ACCELERATION TEST OF THE INS RFQ LINAC 'LITL'

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Introduction

The RFQ linac 'LITL' accelerates particles with charge to mass ratio, ε, of 1/7 from 5 up to 138 keV/u on the design.[1] Driving conditions of the acceleration cavity for various ion beams are optimized with only adjustment of an rf power fed to the cavity. The rf power is adjusted so that the product of an intervane voltage and ε for various ions is constant. The intervane voltage of 61.8 kV, corresponding to the maximun vane surface field of 205 kV/cm, was applied successfully to the cavity.[2] This enables us to accelerate ions with ε =1/7. Momentum spectra and output beam intensity have been measured for values of the intervane voltage by use of ion beams of H^+, H_2^+ and H_3^+.

Test Stand

The LITL acceleration test stand is shown in Fig. 1. A beam from the duoplasmatron ion source is analyzed in the 45° bending magnet (upside of the photograph), and injected to the cavity through the electric quadrupole triplet and the einzel lens. The output beam is transported through the magnetic quadrupole triplet and the 90° analyzing magnet to the beam diagnostic device. The output beam diagnostic device is composed of the multiwire profile monitor, slit system and Faraday cup monitor which is 100 cm long and 8 cm in inner diameter. The analyzing system gives the momentum resolution of 0.25 %.

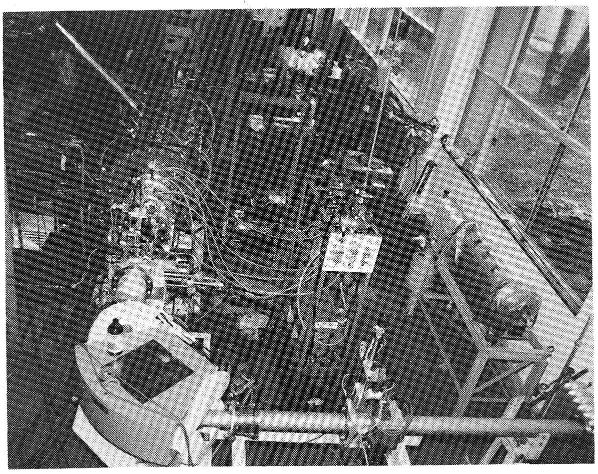


Fig. 1. The LITL test stand

Beam Experiment

The machine is operated with cw or pulse mode. The beam signal of H_3^+ from the Faraday cup is shown in Fig. 2 together with the rf field level in the cavity. Momentum spectra for each beam are shown in Fig. 3, for various values of the intervane voltage. The peak currents of the spectra at normal operational intervane voltages for various ions correspond well to the design energy of 138 keV/u. The shapes of the spectra are independent on the ion species and depend only on the intervane voltage

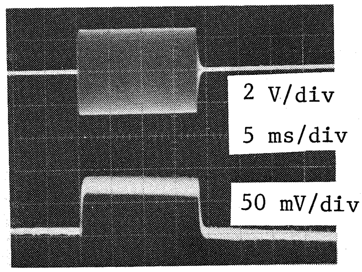


Fig. 2. The signal of H_3^+ (bottom) and the rf field level (top)

normalized to the design value. The momentum spread is 2 % (FWHM) with the normal operation, and broadens with the higher voltage. Figure 4 shows the horizontal and vertical beam profiles observed with the multiwire monitor positioned in front of the slit system.

Intensities of the output beams with momentum spread less than ± 1.25 % are shown in Fig. 5, as the dependence on the intervane voltages for each beam. As the synchronous phase is designed at -30° in the acceleration section, the longitudinal acceptance becomes small rapidly with the lower intervane voltage than the design value and vanishes for the normalized voltage lower than cos(-30°) = 0.866. A, B and C in the figure indicate those values which give zero acceptance in each beam acceleration. The best transmission is obtained up to 1.7 times the normal voltage, since it gives a larger longituginal acceptance. At the higher voltage, the output beam current decreases gradually since the amplitude of the transverse oscillation increases.

The transmission efficiency and emittance growth will be measured with Faraday cups and emittance monitors, which are to be placed just in front of and after th cavity.

Reference

1) Ueda et al., An RFQ Linac for Heavy Ion Acceleration, the 1981 Linear Accelerator Conference, Santa Fe, USA.
2) S. Arai et al., CONSTRUCTION OF THE INS RFQ LINAC 'LITL', contributed to the Symposium.

