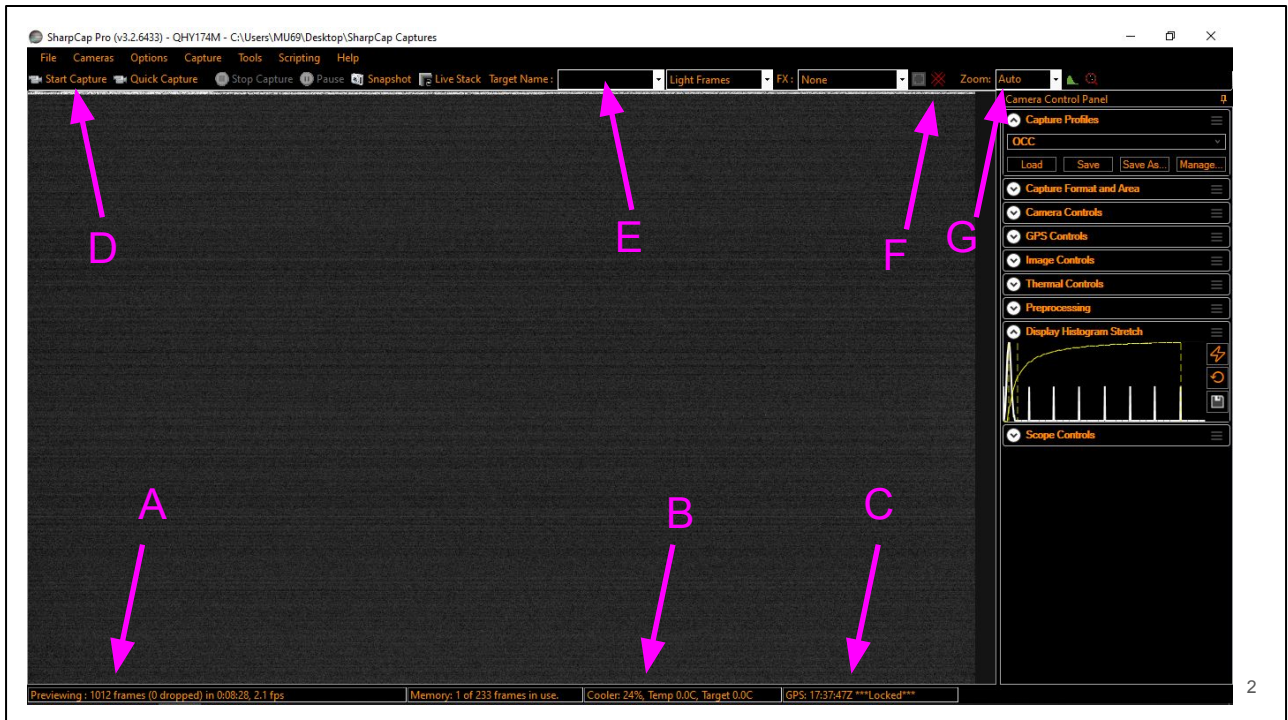# Guided Tour of Essential Parts of SharpCap

This guide shows you the components of the program that we use to collect data with the QHY174M-GPS camera for RECON

Prepared by Marc Buie (v20210410)

This is what your screen should look like after you've dismissed the GPS window and everything is working normally. The bottom line of the screen is for important status information and you should keep an eye on this as you work.

A - Image collection status area. This view says "Previewing" which means that the images from the camera are being displayed but not saved. The number will count up as images are pulled from the camera and the number changes at the same pace the images are read. This also shows if images are being dropped due to a frame rate request that is too fast for the computer. The last item in this area shows an approximate value for the frame rate. In this case you see 2.1 fps (frames per second) which is about right given that the exposure time is set by the OCC profile to be 0.5 seconds (500 ms).

B - Detector temperature status. The default set-point is 0°C, this is the target temperature. The actual temperature is shown in the middle and should generally be within a few tenths of a degree of the set-point. The first number is the current level of the cooler power which will range from 0 up to 100%. Your best clue about the cooler running as desired is to listen for the fan inside the camera. If that's running you are probably in good shape. But this status screen can alert you to abnormal conditions.

C - GPS status area and time display. "Locked" means that the GPS receiver is locked onto the signal and has good time and position data. This is what you want to see for taking data. If you see anything else you need to investigate and fix the problem. Also shown is the current UT time. As you are waiting for the right time to

take data you'll want to keep an eye on this. Also, if you note anything interesting during data collection, note this time.

The top line has the menu will will be described later but there a second row of tools that you will use frequently.

D - Start Capture. This is the button you hit when you are ready to save some data. This will be described in more detail later.

E - Target Name. Before taking data you can and should put in the name of the thing you looking at while saving data.

F - Reticle tool. More details on this to come.

G - Image display Zoom level. More to come here but most of the time this should say "Auto".

Now let's look at the controls on the right hand side. Each of these sections can be individually collapsed and expanded as needed. If you expand them all you will have to scroll back and forth to find the items you want. It's easier to collapse sections that have been set up and are not relevant at the time.

A - Capture Profiles. This one is best to leave expanded (as shown) all the time. You should always know what profile you are using and this has the controls for loading, saving, creating new copies (Save As…) and managing the profiles you've created. A profile is a collection of almost all of the settings provided by the controls on the right for the operation of the camera. The default profile should always be your starting point since it will have all of the usual values set for our project.

B - These three controls, Capture format, camera, and GPS are used routinely and will be discussed in more detail later. These have been ordered to be toward the top of the stack of controls.

C - The next three controls (Image, Thermal, and Preprocessing) are never used or changed. A later step will show what these should be set to but there is nothing in here that you should be using. This is especially true for the Image Controls. This sounds like something useful but it can cause the data to be damaged and should never be used for our project.

D - Display Histogram Stretch. This window shows a histogram of the image pixels and is updated with each image. In this plot, you can see a broad spike at the very

left of the plot. This is the image background and shows that the illumination level on the camera is very low. The regular spikes you see are an artifact of the camera and you can safely ignore them. On the upper right of this control there is a jaggy symbol that looks a bit like a squashed lightning bolt. If you click on this you get an automatic stretch of the image based on the sky signal. With this stretch you can see the faintest things in the image and it what you will use 99.9% of the time while using this program. Note that you can change this stretch at any time, even when taking data. You will almost always need to reset this if you change exposure times.

