C-RED CAMERAS

To make the **invisible visible**

Find the perfect tool for your Short Wave InfraRed project

FIRST LIGHT
ADVANCED IMAGERY

SHORT WAVE INFRARED (SWIR)

## SEEING THE INVISIBLE OPENS AN ENTIRE NEW REALM OF APPLICATIONS

SWIR radiation extends from the far edge of the visible spectrum to the beginning of the MWIR range, from 800 nm to 2500 nm. All C-RED cameras are sensitive within this range, allowing them to detect and image signals that are invisible both to silicon-based detectors and MWIR/LWIR thermal cameras.

SWIR cameras can be based on different detector technologies. All C-RED 2 and C-RED 3 cameras are based on InGaAs detectors. Varying the fraction of indium allows to tune the sensitivity range and create "extended range" InGaAs detectors. HgCdTe (also refered to as MCT) is another material sensitive in the SWIR range. It is used to create electron initiated avalanche photodiodes (e-APD) arrays, as in C-RED One's detector.

FIND YOUR WAVELENGTH

| UV | VISIBLE | SWIR | MWIR / LWIR |

C-RED One
MCT e-APD
800 – 2500 nm
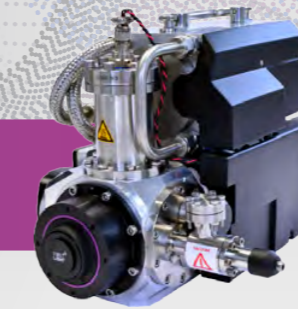
C-RED 2
InGaAs
900 – 1700 nm

C-RED 2 Lite
InGaAs
900 - 1700 nm

C-RED 2 ER 2.2µm
Extended InGaAs
1300 – 2200 nm

C-RED 2 ER 1.9µm
Extended InGaAs
1100 - 1900 nm

C-RED 3
InGaAs
900 – 1700 nm

UV = Ultraviolet
VIS = Visible
SWIR = Short Wave InfraRed
MWIR = Middle Wave InfraRed
LWIR = Long Wave InfraRed

Like the visible spectral band, SWIR imaging relies on the reflectance properties of materials. And like the MWIR/LWIR spectral bands, SWIR enables detection of thermal radiation.

SWIR imaging and sensing is becoming essential in numerous high-end scientific and industrial domains.

SWIR cameras enable easy distinction between regions of similar chromaticity and penetration of opaque materials.

The key applications include:
• Astronomy
• Adaptive optics
• Optical communications
• Hyperspectral sensing
• Small animal imaging
• Fluorescence microscopy
• Surveillance
• Industrial inspection

Visible   SWIR
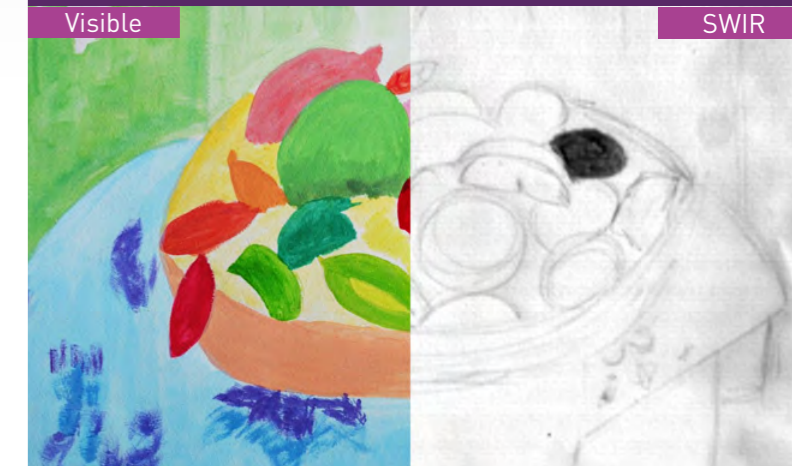
WHY CHOOSING A C-RED CAMERA?

