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High Power Components Fabrication for 100MeV Proton Accelerator

Han-Sung Kim*, Hyeok-Jung Kwon, Ji-Ho Jang, Yong-Sub Cho
Program Proton Engineering Frontier Project, Korea Atomic Energy Institute, Gyeongju, Korea
**Corresponding author:kimhs@kaeri.re.kr*

1. Introduction

Proton Engineering Frontier Project (PEFP) is developing a 100-MeV proton linear accelerator, which consists of ion injector, 3-MeV RFQ, 100-MeV DTL, for basic science research and industrial applications. [1][2]

The design duty factor of the accelerator is as high as 24% up to 20 MeV section and 9% for 100 MeV section. Therefore high heat load is anticipated. The proper cooling of the accelerator components is essential for stable operation of the accelerator. Especially for DTL, many slug tuners are used for frequency tuning and field profile control purpose and active water cooling is required. To control the field profile stability through resonant coupling method, we use several post couplers and these post coupler requires water cooling to remove RF heat load.

In addition, we designed and fabricated the vacuum grills with water cooling because wall current should flow through the vacuum grill. The high power RF coupler is a ridge-loaded waveguide type iris coupler. The length of the coupler for 100-MeV DTL is reduced to about quarter wavelength from half wavelength one used for 20-MeV DTL. In this paper, a brief introduction and fabrication status of the high power components for the DTL such as slug tuners, post couplers, vacuum grills and high power RF couplers are presented.

2. Slug Tuner

A 100-MeV DTL is composed of 7 DTL tanks and each tank consists of three sections. Total 12 slug turns are used for each tank to tune the resonant frequency and uniform field profile. The peak heat load on the slug tuner is estimated to about 21.6 kW, which amounts to 1.9 kW average heat load considering 9% duty factor. Therefore forced water cooling is necessary to remove heat load from the slug tuners. Fig. 1 shows the slug tuner drawing. A spiral cooling channel is machined on copper plate and the cooling plate is assembled to the slug tuner cylinder with vacuum brazing technique. For cooling pipe, 3/8" stainless steel tubing was used. Fig. 2 shows the fabricated slug tuner. Because the main purpose of the slug tuner is to tune the resonant frequency of the tank and to control the field profile, iterative tuning process, which requires fine machining of the top surface of slug tuner cylinder, is essential. Therefore, each slug tuner will be made to standard size and actual slug tuner size will be adjusted during the iterative tuning process.

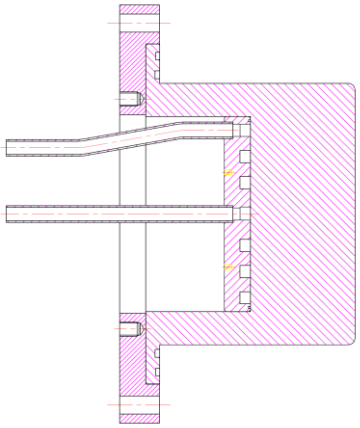

Fig. 1. Drawing of the slug tuner.

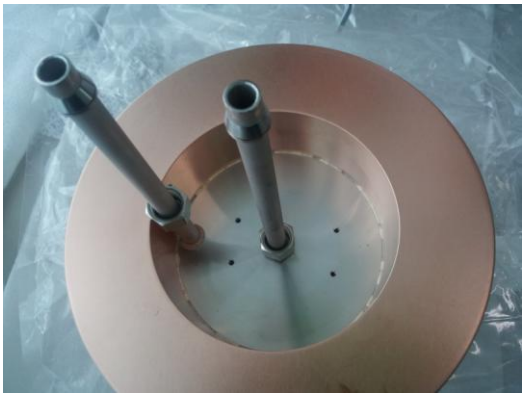

Fig. 2. Fabricated slug tuner.

