Offline commissioning of the old and new HITRAP RFQ

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Introduction

The HITRAP facility is built to decelerate highly charged ions almost to rest and to provide them to experiments [1]. Until now the transition from the first deceleration step, an IH, to the second, a RFQ, was hampered by an energy mismatch as concluded from refined calculations [2]. An offline test at the MPI-K in Heidelberg has been set up to experimentally verify the calculated energy mismatch and to test the newly designed RFQ structure [2], built in-house [3].

The electrostatic accelerator at MPI-K [4] delivers a monochromatic H_2^+ ion beam variable in the required energy range around 500 keV/nucleon. A dedicated setup (Figure 1) was installed and used to measure deceleration for both, the old and the new, electrode structures. The incoming ion beam was chopped, verified on a first diagnostic system, decelerated and energetically selective detected. A wide range detector was used to optimize the working point before the resulting energy spectrum was analysed in detail.

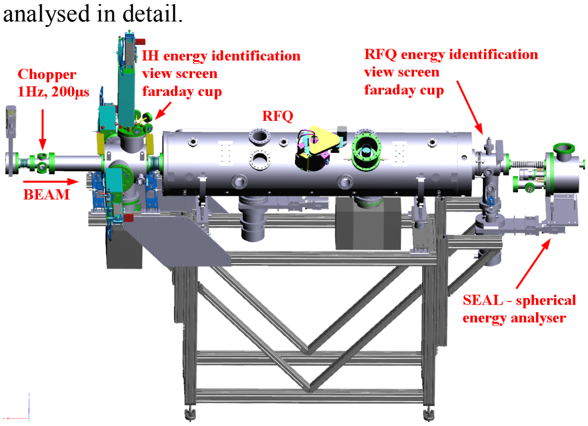

Figure 1: RFQ setup used at MPIK in Heidelberg.

Experimental results

There have been three goals to be achieved with the new design. Most important was to correct the input energy acceptance to match the output distribution of the IH. For the old design the measured energy acceptance shown in Figure 2 was centred at 525 ± 5 keV/nucleon and therefore too high and too narrow to allow for efficient capture. The new design has been tailored to the measured IH output distribution around 490 keV/nucleon, while simultaneously increasing the accepted phase and energy spread. For both RFQ's the energy acceptance has been measured and the rf working point has been found as shown in Figure 2. The accepted energy regime has successfully been corrected to centre on the IH output energy and its width has been increased by approximately 100%.

Indeed the deceleration efficiency for a small energy and rf-band of the old RFQ has been higher as seen in Figure 2, yet the upgraded RFQ will slow down a much larger fraction of the particle distribution as provided by the IH.

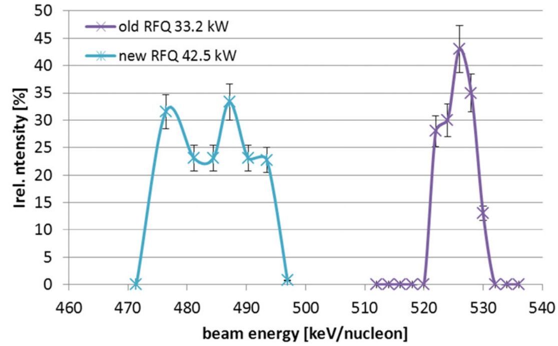

Figure 2: Comparison of the RFQ energy acceptances at their according rf-working points.

As different input energies require different rf-power it was desirable to decrease the touchiness of the RFQ for rf settings around the working point. As shown in Figure 3 the working area for the new RFQ is much less dependent on the rf power. For this reason it should become easier to achieve deceleration also on-line at the HITRAP setup.

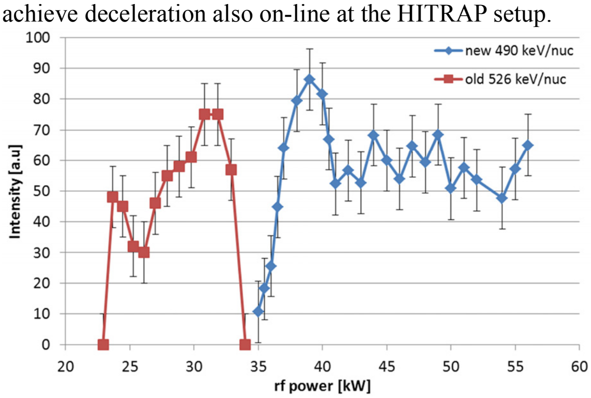

Figure 3: Decelerated beam intensity at the optimum input beam energy for both RFQ's varying the rf-power.

Outlook

The next step, scheduled for autumn 2013, is to achieve deceleration to 6 keV/nucleon on-line at GSI.

References

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[2] S. Yaramyshev, this annual report
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[4] „Der 3UH-Pelletron-Beschleuniger" MPIK (1989) 5