DEVELOPMENT OF FREQUENCY MEASUREMENT SET UP FOR 1.3 GHz SCRF CAVITY HALF CELLS AND DUMBBELLS

G V Kane, S V Kokil, D S Rajpoot & S C Joshi
Raja Ramanna Centre for Advanced Technology, Indore

Abstract

A Programme to set an infrastructure to fabricate, process and test the SCRF cavities has been taken up under the XIth plan project at RRCAT, Indore. 1.3 GHz Elliptical shape SCRF cavities are made by forming and trim machining of half cells before EBW welding. The half cell's geometry requires control on designed frequency and axial length. A pneumatically operated frequency measurement set up has been developed to measure the frequency of half cells. The trim machined half cell is placed in the set up and is loaded using dead weight (~ 20 kg). Resonant RF frequency is measured with the help of a Vector Network Analyzer. Depending on the frequency response; the half cell is re-machined to get required frequency. For fabrication of multicell SCRF cavity; the half cells are EB welded at iris to form dumbbells. A multi-cell cavity is formed by welding of dumbbells at equator. The above mentioned setup also has a provision to measure the frequency of dumbbells. The dumbbell is loaded in the setup for measurement of frequency. A cylinder of di-electric material of known volume is inserted in the dumbbell from each side and the change in frequency is measured. This effect of change of volume on frequency is used to predict the trimming side and length for dumbbells. The detailed design of the system, working scheme and its interpretation would be explained in the paper.

INTRODUCTION

RRCAT is engaged in design and development of 1.3 GHz Superconducting Radiofrequency (SCRF) cavities. A multi-cell cavity is formed by welding of dumbbells at equator and dumbbells are formed by welding of two half cells at iris. Before welding; the half cells are to be checked to confirm for designed RF frequency. Trim machining of the half cells and dumbbells is to be done from both the sides to get desired frequency and size. Since the cavities to be checked would be large in number; a set up has been designed and developed.

DESIGN REQUIREMENTS

The criteria to develop a setup to measure the frequency of half cells and dumbbells of 1.3GHz SCRF cavities are as follows.

a) Should be able to measure resonant RF frequency of half cells and dumbbells of 1.3 GHz SCRF cavity
b) Accurate measurement of resonant RF frequency
c) Repeatability within 10 kHz
d) Easy to load the component
e) Minimum efforts to modify the setup to suit measurement of half cells and dumbbells

A pneumatically operated setup was designed and fabricated satisfying all the above requirements.

CONSTRUCTION AND SET UP DETAILS

The setup (Fig. 1) consists of a pneumatic cylinder with controller, a pillar set, two RF contact plates, a dead weight etc. Pneumatic cylinder of 200 mm stroke is mounted on the top plate. The stroke of pneumatic cylinder can be adjusted with the help of magnetic reed switches and an electronic controller. For better alignment and repeatability of readings; a pillar set with phosphor bronze guide bushing is used. A dead weight of ~ 20 kg is suspended at one end of pneumatic cylinder. The purpose of dead weight is to get repeatability ensuring good RF contact. N type SMA connectors are used to connect VNA using RF coaxial cables. Provision is also made to perturb the dumbbells from both sides by inserting a cylinder of dielectric material. Bottom and top plates are made of the material similar to that of parent cavity. To ensure better RF contact; RF fingers are generated on the periphery by EDM wire cutting technique.

Fig. 1 :- RF Frequency measurement set up for 1.3GHz SCRF cavities

SCHEME OF OPERATION

The setup is operated using a controller which controls the pneumatic cylinder movement. The controller regulates the solenoid valves for the movement of top loading plate. The machined half cell is positioned on the base plate with the help of position locators. The top plate can be lowered with the help of controller for measuring

position. The half cells are uniformly pressed during measurement.

Large numbers of consistent RF frequency measurements are required on half cells and dumbbells during fabrication of multi-cell SCRF cavity. For this a precise and automatic set up is needed. The present set up is with pneumatically operated with good repeatability of measurement.

MEASUREMENT OF RF FREQUENCY

To measure the RF frequency; the moving top plate is lifted to its top most position. The half cell / dumbbell is placed on the bottom RF finger plate. The top RF plate is lowered till the dead weight rests on the component. The fixed dead weight ensures good and repeatable RF contact. Resonant RF frequency (Fig.: 2 and Fig.: 3) of the component is measured with the help of vector network analyzer (VNA)

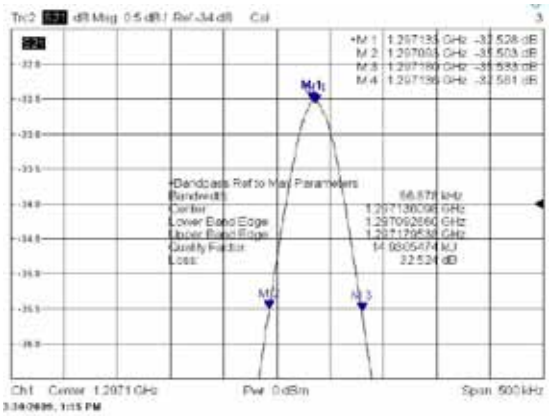

Fig 2.: Frequency spectrum of half cell of 1.3 GHz SCRF cavity.

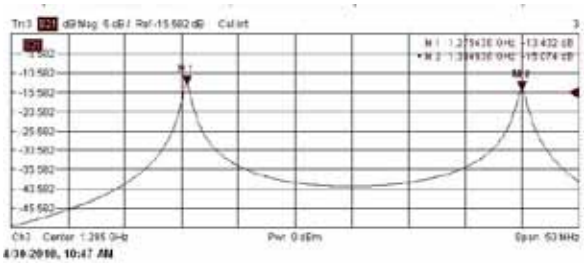

Fig 3.: Frequency spectrum of dumbbell of 1.3 GHz SCRF cavity

A provision to perturb the RF field using a fixed size de-electric cylinder is given in top and bottom plates. The measured frequency helps in estimating the required change in length of half cell for trim machining to reach the target frequency. During trim machining of half cells; the set up was used to establish frequency sensitivity (Df/mm) (Table 1).

Table 1: Frequency sensitivity

Trimming location	Change in frequency per mm (Df/mm)
Equator of half cell	4.710145 MHz / mm
Iris of half cell	-1.915708 MHz / mm

CONCLUSION

The setup has helped in automation and reducing the time of measurement of half cells and dumbbells frequencies. It eliminates the uncertainty in locating the components during the frequency measurement. The setup has been found to give good repeatability (~ 10kHz) during frequency measurements. The setup will be very useful in future during mass production of half cells and dumbbells required to form multi-cell 1.3 GHz SCRF cavities.

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