The bottom-most item, Scope Controls, isn't relevant to us at this time and can always be left closed.
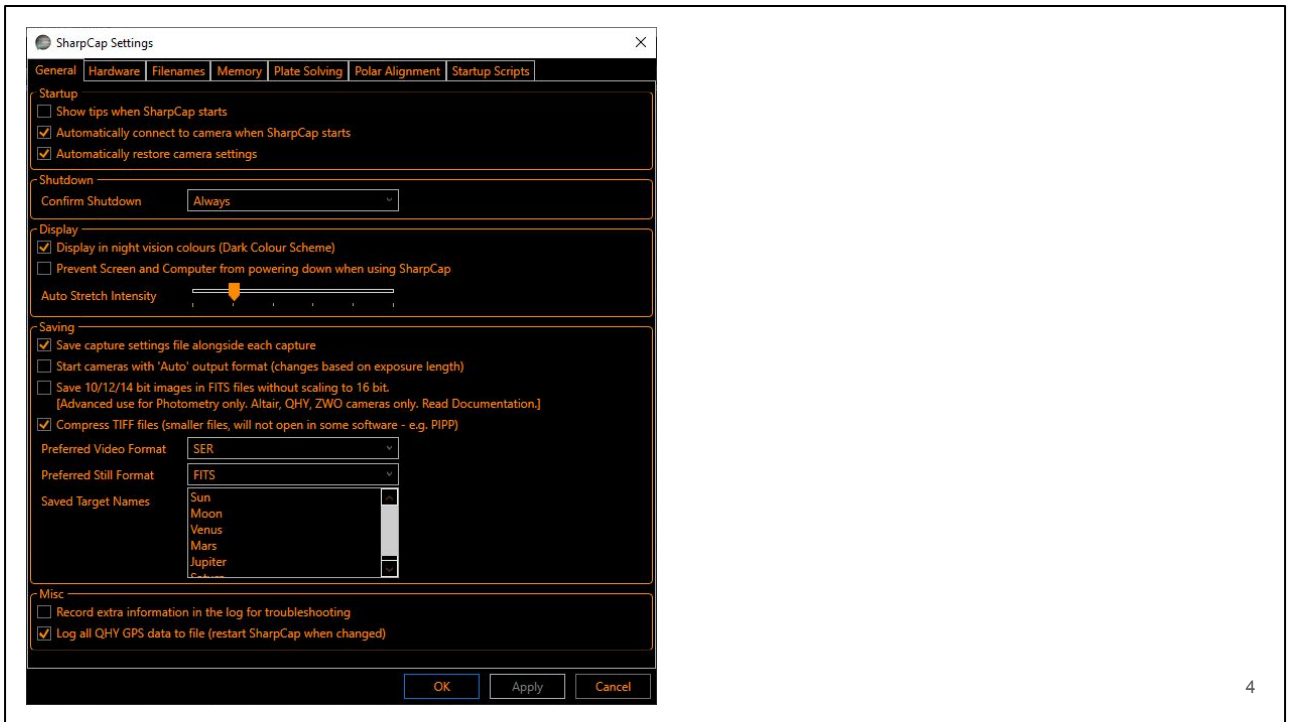
Clicking on the top menu to open up File → SharpCap Settings will bring up this configuration window. You do not normally need to change anything in here but this is shown so you can verify your settings are correct. This menu opens up first to the "General" tab as shown here.

Do note that if you need to make a change, it is important to click "Apply" to make those changes permanent. This applies to all of these configuration tabs.

Note that the "Preferred Video Format" here does show SER. We don't use SER but the file format is over-ridden by values that are saved in the profiles so this setting doesn't matter. See the page showing the "Capture Format and Area" for additional details.

This is the next tab. We don't have any of this hardware and the default settings were changed to turn off the attempt to automatically connect (last item).
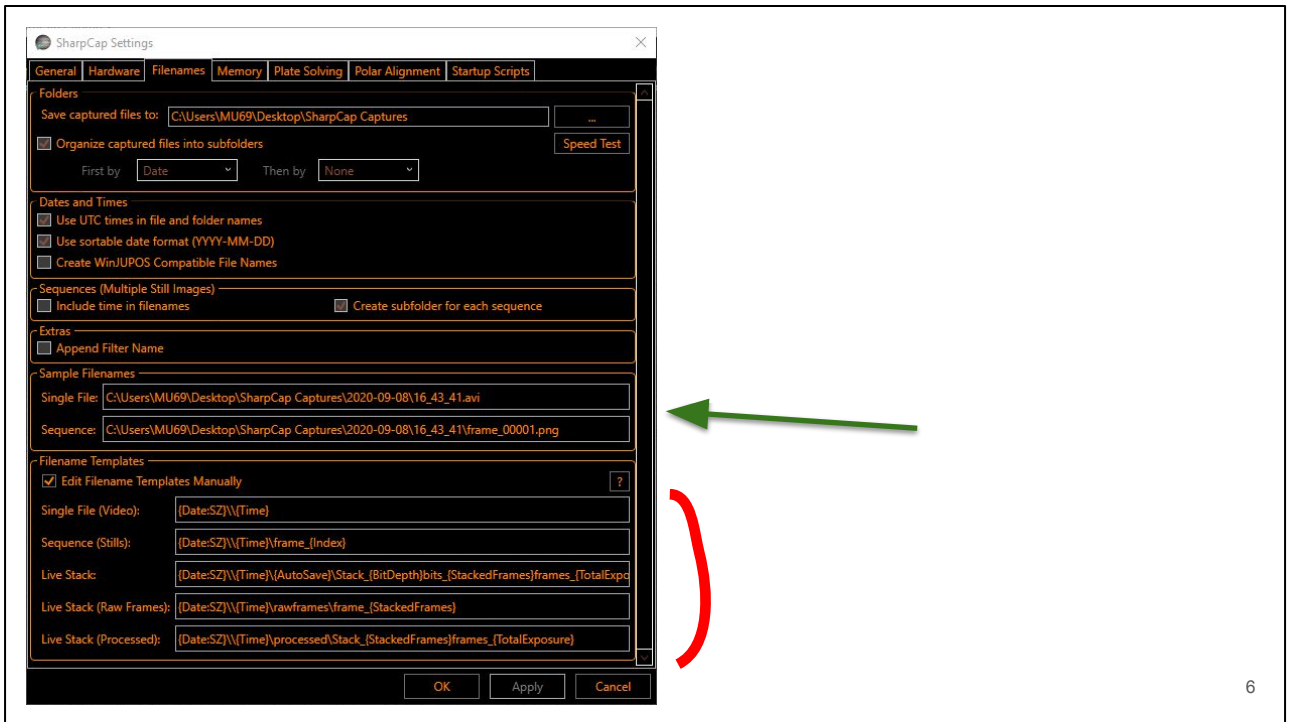
This is an important part of the configuration. Several important changes were made to the installation defaults by editing the filename templates manually. This shows what your screen should look like. These settings make it easier for us to process your data after an occultation campaign.

