Results from FOPI on Λ production in Ni+Ni collisions at 1.93 AGeV

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Experimental data on Λ particle phase space distributions and yields measured with the FOPI detector at SIS (Darmstadt) are presented.

One of the main topics addressed in the study of heavy ion collisions is the question whether hadronic properties undergo modifications in an environment of hot and dense nuclear matter. Particularly interesting is the behaviour of strange particles close to threshold. Possible evidence for in-medium modifications of charged kaon properties at SIS energies has been already observed [1, 2, 3]. We focus here on recent results obtained for neutral strange Λ-hyperons measured in the reaction Ni + Ni at 1.93 AGeV. The results may allow to test the in-medium attractive Λ-nucleon potential predicted by several theoretical calculations [4] which affects both the particle yield and flow.

A high statistics experiment has been performed in the beginning of 2003 with the FOPI detector [5] at the SIS accelerator facility of GSI (Darmstadt). About 110 millions of central (σ_{geo} = 760 mb) Ni + Ni events were recorded thanks to the new data acquisition system.

The Λ's produced in these collisions are identified in the FOPI Central Drift Chamber. This neutral strange hadron (uds) is reconstructed via its decay into charged particles: $\Lambda \rightarrow p + \pi^-$ (branching ratio = 64%). Track quality and kinematic conditions are applied in order to suppress the combinatorial background. We analyzed about $93{\cdot}10^6$ of central events. Figure 1 shows the invariant mass spectrum of $p\pi^-$ pairs which fulfill the Λ conditions for an integrated geometrical cross section of 350 mb ($45{\cdot}10^6$ events). About 77000 Λ are reconstructed with a signal to background ratio equal to 1. The combinatorial background is estimated by means of the event mixing technique and is denoted by the line under the peak (upper part of the figure). The lower part of the figure shows the Λ signal after background subtraction. The peak is fitted with a Gaussian, giving a width of 10.5 MeV/c^2. Finally the number of reconstructed Λ per central event is about $1.7{\cdot}10^{-3}$.

The Λ yield in 4π is obtained from transverse mass spectra $\frac{1}{m_t^2}\frac{d^2N}{d(m_t - m_0)dy^0}$, for different rapidity windows going from target rapidity to mid-rapidity. y^0 is the scaled rapidity ($y^0 = y/y_{cm}$ - 1), $m_t{=}\sqrt{p_t^2 + m_0^2}$ and m_0 is the mass rest. These spectra are corrected for reconstruction efficiency and geometrical acceptance. This correction has been determined by means of a complete simulation of the FOPI detector using the GEANT package. Then, transverse mass spectra are adjusted with

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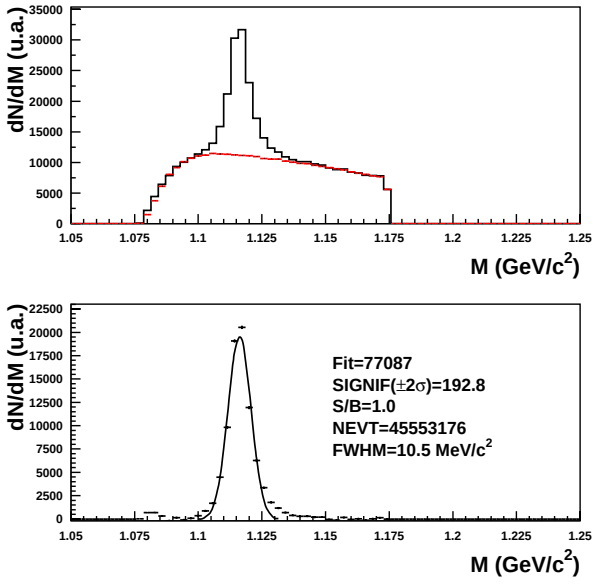

Figure 1: Invariant mass spectra of Λ (upper pannel: signal with combinatorial background, lower pannel: signal after background subtraction).

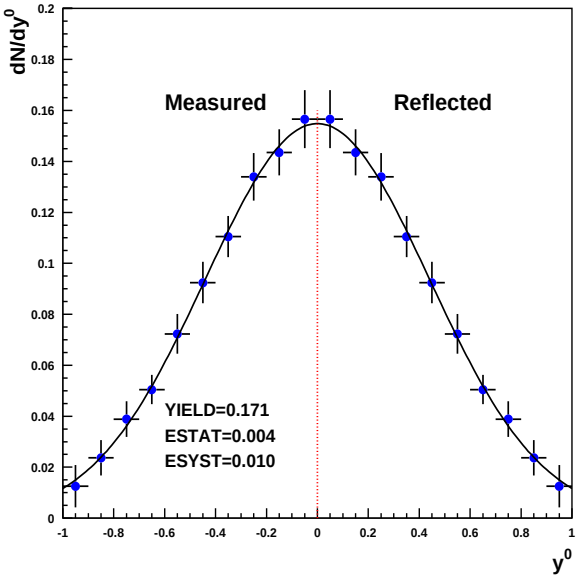

Figure 2: Reconstructed Λ rapidity distribution for central (σ_{geo} = 350 mb) Ni + Ni reactions at 1.93 AGeV.

a Boltzmann type function ($\frac{1}{m_t^2}\frac{d^2N}{d(m_t-m_0)dy^0} = A \cdot exp\frac{-(m_t-m_0)}{T_B}$) where A is a constant of integration and T_B is the apparent temperature (Boltzmann inverse slope parameter). This allows to extract, for each rapidity bin, the Λ yield $\frac{dN}{dy^0}$ by integrating the fitting function from $p_t = 0$ to ∞. The results are presented in Figure 2. The preliminary Λ yield in 4π for central (σ_{geo} = 350 mb) Ni + Ni collisions at 1.93 AGeV is 0.171±0.010(Syst)±0.004(Stat). The systematical errors are obtained with an other set of cuts in order to take into account the fluctuations of the efficiency correction.

The large statistics of reconstructed Λ's will allow for detailed studies on production and propagation (centrality dependence, differential flow, ...). The analyses should bring more light on the production mechanisms for strange particles close to threshold. An analysis using a multilayered neural network to reconstruct Λ's [6] will also be applied on these new data in order to improve the signal identification.

References

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