Monochrome Photography

Contents

Overview

This document assumes that the reader is already familiar with all of the basics of One-Shot Color (OSC) photography, and focuses on the additional complexities of monochrome photography.

OSC cameras have a Bayer filter built-into the camera – which is how they accomplish the RGB separation without any external filters. Monochrome cameras have NO built-in filters – the light coming in falls directly onto the sensor elements.

Because of this, monochrome cameras can capture almost ANY light wavelengths – allowing you to "see" things that would not be visible to the human eye. The drawback to this is that you have to spend more time and money to capture any image because you have to take multiple pictures (each with a different filter) and then do a bunch of work to combine all these images back into a single image when you are done.

I had initially thought that narrow band filters were only used to complement wide band filters – in other words ALL images would use RGB filters.

However, as I learn more, it appears that **narrow-band** photography actually replaces the RGB with SHO filters (using arbitrary colors) whereas **wide-band** photography uses the SHO data to improve the RGB data (see how to section.) I am still uncertain about this however.

Filters

Filters are essential to monochrome photography; please refer to the filter document for more details about filters in general.

As mentioned in the filter document you can spend thousands of dollars getting top of the line 2” filters, however I recommend that you start with a basic set of cheaper filters (which work quite well for most things) until you gain more experience – as you may find that they work quite well for what you need.

Filter Wheels

An automated filter wheel is most essential to taking monochrome pictures. You could use a filter drawer and save a few bucks, but it would be incredibly painful to have to sit there for hours manually changing filters!

There are currently two choices of size: 5 position, or 7 position filter wheels. Generally, you will be using 2” filters as you get more serious with fancier cameras so I would recommend that you get your wheel/filters in this size to start with to save having to them all over again when you do move from 1.25” to 2” filters.

For wide-band, you must have room for R, G, and B filters at a very minimum.

For wide band, you really should have room for L, R, G, and B filters for descent images.

For wide band, you would be better off having room for L, R, G, B, and one narrow band filter.

Ideally (for some more complicated targets) you should have room for L, R, G, B, and H, O, S narrow band filters.

I had initially thought you needed 1 empty position for focusing, but you should use the L position for this.

So, depending on your intended targets you may be able to use a 5-position wheel, or you may have to go with a 7-position wheel. Or you might setup two 5-position wheels; one for wide-band, and the other for narrow-band photography.

The drawbacks to the 7-position wheel are as follows:

1. It is heavier, increasing your optical train weight and possibly exceeding your mount capacity.
2. It is larger and tends to hit the mount if not positioned properly.
3. It is more expensive.

Another confusing thing is that while the 5-position wheels screw into the optical train, the 7-position wheels generally require you to remove the front plate from your camera and attach the wheel directly to the camera using 4 or more screws.

Tracking

This may sound stupid, but a lot of time you can get away without enabling tracking with OSC cameras when taking short exposures.

This DOES NOT work with monochrome photography! Tracking MUST be enabled – even for very short exposures, or you will find that your images get rejected in the post-processing phase.

Confusing Aspect of ASIAir Plan Processing

I had initially cancelled the tracking when my ASIAir Plan was running because it appeared to be "stuck."

The Plan mode has an 'automatic' tracking calibration sequence which is confusing at first because it looks like it is 'stuck' in some sort of calibration mode forever.

However, if you are patient, this mode will eventually complete (after a few minutes) and proceed to taking your images. There is nothing that you have to do except wait.

Take More Subs

In OSC you can usually get away with only taking 3 (or maybe 4) subs because if one looks bad you can just take another one after the set is done. In monochrome photography you need to take more because the capture sequence is so much longer and you may lose your target and not be able to take more after you realize a few were bad.

If you were taking 3x 5-minute exposures on OSC this would take 15 minutes to complete. The same 5-minute exposures on monochrome could take up to 105 minutes (3 * 5 minutes * 7 filters) during which time clouds may have come in, the target may have dropped below the horizon, or into light pollution, etc.

By taking the extra subs, your session will not be ruined if you later find out something is wrong with one of the subs.

Narrow Band Filters Vs LRGB Gains

Because narrow band filters (SHO) let through much fewer photos than LRGB filters it is necessary to alter the gain/exposure times.

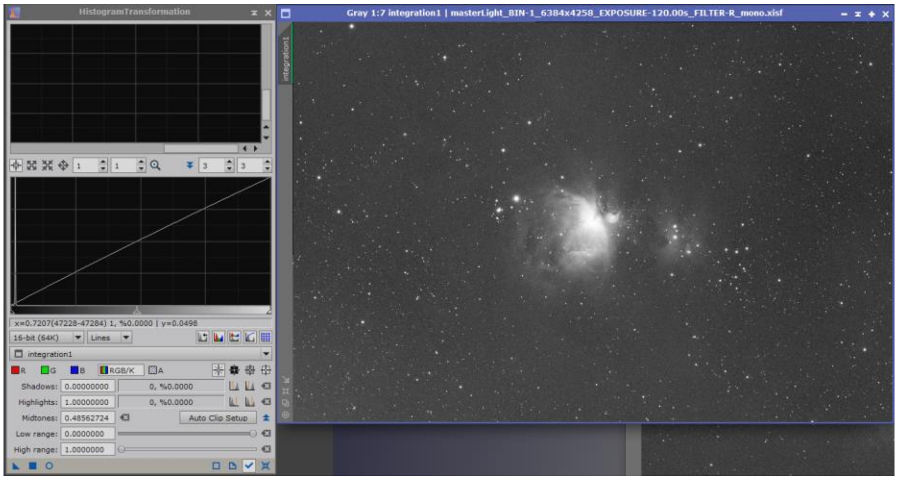
Because extending the exposure time causes the image session to get longer, I thought that a simple trick would be to change the gain. See Test Results Section to see that this didn't really turn out so well.

You will have to play around with your filter/camera setup to find the gain that works best for you.

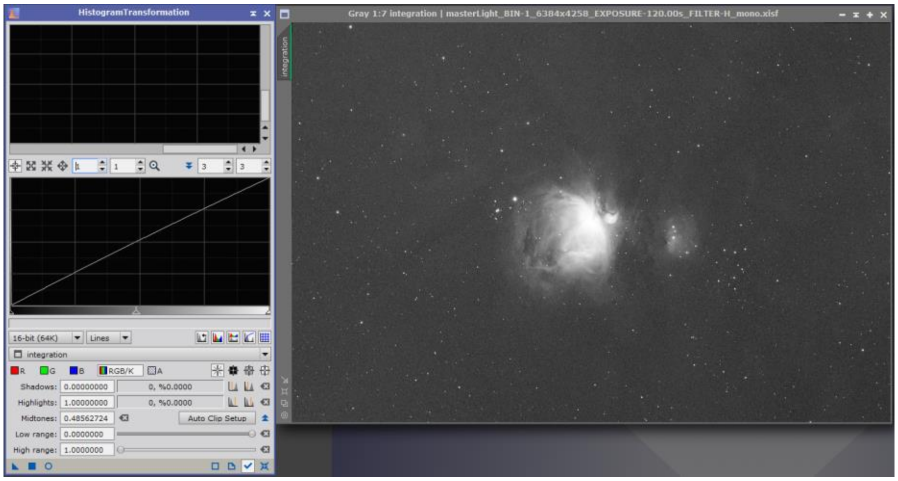
Generally, it appears that, in my situation, LRGB on midrange gain for about 5-10 minutes, and SHO on midrange gain for about 20 minutes or so is a good starting point for bright DSO such as M42. Longer times will be needed for dimmer DSO – but I expect the LRGB:SHO ratio will stay more or less constant around 1:4.

