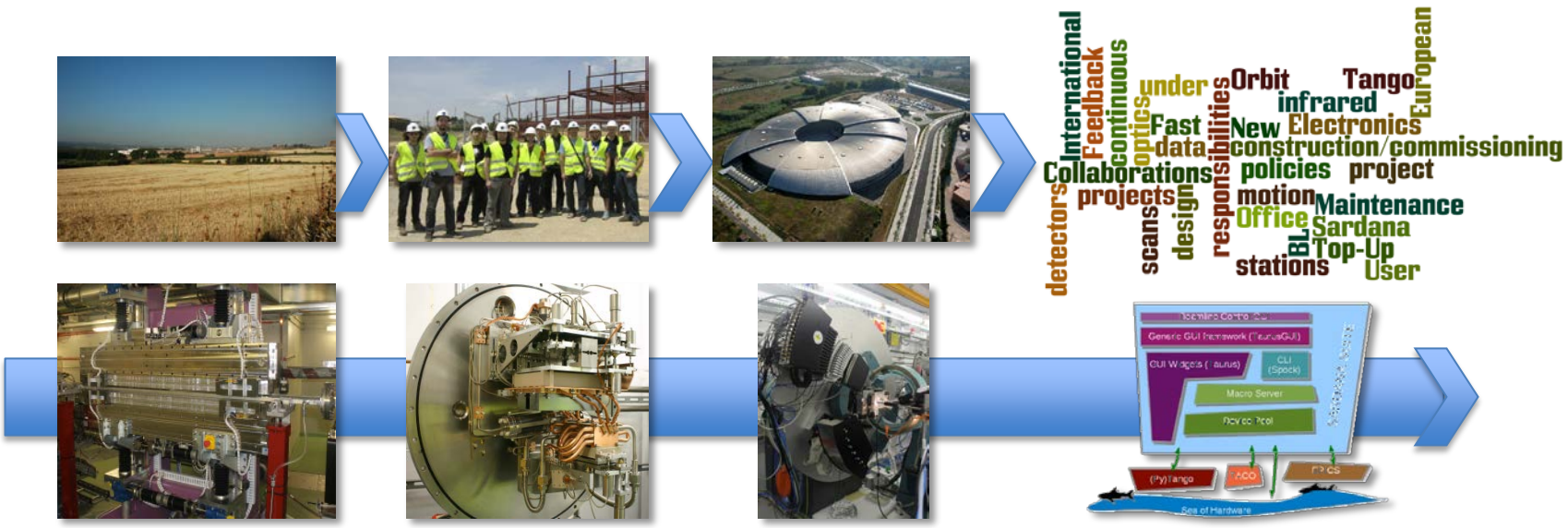


SYNCHRONIZATION OF MOTION AND DETECTORS AND CONTINUOUS SCANS AS THE STANDARD DATA ACQUISITION TECHNIQUE

D. Fernández, F.Becheri, T.Coutinho [on leave], G.Cuní, R.Homs, G.Jover, J. Klora [on leave], O.Matilla, J.Moldes, C.Pascual, Z.Reszela, D.Roldan, S.Rubio, X.Serra, and the Alba Team.

