

Getting Started with Deep Sky Imaging

USING SHARPCAP AND A CMOS COLOUR CAMERA

David Richards

Overview

This document outlines the steps taken to capture a deep sky object using a one shot colour camera.



M31

Equipment

- Celestron AVX mount
- Altair 66ED refractor
- Altair 0.8x reducer/flattener
- Altair 183C camera

Software

- SharpCap 3.2 (capture)
- FITS Liberator (inspect test frame)
- Astro Pixel Processor (stack & process)

For the above image of Messier 31, frames captured: lights 80x90s, flats 90, bias 90, darks 50. [Note: the calibration frames (flats, bias, darks) are optional but would be needed to obtain the best possible outcome.]

Outline Steps

Some of these steps will vary depending on the equipment available or techniques used.

- Focus the camera on a land-based object & align finder scope or red dot finder with telescope.
- Polar alignment: polar scope on mount.
- Mount alignment: 2 alignment stars (west), 4 calibration stars (east).
- Check polar alignment: All Star Polar Align (ASPA on Celestron).
- Focus: using a Bahtinov Mask.
- Frame the object: M31 in this case.
- Test frame: capture a single frame and inspect in FITS Liberator.
https://www.spacetelescope.org/projects/fits_liberator/download_v301/
- Capture light frames (essential).
- Capture flat frames (optional).
- Capture bias frames (optional).
- Capture dark frames (optional).
- Process frames (not covered in this document).

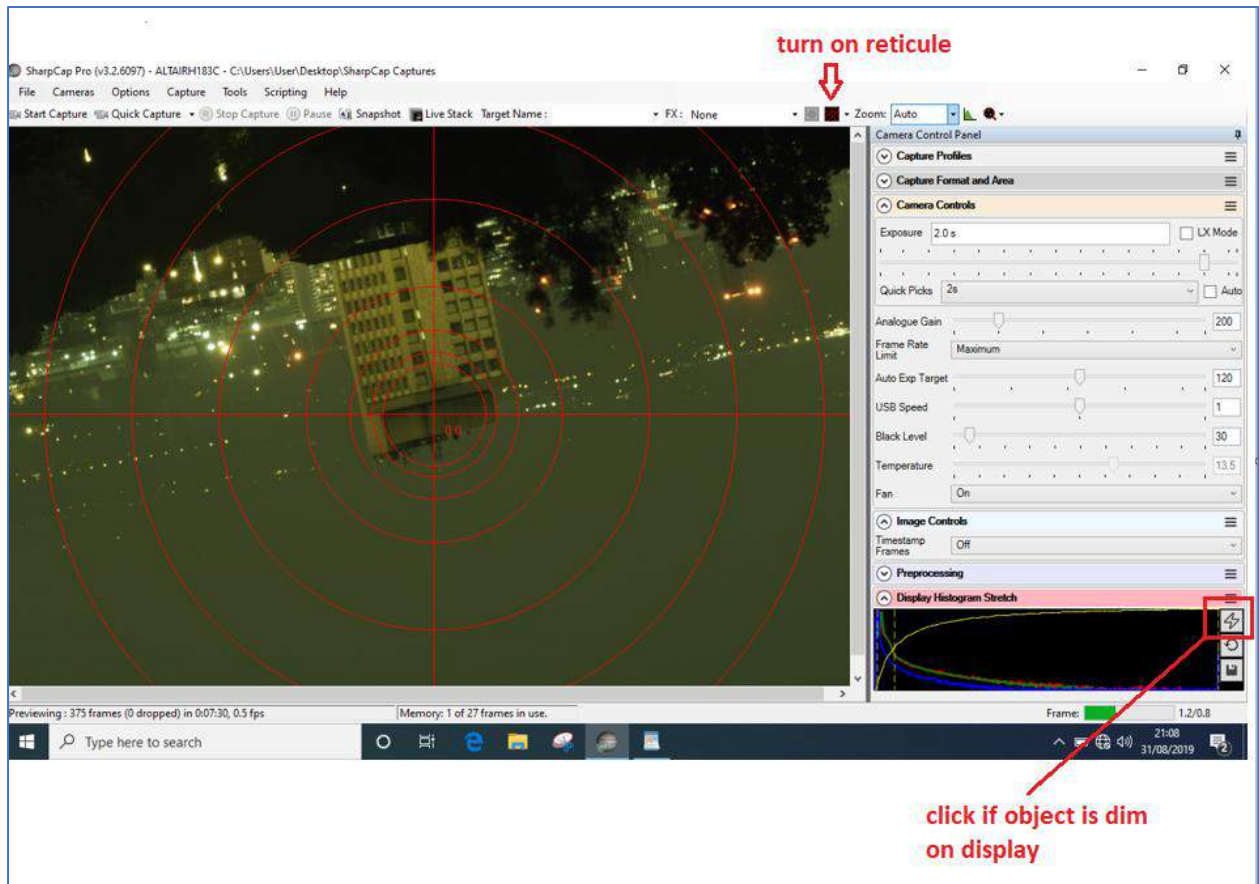
Typical routes for processing the captured frames (there are others) are:

- Deep Sky Stacker <http://deepskystacker.free.fr/english/download.htm> followed by GIMP <https://www.gimp.org/downloads/> or Photoshop .
- Siril <https://www.siril.org/download/>
- Astro Pixel Processor <https://www.astropixelprocessor.com/free-30-day-trial/>
- Star Tools <https://www.startools.org/downloads>
- Pixinsight <https://www.pixinsight.com/downloads/index.html>

The above will require varying degrees of effort in learning how to use.

