Brussels
28/29 March
2019

Making Quantum Technology ready for Industry

Putting Science Into Standards (PSIS) ***Workshop on Quantum Technology***

CEN-CENELEC Management Centre
Rue de la Science 23, 1040-Brussels

CEN CENELEC

European Commission

www.cencenelec.eu
www.ec.europa.eu/jrc/en

#Standards4Quantum

Workshop structure

On 28th and 29th of March 2019, the Joint Research Centre and CEN/CENELEC hold at the CEN/CENELEC Management Centre (CCMC) in rue de la Science 23, Brussels, a workshop titled ***Making Quantum Technology Ready for Industry***.

The workshop focuses on current standards and potential standardisation fields in quantum technologies and is organised with the support of the German Institute for Standardization (DIN) and DG CNECT, the host of the EU Quantum Flagship.

In Europe, the European Telecommunications Standards Institute (ETSI) has established an Industry Specification Group with a specific focus on quantum key distribution (QKD). At the international level, standardization is taking place within Joint Technical Committee 1 of ISO/IEC addressing among others cybersecurity and data protection. CEN and CENELEC have signed agreements with ISO and IEC through which common European and international standards can be developed in parallel, thereby avoiding duplication of work

Since many quantum technology areas are advancing on the technology readiness level scale, it is important to prepare the field for standardization activities, helping to facilitate and accelerate market uptake of quantum technology.

The workshop provides:

1. an overview of how standardization can be useful to the quantum innovation process;
2. what standardizers can do for the quantum science community.

To contribute to the different pace in the main quantum areas, the workshop is divided in four technical sessions. The first session recapitulates the current context and priorities in the Flagship and in the industry and is concluding how standards bodies could contribute and position themselves. The 3 technical sessions on the next day focus on:

a) quantum security and safe communication,
b) metrology, sensing and imaging,
c) and opportunities in other quantum fields, such as quantum internet, computing, ion trapping.

With the direct involvement of the participants the workshop will prepare the ground towards a roadmap of the most pressing technology fields where standardisation can support the deployment of quantum technologies in industrial applications including those for security, sensing, imaging and measurement.

A buy-in of the Quantum Flagship's Coordination and Support Action would be an important outcome for a smooth continuation towards a roadmap.

The quantum science community has been little exposed to market applications, and hence to standardisation. Interlocutors are interested how standardisation can facilitate accelerated market uptake and how research and innovation communities can best feed into standardization.

Thus, the facilitation of an information exchange among the standardisers and the quantum science community is an important outcome.

In conclusion this workshop will:

- Highlight current relevant standard activities
- Contribute to a first quantum standards inventory
- Map the quantum research & innovation - industry - policy triangle
- Propose next steps for the Quantum Flagship

* The Quantum Flight Pack includes a table, in which you kindly are requested to list any standardization initiative that you are aware of, or a potential subject you could imagine a standard is required or where concerted research and standardisation activities are beneficial to enable innovation.

WHY STANDARDISE QUANTUM, WHY NOW?

Technologies built on the basics of quantum mechanics, occurring on an atomic scale, are approaching markets with the promise to create many new businesses and help solve many of today's global challenges. These applications will be a pivotal factor for success in many industries and markets. Some of these applications are of strategic importance to Europe's independence and safety, i.e. in the field of secure information storage and transmission or in creating new materials for energy solutions and medicine.[1]

GLOBAL QUANTUM RACE

After two decades of work on inventions in the laboratory, quantum science is about to be the basis of a technology that will impact our everyday life. Governments and companies worldwide, including Google, Microsoft, Intel, Toshiba and IBM, are investing substantially to unleash this potential. Several countries have positioned themselves to enter into the quantum race to be leaders in areas such computing, communications, sensing and imaging.

To continue at the forefront of this emerging technology and to participate in a global quantum industry, Europe committed to investments to make the best use of its excellence in science and engineering. The European Commission launched in October 2018 its €1 billion Quantum Technology Flagship on a 10 year timescale. It consists of a set of research and innovation projects selected through a thorough peer-review process. Beside the FET Flagship instrument, there is the ERAnet instrument QuantEra with a greater orientation on fundamental research, essentially a Horizon 2020 co-funding instrument that invested €32 million in 2016 including the funds from the member states and another €20 million in 2018. The allocation of 2020 is yet to be defined.

