

# Astronomical Image Post-Processing

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## Tool Evaluations

Credit due to the following online review: [Astrophotography Stacking Software - Which One To Use? \(nightskypix.com\)](#) for the paid software, and to user threads for the ASTAP recommendations.

### ASTAP (Astronomical STacking Program)

This is an astrometric solver and FITS image viewer. It can view, measure, “astrometric solve” and stack deep sky images. It uses an internal star matching routine or an internal astrometric solving routine for image alignment. For RAW file conversion it uses the external programs Ddraw or LibRaw.

This program is free and seems to support many, if not all, of the features of more expensive commercial tools. It can be downloaded at the following site: [ASTAP, Astrometric Stacking Program \(hnsky.org\)](#)

You only need the Program Installer to get started. There are a variety of libraries also available for download (at the same site) but I am unclear at this time what they are all for. I did notice some posts indicating that you should pick the library based on your focal length, what you are observing, etc.

### ASIAIR “Error decoding site longitude or latitude!” Warning

If you are using ASIAIR to capture your FITS files, you will encounter this error when stacking the files.

As described in the following post, ASIAIR does not put the longitude or latitude into the FITS file header – which is a problem with the ASI software. It turns out this is not very critical except for comets, and you can manually enter the longitude/latitude into ASTAP using the “Asteroid and Comet Annotation” window (Ctrl-R) – OR you can just ignore these warnings.

[astap\\_program / Forum / General discussions ASTAP: Missing SITELAT and SITELONG \(sourceforge.net\)](#)

### Stitching Mosaic FITS files together

ASTAP can be used “Stack” multiple images together – this is similar to the ASIAIR functionality and produces a single processed image of ONE camera frame in the sky.

ASTAP can also be used to “Stitch” multiple images together – this is NOT currently supported by ASIAIR and is the reason you need a program like this to re-assemble your “mosaic” files into one image.

ASIAIR does not currently let you specify a stacking level in the “Plan” mode (but it does in the “Live” mode.) So, if you want to stack images in the “Plan” mode, you have to capture multiple images and then manually stack them with ASTAP **BEFORE** you attempt to “Stitch” them back together with ASTAP.

From what I can tell, ASTAP checks to see if two images are of the same object, and if so, “Stacks” them. If they are of different objects it attempts to “Stitch” them.

### Astro Pixel Processor

With Astro Pixel Processor (APP), you step in the realm of full-grown astrophotography packages, with many advanced options and methods to calibrate, stack, and post-process your deep-sky images.

Compared to PixInsight (PI), the software benchmark for the category, APP is cheaper and way easier to use, which makes it one of the best PI alternatives.

If you decide to buy it, you can choose between the renter's license for \$60/year, to always get the latest version of APP, or the owner's license for \$150, but you will have to purchase the license again for major update releases.

[Astro Pixel Processor Aries Productions - latest release APP 2.0.0-beta28](#)

#### Pros

- Full-grown astrophotography package
- Fairly easy to use
- Mosaics are created with ease and are of great quality
- Active and constant development
- Cross-Platform
- 30-days Trial period
- Affordable yearly subscription

