HIT Linac upgrade

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Introduction

The overall achieved transmission for carbon ions through the injector linac at the Heidelberg ion therapy HIT did not ecxeed 30 % due to a mismatch of the beam at the RFQ entrance [1]. Thus a detailed upgrade programm has been started to exchange the RFQ with a new input radial matcher (IRM) design, to correct the misalignment and to optimize beam transport to the IH-DTL. The aim is to achieve a sufficient overall linac transmission above 60%.

Design and production

The design of the IRM based on particle distributions generated from emittance measurements behind the LEBT at HIT was done using the Dynamion simulation code [2] and is shown in Figure 1. Also shown is the original design which requires a beam size and convergence that the existing solenoid, used for the beam matching to the RFQ, is not able to provide.

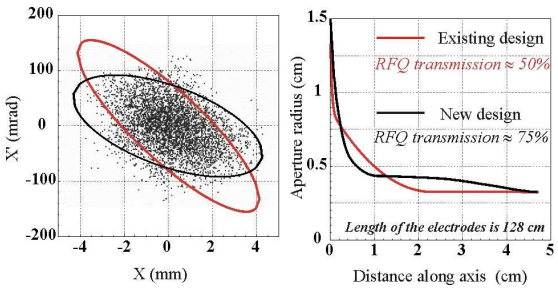

Figure 1: Dynamion simulation of the transmission improvement through the old and the new input radial matcher design.

Figure 2: Final test piece (right), of the RFQ radial matcher section and a plastic model (left) to check the production procedures.

The assembly, alignment and RF tuning of the RFQ was done at IAP Frankfurt in summer 2008.

Measurements

The new RFQ design was tested at a test setup in Risø, Denmark for adjusting the Rebuncher voltage [3]. A test bench comprising a full ion source and LEBT branch to commission the RFQ had been installed by Danfysik.

Results

The beam commissioning at Risø took place in autumn 2008. In summary the results were, that the power consumption of the RFQ is above 200 kW and thus too high for operation in Heidelberg,. The steering of the RFQ depending of the rf-power is stronger than tolerable. The rebuncher voltage was not adjustable within the geometrical limits. Additionally the measured RFQ energy, depending on the rf-power, shows a 'wavy' structure (Figure 3). Furthermore, it was not possible to determine the transmission of the RFQ due to insufficiently defined beam parameters at the RFQ entrance.

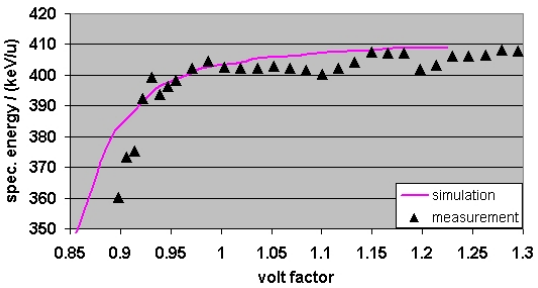

Figure 3: Measurement of the RFQ beam energy versus the volt factor (corresponds to rf-voltage).

The suspected reasons for this unexpected and intolerable behaviour are a misalignment of the electrodes, a too strong influence of the modified rebuncher section on the field distribution and not sufficiently defined beam parameters from the LEBT at Risø.

End of 2008 the RFQ was transported to IAP and there its mechanical and rf-properties will be revised. Depending on the results the whole structure might be reassembled and finally a new location and time has to be found for commissioning of the RFQ and adjusting the rebuncher.

References

[1] M. Maier et al., Proc. PAC 2007, p. 2734
[2] S. Yaramishev et al., NIM A, 2005.
[3] C. Kleffner et al., GSI annual report 2005.