Adjustment of Iris RF Coupling for KOMAC DTL Tank

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***Keywords :** RF coupling, RF coupler, Drift Tube Linac, KOMAC

1. Introduction

The main accelerator of a 100-MeV proton linac for KOMAC is a drift tube linac (DTL), which is composed of seven independent tanks (DTL101 to DTL107), used for accelerating proton beam from 20 MeV to 100 MeV. For the efficient acceleration of proton beam up to 100 MeV, each tank required about 1.2 MW peak RF power, including copper power (~800 kW), beam power (~200 kW) and control margin (~200 kW). Iris coupling with a ridge-loaded waveguide (shown in Fig. 1) was used for RF coupling because iris coupling is better in terms of multipacting and perturbation on the resonant cavity, compared with loop-type coupling [1].

When we adjust the RF coupling to the cavity to minimize the reflection power, we have to consider the beam power as well as copper power, resulting in over-coupling during RF coupling adjustment without beam. The optimum coupling beta is given by Eq. (1),

$$\beta_{op} = 1 + \frac{P_b}{P_c} \quad (1)$$

where P_b is beam power and P_c is cavity copper loss [2]. The optimum coupling beta for each DTL tank about 1.2 to 1.3. In principle, the coupling beta should be maintained its initial value but we found three tanks out of seven showed excessive reflection, which means the coupling beta has changed after almost 10-year operation. To reduce the reflected power, we determined to adjust the coupling of RF coupler during accelerator maintenance period.

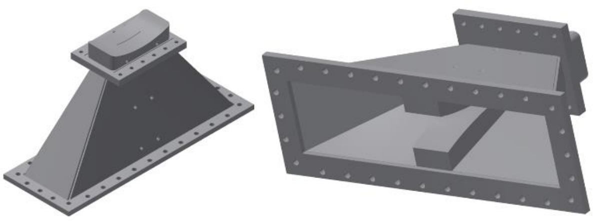

Fig. 1. Ridge-loaded waveguide coupler.

2. Methods and Results

DTL102, DTL106 and DTL107 showed excessive RF reflection during its operation. According to the VSWR measurement for each DTL tank, we found that 26%, 13%, and 30% of RF power were reflected from the RF coupler of DTL102, DTL106, and DTL107, respectively. All three tanks showed heavily over-coupled behavior as shown in Fig. 2. The coupling hole diameter of each iris was 15.7 mm for all three tanks. To reduce the coupling, we fabricated new iris coupling plate with smaller diameter.

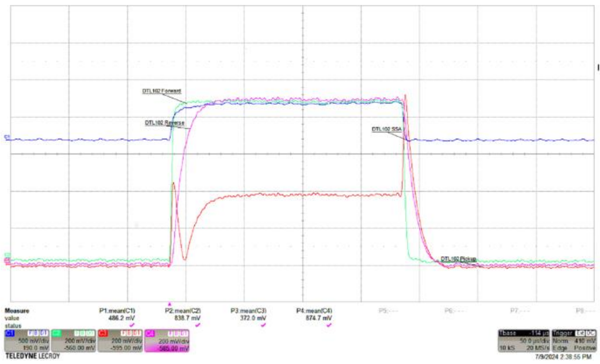

Fig. 2(a). RF waveform for DTL102. The red trace shows the reflected RF waveform.

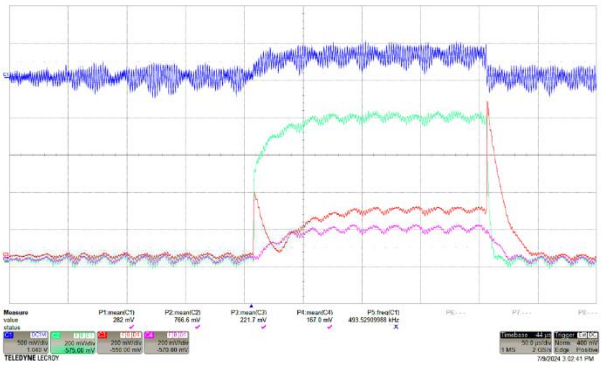

Fig. 2(b). RF waveform for DTL106. The red trace shows the reflected RF waveform.

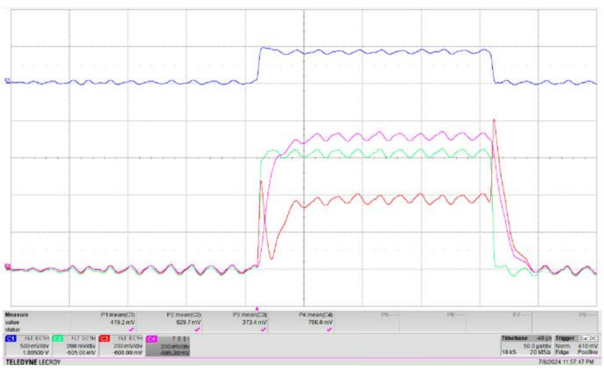

Fig. 2(c). RF waveform for DTL107. The red trace shows the reflected RF waveform.

