Generic open-source frameworks to integrate and control infrared sensors : from laboratory standard experiments to real field measurements

18th International Conference on Quantitative InfraRed Thermography
30 June 2026 – Session “Image & Data Processing I”

Thibaud Toullier [1]
thibaud.toullier@univ-eiffel.fr

Jean Dumoulin [1]
jean.dumoulin@univ-eiffel.fr

[1] Université Gustave Eiffel, Inria, COSYS-SII, I4S Team, F-44344 Bouguenais, France

BRIGHTER has received funding from the Chips Joint Undertaking (JU) under grant agreement No 101096985. The JU receives support from the European Union's Horizon Europe research and innovation program and France, Belgium, Portugal, Spain, Turkey.

Contents

Different cameras and brands

- Various communications interfaces and protocols
  - generic protocol **at best** (GenICam ®),
  - vendor specific SDK,
  - proprietary software

Needs efforts to

- Integrate custom algorithms
- Make reproducible laboratory experiments / pipeline

⚠ | But

Most cameras have same functionalities

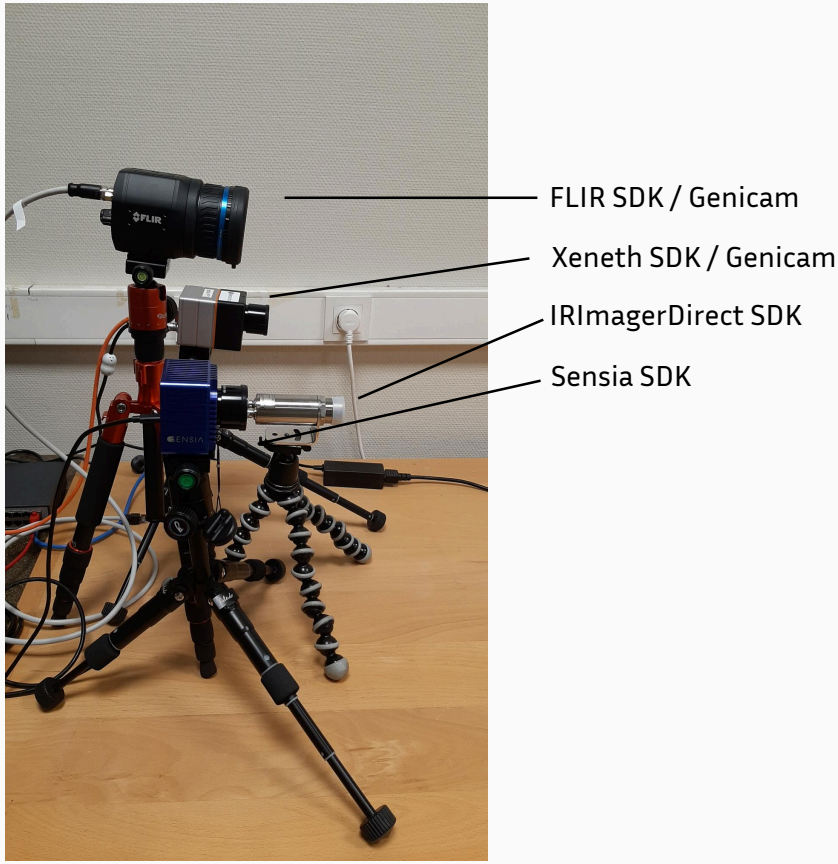


Figure 1: Different models & different SDKs

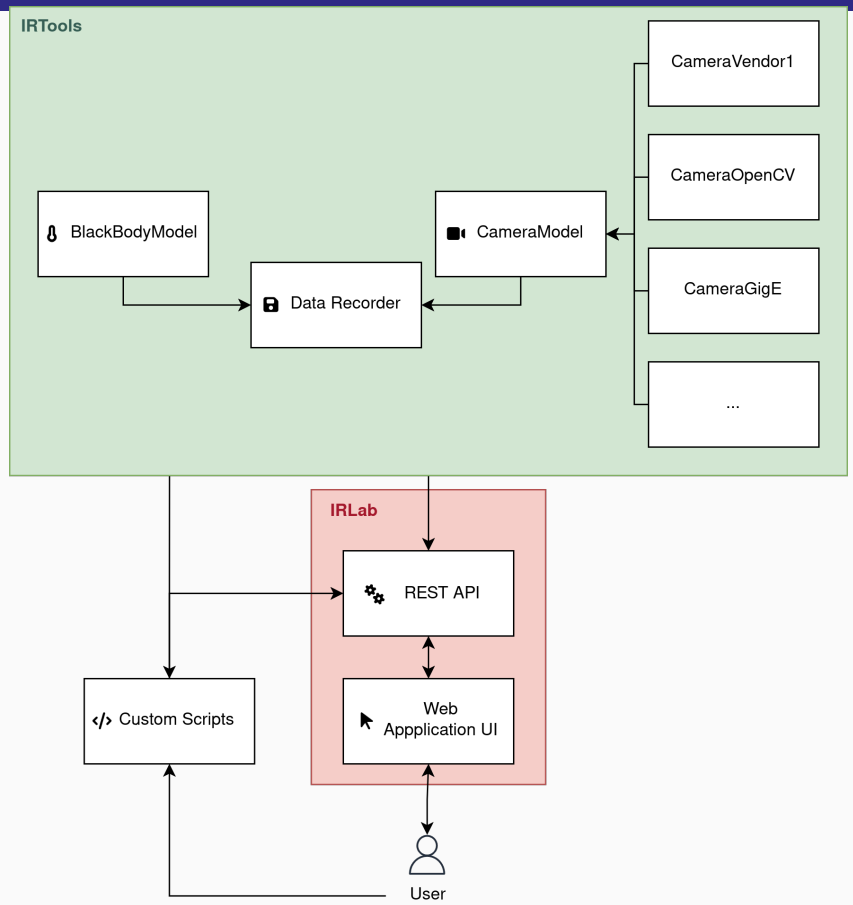
Past tools

- **IRLaw**[1]
  - focused on laboratory experiments (NDT, ...)
  - extended to outdoor applications
  - RTSP streaming capabilities
- **Cloud2IR**[2]
  - asynchronous system
  - focused on using standards (OGC, GenICam®, HDF5, ...)