Important note: there are no parentheses in the templates. They are hard to see in this graphic but the format uses curly braces {} around fields.

Sadly, this step is a little tedious and requires a bit of patience and perseverance to get it right. Matching up the check boxes is easy enough but getting the file names right is where you will expend all your effort. Note that under "Samlpe Filename" (green arrows), you can see examples of what your directory path and file names will be give the settings below. The portion of the path prior to "SharpCap Captures" may be different on your system but everything to the right of this directory needs to match the example shown above exactly. Don't worry about the file suffixes shown (.avi and .png) but the rest matters.

To change the filenames you adjust the 5 lines marked off in red. As you edit these, the samples will change. It is easiest to Edit the "Sequence(Stills)" line first. This will adjust the second sample line. When you get that right, do the "Single File(video)" line next. When you get these right it will be more obvious what needs to be adjusted on the other lines to match the pattern.

The rest of the screens are not modified or used by our project.
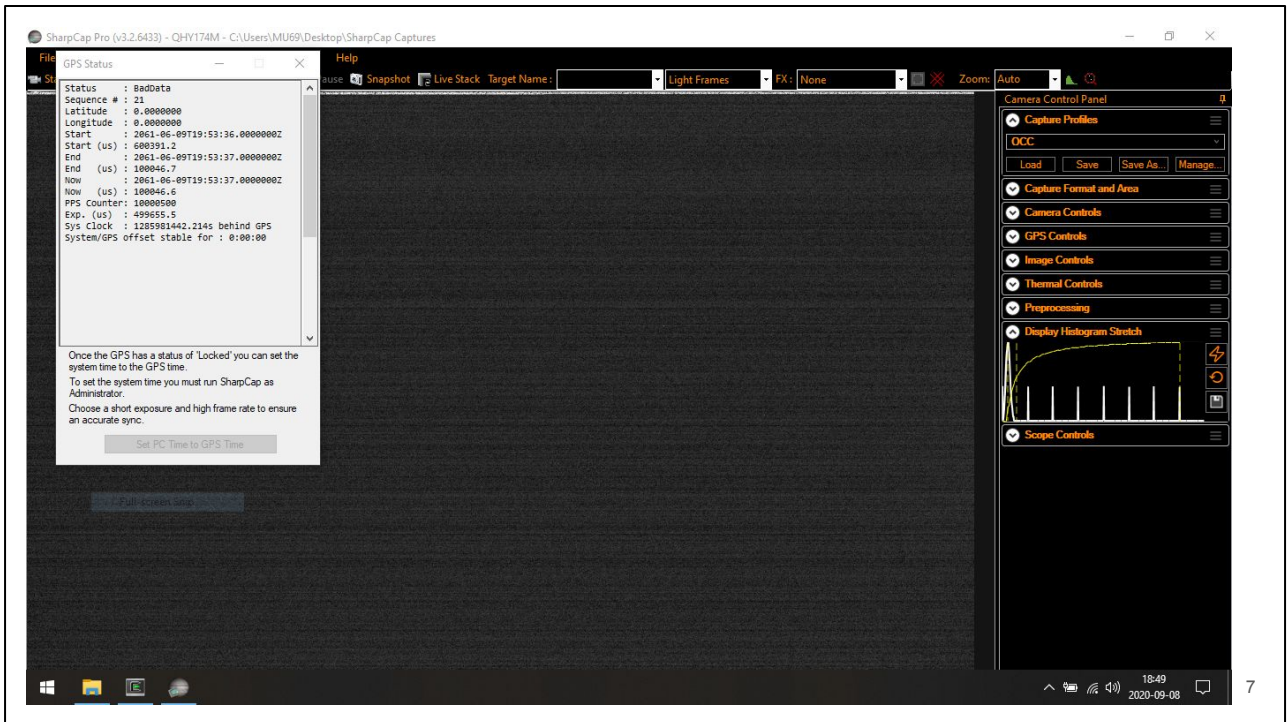
When you start, you will get a GPS Status screen. I recommend leaving this up until the GPS has locked and settled down. If you start SharpCap quickly after plugging in the USB cable you will see a screen like this. The error message is BadData. This message can mean many things. Here are some possibilities:

- Nothing is wrong, you just need to give it some time to acquire a signal
- GPS antenna is not connected
- GPS antenna cable is broken
- GPS antenna is not pointed at the sky or is otherwise blocked from getting a signal

The sequence # shows on the second line of the window is the number of seconds since power was applied to the GPS receiver in the camera. If the number is low (like this case), it's likely you just need to wait a little bit. In fact, this window was really hard to catch to put into this documentation. Usually it quickly moves to a status of "Partial Data" and not long after that it goes to "Locked". Once it is Locked, you want to give it 20 minutes before taking science data if you can.

I have seen cases where BadData persists for an unreasonably long time (many minutes or longer) and there isn't anything wrong with the antenna or cables. In all of these cases, (re)loading the OCC profile seems to eliminate the problem. I don't know why this works but it seems to be a great first step.

GPS Status

```
Status      : PartialData
Sequence # : 37
Latitude    : 0.0000000
Longitude   : 0.0000000
Start       : 2020-09-08T19:51:59.0000000Z
Start (us) : 25624.9
End         : 2020-09-08T19:51:59.0000000Z
End   (us) : 525331.0
Now         : 2020-09-08T19:51:59.0000000Z
Now   (us) : 525331.0
PPS Counter: 10000500
Exp. (us)  : 499706.1
Sys Clock  : 2.456s behind GPS
System/GPS offset stable for : 0:00:12
```

Once the GPS has a status of 'Locked' you can set the system time to the GPS time.

To set the system time you must run SharpCap as Administrator.

Choose a short exposure and high frame rate to ensure an accurate sync.

