Luminosity determination via dp-elastic scattering at ANKE

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Studies on the total cross sections of the reaction $d + p \to {}^3\mathrm{He} + \eta$ are of special interest since they differ strongly from a pure phase space behaviour near threshold [1, 2, 3, 4, 5]. This behaviour could be an indication for a quasi bound state of the $\eta{}^3$He-system [6]. New high precision data from the ANKE experiment [7] at the accelerator ring COSY at the Forschungszentrum Jülich allow the extraction of precise absolute cross section values for the η production up to an excess energy of $Q = 15$ MeV. Therefore, a careful luminosity determination was realized via dp-elastic scattering ($d + p \to d + p$) for 18 beam momenta in a range between 3120.17 $^{\mathrm{MeV}}/_{c} \leq p_d \leq$ 3204.16 $^{\mathrm{MeV}}/_{c}$.

The dp-elastic scattering is very well suited as normalization reaction. Its broad data base of available reference data and their high differential cross sections in the region of interest ensure an excellent signal-to-background ratio.
Most of the deuterons of the dp-elastic scattering cause only a low momentum transfer on the target proton. Consequently, these deuterons have a momentum close to the beam momentum, which means that the D2 magnet of ANKE will deflect them under small laboratory scattering angles towards the forward detection system. This detection system consists of a multiwire drift chamber and two multiwire proportional chambers used for track reconstruction and two layers of scintillation hodoscopes for particle identification. The identification of this reaction is ensued via the missing mass technique (see figure 1 left).

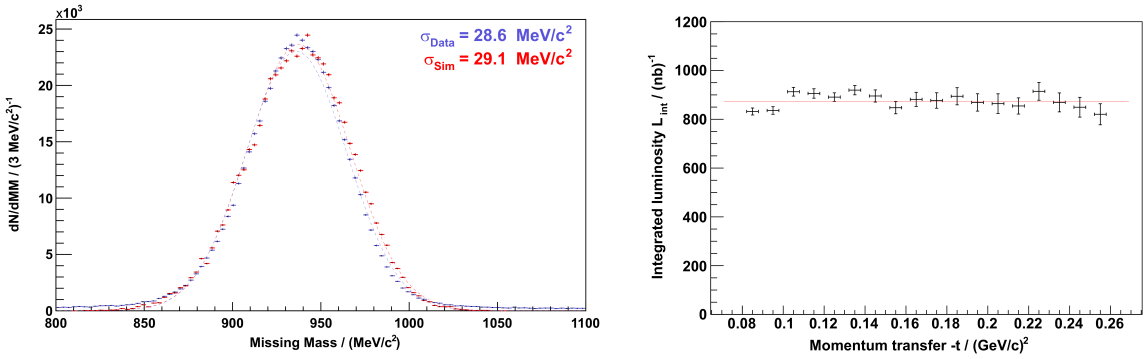

Figure 1: **Left:** Missing-mass distribution of the identified deuteron (blue). The corresponding Monte Carlo simulation is the red distribution. **Right:** Integrated luminosity for 18 momentum transfer bins for a beam momentum of $p_d = 3150.42$ $^{\mathrm{MeV}}/_{c}$.

The luminosity has to be independent of the momentum transfer (see figure 1 right) and for systematic tests the determination has been performed for 18 momentum transfer bins for each of the 18 beam momenta. By this luminosities could be extracted with high

precison ()$\Delta_{\text{stat}} = 1\,\%$ and $\Delta_{\text{sys}} = 6\,\%$). Especially the systematic uncertainties were improved by at least a factor of two compared to previous determinations. These luminosities were already used to determine differential and double differential cross sections for the reaction $d + p \rightarrow {}^3\text{He} + \pi^+\pi^-$ [8].

Furthermore, at higher momentum transfers (≥ 0.12 $(\text{GeV}/c)^2$) the available reference data base shows a limited number of data points and discrepancies between some measurement sets (see 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 an independent absolute normalization is currently in progress. First estimations show that a precision of the extracted differential cross sections of $\Delta_{\text{stat}} = 1\,\% - 2\,\%$ and $\Delta_{\text{sys}} = 2\,\% - 3\,\%$ can be achieved.

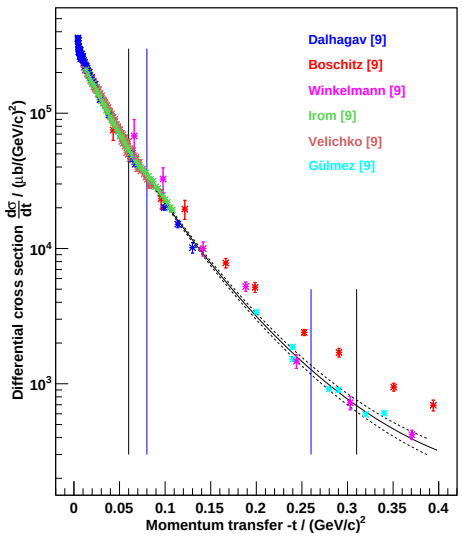

Figure 2: Reference cross sections for *dp*-elastic scattering as a function of momentum transfer $-t$. The black vertical lines tag the range of ANKE acceptance and the blue vertical lines the range which was used for the luminosity determination.

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