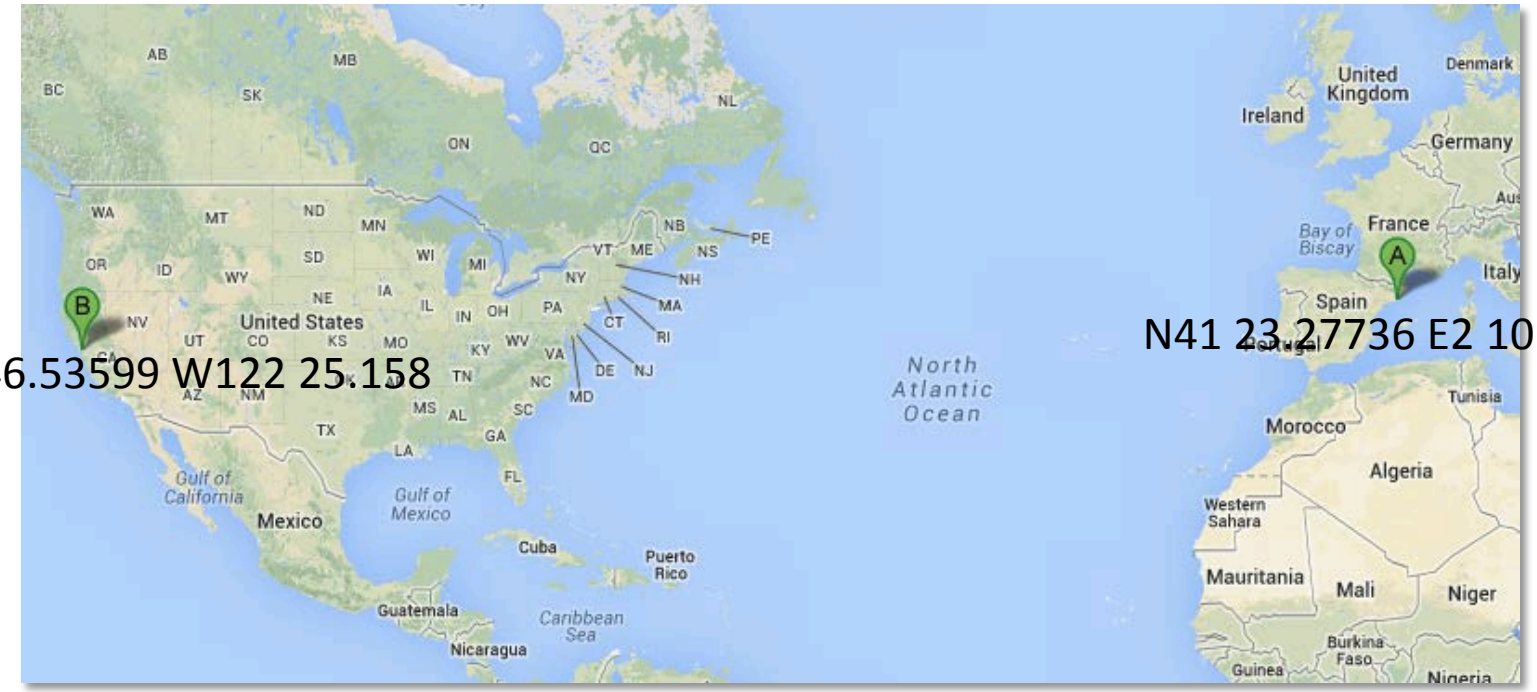
WECOAAB03, 0ct, 9th 2013. ICALEPCS´13

5949 miles / 9573.99 km / 5169.54 nautical miles

N37 46.53599 W122 25.158

N41 23.27736 E2 10.19525

5949 miles / 9573.99 km / 5169.54 nautical miles



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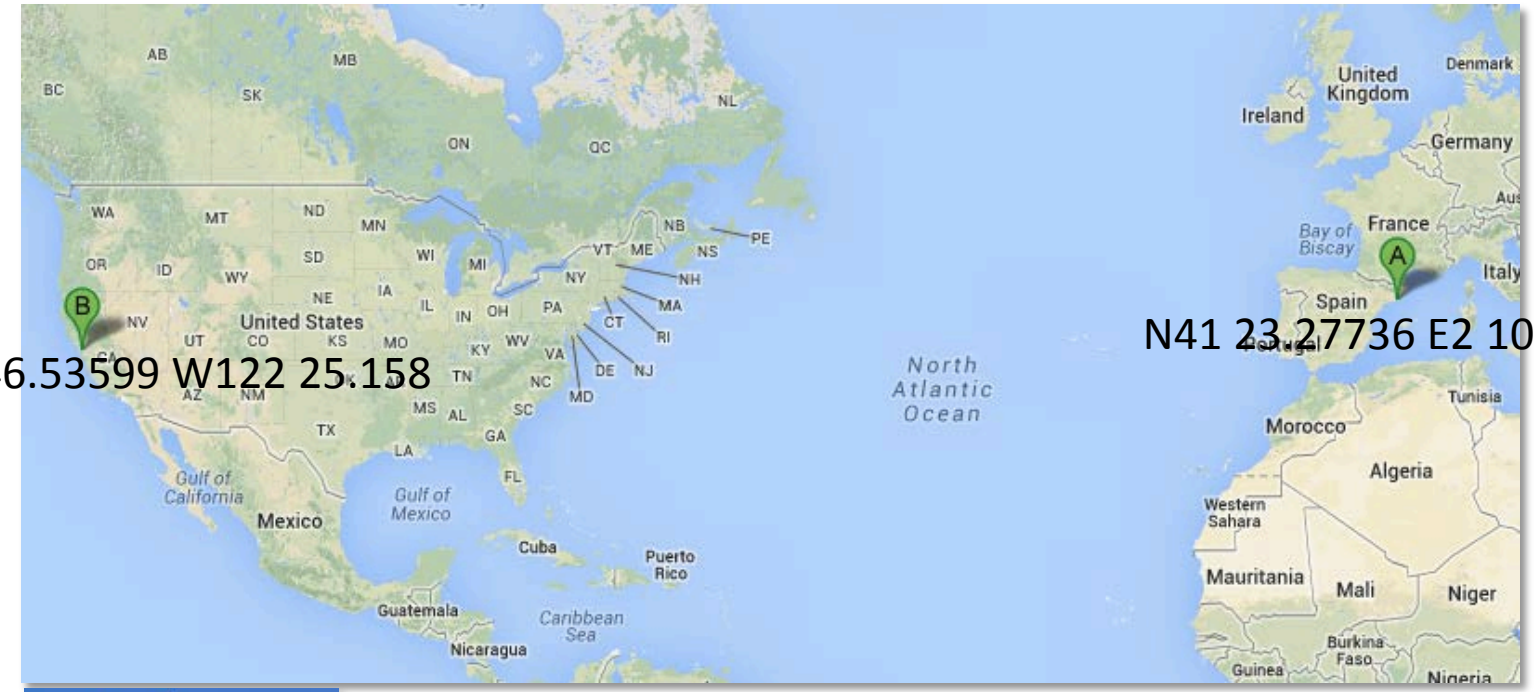

