Efficiencies of GR focal plan detectors for 200 MeV protons

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Recently, we have proposed an experiment to extract proton and neutron density distributions simultaneously from measurements of proton elastic scattering at 200 and 300 MeV [1]. In 2012, we performed the first experiment for Zr isotopes, using the Grand Raiden (GR) spectrometer. In addition, in order to know the absolute values of cross sections, and to extract the density distributions precisely, we have measured efficiency of the Faraday cup and efficiency of the trigger counters of the DAQ system for 200 and 300 MeV protons [2, 3]. In this report, we describe the experimental results for the trigger counters.

The experiment was performed by the same method as the previous experiment [2]. Passing through the GR spectrometer, the faint proton beam was directly transported to the focal plane. The beam intensity was 10^3 particles per second. At the focal plane, three plastic scintillators (TPS), two vertical drift chambers (VDCs), and two 1-cm-thick plastic scintillators (PS1 and PS2) were placed. During the measurement, triple coincidence of TPS was used as a trigger signal. In the physics run, we used coincidence of the signals from PS1 and PS2 as a trigger signal (PS1 × PS2), and put an aluminum plate between PS1 and PS2 to eliminate background electrons. Therefore, we measured the efficiency of PS1 × PS2 by changing the thickness of the Al plate.

Figure 1 (a) and (b) show energy loss distributions of 200 MeV protons in PS1 and PS2 when we inserted a 10-mm-thick Al plate between them. For reference, we also plot the data at 300 MeV [2] in Fig. 1 (c) and (d), which are reanalyzed with the same method as the present data. The proton beam was identified with TPS, and the beam particles scattered in front of the VDCs were rejected by using the tracking information of the VDCs. The efficiencies of PS1 × PS2 for 200 and 300 MeV protons are respectively plotted by closed squares and circles as a function of the thickness of the Al plate in Fig. 2. The definition of the efficiency is $\frac{\mathrm{PS1}\times\mathrm{PS2}}{\mathrm{TPS}}$. Because the total NN cross section does not change drastically between 200 and 300 MeV, we cannot see obvious difference between two data. In offline analysis, we usually select a region in the distribution to eliminate other particles. Therefore, we tentatively selected the regions which are drawn by red lines in Fig. 1 . The region corresponds to $[X - 3\sigma_{\mathrm{L}},\ X + 5\sigma_{\mathrm{H}}]$, where X is the peak channel, and $\sigma_{\mathrm{L,H}}$ are the standard deviations of the distribution for the lower and higher channel sides from the peak position, respectively. The gated efficiencies for 200 and 300 MeV protons are plotted by open markers in Fig. 2. The nucmerical values as well as those for other gates are given in Ref. [4]

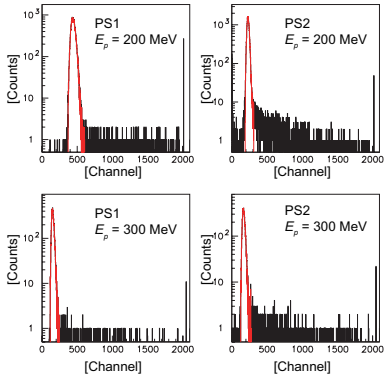

Figure 1: Energy loss distributions of 200 and 300 MeV protons in PS1 and PS2.

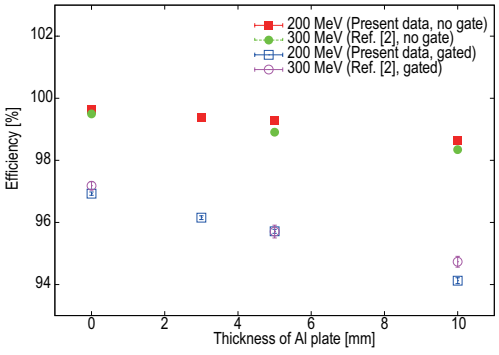

Figure 2: Efficiencies of PS1 × PS2 for protons as a function of the thickness of the Al plate. For details, see text.

References

[1] J. Zenihiro, E366 experiment.
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[4] http://www.rcnp.osaka-u.ac.jp/Divisions/np1-a/pukiwiki/index.php?E375