The original coupling hole diameter of 15.7 mm was reduced to 14 mm, 13 mm, and 12 mm for DTL102, DTL106 and DTL107, respectively. VSWR measurement results before and after adjustment is summarized in Table 1. Over and under in the table mean over-coupling and under-coupling, respectively.

Table 1. VSWR before and after coupling adjustment.

Tank	VSWR before	VSWR after
DTL102	3.09 (over)	1.49 (under)
DTL106	2.10 (over)	1.31 (over)
DTL107	3.45 (over)	1.29 (under)

Fig. 3(a) Smith chart for DTL102

Fig. 3(b) Smith chart for DTL106

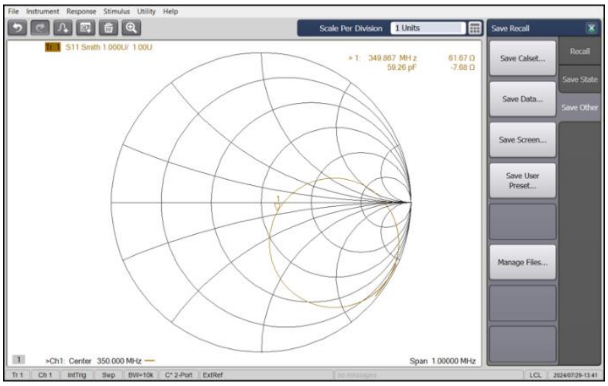

Fig. 3(c) Smith chart for DTL107

The traces in the Smith chart and the RF waveform after coupling adjustment are shown in Fig. 3 and Fig. 4, respectively.

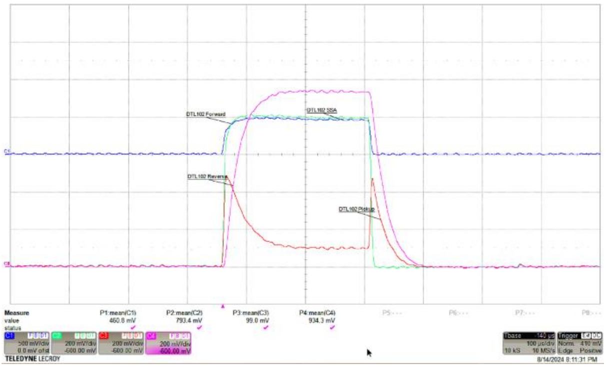

Fig. 4(a). RF waveform after coupling adjustment for DTL102. The red trace shows the reflected RF waveform.

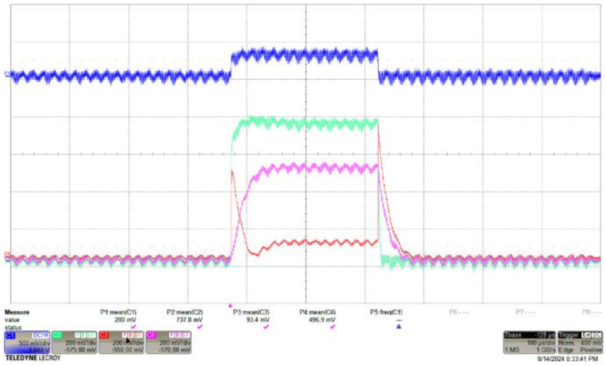

Fig. 4(b). RF waveform after coupling adjustment for DTL106. The red trace shows the reflected RF waveform.

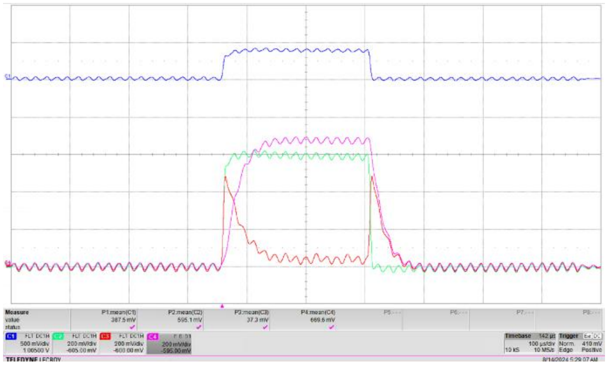

Fig. 4(c). RF waveform after coupling adjustment for DTL107. The red trace shows the reflected RF waveform.

3. Summary

After 10-year operation of the DTL in KOMAC accelerator facility, three DTL tanks out of seven showed excessive RF reflection (almost 30% in worst case). We fabricated new iris coupling plate with reduced coupling hole size to adjust the coupling coefficient. Even though the final adjustment results are not so optimal (for example, the coupling coefficients of DTL102 and DTL107 are less than 1, while optimum coefficient should be around 1.25), the reflected power was greatly reduced, resulting in less than 4% of incident RF power in worst case. In addition, we found some arcing trace in the coupling plate. For better operational stability of RF coupler especially in high-duty operation condition, the RF contact of the iris plate should be revised.

ACKNOWLEDGMENTS

This work has been supported through KOMAC (Korea Multi-purpose Accelerator Complex) operation fund of KAERI by MSIT (KAERI ID: 524320-24)

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