FULL FRAME

HIGH SPEED
C-RED CAMERAS ARE THE FASTEST IN THEIR CATEGORY
600 FPS Full Frame for our InGaAs VGAs and 3500 FPS Full Frame for our e-APD MCT QVGA, and even faster in cropping mode.

e^-

ULTRA LOW NOISE & LOW DARK
C-RED CAMERAS OFFER THE LOWEST NOISE POSSIBLE
Benefit from subelectron readout noise with the amazing C-RED One, or from ultra low dark current <600 electrons per pixel per second with C-RED 2.

THERMAL MANAGEMENT
OPTIMIZED COOLING METHOD FOR EACH CAMERA
Each camera offers the best cooling method with regard to their sensors and targeted applications: cryocooling, air and liquid cooling, TEC stabilization...

HDR

OPTIMIZED DYNAMIC
93 dB AND TRUE 16 BITS
Enhance your vision with our optimized High Dynamic Range available on C-RED 2 and C-RED 3.

$

A FULL RANGE OF CAMERAS
FROM INDUSTRIAL USE TO HIGH-END RESEARCH
C-RED cameras enable all budgets to achieve high performance imaging.

ON-THE-FLY NUC

ON-THE-FLY CORRECTIONS
NUCs CAN BE APPLIED IN REAL TIME
Adaptive bias for C-RED 3, Extended Range specific corrections, dark optimisation for C-RED 2, and two-points NUC corrections for all cameras.

SWIR RANGE
TO COVER THE ENTIRE SWIR SPECTRUM
C-RED cameras integrate detectors that are based on different materials (InGaAs, ER InGaAs, MCT) sensitive to specific bands within the SWIR range.

USER FRIENDLY
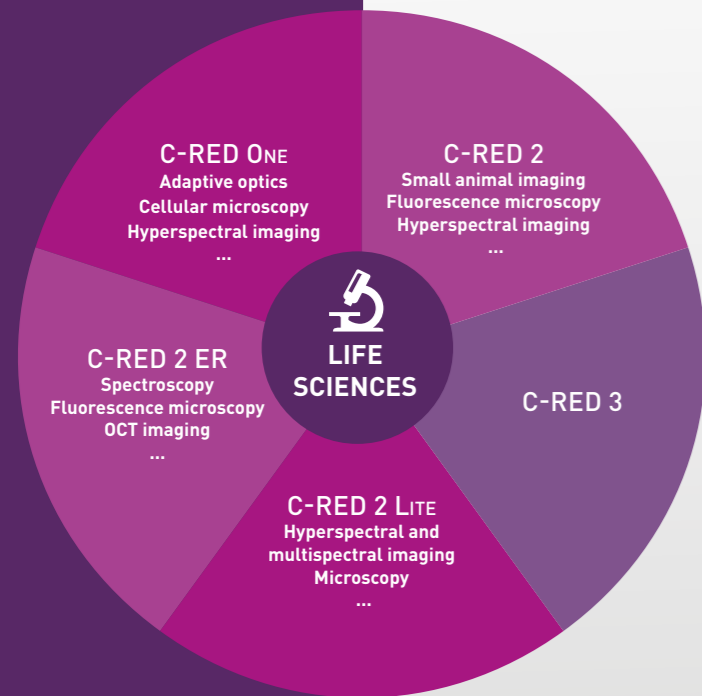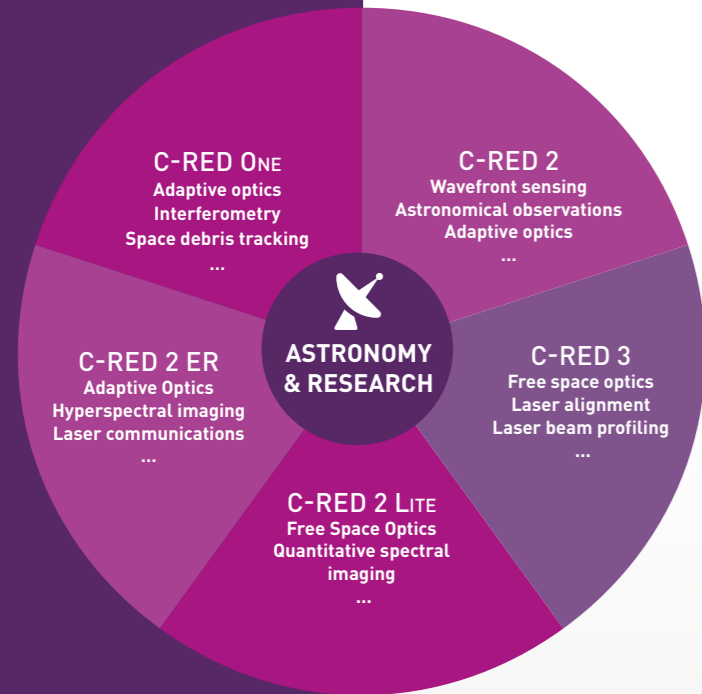**A SINGLE GUI AND SDK FOR ALL C-RED CAMERAS**
The Graphical User Interface and Software Development Kit provide all the functionalities to get the best out of your camera and develop your own software.

