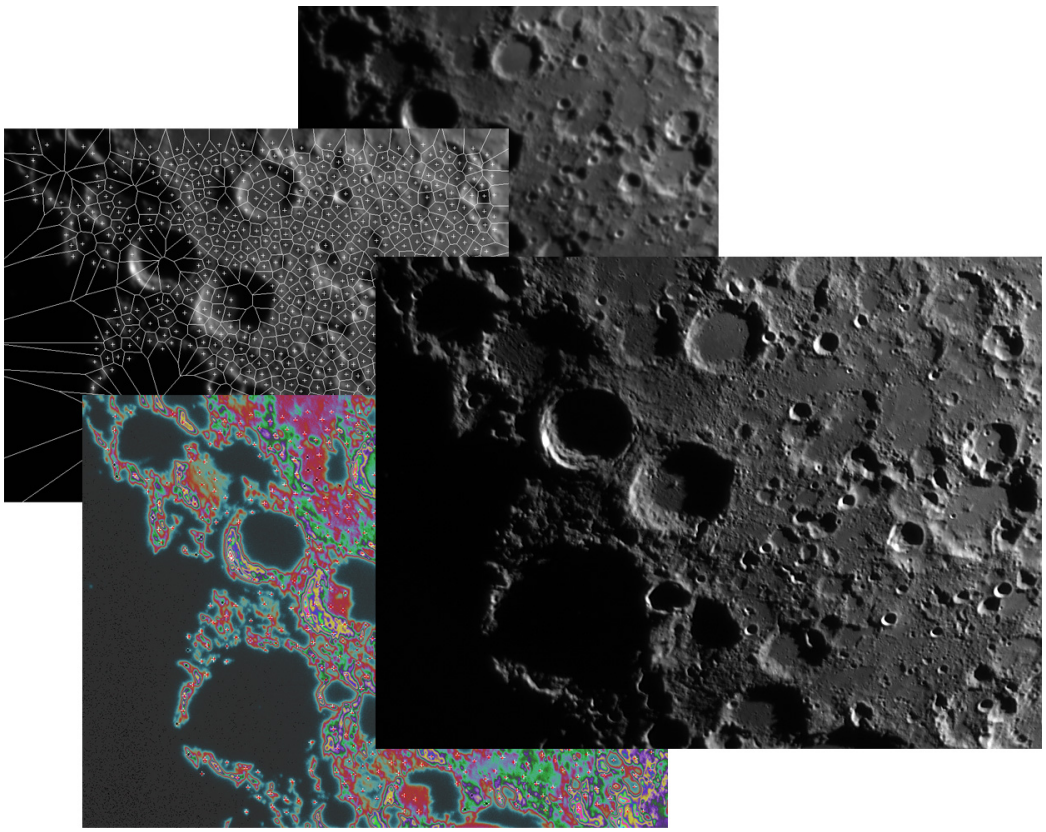

Manual for Program Version 1.8+

Contents

1 Introduction

AviStack was primarily developed to process lunar images, but, it also works well with solar and planetary images. AviStack uses hundreds or even thousands of reference points to compensate for seeing-related distortions most effectively. This is decisive to detect even the smallest details in high resolution lunar images. Despite the large number of reference points, AviStack is noticeably faster than Registax and enables complete batch processing for all time consuming processing steps. Simply prepare within minutes all settings necessary to stack the film, save those settings and start the batch processing. That way you will later, e.g. on the next morning, find all the stacked final images on you computer.

2 AviStack Installation

You can download AviStack from the following internet address: http://www.avistack.de

There, you will find two different program versions:

- One stand-alone .exe version for 32bit-Windows systems (about 14 MB).
- One pre-compiled IDL-save-file that requires the IDL VM (about 1 MB, see below). The IDL VM is practically available for all operating systems so that you can run AviStack under Linux and Mac, too. Have you previously installed the stand-alone-version and there is an AviStack update available, you can simply download the new avi_stack.sav file and replace it in your AviStack programm directory.

To enable AviStack to load a wide range of AVI codecs, you simply have to download an additional DLL- and DLM-file. For Quicktime movies (e.g. Canon DSLR HD videos) and MPEGs you will also need to install the AviSynth frame server. All this is only possible for Windows users! More about this in Section 2.3.

2.1 Stand-alone AviStack version

Simply download and unzip it to the desired location on your computer. Then start AviStack.exe, done!

2.2 IDL VM

2.2.1 Installation

AviStack requires the program package of the IDL VM (about 270 MB) by ITTVIS. It can be downloaded free of charge after registration: http://www.ittvis.com/download/download.asp

Click on IDL VM Download on the left hand side and choose the version suitable for your operating system. For most of you this will likely be the first in the list (Windows 32bit, XP/Vista). Then follows the already mentioned New User Login. After successful registration you can finally download the software package and install it. Simply execute the setup file and follow the instructions. Usually, administrator rights are necessary to install IDL.

2.2.2 AviStack

Simply copy the avi_stack.sav into a folder of your choice. However, under all circumstances, do not change the name of the file or its suffix. Otherwise, it won't execute. Apart from this, no other steps are necessary.

2.3 Supported video codecs

AviStack supports AVIs recorded with the Y800-codec (uncompressed grey scale), DIB-codec (uncompressed color) and I420/IYUV-codec (webcams). I.e. all grey scale and color films recorded with the cameras of The Imaging Source (http://www.astronomycameras.com/de/products/) as well as films taken with the Philips ToUCams. Additionally, it is possible to process series of images of the following formats: PNG, JPG, BMP, TIFF, JP2, FITS (also 16 bit). That way basically every type of AVI can be used if it is split up into single frames beforehand.

AviStack also loads SER movies recorded with the Lucam-Recorder.

For Windows users, only: To load a wide range of AVI codecs with AviStack you can download two additional DLL and DLM files. These were compiled by Ronn Kling and are freely available from his homepage. Click on "krsgravi" on the website http://www.kilvarock.com/dlms.htm to download the file krsgravi.zip. Unzip it and copy the files KRSgrAVI.dll and KRSgrAVI.dlm to the AviStack program directory - done! AviStack is then able to use all the AVI codecs installed on your computer.

Do you also want to load Quicktime videos and MPEGs, you will have to install the AviSynth frame server, additionally. Then a large number of MOVs and MPEGs are readable, but, not all in my experience. Just try it out.

If your codec is still not supported by AviStack, simply use VirtualDub (http://virtualdub.sourceforge.net/) to convert your AVI to DIB (...save as AVI).

Any trouble when using AviStack, or any wishes? Please, send an e-mail to the following address: michael@avistack.de

Or you can join the AviStack User Group: http://tech.groups.yahoo.com/group/AviStack/

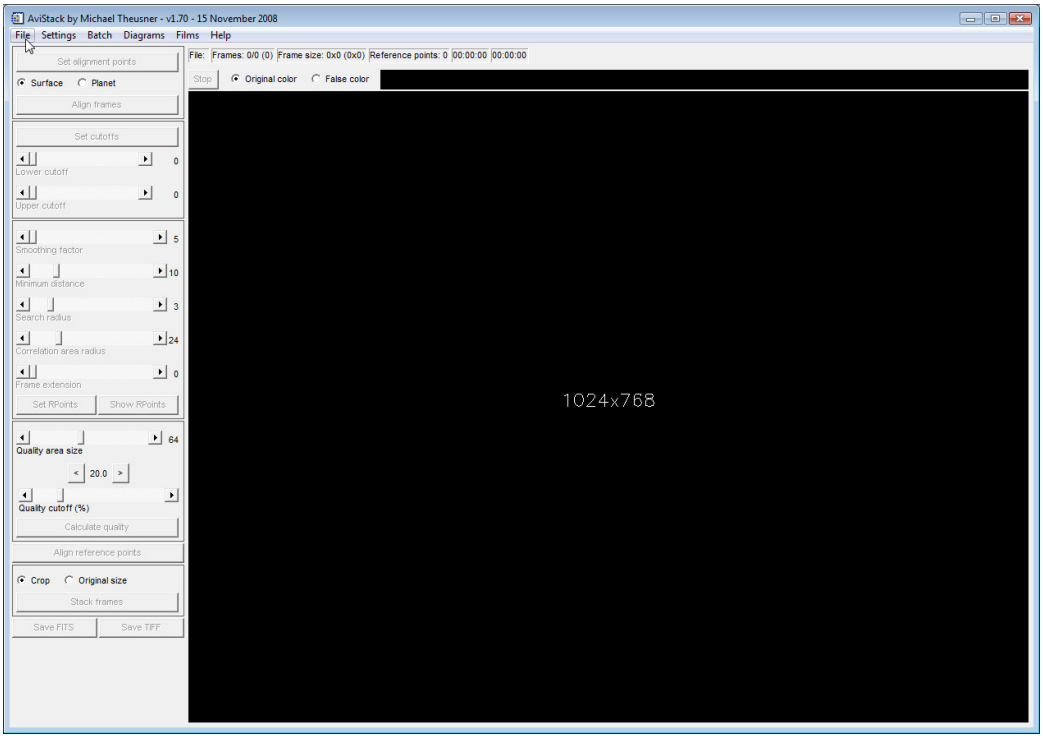

Figure 1: The GUI of AviStack. The various menu bars are to the left and at the top. Most of the sliders and buttons used for the processing settings can be found on the left side.

