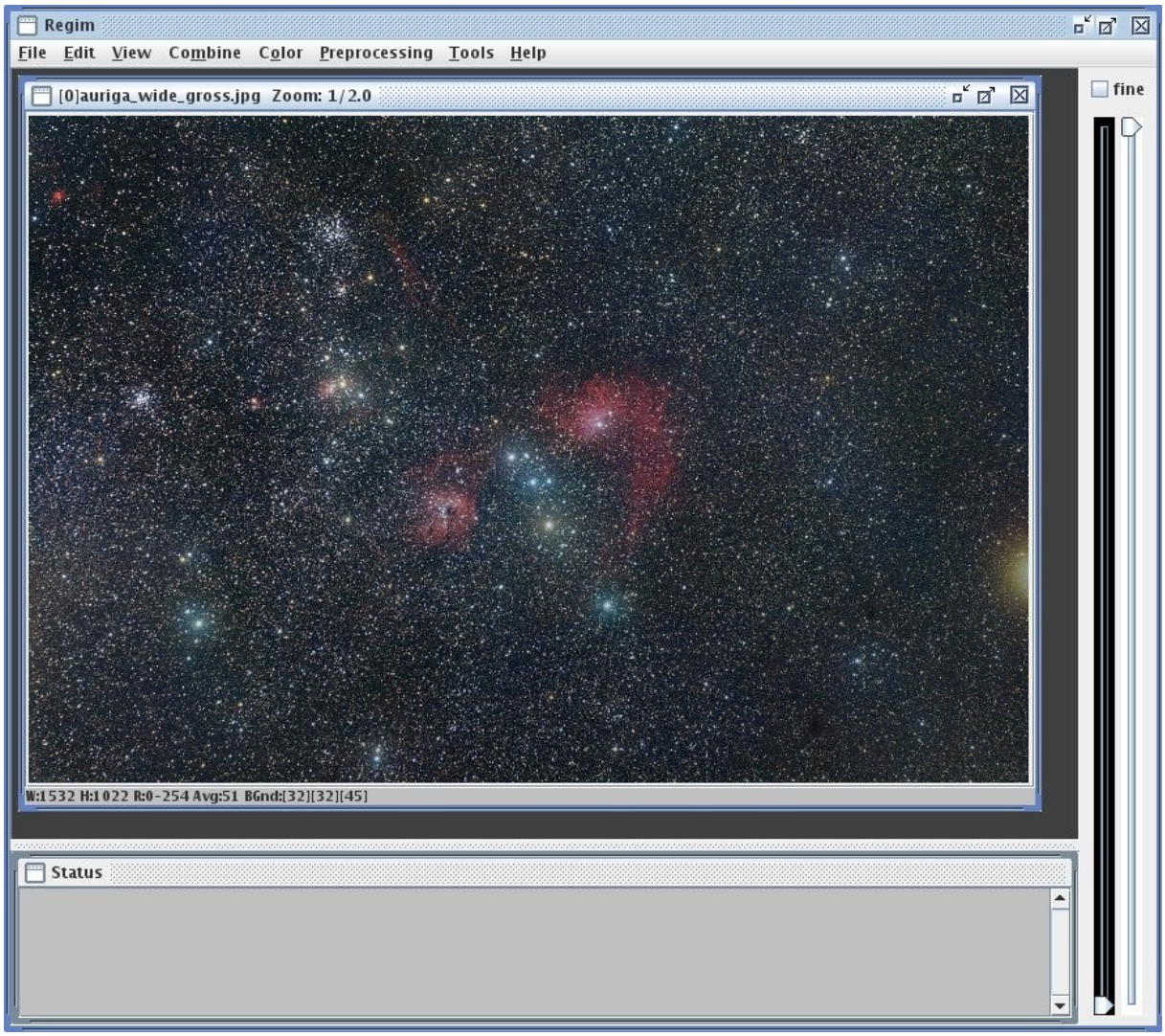
Regim



V 3.9

User Manual

http://www.andreasroerig.de

Inhalt

1 What is Regim?

Regim is a tool that should make processing of astronomical images easier. The focus is on images that were captured with DSLRs or CCD cameras.

Regim is not meant to replace more complex image processing systems like Adobe Photoshop. It is meant to make special processing steps for astronomical images easier. These are calibration of raw images (dark and flat calibration), registration and combination of images.

Installation and usage is at your own risk.

Regim is free and may be used in unchanged form. However there went a lot of work into this program. If you find it useful your donations will be highly appreciated. Simply write me an email.

2 Supported file formats

Regim reads and writes the following file formats:

- TIFF (uncompressed!) RGB/monochrome 8 or 16 bit per channel
- JPG files
- FITS files monochrome/RGB/Raw.
- RAW files of several digital cameras (read only)

To read raw images Regim uses jrawio (included) or optional LibRaw or DCRaw. Thanks to Fabrizio Giudici and all who contributed to jrawio and Dave Coffin the author of DCRaw.

3 Installation preferences

Regim is completely written in Java and should therefore run on every plattform that has an Java runtime environment (JRE) **version 1.8.0** or higher. It was tested on Windows 10 and Ubuntu Linux 18.04 with JRE 1.8. Path and classpath settings for JRE must be set.

For processing large images Regim loves to have a lot of memory available. You should have at least 4 GB or more.

4 Installation and Start

Unzip the file regim.zip to your harddisk. Within the folder regim you will find the files regim.jar, regim.properties and regim.cmd (for Windows) and the file regim.sh (for Linux and Mac OS X).

Note: On Linux and Mac OS X you may need to set the execution flag for the shell script (see command chmod).

Note: To run Regim you will need a Java Runtime Environment (JRE) installed on your computer. If this is not the case you can download it from http://www.java.com/en/download/manual.jsp. Please do not use **OpenJDK**! It will cause problems.
Important for users of 64bit-Windows systems: If you try to download the JRE with Firefox from the website above it seems that you will get the 32bit version. Therefore it might be better to use InternetExplorer or Edge to download the 64bit version of the Java Runtime Environment.

4.1 Start under Windows

In Windows Explorer navigate to the folder where you have unpacked Regim. Now doubleclick on the file *regim.cmd*.

4.2 Start under Linux

Open a terminal window and navigate to the folder where you have unpacked Regim. Now enter *regim.sh*.

4.3 Start under Mac OS X

Open a terminal window and navigate to the folder where you have unpacked Regim. Now enter *sh regim.sh*.

4.4 Memory assignment during start

By default the upper memory limit assigned to Regim is 2GB (2048MB). This is configured in the batch file (regim.cmd, or regim.sh) with the parameter ***-Xmx2048m***. Depending on the amount of memory your computer has you can alos use the following batch files to start Regim:

regimSmall starts Regim with an upper memory limit of 1GB.
regimLarge starts Regim with an upper memory limit of 3GB.

How much memory is required by Regim depends on the size of your images. A 24 megapixel color image for example needs 9 times as much memory as a 8 megapixel monochrome image.

4.5 Multi core systems

If you have a multicore system please have a closer look at chapter 6.Preferences.

5 Menu description

5.1 The *File Menu*

Open...	Opens an image file. The image will be shown in a separate window.
Save As...	Saves the top image as TIFF, or JPG file.
Save As FITS...	Saves the top image as FITS file.
Save As Splited FITS...	Saves the top image separated into RGB channels in three FITS files.
Close all	Closes all open image windows.
Batch conversion..	Allows the conversion of many image files into a different file format.
Preferences..	Opens the dialog for Preferences.
Exit	Will end the program.

5.2 The Edit Menu

Register	does the registration for several opened deep sky images. This is recommended only for a small number of images due to memory consumption.
Register Files...	does the registration for several deep sky images. Recommended for larger numbers of images.
Register Sun	does the registration of several opened sun or moon images. Sun or moon need to be completely on the image. This is recommended only for a small number of images due to memory consumption.
Register Sun Files...	does the registration for several sun or moon images. Sun or moon need to be completely on the image. Recommended for larger numbers of images.
Remove Blooming..	removes blooming spikes on bright stars of an opened image. Only for images of monochrome CCD cameras without antiblooming.
Remove Blooming f. Files	removes blooming spikes for several image files.
Normalize Background..	normalization of the background of several opened images.
Normalize Backg. in Files..	normalization of the background of several image files.
Upsample 2x	doubles width and height of an opened image.
Rotate Left 90°	rotates the image 90° counter clockwise.
Rotate Right 90°	rotates the image 90° clockwise.
Rotate 180°	rotates the image 180°.
Add Offset	adds an offset to an image.

Remove Gradient	removes brightness or colour gradients in an image.
Invert	Inverts the current image.
Mirror X	Flips (mirrors) the current image in X direction.

5.3 The View Menu

Equalize visualization	sets the visualization settings (black and white point) for all opened images to the same values as for the top image.
Auto stretch	sets the black and white point (for visualization) for the top image.
Blink..	blinks the opened images against each other.
Blink Files..	blinks many image files against each other.

5.4 The Combine Menu

Blend...	averages several opened images using weight factors.
Blend Files...	averages several image files. Recommended for large number of images.
Median Combine...	combination of several opened images via median using weight factors.
Median Combine Files...	combination of several image files via median. Recommended for large number of images.
Sigma Combine...	combination of several opened image via Sigma.
Sigma Combine Files...	combination of several image files via Sigma.
SD-Combine...	combination of several opened image via SD-Mask.
SD-Combine Files...	combination of several image files via SD-Mask.
Maximum Combine...	combination of several opened image via Maximum.
Maximum Combine Files...	combination of several image files via Maximum.
Subtract Files...	subtracts the image in the top window from several other images.

5.5 The Color Menu

Multiply Channels...	multiplication of singe color channels with a value.
Combine Channels...	combination of three greyscale images to a RGB image.
Split Channels...	splits a RGB image into three separate channels.
Monochrome	transforms a RGB image into greyscale.
RAW Debayering	transforms a camera RAW image into a RGBimage.
Man. B-V Color Calibration	manual color calibration of an image using a stars color index (B-V).
Auto. B-V Color Calibration	automatic color calibration of an image using stars color index (B-V)..
Non linear g. c. retrieval	allows non linear contrast stretch of an RGB image without changing the color ratios.

5.6 The Preprocessing Menu

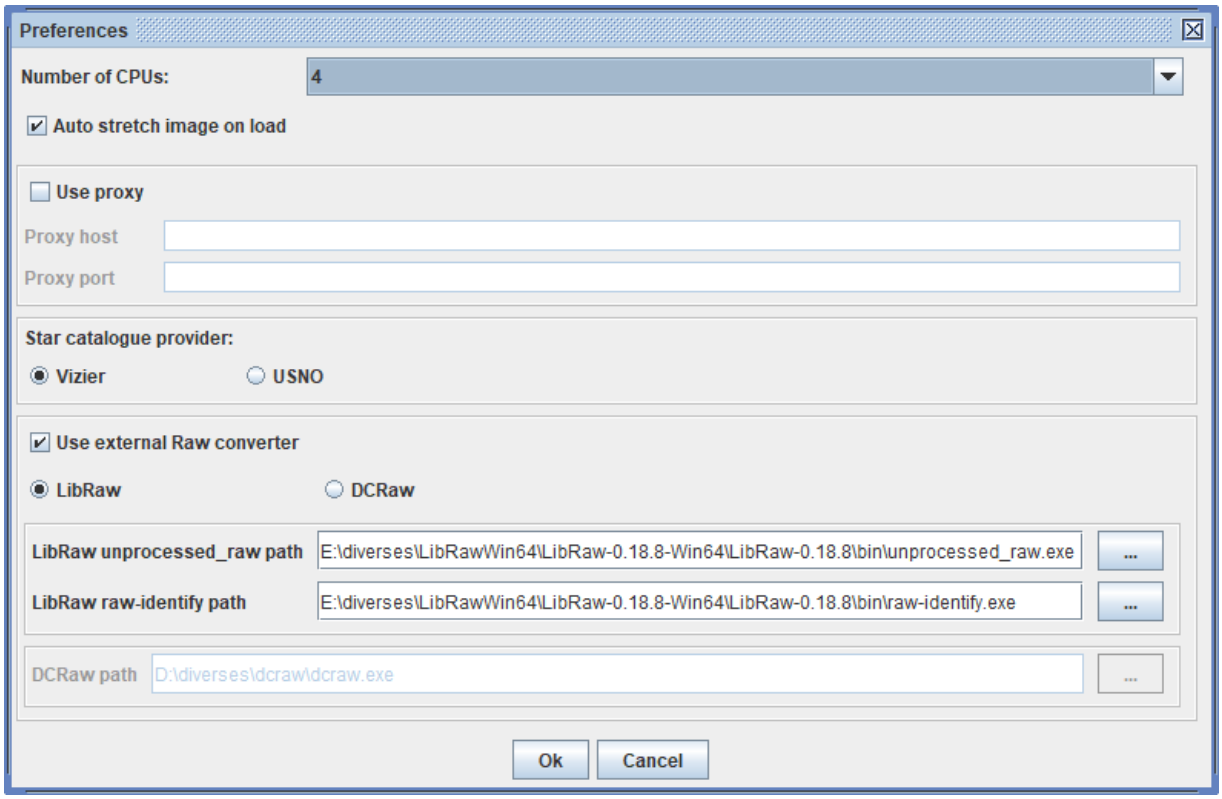
Setup defect list...	opens the dialog to set up defect lists (column or pixel defects) for monochrome CCDs.
Setup darks...	creates a master dark from several files. The files are median combined.
Setup flats...	creates a master flat from several files. The files are median combined.
Preprocessing..	does a complete data reduction (dark and flat, repair of column defects, deblooming, registration, preview and combination) for several image files.

5.7 The Tools Menu

Plate solve	does a plate solving. The exact coordinates, size and orientation of the image are calculated and written into the Fits header.
Star List	Shows a list of stars that the image contains.
Photometry	Opens the photometry dialog.

6 Preferences

You will find the preferences under ***Preferences*** in the ***File*** menu. The following dialog will appear:



Number of CPUs	Here you can set the number of CPUs that you want Regim to use. Based on this setting Regim will use a number of parallel threads for processing. For a computer with quad core CPU you should set this value to 4.
Auto stretch on image load	Causes to auto stretch an image view right after loading.
Use Proxy	This is important for all functionality that require an internet connection (automatic color calibration, plate solving). If your computer requires a proxy for internet connection, so choose this option and fill the two fields. In a home network you probably do not need a proxy.
Proxy host	Enter the name or IP address of the proxy.
Proxy port	Enter the port of the proxy.
Star catalogue provider	Defines the provider for downloading star catalog data that is used for plate solving and color calibration. Vizier is recommended as it is faster and more reliable.

