

QT Flagship Community Consultation Workshop Berlin, 10th November 2016

MINUTES:

[List of Attendees¹](#)

[Agenda](#)

Term of reference:

Q: Question (name of the speaker at the end)

A: answer

C: Comment (name of the speaker at the end)

INTRODUCTION:

The meeting started with a brief address from one of the event organiser, Prof. Tommaso Calarco, who introduced the scope of the meeting, followed by an address from Prof. Jürgen Mlynek, chair of the High Level Steering Committee, and by Gustav Kalbe, Head of Unit for the European Commission

J. Mlynek, underlined that it is important to have an exchange between academia and industry to get a program on the road, not only to do research as such but to contribute to wealth creation, and to create an added value. The idea of today's meeting is to exchange views, especially from the companies' side. After this workshop HLSC will meet and summarize today's deliberations and come up with a mid-term report which should be ready by January. J. Mlynek emphasizes that we must have as much transparency as possible. He does not want anybody to say at a later stage that there was no chance to be heard. Now is the chance and everybody is encouraged to communicate their input, which is also possible via internet.

Gustav Kalbe underlined that the final aim of the flagship is to get the research over the last years into the market, capitalizing on the investments of the last 20 years. The commission has selected a panel of experts. The work of the HLSC is done in a participatory manner, so everybody is encouraged to speak up now, since at a certain time it will be too late to give feedback.

T. Calarco underlined that it is amazing that we can be here to talk about such a program, and this is going to be a challenge for the EU and the entire community to do something that creates added value. Finally, he underscored that it's important that we listen to everybody. This is the chance of the HLSC to get the right input.

¹ Concerning the people that took part via the web-conference service, we are not able to provide a list of names. However, at its peak, the online conference was participated by more than 60 people, bringing the total attendance to around 240 people.

1st Presentation: Governance and Structure

speakers: T. Strohm (Robert Bosch GmbH) and T. Debuisschert (Thales Group)

Presentation

Open Discussion (list of questions or comments):

Q: Is there a political reason behind the percentage of industry-led project? (Vadim Makarov – University of Waterloo)

A: Not at all, what is important is to fulfil the programme.

C: The Board of Stakeholders (BoS) has only a consultancy role in respect to the Executive Board (EB), and it has no possibility to provide feedback, thus making the structure a bit unbalanced. Aiming at a greater transparency, would it be possible to introduce a vote system so that the BoS can express themselves on the EB decisions? (Fabio Cavaliere - Ericsson)

Q: In the QT roadmap the term Technology Readiness Level (TRL) is not even mentioned once, the funding focus should be on large challenge. Where do we get the critical mass to actually make the difference to reach the TRL level that industry needs to pick up the technology to then translate it into real economic activities? (Koen Bertels – TUDELFT).

A: We didn't explicitly mention TRL, but we said that there must be working demonstrators among the Working Programme (WP) goals.

Q: Do you have measures in place to avoid doing the same mistakes as the previous Flagship has done? (Jakob Hardt – EURICE)

A: We have studied their structure and the measures they enacted to solve those problems.

Q: I have a comment on the double blind review of the proposals. While it is important to be fair, I think it that the risk is to select people who do not have the capacity of carrying out the promised work. Moreover, what has been decided on the form the proposals? Large, medium or small size consortia? (Stephanie Wehner – TUDELFT)

A: This is just a proposal, nothing is decided yet.

Q: I have a question on the governance structure, which you showed, it seems heavy weight, have you discussed about how the structure of the projects will be? (Michael Bolle – Robert Bosch GmbH)

A: In the ramp up phase we would have small project covering a very broad field, then we will be more focussed in the steady state phase.

Q: Should we develop a new curriculum on Quantum Engineering? What is the opinion from the industry representatives about this? (Guido Burkard - University of Konstanz)

A: This is a good idea.

Q: There is a confusion between moon-shot grants and smaller one, we should have a balance between those two (John Rarity – University of Bristol).

A: Certainly.

Q: Has it been planned to have small panels that lobby within States that meet regularly and asking the member States for funds (after all a part of the money should come from the national State) integrated with the main structure (Emanuele della Torre – Bar-Ilan University)

A: This is probably part of the outreach activities.

C: We should take into account, in term of inclusiveness, that many southern countries have suffered brain drain, we should take that into consideration in the planning, and at the moment they are excluded because of the crisis. (Dimitri Angelakis – University of Crete)

C: How to make Intellectual Property (IP) easy to do. In Hewlett Packard, it was easy for a group of scientist to come up with an idea and then the IP attorney will do all the paper work: can we have one stop shop for patent for quantum industry so it would be easier for scientists (Radu Ionicioiu - National Physics Institute in Bucarest)

C: It is a big concern that you have smaller projects, while the plan is to have growth all over Europe; would it be that whole countries present their plan and then you select the most promising instead of having many small projects? (Kim van den Bos – Royal Dutch KPN)

C: There are two Valleys of Death; one is between research and industry and one between the industry and the market. Both need proper attention (David Tal – Israeli Government)

C: IP protection should be taken into consideration within the programme (Josep M^a Pujals – Oficina Ponti)