3 Using AviStack

After a successful installation of IDL VM you can run AviStack simply by double-clicking it. Then confirm the following IDL VM window and the main program window will appear (Fig. 1). If you want to switch to a language other than English go to → *Settings* → *Language* select a language and restart AviStack.

Step 1 – Loading an AVI

→ ***File*** → ***Load AVI***

Load an AVI using the dialog window. Immediately after loading, the first frame is displayed and, additionally, all relevant information in the bar just above the main display window (Fig. 2):

- The file name.

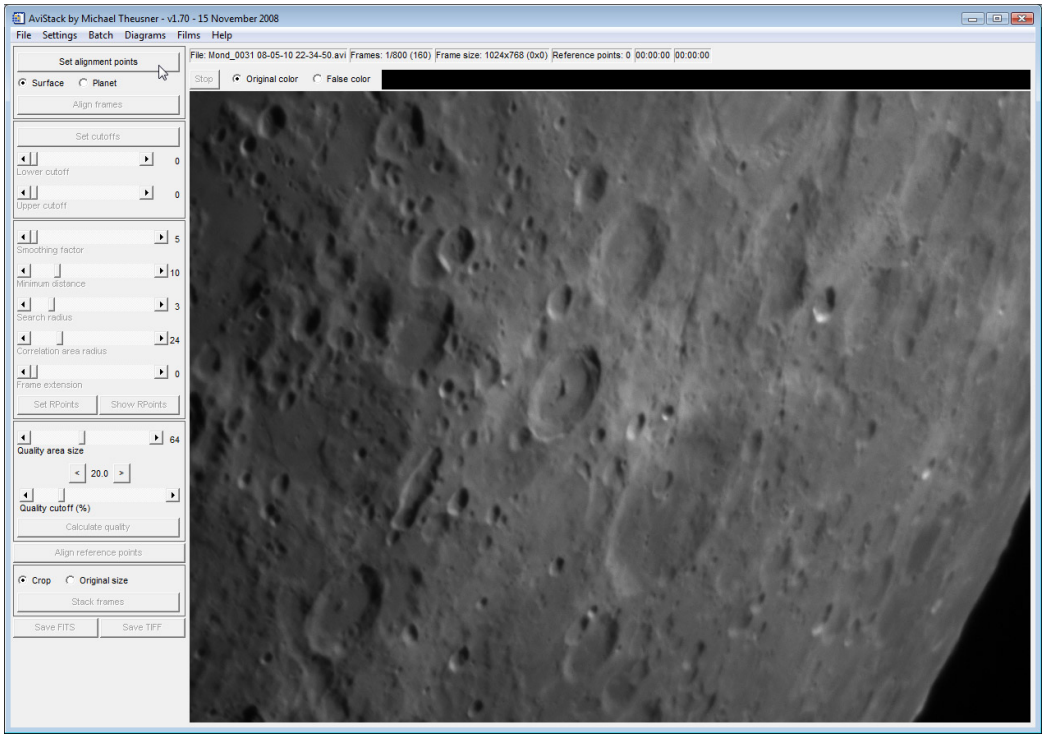

Figure 2: AviStack's GUI after opening an AVI. All relevant information on the file is shown just above the main display.

- The number of frames.
  - Example 1/800 (160).
  - First of 800 Frames, 160 are later used per reference point (depends on the quality cutoff, here 20%, see bottom left of Fig. 2).
- The frame size.
  - Example 1024x768 (0x0).
  - Extension in x and y. In brackets the size of the aligned film is stated later, i.e. the size of the field present in all frames.
- The number of reference points.
  - Is shown after the reference points are set.
- The elapsed computing time and the expected remaining computing time.
  - Is only shown during a long calculation.

Step 2 – Select alignment points/disable frames

→ ***Set alignment points***

A new window appears where you can disable frames (e.g. the ones of insufficient quality) enable them again as well as select alignment points (Figure 3). While this window is active the main GUI is hidden.

Alignment points

You can choose between an original color and false color display. This is to make it easier to select suitable spots to place the two alignment points. These alignment points are used to align the frames of the film and to determine the distortions created by seeing effects, i.e. by how much the first point moves with respect of the second.

Therefore, both points should be placed as far away as possible from each other (Figure 4). But, you must not place the points too close to the edge of the image, especially if the field of view moves considerably due to errors in your mount's tracking. Highly suited locations for the alignment points are areas of high contrast, e.g. small craters.

Select a frame of high quality using the frame sliders and buttons. Then place the alignment points in the frame of your choice.

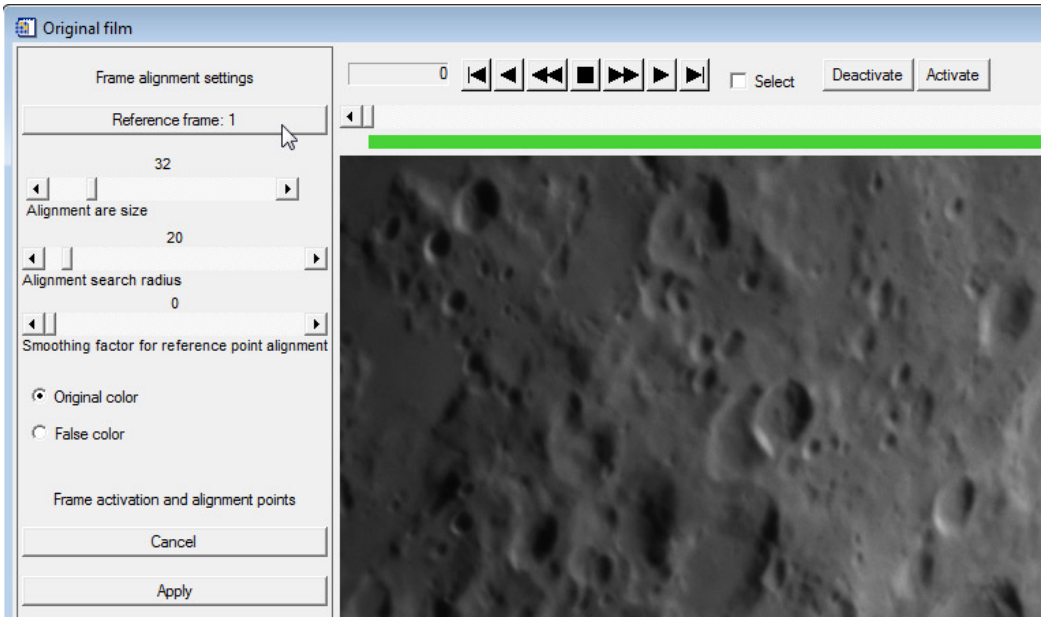

Figure 3: The window for the selection of the two alignment points and for activating and deactivating frames.

- The first point is set using the left mouse button.
- The second point is set using the right mouse button.

→ *Alignmen area size*

This slider determines the size of the template area which is searched for in each frame to find the location of a alignment point. The larger the area is the more different seeing effects are averaged. Therefore, it should not be chosen too large. If the seeing is very bad or there are

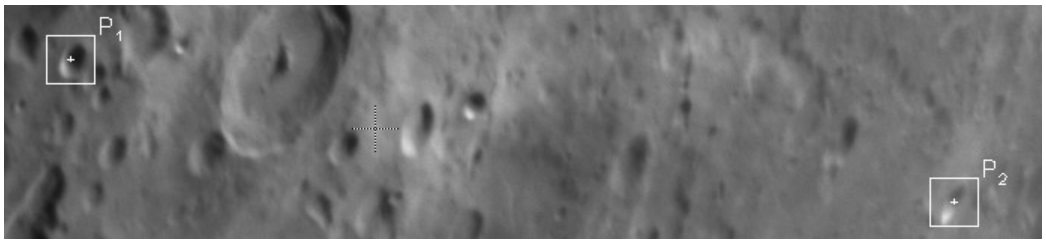

Figure 4: Frame section with the two selected alignment points.