Use external Raw converter	To use an external raw converter instead of jrawio for reading raw files select this option. Unfortunately the development of jrawio has come to an halt some time ago. That means that newer cameras may not be supported. If you use a relative new camera you better use one of the external converters.
LibRaw	To use LibRaw as raw converter select this option.
DCRaw	To use Dcraw as raw converter select this option.
LibRaw unprocessed_raw path	If you have “LibRaw” selected you need to set the path to the program “unprocessed_raw” on your system using the button with the three dots (usually in the bin folder of LibRaw).
LibRaw raw-identify path	If you have “LibRaw” selected you need to set the path to the program “raw-identify” on your system using the button with the three dots (usually in the bin folder of LibRaw).
DCRaw path	If you have “DCRaw” selected you need to set the path to DCRaw on your system using the button with the three dots.

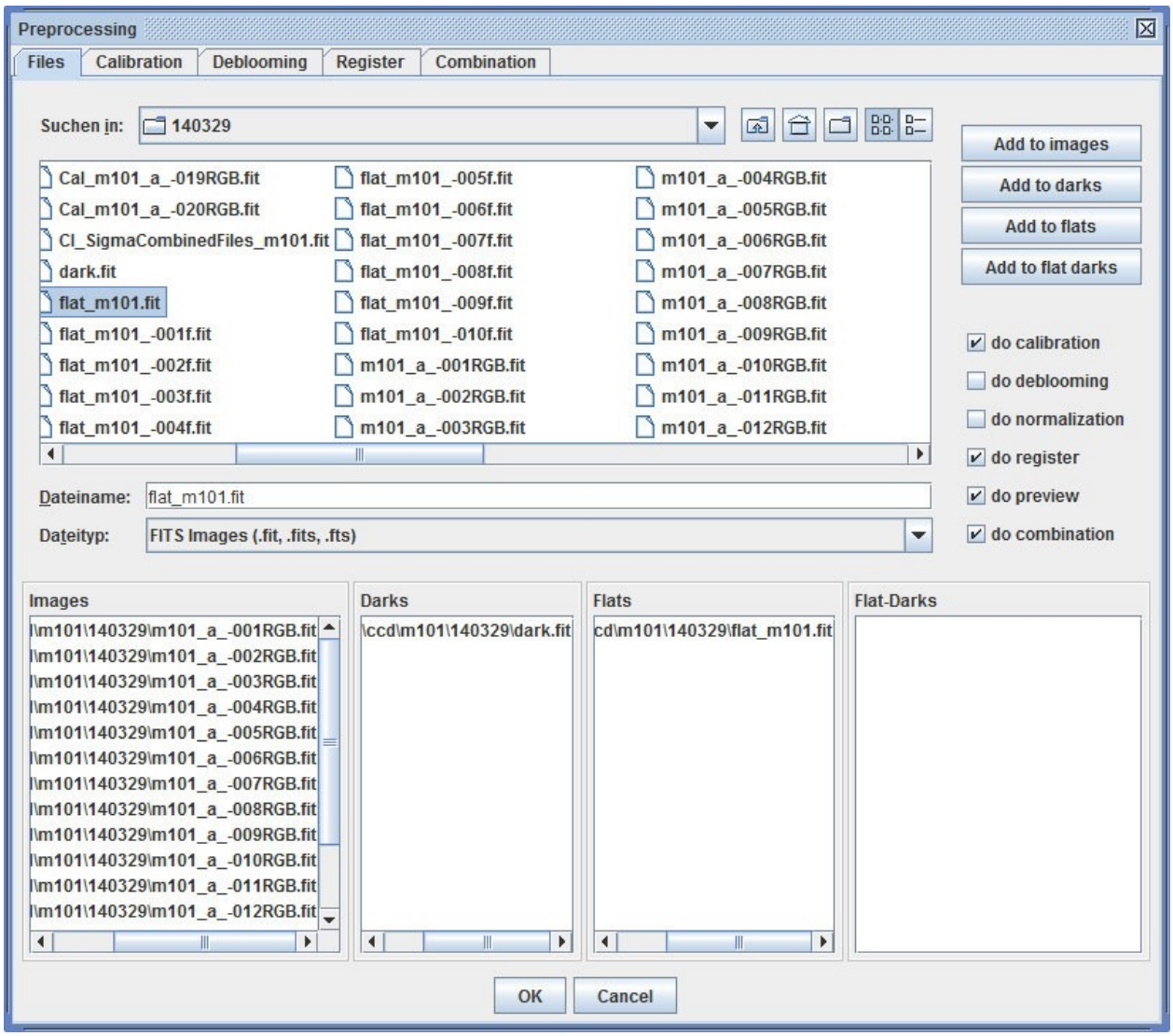
7 Calibration of raw images and preprocessing

7.1 Preprocessing

For calibration and base processing steps the ***Preprocessing*** functionality is used. It can be found in the ***Preprocessing*** menu. It is a very powerful functionality. Within one action you can

- calibrate raw images (dark- and flatfield calibration, repair pixel defects, debayering of raw color images)
- debloom images
- do registration of images
- preview the images
- combine the images.

The following dialog will appear:



There are five checkboxes to activate the processing steps:

do calibration	activates the calibration
do deblooming	activates the deblooming
do normalization	activates the normalization. This is the same as the operation “normalize background” on the “Register” tab and is only needed if normalization should be run separately.
do register	activates the registration
do preview	activates the preview prior to the combination. It allows you to throw out bad images.
do combination	activates the combination

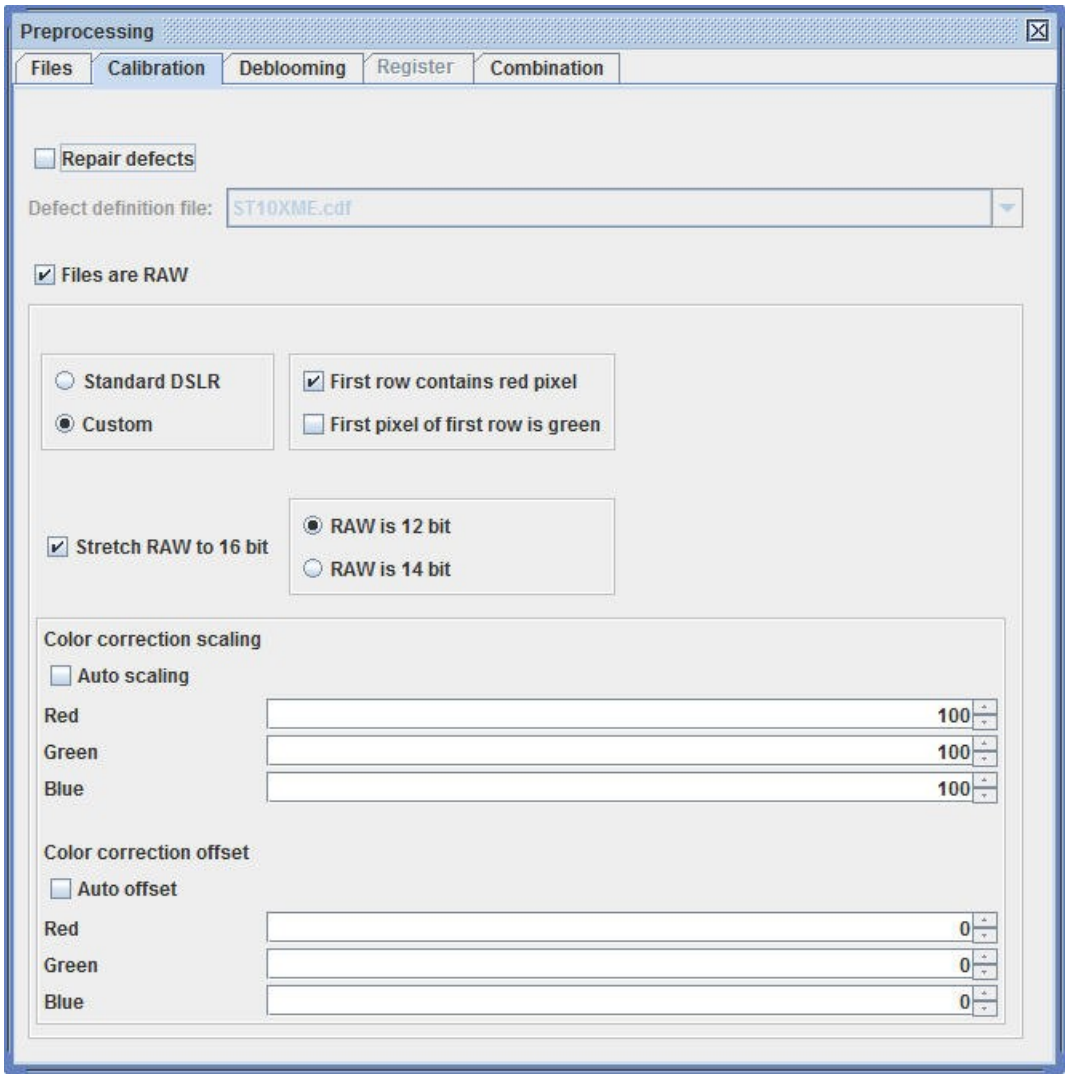
For four of these there exists a tab on top of the dialog where you can modify the settings for the according functionality. The settings are explained in the chapters of the corresponding functionality.
The dialog also contains a file chooser to select the files to process. Simply drag & drop them into the four lists below the file chooser or use the four buttons on the right to assign the files to the corresponding lists. The list are:

Images	the list for the images to process. The first file in the list will be used as masterframe for the registration. If you want to use a specific file as master, add it as first file to the list and then add the rest.
Darks	the list for the dark frames. You can add a set of darks or a masterdark.
Flats	the list for the flat frames. You can add a set of flats or a masterflat.
Flat Darks	the list of darks (or bias) for the flat frames. If you have a masterflat that is already dark/bias calibrated, leave this list empty.

Once your settings are complete click **OK**. The preprocessing will now be started and a new dialog appears that shows the progress. The results of each step are saved with a corresponding name prefix. If you activated the function ***do combination***, you should see the combined image once the preprocessing is complete. You can now save it

7.2 Calibration

Calibration is done via the function ***Preprocessing***. The chosen images will be dark and flat calibrated. Additional settings can be made on the tab ***Calibration*** in the ***Preprocessing*** dialog:



Repair defects	here you can set if you want to repair pixel/column defects of your CCD sensor. If this option is activated you can choose an existing defect list. You need to define a defect list first under ***Preprocessing → Setup defect list***.
Files are RAW	specifies that the images are color images in raw format. This could be images from a DSLR or a one shot color (OSC) CCD camera. Do **NOT** set this option for images from a monochrome CCD.
Standard DSLR	For DSLR-RAWs. The pattern of the Bayer-Matrix will be automatic determined.
Custom	For raw OSC-CCD images or DSLR-RAWs where the Bayer-Matrix can not be automatic determined. In this case two additional checkboxes to the right become active.
First row contains red pixel	To be set if the first row of the raw image contains red pixels.
First pixel of first row green	To be set if the first pixel of the first row represents green. Both parameters must be set in a way to match the pattern of cameras Bayer-Matrix. It may be that you must find out by trial and

	error. A daylight image showing red, green and blue areas is best for this.
Stretch RAW to 16 bit	This option allows you to stretch raw images from a DSLR that usually have 12 or 14 bit depth to 16 bit after calibration but prior to debayering. It is recommended to choose this option because otherwise the images will appear quite dark. If you activate this option choose the right setting (12 or 14 bit) for your DSLR model.
Color correction scaling	Because raw images often have a color cast, youn make scaling corrections here. The values are in percent.
Color correction offset	Offset for the color correction. The values will be added to the corresponding color channel..
Auto scaling	tells Regim to try to automatic calculate the scaling corrections.
Auto offset	tells Regim to try to automatic calculate the offset corrections.

7.3 Create Masterdark

To create a master dark choose ***Setup Darks*** in ***Preprocessing*** menu. A file chooser will appear to select all the dark frames for the master dark. The created master dark will be shown in a new window and can then be saved. You can use this master dark later during the preprocessing instead of the single dark frames.

Standard Masterdark

To create a standard masterdark simply use the dark frames you want to combine. Do **not** use additional BIAS frames.

Scaled Masterdark

If you want to scale your darks to a different exposure time, set the option “Scale darks”, enter a “Scale factor” and add BIAS frames to the list on the right side.