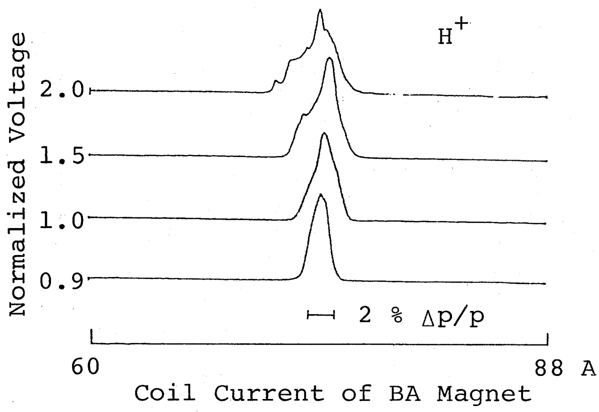
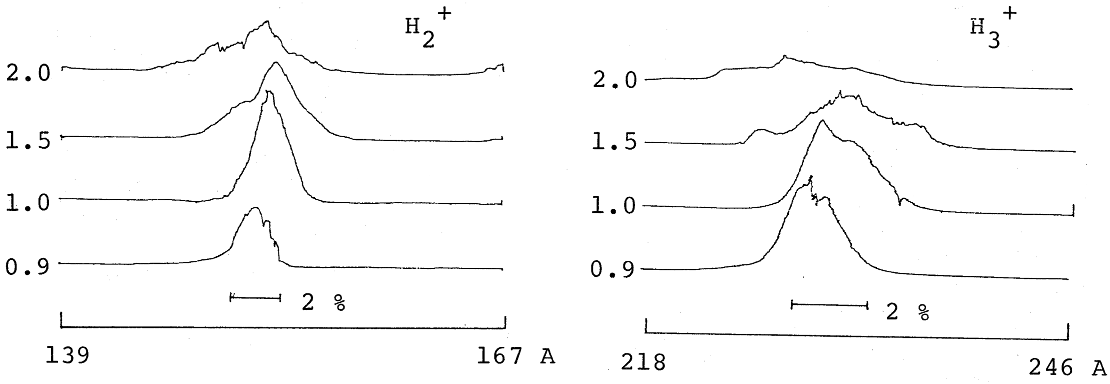


Fig. 3. Momentum spectra for various values of the normalized intervane voltage.



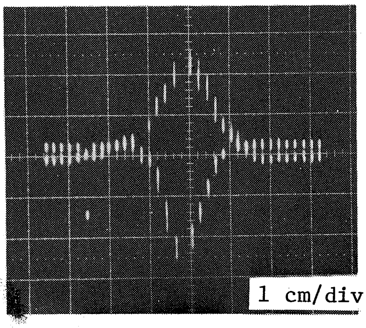


Fig. 4. Profiles of H_3^+ beam through the analyzing magnet with the nomal operation.

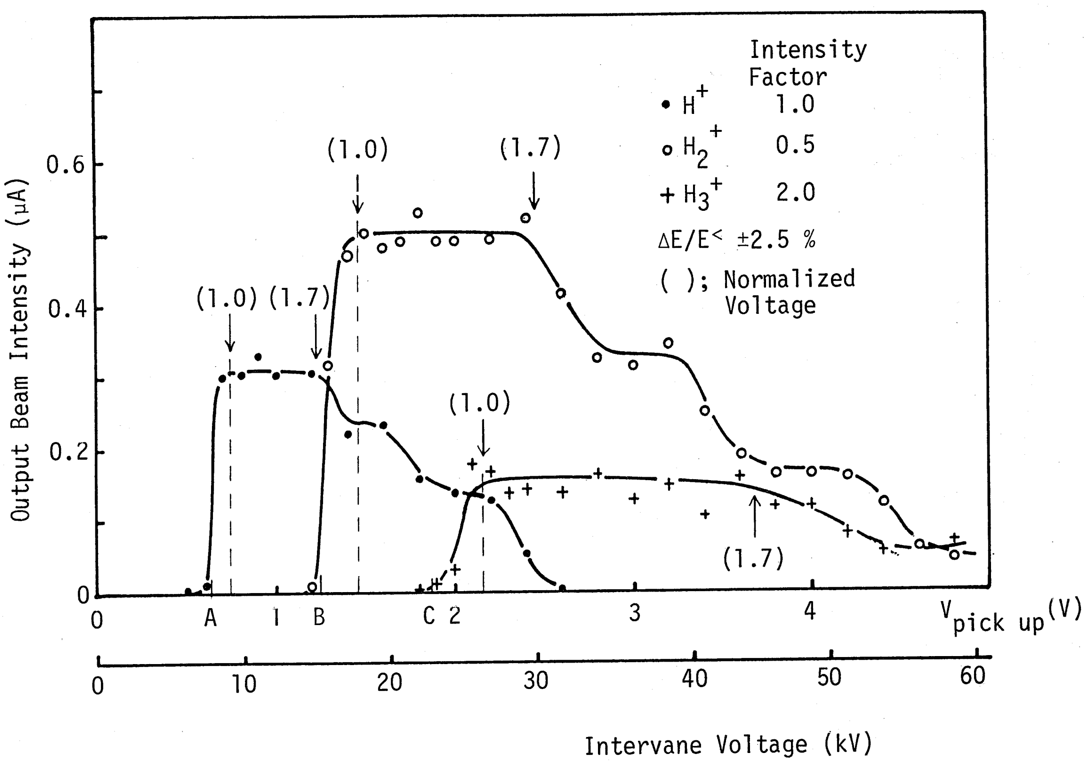


Fig. 5. Output beam intensity vs. intervane voltage