

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, OCAM² 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

Tools View Plugins Help				
yback	Buffer		Image Processing Image Statistics Can	nera Control
	0/6865			Camera Control
fps 🕂		0 🛨	Search	Guru Collapse
Acquisition	File Left mouse click action Image	Processing	Register name	Value
	🔹 💾 🛃 👼 🔀 🔤 🔤 🖊 🖊 Clip	Sharp CLAHE	▼ Temperatures	
			습 MotherBoard (°C)	40.25
			습 FrontEnd (°C)	43.25
			් PowerBoard (°C)	43.25
			් Sensor (°C)	19.42
			습 Peltier (°C)	31.03
			습 Heatsink (°C)	32.17
			Y Common	
			් Preset	3
			☆ Framerate	600.0132 Hz
			습 Exposure	1661.4690 µs
			¥ Cropping	
			් Offset X	0
			ත් Offset Y	0
			☆ Width	640
			Register name: MotherBoard	(
			Display name: MotherBoard (°C)	
			Access mode: Read only	
			Description: MotherBoard temperature (°C).	
6215	7850			

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:

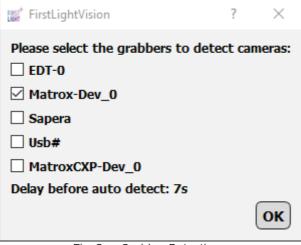


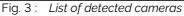
Fig. 2: Grabber Detection

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.





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.

🗱 ⁺ Ocam2 Start State	?	×
In which state do you want to start the sorftwa Attention: all these values will be wrote in the car		
Camera type: Ocam2K Simulator		
Modes		
Standard (240x240@2060Hz)		
O Binning 2x2 (120x120@3620Hz)		
Optionnal Modes (please check if you have subscribed them)		
Cropping (240x120@3680Hz) 🔽 🗆 available		
O Binning 3x3 (80x80@4650Hz) 🗌 available		
O Binning 4x4 (60x60@5900Hz) available		
Gain: 1 - Flat		
Bias offset: 0 🛨 🗆 Bias		
		Ok
Fig. 4 : OCAM ² startup window		

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

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:

Console	Image Processing		Image Statisti
			Console
Frames pe [09:51:53 Result:OK [09:51:55 Frames pe]fli-cli> r second:]fli-cli>]fli-cli> r second:]fli-cli>	83.0002 set fps fps	\$ 400

Fig. 5 : Console command example

5.2. Image Statistics

Console Image Processing Im	nage Statistics Camera Control			
Image Statistics & X				
▼ Tags	True			
Frame Id	0			
Frame number	2110386			
AGC	0			
lmage marker	0			
Nb frame count error	0			
▼ Cube analysis	True			
Depth	50 -			
Temporal standard deviation	61.8685			
Mean	10619.7			
Spatial standard deviation	878.975			
Mean	10622.1			
Min value	6882			
Max value	13558			
Histogram Raw Histogram Display				
500				
b 200				
쇼 300 - 고 - 고 - 고 - 고 - 고 - 고 - 고 - 고 - 고 - 고				
2 100				
7000	0 8000 9000 10000 11000 12000 ADU Value			
	X: 7560.98 Y: 536.60			

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.

×	Tags	True
	N sample	63
	N loop	8
	Readout number	0
	Frame number	(1140
	Nb frame count error	0
		Fig. 7 : Tags C-RED One

5.2.1.1. 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

▼ Tags	True
Frame Id	0
Frame number	2110386
AGC	0
Image marker	0
Nb frame count error	0

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).

▼ Tags	True
Frame number	21005
AGC	1
Image marker	0
Nb frame count error	0

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

▼ Tags	True
Frame number	341036
Nb frame count error	0
	Fig. 10 : Tags OCAM ²

OCAM² has only frame number and error count.

5.2.2. Cube analysis

۷	Cube analysis	True
	Depth	50 -
	Temporal standard deviation	61.8685
	Mean	10619.7

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.

