Lima1 Project Overview

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OUTLINE

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-0f-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

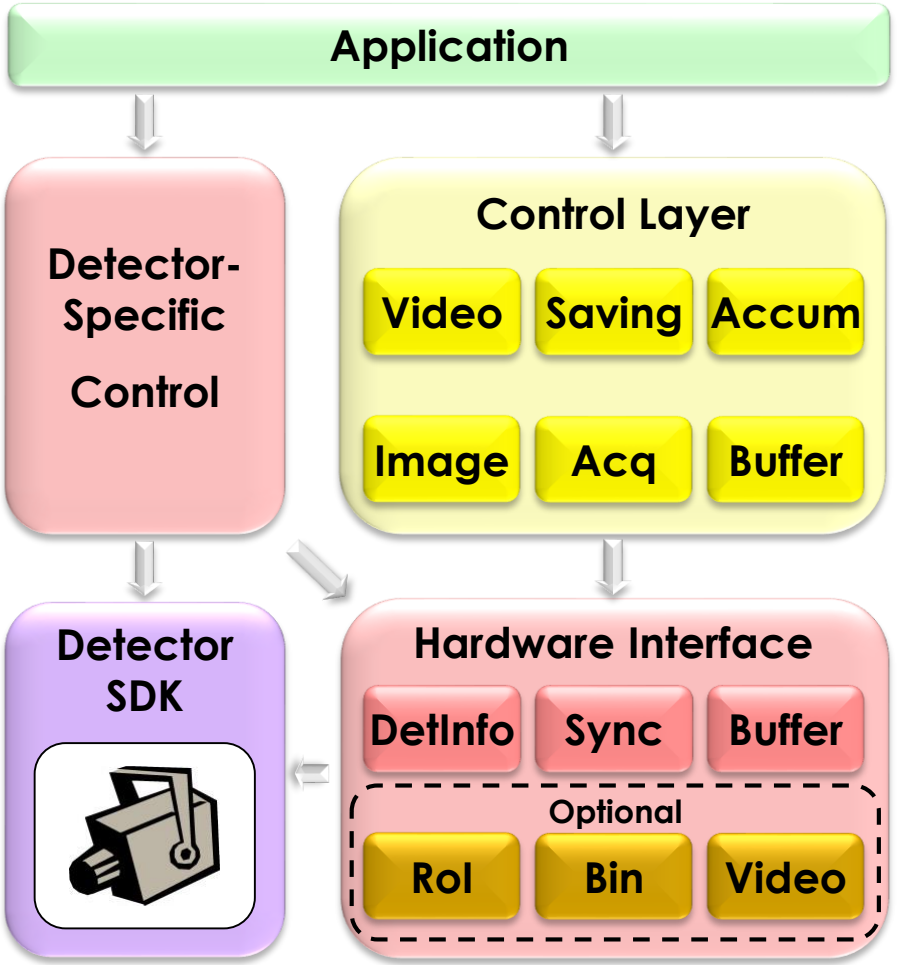


IMAGE RECONSTRUCTION

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

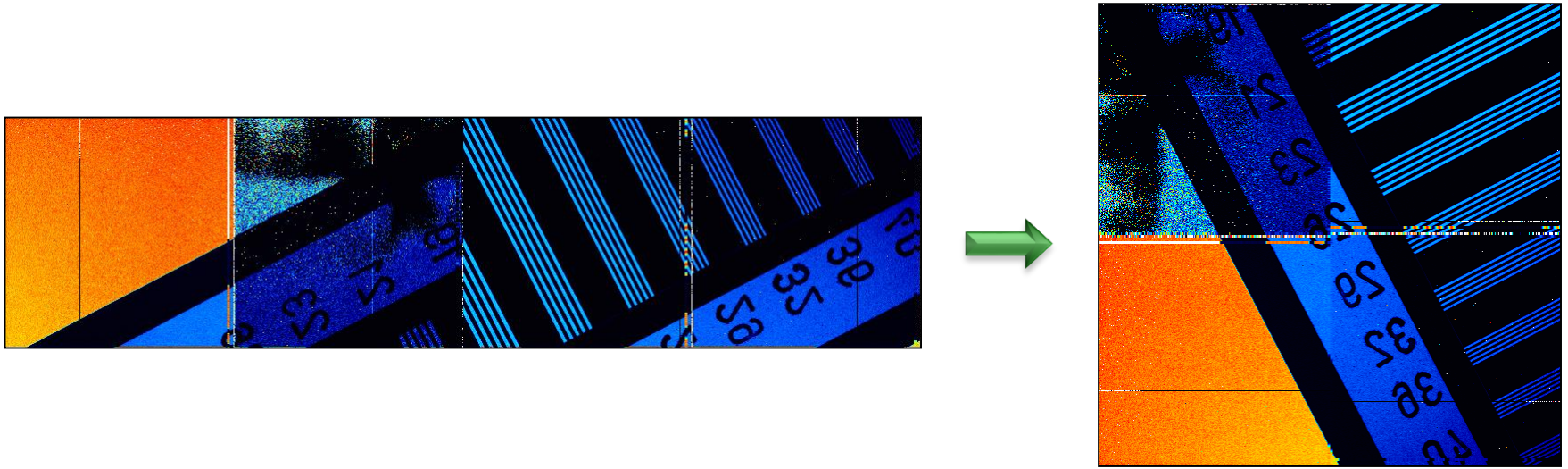
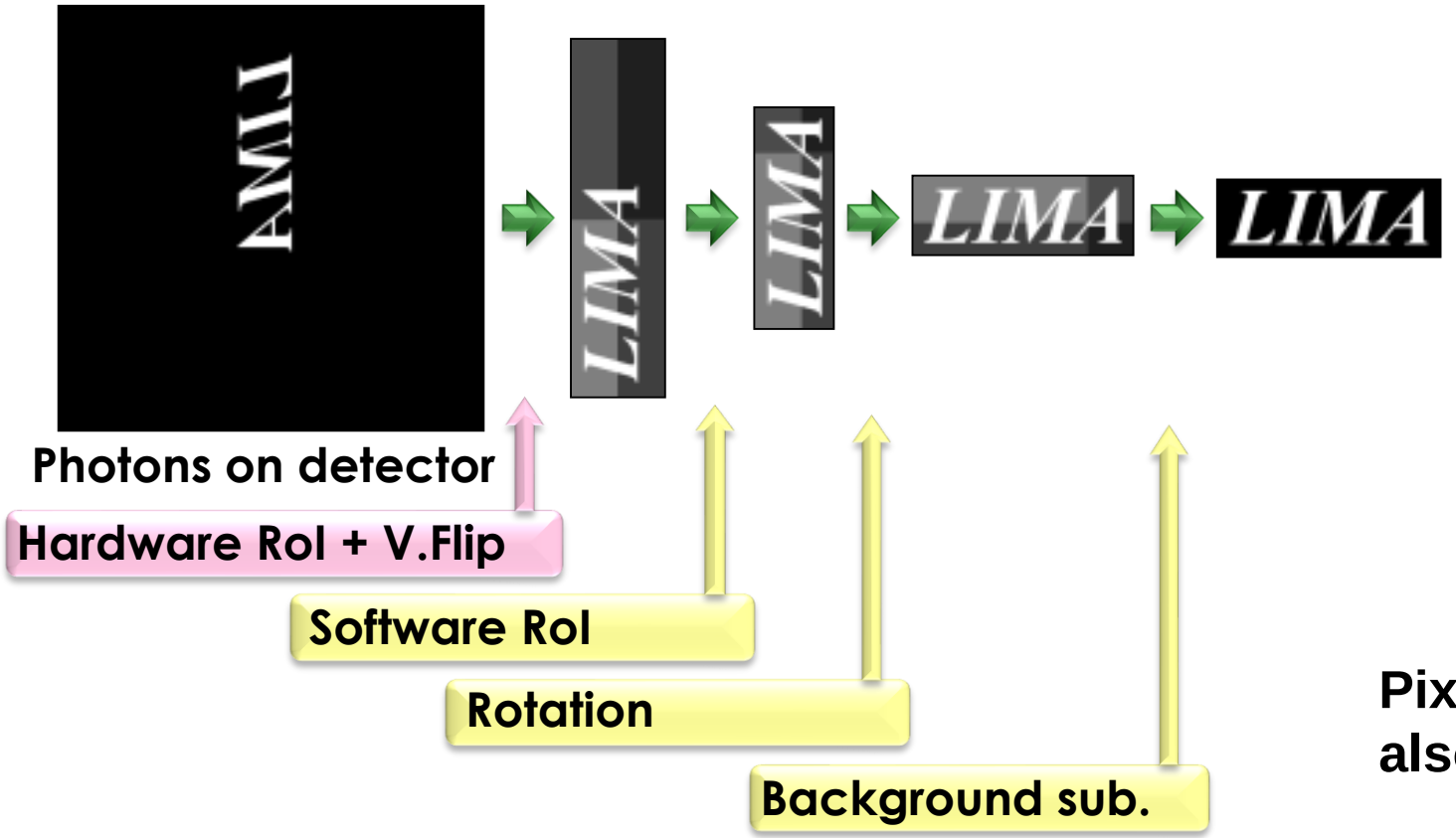


