Press release

EU-funded macQsimal project for quantum technology draws to a close

New miniature atomic watches will soon hit the market

Neuchâtel, 27 June 2022 – The EU-funded macQsimal project, coordinated by CSEM as part of the EU's FET Flagship on Quantum Technologies program, has now drawn to a close, after leading to some promising discoveries. For instance, engineers developed a new kind of miniature atomic watch that will soon hit the market. macQsimal was launched in 2018 to explore how quantum properties can be used to develop sensors with unprecedented precision and sensitivity, and to help establish a high-performance European industry in this field. The project's closing ceremony was held at the University of Neuchâtel (UniNE), a key project consortium member, on 20–21 June through a symposium open to the public and an event held as part of the university's *Temps, Sciences et Société* (*Time, Science, and Society*) conference series.

The first quantum revolution led to the transistors and lasers that form the basis of computers, smartphones and internet connections. Today, a second revolution is on the way thanks to advanced methods for manipulating the fundamental quantum properties of systems and materials. Engineers worldwide are racing to get a handle on these new methods in order to develop breakthrough technology in fields like healthcare, security, transportation, energy and environmental science.

Sensors that push the boundaries of performance

macQsimal was carried out by a consortium of 14 partner organizations spanning the entire technology value chain, from fundamental research to industrial applications. Consortium members worked together to design next-generation, highly effective sensors based on atomic vapor cells, with a view to making the benefits of this technology available to the general public.

Transferring technology in Switzerland by turning prototypes into market-ready products

The Swiss consortium members began transferring the technology developed under macQsimal to industry by creating a miniature atomic watch that runs on very little power. Most of the development work for the watch took place in Neuchâtel, from designing the watch's core – consisting of MEMS cells developed by CSEM – and electronic control system to assembling the final product. Orolia Switzerland SA will market the watch in what's shaping up to be a fast-growing industry with expanding demand for atomic watches.

"We began studying miniaturized atomic watches about 15 years ago, and now our work is leading to new products being marketed in our region," say Christoph Affolderbach and Gaetano Mileti, a senior scientist and professor, respectively, at UniNE's Time-Frequency Laboratory (LTF). "We intend to continue our research in order to maintain Neuchâtel's leadership position in this industry, which is a strategic one for Switzerland."

Mini backup generators

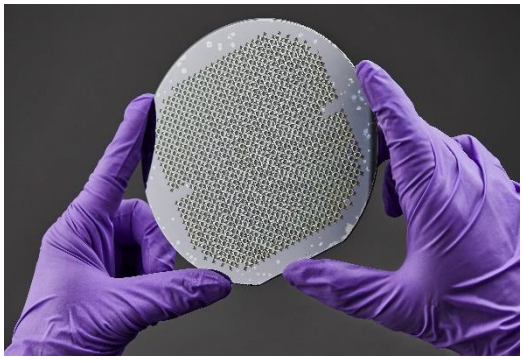
Atomic watches offer unique benefits for coordinating many essential public services like telecom networks, transportation systems and power grids. For now, these services rely on GPS signals and the Galileo satellite system – meaning that if there's a signal interruption or attack, the services could be disrupted. However, if atomic watches are installed, they could take over and keep the services running for a few hours while the problem is being fixed. "Atomic watches could serve as a type of back-up generator in certain applications," says Jacques Haesler, the macQsimal project coordinator and a senior project manager at CSEM.

An uncertain future

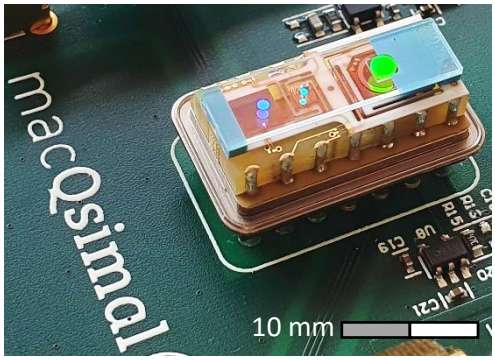
In addition to the miniature atomic watch, other prototypes that came out of macQsimal include quantum sensors with remarkable sensitivity for use in magnetometers and gyroscopes, for example. These instruments have potential in applications ranging from medical diagnostics to autonomous navigation. The prototypes were developed in close collaboration with research groups and companies based in neighboring European countries.

