UNIVERSITEIT VAN AMSTERDAM

The Quantum Delta Netherlands initiative

Kareljan Schoutens
QuSoft & Institute for Theoretical Physics
University of Amsterdam

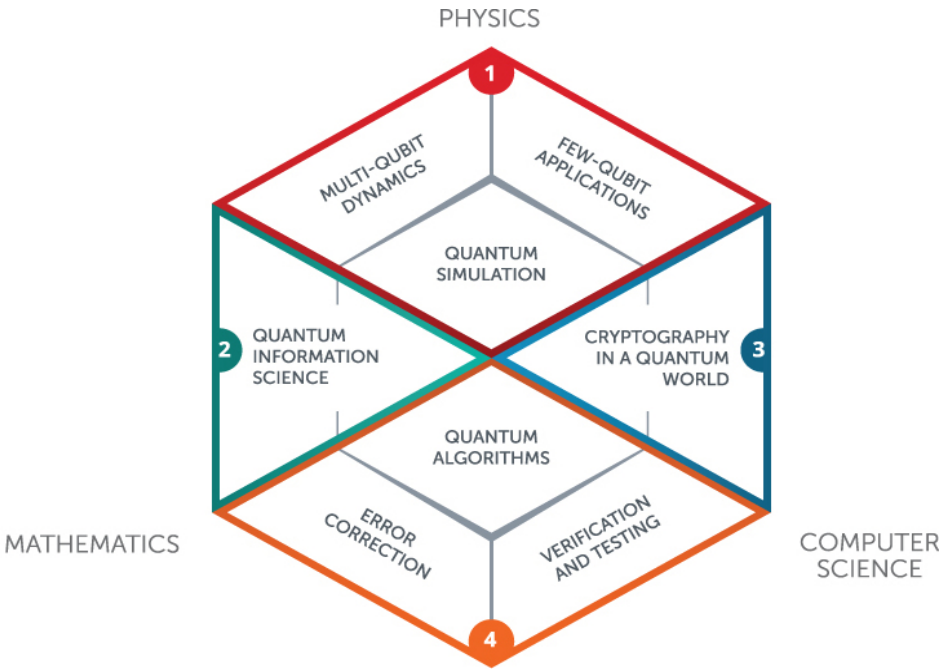
QuSoft
Research Center for Quantum Software

Quantum Delta
Nederland

QuSoft

Research Center for Quantum Software

"Enabling the power of quantum computers"



- Research center of UvA and CWI, founded Dec 2015, now grown to 75 fte
- Computer Science, Physics and Math
- Engagement with business & society via the innovation hub Quantum.Amsterdam

QuSoft

Research Center for Quantum Software

ONE-MONTH LUSTRUM EVENT

A celebration of 5 years excellent, fundamental and multidisciplinary quantum research

For the full program and to register go to www.qusoft.org/lustrum

Keynote speakers are Gilles Brassard, Ignacio Cirac, Dorit Aharonov, Freeke Heijman and more

QuSoft's lustrum covers the first three weeks of December, with Opening day on December 3, Science Week from December 7 to 11, and Business & Society Day on December 17. Save the dates!.

The event is completely online and hosted by Crowdale
The organization is very grateful to CWI and UvA for their financial support

Universiteit van Amsterdam

CWI
Centrum Wiskunde & Informatica

2008: When Eytan met Kareljan …

PRL **103,** 076803 (2009) PHYSICAL REVIEW LETTERS week ending 14 AUGUST 2009

Non-Abelian Anyons: When Ising Meets Fibonacci

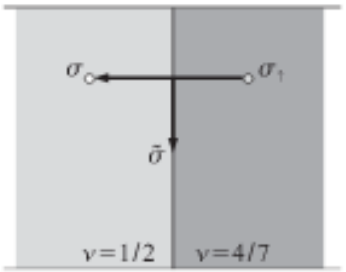
E. Grosfeld[1] and K. Schoutens[2]

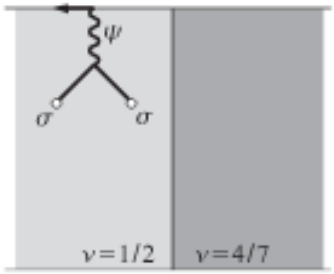
[1]*Department of Physics, University of Illinois, 1110 West Green Street, Urbana Illinois 61801-3080, USA*
[2]*Institute for Theoretical Physics, Valckenierstraat 65, 1018 XE Amsterdam, The Netherlands*

