

MenloSystems



PRECISION IN PHOTONICS.

TOGETHER WE SHAPE LIGHT.

MENLO SYSTEMS

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Have you ever asked yourself what the best way is to see innovations not to stop at the exit doors of research labs but succeed in real world applications? We were confronted with this challenge more than 15 years ago.

Our answer has been MENLO SYSTEMS. Since then, we have formed a globally recognized company that provides innovative products for optical precision measurements.

As part of the photonics community, together we have created new products that enable ever-improving precision and accuracy – and we are convinced that photonics has more to offer to meet the challenges of today's world. We will do our best to be part of the future of photonics.



Dr. Ronald Holzwarth,
CTO

Dr. Michael Mei,
CEO

MENLO SYSTEMS

PRECISION IN PHOTONICS



„To accelerate the advancement of optical technology for precision measurements and their applications from the table tops of research laboratories to standard use in communication and high technology industries“ – our mission defined at the outset remained unchanged and as vivid as ever.

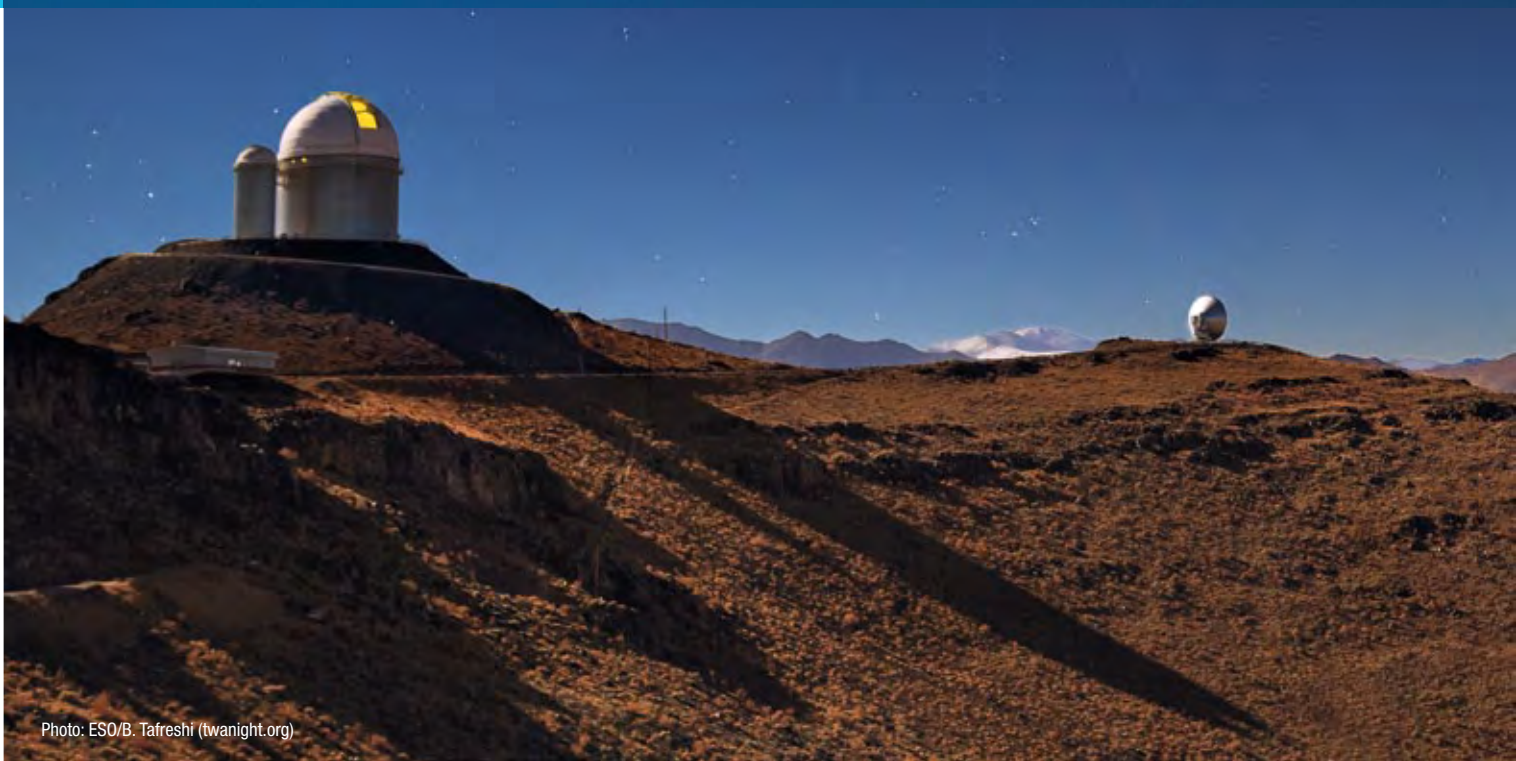
Challenged by the diversity and individuality of the products that we supply to the most demanding applications in photonics we have made continuous improvement and lean manufacturing to cornerstones of our philosophy of how we design, engineer, and manufacture products.

