Press Dossier

Mobile World Congress 2022

February 28 - March 3, 2022
Barcelona, Spain

Index

QUANTUM FLAGSHIP

The European Quantum Space

ABOUT

The world is moving at full speed, pushing forward an amazing wave of novel and disruptive technologies that will change the way we see, move, behave and even communicate. We are at a point in time where those technologies, eager to emerge, will signify a paradigm shift in how we view our place in this world, opening a whole new realm to our understanding of the human being from the inside and out: how it interacts and connects with its environment and other elements.

This year, from February 28th to March 3rd, the Mobile World Congress 2022 (MWC) will host The European Quantum Space, a zone dedicated to showcasing the innovation and development in Quantum Technologies that Europe is driving forward.

Curated by ICFO, the space aims to showcase the latest achievements and advances in the field of quantum technologies, mainly focusing on quantum communication and computing, two of the areas of major interest within the field.

The space, arranged in an area of 70m2, will be located in the 4 Years from Now Hall (4YFN) and staged to host three main areas: The Quantum Flagship, Regional Initiatives and Start-ups/Companies.

Stand 6B2- 4YFN - Hall 6

4YFN Connecting Startups

GSMA MWC™ Barcelona

EXHIBITORS

Quantum Flagship

The European Quantum Flagship Initiative
Quantum Industry Consortium
Quantum Communication's Module
Quantum Simulation Module

Companies

IQM
LuxQuanta
Qblox
Qilimanjaro
Quside

Regional Initiatives

QuantumCAT
Quantum Valley Lower Saxony

QUANTUM FLAGSHIP

The future is Quantum

ABOUT

The Quantum Flagship was launched in 2018 as one of the largest and most ambitious research initiatives of the European Union. With a budget of **€1 billion** and a duration of **10 years**, the flagship brings together research institutions, academia, industry, enterprises, and policy makers, in a joint and collaborative initiative on an unprecedented scale.

The main objective of the Flagship is to consolidate and expand European scientific leadership and excellence in this research area as well as to transfer quantum physics research from the lab to the market by means of commercial applications and disruptive technologies. With over **2000 researchers** from academia and industry involved in this initiative so far, it aims to create the next generation of disruptive technologies that will impact Europe's society, placing the region as a worldwide knowledge-based industry and technological leader in this field.

GOALS

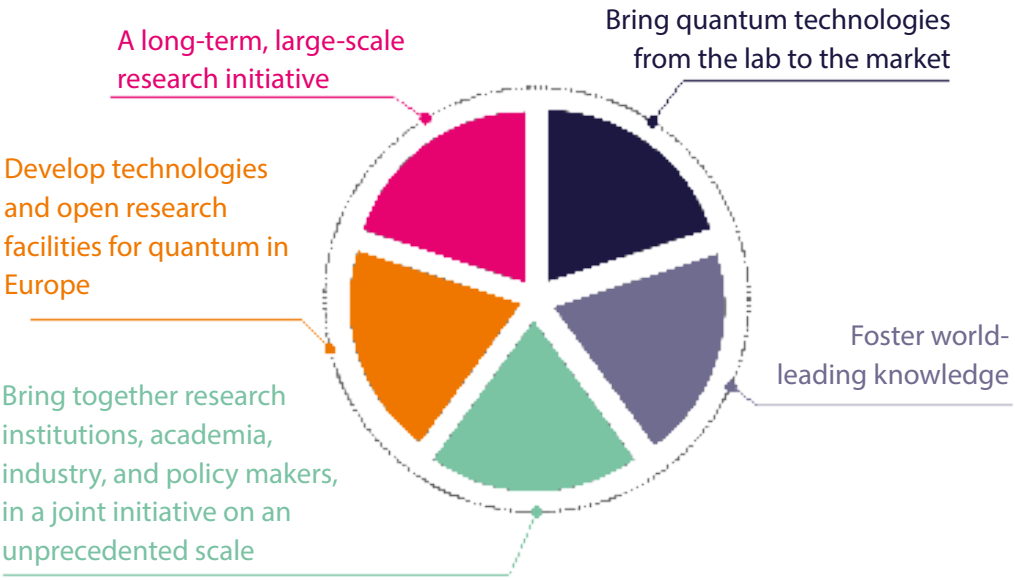
1_ Boost and drive a competitive European quantum industry to position Europe as a leader in the future global industrial landscape

2_ Expand European scientific leadership and excellence in quantum research

3_ Make Europe a dynamic and attractive region for innovative business and investments in quantum technologies

4_ Benefit from advances in quantum technologies to provide better solutions to grand challenges in such fields as energy, health, security and the environment

DRIVE

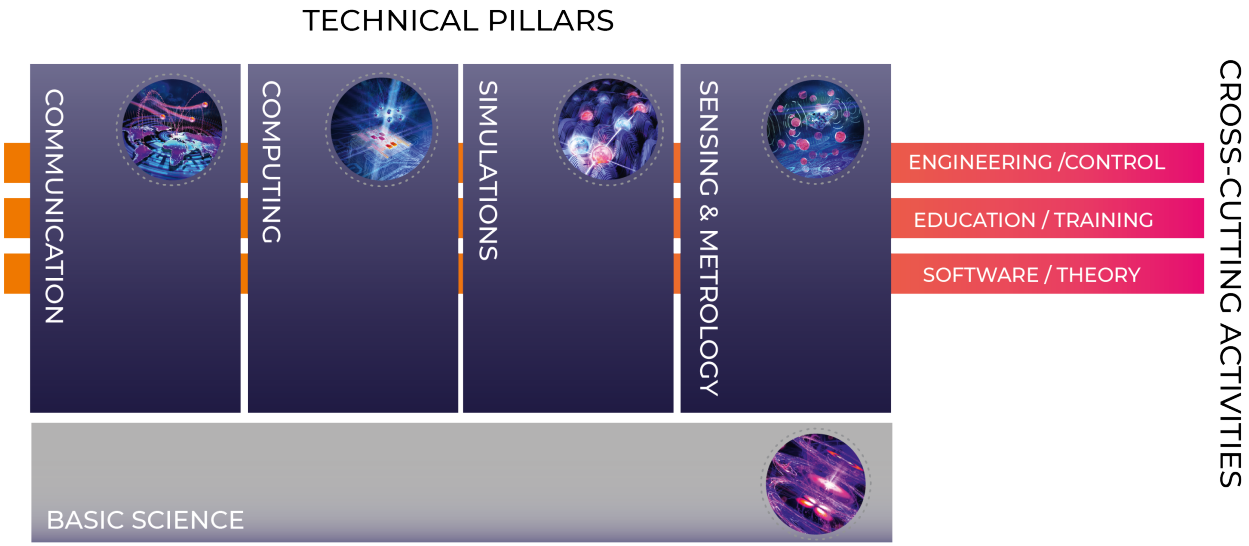


IN NUMBERS

RAMP-UP PHASE 2018-2021

October 2018	2000+	10 years	€1 billion	21 EU-funded projects	€152 million

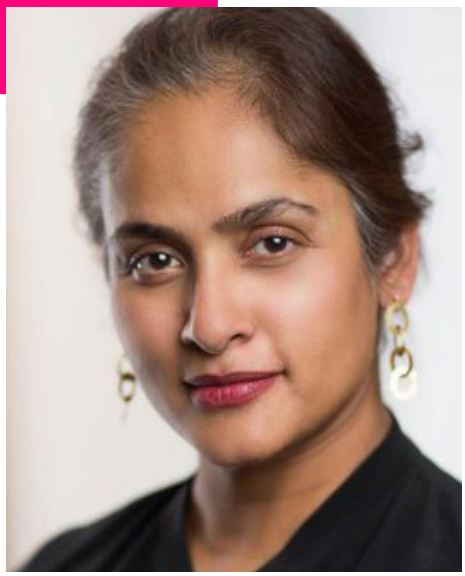
THE PILLARS



Representatives of the Flagship Presentations

"5G Security: A New Threat Landscape"

Monday 28th
14:45-15:30 CEST
Broadcast Stage - Hall 4



Jaya Baloo

Chief Information Security Officer (CISO) at Avast Software

Vice-Chair of the Quantum Flagship Strategic Advisory Board

Jaya Baloo has been working internationally in Information Security for nearly 20 years. In the last few years, she has been named CISO of the year, top 100 CISOs globally, and top 100 Global Security Influencers. Her focus has been on secure network architecture where her work has ranged in areas from Lawful Interception, VoIP & Mobile Security, to designing national MPLS infrastructures, ISP architecture, as well as Quantum Communications networks.

She has worked for numerous telecom providers, Verizon and France Telecom among others, and currently works for KPN Telecom in the Netherlands where she is the Chief Information Security Officer (CISO). A faculty member of Singularity university and a member of various infosec boards, she is always inspired about how much more there is to learn.

As of October 1st, 2019, she has become the Chief Information Security Officer (CISO) for Avast, Czechia

“miXer”

Tuesday March 1st
14:45-15:30 CEST
Networking session & exhibition
Community Club Space

Carlos Abellan

CEO & co-founder of Quside, CiViQ project partner and member of QuIC

Carlos leads the strategic and go-to-market development of the company. He got his PhD in quantum photonics from ICFO, where he developed the quantum randomness technologies that were transferred to Quside. Carlos brings 10 years of experience in quantum and photonics development, is co-inventor of 8+ patent and patent-pending families and co-author of 15+ papers in top journals. He has received multiple awards for his work.

“Frontier Tech Programme (III): Quantum Technologies”

Tueday March 1st
14:45-15:30 CEST
Agora Stage - Hall 6

Vanesa Diaz

Business Development Director at LuxQuanta

Vanesa works as Business Developer Director at LuxQuanta leading the activities related to bussiness development, customer engagement, strategic partnerships and marketing. She has more than 17 years of experience in diverse commercial roles in the optical communication industry where she has built a solid reputation as a communicator with recognized experience at international conferences and industry magazines. Vanesa holds a Masters Engineering Degree in Telecommunications from the University of Cantabria, Spain, and a Master of Business and Marketing from Griffith University, Australia.

REPRESENTATIVES

Valerio Pruneri (Group Leader at ICFO and coordinator of CiVIQ, Partner QuantumCAT)

Valerio Pruneri, project coordinator for CiViQ and partner in QuantumCAT, is an ICREA Industrial Professor, Corning Inc. chair and group leader at ICFO. Previously he worked in industry, Avanex Corporation, formerly Corning OTI and Pirelli Optical Technologies. He has over 50 granted or pending patent families, 100 invited talks at major international conferences in the field of photonics, optical materials, multifunctional surfaces and quantum technologies, an h-index of 58 (Google Scholar). His research at ICFO has so far contributed to three spin-offs (www.quside.com, www.sixsenso.com and www.luxquanta.com) and numerous industrial collaborations with Corporates. For his research and technology transfer effort, he received the Philip Morris Prize, the Pirelli Research Fellowship, the IBM Faculty Award, the Paul Ehrenfest Best Paper Award, the Duran Farell Prize and the Corning Inc. Chair.

Antonio Acín (Group Leader at ICFO and partner CiVIQ, QRANGE, Partner QuantumCAT)

Antonio Acín is ICREA Professor and Head of the Quantum Information Theory group at ICFO since 2008. He obtained his PhD from the University of Barcelona in 2001, and after two years of postdoctoral work at the University of Geneva, he joined ICFO in 2003. His research is primarily focused on new quantum information protocols, with an emphasis on cryptographic applications and methods for characterizing quantum correlations. Dr Acín has been awarded four scholarships from the European Research Council: Starting (2008-13), Proof of Concept (2012-13), Consolidator (2014-19) and Advanced (2020-24) and holds the AXA Chair in Quantum Information Science.

Hugues de Riedmatten (Group Leader at ICFO and partner in QIA, Partner QuantumCAT)

Hugues is ICREA professor and head of the Quantum Photonics group at ICFO since 2010. He obtained his PhD from the University of Geneva in 2003, where he worked as a Principal Scientist until 2010 after a two-year post-doctorate at the California Institute of Technology. His research focuses on the science of experimental quantum information and quantum optics. His group is developing quantum technologies to implement quantum networks and quantum repeaters for long-distance quantum communication, including quantum memories for light, quantum light sources, and quantum frequency conversion (www.qpsa.icfo.es). His research was awarded the City of Barcelona Prize in Experimental Science and Technology in 2017, a Start-up Grant from the European Research Council and a research grant from the Moore Foundation.

REPRESENTATIVES

Samuele Grandi (partner of QIA - ICFO)

Samuele Grandi is a post-doctoral researcher at ICFO. He graduated cum laude from the University of Milan in 2013. During his studies he spent time at the Laboratoire Kastler Brossel - UPMC in Paris, and at the LENS European Laboratories in Florence, where he carried out his Master thesis in the group of Marco Bellini. Samuele received a Marie Curie Early Stage Researcher fellowship to join the group of Ed Hinds at Imperial College London, where he received his Ph.D. in 2017.

During this time he collaborated with several other research groups, including an internship at the NTT Basic Research Laboratories in Japan. In 2018 he received a Marie Curie co-fund fellowship from the Barcelona Institute of Technology to join the group of Hugues de Riedmatten, where he is now based. During his career, Samuele has worked on the generation, manipulation and storage of quantum information in integrated devices, and his results have been published in several peer-reviewed journals. He is now working on the realisation of a quantum repeater, based on solid state quantum memories.

Álvaro Cuevas (Partner of CiViQ- ICFO)

Álvaro Cuevas is a physicist specialized in quantum optics. He obtained his Bachellor and Master degrees in physics at University of Concepción, Chile. Later he received a PhD in physics at Sapienza University of Rome, Italy, where he worked in the group lead by professor Paolo Mataloni. His experience ranges from bulk and integrated photonics for simulation of quantum walks and open quantum systems, to light-matter interaction for polaritonics and fundamental quantum mechanics. He has developed characterization techniques for quantum channels and coherence revival protocols, and also he has worked with fiber optic networks for Bell tests. Currently he has a post-doc position at ICFO as member of the Optoelectronics Group, which is lead by professor Dr. Valerio Pruneri. His work is focused on the development of quantum-enhanced optical microscopy techniques, and quantum generation of random numbers and light modulation in sofisticated materials.

Vito Giovanni Lucivero (Partner of MacQsimal - ICFO)

Gianvito Lucivero is a postdoctoral researcher at ICFO in the Atomic Quantum Optics group, since 2019. He obtained his PhD at ICFO in 2016 and subsequently did a postdoctoral stay until 2019 at Princeton University. His research focuses on Metrology and Quantum Detection, Optical Magnetometry, Spin Noise Spectroscopy, Quantum Optics and Atomic, Molecular and Optical Physics.

REPRESENTATIVES

Dr. Lydia Sanmartí-Vila - (PhD), KTT Outreach coordinator at ICFO

She is ECOP's Executive Officer, where she coordinates the pursuit of new projects for ECOP to encourage collaboration among the centres. She manages ICFO's international outreach projects and activities, such as the Quantum Flagship, CARLA, GoPhoton!, LIGHT2015 and PHABLABS 4.0. She has a degree in chemistry from the Autonomous University of Barcelona and a doctorate in neurobiology from the Otto von Guericke University (research performed at the Leibniz Institute for Neurobiology) in Germany. She has extensive professional international experience having worked at the Memorial Sloan Kettering Cancer Center, the strategic communications firm Euro RSCG Life NRP and the management consulting company Deloitte.

Alina Hirschmann - Science communication officer & media relations - ICFO

Alina holds a double B.Sc. degree in Physics and Astrophysics from Florida Institute of Technology- FloridaTech, USA. In 2009, she obtained her PhD degree in Astrophysics from the Polytechnical Univeristy of Catalonia - Barcelona UPC (Barcelona), through the Institute of Space Studies of Catalonia (IEEC). In 2018, she obtained a Master degree in Communication Management..She has focused her career in Science Communication, a position that she has held since 2009. She is currently a science communication and media relations officer at ICFO, and coordinates the Communication and Dissemination work packages of more than 10 European projects.

Marta Martín - Science Communication officer at ICFO

She holds a BSc in Biology from the Autonomous University of Barcelona, an MSc in Neurosciences from the University of Barcelona and a postgraduate degree in Science Communication. She started her career as a PhD researcher in evolutionary biology and animal behaviour in Barcelona and the Netherlands. She has communicated and disseminated science at the University of Barcelona and associated research institutes. At ICFO, she is a science communications officer for European Projects and the Quantum Flagship

COMPANIES AND START-UPS

Building the next generation of quantum computers with unparalleled know-how

MISSION

We are building world-leading quantum computers for the well-being of humankind, now and for the future.

IQM is the Pan-European category leader in building quantum computers. IQM delivers on-premises quantum computers for supercomputing centers and research laboratories and provides complete access to its hardware. For industrial customers, IQM delivers quantum advantage through a unique, application-specific, co-design approach.