Land-based Focus

Carry out a rough focus on a land-based object about 1 mile away. Turn on the reticule in SharpCap. Ensure that the Red Dot Finder (or finder scope) is aligned on the land-based object as well.



Polar Alignment

Carry out polar alignment and mount alignment. These steps will vary and depend on the type of mount (alt/az or equatorial) available.

Mount Alignment

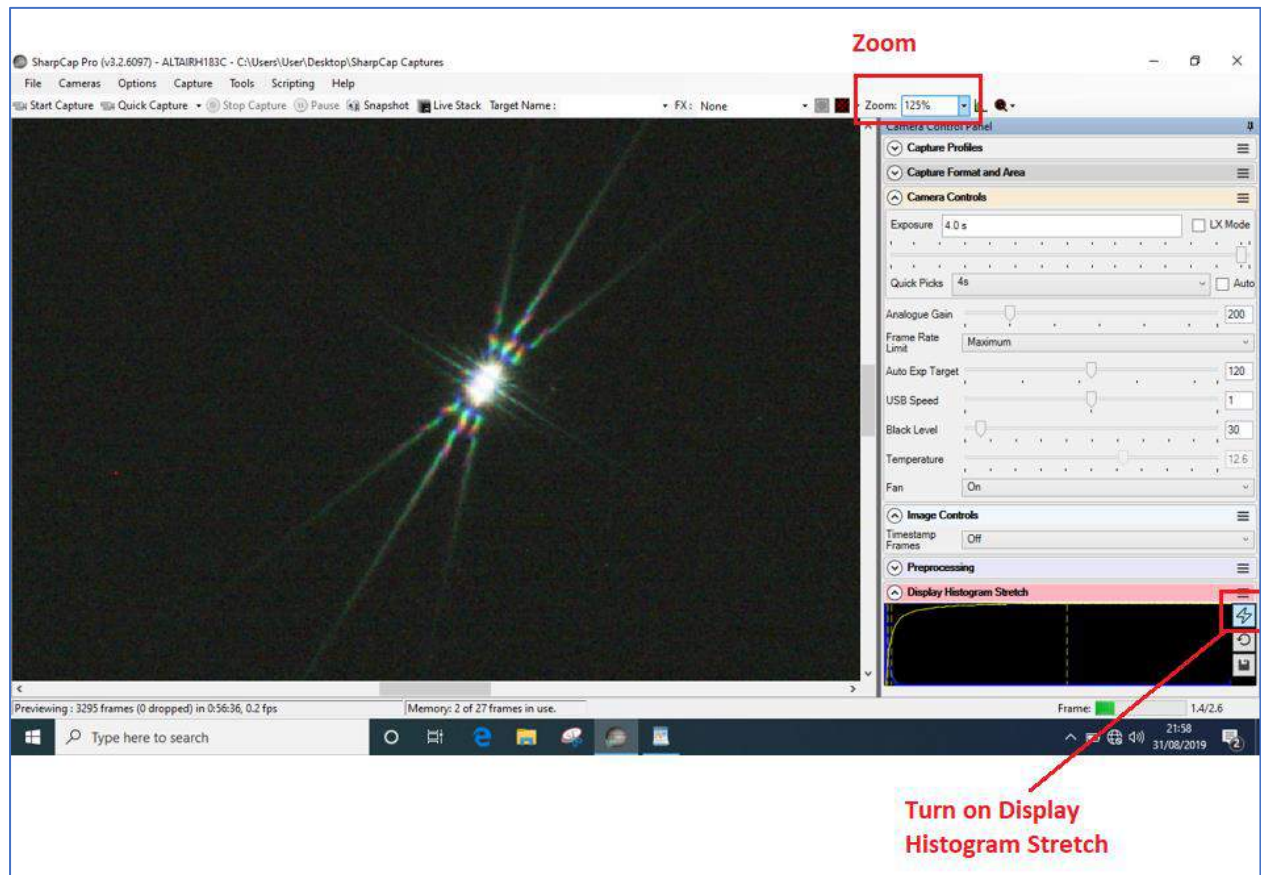
This usually involves using a GOTO hand controller and choosing various stars as directed by the hand controller software.

Focus on Star

Choose a medium brightness star near the object of interest. For M31, the star Alpheratz was used.