EU member states also have set aside individual public funding for research in quantum technology. In September 2018, the German federal government announced a €650 million 4 years programme for quantum technology. The German strategy targets several aspects of quantum computing beyond the fundamental science, from basic R&D to real-world commercialisation. The UK government launched already in 2013 a £270 million five-year investment in quantum technology. Further funding of £80 million was allocated in 2018. A key feature of the UK strategy is the establishment of four "hubs" for computing, communications, imaging and sensing, including the National Quantum Computing Centre, with the goal of building the world's first universal quantum computer. The Netherlands invested €135 million in QuTech, the quantum technology institute which aims to develop the building blocks for the first quantum computer in the coming 10 years. Italy, Austria and France initiated substantial national Quantum initiatives.

The upcoming national quantum plan for China will be "at least of the same order of magnitude" as the European Commission's Flagship. China is building the National Laboratory for Quantum Information Sciences in Hefei, with over $1 billion in initial funding (Kania, E., The Hill, 30.6.2018). Chinese companies, including Baidu and Alibaba, have established their own initiatives in quantum computing, attracting top researchers to their teams. Alibaba plans to invest $15 billion into disruptive technologies in the years to come (Kania, E., Foreign Affairs, 26.9.2018).

In December 2018, the United States' President signed a bill into law that devotes more than $1.2 billion to a national effort dedicated to quantum information science over the next 10 years. The National Quantum Initiative Act represents a push to keep up with China and other countries in developing technologies such as quantum computing, quantum cryptography, and quantum communication. A great advantage in the U.S. is the capacity of the private sector to complement publicly funded efforts in quantum information science. There is a growing industrial interest in quantum information technology, including efforts at Google, Honeywell, Hughes Research, IBM, Intel, Microsoft and Northrop-Grumman. Several start-up companies, funded by venture capital and other equity sources have been established.[2]

1. De Touzalin, AM et al. (2016). Quantum manifesto: A new era of technology. Brussels: QUTE-EUROPE. http://qurope.eu/manifesto.
2. Monroe, C. (2017, 10 24). American Leadership in Quantum Technology. Hearings of the House of Science, Space and Technology Committee, US Government.

QUANTUM MATURITY - WHICH AREAS ARE IMPORTANT?

Technology Readiness Levels (TRL) of Quantum technologies vary among areas, or are for prominent ones such as Quantum computing rather low, hence one could pose the question if it is not too early for standardization activities? Although there are several types of standards, of which some are applying at a very early level, other standards are placed better at a later state; there are vast differences in the maturity among the different quantum areas, as is apparent from the number of patent applications.[3,4] While the field of Quantum safe communication, which includes Quantum Key Distribution is very far evolved and has already established standards, for other areas of quantum technology, standardisation efforts are less developed.

QUANTUM SAFE COMMUNICATION Current communication uses several encryption techniques that could in-principle be defeated by quantum computing. This threat has led to the need for the development of post-quantum encryption, composed of a set of techniques, such as the Quantum Key Distribution (QDK) and quantum secure algorithms that will be safer to attacks from a quantum computer. New research areas encompass quantum repeaters to increase coverage and ways to increase quantum memories. Some solutions are already in the market.[5]

QUANTUM METROLOGY, SENSING AND IMAGING SCIENCE, but also commerce, is based on measurements, which requires standards in metrology and without which there cannot be a common basis for exchange of goods, services and information. Quantum enhanced sensors for a wide range of systems promise significant improvements, achieving more accurate measurements. Due to their sensitivity to signals or alterations of the environment, quantum states provide a very suitable basis for sensors and measuring devices. Quantum states' features are unique in view of their superposition and the consistency which can be exploited in the construction of interferometers (photonic and atomic sensors), solid state sensors, quantum imaging devices, which all would improve dramatically the accuracy and quality of current devices. Other areas are quantum clocks, imaging (microlithography), spin-qubit-based sensing in life sciences and optomechanical sensors which can be employed in hybrid opto-and electro mechanical devices in medicine, security, or navigation. [5,6]

QUANTUM COMPUTING is one of the most notable technologies. The execution of quantum algorithms based on robust logical qubits demonstrates a revolutionary advantage with respect to common programs on classic computers. The development of robust (error-corrected) logical qubits and scalable quantum computers, algorithms and practical programmes are described as one of the great technological challenges.