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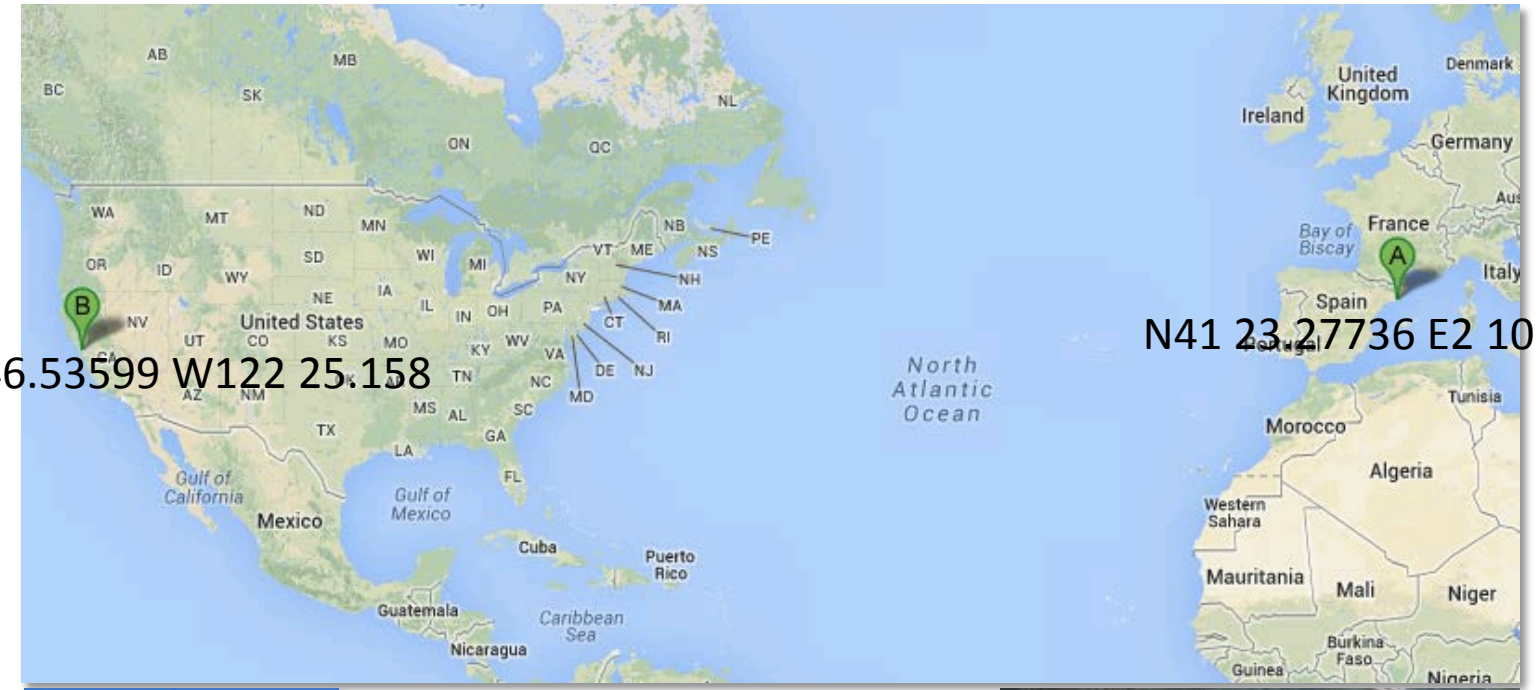
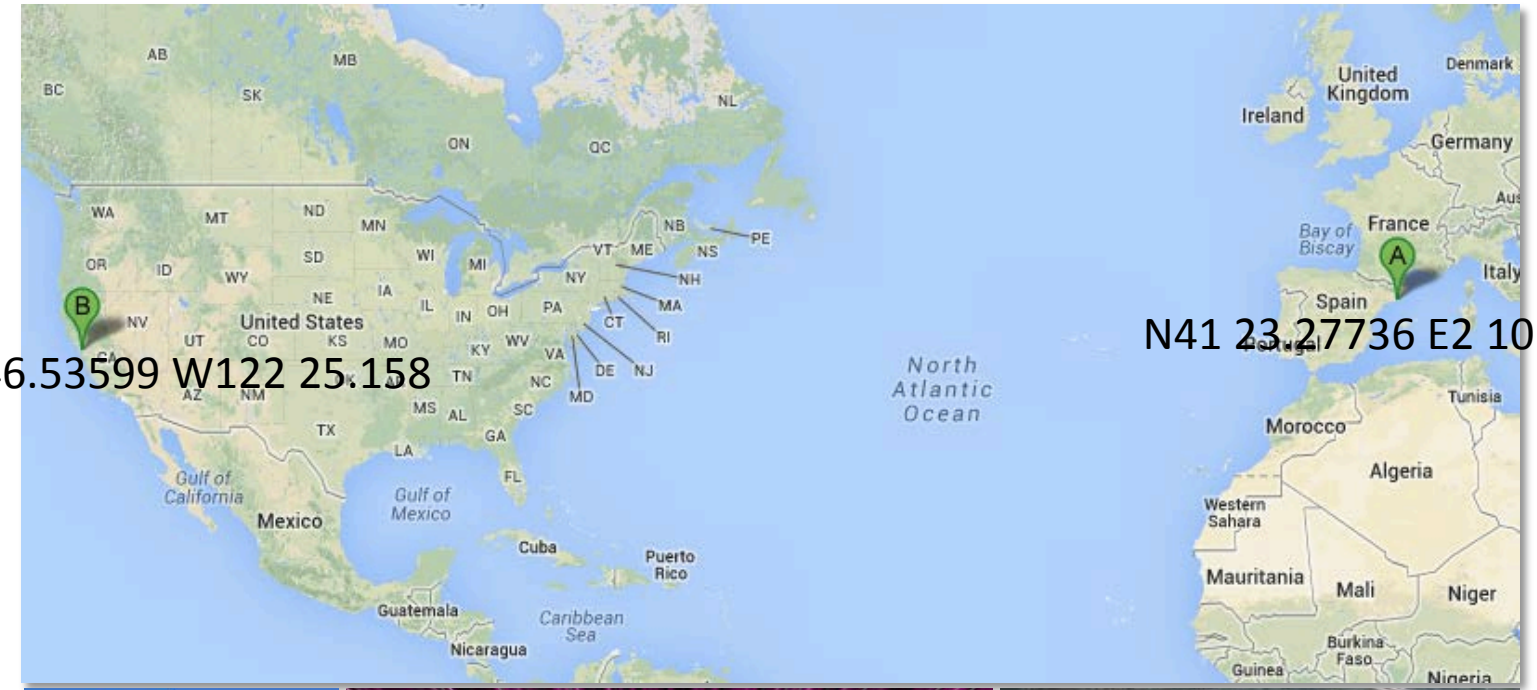


WECOAAB03. Continuous scans as the standard data acquisition technique

5949 miles / 9573.99 km / 5169.54 nautical miles



WECOAAB03. Continuous scans as the standard data acquisition technique

ALBA Synchrotron

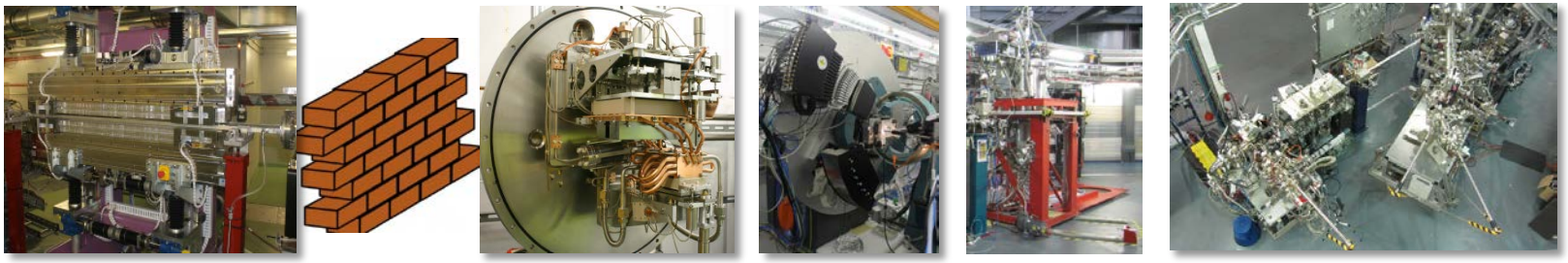
- 3GeV Accelerators Commissioned in 2011
  - Ethernet as a fieldbus. Linux Diskless cPCI IOCs B&R PLCs
  - Firsts Tests of TOP-UP and FOFB in progress (2013)

- 7 Beamlines commissioned in 2012: Official Users since then.
  - Electrometers, VTF Counters, CCD cameras (Rayonix, PCO, Princeton…)
  - Pixel detectors: Pilatus, Mythen, ImXPAD1400…

  …preparing for time resolved experiments…

Experimental station in a X-ray Beamline

ID DCM MAD XMCD PEEM, KNAPP



(…)

- **Insertion devices**: e.g. helical undulator (6 motors) and 6 pseudomotors
- **Monochromators**: e.g. Double crystal monochromator (direct drive 4 DEG/s)
- **Experimental station**: scalers, counters, 0D, 1D, 2D,
  - Counters, Electrometers, Cameras, etc.
  - Slow channels and fast channels

