

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. C-RED 2 and C-RED 3 are based on InGaAs detectors. Varying the fraction of indium allows to tune the sensitivity range and create "extended range" InGaAs detectors. HgCdTe (also referred 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



C-RED One
MCT e-APD sensor
800 - 2430 nm



C-RED 2
InGaAs sensor
900 - 1700 nm



C-RED 2 ER
Extended InGaAs sensor
1300 - 2200 nm



C-RED 3
InGaAs sensor
900 - 1700 nm



UV = Ultraviolet
VIS = Visible
NIR = Near InfraRed
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



WHY CHOOSING A C-RED CAMERA?

FULL
FRAME

HIGH SPEED

C-RED CAMERAS ARE THE FASTEST IN THEIR CATEGORY

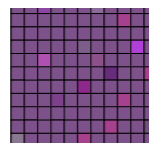
600 FPS Full Frame for our InGaAs VGAs and 3500 FPS Full Frame for our e-APD MCT QVGA, and even faster in cropping mode.

e⁻

ULTRA LOW NOISE

C-RED CAMERAS OFFER THE LOWEST NOISE POSSIBLE

From subelectron readout noise for the amazing C-RED One to below 30 electrons readout noise for our C-RED 2 and C-RED 3.



LOW DARK

OPTIMIZATION FOR ALL CAMERAS

Our engineers have worked hard to optimize dark current for all C-RED's models. Specific hardware tuning for long exposure times is available for C-RED 2.

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

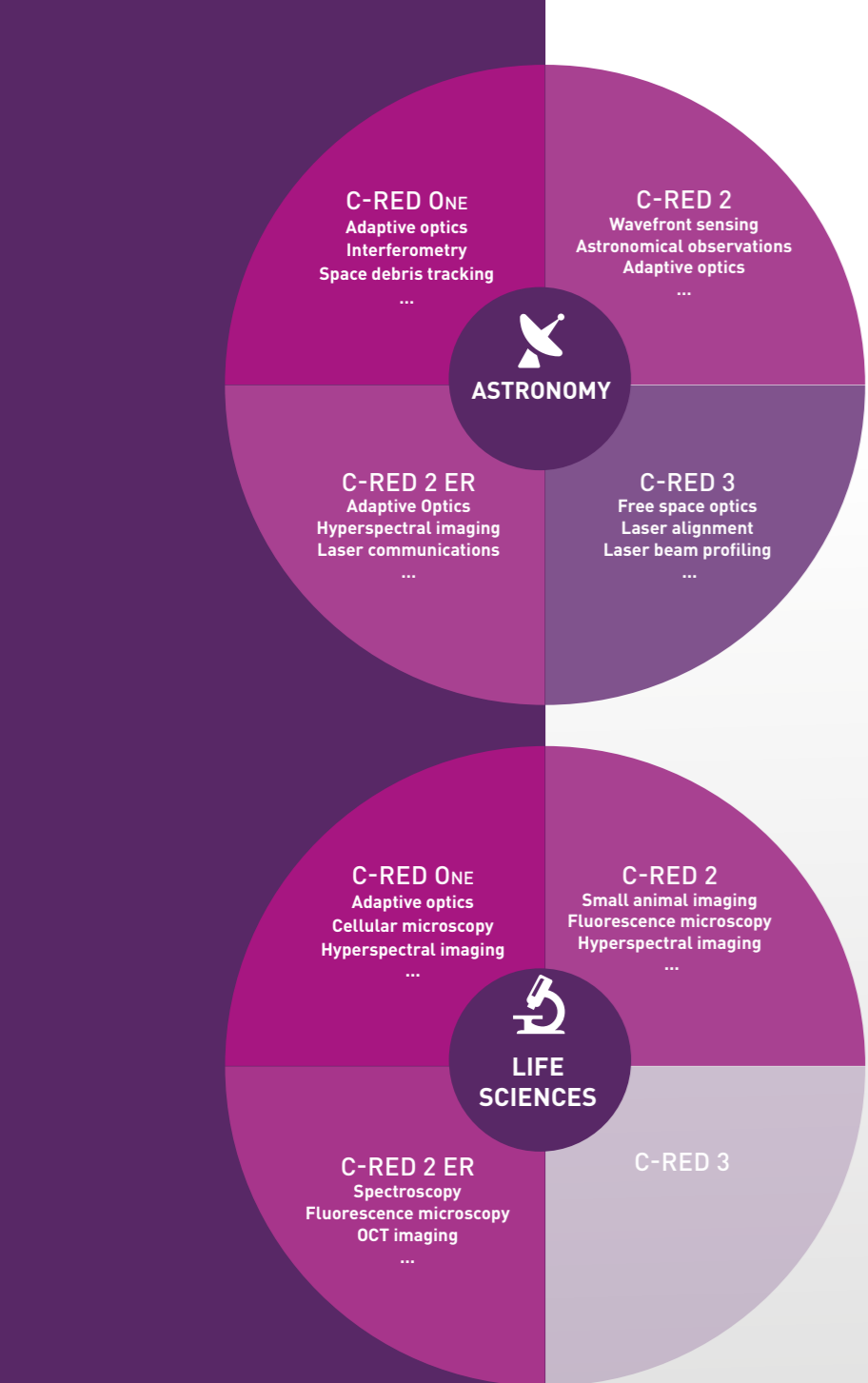
The Graphical User Interface and Software Development Kit provide all the functionalities to get the best out of your camera and develop your own software.



