The RFQ-IH Matching Section of REX-ISOLDE

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The RFQ-section of the REX-accelerator can not be followed immediately by the IH-section for various reasons: (i) There is the demand for beam diagnostics after the RFQ. (ii) Mismatch of the longitudinal phase space: The RFQ has a time waist of $\pm 14°$ 10 cm in front of the tank end, whereas the IH claims a time waist of $\pm 10°$ 13 cm behind its tank entrance. (iii) Mismatch of the transversal phase space: The RFQ output is strongly diverging in the x-plane whereas the IH needs a beam converging in both planes. A matching section is required that provides longitudinal and transversal focusing. The design shown in fig. 1 has been carried out using the code TRANSPORT.

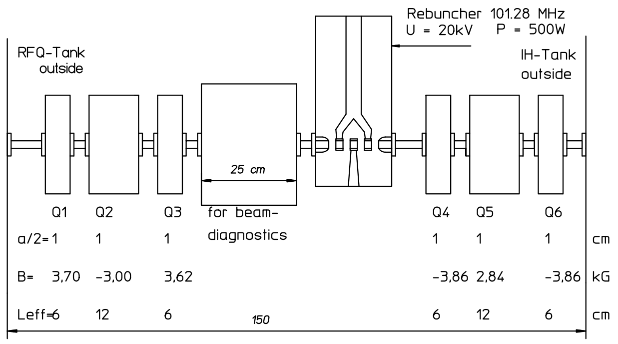

Fig. 1: The RFQ-IH Matching Section of REX-ISOLDE

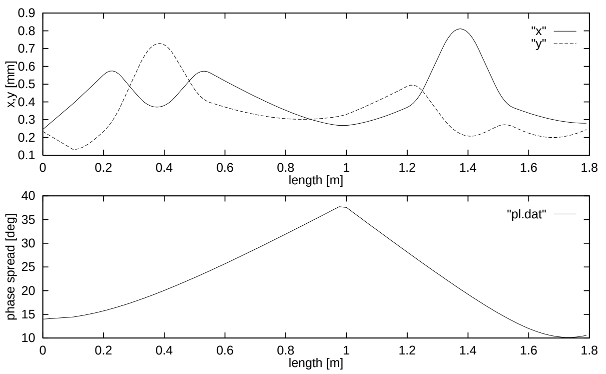

Fig. 2: Beam envelopes calculated with TRANSPORT starting at the end of the RFQ-rods and ending at the first accelerating gap of the IH.

The distance of 150 cm between the two accelerator tanks is the maximum possible given by two conditions: (i) With the given RFQ energy spread of $\pm 1.5\%$ and the given buncher frequency of 101.28 MHz (=repetition rate of the beam pulses) the distance from the RFQ to the buncher gaps is limited to ≤ 100 cm. Otherwise the phase spread at the buncher would exceed the linear part of the sinusoidal modulation voltage.
(ii)In order to obtain the required 10° at the image waist, its distance from the buncher has to be 1.4 times shorter than the object distance.
To place the transversal focusing into this limited space, relatively short quadrupoles with correspondingly small apertures have to be used. Triplet lenses have been chosen to keep the beam extensions in the quadrupoles sufficiently small. Special care has been taken to keep the beam extension small at the buncher gaps. Thus the effect of the radial dependence of the transit time factor is limited to max. $\pm 2.2\%$ and the defocusing effect is minimized as well. Fig. 2 shows the transversal and longitudinal beam envelopes. The buncher voltage and the quadrupole tip fields shown in fig. 1 correspond to the mass to charge ratio A/q=4.5 of the actual design. The buncher quarter wave resonator is equipped with four gaps to cope also with a future A/q=6 within an amplifier power of 2 kW. With a maximum gradient of 59 T/m the quadrupoles are prepared for A/q=6 as well. Fig. 3 and 4 show the development of the transversal and the longitudinal phase space at relevant positions.

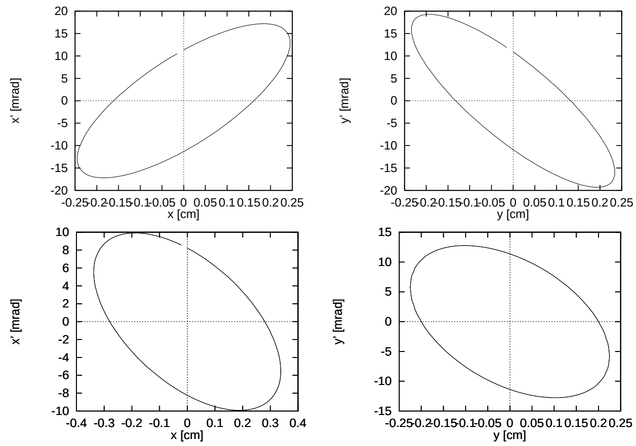

Fig. 3: Transversal phase space at the entrance (above) and the exit (below) of the matching section.

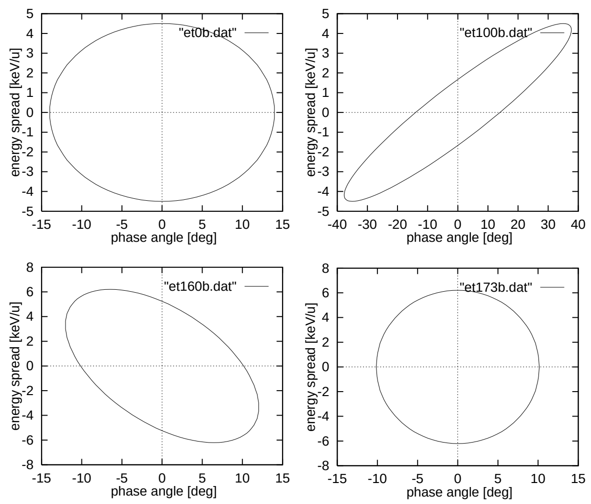

Fig. 4: Longitudinal phase space at the entrance (et0), the buncher (et100), the IH-entrance (et160) and at the time waist 13 cm inside the IH (et173).