QUANTUM SIMULATION A main use of current supercomputers is to conduct simulations of complex natural processes. Systems with quantum behaviour and with increased complexity are beyond the reach of simulations performed by today's supercomputers. A quantum simulator imitates the behaviour of real quantum systems (set of electrons, atomic particles, chemical bonds) and allows controlled experimentation. This technology may lead to better understanding of superconductivity, chemical reactions, atomic and nuclear processes, or biological processes.[5]

3. Lewis, A. M., Ferigato, C., Travagnin, M., & Florescu, E. (2018). The impact of Quantum Technologies on the EU's Future Policies: Part 3 Perspectives for Quantum Computing. Brussels: JRC.
4. Travagnin, M. (2019). Patent analysis of selected quantum technologies. Brussels: JRC doi:10.2760/938284.
5. Acin, A. et al. (2018) The quantum technologies roadmap: a European community view. New Journal of Physics, 20:1367-2630.
6. Stuhler, J. (2015). Quantum optics route to market. Nature Physics, 11:293-295.

CONTRIBUTION OF STANDARDS

That innovation functions as the motor for economic change we know not only since the Lisbon Agenda. Joseph Schumpeter noted already in his Theory of Economic Development in 1911 that "innovation is the market introduction of a technical or organisational novelty, not just its invention".[7] The emerging field of quantum technology is now just at this point.

In Europe's Agenda 2020 standardisation was built-in as an instrument for innovation, with immediate effects on compatibility, interoperability, minimum quality or -safety, variety reduction (as threat and opportunity), and information providing codified knowledge (COM/2010/2020).

A key factor in helping innovative goods, commodities and services to reach the market is to guarantee a close and timely interaction between research and development (R&D) and standardisation. The EU framework programme for research and innovation (H2020) has also reiterated its emphasis on the relationship between its research projects and the standardisation process, specifically by integrating standardisation activities in research projects and by acknowledging the standardisation potential to boost the impact of the research and development results (COM(2018) 26).

Measuring the contribution of standards to the economy, a number of studies across Europe, such as the study by Knut Blind revealed that standards were associated with 5-35% of the economic growth (GDP) across European countries.[8] A recent study for instance indicated that standardisation is strongly associated with labour productivity, with increases of 1% of stock of standards leading to an increase of 0.1% in labour productivity in Nordic Economies.[9]

Standards are a driver for innovation (COM(2011) 311). The elaboration of the relevant scientific and technical data, also known as pre-normative research, is key in the standardisation process, which eventually leads to the drafting of a standard (COM(2018) 26 final) and is established in the regulatory framework following the increased contribution of standardisation to innovation in Europe (EU Regulation No 1025/2012). Standards matter because they promote innovation through early market uptake, technology transfer and interoperability between devices and services; they increase quality and safety by defining features of many products and services, enable jobs and growth by increasing GDP by 0.3-0.9%, support global value chains by opening markets for companies, and overcome costly fragmentation in the single market through a voluntary, market-driven consensus-based standardisation process (SWD(2016)186).

7. Schumpeter, J. (1911). The Theory of Economic Development. Cambridge: Harvard University Press.
8. Blind, K., Jungmittag, A., & Mangelsdorf, A. (2011). Der Gesamtwirtschaftliche Nutzen der Normung. Berlin: DIN.
9. Grimsby, G. 2018 Study on the influence of standards on the Nordic economies. Menon Economics.

Thursday, 28 March

Facilitator and Panel Moderator: Alex PUISSANT, journalist, independent conference facilitator

13:30
REGISTRATION

14:00
OPENING

- **Ruggero LENSI**, Vice-President Technical CEN, Director-General UNI - Ente Nazionale Italiano di Unificazione
- **Maive RUTE**, Deputy Director-General European Commission/DG JRC

14:15
INTRODUCTION

- **Pascal MAILLOT**, Deputy Head of Unit, European Commission/DG CNECT C.2 Quantum Technology
- **Fabio TAUCER**, Deputy Head of Unit, European Commission/DG JRC A.5 Scientific Development

