Experimental Study on Support-Area-Insensitive Position in Cutout Optical Cavity for an Yb Optical Lattice Clock

Won-Kyu Lee, Sang Eon Park, Chang Yong Park, Dai-Hyuk Yu, Sangkyung Lee,

Sang-Bum Lee, Myoung-Sun Heo, Taeg Yong Kwon, and Jongchul Mun,

Center for Time and Frequency, Korea Research Institute of Standards and Science,
Daejeon 305-340, Rep. of Korea

Email: oneqlee@kriss.re.kr

In developing an Yb optical lattice clock at KRISS (Korean Research Institute of Standards and Science)[1], a cutout-type vibration-insensitive ULE cavity[2] has been used as a reference cavity for a clock laser at 578 nm. The location of four support points by small Viton rubber balls should be determined to minimize the vibration sensitivity. With concern that there might be support-size-dependence of the optimum position, because the pressure distribution over the support area would not be uniform, we performed finite element analysis varying the diameter of support area in our previous research[3]. In this report, we experimentally studied this support-area-dependence of the position in a cutout optical cavity. We measured the vibration sensitivity varying the axial displacement (z) of the support point with various support area. We used Viton pads instead of balls with diameters of 1 mm, 2 mm and 3 mm to define the support area more accurately. The results are shown in Fig. 1. The experimental data are well explained by a sliding-support-model (contact points are only vertically constrained) or a fixed-support-model (contacts points are totally constrained) with a very small diameter (0.1 mm). There were no dependences of the vibration sensitivity and the optimum support position on the support area within the experimental reproducibility.

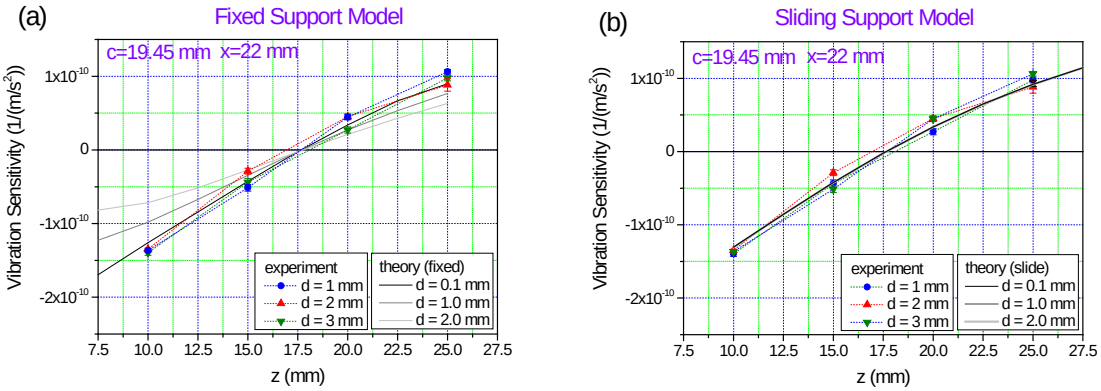

Fig. 1: Experimental (marks with dotted lines) and theoretical (solid lines) result of the vibration sensitivity as functions of z for x=22 mm and c=19.45 mm. (a) fixed support model, (b) sliding support model.

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[1] C. Y. Park, et al., "Absolute frequency measurement of $^1S_0$ (F = 1/2) – $^3P_0$ (F = 1/2) transition of ^{171}Yb atoms in a one-dimensional optical lattice at KRISS", Metrologia, 50, 109, 2013.

[2] S. A. Webster, et al., "Vibration insensitive optical cavity", Phys. Rev. A 77, 033847, 2008.

[3] S. E. Park, et al., "Finite element analysis of support-area-insensitive position in cut-out optical cavity for Yb optical lattice clock", EFTF 2012, pp. 160, 2012.