eXcalibrator User Documentation

by

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(http://bf-astro.com)

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Table of Contents

1. Introduction 2

What is eXcalibrator? 2

What eXcalibrator is Not 3

eXcalibrator Program Highlights 3

2. Initial Product Installation 3

Current Limitations and Requirements 3

eXcalibrator Program Installation 4

3. Performing an Image Calibration (Program Workflow) 5

Summary of Program Workflow 5

Details of Program Workflow 5

i) Save Your Images 5

ii) Plate Solve Your Image 5

iii) Initial Data Input in eXcalibrator 6

iv) Set Your eXcalibrator Options 8

v) Perform the Calibration Calculation 12

vi) Dealing With Slow Downloads 13

vii) Do Post-Calibration Adjustments 14

viii) Manual Calibration 17

4. Using SExtractor 18

What is SExtractor? 18

How eXcalibrator Uses SExtractor 18

The SExtractor Workflow 18

5. Calibrating The Initial RGB Exposures 21

Why Calibrate? 21

How to Make Corrections 21

Enter eXcalibrator 21

The eXcalibrator Image-Train Calibration Work Flow 21

Example Results 21

6. Maintaining A Running Average Of The Results 22

Why Do It? 22

How To Do It 22

7. Creating an RGB Image With eXcalibrator (Program Workflow) 26

8. Troubleshooting 29

9. Ongoing Program Maintenance 30

10. Revision History 31

11. Thanks, Disclaimers, and Copyright 33

1. Introduction

What is eXcalibrator?

eXcalibrator provides an easy means to white balance astrophotos by computing RGB correction factors based on known star color. This method uses star color information from the Sloan Digital Sky Survey (SDSS) or The AAVSO Photometric All-Sky Survey (APASS) database. eXcalibrator uses data in the astrophotographer's final R, G and B FITS files!

Additionally, eXcalibrator is an excellent tool for color calibrating an image-train. This is similar to the long-established G2V method. Except, eXcalibrator produces more consistent night-to-night results. See sections 5 and 6.

A Word About Other White Balance Methods:

The astrophotographer may choose several other options to determine color balance:

- Use G2V stars to calibrate the R, G & B exposures. Although popular, this method has two drawbacks.
  1) Extinction for objects at low altitude causes a problem for all color channels... especially the blue. The problem varies at different altitudes. This makes automatic adjustment difficult.
  2) Bad (variable) transparency: G2V calibration does not compensate for color shifts induced by bad transparency.
- Use the integrated light of a face-on spiral galaxy. This method shows a galaxy with its intrinsic color. If there is galactic or intergalactic extinction, the galaxy and foreground stars are too blue.
- Use the collective light of a star field.
  - Use this method with caution as the general star population is skewed towards the red end of the spectrum.
  - This technique can produce good results with globular clusters, if there is no galactic extinction.
- Simply set the background to a neutral gray. Of course, this will not work with an image completely dominated by a nebula.
- Just wing it by comparing to other images on the Internet.

The Underlying Idea:

Peter Riepe and Harald Tomsik, published in the German magazine 'VdS-Journal' base the idea behind the eXcalibrator approach on two articles. The goal is to make those G2 stars not affected by interstellar extinction, white.

Typical exposure times of object images often run so long that all nearby bright G2 stars become saturated and unusable for color calibration. The unsaturated G2 stars in the image are often faint and we have little or no information on these stars, so we usually cannot search for them successfully. With luck, we can identify a faint unsaturated G2 star, but then interstellar extinction may affect this star and ruin the color balance.

It makes sense to turn towards photometry. Several databases on the Internet catalog the flux of a huge number of faint stars measured through different broadband filters. The most important filter system is the Johnson UBVRI system; where U stands for Ultraviolet, B for Blue, V for Visual (Green), R for Red and I for infrared. For the purposes of color calibration, we focus only on the B, V and R data.

The difference between B and V gives us the “B-V color index," which characterizes the color of the star. A G2 star displays a B-V value of 0.65mag. Red stars have B-V values above 0.65, while blue stars show below 0.65. The difference between V and R builds a further color index. The typical value of V-R of a G2 star in the Johnson filter system is 0.52mag. The Johnson UBV filters are used with the Cousins RI filters rather than in combination with the Johnson RI filters. This usage leads to the Johnson-Cousins color index V-RC = 0.36mag of a G2 star.

For color balance purposes, all of this is useful information.

What eXcalibrator is Not

eXcalibrator is not a scientific photometric tool. It is an aid for the amateur astrophotographer, to consistently obtain reasonably correct color in "pretty pictures." This can be especially useful for those with color vision problems.

eXcalibrator Program Highlights

- Version 2.0 includes SExtractor for greater accuracy. See Section 4 for complete details.
- eXcalibrator may select 100's of appropriate stars within your image to perform its calibration.
- Version 3.0 includes a Linear Regression routine that can use almost any color star. This greatly increases the number of useful stars and provides a more accurate calculation. For more information see URL... http://bf-astro.com/eXcalibrator/LinearRegressionApproach.pdf
- Version 4.0 is faster, easier and fully automatic.
- Version 5.0 provides nearly full-sky coverage for both the northern and southern hemisphere.
- As an alternative to color calibrating the image train, eXcalibrator can keep a running average of the results for multiple telescopes. See section 6 for further details.
- You may select a magnitude range to eliminate the use of over-saturated stars.
- eXcalibrator automatically adjusts the aperture size for each star, or the user may manually select a size to use with all stars.
- eXcalibrator normalizes the star's R, G & B flux values by subtracting the local background level.
- eXcalibrator excludes duplicate and stars with small separation from the calculation.
- When you manually exclude stars from the calculation the program automatically recalculates.
- A simple statistical analysis includes the Standard Deviation (StdDev) and RMS average.
- A single click removes statistical outliers... again with auto recalculation.
- A user-adjustable "dead zone" border eliminates stars without complete RGB data, due to dithering.
- The user can set the window position to "Always On Top," making the program always visible.
- On closing, the program saves the current settings.
- If necessary, eXcalibrator provides a form for a manual calibration.

2. Initial Product Installation

Current Limitations and Requirements

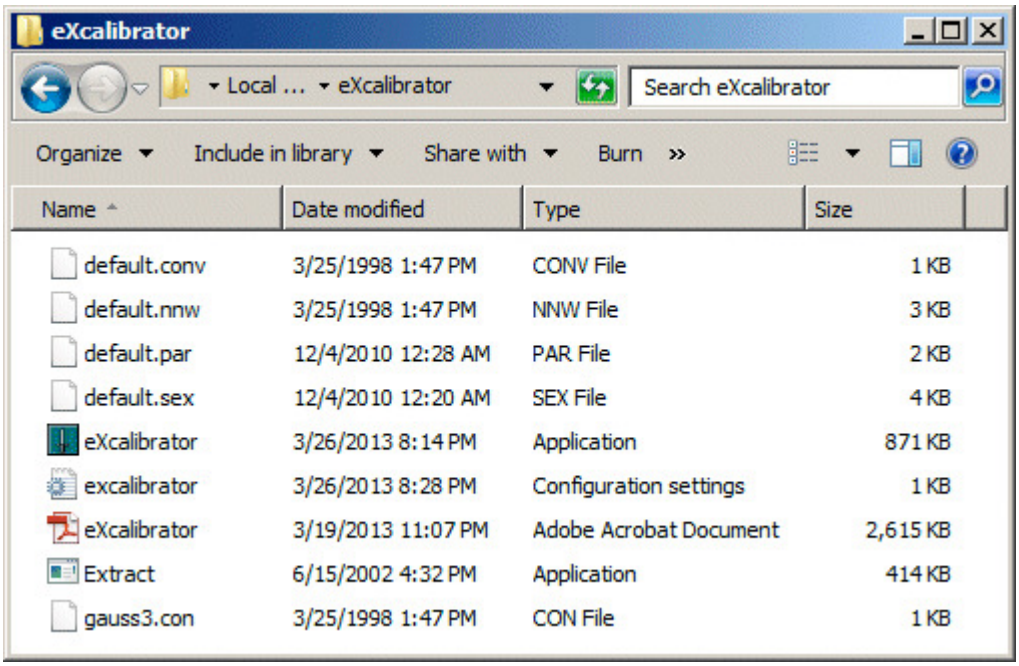
- This is a Windows XP (or higher) based program.
- Save the R, G and B FITS images in 16-bit signed, 16-bit unsigned, 32-bit float, or 32-bit integer formats. Next, plate solve one of the Red, Green, Blue or Luminance channels, in order to insert World Coordinate System (WCS) data. The WCS data must include the following keywords in option A and or B...as shown below:

Option A	Option B
BITPIX	BITPIX
BZERO, BSCALE (16-bit only)	BZERO, BSCALE (16-bit only)
NAXIS1,NAXIS2	NAXIS1, NAXIS2
CRPIX1, CRPIX2	CRPIX1, CRPIX2
RPIX1, CRPIX2	CRPIX1, CRPIX2
CD1_1, CD1_2	CDELT1, CDELT2
CD2_1, CD2_2	CROTA1, CROTA2
CRVAL1, CRVAL2	CRVAL1, CRVAL2
CTYPE1, CTYPE2	CTYPE1, CTYPE2

eXcalibrator Program Installation

Simply download the eXcalibrator program from (http://www.bf-astro.com/eXcalibrator/eXcalibrator.htm), and unzip the contents into a folder of your choice.

Then create an Icon for eXcalibrator.exe and place it on the Window's Desktop.



3. Performing an Image Calibration (Program Workflow)

First, a quick note about the use of the word "calibrate" in this document. "Calibrate" usually refers to the process of computing the white balance. Hence, the program name… eXcalibrator. Sections 5 and 6 use "calibrate" correctly.

Summary of Program Workflow

Use eXcalibrator or G2V calibrated exposures or color-balanced filters. See sections 5 and 6.

In summary, you will:

1. Save your registered R, G and B images in either a 16 or 32-bit FITS format.
2. Do a plate solve on any one of the registered images, to add WCS data; and then resave the file to ensure saving the data into the FITS header.
3. Start eXcalibrator and select your R, G, B and WCS FITS files.
4. Set Your eXcalibrator Options
5. Click the “Calibrate Image” button to generate initial calibration factors.
6. Dealing with slow downloads.
7. Do Post-Calibration Adjustments (if necessary)
8. Enter the calibration values into your favorite image-processing program.

Details of Program Workflow

i) Save Your Images

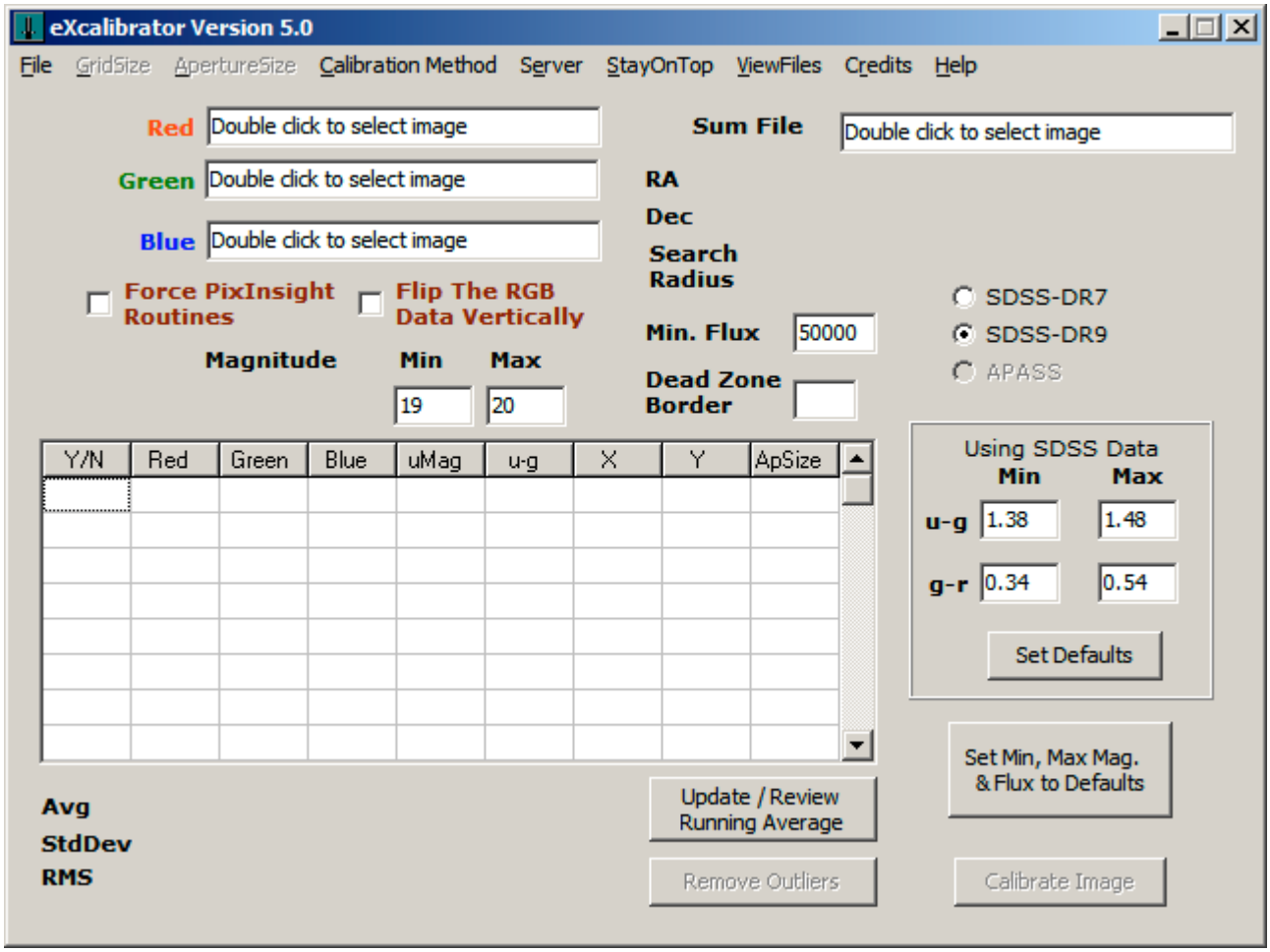
- Save your registered R, G, B images and a WCS or Sum file in either a 16 or 32-bit FITS format. Optionally, one of the R, G or B images may serve as the WCS file.
- Save the three color files at the same bit level.
- The bit level of a separate WCS, or Sum File, may differ from the color files.

ii) Plate Solve Your Image

- With CCDSoft and TheSky6, use any registered image to perform a WCS plate solve.
- Use TheSkyX Image Link.
- In MaxIM DL, you can use the included PinPoint LE engine or the full version of PinPoint to accomplish the same thing.
- With PixInsight
  - If the WCS file is plate solved with PixInsight, then the R, G and B files should be separate and not plate solved. If all three color files are plate solved with PI, then one of them may be used as the WCS file.
  - If one of the three color files is plate solved with other software, that image may be used as the WCS file.
  - For complete details see URL… http://bf-astro.com/eXcalibrator/excalPixInsight2.htm.
- The shareware program Astrometrica at URL http://www.astrometrica.at/ .
- The free online service at URL... http://nova.astrometry.net/ .

