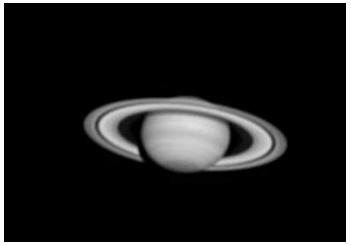
New features of versions 5.33 & 5.34

Version 5.34 - October 9, 2006

Add of deconvolution methods

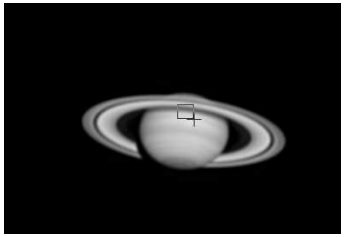
Iris V5.34 add a public convolution Fourier domain function, ideal for test image restoration problems. The command name is **FCONV**.

Consider the following image of Saturn planet :



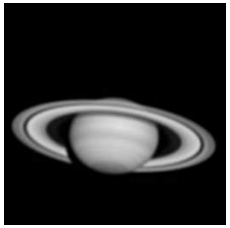
It is the test image, at a "perfect" resolution (assimilated to an infinite spatial resolution).

Before Fourier transform operation a good idea is to promote the image to a size equal to a power of two (128, 256, 512, 1024, ...). The command **WINDOW3** is the ideal tool for this. Select an area near the center of the image (use the mouse pointer):



Only the center of the selected area is important here - not the size. Run the **WINDOW3** command:

>WINDOW3 256



The size of the new image in memory is of 256 x 256 pixels. Click here for download a copy a the image. Save the result, for example:

>SAVE PLANET

Create a blank image of the same size. Use for example the commands

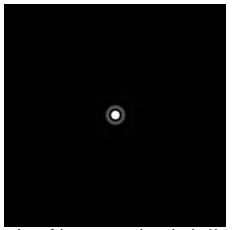
>FILL 0

or

>NEW 256 256

Make a blur function. Here we simulate the airy image produced by a 200 mm telescope and a central obstruction of 0.33. The image scale is supposed of 0.1 arcsec per pixel. The central intensity of the airy image is normalized to 5000 count unit. Finally, the wavelength is of 0.55 microns. Execute the **DRAW_AIRY** command:

>DRAW_AIRY 256 256 5000 200 0.33 0.55 .1



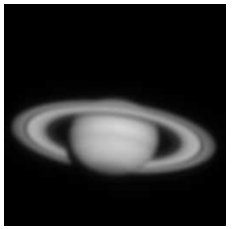
A high contrast view of the computed synthetic Airy stellar image.

Save the Airy image. For example:

>SAVE AIRY

Now convolve the Saturn image and the Airy image:

>FCONV PLANET AIRY



The blurred image of Saturn (diffraction effect of the telescope).

Store on the disk the burred version of Saturn planet:

>SAVE BLUR

The following operation is done:

$$g(x) = p(x) \otimes f(x)$$

where *g(x)* is the result of the **FCONV** command (the observed telescopic image of Saturn), *p(x)* characterizes the imaging system - the point spead function (PSF), here the Airy disk, and *f(x)* is the original image. The symbol $\otimes$ denote the convolution operation.

Note, the command **>FCONV AIRY PLANET** is theoretical similar to **>FCONV PLANET AIRY**, but for internal normalization reason, the second one is preferred.

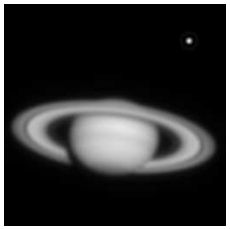
The syntax of **FCONV** is

FCONV [IMAGE] [PSF]

The well know deconvolution command **RL** (Richardson-Lucy algorithm) can be used for recover the original image. But the processed image field must be contain an image of the PSF (a star for example). Here we synthesize an ideal artificial star:

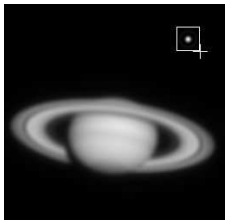
>LOAD AIRY
>TRANS 85 85
>ADD BLUR
>SAVE BLUR

Here the resulting image (note the presence of the PSF in the upper corner):



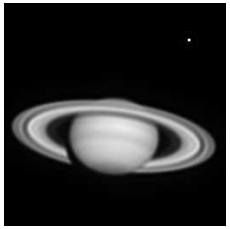
Click here for download the blurred image.

