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Measurement of the space charge effect of a negative hydrogen ion beam

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For the development of boron neutron capture therapy at the Budker Institute of Nuclear Physics it was created a source of epithermal neutrons [1], based on a tandem accelerator with vacuum insulation. In the accelerator it was obtained a stationary proton beam with 2 MeV energy and up to 5 mA current [2]. In order to increase the proton current, it has been in depth studied the transport of a negative hydrogen ion beam and its injection into an accelerator in detail. To measure current and profile it was used a wire scanner OWS-30 (D-Pace, Canada), supplemented with rings under negative potential for suppressing secondary electron emission. The current and the transverse profile of the beam were measured as a function of the residual gas pressure regulated by the installed leak. It is found that, while the pressure of the residual gas is increasing, the current and the transverse beam size are decreasing. The current decrease is caused by stripping, the decrease in the transverse dimension is due to the weakening of the space charge effect, due to the increasing amount of positive ions. The density of the negative hydrogen ion current has a maximum value at the intermediate value of the residual gas pressure. Based on the results of measurements of the wire scanner, the radial profile of the beam was obtained, which turned out to be hollow due to the effect of the space charge of the beam and the spherical aberrations of the magnetic lenses [3]. The paper presents and discusses the results of numerical simulations and experiments. Recommendations are given for injection conditions for increasing the proton current.

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