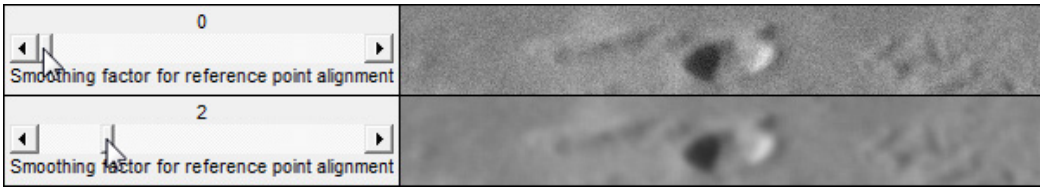

Figure 5: Two frame sections and the corresponding smoothing factors.

only few structures in the image, a larger value for the alignment area size is recommended, however. This enables a successful alignment. At the beginning you will likely have to try out different settings to find the ones optimal for your images.

→ *Alignment search radius*

This slider determines the radius around an alignment point that is searched for a correspondence with the reference frame, i.e. it is the maximum shift allowed between consecutive frames to recover the alignment point in that frame. Large values lead to an increased processing time, however, sometimes, they are inevitable.

→ *Smoothing factor for reference point alignment*

This parameter is used at a later stage of preocessing (for reference point alignment). You can choose it later if you like without having to repeat the previous steps. This parameter is used to reduce noise in the frames which would otherwise negatively impact the reference point alignment. A value of zero means no smoothing. After you have set the slider to a value different from zero, the smoothed frame will be displayed (Fig. 5). You should adjust it such that the noise just disappears (this is usually already achieved by a factor of 1). If the smoothing is too strong, there is the risk that the reference points are not optimally aligned and the qulity of the final result suffers. In the shown example (Fig. 5) the noise is very strong and a smoothing value of 2 required.

This smoothing is used internally for the reference point alignment only and not for the generation of the final image!

How to deactivate/activate frames

The procedure to deactivate a certain frame or a series of frames is as follows:

Figure 6: Select frames.

1. Click *Select* (see Fig. 6)

2. If you want to deactivate only that one frame, click on *Deactivate*. The respective frame is then crossed out white and a black line appears in the activation bar (green, Fig. 7). If you want to deactivate a whole series of frames simply use the arrow buttons and the slider until you have reached the last frame to be deactivated (in the activation bar all selected frames are marked by a white line, Fig. 8) and click *Deactivate*. Now all selected Frames are deactivated (Fig. 9). After you are finished uncheck *Select*.

The same way you can activate frames which you have previously deactivated. Simply use *Activate* instead.

There is one additional feature which makes it very simple to block-wise process an AVI. Say, you have captures a 1000 frame long movie of Jupiter. Now you want to process frame 1 to 200, then 201 to 400 and so forth. First deactivate frames 201 to 1000 and continue processing until you have obtained the final image. Then go back to this window and hold the left mouse button pressed in the activation bar. You can then simply move the activated frames to the next block (frames 201 to 400 in this example) by moving the mouse! With the right mouse button the motion speed is 5x faster. Then, continue processing with this new batch of frames.

After all necessary settings have been performed, click *Apply* (Fig. 10). The window is closed automatically and the alignment procedure is ready to be started. If the window is not closed, you have probably forgotten to uncheck *Select*. If you can cancel this processing step at any time by clicking on *Cancel*. All previously made selections are then lost.

Figure 7: Deactivate one frame.

Figure 8: Select several frames.

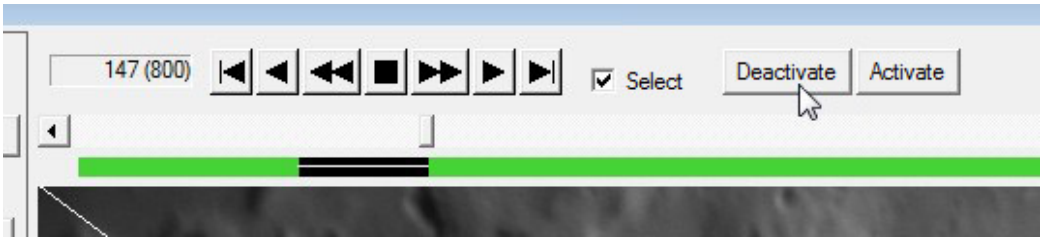

Figure 9: Deactivate several frames.

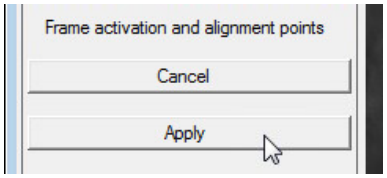

Figure 10: Apply the settings for the alignment points and frames.

Step 3 – Align frames

→ *Align frames*

This button becomes sensitive after you have selected two alignment points. By clicking on the button the frame alignment procedure is started. This procedure can take from seconds to several minutes depending on the computer's processor, the number of frames, the size of the alignment area and the selected search radius. For **planets** it is useful to select the respective button, then it is possible to perform the frame alignment with a smaller search radius.

While the alignment procedure is running, the frames of the AVI are shown as well as the detected locations of the two alignment points (Fig. 11). All Buttons and sliders are disabled, with exception of the *Stop* button. If you notice a jumping or drifting alignment point, simply press the *Stop* button and the alignment procedure is stopped almost immediately. Whenever this happens, it is recommended to choose different alignment points and/or change (increase) the size of the search radius. Then perform the frame alignment anew. Such an occurrence is actually very rare and is usually caused by a too small search radius in case of a strongly jumping or fast drifting field of view.

You can interrupt all time consuming processes by hitting the Stop button!

The frame alignment diagram

After a successful frame alignment a diagram is shown (Fig. 12) which contains information highly important for later settings. In this example the upper diagram in Figure 12 nicely displays the shift of the two reference points with respect of each other. Outliers can quickly be recognized. In such frames the alignment has likely not worked properly. You can then use the slider on the left side of the diagram to deactivate them. Simply pull the slider downwards and a red line appears (Fig. 13). All frames that have values above this line are removed from processing. Now you only have to hit *Apply*. Then, a new average frame is generated which is later used for the reference point alignment.

The drift in x and y as well as manual tracking corrections are visible in the middle diagram. The lower diagram shows a frequency distribution of the relative shift of the first with respect of the second alignment point. It therefore provides information on seeing-related distortions. In this case a one-pixel-difference is most frequent, and differences larger than five pixels are absent. The highest relevant shift is three pixels in this case.

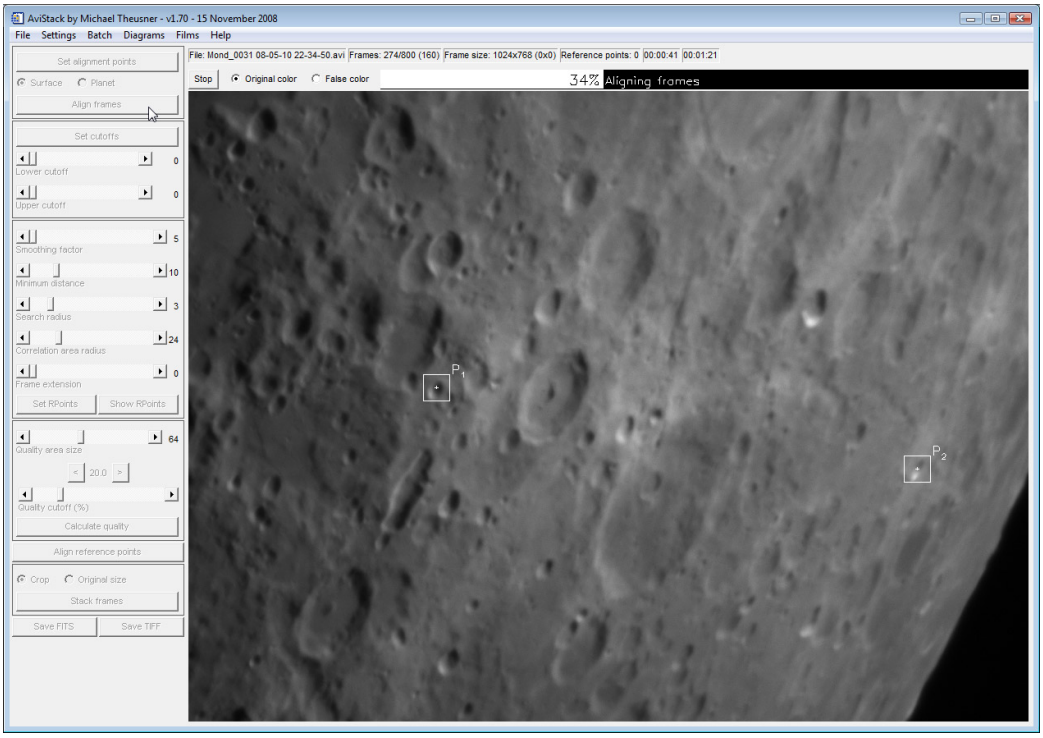

Figure 11: The frame alignment has started.

