

# Enhancing Sardana Continuous Scans

*Insights from a Collaborative Workshop*

by Jordi Aguilar, José Gabadinho, Roberto Homs, Zbigniew Reszela, Oriol Vallcorba, Steven Wohl (ALBA)  
Johan Forsberg, Vanessa Da Silva (MAX IV)  
Michał Piekarski (SOLARIS)  
on behalf of the **Sardana Community**

NOBUGS 2024, 23-27.09.2024



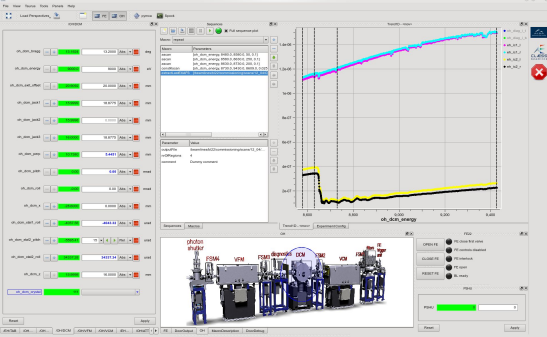
# Outline

1. Context
2. Motivation & Workshop
3. Developments
4. Applications

**Sardana - Scientific SCADA Suite**

Built on top of Tango Control System





Taurus based GUIs

## Sardana - Scientific SCADA Suite

Built on top of Tango Control System

100% Python

Four pillars extendable with plugins

Suite = Sardana & Taurus projects

```

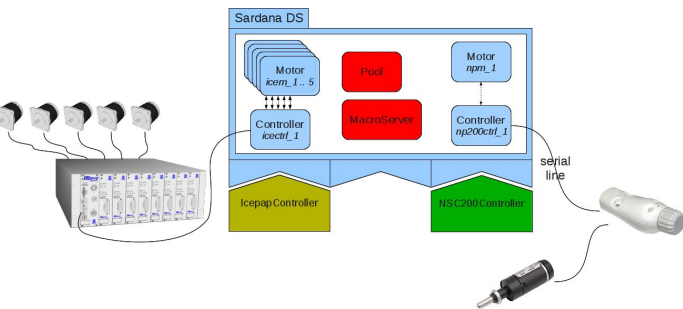
# Active Name Timer Experi. channels
ng_odedtest oned01 oned01
mntgrp01 ct01 ct01, ct02, ct03, ct04
mntgrp02 ct01 ct01, ct02
mntgrp03 ct01 ct01, ct02, ct03, ct04, oned01

# Motor_zrzszela | 14 | lsm
Name Type Controller Axis
-----
gsp01 PseudoMotor slitctrl01 1
icepap1302 Motor icepap13ctrl 2
mot01 Motor motctrl01 1
mot02 Motor motctrl01 2
mot03 Motor motctrl01 3
mot04 Motor motctrl01 4
mot05 Motor motctrl01 5
offset01 PseudoMotor slitctrl01 2
soprolec1 Motor soprolec_ctrl 1

# Motor_zrzszela | 15 | Nascan mot01 0 1 4 0.1
Operation will be saved in /home/zrzszela/ipy/test_h5 (w5)
Scan #329 started at Sun Oct 12 13:43:27 2014. It will take at least 0:00:00.694422
Moving to start positions...
#Fit No. mot01 ct01 ct02 ct03 ct04 dt
0 0 0.1 0.2 0.3 0.4 0.085824
1 0.25 0.1 0.2 0.3 0.4 0.248444
2 0.5 0.1 0.2 0.3 0.4 0.410594
3 0.75 0.1 0.2 0.3 0.4 0.570931
4 1 0.1 0.2 0.3 0.4 0.730435
Operation saved in /home/zrzszela/ipy/test_h5 (w5)
Scan #329 ended at Sun Oct 12 13:43:28 2014, taking 0:00:00.845693,Dead time 40.9%
(taution dead time 29.5%)
    
```

Spock - IPython based CLI

Device Pool - access to the hardware

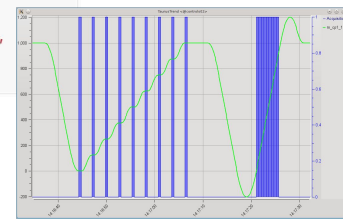


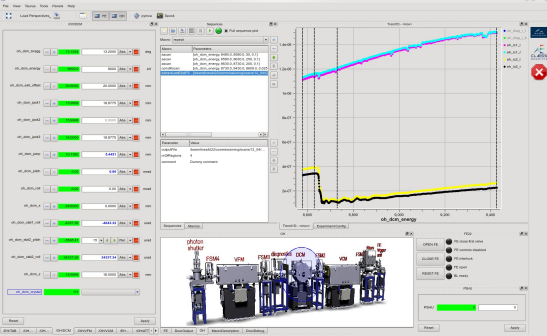
MacroServer - powerful sequencer

```

from sardana.macroserver.macro import macro

@macro()
def hello_world(self):
    """This is a hello world macro"""
    self.output("Hello, World!")
    
```





Taurus based GUIs



## Sardana - Scientific SCADA Suite

Built on top of Tango Control System

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Four pillars extendable with plugins

Suite = Sardana & Taurus projects

Community of users and developers

```

Active      Name      Timer Experi. channels
-----
ng_odedtest oned01 oned01
mtrgrp01    ct01 ct01, ct02, ct03, ct04
mtrgrp02    ct01 ct01, ct02
mtrgrp03    ct01 ct01, ct02, ct03, ct04, oned01

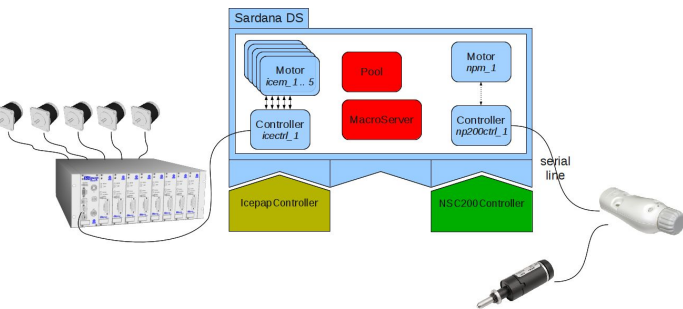
User_zrzeszala | 144 | lsnc
-----
Name      Type      Controller  Axis
-----
gap01     PseudoMotor  slitctrl01  1
icepap1302 Motor      icepap13ctrl  2
mot01     Motor      motctrl01   1
mot02     Motor      motctrl01   2
mot03     Motor      motctrl01   3
mot04     Motor      motctrl01   4
mot05     Motor      motctrl01   5
offset01  PseudoMotor  slitctrl01  2
soprolec1 Motor      soprolec_ctrl  1

User_zrzeszala | 145 | nscan mot01 0 1 4 0.1
Operation will be saved in /home/zrzeszala/tmp/test_h5 (w5)
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Moving to start positions...
#Fit No      mot01      ct01      ct02      ct03      ct04      dt
-----
0      0      0      0.1      0.2      0.3      0.4      0.085824
1      1      0.25      0.1      0.2      0.3      0.4      0.248444
2      2      0.5      0.1      0.2      0.3      0.4      0.410941
3      3      0.75      0.1      0.2      0.3      0.4      0.570931
4      4      1      0.1      0.2      0.3      0.4      0.730435

Operation saved in /home/zrzeszala/tmp/test_h5 (w5)
Scan #329 ended at Sun Oct 12 13:43:28 2014, taking 0:00:00.845693,Dead time 40.9%
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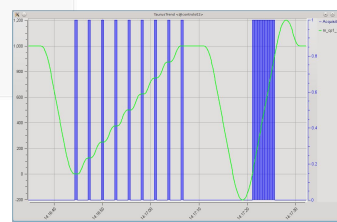


MacroServer - powerful sequencer

