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CBM RICH ring reconstruction using machine learning

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The Compressed Baryonic Matter experiment (CBM) at FAIR is designed to explore the QCD phase diagram at high baryon densities with interaction rates up to 10 MHz using triggerless free-streaming data acquisition. The CBM Ring Imaging Cherenkov detector (RICH) contributes to the overall PID by identification of electrons from the lowest momenta up to 6-8 GeV/c, with a pion suppression factor of more than 100. The RICH reconstruction combines a local Cherenkov ring-finding with a ring-track matching of extrapolated tracks from the Silicon Tracking System (STS) by closest distance.

The existing conventional algorithm for standalone ring-finding based on the Hough transform was revised and optimized. A method based on a Convolutional Neural Network (CNN) architecture was developed for noise suppression while taking into account the latency and data format (space and time, i.e. 3+1) constraints of the triggerless free-streaming readout. The method was tested and validated on simulations taking into account the time data stream and on data from the prototype mini-RICH (mRICH) in the mini-CBM (mCBM) experiment, which shares the same free-streaming readout concept as the future CBM experiment.

An alternative standalone ring-finder based on a Graph Neural Network (GNN) is investigated for its viability for the CBM RICH. It is designed as an end-to-end pipeline for ring-finding, optionally including noise classification as an auxiliary downstream task.

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