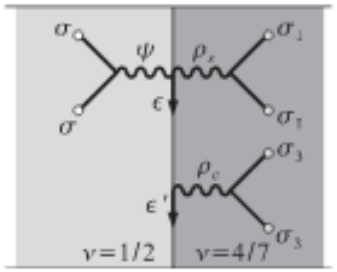
(Received 20 October 2008; published 13 August 2009)

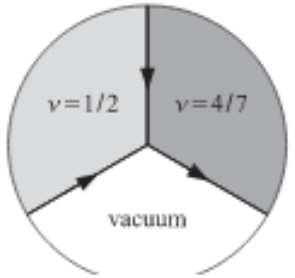
We consider an interface between two non-Abelian quantum Hall states: the Moore-Read state, supporting Ising anyons, and the $k = 2$ non-Abelian spin-singlet state, supporting Fibonacci anyons. It is shown that the interface supports neutral excitations described by a $(1 + 1)$-dimensional conformal field theory with a central charge $c = 7/10$. We discuss effects of the mismatch of the quantum statistical properties of the quasiholes between the two sides, as reflected by the interface theory.

DOI: 10.1103/PhysRevLett.103.076803 PACS numbers: 73.43.Cd

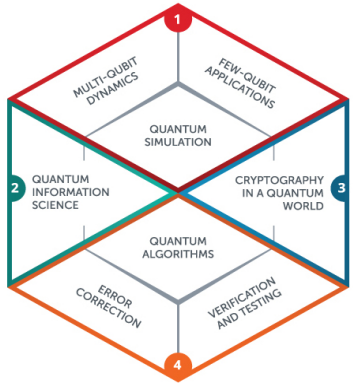


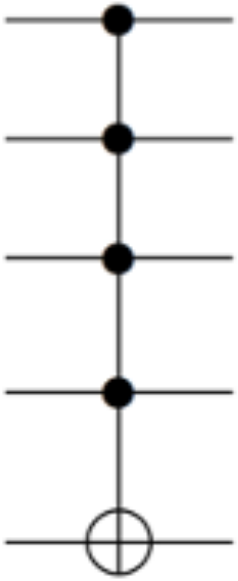






Taste of (my) research at QuSoft…





N-qubit Toffoli quantum gate:

- acts on N qubits
- flips the number-N qubit if and only if all other qubits are in the state |1>

IOP Publishing New J. Phys. 22 (2020) 063006

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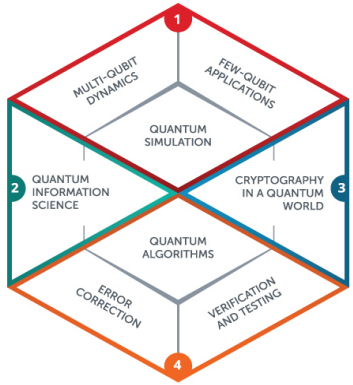

CrossMark

OPEN ACCESS

RECEIVED
27 January 2020

REVISED
27 March 2020

ACCEPTED FOR PUBLICATION
9 April 2020

PUBLISHED
12 June 2020

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PAPER

Signal processing techniques for efficient compilation of controlled rotations in trapped ions

Koen Groenland[1,2,4], Freek Witteveen[1,3], Kareljan Schoutens[1,2] and Rene Gerritsma[2]

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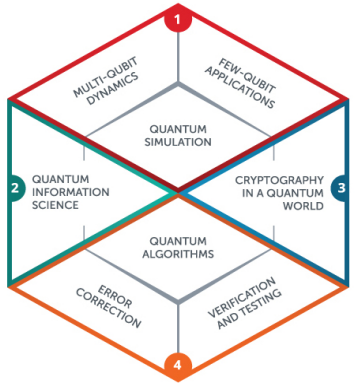
Keywords: Quantum Computing, Trapped ions, Quantum signal processing, Quantum gates



