Quick EXAFS experiments using a new GDA based Eclipse RCP GUI with EPICS hardware control

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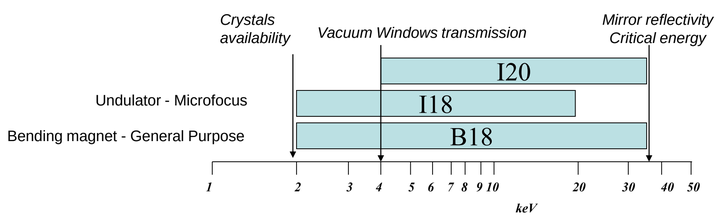
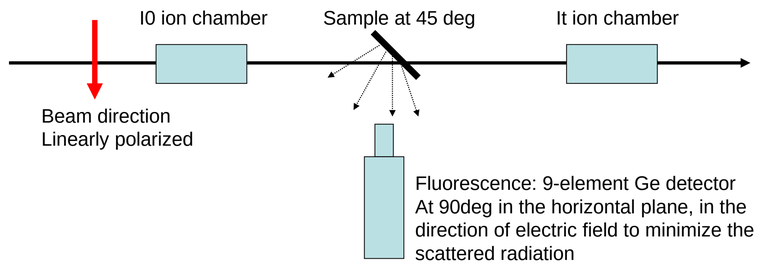
The Generic Data Acquisition (GDA) framework is an open source, Java and Eclipse RCP based data acquisition software for synchrotron and neutron facilities. A new implementation of the GDA on the Diamond B18 beamline has been written which performs XAS energy scanning experiments and includes a continuous-scan mode of the monochromator synchronised with various detectors for Quick EXAFS (QEXAFS) experiments. The underlying motion control is provided by EPICS and the Delta Tau Geobrick LV IMS.

XAFS beamlines at Diamond

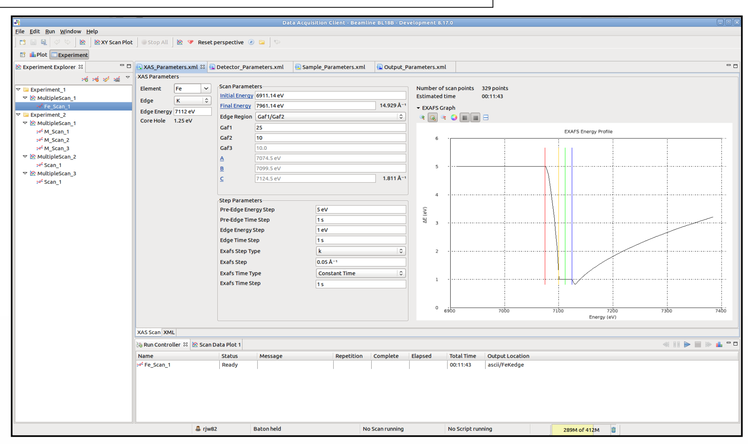
I20 : multipole wiggler	B=2 T 80mm-25 poles Ec=12 keV Energy range: 4-35keV
I20 : dispersive branch	for ultra-fast phenomena
I18 : undulator	27mm period 74 poles, 7mm gap Energy range: 2-20 keV (core 5-13 keV)
B18 : Bending Magnet	B=1.4 T R= 7.1 m Ec=8400 eV Energy range: 2-35 keV

