

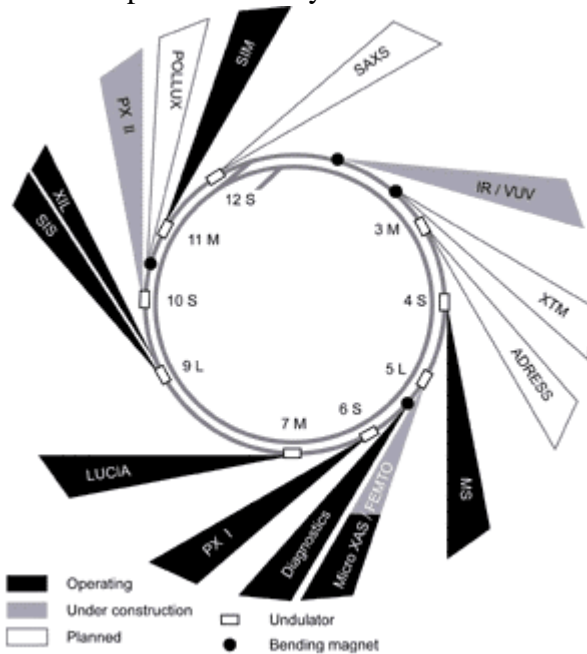
# Protein Crystallography Beamline Simulation

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**The requirement of high availability of the protein crystallography beamlines at the Swiss Light Source (SLS) conflicts with the requirement of software development and debugging at the same beamline. A solution can be implemented with an IOC of EPICS release 3.14 running on a Linux PC. One can test graphical user interfaces and high-level applications using Soft Records to simulate beamline hardware.**

## 1. Introduction

The protein crystallography beamline at the Swiss Light Source (PX I / X06SA) is controlled by a distributed EPICS 3.13.6 database. On the new build second crystallography beamline (PX II / X10SA) it is EPICS 3.13.9. At both beamlines the database is mainly installed on VME computers and only the CA Clients run on Linux PCs.



The schedule on the working beamline X06SA is tight. Five days of the week are provided for measurement of external users, one more day is planned for beamline development but often used for in house research. That leaves one day per week to maintain the beamline, install new hard- and software and test them and do debugging. In addition the users demand a flawless and comfortable control system, that must not fail.

At the new beamline (X10SA) the problems are different but nevertheless came up to the same points. As the beamline is under construction there is no hardware available for testing the software. On the other hand the beamline will be commissioned in nearly

no time and made available for users as soon as possible. To achieve this goal the control system has to work immediately after the installation of the hardware is finished. It should be easy to handle and, of course, it must not fail.

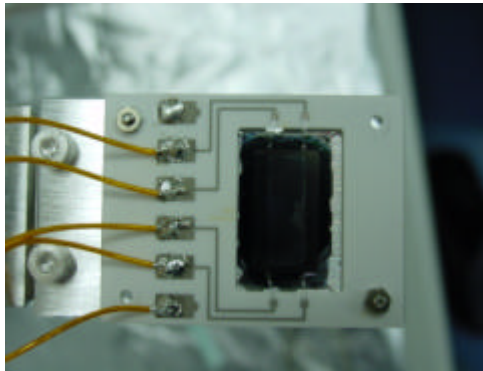
## 2. The Simulation

In order to prepare the control system software properly before installation to the beamline, an EPICS 3.14.x IOC (Input Output Controller) is set up for the use on the Linux office PCs. On this IOC the same EPICS database could be loaded as at the beamline. Some additional work is needed to simulate the behaviour of the hardware. For example input from diagnostic devices has to be simulated by some set value, which could be changed to test applications and limits.

It is obviously an advantage to have a simulated beamline on the office PC. Rebooting can be done in some seconds and there is no fear of breaking hardware accidentally. Furthermore wrong cabling can be deleted from the list of possible errors.

As the simulation uses the same configuration files (template and substitution files) as the beamline, most bugs can be found on the simulation. The only big source of problems is the incorrect mapping from the hardware to the simulation.

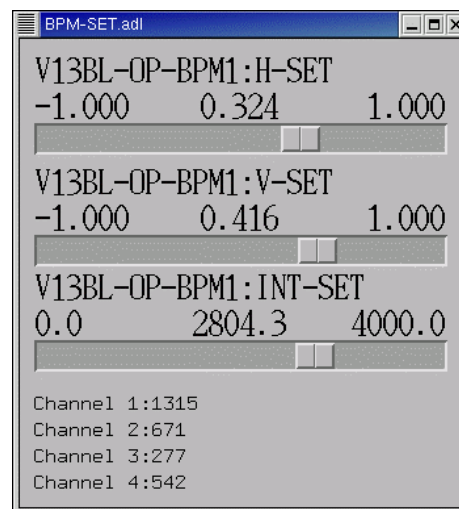
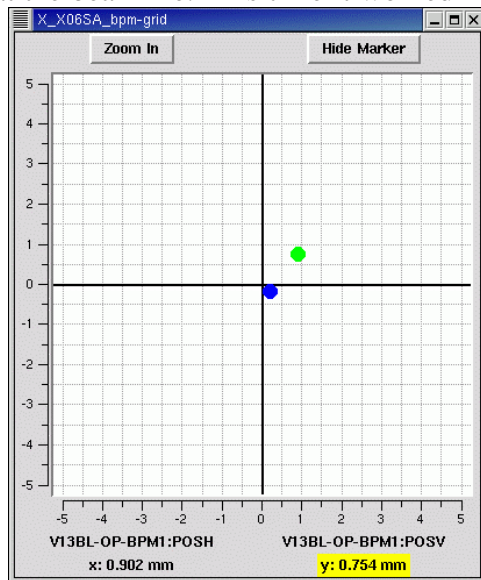
### 3. Example



The first example to use the simulation was the installation of new x-ray beam position monitors (xbpm) at beamline PX I. On the first look it seemed to be simple: four analogue input values for the beam intensity in the four quadrants of the device and a fit of a tan function with four calculated parameters. But on installation at the beamline the EPICS records showed a strange behaviour and did not work properly.

After analysed (with a lot more time) at the simulation, it became clear, that the fit function was only valid in the centre part of the region the beam may use. After

some more records were created and a lot of debugging, the software was once more installed at the beamline. This time it worked from the start.



### 4. Future Prospect

At the moment the simulation includes:

- The insertion device (done by Dirk Zimoch, SLS)
- The monochromator
- Beam conditioning units, like filters, slits, diaphragm
- X-ray beam position monitors (beam diagnostic)

These simulations have been proven to be vital for debugging and development of the EPICS database. In addition the design and test of graphical user interfaces are much easier, because

even rare events could be simulated in advance. To test new computed fit parameters in advance has been proven useful to prevent unstable behaviour at extreme values (limits).

In the future the experiment and the status of the beamline will be simulated as well. The work on this has already started. It would be nice to have a consistent simulation of the x-ray beam as well. This includes the interaction between the beamline parts and requires some physics to be included in the simulation.

At the end the simulation of the beamline may be used for operator training. You can simulate faults and problems, which may rarely occur at the real beamline, and teach the proper respond.

If there is interest from other people, the simulation can be adapted for other beamlines as well. Some more specific hardware may come in additionally, but motors, temperatures, and some common stuff like filters and slits will be already there.

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