Radial injection of a polarised beam into a cyclotron

V. Bejšovec, P. Bém, O. Karban, J. Mareš, and Z. Trejbal
Nuclear Research Institute, Řež u Prahy, Czechoslovakia

A source of polarised ions has been constructed at the Nuclear Research Institute of the Czechoslovak Academy of Sciences in Rez. From this source, polarised particles accelerated to 40 keV energy are injected radially into a cyclotron, which is a Soviet built machine, type U-120. The apparatus consists of two principal parts; the source itself and the injection system. Injection makes use of two successive charge-exchange processes, neutralisation of the beam before entering the cyclotron and ionisation by a stripping foil placed at the centre of the cyclotron.

The first part of the source is conventional. Molecules of hydrogen or deuterium gas are dissociated in an electrode-less rf discharge. The atomic beam is formed by a multichannel glass collimator, then separated according to electron spin states in a quadrupole permanent magnet and finally ionised in an ioniser with a weak longitudinal magnetic field.

Charged particles leaving the ioniser with an energy of 3 keV are focused by two einzel lenses and then accelerated to 40 keV. The beam is deflected in a magnetic field (deflecting angle is 35°), where most of the background ions are removed, and then passed through an electrostatic quadrupole pair which brings it to a focus at the centre of the cyclotron. Before entering the cyclotron magnetic field the beam passes through a differentially pumped, 20 cm long chamber filled with hydrogen gas at a pressure of $\sim 10^{-2}$ mm Hg. To prevent depolarisation during the process of neutralisation, the chamber is placed in a longitudinal magnetic field of 2500 G. Part of the neutral beam is again ionised when passing through the 13 $\mu g/cm^2$ aluminium foil placed between the dees in the centre of the cyclotron, and captured into the accelerating process. To increase the number of ions leaving the foil in favourable phase a buncher is placed before the neutralisation chamber.

The efficiency of the injection system (ratio of the ion current after the stripping foil to the current at the entrance to the neutralisation chamber) has been measured as 0·03 for 50 keV injection energy. The overall efficiency, including the acceleration process and extraction of the beam from the cyclotron, is $2{\cdot}5 \times 10^{-4}$. The intensity of the polarised beam after the ioniser was 2×10^{12} particles/s. Tensor polarisation of −0·28 was measured in the t (d, n) α reaction.

The final testing of the whole device is now in progress. The preliminary figure of the beam intensity after the deflector is 5×10^{8} particles/s. This value may be improved by increasing the acceleration efficiency which is particularly sensitive to the position of the stripping foil inside the cyclotron.