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IMPROVEMENT OF THE LINEAR PART IN THE TUNER SYSTEM OF ADS 25 MeV LINAC

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Abstract

Tuner system is the indispensable part of ADS high current proton superconducting linac. It influences the working frequency of superconducting cavity of particle accelerator. To completely understand the working situation of the tuner system and analyses the problems existing in it, experiments of linear part were fully conducted.

INTRODUCTION

The tuner system of ADS 25 MeV Linac (Fig. 1) built in CM1, CM2 and CM3 consists of 17 tuners[1], and every tuner consists of two parts – linear part and tuning implement unit. Linear part is mainly composed of step motor, reduction box, screw-nut and coupler (Fig. 2). To learn about the working conditions and structure characteristics, the linear parts of 17 tuners were tested and the CM1-2, CM2-3 and CM3-1 were chosen as representatives to give a brief introduction of test procedure and results. Through the analysis of the problem, the linear part was improved and tested again, and the effect was remarkable.

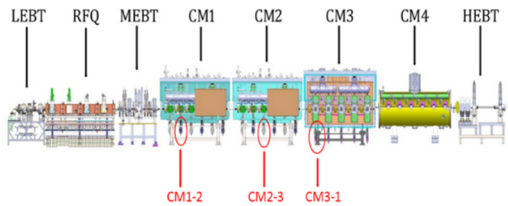

Figure 1: The layout of ADS 25MeV linac.

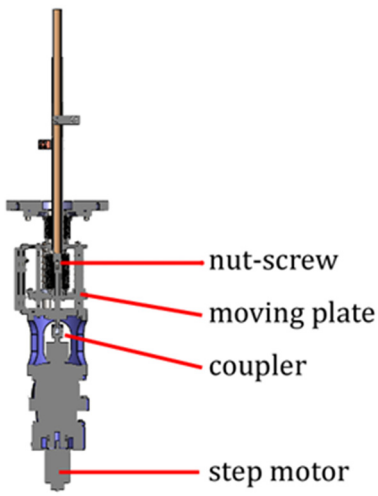

Figure 2: The sectional view of the tuner linear part.

THE TEST OF LINEAR PART

The linear part of tuners was tested at 300 K as shown in Fig. 3. The moving plate was adjusted to a suitable position to ensure enough space to move up and down. Then the dial indicator was fixed on the bracket and was properly set at an indication that later we took as the center. With 200 steps at a time, the step motor was made to move 25 times in the direction where the moving plate rose and fell respectively. Positions of every movement were recorded by the dial indicator.

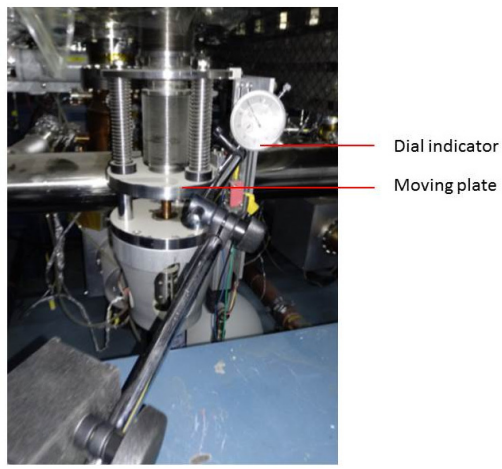

Figure 3: The test of the linear part.

The result of CM1-2 tuner linear driving part (Fig. 4) test shows that the plate tends to move linearly and is barely influenced by hysteresis, which shows the linear drive part works well and meets the requirement of tuners.

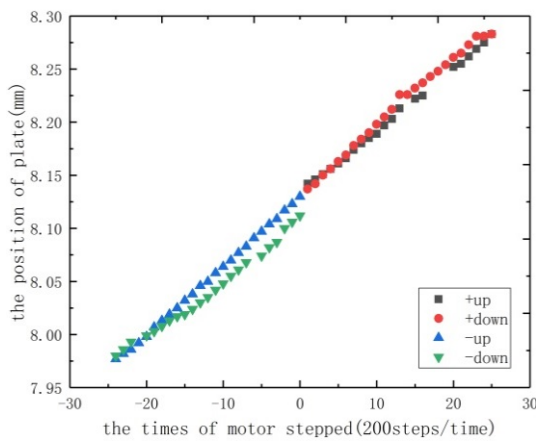

Figure 4: The curve of the line part test in CM1-2.

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From the curve of CM2-3 (Fig. 5), five times (1000 steps) of delay of moving plate can be seen. This could be caused by worn screw-nut and fatigue damage of coupler.

