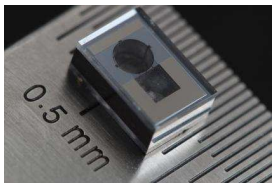
Post-doc researcher position

Subject: Microcell-based optical clocks

Duration: 1 year, with possibility of extension



The interrogation of atoms in microfabricated vapor cells cell has led to the development of high-precision and low-power chip-scale atomic clocks (CSACs) [1]. Microwave CSACs have become commercial devices, offering fractional frequency stability of 10^{-11} at 1 day, in a 17-cm^3 volume and 120-mW power consumption [2].

A significant breakthrough in the performance of atomic clocks can be obtained by transitioning from microwave atomic transition references (e.g. 9.2 GHz for Cs) to higher-frequency optical transitions (few hundreds of terahertz). The use of sub-Doppler spectroscopy techniques, that rely on the interaction of a thermal vapor with two counter-propagating laser fields to cancel the Doppler broadening, allows resolving transitions down to their natural linewidth, ranging from ~330 kHz for the two-photon transition of Rb atom to ~ 5 MHz on Rb and Cs D_1/D_2 lines. Such high Q-factor sub-Doppler optical atomic resonances are attractive candidates for high-precision laser frequency stabilization in a simple-architecture setup (no laser cooling, no UHV), with integration and collective fabrication facilitated by microfabricated vapor cells and on-chip photonics.

Different spectroscopic approaches have been engaged at FEMTO-ST, including the Rb two-photon transition at 778 nm [3], saturated absorption of Cs D_1 line at 895 nm [4], and spectroscopy of the Cs $6S_{1/2}$-$7P_{1/2}$ transition in the blue region at 459 nm [5]. Microcell-based optical references with Allan deviation in the low 10^{-13} range at 1 s, 3 orders of magnitude better than their CPT-based microwave counterparts, have been recently reported.

Interestingly, the margin of progress of these references is still large. Numerous technological progress and metrological studies remain to be performed to push these clocks to their ultimate performances. This involves for instance 1/ the development of microfabricated vapor cells with enhanced purity (to avoid collisional broadening induced by the presence of residual contaminants), improved control and tunability of their inner atmosphere [6-7], enhanced functionalization, and original cell geometries [8], 2/ the use of innovative low noise and ultra-compact laser sources, 3/ the demonstration of advanced interrogation sequences for mitigation of main frequency shifts or 4/ the use of unexplored-yet confinement and atomic transition excitation schemes.

The candidate will be fully involved on this research topic and will contribute to the progress of this strategic activity at FEMTO-ST. In the frame of ambitious research projects, the candidate will contribute to the development of microcell based optical clocks, supporting the progress of the microcell technology and/or their metrological characterization. The candidate will aim to communicate his/her results in high-impact scientific journals and international conferences.

[1] J. Kitching, Appl. Phys. Rev. 5, 031302 (2018)
[2] https://www.microsemi.com/product-directory/clocks-frequency-references/3824-chip-scale-atomic-clock-csac
[3] M. Callejo et al., J. Opt. Soc. Am. B 42, 1, 151 (2025). https://doi.org/10.1364/JOSAB.533904
[4] A. Gusching et al., Opt. Lett. 38, 10, 3254 (2023). https://doi.org/10.1364/OL.485548
[5] E. Klinger et al., Appl. Phys. Lett. 126, 124003 (2025). https://doi.org/10.1063/5.0261771
[6] C. Carlé et al., https://arxiv.org/pdf/2509.00172
[7] V. Maurice et al., Nature Microsys. Nanoeng. 8, 129 (2022) https://doi.org/10.1038/s41378-022-00468-x
[8] L. Peroux et al., https://arxiv.org/pdf/2509.22456

The candidate will integrate the team-project "Microcell clocks" at FEMTO-ST, involving members of the OHMS (http://teams.femto-st.fr/equipe-ohms/) [Time-Frequency Dpt] and MOSAIC groups (https://teams.femto-st.fr/MOSAIC/en) [Micro-Nano Sciences and Systems Dpt]. The candidate will benefit from the support of electronics/mechanics/computing services at FEMTO-ST, the time-frequency metrology platform Oscillator-IMP (http://oscillator-imp.com/dokuwiki/doku.php), and the MIMENTO microfabrication platform (https://www.femto-st.fr/en/Platforms/MIMENTO-Presentation).

Application

Profile:
PhD thesis in physics / applied physics / engineering sciences / optics or MEMS technologies.
Background with atomic/quantum clocks, sensors and metrology is a strong plus-value.
The candidate should enjoy working in a team group.
Start: From 01 January 2026
Duration: 1 year & extension possible
Salary: from 2990 € (gross salary), depending on years of experience
Procedure:
Apply on: https://emploi.cnrs.fr/Offres/CDD/UMR6174-RODBOU-004/Default.aspx

Contacts

Dr. Rodolphe Boudot
FEMTO-ST/CNRS
Département Temps-Fréquence / Site ENSMM
26, rue de l'épitaphe, Besançon, France.
Email: rodolphe.boudot@femto-st.fr
Tel: +33 (0)3 81 40 28 56

Dr. Nicolas Passilly
FEMTO-ST/CNRS
Département MN2S / Site TEMIS
15B avenue des Montboucons, Besançon, France
Email: nicolas.passilly@femto-st.fr
Tel: +33 (0)3 63 08 26 24