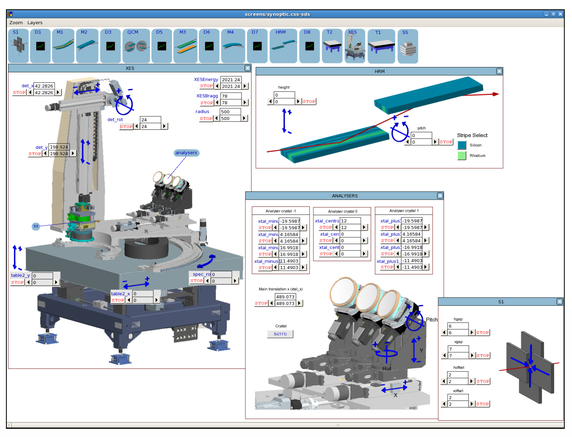


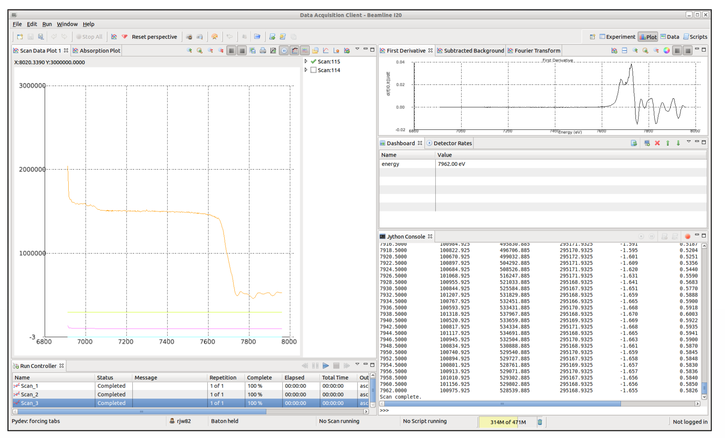
B18 experiment setup



New GDA UI for B18







B18 was the first beamline at Diamond to use a GDA client based on the Eclipse RCP. Users define experimental parameters using graphical editors which persist the options in XML files. These feature rich editors give users a wide range of options to control the experiment. Validation of the XML files ensures that the options they choose are self-consistent and acceptable.

The experiment is performed by Jython scripts running in the GDA Command Server. The XML files are unmarshalled into Java beans which are used within the Jython scripts to prepare the hardware and start scans. Data is collected within the GDAs generic scanning mechanism.

The GDA scanning mechanism provides a generic infrastructure to write files and report scan progress and send data to the UI for display. For the QEXAFS continuous scan mode, a new generic continuous scanning mechanism has been developed. See below for details.

The UI performs and displays basic data analysis routines to indicate the quality of data as it is collected: data normalisation, background subtraction, calculation of the first derivative of the normalised data and FFT results.

Shown are screenshots for the graphical editors, CSS synaptic used within the GDA client, Plot perspective displaying live analyses

Motion Control and EPICS Interface

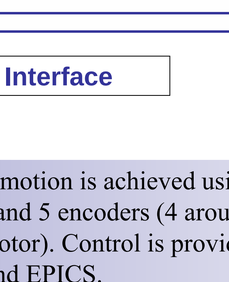
The monochromator Bragg axis motion is achieved using a DC brushless in-vacuum motor and 5 encoders (4 around the stage and 1 on the back of the motor). Control is provided by a Delta Tau Geobrick LV IMS and EPICS.

Coordinated motion of the Bragg axis and distance between crystals is handled by placing these two axes in a coordinate system on the Delta Tau, and running a motion program to execute long constant velocity moves.

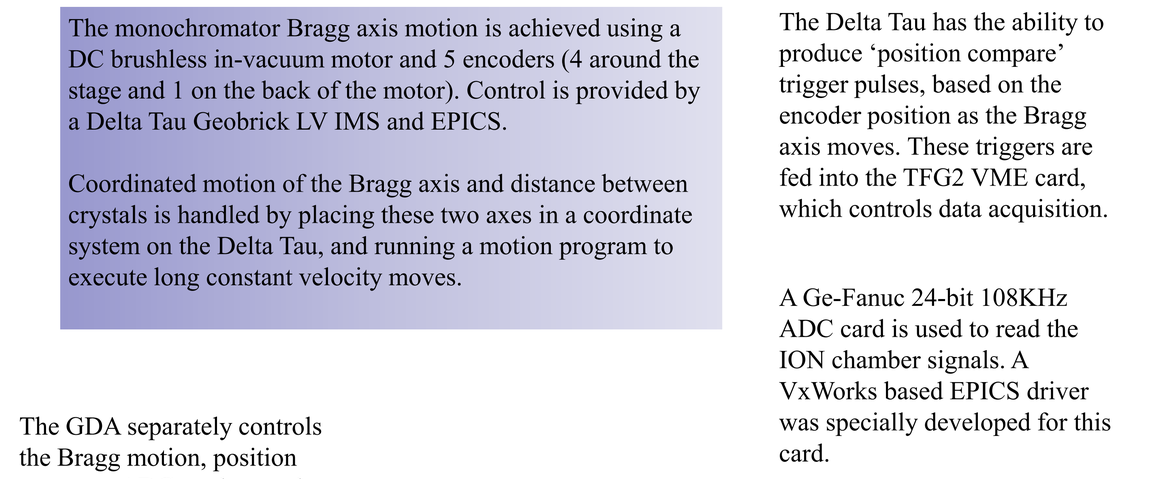
The Delta Tau has the ability to produce 'position compare' trigger pulses, based on the encoder position as the Bragg axis moves. These triggers are fed into the TFG2 VME card, which controls data acquisition.

