# DISK-AND-WASHER LINAC STRUCTURE WITH T SUPPORTS

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## Abstract

One of the disadvantages of the disk-and-washer (DAW) linac structure is the mode overlapping of the TM11 like passband, known as the deflecting mode passband. The difficulty is avoided with biperiodic 4-T support configuration where a couple of washers is supported by 4-T or 4-Y supports. The structure is studied by MAFIA calculation.

## Introduction

Although the disk-and-washer ( DAW ) linac structure has many advantages over the other structures such as the side-coupled structure as the high beta particle accelerating structure, it is not widely used. The advantages are the high coupling between cells, high shunt impedance and good vacuum properties. The higher coupling between cells makes the mechanical tolerances loose and the fabrication becomes easy. The disadvantages are the mode overlapping, and the difficult analysis of the mode structure [1,2,3,4,5,6,7]. The washers have to be supported by supports like the drift tubes in the Alvarez structure. Because two modes ( the accelerating mode and the coupling mode ) are working in the cavity, and they have different field patterns, there is much stem effect on either mode or both modes. This situation is different from the Alvarez structures. The computer analysis is difficult, because the cylindrical symmetry is broken by the stems. The detailed analysis should be done with 3-D calculations or the cold test models. The MAFIA code [8] is used to calculate the dispersion curves of the DAW structures.

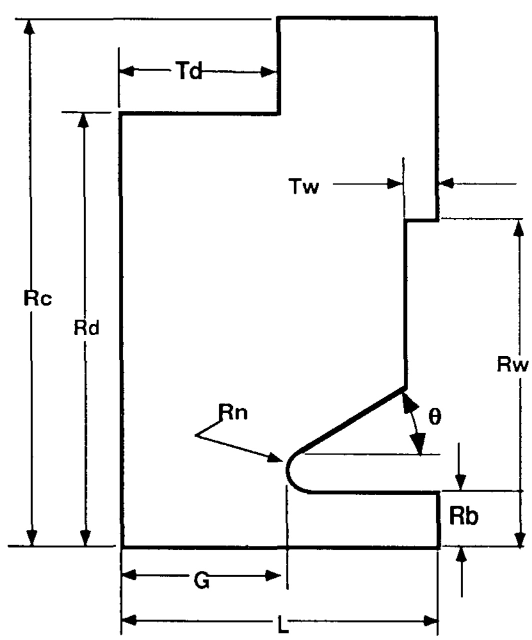


Fig.1 DAW half-cell geometry

## Cavity Geometries

The calculated geometries are as follows;
1) 2-T support lined up
2) 4-T support lined up
3) 4-T support skewed
4) 8-T support

Figure 1 shows the DAW half-cell geometry. The cavity dimensions are shown in table 1. The shunt impedance is obtained by the SUPERFISH results. The DAW cavity is one of the varieties of the large diameter DAW which has larger disk radius than the washer radius.

| | | |
|---|---|---|
| ß | 1.0 | |
| Freq. | 1300 | MHz |
| L | 5.765 | cm |
| Rc | 18.14 | cm |
| Rd | 16.2 | cm |
| Td | 2.752 | cm |
| Rw | 9.024 | cm |
| Tw | 0.324 | cm |
| θ | 30° | deg |
| Rn | 0.256 | cm |
| Rb | 1.128 | cm |
| $ZT^2$ | 91 | MΩ/m |

**Table 1**
**DAW Cavity Geometries.**

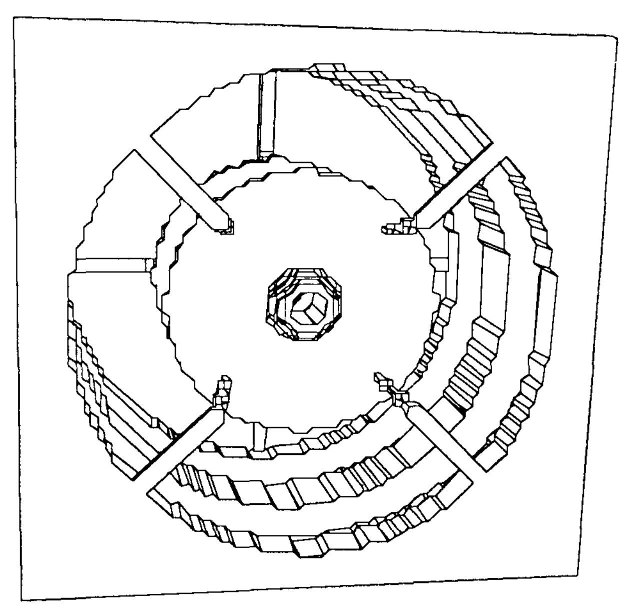

Fig.2 The mesh geometry for the skewed 4-T support configuration

Symmetries are used to reduce the computing resources. Because the lined up 2-T support configuration has one symmetry plane, only the right half of the 2-half cell is calculated. The 4-T support configuration has two symmetry plane, and the upper right quarter of the 2-half call is calculated. Because the skewed 4-T support configuration has much complicated symmetry, the full cavity of 2-half cell is considered. The 8-T support configuration has more symmetry than 4-T support one, and the combinations for the boundary conditions are reduced in azimuthal direction.

