XLive: Data Acquisition and Visualization at the NSLS-II ISS Beamline

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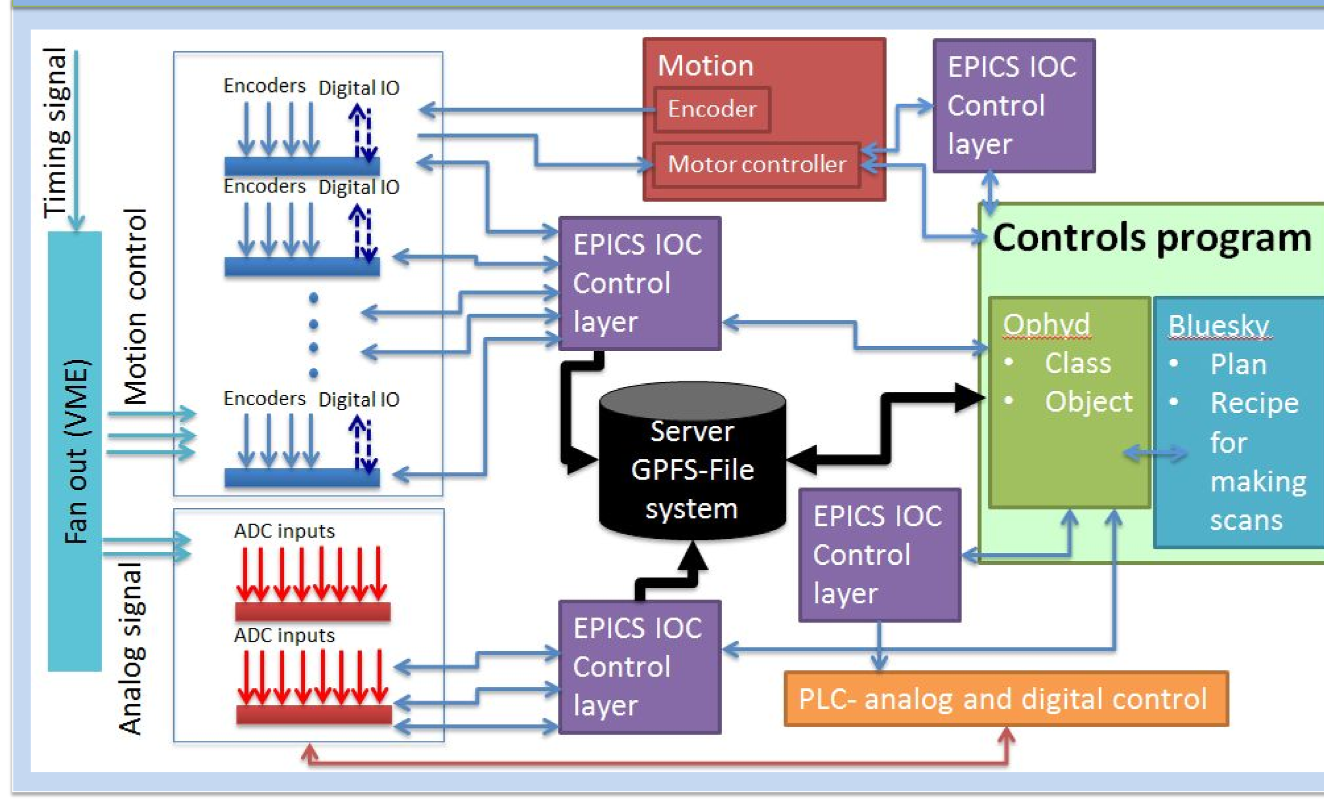
ABSTRACT

