



# Lima1 Project Overview

Laurent Claustre, Samuel Debionne, Alejandro Homs Puron  
Sebastien Petitdemange, Emmanuel Papillon, Vicente Rey Bakaikoa  
@ BCU / SG / ISDD

## Introduction:

- LImA1 design & structure

## Status:

- Features & applications
- Project collaboration
- Detectors

## Conclusions:

- Success & limitations

# LImA: A LIBRARY FOR IMAGE ACQUISITION

## Design

- **C++ library** (+ Python binding), event-based and highly multi-threaded
- Plugins for camera control & DAQ, separated from processing
- Main application: TANGO servers

## Data Acquisition (DAQ)

- **Common API** to configure the detector & receive the data
- Ethernet, PCI-express Camera or Frame Grabber (CameraLink, Espia, ...)

## Processing

- Image transformations
- Visualization / video
- ODR: calculate statistics on Regions-Of-Interest (Rois), ...
- Compress & **Save to files**

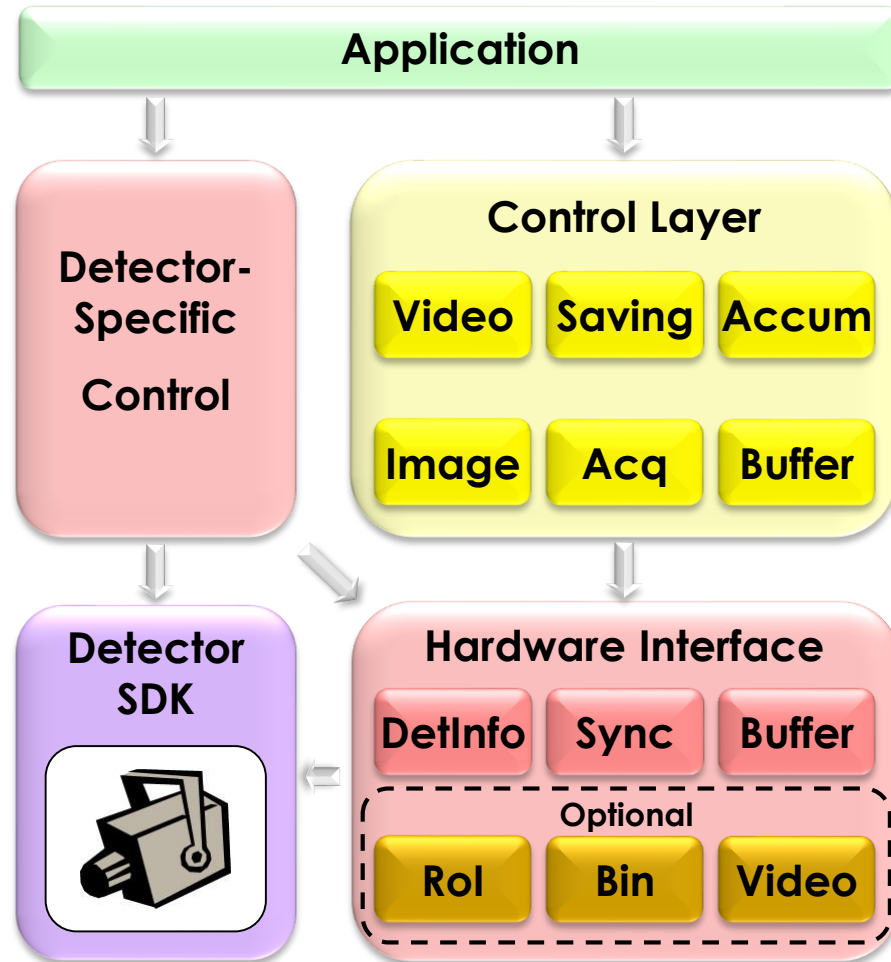
## Keep last images in memory buffers

- Temporary *storage* for advanced ODR



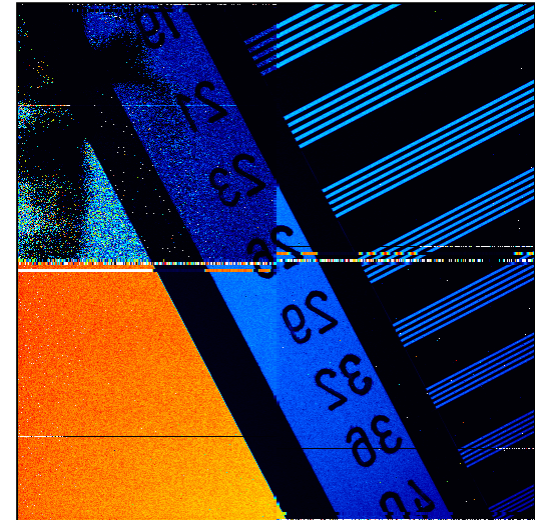
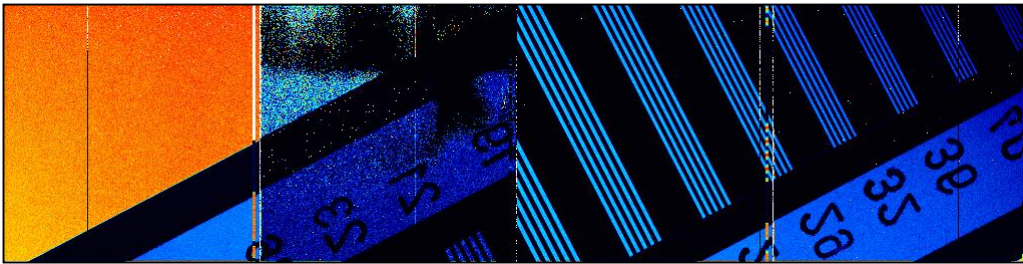
~15 years  
controlling HP  
2D detectors

