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Integration and Optimization of the Muon-Induced X-ray Emission Technique at PSI

Muon-Induced X-ray Emission (MIXE) is considered the only technique that allows for non-destructive elemental analysis of the bulk of a sample, with depth-profiling capabilities. Powered by the high-rate continuous muon beam from the Swiss Muon Source (SμS) at PSI, MIXE has undergone a remarkable revival [1] and has already demonstrated significant advancements [2–4]. To further strengthen PSI's role in this field, we collaborated with the Swiss Data Science Center (SDSC) to develop SAMURAI (Smart Analysis of MUonic X-rays with Artificial Intelligence) [5], an AI-based algorithm that automates data analysis and addresses the speed limitations of manual processing. In addition, a TWIN-GEM TPC [6] has been integrated to precisely track muon trajectories, thereby enabling the transition to 2D imaging and even 3D tomography. Feasibility tests conducted at PSI using multi-layer targets have demonstrated the practicality and effectiveness of this approach. These advancements pave the way for element-specific imaging, positioning MIXE as a unique and powerful tool for non-destructive, depth-resolved elemental analysis across diverse scientific fields.
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