CCDBand-Aid

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CCDOPS is developed and maintained
By
Santa Barbara Instrument Group

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1. Introduction

CCDBand-Aid (CBA) is a program for removing the vertical bar pattern from images created with Kodak's KAI-11000M Series CCDs. By working with 32-bit floating-point FITS files, the program more effectively repairs the image than CCDOPS.

Program Highlights

- Using 32-bit floating-point data allows better repair of the vertical bars.
- With PixInsight files, the default format is assumed... that is with pixel values from 0.0 to 1.0.
- Works with images using the Effective or Active pixel array. That is 4032 x 2688 or 4008 x 2672 pixels respectively
- Not converting to 16-bit provides better processing after repairing the bars.
- The corrected images provide better detail, especially in the faint background.
- CCDBand-Aid can process multiple images.
- The user may manually enter a predetermined correction amplitude for typically noisy narrow band images.
- Double clicking on the answer grid column sorts the data by the selected column.
- On startup, the program checks for updates and any special messages from the developer.

2. How CCDBand-Aid Works

CCDBand-Aid uses the phase of the vertical bar pattern to examine the image and calculate the amplitude of the pattern. CBA then adds the amplitude value to all the pixels in the dark bars and saves the image. By working with 32-bit floating-point images, CBA more effectively repairs the vertical bars.

The CCDOPS program only works with 16-bit unsigned images. If the computed amplitude of the bars is near an integer value, the program very effectively repairs the image. However, if the amplitude is near 0.5 or 1.50, CCDOPS rounds the correction up or down to an integer. This produces a corrected image with a final amplitude of ~ 0.5. A bar amplitude of 0.5 may seem trivial, but after stretching an image, to show faint background galaxies, the vertical bars can become visible.

3. Initial Product Installation

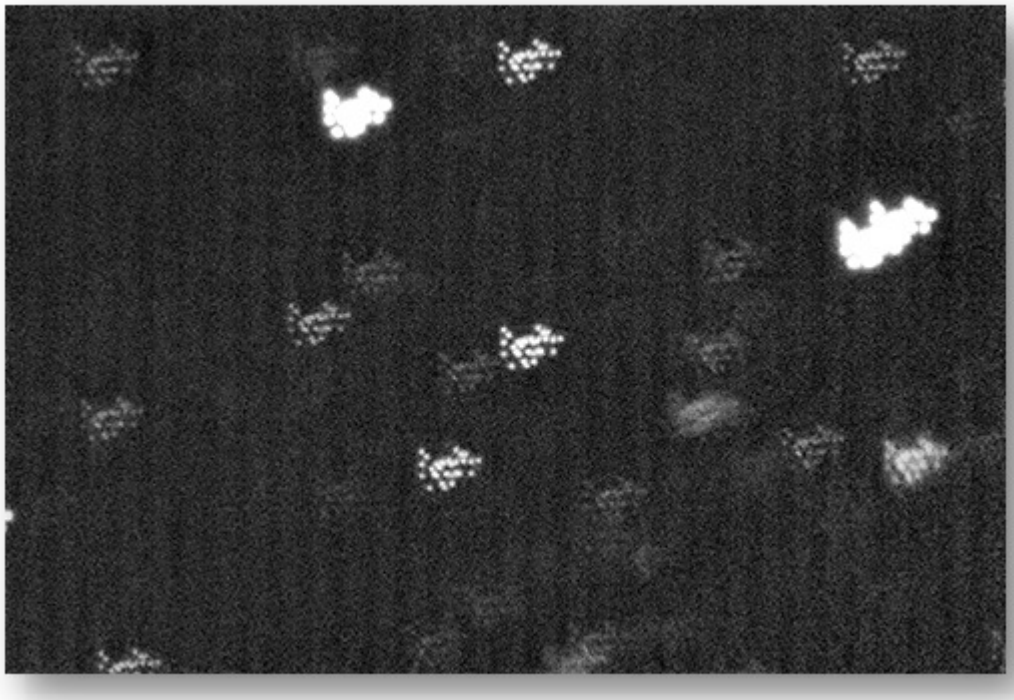
Simply download the installation zip file from URL http://bf-astro.com/ccdBandAid/ccdBandAid.htm. Unzip the file in the folder of your choice and create a shortcut for CCDBand-Aid.exe.