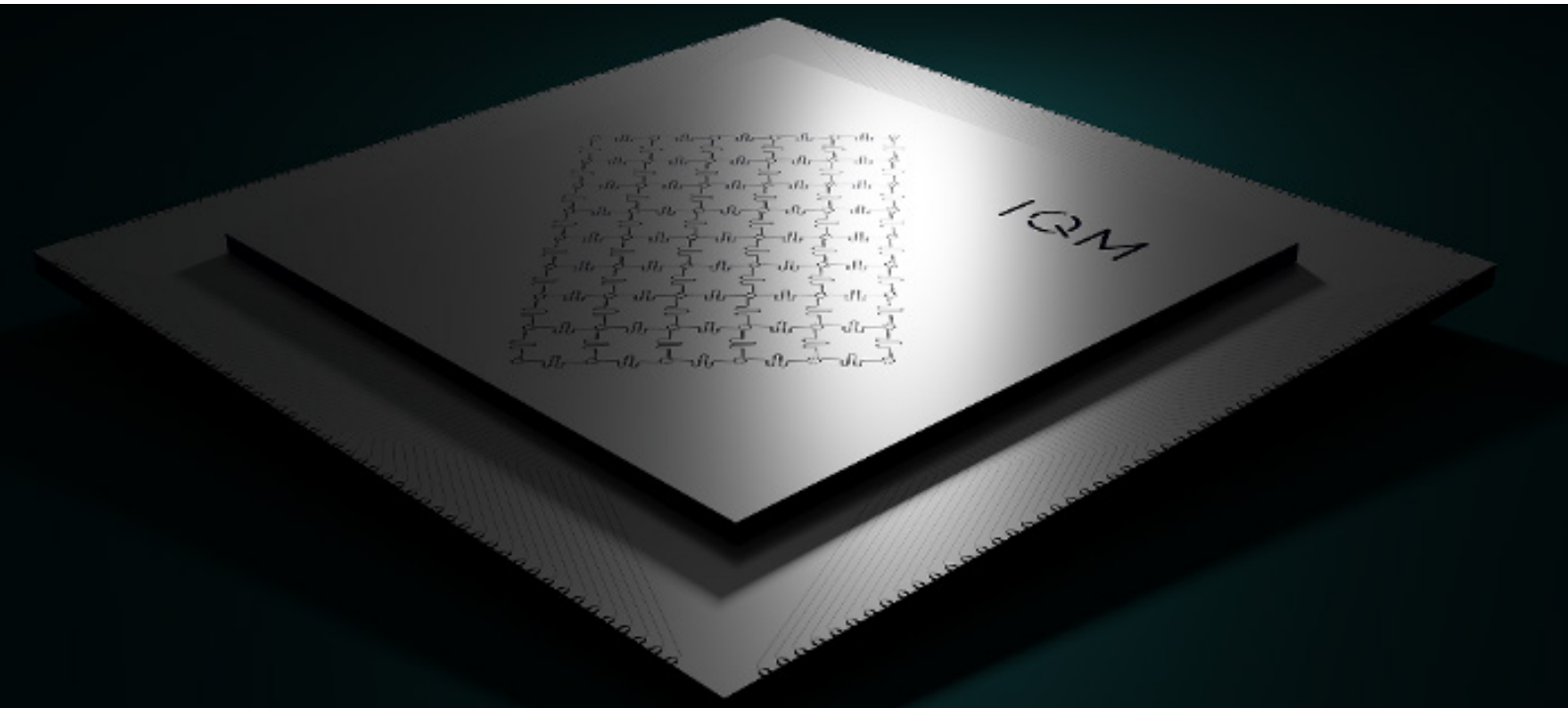
meetiqm.com

OUR STORY

IQM was founded by a highly ambitious team of world-leading scientists having built several successful quantum labs and research centers globally during the past two decades.

The team's pioneering work started with breakthroughs in qubit reset, readout, and thermal management towards large-scale quantum processors. Since then, the work has progressed to unique hardware advantages and novel concepts around digital-analog quantum computing.

Our Nordic values and the vibrant ecosystem gives us a unique advantage in building the future of quantum technologies.



REPRESENTATIVES

Jani Heikkinen (Head of Business Development)

Jani leads IQM's global business development at IQM Quantum Computers. IQM provides on-premises quantum computers and is a leading European quantum computing company for superconducting quantum computers. Jani has an extensive experience from Intel, where he worked as Account Executive for various multinational companies almost 10 years, as well as from Nokia and Ericsson, where he has worked in R&D. Jani has MBA from IE Business School and M.Sc. Engineering in Electrical Engineering from the University of Oulu.

Hong-Mai Nguyen (Marketing Specialist)

Mai is a Marketing professional with a proven track record of building global brands for DeepTech companies. Her current role is Marketing Specialist at IQM Quantum Computers, a Pan-European leader in superconducting quantum computers. She is actively engaged in topics related to branding and communications, including employer branding, social media content creation, marketing design, and event management.

Peter Eder (Head of Partnerships)

Peter leads global partnerships relations at IQM Quantum Computers. IQM provides full-stack quantum computer solutions and is the leading European quantum computing company for superconducting quantum computers. Peter has more than 20 years of experience in management and business development in small and medium economies.

He was leading teams in big change projects at Accenture and Carl Zeiss SMT, involving heavy outsourcing of R&D work. Peter has a diploma in computer science from Paris Lodron Universität Salzburg and a PhD in physics from TU München.

LUXQUANTA

Bringing Quantum Safe Cryptography to the Digital Data World

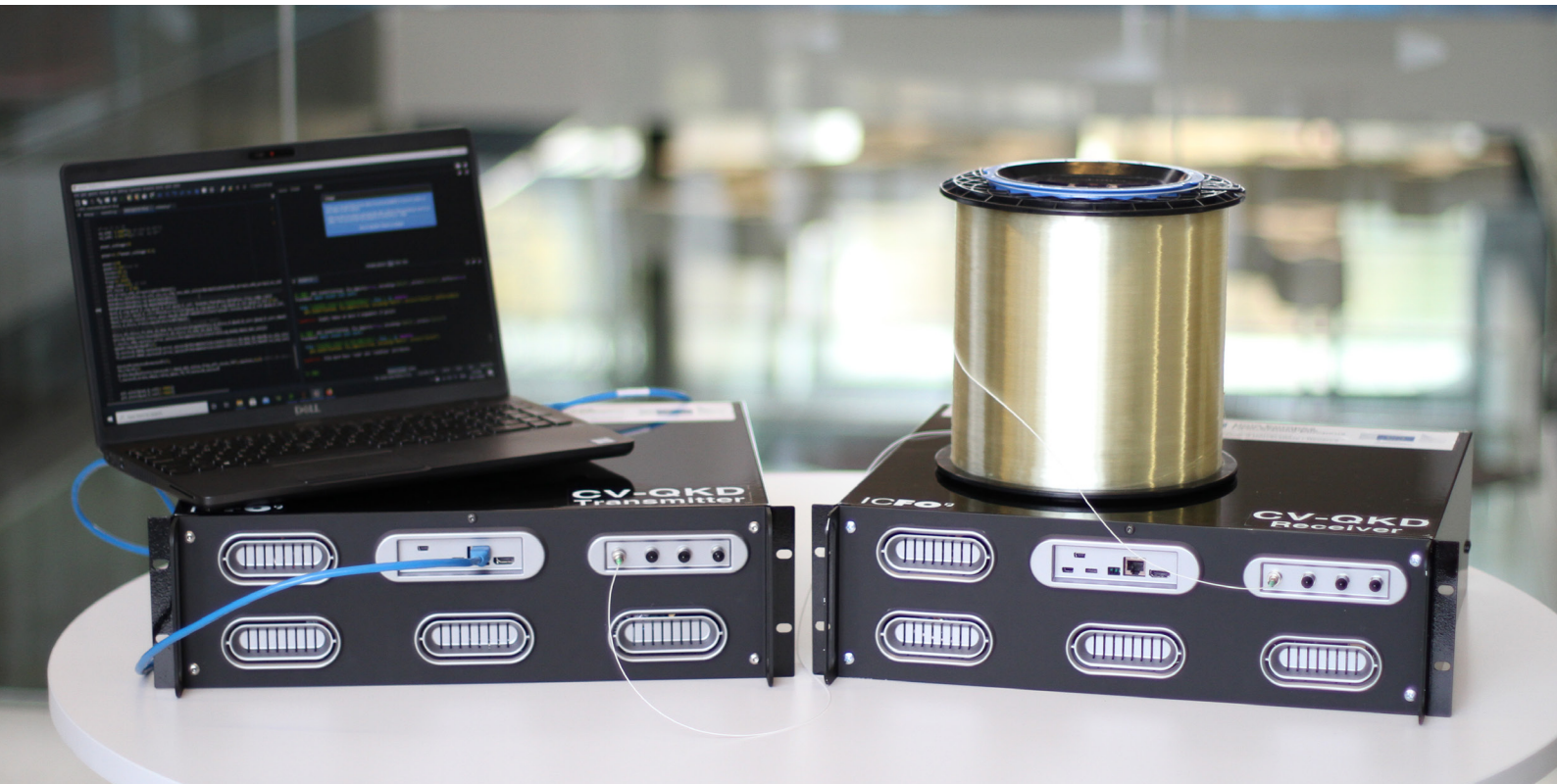
MISSION

LuxQuanta aims at providing high-performance and cost-effective quantum cryptography solutions, including continuous variable quantum key distribution systems, to implement an extra layer of security services for companies and network infrastructures.

OUR STORY

exploits the unique properties of quantum physics to provide cryptography solutions to implement an extra layer of security for companies and telecommunication networks

LuxQuanta.com



REPRESENTATIVES

Sebastian Etcheverry (CEO, Founder)

Sebastián Etcheverry is Founder and CEO of LuxQuanta. He obtained his PhD at the Royal Institute of Technology (KTH) in 2017. He has worked on high-dimensional quantum key distribution, experimental tests of quantum contextually, and tomography of quantum states. During his PhD, he developed optical fibre technologies for electro-optic modulation and life-science applications. His current research is focused on the development of a quantum cryptography system based on continuous variables.

Vanesa Diaz (Business Product Development Director)

Vanesa works as Business Developer Director at LuxQuanta leading the activities related to bussiness development, customer engagement, strategic partnerships and marketing. She has more than 17 years of experience in diverse commercial roles in the optical communication industry where she has built a solid reputation as a communicator with recognized experience at international conferences and industry magazines. Vanesa holds a Masters Engineering Degree in Telecommunications from the University of Cantabria, Spain, and a Master of Business and Marketing from Griffith University, Australia.

Marco Cofano (Software Developer)

His large experience as a back-end software development and data analyst led Marco to join LuxQuanta's team as Software Developer. In this role he focuses on system management and data post-processing software for quantum key distribution. He completed his PhD in 2017 in Mathematics and Physics at the University of Nottingham in UK, where he worked on quantum field theory. From 2018-2021, he worked as a data scientist and software developer for web applications.

Juan Gasparino (Software Developer)

Juan is Software Developer at LuxQuanta. He is a full-stack software developer with large industrial experience. Prior joining LuxQuanta, Juan built a solid experience working as a frontend developed for different customers to later become a Research Engineer at ICFO. In this last role he started the development of the software related to quantum key distribution, including postprocessing, user application, and system management, that he continues doing now in LuxQuanta. Juan graduated from the Universitat Politénica de Catalunya (UPC) with a Bachelor's Degree in Telecommunication Systems specialising in radio and mobile communications.

REPRESENTATIVES

Saeed Ghasemi (Head of Signal Processing)

Saeed currently works as Head of Signal Processing at LuxQuanta where he leads the FPGA developments and works on digital signal processing for continuous variable quantum key distribution. He has large experience in FPGA programming, signal processing for optical communication, and quantum key distribution. Saeed completed a PhD in Optical telecommunication at UPC in 2019, where he worked on real-time digital signal processing methods for optical access networks. From 2019-2021, he also worked at the Institute of Photonic Science (ICFO) developing quantum key distribution systems. Saeed

Pau Gómez Kabelka (R&D Engineer)

He currently works as R&D Engineer at LuxQuanta focusing on FPGA development for quantum key distribution transmitter and receivers. He completed his PhD in Physics at ICFO in 2021, where he worked on atomic quantum optics with focus on Spinor Bose-Einstein Comagnetometers. From 2019-2021, he also worked as a FPGA developer with applications on quantum technologies. Pau has published 8 articles in peer-reviewed journals/indexed papers based on his large experience in Quantum technologies and FPGA programming.

Jeison Tabares (R&D Engineer)

Jeison's experience in Optical Communications Systems led to this role as R&D Engineer at LuxQuanta where he is currently focusing on all the activities related to optical hardware, components integration, and optical system simulation for quantum key distribution. He completed a PhD in Telecommunications in 2021 at UPC, Spain, where he worked on developments related to next generation coherent optical access networks. He has published 24 articles in peer-reviewed journals/ indexed papers, holds 1 patent, and participated in one European research projects.

QBLOX

Scalable qubit control stack technology for quantum computers

MISSION

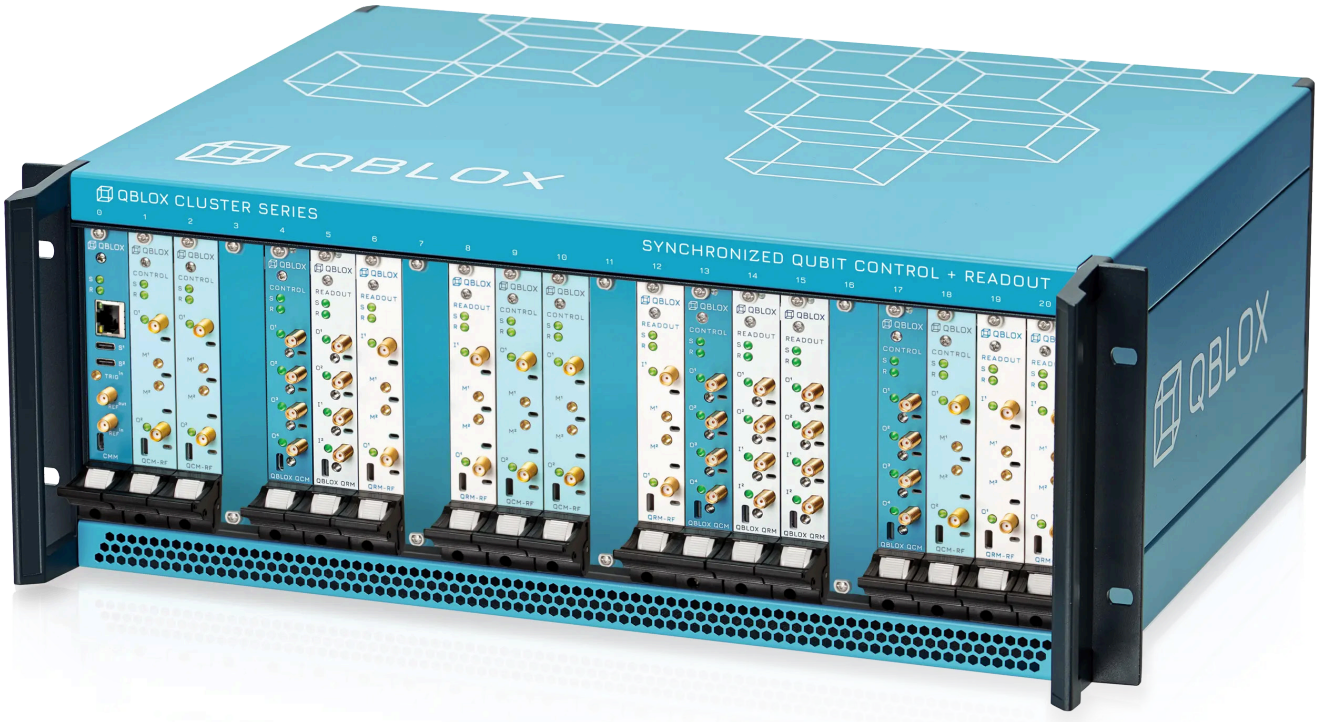
At Qblox we operate at the frontier of the quantum revolution. With a dedicated team of scientists, engineers and developers we are pushing quantum technology to support scientists and institutions worldwide with our scalable and low-latency qubit control equipment.

With a dedicated team of scientists, engineers and developers in the Netherlands, we are pushing quantum technology to support scientists worldwide with our fully-integrated qubit control and readout equipment from ultrastable DC to 18.5 GHz. The Qblox Cluster (CES 2021 Innovation award honoree) will be available for viewing at the Quantum pavilion, it combines unlevelled noise performance, low-latency arbitrary control flows and can be scaled up to 1000s of qubits.

OUR STORY

Based in Delft, the Netherlands, and being a spinoff of the Delft-based quantum technology institute QuTech enables us to implement the latest scientific insights and take a position up front in the worldwide race towards quantum computers.

Qblox.com



REPRESENTATIVES

Jay Jayesingha - Business Operations Manager

Jay is a deep-tech enthusiast who specialises in commercializing state-of-the-art quantum technology at Qblox. Through his experience with two blue-chip corporates and executive education in the UK, Jay has been able to conceptualise, grow and monetise deep-tech initiatives in Silicon Valley, Netherlands and Asia. With Qblox latest and industrialized generation of control stacks, they are paving the way for quantum computer integrators worldwide to reach practical applications in quantum computing.

