Test of the Radio Frequency Quadrupole (RFQ) Accelerator for REX-ISOLDE ◇

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The main characteristic of RFQ-accelerators is the simultaneous Alternating Gradient (AG)-focusing and acceleration of charged particles with electric quadrupole fields. RFQ's can match and bunch the DC-beam from an ion-source with a very high transmission (98%) and additionally provide the required start energy for injection into the following drift tube-Linacs or Cyclotrons. Especially in case of Radioactive Ion Beam (RIB)-Experiments like REX-ISOLDE (Radioactive beam EXperiments at ISOLDE) at CERN [1] and the planned MAFF (Munich Accelerator for Fission Fragments)-Project [2] at the new Munich high flux reactor, it is - due to the comparatively small number of radioactive ions - of highest importance to avoid beam losses during transport and acceleration. Thus RFQ's are predestinated to operate as first modules of accelerators in the RIB-field.

The RFQ for REX-ISOLDE has a total length of 3 m and is similar to the Heidelberg high-current injector RFQ [3]. It will accelerate radioactive ions with an A/q of 3 - 4.5 from 5 keV/u to 300 keV/u and operates at a resonant frequency of 101.28 MHz (duty cycle: 10%). The REX-RFQ is a so called 4-rod-$\lambda/2$-structure [4]. This special RFQ-type consists of a linear arrangement of 18 stems which are mounted on a ground plate and alternately carry the four modulated quadrupole-electrodes (rods).

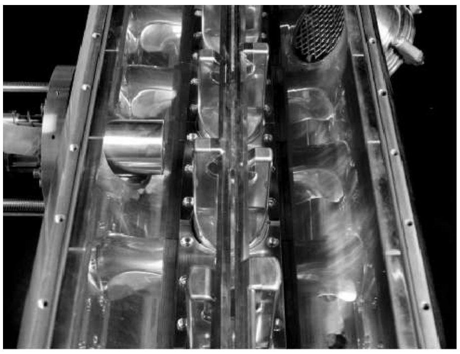

Fig. 1: View inside the RFQ tank.

Except for the rf-coupling loop, the RFQ has been completely assembled. The rf-parameters were measured to f=101.2 MHz, Q=4000 and R_p=170 kΩm. The average Flatness (voltage deviation along the quadrupole electrodes) is 1%. After the RFQ was successfully vacuum tested, it is now prepared for rf-power tests. At the same time a test beamline is built up to perform first He^{1+} beam experiments with the RFQ and the following buncher section. The injection system consists of a duoplasmatron ion-source and an electrostatic quadrupole-quadruplet. It also includes the prototype of a diagnostic box, which was designed for the low beam intensities at REX-ISOLDE and is firstly tested at Munich. For the beam analysis behind the injection system and behind the RFQ our new slit-grid emittance measurement device will be used. The duoplasmatron ion source has been tested and is ready for being mounted to the injection system.

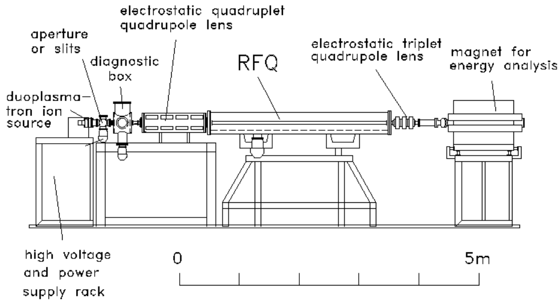

Fig. 2: Experimental setup for the beam tests at Munich.

The injection of the beam into the RFQ has been calculated to third order with the COSY infinity code [5]. The electrostatic quadrupoles have apertures of 60 mm and a pole-shoe length of 200 mm. The maximum electrode-voltage is ±6 kV.

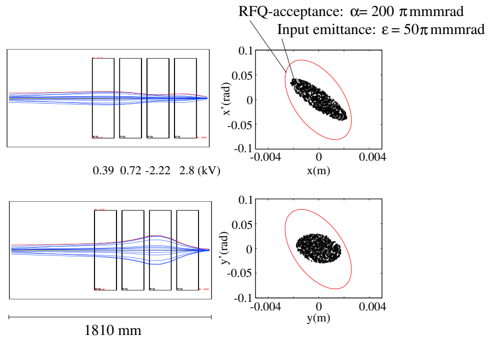

Fig. 3: Beam envelope and emittances of the 20 keV He^{1+} beam.

Fig. 3 shows the beam envelope and the beam emittance together with the RFQ-acceptance in both directions. The required voltages for an acceptable matching of the beam are in the range of 0.4 - 3 kV. For the high energy beam transport behind the RFQ and for the measurement of the energy spread, an electrostatic quadrupole triplet will be used in connection with a 90 degree bending magnet with a maximum field of 0.95 T.

References

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