Development of ultra-low phase gradient X-band resonators for continuous beam Cs clocks

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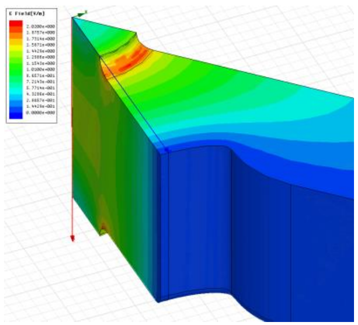
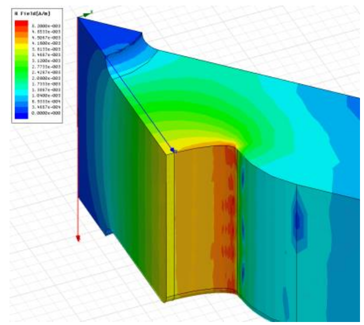
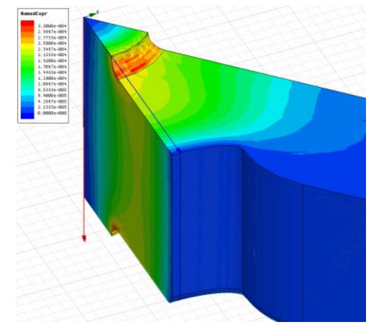
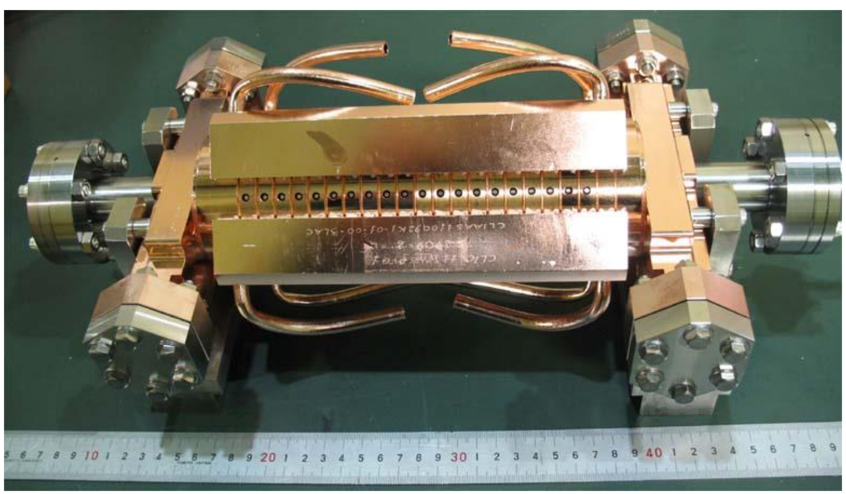
CLIC accelerating structure development

In the context of the study of a TeV-range linear colliders – NLC/JLC and CLIC - we have developed advanced rf design techniques combined with advanced rf component and accelerating structure assembly techniques.









Collaboration with METAS

METAS is the national standards laboratory for Switzerland. They have an on-going continuous beam Cs clock development project. Cs clocks are the current standard for the second, so of crucial importance all throughout society and industry

Through a series of visits we have realized that we could make a significant contribution to their continuous-beam Cs clock project.

A critical component which is limiting their performance is the X-band resonator, in which the atomic interaction occurs. In particular they require extreme phase flatness – micro-radians.