Set PC Time to GPS Time

GPS Status

```
Status      : PartialData
Sequence # : 110
Latitude    : 0.0000000
Longitude   : 0.0000000
Altitude    : NaN
Start       : 2020-09-08T19:52:35.0000000Z
Start (us) : 80972.2
End         : 2020-09-08T19:52:35.0000000Z
End   (us) : 580677.9
Now         : 2020-09-08T19:52:35.0000000Z
Now   (us) : 580677.9
PPS Counter: 9999875
Exp. (us)  : 499705.7
Sys Clock  : 1.967s behind GPS
System/GPS offset stable for : 0:00:29
# Sats      : 3
FixTime    : 19:52:34
FixQuality : Invalid
Hdop       : 4.94
$GPRMC,195234.00,V,,,,,,,080920,,,N*76
$GPVTG,,,,,,,,,N*30
$GPGGA,195234.00,,,,,0,03,4.94,,,,,,*54
$GPGSA,A,1,13,15,20,,,,,,,,,,5.04,4.94,1.00*
```

Once the GPS has a status of 'Locked' you can set the system time to the GPS time.

To set the system time you must run SharpCap as Administrator.

Choose a short exposure and high frame rate to ensure an accurate sync.

Set PC Time to GPS Time

GPS Status

```
Status      : Locked
Sequence # : 184
Latitude    : 40.2529953
Longitude   : -105.1624160
Altitude    : 1588.8M
Start       : 2020-09-08T19:53:12.0000000Z
Start (us) : 125723.4
End         : 2020-09-08T19:53:12.0000000Z
End   (us) : 625429.0
Now         : 2020-09-08T19:53:12.0000000Z
Now   (us) : 625428.9
PPS Counter: 9999871
Exp. (us)  : 499705.6
Sys Clock  : 1.967s behind GPS
System/GPS offset stable for : 0:00:14
# Sats      : 5
FixTime    : 19:53:11
FixQuality : GpsFix
Hdop       : 3.11
$GPRMC,195311.00,A,4015.17972,N,10509.74496,
$GPVTG,,T,,M,0.074,N,0.137,K,A*25
$GPGGA,195311.00,4015.17972,N,10509.74496,W,
$GPGSA,A,3,10,13,15,27,20,,,,,,,,4.40,3.11,3
```

Once the GPS has a status of 'Locked' you can set the system time to the GPS time.

To set the system time you must run SharpCap as Administrator.

Choose a short exposure and high frame rate to ensure an accurate sync.

Set PC Time to GPS Time

Here's a sequence showing how the status information changes as the GPS settles in. The display can vary from a shorter set of lines to more detailed information up until it becomes Locked. In this case, the Locked state was reached in about three minutes. Note how the button on the bottom has become active once the Status show Locked. At this point you can update the system clock by clicking that button.

IMPORTANT: if your camera has the old firmware, you will not see the Altitude nor any of the extended diagnostic and status information from the GPS.

```
GPS Status                      —    □    ×

Status      : Locked                          ^
Sequence # : 243
Latitude   : 40.2529142
Longitude  : -105.1624045
Altitude   : 1583.9M
Start       : 2020-09-08T19:53:41.0000000Z
Start (us) : 661396.0
End         : 2020-09-08T19:53:42.0000000Z
End   (us) : 161114.5
Now         : 2020-09-08T19:53:42.0000000Z
Now   (us) : 161114.4
PPS Counter: 9999869
Exp. (us)  : 499718.5
Sys Clock  : 0.000s behind GPS
System/GPS offset stable for : 0:00:05
# Sats     : 5
FixTime    : 19:53:41
FixQuality : GpsFix
Hdop       : 3.14
$GPRMC,195341.00,A,4015.17485,N,10509.74427,
$GPVTG,,T,,M,0.183,N,0.339,K,A*20
$GPGGA,195341.00,4015.17485,N,10509.74427,W,
$GPGSA,A,3,10,13,15,27,20,,,,,,,,4.42,3.14,3  v

Once the GPS has a status of 'Locked' you can set the
system time to the GPS time.

To set the system time you must run SharpCap as
Administrator.

Choose a short exposure and high frame rate to ensure
an accurate sync.

[        Set PC Time to GPS Time        ]
```
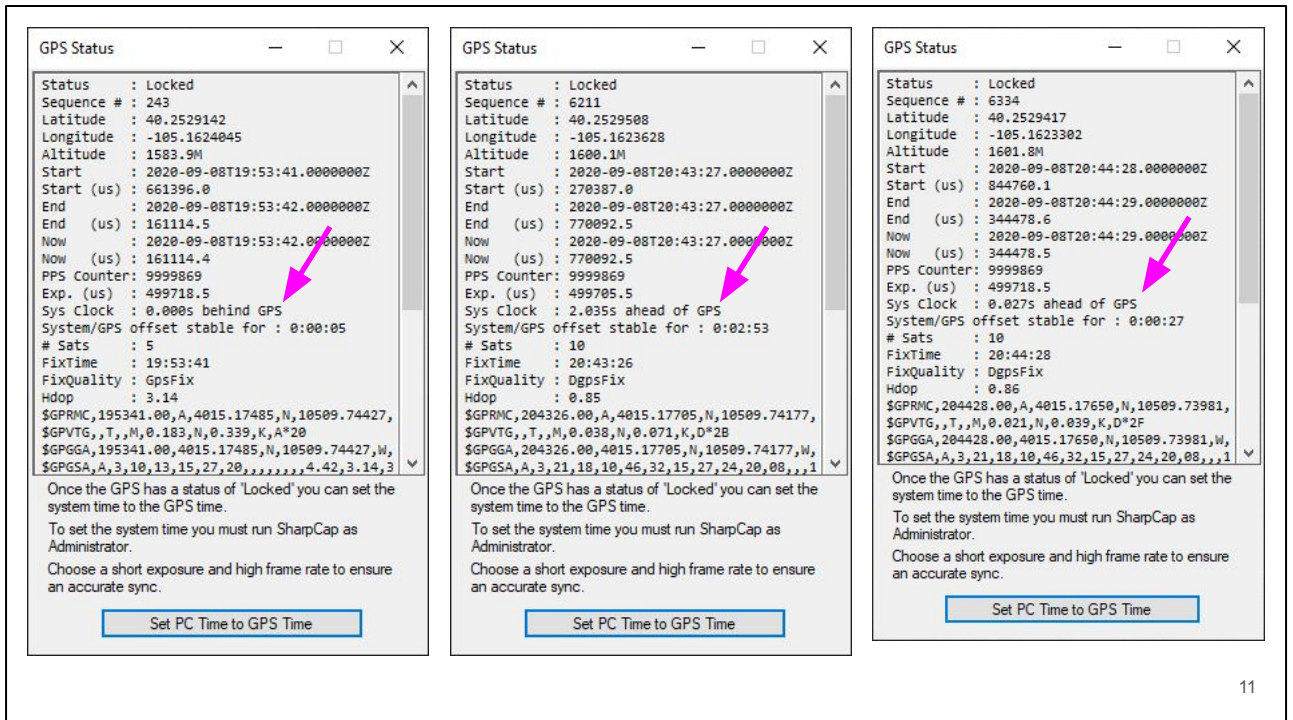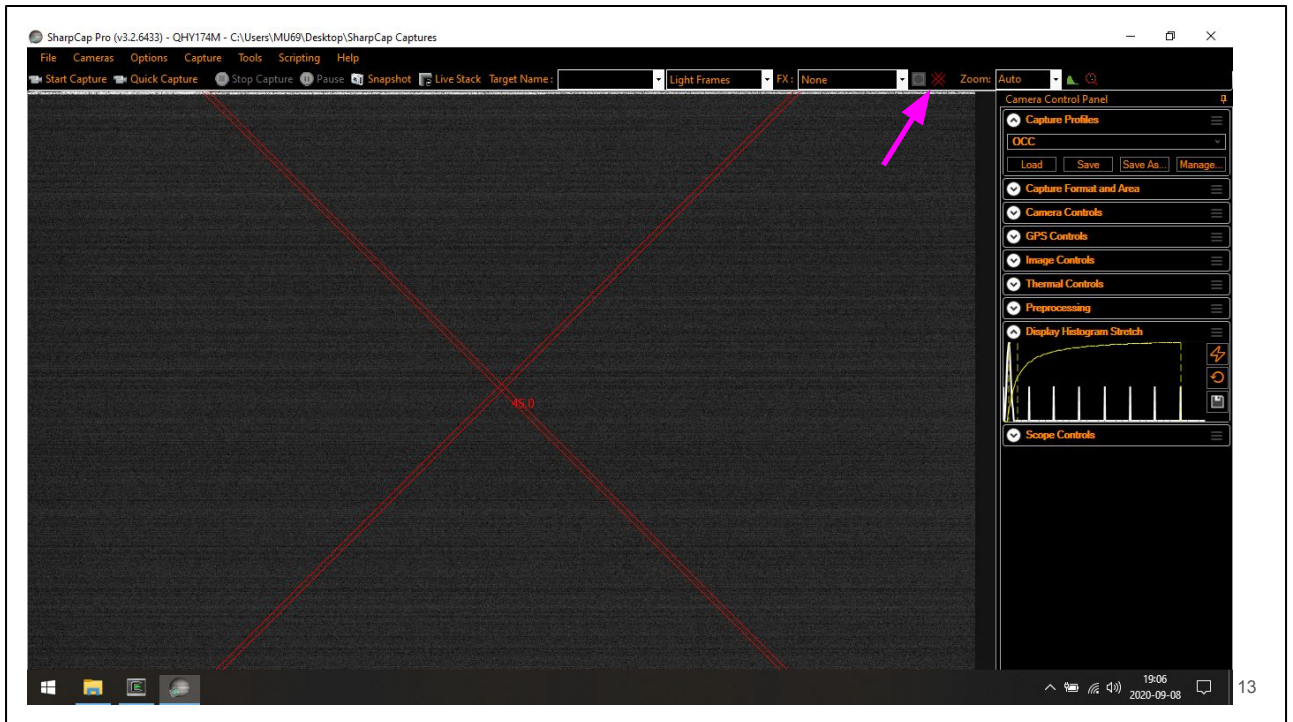
9

