2

BNL 18520

BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, New York

AADD 73-17

ACCELERATOR DEPARTMENT
Informal Report

ECCENTRIC RF DEFLECTING STRUCTURE

J.R. Aggus, S. Giordano and H.J. Halama

December 13, 1973

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Atomic Energy Commission, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

84

Abstract

For superconducting RF separators, assembled by electron beam welding techniques, two types of mode stabilizers are discussed: the elliptical structure, and a new design called the "eccentric structure". For an operating $\pi/2$ or π mode in the lower pass band, it is shown that the various parameters of the eccentric structure can be adjusted to provide the required frequency spacing between the operating mode and the upper dispersion curve.

Due to machining and fabrication tolerances in a typical iris loaded deflecting cavity, it is possible for the transverse deflecting fields to become elliptically polarized, resulting in a rotation of the fields along the length of the structure. For room temperature structures, the machining of flats or the use of rods placed axially down the structure are used to stabilize the mode. Since room temperature structures, made of copper, are assembled by brazing, the above types of mode stabilizers can be used, but for niobium superconducting cavities, which must be assembled by electron beam welding, these stabilizers are not compatible with the available electron beam welding techniques.

There are two basic requirements a joint must have to be electron beam welded: first the joint must be optically visible to the electron beam, and secondly, the joint must have a uniform thickness along its length.

Mode stabilizers which meet the above requirements have been suggested in Ref. 1. By using elliptically shaped cavity irises (Fig. 1), it is possible to maintain a constant joint thickness T , but the machining is both time consuming and costly.

A new type of mode stabilizer, which one shall henceforth refer to as the "eccentric structure", was suggested by the authors in Refs. 2 and 3, and is shown in Fig. 2. The fabrication is accomplished by first final machining the bore hole and sloping side of the iris truly concentric and symmetrical to the cavity center line up to a radius R_0 . The eccentric portion is then machined by moving the cavity off center in the lathe by $d/2$.

The tool is then moved into the work axially at a radius R_0 to the required depth. The tool is then moved radially toward the center of the work until it has cleared the angled face. The eccentric portion, therefore, is actually a small portion of a cylinder. The process is then repeated on the other half of the cavity for symmetry. The weld joint diameters $2R_0+d$ and $2R_0+2T+d$ then machined concentric to the axis of the cavity. This method of fabrication enables the electron beam weld joint to remain truly circular and of constant thickness T .

It is now necessary to consider the electrical characteristics of the eccentric structure as a function of the variables d and W in Fig. 2. For the deflecting mode, all mode stabilizers have the effect of splitting the dispersion curve into two separate dispersion curves, where the corresponding modes in each of the dispersion curves are in space quadrature to each other. Once an operating mode has been selected (in one of the dispersion curves), it is necessary that a sufficiently large frequency difference exist between it (the operating mode) and any mode in the other dispersion curve. It will now be shown how this frequency difference is related to the parameters d and W .

Measurements were made on a 4 cell model at 2.8 GHz. Shown in Fig. 3 are the typical dispersion curves obtained. The $\pi/2$ mode in the lower pass band, at ω_0 , has been selected as the operating mode, and the frequency separation between it and the upper pass band is $\Delta\omega$. (There are reasons for selecting this mode, but they will not be discussed here.) The results of these measurements are shown in the table. It should be pointed out that there was no degradation of the Q in any of the measured structures.

d (mm)	W (mm)	$\frac{\Delta\omega}{\omega_0}$
0.61	0	0.0055
0.61	1.0	0.0035
0.61	2.0	0.00176
0.76	2.0	0.006

Table

For a practical operating $\pi/2$ mode structure, a minimum $\frac{\Delta\omega}{\omega_0}$ of 0.003 would be desirable. To accommodate the electron beam welding, the width W should be at least 2 mm. From the table, we see that $d = 0.076$ mm and $T = 2.0$ mm meets our requirements. It should be pointed out that there is essentially no field in the gap T for the operating $\pi/2$ mode.

Consideration has also been given to the use of the lower π mode as the operating mode. Clearly, the required frequency spacing between it and the upper pass band can be readily achieved.

References

1. W. Bauer, Thesis, Report Kernforschungszentrum Karlsruhe, KFK 1550 (1971).
2. J. Aggus, W. Bauer, S. Giordano, H. Hahn and H.J. Halama, BNL 18292, AADD 73-14 (1973)
3. J. Aggus, W. Bauer, S. Giordano, H. Hahn and H.J. Halama, IEEE Trans. Nucl. Sci. NS-20 No. 3, (1973).

ELECTRON
BEAM
WELDS

SECTION X-X
ELLIPTICAL IRIS STRUCTURE
FIG. 1

FIG.2 ECCENTRIC STRUCTURE IRIS

FIG.3 DISPERSION CURVE