ENGINEERING DESIGN OF 57.5 MHz CW RFQ FOR THE RIA DRIVER LINAC

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A Continuous Wave (CW) Radio Frequency Quadrupole (RFQ) accelerator is being designed for the Rare Isotope Accelerator (RIA) Driver Linac. This device is required to accelerate a wide variety of species of …. as well as perform simultaneous acceleration of multiple charge states. As such, the structure must operate over a wide range of RF power dissipation from ~0.65 kW to 48 kW. The physics design of this pseudo split-coaxial RF structure was established earlier. The design addresses the requirements for efficient cooling throughout the structure, precise alignment, reliable RF contacts, and fine tuning capability. The RF, thermal and structural analyses have been completed in response to these requirements. An RF analysis was used to determine the heat loss distribution on the cavity's internal surfaces. The heat loads were then transferred to a thermal model of a single segment and scaled to match total heat loss obtained from the code CST Microwave Studio. The thermal model includes the cavity vanes, walls and all cooling channels. To determine the coolant temperature rise, one-dimensional pipe flow elements were used. These elements account for fluid heat transport and heat transfer coefficients. The model was then used to minimize coolant flow by connecting the shell coolant channels in series. Temperature distributions were used as input to the structural model to determine stress levels and vane displacements. Different power levels were assessed as well as the thermal and structural response to vane-shell coolant temperature differences, which may be used to tune the resonant frequency. Results of these analyses show that the thermal and structural design of this RFQ is very robust.

~~The favored approach employs furnace brazing for fabrication of details and complete RFQ segments. Six longitudinal segments are mechanically assembled to form the complete 4-meter RFQ structure.~~ A typical segment with cutaway sections to show the cooling passages is shown in Fig. 1. Several different approaches to fabrication of the RIA RFQ were discussed during the conceptual design phase. Ultimately we have chosen a fully brazed assembly using step brazing to fabricate the vanes and quadrant details and finally a complete segment with end flanges. This approach borrows heavily from the techniques used successfully on the LEDA RFQ at Los Alamos. The RFQ is designed as a 100% OFE copper structure with SST end flanges. For the simplicity of machining, fixtures and post-brazed handling the vanes will be made from Glidcop. Six longitudinal segments will be mechanically assembled to form the complete 4-meter RFQ structure

The aluminum cold model of the RFQ segment was designed and constructed. This model is necessary to verify final internal dimensions of the RFQ prior to the fabrication of full cooper structure, testing of machining and final assembly tolerances. An aluminum vane was used for the test of gravity force effect on the horizontal vane profile. Precise measurements for the gravity deflections of the vane show acceptable deviations of the vane's profile. The final assembly of the aluminum model is in progress. An aluminum vane photograph is shown in Fig. 2.

Full power engineering prototype of a single segment of the 57.5 MHz RFQ is being developed. The main reasons to proceed with fabrication and testing of the engineering model are: a) the transverse dimensions of the RFQ are significantly larger than those in 4-vane high-frequency RFQs built using the brazing technique; b) due to the large cut-out in the vane it is prudent to demonstrate mechanical stability during high temperature brazing. Once the fabrication is complete, testing of the RFQ prototype over the wide range of input power is necessary. Successful testing of the RFQ over the wide range of rf power level will simplify the design and minimize the cost of the RIA Driver Front End: the same RFQ will be able to accelerate full range of ions from proton to uranium. Currently we perform pre-tests of major brazed junctions of the RFQ engineering prototype. Figure 2 shows the OFE copper vane prepared for the brazing.