```

from sardana.macroserver.macro import macro

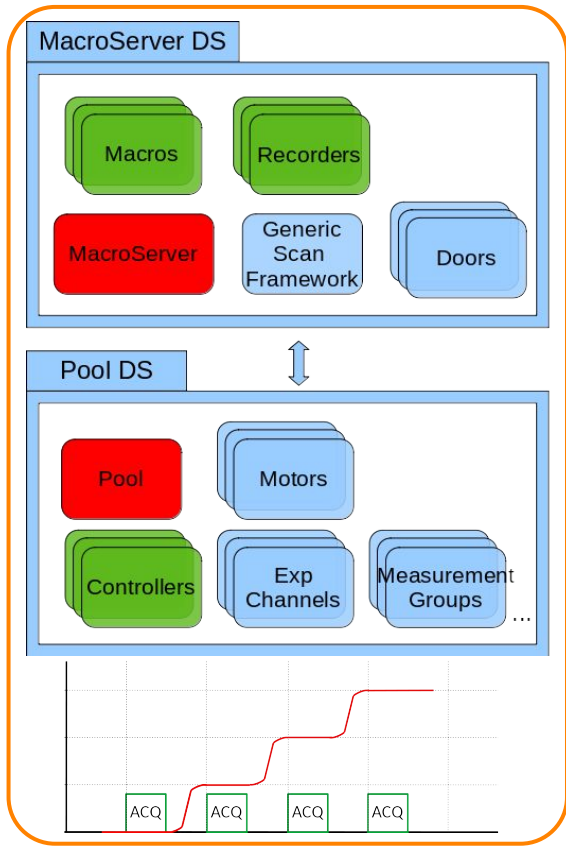
@macro()
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```



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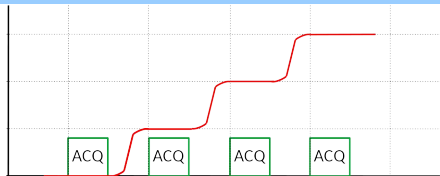
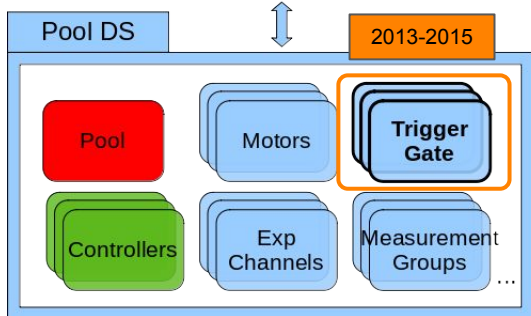
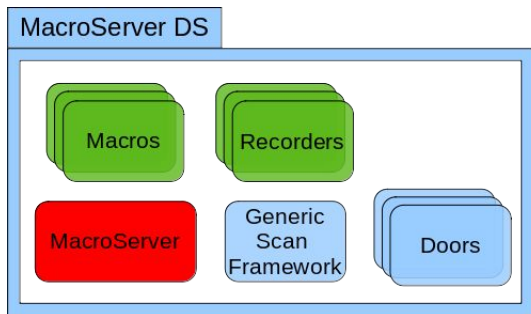
# Sardana continuous scans - iterative & incremental approach



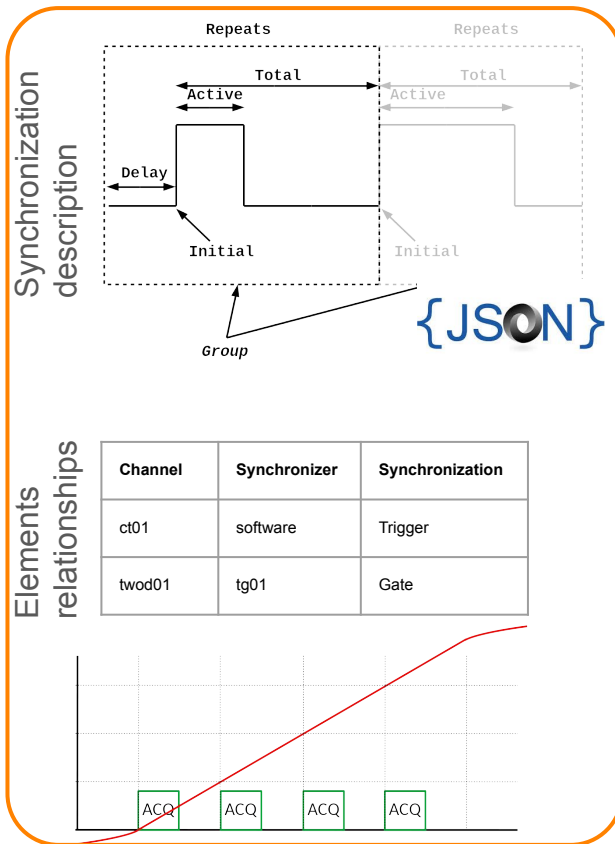
2007-2012



# Sardana continuous scans - iterative & incremental approach



2007-2012

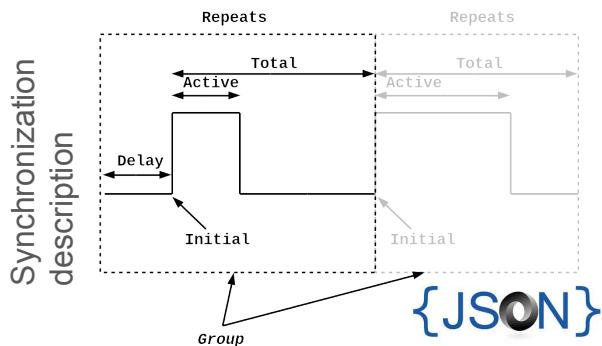
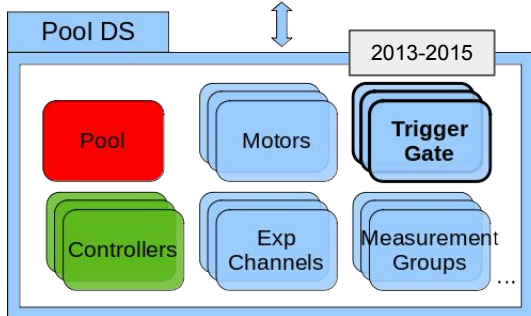
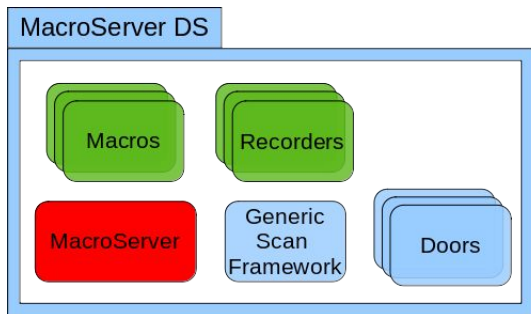


