International cooperation on Quantum technologies

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International cooperation critical but …

- Scientific and technological breakthroughs are happening at an increasing pace
- There is a fierce international competition in which current strong positions in Europe or outside Europe can’t be considered as granted.
- The transition from science to technology faces similar challenges in each country that could be met together.

COOPETITION

EU widely open to International cooperation…

- Scientific community is international and is already collaborating and exchanging ideas and people across the world
- Startups are local but big companies are international, companies and IP can be acquired by other companies within open economies
- Markets for disruptive technologies are global
- Europe science and industry are broadly open to international cooperation, public and private American funds are financing European research, American companies have European branches.
- Europe has no GAFAM, very few unicorns and just one HPC company

Asymmetric situation

QT-Flagship & QT-CSA (QSA, QFLAG, QFLAG-Int)

- Elaborate a focused strategy on international cooperation
  - Competence complementarity & win-win situation
  - Target countries: USA, Canada and Japan.
- Increase networking with international stakeholders excelling in QT
- Improve competitiveness of EU industry through
  - International R&D cooperation, product complementarity, JV and alliances
  - Access to future markets
- Address the issue of protection of EU actors through
  - Reflection on standardization

Reflections and actions

US-EU cooperation on Quantum technologies

US-EU cooperation on Quantum technologies

1	—	First discussions (telCo beginning of 2019)
		First joint declaration of mutual will to increase QT collaborations
2	—	September 3rd and 4th US-EU Meeting in Washington
		Common strategic document about Opportunities for EU-US cooperation in quantum technologies

September 3rd and 4th US-EU Meeting in Washington

U S - E U P a r t i c i p a n t s

- Strong attendance
  - Many US agencies represented

EU Academic Attendees	
Philippe Chomaz	CEA Paris-Saclay
Rob Thew	University Geneva
Frank Wilhelm-Mauch	Saarland University
Lieven Vandersypen	QTech, TU-Delft
Thomas Monz	Innsbruck University
Andreas Wallraff	ETH, Zurich
Eugene Polzik	Niels Bohr Inst., University of Copenhagen
Vladimír Bužek	Inst. of Physics, Slovak Academy of Sciences
John Bagshaw	Independent Technology Consultant
Trevor Cross	Teledyne e2v (England)

US Academic Attendees	
Ken Brown	Duke University
Margo Ginsberg	Duke University, QI Group
Christopher Monroe	University of Maryland
Paul Kwiat	Grainger College of Engineering, Illinois
Liang Jiang	University of Chicago
Margaret Martonosi	Princeton University
Mark A Eriksson	University of Wisconsin-Madison
Mark Saffman	Univeristy of Wisconsin-Madison
Mark Kasevich	Stanford University
Nathalie de Leon	Princeton University
Rob Schoelkopf	* Yale University

EC and EU Government Attendees	
Thomas Skordas	Dir. Digital Excel. & Science Infra, DG Connect, EU
Pascal Maillot	Deputy Head, HPC & QT Unit, EU
Tommaso Calarco	Dir., Inst. Quantum Ctrl, P. Grünberg Inst., DE
Freeke Heijman	Special QT Adv, Min. Eco. Aff. & Climate Pol., NL

US Organization Attendees	
Kent Rochford	CEO of SPIE
Ed White	Committee Chair of National Photonics Initiative
David Steuermann	Kavli Foundation
David Lang	OSA
Elizabeth Rogan	CEO of OSA

US Government Attendees	
Jake Taylor *	OSTP
Alexander Cronin	OSTP
Corey Stambaugh	OSTP
Merin Rajadurai	STATE
Tomasz Durakiewicz	NSF MPS
Denise Caldwell	NSF MPS/PHY
Claire Cramer	DOE ASCR
Nasser Barghouty	NASA SCaN
Gretchen Campbell	NIST
Barbara Goldstein *	NIST
Michael Hayduk	DOD AFRL
Thomas Walsh	FBI
Brad Blakestad	ODNI IARPA
Charles Tahan	UMD LPS
Michael Metcalfe	UMD LPS
Roberto Diener	DOD ONR
Grace Matcalfe	DOD AFOSR
TR Govindan	DOD ARO

