MAX IV BIOMAX Beamline Control System: From Commissioning Into User Operation

M. Eguiraun, R. Appio, V. Hardion, J. Lidon-Simon, A. Milan-Otero, U. Mueller, J. Nan, D. P. Spruce, T. Ursby.
MAX IV Laboratory, Sweden

The BioMAX beamline at MAX IV is devoted to macromolecular crystallography and will achieve a high level of experimental automation when its full potential is reached. The control system is based on Tango and Sardana for managing the main elements of the beamline. Data acquisition and experiment control is done through MXCuBE v3 web application, which interfaces with the control layer. BioMAX has already received its first users, who successfully collected diffraction data and provided feedback on the general performance of the control system and its usability.

Techniques	MX, MAD, SAD, S-SAD, atomic resolution data collection, large sample ensemble screening, in situ crystal diffraction
Beam Size	20x5 μm^2
Energy Range	5-25 keV
Processing Rate	>200 samples / 8 h

Table 1: Main Specifications of the BioMAX beamline at MAX IV

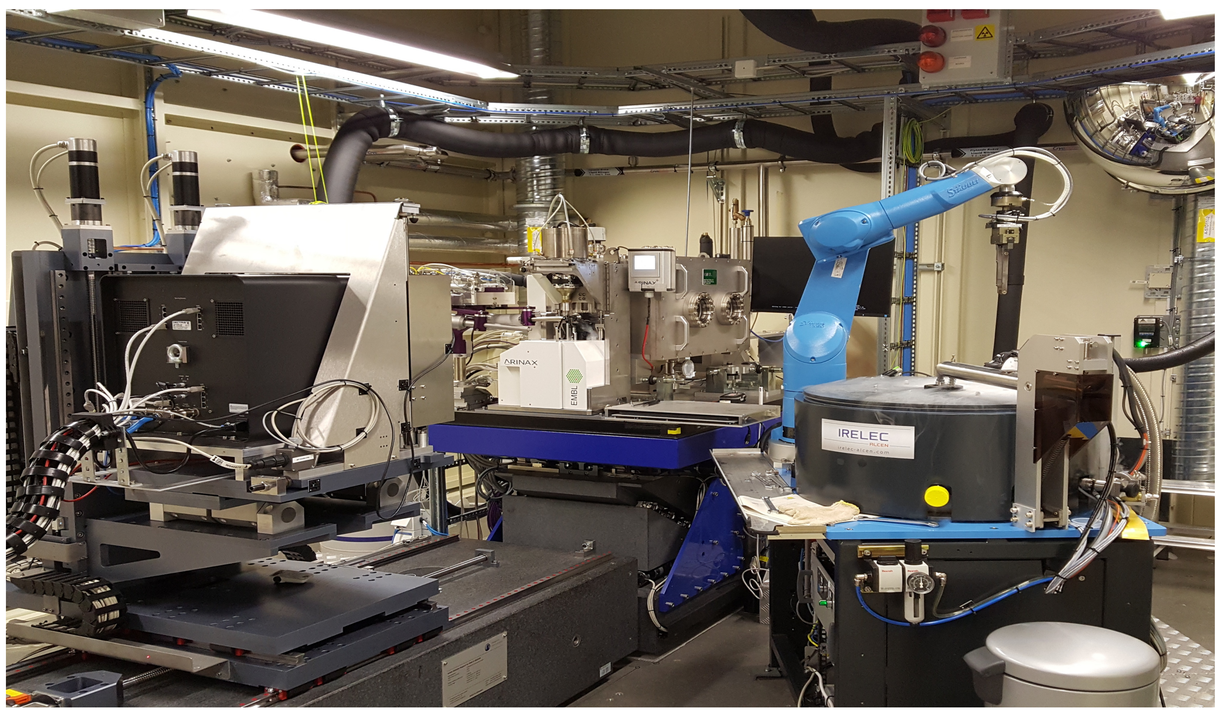

Figure 1: BioMAX experimental station; from left to right: EIGER 16M detector and its support table, MD3 diffractometer and the Beam Conditioning Unit (BCU) on their table, ISARA Sample Changer.

Control system

MAX IV controls and IT group (KITS) have defined a set of procedures, tools and devices as standard to be used for the development of controls systems within the facility. In addition, the team has been involved in the beamline design process since the early stages and provided support as needed. Working in an Agile development environment, the development team is able to provide solutions quickly and react to changing specifications earlier in the process. Moreover, promoting the user autonomy, it is easier for the beamline staff to contribute to the control system development.

