Improving hardware triggered data collections with the PandaBox and Bluesky/Ophyd-async.

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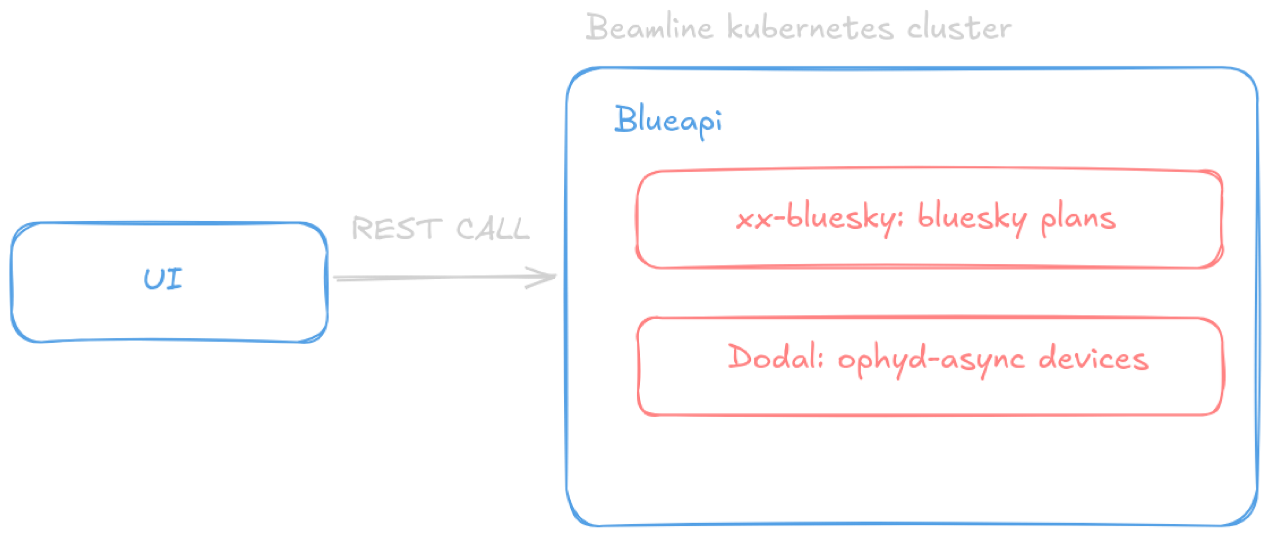
On the road to the Diamond-II upgrade, several beamlines at Diamond Light Source have gradually started adopting bluesky/ophyd-async to run beamline setup tasks and data collections. This is done through Athena, the new experiment orchestration platform, based on the bluesky data collection framework and set to replace the existing data acquisition platform GDA.

At the same time, some of the beamlines in the Soft Condensed Matter and Crystallography (SCM&X) group have been looking at ways to improve hardware triggering in order to be able to continue running standard experiments which are now relying on deprecated hardware, as well as to develop new collection strategies. The Position and Acquisition (PandA) box is a new controls and acquisition system, providing a highly configurable pulse generator to externally trigger detectors.

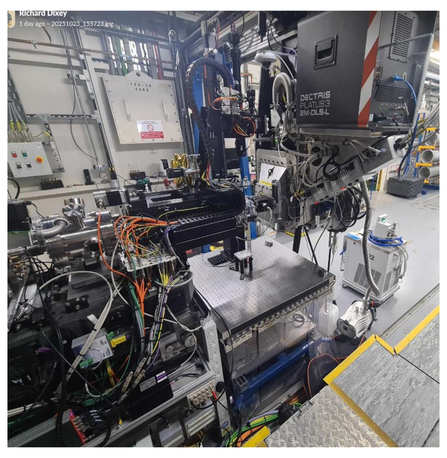
In this poster two examples of implementing a bluesky-based system to control a PandABox for data collection are presented.
Both beamlines use a minimal Athena stack, with a python-based UI operating as a REST client for the Blueapi (a wrapper around beamline-specific bluesky plans and ophyd-async devices) instance running the the beamline kubernetes cluster.



