IOP Institute of Physics

Submission to the House of Commons Science and Technology Committee inquiry into the science budget and Industrial Strategy

3rd November 2017

The Institute of Physics is a leading scientific membership society working to advance physics for the benefit of all. We have a worldwide membership ranging from those early in their career or in academic or technical training to those at the top of their fields in academia, business, education and government. Our purpose is to gather, inspire, guide, represent and celebrate all who share a passion for physics. And, in our role as a charity, we aim to ensure that physics delivers on its exceptional potential to benefit society. Alongside professional support for our members, we engage with policymakers and the public to increase awareness and understanding of the value that physics holds for all of us. Our subsidiary company, IOP Publishing, is a world leader in scientific communications, publishing journals, eBooks, magazines and websites globally.

The IOP welcomes the opportunity to contribute to the House of Commons Science and Technology Committee's inquiry into the science budget and industrial strategy.

Summary

- **The increased investment in science and innovation through the new Industrial Strategy Challenge Fund will assist in creating jobs and economic growth as well as tackling global challenges. However, this new funding should not act as a replacement for lost funding from EU programmes and will not relieve existing budgetary pressures.**
- **Basic, fundamental research must continue to be funded in addition to support for innovation and commercialisation of research. Such research forms the basis of future technology innovation and development.**
- **UK science is world leading: from 0.9% of the world's population the UK contributes 15.2% of the world's most highly-cited papers, ranking 3rd out of comparator countries.[1] Physics-based businesses are major drivers of economic growth and productivity; they contribute £177bn in GVA per annum – a 16.1% share of the entire UK business economy. The people employed contribute more than £88,000, more than double the average UK worker. [2]**
- **Following Brexit, maintaining access to international research facilities as well as continued investment in our national facilities will be crucial in strengthening the UK research base and increasing impact.**

[1] Elsevier, 2017. *International comparative performance of the UK research base*. https://www.elsevier.com/__data/assets/pdf_file/0018/507321/ELS-BEIS-Web.pdf

[2] IOP, 2017. *The role of physics in driving UK economic growth and prosperity.* http://www.iop.org/publications/iop/2017/page_70262.html

- **18.8% of funding for UK physics departments came from EU sources in the 2015-16 academic year. As well as funding for excellent science, this brings talented scientists to the UK and supports international collaboration.**
- **Retaining the strength of the UK science base will require investment in skills and the talent pipeline. It also relies on ensuring the continued inward and outward mobility of scientists to and from the UK when the UK leaves the EU.**

Science supports economic growth and prosperity

1. The UK's gross domestic expenditure on R&D as a proportion of GDP was 1.7% in 2015 and this proportion has remained largely flat over the last ten years.[3] This is below the OECD average, although gross domestic expenditure on R&D has risen with inflation, in line with other economies. The commitment to raise gross domestic expenditure to 2.4% over the next 10 years and the longer term goal to raise this to 3% is very welcome and has long been called for by science organisations. However, a commitment to increase funding alone is not enough to guarantee the continued success of UK science: it must be both delivered appropriately and supported by investment in the wider science and innovation landscape, including the skills pipeline.

2. UK science is world leading and has been shown to drive economic growth. Work commissioned by the IOP on the value of physics to the economy shows physics-based businesses are drivers of economic growth across the nations and regions of the UK**.** Across the UK, physics-based businesses made a £177bn contribution to GDP in 2014. They generated £472bn of turnover, which is larger than the retail, financial services and construction sectors.[4] Physics research is of world-class quality: 88% of assessed physics research was ranked as "internationally excellent" or "world leading" in the 2014 Research Excellence Framework.[5]

3. The recent commitments to increase R&D intensity from government recognise the value of science to economic growth and prosperity, and the risks associated with the UK's current low level of investment. As comparator countries invest more, the UK's current global position in R&D may not be sustainable: China recently overtook the UK in global shares of highly-cited articles. While the UK ranks first in field-weighted citation impact, an indicator of research impact, other countries such as Italy have a higher rate of growth and may overtake the UK in the near future.[6]

