



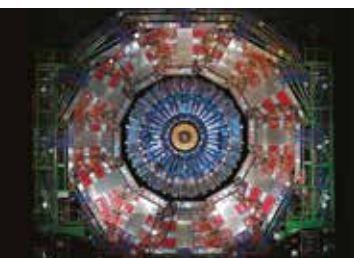
STFC Delivery Plan 2016-2020

To maximise the impact of our knowledge, skills, facilities and resources for the benefit of the United Kingdom and its people



Science & Technology
Facilities Council

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STFC will continue to address the major interdisciplinary challenges of the 21st century and ensure the UK remains the best place to do science.

1. Our Vision

1.1 Introduction

Science and innovation lie at the heart of the nation's long term economic future: delivering a sustainable and balanced economic recovery requires the translation of research into practical application and exploitable outcomes as a route to the creation of new jobs, innovative businesses and wealth. Science also enriches our culture: whether exploring the first moments of the universe, measuring collisions between black holes, or providing the tools to delve into the deep structure of matter.

The 21st century has brought new and serious challenges in areas like energy, the environment, an ageing population and evolving security threats. To overcome these challenges and create the opportunity for the UK to expand into new markets, we must maintain the strength of our world-leading science base, continue to attract young people into science, technology and engineering, provide access to world-class research facilities, and bring academia and industry together in novel partnerships.

We are therefore pleased that the science base continues to be recognised as a vital national asset, a driver for economic success and a source of high quality jobs. In particular we welcome a settlement that allows the Science and Technology Facilities Council to continue to deliver an internationally leading programme while supporting new international flagship science initiatives. Working with our partners and community to prioritise our investments STFC will continue to take the lead in expanding the frontiers of human understanding, support researchers from across the UK research ecosystem to address the major interdisciplinary challenges of the 21st century, and ensure the UK remains the best place to do science.

1.2 Context

A core contribution to this endeavour is STFC's mission to provide the world-leading infrastructure that thousands of UK academic and industrial researchers rely upon to pursue excellent discovery science. Our facilities operate on the frontiers of science and are characterised by their long-term and technically complex nature that takes decades of planning and investment and can only be delivered by national and international scale collaborative efforts.

These facilities lie on a spectrum of scientific activity that range from mission-based facilities at one end, to multi-user and multidisciplinary facilities at the other. Mission-based facilities are built principally to take a specific set of measurements for a well-defined experimental group; typically that group is intimately involved in the facility's design, construction and operation. Primary access is tightly controlled to ensure the mission is delivered on time and on budget. Advanced LIGO, which was set up to solely detect gravitational waves and recently reported success in this endeavour, is an excellent example. At the other extreme, multi-user facilities are built to perform a wide range of experiments for teams of users that apply for "open" access, subject to a well-defined process. Such users change frequently and are not typically involved in a facility's design, construction or operation. The Diamond synchrotron is an excellent example of such a facility, where users study topics that range between the foot and mouth virus, to fading pigments in Turner's paintings, to the structure of aircraft turbines.

There are three consequences of STFC's mandate to provide world-leading research infrastructure. The first is that the research programme is integral to the design, construction and operation of mission-based facilities and is planned meticulously from start to finish. Work at each facility or experiment will vary over time, with some years focusing on upgrades, and others on experimental data and analysis. It is imperative that these are co-ordinated seamlessly; the whole endeavour is rather like sending a man to the moon and delivers equally spectacular results. The second consequence is that STFC is heavily dependent on capital and each of its budgetary partitions directly and indirectly contributes capital to the task of infrastructure support. The third is that we need dependable long-term funding, to match our obligations to deliver stable long-term facilities.

1.3 Our Strategic Approach

This Delivery Plan has been developed to deliver our Vision of maximising the economic and societal impact of our facilities, knowledge and unique capabilities. Our three strategic goals, world-class research, innovation and skills, are essential to sustain the UK's position as a global scientific nation, underpinning economic growth, high-value employment and inward investment. It is through the delivery of these three long-term, durable goals that we generate knowledge, solutions and skilled people, thus supporting the UK's future competitiveness. STFC's Corporate Strategy, originally developed in 2010, focused on the growth of the UK's knowledge economy in tough economic times and its core message remains as relevant for 2016 as when first written. However, during this period the national and international political, research and innovation landscapes in which we are operating have changed considerably. A refresh of our Strategy provides an opportunity to reflect on these incredible achievements and set the direction for the forthcoming decade.

Our Strategy refresh includes the development of three new strategic themes that better reflect our current mix of capabilities and are central to the ideas in the BIS Science and Innovation Strategy. They demonstrate our organisation's ambition to build on new and exciting opportunities, whilst ensuring that public investment in science and research has ever increasing impact on issues that matter most to society. Strategic technology and Data-intensive Science are particular strengths of our organisation over many decades that form two of these new themes. Both are strengthening our contribution to UK science and form an integral part of STFC's response to the Challenges of the 21st century. The third focuses on the two National Science and Innovation Campuses that STFC has developed around our laboratories. The emerging space cluster at Harwell, and the data intense computing cluster at Daresbury are exciting opportunities to demonstrate the way in which Campuses can deliver valuable innovation and important economic benefit.

