

# Using AstroImageJ Data Processor in Macros

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## Background

AstroImageJ is an excellent open source project for the data reduction and analysis of astronomical images. Used by numerous members of the Variable Star community throughout the world, myself included. I use the software Sequence Gen Pro to provide semi robotic control for imaging a number of variable stars of interest on various observation programmes and a list from the BAA of long period variables that need monitoring. About 150 targets are on the list but of course visibilities depend on time of year, northern UK weather, phase of the Moon, sunrise and sunset times, cadence etc.

This can still provide up to 50+ targets in a night run, each with 10 to 25 subs. Each target will have a different exposure and gain setting on the camera to best capture the images and with the filter wheel, BVR filters are added to the mix. Sequence Gen Pro provides an excellent mechanism to control these and to use these settings as part of the directory structure for the saved images.

The images are reduced by using Data Processor feature of AstroImageJ following the tutorial provided by Richard Lee at the BAA website <https://britastro.org/node/15590>. Over the last year it became apparent with the quantities of data I had collected it was taking significant time to process the images into variable star magnitudes for submission to the VSS database. As more data was collected even on the rare clear nights of the UK, I was falling further behind. It was time for some analysis of the processing stages and how to improve the throughput.

## Processing Stages

There are some four stages in the processing

- 1) The images are processed using Data Processor (DP) component of the AstroImageJ software. This applies the bias, darks, and flats to the science images and plate solves the image. The FITS headers are updated with all the WCS information. The images are then saved to the Calibrated directory.
- 2) To ensure the best SNR the calibrated images are aligned using the WCS info and average intensity stacked to produce a single image.
- 3) The final image is then reloaded into AstroImageJ and using the differential analysis of Richard's tutorial (above) which produces a Measurement file.
- 4) The Measurement file is imported into the VSS Photometry Spreadsheet which produces a file ready for direct import into the BAA VSS database. At this point all the data files in the target directory are removed.

The amount of time spent on stages 1 and 2 far outweighed the last two stages. The reason was the setup of the DP fields to ensure the correct Bias, darks and flats were used against the lights images – having first found out which of 150 target directories contained un-processed data images. The stacking process was repetitive and with manual processing the odd errors crept in.

## Using Data Processor in a Macro

By carefully identifying the processes it was possible to replicate the manual process by a macro. However the DP component was not originally designed with this in mind but with a lot of research of the source code and the help of Karen Collins (one of the main architects of DP) the following macro was built to do the job. As a benchmark it achieved processing 50 stars in 18 hours – something which was previously taking weeks.

I present it here as an example to help others who might be wondering how to achieve something similar. Before tackling this approach make sure you can run DP manually with all the settings (and there are lot of them) to produce a clean process of your images. Next look to your directory structures for bias, darks and flats as well as your science images. If these are standardised in a clear way it is much easier to develop your macro to do this kind of processing.

Please do not attempt this if you are not familiar with AstrolImageJ particularly DP and the coding of ImageJ macros. The recording of macros to call various AstrolImageJ functions is a good way to learn.

*Be warned the macro language is not sophisticated and has no concept of types of variables. This can lead to unexpected errors – make sure all calls to write data to the AIJ\_Prefs.txt file are writing strings – see macro code.*

This macro requires the very latest AstrolImageJ – download the daily build and it should be 3.3.1.08 or greater. This operates with an extra parameter which allows the DP to be run in a way that automatically starts and when finished its processing will close the program.

**ALL settings not changed in the macro should be set up before hand by running DP manually. In the event of an error DP might be left in the macro automatic start run and close on finish mode – the DP preferences pull down menu has an extra option which should be unchecked to stop this – then exit the DP and it will reset to normal operation.**

I would recommend that setting the names of the master flats, bias and darks to mflat.fit, mbias.fit and mdark.fit. Also set the filename pattern to \*.fit for all science images and flats/darks/bias build requests.

## The Directory Structure

For this macro I have used the following structure for science images– it only shown to allow an understanding of what the macro is doing – your structure will require modifications to the macro.

### Science Images

Root = X:\\Images\\Variable Stars\\

StarName      Usually the standard identifier  
Date          of the imaging run – if this level and below exists there is data to process  
Filter        for this macro this will be B, R or V but I have others I might add  
Gain         based on my camera- format is from Sequence Gen Pro

If the next level Calibrated exists then this is the marker to ignore this directory it has already been processed and macro loop will go to the next directory entries

### Flats

The Flats directory structure comes in two forms – the raw image files from which the master flats are built and the master flats directory. Once a master flat is built, the macro does this if it does not exist; there is no need to keep processing the raw data. N.B. I produce flats every imaging run for each filter I might use, using a flat panel. The Gain is fixed for this process as I have not found it useful to match the darks and bias settings as it is not used in the same way for image reduction.

For raw flats images

X:\\Flats\\

Date      of the imaging run  
Filter    for this macro this will be B, R or V but I have others I might add  
Gain     based on my camera- format is from Sequence Gen Pro

If the master flat does not exist it will be built by the macro into the following directory structure

X:\\Master\\Flats

Date      of the imaging run  
Filter    for this macro this will be B, R or V but I have others I might add  
Filename is always mflat.fit and this should be defined in DP see above

### Bias

The Bias directory structure comes in two forms – the raw image files from which the master bias are built and the master bias directory. Once a master bias is built, the macro does this if it does not exist; there is no need to keep processing the raw data. As this is not very often the date is set in a variable BiasDarkDate as “//2019=11-19//” in this example. Just change it by macro or by hand when a new bias/dark library is to be built. Adapt to your requirements.

X:\\Master\\Bias\\

Gain based on my camera- format is from Sequence Gen Pro this will be matched to the gain found in the science image path

Date fixed at last run for this macro 2019-11-19 in this example

## Darks

Just like the Bias directory – the same remarks apply to the master dark structure and how it is built if necessary.

X:\\Master\\Darks\\

Gain based on my camera- format is from Sequence Gen Pro this will be matched to the gain found in the science image path

Date fixed at last run for this macro 2019-11-19 in this example

The macro is as simple as possible and not an exercise in clever programming – it is designed to show as clearly as possible the logic needed to achieve the use of DP in batch mode and includes a post processing stacking macro (STAGE THREE) to show a non DP processing sequence. Refine, change and print extra counters, whatever you need. Follow the code and understand the details of how to set up DP by macro and how to run it as a macro process. The key is the AIJ\_Prefs.txt file which you will find on your AstrolmageJ machine, read the contents to expand your ideas, using the same approach as this macro.

Note that processed data and all the images in the StarName sub directories are removed at the end of the analysis phase. The macro will not find any folders to be processed for these targets and they will be skipped. After a night's run the data from the telescope is loaded again in the target directories (I use FileSync for this) and the macro will find this new data. If any previous night's data has not been processed, that too will be picked up. This will happen if we have several clear nights in a row – very rare in the UK, or you process at more infrequent intervals.

I hope this will be of use to those who are using AstrolmageJ to process variable stars in particular but others might find further ways of developing this. Please use the AstrolmageJ and BAA VSS forums to share your ideas and developments.

George Fleming

Clear Skies

25<sup>th</sup> Nov 2019