We have formed a team at MENLO SYSTEMS that is highly dedicated to serve the photonics community. Many of us had the privilege to work in some of the best laboratories around the globe before they have joined our company. It is rewarding to see that our customer's trust and support has led to a continuous and organic growth of our product portfolio, our team, and the whole company. We will continue a trusting collaboration with our customers, delivering products Made in Germany that meet the needs with the expected quality and performance.



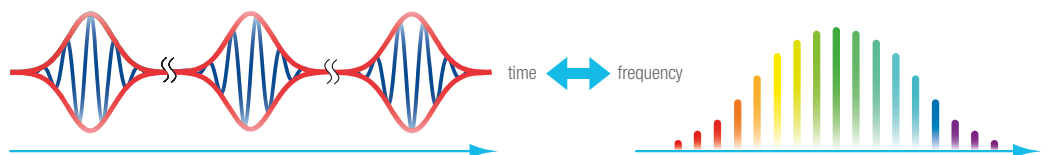
OPTICAL FREQUENCY COMBS MAKE LIGHT MEASURABLE

AstroCombs can serve as routine calibrator for high-resolution astronomical instrumentation, such as the Exoplanet Hunter HARPS, the High Accuracy Radial velocity Planet Searcher at the ESO La Silla 3.6m telescope.



Optical frequency combs measure absolute optical frequencies directly and with utmost accuracy. As one can derive time and length from frequency measurements, this most precise tool vastly simplified metrology and until today enables new directions in physics. MENLO SYSTEMS is honored to be recognized as the market leader and number one supplier of optical frequency combs.

MENLO SYSTEMS continues to shape the market by dedicating its expertise and knowledge to continuous product innovations. Technical milestones include the first commercial system and the introduction of fiber-based laser technology for user-friendly instrumentation. Our goal is to provide the best solution for each application. We open up new spectral ranges. The system with ultra-low phase-noise performance keeps pace with the new clock designs that aim at the new definition of second. A very compact one-rack unit targets usage outside dedicated lab environments. Our AstroCombs autonomously operate at robotic telescopes of distant observatories.



