Future of Computing

Topic Coming Soon

C. Kutter
Executive Director
Fraunhofer EMFT, Munich, Germany

Fraunhofer EMFT

Abstract
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Future Computation Technology from Cryogenics Point of View

D. Gunnarsson
Chief Technology Officer
Bluefors, Leadership Team | Development,
Helsinki, Finland

Abstract
Cryogenics have long been an enabling technology for a wide field of research, and more recently in quantum computing with the potential to revolutionize the world and solve problems with use in all aspects of life. Cryogenics are a very integral part of the value chain by cooling the components and making sure that we can create systems that are producing a scalable way to give reliability and to increase predictability.

Biography
David Gunnarsson, CTO, leads Bluefors' cryogenic development
for the quantum technology community.
He holds a Ph. D. degree from Chalmers University of Technology, Sweden, 2005, on his work on the Josephson junction based quantum bits.
After his Ph. D. he continued research at Low Temperature Laboratory, Helsinki University of Technology (2005-2008) and prior to joining Bluefors, he worked as a Senior Scientist at VTT Technical Research Centre of Finland (2008-2015).
With his background in both microfabrication and cryogenic measurements of superconducting quantum circuits, he has a broad understanding of the future requirements in cryogenics for the quantum computation field.

A Research Fab to Enable and Scale Quantum Computing

T. Rom
Senior Expert - Quantum Technologies and Cooperations
Fraunhofer Group for Microelectronics, Berlin, Germany

Abstract
Quantum computing promises to revolutionise the computing landscape by exponentially accelerating complex calculations in areas such as material simulation, optimisation and artificial intelligence. However, significant scientific and technological challenges still need to be overcome before its application potential can be realised.

Nano- and microelectronics as well as photonics are playing an increasingly important role in tackling these hurdles. On the one hand, their advanced design and manufacturing processes enable successive improvements in the quality and scaling of qubit systems. On the other hand, they provide important enabling technologies, like those needed to precisely control and read out different types of physical qubits.

This talk will address the main challenges in the development of quantum computing hardware. Specific highlights will be used to illustrate how microelectronics can help to overcome these challenges at all system levels, thus driving further hardware scaling and integration. It will also show how the Research Fab Microelectronics Germany (FMD), with its new extension module for quantum and neuromorphic computing (FMD-QNC), can support agile research and development in this field.

Although the focus of the talk is on quantum computing, it will be shown that developments in quantum hardware can also benefit from the latest progress in adjacent fields such as neuromorphic computing, and even unrelated applications such as animated holography. This will highlight the synergies arising from advances in microelectronics and its sophisticated manufacturing processes.

The joint project "FMD-QNC" is funded by the German Federal Ministry of Education and Research (BMBF).

Biography
Professional:

Dr Tim Rom is currently working as a Technology and Collaboration Expert at the Research Fab Microelectronics Germany (FMD). In this role, he is responsible for coordinating the technical aspects of FMD's new extension module for quantum and neuromorphic computing. His main focus is on technology scouting for quantum computing hardware, identifying promising solutions along the entire microelectronics value chain and initiating new collaborations. He is dedicated to helping research and industry partners find cutting-edge microelectronic solutions to their quantum hardware development challenges.

Prior to his current position, Dr Rom was based at the headquarters of the Fraunhofer-Gesellschaft, where he was responsible for research management in the area of Next Generation Computing (NGC). In this role, he coordinated and drove cross-organisational strategy development, collaborative research activities and agenda setting for the NGC initiative.

Dr Rom also has five years' experience as a technology consultant in the automotive industry. During this time, he worked as a quality and test manager in the field of connected vehicles, ensuring the security of the IT infrastructure and the safe introduction of new digital car connectivity services in global markets.

Academia:

Dr Rom spent two years as a postdoctoral researcher at the Max-Planck-Institute for Quantum Optics near

Munich, where he focused on the experimental study of quantum many-body systems in artificial crystals made of laser light.

Tim Rom received his PhD summa cum laude from the Ludwig-Maximilians University in Munich (LMU). His research involved the generation and full quantum control of single isolated molecules, and he designed and built a new apparatus at the University of Mainz for the quantum simulation of solid-state and many-body physics in optical lattices.

He studied at the University of Freiburg and the Technical University of Munich, culminating in a thesis on the development of an "atom chip" for the transport of ultracold atoms.

Throughout his academic career, he has published several important papers in high-impact journals, including first author papers in Physical Review Letters and Nature.

About the Research Fab Microelectronics Germany and its new Module for Quantum and Neuromorphic Computing (FMD-QNC)

The Research Fab FMD has launched its new extension module, FMD-QNC, which supports the development of quantum and neuromorphic computing hardware in Germany and Europe. The consortium comprises 19 institutions, including institutes of the Fraunhofer Society and the Leibniz Association, as well as the Forschungszentrum Jülich and AMO GmbH. FMD-QNC offers research groups, start-ups and industrial companies access to state-of-the-art microelectronics facilities and process know-how.

