3.0MEV KTF RFQ LINAC

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Abstract

The KTF RFQ linac constructed to accelerated to accelerate 20mA proton beam from 50keV to 3MeV. The basic electrical characteristics for an operation of the 3.0MeV RFQ are testing. Before operating of 3.0MeV RFQ , the operation condition with pulsed and cw beam current will extensively studied by using the 0.45MeV RFQ in this year. The present status of the RFQ are described.

1 INTRODUCTION

The 3.0MeV RFQ linac [1-3] has been constructed at the Korea Atomic Energy Research Institute (KAERI). The RFQ is a four-vanes type and consists of fifty-six tuners, sixteen vacuum ports, one coupling plate, four RF drive ports, ninety-six cooling passages, and sixteen stabiliser rods.

In the 3.0MeV RFQ, an average RF power is 417kW. And supplied by one klystron with 1MW operation at 350MHz. RF input coupler has been fabricated and power test of klystron is performing. We have been completed and tested a Low-Level RF system [4].

2 3.0MeV RFQ LINAC

2.1 LEBT System

LEBT system was designed with the codes, TRACE 3D, POISON, PARMTEQM, and ANSYS. 2.2m-long test Low Energy Beam Transport (LEBT) system which match between the ion source and the RFQ linac was assembled. LEBT consists of two solenoid magnets, two steering magnets, and a beam line, as shown in Fig. 1.

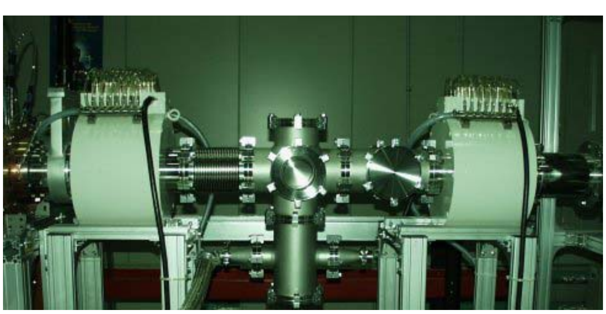

Figure 1. Assembled LEBT system.

The 16cm-i.d, 20cm-long solenoid lenses with polar cores have 72000A/turns, maximum power loss, 8.1kW, and dc fields 5000Gauss at a beam axis. In order to control of X and Y motions, two steering magnets are placed in the LEBT. These can correct 1.7cm horizontal offset on the beam axis.

2.2 RFQ Cavity

The design of the 3MeV RFQ cavity was performed by the beam dynamics codes, PARMTEQM [5] and QLASSI[6], the thermal and stress analysis code, ANSYS, and the cavity design codes, SUPERFISH and MAFIA. The main parameters given in table 1.

Table 1. 3.0MeV RFQ Parameters.

PARAMETER	VALUE
Operating frequency	350 MHz
Particles	Proton
Input / Output Current	21 / 20 mA
Input / Output Energy	0.05 / 3.0 MeV
Input / Output Emittance, Transverse/norm.	0.02 /0.023 π-cm-mrad rms
Output Emittance, Longitudinal	0.246 MeV-deg
Transmission	95 %
RFQ Structure Type	4-vanes
Duty Factor	100 %
Peak Surface Field	1.8 Kilpatrick
Structure Power	350 kW
Beam Power	68 kW
Total Power	418 kw
Length	324 cm

The RFQ cavity was machined into OFH-Copper and was integrated from four separate 81cm-long sections which was fabricated by vacuum furnace brazing. Fig.2 shows the RFQ cavity which is testing a electrical characteristics.

Figure 2. Fabricated RFQ cavity.

2.3 Cooling System

The average RFQ cavity structure power by rf thermal loads is 350kW and the peak surface heat flux on the cavity wall is 0.13 MW/m^2. In the operation of the RFQ, a key issue is to remove this heat. To do it, we constructed 24 longitudinal coolant passages in each of the sections. Total flow designed is 1500l/min with more than 1MΩ-m. In the design of the coolant passages, we considered the thermal behaviour of the vane during CW operation, the efficiency of cooling and fabricating cost. Cooling system constructed consisted of 38 flow meters, 38 thermo-couples and 19 pressure gauges, as shown in Fig. 3.

Figure 3. Cooling System.

2. 4 Vacuum System

In the RFQ, a beam loss designed is about 1mA of proton. Vacuum system constructed to pump beam loss, LEBT gas load and out-gassing from the RFQ cavity and vacuum plumbing. Vacuum pumps which consists of a 600l/min roughing pump and two 3000l/s cryopumps are completely oil-free.

Fig. 4 shows the vacuum pumping station with vacuum gauges and port adapters.

