Quantum Coordination and Support Action (QSA)

D5.1 – Frequently Asked Question
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Description:

The Frequently Asked Questions (FAQ) here below are split in two sections: one more general was prepared based on the question we have been asked by the general public during our interaction with them, and one more focused on the more technical aspect of the work-programme. The document has been reviewed by the P.Is of the project and validated by the Project officer. Of course, the FAQ are a living document and will be updated over the course of the project, as stated in the Grant Agreement.

The FAQ are available at qt.eu, which is currently redirected on qurope.eu. The new website will be live on the 31st March 2018

List of abbreviations:
AI: Artificial Intelligence
CSA: Coordination and Support Action
EC: European Commission
EU: European Union
FET: Future Emerging Technologies
FP9: Framework Programme 9
GA: Grant Agreement
GPS: Global Positioning System
HLSC: High Level Steering Committee
H2020: Horizon 2020
NQN: National Quantum Coordinator Network
QSA: Quantum Coordination and Support Action
QT: Quantum Technologies
R&D: Research and Development
RIA: Research and Innovation Action
RSA: Rivest–Shamir–Adleman (Cryptography system)
SRA: Strategic Research Agenda

About Quantum Technologies

What are Quantum Technologies?

The *First Quantum Revolution* happened in the first half of the 20th century and shaped the world we live in today: without mastering quantum physics, we could not have developed computers, telecommunications, satellite navigation, smartphones, or modern medical diagnostics.

Since some years, we are witnessing the *Second Quantum Revolution*. What seemed impossible to the founding fathers of quantum physics is now routinely done in the lab: we can prepare the state of microscopic *quantum objects* like atoms, electrons, and photons and control their properties, which we experience as very strange. An electron, for example, can be brought into *superposition* and then rotates clockwise and anticlockwise at the same time. Or we *entangle* several quantum objects and thus connect them invisibly across space and time. In many cases, the level of our control has reached a point that allows the use of quantum systems for real-world applications in sensing, secure communication, or for computing and simulation. This is the field of *Quantum Technologies*.

What are the most promising applications of Quantum Technologies?

The four most promising application domains of Quantum Technologies are quantum computing, quantum simulation, quantum communication, and quantum sensing and metrology (the order does not indicate any degree of relevance or priority).

Quantum computers will make enormous computing power available to solve certain problem classes. They are built from "quantum bits" (individual atoms, ions, photons or quantum electronic circuits) and exploit superposition and entanglement, to solve problems we could never solve otherwise. That includes, for example, processing vast amounts of data faster than ever before to recognise patterns and train artificial intelligence systems, e.g. for digital assistants that help doctors to diagnose diseases and suggest the most promising therapy, or optimising the routes of all cars in a city simultaneously to avoid traffic jams and reduce emissions.

Closely related to quantum computers are ***quantum simulators***. They will be key to the design of new chemicals, from drugs to fertilisers for future medicine and agriculture, and of new materials, such as high-temperature superconductors for energy distribution without losses. Like in a wind tunnel, where small models are used to understand aerodynamic properties of cars or planes, a quantum simulator uses simple model quantum systems (such as an array of single atoms) to understand more complex systems.

Quantum communication will help protect the increasing amounts of citizens' data transmitted digitally, for instance health records and financial transactions. A typical implementation of quantum networks uses single photons. If anything intercepts a single photon it will be noticed, meaning that with quantum technology we can achieve the most secure form of communication known, impossible to intercept without detection. For point-to-point communication, this is already on the market today and will be developed further into a quantum internet.

Quantum sensors will arguably be the basis for the first applications of Quantum Technologies. They provide the most accurate measurements and will drastically increase the performance of consumer devices and services, from medical diagnostics and imaging to high-precision navigation, to future applications in the Internet of Things. Quantum sensors use similar technologies as quantum computers and networks: they detect the tiniest disturbances because they are based on e.g., single electrons, the smallest possible charges and magnets. ***Quantum metrology*** uses quantum sensors to define the standards for e.g. time-keeping or electrical measurements.

Which Quantum Technologies are used in (commercial) products today? What can we expect in the future?

Quantum Technologies are already deployed in many applications today. For example, whenever we use GPS navigation, we rely on them: Every GPS satellite is equipped with several atomic clocks and our position is determined by comparing the clock signals from different satellites. Another quantum technology is nuclear magnetic resonance imaging, which has become a standard medical imaging method, applied everyday in almost every hospital in the world. For niche-markets with high security needs, such as finance, banking and defence, quantum key distribution is already used today to avoid eavesdropping for secure communication. And also science is relying on quantum technologies: Next generation gravity wave detectors use so-called *quantum squeezed light* to reach the sensitivity needed to detect the sound of cosmic collisions.