The mesh geometry for the skewed 4-T support configuration is shown in Fig. 2. The obtained dispersion curves are shown in Figs.3~6.

## Mode Spectrum

### TM11 Passband

TM11 modes are known to cause beam-deflection problems in some applications. TM11 passbands are degenerated except for the 2-T support configuration. The unperturbed TM11 passband has the unacceptable property of crossing the operating frequency. The necessary washer supports, however, represent significant perturbations to a number of the passband. It has been shown that the biperiodic 4-T washer-support configuration has a favorable effect on the TM11 passband in this respect. The biperiodic T-support splits the TM11 passband into two narrow passbands separated by a wide ( more than 10% of the operating frequency ) stop band. In all seven geometries studied, the DAW operating frequency falls well within this stop band. The 4-T and 8-T configurations have only the perturbed passbands, because they makes degenerations. It also acts as a mode filter to this passband, and reduces the coupling between each cell, and makes each passband narrow. It is now clear that the 4-T and 8-T configurations are superior to the 2-T ( in-line ) in cases where the deflecting modes are of concern.

### TM01 and TM02 Passband

The operating mode ( accelerating mode ) is the $TM_{02\pi}$ mode and the coupling mode is the $TM_{01\pi}$ mode. These two passbands should be made confluent. The supports perturb the coupling mode frequency, Rd is modified to meet with the condition in each support configuration.

### TE11 Passband

TE11 passbands are degenerated except for the 2-T support configuration. The ß=1 line on the figure crosses the 650MHz point at $\pi/2$ and the TE11$\pi/2$ passbands in some geometries cross this line very close at $\pi/2$. Because TE11 modes are the dipole mode, the coupling situation should be studied

### TE21 Passband

TE21 passbands are degenerated only in the 8-T support configuration. Although quadrupole modes have no field on the beam axis, the field is perturbed to have the axial electric field in 2-T support configuration. The support current canceled out in 4-T and 8-T support configuration. The higher ends of the passbands are close to the operating mode in the large diameter DAW, and the attention should be paid about the separation.

### TE31 Passband

TE31 passbands are degenerated except for the 2-T support configuration.. Although sextupole modes have no field on the beam axis, the field is perturbed to have the axial electric field in all support configuration. The unperturbed passband in 2-T support configuration overlaps on the operating mode.

### Stem Mode Passband

Stem modes are seen in all geometries. The frequencies of the stem modes go up with the number of the stem. Because the phase advance in the figures are not based on the stem period, but the accelerating period, the dispersion curve written on the figures may not be adequate to express the property of the passband.

### Other Modes

TM21 passbands lay above the operating mode frequency. Because these modes have no field on the axis, and the coupling to the operating modes is small even if the field is perturbed by the supports, these modes are of little concern. TE01 modes are seen above the 1.5GHz, these modes are of little concern too. Some unidentified modes are seen above the operating frequency, which have too complicated field pattern to analyze.

## Summary

MAFIA calculations have been done on the several T-support geometries. Among these options, simple 4-T lined up configuration seems the best. The 2-T support configuration has many undegenerated passbands, and the dipole passband of TM11 overlaps on the operating frequency. Hence the 8-T support configuration has only degenerated passbands up to the quadrupole passbands ( TE21 and TM21 ). The lowest undegenerated passband is an octupole one, which should have rather high frequency than the operating frequency. This configuration, however, is not suitable for the large diameter DAW, because the support perturbations are so large that the dipole and sextupole modes are pushed up to overlap with the operating mode. It maybe useful for the small diameter DAW. The skewed 4-T support configuration has less undegenerated passbands, but there are some strongly coupled, or mixed modes of dipole and sextupole modes around the operating mode.

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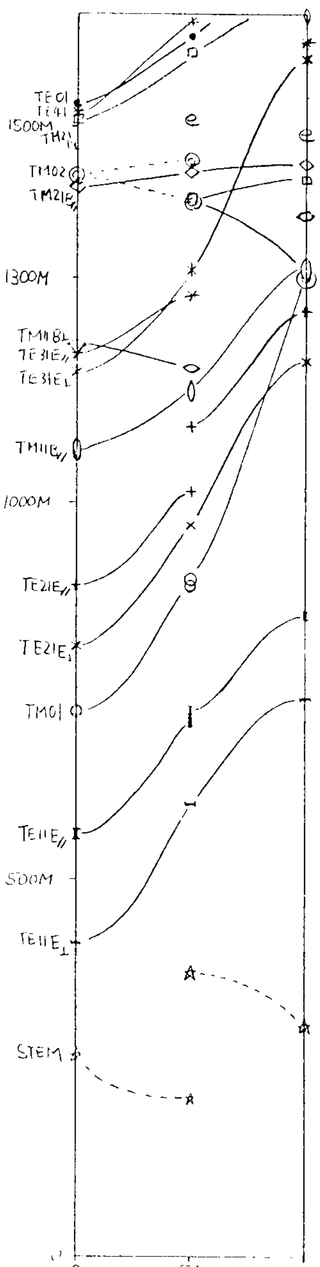