Shooting Using Only Different Gains

Using an ASI6200MMPro with basic ZWO filters, I shot all of the M42 images at 5 minutes exposure, and set the gain for LRGB at 0, and the gain for narrow band filters at 100. These values gave me the following histograms.



The 'R' (above) histogram peak is at the left at x=995-1155. This is not a particularly good histogram, and the exposure time and/or gain should have been higher. In spite of this, I was still able to get a very nice image.



The 'H' (above) histogram peak is almost completely at the left at x=0-164. This is a poor histogram and is barely registering any data. Obviously a much longer exposure time would be needed – probably on the order of about 20 minutes or so.

Case Study – IC443 (Jellyfish Nebula)

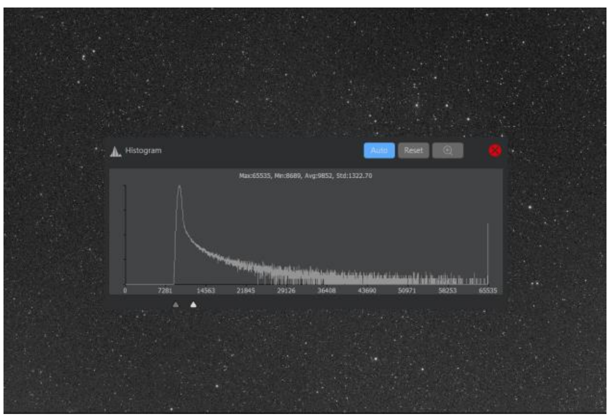
Image Capture

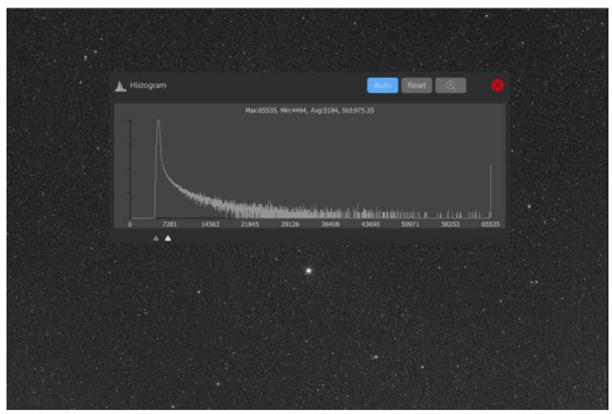
These images were captured under very good conditions on March 26 2025 – clear skies, low wind, no light pollution, and the target started out near the meridian and ended up disappearing behind my house roof – the last 'S' was lost, and the next to last 'S' was slightly distorted by the heat rising from my roof.

My goal with this example was to explore the steps needed to capture a narrow-band DSO image. I had previously obtained good LRGB results (see M42 LRGB Example) so my only concern here was to have a side-by-side comparison of wide-band vs narrow-band.

Step 1 – Determine LRGB Exposure Time

Using the preview feature shots were taken at medium gain, first at 120 seconds, and then at 60 seconds using the 'L' filter – the results are shown below.

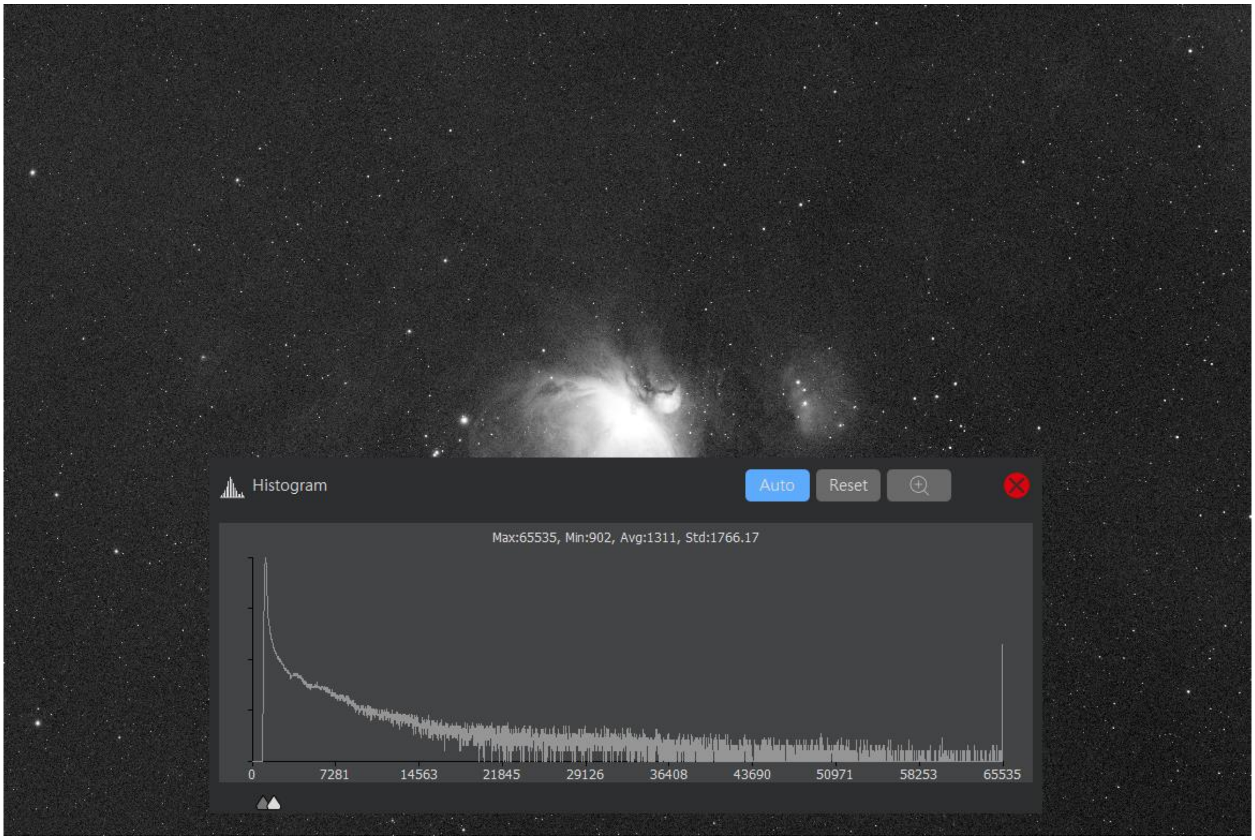




Since both had descent histograms, the 60 second exposure was used to reduce the shooting time.