The first image on the left is what it looked like after resetting the clock shortly after the previous screen shot. The arrow points to the line showing the difference between the PC clock and the GPS. Notice that from the sequence number this is just 4 minutes after powering on the camera. If you work this fast, there is another bit of information you can see that further confirms the time quality. At this point, the clock appears to be set and ready but that's not quite right.

Left window — GPS Status

```
GPS Status                    —   □   ×
Status    : Locked
Sequence # : 243
Latitude  : 40.2529142
Longitude : -105.1624045
Altitude  : 1583.9M
Start     : 2020-09-08T19:53:41.0000000Z
Start (us) : 661396.0
End       : 2020-09-08T19:53:42.0000000Z
End  (us) : 161114.5
Now       : 2020-09-08T19:53:42.0000000Z
Now  (us) : 161114.4
PPS Counter: 9999869
Exp. (us) : 499718.5
Sys Clock : 0.000s behind GPS
System/GPS offset stable for : 0:00:05
# Sats    : 5
FixTime   : 19:53:41
FixQuality : GpsFix
Hdop      : 3.14
$GPRMC,195341.00,A,4015.17485,N,10509.74427,
$GPVTG,,T,,M,0.183,N,0.339,K,A*20
$GPGGA,195341.00,4015.17485,N,10509.74427,W,
$GPGSA,A,3,10,13,15,27,20,,,,,,,,4.42,3.14,3

Once the GPS has a status of 'Locked' you can set the
system time to the GPS time.

To set the system time you must run SharpCap as
Administrator.

Choose a short exposure and high frame rate to ensure
an accurate sync.

        Set PC Time to GPS Time
```

Right window — GPS Status

```
GPS Status                    —   □   ×
Status    : Locked
Sequence # : 6211
Latitude  : 40.2529508
Longitude : -105.1623628
Altitude  : 1600.1M
Start     : 2020-09-08T20:43:27.0000000Z
Start (us) : 270387.0
End       : 2020-09-08T20:43:27.0000000Z
End  (us) : 770092.5
Now       : 2020-09-08T20:43:27.0000000Z
Now  (us) : 770092.5
PPS Counter: 9999869
Exp. (us) : 499705.5
Sys Clock : 2.035s ahead of GPS
System/GPS offset stable for : 0:02:53
# Sats    : 10
FixTime   : 20:43:26
FixQuality : DgpsFix
Hdop      : 0.85
$GPRMC,204326.00,A,4015.17705,N,10509.74177,
$GPVTG,,T,,M,0.038,N,0.071,K,D*2B
$GPGGA,204326.00,4015.17705,N,10509.74177,W,
$GPGSA,A,3,21,18,10,46,32,15,27,24,20,08,,,1

Once the GPS has a status of 'Locked' you can set the
system time to the GPS time.

To set the system time you must run SharpCap as
Administrator.

Choose a short exposure and high frame rate to ensure
an accurate sync.

        Set PC Time to GPS Time
```

Some time later (ignore the sequence number on this one), the clock shift will show something like this. Most of our cameras will show a 2 second error but some will show 3 seconds. What's happened here is that the previous clock reading did not include all the known leap second data. This is transmitted by the GPS system roughly every 20 minutes. Depending on when you start, you could wait that long for the leap second data. It's easier to see this jump if you've set the PC clock before the update. If things are operating normally, it is reasonable to expect that the update has happened if the sequence number is bigger than 1200 (plus the time for the initial lock, so, perhaps more like 1500).

