QuSoft

Research Center for Quantum Software

2023 ANNUAL REPORT

QuSoft Annual Report 2023

Key Organizational Developments

The year 2023 was marked by significant achievements and changes for QuSoft. Most importantly 2023 marked a change in the leadership of QuSoft. In September, Kareljan Schoutens stepped down from his position as director, and Christian Schaffner assumed the role. Later in December, Harry Buhrman also left his directorship and departed from CWI to join Quantinuum as the Chief Scientist for Algorithms and Innovation, based in London.

The organization celebrated several individual achievements this year. Pietro Richelli was awarded the QuSoft master certificate, recognizing his outstanding contributions to the field. Additionally, Stacey Jeffery and Julia Cramer received the prestigious Quantum Delta award for their work with Women in Quantum Development (WIQD), highlighting their significant impact on the field.

Ronald de Wolf is the first (and so far only) Dutch winner of the Gödel Prize, for his contributions to theoretical computer science, an accolade that underscores the high calibre of research being conducted at QuSoft. In April, QuSoft/UvA researchers had the distinguished honour of hosting King Willem-Alexander of the Netherlands and French President Emmanuel Macron, showcasing their groundbreaking work and received as a present a demo of giant qubits developed by the Quantum Experience team.

Freek Witteveen received the Stieltjes Prize for 2021-2022, a recognition of his exceptional research contributions. The University of Amsterdam (UvA) also made strides in infrastructure development by selecting the design by architecture firm Cepezed for the new LabQ building dedicated to quantum science.

Among other notable achievements, Jonas Helsen received an NWO VENI grant for his work on "Random quantum circuits: theory and applications for quantum computers."

Events

QuSoft organized and participated in numerous events throughout the year, furthering its mission to advance quantum research and collaboration. The Quantum Information Processing (QIP) conference in February kicked off a year filled with significant gatherings.

On April 12th, QuSoft had the honor of hosting a visit by King Willem-Alexander and French President Emmanuel Macron, which provided a high-profile opportunity to demonstrate QuSoft's cutting-edge research.

This visit focused on the Dutch-French collaboration on quantum and other fields, highlighting the importance of developing an open European strategic autonomy in quantum, to make the EU less dependent and more secure.

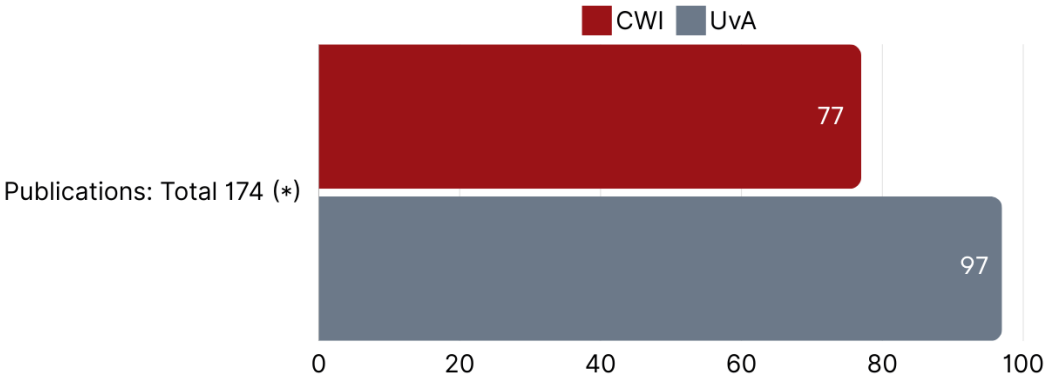
On April 14th, in occasion of the World Quantum Day, the Quantum Experience opened its doors for the first time. From May 30th to June 1st, the QuSoft Science Retreat fostered in-depth discussions and collaborations among researchers. WIQD's annual symposium "Diversify Yourself!" on June 13th promoted diversity in the quantum computing field. The following day, "The Next Q: Meet the Quantum

Startups" featured a popular talk by Michele Mosca, highlighting the burgeoning startup scene in quantum technologies. The eventful month of June also included Quantum Meets 2023 from June 12th-16th, bringing together leading experts in quantum technologies, and the 9th General Assembly of the Quantum Software Consortium (QSC) in Leiden on June 23rd. This was followed by the 4th Quantum Training on quantum-safe cryptography on June 29th. In November, QuSoft hosted the 10th General Assembly of the QSC at OBA, Amsterdam on the 16th, and later in the month, the Masterclass 'Introduction to Quantum Computing' on November 28th and 29th.

