Design of the IH-7-gap Structure (IH7SS) for MAFF

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The MAFF-LINAC [1] is planed to accelerate heavy, neutron rich fission fragments with a charge to mass ratio below 6.3 to final energies between 3.7 MeV/u and 5.9 MeV/u with a low energy spread below 0.2 %. The final energy is varied by the use of the IH-7-Gap structure (IH7SS) consisting of two identical 7-gap resonators which will be placed after the booster LINAC and operated at 202.56 MHz.

The booster LINAC injects the ions at two different energies into the IH7SS (4.15 MeV/u, 5.9 MeV/u respectively) by switching tank 3 of the booster LINAC off or on. This beam is then accelerated or decelerated to the final energy. Therefor it is necessary that each of the 7-gap structures is able to accelerate or decelerate over a range of at least ± 0.3125 MeV/u with a sufficient transit time factor.

To increase the efficiency compared to the split ring resonators used for REX-ISOLDE [2] the 7-gap resonators are planed as IH structures. Due to the higher shunt impedance of IH structures a higher resonator voltage in combination with a very compact design can be achieved with the same generator power.

Furthermore in beam dynamics the combined 0^o-synchronous particle structure is used. This means that the mean particle of the bunch will reach the center gap of each resonator at 0^o phase of the incoupled rf [3]. This results in an overall higher transit time factor over the whole energy range.

Depending on the difference between injection energy and exit energy of the ions, the phase of the bunch can vary significantly from gap to gap. Generally the phase switches its sign at the center gap. Therefor the beam is always longitudinally defocused in either the first 3 gaps of each resonator or in last 3 gaps depending on whether the ions are accelerated or decelerated. However this defocusing effect is compensated by the fact that the beam will be focused in the opposite 3 gaps. In order to achieve the required energy spread debunching might be necessary.

First calculations showed that 150-200 MΩ/m shunt impedance and 2.8 MV total resonator voltage at 100 kW generator power and 200 MHz resonator frequency can typically be expected for a IH-7-gap resonator. Therefor two resonators should be sufficient to cover the planed energy range.

Since the resonators are used both for efficient acceleration and deceleration they are designed identically with constant cell and gap lengths. Based on the assumption that the mean energy would be ca. 4.8 MeV/u and the charge to mass ratio A/q would be 6.3 a design speed of $\beta = 0.1$ was used. This results in a cell length of 74 mm and an overall length of each resonator of 518 mm. A drift tube length of 50 mm and a aperture of 20 mm was chosen for the first calculations. Using identical parts where ever possible reduces the costs and amount of work to built the resonators significantly.

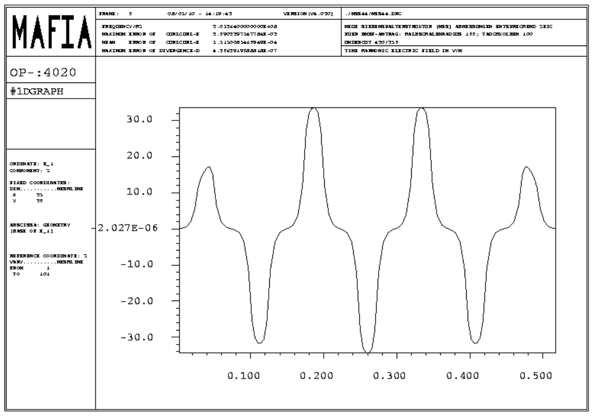

Fig. 1: MAFIA calculation of the bias distribution on the beam axis (abitrary units) of one resonator

In order to determine the values for the cavity characteristics necessary to built a model of one of the resonators extensive MAFIA calculations had been performed. These simulations of the model (not yet optimized!) show that a quality factor of 16 000 and 150 MΩ/m shunt impedance can be expected. Simulations using the LINAC code to calculate the beam dynamics showed that a resonator voltage of 2.2 MV for each resonator is required to cover the full range of the final energies. Assuming 150 MΩ/m shunt impedance the necessary resonator voltage can be reached with a comparably low rf-power of 63 kW.

A 1:1 model is ready to be assembled and first measurements will be done in early march 2000 to prove the MAFIA calculations and determine the optimal dimensions of the undercuts, drift tube radii et cetera.

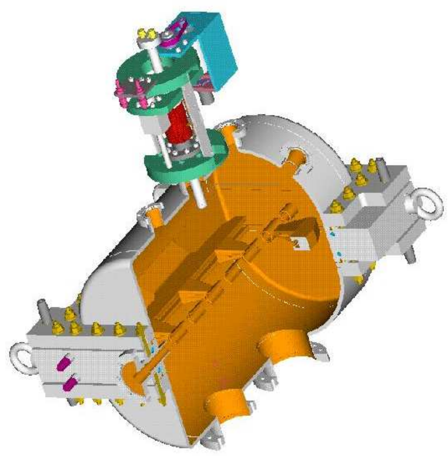

Fig. 2: Design study of one of the IH7SS resonators

References

[1] O. Kester, H. Bongers *et al.*, Jahresbericht 1998, p. 71
[2] O. Kester, H. Bongers *et al.*, this report, p.75
[3] O. Kester, H. Bongers *et al.*, Proceedings of the LINAC98,Chicago 1998