Design and fabrication of high-kinetic superconducting electronics

Master project

General Information

Laboratory: Hybrid Quantum Circuits Laboratory (HQC)
Partners: EPFL, ETH Zürich
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Starting date: September 2024
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Motivation

Superconducting technology plays a key role for a large range of applications, such as low-temperature sensors, quantum bits, and superconducting electronics, mostly rapid single flux quantum electronics (RSFQ, [1]), used generally for readout purposes. However, RSFQ electronics presents multiple challenges, such as signal size, impedance matching, robustness to magnetic fields and compactness, while outperforming the CMOS counterpart in power efficiency, speed and noise characteristics. On the other hand, high-kinetic superconducting electronics, such as the one based on the nanocryotron family (nTrons, yTrons, hTrons, [2-4]) is a young superconducting device technology that tries to merge the best of the two worlds, presenting high speed, low power consumption, better compactness, variable impedance and larger signal sizes.

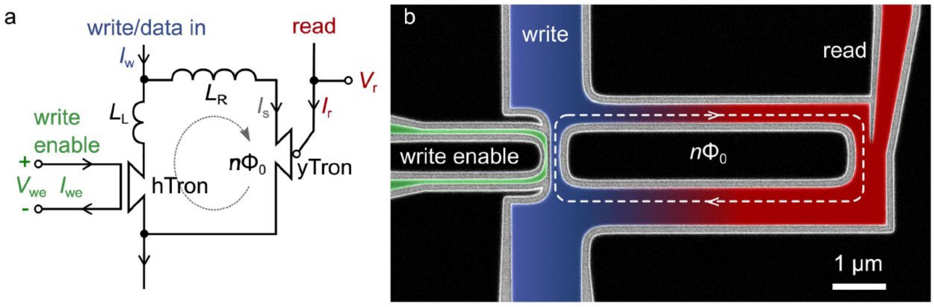

Fig 1: Schematics and SEM image of a superconducting nanowire-based memory made of NbN [4]

Description

The project is going to aim the model, design and test a superconducting nanowire-based circuit for multiple purposes. The project will consist of three main phases:

1. **Characterization and Modeling**. In the first months, the student will focus on designing and simulating the device to ensure correct operation.
2. **Fabrication**. The student will then fabricate the circuit in the CMi cleanrooms.
3. **Testing**. The chip will be tested in one of the cryogenic systems available in HQC.

Tasks

- Literature search
- Design of the required electronic circuit using python
- Simulations and study of performance
- Fabrication of the device
- Experimental characterization

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