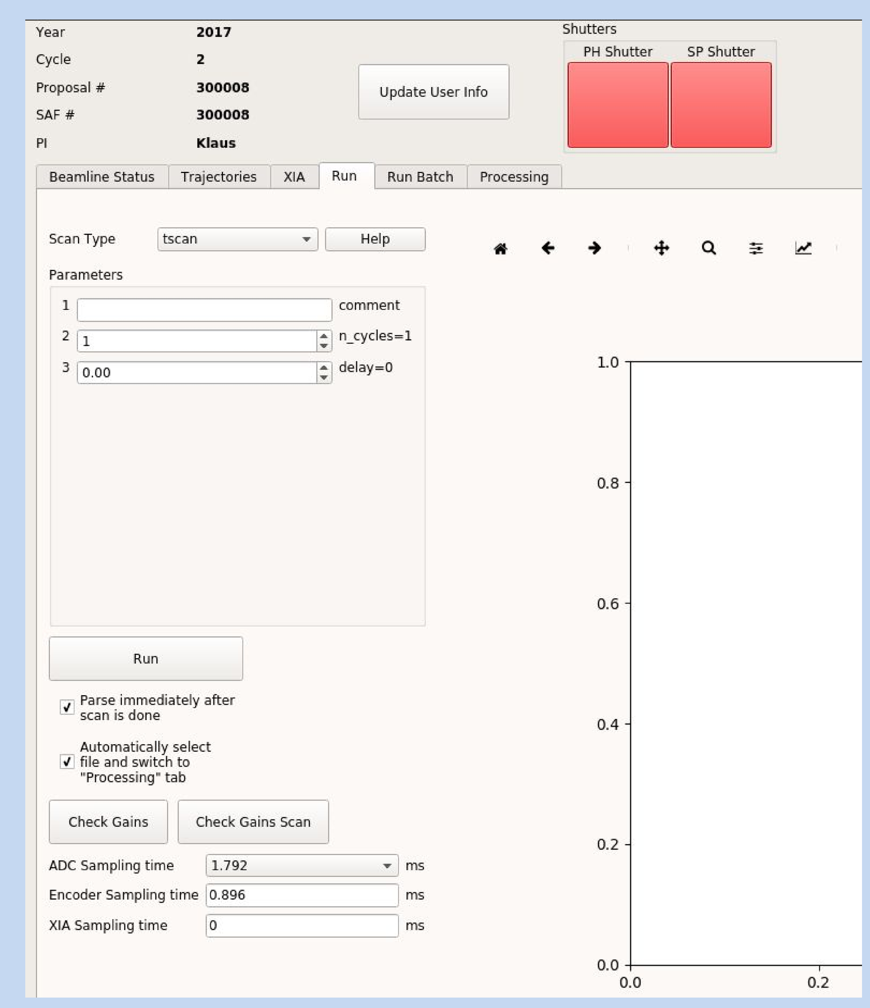
Asynchronous data acquisition at the Inner-Shell Spectroscopy beamline at NSLS-II is performed using custom FPGA based I/O devices ("pizza-boxes"), which store and timestamp data using GPS based clock. During motor scans, incremental encoder signals corresponding to motion as well as analog detector signals are stored using EPICS IOCs. As each input creates a file with different timestamps, the data is first interpolated onto a common time grid. The energy scans are performed by a direct-drive monochromator, controlled with a Power PMAC controller. The motion is programmed to follow the trajectory with speed profiles corresponding to desired data density. The "pizza-boxes" that read analog signals are typically set to oversample the data stream, digitally improving the ADC resolution. Then the data is binned onto a energy grid with data spacing driven by desired point spacing. In order to organize everything in an easy-to-use platform, we developed XLive, a Python based GUI application. It can be used from the pre-experiment preparation to the data visualization and exporting, including beamline tuning and data acquisition.