QILIMANJARO

QUANTUM · TECH

We deliver accessible quantum computing for the real world

MISSION

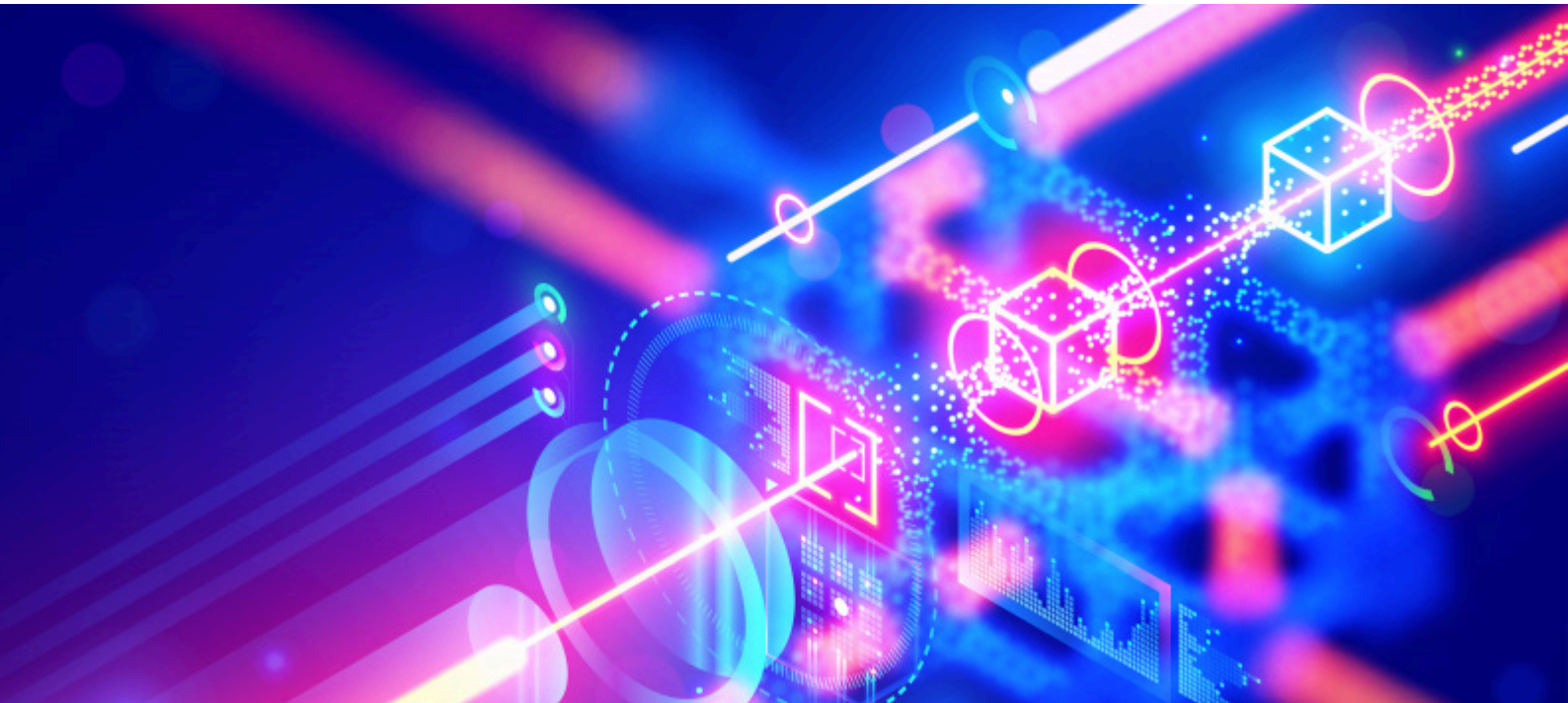
Qilimanjaro's integrated hardware & software team focuses on high-quality qubit architectures to deliver scalable app-specific fully quantum processors and algorithmic services in an accelerated timeframe.

OUR STORY

Qilimanjaro was founded in 2019 and has signed international customer contracts that have paved its funding runway.

Qilimanjaro's team offers algorithmic design support for quantum and so-called hybrid quantum/classical algorithms on a platform-agnostic basis, with a focus on optimization and quantum machine learning problems – the real-world problems to be addressed by Qilimanjaro's platform

qilimanjaro.tech



REPRESENTATIVES

Victor Canivell (CBO)

Victor is a quantum physics PhD with a thirty year successful track record as an executive in the IT industry. He brings to QQT his strategic vision and management experience from his over twenty years in West Coast industry leaders (Hewlett-Packard, Silicon Graphics, 3Com) as EMEA director and VicePresident, plus another twenty years driving software startups in the security and bioinformatics fields as CEO and Board member, having sold the latter startup to PerkinElmer. Victor PhD's is from University of Barcelona and he is also an MBA from ESADE, having followed subsequent trainings at INSEAD and IESE.

Alícia Labián (Projects and Comms Manager)

Alicia has a BSc in Physics and a MSc in Science Communication. She has worked in the field of Corporate Communications in high level research centers such as the Catalan Institute for Nanoscience and Nanotechnology (ICN2) and the Institute for High Energy Physics (IFAE). She complements her scientific background with a wide vision of the startup and agency workflow. Alicia has also worked in advertising and consulting agencies. She joins QQT from the well-known Barcelona delivery unicorn Glovo.

Andreea Costache (Projects and Comms Officer)

Andreea holds a Ph.D. in Communication Contents in the Digital Age(Cum Laude) from Universitat Autònoma de Barcelona. She studied European Media Policy, with a focus on media pluralism and media governance. The research was based on various interviews she conducted in Brussels with European officials and media stakeholders. She has developed high presentation and writing skills during her academic work and also working as a communication and marketing specialist. She brings to QQT communication as well as marketing and EU policy knowledge.

QUSIDE

Delivering high-quality and measurable randomness at scale.

MISSION

At Quside, we believe advances in technology create new capabilities that can transform the way billions of people communicate and compute.

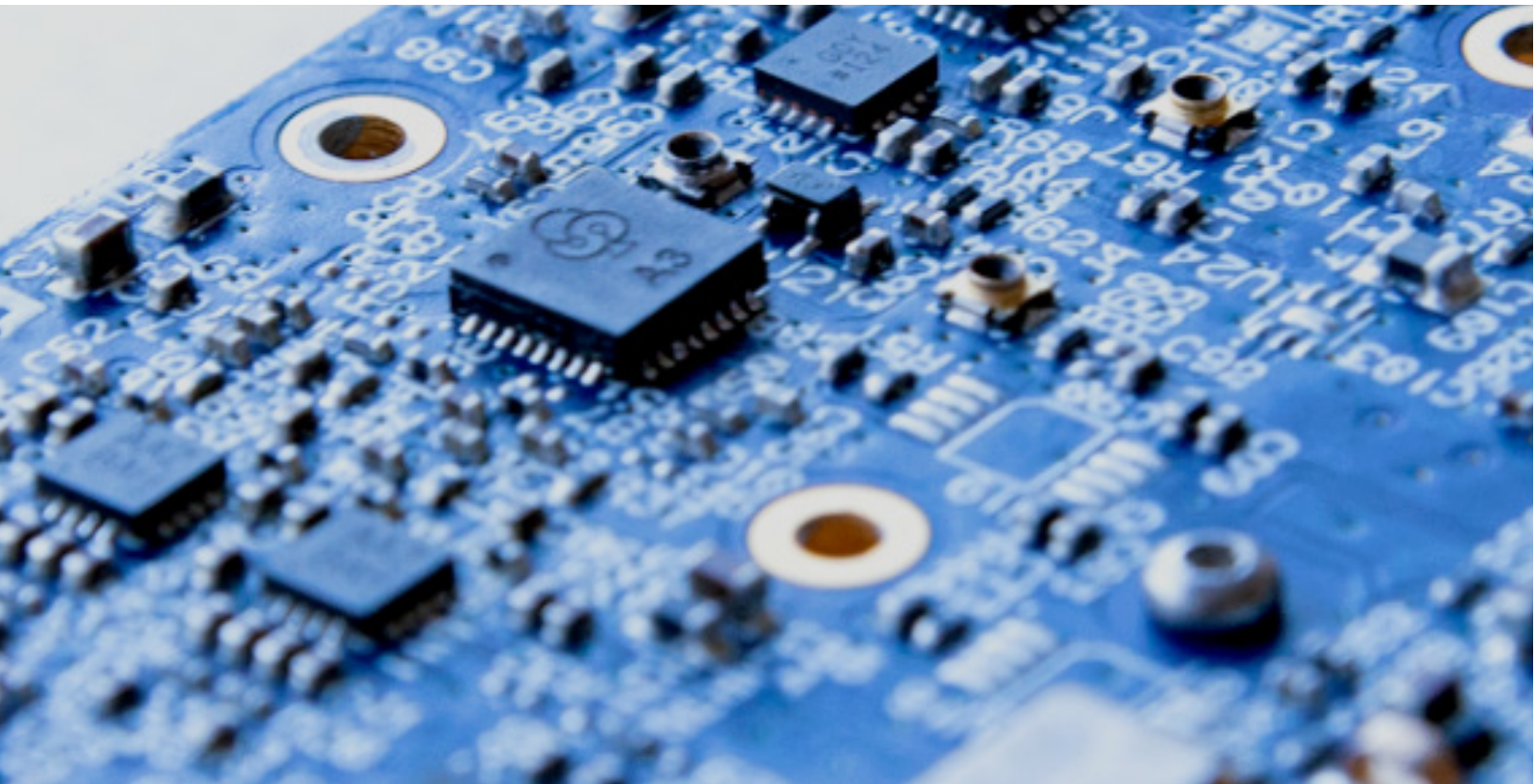
Our mission is to deliver the highest performance quantum random number generators (QRNGs) to empower the transition to safer connectivity and more efficient computation for everyone, everywhere.

OUR STORY

After +6 years of intense R&D effort at ICFO, the Institute of Photonic Sciences in Barcelona, the Quside founding team decided to take the industrialization path and constitute Quside in 2017.

We come from science

quside.com



REPRESENTATIVES

Carlos Abellan (co-founder and CEO)

Carlos leads the strategic and go-to-market development of the company. He got his PhD in quantum photonics from ICFO, where he developed the quantum randomness technologies that were transferred to Quside. Carlos brings 10 years of experience in quantum and photonics development, is co-inventor of 8+ patent and patent-pending families and co-author of 15+ papers in top journals. He has received multiple awards for his work.

Domenico Tulli (CTO, Co-founder)

Domenico is co-founder and Chief Technology Officer at Quside, where he leads the technology strategy. He has a PhD in Photonics from ICFO and a Master's in Telecommunication Engineering from Università di Bologna. Domenico has a broad experience in the full value chain of photonic integration, including design, simulation, manufacturing

José Ramón Martinez (Lead Scientist)

Jose leads the advanced computing activities at Quside. He got his PhD from ICFO, where he focused his research focused on Computational Physics in nanophotonic systems, publishing 10+ articles in high-profile journals and speaking at 5+ technical leading conferences in the field. Jose developed and solved a wide variety of advanced high-performance computing systems and collaborated often with experimental research groups in modelling and problem-solving. He is also an occasional collaborator in scientific dissemination initiatives. Prior to joining Quside, Jose worked at Xerox PARC (Palo Alto, CA) in the Hardware Systems Lab, developing high-performance solutions for industrial initiatives

Steve Takhar (CRO)

Leads the sales and revenue growth strategies for the company. Steve has over 30 years' experience in enterprise sales & marketing roles in the enterprise IT vendor marketplace in both the partner channel and for direct manufacturers. These include Apple, SGi, DEC and EMC and sales leadership positions at both EMEA & global level at VCE, Dell-EMC, and CQC. Steve has successfully delivered in several new business and product launches at notably VCE & Dell-EMC

Fernando de la Iglesia (VP, Cloud)

Leads the cloud product development and strategy for the company. He has more than 20 years' experience in one of the biggest Telecommunication companies in the world where in the last 10+ years was leading innovation proposals related to Cloud Computing both at national and European level and finally working as main infrastructure and solution architect in the most relevant Cloud computing projects in Telefónica. Fernando holds a PhD in theoretical physics from the Universidad Autónoma de Madrid (UAM).

THE REGIONAL INITIATIVES

Quantum Valley Lower Saxony

The ecosystem for breakthroughs in quantum technologies

OUR PARTNERS

For QVLS, research on ion trap quantum processors is particularly important because of the technology's potential for scalable quantum computing applications.

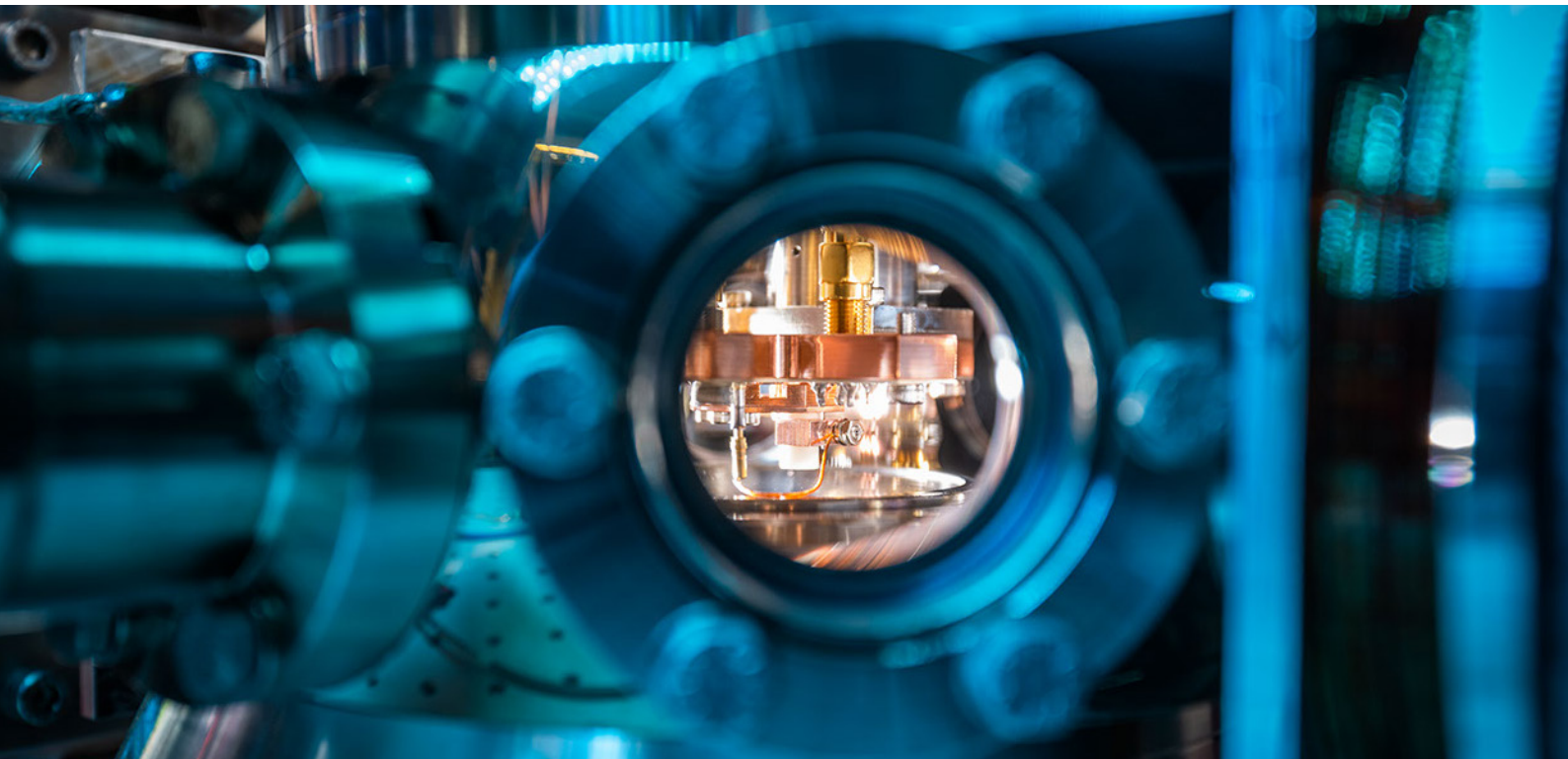
Equipped with a strong infrastructure and a €25 million investment that will be spread over the next five years, the initiative's lighthouse project QVLS-Q1 aims to construct a scalable 50-qubit trapped ion quantum computer by the end of 2025.

OUR PROJECTS

The Hannover-Braunschweig region can look back on numerous achievements in quantum research. In the QVLS, we promote the exchange in the ecosystem and jointly launch new projects.

25 million has already been made available as core funding for the QVLS-Q1 lighthouse project.

qvls.de



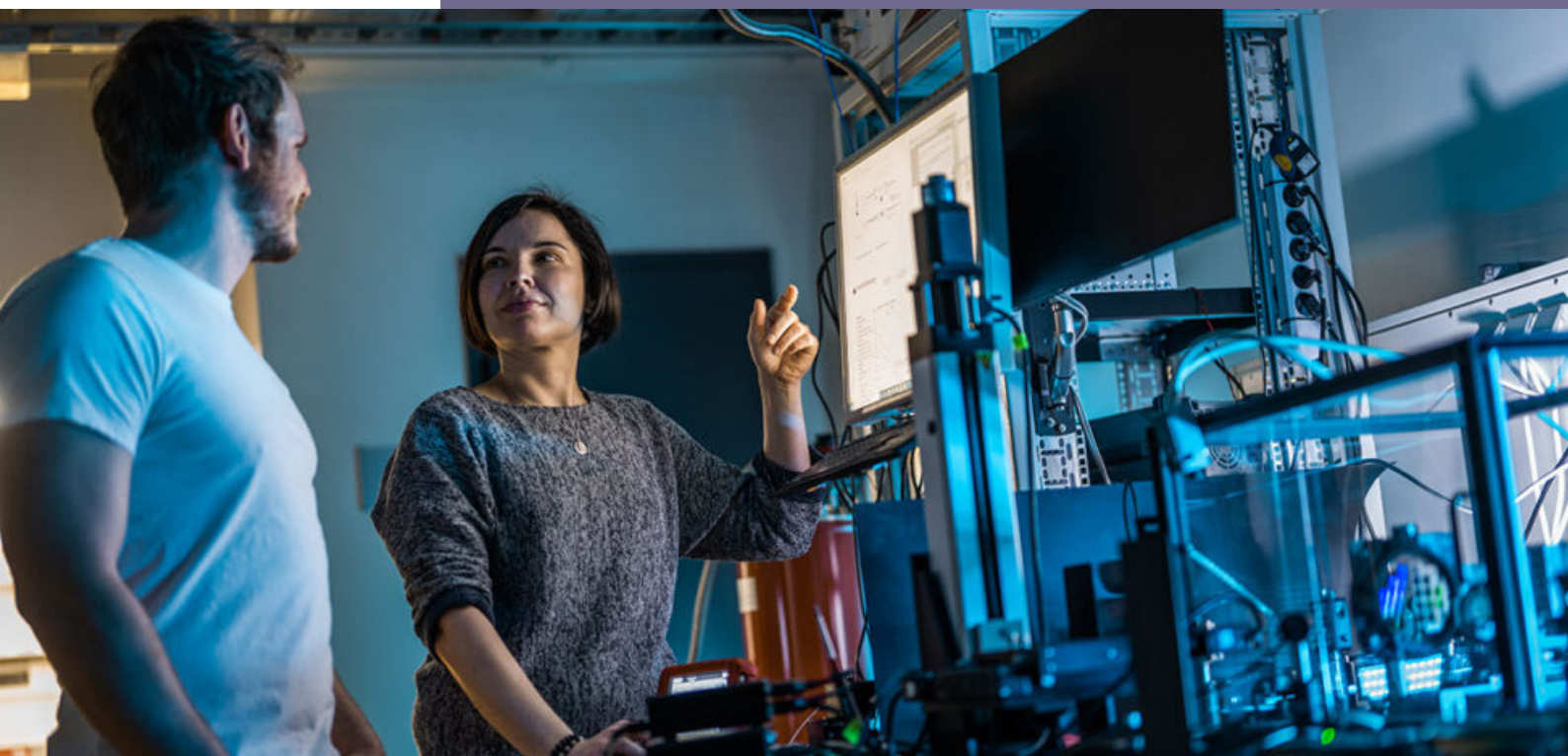
REPRESENTATIVES

Bernd Jungbauer (Managing Director of Quantum Valley Lower Saxony)

Bernd Jungbauer is Managing Director of Quantum Valley Lower Saxony. After investigating a new generation of quantum light sources during his PhD at the Humboldt University of Berlin, he moved to Hannover to bring the next generation of quantum technologies into the industry. In his role at QVLS, he connects academia, industry, and politics to foster the strong local quantum ecosystem through collaborations and knowledge transfer.