<u>Note:</u> 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

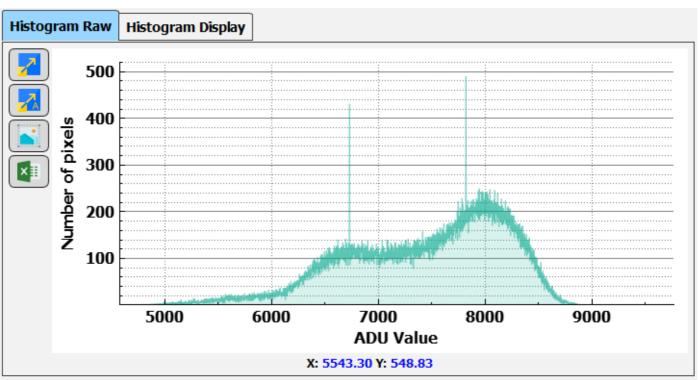


Fig. 12 : Histogram

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

Search Guru Collapse all Register name Value ✓ Temperatures ☆ MotherBoard (°C) 39.5 ☆ FrontEnd (°C) 36 ☆ PowerBoard (°C) 32.5 ☆ Sensor (°C) 19.92 ☆ Pettier (°C) 25.49 ☆ Pettier (°C) 26.1 ✓ Common ✓ Presets ☆ Save Execute ☆ Save Execute ☆ Framerate 83.0006 Hz ☆ Offset X 0 ☆ Offset X 0 ☆ Width 640	Console	Image Processing	Image Statistics	Camera Control				
Register name Value ✓ Temperatures 39.5 ☆ MotherBoard (°C) 39.5 ☆ FrontEnd (°C) 36 ☆ PowerBoard (°C) 32.5 ☆ Sensor (°C) 19.92 ☆ Peltier (°C) 25.49 ☆ Heatsink (°C) 26.1 ✓ Common ✓ ✓ Presets ✓ ☆ Save Execute ☆ Framerate 83.0006 Hz - 1 ☆ Save Execute ☆ Framerate 83.0006 Hz - 1 ☆ Offset X 0 - 1 ☆ Offset X 0 - 1 ☆ With 640 - 1 ☆ With 640 - 1 Access mode: Read write				Camera Control				8 ×
 ▼ Temperatures ☆ MotherBoard (°C) 39.5 ☆ FrontEnd (°C) 36 ☆ PowerBoard (°C) 32.5 ☆ Sensor (°C) 19.92 ☆ Sensor (°C) 19.92 ☆ Peltier (°C) 25.49 ☆ Peltier (°C) 26.1 ♥ Common ♥ Presets ☆ Common ♥ Presets ☆ Common ♥ Presets ☆ Save Execute ☆ Framerate B3.0006 Hz ● ● ● ♥ Copping ☆ Offset X ● - ☆ offset X ● - ☆ width ● 640 - ● ♥ Current ■ ■<td>Search</td><td></td><td></td><td></td><td></td><td>Guru</td><td>-</td><td>Collapse all</td>	Search					Guru	-	Collapse all
☆ MotherBoard (°C) 39.5 ☆ FrontEnd (°C) 36 ☆ PowerBoard (°C) 32.5 ☆ Sensor (°C) 19.92 ☆ Petier (°C) 25.49 ☆ Heatsink (°C) 26.1 Y Common Y Y Common Y Y Current 2 ☆ Save Execute ☆ Save Execute ☆ Framerate 83.0006 Hz -1 ☆ Offset X 0 -1 ☆ Offset X 0 -1 ☆ Offset X 0 -1 ☆ Width 640 -1 ☆ Width 640 -1 ★ ccess mode: Read write Urrent		Register name			Value			
	💙 Tempe	eratures						
	Ľ	7 MotherBoard (°C)			39.5			
	z	강 FrontEnd (°C)			36			
☆ Sensor (°C) 19.92 ☆ Pettier (°C) 25.49 ☆ Heatsink (°C) 26.1 ♥ Common ♥ Presets ☆ Current 2 ☆ Save Execute ☆ Save Execute ☆ Framerate 83.0006 Hz ☆ Exposure 12040.4030 µs ♥ Cropping 0 ☆ offset X 0 ☆ offset X 0 ☆ vidth 640 ▲ ■	L L	7 PowerBoard (°C)			32.5			
 ☆ Pettier (°C) ☆ Heatsink (°C) 26.1 ✓ Common ✓ Presets ☆ Current ☆ Save ▲ Current ☆ Save ▲ Execute B3.0006 Hz ▲ Framerate B3.0006 Hz ▲ Execute ▲ Framerate ▲ 3.0006 Hz ▲ I ▲ Execute ▲ I ▲ Corpping ▲ Offset X ▲ O ▲ O					19.92			
 ☆ Heatsink (°C) Common ✓ Presets ☆ Current 2 ☆ Save Execute ☆ Save Execute ☆ Framerate \$3.0006 Hz ★ Exposure 12040.4030 µs ★ Exposure 12040.4030 µs ★ Offset X 0 0<td></td><td></td><td></td><td></td><td>25.49</td><td></td><td></td><td></td>					25.49			
 ✓ Common ✓ Presets ☆ Current ☆ Save ▲ Framerate ▲ 83.0006 Hz ÷ ▲ Execute ▲ Framerate ▲ 83.0006 Hz ÷ ▲ Execute ▲ Execute ▲ Execute ▲ Cropping ☆ Offset X ▲ ① ÷ ▲ ① ÷ ▲ ② ▲ ③ ▲ ③ ■ ④ ■ ● <li< td=""><td></td><td></td><td></td><td></td><td>26.1</td><td></td><td></td><td></td></li<>					26.1			
 Presets 								
☆ Current 2 ☆ Save Execute ☆ Framerate 83.0006 Hz ÷ ☆ Exposure 12040.4030 µs ÷ ☆ Cropping 12040.4030 µs ÷ ☆ Offset X 0 ÷ ☆ Offset Y 0 ÷ ☆ Width 640 ÷ ★ width 640 ÷ ★ width 640 ÷ ★ width 640 ÷ ★ width 640 ÷								
☆ Save Execute ☆ Framerate 83.0006 Hz ÷ ☆ Exposure 12040.4030 µs ÷ ☆ Cropping • ☆ Offset X 0 ÷ ☆ Offset Y 0 ÷ ☆ Width 640 ÷ ▲ • Register name: PresetNumber Display name: Current Access mode: Read write			0					
 ☆ Save ☆ Framerate ⊗ 3.0006 Hz ÷ ☆ Exposure 12040.4030 µs ÷ ♥ Cropping ☆ Offset X 0 ÷ ↓ ☆ Offset Y 0 ÷ ↓ ☆ Width 640 ÷ ↓ Register name: PresetNumber Display name: Current Access mode: Read write 			2					
 ☆ Exposure ☆ Cropping ☆ Offset X 0 ÷ ☆ offset Y 0 ÷ ☆ width 640 ÷ ▲ · · · · · Register name: PresetNumber Display name: Current Access mode: Read write 		☆ Save			Execute			
Cropping ☆ Offset X ☆ Offset Y ☆ Width 640 ÷ ★ width 640 ÷ Access mode: Read write	Ľ	7 Framerate	8	3.0006 Hz 🛨				
☆ offset X ☆ offset Y ☆ width ★ width	Ľ	2 Exposure	12	2040.4030 µs 🕂 👘				
 ☆ Offset Y ☆ width 640 ÷ Access mode: Read write 	V Cro	opping						
☆ width Gegister name: PresetNumber Display name: Current Access mode: Read write		☆ Offset X						
Register name: PresetNumber Display name: Current Access mode: Read write		☆ Offset Y						
Register name: PresetNumber Display name: Current Access mode: Read write		☆ Width	64	10 <u>+</u>				
Display name: Current Access mode: Read write		<u> </u>						0
Access mode: Read write	Registe	er name: PresetNu	mber					
	Display	name: Current						
Description: Change the preset of the camera.	Access	mode: Read write						
	Descrip	otion: Change the p	preset of the came	ra.				
Possible values: Preset_0:Preset_1:Preset_2:Preset_3:Preset_4:Preset_5:Preset_6:Preset_7:Preset_8:Preset_9	Possibl	e values: Preset_0):Preset_1:Preset_	2:Preset_3:Preset	_4:Preset_5:Preset_	_6:Preset_7	:Preset	_8:Preset_9

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"

- Playback			Buffer0/6865		
50 fps 🕂			0,0005		0 ÷
	Acquisition	File	Left mouse click action	Image Processing Clip Once Auto Clip Sharp CLAHE	
	4272	X: 76 Y: 256 (index: 1639	16) ADU: 0 (Screen value: 0)	8660	
Buffer: 0/6865 - FF	S: 0 - Sensor Temp: 19.32 - Status: operational	5' 11 0	ontral modulo		

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

-Playback	Buffer
	1822/6865
50 fps 主	
	Fig. 15 · Puffer part

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.

Bave Buffer	?	×
E		_
Start: 0		
End: 0		
Count: 1		
Nb bursts: 1 🔄 🗆 Multiple of bursts		
Select all images Decimation: $0 \stackrel{\cdot}{\underbrace{\cdot}}$		
Include metadata (only current configuration of the camera will	l be sa	ved)
Save with offset: 0 🔶 Auto detect 🗆 Save as unsigned	ed	
Save as	Car	ncel

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.

Save buffer			×
← → → ↑ 💽 > Ce PC > Imag	15 >	✓ 💍 Rechercher d	lans : Images 🔎
Organiser 👻 Nouveau dossier			⊾ - ?
Ce PC Bureau Cocuments Cuments Cumages Musique Objets 3D Ciféchargement: Vidéos Cuments Osque local (C:) Osque local (C:) Osque local (C:) Cocuments Cocumen			
]
Nom du fichier : buffer.raw			~
Type : RAW format (*.raw			~
AVI format (*.avi) DICOM format (*.di FITS format (*.fit) FirstLightFrame for RAW format (*.raw	nat (*.flf)		
TIFF format (*.tif)			

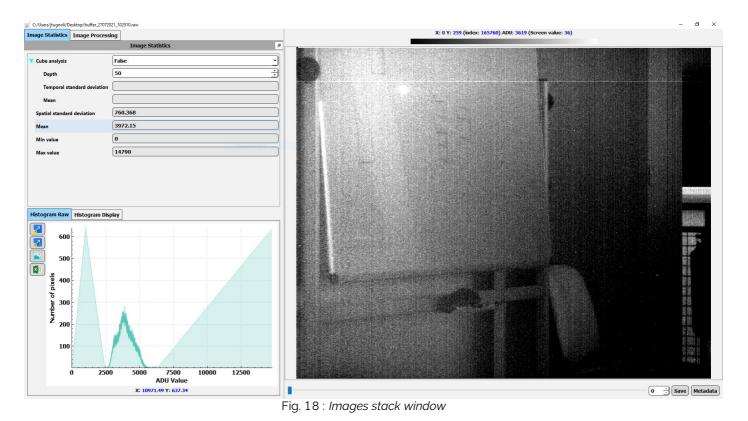
Fig. 17 : Dialog choose file

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;Heig ht: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.



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

FIRST ⁺ LIGHT	FirstLightVision	? ×
Г	1	2
1	Version	1.4
2	HeaderSize	2048
3	Date	Tue Jun 108
4	Nblmages	
5	Decimation	
6	CameraModel	C-RED2
7	Width	640
8	Height	512
9	unsigned pixel	
10	mono8	
11	cropping	{no-0-639-0-511}
12	adu offset	
13	temperatures	{motherboard: 34,250000- frontend: 31,250000- powerboard: 29,500000-sensor: 20,490000-peltier: 22,600000- heatsink: 24,430000}
14	fps	600.013176
15	tint	0.001661
16	maxTintltr	0.000015
17	bad pixel enabled	
18	conversion gain	high
19	bias enabled	
20	flat enabled	
21	raw images enabled	

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.

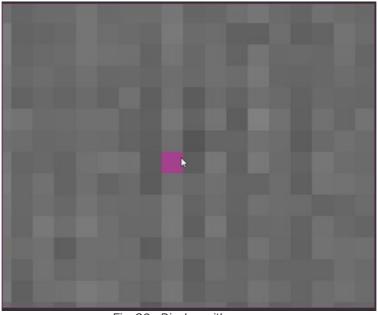
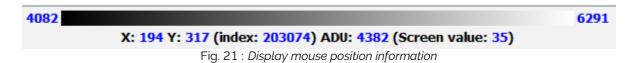


Fig. 20 : Display with mouse

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



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.