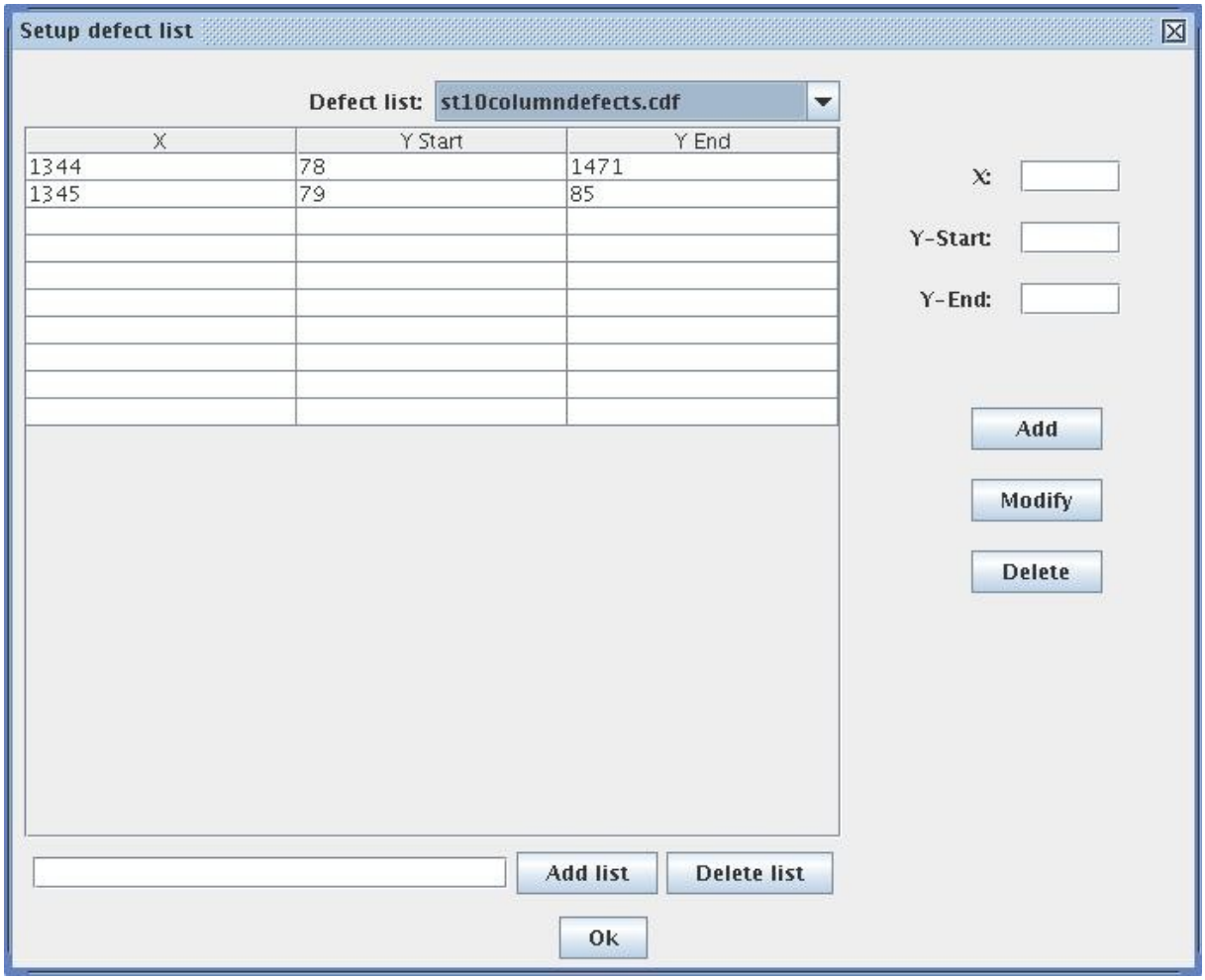
Note:	If possible always use standard masterdarks. From my experience scaled masterdarks are only an option if appropriate darks are not available.

7.4 Create Masterflat

To create a master flat choose ***Setup Flats*** in ***Preprocessing*** menu. A file chooser will appear to select all the flat frames and the darks/bias for the flats (optional). The created master flat will be shown in a new window and can then be saved. You can use this master flat later during the preprocessing instead of the single flat frames.

7.5 Create/Modify defect list

To create a defect list for repair of pixel/columndefects on a monochrome CCD choose ***Setup defect list*** in ***Preprocessing*** menu. The following dialog will appear:



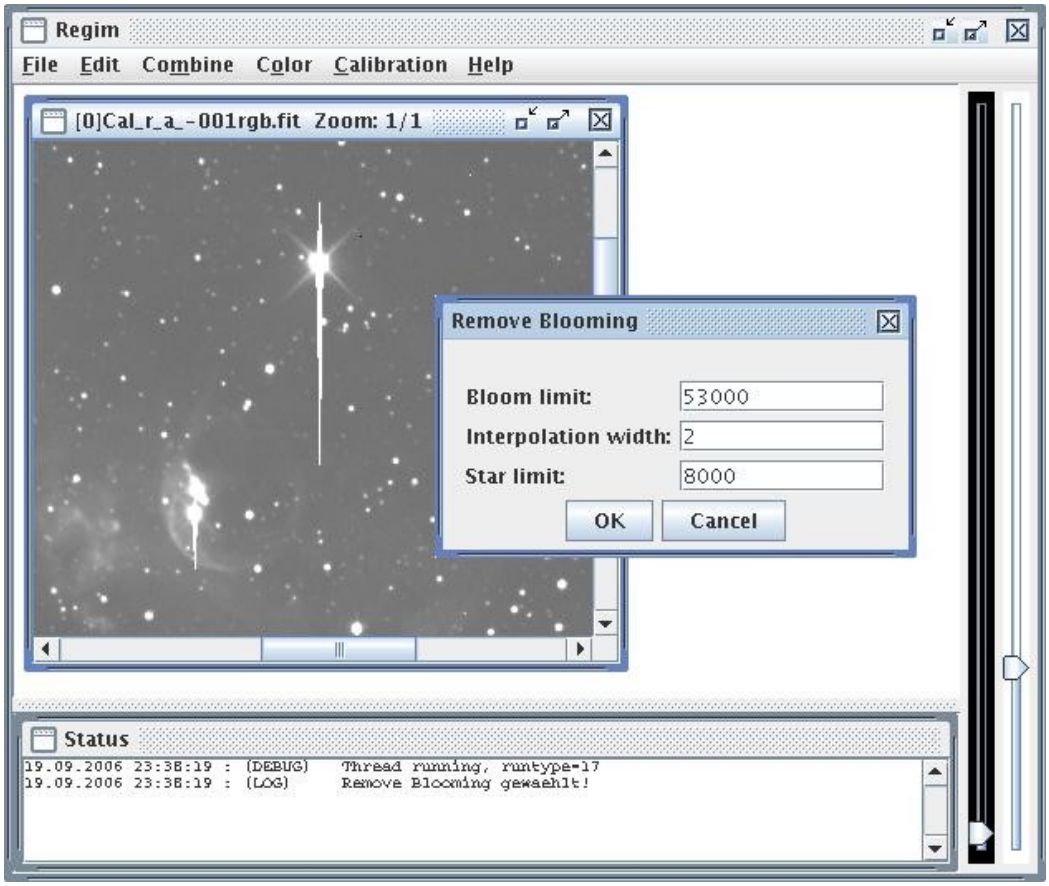
Here you can create defect list for different cameras and add column defects. To find the precise coordinates of the defect pixels/columns it is recommended to use the ***Edit Pixel*** functionality.
The created defect lists can later be selected during ***Preprocessing*** on the tab ***Calibration*** to do the repair of the defects during calibration.

8 Deblooming

8.1 Remove Blooming in an open image

Images created with a CCD camera without antiblooming (e.g. SBig ST10XME) show blooming on bright stars. These bloomingspikes can be removed with the function ***Remove Blooming*** in ***Edit*** menu or during ***Preprocessing***. The following dialog will appear:

Bloom limit	sets the lower brightness value for the search for blooming. All values higher than the specified one will be treated as blooming. The exact value needs to be tested on one image of a series to get the best result. It may vary depending on the used equipment and sky conditions.
Interpolation width	sets the width of the interpolation interval left and right of the blooming spikes. The pixel values left and right of the blooming spikes are used to calculate the new values of the pixels that are covered by the blooming spikes. Also this value needs to be tested on one image. From my experience values of 2 or 3 should deliver good results.
Star limit	sets the lower brightness value to determine if an pixel lies within a star. This value is used by the program to decide if blooming is within or outside a star. The interpolated values will then held a bit higher to maintain the shape of the star. This value should always be significantly higher than the sky background, but as low as possible. It is recommended to test this setting on one image before running over a complete series. The correct value may also depend on the filters used.



Deblooming should be done on single exposures that have been at least dark calibrated but have not been undergone additional processing.

Note: After deblooming the stars center may appear a bit darker than the rest of the star. This effect will most likely disappear once the final image is stretched.

8.2 Remove Blooming in many images

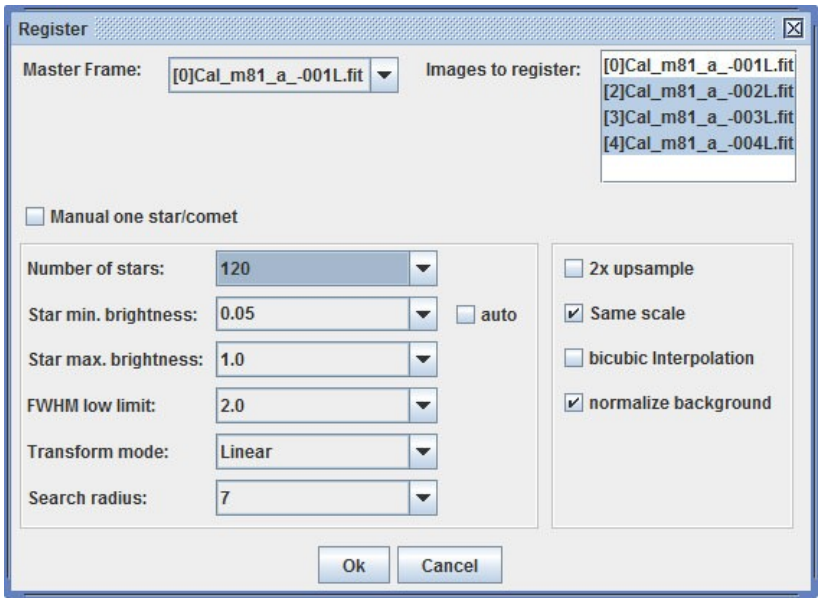
The function ***Remove Blooming from Files*** does the deblooming for a large number of image files. There will appear a f file chooser first to select the images. Afterwards there will appear the dialog that was described in the previous chapter to set the parameters. The debloomed image files will be saved with the prefix **Dbl_** in the same directory

Note: This functionality is also available under ***Preprocessing***.

9 Register images

9.1 Register opened Deep Sky images

To register two or more opened images on each other there is the function ***Register*** in ***Edit*** menu. The following dialog will appear:



Master Frame	choose here the image where all other images should be registered on.
Images to register	here choose the images that should be registered to the master. Only those images will be processed that you explicitly highlighted in this list.
Number of stars	sets the number of stars that are used by the search algorithm. A lower number causes faster processing and lower memory consumption but if the number is too low the accuracy will be compromised or there may be even no matching pattern found at all.
Transform mode:	Transformation mode for the images to register. At the moment always linear.
Star min. brightness:	sets the minimum brightness for detecting a star. A value of 0,2 means that a star must have at least 20 percent of the maximum image brightness. This value must be set depending on the overall image brightness. If not enough stars are found you should lower the value. On the other hands if the program starts to detect background noise as stars, choose a higher value. Pay attention to the status window. There Regim makes an output how many stars were found. If less than 20 stars per image are found registration may fail. This is the most important parameter for registration.
Star max. brightness:	sets the maximum brightness for detecting a star. Bright stars that are in saturation or even bloomed are not well suited for

	registration. With this parameter they can be avoided. A value of 0,8 means that a star must have not more than 80 percent of the maximum brightness of the image.
FWHM low limit	sets a lower limit for the FWHM of detected stars. Stars with a FWHM lower than this value will be discarded to avoid detecting hot pixels and other small artifacts as stars.
Search radius	sets the radius for the star search if an bright spot in the image was found. The value depends on the sampling of the image (arc seconds per pixel).
2x upsample	if set all images are upsampled to double size before registration. This will allow a slightly more precise registration and you may gain some resolution (drizzling or dithering).
same scale	if all images have the same scale (this is usually the case if all images have been created with the same setup), you should select this option. It allows Regim to detect false match patterns during registration. Otherwise deselect this option because it will prevent Regim from finding a match pattern.
bicubic interpolation	switches interpolation on or off. For images that are oversampled (small pixels combined with long focal length) I would recommend to switch it off.
normalize background	if selected Regim will bring the background of all images to the same value (that of the master frame). This is important when the images are later combined using the Sigma or SD method.

Click ***Register*** to start the registration process. After successful registration the registered images will be shown in new windows.

Note:	If you want to register a larger number of images it is recommended to use ***Register Files*** or ***Preprocessing***.

9.2 Register many images

To register a larger number of images there is the function ***Register Files*** in ***Edit*** menu. There will appear a file chooser to select all images to register. Afterwards the same dialog appears that was described in the previous chapter. The registered images will be saved with the prefix **Reg_** in the same directory..

Note:	This functionality is also available under ***Preprocessing***.

9.3 Register comet images on comet

To register comet images on the comet proceed in the same way as for registering deep sky images described in the sections above. In the dialog check the option ***Manual one star/comet***. During the registration process you are asked to click the comet head with the mouse for each image. Regim then tries to calculate the center of the comet head and uses this position for the registration process.
Sometimes if the comet is close or right in front of a star it might happen that Regim takes the star as the center of the comet head. To prevent this you can hold the SHIFT key while

clicking with the mouse. In this case Regim takes the exact position of the mouse cursor and does not try to calculate the comet heads centroid.
To eliminate a possible rotation of the images it might be a good idea to register the images on the stars prior to the registration on the comet.

9.4 Register opened images of the sun or moon

To register two or more opened images of the sun or moon (e.g. for an animation) you can use the operation ***Register Sun*** in ***Edit*** menu.

Note: This is a very basic operation. It only works if the whole disk of the sun or moon is on the image.

9.5 Register many images of the sun or moon

To register a larger number of images use ***Register Sun Files*** in ***Edit*** menu. A file selector dialog will appear that allows to select the images for registration.

10 Normalize background

10.1 Normalize background of opened images

The function ***Normalize Background*** can be used to bring the background of several images to the same level. This is helpful if the images should later be combined using the Sigma- or SD-Mask method. These combination methods work more efficient if the background is normalized. The following dialog will appear:

Choose the image as master that should define the standard for the background level. On the right side mark the images that should be adapted to the master.

10.2 Normalize background of many images

Use the function ***Normalize Background in Files*** to do normalization for a larger set of images without opening them all..

11 Geometric operations

11.1 Double image size

To double the with and height of an image use the operation ***Upsample 2x*** in ***Edit*** menu. A bicubic interpolation is used during upsampling.

11.2 Rotate image

To rotate the current image you can use the operation ***Rotate*** in ***Edit*** menu.

11.3 Flip (mirror) image in X direction

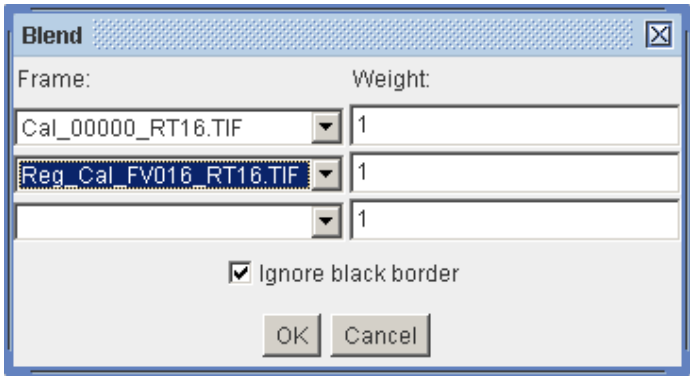
To Flip (mirror) the current image you can use the operation **Mirror X** in **Edit** menu.

