A.17: Development, integration and qualification of end lever tuner for HB650 five-cell SCRF cavity

Superconducting radio frequency (SCRF) cavities have very high quality factor, limiting the frequency of operation to a very narrow band width. Tuner is required to keep the SCRF cavity in operating regime. A slow tuner compensates frequency shift due to manufacturing and cool down errors whereas a fast tuner compensates time varying (internal) disturbances during pulsed accelerator operation viz. Lorenz force detuning (LFD) and external disturbances from surrounding vibrations and helium pressure fluctuation (microphonics). End lever tuners have been developed with Indian industry, and after the pre-qualification, have been integrated with jacketed (SCRF bare cavity dressed with helium vessel) 650 MHz five-cell SCRF cavity. Both slow and fast tuning characterisation has been done at 300 K.

Tuner development: SS 316L end lever tuners have been developed indigenously and qualified for geometrical accuracies and remnant magnetic field. A tuner test set up was developed and qualification of the tuner is done first by testing it with 'no load' and then with cavity equivalent stiffness spring (5.6 kN/mm). The calculated stiffness of 40.3 kN/mm meets the design specification >40 kN/mm measured. (Figure A.17.1).

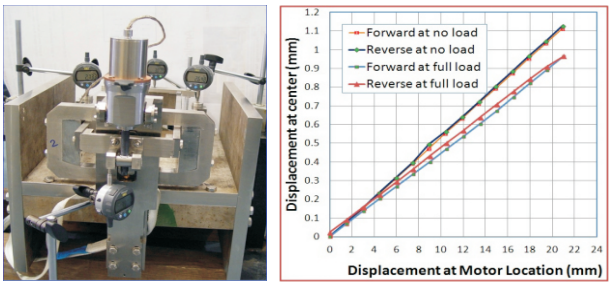

Fig. A.17.1: (a) Tuner qualification on tuner test stand. (b) Response curve at no-load and at full-load.

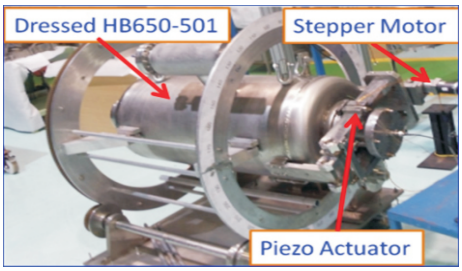

Fig. A.17.2: Integration of tuner and jacketed cavity.

Lever tuner integration on SCRF cavity with tuner control and qualification for slow tuning: An open loop controller with driver has been developed to drive both slow and fast actuators. The actuating motor (for slow tuning) and piezo (for fast tuning) assembly is integrated with dressed cavity as shown Figure A.17.2. The sensitivity of HB650 cavity is measured to be 164 kHz/mm, as shown in Figure A.17.3, which is very close to the design value of 160 kHz/mm.

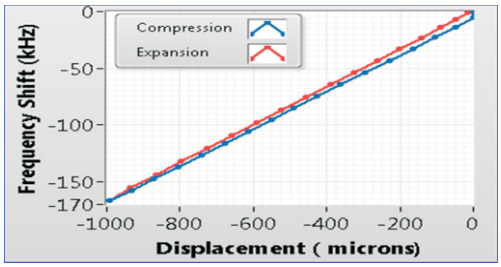

Fig. A.17.3: Frequency response for slow tuning.

Qualification for fast tuning: Piezos assembled on the tuner for fast tuning characterisation were excited with DC up to 100 V and response of change in the frequency was recorded during the increase and decrease of the voltage as shown in Figure A.17.4. A total of 4.4 kHz frequency change was recorded for 100 V at 300 K.

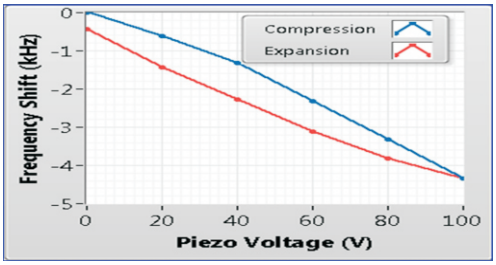

Fig. A.17.4: DC excitation response.

The fast tuning experiment was carried out by exciting 2 piezos with half sinusoidal wave of various durations (1 ms to 100 ms) and repetition rates (1 Hz to 60 Hz). At 62 V amplitude for piezo wave of 10 ms at 50 Hz, 4.7° phase shift was observed, corresponding to 2.8 kHz frequency change. This change in RF frequency also matches with DC experiment.

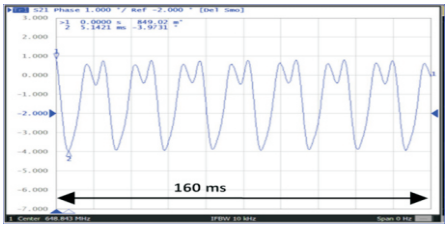

Fig. A.17.5: Cavity response for piezo excitation at 62 V and 10 ms pulse width for 50 Hz repetition rate.

The characterization has provided important information for slow and fast tuning, which will be utilised during testing of tuner in Horizontal Test Stand at 2K, integrated with the SCRF cavity.

Reported by:
Vikas Jain (vikas@rrcat.gov.in)