Cryo-CMOS Design of Scalable SNSPD Front-end

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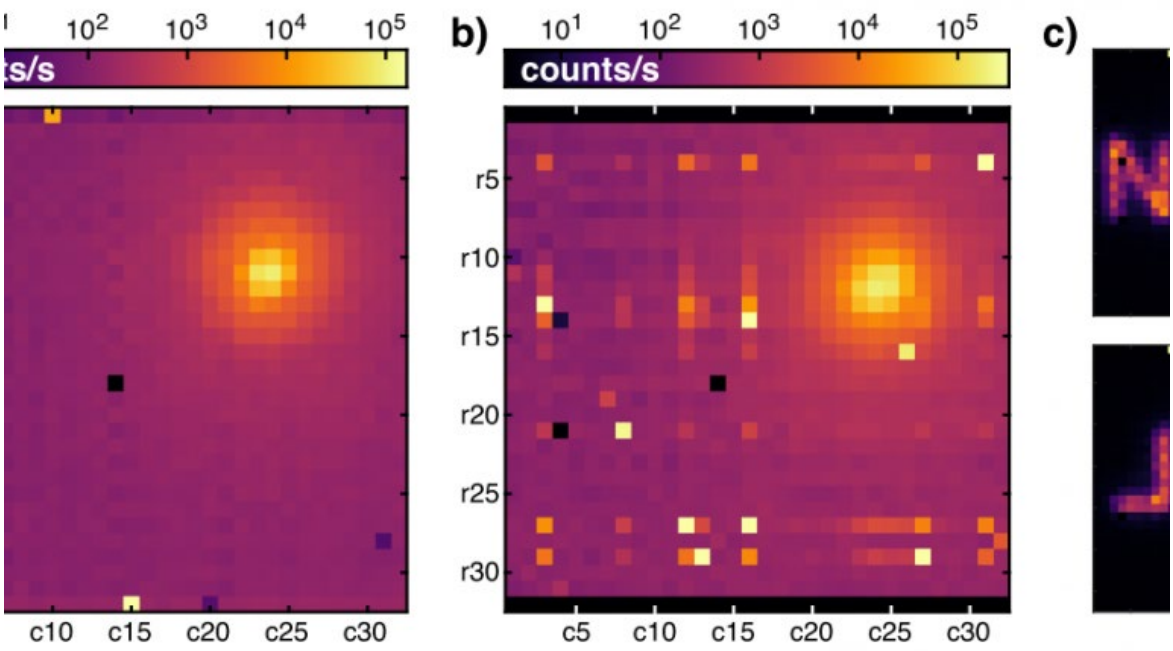
Project Type:	*Master Project*
Location:	*Microcity, Neuchatel*
Start Date:	*Flexible*

Motivation:

Single-photon detectors and nanoscale superconducting devices are two major candidates for realizing and supporting quantum technologies. Superconducting nanowires single-photon detectors (SNSPDs) in particular, cover various applications that evolved in the quantum field for the past few years such as high-rate and long-distance quantum key distribution, satellite laser ranging, long-distance imaging and non-quantum applications like molecular spectroscopy. However, the largest SNSPD array reported so far is the kilo-pixel array. One of the main constraints to achieve high levels of scaling in these detectors is the limited power budget available within the cooling system.

The architectures demonstrated so far, based mainly on analog implementations [1], [2], [3], are promising. However, going beyond one thousand pixels, while maintaining low jitter, low dark counts, high efficiency, and high-count rate is really challenging. For this reason, more innovation is required to scale up SNSPD arrays.



Description:

The master project consists on the design and analysis of a low power readout circuit to interface SNSPDs. The project will consist of three main phases:

1. **Study and understanding** of the physics behind Superconducting detectors. In the first months, Simulations using Cadence and SPICE will be conducted to deeply understand the main limitations from an analog design perspective.
2. **Design**. The student will come up or contribute in building up new ideas for a single pixel readout.
3. **Testing**. The student will help in the test of some building blocks at cryogenic temperatures as well as the realization of prototypes that may be patented.

Tasks:

- Literature research.
- Detailed analysis of the SNSPD-pixel interface on Cadence.
- Electromagnetic analysis of the device using ADS.
- Design of prototypes on Altium.
- Cryogenic Analog and Digital interface testing.

[1] Emma E. Wollman et al., "Kilo pixel array of superconducting nanowire single-photon detectors," Opt. Express 27, 35279-35289 (2019).

[2] Zhao et al. "Single-photon imager based on a superconducting nanowire delay line," Nature Photon 11, 247–251 (2017).

[3] S. Doerner et al., "Frequency-multiplexed bias and readout of a 16-pixel superconducting nanowire single photon detector array," Appl. Phys. Lett. 111(3), 032603 (2017).