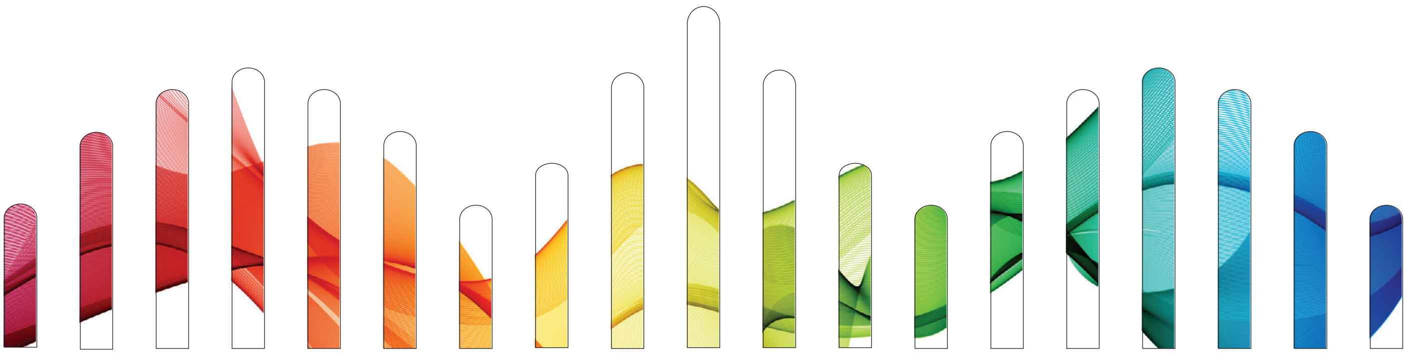
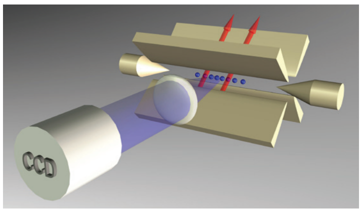
MenloSystems



OPTICAL FREQUENCY COMBS

397 nm
Cold Atoms



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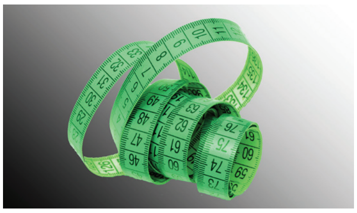
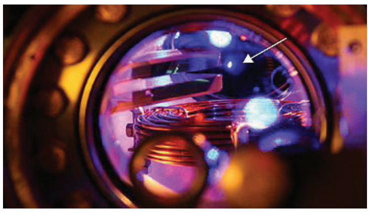
Optical frequency combs are used to replace transfer cavities and absorption spectroscopy cells in cold atom experiments. A prominent example is the laser cooling transition in $^{40}Ca^{+}$ at 397 nm, where a direct lock of the cooling laser to a frequency comb is performed. This results in higher accuracy and stability than with previous methods. Further, it offers much higher flexibility in regard to future requirements.

543 nm
Length Metrology



In precision length metrology National Metrology Institutes worldwide use Menlo Systems optical frequency combs to trace back the Helium-Neon laser wavelengths at 543 nm and 633 nm to the SI-second. In the actual measurement, interferometers use both wavelengths simultaneously to measure absolute distances over several orders of magnitude. Having the lasers stabilized to the frequency comb allows for highest accuracy and stability.

698 nm
Optical Clocks



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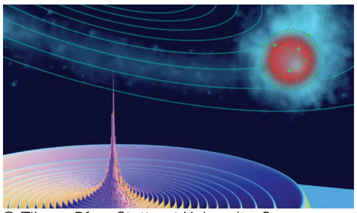
The quest for the most accurate clock is an extreme challenge. Leading groups are using Menlo Systems optical frequency combs. In the measurements, they compare distant clock transitions in the ultraviolet, visible, and infrared via the frequency comb to determine which clock has the best stability and accuracy, and improve the current standard. Currently, the strontium lattice clock is one candidate in the race for the world record in stability.

[Bloom et al., Nature 506, 71 (2014),
Falke et al., New J. Phys. 16, 073023 (2014),
Ushijima et al., Nat. Photonics 9, 185 (2015)]

Rydberg Atoms
480 nm



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With an optical frequency comb any frequency in the visible and infrared can be generated. Only a small amount of laser light is required for the lock to the frequency comb, and it couldn't be simpler. For example, ^{87}Rb atoms require light at specific wavelengths around 480 nm to pump the atoms into the Rydberg state. With the frequency comb, any laser wavelength required can be selected and thus any level be populated.

Rocket Science
780 nm

Optical frequency combs are inevitable for fundamental tests of various physical quantities. A prime example is the comparison of radio frequencies with optical clock transitions. In 2015, 2016, and 2018 Menlo Systems frequency combs were on board of TEXUS sounding rockets. During the flights, all systems had to withstand conditions of 13 g of acceleration before experiencing 360 s of microgravity. Einstein's Equivalence Principle was verified using a Rubidium clock at 780 nm. For final proof, after the landing with 40 g impacts, the combs were recovered and found ready to go again.

[Lezius et al., Optica 3, 1381 (2016)]

972 nm

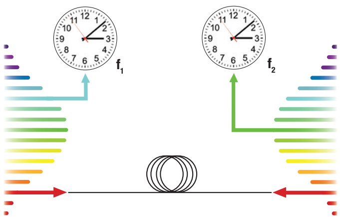
Nobel Prize

The Nobel Prize in Physics 2005 was jointly awarded to co-founder of Menlo Systems, Prof. Theodor W. Hänsch and Prof. John L. Hall "for their contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique". The honored measurements included high resolution spectroscopy on hydrogen atoms using 972 nm lasers and frequency combs. Latest achievements now even allow to perform similar measurements on anti-hydrogen in order to improve our understanding of the relationship between matter and anti-matter.

