XALOC: The dual configuration MX beamline at ALBA

Jordi Juanhuix and Jordi Benach
ALBA Synchrotron, Edifici Ciències, Campus UAB, 08193 Barcelona (Spain)

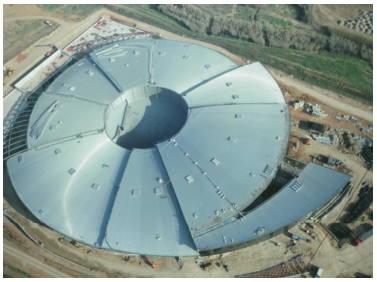
Summary

ALBA is a third generation 3 GeV storage ring being built near Barcelona and foreseen to be operational in 2010. Out of the seven first-phase beamlines, one beamline, called BL13 or XALOC, will be devoted to macromolecular crystallography.

Being the only MX beamline in ALBA, XALOC will have to cope with a broad range of crystallographic cases. On the one hand, it has to be able to cope with large macromolecular complexes, which usually crystallize in large unit cells, and on the other hand the work involving smaller crystals has to be ensured. Two operation modes, namely, focused and unfocused, in both vertical and horizontal directions, together with the variable focusing of the mirrors, will allow matching the beam to very different experiments.

The end-station will be equipped with up-to-date instrumentation to guarantee automated operation and wide-range applicability by the scientific community. Both the diffractometer including beam conditioning elements (attenuators, fast shutter, slits, and diagnostics) and the detector will be placed onto two granite blocks for stability.

A small sample preparation laboratory will be available for users to carry out basic manipulation of macromolecular crystals, together with a more spacious lab close to the beamline for on-site crystal growth.



ALBA and XALOC parameters

ALBA electron beam energy	3 GeV
Emittance	4.3 nm×rad
Circumference	269 m
XALOC photon energy range	6 – 21 keV
Photon flux at sample	>2×10^{12} ph/s in 0.1×0.1 mm^2
Energy resolution	ΔE/E ~ 2 10^{-4}
Energy stability	± 0.1 eV for 3 hours

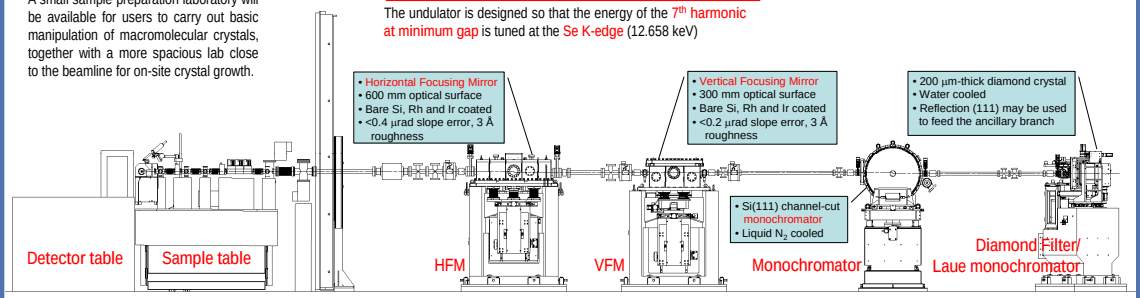
X-ray source

Type of ID	In-vacuum Undulator
Magnetic Array	Sm_2Co_{17} pure permanent magnet
Period (number of periods)	21.8 mm (92)
K (at 5.5 mm gap)	1.60
Photon source size (h×v, FWHM)	309 × 18 μm^2
Photon source divergence (h×v, FWHM)	112 × 28-22 μrad^2

The undulator is designed so that the energy of the 7th harmonic at minimum gap is tuned at the Se K-edge (12.658 keV)

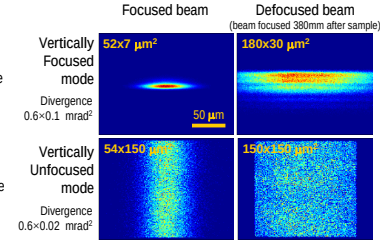
Time schedule

Hutch installation	October 2008
Optics installation	February 2009
End-station installation	June 2009
Light from Undulator	February 2010
First experiments	Mid 2010



Beam matches sample size

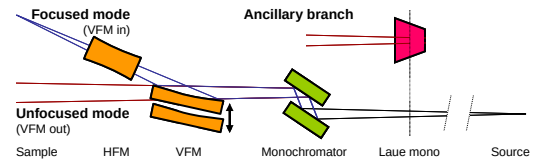
By defocusing and using two available modes, the beam size at sample is flexible and can match a wide variety of crystal morphologies. Slope errors of 0.2 μrad rms are specified to reduce beam striations when defocusing.



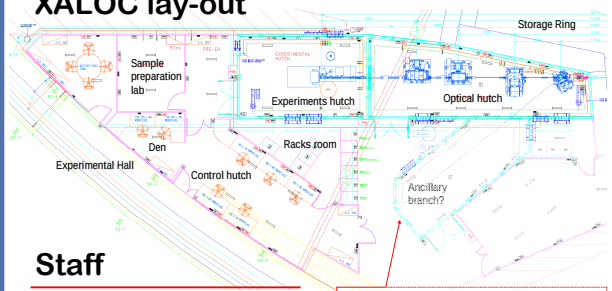
Modeled beam spots at sample, including mirror slope errors and monochromator thermal bump. Values are FWHM.

Dual configuration

The optics are based in a simple, reliable design consisting of a channel-cut Si(111) monochromator and two mirrors focusing independently in both vertical and horizontal dimensions.



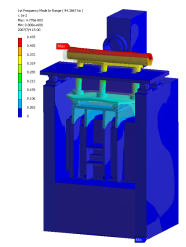
XALOC lay-out

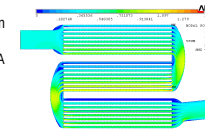


Fixed-energy ancillary branch
The diamond filter may be used as a Laue monochromator to feed an ancillary branch, which is currently under consideration. The ancillary branch would deliver photons at 9.041 keV at a flux of >10^{12} ph/s on a 0.6×0.6 mm^2 and 0.1×0.03 mrad^2 FWHM spot.

Objective: stability

- Extensive monitoring system, including transmissive fluorescent screens, and diamond and PIN-diode 4-quad XBPMs.
- *Ad hoc* correction of mirror surfaces by applying counterweights, whose position and strength will be determined after mirror surface metrology.
- Vibrations modeled through FEA studies on mirrors and monochromator.
- Seismic accelerometers placed close to the optical surfaces to monitor beam vibrations in real time (idea: A. Thompson).
- Monochromator cryocooling will work in laminar regime optimized for vibrations, rather than cooling efficiency. Designed through FEA and Computational Fluid Dynamics.
- Fast feedback: 2nd crystal is tuned by a stepper motor (for adjustment) and by a piezo element (for vertical feedback).





Staff

Beamline responsible	Jordi Juanhuix
Beamline scientist	Jordi Benach
Beamline technician	Pau Mariné
Mechanical engineers	Eva Boter, Claude Ruget, Carles Collderam
Controls engineer	David Beltran, Guifré Cuní
Electronics technician	Andrej Seljak

PLUS: Rafael Triviño (hutches), Marcos Quispe (mono cooling), Eric Pellegrin (vacuum), Liudmila Nikitina (FEA vibrations)

BioXHit 4th annual meeting, 16-18th April 2008, DESY, Hamburg, Germany