Laurenz Koetter (Science Communication Manager)

Laurenz Koetter is Science Communication Manager at the Technical University of Braunschweig and the QuantumFrontiers cluster of excellence. He is home between the soft hills and green meadows of northwest Germany. After studying how to build bridges between religions, he now builds bridges between science and society in Lower Saxony's quantum valley. As a science communicator, he engages in a quantum of comprehensibility. (Photo credit: Kristina Rottig/TU Braunschweig)



QUANTUMCAT

The Quantum Technologies Hub of Catalonia

ABOUT

QuantumCAT is a hub of research institutions in Catalonia and industrial actors that have come together to promote quantum tech transfer projects and innovation with a short-term or mid-term industrial and social impact. The Hub aims to drive discoveries from the research lab to the market through industrially viable implementations and applications, addressing three main issues:

It promotes selected high-potential laboratory technologies and incentivize their industrial deployment through focused collaborative research efforts.

It facilitates community-wide dissemination of successful deployment and innovation strategies.

It carries out outreach actions, such as networking events and workshops, targeted to academic and industry audiences, to discuss experiences and collaborations as well as share know-how among the community on success stories and use cases.

PROJECTS

The Hub focuses its research and development in the following 4 main sectors

Quantum communication: technologies for a secure digital society and future quantum internet compatible with existing infrastructures.

Quantum sensing: Smart, precise and portable atomic sensors for magnetic resonance diagnostics.

Quantum Computing: Bringing innovative solutions to quantum simulation and artificial intelligence.

Quantum Simulation: Software & Hardware enabling quantum computing in the cloud accessible to everyone.

quantum-cat.cat

REPRESENTATIVES

Morgan Mitchell (Group Leader at ICFO & Coordinator of QuantumCAT)

Morgan Mitchell is ICREA Professor and Head of the Atomic Quantum Optics group at ICFO since 2004. He obtained his PhD at the University of California at Berkeley in 1999. He has worked as a postdoctoral fellow at the Laboratoire Kastler Brossel (1999-2000) and at the University of Toronto (2002-2004) and between those periods he taught for two years at Reed College. His research focuses on working with individual neutral atoms such as individual quantum systems, Bose-Einstein spinor condensates, and high-density atomic vapours as extreme sensors, and he has invented various resonant entwined and compressed light sources of atoms. He was awarded an ERC Starting Grant in 2011, an ERC Proof-of-Concept Grant in 2016, and has been recognized with the Vanguard of Science Award in 2012.

Maciej Lewenstein (Group Leader at ICFO)

Maciej Lewenstein is ICREA Professor and Head of the Optical Quantum Theory Research Group at ICFO since 2005. He obtained his PhD at the University of Essen in 1983 and then postdoctoral stays at the University of Essen and Harvard until 1995, when he became a faculty member of the Center de l'Energie Atomique (1995-1998) and of the Leibniz Universität (1998-2005). He is an expert in theoretical physics (atomic and molecular physics, quantum optics, ultrafast and laser physics, condensed matter physics, statistical physics, mathematical physics), quantum information science, theoretical physics for bio-sciences and social sciences.

Bruno Julià-Díaz (Associate Professor - University of Barcelona)

Bruno Julià has been an associate professor in the Department of Quantum Physics and Astrophysics of the UB since 2017. He obtained his PhD at the University of Salamanca in 2003, having subsequently carried out several postdoctoral stays at the University of Helsinki (2003-2004), the Center de l'Energie Atomique (2004-2005) and the University of Pittsburgh (2005). He has been a Juan de la Cierva researcher (2006-2009) at ICFO and a Ramon y Cajal researcher (2012-2017) at the UB. His research ranges from nuclear and hadron physics to ultra-cold gases and quantum many-body physics.

REPRESENTATIVES

Xavier Jordán Parra (Digital Innovation Management Office- i2CAT)

Xavier Jordan has been part of the Innovation Management Office at i2Cat since 2019. Telecommunications Engineer (1997) and Master in Photonics (2019) from the UPC, he has more than 11 years of experience in the telecommunications business, in technical and management aspects, and more than 6 years working in an industrial company in business management and commercial management.

Victor Herrero (Knowledge and Technology Transfer Portfolio Manager - ICFO)

Victor Herrero has a MSc. in chemical engineering and has devoted his professional career to public/private funding at EU level, accumulating +14 years of experience into technology development, research strategy, and venturing. Before joining ICFO, he worked as professional consultant, being the bridge between enterprises and breakthrough technologies offering a seamless end-to-end service to leverage financial resources.

He is currently project manager of the Quantum Technologies portfolio and all related strategic activities within ICFO's Knowledge and tech nology Transfer (KTT) unit.

THE QUANTUM FLAGSHIP PROJECTS

21 Selected Projects

Ramp-up phase (2018-2022)

QUANTUM Communication

4 projects

PROJECT: CiViQ
(Continuous Variable Quantum Communications)
Coordinating Institution:
ICFO - THE INSTITUTE OF PHOTONIC SCIENCES
Coordinator: Valerio Pruneri

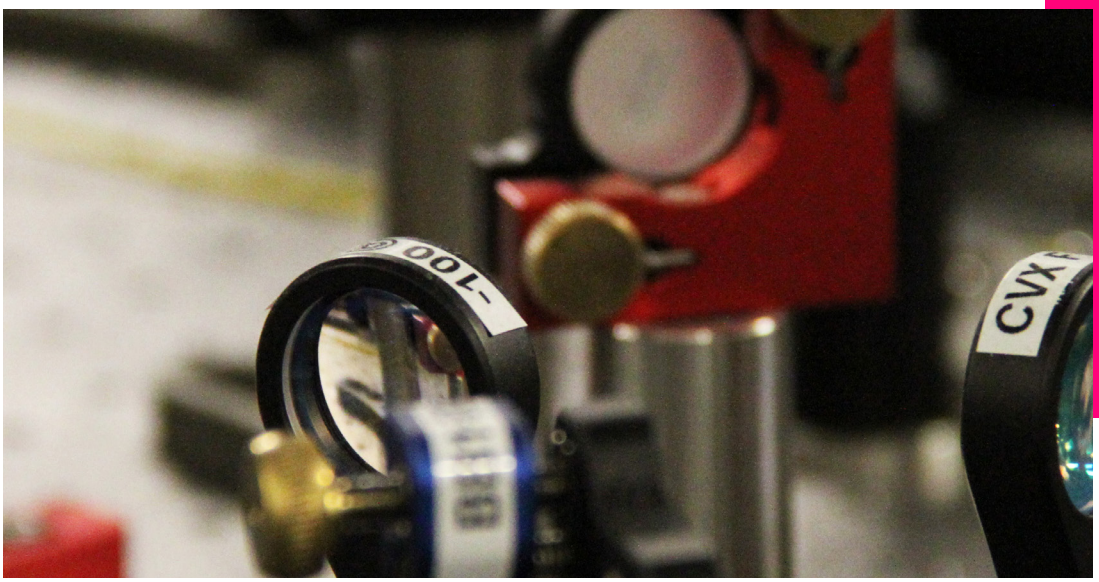
PROJECT: QIA
(Quantum Internet Alliance)
Coordinating Institution:
TECHNISCHE UNIVERSITEIT DELFT
Coordinator: Stephanie Wehner

PROJECT: QRANGE
(Quantum Random Number Generators: cheaper, faster and more secure)
Coordinating Institution:
UNIVERSITE DE GENEVE
Coordinator: Hugo Zbinden

PROJECT: UNIQORN
(Affordable Quantum Communication for Everyone: Revolutionizing the Quantum Ecosystem from Fabrication to Application)
Coordinating Institution:
AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH
Coordinator: Hannes Hübel

PROJECT: CiViQ
(Continuous Variable Quantum Communications)
Coordinating Institution:
ICFO - THE INSTITUTE OF PHOTONIC SCIENCES
Coordinator: Valerio Pruneri

https://civiquantum.eu/



Spokesperson
Valerio Pruneri

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About the Project

The goal of the CiViQ project is to open a radically novel avenue towards flexible and cost-effective integration of quantum communication technologies, and in particular Continuous-Variable QKD, into emerging optical telecommunication networks.

CiViQ aims at a broad technological impact based on a systematic analysis of telecom-defined user-requirements. To this end CiViQ unites for the first time a broad interdisciplinary community of 21 partners with unique breadth of experience, involving major telecoms, integrators and developers of QKD. The work targets advancing both the QKD technology itself and the emerging "software network" approach to lay the foundations of future seamless integration of both. The technological advantage specifically aims to:

· Design architectures and implement protocol extensions of flexible "software based" networks for midterm country-wide QKD reach.

· Drive CV-QKD systems and components up to TRL 6, derive standardized set of interfaces, also allowing a network-aware software defined functionality and open modular development, and pursue cost reduction by seamless integration of off-the-shelf components.

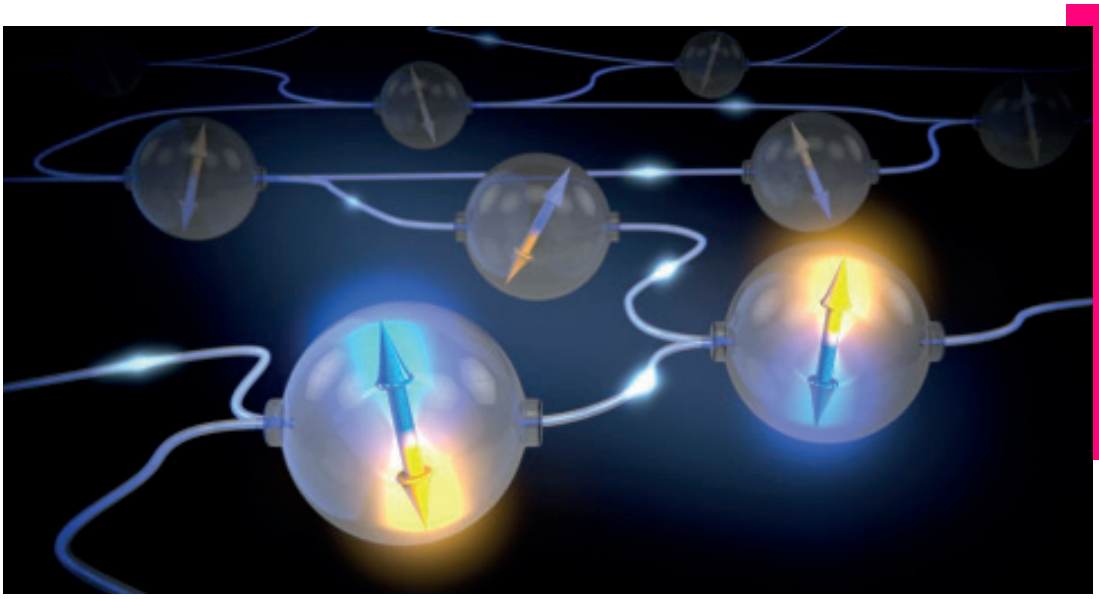
· Push CV-QKD performance boundary forward by developing high-performance photonic integrated circuits (PIC) for CV-QKD, i.e. opening the way for ultra-low cost systems, and improve further the CV-QKD hallmark coexistence capability with standard WDM channels, i.e. reducing dramatically the barriers to optical network co-integration.

· Prepare actively for next-generation networks by developing core enabling technologies and protocols aiming at quantum communication over global distances with minimal trust assumptions.

CiViQ culminates in a validation in true telecom network environment. Project-specific network integration and software development work empowers QKD to be used as a physical-layer-anchor securing critical infrastructures, with demonstration in QKD-extended software-defined networks.

PROJECT: QIA
(Quantum Internet Alliance)
Coordinating Institution:
TECHNISCHE UNIVERSITEIT DELFT
Coordinator: Stephanie Wehner

http://quantum-internet.team/



Spokesperson
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About the Project

The future Quantum Internet will provide radically new internet applications by enabling quantum communication between any two points on Earth. The Quantum Internet Alliance (QIA) targets a Blueprint for a pan-European Quantum Internet by ground-breaking technological advances, culminating in the first experimental demonstration of a fully integrated network stack running on a multi-node quantum network.

QIA pushes the frontier of technology in both end nodes (trapped ion qubits, diamond NV qubits, neutral atom qubits) and quantum repeaters (rare-earth-based memories, atomic gases, quantum dots) and demonstrate the first integration of both subsystems. They aim to achieve entanglement and teleportation across three and four remote quantum network nodes, thereby making the leap from simple point-to-point connections to the first multi-node networks.

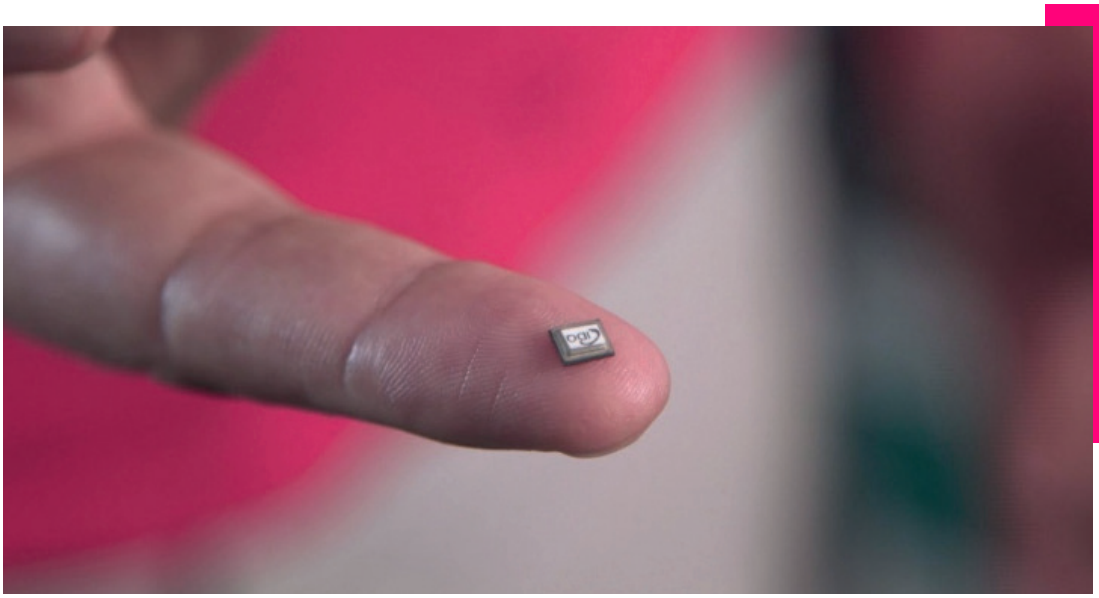
They are demonstrating the key enabling capabilities for memory-based quantum repeaters, resulting in proof-of-principle demonstrations of elementary long-distance repeater links in the real-world, including the longest such link worldwide.

Hand in hand with hardware development, they are realizing a software stack that will provide fast, reactive control and allow arbitrary high-level applications to be realized in platform-independent software.

QIA's industry partners examine real world use cases of application protocols and their hardware requirements. They are aiming to validate the full stack on a small Quantum Internet by performing an elementary secure delegated quantum computation in the cloud. They seek to validate the design of the Blueprint architecture by a large-scale simulation of a pan-European Quantum Internet using real world fibre data. Through synergy of leading industrial, academic and RTO partners, QIA's Blueprint will provide a targeted roadmap for the main Flagship phase and set the stage for a world-leading European Quantum Internet industry.

PROJECT: QRANGE
(Quantum Random Number Generators: cheaper, faster and more secure)
Coordinating Institution:
UNIVERSITE DE GENEVE
Coordinator: Hugo Zbinden

https://qrange.eu/



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About the Project

The generation of random numbers plays a crucial role in many applications in science and impacting society, in particular for simulation and cryptography. It is of fundamental importance that the generated numbers are truly random, as any deviation may adversely effect modelling or jeopardise security. Notably, recent breaches of cryptographic protocols have exploited weaknesses in the random number generation. In this context, schemes exploiting the inherent randomness of quantum physics have been extensively investigated.