Infographics

QuSoft continues to grow, with the following key statistics for 2023: the organization comprised 96 people. This includes 37 senior researchers, 13 postdoctoral researchers, 37 PhD students, and 9 support staff. Employment distribution showes 64 individuals at UvA, 26 at CWI, and 3 at other institutions. Regarding gender distribution, there were 20 males and 10 females among those who indicated their gender. The international makeup of the team was balanced, with 38 individuals of Dutch origin and 40 of international origin. In terms of academic output, QuSoft researchers produced a total of 174 publications, with 77 from CWI and 97 from UvA. Considering the collaborative nature of these works, it is estimated that around 104-122 unique publications were made, accounting for a 30-40% overlap due to collaborations. Here are some graphics to summarize the data (page 4 and 5).

PUBLICATIONS



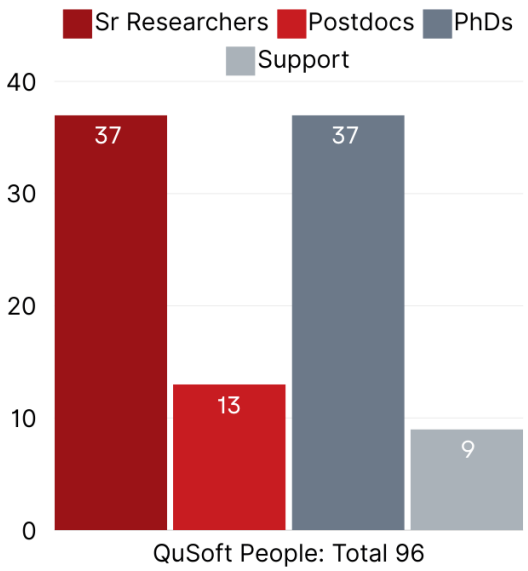
Publications were checked using CWI repository (https://ir.cwi.nl) and Google Scholar with author names from source file in 2023

(*) There is definitely a lot of double counting due to collaborations (about 30%-40% of the articles). Most likely, there were 104-122 unique publications for QuSoft in 2023 (we had ~100 for the previous years).

FINANCIAL TABLE

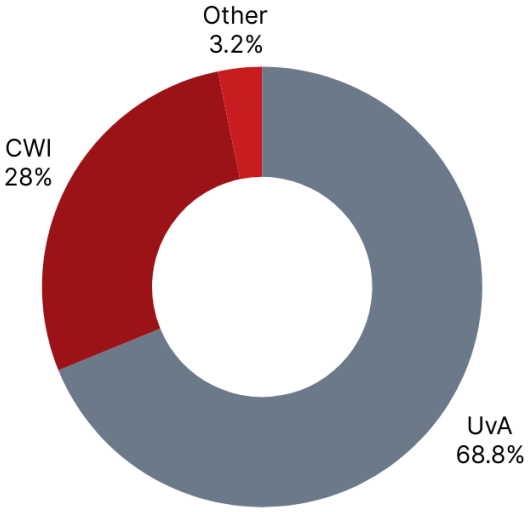
QUSOFT BUDGET TURNOVER 2023 (CWI) (K€)			
Benefits		**Costs**	
CWI Basic Funding	727	Personnel, Scientific	1.437
External Project funding	1.004	Personnel, Support	154
		Housing and Other	140
Total	1.731	**Total**	1.731
QUSOFT BUDGET TURNOVER 2023 (UVA) (K€)			
Benefits		**Costs**	
QM&QI budget 2023	547	Personnel, Scientific	1.114
Q.A services	11	Personnel, Support	204
External funding	1185	Outsourced	37
Extraction Reserve (<2023)	3	Other Expenses	391
Total	1.746	**Total**	1.746
Grand Total	3.477	**Grand Total**	3.477

