EPFL PhD Graduate Research Assistantships in Quantum Technologies at the Swiss Federal Institute of Technology Lausanne (EPFL)

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 electromechanics** and **integrated frequency metrology and nonlinear photonics**. While admission at EPFL requires a completed Master degree, top graded **Bachelor degree students from top institutions can directly be admitted to PhD standing.** The group has in the past decade performed pioneering work in the new fields of **superconducting quantum-electromechanics, quantum optomechanics** and **microresonator frequency combs**. **Our lab belongs to the top 1% "highly cited" in Physics (Clarivate)**

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 and are studying the quantum effects associated with radiation pressure on mechanical oscillators on nanomechanical oscillators[3,4], while studying the coupling of superconducting microwave cavities to mechanical drum oscillators[5]. Cooled to milli-Kelvin temperatures these systems can, for instance, be used to explore mechanical oscillators as a cold dissipative quantum reservoir or to create non-reciprocal microwave devices.

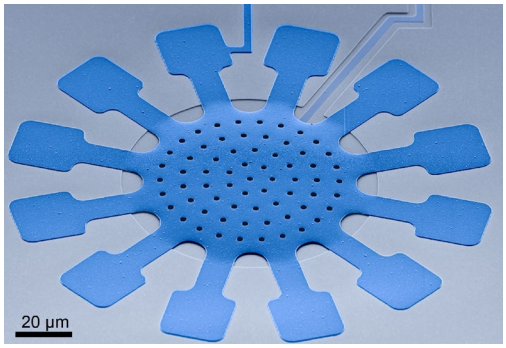

Figure 1: Superconducting electro-mechanical system.

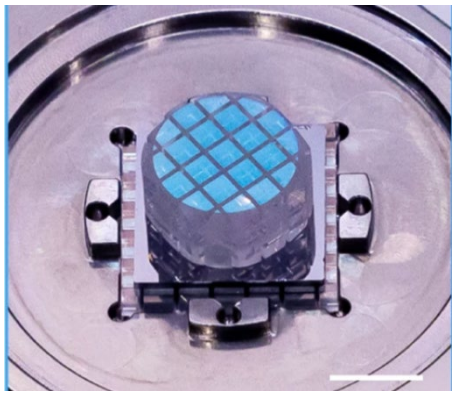

Figure 2: Membrane in the middle cavity (Huang et al, Nature 2024).

Currently topics investigated include real time quantum feedback, room temperature quantum optomechanics[6], collective dynamics in the quantum regime[7] and 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, to create nonclassical states of macroscopic mechanical systems.***

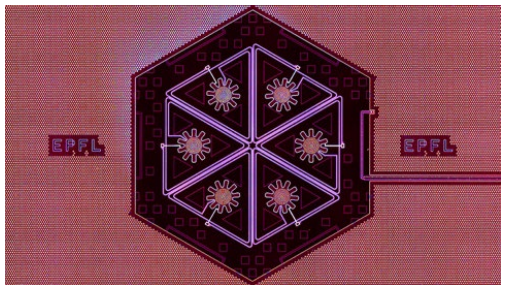

Figure 3: A hexamer of macroscopic mechanical oscillators for quantum collective phenomena (Chegnizadeh et al, Science 2025).

Hybrid "next generation" nonlinear integrated photonics. We have moreover developed and invented a new method to create **optical frequency-combs** using photonic chip based optical microresonators. Frequency combs – which the Nobel Prize in 2005 has been awarded– are of widespread interest for atomic clocks, spectroscopy, sensing, high capacity telecommunications as well as the calibration of astrophysical spectrometers. Towards this end we have developed a novel generation of integrated photonic circuits 'beyond silicon' – specifically silicon nitride. With this platform we have opened a plethora of novel integrated device technologies such as soliton microcombs[8,9], enabling femtosecond pulse generation on a photonic chip[10]. 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, communication[11], computing[12] and fundamental Physics or next generation LiDAR[13,14]. Beyond frequency combs, we have also developed frequency agile lasers[15], integrated optical isolators, coherent microwave-optical transduction, erbium-doped waveguide optical amplifiers[16], chip-based parametric optical amplifier[17,18], and novel electron-photon interaction schemes[19-21] based on our ultra-low loss silicon nitride and lithium niobate/tantalate[22,23] integrated photonic platforms. **Our work is laying the foundation to next generation photonic chip-based technologies**. 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 of experimental techniques. Being one of the two Swiss Federal Institutes, EPFL is known for excellent facilities including a **50 MioUSD cleanroom facilities** for nano-fabrication is available http://cmi.epfl.ch/. 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, including a full-time salary and social employer charges (52kCHF/year)**. KLab has 12 former members that have secured professorships; including **MIT in the US and USTC in China.** The **PhD graduate assistantship** covers the entire **PhD duration** and addresses physicists or students of electrical engineering. **Switzerland visa system allows multiple entrie**s, and a PhD from Switzerland allows to qualify for the **SNF mobility fellowship** (a two-year postdoc funded by the government – anywhere around the world). EPFL **offers admission at the BA level for excellent candidates**.

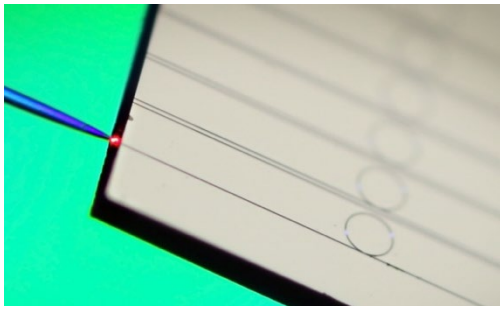

Figure 4: On chip microresonator frequency combs using soliton physics.

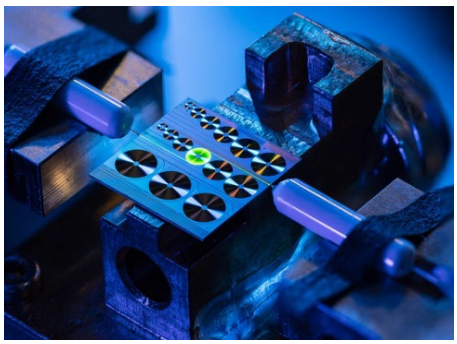

Figure 5: On-chip Er-doped waveguide amplifier. (Liu, Science 2022).

For further information please contact Prof. Tobias J. Kippenberg (tobias.kippenberg@epfl.ch) or consult our webpage k-lab.epfl.ch. **APPLY ONLINE**
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