

Science and Technology Committee

Oral evidence: Quantum technologies, HC 820

Wednesday 12 September 2018

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Watch the meeting

Members present: Norman Lamb (Chair); Darren Jones; Stephen Metcalfe; Carol Monaghan; Graham Stringer; Martin Whitfield.

Questions 356 - 450

Witnesses

I: Mr Sam Gyimah MP, Minister of State for Universities, Science, Research and Innovation, Department for Business, Energy and Industrial Strategy, and Professor Sir Mark Walport, Chief Executive, UK Research and Innovation.

Written evidence from witnesses:

- [UK Research and Innovation](#)

Examination of witnesses

Witnesses: Mr Sam Gyimah and Professor Sir Mark Walport.

Q356 **Chair:** Welcome; it is good to see you both. I do not think we need to worry about introductions; we know who you are.

The UK is clearly in a world-leading position in terms of the research base for quantum technologies. What is the Government's plan for how we move from that to develop a world-class and world-leading UK industry so that we get the economic benefits from the leading position that we have secured, in large part as a result of the first phase of the programme?

Mr Gyimah: Chair, you are absolutely right; the UK has a world-leading position in this technology—I think we are third only to China and the US. In terms of what I will call the critical success factors to make the most of it, obviously the first is funding. In terms of phase 1 of the national quantum technologies programme, a significant amount of investment was made available—£270 million—and that also leveraged in excess of £36.6 million of industry-funded investment. Therefore, making the funding available and getting leverage from industry is crucial, but making sure that research and industry are partnered together so that we can exploit the benefits of this is absolutely crucial.

A lot of success has been achieved in phase 1. The Chancellor's announcement last week of £80 million in Glasgow shows our intent to take that to the next level, but a combination of finance and making sure that we have the right partnerships with industry would help deliver the success that we want to achieve here.

Q357 **Chair:** The Chancellor made the announcement of £80 million, and he confirmed it in his response to our letter. That was very good news. It is subject to the approval of the business case. Can you confirm what the timescale of the business case is likely to be?

Professor Sir Mark Walport: The business case would be routine for an investment of this scale, which is £80 million. It will be led by UKRI through EPSRC and will be done well in time for the putative start of the next programme, which is not until November of next year, so this is all in good time.

Q358 **Chair:** Can we have some greater understanding of the relationship between the £80 million announced and the proposal put forward for the next phase of the programme, which is £333 million or something of that sort? Is this what we hope it is, which is an early announcement to reassure universities that the funding continues for the hubs so that they do not lose highly mobile people drifting off to other places? The full programme will be announced in the Budget. That is what we are hoping for. Is it likely to happen?



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Professor Sir Mark Walport: First, may I also tackle your question about industry? One of the great strengths of the national quantum technologies programme is that industry has been involved throughout, so we are starting in a good place. Indeed, as part of the process for wave 3 of the industrial strategy challenge, we are holding a series of workshops over the summer. A workshop was held yesterday around the quantum technologies proposal. There were over 70 people at that, and the majority came from a very wide range of business, so a momentum has started that involves business.

Q359 **Chair:** Do you feel confident that we will be able to develop that world-leading industry base on the back of the academic expertise?

Professor Sir Mark Walport: Academic expertise is necessary but not sufficient. It is very important, but the challenge is to turn that knowledge into innovation and products.

You are asking a question about momentum. There is not only the £80 million that has been announced but an additional £15 million of capital for the next round of the hubs programme, and there is also the £20 million pioneer fund, which is at the industry interface. That is a competition that is in active process at the moment.

The decision about the rest of the funding will be made as part of the decisions around the next wave of the industrial strategy challenge. A process is going on at the moment, and ultimately it will be a choice for Ministers. We have a great many competing programmes.

Q360 **Chair:** Do you anticipate that it will not be an announcement in the Budget and it will come separately from that?

Professor Sir Mark Walport: I cannot tell you the precise process for announcement at this stage. I do not think it is decided, but the critical thing at the moment is to review the proposals, and the workshops are, if you like, part of our catalytic role in trying to get them in the best possible shape.

One of the critical questions is that at the interface between industry and academia the private sector needs to contribute as well. That is a very important aspect of this. Part of the purpose of the workshops is to see the extent to which industry is prepared to work collaboratively to make this happen, and the extent to which it is willing to dip into its own pocket as well alongside our funding as taxpayers.

Q361 **Chair:** I completely see the value of that. We have also been told that the rules about the percentage share from industry cannot be too prescriptive.

Professor Sir Mark Walport: I am aware of that, but what we are talking about now is economic growth, and, if we are to get the economic growth, we need industry investment.



Q362 **Chair:** We do not want to rule out SMEs, do we?

Professor Sir Mark Walport: SMEs are definitely part of it, and the rules demand more money from the big companies compared with the small ones. We have to recognise their ability to contribute, but if we are to pull this through we need industry funding as well, and I think that point was made strongly at the workshop yesterday.

The bottom line is that I cannot guarantee the outcome of a process that is running at the moment. There is a series of extremely competitive bids. The quantum sectors are very well prepared and should be in a strong position to compete.

Q363 **Chair:** Given the £80 million funding for the hubs that has been announced, do we envisage any change to the purpose and nature of the hubs, or does it simply facilitate a continuation of business as usual?

Professor Sir Mark Walport: No, I think it is continuous evolution. It has been very interesting to go to the national quantum technology showcase at the Queen Elizabeth Centre each year. The fourth one will be held on 9 November this year. Each year you see the combination of academia and industry, but it is moving from bits of kit that do not quite need a room of this size to fit them in. For example, you are beginning to see prototype sensors that could have commercial application. Therefore, the hubs have to evolve.

As to the innovation centres, we are very interested to see what the proposals look like in terms of how they are structured, because I do not think one size will fit all.

Q364 **Chair:** You have already implied a shift towards the application away from core research in the second phase. Is that fair?

Professor Sir Mark Walport: These are not either/or questions. The fundamental research needs to continue.

Chair: Absolutely, but you need to add to that the applications.

Professor Sir Mark Walport: Exactly so.

Q365 **Chair:** I guess that is where the innovation centre idea comes in.

Professor Sir Mark Walport: Yes.

Chair: We have been hearing that the concept of the innovation centres is evolving in the ongoing discussions about what they will be like, with a move away from the concept of bricks and mortar. Can you tell us more about that? You were co-author of the report that made the recommendations.

Professor Sir Mark Walport: Yes.

