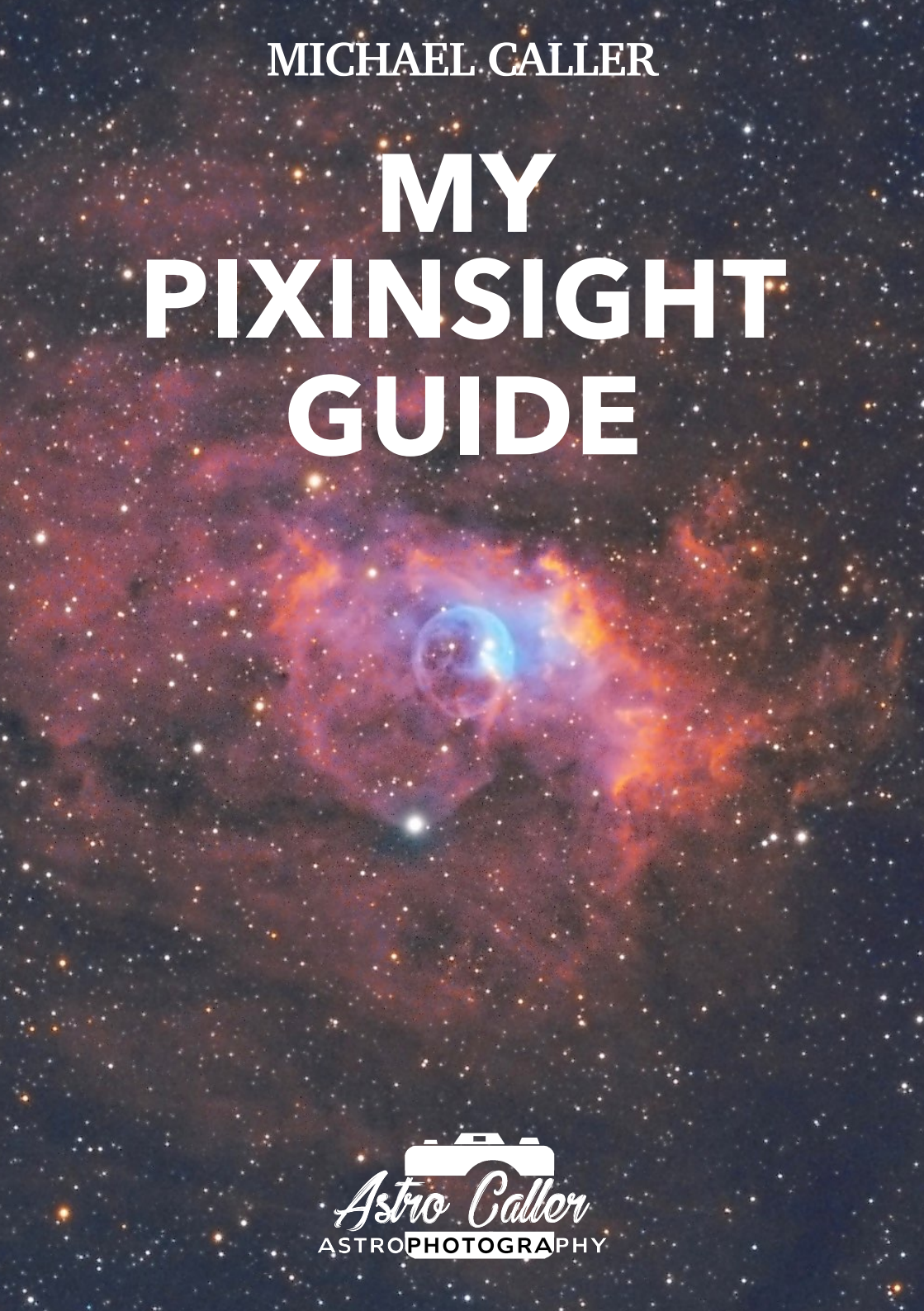
MICHAEL CALLER

MY PIXINSIGHT GUIDE



Astro Caller
ASTROPHOTOGRAPHY

My PixInsight Guide is a personal guide for Calibration, Integration and Processing of deep sky objects through PixInsight 1.8 All methods used in this book are my own personal preference and may vary dependant on data collected.

In this book I share my PixInsight steps but in simple terms without the technical jargon that can put many astrophotographers off using Pixinsight. Or for those that do not understand the complexity of PixInsight modules. Which lets face it they can be very overwhelming.

Please be aware that this book does not explain the in-depth details of these processes. There are other books such as Warren A Keller Inside PixInsight that are great for learning the technical side of astrophotography and more advance processing. Therefore the reader should have experience and knowledge of each process and the basic use of PixInsight.

My recommendation is to experiment with each module to find what meet your needs!