# LIBRARY STRUCTURE LAYOUT

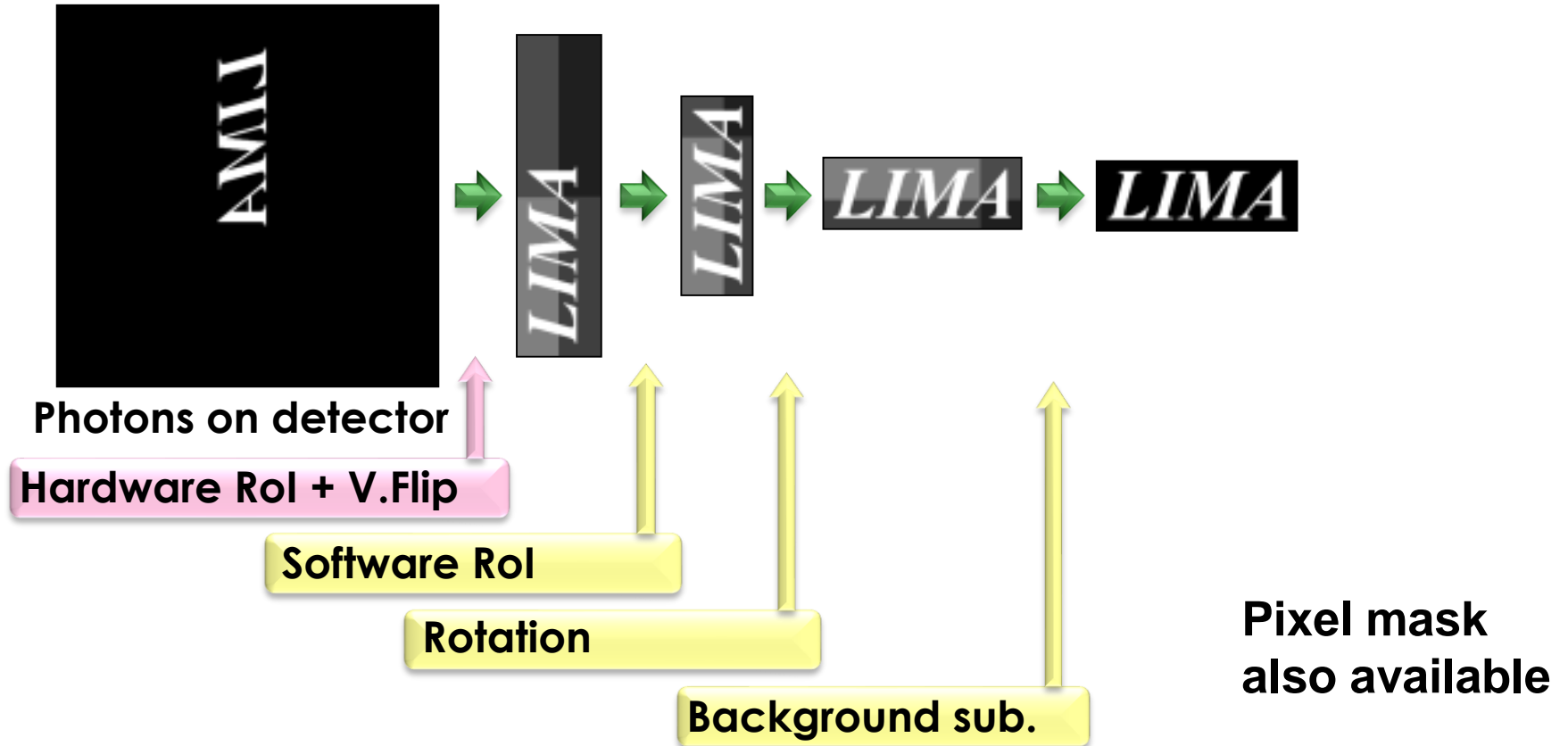


# IMAGE RECONSTRUCTION

- Data readout does not correspond to real geometry
- Pixel intensity is coded in a non-linear scale

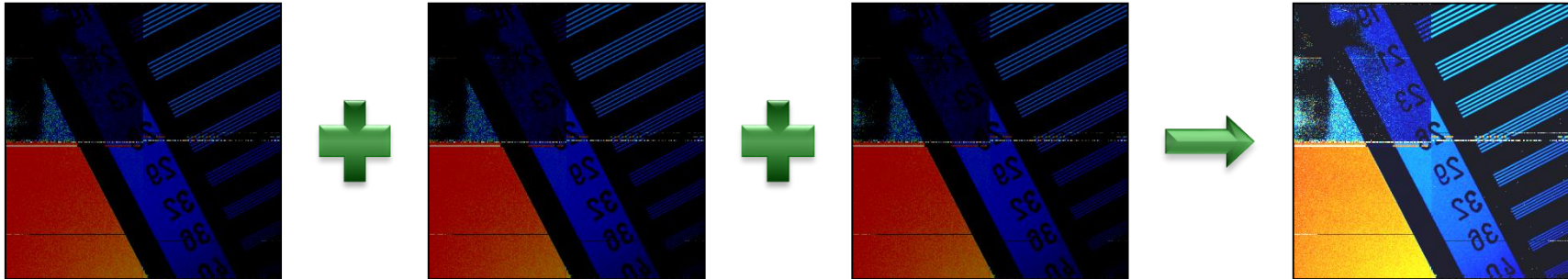


# IMAGE TRANSFORMATIONS



# PIXEL ACCUMULATION

- Limited integration capability: either in time or in pixel capacity



- Avoid pixel saturation  $\Rightarrow$  increase effective dynamic range
  - Detect saturation to signal non-linearity
- Intensity threshold  $\Rightarrow$  sensor protection

# VIDEO IMAGE

The screenshot displays the MXCuBE 3 software interface. At the top, the title bar reads "MXCuBE 3 Proposal: OPID293". Below this, a navigation bar includes "Sample Overview", "Data collection", "Sample Changer", and "System log". The main status bar shows experimental parameters: Energy: 12.7001 keV, Wavelength: 0.9762 Å, Resolution: 2.477 Å, Detector: 500.000 mm, Transmission: 19.998 %, Flux: ph/s, and Cryo: 100.22 K. On the right, there are status indicators for Sample changer (READY), Safety shutter (---), Fast shutter (CLOSED), Beamstop (---), and Ring Current (90.2 mA).