Q366 **Chair:** Remind yourself of what you are proposing. How has your thinking evolved?



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Professor Sir Mark Walport: You will have seen that the proposal on innovation centres was largely around demonstration facilities. It is important to recognise that there are two parts to the industrial opportunity here. There is the opportunity for companies that are manufacturing products—for example, quantum clocks. The role of the UK in quantum clocks has been a leading one, and the big challenge and opportunity now is to miniaturise them, which is important. It is related to one of the recommendations about the resilience of clocks and GNS systems, position navigation timing and our dependence at the moment on satellite technologies. If we had accurate small quantum clocks distributed to go with the right fibre networks, that would provide resilience.

The real point is that we have the companies that make the stuff and then we have the sectors that can benefit. The companies will thrive only if there is a good market. When you look at the market, there is hardly any sector that does not have the opportunity to benefit.

Q367 **Chair:** It cuts across all fields.

Professor Sir Mark Walport: For example, medical imaging and magnetic imaging. If you are in the business of construction, knowing what is underground is very important; if you are in the business of driving autonomous vehicles, being able to see through fog and other obscurations is very important. So the challenge here is at least as much developing the customer base as it is developing the companies.

Q368 **Chair:** And, presumably, raising the awareness of customers.

Professor Sir Mark Walport: Precisely. That was one of the purposes of this report. This is a fairly arcane science, and people do not appreciate what the potential is. This was intended very much to demystify what quantum technologies was about for the policy community but also a broader customer community. Obviously, defence is a lead customer. I know that Peter Knight has had the opportunity to speak to you in the past.

Q369 **Chair:** I go back to the question of how we evolve the innovation centre. You stand by your original recommendation. Can you describe further how that concept has evolved and what it is likely to look like?

Professor Sir Mark Walport: I think the concept essentially is that we need environments where industry and academia can work together. I think you are right that we should avoid too much bricks and mortar. There is an awful lot of bricks and mortar around already, and what we would like to do is get the most out of the existing space. We are very interested in the industry proposals. The industry has been talking about these as well, and I will be quite interested to see what comes up.

If you look at other sectors, there are clusters built around industry itself, for example. If you look in other areas around QinetiQ, there is a cluster; there is effectively an innovation centre around them. In the pharma



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industry, we have examples around the country where there are incubators and other areas where innovation can occur adjacent to particular companies. There is also the catapult model, which works very well in advanced manufacturing.

The essence of this is to bring together industry and academia in an environment where they can work together, preferably not in exclusive one-to-one relationships, because I do not think that works terribly well. One of the big opportunities is for the big companies to develop their supply chains as well.

Mr Gyimah: I agree with all of that. One point to add is that obviously match funding is key to phase 2, and we should leave space for industry to shape how the innovation centres, or whatever we call them, evolve. Industry will have ideas. If commercialisation or capturing economic benefit is key, having industry help to drive that decision is particularly relevant to success.

Chair: In part, that will turn on the governance of the ongoing programme, and we will come to that later. I will now bring Carol in for the next question.

Q370 **Carol Monaghan:** Minister, the announcement by the Chancellor of the £80 million is very welcome, but it is far short of the £338 million that had been sought. When will we hear a decision about further funding? What do you see as the main factors that might influence that decision?

Mr Gyimah: The £80 million is a statement of intent. There is potential for further funding from wave 3 of the industrial strategy challenge fund, which is structured around our grand challenges. One of the grand challenges is artificial intelligence and data, and quantum technologies are taking account of moving the AI and data grand challenge, so there is potentially more funding from that depending on the bids.

Q371 **Chair:** Are you conscious of the urgency of decisions on this, because industry and academia are telling us that they need to know early about the development of this programme?

Mr Gyimah: The decisions around ISCF wave 3 will be made around budget time, so we are talking of a few months. We can then make further decisions in the light of the ISCF bids, but we are determined to maintain our position in this particular field, not just by Government funding but also leveraging funding from industry.

Q372 **Carol Monaghan:** I ask again then: what would be the key factors that would affect the decision on funding?

Professor Sir Mark Walport: It is the quality of the bids and the partnership. We are working with all of the bids that are being considered at the moment to make sure that they make their case in the best possible way. Industry has been working together very well. I had a good



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letter from e2v, a consortium of companies working in quantum. They know what they need to do. We need to see it written down.

Q373 Carol Monaghan: Is there a danger, however, if we simply rely on the quality of the bid, that we do not recognise that we are world leaders at the moment in this technology, and without proper funding we could lose that position?

Professor Sir Mark Walport: One of the corollaries of being in a world-leading position is that organisations should be able to write a world-leading bid. We are in the middle of the process and it is difficult to anticipate the outcome, and I do not think we should. All of the evidence suggests that this is a very good community, but they do need to demonstrate that they are going to put in money. For example, it might turn out that, in spite of fine words, it does not look like funding is going to come from the industrial side as well, because we are talking about economic growth and the growth of companies.

Q374 Carol Monaghan: We are also talking about national security.

Professor Sir Mark Walport: Yes, that is perfectly true, but defence is working with some of those companies directly, so this is not the only source of their funding.

Q375 Carol Monaghan: Minister, why was it decided that the £338 million was not going to be awarded at the outset and it was going to come potentially in a piecemeal manner?

Mr Gyimah: I will give an introduction and Sir Mark can continue. I think the Chancellor wanted to show, given the concerns in industry, that we are serious, but, as Sir Mark said, it is about quality of bids. We already have the industrial strategy challenge fund. Overall, we are committed to spending a lot of R&D, a significant amount of which will go on quantum, so that is not the question. The question is around process and how we do this in a sensible way.

Professor Sir Mark Walport: Of course, this tranche of funding will go into the next spending review period as well, so the case does need to be very well made. While it was a single overall ask, it was in a series of different buckets, if I can put it that way. The quantum hubs are essentially being funded at a continuation of the level they had before. As to the Government commitment towards the £338 million, there is the £80 million, the £15 million of capital, and there is the £20 million of pioneer fund. The sum awarded so far is in excess of £100 million, but the case does need to be made as part of the industrial strategy challenge fund for that piece of it.

Q376 Chair: Just to reinforce the point Carol made about national security, I understand the importance of a good bid, but you see the importance of the second phase of the programme not just for our economic interest but our national security.



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Professor Sir Mark Walport: Absolutely. You will have heard about that separately, but the MOD and DSTL have been important supporters of this area of technology, and I would fully expect them to continue to do so.