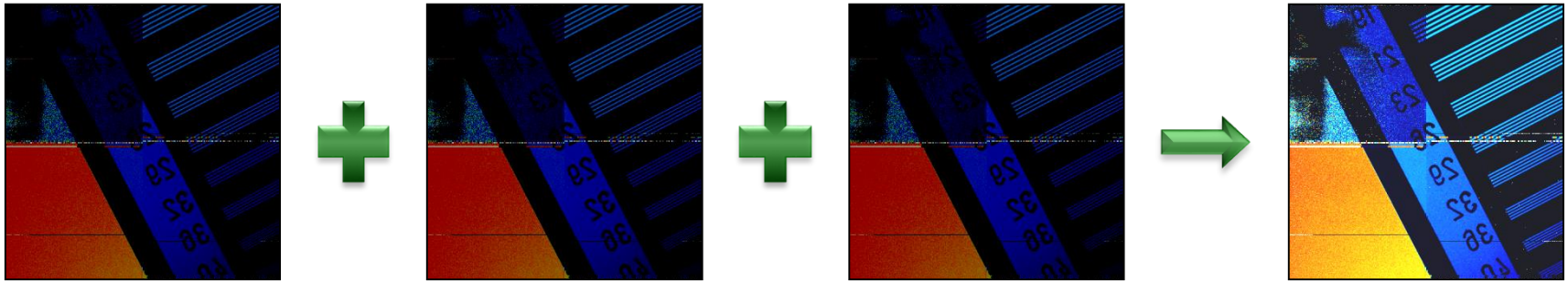
IMAGE TRANSFORMATIONS



Pixel mask also available

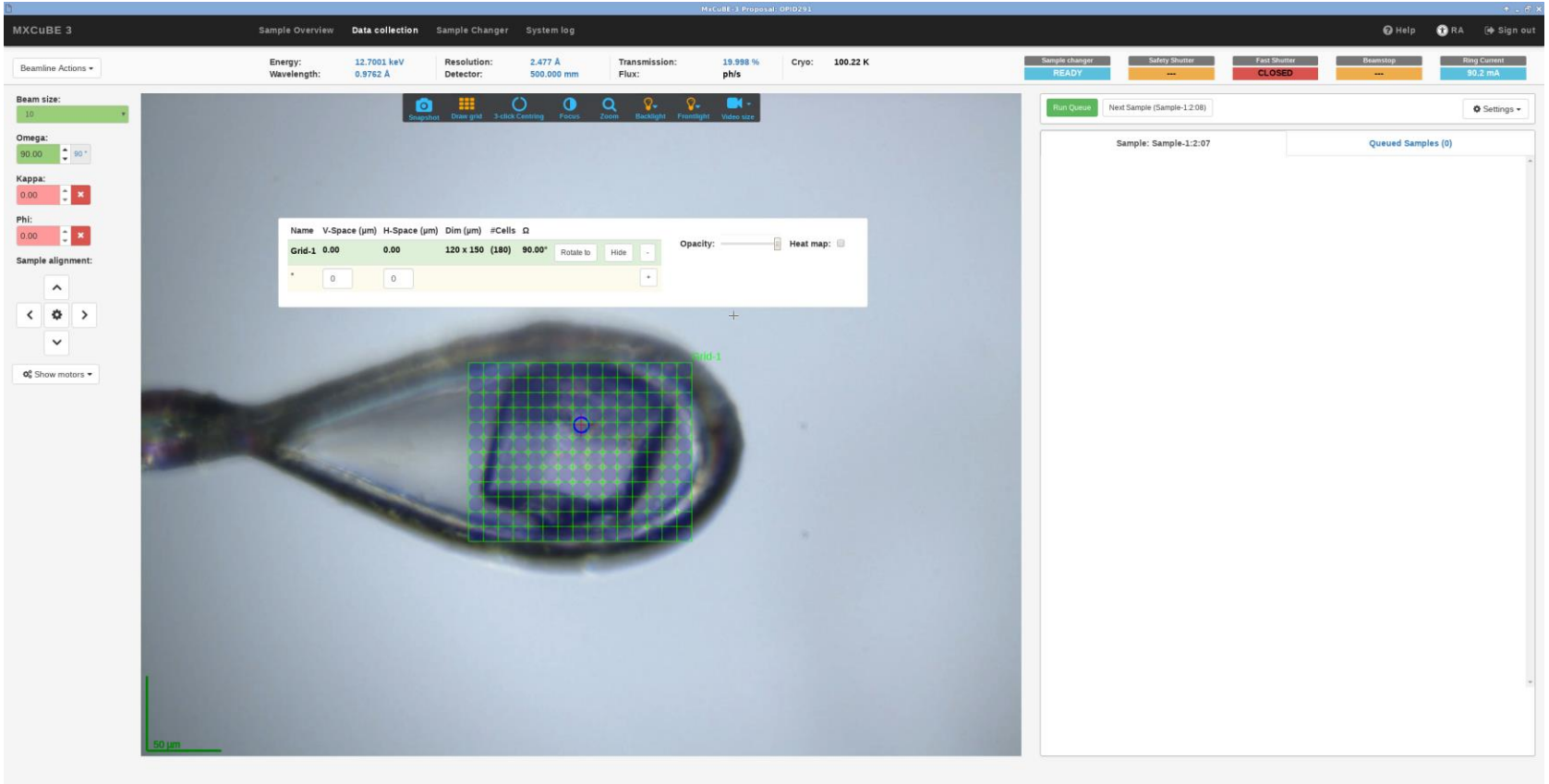
PIXEL ACCUMULATION

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



- Avoid pixel saturation ⇨ increase effective dynamic rage
  - Detect saturation to signal non-linearity
- Intensity threshold ⇨ sensor protection

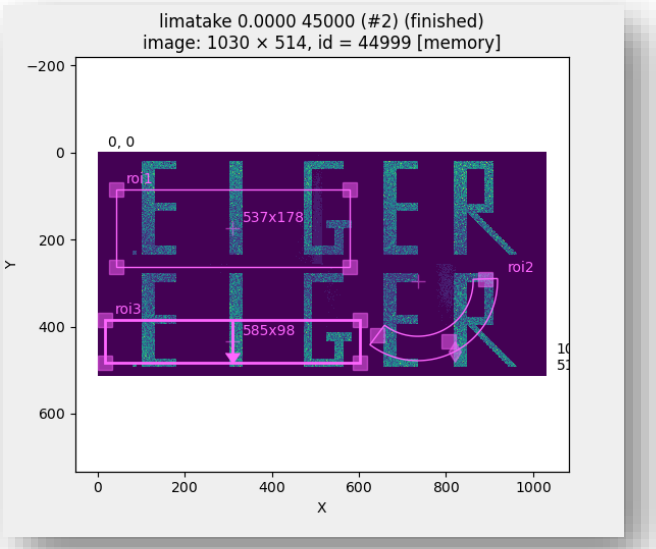
VIDEO IMAGE


MXCuBE 3
Sample Overview
Data collection
Sample Changer
System log
Help
RA
Sign out
Beamline Actions
Energy: 12.7001 keV
Wavelength: 0.9762 Å
Resolution: 2.477 Å
Detector: 500.000 mm
Transmission: 19.998 %
Flux: ph/s
Cryo: 100.22 K
Sample changer
READY
Safety Shutter
Fast Shutter
CLOSED
Beamstop
Ring Current
90.2 mA
Beam size:
Omega:
Kappa:
Phi:
Sample alignment:
Show motors
Snapshot
Draw grid
3-click Centring
Focus
Zoom
Backlight
Frontlight
Video size
Name V-Space (µm) H-Space (µm) Dim (µm) #Cells Ω
Grid-1 0.00 0.00 120 x 150 (180) 90.00°
Rotate to
Hide
Opacity:
Heat map:
Grid-1
50 µm
Run Queue
Next Sample (Sample-1:2:08)
Settings
Sample: Sample-1:2:07
Queued Samples (0)

