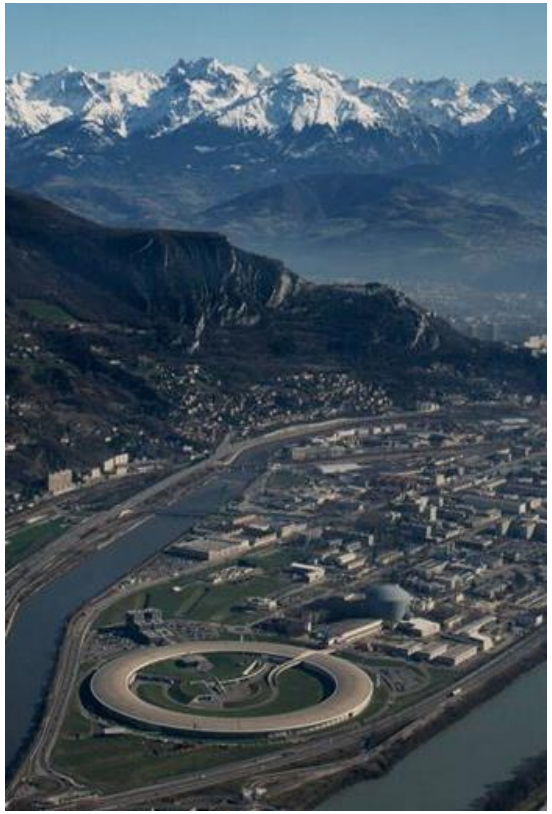

ESRF
The European Synchrotron

BLISS
SOFTWARE ECOSYSTEM



Outline

- **What scientists need**
- **What we have**
- **What can be exported**

Jens Meyer on behalf of the ESRF Beamline Control Unit

WHAT THE SCIENTIST NEEDS

Experiment automation

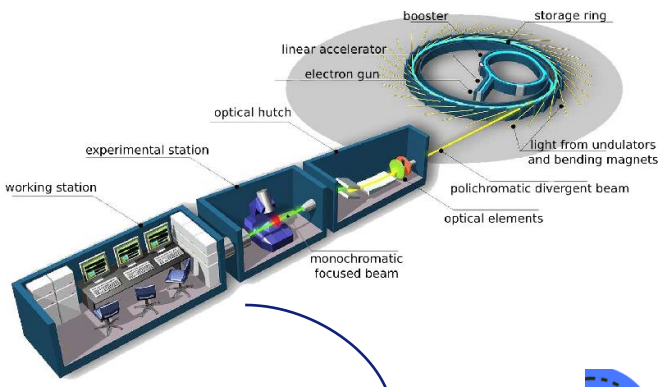
Data acquisition

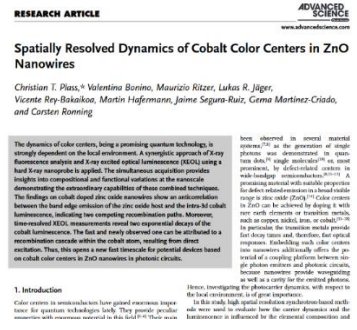
Data and meta data organization

Data reduction

Data analysis

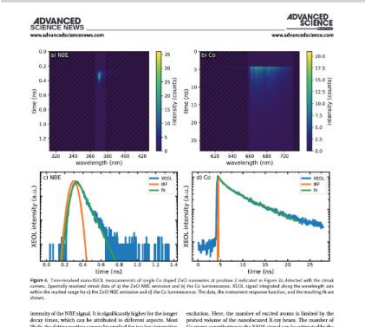
Software: EVERYWHERE from photons to paper publication





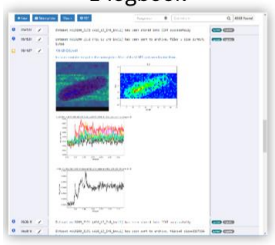
RESEARCH ARTICLE

Spatially Resolved Dynamics of Cobalt Color Centers in ZnO Nanowires

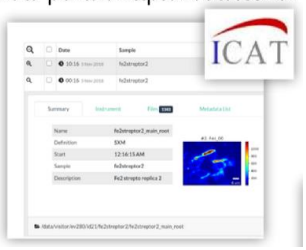


The ESRF Software Ecosystem

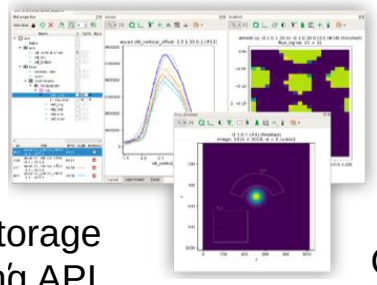
E-logbook



Data portal: https://data.esrf.fr



Live data visualization



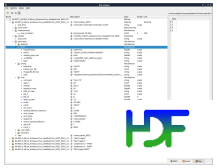
In memory storage and streaming API

On- and offline data analysis workflows

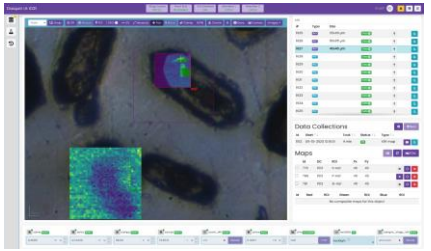
Experiment scripts, user sequences

Sequencing and acquisition

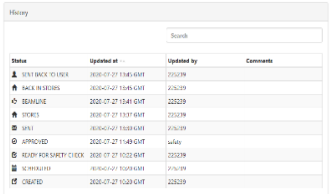
File saving



Experiment GUIs



Sample tracking



Experiment automation

Detector integration

Software modules around BLISS

Base Layer:

- TANGO: The distributes control system
- HKL library: Diffractometer library from F.Picard, Soleil
- LIMA 1+2: 2D detectors image acquisition library, exported as Tango server
- MOSCA: 1D detectors acquisition library, exported as a Tango Server
- FSCAN: Continuous scan library for BLISS based on ESRF synchronization hardware

Administrative Layer:

- Sample Tracking: Tracking of samples send from user institutes. Sample identification for automation with sample changers.
- Data Portal: Registration of all data sets and their meta data acquired for an experiment. BLISS pushes the necessary data to ICAT. Archiving and reloading of data sets. User interface to acquired data.
- E-logbook: Logbook attached to every experiment. Can be filled automatically by BLISS or manually.