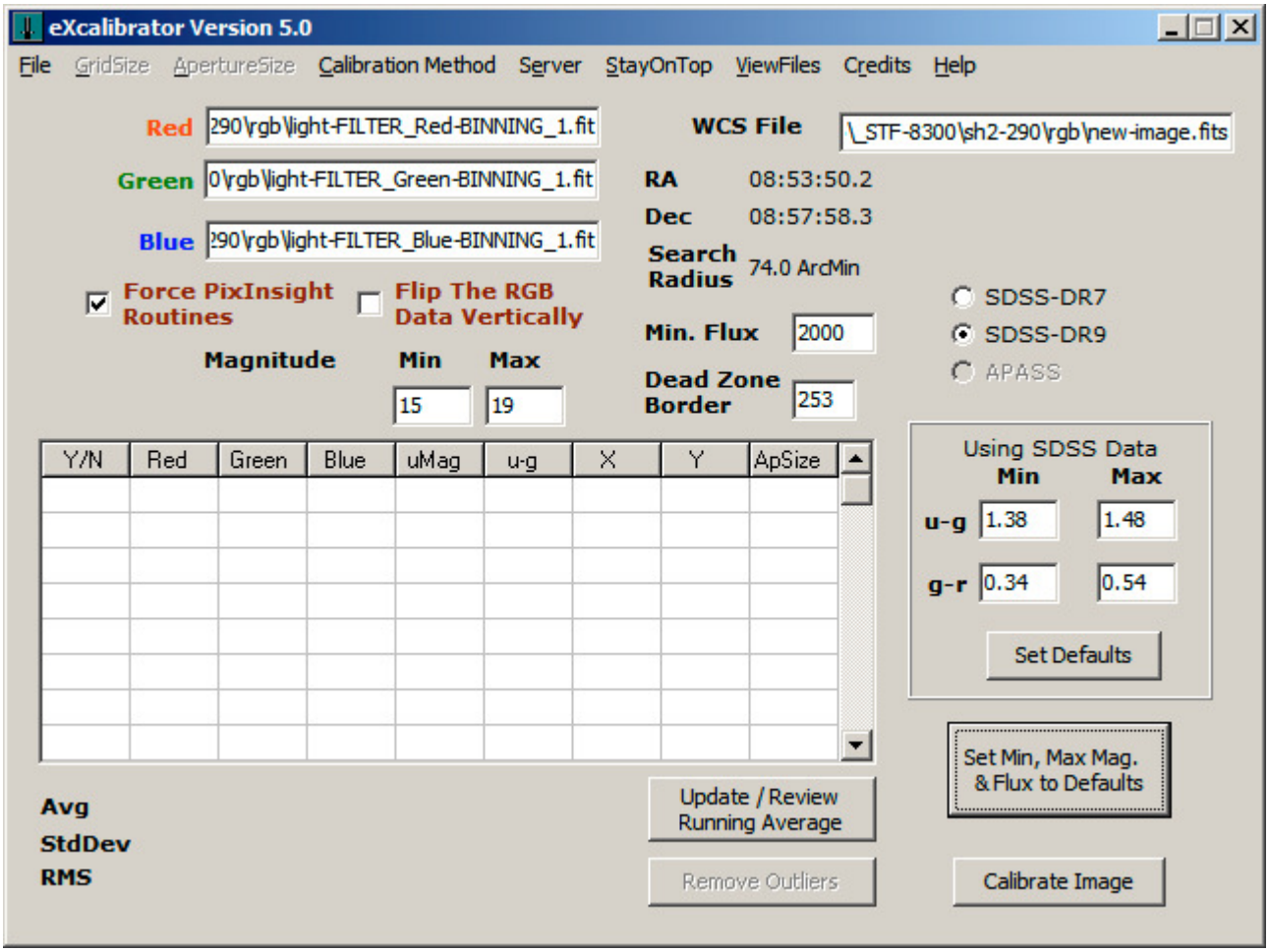
iii) Initial Data Input in eXcalibrator

- Execute or open eXcalibrator and you see the following screen:



- Double click on the WCS File text box and select the plate-solved image.
  - Use any file registered with the three RGB images. Load a luminance image, if you have one, as it is the easiest to plate solve.
  - Lowering the bit level to 16, may make plate solving easier. This way, a 16-bit file can be loaded in the WCS File text box, while using 32-bit files in the Red, Green and Blue boxes.
- Double click on the Red text box to select all three R, G & B files, (it may be necessary to select the files individually). The File Open Dialogue window uses standard Window's file selection methods.
  - If you open all three images from the Red text box, eXcalibrator tries to determine the filter colors and allocates each appropriately. (Opening the files from the Green or Blue text boxes does not do this... the user must make the correct color choice.)

Here is the result:

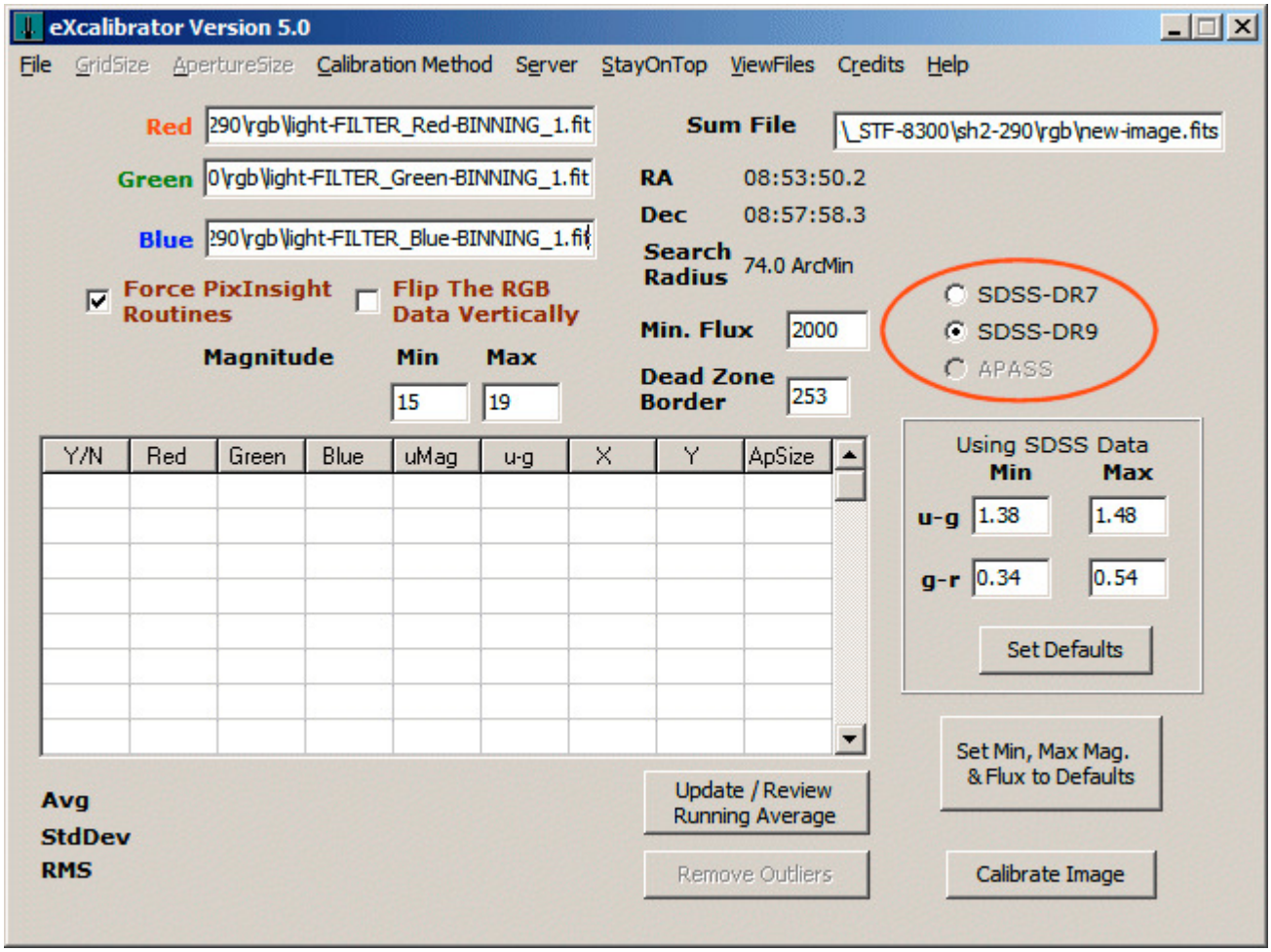


iv) Set Your eXcalibrator Options

Select The Star Catalog

The relatively new APASS catalog is slightly less accurate than the SDSS. Unfortunately, the very accurate SDSS data only cover 25% of the sky. Always try the SDSS-DR9 first and then the DR7.

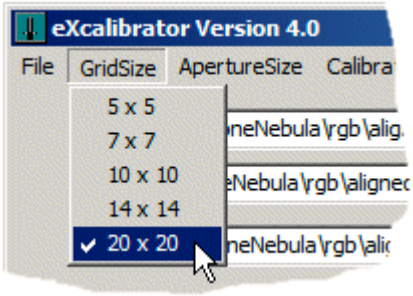
If the SDSS data fail, the APASS catalog usually returns good stars. This selection is limited to the Linear Regression routine as the survey only uses the Sloan g' and r' filters.



GridSize

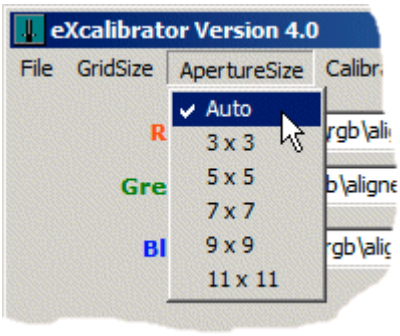
This item sets the number of sections in the local background grid... 20x20 creates 400 sections. For cameras with small chips, 5x5 or 7x7 grids may work better.

Using SExtractor or Linear Regression disables GridSize selection.



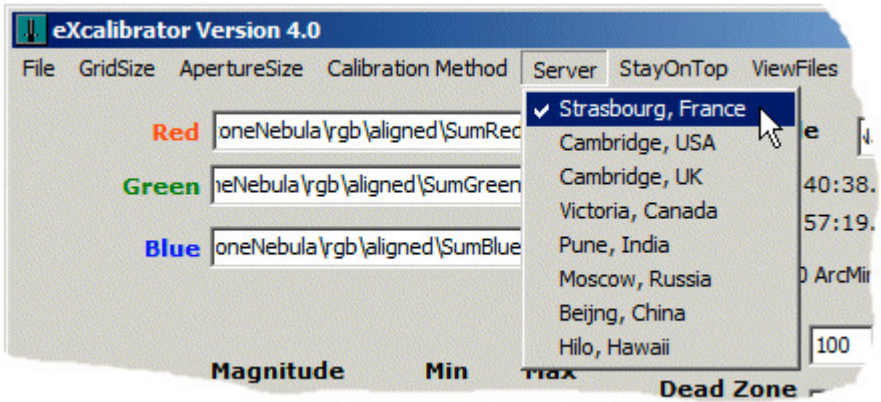
ApertureSize

"ApertureSize" sets the size, in pixels, of the square grid used to compute the average flux for each star. eXcalibrator selects the best size for each star when the user selects "Auto." Otherwise, eXcalibrator applies the user's choice to all stars. Using SExtractor or Linear Regression disables the ApertureSize selection.



Server

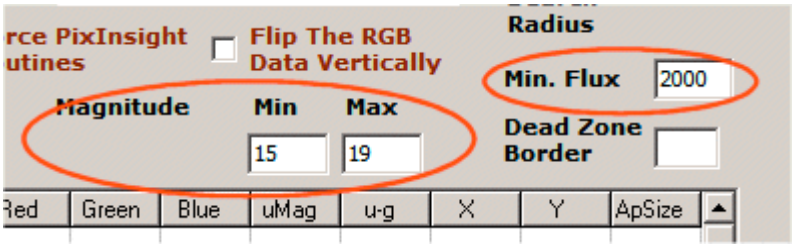
Select the country of origin for the database server. Testing seems to indicate that the French server is generally the most reliable and fastest. The user may experience better results with a geographically closer server.