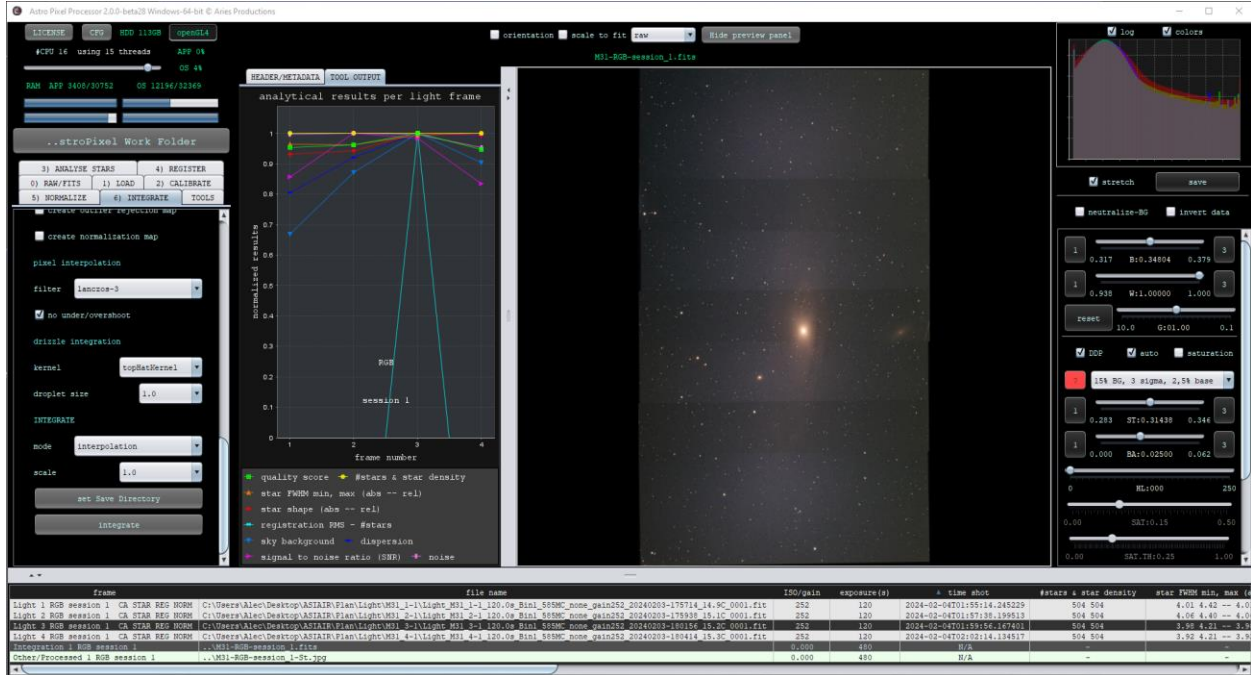
#### Cons

- Only for deep sky astrophotography
- No Comet stacking mode

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## Example Usage – Stitching Mosaics Together

The following image shows the tool after having stitched together four mosaic frames of M32 into one frame. You can see the frame boundaries because I didn't know what I was doing and just went with all the defaults. I'm sure the boundaries can be cleaned up when I know what I'm doing.



After some initial fumbling around I was able to figure out how to do this in about 10 minutes. The program crashed once, I couldn't find any help files, and drag-n-drop doesn't seem to be supported, but it did walk me through suggestions when I made bad choices which was very nice. I'm sure with some more work I will be able to use it better.

So, I have to give this an A+ for ease of use! I did purchase this tool.

## PixInsight

When it comes to astrophotography, PixInsight is the software of reference against which all others are measured. It offers everything you may possibly need to produce pro graded images, and it is objectively the best software in the field.

But user experience can be frustrating, as the learning curve is very steep, the editing is long and convoluted, and your computer must be quite recent and powerful to make it run smoothly.

The €230 + VAT price tag is also quite steep: sure, it is worth every penny, but this makes PI be even more the software of choice for professional and keen amateur astrophotographers.

### [PixInsight — Pleiades Astrophoto](#)

#### Pros

- It has all you need for astrophotography
- 45 days trial period
- A lot of tutorials and information available

#### Cons

- Expensive and without subscription plan
- Extremely steep learning curve
- Long and convoluted process
- Needs a powerful computer

I have spent four full days getting up to speed on this tool and am very impressed so far – I got to the point of being able to stitch mosaics together. However, I have to agree, there is a steep learning curve and it will be likely weeks before you are completely comfortable using it. I originally got the 45-day trial and after a week or so decided to purchase it as everything worked so well.

