First Light Vision GUI

User Manual

First Light Vision GUI User Manual_20230529

REVISION HISTORY

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1. INTRODUCTION

First Light Vision is the new graphical user interface (GUI) of First Light Imaging. It is meant to configure and capture images from C-RED One, C-RED 2, C-RED 2 Extended Range (ER), C-RED 3, OCAM^2 and C-BLUE One cameras.
Features included:

- Configuration: FPS, exposure time, geometry, bias, flat…
- Frame acquisition: start, stop, save buffer, load buffer…
- Basic frame processing: clipping, mirroring, rotation…
- Basic statistics: standard deviation, average, histogram, section…
- Camera monitoring: status, temperatures, power consumption…
- Camera maintenance

2. REQUIREMENTS

This application is available for Windows and Linux.
This application supports the following OS:

- Windows 10 & 11
- Linux ubuntu 16.04 LTS, 18.04 LTS and 20.04 LTS
- CentOS 7

It is also possible to work with Windows 7 but it is not officially supported and we will not provide any support for this OS. Anyway, we recommend using Windows® 10 for USB acquisition.

It supports different acquisition interfaces, currently Camera Link®, USB3 and CXP.
For some frame grabbers, the drivers are not available for Linux so they cannot be used with the Linux version of the application.

Acquisition device	Windows 10 & 11	Ubuntu * 20.04 LTS	Ubuntu ** 18.04 LTS	Ubuntu *** 16.04 LTS	CentOS 7
Matrox Radient ev-CL	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)
Matrox CXP	X (C-BLUE 1)	X (C-BLUE 1)	X (C-BLUE 1)	-	-
EDT Vision Link 4 CL	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)
BitFlow CL	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)
USB 3.0	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)	X (C-RED 3)
Euresys CL	X (C-RED 3)	X (C-RED 3) &	X (C-RED 3) &	X (C-RED 3)	X (C-RED 3)
Euresys CXP	X (C-BLUE 1)	X (C-BLUE 1)	X (C-BLUE 1)	-	-
Pleora iPort CL-Ten	X (C-RED 3)	?	?	?	?
Sapera CL	X (C-RED 3)	-	-	-	-

* : Tested Kernel version Ubuntu 20.04 LTS 5.15.0-69
** : Tested Kernel version Ubuntu 18.04 LTS 5.4.0-139
*** : Tested Kernel version Ubuntu 16.04.7 LTS 4.15.0-142
& : versions multicam-linux-x86_64-6.18.3 and above have some issues, the delivered version multicam-linux-x86_64-6.18.2.4781 must be used
X : available - : not available ? : not available during the test

The screen resolution must be at least 1920x1080.

3. OVERVIEW

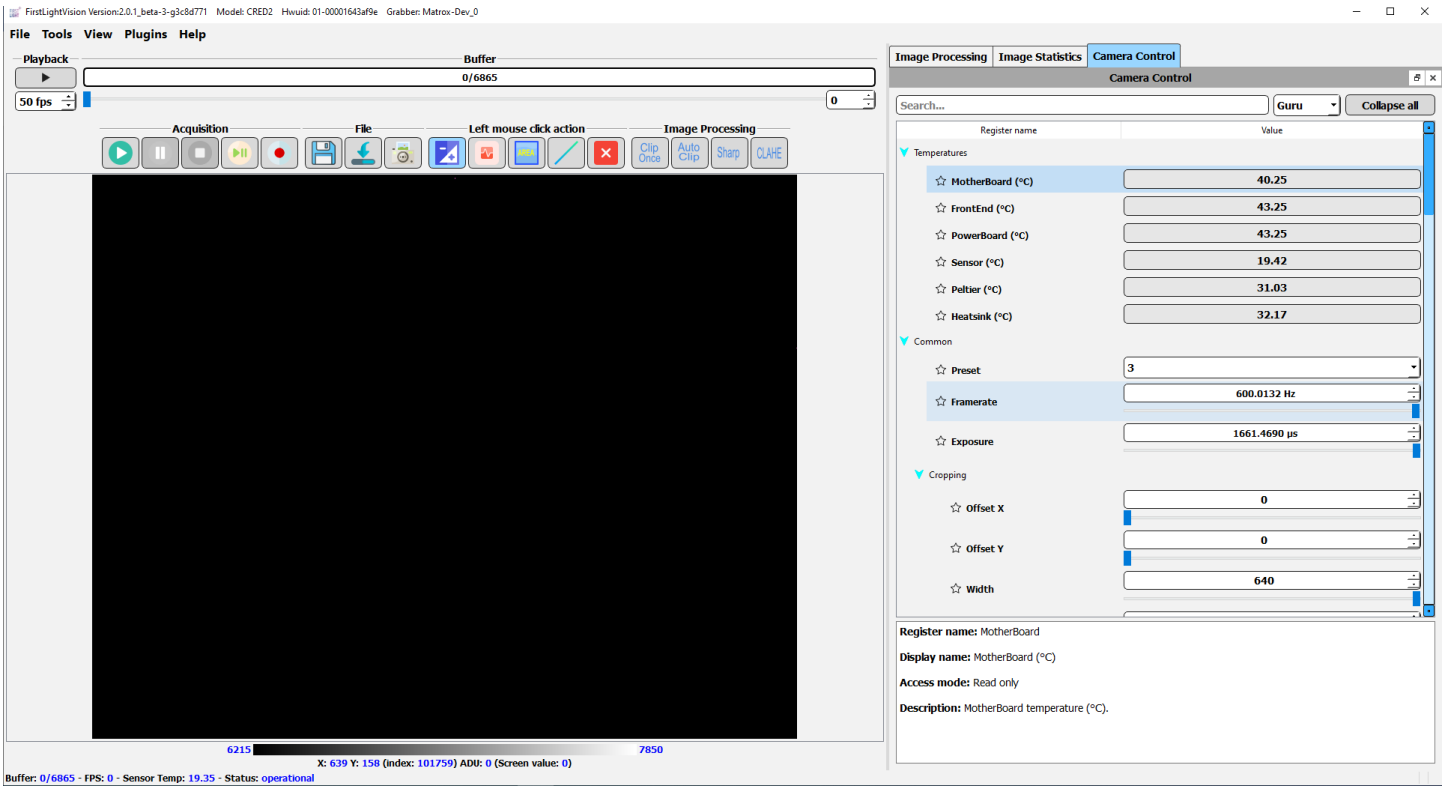


Fig. 1 : *First Light Vision Overview*

The software is divided into two parts:

- Left part is for the image display and acquisition control.
- Right part is a tab for “Image Processing”, “Image Statistics” and “Camera Control” panels.

Each part will be described in this manual.

4. START-UP OF THE SOFTWARE

At first, the software will look for the grabbers connected to the computer:

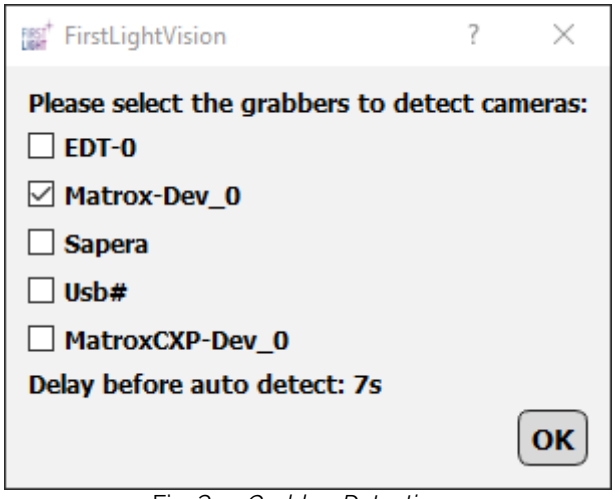


Fig. 2 : *Grabber Detection*

The user must select the grabbers connected to the camera to detect it.
If cameras are detected, the software will automatically choose one and adapt the GUI to the camera.
A list of detected cameras is available in "File" -> "Settings" section "Camera" -> "Selection" to switch easily between cameras.

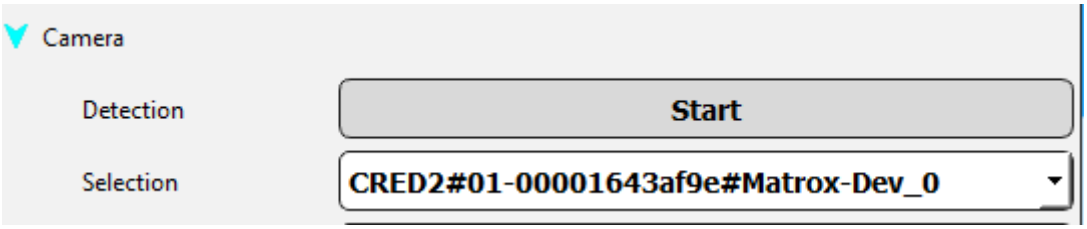


Fig. 3 : *List of detected cameras*

Camera description in the list is: CAMERATYPE#HWUID#GRABBERTYPE. In the example above, we have a C-RED 2 with a hardware UID 01-000.01643af9e connected to a Matrox grabber.
If you choose a different camera (C-RED 3 or C-RED One) the GUI will automatically adapt itself.

If you start the software before the camera, you can restart a detection by clicking on "File" -> "Settings" section "Camera" -> "Detection".

The software reads the available RAM in the computer and takes 20% of this value for the images circular buffer.

At startup, the software will be displayed in basic mode: this mode is a lite version of the software, easier to use.
This document explains the advanced mode of the software, but basic mode has the same behavior.

Note: for OCAM² there will be a specific window at startup.

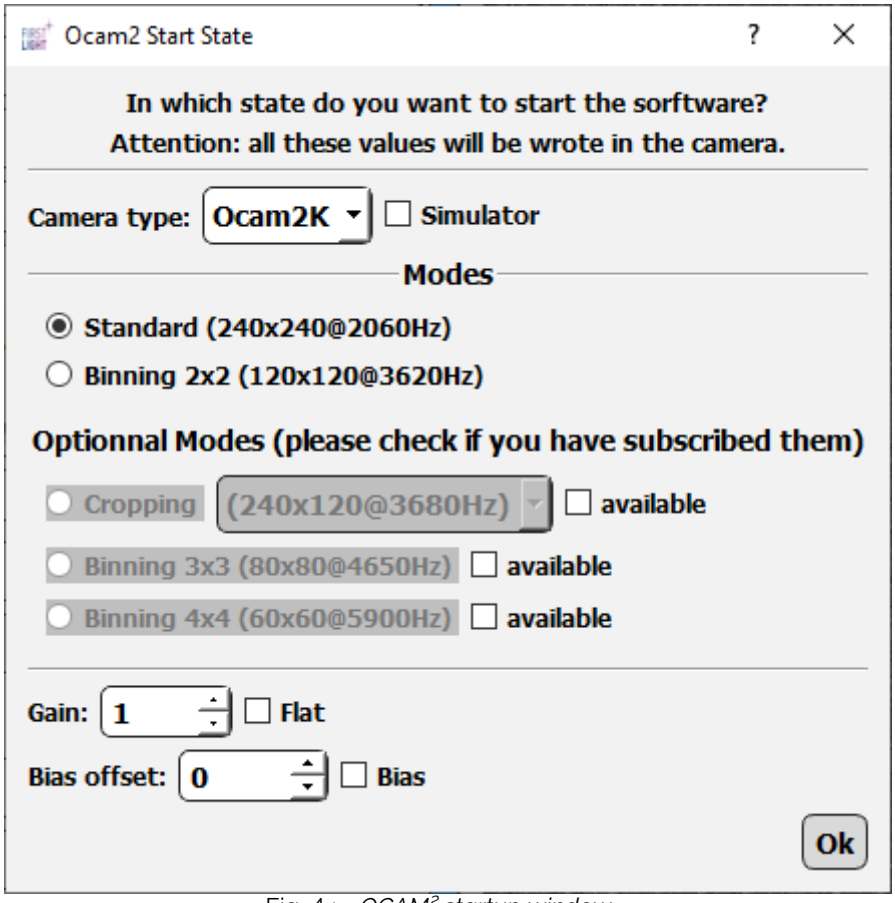


Fig. 4 : *OCAM² startup window*

You will have to set the current configuration of the camera, because these parameters cannot be read from it.

5. DETAILED DESCRIPTION

5.1. Console

The user can use the console to send commands to the camera. When a command is sent, the user gets the response and the GUI is updated.
Below is an example with the FPS command provided:

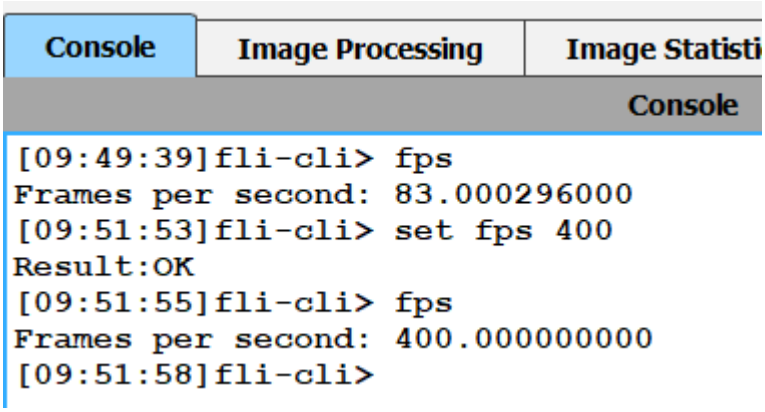


Fig. 5 : *Console command example*

5.2. Image Statistics

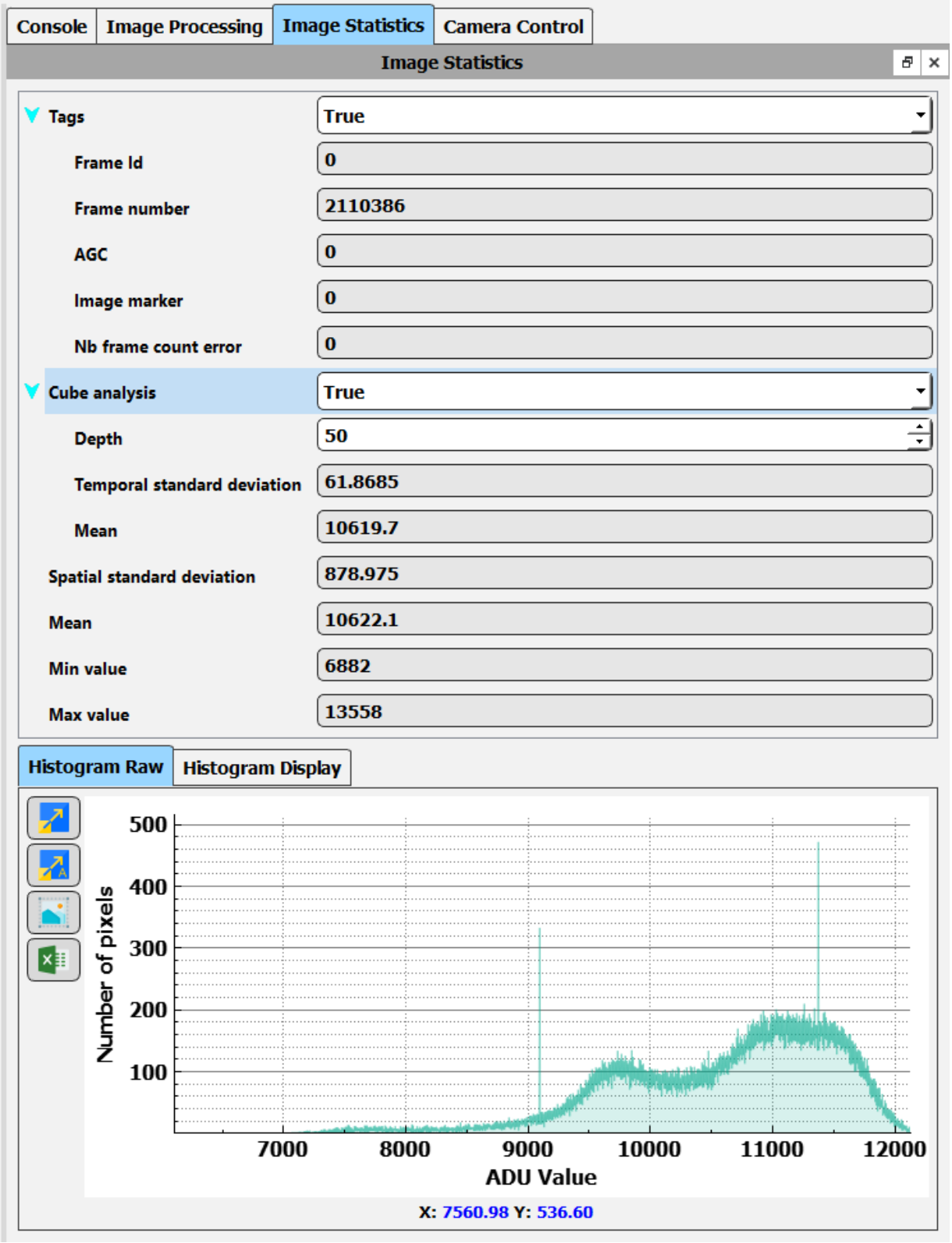


Fig. 6 : *Image Statistics module*

The Image Statistics panel is made up of 4 parts which are refreshed every 200ms.

5.2.1. Tags

The Tags part displays information from the frame tags (first four pixels of the image), this feature can be enabled/disabled with the checkbox.
For more information on the meaning of the displayed information, please refer to the user manual of our camera.

5.2.1.1. Tags C-RED One

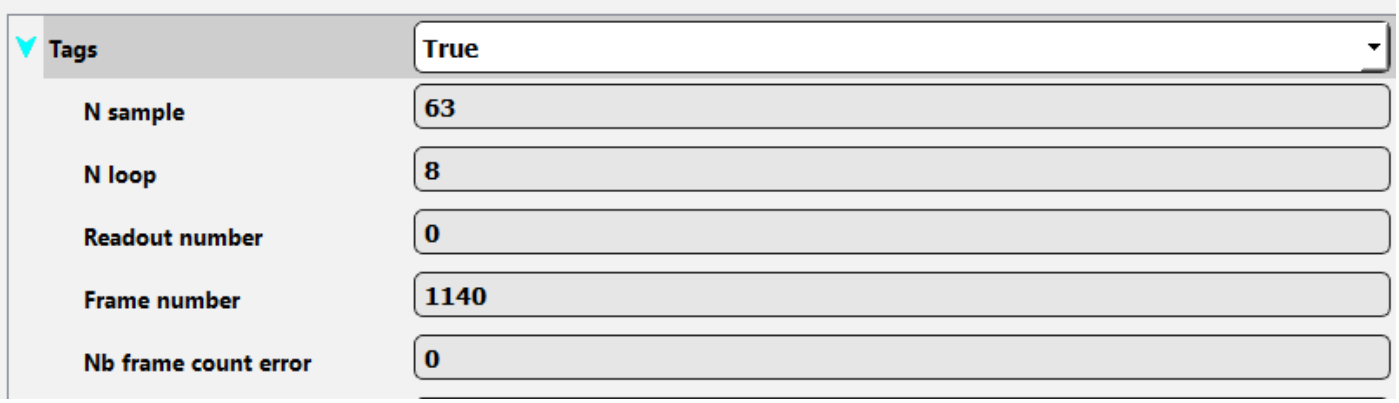


Fig. 7 : *Tags C-RED One*

The C-RED One tags are made up of five parts:

- N sample, the number of the current image sample
- N loop, the number of the current image loop
- Readout number, the number of the image without reset
- Frame number is the number of the frame since the camera has been started or the tag has been enabled.
- Nb frame count error is computed by the software. The software checks that the Frame number is valid. If it is not, it increments the counter value. The frame number is valid if it is equal to the frame number of the previous frame plus 1 (modulo the ring buffer size).

5.2.1.2. Tags C-RED 2 & C-RED 2 ER

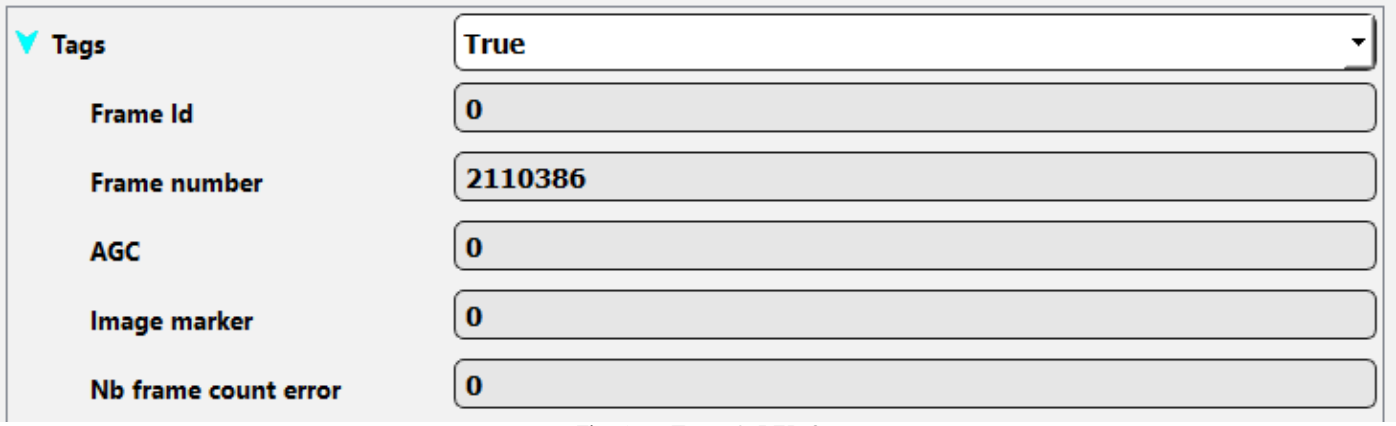


Fig. 8 : *Tags C-RED 2*

The C-RED 2 tags are made up of five parts:

- Frame Id is the ID of the image in IMRO mode. Example, with a burst of size 6, each packet of 6 images will have an ID from 5 to 0.
- Frame number is the number of the frame since the camera has been started or the tag has been enabled.
- AGC is the conversion gain currently applied, 0 for High gain, 1 for medium gain and 2 for low gain.
    - Image Marker indicates if the image has been marked by the user thanks to an external trigger.
- Nb frame count error is computed by the software. The software checks that the Frame number is valid. If it is not, it increments the counter value. The frame number is valid if it is equal to the frame number of the previous frame plus 1 (modulo the ring buffer size).

5.2.1.3. Tags C-RED 3

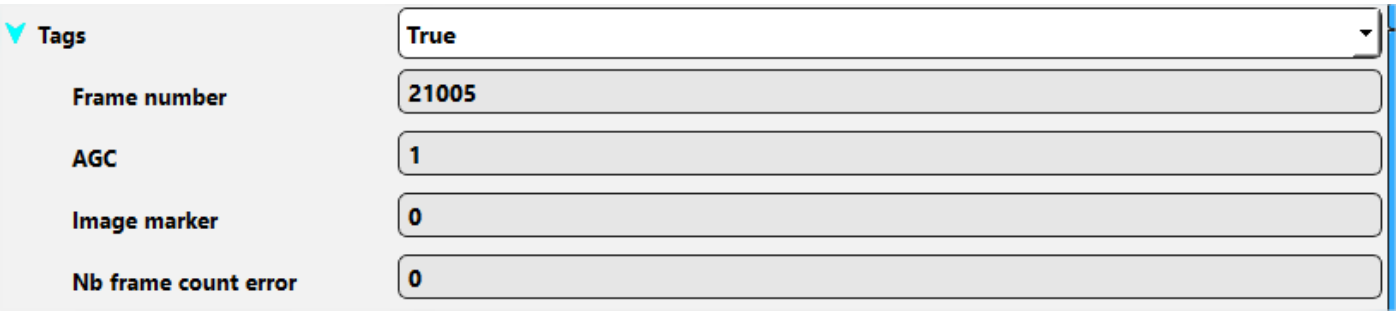


Fig. 9 : *Tags C-RED 3*

C-RED 3 tags are the same as C-RED 2 tags, except for “Frame Id” because there is no IMRO with C-RED 3.

5.2.1.4. Tags OCAM²

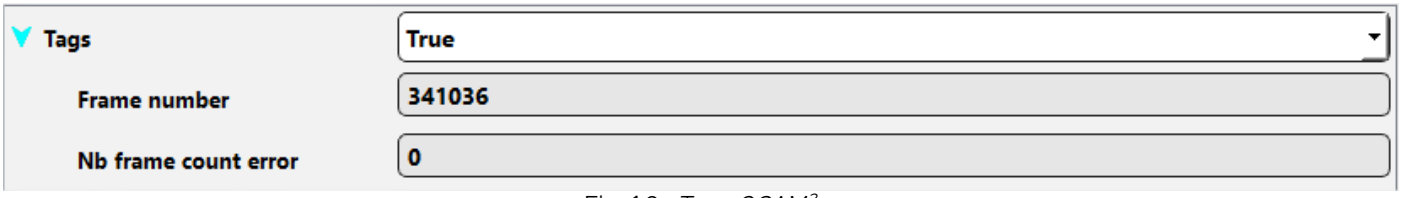


Fig. 10 : *Tags OCAM²*

OCAM² has only frame number and error count.

5.2.2. Cube analysis

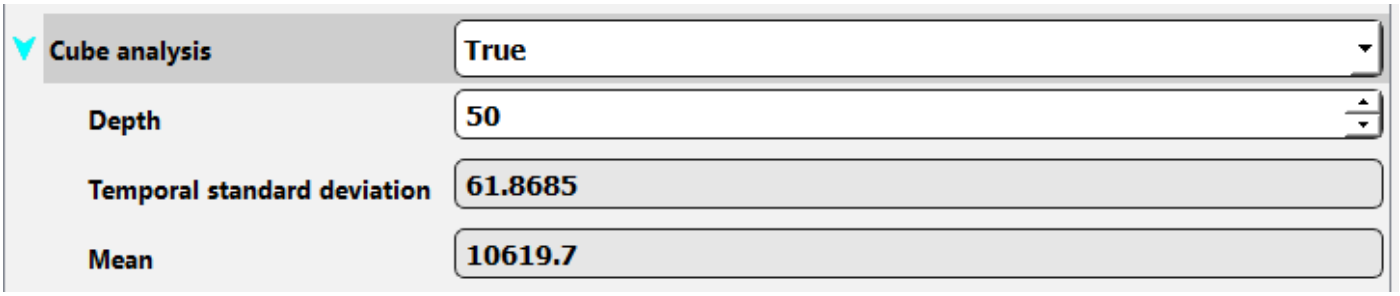


Fig. 11 : *Cube analysis*

The cube analysis part processes a cube of images with a default depth of 50 frames that can be changed by the user. It displays the temporal standard deviation and the mean of the cube. The processing is done with the GPU, if a not compatible GPU is detected, or if no GPU is detected, then this part is not shown. The cube analysis can be enabled/disabled thanks to the checkbox, as it can slow the GUI on slow computers.

Note: if a red rectangle is drawn on the image (analysis rect) then the process is limited to this rectangle.

5.2.3. Basics stats

Spatial standard deviation, spatial mean, min value and max value are always displayed and are computed with the current frame displayed.