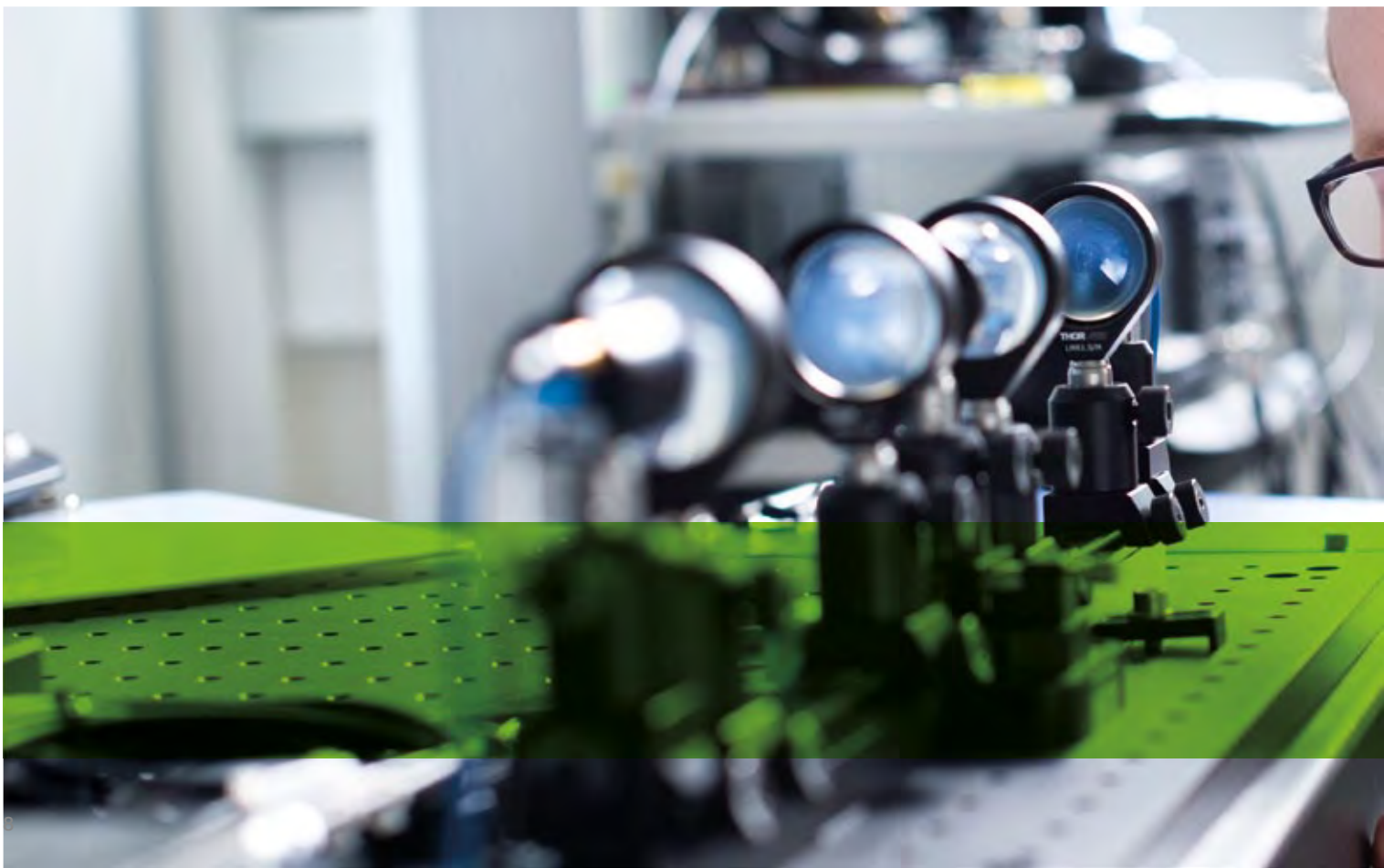
MENLO SYSTEMS' femtosecond-laser-based frequency comb gives precise control of both starting position and spacing between the frequency modes, generating hundreds of thousands of well-defined reference lines.

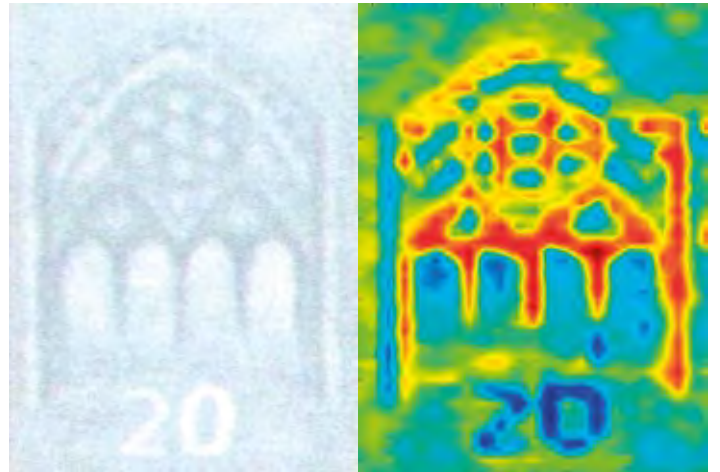
APPLICATIONS: HIGH-RESOLUTION SPECTROSCOPY, OPTICAL CLOCKS, LOW-NOISE MICROWAVE SYNTHESIS, CALIBRATION OF ASTRONOMICAL SPECTROGRAPHS, DIMENSIONAL METROLOGY, FREQUENCY DISSEMINATION, TIMING DISTRIBUTION

DISCOVER THE WORLD OF TERAHERTZ

Originating from our experience in manufacturing high-performance femtosecond fiber lasers and stabilization electronics, MENLO SYSTEMS has been an expert for terahertz technology since 2007. We supply complete and easy-to-use solutions for terahertz time-domain spectroscopy and imaging applications.

