TUNING OF 20MEV PEFP DTL*

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Abstract

The PEFP (Proton Engineering Frontier Project) DTL which accelerate the proton beam having peak current 20 mA to 20 MeV have been constructing in KAERI site [1]. The tank resonant frequency is 350 MHz and a 1 MW klystron is used for 4 tanks. In this paper, the overall features of the PEFP DTL tuning are presented and the measurement results of the DTL tank 1 are discussed.

INTRODUCTION

The tuning goals for PEFP DTL are achieving ±5kHz of designed resonant frequency and ±2% of the design value through the tank. The tilt sensitivity against the perturbation is less than 2%/MHz. The tuning frequency goal is 349.915 MHz at 37 ℃ tank temperature in air. The major parameters of the PEFP 20MeV DTL are summarized in table 1 and the schematic of the tank 1 is shown in figure 1 [2].

Table 1: PEFP 20 MeV DTL major parameter

Parameter	Tank1	Tank1	Tank3	Tank4
Energy (MeV)	3.0 ~ 7.18	7.18 ~ 11.5	11.5 ~ 15.8	15.8 ~ 20.0
No. of cells	51	39	33	29
No. of post couplers	17	19	16	14
No. of slug tuners	8	8	8	8
Tank length (m)	4.431	4.649	4.755	4.776

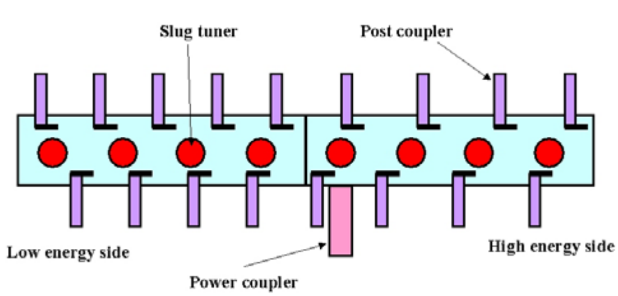

Figure 1: The schematics of the DTL tank1

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MEASUREMENT SETUP

The tuning of the DTL tank means three items, which are frequency tuning, field profile tuning and stability tuning against perturbations. The target frequency is 349.915 MHz at 37°C tank temperature which includes the air effect, humidity and operating conditions. The target of the field profile tuning is within 2% of the designed average accelerating gradient of each cell. The target of the stability tuning is to minimize the stability parameter well below 2%.

A bead perturbation method was used to measure the field distribution of the DTL tank. The network analyser (Agilent 8753ES) was used to measure the phase changes due to aluminium bead of 8mm diameter. It took about 3 minutes for measuring 4.3m long DTL tank 1. With these conditions, the space resolution was about 0.3mm per data point. The Labview program was used for data acquisition.

An algorithm for determining the best tuner length has been setup. It uses the least square method using the data of field profiles at present tuner position and at perturbed position per each tuner. The simulation using SUPERFISH code showed that the set of 8ea. tuner length of the DTL tank1 could be determined using two iterations within 1% field profile from the 25% tilt field profile.

During tuning, the DTL tank was maintained at constant temperature of 37°C through heater with PID controller and heat insulator located around the tank. Long term measurement showed that the frequency changes were within ± 500Hz.

The DTL tank 1 with drift tubes, slug tuners and post couplers is shown in figure 2 and tuning setup for tank 1 in figure 3.

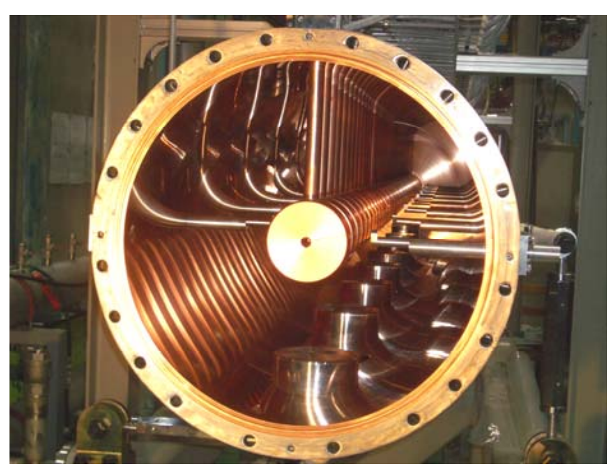

Figure 2: DTL tank 1

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Figure 3: Tuning Setup for DTL tank1

Tuning procedure is basically iteration process. The flow diagram for the DTL tuning can be found in figure 4.