IRTools & IRLab

- Learn from previous tools
- **Generic Python API + REST API**
- **Web-based User Interface (UI)**

- **New standards**
  - WebRTC / RTSP
  - HDF5 / Zarr
  - **Easy Deployment**



[1] J. Dumoulin and R. Averty, "Development of an infrared system coupled with a weather station for real time atmospheric corrections using GPU computing: Application to bridge monitoring," in *Proc of 11th International Conference on Quantitative InfraRed Thermography, Naples Italy*, 2012.

[2] A. Crinière, J. Dumoulin, and L. Mevel, "Management of Local Multi-Sensors Applied to SHM and Long-Term Infrared Monitoring: Cloud2IR Implementation," *Quantitative InfraRed Thermography Journal*, vol. 0, no. 0, pp. 1–19, Oct. 2018, doi: 10.1080/17686733.2018.1519752.

IRTools is a **Python module** made to handle specifically — *but not only* — infrared cameras. It provides a **generic API**, simply based on an abtract camera class.

One module to rule them all!

Camera Features (inspired from GenICam® and OpenCV)

- Automatic cameras discovery,
- Asynchronous,
- Recording,
- Parameters read & write,
- Streaming,
- Autofocus
- ...

> **i | Info**
>
> Once the camera vendor has an implementation, all the features are made available!

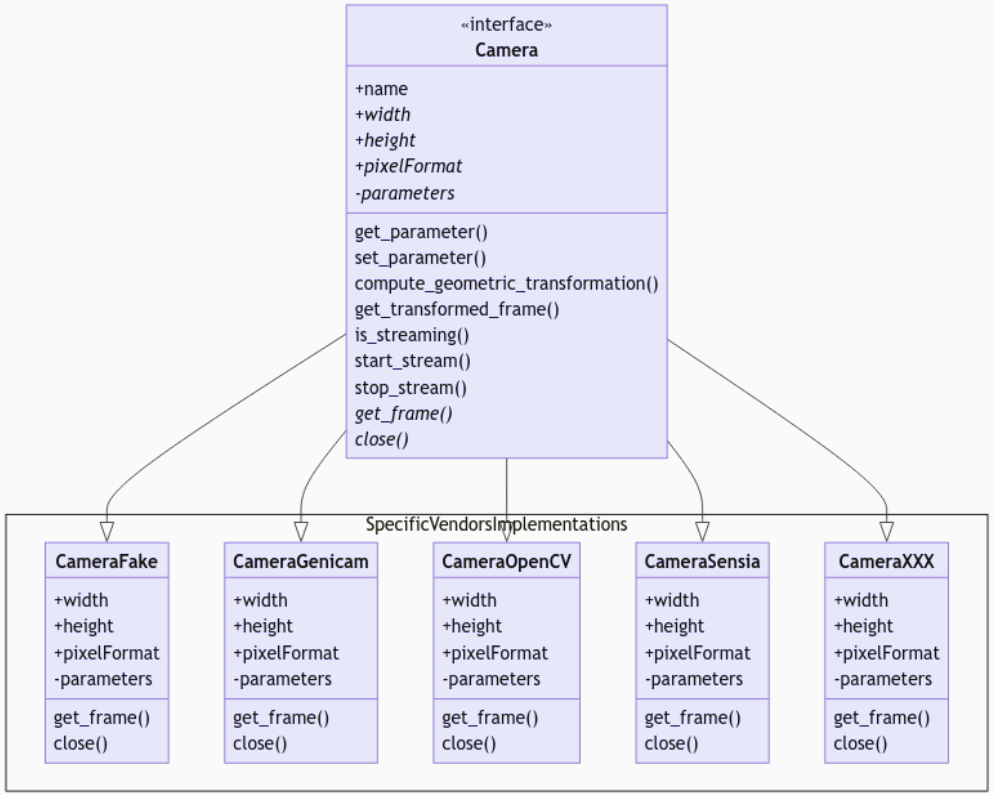


Figure 3: Principle of the architecture of a generic camera API

Why Python?

- many libraries available
- widely used among scientists
- easy to wrap existing code, even for C/C++ SDKs `ctypes`.

Thanks to `irtools` Python module we can:

- create codes that are compatible with different cameras
- avoid to switch between softwares
- integrate more easily new cameras with already existing code base.
- Implement reproducible experiments

Python code example

```python
import asyncio
from irtools.camera import discover

cameras = asyncio.run(await discover())

for camera in cameras:
  print(camera) # show available cameras

camera = cameras[1].get()
```

Automatic discovery of available cameras

Show detected cameras

Use camera

Result

```bash
Aravis/Fake : @25.0FPS (512 x 512) - format: 17301505  -
OpenCV : @27.0FPS (382.0 x 290.0) - format: 16.0  - port: 1
OpenCV : @30.0FPS (640.0 x 480.0) - format: 16.0  - port: 2
Sensia SN#XXXXXXXX : (382 x 288) -  - port: USB/1
```

Derive an object from `irtools.camera.Camera`

```python
class DemoCamera(Camera):
    _counter: int = 0

    def __init__(self):
        super().__init__(name="Demo")

    def get_frame(self):
        self._counter += 1
        return (
            np.random.rand(500,500),
            {"counter": self._counter},
        )

    def close(self):
        pass
```

Give a name

Implement `get_frame` abstract method

Implement `close` abstract method

[optional] Implement discovery method(s)