4. Determining the Vertical Bar Pattern Phase

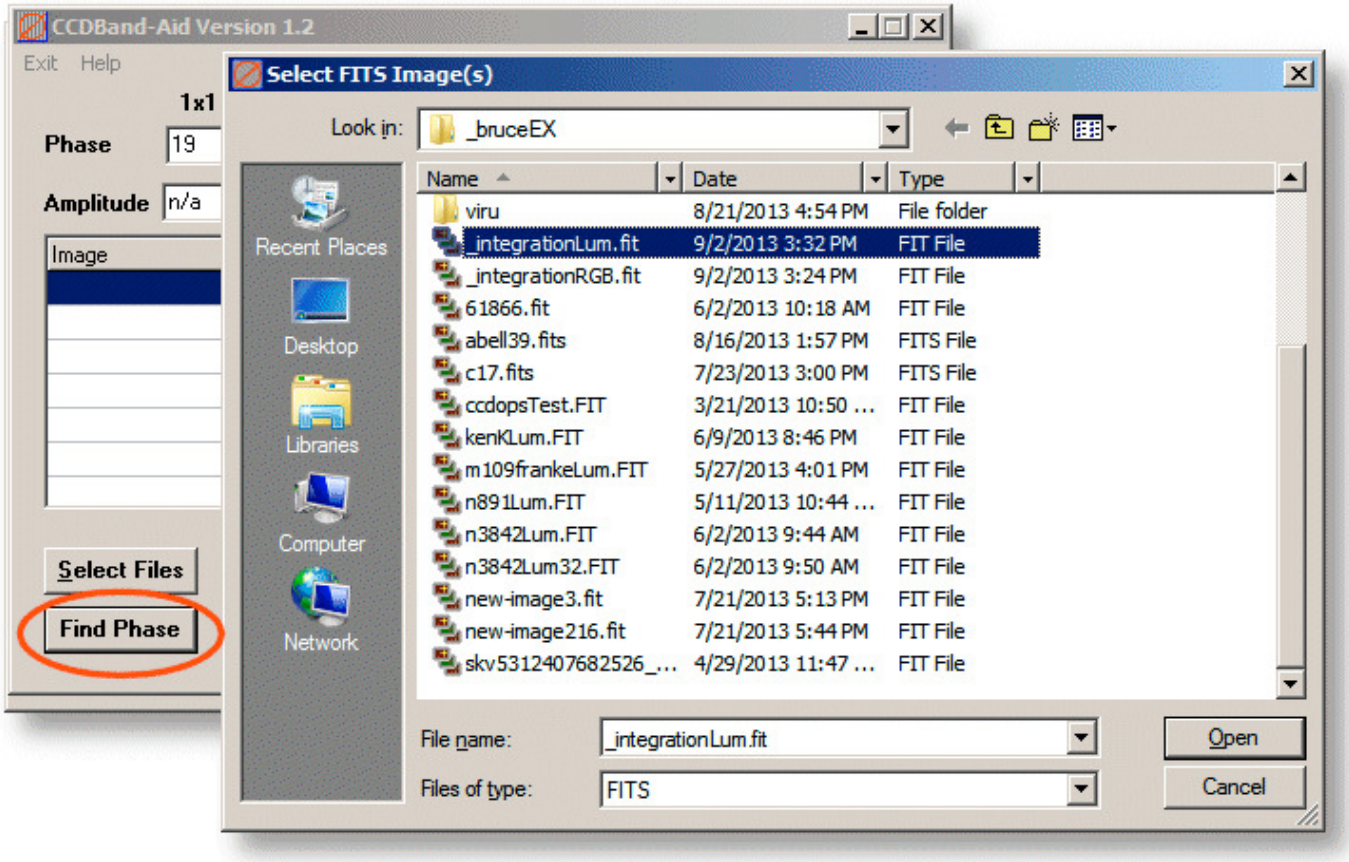
The phase ranges from 0 to Period - 1 and represents the first pixel that is brighter than the one to the left due to the vertical bar pattern. After establishing the phase, use it for correcting future images with that camera.

1. First, we must prepare an image to present data that are easy to analyze.
   - Use an image of a star field, away from the Milky Way, or a small galaxy. We want an image dominated with background.
   - Use images created with a low sensor temperature. As the CCD sensor temperature lowers the amplitude of the vertical bars increases. This makes phase analysis easier.
   - Use all of your calibrated sub exposures, the more the better, and do a mean combine. Do Not register the images. The below example uses 25 sub-exposures.
   - With RGB data, you may use all three color channels to increase the sub exposure count. If your software allows different weight schemes, use the average signal strength.
   - Finally, save the mean combined image as a 16-bit unsigned FITS. For consistency with CCDOPS, CCDBand-Aid only uses 16-bit unsigned files for phase analysis.

Here is a stretched partial view of a properly prepared image for phase analysis.

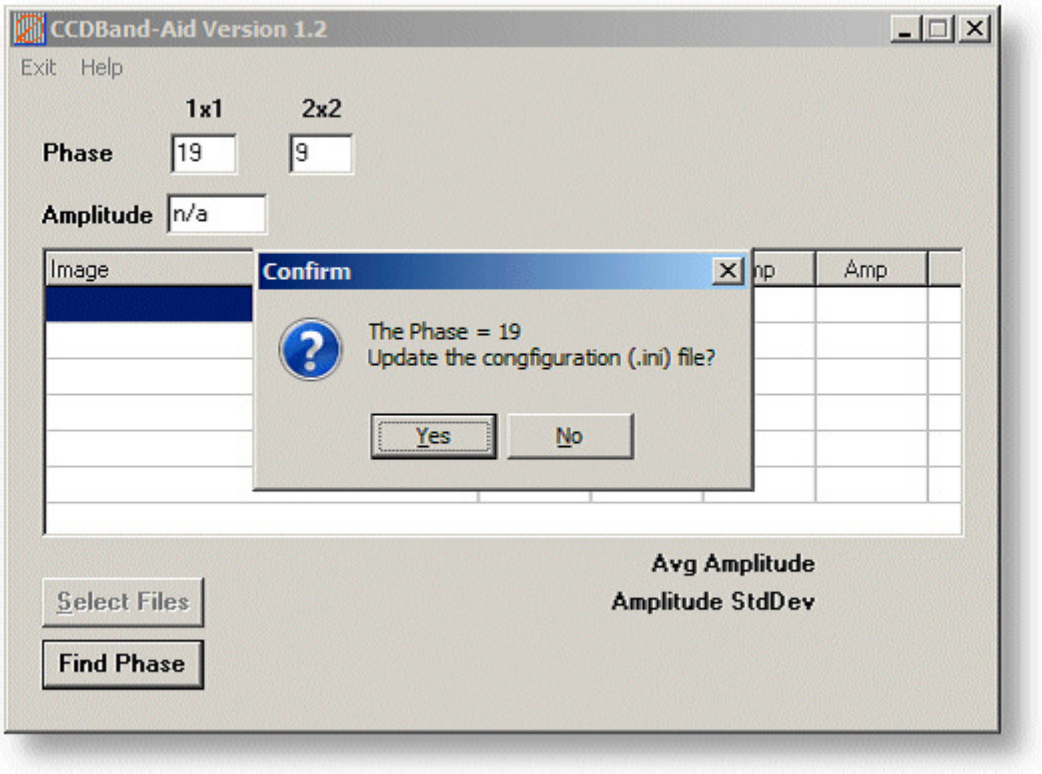


2. Execute CCDBand-Aid, click *Find Phase* and open the prepared mean combined image.



3. After a few seconds you should get a result similar to this. Click yes to update CCDBand-Aid's configuration file. It is suggested to repeat this process with two or three more images to confirm the result. The phase only needs to be determined once, so take the time to get it right.