1.4 Top Priorities

We will deliver the highest quality, internationally leading, data-intensive research leading to new understanding of the structure and evolution of the universe and addressing 21st century challenges:

- Continuing to deliver an excellent programme in particle physics, nuclear physics and astronomy

- Guaranteeing ongoing access to the world-leading international research facilities CERN, ESO, ESRF, ILL and FAIR
- Supporting UK leadership in the technical upgrades at CERN and in the development of the world's largest optical telescope E-ELT and the Large Synoptic Survey Telescope
- Delivering new Government commitments to next-generation flagship European facilities ESS and XFEL, and establishing the UK-headquartered Square Kilometre Array – as the next big global inspirational science project
- Assuring multidisciplinary researchers ongoing access and excellent support at our three world-leading UK national facilities, Diamond, ISIS and the Central Laser Facility, and through their upgrades deliver new capabilities for users

We will realise the innovative capacity of STFC's science and research facilities to support the growth of a high-technology UK economy by:

- Developing opportunities to engage industry and other partners earlier in the development of technology solutions
- Increasing innovation output from our funded activities, including from funded university programmes and STFC laboratories
- Developing and implementing plans with our campus partners to deliver high value job creation and economic growth for the benefit of the UK
- Establishing the Higgs Centre for Innovation in Edinburgh

We will help to deliver a scientific and technically skilled workforce that will sustain the UK as one of the world's leading research nations and support the growth of a high technology economy by:

- Delivering a skills programme that reflects modern science and engineering requirements by coupling traditional STEM disciplines with skills in software engineering, technology development, and innovations in data science
- Delivering a programme that increases the number of apprentices and graduates that join STFC's programmes
- Delivering a strong programme of public engagement in inspirational science to sustain the STEM skills pipeline.

2. Delivering National Needs

2.1 Our Programme for 2016-20

This Delivery Plan sets out our proposed programme for 2016-20. It builds on our achievements and track record of delivering major projects on time and within budget and ensures that the world's most complex scientific infrastructure is sustained at the cutting-edge for UK researchers. It also delivers some outstanding science; most notably resulting in a UK Nobel Prize for the discovery of the Higgs boson and making an indispensable contribution to the first observation of gravitational waves. We will continue to maximise the economic and societal impact of our facilities, knowledge and capabilities in this way to underpin the UK's future competitiveness.

We have grown our research excellence, innovation outcomes and skills impact since 2010. We have become more efficient and, working with the community, have made necessary reductions in volume to deliver the optimal programme. Within the constraints of our own budget, we will continue to invest our resources strategically and prioritise funding for future upgrades, support of world-leading research infrastructures to deliver world-leading multidisciplinary science plus properly supporting science exploitation of all the national and international mission-based facilities and experiments.

Government established three budgetary partitions for STFC in 2010; these protect each area of our programme by avoiding the transfer of financial pressures from other areas. Government separately defines the budget of each partition, and so this Delivery Plan provides an overview of proposed activity within each.

2.2 International Subscriptions

STFC provides UK academia and industry with access to international world-leading science facilities that support UK research in a variety of disciplines. These facilities are at the very leading edge of technology, and facilities of this scale are beyond the resources of any single nation to provide. The quality of these facilities, and the research that is conducted there, is world-leading and they are vital to maintaining the productivity of all Research Councils' programmes, including STFC's own.

The level of funding allocated to the International Subscriptions ranges from £114m resource and £82m capital in 2016 to £134m resource and £62m capital in 2020; the first two years of this allocation are firm while the final two years are indicative. This provides for the broad resource and capital requirements of all our existing International Subscriptions – CERN, ESO, ERSF and the ILL – plus those for the new Governmental commitments to join the international collaborations of SKA, the ESS and XFEL. We are working closely with BIS to ensure that the present shortfall against expected subscription costs is resolved in a way that respects STFC's funding partitions.

The CMS at CERN Credit: CERN



In the meantime we will be seeking to buy forward 90% of our currency requirements to provide some degree of budget certainty while maintaining some flexibility until the full cost of the International Subscriptions is agreed in each successive financial year.

Notwithstanding these two factors, it is expected that the 2016-20 budget allocation will provide us with the ability to continue to play a leading role in the existing international treaties that deliver mission-based facilities at CERN and ESO and our existing multi-user facilities at the ESRF and the ILL. In addition, STFC is pleased that the allocation provides full funding for STFC to join three new international collaborations – SKA, ESS and XFEL.

STFC welcomes the Government's commitment for the UK, with its rich heritage in astronomy, to host the SKA global radio astronomy project. This will provide a transformative change in our understanding of the origin and composition of the universe and keep the UK at forefront of computing and software systems design, data transportation, and antenna and telescope infrastructures. We have already met our goal of securing the permanent headquarters of the future international SKA organisation at Jodrell Bank and are playing a leading role in the intergovernmental negotiations to establish SKA as a treaty organisation. This will be an important feature of our work in 2016-17 and beyond as the collaboration proceeds.