## PixInsight

### Non-Intuitive Things about PixInsight

- Many of the Process/Scripts are order dependent – i.e. ‘this’ process must be run before ‘that’ process. This works because PixInsight stores intermediate results in the ‘.xisf’ file as each process/script is run and subsequent process/scripts use these results.
  - A side effect of this is that when process/scripts are run out of order, you sometimes get very mysterious error messages – like “no stars found” when there are clearly hundreds of stars in the image. If unsure, it is always best to run WeightedBatchProcessing first, **before** doing any advanced work on your image. This will ensure that all of the basic information is present in your image file.
- Always make sure you take at least **THREE** of each calibration frame (bias, dark, light ...) otherwise WeightedBatchProcessing will not be able to create calibration master files properly.
- Using WeightedBatchProcessing, you should only add Light frames from the SAME image – i.e. stacking. Do NOT add multiple mosaic Light frames as it will confuse the script and cause it to fail on many of the frames even if you disable Integration in the Pipeline settings.
- In WeightedBatchProcessing you can include all of the files and sub-files in a folder which is great because ASIAIR separates them all in subfolders, but you have to remember to delete the ‘jpg’ files before processing – I wish there were a way to turn this off on ASIAIR but there isn’t.
- Rotating (or otherwise altering how the star field is aligned) clears the astro metrics from the image, you may need to re-compute it. Also, if you rotate your light frames, you will also need to rotate all of your flat calibration frames which is a pain. Much better to align your camera rotation when taking shots than to rotate them later.
- Rename your file from “Light\_M42\_600.0s\_Bin1\_533MC\_none\_gain100\_20240226-191646\_0.0C\_0001” to something shorter, like “M42\_600S” before processing in PixInsight. Otherwise, it is a real pain trying to see the extensions PI puts at the end of the file name.
  - You can also use the ‘Identifier’ tool (right-click in the image’s named tab) to rename just the identifier (which defaults to the file name) and leave the file name intact. This is actually better as it preserves the original file name data in case you need it.
- It does NOT look like there is any direct support in PixInsight for processing video (.avi, etc.) files, so you need to do this in some other application (ASI Studio supports stacking ‘avi’ file video frames into a single ‘fits’ file which can then be processed in PixInsight.)
- When a script is running, no other PixInsight features will function. You must close the script before you can use the other PixInsight features.
- The ‘Mask’ menu has a quirk – when you drag and drop a mask onto an image, the drop-down menu will not update until you ‘move’ the image. This is very frustrating for a beginner as this menu works fine if you assign the mask using the menu function (vs. drag and drop.)
- The ‘Process’-‘All Processes’ menu has a quirk – If you click on the ‘icon’ of the process you want (as opposed to the text description), it will pick the process to the left! This is quite annoying until you catch on to this issue. Clicking on the ‘text description’ works as expected.

## Databases Required

This was gathered from the following thread: [Gaia Download | PixInsight Forum](#)

- The GAIA process is part of the standard PI distribution. You do not download GAIA.
- To use GAIA you must download one or more of the GAIA databases from the PI software distribution site ([www.pixinsight.com/dist/](http://www.pixinsight.com/dist/) which will require your login information.)
  - To use GAIA for astrometry (plate solving, using the ImageSolver script) you should download the Gaia DR3 astrometric database files.
    - The DR3 database is divided into 16 numbered files of typical size 2.8GB, with a total size of about 40GB.
  - To use GAIA for color calibration (using the SPCC process) you should download the Gaia DR3/SP photometric database files.
    - The DR3/SP database is divided into 20 numbered files of typical size 3.3GB, with a total size of about 63GB.
  - Note that the two databases are different - they are not interchangeable.
- Both databases are ordered by object magnitude, with the brightest objects in the earlier files; the first four DR3 files contain all object down to magnitude 18.69; the first four DR3/SP files contain all objects down to magnitude 15.4. If you have problems downloading all the files you can configure and test the system with just one or two files from each database, but you will probably find that you need more than this for most images.
- You will usually download these using your web browser download interface (there is no function inside PixInsight for downloading the databases).
- You can put the resulting .xpsd files anywhere on your system. It is probably wise to place the different databases in different folders. You must then configure the GAIA process to identify where you have placed the database files. This configuration process does not move or modify the database files.
- These files are probably larger than most files you download. Remembering that your broadband bandwidth will typically be specified in (M)bits per second, a 100Mb broadband link will take 2 - 3 hours running at maximum bandwidth with no interruptions to download the entire database.
- Since such long downloads are often interrupted, the download interface in most browsers will be able to pick up and continue an interrupted download (without starting from the beginning again).

## Basic Image Processing

High Point Scientific has a really good “getting started” tutorial here:

[Basic Post-Processing Tutorial with PixInsight | High Point Scientific](#)

This explains how to get rid of the “green” image using LinearFit. This was frustrating me for a long time as I was trying to use HistogramTransformation but that never quite got it right. For more details see [Example Usage – Color Calibration \(getting the green out\)](#).

Here is another awesome tutorial about how to deal with galaxies which are more complicated because they have bright centers and dim edges.

[Processing the M31 Galaxy using PixInsight in 15 minutes](#)



