Simultaneous acceleration of ions with different charge-to-mass ratio in the SLOWRI post accelerator

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To accelerate beams from SLOWRI, [1)] a post accelerator consisting of a split-coaxial RFQ, a medium energy beam transport (MEBT) and an interdigital-H linac (IH) has been designed. [2)] The main parameters of the accelerator are listed in Table 1. For the sake of experimental convenience, there is a demand to simultaneously accelerate the same element having different charges. Then, the transmission efficiencies of ions with charge-to-mass ratio (q/A) deviating from the design value of 0.125 are investigated by beam simulations. A calculation code PARMTEQ is used for RFQ simulation, and a calculation code TRACEP [3)] is used for MEBT and IH simulations. PARMTEQ cannot calculate the motion of ions with q/A as a variable without

Table 1. Main parameters of the SLOWRI post accelerator.

Parameter	RFQ	MEBT	IH
Frequency (MHz)	79	79	158
Mass to charge ratio: *A*/*q*	8	8	8
Normalized emittance (π·cm mrad)	0.06	0.06	0.06
Energy (MeV/u)	0.005 - 0.5	0.5	0.5 - 5
Synchronous phase (deg)	-25	-90	-25
Electrode voltage (kV)	81.5	82.5	140-250
Number of cavities	1	1	18
Number of acceleration cells in each cavity	244	4	8 - 16
Length (m)	5.19	2.52	23.48
Cavity diameter (cm)	40	25	40

changing the vane parameters from the design values. However, the calculation with vane voltage as a variable is possible. Since the vane voltage is inversely proportional to the charge-to-mass ratio, for example, the simulation result obtained with a normalized vane voltage (V_n=V/V_{design}) of 1.08 can be regarded the same as the simulation result obtained with V_n=1 and q/A=0.135. By using the above characteristic, a beam simulation of the post accelerator, which accelerates ions with q/A different from the design value, is conducted using 500 ions as follows: 1) The operating parameters such as accelerating voltage, Q-magnet field strength, etc. are fixed to accelerate the design ions. 2) The phase space distributions of the output ions of RFQ calculated with V_n as a variable and the q/A corresponding to V_n are used as input data for MEBT simulation. 3) The phase space distributions and q/A of the output ions of MEBT are used as input data for IH simulation. Figure 1 shows the simulation result for the q/A=0.135 ions. From the number (297) of ions distributed in the IH output phase spaces, the beam transmission is found to be 59.4%. By using the above method, beam

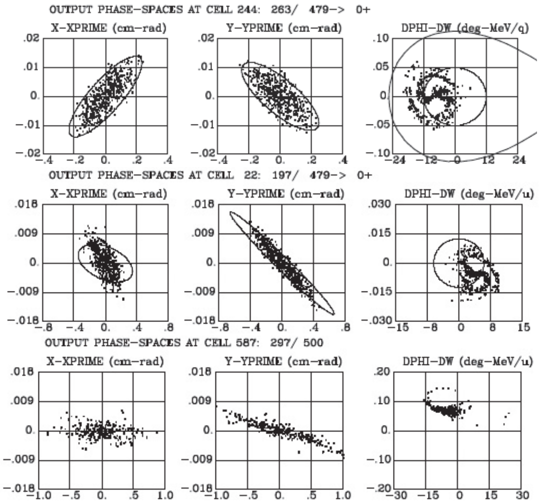

Fig. 1. From top to bottom, results of RFQ, MEBT and IH.

transmission is examined in the range of 0.1125≤q/A≤ 0.1525. The result drawn in red in Fig. 2 is obtained by assuming that the input energy of RFQ is 5 keV/u even for ions different from design ions. However, the kinetic energy per nucleon of ions extracted from the same ion source depends on the charge number of ions. The result of considering this is drawn in green in Fig. 2. The full width at half maximum of the transmission indicated by the green line is mainly determined by the acceleration characteristic of RFQ related to the input energy of ions. [4)]

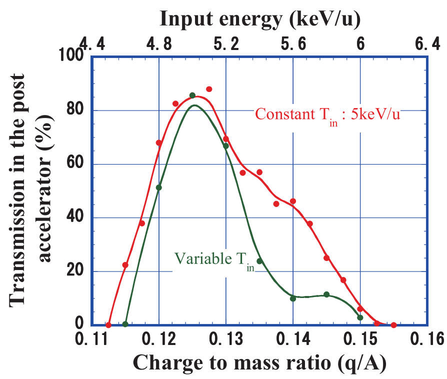

Fig. 2. The q/A dependence of the transmission.

References
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