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Vertex-Reconstructed μSR: From Particle Tracks to Histograms

Vertex-reconstructed μSR (vx-μSR) leverages thin tracking detectors to record incoming muon and emitted positron trajectories, enabling unprecedented capabilities in spatially resolved spectroscopy. This approach overcomes critical limitations of conventional μSR at continuous beam facilities by operating at higher stopped muon rates (>400 kHz) and resolving sub-millimeter sample regions. However, the transition from raw hit data (x,y,z,t) to meaningful μSR histograms presents unique computational challenges.
In this work, we present novel algorithms that, (i) reconstruct particle trajectories from silicon pixel detector hits, (ii) identify valid μSR events through spatial matching of muon stopping and positron emission vertices, and (iii) generate background-suppressed histograms with extended time windows. Our method achieves inherently low uncorrelated background while increasing the event rate capability. We demonstrate how this pipeline enables new μSR applications that were previously inaccessible with traditional scintillator-based systems.

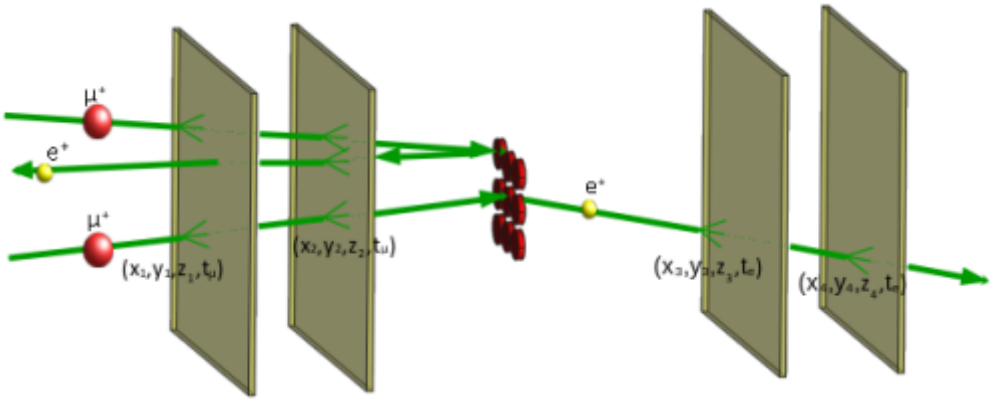

Figure 1: Illustration of tracks of incoming muons and emitted positrons required to perform vx-μSR.

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