A new vision for new times

Impact through inspiration and innovation

The Science and Technology Facilities Council makes strategic investments to support world leading science and technology for the UK. These investments include large scientific facilities used across the research base.

Our vision is to maximise the impact of our knowledge, skills, facilities and resources for the benefit of the United Kingdom and its people.

Changed economic times have highlighted the importance of innovation and the generation of new knowledge to our future prosperity and wellbeing. It is essential that we make full use of the research base to enrich society, develop new skills, drive the economy and improve the lives of citizens. This document describes a new vision that will guide our investments to realise this broad and positive impact.

Our commitments

- We will maximise the impact of our knowledge, skills, facilities and resources, by:
  - working to achieve the greatest return from the long term investments in research facilities and infrastructure that have been made over the past decades;
  - increasingly using an assessment of impact as a key criterion in deciding how to invest; and
  - moving towards a more focused prioritisation of our research.
- We will support world leading research that is both curiosity-driven and application-led.
- We will promote innovation through expansion of the knowledge base, through scientific research and technological development, through training programmes, and by providing the infrastructures and frameworks needed to enable innovation.
- We will work with the UK Government and other Research Councils to secure adequate on-going funding for innovation infrastructure.
- We will work to maximise the benefits to the UK of our global science and technology connections.
- We will consult and engage with our stakeholders, including the public and the scientific communities, as we seek to contribute to a long term sustainable economy based on innovation.
- We will operate to the highest standards of public accountability and effectiveness.
- We will promote and explain the benefits and the impact of our research.

A new vision for new times

Our vision is to maximise the impact of our knowledge, skills, facilities and resources for the benefit of the United Kingdom and its people. STFC began developing its strategy in very different times. In the past six months the UK's economy has entered recession. Moreover, the world at large faces perhaps the most challenging financial and economic situation for half a century, placing even further pressure upon our collective ability to address long term global challenges such as climate change, hunger, poverty and disease, and the insecurity and uncertainty they breed. Now more than ever, the world needs the solutions that science and technology can offer.

In these tough economic times for our world we look to science to provide new solutions, new technologies, new opportunities to further our common goals.

Rt Hon Gordon Brown, Prime Minister

This document sets out how we will contribute to those challenges. It starts from the premise that science and technology should be judged - first, foremost and only – by their ability to bring positive change to peoples' lives. We call this focus on changing lives 'impact'.

We believe that 'impact' takes many forms, from short term to long term, covering economic, social and environmental benefits, and physical and psychological well-being. That is why we are committed to support research across a broad range of science, from application-led challenges focused on near term problems to research that addresses humankind's curiosity.

We will maximise the impact of our knowledge, skills, facilities and resources.

Examples of the kinds of impact we seek are given throughout this document; at the end we summarise what our focus on impact will mean for our programme.

Why does a world in financial crisis need particle physicists or astronomers, or big expensive science projects or facilities? STFC makes strategic investments – long term, ambitious projects that deliver impact through inspiration and innovation. Weathering a global recession demands an innovative and scientifically trained workforce, and our young people must be inspired to become part of that workforce.

The interlinked challenges of the 21st century – energy, global climate, health and security concerns – demand scientific and technical innovation. Successful innovation depends upon the highest quality research facilities, and new ways of bringing technology and applications together between industry and academia.

Impact through inspiration – for a new workforce

The challenges of the 21st century are long term – young people are the answer. How do we attract them into science, technology and engineering?

The important thing is not to stop questioning. Curiosity has its own reason for existing.
Albert Einstein

We are an inquisitive and curious species. We are constantly seeking new knowledge and new answers. This drive has led us to the Moon, to explore the reaches of our Solar System, to understand the inner workings of our own planet, our own environment and our own bodies. We have delved into the atom, and then beyond. We are always asking 'why?'

We will support world leading research that is both curiosity-driven and application-led.

In hard economic times it is imperative to consider the benefits to the UK – the impact – of everything we do. We are confident that the curiosity-driven research we support not only expands the frontiers of human knowledge and scientific understanding, but delivers real world benefits in the medium and longer term.

We can identify some of these benefits in advance. Not least, the scientific disciplines we support catalyse the development of a national technical and technological skills base, and a pool of highly-trained analysts, problem-solvers and innovators. Our research plays a key role in attracting younger people into science, technology, engineering and mathematics (STEM) subjects. A survey of first year physics students in 2007 asked what subject areas had attracted them to study physics. The top three were particle and quantum physics, nuclear physics and astrophysics; 90% of the students expressed a significant interest in at least one of these areas.

In one sense only 20-30% of our astronomy and particle physics programmes are about understanding the Universe – this is the approximate percentage of students who go on to become astronomers or particle physicists. The programmes are mainly about inspiring young people towards science, technology, engineering, and mathematics, with a huge impact on the economy and society. The US Census Bureau has estimated that each science PhD is worth an additional $2.2M to the US economy; we support over 250 PhD students every year.

We will ensure that our curiosity-driven research has the greatest impact by focusing our support on areas and projects that are producing world-class science, where the UK has a leading role, and which deliver broad impact.

