

# Designing Control Systems for Change: Supporting a Facility's Science and Technology Evolution

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Since 2012, software components for a complete upgrade to the SNS data acquisition system have been identified or developed and are under active deployment. Electronics hardware and firmware improvements have begun and are under development.

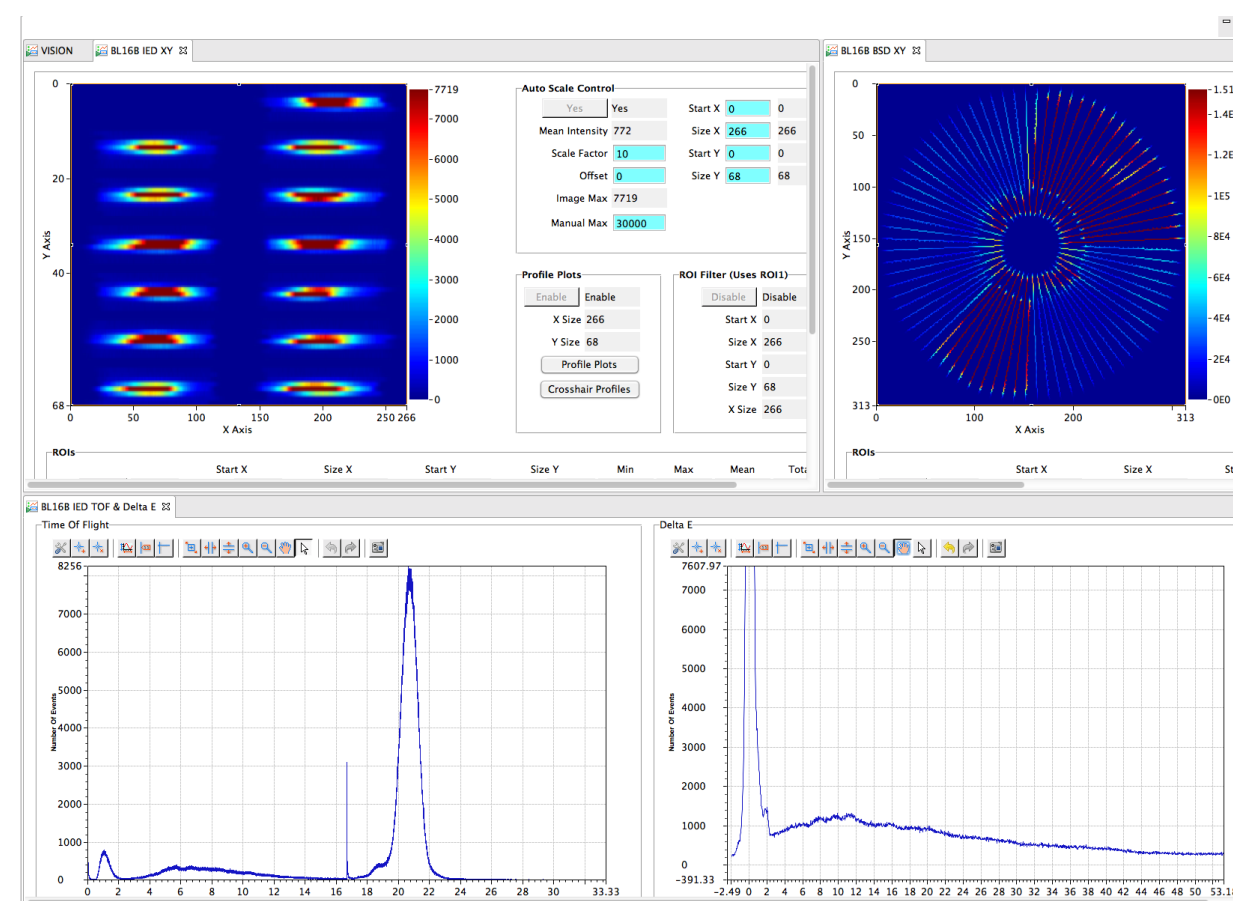
## DAQ Software

**nED** is an EPICS-based software tool for neutron event-mode data acquisition. It uses EPICS V3 for configuration and monitoring, and **EPICS V4** plus **ADARA** for data streaming. It is fully integrated with our EPICS-based control system and user interface, and the ADARA infrastructure.