September 3rd and 4th US-EU Meeting in Washington

U S - E U S c h e d u l e

- **Two days' meeting**
- Back to back EU – US presentations

11:00 - 12:55 am: Quantum computing and simulation

11:00-11:55 am: US scientific presentation (40'presentation + 15'questions)

US Speaker: Christopher Monroe University of Maryland

Margaret Martonosi Princeton University

Mark A Eriksson, University of Wisconsin-Madison

Mark Saffman, Univeristy of Wisconsin-Madison

Mikhail Lukin, Harvard University

12:00-12:55 am: EU scientific presentation (40'presentation + 15'questions)

EU Speaker: Frank Wilhelm-Mauch , Univ. Saarland

Lieven Vandersypen , QTech, TU-Delft

Thomas Monz , Innsbruck Univ.

Andreas Wallraff, ETH, Zurich

Vladimír Bužek , Inst. of Physics, Slovak Academy of Sciences

- General discussions

4:30-5:30 pm: General Discussion on possible topics for collaboration

Co-Chairs: Tommaso Calarco and Chris Monroe

- Round tables on QT pillars

EU-US complementarities and possible topics for collaborations

8:30-10:45 am: Round tables (all participants in each topic)

8:30 - 9:15am: Quantum Networking (45')
Co-Chairs and Rapporteurs: Rob Thew and Liang Jiang

9:15 - 10:00 am: Quantum computing and simulation (45')
Co-Chairs and Rapporteurs: Lieven Vandersypen and Mark Saffman

10:00 -10:45am: Quantum Sensing and Metrology (45')
Co-Chairs and Rapporteurs: Eugene Polzik and Nathalie de Leon

10:45am 11:15am: coffee break (30')

- Conclusion on focused topics
- Rapporteurs writing reports for each pillars
- Writing group to propose a synthesis

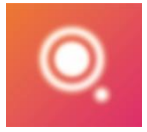
Common strategy for EU-US cooperation in QT

Quantum Communication

Enabling transatlantic quantum networking by a US-EU coordinated action on common **quantum protocols** to connect EU and US quantum networks and on constructing **quantum repeaters** to allow long-distance transmission of quantum resources

Quantum Computing & Simulation

Accelerating the development of quantum computers by sharing developments in enabling sciences and technologies on both ends of the value chain: on one side the **quantum hardware fabrication** and materials and on the other end the **quantum algorithms** and applications



Quantum Sensing & Metrology

Developing nanoscale devices and innovative sensors capable of achieving **ultimate performance** based on increasing quantum complexity such as entanglement and strengthening international collaboration to **use them in basic research in physics, chemistry, biology and medicine**

Other Exploratory Contacts: Japan

- Preliminary workshop:
  September 2018, Paris
- Next workshop:
  December 17th 2019 Kyoto

EU – Japan bilateral meeting on Quantum Science
Kyoto - December 17th 2019

AGENDA

Objective: Discuss on the possibilities for scientific cooperation between The European Union and Japan.

12:00 – 12:30: Lunch Boxes and introduction by EU and Japan

EU and Japan government officials
Global EU and Japan bilateral meeting discussion framework and objectives

12:30 – 14:00: EU – Japan discussions about possible scientific collaborations for each pillar

Animated by the EU-Japan scientific experts of each topics and acting as Co-rapporteurs

Co-rapporteurs will be asked to deliver a report for their pillar at the end of the meeting.

The discussion will be based on the presentations and exchanges of the previous days (Dec. 16th and 17th) and will be triggered by a short common presentation by the Co-rapporteurs about their common proposal for a vision for the EU-Japan collaboration on each QT pillar (see guidelines at the end of this document).

In addition to agreeing on this "big picture" the goal is to identify possible topics and complementary skills and other arguments justifying the EU-Japan collaboration.

A common preparation between EU-Japan scientists will be necessary before the meeting date.