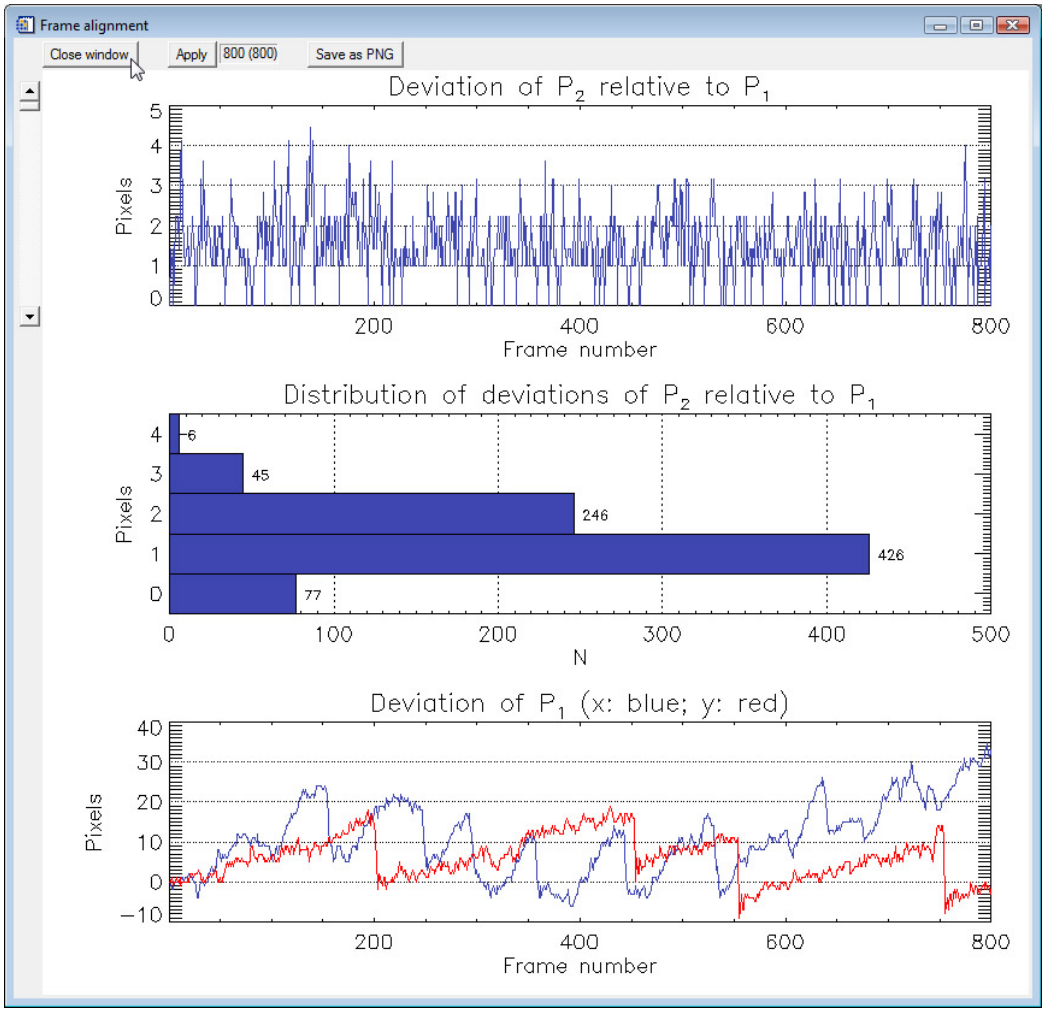

Figure 12: The frame alignment diagram.

It is strongly recommended to use the highest relevant value for the Search radius in the Set reference points section.

It ensures that seeing related distortions are optimally compensated for – at a minimal computing time!

You can close the diagram window and re-open it at any time under

→ *Diagrams* → *Frame alignment*.

That also applies to all other diagrams. Also the ones which are generated later in the processing chain: They are all available under the menu *Diagrams*.

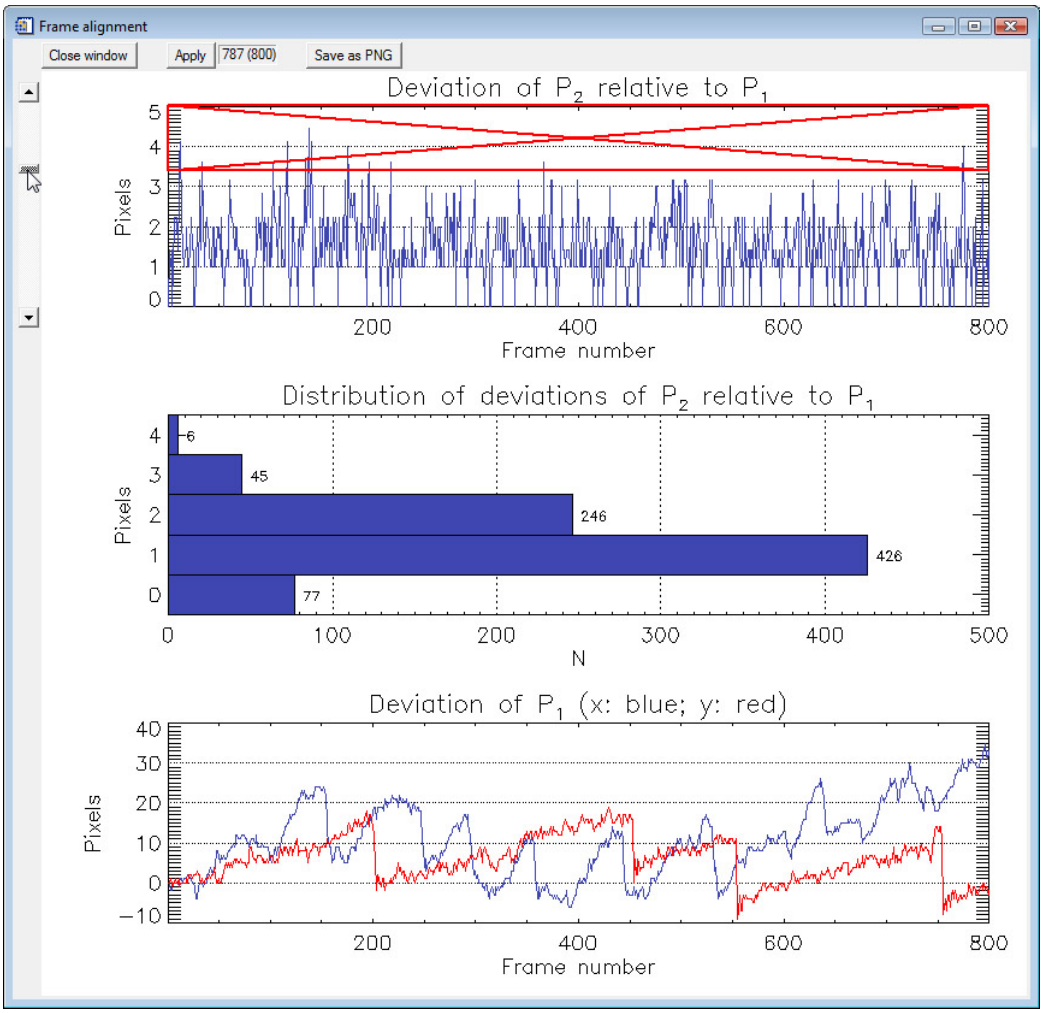

Figure 13: The frame alignment diagram. Deactivating frames.

The average frame diagram

Under → *Diagrams* → *Average frame* you can have a look at the average frames which results from the frame alignment process. Additionally, you can define a so called *active area*. You simply have to move the mouse while the left mouse button is pressed and a frame is generated (Fig. 14) and hit *Apply*.

All further processing steps are then performed for the *active area* only.