2013-2015



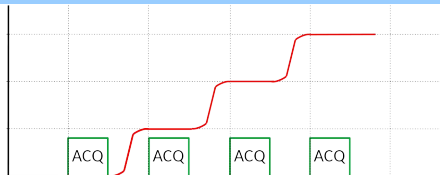


# Sardana continuous scans - iterative & incremental approach

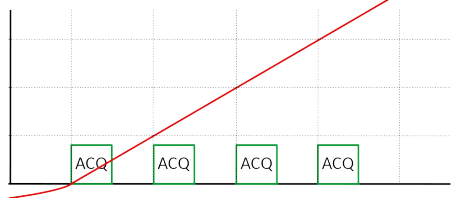


**Elements relationships**

Channel	Synchronizer	Synchronization
ct01	software	Trigger
twod01	tg01	Gate



2007-2012



2013-2015

2018-2019

1D&2D Exp Channel Improvements

Report references to data instead of data.



h5file:///tmp/image.h5::data

Use VDS when detector writes HDF5 files.

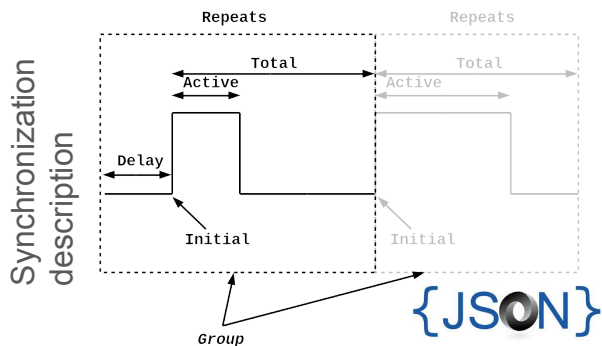
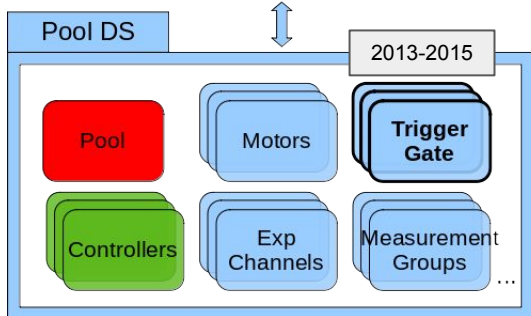
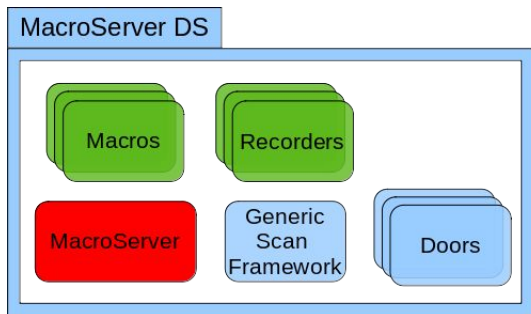


Virtual Data Sets

Smooth integration with LImA (ESRF)

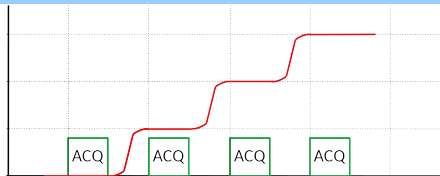


# Sardana continuous scans - iterative & incremental approach

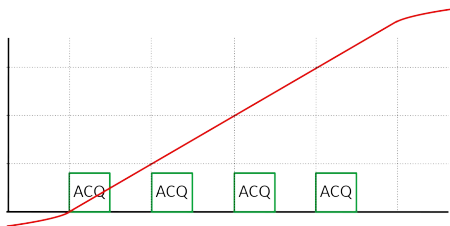


Elements relationships

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ct01	software	Trigger
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2007-2012



2013-2015

Report references to data instead of data.



h5file:///tmp/image.h5::data

Use VDS when detector writes HDF5 files.



Smooth integration with LImA (ESRF)



1D&2D Exp Channel Improvements

What happened after 2019?

