PhD Graduate Research Assistantships
in Quantum Optomechanics
at the Swiss Federal Institute of Technology Lausanne

The **Laboratory of Photonics and Quantum Measurements** https://www.epfl.ch/labs/k-lab/ headed by Professor Tobias J. Kippenberg at the Swiss Federal Institute of Technology Lausanne (EPFL) in Switzerland is currently seeking for doctoral candidates in the field of quantum opto- and electro- mechanics and integrated frequency metrology and nonlinear photonics. The group has in the past decade performed pioneering work in the new fields of superconducting quantum-electromechanics, quantum optomechanics and microresonator frequency combs.

Quantum Optomechanics and Superconducting electromechanics is a field that emerged over the past decade and explores radiation pressure induced coupling between an optical and mechanical degree of freedom[1,2]. This coupling has enabled to extend quantum control from atoms, molecules and ions, to macroscopic mechanical oscillators, and allowed to perform measurements in a regime where quantum mechanics influences the measurement process. We have developed methods that allow cooling a mechanical degree to the quantum mechanical ground state[3] and are studying the quantum effects associated with radiation pressure on mechanical oscillators on nanomechanical oscillators[4], while studying the coupling of superconducting microwave cavities to mechanical drum oscillators. Cooled to milli-Kelvin temperatures, these systems can, for instance, be used to explore mechanical oscillators as a cold dissipative quantum reservoir[8] or to create non-reciprocal microwave devices. Currently topics investigated include real time quantum feedback, combining superconducting electromechanics with Josephson parametric amplifiers for quantum limited microwave measurements, as well as exploring their future coupling to superconducting qubits. Our aim is to explore fundamental predictions of quantum measurement theory in an experimental setting, explore the limit in coherence of macroscopic mechanical oscillators, and to improve our ability to achieve quantum control of the state of mechanical oscillators, as well as coupling the mechanical devices to superconducting qubits.

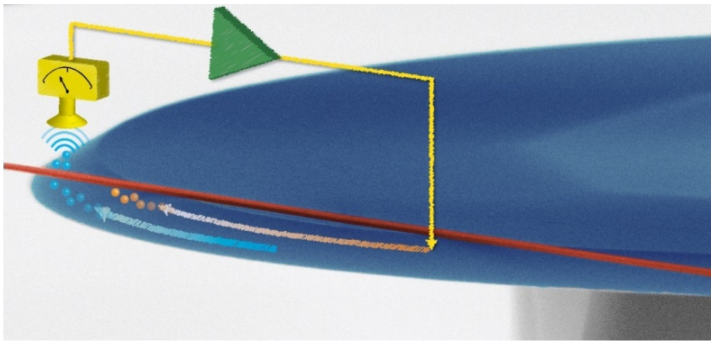

Figure 2: Quantum feedback of a mechanical oscillator (Wilson et al. Nature 2015)

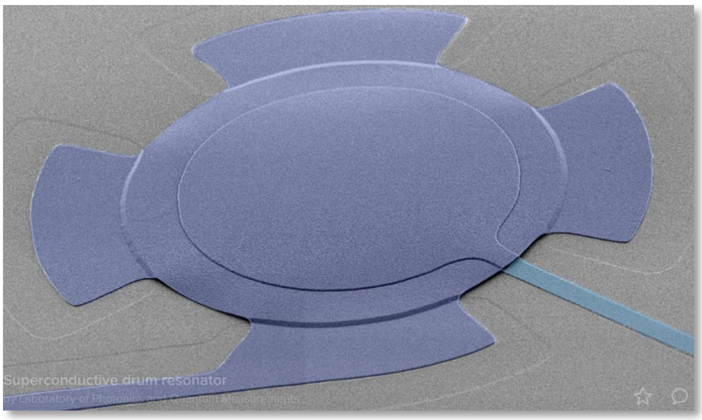

Figure 1: Superconducting electro-mechanical system.

