BEAM TESTS WITH THE MAFF IH-RFQ AT THE IAP-FRANKFURT*

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Abstract

The IH-type RFQ for the MAFF project at the LMU Munich is integrated into a test bench at the IAP in Frankfurt. There are two IH-RFQ existing, the MAFF IH-RFQ and the HIS at GSI. The parameters of the MAFF IH-RFQ are very similar to a 4-rod type machine, the REX-ISOLDE RFQ at CERN. So the results can be compared directly. Experimental results will be presented.

INTRODUCTION

The test bench at the IAP consists of an ion source, an electrostatic quadrupole lens system with implemented steerers and several beam diagnostics like a two-dimensional emittance scanner, bending magnet and a fast Faraday cup. These tests accompanied with theoretical investigations will be done with special respect to the applicability of such normal conducting RFQ accelerators to the EURISOL post accelerator.

ION SOURCE

The filament-driven ion source is a development of the IAP-Frankfurt. The experiments are performed with helium in order to facilitate the ion source operation. During beam tests a beam current up to 3,2 mA could be extracted from the ion source, measured by the current of the power supply. The electrostatic lens system consists of four quadrupoles, the inner parts are electrically combined for triplet conditions. Two additional steerers allow beam bending.

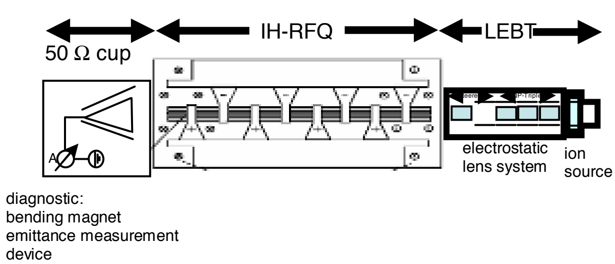

Figure 1: Setup of the test bench.

To optimize beam operation of the Low Energy Beam Transport (LEBT) and match the beam to the IH-RFQ, beam tests were done. The emittance of the LEBT was measured with a slit grid device (fig. 2). A 90 % normalized rms emittance of 0,0137 mm mrad was detected (figs. 3,4). A beam current behind the LEBT up to 1 mA was measured with a fardaycup without secondary electron (SE) (fig. 5). The LEBT delivers an optimized beam for first beam tests with the IH-RFQ.

Table 1: Parameters of the ion source operation during first beam tests (Qp=Quadrupole)

Arc Voltage	100 V	7,68 A
Filament	7 V	63 A
Magnet	7 V	4,21 A
Gas pressure He	$1{,}88\cdot10^{-2}$ mbar	
Extraction	12,5 kV	4,3 mA
Screening	1,77 kV	0,01 mA
Qp X1	-1,06 kV	-1,92 mA
Qp Y1	1,07 kV	1,27 mA
Qp X2	0,43 kV	0,5 mA
Qp Y2	-0,4 kV	-0,16 mA
Qp X4	-0,7 kV	0 mA
Qp Y4	1,02 kV	0,07 mA
horizon. steerer	0,24 kV	0,49 mA
Vertikal steerer	0 kV	0 mA
beam current	1,07 mA	

Figure 2: The emittance scanner.

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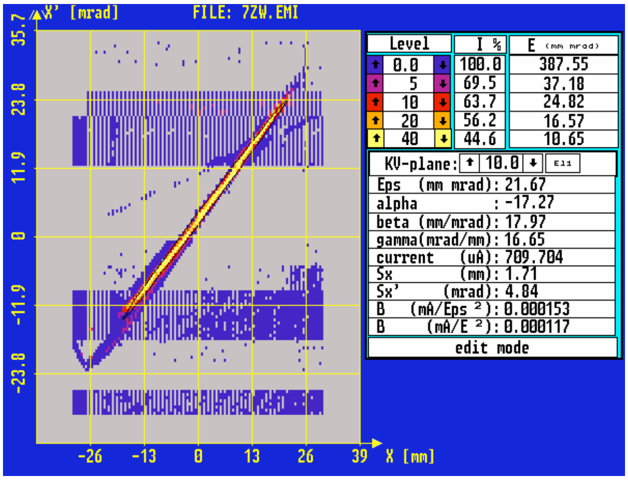

Figure 3: Measured emittance of the LEBT.