14:30
SESSION 1 – *A REVOLUTION, WITHOUT STANDARDS?*

14:30
General overview of the QT-landscape

- **Tommaso CALARCO**, Forschungszentrum Jülich

14:50
Outlook of activities related to standardization in Quantum Flagship CSA

- **Rogier VERBERK**, TNO - Organisation for Applied Scientific Research

15:10
Role of standardization in new technologies (low TRLs) - The graphene example

- **Werner BERGHOLZ**, ISC - International Standards Consulting

15:30
BOOST BREAK

16:00
Role of standardization in new technologies (low TRLs) - The ID Quantique example

- **Nicolas GISIN**, ID Quantique, University of Geneva

16:20
An update on quantum activities at NIST

- **Barbara GOLDSTEIN**, Physical Measurement Laboratory, NIST – National Institute of Standards and Technology

16:40
Overview of the standardization processes

- **Joachim LONIEN**, Innovation Department, DIN - Deutsches Institut für Normung e. V.

17:00
PANEL DISCUSSION 1

17:30
CLOSURE OF DAY 1

20:00
DINNER

Friday, 29 March

09:00
SESSION 2 - *QUANTUM SECURITY MEETS STANDARDISATION (QKD AND QT-SAFE SECURITY)*

Keynote - **Sean KWAK**, ID Quantique; also ITU-T; ETSI; JTC1/SC27/WG3

- QDK Flagship project selected from recent calls - N.N.
- ETSI/ISG QKD - **Martin WARD**, Toshiba Research Europe
- Cybersecurity and Data Protection - **Miguel BAÑÓN**, ISO/IEC JTC1/SC27/WG3 Security evaluation, testing and specification, member of CEN/CLC/JTC 13

HARVESTERS: Stephanie WEHNER and **Jonas HELSEN** (QuTech NL)

PANEL DISCUSSION 2

10:30
BOOST BREAK

10:45
SESSION 3 - *QUANTUM METROLOGY, SENSING AND IMAGING MEETS STANDARDISATION*

Keynote – **Thierry DEBUISSCHERT**, Thales Research and Technology

- macQsimal Project - **Jakob REICHEL**, Laboratoire Kastler Brossel
- Champion of Euramet Metrology Network on QT - **Ivo Pietro DEGIOVANNI**, INRIM - Istituto Nazionale di Ricerca Metrologica
- Gravity sensors - N.N. on (tbc)

HARVESTERS: Marco GRAMEGNA (INRIM)

PANEL DISCUSSION 3

12:15
LUNCH

13:15
SESSION 4 - *OPPORTUNITIES FOR STANDARDS IN OTHER QUANTUM FIELDS*

Keynote - Quantum internet - **Stephanie Wehner**, QuTech - Delft University of Technology

- Quantum Computing - **Walter RIESS**, IBM Zurich
- Investigation of standards on quantum computing – **Mikael HJALMARSON**, Swedish Institute for Standardization, ISO/IEC JTC 1/SC 7/SG 1
- Metrics and Standards in Quantum Computing - **Thomas MONZ,** AQT – Alpine Quantum Technologies Innsbruck

HARVESTERS: Adam Lewis (JRC)

PANEL DISCUSSION 4

14:45
BOOST BREAK

15:00
CLOSING SESSION – NEEDS AND OPPORTUNITIES FOR STANDARDIZATION

15:00
- Feedback on Sessions 2-4 from “Harvesters” (5 min each)
- Discussion among all participants on Needs and opportunities for standardization

15:35
FRAMING THE STATE OF PLAY, AND CONCLUDING REMARKS BY

- **Pascal MAILLOT**, Deputy Head of Unit, European Commission/DG CNECT C.2 Quantum Technology
- **Ruggero LENSI**, Vice-President Technical CEN and Director-General UNI

15:45
CLOSURE

Speakers

MIGUEL BAÑÓN

Miguel Bañón is the Global Technology Leader for Cybersecurity of Epoche & Espri, an IT security evaluation facility that provides evaluation and testing services under the Common Criteria and FIPS 140-2 standards. Epoche & Espri started in 2007, and is now active in a number of IT certification schemes and countries. In October 2017, Epoche & Espri has become part of DEKRA, one of the top 4 players in the testing, inspection, and certification industry worldwide. Together with DEKRA, Epoche & Espri further develops its reach of cyber security testing and evaluation services.

