Inclusive pion and eta production in the 3.5 GeV p+^{93}Nb reaction*

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In recent years HADES has studied inclusive electron pair production in the proton-induced reactions p+p and p+Nb at 3.5 GeV [1, 2]. These data are interpreted with the help of transport models such as UrQMD [3], GiBUU [4], HSD [5], and IQMD [5]. We provide now further constraints from an analysis of 4-lepton events detected in HADES which yield information on the inclusive production of the π^0 and η mesons. Indeed, the electromagnetic decays of the latter, in particular the decays $\pi^0, \eta \rightarrow \gamma e^+e^-$ and $\pi^0, \eta \rightarrow \gamma\gamma$, combined with the external conversion of the decay photon(s) on material in the inner region of HADES, lead to events with a characteristic 4-lepton signature, namely $\pi^0, \eta \rightarrow e^+e^-e^+e^-$. The low conversion probability ($\simeq$4%) and the rather low lepton momenta lead to an overall acceptance for these final states on the order of $10^{-6} - 10^{-5}$ only. Nevertheless, in $9 \cdot 10^9$ triggered p+Nb events a sizeable statistics could be accumulated.

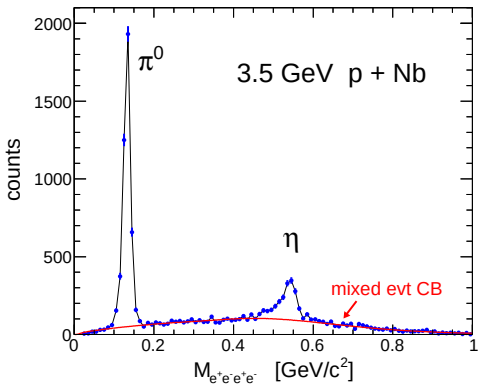

Figure 1: Invariant mass distribution of $e^+e^-e^+e^-$ events measured with HADES in the 3.5 GeV p+Nb reaction.

Figure 1 shows the reconstructed $e^+e^-e^+e^-$ invariant mass spectrum together with its combinatorial background (CB) of uncorrelated lepton pairs as obtained from event mixing. The π^0 and η peaks are prominently visible over the CB with a statistics of a few thousand counts each. Both mesons can easily be selected with appropriate mass cuts and, after having applied corrections for conversion and reconstruction efficiencies, their rapidity and transverse momentum distributions have been obtained. Of those the latter are displayed in Fig. 2. In addition to the π^0 and η distributions we show there the result obtained for negative pions [6]. As the acceptance of π^0 is limited to $p_\perp > 0.3$ we have used the π^- to extrapolate the neutral pion yield to low $p_\perp$ values. Extrapolating as well beyond the accepted rapidity range of $0.2 < y < 1.8$ we obtain (preliminary) inclusive multiplicities of $M_{\pi^-} = 0.62 \pm 0.15$ and $M_{\pi^0} = 0.60 \pm 0.20$ in 3.5 GeV p+Nb reactions.

In contrast to the pions, the eta coverage of HADES is complete in $p_\perp$, as visible in Fig. 2, and nearly so in y. Furthermore, the η phase space distribution seems to be well described by a Boltzmann fit. Integrating and extrapolating to full rapidity yields a (preliminary) multiplicity of $M_\eta = 0.032 \pm 0.005$ for inclusive eta production.

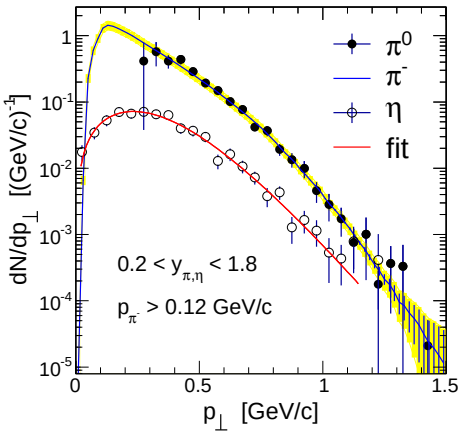

Figure 2: Reconstructed and efficiency-corrected π^0 (closed circles), π^- (blue line) and η (open circles) transverse momentum distributions $dN/dp_\perp$ within the HADES acceptance. Statistical errors are indicated by vertical bars and systematic uncertainties by the yellow shading. A Boltzmann fit (red line) to the η data yields the temperature $T = 84 \pm 3$ MeV.

Our *proof-of-principle* result demonstrates that 4-lepton final states can be reconstructed reliably with HADES and we believe that such data provide additional valuable input for the modeling of proton-nucleus and heavy-ion collisions in the few-GeV regime.

References

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