12 Combination of images

Note: The combination operations are also available under ***Preprocessing***.

12.1 Average combination of opened images

The average combination of several images may be used to improve S/N. The images should have been registered prior to this operation and must have the same size. To combine two or more images using the average use the operation ***Blend*** in ***Combine*** Menu. The following dialog will appear:



Frame	Select the images to average.
Weight	Here you could enter a weight factor for each image. The information of the corresponding image will be multiplied with the weight prior to averaging. This may be used to handle different exposure times of the single images.
Ignore black border	During registration of images there often appears a black border on one or two sides of an image. If this option is set these black borders are ignored during the blend operation and only information from images that have real data for that areas is used.

12.2 Average combination of many images

To average a larger number of images use the operation ***Blend Files*** in ***Combine*** menu. There will appear a file chooser to select all the images. The images should have been registered prior to this operation and must have the same size. The resulting combined image will be opened in a new window and can then be saved.

12.3 Median combination of opened images

The handling is the same as for average combination but the median is used instead of the average.

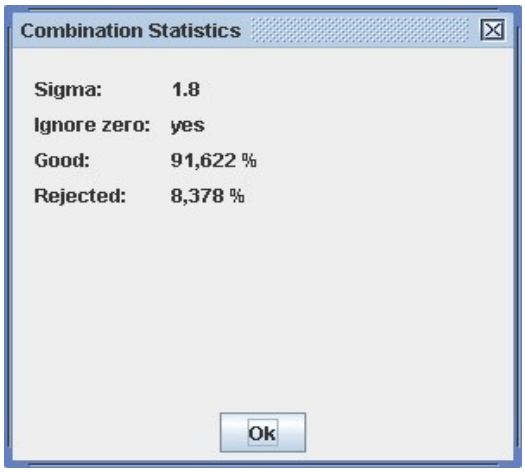
12.4 Median combination of many images

The handling is the same as for average combination but the median is used instead of the average.

12.5 Sigma combination of opened images

The handling is the same as for average combination but the Sigma method is used instead of the average. This method combines the advantages of average and median while avoiding the disadvantages. During combination the empiric standard deviation for each pixel is calculated and only those values that lie within a certain interval. The interval results from the median ± the standard deviation multiplied with a given sigma value. This allows the elimination of outliers like cosmics, satellite or airplane tracks while “good” values are used for averaging and therefore contribute to increase the S/N ratio.

After combination a window with the statistics is shown. It may be used to judge the result. The sigma value should be set to a value that results in a low value of rejected pixels while outliers are still eliminated.



12.6 Sigma combination of many images

The handling is the same as for average combination but the Sigma method is used instead of the average. The dialog for sigma combination will appear with the previous selected files. The sigma value may be changed. The default is 1.8.

12.7 SD-Mask combination of opened images

The handling is the same as for average combination but the SD-Mask method is used instead of the average. This method combines the advantages of average and median while avoiding the disadvantages. During combination the empiric standard deviation for each pixel is calculated and only if the standard deviation does not differ to much from the average standard deviation the values are averaged. Otherwise the median is used. The allowed

difference is calculated from the average standard deviation multiplied by the given sigma value. This allows the elimination of outliers like cosmics, satellite or airplane tracks while “good” values are used for averaging and therefore contribute to increase the S/N ratio.

After combination a window with the statistics is shown.

12.8 SD-Mask combination of many images

The handling is the same as for average combination but the SD-Mask method is used instead of the average. The dialog for SD-Mask combination will appear with the previous selected files. The sigma value may be changed.

12.9 Maximum combination of opened images

The handling is the same as for average combination but the maximum method is used instead of the average. The brightest pixel will be used as the result. This may be useful when combining images through emission line filters (e.g. Hα and OIII) to a single luminance image. Another case would be the combination of star trail images.

12.10 Maximum combination of many images

The handling is the same as for average combination but the maximum method is used instead of the average.

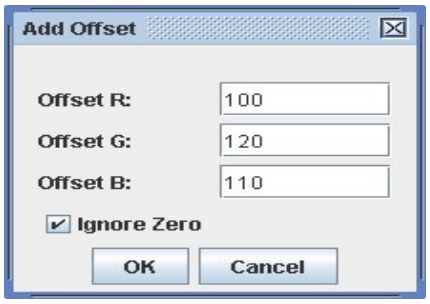
12.11 Subtraction of images

To subtract an image from several others the operation ***Subtract Files*** in ***Combine*** menu may be used. The current opened image will be subtracted from selected image files. All images must have the same dimensions and type (FITS or TIFF).

13 Gradients and Offset

13.1 Add Offset

This operation in ***Edit menu*** may be use to add (or subtract) an offset per channel to an image. The following dialog will appear:



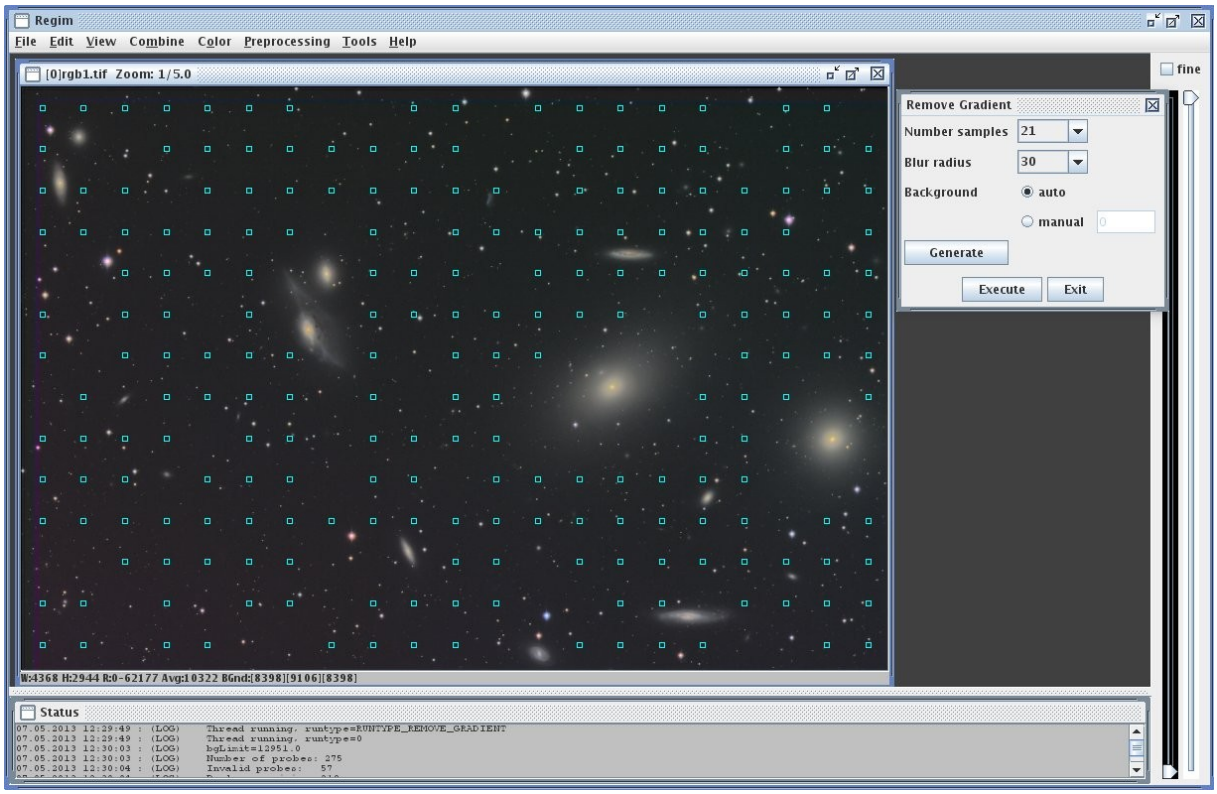
The given values will be added to the corresponding channel. To subtract values simply use negative values. If the resulting value would be below zero or greater than 65535 it will be limited by these values.

The option ***Ignore Zero*** causes that value that are zero will remain unchanged.

13.2 Gradient removal

Images often show unwanted gradients. These can be removed with the operation ***Remove Gradient*** in ***Edit*** menu. This operation should be used preferably on images that are already more or less completely processed. Regim creates based on probes within the image a profile of the background. This background profile will then be subtracted from the image to remove the gradient. The problem is to separate the background from the foreground (stars, galaxies, nebulae etc.). So the probes need to be placed in a meaningful manner. The dialog offers the following options:

Number samples	Defines how many probes will be place over the width of the image. Higher numbers will result in a more detailed background model.
Blur radius	The radius used to blur the background model (not the image background!). Large values often deliver better results.
Background auto/manual	To place the probes only on the background Regim must define the background. This can be done automatically or you can define a value manually. You can get a feeling for the right value if you move the mouse over the image background and take a look at the values shown on the status bar of the image.
Generate	Starts the generation of the probes. The position of the probes are shown as small squares within the image. There should be no square on foreground objects while the background should have a sufficient coverage. If necessary you can set ore remove additional probes with the mouse.
Execute	Once you are satisfied with the distribution of the probes you can start the processing with this button. The background model will be calculated, opened as a separate image and subtracte from the image.
Exit	Leaves the dialog.



Note It might be necessary to correct the brightness of the image slightly after gradient removal. This operation only removes gradients but does not correct the overall color balance.

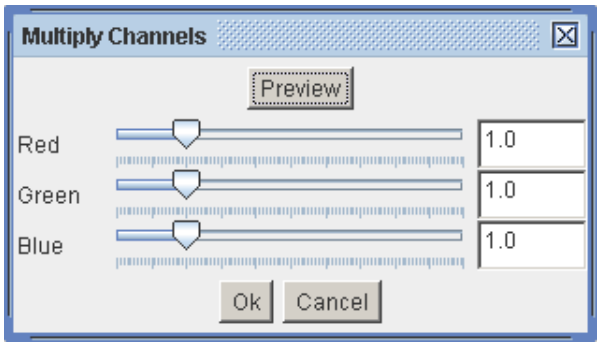
14 Color manipulation

14.1 Combine RGB image

To create a color RGB image from single color channels use the function ***Combine Channels*** in ***Color*** menu. First open the three images that represent you color channels and then choose this menu option. Then assign the images to the corresponding color channels.

14.2 Color channel manipulation

The weight of color channels might be changed with the operation ***Multiply Channels*** in ***Color*** menu. The following dialog will appear:

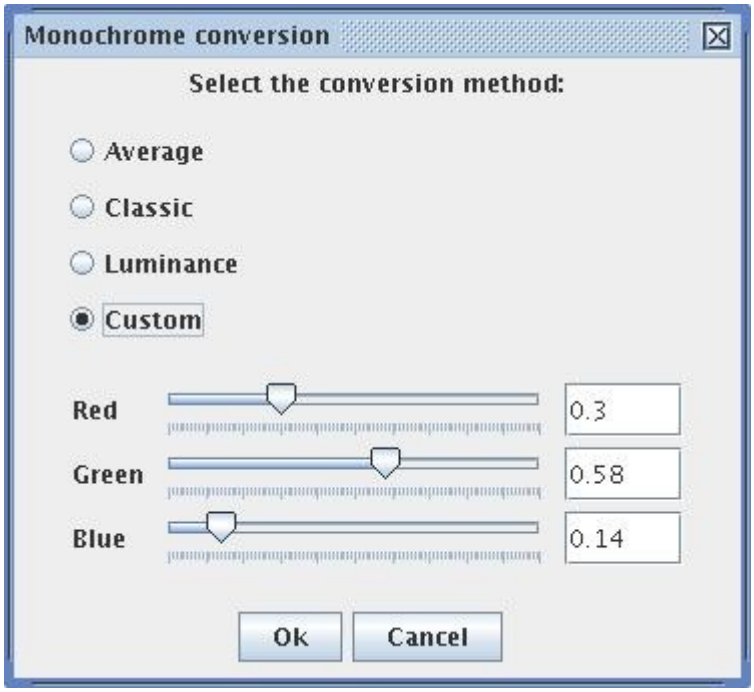


With the three sliders or the entry fields you can multiply the color channels with a certain value. You can judge the changes by pressing the ***Preview*** button. The changes will become active after leaving the dialog with ***Ok***.

14.3 Convert RGB to monochrome

To create monochrome image from a RGB image use ***Monochrome*** in ***Color*** menu. There will appear a dialog to set the conversion parameters. The following options are available:

Average	all color channels will be used at the same weight.
Classic	the classic monochrome conversion with stronger weight on the green channel. This is derived from the human physiology.
Luminance	extracts the luminance from the image.
Custom	here you can choose your own weight for each channel.

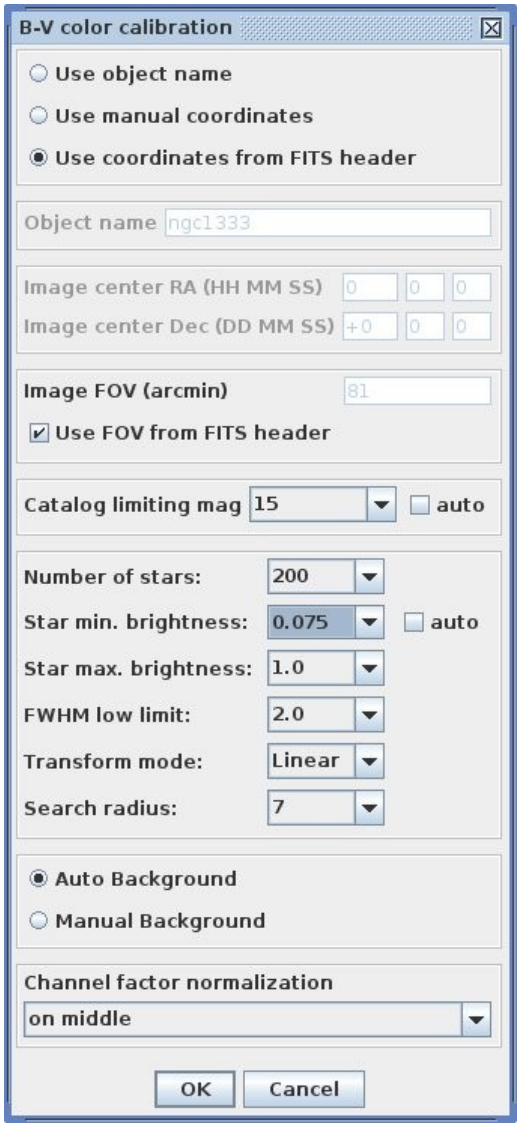


Choose the option you find best.

