Re-measurement of the ^{4}He(^{8}He, ^{8}Be) reaction

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In our previous study, the candidate resonance of the $4n$ system (tetra-neutron) was determined using the ^{4}He(^{8}He, ^{8}Be)$4n$ reaction with a 186 MeV/nucleon ^{8}He beam.[1)] A new measurement with better statistics and better accuracy was performed to confirm the existence of the tetra-neutron system.[2)]

The intensity of the ^{8}He beam was 3.5×10^6 particles per second at the liquid helium target, and approximately twice compared to that of the previous experiment. Low pressure multi-wire drift chambers (LP-MWDCs) were installed at the focal planes F3, F6, and F-H10(S0), to measure the trajectory and momentum of the beam. The time reference to determine the drift time in LP-MWDCs was obtained from a plastic scintillator at F3.

We present the analysis of the LP-MWDCs developed to eliminate accidental coincidence events induced by the high intensity beam. The ^{8}He beam from the SRC had a bunch structure with a periodic cycle of 73 ns. There are two cases of accidental coincidence as illustrated in Fig. 1(a) and (b). The filled circles represent the particle, which triggered the data acquisition. The other particle in the next bunch (open circle) hits in (a), whereas two particles together hit in the same bunch in (b). In the analysis, we carefully treated these events, which created multiple hits within the maximum drift time of 120 ns in the LP-MWDCs. The events of Fig. 1(a) were successfully identified by selecting the drift-time region of the LP-MWDC and the total traveling time from F3 to S2 focus corresponding to the beam energy.

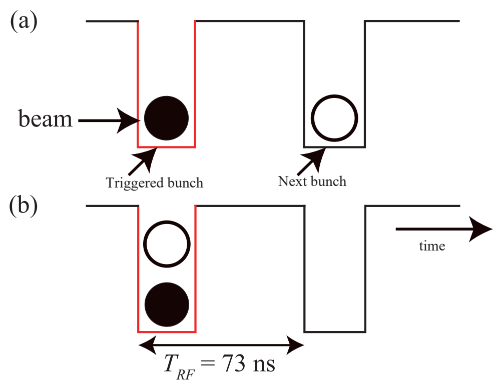

Fig. 1. Time structure of the beam bunch. The solid circles show particles triggering data acquisition, and the open circles are accidental particles. (a) Beam contains both the 'Triggered bunch' and 'Next bunch.' (b) Two particles are in the triggered bunch.

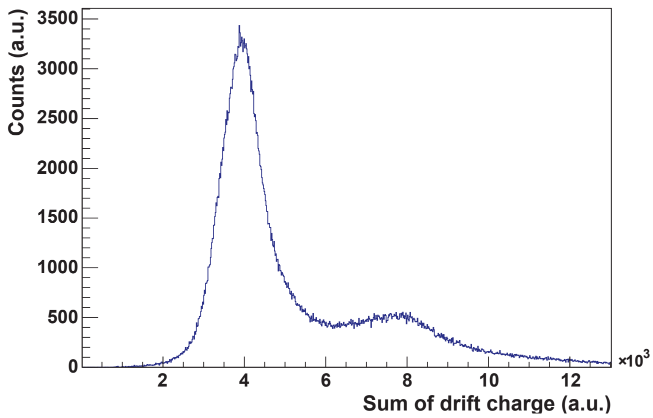

Fig. 2. Energy distribution of LP-MWDC.

In the case of Fig. 1(b), we simply eliminated such events because the triggered beam particle and accidental particle in the same bunch cannot be distinguished. To identify such cases, we estimated the total energy spectrum obtained by using the Time-Over-Threshold data of its signal. Figure 2 shows the total energy distributions measured at LP-MWDC; two peaks are visible. The peak at higher energies results from multiple-hit events, and 75% of the multiple hit events were rejected by selecting energies below 6,000. This value is consistent with the probability of an occurrence of pile up events.

After the treatment, the tracking efficiency of the beam was 95%. In the present experiment, one of the LP-MWDCs installed at F-H10 was damaged under the intense irradiation of the ^{8}He beam and operated with a low efficiency of 48%. The overall tracking efficiency of the ^{8}He beam is therefore 80%, which still ensures better statistics than the previous experiment.

Data analysis is in progress toward the final result.

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References

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