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INDEX

CALIBRATION FRAMES

CREATING CALIBRATION FRAMES

Im not a personal fan of batch stacking or the use of Deep Sky Stacker (DSS) I always find that the batch stacking algorithms don't always give you the best results.

Therefore I prefer to use PixInsight image calibration and image integration to create master calibration frames to then calibrate with my light frames (Chapter 3)

This is very time consuming but the results are worth the time you invest. I would recommend you create a calibration library.

Bias & Darks frames can be kept between 3 - 4 months if using a cooled camera, if you do not have a cooled camera you should change when ambient conditions change by +-5 degrees celsius from your last set of exposures taken. Flat frames must be replaced if you remove your camera from your optical assembly. If like me you don't , then replace flat frames every 1 - 2 months or if you noticed dust bunnies when calibrating you flats with your light frames.

Super Bias

Now you have created a master bias you need to convert this into a master superbias which is very easy.

1. Open Superbias. (Fig 1.3)
2. Change Multiscale to 5 (use 6 if using 50 frames or less).
3. Apply to master bias image. (This will produce a new image).
4. Save as master superbias in FITS format. (32-bit IEEE 754 floating point)

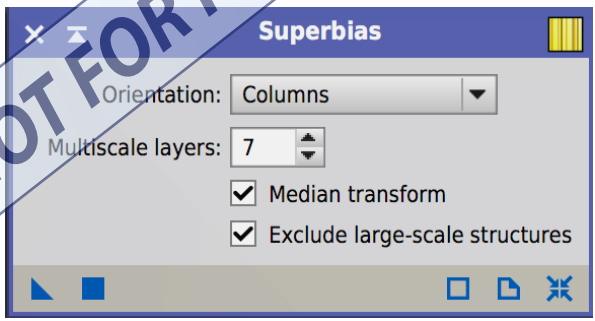

Fig 1.3

Master Dark Calibration Frames

Obtain approx 10 hours of darks at the same temperature and exposure lengths as your light frames.

If using a cooled camera 10 hours of dark data is easy to obtain as you can just pop the camera on whether is mounted to your scope of not, as long as you have the sensor cap on and cooled to the correct temperature you can obtain darks. If you do not have a cooled camera take as many subs as you can to match the approx temperature of your light frames.

1. Open ImageIntegration.
2. Add files (load individual dark frames).
3. Combination method use Average.
4. Normalization use No Normalization.
5. Weights use Don't Care (all weights = 1).
6. Uncheck Evaluate Noise.
7. Pixel Rejection.
   - Less than 7 frames - Percentile Clipping.
   - 7 - 15 frames - Averaged Sigma Clipping.
   - 15 - 25 frames - Winsorized Sigma Clipping.
   - 25 or more frames - Linear Fit Clipping.
8. Normalization use No Normalization.
9. All other defaults are good.
10. Apply Global
11. Save as master dark in FITS format. (32-bit IEEE 754 floating point)

Master Flat Calibration Frames.

Obtain approx 250 flat frames at same temperature (not imperative) as light frames but I like everything to be at same temperature. Remember if your using a mono camera you require a master flat per filter.

1. Open ImageCalibration. (Fig 1.4)
2. Add files (load individual flat frames).
3. Choose output folder.
4. Enable Master Bias and load the master superbias.
5. Enable Master Dark and load master dark and check calibrate. (Keep opitmize checked)
6. All other defaults are good.
7. Apply Global.

Notes:-

- If your using a OSC camera DO NOT debayer your flat frames.
- if using filter wheel each filter requires a master flat frame.

SELECTING LIGHT FRAMES

IDENTIFYING THE BEST LIGHT FRAMES FOR INTEGRATION

It is good practice to carefully inspect your light frames visually and via weighing. Your looking to only integrate the best images for the best results, many astrophotographers will say even if you have aircraft or satellite trails through your images they are still good enough for integration. Which is true as you can process them out! But I still only prefer to use my best data for best results.

Subframe Selector (Weighing)

Before I run through my steps on Subframe Selector I do not use the Subframe Selector installed with PixInsight I have installed Cameron Ledger version of Subframe Selector, the process is the same. However Cameron Ledger version is a lot faster.

You can load load Cameron ledger version at https://github.com/cameronleger/PCL/releases/tag/01.04.01.0001

1. Open SubframeSelector.
2. Add files (load individual visually approved light frames).
3. Set subframe scale, which you can calculate (206 x pixel size in μm ÷ focal length) or you can find this in the FITS header in sequence generator pro, alternatively upload a single FITS image to http://nova.astrometry.net/upload.
4. Set Camera Gain (again you can find this in the FITS header on sequence generator pro or upload a single FITS image to http://nova.astrometry.net/upload).
5. Push Measure and wait for results.

Once you have your results follow the steps below.

