Antihyperon decay reconstruction in the CBM experiment

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One of the most challenging tasks of the CBM experiment is to measure yields, excitation functions and flows of antihyperons. Antihyperons like $\Omega^+$ and $\Xi^+$ will be measured in the CBM-detector by its decay into charged hadrons, which are detected in the Silicon Tracking System (STS) and in the Time-of-Flight detector (TOF). The key role of the TOF detector is antiproton selection in very dense negative pions and Kaons environment. On the Fig. 1 is shown calculated by TOF tracks $m^2$ vs particle momentum. Negative track with $|m^2 - m_{p}^2| < 2\sigma$ and $|m^2 - m_{K}^2| > 3\sigma$ and $|m^2 - m_{\pi}^2| > 3\sigma$ was used as an antiproton candidate to reconstruct $\bar{\Lambda}$.

Figure 1: Tracks $m^2$ vs particle momentum calculated by TOF.

On the Fig. 2 is shown invariant mass distribution of $\bar{p}\pi^+$ pairs in central Au+Au collisions at 35 AGeV. Clear $\bar{\Lambda}$ peak is visible. $\bar{\Lambda}$ reconstruction efficiency is above 14\% for 35 AGeV and achieve its maximum about 22\% at 8 AGeV. One or two antiproton track candidates per event allows significantly decrease the combinatorial background. Signal to background ratio is above 3.4 for central Au + Au UrQMD events at 35 AGeV. KFParticle finder was used in order to reconstruct $\bar{\Lambda}$ combining secondary $\bar{p}$ and $\pi^-$. Then, combining $\bar{\Lambda}$ with positive secondary Kaon or pion, the $\Omega^+$ and $\Xi^+$ candidates were tested. The $\Omega^+$ or $\Xi^+$ was accepted if it has good quality geometrical and topological detached vertex: $(\chi^2_{\text{geo}} < 3\sigma, \chi^2_{\text{topo}} < 3\sigma)$ and $z$-vertex greater than 3 cm downstream the target plane.

To study the feasibility of multi-strange antihyperon 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. Typical invariant mass spectrum is shown in Fig. 3. The $\Xi^+$ reconstruction efficiency is about 3.1\% for central Au + Au UrQMD events at 35 AGeV. The reconstructed mass value $1.321 \pm 0.003$ GeV/c$^2$ is in a good agreement with the simulated PDG’s data. Invariant mass resolution is 2.3 (MeV/c$^2$).

Figure 2: Reconstructed invariant mass distribution of $\bar{p}\pi^+$ pairs in central Au+Au collisions at 35 AGeV. Red line is polynomial background plus signal Gaussian fit.

Figure 3: Reconstructed invariant mass distribution of $\Lambda\pi^+$ pairs in central Au+Au collisions at 35 AGeV. Red line is polynomial background plus signal Gaussian fit.