TOMMASO CALARCO

Tommaso Calarco is the Director of the Institute for Quantum Control at the Peter Grünberg Institute at Forschungszentrum Jülich. He received his PhD at the University of Ferrara in 1998 and started to work as a postdoc in the group of P. Zöller at the University of Innsbruck. He was appointed as a Senior Researcher at the BEC Centre in Trento in 2004 and as a Professor for Physics at the University of Ulm in 2007, where he later became the Director of the Institute for Complex Quantum Systems and of the Centre for Integrated Quantum Science and Technology. He authored the Quantum Manifesto in 2016, which led to the European Commission's Quantum Flagship Initiative. He is currently the Chairman of its Quantum Community Network.

THIERRY DEBUISSCHERT

Thierry Debuisschert is a scientist at Thales Research & Technology where he is responsible for applied quantum physics activity. His expertise covers non-linear optics, quantum optics, quantum cryptography and NV centres in diamond. He was coordinator of the European integrated project DIADEMS (2013-2017) dedicated to the development of magnetometers based on NV centres in diamond. Currently, he coordinates the QuantERA project MICROSENS and is involved in the quantum coordination and support action QSA dedicated to the implementation and support of the Quantum Flagship.

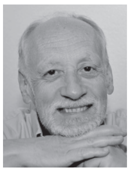
IVO PIETRO DEGIOVANNI

INRIM Senior Researcher Ivo Pietro Degiovanni developed his scientific skills in Metrology for Quantum Photonics Technologies. He has been the coordinator and Unit leader of several European and national projects. He is a member of the ETSI Industry Specification Group on QKD, of the Scientific Research Agenda Working-Group of the EC Quantum Flagship, and of the INRIM Board of the Scientific Director. He is Champion of the EURAMET European Metrology Network for Quantum Technologies (EMN-Q).

WERNER BERGHOLZ

Werner Bergholz held positions in R&D, procurement, QM in Siemens and Infineon. As a Professor of Electrical Engineering at Jacobs University Bremen, he researched microelectronics, PV, QM and standardization. He is co-founder of International Standards Consulting ISC and Co-Chair of the SEMI© ERSC and Assistant Secretary to IEC TC 113.

NICOLAS GISIN



Nicolas Gisin is a Swiss physicist and professor at the University of Geneva working on quantum information and communication, as well as on the foundations of quantum mechanics. His work includes both experimental and theoretical physics. He is one of the pioneers of QKD in telecom fibres; he combined his expertise in optical fibres and in quantum effects in optical fibres to propose and realize key experiments and practical implementations. He is also one of the founders of ID Quantique. In 2009, he was awarded the First Biennial John Stewart Bell Prize for Research on Fundamental Issues in Quantum Mechanics and their Applications. Nicolas Gisin has published a popular book in which he explains without mathematics, but also without hiding the difficult concepts, modern quantum physics and some of its fascinating applications.

BARBARA GOLDSTEIN

Barbara Goldstein is Associate Director of the Physical Measurement Laboratory (NIST-PML) of NIST, the US National Institute of Standards and Technology, the public body that bundles all public efforts in quantum technology. The US Government launched in December 2018 the $1.3b National Quantum Initiative Program which establishes a coordinated multiagency program to support research and training in quantum information science over the next ten years. A Subcommittee on Quantum Information Science, including NIST members will guide program activities. The body has initiated a process to solicit, evaluate, and standardize one or more quantum-resistant public-key cryptographic algorithms.

MIKAEL HJALMARSON

Mikael Hjalmarson is project manager at SIS for the mirror group to ISO and CEN on AIDC, IoT, Cloud and AI (incl. Big Data). In the past, he governed product attributes for describing and setting product characteristics, managed Corporate Standards with focus on product structuring and product identification (marking & traceability) to support product lifecycle management (PLM) and worked on national and international standardization related to Automatic Identification and Data Capture (AIDC), Packaging, and the Internet of Things.

