The Buffer Gas Cell and the Extraction RFQ for SHIPTRAP at GSI

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The design, construction and manufacturing of the test setup of the buffer gas cell and the extraction RFQ is finished after a wide range of simulations. The simulations covered the following topics: stopping of the ions in the buffer gas; drag of the ions via the electric field in the cell towards a supersonic nozzle; drag of the ions through the nozzle with the gas flow; gas flow parameters in the extraction RFQ; cooling of the ions in the extraction RFQ.

Based on the results of most of these simulations a prototype gas cell has been constructed which is shown in Fig. 1. After passing a $565 \mu g/cm^2$ Ni foil the high energy ions are stopped in Argon at pressures of 50 to $200 mbar$ in the center of the gas cell. The electric field geometry in the gas cell is presently created by three electrodes which allow an extraction with a good focusing of the stopped ions within $10 ms$ with maximum voltages of $700 V$ (Fig. 1). Recent simulations have shown that two additional electrodes in the area of the stopped ion cloud can improve the extraction time. To prevent the ion beam defocusing in the supersonic nozzle and to separate the effects of the electrostatic field and the gas flow on the ion beam formation, the nozzle entrance is covered by a high transmission grid at nozzle potential.

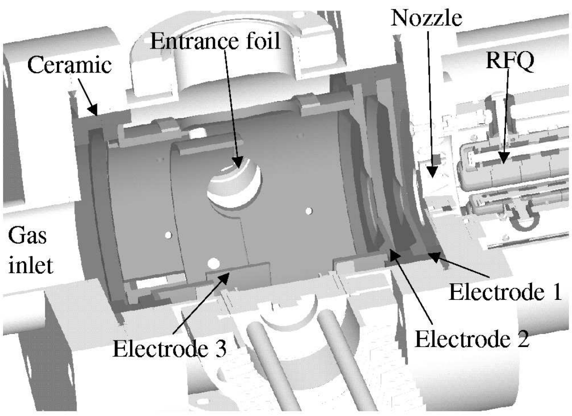

Fig. 1: The SHIPTRAP buffer gas cell and part of the extraction RFQ.

The geometry of the supersonic nozzle with a diameter of the throat of $0.6 mm$ is optimized to drag ions through it into the RFQ with minimum losses on the nozzle wall and in times below $1 ms$. The supersonic part of the nozzle with a opening half angle of 19^o is designed to adapt the shape of the gas/ion jet to the aperture of the RFQ. The upper part of Fig. 2 shows the different components of the ion velocity at the axis of the cell. Upstream the grid position ($2mm$ in front of the nozzle) the ion velocity is caused by the electric field. Downstream the grid position, where the electric field is equal to zero, the ions are transported by the gas flow. Here, the gas velocity has to be high in order to ensure short transport times. The lower part of Fig. 2 shows the geometry of gas cell electrodes, nozzle and first part of the RFQ. The arrowed solid lines are the gas streamlines.

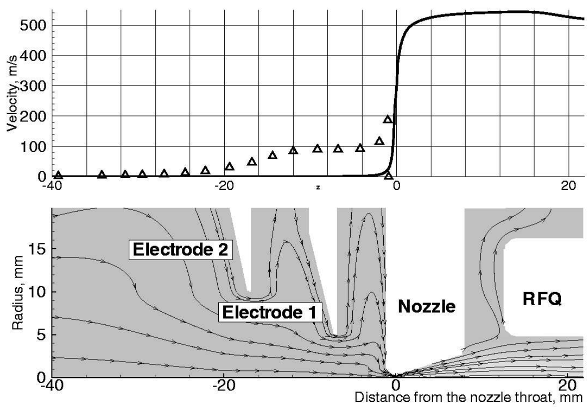

Fig. 2: Ion velocity profile at the axis of the gas cell, caused by the electric field (triangles) and the drag of the gas flow (solid line). Schematic of gas cell electrodes, nozzle and first part of the RFQ, the arrowed solid lines are the gas streamlines (lower part).

The Ni foil has been tested to stand the pressure difference of $200 mbar$ between gas cell and beam line vacuum. The set up of the gas cell and the extraction RFQ is in progress. The first offline test will be to optimize the gas cell geometry and parameters with an Er filament and laser ionisation in the gas cell [1] in order to simulate the stopped ion cloud. In parallel the stopping and straggling of ions through a Ni foil and noble gas will be investigated at the Munich Tandem accelerator in order to optimize the dimensions of the cell and to investigate different degrader configurations.

References

[1] H. Backe *et al.*, GSI Annual Report 1999, in print