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Particle identification at the CERN NA62 experiment using Convolutional Neural Networks

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The rare $K^+ \to \pi^+\nu\bar{\nu}$ decay is an ideal probe for beyond the Standard Model (BSM) physics contributions to the flavor sector. It is heavily suppressed in the SM and its branching ratio is predicted, with remarkable precision for a second order weak process involving hadrons, to be $(8.4 \pm 1.0) \times 10^{-11}$.

The NA62 experiment at the CERN SPS is designed to study precisely the $K^+ \to \pi^+\nu\bar{\nu}$ branching ratio. To reach the required signal sensitivity, the overall muon rejection factor must be of the order of 10^7. Therefore, a redundant particle identification (PID) system composed of a Ring Imaging Chernenkov (RICH), a set of three independent calorimeters, and a scintillator-based veto detector is employed.

Machine learning (ML) algorithms were developed to extract PID information directly from the calorimeter hit information, a departure from the previous approach where reconstructed quantities were used. High purity samples of muon, pion and electron single charged track decays were extracted from the NA62 data for the training and validation of the ML methods.

An architecture based on the ResNet-18 network achieved the best μ^+/π^+ separation with a muon rejection factor of the order of 10^5 while keeping the pion acceptance around 90 %, not including the RICH. The newly developed tool will be incorporated in analysis of the data collected during the 2021 NA62 run.

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