[3] ONS. *UK gross domestic expenditure on research and development: 2015*. https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/2015#uk-gross-domestic-expenditure-on-rd-performed-in-the-uk-2015

[4] IOP, 2017. *The role of physics in driving UK economic growth and prosperity.* http://www.iop.org/publications/iop/2017/page_70262.html

[5] HEFCE. *REF 2014: Unit of assessment summary data – Physics (2014)* - http://www.ref.ac.uk/media/ref/results/AverageProfile_9_Physics.pdf

[6] Elsevier, 2017. *International comparative performance of the UK research base*. https://www.elsevier.com/__data/assets/pdf_file/0018/507321/ELS-BEIS-Web.pdf

4. The UK's withdrawal from the EU exacerbates these risks. The concerns of the scientific community arising from Brexit, relating to the movement of people and collaboration, EU funding and facilities, research infrastructure and regulation have been widely documented.[7,8] Government must ensure that these issues are addressed for UK physics and UK science to continue to prosper; the future success of physics-based businesses and UK science relies on continued investment, collaboration and access to talent.

5. The government should prioritise negotiations with European partners on participation in the remainder of Horizon 2020 from beyond the date at which the UK leaves the EU as well as next Framework programme, and collaborative European programmes such as Erasmus+ and Marie Skłodowska-Curie Actions. UK involvement in these programmes has been extremely advantageous for UK science. In addition to the direct funding, participation in EU programmes has brought valuable collaborations with international partners which are not replaceable. However, future involvement not be 'at any cost': if the UK has to 'buy its way in' to future framework programmes, there will be additional costs involved which could have a significant input on the science budget.

6. UK participation in the European Research Infrastructure Consortium (ERIC) aids the establishment and operation of large European research infrastructure. Although pan-European research facilities are not EU initiatives, they may receive EU support,[9] and are of great scientific value to UK research. The UK currently hosts the headquarters of 6 pan-European research facilities[10] and hosts numerous other facilities that are part of pan-European collaborations.[11] National facilities, like ISIS and Diamond are also a unique capability to maintain strong international links when the UK leaves the EU. Maintaining access to international facilities as well as continued investment in national research infrastructures following Brexit will be crucial in strengthening the UK research base and increasing impact.

---

[7] Parliamentary and Scientific Committee, 2017. *Science priorities for Brexit*. http://www.scienceinparliament.org.uk/wp-content/uploads/2012/09/Science-Priorities-for-Brexit-Final.pdf

[8] Lords Science and Technology Select Committee. *A time for boldness: EU Membership and UK science after the referendum.* https://publications.parliament.uk/pa/ld201617/ldselect/ldsctech/85/85.pdf

[9] Royal Society, 2017. *The role of international research collaboration and researcher mobility.* https://royalsociety.org/topics-policy/projects/uk-research-and-european-union/role-of-eu-researcher-collaboration-and-mobility/

[10] Royal Society, 2017. *UK research and the EU: The role of the EU in funding UK research*. https://royalsociety.org/~/media/policy/projects/eu-uk-funding/uk-membership-of-eu.pdf

[11] European Commission. *Networks of National Research Infrastructures.* http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=mapri

Distribution of funding

Between the Industrial Strategy Challenge Fund and the rest of the Science budget

7. The stated aims of the Industrial Strategy Challenge Fund recognise the transformative power of research in creating jobs, economic growth and tackling global challenges. The fund has been tasked with supporting important areas, including battery technology and manufacturing materials for the future. Such support will in turn develop UK expertise in new areas and support growth across the country.

8. Additional support for Higher Education Innovation Funding through the Industrial Strategy Challenge Fund is welcome. This funding for knowledge exchange is beneficial in assisting universities to develop industrial connections and create spin-outs and is allocated to universities based on recent performance.

9. However, this new investment is not likely to ease budgetary pressures on existing projects and programmes which rely on other 'pots' of funding. Investment through the science budget that supports for basic, fundamental research must be protected. Continued investment in fundamental research forms the basis of future technology innovation and development.

