

## ML4Q Platforms for Quantum Technologies course 2026

20 – 27 February 2026

### Overview

Date	Topic	Lecturer	Location
Fri 20.02.	Introduction to Quantum Information and Algorithms	Markus Müller	FZJ
Mon 23.02.	Quantum Optics for Quantum Computing: Theory and Experiment	Daqing Wang & Simon Jäger	Bonn
Tue 24.02.	Introduction to graphene and related 2D materials for quantum technologies	Christoph Stampfer	Aachen
Wed 25.02.	Introductions to anyons & Basics of quantum circuits	Erwann Bocquillon & Xhek Turkeshi	Cologne
Thr 26.02.	Quantum resources and Out of equilibrium phenomena	Andrea Nava	Düsseldorf
Fri 27.02	ML4Q Technology & Career Day		Cologne

The exact schedule will be slightly different for each day, but usually classes will start around 10:00 and finish around 17:00 and there will be a lunch break.

The **presentations** for the graded assessment are planned for the week of **23–27 March**. Exact dates will be provided later.

### Content Overview

#### Day 1, 20.02.2026 (FZJ)

On this day students will get a brief hands-on introduction to quantum information and quantum circuits. We will discuss ingredients of quantum algorithms, and in particular Grover's quantum search algorithm. Furthermore, we will introduce basic theoretical concepts and recent experimental breakthroughs in quantum error correction, which will be crucial to protect future scalable quantum computers against noise. In addition, a joint lunch, lab tours and discussions with other quantum technology research groups at Forschungszentrum Jülich are planned.

## Day 2, 23.02.2026 (Bonn)

During this day, we explore ways to interface photons with atoms and molecules for the realization of tailored qubits. We will introduce the fundamentals of strong light–matter interactions, where individual photons interact strongly with internal and external degrees of freedom of matter. We will use this formalism to treat realistic atomic and molecular systems and discuss how to achieve quantum control of these systems for quantum computing using light. After that, we will give an overview on ML4Q projects done in Bonn followed by lab tours and a Meet & Greet poster session with the Bonn PhD students.

## Day 3, 24.02.2026 (Aachen)

This day of the ML4Q Platform course introduces students to the physics and implementation of spin qubits in solid–state systems, with a focus on silicon and graphene–based devices. Participants will learn how electron spins can be initialized, manipulated, and read out, and how device design and materials affect coherence and control. The course provides a conceptual and experimental overview of quantum dots as building blocks for scalable quantum architectures. In addition, it highlights the emerging role of two–dimensional (2D) materials and van der Waals heterostructures for quantum technologies, discussing their unique properties, fabrication techniques, and integration potential. Through lectures and discussions, students will gain insight into current challenges and opportunities at the intersection of materials science and quantum computing.

## Day 4, 25.02. 2026 (Cologne)

The aim of this day is to introduce students to two notions of quantum computation. First, we will discuss quantum circuits, sampling and understand how one can accurately define and benchmark quantum advantage, with case studies on recent articles. Second, we'll present basics of anyon, quasiparticles which underpin topological quantum computation, and present experimental efforts. In addition there will be a poster session and lab tours from ML4Q groups

## Day 5, 26.02.2026 (Düsseldorf)

On this day, two main topics will be discussed. First, we introduce the general idea of quantum resources – features that can be used to perform or enhance quantum tasks. Examples include entanglement, magic, or generalised measurements (POVMs). We illustrate how such resources can be identified and used in practice. Furthermore, we discuss exotic nonequilibrium phenomena in open quantum systems, such as the Mpemba effect and dynamical phase transitions. Finally, we show how nonequilibrium dynamics can be implemented to characterize topological phase transitions. The day includes regular seminars, as well as a poster and discussion session with PhD students and postdocs.

## Day 6, 27.02.2026 (Cologne)

**ML4Q Career & Technology Day** – on the final day, course participants, together with ML4Q early career researchers will have a chance to explore diverse career paths in quantum technologies and learn how to prepare for opportunities beyond academia. The program includes also a panel discussion, exploring the unique challenges faced by quantum technology companies of all sizes, from startups to established players (confirmed participants: representatives of IBM, Infosys, Arque Systems and duotec). The panel will address topics such as scaling innovations, securing funding, and navigating regulatory landscapes. The discussion aims to provide practical insights into overcoming these hurdles while fostering collaboration across the ecosystem. Young scientists will gain valuable perspectives on how their research can translate into impactful solutions within this rapidly evolving industry.