Before run the **RL** command, select the PSF with the mouse



Now for example 50 iteration with a relaxation factor of 0.5:

>RL 50 0.5



The version 5.34 add the Wiener inverse filter. The form of the filter is

$$Wiener\ filter = \frac{P^*}{|P|^2 + k}$$

where *P* is the Fourier transform of the PSF, P* is its conjugate value and *k* is a constant. The constant *k* fix the degree of low frequency in the restored image (and the importance of the noise). If k=0, a pure inverse filter is applied, but the amplification of the noise can be considerable. Choose *k* between 1 and 0.0001.

The syntax of the Wiener filter command is

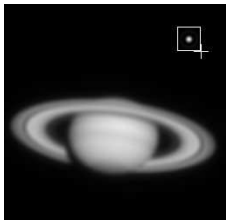
WIENER [K-PARAMETER]

The only one parameter of the command is the value of the k parameter.

Load the image to be restored

>LOAD BLUR

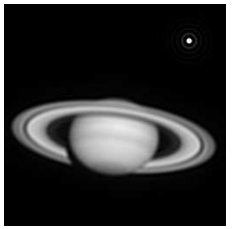
and select the PSF



Try the command

>WIENER 0.001

Here the restoration after a Wiener filtering



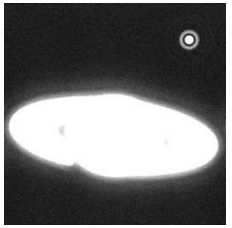
The presence of the noise is very critical during the deblurring process. Add noise to the burred image:

>LOAD BLUR
>ADDNOISE 10 2

The RMS value of the white noise added is of 10 count. The electronic gain of the camera is assumed to 2 electrons by unit count (i.e. some photon noise is also added).

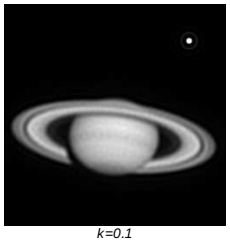
Save the noisy blurred image (a more realistic image):

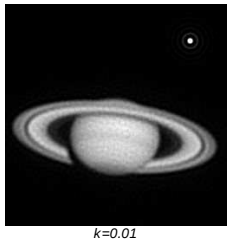
>SAVE BLUR2

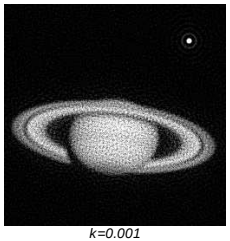


High contrast display of the noisy blurred image.

The importance of the "k" parameter:


k=0.1


k=0.01


k=0.001

For k=0.1 the deconvolution is incomplete. For k=0.001 the noise is amplified.

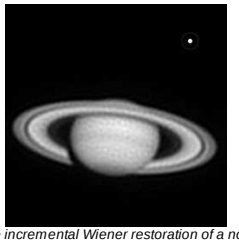
Iris implement also a incremental version of the Wiener filter for a better control of the resolution and noise, the **WIENER2** command. The syntaxe is

WIENER2 [ITERATION #] [K-PARAMETER]

ITERATION # parameter is the number of iteration of the process. K-PARAMETER is the standard Wiener noise parameter.

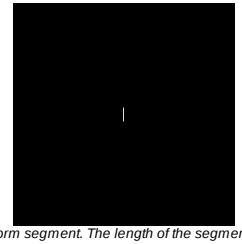
Reload the blurred image, select the star, and

>WIENER2 50 1


Result of the incremental Wiener restoration of a noisy image.

