Multi-strange (anti)baryon enhanced production at FAIR energies

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One of the predicted signatures of the phase transition from nuclear matter to a deconfined phase is the enhanced production of multi-strange particles. Additionally the yield of particles carrying strange (anti)quarks is expected to be sensitive to the fireball evolution and formation of the Quark Gluon Plasma (QGP). In order to estimate the effect of QGP creation in the heavy ion collisions we used PHSD 3.0 model [1] — a microscopic off-shell transport approach that consistently describes the full evolution of a relativistic heavy-ion collision from the initial hard scatterings and string formation through the dynamical deconfinement phase transition to the QGP, as well as hadronization, and to the subsequent interactions in the hadronic phase. The yield of Ω^+ hyperon ($\bar{s}\bar{s}\bar{s}$) seems to be very sensitive to the production mechanism at the FAIR energies. The results of our calculations are shown in Fig. 1, where the red points correspond to the partonic phase mechanism and the blue ones — to subsequent interactions in the hadronic phase. Each point is calculated for 5M central Au+Au

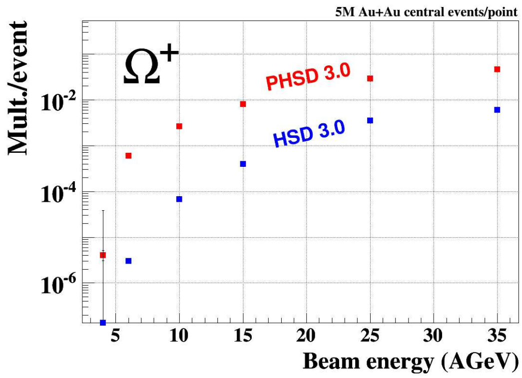

Figure 1: Yields of Ω^+ as a function of the beam energy calculated in the PHSD and HSD models. Each point corresponds to $5 \cdot 10^6$ central Au+Au PHSD (red) or HSD (blue) events.

PHSD (HSD) events. According to the PHSD 3.0 model, most of the Ω^+ particles are produced in the QGP phase.

Multi-strange hyperons will be identified in the CBM experiment by their decays into charged hadrons, which are than detected in the Silicon Tracking System (STS) and the Time-of-Flight (TOF) detector.

To study the performance of multi-strange hyperon reconstruction in the CBM experiment, several sets of $5 \cdot 10^6$ central Au+Au PHSD and HSD events at 4, 6, 10 AGeV for the SIS-100 case and at 15, 25 and 35 AGeV for the SIS-300 energy range have been simulated. The high statistics allows to calculate also the $\Omega^\pm$ reconstruction efficiency directly, avoiding signal embedding into the PHSD events. Together with the wide range of the beam energies, it allows to investigate the systematic behavior of different physics observables, e.g. direct and elliptic flow, excitation function and antihyperon-to-hyperon ratios.

The Ω^+ hyperon decays into $\bar{\Lambda}K^+$ with the branching ratio of 67.8% and $c\tau$ = 2.46 cm. The STS v13d geometry with 8 double-sided segmented strip detectors, cables and support frames was used for the event reconstruction. Particle identification with the realistic "umbrella" shaped TOF v13a geometry for the SIS-100 energies and v13b for the SIS-300 energies were applied. The KF Particle Finder [2] package was used to reconstruct Ω^+. A typical reconstructed invariant-mass spectrum is shown in Fig. 2. The red line indicates the fit the signal and background by a polynomial plus Gaussian function.

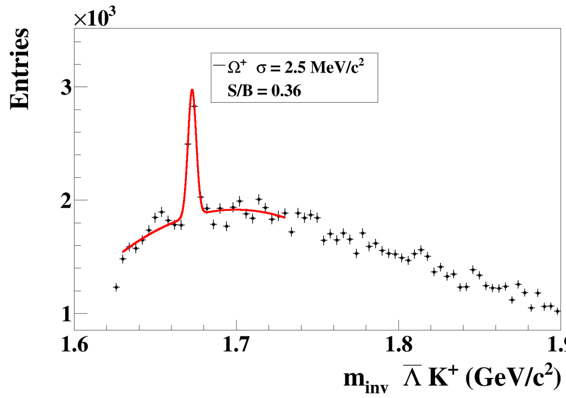

Figure 2: Reconstructed invariant-mass distribution of $\bar{\Lambda}K^+$ pairs in central Au+Au collisions at 25 AGeV, the red line indicates the signal plus background fit by a polynomial plus Gaussian function.

The Ω^+ reconstruction efficiency results in about 6.2% for central PHSD events. A good signal to background ratio of about 0.36 is observed due to the TOF antiproton particle identification procedure and KF Particle $\bar{\Lambda}$ reconstruction.

References

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[2] I. Kisel, I. Kulakov and M. Zyzak, *Standalone First Level Event Selection Package for the CBM Experiment*, IEEE Transactions on Nuclear Science, vol. 60, No. 5, October 2013, p. 3703.

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