Q377 **Carol Monaghan:** Minister, we hear that the MOD has supported quantum tech. What are you doing to encourage other Departments—for example, the Department for Transport or DEFRA—also to support quantum technology that could be relevant to their particular Departments?

Mr Gyimah: My Department, BEIS, does a lot of work with DCMS. We are currently going through a review of quantum computing and quantum technologies. We will report by the end of this year, and there will be recommendations for Ministers to follow. For example, one area we are working on is industrial engagement. In terms of the defence Department, its work here is very well known, going back to the Blackett review. As for other Departments, there is work going on, but it is not directly within my area of responsibility to drive the quantum technologies and how they could be exploited in the transport Department.

Q378 **Carol Monaghan:** To press you on that, you are the Minister for Science and this is about science funding, and science does have tentacles that reach into other Departments.

Mr Gyimah: Which is what UK Research and Innovation is for; it brings together the research councils and innovation.

Q379 **Carol Monaghan:** I am asking what you are doing as Minister for Science to advocate for the importance of quantum tech within these other Departments.

Mr Gyimah: As I said, the work we are doing with DCMS in undertaking a review of the challenges and opportunities will be tremendously beneficial to the Government as a whole.

Q380 **Chair:** Do you encourage other Departments to make use of the small business research initiative to develop these ideas and concepts in transport and other areas?

Mr Gyimah: I am looking at the opportunity for Government to play a role in this as a procurer of innovation. It is of crucial importance to the development. After all, given that quantum is a platform technology applicable in many different areas, we are looking at how we could use that initiative more actively. It is something I will be able to talk about.

Q381 **Chair:** I will talk to you about it.

Professor Sir Mark Walport: UK Research and Innovation also has a role, because through Innovate UK we work with all of the industrial sectors. It is worth saying that the automotive industry, for example, was



at the seminar yesterday to talk about the quantum technologies next phase.

To go back to the point I made earlier, we will be truly successful only if those industrial sectors that can benefit from these sensors, devices and timing systems are part of this. That has been an important part of our work and the work of the programme in getting customers to be interested. Of course, the main Government customer would still be Defence, which is fully engaged.

Mr Gyimah: The £20 million pioneer challenge fund, which is about the role quantum technologies can play in delivering our industrial strategy, through ISCF wave 2, spans all four areas of the grand challenges—mobility, AI and data, healthy ageing, and clean growth—and clearly that brings in the work that other Departments do in developing this major technology.

Q382 **Carol Monaghan:** Minister, what are the main aims of the ministerial review of quantum technology, and is there a timeframe for that review to take place?

Mr Gyimah: Yes. I expect the review to make recommendations to Ministers by the end of the year. The main aim is to look at what support is necessary to realise the commercial benefits and support responsible development.

Q383 **Stephen Metcalfe:** I want to go back to the amount of funding we put into the technology compared with China and the US. We are not putting in as much as they are. How do we intend to compete equally if the budgets are considerably smaller?

Professor Sir Mark Walport: You could ask that question about the whole of the R&D spectrum. When you look at the American budgets for research and innovation, they are very much larger than the UK ones, reflecting the size of population and GDP. Of course, China is going up very quickly. Nevertheless, we are spending very significant amounts of money. Looking at the 2015 figures, which are a bit out of date now, in the US it was 330 million. My note says it is in euros. Anyway, the ratio is probably right: the US was 330; China was 220, and the UK was 105.

You have to look at the outputs and outcomes. Remember that academically we collaborate. This is a global endeavour. There is clearly competition, but there is collaboration as well. We are putting in enough so that we can have a very significant impact, but we have to be mindful that we cannot compete on every front. So, I think it is about targeting.

Our other advantage is that we are a small enough community that we collaborate rather effectively. You could look at Canada, which in investment terms is behind us, but it punches well above its weight pro rata because it is a small and relatively well-connected community. I think our opportunity is to build on the fact that we have depth of expertise. We have industrial and academic strengths and a well-



governed programme, which I know you are going to ask about. I think we can continue to do well, but, at the end of the day, as the Minister says, this does literally apply to everything. You can look at every area and ask, "Are we the top spenders?" No, but would we expect to be the top spenders?

Mr Gyimah: That is absolutely right. The key to success is the strength of our research base and how we continue to foster that. We are focusing on the industry and how we can exploit this for wider economic benefit, but it all starts with having an excellent research base. That is something we are relentlessly focused on as a Government. The Committee is well aware that in areas of research, even here, the UK punches well above its weight internationally.

Professor Sir Mark Walport: I can give you a concrete example, which is around the development of quantum computers themselves, where the investment needed for hardware is enormous. One area in which the UK is very good is software and algorithm development. It is one thing to have the computers. The really important thing is to be able to use them, and the development of algorithms is a good example. How does the UK do well? It is because we focus on the areas that we are good at.

Q384 **Stephen Metcalfe:** That leads me to the next area. Accepting that we cannot invest in everything, that there are limits to what we can do and we need to focus on certain technologies, you have talked about software, Sir Mark. Are there other areas of quantum technology on which the Government want to focus particularly?

Professor Sir Mark Walport: In imaging, we are good at photonics. Photonics is a major strength; it is an area we are very good at, and there is the quantum hub in Glasgow led by Miles Padgett. If you look more broadly at photonics, that is an area where the UK is world leading. We have a UK-wide cluster. It is very strong in southern Scotland, but I was in Southampton recently looking at the work of people such as David Payne. So, we are extremely good at that. The hub in Birmingham is looking at gravity and magnetic sensing. Again, they are world class, so that is another important area.

We are good at clocks historically. There is a nice time line. This report explores all of these, but in quantum clocks we are very good. For example, the National Physical Laboratory has been working on and producing timing signals with the City, so that is another area of strength. Miniaturising these is a competitive area but another important one. In quantum communications, there are things like quantum key distribution. Our areas of strength are quite broad, but not everything.

Q385 **Stephen Metcalfe:** In the future, will the focus be the same as it has been in the past under the current national programme, or are there areas that have emerged on which there will be greater focus and more Government support than on others?



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Professor Sir Mark Walport: That raises another question. The next funding for the hubs is not simply a continuation. There will be a sort of competitive process to make sure that the hubs are doing well and that they have the widest interactions. For example, on the quantum communications hub, EPSRC has been working very hard on this.

Q386 **Chair:** Could others come in to bid for continuation of the hub programme?