It is easy to simulate a motion blur. First create a motion "vector":

```
>NEW 256 256
>PUT 122 128 5000
>PUT 123 128 5000
>PUT 124 128 5000
...
...
>PUT 135 128 5000
>PUT 136 128 5000
>SAVE MOTION
```

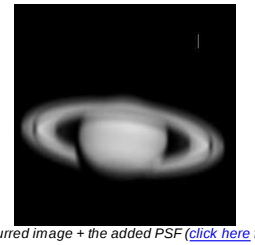

The motion PSF i.e. a simple uniform segment. The length of the segment is equal to the motion amplitude.

Now, generate the motion blurred image of Saturn planet:

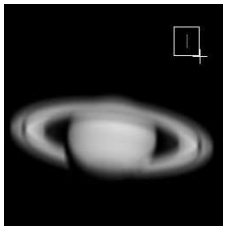
```
>FCONV PLANET MOTION
>SAVE BLUR3
```

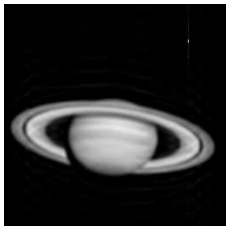

and add the PSF into the burred image:

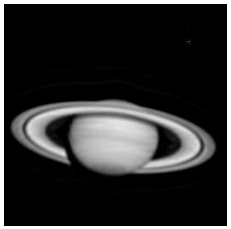
```
>LOAD MOTION
>TRANS 85 85
>ADD BLUR3
>SAVE BLUR3
```


The vertical blurred image + the added PSF (click here for download).

Now the Wiener filtering is applied to the motion blurred image


Select the PSF


Restored image
>WIENER .002


Restored image
>WIENER2 50 .05

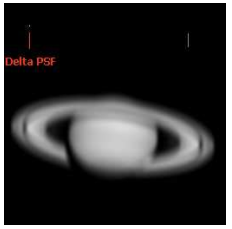
Note: Search the optimal "K" value by successive try.

Note: the restoration functions **RL**, **RL2**, **MEM**, **VANCITTERT**, **WIENER**, ... are now compatible with 48-bits images (true-colors).

Iris V5.34 implement a (very) experimental blind deconvolution algorithm. Blind deconvolution consist to find a degraded image without requiring prior determination of the instrumental PSF. Iris use an iterative blind deconvolution based on the Wiener filtering and include nonnegativity, support contrains and noise relaxation. The operation is complex, a ill-posed problem and time consuming. The algorithm can be instable, the convergence not garanted and more than one solution is possible for the observed image or/and the PSF. The selection of the initial PSF model is critical. Reserve tests to small sub-images (256x256 or 512x512 pixels). But blind deconvolution is fascination field!

Add at the motion blurred image of Saturn an artificial star consisting to a single point (a delta funtion). The corresponding PSF is far from the real PSF.

```
>LOAD BLUR3
>PUT 30 230 8000
>SAVE BLUR4
```



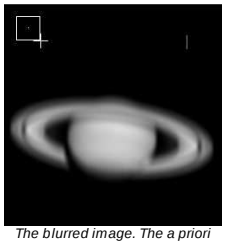
The syntax of **BLIND** command is

BLIND [ITERATION #] [K-PARAMETER] [RELAXATION]

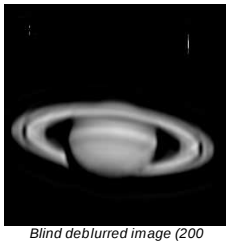
The [RELAXATION] parameter limit the importance of the noise. The typical values of relaxation parameter is beetwen 0 and 2. In most greneral situation RELAXATION=0. The PSF solution is stored in the image @PSF.