5.2.4. Histogram

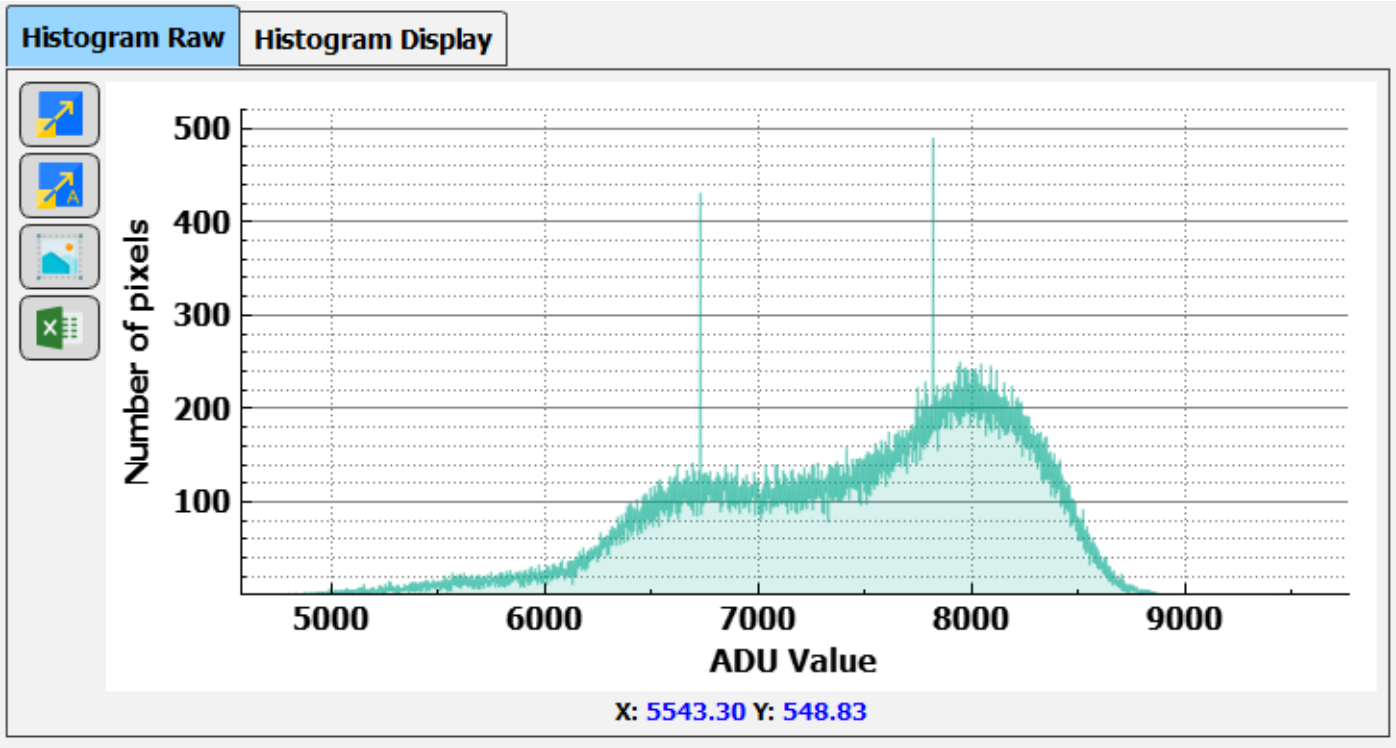


Fig. 12 : *Histogram*

Two histograms are available, one for the 8b image that is the processed image displayed and one for the 16b image that is the image directly received from the camera.
Each histogram displays the number of pixels for each value (0-255 for 8b and -32768-32767 for 16b) to have a repartition of the pixels in the image.

5.3. Camera Control

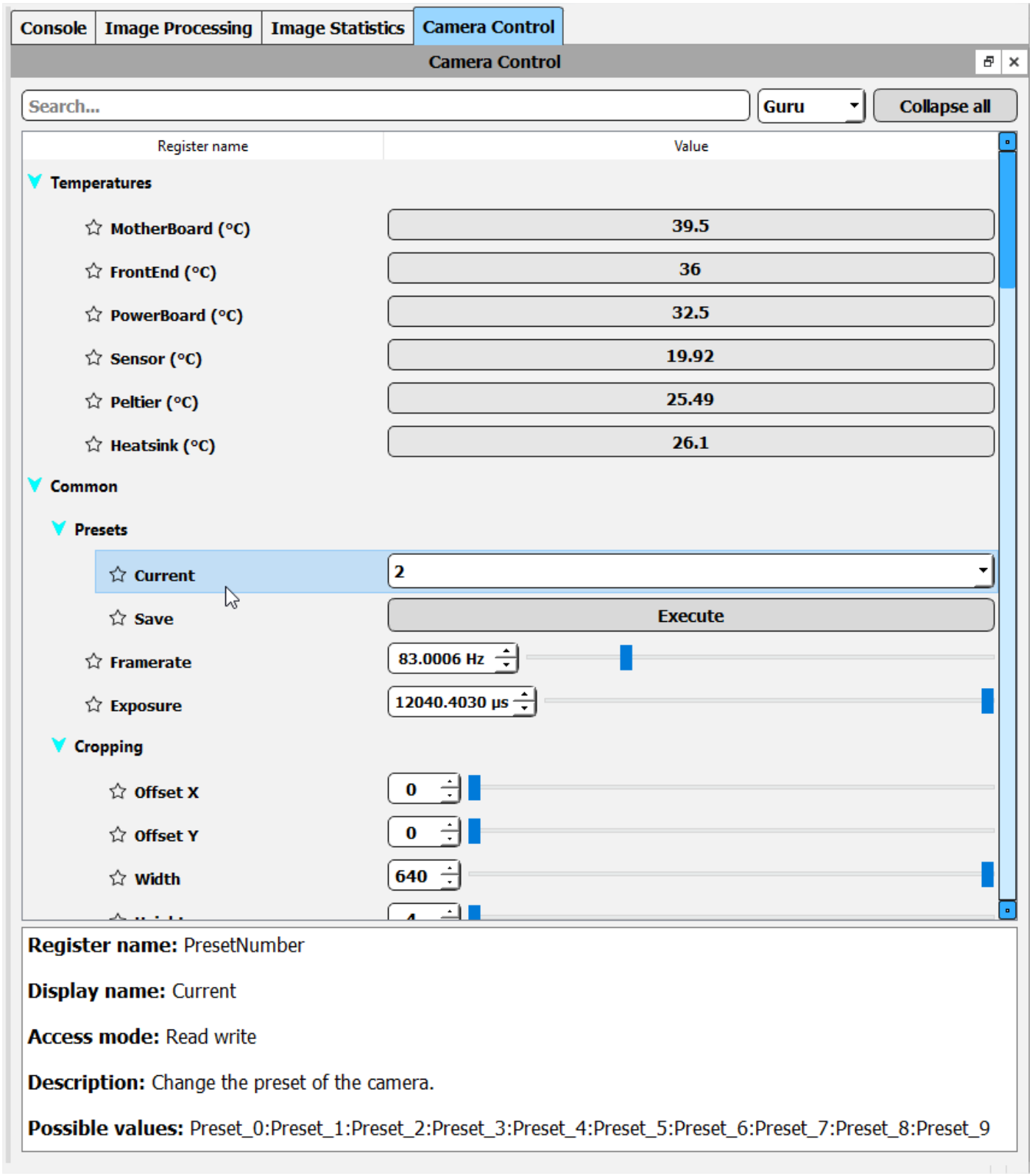


Fig. 13 : *Camera Control panel*

Camera control panel displays all the camera registers available, in order to read or write them. This panel has:

- A tool box (search, filter, expand/collapse all)
- A tree view to interact with registers
- A text view to display register details

Registers are arranged by status (Beginner, Expert or Guru) and each have a specific visibility. Status can be chosen with the box next to the "Search" bar.
A fourth status "favorites" is available. It is possible to add favorites by clicking on the star icon next to a register. The favorites will display the selected registers only.

Registers description of each camera is available in a separate document identified as:
*"camera_name_* Features_Reference_xxx.pdf"

5.4. Central part

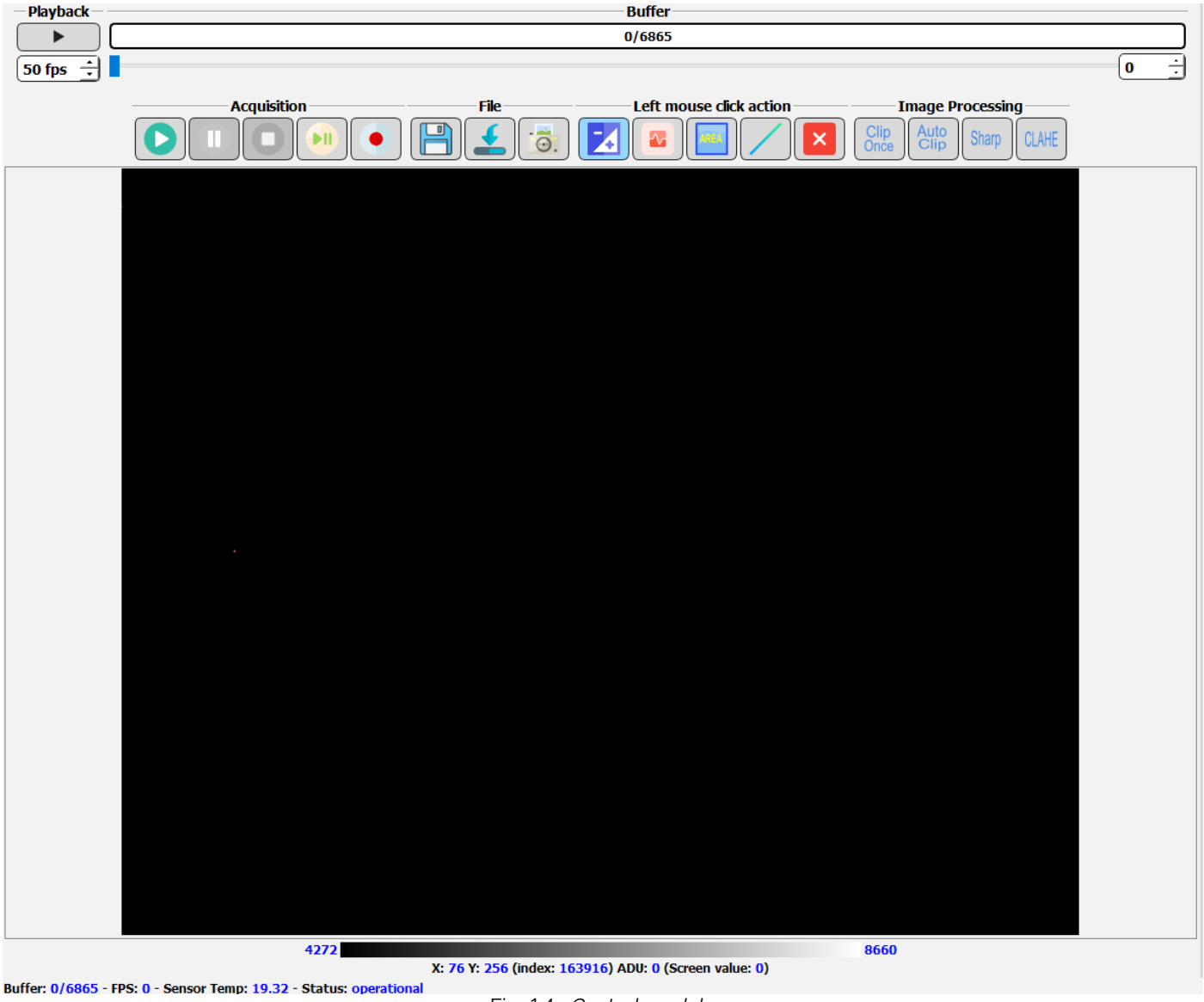


Fig. 14 : *Central module*

This part is common to all cameras and control the images buffer, acquisition, and some image manipulation.

5.4.1. Buffer

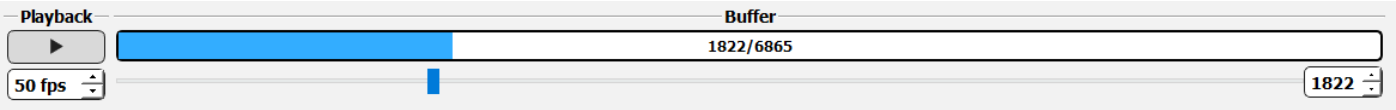


Fig. 15 : *Buffer part*

The buffer part displays a progress bar of the buffer filling, a slider to manually set the image displayed and a Playback button.

When "Save" is clicked, a new window appears to choose the part of the buffer that he wants to save.

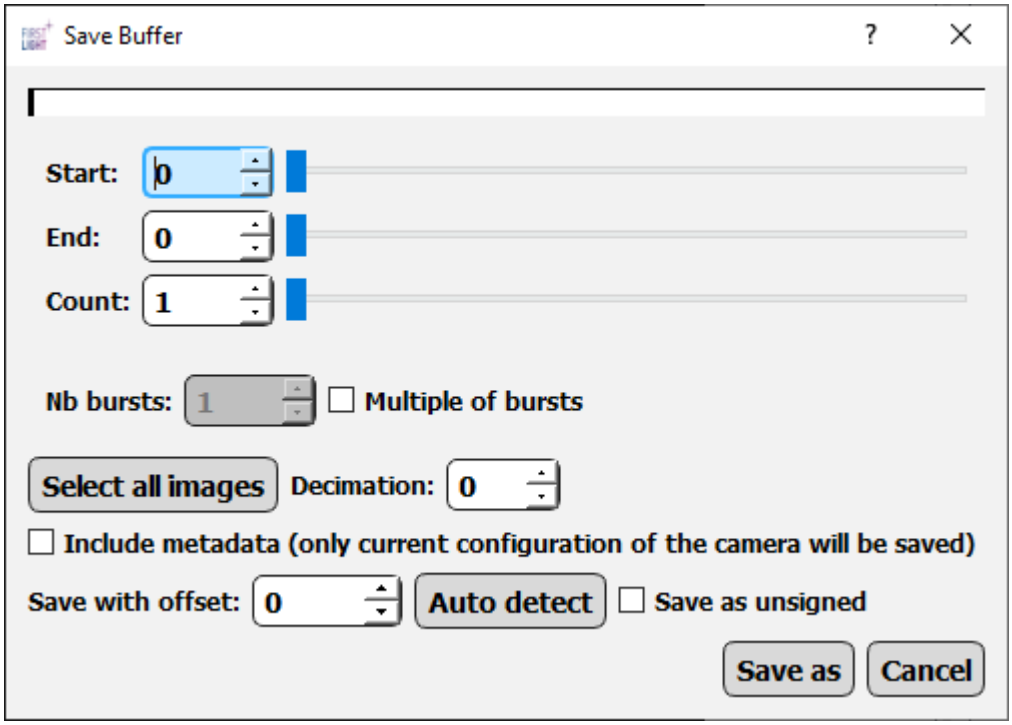


Fig. 16 : *Dialog save buffer*

Many options are available:

- Save a multiple of burst, auto detection of the bursts.
- Select all images
- Apply a decimation of x images
- Include metadata in file (for RAW format a file ".metadata" will be added with the same name of the RAW file)
- Apply an offset on all the pixels of all the images stack.
- Auto detect the value to apply for each pixel to have only positive pixels.
- Force the GUI to save the pixels as unsigned.

When clicking on "Save as", the save dialog is displayed to choose between the available saving formats.

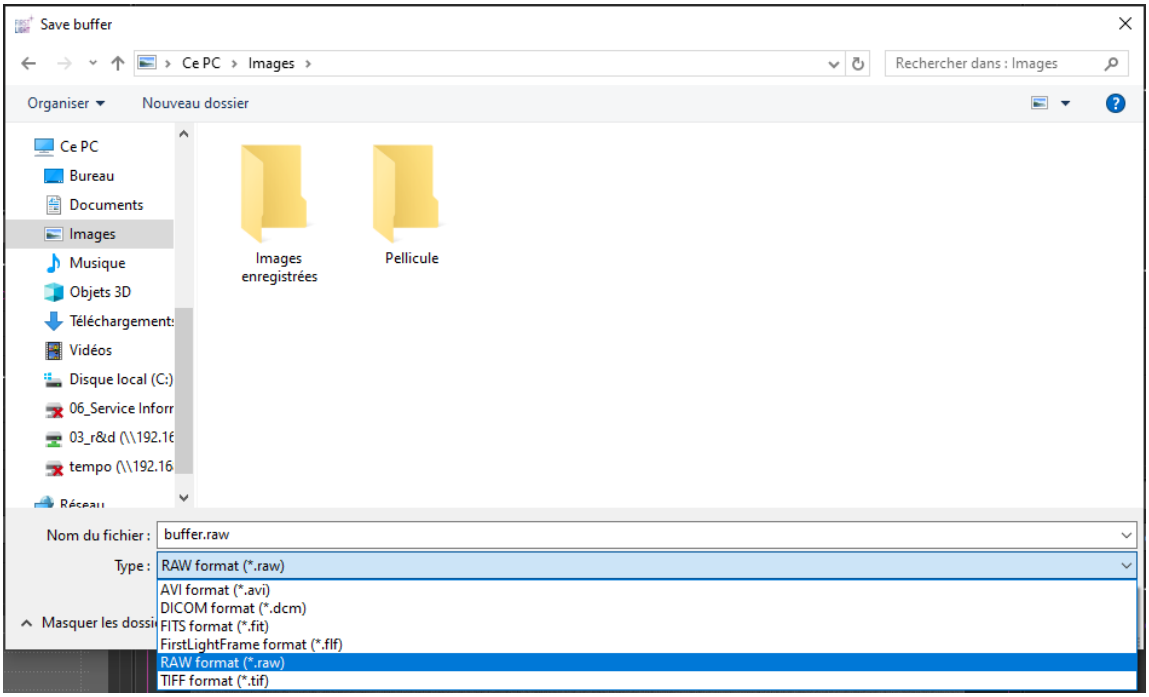


Fig. 17 : *Dialog choose file*

Available formats are AVI, DICOM (plugin), FITS, FirstLightFrame, HDF5, RAW and TIFF. If you want to add your own format as a plugin, please contact First Light Imaging at support@first-light.fr.

FirstLightFrame is a custom format defined by First Light Imaging, the file has a header of 2048 bytes directly readable in an editor and it is composed like this:

"FirstLightFrame;Version:1.4;HeaderSize:2048;Date:XX;NbImages:XX;CameraModel:X;Width:XX;Height:XX;unsigned pixel:yes/no;cropping:XX;...". Information depends on the camera.
This is the beginning of the file, all X are values, the header is then completed with arbitrary bytes to have the 2048 bytes size and the images data are after.

Images stack can be loaded by using the "Load", by right clicking on the buffer progress bar or by dropping the file on the progress bar. When a file is loaded, a new window appears with a central widget and an image statistics widget.

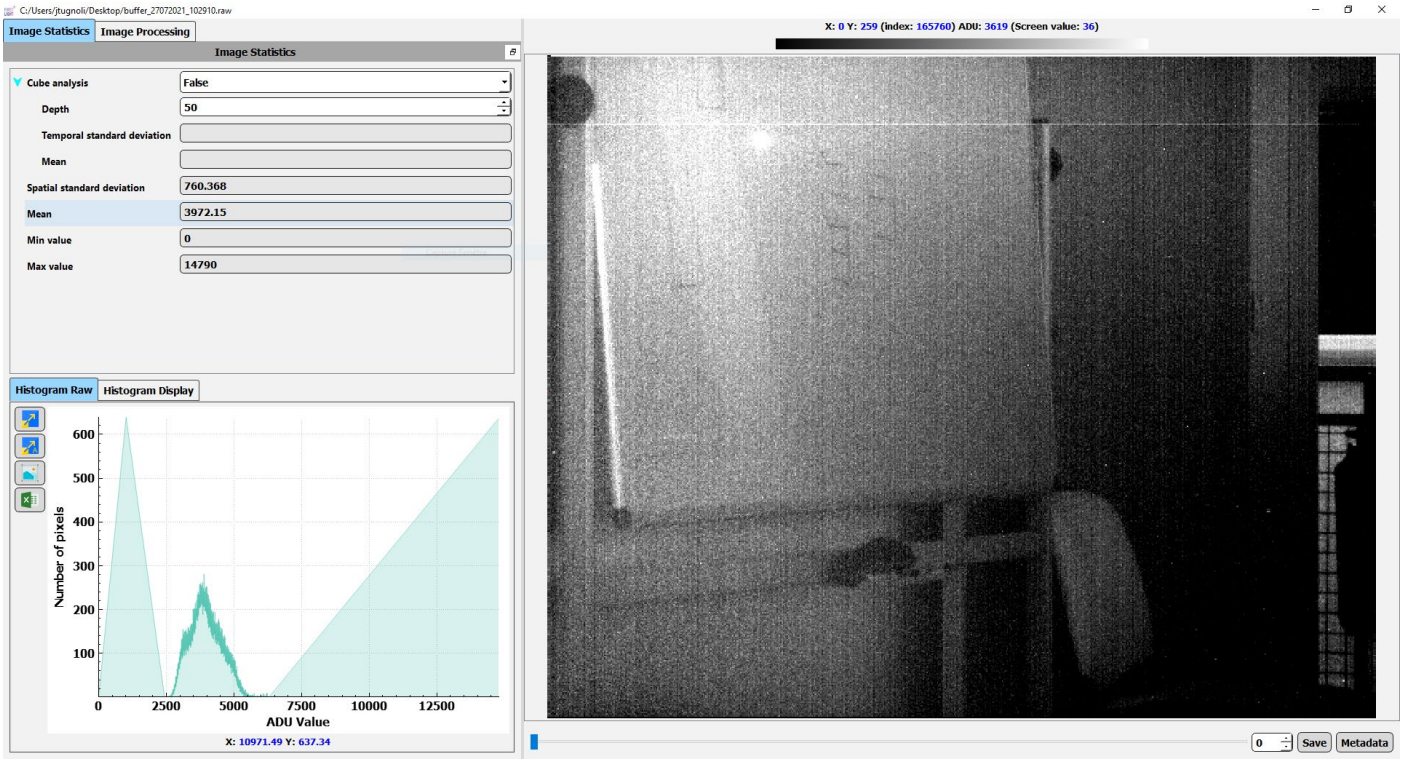


Fig. 18 : *Images stack window*

By clicking on “Display metadata” a window with the corresponding metadata will be displayed.

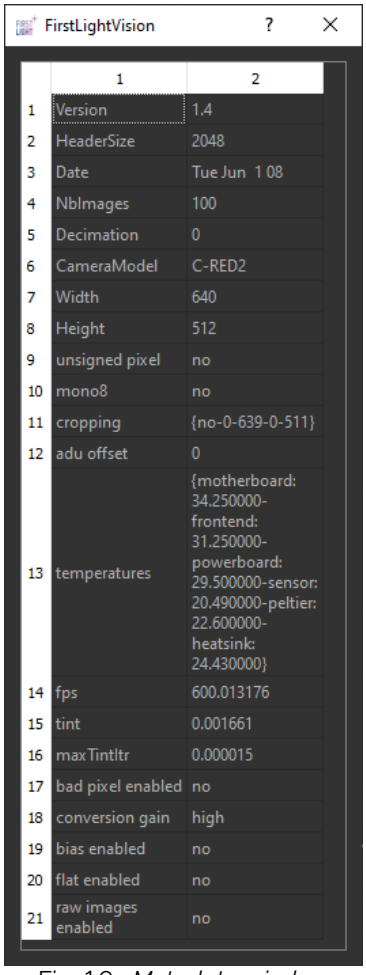


Fig. 19 : *Metadata window*

5.4.2. Display

In the middle there is the display of the image. This display offers multiple functions.

Some basics image manipulations are available with some shortcuts:

- Zoom in/out by keeping “Ctrl” pressed and roll the wheel of the mouse.
- Move the image by keeping “Ctrl” pressed and left mouse button and move the mouse.
- Rotate the image by keeping the wheel mouse button pressed and move the mouse.

Here is an example after a zoom in where you can see that the pixel under the mouse is of a different color.

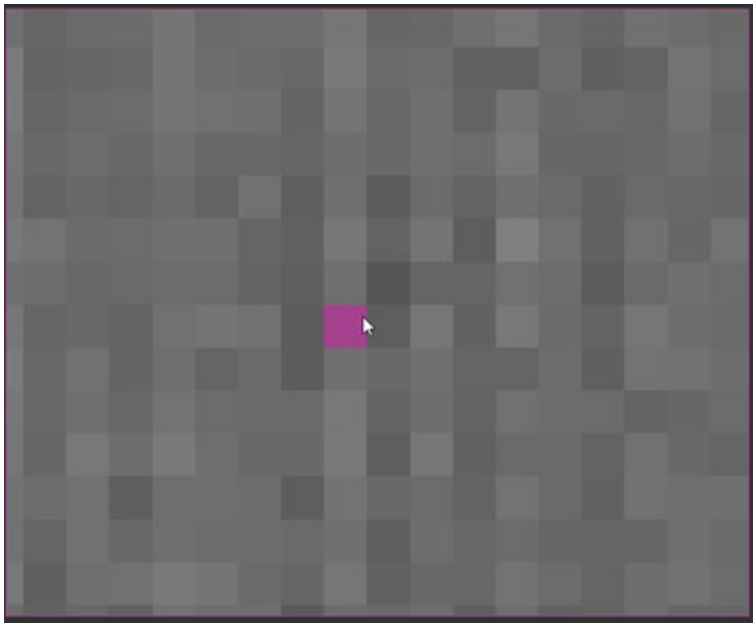


Fig. 20 : *Display with mouse*

Just under the display there is a line that displays useful information:

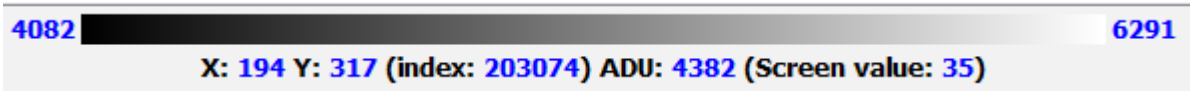


Fig. 21 : *Display mouse position information*

X and Y being the position of the mouse on the image, the index of the corresponding pixel, the value of the pixel in ADU and the value of the pixel after processing.
A color scale is also available with the colors between the min value and the max value.

You can do a manual clip on the image by keeping the left click of the mouse pressed, move it and release it in order to draw a rectangle where the clipping will be computed.

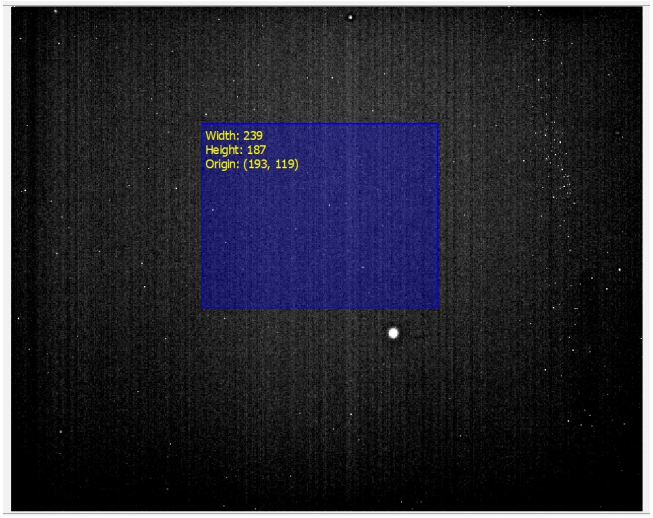


Fig. 22 : *Display clipping*

Same thing can be done with the right click of the mouse to draw a red rectangle (analysis rectangle) that will limit the processing of information in “Image Statistics” module.

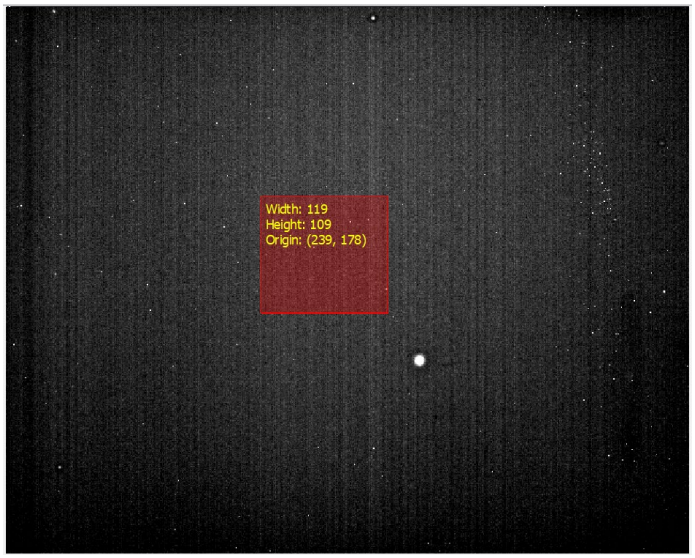


Fig. 23 : *Display analysis rectangle*

The analysis rectangle can be moved by pressing "Ctrl" and click on it, it also can be resized by clicking on a border.

Some other functions are available by right clicking on the display.