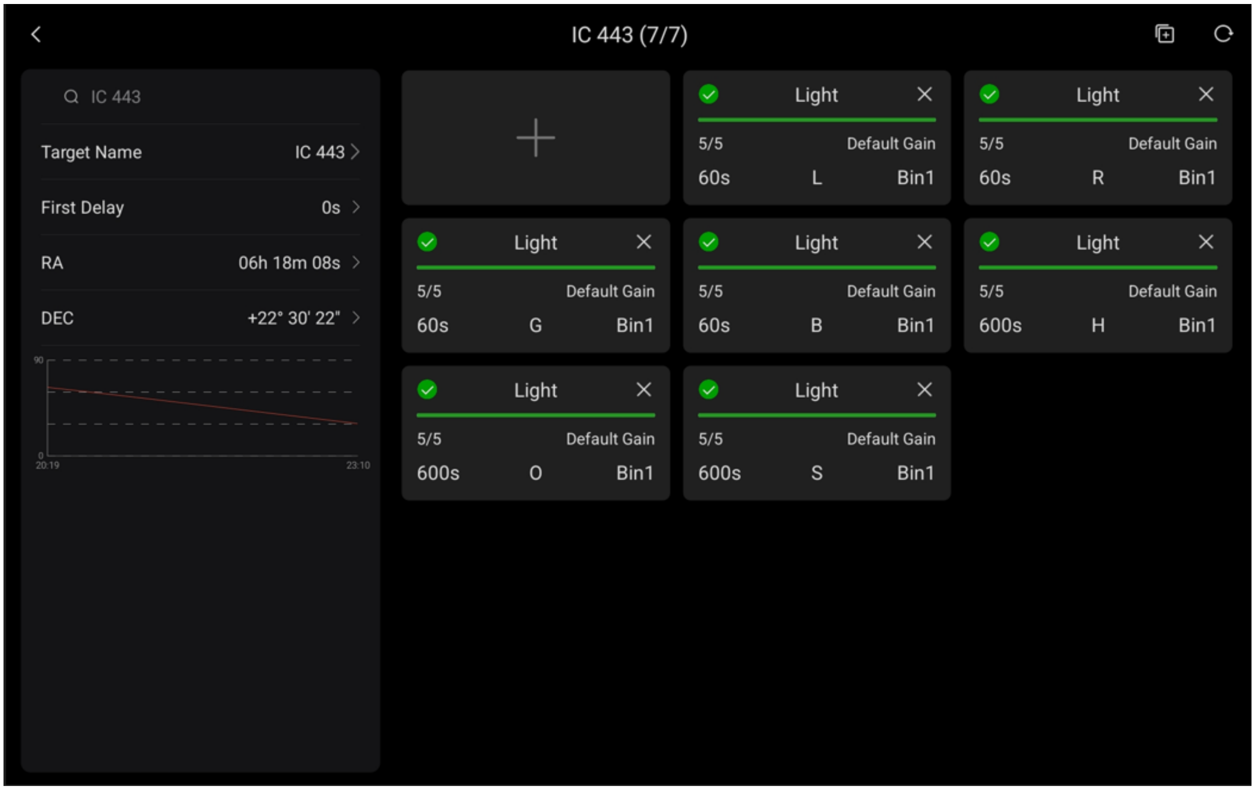
Step 2 – Determine HOS Narrow Band Exposure Time

To save time, a previous test with the 'H' filter (used on M42) showed reasonably good results using medium gain and 600 seconds exposure.



Step 3 Setup Plan

The next step was to setup the shooting plan. As can be seen below, this uses the exposure times determined in the previous steps and takes 5 subs using each filter.



I wasn't sure if this plan would complete before the target went behind the roof of my house.

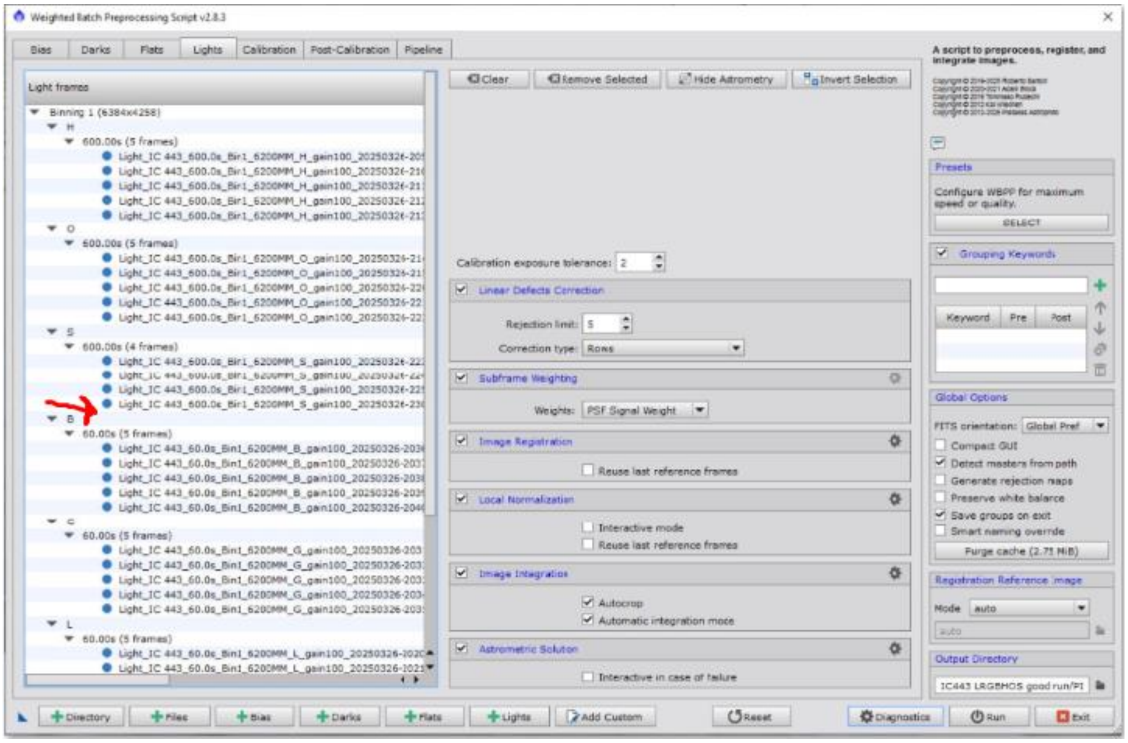
As it turned out, the 4th 'S' frame barely finished (it lost tracking several times and was slightly distorted by the heat coming off the roof), and the 5th 'S' frame was a complete loss as the roof was in the image. But all of the other frames turned out very good.

