

## Installation and test of the MEBT RF coupler

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### 1. Introduction

The 100 MeV proton linac consists of a total of 11 RF systems. One for RFQ, one for 20MeV DTL, two for MEBT and seven for 100MeV DTL. Currently, there are nine RF systems in operation except MEBT. MEBT RF systems are being installed and tested to improve beam delivery rates. Recently, the coupler and window fabrication for MEBT cavity have been completed, vacuum test was performed during the summer maintenance period in 2019 and installed in the MEBT cavity. The high power SSA(60kW SSA for MEBT1, 30kW SSA for MEBT2) and RF transmission lines have been installed and completed the 5kW transmission test.

### 2. MEBT RF System Design

RF system consists of FPGA controlling RF power amplitude and phase, analog chassis performing a RF distribution and an up/down conversion, interlock for the high power RF system protection and SSA amplifying RF power for MEBT tank. In MEBT RF system, an electric field stability of  $\pm 1\%$  in amplitude and  $\pm 1^\circ$  in phase is required [1, 2].

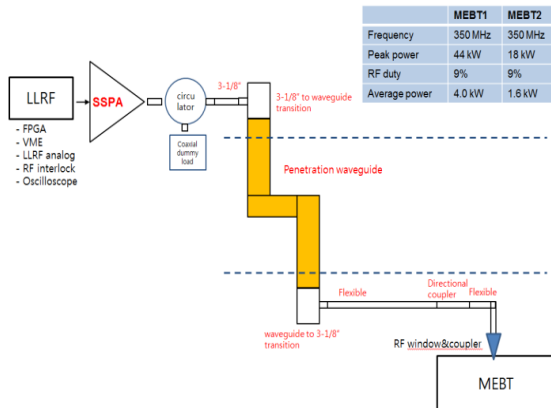


Fig. 1. Diagram of the MEBT RF system

Figure 1 shows the schematic diagram of the MEBT RF system. RF controlled in the LLRF system is amplified by the SSA and then passed through the circulator. The high power RF passing through the circulator passes through the 3-1/8 coaxial line and the waveguide to the MEBT cavity. The specifications of the main high power RF components are as follows.

SSA

: manufactured by Tomco

: Peak RF power up to 30 kW and 60 kW

: Max duty is 9 % (1.5 ms, 60 Hz)

Circulator

: A 350 MHz Y-junction type circulator

: 60 kW peak and 6 kw average RF power for forward and reverse direction at any phase

: manufactured by Advanced Ferrite Technology (AFT)

### 3. Coupler installation and tuning

The SSA installation was completed before installing the MEBT coupler. The installation of RF transmission line from SSA to MEBT RF coupler was completed. Figure 2 shows the SSA for MEBT1 and 2.

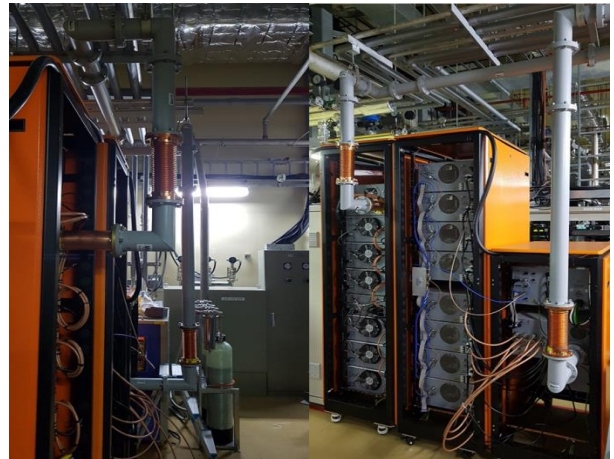


Fig. 2. MEBT1, 2 SSA(60kW, 30kW) and 3-1/8 coaxial transmission line



Fig. 3. Installed MEBT RF Coupler

Figure 3 shows the MEBT coupler before and after installation. The coupler was vacuum tested and then connected to the MEBT cavity. Tuning was done to match the critical coupling. Figure 4 shows the Smith chart before and after tuning the MEBT2 and the SWR values. MEBT coupling was modified from over coupling to critical coupling. The SWR value improved from 2.03 to 1.05.

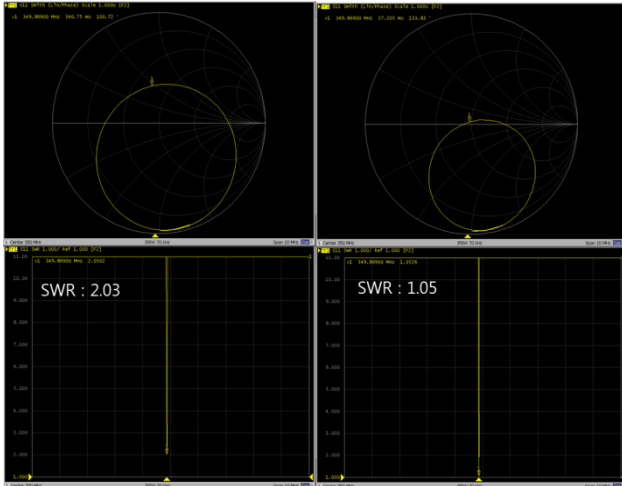


Fig. 4. Smith chart before and after tuning the MEBT2

After the coupler was installed, the resonance frequency of the MEBT tank changed more than 140kHz, so it was impossible to put RF into the MEBT cavity. Instead, the RF transmission test was conducted with a 5kW output by connecting a 1kW(CW) dummy load to the end of the coaxial transmission line. In the case of 5kW, 1Hz and 500us, the output is well transmitted to the dummy without reflection wave.

The slug tuner sensitivity of MEBT1, 2 was measured to match the resonance frequency. The change of resonance frequency was measured by varying the slug tuner to various lengths. Table 1 shows measurement results of the slug tuner sensitivity.

Table I: Measurement of Resonance Frequency Change According to tuner Height

MEBT1				
DT cooling water Temp(°C)	25	25	25	25
Cavity wall Temp(°C)	27	27	27	27
Vacuum condition	Air	Air	Air	Vacuum
Slugtuner height(mm)	87.15	84.9	86.1	86.1
Resonance Frequency(MHz)	349.869	349.7914	349.8304	349.8985
MEBT2				
DT cooling water Temp(°C)	22	22	22	22
Cavity wall Temp(°C)	27	27	27	27
Vacuum condition	Air	Air	Air	Vacuum
Slugtuner height(mm)	86.1	87.15	87.15	87.15
Resonance Frequency(MHz)	349.866	349.897	349.959	

### 3. Conclusions

The MEBT LLRF system and high power system were installed and the SSA and transmission line tests were conducted with 5kW output. The coupler was installed in the cavity after the vacuum test and tuned to the critical coupling. Currently, the resonance frequency of MEBT cavity is about 140kHz lower than the design value, and slug tuner will be modified to adjust the resonance frequency. RF conditioning will be carried out after the slug tuner is replaced.

### REFERENCES

- [1] H. J. Kwon, H. S. Kim, K. T. Seol and Y. S. Cho, J. Korean Phys. Soc. 48, 726 (2006).
- [2] K. T. Seol, H. J. Kwon, H.- J. Choi and Y. S. Cho, J. Korean Phys. Soc. 56, 1994 (2009).