Performance evaluation of an atomic cesium fountain at HUST

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We have developed a cesium atomic fountain clock（HUST-CsF1) at Huazhong University of Science (HUST). It is used for realizing the time and frequency traceability of the National Precise Gravity Measurement Facility (PGMF). We have evaluated the frequency stability and systematic uncertainties of the HUST-CsF1. The preliminary systematic uncertainty is evaluated to be 8.8×10^{-16}.

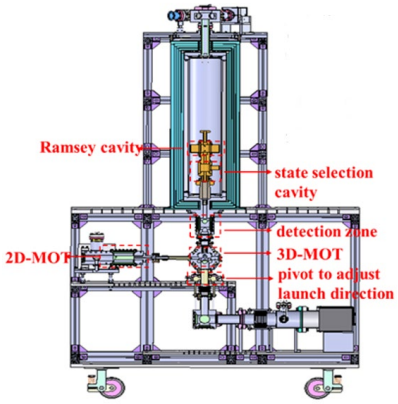

Fig. 1 Sectional view of the HUST-CsF1 physical package[1].

The physical package of the HUST-CsF1 is shown in Fig. 1. This setup is equipped with a 2D-MOT, which can load ~10^9 atoms in one second, the height of the atom launch is ~1 m, the angle of the launch can be adjusted independently, the number of atoms falling down is ~10^6, and the Ramsey fringe contrast is 90.8%.

By comparing with a H-Maser, the stability of the HUST-CsF1 is evaluated to be $1.9\times10^{-13}/\sqrt{\tau}$ as shown in Fig. 2. The preliminary systematic uncertainty is evaluated to be 8.8×10^{-16} as shown in Table 1.

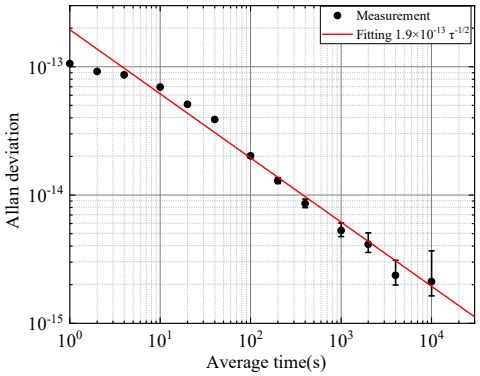

Fig. 2 Stability of the frequency difference between HUST-CsF1 and H maser.

Tab. 1 Preliminary evaluated systematic uncertainties of HUST-CsF1

Contribution	**Bias ($\times10^{-16}$)**	**Uncertainty ($\times10^{-16}$)**
Blackbody radiation	-190.2	1.4
Second-order Zeeman	1577.2	2.8
Light shift	0.0	0.1
Gravitation redshift	54.2	0.1
Cold collision shift	-44.3	6.6
Background gas collisions	0.0	0.1
Distributed cavity phase shift	-59.8	3.4
Microwave leakage	0.0	3.5
Total	1337.1	8.8

[1] H. Li, Y. Du, X. Yang, Y. Guo, M. Liu, W. Li, H. Liu, and Z. Lu, "Optimization of Operation Parameters in a Cesium Atomic Fountain Clock Using Monte Carlo Method," IEEE Access **9**, 132140–132149 (2021).