The main components of the control system are the following:

- TANGO: for interfacing most of the beamline equipment, 471 tango devices are running in the beamline (dozens of high level thermocouple devices, a complex sample changer, various custom controllers, etc.)
- Sardana: easy to operate all the motorization axis through Spock (real or pseudo), plenty of macros and controllers available in the core as well as in the community, custom controllers have also been developed
- Icepap: standard motorization solution at MAX IV. In BioMAX, it manages 30 motors, on top of those there are 18 pseudomotors, 12 piezo actuators are additional movables
- Signal acquisition: ALBA electrometer for BPM measurements, generic DAQ card in an industrial PC, PLC for temperature, flows, vacuum, etc.
- MXCuBE v3: experiment control and data acquisition, it provides all the complex logic for MX experiments, thus configuring equipment and synchronizing acquisition sequence. Python based, it can interface to Tango/sardana and custom protocols. The latest version (v3) provides a web based interface
- Machine and Personnel safety ensured by independent PLC systems.

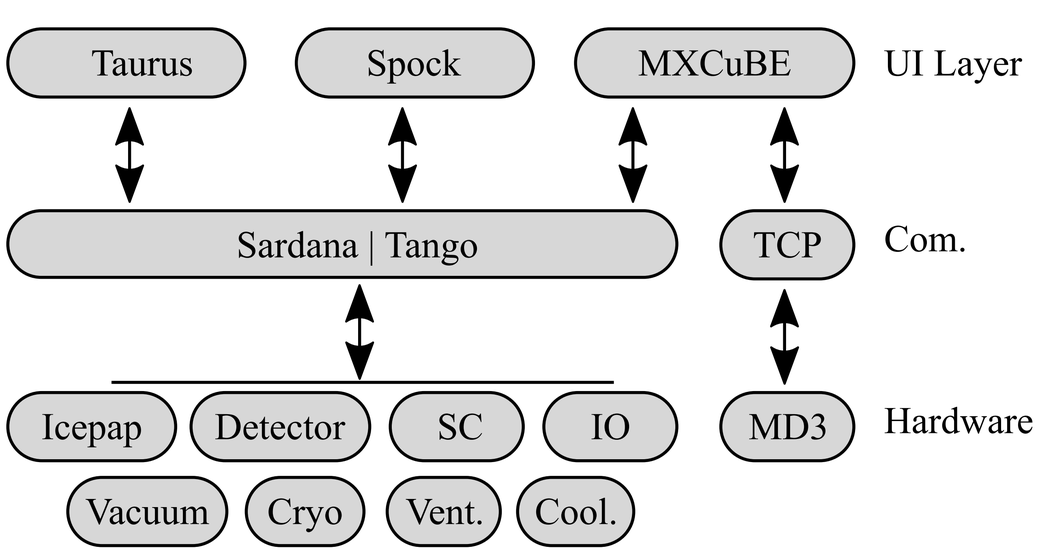

Figure 4: Simplified structure of the control system describing how the different elements are related.

User interfaces

The main user interface is MXCuBE, but there are additional interfaces based on Taurus (display motor positions, temperatures, flows and pressures split by section) and the beamline synoptic displaying a graphical representation of the physical beamline structure. Panicgui for alarm visualization and Archive viewer are also provided.

Figure 2: Beamline Synoptic.

Figure 3: MXCuBE v3 interface during an experiment.

Initial user experience

The first user operation began at the end of 2016 and finished in summer 2017. Initially limited to one or two days a week, while the rest of the time was devoted to beamline and ring commissioning, software development, maintenance and to the installation and testing of new equipment.

- Twelve user groups, after a short introduction they were able to operate the beamline on their own
- Very positive feedback was received from the users. Impressed by the speed of the data collections, by the ease of use of the software, and the general stability of the control system.
- The next user operation is expected before the end of year. Additional features to implement are a fully operational sample changer and a improved and stable data management flow.

Acknowledgements

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MAX IV Laboratory

MAX IV Laboratory has operated successfully for more than 30 years and is currently commissioning the new MAX IV synchrotron facility in Lund. Fully developed it will receive more than 2 000 scientists annually, from Sweden and the rest of the world. They will do research in areas such as materials science, structural biology, chemistry, geology, physics and nanotechnology. MAX IV is the largest and most ambitious Swedish investment in national research infrastructure. It is the brightest source of x-rays worldwide and was inaugurated June 2016.
MAX IV Laboratory is hosted by Lund University.