First Light 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

Wavelength
Field of View, sensor type, pixel pitch
Peak QE
Frame rate (full frame)
Readout noise
Dark current
Reading modes
Operating temperature
Cooling method
Dynamic
Quantization
SWaP (Size, Weight and Power consumption)

C-RED 3



COMPACT

Small, compact, cost effective, available in OEM, C-RED 3 can be integrated in any system

900 – 1700 nm
640 X 512 InGaAs 15 µm
> 70%
600 FPS
< 40 e-
N/A
CDS, NDR
Ambiant
Cooling adapter available for thermal regulation
63 dB 93 dB with HDR mode
14 bits
H55 x W55 x L60 mm 0.230 kg 6.5W typical

C-RED 2



VERSATILE

Adapted to both short and long exposure times, it offers multiple possibilities for industry and science

900 – 1700 nm
640 X 512 InGaAs 15 µm
> 70%
600 FPS
< 30 e-
< 600 e-/p/s
CDS, NDR
From ambient to -40°C
-15°C air / -40°C liquid
63 dB 93 dB with HDR mode
14 bits
H55 x W75 x L140 mm 0.9 kg up to 90W

C-RED 2 ER



EXTENDED RANGE

To see further in the infrared, with a high resolution VGA sensor

1300 – 2200 nm
640 X 512 Extended InGaAs 15 µm
> 70%
600 FPS
< 60 e-
N/A
CDS
-55°C
Liquid (no LN)
63 dB
14 bits
H55 x W75 x L140 mm 0.9 kg up to 90W

