COLD MODEL TEST OF BIPERIODIC L-SUPPORT DISK-AND-WASHER LINAC STRUCTURE

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Cold model test of a biperiodic L-support Disk-and-Washer linac structure is performed. Each washer is supported by two L-shaped supports 180° apart azimuthally. The structure is a variant of the biperiodic 4-T support DAW[1]. Because the coupling-mode frequency is pushed up by the supports, it should be compensated to coincide with the accelerating frequency. The biperiodic supports also break the uniformity of the field distribution on the axis. The compensation methods against these perturbations are described.

I. INTRODUCTION

An electron linac[2] has been installed at the Accelerator Laboratory, Institute for Chemical Research, Kyoto University. It is mainly intended as the injector for the electron storage ring KSR [3,4], which is being assembled. The disc-loaded wave-guides are installed as the accelerator tubes, which are operated at 2857MHz. Because of the limited space in the building, only three of 3-m accelerator tubes can be installed. The available RF power from a klystron is up to 20 MW for each tube, and then the output electron energy is expected to be about 100 MeV at the peak current of 100 mA. In order to have a shorter damping time in the storage ring, however, the higher injection energy is desirable. A new accelerating tube with a higher shunt impedance is thus required to achieve the higher accelerating gradient with the same input RF power.

A cold model made of Aluminum is fabricated to study the possibility of a DAW structure with biperiodic washer supports. The results of the cold model test are described.

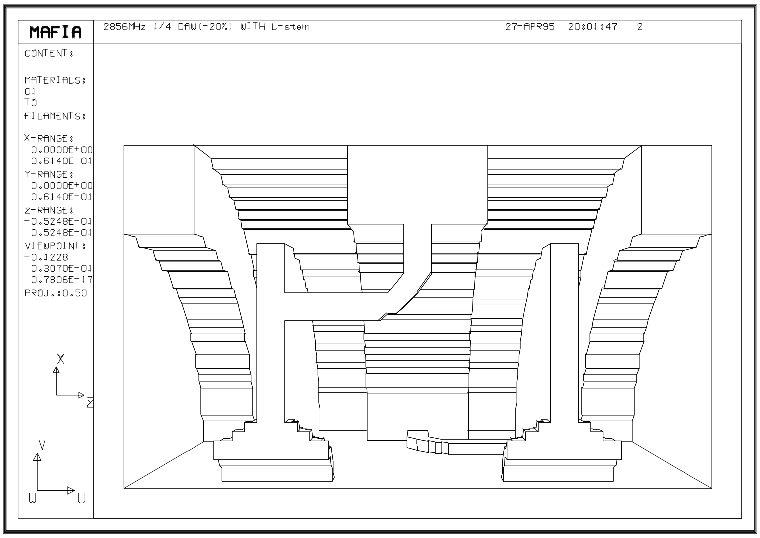

Fig.1 DAW with Biperiodic support

II. BIPERIODIC L-SUPPORT DAW

The DAW structure has outstanding features in high stability, good vacuum properties, high shunt impedance, and ease of fabrication[5]. It was found that the mode overlapping problem can be overcome by the biperiodic support configuration with the careful choice of the tank diameter (See Fig. 1). There is variety of options for DAW linac structure with such washer support. For example, in the configuration with a large tank-diameter, the operating frequency drops between two split TM11(-like) mode passbands, and the shunt impedance is higher. When the tank diameter is small, both passbands are above the operating frequency, and the mode density is smaller. The basic configuration described here is the extension of the PIGMI[6] geometries, except for the thicker washers and the reduced tank diameter by 20%. This geometry has fewer undesirable modes and a shorter filling time compared with the large diameter 4-T support DAW. The washer thickness is increased for the cooling water channels inside the washers. Because the L-support configuration has only two supports on a washer, there are only one inlet and one outlet for the cooling water. This may simplify the fabrication problem compared with the 4-T support geometry, which has two inlets and two outlets on the washer[7]. A typical design specification based on SUPERFISH calculation is listed in Table 1.

III. TUNING METHOD

The positions of the washer supports are determined so that their effect on the accelerating mode is minimized. Then, the coupling mode frequency is inevitably disturbed by the existence of the supports, and its frequency is pushed up. Ideally, fc should be coincide with the accelerating-mode frequency, then some compensation procedure is needed. Besides this effect, the biperiodicity of the supports breaks the uniformity of the electric field distribution on the axis. Because the supports reduce the electric field around them, the coupling coefficients between the cells are not uniform, yielding the biperiodic modulation on the field. In order to improve the coefficient unbalance, the disk radii Rdn and Rds (see Fig. 2) are changed biperiodically; namely, the disks with the washer supports have a larger radius than that without supports, which enlarges the disk-washer opening. Thus, the coupling coefficients are enhanced biperiodically, and the coupling frequency is corrected by adjusting the average of Rdn and Rds. Finally the accelerating frequency will be tuned by modifying the washer radius Rw.

