PA16

COLD MODEL MEASUREMENT OF BIPERIODIC L-SUPPORT DAW

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Abstract

Cold model test of a biperiodic L-support Disk-and-Washer linac structure is performed. The structure is a variant of the biperiodic 4-T support DAW. Each washer is supported by two L-shaped supports 180° apart azimuthally. The results of the cold model tests are described.

1. Introduction

An electron linac[1] has been installed at the Accelerator Laboratory, Institute for Chemical Research, Kyoto University. It is mainly intended to be used as the injector for the electron storage ring KSR [2,3], 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 accelerator tubes of three meter in length 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, 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 RF power.

A cold model made of Aluminum[4] is fabricated to study the possibility of a DAW structure with biperiodic washer supports. The coupling-mode frequency shift by the supports, and biperiodic disturbance on the field distribution are measured and compensated in cold model tests. The mode spectra is also measured.

2. 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, and the fabrication of the coolant path is straightforward, although the design of the path is not strait forward. This may simplify the fabrication problem compared with the 4-T support geometry whose washer has two inlets and two outlets on it[7,8]. The multiple inlets and outlets may cause the fabrication problem when the paths have splits and merges. A typical design specification based on SUPERFISH calculation is listed in Table 1. The notations for the DAW dimensions are shown in Fig.2.

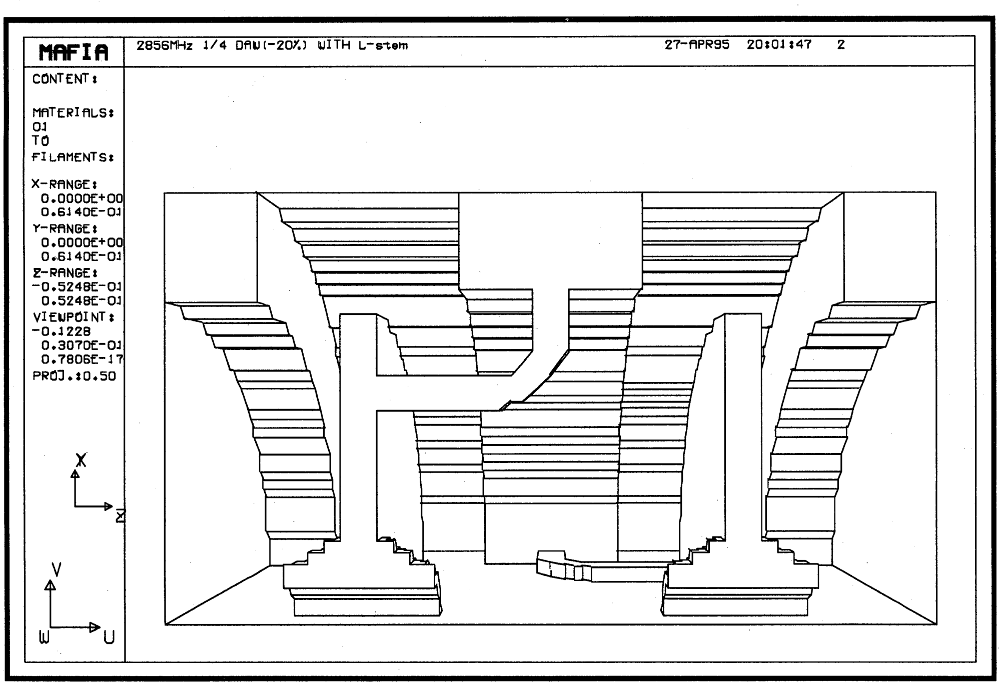

Fig.1 DAW with Biperiodic support

3. Tuning Process

The positions of the washer supports are determined so that their effect on the accelerating mode is minimized. Then, the coupling mode frequency fc is inevitably disturbed by the existence of the supports, and its frequency is pushed up from its calculated value. Because fc should coincide with the accelerating-mode frequency fa, fc should be compensated. 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 distribution. 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.

The tunings 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 in the whole system is broken, this geometry will give the correct coupling frequency[4]. There is another option of the support direction; namely, the quad-periodic geometry where the support direction changes alternatively (See Fig. 3-b). Photos 1 and 2 show the typical parts for the model cavity, and the close view of the disk-support-washer assembly.

