QUANTERA
ERA-NET Cofund in Quantum Technologies

MQSens: Quantum sensing with nonclassical mechanical oscillators

The team

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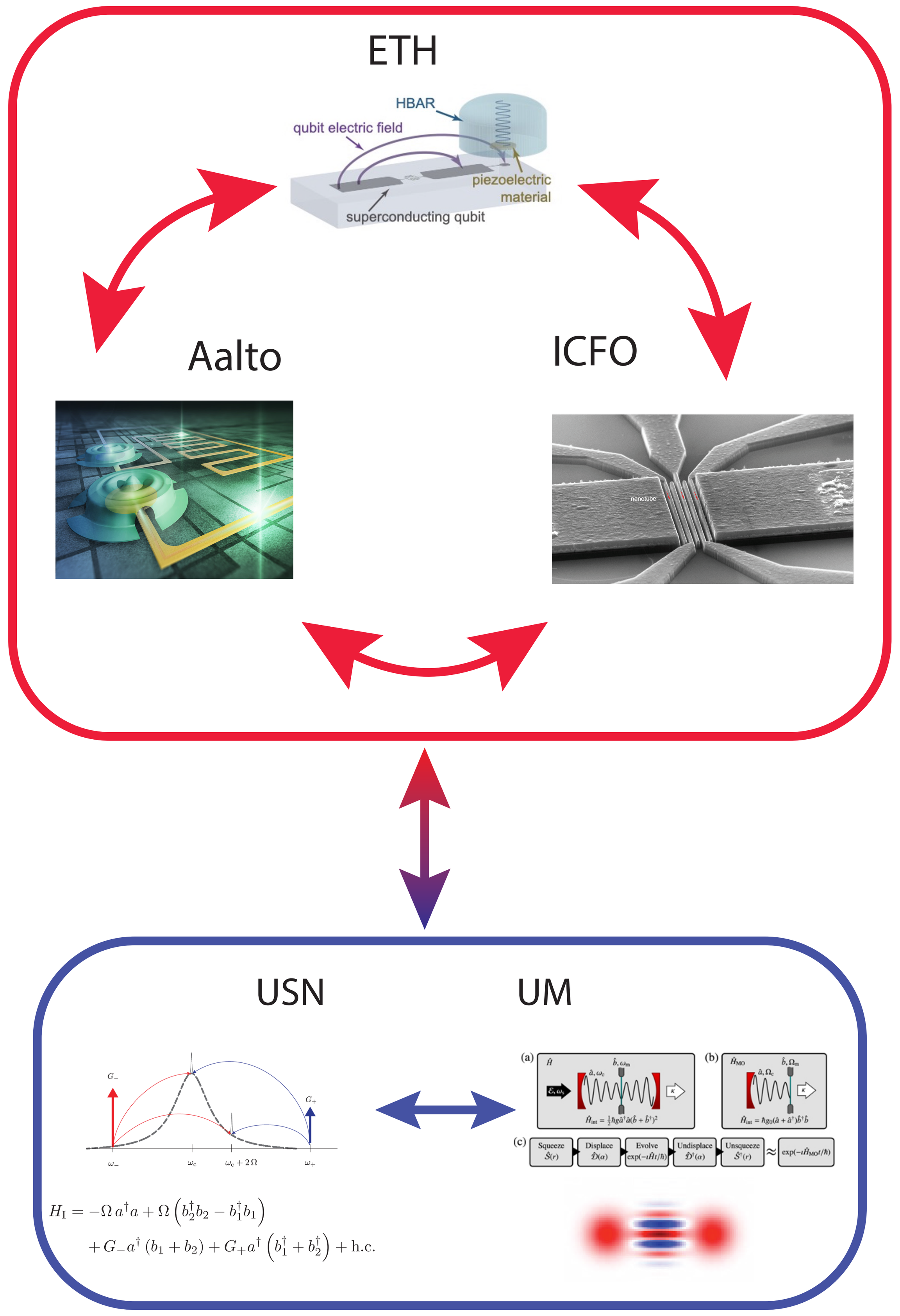


The Project

The goal of this project is to establish the usefulness of quantum states for mechanical sensing through new theoretical developments and experimental demonstrations in three complimentary physical platforms: high-overtone bulk acoustic wave resonators (**HBARs**), **membrane resonators**, and **carbon nanotubes**.

ETH: (exp) HBAR resonators coupled to superconducting qubits. Generation of non-Gaussian mechanical states

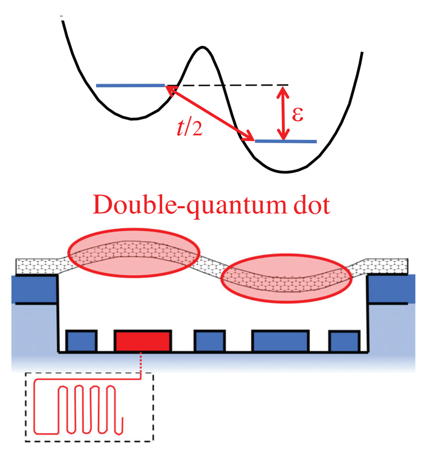
Aalto: (exp) measurement-based feedback to stabilize squeezed and entangled quantum states in mw optomechanical systems.
Mechanical device consisting of drumhead and membrane resonators.

ICFO: (exp) Nonlinear mechanical oscillators (CNTs) in the quantum regime. All mechanical qubits.

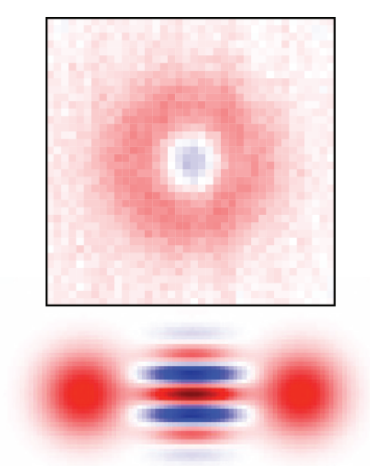
USN: (theory) coupling of mechanical motion to mw cavities and qubits; nonlinear mechanics in the q. regime. Application of non-Gaussian states to sensing.

U. of Malta: (theory) creation and stabilisation of non-classical states of motion through means such as Quantum Zeno Dynamics. Development of new protocols and models.

Early examples:



CNT qubit:
Double quantum dot embedded in a gated carbon nanotube. Electronic potential (top) and physical realization. Coupling between mechanical motion and electronic degrees of freedom can be used fpr computation and sensing[1].



Nonclassical mechanical states:
Wigner functions of a 1-phonon Fock state (top, measured[2]) and a Schrödinger cat state (bottom, simulated).
The unique features of these Wigner functions (negativity, interference fringes, etc.) help us visualize how such states can be used for metrology sensing, and tests of fundamental physics.

1. Pistolesi, A. N. Cleland, and A. Bachtold, Phys Rev X (2021)

2. U. von Lüpke, Y. Yang, M. Bild et al. Nature Physics (2022)