14.4 Automatic color calibration using star colors

Color calibration of astronomical images is a difficult task. Often a calibration using a G2 star is recommended. Unfortunately the spectral type is not available for most stars and those contain only a small number of type G2. Especially if the image field is small, the chance of having a G2 star in the field is low. A solution is to use the color index (B-V) of stars for calibration. The color index is available for a significantly higher number of stars and therefore the possibility to have several of them in your image field is higher. The idea behind is as follows: Find a start in your image with known color index (B-V). For this color index Regim knows the corresponding color. The system will now change the color scale in a way that the star has the correct color. Additionally the image background will be changed to show a neutral color. The method is explained in detail in the article by P. Riepe and H. Tomsik in VdS-Journal[1].
The automatic color calibration in Regim uses this method. It is nor necessary to select the stars by hand. Regim will look for the stars and does a plate solving against the star catalog (NOMAD). It will uses up to 200 stars to calculate the color correction. In rare occasions when no plate solving works, the manual version of the method may be used.
After choosing ***Automatic B-V Color Calibration*** in ***Color*** menu the following dialog will appear:

1 P. Riepe, H. Tomsik, Die Farben der Sterne, VdS-Journal Nr. 25 S. 53ff & VdS-Journal Nr. 26 S. 48ff
H. Tomsik, P. Riepe, Farbkalibration einer CCD-Aufnahme mit Hilfe von G-Sternen, VdS-Journal Nr.25 S. 57ff & VdS-Journal Nr. 26 S. 50ff



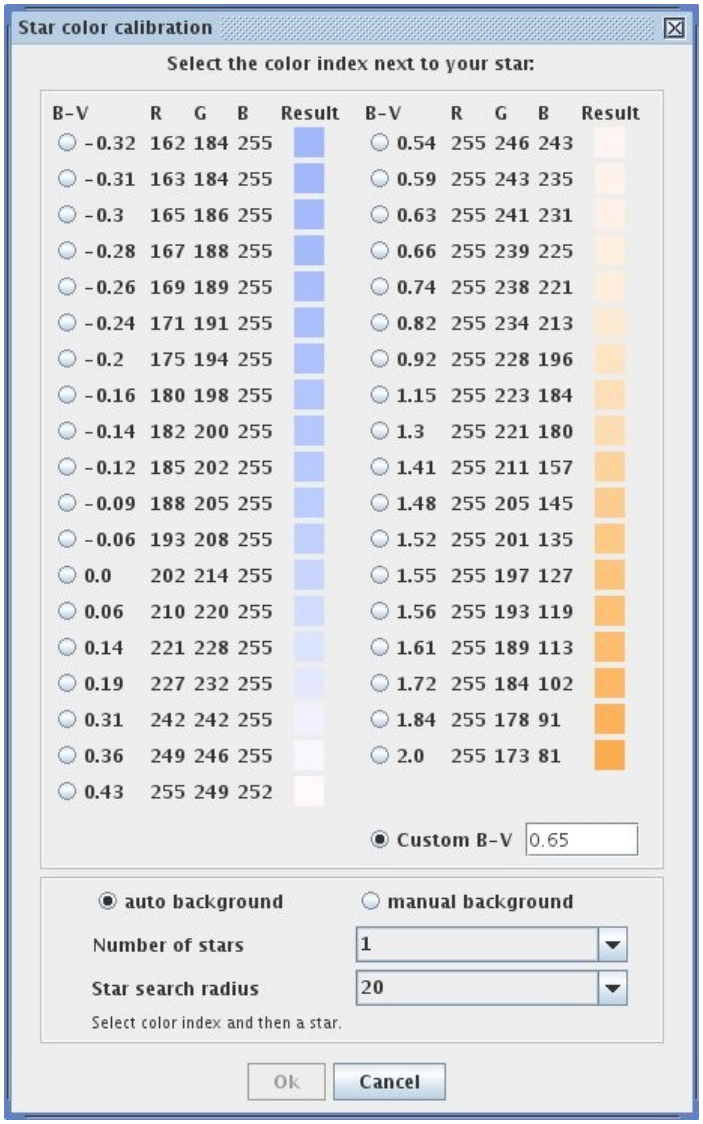
Use object name	To find the stars in the star catalog the program needs to know in which field is has to search. If you select ***Use object name*** you can enter the catalog designation (e.g. M94, NGC2403 or Collinder399) of your object in the field below. The object should be more or less in the center of the image. The object name will be looked up via the internet service Simbad. If the object name can not be found in Simbad you can use ***Use manual coordinates*** and enter the equatorial coordinates of the image center instead. If your image contains valid coordinate information in the FITS header you can also select the option ***Use coordinates from FITS header***.
Object name	Here you can enter the catalog designation of your object.
Image center	Here you can enter the equatorial coordinates of the image center.
Image FOV	Here you can enter the size of the image field in arc minutes. For rectangular fields use the longer side of the rectangle. Do not use a value significantly larger than your field because that may lead to problems identifying the correct stars. If your

	image contains the needed information in the FITS header you can also select the option ***Use FOV from FITS header***.
Number of stars	to Search radius. These parameters influence the search for stars within the image and they are described in the chapter about image registration.
auto background	If set Regim tries to find the background values. This will work well in most cases.
manual background	If set Regim will prompt you to select a background region in the image with the mouse. This is useful if your image contains large nebulae. Choose a dark neutral background area.
Note:	An internet connection is required for this operation to query the Simbad and the NOMAD catalog. See also chapter 6.Preferences

When the program tries to match the stars in the image against the stars from the catalog an additional window is shown with the distribution of the catalog stars. This window allows you to compare the match patterns and may be closed after color calibration.

14.5 Manual color calibration using star colors

This function is based on the same principles as the one described in the previous chapter but the star selection is done manually.
Open the image you want to calibrate and identify one or up to 5 stars with known color index (e.g. with your planetarium program or Simbad/Aladin). With ***Manual B-V Color Calibration*** in ***Color*** menu you will see the following dialog:



Select the color index from the list that is closest to the one of your star or select ***Custom B-V*** and enter the value.

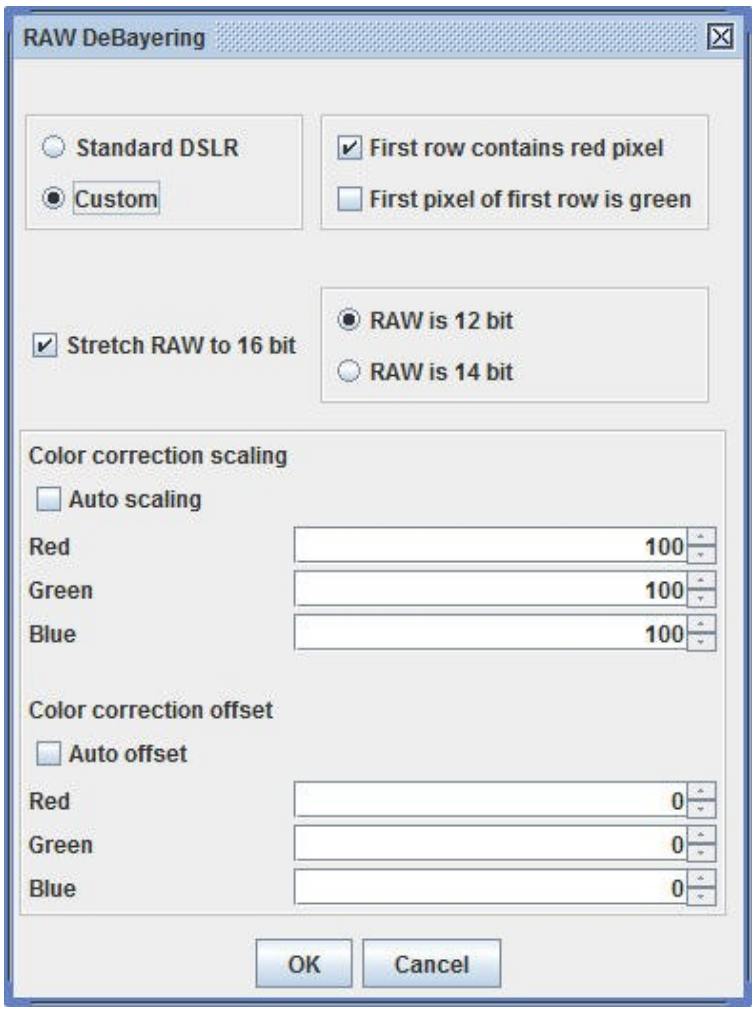
auto background	if this option is set Regim tries to evaluate the background. In most cases this will work very well.
manual background	if set you can choose an area of the image that should represent the background with the mouse. Select an dark neutral area.
Number of stars	defines how many stars are used for the calibration.
Star search radius	the radius for star detection. If you click on a star Regim tries to exactly get hold of it within the given radius. The best value depends on the sampling of your image.

After selecting the color index click on the corresponding star within the image. You may repeat this up to 5 times (setting Number of stars). The selected stars will be marked with a circle. After selecting the stars click ***OK*** and the color calibration will start. If you have selected ***manual background*** you will be prompted to select the background region with the mouse.

Note: This operation is only available for RGB images.

14.6 Convert RAW images to RGB

This is done by the operation ***RAW Debayering*** in ***Color*** menu. The following dialog will appear:



The description of the parameters can be found in chapter 7.2.Calibration.

14.7 NoLiGCRA

This strange word stands for „Non linear gradation color retrieval algorithm“. It is a method developed by Harald Tomsik and Peter Riepe that allows to stretch a RGB image without changing the color ratio of the pixels. The basics of this method can be found in the corresponding article[2].

To use this method you must first create a monochrome image from the RGB image. The histogram of this monochrome image can now be stretched using a software of your choice. Afterward this stretched monochrome image will be used to stretch the RGB image within the NoLIGCRA procedure. If you have already a luminance image it can be used instead of creating a monochrome image from the RGB data.

These are the steps:

1. Open the RGB and the stretched monochrome image.
2. Select from the ***Color*** menu the operation ***Non linear gradation color retrieval***.
3. A dialog with two select boxes will appear. Select under Luminance frame the stretched monochrome image and under RGB Image the original RGB image.
4. Click OK.

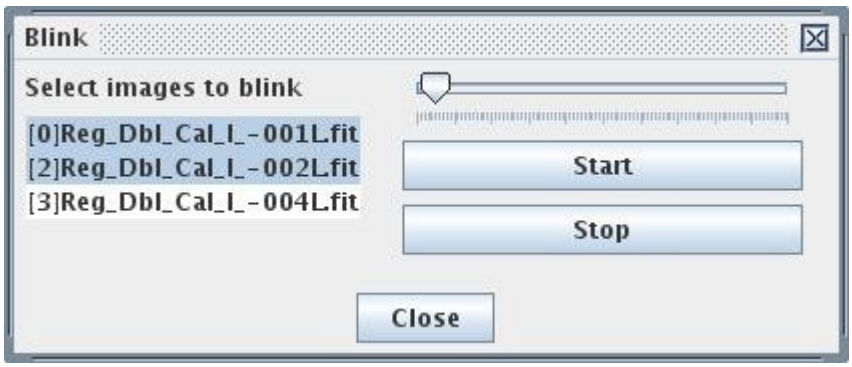
After a short time the stretched RGB image will be opened in a new window.

2 H. Tomsik, P. Riepe, NOLIGCRA eine Reise durch das All, um der Farbe willen, Sterne und Weltraum 04/2009 S. 86ff

15 Blink comparator

15.1 Blinking of opened images

To blink several opened images select ***Blink*** from the ***View*** menu. The following dialog will appear:



Highlight the images you want to blink on the box on the left side. Click on ***Start*** to start blinking. Click ***Stop*** to stop blinking. The slider allows to set the blink rate.

The blink comparator can be used for the following purposes:

1. To check if image registration is ok.
2. To look for moving objects (comets, minor planets etc.).

15.2 Blinking of many images

If you want to blink a large number of images it is recommended to use the function ***Blink Files***. A file chooser will appear to select all images you want to blink. Then the dialog described in the previous chapter appears. The images are then loaded in a cycle. This allows to blink an unlimited number of images.

Note: The files are loaded cyclic into an internal buffer to allow blinking without delay. The standard size of the buffer is four. That means there may be up to four images in the buffer. If you have very large images it may happen that your run out of memory. In such cases the buffer size may be reduced. To do so change the value of the parameter ***blinkFifoSize*** in the file ***regim.properties***.

16 Visualization

16.1 Setting black and white point

On the right side of the program window there are two sliders. These sliders can be used to set the black and white point for the current image window. This may be helpful to make weak details in an image visible. If you have set the settings and want to do a further stretch you can use the ***fine*** option. This sets the sliders back, but leaves the value range you set. Then the sliders cover the remaining intervall.

Important note: This setting just changes the current visualization on the screen. The image data will not be changed.

16.2 Equalize Visualization

If you have several images open you can apply the visualization settings of the current image to all other images. First set the settings for the current image as described in the previous section. Then choose ***Equalize Visualization*** from the ***View*** menu. The black and white point will then be set for all open images.

16.3 Auto Stretch

In the menu ***View*** you will find the operation ***Auto Stretch***. This operation causes that the black and white point are set close to the average brightness value of the image. This is useful for a quick evaluation of images. This operation is also available via the popup menu of an image or by pressing F4.

