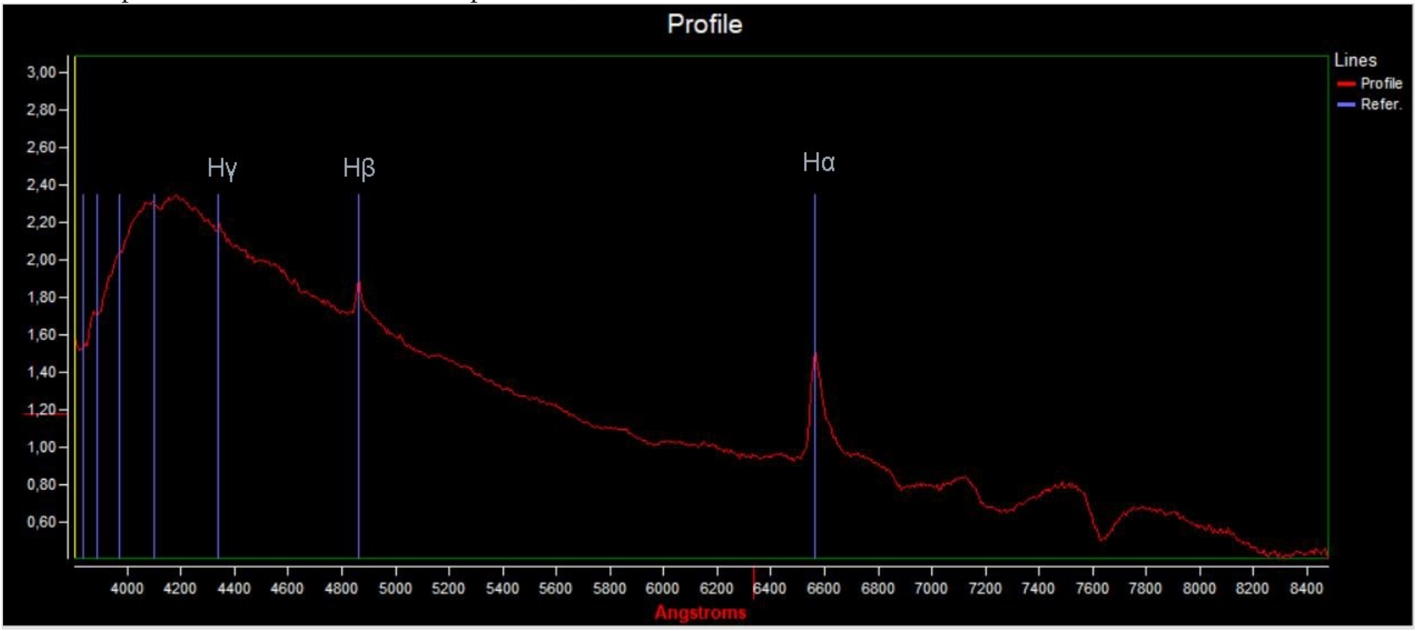


We can also see that the star emits the majority of energy in red and infrared (intensity increases towards high wavelengths). The blue lines indicate the positionts of the molecular bands of Titanium Oxide. Monitoring the changing of the spectrum of this star during time give us a hint of the behaviour of this class of pulsating stars.

We have the decided to push a bit the camera by using a smaller telescope (Apo 80mm f/6 refractor) and setting the sensor temperature at -1C. The following is a stack of 20 images of 2 second exposure each, taken in mode #1, gain 59 and offset 20, of variable star Gamma Cassiopeiae, a Be star, that ejects gas into the stellar medium as it looses matter under a sort of stellar wind. The spectrum clearly shows the H-alpha emission line that appears as a bright dot towards the right end of the strip of light.

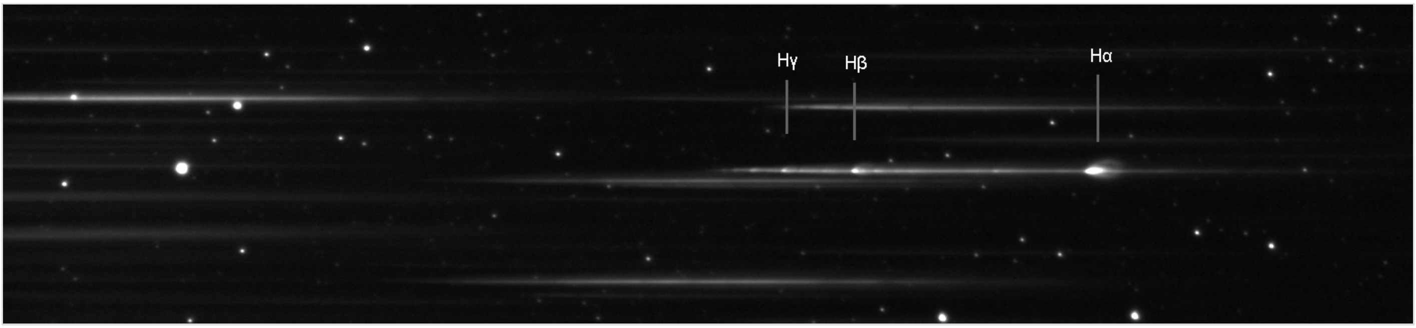


The emission line can be clearly seen and measured by plotting the spectrum in a specific software. The blue lines in the graph show the positions of the Hydrogen Balmer lines. You can see the H-alpha, H-beta and H-gamma lines are all in emission (peaks over the red line of the spectrum).

