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RF Field Distribution Tuning of Drift Tube Linac

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1. Introduction

To make a design field profile, we performed the RF tuning process for a 100-MeV drift tube linac (DTL) of Korea Multipurpose Accelerator Complex (KOMAC). The tuning process includes the field flatness tuning by using the slug tuners and the tilt sensitivity tuning by using the post couplers. The target values of the tuning process are like followings;

- Field uniformity: better than 2%
- Tilt sensitivity: less than 150%/MHz.

During the tilt sensitivity tuning, we found that the slug tuners prevented the field stabilization if they were inserted too much. However, if the slug tuner positions were limited, then it was not possible to tune the DTL tank to the right resonant frequency. To solve the problem, we attached the tuning rings around each post couplers, which compensate the frequency gap caused by the slug tuner position limitations. We present the tuning process and results in this paper.

2. RF tuning setup

In this section we describe the experimental setup for RF field tuning. We measured the RF field distribution along the DTL tank by using the bead perturbation technique based on Slater's perturbation theory [1]. The amount of the RF phase shift was measured by using a network analyzer while a small metal bead was transported through the DTL tank. The phase shift is proportional to the frequency shift caused by the bead perturbation and the frequency shift is proportional to the square of the electric field intensity at the bead postion. Figure 1 shows the overall setup for the RF tuning of the DTL.

A DTL tank has 12 slug tuners and a number of post couplers. Total number of the post couplers depends on how many cells are in the DTL tank. The KOMAC DTL tank has as many post couplers as the cell number and each post coupler is installed in alternating position along the tank. By pushing or pulling each slug in the tank, we can change the field profile along the tank as well as the resonant frequency. Post couplers are used to make confluence condition and make the RF field stable against any kind of perturbation. The schematics of the slug tuners and post couplers can be seen in Fig. 2, which is based on the fifth DTL tank of KOMAC DTL.

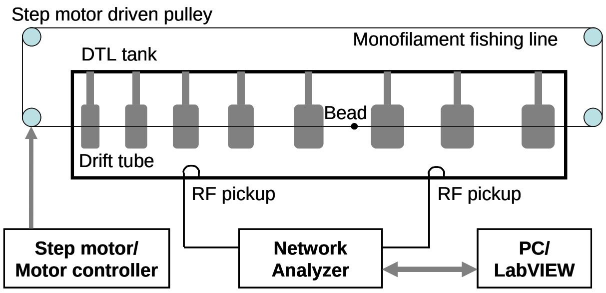

Figure 1. Schematics of the bead pull measurement.

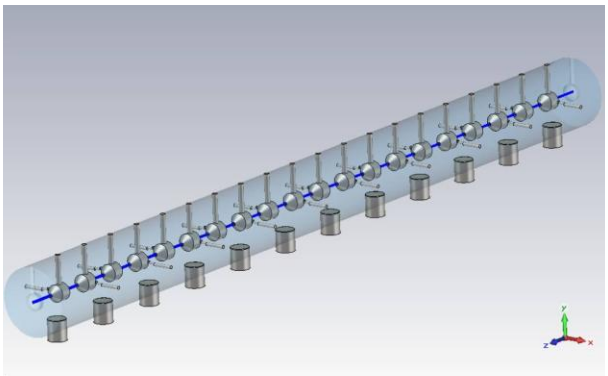

Figure 2. Slug tuners and post couplers in DTL tank.

3. Field flatness tuning

The RF field profile along the DTL tank is not uniform due to the errors in machining and/or alignment. The slug tuners can fix the field distribution and make the field flat. Figure 3 shows the RF field profile before and after the field flatness tuning.

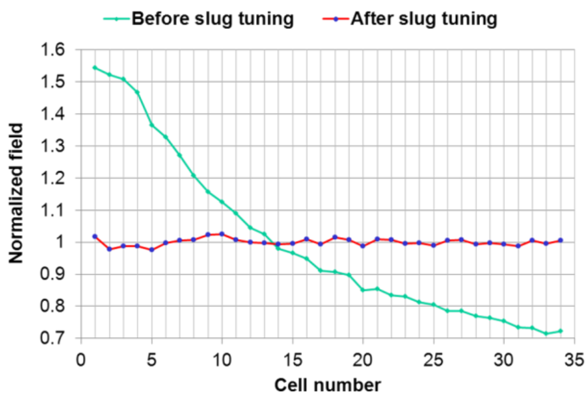

Figure 3. Field profile before and after tuning.

4. Tilt sensitivity tuning

For stabilizing the RF field in the DTL tank through the resonant coupling, the frequency band between the post mode and cavity mode should be closed and the field profile of the highest post mode should be similar to that of TM011 mode [2]. Figure 4 shows the mode spectrum for the fifth DTL tank of KOMAC DTL. When the post couplers are properly tuned, the field profile of the highest post and TM011 mode look similar as shown in Fig. 5 and Fig. 6.