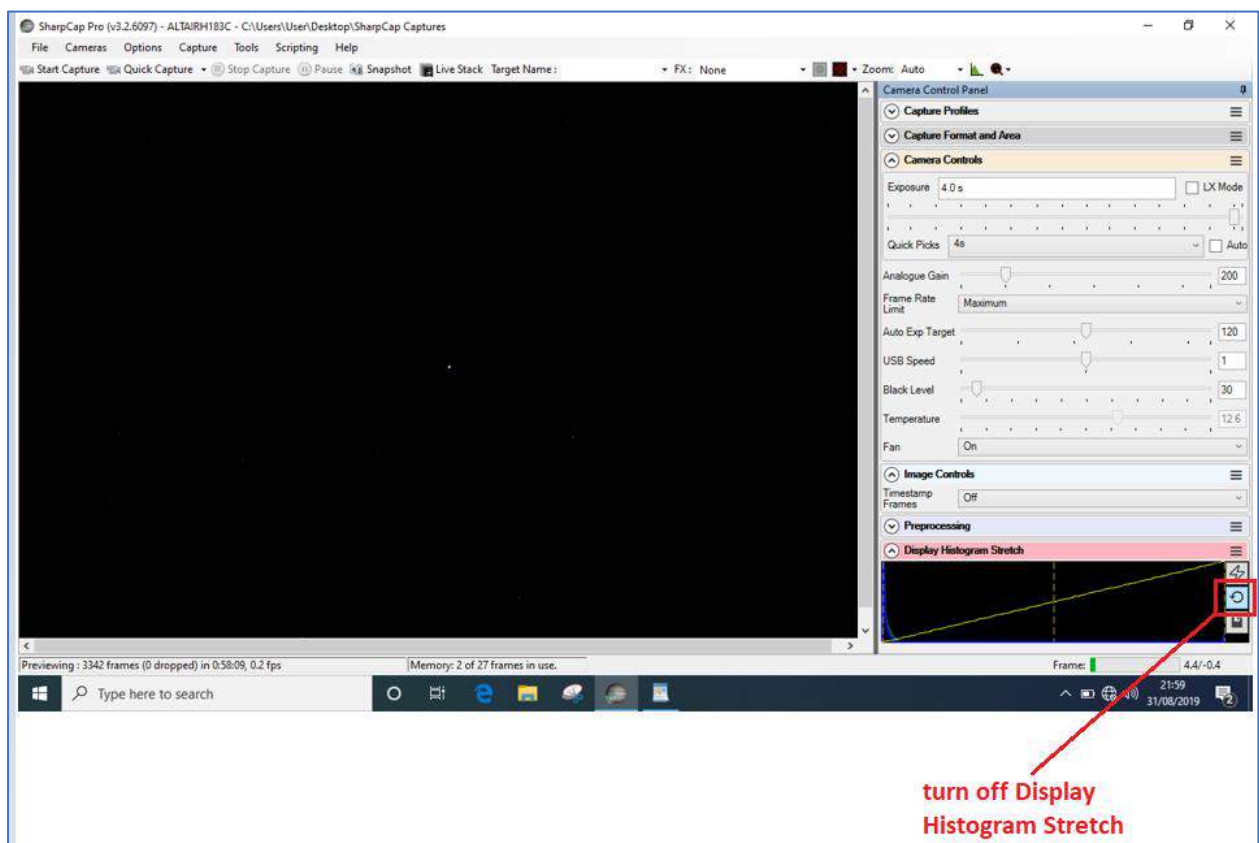
To obtain good focus, use a Bahtinov Mask. Zoom in to 125% - 150% and enable *Display Histogram Stretch*. Adjust focus to obtain pattern below.

4s exposure with *Display Histogram Stretch*.

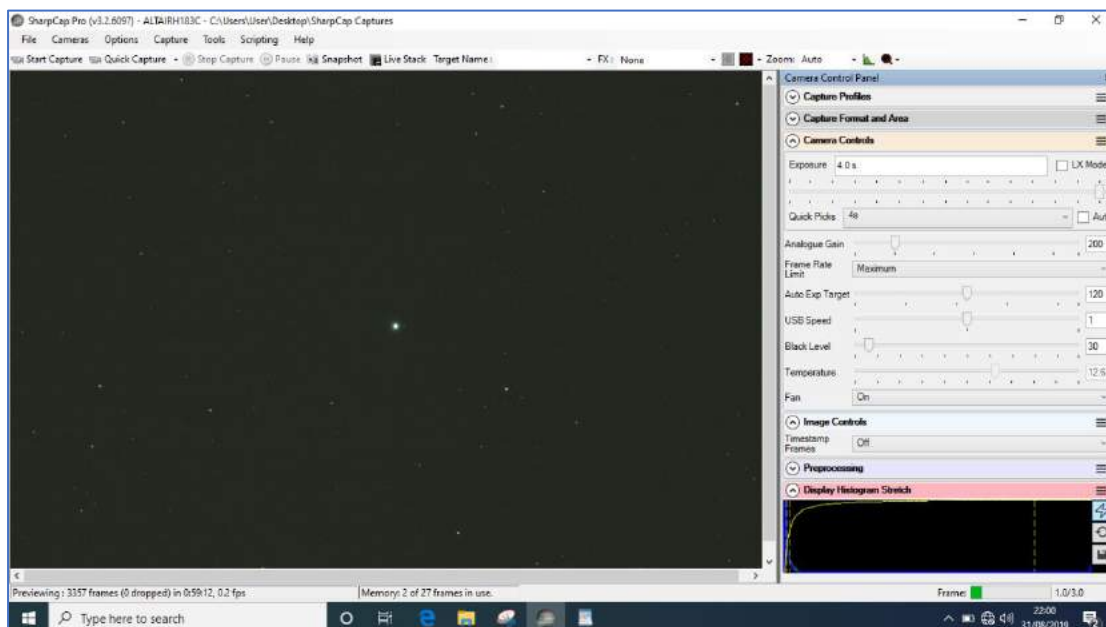


Remove the Bahtinov Mask.

This is the in-focus star, 4 second exposure unstretched.