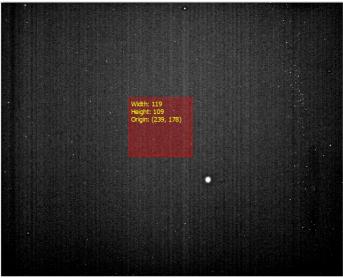


Fig. 23 : Display analysis rectangle

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.

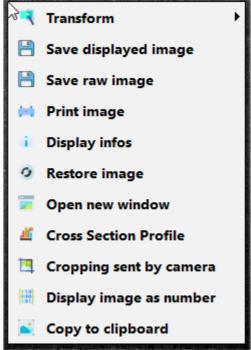


Fig. 24 : Right click menu

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

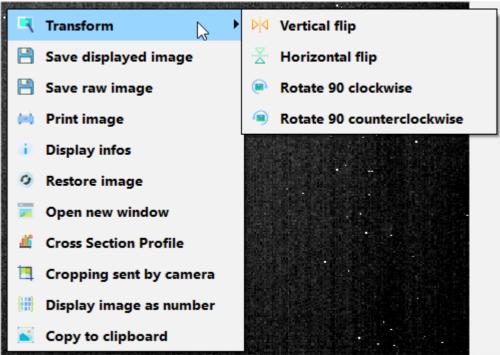


Fig. 25 : Transform submenu

- "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.

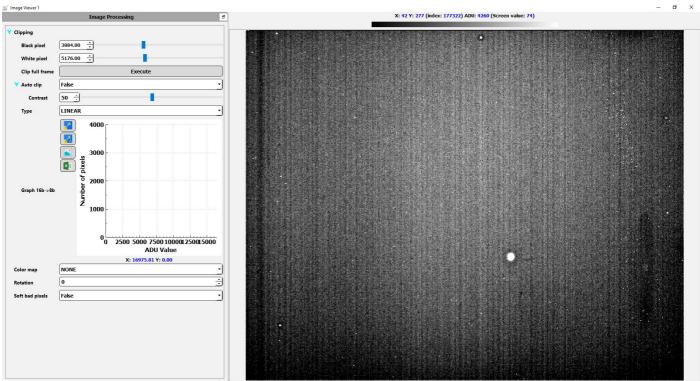


Fig. 27 : New display window

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

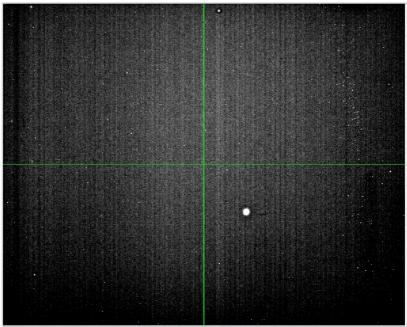
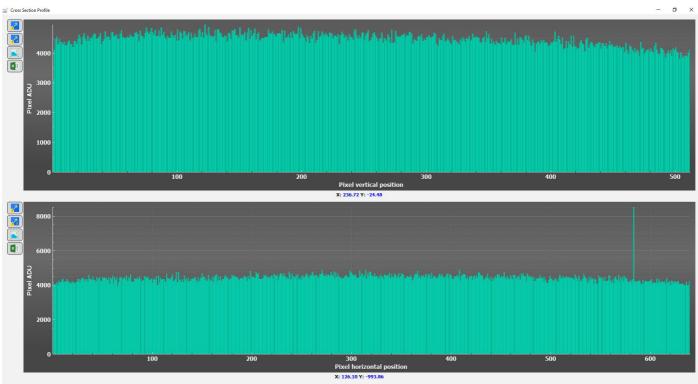
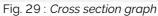
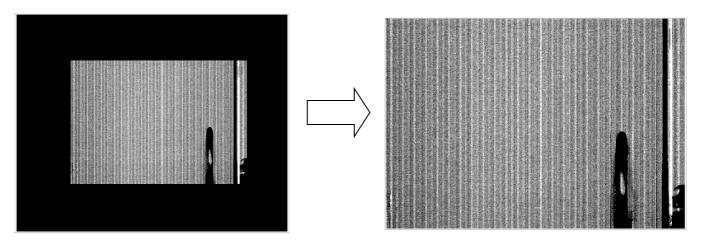


Fig. 28 : Display with cross section





• "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.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
8076	31	0	3ff8	b7b	ac7	bab	aac	9f6	ac2	629	aSc	c77	bc3	b9e	b2a	a36	a09	a21
fa8	ef9	1018	fc1	fce	f2f	10a8	f39	103d	f89	fc5	fac	ff8	100d	f6e	fb6	f45	f45	f49
f97	ea3	fa2	fed	f83	f69	f98	fbe	f7e	fd7	1022	f10	10a2	1082	102a	f0f	fc9	102d	ff
100e	flc	fd7	f22	fda	1006	1063	fa3	1016	1011	fbc	1026	fce	1028	f8f	f78	104f	f5a	fe
faf	f6b	1045	fb9	1011	f4f	105d	f82	fcc	fb1	102d	f55	fe5	fba	1047	1036	fa5	f1d	f
1055	f2a	f7a	ff6	11a9	f98	101a	1065	101ь	ffa	102e	fc9	1002	fc9	ff0	10a2	fa7	f59	fa
10d1	ec4	102b	f65	1094	fb5	1019	f73	1037	1038	fa8	fdd	10d3	101e	10ba	10e6	f36	107ь	10
1130	fac	ee2	f94	1001	f89	fc7	f72	105f	f4b	fbb	105f	106d	fbf	102b	103a	1028	f9c	fe
108b	1001	f79	103f	107f	1020	100b	101ь	f83	f89	f56	1046	1000	fb0	105e	fe7	1014	ff2	10
fc2	f05	fb1	fef	10a2	f4f	fab	1003	fed	1038	f88	fd6	106c	1029	1101	104a	108d	102a	e
1041	f0c	f5d	1002	fb8	fe1	1057	10a2	fbd	1051	fd6	1069	105f	fc4	fe7	100ь	104c	f82	ff
102e	f74	f94	fed	1085	f9b	102c	1014	1034	fe1	101d	fee	103a	1054	1089	1039	1039	f7a	fo
100ь	ed1	ef9	f76	f89	1093	fc5	106a	1060	101c	f71	107f	1004	1029	1065	107d	1059	f40	f
1059	ff9	f92	ff7	10fa	1025	109e	1026	1018	fdd	102d	100ь	1072	100ь	1094	10d5	10c8	1084	10
1033	eed	f55	eff	f35	ff9	1046	fbe	105a	fcc	f44	1003	1113	10ec	113f	1067	f46	f78	10
10d5	fe9	fdc	1037	100e	flc	10ea	fed	1120	1012	109f	1023	ff0	1082	1099	1062	fe5	fa9	f
1037	ed5	ffb	f69	1064	f80	fd9	f66	10be	fc5	ffd	f91	1096	fae	10da	f80	103f	f44	1
1030	f54	1057	f3e	fba	fb0	117ь	fe4	1031	1078	1068	fa9	106f	10d3	10af	1008	fe9	ff1	10
109Ь	f94	fe5	1005	105e	102e	10ec	104a	1016	109c	ffa	fdf	1076	1058	1118	10a0	faf	f6b	f
107f	f4c	fcf	f6f	fb2	1071	1019	1053	102f	fb0	1041	1021	10bc	106d	10cc	108e	ff8	103a	f
10a8	1027	1085	f53	1074	f71	fd8	f93	fef	f78	1034	1083	10c6	fe8	102d	1095	101b	fa0	f
1094	f86	ffa	fb0	1162	fd1	1037	102c	1024	fd2	1085	ff9	10a5	1008	1059	10e5	1052	f86	f
1000	1040	1092	fdd	1053	fcf	10da	1051	fbb	ff9	1007	ff0	1081	1050	ffd	10ca	fe6	faa	f
ff3	1055	ff4	f58	1095	fbf	1066	ff2	108d	1093	1022	103b	10cb	105f	1023	1103	f73	fc5	f
110Ь	f3a	fec	f60	1042	f20	1054	1056	1027	f81	1062	1016	1031	ffa	11a6	f81	fb0	1052	1
102a	f64	fb1	f46	109e	102d	1136	f89	101f	1042	fd4	fdd	110f	10ac	1092	116f	1066	1005	•
10a5	f45	103b	f58	1010	100b	10dd	1042	103b	1105	1019	1048	fe1	101c	10f3	fea	fdd	1034	10
1094	ee1	1101	f6b	1083	1003	106c	1017	108b	1014	100c	1048	108c	1019	1034	fe5	f4d	1029	f
10f2	fb8	f43	edc	109b	fb1	104e	1036	f90	1057	1082	fdf	1051	104e	10df	10c5	fe3	ffc	f
1064	fdd	f5c	f33	1060	f19	108a	10a2	10d1	1062	fb2	1044	104d	ffc	100ь	10Ь1	10a0	fdb	10
1073	fa5	106e	f86	10a1	1028	1138	f6b	f92	102f	108a	f89	1024	fee	1125	103f	1048	fc4	10

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.