For counting criteria and online visualization, an **AreaDetector** extension for **nED** has been developed. AreaDetector, a software package developed for light source beam lines, is also being used for the HFIR Imaging beam line.

**nED** been demonstrated with data rates >5M events per second, sufficient for all SNS instruments. It is fully functional with LPSD detectors and the ADC-ROC, in testing for Anger Cameras, with ongoing development for the 2D and WLSF detectors.

Instrument	Deployed
HFIR IMAGING	2013-A
SNS CORELLI	2015-A
SNS USANS	2015-A
SNS VISION	2015-A
SNS HYSPEC	2015-B
SNS SEQUOIA	2015-B
SNS REF-L	2016-A (planned)



nED is capable of meeting the high data rates at VISION. ADnED provides live detector view and time-of-flight plots, and can do basic transformations such as energy transfer and d-space plots.

## DAQ Electronics and Firmware

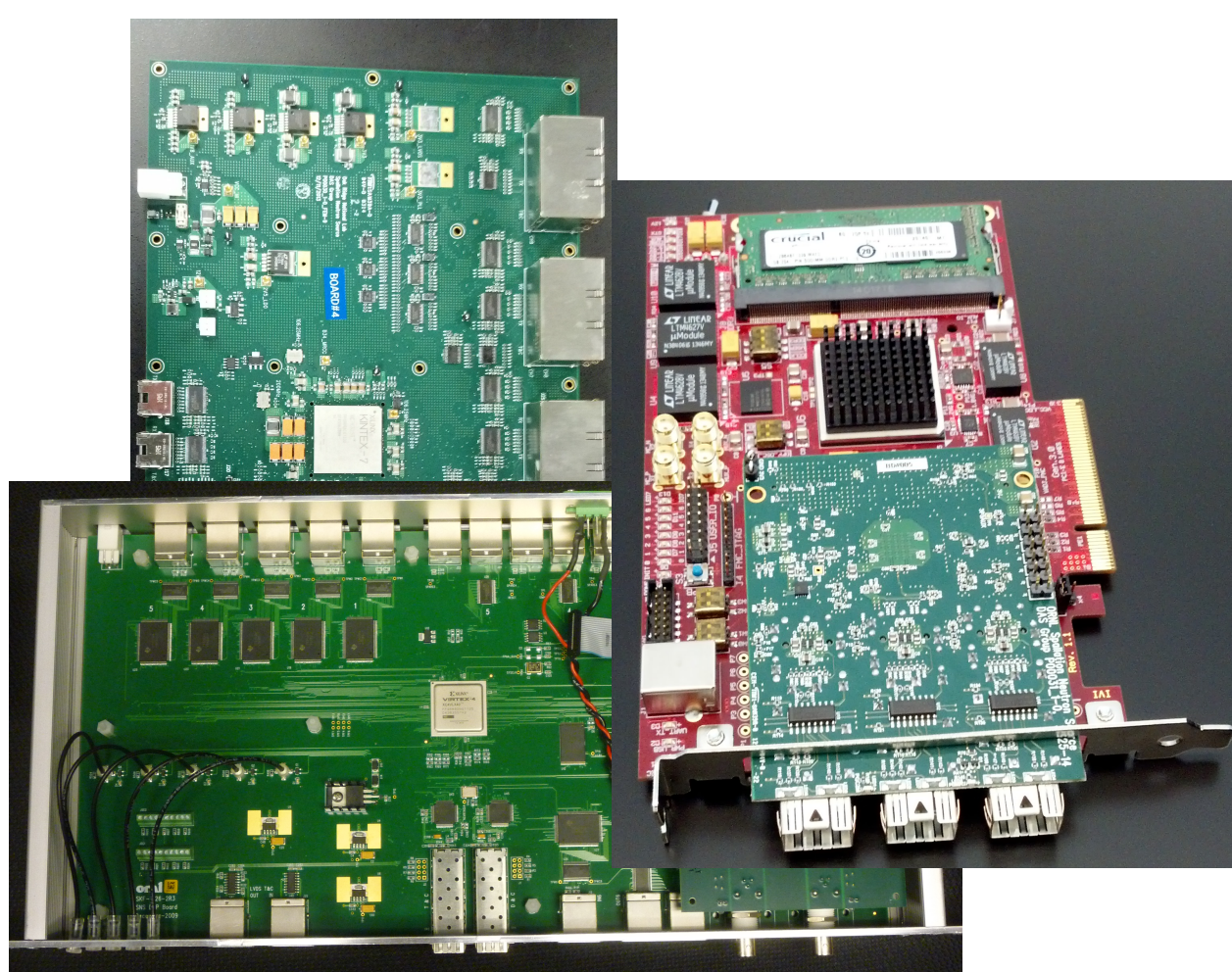
Instrument	DSP-T	OCC	FEM9	ACPC Firmware	ROC Firmware
SNS HYSPEC	2012-B	2015-B	2015-B		2015-B
SNS SEQUOIA	2013-A	2015-B			2015-B
SNS VISION	2013-B	2015-A	2015-A		2015-A
SNS CORELLI	2014-B	2015-A	2014-B		2015-B
SNS USANS	2014-B	2015-A			2015-A
SNS MANDI				2014-B	
SNS SNAP			2015-B	2015-B	
SNS REF-L	2016-A (planned)	2016-A (planned)			