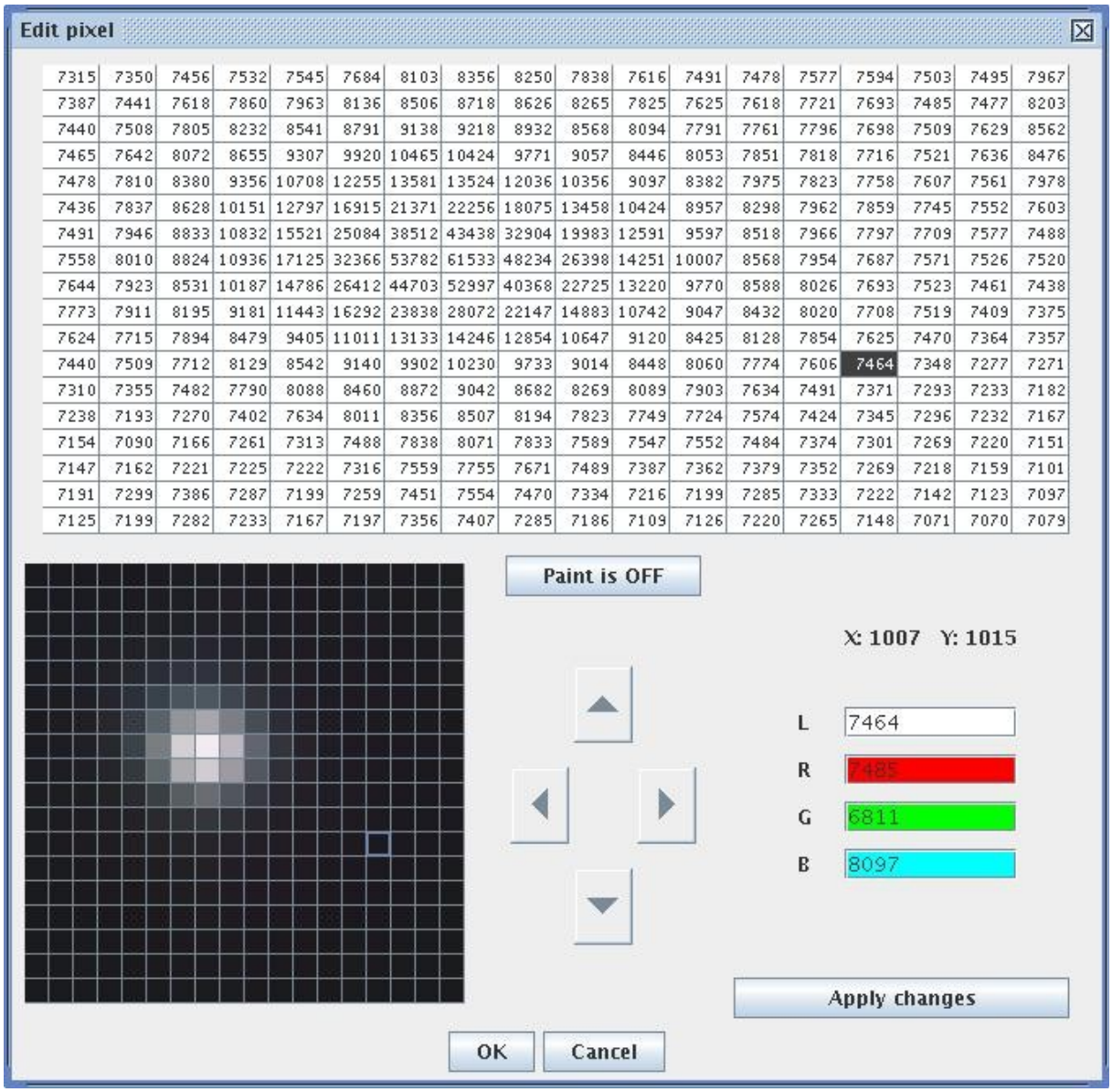
16.4 Image zoom

Regim tries to show an image completely in a window after loading. Therefore the image may be shown scaled down. The current zoom level is shown in the title bar of the image window. You can change the zoom level (from 1/1 to 1/19) via the image popup menu (right click into the image) or via the keyboard (using the keys +, - and 1).

Important note: This setting just changes the current visualization on the screen. The image data will not be changed.

17 Edit Pixel

The function ***Edit Pixel*** can be found via the popup menu (right click into the image) of the image. The following dialog will appear:



The options will be explained in the following sections.

17.1 The display elements

Within the window the pixels are shown. On the upper table the brightness values are shown while on the lower left you will see the image representation. With the mouse you can select a single pixel. The exact position and the values of the channels for that pixel are shown on the right side. The visualization settings (black and white point) are the same as for the corresponding image window.

17.2 Editing

After selecting a pixel you can edit the pixel data in the following ways:

- By entering values into the entry fields on the right side. After changing a value you must press Enter to make the change take effect.
- By entering brightness values into a field of the upper table. After changing a value you must press Enter to make the change take effect.
- By using the paint mode. Select a pixel that you like to copy. Then select the paint mode by clicking the paint button. Now you can click on all pixels that you want to be overwritten in the lower left table..

Note: All changes are hold in an internal buffer and will not directly change the image. The changes will only be copied to the image after choosing ***Apply changes*** or when leaving the dialog by pressing ***OK***.

17.3 Navigation

If you like to move the visible image area you can do that by using the four navigation buttons. Already made changes must be applied first or you must confirm to discard them.

Tip: Instead of the navigation buttons you can also use the cursor keys in combination with the Alt key.

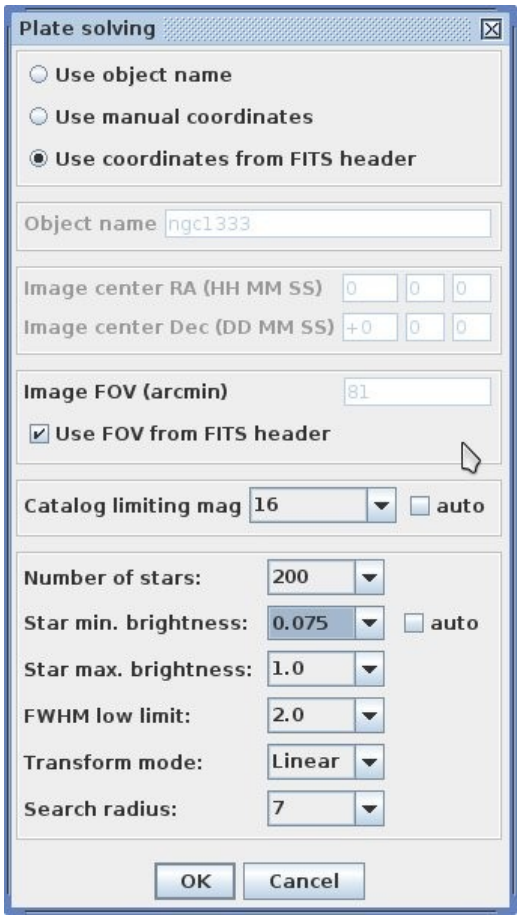
18 Astrometry (Plate Solving)

For further investigation of an image it is often helpful when the image contains information about the shown field. This allows analysis with tools like Aladin[3].

Obtaining these information is called Plate Solving. This is done by matching the stars in the image against data from a star catalog. If the matching was successful, the calculated data (coordinates of the image center, rotation angle etc.) will be written to the FITS-Header. The FITS-Header can be used by other tools (e.g.. Aladin).

Note: For this operation an internet connection is required. See also chapter 6.Preferences

You will find this operation in the menu **Tools->Plate Solve**. The following dialog will appear:



This dialog is similar to the dialog for automatic color calibration (see chapter 14.4.Automatic color calibration using star colors).

After setting the required parameters and pressing OK, another dialog will appear that shows the progress and if the operation was successful. If plate solving was successful, Regim writes

3 See http://aladin.u-strasbg.fr/

the WCS[4] parameters into the FITS-Header of the image. You should now save the images as FITS file.

Showing the FITS-Header is described in chapter Show Fits-Header.

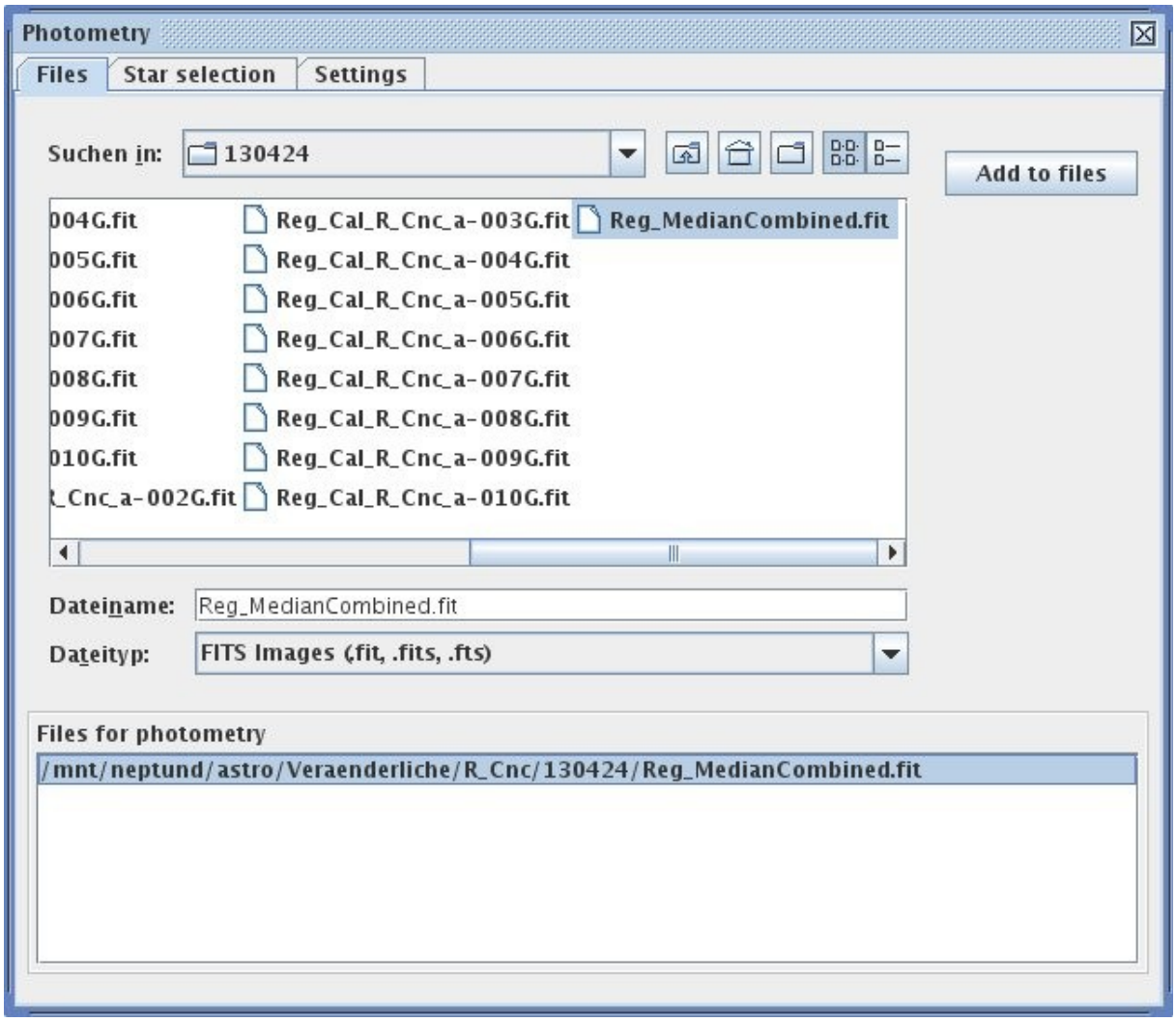
If you have loaded an image that contains the WCS parameters in the header, then you will see the equatorial coordinates for the position of the mouse in the status bar of the image (see chapter The status bar of the image window).

4 WCS = World Coordinate System. See http://fits.gsfc.nasa.gov/fits_wcs.html

19 Photometry

19.1 File selection

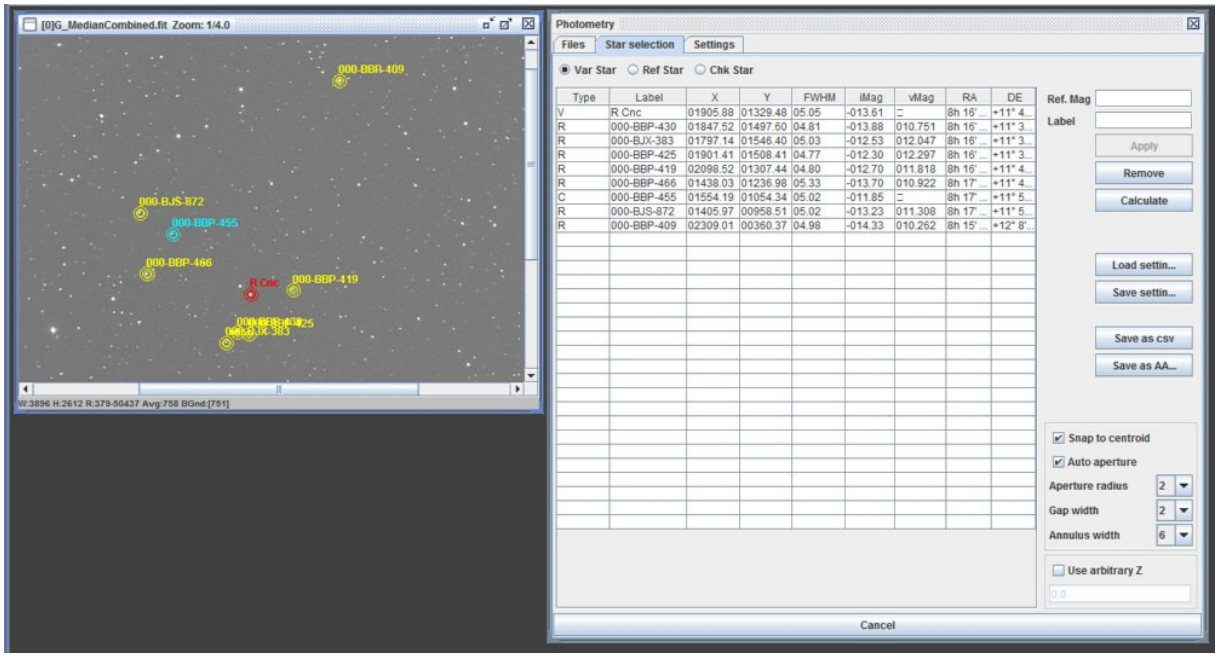
You can open the photometry module via the menu ***Tools->Photometry***. There will appear a dialog to select the image files (FITS) you want to analyze:



If you want to process more than one file in one run all the files need to have been registered first.
After you have added the files to the list ***Files for photometry*** using the button ***Add to files*** you can switch to the tab ***Star selection***.

19.2 Star selection

Now the first image will be opened:



Adding stars to the selection

Now you can start to mark stars by selection the star type and then click on the star in the image. The star types are:

Var Star	Variable star that is to be measured.
Ref Star	Reference star with precisely known brightness.
Chk Star	A check star (optional).