Select the isolated point-like PSF, then

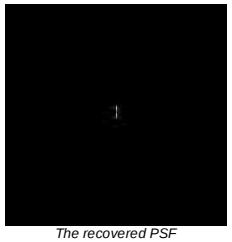
>BLIND 200 .2 0



The blurred image. The a priori solution for the PSF is selected.



Blind deblurred image (200 iterations).



The recovered PSF >LOAD @PSF

See also here more informations about deconvolution functions of Iris. See also the commands **FFTD**, **FFTI**, **FCORREL**, and periodic pattern removal methods here.

NEW COMMANDS

FILL_INV [VALUE]
Give the intensity [value] at the pixels located outside a selection rectangle.

WORK [PATH]
Definition of the working path from the console. Example

>WORK C:\MYIMAGES\SESSION21

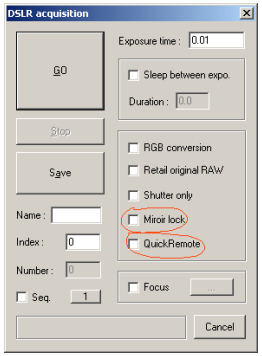
Version 5.33 - September 17, 2006

Improvement of acquisition functions for digital cameras

The DSLR concerned are the Canon EOS.

Capacity to control the acquisition by using the standard USB link was added for exposure times lower than 30 seconds. You can thus control your EOS without employing a specific interface (your computer is now a powerful intervalometer). However, for take exposure higher than 30 seconds with Iris, the QuickRemote USB interface remains necessary.

For example, for a 1/100 second exposure, use the M mode of the DSLR (Manual mode), then enter the exposure time in the **Acquisition** dialog box (**Digital photo** menu), then click on the GO button, it is all:



Check the button *QuickRemote* for use the QuickRemote interface.

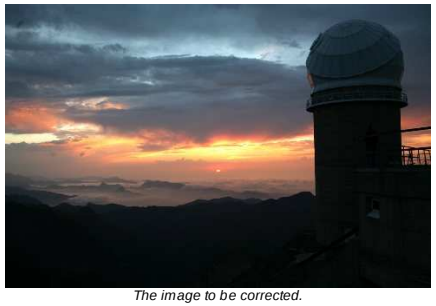
For lock the mirror of the DSRL 3 seconds before exposition, select the corresponding function. The QuickRemote is necessary and select the mirror locking option in the personal function of the DSLR.

All the other possibilities of the DSLR acquisition are kept identical. See here for more details.

Addition of a function for adjust the contrast

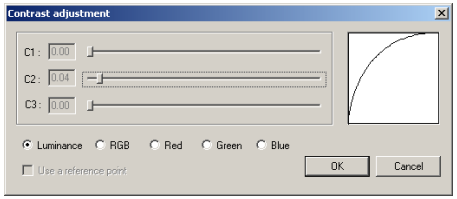
Open the **Contrast adjustment** dialog box from the **Visu** menu.

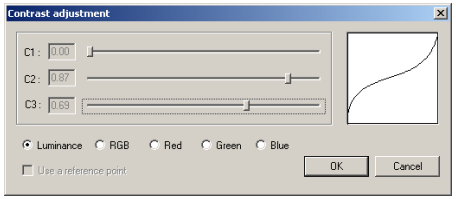
You can adjust the tonal luminance of the image in memory, modify the contrast of the RGB layers simultaneously (option RGB) or act on the color layers individually. The *Luminance* option is of the most general use (neutral color result).

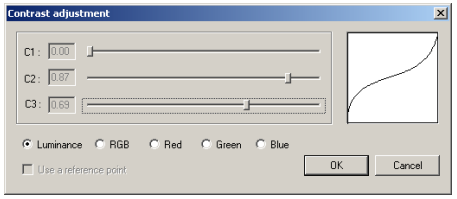


The image to be corrected.