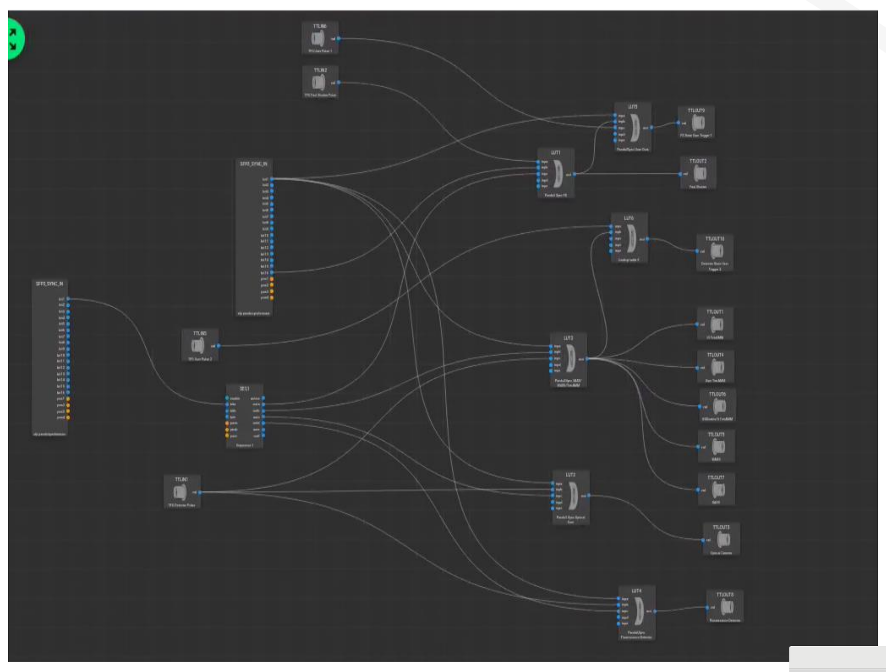
I22 (SCM): Moving to bluesky-driven SAXS

The Problem: in the past hardware triggering for SAXS/WAXS time resolved experiments has been achieved through a Time Frame Generator (TFG2), a timing module that is now end-of-life. Additionally, there is a need to reduce the time between data collections, as a lot of the small tasks setting up the beamline can take time when run sequentially.

The proposed solution:
- The PandA makes it possible to send TTL triggers to any of the 8 detectors in use on the beamline and to keep them in sync with each other withing a 1ns resolution.
- Using ophyd-async devices and carefully crafted bluesky plans allows to speed up the time between collections as multiple tasks can be run concurrently.

