Building Ophyd Objects for CXI Jet Tracking

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Introduction

In Coherent X-ray Imaging (CXI), user groups use hard x-rays from the LCLS to perform x-ray crystallography by shooting samples of protein crystals into the x-ray beam. The goal of my project was to automate CXI sample delivery through tracking and moving the sample jet, which would make it easier for users to conduct their experiments accurately and consistently. This required two parts, writing the jet tracking algorithms, and building Ophyd objects for the CXI instruments to allow us to control and read information from them.

Keywords: LCLS, CXI, jet tracking, Ophyd objects

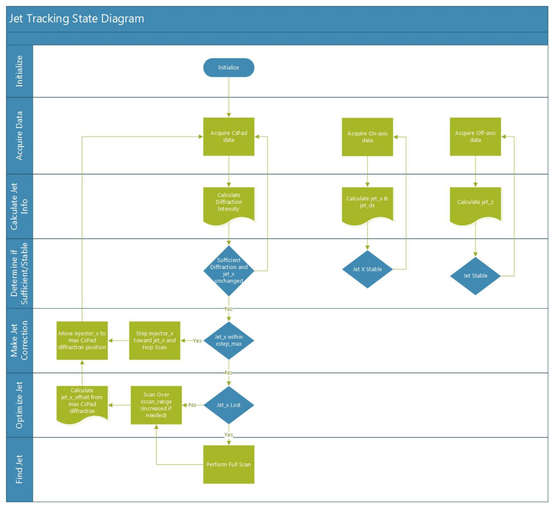

Fig 1. Jet tracking processes

Jet Tracking

As it is difficult to move the x-ray beam, to perform experiments user groups must instead move the sample jet to the x-rays. Automating this sample delivery system requires us to be able to track the positions of the x-ray beam and of the sample jet, then move the jet to the x-ray interaction point using the sample injector.

Matias Arola wrote several Python methods to allow us to determine the position of the jet from the camera in the sample chamber. I then implemented these methods in the CXI Hutch Python.

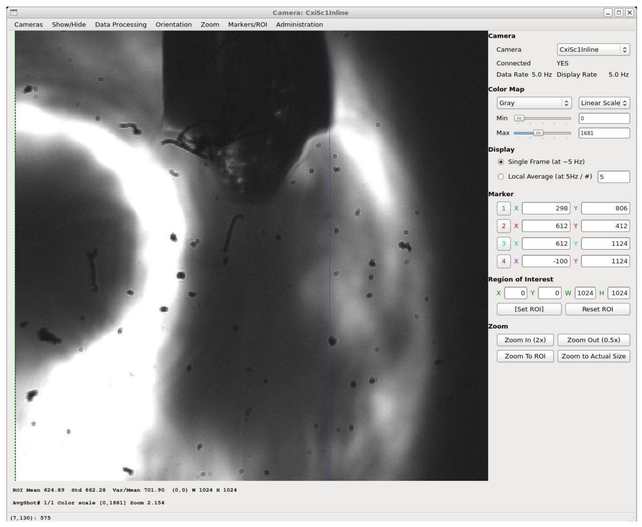

Fig 2. Water jet used for testing

Ophyd Objects

To be able to control and get information from the CXI instruments, Ophyd objects must be built.

Ophyd is a Python library that allows us to represent hardware as Python 'Ophyd devices.' Each Ophyd device is made of many different components, usually EpicsSignals. The modularity of Ophyd objects allows us to add new devices, components, and/or methods as needed.

Once the objects are built, we can then use these Ophyd devices to read and put to the instruments.

Testing

The jet tracking methods were written using old recorded data. Though we started live testing using a water jet, currently the illumination in the sample chamber is not good enough to clearly show the jet. Thus the accuracy and consistency of the jet tracking results is still unclear and further testing is needed.

Testing of the Ophyd objects has demonstrated that we can successfully control the CXI instruments using Python code.

Injector
- *3 coarse motors (coarseX, coarseY, coarseZ)*
- *3 fine motors (fineX, fineY, fineZ)*

Sample Delivery System

Selector
- *remote control enabled, connection status*
- *flow, flow state, flow type*
- *FM, FM rb, FM reset*
- *names*
- *4 shakers*

Flow Integrator
- *10 'channels'*
  - *starting volume, flow rate, estimated depletion time*
- *names*

Pressure Controller
- *connection status*
- *2 channels*
  - *pressure, enabled status, high pressure limit, pressure set point*

Cooler/Shaker
- *reboot*
- *2 channels*
  - *temperature, set point, set set point, current*

HPLC
- *status, run, clear errors*
- *flow rate, set flow rate, flow rate set point*
- *pressure, pressure units, maximum pressure, set maximum pressure*

Questar (PCDSDetector)
- *ROI, ROI_stats, ROI_image*
- *from PCDSDetector: image, stats*

Fig 3. Ophyd devices built for CXI

Conclusions

Building Ophyd objects allows us to control hardware instruments using code. This allows us to write methods to automate processes such as jet tracking. In the future other processes may also become automated, making it easier for users to use the instruments.

Acknowledgments

Use of the Linac Coherent Light Source (LCLS), SLAC National Accelerator Laboratory, is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under Contract No. DE-AC02-76SF00515. Special thanks to Jason Koglin, my mentor, and Matias Arola, who worked with me on this project.

Date: 08/24/2018