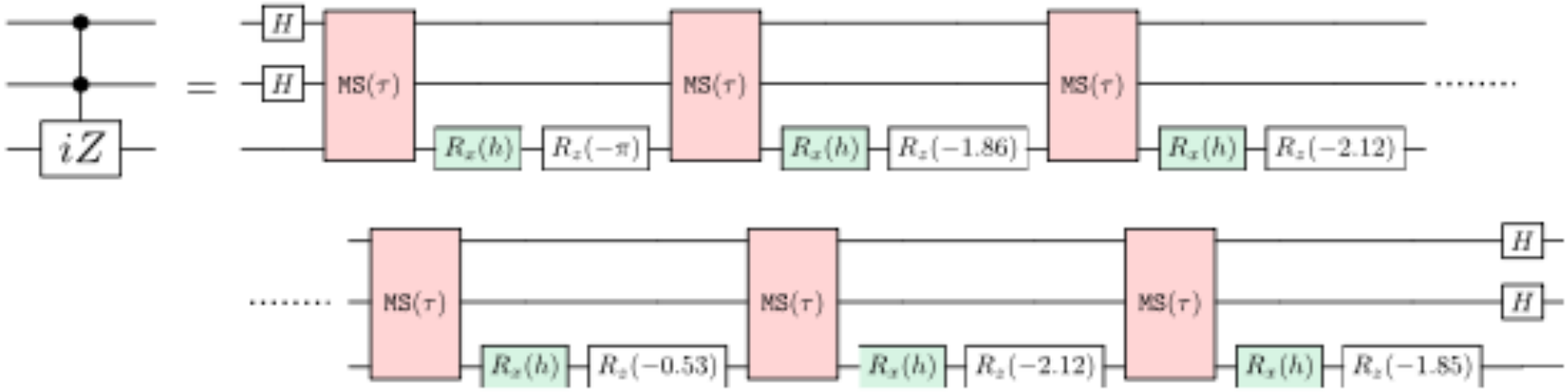
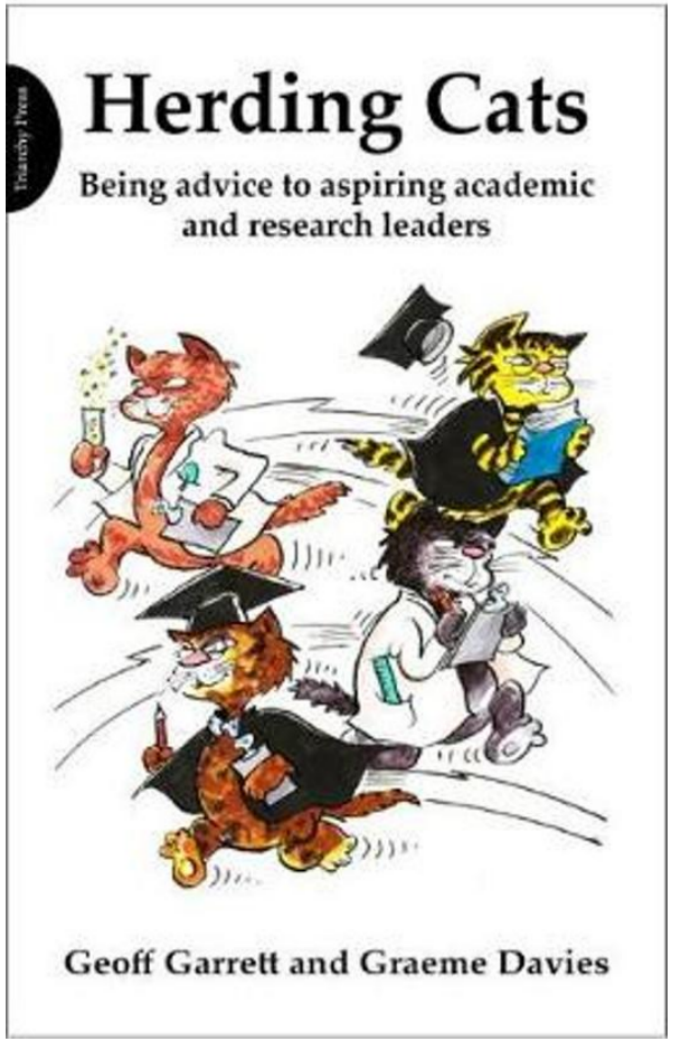
