Interspecies comparisons between optical and microwave clocks

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Optical lattice clocks have greatly improved over the last decade. The comparison between the optical and the microwave frequency domains has now reached an uncertainty of a few 10^{-16}, which allows high resolution measurements of frequency ratios between optical and microwave transitions[1]. The LNE-SYRTE clock ensemble implemented comparison configuration, thus enabling to perform fundamental physics test and to constrain a possible drift of the fundamental constants.

We present a series of high resolution extensive comparisons between a strontium optical lattice clock and an ensemble of microwave clocks at LNE-SYRTE comprising a dual Cs and Rb fountain. This work was performed in the context of a long term effort to track reproducibility of the comparison between optical clocks and primary frequency standards, which is a necessary prerequisite for a robust definition of the SI second.

Finally, we will present ongoing work to improve the performances of strontium optical lattice clocks. In terms of uncertainty budget, our effort is focused on the control of the temperature experienced by the atomic cloud in order to reduce the uncertainty due to BBR effect. To reach a better stability, we will present progress towards a cavity-based nondestructive detection that can contribute to largely reduce the dead time in the clock cycle[2].

[1] R. Le Targat et al., "Experimenting an optical second with strontium lattice clocks", Nature Commun. 4, 2109, (2013)

[2] J. Lodewyck et al., "Nondestructive measurement of the transition probability in a Sr optical lattice clock" Phys. Rev. A 79, 061401(R) (2009)