Control and Data Acquisition in TANGO and SARDANA at the NanoMAX Beamline at MAX IV

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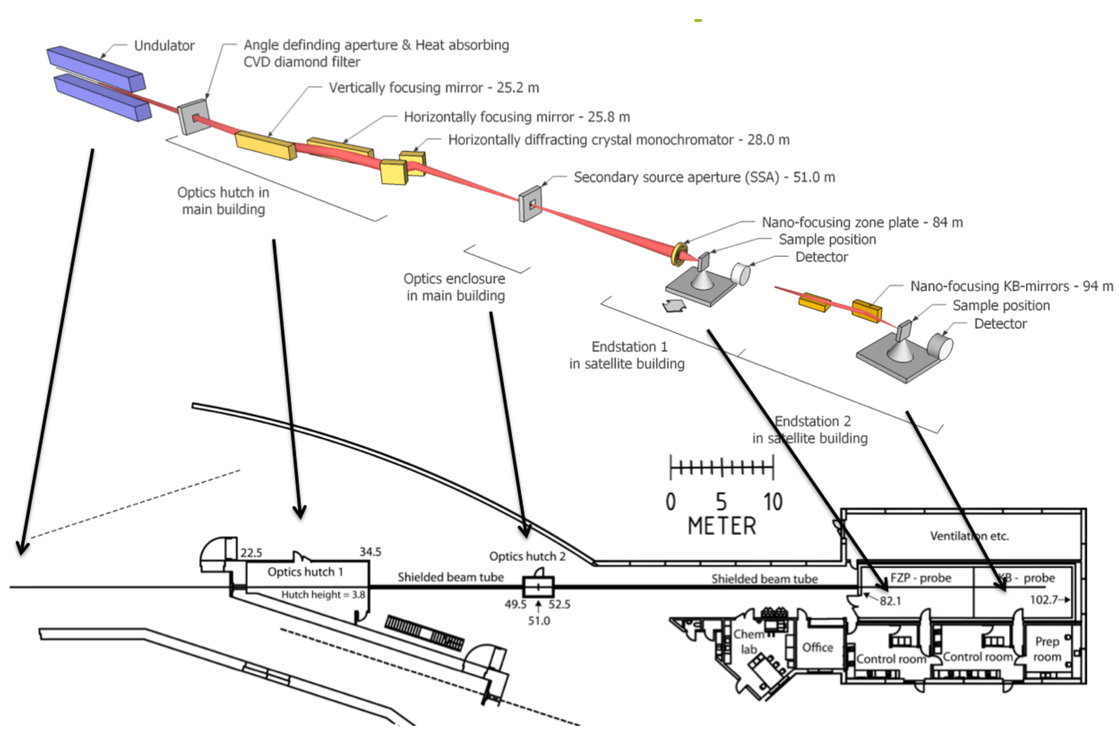
Introduction

The MAX IV synchrotron radiation facility in Lund, Sweden received its first commissioning users in November 2016 at the NanoMAX hard X-ray beamline. All components of the beamline, including the motorisation, vacuum and diagnostic elements, were integrated into the TANGO [1] control system. SARDANA [2] managed the collection of diffraction and fluorescence data from one- and two-dimensional detector channels. To significantly improve the efficiency of data collection, a system to perform hardware-synchronised continuous scanning of the sample was implemented.



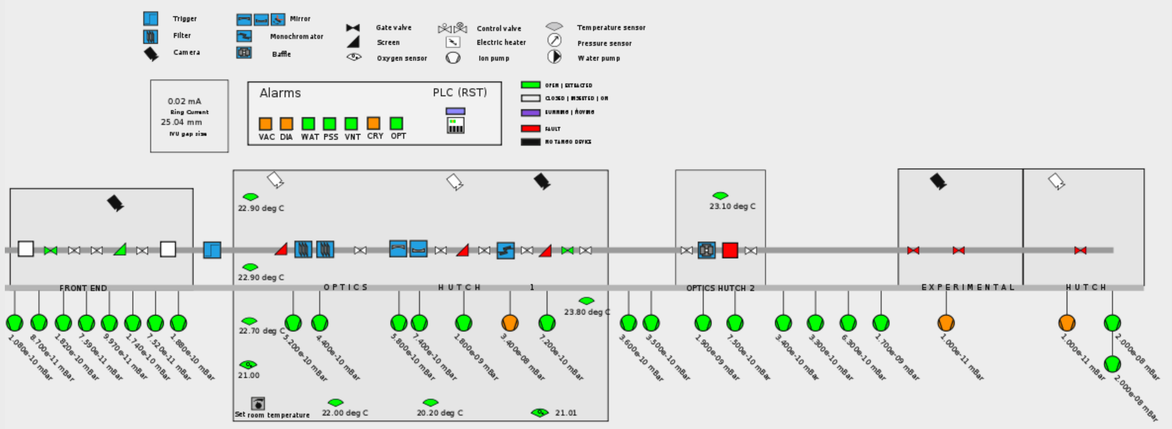
Beamline Control

Main subsystems:

Motorisation: over 30 axes for control of monochromator, mirrors, slits and diagnostic devices, all using IcePAP motion control (the MAX IV standard).