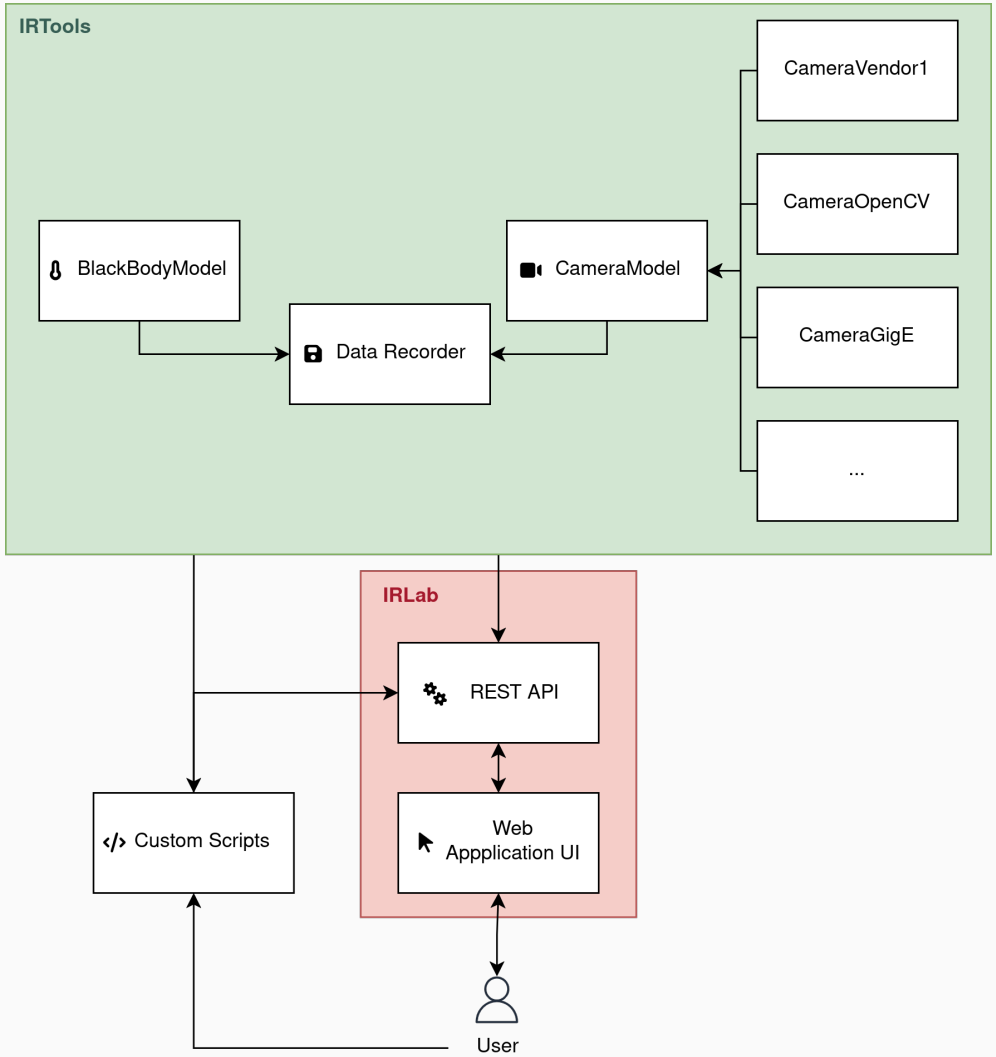
```python
@discovery_method
async def discover() -> CameraSummary:
    pass
```

> **i | Info**
>
> The discovery methods are automatically registered by `irtools` and enable the camera to be listed among others.

Currently implemented protocols / libraries / SDK

- OpenCV
- GenICam® (through Aravis library) ⟹ compliant with Teledyne FLIR
- EvoCortex SDK (Optris)
- [⚠️ WIP] Sensia SDK
- [⚠️ WIP] Xeneth SDK (Xenics)
- ...

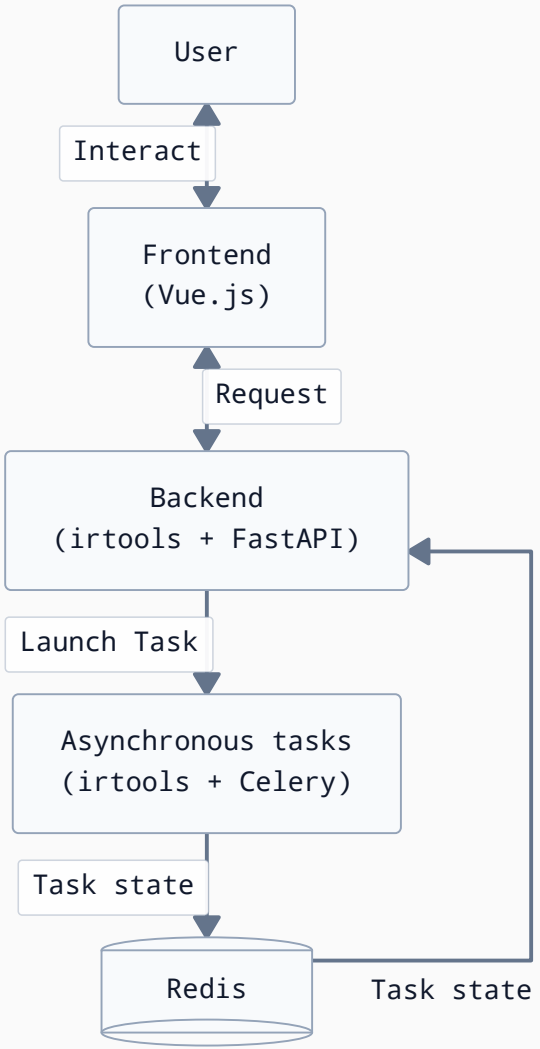
- IRTools provides the core functionalities
- IRLab will operate and manage this functionalities