Beer D	🎬 ⁺ Display as number								
	1		2						
1	べ Hexadecima	√ Hexadecimal							
2	Decimal								
3	Save as CSV			fa2					
4	100e	f1c		fd7					
5	faf	f6b		1045					
6	1055	f2a		f7a					
1	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.

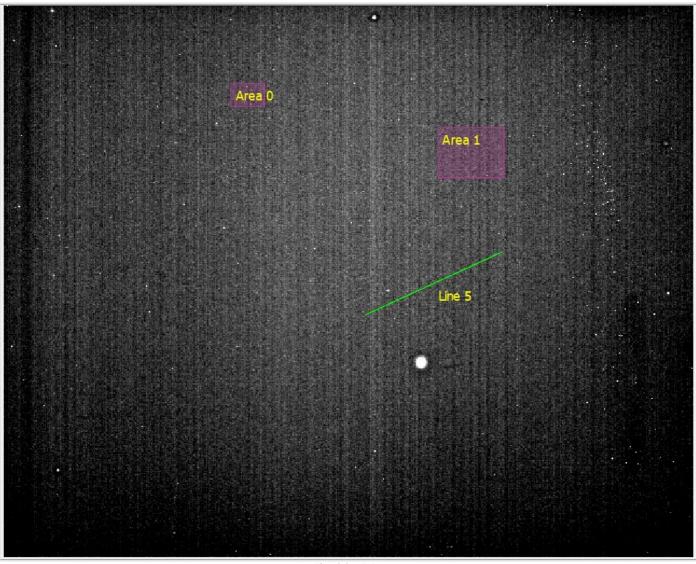


Fig. 32 : *ROIs*

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

Console Image Statistics I	mage Processing Re	gions of interest Camera	Cont
	Regi	ons of interest	ē ×
Name	Value		
Y Area 0)		
> Rect	{112, 52, 96, 33}	Rectangle area properties	
💙 Mean	15256.7	🗌 Display on image	
Alarm min	0.00	🗌 Enable/disable min alarm	alarm.mp3
Alarm max		🗌 Enable/disable max alarm	alarm.mp3
Spatial Standard Deviation	88.0116	Display on image	
Text color			
Histogram	Show		
V Area 1)[]		
> Rect	{360, 194, 49, 79}	Rectangle area properties	
> Mean	15294.2	🗌 Display on image	
Spatial Standard Deviation	79.819	🗌 Display on image	
Text color			
Histogram	Show		
V Line 2)		
> Line	{211, 260, 268, 170}	Line properties	
💙 Mean	15295.7	🗌 Display on image	
Alarm min	0.00	🗌 Enable/disable min alarm	alarm.mp3
Alarm max	0.00	🗌 Enable/disable max alarm	alarm.mp3
Spatial Standard Deviation	94.0208	🗌 Display on image	
Text color			
Histogram	Show		

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

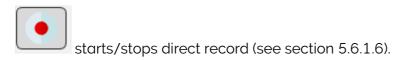
There are five buttons for this section:

- 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

	FirstLightVision	?	×
	Number of images to	grab	
	256		÷
	Minimum time for the	e grabN:	0.64s
	🗌 Don't ask me agair	ı	
opens a boy	•	ок) Са	ncel

and start a grab of N frames. If you

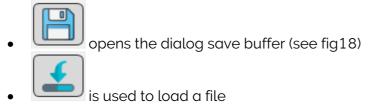
click on "Don't ask me again" then the box will not appear until the next software start, but you can change the number of images in "File"->"Settings" (see section 5.6.1.2).



5.4.4.2. File



There are three buttons for this section:





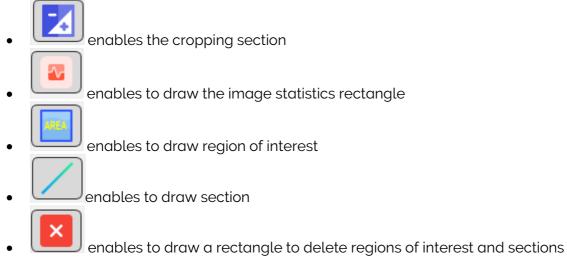
takes a snapshot of the current image (see section 5.6.1.5).

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:



5.4.4.4. Image processing



Fig. 37 : Image processing shortcuts

There are four buttons in this section:

Clip once on all the image
 Auto enables the autoclip on all the image
 Sharp enables the sharpen processing
 CLAHE enables the CLAHE processing

<u>Clip</u>: 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.

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

5.5. Image processing

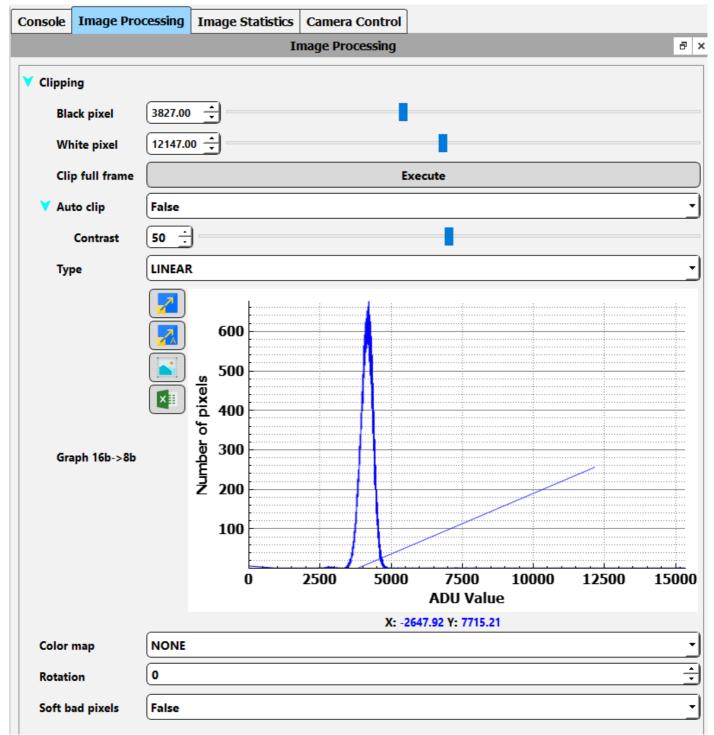


Fig. 38 : Image processing tab

5.6. File menu

first" Fi	rstLightVisio	n Version:2	2.0.3_beta-67-ga
File	Tools	View	Plugins
*	Settings		
B	Save sett	ings	
0	Refresh (SUI	F5
Ē	Open we	b server	page
	Get came	era logs	
9	Detect ca	meras	
R i	Mode		•

Fig. 39 : *File menu*

5.6.1. Settings

5.6.1.1. Buffer

V Buffer			
Size (images)	7366	<u>+</u>	
Size (Mo)	4604	<u>+</u>	
Display	True	<u> </u>	

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

💙 Grab	
Nb images per buffer	1
Auto start	False 🔹
Substract Mode	False
Burst filter	-1
GrabN count	256 <u>*</u>
	Fig. 11 Crab sottings

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

💙 Camera	
Detection	Start
Selection	CRED2#01-00001643af9e#Matrox-Dev_0
Poll interval	1s
Enable Polling	True
Ethernet	Add

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:

ﷺ ⁺ FirstLightVisi ? ×			
IP Address			
169.254.123.123			
Login			
admin			
Password			
flicred 1			
Automatic detection			
OK Cancel			

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

V V	ser Interface	
	Configuration	Full
	Theme	White
	Hide logo	True
	Mode	Expert 🔹

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

▼ Snapshot	
Image type	Raw image 🔹
Path	C:/Users/jtugnoli/Documents
File name	snapshot
Format	FITS

Fig. 45 : Snapshot



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

5.6.1.6. Record

V Record			
Path	C:/Users/jtugnoli/Documents		
File name	record		
Number of frames	100 *		
Estimated size	62.5 Mo		
Decimation	1		
Estimated bandwidth	99.3752 Mo/s		
Metadata	False 🔹		
Disk benchmark	Run		
Calculated bandwidth	2503.13 Mo/s		
	Fig. 46 : 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.