Professor Sir Mark Walport: There will be a bidding process for this. Of course, the whole point of the hubs is that they work very widely. I actually have a rather nice map of the interactions. There is a wiring diagram, which I can send to you. When you look around, there are the four hubs in Glasgow, York, Birmingham and Oxford, but there are tentacles going across southern Scotland: Heriot-Watt, Edinburgh and Strathclyde. Durham is involved, as are Leeds, Sheffield, Nottingham, Warwick, Cambridge, Cranfield, Sussex, Southampton and Exeter. This works only because it is very wide, but there is work on the priorities. I could pick any one of them.

For example, if we talk about quantum communications, there is the satellite programme. This is another area that the UK is good at, bringing free space communications capability into the UK, because transmitting this stuff through vacuums is much easier than through other things. There is entanglement-based networking. Please don't ask me to explain that.

Q387 **Chair:** Please explain that.

Professor Sir Mark Walport: I will ask Peter Knight to pass over a piece of paper. There is the development of continuous-variable as well as discrete-variable QKD for coherent systems. My message is that this is being thought about very carefully.

Mr Gyimah: We can write to provide more detail.

Chair: That would be good.

Q388 **Stephen Metcalfe:** Priorities in the future may well be different from priorities in the past because we are in that process. So, there will be a bidding process. What are the criteria by which bids will succeed and promote different technologies from the ones we have done in the past, and what will be the criteria for not supporting things that we might have done?

Professor Sir Mark Walport: On a review process that is based on excellence essentially—evidence that there is track record and that they are asking important questions. For the hubs, it is the criteria that are used to determine what is the best research and innovation to fund.

Q389 **Stephen Metcalfe:** It is based just on the excellence of the research.



Professor Sir Mark Walport: It is excellence ultimately, but that is true of innovation too.

Q390 **Stephen Metcalfe:** And demonstrable outcomes from the past.

Professor Sir Mark Walport: Yes, absolutely.

Q391 **Stephen Metcalfe:** There is not a commercial aspect to that—that we think we can commercialise this sooner rather than later?

Professor Sir Mark Walport: There is a commercial aspect to it, which is the nature of their interactions with innovation and research in business. The danger here is looking at this as a sort of discontinuous activity. I pick three examples. Martin Sweeting in Surrey, Greg Winter in Cambridge and David Payne in Southampton work continuously between fundamental research and its application. We need to look at this as a continuum, and part of the review process will be the extent to which they are operating in a continuum.

Q392 **Stephen Metcalfe:** Is the end-user requirement for this technology a factor as well?

Professor Sir Mark Walport: Yes, it is.

Q393 **Stephen Metcalfe:** That would add weight to any particular bid.

Professor Sir Mark Walport: Yes. That could be described as application-inspired fundamental research. The Faraday challenge is a good example of that, where electrochemistry and material science are significantly influenced by the questions that are needed in the applications. I think it is a mistake to view research and innovation questions as coming out of the blue. They do not. They are all inspired by previous discovery or in some cases it is pure inspiration.

Q394 **Stephen Metcalfe:** It all sounds very good, and I am pleased it does. Reflecting on it, are there areas where the interaction between the Government, the research community and industry could be improved to make it even more seamless?

Professor Sir Mark Walport: The answer to that is that it would be ridiculous not to say yes to that. Of course there are such areas. Without being complacent, this is one area where joint working has been very extensive. When I turn to the letter from Teledyne e2v—it came from a series of industrial partners—they have been looking at the work we have done through this, for example, and it is joined up. Probably the biggest challenge remains persuading incumbent industries that this technology offers advantages. That is a generic issue, but it is perhaps harder in this area than in some others because it is so esoteric.

Q395 **Stephen Metcalfe:** I understand that. There is a challenge for all of us.

My final question is specifically about quantum computers. We have tended in the UK to go down the trapped ion route as the platform on which to run quantum computer software, but there are available at least



two other main technologies. If those prosper more than the trapped ion technology, how will we mitigate that risk, or rise to that impact or adapt to that?

Professor Sir Mark Walport: We do not have all of our eggs in one basket. We have investments in superconducting devices. It is another of those areas where the investment in each of these technologies is potentially enormous. Some of the very big US companies are involved. Google and IBM are putting a lot of effort into this, but there are strengths in this. We certainly have not thrown out of the window the possibility of further investment in superconducting devices and others.

There is no doubt that we could change the pattern of investment. Again, it has to be based on very solid proposals. It is no use saying that a particular area of technology is very promising if there is literally no seed corn with which to build. There are strong approaches to superconducting in the UK—for example, around Oxford. We will look at them, and, if a strong case is made, we will think about it.

Q396 **Stephen Metcalfe:** Clarifying that point, is this a battle similar to the one between VHS and Betamax? Is one technology going to win out? Will there be a variety of platforms and different technologies for different applications?

Professor Sir Mark Walport: You are testing beyond my expertise. There are others sitting behind me who know better. I will answer this with caution. I do not think it is quite analogous to VHS and Betamax. These are different technologies and it is possible we may end up with both.

Mr Gyimah: We can look at this from a regulatory perspective as well. There are lots of emerging technologies out there. We know that they could all have a transformational impact. Which aspect of them has impact and on what particular industries is not always very clear now, but one of the things we can do as a country is to make sure that when it comes to regulatory standards we lead the way—because regulation is emerging—and, in doing so, we can make the UK one of the places a researcher or entrepreneur looks to in order to turn their ideas into reality.

That is what I see as the purpose of the regulatory pioneers fund; it is beginning to allow us to do that. Whether in the field of AI or quanta, we can begin to think about the standards that can help move industry forward but also protect society, and, through that, make ourselves attractive to people with ideas. That is another way to approach this, rather than trying to guess and predict, and I am certainly not the one to do this. We definitely do not want Ministers playing that game. What we can do is create the right environment for people to turn ideas into reality.



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Professor Sir Mark Walport: It comes back to the broader value chain, in that we have to work out where our strengths are. It is not only the hard way; it is also the algorithms where we have a lot to offer.

We are very good on trapped ions. Apparently, we have a world record in the fidelity—which, of course, is an issue.

Q397 **Martin Whitfield:** Following on from that, what role do the Government want industry to play? If you had the ability to create the slogan—and I suppose you do—to excite and entice industry, what role do you want them to play in the development of the UK quantum sector? This is advert time.