Software modules around BLISS

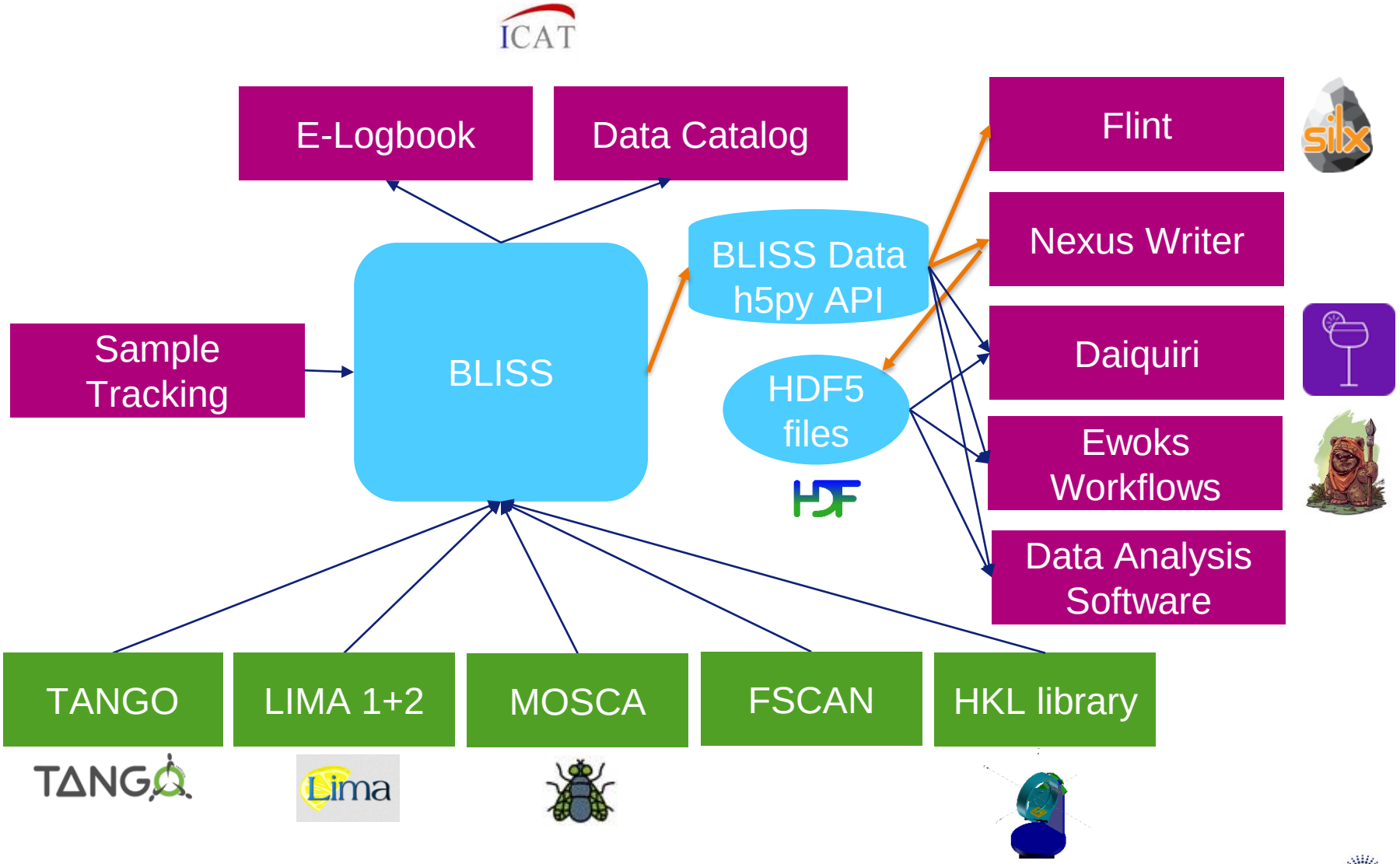
BLISS Layer:

- BLISS: Experiment sequencing and data acquisition system, REDIS as in-memory storage
- BLISS Data: Interface library to stream acquired data from REDIS or from other in-memory data sources.
- Flint: Live data display of acquired data. Can display scan data or user data
- Nexus Writer: Saving of acquired data in a Nexus compatible HDF5 file tree for an experiment

High Level Layer:

- EWOKS: On- and offline workflow system for data reduction and data analysis
- Daiquiri: Web framework for experiment GUIs

Software Modules around BLISS



Common interface for 2D image acquisition

- Starting, stopping, triggering, reading, saving

Common interface for 2D image manipulation

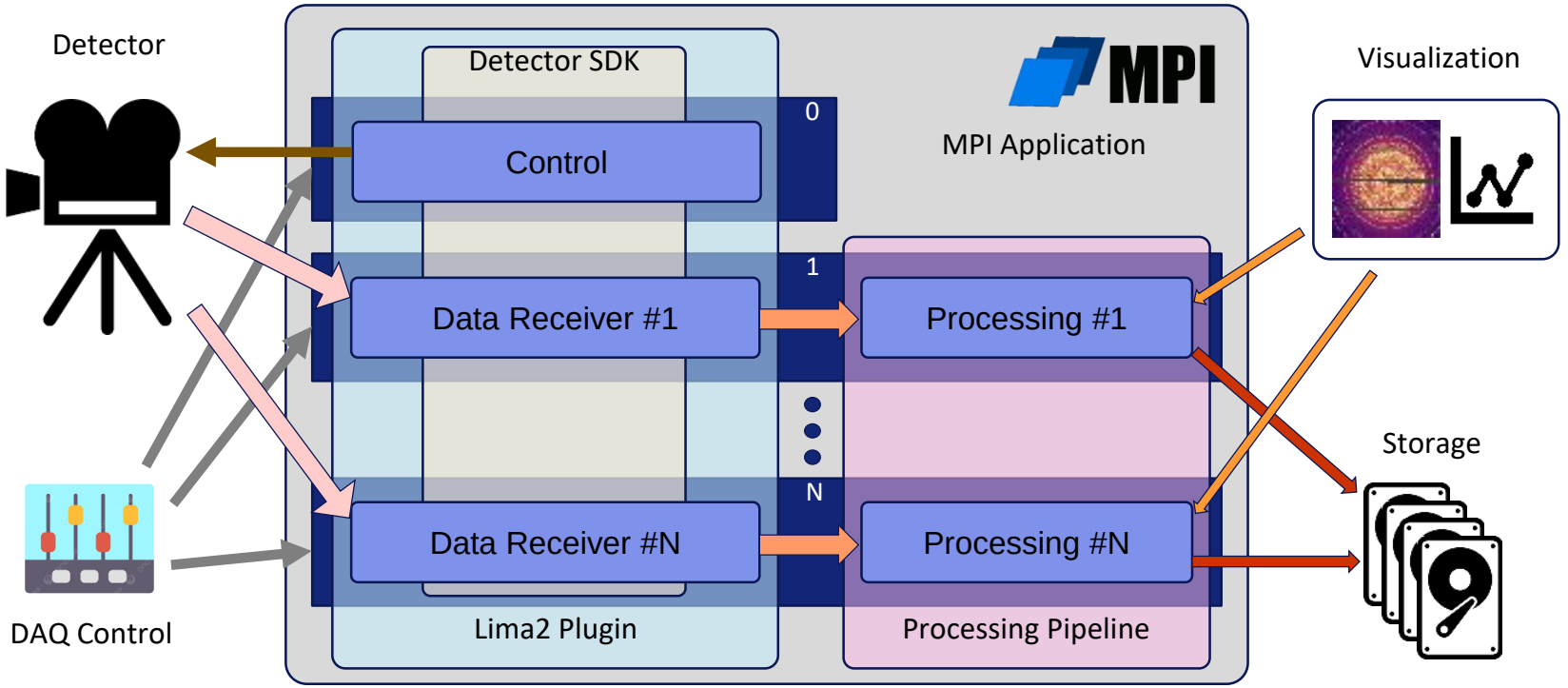
- Binning, flipping, ROIs, ROI collections, dark and flat subtraction, etc