Our systems address the various needs ranging from demanding scientific laboratory experiments to the harsh conditions at industrial production sites. Our terahertz technology benefits from strong collaborations with research institutes, ensuring the high quality standard of our components. We integrate our own femtosecond lasers, and provide products specifically tailored to the demands of our OEMs and system integrators. Applications aiming at novel standards for safety and quality control drive the development of our terahertz systems.





Mapping the formation of paper products with terahertz: backlight (left) and terahertz image (right) of a watermark

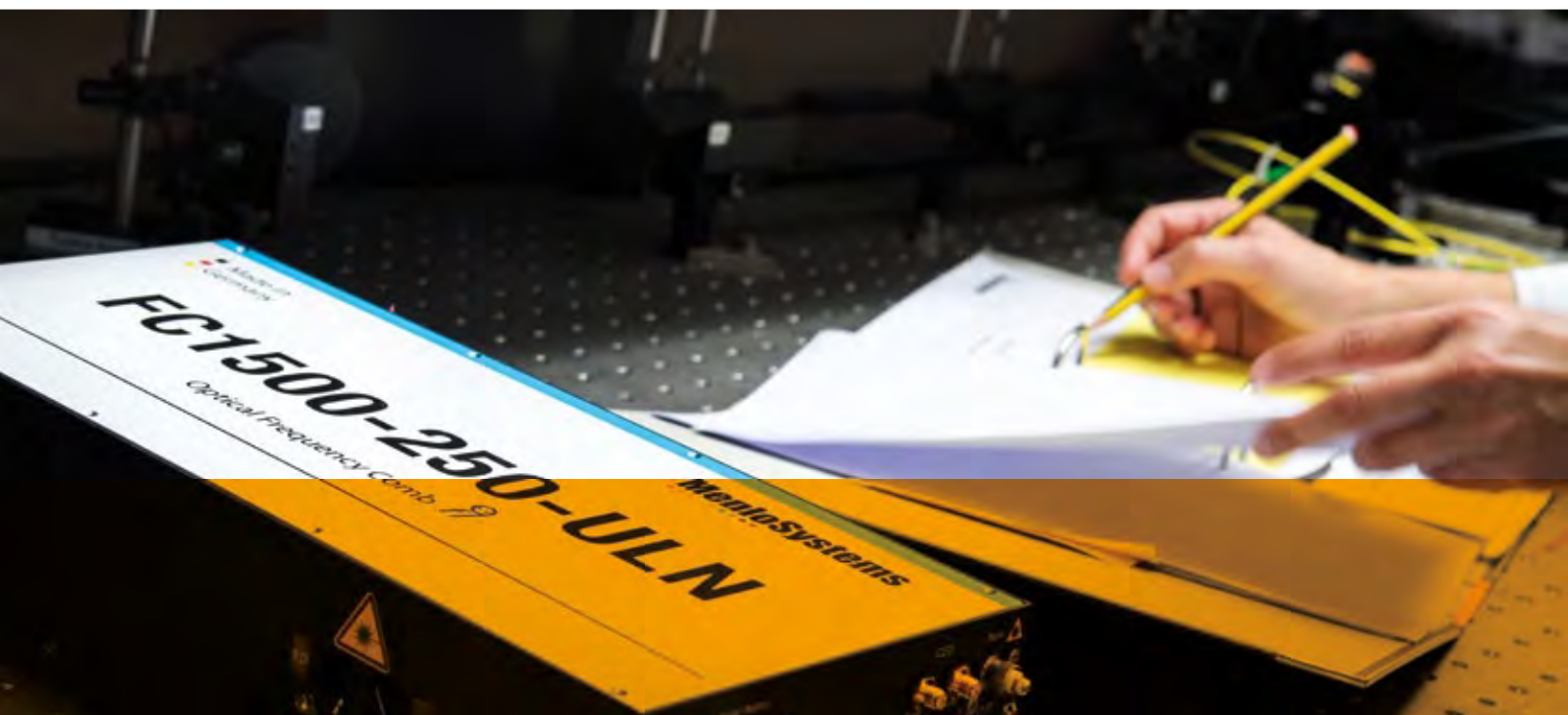


APPLICATIONS: TIME-RESOLVED TERAHERTZ SPECTROSCOPY, QUALITY INSPECTION AND PROCESS CONTROL, TERAHERTZ IMAGING, NON-DESTRUCTIVE TESTING, CHEMICAL FINGERPRINTING, QUALITY CONTROL IN PLASTICS AND PAPER INDUSTRY

