A.2: Performance characterization of first 650 MHz single-cell SCRF cavity

Development of 650 MHz Superconducting Radio Frequency (SCRF) cavity has been taken up under "R&D activities for high energy superconducting proton linac based Spallation Neutron Source". The 650 MHz SCRF cavities will be used for accelerating the H^- ions in medium and high energy section of the superconducting linac.

During early 2013, a prototype 650 MHz (β=0.9) single-cell SCRF cavity was fabricated at RRCAT. *{RRCAT News letter Article A.3, Vol 26, Issue 2- 2013, "First Development of 650 MHZ (β=0.9) Single-cell Bulk Niobium SCRF cavity".}*

The prototype 650 MHZ (β=0.9) single-cell SCRF cavity was sent to Fermilab, USA under Indian Institution Femilab Collaboration (IIFC) for performance evaluation. The cavity has been recently tested and has achieved accelerating gradient (Eacc) of 19.3 MV/m at 2K, exceeding the design parameters.

Cavity processing and testing:

The prototype 650 MHZ (β=0.9) single cell SCRF cavity "*B9AS-RRCAT-301*" was inspected and processed jointly by Argonne National Lab (ANL) and Fermi National Accelerator Lab (FNAL).

The steps of cavity inspection and processing consist of visual inspection, mechanical measurement, RF measurement, internal optical inspection, electro-polishing (EP), vacuum heat treatment, High Pressure Rinsing (HPR) and low temperature baking.

During the room temperature measurements the resonant frequency and quality factor of the cavity were measured and vacuum leak test was performed. Results are as given in Table A.2.1.

Table A.2.1: Measured parameters for the cavity

Parameter	Value
Pi mode Frequency	646.7 *MHz*
Quality factor	12758
Vacuum test leak rate	$< 1x10^{-10}$ *mbar. l/sec*

Under the cavity processing, the internal surface of cavity was removed by 120 µm by EP, followed by heat treatment at 600°C for 10 hrs. The cavity also received a light EP of 20 µm followed by HPR using ultra pure water at ~ 80 bar. The cavity was assembled in Class-10 clean room for mounting RF-coupler. Before VTS testing, cavity underwent to low temperature baking at 120 ^{0} C for 48 hrs. Figure A.2.1 shows the 650 MHz cavity mounted on VTS insert for testing.

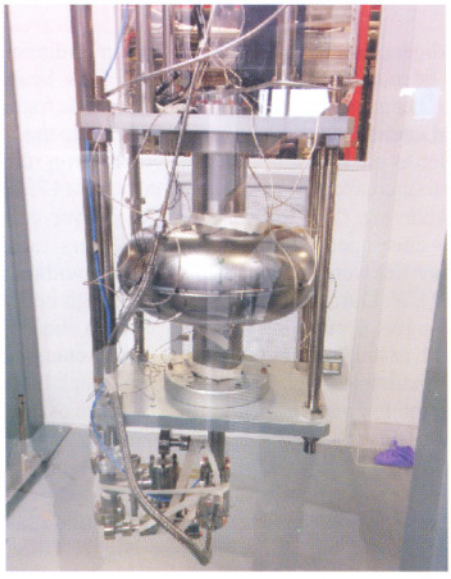

Fig. A.2.1: 650 MHz single-cell SCRF cavity mounted on VTS insert.

The cavity achieved the accelerating gradient (Eacc) of 19.3 MV/m with excellent quality factor Q_0 of $7x10^{10}$ at 2.1K during VTS testing as shown in Figure A.2.2. The cavity performance exceeds the rated specification of acceleration gradient (Eacc) of 17 MV/m with quality factor $Q_0 > 2.0 \times 10^{10}$. The quality factor increased to 10^{11} at 1.6 K. The very high Q_0 of cavity was evident of quite low residual resistance. The cavity was free from field emission and multipacting.

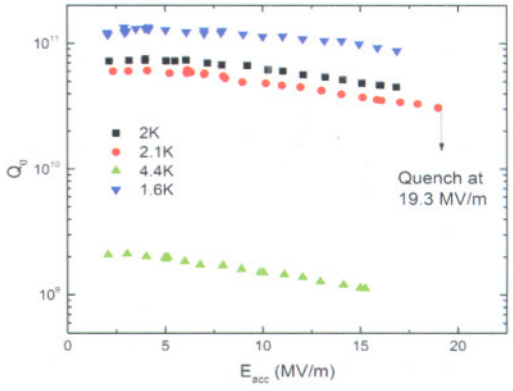

Fig. A.2.2: The Q vs E plot for B9AS-RRCAT-301.

Future plans: The performance of first 650 MHz single cell SCRF cavity is very encouraging and will expedite the development efforts on 650 MHz multi-cell SCRF cavities.

Reported by:
M Bagre, A Bose, A Puntambekar and S C Joshi,
(scjoshi@rrcat.gov.in), PLSCD