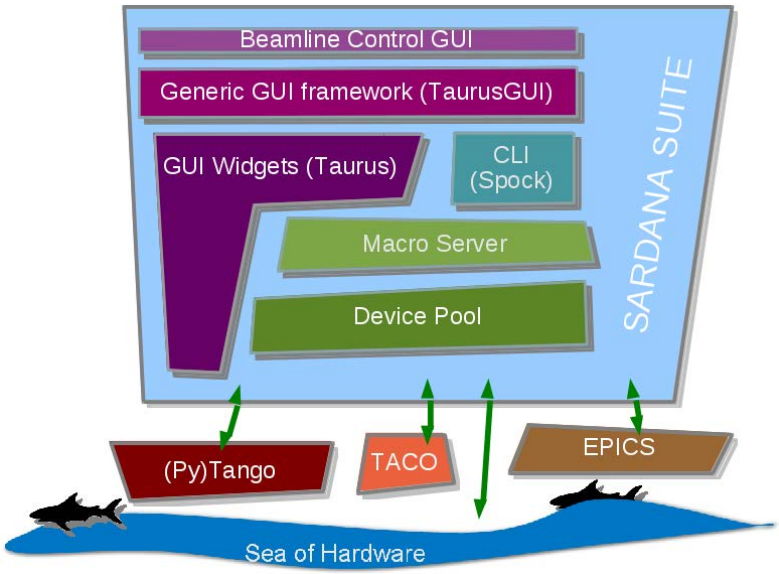
Need a "scanning machine" having **movable channels** and **experimental channels.**

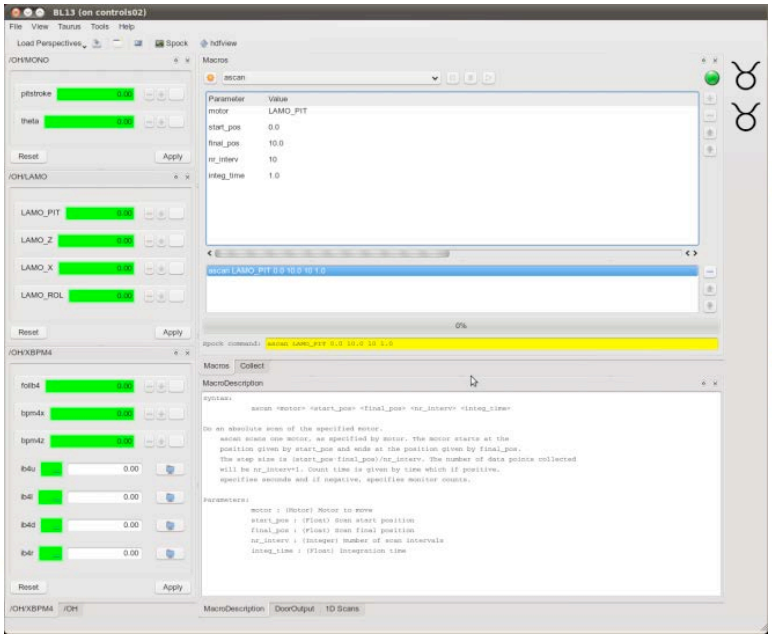
:Configure any combination of motors and counters + detectors in a step scan.

:Write my own sequences "macros" and scans,

:have pseudo-motors and pseudo-counters as a combination of several channels

Sardana: towards the scientific SCADA





- Generic, configurable Graphical User Interfaces. Trends, plots, forms, channels, synoptics, …
- Interfaces with PLCs, databases, and different fieldbuses.
- Historical archives for supervision data.
- Configuration management. Configuration tool and state snapshots capabilities.
- Alarm handling, states, notification, acknowledgement and archiving.
- Self diagnostics and management tools

