## A.13: Development and Testing of a Prototype Coaxial Blade Tuner

Tuner is an essential part of SCRF cavity, which corrects the resonance frequency of RF cavity after cool down to 2K. It also controls the RF frequency instabilities (like LDF, microphonics etc.) during operation. Development of blade tuner is taken up to understand the tuning issues of 1.3 GHz SCRF cavity. A prototype blade tuner is fabricated in which the blades of the tuner are joined with its rings by using Nd:YAG laser welding. Further, a prototype 9-cell 1.3 GHz normal conducting (in copper) dressed cavity is prepared, tested and integrated with blade tuner for measurements (Fig. A.13.1). 3D FEA analysis of the dressed cavity with blade tuner is performed and various parameters have been calculated. The vector plot of displacement for moving the central ring is shown in Fig.A.13.2. The tuner sensitivity, stiffness, hysteresis, resolution and precise control of the tuner at liquid nitrogen temperature are the important tests, which are carried out on this assembly. Fig.A.13.3 shows the hysteresis of tuner for different power screw rotations during expansion and compression cycles.

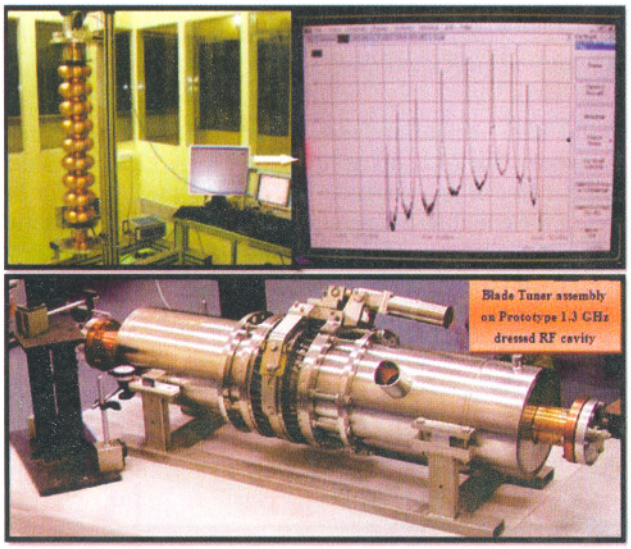


*Figure A.13.1. 9-Cell Cu cavity & RF measurement (Top) and assembly of 1.3 GHz 9-cell prototype RF dressed cavity with blade tuner (bottom).*

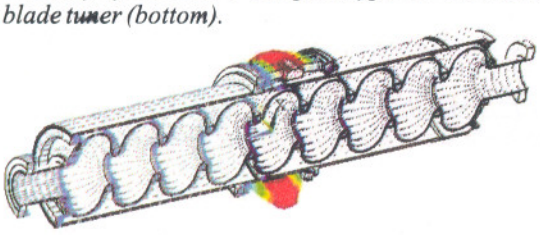

*Fig.A.13.2 FEA analysis showingcavity expansion by moving of central ring of the blade tuner.*

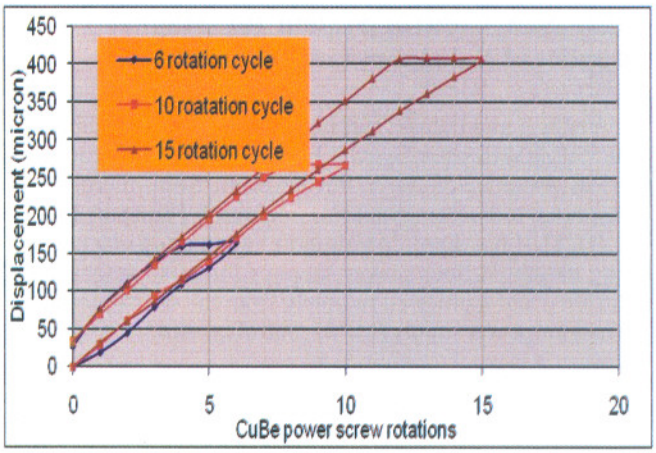


*Fig.A.13.3 Hysteresis loops for various power screw rotations with respect to net cavity displacement.*

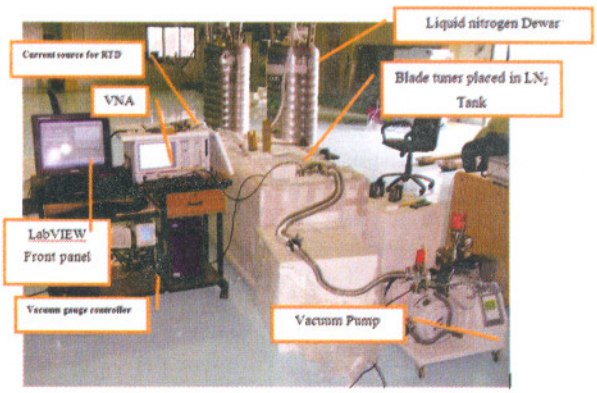


*Fig. A.13.4 Testing setup for Blade tuner at liquid nitrogen temperature.*

*Table A.13.1: RF testing of Blade Tuner*

| Testing condition | Cavity Tuning Direction | Change in π-mode freq. for 18 turns (kHz) | Sensitivity (kHz/turn) |
|---|---|---|---|
| Room temp. | Expansion | 105.8 | 5.9 |
| | Comp. | -104.8 | -5.8 |
| $LN_2$ temp. | Expansion | 113.8 | 6.3 |
| | Comp. | -111.9 | -6.2 |

The $LN_2$ temp. testing (Fig. A.13.4) reveals that the cavity sensitivity for tuning increases at lower temperatures (Table A.13.1). Following important parameters are evaluated in the prototype dressed cavity using blade tuner:

Freq. sensitivity:~320 kHz/mm (at room temp.)
Cavity freq. change: ~25Hz each motor rotation
Hysteresis of the tuner: <35 micron

Based on this experience,1.3 GHz titanium blade tuner for SCRF cavity is being taken up for fabrication.

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