HEAVY-ION POST ACCELERATOR FOR THE UTTAC 12 UD PELLETRON TANDEM ACCELERATOR

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The 12 UD Pelletron tandem accelerator at the University of Tsukuba has been successfully operated at terminal voltages up to 11 MV. Recently a beam pulsing system has been developed. The system cosists of a pre-acceleration chopper, a klystron buncher and a post-acceleration chopper. Pulsed beams are used in measurements of lifetime of time-of-flight at present. The energies of heavy ions obtained by the tandem accelerator are as high as ∿3MeV/A for a mass A≃30. Higher energies are desired to extend target-projectile combinations to heavy elements. A small post accelerator, which is an rf linear accelerator with interdigital-H structure, is being constructed for this purpose. The most attractive feature of this structure is that the effective shunt impedance is very high at ion velocities in the range $0.05c \lesssim v \lesssim 0.1c$, where c denotes the light velocity.

1. Cavity

A schematic view of the cavity is shown in Fig. 1. The inner diameter and the total inner length are 0.7 and 3.03 m, respectively. The cavity consists of three parts. The top hat and the bottm vase are manufactured of steel 10 mm thick, and are equipped with water jackets for cooling over the cylindrical surface. Several ribs are welded to give the cavity mechanical rigidity. The rf power (∿10 kW, CW) is introduced into the cavity by an inductive coupling loop at the center of the bottom vase. The middle frame with two ridges on both sides is also made of steel. Ridges are cooled by water. The ridge is 2.3 m long and 0.08 m thick. All inner surfaces are covered with electrolitic copper plating. The thickness of the copper layer was measured to be 50 μm on an average. Drift tubes are designed for the acceleration of ^{35}Cl (15^+) from 110 to 140 MeV, and are mounted on the ridges alternately as shown in Fig. 1. The number of drift tubes is 18. The middle frame is sandwiched together with the top hat and the bottom vase using aluminum wires 0.8 mm in diameter and O-rings. The wires are mainly for the good rf contact and the O-rings are for the vacuum sealing. The vacuum of the cavity is generated by a crygenic jump with 3000 l/s(N_2).

The resonance frequency was measured to be 100.55 MHz at the lowest order. The resonance frequencies at higher order (dispersion) vary as those of TE_{11n} mode in a cylindrical cavity. The quality factor Q was measured to be $\sim 2\times10^4$ ($f_r/\Delta f$).

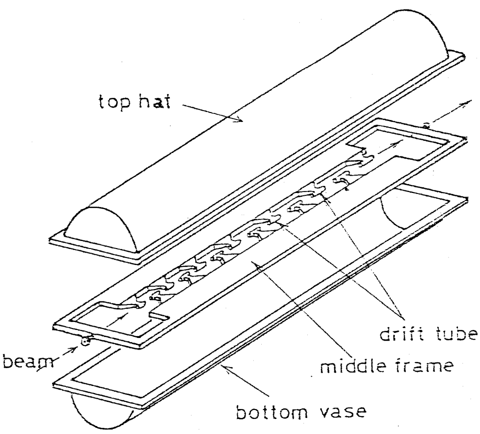

Fig.1 Schematic view of the cavity

2. RF system

The rf power for the linac is supplied by an used amplifier for a local TV broadcasting station. The power is transmitted to the cavity through a phase shifter (a trombone) and a series variable capacitor. The linac has to be incorporated with the existing beam pulsing system. A schematic block diagram of the rf system is shown in Fig. 2.

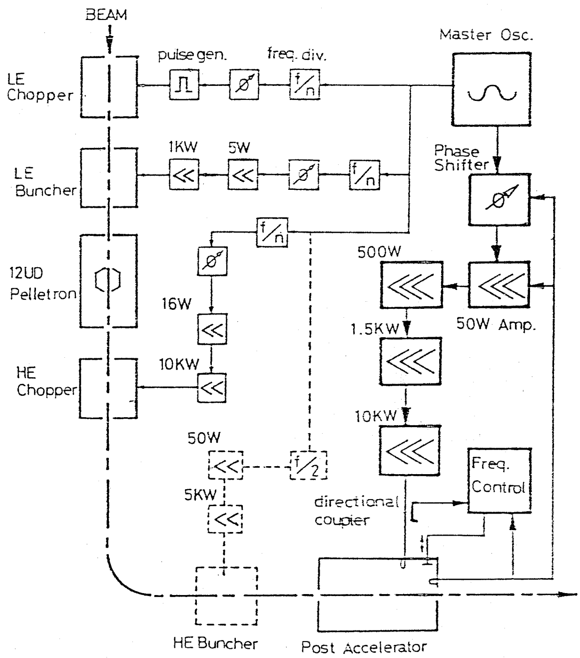

Fig.2 Block diagram of the RF system

3. Field Distribution

The distribution of accelerating fields was measured by perturbation method. Electric field in each gap is distributed in a sinusoidal form for the drift tubes arranged for a constant value of β and a constant g/L ratio. A flat distribution of fields is preferable to avoid local heating or a discharge problem. We have developed an empirical method to obtain a reasonably uniform distribution by varing g/L rations. With the cell length l_c at the middle of the linac, the distance of the n-th gap is given by $g_n=0.5l_c[(l_c/l_n)\sin(\pi z_n/L)]^{1/2}$, where l_n denotes the n-th cell length, z_n stands for the coordinate of the center in the n-th gap, and L is the length of the cavity. Fig. 3 shows the g/L ratios, transittime factors (TTF) and gap voltages estimated for the excitation with an rf power of 10 kW. Gap voltages and TTF are obtained from experimental data of gap fields. The effective shunt impedance was also estimated to be 120 MΩ/m. It is expected that total accelerating voltages up to 2 MV/q could be obtained with an rf power ∿10 kW.

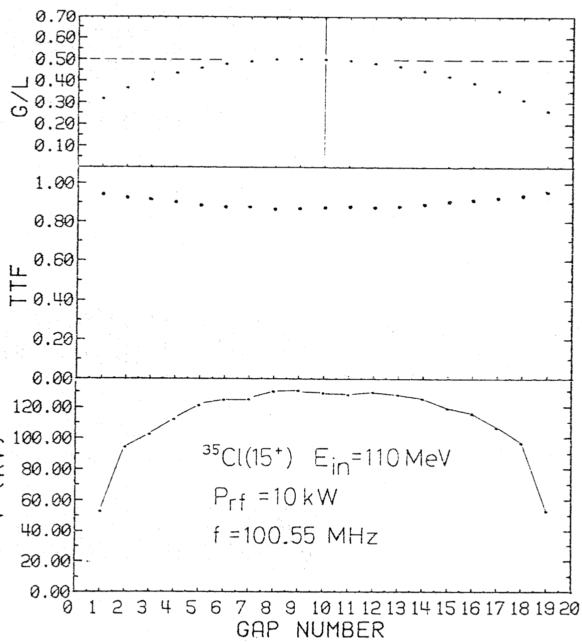

Fig.3