FMD-QNC supports the development of a wide range of quantum and neuromorphic computing hardware with tailor-made technologies and processes from various fields such as nanotechnology, microelectronics, optics and photonics. In addition to manufacturing and pilot production capabilities, the range of services includes design, simulation, system integration, test and evaluation to deliver solutions that meet the demanding requirements for system scale-up and subsequent transfer to industry.

The Research Fab offers technological breadth, quality and agility through a networked clean room infrastructure and advanced machinery. The joint business office facilitates coordination between all partners to provide optimal solutions for academic and industrial users.

Funded by the German Federal Ministry of Education and Research (BMBF), the FMD-QNC project is an important step towards the development of next-generation computers in Germany and Europe.

Neuromorphic Computing for Autonomous AI Systems – the NeuroSys Cluster4Excllence in the Aachen Region

M. C. Lemme
Managing Director
AMO GmbH, Aachen, Germany

Abstract
AI as software dominates areas such as computer vision and speech processing. However, innovative new hardware concepts are needed to sustainably realize applications such as autonomous driving, personalized healthcare, smart cities, the Internet of Things, and Economy 4.0, because conventional computer hardware is increasingly hitting inherent limits in energy efficiency for AI applications. The regional cluster NeuroSys aims to overcome these limits by developing neuro-inspired hardware that can revolutionize AI systems in terms of energy efficiency and performance.

NeuroSys collects a broad spectrum of experts who initiated an integrated and sustainable research and transformation process through interdisciplinary research and development: physicists, engineers, and material-, neuro-, and computer scientists collaborate with economists, ethicists, and sociologists on innovations that are not only technologically advanced but also economically viable and socially useful and desirable. RWTH Aachen University, as the coordinator and nucleus, works closely together with the Helmholtz Institute Forschungszentrum Jülich and the Johannes Rau Institute AMO GmbH. Regional start-ups and companies complete the cluster, while global corporations and internationally renowned scientists make up the advisory board.

I will present our goals and approach to maximize the impact of our cluster and showcase selected socio-technological highlights of our activities throughout the first two years.

This work has received funding from the German Ministry of Education and Research (BMBF) through the Clusters4Future NeuroSys (03ZU1106xx).

Biography
Max Lemme is a Full Professor at RWTH Aachen University and Scientific Director of AMO GmbH, a non-profit nanotechnology company in Aachen, Germany. He is a co-founder of Black Semiconductor GmbH, Aachen.

Lemme obtained his Ph.D. degree (Dr.-Ing.) on nano-CMOS field effect transistors like FinFETs and ultra-thin SOI-MOSFETs from RWTH Aachen University in 2004. He has since worked on high-k /metal gate integration, and electronic, optoelectronic and nanoelectromechanical devices based on graphene and related 2D materials, Perovskites, and phase change materials, and their integration into the silicon technology platform. His work includes the world's first top-gated graphene MOSFET, graphene-based non-volatile memory, vertical graphene hot electron transistors, graphene NEMS, ion-based memristive switches from molybdenum disulfide and silicon photonics-integrated Perovskite Lasers.

Lemme received the "NanoFutur" young researchers' award from the German Ministry for Education and Research in 2006 and a Lynen Research Fellowship from the Alexander von Humboldt Foundation in 2007. From 1998 to 2008, he worked at AMO, where his last position was as Head of the Technology Department. In 2008, he joined Harvard University in Cambridge, USA, where he pioneered a helium ion-based nanolithography method for graphene and investigated graphene photodetectors. In September 2010, he became a Guest Professor at KTH, where he initiated graphene activities within the School of ICT. He

received an ERC Starting Grant and a Heisenberg Professorship funded by the German Research Foundation (DFG) in 2012 and joined the University of Siegen, Germany as a Full Professor in the same year. In February 2017, Lemme was appointed Full Professor at RWTH Aachen University and Scientific Director of AMO GmbH. In 2018, he received an ERC Proof of Concept grant, which contributed to the founding of Black Semiconductor. He has managed numerous national and international research projects with academic and industrial partners. Recently, his research interests include materials and electronic devices for quantum and neuromorphic computing. Lemme is the coordinator of the Cluster “NeuroSys – Neuromorphic Computing for Autonomous Artificial Intelligence Systems”, one of 14 Clusters4Excllence funded by the German Ministry of Education and Research.

Challenges and Technologies towards Secure Embedded Systems and Trusted Electronics

M. Hiller
Head of Department Hardware Security
Fraunhofer Institute for Applied and Integrated Security AISEC, Garching, Germany

Fraunhofer AISEC

Abstract
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Biography
As Head of Department Hardware Security at Fraunhofer AISEC, Matthias Hiller is driving applied research on secure embedded systems and trusted electronics in customer projects and publicly funded research. Matthias Hiller holds a PhD in electrical engineering and information technology from the Technical University of Munich and a Diploma degree from Ulm University. In particular his research interests are in the area of secure implementations, tamper protection and physical unclonable functions.