Learning plan – Project outside the course scope Blocks 1&2 2019-2020

Stef Petrus Jacobus Koenis

Title of the project: *Identifying and characterizing sources of decoherence affecting qubits*
Organisation: Lab of superconducting metamaterials (SMM) at National University of Science and Technology (MISIS) in Moscow, Russia
NBI supervisor: Jens Paaske (associate professor)
MISIS supervisors: Alexey Ustinov (professor) and Ilya Besedin (researcher)
Language of project: English
Start date: 02-09-2019 (expected)
End date: 20-12-2019 (expected)

Skills

- Perform a problem analysis and come up with an experimental approach to solve it (: the research programme).
- Find and utilise state of the art literature when setting up and carrying out a research programme.
- Work with state of the art equipment like dilution fridges and microwave electronics.
- Draw conclusions from the experimental results and articulate these (by means of a report/paper/presentation).
- Perform and communicate about scientific research in an international context.

(Specific)

- Design a superconducting qubit chit based on transmon qubits with different shunt capacitance and SQUID geometry, and, possibly local voltage gates to locally tune the energy of charge-coupled two-level systems (TLSs)
- Develop experimental measurement software to perform T1, T2*, T2 and CPMG measurement sequences within the cQED architecture using Zurich Instruments' HDAWG device
- Test the design and software: mount the chip into the dilution fridge in lab, perform the measurements using the developed software and presenting the results.

Knowledge

- Knowledge about the field of superconducting qubits
    - The engineering alternatives for qubits and their relative merits and drawbacks.
    - Different sources of decoherence (noise from control lines, thermal fluctuations of current and voltage (Johnson-Nyquist noise), and noise from charges and spins localised on the chip.
- Knowledge about the methods and apparatuses used in experimental solid state physics.

(Specific)

- Detailed knowledge about transmon qubits

Competences

- Reflect on the research project and put it into perspective in relation to other issues within the subject area of solid state physics and more specifically quantum computation hardware.
- Independently set up and carry out a scientific research project.

Syllabus

Most of this is still to be determined in consultation with supervisors. As a start, I will read and understand:

- Krantz, P., Kjaergaard, M., Yan, F., Orlando, T. P., Gustavsson, S., & Oliver, W. D. (2019). A quantum engineer's guide to superconducting qubits. Applied Physics Reviews, 6(2), 021318.