160 detectors running with LIMA at the ESRF

- 14 Frelon
- 17 Maxipix (Single chip, 2x2, 5x1, Meta 2x (3x1))
- 15 Dectris Eiger2
- 10 Dectris Pilatus3
- 70 GigaE video camera: Basler, Prosilica, PointGrey, uEye
- 4 Andor I-Kon ccd, Zyla, Neo, Marana cmos
- 4 imXPAD
- 10 PCO Dimax & Edge, Edge HS, 2K, Camlink and USB
- 3 Perkin Elmer flat panel
- 2 Dexela flat panel
- 2 RoperScientific (aka Princeton)
- 3 Rayonix HS ccd
- 2 PSI Eiger 2M and 500K, 2 JungFrau 4M
- 1 FLI ccd
- 2 Advacam Minipix
- 2 Tucsen Dhyana cmos

Provide scalable data acquisition and low latency processing

Evolution of LIMA towards distributed systems



MOSCA

Common interface for 1D data acquisition

- Starting, stopping, triggering, reading, saving

Common interface for 1D data manipulation

- ROI, statistics

Available detectors

- Mercury, FalconX, OceanOptics, Hamamatsu, XGLab

Still under development

Command line driven data acquisition sequencer written in Python

Main concepts

- **Hardware abstraction layer** for all instrumentation used during a data acquisition sequence

  Motors, counters, monochromators, spectrometers, diffractometers, 2D detectors, etc.

- **A generic scan engine** for step and continuous scans

  The use of trajectories and HKL space is possible with all scans

- **Decoupling of data acquisition** from data saving and analysis

  All data buffered in memory. Allows higher acquisition speed without blocking

- **Coherent HDF5 storage** of all acquired data at high speed and for large data volumes

  All data of a proposal, its samples and the produced datasets is saved as a coherent HDF5 data tree

- **Live data display** of all acquired data

  Immediate visibility of acquisition results for the user

- **Easy configuration** of hardware and experimental environment

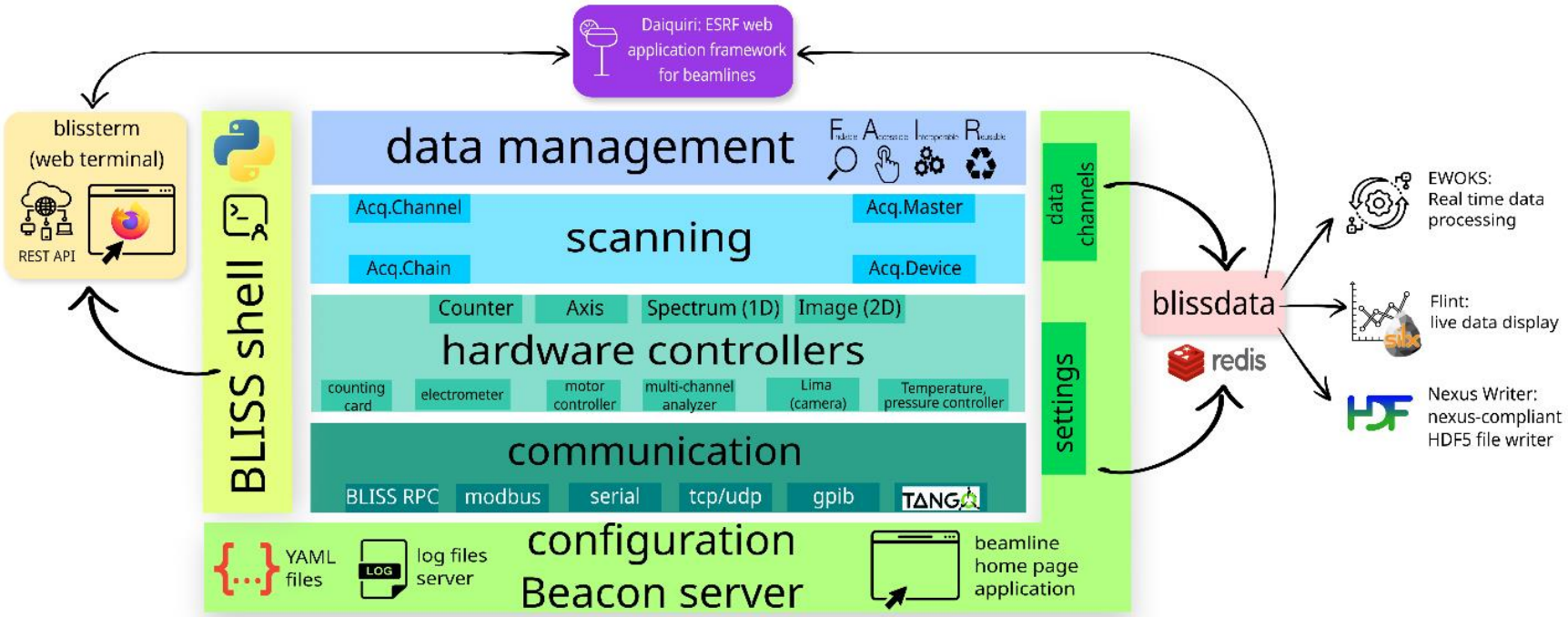
  Switch between predefined acquisitions set-ups on the fly