C: Talking about moon-shot grants and individual grants, there might be also the space-station, something intermediate, so with a bit more value of the individual grant but still feasible, however, I would suggest to paint a picture of how we would like to see European community in 20 years from here. Then, you start to understand what you should do in terms of small individual grants, the “space-station” or the moon-shots. (Paolo Bianco – Airbus Space & Defence)

C: I would like to give another push for the education part because one of the things that is promised within the flagship is the creation of a new generation of quantum professionals, and to see it on a European scale it needs lots of coordination and I would like to see someone within the governance structure responsible for coordinating this kind of events and also including people from the science education community. (Torsten Franz – Technical University of Braunschweig)

C: Of course I'm going to have a comment about the idea of having each individual country presenting their own programme and then a pan-European direction is chosen (see comment from Kim Van den Bos). With countries that have limited available resources it will be difficult for those countries to concentrate on multiple avenue and hoping that one will be chosen. I'm definitely against this aforementioned approach (André Xuereb – University of Malta)

C: We are discussing about boundary conditions but those condition should not be fixed and left open to be adjusted, for instance the 50% of industry-led projects. (Gerd Leuchs – MPG institute for science of light)

C: Concerning the industry-led projects vs academia-led I found really useful to have both. I found very useful to have projects that started as academia-led and then have been taken over by industry. The project was of course separated in phases (Jörg Wrachtrup – University of Stuttgart)

C: I think it is also important to look at the global development, so we see a lot of initiatives in the USA and in Asia and there is a window of opportunity to act in this field but it is short and that is the reason why the EU and the member States have decided to launch this flagship initiative even before there was a real selection procedure for other flagships, and we should grasp this opportunity for the discussion on the ambitions of the flagship and the goals and the moon-shot approach and the small-project approach. We should clear out that first before starting a discussion on the governance. The governance should be focussed around these ambitions (Freeke Heijman – Dutch Ministry for Economic Affairs; QuTech Delft)

C: I'm a bit astonished. I think the opening remarks by Jürgen Mlynek were that we should involve the economy, the industry and the growth of the society, but here I see that only 50% of the money goes to industry and not more and as Jörg Wrachtrup said, I think it is important to have measures to involve really the industry. And there may be a problem also with the definition of excellence; in our academic fields we know of course what excellence is but now imagine some project from industry; who judges it? What is the benchmark for excellence in that sense? So to implement some steps, to involve the industry and the economy and I think it is very important. So it should be more of this exact point if we want to get this. (Wolfgang Ertmer – University of Hannover)

C: I would like to propose that the term excellence from the point of view of industry is broader than just sophisticated solution but also time-to-market or cost effectiveness (Jürgen Stuhler – Toptica)

C: You may be able to seek inspiration in the Danish programme called “Innoboost”, from the Innovation Fund of Denmark. It is exclusively for industry but it has three-step proposals that you can start first with a little bit of money, then you demonstrate that you have some traction, you actually live up to your milestones and you can ramp up. It might be a way for bridging the gap between small project and moon-shot. My question is: how to determine the impact because some of the technologies we are talking about will certainly have a long time horizon; will there be a centralised business development function? How to determine what is the impact for society because that might be on a time scale that goes beyond the flagship, but on the other hand it will be probably unwise to shut quantum computation because the timescale is too long (Soren Stobbe – Sparrow Quantum)

Comments from the web-part of the conference:

C: I’m opposed to have the governance formed by “wise retired people” (Sebastien Bourdeauducq)

C: On web consultation: double-blind review seems like an interesting option but how can one show excellence (previous work) if one needs to hide one's identity? (Mikko Möttönen – Aalto University)

C: Definitely too much to have 50% of industry-lead projects... EU should give momentum to pure blue-sky research to counter the shrinking of national base funding. Not everything should (and could) have immediate impact on industry... (Matteo Rizzi – JGU Mainz)

C: What will be the role of (European) standards in the project, either as a reference, an eventual target, and/or an enabler to the overall project (David Boswarthick – ETSI)

C: On governance: Did I understand correctly that the MB is suggested to take care of technical (not scientific) administration (reporting, organizing meetings etc.) of the actual research projects? I endorse this! (Mikko Möttönen – Aalto University)

C: What I am missing is a European quantum incubator lab – as a central European institution - that is not directly operated by the basic research leaders (i.e. the current players) but by dedicated people that are focusing their full effort on bridging the “valley of death” between basic research and industrial applications. It seems as it looks to me today calls are open for the existing research institutions and groups as well as R&D in industry and we distinguish between industry-lead and science-lead projects. But in order to really make a difference and not just distribute the money to the usual suspects I think we need a dedicated and operating institution which acts independently as a link between the basic researchers and the R&D in industry. It should be following selected projects in their own labs and should be directly setup and funded by the Flagship. This would eventually really make a difference. (Tilman Pfau – University of Stuttgart) [this message received approval messages from Luciano Viverit, Mikko Möttönen, Matteo Rizzi and Emanuele Rocco]

C: Moon-shot vs. individual could be correlated with seniority of applicants. Smaller riskier projects for younger scientists and less risky but long term moon-shot projects for established researchers. (Christian Gogolin – ICFO) [this message received approval from Matteo Rizzi and Emanuele Rocco]