SEAN KWAK

Sean Kwak, Executive VP Strategy & Innovation, joined ID Quantique in September 2018, bringing over 23 years of experience in electronics engineering. Prior to this, he worked for SK Telecom, the largest South Korean telecom. Since joining SK Telecom in 1997, he managed the commercialisation of SMS, packet core networks and Internet protocol Multimedia Subsystem (IMS). While working on solutions for packet core security, he became acquainted with quantum cryptography and led the founding of SK Telecom's Quantum Tech. Lab in 2011. He also led the investment from SK Telecom in ID Quantique. Sean Kwak is a Ph.D candidate in University of Seoul.

RUGGERO LENSI

Director-General of CEN's Italian Member UNI (Ente nazionale italiano di unificazione, Italian National Standardization Body), civil engineer Ruggero Lensi began working for UNI in 1995 where he held various posts, first as Technical Project Manager, as Head of Standardization Activities, and Technical Director before becoming the Director of External Relations, New Business and Innovation in 2010. In this position, he was responsible for the development and monitoring of actions related to the objectives of UNI's strategic plan. He became a CEN Board member in 2014.

JOACHIM LONIEN

Joachim Lonien holds degrees in Chemistry, Biotechnology and Global Operations Management. His research projects allowed him to work in a number of internationally renowned life science groups before focusing on the development of international standards (ISO, IEC). He is currently leading a group at DIN's innovation department, specializing in technology foresight analysis, standardization consulting and organizing international committees in the realm of smart technologies. His specialties are the development of International Standards, consulting various stakeholders in the organization of standardization projects, technology foresight analysis and gene expression analysis as well as molecular biology and analytical techniques.

PASCAL MAILLOT

Pascal Maillot is deputy Head of Unit of CNECT/C2 (High Performance Computing & Quantum Technologies) in the European Commission and is in charge of the 20-project Quantum Flagship launched in October 2018. He graduated as a computer engineer in 1998 and held several positions in the private and public sector as telecom project manager and cyber-security analyst. He then moved to the quantum domain and focuses specifically on the future quantum internet.

THOMAS MONZ

Dr Thomas Monz finished his PhD in the group of Rainer Blatt. Including his PostDoc time, Dr Monz achieved genuine 14-qubit entanglement, implemented Shor's algorithm in a scalable fashion, and supplemented this research with novel quantum characterisation, verification and validation methods.

JAKOB REICHEL

Jakob Reichel is professor at the Kastler Brossel Laboratory of the Sorbonne University and one of the implementing partners of the macQsimal project. macQsimal is an EU-funded Horizon 2020 research project which will design, develop, miniaturise and integrate advanced quantum-enabled sensors with outstanding sensitivity, to measure physical observables in five key areas: magnetic fields, time, rotation, electro-magnetic radiation and gas concentration. macQsimal is part of the FET Quantum Technologies (QT) Flagship.

WALTER RIESS

Dr Walter Riess is Head of the Science & Technology department at IBM Research – Zurich and coordinator of the Binnig and Rohrer Nanotechnology Center. The research activities his department include future device concepts, quantum computing, personalized medicine, mobile health, human body data interfaces and nanotechnology. Dr Riess joined IBM Research – Zurich as a research staff member in 1995, working on organic light-emitting diodes (LED). In 1998, he became manager of the display technology group for display applications of electroluminescent organic materials, which today are game-changing technologies used in many television displays and mobile devices. Dr Riess holds a PhD in Physics from the University of Bayreuthwhere he habilitated in 1996. He is a senior member of IEEE, member of the German Physical Society, the Swiss Physical Society, and the Materials Research Society.

MAIVE RUTE

Maive Rute is Deputy Director-General of the Joint Research Centre (JRC)), the science and knowledge service of the European Commission. There, her responsibilities span from the supervision of energy, mobility and nuclear research to the development of JRC organisation and sites in five countries. Prior to that, she has served as Director for Biotechnology and Director for Resources in DG Research as well as Director for Small Business and Entrepreneurship in DG Enterprise. Before joining the Commission in 2005, Maive Rute was CEO of KredEx, the Estonian funding body for businesses, innovation, housing and export. She graduated cum laude as an economist from the Estonian University of Life Sciences and holds an MBA from the Danube University, Austria, received an MA in international politics from CERIS, Brussels and has been a Visiting Research Fellow at Harvard University.