FEMTOSECOND LASERS FOR RESEARCH AND INDUSTRY

MENLO SYSTEMS' laser product portfolio spans from complex stabilized multibranch laser systems to compact ready-to-integrate OEM modules, which are indeed as easy to snap into place in a machine as installing a light bulb.

We have built up a dedicated team of product and application specialists. Our engineers truly understand capabilities of our systems, have an extensive knowledge of relevant applications, and make all efforts needed to define the most suitable solution together with our customers. Our novel ultrastable figure 9[®] laser technology is implemented in all femtosecond fiber lasers. With the figure 9[®] all-PM fiber design Menlo's laser systems offer highest stability and lowest-noise operation, engineered for 24/7 operation with highest reliability and reproducibility.



APPLICATIONS: TIME-RESOLVED STUDIES, MULTI-PHOTON MICROSCOPY, 2-PHOTON POLYMERIZATION 3D PRINTING, MICROMACHINING, TERAHERTZ GENERATION, AMPLIFIER SEEDING



SPIN-OFF PRODUCTS TAKING THE LEAD

Quality components assure reliability and performance. This concept is central to our product development philosophy: In-house technology gives better control over quality.

This understanding triggered us to develop and continuously improve our own technology for detection and synchronization. Products originally designed to serve in our optical frequency combs became bestsellers as stand-alone devices for a wide range of applications. At the same time, fully integrated solutions of similar complexity as our metrology systems emerged for new applications. Our timing distribution and synchronization system is a great example how low-noise pulsed lasers, stabilized optical fiber links and high-resolution detectors can merge together to provide clock-signal with state-of-the-art sub-10 fs precision for large scale facilities.

APPLICATIONS: SYNCHRONIZATION AND TIMING, ASYNCHRONOUS OPTICAL SAMPLING, CEP STABILIZATION FOR HIGH HARMONIC GENERATION AND COHERENT CONTROL, DETECTION OF WEAK LIGHT SIGNAL, PUMP-PROBE SPECTROSCOPY

OUR PROMISE TO CUSTOMERS



With SmartComb, precision measurements became possible outside the optics labs. The single enclosure instrument has fully automated operation. This new tool combines the simplicity of an easy-to-use wavelength meter with ultimate precision of 10^{-14} and beyond.



We respect time. Nothing can bring back time wasted. Continuous development of our employees and improvement of our processes are the basis of efficiency in our organization. With quality in design, engineering, and production, MENLO SYSTEMS can offer solutions with excellent performance and long lifetime. Reliability and high uptime saves your time.

All of our products are built in a controlled environment and must pass rigorous final tests both at component and system level before leaving our factory. We select the best suppliers for high quality components; all products have fully traceable components. Our manufacturing is organized according to lean manufacturing standards. Processes are documented and operators undergo continuous training to ensure repeatability and reliability in the operation. And indeed, with the optical frequency combs we do manufacture the most precise optical measuring tools; so we make use of our in-house reference systems to qualify and calibrate our products against the best standards available.



WE ARE THERE FOR YOU



Participants of the in-house optical frequency comb seminar: the annual event attracts current users of the systems, interested scientists and students who would like to learn more about the technology. The four-day workshop focuses on the technology and measurement techniques, offering in-depth lectures, along with technical discussions and hands-on training in small groups.