C: Are there any measures taken to support spin-offs from academia to create "new industry"? (Christine Silberhorn)

C: On the role of Technical Universities: Quantum control should not be separated completely from quantum engineering. The UK has invested in Quantum Engineering training centres, but these seem to be more geared for producing “technicians” to support quantum industries, rather than the equivalent of high-level control-theoretic engineering design one sees in modern technologies when taking products to market stage. There is an opportunity for the EU to be the first do this necessary training, but this has to be substantially broader than just technician support – it has to tap into basic research. (John Gough)

C: there should be some dedicated outreach activities to educate the investor community (Emanuele Rocco - Niu Tech)

2nd Presentation: Joint Research Centre

speakers: M. Travagnin (JRC, European Commission)

[Presentation](#)

Industry Panel Session

Moderator: Gustav Kalbe (European Commission)

1st presentation: Industry White Paper

speaker: R. Murray (Innovate UK)

Presentation

Q&A:

Q: We could also draw inspiration from programmes that are much more industry-driven like “Clean Sky” for aeronautic, especially when it comes to innovation gauge, structuring funding. (Andreas Schweinberger - ARTICC)

A: The Flagship can learn from more mature programmes. We should not however forget that quantum technologies are still quite immature and there is still a long step to be done before being on the same level of clean tech. For instance, in clean tech it is quite easy to go to a company and talk about it. In comparison, if you speak about quantum technologies the first response is “what do you mean by that?”. It might take actually few years to the flagship to answer that.

Q: I was wondering what you imagine doing and what you have done already in the UK to identify what the actual products are that the industry is going to develop. What are the products that you want to push forward? (Andreas Wallraff – ETH-Zürich)

A: The UK is doing a few different things and we have funding which is available for companies to carry out non-technical projects. It allows them to speak internally and externally to their sales teams. Matching up the technical capability with what their customers are saying it is important and requires funding. Taking care of communication is also quite important, it can help with reports. We have tried over several workshops to bring scientists and industrial together, so the scientists are able to have also a short term view, while at the same time the industrial people are able to think far enough in what they are trying to do.

Comments from the web part of the conference

C: Isn't the EU program funded specifically for quantum technologies for cyber-security and big data? I don't think a quantum computer should be considered as a far-off aim: it is, in fact, the promised output. That's not to say that other quantum technologies shouldn't happen in the process, but they should happen as a spin-off on the road to the promised deliverables. (E.g., NASA put a man on the moon because that's what they were paid to do. Yes, they developed freeze-dried food and cochlear implants in the process, but the agency would have failed in its mission if this was all they did without getting a man into space.) (John Gough – Aberystwyth University)

2nd presentation: Computing and Simulation

speaker: Walter Riess (IBM Research Zürich)

Presentation

Q&A

Q: Roadmaps always assume that one knows what will make it to the product stage, but is this clear at the current stage? Because also photonics systems or ions might make it to be a quantum simulators (Martin Weitz – University of Bonn)

A: IBM interest is to come up with a quantum computer, what you can do with it is up to you, but we want to provide the technologies. We speak of a roadmap but we first have to have the scalability, then we can define the roadmap.

Q: I very much like the focus on the roadmap as tool to align academia and industry, but on your last slide, where you describe interdependencies between academia and industry, I missed it. Why don't you consider it as an important tool also to structure the initiative? (Michael Totzeck – Carl Zeiss)

A: This is not the final word from us – the roadmap will be a future target also in this sense.

Q: What are your expectations, as a company that also has activities in Europe, with respect to the Flagship? (Jürgen Mlynek – Humbolt University)

A: In IBM research Zürich, 95% of my people are from Europe. 98% end up in EU academia and industry in Europe. This is why I regard it as a part of Europe. My expectation is that the EU will be successful.

3rd presentation: Quantum Communication

speaker: Andrew Shields (Toshiba Research Europe Ltd)

Presentation

Q&A

Q: My question refers to the GDP. I want to address the industrial people about their turnover with the technologies we are talking about. Who earns money? Because we cannot promise more than we can deliver (Jürgen Mlynek – Humbolt University)

A: Currently we have an equipment market that is in the order of 10s of millions, but to justify the investment we should look for revenue of 10s of billions.

Q: I would like to ask Michael Bolle [CEO of Robert Bosch GmbH]: if we project from 5 to 10 year what you estimate as revenue? (Jürgen Mlynek – Humbolt University)

A: As we discussed in the previous meeting, the first step we will see are in communication and sensing. In five to ten years from now, if we have 100 million or plus revenue then we have made a successful step. I find the calculation of the 2 billion visionary but it is far out in the future. We should not create the impression in the society that we would be able to do that in such few years. (Michael Bolle – Robert Bosch GmbH)

A In 5 to 10 years we expect in sensing-related technologies a revenue of 10 to 15 millions (Trevor Cross – E2V)

A: Clearly there is a market possibility in access or mobile access, there is high potential but also some risks. It is a bet. We see some possibility to make money. (Fabio Cavaliere – Ericsson)

A: We have to look also at the savings: data breach has costed us an enormous amount of money. When we talk about QKD we have to talk also about the potential savings. (Kim Van de Bos – KPN)

Comments from the web part of the conference

Q: Currently quantum communications is limited to fibers or line of sight but currently most of the commutations is taking place with mobile devices. Why you do not consider mobile QKD as a challenge? This might be possible in the future using microwave photons. (Mikko Möttönen – Aalto University)

A: Maybe, and optical free space communication.

