Design Study on the RF Power Coupler for PEFP DTL

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1. Introduction

The ridge-loaded waveguide power coupler for PEFP(Proton Engineering Frontier Project) DTL(Drift Tube Linac) is under development in KAERI. The DTL power coupler should provide the RF power of about 225 kW for each DTL tank. The coupler is the link between the WR2300 half height waveguide and the DTL cavity wall. The coupler should be designed with special care in order to satisfy the various requirements such as RF matching, negligible perturbation on DTL cavity, moderate operating temperature and stress, etc.

In addition the effect of the iris geometry on the coupling beta should be examined for the realization of high-quality transmission of RF power. In this paper, various methods including the analytic and numerical methods are tried to determine the optimum iris geometry of the coupler.

2. Methods and Results

In this section some of the methods used to find the coupling beta of coupler are described.

2.1 Analytical Method

In a cavity-waveguide coupling system, the coupling beta can be expressed as follows [1].

$$\beta = \frac{\pi^2 Z_0 k_0 \Gamma_{10} e_0^4 l_1^6}{9ab\left(K(e_0) - E(e_0)\right)^2} \frac{H_1^2}{P_0} \qquad (1)$$

The above equation is based on the equivalent circuit analysis combined with the equivalent magnetic dipole description for the aperture. Detailed derivation and the definition of the parameters used in Eq. (1) can be found in reference [1]. We have somewhat modified the above expression to fit the ridged waveguide case, because the original one is for the elliptical aperture geometry and waveguide without ridge, and applied it to the ride-loaded waveguide coupler of the LEDA RFQ, IPHI RFQ and SNS DTL to see the validity of the method. The reported design value and the calculation results are shown in Table 1 [2][3].

As can be seen in Table 1, the analytical approach gives the consistent values and makes it possible to determine the coupler iris geometry with ease and reliability.

2.2 Numerical Method

The coupling beta can be found by calculating the unloaded Q of the cavity and the external Q of the coupler from the definition of the coupling beta.

$$\beta \equiv \frac{P_{ex}}{P_c} = \frac{Q_0}{Q_{ex}} \qquad (2)$$

To compute the external Q, we applied the method developed by Balleyguier [4][5]. The reliability of the method was tested by the model case of LAL RF gun reported in [1]. The numerical results were matched to the analytical values within 15%.

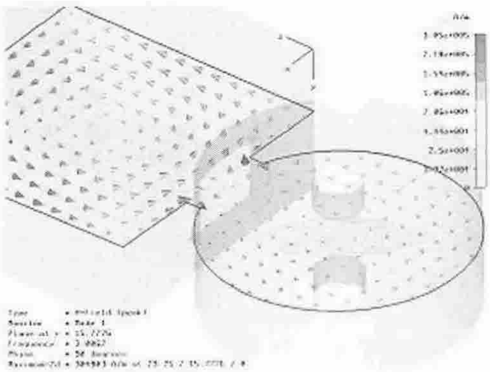

Figure 1. MWS model for coupling beta calculation

3. Conclusions and Future Works

The analytical and numerical method to determine the coupling beta for the given geometry were verified and showed the consistent results. The actual ridge-loaded waveguide coupler will be designed based on these methods and the cold model for the engineering validation will be fabricated and tested in near future.

Table 1. Design Beta and Calculated Result

	LEDA RFQ	IPHI RFQ	SNS DTL
Design beta	0.132	0.355	1.524
Cal. Beta	0.118	0.325	1.393
Ratio	0.896	0.916	0.914

REFERENCES

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