Quantum random number generation (QRNG) devices are now commercially available, which arguably represents one of the most successful developments of quantum technologies so far. QRANGE wants to push the QRNG technology further, allowing for a wide range of commercial applications of QRNG.

They are building three different prototypes, which are cheaper, faster and more secure than existing devices:

i) A fully integrated low-cost QRNG based on standard CMOS technology with a cost of the order of 1€ for IoT.

ii) A high-speed phase-diffusion scheme based on the interference of laser pulses with random phase relationship featuring bit rates of up to 10Gb/s.

iii) Inspired by device independent schemes, a self-testing QRNG, which allows for a continuous estimation of the generated entropy, with few assumptions on the devices. Moreover, they are making considerable theoretical effort for modelling the devices, designing efficient randomness extractors and studying new semi device-independent concepts.

Last but not least, they are working together with the competent institutions towards a full certification scheme of QRNG devices compliant with the highest security standards. This project addresses many key points in the call and is well-aligned with the vision and objectives of the Quantum Technologies Flagship, especially in terms of taking quantum technologies from the laboratory to industry with concrete prototype applications and marketable products.

PROJECT: UNIQORN

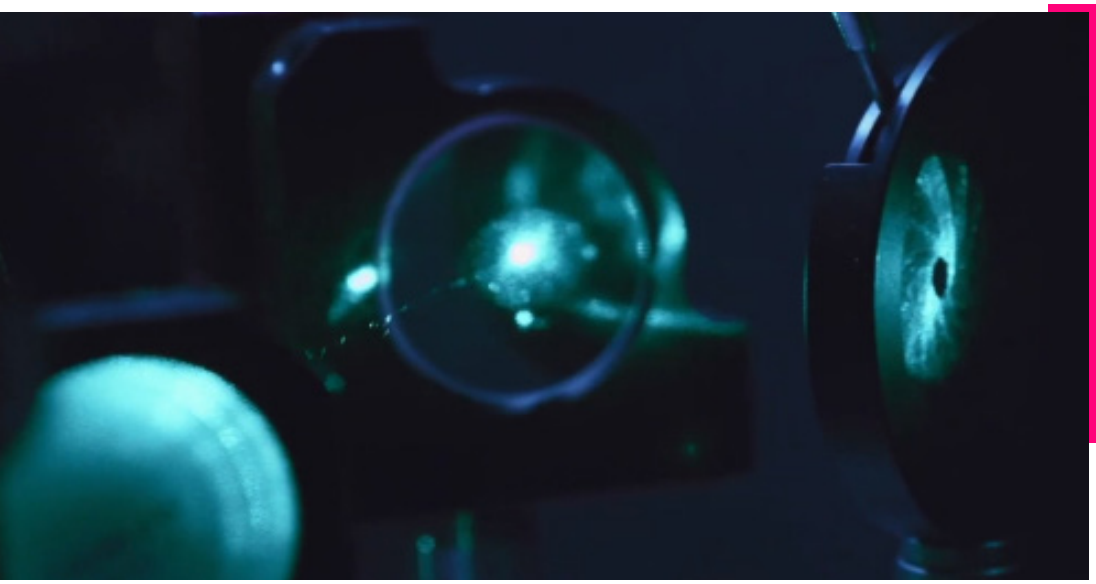
(Affordable Quantum Communication for Everyone: Revolutionizing the Quantum Ecosystem from Fabrication to Application)

Coordinating Institution:

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH

Coordinator: Hannes Hübel

https://quantum-uniqorn.eu/



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About the Project

Quantum Communication is recognised as one of the pillars for the second quantum revolution thanks to its unique potential for information-theoretical data security. Turning this promise into tangible assets depends however, on the availability of high-performance, compact and cost-effective modules for practical implementations.

UNIQORN is a well-orchestrated design and manufacturing framework aiming to advance the quantum communication technology for DV and CV systems by carefully laying out each element along the development chain from fabrication to application.

Component-wise, UNIQORN is leveraging the monolithic integration potential of InP platform, the flexibility of polymer platform and low-cost assembly techniques to develop quantum system-on-chip modules in a cheap, scalable and reproducible way.

UNIQORN aims at delivering bright (10M pairs/s/mW/THz) heralded, entangled and squeezed light sources with 70-fold size reduction and almost 90% cost savings, room-temperature arrayed SPADs and a 10-GHz CV receiver with low-noise TIAs. Fully functional systems based on these assets include:

(i) a network adapter card with integrated real-time QRNG engine,

(ii) the first DPS transmitter as pluggable SFP module for low-cost 1-kb/s QKD, and

(iii) novel oblivious transfer and quantum FPGA systems.

Network-integration and system evaluation in real fibre networks will be enabled by quantum-aware software defined networking and field trials in the live Smart-City demonstrator Bristol-is-Open. The power of the developed ecosystem will be also validated by pushing current QKD-centric work into higher grounds, and demonstrating one-time programs and secure database access through oblivious transfer.

The trans-disciplinary approach of UNIQORN brings together leading European players from quantum optics and photonics enabling to move from lab science to field deployment and bridge the quantum divide between large (governmental) and small (residential) end-users.

QUANTUM Sensing and Metrology

4 projects

PROJECT: ASTERIQS

(Advancing Science and TEchnology thRough dIamond Quantum Sensing)

Coordinating Institution:

THALES SA

Coordinator: Thierry Debuisschert

PROJECT: iqClock

(Integrated Quantum Clock)

Coordinating Institution:

UNIVERSITEIT VAN AMSTERDAM

Coordinator: Florian Schreck

PROJECT: MetaboliQs

(Leveraging room temperature diamond quantum dynamics to enable safe, first-of-its-kind, multimodal cardiac imaging)

Coordinating Institution:

FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.

Coordinator: Ilai Schwartz, Co-coordinator

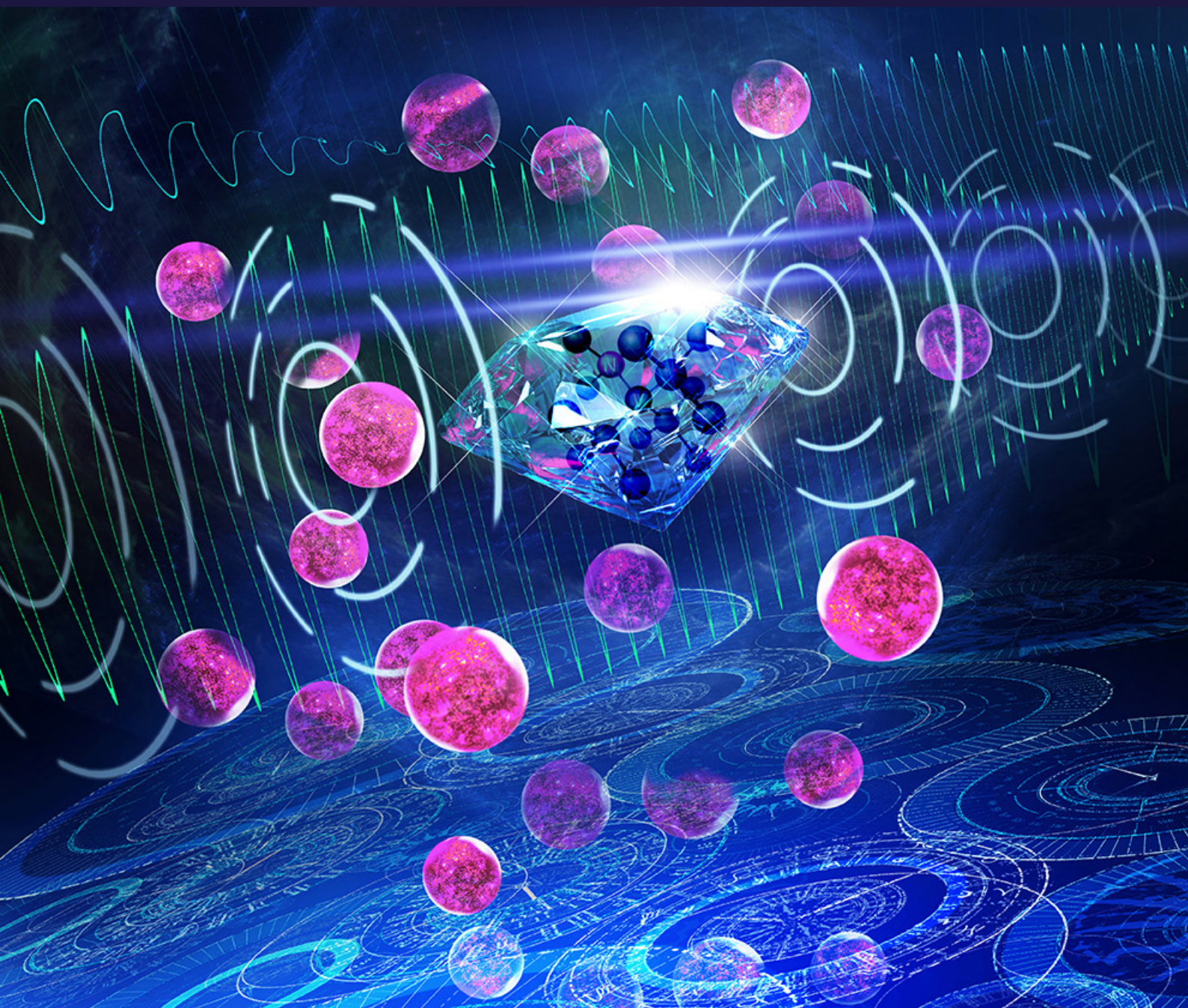
PROJECT: macQsimal

(Miniature Atomic vapor-Cells Quantum devices for SensIng and Metrology AppLications)

Coordinating Institution:

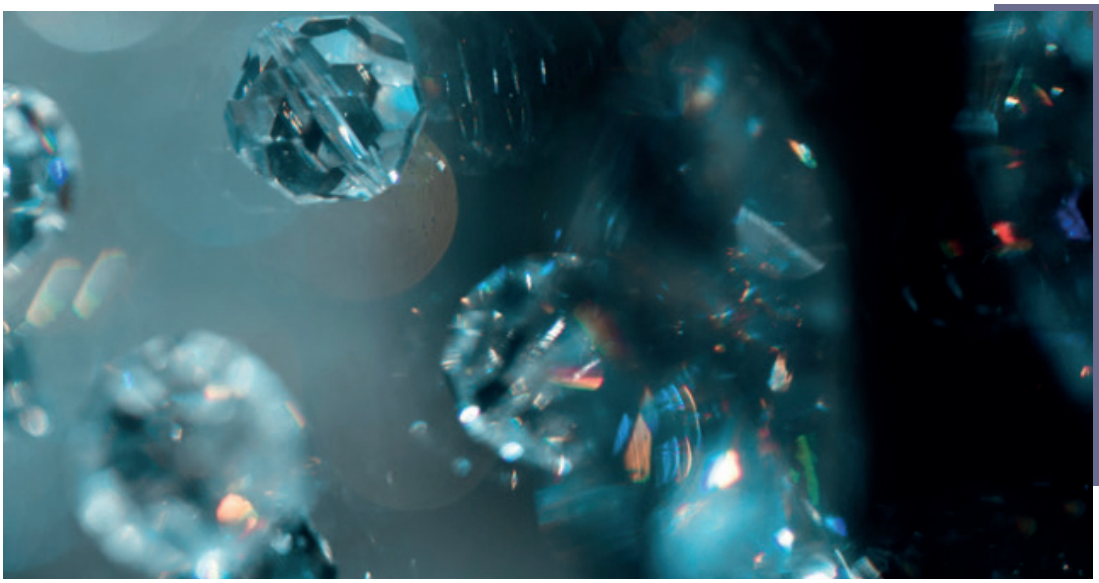
CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT

Coordinator: Jacques Haesler



PROJECT: ASTERIQS
(Advancing Science and TEchnology thRough dIamond Quantum Sensing)
Coordinating Institution:
THALES SA
Coordinator: Thierry Debuisschert

https://www.asteriqs.eu/



Spokesperson
Thierry Debuisschert

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About the Project

ASTERIQS exploits quantum sensing based on the NV centre in ultrapure diamond to bring solutions to societal and economical needs for which no solution exists yet. Its objectives are to develop:

1) Advanced applications based on magnetic field measurement: fully integrated scanning diamond magnetometer instrument for nanometer scale measurements, high dynamics range magnetic field sensor to control advanced batteries used in electrical car industry, lab-on-Chip Nuclear Magnetic Resonance (NMR) detector for early diagnosis of disease, magnetic field imaging camera for biology or robotics, instantaneous spectrum analyser for wireless communications management;

2) New sensing applications to sense temperature within a cell, to monitor new states of matter under high pressure, to sense electric field with ultimate sensitivity;

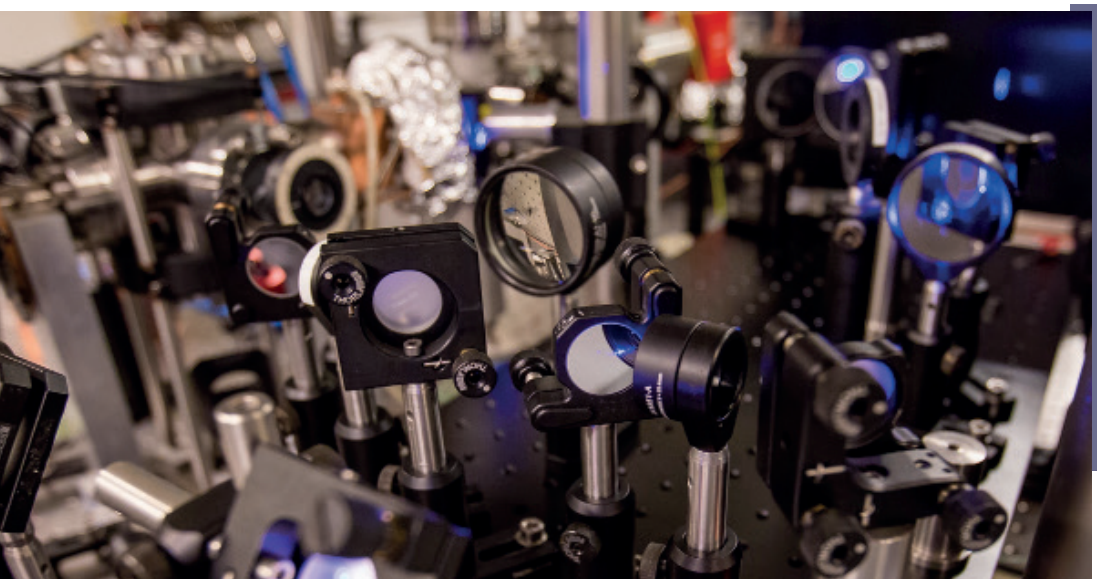
3) New measurement tools to elucidate the chemical structure of single molecules by NMR for pharmaceutical industry or the structure of spintronics devices at the nanoscale for new generation spin-based electronic devices.

ASTERIQS is developing enabling tools to achieve these goals: highest grade diamond material with ultralow impurity level, advanced protocols to overcome residual noise in sensing schemes, optimized engineering for miniaturized and efficient devices..

The ASTERIQS consortium federates world leading European academic and industrial partners to bring quantum sensing from the laboratory to applications for the benefit of European citizens.

PROJECT: iqClock
(Integrated Quantum Clock)
Coordinating Institution:
UNIVERSITEIT VAN AMSTERDAM
Coordinator: Florian Schreck

https://www.iqclock.eu/



Spokesperson
Florian Schreck

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About the Project

Optical clocks are amazingly stable frequency standards, which would be off by only one second over the age of the universe. Bringing those clocks from the laboratory into a robust and compact form will have a large impact on telecommunication (e.g. network synchronization, traffic bandwidth, GPS free navigation), geology (e.g. underground exploration, monitoring of water tables or ice sheets), astronomy (e.g. low-frequency gravitational wave detection, radio telescope synchronization), and other fields. Likewise, techniques developed for robust clocks will improve laboratory clocks, potentially leading to physics beyond the standard model.

To make this a reality, they have founded the iqClock consortium, assembling leading experts from academia, strong industry partners, and relevant end users. They are seizing on recent developments in clock concepts and technology to start-up a clock development pipeline along the TRL scale. Their consortium represents a nucleus for a European optical clock ecosystem, which will continuously deliver competitive products and foster the development of clock applications. Their first product prototype is a field-ready strontium optical clock, which they aim to benchmark in real use cases, such as network synchronization (TRL 6).

This clock will be based on a modular concept, already with the next-generation clocks in mind, which their academic partners will realize (TRL 3-4). By their operation principle, these optical clocks are more robust than the current ones and have come into reach by recent breakthroughs, some of which achieved by our partners.

PROJECT: MetaboliQs

(Leveraging room temperature diamond quantum dynamics to enable safe, first-of-its-kind, multimodal cardiac imaging)

Coordinating Institution:

FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.

Coordinator: Christoph Nebel

http://www.metaboliqs.eu/

Spokesperson
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Ilai Schwartz

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About the Project

Cardiovascular Diseases (CVDs) are the number 1 cause of death globally: more people die annually from CVDs than from any other cause. Despite emerging diagnostics tools and therapeutics, several areas of significant unmet need remain unaddressed among CVD patients.

The ability to personalize cardiovascular medical care and improve outcomes, will require characterization of disease processes at a molecular level. The current state-of-the-art, e.g., Positron emission tomography (PET), does not provide detailed information about the chemical state of the tissue at a molecular level, therefore it remains difficult to accurately diagnose and confidently select appropriate therapy in many circumstances.

