

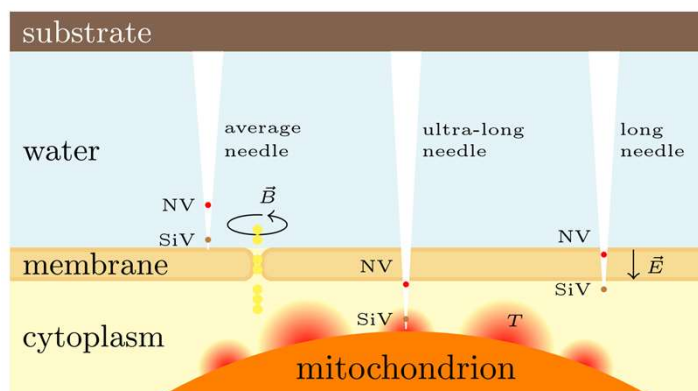
Super-resolved multi-parameter quantum sensing with arrays of diamond nanoneedles – MultiQS

Every living cell depends on a delicate balance of physical and chemical conditions, such as temperature, acidity (pH), electrical activity, magnetic fields, and reactive molecules. Changes in these conditions can reveal how cells function, adapt, or become diseased. However, current technologies cannot measure several of these signals at the same time, with high precision, inside living cells, and without disturbing their natural behaviour. The MultiQS project aims to overcome this challenge by developing a new generation of quantum sensors based on diamond. These sensors use tiny defects in diamond crystals that are extremely sensitive to their surroundings. Unlike previous approaches that relied on individual sensing needles, MultiQS will create ordered arrays of nanoscale diamond needles on a chip. This design enables stable measurements, precise calibration, and highly detailed mapping of multiple cellular signals simultaneously. The technology will allow researchers to monitor temperature, magnetic and electric fields, pH, and reactive oxygen species in living cells in real time and at an unprecedented scale. This will help scientists better understand diseases such as cancer, neurodegenerative disorders, and cardiovascular conditions.

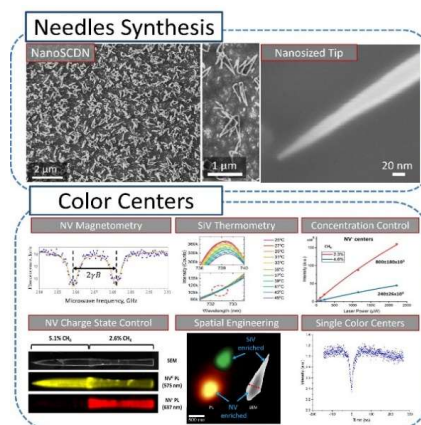
Objectives

- 01.** Fabrication of **monocrystalline diamond needle arrays** on silicon substrates with tip sizes of 10–100 nm and inter-needle spacing of 200–1000 nm, incorporating SiV^- and NV^- centers at a defined distance (tens of nanometers) from each other to avoid their interaction.
- 02.** Development of a **calibration technique** for diamond needle arrays using optical super-resolved imaging (STORM-ODMR) of NV^-/SiV^- properties (position, ZPL, spin resonance frequencies, photon rates).
- 03.** Experimental demonstration of **super-resolved multimodal sensing** (fluctuating magnetic fields, constant electric fields, temperature, pH, ROS concentration) in a modelled environment.
- 04.** Experimental demonstration of super-resolved multimodal sensing, including fluctuating magnetic fields, static electric fields, temperature, pH, and ROS on both sides of the plasma membrane **in living cells**, provided the chip is appropriately and biocompatibly functionalized.

MultiQS concept



Fabricated diamond needles



Partners



Based on partners' publications

1. Adv. Funct. Mater. 36, e20907 (2026).
2. Sci. Adv. 11, sciadv.adq6836 (2025).
3. Phys. Rev. Research 7, 033065 (2025).
4. J. Mater. Chem. C 12, 11995, (2024).
5. Adv. Opt. Mater. 10, 2200631 (2022).



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