Updates to custom **electronics** for data acquisition have initially been aimed at addressing obsolescence.

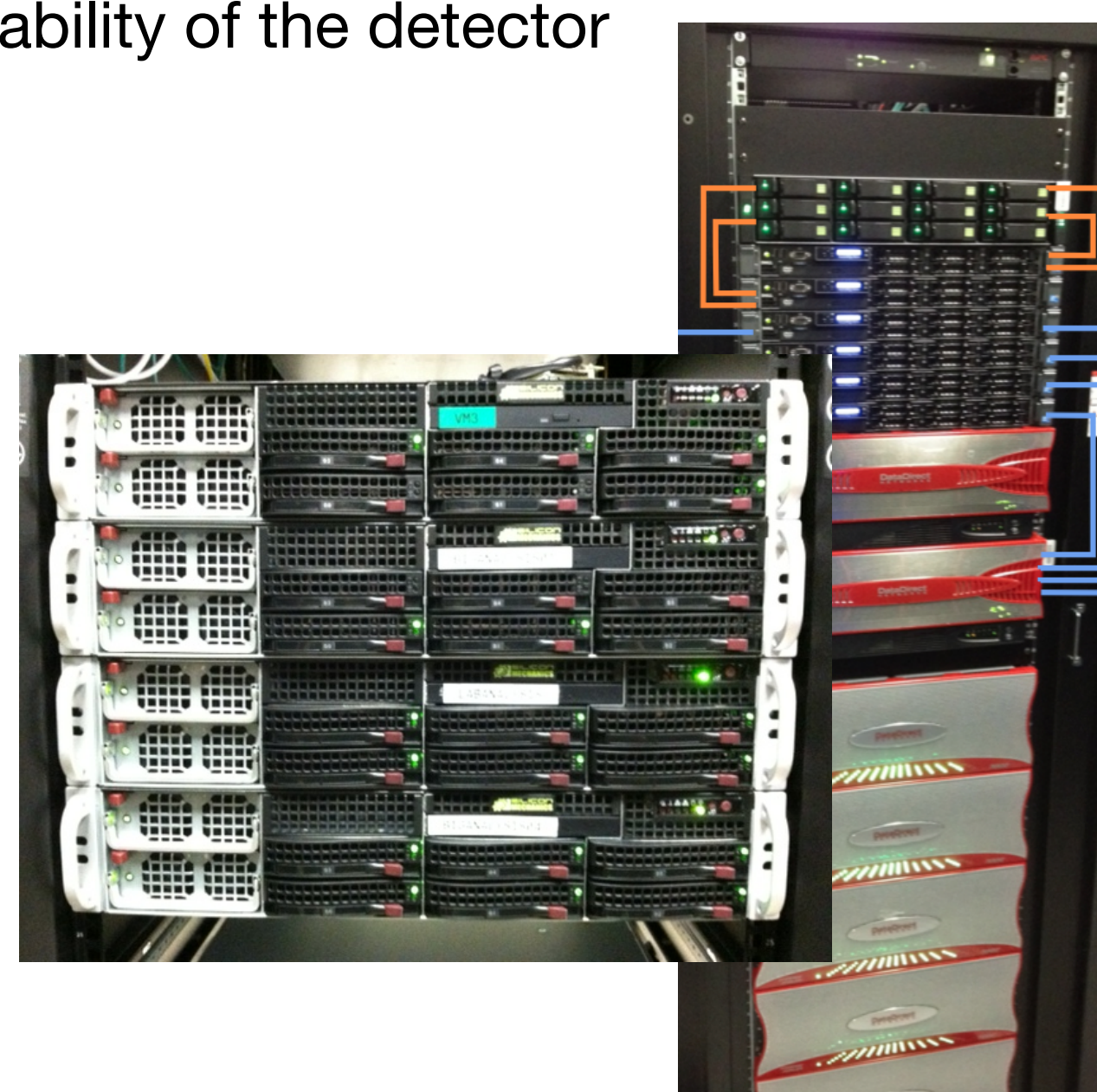
- Obsolete timing receiver PCI cards replaced by combing timing firmware with existing data aggregator board (**DSP-T**).
- Obsolete DAQ computer interface PCI board (**OCC**) replaced with commercial PCI carrier board and custom FMC for optical TLK link.
- A new fan-out module (**FEM9**) fixes design fault from prior versions.

