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# DESIGN OF THE SUPERCONDUCTING QUARTER WAVE RESONATORS FOR HIAF

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*Abstract*

A heavy ion accelerator facility (HIAF) is under development in the Institute of Modern Physics. For the low energy superconducting accelerating section, two types of quarter wave resonators with frequency of 81.25 MHz and β of 0.05 and 0.09 have been proposed. The electromagnetic design has been optimized in order to reach the high accelerating voltage, and the optimization also included the drift tube face tilting to compensate for the beam steering caused by the asymmetry in the quarter wave resonator geometry.

## INTRODUCTION

HIAF is a high intensity heavy ion multi-function research facility, and it contains a linac as injector and several rings. The HIAF Linac will accelerate ions from H to U, and it contains ECR, LEBT, RFQ, low energy superconducting section (QWRs) and the high energy superconducting section(HWRs). For the low energy superconducting section, f=81.25 MHz, $\beta_{opt}$=0.05 and 0.10 QWRs have been proposed consistent with beam dynamics [1].

## ELECTRO-MAGNETIC DESIGN

With Microwave Studio of CST [2], the cavity optimization has been done in order to minimize the surface electro-magnetic field and keep high $R_a/Q_0$ and G values. Using the QWR in the ATLAS upgrade design for reference [3], tapered inner and outer conductors have been adopted (Figure 1). There are two ports on the top and on the bottom, respectively, for the cavity surface treatment. And there are two coupler ports on the outer conductor. The final design of the RF parameters has been presented in Table 1, and the RF field distributions have been shown in Figure 2.

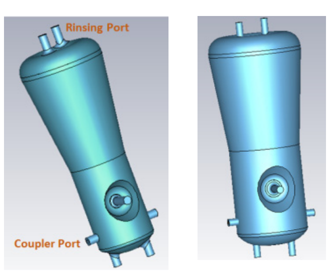


Figure 1: f=81.25 MHz, βopt=0.05, 0.10 QWR cavity model (from MWS of CST).

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Table 1: Design RF Parameters of the QWR

| Cavity Type | QWR-0.05 | QWR-0.10 |
|---|---|---|
| Frequency (MHz) | 81.25 | 81.25 |
| $\beta_{opt}$ | 0.05 | 0.10 |
| $L_{eff}$ (β*λ,mm) | 185 | 369 |
| $E_{peak}/E_{acc}$ | 5.65 | 5.17 |
| $B_{peak}/E_{acc}$ (mT/(MV/m)) | 5.52 | 7.35 |
| G (Ω) | 28 | 39 |
| $R_a/Q_0$ (Ω) | 548 | 550 |

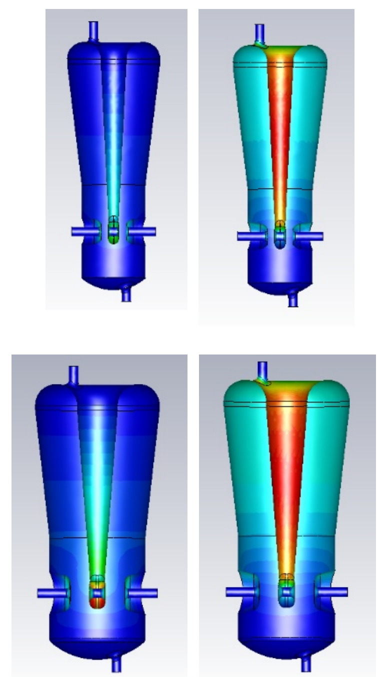

Figure 2: QWR surface fields (upper for QWR-0.05, nether for QWR-0.10).

## CORRECTIONS OF THE BEAM STEERING EFFECT

The beam steering caused by the up-down asymmetry with respect to the beam axis needs to be compensated. Generally, three correction methods can be applied [4]: (I) donut-shaped axisymmetric drift tube used to reduce the magnetic field in the gap; (II) beam offset used to introduce the RF defocus field to counteract the electric and magnetic field effects; (III) beam port tilting used to create the artificial $E_y$ to counteract the steering. In our design, the third method was employed (Figure 3). By properly tilting the beam ports, it's possible to create new $E_y$ components (Figure 4), and adjusting the tilting angle

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one can find the minimum vertical angle centroid y' (Figure 5).

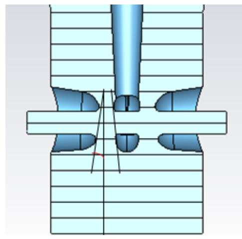

Figure 3: Tilting angle for steering correction.

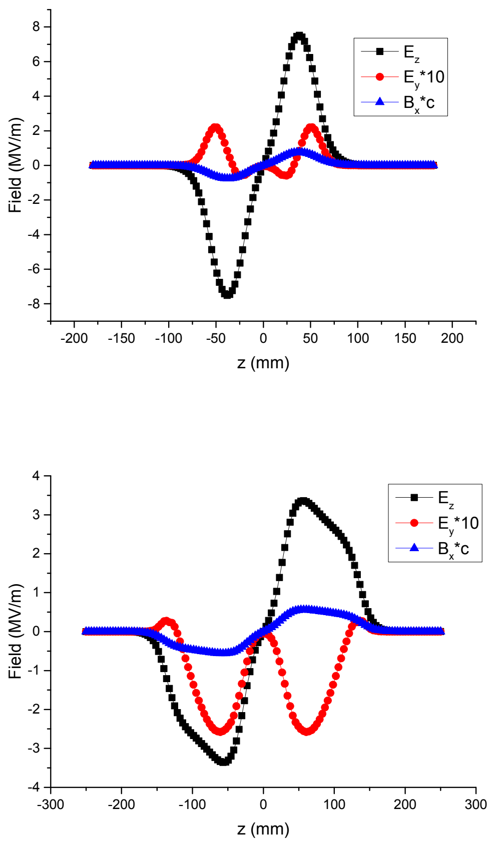


Figure 4: Field distribution along the beam axis after being tilted the beam port (tilting angle for QWR-0.05 1.50 and for QWR-0.10 0.50).

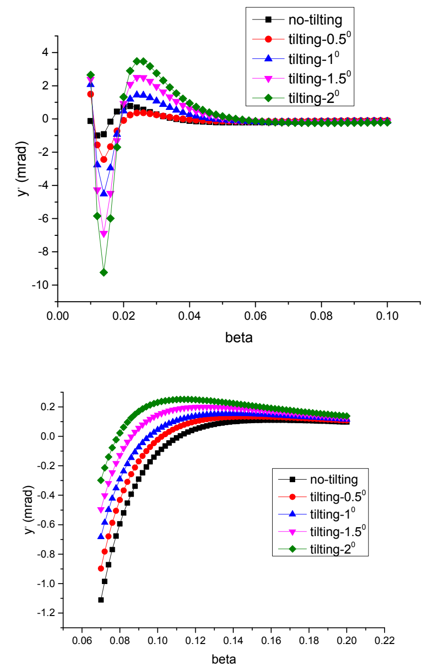


Figure 5: Sweep of the tilting angle to find the optimum one to correct the vertical angle centroid y'.

## SUMMARY

The frequency of 81.25 MHz, $\beta_{opt}$ of 0.05 and 0.10 QWRs have been RF designed and the beam steering effects have been corrected. And the multipacting simulation and mechanical design have been ongoing.

## REFERENCES

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