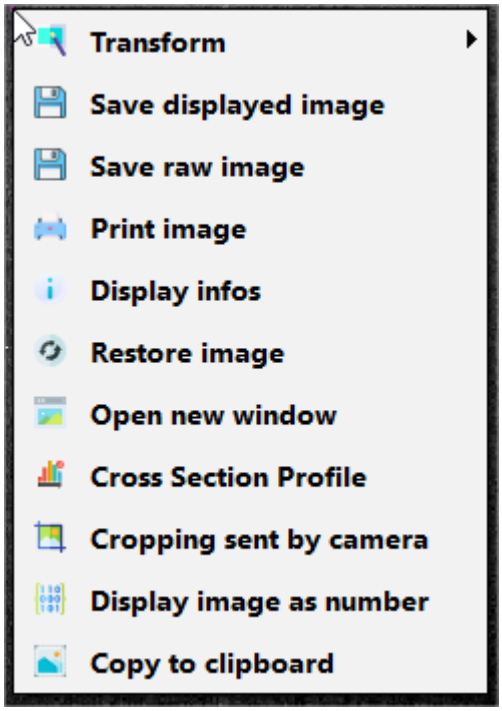


Fig. 24 : *Right click menu*

- "Transform" is a submenu to do some basic transformation on the image.

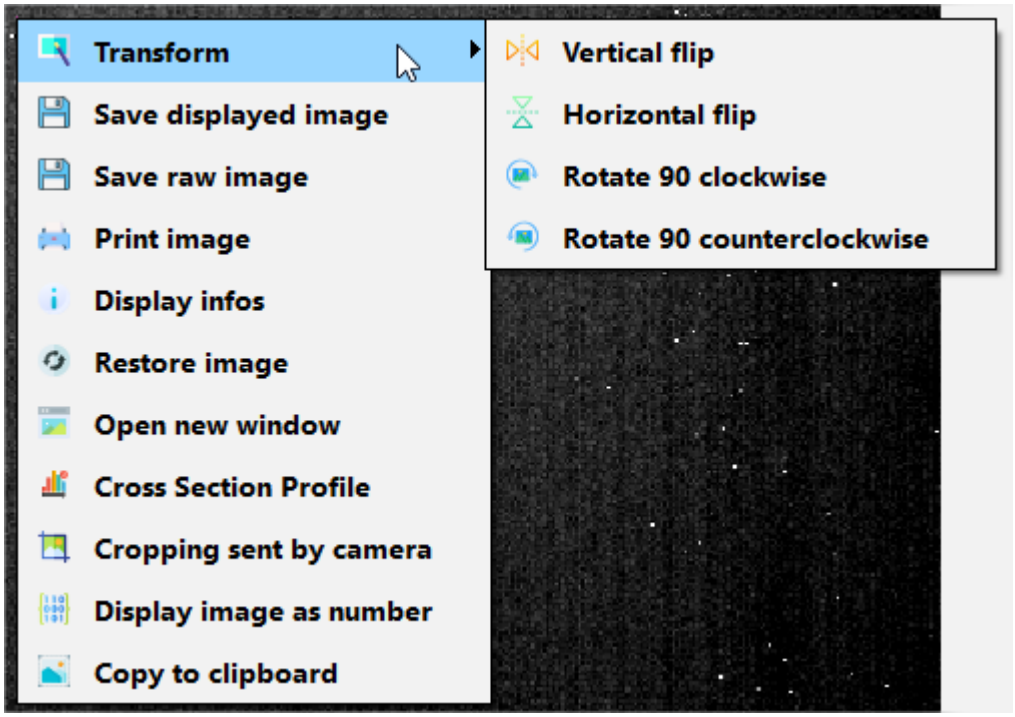


Fig. 25 : *Transform submenu*

- "Save displayed image" will save the displayed image in PNG, JPEG or TIFF.
- "Save RAW image" in order to save the current image from the buffer in RAW.
- "Print image" will start a printer preview with the current displayed image.
- "Display infos" will display some information directly on the image, if you save image with this option enabled, they will be saved too.

Fig. 26 : *Display with Display infos enabled*

- "Restore image" will disable all transformations done on the image like zoom, rotation, flip, ….
- "Open new window" will open a window with a new display that will be independent of the others.

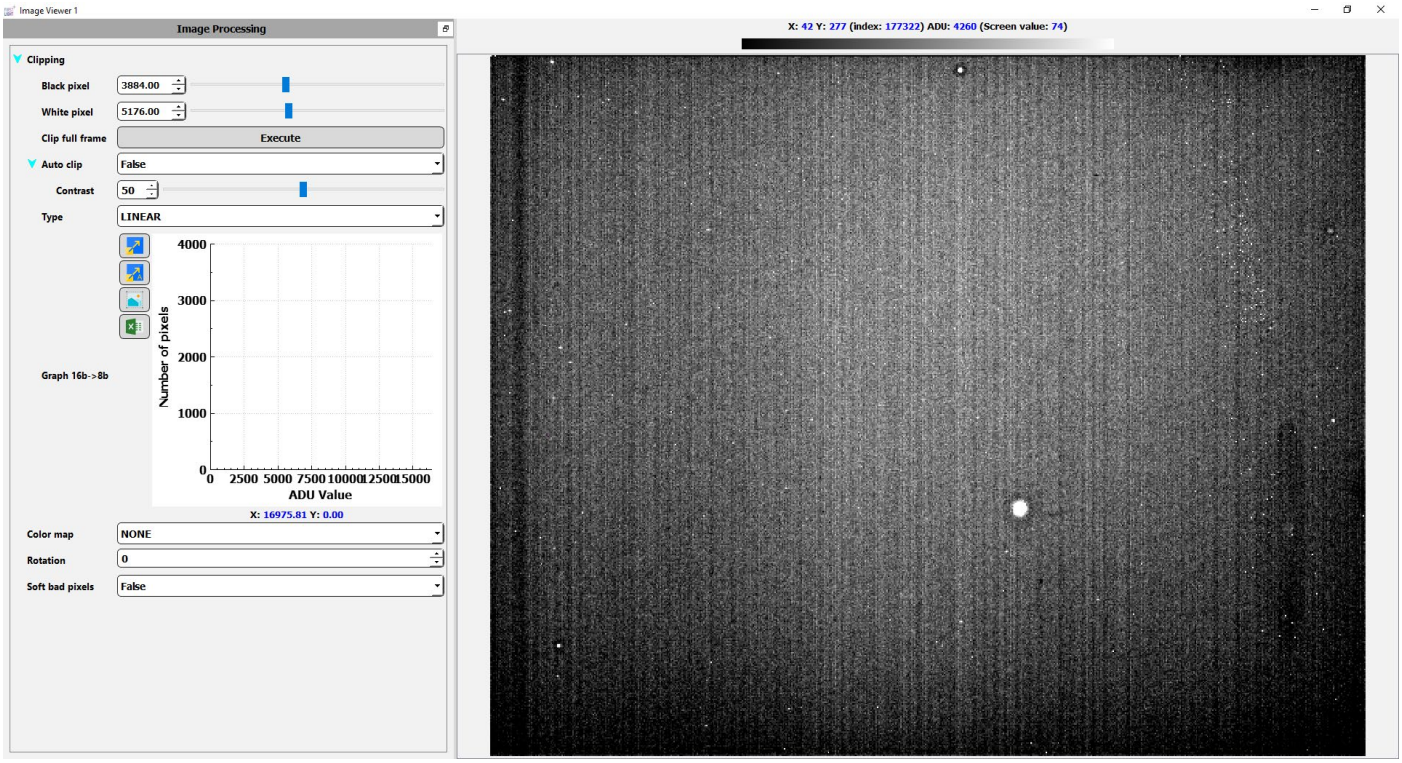


Fig. 27 : *New display window*

- "Cross section profile" will draw a cross section on the image and display a new window with the pixel's values under the lines.

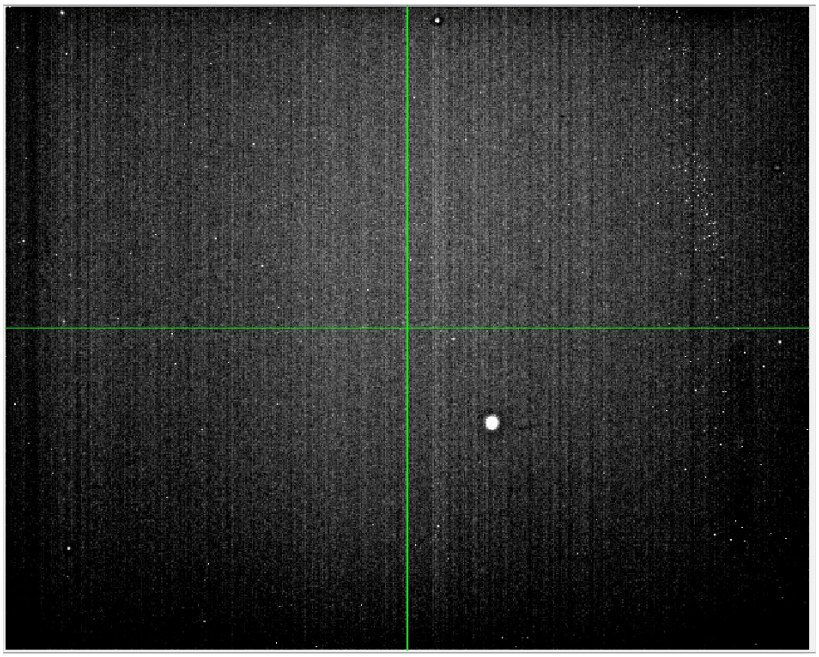


Fig. 28 : *Display with cross section*

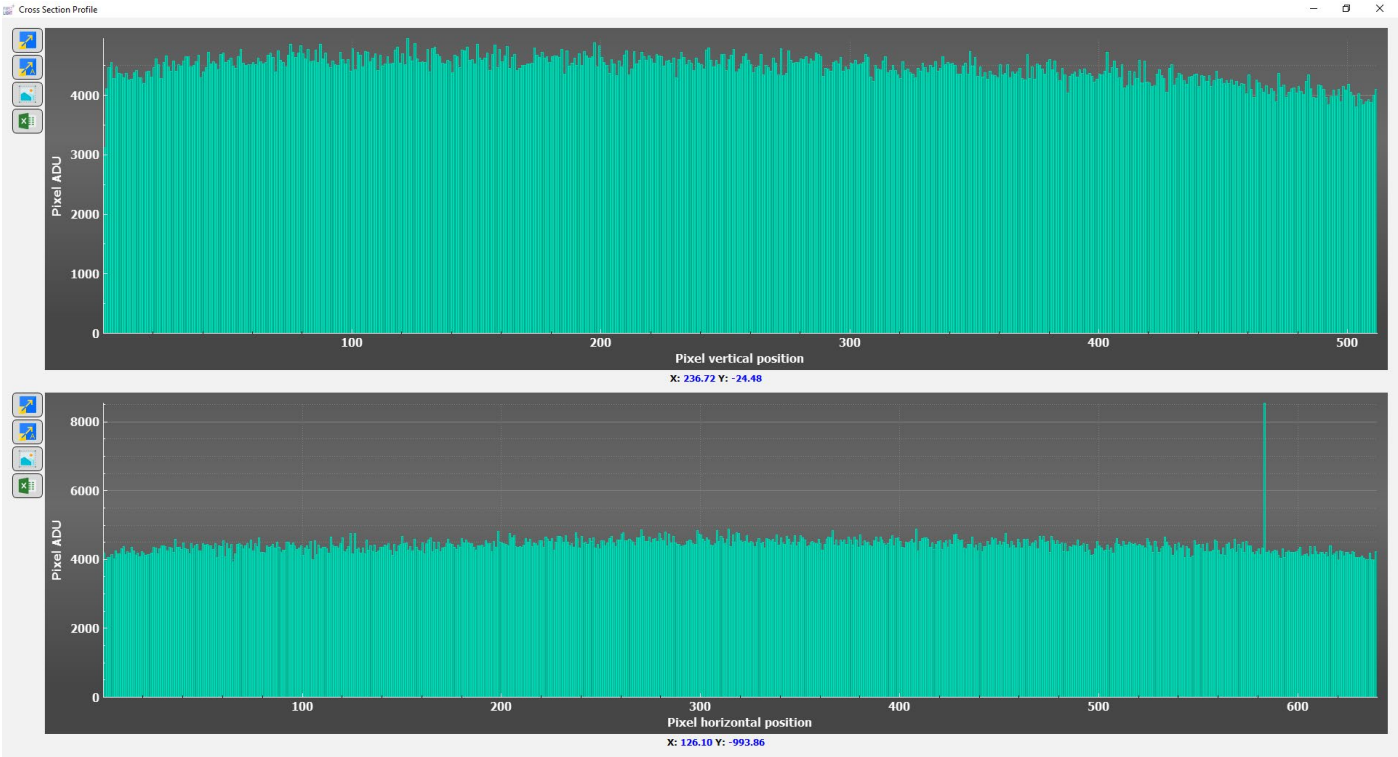
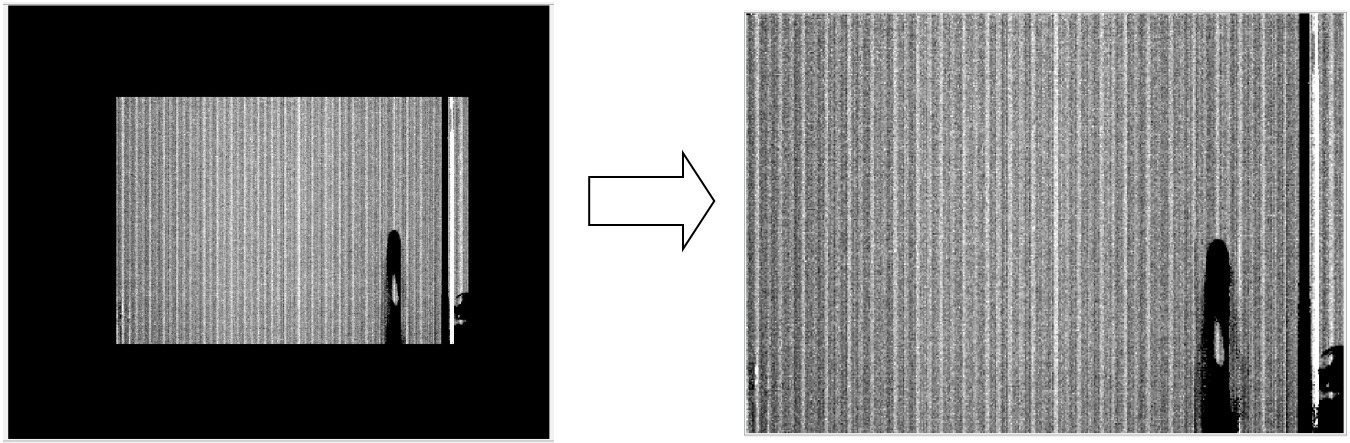


Fig. 29 : *Cross section graph*

- "Cropping sent by camera" if it is enabled then the cropping will be the true image sent by the camera. If it is disabled, the GUI will adjust the image to the cropped zones.



- "Display image as number" will display a new window with a number representation of the image.

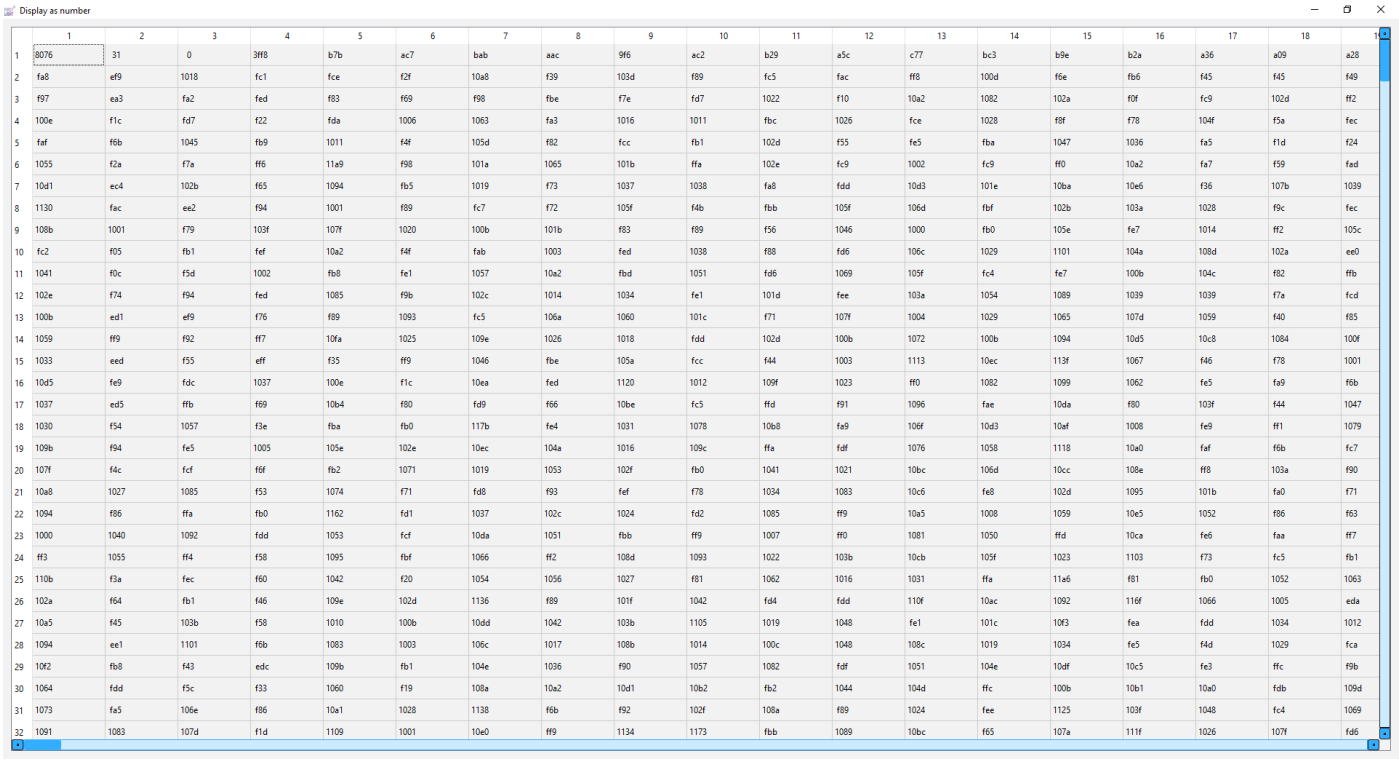


Fig. 30 : *Image as number*

Right click on the top left corner of the array to change the number representation between Hexadecimal or Decimal, or export value in a CSV file.

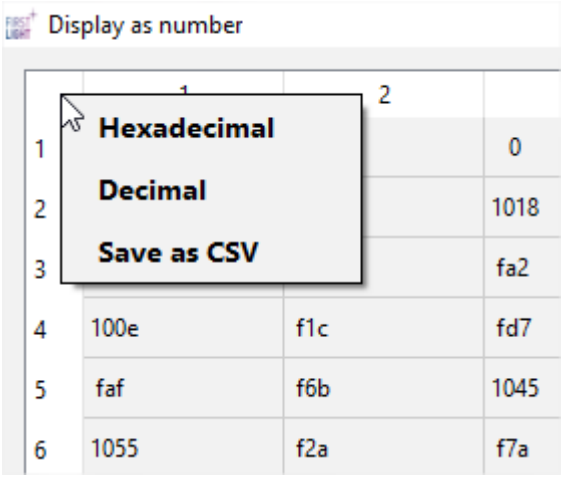


Fig. 31 : *Hexadecimal or Decimal*

- "Copy to clipboard" will copy all the displayed image (with form and text) to your clipboard.

5.4.3. Multiple ROIs

It is possible to add ROIs on image by clicking “Alt” + mouse left click.

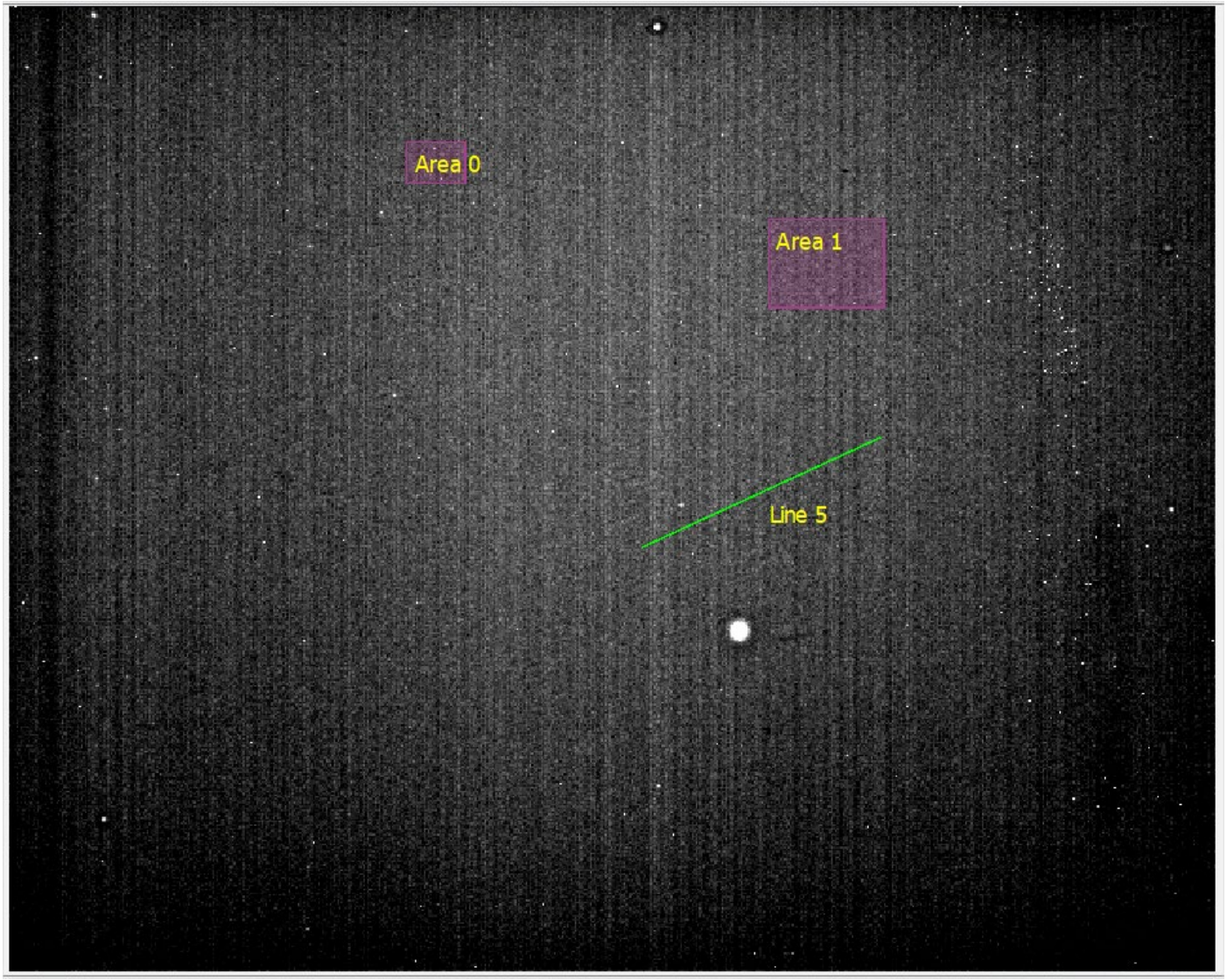


Fig. 32 : *ROIs*

Each ROI has a default name and ROIs parameters can be accessed thanks to the new window “Region of interest”.

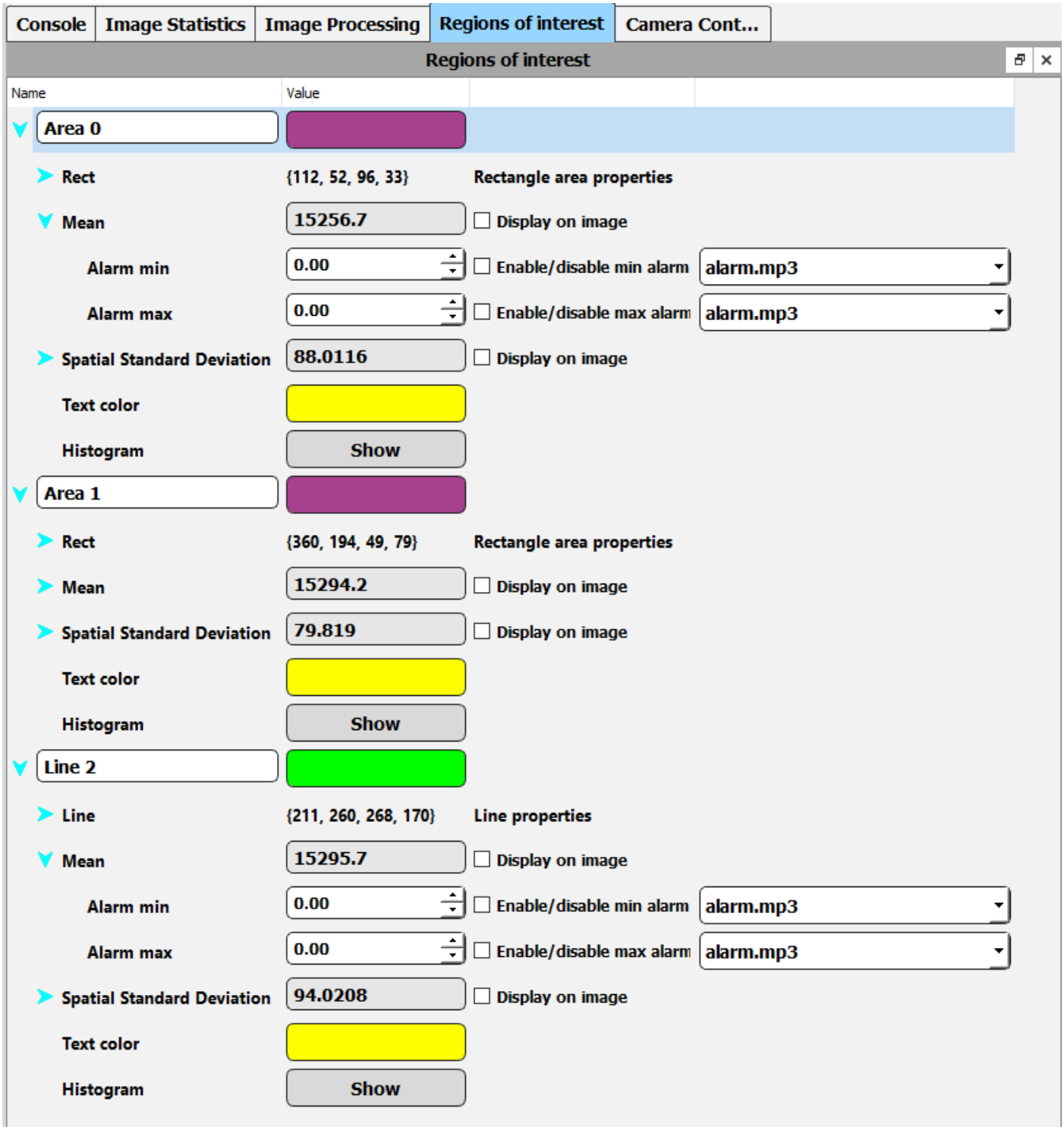


Fig. 33 : *Region of interest window*

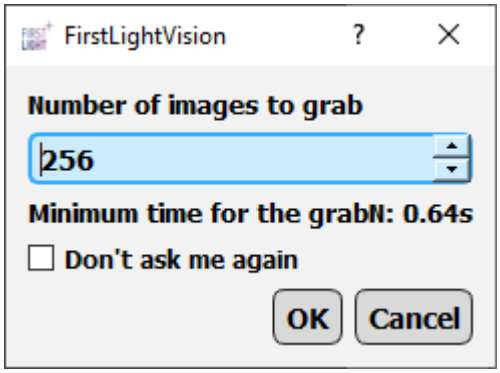
You can change the ROI background color and text color or display more information on image like "Mean" or "Spatial standard deviation" of the ROI. You can change the size and position of the ROI. Alarm can be activated to notify the observer when the value of the parameter is not any more in the specified range.

5.4.4. Shortcut's button

5.4.4.1. Acquisition

Fig. 34 : *Acquisition shortcuts*

There are five buttons for this section:

- starts the grab
- pauses the grab and does not reset the buffer at next grab start
- stops the grab and reset the buffer at the next grab start
- opens a box 

and start a grab of N frames. If you click on “Don't ask me again” then the box will not appear until the next software start, but you can change the number of images in “File”->”Settings” (see section 5.6.1.2).
- starts/stops direct record (see section 5.6.1.6).

