14th Symposium on Accelerator Physics

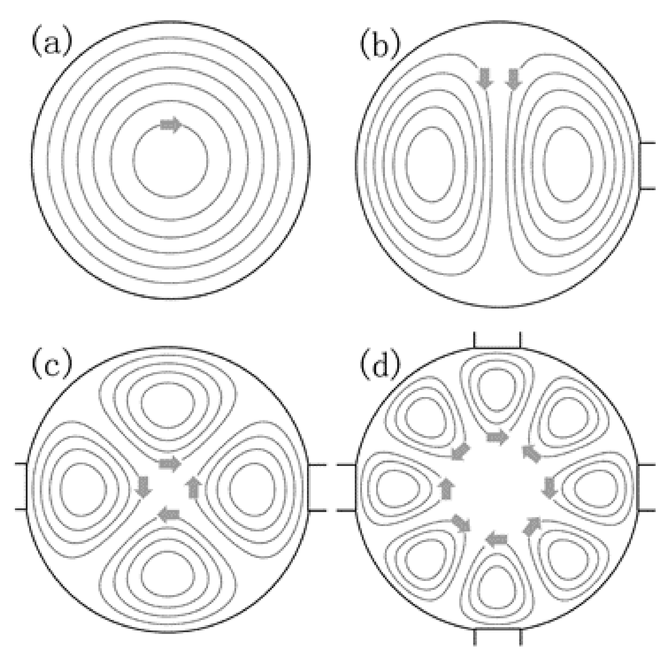
Multipole Field Optimization of X-Band High Gradient Structure

B. Feng [1,†], Q. Gao [1,*], J. Shi[1], H. Zha[1], X. Lin[1] and H. Chen[1]

[1]Department of Engineering Physics, Tsinghua University, Beijing 100084, PR China

Motivation and Objective

The presence of a multipole field component in the X-band acceleration structure's coupler leads to an increase in ray band-width and a decrease in yield, ultimately affecting the quality of the generated rays. Through calculations, it has been determined that the quadrupole field compo-nent is particularly prominent in the original structure, accounting for 29.5% of the fundamental mode strength.



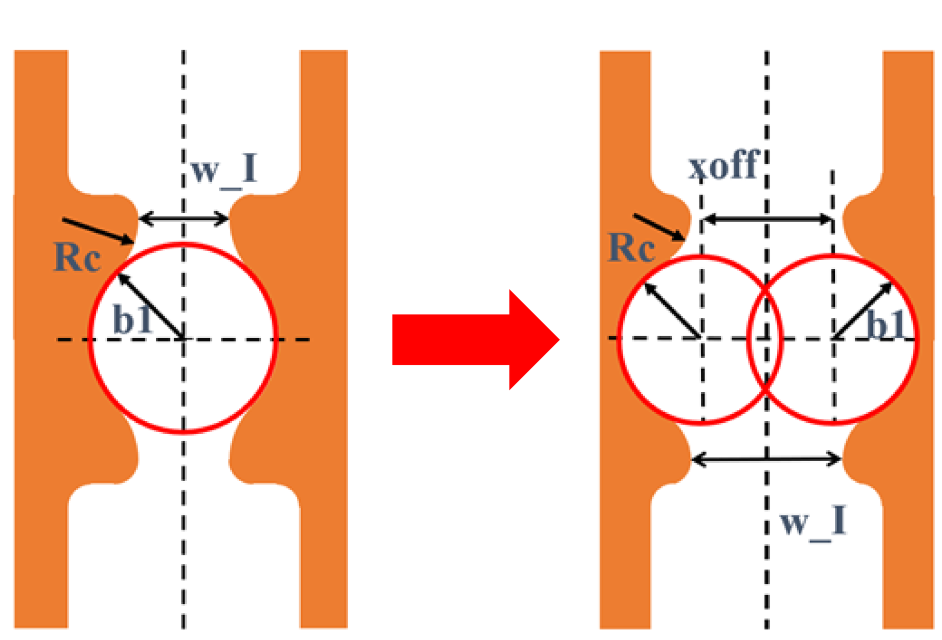
Different drilling situation in the cavity and the distribution of the multi-pole magnetic field

Goal - optimize the coupler structure to suppress multipole field components. Use the non-resonant perturbation method to measure the multipole field components within the coupler.

