FM 51: Industry II: Computing

Time: Wednesday 14:00–16:00 Location: Aula

Invited Talk FM 51.1 Wed 14:00 Aula

Early-stage quantum computing in an industrial context — •Florian Neukart — Volkswagen Group of America, San Francisco, California, United States of America

With the computers we use today, some of the most important problems will never be solved, among these simulated chemistry, drug discovery, transportation, and artificial intelligence. Practical quantum computers herald a new era in information technology, and it*s happening right now. In industry, we must be aware of it, understand why and when quantum computers are more powerful than classical computers, and develop knowledge about architectures, algorithms, and programming languages. It*s an exciting field, of which it is clear that despite the progress made, many hurdles still have to be taken. The audience will learn about early-stage quantum computing in an industrial context and about potential benefits today and in the future in the most practical way.

Invited Talk FM 51.2 Wed 14:20 Aula

Quantum communication and quantum sensing at Airbus — •Friedhelm Serwane and Thierry Botter — Airbus Blue Sky - Central R&T, Taufkirchen

Quantum systems are emerging as enabling technology in a variety of areas, ranging from communication and computation to sensing.

Airbus Blue Sky is Airbus' gateway to new technologies. As part of the Airbus Central Technology Office, we define the direction of fundamental research at the centre of the international organization. We explore emerging technologies including quantum systems, biomaterials and neuromorphic computing, for the benefits of aerospace.

An overview over Airbus activities on quantum technologies will be presented with a focus on quantum secured communication and quantum sensing.

Invited Talk FM 51.3 Wed 14:40 Aula

Quantum Computing in the Chemical Industry - First impressions and resource estimations for quantum chemistry on quantum computers — •Michael Kuehn[1], Sebastian Zanker[2], Peter Deglmann[1], Michael Marthaler[2], and Horst Weiss[1] — [1]BASF SE, Ludwigshafen, Germany — [2]HQS Quantum Simulations, Karlsruhe, Germany

The study and prediction of chemical reactivity is probably one of the most important application areas of molecular quantum chemistry. Fully error-tolerant quantum computers could provide exact or near-exact solutions to the underlying electronic structure problem with exponentially less effort than a classical computer thus enabling highly accurate predictions for comparably large molecular systems. In the nearer future, however, only noisy devices with a limited number of qubits will be available. For such near-term quantum computers the hybrid quantum-classical variational quantum eigensolver algorithm in combination with the unitary coupled-cluster ansatz (UCCSD-VQE) has been an intensively discussed approach that could provide accurate results before the dawn of error-tolerant quantum computing. After a brief introduction to our activities in the field of Digitalization in R&D, we present a study applying our UCCSD-VQE implementation to the calculation of reaction energies of small, exemplary chemical reactions and compare to well-established electronic structure methods like traditional coupled-cluster and density functional theory. Finally, we roughly estimate the required quantum hardware resources to obtain "useful" results for practical purposes when using UCCSD-VQE.

Invited Talk FM 51.4 Wed 15:00 Aula

A Semiconductor Corporation View on Quantum Technologies — •Sebastian M. Luber and Thomas Kurth — Infineon Technologies AG, 85579 Neubiberg

Quantum technologies based on influencing individual quantum systems have gained increasing attention during the last decade in academic research as well as in the private sector. Especially the bright prospects of quantum computing are being discussed prominently on information technology events and in the media. Cleary, the effect on the business of traditional semiconductor companies e.g. in the field of security technologies could be large, potentially even disruptive. Hence, Infineon Technologies has already engaged in the research on quantum technologies in collaboration with leading academic experts. In this talk, we will give an industry view on quantum technologies sharing insights into related research activities at Infineon.

Invited Talk FM 51.5 Wed 15:20 Aula

Scalable instrumentation for quantum computing — •Sadik Hafizovic — Zurich Instruments AG, Zurich, Switzerland

Building a quantum computer is one of the most demanding challenges scientist and engineers are currently facing. All promising realizations of physical qubits share a common challenge: the need for classical instrumentation with unprecedented requirements which scales from a single qubit to 100s of qubits. Zurich Instruments' mission is to support scientists and engineers in that challenge by providing the most advanced instrumentation to efficiently link their analog qubits with the digital domain. We are presenting a Quantum Computing Control System (QCCS) that we have developed and tested in close collaboration with our project partners Leo DiCarlo (TU Delft, QuSurf project) and Andreas Wallraff (ETH Zurich, QuSurf and OpenSuperQ projects). The QCCS integrates 3 building blocks: The HDAWG Arbitrary Waveform Generator to provide the control pulses for qubit gates. The UHFQA Quantum Analyzer to readout and discriminate the quantum states. And the PQSC, Programmable Quantum System Controller, which completes the control system by ensuring the synchronization of all channels, fast gate operation, and reliable real-time execution of algorithms. The quantum scientists can work both on waveform-level or connect to higher levels of the quantum stack like the Qiskit framework, which is natively supported by the QCCS.

Invited Talk FM 51.6 Wed 15:40 Aula

Approach and use cases: When and where may we start to search for quantum applications? — •Tim Leonhardt — Accenture

From application perspective quantum computing maturity evaluations and derived predictions are challenging: Hardware benchmarks are plentiful and improvements are - arguably "doubly-exponential" - rapid. Strategies with quantity or quality focus enabled magnetic phase transition or chemical accuracy molecular simulation. In parallel "Software" with an algorithm landscape from heuristics to "big-O" reduces resource requirements, generating "quantum-inspired" solutions alongside. On user-side the stage for QC applications needs to be set identifying business value-added use cases and translating into QC problem archetypes followed by implementation challenges similar to ML applications. The time of fruitful intersection of the QC advent and application readiness period depends on full-stack development and work in a partner network illustrated by a use case, model and solution approach in optimization.