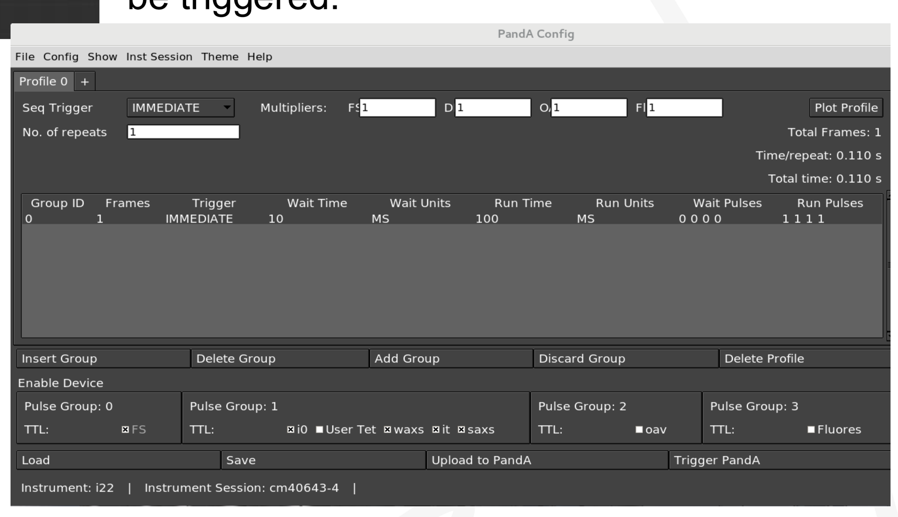


Configuring the Panda



PandA configuration for I22

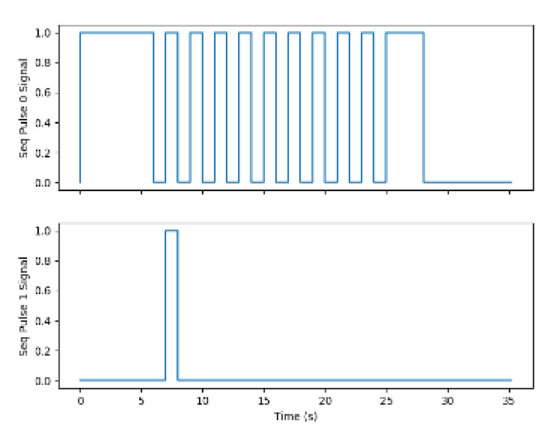
The sequencer table is configured from the UI input groups, which specify information such as the trigger type, the number of frames, the pulse groups and the run time.
The table can be configured to be run multiple times by setting the repeats value.
The list of detectors required for the collection can also be selected by the user from the UI, and only the ones checked in each pulse group will be triggered.



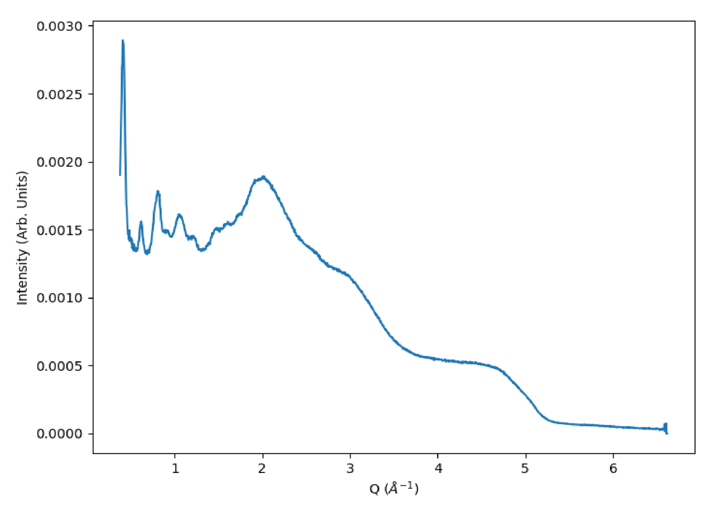
PandA GUI

A first experiment completely run through Bluesky: characterisation of the structure of Guinness foam after pouring.

This dataset was collected by triggering 4 detectors simultaneously and collating the data: two Pilatus detectors (SAXS and WAXS) and two Tetramm (i0, measuring beam intensity at optics, and it, measuring transmitted intensity).



User timing signals for Pulse blocks 0 and 1



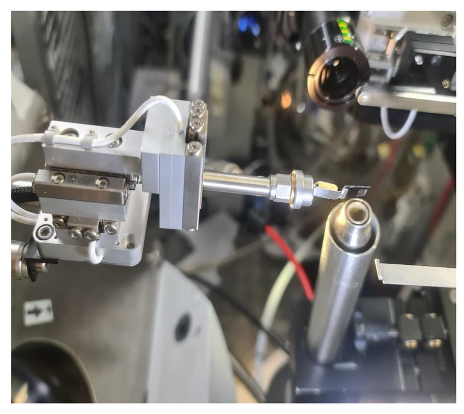
WAXS scattering pattern for Guinness foam

This experiment was conducted with the intent to demonstrate that the new hardware triggering solution via a PandaBox and a bluesky-based software stack can fulfill the typical use cases of the I22 beamline.