This is the in-focus star, 4 second exposure and Display Histogram stretch



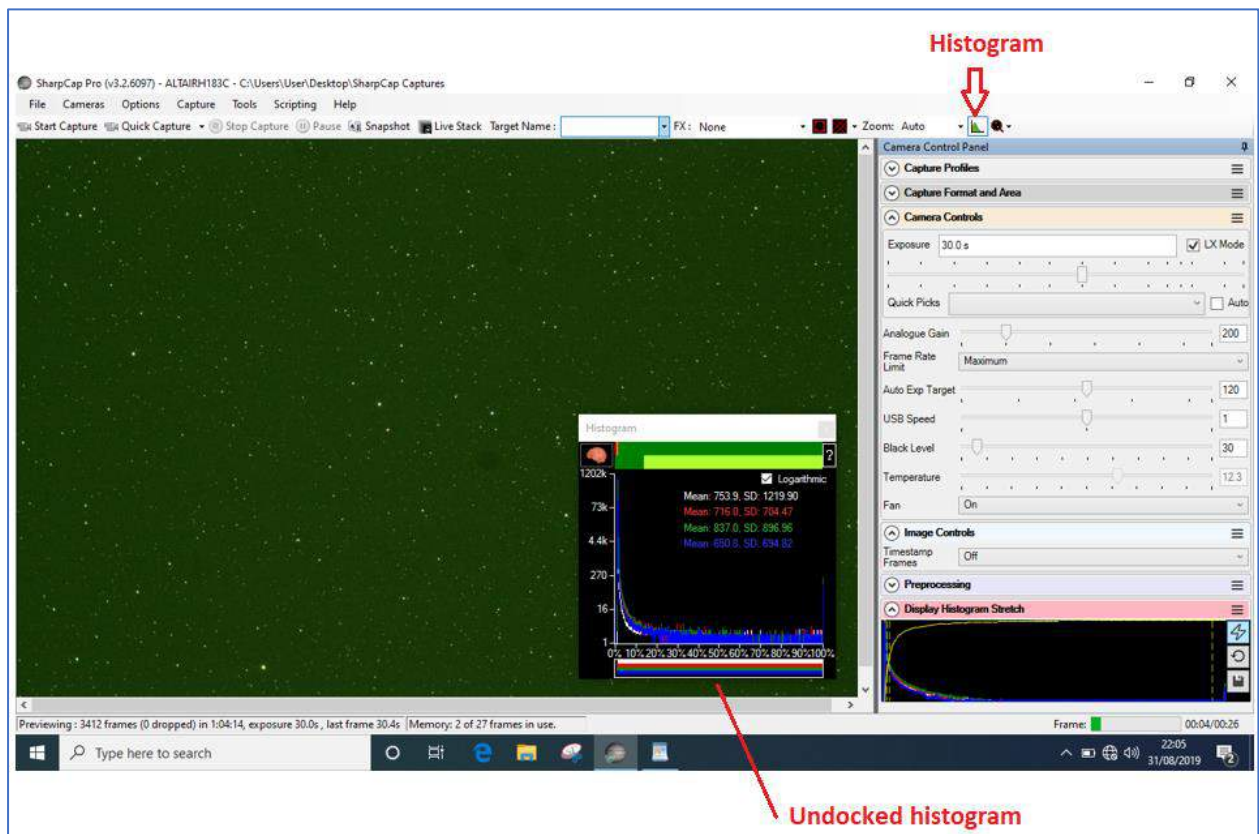
Capture a Test Frame

Slew to object – M31 in this case

With a 30s exposure, the object may not be visible. Ways to make the object visible are:

- Increase the gain to a large value (the display may look ugly).
- Turn on *Display Histogram Stretch*.
- Try the above together.

Turn on the histogram. Undock it by grabbing the histogram title bar with the mouse and move to one side. This results in a smaller histogram (which is adequate) and larger view of the target.



For this capture, the following settings were used:

- Capture Area = 5440 x 3648
- FITS
- RAW12
- Exposure = 90s
- Gain = 200
- Black_level = 30 (for how to establish black_level see end of document)

[Note: *black_level* is the term used by Altair cameras to denote *offset*. The equivalent setting for QHY cameras is *offset* and for ZWO *brightness*.]