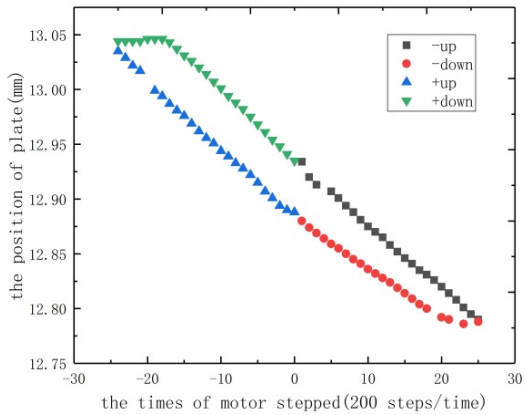

Figure 5: The curve of line part test in CM2-3.

The curve in Fig. 6 shows much of delays in linear part of CM3-1. 3800 steps of returns occurred throughout all 5000 steps of processes. The rate is up to 76%. This may also result from worn screw-nut and fatigue damage of coupler. Moreover, the positon of the return processes in positive direction slightly lifts before it descends. As for this phenomenon, further experimental analysis is needed.

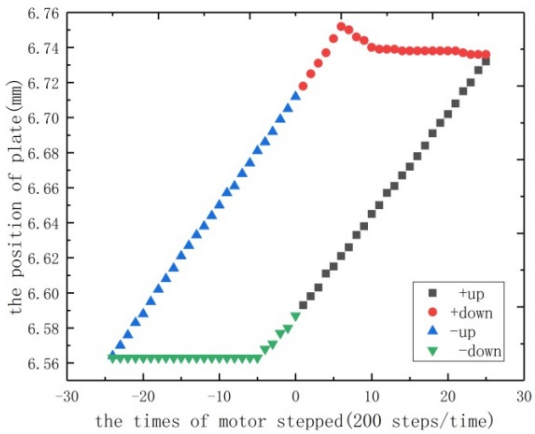

Figure 6: The curve of linear part test in CM3-1.

THE IMPROVEMENT IN LINEAR PART

Tests in the linear part helped find the main reasons, the gap formed when the reduction box is moving and the wear of the nut-screw, for hysteresis. Therefore, we substituted the trapezoidal screw with ball screw that is more precise and the precision can reach 30 um level. Then we accurately computed the tuning force and torque according to the tuning requirement of HWR cavity, and selected a step motor which is 4.2 Nm in torque and removed the reduction box.

The mechanical structure of tuner was modified as well. The top of the screw was fixed on the third flange, the third flange and the first flange were fixed on the support of motor. So the situation of the screw deviation from axis when it works is avoided. Nut was fixed on the second flange, second flange and the forth flange was install together. Three linear bearings are evenly distributed on the second flange and forth flange. It increases the flexibility and linearity of the second and forth flanges linear motion. The rotational motion of screw was converted to the linear motion of second flange and forth flange. Guide rod fixed on forth flange, so it can motion with forth flange. Figure 7 shows the structure of the improved tuner linear part.

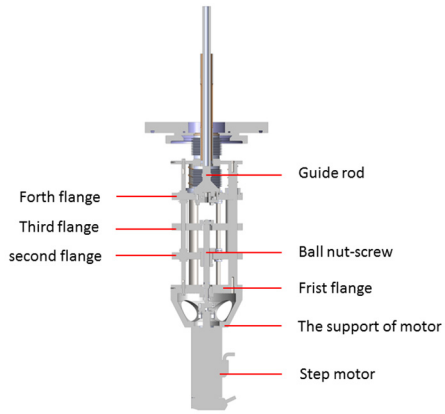

Figure 7: The sectional view of improved linear part.

The improved linear part was tested. Figure 8 shows the relationships between motor stepped and positions of the forth flange. As is shown above, the motion of forth flange almost linear. The coincidence degree of the three lines is high, and when the motor rotate reversed, there is no delay. After 800 steps of the motor stepped, there are 25 μm return. The 25 μm return main come from the precision of ball nut-screw.

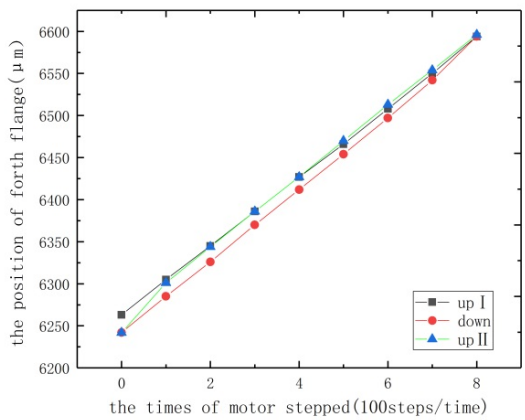

Figure 8: The curve of improved linear part.

CONCLUSION

The experiment found the delays of the tuner linear part in ADS 25 MeV Linac. After analysised the problem and found the cause of the problem, and proposed improvements. The improved linear part solves the cause of delays well, but there is still a little return. The reason for this phenomenon comes from the difference in the return stroke that the mechanical structure itself cannot be excluded, and the accuracy of the ball screw nut. This phenomenon can be greatly improved if a higher precision ball screw is used.

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