Data Acquisition System Overview

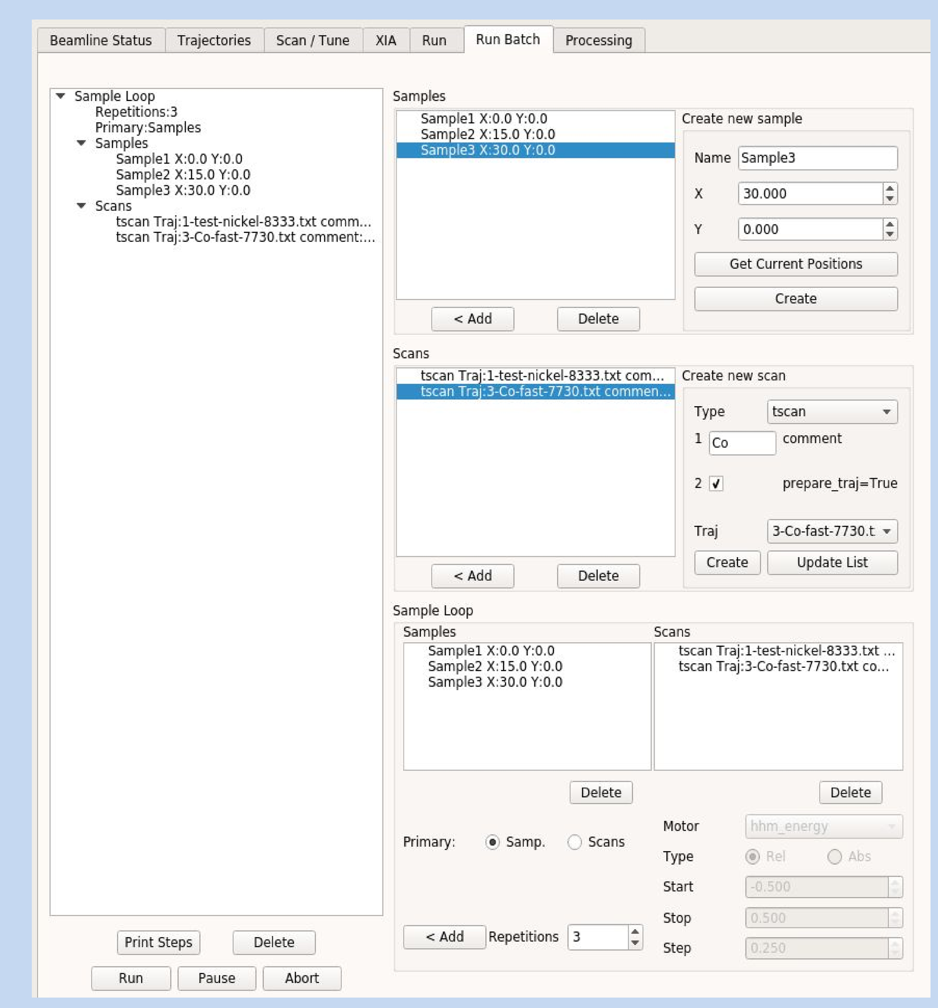


Background

- ❑ Fly-scan an energy range by moving the monochromator while collecting data from multiple detectors.
- ❑ Fast and asynchronous data collection allows the beamline to get to the next level of complexity for spectroscopy measurements: n-dimensional data sets.
- ❑ GUI application (Python) to handle everything needed by the beamline from the pre-experiment preparation to data acquisition, visualization and processing, being as simple as possible for users and as flexible as possible to be eventually exported to other NSLS-II spectroscopy beamlines .
- ❑ The beamline has analog inputs, digital outputs that can be used as triggers and digital inputs available, which makes it accessible to an assortment of detectors that can be integrated into the data acquisition system to fulfill users' needs.