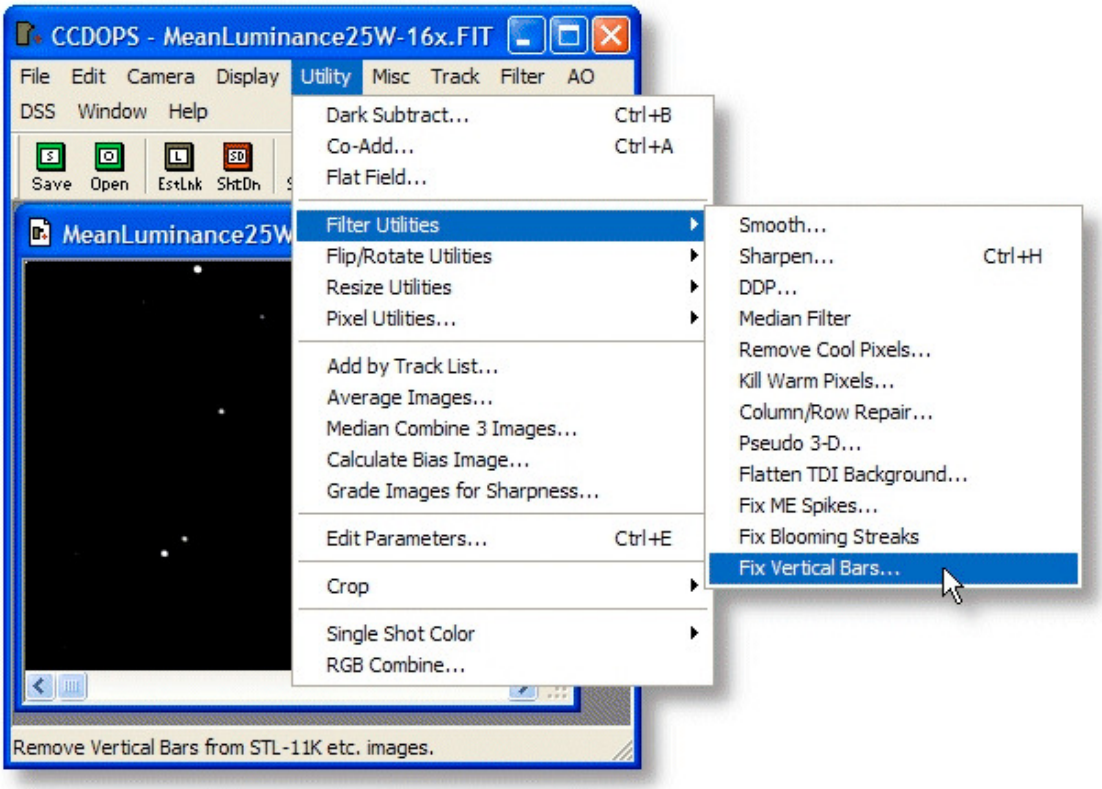
   For the Focal Pointe Observatory (FPO) camera, the phase is 19. Repeating the process with, a binned 2x2 image, gives a phase of 9. The two phase numbers vary from camera to camera, but remain constant for a given camera.



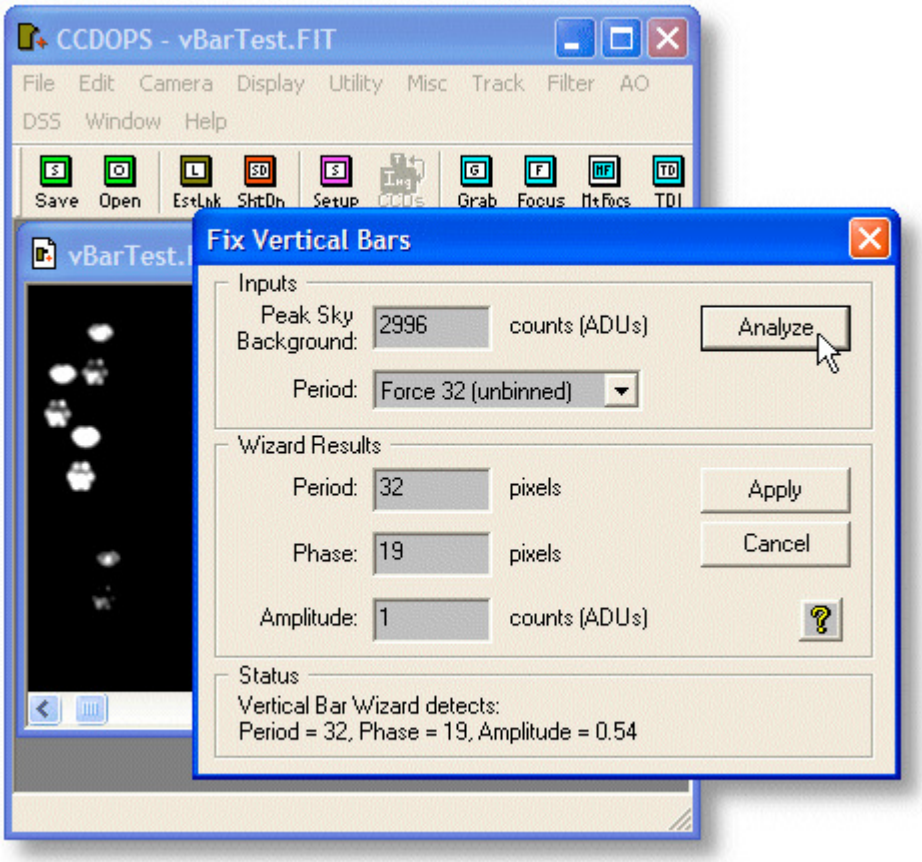
5. Using CCDOPS to Determine the Phase

Another option for phase determination is the program CCDOPS. This program has excellent routines and is useful to confirm the phase as determined by CCDBand-Aid.

