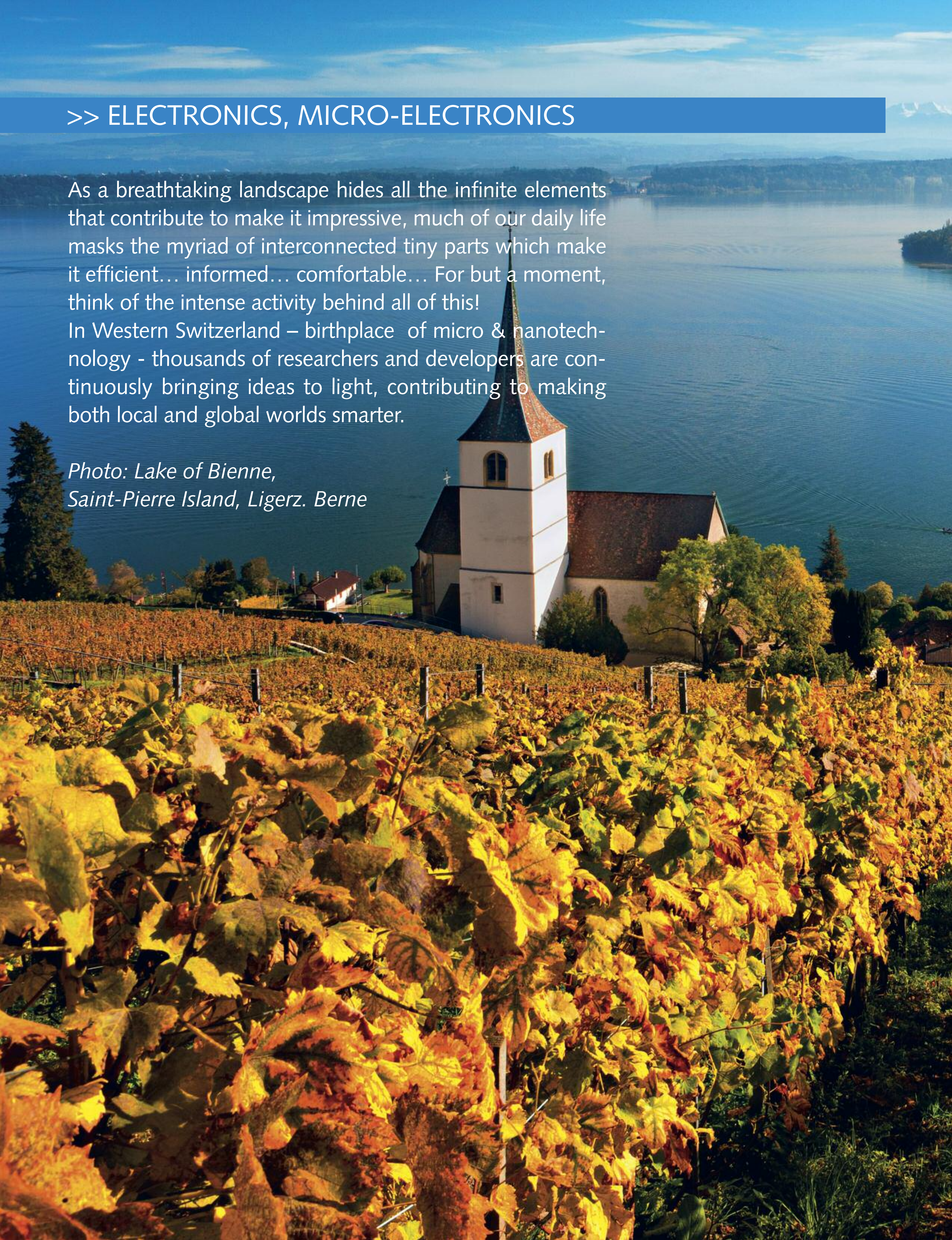
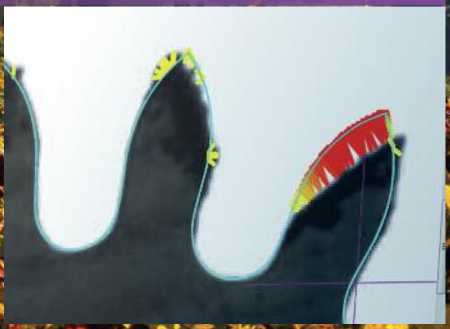
>> ELECTRONICS, MICRO-ELECTRONICS