On the left side, there are control panels for "Beam size" (set to 10), "Omega" (90.00), "Kappa" (0.00), and "Phi" (0.00). Below these are "Sample alignment" controls and a "Show motors" checkbox.

The central area shows a video image of a sample with a green grid overlay labeled "Grid-1". A white tooltip window is open over the grid, displaying the following table:

Name	V-Space (µm)	H-Space (µm)	Dim (µm)	#Cells	Ω
Grid-1	0.00	0.00	120 x 150 (180)	90.00°	

The tooltip also includes "Rotate to", "Hide", "Opacity", and "Heat map" options. A 50 µm scale bar is visible in the bottom left corner of the video image.

On the right side, there is a "Run Queue" section with a "Next Sample (Sample-1 2.08)" button and a "Settings" dropdown. Below this, a "Sample: Sample-1:2:07" section shows "Queued Samples (0)".



## ROI Counters

- Basic statistics on Regions-Of-Interest
- Rectangular or arc-shaped geometries
- Diffraction mappings & sinograms for tomography

## ROI Collections

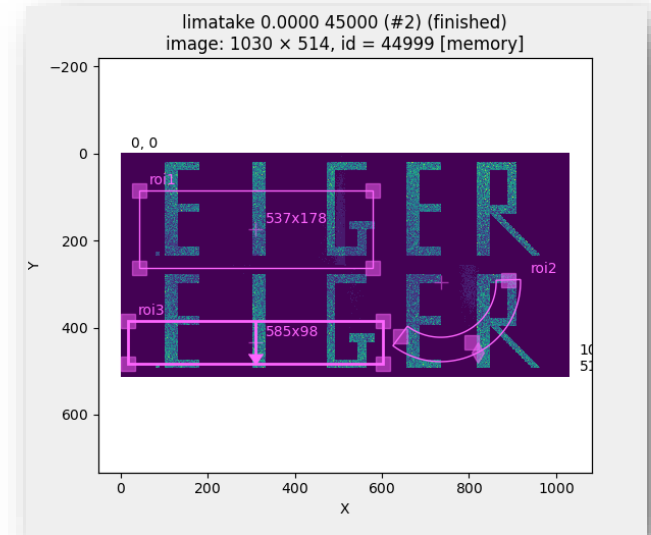
- Large number of ROI counters:  $\sim 5000$

## ROI-2-Spectrum

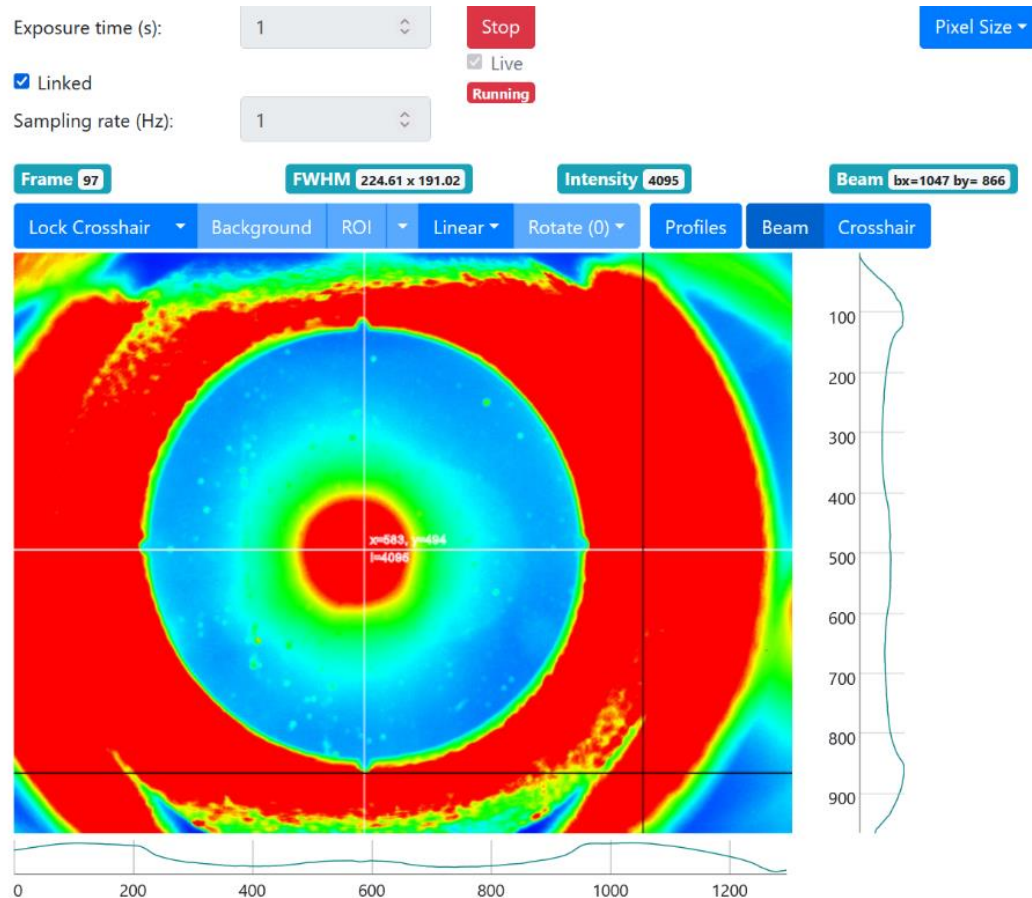
- Binning projection over X / Y axis
- Beam-position-monitor: beam profile
- Blisstomo  $\Leftrightarrow$  Sinogram
- Powder diffraction central region  $\Leftrightarrow$  Primitive azimuthal integration (fast)

