Luminosity determination via dp-elastic scattering at ANKE *

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The ANKE collaboration has performed a beam time to determine the η meson mass with high precision using the $d + p \rightarrow {}^3\mathrm{He} + \eta$ reaction [1] and to study the two pion production using $d + p \rightarrow {}^3\mathrm{He} + \pi^+ + \pi^-$ [2]. In order to determine the η mass, data has been studied at 18 deuteron beam momenta in a range between $3120.17\ \mathrm{MeV}/c \leq p_d \leq 3204.16\ \mathrm{MeV}/c$ which could be extracted very accurately via the resonant depolarisation technique with a precision of $\Delta p_d/p_d < 6 \times 10^{-5}$ [1, 3]. Moreover, due to the high statistics of more than 1×10^5 ${}^3\mathrm{He}\eta$ events per energy in combination with full angle coverage these high precision ANKE data allow to investigate the total and differential cross sections of the reaction $d + p \rightarrow {}^3\mathrm{He} + \eta$. Such data are of special interest since they differ strongly from a pure phase space behaviour near threshold which is explained by an unexpected strong final state interaction (FSI) between η mesons and ^{3}He nuclei which could lead to the formation of a quasi bound state of the $\eta{}^3$He-system [4, 5]. To extract total and differential cross section values a careful luminosity determination was performed for each of the 18 beam momenta of the beam time via dp-elastic scattering. Because of the broad data base of available differential cross sections in the range of $-t \approx 0.1\ (\mathrm{GeV}/c)^2$ the dp-elastic scattering is very well suited as normalization reaction. The identifcation of the reaction was ensured via the missing mass technique (cf. figure 1) by detecting deuterons in the forward system which carry a momentum close to the beam momentum due to a low momentum transfer on the target proton.

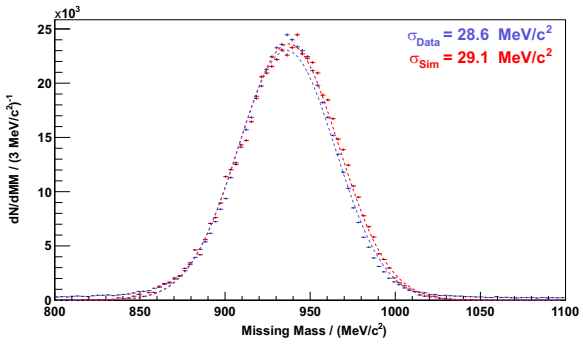

Fig. 1: Missing-mass distribution of the identified deuteron (blue) compared with the corresponding Monte Carlo simulation (red).

In this way luminosities could be extracted with high precision ($\Delta_{stat} = 1\%$, $\Delta_{sys} = 6\%$). Especially the systematic uncertainties were improved by at least a factor of two compared to previous determinations. At higher momentum transfers ($-t \geq 0.12\ (\mathrm{GeV}/c)^2$) the reference data show only a limited number of data points and discrepancies between data sets (cf. figure 2).
Due to the high quality and statistics of the ANKE data set on the dp-elastic scattering in this momentum transfer region, new precision data can be provided. For this purpose and to verify the results of the dp-elastic scattering an independent

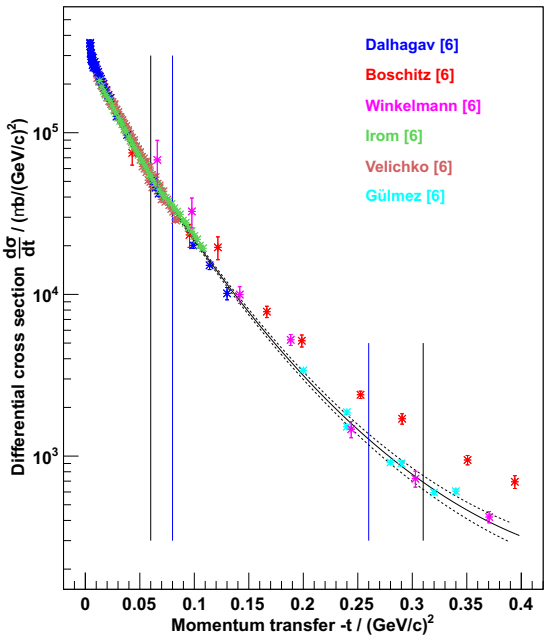

Fig. 2: Reference cross sections for dp-elastic scattering as a function of momentum transfer $-t$. The black vertical lines tag the range of ANKE acceptance and the blue vertical lines the range which was used for the luminosity determination.

absolute normalization via $d+p \rightarrow d+\pi^0+p_{sp}$ is currently in progress. The identifaction of the dp pairs in the forward detection system of the ANKE spectrometer is ensured via the time-of-flight difference between the particles. Result will be available soon, so that it will be possible to determine precise total and differential cross sections for the η production up to an excess energy of $Q = 15$ MeV as well as differential cross sections for the dp-elastic scattering in the interesting momentum transfer region of $0.08\ (\mathrm{GeV}/c)^2 \leq -t \leq 0.26\ (\mathrm{GeV}/c)^2$. The final η production data will be discussed together with results from a further beam time from WASA-at-COSY investigating the behaviour at excess energies of $13\ \mathrm{MeV} < Q < 81\ \mathrm{MeV}$ [7].

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