## My Workflow

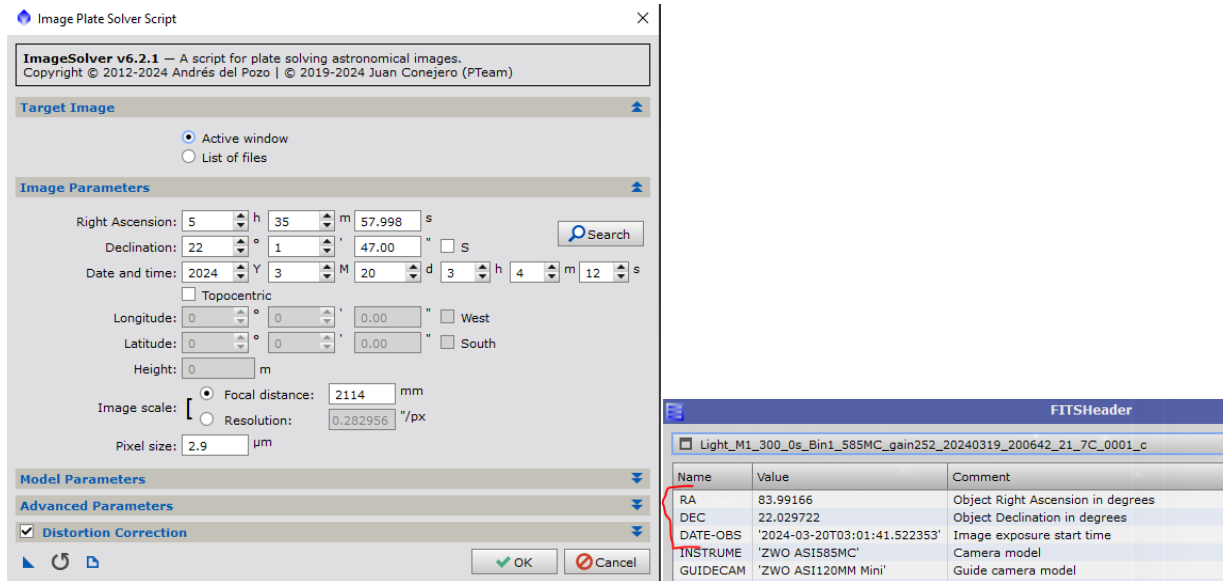
1. Shoot light frames (and optionally flats) outside.
  - a. Stack AND check the “save all frames” option. This lets me see the stacked image outside, AND also allows me to re-stack the raw frames again later with PixInsight (which does a better job.)
2. Run each set of stacked frames through WeightedBatchPreprocessing
3. If building a matrix do the steps in [Example Usage – Stitching Mosaics Together](#)
4. Stretch the final images with Ctrl-A
5. Run [SpectrophotometricColorCalibration](#) on the final images to fix the colors.
6. Run HistogramTransformation on the final image to make it look great.
  - a. Make sure to change the preview window Quality from “Smooth” to “Maximum” for best quality.
7. If you want to share them do a screen capture and save it as a JPG (PixInsight “save as JPG” doesn’t save the screen “stretch” so the colors are wrong.)

## For a ‘quick test’ on a single file

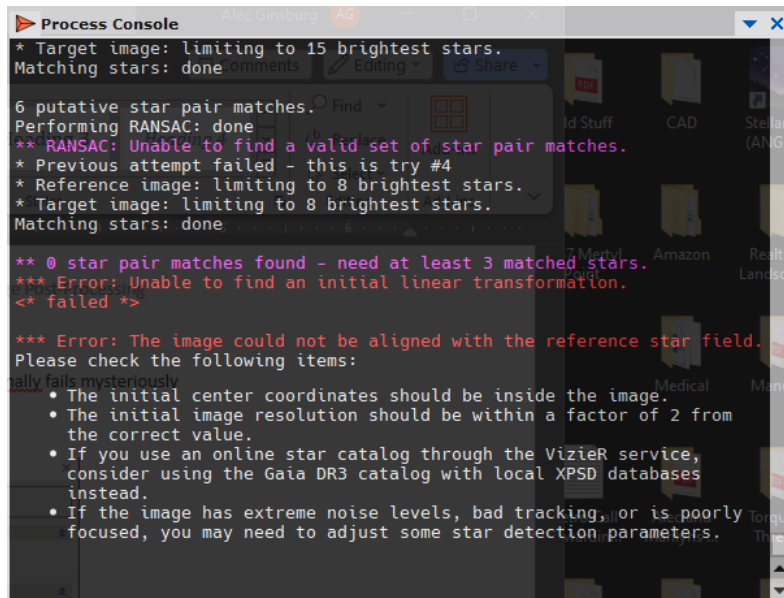
1. Run ‘GradientCorrection’ process – to clean the image up (otherwise ‘ImageSolver’ will fail most of the time.)
2. Run ‘ImageSolver’ script – to embed an astronomic solution in the image.
3. Run ‘Debayer’ process – to convert the image to color.
4. Run ‘SpectrophotometricColorCalibration’ to adjust the colors correctly
5. Stretch the image with Ctrl-A

## ImageSolver Issues

ImageSolver generally works pretty well but occasionally fails mysteriously. Here is an example with the M1 galaxy. As you can see ImageSolver automatically extracts the RA/DEC time from the FITS header (and converts it from decimal to hh:mm:ss.)