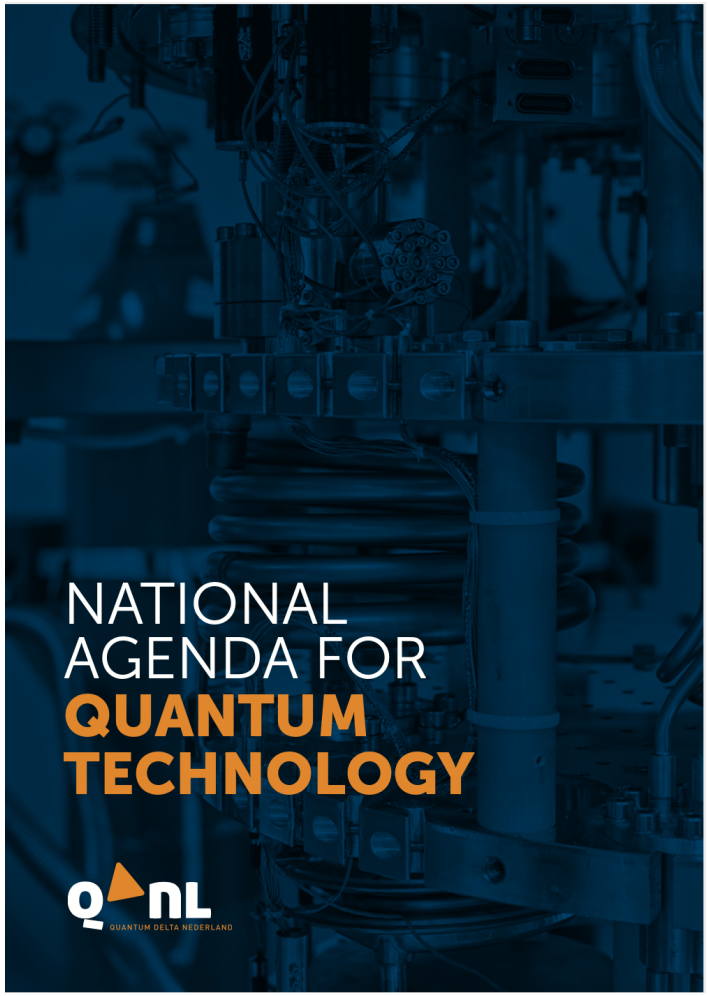