We will continue our wide range of public engagement activities and schemes, including a vigorous media relations programme. The inspiration and importance of our science and technology in attracting young people into science contributes to the national STEM recruiting agenda.

Impact through innovation – for a new economy

Curiosity has a more tangible impact; it is the source of all innovation.

We need (people) who can dream of things that never were.
John F. Kennedy

The World Wide Web, medical imaging, gene technology, clean energy, life-prolonging drug delivery systems, and improved security devices were all once 'things that never were'. They were dreamt of, and then turned into reality. The UK needs to turn more dreams into realities if it is to remain economically competitive globally and thus be able to afford to maintain our high standard of living and high social values. We are not a low cost economy based on extractive industries or cheap labour. To compete we need to innovate.

Innovation – the successful exploitation of new ideas – is the major source of competitive advantage for mature economies such as the UK, and has been identified by HM Treasury as one of its five drivers of productivity.

We need to use the prodigious talents, knowledge and curiosity of our scientists and engineers to encourage innovation, and thus help build a more sustainable economy, able to recover rapidly from slowdowns of the kind we are currently experiencing, and move forward robustly to address the global challenges humankind faces over the next 20 years and beyond.

We will promote innovation through expansion of the knowledge base, through scientific research and technological development, through training programmes, and by providing the infrastructures and frameworks needed to enable innovation.

We will do this by developing high added-value skills, challenging the brightest minds and ensuring a broad market for their insights, promoting interactions across disciplines and across sectors, and providing the large scale investments in tools and facilities that are increasingly essential to keep UK research at the forefront. Our development of the Daresbury and Harwell Science and Innovation Campuses is part of our commitment to provide innovation infrastructures and collaborative frameworks to deliver maximum impact.

Understanding our Universe

Ever since our distant ancestors first looked up at the night sky and tried to make sense of what they saw, humans have wondered how the Universe came into being and why it is the way it is today. Centuries of experimentation and observation have succeeded in revealing the basic building blocks that we, along with our planet and our Solar System, are made of, and in explaining the forces that hold them together.

These discoveries form much of the basis of our technological civilization – electricity, semiconductors, television, the chemical industry are all based on our understanding of atoms, electrons, quantum theory and electromagnetism. And yet, inevitably, though we now know a great deal about the structure and constituents of the world in which we live, this knowledge has revealed deeper questions and mysteries.

The recent discoveries that dark matter and dark energy dominate the content of the Universe imply that the bulk of the cosmos is not made of the 'normal' matter – protons and neutrons or electrons – which we understand well. In a real sense, we now realise that we do not understand what our world is made of at all.

Fortunately, we are in a position to greatly advance our understanding over the next decade. New astronomical observatories coming online will reveal the large scale structure of the Universe, and probe the role and nature of dark energy. New particle physics experiments will explore the properties of neutrinos and the role they played in the origin of the Universe, and reveal the basic laws of nature at energies where our current models fail. We also expect to detect, for the first time, gravitational waves from distant cosmic phenomena.

Our highest priority in particle physics is to exploit the Large Hadron Collider (LHC) at CERN. The LHC will reveal how nature operates at the energy scales where our current standard model of particle physics breaks down and will transform our understanding of the fundamental rules of the universe.

Our highest priorities in ground-based astronomy are to exploit our membership of the European Southern Observatory, which gives access to the world-leading Very Large Telescope and to the new ALMA millimetre astronomy array, and to carry out R&D towards the next generation European Extremely Large Telescope and the UK-led Square Kilometre Array radio telescope project.

Nuclear physics seeks to understand the behaviour and origin of the protons, neutrons and nuclei of which we are made. A new generation of experimental facilities offering beams of highly unstable ions will allow breakthroughs in nuclear research.

Our highest priority in nuclear physics is to participate in the Facility for Antiproton and Ion Research, the new European laboratory being constructed in Darmstadt, Germany that will offer an array of new experimental tools for nuclear research.

STFC is a major funding partner in the British National Space Centre. Through our European Space Agency (ESA) subscription and bilateral endeavours, with NASA for example, we provide access to space missions aimed at understanding the evolution of our Universe. These include the Herschel and Planck space observatories launched in 2009, the GAIA Galaxy survey mission (to be launched in 2012), and the James Webb Space Telescope.

Our highest priorities in space-based astronomy are to exploit the new observatories such as Herschel, Planck, GAIA and James Webb Space Telescope, and to lay the technical groundwork for future cutting edge missions in the ESA Cosmic Visions programme.

UK researchers in particle and nuclear physics and astronomy are among the very best in the world, and will take leading roles in the discoveries of the next decade. The technological advances that are driven by the needs of these programmes have major impact on the economy and industry.