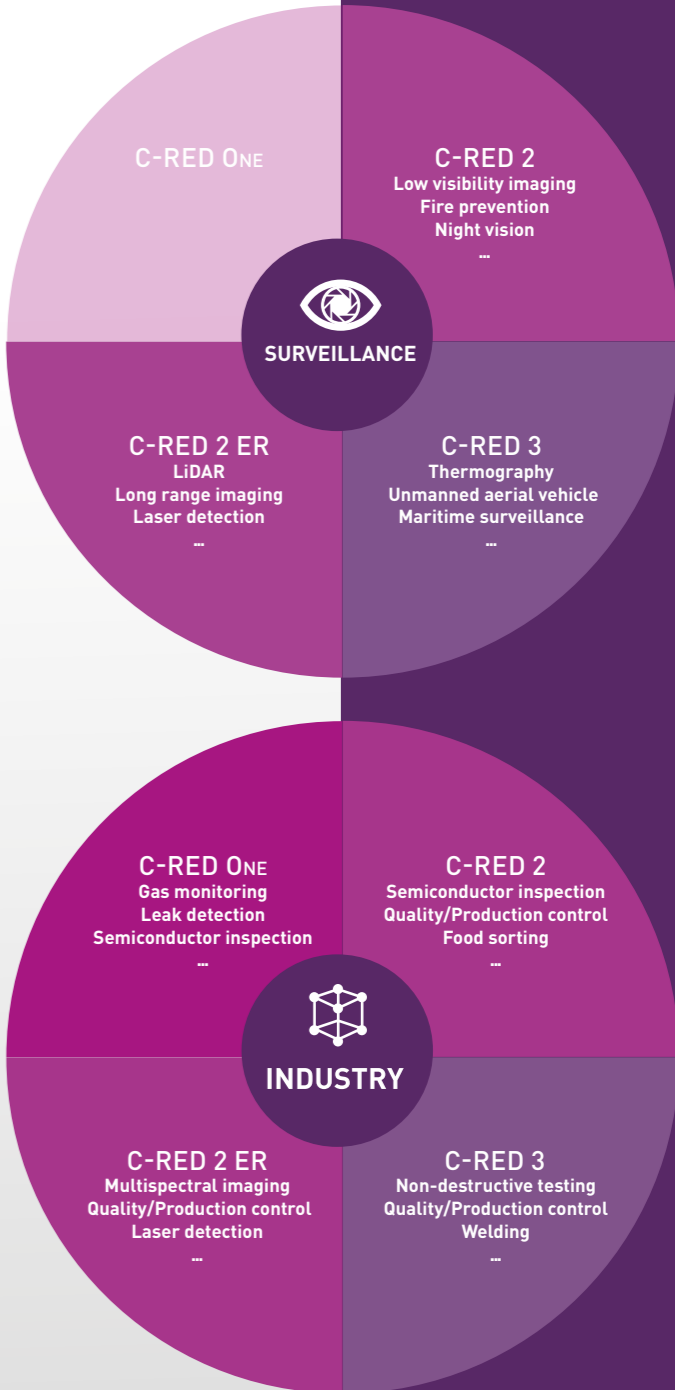
C-RED ONE



HIGH SPEED PHOTON COUNTING

A unique camera for high-end scientific applications

800 - 2430 nm
320 X 256 e-APD MCT 24 µm
> 60%
3500 FPS
< 1 e-
< 80 e-/p/s
Global reset, Rolling reset, Single, CDS or multiple NDR
-200°C (80K)
Autonomous cryocooling
N/A
16 bits
H238 x W180 x L365 mm 19.4 kg up to 300W



CDS = Correlated Double Sampling
NDR = Non Destructive Readout
LN = Liquid Nitrogen

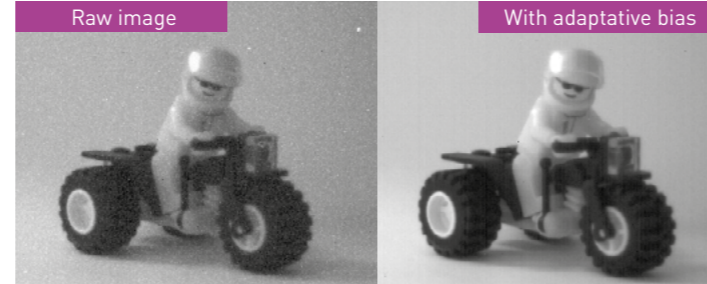
C-RED 3



1

ADAPTIVE BIAS
WITH C-RED 3

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.