1. Prepare an image as explained in section 4.
2. Execute CCDOPS, load the mean combined image and select *Fix Vertical Bars*.



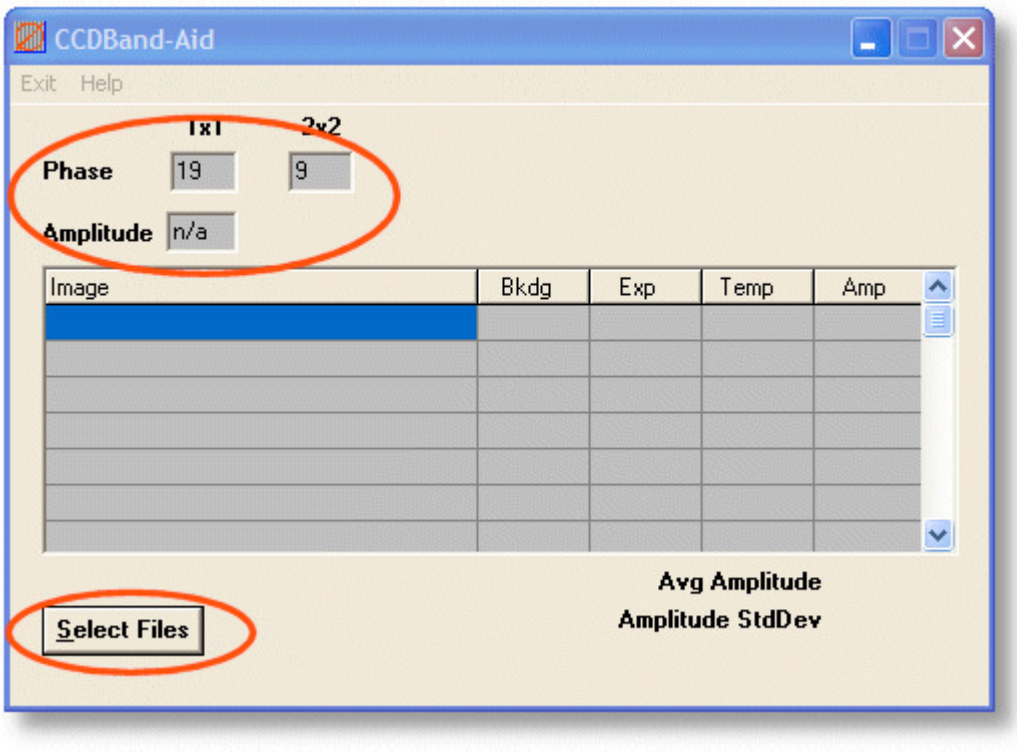
3. For unbinned images set the period to *Force 32 (unbinned)*. For binned images use *Force 16 (binned 2x2).* Do not use *Auto*, forcing the period gives better results. Finally, just click the *Analyze* button. Thanks to excellent programming, CCDOPS very quickly and accurately determines the phase of the bars. For the Focal Pointe Observatory camera, the phase is 19. Repeating the process with, a binned 2x2 image, gives a phase of 9. The two phase numbers vary from camera to camera. However, the phase remains constant for a given camera.



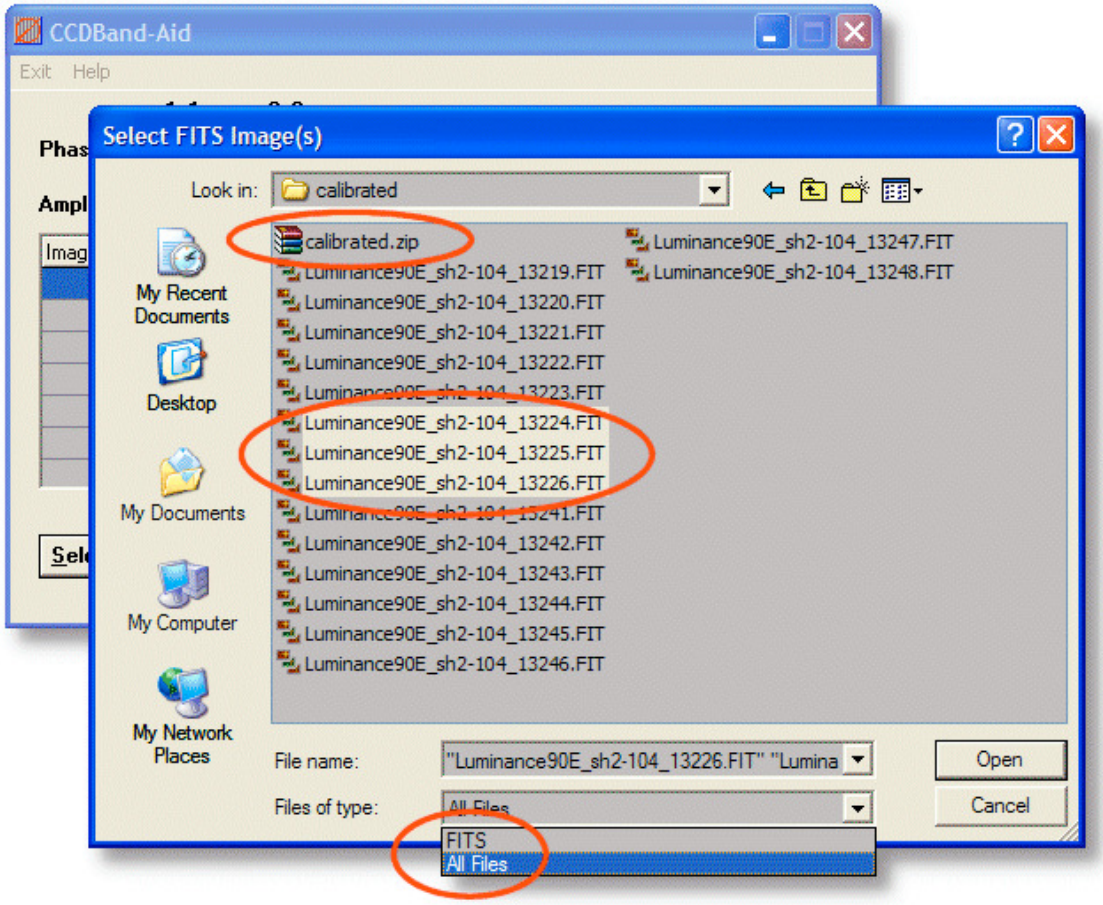
6. Using CCDBand-Aid

First, prepare your images. Calibrate and run any software for pixel clean up on all the sub-exposures. Do not register the images.