Step 4 Transfer Subs from ASIAir to File Server

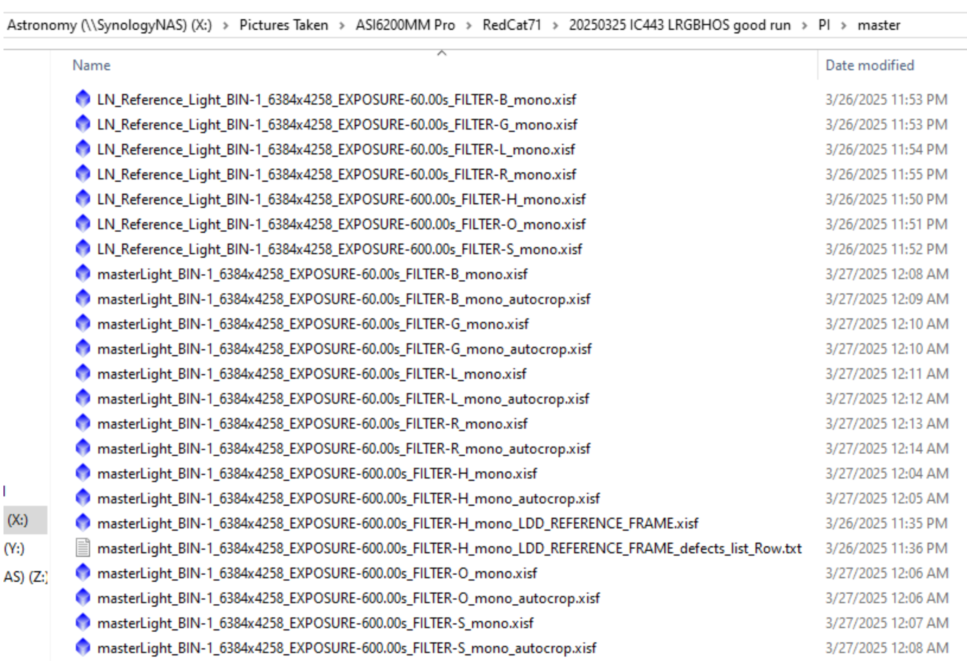
This was a simple file copy from the USB stick used on the ASIAir to my file server.

Step 5 Weighted Batch PreProcessing

I started this before going to bed (as it takes a while to complete.) You can see below that the 5th 'S' frame was removed (as it hit the roof.)



This took 42 minutes to complete and put the image masters in the following folder on my file server.


Astronomy (\\SynologyNAS) (X:) > Pictures Taken > ASI6200MM Pro > RedCat71 > 20250325 IC443 LRGBHOS good run > PI > master

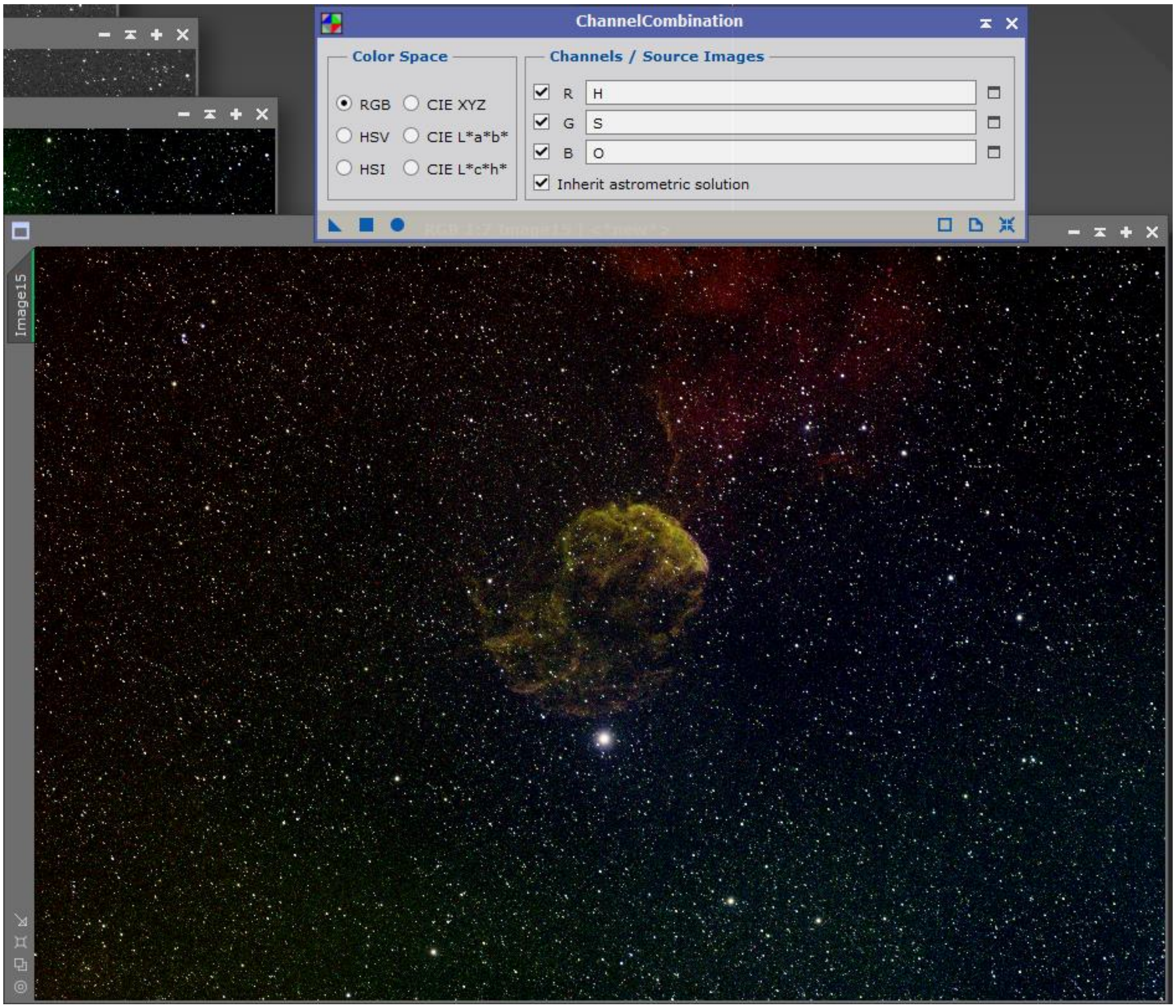
Name	Date modified
LN_Reference_Light_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-B_mono.xisf	3/26/2025 11:53 PM
LN_Reference_Light_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-G_mono.xisf	3/26/2025 11:53 PM
LN_Reference_Light_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-L_mono.xisf	3/26/2025 11:54 PM
LN_Reference_Light_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-R_mono.xisf	3/26/2025 11:55 PM
LN_Reference_Light_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-H_mono.xisf	3/26/2025 11:50 PM
LN_Reference_Light_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-O_mono.xisf	3/26/2025 11:51 PM
LN_Reference_Light_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-S_mono.xisf	3/26/2025 11:52 PM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-B_mono.xisf	3/27/2025 12:08 AM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-B_mono_autocrop.xisf	3/27/2025 12:09 AM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-G_mono.xisf	3/27/2025 12:10 AM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-G_mono_autocrop.xisf	3/27/2025 12:10 AM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-L_mono.xisf	3/27/2025 12:11 AM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-L_mono_autocrop.xisf	3/27/2025 12:12 AM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-R_mono.xisf	3/27/2025 12:13 AM
masterLight_BIN-1_6384x4258_EXPOSURE-60.00s_FILTER-R_mono_autocrop.xisf	3/27/2025 12:14 AM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-H_mono.xisf	3/27/2025 12:04 AM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-H_mono_autocrop.xisf	3/27/2025 12:05 AM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-H_mono_LDD_REFERENCE_FRAME.xisf	3/26/2025 11:35 PM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-H_mono_LDD_REFERENCE_FRAME_defects_list_Row.txt	3/26/2025 11:36 PM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-O_mono.xisf	3/27/2025 12:06 AM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-O_mono_autocrop.xisf	3/27/2025 12:06 AM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-S_mono.xisf	3/27/2025 12:07 AM
masterLight_BIN-1_6384x4258_EXPOSURE-600.00s_FILTER-S_mono_autocrop.xisf	3/27/2025 12:08 AM