After one more update, the timing is now set and as long as it stays Locked, you can safely dismiss this window and move on with the rest of your set up.

Once again, here's the screen in a state where the GPS is Locked, it's taking 0.5 second images and you are ready to move on.

Clicking the reticle button turns on a marker on the screen (marked with the purple arrow). This can help you put the telescope setup stars in a consistent place in the image. There are other reticles and you can turn them on or off with this control.
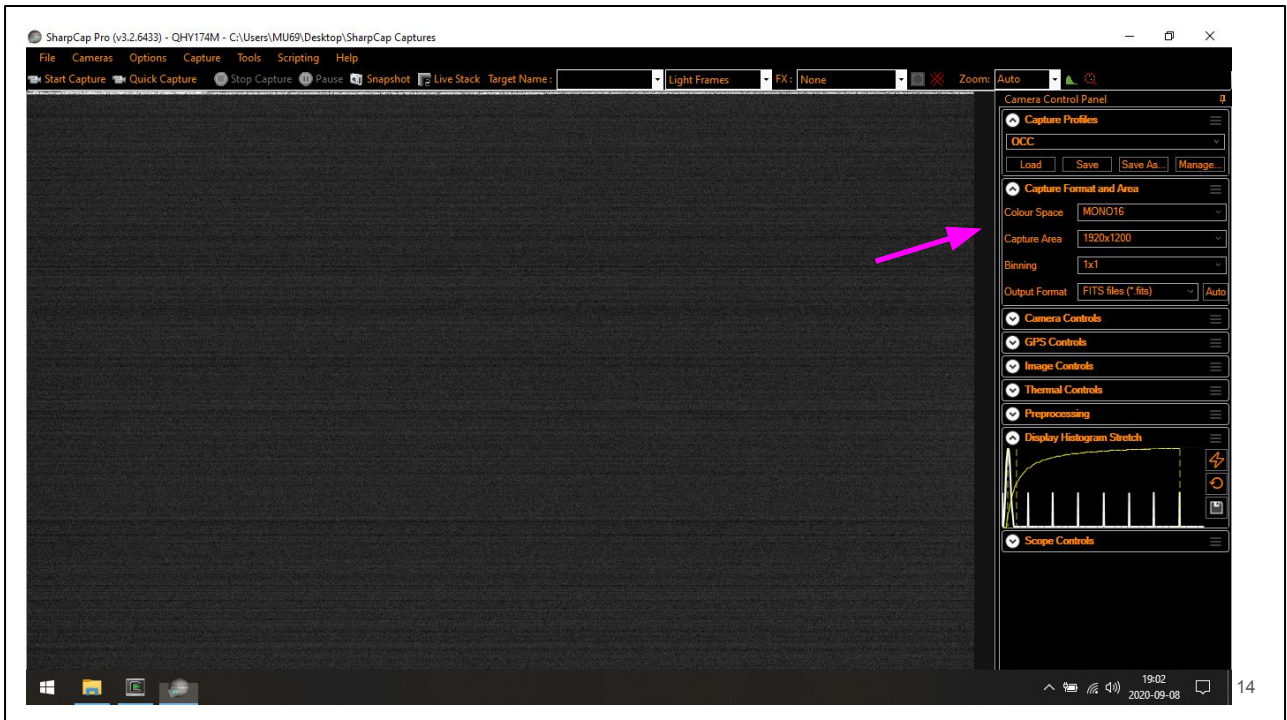
Here the "Capture Format and Area" control has been opened up. We use MONO16 exclusively (there is another option called MONO8 we don't use). The capture area can be adjusted but the value shown is for the full array size. We will normally use 1x1 binning and we *always* use FITS files. One result of this setting is that every image you take is saved to a single file. There are special circumstances where we might change the capture area and the binning but that will be rare and this control can usually be left collapsed.

If you see "FITS files" here then you know the settings are correct for the file format to use when saving data. Normally, once this is set properly in the OCC profile, you never need to change it again.

Next the Camera Controls are opened up. This is where you change the exposure time. Be mindful of the units shown. Sometimes it will show ms (for milli-seconds) and sometimes it can show seconds. LX Mode is for long exposures but all our occultation work is with "short" exposures, generally 2 seconds or less. The slider shown can also be used to adjust the exposure time. A click to the left of the slider position decreases the exposure time by a factor of 2. Click to the right increase it by a factor of 2. You can also click and drag it to just about any arbitrary value you want.

Gain is normally set to 300 and offset to 100 for our observations. All of the other controls should have the values shown here and are the normal defaults.