Similarly the budgetary allocation will also allow STFC to maintain access to our multi-user, multidisciplinary international facilities at the following levels:

- Continued access to the European Synchrotron Radiation Facility, participating at the 10.5% level
- Continued access to the Institut Laue-Langevin neutron source as a full partner (one of three 'Associates')

In addition, STFC welcomes the Government's commitment for the UK to join the international organisations constructing the European Spallation Source in Sweden and the European X-ray Free Electron Laser in Hamburg. These next generation neutron and photon sources will be the next multi-user facilities in our portfolio. Our membership, as well as lending our world-leading expertise support to the collaborations, will provide UK researchers with access to powerful and unique multidisciplinary capabilities that will complement ISIS and Diamond and bring valuable capability to discover materials for faster planes, better computer chips, new drugs and powerful long-life batteries. We have already agreed a Memorandum of Understanding to provide

extensive technological support from ISIS to ESS, and we will continue our strong participation with the project in 2016-17 and beyond to support the commissioning phase and bringing the first instruments into operation in 2020. Construction at XFEL is more advanced with operations due to start in 2017. STFC will be contributing towards ongoing construction costs in 2016-17 and negotiating the terms of UK membership and arrangements for UK researcher access.

Increasingly, UK-based businesses use STFC facilities to maintain their international competitive advantage. We need to make sure that these facilities stay available to them, both to deliver the technical programmes for those businesses, and to maintain the UK's world-leading science base that is an important factor in retaining internationally-mobile businesses in this country.

2.3 UK National Facilities

STFC also provides UK researchers and industry with access to three world-leading, UK-based multi-user science facilities that support all scientific disciplines: the Diamond Light Source synchrotron, the ISIS neutron source and the Central Laser Facility. These facilities are at the very leading edge of technology and deliver national-scale capability beyond the resources of any individual institution. They are essential to biomedical and material science disciplines and capabilities to meet the challenges of the 21st century in areas like energy storage, catalysis, and novel materials. They also provide opportunity to apply the technology and expertise developed in the physical sciences to frontier developments in the life sciences.

The level of funding allocated to the UK National Facilities ranges from £108m resource and £45m capital in 2016 to £110m resource and £46m capital in 2020; the first two years of this allocation are firm while the final two years are indicative. This initially provides for a constant-volume resource and capital allocation in line with the approach adopted by Government in SR13, and is warmly welcomed. While this did not support optimal operational levels at all facilities in 2015/16, it did nevertheless provide STFC with the ability to reap the benefit of the UK's significant capital investment, by supporting over 4,000 researchers funded by the other Councils, medical charities, industry and Innovate UK to pursue research across a wide spectrum of disciplines.



STFC welcomes the Government's commitment for the UK, with its rich heritage in astronomy, to host the SKA global radio astronomy project.

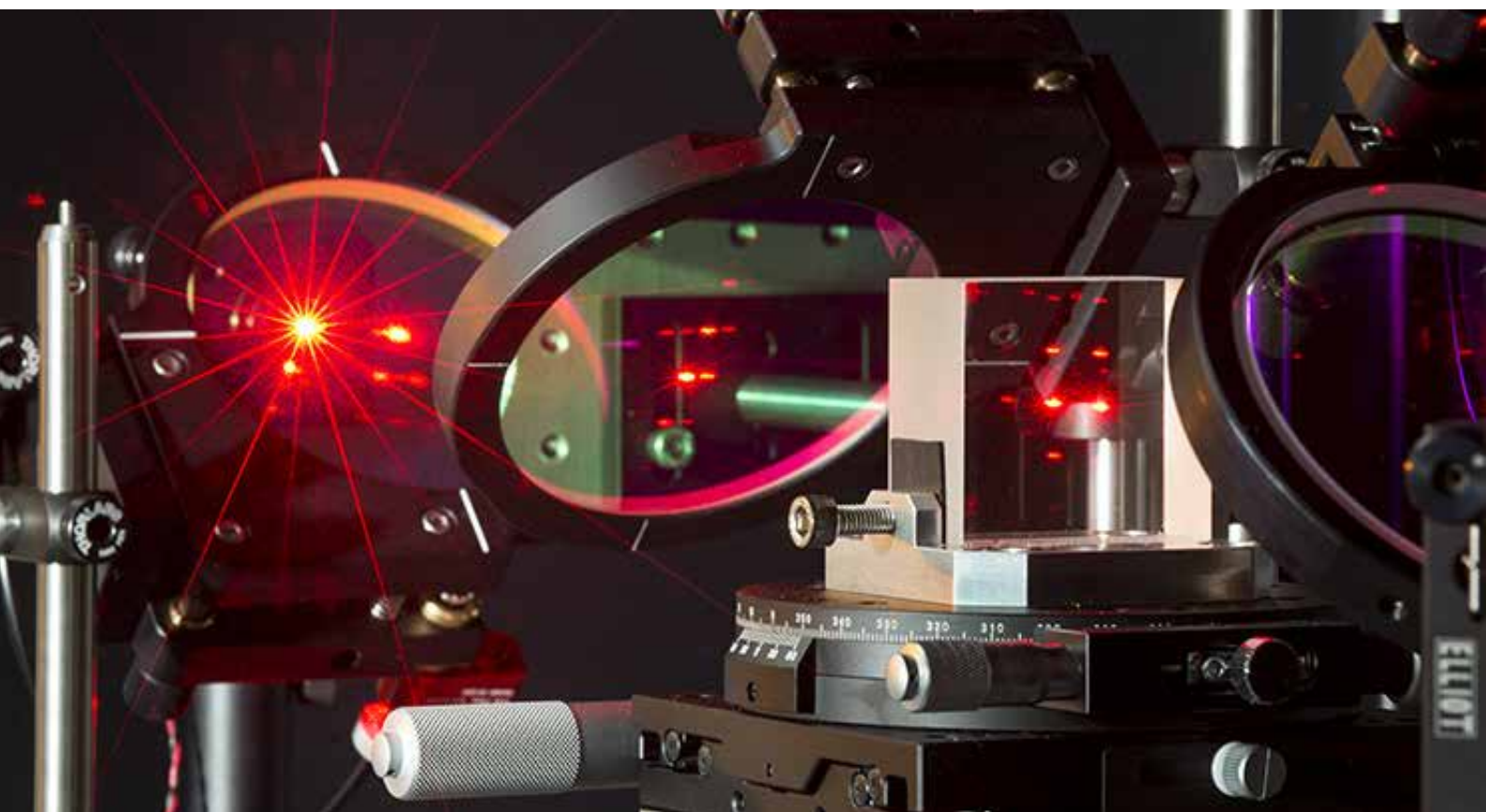
While Government recognises the importance of national-scale world-class research infrastructures, it has also indicated that it is keen to thoroughly investigate whether a reduced funding position could be developed. The allocation therefore includes resource funding saving targets that could be met via efficiencies or by attracting additional income. These funding targets start at £1.8m for 2016/17 and rise to £7.8m in 2019/20. To help BIS and STFC to review the appropriateness of the current operational models, identify whether there are any potential radical solutions for putting the facility operation onto a lower-cost footing and articulate the risks of any proposals, BIS is proposing to hold an International Review of the three facilities.