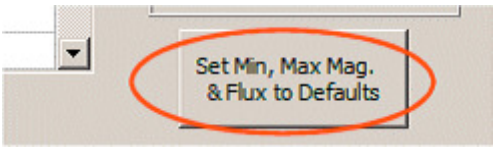
Min. , Max Magnitude & Min. Flux

Min and Max Magnitude sets the values to use in the downloaded SDSS or APASS data. The default is 15 & 19 for SDSS data, and 11 & 16 for APASS.

Min. Flux is the minimum useable brightness for a star in the red, green or blue image. The default value is 125 for eXcalibrator Classic, 2000 for SExtractor & Linear Regression w/ SDSS data and 10,000 with the APASS data.

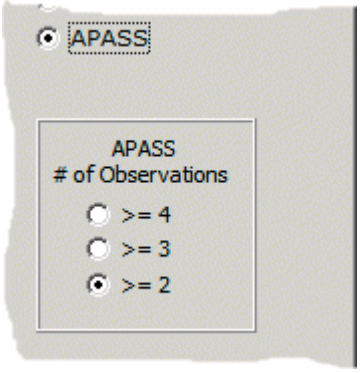


There is a button to reset these three values to the defaults.



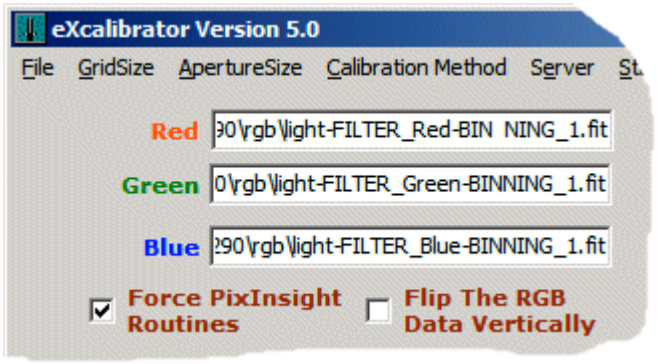
APASS # of Observations

Data with higher observation counts are more accurate but are also less available. By using a lower number of observations, eXcalibrator will find a larger number of usable stars. Although these data are less accurate, they often average out to a very good white balance solution.



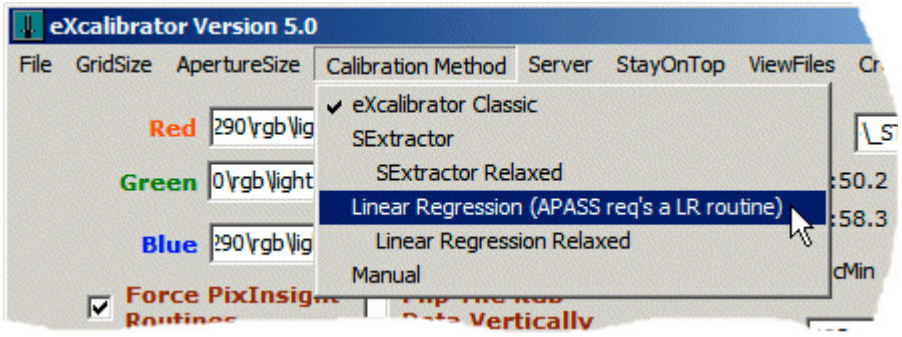
Special Selections For PixInsight Images

- **Force PixInsght Routines:** By default, PixInsight scales data from 0.0 to 1.0. eXcalibrator has special routines for this. If PI files are not correctly recognized, the user may force the use of these routines.
- **Flip The RGB Data Vertically*:*** PixInsight plate solved images display flipped vertically. This may not agree with the three color files. Checking this box tells eXcalibrator to flip the color files. If in doubt, try it both ways. The correct choice returns more usable stars.



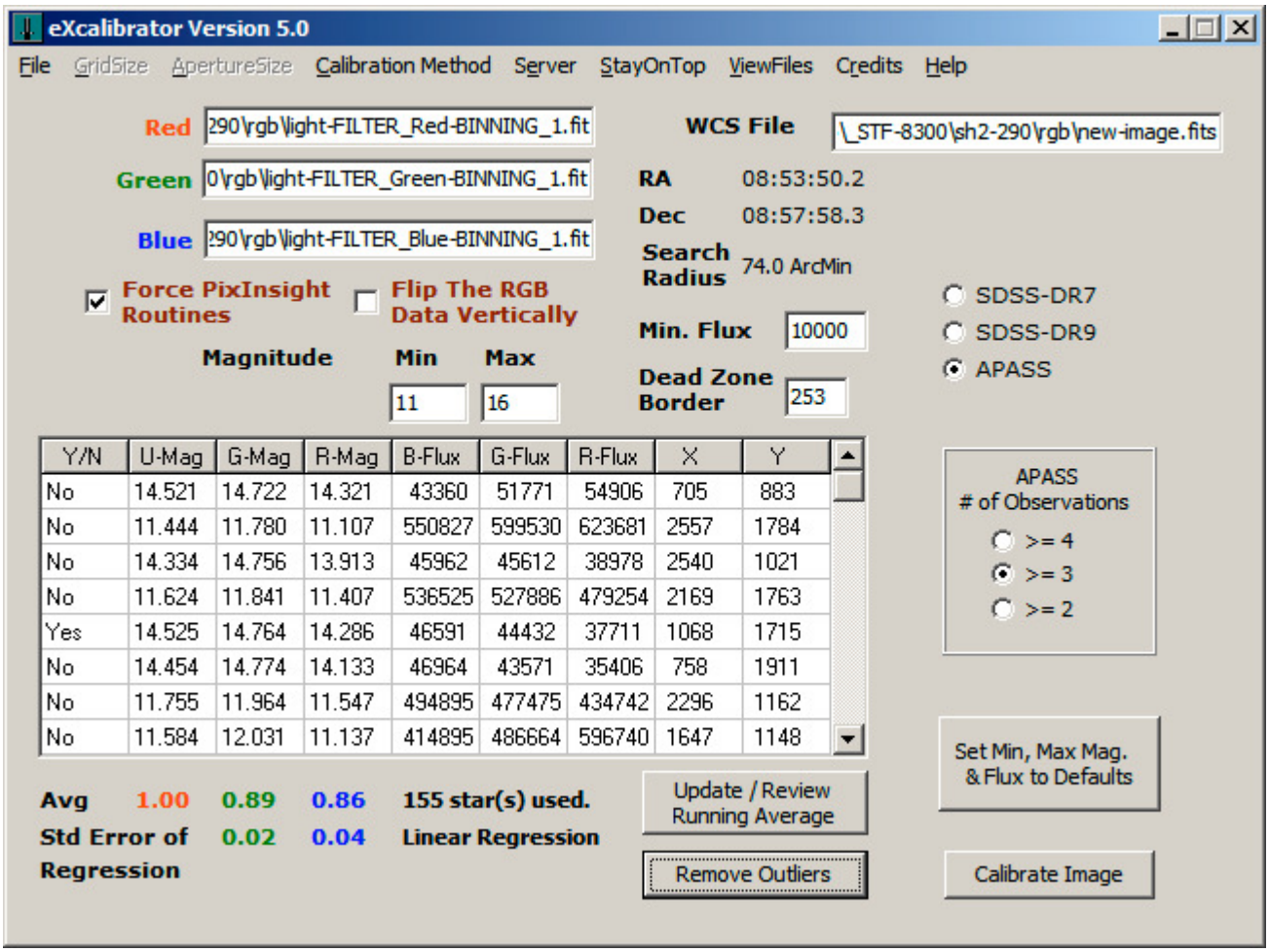
Calibration Method

- The ”eXcalibrator Classic” method uses the original program functions to compute the color ratio factors.
- “SExtractor” is an external program that very accurately locates and calculates light sources in the image. Although it is slightly slower than the eXcalibrator process, it is more accurate and only uses the highest-quality stars.
- “SExtractor Relaxed” finds more stars, as it accepts slightly lower quality light sources.
- The "Linear Regression" routine uses cyan to white to orange stars. APASS data require using Linear Regression.
  - The calculation may use hundreds of stars. This is particularly useful for systems with a small field of view.
  - This method also uses SExtractor.
  - For detailed information about the Linear Regression calculation see URL... http://bf-astro.com/eXcalibrator/LinearRegressionApproach.pdf
- Use the “Manual” process when a plate solve is not achieved.



v) Perform the Calibration Calculation

- Now click the "*Calibrate Image*" button.
- In about three to fifteen seconds, you should get a result similar to this. The calculation time is dependent on the field of view size and speed of the Internet connection.

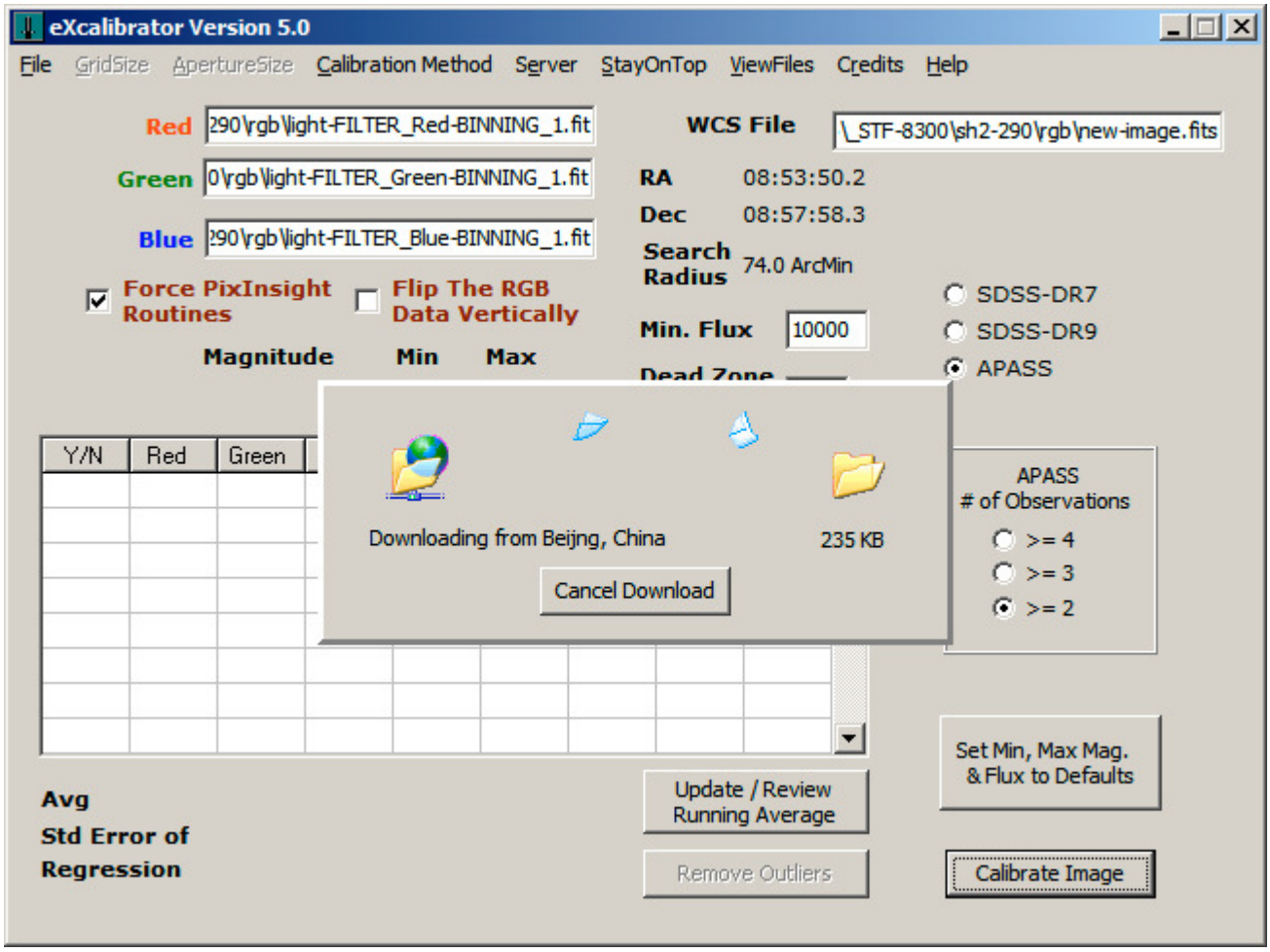


vi) Dealing With Slow Downloads

Several scenarios cause slow downloads. Most commonly, it is because the VizieR server is busy or it is down for maintenance

After clicking "*Calibrate Image*," eXcalibrator displays the download animation box. This shows the server origin and the download progress. Initially, the cancel button is disabled. Unfortunately, eXcalibrator cannot allow download cancellation until the VizieR server actually responds. This usually takes one or two seconds and should be no longer than about thirty. If the server has not responded after about 30 seconds, it may be necessary to stop eXcalibrator with the Task Manager.

Once the "*Cancel Download"* button is enabled, the user may decide to cancel the download and select another server.