ONLINE DATA ANALYSIS AND REDUCTION

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: ~ 5000

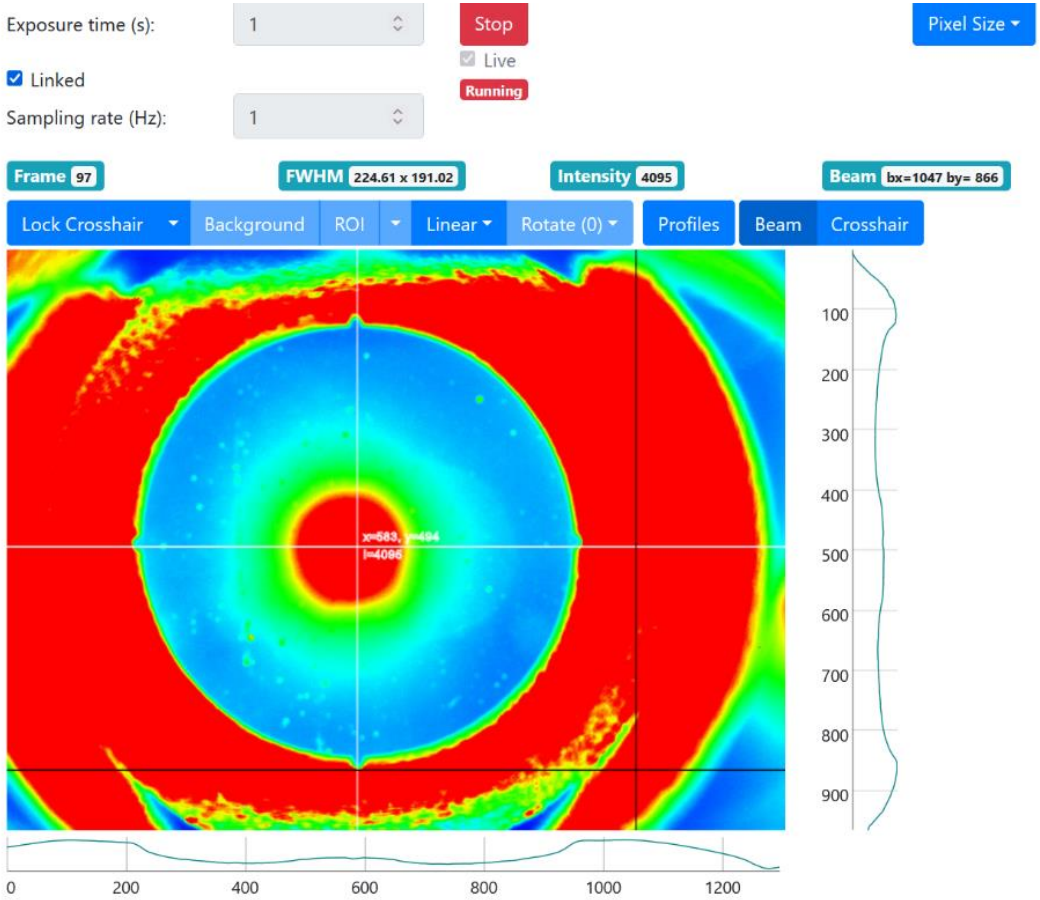
ROI-2-Spectrum

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

BPM

- Beam centroid & FWHM

BEAM POSITION MONITOR WEB APPLICATION



DATA SAVING