FIRST LIGHT
ADVANCED IMAGERY

First Light Imaging offers advanced imaging solutions for extremely low-light environment and real time applications to the world scientific and industrial communities.

From the infinitely large to the microscopic world, First Light Imaging will help you imaging science by constantly improving to use technology at its highest potential.

Our goal is to offer you the most innovative vision system to achieve your goals.

FIND THE BEST CAMERA FOR YOUR PROJECT

ASTRONOMY & RESEARCH

C-RED One
Adaptive optics
Interferometry
Space debris tracking
...

C-RED 2
Wavefront sensing
Astronomical observations
Adaptive optics
...

C-RED 2 ER
Adaptive Optics
Hyperspectral imaging
Laser communications
...

C-RED 3
Free space optics
Laser alignment
Laser beam profiling
...

C-RED 2 Lite
Free Space Optics
Quantitative spectral imaging
...

LIFE SCIENCES

C-RED One
Adaptive optics
Cellular microscopy
Hyperspectral imaging
...

C-RED 2
Small animal imaging
Fluorescence microscopy
Hyperspectral imaging
...

C-RED 2 ER
Spectroscopy
Fluorescence microscopy
OCT imaging
...

C-RED 3

C-RED 2 Lite
Hyperspectral and multispectral imaging
Microscopy
...

SURVEILLANCE

C-RED One

C-RED 2
Low visibility imaging
Fire prevention
Night vision
—

C-RED 2 ER
LiDAR
Long range imaging
Laser detection
—

C-RED 3
Thermography
Unmanned aerial vehicle
Maritime surveillance
—

C-RED 2 Lite
Thermography
Maritime surveillance
Security / night vision
...

INDUSTRY

C-RED One
Gas monitoring
Leak detection
Semiconductor inspection
—

C-RED 2
Semiconductor inspection
Quality/Production control
Food sorting
—

C-RED 2 ER
Multispectral imaging
Quality/Production control
Laser detection
—

C-RED 3
Non-destructive testing
Quality/Production control
Welding
—

C-RED 2 Lite
Additive manufacturing
Non destructive inspection
Laser beam profiling
...