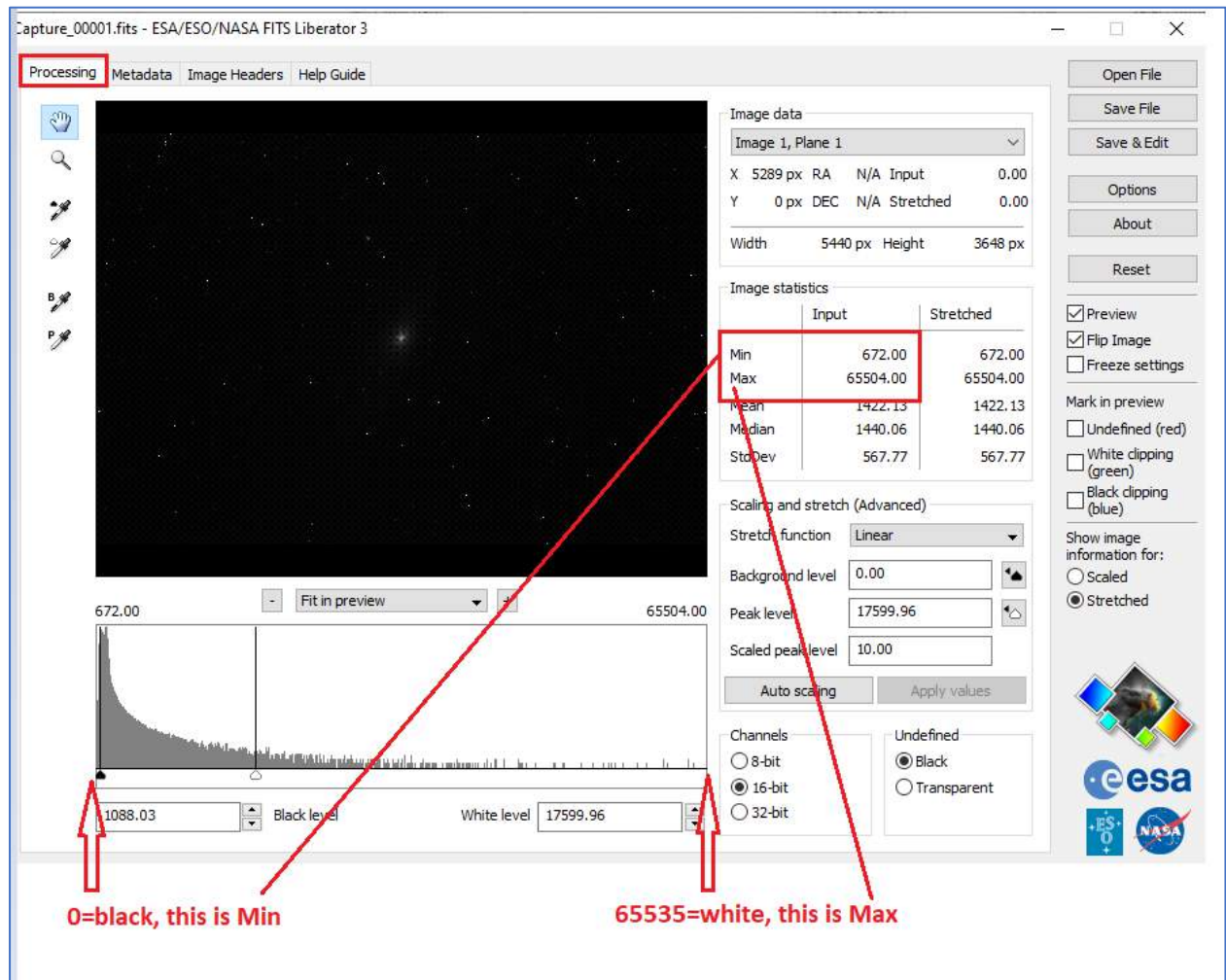
These capture settings are guidelines – they will vary depending on the equipment used.

Capture a Single Frame

Next steps require the *FITS Liberator* software to be downloaded and installed. Capture a test frame using the above settings. *It is far better to capture and inspect a single frame before spending hours capturing data when the capture settings might not be optimal!*

In SharpCap, from the Menu, *Capture > Start Capture* and select *Single Frame*.

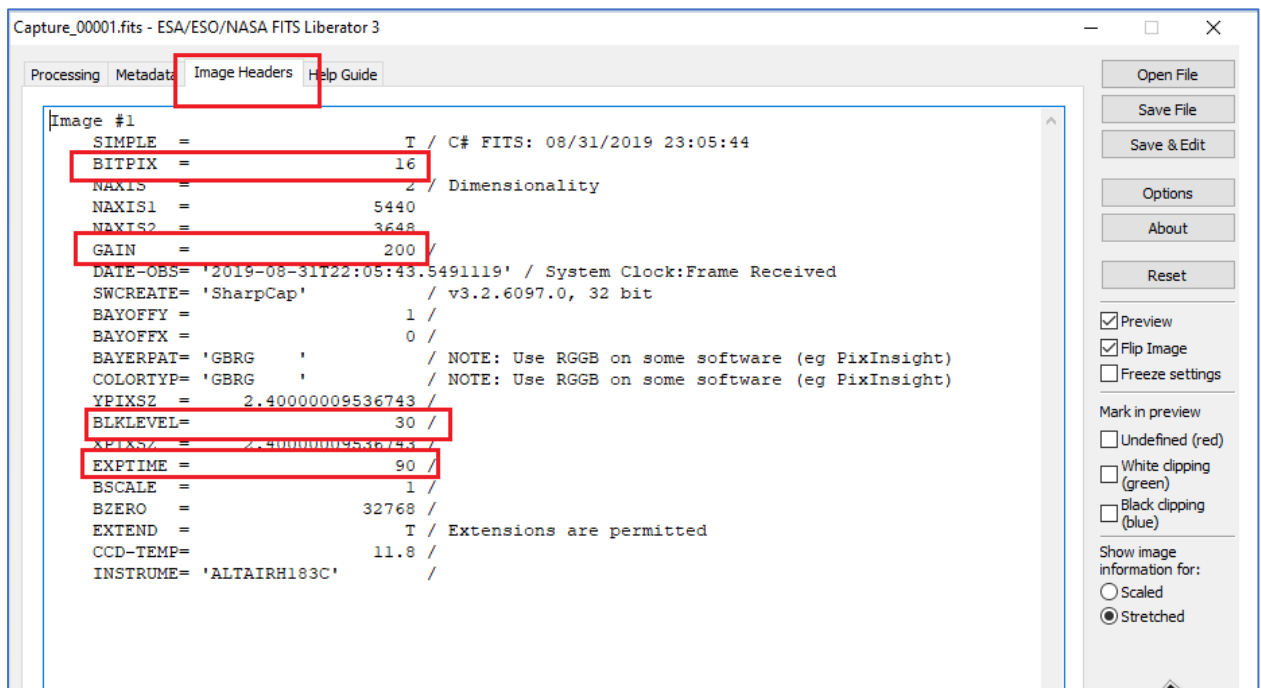
Double click the frame and it will open in FITS Liberator.