Multiple file formats

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

Compression

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

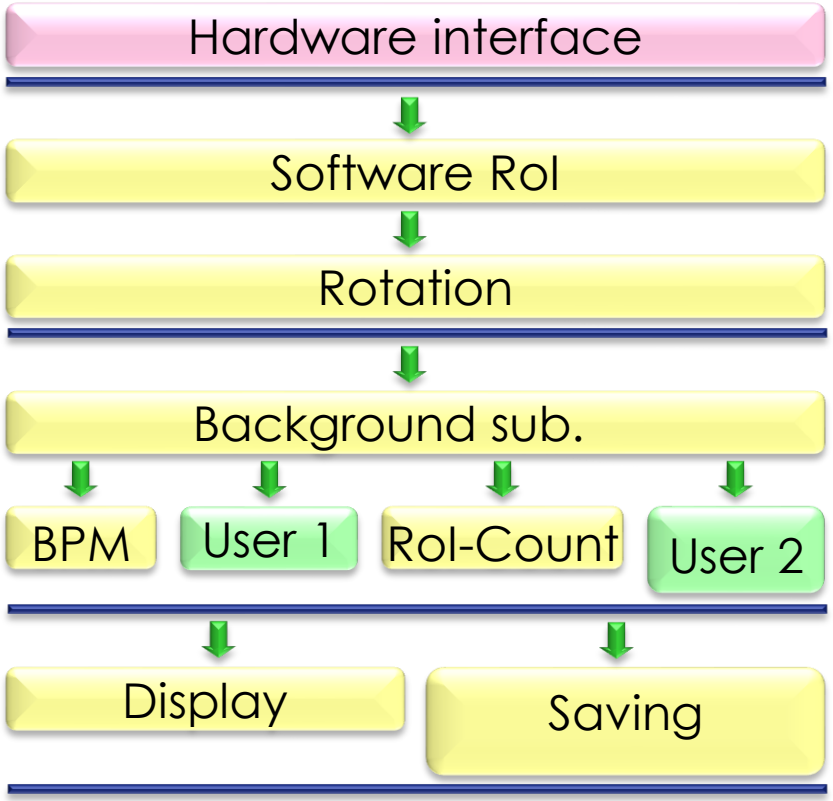
Performance

- ~ 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



Hardware frame ready

Base frame ready