The long-term vision is a Quantum Web: quantum computers, simulators and sensors interconnected via quantum networks distributing information and quantum resources such as superposition and entanglement. The performance enhancements resulting from quantum technologies will yield unprecedented computing power, guarantee communication security, and provide ultra-high precision synchronization, measurements and diagnostics for a range of applications available to everyone locally and in the cloud.

What risks are associated with Quantum Technologies?

Quantum Technologies use single quanta with very low energies (single visual or infrared photons, single atoms, ultra-small currents …) in the same way as Nature does incessantly. They themselves thus do not pose any danger to health and safety. Note especially that although many Quantum Technologies manipulate neutral or ionized atoms, they should not be confused with nuclear technology - no harmful radiation is created. The tools used for the manipulation of single quanta can include high-power lasers, high-voltage sources and liquid helium at about -270 °C, but users are well separated and protected from these device components.

Quantum Computing might have a high impact on artificial intelligence (AI). The discussion on benefits and dangers of AI (e.g. impact on future jobs) is ongoing and very important. However, Quantum Computing is only one among many underlying technologies to potentially increase the power of AI.

Moreover, Quantum Computing could turn any cryptography based on number factorization, e.g., RSA and elliptic curve cryptography, obsolete. New cryptography methods, that are based on other mathematical models, are being developed to ensure continued privacy. Also, Quantum Cryptography will provide a means for provable secure communication, based on the basic principles of quantum mechanics.

About the Quantum Flagship

What is the Quantum Flagship?
The Quantum Flagship is a large-scale initiative (10 years, 1 billion EUR) started by the European Commission to push forward Quantum Technologies in Europe.

What are the goals of the Quantum Flagship?
The three main goals of the Quantum Flagship are:

- Consolidate and expand European scientific leadership and excellence in quantum research, including training the relevant skills;
- Kick-start a competitive European industry in quantum technologies to position Europe as a leader in the future global industrial landscape;
- Make Europe a dynamic and attractive region for innovative research, business and investments in QT, thus accelerating their development and take-up by the market.

How is the Quantum Flagship organised?
The Flagship will be organised as a funding program, with a close coordination between its funded projects and with European national QT programs. The number of projects will be on the order of 20-30 in the ramp-up phase (2019-21) and should be reduced in the following years to focus the efforts on the most promising technologies and applications. A Strategic Research Agenda, developed based on the progress of the Flagship projects and the field of QT in general, will be an essential tool to achieve this focusing. At the same time, throughout the lifetime of the Flagship, there will be funding for basic research to generate new ideas, tackle fundamental problems and eventually enable “quantum leaps” in the technology development.

How can I engage in the Quantum Flagship?
The first call for project proposals, FETFLAG-03-2018, is currently open and can be found here. Additionally, the whole European QT community is invited to give input to the Strategic Research Agenda and to cooperate on fostering innovation, education and outreach. If you are interested to engage in this way, please participate in the QT community meeting on April 19 in Oberkochen, Germany.

Where can I find the High-Level Steering Committee report with recommendations on the Flagship?
You can find the final report here.

Where can I find news from the Quantum Flagship?
News and other information can be found on the EC website and on the Coordination and Support Action website at www.qt.eu (a new website will be launched in April 2018).

What is a Future and Emerging Technology Flagship? Are there any other Flagships?
In 2009, the European Commission identified the need for Europe to address the big scientific and technological challenges of the age through long-term, multidisciplinary R&D efforts. The first European Future and Emerging Technology (FET) Flagship, the Graphene Flagship was founded in October 2013 - www.graphene-flagship.eu. A second FET Flagship, The Human Brain Project, is charged with revolutionizing the future of neuroscience - www.humanbrainproject.eu. The Quantum Flagship is the third and latest FET Flagship.

What is the relation between the Quantum Flagship and QuantERA?
QuantERA is an ERA-NET Cofund - a network of 32 organisations from 26 countries, coordinated by the National Science Centre, Poland, supporting research in Quantum Technologies (QT). With a budget of 36 M €, including co-funding from the European Commission, QuantERA will support international research projects in the field of QT. The first QuantERA call opened in January 2017, 26 projects from more than 200 submitted pre-proposals have been awarded funding and are starting in 2018.
QuantERA will continue in parallel to and will closely collaborate with the Quantum Flagship.

How will the Quantum Flagship be continued in FP9?
Details on FP9, like funding instruments, are still in discussion. But commitment from both EC and EU Parliament to QT is very strong and the Flagship will certainly continue in FP9 with at least the planned budget.