QUSOFT PEOPLE



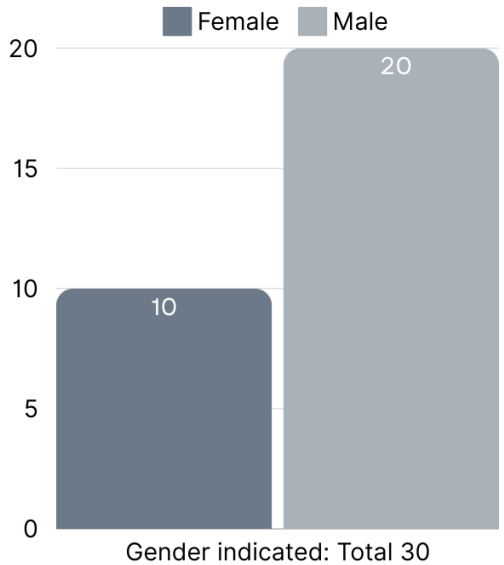
QuSoft People: Total 96

EMPLOYMENT



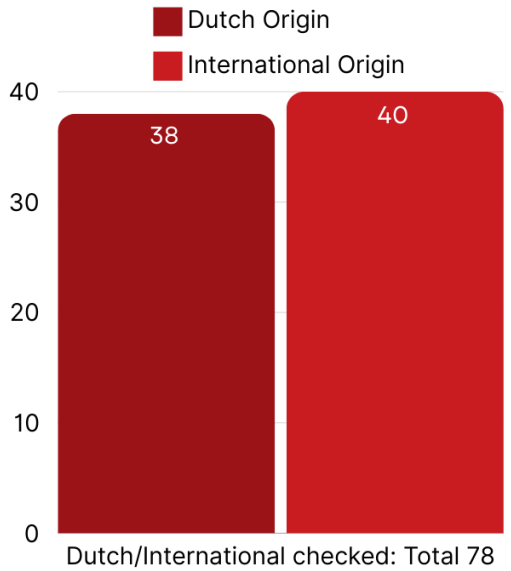
Employment checked: Total 93

GENDER



Gender indicated: Total 30

DUTCH/INTERNATIONAL



Dutch/International checked: Total 78

Collaborations

QAL (Quantum Application Lab)

The Quantum Application Lab (QAL) has been significantly active in securing grants and fostering collaborations in 2023. Notably, QAL secured a SESA Grant from the Amsterdam Municipality amounting to €1.2 million in November 2023. This grant aims to support quantum computing application development.[1]

In addition, QAL received a substantial grant of €600,000 from QDNL to work on application development. This project includes partnerships with Toyota Motor Europe, Wageningen University & Research, Twente University, and Quix Quantum.[2]

Moreover, QAL organized an Open Call for Science Application Development proposals, supporting a project on brick wall circuits in collaboration with UvA, led by Alberto Zorzato and Kareljan Schoutens.[3]

Throughout 2023, QAL collaborated with several key partners, including:

- Toyota Motor Europe

- Wageningen University & Research

- Twente University

- Quix Quantum

- Alliander

Quantum.Amsterdam

Quantum.Amsterdam has played a pivotal role in promoting the Amsterdam quantum ecosystem through various events and media engagements. For instance, an event in collaboration with The Next Web aimed to spotlight Amsterdam's quantum advancements.[4]

Koen Groenland delivered a public talk at the AG TechFest on September 20th, 2023.[5] Additionally, Richard van Harderwijk spoke about Quantum Applications at the MinacNed International Conference held on October 28th-29th, 2023.***[6]

[1] https://quantumapplicationlab.com/2023/11/23/quantum-application-lab-secures-sesa-grant-for-quantum-computing-application-development/
[2] https://quantumapplicationlab.com/2023/10/26/large-grant-awarded-to-quantum-application-lab/
[3] https://quantumapplicationlab.com/2023/05/17/quantum-application-lab-open-call-for-science/
[4] https://siliconcanals.com/amsterdam-the-next-q-quantum-computing-event/
[5] https://web.archive.org/web/20230928021927/https://agtechfest.nl/sessie/hoe-programmeer-je-een-quantumcomputer/
[6] https://web.archive.org/web/20230923140736/https://www.minacned.nl/imnc/