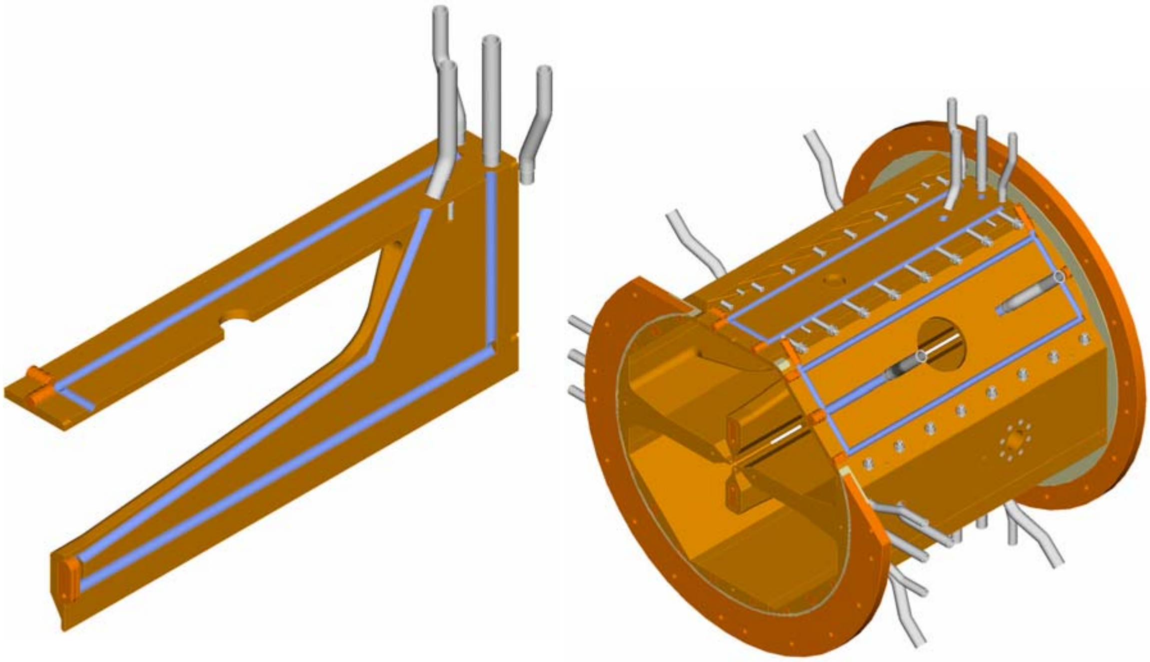

Figure 1. Segment details with cooling channels. The vane assembly is shown separately on the left.

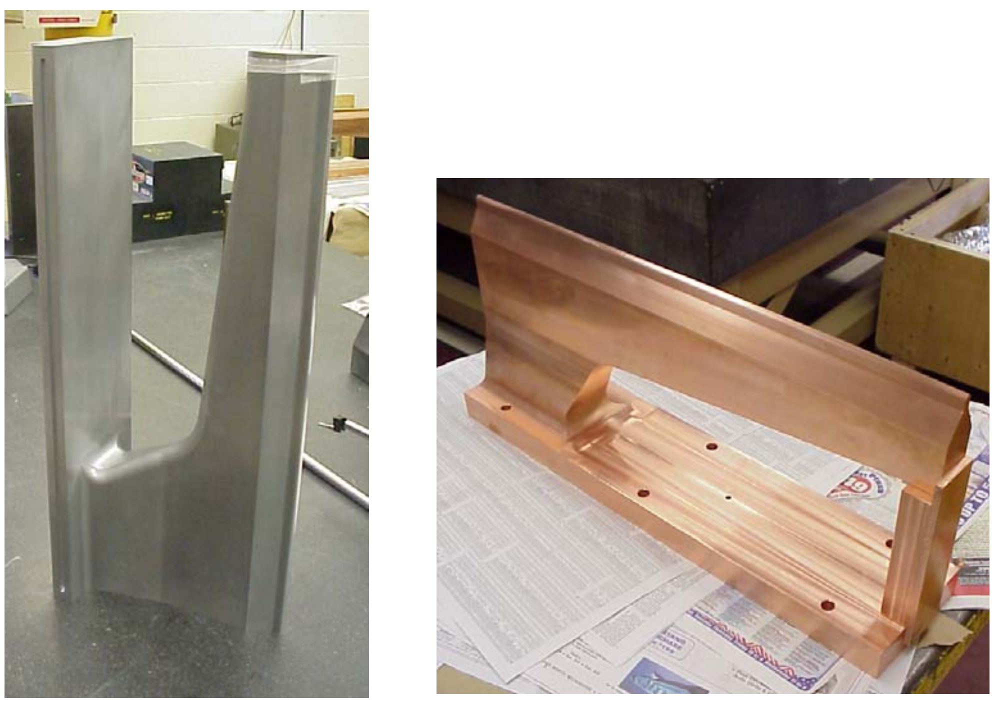

Fig. 2. Photographs of the aluminum (on the left) and copper (on the right) vanes.