380 - 2400 nm

AstroCombs

Precise calibration of astronomical spectrographs allows for gravitational red-shift detection of stars on the order of cm^{-1}. By using the spectrally flat, evenly spaced output of a Menlo Systems AstroComb, the most precise telescopes on earth are improving their ability to detect exoplanets. Each AstroComb is precisely adapted to the telescope, e.g. offering 18 GHz mode spacing adapted to the resolution of the Echelle spectrometer. AstroCombs hold many advantages compared to other calibration sources, such as thorium-argon lamps or Fabry-Pérot interferometers. Most importantly, they allow for an absolute calibration.



Lasers operating in the telecom range at 1550 nm and linked to stable optical clocks allow for the dissemination of ultrastable frequencies via optical fibers. Using optical frequency combs on both ends of the fiber connections and technologies for noise cancellation resulting from fiber length changes, stabilities better than 10^{-16} in one second have been achieved in fiber networks over hundreds of kilometers.

[Predehl et al., Science 336, 441 (2012)]

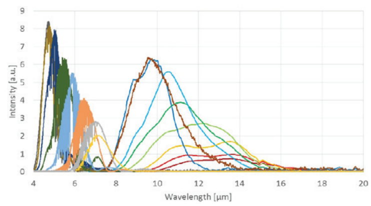
Optical Networks

1550 nm

In medicine, non-invasive and instantaneous determination of diseases can be performed by carefully analyzing the breath of a patient. Diseases ranging from diabetes to smallpox have molecular signatures that can be analyzed in real-time using frequency comb spectroscopy in the infrared. By shifting the output of a frequency comb via nonlinear optics, any wavelength required for the analysis can be generated.

Breath Analysis

1600 - 1900 nm



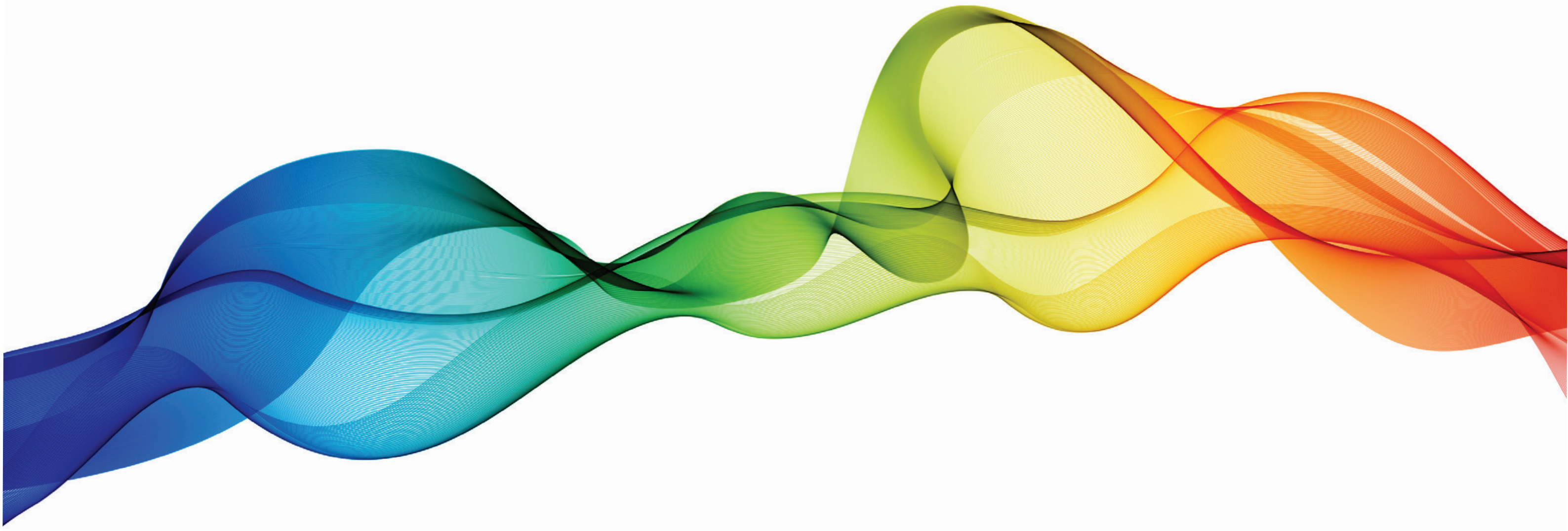
The field of mid-infrared spectroscopy is growing rapidly. Astrochemistry, plasma physics, molecular spectroscopy, and other disciplines are benefitting from absolute frequency measurements between 1 and 15 µm using optical frequency combs. From standard frequency combs, offset-free DFG frequency combs, to dual comb systems, the Menlo Systems portfolio offers the best frequency comb for any application covering all wavelengths from NIR to mid-IR.

Mid-IR Spectroscopy

1-15 µm

PRECISION IN PHOTONICS. TOGETHER WE SHAPE LIGHT.

Menlo Systems GmbH is a leading developer and global supplier of instrumentation for high-precision metrology. The company with headquarters in Martinsried near Munich is known for its Nobel Prize winning optical frequency comb technology. With subsidiaries in the US and China and a global distributor network, Menlo Systems is closely connected to its customers from science and industry. The main product lines are optical frequency combs, time and frequency distribution, terahertz systems, ultrafast and ultrastable lasers, and corresponding control electronics. Besides standard production, Menlo Systems develops and manufactures custom made solutions for laser-based precision measurements.



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, NJ07860
USA
T+1 973 579 7227
F+1 973 300 3600
sales@thorlabs.com

www.menlosystems.com