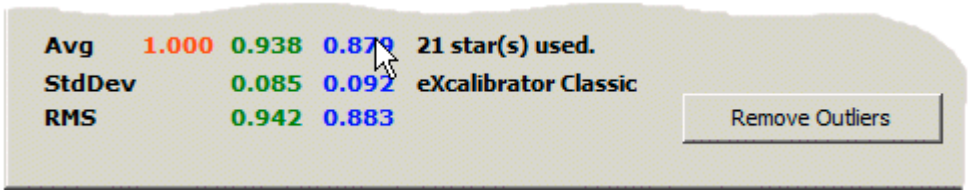


vii) Do Post-Calibration Adjustments

Change the Normalization for the RGB Factors (if required)

By default, eXcalibrator calculates the R, G and B color ratios relative to the red. Therefore, the factor for the red channel is always 1.00. Some programs, most notably PixInsight, require color ratios with a maximum value of 1.00. You may recalculate eXcalibrator's results by double-clicking on the desired text by color.

In the below example, double-clicking on the blue text, 0.879, changes the red, green and blue values to 1.138, 1.067 and 1.000. For PixInsight users, just double-click on the highest value in the "average" row.

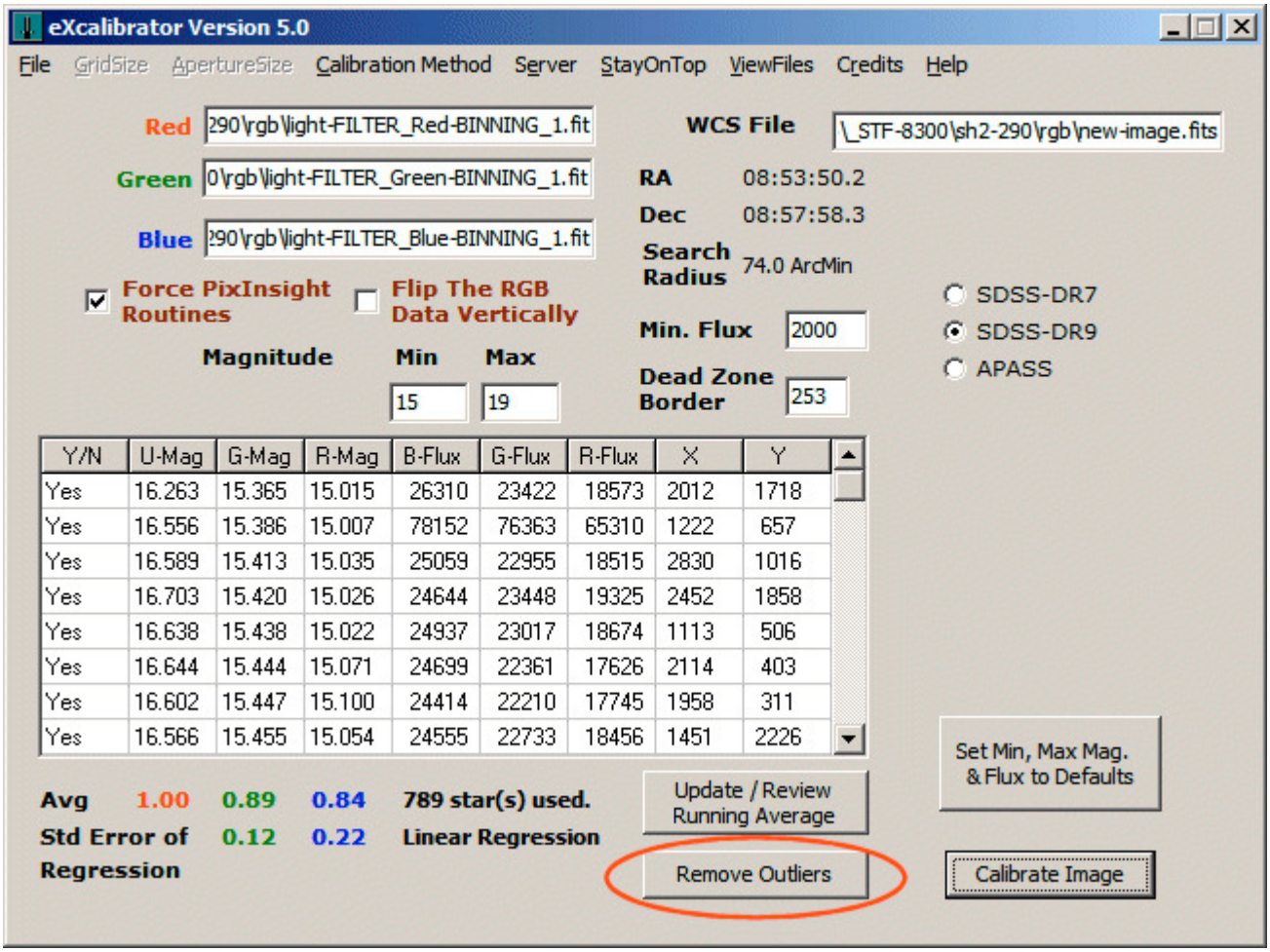


Star Selection:

- If you did not get enough calibration stars, you may...
  - Change the Min and/or Max Magnitude values and click "*Calibrate Image*" again.
  - Increase the usable image area by reducing the size of the "Dead Zone Border."
  - Increase the range of the (u-g), (g-r) values. A small change has little affect on the final color ratios. Try plus and minus 0.05. Also, the "Linear Regression" routine will usually provide an ample star count.
- Experience shows the magnitudes of Min=15 and Max=19, give good results with the SDSS data. With APASS, the data are only reliable from 11 to 16.
- To use more centrally located stars, increase the size of the "Dead Zone Border."
- Double click in the "Y/N" column to include or exclude individual stars. To aid the decision-making process, double click the desired column to sort the grid.

Improving the Variability of the Data:

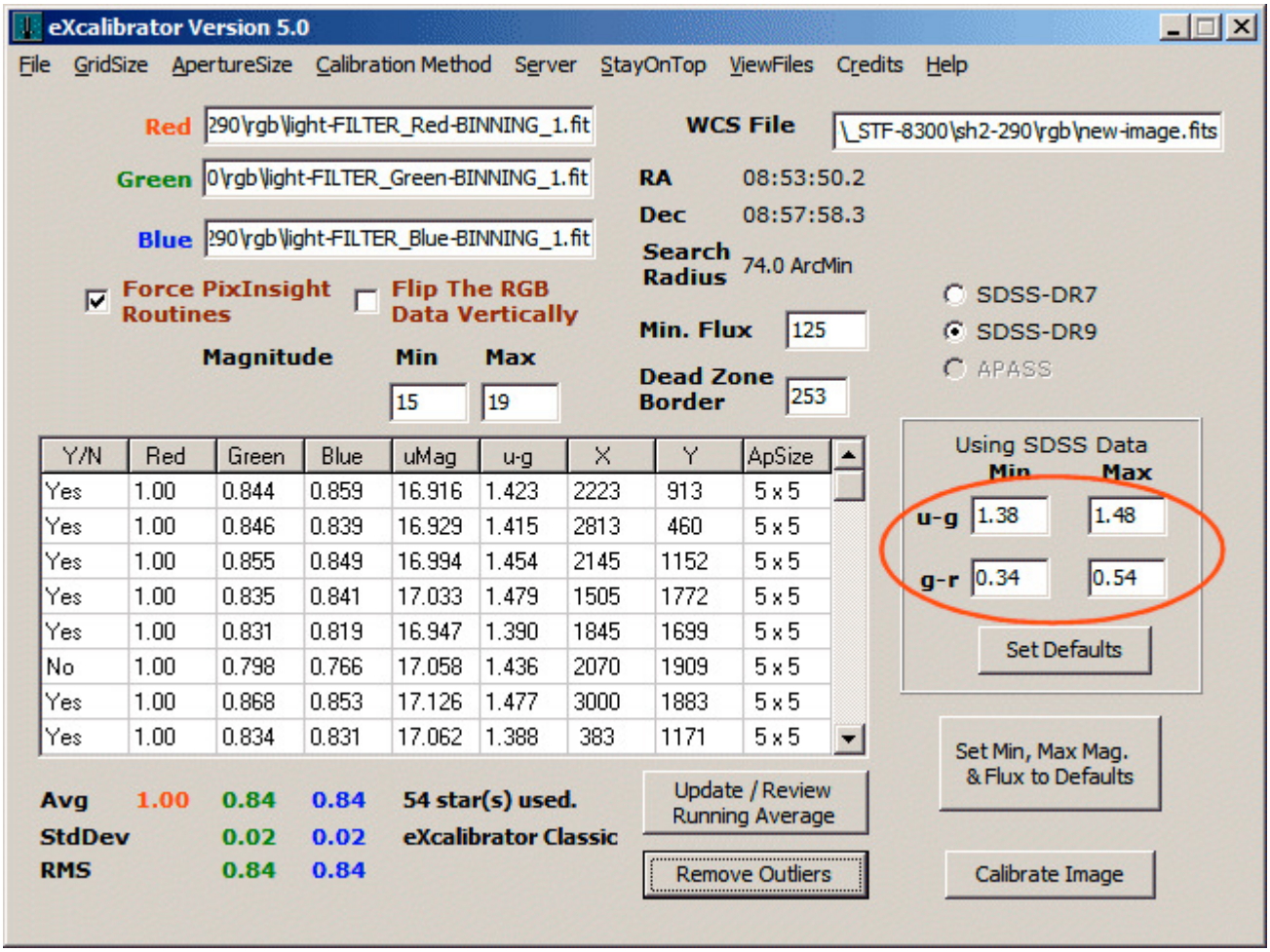
- In the example below, the values for the Standard Error of Regression, or StdDev, for the Green (0.12) and Blue (0.22) are a bit high. Reduce this variability by removing stars where the green or blue results fall outside the current StdDev values.
- One click of the "*Remove Outliers*" button lowers the star count to 512, and reduces the Green and Blue StdDev values to 0.05 and 0.11. respectively. A StdDev less than 0.10 is suggested.
- A second click further reduces the star count to 278 and the green and blue StdDev values to 0.03 and 0.06. It is up to the user to determine if removing outliers more than once is statistically valid.



Further Fine Tuning:

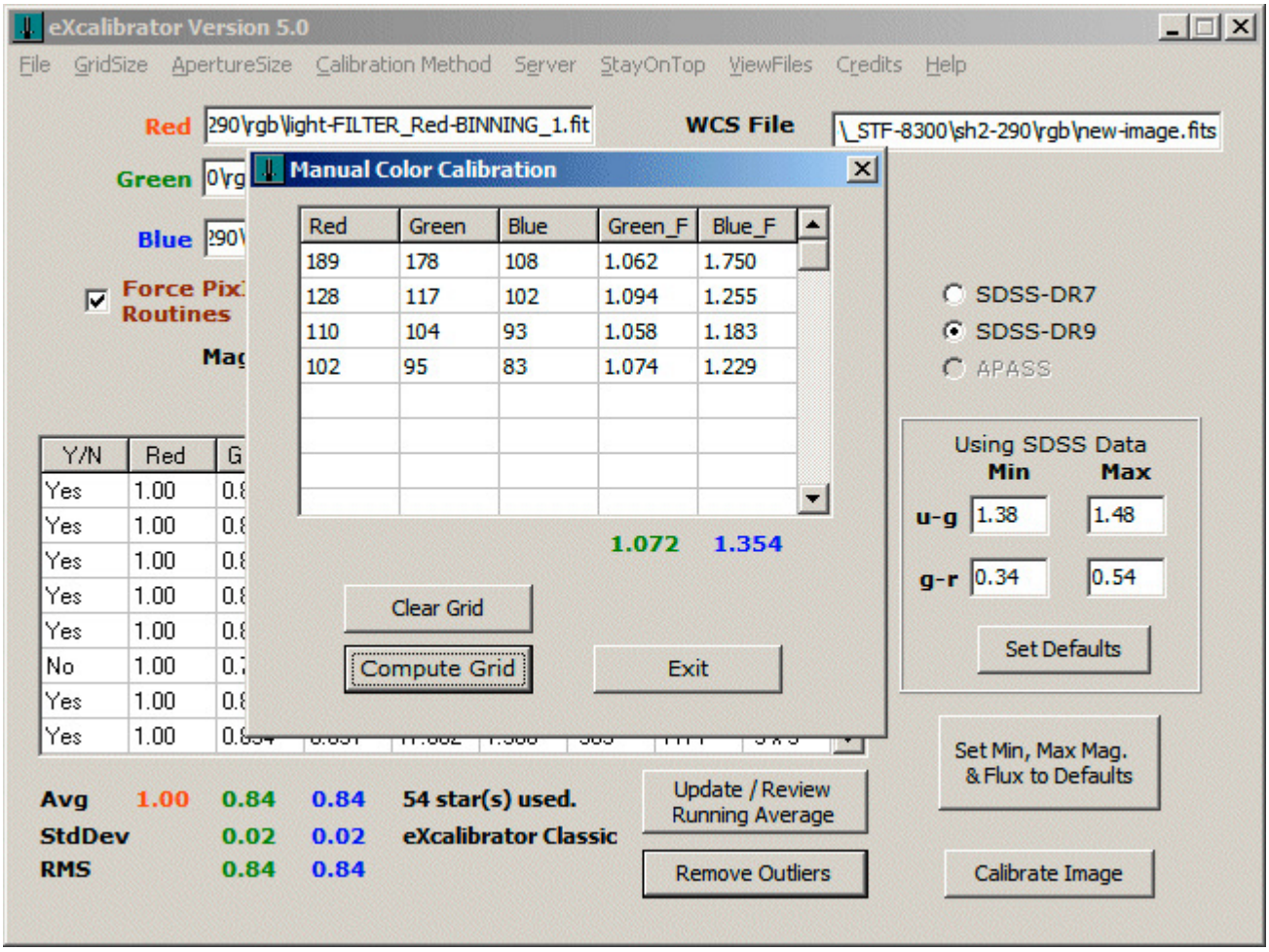
- For further fine-tuning; modify the Min and Max (u-g), (g-r) result values for the SDSS filter subtractions. A small change of about ± 0.05 is OK and can greatly increase the star count. It is suggested to use the default values. You are strictly on your own here.