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

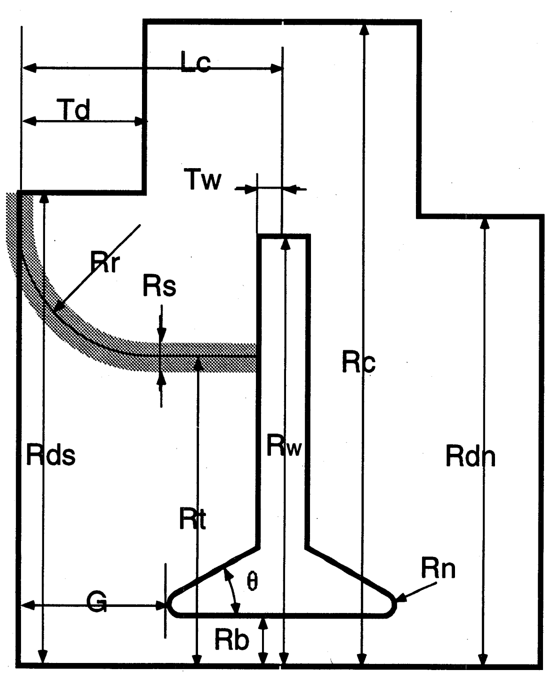

Fig. 2 Notations for DAW dimensions

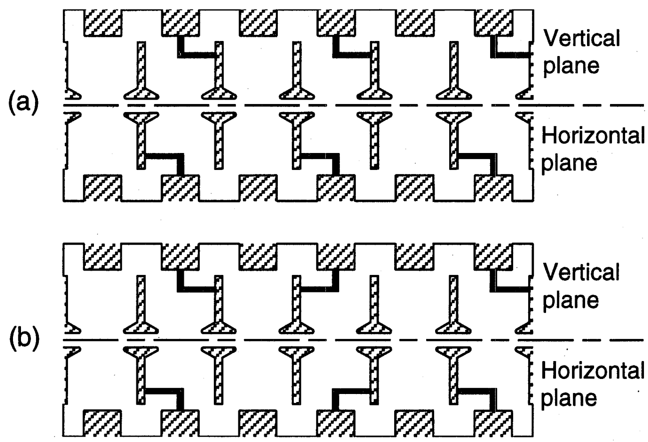

Fig. 3 Geometry for the measurement of the coupling mode frequency. (a) biperiodic (b) quad-periodic.

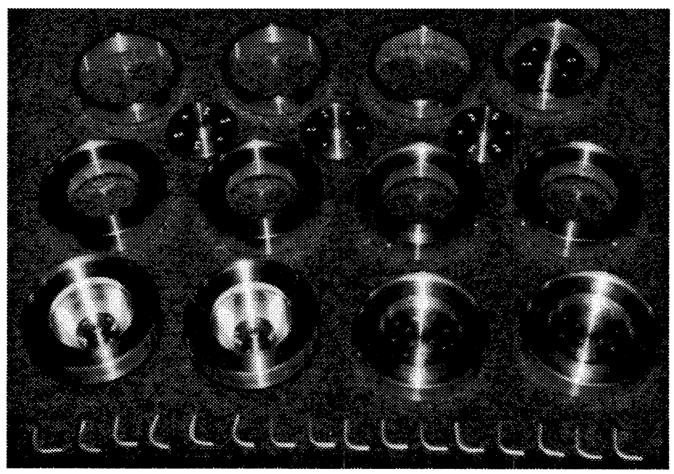

Photo 1 The typical parts for the DAW cold model

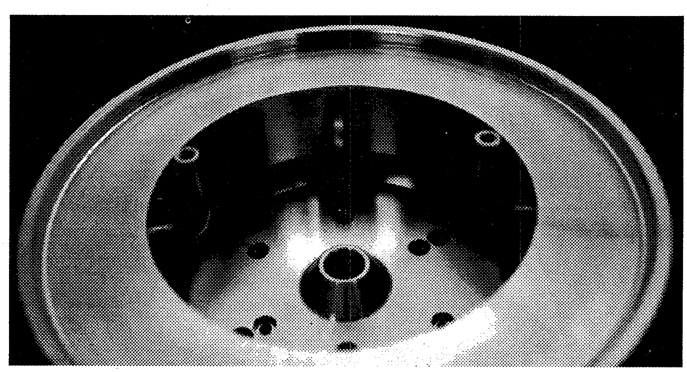

Photo 2 Close view of the disk-support-washer assembly

4. Measurements and results

Figure 4 shows the geometry for the mode spectra measurement. Although it is intended to be the "bi-periodic configuration", the bi-periodicity is broken by the terminations. It does not have a mirror symmetry even. Figure 5 shows the preliminary result of the mode spectra measurement for the "bi-periodic configuration". Because of the broken bi-periodicity and the fewer number of cells, the understanding of the mode spectra is somewhat complicated. Because the stem modes have very low Q-values, and could not be observed easily, they are not shown in the figure. The TE_{11} mode passband is degenerated in this support configuration, and only one passband is shown. Because the symmetry of the support configuration breaks the degeneracy, TE_{21} mode has two passbands; namely $TE_{21E//}$ (electric field parallel to the support) and $TE_{21E\perp}$ (electric field perpendicular to the support). The $TE_{21E//}$ couple strongly to the TM_{01} modes, and they are mixed together particularly around the π mode. It makes the mode identification process difficult.

