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Scientific opportunities for Serial Crystallography at ALBA synchrotron

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The ALBA Synchrotron, the 3 GeV light source in Southern Europe, is preparing for its upgrade to a 4th generation storage ring (ALBA II) together with the construction of 3 beamlines and major upgrades on the existing ones, early next decade. Within this framework, serial and time-resolved macromolecular crystallography (SSX and TR-MX) are identified as strategic growth areas.
BL13-XALOC, in operation since 2012 [1], has been the workhorse MX beamline at ALBA, delivering photon fluxes up to 2.5×10^{12} ph/s with beam sizes from 50×7 μm² to 300×100 μm² over 5.2–22 keV. The beamline has undergone an upgrade process including a Pilatus-3X 6M (100Hz) detector and a new automated sample changer. Besides, the beamline is equipped with a high viscosity extrusion injector for SSX experiments. The transition from single crystal oscillation MX to SSX is highly simplified thanks a three-axis motorized stage and sample extrusion is facilitated thanks to a PID pressure control system. Proof-of-concept SSX experiments with test proteins have demonstrated compatibility with room-temperature data collection and negligible radiation damage [2]. Pump–probe TR-MX experiments using visible-light activation have also been successfully performed, establishing a baseline for further developments [3].
A second MX beamline, BL06-XAIRA, started regular user operation in June 2025, offering a highly stable microfocus beam of 3×1 μm² and photon energy range of <4.0–14 keV. Equipped with a <60nm runout diffractometer, an EIGER2 XE 9M and a dual Channel-Cut/multilayer monochromator [4], it enables high-flux, high-stability microcrystallography. This equipment, combined with the implementation in the following months of a fast (up to 750 mm/s) SSX stage, designed for chips up to 60x40 mm will enable fixed-target SSX experiments at higher time resolution. Background reduction and long wavelength experiments are possible due to the recirculated He environment enclosing the entire end station.
The ALBA II upgrade plan foresees substantial investment in SSX/TR-MX capabilities for both beamlines. For XALOC, this includes hybrid tape-drive systems for tunable soaking times, and microfluidic injectors. XAIRA will focus on microfluidic chips, acoustic droplet ejection, and conveyor-belt systems for continuous fresh sample delivery. A pump-probe set up will be developed for both beamlines to allow for μs–ms TR-MX, including choppers, tunable lasers, and synchronization systems.

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