- Migration from Py2 to Py3
- Config file format (YAML) and tools

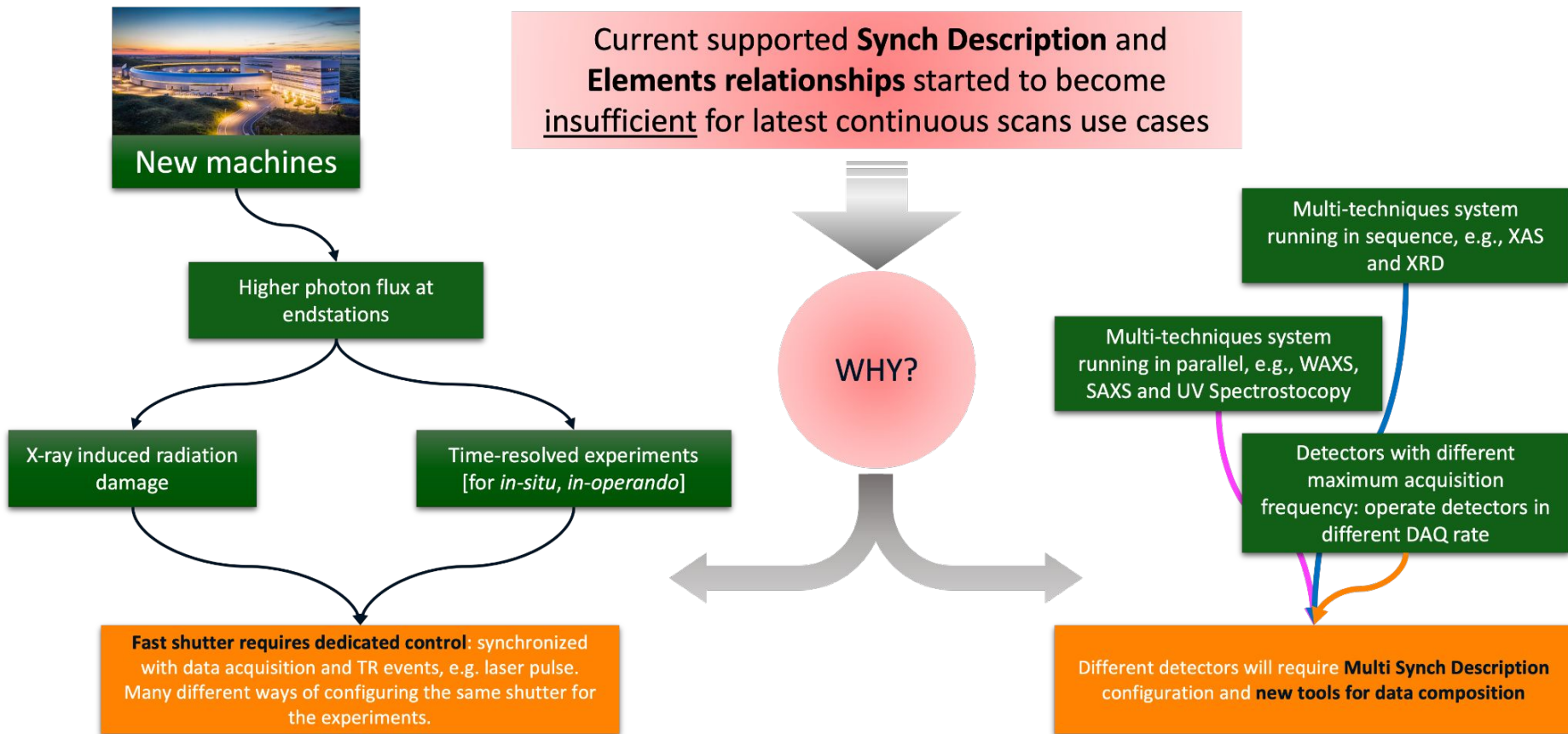
2018-2019

2019 - 2023

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# Current challenges for Continuous Scans



# Share with others and learn from others - workshop at SOLARIS



CONTINUOUS SCANS WORKSHOP  
20th-21st September, SOLARIS, hybrid





















Acknowledgements to all participants:

- DESY (PiLC + MTCA),
- DIAMOND (PandABox + malcolm + bluesky)
- ESRF (BLISS)
- SOLEIL (Flyscan)
- S2Innovation
- ALBA, MAXIV, SOLARIS (Sardana)
- + NSLSII (bluesky) meeting later

Ideas gathered during the workshop:

- Presentation of blissdata 1.0 (Redis)
- Push synchronization down to the hardware whenever possible (PandABox, PowerBrick, MAESTRIO)
- Flyscan GUI - state of all involved elements of the scan
- Bliss Acquisition Chain - represents relationships between the elements involved in the scan.
- Motion Trajectory Control with PowerPmac, IcePAP, etc.

# Identified missing features and implementation roadmap

	Requirements	Design	Coding	Review
<u>Short and mid-term roadmap:</u>				
Mesh scan improvements				
<b>Multiple synchronization descriptions</b>				
<b>Native shutter control</b>				
<b>Data publishing into an in-memory data store</b>				
Master-secondary relationship between elements				
Scans programmatic API improvements				

## To be evaluated in the future:

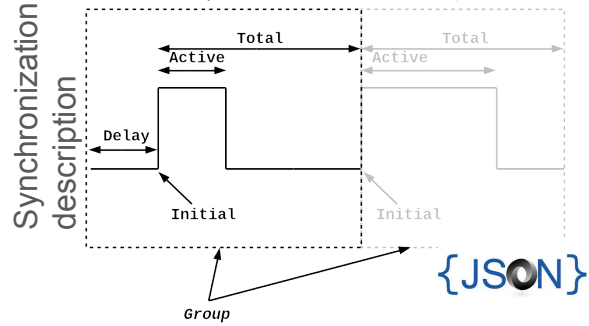
Native trajectory control with pseudo motors / motor groups.

Controller API refactoring

# Outline

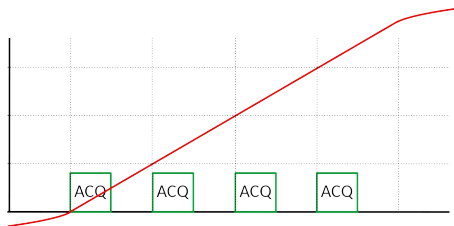
1. Context
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# Multiple Synchronization Description



Elements relationships

Channel	Synchronizer	Synchronization
ct01	software	Trigger
twod01	tg01	Gate

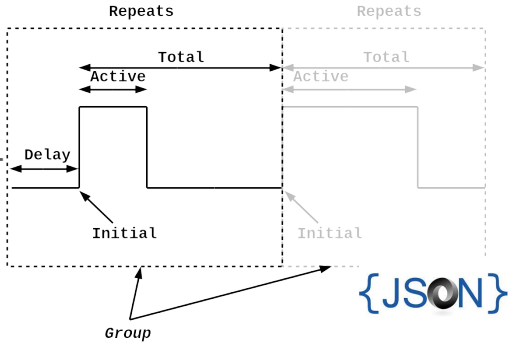


2013-2015

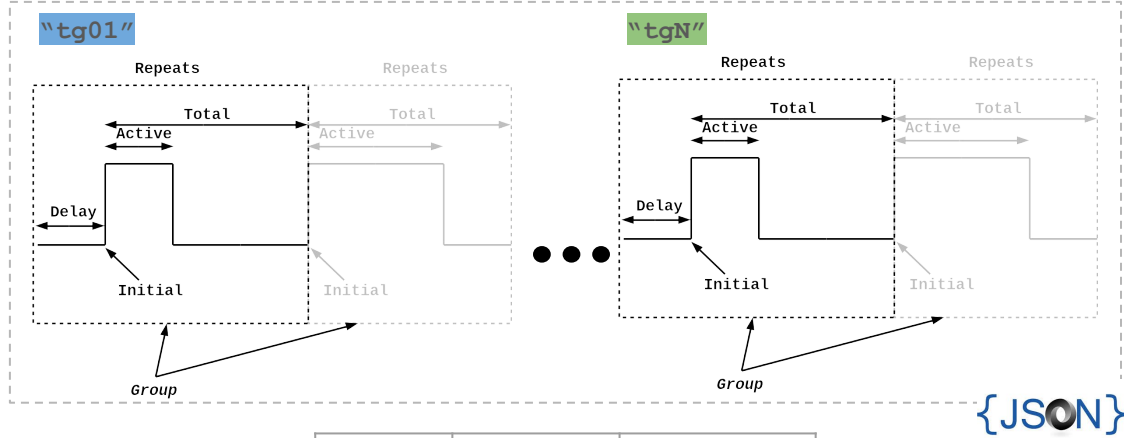


# Multiple Synchronization Description

Synchronization description



Multiple synchronization description



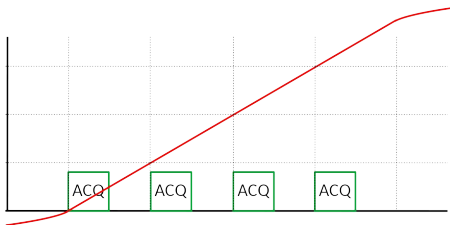
Elements relationships

Channel	Synchronizer	Synchronization
ct01	software	Trigger
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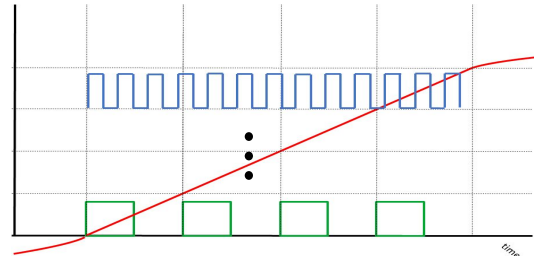