…

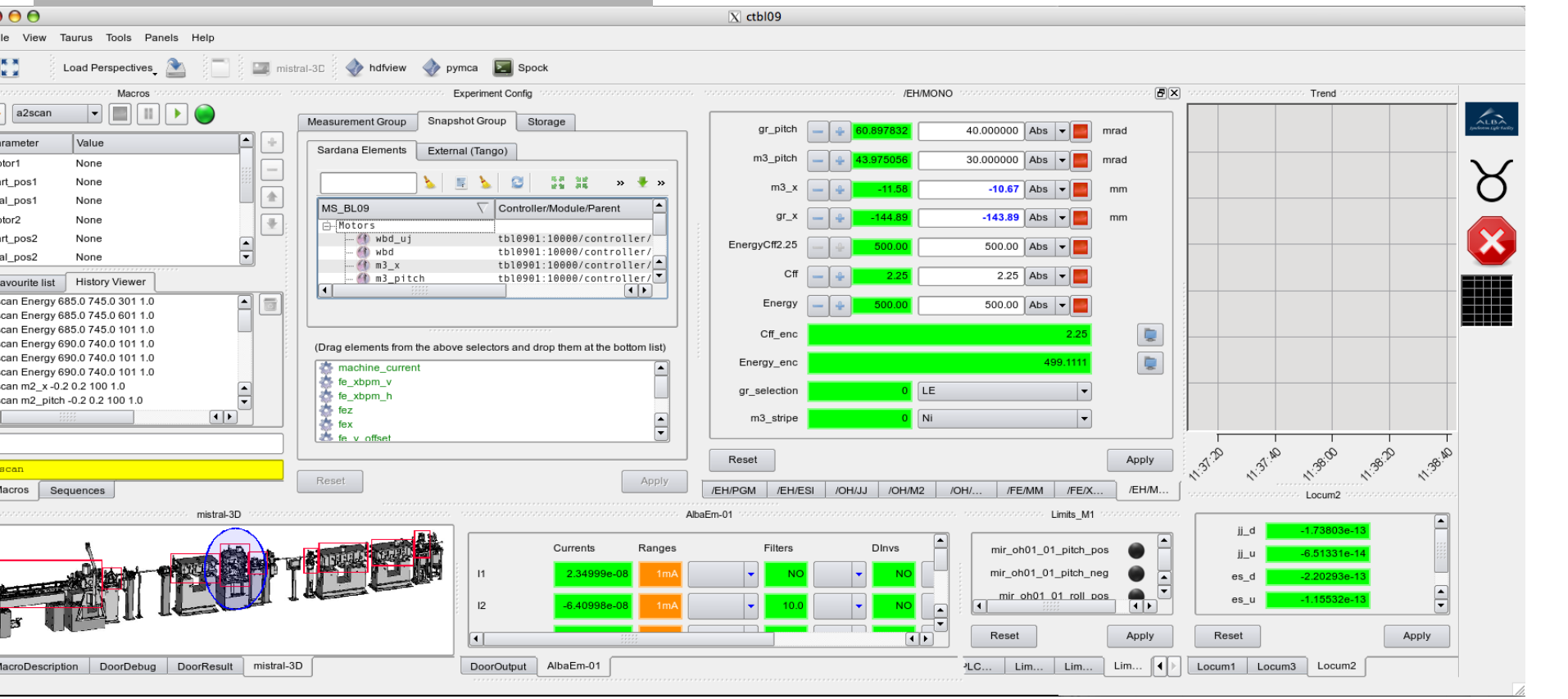
Sardana: towards the scientific SCADA

FLEXIBILITY

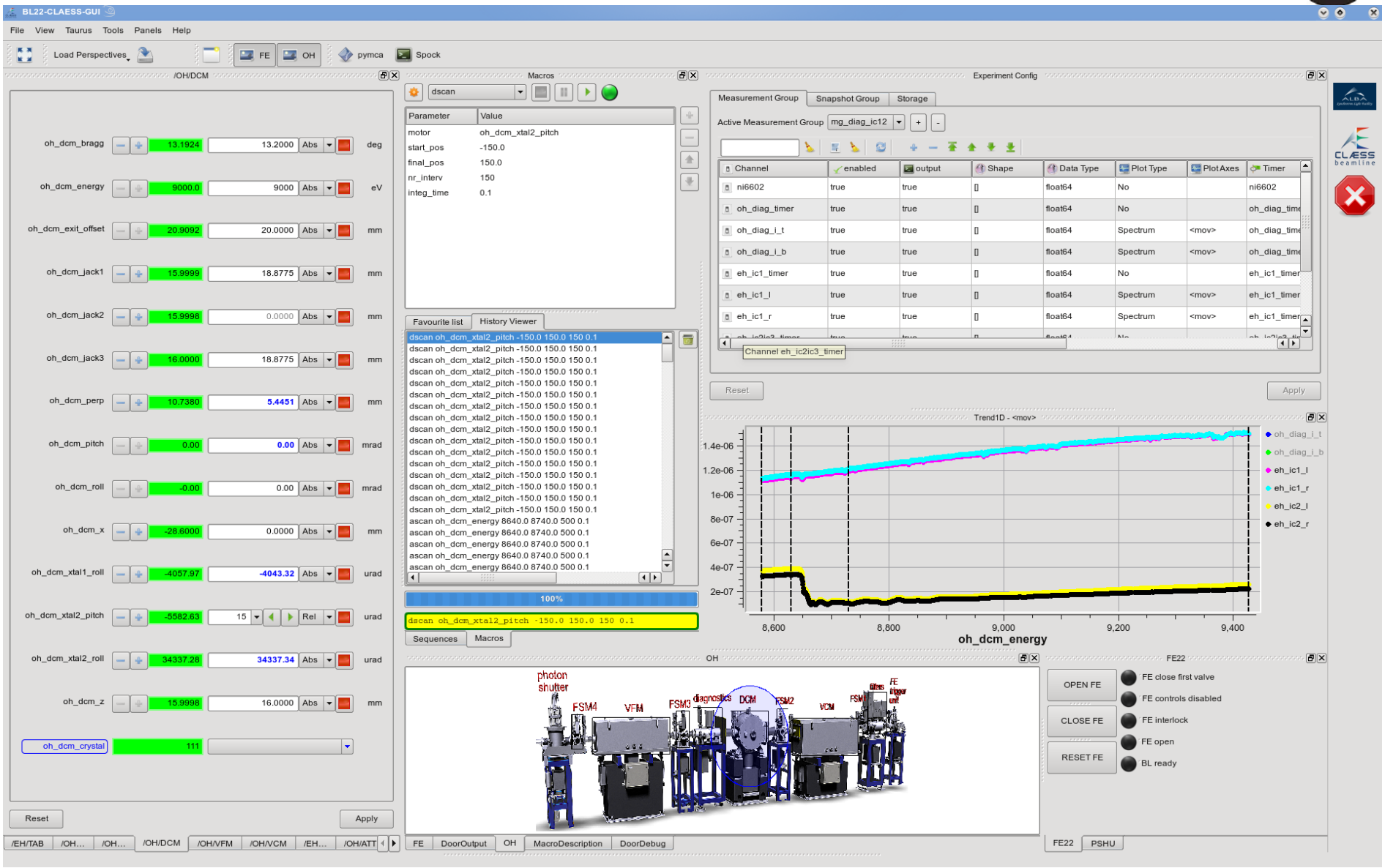
- Simple to download, install and startup.
- . and above all: well documented.

www.sardana-controls.org

www.tango-controls.org/static/sardana/latest/doc/html/



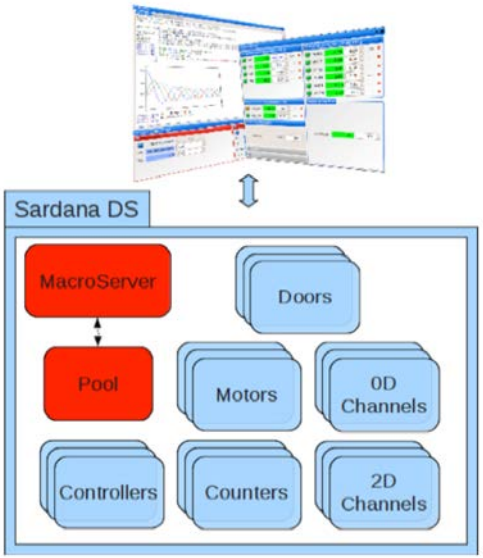
Sardana: towards the scientific SCADA

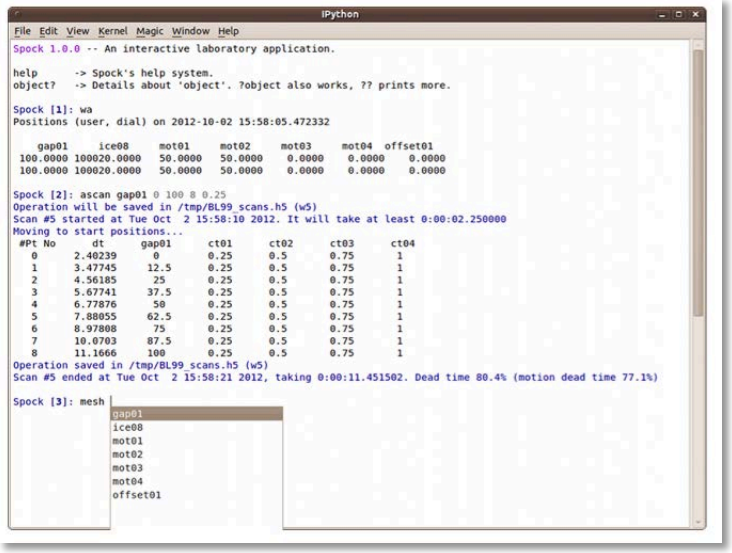


WECOAAB03. Continuous scans as the standard data acquisition technique

The control system. Step scans

TUPC061 G.Cuní et. al





- **Flexible, present in beamlines in "virtually" all synchrotrons. Extensively used in the day-to-day: Alignment, data acquisition, day-to-day operation in the Beamline.**
- **They are at the center of the control system:**
  - **Require motion, counter-timers, often a scripting-macro language,**
  - **Integrated with data formats, detectors, experimental channels, sample environment…**

…very robust …although …slow …

The control system. Continuous scans

- A **step scan**, depending on the experiment, exposure times and number of points can be **time consuming**.
- In some cases (**time resolved**), the experiment itself needs to be done on certain time constraints.
- The longer the scan takes, the more vulnerable is to changes in the environment (thermal drifts, machine current, orbit, etc…)
- Occasionally, it is more convenient (or mandatory) **taking data during the motion**:
    - **The data is taken at given intervals while the motor(s) are moving**.

