RECENT CHANGES TO BEAMLINE SOFTWARE AT THE CANADIAN LIGHT SOURCE*

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Abstract

The Canadian Light Source (CLS) is a world-class, state-of-the-art facility that is advancing Canadian science, enhancing the competitiveness of Canadian industry and contributing to the quality of life of people around the world. Our commitment is to be a world-leading centre of excellence in synchrotron science and its applications by working with the scientific community to promote the use of synchrotron light, promoting industrial partnerships and innovation, and engaging in scientific and educational outreach. Part of obtaining this goal is ensuring that the software at the beamlines provides the best tools for running experiments.

THE CHALLENGES

The beamlines at the CLS vary in their intended use. The types of controls and detectors must match the range of types of experiments. The software must be capable of supporting both the researchers new to synchrotron science and the researchers with many years of experience running experiments. Similar types of experiments may have totally different expectations from different user communities.

CROSS-BEAMLINE SOFTWARE

A major undertaking within the Experimental Facilities Group (EFD) at the CLS has been the development of Acquaman experiment management software. This has been successfully deployed at the SGM, REIXS, and VESPERS beamlines with more beamlines expected to be added in the near future.

The CLS developed Science Studio in collaboration with IBM and University of Western Ontario. As well as being available for use at the VESPERS beamline, Science Studio is used at the Nanofabrication Lab at UWO.[1] Beyond providing a general framework to manage experiments, Science Studio also provides a method for remote control of an experiment and for remote access to data. Interest has been shown in Science Studio by other facilities.

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BMIT (05B1-1, 05ID-2) BEAMLINES

Recent software development on the Biomedical Imaging and Therapy (BMIT) beamlines has focused on the 05ID-2 insertion device beamline, the second of two biomedical beamlines of the BMIT facility. An imaging program on the 05ID-2 beamline is now slated to begin in January 2014. Software development in support of this imaging program has included operational software for a number of large positioning devices, such as the POE-3 Optics Table, SOE-1 Camera Positioner, Large Animal Positioning System (LAPS), and Microbeam Radiation Therapy (MRT) Lift. In addition, software has been developed to operate the second of four monochromators on this beamline: the K-Edge Subtraction (KES) mono. This single bent Laue crystal monochromator produces a beam which is deflected at an angle either above (up bounce mode) or below (down bounce mode) the horizontal plane. Accurate positioning of both height and angle of all four downstream positioning devices, and the movable shutter at the end of its optics hutch, becomes critical when using this monochromator.

As well as operational software, additional monitoring software has also recently been developed for the 05ID-2 beamline. This includes: software to monitor hutch conditions such as humidity, temperature and air flow, and to remotely adjust all settings as required for various experiment and sample types; software to monitor power hitting each component along the beamline; software to track total beam exposure time at each location along the beamline etc. In addition, ease-of-use features have been deployed, such as an integrated main beamline operations screen which includes a dashboard of indicators to quickly alert the user of any problems with machine protection components, a summary of currently selected beamline settings on the main screen, and a point from which to launch other operational software. Beamline status screens feature a 3D beamline model showing staff the exact location of any problems on the beamline.

The majority of the BMIT 05ID-2 beamline software has been developed using CLS' standard of EPICS IOC programs and EPICS EDM or Qt / Python GUIs, with Pro-Dex MAXv / VME-based motor control. The exceptions to this are the control programs for the LAPS and MRT Lift. In these cases, the main control program was written in C, communicating via Modbus to the Bosch motor drive-integrated PLCs for these devices, with GUIs developed using Qt and C++.

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To enable beamline staff to capture and record details of their experiment setup and operating conditions, BMIT's "Logit" application has been created and deployed. Information is both recorded to a database and summarized as an "automatic logbook" entry for users. Beamline settings, information about the particular detector in use, and detector settings, can all be captured automatically by this application. This data can then be supplemented by manually entered details about the sample and experiment type. The database is searchable by beamline staff, enabling them to exactly recreate experiment conditions at a later date, for example. [2] Logit is a web-based application created using JavaScript (node.js) communicating to a MySQL database.

HXMA (06ID-1) BEAMLINE

Testing of an upgraded interface at the HXMA beamline is underway. The major focus of this effort is to reduce the number of screens that visiting scientists need to access and understand in order to successfully control the beamline.

