

INTERNSHIP/PHD PROPOSAL IN QUANTUM TECHNOLOGY

Laboratory name: **Laboratoire de Physique des Solides**

CNRS identification code: UMR8502

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Internship location: Laboratoire de Physique des Solides -

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Thesis possibility after internship: YES

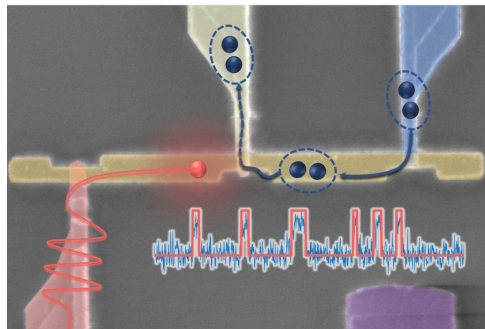
Funding: YES/NO If YES, which type of funding: Ecole doctorale/Quantum saclay

Microwave Photon Detectors for Superconducting Qubit Readout

Subject :

The ability to detect individual microwave photons is a key enabling technology for quantum computing, quantum sensing, and fundamental physics experiments. Despite recent breakthroughs in detection efficiency, existing single-photon detectors typically suffer from a limited dynamic range, making them unsuitable for measuring signals containing more than a few photons. Overcoming this limitation by developing detectors sensitive to microwave pulses spanning **1 to 100 photons** would represent a major step forward, particularly towards **single-shot readout of superconducting qubits without the need for parametric amplifiers**.

Our group has recently demonstrated a novel approach to microwave photon detection based on a **microwave photon-to-electron converter**, in which a superconducting tunnel junction acts as a voltage-tunable quantum absorber through photon-assisted quasiparticle tunneling [1,2]. By developing an ultrasensitive charge detection technique, we have further demonstrated the detection of individual microwave photons [3].



Electron microscope picture of the photoelectric microwave detector from reference [3].

Building on this expertise, we now aim to explore a complementary detection strategy exploiting the **extreme temperature sensitivity of diffusive Josephson junctions**. By operating a junction close to its switching instability, the absorption of a few microwave photons can trigger a transition from the superconducting to the resistive state, converting energy deposition into a robust electrical signal. Crucially, the tunable switching threshold could enable discrimination between vacuum and multiphoton coherent states, a key ingredient for efficient qubit readout.

We are seeking an enthusiastic student to contribute to the **design, nanofabrication, and experimental characterization of this new detector**. The student will work closely with permanent researchers and gain hands-on experience in superconducting circuits, electron-beam lithography, metal deposition, and ultrasensitive measurements in a **dilution refrigerator operating at 20 mK**.

Beyond advancing fundamental research, this project opens promising perspectives for **quantum computing and sensing**, offering the student an opportunity to develop experimental skills at the forefront of quantum technologies.

[1] Aiello et al, *Quantum bath engineering of a high impedance microwave mode through quasiparticle tunnelling*, [Nature Communications](https://www.iledefrance-gif.cnrs.fr/fr/cnrsinfo/de-leffet-photoelectrique-aux-technologies-quantiques) **13**, 7146 (2022). <https://www.iledefrance-gif.cnrs.fr/fr/cnrsinfo/de-leffet-photoelectrique-aux-technologies-quantiques>

[2] Stanisavljevic et al, *Efficient Microwave Photon-to-Electron Conversion in a High-Impedance Quantum Circuit*, [Physical Review Letters](https://physics.aps.org/articles/v17/127) **133**, 076302 (2024). <https://physics.aps.org/articles/v17/127>

[3] Basset et al, *Fast and Continuous Detection of Single Microwave Photons via Photoassisted Quasiparticle Tunneling to a Superconducting Island* [Physical Review Letters](https://doi.org/10.1103/PhysRevLett.136.237001) **136**, 237001 (2026)

Condensed Matter Physics: YES

Quantum Physics: YES

Macroscopic Physics and complexity: NO

Theoretical Physics: NO