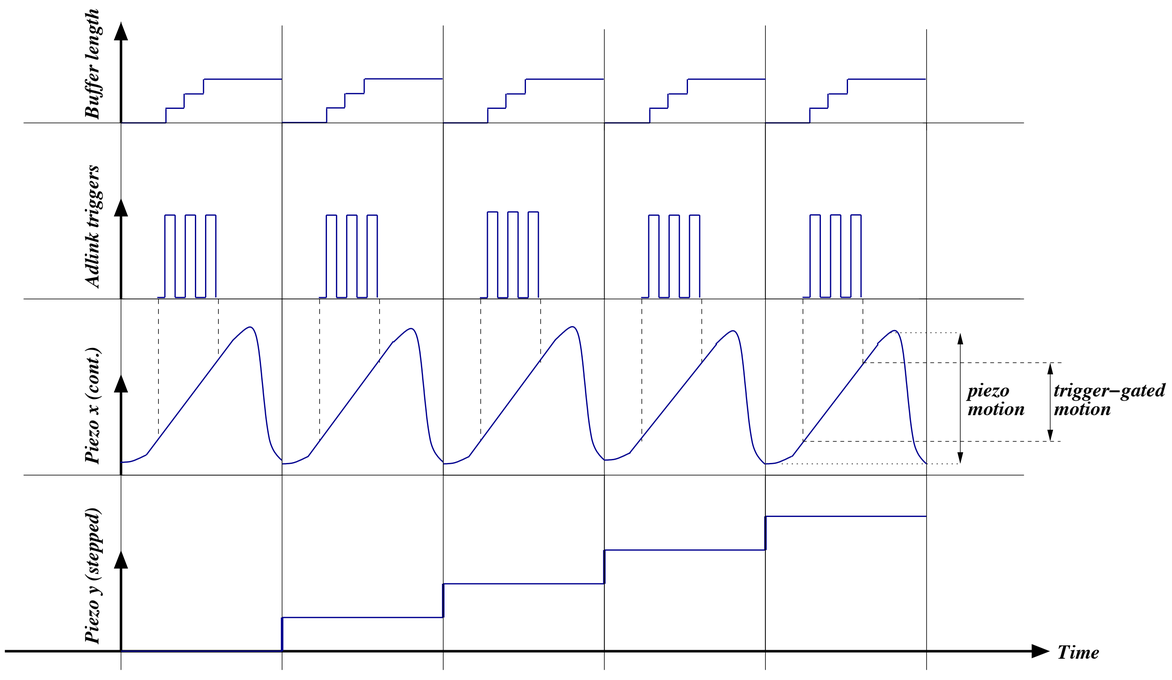
Vacuum PLC: around 100 components read-out by an Allen-Bradley PLC, interfaced to TANGO and each represented by a TANGO device.

Custom synoptic GUI to access all equipment:



Fly-Scan System Timing Scheme

A “fly-scanning” system based on an Adlink DAQ-2005 card provided time-based hardware-synchronised continuous scanning of the sample mounted on a Physik Instrumente piezo stage. Typical scan parameters: 100 x 100 points in *x* and *y*, exposure time per point in ms range.



