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Enhancing X-ray Absorption Spectroscopy with Time-Resolved Pixel Detectors

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X-ray absorption spectroscopy (XAS) is a powerful technique for probing the local atomic structure of specific elements, providing crucial insights into oxidation states and atomic coordination environments [1]. Typically performed at a synchrotron light source, XAS involves scanning the incident X-ray energy across an element' s absorption edge while recording the transmitted intensity, traditionally using a set of ionization chambers [2]. This conventional approach assumes a uniform sample composition within the X-ray beam path; however, variations in thickness, structural defects, or material inhomogeneities can distort the spectra, leading to inaccurate structural parameters. During in-situ and operando studies, such as catalytic reactions or battery cycling, these spectral distortions significantly affect data quality. Ionization chambers provide only an averaged absorption measurement across the entire sample providing an average information of the samples and masking localized effects. In contrast, 2D pixel detectors [3-5] enable spatially resolved absorption measurements, allowing the detection of sample heterogeneities that would otherwise go unnoticed. When combined with high frame rates, this capability becomes particularly valuable for tracking dynamic material changes under experimental conditions.

In this study, we evaluate the performance of a Timepix 3 hybrid pixel detector for Extended X-ray absorption fine structure (EXAFS) measurements using model and real samples at the XAFS beamline at Elettra Sincrotrone Trieste. Our findings demonstrate the advantages of localized detection in improving data quality and reliability, reinforcing the potential of pixel detectors as a transformative tool for complex material investigations.

References

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Workshop topics

Applications

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