- Acquisitions can be synchronized in different ways:
    - Time (pulses given at certain time) usually by a time frame generator or a timer
    - Position (reading encoder positions and producing pulses at the given points)

        - …what if non linear trajectories or non equal intervals?

Continuous scans “ad hoc”

TUPC060 Z.Reszela et. al

- **Running in most Beamlines synchrotrons**
  - **Overcome the “slow” issue of step scans**

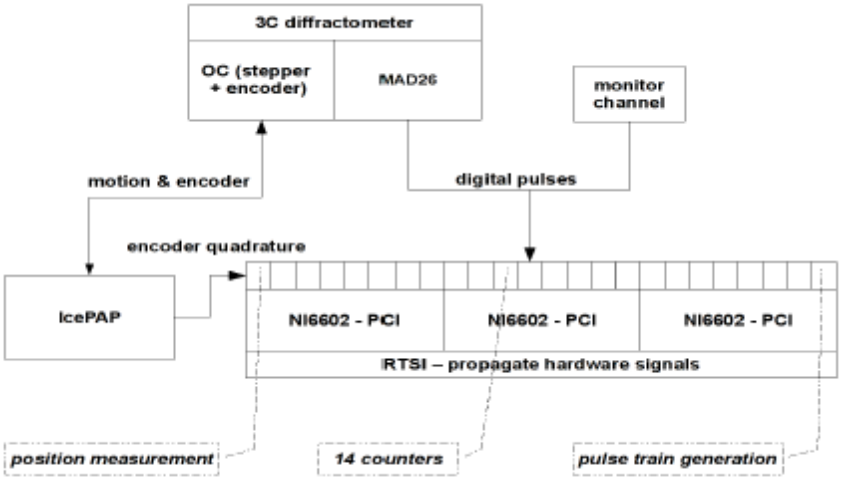
Need dedicated hardware with dedicated cabling for a particular purpose.

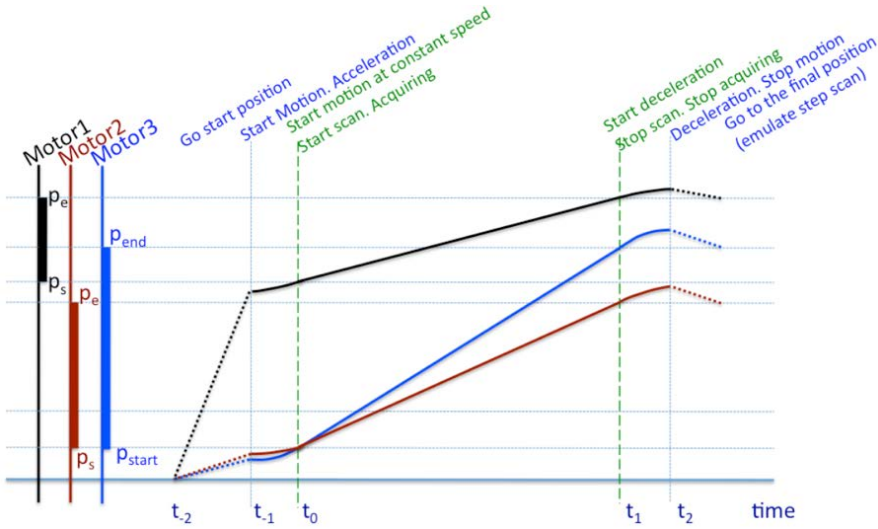
: Solve the problem for a particular type of experiment.

: Adapted to the purpose.

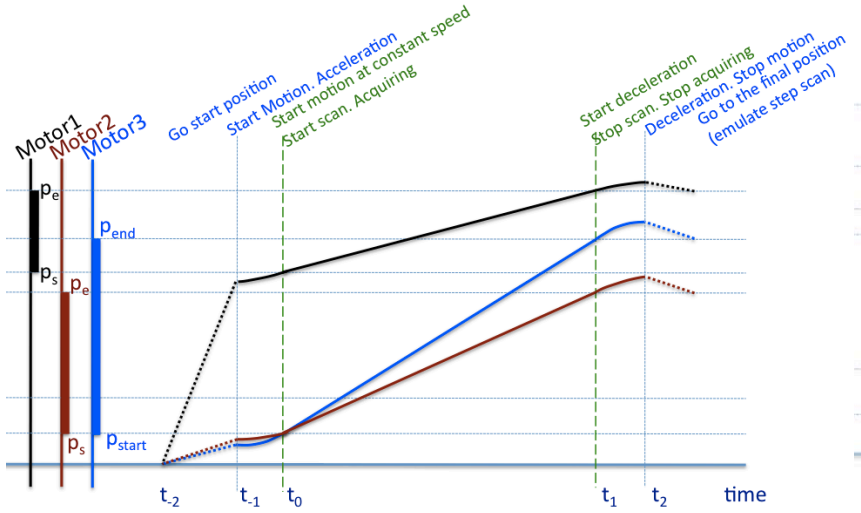
: Fast, optimized.

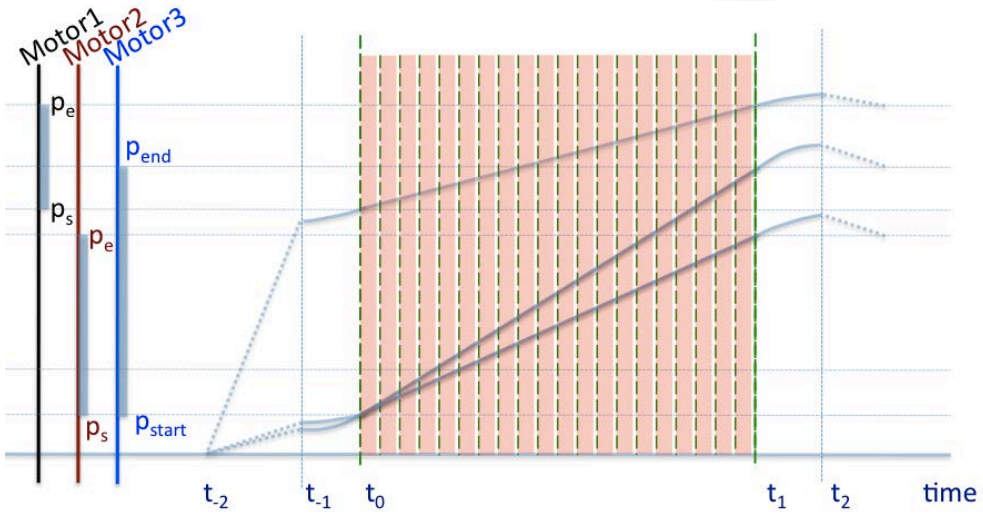
They do not solve all problems, being necessary to reprogram the beamline for other experiments using another hardware.