USB Traffic defaults to 50 but this is rarely a good value. For the SSD-based standard RECON laptops, this appears to be best when set to 0. For slower systems, it may require experimentation to find the best value for your system, likely between 5-15. This only matters when trying to run very fast, that is less than about 200 ms. If set wrong, it can lead to dropped frames and SharpCap doesn't always know when it drops frames under this circumstance.
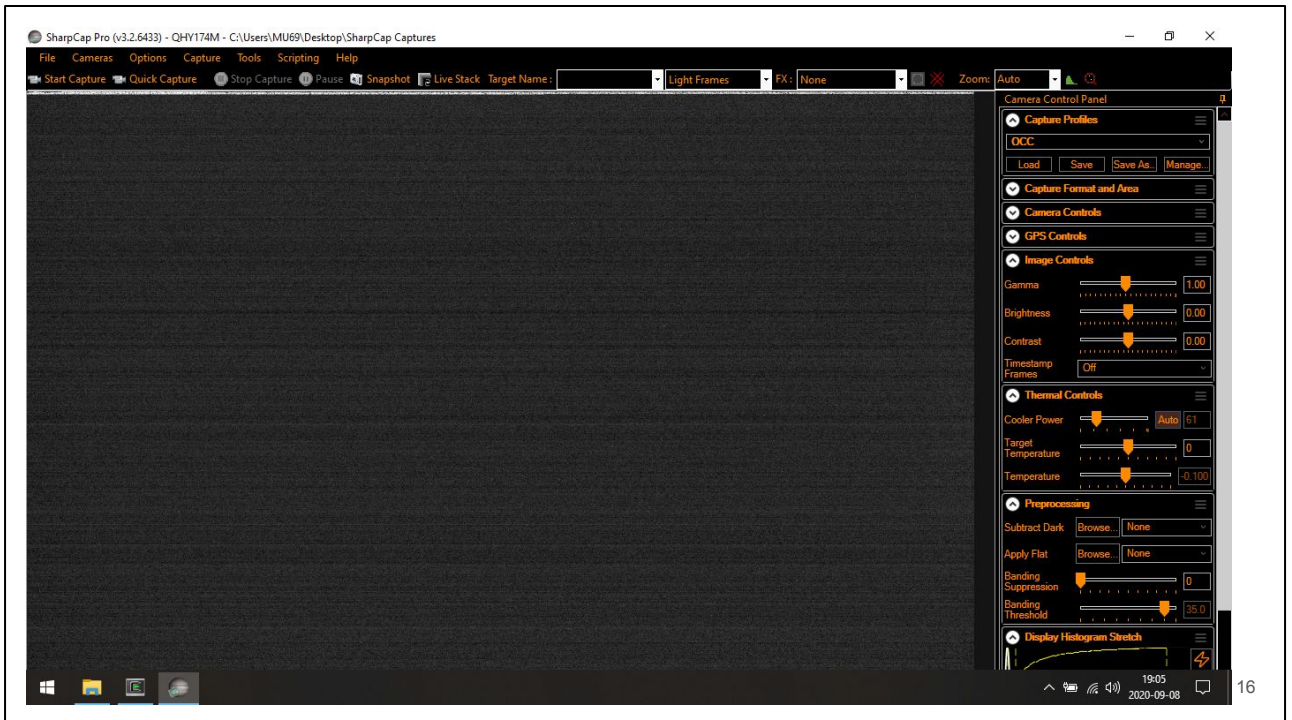
We're going to skip over the GPS and come back to that. The next three controls are not used but shown so you can see the normal and correct values. Image Controls, Thermal Controls, and Preprocessing should all look like this. Note that the values for Image Controls are really important to be as shown. These are the normal values but there is a chance you might mistake these for tools to let you see the image better. In fact, Image Controls change the values of the data and will make data analysis much more difficult and could actually damage data quality. The histogram stretch is the only tool you should use to change how the image looks. That tool doesn't change the data, only the view.
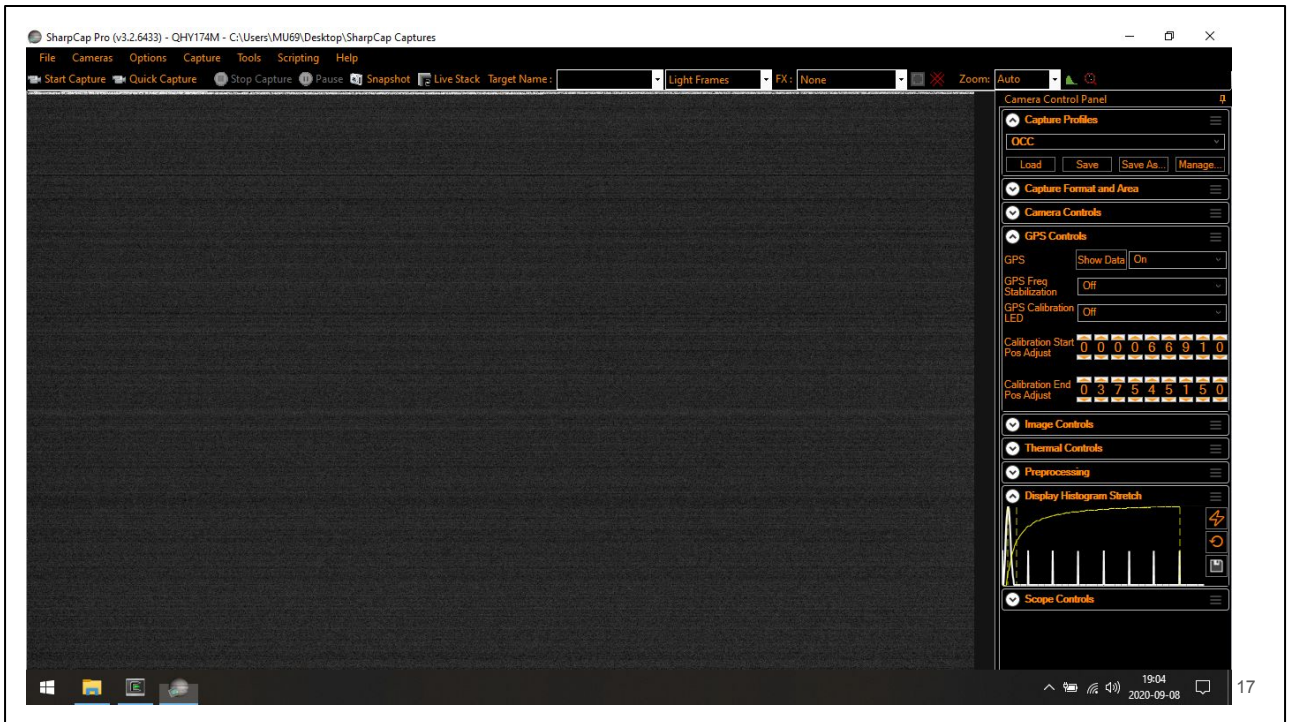
The GPS controls are now expanded. The GPS is, of course, on here and should always be on. The "Show Data" button can be used to bring back the GPS status window you see at the start. The bottom three controls "GPS Calibration LED", "Calibration Start Pos Adjust", and "Calibration