Figure A1. The circuit for the $C^2R_z(-\pi)$ operation derived using the method presented in this paper. Note that adjacent $R_z(\phi_j)$ operations have been merged, leading to a more compact form than equation (3). Generalization to larger a larger number of qubits N is straightforward using the numbers in table A1.

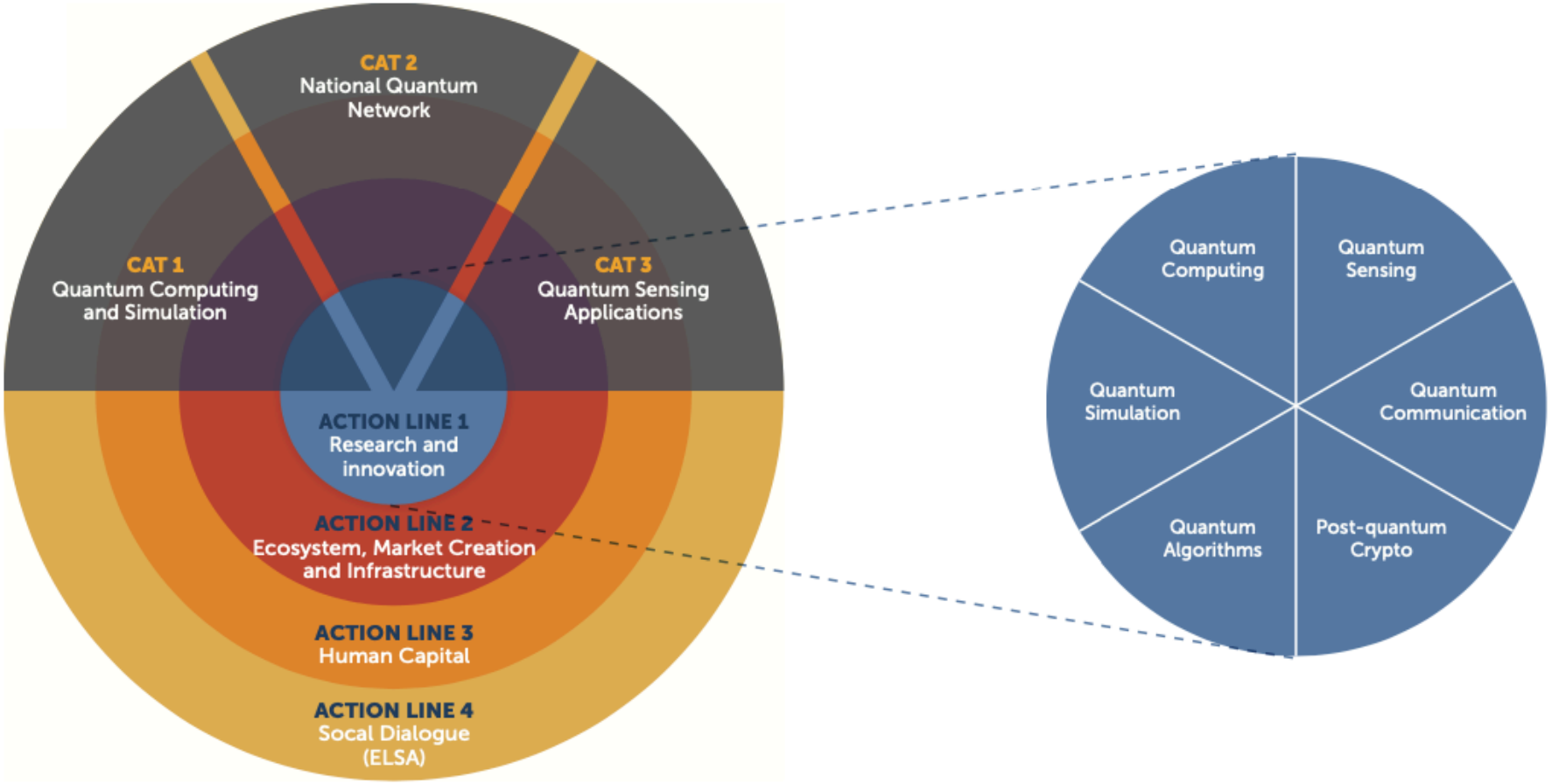
Organizing quantum science & technology in the Netherlands