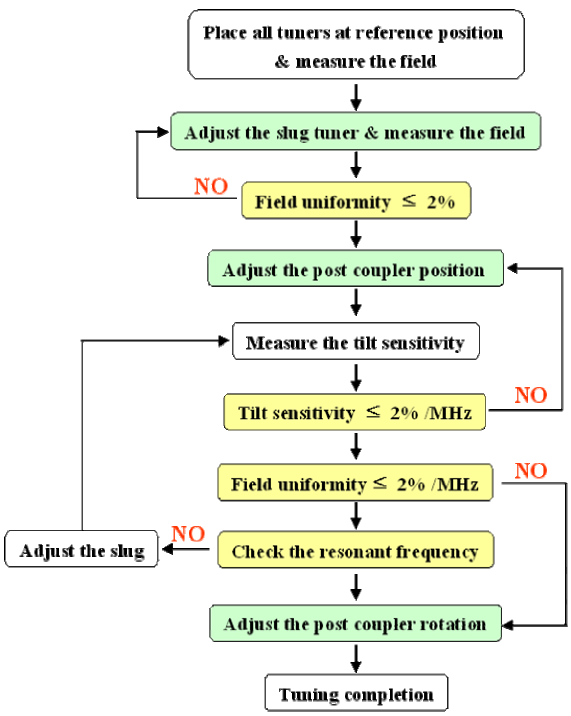

Figure 4: DTL tuing procedure

Typical shape of measured raw data during the tuning process is shown in figure 5.

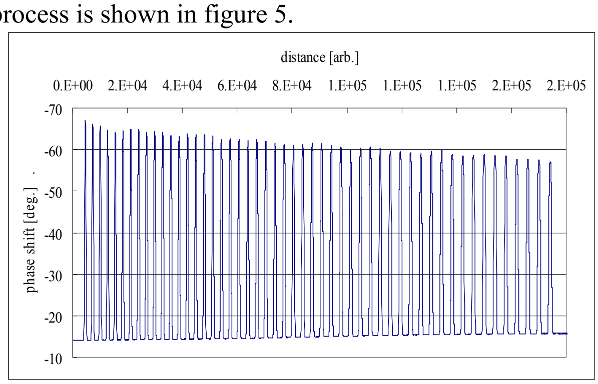

Figure 5: The shape of raw data measured for tank 1

RESULTS AND DISCUSSIONS

Adjustment of Slug Tuners Without Post Couplers

The first of the tuning process is slug tuner position adjustment for the required field profile. Each tank has 8 slug tuners. For the 20 MeV PEFP DTL, the designed field profile is flat without any ramping of the field. Figure 6 shows the field profile before and after the slug tuner position adjustment.

Adjustment of the Post Couplers

Following the slug tuner adjustment, the post coupler position and rotation was adjusted. Each tank has one post coupler for every 3 drift tubes for tank1 and every 2 drift tubes for tank 2, 3 4. The resonant frequency shift by the insertion of the post coupler was about 250 kHz. Figure 7 shows the effect of the post coupler adjustment.

