Uncertainty Evaluation of the Fountain Primary frequency standard KRISS-F1(Cs)

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We are developing a Cs/Rb dual fountain frequency standard, KRISS-F1 to contribute to International Atomic Time (TAI) and accurately generate of UTC(KRIS) [1].

With a goal of continuous operation of our fountain clock and minimal outages for maintenance, we have given special attention to design of physics package and laser system. Features include precisely pre-aligned six fiber collimators that are directly attached to the surfaces of trap chamber ports to minimize changes in beam alignments. Small photodiodes in each fiber collimator monitor the trapping laser power. Two CCD cameras are installed on the trap chamber to monitor the cloud size and initial position during the operation of the frequency standard. We monitor the temperature of the physics package with several calibrated PT-100 temperature sensors that are distributed over the physics package. A master ECDL is used for cooling and detection, stabilized to the near F=4 to F´=5 transition of Cs D_2 line by using a modulation transfer spectroscopy (MTS) with high servo bandwidth, which reduces noise, including from the vibration of shutters on the optical table. For repumping light, a DFB (distributed feedback) laser is frequency offset locked at about 9 GHz from the master ECDL using a sideband injection-locking with a high efficiency waveguide EOM. We installed two cylindrical TE_{011} cavities for ^{133}Cs and ^{87}Rb interrogation that are expected to minimize distributed cavity phase (DCP) frequency shifts[2]. We adapted a Cs cavity of the same design with NPL-CsF3[3] and designed a new Rb cavity using the same ideas[1].

Fig. 1: Physics package of the fountain frequency standard KRISS-F1.

We are currently evaluating the cold collision and DCP shifts for an accuracy evaluation of the Cs fountain standard. Other frequency shifts are evaluated to be less than 10^{-16}. We aim for a total uncertainty of KRISS-F1(Cs) at the low 10^{-16} level. We will present our recent results at the conference.

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