5.4.4.2. File

Fig. 35 : *File shortcuts*

There are three buttons for this section:

- opens the dialog save buffer (see fig18)
- is used to load a file

- takes a snapshot of the current image (see section 5.6.1.5).

5.4.4.3. Left mouse click action

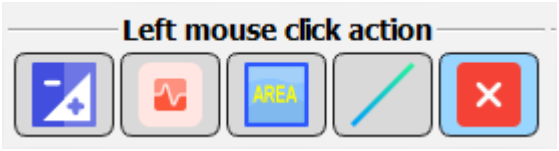


Fig. 36 : *Left mouse click action shortcuts*

There are five buttons in this section, each button changes the function realized by the left mouse click on the image:

- enables the cropping section
- enables to draw the image statistics rectangle
- enables to draw region of interest
- enables to draw section
- enables to draw a rectangle to delete regions of interest and sections

5.4.4.4. Image processing

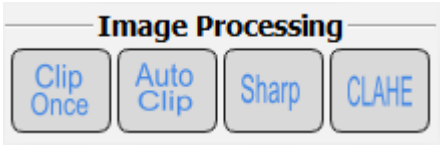


Fig. 37 : *Image processing shortcuts*

There are four buttons in this section:

- to clip once on all the image
- enables the autoclip on all the image
- enables the sharpen processing
- enables the CLAHE processing

Clip: Clip function is a way to automatically set the best values for the white and black points. All the ADU above the white point will be displayed as white (RGB=255,255,255) and all the ADU values below the black point as black (RGB=0,0,0). It is required to set these points because the dynamic of a pixel on a screen for grayscale images is limited to [0-255] which is lower than the

dynamic of the images coming from the cameras. The clip function maps as best as possible the dynamic of the images to the dynamic of the screen.
This mapping is linear(default), logarithmic or gamma depending on the type selected in the image processing / clipping section.

Sharpen: Sharpen processing is a way to increase the contrast between bright and dark region.

Clahe: Clahe processing is a way to improve the image using an adaptive histogram equalization.

5.5. Image processing

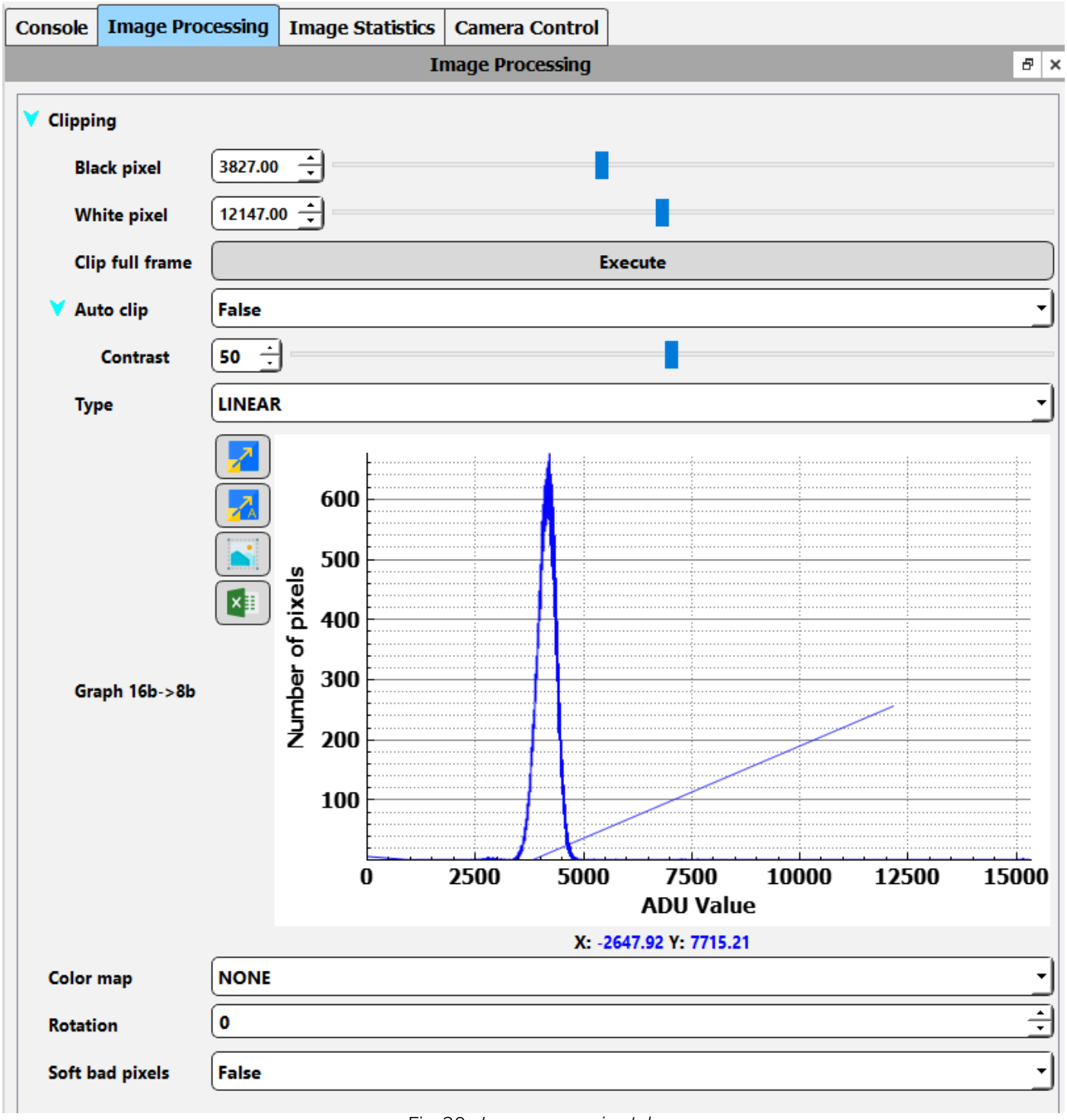


Fig. 38 : *Image processing tab*

5.6. File menu

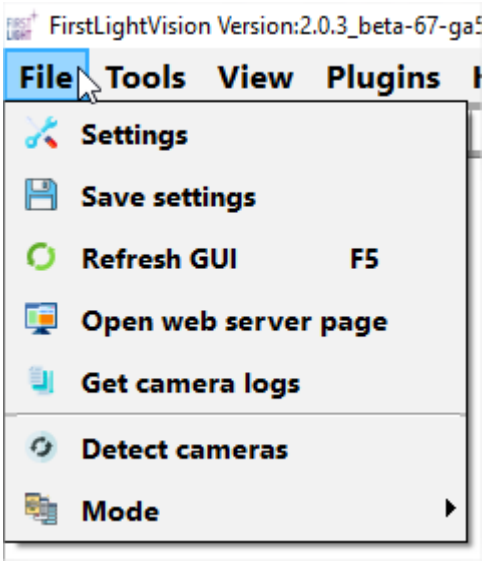


Fig. 39 : *File menu*

5.6.1. Settings

5.6.1.1. Buffer

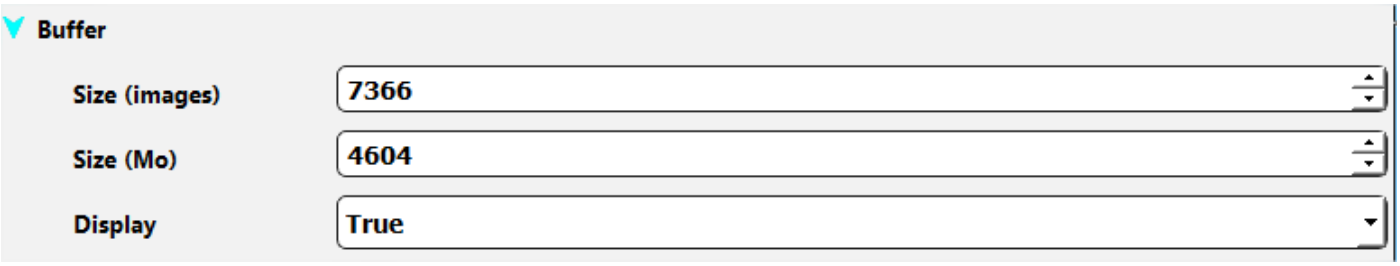


Fig. 40 : *Buffer settings*

In this section the user can change the size of the buffer (in number of images or in Mo) and choose to display the buffer part in the central view.

5.6.1.2. Grab

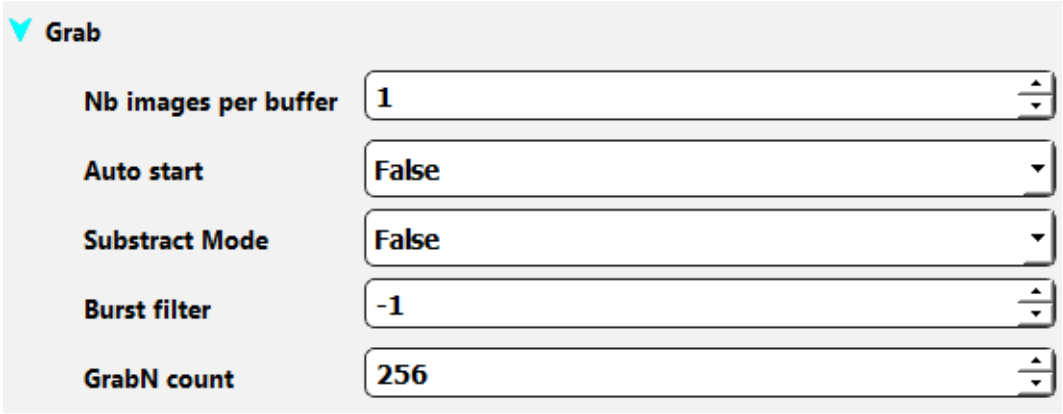


Fig. 41 : *Grab settings*

In this section the user can:

- Change the number of images per buffer (useful for high FPS).
- Auto start mode, if enabled then the grab will start automatically when the software start.
- Substract mode, if enabled then the image is a substraction of the image N minus the image N-1, the subtracted image is saved in the ring buffer.

- Burst filter, when tags are enabled and IMRO mode is enabled, the burst filter will display only the images with a burst tag of the indicated value.

5.6.1.3. Camera

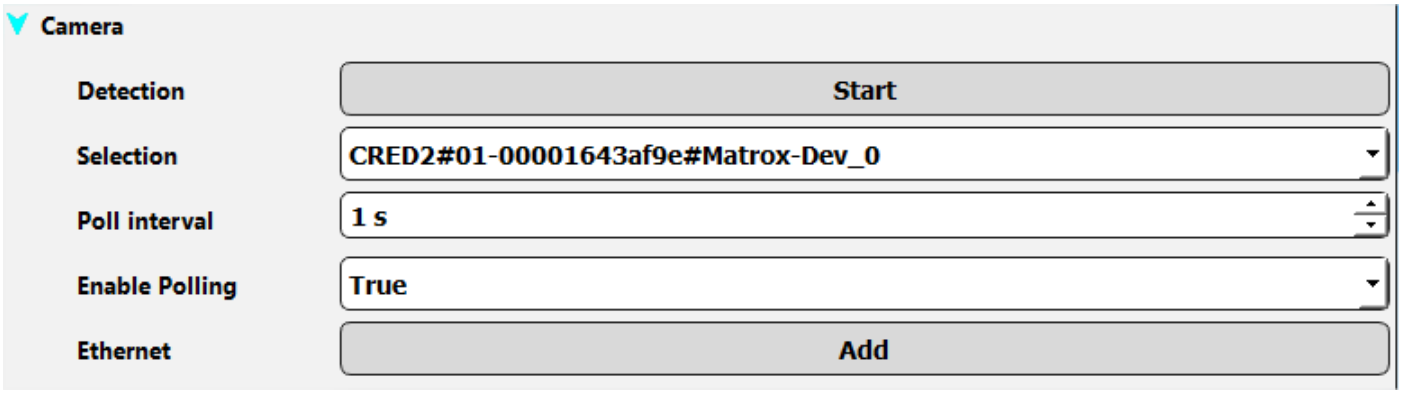


Fig. 42 : *Camera settings*

In this section the user can:

- Start a camera detection.
- Change the camera used.
- Change the polling interval.
- Enable/disable the polling.
- Add an ethernet camera:

Fig. 43 : *Add ethernet camera*

This feature makes possible the use the GUI through an ethernet connection to the camera. By clicking on it you will have to enter the IP and the login/password of the camera.
Once the connection is done all features of the GUI are available but with a grab FPS lowered (around 25-30 FPS).

Note: function is available on C-RED 3 minimum firmware version 1.3.x, on C-RED 2 minimum firmware version 4.1.x, and on C-RED One minimum firmware version 4.2.x.

You can set a range of IP in order to auto detect a camera on the same subnetwork (only class C network), example: 192.168.100.20-60
This will send a ping to all the IP between 192.168.100.20 and 192.168.100.60, and will compare the MAC address to the known range of our camera MAC address. "Automatic detection" button will do a detection for all the range of the subnet.

5.6.1.4. User interface

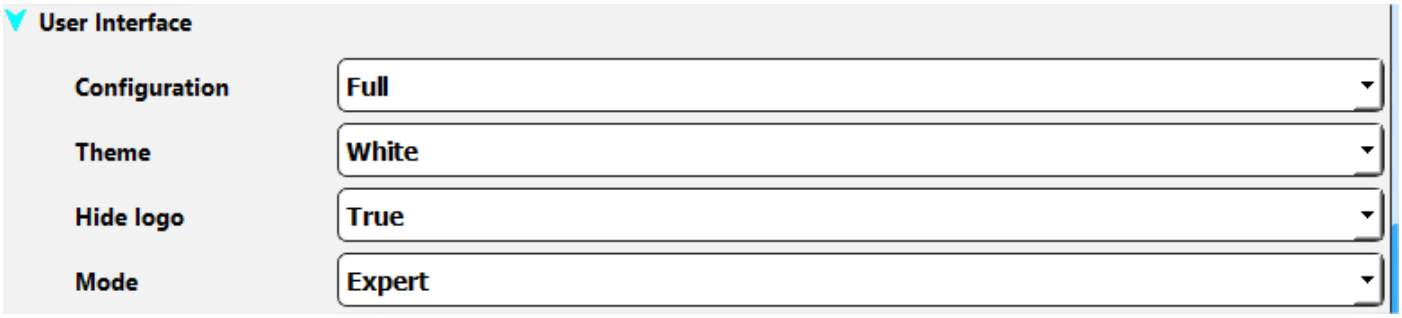


Fig. 44 : *User interface*

In this section the user can:

- Change the software configuration (full, grab only or control only).
- Change the software theme.
- Hide/show the logo.
- Change the software mode (basic or advanced).

The software has 3 modes of operation:

- In "Full" mode, the software displays all the modules and the captured frames.
- In "Grab only" mode, the software displays the captured frames and Image Statistics module only.
- In "Configuration only" mode, the software displays the camera configuration modules, "Console", "Camera Status" and "Camera Parameters" only. In this mode, **frames from the camera can be captured by another software**.

5.6.1.5. Snapshot

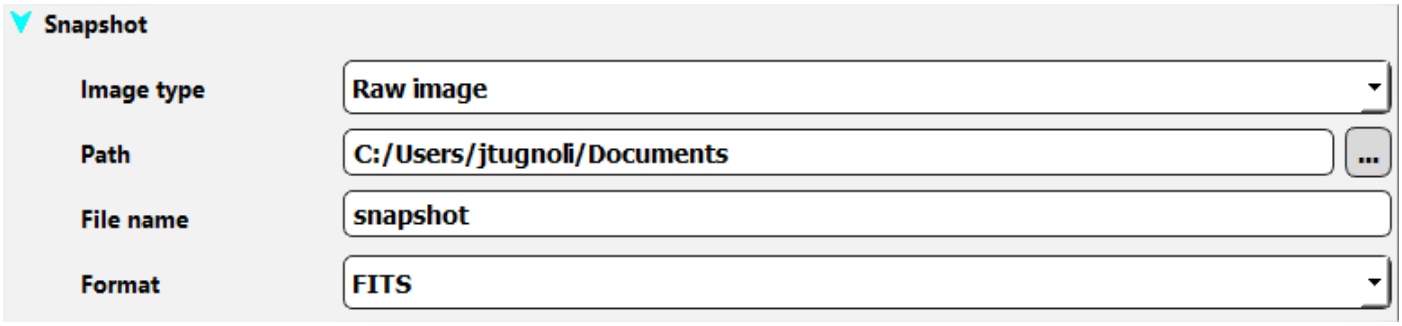


Fig. 45 : *Snapshot*

These are the parameters used when a snapshot is taken with the button .

5.6.1.6. Record

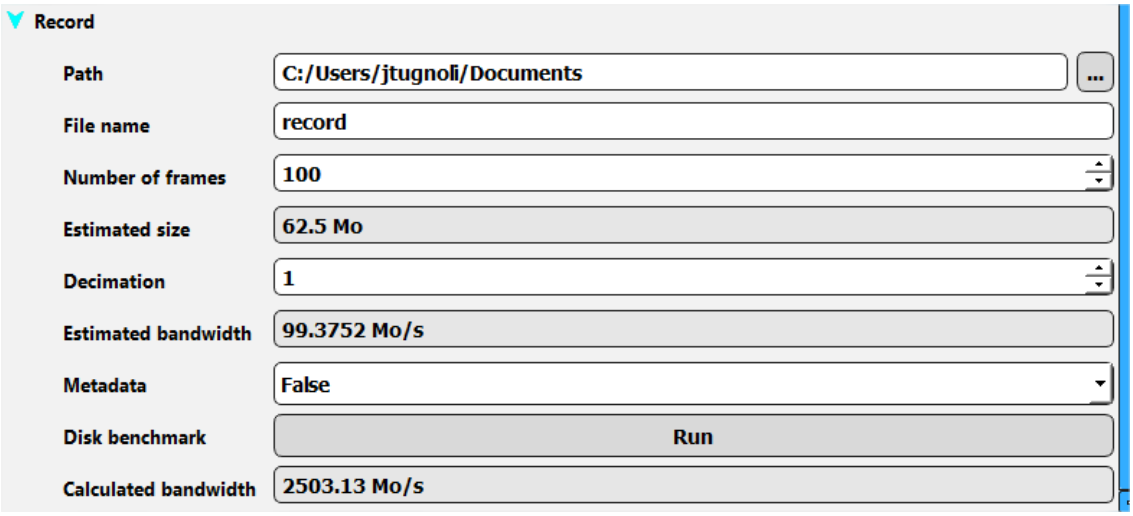


Fig. 46 : *Record*

These are the parameters for a direct record with the button . User must select path, file name, number of frames to save, the decimation and enable/disable metadata.
By clicking on "Run", a benchmark of the path will be done to know the maximum bandwidth available then user must adjust the parameters to fit the estimated bandwidth to the calculated bandwidth.

5.6.2. Save settings

Click on "Save settings" to save settings and apply them at the next startup.

5.6.3. Refresh GUI

Click on "Refresh GUI" (or F5 shortcut) to reread camera parameters.

5.6.4. Open web server page

For compatible cameras, this button will activate the web server on the camera and open a web page using default browser.

5.6.5. Get camera logs

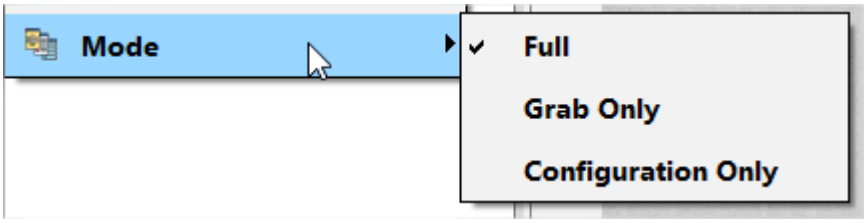
Click on "Get camera logs" to download logs file from camera.

This window will appear, enter the number of days to compose the logs file and click "Ok" to download it.

5.6.6. Detect Cameras

A shortcut for camera detection.

5.6.7. Mode



The software has 3 modes of operation:

- In "Full" mode, the software displays all the modules and the captured frames.
- In "Grab only" mode, the software displays the captured frames and Image Statistics module only.
- In "Configuration only" mode, the software displays the camera configuration modules, "Console", and "Camera Control" only. In this mode, **frames from the camera can be captured by another software**.

5.7. Tools menu

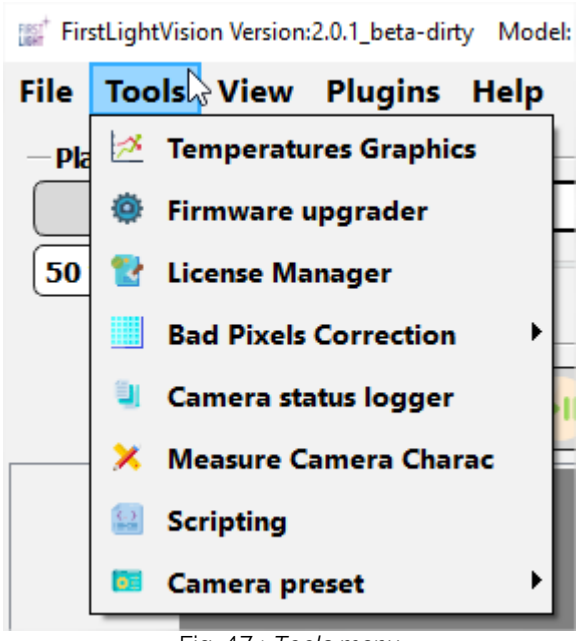


Fig. 47 : *Tools menu*

Note: All these features are not available for all the cameras.

5.7.1. Temperatures Graphics

This option displays a new window with a graphic of camera temperatures since the opening of the graph.

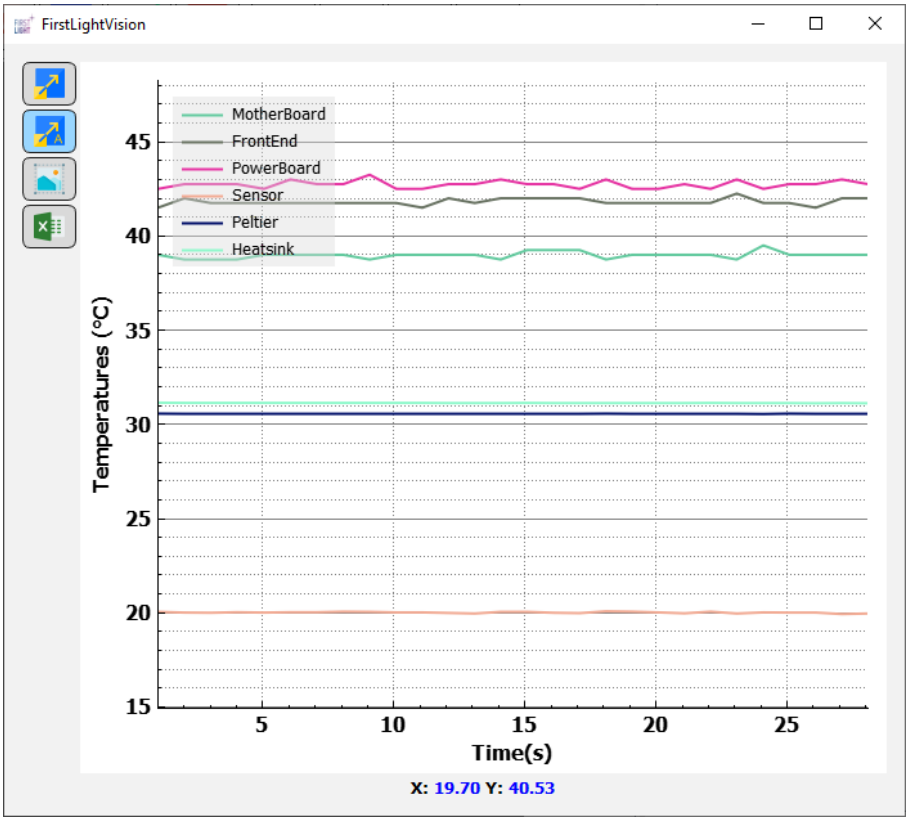


Fig. 48 : *Temperature graphics*

5.7.2. Firmware upgrader

This option displays a new window for the camera maintenance.

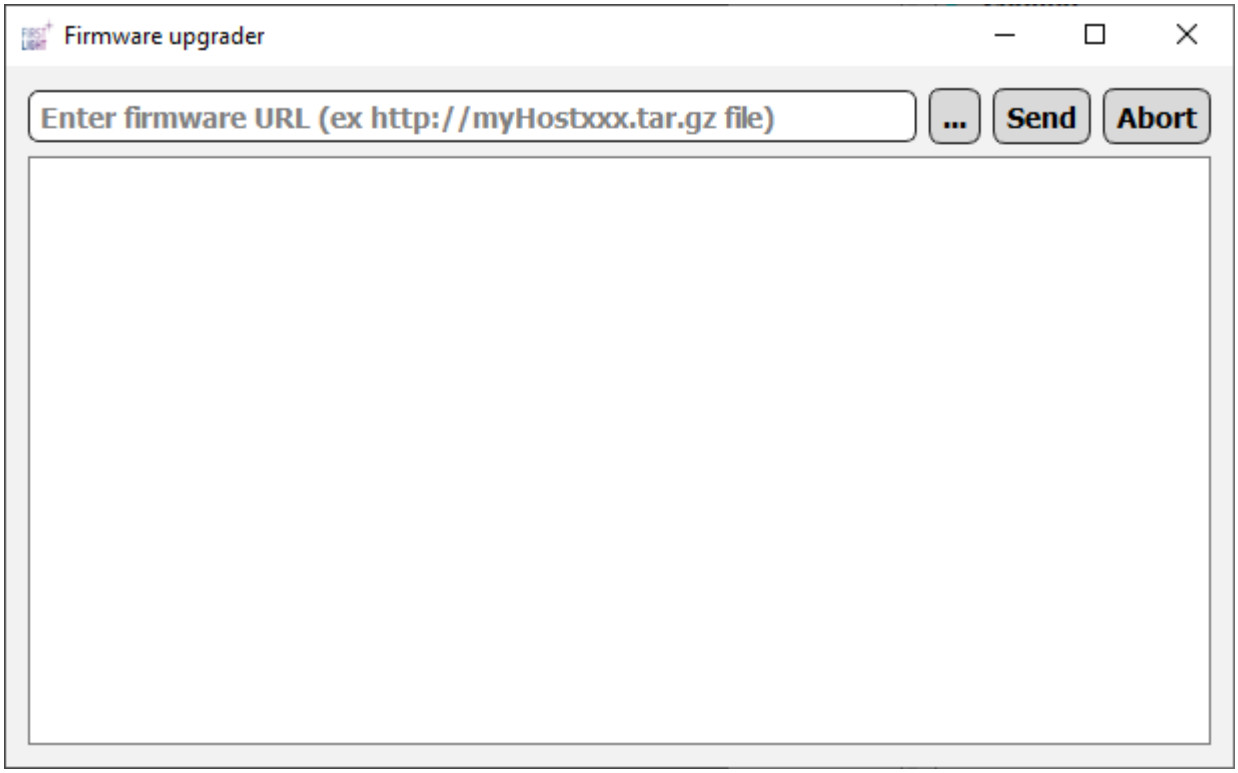


Fig. 49 : *Camera maintenance*

The camera's firmware can be easily upgraded using the application. Firmware being transferred to the camera using TCP/IP, ensure that the camera is properly connected to IP network before performing the upgrade.

The current IP configuration of the camera can be displayed by typing “ipaddress” command in the main application console.

```
[16:44:30]fli-cli> ipa
MAC_ADDRESS:70:B3:D5:B0:90:17 IP_ADDRESS:192.168.120.39 MASK:255.255.255.0
LINK_ESTABLISHED:yes
OK
```

Fig. 50 : *Console IP address example*

To perform the update, the firmware can be either hosted on a server (http, ftp or tftp) accessible by the camera, or directly on the PC controlling the camera.

When the firmware is hosted on a server, simply write the URL of the firmware in the upgrade firmware entry and click “Send” to proceed.

The “Abort” button abort the current update procedure. This is typically used when the specified URL is invalid or unreachable. It is used to unblock the FW camera download procedure.

When the firmware is located on the PC, click on the button to select the firmware file. Once selected, the firmware file location will appear on the text entry.