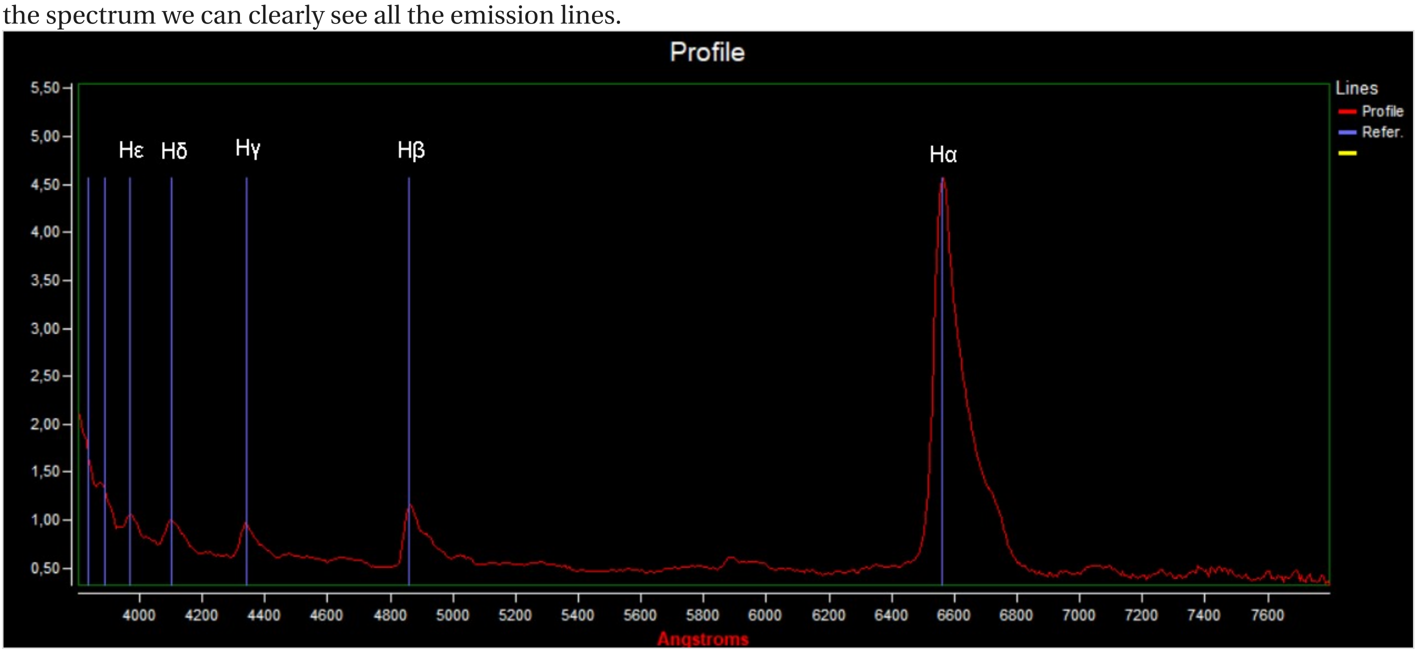


It can be noticed that even under less favourable conditions the spectrum has a quite regular profile indicating little scatter. Measuring the intensity and shape of emission lines enables us to understand the evolution of the variability of this star that in the past reached about mag. 1.5.

The following image is a stack of 10 images of 240 seconds each of the spectrum of Nova Cassiopeiae 2021 (V1405 Cas) a slow nova that reached about mag. 5.5 and that at the time of this image was at around mag. 8. We still use an 80 f/6 Apo refractor here and the QHY268 Mono at Gain 59 offset 20 and sensor temperature -1C.