## BPM

- Beam centroid & FWHM



# BEAM POSITION MONITOR WEB APPLICATION



## Multiple file formats

- EDF, CBF, FITS, TIFF
- Nexus/HDF5

## Compression

- GZIP, LZ4, BS-LZ4
- Frames are compressed in parallel

## Performance

- ~ 300 MByte/s with NFS
- > 1 GByte/s with GPFS

## Direct SDK saving

- LImA will configure SDK to save files
  - Dectris/Eiger in FileWriter mode
- Images are not systematically read by LImA, no processing available



# FRAME PROCESSING & EVENTS

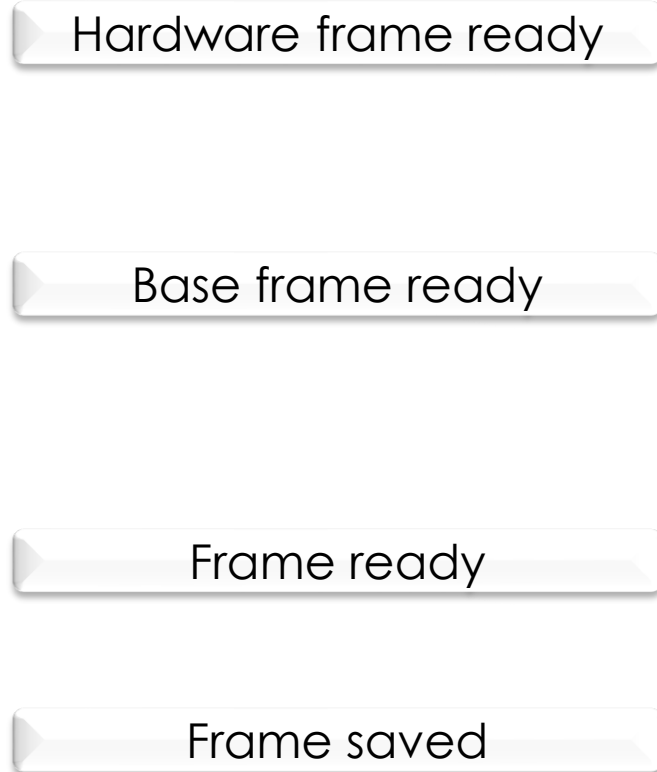
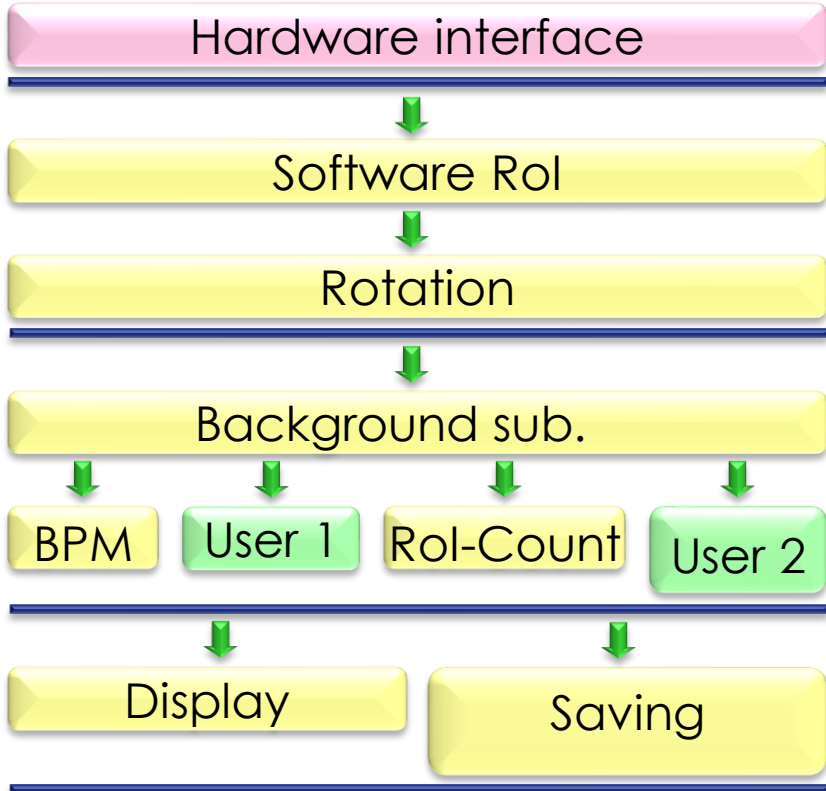
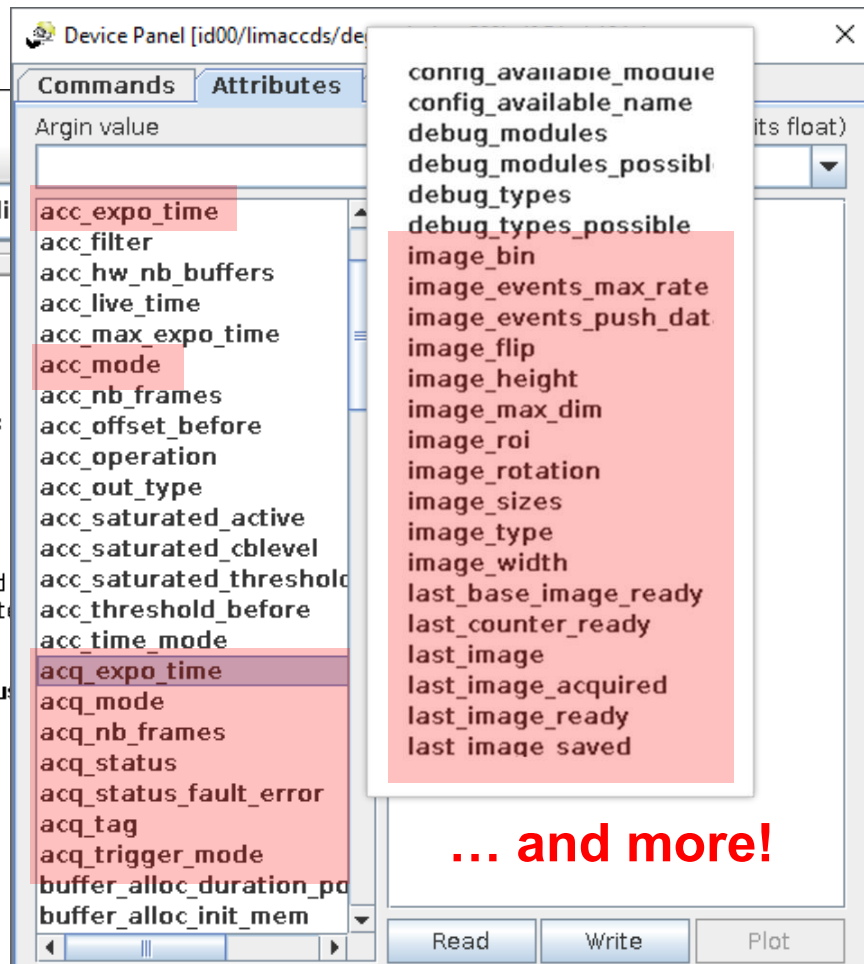
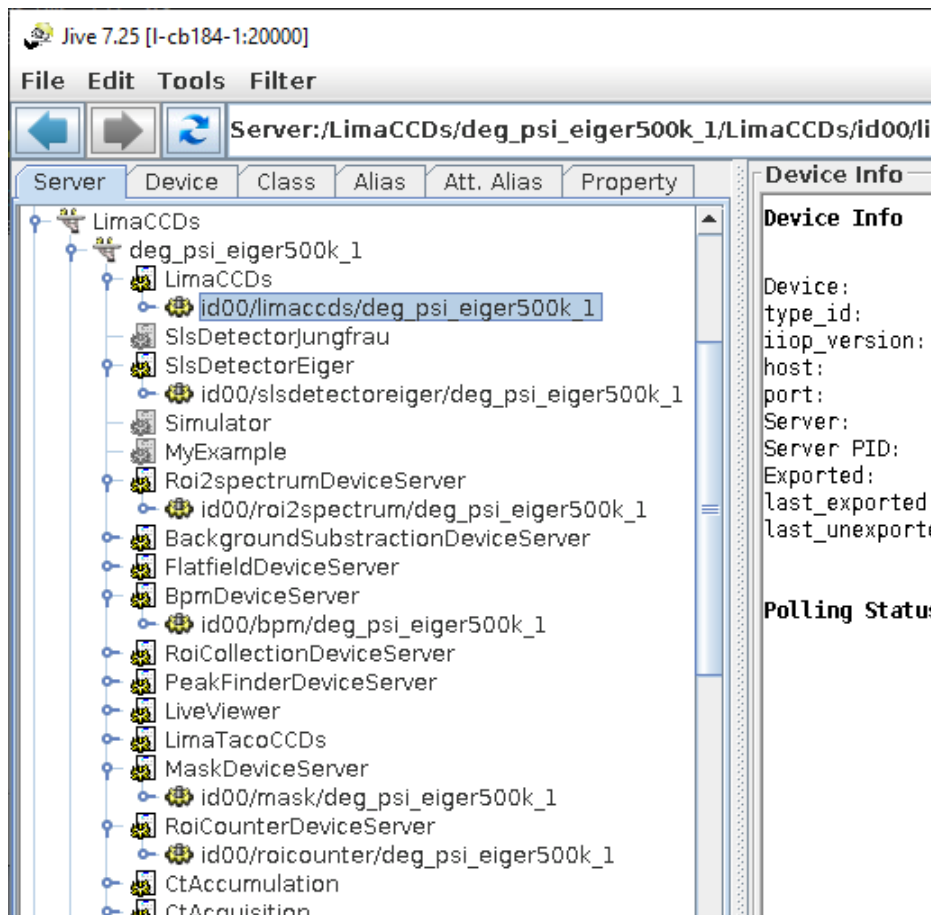
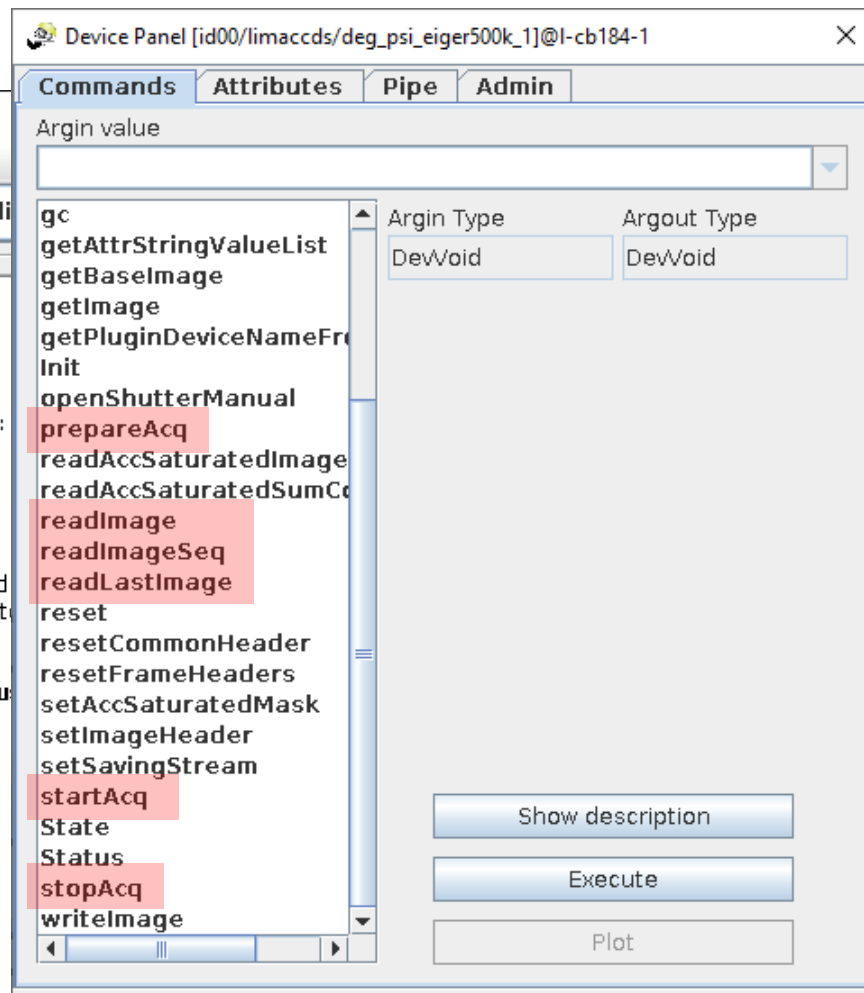
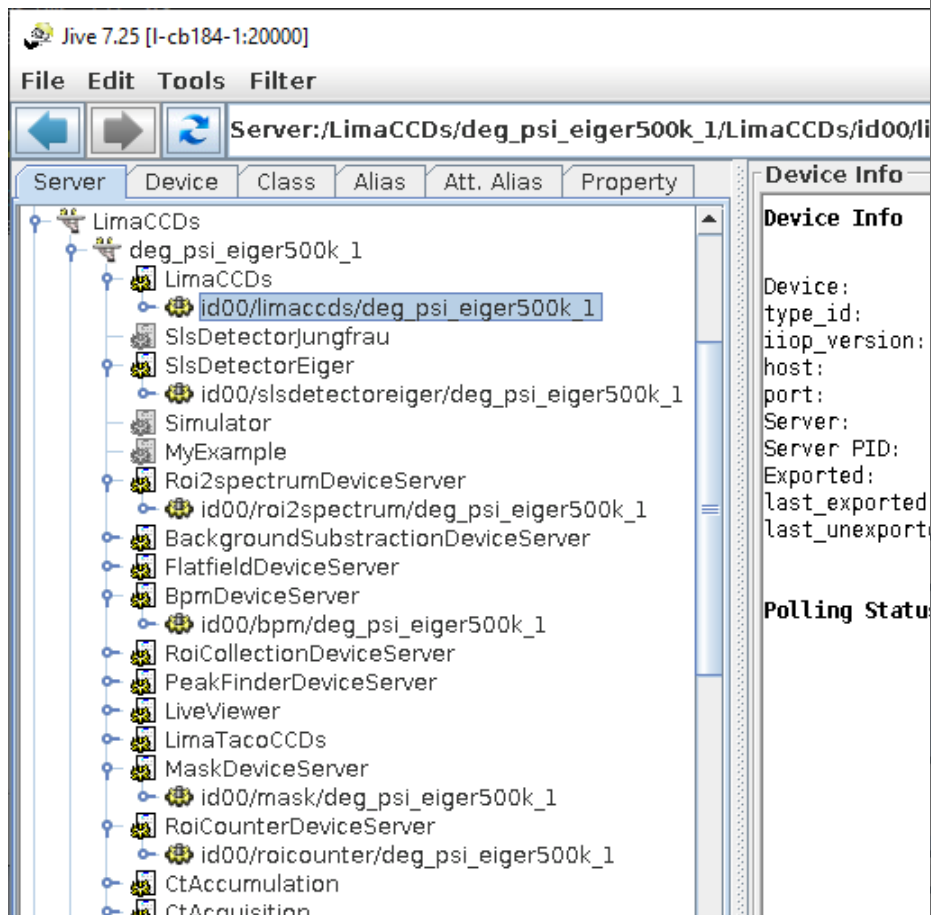