As a breathtaking landscape hides all the infinite elements that contribute to make it impressive, much of our daily life masks the myriad of interconnected tiny parts which make it efficient… informed… comfortable… For but a moment, think of the intense activity behind all of this!
In Western Switzerland – birthplace of micro & nanotechnology - thousands of researchers and developers are continuously bringing ideas to light, contributing to making both local and global worlds smarter.

Photo: Lake of Bienne,
Saint-Pierre Island, Ligerz. Berne



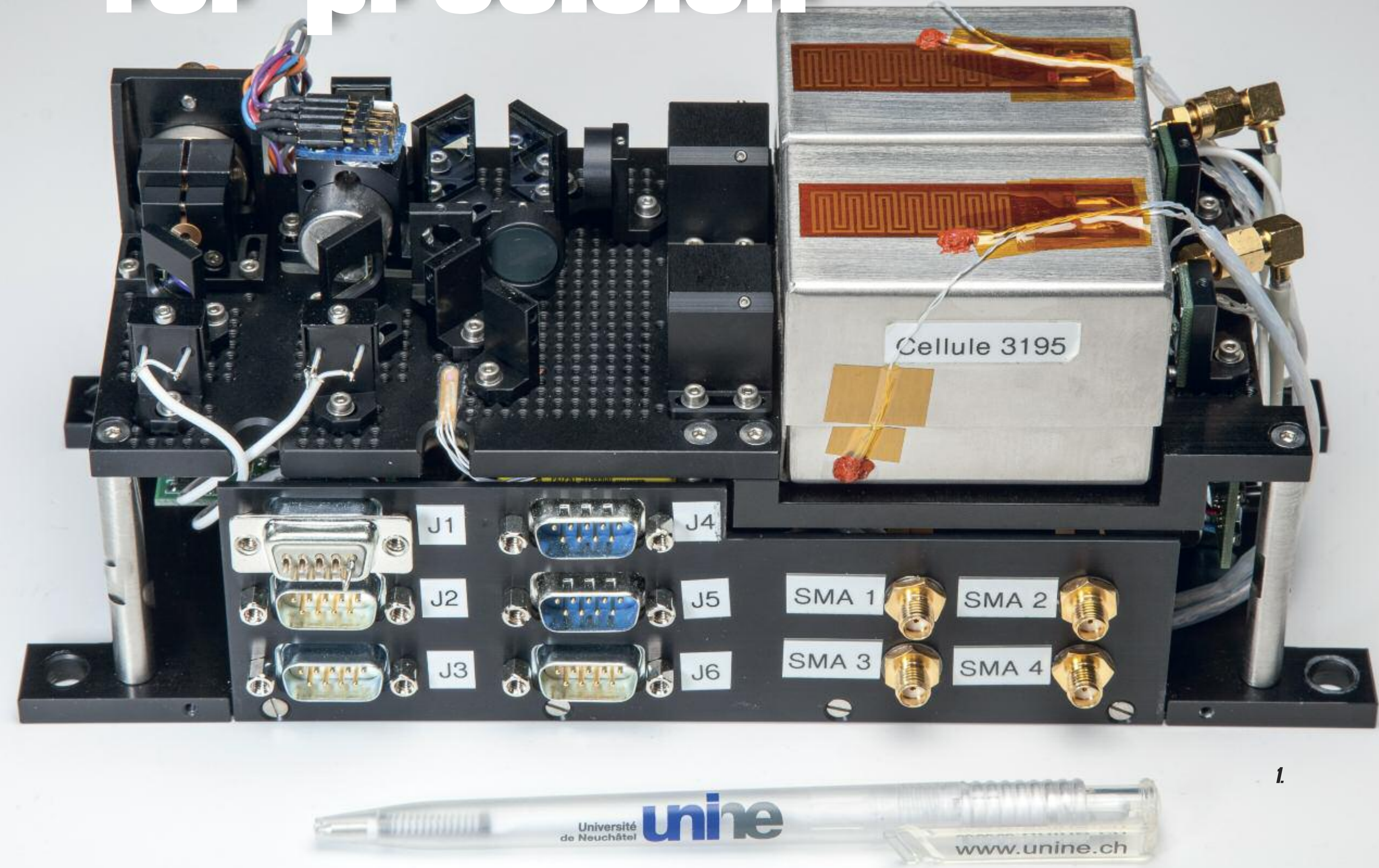


Quality control equipments integrating vision systems

Highly-stable laser-pumped rubidium atomic clock developed at University of Neuchâtel

In the future more accurate geolocation and faster data exchanges will require improved time-keepers. The Time and Frequency Laboratory at the University of Neuchâtel (LTF) develops techniques for tomorrow's high-precision atomic frequency standards, metrology, lidars and other sensors.

Mastering atoms for precision



1.

2.

In addition to its teaching and fundamental research activities, LTF is involved in several research projects encouraging technological transfer and innovation.

Very precise clocks are required on board GPS (global positioning system) satellites: for 1-meter precision, the instability must be below 3 ns on timescales of one day, which is only achievable by atomic clocks. In the European global navigation system Galileo, each satellite carries two types of atomic clocks, hydrogen passive masers and rubidium clocks, manufactured by the company Spectratime SA in Neuchâtel and initially developed in the Neuchâtel Observatory with the participation of LTF scientists.

At LTF, the team of Professor Gaetano Mileti anticipates future generations of rubidium clocks, aiming to achieve the performances of the passive maser, the best-performing clock ever on a satellite, but with a clock of much less weight, volume and consumption. To reach this objective, Christoph Affolderbach and colleagues work along two lines. Firstly, they replace the discharge lamp used to prepare the rubidium atoms by a laser diode. Secondly, in collaboration with EPFL, they have developed a new microwave cavity for interrogating the atoms, providing improved field geometry combined with significantly reduced size.