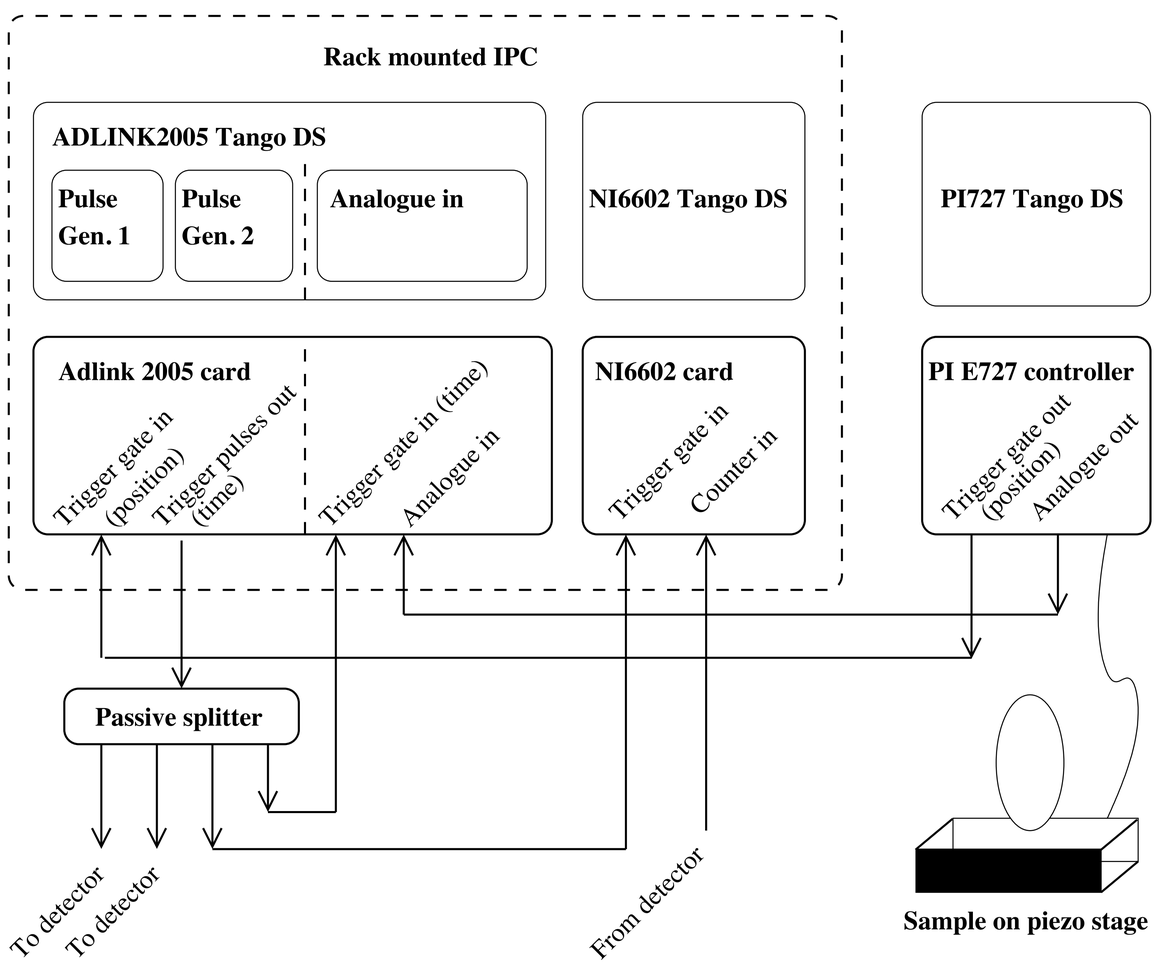
- **piezo controller executes programmed ramp in *x* direction**
- **position-based trigger gate defined for a linear portion of the ramp**
- **Adlink 2005 card generates triggers while piezo *x* in trigger window**
- **triggers distributed to detectors**
- **triggers also sent to Adlink analogue input to read piezo position**
  thus positions buffered in synchronisation with detector triggering
- **at end of motion, Adlink card holds buffer of piezo *x* positions**
- **piezo steps in *y* and continuous motion repeated**

TANGO Devices

A dedicated Scan Control TANGO device manages the TANGO devices for the Adlink card and the piezo controller.

Scan control Tango DS

– Configure Adlink 2005 ()
– Configure NI6602 ()
– Configure PI E727 ()
– Go()
– Read Adlink 2005 buffer ()
– Read NI6602 buffer ()



Detector Data

Imaging and fluorescence detectors from Dectris and Quantum Detectors were used. These have Lima [3] support and could write data directly to bulk storage in HDF5 format. The new MAX IV Scientific Data Management tools configured the data paths according to the beamline user.

SARDANA Integration

The Scan Control device was integrated to SARDANA as a “one-dimensional experimental channel”. The controller calls the Go() method that executes the piezo ramp in the *x* direction and subsequently returns the array of positions. A custom macro was written with a pre-scan hook to call the configure methods of the Scan Control device and prepare the detectors to expect external triggers. The scan then proceeds as a standard step scan in the piezo *y* direction, returning an array of *x* positions after each step.

References

[1] The TANGO Control system website: http://www.tango-controls.org
[2] The SARDANA software website: http://www.sardana-controls.org
[3] Lima: A Library for Image Acquisition http://www.lima.blissgarden.org

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 2000 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.