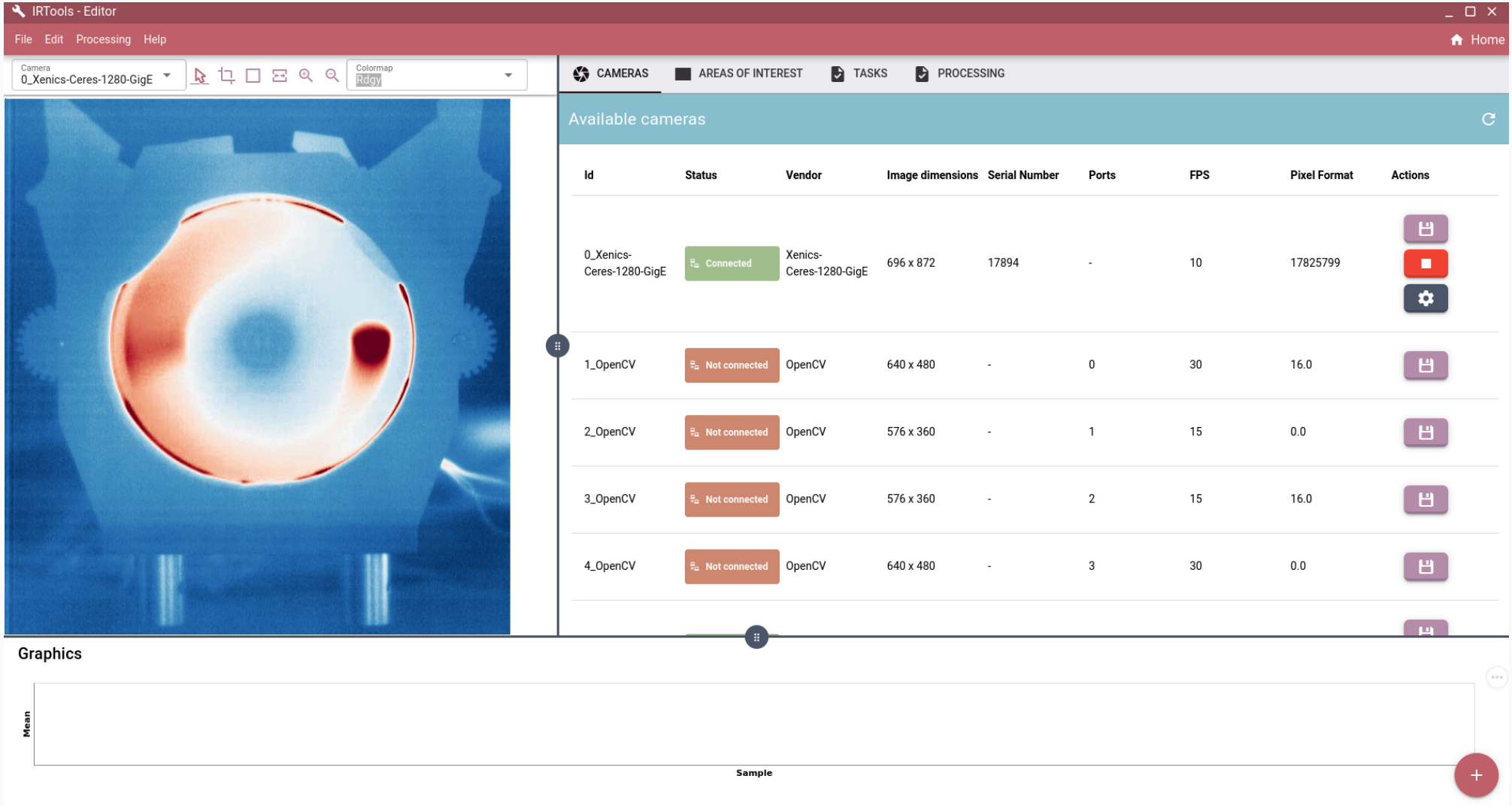
IRLab

A **modern** server to communicate with cameras through a **REST API** and a **user interface** using the IRTools python API;

- Compatible with all platforms (Web interface)
- REST API to communicate with any camera (OpenAPI compatible)
- Remote camera control
- Camera Streaming (WebRTC)
- Images / Sequences recording (various images formats, `hdf5`, ...)
- Custom procedures
- ...



Screenshots – Streaming moving target



Screenshots – Recording

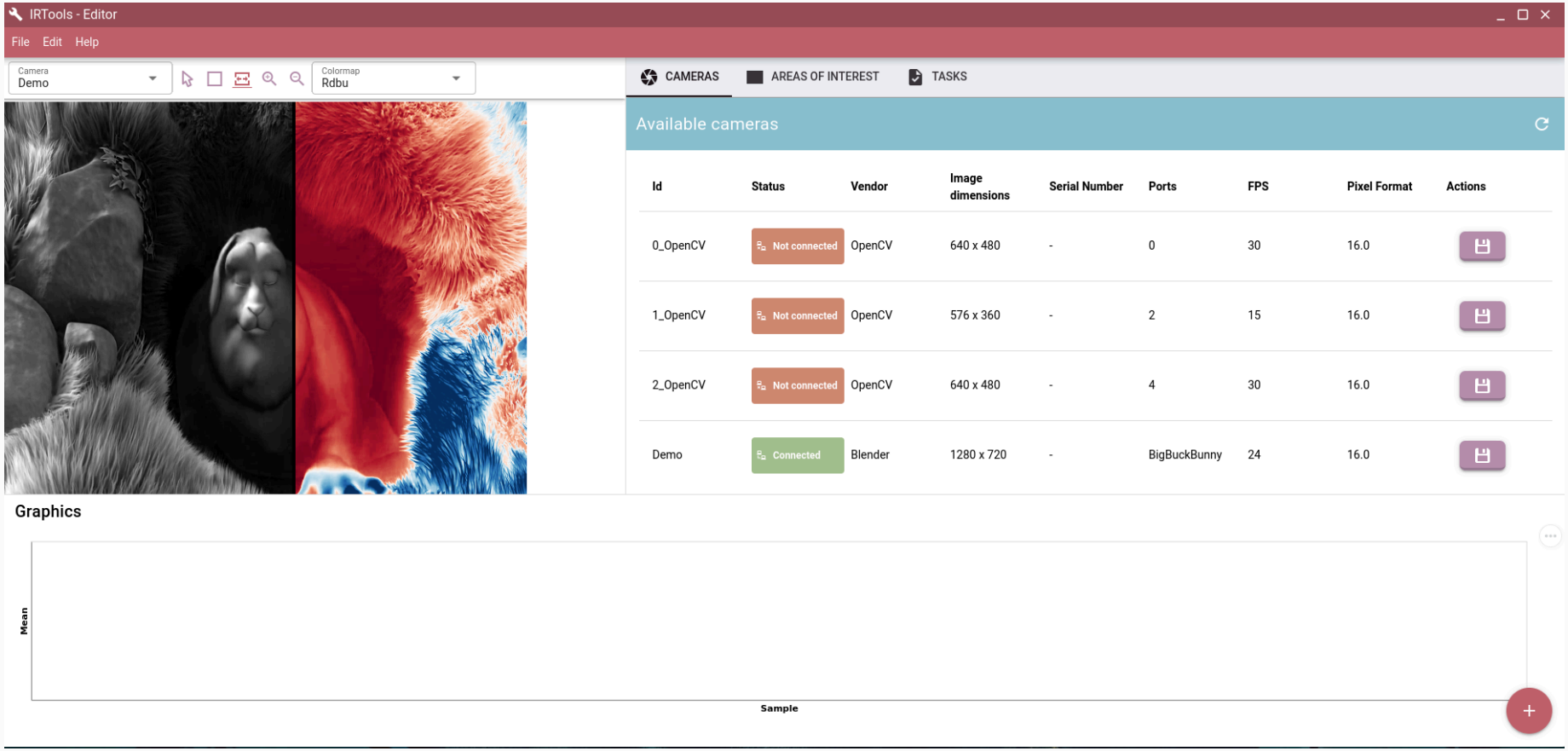
Not only useful for laboratory but also for real site implementations