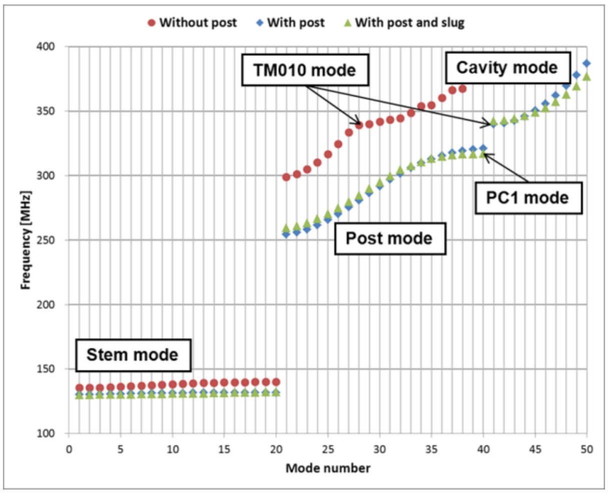

Figure 4. Mode spectrum of the DTL tank.

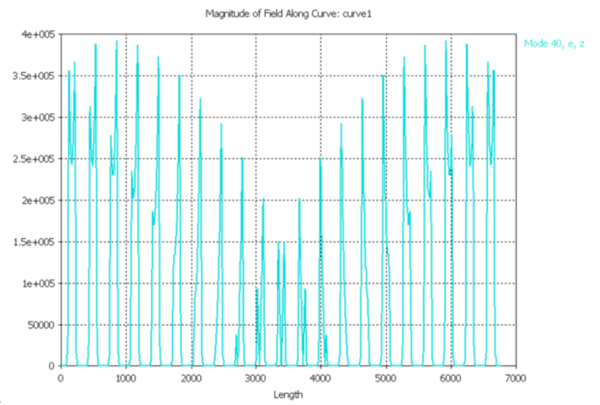

Figure 5. Field profile of the highest post mode.

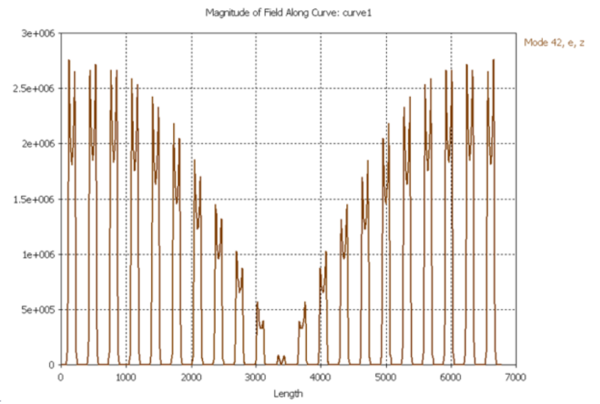

Figure 6. Field profile of TM011 mode.

When the slug tuners are inserted too much into the tank, the similarity between the highest post mode and TM011 mode disappears and the post couplers cannot stabilize the field. In KOMAC DTL case, the slug insertions were limited to make it easy to complete the tilt sensitivity tuning. To compensate the lowered frequency due to the limited slug insertion, we installed the tuning ring around each post coupler as shown in Fig. 7. By adjusting the insertion of the post couplers, the tilt sensitivity could be lowered below 150%/MHz as shown in Fig. 8.

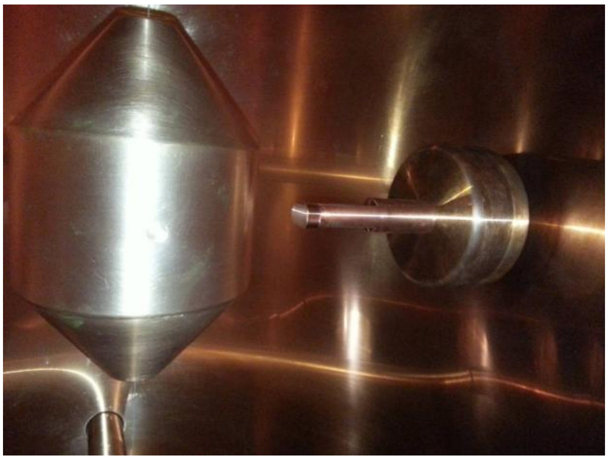

Figure 7. Tuning ring around the post coupler.

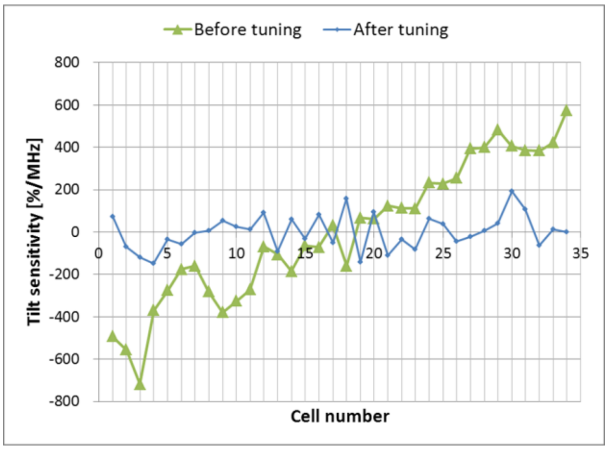

Figure 8. Tilt sensitivity results.

Acknowledgements

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REFERENCES

[1] David M. Pozar, Microwave Engineering, 2nd ed. John Wiley & Sons, Inc., 1998.
[2] Thomas P. Wangler, RF Linear Accelerators, 2nd ed. Wiley-VCH Verlag GmbH & Co. 2008.