Then click “Send”. The application will directly upload the firmware file into the camera.
The firmware update progress will be shown in the application console. In case of successful installation, the camera reboots automatically to use the new firmware.

Note: For more information on camera firmware upgrade, please refer to the C-RED 2-3 TS4 UpgradeC-RED2-3firmware document.

5.7.3. License Manager

This option displays a new window to manage the camera's licenses.

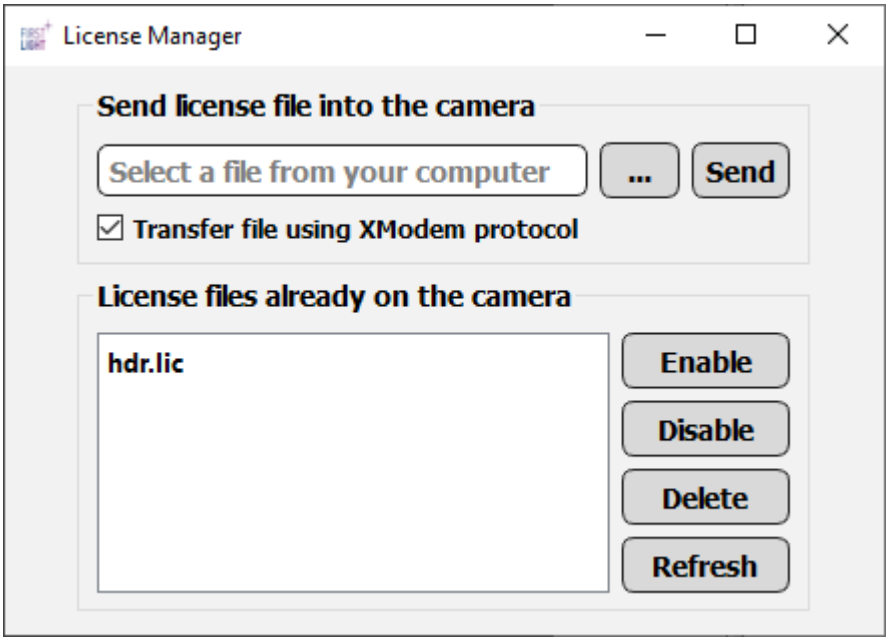


Fig. 51 : *License manager*

Camera optional features are enabled using license files uploaded into the camera.
The license manager window upload, enable, disable or remove license files.

To upload a license file into the camera, select the file by clicking the button .
Click on "Send", the file will be automatically sent to the camera using the serial link.
The checkbox "Transfer file using XModem protocol" specify the transfer protocol (XModem or raw).
To reenable a currently disabled license (appears in the list with a ".disabled" suffix), select it and click on the button "Enable".
To disable a currently activated license (appears in the list without ".disabled" suffix), select it and click on the button "Disable".
To remove a license file, select it and click on the button "Delete".
The button "Refresh" refresh the list of license files installed in the camera.

Changes on license files will only be active after a camera reboot. It is recommended to restore the camera factory settings to keep the camera configuration consistent when enabling/disabling the 600fps option.

5.7.4. Bad pixels editor

This option displays a new window to edit the bad pixels user map. The bad pixels editor is not available for C-RED 2 ER, C-RED One and C-BLUE One.

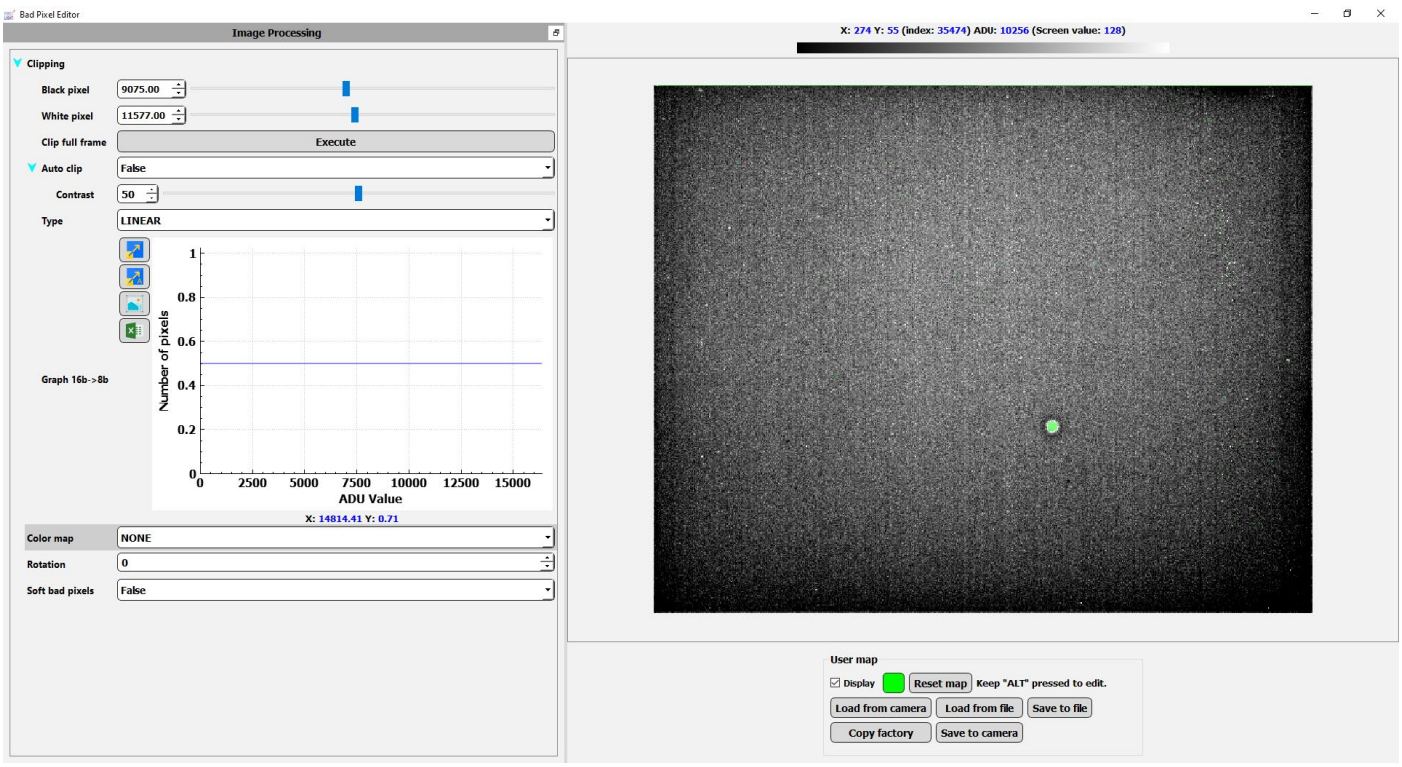


Fig. 52 : *Bad pixel editor*

First thing to do is to enable “Display” checkbox and click on the “Load from camera” button to display the user map of bad pixels. This map will appear with green pixels by default, but the color can be changed by clicking on the colored button next to “Display” checkbox.

“Reset map” button reset all the map. To edit the map, keep “Alt” pressed and left click on pixels that you want to choose as bad pixels. By keeping the left click pressed you can choose pixels just by passing on it.
If you click on a pixel already in the map, then it is deleted. It possible to delete pixels from the map with a rectangle selection, keep “Shift” pressed and draw a rectangle with the left click of the mouse, all pixels in the map that are in the selection will be deleted.

“Load from file” load a map from a selected file in the computer.
“Save to file” save the map on a file in the computer.
“Copy factory” will copy the factory map of the camera.
“Save to camera” will update the user map in the camera.

Note: To restore the factory map, click on “Copy factory” then on “Save to camera”.

5.7.5. Bad pixels detection wizard

Available for C-RED 2 and C-RED 3 only.
This will open a wizard that will guide you to build a custom bad pixel map. At the end it will also provide some options to improve the image quality.
The first step is to put the camera in the configuration you want to use.

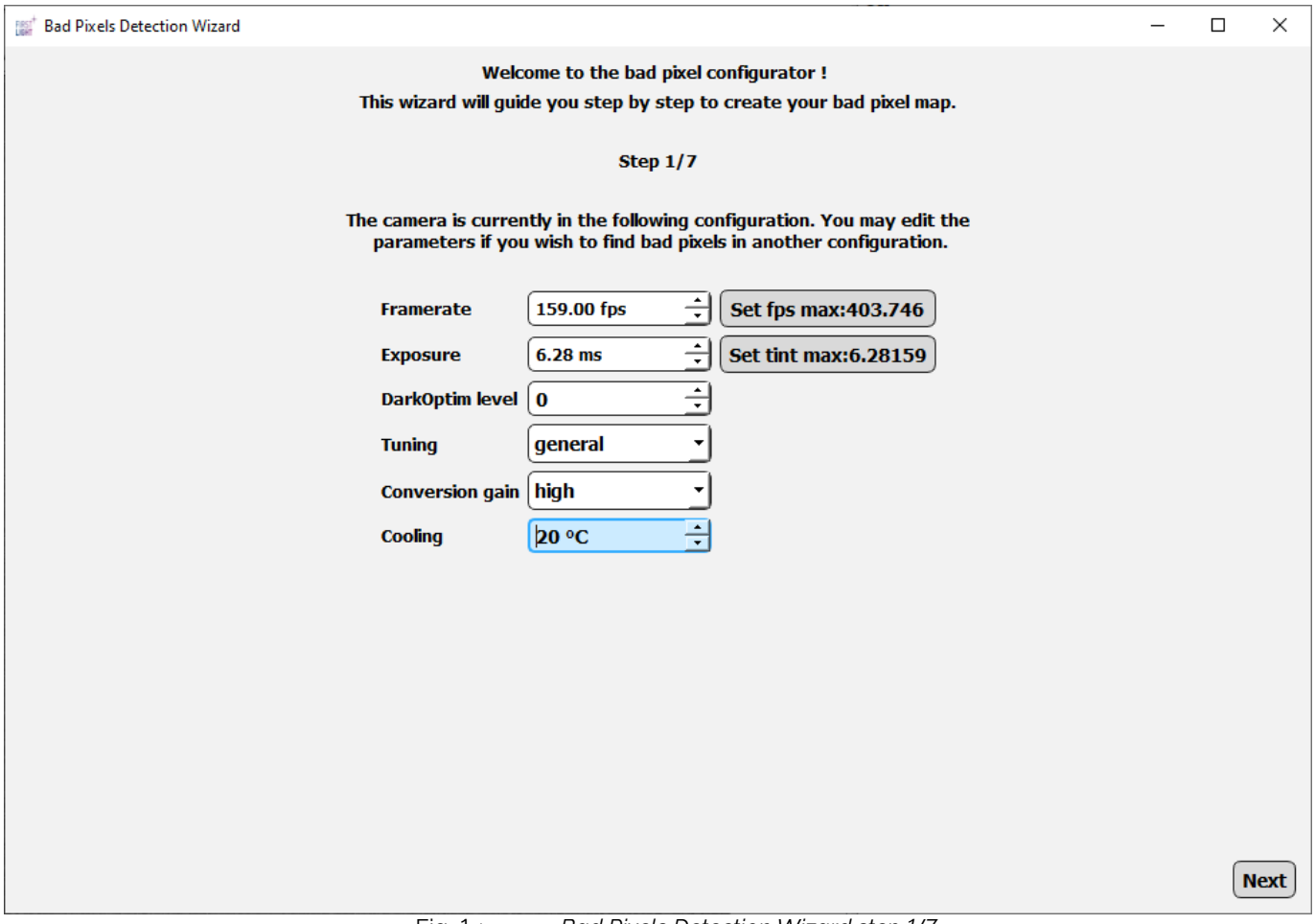


Fig. 1 : *Bad Pixels Detection Wizard step 1/7*

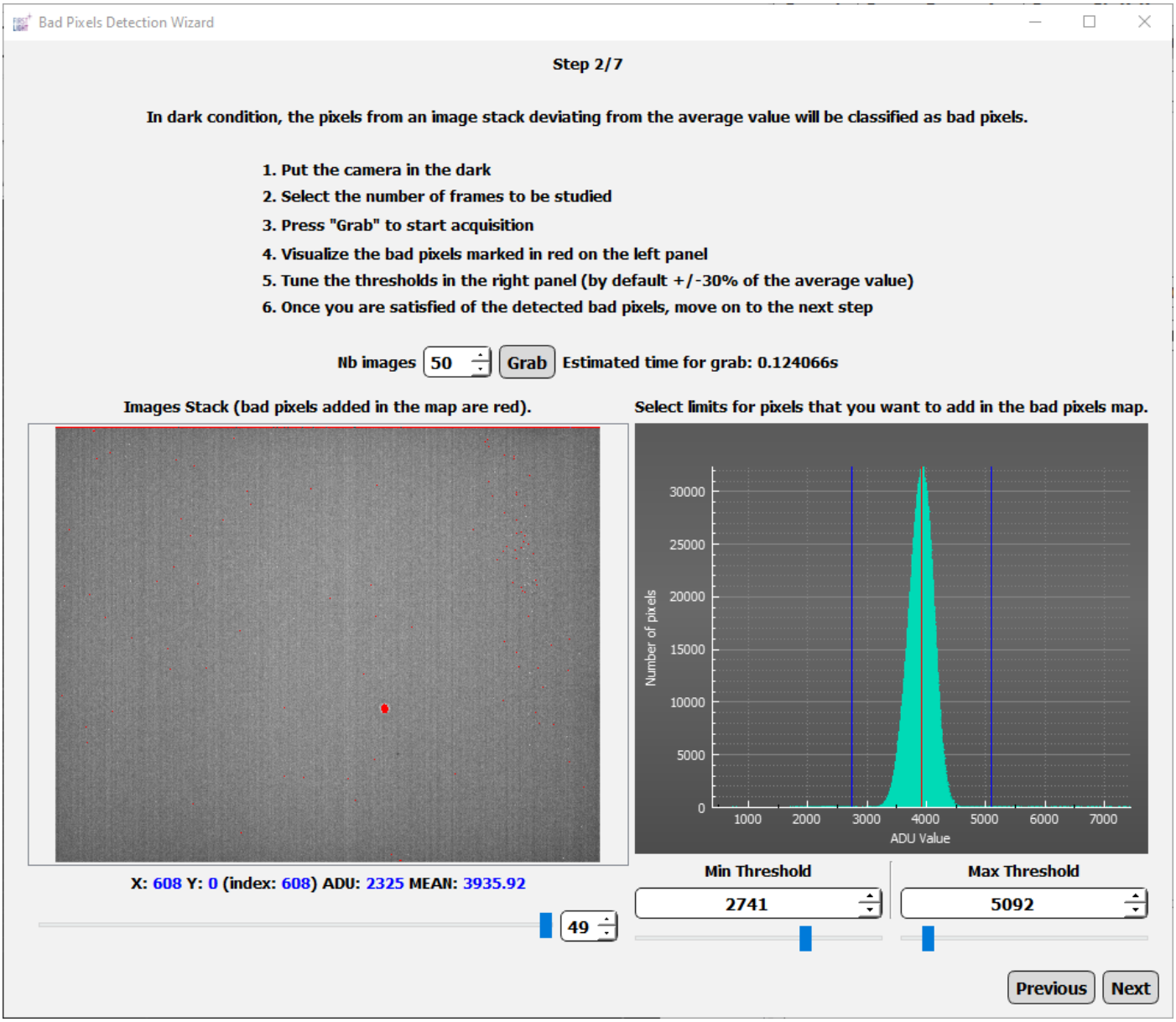


Fig. 2 : *Bad Pixels Detection Wizard step 2/7*

With the camera in the dark, a first criterion, based on the level is provided to detect the bad pixels. The default thresholds usually provide good results, but if needed, it is possible to adjust them.

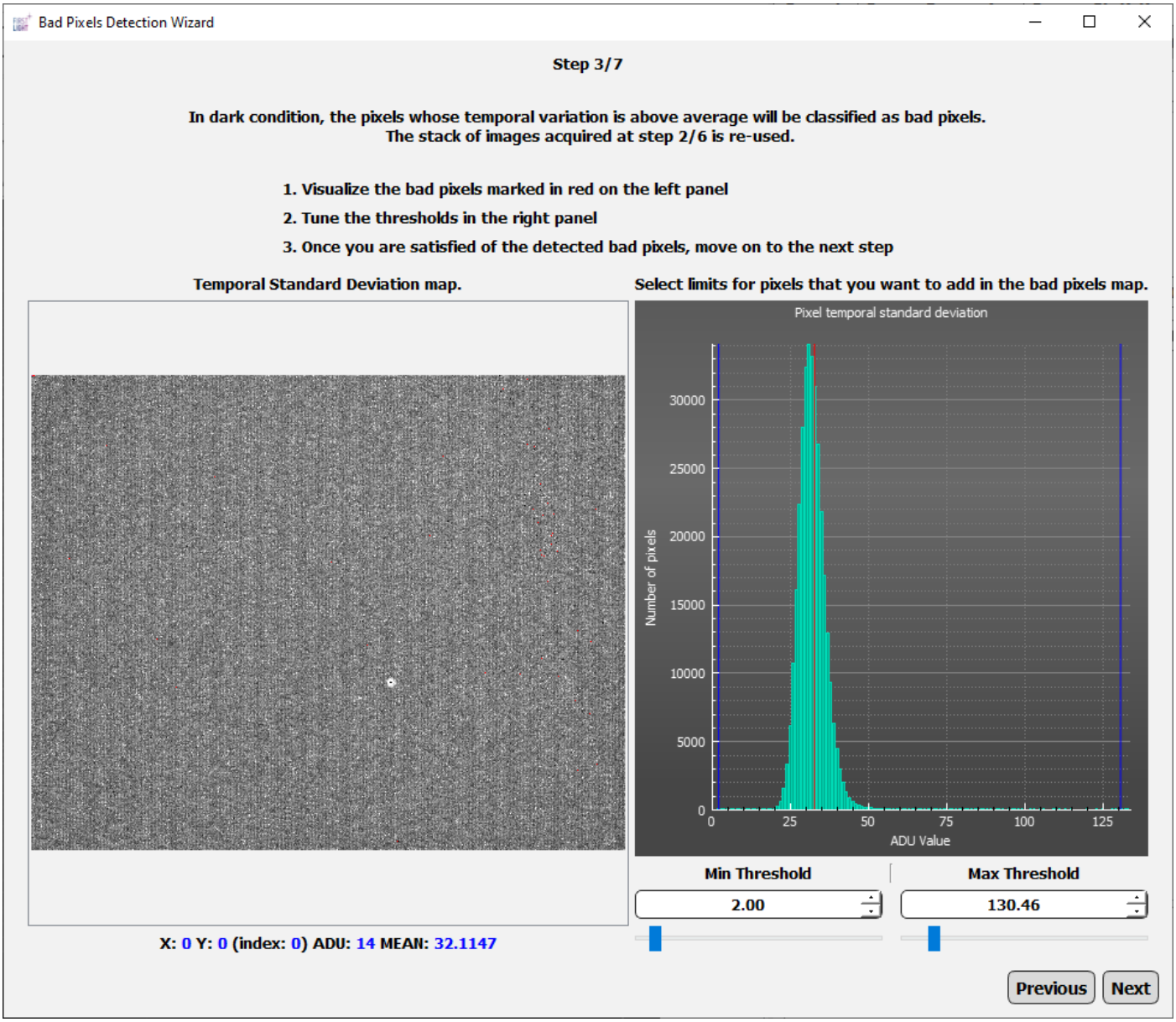


Fig. 3 : *Bad Pixels Detection Wizard step 3/7*

With the camera in the dark, a second criterion, based on the noise is provided to detect the bad pixels.
The default thresholds usually provide good results, but if needed, it is possible to adjust them.

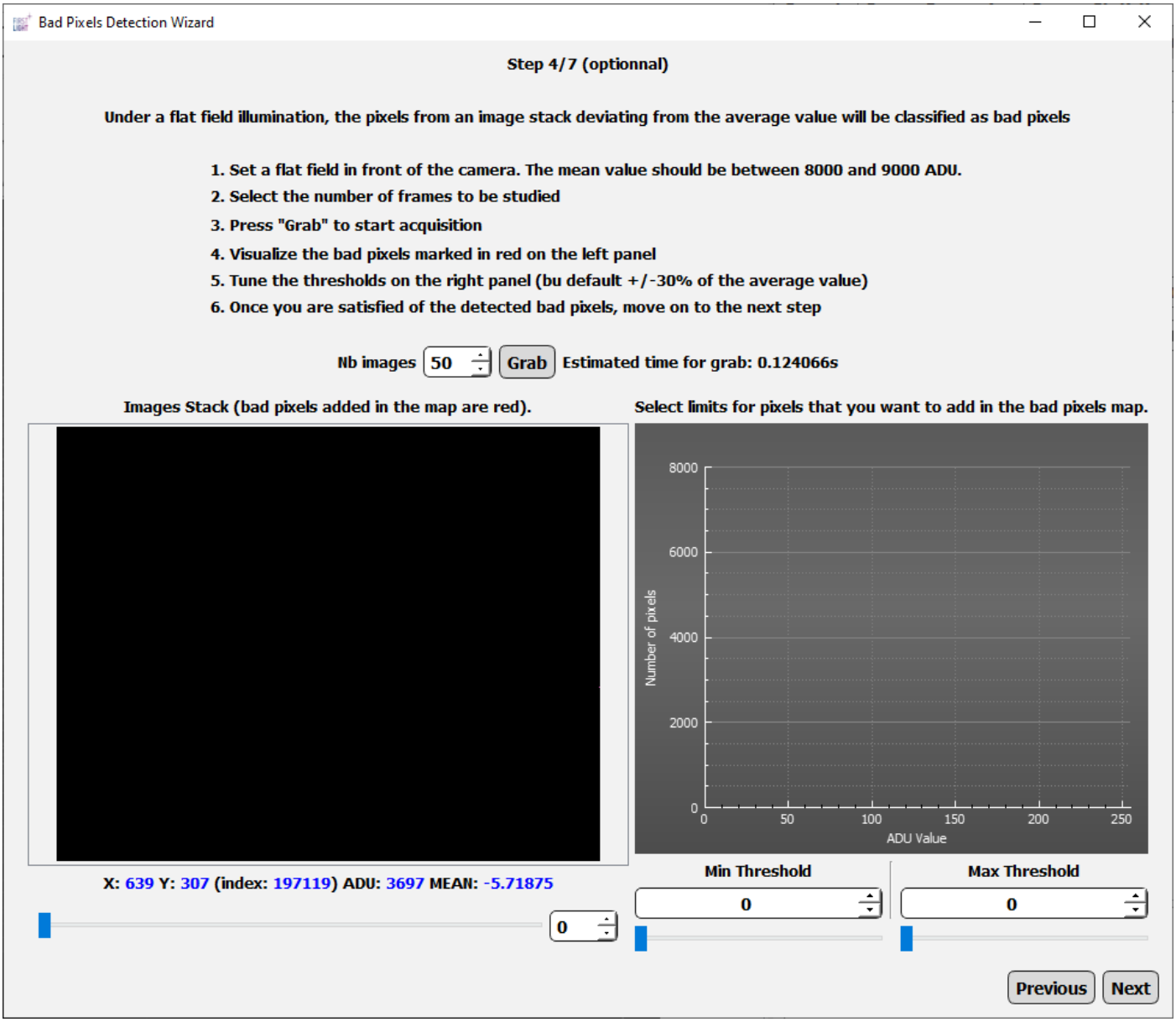


Fig. 4 : *Bad Pixels Detection Wizard step 4/7 (optional)*

With the camera in front of a flat field, a third criterion, based on the level is provided to detect the bad pixels.
The default thresholds usually provide good results, but if needed, it is possible to adjust them.

Note: Because it is not always easy to have a flat field, this step is optional. Criteria in the dark usually already provide good results.

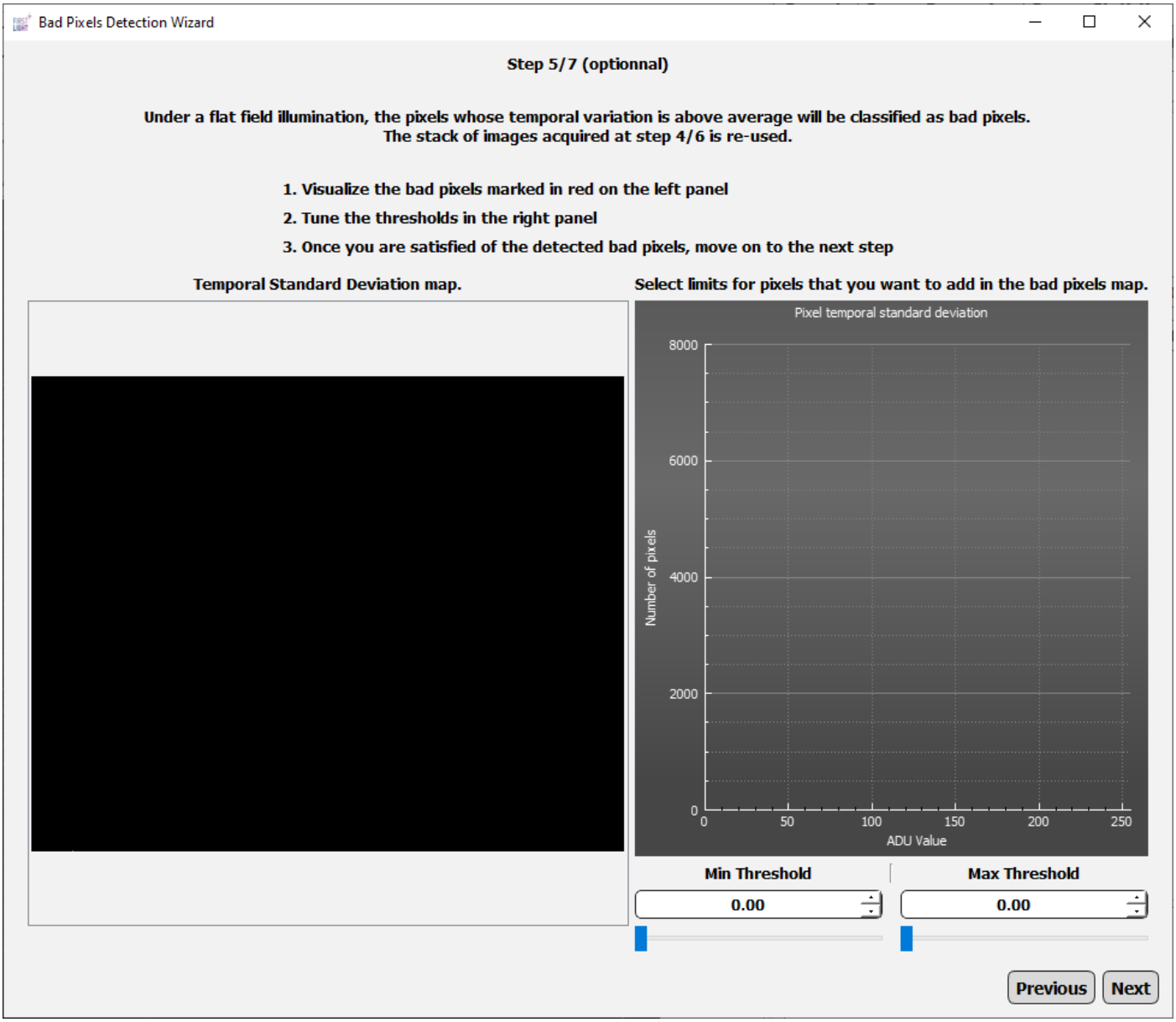


Fig. 5 : *Bad Pixels Detection Wizard step 5/7 (optional)*

With the camera in front of a flat field, a fourth criterion, based on the noise is provided to detect the bad pixels.
The default thresholds usually provide good results, but if needed, it is possible to adjust them.