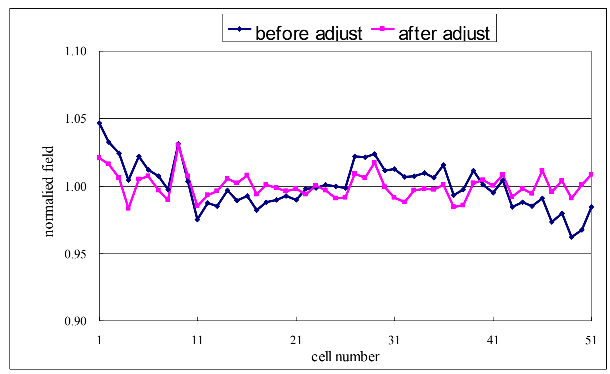

Figure 6: Slug tuner adjustment

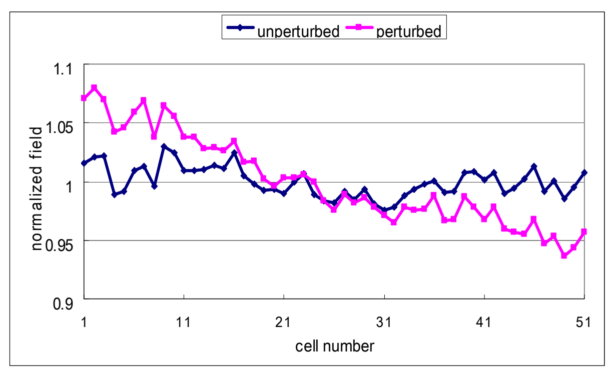

Figure 7a: Field profile before post coupler adjustment

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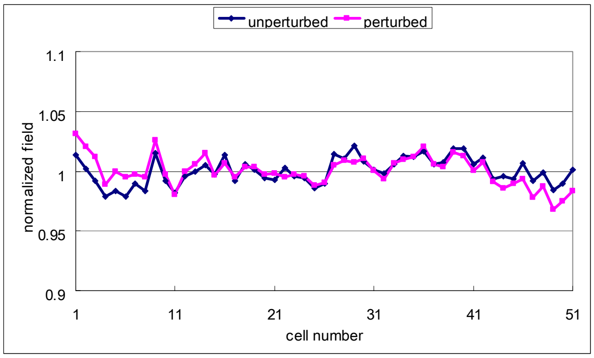

Figure 7b: Field profile after post coupler adjustment

In figure 7, the perturbation was given to the tank by two slug tuners located at both end side. The frequency change due to perturbation from low energy end side slug tuner was -10 kHz and high energy end was +10 kHz. As can be seen in figure 7b, the properly tuned DTL is insensitive to the external perturbation, which can be explained by the confluence effect. At confluence, the accelerating mode frequency is located near the center of two neighbouring mode frequencies in the spectrum. Figure 8 shows the frequency spectrum of the DTL tank 1.

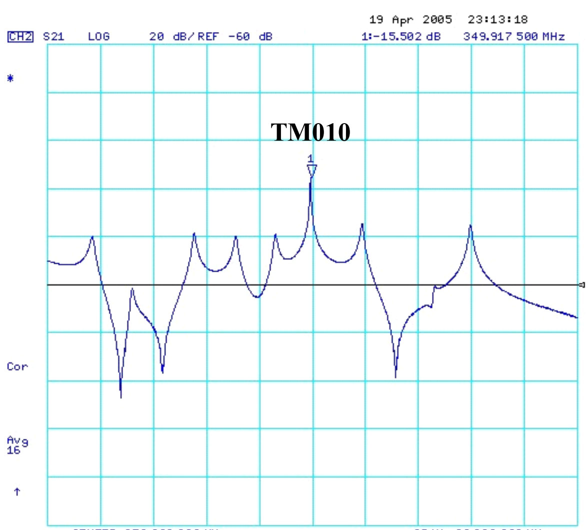

Figure 8: The frequency spectrum near the properly tuned condition

During the tuning of the DTL, the temporary movable aluminium slug tuners were used for convenience. After completion of the tuning, the movable slug tuners are replaced with the fixed tuners made of OFHC. Figure 9 shows the machined fixed tuner and post coupler.

Figure 9a: Slug tuner with STS supporting flange

Figure 9b: Post coupler with mounting flange

CONCLUSION

The tuning schemes and the procedures for PEFP DTL are established and the DTL tank 1 was successfully tuned to meet the tuning requirement. Tuning of tank 2 is now in progress using the same equipments and the procedure. After the completion of the tuning of all tanks, the RF power coupler will be tuned.

REFERENCES

[1] B. H. Choi, "Status of the Proton Engineering Frontier Project", in these proceedings.

[2] H. S. Kim, "Initial Test of the PEFP 20 MeV DTL", in these proceedings.