Multimodal data acquisition system for sub-second time resolution using motor trajectory control in Sardana

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INTRODUCTION

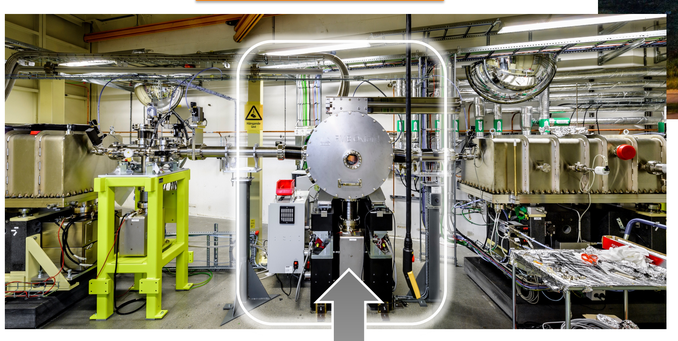
This work describes the multimodal DAQ system implemented at the Balder beamline, combining the complementary techniques X-ray absorption spectroscopy **(XAS)** and X-ray diffraction (**XRD**) in a single experiment, i.e., the different techniques are performed sequentially for multiple energy edges automatically in a **single scan** launch.

THE CHALLENGE

Implement energy **hardware orchestrated scan** in Sardana. The experiment should configure multiple energy edges and multiple techniques (XAS and XRD) into the related devices (ACS, detectors, etc) in the beginning of the scan and only once. The scan should be driven entirely by hardware: **PandABox** and **ACS** loaded trajectories. Sardana should handle the DAQ.

Placed at the 3 GeV storage ring at MAX IV Laboratory and is dedicated to X-ray absorption and emission spectroscopy in the energy range of 2.4–40 keV.

Balder beamline



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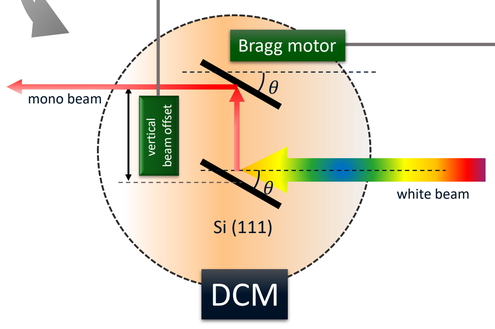
SYSTEM OVERVIEW

Specialized quick scanning fixed exit monochromator together with a closed loop fine adjustment of the beam position allows relatively quick, sub second energy scans, while keeping the beam position constant within several micrometres.

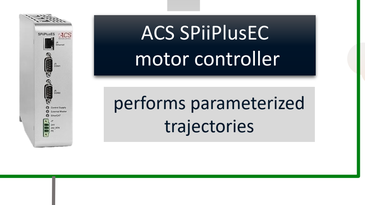


BUFFERS

Allow programs in the buffers. Different functions can be programmed as modules

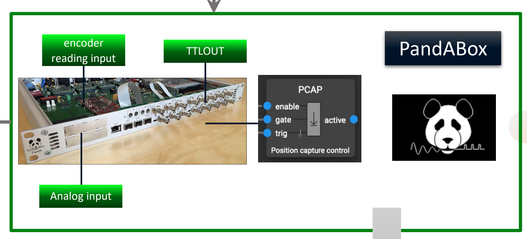
```
!function definitions
!internal functions

real calcEnergy(real angle){        !calculate energy in eV from angle in degrees

                real energy = hc_2e / d_Si(mono_crystal) / SIN(angle / 180 * pi);
                RET energy;
        }
```

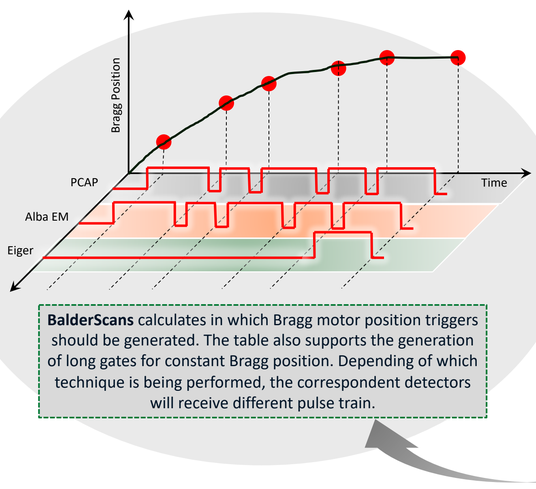
ACS is integrated in the control system as a tango device. Provides commands for buffer programs controls [Compile, Start, Stop, Load], as well, commands to perform motion control.