Who can I contact at the Flagship for further questions?
You can direct your question to the coordinator and current work-package leaders of the QSA who are currently preparing the Quantum Flagship launch.

Coordinator:
Tommaso Calarco (University of Ulm) - mailto:tommaso.calarco@uni-ulm.de

Work-package “Strategy and Structuring”:
Robert Thew (University of Geneve) - mailto:robert.thew@unige.ch

Work-package “Innovation and Exploitation”:
Thierry Debuisschert (Thales) - mailto:thierry.debuisschert@thalesgroup.com

Work-package “Outreach and Education:
Frank Wilhelm-Mauch (University of Saarland) - mailto:fwm@lusi.uni-sb.de

Work-package “Organisational Structures and Processes”:
Thomas Strohm (Bosch) - mailto:Thomas.Strohm@de.bosch.com

Who can I contact in my country regarding Quantum Technologies?

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

Name	**State**	**Address**
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Walmsley, Ian	United Kingdom	Ian.Walmsley@physics.ox.ac.uk

About the first call for proposals

Where can I find the call text?
The call text is available here:
http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/fetflag-03-2018.html

How do I submit my proposal?
Please use the participant portal here:
http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/fetflag-03-2018.html - please select “Research and Innovation Action [RIA]”

How many projects will be funded?
We expect up to 30 projects.

How many domains should/can my proposal address?
Your proposal should address at least one domain clearly, but is not limited to one domain.

How many partners and or countries should/can be involved?
At least three organisations from different countries.

Which countries are eligible?
Legal entities established in the following countries are eligible to receive funding in Horizon 2020:

> ***Member States*** of the European Union, including their overseas departments and outermost regions.
>
> ***For British applicants****:* Please note that until the UK leaves the EU, EU law continues to apply to and within the UK, when it comes to rights and obligations; this includes the eligibility of UK legal entities to fully participate and receive funding in Horizon 2020 actions. Please be aware however that the eligibility criteria must be complied with for the entire duration of the grant. If the United Kingdom withdraws from the EU during the grant period without concluding an agreement with the EU ensuring in particular that British applicants continue to be eligible, you will cease to be eligible to receive EU funding (while continuing, where possible, to participate) or be required to leave the project on the basis of Article 50 of the grant agreement.
>
> ***Associated Countries*** - the following countries have stated their intention to become associated to Horizon 2020 by the time the first grant agreements are being signed.
> These are Albania, Bosnia and Herzigovina, Faroe Islands, former Yugoslav

Republic of Macedonia, Iceland, Israel, Moldova, Montenegro, Norway, Serbia, Switzerland, Turkey and Ukraine.

Check the List of H2020 Associated Countries.

Third Countries – see the 'Annex A - List of countries, and applicable rules for funding' for the list of third countries that are eligible for funding. In Horizon 2020 there are more opportunities for cooperation with and participation by researchers from non-EU countries.
International European interest organisations are also eligible to receive funding

What is the maximum duration of a project?
While there is no mandatory duration, the EC considers the duration of 3 years as appropriate for RIA.

What is the maximum amount of funding for each project?
The EC suggests the following

- Up to EUR 10 million for the following pillars: Quantum Communication, Quantum Computing Systems; Quantum Simulation; Quantum Metrology and Sensing
- Between EUR 2 and 3 million for Fundamental Science

Is there a limit for funding for each partner?
No limit has been foreseen in this sense

Is there a limit for funding for each Country?
No limit has been foreseen in this sense

Which costs categories and activities are eligible for funding? Is subcontracting allowed?
The cost categories which could be eligible are, concerning direct costs:

- personnel costs,
- travel costs,
- Equipment,
- Consumables;

Subcontracting is allowed, as long as it cover only a limited part of the action. This need to be set out at the time of the proposal preparation. The EC may however approve subcontracts not set out in the Grant Agreement without amendment if:
- they are specifically justified in the periodic technical report and
- they do not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.
Concerning the actual eligibility of the costs, we strongly recommend to consult the Annotated grant agreement, with respect to this point. You can download it here.

Where can I find information about national activities in the QT field?
Through our National Quantum Coordinator Network (NQN) we have started collecting information concerning these activities. The result is a survey, which you can find here

How will my project be connected to the other Quantum Flagship projects?
In order to properly structure and coordinate the activities between various projects and to have them robustly connected, the QSA is planning a collaboration agreement between all funded Quantum Flagship projects. This agreement will be the basis for the so-called *Science and Engineering Board* in which project coordinators will identify collaboration opportunities and drive joint developments and sharing of infrastructures among projects. The rules for this agreement are laid out in the article 41.4 of the Grant Agreement.