Superconducting cavities

650 MHz β=0.6 superconducting radiofrequency cavity

The 650 MHz superconducting radiofrequency (SCRF) cavities are being design, fabricated and testied for use in the Fermilab Collaboration as well as Indian SNS programme. This cavity is subjected to external pressure during operation at 2K. The structural analysis of cavity has been carried out to find out the stresses and deflections under external pressure load and operating temperature. The important part of the simulation is devoted to the determination of membrane stress, bending stress, secondary stress, etc.

Two separate cases for primary loading alone and primary loading combined with secondary loading has been considered. During cool-down, the cavity may be subjected to a 2.2 atm. external pressure while still near room temperature. In first case, a scenario of 2.2 atm. external pressure at room temperature has been considered thinking of initial cool down. In a second case, 3 atms. external pressure at 2K has been considered for a situation of loss of insulation vacuum.

Mechanical modal analysis has been carried out for un-stiffened cavity for different end conditions to find out lowest natural frequency. Analysis has also been carried out for addition of stiffener to find out the optimum position of placing it to ensure that the lowest natural frequency lies well above the 100Hz. It ensures any surrounding noise and vibration does not affect cavity performance.

Limit load analysis has also been done to establish and compare the collapse pressure for stiffened & un-stiffened cavity.

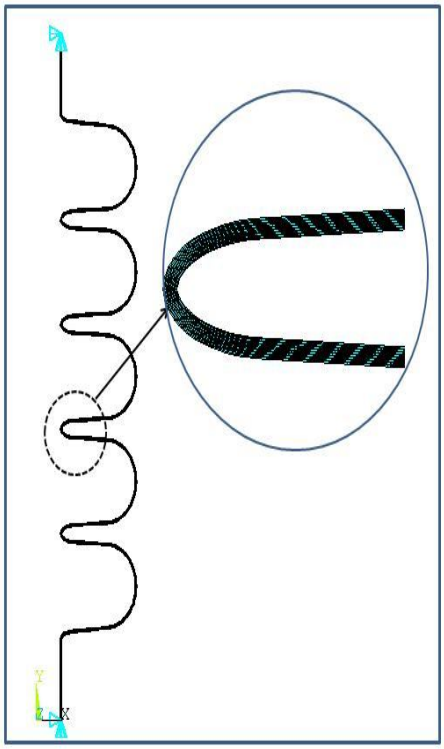


Figure A: FEM Model for analysis;

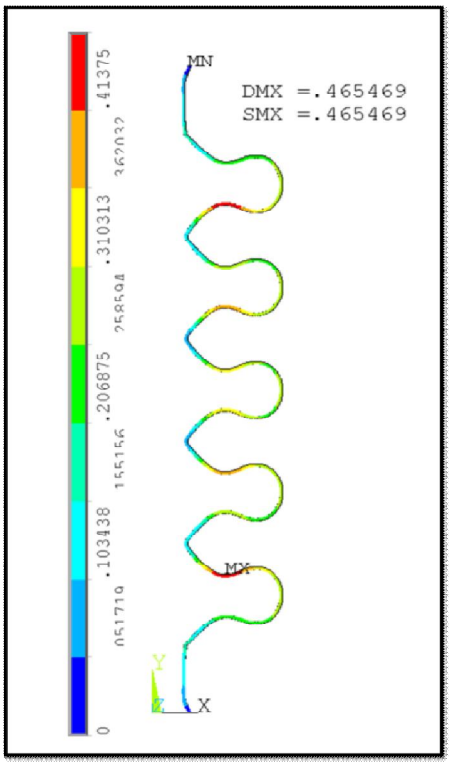


Figure B: Deformation due to cooldown and

3atm. Pressure

In order to develop expertise in forming Niobium cavities, several trials were taken on aluminium cavities. The first single cell cavity has already been made. The cavity was sent to Fermilab for processing and testing. The cavity successfully demonstrated the desired performance. Design and development of multi-cell cavity has subsequently been taken up.