Nuclear skills for medicine, energy and the environment

Training in nuclear physics and related areas is recognised to be increasingly important for the nation. There is a growing application of isotopes and radiation in medicine, the desire to build, license and operate a new fleet of nuclear power plants and the continuing requirement to dispose of nuclear waste safely. Industry has already identified a skills shortage which will only grow in the future. We are therefore conducting a joint review, with the EPSRC, of the research and training that we fund in nuclear physics and engineering. Our aim is to identify the skills and expertise required for future nuclear applications, and ensure that we target our funding to deliver this expertise for the benefit of the UK and its people.

Exploring the Solar System and searching for life elsewhere

How did our Solar System evolve? Are we alone in the Galaxy? Is the Earth unique in harbouring life? Under what conditions did life evolve on Earth? Being able to give a definitive answer to such questions would deeply alter our view of our place in the Universe and our understanding of terrestrial biology, and would have huge cultural impact.

We now know of over 300 planets in orbit around other stars, and the first images of such planets have recently been recorded. How do planetary systems develop? Do any of these planets harbour life?

The first place to search for extra-terrestrial life is within our own Solar System. On Earth, we have found microbial life in the most hostile and extreme of environments. It seems that wherever there is (or has been) liquid water and an energy source there is a possibility of discovering life, or evidence of life having existed in the past. The exploration of such environments on other planets in the Solar System is therefore a key part of our attempts to discover whether or not there is life elsewhere in the Galaxy. Programmes such as these not only advance science and our knowledge of our place in the Universe, but also drive new technology such as autonomous robotics, novel power sources and miniaturised, robust and low-power consumption sensors that have ready application here on Earth.

Our highest priority in space exploration is understanding how our Solar System evolved and how this influenced the development of life on Earth. This is being pursued by taking a leading role in the ESA's AURORA planetary exploration programme whose primary goal is the exploration of Mars with a focus on finding evidence of past or present life.

Infrastructures for impact

The breakthroughs and developments of 21st century science and technology will be dominated by our ability to manipulate and image matter at the scales from single atoms (10^{-10} m) to living cells (10^{-6} m). This research requires large scale infrastructures and facilities that are beyond the scale of any single university or research group, or indeed sometimes any single nation. STFC's role is to plan, develop and ensure access to these facilities for UK researchers so as to have maximum impact.

We provide access to over 100 worldwide facilities which we operate ourselves or provide through partnership. These support the development of applications for the benefit of the UK, taking advantage of the technology and skills developed in our own laboratories, within the UK's strong national skills base and through our international partnerships. The facilities we provide collaboratively cover a broad range including the Large Hadron Collider at CERN, space-based observatories and intense light sources based on synchrotron storage rings. We also provide a number of facilities directly including ground based telescopes, lasers, and powerful neutron sources. Some of these facilities, particularly the intense light sources, lasers and neutron sources find application across the entire research base, revealing the structure of artefacts, new materials or biological agents at the atomic and nuclear level. We have identified four areas of particular importance for society and the economy where STFC, by providing access to these world-class facilities, is uniquely placed to assist:

- Energy;
- Biomedical research; and
- Climate and the environment;
- Security.

It is essential that the UK is driving change in these areas, both because of the impact on global society and also because of the huge potential to benefit the UK economy if we can capture technological solutions in these areas. We will be designating responsibility at Director level for each of these areas and will increasingly look to prioritise impact in these areas when we plan how to direct our resources, in collaboration with the other Government, Research Councils and academia.

Research on STFC facilities is undertaken in partnership with the other UK Research Councils, who support our users. It includes both curiosity-driven projects and projects focused on specific near term application. Examples include the deeper understanding of enzymes, viruses and cell function, which is leading to the development of new drugs, novel vaccines and progress in cancer research. Research into electronic and magnetic phenomena at the atomic level is making possible new opportunities in information technology, in fields such as spintronics and quantum computing. In the energy and environment sectors, knowledge of materials behaviour at the atomic and molecular level is facilitating the development of new catalysts and batteries as well as novel ways to capture CO_2 emissions from power stations.

More examples of how our facilities impact on these areas are given in the following sections.

Impact on new challenges: Energy

Reducing carbon dioxide emissions, decreasing our dependence on fossil fuels, developing new renewable technologies and increasing energy efficiency are all essential if we are to stabilise our global environment for future generations. Many of these challenges require the development of new materials – novel catalysts for cleaner, more energy-efficient chemical processes, new processes for carbon capture and sequestration, breakthroughs in the carbon-free production and efficient storage of hydrogen, developments in battery technologies for electric cars and more efficient, cheaper photovoltaic systems. All these future technologies depend on the discovery, characterisation, development and optimisation of new material systems.

Progress in energy research will be driven by the development of novel materials for energy storage and generation and, in the longer term new sources of energy. STFC delivers impact on energy through its world leading facilities for materials science, through R&D towards new sources of energy, and by training nuclear physicists for the new generation of power reactors.