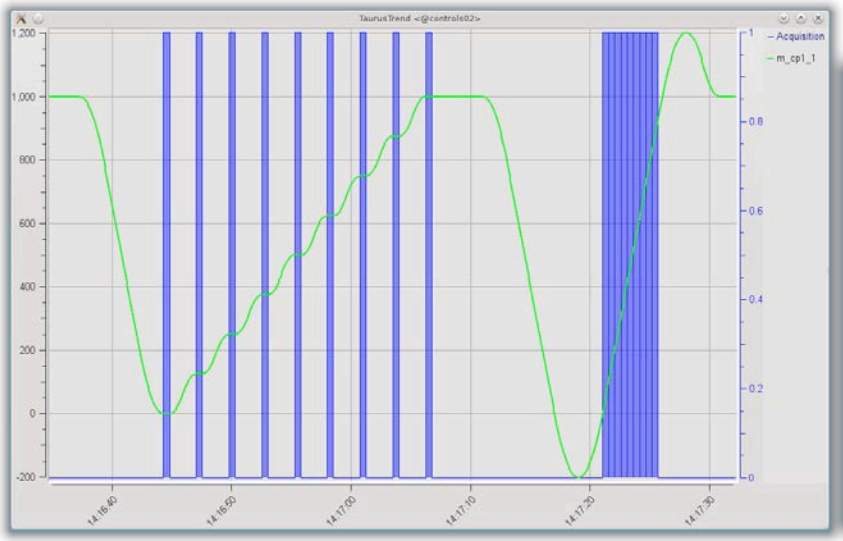


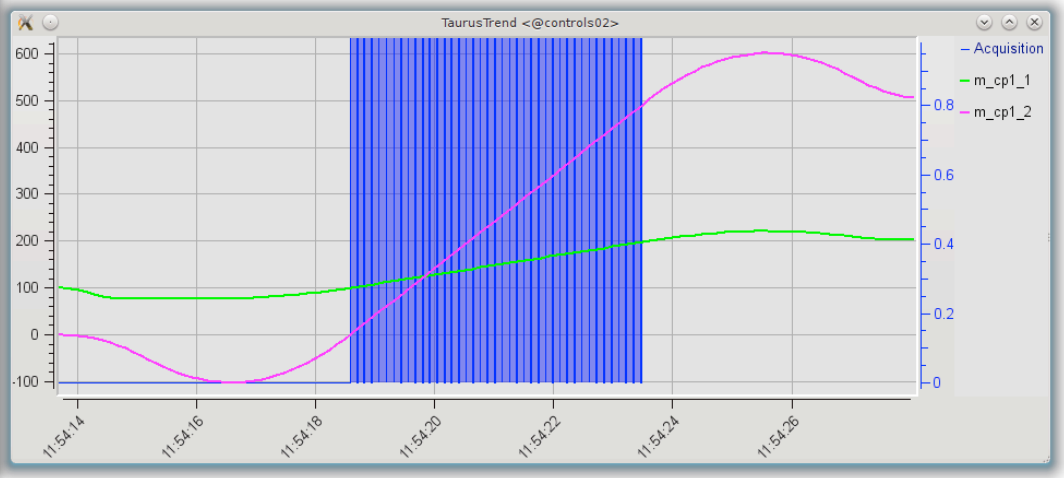


Continuous scans: Generic approach







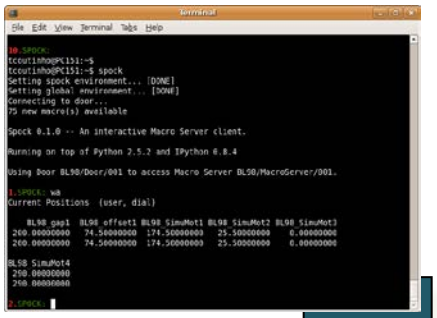


Continuous scans: Generic approach

- *Do **continuous scans** in a **generic way** as if they were step scans*
  - *Share the **same syntax**, have the same flexibility. Have the same motors, pseudomotors, channels and detectors available*

- Trigger objects
  - Produce triggers (a timer or any particular axis at the given positions)
  - All motors shall be prepared to act as input for synchronization.
    - This means having encoder signals or indexers routed multiplexed and feed to the triggering hardware
- Buffering
  - Different data rates need different buffer capabilities.
    - Slow data from sample environment, accelerators, etc. do not need/can not achieve the same data rate. Interpolated
- Timestamps:
  - Having a accurate enough timestamp would make eventually unnecessary hardware triggers in several applications.
    - In the case of a spectroscopy moving the energy with a motorized Bragg angle (4 degrees per second, taking 4000 points in one second), we would need a precision of about 13 microseconds (not achievable by NTP)