Before using CCDBand-Aid the first time, determine the phase for unbinned and 2x2 binned images. See sections 4 and 5 for instructions. Then start CBA and enter the two phase numbers in their respective textboxes. If you are using narrow band images, enter a predetermined amplitude. Otherwise leave the *Amplitude* textbox empty or enter "n/a". Then click the *Select Files* button.

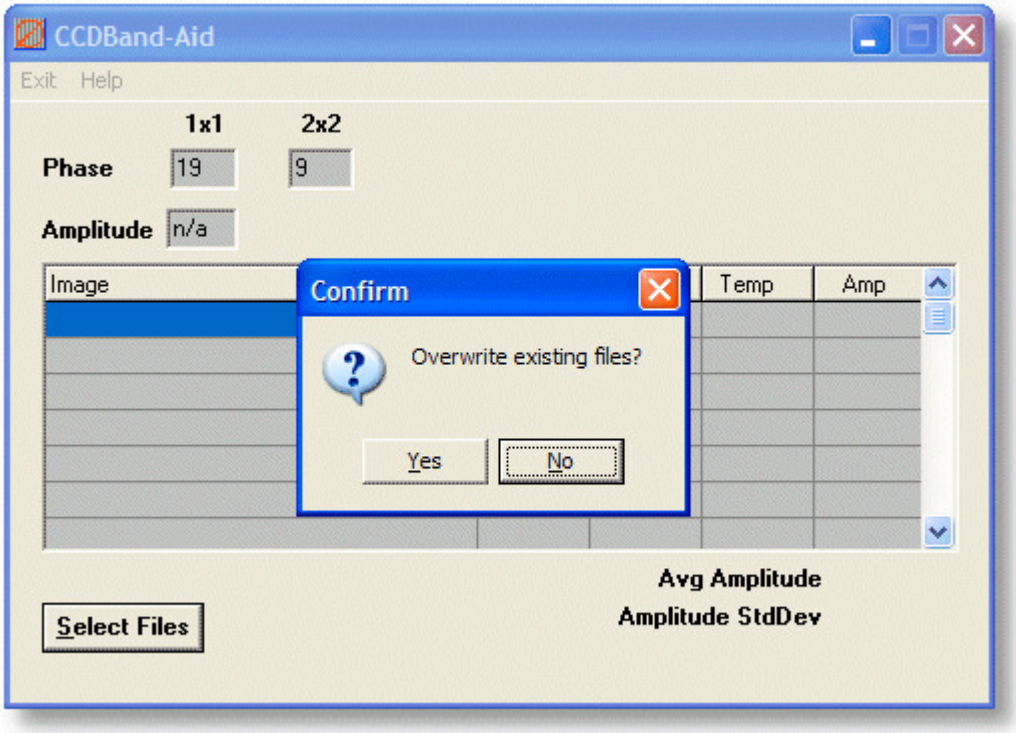


After clicking *Select Files*, CCDBand-Aid opens the Windows dialog box for selecting and opening files. This box has all the functions of Windows Explorer. You may choose file types, select files and even unzip an archive. Select the desired files and click the *Open* button.

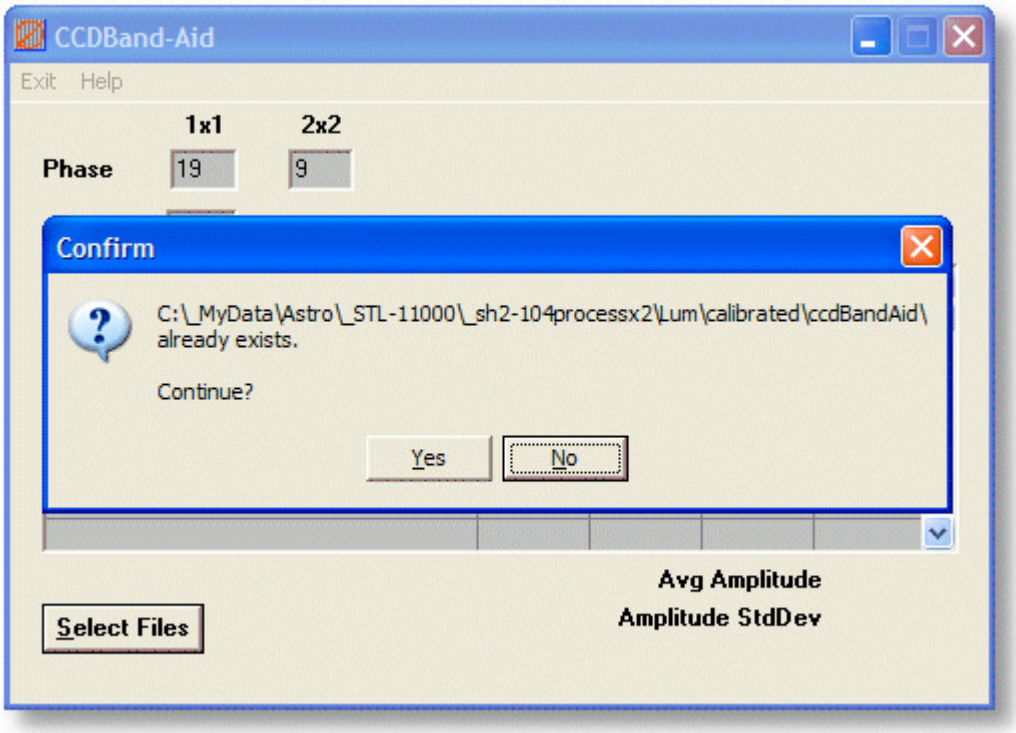


After selecting the files to process, CBA will ask one or two questions about over-writing files.