🛒 FirstLight	Visi	?	×
Nb days:	ի		÷
	ОК		ancel

file and click "Ok" to download it.

5.6.6. Detect Cameras

A shortcut for camera detection.

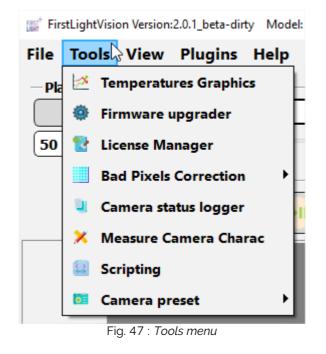
5.6.7. Mode



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



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.

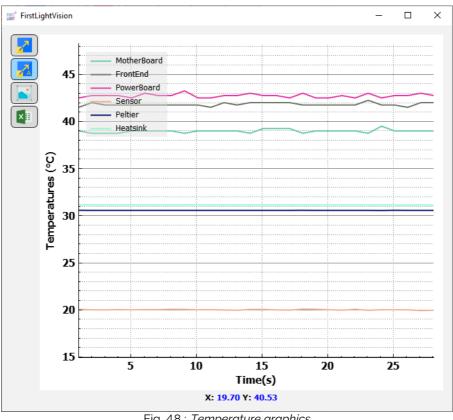


Fig. 48 : Temperature graphics

5.7.2. Firmware upgrader

This option displays a new window for the camera maintenance.

jﷺ [†] Firmware upgrader	_		×
Enter firmware URL (ex http://myHostxxx.tar.gz file)	Sen	d At	ort

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.

<u>Note</u>: 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.

Bear ⁺ Li	cense Manager	_		×
	Send license file into the camera			
	Select a file from your computer)[Send	
	☑ Transfer file using XModem protocol			
	License files already on the camera			
	hdr.lic	Ena	ble	
		Disa	able	
		Del	ete	
		Refi	resh	

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.

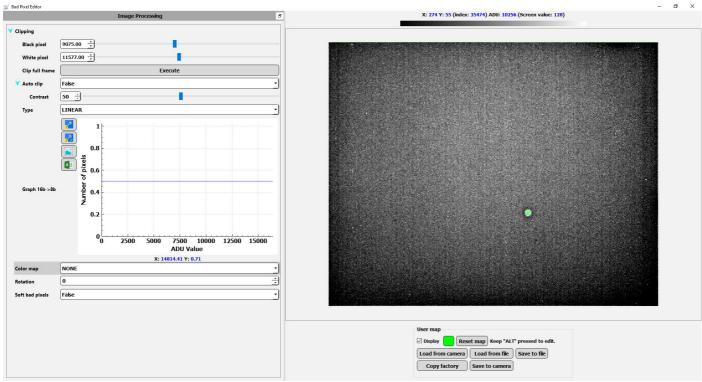


Fig. 52 : Bad pixel editor

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.

Bad Pixels Detection Wizard		_		×
Welc	ome to the bad pixel configurator !			
This wizard will gui	e you step by step to create your bad pixel map.			
	Step 1/7			
The camera is currer parameters if you	tly in the following configuration. You may edit the wish to find bad pixels in another configuration.			
Framerate	159.00 fps Set fps max:403.746			
Exposure	6.28 ms <u>•</u> Set tint max:6.28159			
DarkOptim level				
Tuning	general _			
Conversion gain	high _			
Cooling	20 °C ÷			
			C	
			N	lext

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

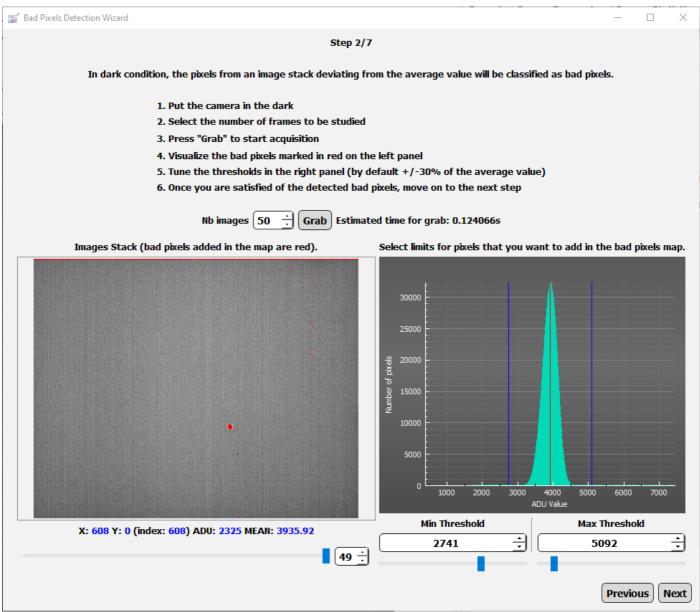


Fig. 2 : Bad Pixels Detection Wizard step 2/7

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.

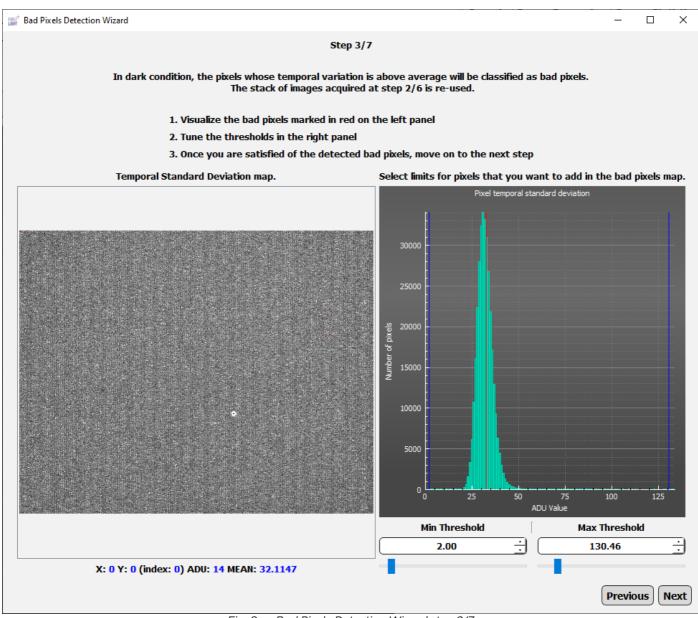


Fig. 3 : Bad Pixels Detection Wizard step 3/7

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.

🛒 Bad Pixels Detection Wizard		– 🗆 X
Step 4/7 (optio	nnal)	
Under a flat field illumination, the pixels from an image stack deviati	ng from the average value will be classified a	s bad pixels
 Set a flat field in front of the camera. The mean val Select the number of frames to be studied Press "Grab" to start acquisition 		
4. Visualize the bad pixels marked in red on the left pa		
5. Tune the thresholds on the right panel (bu default 6. Once you are satisfied of the detected bad pixels, m		
	d time for grab: 0.124066s	
Images Stack (bad pixels added in the map are red).	Select limits for pixels that you want to add i	n the bad pixels map.
	8000 6000 4000 2000 0 50 100 400 4000 4000 0 4000 4000 4	200 250
X: 639 Y: 307 (index: 197119) ADU: 3697 MEAN: -5.71875	Min Threshold M	ax Threshold
X: 039 Y: 307 (INDEX: 197119) ADD: 3097 MEAN: -5./1875		0 +
		Previous Next

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.