IV. MEASUREMENTS

The measurements are performed with a six-washer geometry. The coupling mode frequency is measured in the geometry with the half washer endplates, which has three disks with supports and three disks without support (See Fig. 3-a). Although the simple biperiodicity of the total system is broken, this geometry will give the correct coupling frequency [1]. There is another option of the support direction; namely, the quad-periodic geometry where the support direction changes alternatively (See Fig. 3-b). Although we measure both configurations, the biperiodic one is of concern. Considering the fact that Rt indicated in Fig. 2 also affects the field distribution, three sets of the supports with different lengths (different Rt) are prepared. Photos 1 and 2 show the typical parts for the model cavity, and the close view of the disk-support-washer assembly.

Figure 4 shows the geometry for the accelerating-mode measurement. The configuration of the measurement system for the field distribution on the axis is shown in Fig. 5. The resonant frequency is tracked by the Phase Locked Loop. The feedback voltage to the DC-FM input of Synthesized Signal Generator is recorded as the frequency shift due to the bead-pull-perturbation.

Rc/λ	0.585	-
ß	1.0	-
Frequency	2.856	GHz
L=ßλ/4	26.24	mm
Rc (cavity radius)	61.40	mm
Rd (disk radius)	49.6	mm
Td (half disk thickness)	12.53	mm
Rw (washer radius)	42.	mm
Tw (half washer thickness)	2.5	mm
θ (nose angle)	30	degree
Rn (nose radius)	1.2	mm
Rb (bore radius)	5.13	mm
G (gap)	14.84	mm
Rt (supporting point)	32.3	mm
Rr (support curvature)	9.	mm

Table 1 DAW cavity dimensions

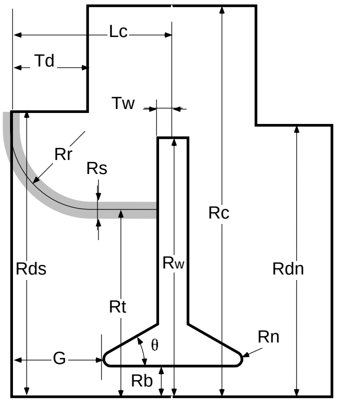

Fig. 2 Notations for DAW dimensions

V. RESULTS

Figure 6 shows the frequencies of the coupling mode and the accelerating mode as a function of Rdn. Rds is 46mm in this case. The coupling mode frequency increases with the Rdn, while the accelerating mode frequency does not change

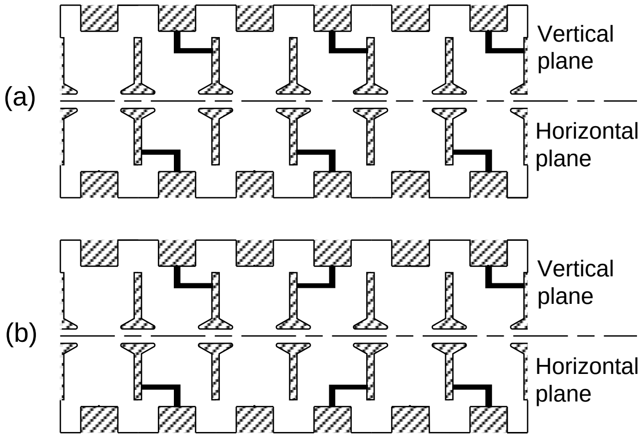

Fig. 3 Geometry for the measurement of the coupling mode frequency. (a) biperiodic (b) quad-periodic.

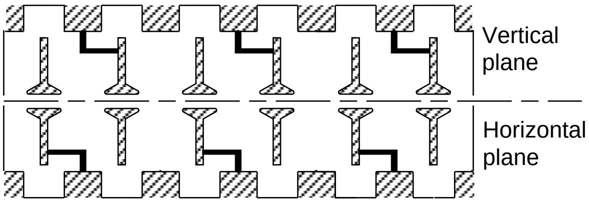

Fig. 4 Geometry for the accelerating mode

Photo 1 The typical parts for the DAW cold model

Photo 2 Close view of the disk-support-washer assembly

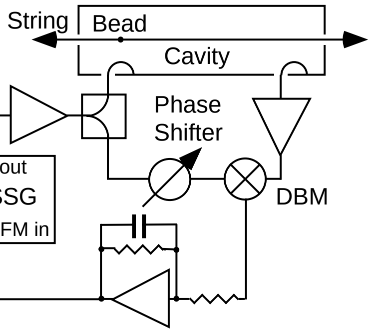

Fig. 5 Phase Locked Loop for the Bead Perturbation Method

much. The typical result of the field distribution measurements is shown in Fig. 7. The values of field strength are taken at the center of the cell where the strength has dip, then the values are averaged among the cells with supports or those without support. Figure 8 shows the uniformity of the field distribution on the axis as a function of Rdn, which is the ratio of electric field strength in the cell-with-supports to that-without-support.

