Proton Scattering of Neutron-Rich He-Isotopes in Inverse Kinematics A New Setup for the High Momentum Transfer Measurements

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Proton elastic scattering at intermediate energies of around 700 MeV/u is well suited for determining radii and nuclear matter distributions of halo nuclei such as ^{6,8}He [1] and ^{11}Li [2]. The first measurement on the ^{6,8}He nuclei in inverse kinematics has been performed at low momentum transfer up to $|t| = 0.05$ $(\mathrm{GeV/c})^2$ using gaseous hydrogen as proton target. From theoretical investigations [3] a high sensitivity on the inner part of the nuclear matter distributions is predicted when extending the p^{6}He and p^{8}He elastic cross section measurement to the higher momentum transfer region ($|t|$ = 0.1 - 0.4 $(\mathrm{GeV/c})^2$). Calculations based on Glauber theory show that the position of the first diffraction minimum depends on the shape of the density distribution, and is within the model strongly correlated to the core radius of the halo nucleus . We conclude, that a measurement of the angular distribution at higher momentum transfer should yield unambiguous information about the intrinsic structure of these nuclei. In addition, also inelastic reaction channels may be investigated.

A recent experiment has been carried out at GSI in October 2000. The ^{6,8}He beams were obtained via fragmentation of an ^{18}O primary beam of about 10^{10} ions/spill. The projectile fragments were separated by the FRS yielding secondary beam intensities of 5×10^3-10^5 ions/s with an energy of about 700 MeV/u. The experimental setup installed in cave B is shown in fig.1. A forward spectrometer has been used for tracking and identifying the projectile nuclei and for separating the elastic events from the inelastic and break-up channels. It also provided the signal for the first level trigger. This spectrometer consisted of four X-Y position sensitive multiwire proportional chambers (MWPC) P1-P4 with cathode strip channel-by-channel readout, several beam scintillators (S1-S3, Veto), the ALADIN magnet and a position sensitive scintillator wall behind. The proportional chambers had rather high position resolution of 100-150 μm and an efficiency close to 100%. A second position sensitive scintillator wall was used to measure ΔE and time-of-flight of the recoil protons. The second level trigger used the signals from two proportional chambers (P5, P6) detecting and tracking the recoil protons. The essential difference with respect to the previous ^{6,8}He experiment [1] was, that the high recoil proton energies up to E_p = 160 MeV allowed to replace the gaseous H_2 target by a 600 mg/cm^2 liquid H_2 target. This target and the cryogenic device used for the experiment were constructed at CEA, Saclay. The cylindrical target had a total length of 120 mm and an inner diameter of 30 mm. The use of a liquid hydrogen target allows to decrease significantly the background as compared to similar experiments with CH_2 targets.

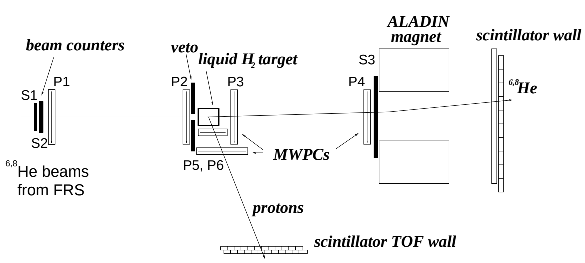

Figure 1: Schematic drawing of the S174 experimental setup.

The data analysis is still in progress. To illustrate the quality of the acquired data, X-position spectra obtained with the MWPC P4 in the field free region before the ALADIN magnet for two different experimental conditions are displayed in fig.2. The spectrum on the left side was taken for the case the second level trigger (that demands recoil protons) being switched on. The one shown on the right side was obtained for the case the second level trigger was switched off, thus displaying the profile of the unscattered beam. The dominant peak in the spectrum on the left side clearly reflects the distribution of elastically and inelastically scattered ^{6}He projectiles, whereas the peak around X=0 is due to the unscattered beam particles contributing to the background. From these online raw spectra we conclude that practically background free data on elastic and inelastic p^{6,8}He scattering will be available after the final analysis taking into account all measured parameters.

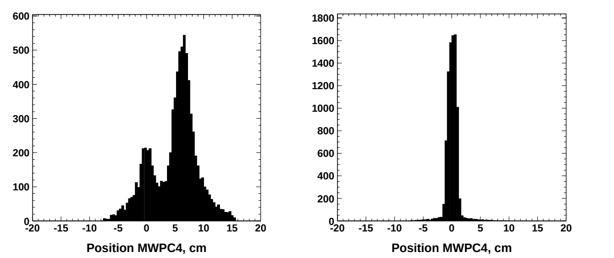

Figure 2: X position spectra from the MWPC P4 obtained for p^{6}He scattering for two different experimental conditions (see text).

References

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