Q: I disagree with John Gough's comment [see web comment on Richard Murray's presentation]. Many applications of e.g. quantum sensors are relevant as well, and they would hardly raise up as mere spin-offs of research towards cyber-security and big data. (Fiodor Sorrentino) [Emanuele Rocco supported this comment]

A: I was probably misunderstood. I did not want to imply that Quantum Sensing is a sub-field of Quantum Communication, but distributed sensors are a very important application.

4th presentation: Quantum Sensing

speaker: Bruno Desruelle (MUQUANS)

[Presentation](#)

Q&A

Q: What do you think can be done to facilitate the contact between the inventors and the companies? (Eugene Polzik – Niels Bohr Institute)

A: I think that the QT flagship itself can be the right place, via workshops organised for this reason.

C: I think that the type of market that you want to address needs to be discussed. (Elisabeth Giacobino – CNRS)

C: There is a huge gap between an experimentally proven concept and a final product. It is important that transition is done smoothly and it is important to work together to reach the final products. The final products are always in large systems. (Paolo Bianco – Airbus Space & Defence)

Comments from the web part of the conference

C: I thought research on atomic clocks was already funded very actively through the Galileo programme(?) (David)

C: Comment: Vapor-cell-based magnetometry is an example for a very advanced field in terms of basic research. The building of a chip-scale clock was successful (from NIST i.e. governmental research lab) but did not yet lead to a killer application. It is still too expensive (~1000 \$). This is a clear case to build on for an industrial collaboration as one has to find ways to make it significantly cheaper. Medical imaging/sensing with vapor-cell-based magneto and electrometers is facing the same challenge. (Tilman Pfau – University of Stuttgart)

OPEN DISCUSSION on INDUSTRY

Q: It was an interesting discussion on what is a quantum product and if the revenues that are generated are actually coming from Quantum technologies. From our own experience we are cooperating with SMEs developing technologies for Quantum, such as cryogenics, and they are developing not only quantum products strictly speaking but also other application that benefits from Quantum, and generated quite revenue. We should not be dismissive on those revenues. Of course, one of the big goals is building the Quantum Computer and we have to strive, but without dismissing the spin-offs on the path toward there. I would not be so pessimistic about the revenue target. QT is one of the things you have to pay in advance, you have to trust that the goal is worthwhile. (Andreas Wallraff – ETH Zürich) [commenting on the revenue discussion from before]

A: I'm completely in agreement with you. The return to society comes in many forms. But the point I tried to make is that we have to be ambitious, like creating a large scale Quantum computer, implementing quantum security and we can make others as well. (Andrew Shields – Toshiba Research Europe Ltd.)

A: I'm not against QT, I was just puzzled by the number. You gave just qualitative arguments. If we have to convince others, we have to provide data. (Jürgen Mlynek – Humbolt University)

Q: I'm confused on the definition of Quantum Technologies. We have seen many applications which have big potentiality such as magnetic sensors or single-electron transistors which are quantum in some sense, but do not use entanglement or superposition. Should we include those as well or should we be stricter and only include those technologies that use entanglement or superposition. (Marco Affronte – University of Modena and Reggio Emilia)

A: My personal feeling is that we should not get too hang up on definitions at least on the industry side of things. We should set a very clear direction or directions, however I would be worried if we focus only on those that are Quantum in a strict sense and ignore all the other ecosystems which are important to enable that quantum thing. In UK we had a complex discussion and the short crude answer is that we don't care. I don't mind founding a laser company even for short term application in something that isn't quantum, if the generated revenue helps ultimately to develop a product that helps to produce something that is quantum. (Richard Murray – Innovate UK)

C: I agree with that, we were doing the photon detectors and that developed a whole industry which is quantum in a sense. Moreover, the photonics industry has produced many billions of revenues. So the industry developed due to the fundamental research is contributing already to the GDP. That the flagship needs to be aiming our small truly quantum industry should aim in the next 5-10 years' timescale to the billion revenue. We are not saying that an industry is existing now. (John Rarity – University of Bristol)

C: I would like to get back to the question of Prof. Mlynek about collaboration with international parties and the JRC was saying that US in Quantum Computing is ahead. We should not however forget that some of these US companies come to Europe to cooperate with European academics because in some field we are ahead. For us is really important to invest in these relationships and embed them in the European ecosystem. Otherwise there is a risk of brain-drain from Europe and the flagship should be a way to prevent that. (Freeke Heijmann – Dutch Ministry of economic development, QuTech)

C: I liked the wish list from Andrew Shields' presentation and I would like to have one wish to that list, which is to try to look at the DARPA challenges which has been a very powerful way to drive robotics in US. It is a different way of funding, it is up to you to find a venture capitalist but gives you the chance to win 2 million euros, for instance. (Soren Stobbe – Sparrow Quantum)

