

A Brief Guide on Operating the CMOS Camera at the Maryland Space Grant Observatory

This document reviews installation and operation of the CMOS camera at the Maryland Space Grant Observatory. *This document is a work-in-progress. Please alert observatory staff of any inaccuracies, omissions, etc.* Rev. 03/05/2020

Basic Information on the Camera and Filter Wheel

The camera is a ZWO ASI1600MM Pro monochrome CMOS camera. An EFW mini filter wheel is attached to the camera. The camera, filter wheel, and all accessories are found in a teal-colored box in the cabinet. **The filter wheel assembly is to remain attached to the camera during all observations. Do not attempt to remove it.** Attached to the filter wheel's 2" adapter piece is a dust filter. **Do not remove the dust filter.** The camera has a translucent white plastic protective cap that covers the dust filter. The protective cap must be removed before mounting the camera on the telescope and must be reattached before stowing the camera in its box.

A USB2.0 - USB3.0 cord connects the camera to the filter wheel. A USB2.0 - USB2.0 cord connects the camera to a computer. The camera is cooled using a fan located at the bottom of the camera assembly. To power the fan, a 12.0 V adapter must be plugged in to the bottom of the camera.

Mounting the Camera to a Telescope

There are two telescopes at the Maryland Space Grant Observatory: the Morris W. Offit telescope, a 20 inch reflector, and the Meade 127ED/APO, a 5 inch refractor. **Before mounting the camera to either telescope, ensure that all parts of the camera assembly -- camera, filter wheel, 2" adapter, and dust filter -- are tightly attached.** The telescope should be slewed to zenith prior to mounting the camera. **Be mindful of how you orient the camera.** The detector is not square, so exercise some thought in how the camera should be oriented. **Make sure to remove the protective plastic cap before mounting the camera to a telescope.**

If you wish to perform spectroscopic observations, the grating must be installed in a certain orientation to get the entire first-order spectrum to appear in the field of view of the camera. To install the grating, first take note of the text on the grating and the text on the 2" adapter of the filter wheel. You should be able to identify the words "Star

Analyzer” on the grating and the words “21mm” on the filter wheel. Start threading the grating onto the dust filter. Screw in the grating such that the “S” in “Star Analyzer” lies between the “1” and “m” in “21mm.”

Having removed the dust cap and attaching the grating (if desired), you can begin mounting the camera. **Make sure to handle the camera securely and gently as you mount it to a telescope.**

To mount the camera to the 20” Morris W. Offit telescope:

1. Remove the yellow eyepiece cover by loosening the set screw. Loosen the set screw until it no longer obstructs the opening.
2. Insert the camera and its filter wheel assembly with the filter wheel pointing up. Make sure the filter wheel makes contact with the eyepiece adapter of the telescope.
3. Using one hand to hold the camera + filter wheel assembly, orient the camera as desired and tighten the set screw by hand as much as you can, until you cannot tighten it further.
4. Still keeping one hand directly beneath the camera, lightly tug on the camera to ensure it is tightly secured. Holding onto the filter wheel housing, gently try rotating the camera/filter wheel assembly with respect to the telescope. It should not readily rotate if the set screw and all components of the camera assembly are correctly tightened.

To mount the camera to the Meade 127ED/APO telescope:

1. Remove the eyepiece by loosening the two set screws right above the eyepiece. Loosen the set screws until they no longer obstruct the opening.
2. Insert the camera and its filter wheel assembly with the filter wheel pointing up. Make sure the filter wheel makes contact with the eyepiece adapter of the telescope.
3. Using one hand to hold the camera + filter wheel assembly, orient the camera as desired and tighten the set screws by hand as much as you can, until you cannot tighten them further.
4. Still keeping one hand directly beneath the camera, lightly tug on the camera to ensure it is tightly secured. Holding onto the filter wheel housing, gently try rotating the camera/filter wheel assembly with respect to the telescope. It should not readily rotate if the set screw and all components of the camera assembly are correctly tightened.

With the camera firmly in place, plug the USB2.0 - USB2.0 cord into the observatory laptop. Plug the 12.0 V adapter into an outlet in the extension cord and plug the adapter

into the camera. **Pay attention to where the cords are and where they will go when you slew the telescope.**

Operating the Camera Software

Now that the camera is mounted, start up the observatory laptop and launch TheSkyX Professional. **Before connecting the camera and/or taking exposures, there are three parameters you should consider: exposure time, binning, and gain.**

Exposure time indicates the time the camera spends collecting light; binning is the factor by which pixels are grouped into larger super-pixels; and gain is a multiplicative factor that allows you to better differentiate brightness levels between pixels. While exposure time and binning can be changed after connecting the camera, the gain must be set before connecting the camera.