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

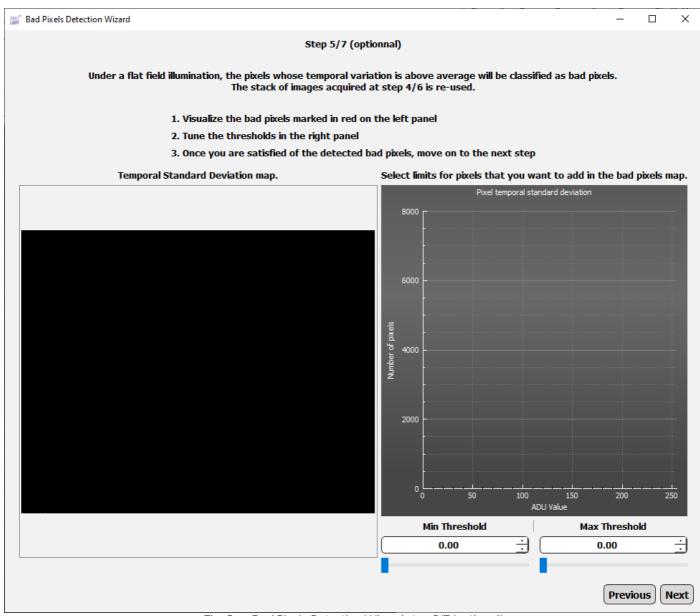


Fig. 5 : Bad Pixels Detection Wizard step 5/7 (optional)

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.

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

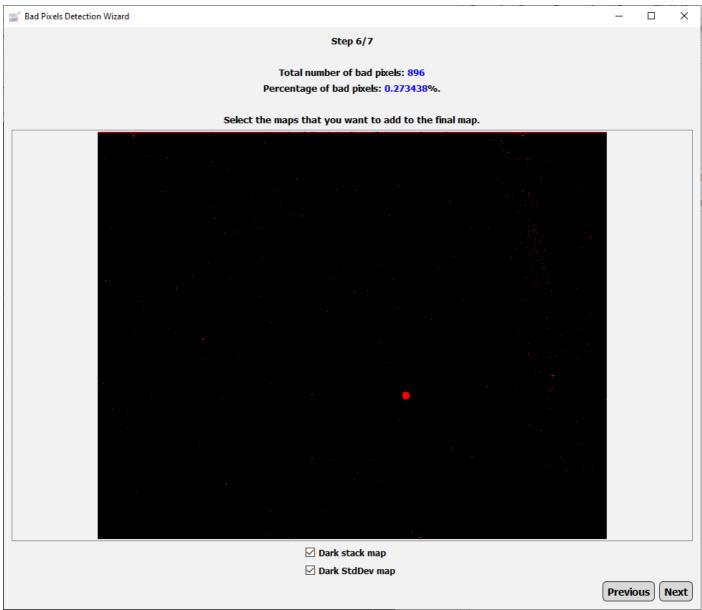
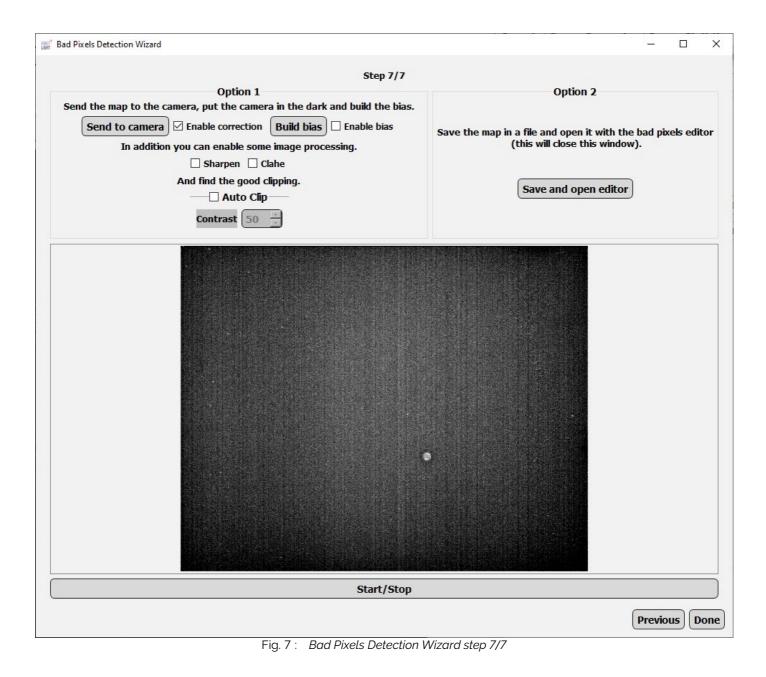


Fig. 6 : Bad Pixels Detection Wizard step 6/7 (optional)

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



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.

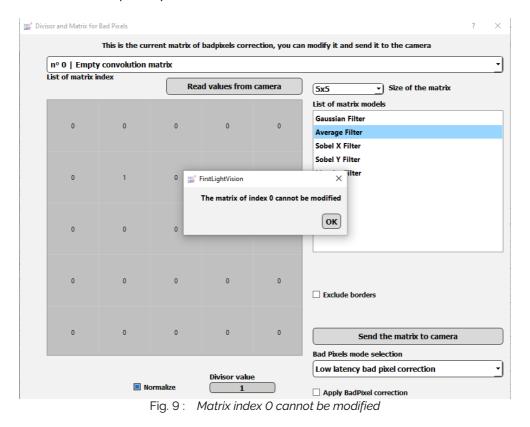
5.7.6. Bad pixels Matrix Convolution

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:

List of matrix ind		natrix			
	ex		ad values from	camera	5x5 Size of the matrix
1	0	0	0	0	List of matrix models Gaussian Filter Average Filter Sobel X Filter
0	1	0	0	0	Sobel Y Filter Identity Filter
0	0	0	0	0	
0	0	0	0	0	Exclude borders
0	0	0	0	0	Send the matrix to camera Bad Pixels mode selection

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.



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.

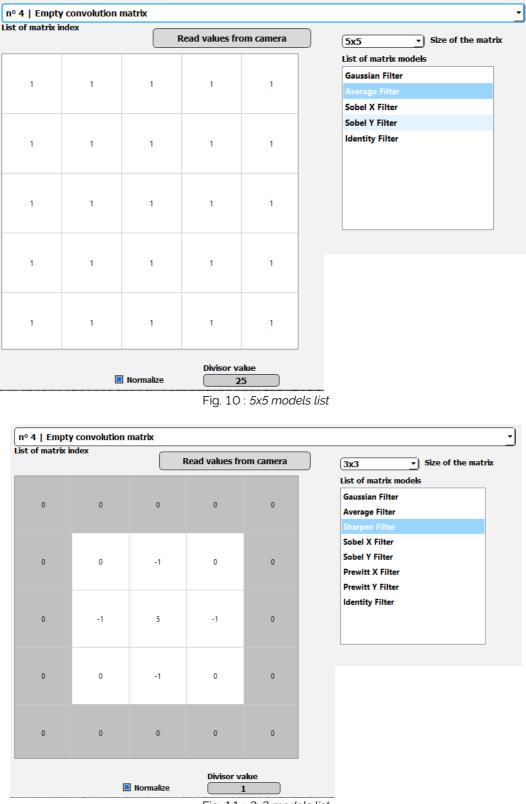


Fig. 11 : 3x3 models list

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:

FIR

st of matrix	y convolution i	matrix			
st of matrix	index	Rea	ad values from	camera	3x3 Size of the matrix
0	0	0	0	0	List of matrix models Gaussian Filter Average Filter
					Sharpen Filter Sobel X Filter
0	0.0605	5.4432	0.0605	0	Sobel Y Filter Prewitt X Filter Prewitt Y Filter
0	5.4432	489.99	5.4432	0	Identity Filter
0	0.0605	5.4432	0.0605	0	Exclude borders
0	0	0	0	0	Send the matrix to camera Bad Pixels mode selection

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:

	y convolution	matrix			
ist of matrix i	ndex		Read values fro	om camera	3x3 _ Size of the matrix
0	0	0	0	0	List of matrix models Gaussian Filter Average Filter Sharpen Filter
0	1	1	1	0	Sobel X Filter Sobel Y Filter Prewitt X Filter Prewitt Y Filter
0	0	0	0	0	Identity Filter
0	-1	-1	-1	0	
0	0	0	0	0	Send the matrix to camera

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.