Elements relationships

Channel	Synchronizer	Synchronization
ct01	tg01	Trigger
...		...
...	...	...
twod01	tgN	Gate



2013-2015



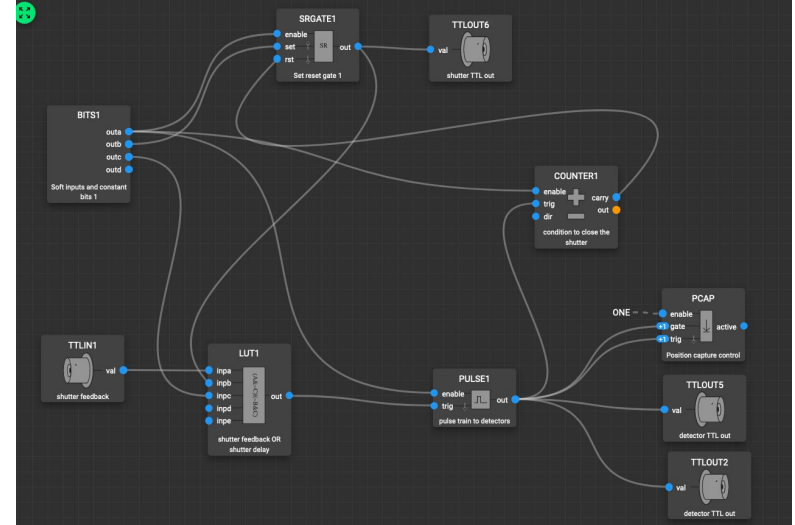
2024

# Shutter element

Previous shutter implementation:

- Software shutter control at macro level
- Hardware shutter control with custom Trigger/Gate controllers (dedicated PandABox layout at MAX IV and NI6602 at ALBA)

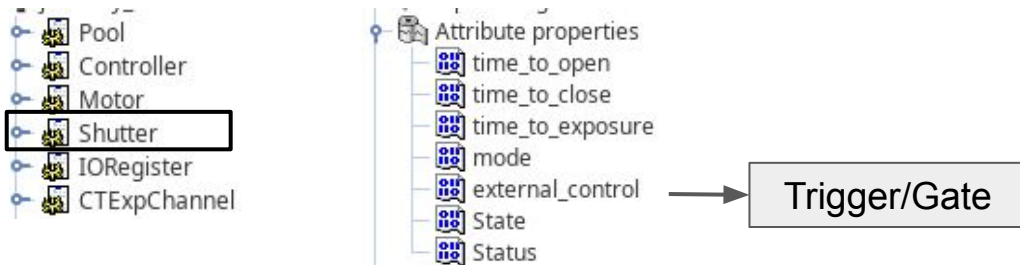
```
def SynchOne(self, axis, configuration):  
    """ Configures the axis with the synchronization description.  
    We configure here all three NI channels:  
        position counter  
        detector pulse  
        shutter pulse  
    :param int axis: axis number. First axis corresponds to omega  
    and axis 2 corresponds to omegax motor.  
    :param list<dict> configuration: synchronization description"""  
  
    group = configuration[0]  
    user_delay = group[SynchParam.Delay][SynchDomain.Position]  
    user_initial = group[SynchParam.Initial][SynchDomain.Position]  
    user_active = group[SynchParam.Active][SynchDomain.Position]  
    user_total = group[SynchParam.Total][SynchDomain.Position]  
    r_points = group[SynchParam.Repeats]  
  
    # Convert from user units to ticks (X1)  
    # MUST use decoding X1 - this reduces resolution by factor of 4 in  
    # comparison to X4. In X4 any transition of each of the phases A and  
    # B counts. In X1 only a certain transition of one of the phases counts  
    delay = self.pos_to_x1_counts(user_delay, ENCRES[motor_name])  
    initial = self.pos_to_x1_counts(user_initial, ENCRES[motor_name])  
    active = self.pos_to_x1_counts(user_active, ENCRES[motor_name])  
    total = self.pos_to_x1_counts(user_total, ENCRES[motor_name])
```



**Aim to integrate shutters independently of its synchronization hardware.**

# Shutter element

- 1 Sardana first-class citizen with configuration attributes

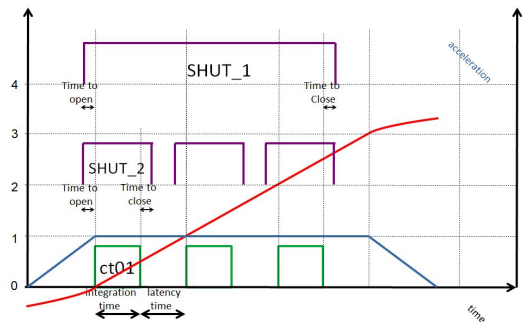


- 2 Measurement Group member

Active Measurement Group | mntgrp02

Channel	enabled	output	Plot Type	Plot Axes
ct01	true	true	No	
SHUT_1	true	true	No	
SHUT_2	true	true	No	

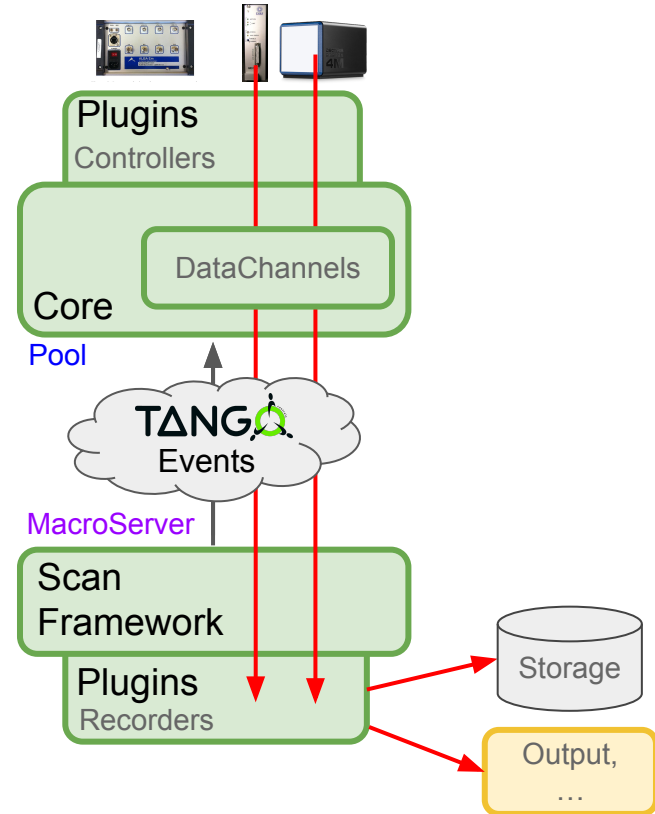
- 3 Native software and hardware control using Multiple Synch. Description