Once you clicked on a star in the image there will appear a new entry in the table. For the reference stars you need to enter the brightness. To do so select the star within the table and enter the brightness in the field ***Ref. Mag***. Additionally you can enter a ***Label*** for each star. By pressing the button ***Apply*** the changes will be transferred to the table.

The size of the aperture, gap and annulus will be automatically calculated depending on the FWHM of the corresponding star.

Removing stars from the selection

To remove a star from the selection, select the star within the table and press the button ***Remove***.

Brightness calculation

After you have selected the star you want to measure and at least one reference star, you can start the brightness calculation for the variable and the check stars by pressing the ***Calculate*** button. The calculated values for the first selected image will be displayed within the table.

Saving the results

The results can be saved in two different formats. First as CSV file for import into a spreadsheet etc. or in the format for the upload to AAVSO[5]. In both cases one data record per image file will be generated.

Saving and loading the settings

If you want to measure the same star field frequently you can save the settings and load them again next time so you do not need to enter the stars, their brightness and labels again. However this requires that the images of your next session are registered to the first image of the current session or have been platesolved. To save and load the settings use the buttons ***Save settings*** and ***Load settings***.

Additional settings

Snap to centroid	If selected the system tries to find the exact position of the star centroid and use this as the position of the star.
Auto aperture	If selected the system calculates the best values for aperture, annulus and gap. If not selected these values need to be set manually via the three combo boxes below.

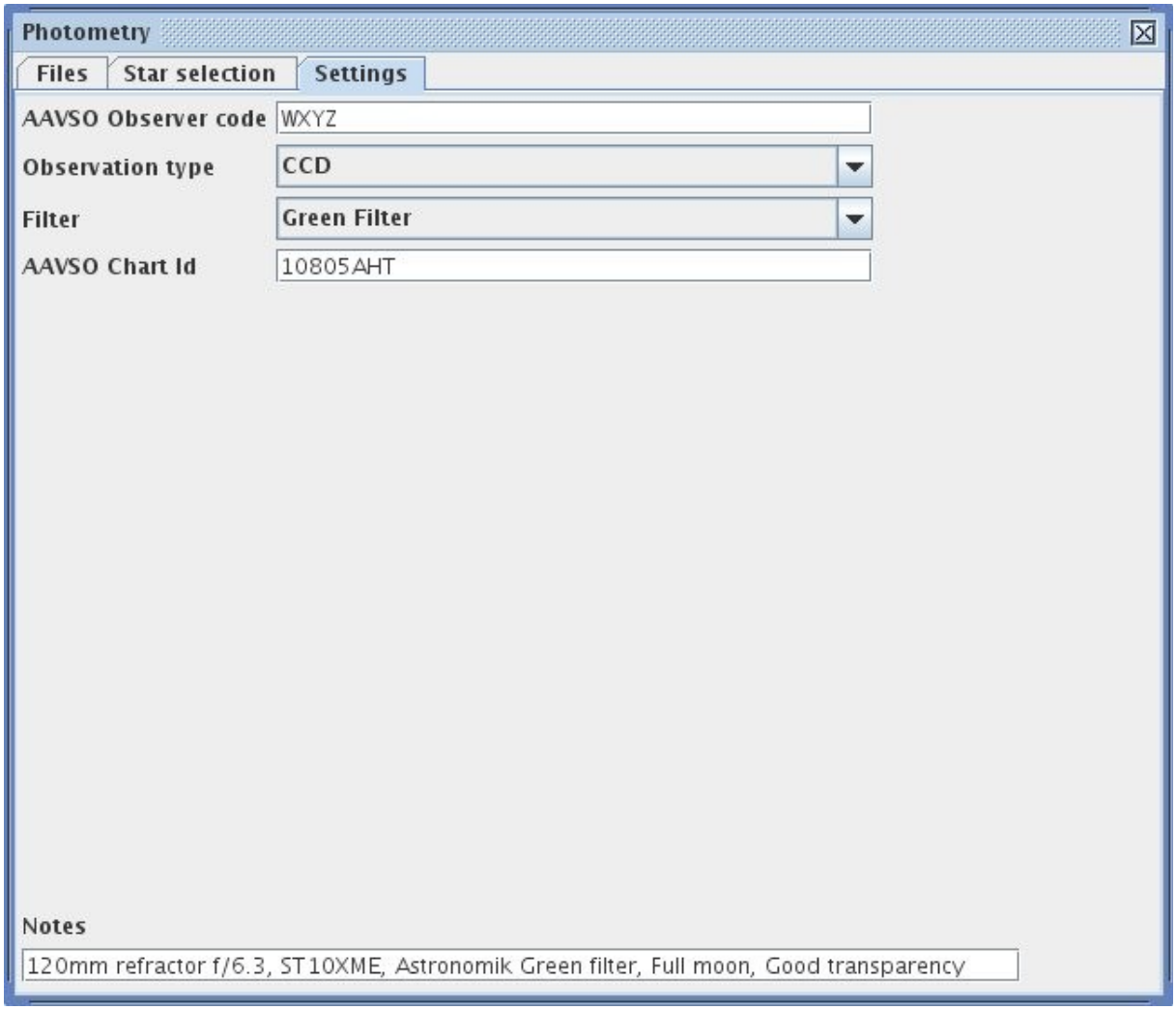
Arbitrary Z

For very special purposes it is possible to set an arbitrary zero point using the option ***Use arbitrary Z***. For normal photometry this option should not be used as this value is been calculated using the reference stars.

19.3 Advanced settings

On the tab ***Settings*** you will find some additional setting that are required if you want to send your results to the AAVSO:

5 **A**merican **A**ssociation of **V**ariable **S**tar **O**bservers

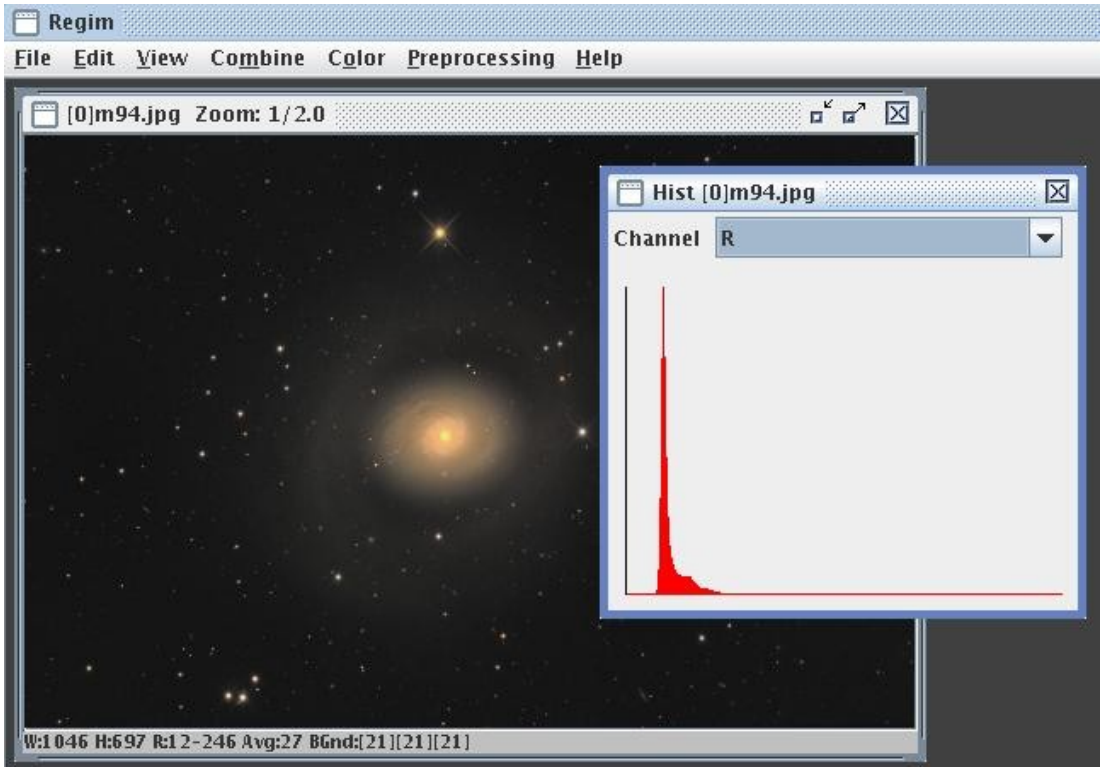


For a detailed description of the parameters please see “AAVSO Extended File Format” on the AAVSO website.

These settings will also be saved or loaded when you use ***Save settings*** or ***Load settings*** on the previous tab.

20 Show Histogram

To show the histogram of an image right click into the image. From the popup menu that appears select **Histogram**. An window will be opened that shows the histogram.



For color images you can choose between the sum of all channels and the single channels.

21 The status bar of the image window

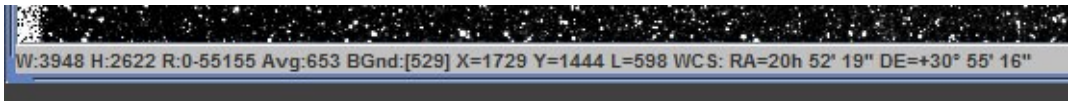
The image window has a status bar that shows additional information about the image. These are:

W	The width of the image in pixels.
H	The height of the image in pixels.
R	The brightness range (from-to) of the image.
Avg	The average brightness of the image.
BGnd	The brightness of the background

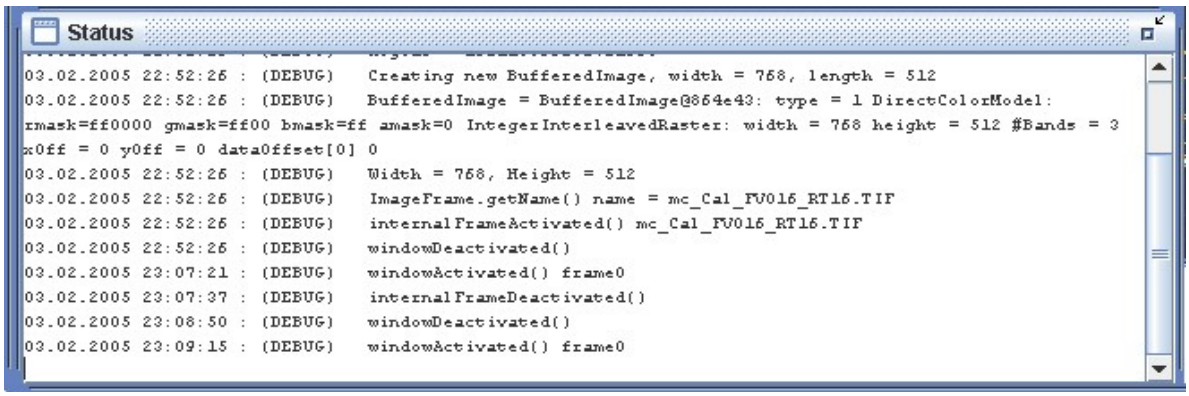
When you move the mouse across the image also the following information will be shown:

X,Y	The pixel coordinates of the mouse pointer.
RGB or L	The RGB values (for RGB images) or the brightness value (for B&W images) of the current mouse position.

If the image contains WCS data in the FITS-Header, also the equatorial coordinates (RA and DEC) for the current mouse position will be shown.

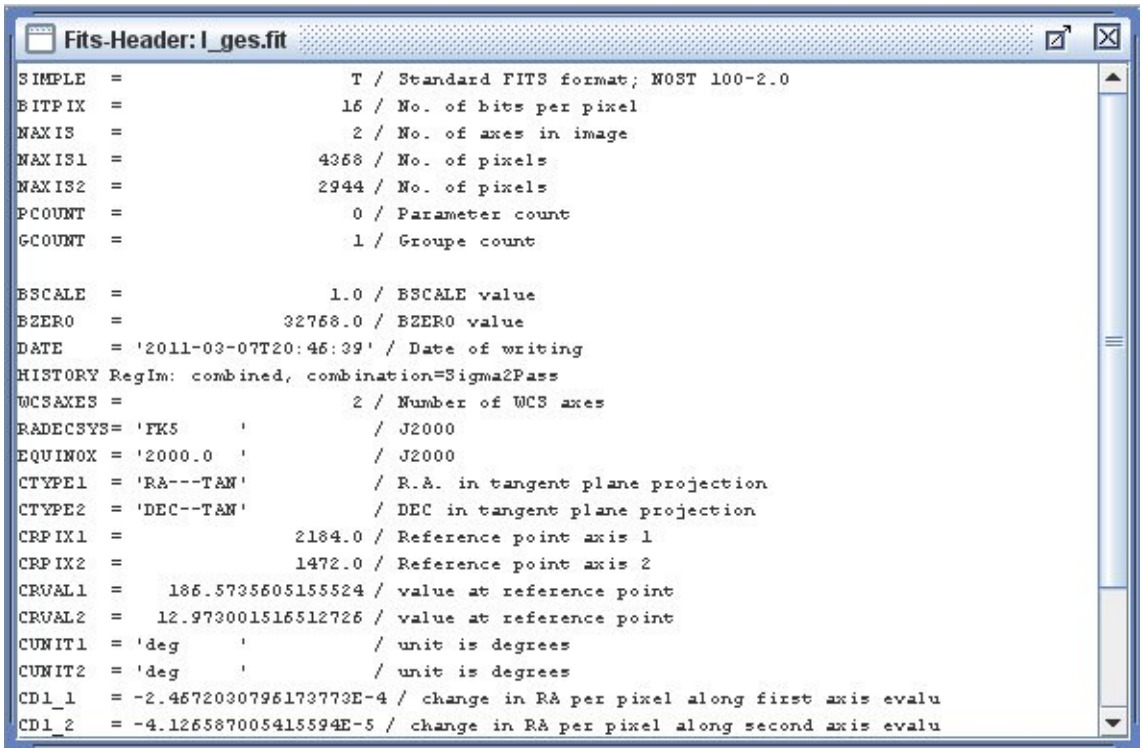


22 The Status Window



The status window shows information about the current running operations. It also contains information that may be helpful for me to analyze problems that may occur. To have an eye on the status window is an good idea. During some operations there will also be a progress bar at the bottom of the status window.