> ***Note:*** *Because it not always easy to have a flat field, this step is optional. Criteria in the dark usually already provide good results.*

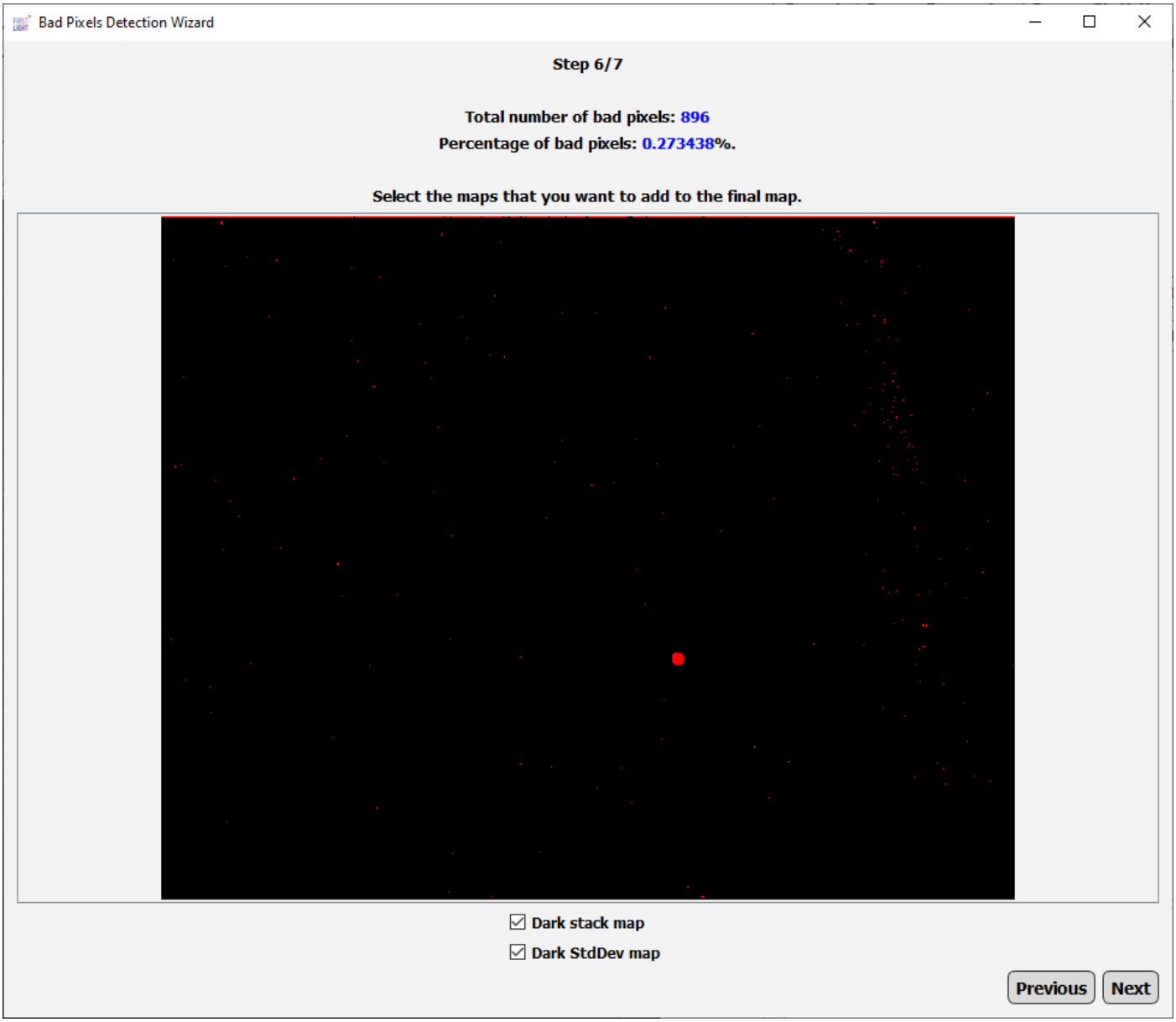


Fig. 6 : *Bad Pixels Detection Wizard step 6/7 (optional)*

This step summarizes the detected bad pixels. The bad pixels detected for each criterion are displayed as different layers.

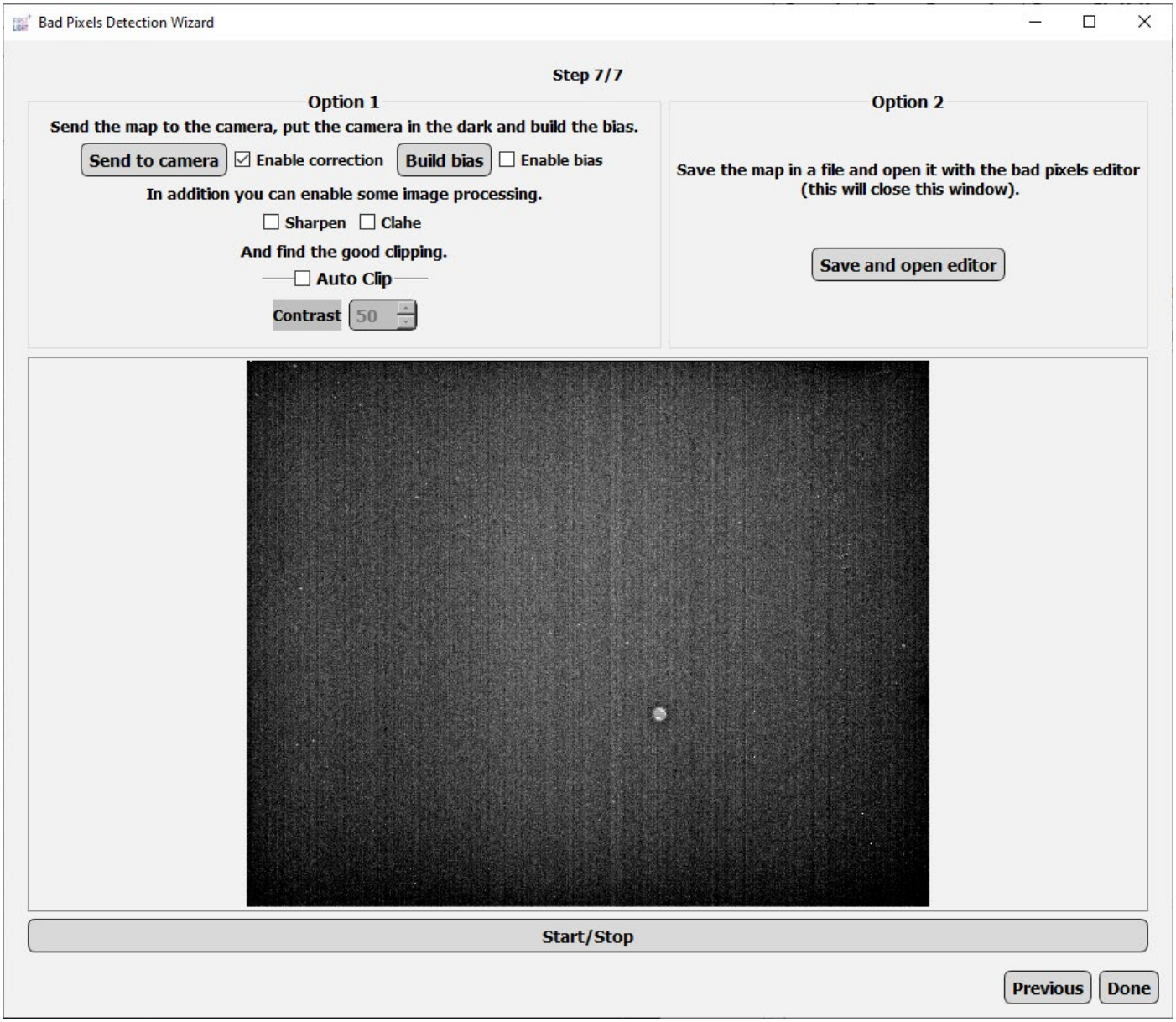


Fig. 7 : *Bad Pixels Detection Wizard step 7/7*

At the end, if you agree with the bad pixels map, you can send it to the camera. Otherwise, you can edit the map in the bad pixels editor to remove or add some specific bad pixels.
In case you agree with the bad pixels map, it is recommended to build the bias, enable the image processing and the clip option to directly get the best image.

5.7.6. Bad pixels Matrix Convolution

The bad pixels Matrix Convolution is only available for C-RED 2 Lite and C-RED Three.
This tool displays a new window where the user can vary the matrices' coefficients, their divisor value and which kind of bad pixel correction to apply:

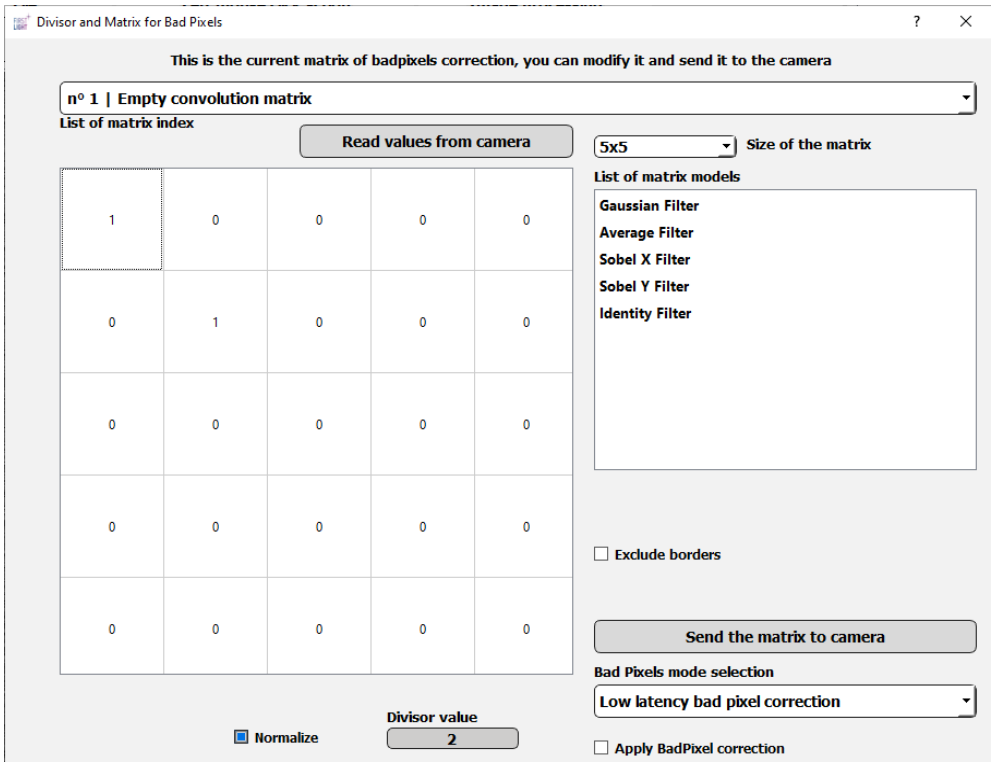


Fig. 8 : *Bad Pixels Convolution Matrix Window*

The drop down menu at the top lists 10 matrices, numbered 0 to 9. The 0th matrix cannot be modified by users : it is the default matrix for First Light Vision. Its cells have a grey background to signify that. The other 9 matrices are completely user customizable.

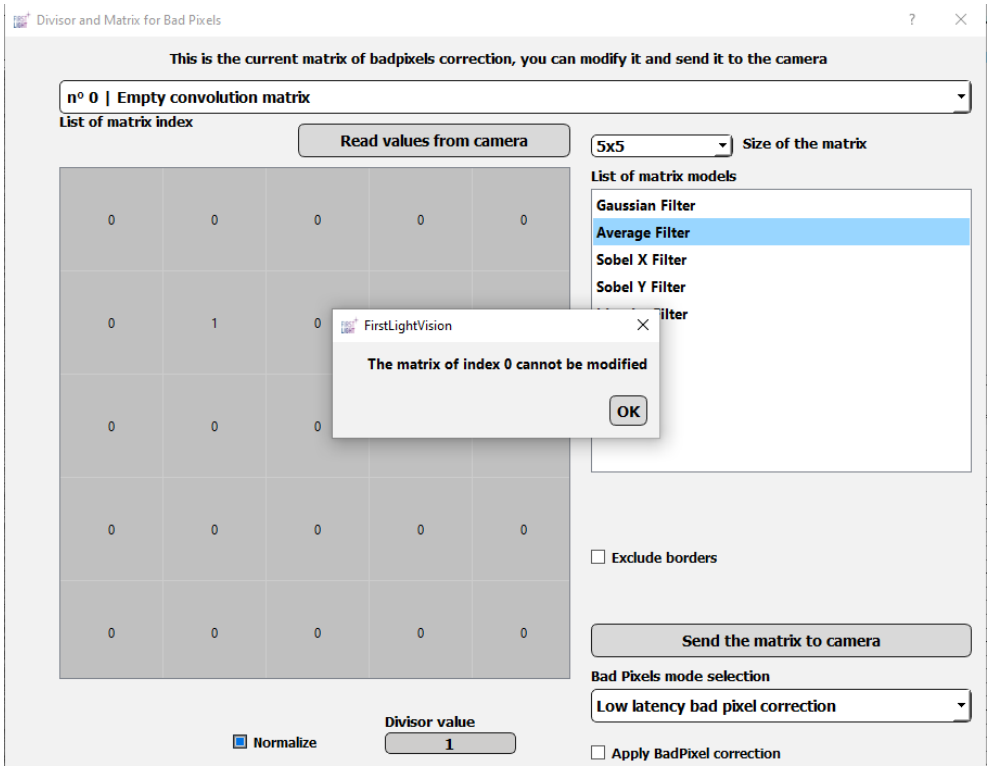


Fig. 9 : *Matrix index 0 cannot be modified*

The “Read values from camera” button is used to get the value recorded inside the camera for the selected matrix. For matrices 1 to 9, the values of the cells can be changed manually by clicking on a cell and entering a new value. A list of default matrix models is available for matrix sizes 5x5 or 3x3. 3x3 has more default models available.

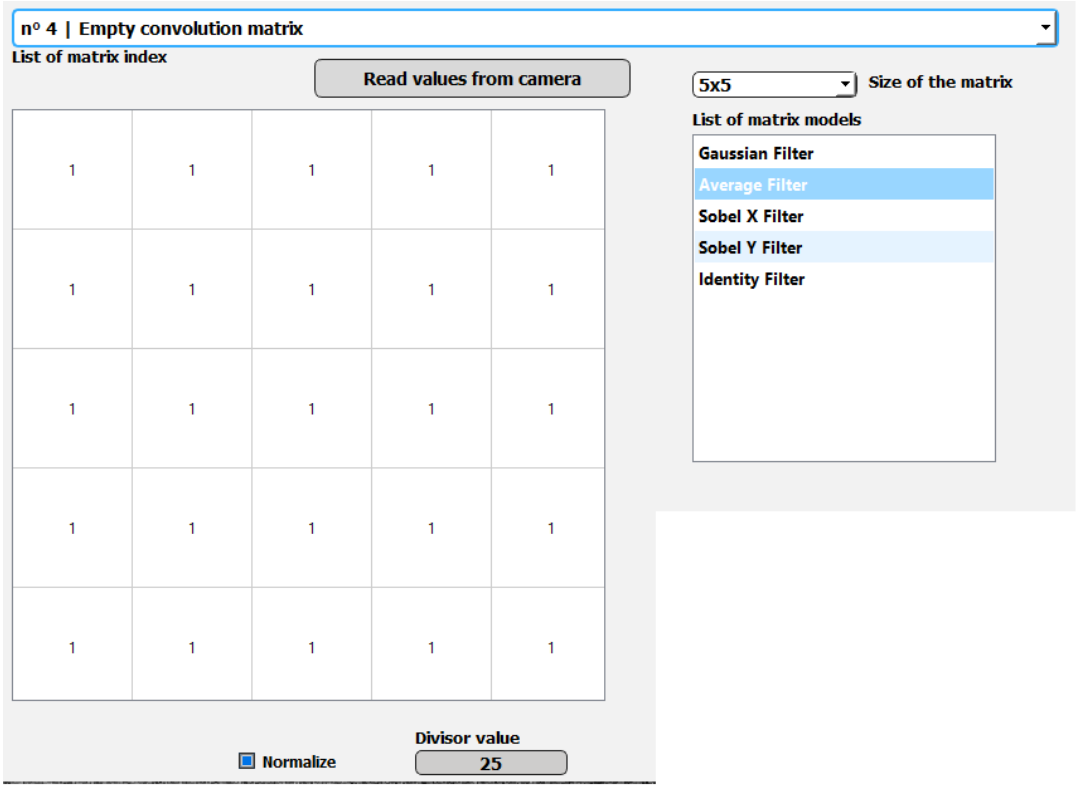


Fig. 10 : *5x5 models list*

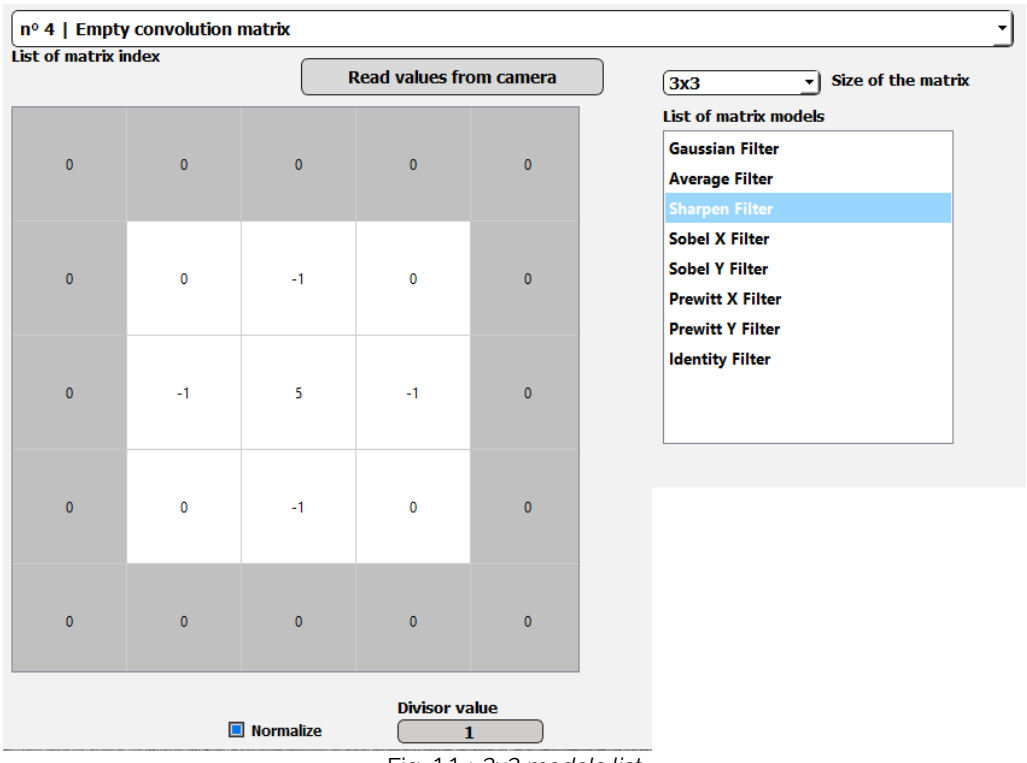


Fig. 11 : *3x3 models list*

3x3 matrices are treated as 5x5 matrices with the borders coefficients forcibly set to 0. These border cells are unmodifiable and have a grey background to signify that.

By default, the value of the divisor is normalized to the sum of all the cells. The user can uncheck the Normalize check box to enter a different value. The divisor value will be used to divide the values in all the cell. For example, with cells all filled with 1 (Identity filter), setting the divisor value to 2 will divide all the pixel values by 2. Setting it to 0.5 will multiply all the pixel values by 2.

Once the matrix is properly configured, the user can send it to the camera with the "Send the matrix to the camera" button. The user can then select the Bad Pixels Mode inside the drop-down list in the bottom-right:

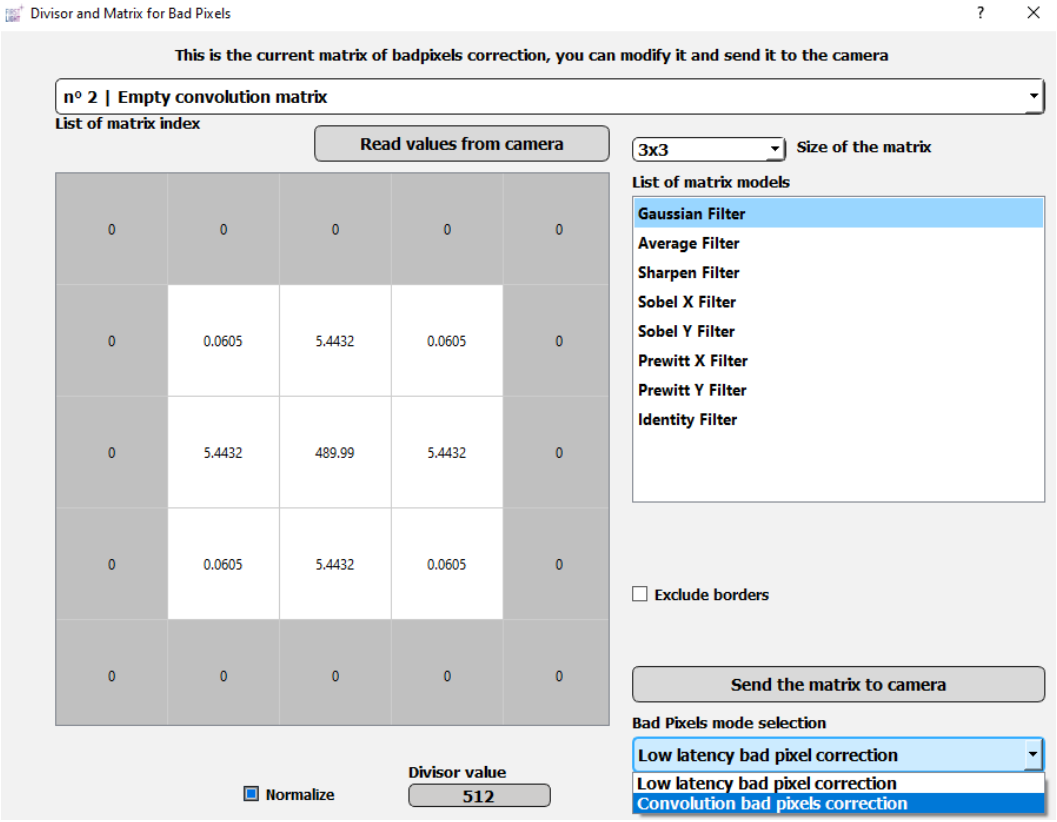


Fig. 12 : *Mode selection*

"Low latency bad pixel correction" is the mode that does not use matrix convolution (legacy mode). "Convolution bap pixel correction" will apply the selected matrix convolution.

At the bottom of the window, the "Apply Bad Pixels correction" check box activates the correction. The bad pixel correction in "Convolution bap pixel correction" mode can only be activated if there is no filtering already ON (see next Section).

The last check box, "Exclude borders", will make the correction ignore the border of the frame: the first line, last line, first column and last column. This border often has abnormal pixels values and may disturb the correction. This exclusion is made by setting an arbitrary 0 value (black) for these pixels when correction is applied, if the "Exclude borders" check box is checked.

5.7.7. Filtering

The Filtering shares the same convolution matrix as the bad pixels correction but applies the convolution to every pixel instead of just the selected bad pixels.
Functionalities are mostly the same as the bad pixel Tool, except for the bottom right part of it that will be specific to the filtering:

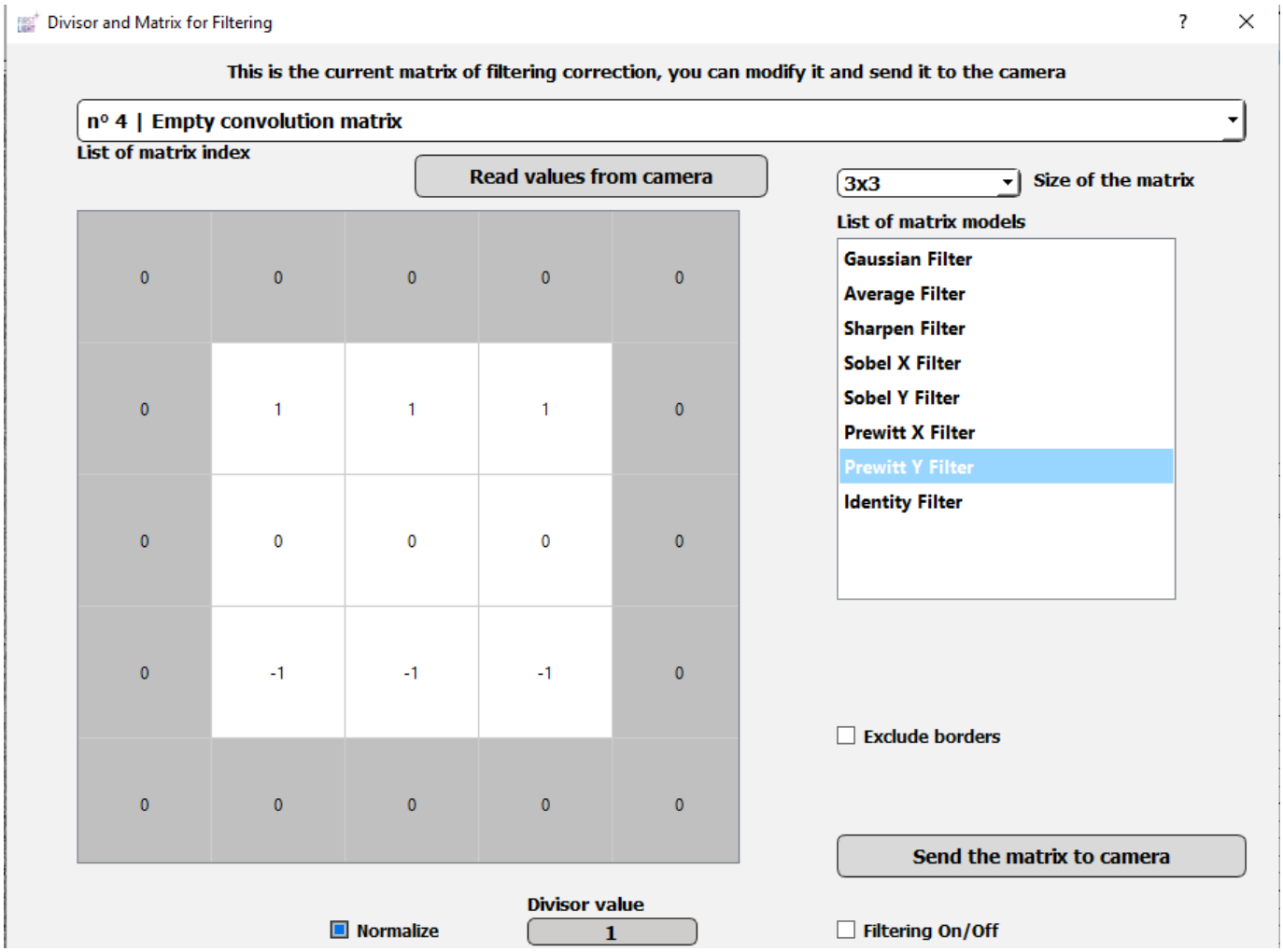


Fig. 13 : *Filtering*

The change concerns the different modes available with the bad pixel correction. Here, there is only the "Filtering On/Off" check box. Checking this box will activate the filtering and unchecking it will deactivate it.

Filtering can only be activated if there is no bad pixel correction activated in the "Convolution bap pixel correction" mode.

5.7.8. Camera status logger

This option will start the log of some camera parameters that are displayed in the GUI. It will ask you for the file name to save the information.

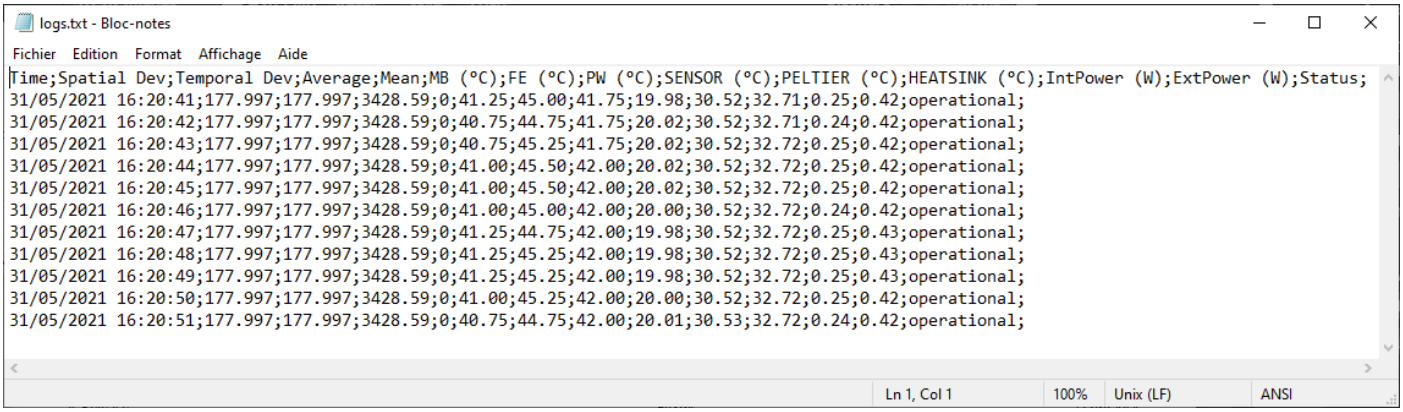


Fig. 14 : *Logger file example*

The file can be renamed with a ".csv" extension to open it with Microsoft Excel.

