Status Report on Yb optical lattice clocks at KRISS

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Optical lattice clocks based on Yb atoms have been developed at KRISS since 2002. The absolute frequency of the first Yb optical lattice clock at KRISS (KRISS-Yb1) has been reported in 2013 [1], in 2017 [2], and in 2021 [3], contributing to the determination of the BIPM recommended values of standard frequencies. KRISS-Yb1 is now being operated regularly to contribute to International Atomic Time (TAI) as one of the most contributing optical clocks worldwide. The total systematic uncertainty of KRISS-Yb1 has been gradually improved and it now reached 1.7×10^{-17}, however, further improvement was considered to be impossible. This uncertainty limit was mainly caused by the blackbody radiation (BBR) shift uncertainty due to the temperature inhomogeneity of the stainless steel vacuum chamber of KRISS-Yb1.

We developed the second Yb optical lattice clock (KRISS-Yb2) to reach the 10^{-18} uncertainty level overcoming this BBR shift uncertainty. KRISS-Yb2 introduced a copper BBR shield for more homogeneous thermal environment. After the temperature stabilization of the BBR shield, the temperature at the atom trap site was determined with an uncertainty of 13 mK. The total uncertainty of the BBR shift including the atomic response was evaluated as 9.5×10^{-19} [4]. Also, six electrodes were installed in the BBR shield to evaluate the DC Stark shift along three axes. We expect that the total systematic uncertainty of KRISS-Yb2 would be improved to be less than 5×10^{-18} with these upgrades. Preliminary uncertainty evaluation results will be presented at the conference.

References

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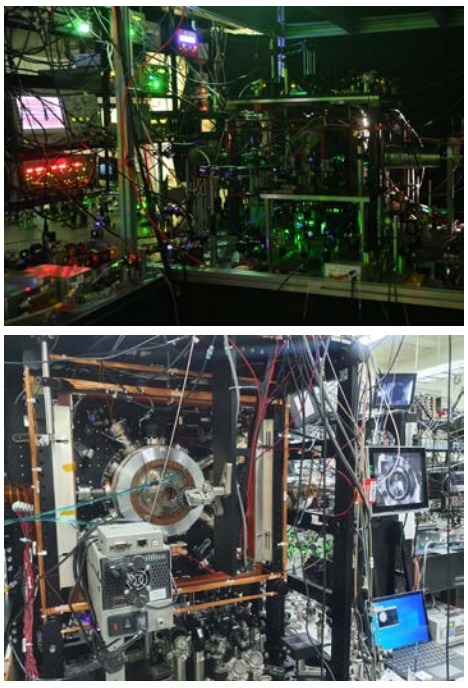

Fig.1. Photo of KRISS-Yb1 (upper) and KRISS-Yb2 (lower).