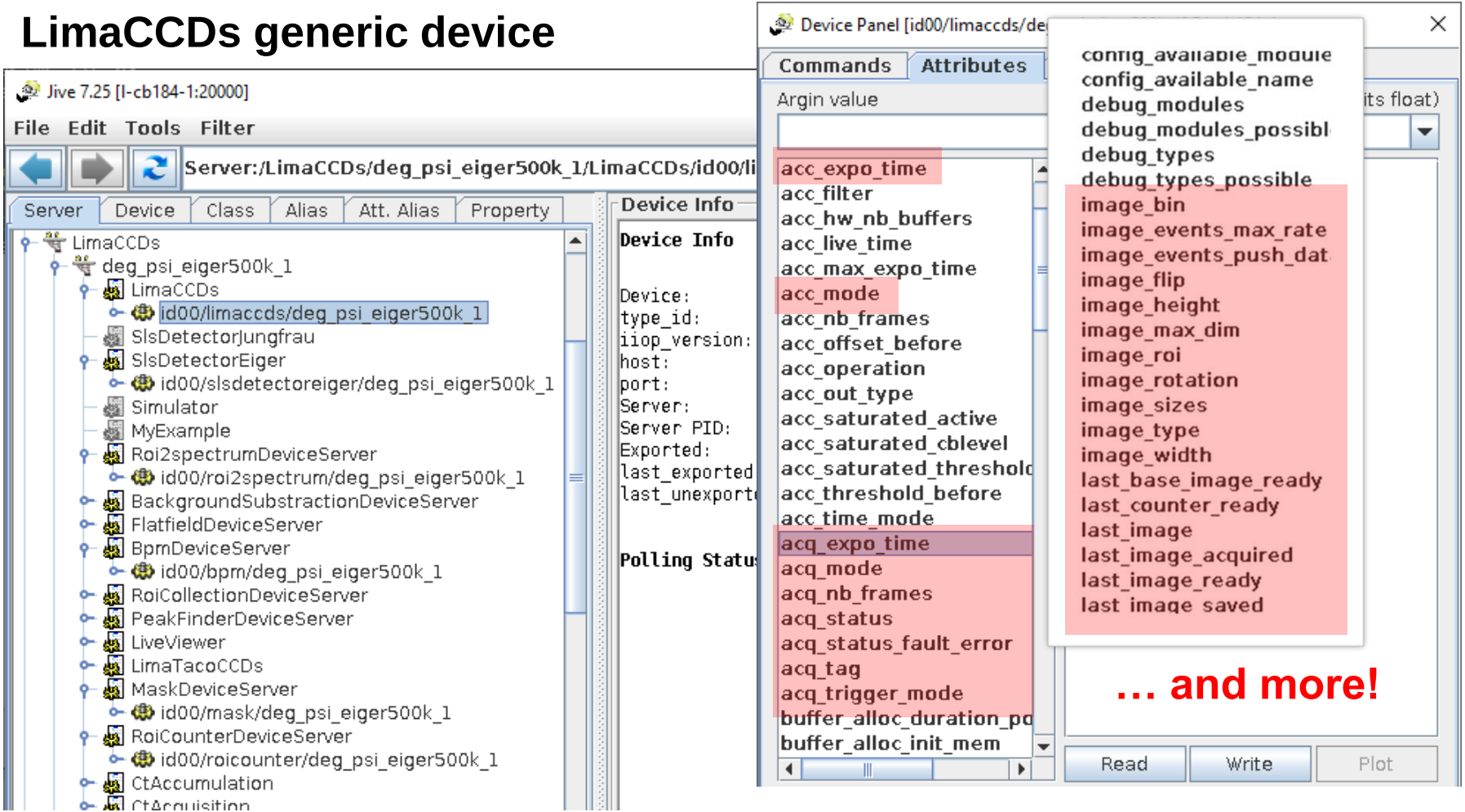
Image counters get incremented

Frame ready

Frame saved

TANGO PYTHON APPLICATION

- **LimaCCDs generic device**



TANGO PYTHON APPLICATION

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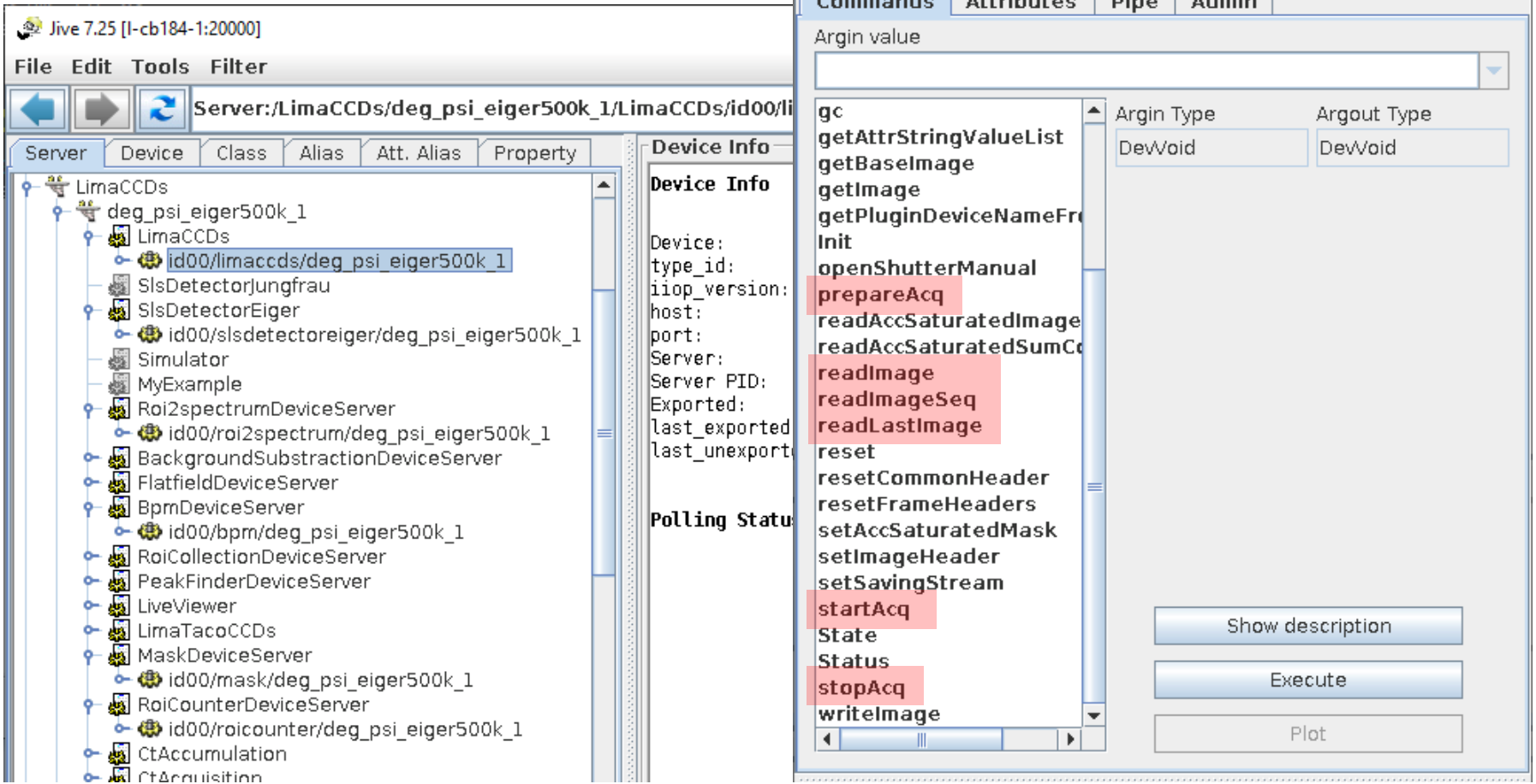
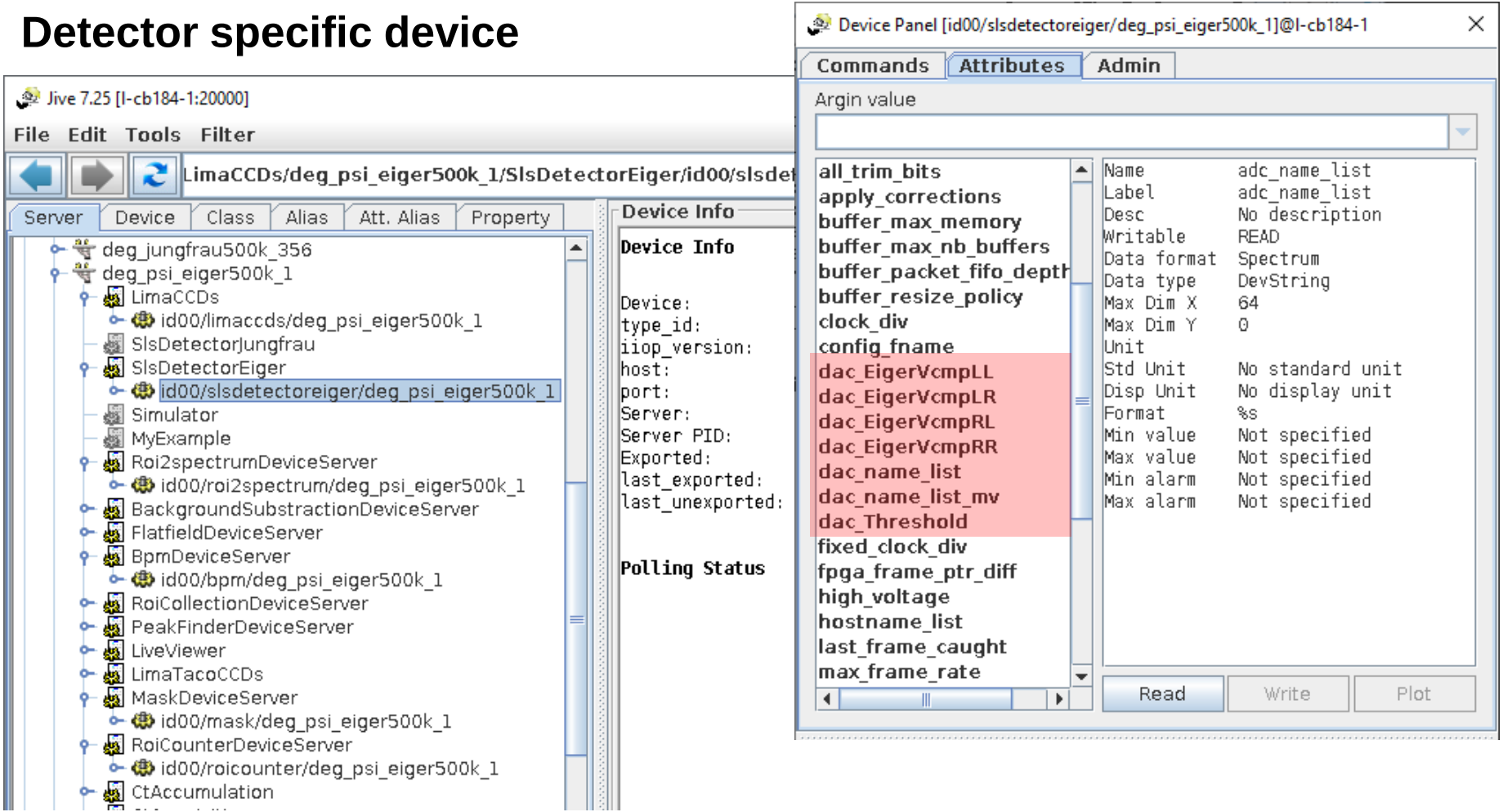