Step 7 Channel Combination

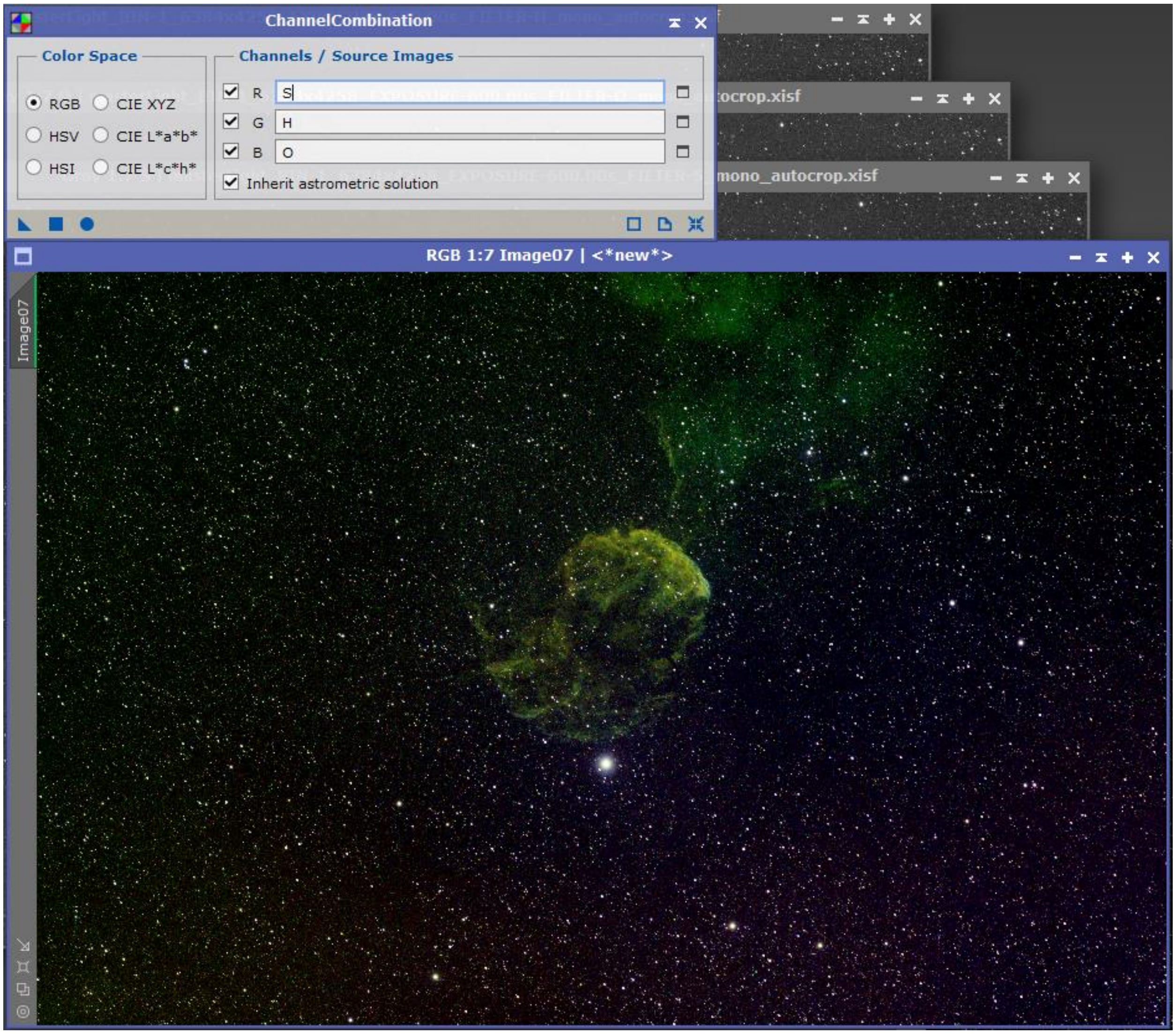
You can then play around by choosing which narrow-band filter data will be translated into RGB.

After channel combination, you need to do spectroscopic color calibrations and histogram transformation.

Using HSO->RGB produced the following image which is reddish.

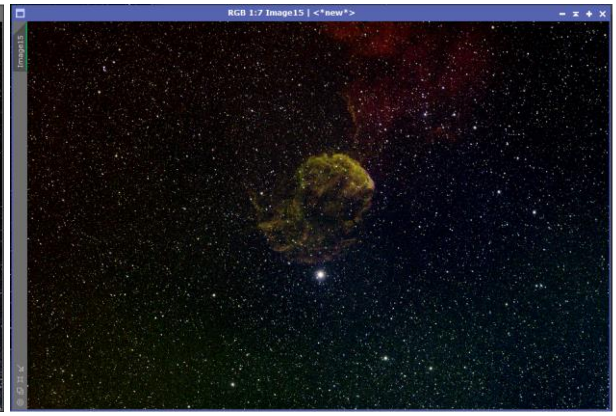


Whereas using SHO->RGB produced this image which is more yellowish.



Step 8 Narrow-Band vs Wide-Band Comparison

As can plainly be seen below the wide-band (left) image shows almost nothing of the nebula – only a slight red tinge near the top of the nebula. Whereas the narrow-band (right) image clearly shows the nebula in detail.