- **PyTango** to interface any device from the Tango world

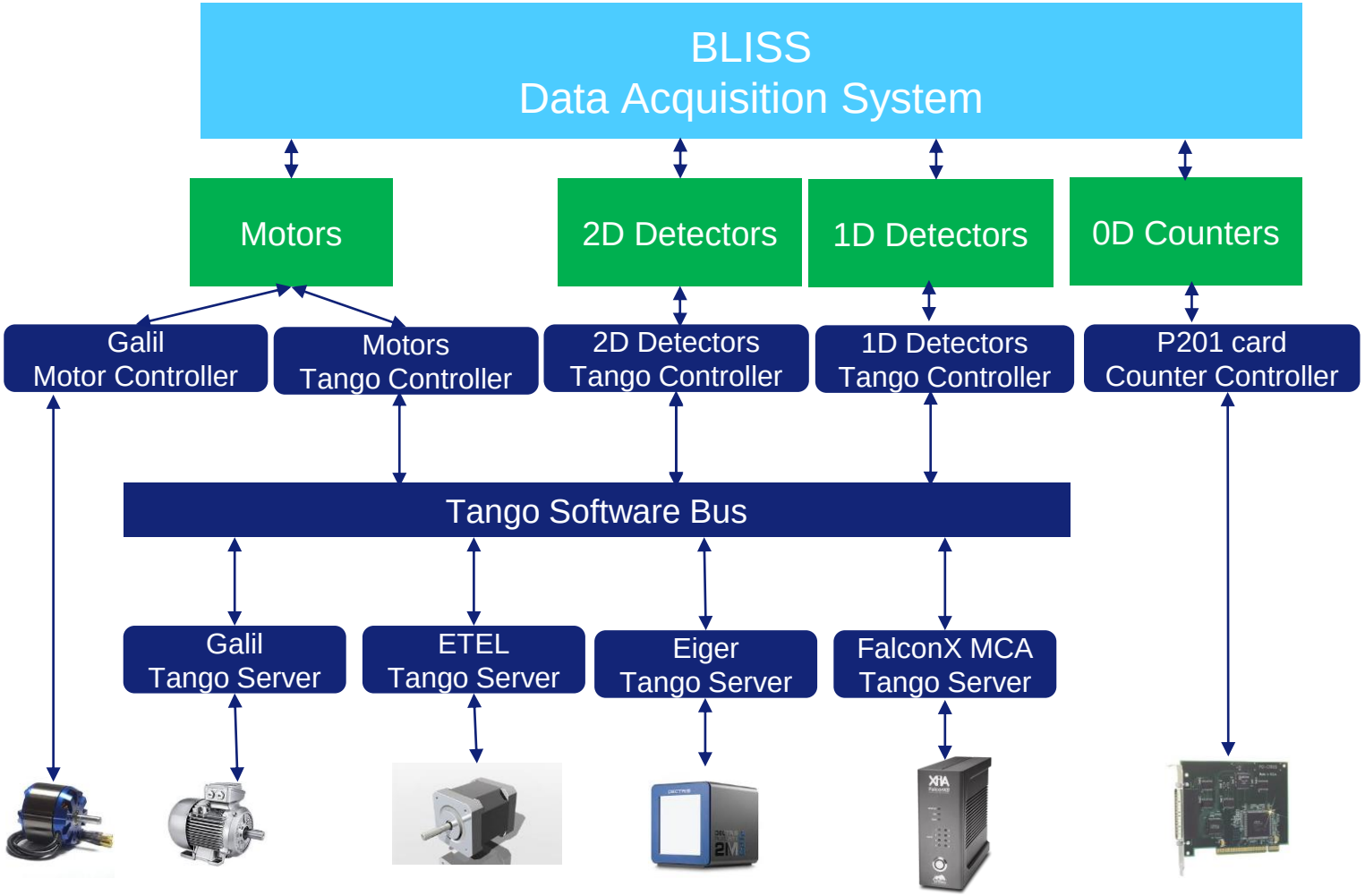
  https://www.tango-controls.org

https://bliss.gitlab-pages.esrf.fr/bliss/master

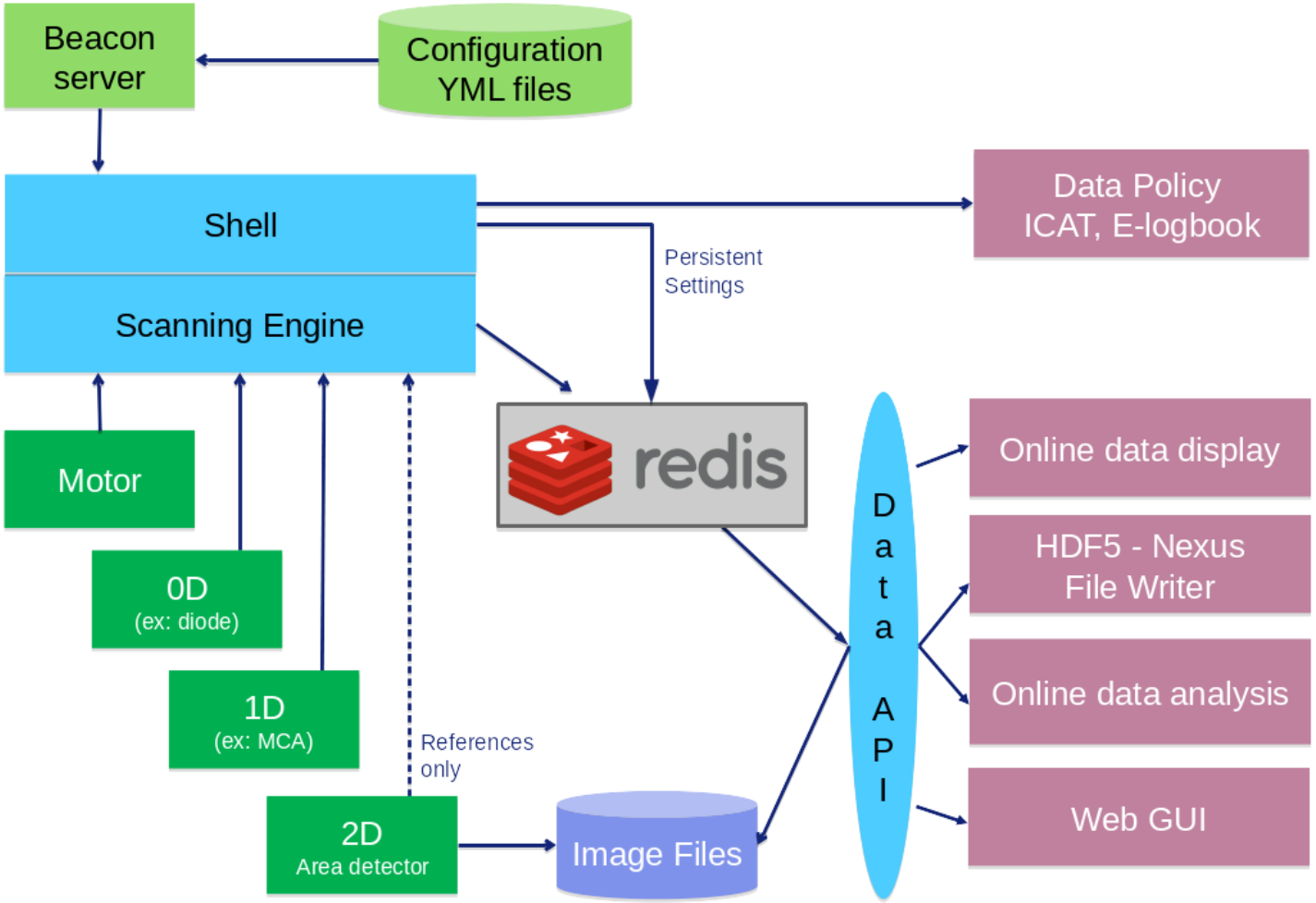
Schematic view of the BLISS software layers