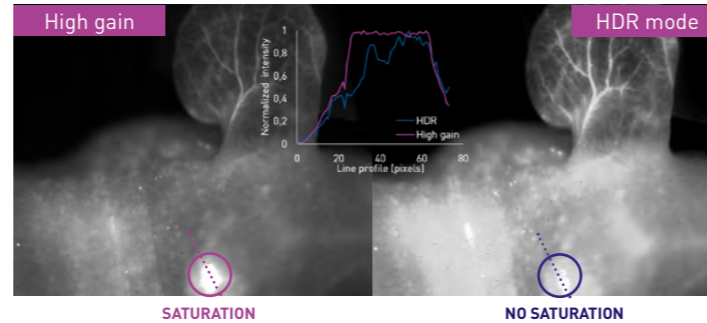
2

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

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 capacitors in the same frame:

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



For highly illuminated areas:
the camera uses the signal from the Low gain capacitor which has the highest storage capacity.

C-RED 2

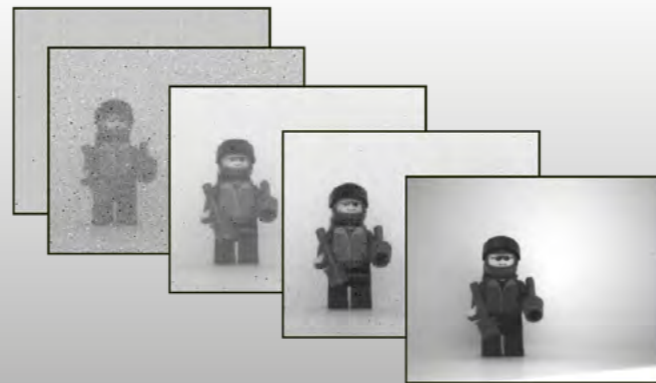


3

LONG EXPOSURE OPTIMIZATIONS
WITH C-RED 2

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.