  The better way to increase the star count is to use the Linear Regression routine.



viii) Manual Calibration

- If eXcalibrator produces incorrect color, the program provides the Manual Color Calibration (MCC) form. Use the x- and y-column data in the Result Grid to locate calibration stars in your RGB image. Then use your favorite image processor to measure the R, G and B values for the stars and enter the data into the first three columns of the MCC form. The MCC form can take data for ten stars, but four or five should do the job. Then click "Compute Grid" to calculate the average green and blue correction factors, shown just below the grid.
- eXcalibrator usually provides very good results. A manual calculation can verify it.



4. Using SExtractor

What is SExtractor?

SExtractor is a program that builds a catalog of objects from an astronomical image. The program was written by Emmanuel Bertin and S. Arnouts at the Institut d'Astrophysique de Paris. Back in the early nineties, the purpose of SExtractor was to find a compromise between refinement in both detection and measurements, and computational speed. SExtractor is very good at extracting accurate photometry data.

How eXcalibrator Uses SExtractor

eXcalibrator runs SExtractor in a hidden window and uses the "double-image mode." Image1 (the Sum File) supplies light source centroids, and image2 provides flux measurements. For image1, use any of the R, G, B images or the luminance. Also, for image1, use a plate-solved image. The "double-image mode" insures measuring the flux of the three RGB images at the exact same place and in the same manner.

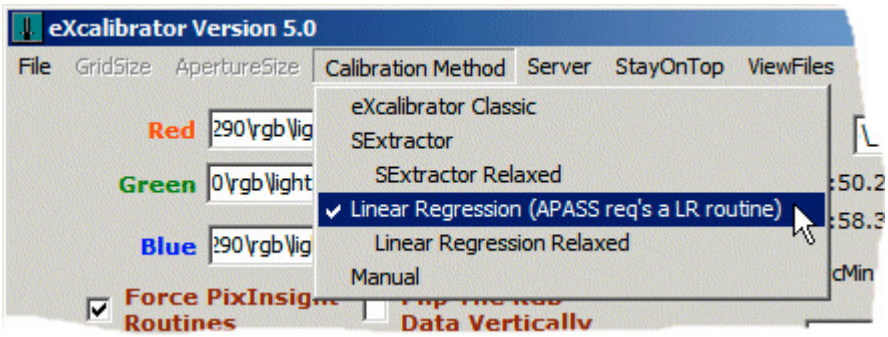
SExtractor reverses the eXcalibrator calculation process.

- SExtractor creates catalogs of all the high quality light sources, in the R, G and B images, and writes the data to simple, formatted, text files. The process may be bit slower because SExtractor searches the entire image. The standard eXcalibrator process only looks for the stars in the downloaded data.
- eXcalibrator then loads the SExtractor catalogs and looks up the matching entries in the data downloaded from the VizieR server.
- Finally, eXcalibrator computes the RGB correction factors, in the usual manner.

The SExtractor Workflow

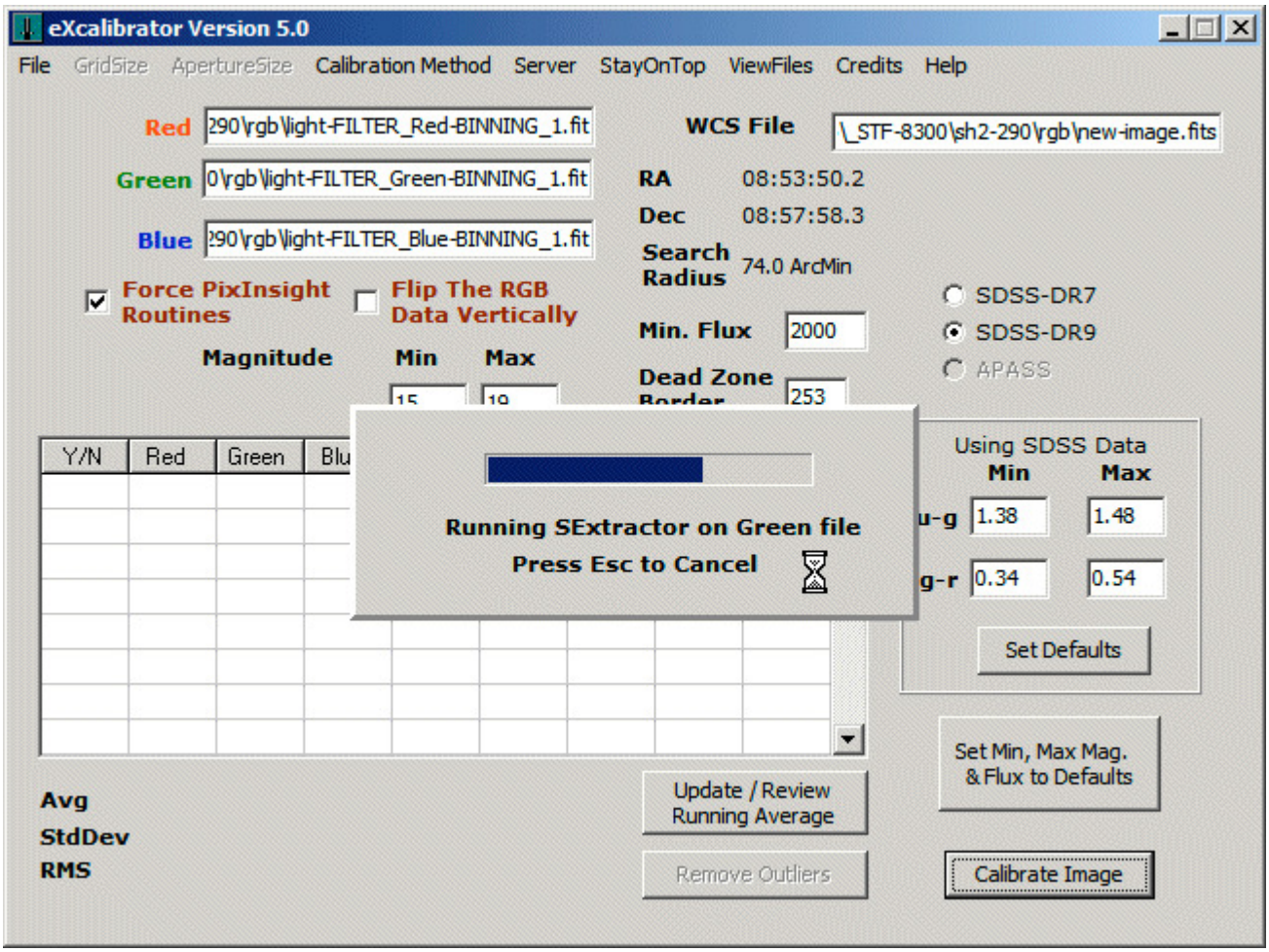
The Source Extractor workflow is the same as eXcalibrator Classic. Simply select one of the four SExtractor calculation methods.

- "SExtractor" only uses the highest quality stars in the image.
- "SExtractor Relaxed" finds more stars, as it accepts slightly lower quality light sources.
- "Linear Regression" uses stars with an expanded color range and the highest-quality stars.
- "Linear Regression Relaxed" uses stars with an expanded color range and slightly lower-quality stars.



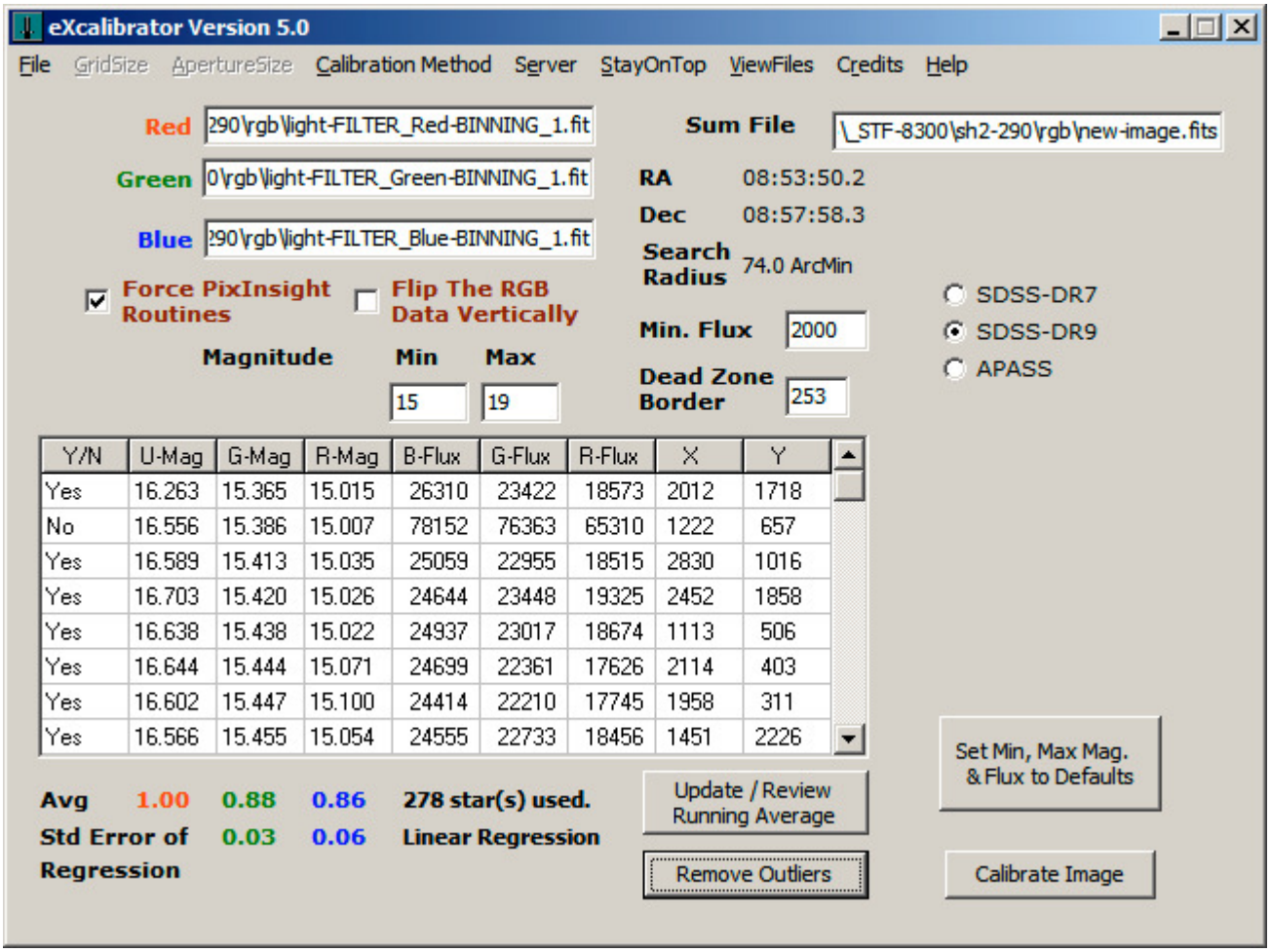
- After clicking "*calibrate image*," eXcalibrator adds an additional step to the process. eXcalibrator runs SExtractor with the three RGB images. This creates text files in eXcalibrator's home folder, named r.txt, g.txt and b.txt. This process takes about ten seconds. eXcalibrator does not repeat the SExtractor analysis unless one of the image files changes.

Here is a screenshot of eXcalibrator while SExtractor analyzes the images.



After SExtractor finishes, eXcalibrator immediately starts the rest of the calibration process.

Here is a typical Linear Regression result with a wide field of view.



Do Post-Calibration Adjustments (see pages 14 - 16)

5. Calibrating The Initial RGB Exposures

Why Calibrate?

Quality color images require an equal balance in the signal-to-noise ratio between the three color channels. Let us consider an image-train that requires a 50% increase with the blue filter and the astrophotographer uses equal length red, green and blue exposures. With image processing, it is possible to multiply the blue data by 1.5 and produce an image with good color. However, the signal-to-noise ratio, in the blue channel, will be less than the other two. This may produce noticeable noise and reduced detail in the blue areas.

How to Make Corrections

There are two ways to correct the color. One can use equal length R, G and B subexposures and take 50% more with the blue filter. Alternately, the astrophotographer can use equal subexposure counts and take 50% longer exposures with the blue filter. With both methods, mean combine the subexposures.

The first method is preferred, as it requires just one set of dark frames. When creating the RGB image, multiply the blue data by 1.5. This gives the color correction. The extra blue subexposures maintain the equal SNR between color channels.

In the second case, simply create the RGB image with red, blue and green ratios of 1:1:1. The longer blue exposures supply the color balance and equalization of the signal-to-noise ratios. This method requires extra sets of dark frames or scaled darks.

Enter eXcalibrator

So, how do we determine the correct RGB ratios for a given image-train? The long-established method is to use G2V stars. Our sun is a G2V star and we perceive its light as white. The goal is to adjust the exposures so that a G2V star appears white in our images. eXcalibrator offers an alternative method, although the goal is the same. The G2V method uses exposures of a single star. eXcalibrator can use hundreds of stars from a single field of view. By using a much larger sample, eXcalibrator produces more consistent results.

The eXcalibrator Image-Train Calibration Work Flow

- First, pick a very clear night.
- Identify a field of view, near the zenith, and covered by the Sloan Digital Sky Survey. Here is a web page with the tool to determine if a specific area of the sky is covered by the Sloan survey. http://www.sdss3.org/dr9/index.php#coverage
- For each filter, take a five-minute guided exposure.
- Apply dark and flat frames in the normal manner.
- It may not be necessary to register the images. If so, use a Nearest Neighbor alignment routine.
- Run the red, green and blue images through the eXcalibrator process... as described in sections 3 and 4.