## Schedule

Friday 20.02.2026– Introduction to Quantum Information and Algorithms (FZ Jülich)	
10:15	Pick-up of visiting students from Hauptwache (Main Entrance)
10:30 – 10:40	Welcome Short Overview of Week and Day Programme
10:40 – 11:40	Morning Lecture: Introduction to Quantum Information, Computation and Algorithms covering: <ul style="list-style-type: none"> <li>- High level motivation</li> <li>- Dirac notation and quantum circuit model</li> <li>- Complexity classes, Grover algorithm</li> </ul>
11:40 – 11:50	Coffee Break
11:50 – 12:30	Talks by FZJ Researchers
12:30 – 14:00	Joint Lunch at Seecasino
14:00 – 14:20	Lab visit/ talk by FZJ Researcher
14:30	Coffee Break
14:45 – 15:30	Afternoon Lecture Introduction to Quantum Information, Computation and Algorithms covering: <ul style="list-style-type: none"> <li>- Basic Quantum Error correction with the 3-qubit repetition code and topological codes</li> </ul>
15:50 – 16:20	Lab visit/ talk by FZJ Researcher
16:30	Departure

# ML4Q MATTER AND LIGHT FOR QUANTUM COMPUTING

Cluster of Excellence ML4Q • Pohligstr. 3 • D-50969 Cologne • Germany • <https://ml4q.de>

Monday 23.02.2026- Quantum Optics for Quantum Computing: Theory and Experiment (Bonn)	
10:00 – 11:30	Lecture: Theory of Strong Light-Matter Interactions
11:45 – 13:00	Lecture: Applications of Light-Matter Interactions in Quantum Technologies
13:00 – 14:00	Lunch Break
14:00 – 14:30	Short Presentations: ML4Q Research in Bonn
14:45 – 16:00	Lab Tours (Two sessions of 25 min each)
16:00 – 17:30	Meet & Greet Poster Session: Theory & Experiment

Tuesday 24.02.2026 – Introduction to graphene and related 2D materials for quantum technologies (Aachen)	
10:00 – 12:30	Lectures: by Christoph Stampfer and Vincent Mourik (title TBA)
12:30 – 14:00	Lunch break
14:00 – 16:00	Lab tours

Wednesday 25.02.2026 – Introductions to anyons & Basics of quantum circuits (Cologne)	
10:00 – 12:00	Lecture: Sampling quantum circuits & Benchmarking quantum advantage – Case study of the recent Google papers
12:00 – 13:30	Lunch break
13:30 – 15:30	Lecture: Introduction to anyons
15:30 – 17:00	Lab tours & poster session

Thursday 26.02.2026 – Quantum resources and Out of equilibrium phenomena (Düsseldorf)	
10:00 – 12:00	Lecture: Resources in quantum information
12:00 – 13:30	Lunch at the mensa
13:30 – 15:30	Lecture: Anomalous relaxation dynamics in open quantum systems
15:30 – 17:00	Poster session with PhD students and postdocs



# ML4Q MATTER AND LIGHT FOR QUANTUM COMPUTING

Cluster of Excellence ML4Q • Pohligstr. 3 • D-50969 Cologne • Germany • <https://ml4q.de>

Friday 27.02.2026 ML4Q Career & Technology Day (Cologne) Organised together with EINQuantumNRW, Gateway Exzellenz Start-up Centre UoC & enaCom Transfer Centre at the University of Bonn	
10:00 – 11:05	Career Talks by ML4Q Alumni
11:05 – 11:30	Coffee Break
11:30 – 12:00	Career Talk
12:00 – 12:30	Preparing for career outside academia – personal lessons & practical advice
12:30 – 13:45	Lunch & Networking
13:45 – 16:30	Challenges in Quantum Technologies Industry – how can scientists contribute to finding solutions: Introductory Talks by BÜSRA KÖSOĞLU-KIND (IBM) & Dr. GOPAKUMAR GOPALAKRISHNAN (Infosys) Panel discussion: What are the challenges scientists could help with?