Title: Quantum Physics for Technology: How and why?

Abstract
In the quantum technology session you will hear four speakers, each with a very different perspective, explain their work in quantum science. Prof. Erik Bakker (TU Eindhoven) and Prof. Gary Steele (TU Delft) will report on their research how to grow, build and manipulate some of the best possible solid-state qubits. Then our speaker Dr. Stacey Jeffrey (QuSoft Amsterdam) will tell you what to use these qubits for, namely to run quantum algorithms which outperform classical computing. Last but not least, Dr. Carmina Almudever (TU Delft) will show how the hardware can meet the software, namely through the design of a quantum computer architecture.

Conveners: Barbara Terhal (TU Delft) and Joel Klassen (TU Delft)

Speakers (In order of appearance)

Gary Steele (TU Delft)
Title: Quantum circuits 101: How a superconducting qubit works and what we can use it for
Abstract: Superconducting circuits have emerged recently as the preferred platform for industrial quantum computing, in particular with the recent announcement of the 50 qubit machine from IBM. Sounds very cool, but what are these qubits? How do they make them and how do they work? In this talk, I will introduce the basics of superconducting qubits and discuss their applications in quantum information technologies and in experiments exploring new regimes of physics.

Erik Bakkers (TU Eindhoven, TU Delft, QuTech and Kavli Institute of NanoScience)
Title: Bottom-up grown nanowire quantum devices
Abstract: Signatures of Majorana's have been obtained in devices based on InSb nanowires coupled to a superconductor [1]. Different schemes for uncovering their non-Abelian statistics are proposed, for which a nanowire network assembly is needed. Here, we demonstrate a generic process by which we can design any proposed nanowire network device by manipulating an InP substrate and thereby the nanowire growth position and orientation [2]. Nanowire "hashtag" structures are grown in which phase coherent transport is demonstrated by the Aharonov–Bohm (AB) effect. In addition, we can in-situ grow Al islands on the nanowires, resulting in a quantized Majorana signal [3].

1. V. Mourik et al., Science 2012, 336, 1003
2. S. Gazibegovic et al. Nature 548 2017, 434
3. H. Zhang et al. Nature 2018, accepted

Stacey Jeffery (CWI and QuSoft)
Title: What could we do with a quantum computer?
Abstract: Quantum computers have the potential to bring about the next revolution in computing. While they can't be used to solve every problem faster than a normal computer, there are a number of surprising areas of computation where quantum computers seem to have a significant advantage. In this talk, I will describe:
- why we hope to solve some problems faster with a quantum computer;
- why figuring out which problems, and how, is hard;
- some problems where quantum computing has already been found to have an advantage.

Carmen G. Almudever (QuTech, TU Delft)
Title: An architecture for a quantum computer
Abstract: Quantum computing is a radical technology that promises to bring an exponential performance increase over conventional computers for various class of computationally complex problems. However, for quantum computing to become a mainstream application platform different challenges need to be addressed such as the development of a system architecture. In this talk, we will discuss what the different system layers are and how they relate to each other.