Example Results

With the author's RCOS scope and STL–11000 camera, using AstroDon filters, the red, green and blue eXcalibrator ratios are 1.00, 0.95 and 1.05. This is close enough to 1,1,1 to allow equal length exposures. After stacking the subexposures, for the final R, G and B images, eXcalibrator determines a final adjustment. If there were no problems with variable seeing conditions, this is usually a minor change.

With the authors FSQ–106 scope and STF–8300 camera, using Baader filters, the R, G and B exposure ratios are 1.00, 1.20 and 1.43. This image-train uses equal-length exposures with subframe counts of 10, 12 and 14. After stacking and mean combining the subexposures, eXcalibrator determines the color channel ratios for the final RGB image. These ratios are usually similar to the previously determined image-train calibration.

6. Maintaining A Running Average Of The Results

Why Do It?

This is a good alternative for color calibrating the image-train. Many astrophotographers do not like to spend the time or devote a precious clear night for calibrating.

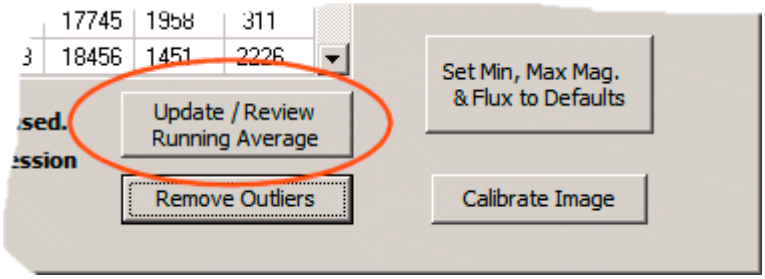
Sometimes the current field of view is not included in both the SDSS and APASS databases. Then, we can use the image image-train calibration or the average eXcalibrator result for the white balance adjustment.

If the field of view is less than 60 degrees above the horizon, adjust the RGB color ratios for altitude extinction. Use the Focal Pointe Observatory's freeware program to determine the adjustment.
http://bf-astro.com/extinction/staci.htm

How To Do It

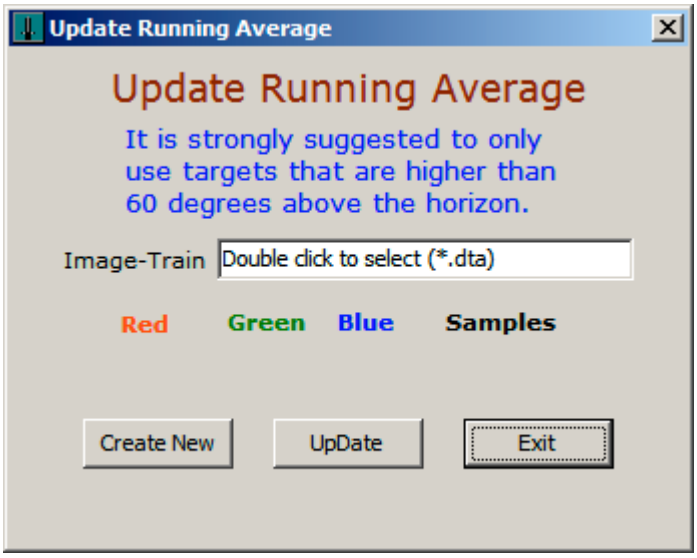
It is strongly suggested to only update a running average with targets greater than 60 degrees above the horizon.

To display an existing, or to update a running average, click the button shown below.

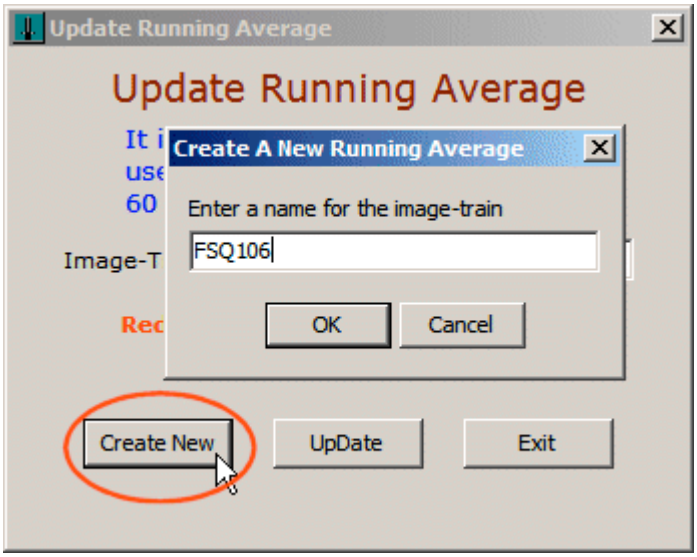


First Time Usage:

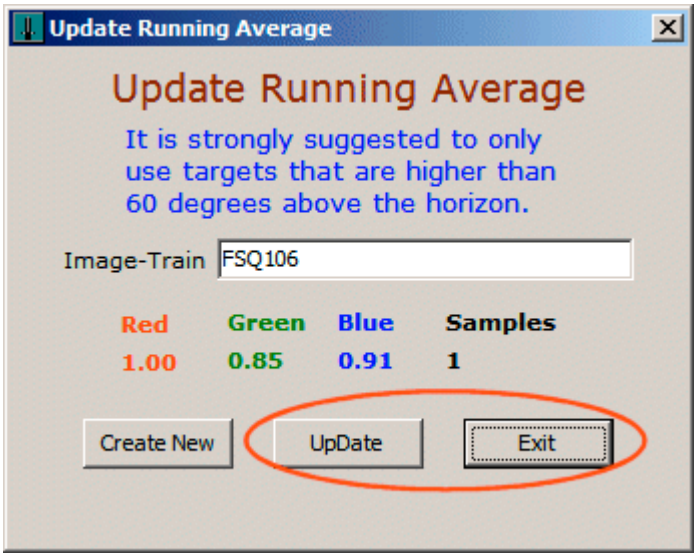
Click the above button to display the "Update Running Average" window.



Click "Create New," enter a name for the current image-train and click OK. eXcalibrator allows keeping a running average for multiple telescopes.

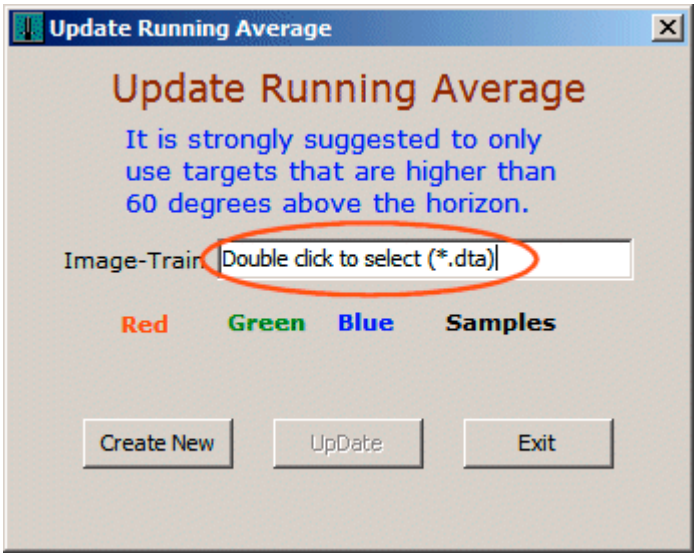


Then click "UpDate" and "Exit."

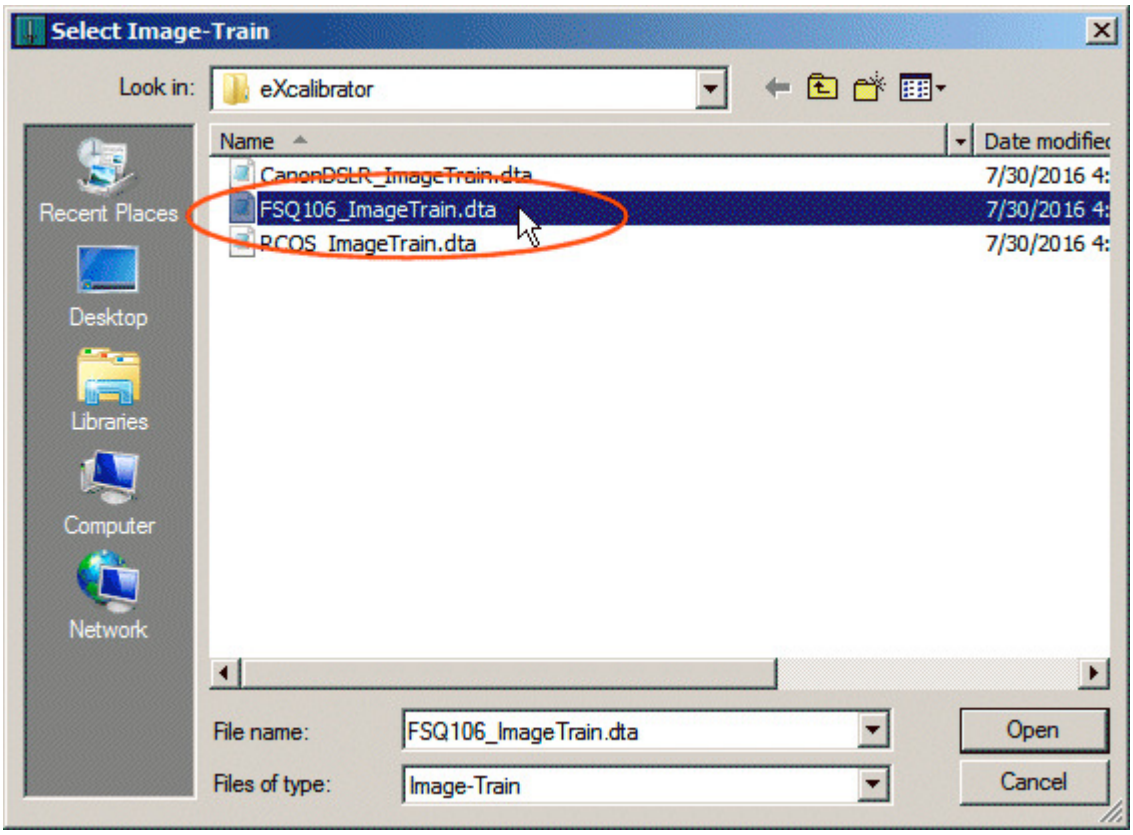


Subsequent Updates or Simply Displaying Existing Results:

Double-click the "Image–Train" text box to select an existing running average.

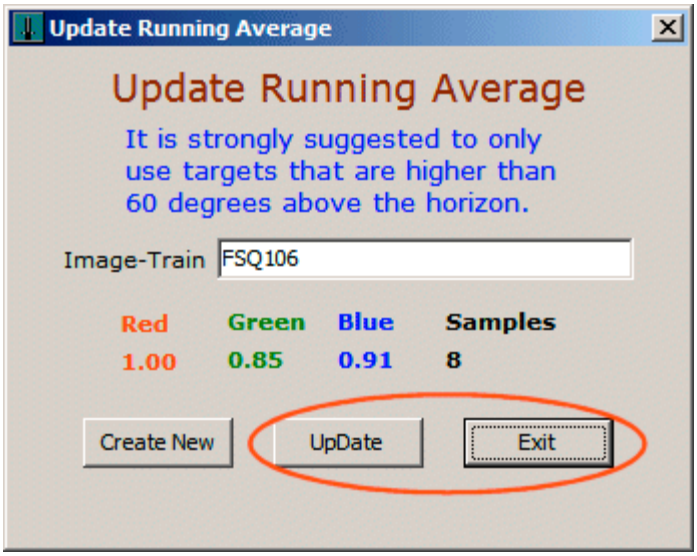


Select the desired image train by double clicking on its ".dta" filename.



To add new data click, "UpDate" and then "Exit" or... just click "Exit."