The continued development of facilities like Diamond Light Source and the ISIS neutron source will ensure the UK is in a leading position to accelerate materials discovery, to understand and optimise advanced systems under operational conditions, and thus benefit economically and socially from these discoveries. For example, Diamond and ISIS have been used to unravel the mechanisms of new catalyst systems to burn fuel more efficiently, while ISIS has given unparalleled insights into new materials for use in hydrogen-powered cars. Hydrogen contains less energy than petrol, so one of the key challenges is to find ways to store enough of it on board a car. These new materials can safely absorb hydrogen at a higher density than liquid hydrogen itself. Smart polymers developed using neutron scattering also offer the potential for lower cost, higher efficiency photovoltaic cells to generate electricity from sunlight; around 20% of the research done at ISIS relates to energy challenges.

Workings of photosynthesis revealed

Using STFC's ASTRA laser, images showing how the Sun's energy is captured by plants have been taken for the first time. The images unravel some of the inner workings of the most efficient solar energy process on earth – photosynthesis. Scientists are using these data to try to replicate this process and provide new energy solutions to replace fossil fuels.

Impact on new challenges: Biomedical research

Improved health care and nutrition lead to lower mortality rates. Coupled with falling birth rates, there is an overall ageing of the population in the UK and many developed nations. Maintaining the quality of life as we age is increasingly important.

Progress in biomedical research is increasingly driven by the ability to image molecular structures. STFC delivers impact on biomedical research by providing UK researchers access to world leading facilities for imaging, through technological developments, and through computational modeling.

Researchers funded by the Biotechnology and Biological Sciences Research Council (BBSRC), Medical Research Council (MRC) and biomedical charities use our advanced light and neutron sources to study individual molecular components of human physiological systems. This has led to improved techniques in, for example, stem cell research and predictive medicine. It is assisting our understanding of cancer, heart and neurological diseases, and helping develop new means of combating these diseases.

Technologies we have developed, such as electro-spinning and micro-cantilevers, have already found applications in regenerative medicine and point-of-care analysis, resulting in the formation of spin-out companies. Imaging detectors based on particle physics and astronomy technologies also have broad uses. We have recently established a Medical Technology Exchange Centre (MedTEC) to ensure impact from our technology and to facilitate new partnerships.

Research Complex at Harwell

This Research Complex at Harwell will provide facilities for both life and physical scientists to undertake cutting edge scientific research. It is under construction at STFC's Rutherford Appleton Laboratory on the Harwell Science and Innovation Campus, adjacent to the Diamond Light Source. MRC is leading the project on behalf of the Research Councils, in partnership with BBSRC, EPSRC, NERC, STFC and the Diamond Light Source.

Impact on new challenges: Climate and the environment

It is now accepted that human activities have major consequences for the global environment, and that climate change will affect the entire planet. But the global climate system is complex, and the impacts of change on human activity are varied. Tackling the many environmental challenges facing us requires a new level of understanding of this highly complex system and a multi-disciplinary approach.

Progress in understanding environmental change is driven by the ability to observe the Earth from space. STFC delivers impact on environmental research through its world leading facilities for satellite instrumentation and through the new ESA Centre at Harwell.

Earth observation provides global information on the state of our atmosphere and is essential for long-term climate monitoring. STFC-supported scientists are closely involved in satellite instrumentation and interpretation of data. They were among the first to note that the Sun has become significantly less active over the past two decades but that this change has not had any detectable impact on our climate.

STFC operates Europe's largest space science and technology department at the Rutherford Appleton Laboratory. Here, we are developing new technology for remote environmental sensing and in-situ monitoring, and are a partner in the NERC-BIS Centre for Earth Observation Instrumentation.

We work in partnership with other agencies and Research Councils to provide services and facilities to the research community. We operate the British Atmospheric Data Centre, the Chilbolton Observatory, the Mesosphere-Stratosphere-Troposphere Radar and the Molecular Spectroscopy Facility in support of the strategic priorities of NERC.

The Intergovernmental Panel on Climate Change has identified the radiative properties of aerosols as one of the largest uncertainties in the energy balance of the atmosphere, and new techniques for probing aerosol particles are being developed by STFC's Central Laser Facility. Measurements at the Chilbolton Observatory are helping to improve our understanding of the science that underlies the effects of clouds, aerosols and rain, leading to better weather and climate change predictions.

The European Space Agency Centre at Harwell

In November 2008, the Minister of State for Science and Innovation, Lord Drayson, announced that a new ESA Centre will be sited at the Harwell Science and Innovation Campus. It will encourage inward investment into the UK in three priority areas; a global/climate change theme will exploit Earth observation satellite data; an integrated application unit will draw together telecoms, navigation and Earth observation space data, together with terrestrial data to create new services; and units will support the science and technology of the European space exploration programme including robotics, novel power sources, and the handling and curation of materials from space. The ESA Centre will be formally inaugurated in July 2009 and North American aerospace companies are already showing interest in collaboration and co-location.

Impact on new challenges: Security in a changing world

The world has always been an uncertain place, but the 21st century has brought unpredictable threats from new directions, including terrorism and failed or failing states. The pressure that climate change will bring to the environment in many of the most unstable parts of the globe will only exacerbate this trend. These new threats are often indiscriminate and involve nonmilitary targets. We need to protect ourselves in new ways, whether in our homes, our workplaces or while travelling. The safety and security of the people of the UK must be a priority.

