Current developments of the new $\mu$-focus MX beamline at the ALBA synchrotron

Judith Juanhuix
NSLS-II MCE 2021 workshop, March 18
ALBA synchrotron

- User operation since 2012
- 270 m circumference, 3 GeV
- 8 operating beamlines, 5 in construction (1 for European Space Agency)
- 1 MX beamline, XALOC (115 PDB struct w/out SBDD program)
- 4 nm·rad emittance
Green light to design ALBA-2

- To design a 4\textsuperscript{th} generation source
- Please do not ask for time lines
- Research centers on Materials Science and Biosciences
- 2 MX beamlines
  - Upgraded XALOC, high E, “standard”
  - µMX XAIRA, low E, “not so standard”
**BL06-XAIRA µMX BEAMLINE**

**Scientific cases**
- Microcrystal diffraction (Fixed-target) serial MX
- Native phasing at 4 keV (3.1 Å)
- Chemical single-crystal microcrystallography

**Beamline characteristics**
- **Beam size of 1 ×1 µm²** at 1 Å (full beam 3×1 µm²)
- Beam defocusing up to 10×10 µm²
- High flux
- Energy range of 4–14 keV

**Schedule**
- Install optics: May’21
- First beam OH: Nov’21
- First beam EH: Jul’22
- First users: Beg’23

**Instrumentation research**
- **Mono**: Novel concept (Si111 and ML)
- **He atm** at sample to increase S/N
- **Interferometers** to monitor the optics

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Optics: Dual monochromator
Changing optical surface like photon energy

- Anomalous data collection: low energies (< 6 keV)
- High resolution data: high energies (>12 keV)
- Serial Crystallography: high fluxes (> $10^{13}$ ph/s)

Channel-cut Si(111) mono (CCM)
Double Multilayer monochromator (DMM)

2-in-1 CCM+DMM

Install June 2021

2 operation modes - 1 movement

- Rotation center below the surface
- Beam height changes by 1.18mm upon $E$ at the exit of the mono, but just 60 µm at sample pos

3 – 15 keV
(a) Si (111) channel-cut mode ($\theta_{Bragg} = 7.5^\circ \ldots 42.5^\circ$)

8 – 13 keV
(b) Multilayer mode ($\theta_{Bragg} = 1^\circ \ldots 2.4^\circ$)

Vertical beam offset at sample position

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Optics: mirror benders with correctors

Nanobender
Compression springs bend the mirror ensuring the required resolution, repeatability and stability
New algorithms for surface optimization including thermal load

Bending force contact
Mirror support
UHV Load Cell

Shape correctors
To correct gravity sag AND slope errors
Dynamically or manually adjustable

Nanobender at ALBA NOM
End station: some

beam @ 5 mm translation: 14×4 µm²
Simple operation
Requires solidary movement of OAV, cryostream, beamstop, ...

CFD on He/N2 cryostream flow to check sample conditions when defocusing the beam as cryostream is not moveable
Cold He Gas [@ 30K]
(ambient pressure)

Pressure control unit

He Cryostream

IN
35 l/min @ 1 bar
(ambient T)

OUT (95%)
33 l/min @ 1 bar

≈16-20 l/min @~1 bar

Helium Bearing Goniometer

1.75 l/min @ 1 bar

5-10 l/min @1 bar

He recovery plant

11.4 l/min @ 1 bar
(1.75 l/min @ 5.5 bar)

compressor

Robot operation
Adapted gripper

Cryostream

He & N₂ flow
Not moveable

He chamber
(compatible with air operation)

Vacuum window
Diamond 10 µm
Only one in BL

He/air bearing
He & air @5.5bar
95% recirculation
Compatible
Custom design

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BL instrumentation and control

Detector: **To be awarded**

Frame rate: >500 Hz (FIRST High frame rate detector at ALBA)

Robot: To be tendered, compatible gripper with He chamber required.

On axis view: Double objective, double optics and camera

OS platform: Linux Debian9 + conda for clients

Beamline control: Sardana/Taurus4 + Tango 9.

Autoindex: AuctoPROC via EDNA plugin.

Non-trivial data collections: Integrated into Sardana Scan Framework (det must be also controlled)

UI: Currently in XALOC bl: MXCuBE2/Qt4, next to come with XAIRA is MXCuBE3/(Qt5+)

LIMS: ISPyB, following developments

Remote connection: NX
MXCuBE2 as implemented at ALBA

- MXCuBE2 Qt4

LDAP
Authentication

LIMS
ISPyB web & db

ALBA Cluster
EDNA plugins

MXCuBE application

Tango
Diffractometer DS
Beamline Supervisor DS
CATS DS
...

Taurus
Taurus Device
Taurus Attribute

Sardana
Door Device (macros)
Generic Scan Framework

Beamline Hardware Layer
Sample Changer
Diffractometer
Detector
Motors
Actuators

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**Exiting Beamlines:** Data is stored (< 100MB/s) into Central Storage and travels from the beamlines through the standard network (10GbE).

**New approach:** Data is stored (XAIRA: 1.3 GB/s, Tomo: 11.5 GB/s) into the Ultra fast Storage and travels from/to the beamlines through the low latency Storage Network (100GbE).

VDI Server connected directly to the Storage Network (burst buffer), which may be locale or at CPD.
CPU specification tests

Hardware specifications are under evaluation.

Tests of XDS jobs are performed with groups of 4 nodes (preliminary)

Wall-Clock vs. #nodes (012-015)

Wall-Clock vs. #nodes (025-028)

24 cores
256GB
CPU Xeon Gold 6136 CPU @ 3. GHz

40 cores
256GB
CPU Xeon Gold 6248 @ 2.50GHz
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**Thanks**
Thanks
**Beam optics**

- Mono: pseudo channel cut Si(111) and ML for high stability and flux.
- “Simplest” focusing Optics
- But: beam changes height with E
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Installation Dates

Mar21 Fall21

installed Feb21 May21 Mar21

installed