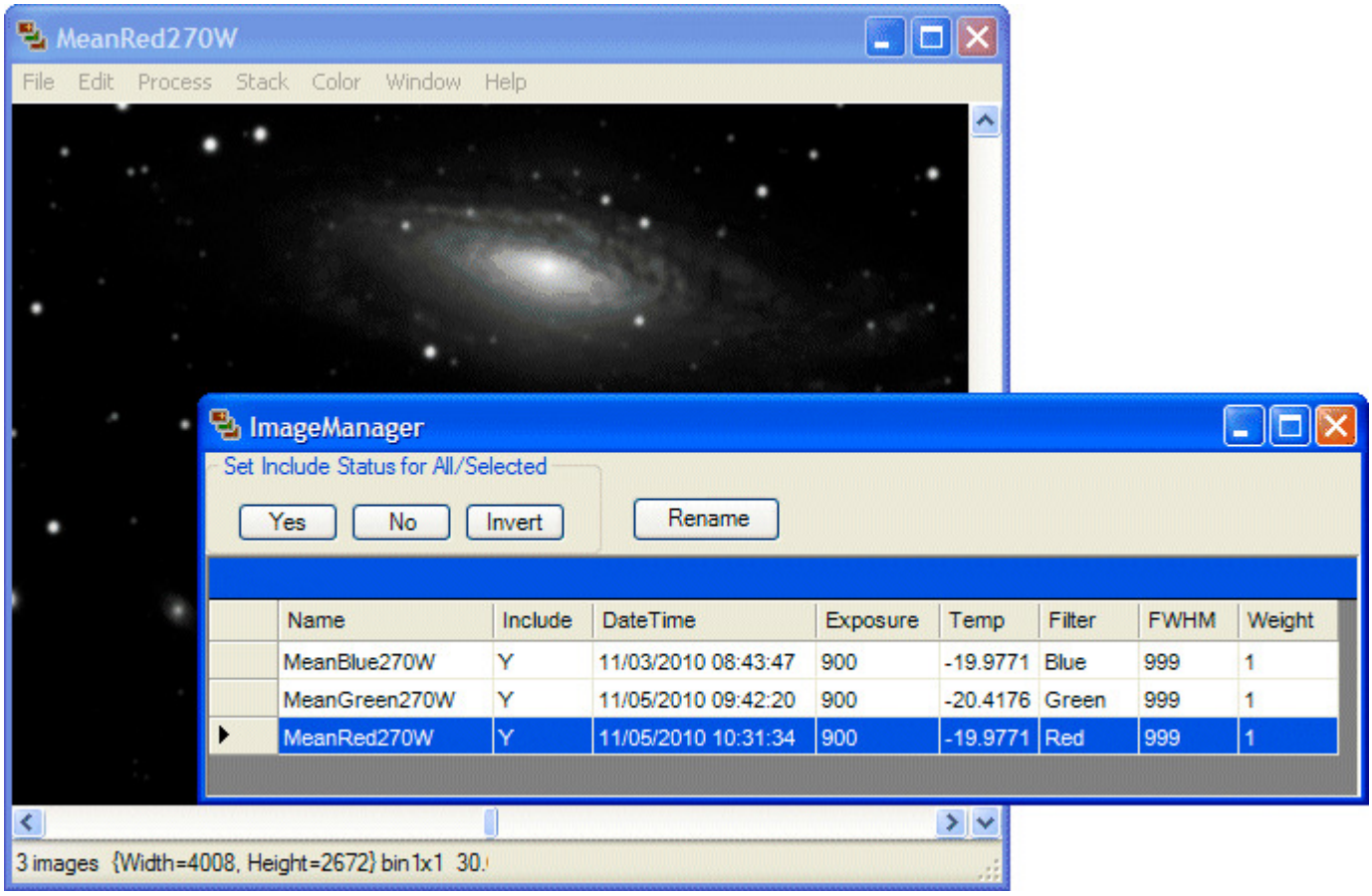
After adding about 10 samples, the average numbers may stop changing.



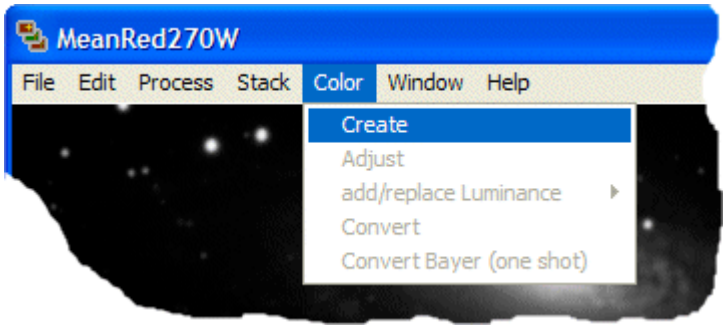
7. Creating an RGB Image With eXcalibrator (Program Workflow)

Note: For illustration purposes, the process below utilizes CCDWare's CCDStack. You may, of course, use whatever image-processing program you desire!

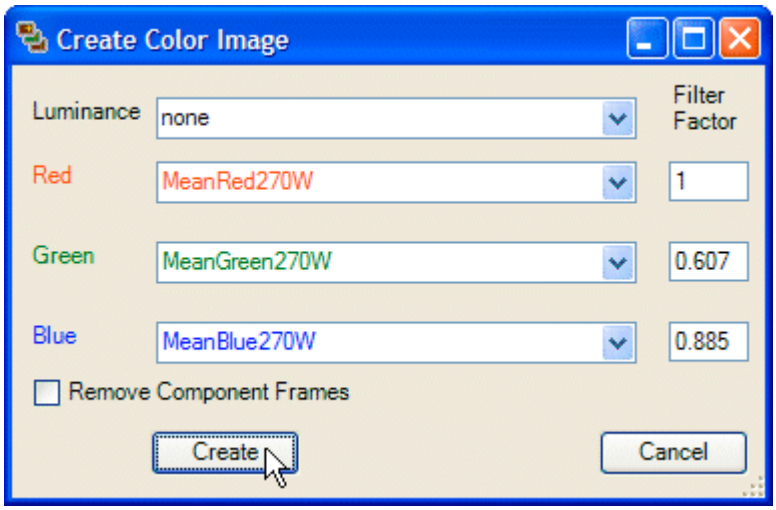
- First, load your three master channel combines into the program:



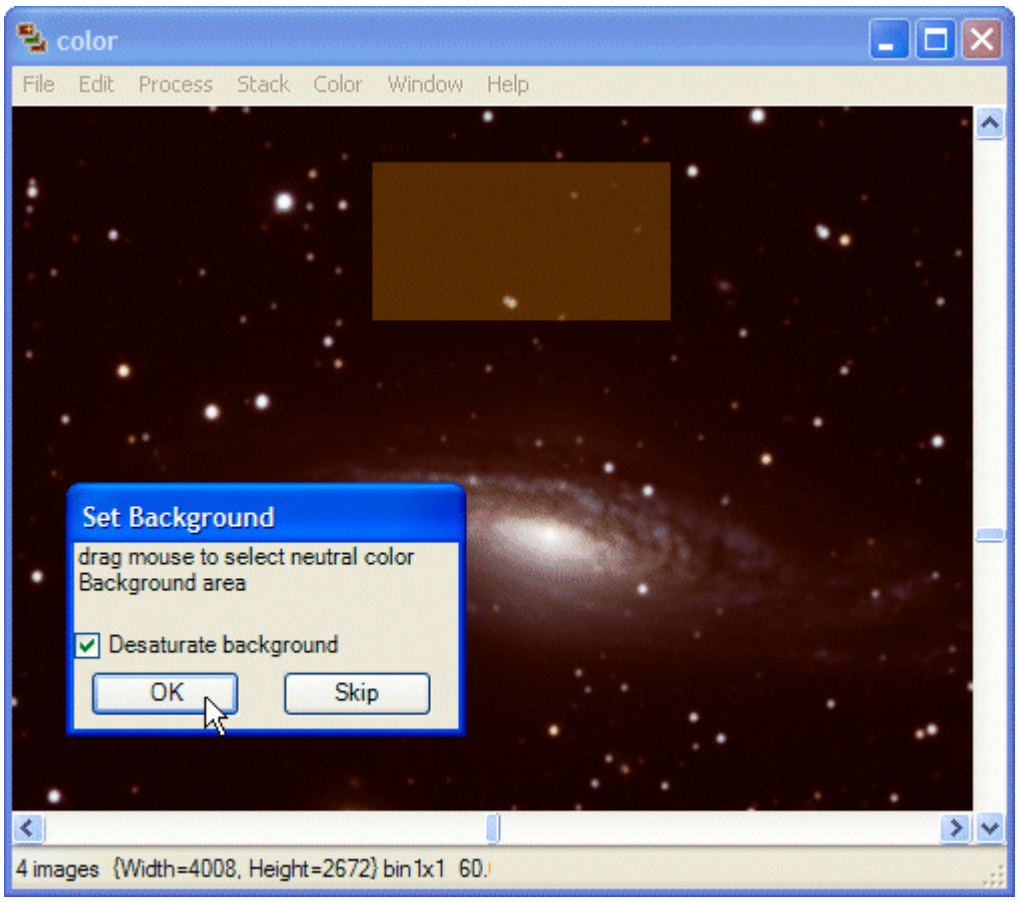
- Then, select the option to “Create” a color image:



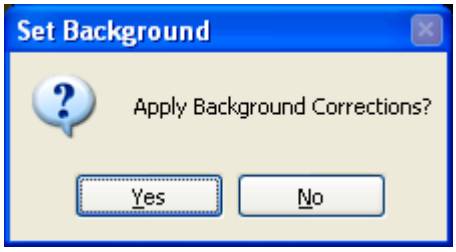
- Enter the ratios provided by eXcalibrator, and click the “Create” button:



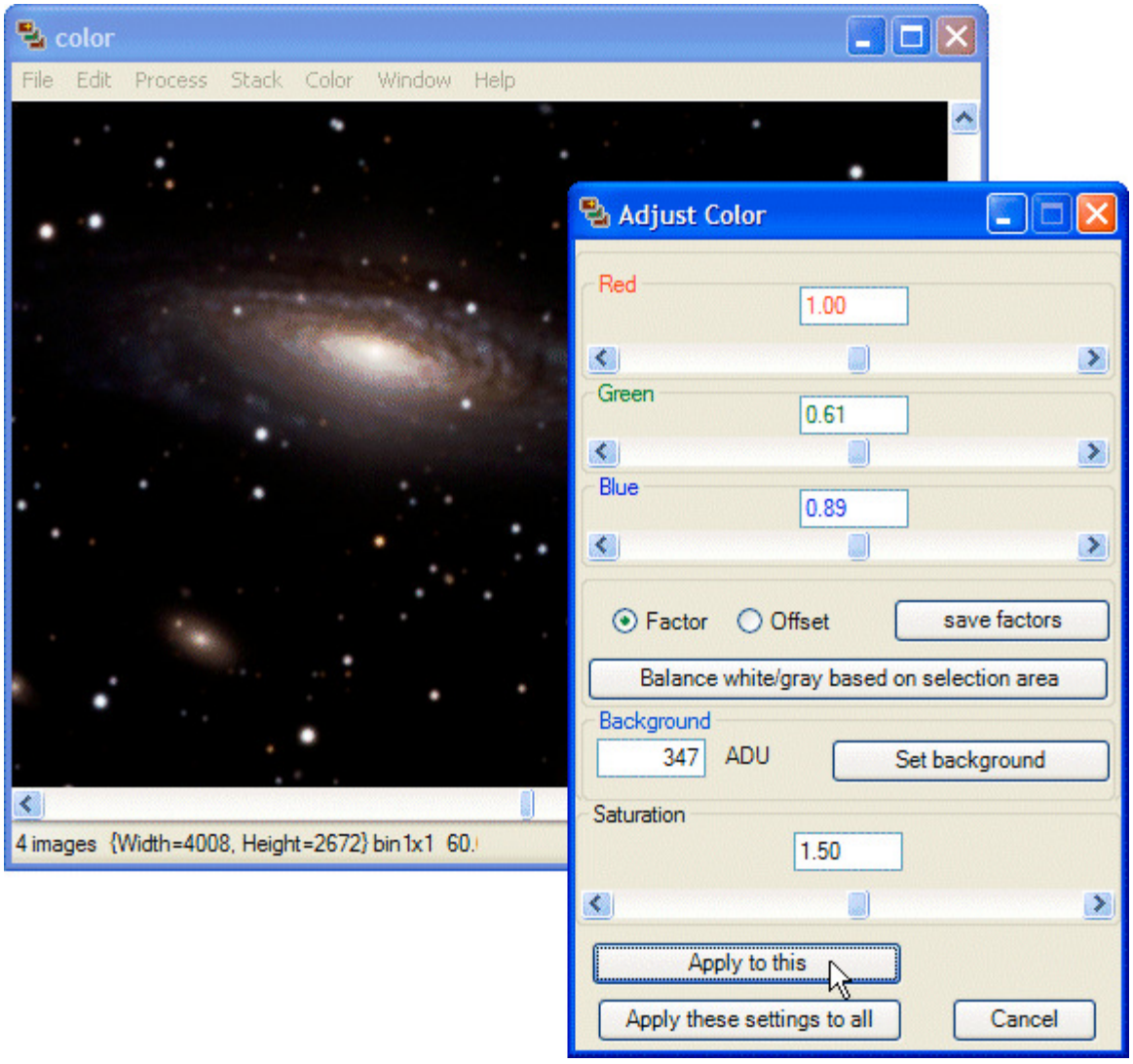
- Once the initial combine is done, select an area of the image that represents dark sky background. With a gradient, select the brightest area of the background. Click "OK."