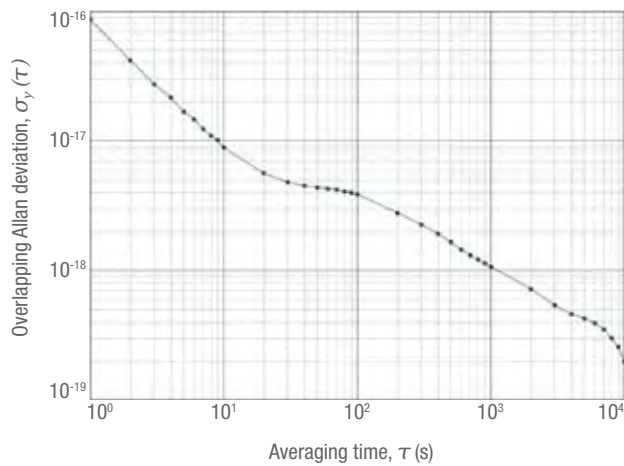


MENLO SYSTEMS goes beyond being a supplier. We remain a partner through the lifetime of the products. People of many different cultures and nationalities work in our regional offices and at the headquarters in Munich, understanding technical requirements as well as local conditions.

Our service program benefits from the knowledge we have built up over the years. A skilled and resourced team of field-service engineers provides excellent on-site installation and user training. We make our expertise available to our customers when it comes to adapting existing systems to changing user requirements or provide extended on-site service and support during measurement campaigns.

TODAY'S IDEAS FOR TOMORROW'S PRODUCTS





Unrivalled stability better than $3 \cdot 10^{-18}$ in 1000 seconds – performance data of the ultra-low phase-noise optical frequency comb system: two FC1500-250-ULN systems have been referenced to a common state-of-the-art ORS1500 1-Hz laser at 1542 nm. Stability has been measured out-of-loop via beat note between respective comb lines at 1064 nm. Stability is calculated from raw data – no assumption regarding equivalence of the two combs, no division by factor of $\sqrt{2}$.

Prof. Dr. Theodor W. Hänsch

Founder and scientific advisor, Theodor W. Hänsch is professor of physics at the Ludwig-Maximilians University of Munich and director of the Max Planck Institute of Quantum Optics. As one of the pioneers of laser physics, he has shaped its evolution in an unprecedented way. He is recognized as one of the leading scientists in his field. He received the Nobel Prize in Physics in 2005. One of his outstanding developments has been the optical frequency comb technology. His dream to make this fascinating technology commercially available led to the foundation of MENLO SYSTEMS in 2001.

MENLO SYSTEMS maintains strong bonds to its origins. We are grateful for the opportunities to work in projects with partners within Germany, the EU, and worldwide. Within each individual project, we try to focus on the solution for a specific task. Very often, this requires profound R&D work. Our partners give us inspiration and support.

We were part of the FOKUS projects, a prototype experiment of clock comparison for possible satellite based tests of fundamental physics: In future experiments, a space grade optical frequency comb will enable precision clock comparisons between state of the art space optical clocks. Such a space-based clock comparison with unprecedented sensitivity is testing Einstein's general theory of relativity, and in particular the local position invariance. Eventually such experiments might lead to new theories of gravity and will completely change our understanding of the world. Within the FOKUS projects, we developed an optical frequency comb for sounding rocket flights and significantly increased the technological maturity for space application. Newly gained knowledge finds immediate implementation in current and future products.



Photo: Volker Steger

FACTS AND FIGURES

Founded: 2001

Founding partners: Prof. Dr. Theodor W. Hänsch, Dr. Ronald Holzwarth, Dr. Michael Mei and Alex Cable

Established as spin-off of the Max Planck Institute of Quantum Optics, Garching, Germany