Image counters  
get incremented

- LimaCCDs generic device



- LimaCCDs generic device



- **Detector specific device**

Jive 7.25 [I-cb184-1:20000]

File Edit Tools Filter

Server Device Class Alias Att. Alias Property

- deg\_jungfrau500k\_356
- deg\_psi\_eiger500k\_1
  - LimaCCDs
    - id00/limaccds/deg\_psi\_eiger500k\_1
  - SlsDetectorjungfrau
  - SlsDetectorEiger
    - id00/slsdetectoreiger/deg\_psi\_eiger500k\_1
  - Simulator
  - MyExample
  - Roi2spectrumDeviceServer
    - id00/roi2spectrum/deg\_psi\_eiger500k\_1
  - BackgroundSubstractionDeviceServer
  - FlatfieldDeviceServer
  - BpmDeviceServer
    - id00/bpm/deg\_psi\_eiger500k\_1
  - RoiCollectionDeviceServer
  - PeakFinderDeviceServer
  - LiveViewer
  - LimaTacoCCDs
  - MaskDeviceServer
    - id00/mask/deg\_psi\_eiger500k\_1
  - RoiCounterDeviceServer
    - id00/roicounter/deg\_psi\_eiger500k\_1
  - CtAccumulation

**Device Info**

Device:  
type\_id:  
iiop\_version:  
host:  
port:  
Server:  
Server PID:  
Exported:  
last\_exported:  
last\_unexported:

**Polling Status**

Device Panel [id00/slsdetectoreiger/deg\_psi\_eiger500k\_1]@I-cb184-1

Commands Attributes Admin

Argin value

all_trim_bits	Name	adc_name_list
apply_corrections	Label	adc_name_list
buffer_max_memory	Desc	No description
buffer_max_nb_buffers	Writable	READ
buffer_packet_fifo_depth	Data format	Spectrum
buffer_resize_policy	Data type	DevString
clock_div	Max Dim X	64
config_frame	Max Dim Y	0
dac_EigerVcmpLL	Unit	
dac_EigerVcmpLR	Std Unit	No standard unit
dac_EigerVcmpRL	Disp Unit	No display unit
dac_EigerVcmpRR	Format	%s
dac_name_list	Min value	Not specified
dac_name_list_mv	Max value	Not specified
dac_Threshold	Min alarm	Not specified
fixed_clock_div	Max alarm	Not specified
fpga_frame_ptr_diff		
high_voltage		
hostname_list		
last_frame_caught		
max_frame_rate		

Read Write Plot

- Processing specific devices

Jive 7.25 [I-cb184-1:20000]

File Edit Tools Filter

imaCCDs/deg\_psi\_eiger500k\_1/RoiCounterDeviceServer/id00

Server	Device	Class	Alias	Att. Alias	Property
	deg_jungfrau500k_356				
	deg_psi_eiger500k_1				
	LimaCCDs				
	id00/limaccds/deg_psi_eiger500k_1				
	SlsDetectorjungfrau				
	SlsDetectorEiger				
	id00/slsdetectoreiger/deg_psi_eiger500k_1				
	Simulator				
	MyExample				
	Roi2spectrumDeviceServer				
	id00/roi2spectrum/deg_psi_eiger500k_1				
	BackgroundSubstractionDeviceServer				
	FlatfieldDeviceServer				
	BpmDeviceServer				
	id00/bpm/deg_psi_eiger500k_1				
	RoiCollectionDeviceServer				
	PeakFinderDeviceServer				
	LiveViewer				
	LimaTacoCCDs				
	MaskDeviceServer				
	id00/mask/deg_psi_eiger500k_1				
	RoiCounterDeviceServer				
	id00/roicounter/deg_psi_eiger500k_1				
	CtAccumulation				
	CtAcquisition				

Device Panel [id00/roicounter/deg\_psi\_eiger500k\_1]@I-cb184-1

Commands Attributes Pipe Admin

Argin value Ex: Dance,"the TANGO" (quotes needed for string with sp...)

Command	Argin Type	Argout Type
addNames		
clearAllRois	DevVarStringArray	DevVarLongArray
getArcRois		
getNames		
getRois		
getRoiTypes		
Init		
readCounters		
removeRois		
setArcRois		
setMaskFile		
setRois		
Start		
State		
Status		
Stop		

Show description

Execute

Plot



# COLLABORATION

- SOLEIL
- PETRA-III / DESY
- FRM-II / TUM
- ALBA
- MAX-Lab
- ADSC
- Rayonix
- DSG / Daresbury / STFC
- Nexeya Systems
- ILE/LULI/Ecole Polytechnique
- IMXPAD
- S2 Innovation



FRM II  
Forschungs-Neutronenquelle  
Heinz Maier-Leibnitz



ADSC  
Area Detector Systems Corporation



# DETECTORS

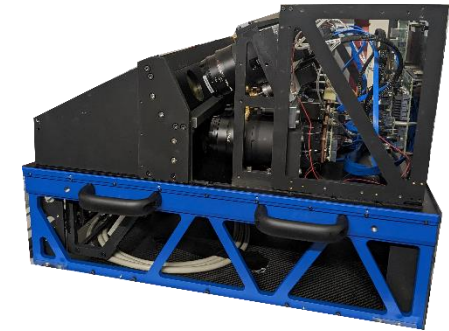
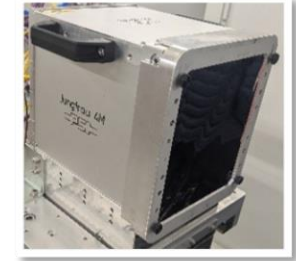
Camera plugins: 44 [active: 32]

- ESRF: Frelon & Maxipix
- Dectris: Pilatus & Eiger
- PSI/SLS: Eiger
- pco: Dimax & Edge
- Basler, Prosilica, IDS, uEye
- Andor, I-Kon
- XH, XPAD, XSPRESS3
- Perkin Elmer
- Photonic Science
- ZWO
- ...



# LATEST DETECTORS

- Arinax
- Ximea
- Photometrics
- SLS/PSI Jungfrau
- Princeton
- Dhyana
- Teledyne Iris
- Minipix
- Fraunhofer IIS Xeye (ESRF BM18 LAD)