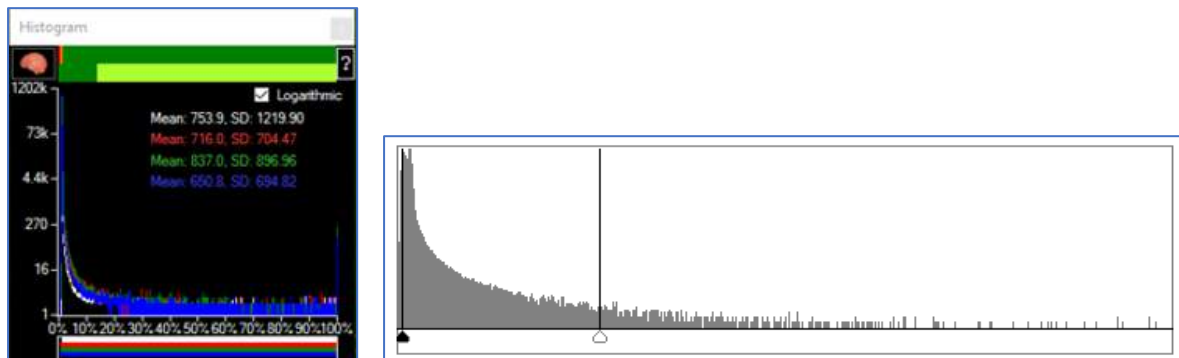
The idea is to have an exposure such that *Min* is greater than 0 and *Max* is less than 65535.

If $\text{Min}=0$ then we lose faint data. If $\text{Max} = 65535$ we can burn out bright areas. **In both cases, data is lost and cannot be recovered by processing.**

Below, the *Image Headers* tab shows the settings used to capture the frame. This information is stored in the frame and can be accessed by processing software.

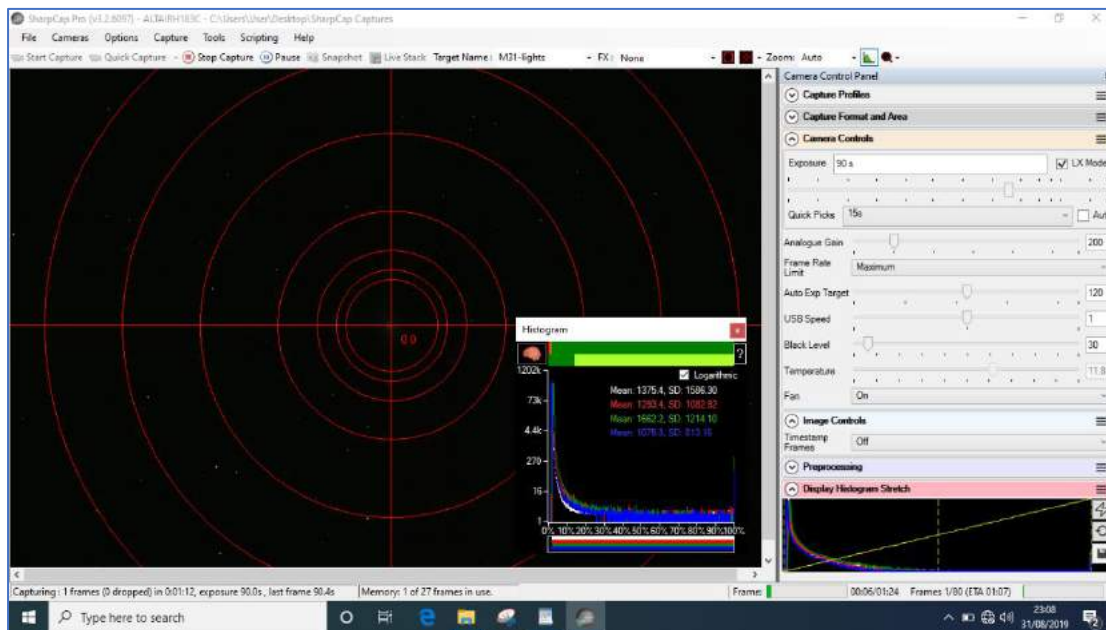


If the SharpCap histogram and the FITS Liberator Histogram look like this, the capture settings are *good enough* and we are ready to capture a set of frames.