A Ge-Fanuc 24-bit 108KHz ADC card is used to read the ION chamber signals. A VxWorks based EPICS driver was specially developed for this card.

The GDA separately controls the Bragg motion, position compare, ADC readout and TFG2 card, to provide a complete experimental system. It communicates to two separate EPICS IOC using EPICS channel access.

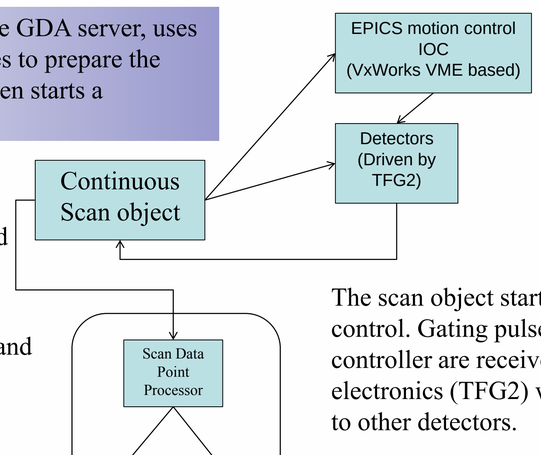


EPICS motor record interface to Bragg axis.



New continuous scanning mechanism

Jython script, running in the GDA server, uses the options in the XML files to prepare the sample environment and then starts a Continuous Scan object.



Relevant scan parameters sent to motion control hardware and the detectors.

Data is held by the detectors, and read asynchronously by the Continuous Scan object.

This passes the data in discreet frames (Scan Data Point) which are written to file and displayed to the UI using the same mechanism as the GDA's existing n-dimensional step scan mechanism.

The scan object starts the EPICS motion control. Gating pulses from the motion controller are received by the Ge Detector electronics (TFG2) which fans out the pulse to other detectors.

The re-use of the step scan mechanism allows continuous scans to be the innermost dimension of a multi-dimensional scan. For example, incrementing sample temperature after each QEXAFS scan.

Current status

- ~30% of proposals now ask for the fast scanning QEXAFS
- scans take 30s, instead of 40 minutes. Scans may now be repeated, even thousands of times, for improved statistics
- comparison of data quality:

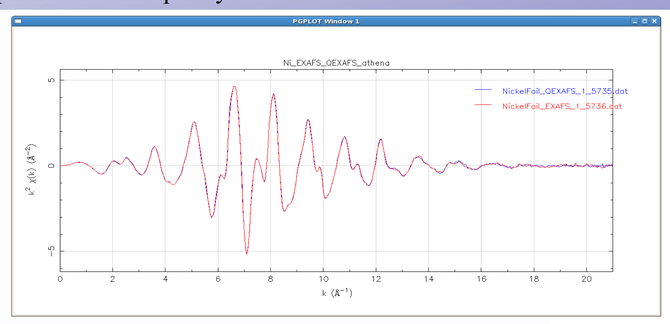


Figure shows first Quick EXAFS spectrum taken 60s - 25ms/point

Compared to normal step scan 50 minutes, 1s-5s/point

For more information please visit www.diamond.ac.uk, www.opengda.org or contact Richard Woolliscroft at richard.woolliscroft@diamond.ac.uk