# FIRST BEAM TEST OF THE RFQ LINAC 'TALL'

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## Abstract

The INS RFQ linac 'TALL' accelerated successfully the first protons July 19, 1985. The RFQ is of four vane structure driven with a single loop coupler at 101.3 MHz. The machine is designed to accelerate ions with charge to mass ratio of 1 - 1/7 up to 800 keV/u in the vane length of 7.25 m.

## 1. Introduction

The RFQ 'TALL' has been constructed as the lowest energy stage of an injector linac system for the heavy ion synchrotron 'TARN II' which is under construction at INS. The RFQ was designed on the basis of the experience of the test RFQ linac 'LITL'.[1) The design parameters of the TALL are given in Table 1. A detailed description of the structure and alignment is given in anohter paper.[2)

Table 1. Design parameters of the TALL.

| | | |
|---|---|---|
| Ions (q/A) | | 1 - 1/7 |
| Operating frequency (MHz) | | 100 |
| Input energy (keV/u) | | 8 |
| Output energy (keV/u) | | 800 |
| Vane length (cm) | | 725 |
| Cavity diameter (cm) | | 58 |
| Characteristic bore radius, $r_0$ (cm) | | 0.54 |
| Minimum bore radius, $a$ (cm) | | 0.29 |
| Intervane voltage for q/A = 1/7 (kV) | | 81 |
| Maximum field (kV/cm) | | 205 (1.8 Kilpat.) |
| Rf power wall loss for q/A = 1/7 (kW) | | 180 |
| Transmission for input beam with | 0 mA | 0.94 |
| a normalized emittance of | 2 mA | 0.91 |
| $0.6\pi$ mm.mrad for q/A = 1/7 | 10 mA | 0.63 |

## 2. Acceleration Cavity

The four vane cavity is separated longitudinally into four sections, each of which is about 1.8 m long and was assembled independently (Figs.1, 2). The cavity cylinder is made of mild steel, copper plated to a thickness of 100 μm. Two sets of vanes are prepared for the TALL. One is for low power operation. It is made of aluminum and has no cooling channel. The other is made of copper and has cooling channels for high power operation. Now the cavity is equipped with the aluminum vanes. The vane is mounted into the cylinder with three base plugs. The vanes and cylinders are electrically contacted with C-shaped contactors made of stainless steel, silver coated to a thickness of 50 μm.

The vane were aligned within an error of ± 50 μm of the vane top positions. The four section are joined on a bed which has five supporting flats. The flats are levelled within an error of ± 20 μm. The beam axis is aligned within an error of 200 μm over the length of 7.3 m. The steps between the longitudinally adjacent vanes are within 100 μm. A computer simulation shows that alignement errors of the beam axis of 100 μm at the three joints do not decrease the transmission significantly.[3)]

