APPROACH TOWARDS ESTABLISHING CRYOGENIC TEST FACILITY FOR SCRF CAVITIES OF 10 MeV PROTON LINAC

Prashant Khare , P. K. Kush, M. G. Karmarkar
Centre for Advanced Technology (CAT), Indore, INDIA

Abstract

The work is a part of development of 10 MeV first phase of the proposed CW Proton LINAC being pursued by Centre for Advanced Technology, Indore (India). This paper describes our approach for establishing a cryogenic facility for testing of SCRF cavities (350 MHz) at 4.2K. These cavities, made from bulk Niobium, are proposed for Proton LINAC . This test facility will be used for validating fabrication and processing schemes adopted in manufacturing the cavities. The tests to be performed will include (i) testing the inner and outer cavity vessel for leak at 4.2 K and after warm up (ii) Thermal mapping of the cavity inner vessel to investigate cause of quench or any other anomalous signal (iii) effect of helium pressure fluctuation on tuning of the cavity & (iv) full power RF test at 4.2K for obtaining Q_0/E_{acc} , E_{pk} / E_{acc} and B_p / E_{acc}

INTRODUCTION

Bulk Nb cavities (350 MHz) will be developed for proposed proton linac at CAT [1]. During the prototyping phase a Cryogenic test facility (CTF) is necessary to ascertain the performance of cavities under cryogenic conditions. The CTF will comprise of a vertical cavity test facility. The tests are mainly directed towards measuring unloaded quality factor Qo as a function of cavity's field level (Qo / Eacc) .The different important curves Epk / Eacc (Ratio of peak surface electric field to accl. Field) and Bpk/Eacc (Ratio of peak magnetic field to accelerating field) are obtained in this test.

The facility is also used to measure mechanical integrity under cryogenic conditions and resonating frequency of cavity after it has been evacuated, undergone shrinkage at 4.2 K and is under pressure of liquid helium in the enclosure. The RF measurements give only average behaviour of cavity as we measure only total RF loss. To resolve local distribution of energy losses by mechanisms such as field emission, multipacting and thermal breakdown we adopt temperature mapping and x-ray detection.

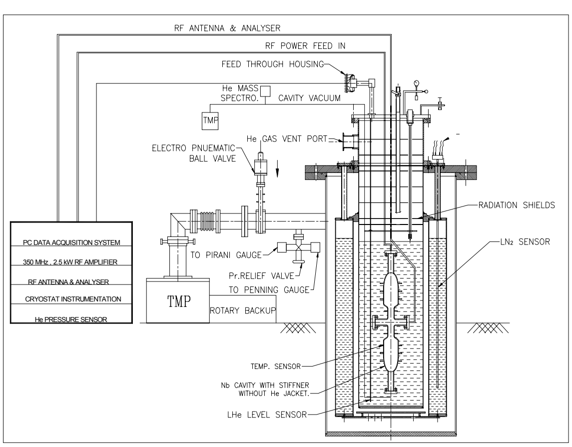

Fig. 1: Schematic of the Vertical Cavity test facility(inner vessel cryostat)

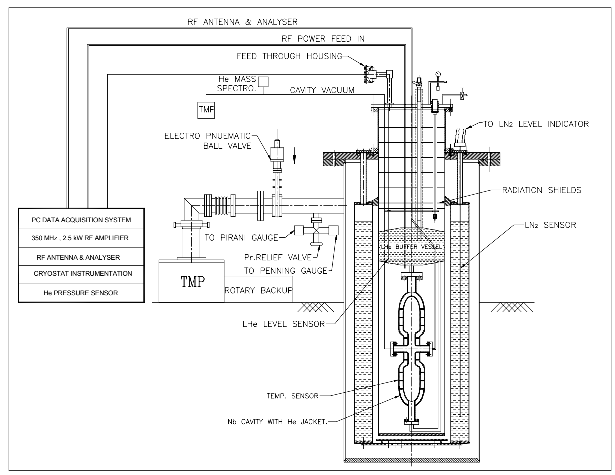

Fig. 2: Schematic of the Cavity test facility (outer vessel cryostat)

CAVITY TEST FACILITY

The test facility will comprise of two vertical cryostats, one for the testing of inner vessel (Fig.1) that needs to be immersed in a liquid helium bath. The other cryostat (Fig.2) will be used for testing of assembled cavity with its own helium capacity. This cryostat will have a container of helium positioned on top of the cavity. Suitable system for RF powering and pick up antenna will be provided. The cryostat will have appropriate instruments for monitoring helium pressure, vessel vibration etc. Thermometers with milli kelvin resolution and capacity to scan quickly will be fixed on cavity surface for thermal mapping of the cavity. X-ray detectors are to be placed outside the cavity wall. A Computer based Data Acquisition system, required to keep record of numerous resistors and their angular positions is being developed for the purpose.

THE TEST PROCEDURE

The test procedure is shown in Fig.3. The cavity dimensions based on RF design are transferred to room temperature dimensions and measured physically. The cavity as fabricated will be first tested at room temperature for leak by MSLD technique. Subsequently RF test will be performed to ascertain the resonating frequency of the cavity. Any deviation in the frequency will be corrected by deforming the cavity plastically in a specially designed fixture. Thermal fatigue test is performed at 77K. To check the cryogenic integrity of the prototype, the bare cavity is again immersed in Liquid Helium at 4.2K and tested for leak in the cryostat fabricated for the purpose. The cavity will be then mounted with helium jacket and tested in the second cryostat for leak in the outer vessel. As a final step full power RF test is performed. The factor Qo describes the characteristics of the cavity independent of the set up used to drive it. Temperature maps will be obtained at regular intervals to monitor heat distribution as a function of field. X-ray detectors will show x-rays due to bremstrahlung from field emitted electrons when they hit cavity walls.

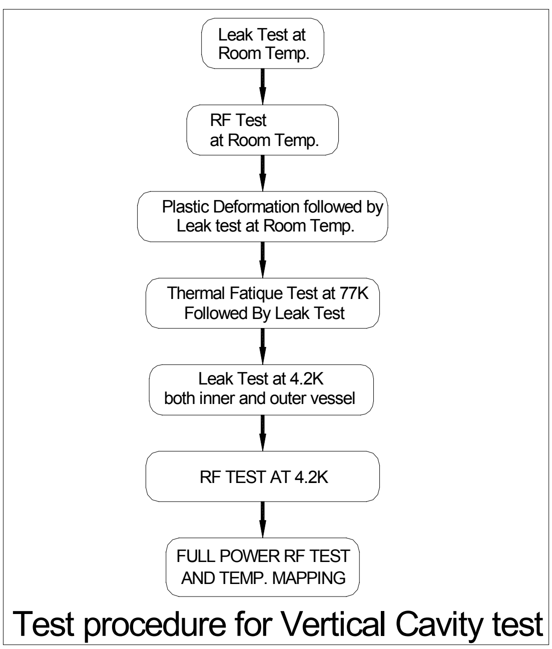

Fig. 3: Sequence of tests to be performed in prototyping phase

Sensors will monitor mechanical deformations of the cavity due to helium pressure. This data is useful for improving the design of the cavities. RF performance and temperature maps thus obtained will provide a good assessment of the fabrication and processing techniques adopted for manufacturing the prototype cavity.

CONCLUSION

The work on Cryogenic test facility has been launched. The preliminary studies have been completed and designing of the cryomodule test set up is being taken up.

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