One of the efforts at HXMA was to merge the display technology for display applications developed in C++ and Qt, and displays built using the EPICS EDM display tool. By changing the development language to Python it is possible to make use of software already developed at the CLS to support showing EDM display files using Qt and have these windows as an area of the main window, rather than opening as a separate display. This reduces the number of windows open at any one time, and assists in quickly accessing the controls or information required while running an experiment. The use of "Notebook Tabs" for selecting embedded windows keeps the user information readily available in a constant location.

SXRMB (06B1-1) BEAMLINE

The SXRMB Beamline has upgraded the XAFS data acquisition user interface to incorporate more display and control for different experiment endstations. This work was done in collaboration with the Shanghai Synchrotron Radiation Facility. The application (IDAV) has a docking window for the endstations which allows the window to be visible during setup, but can be removed from the main window and the window resized to make better use of display real estate. This is a trial setup, and user response will indicate whether we should move forward with windows that have dynamic reconfiguration capabilities.

PGM (11ID-2) BEAMLINE

The "Variable Line-Spacing Plane Grating Monochromator"(VLS-PGM) beamline recently commissioned data acquisition software for two types of gas-phase measurements, both involving event-by-event data acquisition and processing.

VLS-PGM's "Time of Flight" (ToF) apparatus measures the time difference of the drift time of ions and electrons generated by the ionization of molecules by soft X-rays.

Mass spectrograms of ions are generated by the software in the form of multichannel analyzer (MCA) plots. Since multiple products can be produced for a number of reactions (e.g. double or triple ionization), the systems is designed to record the time signatures of all products for each reaction as they occur (event-by-event). These can then be separated and more finely analyzed in post-processing. At the same time, roughly calibrated yields analogous to single channel analyzers (SCA) are plotted against photon energy.

The software is a combination of EPICS to interface with a CAEN V1290N VME TDC, and a GUI based on the Qt toolkit and the CERN ROOT toolkit, both running on Linux OS.

The primary window provides general control of the TDC and displays an MCA. A second window was added to display single and 2-dimensional results of preliminary post-processing of the event-by-event data.

VLS-PGM's Toroidal Spectrometer apparatus measures the angle, energy, and relative drift time of ions and electrons generated by the ionization of molecules by soft X-rays. The emphasis of this apparatus is on the measurement of the angular distributions of different reactions, but it is also designed to measure mass spectrograms in conjunction. These data are recorded by the software for each reaction as they occur (event-by-event), for more refined analysis in post-processing. Data can be collected as a single photon energy over an extended period or as a function of photon energy. The software currently runs as a monolithic program that communicates with CAMAC ADCs (up to 6) and scalers (up to 3), collects the data, and displays positional and mass distributions in accordance to the required measurement type. It is written in C++ and the graphics are based on Qt, currently running under Cygwin on Windows XP. The final version intends to separate the data acquisition from the display, transfer data to a Linux-based GUI over the network, and run the acquisition natively under Windows.

OSR/XSR – DIAGNOSTIC BEAMLINES

The OSR and XSR Beamlines supply the CLS with status and diagnostic information when operating the storage ring.

A diagnostic system for profiling the synchrotron light on the XSR beam line was put together consisting of BeamGage software and camera from Ophir. [3] A custom software application which acts as a server connects the industry standard measurements and statistics that are generated by the BeamGage software and pushes those values out to process variables that are hosted from an EPICS application. The EPICS process variables are visible on an EDM screen located in the control room.

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UPGRADE OF OBSOLETE COMPUTERS

Early deployment of Input/Output Controllers (IOCs) at the CLS was primarily RTEMS running on Motorola 68360 CPUs as part of a hardware system designed in-house. Parts obsolescence has led to the CLS using Moxa UC7408 and Moxa Da-662 systems as replacements for the 68360 systems. In 2012 and 2013, most of the older systems were upgraded. As the Moxa computers are running Linux, device drivers were modified to run under Linux as well as RTEMS, and were upgraded from using EPICS 3.14.Beta1 to EPICS 3.14.12. These changes were done without necessitating changes to the user interface at the beamlines.

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