- Scheduled recording
- Acquisition frequency
- Recording frequency
- Compliant with instrumentation system supervisor[1]
- HDF5 data recording including metadata

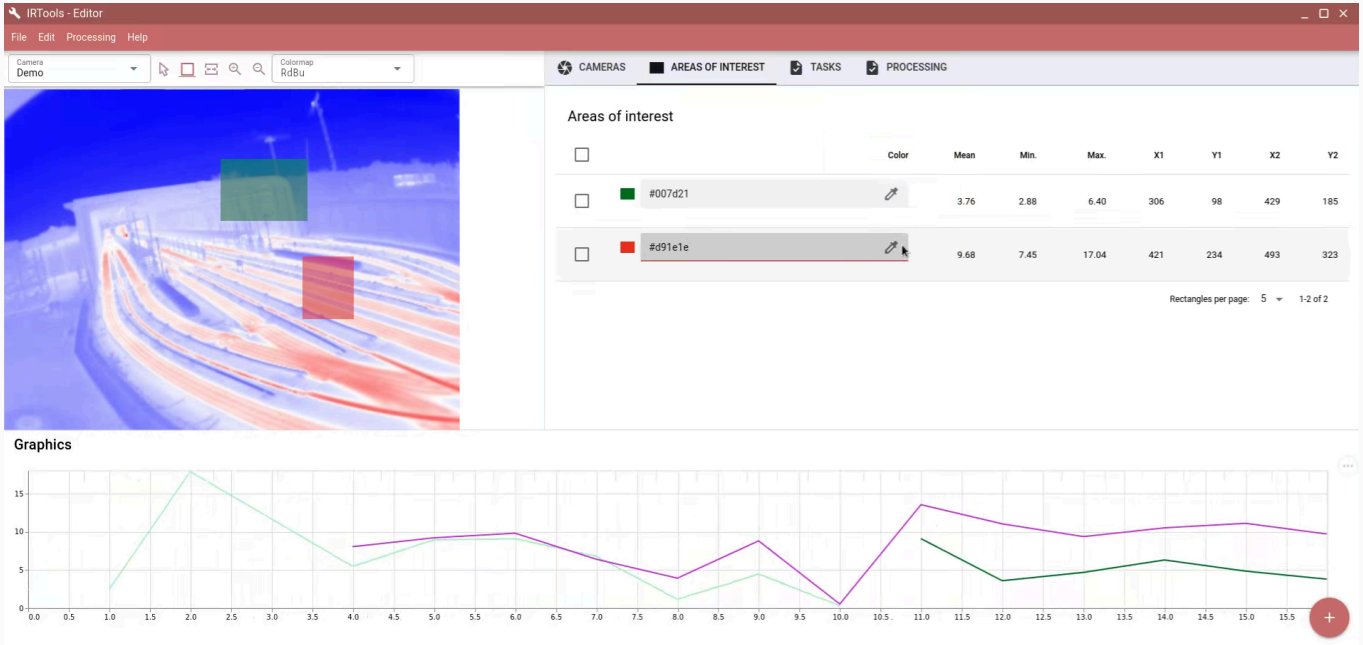
[1] [3] T. Toullier, A. Bouché, and J. Dumoulin, "Design and study of an instrumentation and software for permanent monitoring of a cable-stayed bridge," in *Proceedings*, in Proceedings. Cartagena de Indias, Colombia, Dec. 2023, pp. 1–8. [Online]. Available: https://inria.hal.science/hal-04303006

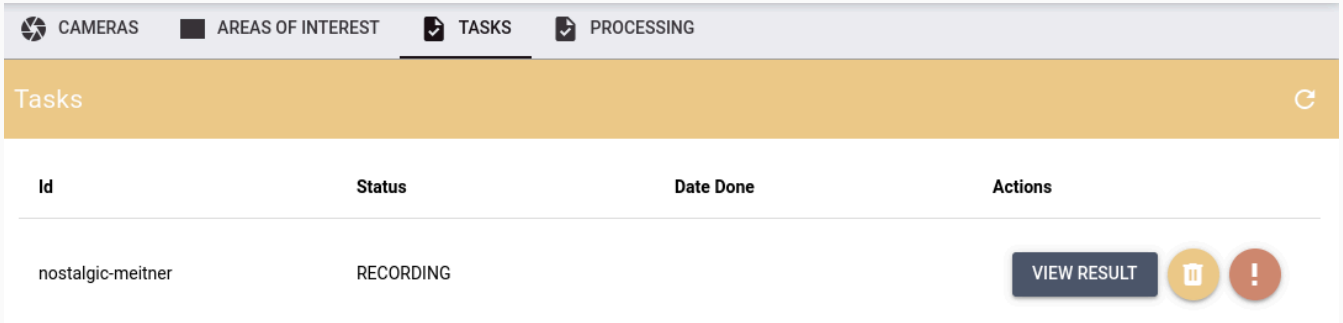
Same image, two colormaps instantaneous results

