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Design of the RF Coupler for the 350MHz RFQ Linac

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Abstract

The 350MHz Radio-Frequency Quadrupole (RFQ) linac has been fabricated to accelerate a 20mA proton beam from 50keV to 3MeV. A 1.0MW CW RF system will be used to provide power to the RFQ. Two types of a input RF coupler were designed and fabricated to feed the RF power generated by klystron into the RFQ accelerating cavity..

1. Introduction

The KTF RFQ linac [2-4] designed and has been fabricated as the first phase of the Korea Multipurpose Accelerator Complex (KOMAC) project 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. The RFQ was machined into OFH-Copper and is being integrated from four separate 81cm-long sections which was fabricated by vacuum furnace brazing.

In the KTF RFQ, an average RF power is 417kW. And supplied by one klystron, rated for 1MW operation at 350MHz. The output of each klystron is divided two or four ways to create nominally 210kW or 104kW each. We have been completed a Low-Level RF system [5] and will install and test the klystron.

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 linac and the other is an iris-type for 3.0MeV RFQ linac.

2. Design and fabrication of the input Rf coupler

The input RF couplers have been studied by using the code, High Frequency Structure Simulator (HFSS) V7.0.

2-1. Coaxial-Type RF Coupler

Fig. 1 shows a drawing of the input RF coupler which consists of a loop antenna, coaxial line and half-height WR2300 waveguide. One end of the waveguide matches the half-height WR2300 waveguide including the RF vacuum window. The characteristic impedance of the coaxial line is 50 ohms.

In order to study a low return loss transmission of the 350MHz RF power by the input coupler, we adjusted the positions of the short plates of the WR2300 waveguide and coaxial line. Fig.2 shows that the frequency with a minimum return loss decreases as a distance from center.

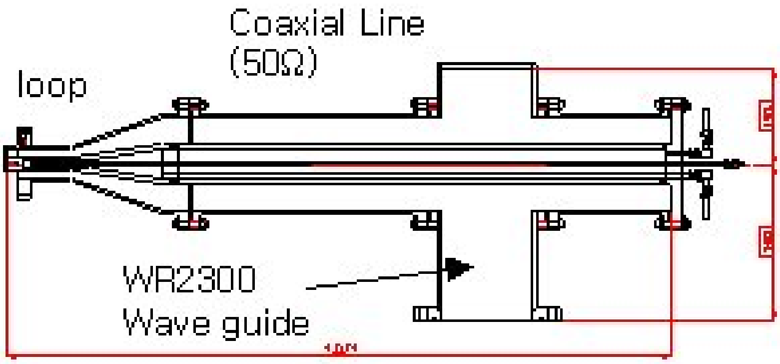

Figure 1. Drawing of the coaxial-type input coupler.

axis of the coaxial line to the short plate of the WR2300 waveguide increases. The position of the short plate of the waveguide, which has the minimum return loss at an operating frequency, 350MHz, is located at 153mm away from the center-axis of the coaxial line. In this case, the S-parameter is 0.0045 and VSWR is 1.01:1.

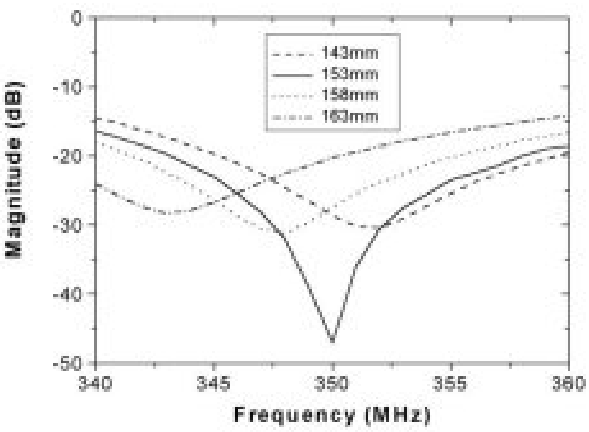

Figure 2. Return loss versus the position of short plate of the waveguide.

The frequency with a minimum return loss decreases as a distance from a left wall of the WR2300 waveguide to a short plate of the coaxial line increases, as shown in Fig. 3. The position of the short plate of the coaxial line, which has the minimum return loss at an operating frequency, 350MHz, is located at 371mm away from the left wall of the waveguide.

Fig 4. shows a distribution of an electric field in the RFQ and the coaxial type input coupler. Input power is 30dBm and an unit of the electric field is V/m. A direction of the loop antenna is perpendicular to an axis of the RFQ cavity. When the RFQ cavity and the input coupler is matched, the S-parameter calculated is 0.008 and VSWR is 1.02:1.

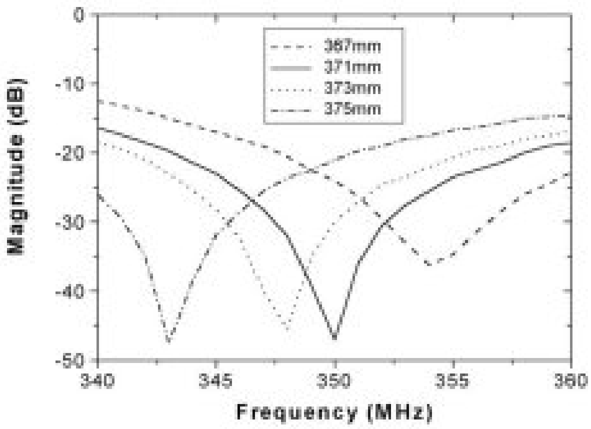

Figure 3. Return loss versus the position of short plate of the coaxial line.

