BIPERIODIC DISK-AND-WASHER CAVITY FOR ELECTRON ACCELERATION

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Abstract

Fabrication of the disk-and-washer(DAW) cavity is in the stage of high power model fabrication. In order to determine the final dimensions, we measured the frequencies of OFC models which were fabricated with the same fabrication process as the final cavity. This paper describes these measurement results.

1 INTRODUCTION

The biperiodic DAW [1] cavity has been investigated for these years. Basic dimensions of the DAW cavity have been studied by computer simulations and measurements on aluminum models (cold model). Eight units of such cold model were fabricated. The RF characteristics and the dependence of frequency on the number of units have been measured by these models. Before making a final high power structure, another test cavities made of OFC(OFC model) and high accuracy aluminum models(G2 model) were fabricated. The G2 model and the OFC model cavities were machined at the same shop. The OFC models were used for studying a fabrication process and final properties of cavities. The G2 models which had the same dimensions of OFC model on the drawing were used for optimization of the final dimensions. The G2 model is different from the OFC model in only two points: (i) the material is aluminum, (ii) each part is fixed by screws without brazing. Table 1 shows the frequency measurement results of these models.

	cold model	G2 model	OFC model
fa [MHz]	2857.4	2863.0	2859.6
fc [MHz]	2872.2	2873.0	2876.3

Table 1: Frequency of cold model, G2 model and OFC model. In the DAW structure, two modes should be tuned to an operating frequency(2857[MHz]). One is an accelerating mode(fa) and the other is a coupling mode(fc). In the accelerating mode, strong electric field is generated between the acceleration gap.

This results shows the slight difference in frequency among these models. The actual dimensions of each model measured by a coordinate measuring machine showed that there was no significant difference in the measurable region. The cause of frequency difference have been investigated, and it seemed to arise from the washer part [2]. The detail, however, has not been made clear yet. We discuss about this problem in a later session.

Assuming the reproducibility of fabrication process of washer part, we decided to tune the frequency to an operation one by correcting the dimensions of cavity. The frequency was measured for several sets of dimensions to accumulate correction data. All these measurement were performed on the G2-model for accuracy of dimensions.

2 MEASUREMENT RESULTS

2.1 Parameters of dimensions

Figure 1 shows the schematic view of the biperiodic L-support DAW. Frequencies were measured varying the washer radius (Rw), the inner radius of disk with supports (Rds) and the inner radius of disk without supports (Rdn).

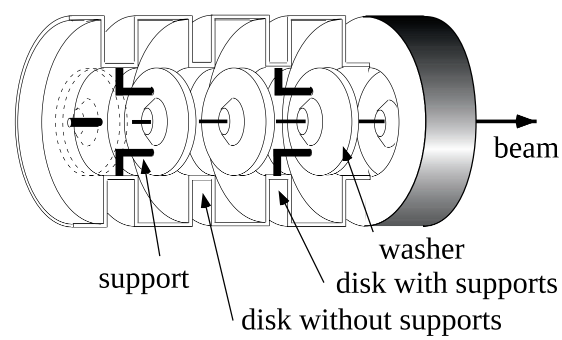

Figure 1: Disk-and-Washer structure

2.2 Accelerating mode

Coefficient of washer radius (Rw) The frequencies were measured with three washer sizes: Rw=44.0(original), 44.05, 44.5. (See Figure 2)

The frequency dependence of the number of units in Rw=44.0 or 44.05 is different from that of Rw=44.5. This is because an end plate has its intrinsic frequency tuned to 2857[MHz] (operating frequency), and thus the effect from both the end plates falls off with increase of the number of units. The intrinsic frequency of Rw=44.0 or 44.05 cavity is higher than 2857 [MHz], while that of Rw=44.5 is lower than 2857[MHz]. The coefficient for the frequency correction was calculated from the extrapolated frequencies at 24 units: the number of units in the high power model. Figure 3 shows the plots of the extrapolated value. Because the

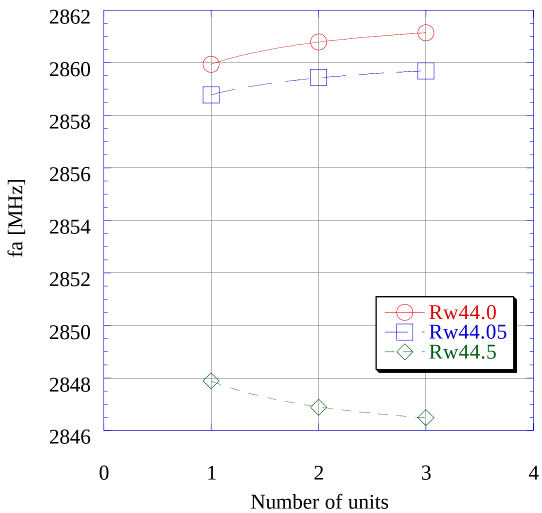

Figure 2: Frequencies as functions of the number of units at three Rw values

three frequencies (Rw=44.0,44.05,44.5) are lined up along a line, the linearity can be assumed. The correction coefficient for Rw was calculated as -32.8 [MHz/mm] from these results.