# Data publishing into an in-memory data store

## Motivation:

- Minimize the stress on the MacroServer
- Data available on the fly for external consumers
- Avoid potential bottlenecks in Tango events
- Enable external data composition



# Data publishing into an in-memory data store

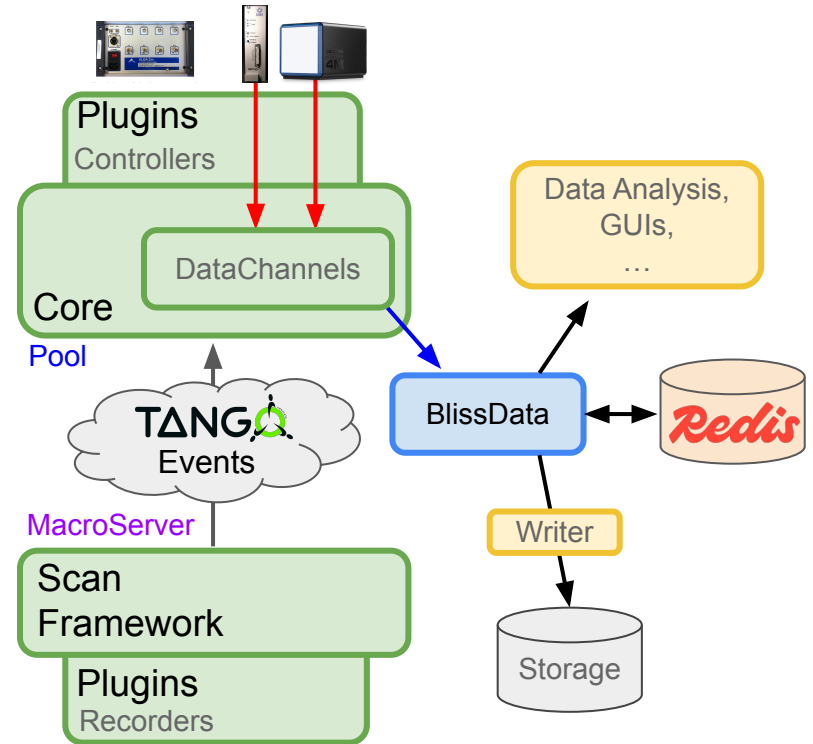
## Motivation:

- Minimize the stress on the MS
- Data available on the fly for external consumers
- Avoid potential bottlenecks in Tango events
- Enable external data composition



## Integrate ESRF **Blissdata** in Sardana

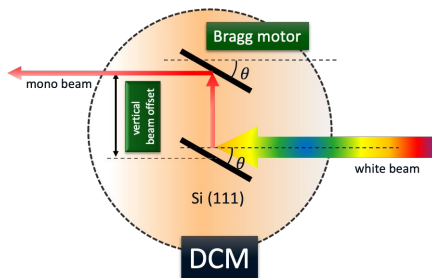
- Store from **Scan Framework**
  - Store from the **Core**
- Tested successfully with multiple sync descriptions  
WiP for final integration



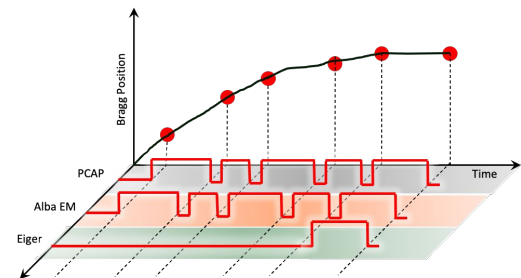
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# Continuous Scans applications at MAX IV

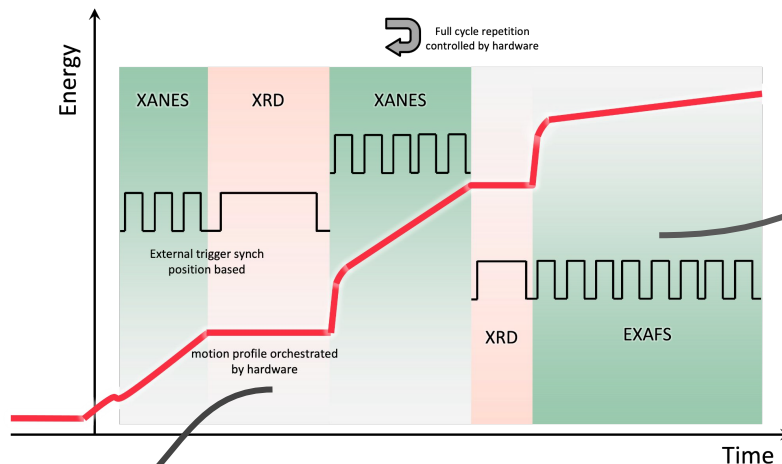


- Continuous scan position-based
- Multiple techniques sequentially: XAS and XRD
- Scan driven by hardware: **PandABox** and **ACS** loaded trajectories



ACS SPIIPlusEC  
motor controller

Allow programs in the buffers.  
Different functions can be  
programmed as modules.  
The programmed functions can  
also orchestrate the motion.



PandABox

Responsible for the experiment  
DAQ synchronization. Generates GATES  
based on Bragg position. Different  
detectors [of different techniques] get  
different pulse train

# Continuous Scans applications at MAX IV



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

Vinuesa Siles, Marcello Alcocer, Michele Casella, Daphne van Dijk, Mikel Equirraun, Justus Jurt, Konstantin Kamenov, Mirjam Lindberg  
MAX IV Laboratory, Lund, Sweden  
Contact: information.sordana@maxiv.se



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



MAX IV Laboratory



### 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.

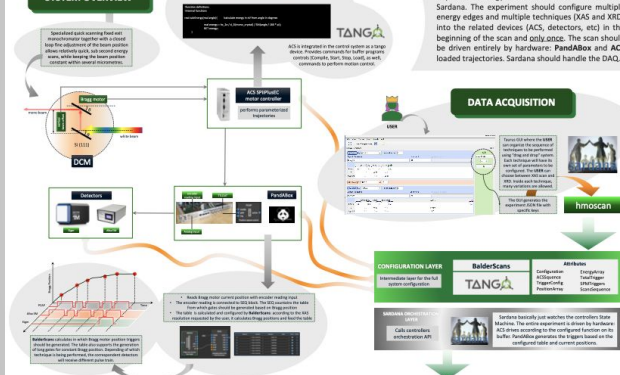
### THE CHALLENGE

Implement energy hardware orchestrated scan in Sordana. 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. Sordana should handle the DAQ.

