Qualitative performance study of the $\overline{\text{P}}$ANDA GEM-tracker in physics simulations

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Abstract

One of the most challenging and exciting goals of modern physics is to gain a good and quantitative understanding of the strong interaction. Significant progress has been achieved in recent years thanks to the remarkable progress in empirical and speculative researches. Of course, there are still many fundamental questions remained basically unanswered. There are phenomena such as quarks confinement, the existence of glueballs and hybrids, the origin of hadron masses in the theory of chiral symmetry breaking as a long-standing puzzle, an intellectual challenge in trying to understand the nature of the strong interaction, and the hadronic matter. Tentatively, the study of hadron structure can be done by electrons, pions, kaons, protons, and antiprotons. Antiprotons are excellent tools to inspect the antiproton-proton annihilation problems, particles with gluonic degrees of freedom, and particle and antiparticle pairs which are produced repeatedly, and allow spectroscopy studies with very high precision and statistical power. In order to identify more such cases, $\overline{\text{P}}$ANDA experiment is designed to fully exploit the extraordinary physics potential arising from the availability of high-intensity cooled antiproton beams. The aim of the versatile experimental program is to improve our knowledge of the strong interaction and hadron structure. One of the significant parts of the $\overline{\text{P}}$ANDA set-up is particle tracking with gas electron multiplier (GEM) detectors. In this article, Monte Carlo simulation of this detector is presented, and its performance is studied qualitatively. The results of this study reveal that this detector effectively improves the mass resolution in benchmark J/ψ decay channel, tracking efficiency, and momentum resolution at forward angles (below 22 degrees).

Keywords: $\overline{\text{P}}$ANDA experiment, GEM detectors, Benchmark J/ψ decay channel, invariant mass measurement, tracking efficiency, momentum resolution.

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