Investigation of the Beam Quality from High Current Ion Sources on HOSTI

A. Adonin, R. Hollinger, and P. Spädtke
GSI, Darmstadt, Germany.

With the coming FAIR project at GSI the requirements for beam brilliance for heavy ion beams provided by the high current injector will increase, especially for uranium ions. To perform and to demonstrate the required improvements the high current test injector (HOSTI) has been built up. The main purpose of HOSTI is an optimization of the experimental setup of a high current ion source and the post acceleration gap to increase the beam brilliance [1].

The investigations have been performed in two stages [2]. The first stage of investigations includes the measurements of the transversal ion beam emittance with slit-grid scanner installed directly behind the post acceleration gap. The measurements were performed with a singly charged Ar-beam provided by MUCIS with fixed ion velocity of 2.2 keV per nucleon (actual requirements of existing RFQ). During this stage the beam emittance has been investigated as a function of the following parameters: ratio between extraction ($U_{\text{ext}}$) and post acceleration ($U_{\text{PA}}$) voltages at fixed ion energy; width of the high voltage gap in the post acceleration system; emission current density of the ion source; ion beam current in the beamline.

For the second stage of the measurements the superconducting solenoid (built by Cryogenic LTD) was installed directly behind the post acceleration gap. The solenoid represents a two-magnet system with the main coil in the middle and two serially connected compensation coils positioned symmetrically at each end of the main coil.

Figure 1: Influence of the longitudinal profile of the solenoid field on the beam emittance.

During the second stage the influence of the solenoid field with different focusing strength and various profile shapes on the beam emittance was investigated [2]. Of particular interest were the measurements with variation of the longitudinal field profile keeping the same focusing strength. In Fig.1 the emittance pictures and the field profiles for three drastically different solenoid field shapes: only compensation coil, main and compensation coils and only main coil are shown.

In addition we measured the real space profile of the ion beam. Measurements were performed using the viewing screen installed on the same position as the scanner slit with 45 degrees to the ion beam axis. The beam profile has been investigated as a function of various settings of the ion source, post acceleration system as well as the solenoid field. As a main result of these measurements it was shown that the structure of the ion beam after extraction is conserved and there is no full homogenization of the ion distribution in the post acceleration gap. Thereby with adjustment of certain parameters it is possible to reproduce the image of the extraction electrode on the viewing screen (several meters behind the gap) (Fig.2).

Figure 2: (left) electrode shape of 13-hole extraction system; (right) reflected image of the extraction electrode.

From these investigations the following conclusions can be drawn:

– the superconducting solenoid is suitable for transporting and focusing the high current heavy ion beam with the required parameters;
– we could not observe any reasonable growth of the beam emittance due to solenoid focusing;
– the strong magnetic field of the solenoid does not disturb the space-charge compensation of the ion beam and does not produce any additional optical aberrations;
– we did not observe any appreciable influence of the longitudinal magnetic field profile on beam emittance beside different focal length;
– the beam profile measurements provided simultaneously with emittance measurements can give necessary information about the ion distribution.

References