Coefficient of disk radius (Rds) Figure 4 shows the measured frequencies as functions of the number of units, in a similar way as Rw. The extrapolated frequency at 24 units was calculated for each Rds size. Thus the coefficient of Rds was obtained as -6.9 [MHz/mm]. There was a good linearity in these three points.

Coefficient of disk radius (Rdn) *N* units setup are required for *N* Rds disks and *N*-1 Rdn disks. Because there were only three G2-model cavity units, only two points data could be measured, while three data points at least are required for a curve fitting. Hence, we used the result

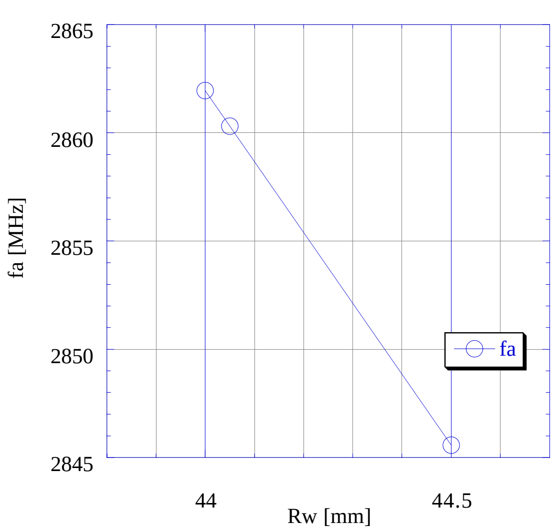

Figure 3: Correction coefficient for washer radius Rw

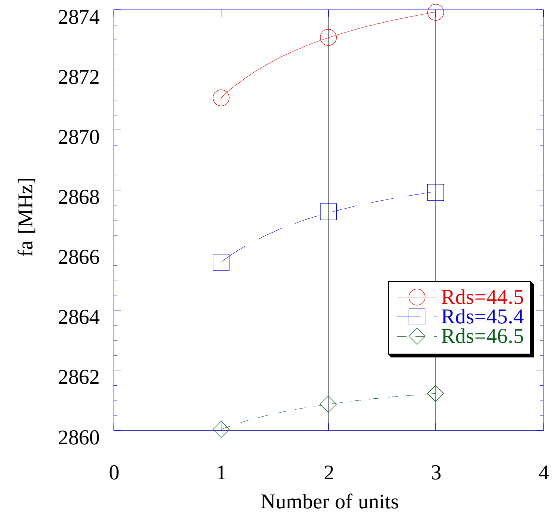

Figure 4: Frequencies as functions of the number of units at three Rds values

from one unit setup, which had no Rdn disk, as the one data point. Thus the extrapolated frequency at 24 units was estimated and the correction coefficient for Rdn was obtained as -8.7 [MHz/mm].

2.3 *Coupling mode*

Coefficient of washer radius (Rw) Figure 5 shows the measured frequencies for each washer radius. The dependence of the number of units in the coupling mode is larger than that of the accelerating mode. It should be noted that the scale of vertical axis is larger than that of accelerating mode in previous subsection. The extrapolated frequency was estimated by similar way in the accelerating mode and the correction coefficient was calculated as -32.8 [MHz/mm].

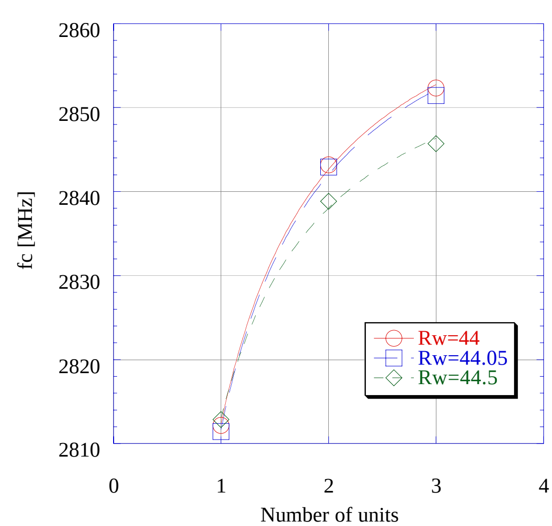

Figure 5: Frequencies as functions of the number of units at three Rw values (coupling mode)

Coefficient of disk radius (Rds) With similar way, the coefficient was obtained. Figure 6 shows the measurement results. The calculated coefficient was 9.8 [MHz/mm].