A noteworthy Business Meetup was also organized in collaboration with Amsterdam Science Park, focusing on accelerating quantum technology developments.[7]

QDNL (Quantum Delta NL)

QDNL has been instrumental in funding and supporting quantum research and development. Prominent scientists, including Rene Gerritsma (UvA), Jonas Helsen (CWI), Maris Ozols (CWI), and Florian Schreck (UvA), were granted projects in the 2nd QDNL Actionline 1 "Research & Innovation" call.[8]

Amsterdam Scientific Instruments, a spin-off from Nikhef, received funding in the 2nd QDNL SME Call in July 2023.[9] Furthermore, Kareljan Schoutens and Garazi Muguruza Lasa benefited from the QDNL Visitors program, visiting Oxford and Sorbonne University respectively.[10]

QDNL also launched a national network of four Quantum Talent Learning Centres on November 7th, enhancing talent development across the Netherlands.[11]

QuSoft and its members have remained pivotal in various KATs (Key Application Tracks) and ALs (Action Lines) of QDNL. Key figures include:

- Victor Land: Coordinator AL4, Member IP Pool Team

- Kareljan Schoutens: Member Supervisory Board QDNL

- Philippe Bouyer: Board Member QDNL

- Florian Schreck leading efforts in building a cold-atom quantum computer with TU/e (KAT1) and developing ultra-precise clocks for quantum network timing signals (KAT3)

- Harry Buhman: KAT1 member, coordinatingn Amsterdam activities

- Florian Speelman: KAT2 member, coordinating Amsterdam activities

- Richard van Harderwijk: Member Q3T team

- Vania Lopez Diaz: Community Manager AL4

- Tony Gomez: Management Support Officer AL4

- Doutzen Abma: Member AL3 – Education < 18 years

- Joris van Hoboken: Science Track Leader in AL4

- Multiple PhDs and postdocs conducting research in KAT1, KAT2, and KAT3

[7] https://www.amsterdamsciencepark.nl/
[8] https://quantumdelta.nl/news/10-million-to-19-dutch-daring-quantum-research-projects
[9] https://quantumdelta.nl/news/quantum-delta-nl-sme-call-awards-nearly-5-million-euros-to-winners
[10] https://quantumdelta.nl/news/qdnl-visitor-s-programme-update-kareljan-schoutens-garazi-muguruza-lasa
[11] https://quantumdelta.nl/news/quantum-delta-nl-opens-national-network-of-four-quantum-talent-learning-centres

As a major hire, UvA and TU/e have attracted Philippe Bouyer, who now serves as Director of Research and Technology on the executive board of QDNL. Tony Gomez Perez has joined CWI as a Management Support Officer for the Quantum & Society Actionline and QuSoft, starting December 1.

CQS (Centre for Quantum and Society)

In the fall of 2023, CQS organized an Open Call for impact proposals, resulting in six funded projects across the Dutch quantum ecosystem.[12]

CQS also launched the Topical Collection "Quantum Society" at Springer Nature.[13] Additionally, the Exploratory Quantum Technology Assessment was initiated, highlighting the future implications of quantum technologies.[14]

Furthermore, the Future Scenarios Project was launched, marking a pioneering step into envisioning the quantum future.[15]

QuSoft Education

QuSoft's commitment to education during 2023 sees the finalization of the development of the master's program: the UvA MSc in Quantum Computer Science. This MSc is designed to provide a comprehensive understanding of quantum computing principles and their applications. The program includes a mix of theoretical and practical courses, with opportunities for students to engage in cutting-edge research.

For younger generations, the Quantum Quest online course for high school students[16] was a significant success in 2023. This five-week course allowed students to explore the unique aspects of quantum computers, solve complex puzzles, and learn the mathematics of real quantum algorithms. This edition saw participation from 289 students (ages 16-19) from over 100 high schools worldwide. The course was jointly organized by the QuSoft research centre in Amsterdam and the Cluster of Excellence CASA of the Ruhr-Universität Bochum. Of the 250 international students, 175 passed modules 1-3, and 88 students successfully completed modules 1-5.