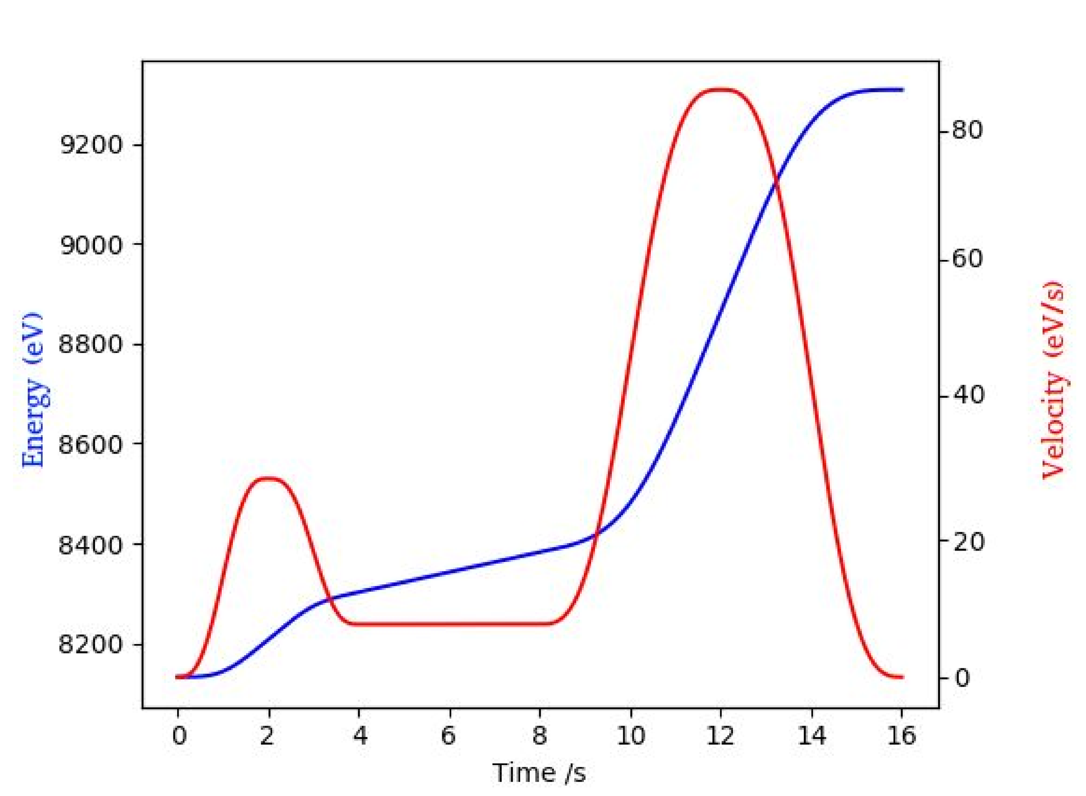
- **XLive's GUI - tabs and controls**



- **Batch mode configuration example**

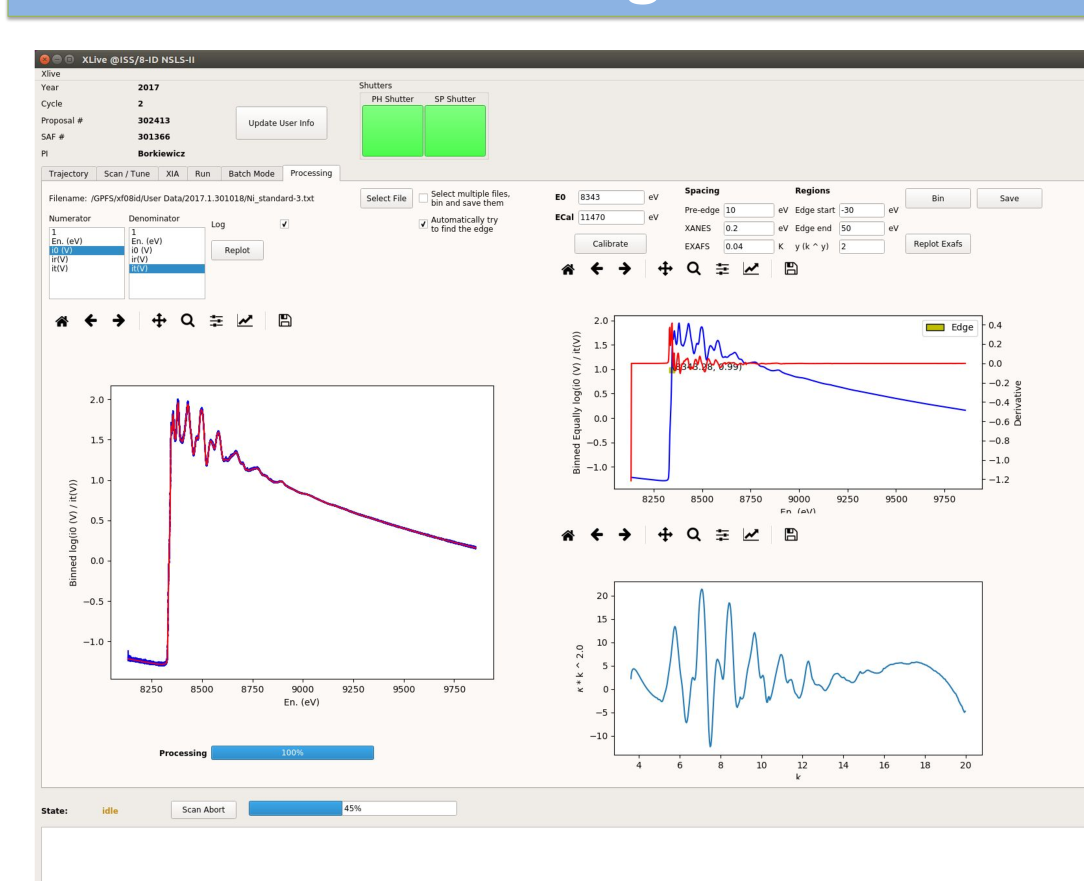
ISS Operation

Monochromator Trajectory



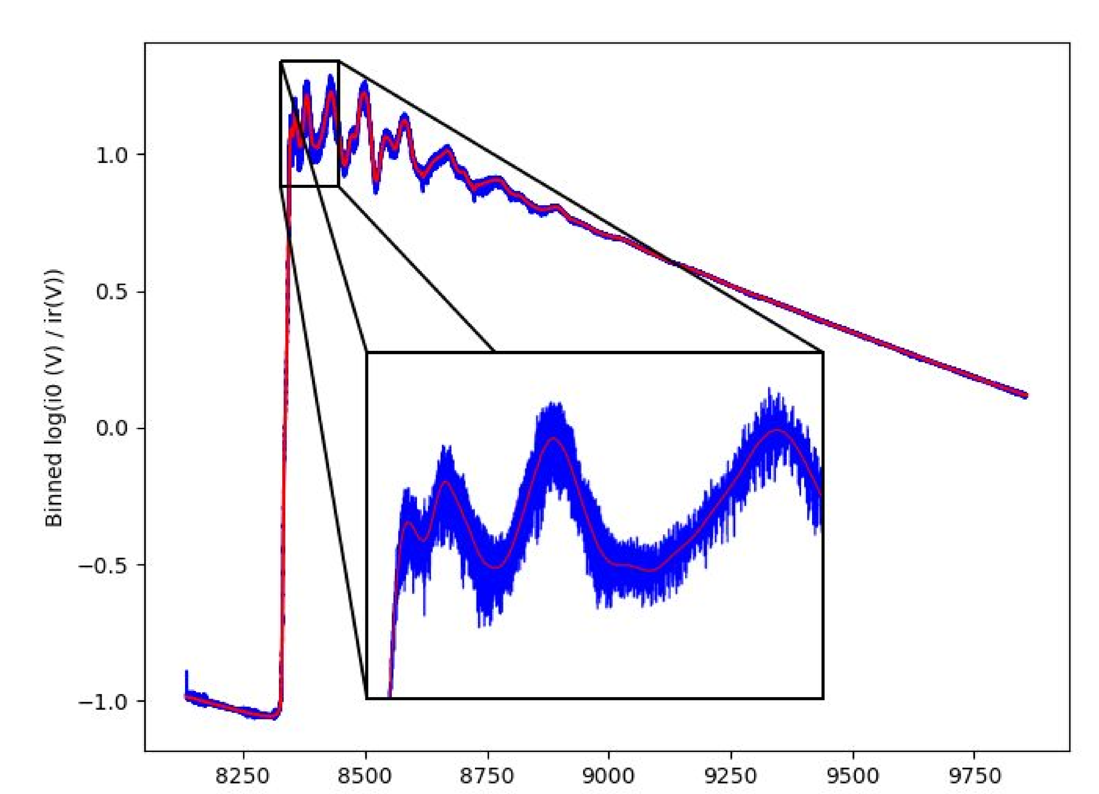
Double Sine/Constant Edge trajectory: The user defines the first, last and edge positions (eV), pre-edge and post-edge durations (s) and the edge velocity. The monochromator will follow this trajectory when the user is running scans.

Processing Tab



After running the scans, the last step is opening the data, binning and exporting it. The last tab of the software, "Processing", is used for that. The exported file typically has around a thousand points after binning – typical number for spectroscopy measurements.

Gaussian Binning Output



The binning is done using a Gaussian Filter, by a convolution of the original data and a Gaussian function.

CONCLUSIONS

- ❑ Handling everything a beamline needs from experiment preparation to data acquisition and processing can be complex. XLive is able handle multiple operations and provides the best option to make its usability better and to make it easier to port to other beamlines.
- ❑ The next steps will be to integrate tools for data analysis to the system, reducing the need for third-party software and rewrite part of the code to make it even easier to port to other beamlines.

Further details

- ❑ The minimum acquisition time for analog inputs is 1 µs. Typically the acquisition time used is around 1 ms (after hardware averaging).
- ❑ Each device is controlled by and share data through an EPICS IOC, which is responsible to control data acquisition, triggers and to generate data files.