Abstract

Self-supporting straw tube detectors, which were developed for the COSY-TOF experiment, will be also used for tracking charged particles in the PANDA experiment. We investigate the applicability of the PANDA straw tube tracker for identification of protons, charged pions and kaons based on the energy loss information. For this aim, the Garfield program is used to simulate straw tube signals which are convoluted with the transfer function of the front-end electronics. The energy losses in the straw tubes are determined using the information about the Time Over Threshold (TOT) of the straw tube signals and, independently, about the integrated charge of the signals. The separation powers of protons, charged pions and kaons based on the TOT and the integrated charge are comparable and exceed a 5σ level for particle momenta below $0.6\,\mathrm{GeV}/c$ as required for PANDA. We simulate also the gas gain in the straw tubes with the Magboltz and Garfield program. The experimental results for the gain are reproduced after adding 34% Penning transfer rate in the simulation.

The straw tube tracker performance is also studied in the COSY-TOF experiment with analysis of the data for the $\vec{p}p \to pK^+\Lambda$ reaction measured with a proton beam at $2.95\,\mathrm{GeV}/c$ momentum. The polarization of the beam is determined to be about 87% by analysis the pp elastic scattering events. The analysis using only the straw tube tracker information shows a high reconstruction efficiency of 20% for the $pK^+\Lambda$ events and the $p\Lambda$ invariant mass resolution of $1\,\mathrm{MeV}/c^2$. The angular distributions of protons, kaons and Λ-hyperons are determined in the CMS and are fit with the Legendre polynomials. The fitting coefficients show that both S and D-wave contributions are dominant for the proton distribution, whereas in the Λ distribution all S, P and D-waves are significant. The Dalitz plot with the selected $pK^+\Lambda$ events shows significant enhancements due to the $p\Lambda$-FSI and the $N\Sigma$ cusp effect. The $N\Sigma$ cusp is stronger in the region of the Dalitz plot with the Helicity angle $\cos\theta_{pK}^{Rp\Lambda} \leq -0.33$, and its angular distribution has a dominant S-wave contribution. The angular distribution of the analyzing power of the proton, kaon and Λ-hyperon is also determined and fit with the associated Legendre polynomials. In the CMS the distributions are more symmetric for the proton compared to kaon and Λ-hyperon. The (S,P)-wave interference contribution to the kaon analyzing power is determined to be about 0.04 at low $p\Lambda$ invariant mass, and it can be used to extract the $p\Lambda$ spin triplet scattering length.