Approach - parameter scanning, non-resonant perturbation method

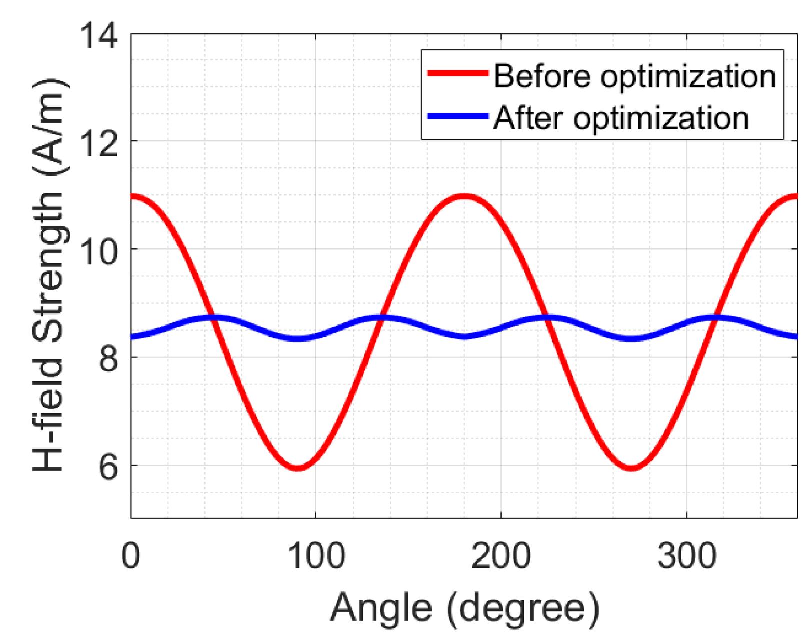
Optimization

Approach - The entire cavity of the coupler was transformed from a circular structure to two staggered circular structures, creating a racetrack-type structure.



Schematic diagram of coupler structure optimization

Parameters	Value [mm]
Rc	4.0
xoff	7.0
b1	5.891
w_I	9.173

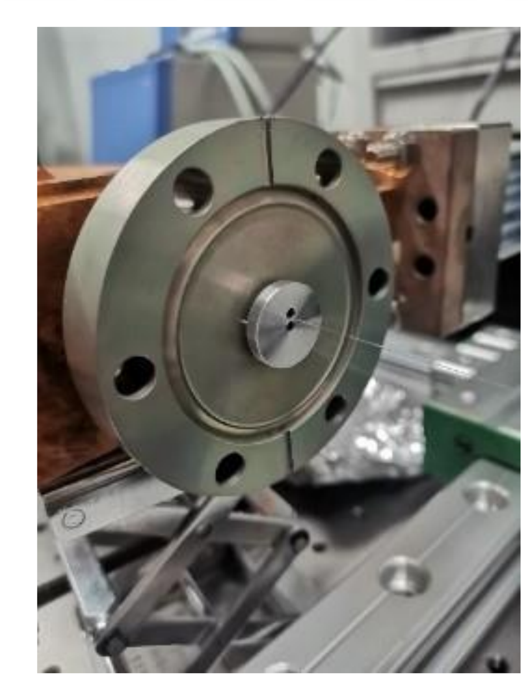


The strength of the quadrupole field component:

- Before optimization: 29.5%
- After optimization: 0.28%

Measure

Approach - involve introducing a perturbation object into the acceleration structure and measuring the reflection coefficient S11 at the input port. By analyzing the S11 measurement, the electromagnetic field at the location of the perturbation object within the acceleration cavity can be obtained.



Conclusion

The optimization of the X-band acceleration structure has successfully suppressed the strength of the multipole field in the coupler. The strength of the quadrupole field component has been reduced to just 0.28% after the optimization process. The non-resonant perturbation method has been em-ployed to measure the electromagnetic field within the X-band acceleration structure, both through simulation and experimental approaches.

References

[1] H. Chen, Y. Du, L. Yan, J. Shi, W. Huang and C. Tang, "Optimization of the Compact Gamma-ray Source Based on Inverse Compton Scattering Design," 2018 IEEE Ad-vanced Accelerator Concepts Workshop (AAC), Brecken-ridge, CO, USA, 2018, pp. 1-5, doi: 10.1109/AAC.2018.8659417.

[2] Chae, M., Hong, J.H., Parc, Y.W., Ko, I.S., Park, S.J., Qian, H., Huang, W.H., & Tang, C.X. (2011). Emittance growth due to multipole transverse magnetic modes in an rf gun. Physical Review Special Topics-accelerators and Beams, 14, 104203.

[3] Ainsworth, R., Molloy, S., Boorman, G., Lyapin, A., Ga-bor, C., Garbayo, A., Letchford, A., & Savage, P. (2011). Bead-pull Test Bench for Studying Accelerating Structures at RHUL. Paper presented at IPAC11, San Sebastian, Spain. http://accelconf.web.cern.ch/accelconf/IPAC2011/papers/mopc049.pdf