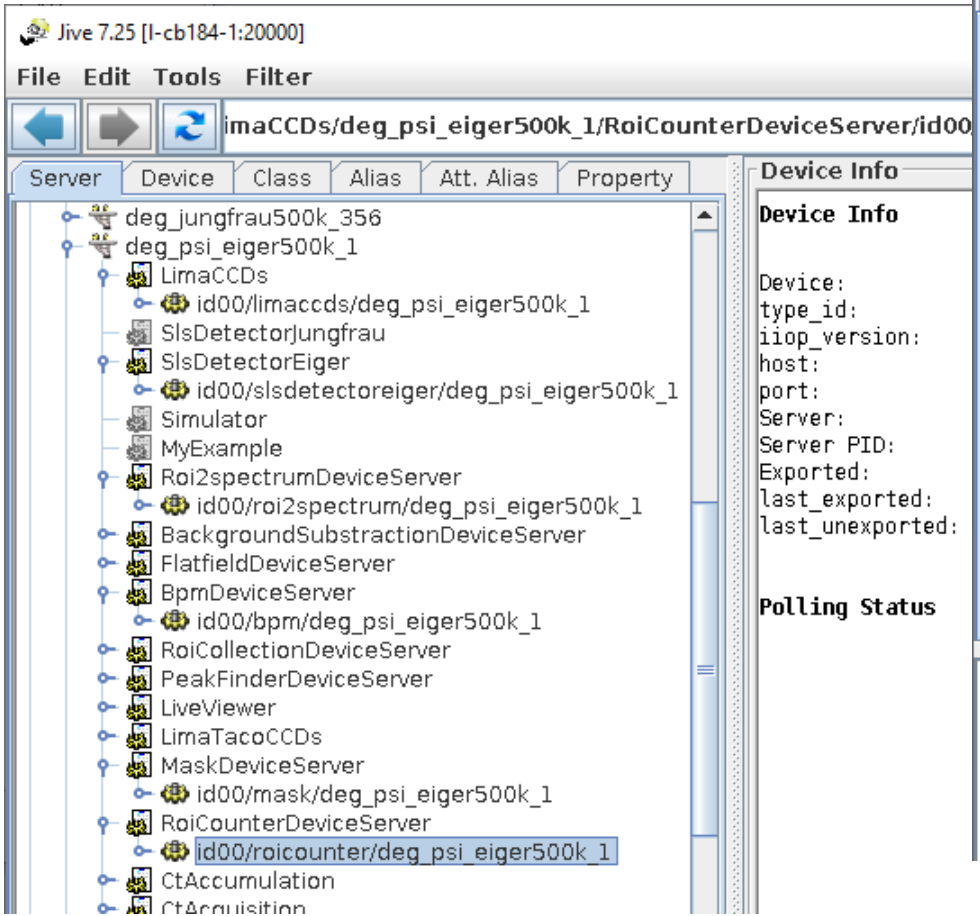
TANGO PYTHON IMPLEMENTATION

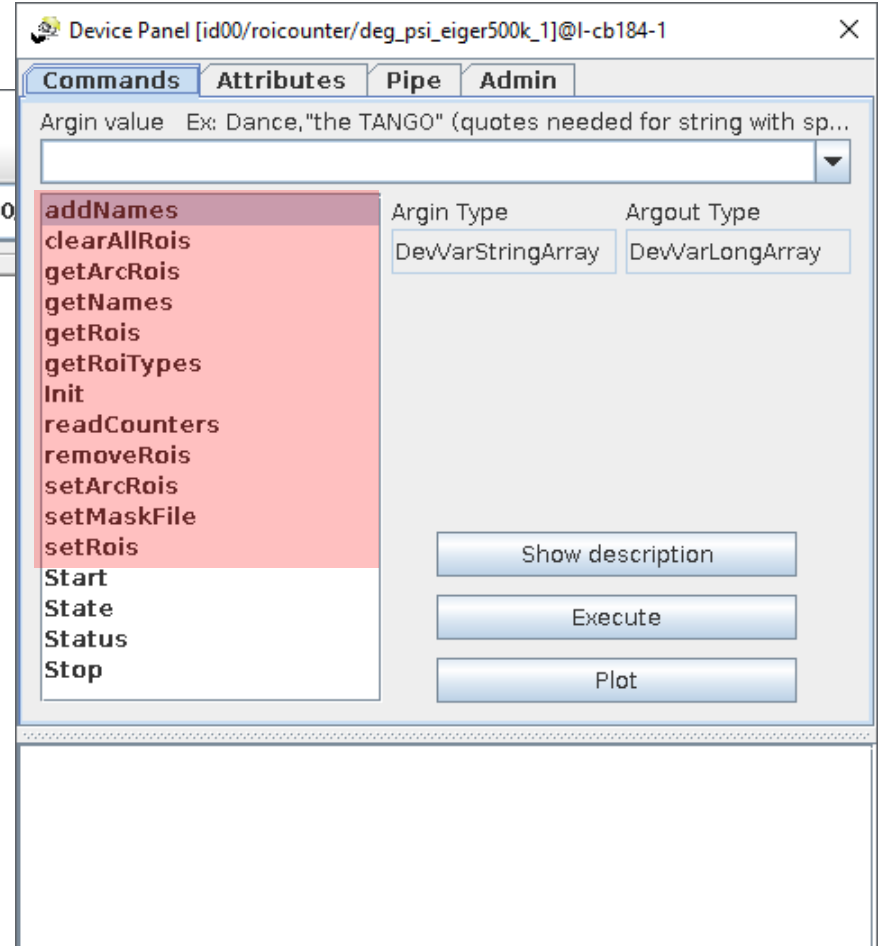
- **Detector specific device**



TANGO PYTHON APPLICATION

- **Processing specific devices**





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

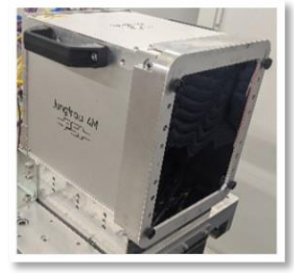
DETECTORS

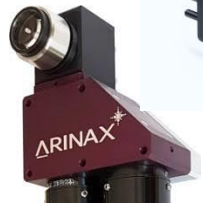
Camera plugins: 44 [active: 32]

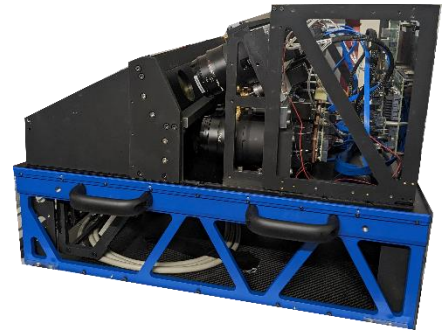
- **ESRF: Frelon & Maxipix**
- **Dectris: Pilatus & Eiger**
- **PSI/SLS: Eiger**
- **pco: Dimax & Edge**
- **Basler, Prosilica, IDS, uEye**
- **Andor, I-Kon**
- **XH, XPAD, XSPRESS3**
- **Perkin Elmer**
- **Photonic Science**
- **ZWO**
- **…**