STFC recognises the finite nature of the science budget and appreciates the need to maximise the return on investment of these large research facilities. We will be ensuring that the facilities continue to produce excellent science and maintain a strong focus on efficiency and effectiveness, while working to encourage their use by UK businesses and international partners. We also welcome the opportunity to be involved in this International Review, and are keen to identify any credible new funding streams and operational efficiencies. We are already working with BIS to progress the terms of reference and ensure a high calibre of panel members. Active participation by STFC to ensure the review is carried out in a positive and enabling way that leads to an intelligent outcome will be a key part of our work programme in 2016.

Notwithstanding the International Review, the governmental savings targets and input from the Large Facilities Advisory Board (LFAB), the 2016-20 capital and resource budget for this partition provides STFC in 2016/17 with the ability to maintain operations and provide access at UK National Facilities to broadly the following levels:

- 200 days per year operation at Diamond, including the operation of all Phase 2 and 3 beamlines available for operation within the period
- 140 days per year operation at ISIS Target Station 1 and 2
- 98 user weeks operation for the High Powered Lasers of the CLF
- 188 user weeks operation for the Lasers for Science Facility.

Beyond 2016/17 the levels will be subject to further discussion following the conclusion of the BIS International Review and with LFAB. Looking ahead to specific initiatives, STFC's allocation also included the capital and resource for the construction and operation of the new Phase 3 beamlines at Diamond. This will give UK researchers access to new, urgently needed techniques, complete the facility as originally envisaged and provide world-leading capability that will push the limits of resolution into the nano-scale, and have a major impact in the study of advanced materials, engineering, life



sciences and in environmental research. The construction and bringing these on line will be a key task in 2016-17 and future years. At ISIS we are constructing a further four instruments to add capabilities unique in Europe and open up new areas of science. One of these will provide the UK with the only dedicated testing facility outside the US to look at how silicon microchips respond to cosmic radiation. This will help aerospace companies improve safety and address the issue of radiation damage which currently costs £2.5bn each year; future users are expected to include BAE, Goodrich, QinetiQ and MBDA. We will also build upon the outstanding international reputation of ISIS to develop greater “Europeanisation” of the facility through an alliance with the ESS and closer collaboration with long-standing partners such as Italy and the newly industrialised nations of China and India.

Much of STFC’s success is built on a culture of internal technology transfer, taking capabilities developed in delivering frontier science projects – the Higgs discovery, the detection of gravitational waves, rendezvous with comet 67P – and using these to realise advances in the facilities we provide for academia and industrial researchers – synchrotron light sources, state of the art electron microscopy.

We are equally committed through our business development strategy to transfer our technology to ensure that innovation developed through STFC’s programmes can benefit the wider economy. The recent success of applying Spatially Offset Raman Spectroscopy - the key technology behind Cobalt Light Systems - in the security sector, is an example.

2.4 Core Programme

2.4.1 Frontier research

STFC is the UK steward of frontier research in astronomy, particle physics and nuclear physics. Frontier research in STFC’s core programme supports around 300 Principal Investigators in around 80 universities and other research institutes. More than 75% of our current Core Programme funding is spent on research in these areas, including approximately 15% on PhD studentships and fellowships.

The quality of our research is universally agreed to be world-class – we are first in the world in particle physics, nuclear physics and astronomy when measured by citation impact. The skills and capabilities that go with this leadership not only profit the scientific programme but also bring economic benefits to the UK. The UK enjoys this excellent international standing in these disciplines as a

result of two complementary but distinctive components; firstly, the technological and scientific competences in the universities and STFC laboratories built up over many years and, secondly, the access we provide our researchers to the world’s leading mission-based facilities and experiments. As explained in section 1.2, these two components are intertwined and inseparable; researchers are intimately involved in the design, construction and upgrading of detectors, are involved in day-to-day operations, and also design and run experiments. In some years researcher effort will heavily lean towards construction – for example during a major upgrade – while in others there will be more of a focus on running experiments and analysis.