This was one of the most frustrating things for me when I started out using One Shot Color cameras because most of the DSO images I took looked like the above left image – which is very disappointing when you are expecting the above right image after seeing the DSO on the internet.

Step 9 Conclusions

Although the overall image quality turned out to be mediocre, I was very happy to finally figure out how to be able to see 'all' of the DSO in the sky!

I need to spend more time using longer exposures to get better detail in the images.

If I had this experience when I started in astronomy, I would have gone directly to mono photography and saved myself the thousands of dollars that I spent on One Shot Color cameras. But it was a learning experience – and I might have gotten discouraged if I started out dealing with the complexity of mono photography right off the bat.

PixInsight Post Processing Tips

Default Filters

SPCC (and other tools) populate the filter fields with default values. However, the defaults are almost never what you are using so you have to spend time changing these values EVERY TIME you use these tools which is incredibly annoying.

Sadly, PI does NOT have an easy way to change the default filter values.

To modify the default filters, you can hand edit the file located here:

C:\Program Files\PixInsight\library\filters.xspd

Move the following from the end of the old filter definition to the end of the one you now want to use as RGB filters:

' default="G"' (and R/B/L)

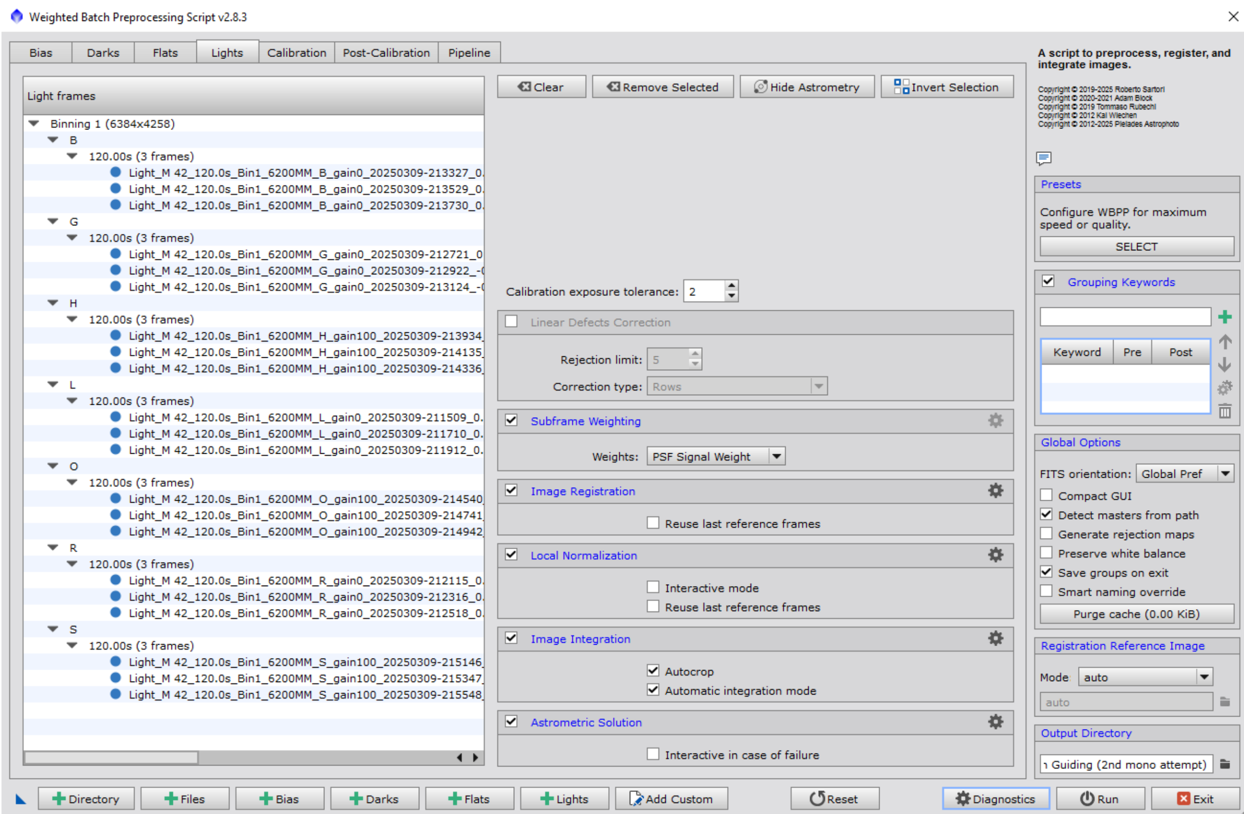
Move the following from the end of the camera characteristics to the one you now want to use:

' default="Q"'

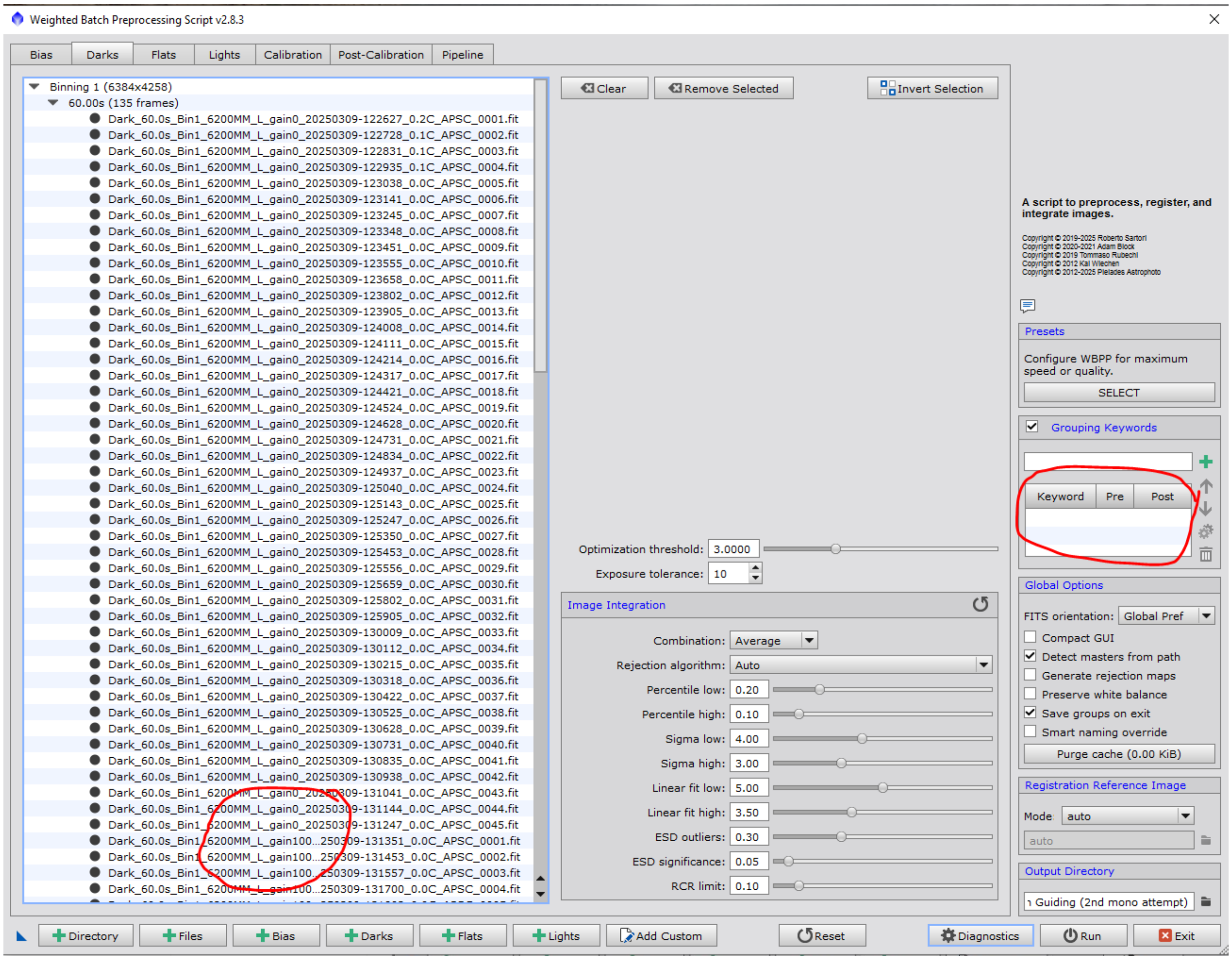
<u>Note</u>: this file gets reset every time you get a new version of PixInsight so you have to re-do this work after every update.