Q: I would like to see in the future a last slide [referring to Richard Murray's presentation] in which you paint what you would like to see at the end of the roadmap. Coming to my question, don't you think that time is of essence? We have seen so many technologies for sensors and Quantum computer. The first one will dominate the market, the second coming will have harder time to challenge it. You need to come first. (Paolo Bianco – Airbus Space & Defence)

A: It is a very good point. We are not saying that we want to cover everything. We have plenty of ideas, but we need to make a successful product and make it fast. We need to come together, we need to make choices, and to make them we need to make analysis and find out which is the most promising. (Bruno Desruelle – MUQUANS)

A: I think that communication time is of the essence at the minute, especially having seen what is going on in China, where they build this massive fiber optic network, 2000km length and they launched the Quantum satellite, so we need to accelerate. (Andrew Shields – Toshiba Europe Research)

Q: I think it is very important to think about the connection between the various items will happen. How does education connect with industry?. How do these people connect to industry? (Stephanie Wehner – QuTech)

A: In terms of collaboration, we have at IBM a sophisticated programme, unfortunately I have too many requests and I have to turn down some of them. What we realized it is that these young researchers are the basis of our ecosystem. I regard as a task for this flagship that we create this type of structure. I think this is a very important instrument to tear down the walls between silos. (Walter Riess – IBM research Lab)

A: I think one of the problem with these diagrams that show the important components is that they give the impression that there are a lot of separated activities. In reality each component should overlap significantly – innovation is overlapping with engineering, (Richard Murray – Innovate UK)

C: Revenue into existing industries is important but also cofinancing from companies and startups and EC funding that they are able to attract is very important. (Peter Lodahl – Niels Bohr institute)

C: I would like to highlight one point, that is that at the end of the day the HLSC should decide which project should be done at European level and which one can be done at national level. And by this I mean that doing things together at European level might be more effective but might be more demanding. I would like to hear more about what should be done at European level and what at national level. (Frank Schlie-Roosen – German Government)

Q: I would like to build upon the observation made by Innovate UK that you commit your house as an industry. We have different sizes of industry. I would invite all of us, and the EC especially, in finding a way to mitigate a problem of the SME to access this kind of technology. You have to support the smaller industry and sort of protect them. (Francesco Cataliotti – CNRS)

A: I completely agree (Gustav Kalbe – European Commission)

C: Are we forgetting the possible dark sides of Quantum Technologies? Some technologies such as magnetic imaging of the brain can entail some ethical question, artificial intelligence can rise question about privacy, we have to create some sort of safeguard. (Martino Travagnin – JCR, European Commission)

C: We have plenty of ideas, but making a successful product is something completely different. Before funding a project, we have to reconfirm the commercial the value of the product. (Bruno Desruelles – MUQUANS)

Comments from the web part of the conference

C: The development of chip-scale clocks was financed by DARPA (100 million \$ project). The killer application is probably military for such clocks. (André Stefanov)

C: Full support the wider view of industrial impact expressed by Andreas Wallraff. (Slava Kashcheyevs) [see comment in the above section]

C: While the US companies are investing heavily on Quantum computing, here in Europe we are trying to partition an already very limited budget into 1000 different quantum technologies. (David)

C: Perhaps we need to step back and ask what a multinational company, say HP or IBM, would do if they wanted to build a quantum computer – first step, I guess, would be to assemble an interdisciplinary team representing all the necessary fields (engineering, physics, mathematics, technical support, etc.). At the moment, there seems to be still too much focus in the Roadmap on the (competing?) experimental platforms that could lead to quantum technologies, rather than the interdisciplinary structure needed to have a functioning industry. A dedicated quantum control engineering should be part of this structure. (John Gough – Aberystwyth University)

C: John, I agree, instead we will end up in having a plethora of medium-sized projects, with no real impact, apart from top scientific publications (of course) and having pleased a large part of the quantum community (or should I call it quantum research groups active in Europe). (David)

C: As a historical example, the Kalman filter was critical in the Apollo 11 moon landing, but was a theoretical idea from the early 1960's which had already been applied to airplane gyroscopes, and subsequently widely applied to the telecommunications industry. My sense is that quantum engineering control theory is significantly ahead of experiment, and that the control-theoretic elements are not familiar or well-understood in the physics community. The aim of building a quantum computer ought in principle to lead to a body of knowledge and practice in applied quantum engineering, which in turn should filter down to the benefit of quantum technologies (including quantum sensors, quantum communications, etc.). This would be a more natural sequence of development. (John Gough – Aberystwyth University)

Q: Regarding sensors/metrology: One should keep in mind that specialized systems can have large economic benefits that are not well quantified by the revenue they generate. The clearest example is high-precision clocks, which are not sold in large numbers, but which have very large economic benefits by underlying navigation and communication activities. Similarly, a breakthrough in inertial sensing could have a large return in energy and environmental fields, and in medical imaging. (Morgan W. Mitchell - ICFO)

A: Today I think it is very difficult to connect the strategies for the Quantum Computer, so they should be seen as two different fields within the Flagship. The DARPA challenges are certainly useful and have been proven to be really effective. We should have this market-driven technology goals. It would be useful if we could put together something like it. (Bruno Desruelle – MUQUANS)

