A.9: Testing of fast tuning system with 1.3 GHz prototype RF cavity

Superconducting RF (SCRF) cavities operating at 2K temperature are very sensitive to small mechanical perturbations due to narrow bandwidth (~200 Hz essentially due to high Q_L) of their resonating RF frequency. Pulse operation of high gradient cavity experiences dynamic Lorentz Forces on the cavity leading to cyclic mechanical deformations and hence fast detuning of cavity resonance frequency. In order to compensate dynamic detuning of pulse operated SCRF cavity, fast tuning is an essential requirement, which is generally done by using piezo actuators in tuning mechanism.

In order to develop fast tuning scheme, a test setup has been established for fast tuning measurements of a prototype 1.3 GHz 9-cell dressed RF cavity at room temperature. The test setup includes a blade tuner mechanism integrated with piezo actuator, its driver, RF signal generator, RF amplifier, envelope detector etc. as shown in Fig.A.9.1.

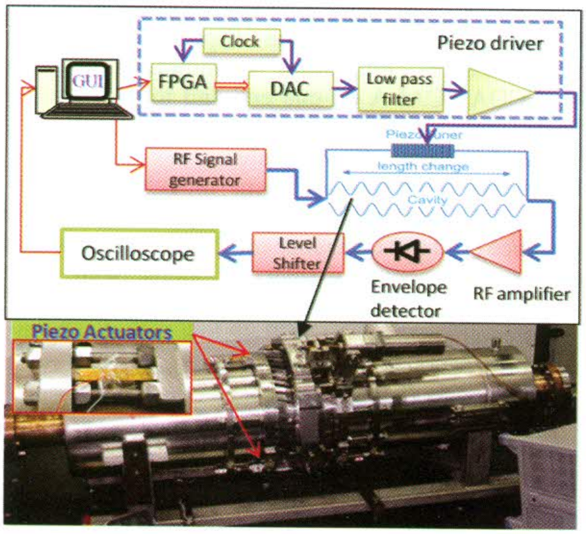

Fig A.9.1:Layout of fast tuning setup (top), Piezo actuators for fast tuning on prototype cavity (bottom)

Change in resonance frequency of the cavity is measured by change in amplitude method. This change in amplitude is calibrated for change in resonance frequency of the cavity. In order to measure change in resonance frequency of the cavity due to piezo excitation, cavity is fed by RF signal generator from one end and change in amplitude of RF signal is measured from other end, using the scheme as shown in Fig.A.9.1. Screenshot of the oscilloscope for the cavity response is shown in the Fig. A.9.2, for half sine-wave excitation of piezo actuator at 190 V amplitude, 5 Hz repetition rate and 50 ms pulse width. It is found that maximum change in resonance frequency is 6.5 kHz. Change in resonance frequency has been observed for various combinations of pulse widths (from 0.7 ms to 100 ms), amplitude (25 V to 200 V) and repetition rate (1 Hz to 50 Hz) of the half sine-wave. It is observed that at high repetition rate, the previous pulse affects the cavity response

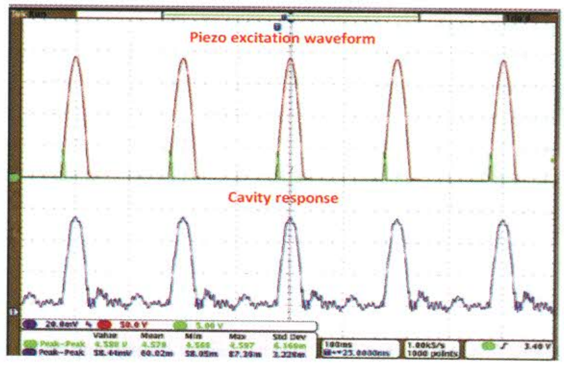

Fig. A.9.2: Cavity response due to peizo excitation

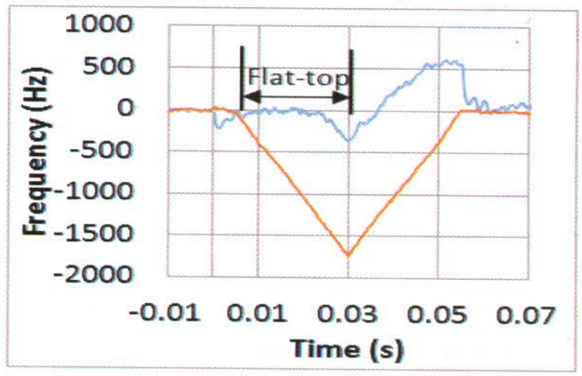

Fig. A.9.3: Result of LFD simulation

In an experimental simulation of Lorentz force detuning (LFD), RF signal generator waveform is frequency modulated (frequency deviation = 1.7 kHz) by triangular pulses of pulse width 50 ms at 1 Hz. This modulated RF power is fed to the cavity. Cavity response to this modulated signal is plotted in Fig. A.9.3 by orange colour. This detuning (dynamic disturbances) is analogous to LFD, which occurs in the SCRF cavities at high voltage gradient. Now, piezo actuators are excited by half sine-wave at different time advances and pulse widths. To improve the cavity response for detuning the piezo actuator was operated by advancing the pulse by 5 ms.

In the next stage, a test at LN_2 testing is being planned for prequalification of the fast tuning mechanism before performing high power testing at 2K with SCRF cavity.

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