Iogs.txt - Bloc-notes			- 🗆	×
Fichier Edition Format Affichage	Aide			
31/05/2021 16:20:41;177.99 31/05/2021 16:20:42;177.99 31/05/2021 16:20:43;177.99 31/05/2021 16:20:44;177.99 31/05/2021 16:20:45;177.99 31/05/2021 16:20:46;177.99 31/05/2021 16:20:46;177.99 31/05/2021 16:20:48;177.99 31/05/2021 16:20:49;177.99 31/05/2021 16:20:50;177.99	<pre>hev;Average;Mean;MB (°C);FE (°C);PW (°C);SENSOR (°C);PELTIER (°C);HEATSINK (°C);IntPower (W) ';177.997;3428.59;0;41.25;45.00;41.75;19.98;30.52;32.71;0.25;0.42;operational; ';177.997;3428.59;0;40.75;44.75;21.02;30.52;32.72;0.25;0.42;operational; ';177.997;3428.59;0;40.75;45.25;41.75;20.02;30.52;32.72;0.25;0.42;operational; ';177.997;3428.59;0;41.00;45.50;42.00;20.02;30.52;32.72;0.25;0.42;operational; ';177.997;3428.59;0;41.00;45.50;42.00;20.02;30.52;32.72;0.25;0.42;operational; ';177.997;3428.59;0;41.00;45.00;42.00;20.02;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.25;44.75;42.00;19.98;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.25;45.25;42.00;19.98;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.25;45.25;42.00;19.98;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.25;45.25;42.00;19.98;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.25;45.25;42.00;20.00;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.00;45.25;42.00;20.00;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.00;45.25;42.00;20.00;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.00;45.25;42.00;20.00;30.52;32.72;0.25;0.43;operational; ';177.997;3428.59;0;41.00;45.25;42.00;20.00;30.52;32.72;0.25;0.42;operational; ';177.997;3428.59;0;41.00;45.25;42.00;20.00;30.52;32.72;0.25;0.42;operational; ';177.997;3428.59;0;41.00;45.25;42.00;20.00;30.52;32.72;0.25;0.42;operational; ';177.997;3428.59;0;40.75;44.75;42.00;20.01;30.53;32.72;0.24;0.42;operational;</pre>);ExtPower	(W);Sta	tus;
<				>
	Ln 1. Col 1 100% Unix (L	IE)	ANSI	

Fig. 14 : Logger file example

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

En	registrement automa	tique 💽	日 り~ (Ž~ ⇒	logs.csv 👻	, ∕ R	echercher				Julien	TUGNOLI	Ē	-
Fich	ier Accueil	Insertion	Mise en page	e Formule	s Donnée	s Révisio	n Affichag	ge Aide				ß۲	Partager 🖓	Commentaires
Coll Presse	er of G I	 <u>S</u> ~ ⊞ + Police	- 11 → A^ ~ <u>⊘</u> ~ <u>A</u>	• <u>=</u> =	III ≫ ~ IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	₩ ₩ ₩ * 500	~ % 000		rme conditionne is forme de table ellules ~ Styles	au ~ 🛣 Su	sérer 👻 pprimer 👻 rmat ~ Cellules	🞸 🎽 filtrer ~	Rechercher et sélectionner ~ ition	
G22		× × .	f _x											~
	А	В	с	D	E	F	G	н	I	J	к	L	м	N
1 T	ïme	Spatial Dev	Temporal De	Average	Mean	MB (°C)	FE (°C)	PW (°C)	SENSOR (°C)	PELTIER (°C)	HEATSINK ((IntPower (W	ExtPower (V	Status
2	31/05/2021 16:20	177.997	177.997	3428.59	0	41.25	45.00	41.75	19.98	30.52	32.71	0.25	0.42	operational
3	31/05/2021 16:20	177.997	177.997	3428.59	0	40.75	44.75	41.75	20.02	30.52	32.71	0.24	0.42	operational
4	31/05/2021 16:20	177.997	177.997	3428.59	0	40.75	45.25	41.75	20.02	30.52	32.72	0.25	0.42	operational
5	31/05/2021 16:20	177.997	177.997	3428.59	0	41.00	45.50	42.00	20.02	30.52	32.72	0.25	0.42	operational
6	31/05/2021 16:20	177.997	177.997	3428.59	0	41.00	45.50	42.00	20.02	30.52	32.72	0.25	0.42	operational
7	31/05/2021 16:20	177.997	177.997	3428.59	0	41.00	45.00	42.00	20.00	30.52	32.72	0.24	0.42	operational
8	31/05/2021 16:20	177.997	177.997	3428.59	0	41.25	44.75	42.00	19.98	30.52	32.72	0.25	0.43	operational
9	31/05/2021 16:20	177.997	177.997	3428.59	0	41.25	45.25	42.00	19.98	30.52	32.72	0.25	0.43	operational
10	31/05/2021 16:20	177.997	177.997	3428.59	0	41.25	45.25	42.00	19.98	30.52	32.72	0.25	0.43	operational
11	31/05/2021 16:20	177.997	177.997	3428.59	0	41.00	45.25	42.00	20.00	30.52	32.72	0.25	0.42	operational
12	31/05/2021 16:20	177.997	177.997	3428.59	0	40.75	44.75	42.00	20.01	30.53	32.72	0.24	0.42	operational
13														
4	> logs	\oplus												•
Prêt						E' 4 E		<i>cu</i>						+ 100 %

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.

