# RF and Beam Tests with the REX-ISOLDE RFQ ◇

T. Sieber, O. Kester, D. Habs, K. Rudolph, W. Carli, S. Emhofer, and A. Schempp [a]
[a] IAP, Johann Wolfgang Goethe-Universität, D-60325 Frankfurt/M

The mass separator, the RFQ and the IH-drift- tube accelerator of the REX-ISOLDE Linac at CERN [1] are developed and tested at Garching. For the REX-RFQ [2] and the matching section between RFQ and IH-structure [3], a test beamline has been built up for beam experiments with $He^{1+}$. Parallely to the installation of this test beamline, rf-power tests with the RFQ and emittance measurements behind the injection system were performed.

Before the beginning of operation, an rf-conditioning phase at high power levels was necessary to get rid of impurities on the copper surfaces of the REX-RFQ. The conditioning could be done up to 80 kW (pulse: 2ms, 50Hz) during one week. The RFQ, the transmitter and the control system showed stable operation. After conditioning, the temperature rise of the cooling water in different components of the resonator has been measured at 50 kW. Table 1. shows, that the results in principle fit to our MAFIA-calculations (the tank is cooled indirectly by the ground plate). The maximum temperature rise in the main components of the resonator at a flow rate of ≈ 3 l/min was 3.5 K. The resulting thermal expansion is very small (<1/10 mm) and has a negligible effect on the rf-behaviour and the quadrupole symmetry of the resonator.

| | MAFIA | Measured |
|---|---|---|
| tank | 7% | - |
| stems | 34% | 30% |
| ground-plate | 7% | 17% |
| electrodes | 52% | 53% |

Table 1: Power dissipation at different accelerator components calculated with MAFIA and measured at 50 kW.

A very simple but quite accurate (±3%) measurement of the efficiency of a resonator is the so called $\gamma$-spectroscopy method. Here, the Bremsstrahlung of electrons, which are accelerated transversely between the electrodes, is measured with a germanium detector. The maximum detected X-ray energy is produced by electrons, which are accelerated through the potential difference between neighbouring electrodes (+U/2 to -U/2) at peak voltage. The electrode voltage corresponding to 50 kW was measured to 49,07 kV. The resulting Rp-value is 145 kΩm. This is in excellent agreement with low-level values of 140 - 150 kΩm for pertubation capacitors of 1 - 3 pF.

For the beam experiments, the injection system - consisting of a duoplasmatron source and an electrostatic quadrupole quadruplet - was placed in front of the RFQ after the COSY [4] calculations for beam injection could be verified by emittance measurements [5]. Behind the accelerator, the RFQ/IH matching section was built in. A 90 degree bending magnet was installed, to measure the final energy and the energy spread behind the RFQ. Figure 3. shows an energy spectrum at 28.35 kW compared to data from the design calculations with PARMTEQ. The RFQ reaches nicely the desired energy spread of ±1.5 %, while the final energy lies slightly above the postulated 1.2 MeV. This discrepancy is certainly caused by problems with the calibration of the magnet at higher field levels (saturation, hysteresis), because as a matter of principle a small energy spread can only be available, if the ions exactly follow the $\beta\lambda/2$ velocity profile of the accelerator. The required rf-power of 28.35 kW indicates, that the Rp-value of the REX-RFQ is even a bit higher (146.5 kΩm) than the value derived from $\gamma$-spectroscopy.

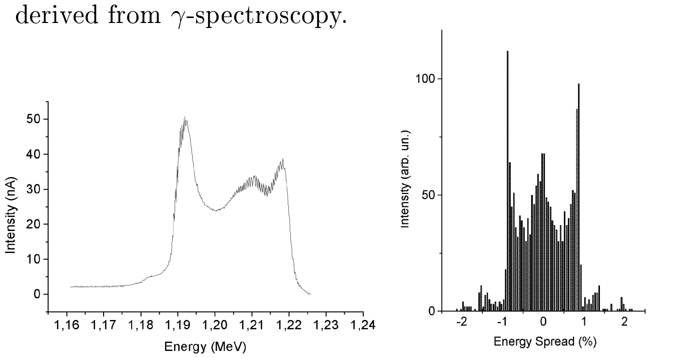


Fig. 1: Measured energy peak at 28.35 kW and PARMTEQ output at design voltage.

The transmission through the RFQ was measured with identical faraday-cups of the diagnostic boxes in front and behind the RFQ. It is close to 100% beginning at an electrode voltage of about 33 kV. The error is presently (due to source instabilities and secondary electron effects) estimated to 5% and will be improved. The measurements were done with 1 ms beam pulses at electrode voltages of 0 - 50 kV.

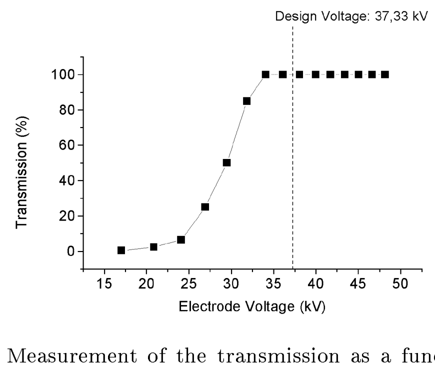


Fig. 2: Measurement of the transmission as a function of the electrode voltage.

## References

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