- Useful to quickly test impact of colormaps for visual analysis

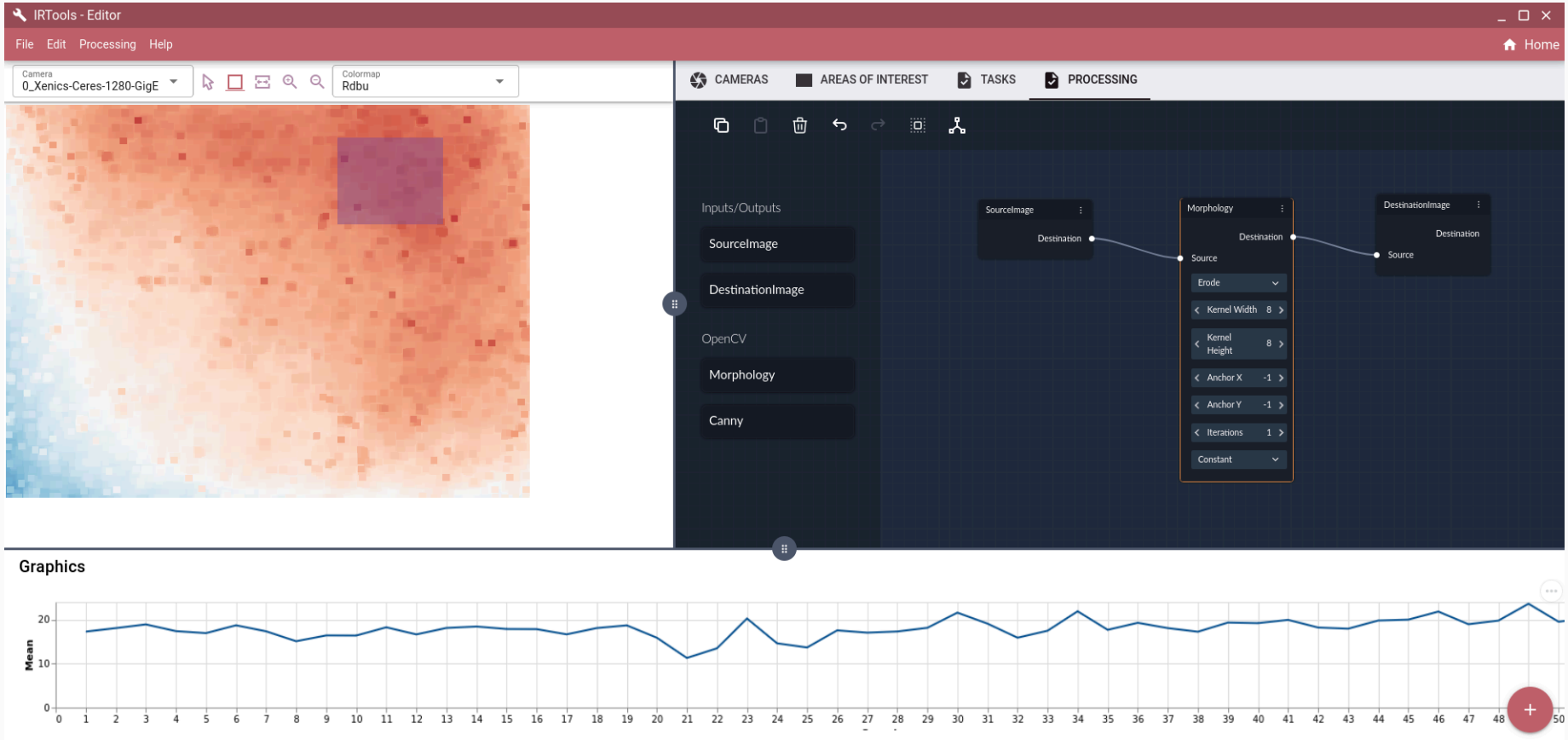


Screenshots – Region of interest & Tasks view



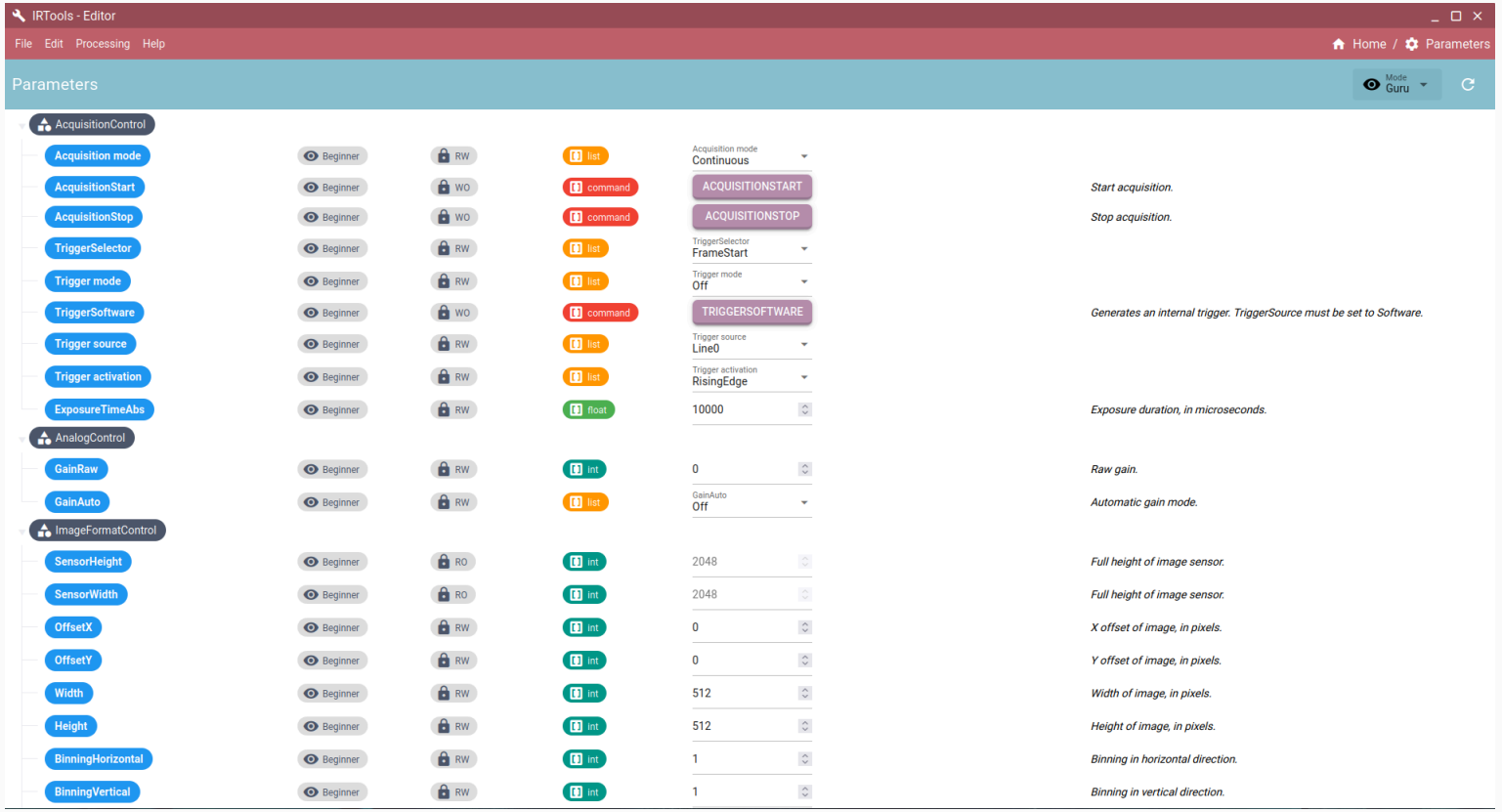


Screenshots – OpenCV live processing in-browser



Screenshots – Camera control and settings

- View and act on GenICam® settings
  - Customize calibration
  - Modify windowing
  - …



OpenAPI Compatibility

- Specification for describing, producing, consuming and visualizing web services.
- An OpenAPI Description (OAD) is a formal description of an API
  - allows to generate code, documentation, test cases, and more.