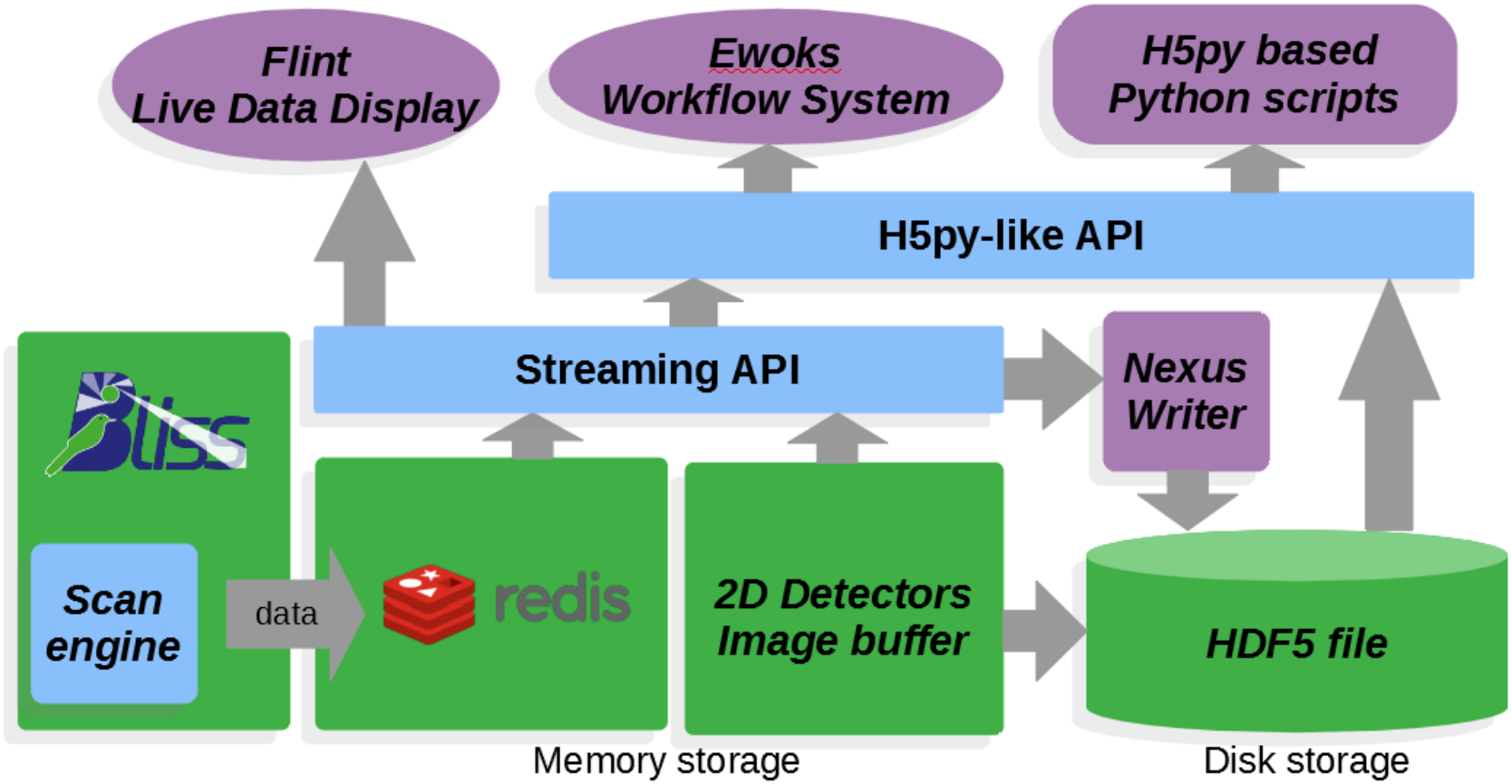
Direct hardware access or underlying control system?



