TOPTICA Introduces TOPTICLOCK

World's First Commercial Optical Quantum Clock Using a Single Trapped Yb^+ Ion

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At this year's LASER World of PHOTONICS, TOPTICA has introduced to the market the first commercially available optical quantum clock based on a single laser-cooled, trapped Yb^+ ion.

TOPTICA's new Optical Quantum Clock TOPTICLOCK at the German National Metrology Institute PTB. TOPTICLOCK stands side-by-side with Germany's oldest atomic clock CS1 - a symbolic meeting of past and future, as PTB expands its services for metrological evaluation within the EU project Qu-Test. Image: Physikalisch-Technische Bundesanstalt (PTB).

The TOPTICLOCK system was now delivered to a first customer in September 2025 and set into operation within a few days. With its relative stability and accuracy on the order of 10^{-17}, TOPTICLOCK sets a new benchmark for commercial atomic clocks and frequency standards with applications in time scales and time services, network synchronization, and as a ground reference for satellite navigation. Such performance in an industrial form factor marks an important milestone towards redefinition of the SI-second based on optical transitions.

Microwave-based cesium atomic clocks have long been the gold standard for timekeeping and are an implementation of the current definition of the second as the base unit of time. Optical quantum clocks with their much higher oscillation frequency now rewrite the rules, offering orders of magnitude improvements in stability and accuracy. TOPTICLOCK features transport stability and ease-of-use while demonstrating superior performance unprecedented for any commercially available clock. This is proven by the installation and operation of TOPTICLOCK at PTB, the German National Metrology Institute, for qualification and its subsequent transfer to a customer site in Vienna/Austria. The clock system consists of two 19-inch industrial racks and can be operated as well as monitored remotely. It bridges the gap between advanced metrology and deployable quantum infrastructure.

About TOPTICA

TOPTICA has been developing, producing, and marketing high-end lasers and laser systems for science, research, and industry for over 25 years. The portfolio includes tunable diode lasers, ultrafast fiber lasers, terahertz systems, and optical frequency combs.
Worldwide, TOPTICA has 600 employees, organized in seven business entities with a consolidated group revenue of €140 million.

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“This is a huge leap for applied quantum technology,” said Dr. Stephan Ritter, Senior Director Quantum Technology Solutions at TOPTICA. “Our clock makes highest-precision timekeeping a commercial reality, with a proven quantum advantage for applications in science and industry.”

Dr. Juergen Stuhler, Vice President Quantum Technologies at TOPTICA adds: “I would like to congratulate my team for this wonderful achievement, made possible by courage, commitment and expertise. We are also grateful to PTB for supporting us in the leap from a joint research project demonstrator to a commercially available instrument.”

The development of TOPTICLOCK is the result of years of collaboration between TOPTICA and PTB, particularly through the highly successful nationally funded QT pilot project ‘opticlock’.
TOPTICLOCK marks TOPTICA’s expansion of the company portfolio from high-end laser systems into full quantum technology solutions. By combining laser cooling and quantum-state control of a single ion with ultra-stable clock laser technology, TOPTICLOCK offers a commercially unprecedented level of stability and accuracy while still allowing for flexible usage and modifications. With an optical output at 871 nm and the option to integrate TOPTICA’s Difference Frequency Comb (DFC) for a phase-stable linkage into the microwave regime, TOPTICLOCK delivers complete optical and low-phase-noise RF clock signals.

Key Features of the Optical Quantum Clock:

- Laser-cooled trapped Yb^+ ion for exceptional frequency precision
- Fully integrated into two 19-inch industrial racks for reliable operation
- Remote access and control for modern laboratory environments
- Fiber optical output at 871 nm
- Seamless combination with TOPTICA’s optical frequency comb DFC for RF and PPS outputs (optical clock version only)
- Customizable configurations to meet specific application needs

“TOPTICA’s legacy and technological breadth in laser innovation now empowers a new generation of quantum clocks,” said Dr. Wilhelm Kaenders, founder and CTO of TOPTICA Photonics. “We are ready and proud to provide the building blocks and backbone for tomorrow’s time and frequency infrastructure.”

Visit www.toptica.com for further information.