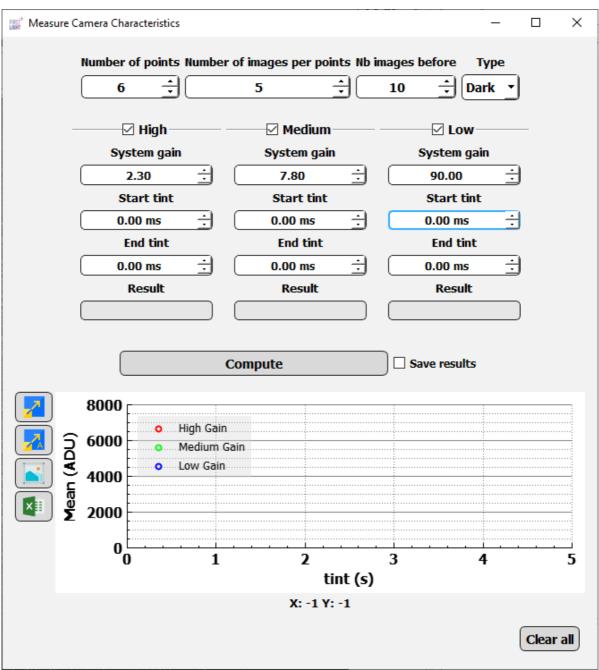


Fig. 16 : Measure Camera Characteristics window

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

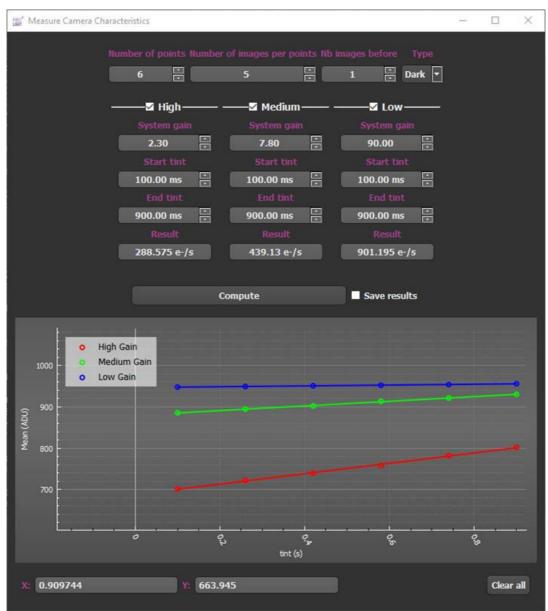


Fig. 17 : Dark computing example

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

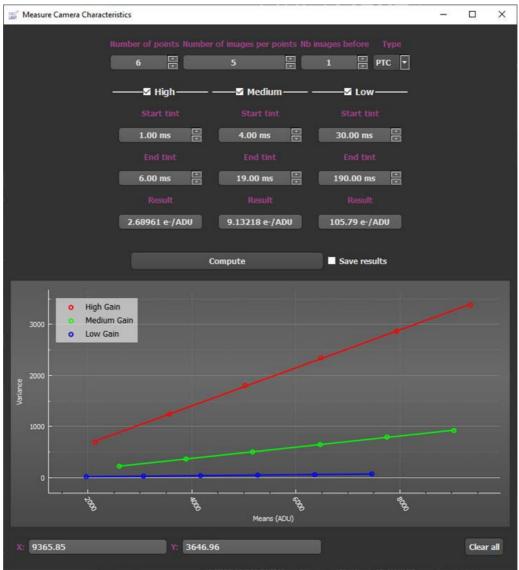


Fig. 18 : PTC computing example

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.

<u>Note:</u> 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

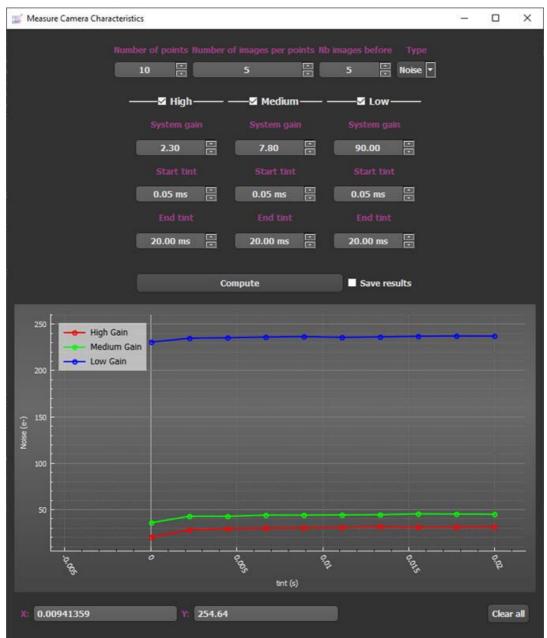


Fig. 19 : Noise computing example

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.

script	– 🗆 X	📓 Script	– 🗆 X
With File		☑ With File	
	Open		Open
Root path C:/Users/jtugnoli/Documents		Root path C:/	
Suffix path		Suffix path	
	▶ play ■ stop		▶ play ■ stop
☑ With Server		With Server	
Stop IP : 192.168.120.31	Port 4000	Start IP:	Port
L	Clear logs Save logs		Clear logs Save logs

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

<u>Remark</u>: 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.

<u>Note 1</u>: 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 ...

<u>Note 2</u>: 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.

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

K:\tcltk86-8.6.10.5.tcl86.Win10.x86_64\tcltk86-8.6.10.5.tcl86.Win10.x86_64	
× set tcpchan [socket 192.168.100.27 4000]; sock000000001DC04C0	# Connect to the GUI tcp socket
🗶 puts \$tcpchan "echo Hello word";flush \$tcpchan;	# Send a dummy command
<pre>% puts "192.168.100.27:4000 answer [gets \$tcpchan]"; 192.168.100.27:4000 answer OK</pre>	# Receive a string
% puts \$tcpchan "cam fps raw";flush \$tcpchan;	# Send a fps command to the camera
z puts "192.168.100.27:4000 answer [gets \$tcpchan]"; 192.168.100.27:4000 answer 600.013176000:0K	# Receive a string
z close \$tcpchan;	# Close the GUI tcp socket
× ×	

Stop	IP: 192.168.100.27	Port 4000					
Handling comman Hello word Handling comman	nd:echo Hello word nd:cam fps raw						

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
```



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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": {
        "coll": 0,
        "col2": 639,
        "priority": "None",
        "rowl": 0,
        "row2": 511,
        "state": false
    },
    "aduOffset": 0,
    "antiBloomingState": false,
    "badPixelState": true,
    "biasState": false,
    "conversionGain": "high",
    "cropping": {
        "coll": 0,
        "col2": 639,
        "rowl": 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"
1
```

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.

Hot Pixel Correction		?	×
-Load Images From :-			
From Buffer	From Raw	file)
From Buffer	From Raw	file)
From Buffer	From Raw	file	

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 :

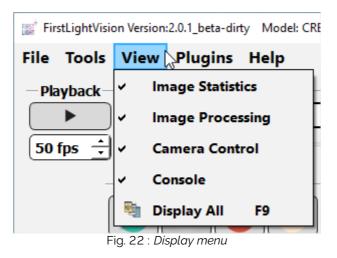
- The threshold, in percentage of the median of the pixel, for when to use the filter on the pixel.
- If you want to activate the correction with the threshold
- If you want tot activate the pixel saturation correction
- You can chose to preview on the image the correction or on half the image.

```
? X
```

X: 1632 Y: 3385 (index: 18036912) ADU: 305 (Screen value: 10)	Median Filtering		
	Coefficient 5.0000		
	<u>+</u>		
	 Interval correction Saturation Correction 		
	Display Setting Preview I Half		
Close	Save To Camera		

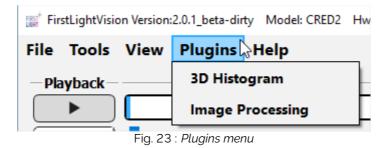
If you press the "Save To Camera" button it will close the interface and send the parameter to the camera (threshold value, threshold activated or not, etc ...). If you just close the interface no parameters will be send to the camera.

5.8. View menu



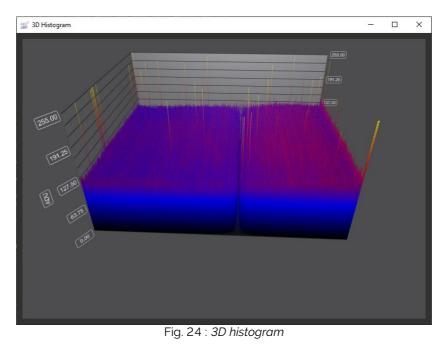
This menu show/hide panels of the software and to display all (F9 shortcut).

5.9. 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.



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

5.9.2. Image Processing

📓 Image Processing	_		×
profil_2 Delete profil Save			
Filters Common Tone Mapping			
☑ Filters (can slow down the application)			_
Denoising			
□ Enable H coeff: 3.00 + Template Window Size: 7 + Search Window	eres (<u>.</u>	
	w size:	21 .	
Sharpen			
Clahe			
Raw Image infos			
Clip black: 1020 Clip white: 1706			
Spatial Std dev: 102.741 Mean: 1319.23			
Histogram			
	ean 🗌 S	tandard	dev
8000			
6000			_
<u>역</u>			
2000			
	<u> </u>		
です。 場 境 境 Value 0-255	100		150
X -2.83859 Y 307.692	Res	cale Gra	aph

Fig. 25 : Image processing plugin

Filters	Common	Tone Mapping	
⊘ Filte	rs (can slow	r down the applie	cation)
Denoisi	ng		
🗆 Er	nable		
Нсо	eff: 3.00	🕂 Template W	indow Size: 7 📩 Search Window Size: 21 📩
Sharpe	n		
Clahe			

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.

Filters	Common	Tone Mapping				
Manual Clipping						
DisplayedPixelValue = alpha * pixelValue + beta						
Alpha	Alpha: 0.00000 * Beta: 0.00000 *					
Nb Images for accumulation: 10 🕂 🗆 Enable						
Clipping parameters						
	Limit typ	e	Clip depth		Limit value	
Mear	า	<u> </u>	1	÷	2000	÷
Fig. 27 - Common tab						

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.

Filters Common Tone Mapping			
Drago _			
Gamma 1.23 🛨			
Saturation 0.99 🕂			
Bias 0.97 🔆			
Multiplicator 2			

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.



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.