Mr Gyimah: What we want is quite straightforward. As for what we want industry to do, there is a significant amount of taxpayer money being pumped into research and development in this area. The role we want industry to play is to help augment that funding, but also capture economic benefits for the UK. We are looking at a sector that could be worth about £50 billion, and we want a big slice of that.

Q398 **Martin Whitfield:** We have heard about the workshops this morning. In what other ways are Government engaging with the quantum industry to entice or tempt?

Mr Gyimah: There has already been extensive engagement with industry, particularly in helping to shape the second phase, and that will continue.

As part of the review that I mentioned, we are considering how we can help, how we can work better with the community, how we can increase awareness of the applications and how we can ensure that businesses in the UK gain competitive advantage.

There are a number of models that we could use as we go forward. We have recently established a number of sector councils in some other areas. For example, there is the AI sector council. These can be effective in bringing industry, researchers from academia and other experts together.

We look at our review and, as we go ahead, we think, “What is the right structure to”—

Q399 **Chair:** Do you see a role for a sector council here—in quantum?

Mr Gyimah: No—I am just mentioning that as a structure.

Professor Sir Mark Walport: Perhaps I could comment on the governance of the programme—I know that is a question you are interested in.

We very recently appointed Roger McKinlay as the challenge director for the quantum technologies challenge, and I am pleased to say it was a strong competition, with a number of very good candidates. Roger is a



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member of the quantum technology strategic advisory board. He is a chartered engineer, and he has worked in defence, aerospace, maritime and rail. He will be working very closely with the advisory board for the quantum technologies.

That will probably be the key interface. We are bringing it all under that single governance structure. We have someone who will be working as a full-time executive in the role. He comes from industry, and he is very well connected with industry and academia. He has been involved in the programme over the past four years. I think we have an engagement process there that is working with the industrial strategy, and it is quite powerful. It will be a single governance model.

Q400 **Martin Whitfield:** Absolutely. Just to push on that slightly—and I know this is in wide terms—what do you envisage the objectives of that governance board as being?

Professor Sir Mark Walport: The objectives are to achieve proper co-ordination, to keep ongoing surveillance of what is going on, to maintain constant industry liaison and to play a catalytic role, which is needed—for example, in bringing suppliers and potential customers together.

The word “challenge” is very applicable here. It is about providing challenge, but also about providing support.

Q401 **Martin Whitfield:** Do you envisage that extending as far as raising awareness of the potential outwith the immediate industry for quantum technologies? Do you see that resting with the Government, or with another—

Professor Sir Mark Walport: Yes. You could ask the Government Office for Science. I did this in my Government Office for Science role. Across Government, the chief scientist network has an important role to play, and it is closely networked into UK Research and Innovation, so each of the research councils has a chief scientist as a member of the council.

Q402 **Martin Whitfield:** So, you see that obligation of raising awareness resting on everyone who can advocate—

Professor Sir Mark Walport: It cannot be a single—

Martin Whitfield: Yes, it needs to be that.

Professor Sir Mark Walport: It is one area where I would say there is a co-ordinated community.

Q403 **Martin Whitfield:** Yes, which can build on it.

To go back to the governance structure, how are you going to measure the success of that? Which matrix are you going to use? How are you going to articulate, define and judge success with it?



Professor Sir Mark Walport: This is obviously an important general question for you, because research and innovation is one thing that you will worry about a lot. At the end of the day, first, this is about economic growth.

Secondly, as has already been raised, it is about national resilience. There are some defence aspects that are important. It is about the future of communications and the whole question of cryptography in a world where quantum computers are up and running.

We have to look through all those dimensions. We have to start with the outputs and the outcomes, because that is what you get immediately. Then, we have to look at the longer term impacts. I think that, ultimately, the impacts are, "Is it delivering the resilience that the country needs?" and, "Is it delivering the economic growth?", but those take a long time to measure.

Q404 **Martin Whitfield:** They do. But are you satisfied that the development of the outputs is such that you will look at it the other way, in that, if it is going to go wrong, you will spot that earlier?

Professor Sir Mark Walport: Yes, but it is not going to go singularly wrong, because it is quite diversified. That is the point: it is not a single thing. If it was all about developing a superconducting quantum computer, the question would be, "Have you done it, or haven't you?" But this is much broader than that.

I would encourage you to go to the quantum technologies showcase in November. There is nothing quite like looking at the companies and seeing how they are developing.

Q405 **Martin Whitfield:** Just to go back to the previous discussion about a sector council, is that your preferred model, or do you not have a preferred model yet for that engagement role?

Mr Gyimah: The situation is evolving. We are mindful that we must find forums to bring different groups of people together. We have gone for the sector council model in the case of AI. We would look to see what best suits quantum, but this is just to give the Committee an assurance that we do think about how we can do this.

Martin Whitfield: Excellent; I am grateful.

Q406 **Stephen Metcalfe:** I want to go back to the issue of matched funding, which we touched on earlier. What is your expectation, particularly for the research and innovation projects? Is it that all projects should be match-funded?

Professor Sir Mark Walport: No. Around the more fundamental research, we do not expect matched funding there. If you like, this is part of the generic model. It is about where there is market failure. At the interface between industry and discovery research, that is where



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Innovate UK operates, but Innovate UK operates in a model of partnership, and that works well.

Q407 **Stephen Metcalfe:** When you say market failure, it is not necessarily market failure; it just may not be that there is a market there yet. Professor Delpy told us that "it would be unfair" to expect matched funding from industry when there is not an industry there yet. Is that a fair comment?

Professor Sir Mark Walport: Only up to a point. I am not sure there was a market for light bulbs when Edison started his work, or Swan here. That was going back a while, but, all right, let us look more recently.

Stephen Metcalfe: We could go back to VHS and Betamax.

Professor Sir Mark Walport: Look at the emergence of companies such as Google. Look at the work of Bell Laboratories. Was there a market for the transistor before it was created? Far-sighted, technologically based industry does invest in its research and development. Look at the pharmaceutical industry. It does an enormous amount of R&D on its own account in order to get new drugs and vaccines to market.

There is no question that, at that interface between academia where it really is too early, that is where there is co-investment. That is what this programme aims to do.

Q408 **Stephen Metcalfe:** You have talked about forward-thinking companies investing in emerging technologies without necessarily knowing where it is going to lead. What are the Government doing to encourage that, to ensure that we continue the growth trajectory of the quantum sector?

Professor Sir Mark Walport: In a sense, they are working through this programme: I think this is a major part of it.

