

3 year- PhD fully funded position at FEMTO-ST Institute

Non-Linear Surface acoustic wave platform enabled by spin wave hybridization

Keywords : material science, piezoelectricity, surface acoustic waves, growth, Brillouin spectroscopy, spin waves

Description of the Laboratory:

The **FEMTO-ST institute** (www.femto-st.fr) is a multidisciplinary research institute composed of seven departments covering numerous domains of engineering sciences and including more than 500 scientific, administrative and technical support staff. About 225 PhD students receive a high-level training in scientific research. It is one of the most competitive research institutes in France and is among the leaders in the world on Engineering for micro and nanoscale. One of the key research topics at FEMTO-ST institute is the development of devices based on electroactive materials with particular emphasis on microelectromechanical systems (MEMS), photonics, electro-optics, phononics, acoustics and robotics. FEMTO-ST institute has a microfabrication technology center with clean room facilities MIMENTO mixing technologies from microelectronics to micromechanics. MIMENTO is a member of the national network of the seven largest clean rooms in France (RTB).

The PhD thesis will be performed by crossing the expertise of two research groups of FEMTO-ST: PiezoMEMS group of the Time & Frequency Department and Phononics group of the MN2S Department.

PiezoMEMS group: The link between research and lead-free piezoelectric industry has been the DNA of FEMTO-ST for more than 60 years, with the development of quartz in metrology and for 30 years with the development of LiNbO₃ devices. Our current team gathers researchers in electronics and instrumentation of resonator metrology, in material science, in modelling and simulations in mechanical and electronic, and in microfabrication of piezoelectric and electronic packaging. Over the past 6 years, our group filed 6 patents, published 100 regular articles, received 8 PhD awards in conferences, a Grand Prix i-PhD (BPI France) and a professor member of the Institut Universitaire de France. PiezoMEMS is the biggest academic user of MIMENTO facilities and world leader of MOCVD growth of LiNbO₃. For more information you can view our website : <https://teams.femto-st.fr/piezomems/> & <http://members.femto-st.fr/ausrine-bartasyte/>

Phononics and Microscopy group: The group stands at the crossroad of phononics (the analysis and the control of phonons), of metamaterials (artificial materials whose properties are dictated by structure rather than composition), of wave physics, and of micro-instrumentation (the metrology of physical phenomena at the micro scale and below). Within phononics, the group is recognized internationally for contributions to phononic crystals, notably at the microscale and for theory, for metamaterials of different types, as well as for the study of the interaction of photons and phonons (Brillouin light scattering, optoacoustics). Over the years, the group has accumulated a lot of experience about the numerical simulation of surface acoustic wave devices, especially on lithium niobate and other piezoelectric substrates.

<https://teams.femto-st.fr/phononics-microscopy/en>
<https://members.femto-st.fr/vincent-laude/en>

Context

Radiofrequency (rf) signals are everywhere in today's connected society. Surface Acoustic Wave (SAW) devices are widely used to distinguish between frequencies. While energy efficient, SAW devices

mostly operate in narrowband applications and perform linear, frequency-conserving operations. Thin films of the **piezoelectric** KNbO_3 (KNO) material have larger electromechanical coupling ratio than any other SAW-friendly material, but they were so far almost never used because of their **very difficult growth** and the associated cost. Their record electromechanical coupling would enable the design of transducers with broadband capability, making them suited for non-linear signal processing, including frequency conversion applications. Conversely, Spin Waves (SWs) –the low-energy, collective excitations of a magnet– are used in specific microwave applications requiring non-linearity.

The PhD project aims to use the specific features of spin-waves (SW) –broadband capability and inherent non-linearity– to **confer non-linearity (NL) functionalities to state-of-the-art SAW-based microwave devices**. This will enable the design of power limiters devices on a SAW platform technology.

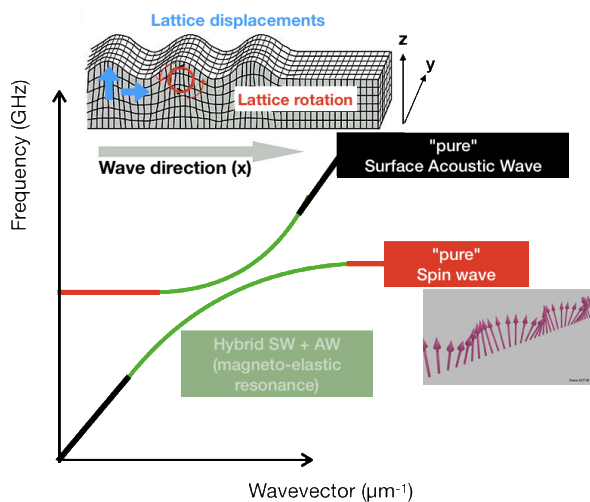


Fig. 1 : Coupling of acoustic waves (AW) with spin waves (SW) via magneto-elastic coupling

The difficulty is to integrate two very different families of materials (piezoelectric oxydes such as KNO and ferromagnetic multilayers) in a single multifunctional device.

The student will participate in the **functional characterization** of KNO single crystals and thin films (in particular by Brillouin spectroscopy) and the **μfabrication** of surface acoustic wave devices in the **clean room**. He/she will study how **to generate surface acoustic waves in KNO and how to efficiently couple them to spin waves in magnetic nanostructures**. This will enable to benefit from the inherent non-linearity of spin waves to design new functionalities on a SAW platform.

In addition to the practical learning of thin film growth, characterization and nanofabrication, finite element simulation of SAW devices, the PhD student

will have to learn about advanced μ wave design and measurements.

Starting date: from October 2026

PhD supervisors: Prof. Ausrine Bartasyte & Vincent Laude, Research Director

Offer requirements

Education level: Master degree or equivalent in Material science/Physics/Engineering, which formally entitle to embark on a doctorate;

Qualifications & experience:

- Fluent English (oral and written);
- Background in physics (experience in microacoustics or piezoelectricity is a bonus)
- Background and expertise in the field of Physics/Material Science and/or Engineering;
- Excellent IT skills (Finite element method, Python, Matlab or Labview programming);
- Experience with wave physics (optional)
- Experience with clean-room, laser- or micro-fabrication (optional)

Personal skills:

The candidate should have a high motivation, excellent interpersonal, time and stress management, and excellent verbal and written communication skills.

How to apply:

CV, motivation letter, recommendation letter from Master supervisor, official transcripts of master (1st and 2nd year) and bachelor/license records and rankings (including total number of students in cursus) have to be emailed to ausrine.bartasyte@univ-fcomte.fr and vincent.laude@femto-st.fr

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