6. Change index table to SNRWeight.
7. Set table to descending.

You are looking for the image with the highest SNRWeight this will be the image you set as references during the calibration , registration and integration of light frames in (Chapter 3).

CALIBRATION & INTEGRATION OF LIGHT FRAMES

CREATING A MASTER LIGHT FRAME

A master light frame in simple terms are your main light frames that have been calibrated with your calibration frames and integrated.

It is very important that you calibrate your light frames with your master superbias, dark and flat frames to obtain those perfect images with balanced backgrounds, reduced noise and most common issue vignetting.

Cosmetic Correction

1. Open cosmetic correction. (Fig 3.1)
2. Add files. (load individual light frames from Lights_Cal)
3. Choose output folder Lights_Cal_CC.
4. Enable auto detect.
5. Check hot pixels.
6. All other defaults are good.
7. Apply Global.

Notes:-
- Enable CFA if your using a OSC or DSLR camera.
- Enable cold pixels if you have any cold pixels present which are not as common as hot pixels.
- Experiment with Hot & Cold Sigma if bad pixels are still present.

Debayer

Only applies to light frames obtained from OSC or DSLR RAW camera.

1. Open Debayer. (Fig 3.2)
2. Set bayer pattern to RGGB. (Select Auto for DSLR)
3. Add files. (load individual frames from Lights_Cal_CC).
4. Choose output folder Lights_Cal_CC_DB.
5. All other defaults are good.
6. Apply Global.

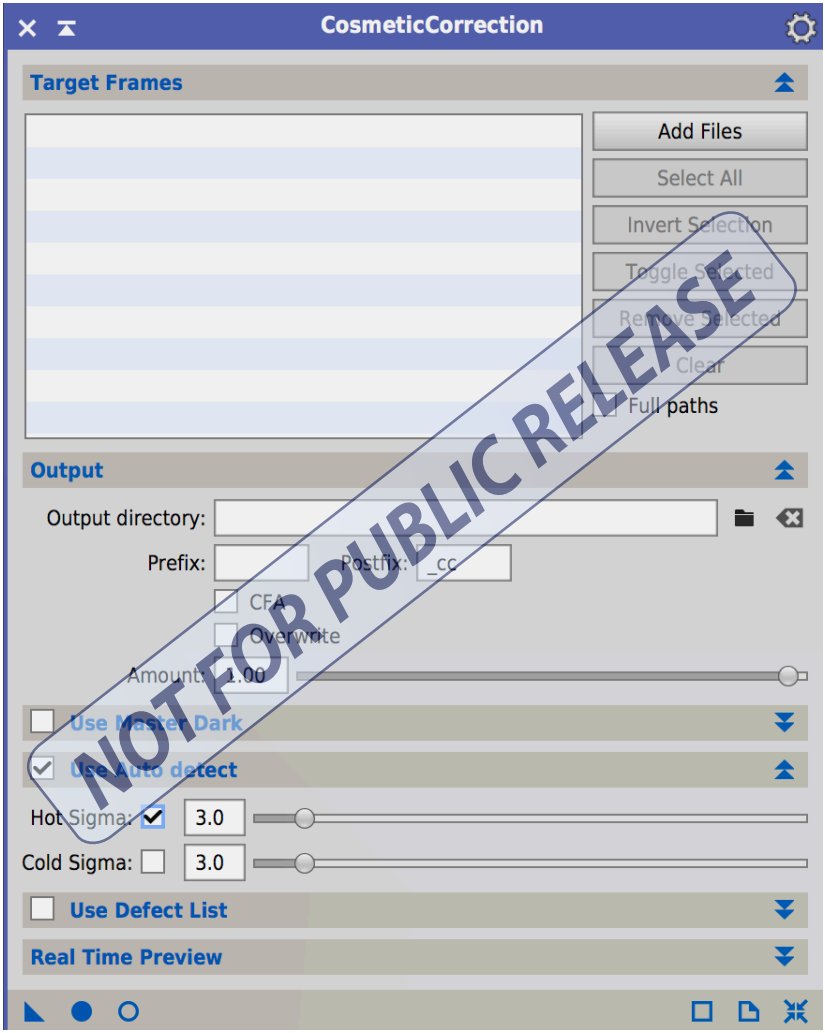
CosmeticCorrection
Target Frames
Add Files
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Full paths
Output
Output directory:
Prefix:
Postfix:
_cc
CFA
Overwrite
Amount:
1.00
Use Master Dark
Use Auto detect
Hot Sigma:
3.0
Cold Sigma:
3.0
Use Defect List
Real Time Preview
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Fig 3.1

Star Alignment

1. Open Star Alignment. (Fig 3.3)
2. Set reference image. (image with highest SNR refer to chapter 2)
3. Ensure Generate Drizzle Data is enabled.
4. Add files. (load individual light frames from Lights_Cal_CC)
5. Choose output folder Lights_Cal_Reg.
6. All other defaults are good, if you have failed frames try increasing star detection.
7. Apply Global.