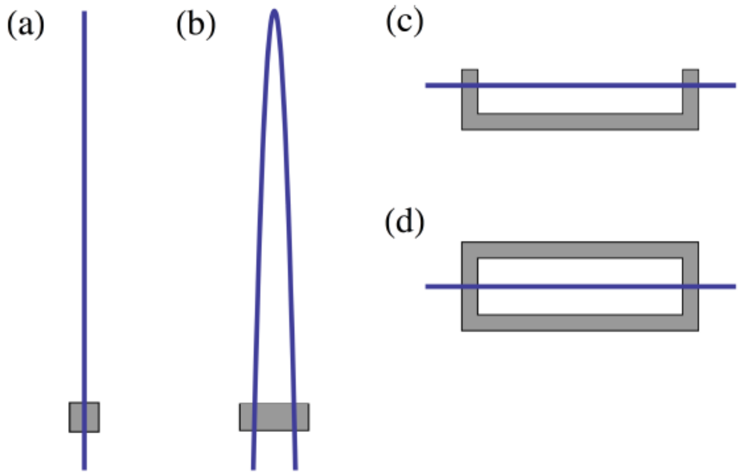
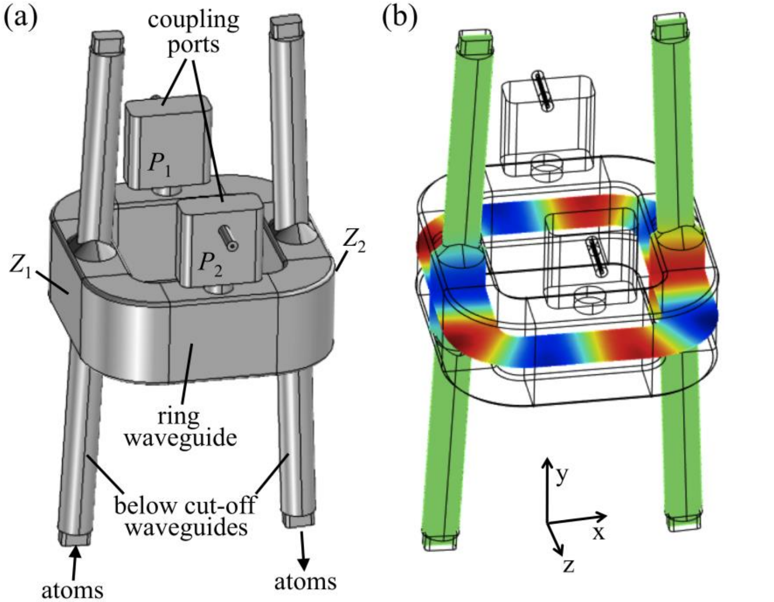
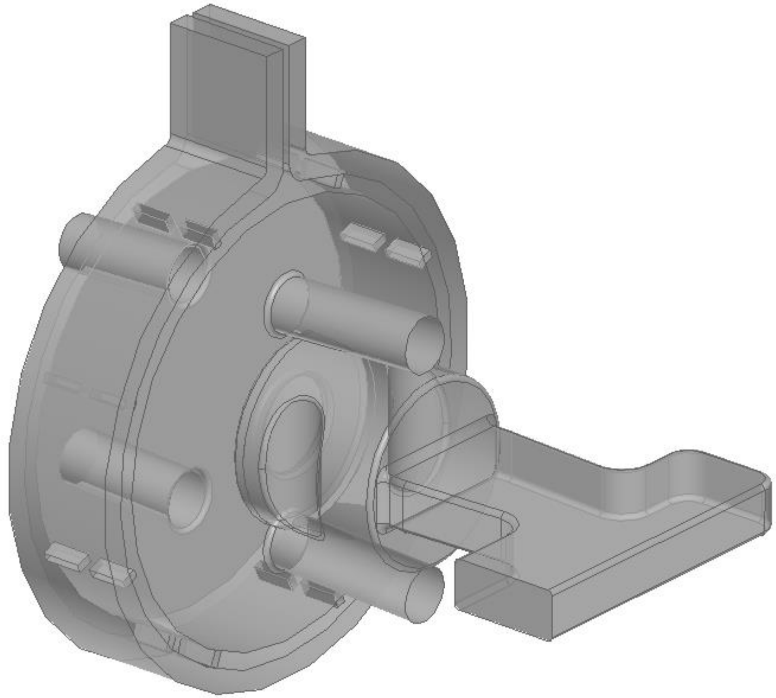


FIG. 1: Atomic beam and microwave cavity configurations for different atomic clocks. The continuous line shows the average atomic trajectory. (a) Pulsed fountain clock configuration. (b) Continuous fountain clock configuration. (c) Thermal beam configuration. (d) Space clock beam configuration.

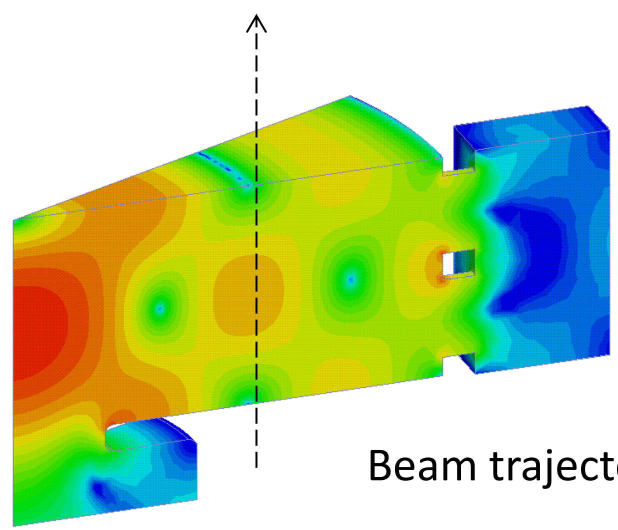
Our potential contribution in innovative rf design



Current design



Possible
improvement



Beam trajectory

Design Summary

1. The $TE_{0,N(N>1)}$ cavity with opposite RF power flow can provide "flat-phase" zones with RF phase variation < 1microradian in the area of ~ 7x7 mm^2.
2. This cavity can host multiple beam lines.
3. We have designed (built already) all the specific components like TE_{11}-> TE_{01} mode converter.
4. The presented results mostly illustrate the concept, more detailed evaluation will certainly be needed (TE_{03}?, more then 8 coupling slots?, sensitivity analysis…etc.)

Our proposal

- Design study of ultra-low phase gradient resonator configurations.
- Realization of a prototype resonator.
- Electrical characterization of the prototype using rf techniques and test with Cs beam in the clock at METAS.

By means of a PhD student jointly supervised by the Laboratoire Temps-Fréquence (LTF) of the University of Neuchatel and CERN.

We plan to apply for KT funding for partial support of the student. METAS will manufacture/supply the prototype cavity and measurements will occur at both laboratories.