Compact and Robust Laser System for Transportable Strontium Optical Lattice Clock

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An optical lattice clock [1] realizes a fractional frequency uncertainty of 10^{-18} level [2] and is a promising candidate for a redefinition of the SI second. Furthermore, it is expected to be used for geodesy [3] and fundamental physics [4]. Most of optical lattice clocks have been developed as stationary systems in laboratories because of complexity of system containing multiple lasers and control electronics. On the other hand, for use outside laboratories, clocks need to be compact and to operate continuously over a long period. In our previous work, a transportable optical lattice clock with a volume of 920 L were developed to test the gravitational redshift at Tokyo Skytree [5, 6].

One of our goals is to make optical lattice clocks easier to use in various applications. We are downsizing the clock while improving robustness and maintainability. The optics were fixed by laser welding to prevent misalignment during transportation and operation. The volume of the laser system was reduced by removing adjustable mechanisms and integrating multi-function electronics. To facilitate maintenance, the laser system was divided into modules that can be easily replaced. By utilizing the developed laser system, an optical lattice clock with a volume of 250 L was realized as shown in Fig. 1.

This work was supported by JST-Mirai Program Grant Number JPMJMI18A1, Japan.

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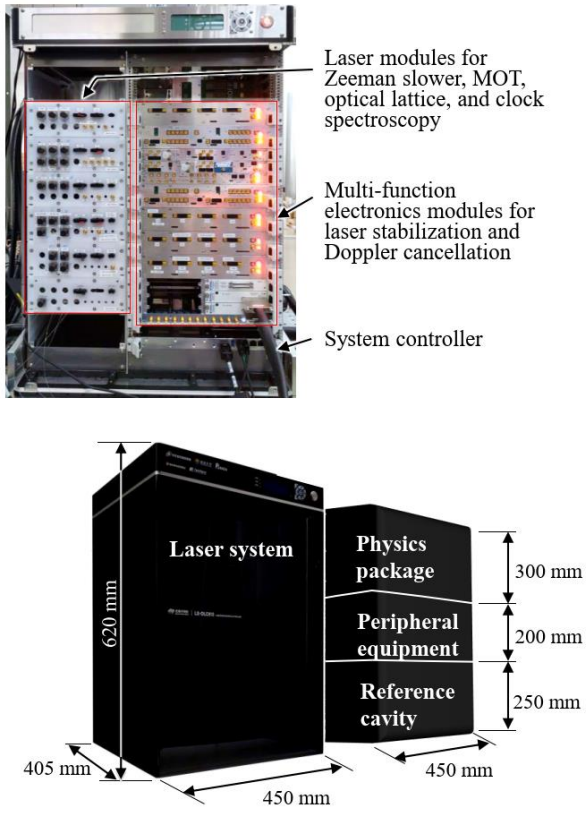

Fig. 1 Developed laser system and optical lattice clock. (a) Front view of the laser system. (b) Overview of an optical lattice clock composed of the developed laser system, a physics package and a reference cavity.