12:30 – 13:00: Quantum Sensing and Metrology

Thierry Debuisschert (Thales)	Shigeki Takeuchi (Kyoto University)
EU Co-rapporteur	**Japan Co-rapporteur**

13:00 – 13:30: Quantum Network & Communication

Wolfgang Tittel (QuTech)	Masahide Sasaki (NICT)
EU Co-rapporteur	**Japan Co-rapporteur**

13:30 – 14:00: Quantum Computing and simulation

Immanuel Bloch (MP Institut- Quantenoptik)	Yasunobu Nakamura (The University of Tokyo)
EU Co-rapporteur	**Japan Co-rapporteur**

EU – Japan bilateral meeting on Quantum Science
Kyoto - December 17th 2019

14:00 – 14:40: General discussion including basic science

Tommaso Calarco (Forschungszentrum Jülich)	Kenji Ohmori (Institute for Molecular Science, National Institutes of Natural Sciences)
EU Co-chair	**Japan Co-chair**

Discussion on the basic science based on the pillar needs and on the fundamental and theoretical aspects.

General wrap-up based on the pillar discussion.

This discussion will lead to a one-page report on the vision and proposed topics of collaboration in basic science and theory and will also be the basis for another one-page executive summary.

14:40 – 15:00: Conclusion and next steps

EU and Japan government officials

Pascal Maillot	Atsuhi OKu
European Commission	**Japan**

General conclusion and next steps to be followed by both parties.

End of meeting

Other Exploratory Contacts: Japan

List of EU participants to the bilateral meeting on Dec. 17th 2019:

- Pascal Maillot (European Commission)
- Gustav Kalbe (European Commission) – *To Be Confirmed*
- Tommaso Calarco (Forschungszentrum Jülich)
- Philippe Chomaz (CEA Paris Saclay)
- Immanuel Bloch (Max-Planck-Institut für Quantenoptik)
- Thierry Debuisschert (Thales)
- Wolfgang Tittel (QuTech)
- Paolo Villoresi (Padova University)

List of Japan participants to the bilateral meeting on Dec. 17th 2019:

(tentative list)

- Atsushi Oku (MEXT)
- Hidetoshi Katori (The University of Tokyo)
- Shigeki Takeuchi (Kyoto UIniversity)
- Masahide Sasaki (NICT.)
- Yasunobu Nakamura (The University of Tokyo)
- Kenji Ohmori (Institute for Molecular Science)
- Kohei Itoh (Keio University) i*n part**
- Katsuhiro Kitagawa (Osaka University), *in part**
- Mutsuko Hatano (Tokyo Institu of Technllogy) *in part**
- Yasuhiko Arakawa (University of Tokyo), *in part**

*Some of Japanese participants need to attend the topical workshops starting 2pm.

Other Exploratory Contacts: Canada

- **EU/CANADA**: draft list of topics/joint declaration and accompanying text
- Discussed in the Digital Dialogue in Ottawa (R. Viola for the EC)
- Identified main collaboration areas
  - Quantum Communication
  - Quantum Computing Platforms
  - Theory and Algorithms for Quantum Computation
  - Analog and Digital Quantum Simulation
  - Quantum Sensing and Metrology
  - Fundamental Questions and Novel Approaches to Quantum Information
  - Training and Education

Quantum Flagship - CSA- International

FETFLAG-06-2020 (CSA) : International Cooperation on Quantum Technologies

Final objective: Make Europe competitive on Q Technologies & markets
Expected impacts :

- Focused strategy on international cooperation
- Increased networking between EU and international stakeholders excelling in QT
- Improve competitiveness of EU industry (international cooperation, access to future markets)

Timing : call deadline 13/11/2019
Budget : 500 k€
Duration : 36 months

CSA - International Collaboration What is asked

- **Deliver a roadmap** for international cooperation on QT
- **Identify partners** with complementary competencies
  - →Targeted countries : USA, Japan, Canada
  - →Use consultations, workshops…
  - →Stay in line with QSA/QFLAG deliverables
- **Give concrete recommendations** on EU future actions for developing win-win collaborations