Progress in addressing security concerns requires new imaging and detection techniques. STFC delivers impact on security through its technology and its world leading facilities for detector development.

We are exploiting the knowledge and technology developed for our science programmes by developing innovative solutions in areas such as baggage scanning, detection of radioactive sources and surveillance. Scanning equipment based on STFC technology is now operating at Heathrow Airport.

We regularly call for proposals to support work in the security sector, and aim to expand this kind of challenge-led approach. These are initiated in conjunction with our strategic alliance partners, which include the Ministry of Defence, the Home Office and industrial partners. We have recently signed a concordat with the Defence Science and Technology Laboratory to enhance our impact on security challenges.

We also support work at our facilities to help develop a safer environment. This includes working with industry on the detection of material faults in heavy engineering structures and developing novel lighter materials for better performance over longer lifetimes.

Detecting ‘dirty bombs’

STFC is working with the University of Liverpool to develop a demonstrator of a novel, radiation detector. The Portable Gamma Ray Spectrometer system will be capable of precisely identifying the energy of, and imaging the radiation field associated with radioactive material. New technology to allow for room temperature operation and the small detector size will enable it to be remotely operated in hostile environments. This will make it ideal to be used to monitor radioactive waste, and by security services to detect ‘dirty bombs’.

World Class Research Facilities

The key challenges we have outlined above – energy, biomedical research, climate and the environment, and security – all demand scientific and technical innovation, which in turn depends upon access to the highest quality research facilities. STFC-provided facilities and our priorities for their development in support of these goals are outlined below.

Neutron Sources

Our goal is to provide the key facilities that enable the atomic structure of new materials to be explored. X-ray and neutron scattering together give particularly powerful insights into the structure and properties of systems across the materials world.

ISIS is the world's most productive spallation neutron source and has been recently enhanced by the development of a low repetition rate second target station which will give a new understanding of magnetism, hydrogenous systems and soft matter ranging from polymers and plastics to drug delivery systems. The Institut Laue-Langevin (ILL) in Grenoble, also recently enhanced through its Millennium Programme, continues to provide world-leading opportunities in reactor-based neutron scattering.

We believe that any major new investments in neutron facilities in Europe such as the proposed European Spallation Source should be considered within the overall European landscape in neutron scattering and we are working to ensure Europe has access to a range of complementary capabilities in this area.

Our highest priorities in neutron scattering are the continued exploitation and upgrade of ILL and ISIS for maximum impact in the key areas of energy, biomedical research, climate and the environment and security, through improvements to instrumentation and where appropriate to the source itself. In the longer term we will work with international partners towards the development of a multi-megawatt ISIS upgrade.

Spintronics

Spintronics is the world beyond electronics – where the magnetic properties of electrons are used to store and process information. These 'nanomagnetic' systems are already a multi-billion dollar industry for computer storage media. They offer future possibilities such as higher speed, lower power consumption, and instant-start computing, reconfigurable logic and potentially quantum computation. The neutron scattering facilities provided by STFC are essential in providing the detailed structural and magnetic information needed to design and understand these phenomena.

Light sources

The Diamond Light Source at the Harwell Science and Innovation Campus is the largest scientific instrument built in the UK in over 40 years. It is the best medium energy light source in the world. Diamond uses an electron accelerator to produce beams of X-ray, infra-red and ultra-violet light to probe the structure of matter and materials. Research at Diamond emphasises applications in biosciences and medicine, but will also benefit the environment, nanoscience and nanotechnology, materials processing, energy, and engineering, as well as fundamental physics and chemistry. By 2011 Diamond will have 22 beamlines in place.

The European Synchrotron Radiation Facility in Grenoble, France, operates the most powerful and successful high energy synchrotron light source in Europe. We will continue to support access to this facility for UK researchers while ensuring that it provides capabilities that complement those of Diamond.

Looking to the future, a new generation of light sources will be able to deliver synchronised, extremely short pulses of light, which are rapid enough to follow chemical processes as they occur. This will revolutionise our investigative toolkit, allowing us to explore not just the structure of molecules, but how they interact and function too. STFC is developing a proposal for a New Light Source of this type. The science case was approved in 2008 and a technical design is now being produced. In parallel, the UK is collaborating on the European X-ray Free Electron Laser to be built in Hamburg, and we are exploring possible modest

contributions to the Linac Coherent Light Source in Stanford, USA, which is now starting operations. We have set up a new Research Institute for Photon Science jointly with UK universities with the goal of building up the UK research community's skills in exploiting these new capabilities.

The highest priorities for our light sources are to develop and fully exploit the Diamond Light Source for maximum impact in the key areas of energy, biomedical research, climate and the environment and security. We will pursue R&D on the New Light Source project with the goal of making a decision on the next phase in early 2010.