**Firmware** updates for the Anger Camera detectors moves the position calculation routines to hardware (**ACPC**) for greater performance, enhanced reliability and better diagnostics. Firmware updates for the **ROC** boards adds improved diagnostics and provides the start of a path forward towards higher reliability.

Additional effort towards improving the reliability of the detector electronics will require ongoing resources.



Updated data acquisition electronics include (from top to bottom), the FEM9 fan-out board, the DSP-T with integrated accelerator timing receiver, and the OCC PCI card with FMC daughter card.

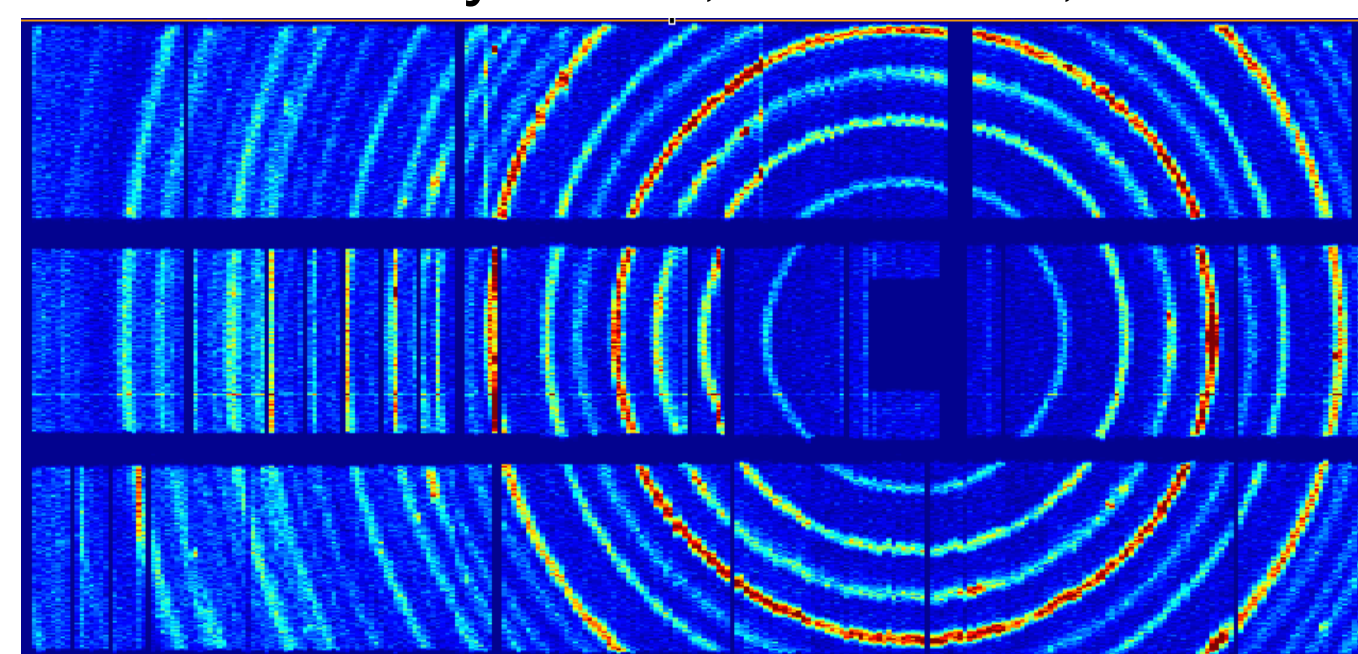