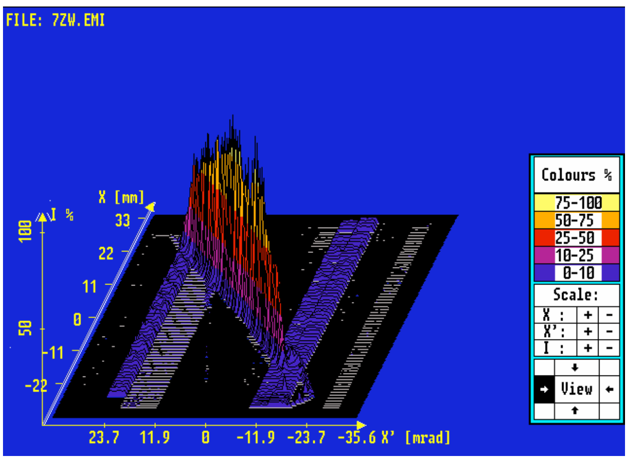

Figure 4: 3d-view of the measured emittance.

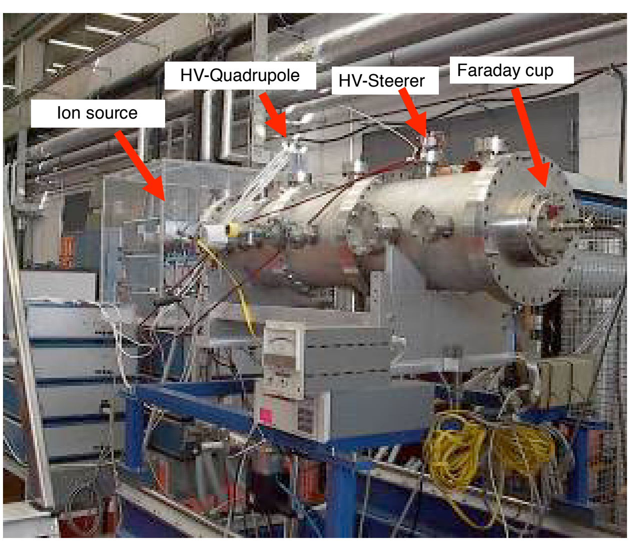

Figure 5: Injection system of the RFQ testbench including the ion source, the quadrupole lens and steerer system followed by a Faraday cup for stand-alone testing of the low energy transport system (LEBT).

IH-RFQ

The IH-RFQ was developed at the LMU in Munich [1,2] and assembled at the IAP in Frankfurt[3]. The structure is divided into 7 separate cavity modules. The resonance frequency under vacuum conditions is 103,8 MHz.

To measure the voltage between the electrodes an Amptec XR-100T-CdTe gamma ray detector was used (fig. 6.). First, the detector was calibrated with ^{241}Am.

Figure 6: Used XR-100 T detector.

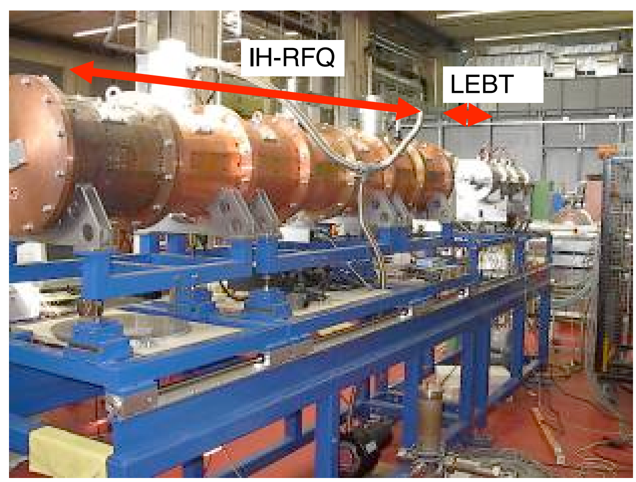

Figure 7: The IH-RFQ test bench.

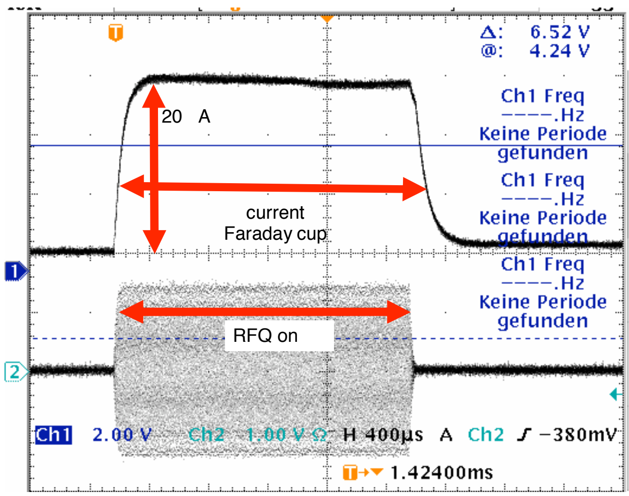

Figure 8: Detected beam on a fast Faraday cup.