High power lasers

The Central Laser Facility (CLF) provides an internationally leading capability in the provision and application of ultra-fast and high intensity lasers. Our goal is to build coherent capabilities in the areas of fusion energy research, plasma-based particle acceleration, and ultra-fast spectroscopy for bioscience and nanotechnology applications, whilst maintaining a flexible capability for innovative research in other areas.

The highest priorities for our laser facilities are to exploit the existing laser systems for maximum impact in the key areas of energy, biomedical research, climate and the environment and security, while carrying out a programme of upgrades to maintain the competitive performance of the facility by pushing into new areas of ultra-short pulses and ultra-high power beams.

We are pursuing R&D towards the longer-term possibility of building HiPER, a high power laser designed to demonstrate practical energy generation from nuclear fusion, a potential sustainable source of energy for human needs. HiPER exploits a revolutionary laser driven fusion technique known as fast ignition, which reduces the scale of the facility required by a factor of ten. The UK is leading on this European project.

We are taking a leading role in the HiPER project, which aims to demonstrate viable energy generation by nuclear fusion using inertial confinement, and pursue the long term possibility that the HiPER facility might be built in the UK.

Technology to underpin science

To optimise the capabilities of our facilities in meeting the goals of our research programme and to address the key challenges of energy, biomedical research, climate and the environment, and security, we must develop and deliver innovative technologies. We do this in our own laboratories and in collaboration with university groups that we fund. We have particular strengths in instrumentation (for astronomy, space science, particle and nuclear physics, and light and neutron sources), detectors and sensors, data acquisition systems, microelectronics design and micro- and nanotechnology. Our mechanical and electrical engineering capabilities have developed to address the unique challenges of large scale science research projects, allowing us to build teams of highly skilled engineers.

We have recently established Engineering Technology Centres on our Science and Innovation Campuses at Daresbury and Harwell. These centres will provide integrated engineering solutions for STFC programmes and facilities, campus tenants and other stakeholders. These will be focal points for training and knowledge exchange.

Leading in Accelerator Technology

Particle accelerators were originally developed to explore the fundamental questions of particle physics, but they now underpin a very wide range of research. The intense beams of X-rays at the Diamond Light Source and the neutrons at ISIS are all generated by particle accelerators. The ultra-short X-ray pulses obtained in next generation light sources are only possible because of advances in accelerator capabilities.

Over the past seven years, we have made a targeted and effective investment in accelerator science by setting up two new UK-based accelerator science and technology centres: the John Adams Institute at Oxford and the Cockcroft Institute located at the Daresbury Science and Innovation Campus. Together with universities and the STFC national laboratories, these have revitalised the national skill base, attracted internationally recognised accelerator experts to the UK and increased the number of PhD students in this field tenfold. We are now exploring how we can exploit this skills base to develop transformative solutions

to some of the major problems facing the nation: in medicine, through the development of particle beam therapies for cancer; in energy, through the development of safer nuclear reactors driven by particle beams; and for the environment, by using accelerators to render nuclear waste less harmful.

Impact through the Science and Innovation Campuses

In the 20th century, big science problems demanded the creation and application of a dedicated workforce in national facilities. In the 21st century, the challenges are more complex, more interdisciplinary and more inter-related. Solutions to 21st century problems will be found by working with the national facilities, and not purely by working within the national facilities.

We are developing our laboratory sites at Daresbury and Harwell as National Science and Innovation Campuses. They will combine our skills and facilities with the knowledge of higher education institutions and support from the private sector. Together we will deliver a new model of collaborative science and technology programmes across a wide range of disciplines and sectors.

We will fight our battles not on the low road to commoditization, but on the high road of innovation.
Howard Stringer, Chairman and CEO, Sony

The Campuses are attracting additional inward investment and fostering international collaborations, which again help strengthen the UK economy by providing skilled employment and generating new products and techniques.

The Science and Innovation Campuses form two national centres of excellence, building on, and expanding, their expertise within science, technology, innovation and business. The benefits to Campus tenants and partners include:

- Working in an amenity rich, collaborative environment that will promote exciting new open innovation techniques and new partnership models for collaborative work with STFC, the broader research council family and the other Campus partners;
- Access to the STFC's advanced facilities and scientific and technical expertise; and
- Access to unique training opportunities with a highly qualified mix of professionals, ranging from experienced technicians through to dynamic researchers and academics.

Both Campuses will become world-leading locations for science and innovation. They will provide opportunities for businesses, universities and other public sector bodies to thrive in a high technology environment whilst engaging in open innovation. We will develop the estates and built environment necessary to deliver the Science and Innovation Campuses through partnerships with the private sector. At Harwell we have established a Joint Venture with Goodman International, and at Daresbury we are actively engaged in attracting a private sector development partner.

The Detector Systems Centre

The Detector Systems Centre is one of the Science and Technology Gateway Centres and will provide a point of focus for collaboration between STFC, academia and industry at both the Harwell and Daresbury Science and Innovation Campuses. Its goal is to build on our successes in exploiting our advanced detector and sensor systems technologies to address global challenges, and optimise the impact of emerging technologies on a wide range of economically important application areas.