Chipscale Soliton Microcombs. We have developed and invented a new method to create optical frequency-combs using chip-based micro cavities[5,6]. Frequency combs, which the Nobel Prize in 2005 has been awarded to Hänsch and Hall for its development, are of widespread interest for atomic clocks, spectroscopy, sensing, high capacity telecommunications as well as the calibration of astrophysical spectrometers. We are studying how to integrate optical and electrical functionality in such devices on photonic chips that are CMOS compatible. Our research has moreover shown that solitons can be generated in these optical microresonators, enabling femtosecond pulse generation on a photonic chip[7]. Our aim is to bring frequency metrology to wide-spread use by developing compact, portable and fully on chip sources that coherently link optical and radio frequency signals for timing, navigation, sensing and fundamental Physics.

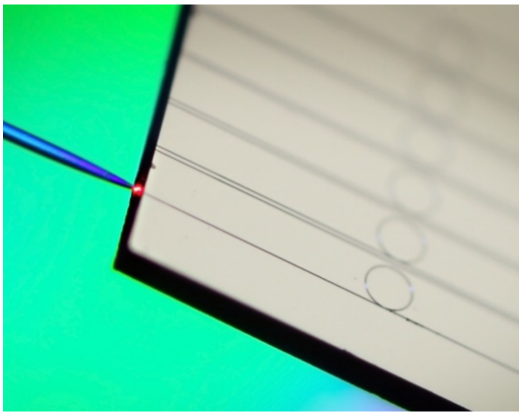

Figure 3: On chip microresonator frequency combs using soliton Physics (V. Brasch, Science, 2016)

Our experiments are at the interface of nanophysics and quantum optics closely linking experiment and theory, and thus allow acquiring a broad knowledge in several fields and experimental techniques. Being one of the two Swiss Federal Institutes, EPFL is known for its high international reputation and outstanding infrastructure. Access to its unique 1500 square meter cleanroom facilities for nano-fabrication is available http://cmi.epfl.ch/ for the PhD thesis project. The EPFL campus in Lausanne is only at a few steps from Lake Geneva and the Swiss Alps. The position is a full-time graduate research assistantship (typically 4 years), including a full-time salary and social employer charges (52kCHF/year). EPFL ranks among the top 20 of universities worldwide, in all major university rankings, and is in the top 3 in Europe.

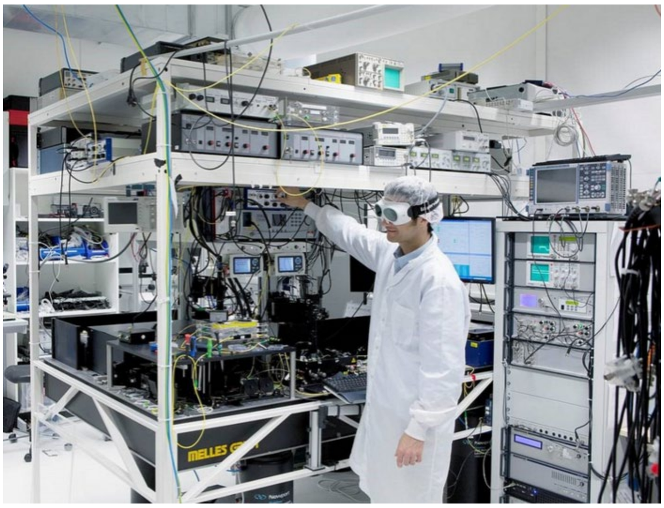

Figure 4: Laboratory of Photonics and Quantum Measurements

The PhD graduate assistantship covers the entire PhD duration and appeals to students in physics or electrical engineering (and in particular double Physics-EE majors) interested in carrying out cutting-edge research in the domain of quantum optomechanics and on chip frequency combs. EPFL has extensive cleanroom facilities for advanced nanofabrication. Requirements are a keen interest in photonics and quantum science and technology, and a Bachelor degree in Physics or EE. EPFL offers admission at the BA level for suitable candidates. Applications should be addressed to the EE graduate school at EPFL, but applicants should contact Prof. Kippenberg in advance.

References

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