WBPP "Grouping"

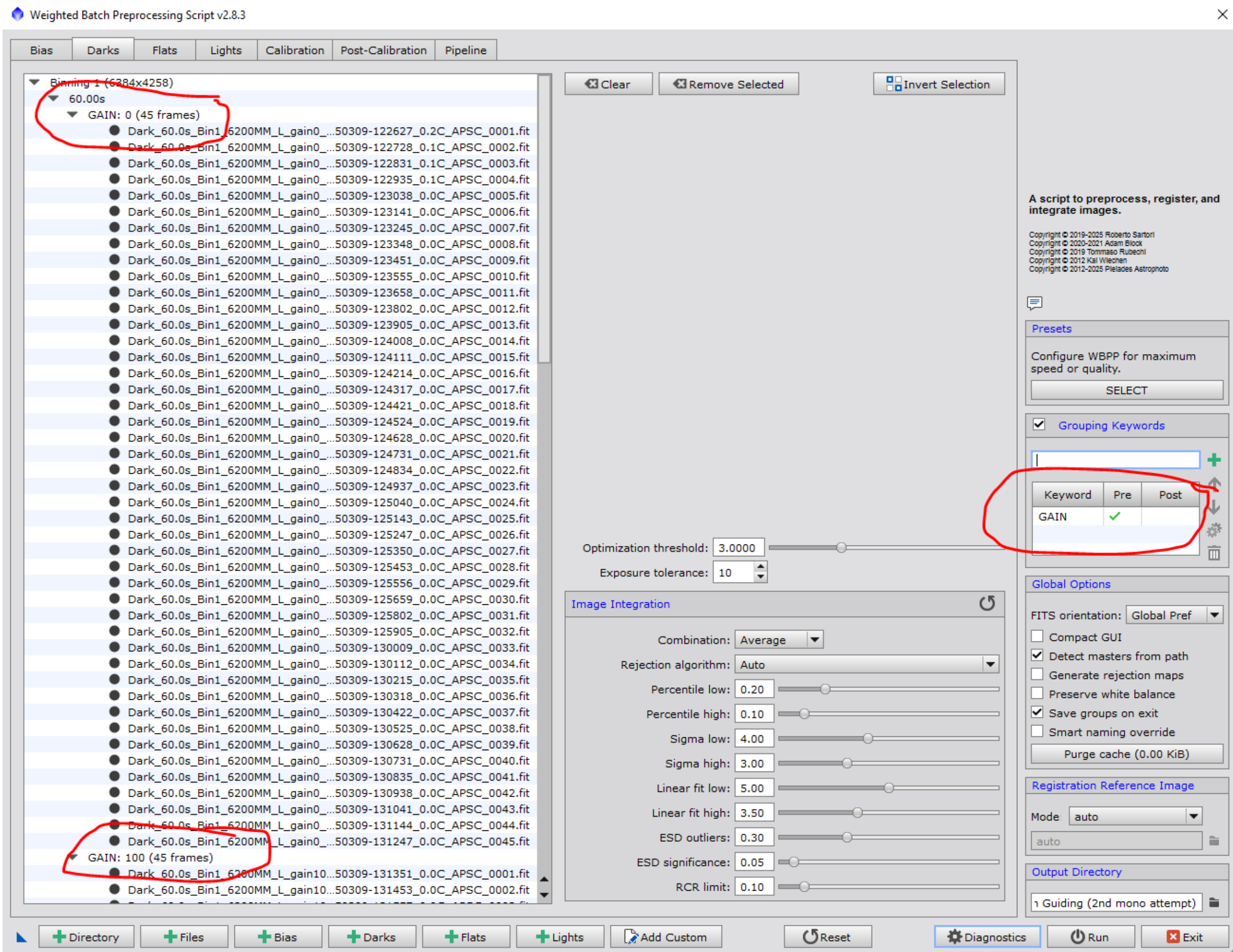
PI is pre-configured to break subs into groups of 'Bin', 'Filter', 'Exposure Time' which is really cool because you can just dump all of your light subs into a single folder and it will be able to break them apart in the individual images you wanted.



However, when you are processing Darks (and Bias, Flats, etc…) at different gain levels, it doesn't work so well, and will combine all of the subs into a single image – which is NOT what you want!



But by specifying a Grouping keyword of GAIN you can break these up into separate files based upon the different gain settings.



Basic Post Processing

RGB Combination

1. Run all of the light subs through WBPP.
    a. You will end up with “MASTER” files for each of your L/R/G/B sub sets.
2. Load each of the L/R/G/B sub “MASTER” files into PI
3. Process the RGB image
    a. Use the “Channel Combination” process with the ‘RGB’ button checked
    b. Choose each of the R/G/B images you want to use in the slots on the right
    c. Press the round ‘O’ button
        i. A combined RGB image will be generated for you.
    d. Use the SpectrophotometricColorCalibration process to adjust the colors.
    e. Stretch the image using ^A
    f. Use the HistogramTransformation process to apply final adjustments.