Given the complexity, long-term investment and inherent risk of such large missions, STFC’s role is to ensure that everything from start to finish is planned meticulously over a period of at least ten years, so that technology and instrument development – funded through our Core Programme – is seamlessly coordinated with facility upgrade cycles – funded through our International Subscriptions – and that researcher teams are clear on their forward work plans. To support and enable full scientific exploitation at these mission-based facilities also requires a range of skills and competences – embedded in STFC and its scientific community – that include thought leadership, common technologies including computing and project management oversight. Again it is necessary to coordinate and fund these as an integral part of delivering frontier research in these disciplines.

The level of funding allocated to this partition ranges from £166m resource and £47m capital in 2016 to £166m resource and £25m capital in 2020 but with an additional £3.5m allocation from its Global Challenges Research Funding for each year starting in 2017-18. As with the other partitions, the first two years of this allocation are firm while the final two years are indicative. This allocation provides for flat-cash resource over all four years and flat-cash capital in the first three years of the spending review period.

Now that we have our budget settlement, we will be working with our community to construct the optimal research portfolio for our Core Programme. We conducted a full Programmatic Review to review priorities in 2013 and will use this to help inform the development of an optimal research programme for 2016-20. We will also run a balance of programme exercise for this programme to help guide us and maintain the UK skills and capabilities within our disciplines and continue leadership in the highest priority international projects, where the UK is

often seen as a partner of choice. We will seek to protect the breadth and depth of the programme wherever possible.

In particle physics, participation in the CERN LHC experiments and their upgrades remains the highest priority and it is our ambition to invest in all four experiments. The European Strategy for Particle Physics recognises the importance of future neutrino projects, and our ambition will be to make investments in existing and new international neutrino projects such as T2K and a long baseline neutrino experiment outside Europe, to allow the UK to influence the development of this science area worldwide.

The UK has a rich heritage in astronomy and it is our ambition to continue exploitation of major current facilities and strong participation in the E-ELT and SKA projects and exploitation of missions funded by UKSA. That will keep the UK at forefront of the design of computing and software systems, data transportation and processing, and antenna and telescope infrastructures.

The nuclear physics programme in the UK is strong but limited in scope. It is our ambition to continue to enable participation for UK groups in a small number of new projects, and work towards a sustainable balance between building new capabilities and exploiting existing ones. Particle astrophysics is a growing interdisciplinary area. As part of this programme we will continue to exploit our investment in gravitational wave experiments, where our world lead in technology development was pivotal in the recent first observations of gravitational waves.

Continued improvement in scientific capability and infrastructure support requires advances in technology and computation. It is our ambition to maintain a programme in accelerator and strategic technology R&D to underpin upgrades to existing facilities, support the development of new facilities – in the UK or internationally – and provide continuity of capability in areas such as detector development and cryogenics. We will also maximise the application of our innovations in technology to underpin our response to the Challenges of the 21st century and in translational activities that develop commercial applications to support the UK's economic recovery. Our national laboratories at Harwell and Sci-Tech Daresbury have sophisticated capabilities in large-scale data-intensive computational science that have grown up naturally as we developed storage and processing of petabyte-scale datasets, use of world-wide computer

networks and ground-breaking computer graphics and animation technologies to help researchers visualise complex mathematical datasets. We will continue to invest strategically to focus our research activities in these areas where we can make unique contributions to UK priorities.

2.4.2 Skills training

STFC is in a strong position to contribute to the skills agenda urgently required for tomorrow's challenges. STFC's university groups are fundamental to delivering our skills training and these become an integral part of the support for research infrastructures; working as part of a university team, students will build upgrades and deliver operational support at our mission-based facilities. Our research areas attract 90% of the growing segment of undergraduates who study physics; applications to university physics courses continue to rise with a 47% overall increase between 2008 and 2014. Our world-class researchers not only teach the finest physics undergraduates but also train our rolling cohort of around 800 PhD students in high-end scientific, analytic and technical skills. Initially around half our PhDs continue in research, sustaining the bedrock of the UK's scientific excellence. The remainder, who are much valued for their numerical, problem-solving and project management skills, choose equally important industrial, commercial or Government careers.

UK business is experiencing a shortage of high-tech expertise and data-intensive skills. STFC's facilities require world-class scientists to run experiments in collaboration with external researchers, and high-end engineers and technologists to operate, maintain, upgrade and keep the facilities at the leading edge. We nurture the talent residing within our laboratories and facilities, developing apprenticeships and training our staff, many of whom transfer these skills to industry. We also fund PhDs and researchers with expertise in e-infrastructure and software development and support research computing in university departments.

Subject to available resources, we will take steps to strengthen the skills pipeline that underpins STFC's strategic research programmes, including an ambition to maintain studentships at around 220 new starts and double the size of our successful apprentice and graduate training programme. In discussion with some of our strategically important universities and with Innovate UK, we are exploring options to develop Centres for

Doctoral Training for data-intensive science by utilising our strengths in big science and technology to enhance the UK's position to be a world leader in the analysis and application of data and thereby create innovation, high value jobs and drive economic growth.

