

Quantum

Research Center

**Driving
quantum
advantage**

21st century quantum technology

Deep in the heart of the UAE, in Abu Dhabi, the race is on to build the MENA region's most advanced quantum technologies – and the Technology Innovation Institute (TII) is leading the way. Our pioneering Quantum Research Center (QRC) has been created to develop world-class quantum theoretical and explorative research by building and operating the first quantum computer in the region while advancing quantum communications and quantum sensors.

Today, as we stand on the edge of a new era of computing, quantum devices will help unlock solutions to some of the most intractable challenges – from drug discovery and medicine to investigating new materials and powering the artificial intelligence revolution. A new generation of ultra-precise quantum sensors will bring the means to enable GPS-deprived navigation. Communications will remain safe against quantum attacks with the implementation of quantum cryptography. QRC aims to develop world-class quantum technologies building on the expertise of an international team of leading researchers.

Who We Are

The Quantum Research Center (QRC) drives the research and development of quantum technologies in the region. Led by globally recognized experts in the field, we are inspired by our vision of quantum technologies that identifies the multiple positive applications our work can have in industries and scientific disciplines far beyond our core areas of focus.

QRC is part of the Technology Innovation Institute (TII), a global scientific research center attracting the world's foremost scientists and researchers. TII leads worldwide advances in artificial intelligence, autonomous robotics, quantum computing, cryptography and quantum communications, directed energy, secure communication, smart devices, advanced materials, and propulsion and space technologies, and biotechnology fields.

TII belongs to the Abu Dhabi Government's Advanced Technology Research Council (ATRC), which oversees the technology research in the emirate.

What We Do

We develop state-of-the-art, next generation quantum technologies such as quantum cryptography, quantum communications and quantum sensing. We conduct basic research and partner with other scientific institutions to pioneer new projects.

We operate a full-stack approach to quantum computation based on superconducting circuits, crafting ultra-precise quantum sensors that exploit the levitation properties of microscopic objects, and designing entanglement distribution for quantum communication to provide real-life quantum cryptographic solutions.

Operating at the edge of science

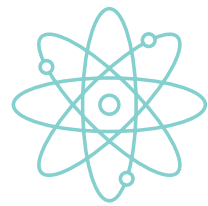
QRC is an international center of excellence for research into quantum technologies. Led by a globally recognized expert, we are dedicated to achieving a 'Quantum Advantage' in computing that will transform the power and scope of computers. QRC operates at the very edge of science – on the smallest scale... and in one of the coldest places on earth.

Pioneering projects

At TII, QRC is developing a new generation of quantum technologies, from quantum cryptography and quantum communication to quantum sensors. Designed as a hub of quantum technology in the region, it works on basic science and beyond, partnering with industry leaders to pioneer new projects.

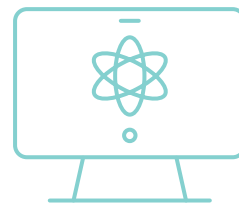
Our core research areas

QRC works on multiple research areas in fundamental as well as applied science disciplines.



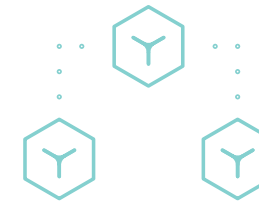
Quantum physics

The Quantum Physics group investigates quantum matter for quantum technology. We study quantum correlations and entanglement in many-body theory, with specific applications to quantum gases spatially confined in low-dimensional structures, atomtronics, mesoscopic networks, and superconducting circuits. In close contact with experiments, we conceive quantum devices and sensors characterised by enhanced control and flexibility of their operating conditions. At the same time, we investigate fundamental aspects of the quantum phases of matter.



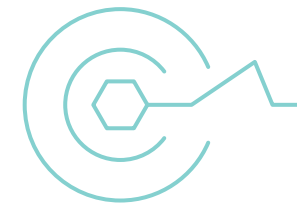
Quantum computation

The Quantum Computation group will build and operate the first quantum computer in the region, using superconducting circuits at nearly zero temperature, where quantum correlations survive thermal fluctuations. Qubits, computer architecture and control circuits are being designed in collaboration with other groups at QRC and will be produced in our own on-site quantum foundry.



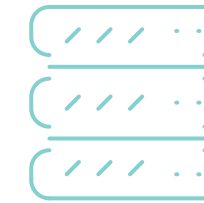
Quantum algorithms

The Quantum Algorithms group focuses on quantum computation theory and applications, with emphasis on the development of quantum algorithms for complex optimisations, machine learning, and many-body system simulations. We are interested in both practical primitives for near-term devices and advanced procedures for future, fully-fledged universal quantum computers. We explore hybrid classical-quantum approaches, neural- and tensor- networks, imaginary-time evolution, quantum signal processing, error correction and mitigation, computational complexity, verification and benchmarking, and quantum-circuit compiling, etc.



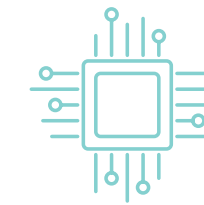
Quantum sensing

The Quantum Sensing group is interested in fundamental studies and technology development of optomechanical sensors. The group's main experimental research line addresses levitated particle sensors under ultra-high vacuum conditions. Levitation and vacuum provide a high level of system isolation, enabling us to probe and use quantum mechanical effects. Our systems are promising candidates for high-end inertial sensors, sensing of minute torques and forces, and chemical sensing, among others. Due to stability demands of real-world sensors, an extension of our research to more robust clamped optomechanical setups is possible.



Quantum middleware

The simulation and control of quantum systems requires the development of dedicated software. The Quantum Middleware group focuses on implementing the code libraries required for efficient quantum algorithms design, classical simulation of quantum computation, and control of quantum devices. The main area of research for the group is the development of Qibo, an open-source software for quantum computing.



Quantum communications

The Quantum Communications group is focused on developing quantum communication devices for tomorrow's networks by building systems that can operate in the real world, outside of the lab. Our research includes the translation of bench-top experiments into chip-scale systems, designing and building entangled photon sources and single photon emitters for next-generation quantum networks. To address near-term challenges in private communication, we also develop quantum key distribution systems, using quantum entanglement to enable ultra-secure communication over fibre and free-space links.

Sharpest minds, toughest questions

QRC brings together a team of the sharpest minds from across the global quantum community to investigate the toughest questions and respond to critical challenges while always following strict ethical principles.

Innovation for a better world

TII helps build a better world by developing the most advanced, transformative technological innovations designed to benefit society. As a key component of the Abu Dhabi Government's Advanced Technology Research Council (ATRC), it promotes a culture of exploration with the aim of establishing Abu Dhabi and the UAE as an R&D hub and one of the next global leaders in breakthrough technology solutions.

Advancing quantum computation

Quantum computation is the gateway to a new world of problem-solving, addressing complex challenges of an entirely new order. Operating at the very edge of known science – on the smallest scale and in one of the coldest places on earth – TII's QRC offers limitless opportunities for research and fresh scientific discovery.



QRC's primary mission is to construct the first quantum computer in the MENA region. Taking a full-stack approach, we are also developing the quantum algorithms and middleware to run on our quantum device.

Quantum Research Center



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