3. Post Coupler

For field stabilization through resonant coupling, we used post couplers. A 100-MeV DTL contains as many post couplers as the cell number in the tank. For example, DTL101 (first tank in 100-MeV section) includes 33 post couplers. The peak heat load on the post coupler is estimated to about 50 kW, which amounts to 4.5 kW average heat load considering 9% duty factor. Fig. 3 shows the slug tuner drawing. A coaxial cooling channel is used for post coupler cooling. Fig. 4 shows the fabricated post couplers.

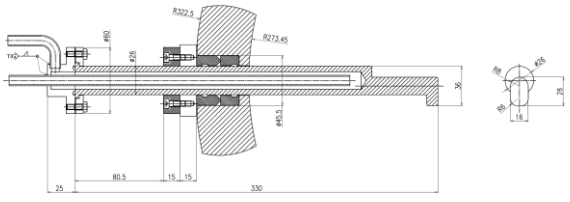

Fig. 3 Drawing of the post coupler.

Fig. 4. Fabricated post couplers.

4. Vacuum Grill

For vacuum pumping, we designed high power vacuum grill with water cooling channel. The vacuum grill was divided into two pieces and the cooling channel was fabricated between them. Two pieces were joined with the vacuum brazing technique. The peak heat load on the post coupler is estimated to about 3.9 kW, which amounts to 0.4 kW average heat load considering 9% duty factor. Fig. 5 shows the slug tuner drawing and Fig. 6 shows the fabricated vacuum grill.

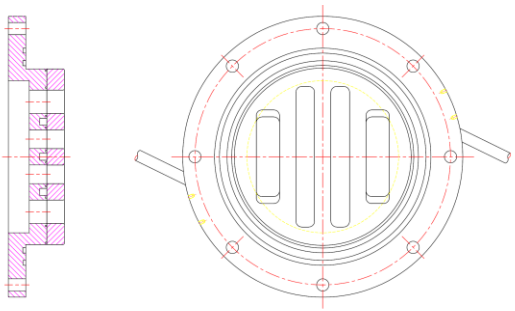

Fig. 5. Drawing of the vacuum grill.

Fig. 6. Fabricated vacuum grill.

5. High power RF Coupler

The high power RF coupler for the DTL is ridge-loaded waveguide type iris coupler. This type of RF coupler was successfully used for 20-MeV section. The length of the RF power coupler was reduced to about quarter wavelength compared with half wavelength for 20-MeV section coupler. Base material is steel and inside of the coupler is copper plated to reduce RF loss. Fig. 7 shows the drawing of the RF power coupler and the prototype is under fabrication.

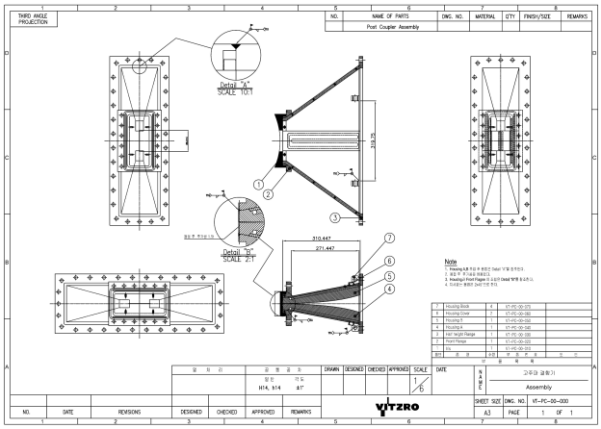

Fig. 7. Drawing of the RF power coupler.

6. Summary

The high power components for 100-MeV DTL such as slug tuner, post coupler, vacuum grill were designed and fabricated. In consideration for high heat load, active water cooling was adopted. After fabrication, each part was tested including vacuum tightness and water pressure proof. The fabricated high power component will be assembled into the tank with proper vacuum sealing and RF sealing.

Acknowledgement

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REFERENCES

[1] B. H. Choi, et al., "The Proton Engineering Frontier Project", Proceedings of IPAC10, Kyoto, p3616 (2010).
[2] Y. S. Cho, et al., "100-MeV High-Duty-Factor Proton Linac Development at KAERI", Proceedings of LINAC2006, Knoxville, p501 (2006).