Computing resources available to users include high performance workstations and clusters backed by a parallel file system for experiment data.

## Experiment Control and Automation

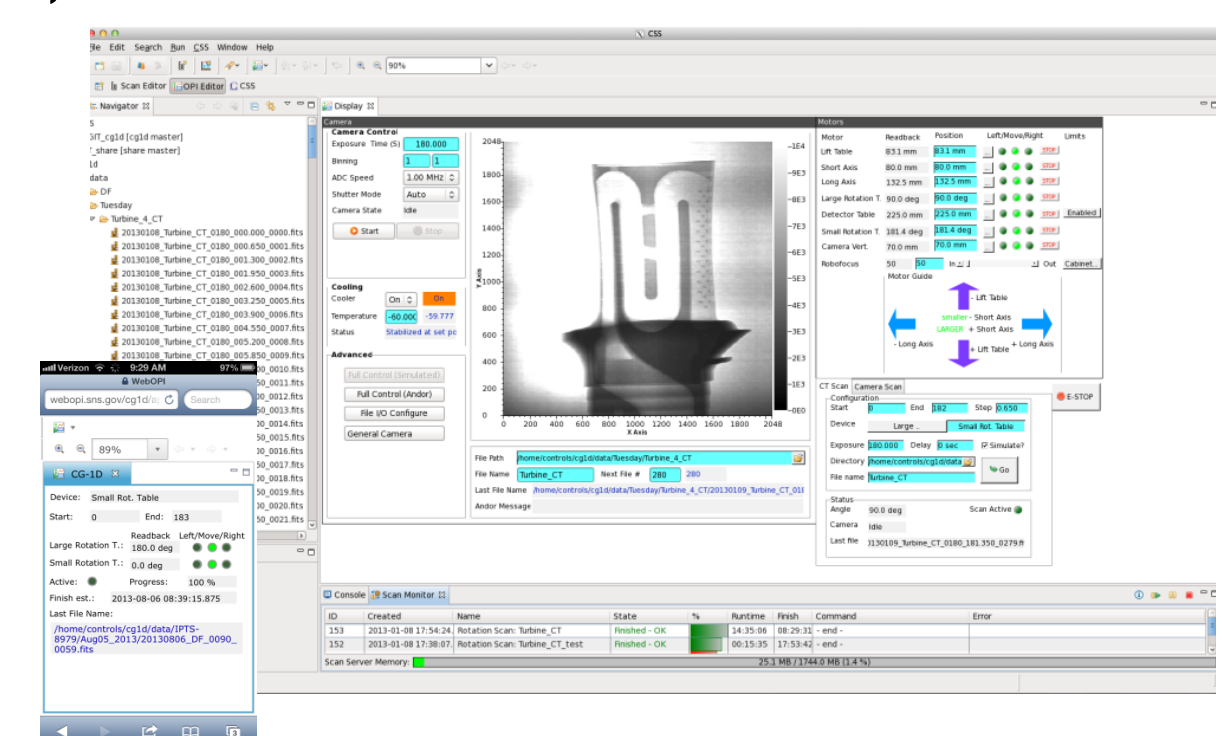
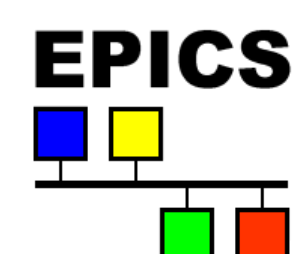
**EPICS** is a software toolkit for building controls systems for experimental physics projects. It has been used for the SNS accelerator and many other accelerators, beam lines and telescopes throughout the world. The EPICS toolkit provides a capable, reliable and maintainable structure for building neutron instrument control systems, with a large international collaboration for leveraging development efforts.