10. Nor will the new investment be a sufficient replacement for funding that will be lost if EU funding mechanisms can no longer be accessed; the natures of funding through EU programmes and the ISCF are different and cannot be used interchangeably. EU sources are a significant contributor to the strength of UK science and enable the UK to benefit from early access to a wider spectrum of research than would otherwise be possible for a country of our size. The UK ranks first out of all participations in Horizon 2020, with a 12.8% share of participations.[12] EU funding is particularly important to UK physics: £67m, or 18.8% of funding for UK physics departments came from EU sources in the 2015-16 academic year.[13] Guarantees should be made for Horizon2020 for the period March 2019 to December 2020.

11. Within Horizon 2020, Marie Skłodowska-Curie actions, which make up 8.2% of the Horizon 2020 budget, provide an opportunity to host high level international researchers to develop international collaborations, and attract talented students to the UK from the EU. Secondly, European Research Council grants fund scientific excellence and are highly prized by researchers.[14] Initiatives like these increase both the volume and the quality of UK research.

---

[12] BEIS, 2017. *UK's participation in Horizon 2020.* https://www.gov.uk/government/statistics/uks-participation-in-horizon-2020-may-2017

[13] HESA data analysed by the IOP.

[14] Royal Society, *The role of the EU in funding UK research.* https://royalsociety.org/topics-policy/projects/uk-research-and-european-union/role-of-EU-in-funding-UK-research/

Between the two arms of the 'dual-support' system

12. The dual-support system serves UK science well and there is currently a good balance of funding between the four Funding Councils and the seven Research Councils.

Between innovation and research

13. Fundamental research can lay the groundwork for future breakthroughs and applications and funding should be distributed across the various initiatives to financially support innovation and the commercialisation of research as well as support for basic, fundamental research. These types of research all play a role in the development of new technologies and meeting global challenges and driving economic growth across the UK. The research councils already recognise the value of the range of research in their royal charters[15] and it is appropriate that their autonomy will be maintained when brought together under UKRI.

14. The model adopted by the Faraday challenge provides focused investment in important areas to support innovation and development of the UK's strength in areas which contribute to tackling global challenges. We consider this to be an effective model for well-chosen identified challenges. Whilst battery technology is one example of this, it only covers one aspect of the broader electrification challenge and it is important that other areas are not ignored as a consequence. There are many other areas where science and engineering work with other sectors, such as clean energy, healthcare and medicine, and satellite and space technology. The UK must have a clear process for choosing which challenges to tackle in this style of model, in order to avoid focussing too tightly on some areas and missing others. These decisions should involve the scientific community, including the research councils and learned societies, as part of an informed process, as opposed to what may seem a piecemeal approach.

15. Recent work commissioned by the IOP shows that physics-based businesses have significant GVA contributions in all regions and nations of the UK, ranging from £3.2m in Northern Ireland to £33.2m in London, with a share of the region's economy ranging from 9.4% in the East of England to 12.1% in Scotland.[16] Programmes like the Faraday challenge will contribute to maintaining and increasing the GVA contributions of physics-based businesses as companies of all sizes benefit from a scale-up programme to get new technologies to the market. Physics-based businesses will require ongoing support to continue making such substantial

[15] e.g. EPSRC Royal Charter. https://www.epsrc.ac.uk/about/history/royalcharter2003/
[16] IOP, 2017. *The role of physics in supporting economic growth and national productivity.* http://www.iop.org/publications/iop/2017/page_70262.html

contributions to the economy in the future.

16. The model adopted by the Faraday challenge supports innovation and we welcome the sector deals to broaden the areas of strength and to support economic growth and opportunities for STEM graduates and businesses of all sizes. Continued investment in fundamental research should be seen as a requirement for supporting innovation.