Quantum Experience

[12] https://quantumdelta.nl/news/quantum-society-open-call-2023-open-for-submission-from-september-18
[13] https://quantumdelta.nl/news/the-centre-for-quantum-and-society-launches-topical-collection-quantum-society-at-springer-nature-group
[14] https://quantumdelta.nl/news/quantum-delta-nl-launches-exploratory-quantum-technology-assessment-eqta
[15] https://quantumdelta.nl/news/future-scenarios-project-a-pioneering-leap-into-the-quantum-future/
[16] https://www.quantum-quest.org/

In April, the Quantum Experience was inaugurated, with funding coming from QuSoft (CWI & UvA) and QDNL (AL3). Located at Start-Up Village, it offers demonstrations and educational activities, with future expansions planned for the new LabQ building. The project is led by Dr. Giada La Gala, who has a background in quantum physics and ongoing studies in fine arts and design. Giada organizes projects at the intersection of science, art, and design, and she also serves as the science communication officer for QuSoft.

QuSoft Seminars

Throughout 2023, QuSoft hosted an extensive series of seminars, featuring distinguished speakers from various institutions. These seminars provided a platform for sharing knowledge and fostering discussions on the latest developments in quantum research, reflecting QuSoft's dedication to fostering a vibrant academic community and advancing the frontiers of quantum research.

The seminars included:

January 13	John van de Wetering	UvA
January 23	Alex May	Stanford
January 27	Devin Smith	QuiX Quantum, UT Sydney
February 3	Hamoon Mousavi	Columbia University
February 13	Min Hsiu Hsieh	Hon Hai Foxconn
February 14	Sarah Meng Li, Lia Yeh	University of Waterloo, University of Oxford
February 17	András Gilyén	Rényi Institute
March 2	Shashanka Ubaru	IBM Research
March 3	Adrián Pérez Salinas	Leiden University
March 6	Suryajith Chillara	IIIT Hyderabad
March 10	Jordi Weggemans	QuSoft
March 17	Markus Heinrich	Heinrich Heine University Düsseldorf
March 24	Sebastian Feld	QuTech
March 31	Simon Rommel, Kathrin Hövelmanns, Sebastian Verschoor	TU Eindhoven
May 12	Hartmut Klauck	CQT Singapore
May 26	Cécilia Lancien	Institut Fourier Grenoble
June 9	Seenivasan Hariharan	QuSoft
June 14	Michele Mosca (popular talk)	IQC Waterloo
June 16	Llorenç Escolà Farràs	QuSoft
July 7	Léo Colisson	QuSoft
July 21	Yuming Zhao	University of Waterloo
August 11	Mark Jackson	Quantinuum
September 1	Abhinav Deshpande	University of Maryland
September 4	Ronald de Wolf	QuSoft
September 15	Jaap Henk Hoepman	RU Nijmegen
October 6	Daan Camps	QuSoft
October 9	Reuben Lim	QuSoft
October 20	Yingkai Ouyang	Yale NUS College
October 27	Andrea Coladangelo	Caltech
November 10	Jonas Helsen	QuSoft

November 24	Rhea Mehta	University of Michigan
December 1	Kasper Duivenvoorden	QuSoft
December 8	Ross Duncan	Cambridge Quantum Computing

PhD Defenses

Several PhD candidates successfully defended their dissertations this year:

• Subhasree Patro on "Quantum Fine-Grained Complexity" (February 16)

•Arjan Cornelissen on "Quantum Multivariate Estimation and Span Program Algorithms" (February 17)

• Alex Urech on "Single Strontium Atoms in Optical Tweezers" (April 25)

• Matteo Mazzanti on "Trapped Ions in Optical Tweezers" (October 12)

• Ward Vleeshouwers on "Unitary Matrix Integrals, Long-Range Random Walks, and Spectral Statistics" (October 20)

Overall, 2023 was a year of growth, recognition, and collaboration for QuSoft, underscoring its leading role in the quantum computing landscape.