### DATA ACQUISITION



### SYSTEM OVERVIEW



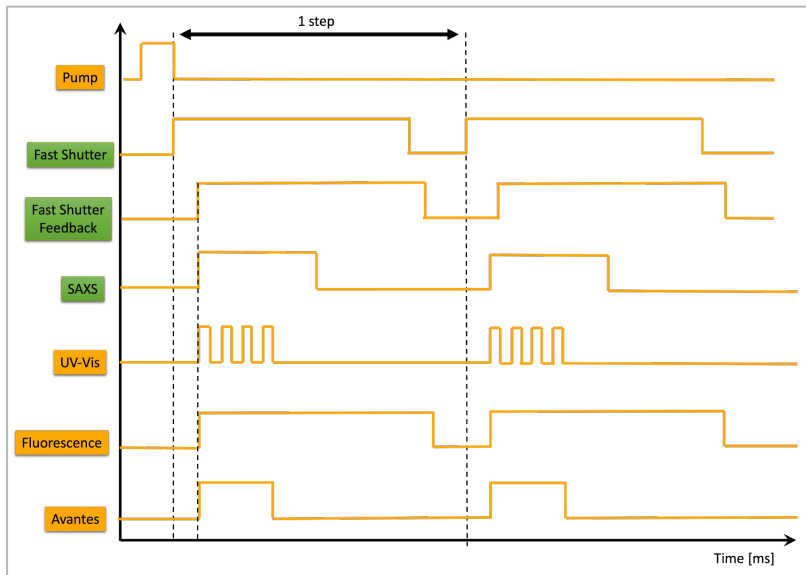
### NEXT STEPS

- Full replacement of the Configuration Layer by Sordana 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 downtime

Discussed in details at poster #116



# Continuous Scans applications at MAX IV



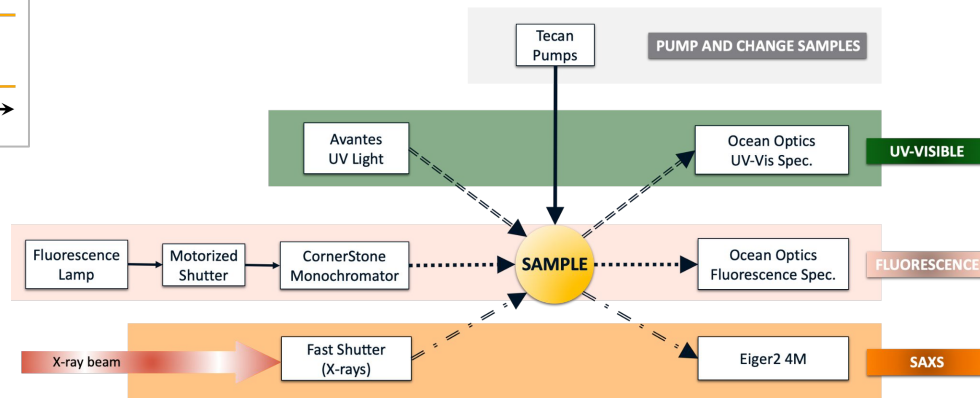
PandABox

Responsible for the experiment DAQ synchronization. Each technique related detector gets a different pulse train. The start of each technique pulse train is synchronized.

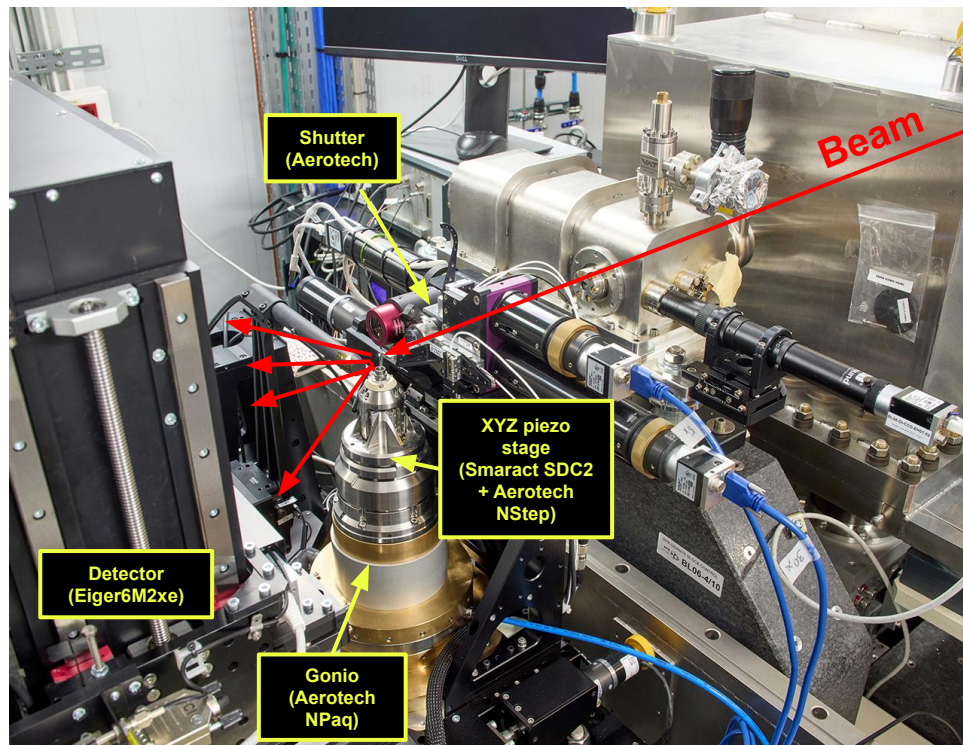


CoSAXS beamline

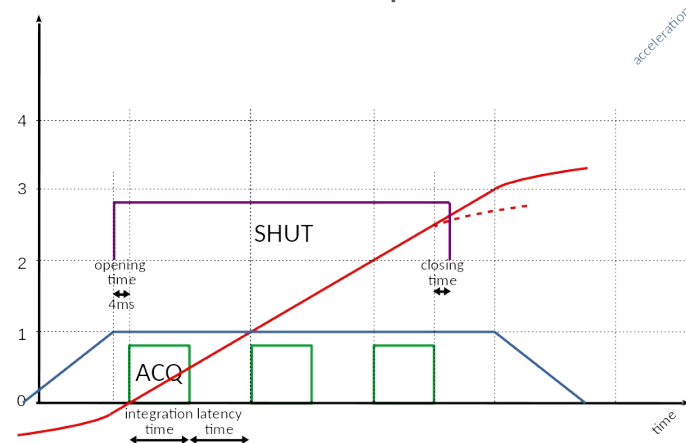
- Continuous scan time-based
- Multiple techniques performed simultaneously: SAXS, UV-Vis and Fluorescence Spectroscopy



