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Enhancing PEPT: high fidelity analysis with augmented detection

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The Positron Emission Particle Tracking (PEPT) technique enables the tracking of a moving radioactive tracer particle at high spatial and temporal resolution, from which its trajectory can be accurately reconstructed. The uncertainty budget is complex and poorly understood, particularly for derived quantities such as momenta, energies, and forces, which are typically calculated using numerical differentiation techniques.

We report a filtering and data processing method based on a local polynomial least squares fitting approach known as the Savitzky-Golay filter. The method is adapted to incorporate the propagation of measurement uncertainties, maintaining them within useful bounds. The method is benchmarked against several systems of known particle motion, including constant velocity and constant acceleration, to place confidence limits on the results. Across all tested regimes the Savitzky-Golay filter resolves higher precision than existing methods, providing notable improvements to the uncertainty budget in PEPT analysis. We demonstrate tracking of a particle moving up to 3 m/s with location precision within its diameter, and a 60% and 40% average reduction in uncertainty bounds for velocity and acceleration respectively.

These results have motivated development of a high-resolution detector array for PEPT, enabling measurements on the micro-scale by making immediate use of the improvements in precision. Successful implementation will allow the meaningful application of PEPT to identified problems in diagnostic medicine and in the study of micro-fluidic devices.

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc

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