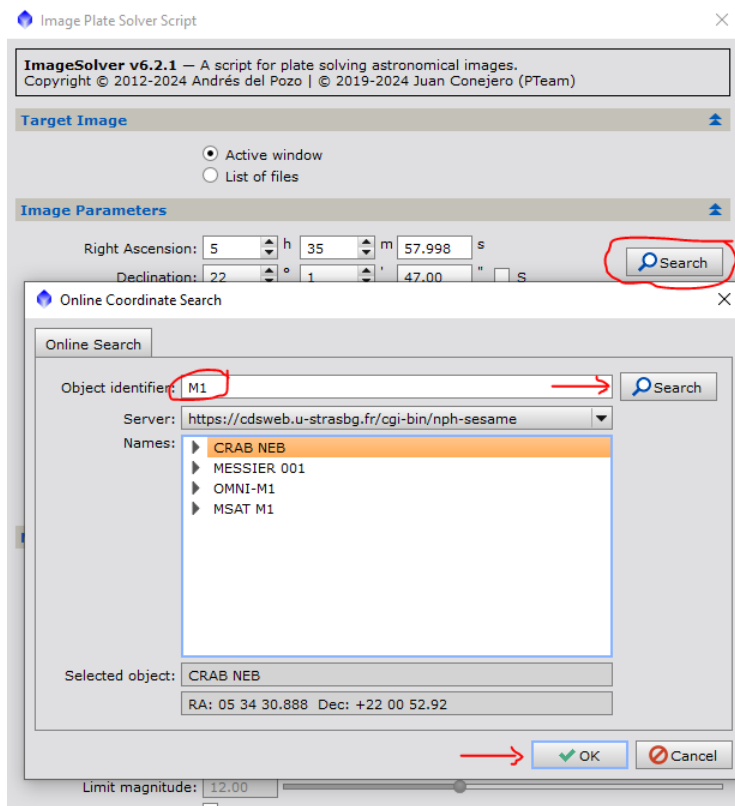
And this results in the following error message and failure of the script.



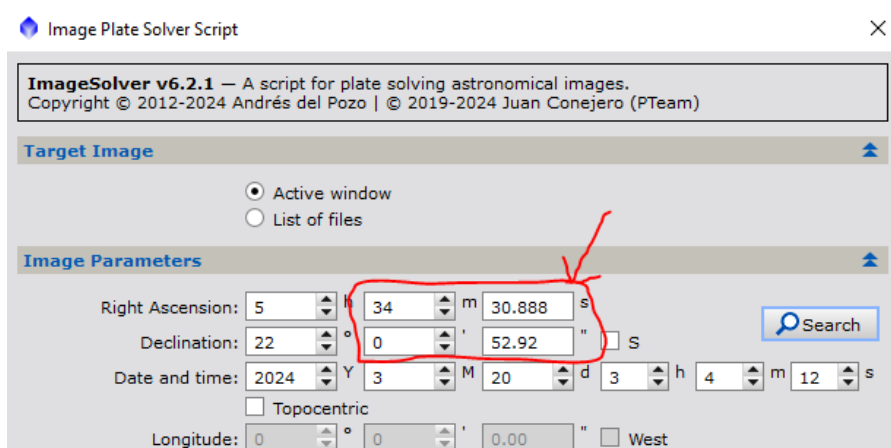
The problem is that the embedded RA/Dec is actually not quite right – and I’m not sure why this is. I believe this may be because ASIAir may choose the brightest stars to locate the coordinates and if they are not in the center, this would cause the problem.

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To fix this (if you are targeting a 'known' object) you can lookup the objects 'correct' RA/DEC for the particular time/day using the 'Search' feature shown below.



This will give you new 'corrected' numbers for the RA/Dec which should then work properly to find the matching GAIA objects.



If you are not targeting a 'known' object, you need to locate a star that is near the center of the image (using 3<sup>rd</sup> party astronomy tools) and use it's coordinates in the ImageSolver script.

## WBPP (Weighted Batch Pre-Processing) Script Issues

### ImageSolver Issues

Please refer to the [ImageSolver section](#).

