CURRENT RESEARCH IN TIME & FREQUENCY AND NEXT GENERATION ATOMIC CLOCKS

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Many applications and scientific experiments, on ground and in space, require accurate and/or stable time & frequency references that can be provided only thanks to atomic clocks. Even though a few companies produce them industrially, these precision instruments are still subject of fundamental and applied research.

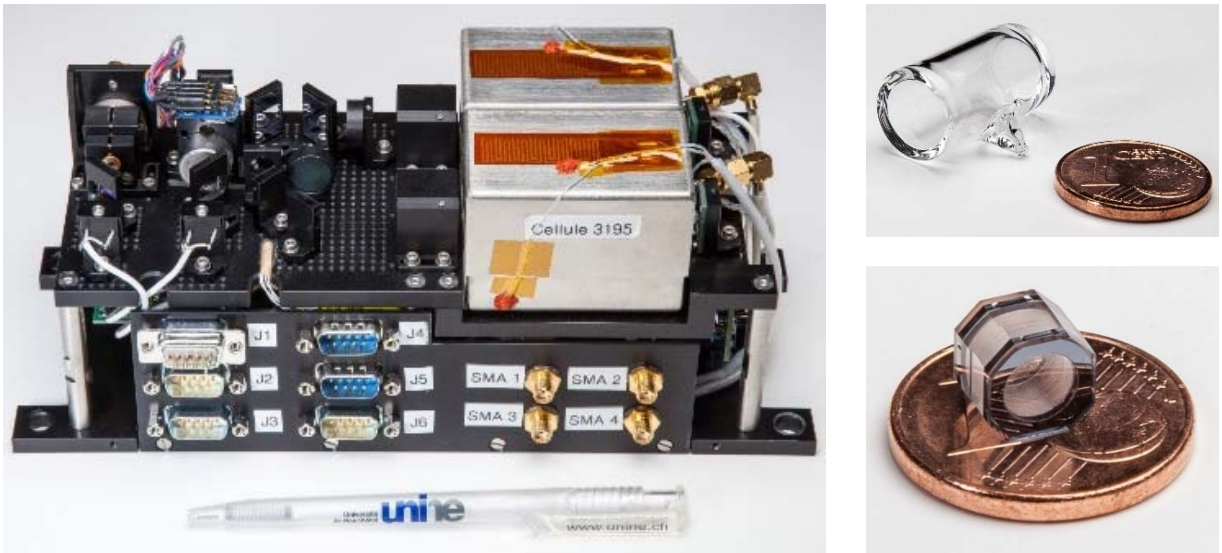
Key words: atomic clocks, time & frequency, lasers.

1. Principle of atomic clocks and applications

In an atomic clock, the frequency of a quartz oscillator is stabilised by using a well-selected atomic transition as a reference. The basic physical phenomenon at its heart is generalised Nuclear Magnetic Resonance (NMR). This NMR-like system can be realised in various ways, by exciting atoms stored in a vapour or in a beam, and may involve different elements such as Rubidium, Cesium, Hydrogen, etc. The precision and the stability of each atomic clock depend on its practical realisation and on the available spectroscopic and metrological data. Thus, various types of atomic clocks were developed during the last decades, by selecting the implementaion of the NMR principle and the employed technologies that will match the specific need of each application: fixed and mobile telecommunications, network synchronisation, smart grids, underwater seismic exploration, satellite positioning and navigations, etc.

2. Examples of current research

Atomic clocks still constitute a very active field of research that is simulteneously close to fundamental research, to technological developments and to everyday life applications. In the second part of our presentation, we will summarize the main axis of this worlwide effort, aiming to better understand the basic physical phenomena, to exploit the newly available technologies and ultimately to improve the performances of atomic clocks while expanding the range of their applications. The area of Neuchâtel has been particularly active in this field and still constitutes a unique concentration of research laboratories and of companies operating in the domain of *„Time and Frequency"*. We will conclude our talk by presenting a few examples of research projects towards next generation atomic clocks.



***Left**: prototype of laser-pumped Rubidium atomic clock for next generation satellite navigation system (Galileo).*
***Upper right**: glass-blown Rubidium vapor cell for laser wavelength stabilisation (for atomic clocks and Lidars).*
***Lower right**: micro-fabricated Rubidium vapour cell for next generation chip-scale atomic clocks.*

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