A LINAC for the Munich Fission Fragment Accelerator

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With the high intensities of neutron rich ions from a reactor based radioactive ion beam facility, the post acceleration of these ions is of foremost interest. For the Munich fission fragment accelerator [1–3], a linear accelerator is under design which accelerates highly charged neutron-rich ions from an injection energy of 2.5 keV/u to a final energy between 3.7 and 5.9 MeV/u. This accelerator is dedicated to deliver intense beams of fission fragments out of a target ion source located inside of a reactor beam tube [4]. The LINAC will work with 10% duty cycle and a resonance frequency of 101.28 MHz. In order to obtain an efficient acceleration and a rather short LINAC, charge breeding of the 1^+ ions from the target source to multiple charged ions with a q/A≥0.16 has to take place. Two types of ion sources are well suited for charge multiplication, the electron beam ion source (EBIS) and the electron cyclotron resonance ion source (ECRIS). Different kinds of charge breeding concepts have been discussed, concerning the higher charge states in case of the EBIS and the higher trapping capacity of the ECRIS. The trapping capacity is the main problem of the EBIS concept, if the intensities of the beams are in the order of 10^{12} ions/s.

The LINAC consists of several structures (fig. 1), in order to reach the tunable final energy with a small energy spread. The energy width of the final beam has to be smaller than 1 MeV to fit the requirements of the very narrow excitation function for the production of very heavy elements via fusion reactions. The first structure is a radio frequency quadrupole (RFQ) accelerator, which is driven by a cavity working in the TE111 (transverse electric) resonant mode and will accelerate the ions to a final energy of about 300 keV/u. This concept is similar to the IH-RFQ of the GSI high current IH-RFQ [5] but with a change in the resonance frequency from 36 MHz to 101.28 MHz. Investigations on a 101 MHz IH-RFQ structure are now under progress in Munich. The advantages of an IH-RFQ in comparison to a 4-rod RFQ could be the higher shunt impedance and the indirect cooling of the rods via the supports. The booster part consists of three interdigital-H-type structures similar to the CERN lead LINAC [6]. After acceleration to 2.1 MeV/u with the first tank, a jump to a higher frequency of 202.56 MHz is required to reduce the size of the following structures and to increase the effective acceleration voltage to 6 MV/m. Tank2 leads to the main energy gain with an exit energy of 4.15 MeV/u.

The variation of the final energy is done by switching tank3 of the booster LINAC on and off and by acceleration or deceleration via the two seven-gap IH-resonators. Thus tank3 has to have twice the effective voltage of both 7-gap resonators. In contrast to comparable 7-gap structures in Heidelberg [7], which are spiral resonators, the 7-gap IH-structures combine the high shunt impedance of an IH-structure and the possibility to accelerate at 0^o synchronous phase. The design synchronous particle velocity of the 7-gap resonators is β=10% and the expected resonator voltage is 2.1 MV at 80 kW incoupled rf-power. A power prototype of such a new kind of energy variable accelerator could be tested in the required energy range at the tandem laboratory.

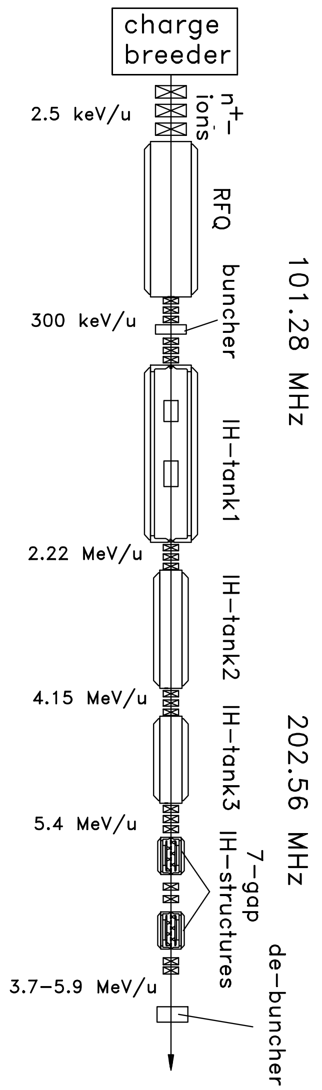

Fig. 1: Lay-out of the LINAC of the fission fragment accelerator

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