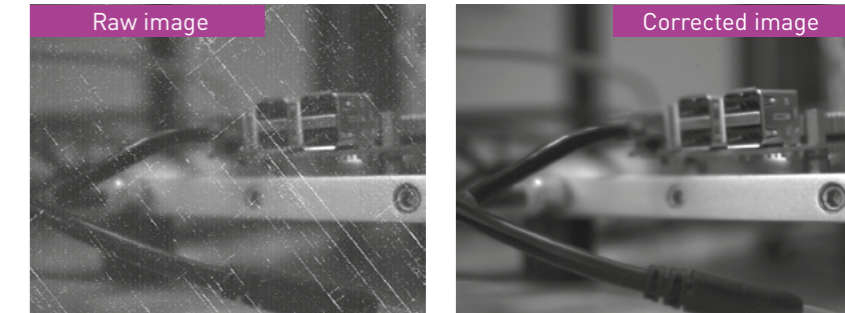
C-RED 2 ER



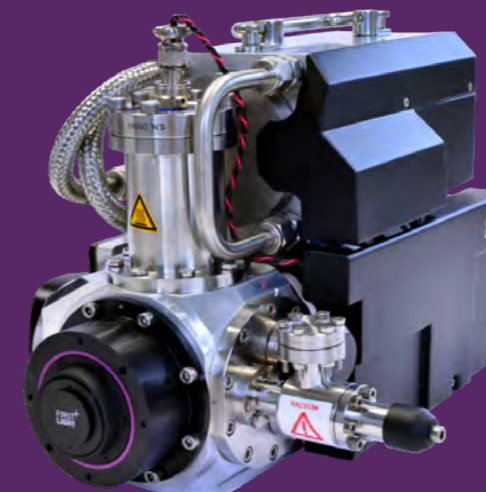
4

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

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 ONE

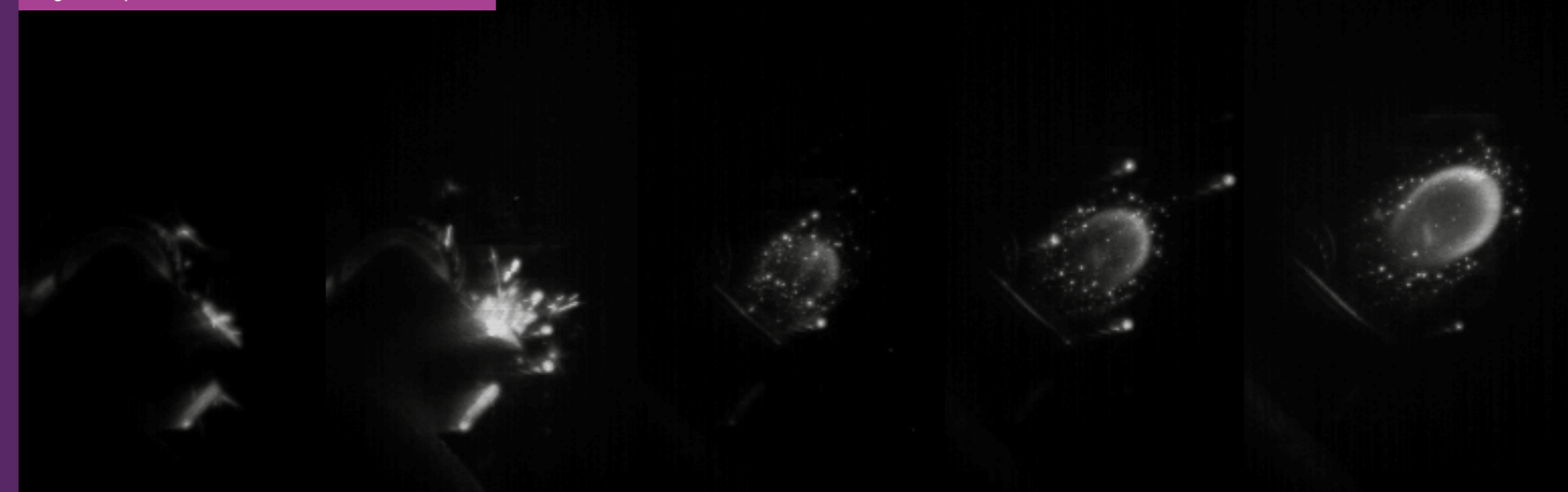


5

SIMULTANEOUS 3500 FPS FF & $<1\text{e-}$ RON
WITH C-RED ONE

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

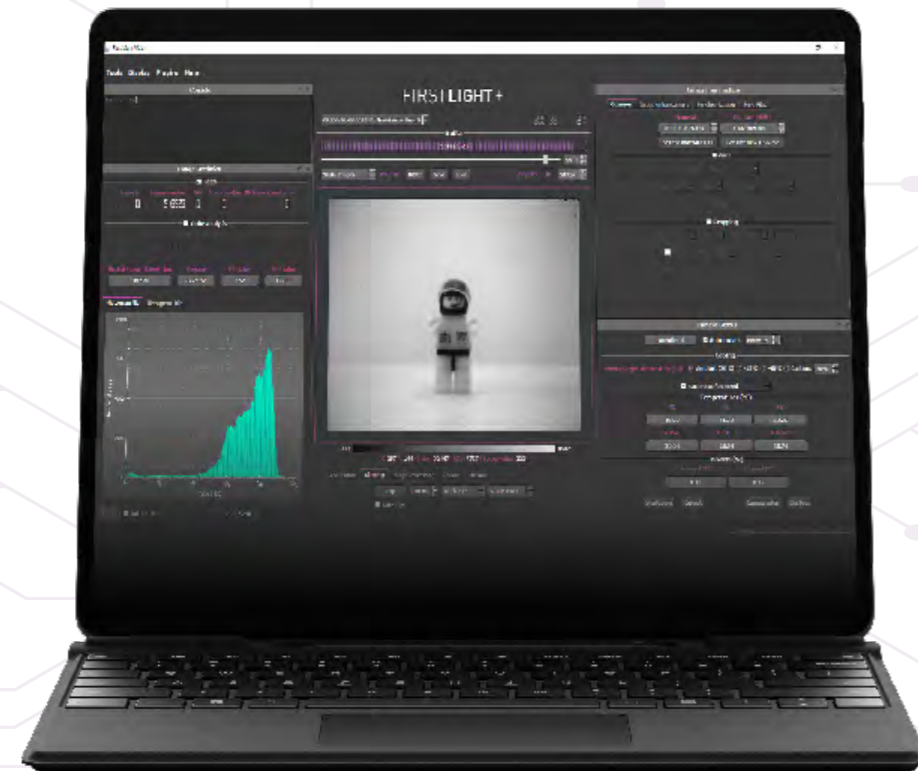
FIRST LIGHT VISION, A SINGLE GUI FOR ALL C-RED CAMERAS.

