

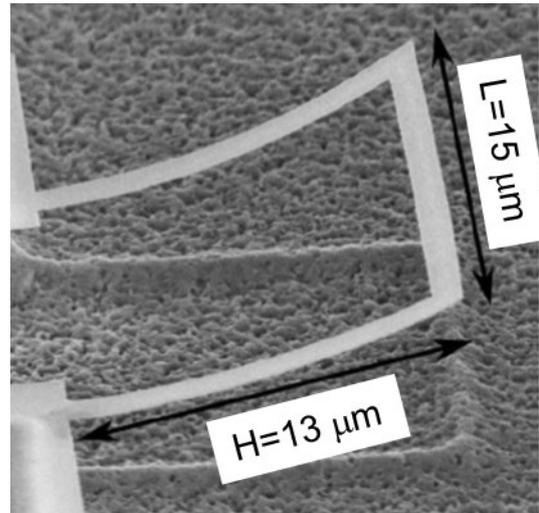
### Tuning the curvature of nanomechanics at very low temperatures

**General Scope :** Modern “top-down” fabrication techniques allow the production of mechanical resonators with one or more dimensions much less than 1  $\mu\text{m}$ . Nanomechanical resonators with high length to thickness ratios can be extremely floppy, making them sensitive force detectors and increasing the prominence of their thermal motion. Cooling such resonators to very low temperatures reduces the thermal motion and usually increases the quality factor, greatly increasing their sensitivity. The quantum zero-point motion of a nanomechanical resonator was first distinguished from its thermal noise about 15 years ago, and this capability has become increasingly widespread since then.

These versatile devices have a wide range of applications. They can be used to study thermodynamics at the nanoscale, and nanomechanical detection of gravitons and relativistic effects in quantum mechanics has been proposed. Furthermore, nanomechanics allows low noise conversion of signals between microwave and infrared frequencies and long-term storage of quantum states. Recently, high quality membranes with thicknesses near 100 nm have been used to improve the sensitivity of scanning force microscopy.

**Research topic and facilities available :**

Mechanical resonators also function as useful probes of cryogenic fluids such as  $^4\text{He}$  and  $^3\text{He}$ . They can be used as viscometers, thermometers and bolometers, as well as for generating and detecting turbulence. They can even be used for studying the dynamics of a single quantum vortex in the fluid. An aluminum cantilever with a “goalpost” geometry (image at right) is desirable for these applications due to its relatively low resonance frequency, yielding low acoustic emission into the fluid and consequently low damping.



Stresses induced during fabrication and differential thermal contraction of goalposts result in unpredictable curvature. Curvature reduces the sensitivity of the motion detection, thereby decreasing the signal to noise ratio in the superconducting state.

We found a technique for tuning the goalpost curvature *in situ* over a wide range. It appears possible to flatten or even reverse the curvature. The intern will test this technique and determine its potential for improving the performance of goalpost resonators.

**Required skills :**

Enthusiasm for challenging measurements at very low temperatures. Please send CV and academic transcripts.

**Starting date :** Negotiable

# **INSTITUT NÉEL Grenoble**

## **Topic for Master 1 internship – Academic year 2025-2026**

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