A: If we think about Quantum Computing, I showed you technologies such as semiconducting quantum dots. However, you need to have advanced manufacturing technologies, which really go

down to nanometre scale. In order to be successful we need to have sophisticated advanced manufacturing but we are continuously losing our ground. (Walter Riess – IBM Research Lab)

C: I agree with the point about young people. They are driving the field and the best way to guarantee sustained progress. So one part that needs to be discussed is how mostly universities can be steered towards more save jobs for young researchers in the interdisciplinary quantum field. Can there be an incentive from the Flagship initiative towards this goal? For example, a call for young researcher projects with a promise of tenure positions by the universities a prerequisite. (Tilman Pfau – University of Stuttgart) [position supported by Matteo Rizzi – University of Mainz]

C: Putting together John's suggestion and the suggestion of the German Government representative, we could go for specialised pan-European centres (or hubs) to tackle a few of the ambitious technologies (quantum computing, quantum communication, for instance) and this could be done by building up on already existing national initiatives (investments). The UK hubs is a very good example (hopefully Brexit will not have a negative impact here), the Netherlands initiative is another examples, but also the ATOS Quantum in France. This will be more effective than the 1000-little-projects scenario (David)

Scientific Panel Session

Moderator: Robert Thew (University of Geneva)

1st presentation: Quantum Simulation

speaker: I. Bloch (Max Planck Institute for Quantum Optics)

[Presentation](#)

Q&A

Q: In your platform you could have molecules not in quantum gas, but in a vacuum for instance. (Francoise Remacle – University of Liege)

A: We should talk about that. (Immanuel Bloch – MPQ)

Q: I expect there should be three dots at the end of that. (Dragan Mihailovic – Jozef Stefan Institute)

2nd presentation: Quantum Computing

speaker: D. Lucas (University of Oxford)

[Presentation](#)

3rd presentation: Quantum Sensing

speaker: P. Schmidt (PTB)

[Presentation](#)

Q: I just want to point out that we should not be too restrictive into define what a quantum sensor is. For instance, magnetometry so far the best magnetometer does not involve any quantumness beside spin coherence. (Ioannis Komminis – University of Crete)

A: The list I provided [see presentation] is an “or” list. If your system has at least one of the characteristic, for me it is a quantum system. (Piet Schmidt – PTB)

[Comments from the web part of the conference](#)

Q: I am concerned that in the current Roadmap, very young quantum technologies such as opto-mechanics and sensing with a small number of entangled photons are given specific lists of goals, whereas more established quantum technologies such as atom interferometry and squeezed light are described almost entirely in the "state of the art" sections. Does this mean that the Flagship does not aim to advance quantum sensors that are closer to application? In the hopes that the Flagship will indeed support these, and with the encouragement of Toni Acín and Ian Walmsley, I collected from the precision-sensing community proposed goals for atomic clocks, atom interferometry, optical interferometry, hot-atom and ultra-cold-atom sensors, and non-destructive testing. These suggestions were delivered to Toni, Ian and Fedor Jelezko three weeks ago. I would like to know the status of these contributions, and whether they will be included in the Roadmap and other documents that define the Flagship. (Morgan W. Mitchell – ICFO)

A: I don't think there is yet an exclusion. Particular goals might have to be added, but they are well established and we expect to have them into the flagship (Ian Walmsley)

4th presentation: Quantum Communication

speaker: N. Gisin (University of Geneva)

[Presentation](#)

Q&A

Q: Shouldn't it be one of the goal of the flagship to make single-photon sources as convenient as the weak coherent pulses? (Tobias Heindel – Berlin Technical University)

A: It depends on what are the goals. If the goal is to have better detectors for longer distance QKD then I would not work on that; but if the goal is to make the 500 km long quantum repeater then I would certainly work on that. (Nicolas Gisin)

Comments from the web:

Q: On the synergies with other programmes, the scoping paper of FET for the years 2018-2020 already points towards potential synergies with the LEIT ICT for quantum areas within higher maturity level (sensors, metrology, communication, for example) and with Societal Challenge 7 for postquantum cybersecurity (maybe through the new cyber PPP?) we need leverage from other programmes, 1 billion in 10 years is very limited for our quantum ambitions. (David)

5th presentation: Quantum Information Theory

speaker: A. Acín (ICFO)

[Presentation](#)

Q&A

Open Discussion

Q: What is the purpose of the roadmap? Does it tell us “you should be doing this?”, or if it doesn’t, is this to be regarded as a showcase of what was going on in the community?

A: The roadmap is only describing what was going on in the field. For the flagship we need not a roadmap but a research agenda which tells us what needs to be in the flagship in terms of what are going to be the activities. The HLSC has a mandate from the EC to develop the research agenda which is telling the flagship what should do, which is coming from the Roadmap and from the Industry input.

