

§1. Development of a Double-Charge-Exchange He⁻ Beam Source

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A DC-mode He⁻ source of double charge exchange type has been developed for the purpose of application to the alpha-particle measurement. Because the optimum energy for double charge exchange in a Rb vapor was reported to be around 6 keV, the essential point of the development is the extraction of an intense He⁺ beam at relatively low energy. The beam transport to the charge exchange cell, and development of an effective and long-life Rb gas cell are also important.

The beam of He⁺ is extracted from an 8.5 cm-diam 10 cm-long compact multicusp ion source by using a 6 mm-diam three-electrode-extraction-structure. Then, it passes through the 1 cm-diam entrance aperture of the charge exchange cell. The He⁻ beam produced in the cell is diagnosed by a Faraday cup located about 30 cm downstream, after the mass separation by the magnetic field produced with a pair of permanent magnets. The opening of F.C. is 2.5 mm (vertical) x 10 mm. The Rb pressure in the cell is spectroscopically monitored so as to be operated at the pressure to convert He⁺ to He⁻ at the maximum efficiency. Because the extraction voltage is relatively low

In Fig.1 are shown the He⁺ beam (a) and the He⁻ beam (b) profiles measured by moving the F.C. The vertical opening of F.C. is 2.5 mm. The negative beam has a narrower beam width. In Fig. 2, the total He⁻ current (triangle), which is obtained by integrating the beam profile vertically. The conversion efficiency from He⁺ to He⁻ (rectangular) is also plotted.

The He⁻ current is limited by the discharge current of the He⁺ ion source. Because the extraction voltage is relatively low (less than 11 kV), the maximum current is obtained when the plasma density in the ion source is low. As the plasma density is increased, the focusing property goes worse, and higher electrostatic field is required. The beam current was estimated by

vertically integrating the beam profile measured by the F. C.. The maximum He⁻ current was 0.07 mA. The conversion efficiency from He⁺ to He⁻ is about 2-3 % in the energy region of 5 - 10 keV. (a)

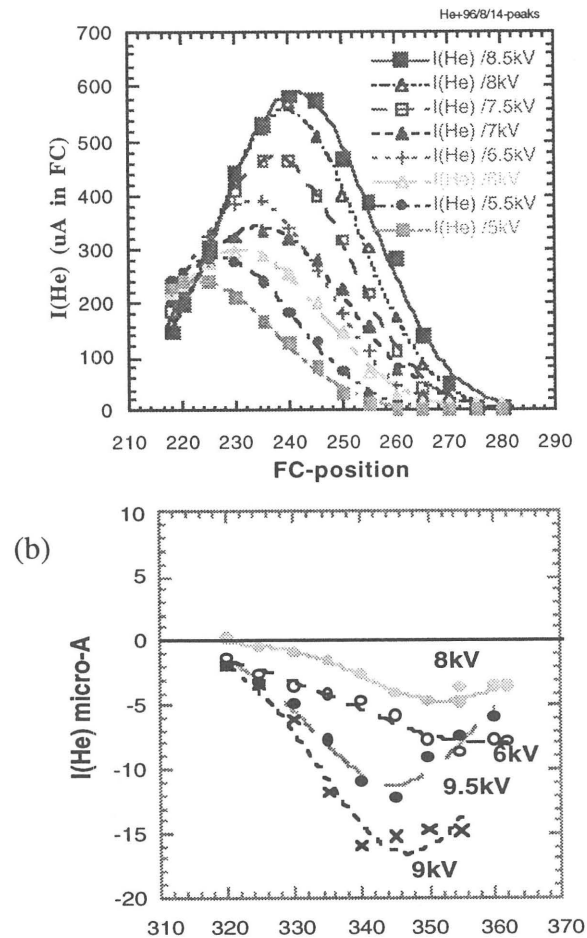


Fig. 1 The beam profile of the He⁺ beam (a) and the He⁻ beam (b) at the energy from 5-10 keV.

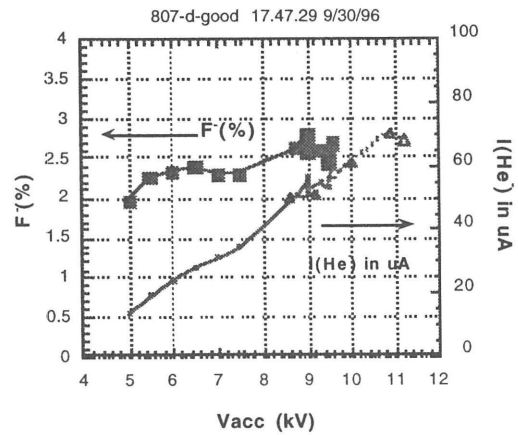


Fig.2. The total current of He⁻ and the conversion efficiency.