CBA first asks if you want to overwrite the selected files. Click *No* to tell CCDBand-Aid to create a new folder for the processed images.



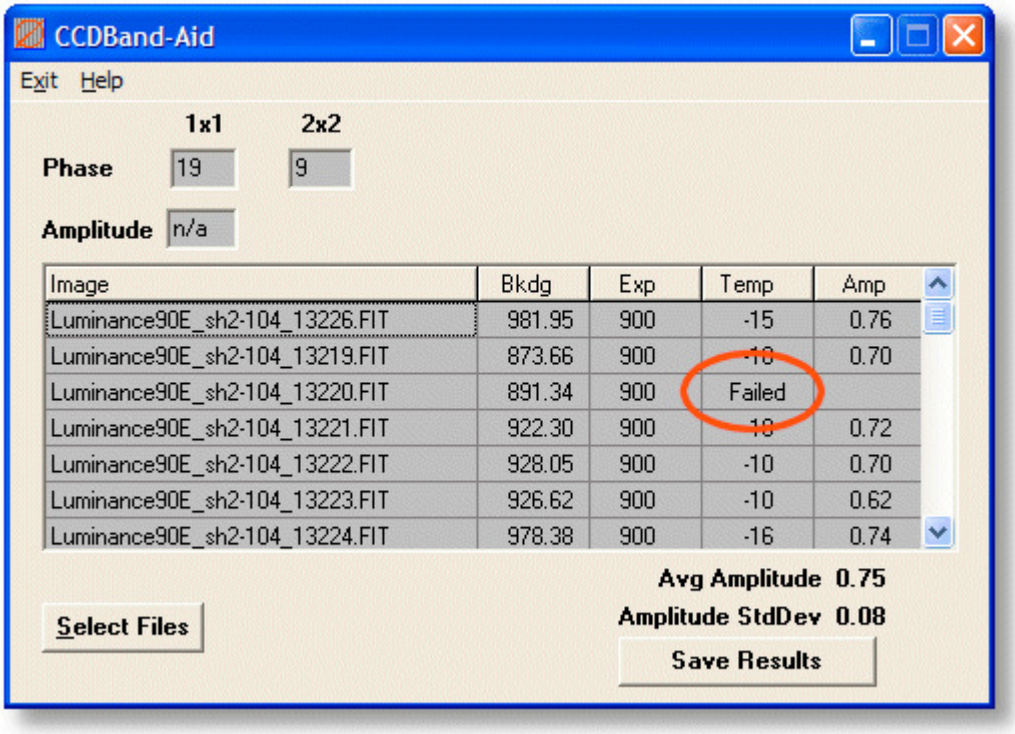
If a ccdBandAid sub-folder already exists, then CBA displays this message. Click *No* to stop the process.



After awhile, about 10 seconds per unbinned image, your CCDBand-Aid window should look as shown below.

Using a registered image is the usual reason for a failed repair with wide-band images.

Clicking the *Save Results* button appends the data to the ccdbandaid.csv file. This file is located in the same folder as ccdBandAid.exe. If you have Excel or OpenOffice Calc, double-clicking ccdbandaid.csv should load the file into a spreadsheet. If only one file is processed or the *Amplitude* textbox is used, the *Save Results* button remains hidden.

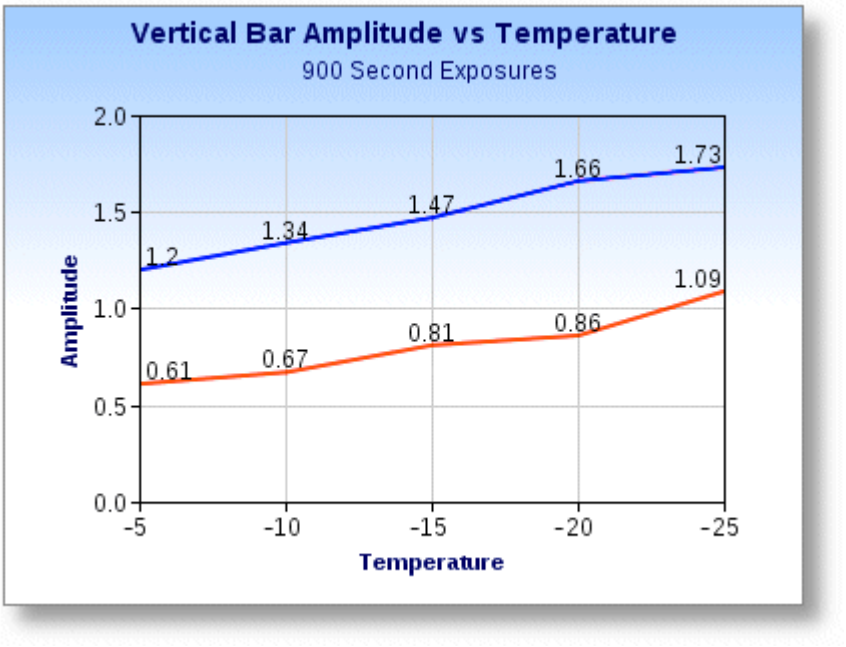


7. Analyzing the Data

The Focal Pointe Observatory Data

The below graph reveals some interesting information about the nature of the vertical bars. The blue line is with 2x2 binning and the red is 1x1. The data source is nearly two years of exposures from the FPO, with over 1700 data points, saved to a CSV file with CCDBand-Aid.

The slope of the two lines is similar and the data are nearly linear. The 2x2 data are especially linear. Changing the -20 degree data-point to 1.61 makes the line almost perfectly straight. Individual cameras will have different band amplitudes. However, the relationship between 1x1 and 2x2 binning will probably be similar to the below graph.