Fig. 3 Mode spectra for lined up 2-T configuration

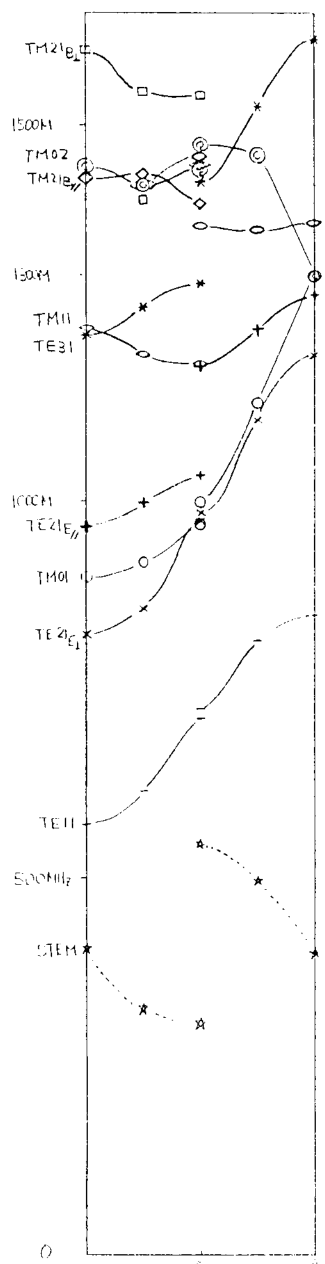


Fig. 4 Mode spectra for lined up 4-T configuration

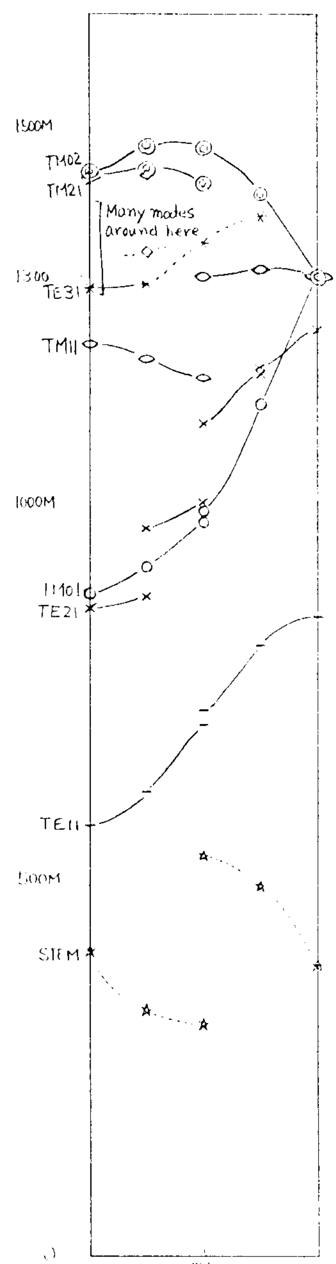


Fig. 5 Mode spectra for skewed 4-T configuration

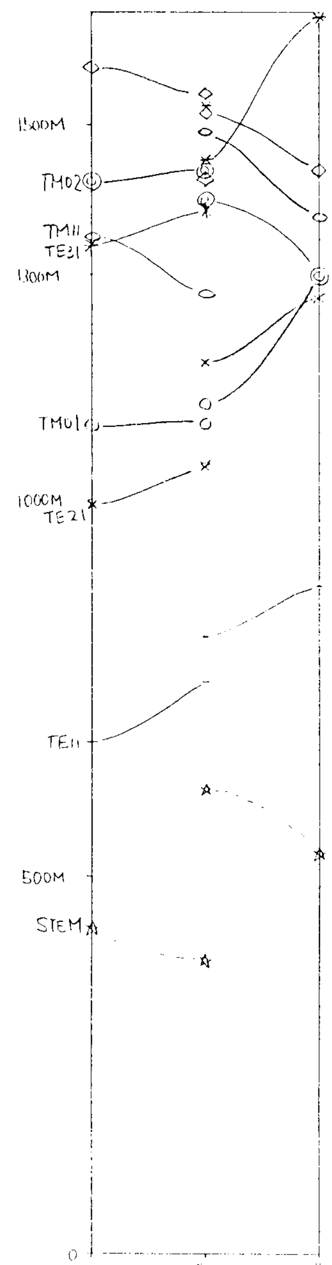


Fig. 6 Mode spectra for 8-T configuration