It is confirmed that the uniformity can be controlled by adjusting the difference between Rds and Rdn. The coupling mode frequency could be controlled by modifying the average of Rds and Rdn. The dimensions of Rdn, Rds, and Rw may be good parameters to meet the three requirements; 1) fa and 2) fc should match to the operating frequency, 3) the field distribution should be as uniform as possible. The research for the tuning process is going on.

VI. ACKNOWLEDGMENT

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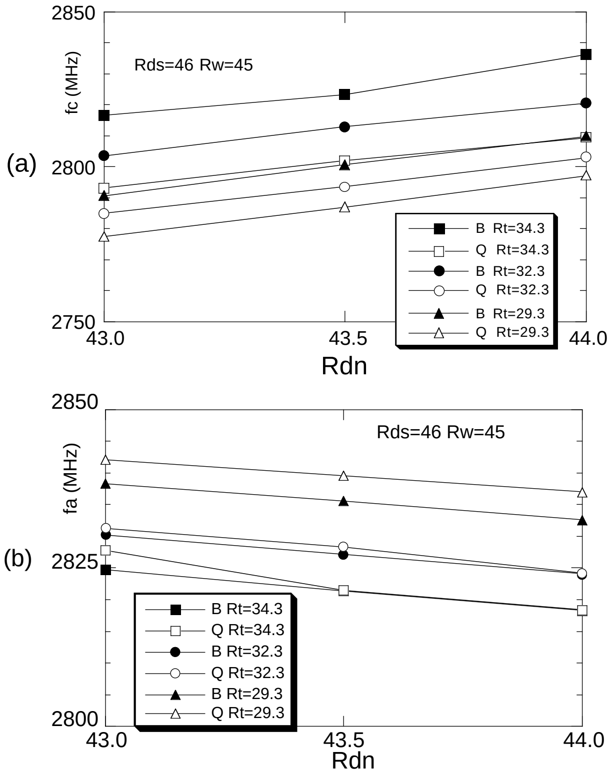

Fig. 6 (a) Coupling mode frequency as a function of Rdn.
(b) Accelerating mode frequency as a function of Rdn.

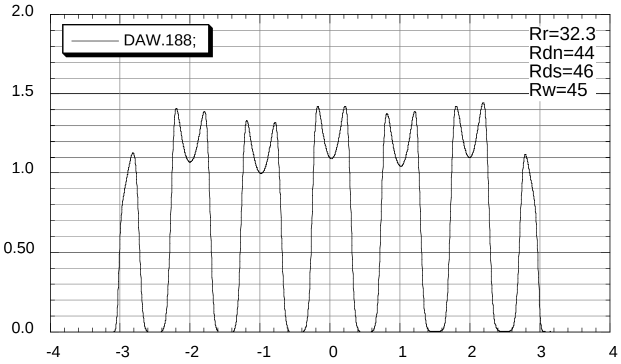

Fig. 7 The typical result of field distribution measurements

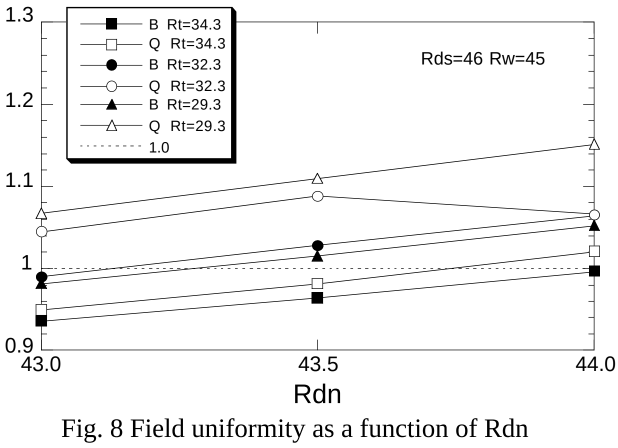

Fig. 8 Field uniformity as a function of Rdn