CONSTRUCTION OF THE INS RFQ LINAC 'LITL'

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Abstract

An RFQ linac 'LITL' (Lithium Ion Test Linac) has been constructed. The machine is designed to accelerate heavy ions with charge to mass ratio of 1 ∿ 1/7 from 5 up to 138 keV/u in the vane length of 122 cm. The design consideration, the cavity construction and the microwave characteristics are described.

1. Design Consideration

In order to test the feasibility of an RFQ linac as a heavy ion preinjector between an ion source and a drift tube linac, the RFQ linac 'LITL' has been constructed after following design considerations: 1) Ions with charge to mass ratio, ε, of 1 ∿ 1/7 have been chosen as the accelerated ions, as they are available with an existing ion source at INS. A 100 MHz RFQ is feasible to accelerate such ions up to energies acceptable by a conventional linac of the same rf frequency. A four-vane RFQ cavity is around 60 cm in diameter, and its fabrication is not difficult. 2) The injection energy is set at 5 keV/u, because the ion source is simple, and rapid bunching is available. At the input βλ is 0.49 cm and long enough to cut with an NC milling machine. 3) The intervane voltage is set at 62 kV for ions of ε = 1/7. The maximum surface field is 204 kV/cm, 1.8 times of the so called Kilpatrick's limit. 4) A single loop coupler has been adopted for its merits; a small and simple structure, and tunable coupling and rf power saving. The cold model test[1] shows that this coupling provides satisfactory mode separation and field balance in the four chambers. 5) In order to keep the end space for the return path of magnetic flux and to increase the Q-value, a 'pan' type end wall has been adopted. With this end wall, the preferable effect on the mode separation is also expected. 6) The vane parameters have been determined using the computer code PARMTEQ. As the beam current from the ion source is a few mA, the design was done without considering space charge effect. The designed output current is 4 emA for ions of ε = 1/7. The designed parameters are summarized in Table 1.

2. Construction of the Cavity

The structure of acceleration cavity is shown in Fig. 1. The tank is 56 cm in inner diameter, 138 cm in length and made of mild steel plated by copper to thickness of 100 μm. The vave has a length of 122.3 cm and gaps of 0.5 cm to the end wall, and is made of oxygen free copper. The modulation has been machined with an NC milling machine within a torelance of 30 μm. As shown in Fig. 2, the vanes are attached to the tank within a torelance of 100 μm. The electric contact between them is assured by a silver coated stainless steel tube of 2.4 mm in diameter. The thickness of the coating is 100 μm. The vane tip is approximated to a circular arc of a radius equal to that of curvature of the theoretical shape at the vane top. The cavity is evacuated below 2 x

accelerated ions	H^+, He^+, N^{2+}, ···	vane type	const. ave. radius (r_0 = 0.41 cm)
duty factor	100 %		
frequency	100 MHz	min. aperture radius	0.25 cm
intervane voltage	62 kV (ε = 1/7)	tank diameter	56 cm
input energy	5 keV/u	tank length	130 cm
output energy	138 keV/u	limiting current	4 emA (ε = 1/7)
transmission	97 % (0 emA)	max. rf power	25 kW

Table 1. Specification of LITL.

10^{-7} Torr with a turbomolecular pump. The thermal strain of the tank and vanes is suppressed below 100 μm by water cooling at cw operation with full power.

3. Microwave Characteristics

By rotating the coupler loop, the relation between the loaded Q and the coupling strength has been measured. From the most loose coupling point, the unloaded Q is obtained as 10600, 60 % of the SUPERFISH value. The cavity is tuned with end and side tuners so that the magnetic field distribution might be uniform longitudinally and azimuthally in the four chambers. The azimuthal unbalance within ±3 % and the longitudinal flatness of the intervane voltage within ±2 % have been attained after the tuning. The mode separation between the TE_{210} and TE_{110} modes is 2 MHz, as shown in Fig. 3. According to the beam test[2], the relation between the intervane voltage and the rf input power is given by an experimental equation, $V(kV) = 13.5 \times \sqrt{P(kW)}$.

Acknowledgments

The LITL was manufactured at Toshiba Electric Corporation Tsurumi Works. The SUPERFISH calculation was done with FACOM 180 II AD at INS computer center.

References

1. T. Nakanishi et al., Measurement of the RF Field on RFQ Linac Model Cavities, INS report, INS-NUMA-30, 1982.
2. T. Nakanishi et al., Acceleration Test of the INS RFQ Linac 'LITL', presented at this symposium.

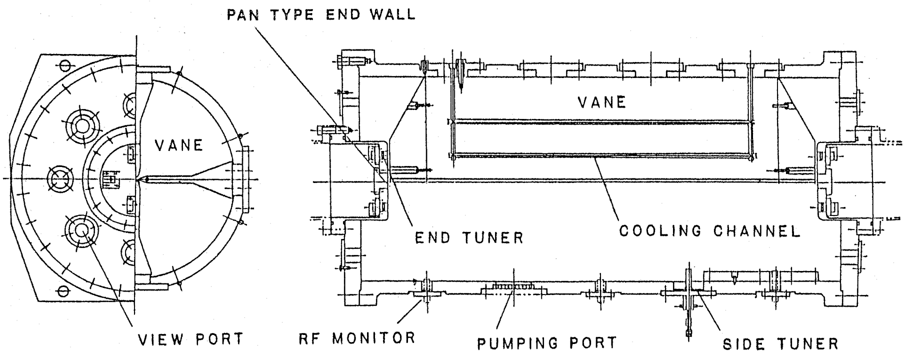

Fig. 1. View of the RFQ cavity of LITL.

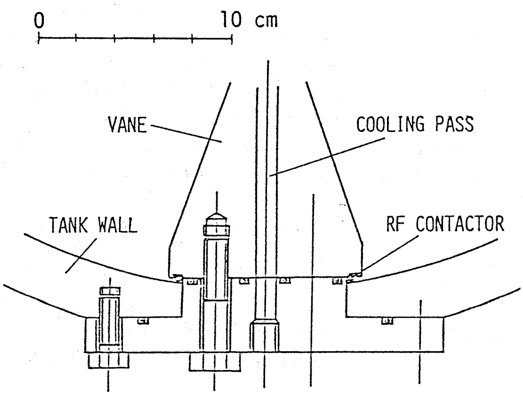

Fig. 2. Contact of vane and tank.

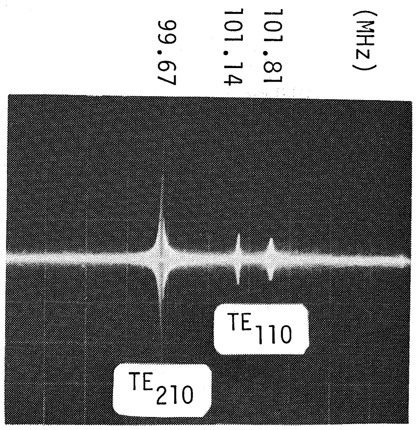

Fig. 3. Mode separation.