Decoupling of data acquisition from data saving and analysis



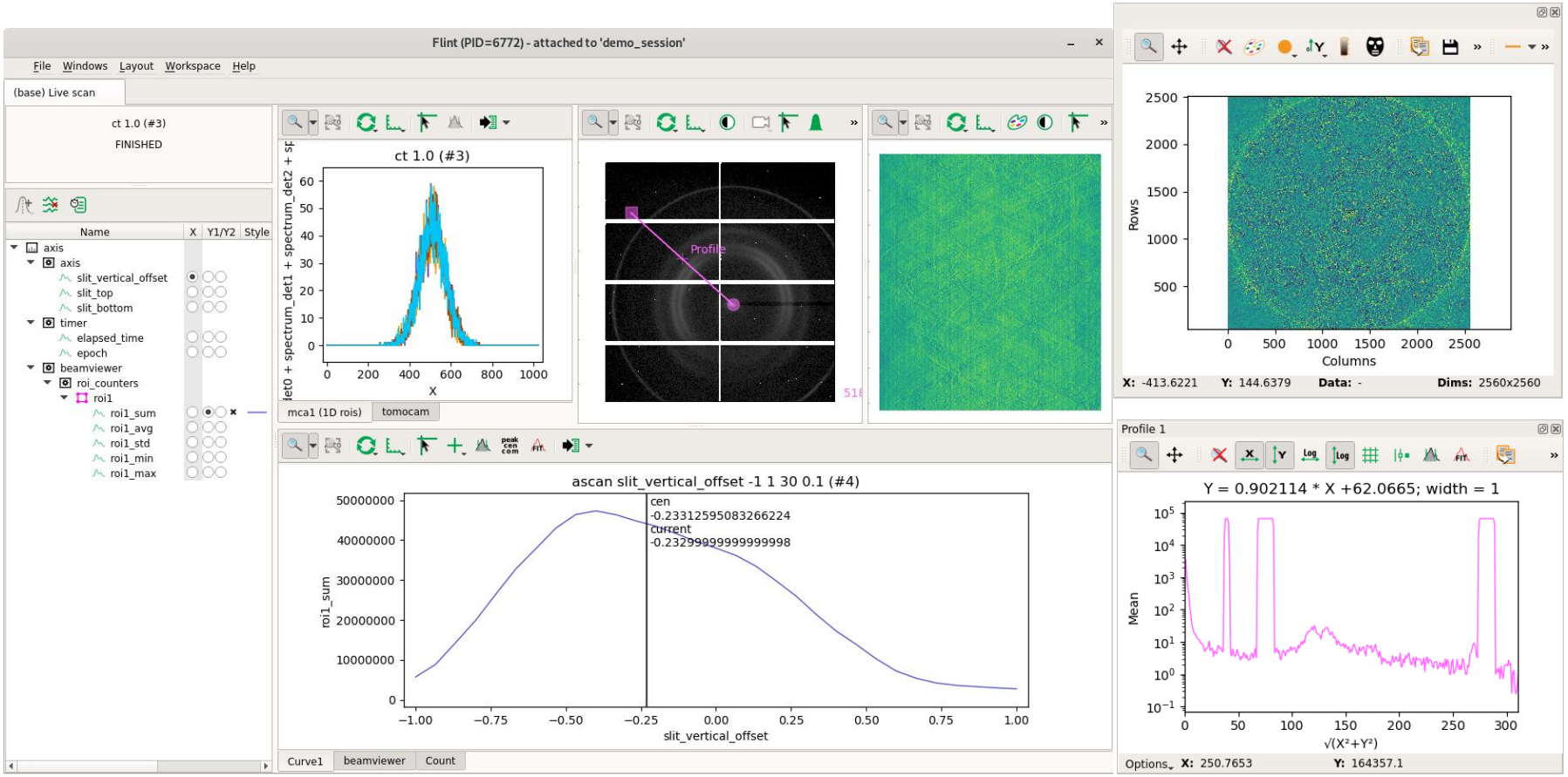
Data streaming APIs



Flint - Live data display

Live scan data

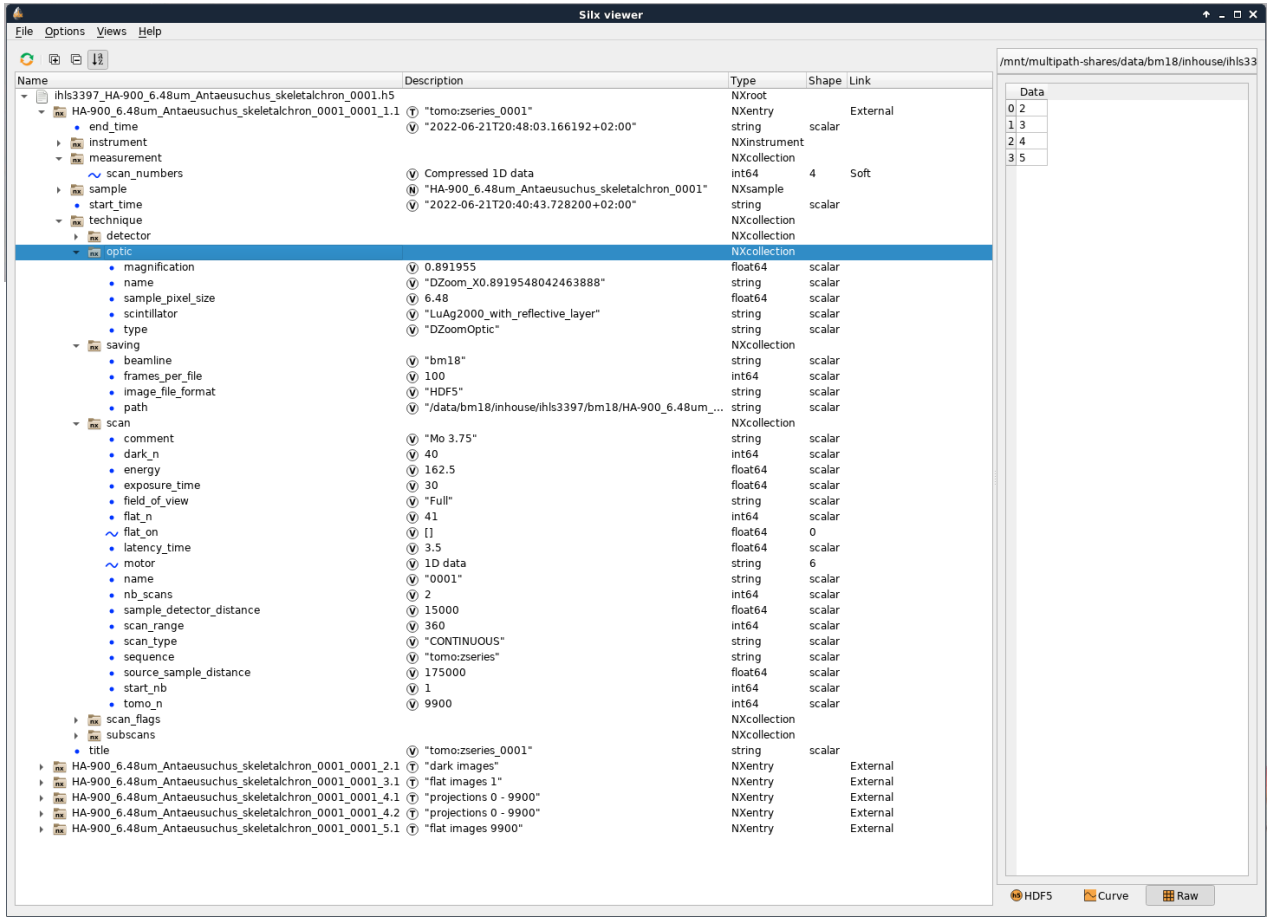
Calculated data can be pushed to Flint



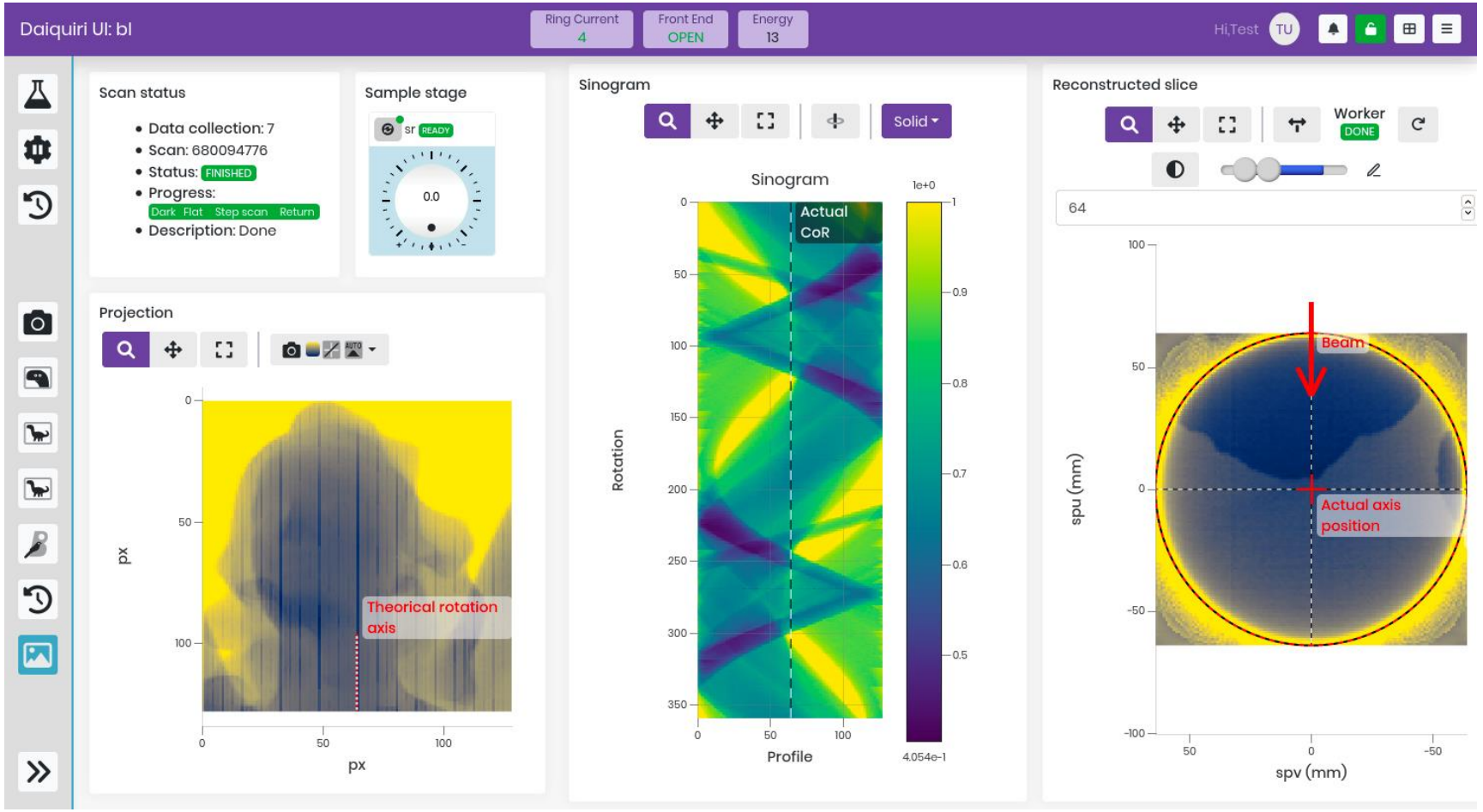
NEXUS Writer - Scan data and meta data saving

