Low-pressure MWDC system for ESPRI experiment (Ⅱ)

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Elastic scattering of protons with RI beams (ESPRI) has been used to study the ground-state properties of unstable nuclei[1]. In ESPRI experiments, the trajectories of the RI beams, the energy and intensity of which are respectively 200-300 MeV/nucleon and 10^{5-6} particles per second, should be measured. Recently, in order to improve the detection efficiency and tracking resolution, a low-pressure multi wire drift chamber (MWDC) system was constructed[2]. This report describes the characteristics evaluated with various beams (^{132}Xe and its secondary beams) and detector gases (CH_4, C_2H_6, and i-C_4H_{10}).

The experiment was performed at NIRS-HIMAC. Figure 1 shows the detection efficiency for the 300 MeV/nucleon Xe beam when the pressure of each gas was controlled at 50 Torr. The beam intensity was 5×10^3 particles per pulse (pulse width of 1 s). The threshold voltage of the ASDs was −20 mV. The definition of symbols in Fig. 1 is the same as in Sec. 2.3 of Ref. 3. For all the gases, the efficiency reaches 100%. While the voltage increased with an increase in the pressure, the voltage at $\leq$ 50 Torr was almost unchanged. Figure 2 shows the position resolution for an X plane. For all gases at 50–200 Torr, the resolution reaches about 50 μm (rms).

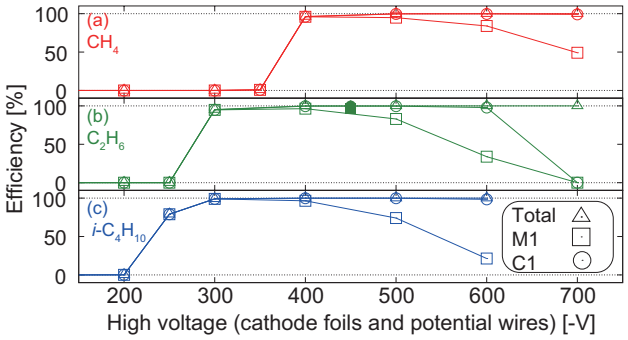

Fig. 1. Detection efficiency at 50 Torr for Xe beam. (a) CH_4, (b) C_2H_6, and (c) i-C_4H_{10}.

Next, the dependence of these quantities on the beam intensity and energy was investigated. The data corresponding to 300 $\times10^3$ particles per pulse are plotted with closed markers in Fig. 1 and 2. The data indicate negligibe intensity dependence. This is because of a small cell size of 5 mm. The results for the 200 MeV/nucleon Xe beam were the same as above.

Finally, the detection efficiency for a cocktail beam was investigated. Figure 3 shows the total detection efficiency for the Z =25, 35, and 40 particles when the pressure of each gas is 50 Torr. Except for the absolute voltage, a specific difference of the tendency does not exist among the gases.

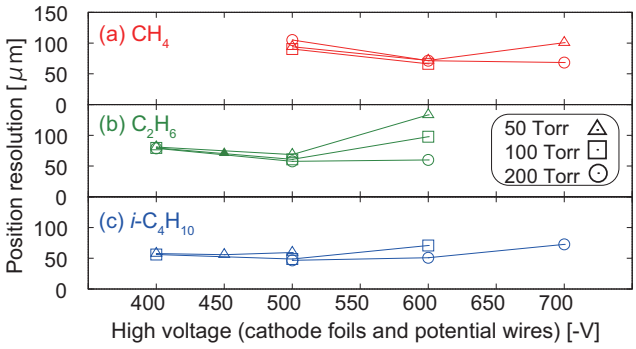

Fig. 2. Position resolution at 50-200 Torr for Xe beam. (a) CH_4, (b) C_2H_6, and (c) i-C_4H_{10}.

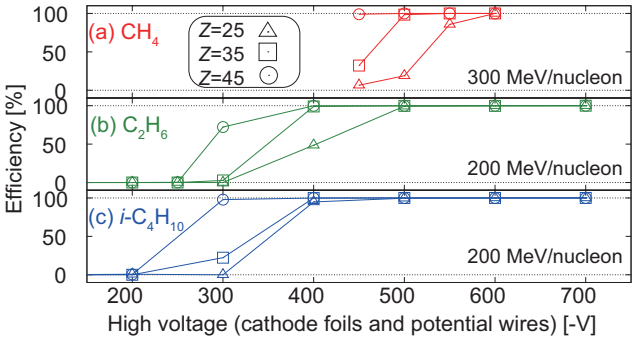

Fig. 3. Total detection efficiency at 50 Torr for secondary beams. (a) CH_4, (b) C_2H_6, and (c) i-C_4H_{10}.

In summary, we evaluated the characteristics of a low-pressure MWDC system with heavy-ion beams. The detection efficiency and position resolution reach 100% and about 50 μm, respectively, with all the tested gases (CH_4, C_2H_6, and i-C_4H_{10}). These results demonstrate that the constructed system is suitable as a beam tracker for ESPRI experiments, and the system shows potential for experiments using various heavy-ion beams.

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References

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