Investment in skills is vital for the strength of UK science

17. Public investment in science brings rewards through the creation of skilled workers. The intentions to raise productivity and drive growth across the country set out in the industrial strategy will demand a highly skilled workforce. The most recent education and skills survey from the CBI highlighted that STEM graduates have higher than average employment rates and their skills are essential for jobs in high-growth sectors,[17] while the Social Market Foundation has reported that an additional 40,000 STEM graduates are required annually to meet demand.[18] The recent industrial strategy green paper acknowledged that the UK has particular skills shortages in sectors dependent on STEM subjects.[19]

18. Skilled workers in STEM fields are a fundamental component of the strength of the UK research base and investment in the skills base is a vital factor in creating the best environment for research and innovation in the UK. Currently, small numbers of students take apprenticeships in science and mathematics: in the 2016-17 academic year, there were 290 students – 86% were at level 3 or above. By contrast, there were 74,010 starting apprenticeships in engineering and manufacturing technologies, but only 43% were at level 3 or above.[20] Across all subjects, growth in apprenticeships has been mainly at Level 2 and in retail, health and business subjects, meaning there are particular skills gaps in well-qualified STEM technicians.[21]

19. The £500m pledge from government to reform technical education with the new 'T-levels' aims to reduce complexity in the system and skills pipeline and provide opportunities for young people whatever route they choose to take. Opportunities should be available across the UK to support regions with lower rates of employment,

[17] CBI/Pearson 2017. *Helping the UK Thrive, Education and Skills Survey 2017*. http://www.cbi.org.uk/insight-and-analysis/helping-the-uk-thrive/

[18] SMF, 2013. *In the Balance: The STEM human capital crunch*. http://www.smf.co.uk/publications/in-the-balance-the-stem-human-capital-crunch/

[19] HM Government, *Building Our Industrial Strategy*. https://beisgovuk.citizenspace.com/strategy/industrial-strategy/supporting_documents/buildingourindustrialstrategygreenpaper.pdf

[20] FE data library. https://www.gov.uk/government/statistical-data-sets/fe-data-library-apprenticeships

[21] Royal Academy of Engineering, 2016. *The UK STEM Education Landscape.* http://www.raeng.org.uk/publications/reports/uk-stem-education-landscape

and industries with particular skills needs. The opportunity to work with government to ensure that the courses align with physics-based occupations to support our young people is very welcome. To achieve this, focus must also be placed on ensuring we are recruiting and retaining sufficient numbers of teachers to train and inspire the next generation of skilled workers.

20. Improving training for 'home grown' research talent, such as the 1000 new PhD places announced in the last autumn statement is welcome and will provide support for more postgraduate students in STEM subjects. However, even measures to increase the numbers of young people to work in STEM at all levels will not meet the demands of a growing and evolving workforce and talent must still be sought from overseas. International mobility of scientists is critical to meet demand to maintain the strength of the UK research base. The House of Commons Science and Technology committee in the last parliament highlighted the importance of making use of existing STEM skills from overseas, and the value of researcher mobility in the success of the UK research base.[22]

21. The new industrial strategy should be aligned with post-Brexit immigration policy to ensure that the UK retains its position as a destination of choice for qualified international students, and academic, technical and research talent to allow scientists to continue to come to the UK. International mobility is a crucial component in maintaining the strength of the UK science base.

What further measures the Government should take to use its spending and facilities to strengthen innovation, research and associated 'place'-based growth.

22. Government should work with the science community, through organisations including the learned societies, the National Academies, academic institutions and businesses, when developing plans for spending to strengthen innovation and research. The IOP is currently developing 'Physics2020' – a data capability which allows cutting edge analysis of datasets relating to physics activity; including research, innovation and publishing. It will provide a strong evidence base to allow us to identify links between fundamental research and economic growth, and to analyse changes in the research landscape.

23. Another measure to strengthen innovation and research would be to back initiatives to develop regional 'hubs' of expertise, which would also support opportunities to commercialise exploits and encourage 'place'-based growth.

24. Continued commitments to increasing spending for all types of research across core disciplines as well as for innovation and commercial research will be essential for the

---

[22] House of Commons Science and Technology Committee, 2017. *Industrial Strategy: Science and STEM skills*. https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/991/991.pdf

UK to remain competitive with growing research countries. Investment in the skills base and allowing continued researcher mobility are essential to ensure that innovation, research and economic growth can continue for the continued strength of UK science.