This way you can quickly find out which settings lead to optimal results. That especially applies to the search radius and correlation area radius. Have you found the optimal settings, you can simply go back to the average frame diagram and removes the active area by hitting *Reset*. Then, redo the following processing steps.

Using this procedure you will quickly find the optimal settings and save lots of time!

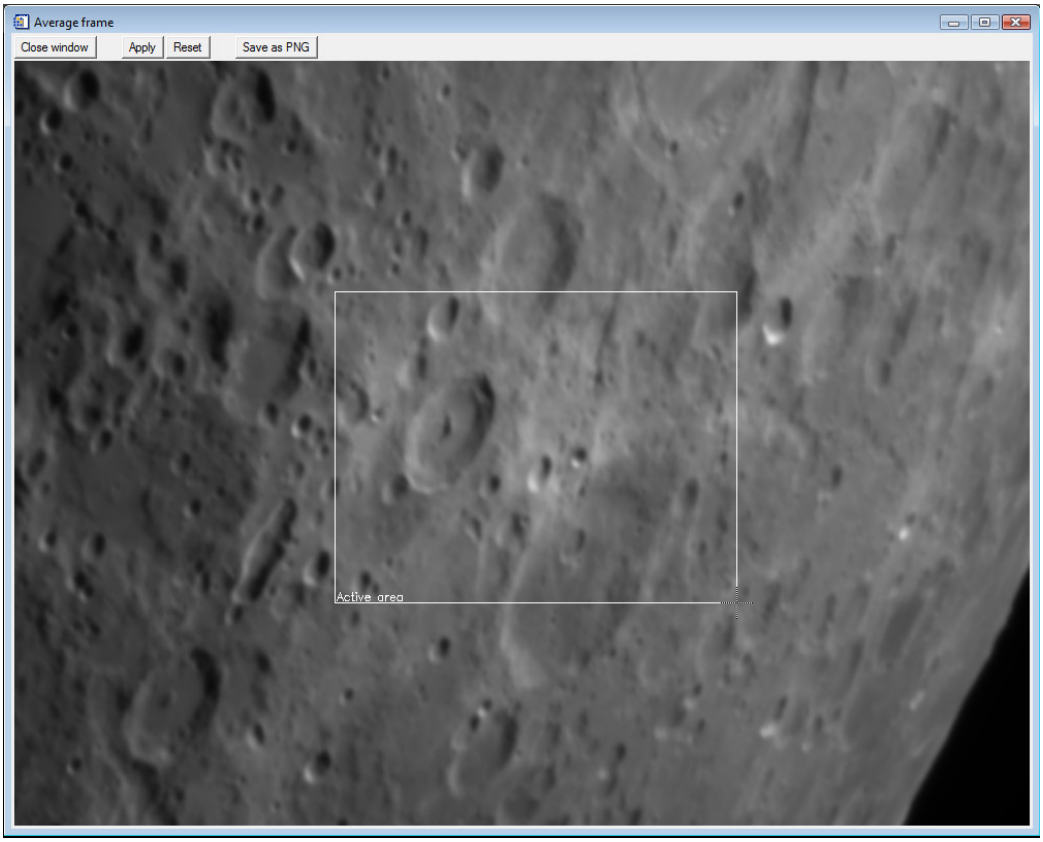

Figure 14: The average frame diagram and the selected *active area*.

Figure 15: The background of the average frame is not black.

Step 4 – Setting cutoffs

Before you can set reference points you have to tell AviStack in which parts of the image none should be placed. This is because the reference points are placed automatically and it can be time consuming to manually remove the unwanted ones. In the example it would not be sensible to place reference points in the lower right part of the image as it only contains black sky. It might look black, but, in reality, it is not due to noise. This noise would cause AviStack's routines to search for suitable reference point locations also in that part of the image. This can be prevented with to slider settings. But, first:

→ ***Set cutoffs***

A false color image is displayed which represents the average of all active and aligned frames. This average image is later also used to automatically place reference points. It is apparent that the sky background is not entirely black (Fig. 15). If you now move the slider *Lower cutoff* to a higher value you will notice that the darkest parts of the image become black. If you move the slider to higher values parts of the moon start to disappear as well which is naturally unwanted. The slider should be placed such that as much of the sky background becomes black without excluding parts of the lunar surface.

In all black areas no reference points will be placed!

With the slider *Upper cutoff* you can exclude overexposed areas. This is probably useful for H-alpha images of the sun where faint protuberances are visible at the sun's edge and the surface is overexposed. Overexposed parts of the moon can certainly be excluded this way as well.

You cannot move the Upper cutoff slider to values lower than the setting of the Lower cutoff and the other way around.

It is not mandatory to change the cutoffs. Especially if the whole field of view is covered by lunar surface.

When you hit the *Set cutoffs* button the sliders and buttons for the reference points are unblocked as well.

Step 5 – Setting reference points

Before you click on *Set RPoints* (set reference points) you should modify some of the settings that determine where and how many reference points are automatically generated. If you have already set some reference points and change one of these sliders afterwards you must click on *Set RPoints* again before you are allowed to proceed to *Step 6*.

→ *Smooting factor*

The smoothing factor is the parameter which determines how many reference points are generated.

- The larger the smoothing factor the fewer reference points.
- The smaller the smoothing factor the more reference points.

The stronger the average frame is smoothed the more structures disappear and, consequently, there are fewer locations to place reference points.

→ *Minimum distance*

The minimum distance determines how close a reference point is placed to another one.

- The larger the minimum distance the fewer reference points.
- The smaller the minimum distance the more reference points.

→ *Search radius*

The search radius defines the radius around a reference point that is searched for a corresponding location in the frames of the AVI. **Here you should use the highest relevant difference that was established during the frame alignment** (→ *Diagrams* → *Frame alignment*, see *Step 2, The alignment diagram*). It ensures optimal compensation of seeing related distortions and a minimal computing time. The computing time actually increases by the square of the search radius.

→ ***Correlation area radius***

This value determines the size of the area around a reference point that is used to detect the location of the reference point in one of the AVI's frames (similar to the *Alignment area size*). Here, again, a large value implies averaging of seeing effects over a larger area so that very delicate structures are possibly not as well visible in the final image as they were when a small value were used. However, in featureless mare areas a large correlation area size is usually mandatory as, otherwise, the location of a reference point is not reliably recovered. The optimal value depends on many different factors: E.g. seeing, focal length and aperture. Computing time increases by the square of the search area, approximately.

Have you finished all the settings you can click on:

→ ***Set RPoints***

The generation of reference points begins and will take a few seconds. Finally, the generated reference points are displayed in the main display and the *reference point diagram* appears (Fig. 16). The latter shows the reference points (white plus signs) and the region belonging to each reference point (white lines).

In the main display you can now delete reference points with the mouse and also place additional ones.

- Deleting: Click near a reference point (5 pixels maximum).
- Deleting: Hold the right mouse button and draw a rectangle. All reference points within the rectangle are deleted.
- Set new one: Click a location without a reference point.

When you are happy with the reference point selection you can continue with the next step. Or, you can save all previously made settings and use the generated .asd file for later batch processing!

In the latter case you should first check the *Quality cutoff* (%) and choose a desired value (see *Step 6*). Additionally you can choose a flat and dark as well (see *Step 8*). Afterwards:

→ *File* → *Save data*

It is actually possible to save the processing data at any time and continue at a kater time (→ *File* → *Load data*).

If you choose to continue, *Step 6* comes next.