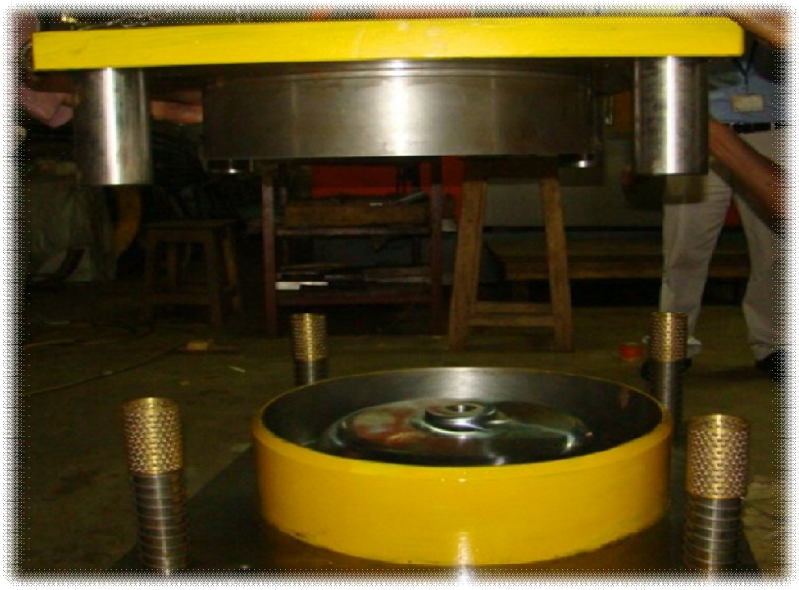


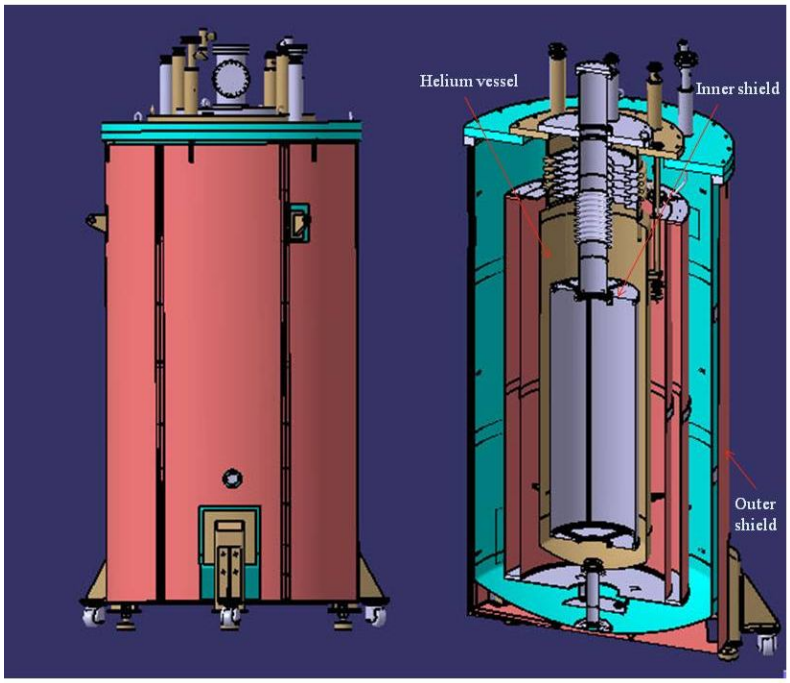
Figure C: Die-Punch for deep drawing trial

Figure D: Nb Half cells and end tubes assembled with the welding fixtures

Vertical test cryostat for SCRF cavity

Design of the test cryostat for 5 cell 6.5MHz β=0.61 for testing these cavities at liquid helium temperature has been completed and procurement of the cryostat is in progress. The superconducting RF cavity has to be shielded from magnetic fields present during cool down below the critical temperature to avoid freezing in the magnetic flux at localized impurities, thereby degrading the cavity intrinsic quality factor Q_0. The design of the magnetic shielding for the vertical cavity test facility has been completed. Two cylindrical layers: a room temperature outer shield of Mumetal

and a 2K inner shield of Cryoperm 10, is planned.



Model of test cryostat