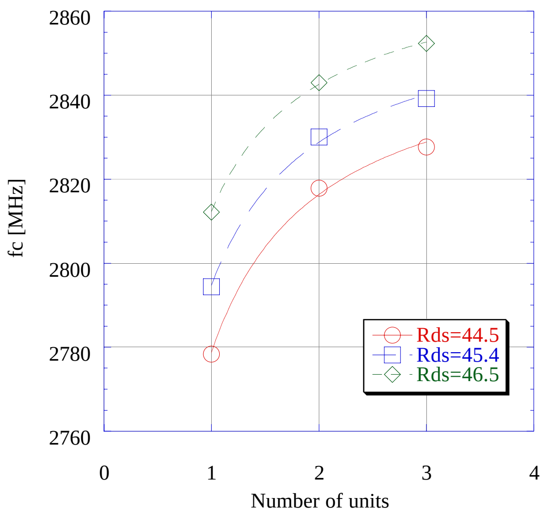

Figure 6: Frequencies as functions of the number of units at three Rds values

Coefficient for disk radius (Rdn) Figure 7 shows the measurement results, and the coefficient was calculated as 14.2 [MHz/mm].

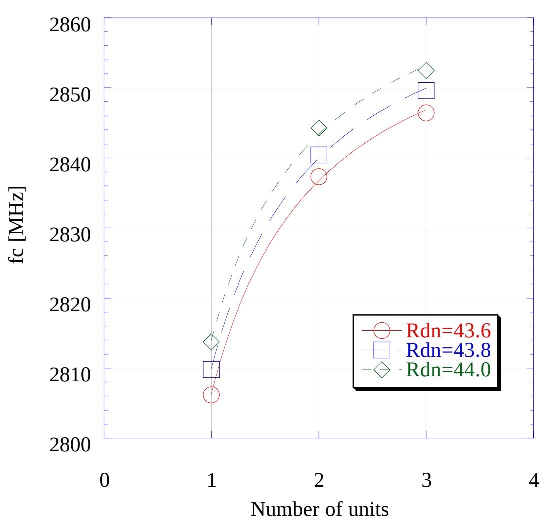

Figure 7: Frequencies as functions of the number of units at three Rdn values

3 DISCUSSION AND CONCLUSION

3.1 Correction coefficient

Because the frequency depends on the number of cavity units, an extrapolated frequency at 24 units was used to evaluate the correction value. Table 2 shows the summary about the coefficients obtained from these measurements.

	df/dRdn	df/dRds	df/dRw
fa [MHz/mm]	-8.7	-6.9	-32.8
fc [MHz/mm]	14.2	9.8	-19.4

Table 2: Summary of correction coefficient

As the coefficients of accelerating mode, df/dRdn=-9.2 [MHz/mm], df/dRds=-7.3 [MHz/mm] and df/dRw=-28.4 [MHz/mm] were calculated by SUPERFISH. These values are compatible with the measurement results. For the coupling mode, it is difficult to estimate the coefficient by SUPERFISH because the support effect was too large.

3.2 Frequency difference among three models

The frequency difference seems to arise from the washer part. Because washer has a curved surface (nose), it is difficult to measure all dimensions precisely. We tried to measure the more fine shape of nose part by a contracer (contour measuring device). An output from our device, however, is only a line drawing. The obtained data are analyzed to estimate the frequency difference. The shape of nose part is very sensitive to the accelerating frequency. It is important fabrication technology to fall in with the tolerance of frequency keeping the reproducibility of RF properties with available machining technique.

The curved surface is considered most critical point in the fabrication of the DAW. It is important fabrication technology to control the frequency with keeping the reproducibility of RF properties.

4 REFERENCES

[1] Y. Iwashita, ”Disk-and-washer structure with biperiodic support”, Nucl. Instrm. and Meth. in Phys. Res. A 348(1994)15-33

[2] H. Ao, et al., ”Fabrication of disk-and-washer cavity”, Proc. of the First Asian Particle Accelerator Conference, Tsukuba, Japan, in printing.