To connect the camera, click the “Camera” tab in the lower left of TheSkyX Pro; the camera menu may also appear upon launch. To check what the gain is, click “Camera Setup” → Choose, then select ASCOM → Ascom Camera. In “Camera Setup” click “Settings” and choose ASI Camera (1). Clicking the “Properties” button will allow you to adjust the gain. Once a suitable gain is selected, click “Ok,” and in “Properties” click “Ok.” In “Camera Setup” click “Connect” and the camera should connect. If successful, the status of the camera will read “Ready” in green, as in Figure 1. The filter wheel has already been configured, and in the filter wheel tab, its status should also read “Ready.”

To change the gain, the camera must be disconnected, and the procedure above must be followed again, this time with a different gain value. After adjusting the gain, connect the camera once more.

Figure 1 shows a typical arrangement of the tabs and buttons in TheSkyX Pro. The current filter selected is indicated in the filter wheel window to the far left of the screen. In the middle of the screen, from top to bottom, is the “Camera Setup” button, buttons to connect, disconnect, and control the temperature of the camera, a progress bar for the exposure being taken, temperature data, power dedicated to the fan, three tabs for taking a photo, focusing the telescope and taking a series of images, buttons for taking/aborting an exposure, and fields that specify aspects of the exposure, such as exposure time and binning. You can also specify what kind of exposure you’re taking and whether you would like to automatically calibrate an exposure. You can automatically save exposures by checking the “Automatically Save Photos” box and adjusting the parameters in the “AutoSave” button. After taking an exposure, a pop-up window will appear displaying the latest exposure.

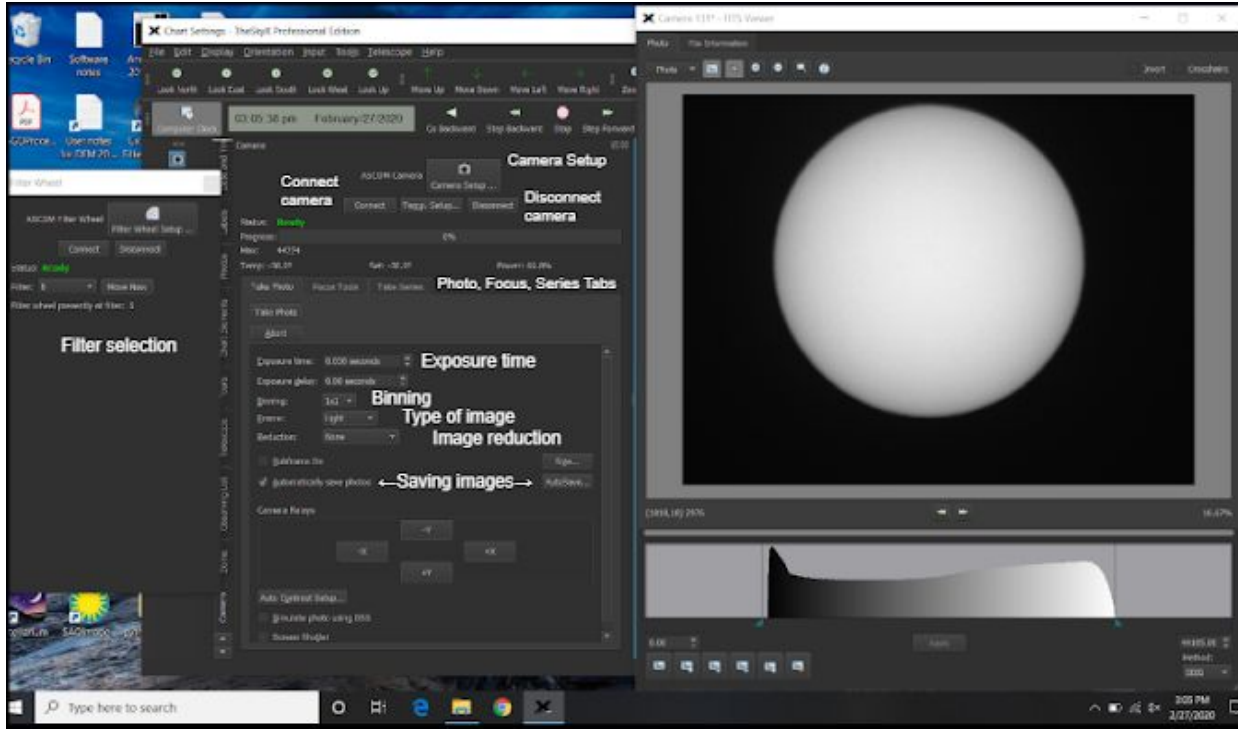


Figure 1. An annotated screenshot of TheSkyX Pro. In this mode, an exposure is about to be taken. Most of the parameters you need to adjust (binning, exposure time) can be modified here. You can change how files are saved through the “AutoSave” button. An image that was just taken is shown to the right. Its histogram of pixel values is shown beneath the image.