Adding Luminance (L Channel)

1. Watch the [PixInsight LRGB Video Tutorial] and follow those steps to properly adjust the balance between your L and your RGB (an excerpt of some steps is below.)
    a. Adjust the L layer down so that it doesn't oversaturate the combined image.
    b. Use HDRMultiscaleTransform to try different #of 'layers' until the images look good.
        i. OR I was able to also get a good result using ScreenTransferFunction with 'Shadows clipping' of -2.8 (to tone down the bright white) and 'Target background' of 0.25 (to darken the background) which was much easier.
    c. Use ChannelCombination (with the 'CIE L*a*b' button checked, and 'a' and 'b' unchecked) with the balanced L image in the 'L' slot. Drag the triangle tool onto the RGB image to combine the images.
2. Failure to properly balance everything will result in a washed out overly bright image and loss of most (if not all) of the color. You can see below that the LRGB image (left) is washed out and lost all color, compared with the RGB image (right.) This is because I performed no image balancing – step 1.

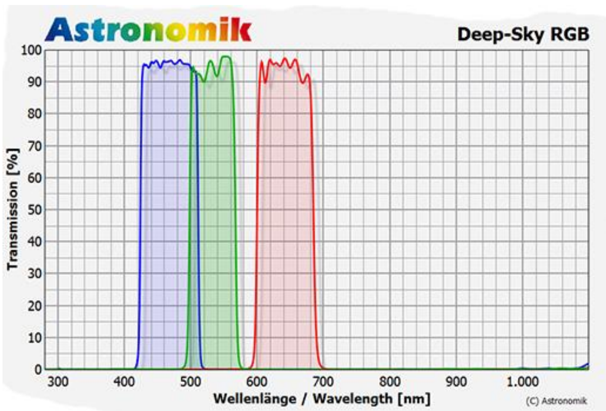
 

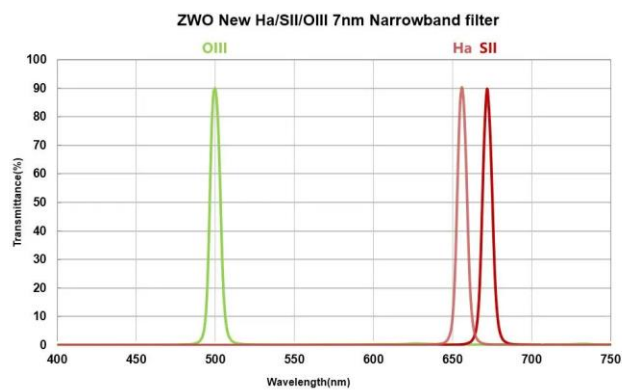
When done properly you should end up with a breathtaking image as follows.

Adding Ha (or SII, or OIII) Filter Data

Separate the Desired Narrow Band from Surrounding Noise

You can see below how the narrow band filters overlap the visible range.

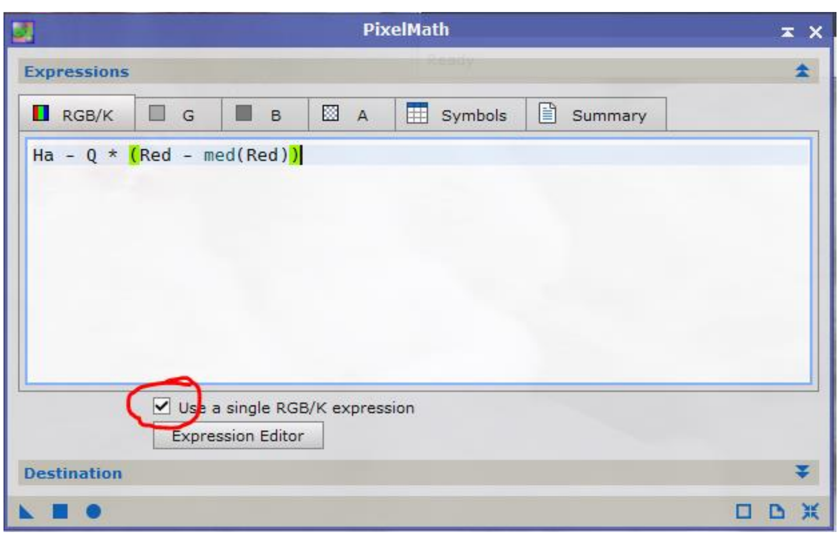




Ha and SII both fall into the Red spectrum area, whereas OIII falls into the overlap region between Blue and Green. So, you will likely need to "reduce" what you see in the filter to get the more delicate center of the frequency range that you really want.

You can use the following equation to do this. You can setup 'Q' as a Symbol and play with it's value by applying the equation to the 'Ha' image (drag the triangle onto the 'Ha' image) until it looks good. Typical values for 'Q' are 0.3-0.1.

This assumes that your image identifiers are 'Red', 'Green', 'Blue', and 'Ha'.



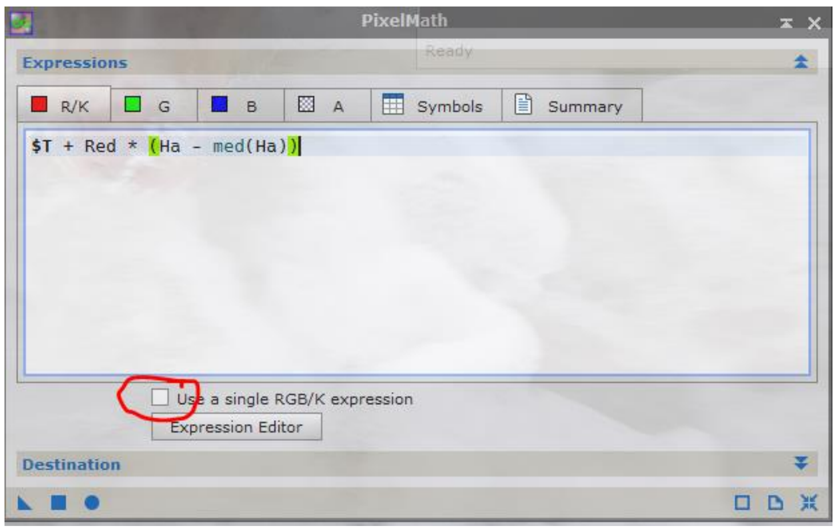
For OIII you would use Blue or Green, instead of Red, as OIII falls into these other regions.

Combining the Narrow Band Data with RGB

Since Ha falls in lower portion of the Red spectrum, it would naturally have a pinkish color. As pink is a combination of red and blue, you would use the following equations to add Ha back into your RGB image:

- Red += Ha * 1.0   or PI math: $T + Red * (Ha – med(Ha))
- Green += 0   or PI math: $T
- Blue += Ha * 0.2   or PI math: $T + Blue * (Ha – med(Ha))

As you can imagine this applies the Ha to the RGB at full strength in the Red and 1/5 strength in the Blue region – resulting in a light pink color applied. You can change the color to anything you want by simply changing where the multiplication factors are applied and their magnitude.



Once you set the R/G/B equations up, simply drag the triangle tool onto you RGB image to apply the math.

Here is a good article describing how the standard colors are picked: Starizona Narrowband-Imaging.