Simultaneous emission of infrared free electron laser light and a quasi-monochromatic X-ray beam

Development of a two-color light source of infrared light and X-ray with variable energy

We have developed a free electron laser (FEL) with a compact storage ring in the infrared region. The wavelength of infrared FEL light was in the region of 0.84–1.50 µm. The maximum power of the infrared FEL light transmitted through an optical cavity was about 1.6 mW, and the intracavity power was about 5W. We have also developed intensive quasi-monochromatic X-ray by using FEL Compton backscattering. The yield of the generated X-ray beam is roughly 10^6 photons/s with the energy of 1.2-2.1 MeV. A prospective application of the present system would be a high-flux two-color light source of infrared light and an X-ray with variable energy.

If applied to the accelerator such as an energy-recovery linac, we would be able to realize a near monochromatic X-ray source with the energy of over 0.3 MeV and the yield of 10^{12} photons/s, of the level not easily attainable even in a large synchrotron radiation facility. This type of X-ray beam would offer new measuring methods for magnetic material research, and would also contribute to the development of an ultra-high density magnetic recording system.

Norihiro Sei

Research Institute of Instrumentation Frontier

sei.n@aist.go.jp

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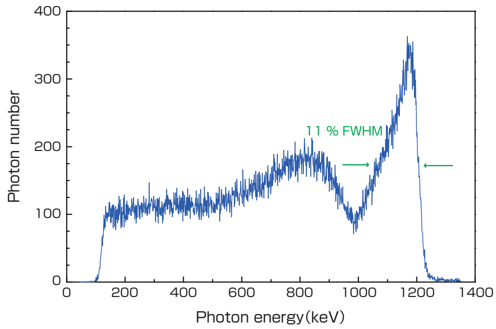

Example of an energy spectrum of an X-ray beam by Compton backscattering

Metrology and Measurement Science

High-precision frequency measurement using an optical fiber link

Remote absolute frequency measurement of a strontium optical lattice clock

The precise measurement of time and frequency, which has the smallest uncertainty (10^{-15}~10^{-18}) of all types of measurement, is of great interest for a wide range of applications including basic science, metrology, broadband communication networks and navigation with the Global Positioning Systems (GPS). The recent development of optical frequency measurement based on femtosecond combs has stimulated the field of frequency metrology, especially research on optical frequency standards. One major challenge for scientists working on high-precision frequency standards and measurements is to deliver and compare state-of-the-art clocks at different locations. Here we demonstrate a precise frequency measurement over a physical distance of 50 km between Tokyo and Tsukuba using a phase-stabilized 120 km optical fiber link and coherent optical transfer. The transition frequency of the strontium optical lattice clock at the University of Tokyo is measured to be 429228004229874.1(2.4) Hz. The results demonstrate the excellent functions of the intercity optical fiber link, and the clear potential of optical lattice clocks for use in the redefinition of the second.

Feng-Lei Hong

Metrology Institute of Japan

f.hong@aist.go.jp

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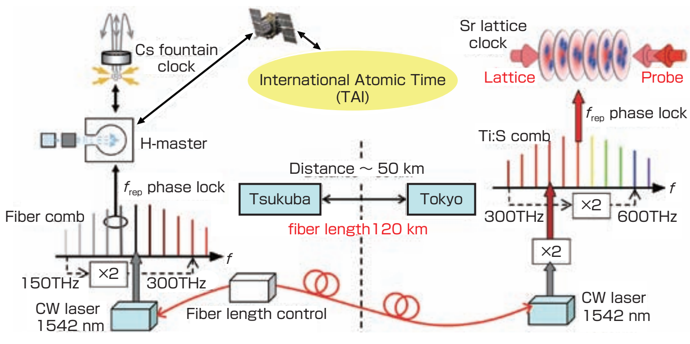

Optical carrier transfer and absolute frequency measurement using a 120-km fiber link between Tsukuba and Tokyo