Q409 **Stephen Metcalfe:** Are there any particular industrial sectors that have not yet engaged as much as you would have thought they should or would have liked them to?

Professor Sir Mark Walport: The sector that has probably engaged the most, broadly, is telecommunications and timing, because they know their business is dependent on this stuff. When it comes to the sensors, it is less obvious.

I think the automotive sector is still tentative, but it is trying very hard to work out how it can get autonomous vehicles. The sensing by a vehicle about its immediate environment is going to be absolutely critical. There, we will have to see the imaging techniques starting to work.

Q410 **Stephen Metcalfe:** Is there any role for you or for the Government to encourage those sectors that are not engaged as much as we would like?

Professor Sir Mark Walport: It is through the sort of engagement that we are doing. It is through things like the quantum technologies



showcase. That goes to the recommendation before us, which is that we need to create environments where companies can see this stuff working. It is, in a sense, what the Catapult network is about in manufacturing. It is part of a general issue.

Q411 Stephen Metcalfe: You mentioned Innovate UK in your answer to my previous question. It has a current limit of 30% of funding that can go towards non-commercial organisations. Is that accurate?

Professor Sir Mark Walport: Yes, but it varies according to whether they are big companies or small companies. Small companies can give a bit less. I have the figures. It is on page 27 of my briefing.

The 30% was used for the pioneer challenge competition. Here we are. For the pioneers programmes industrial participants, we are seeking between 30% and 50%, depending on the size of the company. The principle is that, in general, large companies work on a 50:50 basis, and we are looking for 30% from small companies.

These things are not absolutely set in stone. There are obviously state aid rules that we have to be careful of.

Q412 Stephen Metcalfe: So it is a 30% contribution from the business, not from Innovate UK.

Professor Sir Mark Walport: Yes, it is 30% from the business, and it can be in kind. We look at it carefully.

Q413 Stephen Metcalfe: So there is some flexibility around that.

Professor Sir Mark Walport: Yes.

Q414 Stephen Metcalfe: You do not see it as necessarily a barrier to engaging research in technology organisations.

Chair: Is that correct—30% from the business? I thought it was the other way round.

Professor Sir Mark Walport: No. I will tell you if my briefing is wrong, but it says that, for the pioneer programmes industrial participants, we are seeking between 30% and 50% of the company's spend on the project, depending on the size of the company. I think that is accurate.

Q415 Stephen Metcalfe: Thank you for that clarification, which is very useful.

Some of the witnesses from whom we have heard evidence in this inquiry identified the fact that the innovation centres and the hubs will be very different; they are different things. Is that a fair observation?

Professor Sir Mark Walport: Yes. In a sense, the question is about location, to some extent. There is no reason in principle why they couldn't. For this to work, we need to have some clusters emerging. If you look at it, there already are clusters.

Q416 Stephen Metcalfe: One of the fears that emerged was that, because the



innovation centres and the hubs are very different from each other, this will exacerbate the valley of death. The gap between research and commercialisation will get even greater. You are shaking your head.

Professor Sir Mark Walport: We are trying to avoid that sort of discontinuity. We are not going to wreck a programme that is working pretty well. There are potentially differing interests, in that some of the academic research is quite far from market. It comes back to the fact that we have to view this much more as a continuous project.

Q417 **Stephen Metcalfe:** Okay, as long as you are alive to—

Professor Sir Mark Walport: We are alive to the issues—absolutely.

Q418 **Darren Jones:** We have been hearing in previous sessions about how many of the commercial applications of quantum technologies have a dual use in defence and security. So there are ethical but also national security concerns that those who are working in start-ups, scale-ups and big corporates need to bear in mind. What role do the Government and/or UKRI have in ensuring a dialogue with those businesses so that they understand the potential risks that could develop as a consequence of positive commercialisation?

Mr Gyimah: The regulatory pioneers fund, which is about standards in regulation to protect the public and to understand all the dynamics around these emerging technologies, is one vehicle through which we are doing this. The challenges are not just around quantum; the challenge is around artificial intelligence, and we want to ensure that, as a country, we are leading the way in regulation, in a regulatory way that is supportive of innovation. That is one way in which we are ensuring that we have that conversation, but also coming up with active, concrete proposals to solve it.

Q419 **Darren Jones:** So, those businesses that are funded by the pioneer fund as part of their funding are in a dialogue with Government agencies around security.

Mr Gyimah: The fund is about looking specifically at regulatory standards in the areas of emerging technologies. That will help us to develop our thinking on how best to create the right environment for these technologies to thrive, but it will also help us to have the right regulatory regime for their commercial application.

Q420 **Darren Jones:** And from UKRI?

Professor Sir Mark Walport: The first thing to say is that there are no new principles here. Every emerging technology—or almost every technology—has the potential for use in the defence sector. Almost every technology has the potential for bad uses as well as good uses. There are no new principles.

EPSRC has a responsible research and innovation framework. It has commissioned a public dialogue, which was published earlier this year.



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The public voiced concerns that quantum computing and the security of private and personal information needed to be addressed. Of course, that is a generic and live issue at the moment, which affects information technology in general.

It is part of our work as a whole. We are addressing it by ensuring that responsible research and innovation is embedded in the hubs and the centres for doctoral training. I think this is a general issue, if you like, for research culture and innovation culture, and quantum is no different from the others, I don't think.

Q421 Darren Jones: So there is no specific conversation happening between businesses and Government.

Professor Sir Mark Walport: Of course there are specific conversations in the context of quantum, in that everyone who is involved needs to be alive to what the possible uses and potential abuses are, and where there are potential vulnerabilities, threats and so on. That is very much part of the conversation.

I am not sure that there are any new principles here, as I say; I think this applies in almost every area—gene editing, you name it. One needs to consider dual use, and one also needs to consider how you get the best possible use.

Q422 Darren Jones: Sir Mark, you spoke earlier about the co-ordination between players in the crypto space. If I was a start-up entrepreneur wanting to move into this area, and if I got some PhD graduates and some clever people together, would it be inevitable, as a consequence of the funding, the networking and the organisations in this space, that I would therefore be part of conversations that would alert me to ensure that I was thinking about these issues?

Professor Sir Mark Walport: I do not think it would be inevitable—that is a very strong word—but if you were engaging at a competitive level and had people working with you who were competitive in the field, by nature they would be part of the broader networks of the community.

