Towards a High Duty Cycle Transportable ^{171}Yb Clock

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Progress in the field of optical clocks has been continuous in the last decade, and the best published results demonstrate they are now able to surpass state-of-the-art microwave clocks by more than two orders of magnitude both in stability and in total uncertainty. This level of control of the frequency, at the level of 18 digits or better, raises the prospect of new application fields for these instruments, e.g. Fundamental Physics (tests of Lorentz invariance, search for a drift of fundamental constants), Astronomy (search for dark matter) or Earth Sciences (Chronometric geodesy).

A refined knowledge of the geoid (equigeopotential best matching the level of the ocean at rest) is an important aspect of a future redefinition of the second, since it is key to comparing remote clocks. In order to meet this need, SYRTE, Observatoire de Paris, started in 2021 the design and construction of a transportable ytterbium lattice clock based on ^{171}Yb. The scientific objective is to develop an instrument that can be connected to some of the ~60 outputs of the French research infrastructure REFIMEVE disseminating a 1542 nm ultrastable carrier throughout the territory. Remote comparisons to ~12 operational European optical clocks will allow measurements of geopotential changes in space and time.

In this paper, we present recent developments of the assembly of this transportable instrument. In order to circumvent the foreseeable degradation of the reference optical cavity in field conditions, the design aims at ultrasfast loading of the atoms (target $>10^4$ atoms in <100 ms) so as to dwarf the Dick effect and reach a duty cycle larger than 0.5. We will describe the effect of the atomic beam collimation by the multi-detunings 2D-optical molasses, aiming at addressing all transverse velocity classes up to ± 20 m/s. We will report on the deceleration achieved by a permanent magnets based Zeeman slower, on our capacity to control the output velocity and direction by fine tuning the position of the last magnets, and we will compare these results with our former numerical simulations. Finally, we will present the next steps of the construction (2D magneto-optical trap, Science chamber with a cavity-formed optical lattice) and we will propose steps toward testing the instrument in the field.