Recoil proton counter for elimination of hydrogen background

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In the measurement of the α inelastic scattering at forward angles, hydrogenous contaminants in the target cause backgrounds since the cross section for the $\alpha + p$ elastic scattering is larger than that for the inelastic scattering. The hydrogenous contaminants easily cling to the target while it was kept in the air or when it was prepared using water. When the target contains hydrogen, not only the expected excited states in the target but also the ground state of hydrogen are measured. Fig. 1 shows the two dimensional plot of the scattering angles of the alpha particles versus their horizontal poisitions on the focal plane of Grand Raiden (GR) for the ^{nat}C(α,α') reaction. The oblique locus for the $\alpha + p$ scattering is observed as well as the vertical loci for the ^{nat}C(α,α') reaction exciting the 2^+_1 (4.44 MeV) and 0^+_2 (7.65 MeV) states.

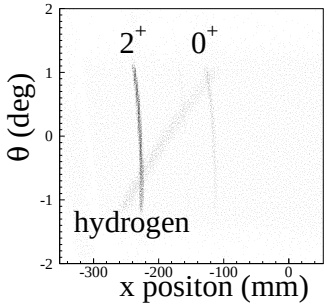

Figure 1: Two dimensional plot of the scattering angles of the alpha particles versus their horizontal positions on the focal plane of GR with ^{nat}C(α,α') reaction.

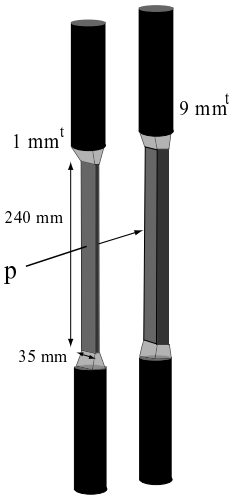

Figure 2: Schematic view of the recoil proton counter (RPC).

In the present work, we developed a recoil proton counter (RPC) to tag the background events. The recoil protons from the $\alpha + p$ scattering are detected by the RPC installed in the scattering chamber. The RPC position in the scattering chamber was remotely changed according to the GR angle since the detection angles of the scattered α particles and recoil protons are strongly correlated in the $\alpha + p$ scattering.

The RPC consists of the two plastic scintillation detectors as shown in Fig. 2. The two scintillators are used as a $\Delta E - E$ counter. Thickness of the plastic scintillators are 1 mm and 9 mm, respectively. The 33 mmϕ PMTs, which are designed to be used in the vacuum, are glued on both sides of the each scintillator. The vertical and horizontal length of the scintillators are 240 mm and 35 mm. The distance between the target and the RPC is 20 cm. The vertical size of the RPC was decided to be large enough to detect all the protons recoiled from the α particles whose scattering angles were within the GR vertical angular accptance of $\pm$ 20 mr.

The recoil protons were discriminated from γ rays emitted from the target by using the correlation between the time of flight and the energy loss in the scintillator. Fig. 3 (a) is plotted for the events where the RPC detected the recoil protons, while Fig. 3 (b) is plotted for those where the RPC did not detected the recoil protons. The background events scattered from hydrogen in the target was successfully separated from the (α,α') events by using the RPC. The RPC is also successfully used in the measurements of the α inelastic scattering from ^{11}B and ^{13}C [1].

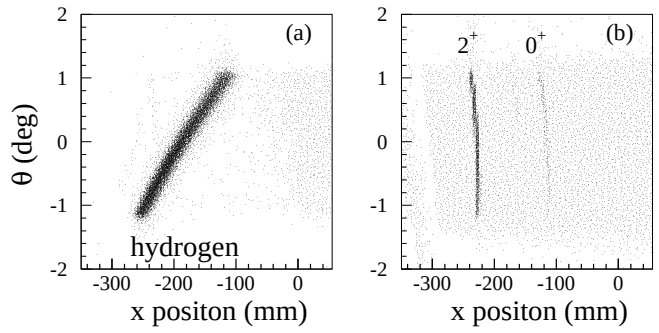

Figure 3: Same two domensional plot as Fig. 1, but plotted under the condition where the recoil protons are detected (a) and not detected (b) by the RPC.

References

[1] Y. Sasamoto *et al.* , in this Annual Report.