Q423 Darren Jones: Minister, one of the concerns that some of us have discussed in the past is around foreign direct investment into quantum technology companies in the UK. What level of confidence do you have in the Enterprise Act and in the Government's ability to intervene or to check, whether it is through venture capital funds or state-backed funding, that national security concerns are adequately managed with regard to the ownership of British companies and intellectual property?

Mr Gyimah: I am not familiar with the details of the Enterprise Act and whether that is the best way in which to do that. Of course, private UK companies can raise venture capital from all over the world—it does not matter which industry they are in. They could be part located here and part located in other parts of the world.



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On defence and security concerns, I am confident that we have the right processes within the MOD to deal with those, but as for how you raise venture capital—

Q424 Darren Jones: That is an important point. I do not think it would be the MOD that would have oversight of an acquisition of shareholding or equity financing of a company. That would be your Department, Minister. You can write to us if you like, but I have some nervousness about some of the mechanisms that the Government have to ensure confidence over national security concerns for mergers and acquisitions in private companies.

Mr Gyimah: On mergers and acquisitions, one of the key tests for whether or not a merger can go ahead is a national security concern; that is one of the key tests that we apply.

Q425 Darren Jones: And the threshold for that is what? What size of business?

Mr Gyimah: I would have to write to give the detail. That is very different from having three PhD students getting together and raising money from high-net-worth individuals or a venture capital fund to embark on a piece of research. That is completely different.

Q426 Darren Jones: It would be useful if you could write, Minister.

Just to conclude on this question, the example I am considering is that, in that environment, say there was a Chinese Government-backed venture capital fund that came to those entrepreneurs and PhDs and said, "Hey, here's £100 million to scale your business." It is a very competitive marketplace and, understandably, they would want that investment.

What I am keen to understand—as I say, you can write to us with the answer—is what checks and balances are in place to ensure that we have national security confidence over that. That was my particular example.

Q427 Chair: Just before we leave that subject, is there a case, Minister, for a specific notification system for those PhD individuals who are setting up this start-up and have been approached by a fund from China with a substantial investment, which might potentially have some malign concerns? Should there be a notification system, whereby they notify the Competition and Markets Authority that this foreign direct investment proposal has been made to them?

Mr Gyimah: I don't know how you do it. These three PhDs could move to Taiwan or to a different country to do their research.

Darren Jones: British companies.

Mr Gyimah: If you have three PhDs, who are by definition very nimble—I do not know the mechanism—

Q428 Chair: The mechanism could simply be that, if they are based in this country, they notify the Competition and Markets Authority that a



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proposal for foreign direct investment has come to them.

Mr Gyimah: I can see—

Q429 **Chair:** So that it can trigger the national security consideration.

Mr Gyimah: I will have to write back to the Committee on that.

Q430 **Darren Jones:** It is an important point, to be considered carefully.

Moving on to the security question, I am conscious that it was in the press that the Government were using publicly accessible Trello boards a few weeks ago, so I am nervous as to the answer to this question. Trello boards are platforms where you share information between workers in a workplace. It is an external company. It turned out that the Government did not pay for the service but made it private, and you could google access to information that Government were sharing between civil servants. Anyway, that is not my question.

My question is about the concerns around encryption and security due to quantum computers and cryptography weakening our current levels of security. What steps are the Government taking to ensure that sensitive information in Government is going to be secure in a world where crypto-computers might be able to hack current encryption methods?

Professor Sir Mark Walport: That, of course, is what the National Cyber Security Centre plays an important role in. This is an area where GCHQ, broadly, provides a great deal of advice to Government as a part of Government. This is something that everyone is well aware of. You have had the opportunity to talk to Sir Peter Knight, who has given evidence, so this is an area that the Government are very much aware of—as Governments worldwide are aware of—which is the threat that the existing public key cryptography can be broken.

Obviously, one of the challenges is to develop secure post-quantum cryptography—which can be done. The traditional one-time pad is secure against quantum computers. The question is how you distribute them, and that is why quantum key distribution is an important area. It is an area where the Government have a great deal of advice.

Q431 **Darren Jones:** I am conscious that you have answered the content and the academic substance of my question perfectly there, but what are the Government doing? Is there a co-ordination between Departments? Is it just something where you say, “NCSC is responsible for this,” and you are comfortable that that is the output? Is this security concern on your agenda, Minister?

Mr Gyimah: It is not just a concern to do with quantum; it is a concern to do with security and encryption more broadly. That is what—

Darren Jones: I am asking specifically about quantum.

Mr Gyimah: Sorry—what specifically about quantum?



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Q432 Darren Jones: To go to the answer that Sir Mark just gave, the fact that the encryption that we currently use and the way that we communicate sensitive information could be accessed as a consequence of quantum computers. Is this something that is on your agenda as a Minister, perhaps when you are liaising with NCSC or other Government Departments? Is it something that you have had conversations about?

Mr Gyimah: It is on the agenda. I am aware that cryptographers and academics are developing next-generation quantum-safe cryptography. The whole purpose here is to ensure that there is a future internet and that mobile communications are safe, so there is work going on.

Q433 Darren Jones: I think that was the right answer.

There is one thing here I do not have a feel for. This is one of these cross-Department issues. There is DCMS, which you mentioned earlier; there is you in BEIS; there is Defence; there is the Cabinet Office, with NSCS and GCHQ; and there is the Foreign Office. Is there a body that is co-ordinating on this area of security? Is there a meeting that you go to, or is there not? That is what I am trying to get to.

Mr Gyimah: I know that the National Cyber Security Centre is the body that looks actively at this. The work the centre is doing includes looking at the potential of the quantum computer and at algorithms, to ensure that quantum computing is safe. It is looking at gaining international agreement around some of these standards. That is not within my direct area of responsibility, but there is work going on within Government.

Q434 Darren Jones: I think the answer is no, but, anyway, I will move on.

My final question is around research and skills. This is one example of an area of research, development and commercialisation where collaboration is often useful. We have heard that our continued membership of FP9/Horizon Europe after Brexit is going to be an important part of ensuring that collaboration around research and development.

Linked to that is the ability, which you have seen in our recent Select Committee paper on immigration and Brexit, of academic teams and skilled workers to move freely between the EU and the UK. Is there anything in particular on quantum computing that you are able to give us information on today concerning our commitment to try to get access to FP9 and the movement of workers and researchers?

Mr Gyimah: I am sorry—I did not hear all of the question.

Q435 Darren Jones: Is there anything specifically that you are doing on quantum computing and this sector of research in terms of our continued membership of Horizon Europe and the free movement of workers and researchers after Brexit?

