

Engineering Quantum Precision for the Real World

TOPTICA's TOPTICLOCK team has been awarded the 2026 Paul F. Forman Team Engineering Excellence Award for outstanding team engineering and innovation.

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TOPTICA Photonics is proud to announce that its TOPTICLOCK Team has been awarded the 2026 Paul F. Forman Team Engineering Excellence Award presented by OPTICA, recognizing outstanding teamwork and engineering achievement in the successful transfer of cutting-edge research into commercial optical atomic clock.



TOPTICLOCK Team, from left to right: Christoph Tresp, Dario Lago-Rivera, Pierre Thoumany, Jürgen Stuhler, Stephan Ritter, Axel Friedenauer, Daniel Heinrich, and Rami Al Kamand. Nils Huntemann (PTB) is missing in the picture.

The award honors the development of TOPTICLOCK, a commercial single-ion optical clock that combines ultra-low-noise photonics with advanced quantum technology to achieve unprecedented accuracy in an industrial form factor. Within just three years, the TOPTICLOCK Team developed and qualified the commercial optical quantum clock and successfully commissioned it at a lead customer site.

From Fundamental Metrology to Industrial Reality

The TOPTICLOCK initiative originated from a close collaboration between TOPTICA Photonics and Germany's national metrology institute PTB (Physikalisch-Technische Bundesanstalt). Building on the joint research project optclock, coordinated by TOPTICA and PTB, the team transferred key know-how from a research demonstrator into an industrial optical frequency standard.

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 more than €140 million.

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The TOPTICLOCK Team consists of TOPTICA engineers and scientists with deep expertise in quantum technologies, lasers, photonics, and software, and PTB optical clock expert Dr. Nils Huntemann as scientific advisor. This close collaboration across institutional and disciplinary boundaries was a decisive factor in achieving the project's ambitious goals.

Engineering Excellence at the Quantum Limit

Optical quantum clocks provide unprecedented stability and accuracy. At their heart are a local oscillator, a quantum reference, and an optical frequency comb – each requiring extreme stability and control. In TOPTICLOCK, the local oscillator is a diode laser system whose linewidth is reduced to below the Hz-level by translating the passive length stability of an optical cavity into frequency stability of the laser.

For long-term accuracy, the clock laser is disciplined to the electric quadrupole transition of a single laser-cooled $^{171}\text{Yb}^+$ ion at 436 nm. Four additional frequency-stabilized laser systems spanning wavelengths from 370 nm to 935 nm are required to prepare, cool, and read out the ion's quantum state. All optical, electronic, thermal, and magnetic influences on the ion must be precisely controlled or characterized to fully exploit the potential of quantum-state-based timekeeping.

What makes TOPTICLOCK exceptional is not only its performance – with relative stability and accuracy on the order of 10^{-17} , outperforming thermal-vapor-based optical clocks by around two orders of magnitude – but the fact that this performance is achieved in a transportable, industrial 19-inch rack system. All subsystems are integrated into two racks, combining optics, electronics, vacuum technology, control hardware, and comprehensive software into a reliable system designed.

“The engineering challenges to transfer a laboratory setup that can only be operated by experienced scientists into an industrial footprint – while maintaining world-class performance – are enormous,” said Dr. Stephan Ritter, Senior Director Quantum Technology Solutions, TOPTICA Photonics.

Impact Beyond the Lab

This level of performance in an industrial form factor marks an important milestone on the path toward a future redefinition of the SI second based on optical clocks. Beyond fundamental metrology, TOPTICLOCK opens new possibilities for applications such as advanced time scales and time services, network synchronization, ground references for satellite navigation, and high-precision fundamental research.

“The Paul F. Forman Team Engineering Excellence Award recognizes exactly what made this project successful – a truly collaborative team that mastered extraordinary engineering challenges to bring quantum-enabled performance into the real world,” said Dr. Jürgen Stuhler, Vice President Quantum Technologies of TOPTICA Photonics. “This award underlines TOPTICA's commitment to translating pioneering photonics and quantum research into technologies that create real impact.”

With the TOPTICLOCK project, TOPTICA once again demonstrates how close cooperation between research institutions and industry, combined with strong systems engineering and team excellence, can turn visionary science into commercial solutions.

About the Paul F. Forman Team Engineering Excellence Award

The award was established in 1989 to recognize the achievements of optical engineers. It was renamed in 2007 to honor Paul Forman's work in raising the visibility of optical engineering.

In 2012, the scope was updated making team nominations mandatory. Previously, the award could be presented to an individual or team.

OPTICA (formerly The Optical Society, OSA) is the professional association for light science and technology that presents the Paul F. Forman Team Engineering Excellence Award.

About TOPTICA

TOPTICA has been developing, manufacturing, and marketing high-end laser systems for scientific and industrial applications for over 25 years. Its product portfolio includes tunable diode lasers, ultrafast fiber lasers, terahertz systems, and optical frequency combs. TOPTICA employs over 600 people worldwide across seven business units and achieved a consolidated group revenue of more than €140 million.

Learn more about TOPTICLOCK: www.toptica.com/TOPTICLOCK