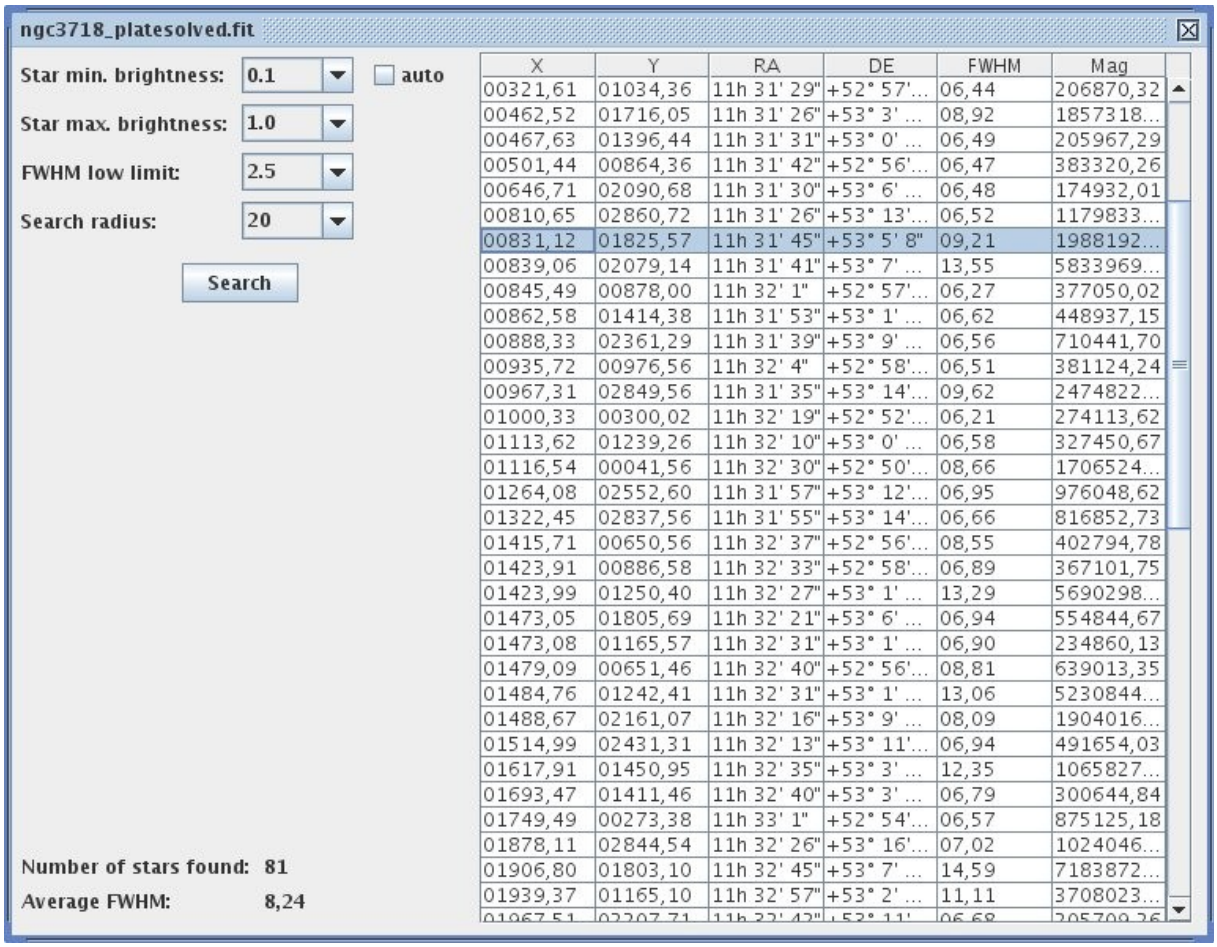
23 Show Fits-Header



To show the Fits-Header of an FITS image right click into the image. From the popup menus that appears select **Show Fits-Header**. A window will be opened that shows the content of the FITS-Headers.

24 Star List Tool

To show a list of all stars in the image choose ***Star List*** from the ***Tools*** menu. The following window will appear:



X	Y	RA	DE	FWHM	Mag
00321,61	01034,36	11h 31' 29"	+52° 57'...	06,44	206870,32
00462,52	01716,05	11h 31' 26"	+53° 3' ...	08,92	1857318...
00467,63	01396,44	11h 31' 31"	+53° 0' ...	06,49	205967,29
00501,44	00864,36	11h 31' 42"	+52° 56'...	06,47	383320,26
00646,71	02090,68	11h 31' 30"	+53° 6' ...	06,48	174932,01
00810,65	02860,72	11h 31' 26"	+53° 13'...	06,52	1179833...
00831,12	01825,57	11h 31' 45"	+53° 5' 8"	09,21	1988192...
00839,06	02079,14	11h 31' 41"	+53° 7' ...	13,55	5833969...
00845,49	00878,00	11h 32' 1"	+52° 57'...	06,27	377050,02
00862,58	01414,38	11h 31' 53"	+53° 1' ...	06,62	448937,15
00888,33	02361,29	11h 31' 39"	+53° 9' ...	06,56	710441,70
00935,72	00976,56	11h 32' 4"	+52° 58'...	06,51	381124,24
00967,31	02849,56	11h 31' 35"	+53° 14'...	09,62	2474822...
01000,33	00300,02	11h 32' 19"	+52° 52'...	06,21	274113,62
01113,62	01239,26	11h 32' 10"	+53° 0' ...	06,58	327450,67
01116,54	00041,56	11h 32' 30"	+52° 50'...	08,66	1706524...
01264,08	02552,60	11h 31' 57"	+53° 12'...	06,95	976048,62
01322,45	02837,56	11h 31' 55"	+53° 14'...	06,66	816852,73
01415,71	00650,56	11h 32' 37"	+52° 56'...	08,55	402794,78
01423,91	00886,58	11h 32' 33"	+52° 58'...	06,89	367101,75
01423,99	01250,40	11h 32' 27"	+53° 1' ...	13,29	5690298...
01473,05	01805,69	11h 32' 21"	+53° 6' ...	06,94	554844,67
01473,08	01165,57	11h 32' 31"	+53° 1' ...	06,90	234860,13
01479,09	00651,46	11h 32' 40"	+52° 56'...	08,81	639013,35
01484,76	01242,41	11h 32' 31"	+53° 1' ...	13,06	5230844...
01488,67	02161,07	11h 32' 16"	+53° 9' ...	08,09	1904016...
01514,99	02431,31	11h 32' 13"	+53° 11'...	06,94	491654,03
01617,91	01450,95	11h 32' 35"	+53° 3' ...	12,35	1065827...
01693,47	01411,46	11h 32' 40"	+53° 3' ...	06,79	300644,84
01749,49	00273,38	11h 33' 1"	+52° 54'...	06,57	875125,18
01878,11	02844,54	11h 32' 26"	+53° 16'...	07,02	1024046...
01906,80	01803,10	11h 32' 45"	+53° 7' ...	14,59	7183872...
01939,37	01165,10	11h 32' 57"	+53° 2' ...	11,11	3708023...
01967,51	02207,71	11h 32' 42"	+53° 11'	06,68	205709,26

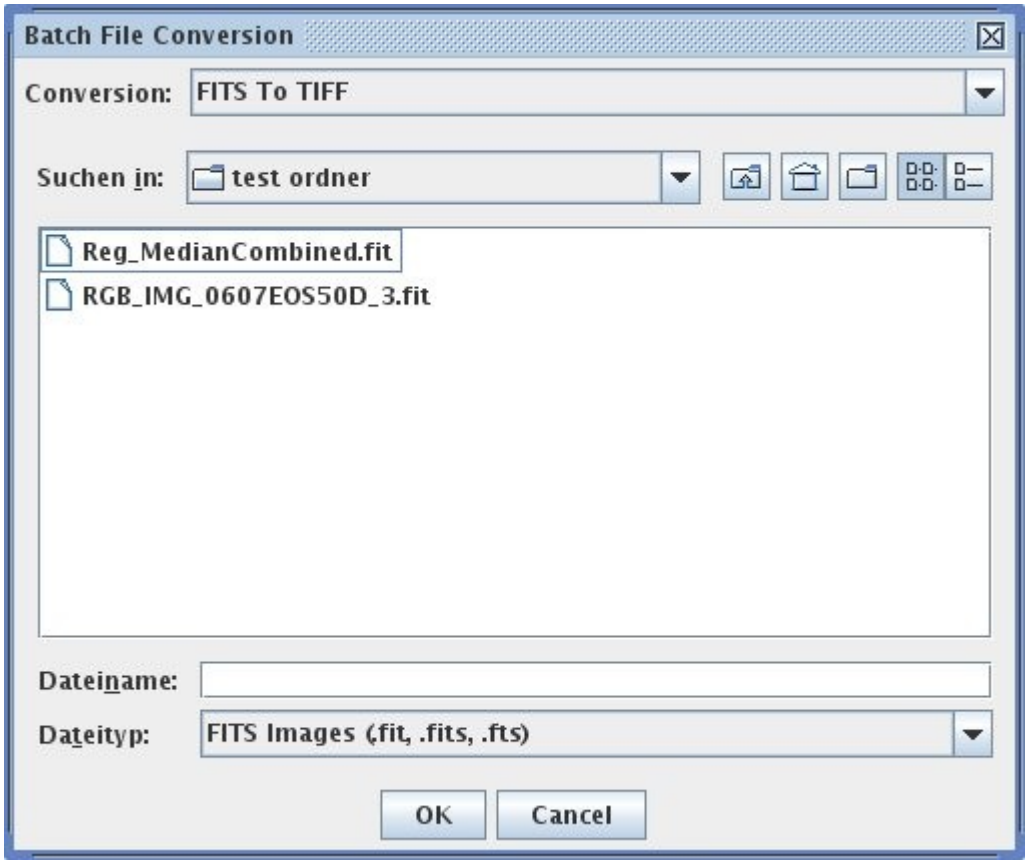
First the list on the right side is empty. You can now search for the stars in the image. The parameters are the same as for registering of images.
After the search the list will be filled with the entries for the stars. These contain:

- The pixel coordinates of the star within the image.
- The equatorial coordinates of the star. Therefore a plate solving is needed prior to showing this star list. Otherwise these columns will be empty.
- TheFWHM value of the star.
- The brightness of the star. This is an instrumental magnitude and should not be mistaken for brightness values from star catalogs!

If you click on an entry in the list, the corresponding star in the image will be highlighted by a cross hair.
On the other hand if you move the mouse over a star within the image, the corresponding entry in the list will be highlighted.

25 Batch conversion of image files

To convert image files from one format to another select ***Batch Conversion*** from the ***Files*** menu.
The following file selection dialog will appear:



Via the selection ***Conversion*** you can choose which format you want to convert into another. After that you select the files to convert and click ***OK***.

The following conversion options are available:

- TIFF to FITS,
- TIFF to JPG
- FITS to TIFF
- FITS to JPG
- RAW to FITS
- JPG to FITS

26 General tips for processing

The quality of the result depends on the quality of the raw data. So always try to get good raw data. Important is to take accurate dark and flat images. It is a good idea to take a look into a book about the theory of astronomic image processing.

The processing within Regim should the be done more or less in the following order:

1. Create a master dark (Menu Preprocessing->Setup darks)
2. Create a master flat (Menu Preprocessing->Setup flats)
3. Calibrate the raw images (Menu Preprocessing->Preprocessing)
4. If necessary remove blooming from the calibrated images (Menu Edit->Remove Blooming from Files or even better directly under Preprocessing)
5. Register the calibrated images (Menu Edit->Register Files or even better directly under Preprocessing)
6. Blink the images against each other to be sure they are registered correctly and to get a feeling for the different quality of the images.
7. Combine the registered images (Menu Combine->Blend Files, Median combine Files, Sigma combine Files or SD combine files or even better directly under Preprocessing).
8. Save the result.

For further processing a standard image processing tool like Picture Window, Photoshop or Gimp is recommended.

27 Read raw files with external raw converter

To read raw files (e.g. from DSLRs) with an external converter instead of jrawio (development has come to halt), Regim offers two possibilities:

- LibRaw is an open source library to read raws under Windows, Max OS X and Linux
- DCRaw by Dave coffin is a raw converter available for Windows, Mac OS X and Linux

The settings to use one of these converters need to be made under Preferences.

27.1 LibRaw

LibRaw seems to be the most up to date library to read raw files. To use LibRaw in combination with Regim you need to download and install the latest version for your operating system. Then you have to tell Regim where on your computer the relevant programs are located. See chapter Preferences.

You can find LibRaw here: https://www.libraw.org/

27.2 DCRaw

DCRaw is a free program written by Dave Coffin to read an convert Raw image files. If your camera is not supported by jrawio then DCRaw may be the right choice.

To use DCRaw to read raw files you need to download and install DCRaw on your computer. As DCRaw in contrast to Regim is not system independent, you need to download and install the correct version of DCRaw for your operating system. The latest version of DCRaw is 9.27 (as at March 2018).

After that you need to tell Regim where on your computer DCRaw is located. See chapter Preferences.

Special notes for Mac users

It seems there is no easy to install up to date version of DCRaw for Mac OS X available on the web. Therefore the installation is not as straight forward as on Windows or Linux. Marco Frissen was so kind to prepare an installation guide for DCRaw on Mac OS X. As I do not have a Mac myself I have included Marco's guide here:

=== How to install dcraw on Mac OS X using MacPorts. ===

To install dcraw on Mac OS X you first need to have a number of OS X specific items installed.

1. XCode 4.x is essential, and can be found in the Mac Appstore (https://itunes.apple.com/nl/app/xcode/id497799835?l=en&mt=12). Install it, run it to accept the EULA.
   Go to https://developer.apple.com/programs/register/ and register for a free a developer account. You do not have to purchase any iOS or Mac specific programs to use XCode, but you do need a developer account to get the Command Line Tools, which are needed for MacPorts.
2. Once you did this, open XCode again and from Preferences -> Downloads select the command line tools to install.
3. Download MacPorts from http://www.macports.org/install.php. Choose the 'pkg' installer for your platform and run the downloaded install file. Note that during install you will need to enter your user password because MacPorts will add files to your system directories.
   If there is a new MacPorts release, all you need to do is open a Terminal and enter

   sudo port selfupdate

   Of course, you can also download a new installer package from their site.

4. open up a Terminal and enter
   sudo port install dcraw

   This will again ask for your password. Depending on the speed of your internet and computer this can take some time, do not close the Terminal window until it is finished!

When the installation is finished dcraw is installed as:
/opt/local/bin/dcraw

This is the folder you need to enter in regim for the dcraw location.

To upgrade to a new version of dcraw, just type:

sudo port upgrade dcraw

And to uninstall dcraw enter:

sudo port uninstall dcraw

that's it!