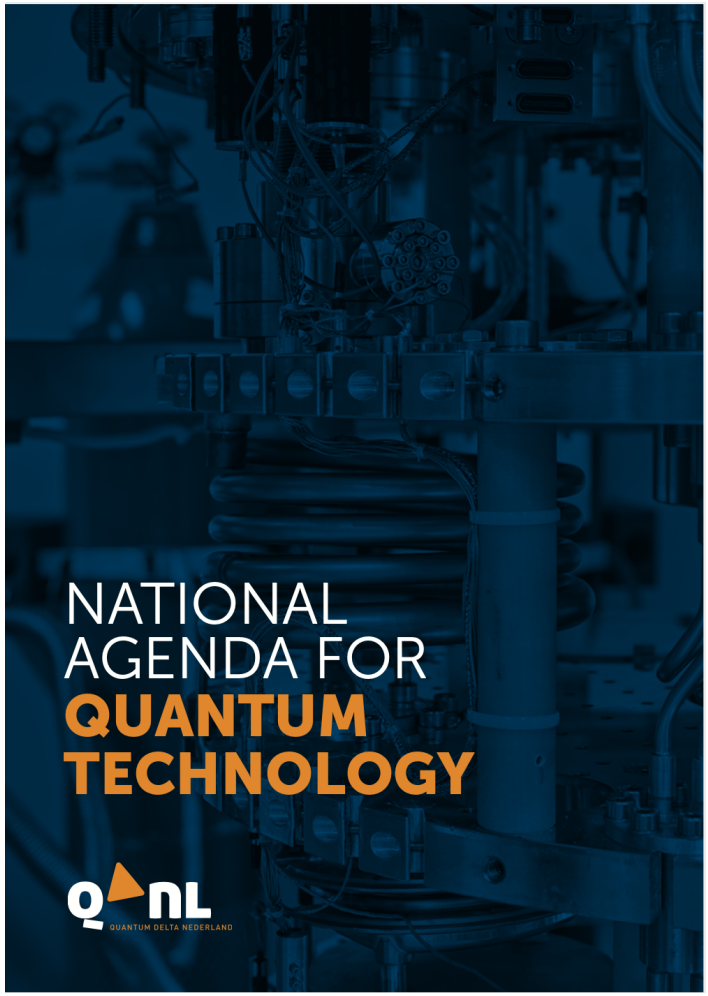
Organizing science & technology





- **2019** – national quantum coalition presents National Agenda Quantum Technology (NAQT) to Dutch government


CAT 2
National Quantum Network
CAT 1
Quantum Computing and Simulation
CAT 3
Quantum Sensing Applications
ACTION LINE 1
Research and innovation
ACTION LINE 2
Ecosystem, Market Creation and Infrastructure
ACTION LINE 3
Human Capital
ACTION LINE 4
Socal Dialogue (ELSA)
Quantum Computing
Quantum Sensing
Quantum Simulation
Quantum Communication
Quantum Algorithms
Post-quantum Crypto



- **2020** – ministery of Economic Affairs & Climate gave initial grant (23.5 M€) to start implementing the NAQT
- outstanding request to Nl government for funding the full NAQT
- quantum coalition now organized via foundation Quantumdelta Netherlands www.quantumdelta.nl

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Taking a leap into the future

The Netherlands is ready for the quantum decade

A STRONG NATIONAL ECOSYSTEM

What is Quantum Delta?

The Netherlands is a vibrant international hotspot for quantum technology, with leading science, technology and talent. With Quantum Delta, we are creating a fully functional national **ecosystem for excellence** in quantum innovation, for highly talented professionals to bring quantum computers, quantum networks and quantum sensors to the market.

- Forging strong bonds between our **five major quantum research hubs** and affiliated universities and research centres
- Accelerating developments in network creation, in simulation and in applications in **three catalyst (CAT) programmes**
- **Strengthening large-scale facilities** across the country in five locations for nanotechnological research in a National Cleanroom Infrastructure programme
- Kicking off **four action programmes** to facilitate research and cooperation and to boost social readiness levels

Quantum Delta Nederland

LET'S INTRODUCE

Our hubs

Despite being a small country, the Netherlands is well endowed with expertise and facilities in the field of quantum technology. The backbone of the nation's unique knowledge and innovation landscape is formed by **five specialist innovation hubs**. Each hub contains of research institutes, university, companies and start-ups/scale-ups and with a different focus. All these parties have a strong focus on collaborative research and innovation, not only with one another, but also with national and international enterprises.

- **Delft:** quantum computing, internet & network, with QuTech, Kavli Institute, Microsoft, Intel and others
- **Amsterdam:** applied quantum algorithms, quantum sensing & simulation, with QuSoft, CWI, UvA, VU, SURFsara and others
- **Leiden:** applied quantum algorithms, with aQa, Google, Shell, Volkswagen, Total and others
- **Eindhoven:** post-quantum crypto, quantum simulation & materials, with ASML, ThermoFisher, NanoLabNL and others
- **Twente:** quantum electronics and quantum photonics, with MESA+, Lockheed Martin, QuiX, Imec and others

Quantum Delta
Nederland

Economic impact of Quantum in The Netherlands

FINAL VERSION

18 May 2020, update 28 July 2020

A Quantum has the potential to enable new capabilities across industries

Quantum computing (QC) could enable completely new territories of computing and allow for next generation of exponential perfor-mance improvement for some applications, after slow-down of Moore's law as we approach atomic size features

Quantum communications (QComms) could ensure security of communications even in the face of unlimited (quantum) computing power

Quantum sensing (QS) could provide measurements of various quantities (e.g., gravity, time, electromagnetism) that are orders of magnitude more sensitive than classical sensors

Potentially impacting many different industries

kpn
ING
Ministerie van Defensie
Shell
DSM
janssen
AkzoNobel
ABN·AMRO
TOMTOM

Source: Expert interviews

Contact

- www.quantumdelta.nl

- www.qusoft.org