ACCELERATION OF HORIZONTALLY POLARIZED PROTONS AND DEUTERONS BY THE RCNP CYCLOTRON

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Abstract

Polarized protons and deuterons with their polarization axis in the horizontal plane were successfully accelerated by the AVF cyclotron. To obtain a high beam polarization, test experiments were performed to distinguish the turn numbers of the beam in the cyclotron.

Previously, polarized protons and deuterons with their polarization axis in the horizontal plane were successfully accelerated by the RCNP cyclotron[1]. Rotation of the beam polarization axis was achieved by using a Wien filter installed just after the atomic type polarized ion source (fig. 1). The performance of the Wien filter was described elsewhere[1]. The measured vertical polarization of 56 MeV deuterons is shown in fig. 2 as a function of the magnetic field strength of the Wien filter. Fig. 3 shows an example of the up-down asymmetries as a function of the Dee veltage. It was found that the horizontal beam polarization was mainly determined by the turn number of the beam in the cyclotron. The period of the oscillation of the up-down asymmetries should correspond to seven turns due to the deuteron anomalous magnetic moment. Actually, a periodical variation of up-down asymmetry with the Dee voltage was observed (fig. 3). The measured maximum horizontal beam polarization was about 70% of the initial value at the ion source. It was also found that the final beam polarization was sensitive to the various parameters of the cyclotron.

If the turn number of the beam in the cyclotron can be determined, high beam polarization can be obtained. A preliminary test was performed to distinguish the turn number of beam. A pulsed beam was generated at the Wien filter by adding an appropriate voltage. The accelerated beam was detected by a plastic scintillator inserted in the beam line. By selecting a proper duty-cycle, one can observe the distributions of the turn number of the extracted beam. Fig. 4 shows the case of 1/48 duty-cycle, where multi-turn extraction is observed. The turn number were descreased to 2 or 3 by a careful tuning of the cyclotron parameters associated with the use of the phase-defining slit. Efforts are now in progress to increase the beam intensity and to reduce the mixture of the turn numbers.

Reference

1) K. Hatanaka et al., Proc. Ninth Int. Conf. on Cyclotrons and Their Applications, Caen, les Editions de Physique (1981) p. 453.

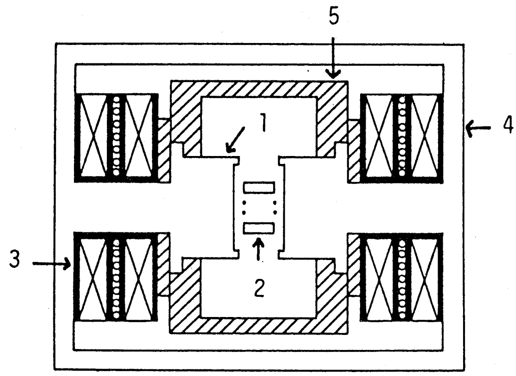

Fig. 1. Cross sectional view of the Wien filter. 1:pole piece, 2:electrode, 3:coil, 4:yoke, 5: vacuum housing.

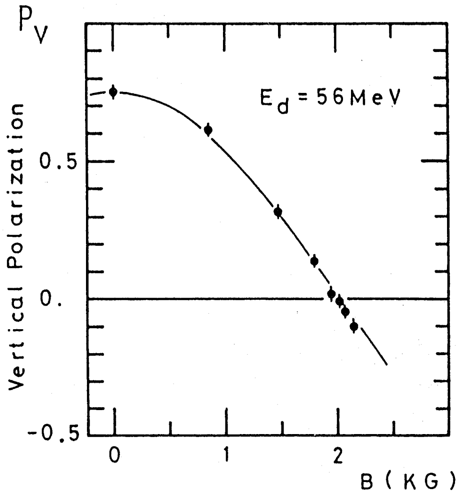

Fig. 2. Rotation of deuteron spin by the Wien filter. Solid line shows the curve of P_V=0.72 0.433 cos(B/B_0 /2), where B_0=2KG and 0.72 and 0.433 are beam polarization and the vector analyzing power of the ^{12}C-polarimiter.

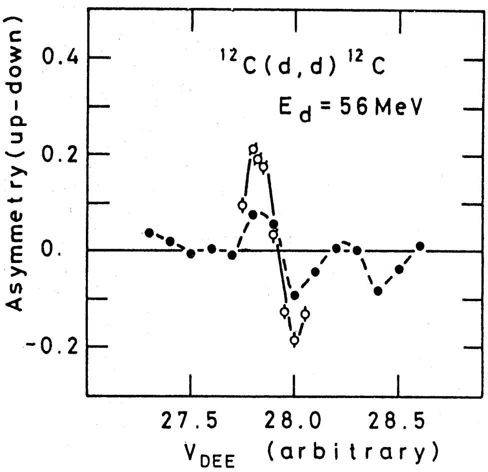

Fig. 3. Up-down asymmetries of 56 MeV deuterons as a function of the Dee volgate. Open circles were measured using a phase-defining slit. The lines drawn through the experimental data are only for eye guide.

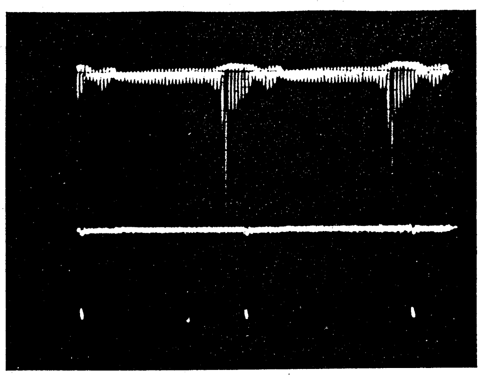

Fig. 4. Distribution of the turn numbers observed by a plastic scintillator in the beam line. A duty cycle is 1/48.