Camera comparison

	C-RED 3 — COMPACT	C-RED 2 Lite — STABILIZED	C-RED 2 — VERSATILE	C-RED 2 ER 1.9 µm — EXTENDED RANGE 1.9 µm	C-RED 2 ER 2.2 µm — EXTENDED RANGE 2.2 µm	C-RED One — HIGH SPEED PHOTON COUNTING
	Small, compact, cost effective, available in OEM, C-RED 3 can be integrated in any system	A compact and robust TEC-cooled high-speed camera	Adapted to both short and long exposure times, it offers multiple possibilities for industry and science	To go beyond the cutoff wavelength of standard InGaAs	To see further in the infrared, with a high resolution VGA sensor	A unique camera for high-end scientific applications
Wavelength	900 – 1700 nm	900 – 1700 nm	900 – 1700 nm	1100 – 1900 nm	1300 – 2200 nm	800 - 2430 nm
Field of View, sensor type, pixel pitch	640 X 512 InGaAs 15 µm	640 X 512 InGaAs 15 µm	640 X 512 InGaAs 15 µm	640 X 512 Extended InGaAs 15 µm	640 X 512 Extended InGaAs 15 µm	320 X 256 e-APD MCT 24 µm
Peak QE	> 70%	> 70%	> 70%	> 70%	> 70%	> 60%
Frame rate (full frame)	600 FPS	600 FPS	600 FPS	600 FPS	600 FPS	3500 FPS
Readout noise	< 40 e-	< 30 e-	< 30 e-	< 45 e-	< 50 e-	< 1 e-
Dark current	N/A	N/A	< 600 e-/p/s	12 ke-/p/s (@-40°C)	120 ke-/p/s (@-40°C)	< 80 e-/p/s
Reading modes	CDS, NDR	CDS, NDR	CDS, NDR	CDS	CDS	Global reset, Rolling reset, Single, CDS or multiple NDR
Operating temperature	Ambiant	40°C to +60°C, 25°C ΔT between case and sensor	From ambiant to -40°C	-40°C	-55°C	-190°C (80K) or - 180°C (90K)
Cooling method	Optional cooling plate	TEC-cooled / Optional heat sinks and cooling plate	-15°C air / -40°C liquid (no LN)	-15°C air / -40°C liquid (no LN)	-15°C air / -55°C liquid (no LN)	Autonomous cryocooling
Dynamic	63 dB 93 dB with HDR mode	63 dB 93 dB with HDR mode	63 dB 93 dB with HDR mode	63 dB	63 dB	N/A
Quantization	14 bits	14 bits	14 bits	14 bits	14 bits	16 bits
SWaP (Size, Weight and Power consumption)	H55 x W55 x L60 mm 0.230 kg 6.5W typical	H65 x W65 x L78.1 mm 0.460 kg 20W Max	H55 x W75 x L140 mm 0.9 kg up to 90W	H55 x W75 x L140 mm 0.9 kg Up to 90W	H55 x W75 x L140 mm 0.9 kg up to 90W	H238 x W180 x L365 mm 19.4 kg up to 300W
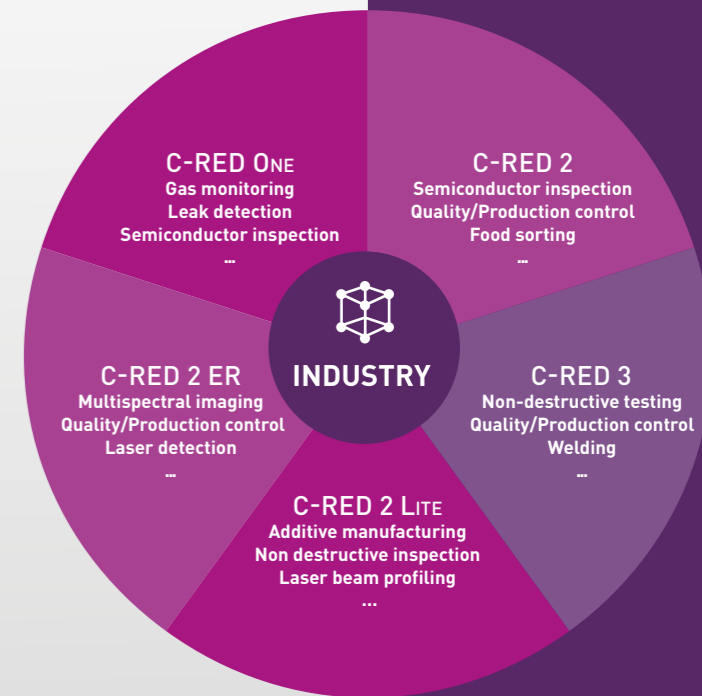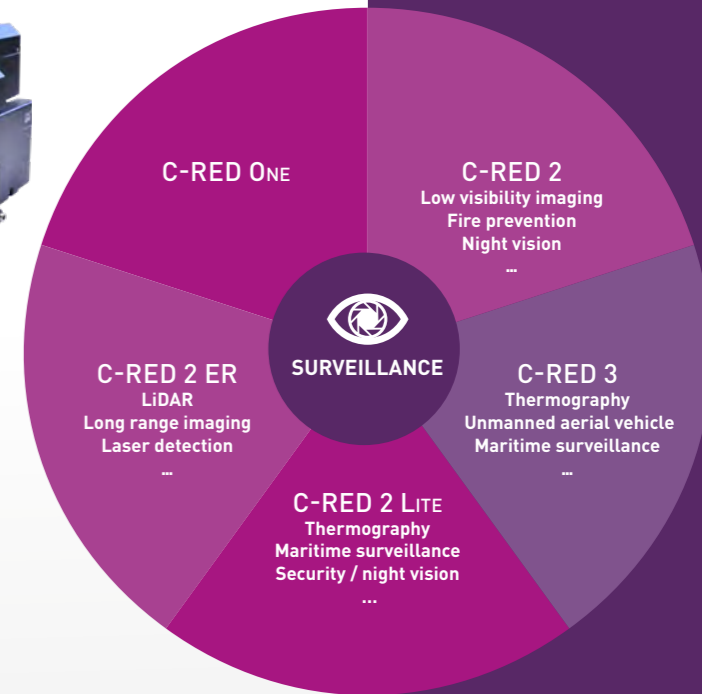
CDS = Correlated Double Sampling
NDR = Non Destructive Readout
LN = Liquid Nitrogen