The mode overlapping on the acceleration mode is avoided in this configuration. The TM_{11}(-like) passband splits into two narrow passbands and both passbands sit 86MHz above the operating frequency. The slope of the TM_{02} passband around the π mode shows the high coupling and is the same as the designed one, which indicates that the confluence condition comes close sufficiently. Because of the boundary condition of the termination, the coupling mode cannot be observed in the same configuration as the one that shows the accelerating mode. This situation makes the confirmation of the confluence difficult. The measurement with more cells is going on.

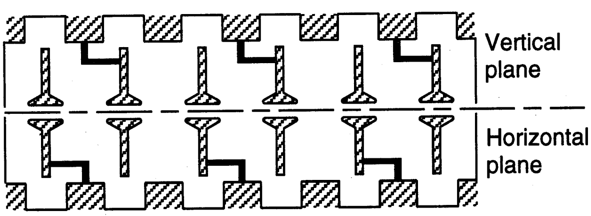

Fig. 4 Geometry for the accelerating mode

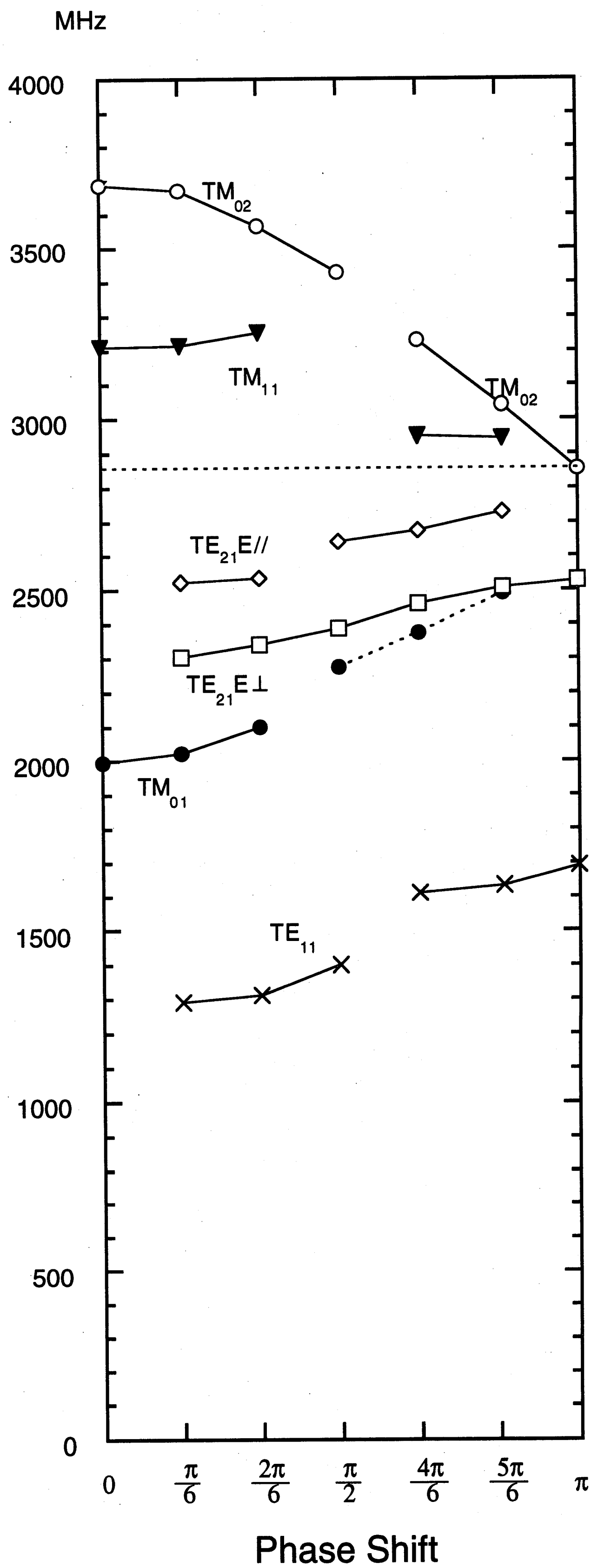

Fig. 5 Mode spectra for bi-periodic configuration.

5. Acknowledgment

The authors thank Mr. Tonguu for his help in the measurement. The present work is supported by Grant-in Aid for Scientific Research from Ministry of Education Science and Culture of Japan.

6. References

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