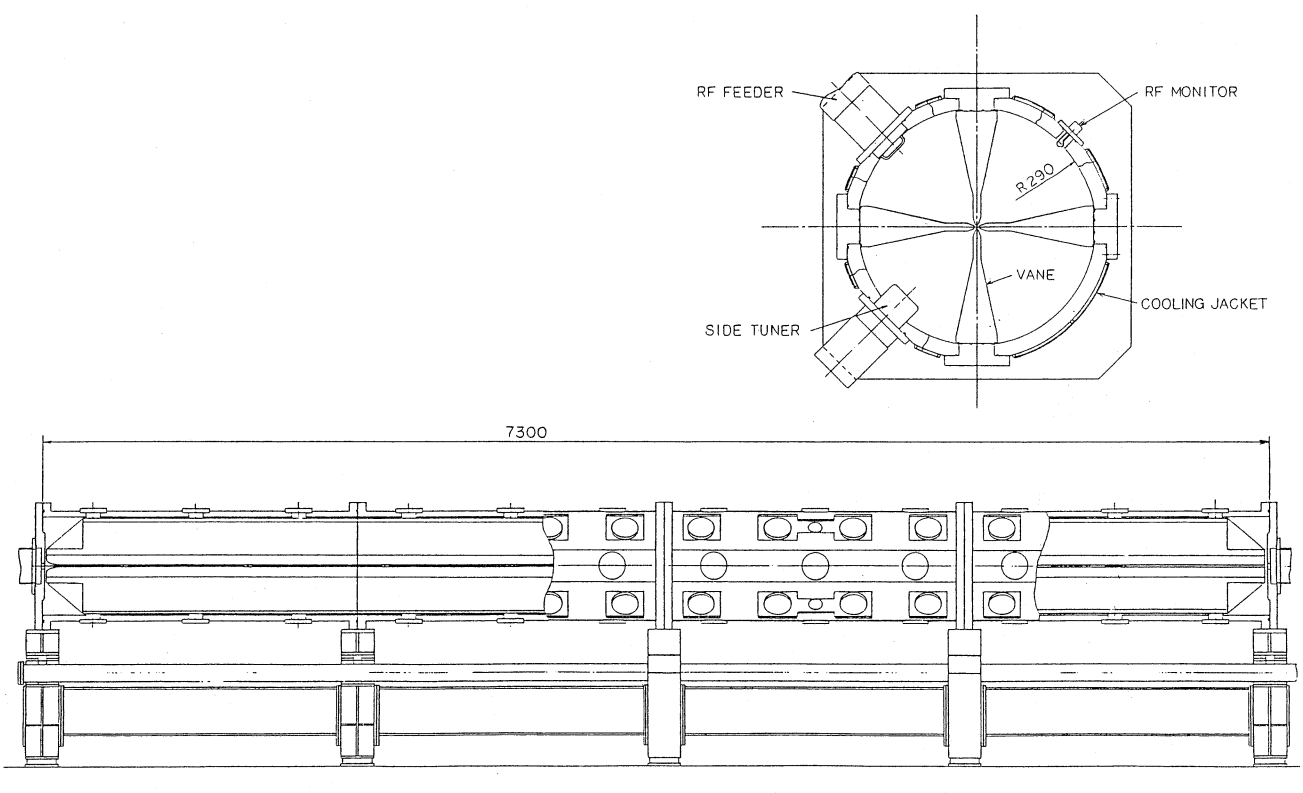


Fig.1. Schematic drawing of the TALL.

## 3. Rf Characteristics

The field distribution was tuned by using end inductive tuners roughly, and fine tuning was done with side inductive and end capacitive tuners. The electric field distribution was measured by using a dielectric perturbator which was ran guided with the vanes. The field uniformity error is within ± 2% azimuthally and ± 5% longitudinally. The resonant frequency of the TE210 mode is 101.3 MHz. The closest mode TE111 has a frequency of 0.9 MHz higher. The quality factor is 7100, about 70% of the ideal one.

## 4. Beam test

Proton beam from a microwave ion source was injected at 8 keV into the RFQ. Figure 3 shows the output beam current vs. the forward rf power. The duty factor is 6% and repetion period is 2 ms. The ouput beam energy was assured to be about 800 keV calorimetically by measuring the temperature rise of a copper target and beam current. Also bunch structure of the output beam was observed. Precise momentum measurement will be made before long with an analyzer magnet. Multipactorings were observed in three ranges of rf level (Fig.3). They were past over easily after a few hour outgassing on the first power test. Power feed with the single loop coupler had no problem upto the maximum output 25 kW of the rf power supply.

The cavity is pumped with two turbomolecular pumps of 500 $l$/s. The vacuum pressure was $1 \cdot 10^{-6}$ Torr with no rf power. It increased to a range of $10^{-5}$ Torr on the outgassing.