HDF5 files with Nexus tags

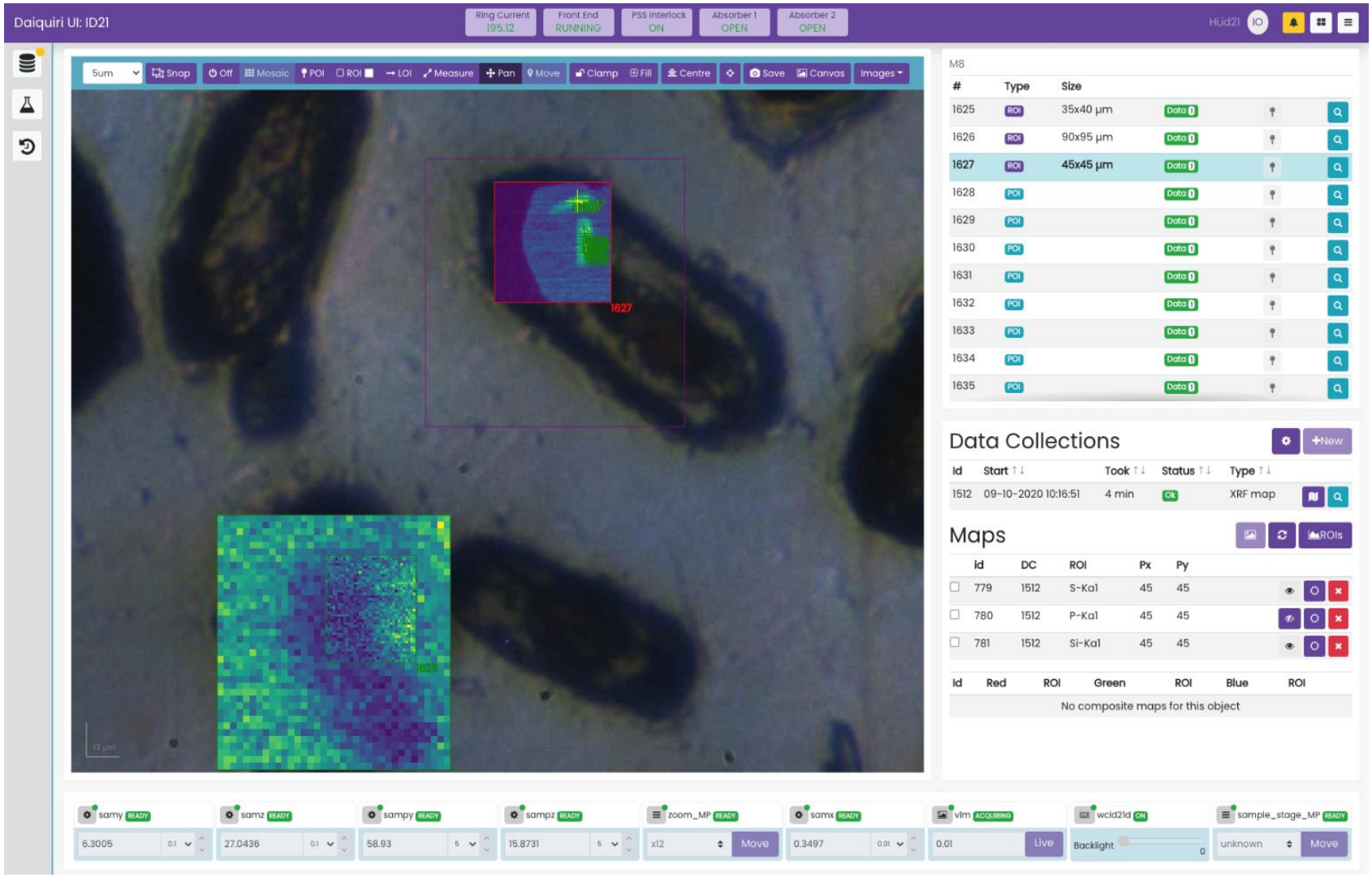
Coherent HDF5 file tree for all data sets of an experiment



