Santa Barbara Instrument Group
1482 East Valley Road · Suite 31
PO Box 50437
Santa Barbara, CA 93150
(805) 969-1851

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Application Note
Flat Fielding Track and Accumulate Images

This application note gives the step by step procedure for flat field correcting images taken using the Track and Accumulate feature. The process is lengthy and the description in the manual is a little terse henceforth the need for this note.

Flat field correcting images allows the user to remove the effects of CCD response non-uniformity (typically less than a few percent) and optical vignetting which for some optical systems can be as much as a 50% effect from center to edge. The CCDOPS software allows flat field correcting images using the **Flat Field** command in the **Utility** menu, but some preparation must be made to use that command with Track and Accumulate images. Essentially you must prepare a special flat field correction image for Track and Accumulate images. This special preparation is necessary to have the same set of alignment and co-addition operations apply to the flat field file that have occurred in acquiring the Track and Accumulate image. In general, the following procedure should be followed when flat field correction of Track and Accumulate images is desired:

1. Take a normal flat field image using the **Grab** command in the **Camera** menu as described in the operating manual. You can use the dusk sky or a neutral gray or white card held in front of the telescope. Try to adjust the illumination and/or exposure so that the build up of light in the image yields values that when co-added several times will not overflow 65,000 counts. The number of times the image will need to be co-added without overflowing is set by how many snapshots you intend to use in Track and Accumulate. A good goal is to try and attain a maximum level in the flat field image of 1,000 to 2,000 counts which will allow co-addition 32 times without overflow. Note that you will have to take a new flat field image anytime you change the optical configuration of your telescope such as removing and replacing the camera in the eyepiece holder.

2. Save the flat field image on your disk using the **Save Image** command in the **File** menu. In the following discussions this flat field file will be referred to as FLAT.

3. Take your Track and Accumulate image using the **Track and Accumulate** command in the **Camera** menu and save it on the disk using the **Save Image** command in the **File** menu. In the following discussions this Track and Accumulate image file will be referred to as IMAGE.

4. Immediately after saving the IMAGE use the **Save Track List** command in the **File** menu to save the Track and Accumulate track list. The track list is a file that describes what alignment operations were done to the individual components of IMAGE to achieve the end result. In the following discussions this track list file will be referred to as TRACK.

5. Repeat steps 3 and 4 as many times as desired for all the objects you wish to image, each time choosing a set of corresponding new names for the IMAGE and TRACK files.

6. You will now create a combined flat field image for each Track and Accumulate image you captured. Invoke the **Add by Track List** command in the **Utility** menu. The software will present a dialog box asking for an offset parameter. Enter zero and the software will bring up a file directory dialog showing all the track list files. Select the TRACK file corresponding to the image you wish to correct. The software will load the TRACK file and present you with another file directory dialog showing all the images. Select the appropriate FLAT image. The software will align and co-add the FLAT image using the same operations it performed on the Track and Accumulate image. Finally save the combined flat field image using the **Save** command in the **File** menu. In the following discussions this combined flat field image will be referred to as COMBINED-FLAT. Repeat this step for each of the TRACK files using a corresponding name for the COMBINED-FLAT image.

7. You will now flat field correct the Track and Accumulate image with the combined flat field image. Use the **Open** command in the **File** menu to load the IMAGE file. Then use the **Flat Field** command in the **Utility** menu. The software will present you with a file directory dialog where you should select the corresponding COMBINED-FLAT image. After the software has finished correcting the image you can view the results and save the flat field corrected image with the **Save** command in the **File** menu. This image will be referred to as the CORRECTED-IMAGE file. Repeat this step for each of the IMAGE files using the corresponding COMBINED-FLAT image.

As a final topic for discussion, the offset parameter discussed in step 6 above can be adjusted above zero to take advantage of the maximum dynamic range of the image files. Just as the Track and Accumulate software removes a pedestal from the final image to allow the 16 bit dynamic range of the images to not be reduced due to a build up of sky background, the **Add by Track List** command can remove a fixed offset from each copy of the FLAT image as it is aligning and co-adding them. The optimal setting for the offset parameter is determined by measuring the background level in the FLAT images and using a value slightly below the background or minimum pixel value in the image. In this way the process of aligning and co-adding will not saturate due to high overall background conditions but only due to large variations in the FLAT image.