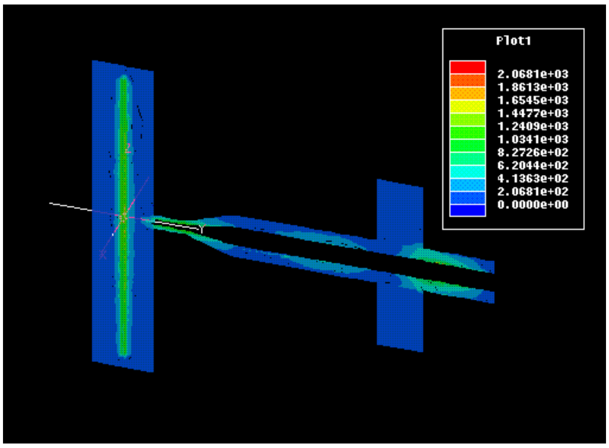

Figure 4. Electric field distribution in the matched RFQ and input coupler.

Coaxial-type input RF coupler has been fabricated with OFH-Copper and will test a low power test on the 0.45MeV RFQ linac next month. 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. 5 shows the fabricated Coaxial-type input RF coupler.

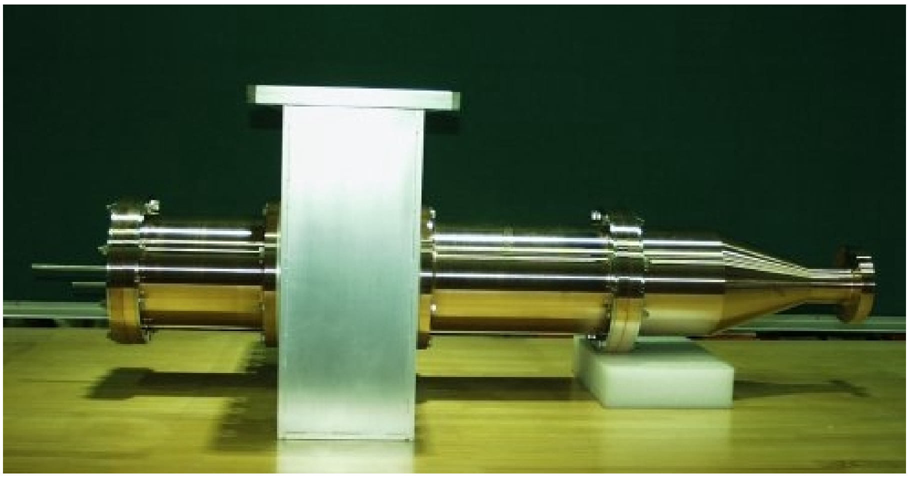

Figure 5.The fabricated Coaxial-type input RF coupler.

2-2. Iris-Type RF Coupler

Fig. 6 shows a drawing of 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

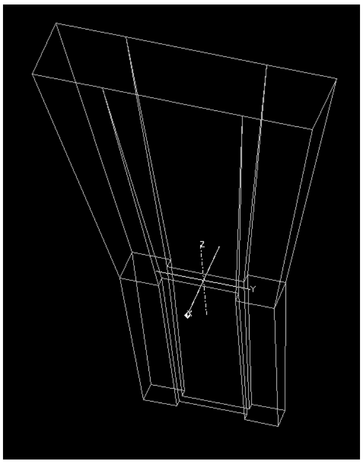

Figure 6. View of the ridge waveguide.

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.

Fig. 7 shows a return loss for the operating frequency, 350MHz. The S-parameter calculated is 0.07 and VSWR is 1.15:1

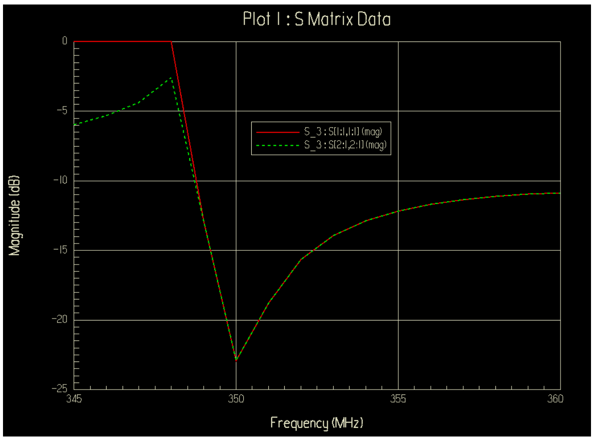

Figure 7. Return loss versus the frequency.

Fig. 8 shows that an electric field distribution in the matched RFQ cavity and input RF coupler.

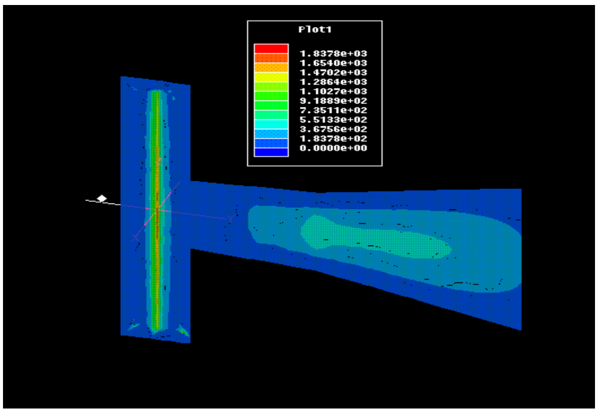

Figure 8. Electric field distribution in the RFQ and input RF coupler

3. Present Status

Design of the input RF couplers for the KTF RFQ began June of 1999. The coaxial-type input RF coupler was designed and has been fabricated. The engineering design of iris-type RF coupler is being done. We are getting ready for test of the coaxial-type input RF coupler. The Low Level RF (LLRF) system has been constructed to run a 1MW klystron and the input RF coupler.

4. Acknowledgment

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