Comments from the web part of the conference

C: We have seen a lot of great and fascinating research directions, which are exciting and therefore fundable by regular funding agencies. Shouldn’t we use the flagship in the sense of “added value” to fund things that are not fundable in conventional programs. This would apply to a special quantum incubator or a program that explicitly is linked to tenure positions for young researchers. With the latter mostly universities can be steered towards more save jobs for young researchers in the interdisciplinary quantum field. This will lead to a sustained multiplication of the flagship funds. (Tilman Pfau – University of Stuttgart)

Wrap up session

speaker: T. Debuisschert (Thales Group)

Engineering and control: [presentation](#) and [wrap up](#)

Enabling science: [presentation](#) and [wrap up](#)

Theory, algorithm and protocols: [wrap up](#)

Moderator: T. Calarco (University of Ulm, IQST)

Q&A:

C: One additional aspect that came up, is the question “do we need a more organised effort?”. There are many diverse feelings about it, some say it should be avoided and some think it should be done. I guess it will be one of the challenges of the HLSC to understand if concentrating the know-how in a particular direction could lead to benefit. My personal opinion is that we should be flexible enough to have both options open. (Andreas Wallraff – ETHZ)

C: Once the flagship is running, how are we choosing proposals, are we going for a traditional peer-review system like in FP7, or are we going to go for more alternative models, like DARPA or IARPA, or even using retired people. It is absolutely critical how to select funding and absolutely make sure that there is no conflict of interest, which may hinder the success. (Winfried Hensinger – University of Sussex)

C: As suggestion, a good way to summarize everything is asking ourselves what do we want and what we would like to see as idealistic scenario in the future, at the end of the flagship. How do we imagine the future to be with the technologies we should have brought into fruition with our work and what we expect in the 10 years after the flagship? We should get together the different aspects and have one per pillar. (Paolo Bianco – Airbus Space & Defence)

C: I would hope to see in the future a set of grand challenges that everyone in the flagship is contributing to in some way. There must be an overarching set of targets. Some sort of tangible thing we are aiming for, including the 10 billion € enterprise. (John Rarity – University of Bristol)

C: About peer review – in order to gather more information, I was approached by the ESF concerning this. I have asked them to prepare a small presentation on how they could envision that. This will be one of the possibilities available for discussion in the HLSC. (Tommaso Calarco – University of Ulm, IQST)

Q: The idea for us is to offer our support in designing the peer review process. We have a long experience on that (40 years experience on peer reviews) and we put a lot of effort. For us is very important the transparency, gender balance and avoiding conflict of interest. I have also one question, on the coordination side, with programs and initiative at national level, maybe you need

to think a bit when defining your research agenda in order not to duplicate. (Ana Maria Ciubotaru – ESF European Science Foundation)

A: Absolutely, we are doing it since a couple of years and we are having a strong discussion in that direction. (Tommaso Calarco – University of Ulm, IQST)

C: I think that our community is not used to work on topics with commercial impact. One should discuss that one can have science and industry working together and making sure that IP protection doesn't hinder other possible development. Maybe there is a clever thing that one can do within the flagship in order to make it appealing for both the industry and the scientists. (Andreas Wallraff – ETHZ)

Q: I would like to make a comment on the governance. I saw it is inspired by Photonics21. I would like to see that the BoS gets to meet slightly more frequently. It is important to vote more frequently and not leaving everything to the Board of Directors. Moreover, how do we see the flagship with other pillars of H2020, for instance with calls that will appear in cyber security, photonics, how people that will participate in the QT flagship might profit from that. (Eleni Diamanti – CNRS)

A: Concerning the comment on governance, we have received today an input from Mario Agio and we will discuss the point in the HLSC. (Tommaso Calarco – University of Ulm, IQST)

A: For the moment is premature to talk about measures to link part of the funding to other programmes. It will be sure that we will have speak about it, but not now. (Gustav Kalbe – European Commission)

A: Let me add that tomorrow I will speak with the MEP from Berlin who was the rapporteur for rules of participation on H2020 about Quantum in FP9, since it is important to have the parliament on board, so this is something that we are starting. (Tommaso Calarco – University of Ulm, IQST)

Q: It could be useful to think about a special working group on the RTD structure you want to create. I think it was addressed if you wish to have a centralized structure or many different organisations. It is important to define which is the “dress” that suits more your research. (Andreas Schweinberger – Arttic)

A: Of course that is the implementation aspect and is in the mandate of the HLSC. This is of course one of the three big components of the mandate. (Tommaso Calarco – University of Ulm, IQST)

C: It was a very useful day, I personally favour the inclusive approach because we want to deliver on short-, medium-, and longtime scale, we should have many different directions and types of calls. We have to be flexible. (Eugene Polzik – Niels Bohr Institute)

C: I see a bit of tension between the academic world and the economic world. Perhaps not everybody realizes that with this flagship at least in the academic world we are losing a bit of our

innocence. We are not here anymore just for “true research” but also to create wealth. It means also nasty things like IP, yes the information will not flow freely between companies. This means that I see us here in a learning phase, yes we still have research but we have to bridge between “true research and real application” in order to put Europe on the forefront. (Markus Matthes – ASML)

C: As a member of the HLSC, I was impressed by the amount of input, it will be hard for us to put it together. More and more today I sense a sort of session between industry and the academia the way we operate and how we can work together. (Paolo Bianco – Airbus Space & Defence)