# Continuous Scans applications at ALBA



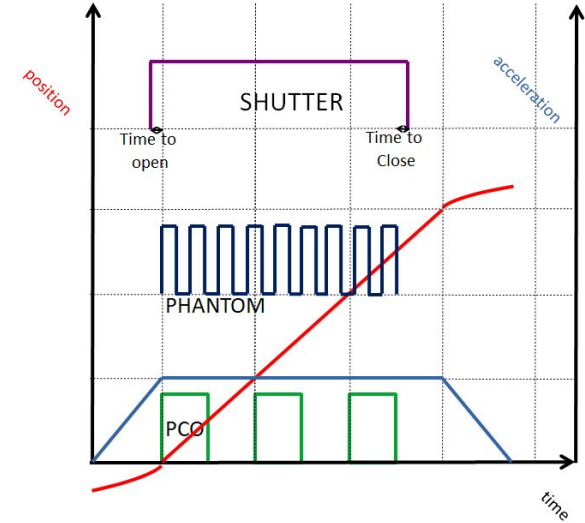
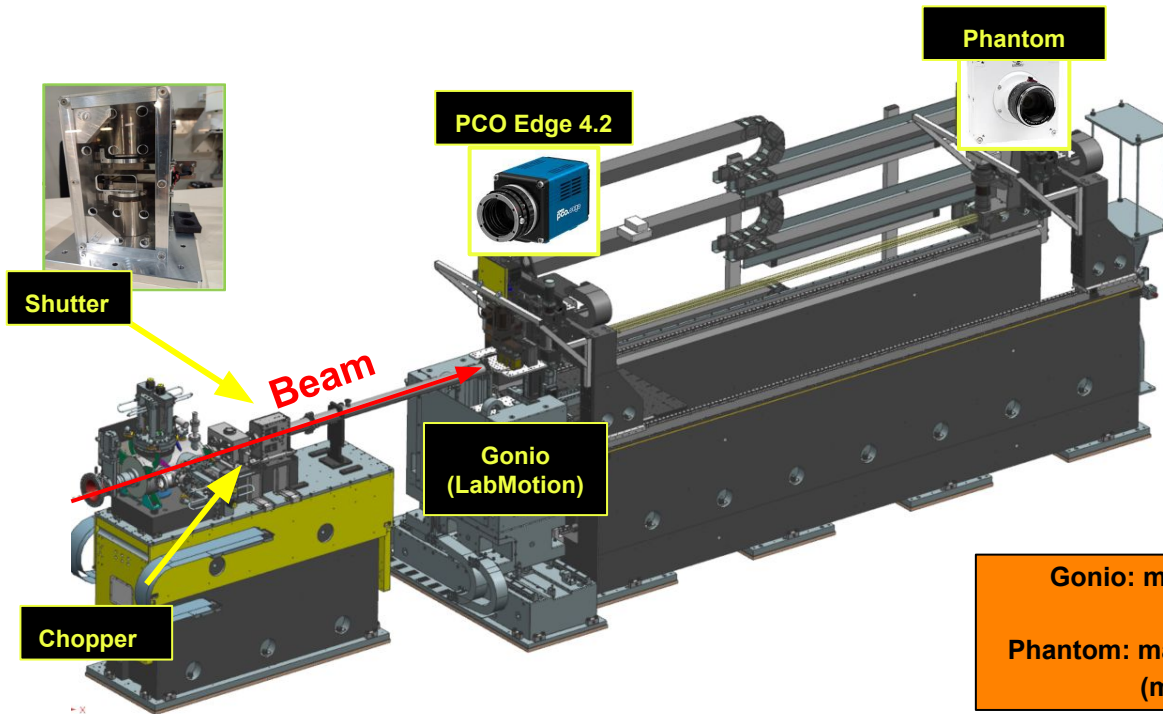
- BL06-XAIRA microfocus MX beamline in He atmosphere (in construction)
- Oscillation and Raster Scan:
  - Trigger detector by position
  - Trigger fast-shutter by constant speed



# Continuous Scans applications at ALBA



- BL31-FAXTOR - Fast tomography beamline (in construction)
- Involved elements: Multiple detectors (4 in total, 2 used simultaneously), Chopper (unknown), Shutter, Goniometer, Synchronization with NI6602.



**Gonio: max. rotation speed: 4860 deg/s  
(15 tomos/s)**  
**Phantom: max. acq. rate: 7000 fps (8bit mode)  
(max. data rate 60 Gbit/s)**

# Continuous Scans applications at ALBA

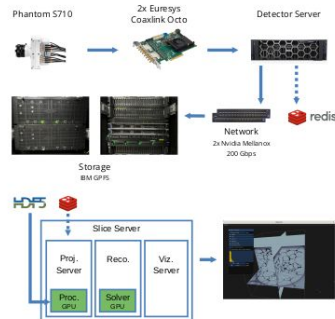
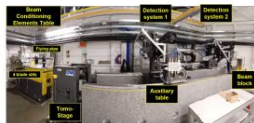
## FaXToR data processing

G. Jover-Mañas, F. Cova, V. Bouffetier, A. Patera  
CELLS-ALBA, Cerdanyola del Valles (Barcelona) SPAIN

FaXToR: East X-ray Tomography and Radioscopy Beamline.

Very versatile beamline with resolutions up to  $1\ \mu\text{m}$  at its early stage. FaXToR is capable of taking 15 tomographies per second, allowing in-situ / in-operando measurements.

First users are coming in 2025.



Provided with fast storage, data acquisition and data processing, the beamline can offer on-the-fly data reconstruction and visualization with a refresh period of 330ms.

Phantom S710 data is stored in bunches of 360 projections at 9 GB/s.

The projection server loads data to GPU and generates the sinogram in 270 ms. Slices of  $1280 \times 1280$  pixels are reconstructed in 12 ms and sent to the visualization workstation.

Overall latency is estimated to be less than a second with a visualization rate better than 3 Hz.

Friendly user interface has been developed using Orange to define and configure reconstruction workflows.

Each task in the workflow is executed with Dask on our Slurm HPC cluster.



Discussed in details at poster #80 by Gabriel Jover-Mañas (ALBA SDM)

# Conclusions

- Institutes using Sardana have similar needs for continuous scans:
  - Faster scans with time resolution precision
  - Diversity of involved elements
  - Shift of complexity from software to the hardware
- Even if we use a different hardware we aim to develop and use together the same continuous scan software.
- Sardana continuous scans enhancement is an ongoing project currently being tested at our beamlines.
- Acknowledgements to the Community for sharing your experience with us!
- We look forward for a second edition of the workshop. Hope to see you there!

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Thank you for your attention!