Study on the Design of the PEFP 3MeV RFQ Upgarde

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1. Introduction

A 100MeV proton accelerator has been developed at PEFP as a 21C Frontier Project [1]. The goal of the first stage of the project is to develop a 20MeV accelerator. The 20MeV accelerator consists of ion source, LEBT, 3MeV RFQ and 20MeV DTL. The 3MeV RFQ were already installed and being tested [2]. The fabrication of the 20MeV DTL has been carried out [3]. Some problems, such as the resonant frequency and field profile tuning, sharp edge in the vane end, inadequate RF seals have been found during the preliminary test of the 3MeV RFQ. To solve the problems, the upgrade design of the RFQ has been decided. Until now, the beam dynamics and cavity design have been completed and machining of the first section is prepared.

2. Beam Dynamics Design

2.1 Design Concept

The PEFP 3MeV RFQ upgrade was designed with the following concepts. 1) To maintain the constant voltage profile because of easier fabrication and simpler tuning. 2) To adopt the transition cell at the end of the RFQ because of the elimination of the energy uncertainty. 3) To maintain the physical dimension to be the same as the old one because of the availability of the components used for present RFQ. 4) To maintain the resonant coupling method and dipole stabilizer rods for stability against perturbation.

2.2 RFQ Design

The PEFP 3MeV RFQ upgrade has been designed by using the RFQ design codes developed and distributed by LANL [1]. The RFQ is 4 vane type with 4 sections. Each of 2 sections constitutes 1 segment and 2 segments are resonant coupled through coupling plate. The radial matching section consists of 6 cells for the smooth matching of the RFQ input beam controlled by the solenoids of the LEBT. A constant ρ/r0 as 0.87 is used throughout the vane design which limits the surface electric field below the 1.8 Kilpatrick. The fraction of the octupole component becomes less than 10% of quadrupole. A transition cell is included at the last cell of the RFQ which eliminates the energy uncertainty at the end of the RFQ and gives the same length between horizontal and vertical vane. Because it offers well defined ending scheme for RFQ, the additional fringing field region after transition cell can be used for the transverse matching between the RFQ and DTL. The PEFP 3MeV RFQ upgrade design parameters are shown in Figure 1.

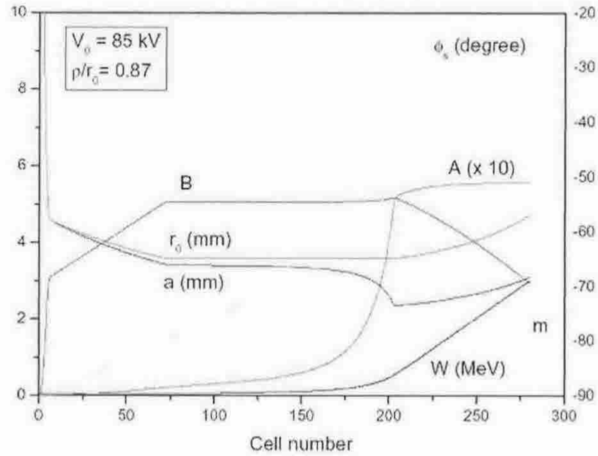

Figure 1. Design parameters of PEFP 3MeV RFQ upgrade

2.3 Beam Dynamics Calculation

To calculate the beam dynamics, PARMTEQM code was used. 10,000 particles have been used through the calculations. Figure 1 shows the input and output beam in the trace space and Figure 2 shows the configuration plots of the beam in the RFQ with the transmission rate of 98%.

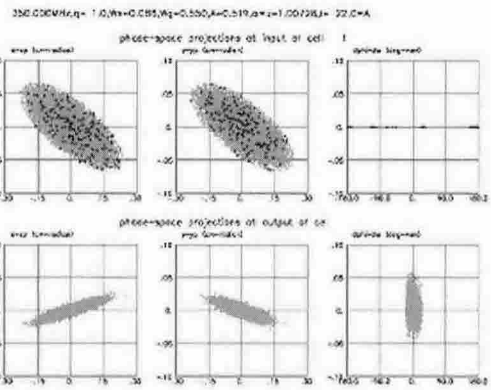

Figure 2. Input and output beam in trace space.

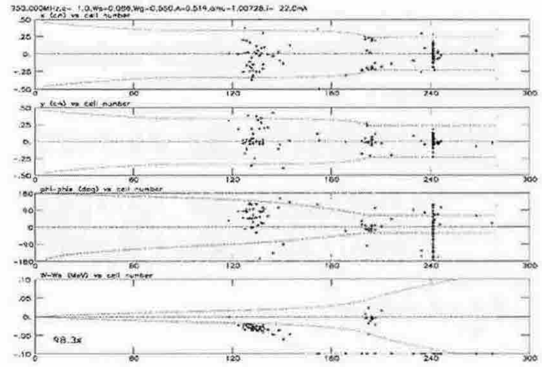

Figure 3. Configuration plot of the beam obtained by PARMTEQM with 10,000 particles

3. Cavity Design

2.1 Cavity Geometry Design

The cavity geometry such as vane skirt has been designed using 2D superfish code. Because the aperture and modulation are changed along the RFQ, average aperture radius values are determined along the RFQ using the output data from vane code and interpolate the vane skirt width to meet to resonant frequency. The undercut depth at each ends of the segments and coupling gap size have been designed using 3D MWS code. The undercut depth was determined to meet the resonant frequency of the RFQ and the values are 38.85 for low energy side, 38.49mm for high energy side and 48.33mm for coupling region, The coupling gap size was determined to equalize the mode separation between nearest upper and lower modes that were the PI mode of TE110 mode and PI mode of TE111 mode. The determined gap distance is 2.86mm. The thermal and structural analysis of the cavity should be done using those cavity data.

4. Conclusion

Some problems such as cavity tuning, sharp edge of the vane end have been found during the preliminary test of the RFQ and upgrade design of the new RFQ was determined. The beam dynamics design was carried out to satisfy the some features such as constant voltage profile, transition cell, physical dimension and field stabilization against perturbations. The cavity design was also completed to determine the cavity dimensions, under depth of each end of the segment and coupling gap size. The thermal and structural analysis should be done. Also the machining of the first section was prepared to check the fabrication method.

ACKNOWLEDGEMENT

This work was supported by the 21C Frontier R&D program of MOST.

REFERENCES

[1] B. H. Choi, High Power Proton Linac Program in Korea, Proc. Of Linac 2002, p26, 2002.
[2] Y. S. Cho, et al., PEFP 3MeV RFQ Test, Korea Nuclear Society Spring Meeting, 2004.
[3] Y. S. Cho, et al., Design of the 20MeV DTL for PEFP, Proc. Of PAC2003, p1219, 2003.