# HIGHLIGHTS

C-RED 3

C-RED 2 LITE

ADAPTIVE BIAS
WITH C-RED 3 AND C-RED 2 LITE

1

Dark current level depends on temperature and integration time. First Light Imaging developed a modeling theory based on the expected physical behavior of the sensor: a bias frame is autonomously computed and subtracted on-the-fly when operating conditions vary.


Raw image | With adaptative bias

HIGH DYNAMIC RANGE
WITH C-RED 2, C-RED 2 LITE & C-RED 3
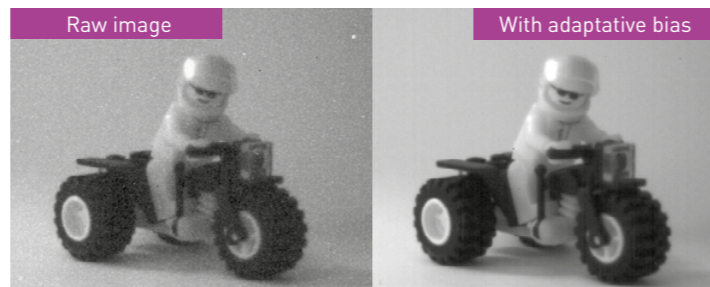
2

High Dynamic Range (HDR) is a mode in which the signal from two capacitors is linearly combined to form one single frame with higher dynamics.
The maximum framerate is not affected.
There are many advantages to combine images from two different cap acitors in the same frame:

For low light illuminated areas:
the camera uses the signal from the High gain capacitor which has the lowest noise.

High gain | HDR mode
SATURATION | NO SATURATION
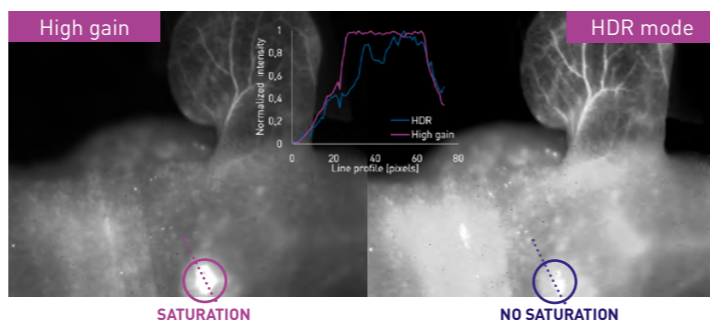
For highly illuminated areas:
the camera uses the signal from the Low gain capacitor which has the highest storage capacity.
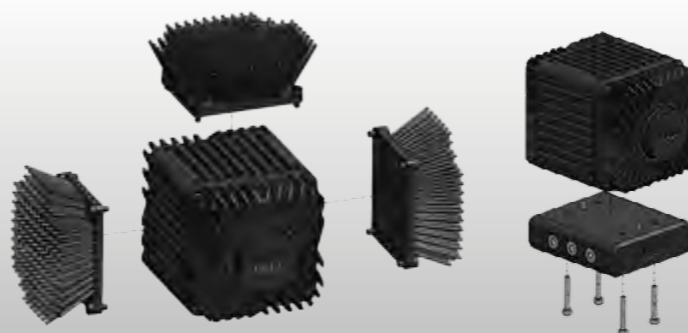