Notes:-

- If using multiple filters its good practice to register all lights frames to the same reference image which should always be a Red, luminance or Hydrogen Alpha image i.e. the image with the most detail.
- If binned images to be registered with un-binned images use full resolution luminance image as reference.
- Your drizzle data will be saved in the same output folder as registered files.
- If registering images from two different optical and camera combination adjust Registration model to Thin Plate Splines and Check Distortion Correction.

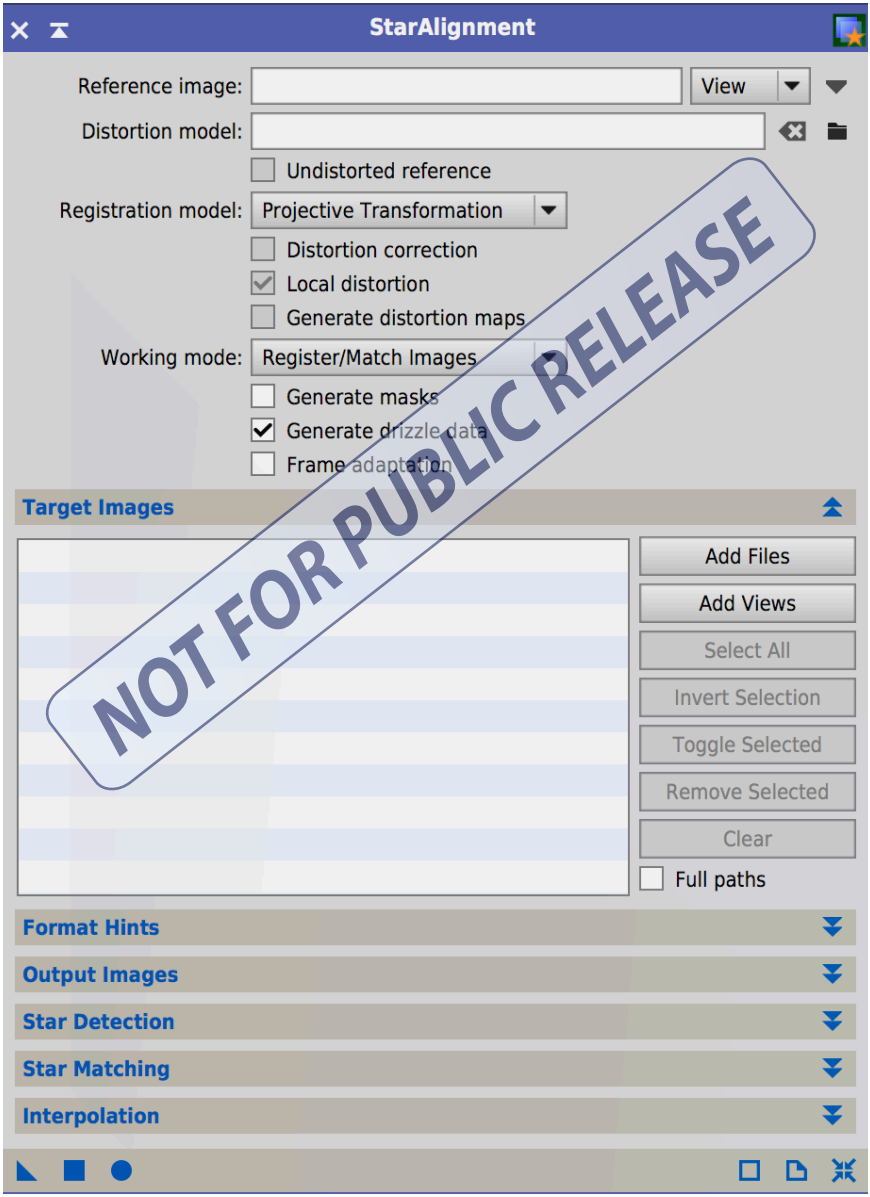
StarAlignment
Reference image:
View
Distortion model:
Undistorted reference
Registration model:
Projective Transformation
Distortion correction
Local distortion
Generate distortion maps
Working mode:
Register/Match Images
Generate masks
Generate drizzle data
Frame adaptation
Target Images
Add Files
Add Views
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Full paths
Format Hints
Output Images
Star Detection
Star Matching
Interpolation
NOT FOR PUBLIC RELEASE

Fig 3.3

Drizzle Integration

1. Open Drizzle Integration. (Fig 3.5)
2. Add files. (load individual drizzle frames from Lights_Cal_CC_Reg)
3. Add Norm.L Files, you will see (n) appear next to each light frame. (load individual normalization frames from normalization folder within Lights_Cal_CC_Reg).
4. All defaults are good.
5. Apply Global.
6. Save DrizzleIntegrated image as FITS file. (32-bit IEEE 754 floating point)

Notes:-

- If integrating data from a OSC or DSLR check enable CFA drizzle.