C: It has been an interesting day, of course I hope you all realize that it will be a hard job to do. There are of course rather different opinions on how this should be done. But I have two reflections: one is the balance industry/academia, that should change over time. I personally believe that at the beginning there should be more academia and then, over time, industry should take over. How the balance will fall out, this has to be discussed. The other theme is on large nodes vs small ones. This is largely depending on which pillar we are talking about. If you are talking about computing you need large node, but if we talk about sensing it can be done by smaller groups. Thus this should be pillar-dependent. (Per Delsing – Chalmers University)

C: I fully agree with what has been said, there have to be several kind of activities, there is a large variety of research that can be developed and we should not miss any opportunity, and the flexibility should be there for this. The field is not that well defined yet. Coming back to IP, it is a big problem, if every project signs the IP agreement. It raises really large problems on the ownership, we have to think about general rules, although it will not be easy. (Elisabeth Giacobino – CNRS)

C: I think that the workshop has really successful, the community is really involved. This is a democratic process and it is something new. I think inclusion is important for the success of the flagship. Of course, at the end of the democratic process we have to find guidelines, in order to design a new structure. The main point is to organise the research in order to promote the translation from science to technology to engineering. If we are successful we will provide a methodology for the EC for structuring this kind of things. Therefore, I would like to encourage you to participate in a constructive way and contributing to construct a new instrument. I personally think that this should not be transformed into an agency, you have to be more flexible. The EC has given you a priori a large amount of funds, larger than other areas. This effort must be seen as a useful example that could in the future be replicated for other fields. (Maria Chiara Carrozza – Sant’Anna School of Advanced Studies)

Comments from the web part of the conference

C: Encouraging the creation of more permanent jobs for young researchers will have a long lasting positive effect and help stop the brain drain caused by the lack of opportunities inside Europe that is driving the young and talented to work for companies in the US. (Christian Gogolin – ICFO)

C: The national programmes are centred on national capabilities, and often do not look beyond their time-frame (my experience of UK at any rate) – pan-EU hubs, as mentioned by David earlier, would address this but I would be wary of building on national programme. The added value argument would certainly help. (John Gough – Aberystwyth University)

C: Quantum Incubators could be designed on the model of UK Catapult program, they are theme-based (medical, space, etc), and very effective to bring in the same rooms all the needed stakeholders (scientists, entrepreneurs, industry, VC, etc) for the tech transfer from the lab to innovative solutions. UK Catapults program are very effective in creating new startup/spin-off offering tech jobs to researchers and tech knowledge workers. They could be a good model to follow. (Emanuele Rocco - Niu Tech)

C: The brain drain (also into banking etc.) and the lack of perspectives for the best young scientists in the field is a strategic disadvantage that we have in Europe and we should fight against if we want to remain competitive. A highly competitive, focused young researcher program linked to tenure positions could contribute to solve this. (Tilman Pfau – University of Stuttgart)

C: It would be important also from the industry perspective to have a larger community of gifted young tenure track researchers exploring new ideas in EU, with whom potentially collaborate with and build stronger synergies (like in US). (Emanuele Rocco – Niu Tech)

C: I would strongly support the idea of training of engineers in quantum physics and vice versa training of quantum physicist in engineering. This however is very hard to achieve from a European program, as the decision of curriculum is made by local faculties. Are there any ideas on how to realize this in practice? How can we create incentives to training institutions like universities/faculties to include this training at least on the Master course level? (Tilman Pfau – University of Stuttgart)

C: A quantum engineer ought to be a quantum 2.0 engineer. It should be more than just putting engineering and quantum modules together in a degree scheme. As an example of classical control engineering embedded into quantum physics, which is not quantum 1.0 engineering, the following recent preprint (by young researchers) is recommended <https://arxiv.org/pdf/1611.00375.pdf> (John Gough – Aberystwyth University)

C: What about using an open-source hardware approach or some key common engineering parts, as control electronics? And so help other non-experts entering the field faster? (Emanuele Rocco – Niu Tech)

C: How do we connect the science and technology roadmaps? Is there any "boring" activity foreseen in pushing the technology being the fundamental roadmap to the point where industry can pick it up? (Kai Bongs – University of Birmingham)

Concluding Remarks:

Speaker: Jürgen Mlynek (Humbolt University)

J. Mlynek stated that the flagship is a strategic initiative; not a funding agency where one can apply for arbitrary things. He stated that, concerning the evaluation process, it is something that needs to be thought about, but this is nothing that has not been done before.

Concerning the workshop J. Mlynek said he was impressed by the information, but was disappointed that there was very little information about where we are standing now.

J. Mlynek remarks also that a discussion on the balance and on the education needs to be done and needs to be taken seriously into account.

J. Mlynek stated that the goals by mid-January are:

- Content,
- Structure,
- Ramp-up phase (more inclusive, more open),
- How to organize the next phase.

He stated that blue-sky research is important, but the Flagship needs a quality management to be able to stop activities that do not deliver.

J. Mlynek commented also that the Governance approach need to be carefully planned, and he would in generally lean toward simpler approach.

Finally, he issued a note for caution, in the sense that one should not expect that the HLSC will be able to deliver wonders in a few weeks. There will be a feedback round but by mid-January with a 10 page draft report for the EC.

End of the workshop