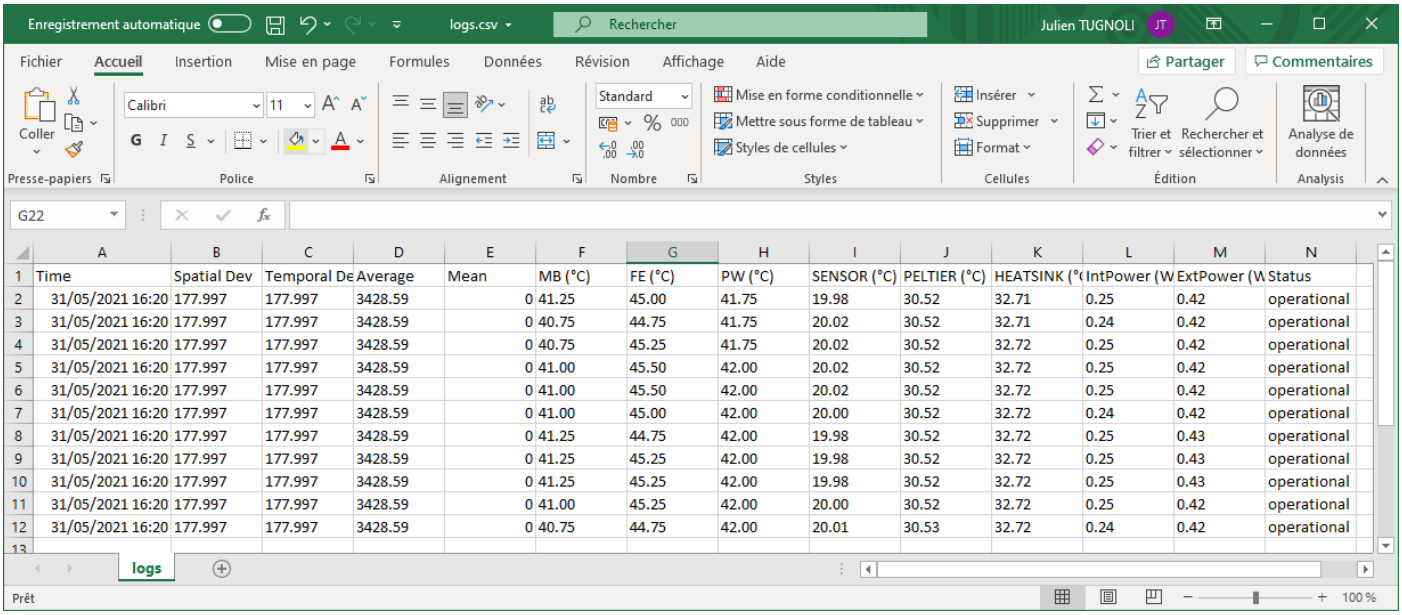


Fig. 15 : *Logger file with Excel*

5.7.9. Measure Camera Characteristics

This option opens a new window to run some measurements on the camera. Three modes are available: Dark, PTC and Noise.
In addition, for C-RED 2 and C-RED 3 the measurements can be made for each sensitivity.

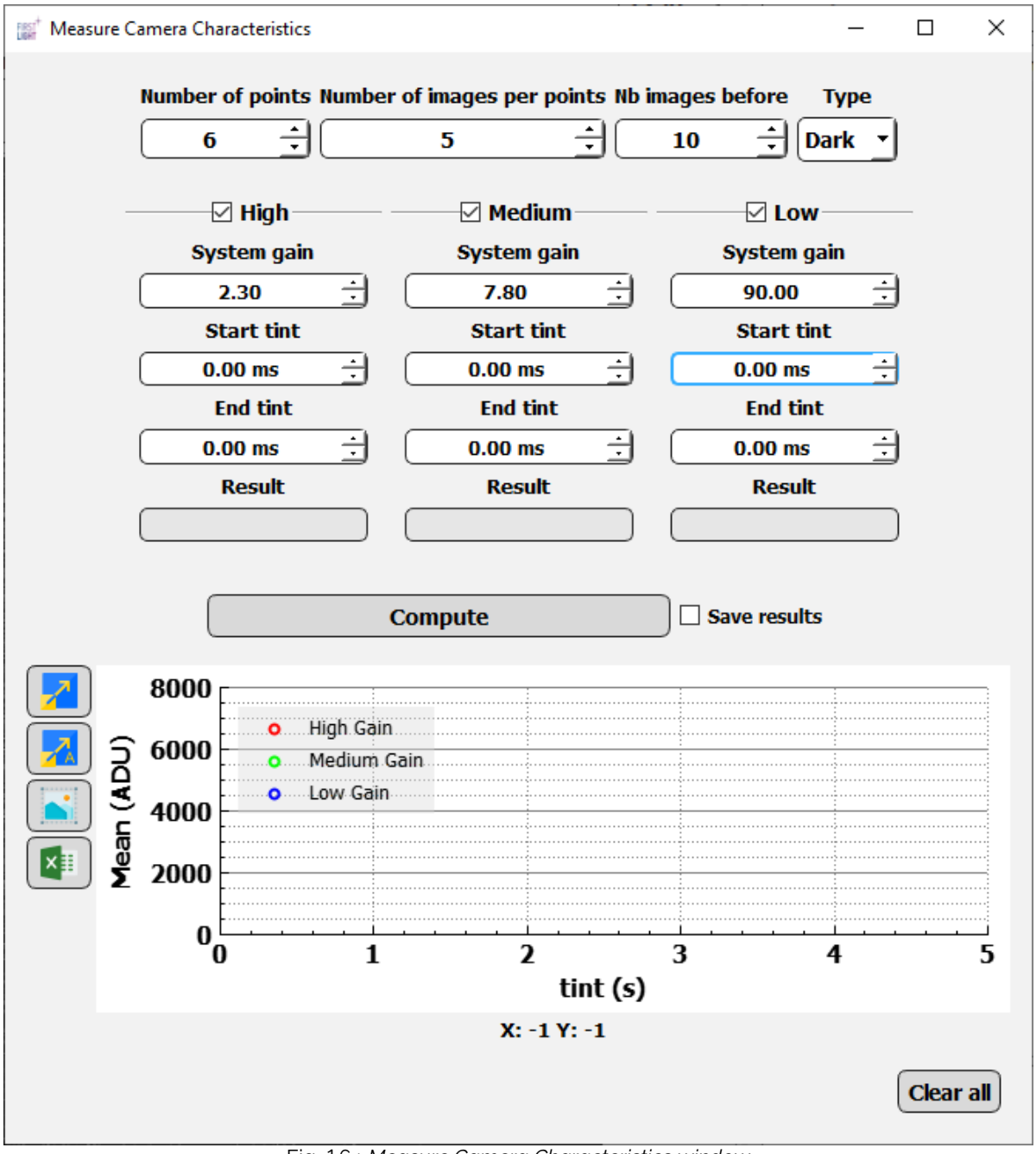


Fig. 16 : *Measure Camera Characteristics window*

For all modes there are three common parameters:

- "Number of points" is the number of points between the "Start tint" and the "End tint", for each point the exposure time of the camera will be automatically changed. Please ensure to set an FPS that can go at the "End tint" value.
- "Number of images per points" is the number of images for each point.
- "Nb images before" is the number of images that are thrown before the images used for the processing. With a low FPS the waiting time can be very long.

5.7.9.1. Dark computing

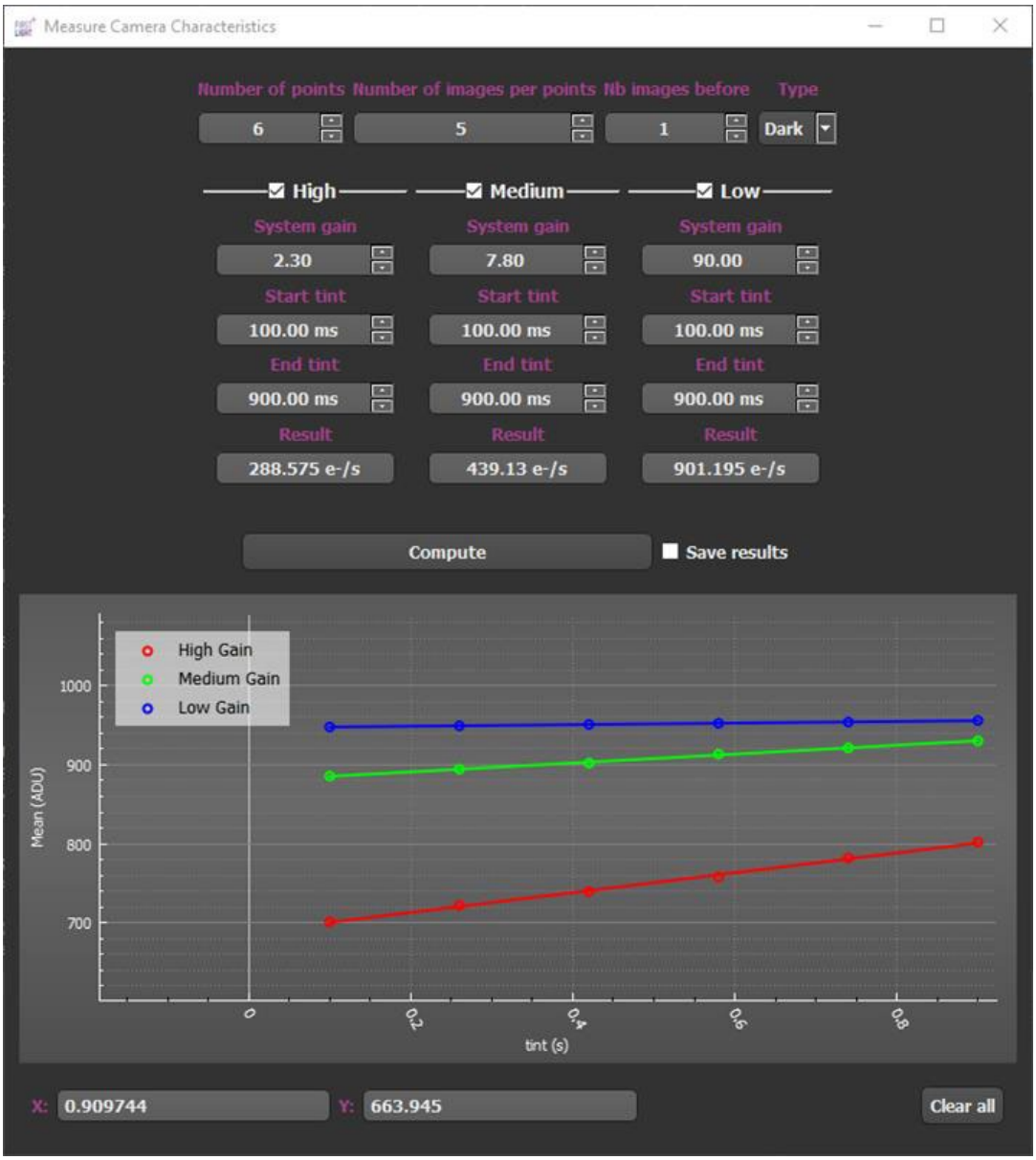


Fig. 17 : *Dark computing example*

To do a dark measurement you need to put a cap on the camera.
Choose an integration time range well below the saturation and press compute.
The picture above is an example, but usually the suited integration time is not the same for the different sensitivity. Usually, the higher the full well, the greater the integration time must be.

5.7.9.2. PTC computing

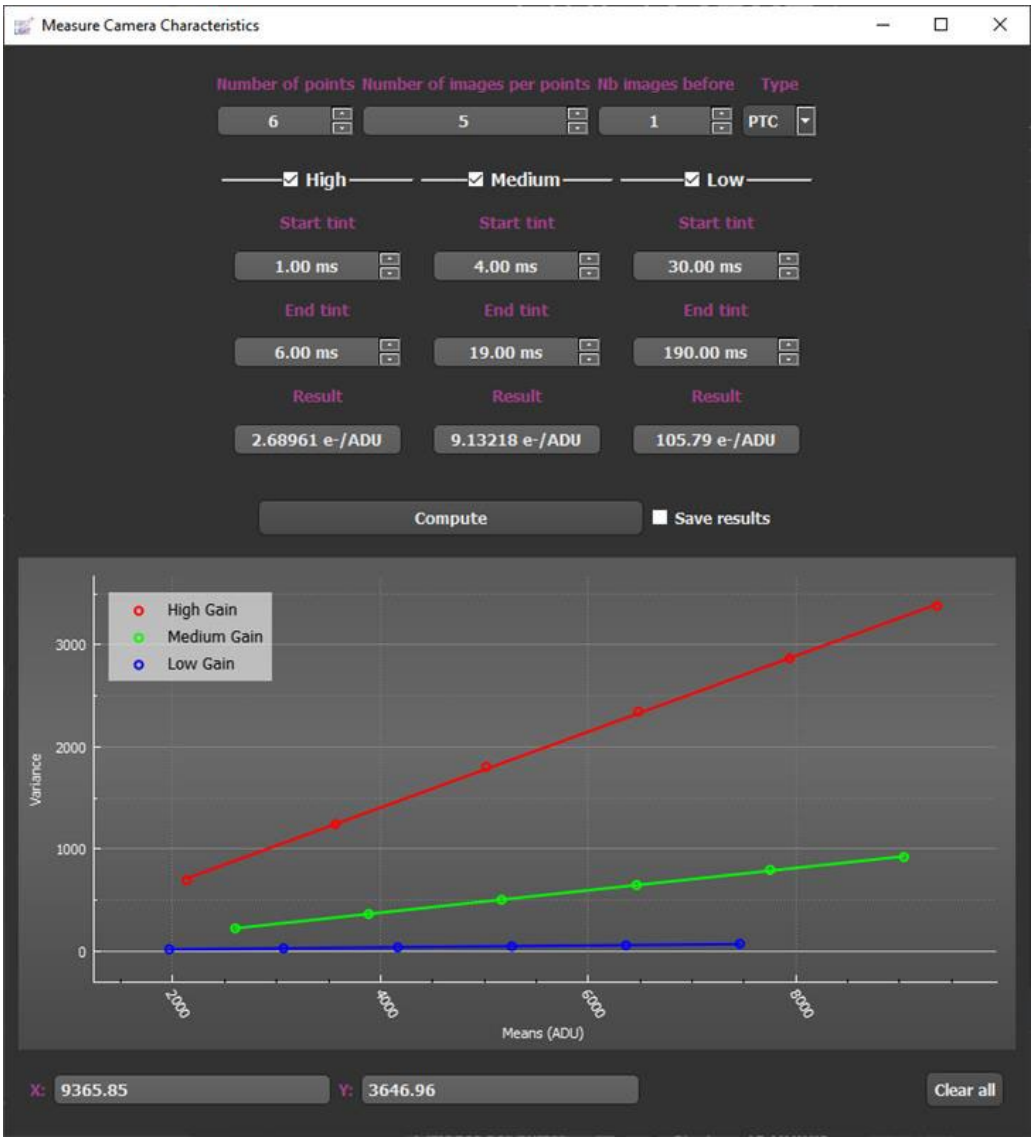


Fig. 18 : *PTC computing example*

The photon transfer curve is a method used to find the system gain of a camera.
This tool uses this method, it plots the variance versus the illumination level and from the slope computes the system gain.
To vary the illumination, different integration times are used on a constant illumination source.
To do this measurement, the camera must look at a uniform flat field. The ideal tool is an integration sphere, but it is not always available. Usually, as simple sheet of paper in front of the camera (without objective) gives good results. The min level should be above the read noise and max level far below the saturation.

__Note:__ The PTC method is very sensitive to the flat field used and its stability. The tool is provided for convenience, but the user should rely on the system gain values provided in the camera test report which are made in controlled environmental conditions (black box, integration sphere, …).

5.7.9.3. Noise computing

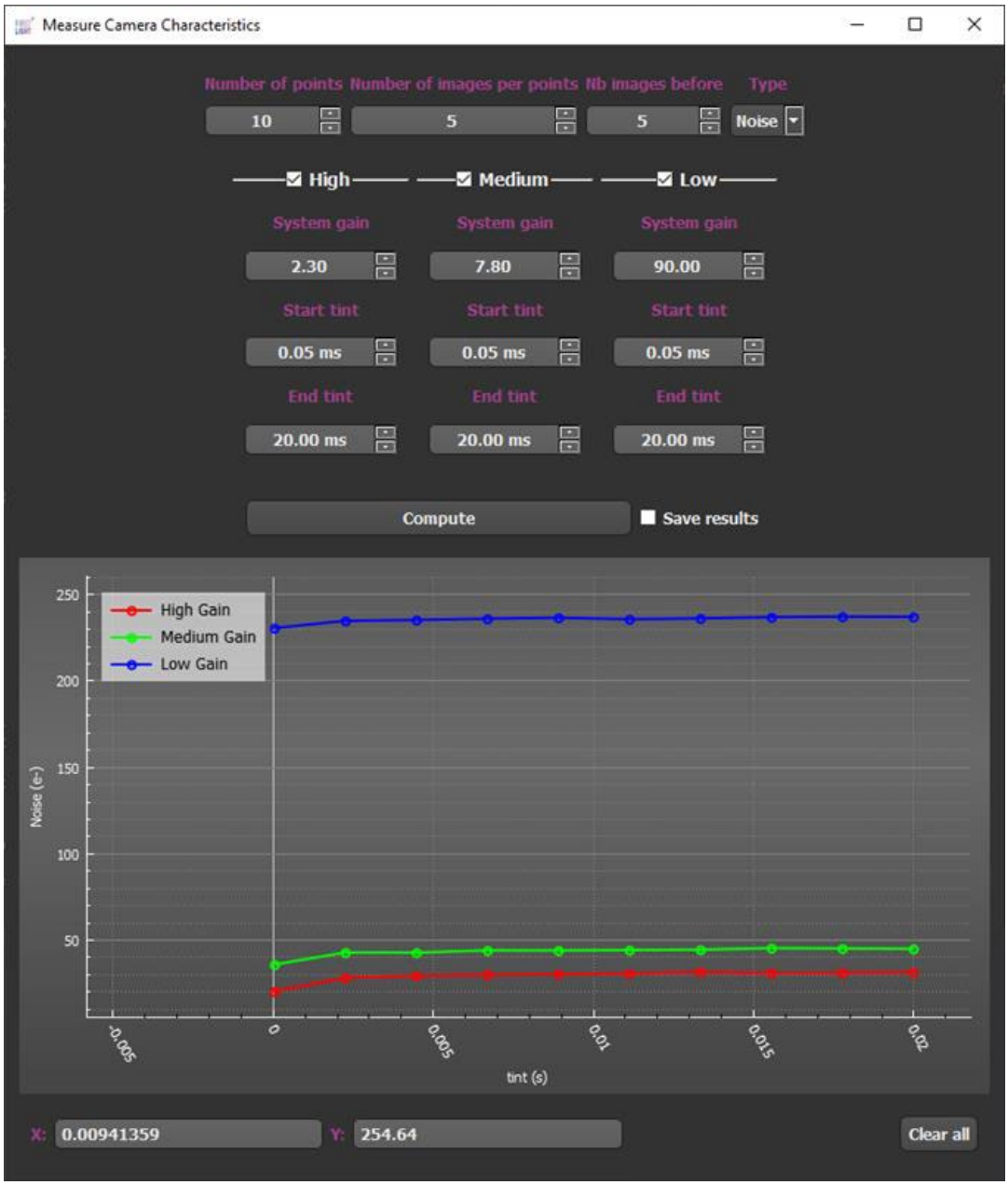


Fig. 19 : *Noise computing example*

To do a noise measurement you need to put a cover on the camera.
The noise is computed making an average of the temporal standard deviation of all the pixels.
Using the tool, you can compute this value for various integration time.
The depth of the cube used to compute the temporal std is indicated by "number of images per points".
The higher the depth, the more accurate the result, but usually 50 already provides good values.

5.7.10.Scripting

This option opens a new window to run scripts to control the camera and the GUI.

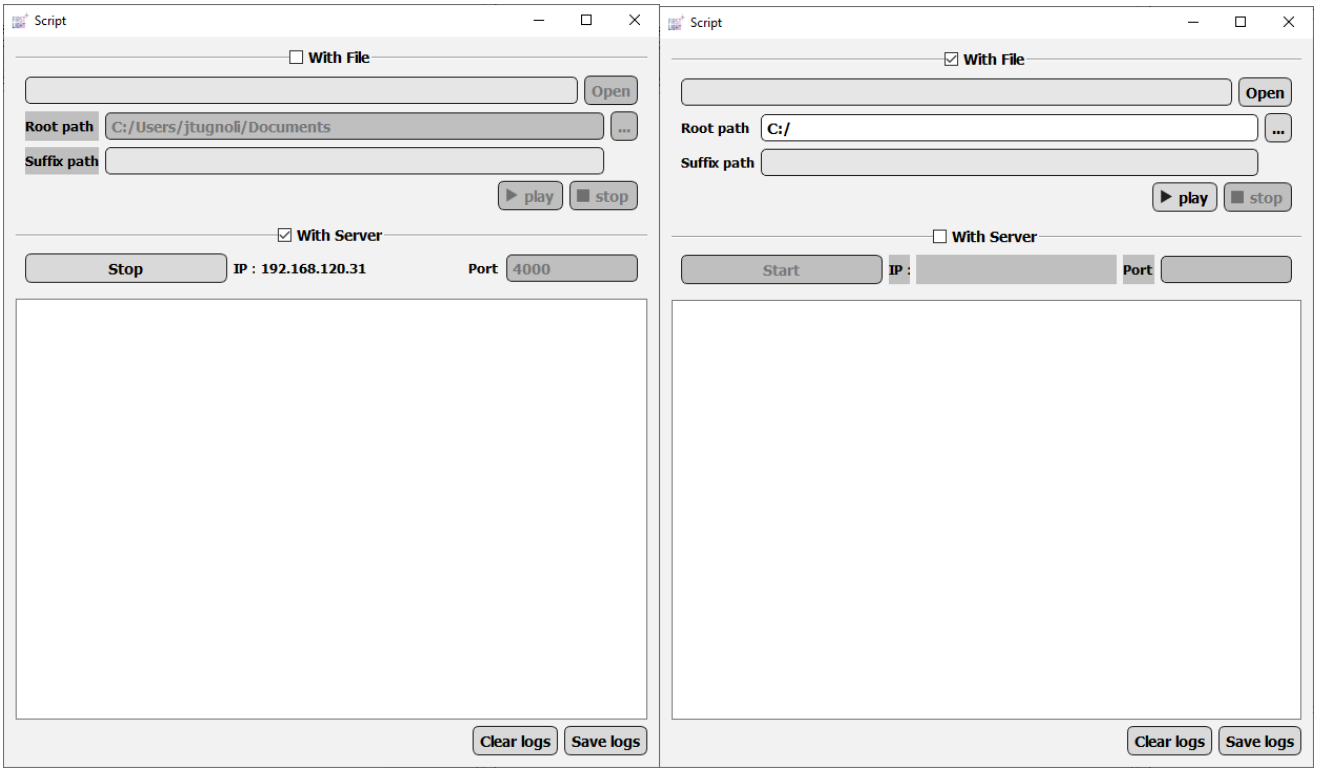


Fig. 20 : *Scripting window*

Two modes are available:

- "With file" select a script file and start it.
- "With server" to send a script through a TCP/IP connection.

The commands to use in both modes are identical and described below.

The commands available are:

- "rootpath x" sets the line edit "Root path" to x.
- "suffixpath x" overwrites the line edit suffix path to x. By default, suffixpath is set to scriptname/date/time.
- "echo x" do an echo of x in the logs window.
- "sleep x" sleeps during x ms.
- "wait x" waits an action from the user while displaying the x message.
- "resetbuffer" resets the GUI buffer.
- "grabN x" starts a grab of x images.
- "saveframes x y" saves x frames to the file rootpath /suffixpath/y
- "camerainfos y" saves camera infos to rootpath/suffixpath/y.
- "cam x" sends the command x to the cam and return the result (see the camera documentation to see the available commands).
- "tint [x or max]" sets the integration time or the maximum integration time for the current fps.
- "fps [x or max]" sets the fps or the maximum fps for the current geometry.
- "counterror" returns the detected grab errors."
- "logparameters": records all the parameters of the camera (temperatures, power, status, …).

In addition, 3 tags are available to ease the suffixpath building.
#SCRIPTNAME# is expanded as the script name.
#DATE# as the current date.
#TIME# as the time at the script start up.

For example, the command:
Suffixpath = #SCRIPTNAME#/#DATE#/#TIME#
set Suffixpath to its default value

Remark: Fps and tint can also be set using the "cam" command, but the max argument is not valid in this case, and numeric value must be provided.

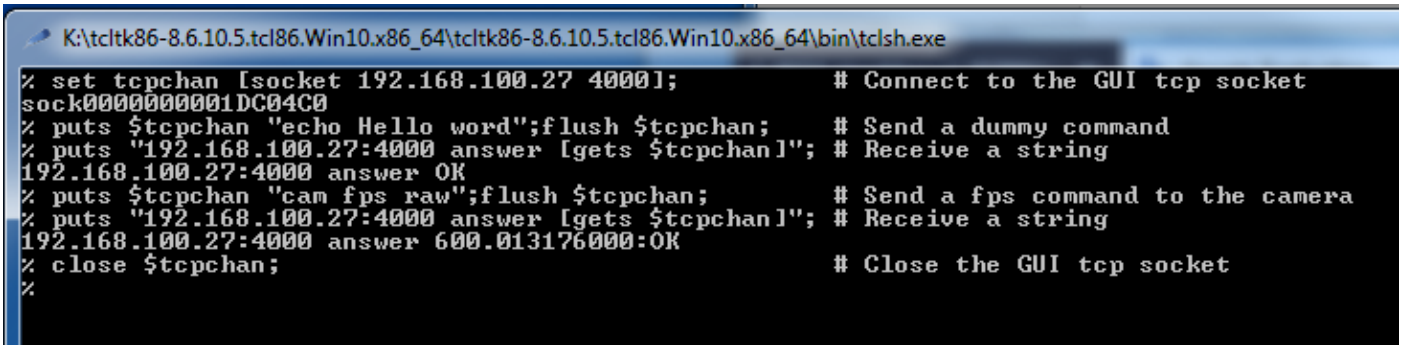
Note 1: The TCP connection is completely independent of the scripting language used. Any language capable of opening a TCP socket (and most of them can do it) can be used. The TCP socket can also be used to execute the scripts on a PC other than the one which gets the data. For convenience, a text file script is also available, but it should be reserved for very simple scripts as it does not provide any control structure such as variable, loop, test ...