The MetaboliQs project brings together two areas of European excellence - diamond-based quantum sensing and medical imaging. They are translateinga newly developed hyperpolarization method for magnetic resonance imaging (MRI) based on the quantum dynamics of nitrogen-vacancy (NV) centers. This breakthrough quantum technology enables previously unachievable, highly sensitive quantification of metabolic activity, paving the way for precision diagnostics and better personalized treatment of cardiovascular and other metabolic diseases.

For realizing and eventually commercializing the technology, MetaboliQs brings together a world-class multidisciplinary consortium with end to end expertise - leading diamond quantum technology research institutes (Fraunhofer IAF - quantum-grade diamond growth and fabrication, HUJI - quantum sensing) and innovative companies (Element 6 - worldwide leader in synthetic diamonds, NVision - inventor of diamond-based polarization), as well as two expert users of hyperpolarized and cardiovascular MRI (TUM, ETH Zurich - first in continental Europe to conduct clinical trials of hyperpolarized MRI for cardiovascular disease) and the market leader in electron paramagnetic resonance and preclinical MRI (Bruker).

PROJECT: macQsimal

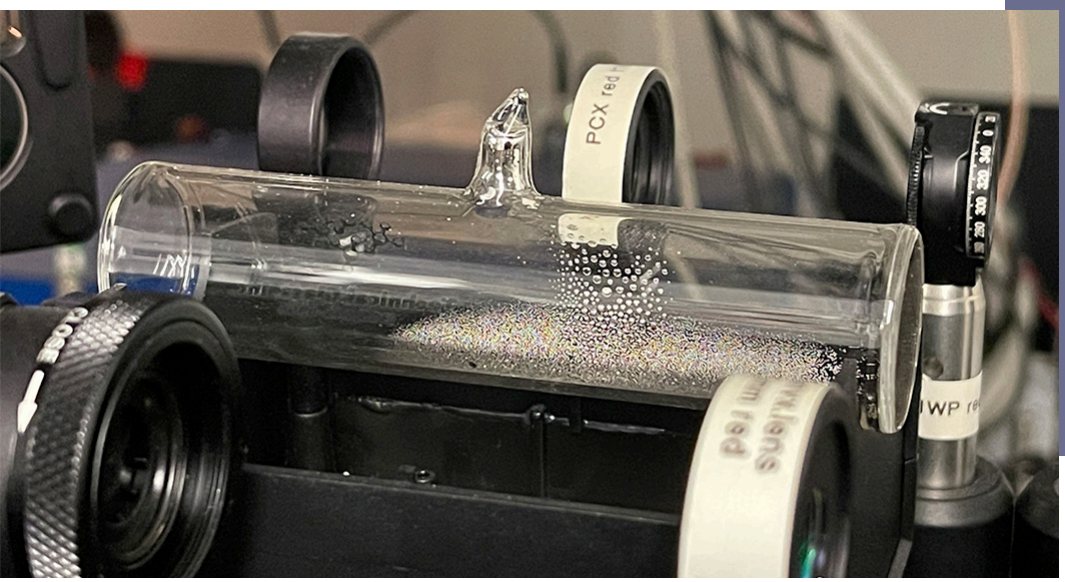
(Miniature Atomic vapor-Cells Quantum devices for SensIng and Metrology AppLications)

Coordinating Institution:

CSEM CENTRE SUISSE D'ELECTRONIQUE ET DE MICROTECHNIQUE SA - RECHERCHE ET DEVELOPPEMENT

Coordinator: Jacques Haesler

https://www.macqsimal.eu/



Spokesperson
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About the Project

Sensors provide the interface between the real world and the digital world. Quantum technologies are poised to revolutionize this interface, and with it sensor-driven industries such as navigation and medical imaging. MACQSIMAL combines the expertise of world-leading research groups, RTOs and companies, covering the whole knowledge chain from basic science to industrial deployment, and aims at breakthroughs that will firmly establish European leadership in the quantum sensor industry.

MACQSIMAL is developing quantum-enabled sensors with outstanding sensitivity for five key physical observables: magnetic fields, time, rotation, electromagnetic radiation and gas concentration. These sensors are chosen for their high impact and their potential to quickly advance to a product: Within MACQSIMAL all these sensors will reach TRLs between 3 and 6 and will outperform other solutions in the respective markets.

The common core technology in these diverse sensors is atomic vapor cells realized as integrated microelectromechanical systems (MEMS). Atomic vapor cells make coherent quantum processes available to applications: advanced cell-based sensors optimally exploit single-particle coherence, with the potential to harness also multi-particle quantum coherence for still greater sensitivity. Fabricating such atomic vapor cells as MEMS allows for high-volume, high-reliability and low-cost deployment of miniaturized, integrated sensors, critical to widespread adoption.

MACQSIMAL combines state-of-the-art sensor physics with the MEMS atomic vapor cell platform, for highly advanced prototypes and demonstrators. Concurrently, advanced squeezing, entanglement and cavity-QED methods are being applied for the first time in miniaturized sensors, bringing quantum enhancement closer than ever to industrial application. This advanced, multi-target, quantum-enabled sensor platform marks the start of a dynamic and multi-sector quantum sensor industry in Europe.

QUANTUM Simulations

2 projects

PROJECT: PASQuanS

(Programmable Atomic Large-Scale Quantum Simulation)

Coordinating Institution:

MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV

Coordinator: Immanuel Bloch

PROJECT: Qombs

(Quantum simulation and entanglement engineering in quantum cascade laser frequency combs)

Coordinating Institution:

CONSIGLIO NAZIONALE DELLE RICERCHE

Coordinator: Augusto Smerzi

PROJECT: PASQuanS
(Programmable Atomic Large-Scale Quantum Simulation)
Coordinating Institution:
MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV
Coordinator: Immanuel Bloch

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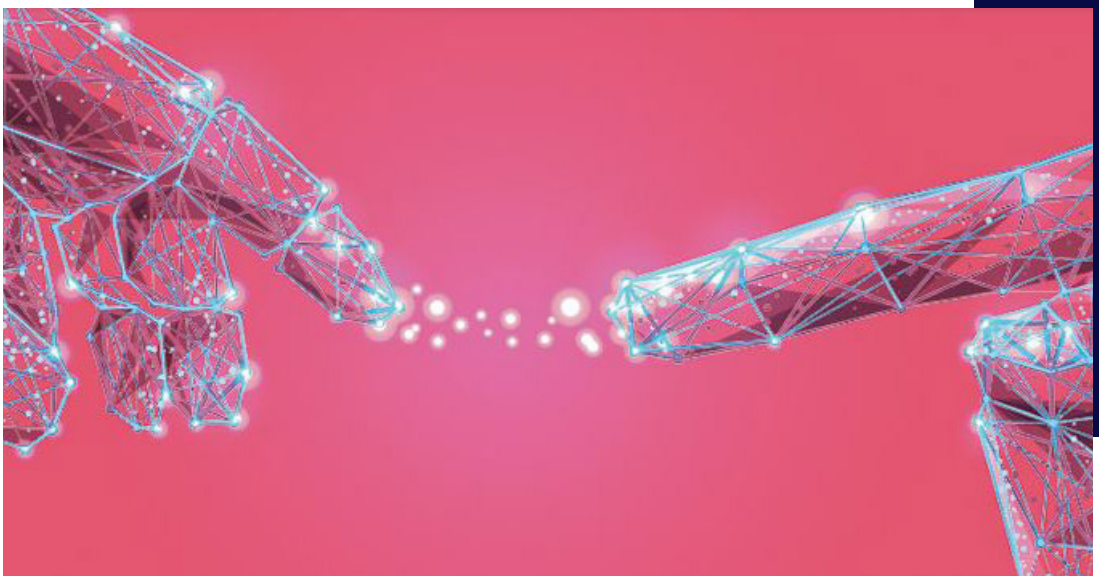

About the Project

PASQuanS is performing a decisive transformative step for quantum simulation towards programmable analogue simulators addressing questions in fundamental science, materials development, quantum chemistry and real-world problems of high importance in industry. PASQuanS builds on the impressive achievements of the most advanced quantum simulation platforms, based on atoms and ions.

The neutral-atom simulators handle more than 50 cold atoms in optical lattices or arrays of optical tweezers, interacting via either collisional or Rydberg-state-mediated interactions. The ion-trap platform reaches unsurpassed control with up to 20 ions. By scaling up these platforms towards >1000 atoms/ions, by improving control methods and making these simulators fully programmable, PASQuanS is pushing these already well-advanced platforms far beyond both the state-of-the-art and the reach of classical computation. Full programmability is making it possible to address quantum annealing or optimization problems much sooner than digital quantum computation. PASQuanS is aiming to demonstrate a quantum advantage for non-trivial problems, paving the way towards practical and industrial applications.

PASQuanS tightly unites five experimental groups with complementary methods to achieve the technological goals, connected with six theoretical teams focusing on certification, control techniques and applications of the programmable platforms, and five industrial partners in charge of the key developments of enabling technologies and possible commercial spin-offs of the project.

PASQuanS is developing modular building blocks for a future generation of quantum simulators. Possible end-users of these simulators, major industrial actors, are tightly associated with the consortium. In a cross-fertilization process, they will be engaged in a dialogue on quantum simulation, and help to identify and implement key applications where quantum simulation provides a competitive advantage.

PROJECT: Qombs

(Quantum simulation and entanglement engineering in quantum cascade laser frequency combs)

Coordinating Institution:

CONSIGLIO NAZIONALE DELLE RICERCHE

Coordinator: Augusto Smerzi

https://www.qombs-project.eu/index.php/Home

Spokesperson
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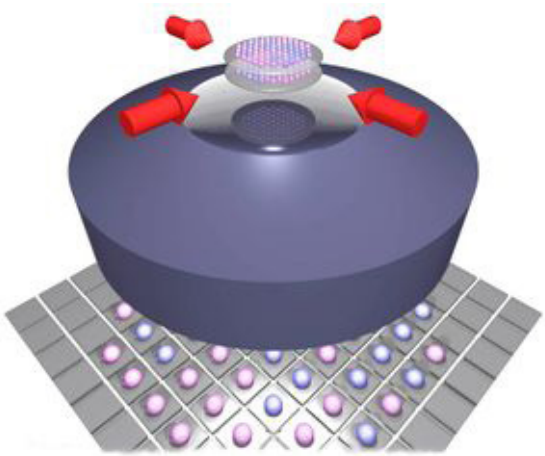


About the Project

The Qombs project aims to create a quantum simulator platform made of ultracold atoms in optical lattices. The quantum platform will allow to design and engineer a new generation of quantum cascade laser frequency combs. This unprecedented quantum simulation of semiconductor structures will endow the devices with brand new features, like non-classical emission modes, entanglement among the modes of the comb and parametric generation of comb patterns far from the central emission frequency. In parallel, the quantum simulation will allow to improve present-day performances of quantum cascade lasers (QCLs) and quantum well structures for photon detection. Full quantum simulation will be followed by real manufacturing and state-of-the-art characterization.

The consortium gathers research institutions that have a leading expertise in the physics of ultracold atoms, quantum optics and have first introduced and developed frequency comb synthesizers and quantum well structures during the last 20 years. Moreover, half of the ten partners of the Project are companies of different size that are already leading the QCL and frequency comb market. This unique combination will allow to rapidly move from the fundamental quantum simulation protocols to prototypes and eventually to the industrial production and commercialization of the new devices.

The long term vision of the Qombs consortium is to create a strong and world-wide leading European quantum industry on quantum cascade laser frequency combs tightly and strategically connected to the academic world.

QUANTUM Computing

4 projects

PROJECT: AQTION

(Advanced quantum computing with trapped ions)

Coordinating Institution:

UNIVERSITAET INNSBRUCK

Coordinator: Thomas Monz

PROJECT: OpenSuperQ

(An Open Superconducting Quantum Computer)

Coordinating Institution:

UNIVERSITAT DES SAARLANDES

Coordinator: Frank Wilhelm-Mauch

PROJECT: NEASQC

(NExt ApplicationS of Quantum Computing)

Coordinating Institution:

Atos (Bull SAS)

Coordinator: Pascale Bernier-Bruna

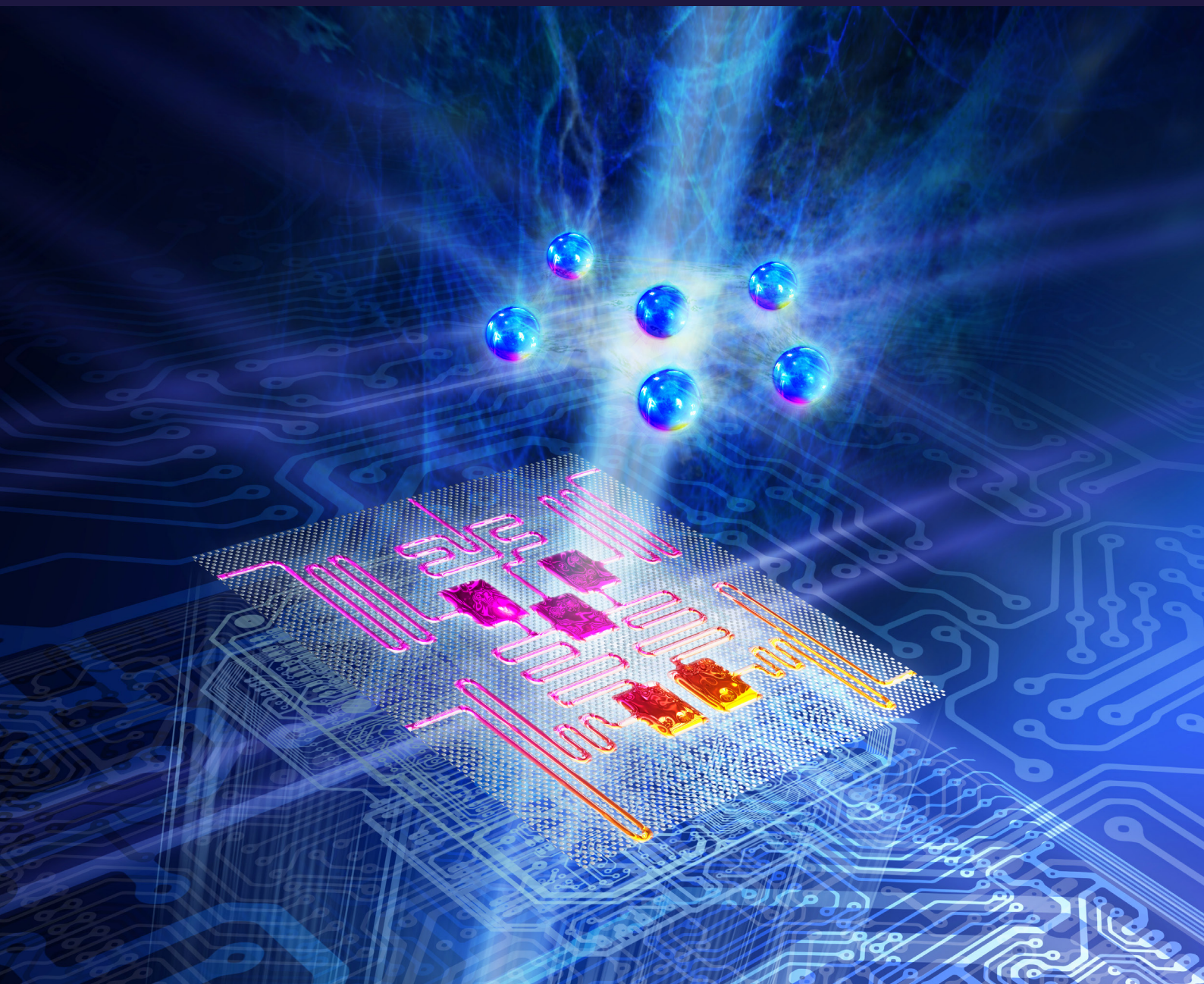
PROJECT: QSLI

(Quantum Large Scale Integration in Silicon)

Coordinating Institution:

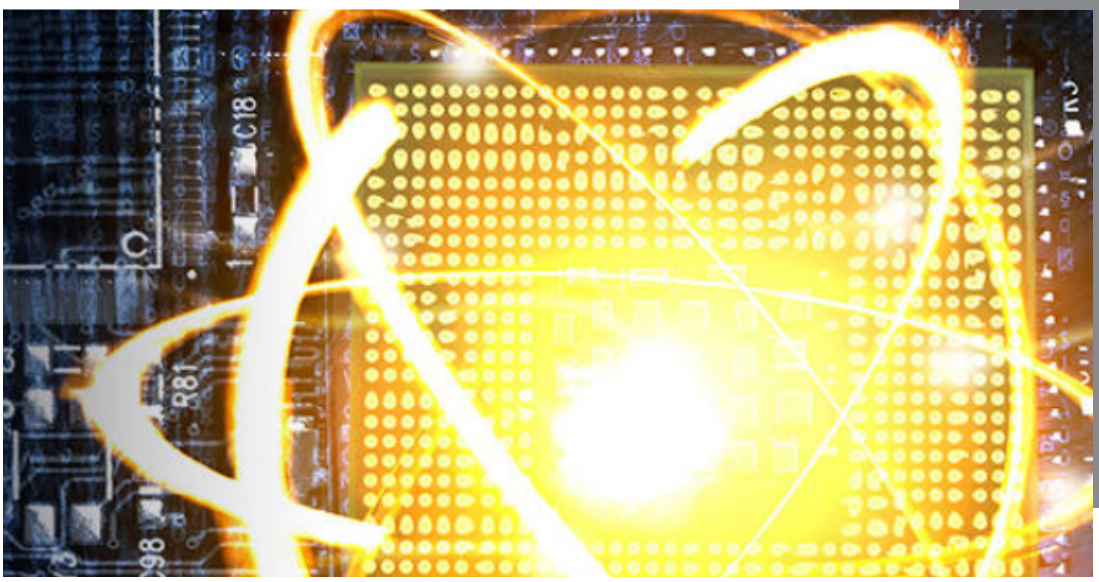
CEA, France

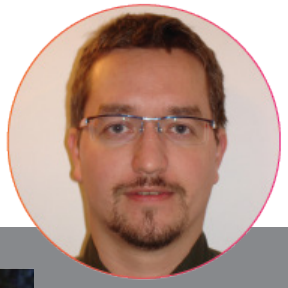
Coordinator: Eric Mercier



PROJECT: AQTION
(Advanced quantum computing with trapped ions)
Coordinating Institution:
UNIVERSITAET INNSBRUCK
Coordinator: Thomas Monz

https://www.aqtion.eu/





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About the Project

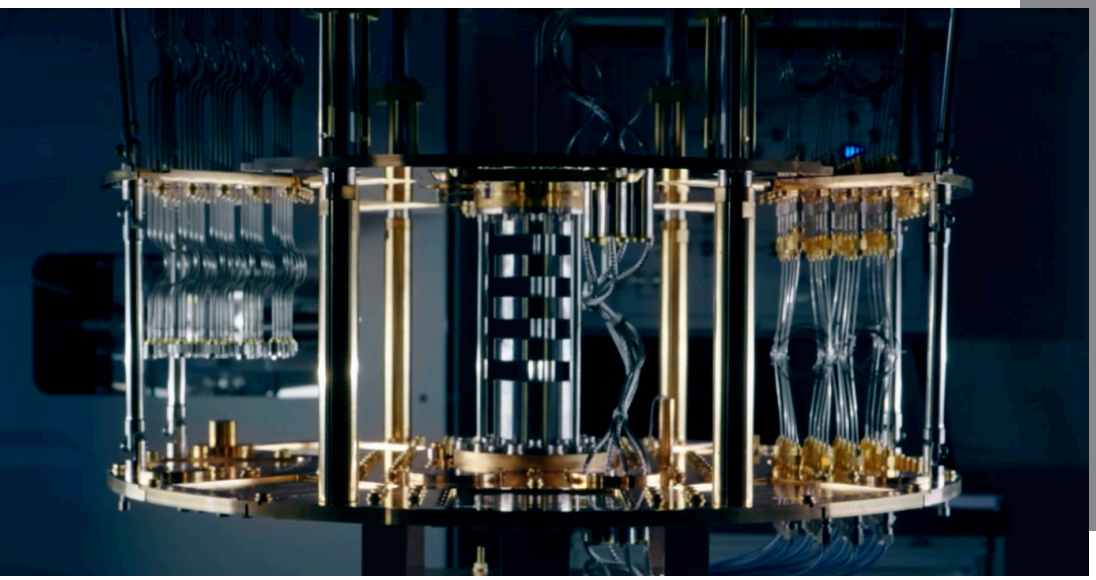
This project focuses on scalability, availability, and applicability aspects of trapped-ion quantum computers, tackling the transition from current laboratory-based experiments to industry-grade quantum computing technologies. The project is providing the technological framework for quantum computers to solve real-world problems inaccessible to current classical computers.

Taking advantage of the unrivalled low error rates of operations available in trapped-ion quantum processors today, they are developing a fully connected 50-qubit device, allowing the implementation of calculations that are out of the reach of classical computers. The system will enable straightforward high-level user access via a robust hardware and software stack, allowing remote execution of complex algorithms without hardware-specific knowledge. The project is paving the way to large-scale and fault-tolerant quantum computing by introducing long-range connectivity via ion-shuttling between sub-processors and by establishing remote operations between quantum processors using photonic interconnects. These scalable techniques will make systems exceeding thousands of qubits possible, in combination with error correction and entanglement purification techniques. Within this project, the consortium is combining these quantum information techniques with trap fabrication and packaging technologies which integrate optical and electronic components to achieve stable long-term operation in an industrial environment.

These scientific and technological advances will provide a powerful platform to demonstrate trapped-ion quantum computers capable of solving problems of major commercial importance including computational problems in chemistry and machine learning.

PROJECT: OpenSuperQ
(An Open Superconducting Quantum Computer)
Coordinating Institution:
UNIVERSITAT DES SAARLANDES
Coordinator: Frank Wilhelm-Mauch

http://opensuperq.eu/



Spokesperson
Frank Wilhelm-Mauch

Spoken Languages
German, English, French

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Photo credit: @Thorsten_Mohr

About the Project

OpenSuperQ is developing a full-stack quantum computing system of up to 100 qubits and to sustainably make it available at a central site for external users.

This system will be applied to tasks of quantum simulation in quantum chemistry which serve as a high-level benchmark, and to problems related to optimization and machine learning. The core of the system is a processor of superconducting qubits of the planar transmon type, with a square 2D layout and nearest-neighbour connectivity. The processor will be packaged with a control chip and integrated in a custom-made cryogenic system.

This quantum computing system aims to be equipped with integrated control soft- and hardware ready for applications. The computer will be among the leading platforms in the world, and the first of its kind in Europe. A distinguishing and globally unique feature of OpenSuperQ is its open approach ready to serve a large community of users of the system as well as of underlying technologies.

The OpenSuperQ consortium works in a collaborative way with broad distribution of tasks and brings together theoretical and experimental teams, a central site including a high-performance computing centre, and technology companies. It is supported by an advisory board, a basic science group, and a user board. This broad approach leads to near-term exploitation, multi-level communication and aims to develop interfaces and standards made available to the quantum technology community at large.

PROJECT: NEASQC
(NExt ApplicationS of Quantum Computin)
Coordinating Institution:
Atos (Bull SAS)
Coordinator: Pascale Bernier-Bruna

https://www.neasqc.eu/

Spokesperson
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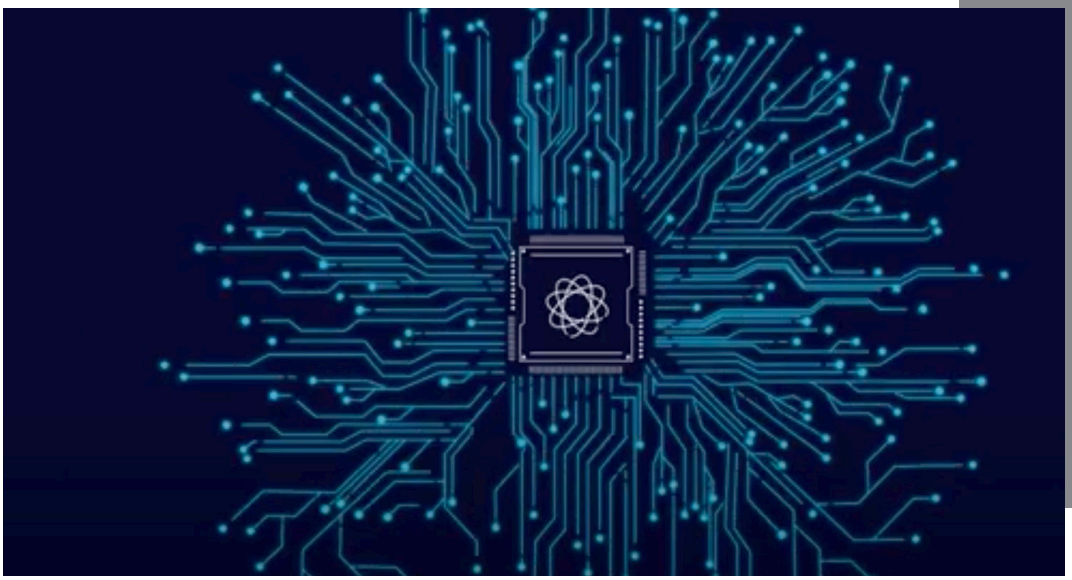

About the Project

NEASQC aims at demonstrating that, though the millions of qubits that will guarantee fully fault-tolerant quantum computing are still far away, there are practical use cases for the NISQ (Noise Intermediate-Scale Quantum) devices that will be available in the near future.

NISQ computing can deliver significant advantages when running certain applications, thus bringing game-changing benefits to users, and particularly industrial users.

The NEASQC consortium has chosen a wide selection of NISQ-compatible industrial and Financial use-cases, and is developing new quantum software techniques to solve those use-cases with a practical quantum advantage. To achieve this, the project brings together an unprecedented multidisciplinary consortium of academic and industry experts in Quantum Computing, High Performance Computing, Artificial Intelligence, Chemistry...

The ultimate ambition of NEASQC is to encourage European user communities to investigate NISQ quantum computing. For this purpose, the project consortium will define and make available a complete and common toolset that new industrial actors can use to start their own practical investigation and share their results.

PROJECT: QLSI

Quantum Large Scale Integretion in Silicon

Coordinating Institution:

Atos (Bull SAS)

Coordinator: Eric Mercier

Spokesperson
Eric Mercier

Spoken Languages
English, French

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About the Project

Quantum computers could provide breakthroughs in many disciplines. However, the number of qubits needed for a useful quantum computer, one that could compete with a classical PC in solving complex computational problems, is in the hundreds of thousands. Silicon spin qubits are an appealing alternative to competing qubit technologies.

The project aims to demonstrate that silicon spin qubits are a compelling platform for scaling to very large numbers of qubits. Demonstration activities will focus on the following:

- Demonstration of high-fidelity (>99%) single and two-qubit gates, read-out and initialization;

- Demonstration of a quantum computer prototype, with online open-access for the community (up to 8 qubits available online);

- Documentation of the detailed requirements to address scalability towards large systems >1000 qubits.

To achieve these results, the consortium brings together an unrivalled multidisciplinary team of European groups in academia, RTOs and industry working on silicon-based quantum devices. These groups are committed to playing an active part in developing the industrial ecosystem in silicon-based quantum technologies.

QUANTUM Basic Science

7 projects

PROJECT: S2QUIP
(Scalable Two-Dimensional Quantum Integrated Photonics)
Coordinating Institution:
KUNGLIGA TEKNISKA HOEGSKOLAN
Coordinator: Klaus Jöns

PROJECT: 2D-SIPC
(Two-dimensional quantum materials and devices for scalable integrated photonic circuits)
Coordinating Institution:
ICFO - THE INSTITUTE OF PHOTONIC SCIENCES
Coordinator: Dmitri Efetov

PROJECT: QMiCS
(Quantum Microwave Communcation and Sensing)
Coordinating Institution:
BAYERISCHE AKADEMIE DER WISSENSCHAFTEN
Coordinator: Frank Deppe

PROJECT: SQUARE
(Scalable Rare Earth Ion Quantum Computing Nodes)
Coordinating Institution:
KARLSRUHER INSTITUT FUER TECHNOLOGIE
Coordinator: David Hunger

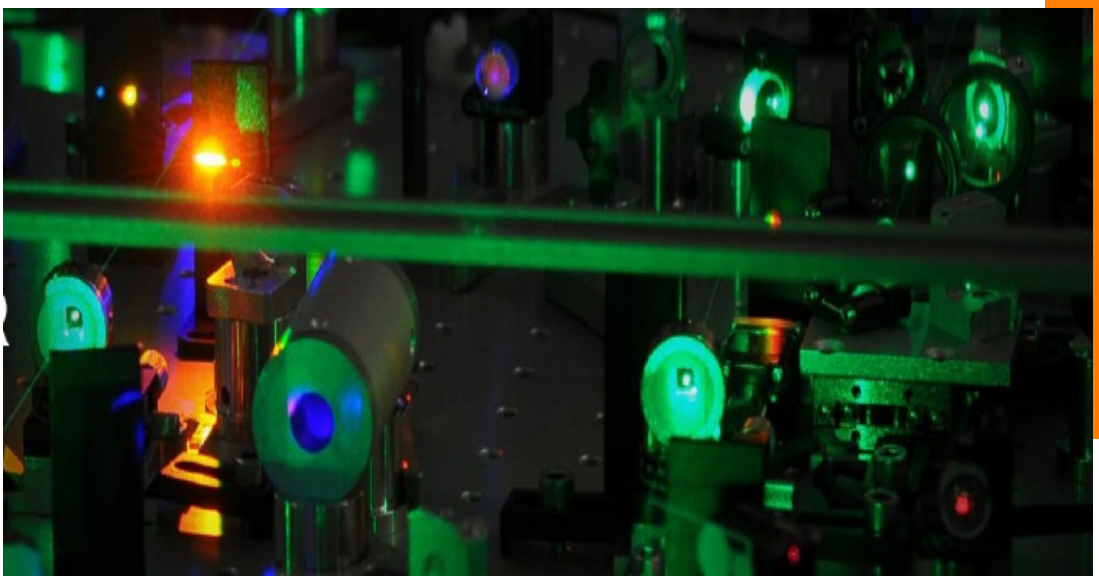
PROJECT: PhoG
(Sub-Poissonian Photon Gun by Coherent Diffusive Photonics)
Coordinating Institution:
THE UNIVERSITY COURT OF THE UNIVERSITY OF ST ANDREWS
Coordinator: Natalia Korolkova

PROJECT: PhoQuS
(Photons for Quantum Simulation)
Coordinating Institution:
SORBONNE UNIVERSITE
Coordinator: Alberto Bramati

PROJECT: MicroQC
(Microwave driven ion trap quantum computing)
Coordinating Institution:
FOUNDATION FOR THEORETICAL AND COMPUTATIONAL PHYSICS AND ASTROPHYSICS
Coordinator: Nikolay Vitanov

PROJECT: S2QUIP
(Scalable Two-Dimensional Quantum Integrated Photonics)
Coordinating Institution:
KUNGLIGA TEKNISKA HOEGSKOLAN
Coordinator: Klaus Jöns

https://s2quip.eu/



Spokesperson
Klaus Jöns

Spoken Languages
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About the Project

S2QUIP is introducing a paradigm shift in the development of scalable cost-effective integrated-chip quantum light sources. Scalable quantum light sources are of significant importance for the future quantum photonics technology applications.

Current technologies still lack on-chip scalability due to the cumbersome integration of quantum light sources (e.g. quantum dots or crystal defects) that require a high-quality bulk matrix environment to operate.

Here, S2QUIP is using atomically flat two-dimensional (2D) layered semiconductors to provide maximum flexibility for incorporation of quantum light sources into scalable photonic chip architectures using surface processing instead of bulk processing.

Single and entangled photons are being deterministically generated using 2D semiconductors and efficiently coupled to on-chip cavities and multiplexed using integrated waveguides, switches, and beam-splitters.

This approach aims to allow the demonstration of useful entangled photon states in a deterministic and scalable fashion that far surpasses the state-of-the-art using bulk semiconductors and optics. S2QUIP's ambitious goal is to achieve 20 multiplexed quantum light sources that can fulfil the long-awaited expectation of scalable on-chip quantum light sources for numerous quantum technologies (e.g., large-scale quantum computation, communication and sensing).

PROJECT: 2D-SIPC
(Two-dimensional quantum materials and devices for scalable integrated photonic circuits)
Coordinating Institution:
ICFO - THE INSTITUTE OF PHOTONIC SCIENCES
Coordinator: Dmitri Efetov

http://2d-sipc.eu/

Spokesperson
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Spoken Languages
English, German, Russian

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About the Project

The proposed project aims at developing scalable quantum networks, based on photonic chip integration of novel 2D material quantum devices, with the main goal to demonstrate all-optical on-chip quantum processing. The recent demonstration of effortless integration of 2D materials onto photonics and CMOS platforms will result in a breakthrough in the development of on-chip quantum networks.

2D-SIPC is taking full advantage of the huge variety of 2D materials and heterostructures and prototype novel quantum devices with revolutionary functionalities. In particular, they are developing electrically driven and entangled single photon emitters, broadband and high temperature single photon detectors, ultra-fast waveguide integrated optical modulators and non-linear gates.

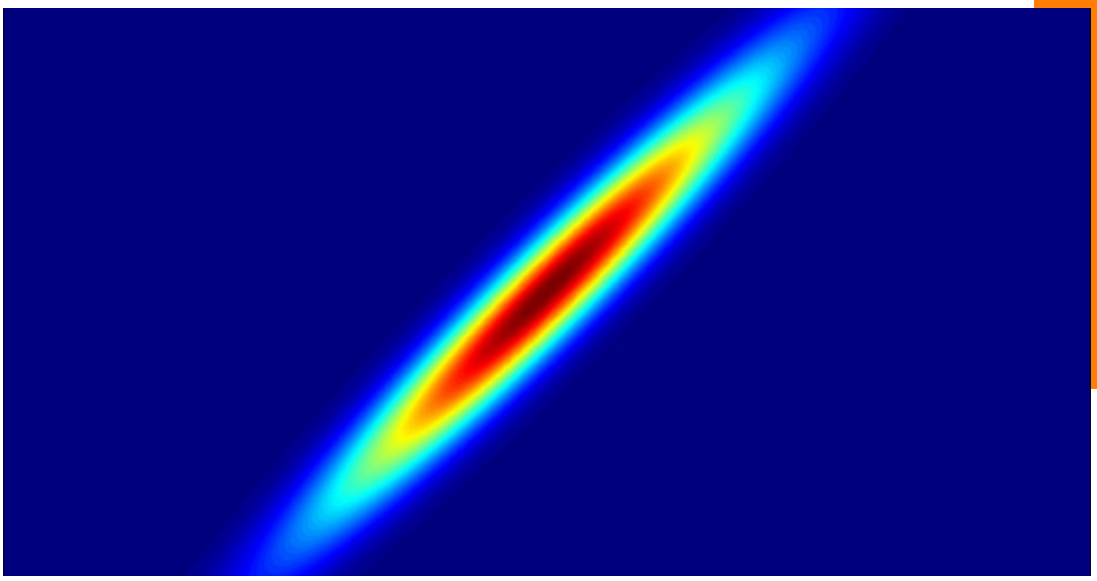
To pave the way to scalable networks, 2D-SIPC is developing large scale growth techniques of the most promising 2D materials. With the project will allow the first demonstration of on-chip optical quantum processing, a key milestone for many quantum network concepts, such as extended secure quantum communication, scaling up of quantum computers and simulators, and novel quantum sensing applications with entangled photons.