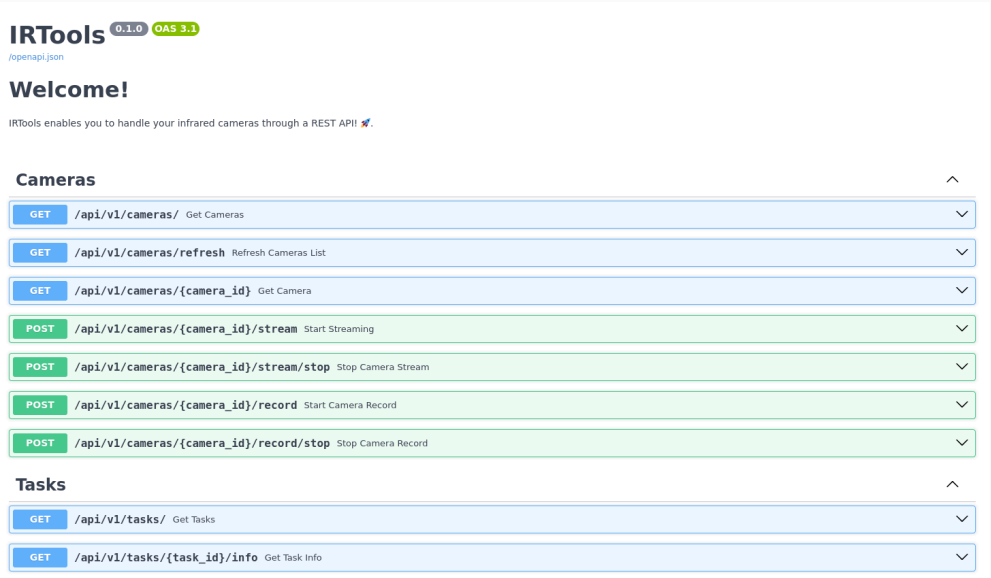


Figure 13: Swagger UI

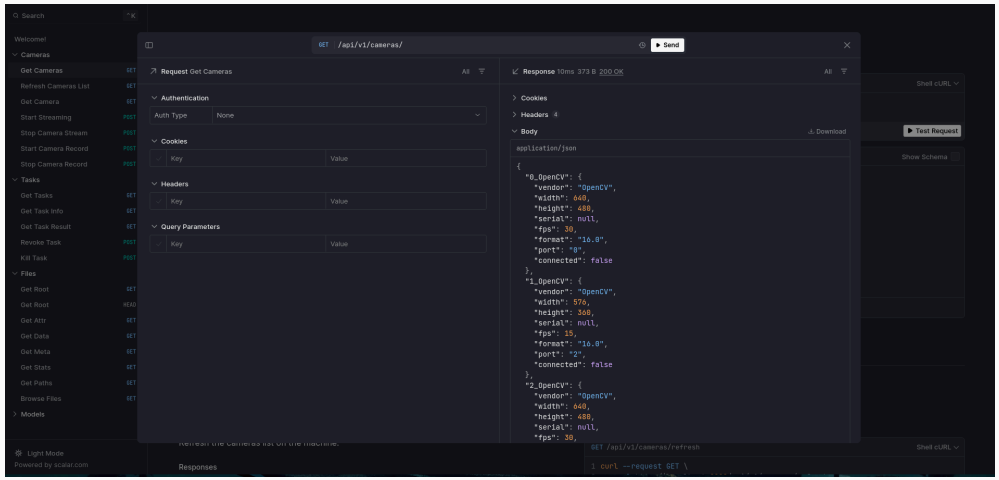
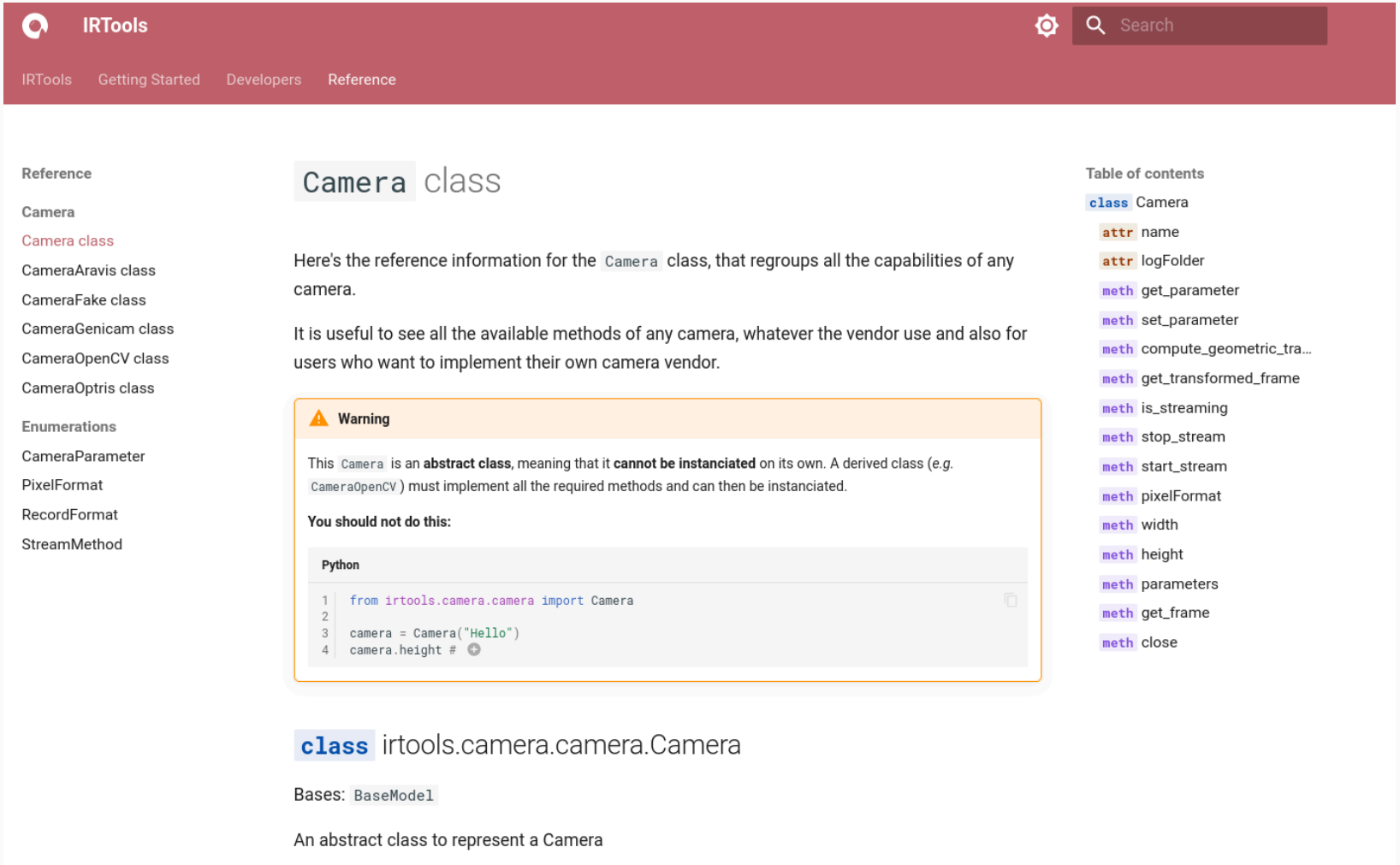


Figure 14: Redoc UI


IRTools
Search
IRTools
Getting Started
Developers
Reference
Reference
Camera
Camera class
CameraAravis class
CameraFake class
CameraGenicam class
CameraOpenCV class
CameraOptris class
Enumerations
CameraParameter
PixelFormat
RecordFormat
StreamMethod
Camera class
Here's the reference information for the Camera class, that regroups all the capabilities of any camera.
It is useful to see all the available methods of any camera, whatever the vendor use and also for users who want to implement their own camera vendor.
Warning
This Camera is an abstract class, meaning that it cannot be instanciated on its own. A derived class (e.g. CameraOpenCV) must implement all the required methods and can then be instanciated.
You should not do this:
Python
1 from irtools.camera.camera import Camera
2
3 camera = Camera("Hello")
4 camera.height #
class irtools.camera.camera.Camera
Bases: BaseModel
An abstract class to represent a Camera
Table of contents
class Camera
attr name
attr logFolder
meth get_parameter
meth set_parameter
meth compute_geometric_tra...
meth get_transformed_frame
meth is_streaming
meth stop_stream
meth start_stream
meth pixelFormat
meth width
meth height
meth parameters
meth get_frame
meth close

Conclusions

- 🚀 First working version IRTools & IRLab
- Compatible with multiple cameras (OpenCV, GenICam® (Teledyne FLIR), EvoCortex SDK (Optris), Sensia SDK, Xeneth SDK (Xenics)
- Modern UI
- Data recording including metadata (HDF5)
- WebRTC streaming
- Live OpenCV processing
- Remote control

Perspectives

- implement correction tools
  - temperature estimation algorithms
  - spatial correction
- add further utilities
  - autofocus
  - automatic cropping
- integrate laboratory hardware and test bench
  - target test bench : see this morning presentation (23)
  - black body
  - oven
- toward an **open version** next year

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Thank you!

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