The FPO data also suggest that shorter exposures produce images with lower band amplitudes. Unfortunately, there were not enough data points to attempt showing proof by plotting exposure vs. amplitude at a specific temperature. Dark and flat frames further support this assumption. Although darks are long exposures, light-wise they are an exposure of zero duration.

Why Analyze the Data?

Both CCDBand-Aid and CCDOPS usually fail to properly analyze and correct narrow-band (NB) images. Even with 30-minute exposures, NB images are noisy. This noise tends to mask over the low-level data, effectively hiding the bars from the software. This may also explain why the amplitude of the bars is lower at warmer CCD temperatures. The warmer the CCD, the more the noise.

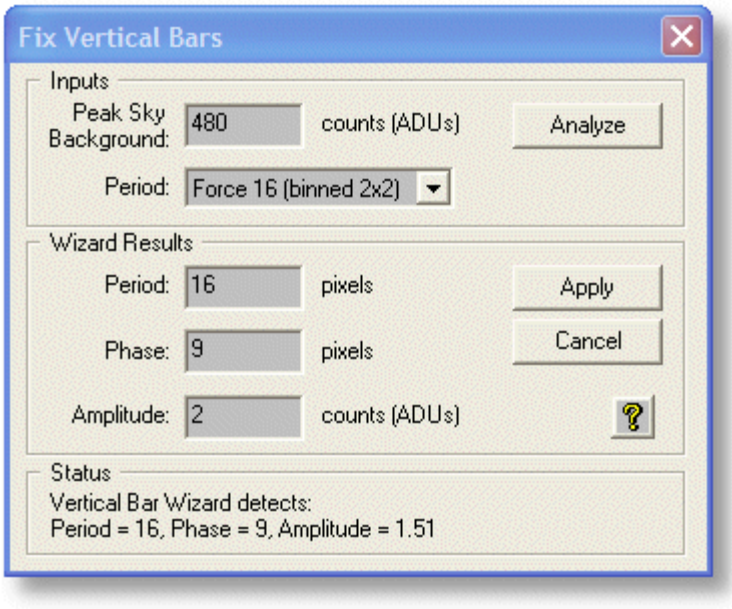
With a good database of previously determined amplitudes, it is possible to make an intelligent estimate for repairing narrow-band images. For unbinned, -15 degree, 900-second exposures the FPO camera bar correction is about 0.81. This number may also work with 30-minute exposures.

7. CCDBand-Aid vs. CCDOPS

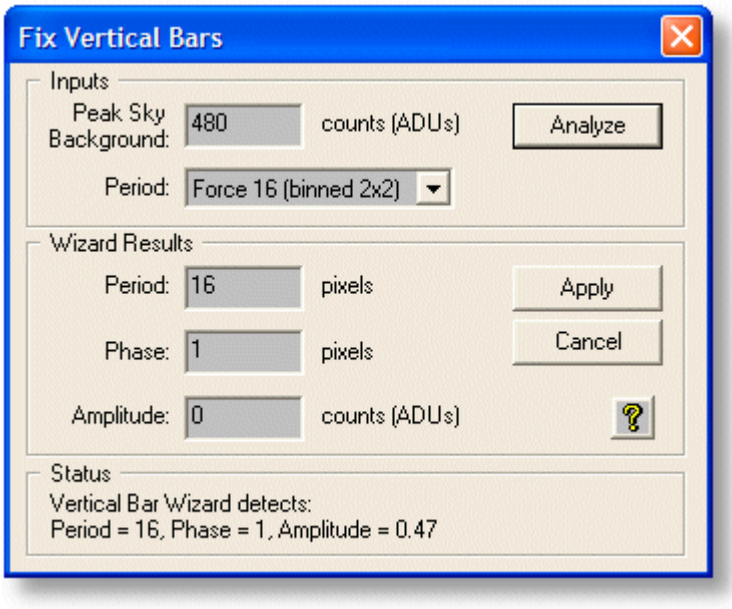
This section uses a group of nine dithered images, binned at 2x2.

CCDOPS Test

A mean combine, with no registration, produces this CCDOPS result. Note that CCDOPS rounded the 1.51 amplitude up to the integer 2.



After clicking *Apply*, saving and reloading CCDOPS gives the below analysis. CCDOPS reversed the phase... the light bars are now the dark. The amplitude is 0.47, nearly equal to (2 - 1.51). Subtracting 2 from the bright bars is an over correction of about 0.49.

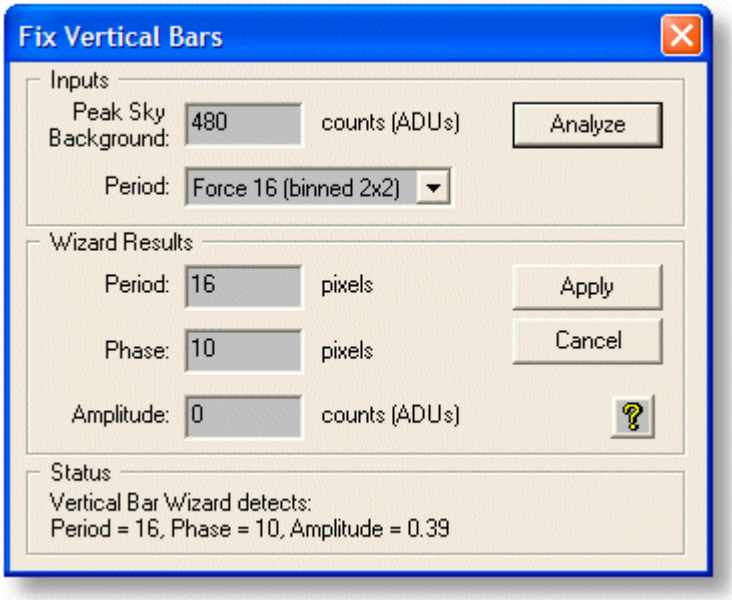


CCDBand-Aid Test

The 32-bit floating-point versions of the 9 sub-exposures were mean combined and repaired with CCDBand-Aid. The result was saved as a 16-bit unsigned FITS for CCDOPS analysis. The below image shows the CCDOPS result.

