**Pycam manual**

**Introduction**

Much, but not all, of pycam implements the pyplis (<https://www.mdpi.com/2076-3263/7/4/134>) package as a backend, since a lot of time has already been put into developing this package and it is quite a powerful tool for SO2 camera data analysis. [iFit](https://www.sciencedirect.com/science/article/pii/S037702731930647X) is also used for processing of spectra for SO2 column density retrievals.

**Pi networking**

Pi 1 IP: 169.254.10.180 Controls on-band camera, GPS, external SSD storage, external communications.

Pi 2 IP: 169.254.10.178 Controls off-band camera and spectrometer

**Hardware setup**

If using a 128GB microSD must expand filesystem after copying disk image. sudo raspi-config > advanced options > expand filesystem. All space should then be available to pi

Jumper cable on GPIOs for Pi start up should be placed from GPIO23 (physical pin 16) on the Witty Pi to GPIO 3 (physical pin 5) on the second pi.

GPS connections:

Red - VIN

Black - GND

Green - RX

White – TX

**Software installation**

Download and install git from <https://git-scm.com/download/win>

Install conda – makes it easier to install other python packages

Python 3.8.2 definitely works.

Some versions of conda seem to fail when installing pyplis. They give a malformed “~” error. Can use “conda install conda=4.8.3” to install specific version. 4.8.3 definitely works.

Some pip installs:

* ttkthemes
* shapely

IMPORANT: May need to manually go into pyplis and add volcano source information file to pyplis package. Need to add it to the ./pyplis/data/my\_sources.txt file, which should be relatively straightforward. Source\_id is caps sensitive, so just add two source IDs, one with capital letter to start and one without. UPDATE: volcano source information can be saved through the GUI – go into geometry configuration and edit the volcano info, this will save directly to the pyplis my\_sources.txt location.

Currently pyplis has an error which stops cell calibration from working. To get this to work, after installing pyplis go to line 467 in calib\_base.py and change min(cds) to max(cds).

Copy ifit and ifit\_ld folders from memory stick into pycam folder.

Filenames in tests/test\_data/test\_spectra/ must be changed – for some reason github has them as lower case but should have first letter upper case e.g. plume must be changed to Plume.

**Background modelling**

The background intensity is used to find the optical depth of each band, and subsequently, the SO2 differential optical depth. It is therefore critical that a good estimate of the background intensity is

There are a range of options available for background intensity modelling in pycam. Options 0-6 and 99 are all pyplis methods as described in Table 2 therein. Option 7 is a very basic method which uses vignette correction and then finds the average intensity in the ambient region (defined by the rectangle on the SO2 image of the Analysis tab), for each band separately. This intensity is taken as *I0* and tau is calculated from this.

**Instrument acquisition**

NOTE SSA, SSB, SSS will not change if Auto shutter speed is enabled. May need to send 2 rounds of commands, one to shut

off Auto SS and the second to set shutter speed - if done in one round, if the SSA command is applied first, it will

fail as AutoSS still won't have been turned off yet.

**Light Dilution**

Options are available for both spectrometer and camera light dilution corrections. Each can be toggled on and off separately. IMPORTANT NOTE: The ifit (spectrometer) light dilution correct is extremely slow – it will not be able to keep up with real-time processing. It is therefore strongly suggested that any real-time monitoring setup of pycam is run without spectrometer light dilution correction; in circumstances where the correction is required for the data it could then be reanalysed at a later date – for most instrument setups neglecting light dilution can still provide an adequate first approximation of emission rates, with later refinement most critical for high-accuracy applications.