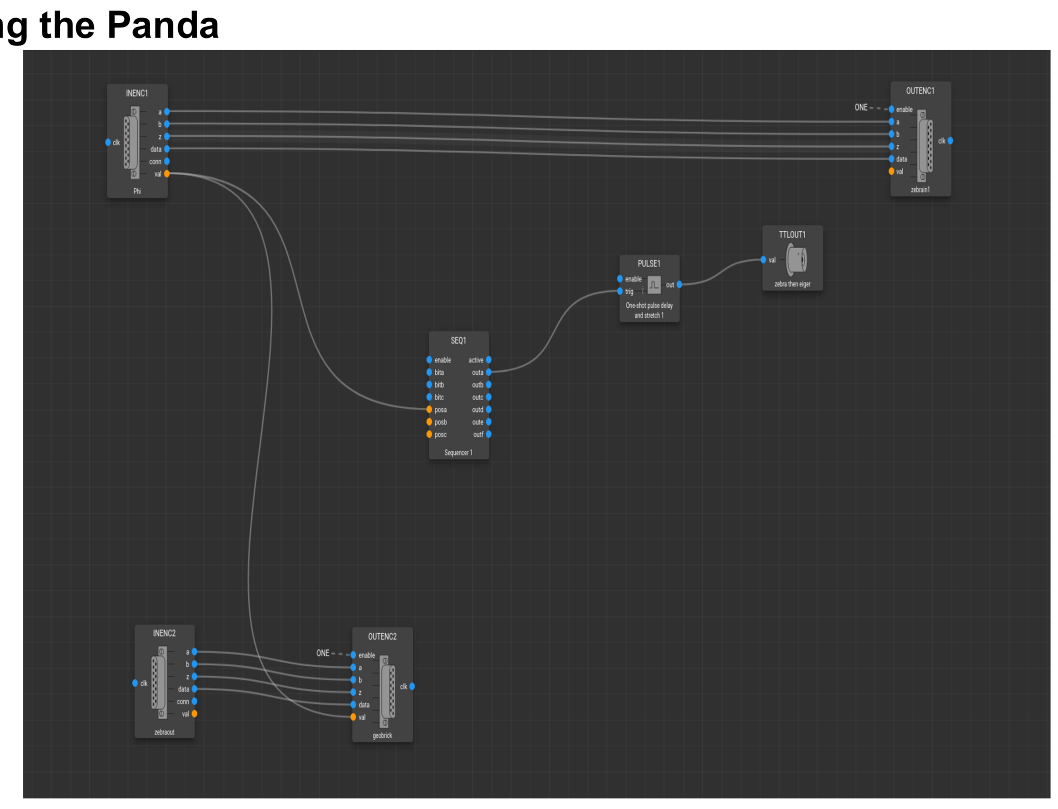
I19-2 (X): Increasing the efficiency of SSX

The Problem: serial crystallography on the small molecule single crystal beamline has so far been achieved using a ZebraBox for triggering, which introduces overheads in collection times when running consecutive rotations, either by having to wait for the diffractometer axis to go back to the start position or by needing to be reset to perform a rotation in the opposite direction.

The proposed solution:
- The PandA provides a sequencer table that can be programmed to specify when the detector should be triggered. This will allow to set the conditions to perform forwards and backwards consecutive rotations, by sending pulses based on reading the encoder signals from the axis motor.
- SSX on I19 is under continued development and using the Athena stack makes it easier to implement new procedures and integrate them in the existing software stack.
- This beamline has an additional problem of needing to check which experimental is in use at any time and gating access to the optics control to avoid interfering with ongoing collections. A first solution for this issue has been implemented in bluesky and is running on the beamline.



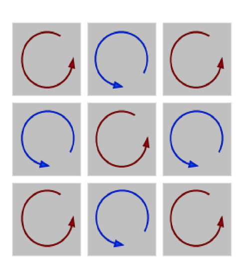
Configuring the Panda



PandA configuration for I19-2

The PandA here is configured so that it can read the current motor axis position from the input encoder and pass it on to the sequncer table, which will generate the pulses to trigger the detector according to the table here below:

CONDITION	TTL OUT	TIME1	ACTION POST TIME1
POS phi > phi start	1	Exposure time	TTL=0
POS phi < phi end	1	Exposure time	TTL=0



How the sequencer table is configured to perform the position compare:

I. At the start of the scan, the enable signal goes high
II. For forwards rotations, TTL triggers are sent to the detector once the phi axis reaches the "start" position, and they stop after the exposure time
III. For backwards rotations, TTL triggers are sent to the detector once the phi axis reaches the "end" position, and they stop after the exposure time
IV. The rows are repeated until enable is goes low again, signaling the end of the collection

This project is still a work in progress and the move to Bluesky/Ophyd-async has only started recently and a first test is set towards the end of the year.

For more information please visit www.diamond.ac.uk or contact Noemi Frisina at noemi.frisina@diamond.ac.uk

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