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Single pion production in proton-proton collisions at 1.25 GeV measured with HADES and the Bonn-Gatchina PWA description

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Collaboration

HADES

Abstract content

HADES is a versatile magnetic spectrometer installed at GSI Darmstadt at SIS18 [1]. Thanks to its high acceptance, powerful particle ($p/K/\pi/e$) identification and very good mass resolution ($2-3\%$ for dielectrons in the light vector meson mass range) it allows to study both hadron and rare dilepton production in $N+N$, $p+A$, $A+A$ collisions at a few AGeV beam energy range. In collisions $p+p$ @ 1.25 GeV, the intermediate $\Delta(1232)$ resonance is expected to play a dominant role in the pion production, but it is known to be not sufficient to describe fully the data. The resonance cross section was determined from exclusive $pp\pi^0$ and $np\pi^+$ channels [2] in the framework of a OPE model with accuracy of $20-30\%$. Investigation of these reaction channels by means of the PWA (Partial Wave Analysis) was also done [3] by the Bonn-Gatchina group at a smaller beam energy [4]. It revealed a dominant contribution of $\Delta(1232)p$ intermediate state but also sizeable non-resonant terms and interference effects. In this work we report on the PWA of the single-pion production in proton-proton collisions (as in [2]) measured with HADES. The pp is a pure isospin $I=1$ state and, at this beam energy the following initial pp-states contribute: (J=0) $^1S_0$, $^3P_0$, (J=1) $^3P_1$, (J=2) $^1D_2$, $^3P_2$, $^3F_2$, (J=3) $^3F_3$ and (J=4) $^1G_4$, $^3H_4$. Unlike in proton-proton collisions at lower energies, higher partial waves are necessary for a proper data description. The final states are limited to $S-$, $P-$, $D-$, $F-$, $G-$ and $H-$ wave states with the two possible intermediate resonance states $P_{33}(1232)$ and $P_{11}(1440)$. The data samples (for both channels, $pp\pi^0$ and $pn\pi^+$) were analysed with the event-by-event background estimation (Q factors). The analysis was preformed together with other available data (see [5], 11 measurements for $pp\pi^0$ and only two for $pn\pi^+$ channel) covering mostly lower beam energies. The stability of solutions was investigated based on a few parametrisations of the transition amplitude A_{tr} (with total energy dependence) and various descriptions of resonance states (Δ and N^*). The obtained solutions generally describe the HADES data very well in various projection observables (CM angular distributions, invariant masses, angular distributions in the helicity and the Gottfried-Jackson frames). The analysis shows the dominant $P_{33}(1232)$ contribution in $np\pi^+$ at the level of 95% and in $pp\pi^0$ (80%) which is an important message for the dilepton analysis, where the branching of Δ Dalitz decays can be identified (in the pe^+e^- channel).
[1] G. Agakishiev et al., Eur. Phys. J. A41 (2009) 243 [2] G. Agakishiev et al., Eur. Phys. J. A48 (2012) 74 [3] A. V. Anisovich et al., Eur Phys. J. A34 (2007) 129 [4] K. N. Ermakov et al., Eur. Phys. J. A47 (2011) 159 [5] Data Base on page http://pwa.hiskp.uni-bonn.de/

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