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A Study on CCDTL Structure

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Abstract: The CCDTL (Coupled Cavity Drift Tube Linac) structure presented by Los Alamos Lab is a new structure for proton's velocity from 0.1*c* to 0.5*c*. The CCDTL aluminium and copper model are manufactured. The final OFHC (Oxygen Free High Conductivity) model consists of four accelerating cavities and three coupling cavities. There is only one drift tube in the accelerating cavity, so one accelerating cavity has two accelerating gaps. The model was made and tuned. The basic characteristics of the structure such as cavity frequency, dispersion curve, coupling, field profile are measured.

Key words: Coupled Cavity Drift Tube Linac, Cold model, RF measurement

INTRODUTION

The CCDTL concept was invented in 1994[1]. Then it plays a major role in the APT Low-Energy Linac (LEL) design. In China, we plan to research the CCDTL due to its merits. Since 1998, we have got the support fund from National Natural Science Foundation of China. Firstly the cold aluminium model was made. The coupling slot influence was measured. And the relationship between coupling k_1 and coupling slot area was simply tested. Then an OFHC copper cold model was designed and made. The basic technological machine steps and design steps were explored. By the help of experience in tuning SSC CCL modules, we are tuning the OFHC copper cavity. Before the model study on CCDTL, the symmetrical design of the CCDTL is explored[2]. Because of the basis of using computer simulation on

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the beam dynamic is poor, the research work is not continued.

In the process of research, we got the news from the international conference. In new intense proton beam accelerator project, the Los Alamos scientist did not choose the CCDTL structure. The reason was not published. It is said that in the high power test, the CCDTL structure did not work stablly. But we think that the CCDTL may be used in the weak beam and low duty factor conditions.

1 CCDTL DESIGN

Firstly, the design frequency was chosen. We only have the power source of 201 MHz, so the suitable power source is absent. And in a long time, we can not get the suitable power source. So according to the traditional method of study on new structure, the 1300 MHz virtual work frequency was chosen. The geometric β is 0.283. Taking account of the influence of coupling slot, the initial frequency of accelerator cavity without stems is about 1311 MHz, the coupling cell is 1308 MHz. Table 1 and Table 2 present the parameters of the cavities calculated by SUPREFISH. All the names of the parameters are the same as the denomination of SUPERFISH.

Table 1 The parameter of the accelerator cavity

Cavity diameter	14.0 cm
g/βλ	0.22
Equator flat	4 cm
Inner corner radius	0.4 cm
Nose radius	0.2 cm
Cone angle	30 degree
Septum thickness	0.8 cm
Bore radius	1 cm
DT diameter	4.8 cm
DT corner radius	0.3 cm
DT nose radius	0.2 cm
DT stem diameter	1.0 cm
Stem count	2
DT face angle	60 degree

Table 2 The parameter of the coupling cavity

Diameter	11 cm
Length	4 cm
Post diameter	3.7 cm
Post length	1.51 cm
Outer post radius	0.2 cm

The nearest neighbour coupling k_1 and the second nearest neighbour couplings k_2 and k_3 will also be measured. So the aluminium mode consists of 7 cavities. Fig. 1 is the drawing of CCDTL cold model. The symmetric design is used, so all accelerating cavities are the same. Another key parameter is the distance Lac between the axis of the coupling cavity and the axis of the accelerating cavity. The initial value of Lac is 12.0 cm. Although k_1 can be calculated approximately using SF8 (one program in SUPERFISH), we tend to decide the Lac in experiment. In the experiment, Lac is decreased several times. At the same time, the parameters of accelerating cavity and coupling cavity are changed a little. Then using the data from aluminium model, we design a same OFHC model. With the help of our factory, the OFHC model is manufactured. At last, all the parts of the model are welded to form a segment. During the manufacturing, we had an inconceivable problem. The first

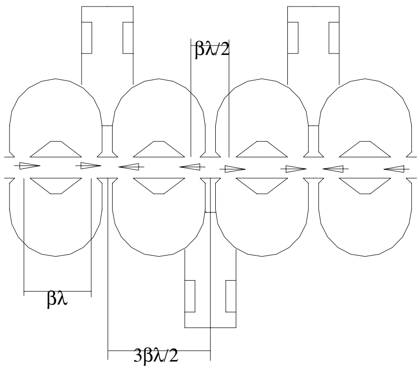

Fig. 1 Drawing of CCDTL cold model

coupling cavities were made and welded. But we can not vacuum it. When we fill high-pressure nitrogen gas into the cavity and deep the cavity into alcohol liquid, it produces a lot of tiny bubbles from the surface of the cavity. Based on our analysis, the reason is that the OFHC material has stored in atmosphere for a long time, so the characteristic of the material is changed. So we must test the characteristic of material before using it.