THERMAL MANAGEMENT
WITH C-RED 2 LITE

3

The performances of InGaAs sensors depend on temperature. C-RED 2 LITE offers a wide range of thermal management solutions to get the best compromise between compactness and efficiency:

•Temperature stabilization algorithm
•Passive heat sinks
•Heat sinks with integrated fan
•Hydraulic cooling system

C-RED 2

LONG EXPOSURE OPTIMIZATIONS
WITH C-RED 2

4

Your acquisition at long exposure times can be optimized in 4 easy steps:

1 Cool down your C-RED 2 camera to -40°C
2 Apply on-the-fly dark correction
3 Tune the "darkoptim" parameter to optimize Signal-to-Noise ratio
4 Use the "long exposure" mode to remove defective pixels, and if necessary, manually edit your bad pixel map.
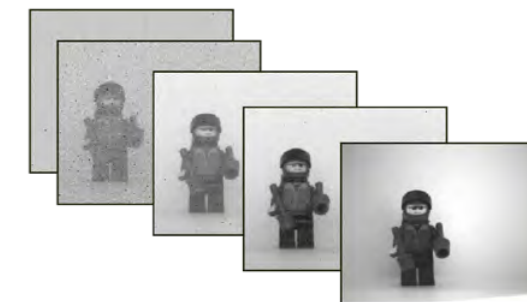
C-RED 2 ER

### HIGH QUALITY IMAGING IN EXTENDED RANGE SWIR
WITH C-RED 2 ER

5

Standard InGaAs has a long cutoff wavelength of 1700 nm. Introducing more Indium into GaAs enables the detection of longer wavelengths, this is called "extended wavelength InGaAs".
Variation in the substrate composition results in lattice-mismatch artefacts, which degrade image quality. First Light Imaging has developed a specific correction to compensate the artefacts on-the-fly.


C-RED 2 ER 1.9 µm | C-RED 2 ER 2.2 µm
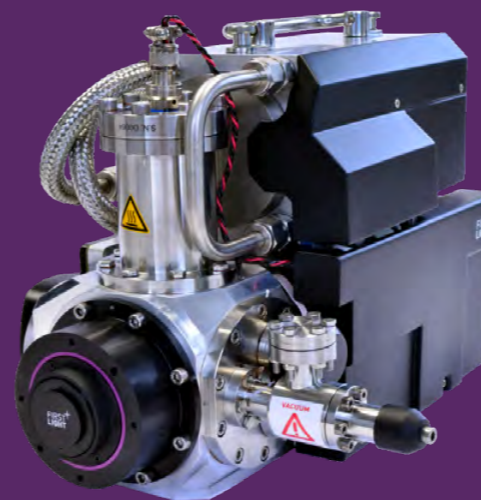
C-RED ONE

SIMULTANEOUS 3500 FPS FF & <1e- RON
WITH C-RED ONE

6

First Light Imaging's C-RED One infrared camera is capable of capturing up to 3500 full frames per second with a subelectron readout noise and very low background. This breakthrough has been made possible thanks to the use of an e-APD infrared focal plane array. One of the advantage of this sensor is its extremely good cosmetics, even when high gain is applied. C-RED One targets high-end scientific applications.