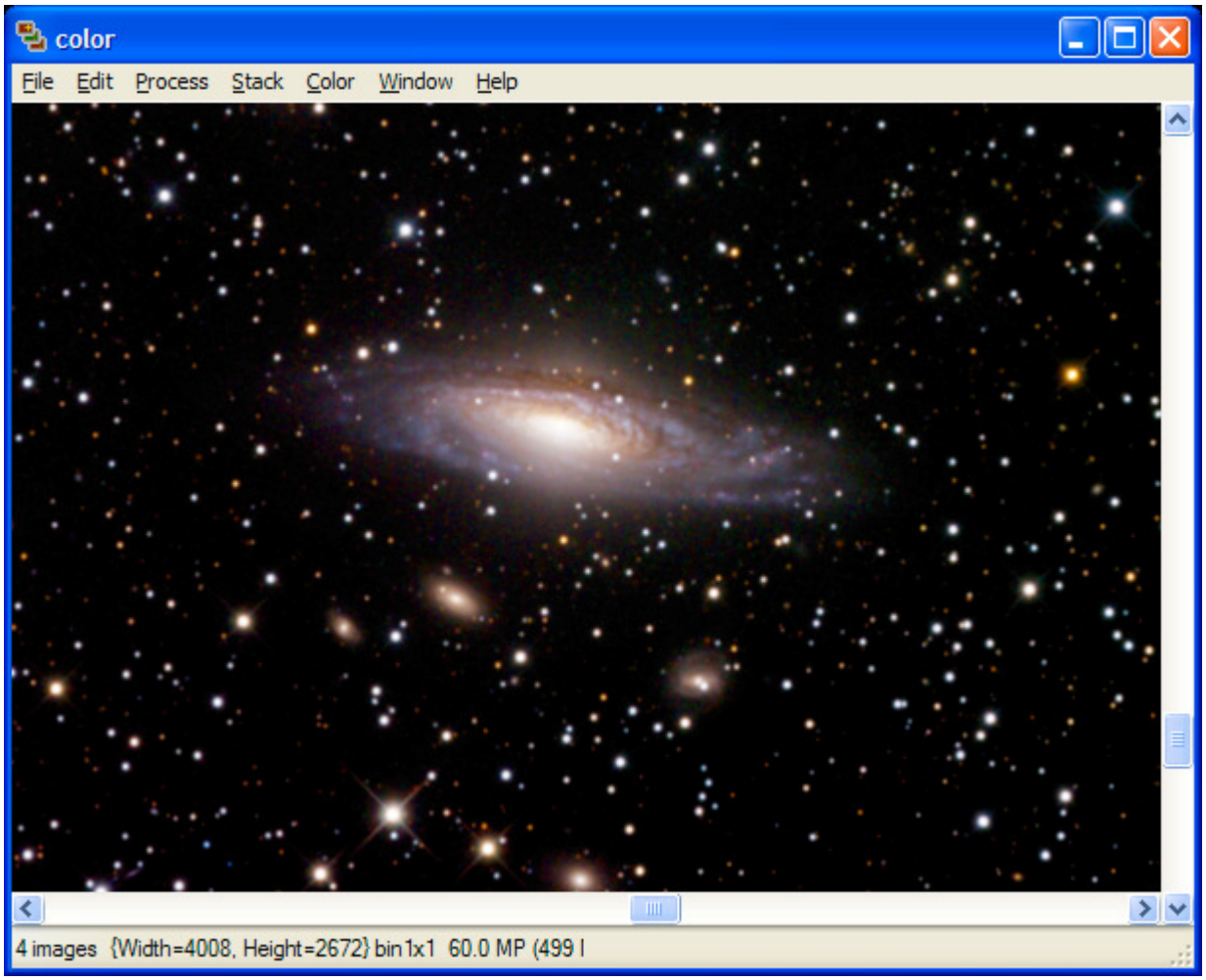
- Click “Yes” when asked if you want to “Apply Background Corrections.”



- Adjust the saturation, as desired, and click “Apply to this.”



- Your initial color combine is finished!



8. Troubleshooting

What to do with an Invalid Calibration

As mentioned earlier, eXcalibrator occasionally produces an invalid result. The program still provides useful information to make a manual calibration much easier. Use the Manual Color Calibration, described above, to obtain green and blue channel correction factors.

The x, y Locations Are Not Dead Center on the Stars

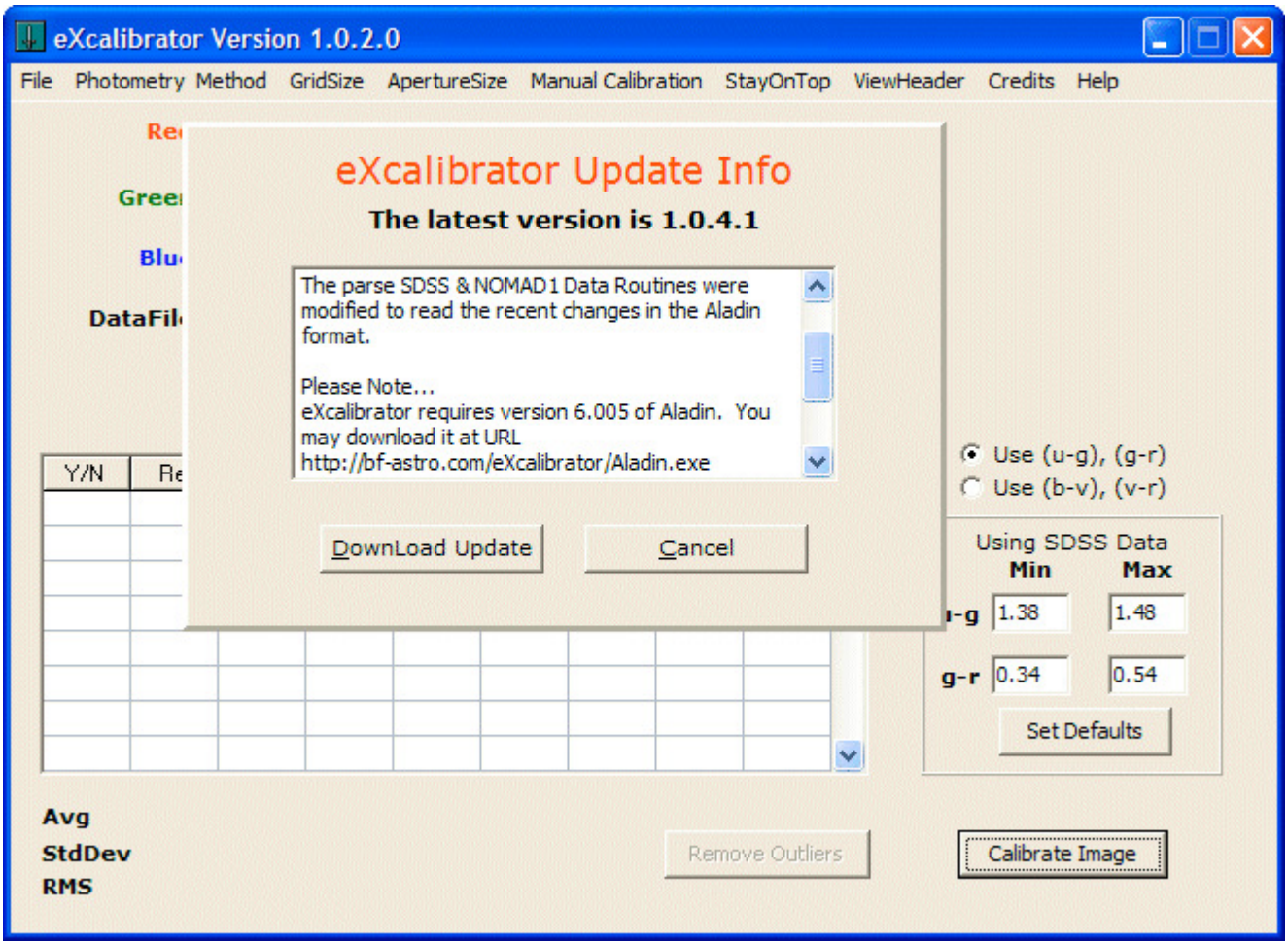
When doing a manual calibration, the user may notice that the x, y pixel locations are not always at exact star centers. If the R, G and B images are properly registered, the eXcalibrator calculation is still valid. To account for hot and cold pixels, the program uses the average of a 3x3 to 11x11 pixel array, to determine the color values.

Suggestions and Bug Reporting

Send an email to bfranke@bf-astro.com, with the subject line starting with “eXcalibrator.” The program has a link, under the Help menu, to start an email for you, with the recipient already filled in and the subject line started.

9. Ongoing Program Maintenance

Program Updates



On startup, eXcalibrator downloads a small text file with update information. The program displays an update panel, if a new version is available. After downloading, close eXcalibrator to unzip and install the new executable.

If necessary, go to the eXcalibrator web page to download a new documentation (PDF) file.
See URL: http://bf-astro.com/eXcalibrator/eXcalibrator.htm

10. Revision History

Version 5.0 June. 30, 2016

- Improvement... Added access to the AAVSO Photometric All-Sky Survey (APASS) database. This gives about 90% sky coverage in both the northern and southern hemisphere.
- New feature... Added running averages for multiple telescope results.
- Removed access to the lesser quality NOMAD data.
- The progam now excepts any legal Windows file or folder name.
- User Interface improvements.

Version 4.36 Sept. 16, 2015

Neglected to update some of the internal program messages to match the current version number.

Version 4.35 Sept. 16, 2015

- Improvement... With 16-bit files, the required use of the keywords, BZERO and BSCALE is relaxed. If BZERO = 32768 and BSCALE = 1, or is missing, the file type is 16-bit unsigned. If BZERO = 0 and BSCALE = 1, or both are missing, the file type is 16-bit signed..
- Improvement... A few error messages were clarified.

Version 4.30 Nov. 5, 2014

- Bug Fix... Improved recognition of PixInsight (PI) data. With the use of some plate solving software, eXcalibrator was failing to recognize PI data.
- Added Feature... In the event that eXcalibrator fails to recognize PixInsight data, a checkbox is added to force the use of the PI routines.

Version 4.25 Dec 19, 2013

- Bug Fix... EXcalibrator, version 4.2, had an embarrassing programming error. This resulted in a 0 to 15% error in the color correction for the green channel. The error occurred when using Source Extractor and files NOT saved with PixInsight.
- This illustrates just how far off the color balance calculation can be and still result in a good-looking image. This also shows one of the reasons why eXcalibrator remains freeware

Version 4.2 Sept. 23, 2013

Improvement... The program now works with PixInsight 32-bit floating point and both 16-bit FITS files.

Version 4.1 May 31, 2013

- Bug Fix... eXcalibrator now correctly determines the vertical flip orientation with images plate solved by PixInsight.
- Improvement... The "Help" drop-down menu includes special instructions for using PixInsight 0.0 to 1.0 scaled data.

Version 4.01 April 7, 2013

Minor incorrect error message... All references to "SDSS-DR8" are changed to "SDSS-DR9".

Version 4.0 April 6, 2013

- Improvement... eXcalibrator no longer requires manual downloading of NOMAD or SDSS data. The program now automatically downloads the required information.
- Improvement… The calculated R, G and B factors may be normalized to any of the three colors. This is especially useful for PixInsight users.
- Bug fix… eXcalibrator now allows processing a new set of images without the need to reload the program.

***Version 3.2* Feb 24, 2013**

- Bug Fix... The parse SDSS Data Routine is modified to read the recent changes in the Aladin SDSS-DR7 format.
- Improvement... eXcalibrator no longer downloads update info and general messages to the hard disk. They now load directly into memory.

***Version 3.1* May 29, 2012**

Bug Fix... Fixed a divide by zero error in the getBackGroundLevel function.

***Version 3.0* 2nd Qtr. 2012**

- Added the Linear Regression calculation... for use with SDSS stars.
- A new Aladin filter is included.
- In Aladin, the Excel format is now use for copying data to the clipboard.
- A faster version of SExtractor is included.
- Error messages are improved.

***Version 2.06* Jan. 22, 2012**

New Feature... A message display system is added. This allows the broadcast of emergency information to the user when eXcalibrator executes. The message will display at program startup until the noted problem is repaired.

***Version 2.05* 2July 27, 2011**

Bug Fix... eXcalibrator was not correctly checking for the absence of the FITS keywords CROTA1 and CROTA2.eXcalibrator now allows 16-bit signed FITS files.

***Version 1.0.4.1* Feb. 5, 2011**

Bug Fix... The parse SDSS & NOMAD1 Data Routines are modified, again, to read the recent changes in the Aladin format.

***Version 1.0.4.0* Oct. 14, 2010**

- Bug Fix... The parse SDSS Data Routine is modified to read the recent changes in the Aladin format.
- Improvement... The program can now use any registered image to obtain the WCS data.
- Improvement... eXcalibrator now automatically applies the NOMAD1 adjustment factors.
- Special Note... See Appendix A for documentation on the above changes. This is currently only available in the English version.

***Version 1.0.3.0* Mar 22, 2010**

- Bug Fix... When using the "Use Local Background" photometry method, the program sometimes found no usable stars, resulting in a later floating-point error. An added error message now suggests input changes to find more stars.
- Improvement... Added more error messages.

***Version 1.0.2.0* Mar 13, 2010**

No software changes... just added the French translation for the documentation. Thanks go to Thierry Serieys for this work.

***Version 1.0.2.0* Feb 10, 2010**

No software changes... just an organizational rewrite of the documentation into clearer setup and workflow sections. An added example workflow shows how to use eXcalibrator's results in an image-processing program. Thanks go to Neil Fleming for his work on this rewrite.

***Version 1.0.2.0* Sept. 1, 2009**

- On startup, eXcalibrator now informs the user if a program update is available. After downloading, it is necessary to exit the program to unzip and install the new executable. It may be necessary to go to the web page to download a new documentation (PDF) file.
- Bug Fix... To avoid divide-by-zero errors, a Minimum Star Value is added. The brightness for red, green and blue must all be above this value to include the star in the calibration.

Version 1.0.1.0 ***Sept. 1, 2009***

With 16-bit images, some programs placed the value, 32767, in the FITS header for the keyword BZERO. eXcalibrator now looks for 32767 and 32768.

11. Thanks, Disclaimers, and Copyright

I'd like to thank...

- Bernhard Hubl for providing background information on the underlying process.
- Mischa Schirmer for design information and GUI assistance.
- Neil Fleming for documentation edits and additional contributions.
- Bruce Waddington for developing the Linear Regression Algorithm, beta testing and software design contributions.
- Chris Abissi for the original beta testing and software design contributions.
- Alan Klotz, for compiling V2.2 of SExtractor as an executable that can run on the Windows O.S.
- Herbert Raab, the author of Astrometrica, for routines to convert coordinates to image pixel locations.
- ST-ECF, for publishing the code for their Footprintfinder program as freeware.
- Centre de Donnees astronomiques de Strasbourg (CDS) for providing the VizieR Catalogue Service .
- Thierry Serieys for the documentation French translation.
- Felipe Largo for the documentation Spanish translation.
- Herbert Walter for the documentation German translation.

…Bob Franke

End of Document