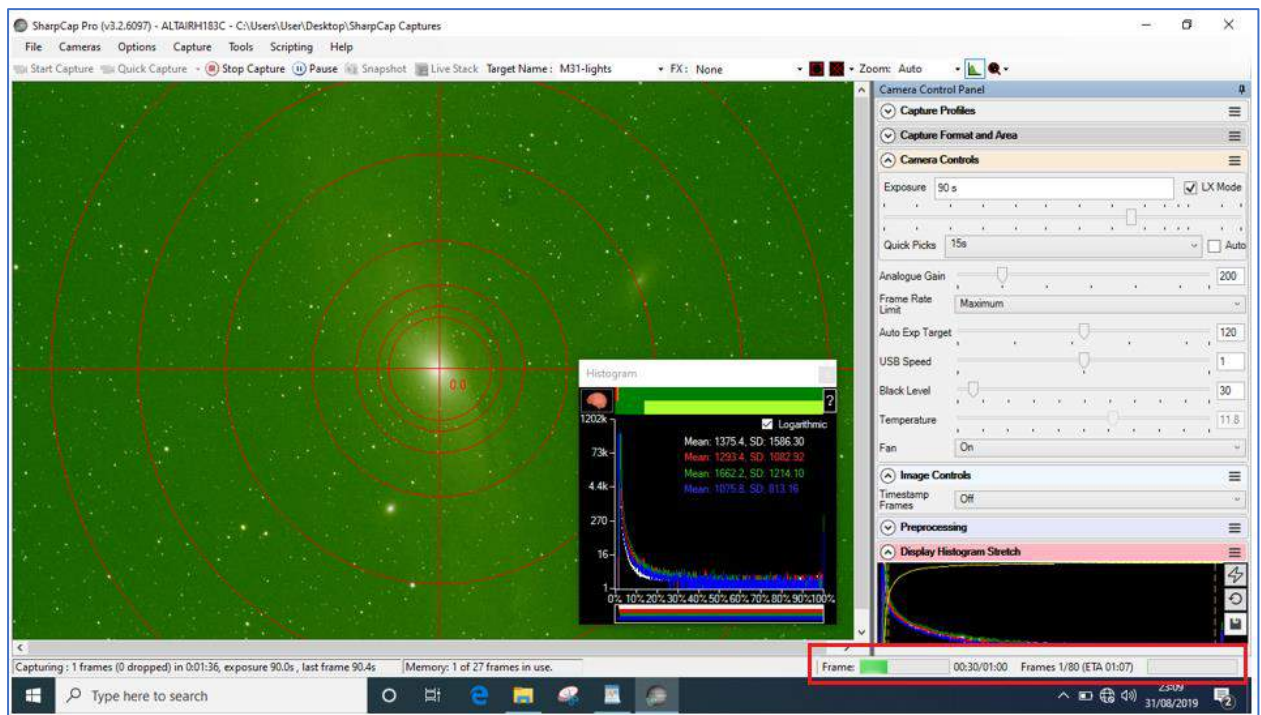


M31 Capture Multiple Frames

An unstretched frame (Display Histogram Stretch turned off) will look like this. The object is not visible because it is faint – this is not unusual.



A stretched frame (Display Histogram Stretch turned on) will look like this. The object is visible and centered on the reticule.

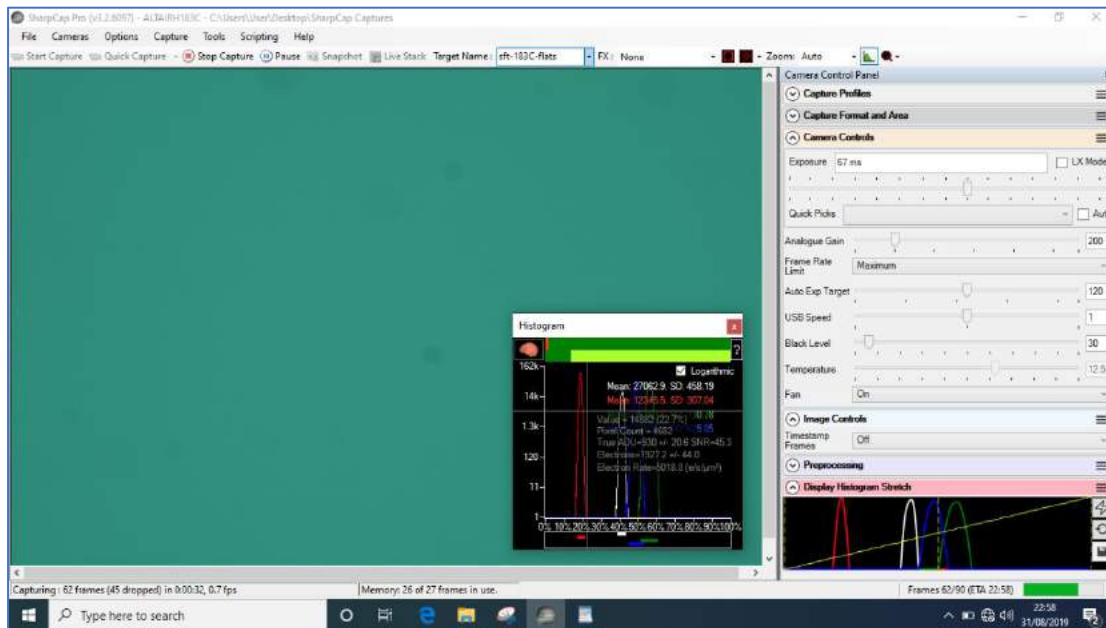


From the SharpCap Menu, *Capture > Start Capture* and select *Multiple Frames* and choose a number (say 30). The capture will commence and progress plus estimated time of finish will be displayed at the bottom right of the SharpCap screen.