During first beam tests the IH structure could be tested with a power up to 45 kW, read-out from the amplifier meter. The duty cycle was 1%. On a fast Faraday cup, which was mounted directly behind the IH-RFQ, a current up to 20 μA was measured (fig. 8). This current is just the transported beam.

To measure the flatness, the voltage between the electrodes was measured during IH-RFQ operation.

The calibrated detector was placed subsequently at access points provided by vacuum flanges at the front (low energy side), center and rear side (high energy side) of the accelerator. The measured voltage is in the region where acceleration should be detected. Figure 10 shows the hereby measured flatness, the deviation is around 3%, the RFQ was running at 28 and 38 kW rf-power. The responding R_p-value is only 31 kΩ, which does not match the MWS calculation of 63,2 kΩ [2]. This factor could either indicates significant problems inside the resonator structure or the meter of the rf-amplifier used.

In order to calibrate the rf-power meter of the Herfurt rf-amplifier a directional coupler from Bird Electronic Corporation was used. This comparison shows a deviation up to the factor 3 between the rf-amplifier meter and the value by the directional coupler. A low level measurement of the directional coupler, which is shown in figure 11, confirm the factory value.

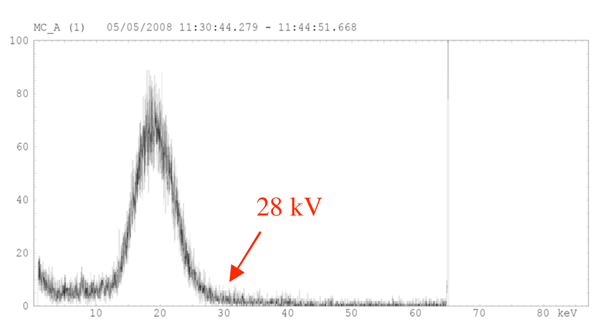

Figure 9: Measured electrode voltage during IH-RFQ operation, power 28 kW (scale amplifier).

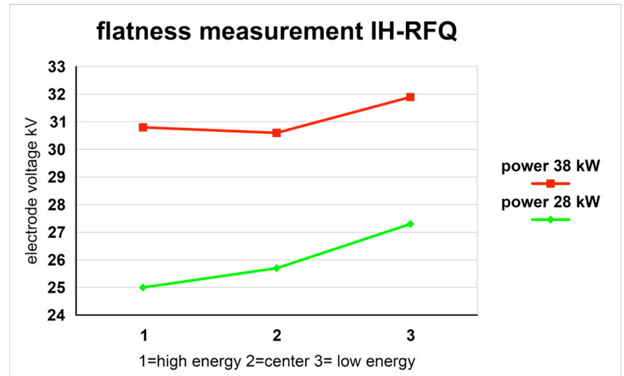

Figure 10: Measured flatness during operation of the IH-RFQ.

Figure 11: Calibration of the directional coupler by low level measurements.

CONCLUSIONS

The IH-RFQ was driven successful with high power. During beam tests a transported beam could be measured.

Next steps will be further check of the power of the amplifier and the IH-RFQ Rp- value by perturbing capacitor method at low level measurement.

REFERENCES

[1] M. Pasini, O. Kester, D. Habs, T. Sieber, "BEAM DYNAMICS STUDIES FOR THE LOW ENGERY SECTION AT MAFF“ RF-Design of the MAFF IH-RFQ", EPAC2004, p.1216.

[2] M. Pasini, O. Kester, D. Habs, T. Sieber, "RF-Design of the MAFF IH-RFQ", EPAC2004, p.1216.

[3] A. Bechtold, D. Habs, J. Fischbach, U. Ratzinger, J. Rehberg, M. Reichwein, A. Schempp, O. Kester, J. Häuser, „THE MAFF IH-RFQ TEST STAND AT THE IAP FRANKFURT”, EPAC 2006, p. 1577, http://www.jacow.org.