A study of ^{6}He + p reaction: elastic scattering and neutron transfer reactions

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We investigated the elastic scattering and the neutron transfer reactions for the ^{6}He + p system at 8 MeV/nucleon.[1] By simultaneously measuring the ^{6}He$(p,p)^6$He, ^{6}He$(p,d)^5$He and ^{6}He$(p,t)^4$He reactions in the angle range from 8° to 75° in the laboratory system, a full description of the processes is obtained; in particular, the 1- and 2-n transfers helps obtain some information on the halo structure of ^{6}He. Break-up of the ^{6}He is also probed in the experiment.

A machine study for the ^{6}He beam production was performed in Oct. 2022,[2] demonstrating the optimum beam parameters, which were used in the experiment.

The first part of the experiment was performed in May 2023 at the CNS Radio-isotope Beam Separator (CRIB). The ^{7}Li^{3+} beam at 8.3 MeV/nucleon with a maximum intensity of ∼6 electric μA (eμA) was extracted through the AVF cyclotron to bombard the cryogenic gas cell filled with deuteron gas. The ^{6}He particles were produced via the ^{7}Li$(d,^3$He$)^6$He reaction in inverse kinematics method. The ^{6}He beam energy at the CH_2 target was 7.67 MeV/nucleon, and the intensity reached to 6×10^5 cps with a purity of >87% in an optimal experimental condition. The main contamination was triton due to the same ratio of charge-to-mass. We used two multi-wire drift chambers (MWDC)[3] to monitor the beam intensity and track the beam position event by event, as shown in Fig. 1. The tracking efficiencies of MWDCa and MWDCb were 90% and 93%, respectively, with the applied voltages of −879 V and −800 V. Note that we had a low-gain problem in the X' layer of MWDCa and the efficiency was calculated without that layer.

The CH_2 target and carbon target were used to measure the physical and background events. Six silicon telescopes were installed in the F3 chamber to detect the reaction products. The active size of each layer was 50×50 mm^2 with a spacing of <10 mm. For the telescopes, double-sided silicon detectors (16×16 strips, 42–301 μm) were used as the first layer to measure the hit position (X and Y) and energy loss (ΔE) of the produced particles. The remaining silicon detectors of each

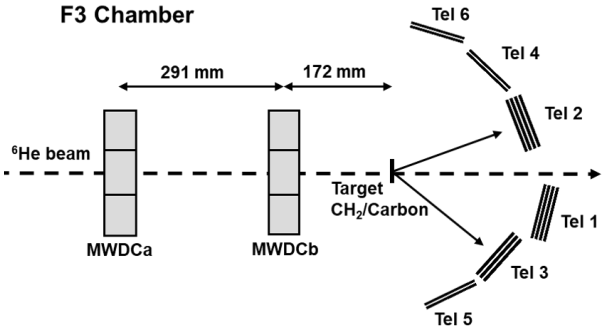

Fig. 1. Schematic of the detector setup in the F3 chamber.

telescope measured the residual energies of the particles. The angle resolution for each telescope was ∼1° in the laboratory system. Proton (p), deuteron (d), triton (t), alpha (α), and ^{6}He particles were detected using the ΔE-E method, as shown in Fig. 2. Analysis of the data is being pursed and will combine the second part of the current research proposal (to be performed in 2024).

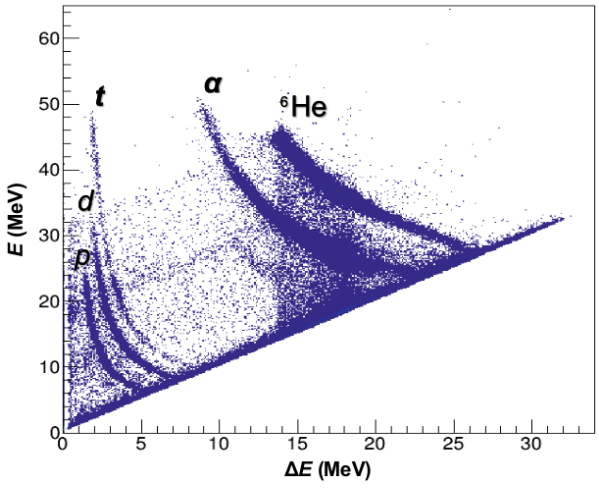

Fig. 2. E-ΔE plot of the elastic and transfer reaction of the telescope 1. Data were collected in only 52 minutes using an intense ^{6}He beam of 1.5×10^5 cps.

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