Cavity Design Simulation for an Atomic Fountain Clock KRISS-F2

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A cesium atomic fountain clock KRISS-F1 [1-3] and an optical lattice clock KRISS-Yb1 [4] share their duty of steering a hydrogen maser that generates local time scale in Korea. In order to secure the redundancy of primary frequency standards, we plan to build another fountain clock named KRISS-F2. Since the performance of a fountain clock depends largely on the microwave cavity, we make efforts on the cavity design estimating the distributed cavity phase (DCP) and cavity pulling effects by calculating field distribution using the finite element method (FEM). We have built a Monte-Carlo simulation code using MATLAB that calculates DCP shifts from the field distribution inside the cavity as shown in Fig. 1. Another effort we make on the cavity design is to reduce the rate of change of the cavity resonance frequency against temperature variation (df/dT) for the robust operation under loosely temperature-controlled environment. By using a bimetal (Ti + Cu) structure, Fasong Zheng *et al*. [5] reported achieving df/dT value 150 times smaller than that of typical microwave cavities with uni-metal (copper) material. We find that a bimetal cavity with around 10-cm long aluminum caps plus a copper cylinder tube exhibits fairly reduced df/dT value with only a small loss of Q. In this symposium, we present our cavity design and the estimated shifts and uncertainties of cavity-related effects like DCP and cavity pulling under temperature changes.

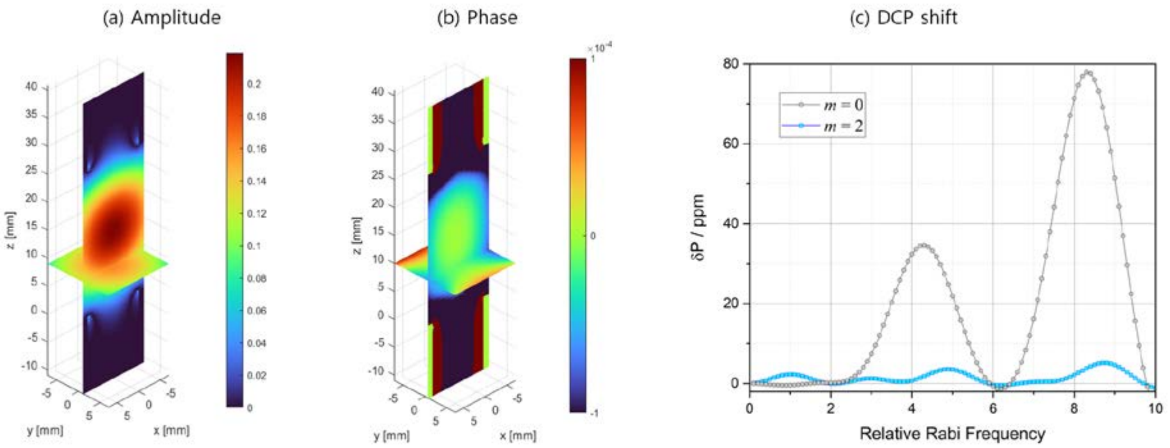

Fig. 1 . Example of a DCP shift calculation with the Monte-Carlo method. (a) Amplitude and (b) phase of *z*-component of the magnetic field inside a normal cylindrical cavity calculated from FEM simulation code (COMSOL). (c) Difference of the transition probability at the two sides of the central Ramsey fringe due to the DCP variation of $\boldsymbol{m = 0}$ and $\boldsymbol{m = 2}$ azimuthal modes when 10^6 atoms are launched and probed by a Gaussian laser beam.

References

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