Conceptual design of a post accelerator for SLOWRI

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As an extension plan of the slow radioactive nuclear ion beam facility (SLOWRI)[1], construction of a post accelerator has been proposed. The radioactive ions from SLOWRI are mass-analyzed, charge-bred, and injected into the post accelerator. The post accelerator is a normal conductive linear accelerator complex composed of a radio-frequency quadrupole (RFQ), a medium energy beam transport (MEBT), and a drift-tube linac (DT linac). The RFQ accelerates ions with mass to charge ratio (A/q) of less than 9 from 5 to 500 keV/u. The beam from RFQ is transported to the DT linac through the MEBT. The output beam energy of the DT linac varies between 500 keV/u and 1.5 MeV/u. The layout and main parameters of the post accelerator are shown in Fig. 1 and Table 1, respectively.

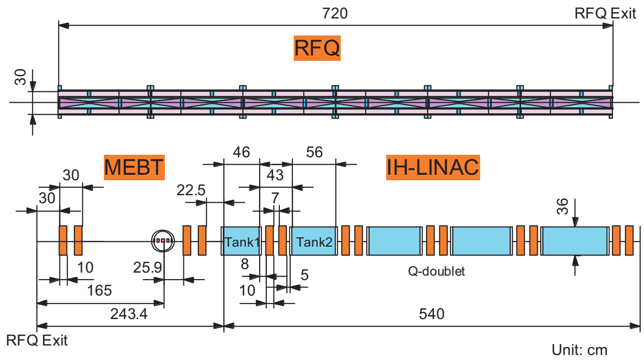

Fig. 1. Layout of the post accelerator.

Table 1. Main parameters of the post accelerator

	RFQ	Drift-tube linac				
Structure	Split coaxial	Interdigital H				
Tank No.		1	2	3	4	5
Frequency (MHz)	79	158				
A/q	9	9				
Duty factor (%)	100	100				
Input energy (kev/u)	5	500	640	810	1000	1230
Output energy (kev/u)	500	640	810	1000	1230	1500
Normalized emittance (π cm·mrad)	0.047	0.047				
Number of cells	290	14	15	16	16	16
Bore radius (cm)	0.54	1.2	1.4	1.6	1.6	1.6
Electrode voltage (kV)	65.1	160	180	200	220	250
Synch. phase (deg)	-30	-25				
Cavity diameter (cm)	30	36				
Total cell length (cm)	719	46.4	56	66.7	74.2	82
Power loss (kW)	186	31	44	62	72	91

RFQ parameters were determined with reference to the RFQ "TALL"[2]. The RFQ has a split coaxial-type structure, which is almost the same as that of the INS-type SCRFQ[3], while the mechanism for supporting the vanes is modified as shown in Fig. 2 in order to reduce the electrode capacitance. The cavity comprises 18 module cavities each of which is 30 cm in inner diameter and 40 cm in length. The cavity dimensions and RF parameters such as resonant frequency, unloaded Q, and power loss were estimated by means of numerical analysis based on an equivalent circuit.

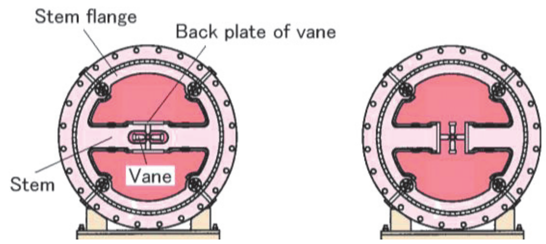

Fig. 2. Cross-sectional views of INS-type SCRFQ (left) and modified RFQ (right).

As the DT linac, an interdigital-H (IH) type comprising five tanks and five quadrupole doublets is adopted to obtain high shunt impedance and variable output energy. Quadrupole doublets are placed in a short space of 37 cm between the tanks to avoid the reduction of longitudinal acceptance of the linac. The IH cavities were designed in the same manner as those of the RFQ were. The longitudinal sectional view of a cavity and the gap-voltage distribution along the beam axis for tank1 are shown in Fig. 3. The goal frequency and uniform distribution are obtained by optimizing the ridge-cut shapes of both the ends. Ridges are made from the flat plate with 4cm thickness. Stems supporting the drift tubes are in the form of a truncated cone with the top and bottom diameters of 1 and 3 cm, respectively.

The beam simulation results are as follows: For the beam with a normalized emittance of 0.047 π cm·mrad, the RFQ transmission is more than 90%. The output beam emittance profile of the RFQ is well matched with the acceptance profile of the IH linac by means of two quadrupole doublets and a 4-gap rebuncher of the quarter-wave resonator in the MEBT. Transmission of the IH linac is 100%.

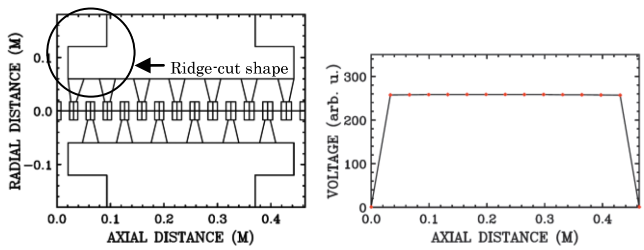

Fig. 3. Longitudinal sectional view (left) and gap-voltage distribution (right) for the 158.1-MHz IH tank1.

References

1) M. Wada et al.: Hyp. Int. 199 (2011) 269-277.
2) N. Ueda et al.: Proc. LINAC'84, 1984, p. 71.
3) S. Arai et al.: Nucl. Instr. and Meth. A 390 (1997) 9-24.

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