ACS SPiiPlusEC motor controller

performs parameterized trajectories

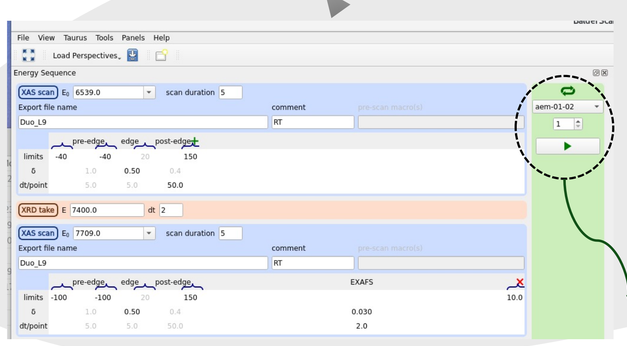




BalderScans calculates in which Bragg motor position triggers should be generated. The table also supports the generation of long gates for constant Bragg position. Depending of which technique is being performed, the correspondent detectors will receive different pulse train.

- Reads Bragg motor current position with encoder reading input
- The encoder reading is connected to SEQ block. The SEQ countains the table from which gates should be generated based on Bragg position
- The table is calculated and configured by **BalderScans**: according to the XAS resolution requested by the user, it calculates Bragg positions and feed the table

USER



Taurus GUI where the **USER** can organize the sequence of techniques to be performed using “drag and drop” system. Each technique will have its own set of parameters to be configured. The **USER** can choose between XAS scan and XRD. Inside each technique, many variations are allowed.

The GUI generates the experiment JSON file with specific keys

hmoscan

DATA ACQUISITION

CONFIGURATION LAYER

Intermediate layer for the full system configuration

BalderScans

TANGO

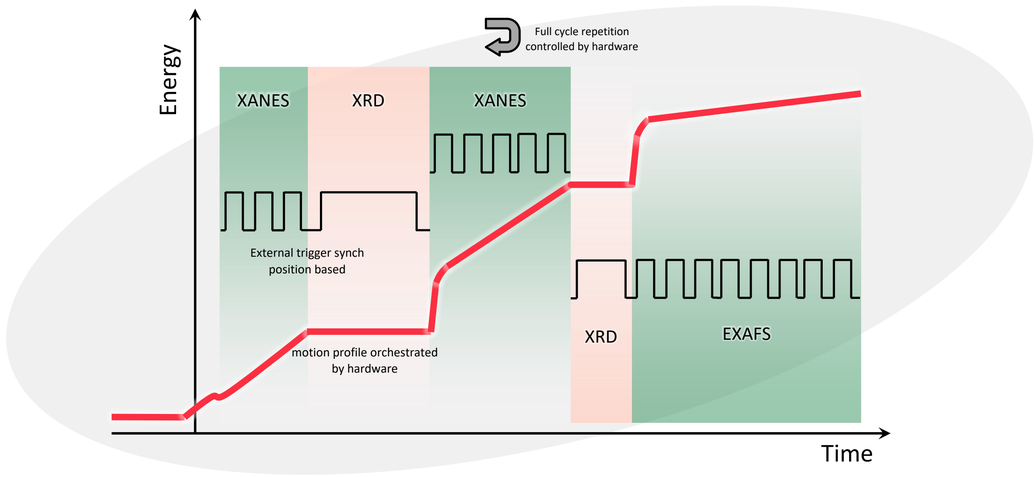
Attributes

Configuration
ACSSquence
TriggerConfig
PositionArray
EnergyArray
TotalTrigger
SPMTriggers
ScansSequence

SARDANA ORCHESTRATION LAYER

Calls controllers orchestration API

Sardana basically just watches the controllers State Machine. The entire experiment is driven by hardware: ACS drives according to the configured function on its buffer. PandABox generates the triggers based on the configured table and current positions.



NEXT STEPS

- Full replacement of the **Configuration Layer** by Sardana new features
  - MultiSynchDescription: allow detectors to be configured for different pulse trains
  - Trajectory scans fully orchestrated by hardware
- Allow up and down scans: useful when the user wants to scan over an edge multiple times, then this feature will allow the scan to be performed while the motor is moving to the start position, decreasing the deadtime