2.4.3 Campuses and innovation activities

The Sci-Tech Daresbury Campus and the Harwell Campus, with their long-standing heritage of world-leading scientific infrastructure, are exceptional national assets. These Campuses are places where science, innovation and entrepreneurship converge to deliver business growth and high-value jobs. They host a critical mass of facilities, skills and businesses from public and private sectors and universities, and are centres for collaboration, partnerships and inward investment. The Campuses host over 300 high-tech enterprises and support more than 6,000 jobs, and continue to grow as locations of national and international prominence. Collaboration is fundamental to the mind-set of the Campuses with the majority of companies collaborating with either STFC or a University, so it is no surprise that Campus companies experience strong growth, high-value job creation and high levels of commercial innovation. Through our business development focus we partner with a wide range of companies so they can benefit from our advanced technology and facilities. We have created £50m annually with businesses such as Unilever, IBM, e2v and Lockheed Martin.

Both Campuses have seen an increase in pace over the past two years with major new investment and new organisations locating on site. We have ambitious master plans to capitalise on this success and become global leaders in the transformation of science to innovation and economic benefits. We will foster the development of economically productive clusters of activity in areas where we are world-leading, which will be achieved through partnerships with key organisations in the public and private sectors. The right physical infrastructure is critical to the realisation of our ambitions, and together with our Joint Venture partners we will work to ensure that the Campuses are attractive, inspirational and sustainable places of work.

To ensure that all aspects of our work support the overall Campus vision and that the synergies are fully realised, we will focus our activities on seeding and developing clusters of economic activity at each Campus around specific sectors or areas of excellence; emulating and replicating the success of the space cluster at Harwell – widely recognised as the national lead for economic growth through the exploitation of space technologies. A specific aspiration is to build a cluster of data-intensive enterprises around STFC's Hartree Centre at Daresbury. Government confirmed the continuation of the funding required to deliver Hartree Phase III in our spending review settlement, which in partnership with IBM will provide a major expansion and development of the existing Centre. By integrating a combination of cutting-edge technology,

The Hartree Centre's visualisation suite



advanced algorithms and software engineering with domain expertise, Hartree III will accelerate innovation in industry and provide opportunities for working with partners such as the Met Office and Alan Turing Institute by delivering a step change in UK capability to extract wealth from the vast and readily available array of 'big data'. The Government's £116m investment will leverage at least £200m of value from IBM, who is recognised as the world leader in 'big data' and cognitive computing. It is anticipated that this activity could provide up to 24 months competitive lead in this field for the UK against its international competitors.

Another example of increasing innovation activity at our sites and Campuses is our Business Incubator Programme. This has an impressive track record supporting innovative companies in their use of intellectual property arising from our research investments and since 2010 over 80 companies have benefited from this programme.

At Harwell, we operate a highly successful business incubator for the European Space Agency – this nurtures small businesses to develop marketable services and products based on technologies with a space heritage. We have built on that success at Sci-Tech Daresbury to launch the first CERN business incubator in the world where companies explore how technologies can assist in their business. The £7m capital funding within our allocation confirms continued investment in a new business incubation Centre at our UK Astronomy Technology Centre in Edinburgh. A key focus of the Centre will be business incubation and start-up business support, leveraging our remote-sensing and space instrumentation expertise and academic capability for commercial purposes. The Centre will house start-up firms, principally in the space sector, and a number of University of Edinburgh academics specialising in data-intensive science in astronomy and particle physics research. By bringing together academic research, STFC technical expertise and small business through co-location with key laboratory infrastructure, the Centre will enable the translation of knowledge into innovation for economic and societal benefit. We will work with ESA, CERN, Innovate UK and others to expand and develop these methods of engagement.

2.4.4 Public engagement

Our organisation plays a key role in raising scientific literacy and appreciation, and attracting young people to follow STEM careers. From 2009 to 2014, STFC reached tens of millions of people through mass media initiatives. These initiatives covered major scientific discoveries and achievements that included the discovery of the Higgs Boson at CERN, through to the landing on a comet with the Rosetta mission, and the discovery of gravitational waves. Inspirational events such as these capture the public's imagination and can be used to inspire future generations of students to study STEM subjects.

Not only do our facilities provide a unique training ground for developing the skills the country needs, but they also provide an inimitable opportunity to inspire and educate the public, promote scientific literacy and support the national STEM agenda. During this spending review period, public engagement will remain an important component of STFC's work and we will continue to play a key role in raising scientific literacy and appreciation and attracting young people to follow STEM careers.

Subject to available resources, we will continue to establish and grow key national and international partnerships to improve science and engineering literacy, promote and communicate our research and engage and enthuse the next generation of scientists. We do this by working with partners such as the UK Association of Science and Discovery Centres, connecting and running joint events with the international facilities, coordinating activities with learned societies such as the Institute of Physics and the Royal Society, and identifying key national priorities by working in conjunction with the other research councils. Schools public engagement activities with our laboratories will remain a significant pillar of our work in 2016 and beyond, with a focus on schools in deprived areas and groups that are geographically-remote from STEM and STFC science. This is linked to plans to develop partnerships with co-produced research activities, such as Citizen Science. There will also be an emphasis on engaging teachers through structured programmes and partnership, for example with the Science Learning Centres.