FABIO TAUCER

Fabio Taucer is Deputy Head of Unit at the JRC at the Unit for Scientific Development. He is responsible for the coordination of all JRC 58 Research Infrastructures and for the implementation of the open access strategy to JRC experimental facilities. He also coordinates all standardisation related activities at the JRC, in particular linking research and innovation with standardisation as part of the Joint Initiative on Standardisation. In his previous post at the JRC he matured a long-standing experience in the management of transnational access to research infrastructures financed by DG RTD in the field of earthquake engineering.

ROGIER VERBERK

Rogier Verberk is leading the Working Group on Innovation and Infrastructure of the Coordination and Support Action, the structure that runs the European Quantum Technology Flagship. He is Principal Project Manager at the Netherlands Organisation for Applied Scientific Research (TNO) and Roadmap Leader at QuTech, the joint initiative of TU Delft and TNO. The Quantum Technologies Flagship is a large-scale, long-term research initiative that brings together research institutions, industry and public funders, consolidating and expanding European scientific leadership and excellence in this field. It will run for ten years, with an expected budget of EUR 1b. The vision of the Flagship is to develop in Europe a so-called quantum web, where quantum computers, simulators and sensors are interconnected via quantum communication networks.

MARTIN WARD

Martin Ward is Senior Research Scientist at Toshiba Research Europe. Together with Andrew Shields he is member of the Industry Specification Group for Quantum Key Distribution (ISG QKD) at ETSI. Quantum Information Technology concerns the transport and processing of information using individual particles such as electrons or photons; by sending information encoded upon single photons (the particles of light) it is possible to test the secrecy of each communication. Toshiba has exploited this phenomenon to create a practical system for secure communication over fibre optical cables. Quantum Cryptography, as this communication method is known, is the first in a series of quantum innovations which might revolutionise the IT industry.

STEPHANIE WEHNER

German physicist and computer scientist Stephanie Wehner is Antoni van Leeuwenhoek professor in quantum information and the Roadmap Leader of the Quantum Internet and Networked Computing initiative at QuTech, Delft University of Technology. She is also known for introducing the noisy-storage model in quantum cryptography. Wehner's research focuses mainly on quantum cryptography and quantum communications. Together with Jonathan Oppenheim, she discovered that the amount of non-locality in quantum mechanics is limited by the uncertainty principle.

Notes

#Standards4Quantum – Quantum Flight Pack

NAME: ....

Table 1. Existing QT standards initiatives

Standards organisation	Designation of group	Topic	Link
ETSI	*ISG QKD*	*QKD*	*https://www.etsi.org/committee/qkd*
etc.			
etc.			

Table 2. Existing quantum technology standards and formal specifications

Designation	Title
ETSI GR QKD 007 v1.1.1 (2018-2)	*Quantum Key Distribution (QKD); Vocabulary*
etc.	
etc.	

About Putting Science into Standards (PSIS)

Moving forward to enhance and accelerate the sustainable growth of the European economy, the Joint Research Centre (JRC) of the European Commission, together with the European Standardisation Organisations CEN and CENELEC, and the European Commission Directorate General for Communications Networks, Content and Technology have launched this particular initiative, ***Putting Science into Standards(PSIS)*** which aims to bring the research, industry and standardisation communities closer together.

This is the 6th workshop of the ***Putting Science into Standards (PSIS)*** conference series which fit into the JRC led Action 2 of the Joint Initiative on Standardisation "Linking research and innovation with standardisation", encouraging a natural collaboration between researchers and innovators and the European Standardisation System, and hence allowing for the smooth uptake of research and innovation outputs into standardization.

By bringing scientific- and standardisation communities closer together, new issues requiring standards are anticipated and screening of emerging science areas facilitated to identify those topics where concerted research and standardisation activities are vital to enable innovation and promote industrial competitiveness.

European Commission DG Joint Research Centre (JRC), 1049 Bruxelles/Brussel, Belgium

European Commission DG Communications Networks, Content and Technology (CNECT) EUFO1 - L-2920, Luxembourg

European Committee for Standardization (CEN), Rue de la Science 23, 1000 Bruxelles

European Committee for Electrotechnical Standardization (CENELEC), Rue de la Science 23, 1000 Bruxelles

German Institute for Standardization (DIN), Saatwinkler Damm 42/43, 13627 Berlin, Germany

European Telecommunications Standards Institute (ETSI), 06921 Sophia Antipolis, France