### Linear Normalization Issues

If you run into the following issue:

Operation	Group involved	Elapsed	Status	Note
Calibration	Light frames, 3840x2160, NoFilter, CFA, 1x1, 300.00s, frames = 5 (5 active)	118 ms	✓ success	5 cached
Linear Defects Correction		7 ms	✓ success	0 frame(s)
Debayer	Light frames, 3840x2160, NoFilter, CFA, 1x1, 300.00s, frames = 5 (5 active)	89 ms	✓ success	5 cached
Measurements		110 ms	✓ success	5 cached
Bad frames rejection		10 ms	✓ success	0 rejected
Reference frame selection		15 ms	✓ success	
Plate solving reference frames		13 ms	✓ success	
Registration	Light frames, 3840x2160, NoFilter, RGB, 1x1, 300.00s, frames = 5 (5 active)	122 ms	✓ success	5 cached
LN reference generation	Light frames, 3840x2160, NoFilter, RGB, 1x1, 300.00s, frames = 5 (5 active)	0 ms	● failed	
Local Normalization	Light frames, 3840x2160, NoFilter, RGB, 1x1, 300.00s, frames = 5 (5 active)	1 ms	● failed	unable to fin...ference frame
Integration	Light frames, 3840x2160, NoFilter, RGB, 1x1, 300.00s, frames = 5 (5 active)	96 ms	✓ success	cached
Autocrop		17 ms	✓ success	1 cached

Executed in 16 s DONE

then it may help in some cases to change the 'Output Pedestal Setting'-'Mode' to 'Automatic' as shown below.

Weighted Batch Preprocessing Script v2.7.0

Bias Darks Flats Lights Calibration Post-Calibration Pipeline

#	BIAS	Bin	Overscan Info
1	masterBia...840x2160)	1x1	

#	DARK	Bin	Exposure	Overscan Info
1	masterDar...840x2160)	1x1	180.00s	

#	FLAT	Bin	Exposure	Filter	STATUS	Bias	Dark	Optimize Dark
1	5 frames ...840x2160)	1x1	300.00s	NoFilter	!	x	✓	

Output Pedestal Settings

Mode: **Literal value**

Value (DN): 0

Limit: 0.00010

Apply to all light frames

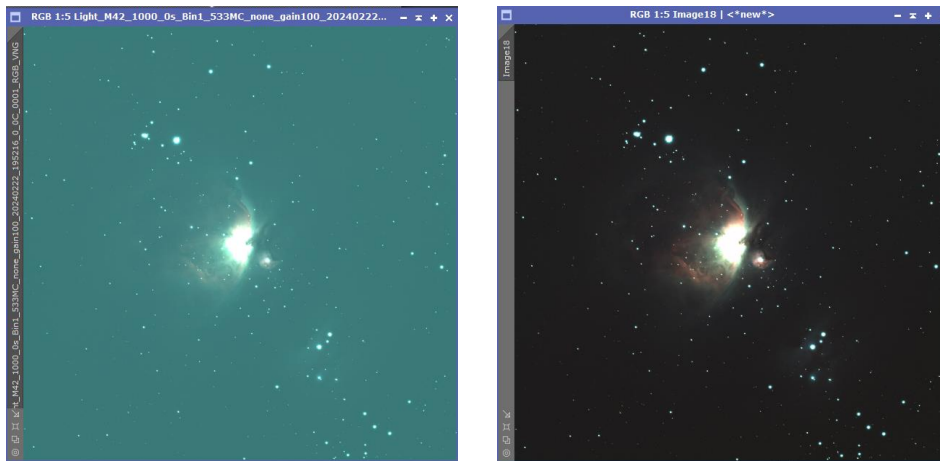
## Example Usage – Color Calibration (getting the green out)

### Method #1 – lots of work from tutorial

Here are the basic steps to balance the colors (from the tutorial):

1. Open the saved image.
2. Apply an autostretch to the image (ctrl+A on Windows) to display a preview of what PixInsight believes to be the best stretch for the image.
3. Split the RGB channels so that we can get ready to apply a linear fit to fix the green color cast. You can find the split RGB tool on the toolbar above the image, usually on the left-hand side.
4. Go to Process > All Processes > Linear Fit. Use the green channel as your reference frame, then apply the linear fit to the red and blue channels. Linear fit will give you more accurate color consistency in your image that is inherently off, especially when using a cooled CMOS sensor or similar.
5. Go to Process > All Processes > ChannelCombination. Make sure Color Space is set as “RGB”. Then under Channels / Source Images, apply each of the correct channels that you extracted earlier. Click the circle that says “Apply Global” or press F6.
6. Now it’s time to accurately color calibrate this image. Go to Process > Color Calibration > ColorCalibration. This tool will ensure that the colors in your image are more accurate to the real thing. Set the Background reference image to the preview used in the last step, and (optional) set the white reference as the whitest part of your image.

This will change the left image to the right image below.



