

### A.15: Testing of tuner mechanism with 1.3 GHz single-cell SCRF cavity at 2 K

Tuner is an important part of accelerator RF cavity for resonance frequency control. Functioning of a tuner is crucial in case of a superconducting RF cavities as the cavity quality factor is very high ( $>10^9$ ) resulting in narrow bandwidth. The RF frequency of SCRF cavities is tuned by axial deformation within elastic limit. Both slow and fast tuning features of a tuner are used for correction of static and dynamic deviations in SCRF cavities. RRCAT has developed a tuner mechanism for 1.3 GHz SCRF cavity. In order to qualify the tuner performance with SCRF cavity in superconducting state, a blade tuner is assembled with 1.3 GHz single-cell SCRF cavity and tested at 2 K. Fig. A.15.1 below shows the 1.3 GHz single-cell SCRF cavity assembled with tuner ready for Vertical Test Stand (VTS) testing.

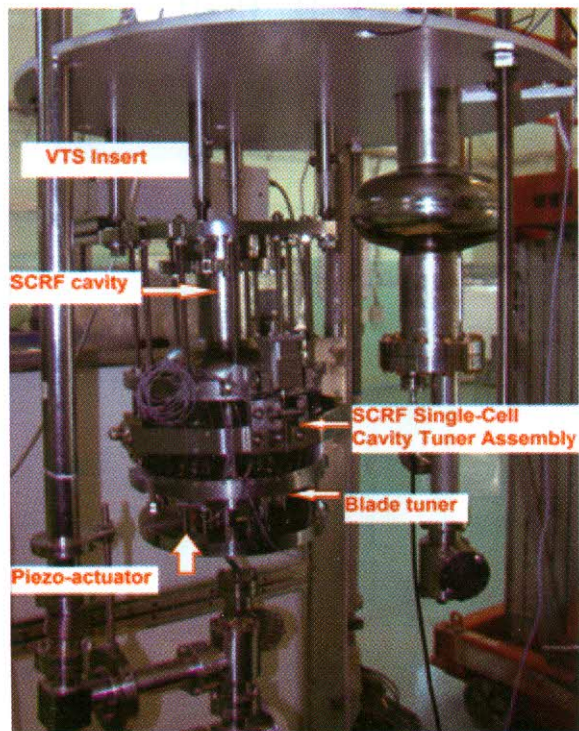


Fig. A.15.1: The 1.3 GHz single-cell SCRF cavity with tuner assembly on VTS insert.

The testing of single-cell SCRF cavity and tuner assembly was carried out in VTS at 2 K temperature. This temperature was achieved in liquid helium (LHe) pool by pumping LHe up to 30 mbar pressure. The tuner operation was carried out using piezo actuators excitation. The change in RF resonance frequency due to 200 V DC excitation was measured to be 10.8 kHz (i.e. 54 Hz/V tuning sensitivity) in single-cell cavity at 2 K. The plot of piezo excitation at 2 K operation shows tuning characteristics up to 200 V piezo excitation (Fig.

A.15.2). It is also observed that the increase in RF resonance frequency of single-cell cavity due to cool-down to 2 K from 300 K is 2.051 MHz.

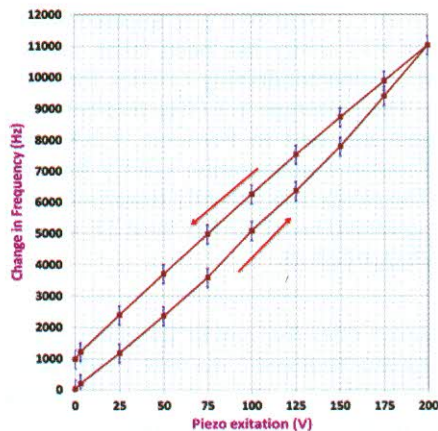


Fig. A.15.2. Characteristic of single-cell cavity tuner assembly for piezo DC excitation at 2 K.

Further, a comparison of 2 K and 77 K data is done with 300 K data, which reveals that the piezo stroke reduces by ~87% at 2 K and by ~61.6% at 77 K to that of room temperature stroke (Table A.15.1). The hysteresis in piezo operation also reduced from 12.9% at 300 K to 8.81% at 2 K temperature.

Table A.15.1 Characteristics of tuner during piezo excitation to 200 V at various temperatures

Operating condition in VTS	Range of frequency shift with piezo actuator excitation to 200V	Hysteresis
300 K	82 kHz	11 kHz
77 K	31.5 kHz	2.9 kHz
2 K	10.8 kHz	950 Hz

A piezo driver has been developed to drive the actuator by half sine wave of 0 to 200 V amplitude and pulse width upto 1 ms at repetition rate up to 100 Hz for fast control of the tuner. The effect of fast piezo actuation is tested at low RF power. The change of frequency of single-cell 1.3 GHz cavity at 2 K for 200 V corresponds to 1.2 kHz in 9-cell 1.3 GHz SCRF cavity. The piezo stroke achieved is adequate to compensate LFD and microphonics instabilities at 2 K during high power operation.

This exercise of qualifying the tuner assembly with piezo in VTS has been carried out for the first time. This is first step towards performance study of a SCRF cavity tuning mechanism. The testing was carried out by members of PLSCD, PHPMS & CCDS.

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