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GNN-based Track and Vertex Finding at Belle II

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In many new physics extensions of the Standard Model, new mediator particles may decay into a pair of charged particles leaving a unique signature of a displaced vertex and charged tracks. These displaced decay products are an important signature in searches for dark sectors in collider experiments.

The current Belle II trigger algorithm is not designed for events with displaced vertices and therefore insufficient to detect these events. Traditional tracking algorithms such as Legendre transformation and Combinatorial Kalman Filter scale poorly with the high beam-background, which is expected to increase significantly in the upcoming data-taking of the Belle II experiment.

Therefore, we develop a Graph Neural Network (GNN) based approach to find particle tracks and displaced vertices in the Central Drift Chamber of Belle II, where we can realize track measurements using a graph representation of detector hits.

Our GNN-based track and vertex finding is split in a pipeline to enable FPGA implementation for real-time reconstruction. The first step consists of building the graph out of the detector measurements. Next a GNN model is applied to classify the edges of the previously built graph to filter out beam-background. Finally, additional machine learning methods will be added to find all particle tracks and the displaced vertices.

This work introduces our approach and focuses on the graph building aspect as well as introducing the model evaluation for edge classification.

Category

Particle / Astroparticle / Cosmology (Experiment)

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