The control system. Block diagram

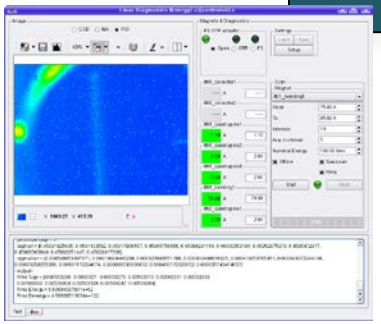


Door

Door

Macro Server

RECORDERS



Macro Lib

Data

Motor Groups

Motors

Pseudo Motors

Pool

Motor Ctrl

Tango DS

Simu Motor Ctrl

2D

1D

0D

Counters

Motor Groups

Motors

Pseudo Counters

Registers

Pool

Com. Channels

Pseudo Motors

Reg. Ctrl

1D Ctrl

0D Ctrl

Counter Ctrl

Timer

Motor Ctrl

2D Ctrl

Ctrl Lib

Tango DS

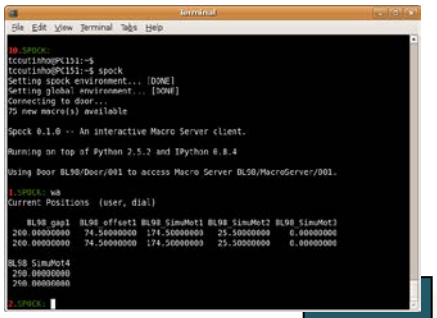
Tango DS

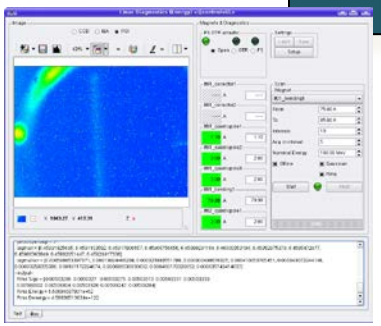
Ctrl

Tango DS

Ctrl

The control system. Block diagram





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0D

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Pseudo Motors

Trigger ctrl

Reg. Ctrl

1D Ctrl

0D Ctrl

Ctrl

2D Ctrl

Ctrl Lib

Tango DS

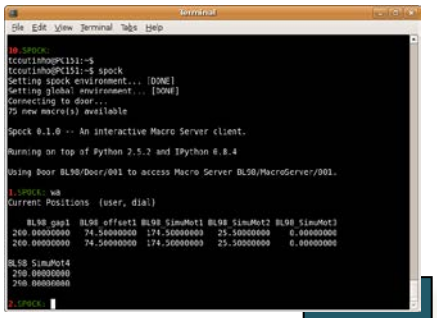
Tango DS

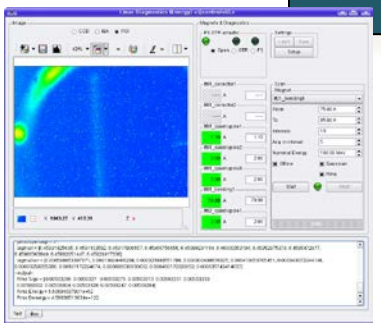
Ctrl

Tango DS

Ctrl

The control system. Block diagram





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Simu Motor Ctrl

2D

1D

0D

Counters

Motor Groups

Motors

Pseudo Counte

Pool

Com.

Pseudo Motors

Buffering (1)

Trigger ctrl

Reg. Ctrl

Ctrl

Ctrl

Ctrl

2D Ctrl

Ctrl Lib

Tango DS

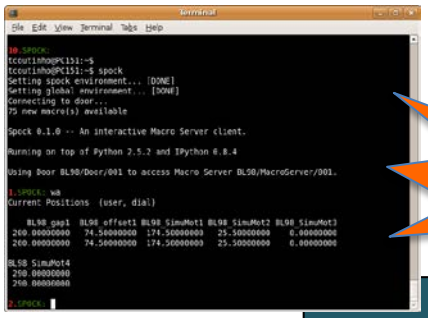
Tango DS

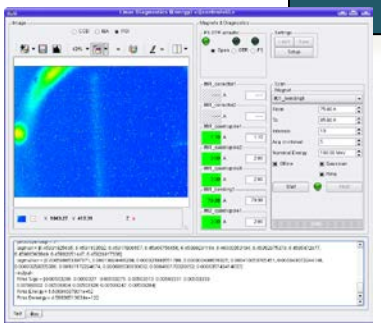
Ctrl

Tango DS

Ctrl

The control system. Block diagram





Buffering (2)

Door

Door

Macro Server

RECORDERS

Macro Lib

Data

Motor Groups

Motors

Pseudo Motors

Pool

Motor Ctrl

Tango DS

Simu Motor Ctrl

2D

1D

0D

Counters

Motor Groups

Motors

Pseudo Counte

Pool

Com.

Pseudo Motors

Buffering (1)

Trigger ctrl

Reg. Ctrl

Ctrl

Ctrl

Ctrl

2D Ctrl

Ctrl Lib

Tango DS

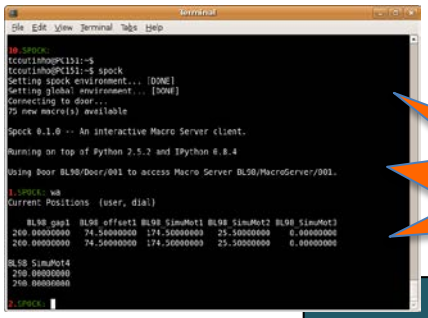
Ctrl

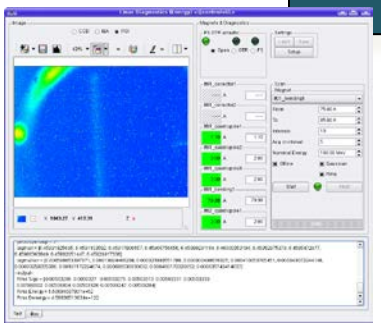
Tango DS

Ctrl

Tango DS

The control system. Block diagram





Buffering (2)

Door

Door

Macro Server

RECORDERS

Macro Lib

Data

Motor Groups

Motors

Pseudo Motors

Pool

Motor Ctrl

Tango DS

Simu Motor Ctrl

2D

1D

0D

Counters

Motor Groups

Motors

Pseudo Counte

Pool

Com.

Pseudo Motors

Buffering (1)

Trigger ctrl

Reg. Ctrl

Ctrl

Ctrl

Ctrl

2D Ctrl

Ctrl Lib

timestamps

Tango DS

Ctrl

Ctrl

Generic continuous scans: triggering, buffering and timestamps

•**Triggering at time** intervals occasionally is simpler and more convenient than getting the motor position. Motor encoders treated as experimental channels.

•**Buffers** manage fast acquisition combined with local buffers and slow acquisitions managed directly**.**

•**Scalers, 0D,**

•**1D, 2D …** LIMA (ESRF)

•**Timestamps**

- •Timing system (MRF) from the Accelerators distributed to the Beamlines.
- •IOCs synchronized by NTP (10 ms offsets)
  - •PTP to be considered.
- •Data is timestamped when acquired, the closest to the hardware.

Conclusion

- **Generic scientific SCADAS require a tighter integration of software components,**
  - Sequencer (friendly (powerful) (scripting) language (python))
    - Users write their own sequences/macros. Standard macro library.

- **Hardware easy to install and plug in. Flexible software**
  - Motion control, and fast detectors/channels triggered/configured with no hardware/cabling re-installation.

- **Triggering and buffering**
  - Central trigger object and device managing multiple motor inputs (potentially all in a beamline) and detectors.
    - Slow channels and fast channels, archived and interpolated

- **Timestamps**
  - Close to hardware. Detectors must have an accurate timestamp which attach to the data.
  - Accurate, but feasible with standard technologies, (microsecond range).
  - Triggers are the first option when available:
    - Timestamps do not avoid triggers.

TUPPC094 X. Serra et al.

Thank you for your attention.