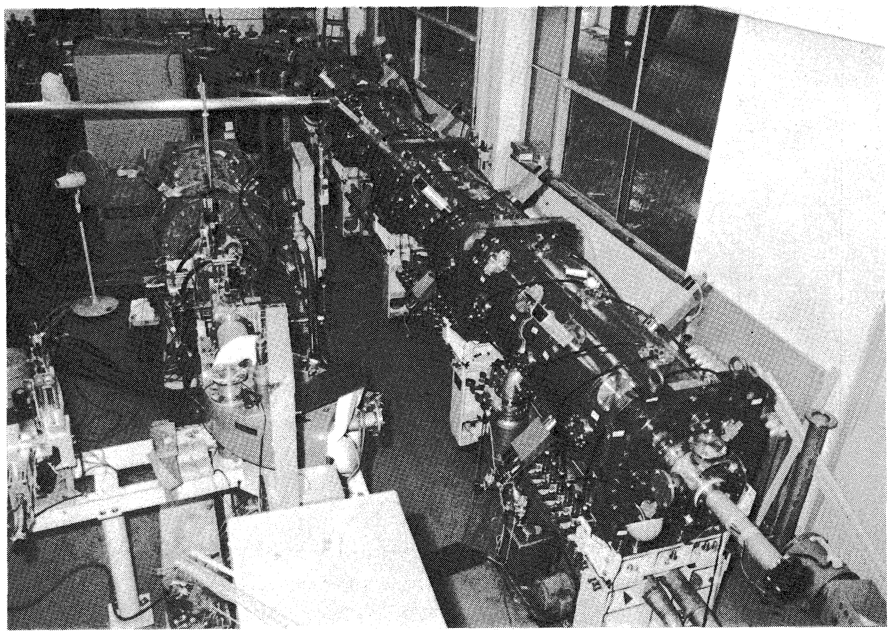

Fig.2. TALL test stand. Rf power is fed through a coaxial line WX-77D.

## 5. Conclusion

The RFQ TALL has a length of 7.3 m or 2.4 times the wave length. It is driven with a single loop and has no vane coupling ring. The field uniformity obtained so far is within ± 2% azimuthally, and ± 5% longitudinally. The TE210 mode has an enough separation of 0.9 MHz to the closest mode TE111. The successful acceleration shows that the vane separation is another answer for a long RFQ to get a field uniformity. It makes much easy the vane mchining and assembly.

## Acknowledgements

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## References

1) N. Ueda et al., Proc., 1983 Particle Acc. Conf., Santa Fe, NM, USA, IEEE Trans. Nuclear Sci., NS-30, No.4 (1983).
2) N. Ueda et al., Proc. 1985 Particle Acc. Conf., May 13-17, 1985, Vancouver, Canada.
3) T. Nakanishi et al., Proc. 5th Symp. Acc. Sci. & Technology, 1984, KEK, Ohomachi, Ibaraki, Japan.

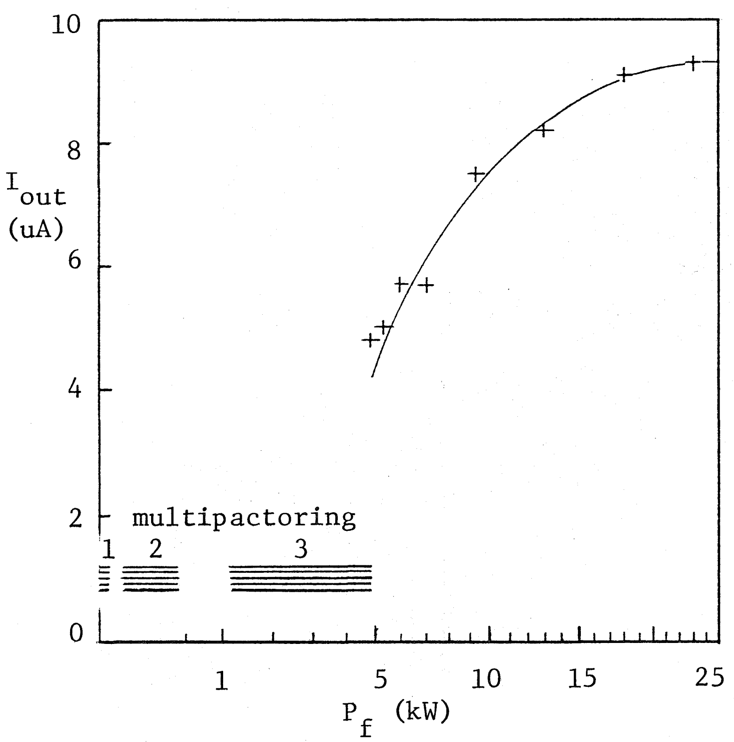


Fig.3. Output beam current vs. foward rf power (peak values).