End Pos Adjust" are used to make precise adjustments to you camera, from version 3.2.8642.0 onward, these values are set automatically and do not require any modifications. Your values will NOT be the same as those shown here for start and end pos.
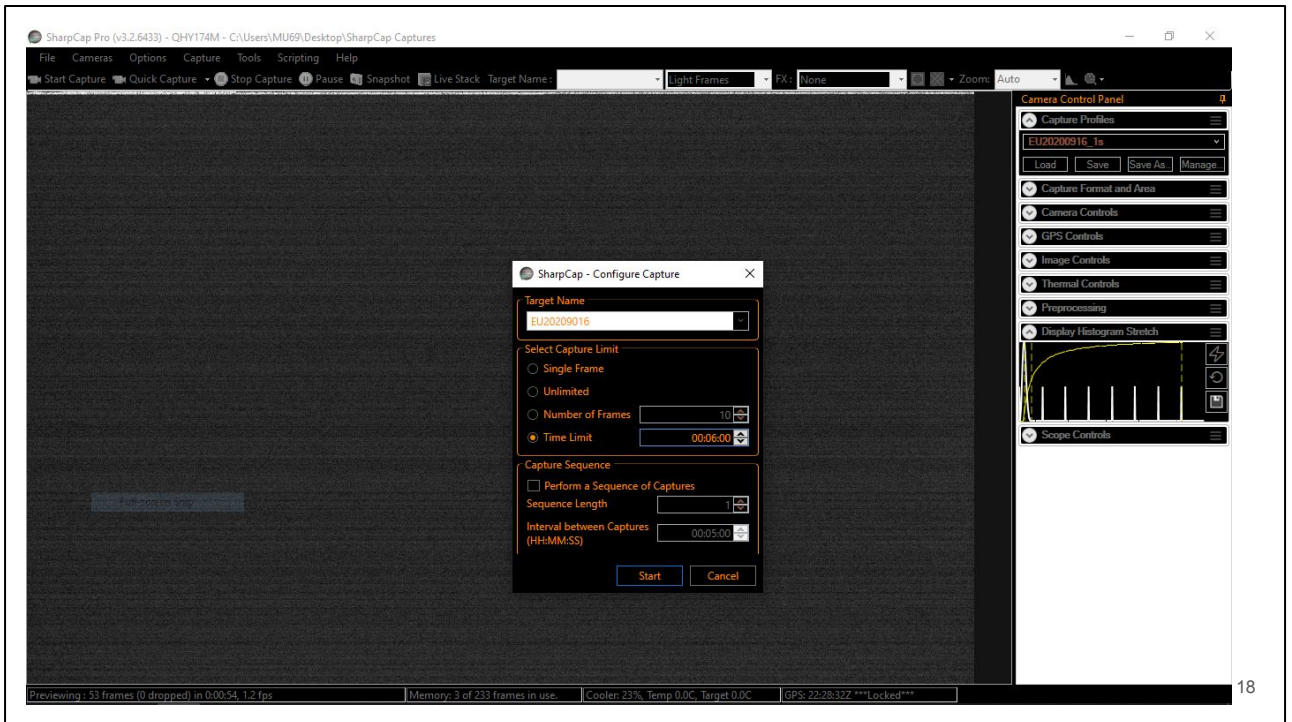
Most of the rest of this document was for general awareness. This screen is shown at the start of a data capture. Clicking on "Start Capture" (upper left) will bring up this dialog box. I've entered the target name on this screen and set the Time Limit to 6 minutes (00:06:00). When you click Start, it will begin taking data. While this screen is up you can still see the GPS clock and can click Start at the right time.
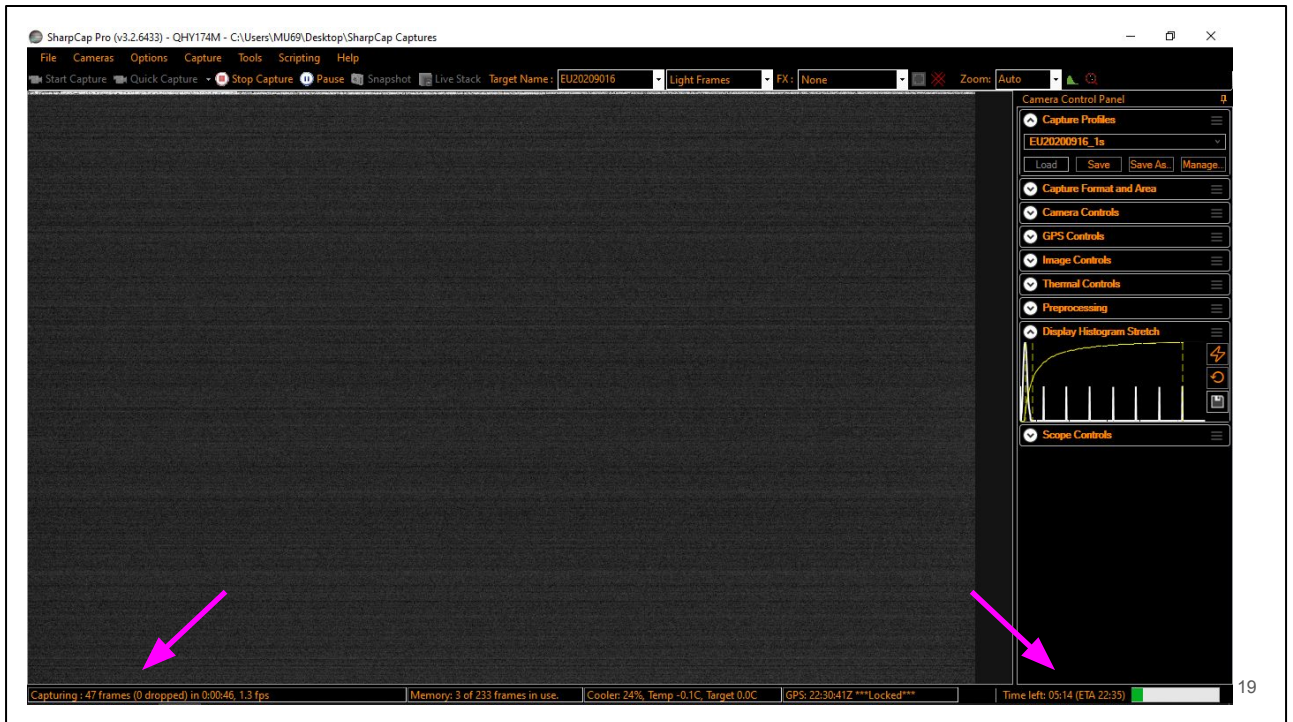
This is what the screen looks like during a capture (though I hope you see stars instead of a blank field). On the left of the status line you see that I'm 47 frames (46 seconds) into the data collection. It starts counting from 0 at the start of a sequence. On the right side, there is additional information to tell you where you are in the sequence you requested. Here it says there is 5 minutes and 14 seconds left to go, expected to finish at 22:35 UT. The green bar increases from the left becoming full green at the end.

As soon as the data collection ends there is a popup line toward the top of the screen that is present for about 30 seconds to tell you the sequence has completed and where the data were saved. SharpCap goes back to Preview mode as well.