**EPICS** provides an integrated environment for all aspects of instrument controls: sample environments, motion control, choppers, vacuum systems, detectors, etc.



A detector view from SEQUOIA showing diffraction rings from a power sample from the first commissioning days with EPICS and nED.

Instrument	Deployed
HFIR IMAGING	2013-A
SNS VULCAN	2014-A
SNS CORELLI	2014-B
SNS USANS	2014-B
SNS VISION	2015-A
SNS HYSPEC	2015-B
SNS SEQUOIA	2015-B
SNS REF-L	2016-A (planned)



EPICS and CS-Studio provide an integrated environment for conducting neutron tomography at the Imaging beam line, combining image acquisition, motion control and automated scanning.

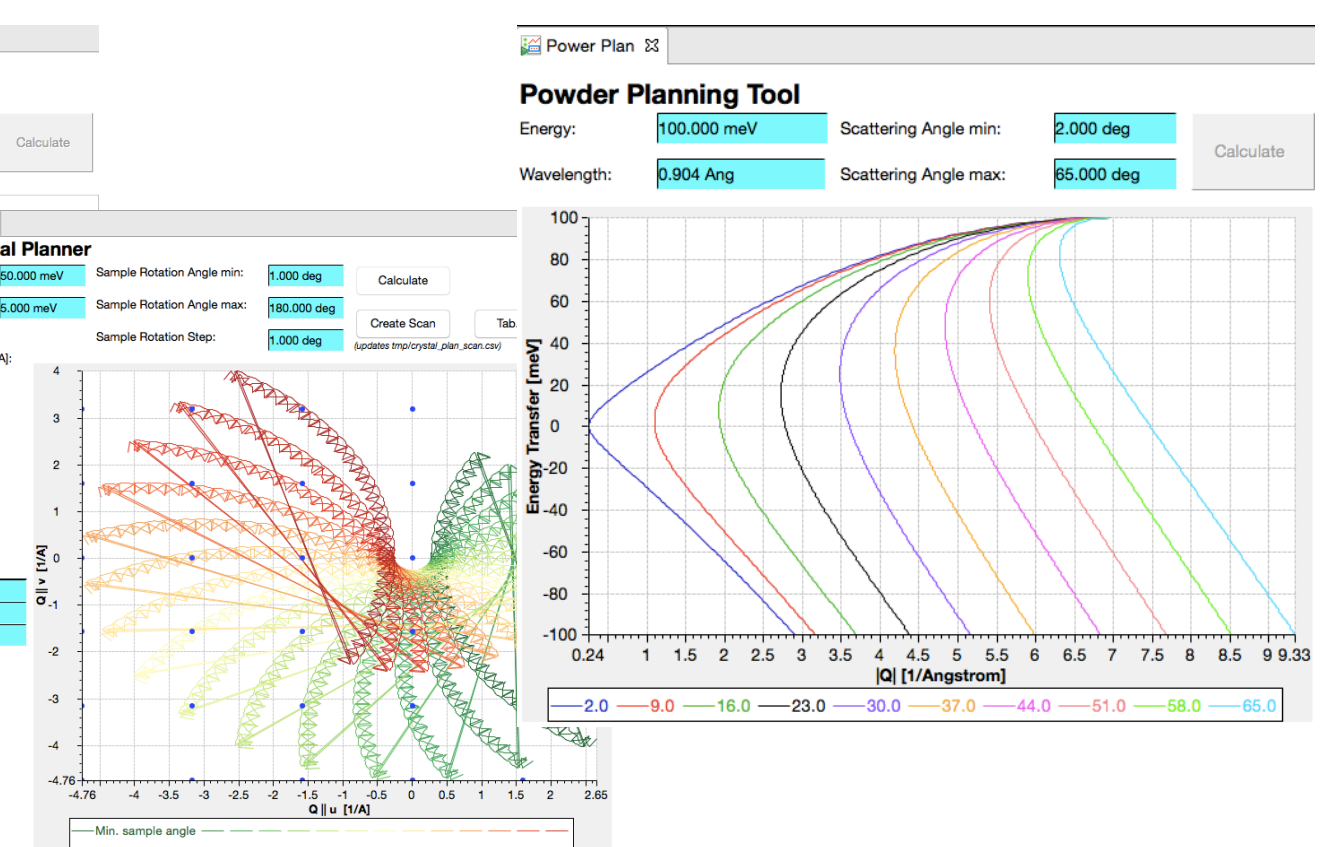
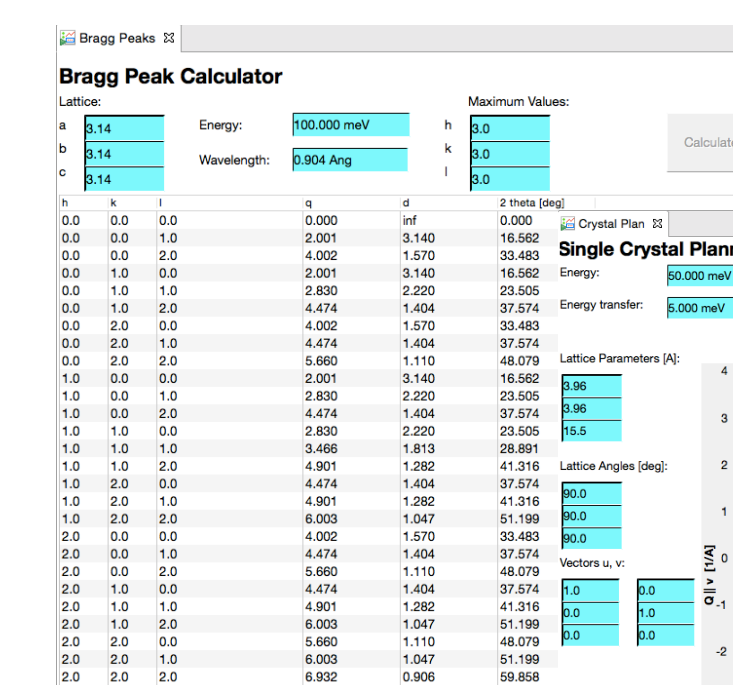
## User Interface and Planning Tools

**CS-Studio** is a framework for building user interfaces for **EPICS**-based control systems. It provides a synoptic display tool for instrument control, a **ScanServer** for experiment automation, Archive viewer for time-series trends, an Alarm system for fault notification, a save/restore tool, and many other tools. CS-Studio is a collaborative project, built on the open-source Eclipse RCP framework.

**CS-Studio** provides an integrated user interface to all aspects of running an experiment.



The CS-Studio ScanServer provides several ways to submit scans to its queuing service including alignment scans, table scans and a python scripting interface. The Scan Monitor allows interaction with the scan queue.



CS-Studio also provides a user interface to online calculators and experiment planning tools under development.

## Computing Infrastructure

Computing resources for data reduction, data analysis and the new data acquisition system are built on **Linux**. Software and server-class workstations are available to instrument users for processing data with Mantid and other community and commercial software packages. Remote access is provided through a shared cluster available at **analysis.sns.gov** consisting of high memory (up to 512 GB) and high density (up to 64 cores) computing nodes. Experiment data is saved to a high performance **Lustre** parallel file system with 1 petabyte of data storage.