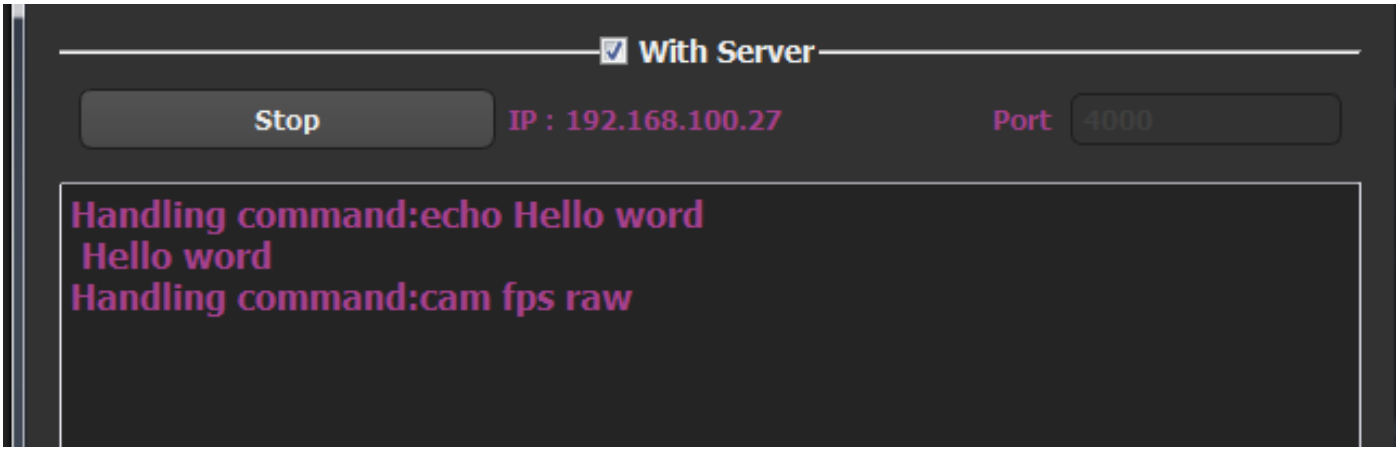
Note 2: Another possibility to write scripts is to use the FliSdk. In that case, First Light Vision is not needed. Some wrappers are available for two script languages, Python and MatLab. If your favourite scripting language is not one of them, you can write a wrapper for it from the FliSdk.dll or use the First Light Vision scripting through TCP feature.

Below are provided 2 very simple examples.

5.7.10.1. Very simple Tcl example using the tcp socket connexion:

```
set tcpchan [socket 192.168.100.27 4000];           # Connect to the GUI tcp socket
puts $tcpchan "echo Hello word";flush $tcpchan;     # Send a dummy command
puts "192.168.100.27:4000 answer [gets $tcpchan]"; # Receive a string
puts $tcpchan "cam fps raw";flush $tcpchan;         # Send a fps command to the
camera
puts "192.168.100.27:4000 answer [gets $tcpchan]"; # Receive a string
close $tcpchan;                                     # Close the GUI tcp socket
```





5.7.10.2. Very simple acquisition text script

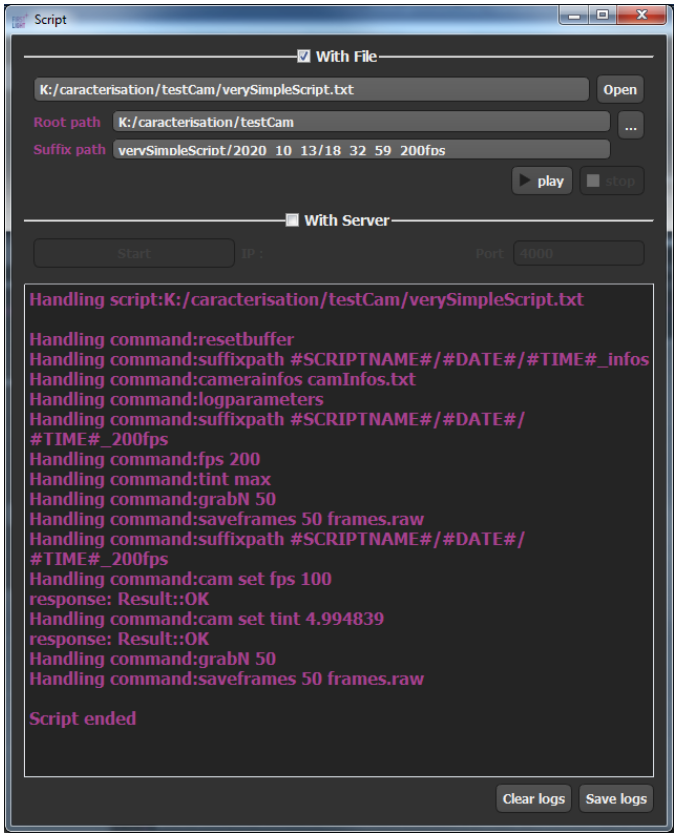
```
# Acquisition script example
# Default
suffixpath:#SCRIPTNAME#/#DATE#/#TIM
E#

resetbuffer

# Overwrite default suffix path
suffixpath
#SCRIPTNAME#/#DATE#/#TIME#_infos
camerainfos camInfos.txt
logparameters

suffixpath
#SCRIPTNAME#/#DATE#/#TIME#_200fps
fps 200
tint max
grabN 50
saveframes 50 frames.raw

suffixpath
#SCRIPTNAME#/#DATE#/#TIME#_200fps
cam set fps 100
cam set tint 4.994839
grabN 50
saveframes 50 frames.raw
```



5.7.12.Camera preset

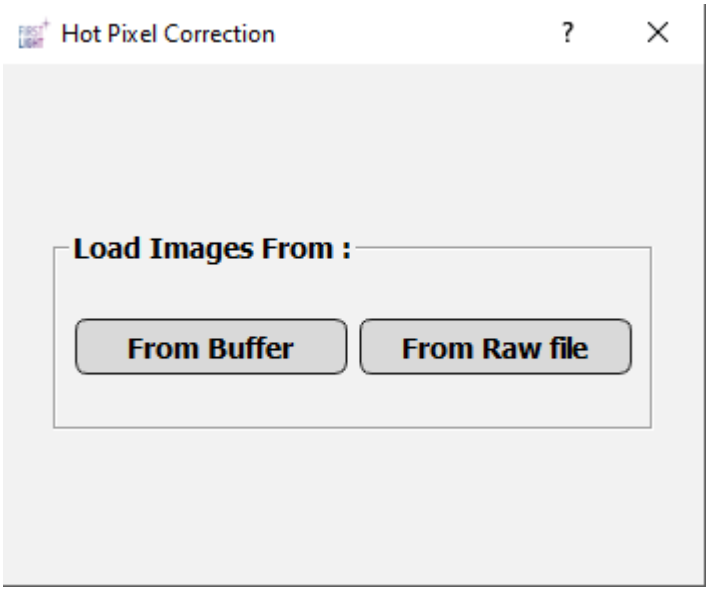
You can save some parameters of a camera in a file and load it in another camera to have the same parameters.
When you save the configuration the camera type and hwuid will be concatenated in order to generate a file name with the extension ".fliconf". This file can be read and edited with a simple text editor and it is in a JSON format.


```
{
    "cameraModel": 2,
    "parameters": {
        "AGC": {
            "col1": 0,
            "col2": 639,
            "priority": "None",
            "row1": 0,
            "row2": 511,
            "state": false
        },
        "aduOffset": 0,
        "antiBloomingState": false,
        "badPixelState": true,
        "biasState": false,
        "conversionGain": "high",
        "cropping": {
            "col1": 0,
            "col2": 639,
            "row1": 0,
            "row2": 511,
            "state": false
        },
        "darkOptimLevel": 0,
        "exposure": 1.661469,
        "extSynchroExposure": "external",
        "extSynchroState": false,
        "factoryState": false,
        "flatState": false,
        "framerate": 600.013176,
        "hdrCalibrationMode": "off",
        "hdrExtendedState": false,
        "hdrState": false,
        "nbFramesPerSwTrig": 1,
        "nbReadWoReset": 1,
        "rawImagesState": false,
        "swSynchroState": false,
        "tuning": "general"
    }
}
```


Fig. 21 : *Camera configuration file example*

5.7.13.Hotpixel Correction

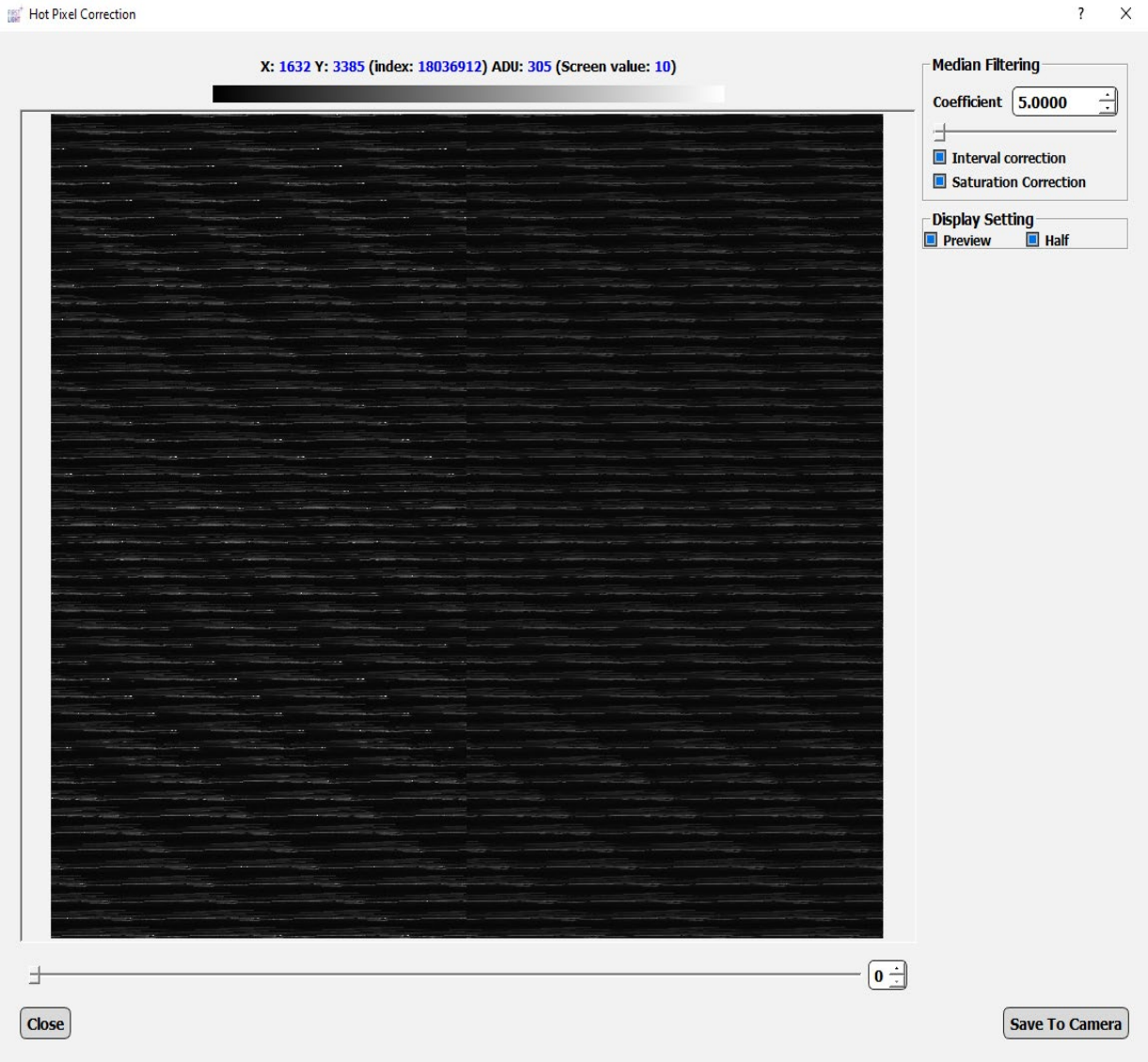
You can use the “HotPixel correction” tool to preview and configure the Hotpixel correction of the camera.



When you open the Hot Pixel Correction interface you need to chose between working with data from a file or from the current buffer of FirstLightVision.

Once the source is selected the interface will open the wizard for previewing the correction the camera will apply on the image.
You can configure some parameters :

- The threshold, in percentage of the median of the pixel, for when to use the filter on the pixel.
- If you want to activate the correction with the threshold
- If you want tot activate the pixel saturation correction
- You can chose to preview on the image the correction or on half the image.



If you press the “Save To Camera” button it will close the interface and send the parameter to the camera (threshold value, threshold activated or not, etc …).
If you just close the interface no parameters will be send to the camera.

5.8. View menu

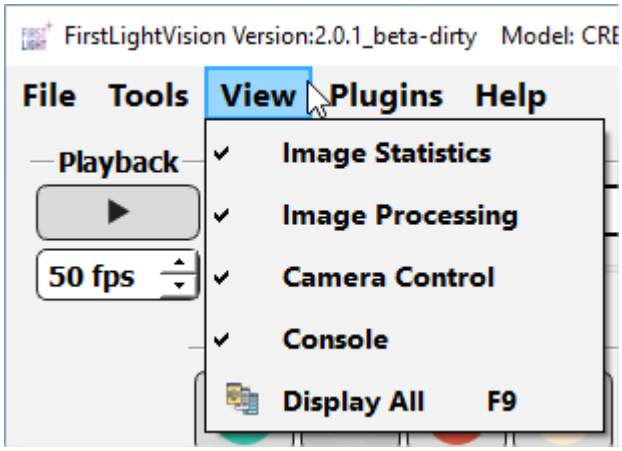


Fig. 22 : *Display menu*

This menu show/hide panels of the software and to display all (F9 shortcut).

5.9. Plugins menu

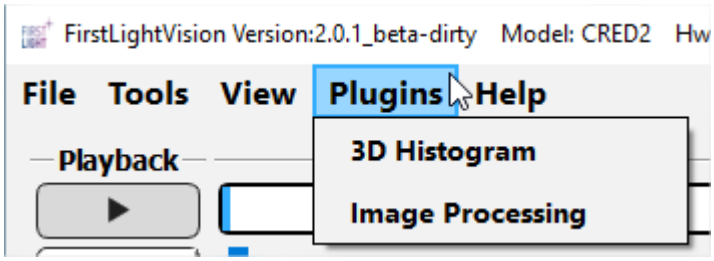


Fig. 23 : *Plugins menu*

5.9.1. 3D Histogram (optional)

This option displays a new window with a 3D bar chart of the image or the analysis rectangle (see section 5.5.2). This window could slow the software.

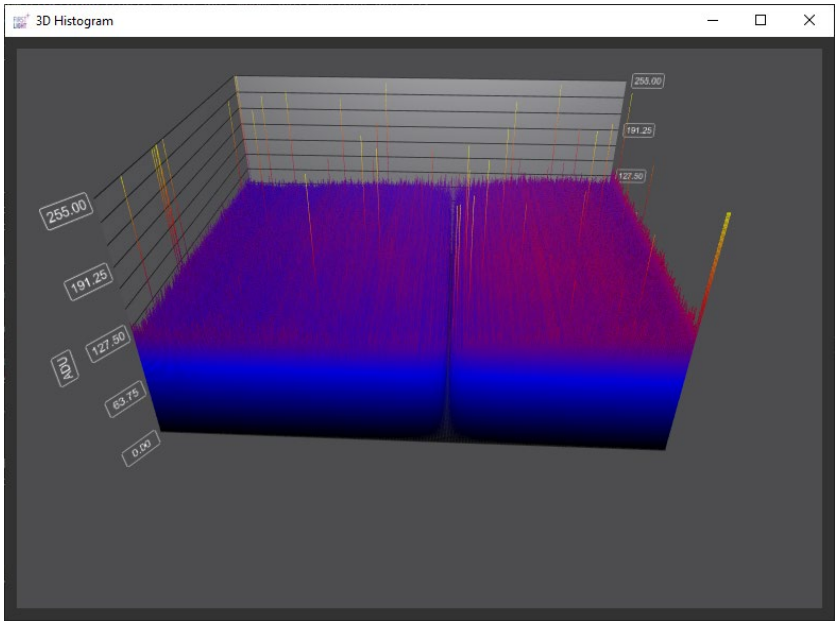


Fig. 24 : *3D histogram*

The graph can be moved with the mouse right click and zoom in/out with “Ctrl” and mouse wheel.

5.9.2. Image Processing

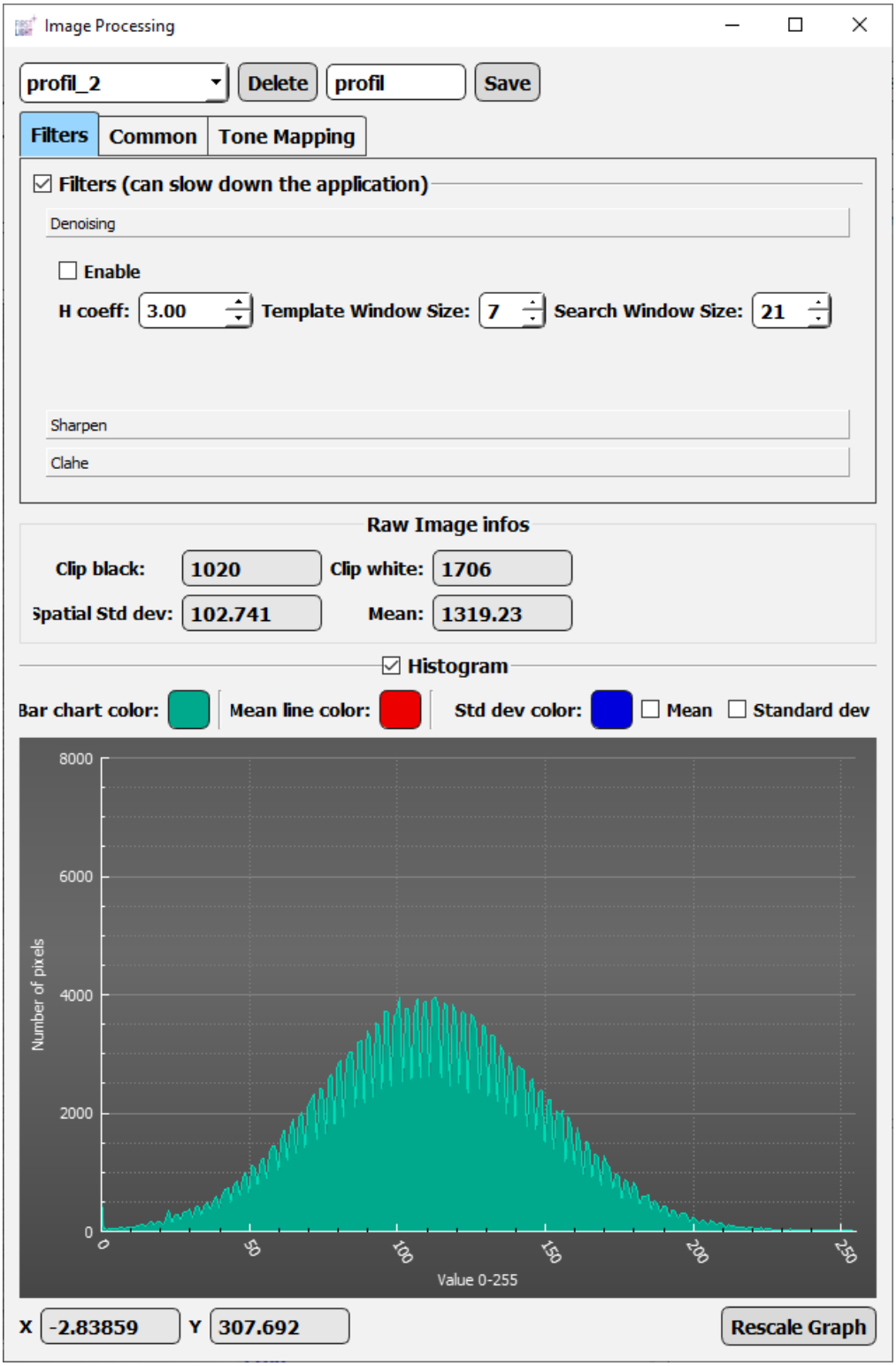


Fig. 25 : *Image processing plugin*

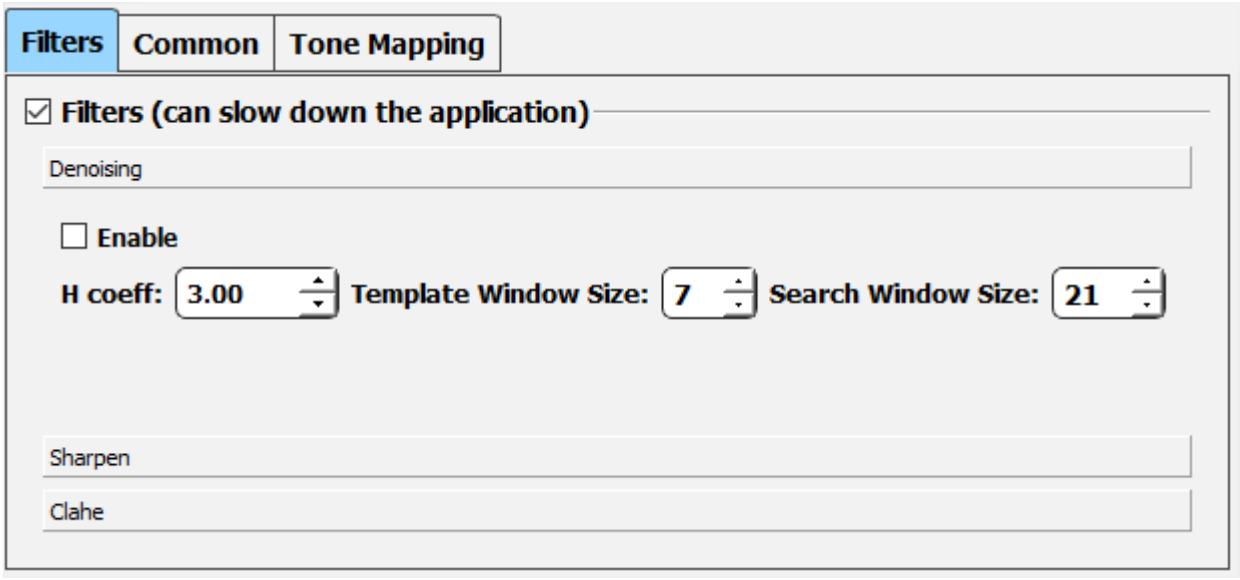


Fig. 26 : *Filters tab*

The software offers some basic image processing functions, in the "Filters" tab you will have access to a "Denoising" filter, a "Sharpen" filter and "Clahe" filter with all their parameters.

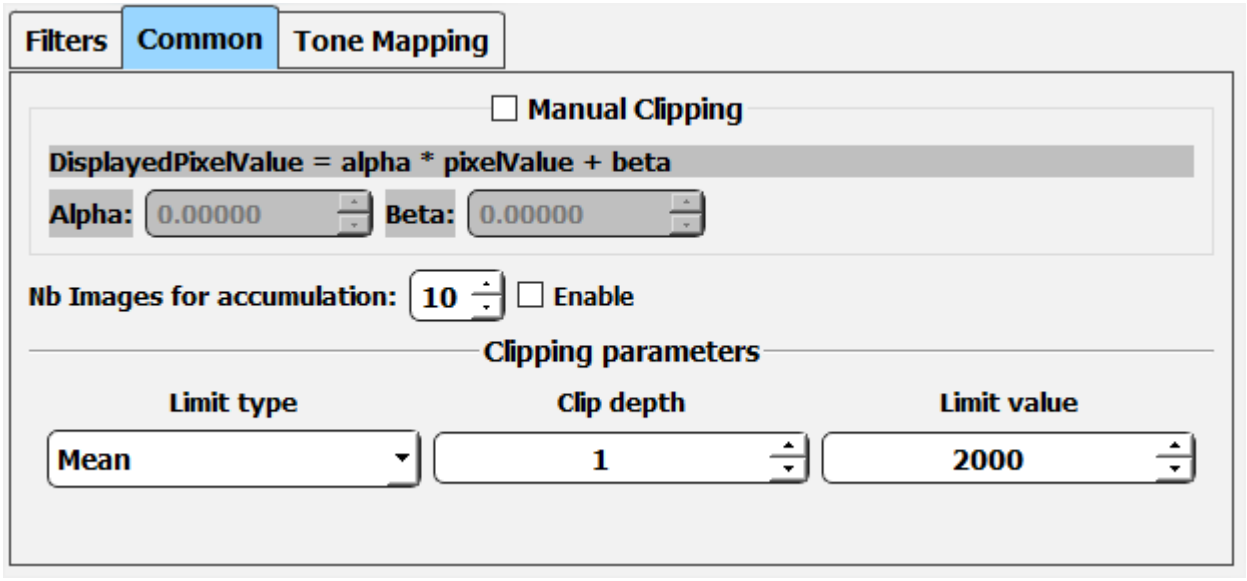


Fig. 27 : *Common tab*

The "Common" tab has the software bad pixels correction (see section 5.5.3.3). A manual clipping with a function "Alpha" * pixel value + "Beta", and an image accumulation.

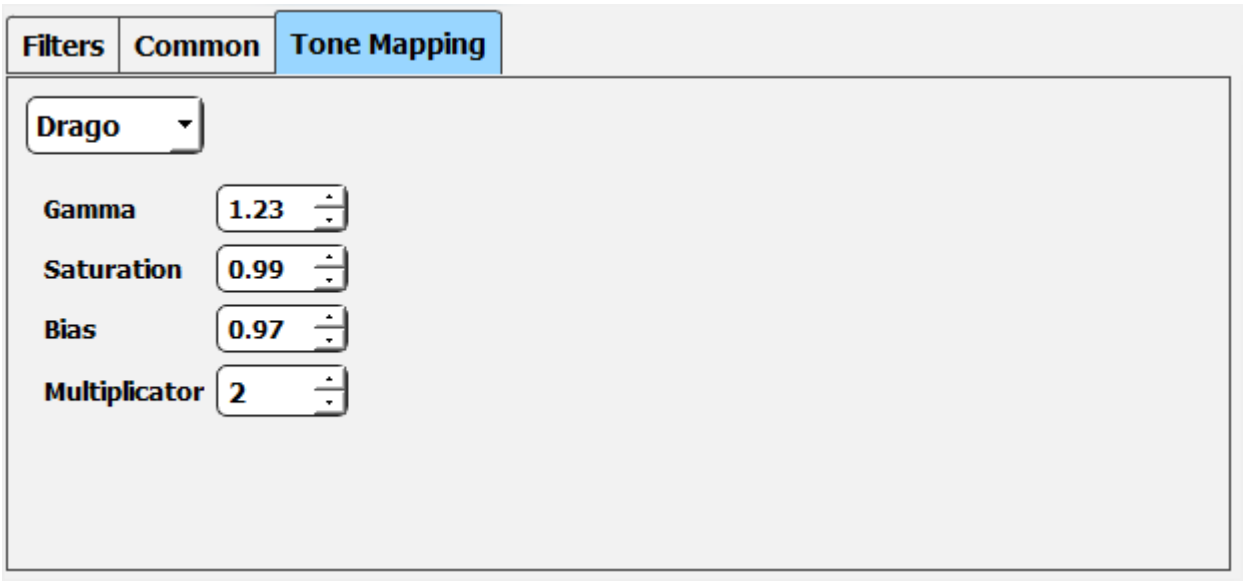


Fig. 28 : *Tone mapping tab*

The “Tone Mapping” tab change the tone mapping used to transform the 16b image to the 8b image, four tone mappings are available, “Normal”, “Drago”, “Reinhard” and “Mantiuk”. All these tone mappings come with their parameters that you can change when you want to have the best result.

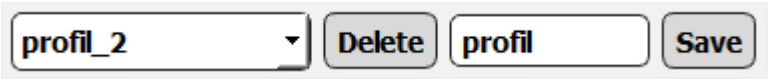


Fig. 29 : *Image processing profiles*

All parameters can be saved in different profiles, just enter a name in the line edit next to “Save” button, click on “Save” and the profile will be added to the list. To delete a profile, choose it in the list and click on “Delete”.

6. SHORTCUTS

6.1. Main window

- Mouse left click and move on image -> blue rectangle for clipping.
- Mouse right click and move on image -> red rectangle for analysis (disable it by right click in another place of the image).
- “Shift” + mouse left click and move on image -> green line for section (disable it by “Shift” + mouse left click in another place of the image).
- “Ctrl” + mouse wheel on image -> zoom in/out.
- “Ctrl” + mouse left click and move -> move the image.
- Mouse wheel click and move -> rotate image.
- “Ctrl +s” start/stop acquisition.
- “F5” refresh GUI by reading all parameters from camera.
- “Alt” + mouse left click -> draw a region of interest
- “Alt” + mouse right click -> draw a rectangle which remove all region of interest inside it.

6.2. Bad pixel editor

- “Alt” + left mouse click on pixel not in the map -> add pixel to map.
- “Alt” + left mouse click and move -> add pixels to map.
- “Alt” + left mouse click on pixel already in the map -> remove pixel from map.
- “Shift” + left mouse click and move -> yellow rectangle, all pixels in the rectangle and in the map will be removed from the map.