### Method #2 – easy way

**AFTER** you have downloaded the [GAIA/SP databases](#), you can run the SpectrophotometricColorClibration process on your image. Make sure to select the correct RGB filters that match your camera configuration – mine was ZWO R/G/B. This results in a slightly better-quality image than the ones in the previous step.

## Example Usage – Stitching Mosaics Together

Here is an excellent article describing how to do this: [Assembling a Mosaic Using PixInsight - Remote Astrophotography Using Slooh.com](https://www.astrophotographyusing.com/2024/02/20/20240203_180156_15_2C_0001.ra). I have summarized it below with my example data.

First do all your calibration and correction work, or just skip it if you just want to see how to assemble mosaics.

**Important Note:** I used ASIAIR to capture my mosaic panels and it encodes all of the necessary template information into the FITS file generated by the camera. If you are using another system you may have to hand fill in this information (time, date, RA, DEC, etc.) in some of the screens.

### Step 1 – plate solving

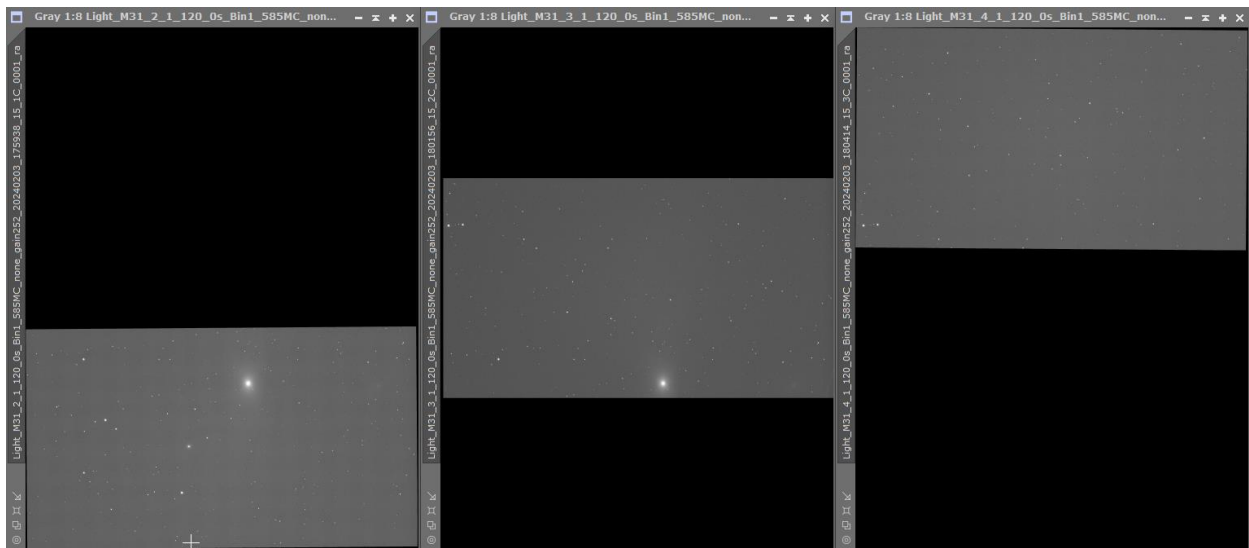
Embed the exact location and size of your image into the FITS file.

Select Script – Image Analysis – ImageSolver (after calibrating them.) Select each of your mosaic images in turn, (if missing, enter the image information by hand) run the script and save the file as an XSIF file. Ideally, you should use WeightedBatchPreprocessing (instead of ImageSolver) which calibrates and solves the images in one step.

### Step 2 – create mosaic templates

Create a full size mosaic image with each panel in it's appropriate location in the mosaic.

Select Script – Mosaic – MosaicByCoordinates. Add all of the files produced in the previous step, run the script and you should end up with files like the following (this example has 3 panels in the mosaic), save each file as an XSIF file. Note how the script figured out how to align the overlapping portions of the mosaic panels.



**Step 3 – merge the mosaic panels together**

Use the GradientMergeMosaic process. Add all of the files produced in the previous step, and run the process. You should end up with a single image with all of the panels merged correctly as shown below.



You can now save this as your assembled mosaic file. Note the black edges in this file – this is the result of the mosaic panels not being lined up perfectly square; you can use the crop feature to remove this if you like. You may also have to play around with the parameters in this last step if the final image has visible “seams” where the panels were stitched together.

## PixInsight Add-Ons

I found out about add-on modules when viewing the following mask video:

[PixInsight Mask Training Video](#)

I recommend that you watch the video and then install the add-ons and start using them.