Lighter spark detection - 3500 FPS full frame
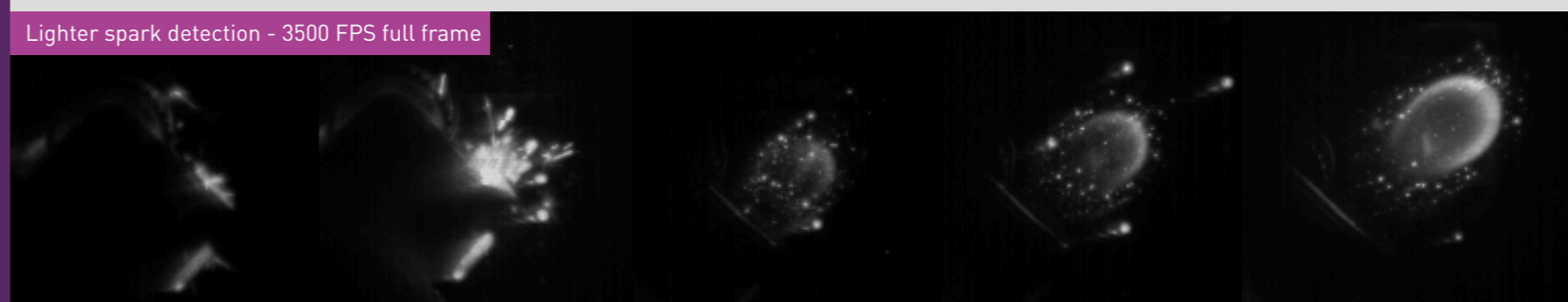
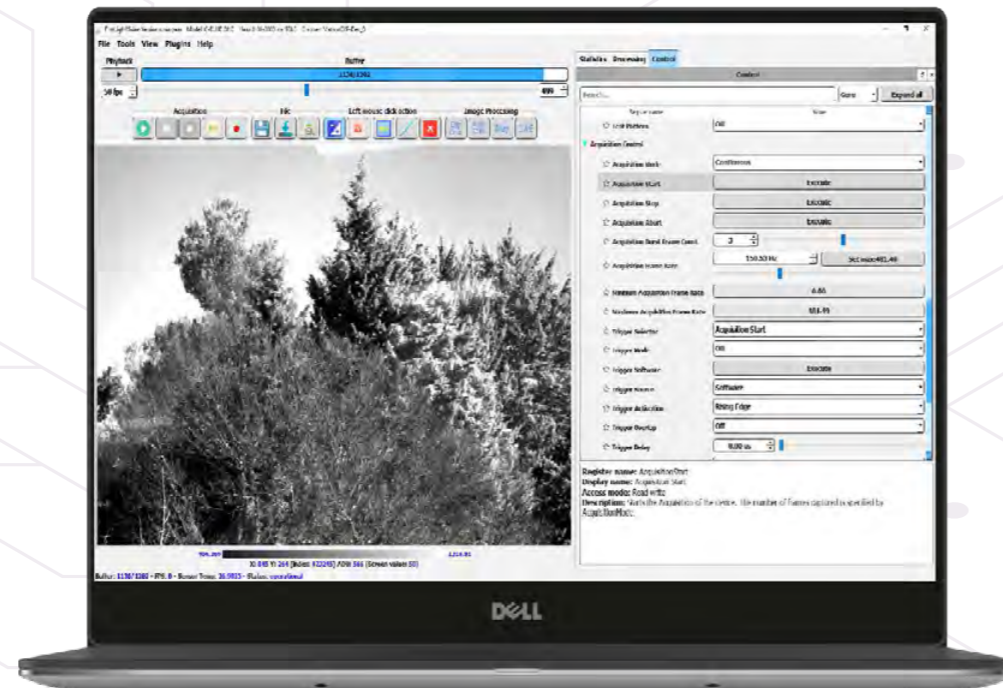**SOFTWARE**

GRAPHICAL USER INTERFACE

FIRST LIGHT VISION, A SINGLE GUI FOR ALL C-RED CAMERAS.

Our GUI offers a user-friendly environnement and advanced tools for high end applications: on-the-fly corrections, real time monitoring, statistical analysis, image processing, thermography display and many more...

