Manufacturing and assembly of the upgraded HITRAP RFQ decelerator

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Introduction

A new HITRAP RFQ structure was designed and built at GSI according to the requirements and specifications of the accelerator physicists [1], [2]. There have been three goals to be achieved with the new construction. First an exact modulation of the electrodes, second an exact and repeatable mounting structure that needs not to be aligned and thirdly an ultra-high vacuum compatible construction.

Manufacturing

In the new design the stems as well as the electrodes were manufactured out of one peace. The electrodes were screwed on to the stems using a fit as shown in Figure 1. No brazing and alignment was needed for the fitting of the electrodes. The stems were additionally equipped with a base that was fitted into grooves on the revised ground plate. In order to match the ultra-high vacuum requirements ($< 10^{-8}$ *mbar*) no thread inserts were used anymore.

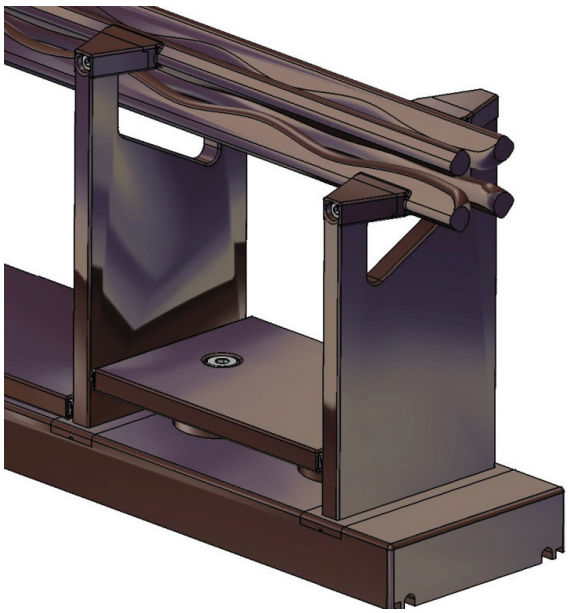

Figure 1: The new RFQ design.

All parts of the structure were made of oxygen free copper and manufactured in the workshop of GSI. A special treatment was carried out on the copper bars which were used for the RFQ electrodes. To relieve the residual stresses the bars were annealed under vacuum at 600°*C*. Additionally the bars were strain hardened through stretching of 1%. The stretch treatment took place at the Department for Material Science of the Technical University of Darmstadt. Due to this treatment residual stresses were reduced so that the deformations that appear during milling are reduced. An important issue, the vibrations during milling of the one meter long copper bars, were reduced by optimizing the feed rate and rotation speed of the milling tools. For the milling of the electrode modulation the design data of the code DESRFQ [2] was interpolated and a 3D surface for the milling machine has been created.

Assembly

Each produced part was directly measured and refinished after. The ground plate of the structure was mounted on a milling machine to simulate the mounting in the tank. Every stem was individually machined and aligned to the ground plate. After this step, the electrodes were mounted and final retouching applied. Finally the whole structure was placed and reassembled inside the tank, Figure 2.

Figure 2: Final assembly inside the RFQ tank.

Result

The new RFQ was commissioned with the expected performance. The sophisticated design of the stems and the electrodes was approved and an overall accuracy of better than ±0.15 *mm* referring to the beam axis has been achieved. To increase the performance for future projects is intended to reach an accuracy of better than ±0.05 *mm* referring to the beam axis. The fabrication procedure, measurement protocols and the gained experience might be used for upcoming accelerator projects.

References

[1] M. Maier, this anrep
[2] S. Yaramyshev, this anrep