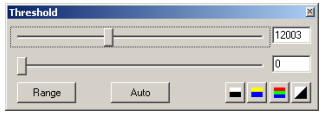
Some manipulations (the graph shows relation between the input intensities - the horizontal axis - and the output intensities - the vertical axis):

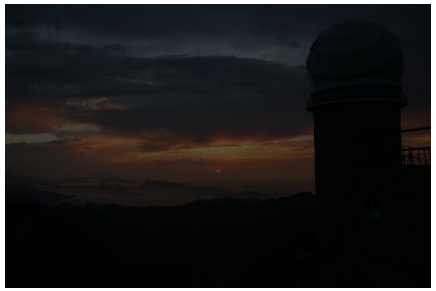




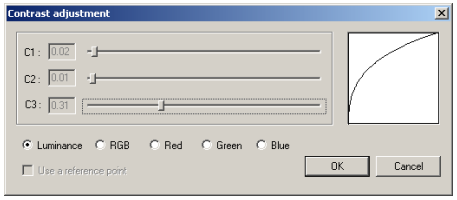


The position of the visualization thresholds before adjustment is significant because the modification of the image intensities is effective only between the high and low threshold. For example, modify the threshold:



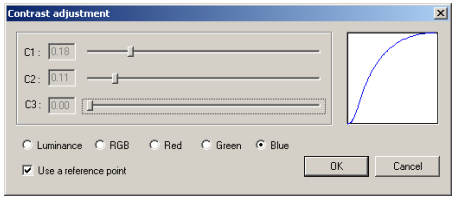


... and you can obtain new effects (here a lower saturation):



Before run the command, you can select a zone of the image which will keep the same dial tone after modification of the image. Select the "neutral" area with the mouse:

Then, check the option *Use a reference point* and modify the color balance by using the R, G and B slider:



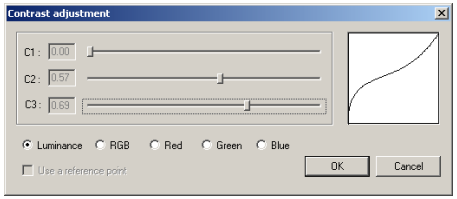
The white balance of the selected area is not modified.

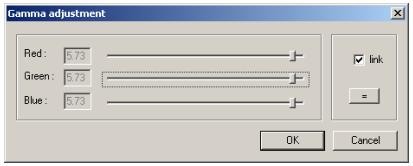
Improved gamma adjustment function

The action on gamma is a simple and effective method for display all the parts of a contrasted image. Open the **Gamma adjustment** dialog box of **Visu** menu:

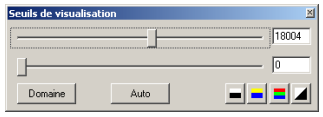
The starting image

Some tests:





The saturation of the colors is less marked in this last case. It can be a wanted effect, but you can also enhance this saturation by using **Saturation adjustment** tool of **Visu** menu. The position of the visualisation threshold is important before run the gamma tool. For an optimal result, not hesitate to increase the distance between the two thresholds before adjusting gamma. For example:



Display of a reticle in the video window

It is possible to display dynamically a reticle in the video window (**Preview** command of **Video** menu).

For display a crow into the video image, enter the command:

>R_START

To position the reticle, make a double click with the left button of the mouse in the desired part of the image.

You can change the size of the reticle with command **R_SIZE**. For example:

>R_SIZE 100

You can modify the color by providing the values R, G and B in this order with the command **R_COLOR**. For example, to display the reticle in the red color:

>R_COLOR 255 0 0

For erase the reticle:

>R_STOP

Others

A bug was fixed during the automatic preprocessing of DSLR RAW images for Nikon models.

Iris can decode RAW images of the Canon EOS 400D (Rebel XTi). Select the 5D/20D... model in the camera setup dialog box.

Add of the **SCAN2PIC3** command (a spectroheliogram construction family command - see Lhires 3 spectrograph documentation).