ACCELERATION OF PROTONS WITH THE SPIN AXIS IN THE HORIZONTAL PLANE

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Abstract

Protons with spin in the horizontal plane were accelerated by the AVF cyclotron at RCNP. The maximum polarization of the beam accelerated up to 65 MeV maintained about 70% of the initial value at ion source. The dependence of the final beam polarization on various parameters of the cyclotron was also investigated.

1. Introduction

It has been believed that the beam polarization would be lost when an along beam (a beam with spin in the horizontal plane) was accelerated with circular accelerators. The along beam has been, therefore, accelerated only by linear accelerators, for example, by the Van de Graaff accelerators. This is a reason why the tensor analyzing power T_{21} could not be measured at higher energies than 15 MeV. However it may be possible to accelerate the along beam with a cyclotron, if a good condition of turn-separation can be obtained. It is important to measure the T_{21} above the Coulomb barrier for the study of the tensor interactions between the deuteron and the nucleus.

Before the acceleration of deuterons, a test was performed for a proton beam with spin in the horizontal plane. It was found that the maximum polarization of 65 MeV protons was about 70% of the initial value at ion source and was very large. We also investigated the dependence of the final beam polarization on various parameters of the cyclotron.

2. Measurements and Results

The test experiments were performed with 65 MeV polarized protons accelerated by the AVF cyclotron at RCNP. Polarized protons were produced by the atomic beam type ion source. The beam quantization axis (the beam's spin) was rotated in a vertical plane by a Wien Filter located just after the ion source. The beam polarization was measured by a polarization monitor system with two turn tables in the horizontal (left, right) and vertical (up, down) planes.

The vertical and horizontal components of the beam polarization can be determined from measurements of left-right and up-down asymmetries, respectively. The magnetic and the electric fields of the Wien Filter were adjusted to minimize the absolute value of the vertical polarization. The decrease of beam intensity was recovered with slight re-adjustment of the parameters of the injection system. When the Wien Filter was rotated around the beam axis, the measured up-down asymmetry varied on a sine curve as expected, and is shown in fig. 1. The Wien Filter was fixed at the angle which gave the maximum up-down asymmetry. The parameters of cyclotron were changed to investigate the effects on the asymmetries. An example is given in fig. 2, where the dependence on the Dee voltage is shown. Other parameters investigated were trim-coil and valley-coil currents. It was found from these measurements that the final polarization was insensitive to the condition of the central region of the cyclotron and was mainly determined by the number of the rotations of the beam in the cyclotron and then the condition of the turn-separations. We now intend to make a test with polarized deuterons at 56 MeV.

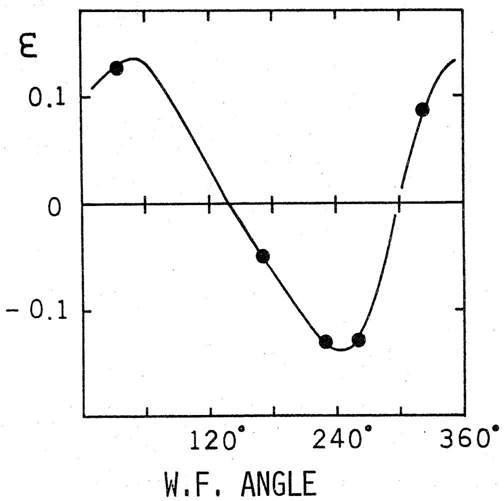

Fig. 1. Up-down asymmetries as a function of the angle of the Wien-Filter. The line presented is only the eye-guide.

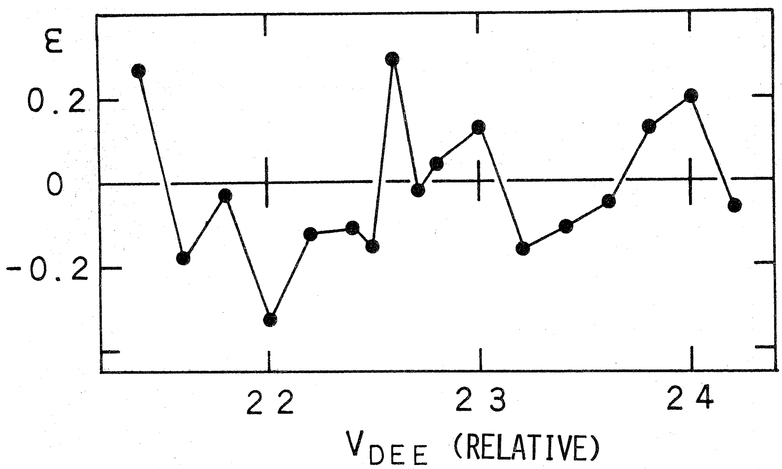

Fig. 2. Up-down asymmetries as a function of the Dee voltage. The line is only the eye-guide.