POST PROCESSING

PREPARING LINEAR IMAGES

Now you have successfully calibrated, cosmically corrected, star aligned, normalised and integrated your light frames the next step is to prepare your linear image prior to converting to a nonlinear image.

Screen Transfer Function

Screen Transfer Function also known as STF, this function automatically stretches your data while remaining linear. Therefore it allows you to see your data while you perform repair and preparatory functions prior to a nonlinear histogram stretch.

1. Open STF .(Fig 4.1)
2. Reset STF from any prior functions applied by left clicking the four arrows in the Botton right corner.
3. Apply STF auto stretch.
4. Review your data.
5. If required remove channel link and reapply STF auto stretch.

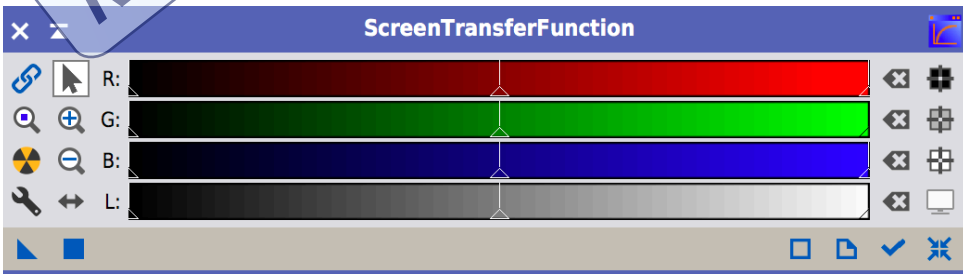

Fig 4.1

Background Modelization

PixInsight offers two different modules DBE (dynamic background extraction) & ABE (automatic background extraction).

My personal preference is to us DBE therefore I will cover these steps below.

1. Open DBE. (Fig 4.3)
2. Activate DBE by left clicking cursor on selected image.
3. Set sample radius to 5. (Fig 4.4)
4. Set sample row to 15. (Fig 4.4)
5. Generate samples
6. Set correction to Subtraction. (Fig 4.5)
7. Check discard background model. (Fig 4.5)
8. Check replace target image (Fig 4.5)

Now you need to inspect your samples. You need to review each sample and ensure there are no stars in the sample area (Fig 4.6), the samples are not located in heavy nebulosity or centre of galaxy. The sample area on DBE will show stars as black pixels, see (FIG 4.6) this is good example of a star in the sample area.

(Fig 4.7) shows typical image with approved samples. If your samples are red that means they are poor samples and just simply move them until they become green avoiding nebulosity, galaxies or stars.

Once you are happy with your samples, save your DBE process by dragging triangle to workspace, you will need to repeat this DBE for each filter image. Then just left click the green tick to apply this DBE to your image.

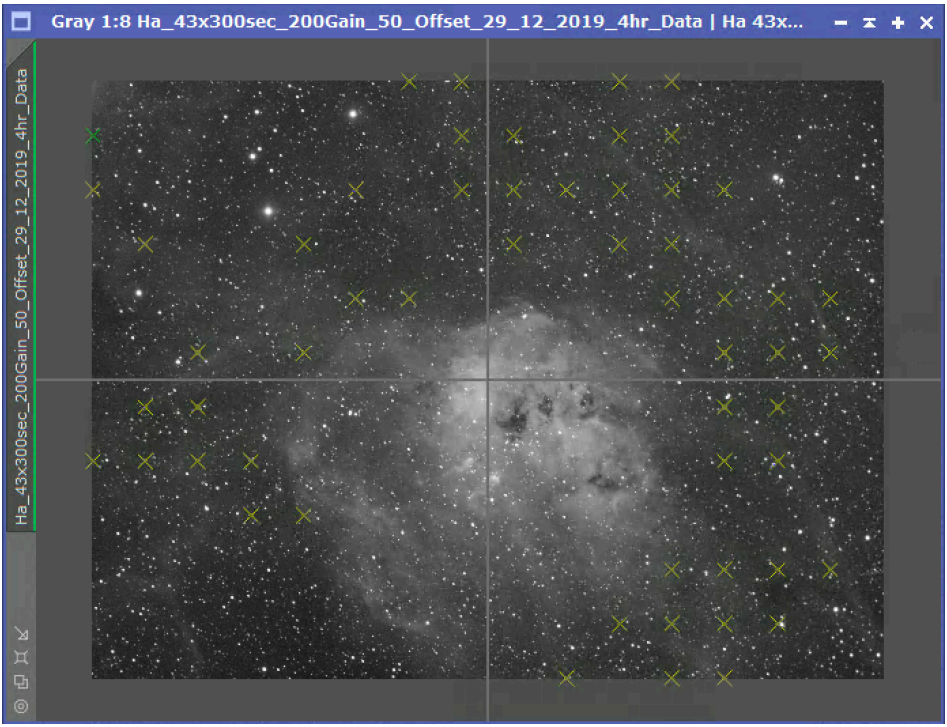

Fig 4.7

Creating a Range Mask

Range mask are very important for processing and should be created before any further processing. They help protect the certain areas of the image such as nebulosity, galaxy cores and stars during processing.

