A.6: Indigenous development of semi-automatic cavity tuning machine

A semi-automatic cavity tuning machine has been indigenously designed and developed for a multi-cell 1.3 GHz SCRF cavity to achieve the designed resonating frequency and field flatness. Development of a multi-cell SCRF cavity involves forming, trimming, welding, annealing, processing etc. Due to the above processes, the cavity gets detuned from the resonating frequency. The cavity tuning machine tunes the cavity by deforming the individual cells. A schematic layout of the semi-automatic tuning machine is shown in Fig. A.6.1.

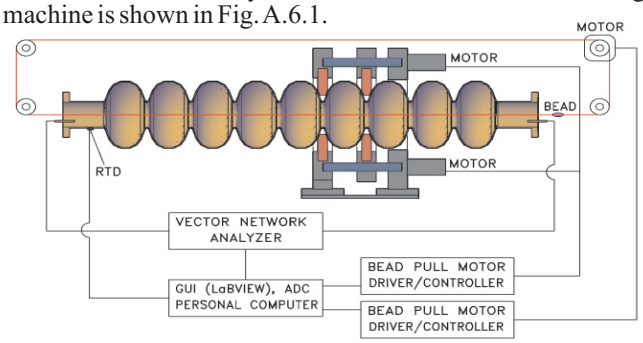

Fig. A.6.1: Schematic layout of semi-automatic cavity tuning machine

Tuning machine comprises of motor driven tuning jaws to deform the individual cells, cavity mounting system and bead pull measurement system. The resonating modes of the SCRF cavity are scanned and recorded using a vector network analyzer (VNA). A programme, developed using LabVIEW software, calculates the frequency correction required for individual cells to achieve the target frequency with the required electric field flatness (> 90%). The programme requires frequency of first mode, desired π mode frequency and field measurement at current π mode frequency. The indigenously developed semi-automatic cavity tuning machine is shown in Fig.A.6.2.

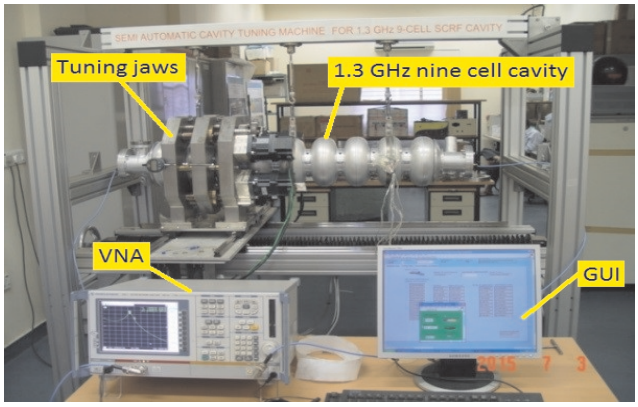

Fig. A.6.2: Indigenously developed semi-automatic cavity tuning machine

A multi-cell SCRF cavity is suspended at three locations from the top using cavity mounting system. By moving the jaws, individual cell of the cavity is selectively deformed to get the required change in frequency. The motion of jaws is controlled by stepper motors. The base structure of the cavity tuning machine has a provision to move the tuning jaw assembly along the cavity axis.

A prototype nine-cell 1.3 GHz cavity fabricated in aluminium was used to validate the tuning process of a multi-cell SCRF cavity. All nine modes of the nine-cell aluminium cavity were measured using VNA. Measured normalised electric field profile, using bead pull measurement system, has been depicted in Fig.A.6.3. Measured resonating frequency was 1.2969 GHz and field flatness was 23.8%.

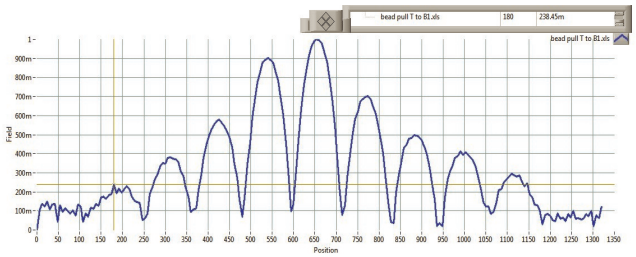

Fig. A.6.3: Normalised electric field distribution along the axis of nine-cell 1.3 GHz aluminium cavity after fabrication and before tuning

Above data was used in tuning programme to predict the required frequency change in each cell to tune the cavity. Cavity tuning machine was used to compress or stretch the cavity cells plastically to tune them for frequency and field flatness. Field flatness was improved to 95.8 % and resonating frequency of 1.2974 GHz was achieved. The final normalised electric field profile is shown in Fig. A.6.4.

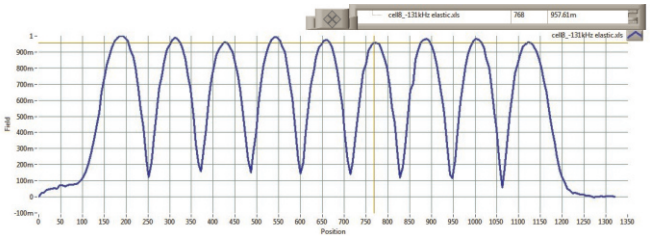

Fig. A.6.4: Normalised electric field distribution along the axis of nine-cell 1.3 GHz aluminium cavity after tuning.

Tuning of aluminium nine-cell 1.3 GHz cavity was carried out successfully using an inhouse developed tuning programme and semi-automatic cavity tuning machine. This tuning exercise also validated the developed tuning programme. The experience gained from this tuning exercise will be helpful in tuning of nine-cell 1.3 GHz niobium SCRF cavity.

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