MECHANICAL DESIGN, FABRICATION & TESTING OF PROTOTYPE RFQ

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INTRODUCTION

As part of the accelerator augmentation program at IUAC, a high current injector (HCI) is being developed to inject large currents highly charged ions into the superconducting LINAC.

The HCI consists of a superconducting (High TC) ECR source operated on a high voltage deck, producing the high currents of highly charged ions. The ion beams produced by the ECR (PKDELIS) source will be injected into a Radio frequency quadrupole accelerator (RFQ) and be accelerated to 180 keV/u. For the development of the RFQ accelerator, a prototype is being built at IUAC to test the mechanical cooling, RF and beam optical design.

The IUAC RFQ is a four-rod cavity structure consisting of individual, demountable vanes on vane posts. The vane posts are mounted inside the UHV chamber on its base plate. A detailed 3-D CAD model of the final design was developed using solid-works. Also a complete set of fabrication drawings were made before the start of fabrication.

Prototype RFQ can be divided in two parts :

1) High Vacuum Chamber
2) Inner Assembly
3) a.Base Plate
4) Vane Posts
5) Vanes

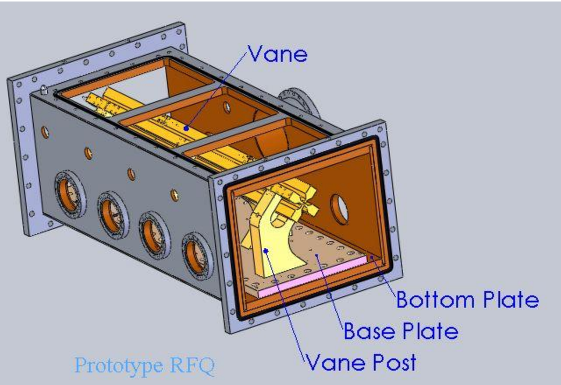

Figure 1. Assembled structure of the prototype RFQ (schematic)

HIGH VACUUM CHAMBER

The high vacuum system provides the necessary operating environment for the ion beam. The inner dimensions were fixed by simulation on CST Microwave studio program and mechanical design work was done using solidworks drawing and design software. Buckling load acting due to vacuum was simulated and found satisfactory in terms of deformation and stresses.

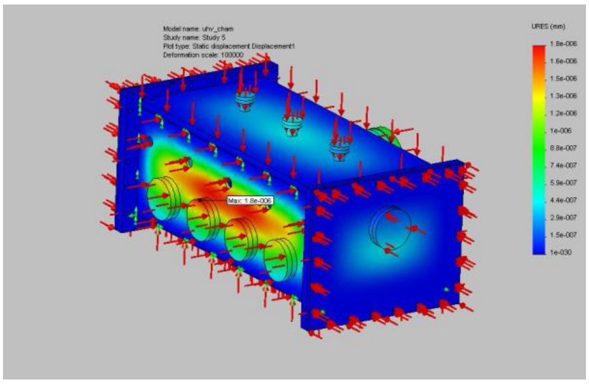

Figure 2. Load analysis of the vacuum chamber

The design, fabrication and testing of high vacuum system with internal dimensions of 1194 x 500 x 355 mm has been successfully achieved. The chamber can hold a vacuum of the order of $1x10^{-7}$ torr or less.

Copper Plating of Chamber

The inner surface of the chamber is copper plated with a plating thickness of 70 microns. It was first plated by one local vendor in Delhi but the quality of the plating was not satisfactory so we finally got it done from RRCAT.

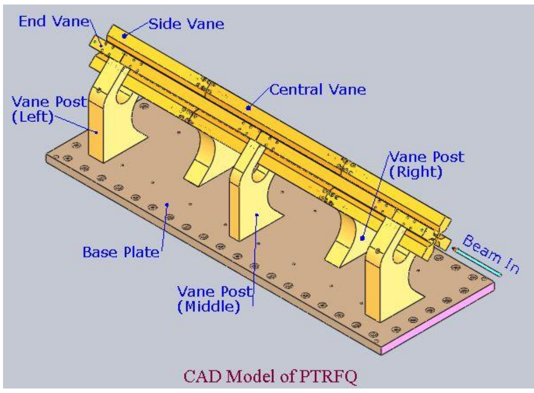

Figure 3. Inner assembly structure (schematic)

Inner Assembly Components

PTRFQ consists of five numbers of vane posts and 14 numbers of vanes. Vanes have modulation on the beam side. Vanes and vane posts were made on CNC machines within an accuracy of 40 microns and were inspected on CMM (co-ordinate measurement machine). Cooling channels have been provided in posts as well as in vanes. Water enters from lower side of the posts and passes through vanes before coming out. Load analysis of the vane and vanes posts was done on solidworks.

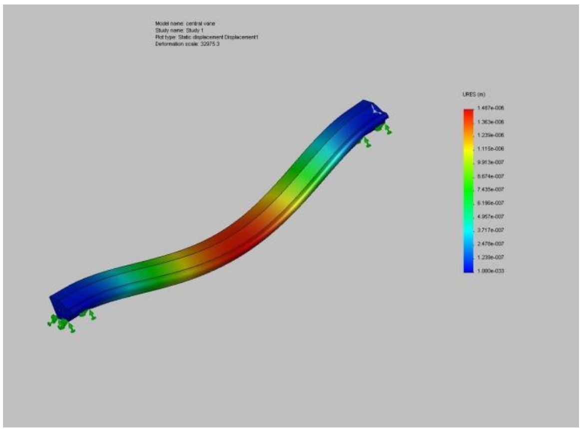

Figure 4. Load analysis of the central vane due to its own weight

As per our design the accurate positioning of the vanes is dependent on the accurate positioning of the vane posts. And the positioning of the vane post depends upon the size and positioning of the pockets made in the base plate for the vane post as well as the straightness of the base plate. The base plate sits on the bottom plate of the chamber on O-ring. All the vanes are sitting on posts with dowels and bolts. So to get the required accuracy in assembly of the vanes, a thorough and stringent inspection was done after machining of each and every component. A proper sequence was adopted for the assembly of vanes as under:

Assembly Sequences:

1) Base Plate fixing and Alignment
2) Vacuum testing
3) Vane-post assembly
4) Vacuum testing
5) Vanes assembly
6) Vacuum testing
7) Water accessories assembly

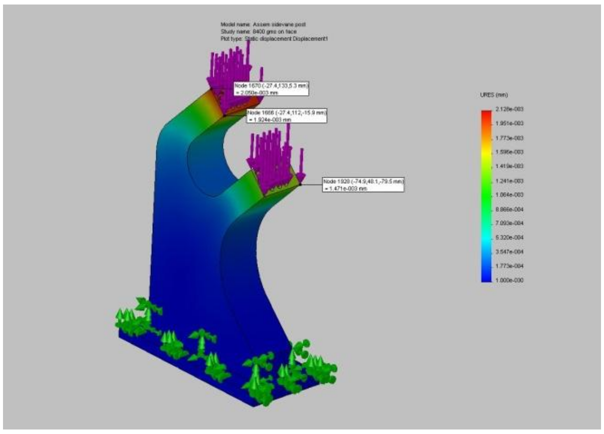

Figure 5. Load analysis of side vane-post with load equal to central vane on each face

Assembly of vanes has been achieved within an accuracy of 100 microns taking the help of high accuracy dial indicators, surface table and portable CMM.

CONCLUSION

A prototype has been fabricated to carry out RF structure studies and the tests have confirmed the success of design of RF structure.

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