So if you have captured luminance with a mono camera the steps are very simple, you just need to clone you linear image and make it nonlinear using STF & HT. see steps below. If you have not got a

Range Selection

Range selection is used to create black and white range mask which are more preferred when making enhancements to areas such as nebulosity without impacting the background or stars.

1. Open RangeSelection. (Fig 4.9)
2. Open live preview. (to range mask created on page 38)
3. Drag the lower limit slider right as required.
4. Drag the upper limit slide left as required.
5. Adjust fuzziness & smoothness as required.

Notes:-

- Fuzziness feathers your mask and smoothness softens the edges.
- Mask can be inverted by heading to the menu mask and invert.

Deconvolution

Deconvolution should only be applied to luminance or the luminance component of an OSC image. If you do not have a luminance layer please skip this section.

First of all we need to create a average Point Spread Function (PSF) of the stars. See steps below.

1. Open Dynamic PSF. (Fig 4.10)
2. Generate star points (collect approx 20 - 30 stars) you do NOT want saturated stars, best way to identify saturated stars is to remove the STF auto stretch , as only saturated stars will appear. You want to avoid image edges and nebulosity.
3. Select all the star point CLT + A.
4. Left click the camera button to generate average PSF.

LINEAR COLOR PROCESSING

COMBINING DATA TO CREATE A COLOUR IMAGE

In this chapter we will now put all the images together to create a RGB image for colour processing and noise reduction prior to making our image nonlinear.

Channel Combination

1. Open channel combination. (Fig 5.1)
2. Add your filtered images into what channels you require. (Fig 5.1)
3. Apply Global.
4. Rename & Save image. (examples SHO, RGB, HOO)

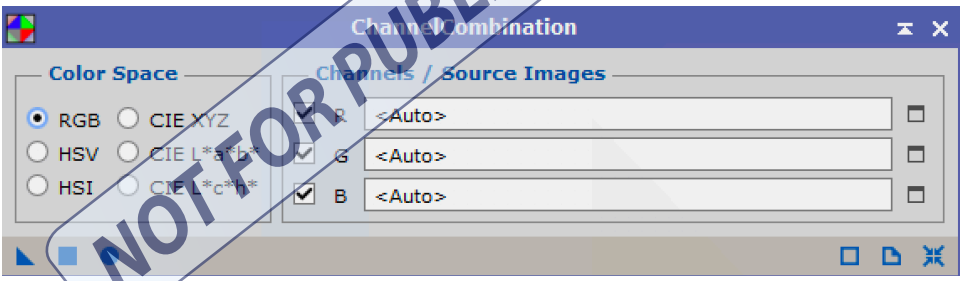

Fig 5.1

Description	Red Channel	Green Channel	Blue Channel
RGB	Red	Green	Blue
Hubble Palette	S-II	Ha	O-III
HOO Palette	Ha	O-III	O-III

Luminance and narrowband images can also be combined with RGB data and will be explained in chapter 6.

Dynamic Background Extraction

As you did before in (Chapter 4) apply a DBE to the coloured image.

1. Open DBE.
2. Active DBE by left clicking cursor on selected image.
3. Set sample radius to 5.
4. Set sample row to 15.
5. Set correction to Subtraction.
6. Check discard background model.
7. Check replace target image.
8. Apply to image. (Reset STF)
9. Save your DB to workspace you will need this in chapter 6.

Background Neutralization

1. Open Background Neutralization (Fig 5.2).
2. Create preview, must be in neutral area of the sky with no stars , if any just some very small faint stars.
3. Set reference image as preview.
4. Apply to image. (Reset STF)

Note:- Keep preview active your need this for colour calibration.

Colour Calibration

1. Open Colour Calibration (Fig 5.3).
2. Leave white reference at <target image>.
3. Check structure detection.
4. Set dark reference as preview created in BN.
5. All defaults should be good.
6. Apply to image. (Reset STF)

NON-LINEAR PROCESSING IN

MAKING YOUR IMAGE NONLINEAR (DELINEARIZATION)

Ok your data is now ready to covert to non-linear. In this chapter we have to split these steps up depending on what combination you are going for whether its LRGB or SHO, they all have different techniques.

Non-Linear Processing

So after a HT stretch your coloured image is ready to continue to the following steps.