2 THE CCDTL MODEL TEST

We use the HP network analyzer 8753C/85047A to tune and test the OFHC CCDTL segment. First each cavity's frequency is measured before and after weld. The influence of welding procedure is indefinite. Some cavity frequencies are higher, some lower, but the variation is less than 0.3%. First the accelerating cavities are tuned by deforming the cavity, then the coupling cavity is tuned by putting the plug into the cavity through vacuum pipe. Fig. 2 is the frequency spectrum of the CCDTL segment. Then we use the code DISPER to calculated k_1. The result is as follows: ω_1=1300.09 MHz, ω_2=1300.06 MHz, k_1=2.29%, k_2=−0.0457%, k_3=−0.0462%. So we can calculate ω_a=1299.793 MHz, ω_c=1299.760 MHz. The $f_{\pi/2}$ of the segment is also tested, which is 1299.796 MHz. The corresponding Q is about 14 000. Fig. 3 displays the result calculated from DISPER.

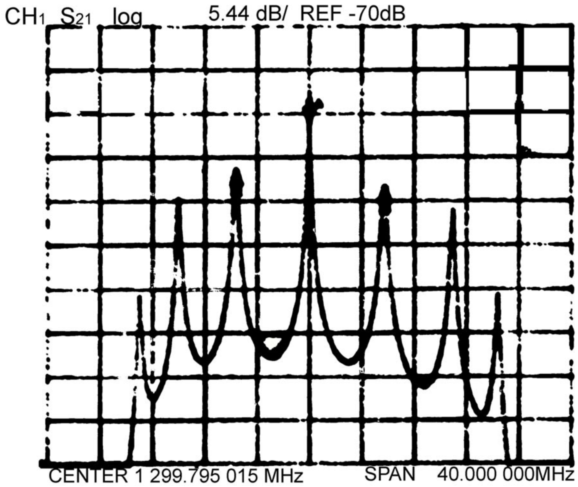

Fig. 2 The frequency spectrum of CCDTL segment

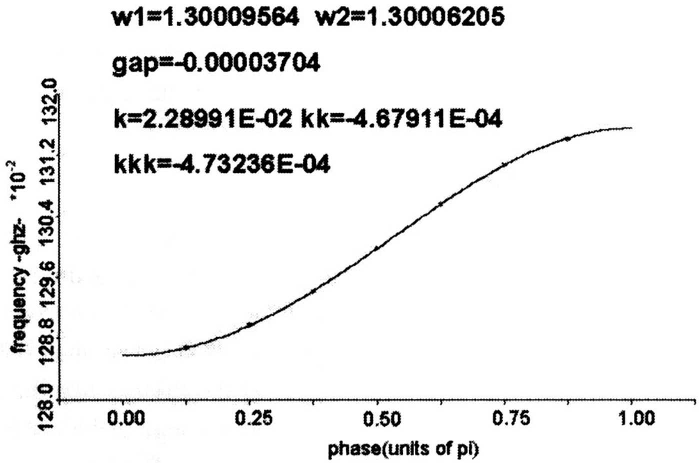

Fig. 3 The dispersion curve of the CCDTL segment

At last, we use the bead perturbation method to measure the field profile of the CCDTL segment. The bead is an aluminium sphere with 3 mm diameter. The result is illustrated in Fig. 4.

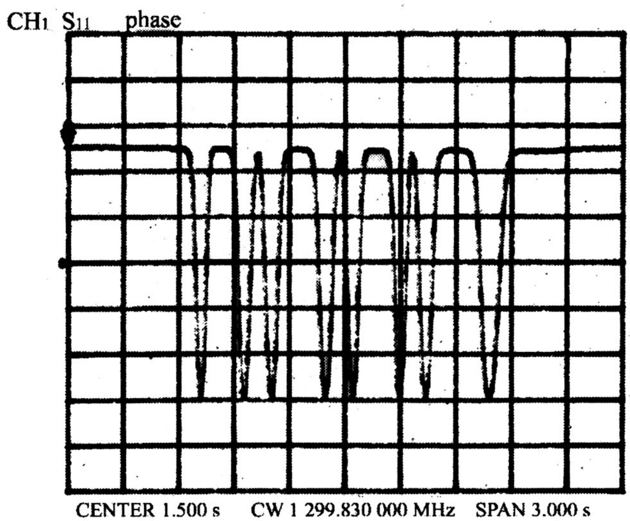

Fig. 4 The axial field profile

We do not find the influence of the end cavity. We will test the model thoroughly.

ACKNOWLEDGEMENT

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CCDTL 结构的研究

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摘 要：在质子速度为 0.1～0.5c 范围，美国 Los Alamos 实验室提出一种新的加速结构 CCDTL。我们利用铝模及铜模，对 CCDTL 结构进行研究。CCTDL 模型腔列由四个加速单元及三个耦合单元组成。采用单漂移管 CCDTL 结构。对 CCDTL 的模型进行了调谐及测试，获取了初步的实验数据，如谐振频率、色散曲线、耦合系数、场分布等。

关键词：CCTDL 冷模型 射频测量