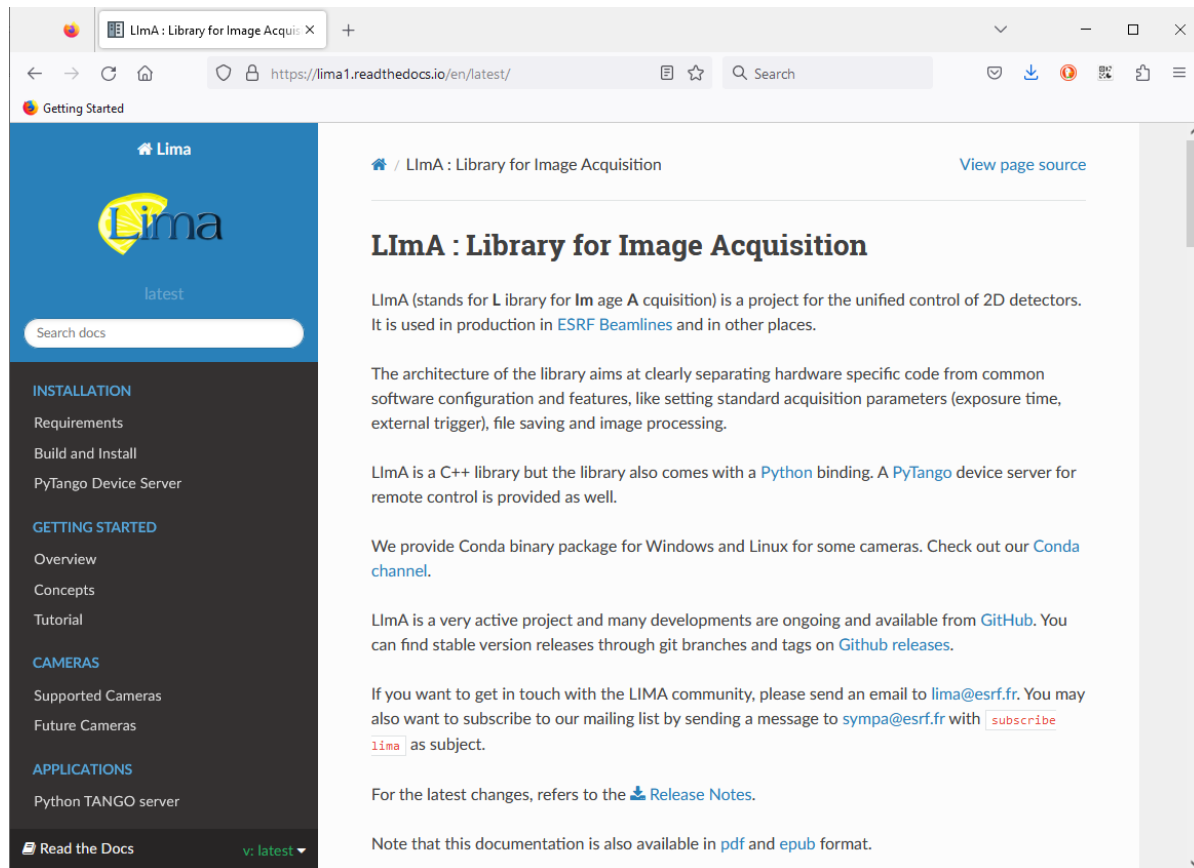


# PACKAGING: CONDA

The screenshot shows a web browser window with the URL `https://anaconda.org/esrf-bcu`. The page displays the profile for the organization 'Beamline Control Unit' (ESRF), created on Sep 27, 2017. The 'Packages' section lists several packages with their upload times:

- blissdata (2 hours and 1 minute ago)
- lima2-client (21 hours and 56 minutes ago)
- lima-camera-basler (2 days and 21 hours ago)
- lima-camera-basler-tango (2 days and 21 hours ago)
- redis-om (2 days and 21 hours ago)
- processlib (15 days and 17 hours ago)
- lima-common-espia (16 days and 20 hours ago)
- lima-camera-maxipix-tango (16 days ago)
- lima-camera-maxipix (16 days and 21 hours ago)
- lima-camera-meta-tango (16 days and 21 hours ago)

Conda channel: *esrf-bcu*



The screenshot shows a web browser window displaying the LIMA documentation page. The browser's address bar shows the URL <https://lima1.readthedocs.io/en/latest/>. The page has a dark blue sidebar on the left with the LIMA logo and a search bar. The main content area has a white background with a blue header. The page title is "LIMA : Library for Image Acquisition". The main text describes LIMA as a project for the unified control of 2D detectors, used in production at ESRF Beamlines. It details the library's architecture, its C++ core with a Python binding, and the availability of a Conda binary package. It also mentions the project's activity on GitHub and provides contact information for the community.

Getting Started

LIMA

latest

Search docs

INSTALLATION

- Requirements
- Build and Install
- PyTango Device Server

GETTING STARTED

- Overview
- Concepts
- Tutorial

CAMERAS

- Supported Cameras
- Future Cameras

APPLICATIONS

- Python TANGO server

Read the Docs v: latest

LIMA : Library for Image Acquisition [View page source](#)

## LIMA : Library for Image Acquisition

LIMA (stands for L library for Im age A cquisition) is a project for the unified control of 2D detectors. It is used in production in [ESRF Beamlines](#) and in other places.

The architecture of the library aims at clearly separating hardware specific code from common software configuration and features, like setting standard acquisition parameters (exposure time, external trigger), file saving and image processing.

LIMA is a C++ library but the library also comes with a [Python](#) binding. A [PyTango](#) device server for remote control is provided as well.

We provide Conda binary package for Windows and Linux for some cameras. Check out our [Conda channel](#).

LIMA is a very active project and many developments are ongoing and available from [GitHub](#). You can find stable version releases through git branches and tags on [Github releases](#).

If you want to get in touch with the LIMA community, please send an email to [lima@esrf.fr](mailto:lima@esrf.fr). You may also want to subscribe to our mailing list by sending a message to [sympa@esrf.fr](mailto:sympa@esrf.fr) with [subscribe](#) [lima](#) as subject.

For the latest changes, refers to the [Release Notes](#).

Note that this documentation is also available in [pdf](#) and [epub](#) format.

<https://lima1.readthedocs.io/en/latest/>

# SUCCESS

- LImA is extensively used at the ESRF: ~160 detectors
  - Also used in other facilities
- Provides uniform and reliable 2D detector DAQ
- Ensures saving of experimental data
- Satisfies many needs for on-the-fly image processing at the BLs
- Is not dead yet – see presentation on latest developments
  - Core developments will be limited to bug fixes, though

# LIMITATIONS

- Developed on old C++ standards
  - Lack of modern features
- When the acquisition fails there is no explicit processing status
  - Most poll saving and ODR counters
- Issues around changing nested HW & SW image transformations
- Cannot start a new acquisition before the previous processing ends
- Only one data source for saving
  - User processing plugins must handle saving independently
- Limited to a single computer backend
- Monolithic processing chain with user plugins
- ... and many others that **we would like to here from you!**

# Thank you very much!



# Any question?