Headquarters: Martinsried/Munich, Germany

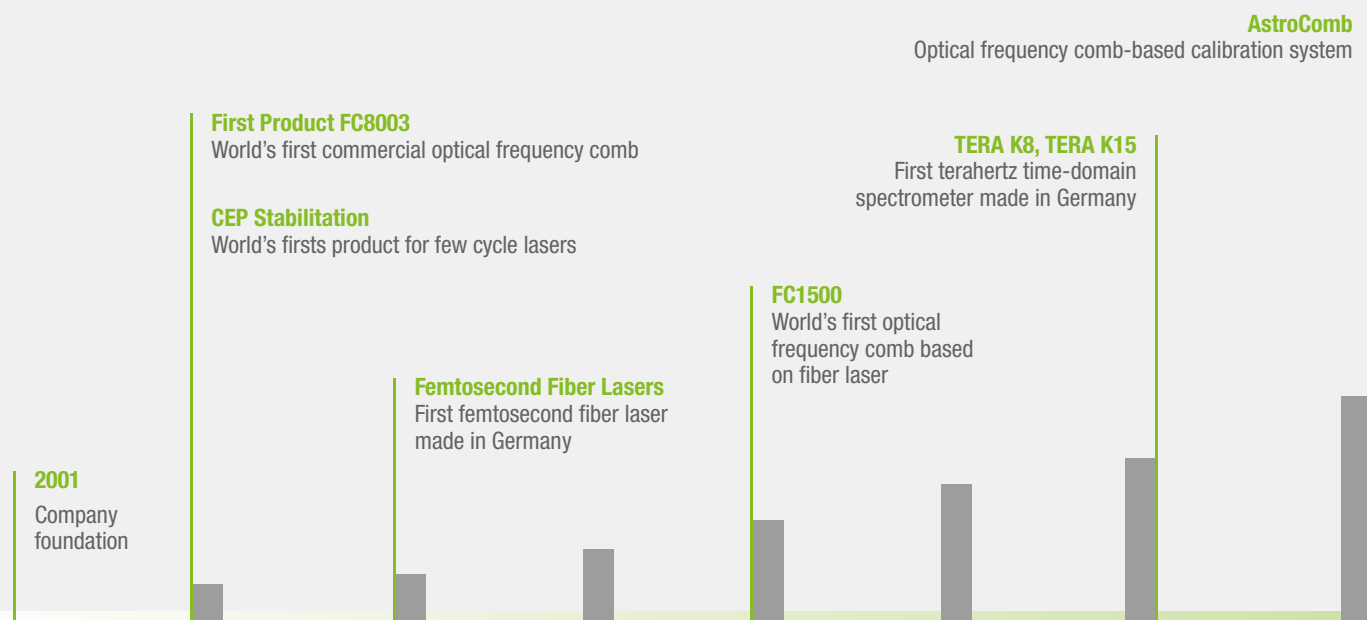
Offices in Newton, NJ in the US, and in Shanghai, China, in partnership with Thorlabs Inc.

Legal entity: GmbH, privately owned

Management: Dr. Ronald Holzwarth and Dr. Michael Mei

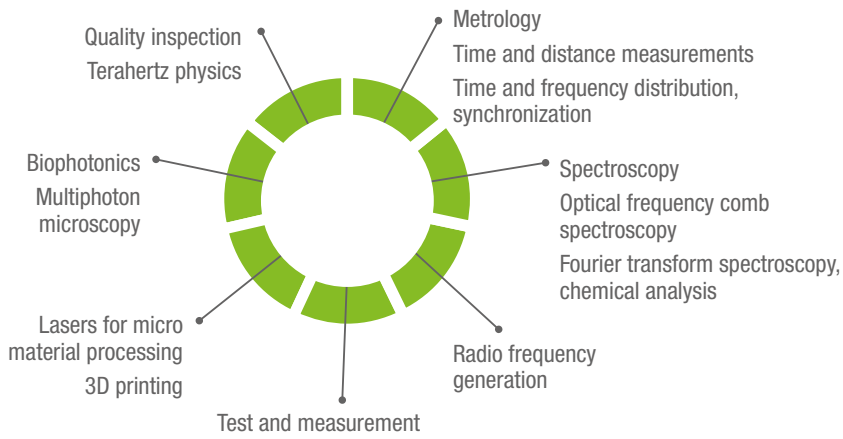
Employees worldwide: >100, over one third having a PhD in physics or engineering

TECHNOLOGY HIGHLIGHTS REVENUE GROWTH

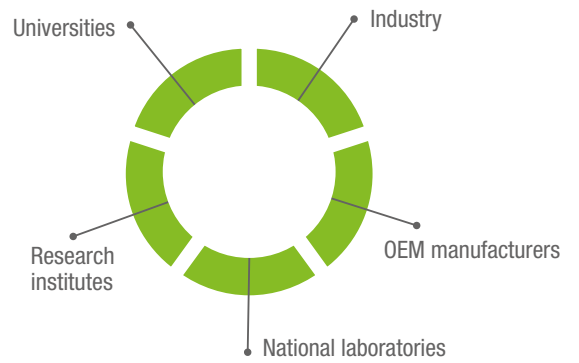




MARKETS



CUSTOMERS



TDS

Joint project with MIT for timing distribution solution

ORS 1500

Ultra narrow linewidth laser with <math><1\text{ Hz}</math> for highest precision

