The reaction $pp \to d\pi^+\eta$ measured at ANKE*

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a_0^+(980)-resonance production has been studied for the first time with ANKE in January 2001 at a beam energy of $T = 2.65$ GeV in the reaction $pp \to da_0^+$ with subsequent decays $a_0^+ \to K^+\bar{K}^0$ [1] and $a_0^+ \to \pi^+\eta$. The total cross sections for the $\pi^+\eta$ channel have been deduced for a_0^+ and for non-resonant $\pi^+\eta$ production from a model dependent analysis [2]. The results of a model independent analysis of the reaction $pp \to d\pi^+\eta$ are presented here.

The reaction $pp \to d\pi^+\eta$ has been measured by detecting in coincidence the two charged final particles. Subsequently, the reaction has been identified by selecting the η peak in the $mm(pp,d\pi^+)$ missing mass spectrum. The missing mass distributions $mm(pp,d)$ and $mm(pp,d\pi^+)$ for the selected $d\pi^+$ pairs [3] are presented in Fig. 1. In the $(pp,d\pi^+)$ missing mass distribution a clear peak is observed around $m(\eta) = 547$ MeV/c^2 with about 6200 events. The peak sits on top of a smooth background from multi-pion production $pp \to d\pi^+(n\pi)$ $(n \geq 2)$ [4]. After selecting the mass range $(530-560)$ MeV/c^2 around the η peak the missing mass spectrum $mm(pp,d)$ exhibits a shoulder at 980 MeV/c^2 (Fig. 1b, dotted), where the peak from the a_0^+(980) resonance is expected.

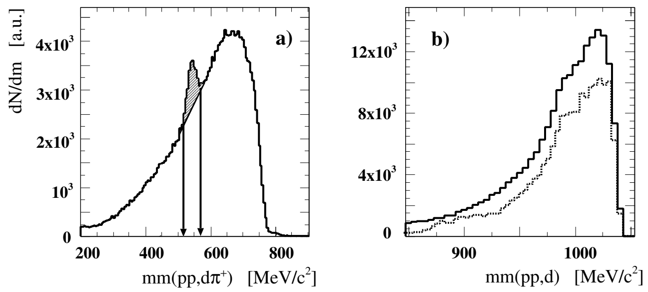

Fig. 1: Missing mass distributions (a) $mm(pp,d\pi^+)$, (b) $mm(pp,d)$ for the reaction $pp \to d\pi^+X$. The dotted histogram in $mm(pp,d)$ (scaled by factor 6) corresponds to the selected area around the η peak ($530-560$ MeV/c^2) in $mm(pp,d\pi^+)$ (indicated by arrows).

With the limited phase-space coverage of ANKE a partial wave decomposition, as it was performed in Ref. [1], is not possible in this case. Only differential cross sections of the reaction $pp \to d\pi^+\eta$ could be determined model independently. For this purpose two regions of phase space have been selected, where the acceptance of ANKE is 100% for this reaction. Six variables in the lab. system have been chosen for describing these rectangular areas: the vertical (θ_y) and horizontal (θ_x) angles and momenta of the two detected particles. The angles are defined as $tan(\theta_y) = p_y/p_z$, $tan(\theta_x) = p_x/p_z$. Figure 2 shows the missing mass distributions $mm(pp,d\pi^+)$, which correspond to the selected regions of phase space. The number of events under the η peak have been determined by fitting the missing mass spectra $mm(pp,d\pi^+)$ by the sum of a Gaussian distribution and a 3rd order polynomial. The results for the differential cross sections are shown in Table 1.

To summarize, the differential production cross section $d^4\sigma/d\Omega_d d\Omega_{\pi^+} dp_d dp_{\pi^+}$ for the reaction $pp \to d\pi^+\eta$ has been determined model independently for two regions of phase space. Both a_0^+ and non-resonant $\pi^+\eta$ productions contribute. For the momentum range $p_d = (1.4-1.6)$ GeV/c the non-resonant $\pi^+\eta$ production should be dominant, because this momentum range corresponds to low masses of the $\pi^+\eta$ system, where the a_0^+ production is suppressed.

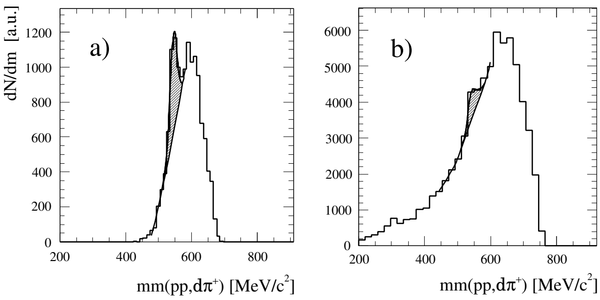

Fig. 2: Missing mass distribution $mm(pp,d\pi^+)$ for the selected regions of phase space: the momentum ranges $p_d = (1.4-1.6)$ GeV/c (a) and $p_d = (1.8-2.7)$ GeV/c (b).

$d^4\sigma/d\Omega_d d\Omega_{\pi^+} dp_d dp_{\pi^+}$ (μb/sr^2(GeV/c)^2)	variables, lab. system		
	θ_y (deg.)	θ_x (deg.)	p (GeV/c)
$71 \pm 6_{stat} \pm 20_{sys}$	deuteron variables		
	$(-3,+3)$	$(-3.5,+3.5)$	$(+1.4,+1.6)$
	pion variables		
	$(-4,+4)$	$(-11,-3)$	$(+0.65,+0.95)$
$30 \pm 4_{stat} \pm 9_{sys}$	deuteron variables		
	$(-3,+3)$	$(-6,-2)$	$(+1.8,2.7)$
	pion variables		
	$(-4,+4)$	$(-11,-3)$	$(+0.65,+0.95)$

Table 1: Differential production cross sections for the reaction $pp \to d\pi^+\eta$ for two regions of phase space where the acceptance of ANKE is 100% for this reaction.

References:

[1] V. Kleber *et al.*, Phys. Rev. Lett. **91**, 172304 (2003).
[2] P. Fedorets *et al.*, IKP Annual Report 2003
[3] V. Kleber *et al.*, IKP Annual Report 2001
[4] P. Fedorets *et al.*, IKP Annual Report 2002

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