Simulation and Modelling: The Hartree Centre

Designed to address challenges of a global scale, the Hartree Centre will be a new kind of computational sciences institute for the UK based at the Daresbury Science and Innovation Campus. It will bring together academic, Government and industry communities, and focus on multidisciplinary, multi-scale, efficient and effective simulation. As a Science and Technology Gateway Centre, it will bring together a critical mass of researchers and computing infrastructure and focus them on problems of immediate relevance to society. The goal is to provide a step-change in modelling capabilities for strategic themes including energy, life sciences, materials and the environment.

Imaging Solutions Centre

The Imaging Solutions Centre will provide state of the art technology, consulting services and a gateway to deliver one-stop problem-solving capabilities. It is designed to enable access especially for non-specialist researchers from academia or industry with applied problems in fields such as drug-design or advanced engineering. As one of the Science and Technology Gateway Centres, it will be co-located on the Harwell Science and Innovation Campus alongside the existing large-scale facilities – Diamond, ISIS and the Central Laser Facility.

Economic impact

STFC is committed to the development of economic impact as a core competence within the organisation and aims to maximise the output of economic impact from its core programmes. As well as implementing the Science and Innovation Campuses, we will work with research communities, international facilities and shareholdings to capture economic impact arising from STFC investments; build an understanding of economic impact, and its strategic importance among our staff, community and key stakeholders; and benchmark and develop measurement criteria and evaluation methodologies for economic impact across our investments and activities.

We have embarked on a significant programme to broker interactions between key communities, facilitate access to STFC facilities and skills, support the commercial exploitation of new ideas and foster a deeper understanding of the challenges and problems faced by industry and society. We will focus our activity on the implementation of knowledge exchange initiatives aligned to high priority challenges, including a new Challenge-Led Applied Systems Programme to be launched in 2009; the appointment of interface managers to establish and manage key strategic partnerships with relevant academic, industrial and co-funding organisations; and the organisation of brokering events and targeted funding to match our technologies with the needs of other scientific disciplines.

To bring greater prominence and cohesion to all these activities, they will be grouped and branded under the new name ‘STFC Innovation.’

Sustainable impact

Innovations, especially those based on new scientific discoveries, often take many years to diffuse through the economy and society and create value. Similarly, the time scale for investment in our infrastructure is lengthy. It can require 15 years to plan, design and build significant research infrastructure, which must then operate for 20 or more years to provide the science that leads to innovation. We must therefore look 10-20 years ahead when we plan our investments, and we need to be sure that funding is in place to operate facilities over these timescales so as to ensure maximum impact. Similarly, to maximise access to the scientific infrastructures that the UK needs, we enter into international collaborations. These are usually long-term agreements, and require long-term funding commitments.

We will work with the UK Government and other Research Councils to secure adequate ongoing funding for innovation infrastructure.

International impact

The UK is internationally recognised in science and has an influence disproportionate to its size and investment in science. This is something to nurture and build upon. STFC represents the UK in, and contributes to, many international scientific decisionmaking and research organisations. We will ensure that the UK's specific scientific and technology requirements are fully considered. We will work to maximise the benefits for the UK of our global science and technology connections by ensuring our national investment and participation in these organisations provides access to facilities, projects, research outcomes, scientific advances and intellectual property for UK researchers.

Our international engagement further strengthens and showcases the UK's position as a world leader in science, technology and innovation. This increases our international influence, maximises the attractiveness of the UK and its universities in recruiting the best scientists and researchers in an increasingly global market, and stimulates inward investment in high technology industries. The Science and Innovation Campuses are a particular focus for such inward investments. Within Europe, new forums like the European Strategy Forum on Research infrastructures, new funding mechanisms for research like Joint Programming, and the strategic goal of promoting a European Research Area, all require our engagement and input.

In the longer term, we will work towards the goal of siting a major international research facility in the UK, given the significant economic impact such an investment would have. Internationalising future facilities would also provide a mechanism to share the operations costs across many partners.

Our priorities for maximising international impact are:
• to seek increased influence for the UK in research, especially in Europe;
• in the long term to work towards the siting of a major international research facility in the UK.

World Wide Web turns twenty

Celebrations in March 2009 marked the 20th birthday of the World Wide Web. Developed at CERN to meet the specific needs of the particle physics research community, the Web has transformed our lives, the economy, entertainment, medicine and even our social values. The Web is undoubtedly the most well known spin-off from CERN, but it's not the only one – technologies developed there have found applications in areas as varied as solar energy collection and medical imaging. STFC is the UK funding agency for CERN.

Who we are and how we work

STFC is a Non-Departmental Public Body of the Department of Business, Innovation and Skills (BIS) funded by the UK Government and operating under a Royal Charter from Her Majesty Queen Elizabeth II. STFC is one of seven Research Councils which collectively constitute Research Councils UK, and is one of Europe's largest multidisciplinary scientific and technological research organisations. We are a member of the British National Space Centre. We employ over 2000 highly skilled scientists, researchers, technologists, engineers, technicians, apprentices, science communicators and support staff, and we fund more than 1700 academics, research associates, engineers and technicians in UK universities.