1. Replace stars with RGB (only applies to SHO palette)
2. Noise Reduction.
3. Contrast & Sharpness.
4. Colour Saturation.

However if your data is not just a basic RGB image you will need to undertake further pre-processing before you continue with the steps listed above.

Therefore the next steps will cover the following combinations.

1. LRGB (Luminance + RGB)
2. HaLRGB (Ha + LRGB)
3. HOO-RGB (Ha+Oiii+Oiii+RGB)
4. HOO (Ha + Oiii + Oiii)
5. SHO (Hubble Palette)

LRGB Combination

If you intend to add luminance to your non-linear RGB image you will need to perform a HT stretch to your linear luminance image, if you perform a STF stretch I would recommend that you manually darken your luminance stretch slightly so you do not saturate your stars or DSO.

If you have imaged with a OSC camera you will need to extract your luminance from your RGB data as OSC contain luminance data.

21. Select NBRGB button. This will create a preview. If you are happy with your image select apply.

Notes:-

- If you have obtained Oiii data try adding this via NBRGB to create HOO-RGB, follow the same steps as adding Ha, however add your Oiii data to the green and blue channel during the process. Recommended scale for green and blue channel is 0.30 - 0.50.

HOO Palette

This palette is very simple and does not require any further pre-processing, therefore you can continue with non-linear processing.

SHO Hubble Palette

The Hubble Palette requires the most amount of pre-processing to get those beautiful gold and blue details, these steps are simple however you need to experiment a lot with curves transformation to get the colours you want.

22. Open Non-Linear SHO image.
23. Open color mask script. (Fig 6.3)
24. Select target image.
25. Set mask blur to 3. (must be done prior to selecting colour)
26. Select Green.
27. Apply. (Ok)
28. Save mask as Green_Mask.
29. Repeat this for Magenta & Cyan.
30. Extract luminance and save as SHO_Luminance.

Noise Reduction

Firstly not all images require aggressive noise reduction! Providing you have a low SNR camera and good quality data you won't need to be so aggressive with your noise reduction.

1. Copy your image and rename as Noise_Reduction_Test.
2. Create a small to medium size preview box on your clone image, you want a mixture of stars and DSO. The reason we are doing this is because the process can take along time to finish on a full scale image. So performing this test task on a small area saves you a lot of waiting time.
3. Open TVGDenoise. (Fig 6.6)
4. If you are working on RGB or greyscale image check RGB/K, if your working on a tricolour image (SHO) check CIE L*a*b* mode.
5. Enable Automatic Convergence. (This speeds things up)
6. Adjust strength. (higher the value the more aggressive the smoothness.
7. Adjust edge protection (smaller values are more protective of the edges and will preserve finer details.
8. Adjust smoothness if required, generally the defaults work well. Reduce value.
9. Adjust Iterations to 250 for experimenting phase. (However after experimenting increase to 500 - 1000 when applying to main image)

Notes:-

• These steps are not suitable for linear data.

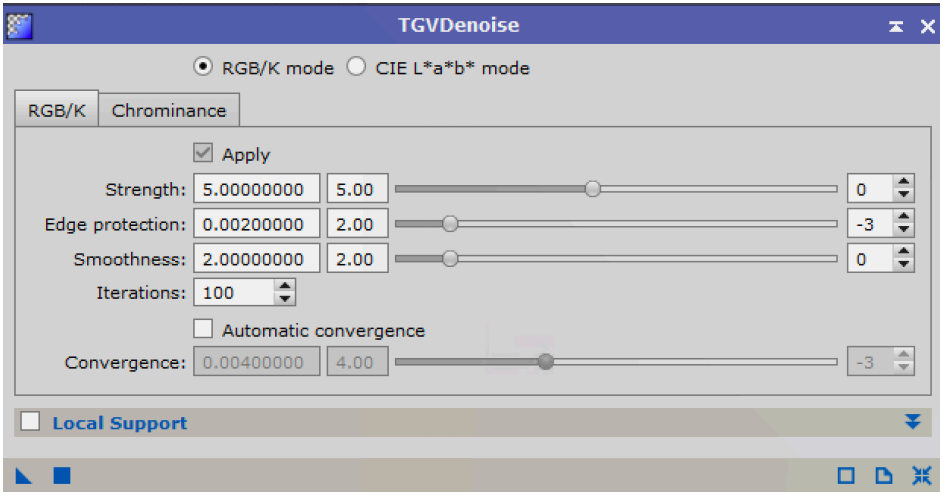

Fig 6.6

Constrast & Sharpness

This is my favourite part of processing! This is where you can really make your image a beautiful master peace.

Constrast

This is very hard to explain when writing it down, a lot easier on a video tutorial but lets give it a go! For this stage you will need to understand curves transformation and the 3 different parts to the diagonal line, see below.