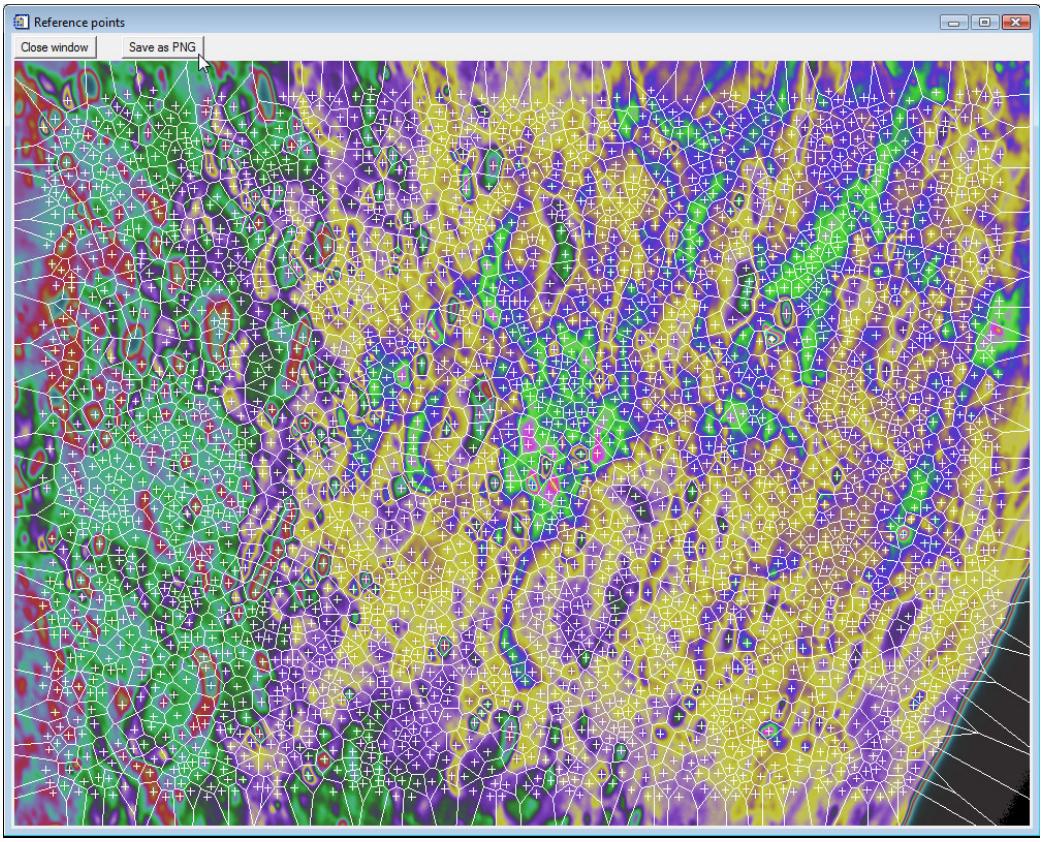

Figure 16: The reference point diagram. White plus signs mark reference points. the white lines seperate from each other the regions belonging to each reference point.

Step 6 – Calculate quality

Warning: In case of very noise images the quality calculation may not be quite reliable! This processing Step becomes unblocked after you have set reference points. But, before you click on *Calculate quality*, you can modify the *Quality area size* and the *Quality cutoff (%)*

→ *Quality area size*

As the image quality varies within a frame due to seeing related distortions, the quality is calculated for small areas of the image, separately. That way only the best parts of an image are later used, even if it is only one small area of a whole frame. The size of these areas is determined by the *Quality area size*.

→ *Quality cutoff*

This value defines how many frames are used for each reference point. I.e. only the best x% frames are later selected for each reference point. How many frames are actually used is stated in the information bar above the main display (the bracketed value after *Frames:*). The Quality cutoff may be changed in 0.1% increments. (< and > right an left of the number above the slider, the slider's < and > cause 1% increment changes)

Have you finished these settings continue with:

→ *Calculate quality*

Now the quality of each quality area is calculated for each frame. The quality areas are represented by the white grid (see Figure 17). Again, you can interrupt the process with the *Stop* button.

Finally, the *Average frame quality* diagram is displayed. It illustrates the average quality of each frame (all quality areas of a frame averaged). Additionally, you can have a look at the sorted quality:

→ *Diagram* → *Quality (sorted)*

Now is also a good time to define the previously made settings as the new default settings (→ *Settings* → *Default settings* → *Set as default*). You can also save them in a separate .asi-file (*...*→ *Save settings*) and reload them later (*...*→ *Load settings*). You can also restore AviStack's built-in settings.

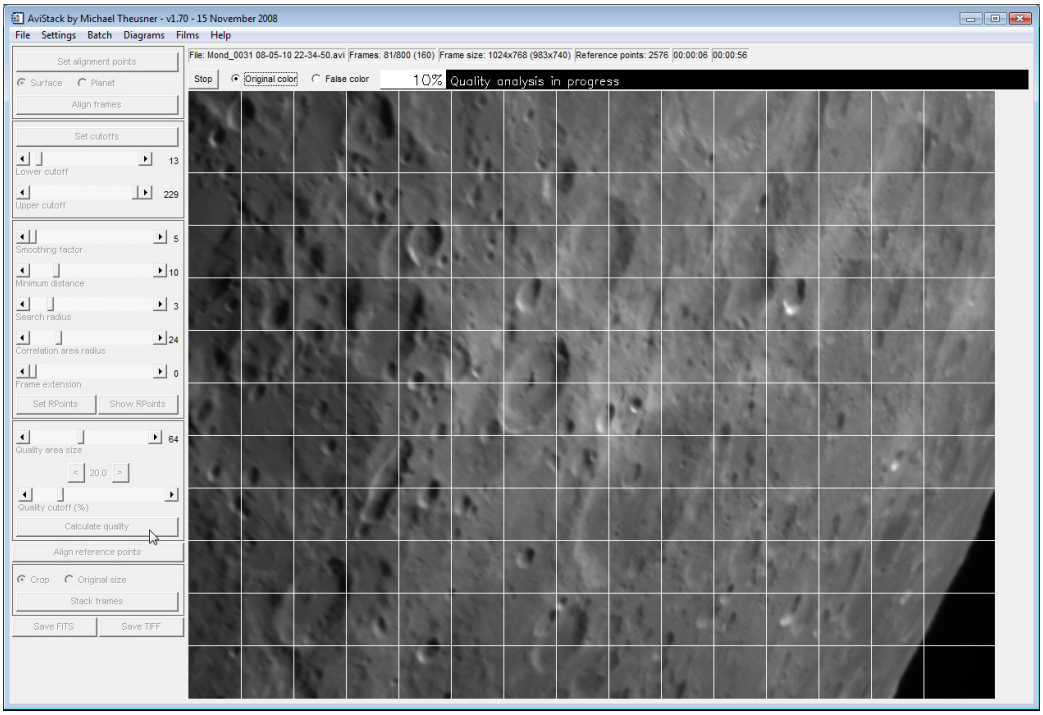

Figure 17: The quality of each area (markiert by the white lines) is beeing calculated.

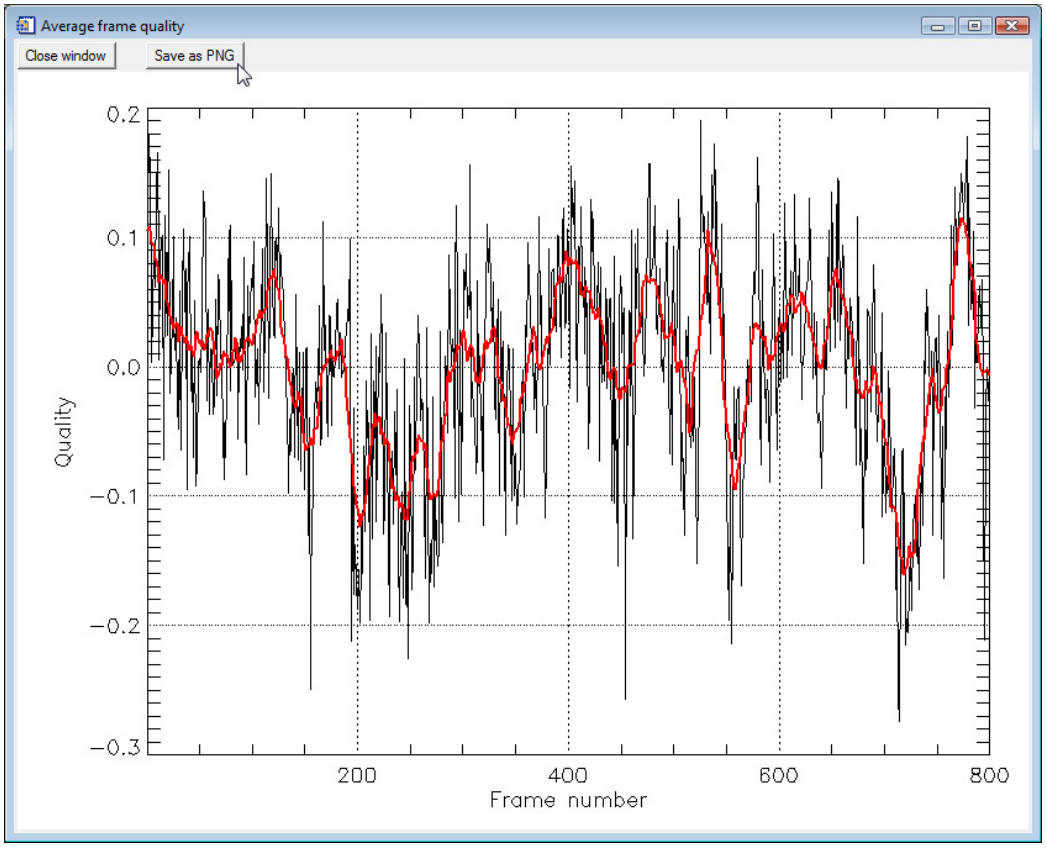

Figure 18: From the quality diagram you can see when the seeing was rather good or rather bad. The average quality of each frame is shown as deviation from the average quality of all frames combined (black line). The red line is a smoothed version of the black one.