We support science and technology in three ways – by providing access to world-class facilities, by funding world-class researchers and by ensuring a strong supply of future scientists. In determining the balance of funding across research disciplines, our Council relies upon an advisory structure comprising a Science Board and two Science Committees – the Particle Physics, Astronomy and Nuclear Physics Science Committee (PPAN) and the Physical and Life Sciences Science Committee (PALS). PPAN and PALS have established advisory panels to develop roadmaps for the future of specific disciplines. They are supported by peer review and grants panels and programme advisory bodies such as the Space Science Advisory Committee and the Aurora Advisory Committee. We consult with our scientific communities, other Research Councils, the Government (especially BIS), and international partners. We plan on a 10 year basis, tensioning investments across our broad portfolio whilst seeking to balance immediate outcomes against longer term requirements and goals.

Allocation of funds for scientific projects or programmes is determined with advice from our peer review processes, as is the allocation of time on our facilities.

Our facilities host more than 3000 scientists each year, over half of whom are under the age of 30. The broad range of multidisciplinary research that they conduct provides collaborative opportunities that are crucial for innovation and for the next generation of technological breakthroughs – physicists can talk with pharmaceutical scientists; engineers can explore new ideas with environmental scientists.

We work with industry in our science programmes and by providing a high level of support and assistance to the industrial users of our facilities. We have a number of spin-out companies and license agreements with UK industry. We are working with the Technology Strategy Board to ensure that UK industry reaps the benefits from our research and technology development.

People are at the heart of what we do. They contribute knowledge, develop expertise, and build, operate and exploit our facilities. They are also one of the most important ways in which we transfer and exchange knowledge. We support the education and training of young people in a variety of ways including our research studentships, a four year paid apprenticeship scheme, training through our domestic and international facilities, and fellowships. We currently support over 700 PhD students with a new intake of more than 250 per year. We will work with key partner organisations to establish the Daresbury and Harwell Science and Innovation Campuses as national centres for skills training activities, and we will promote training at the innovation interface to help researchers develop innovation and enterprise skills.

Taking our science to a wider audience

Our comprehensive planning of public engagement activities for the Large Hadron Collider project at CERN culminated in major media coverage in September 2008, a national touring exhibition seen by over 500,000 people, and a large uptake of educational resources with good feedback. Of the 500 secondary school students who attended Particle Physics Masterclasses at the STFC Rutherford Appleton Laboratory in March 2009, 70% said they would consider a career in science or engineering after being inspired by the activities. At Canterbury's Simon Langton School, a combination of inspirational teaching and pupils' engagement with frontier research supported by STFC resulted in 150 pupils taking A-level Physics from a school roll of 600. Last year 15 Simon Langton pupils entered university to study physics and 25 to study engineering. For the International Year of Astronomy 2009, STFC's offer of 'A Thousand Telescopes' was fully taken up by UK secondary schools. STFC's Rutherford Appleton and Daresbury Laboratories continue to inspire, with 10,040 general public, 4720 students and 803 teachers directly engaged through visits, lectures, outreach, continuous professional development for teacher and work experience activities last year.

What will our focus on impact mean?

New times and new challenges call for a new focus. In positioning STFC to meet these challenges, we intend to maximise the impact of our unique combination of knowledge, skills and capabilities.

When we say that we will ensure all our activities deliver maximum impact, this means:

- working to achieve the greatest return from the long term investments in research facilities and infrastructure that have been made over the past decades; and
- increasing the importance of impact as a key criterion in deciding how to invest, and moving towards a more focused prioritisation of our research.

We have embarked upon change. For most of our activities it will be evolutionary, not revolutionary, but in some areas radical new approaches will be called for. This approach will require extensive consultation.

We will consult and engage with our stakeholders, including the public and the scientific communities, as we seek to contribute to a long term sustainable economy based on innovation.

We have an obligation to the people of the UK who fund our research to use their money wisely, efficiently and effectively.

We will operate to the highest standards of public accountability and effectiveness.

We must also explain and promote the work we do, demonstrate its impact on peoples' lives and seek to convey the sense of wonder and excitement of our science. Tens of thousands of primary and secondary students have been encouraged into science through our Science in Society and public outreach campaigns.

We will promote and explain the benefits and impact of our research.

This document sets out our vision, expands upon our goals, demonstrates our impact, and explains who we are and what we do. It seeks to look forward, past the current financial situation. It identifies our priority areas for investment and demonstrates how our research efforts contribute to these priorities.

Specific objectives and measures are contained in our triennial Delivery Plan, with further detail in our annual Operating Plan.

Success in achieving our strategic and tactical goals will rely on more than access to adequate investment, skills, collaboration and effort. It will require a constant supply of curious minds.

At such a difficult moment, there are those who say we cannot afford to invest in science, that support for research is somehow a luxury at moments defined by necessities. I fundamentally disagree. Science is more essential for our prosperity, our security, our health, our environment and our quality of life than it has ever been before.

President Barack Obama