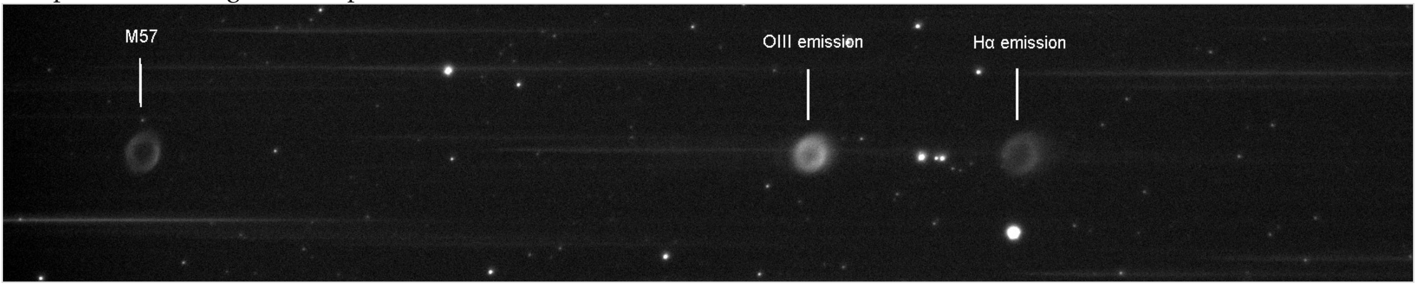


The spectrum shows a series of bright dots showing emission lines including a very bright H-alpha emission line. Plotting the spectrum we can clearly see all the emission lines.



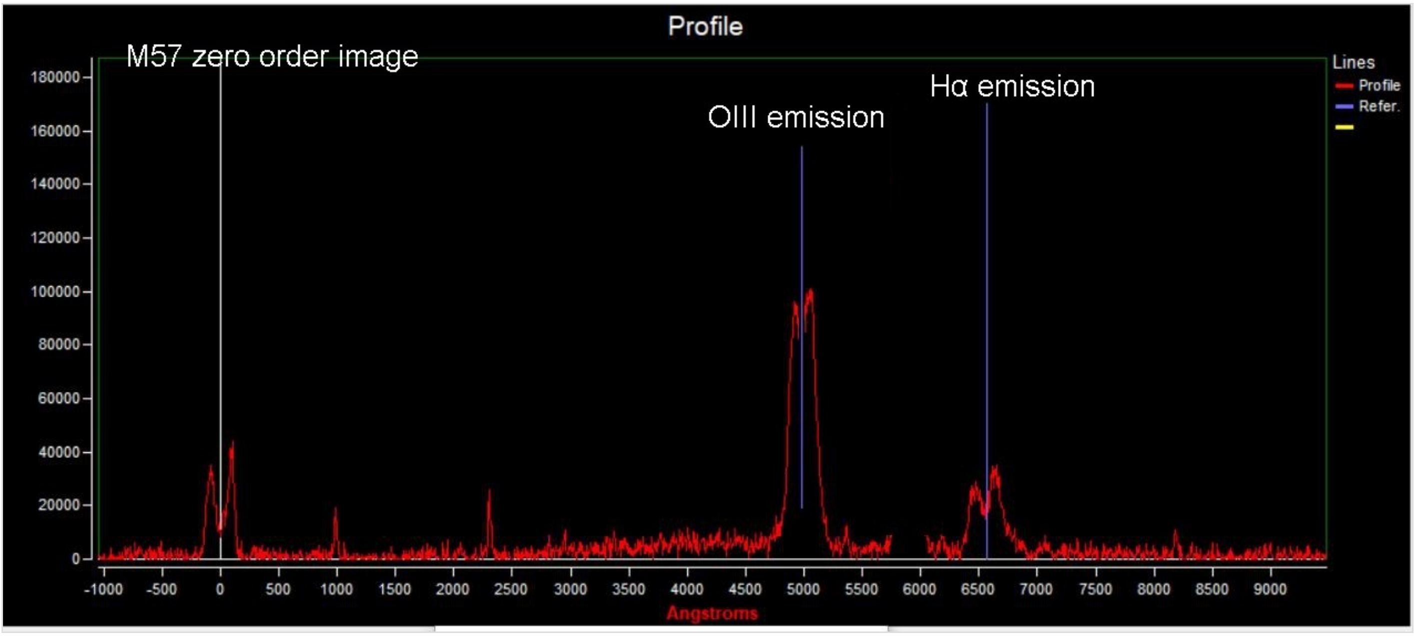
Again, the spectrum shows very little scatter indicating little noise regardless the images were taken under urban sky. Taking good spectra of novae is among the most useful work an amateur can do as it enables us to refine the physical models of this peculiar stars.

The following image is the spectrum of the famous ring nebula M57, an emission planetary nebula in the constellation of Lyra. In this case we can see different images of the nebula rather than a strip of light with emission lines. The two images towards the right hand side of the frame are actually the emission lines of OIII and H-alpha showing the main composition of the gas envelope.



Spectrum of the ring nebula taken through an Apo 80 mm f/6 refractor and the QHY268 mono. Stack of 3 exposures 240 seconds each. Camera settings: Mode #1, Gain 59, offset 20 and sensor temperature -1C.

Plotting the spectrum in the software shows the OIII and HA emission lines of the nebula at the corresponding Angstrom.