A caveat on taking exposures while cooling the camera: it has been noticed that the camera will stop taking and saving exposures after a few hours if the fan has been working at 100% power. If this occurs, disconnect the camera and reconnect following the procedures above. To avoid this, it would be best to use the fan at 80-90% power at most (approximately 30-35 C below ambient).

To summarize, here is the procedure you should follow to begin operating the camera after it has been mounted:

1. Plug the USB2.0 - USB2.0 cord into the camera and the observatory laptop and plug the 12.0 V adapter into the camera to power the fan.
2. Turn on the laptop, if it's not turned on already.
3. Launch TheSkyX Pro.
4. Follow the procedure above to set the gain and connect the camera.
5. After the camera is connected, set the target temperature using the “Temp. Setup” button. It may take several minutes to reach the desired temperature.
6. You may now begin taking exposures.

Focusing

To help you focus the telescope, select the “Focus Tools” tab, as seen in Figure 1. In this menu, you can continuously take exposures so you can use the handpaddle/TCS to adjust the focus of the telescope. You can also use this setting to reposition your target within the field of view. After an exposure is taken, a pop-up window will appear displaying the latest exposure. Crosshairs can be toggled to center the target. The stretch of the image can be modified by clicking the histogram button to the left of the magnifying glass icons.

Taking a Series of Exposures

You can set up one or more series of exposures by selecting the “Take Series” tab as shown in Figure 1. Figure 2 shows the menu when taking a series of exposures. For each series you have the options of the exposure time, the binning, the kind of exposure it is, the filter to be used, how many times the exposure will occur, and whether automatic calibration is desired.

Sets of series can be taken “across” or “per” series. This means that exposures can be taken one at a time for different sets of series (“across”) or all exposures for one series are taken first, then another series proceeds (“per”).

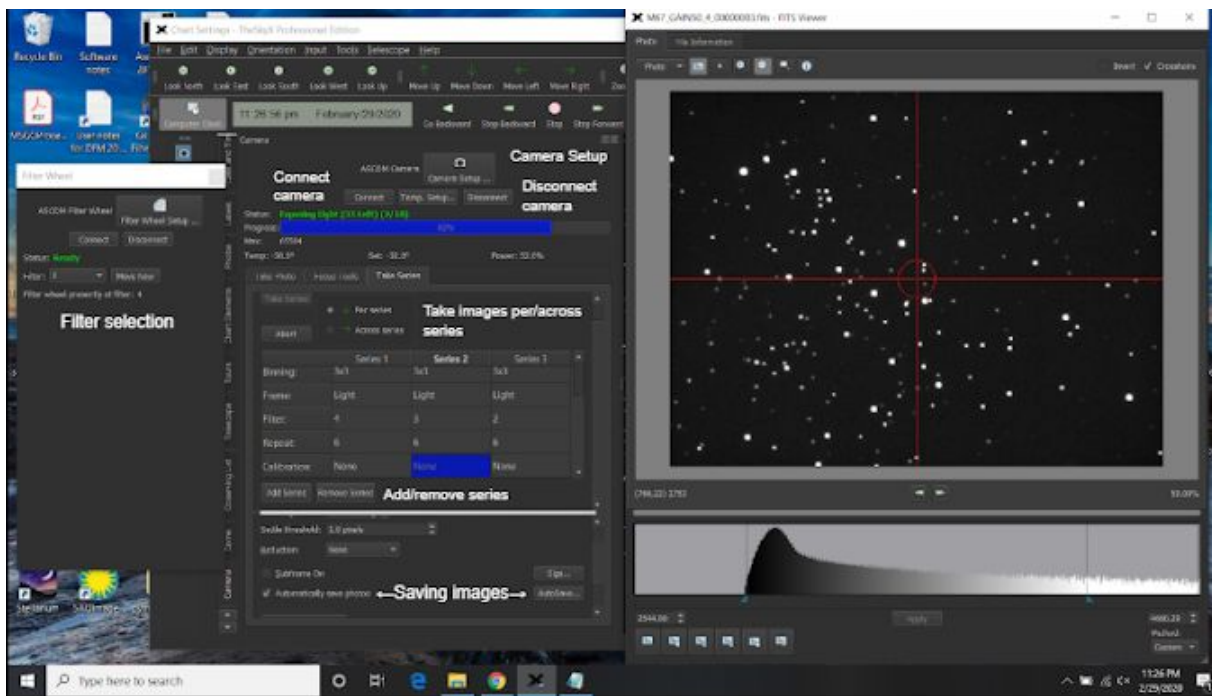


Figure 2. Same as Figure 1, except in this mode, a series of images in three different filters is being taken.

Shutting Down The Camera Software

When you are done taking exposures, click the “Disconnect” button. The status will read “Disconnected” in red. You may then close TheSkyX.