Flat Frames

When the capture completes, capture some flat frames. These will remove vignetting (tunnel effect) and any dust or dew blemishes on the optics. A light source such as an electroluminescent panel or even a tablet computer will be needed.

Use the histogram to obtain a correct exposure to capture the flat. Do not adjust gain or black_level. Decrease the exposure until the luminance (white histogram) is around 50% on the bottom histogram scale. In this case, the exposure was 67ms. Then capture a set of flat frames (a minimum of 20), more is better.



Bias Frames

To capture bias frames, leave the settings for gain and black_level the same as for the light frames but reduce the exposure to the smallest possible value. Cover the telescope with its cap. Then capture a set of bias frames (a minimum of 20), more is better. The bias frames are used by stacking software to process the flat frames.

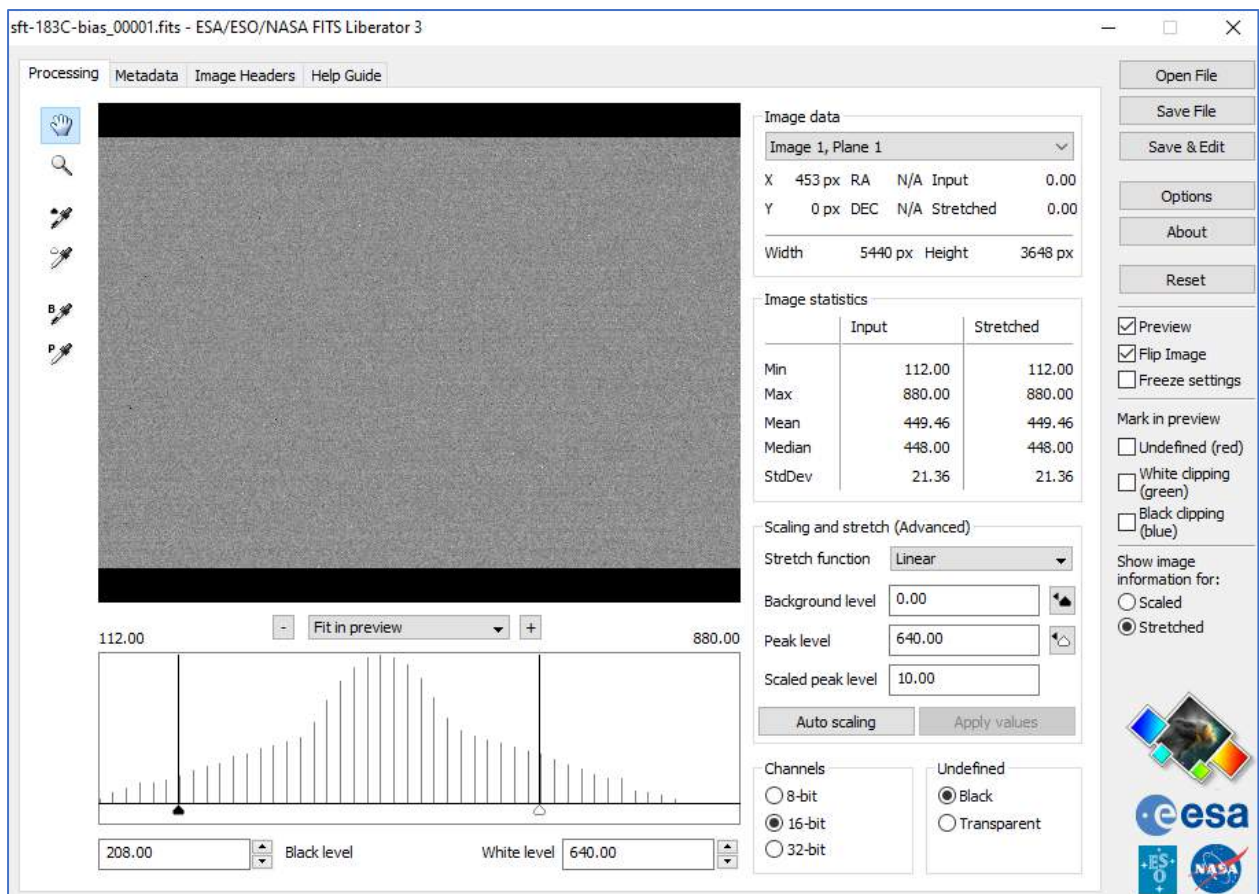
Dark Frames

To capture dark frames, ensure gain, black_level & exposure are all set the same as for light frames. Cover the telescope with its cap. Then capture a set of dark frames (a minimum of 20), more is better. The dark frames are used to remove hot pixels and amp glow.

How to establish the value for black_level

Decide on the gain being used – 200 in this case. Set the exposure to the minimum possible and take a bias frame. The idea is to choose the *lowest value* for black_level which makes the bias frame histogram appear to be centralised. If the histogram is not central, then adjust the black_level as follows:

- Histogram hits right hand side then decrease black_level.
- Histogram hits left hand side then increase the black_level.



Note: if the gain is changed, then retest the black_level as above.

For an Altair 183C:

- For gain = 200, black_level = 30 seems ok (centralised bias frame histogram).
- For gain = 400, black_level = 50 seems ok (centralised bias frame histogram).