Extensive plugins for advanced use

Automatic camera detection

Interactive windows

User friendly

CROSS-PLATFORM:
• Windows® 10
• Linux® Ubuntu 16.04 LTS & 18.04 LTS
• NVIDIA® Jetson Tx2, Xavier NX et Nano

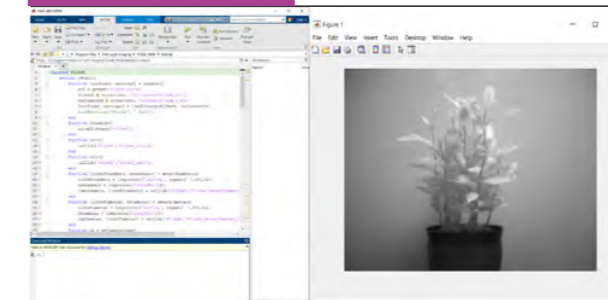MULTIPLE INTERFACES:
• USB 3
• Camera Link®
• CoaXPress 2.0

SOFTWARE DEVELOPPEMENT KIT

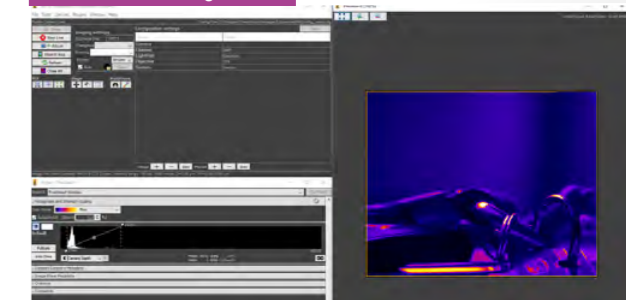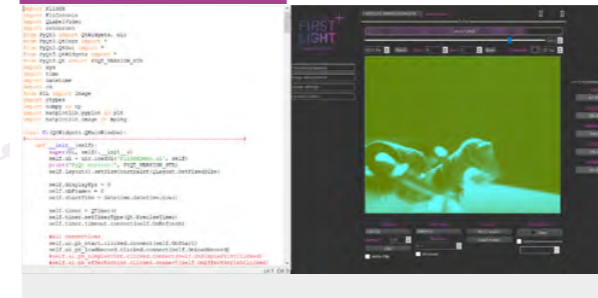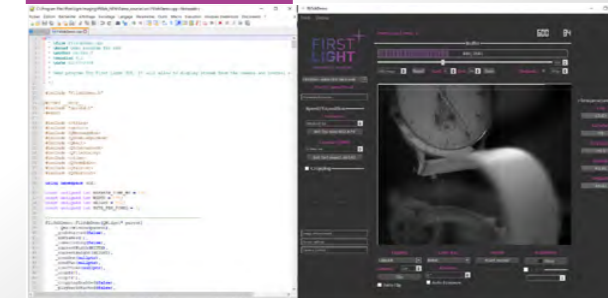**A UNIQUE SDK FOR ALL C-RED CAMERAS.**

LabView
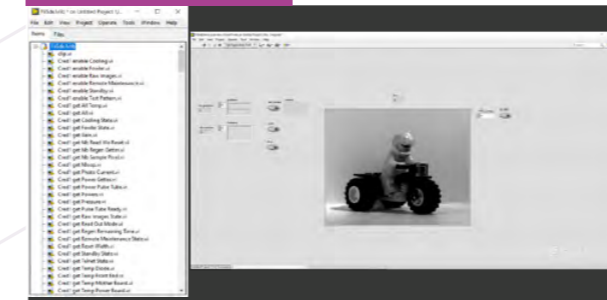
MATLAB

MicroManager

Python

C/C++

MULTI GRABBERS:
• MATROX Radient eV-CL Camera Link®
• EDT Vision Link F4 Camera Link®
• EURESYS Grablink Full
• BITFLOW Axion 1XE
• PLEORA GigE Vision® 2.0 over 10 GigE
(External grabber for Camera Link®)

DEMO CODES PROVIDED IN:
• C/C++
• MATLAB
• Python

INTERFACES PROVIDED FOR:
• LabVIEW
• MicroManager

GO FOR IT!

Choose your C-RED camera and make the invisible visible

Today, observatories, universities research institutes, and industrials on 4 continents have given us their trust

THANK YOU TO OUR PARTNERS AND CUSTOMERS

First Light Imaging SAS
Europarc Sainte Victoire Bât 5, Route de Valbrillant, Le Canet 13590
Meyreuil FRANCE
Tel.: + 33 4 42 61 29 20
www.first-light-imaging.com
contact@first-light.fr

First Light Imaging Corp.
185 Alewife Brook Parkway, Suite 210, Cambridge, MA 02138 USA
www.first-light.us

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