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## Model-Robust CNN-Based Event Selection for QGP-Sensitive Heavy-Ion Collisions

Identifying rare events with enhanced sensitivity to deconfined quantum chromodynamics (QCD) matter in high-rate heavy-ion experiments requires fast event-selection methods that are robust against detector effects and theoretical model uncertainties. We present a convolutional neural network (CNN) based approach for event-by-event identification of QGP-sensitive collision patterns using compact multidimensional representations of the reconstructed final state, encoding particle species and momentum-space information.

The classifier is trained and validated using Au+Au collisions at 30 AGeV simulated with the Parton-Hadron-String Dynamics (PHSD) and Ultra-relativistic Quantum Molecular Dynamics (UrQMD) transport approaches. Cross-model tests are performed to determine whether the learned response reflects robust physical correlations rather than generator-specific features. The classifier retains its discriminating power when transferred between the two transport descriptions, which provides evidence for a model-robust, QGP-sensitive event representation. After propagation through the detector of the Compressed Baryonic Matter (CBM) experiment and reconstruction chain, classification accuracy decreases from 95.1% at the generator level to 83.7% after full reconstruction. This demonstrates substantial robustness under realistic experimental conditions. SHAP-based interpretability studies show that strange hadrons and antibaryon-related channels significantly contribute to the network's decision-making process.

These results demonstrate the potential of interpretable, transport-model-robust machine learning for fast event enrichment and physics-driven data reduction in future high-rate heavy-ion experiments.

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