Mr Gyimah: We had quite an extensive debate on this last week. It is clear that it is not only continued membership of Horizon Europe—which is the successor to Horizon 2020—that is important to us. Having open movement of researchers will be critical to our continued success.



That is not just restricted to quantum computing. There are some great researchers here, but it is a global effort, and we want to attract the brightest and the best. We will continue to look to do so, not just from the EU but globally.

- Q436 **Darren Jones:** Sure, but is there any area of risk for us as a consequence? If we do not have associate membership of Horizon Europe, for example, what is the consequence? Has there been an assessment of the consequence? Are there EU collaborations where British universities are leading that we will no longer be able to be part of? What is the impact for quantum research in the UK if we do not get associate membership of Horizon Europe?

Mr Gyimah: The question is not whether we get associate membership. We have indicated that we want to associate—

- Q437 **Darren Jones:** I know that, Minister, but you will have done a risk assessment, I think, that says, if you don't get it, what the consequence is. What is the answer to that question?

Mr Gyimah: If we were not to associate, the areas that would be hit would include things like the areas of research that we do quite well in from Horizon 2020. Some of them are on beneficiary schemes.

Regarding the ERC, we would want to be able to continue doing that kind of research activity, which is based on excellence. We would have to look at how we can replicate some of those research schemes. With MSCA as well, we would have to consider whether we can replicate them.

- Q438 **Chair:** But you are conscious of the concern about skill shortages in quantum technologies. The message that we have had from lots of witnesses is that it is going to be vitally important for them to attract the best people for us to maintain our pre-eminent position.

Mr Gyimah: That goes without saying. Saying that is stating the obvious, as far as I am concerned. These are areas of technology that are highly competitive around the world. We have already heard the Committee's—

- Q439 **Chair:** Does everyone in Government share your view?

Mr Gyimah: Absolutely. The Committee has made the point that other countries are investing more than we have done. That is why we have said that we will pay tens of millions to associate with the next EU framework programme. We have to negotiate it, and research mobility is particularly important.

I happen to know that, domestically, EPSRC is supporting PhD students in quantum technologies via three CDT skills and training hubs, and there are doctoral training partnerships. In addition, quantum technology is a priority for EPSRC's 2018 call for centres for doctoral training, and we are considering several proposals.



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Independent of the benefits of association, work is going on domestically to ensure that we attract the talent that is needed for us to be successful in this space.

Q440 Darren Jones: Sir Mark, from a UKRI perspective, has there been any assessment of the impact of not getting associate membership of Horizon Europe for current research in the UK?

Professor Sir Mark Walport: That is a very broad question, but, yes, of course.

Darren Jones: In quantum computing, is my question.

Professor Sir Mark Walport: We have not looked at it specifically in the context of quantum computing. The same issues that apply to quantum computing are for every area, but we are of course working closely with BEIS on the implications of what happens depending on whether or not we manage to negotiate access to Horizon Europe.

Q441 Darren Jones: I suppose the answer at this time is that we do not know in detail.

Professor Sir Mark Walport: We do not know in detail for quantum. On the macro questions, this applies in every area.

Q442 Darren Jones: Taking the Galileo example, there have been cases where traditional collaborations have ended up having security implications. We have collaborated with a member of the EU and we have then not been allowed to continue because of the rule that you cannot be collaborative on security matters if you are not a member state. Are there any live projects in quantum computing where we are collaborating with European partners where there are security aspects that will cause us the same types of concerns around our continued participation, or is it too early in this field for that to be an issue right now?

Mr Gyimah: There is none that I have been made aware of.

Q443 Darren Jones: And none from your perspective?

Professor Sir Mark Walport: Not that I am aware of.

Darren Jones: Okay—that is it from me.

Q444 Chair: Can I just clarify one thing? You have talked about how the funding of the second phase is going through the challenge fund. We know that the proposition was £338 million. I do not think there was an exact science to that figure. Can you clarify whether, if successful, there could be a total funding of the second phase of that order? Do you have any idea? Can you give us any guidance about what is in play?

Professor Sir Mark Walport: That is one of the other things we are looking at. The first thing to say is that the £338 million included the quantum hub.



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Chair: I understand.

Professor Sir Mark Walport: There is over £100 million already accounted for. One of the other things that we are actively considering at the moment is to test whether the size of the ask is justified. It is a big number, and it needs to be justified, and that is one of the questions that we are considering.

Q445 **Chair:** But if it is justified, the potential is there for that to be delivered.

Professor Sir Mark Walport: Again, it is in competition with other funding causes. There are many areas—

Q446 **Chair:** Subject to that competition, it is possible that that scale of bid could succeed through the challenge fund route.

Professor Sir Mark Walport: It is certainly conceivable that a challenge would or could be at that scale.

Q447 **Chair:** Taking into account the £80 million.

Professor Sir Mark Walport: However, there is a finite amount of money. I cannot second-guess what the outcome will be.

Chair: Thank you both very much—

Professor Sir Mark Walport: Chair, I just want to clarify something. I want to be sure that I did not misunderstand the question that Stephen Metcalfe was asking earlier. The figures I was quoting were the contribution that is expected from a company when it receives Innovate UK funding.

There is a second question, which is on the funding limit on non-commercial involvement in the pioneer programme. That has been set at 30%, and there is a very good reason for that, which is that the pioneer programme is about getting industrial application. It is not a route to funding the more fundamental inquiry. That seems like a reasonable setting—to ensure that, in the end, this is about the commercial exploitation of the technology.

I am not sure whether I misunderstood your question.

Stephen Metcalfe: That is very useful.

Professor Sir Mark Walport: I got on to both questions, I think.

Stephen Metcalfe: Yes, I think you did.

Q448 **Chair:** What confused me was that, on Innovate UK funding, our briefing says that “at least 70% of total eligible project costs should be incurred by commercial organisations.”

Professor Sir Mark Walport: No.



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Q449 **Chair:** That, apparently, comes from Innovate UK's website. What you were saying appeared to be the other way round. I think the best thing is—

Professor Sir Mark Walport: We expect it to be 50:50 for big companies, but we recognise that small companies may not be able to contribute 50:50, so they have to contribute 30%.

Q450 **Chair:** A note clarifying that, in liaison with others—

Professor Sir Mark Walport: I will clarify that for the avoidance of doubt. I think I probably did answer the question you asked, but—

Stephen Metcalfe: I think you might have done.

Chair: Thank you both very much indeed. We appreciate your time.