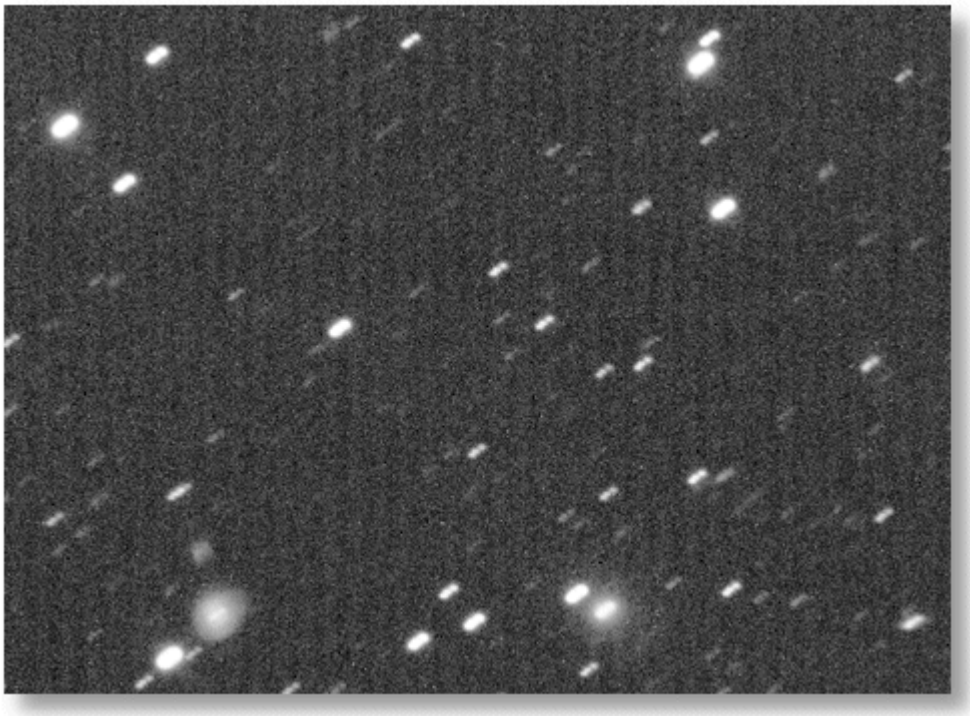
In this case, CCDBand-Aid and CCDOPS were unable to correctly determine the phase, making the amplitude answer invalid. The phase should be one or nine. Running the 32-bit version back through CCDBand-Aid shows amplitude of 0.0. CCDBand-Aid reduced the bands amplitude to a level that makes the bar phase undetermined or no longer correct..

Now, the only possible proof is in viewing the before and after images on the next page.

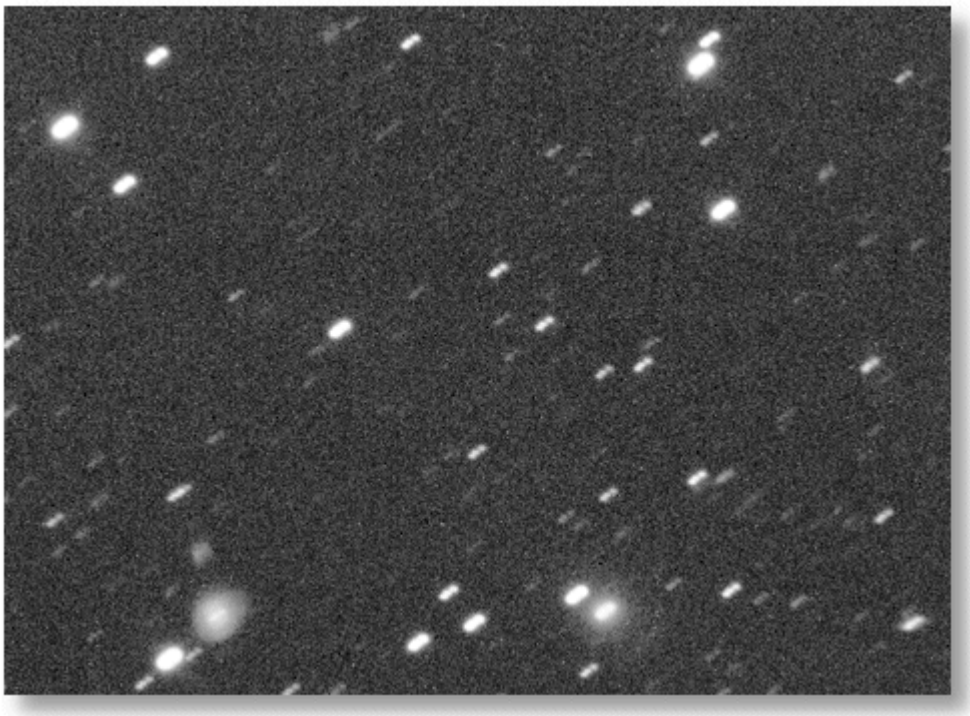


The processing for the following two images is identical.

Without CCDBand-Aid repair



With CCDBand-Aid repair



9. Revision History

***Version 1.25* Sept. 23, 2013**

Bug Fix... The PixInsight algorithm is revised to avoid divide by zero errors.

***Version 1.2* Sept. 14, 2013**

- The program now has a routine to determine the vertical bar phase.
- CCD Band-Aid can now process PixInsight 32-bit floating-point files. The default format is assumed... that is with pixel values from 0.0 to 1.0.

***Version 1.1* June 2, 2013**

The program is now considered for use with any manufacturer's camera. The camera may use the Effective or Active pixel array. That is 4032 x 2688 or 4008 x 2672 pixels respectively.

10. Disclaimers, and Copyright

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CCDBand-Aid is provided as-is, and although I will attempt to make changes and fixes as they become necessary, I provide no guarantees about its suitability for any purpose whatsoever.

…Bob Franke

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