Members of the public taking part in one of STFC's open day events

3 Effectiveness through Partnerships

3.1 Collaborations and Building International Influence

Strong partnerships are integral to the delivery of our programme. STFC and the communities it supports have a reputation in science, engineering and project management which provides us with significant influence over the international partnerships and projects with which we engage. Our strengths and track record make us a partner of choice for many countries and organisations. For example, we work closely with the Wellcome Trust to provide and enhance the Diamond Light Source, with the Japanese institute RIKEN in the construction of the world's most productive pulsed muon beam at our ISIS facility, and with numerous international research agencies and other European governments through ESFRI to develop international facilities. We also work through Strategic Partners, such as IBM and Unilever, and our Strategic Universities to deliver key elements of our programme on our Campuses, at our UK National Facilities and our laboratories through strong, effective and mutually supportive relationships.

3.2 Supporting Interdisciplinary Research

The UK Research Councils are recognised internationally as leaders and innovators in supporting interdisciplinary research. Many other funders look to us for best practice. At any one time, more than 50% of Research Council grant portfolios are interdisciplinary¹.

We have a strong track record of co-facilitating and co-funding interdisciplinary research, innovation and PhD training – through individual Council investments and through multi-agency 'grand challenge' programmes. We are agile in responding to emerging UK needs and new partnership opportunities.

We will now use our experience, convening power and international connections to help design and implement the new, multi-agency Global Challenges Research Fund (GCRF), working with BIS to develop a consistent approach to the GCRF and to maximise the fund's impact in meeting combined UK aid and research goals. Within our own budgets, Research Councils will continue working together to address complex UK and global challenges that require interdisciplinary approaches.

STFC will continue to develop collaborative and innovative solutions that apply our capabilities and the technologies we have developed to sustainable energy, environmental change, ageing populations and rapidly evolving threats

¹ RCUK analysis of open data available on Gateway to Research (<http://gtr.rcuk.ac.uk/>), based on active grants in 2014 where investigators come from different departments.

to UK and international security. We will also apply our capabilities, technologies, facilities and Campuses to drive the cross-council Data for Discovery priority as well as supporting cross council contributions to Urban Living, Sustainable Agri-Food Systems, Technology Touching Life and Anti-Microbial Resistance.

4 An Effective and Efficient Organisation

4.1 Continuous Improvement in STFC

UK research is the most productive in the world². The Research Councils, including STFC, will continue to work with BIS, HEFCE, Universities UK and the HEI sector to promote collaboration and sharing of infrastructure, data assets and other resources to further raise efficiency and productivity across the sector. Using our expertise as funders of research and facilities, we will work with the sector to pioneer policies, incentives and performance measures for efficient sharing and utilisation of research assets.

STFC is very conscious of the need to ensure that our resources are used to generate maximum scientific and economic benefit for the UK economy. Over the last spending review period we made great strides to improve efficiency and effectiveness, transforming our organisational structure to provide a more coherent, cost-effective and accountable structure, re-focussing the work of our national laboratories, reviewing our investment in ICT, simplifying and standardising operational processes to move to consistent frameworks and where possible shared systems and platforms, undertaking a Triennial Review of Diamond, as well as strengthening connections between strategic and financial planning functions. STFC, with RCUK, has also worked hard to identify and implement efficiency savings and harmonise processes and encourage efficiencies. The current economic climate makes it even more important that we investigate all avenues to achieve efficiency in the way we work, and that the costs of providing supporting functions are minimised. This commitment extends beyond the current target to reduce administration costs and covers all aspects of our operations.

Over the course of the next spending review period we will be continuing this direction of travel and setting out a programme to demonstrate cost leadership and prudent financial management. This continuous improvement programme will formalise existing departmental and directorate efficiency efforts, create formal management oversight of cost reduction efforts that draws on our quality approach to Project Management and drives

best practice across STFC. It will formalise and provide a reporting and implementation framework for internal and external reviews, such as the BIS led International Review of the UK National Facilities, the implementation of the Diamond Triennial Review, the Corporate Services Directorate change programme and the outcomes of our estate management strategy that will look to further optimise space utilisation and the delivery of facilities management across all our sites.

4.2 Equality and diversity in STFC

STFC aspires to attract and employ high calibre people from the widest possible pool of talent to ensure that we benefit from the skills, experience and approach that a truly diverse workforce can bring.

STFC is an inherently international organisation, with the majority of our funded projects involving one or more non-UK partners, and we employ around 40 different nationalities. We are proactively working to attract more women to senior positions, and science, engineering and technical roles and our Equality and Diversity scheme was specifically commended in our 2014 IIP Gold Award.

RCUK and STFC are implementing new action plans to promote equality and diversity in our roles as employers, decision-makers and commissioners of science. STFC's Equality and Diversity Strategy includes challenging goals to help us achieve greater inclusiveness and build on our work to date. We will continue to increase diversity among our staff, leaders and governance bodies. We will continue to implement best practice in recruitment and management through formal schemes such as Two Ticks, Athena Swan, and Investors in People, as well as through our leadership development and unconscious bias training programmes. We have many active groups that progress this agenda; groups support Women in STEM as well as Black and Minority Ethnic colleagues to achieve their best and the work of our Dyslexic working group has become an exemplar of best practice – which we have shared with other organisations.

