Multi-strange baryon decay reconstruction in the CBM experiment

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One of the predicted signatures of the phase transition from nuclear matter to deconfined quark gluon plasma is the enhanced production of multi-strange particles. Also the yield of particles carrying strange quarks is expected to be sensitive to the fireball evolution. The CBM detector will provide an unique opportunity to measure yields, direct and elliptic flows, excitation functions of multi-strange baryons at different energies and sizes of the colliding heavy ions. Ω^- baryon consists of 3 strange quarks, Ξ^- baryon contains 2 strange quarks and Λ — one strange quark. Multi-strange baryons will be measured in CBM by its decay into charged hadrons, which are detected in the Silicon Tracking System (STS) and in the Time-of-Flight detector (TOF).

To study the feasibility of multi-strange baryons decay reconstruction in the CBM experiment, a sets of 10^6 central Au+Au UrQMD events at 2, 4, 6, 8, 10, 15, 20, 25, 30 and 35 AGeV were simulated. High statistic allows to calculate even $\Omega^{\pm}$ reconstruction efficiency directly, avoiding signal embedding into the UrQMD events. Together with wide range of the beam energies, it allows to investigate systematic behavior of different physics observables like direct and elliptic flows, excitation functions, antibaryon to baryon ratios and many others. In Fig. 1 the reconstructed multi-strange antibaryon to baryon production ratios versus beam energy is shown. Strange quarks number hierarchy is clearly visible. Black points correspond to Ω^+ to Ω^- ratios (S = 3), red points are Ξ^+ to Ξ^- ratios (S = 2) and blue points are $\bar{\Lambda}$ to Λ ratios (S = 1).

The Ω^- decays into $\Lambda + K^-$ with branching ratio 67.8% and $c\tau$ = 2.46 cm., the Ξ^- decays to $\Lambda + \pi^-$ with branching ratio 99.89% and $c\tau$ = 4.92 cm decays of Λ happen most often in the STS detector. The STS geometry with 8 double-sided segmented strip detectors, cables and support frames were used for event reconstruction. Particle identification with TOF was applied. The KFParticle Finder package was used to reconstruct about 50 particles and resonances including $\Omega^{\pm}$, $\Xi^{\pm}$, Λ and $\bar{\Lambda}$. Typical invariant mass spectrum is shown in Fig. 2. The Ω^- reconstruction efficiency is about 1.8% for central UrQMD events. The reconstructed mass value $1.672 \pm 0.003\ GeV/c^2$ is in a good agreement with the simulated PDG's data. The Ω^- invariant mass resolution is 2.3 (MeV/c^2).

The $\Omega^{\pm}$ or $\Xi^{\pm}$ are accepted if they have good quality geometrical and topological detached vertex with ($\chi^2_{geo} < 3\sigma$, $\chi^2_{topo} < 3\sigma$) and z-vertex farther than 3 cm downstream of the target plane.

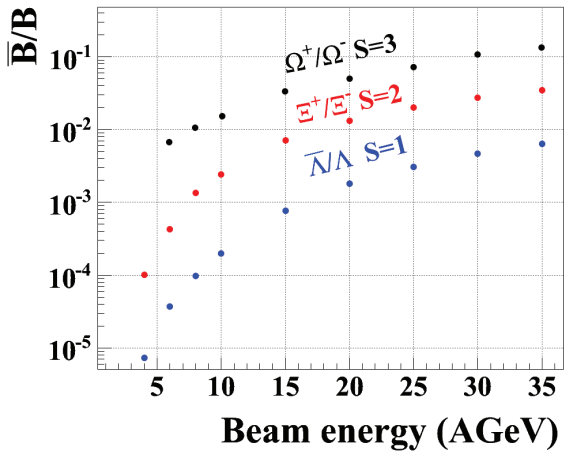

Figure 1: Recalculated ratios of anti-baryon to baryons yields versus beam energy

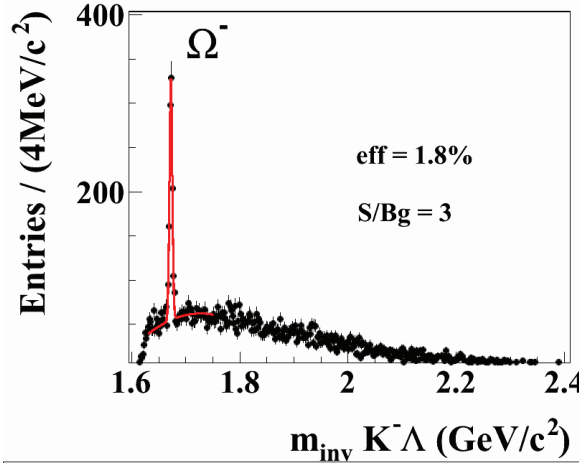

Figure 2: Reconstructed invariant mass distribution of $\Lambda\ K^-$ pairs in central Au+Au collisions at 35 AGeV. Red line is polynomial background plus signal Gaussian fit.