## StarNet

This does a better job of creating star masks than the built-in tools – and it takes longer to run with default values. In several cases of extreme light pollution, it was able to create star masks when the other tools could not. I am not sure why this is so, and it is also possible the built-in tools would have worked if I knew how to properly re-configure them.

### **Installation**

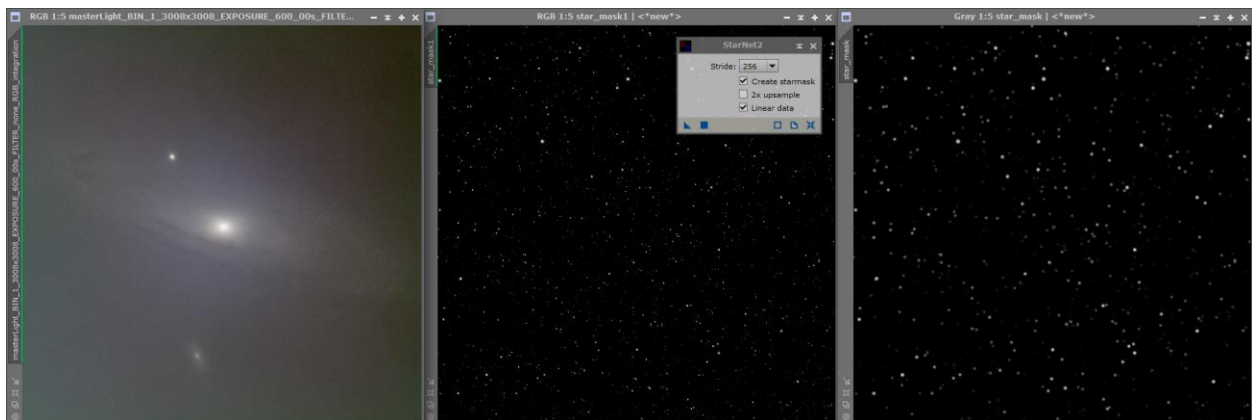
Go to the following page and follow the instructions. This involved copying files into the PixInsight bin folder and restarting PixInsight last time I did it.

[Download | StarNet \(starnetastro.com\)](https://starnetastro.com)

This will be available in ‘Process’-‘<Etc>’-‘StarNet2’

### **Example**

Here is an example run on M31. The image on the right is the star mask created by PixInsights ‘StarMask’ tool. The left and center images are created by StarNet. The first thing you see is that StarNet physically removed the stars from the original (left) image – leaving you with an image that is easier to work on galactic structures. The second thing you see is that StarNet’s star mask is MUCH more detailed than the PixInsight star map.



## EZ Processing Suite

I only started looking at this and it looks extremely powerful for noise processing and creating the associated extremely complex masks required. I will need to spend more time getting up to speed on this tool.

### **Installation**

IMPORTANT – [StarNet](#) MUST be installed before this

Add the following to ‘Resources’-‘Updates’-‘Manage Updates’:

<https://elveteeek.ch/pixinsight-updates/ez-processing-suite/>

Then do ‘Resources’-‘Updates’-‘Check For Updates’. This will prompt you to download and install the module – a PixInsight restart will be required to complete the process.

For more information, please refer to this page: [🚀 Exciting News! The EZ Processing Suite Project Continues! 🚀 | PixInsight Forum](#)

This will be available in ‘Scripts’-‘EZ Processing Suite’

## Game

This tool picks up where the built-in 'RangeSelection' tool leaves off. Instead of having to rely on pixel intensity to create a mask, 'Game' allows you to create elliptical and free-hand masks wherever you want them which is ideal for processing galaxies or other large structures. This feature is essential when you are working with heavily light polluted images because it is very difficult to create a mask when there is almost no difference between the object and the background with 'RangeSelection'.

## Installation

Add the following to 'Resources'-'Updates'-'Manage Updates':

[https://www.skypixels.at/HVB\\_Repository/](https://www.skypixels.at/HVB_Repository/)

Then do 'Resources'-'Updates'-'Check For Updates'. This will prompt you to download and install the module – a PixInsight restart will be required to complete the process.

Note: this is an un-signed package but appears to be trustworthy.

For more information, please refer to this page: [How to install Hartmut Bornemann's GAME script | PixInsight Forum](#)

This will be available in 'Scripts'-'Utility'-'Game'

## Example

The following shows how easy it is to create elliptical (or free-form) galaxy masks using this tool. The left image shows the tool interface and your original image. The right image shows the gradient mask produced by the tool. This is WAY easier and accurate than using the 'RangeSelection' tool.