4.3 Reforming the Research Councils

The Research Councils together will continue to participate actively in a suite of Government reforms involving BIS partners across the UK research and innovation funding landscape. These reforms aim to deliver the best return on public investment while we ensure that the UK is the best place in the world to do research, to innovate and to grow businesses. They include: reform of higher education; implementation of the Nurse Review recommendations³;

BIS 2020 organisational and efficiency reform; BIS common technology platform; BIS grants programme.

As proposed by Sir Paul Nurse, and subject to Parliament, we will work with Government and BIS partners to bring together the seven Research Councils and dual support system as 'Research UK'. This new organisation will take responsibility for national research strategy, simplify transactional operations and reduce administration costs. In parallel we will work with Innovate UK to address the recommendations of the Dowling Review⁴ to simplify public support for innovation.

For successful reform, we will be mindful of key principles identified by Sir Paul Nurse, Government and the Research Councils⁵. These principles include: commitment to the dual support system for funding UK research; clear delegation from Government for research funding decisions and their management; commitment to the Haldane principles; recognition of the breadth and scale of research investments within and across disciplines. In preparation for reform, the Research Councils will plan and implement internal change and cost-reduction measures from 2016, ensuring that our changes support wider Government reforms.

² Based on article volume and citations per pound invested: <https://www.gov.uk/government/publications/performance-of-the-uk-research-base-international-comparison-2013>

³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/478125/BIS-15-625-ensuring-a-successful-UK-research-endeavour.pdf

4.4 Evaluating Research Council Investment

The UK's dual support system for publicly funded research⁶ provides a holistic and efficient investment appraisal and evaluation cycle compliant with HM Treasury guidance⁷. Playing complementary roles, Research Councils focus on prospective quality assurance through rigorous peer reviewed competition for grants, while Higher Education Funding Councils focus on retrospective quality evaluation through the Research Excellence Framework (REF). Besides informing Funding Council allocations, REF evaluates the excellence and impact (economic and societal benefit) of university research supported by all funders, including Research Councils.

Research Councils also evaluate or audit specific investments and processes, during or after their lifetimes. Large capital proposals require business cases and economic valuation to

inform investment decisions and to evaluate benefits realised. We use our own and independent evidence, including REF, to evaluate long-term impact outcomes⁸ and performance against Royal Charter objectives.

Through the monitoring and evaluation of our impact we continue to track our progress towards delivering our Vision and Strategy. Our fifth Impact report has recently been published which has illustrated the breadth and depth of our economic and societal impact. Our research seeks to understand the Universe from the largest astronomical scale to the tiniest constituents of matter, yet creates impact on a very tangible level. From cancer research to clean energy, powering transport to cultural heritage, our impact is felt across many aspects of daily life. By their nature, short-term output metrics cannot provide a full picture of the broader economic and societal benefits derived from STFC's long-term strategic programmes. Our evaluation programme therefore includes impact evaluations of significant investments. In 2016 we will continue with our ISIS and Sci-Tech Daresbury Campus studies to demonstrate impact in these key areas of our programme.

We will also be aligning our impact programme with the newly revised Corporate Strategy, focusing on key impacts from our new themes such as Data-intensive science. We will also support STFC colleagues in identifying key metrics to demonstrate the impact of new investment such as the recent £116m capital investment in the Hartree Centre. This will also be a key part of STFC's response to the BIS aims of strengthen its links with Partner Organisations in monitoring and evaluation⁹.

⁴ <https://www.gov.uk/government/publications/business-university-research-collaborations-dowling-review-final-report>

⁵ For principles see: <http://www.rcuk.ac.uk/documents/documents/strategicprioritiesandspendingplan2016/>

⁶ Dual support: Higher Education Funding Councils provide stable 'quality-related' (QR) funding to support research capability in universities; Research Councils operate at arms-length from government under the Haldane principles (<http://www.publications.parliament.uk/pa/cm200809/cmselect/cmdius/168/16807.htm>) and provide specific project funding to named researchers.

⁷ HMT Green Book and Magenta Book: ROAMEF cycle.

⁸ See, for example, Research Council impact reports: <http://www.rcuk.ac.uk/media/news/impa>

⁹ <https://www.gov.uk/government/publications/bis-evaluation-plan-2016>, <http://www.gov.uk/government/publications/improving-evaluation-in-bis-recommendations>

Annex 1 - STFC Financial Allocations

Planned expenditure profile:

£m	2015/16 baseline	2016/17	2017/18	2018/19*	2019/20*
International Subscriptions					
Resource	127.5	114.3	118.2	127.0	133.9
Sustaining Capital	27.3	38.6	39.3	40.6	42.9
£m					
Facilities					
Resource	107.4	107.7	108.2	109.1	110.1
Sustaining Capital	48.5	45.4	38.8	45.2	46.1
£m					
Core Programme					
Resource	165.1	166.1	166.1	166.1	166.1
Global Challenges Research Fund			3.5	3.5	3.5
Sustaining Capital	43.7	46.7	44.9	43.6	25.2

Planned expenditure – Grand Challenges Projects

£m	2016/17	2017/18	2018/19*	2019/20*
Hartree Phase 3	40.4	17.9	21.2	16.6
The X-Ray Free Electron Laser (XFEL)	10.0	18.0		
Square Kilometre Array (SKA)	8.0	10.0	18.0	18.0
European Spallation Source (ESS)	23.0	30.0	45.0	35.0
Higgs Centre for Innovation	7.0			

*indicative funding

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