- Shadows - Bottom left of the diagonal darkens the shadows by pulling it down.
- Midtones - middle of the diagonal boost the midtowns bu pulling it up.

Colour Saturation

There are two methods I use for colour saturation, which is all dependant on the data. Method 2 is probably the better of the two and allows you to adjust the saturation levels to direct colours.

Method 1:-

1. Apply a mask to image. (protected areas)
2. Open CurvesTransformation.
3. Open real-time preview.
4. Select (S) saturation and adjust to suit your needs.
5. Select (C) colour and adjust to suit your needs.
6. Select (RGB) and adjust to suit your needs.
7. Remove mask.

Method 2:-

1. Open ColorSaturation.
2. Open real-time preview.
3. Apply points to the horizontal line where you want to lock in colours leaving gaps between the colours you want to adjust and pull the line up (Fig 6.11) this example would increase the blue saturation levels on a SHO image.
4. Once you happy with your adjustments apply to image.
5. Remove mask.

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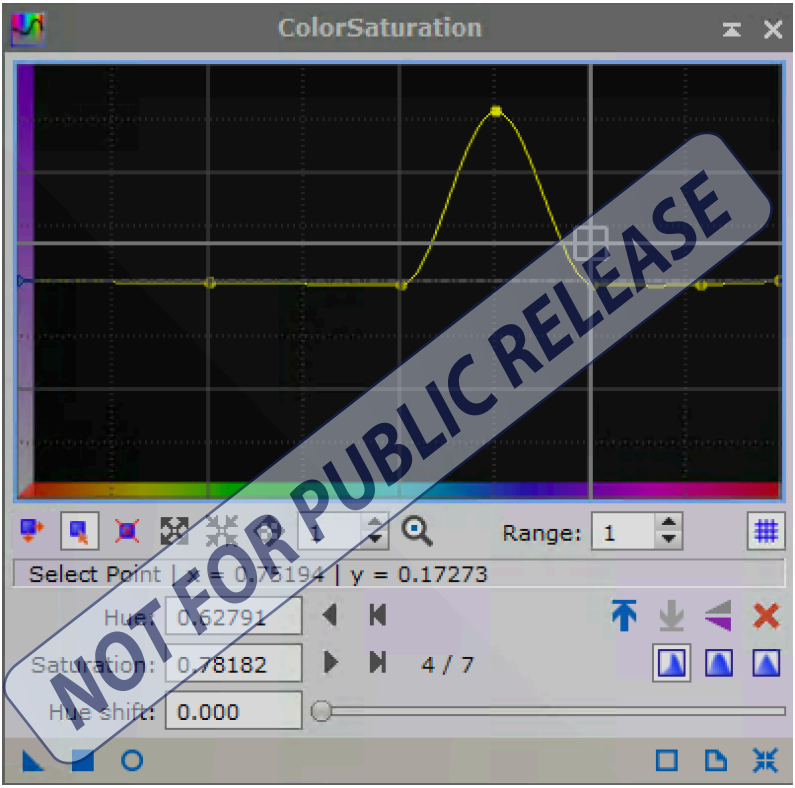
ColorSaturation
Range: 1
Select Point | x = 0.75194 | y = 0.17273
Hue: 0.62791
Saturation: 0.78182
4 / 7
Hue shift: 0.000
NOT FOR PUBLIC RELEASE

Fig 6.11

END OF PROCESSING

This is the end of processing! Your image is complete and you can now step back and proudly say I did that, after all the images I have ever captured and processed that moment at the end never changes.

Thank you for following my steps I hope you have learnt that Pixinsight can be very simple when its put into simple steps and you invest the time to experiment with your data.

Saving your image

1. Select file.
2. Save as FITS file (32bit IEEE 754 floating point) example SHO_RGB_STARS_REV_A.
3. I also save my image as a TIFF file (16bit unsigned integer) this is for opening up in Photoshop CC.

Adding your logo & signature

If like me you have produced your own logo and signature in Photoshop CC and have saved as a PNG file you can add this to your image.

1. Open Photoshop CC.
2. Open TIFF file.
3. Drag your PNG files onto your image.
4. Adjust size.
5. Save image as JPEG at highest quality.

DONATIONS

AUSTRALIAN BUSHFIRES 2019

All monies received for the purchase of My PixInsight Guide digital copies (£10.00) and £5.00 for each printed A5 paperback copy has been proudly donated to The Longleat Charitable Trust that are currently supporting three rescue centres in Australia **Minton farm recuse, Manfred Heide Wombat recuse & SAVEM**

These centres are currently working around the clock rescuing all wildlife from the deviating bushfire that hit Australia in November 2019 including the Koala, Kangaroo and Wombat.

These animals need a lot of medical attention and more importantly a new home where they will be safe from the danger.

Therefore I would personally like to thank you for supporting The Longleat Charitable Trust by purchasing My PixInsight Guide.