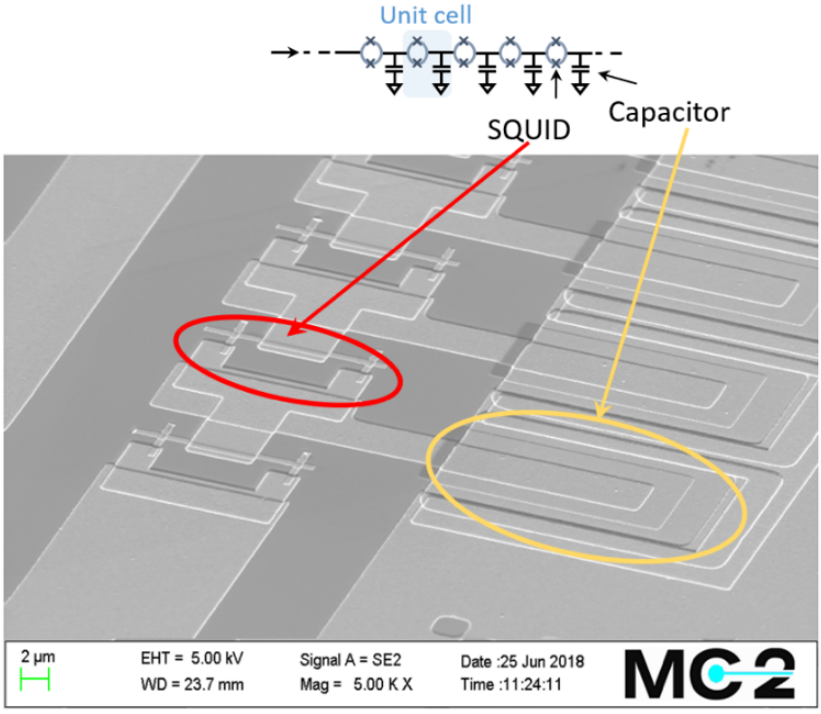
Master's thesis projects co-supervised by the Microwave Electronics and Quantum Technology groups at MC2

PROJECT 1: Modeling of Josephson Junctions and SQUIDs in ADS/Microwave Office

Background: To acquire the quantum information stored in superconducting qubits, the read-out circuit requires ultra-low-noise amplifiers for the very weak microwave signal that carries the information. In order to keep the noise level as low as possible in qubit read-out, the first stage of the amplification chain uses amplifiers consisting of passive nonlinear elements called Josephson junctions (JJ) instead of active and noisy devices like transistors. Such amplifiers are called parametric amplifiers. The fast turn-around design, simulation and test of parametric amplifiers requires a precise nonlinear or behavioral model of the JJ in a standard circuit simulation tool, for example ADS® or Microwave Office®.



A travelling wave parametric amplifier (TWPA) made of approx. 500-unit cells. Each unit cell has one SQUID (composed of two JJs in parallel) and a parallel capacitor to ground.

Project Goals: The aims of this project are:

(1) To model a JJ as a sub-circuit nonlinear element. Thereafter, simple building blocks like SQUIDs will be simulated and characterized. A SQUID (superconducting quantum interference device) is a parallel combination of two or more JJs and works as a nonlinear tunable inductor. A SQUID can be used as a qubit that is tunable by applying magnetic flux.

(2) To simulate our parametric amplifier design, which is based on an array of Josephson junctions or SQUIDs, using the sub-circuit developed in the first step. Newer amplifier versions will be designed and simulated too. The results are then compared with previous numerical MATLAB-based calculations as well as the experimental measurement data.

Student(s) also help the experimental colleagues who are active in cryogenic measurement and characterization of the amplifiers and data processing.

Supervisors: These projects are co-supervised by principal investigators in the Microwave Electronics and Quantum Technology Laboratories a. These projects will contribute to the goal of the Wallenberg

Center for Quantum Technologies (WACQT), which is to scale up the size of our quantum processor to 100 qubits. For more information about the activities of both groups consult with the websites, publications or directly contact Professors **Per Delsing, Herbert Zirath, Christian Fager, Jonas Bylander.**

https://www.chalmers.se/en/centres/wacqt/Pages/default.aspx
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For more detailed questions about each project please feel free to contact us or directly ask **Daryoush Shiri** (researcher at QTL) via [shiri@chalmers.se].