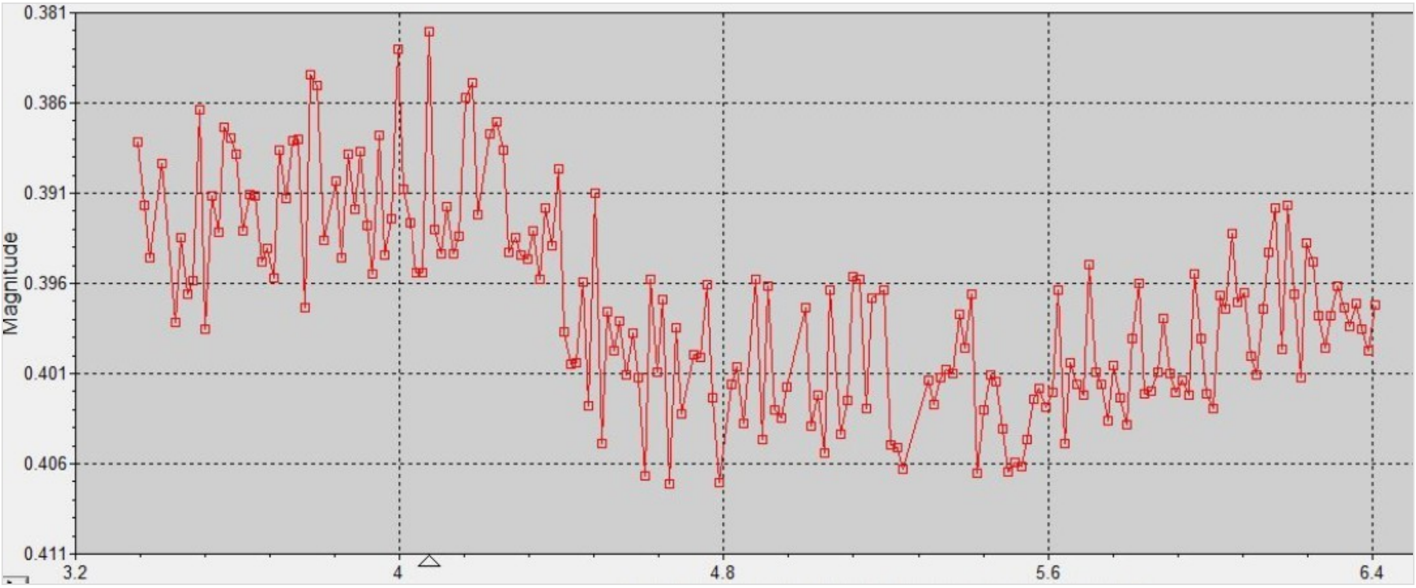
We can conclude that even under polluted skies, with a small telescope and with the sensor relatively warm (-1C), valuable results in the field of spectroscopy can be effectively produced with the QHY268 mono.

4. Testing the QHY268 mono for demanding photometry – exoplanet transits

We have then tested the camera to take photometric measures of an exoplanet transit. Transiting exoplanets are very demanding as they just obstruct a very tiny fraction of the incoming light of the star when they pass in front of it. For this type of observation we have chosen mode #3 at Gain 0 as it is necessary to get a good dynamic range and to use sufficiently long exopsures to reduce the effects of scintillation and to get the highest possible Signal to Noise ratio without saturating the star.

The following image is the star field of the candidate exoplanet TOI 1480.01.b in Cepheus. Observations from the TESS satellite indicate that the parent star (mag. 9.2) shows a very dim occultation (0.0109 mag) that may be caused by an exoplanet. Obervations of this star are important to potentially confirm the presence of an exoplanet. The telescope used is a Newtonian 6” reflector at f/4.6. We have used a red filter to reduce the effects of seeing and 50 second exposures.

We have then plotted the instrumental magnitudes measured after using 6 comparison stars of similar brightness of the parent star to get the light curve.



We can clearly see the decrease in brightness of the parent star at the predicted time regardless the decrease in brightness is very little. Notice that on the Y axis the plotted intervals in brightness are only 5 millimag.

Conclusions

The QHY268 Mono passed all our tests and can be considered a suitable camera for doing science observations.

Very little noise, very good linearity, stable electronics and the possibility of using different operating modes (we have found modes #1 and #3 as the most promising for our purposes) make the QHY268 Mono an ideal camera for the advanced amateur that wants to give a contribution to science rather than just taking pretty images of the night sky.

Additional tests, particularly in the field of photometic measures with Sloan filters, will be carried out over the next months to assess the transformation coefficients needed to transform instrumental magnitudes into the standard system and to study red pulsating giants in the ‘r and ‘i passbands. For future reference please check the following URL: https://alto-observatory.smugmug.com

We thank you QHYCCD for lending us the camera to perform the tests.