Step 7 – Reference point alignment

After the quality analysis you can start the reference point alignment. Reference points are aligned in those frames only which have a sufficient quality. Have you chosen a quality cutoff of 30% then each reference point is aligned in the 30% best frames.

If you want to increase the quality cutoff and you have already performed a reference point alignment, the process is repeated for all those frames where a reference point was not previously aligned. So AviStack always remembers which reference points were already aligned to prevent unnecessary computations.

Before you start the reference point alignment, you can choose a smoothing factor as described in *Step 2*. That way the noise in the frames is reduced. It is then easier for AviStack to correctly align a reference point without using a very large *correlation area radius*.

→ *Align reference points*

After a few seconds the false color view with the reference points (white plus signs) appears (Fig. 19). Inactive reference points are marked black. For the latter the quality of their area was too low in this frame and, thus, these reference points are not aligned.

Red marked ones are active, however: In these cases the quality of the area was found to be sufficient. The red plus marks the location where the reference point was detected in this frame. The white plusses indicate the location of the reference point where it was set in the reference frame (the average frame). It is apparent that deviations in the same area are often similar.

However, you should have an eye on featureless areas: If the *Correlation area size* is too small the deviations can be entirely random. Then, you should stop the processing (*Stop* button) and continue with a larger *Correlation area size* (that also means new reference points etc., unfortunately). The expected computation time can be found in the information bar.

Diagram of the reference point deviation distribution

When the reference point alignment is finished the *Reference point deviation distribution* is displayed (Fig. 20). It provides information on how often certain deviations from the reference location of a reference point occurred. In this case, a deviation of one pixel was most frequently encountered.

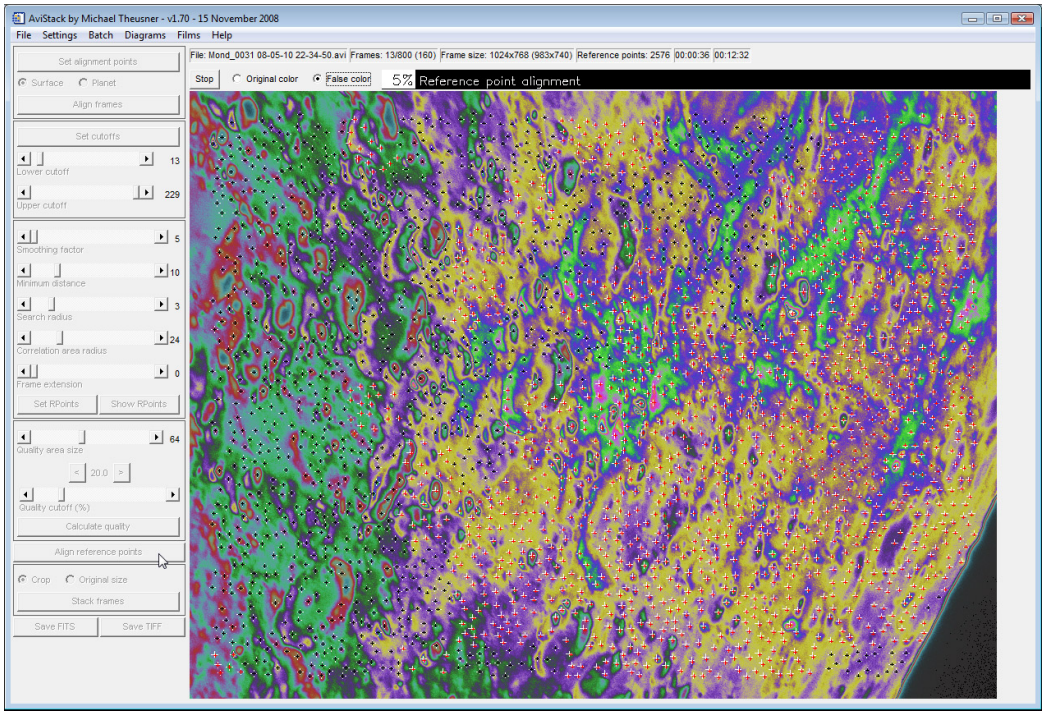

Figure 19: The GUI during reference point alignment. Active reference points are marked red, the inactive ones black.

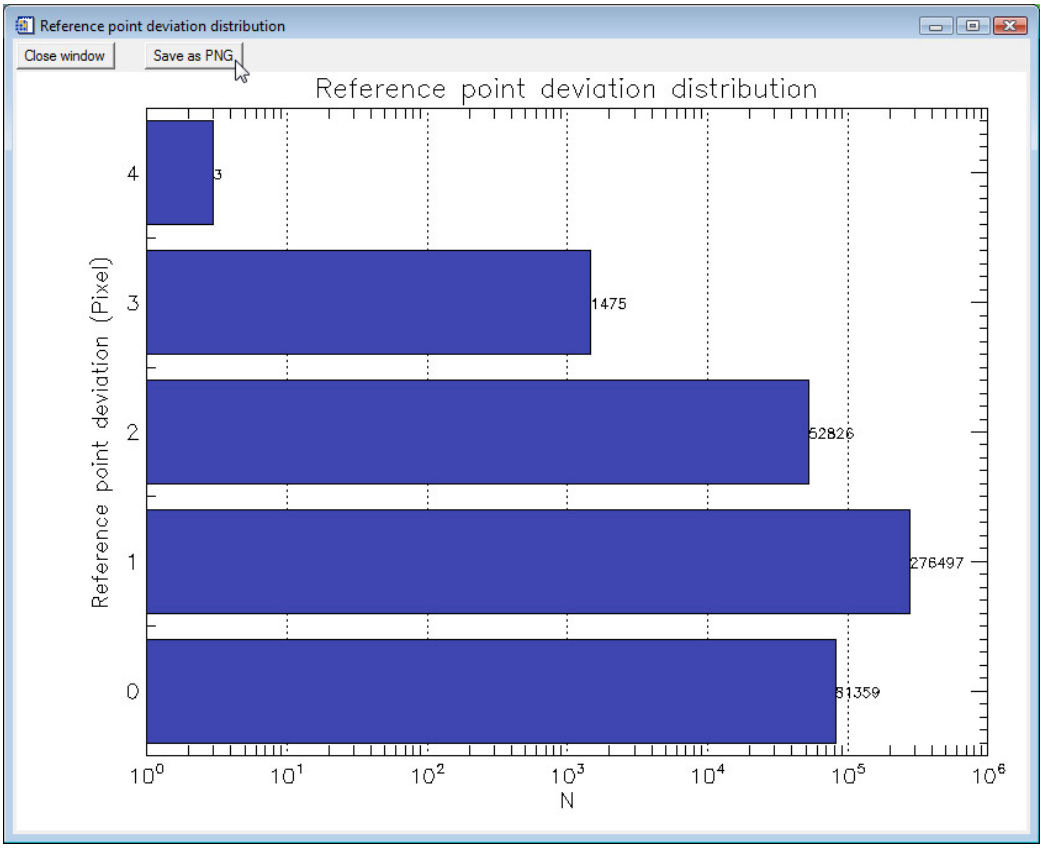

Figure 20: The reference point deviation distribution shows how often each deviation ocurred.

The distribution shows that the pre-determined value of four pixels as the maximum expected deviation (*Search radius*!) was rightly chosen. Due to the reference point alignment procedure, deviations of four pixels could have been possible, and they actually occured (three times).

This distribution also shows you if the *Search radius* (and/or the *Correlation area radius*) was chosen too low. In such cases the distribution does not drop-off towards higher deviations or even increases!

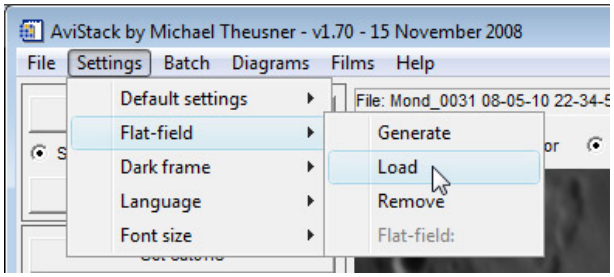

Figure 21: Selection of a flat field.