figure 9® Technology

Release of new series of lasers based on proprietary mode locking technology

BlueCut

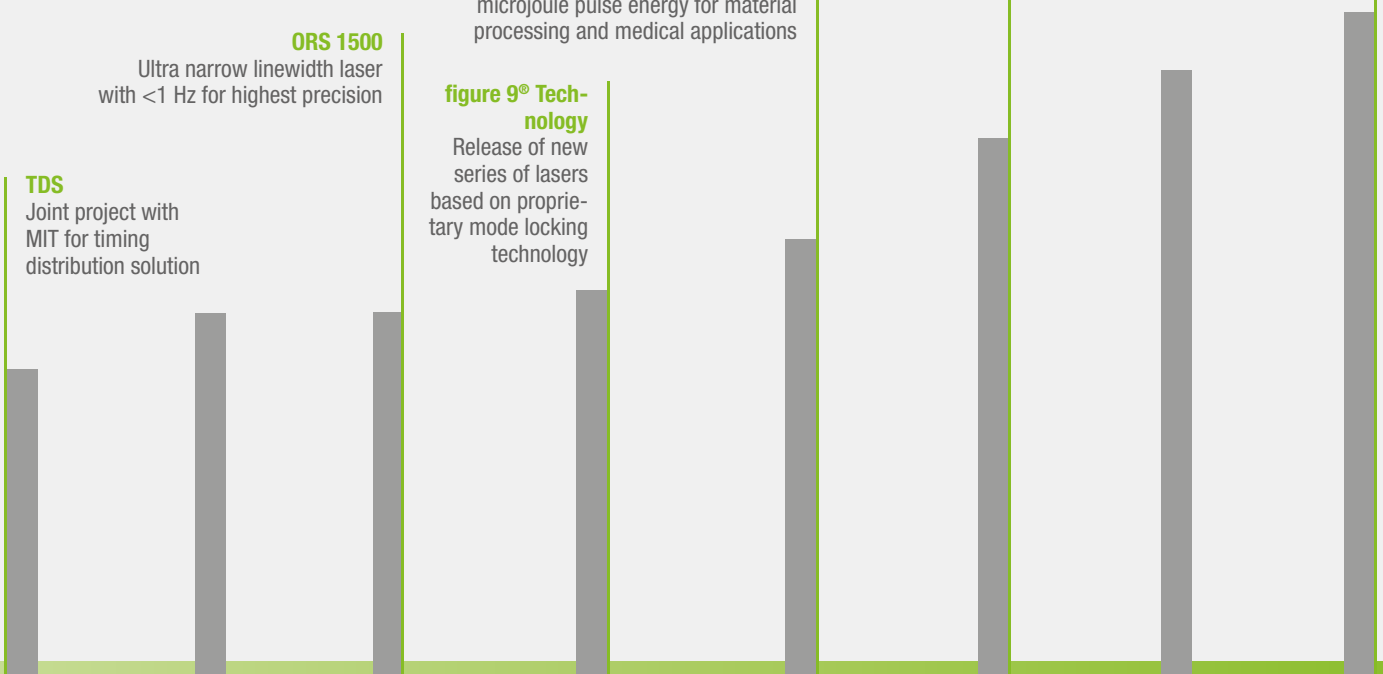
Femtosecond fiber laser with microjoule pulse energy for material processing and medical applications

ELMO, ELMO 780

New platform for femtosecond fiber lasers for OEM customers

SmartComb, FC1500-250-ULN

New optical frequency comb models with most compact design and most stable operation



MenloSystems



Menlo Systems GmbH

Bunsenstraße 5
D-82152 Martinsried
Germany
T+49 89 189 166 0
F+49 89 189 166 111
sales@menlosystems.com

Menlo Systems, Inc.

56 Sparta Avenue
Newton, NJ07860
USA
T+1 973 300 4490
F+1 973 300 3600
ussales@menlosystems.com

Thorlabs, Inc.

56 Sparta Avenue
Newton, NJ 07860
USA
T+1 973 579 7227
F+1 973 300 3600
sales@thorlabs.com