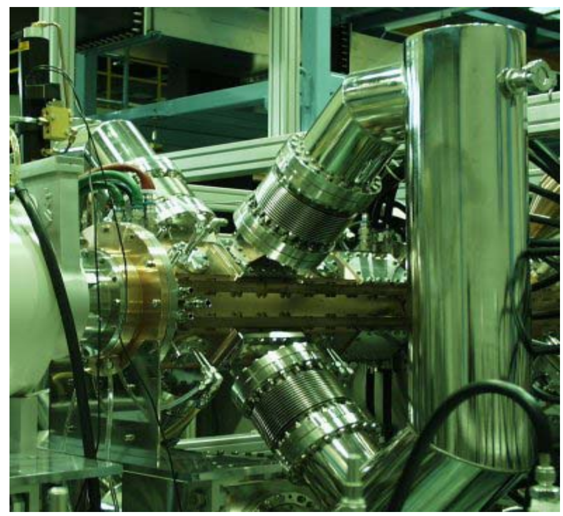

Figure 4. Vacuum Pumping Station.

2.5 Input RF Coupler

RF feed is in the third section. In order to supply the RF power in the RFQ, we studied two types of the input RF couplers which one is a coaxial-type for 0.45MeV RFQ and the other is an iris-type for 3.0MeV RFQ.

The coaxial-type RF coupler fabricated is shown in Fig.5. When the RFQ cavity and the input coaxial coupler is matched, the S-parameter calculated is 0.008 and VSWR is 1.02:1. Coaxial-type input RF coupler has been fabricated with OFH-Copper. Inner conductor of the coaxial line has cooling channel. The input coupler has a structure that the coupling loop can be rotatable to adjust the coupling coefficient to the RFQ cavity. Helicoflex RF seal is inserted between the RF drive ports and the input coupler to avoid the RF current flow on a vacuum flange surface and to tight a vacuum leak.

Fig. 6 shows the iris-type input RF coupler connecting the RFQ cavity to the RF vacuum window. The input coupler designed is the tapered ridge-loaded waveguide which is interesting from an electromagnetic point of view since the cutoff frequency is lowered because of the capacitive effect center, and could in principle be made as low as desired by decreasing the gap width sufficiently. Of course the effective impedance of the guide also decreases as the gap width is made smaller. The tapered ridge-loaded waveguide operates in the dominant TE10 mode, the same mode as in half-height WR2300 waveguide used for the RF window side RF waveguide. The cutoff frequency of any cross section through the tapered ridge-loaded waveguide is equal to the cutoff frequency of the half-height WR2300 waveguide. In order to couple the RF power into the RFQ cavity with an iris slit, the field is intensified at the end of the ridged waveguide. The RF vacuum window section consists of a straight WR2300 waveguide which includes a vacuum window and a port for vacuum pumping the waveguide.

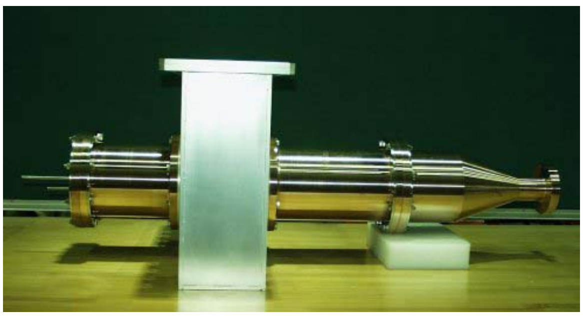

Figure 5. Coaxial-type RF input coupler.

Figure 6. Iris-type RF input coupler

2.6 LLRF System

Low level RF (LLRF) system constructed include the RF reference, resonance control of the RFQ cavity, klystron control, interlocks, and feedback loop. The main function of the LLRF system is to control RF fields in the RFQ cavity and maintain field stability in the range of ±1.0% peak to peak amplitude and ±1.4^{o} peak to peak phase. All RF feedbacks loops will use baseband In-phase and Quadrature techniques. Maximum output power of the LLRF system is 200W. The software control of the LLRF system performs with LabVIEW.

3 PRESENT STATUS

The fabrication, electrical test, and vacuum leak test of the KTF RFQ cavity has been completed. Fig. 7 shows the assembled 3.0MeV RFQ linac.

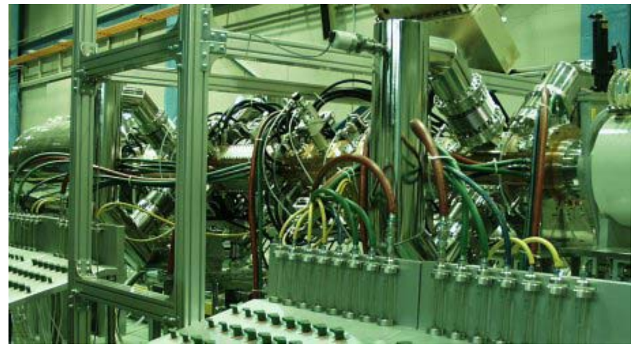

Figure 7. Assembled 3.0MeV RFQ.

4 ACKNOWLEDGMENT

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