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FaXToR: The first fast hard X-ray micro-tomography beamline at the ALBA synchrotron

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FaXToR (FAst X-ray TOmography and Radioscopy) is the first micro-tomography beamline in the hard X-ray regime at the ALBA synchrotron. The beamline is fed by a short in-vacuum multipole wiggler, providing high flux across an energy range from 8 keV to 70 keV in both monochromatic (8–50 keV) and filtered white beam modes (30–70 keV) and maximum beam size of 35 mm x 12 mm (H x V) at the entrance of the sample. Utilizing a Double Multilayer Monochromator with Ru/C and W/B4C stripes, FaXToR delivers a high photon flux of up to 1011 photons/s/mm² at 15 keV, enabling the rapid acquisition rates necessary for dynamic studies. Downstream, the sample is located at 36.5 m from the source, where a versatile detection system is utilized for multi-scale imaging. It consists of two indirect detection microscopes coupled with a set of four distinct cameras, allowing users to choose the optimal spatial and temporal resolution for their experiments. In quasi-simultaneous mode, operando experiments with acquisition rates up to 5000 fps and a centimeter-scale field of view can be performed, while zooming in on specific regions of interest to achieve sub-micron resolution. Since the start of user operation in early 2025, FaXToR has hosted both academic and industrial users with interests in biomedicine, biomaterials, paleontology, and materials science, among others. This work presents several successful case studies showcasing the capabilities of FaXToR for multi-scale structural characterization, utilizing propagation-based phase-contrast and absorption-based imaging techniques for both standard micro-CT and operando experiments. In particular, we present the workflow that has enabled dynamic imaging for the materials and life sciences at the beamline, including novelties in hardware design, system synchronization, optimization of reconstruction algorithms, and user interface development. Additionally, we present our plan for expanding phase-contrast imaging beyond conventional free-space propagation, as well as dark-field contrast X-ray imaging through the implementation of Talbot grating interferometry technique at the beamline. Finally, in light of the ALBA upgrade plan foreseen in the near future, we discuss our vision for FaXToR within the 4th Generation synchrotron.