SUNDAY 08:30 – 17:50

Opportunities and Challenges for the Cryogenic Microwave Control of Quantum Processors

WS05
EuMC/ EuMIC

Chair: Masoud Babaie[1]
Co-Chair: Fabio Sebastiano[1]
[1]TU Delft

Room: Spark

Quantum computers have the potential to solve problems that are intractable for classical digital computers, offering breakthroughs in fields such as cryptography, material science, and optimization. A quantum computing system consists of two main components: the quantum processor, which operates at milli-Kelvin (mK) temperatures, and the electronic interface, which must function at cryogenic temperatures to address scalability challenges. This interface plays a critical role and involves three primary functions: multiplexing and demultiplexing, control, and readout. As a result, microwave engineering and circuit design are essential to developing this interface, ensuring high-fidelity qubit control and readout.

To effectively design this interface, microwave engineers must first understand the specific operational requirements of different qubit platforms and the associated needs for signal generation and acquisition. The workshop will begin with an introduction to two of the most promising qubit platforms: transmons and color centers, focusing on their unique signal requirements and control challenges.

Designing circuits for cryogenic temperatures also requires robust modeling techniques. We will discuss key device characteristics and modeling strategies at 4K, which are essential for developing reliable cryogenic electronics that can function in quantum systems.

One major challenge in quantum computing is minimizing the number of cables between the qubit stage (milli-Kelvin) and the electronics stage (4K). To address this, we will explore the role of cryogenic multiplexers in reducing cable complexity and improving signal transmission. The workshop will then cover the readout chain, where achieving an ultra-low noise figure across the entire receiver is crucial. We will present two approaches: the use of active low-noise amplifiers (LNAs) in FD-SOI technology, and a fully passive amplification strategy using parametric amplifiers. Finally, the session will focus on qubit control, highlighting the design of high-speed DACs capable of generating precise control pulses for transmon qubits, as well as the generation of high-voltage pulses for ion-trap qubits.

PROGRAMME

Engineering Quantum Control: Challenges and Innivations in the Microwave Domain

Adriaan Rol[1]
[1]Orange Quantum Systems

Realising entanglement networks with colour-center qubits

Conor Bradley[1]
[1]Delft Networks

MOSFET Modeling for the Design of Cryo-CMOS Cirsuits with the sEKV Model

Christian Enz[1]
[1]EPFL

Developing Cryogenic Standard Responses with Uncertainties at 4.2 K using a Thermo-Mechanical EM Approach

Marco Spirito[1]
[1]Delft University of Technology

Scaling silicon-based quantum computing using 22 nm FDSOI technology

Fernando Gonzalez-Zalba[1]
[1]Quantum Motion

A 40 GS/s 8b-DAC SST-TX in 7 nm FinFET CMOS for cryogenic quantum applications with 32kB SRAM-based RF-DDS AWG

Marcel Kossel[1]
[1]IBM

Design of Cryogenic Integrated Circuits for a Trapped Ion Quantum Computer

Vadim Issakov[1]
[1]U.Braunschweig

Cryo-CMOS Degenerate Parametric Amplifier: An Exploration of Ultra-low Noise Quantum State Discrimination on Silicon

Cheng Wang[1]
[1]UESTC