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



CROSS-PLATFORM:

- Windows
- Linux
- NVIDIA Jetson

MULTIPLE INTERFACES:

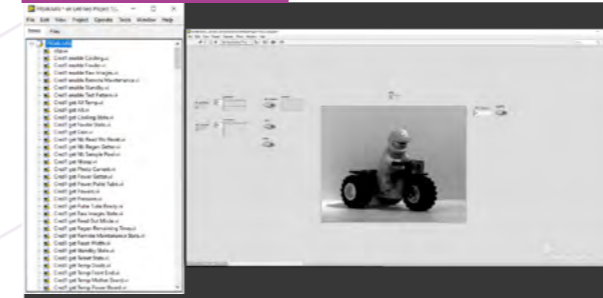
- USB
- Camera Link
- CoaXpress

User friendly

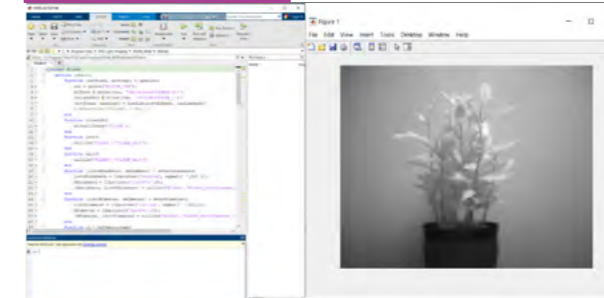
SOFTWARE DEVELOPPEMENT KIT

A UNIQUE SDK FOR ALL C-RED CAMERAS.

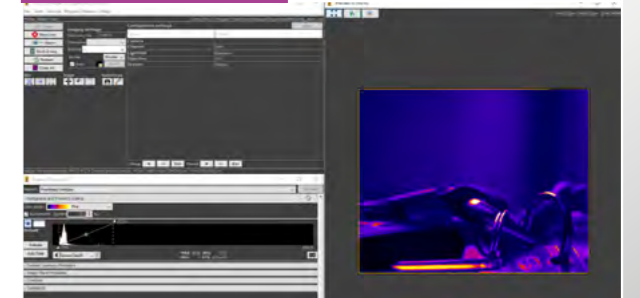
LabView



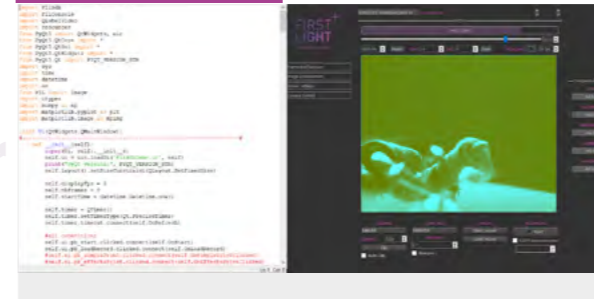
MATLAB



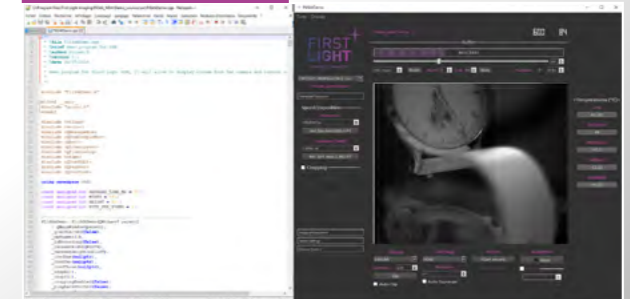
MicroManager



Python



C/C++



MULTI GRABBERS:

- Matrox
- EDT
- Spera...

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



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