BSc/MSc Thesis: Plasmonically Enhanced Superconducting Nanowire Single Photon Detectors

Single-photon based applications in quantum technologies such as quantum computing require photon detection with high precision and near-unity efficiency. One way to achieve this goal are Superconducting Nanowire Single Photon Detectors. Due to the high resonant absorption cross section of plasmonic resonances, they represent an effective way to increase the absorption efficiency of such detectors. In order to have optimum detection efficiency we integrate the so-called plasmonic perfect absorber structure to enhance the performance even further to reach almost 100% absorption with our detector.

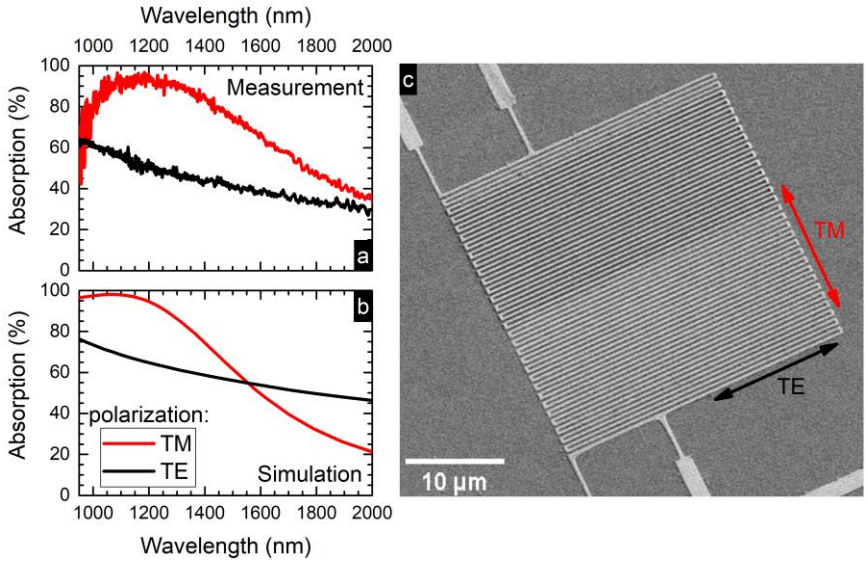

Fig. 1 Absorption spectra and design of the 20 nm thick NbN detector and its active area of $30 \times 30\ \mu m^2$. (a) Measured absorption spectra, which confirm the enhancement of the absorption by utilization the plasmonic properties of NbN and perfect absorber principle, which leads to near-100% absorption in the optimized frequency range. (b) Simulated absorption spectrum of the detector. (c) SEM image of the active area of the NbN detector.

Your Task:

We have been able to reliably detect light and even different polarizations by measuring the voltage drop (µV) caused by the detector, as the incoming light breaks the Cooper pairs. Your first task is to find a way to test the response time of our detectors. To do this, you would work together with the experts in the electronics workshop and develop and build a suitable circuit. We can then connect it to our cryostat and test the detectors at temperatures of around 2 K. Then, you will optimize the response time of the detectors by suitable methods, such as reducing parasitic capacitances and inductances.

Required skills:

- Interest in optics, experimental and low-temperature physics
- Hands-on and practical attitude

You gain:

- Handling of ultra-cold liquids nitrogen and helium
- Know-how about superconductors, lasers, and measurement techniques for quantum technologies
- Experience in designing and building high-speed electrical circuits

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Literature:

- Farag, M. Ubl, A. Konzelmann, M. Hentschel, and H. Giessen, "Utilizing niobium plasmonic perfect absorbers for tunable near- and mid IR photodetection," Opt. Express **27**, 25012 (2019).