Background estimation for multi-charged particle coincidence events with SAMURAI

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Several experiments have been performed with the SAMURAI spectrometer[1)] in recent years. Some of these experiments performed invariant-mass spectroscopy for the particle-unbound states of unstable nuclei. For the invariant-mass spectroscopy of multi-charged particles (MCPs) such as protons or α particles and residuals, it is important to select MCP coincidence events. Charged-particle events can be identified by a hodoscope (HOD)[1)] composed of plastic scintillator slats, which is placed downstream of the SAMURAI magnet. Therefore, a value of more than two of HOD slats ($M2$) is able to select MCP coincidence events. In this report, we estimate the origins of the background for MCP coincidence events.

For the estimation, we analyzed the data of the SAMURAI08 experiment.[2)] In this experiment, α-cluster levels in ^{16}C were investigated with a 200 MeV/nucleon ^{16}C beam and liquid He target. Here, we used down-scaled *Beam* trigger events. A *Beam* trigger is generated by the coincidence of two plastic scintillators SBT1 and SBT2[1)] and the anti-coincidence of a perforated plastic scintillator SBV. The SBV is installed to reject events in which a ^{16}C beam hits the target cell frame. The averaged count rate of the *Beam* trigger is 100 kcps and the purity of the ^{16}C is more than 99 %. An $M2$ event is 2.5 % of the *Beam* trigger events for a 150 mg/cm^2-thick liquid He filled tearget and 2.3 % for empty. Therefore, the 8 % of $M2$ events are caused by the reaction between the ^{16}C and the He target. We define the other 92 % of $M2$ events as background.

The main component of the background is found to be fragmentation of the ^{16}C beam downstream of the SAMURAI magnet. The time of flight (ToF) versus the light output (LO) plot of a typical slat of HOD gated by a multiplicity of one and $M2$ is shown in Figs. 1(a) and (b), respectively. Several isotopes can be identified in Fig. 1(a), while loci in low LO events occupy the main part in Fig. 1(b). These loci are identified as light ions originating from the ^{16}C beam downstream of the SAMURAI magnet as follows. The positions and angles of these loci can be deduced by drift chamber FDC2.[1)] Reaction points can be vertex-reconstructed when two positions and angles are deduced in one event, as shown in Fig. 2(a). In this figure, the coordinate origin ($x = z = 0$) is the box center of FDC2. Both the $x-$axis and $z-$axis are perpendicular to the gravity direction and the $x-$axis is parallel to the FDC2 entrance window. The red line in Fig. 2(a) is a typical trajectory of the ^{16}C beam which overlaps with the reaction points. The projection for the $z-$axis is shown in Fig. 2(b). Two peaks around $z = -440$ mm and $z = -930$ mm are significant. These values are consistent with the z positions of the FDC2 entrance window and the charged particle exit window of the SAMURAI magnet ,[3)] and 92 % of the background is tagged as this component.

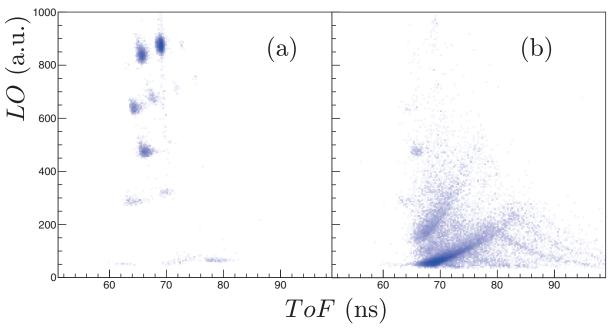

Fig. 1. ToF versus LO of a typical slat of HOD gated by (a) multiplicity of one and (b) $M2$.

Other minor components of the background are single events including more than two beam particles (3 %) and one particle going through neighboring HOD slats (1 %). The other component (4 %) probably consists of reactions with materials upstream of the SAMURAI magnet other than the He target.

In conclusion, the origins of the background for MCP coincidence events are identified and the main component of the background is beam fragmentation downstream of the SAMURAI magnet.

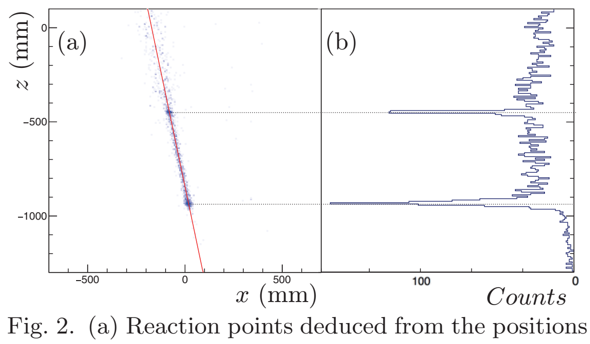

Fig. 2. (a) Reaction points deduced from the positions and angles of two fragments. The red line is a typical trajectory of the ^{16}C beam. (b) Projection for z of (a).

References

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