But the process of turning the prototypes into marketable products is on hold since Switzerland has been excluded from EU-funded research programs (following the break in negotiations on the country's framework agreement with the EU). Switzerland provides the MEMS cells that form the core of the sensors.

The second stage of the FET Flagship on Quantum Technologies program has just attributed funding for the first set of technology transfer initiatives to industry – but it doesn't include Switzerland. "The Swiss federal government has announced some initial temporary measures to fill the funding gap caused by Switzerland's exclusion," says Haesler. "These measures will let Swiss researchers and businesses working on quantum technology continue with their R&D for the near term. But since they've now been sidelined, they won't be able to keep working with organizations elsewhere in Europe. If we're able to get back into EU-funded research programs quickly, we can make up for the lost time with as little collateral damage as possible."




A wafer containing atomic-vapor MEMS cells, and the CSEM clean room where the cells were developed



Prototype of a market-ready miniature atomic watch

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About quantum technologies

Quantum technologies harness the behavioural quirks of energy and matter at the quantum - atomic and subatomic - level to gain functionality and performance that would otherwise be unattainable. At these very small scales, the classical laws of physics break down and the laws of quantum mechanics take over, leading to peculiar quantum effects such as superposition and entanglement. Superposition, which allows a particle to exist simultaneously in two states at once, and entanglement, in which the state of a particle "here" can depend on the state of another particle – even far away, open up new and exciting possibilities and applications. A new generation of quantum technologies have now moved beyond exploiting these naturally-occurring quantum effects to actively engineering them into breathtakingly powerful and novel devices and systems.

About macQsimal

macQsimal (Miniature Atomic Vapor-Cell Quantum Devices for Sensing and Metrology Applications) was launched in October 2018 to unlock the potential of quantum technologies for sensing and metrology and stimulate the development of a dynamic and competitive European quantum-enhanced sensor industry. The project has developed sensors in five application areas: miniature optically-pumped magnetometers, miniature atomic clocks, compact atomic gyroscopes, atomic GHz and THz sensors and vector imagers as well as gas sensors. These applications have been chosen for their high potential to quickly advance to products, which will be manufactured in Europe, within the next five to 10 years.

The macQsimal consortium was made up of:

- 2 research and technology organisations: (RTOs) CSEM, and VTT – Technical Research Centre of Finland Ltd,
- 3 industrial partners: Robert Bosch GmbH, Orolia Switzerland SA and Elekta Oy (Megin),
- 8 academic partners: The Institute of Photonic Sciences (ICFO), University of Copenhagen (The Niels Bohr Institute), Centre National de la Recherche Scientifique (CNRS – Laboratoire Kastler Brossel), Aalto University, University of Basel, University of Durham, University of Stuttgart and University of Neuchâtel,

assisted by accelopment AG for the project management and the dissemination and exploitation of project results.

macQsimal is a Quantum Technologies Flagship project managed as part of the Future and Emerging Technologies (FET) programme and funded within the Horizon 2020 Framework Programme under grant agreement number 820393. The project had a budget of €10.2 million.

Project website: http://www.macqsimal.eu

About the Quantum Flagship

The Quantum Flagship was launched in 2018 as one of the largest and most ambitious research initiatives of the European Union. With a budget of €1 billion and a duration of 10 years, the flagship brings together research institutions, academia, industry, enterprises, and policy makers, in a joint and collaborative initiative on an unprecedented scale. The main objective of the Flagship is to consolidate and expand European scientific leadership and excellence in this research area as well as to transfer quantum physics research from the lab to the market by means of commercial applications and disruptive technologies. With over 5000 researchers from academia and industry involved in this initiative throughout its lifetime, it aims to create the next generation of disruptive technologies that will impact Europe's society, placing the region as a worldwide knowledge-based industry and technological leader in this field.

The Quantum Technologies Flagship website: https://qt.eu/

About CSEM

CSEM – Meeting the challenges of our time

CSEM is an internationally recognized Swiss innovation center developing disruptive technologies with a high societal impact, which it then transfers to industry. A public-private organization, its mission is to support the innovation activity of Swiss companies and strengthen the economy. CSEM is active in the domains of precision manufacturing, digitalization, and sustainable energy. Daily, CSEM's 550 employees from 44 countries collaborate with leading universities, research institutes, and industrial partners. Headquartered in Neuchâtel, CSEM also has sites in the cantons of Basel, Bern, Obwalden, Zurich, and the Grisons.

www.csem.ch