Experimental setup of the ^{6}He(p, n) measurement at HIMAC and identification of the charge-exchange (p, n) reaction channel

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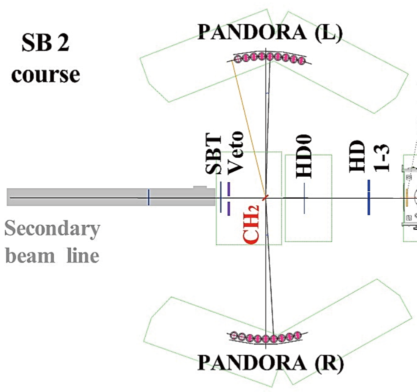
As reported in another article[1)] in this volume, we performed a measurement of the ^{6}He(p, n) reaction in the SB2 course at HIMAC in the winter of 2017 (H391 experiment). In this report, the setup used in the HIMAC experiment is presented with a preliminary result of the analysis to identify the (p, n) reaction channel.



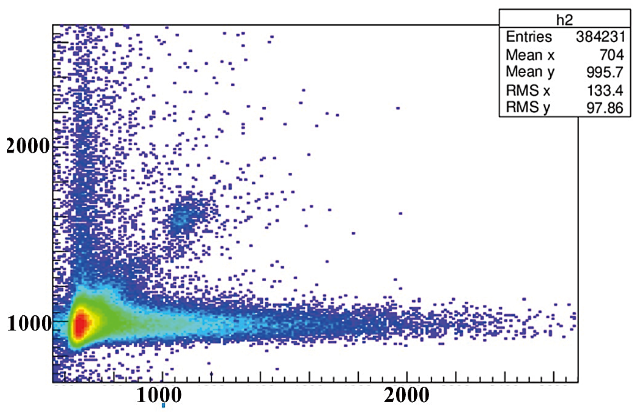


Fig. 1. (top) Layout of the experimental setup used in the HIMAC H391 experiment. (bottom) Particle-identification plot of reaction residues. The vertical and horizontal axes correspond to the energy losses in HD0 and HD1 (E_0 and E_1), respectively. The units are QDC channels.

Figure 1 (top) shows the layout of the experimental setup. In the experiment, a secondary beam of ^{6}He at 123 MeV/nucleon was produced through a fragmentation reaction with a 160 MeV/nucleon primary beam of ^{11}B. The resulting cocktail beam had a total intensity of 2×10^4 particles/s, containing ^{6}He with a purity of 96%. The particle identification (PID) of the beam particles was performed on an event-by-event basis by using the energy loss information in the SBT plastic scintillator. The secondary beam was impinged on a polyethylene target with a thickness of 7 mm. The recoil neutrons were detected using the PANDORA[2)] neutron detectors surrounding the target. The hodoscope bars were placed downstream of the target to identify the reaction residues produced in the (p, n) reaction from the incident ^{6}He particles. Depending on the excitation energy, the daughter nucleus, *i.e.* ^{6}Li, decays into multiple reaction residues of light nuclei such as protons, neutrons, and tritons. With the aim of distinguishing such events, the hodoscope setup consisted of three layers: the first layer was used to identify ^{6}Li only, while the other two layers were segmented so as to detect light nuclei. HD0 (HD1-8) had a plastic scintillator plate with dimensions of $240^W \times 80^H \times 2^D$ mm^3 ($100^W \times 1000^H \times 10^D$ mm^3). HD0 covered the solid angle for ^{6}Li particles emitted at angles up to 7°, which was sufficient to measure the (p, n) reaction at scattering angles up to 15° in the center-of-mass system. As a parasitic setup, the silicon detector setup developed for SAMURAI heavy-ion proton experiments was also installed.

Figure 1 (bottom) shows a PID plot of reaction residues obtained by comparing the charge information in the hodoscope in the first layer (HD0) and that in the second layer immediately behind HD0 (HD2), after selecting events corresponding to ^{6}He beam particles. The data shown here were accumulated within a two hour run. The most intense PID blob corresponds to the events in which the ^{6}He beam particles penetrated both HD0 and HD2 (unreacted events). The blob around (E_0, E_1) = (1600, 1100) is due to the events in which the ^{6}Li beam particles penetrated both HD0 and HD2, corresponding to the (p, n) reaction channel. The ^{6}Li events are clearly separated from the unreacted events in this two-dimensional plot. We have an issue that the energy loss information in HD2 for the unreacted channel has a long tail for higher QDC values. For clarifying the origin of this tail, we are planning to analyze the waveform data of HD2 taken by the CAEN digtizer modules reported in another article[3)] in this volume. The analysis is in progress.

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References

1) L. Stuhl *et al.*, in this report.
2) L. Stuhl *et al.*, Nucl. Instrum. Methods Phys. Res. A **866**, 164 (2017).
3) J. Gao *et al.*, in this report.