Step 8 – Stacking frames

Before you start stacking the frames, you can select a *flat field* and/or a *dark frame* which will be applied to the single frames during the stacking process. All the necessary settings can be found under → *Settings* (Fig. 21). It is explained in Chapter *Flat-field/Dark frame generation* how you can generate them. Otherwise, immediately after a successful reference point alignment you can click on

→ *Stack frames*.

You can also decide whether you want a cropped result (i.e. including only the area which is present in all frames) or the original frame size. In the latter case, there are fewer frames stacked at the borders of the image, with the consequence that noise is stronger there.

While all the frames of the AVI are processed, it is shown (Fig. 22) which parts of a frame are currently added to the final result. Each of the small areas is taken from a frame, shifted (reference point alignment!) and added to its final location. When the stacking is finished, the final image is displayed. Now you can proceed to the last step: saving the image!

Step 9 – Save FITS

Click on → *Save FITS*, choose a file name and save the file - done!

RGB-images are saved as three separate fits-files with a _r, _g and _b suffix.

Now you can load the final image(s) into AviStack's postprocessing tool or (e.g. wavelet filtering, sharpening) into e.g. Registax or FitsWork for further processing.

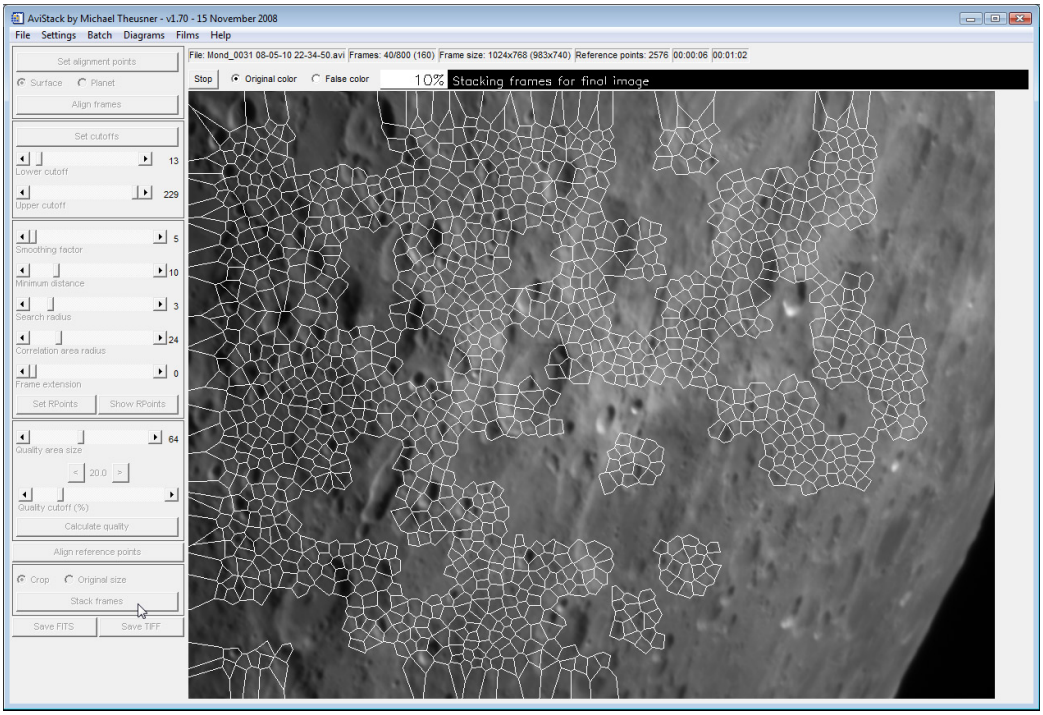

Figure 22: Stacking of the frames. The areas marked by a white frame are currently added to the final image.

Step 10 – Postprocessing

→ *Wavelet sharpening*

Using this tool you can sharpen your final image or perform levels adjustment. How this is done exactly, you can read here: http://joe.zawodny.com.

You can also load any image using AviStack's "Load images" menu and go directly to the postprocessing tool.

4 Flat-field/Dark frame generation

The generation of flat-fields and drak frames is very simple. Just open a film or series of images that contains the flat-field frames or dark frame frames. Do this before you process a film. After that you can click on the button *Set alignment points* and deactivate frames (you don't have to). Then, you can go to → *Settings*→ *Flat-field* (for a flat-field) or → *Settings* → *Dark frame* (for a dark frame) and select *Generate*. Following this, all the frames are averaged and converted to a flat-field or dark frame which can be saved afterwards.

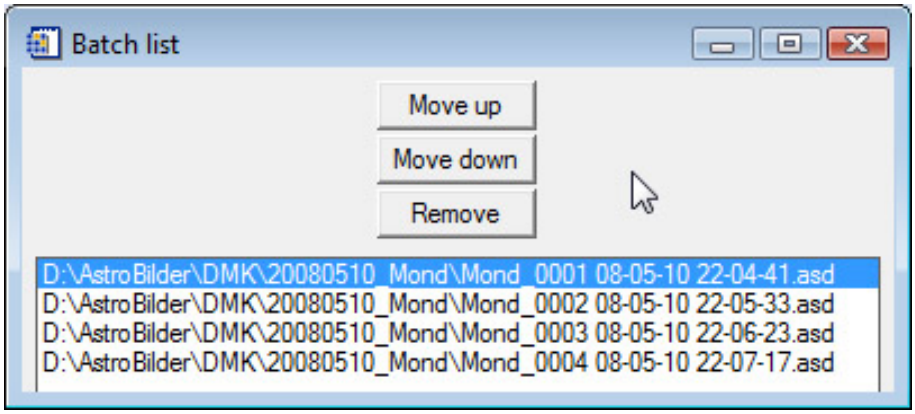

Figure 23: The batch list contains all files added to the batch.

5 Batch processing

If you have saved an AviStack data file (→ *File* → *Save data*) after the generation of reference points (procedure explained in *Steps 1* to *4*), you can use the file for batch processing.

It is mandatory to have completed *Step 4* (*set reference points*). Otherwise, an .asd-file cannot be used for batch processing!

Step 1 – Load data

First alternative: Load a single .asd-file and add it to the batch:

→ *File* → *Load data*

→ *Batch* → *Add data*

Second alternative: Load several data files at once (simply select more than one):

→ *File* → *Load data*

All these data files are then added to the batch and the batch list appears (Fig. 23).

There, you can modify the processing order (→ *Move up,* → *Move down*) and you can also remove files from the list (select it with the mouse → *Remove*).

In case you close the batch list window, you can open it again: → *Batch* → *Show list*

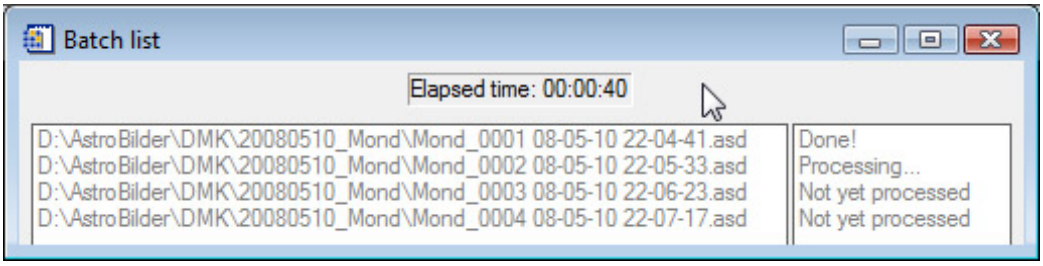

Figure 24: While batch processing is running the batch list shows the current progress.

Step 2 – Save a batch

This step is compulsory, though, sensible:

→ *Batch* → *Save*

A .asb-file is created and saved at the desired location.

That way you can save the batch list and continue at a later time:

→ *Batch* → *Open*

Step 3 – Start batch processing

If you have generated a batch list or you have loaded one, you can have it processed automatically:

→ *Batch* → *Start*

On the main display you can now follow each single processing step and also interrupt processing:

→ *Stop*

In the latter case you are asked whether or not you'd like to continue with the next file on the list or if you want to stop the batch processing.

You can also follow the progress in the small Batch list window (Fig. 24).

Each final result is automatically saved as fits. A suffix (_bp) is added to the file name to mark this file as batch processed. It is saved in the same folder as the .asd-file. E.g. Moon.asd becomes Moon_bp.fit.