Beyond the 2D-SIPC platform, each developed component will be exploited in such distant fields as biological and medical imaging, radio-astronomy and environmental monitoring.

The 2D-SIPC consortium includes four academic and one industrial partner with a high degree of complementarity that are at the forefronts of their fields, including single photon detection (ICFO), theory and fabrication of 2D materials and their heterostructures (UNIMAN), single photon emission (UCAM), chip based photonic circuits (CNIT) and commercial single photon detection, single photon emission and packaging (SQ).

PROJECT: QMiCS
(Quantum Microwave Communcation and Sensing)
Coordinating Institution:
BAYERISCHE AKADEMIE DER WISSENSCHAFTEN
Coordinator: Frank Deppe

https://qmics.wmi.badw.de/



Spokesperson
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About the Project

The mission of QMiCS is to combine European expertise and lead the efforts in developing novel components, experimental techniques, and theory models building on the quantum properties of continuous-variable propagating microwaves. QMiCS' long-term visions are

(i) distributed quantum computing & communication via microwave quantum local area networks (QLANs) and

(ii) sensing applications based on the illumination of an object with quantum microwaves (quantum radar).

With respect to key quantum computing platforms (superconducting circuits, NV centres, quantum dots), microwaves intrinsically allow for zero frequency conversion loss since they are the natural frequency scale. They can be distributed via superconducting cables with surprisingly little losses, eventually allowing for quantum communication and cryptography applications. Radar works at gigahertz frequencies because of the atmospheric transparency windows anyways.

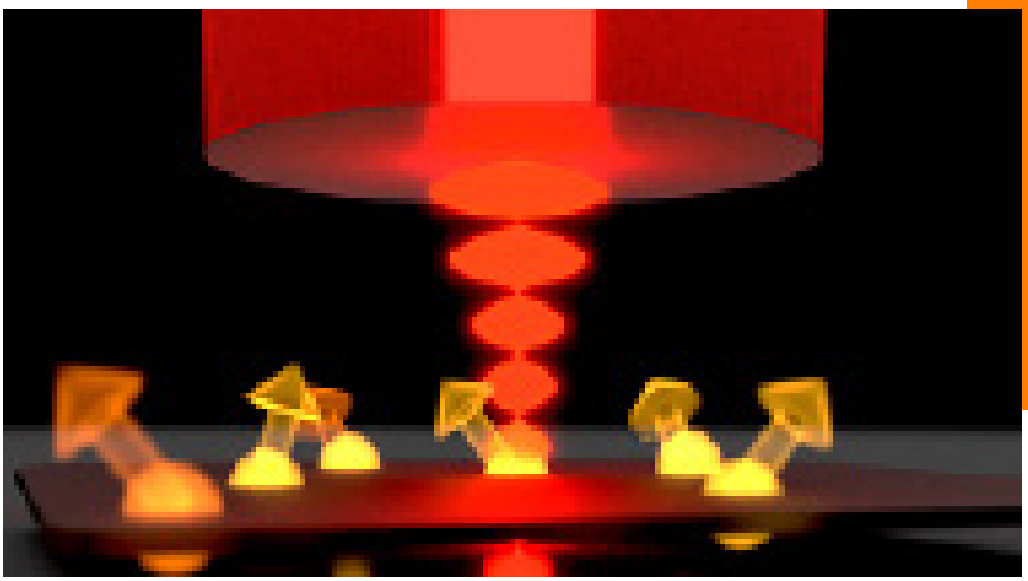
Scientifically, QMiCS is targeting a QLAN demonstration via quantum teleportation, a quantum advantage in microwave illumination, and a roadmap to real-life applications for the second/third phase of the QT Flagship.

Beneath these three grand goals lies a strong component of disruptive enabling technology provided by two full and one external industry partner: the development of a microwave QLAN cable connecting the millikevin stages of two dilution refrigerators, improved cryogenic semiconductor amplifiers, and packaged pre-quantum ultrasensitive microwave detectors. The resulting ""enabling"" commercial products are beneficial for quantum technologies at microwave frequencies in general.

Finally, QMiCS fosters awareness in industry about the revolutionary business potential of quantum microwave technologies, especially via the advisory third parties "Airbus Defence and Space Ltd" and "Cisco Systems GmbH". In this way, QMiCS helps placing Europe at the forefront of the second quantum revolution and kick-starting a competitive European quantum industry.

PROJECT: SQUARE
(Scalable Rare Earth Ion Quantum Computing Nodes)
Coordinating Institution:
KARLSRUHER INSTITUT FUER TECHNOLOGIE
Coordinator: David Hunger

http://square.phi.kit.edu/



Spokesperson
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About the Project

Quantum technologies rely on materials that offer the central resource of quantum coherence, that allow one to control this resource, and that provide suitable interactions to create entanglement.

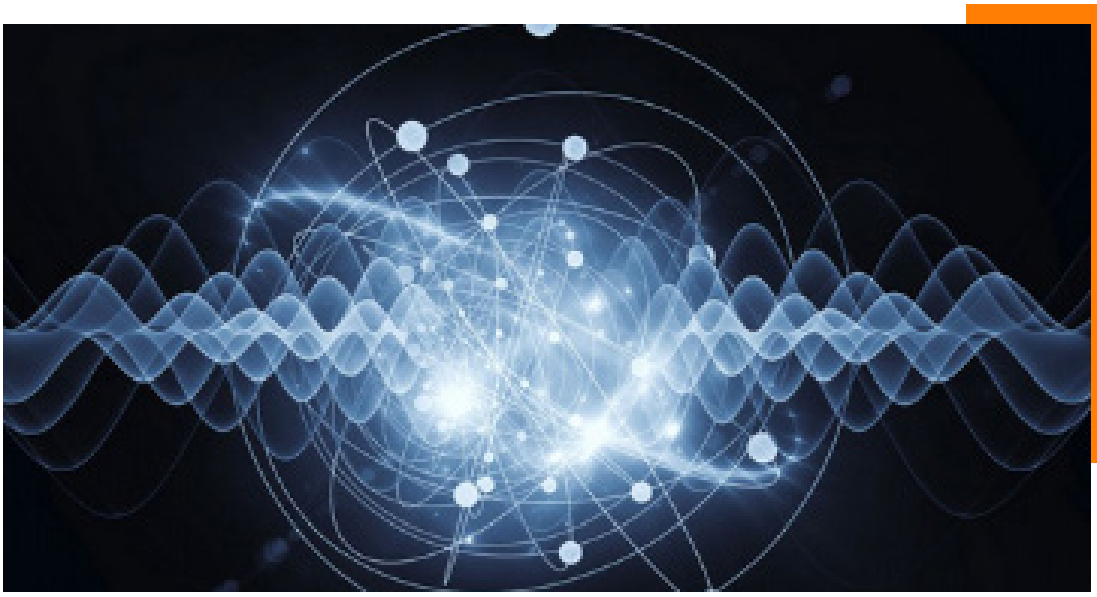
Rare earth ions (REI) doped into solids have an outstanding potential in this context and could serve as a scalable, multi-functional quantum material. REI provide a unique physical system enabling a quantum register with a large number of qubits, strong dipolar interactions between the qubits allowing fast quantum gates, and coupling to optical photons – including telecom wavelengths – opening the door to connect quantum processors in a quantum network.

This project is establishing individually addressable rare earth ions as a fundamental building block of a quantum computer, and to overcome the main roadblocks on the way towards scalable quantum hardware.

The goal is to realize the basic elements of a multifunctional quantum processor node, where multiple qubits can be used for quantum storage, quantum gates, and for coherent spin-photon quantum state mapping. Novel schemes and protocols targeting a scalable architecture will be developed. The central photonic elements that enable efficient single ion addressing will be engineered into deployable technologies.

PROJECT: PhoG
(Sub-Poissonian Photon Gun by Coherent Diffusive Photonics)
Coordinating Institution:
THE UNIVERSITY COURT OF THE UNIVERSITY OF ST ANDREWS
Coordinator: Natalia Korolkova

https://www.st-andrews.ac.uk/~phog/



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About the Project

The project is delivering deterministic compact sources of highly non-classical states, from sub-Poissonian light to multi-mode entanglement, all utilizing a solitary technological platform.

The project is building working prototypes and developing the technology foundation for applications of these sources in an advanced optical imaging and metrology. The proposed sources are based on a novel paradigm in photonic devices: diffusive coherent photonics operating with dissipatively coupled photonic circuits.

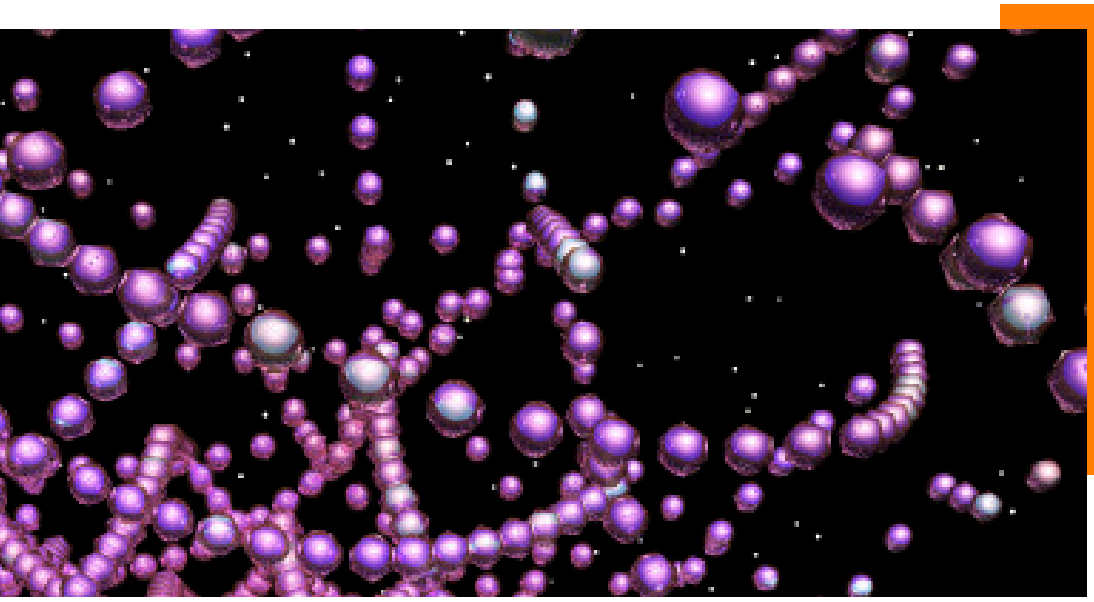
The project is demonstrating that light can flow diffusively retaining coherence and even entanglement, be effectively equalized, distributed in a controlled way or even localized in perfectly periodic structures by means of dissipative coupling. Such unique light propagation regimes will be realized with the help of a photonic analogue of a tight-binding lattice using coupled waveguide networks in linear and non-linear glass materials. These coherent photonic devices are being fabricated by ultrafast laser inscription, and the dissipative coupling implemented by mutually coupling each pair of waveguides in the chain to a linear arrangement of waveguides. Efficient quantum diagnostics methods are being developed to verify the source characteristics and to assess their technological readiness. They expect coherent diffusive photonic devices to find applications in photonic networks and in a range of metrology tasks, potentially also for simulations of complex quantum dynamics.

Goals of the project

1) to implement a family of compact sub-Poissonian photon guns, capable of robust generation of mesoscopic non-classical and entangled states;

2) to perform a feasibility study of their applications in entanglement-enhanced imaging and atomic clocks aiming at the 2 times better clock frequency stability.

PROJECT: PhoQuS
(Photons for Quantum Simulation)
Coordinating Institution:
SORBONNE UNIVERSITE
Coordinator: Alberto Bramati



Spokesperson
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Spoken Languages
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About the Project

Quantum simulation is an emerging and exciting field for which several systems, such as ultracold-atoms, trapped ions or superconducting circuits are being actively investigated.

In this project the team aims to to develop a novel platform for quantum simulation, based on photonic quantum fluids. Quantum fluids of light can be realised in different photonic systems with suitable nonlinearities, thus engineering an effective photon-photon interaction.

The photon-photon interaction necessary to form a superfluid is provided by the optical nonlinearity of the medium. Firstly they are fully characterizing the superfluid and quantum turbulent regimes for quantum fluids of light, investigating the propagation in optically controlled landscapes with the demonstration of important milestones such as many-body localization and the superfluid to Mott–insulator transition.

Based on these achievements and on the unprecedented flexibility offered by the all- optical control in quantum fluids of light, they aim to implement quantum simulations and simulate systems of very different nature, ranging from astrophysics to condensed matter.

Fundamental open questions such as superconductivity, black hole physics, and quantum gravity seek to be addressed within the photon fluid platform.

PROJECT: MicroQC
(Microwave driven ion trap quantum computing)
Coordinating Institution:
FOUNDATION FOR THEORETICAL AND COMPUTATIONAL PHYSICS AND ASTROPHYSICS
Coordinator: Nikolay Vitanov

http://microqc.eu/

Spokesperson
Nikolay V. Vitanov

Spoken Languages
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About the Project

The construction of a large-scale trapped-ion quantum information processor can be made decisively simpler by using the well-developed and compact microwave technology present already in today's mobile phones and other devices. Microwave technology has tremendous simplification potential by condensing experimental effort from an optical table with several square meters of accurately aligned optical components down to an engineered conductor microstructure embedded into a chip surface and a few off-the-shelve microwave components.

Thus, this technology can be the key enabling step for addressing the formidable challenge of a scalable quantum processor. Although the field is still in its infancy, there is rapid progress: a fidelity of over 99.9999% has been achieved for single-qubit gates and 99.7% for two-qubit gates. This technology allows execution of quantum gates by the application of a voltage to a microchip potentially replacing millions of laser beams and it can operate at room temperature or mild cooling.

There are still enormous technical challenges in scaling ion trap (or any other) systems up to the millions of qubits required to implement meaningful full-sale quantum computation and simulation. The main objective of MicroQC is to demonstrate, through state-of-art quantum engineering, fast and fault-tolerant microwave two-qubit and multi-qubit gates and to design scalable technology components that apply these techniques in multi-qubit quantum processors.

The successful accomplishment of these objectives, in a combined effort by five leading groups in this field – three experimental groups, including the pioneers in microwave quantum logic with static and oscillating magnetic gradients, and two leading theory groups – will make large-scale quantum computation and simulation with microwave-controlled microfabricated ion traps possible. In addition, MicroQC will produce a roadmap, to take microwave quantum computation to high technology readiness levels.

THE QUANTUM COMMUNITY NETWORK AND THE CSA

Quantum Community Network

In order to be able to engage the large number of stakeholders in Europe appropriately, the Quantum Support Action (QSA) has established a network of multipliers, the Quantum Community Network (QCN).

The QCN is composed of distinguished members of the Quantum Technology (QT) community, who have agreed to commit to liaising with their national stakeholders and build the links to the QSA.

QCN members are encouraged to carry out the following actions:

Collect and share information and/or best practices on QT-relevant activities in their

Help coordinate the interaction between the Flagship and National Initiatives

Assist in the promotion of gender equality in science

Provide, upon request, additional information about activities, regulation etc. in their country

List of the current QCN members

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The CSA team

The CSA team's aims to continue the coordination and support actions established by the previous QSA team and ensure the success of the initiative.

WP1 Strategy and Structuring

WP1 will update the strategic research agenda and related technical roadmaps for the QT community and the QT Flagship, as well as define and evaluate benchmarks for the QT Flagship to better understand its status and progress towards its main objectives. We will coordinate the community and community events by identifying and supporting activities that help it to grow and identify synergies that can accelerate RDI. It will actively work towards significant improvement in gender equality in the field, through a wide range of activities and programs, coordinating both on a National and European level.

Leader: **Dr. Rob Thew (University of Geneva, CH)**

E. Robert.Thew@unige.ch

WP2 Innovation and Infrastructure

WP2 will strengthen connections and interaction between academia and industry, aimed at innovation and infrastructure. We will facilitate the transfer of results from academic research to industry, as well as knowhow in the opposite direction, and foster the applications of Quantum Technology.

Leader: **Dr. Rogier Verberk**

E. rogier.verberk@tno.nl

WP3 Applications and Markets

WP3 will foster the development of Quantum Technology (QT) applications and accelerate a broad adoption by industry, including start-ups. The task aims at easing the adoption of QT by industry by making relevant information easily available, bringing stakeholders together, and dealing with IPR. The impact will be enhanced through an active identification of new use cases in cooperation with end-users. The focus is on (a) research and high-tech organizations needing ultimate performances and on (b) industries looking for new products and services for their customers.

Leader: **Dr. Hab. Philippe Chomaz**

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WP4 Education, Training and Outreach

WP4 will promote European curricula in Q-engineering and coordinate education activities, and identify future training needs through transformation of value-chains. It will also aim to reach out to citizens and all stakeholders promoting societal, scientific and economic impact of QT and develop international outreach, partnerships and strategy sharing on QT.

Leader: **Dr. Chiara Macchiavello (Consiglio Nazionale delle Ricerche)**

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WP5 QT Flagship Governance & National QT Programme Cooperation & WP6 Management

WP5 will provide support to the QT Flagship Governance – guarantee inclusive, open, transparent and efficient strategy development and implementation. It will coordinate European QT Flagship activities with National Programmes – create synergies and leverage impact.

Leader: **Dr. Markus Wilkens**

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