Electromagnetic design of a β=0.9, 650 MHz elliptic superconducting radio frequency cavity

Arup Ratan Jana and V. Kumar*
Materials and Accelerator Science Division, Raja Ramanna Centre for Advanced Technology, Indore, INDIA
** email: vinit@rrcat.gov.in*

Abstract

We have recently performed two-dimensional (2D) electromagnetic design studies of a β=0.9, 650 MHz, elliptic superconducting radio frequency (SCRF) cavity using electromagnetic field solver code SUPERFISH [1]. We have evolved the design starting from the design parameters of β=1, 1300 MHz, TESLA design SCRF cavity [2] and then scaled it for the β=0.9 and 650 MHz case. The design has been optimized for minimizing the SCRF cavity power loss. One of the important parameters in the design of such elliptic SCRF cavities is the wall angle, which is defined as the vertical angle made by the common tangent to the iris and equator ellipses. Generally, there is a constraint on the minimum value of the wall angle, which is decided by the mechanical considerations, ease of chemical cleaning etc. In our optimization studies, we have first explored the case when there is no such constraint on wall angle. We find that from the point of view of low cavity power dissipation, the optimized design has a re-entrant geometry, where the wall angle is negative. We then perform design optimizations, keeping the constraint that the wall angle should be greater than 5 degree. Keeping this constraint, we find that our optimized design parameters for the single cell match closely with the design parameters reported for Project-X [3]. We discuss the results of 2D electromagnetic field calculations for this design using SUPERFISH.

In the next, we have performed the design studies of the multi-cell β=0.9, 650 MHz, elliptic SCRF cavity. The design parameters of end-cells are optimized such that the frequency of the end-cell is matched to that of mid-cells. We have studied all the normal modes for the multi-cell cavity. The frequency of different normal modes is also calculated using a finite element code ANSYS[4] and results are compared with those obtained using SUPERFISH. The field flatness, which is an important design criterion, is also studied. For multi-cell cavity, another important aspect is the cell to cell coupling coefficient, which we have calculated using the dispersion diagram for the multi-cell cavity structure. Finally, we present the analytical calculation on the β-acceptance of the multi-cell cavity, based on which the number of cells in the multi-cell cavity structure is optimized.

References

[1] James Billen and Lloyd M. Young, *POISSON, SUPERFISH reference manual, LA-UR-96-1834.*
[2] B. Aune, Phys. Rev. ST Accel. Beams 3, 092001 (2000).
[3] V. Yakovlev et al., Proceedings of IPAC-2010.
[4] *ANSYS Theory Reference,* online guide, www.ansys.com.