# Design and Fabrication of PEFP 350MHz RFQ

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## 1. Introduction

A new PEFP RFQ has been designed with the following features. 1) The vane voltage is constant for easier fabrication and simpler tuning. 2) The transition cell for the last cell of the RFQ [1] is chosen. 3) The physical dimension of the new RFQ is essentially same as the old one because we want to use the prepared components like vacuum system and wave guiding system connecting the RFQ and klystron. 4) We have also maintained the resonant coupling method [2] in order to get the more stable field distribution.

## 2. Design

We have designed the RFQ by RFQ Design Codes developed and distributed by LANL [3].

The RFQ is 4-vane type with 4 sections. We have adapted the constant vane voltage for the simple cavity design, easier fabrication, and uncomplicated tuning process. In order to maintain the RFQ length similar to that of the old design, we have selected the shaper energy as 86.5 keV where the synchronous phase is linearly increased. We have chosen the constant $\rho/r_0$ as 0.87 which limits the surface electric field below the 1.8 Kilpatrick field. The new design parameters for PEFP RFQ are summarized in Table 1 and Figure 1.

Table 1. PEFP 3MeV RFQ Linac Parameters

| | |
|---|---|
| Frequency | 350 MHz |
| Input / Output energy | 50 keV / 3 MeV |
| Input / Output current | 22 mA / 20 mA |
| Vane voltage | 85 kV (constant) |
| $\rho/r_0$ | 0.87 |
| Radial matching section | 6 cells |
| Power | 385 kW (total)<br>320 kW (Cu), 65 kW(beam) |
| Input emittance | 0.02 cm-mrad<br>(normalized rms) |
| Output emittance | 0.022 cm-mrad<br>0.112 deg-MeV |
| Capture rate | 97 % |
| Transmission rate | 98.3 % |
| Duty | 24 % (Max.) |
| Repetition rate | 120 Hz |
| Total length | 321 cm |

Figure 1 shows the input and output beam in the trace space. In this simulation, we have used 10,000 particles. The twiss parameters of the output beam in the transverse direction are given as $\alpha_x$= -1.89, $\beta_x$= 17.80 cm/rad and $\alpha_y$=1.33 $\beta_y$= 11.75 cm/rad in x- and y-directions, respectively. Figure 2 represents the configuration plots of the beam in the RFQ with the transmission rate of 98.3 %. The figure shows the particle distribution in x- and y-directions, the phase and energy deviation from the designed values, from the top part of the figure, respectively.

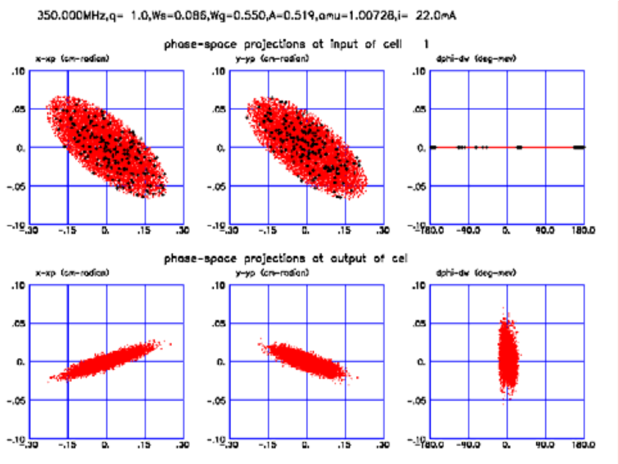


Figure 1. Input and output beam in trace space.

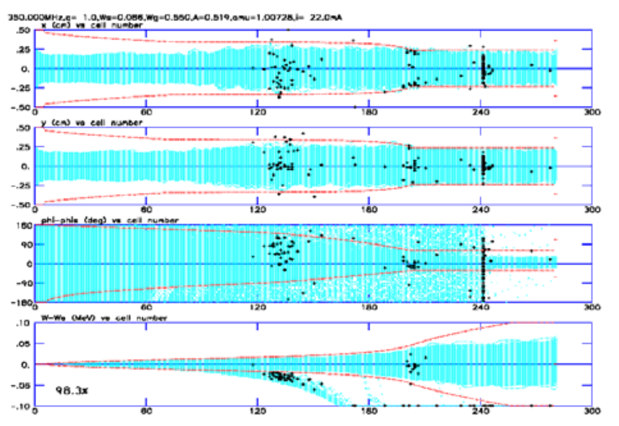


Figure 2. Configuration plot of the beam obtained by PARMTEQM with 10,000 particles.

## 3. Fabrication

The physical dimension of the new RFQ is essentially same as the old one because we want to use the prepared components like vacuum system, input-coupler, LEBT, and wave-guide.

There was some problem during the CNC-machining of RFQ vane, especially in entrance side. To check this, the machining check had been done. Figure 3 shows the sample of RFQ vane machining, and it is within the requirements.

Figure 3. Vane end for machining check

4 Sections have been machined and tested. Before the brazing, each section has been assembled with dummy end cavity and measured the frequency and the quadrupole field profile in order to check the machining. Figure 4 shows the set-up of bead pull measurement to measure the field profile with a network analyzer. Figure 5 shows the result, which is good to braze the section.

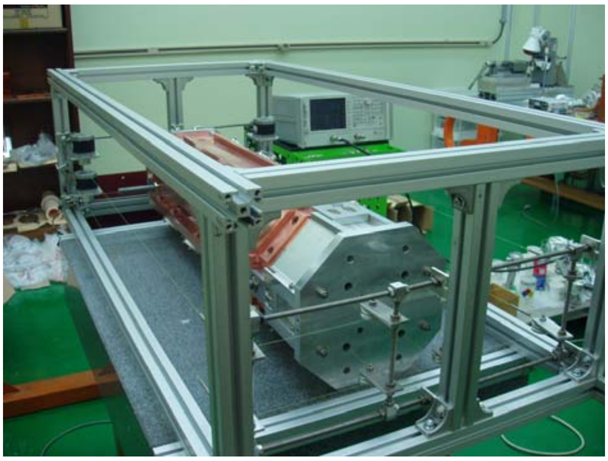

Figure 4. Bead Pull Measurement

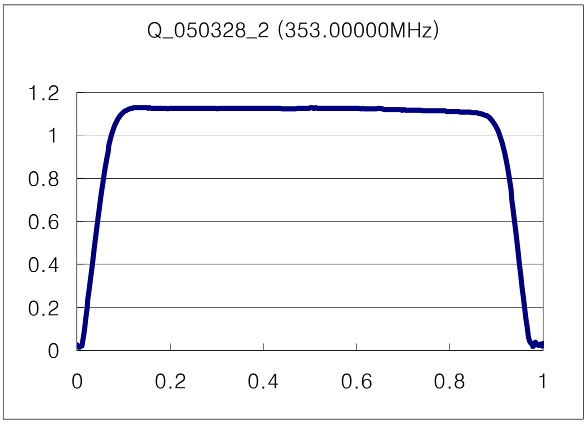


Figure 5. Field Profile in a RFQ section

## 4. Conclusion

We have designed a new 3 MeV RFQ which has the similar geometrical dimension with the existing one. The major changes are the constant vane of 85 keV along the full vane tips, and the transition cell in order to remove the energy uncertainty and use the fringe field region for matching between RFQ and DTL. For the field stabilization, the resonant coupling method is adapted.

There is no major change in engineering design, and machining and brazing of the RFQ cavities are under progress. It will be tested in this year.

## ACKNOWLEDGEMENT

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