Design Calculations for the MAFF-RFQ

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For the MAFF-Linac [1] we investigate a new type of Radio Frequency Quadrupole accelerator, the so called IH (Interdigital H)- RFQ. The IH-RFQ was developed from the IH-drifttube structures [2]. It consists of a cavity excited in the H_{111}-Mode, in which two opposite girders are mounted. These girders carry equidistant interdigital holders on which the quadrupole electrodes are fixed.

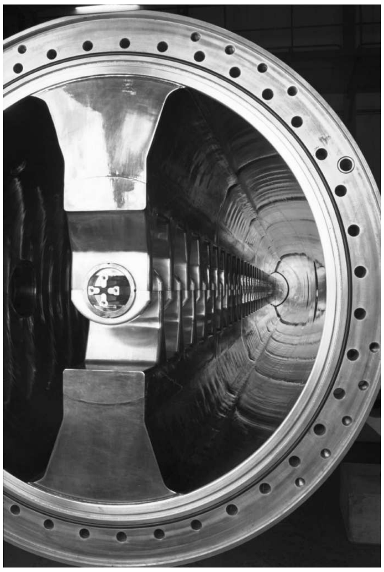

Fig. 1: View inside the first operational IH-RFQ. The GSI 36 MHz high current injector RFQ (length: 9 m, diameter: 0.8 m).

The motivation to investigate the IH-RFQ at the MAFF frequency of 101.28 MHz is given in several advantages these structures possibly have, such as a high efficiency (Rp-value), the possibility of indirect electrode cooling (because of the numerous holders) and a very small dipole content in the quadrupole.

The resonator design of the MAFF-RFQ is done by calculations with the code MAFIA. In the first step, a 3-cell module - cut out of an infinitely long resonator - was optimized to a high efficiency and quality factor as well as a minimum power dissipation on the electrodes and a minimum dipole field. Some of the geometric parameters of the structure are fixed from the beginning for reasons of particle dynamics (electrode geometry) and mechanical stability (girder heigth and thickness). As a consequence the distances between the holders, their thickness and the diameter of the cavity are in principle the only parameters, which can be varied for optimization of the resonator. The calculations in Fig. 2 were done with a thickness of the holders of 1 cm. Since variation of the holder distance changes the resonant frequency and therewith the Rp-value, the cavity diameter had to be adjusted to get comparable results for the Rp-value.

As a result of the MAFIA calculations, a holder distance of 7 cm in connection with a cavity diameter of 31 cm is seen as a good compromise between a high efficiency, a small dipole content and a small power dissipation on the electrodes. The final design of the 3 m power resonator is currently under progress.

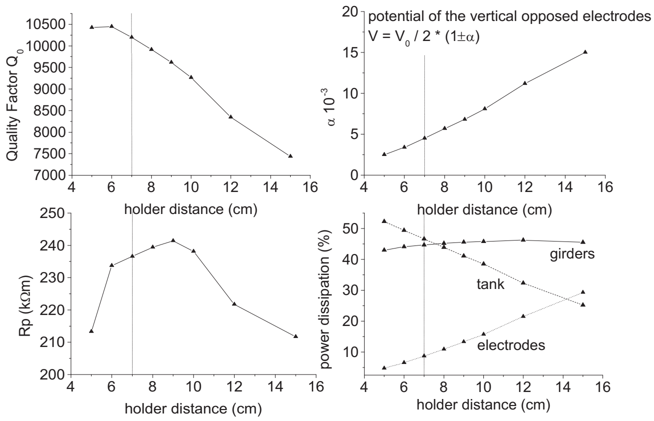

Fig. 2: Quality factor, Rp-value, dipole content and fraction of the total power, which is dissipated on the RFQ-electrodes as a function of the holder distance.

On the particle dynamics side, the electrode design of the MAFF-RFQ could be derived by PARMTEQ calculations from the design of the comparable REX-RFQ [3]. The input energy is 2.5 keV/u, the final energy 300 keV/u at a length of 3 m (287 acceleration cells). The design could be optimized to a transmission higher than 99%, while the energy and phase spread are ±1.5% and ±15 degrees. The radial acceptance is 200 π mm mrad. Figure 3 shows the electrode Parameters of the MAFF-RFQ at one glance.

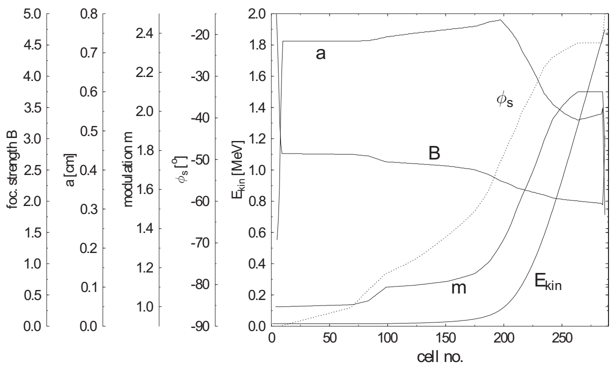

Fig. 3: Electrode design of the MAFF-RFQ, calculated with PARMTEQ. Plotted is the radial focusing strength (B), the aperture (a), the modulation (m), the synchronous phase (ϕ) and the particle energy (E).

References

[1] O. Kester etal, AIP Conf. Proc. **473** (1998) 536
[2] U. Ratzinger, Habilitationsschrift, IAP Frankfurt/Main, 1998
[3] T. Sieber *et al.*, Proceedings LINAC'98, Chicago, 1998, p. 777