While aiming for state-of-the-art clocks for space, LTF still keeps a foot firmly planted on the ground. Jointly with industrial and public partners, it imagines and develops solutions for atomic clocks for ground applications. Important features of such clocks are superior stability compared to quartz oscillators, a small form-factor, operation over an extended temperature range, low power consumption, and low fabrication costs, in order to access existing, emerging, and future markets like telecommunication networks and power smart-grid synchronization. Either rubidium or caesium atoms act as frequency references and are confined in small cells made of glass or other materials.

«We use our scientific and technological expertise for conceiving future high-precision time-keepers.»

Prof. Gaetano Mileti,
LTF deputy director

The expertise of LTF in the fields of atomic physics, optics and metrology, combined with the unique local know-how in micro-technology (in particular in Microcity/EPFL and CSEM) has already resulted in the development of key components of future industrial chip-scale atomic clocks. Laser diodes are also very useful in caesium beam frequency standards, to replace the traditional magnetic beam selectors and improve clocks' performances. LTF is also involved in this field of research, in collaboration with another regional industrial partner, Oscilloquartz SA.

1. Highly-stable laser-pumped rubidium atomic clock developed at University of Neuchâtel.

2. Cell-confined rubidium atoms are at the heart of ultimate precision atomic clocks and sensors.

LTF has developed very compact frequency-stabilized laser modules. With the lasers' excellent frequency stability over long time intervals – as required for atomic clocks – this technology can also serve other purposes such as lidars (laser remote sensing). Recently, a team led by Renaud Matthey successfully demonstrated how to transfer the stability achieved at rubidium wavelengths (red light) to the near infra-red wavelength range. In particular, a highly stable rubidium-based optical frequency reference has been realized, under a mandate from the European Space Agency. This enables calibrating space-based measurements of variations in CO_2 concentration in the atmosphere with a precision of 0.5 ppm (1 molecule among two million), with the aim to refine the predictions about the climate change evolution.

«It is very rewarding that we can use our scientific and technological expertise for conceiving future high-precision time-keepers, and also for other precision measurements, like lidars, and compact sensors» rejoices Gaetano Mileti.

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