# Investigation of multi-pion background in the $a_0^+ \to \pi^+\eta$ decay channel*

P. Fedorets[a], M. Büscher, V. Chernyshev[a], Ye.S. Golubeva[b], V.Yu. Grishina[b], V. Kleber, L.A. Kondratyuk[a]

The first measurement of $a_0^+(980)$-resonance production with ANKE was performed in January 2001 at a beam energy of $T$=2.65 GeV [1]. The goal of the experiment is to detect $a_0^+$-resonance production in the reaction $pp \to da_0^+$ with subsequent decays $a_0^+ \to K^+\overline{K^0}$ and $a_0^+ \to \pi^+\eta$.
ANKE allows to simultaneously detect two charged particles, deuterons and pions (kaons). The $m(pp, d\pi^+)$ missing-mass spectrum (Fig. 1) exhibits a peak around the $\eta$ mass containing ~2300 events. This peak sits on a large background supposed to stem from multi-pion production $pp \to d\pi^+ (n\pi)$ $(n{\geq}2)$.

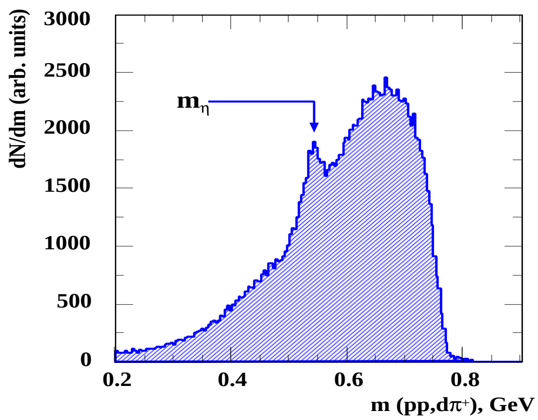


Fig. 1: Measured missing-mass distribution of $d\pi^+$ pairs at $T$=2.65 GeV.

A detailed study of this multi-pion background has been performed with the help of GEANT simulations. According to these simulations, only the reactions $pp \to d\pi^+ (n\pi)$ $(n)$=2,3,4,5 are going into the ANKE acceptance. There are no experimental data on the cross section for the reaction $pp \to d\pi^+5\pi$, but it is expected to be small and negligible in comparison with other multi-pion reactions.

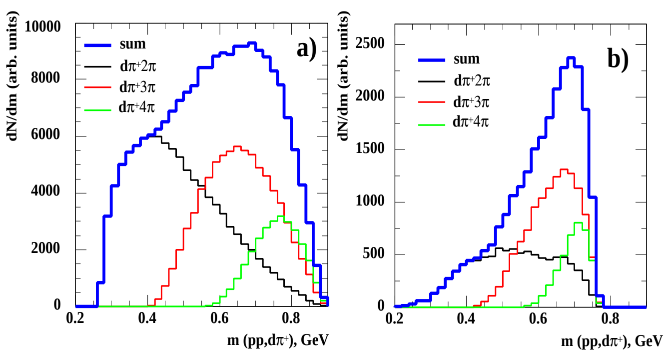


Fig. 2: Simulated missing-mass distributions of multi-pion reactions: initial (a) and accepted in ANKE (b)

The cross sections for $n$=2,3,4 were calculated by adjusting the total cross section to experimental data from literature measured at other beam energies and by assuming a phase-space behavior to extrapolate to $T_\mathrm{p}$=2.65 GeV. Cross sections of 58$\mu b$, 45$\mu b$ and 8$\mu b$ are obtained for $3\pi$, $4\pi$ and $5\pi$ production, respectively.

Figure 2 shows the initial missing mass distributions of multi-pion reactions and the ones accepted in ANKE. The main contribution is due to the reactions $pp \to d\pi^+2\pi$ and $pp \to d\pi^+3\pi$.
The comparison between the simulated and measured missing-mass distribution $m(pp, d\pi^+)$ is presented in Fig. 3. A good agreement between simulated and experimental distributions has been achieved for the following ratio of cross sections: $3\pi$:$4\pi$:$5\pi$=48$\mu b$:45$\mu b$:2$\mu b$.

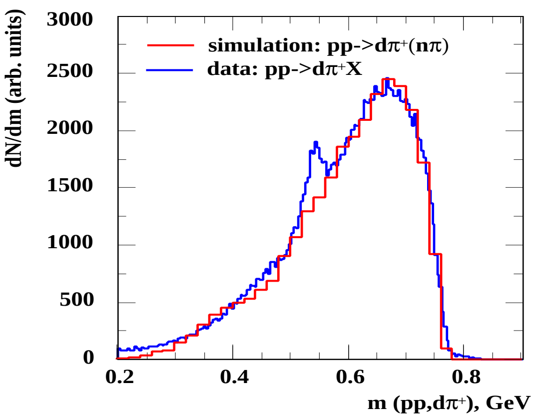


Fig. 3: Simulated missing-mass $m(pp, d\pi^+)$ for multi-pion background and experimental data for $T$=2.65 GeV.

Summarizing, the shape of the missing mass $m(pp, d\pi^+)$ distribution (without the $\eta$ peak) is well described by multi-pion production reactions. The simulations of multi-pion production do not predict any peak around the $\eta$ mass. That means, the background behavior under the peak is smooth and it can be subtracted by fitting.

**References:**

[1] V. Kleber et al.,"Investigation of the $a_0^+(980)$ resonance at ANKE.", Annual Report 2001 of the IKP, FZ Jülich

[a]ITEP, Moscow, Russia
[b]INR, Moscow, Russia

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