LATEST DETECTORS

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

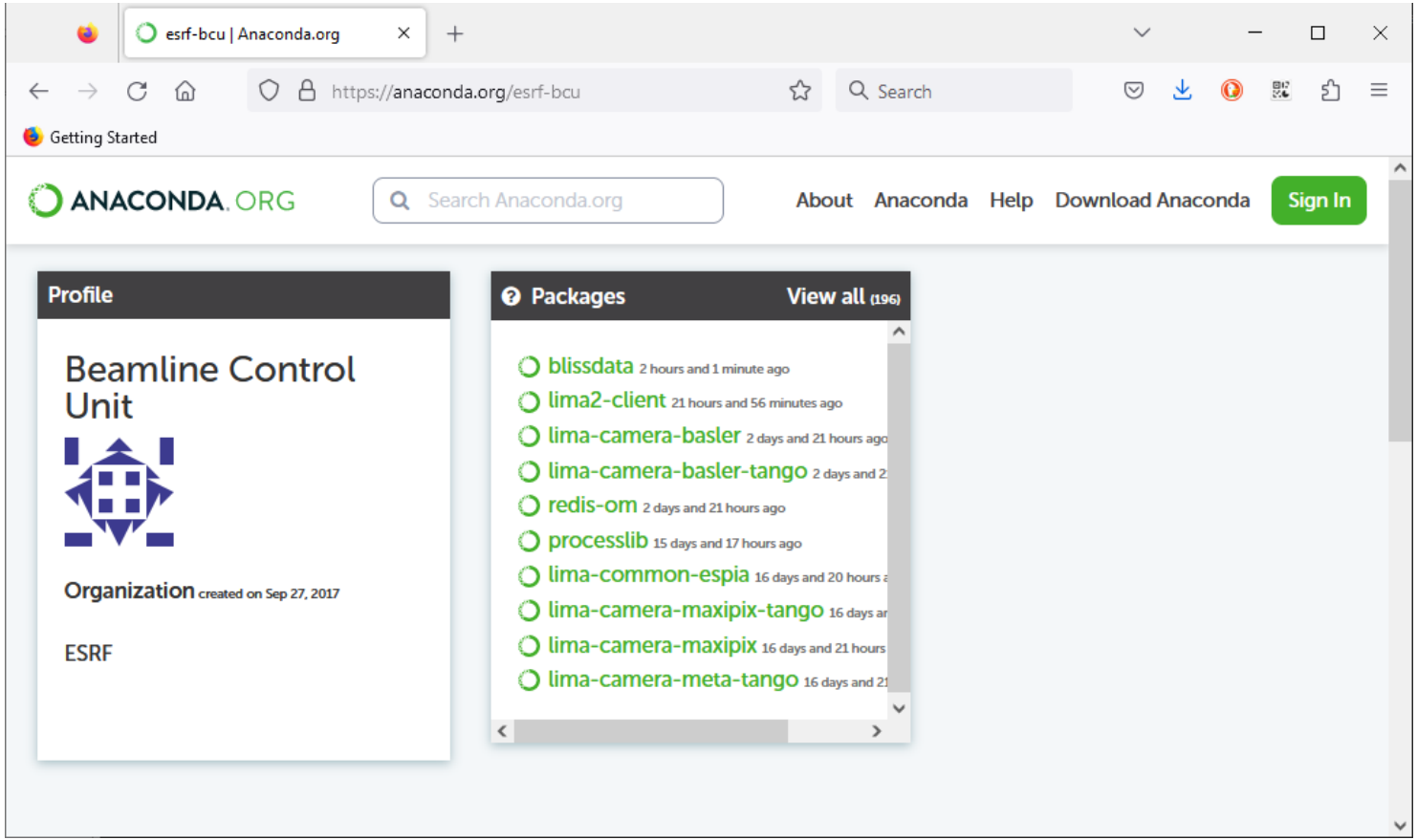






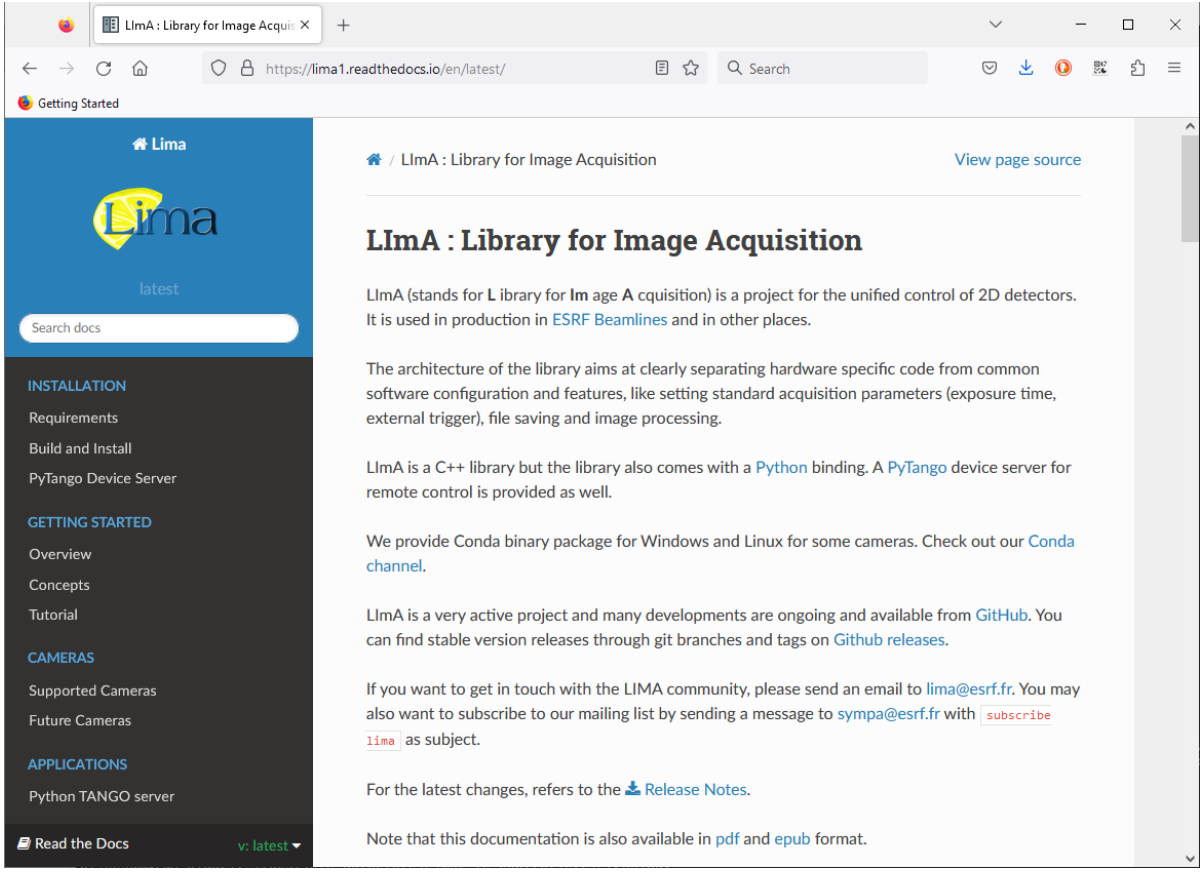
Fraunhofer IIS

PACKAGING: CONDA



Conda channel: *esrf-bcu*

DOCUMENTATION



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!

THE END

Thank you very much!

Any question?