Experiment GUI examples: Tomography

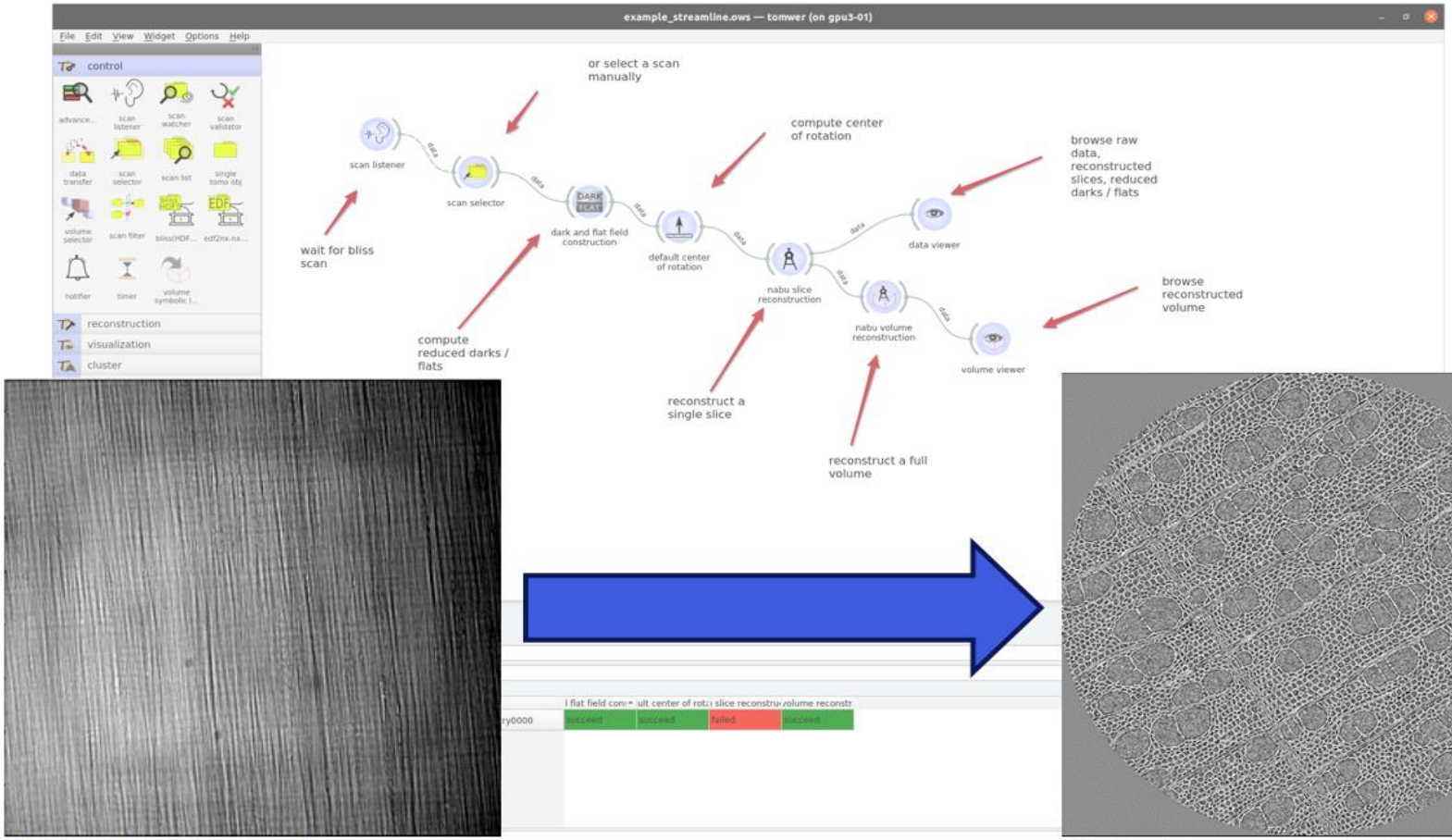


Experiment GUI examples: XRF Mapping



Workflow for Tomography reconstruction

Tomography reconstruction (ID19, BM05, BM18, ID11, ID16B)



Inputs: BLISS scan data
(darks, flats, projections + metadata)

Outputs: reconstructed volumes

Workflow for EXAFS visualization

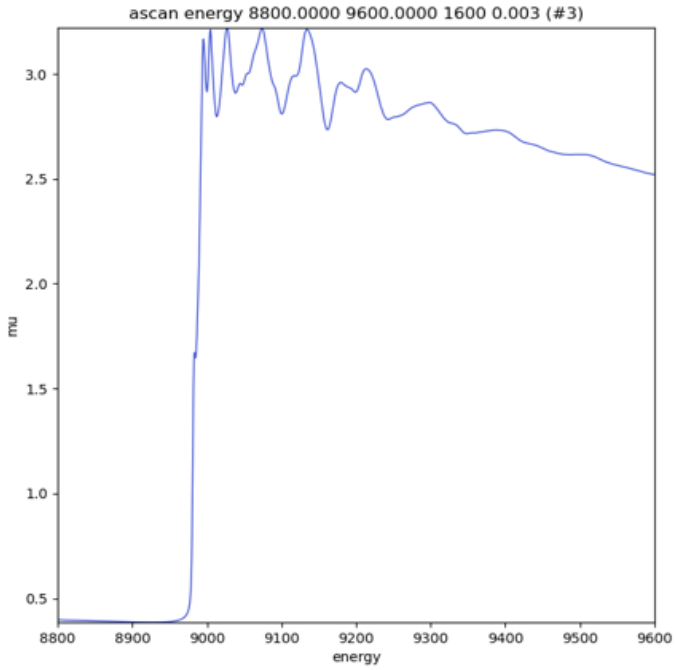
EXAFS visualization (BM23)

Data acquisition

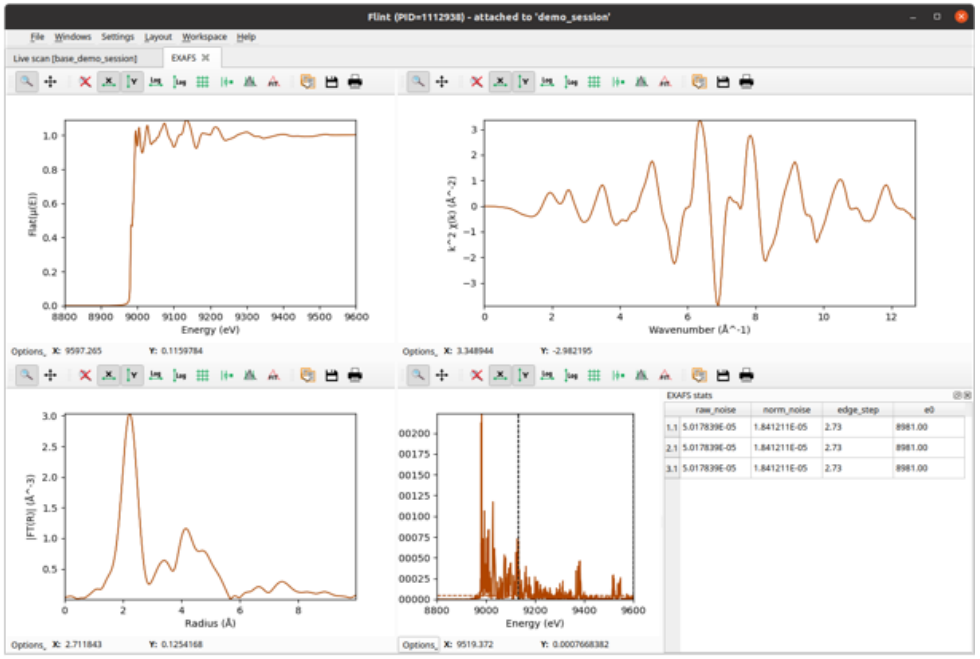
Bliss

Bliss

On-line EXAFS visualization



EXAFS spectrum



Parameter space in which scientific decisions are made

WHAT CAN BE EXPORTED

Collaboration is possible on all the different software modules!

Tango, LIMA and the HKL library are already collaborative projects

Data Portal and E-logbooks have been presented to other institutes

BLISS Data API with Flint and NexusWriter

- Prototype version at ALBA connected to Sardana
- Prototype version at DESY connected to Bluesky
- Prototype version at SLS connected to BEC

EWOKS is a meta workflow system that uses other workflow systems for automating experiments and data processing adapted to the use case.

DAIQUIRI

- Completely independent from controls system and scan engine
- Proof of concepts at SLS connected to BEC, DESY connected to Bluesky
- daiquiri-lib for shared UI components without committing to a full framework

CONCLUSION

BLISS and EWOKS in daily operation on 35 beamlines

Abstraction for scanning (step or fly)

The use of trajectories and HKL space is possible with all scans

Live data display for all acquired data

Standardized HDF5/Nexus file tree for all data acquisition

In memory data buffers for on-line data analysis

Standardized data extraction API for on- and off-line data

On-line data processing at detector level (LIMA) or with workflows

Web GUIs for scientific applications

THANK YOU

Acknowledgements to

- The members of the software group for the development of all the different software tools

- Any Questions?