

Inspiration Innovation Impact



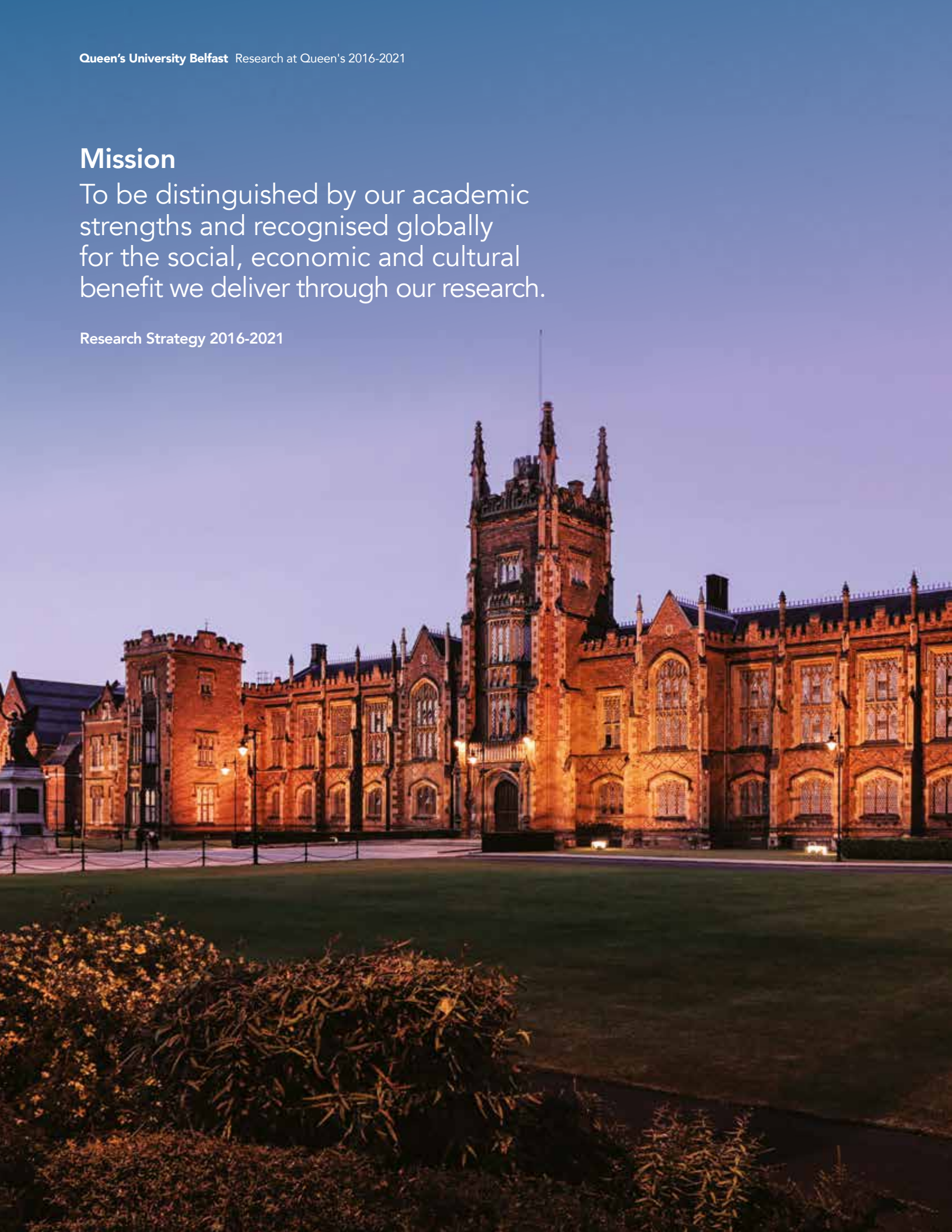
Queen's University
Belfast

RESEARCH AT QUEEN'S
2016-2021

Mission

To be distinguished by our academic strengths and recognised globally for the social, economic and cultural benefit we deliver through our research.

Research Strategy 2016-2021



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" Building on our disciplinary excellence, we have established interdisciplinary Global Research Institutes and Pioneer Research Programmes which bring researchers together to tackle some of the greatest global challenges of our age."



Introduction

Excellence in research and innovation, and making a positive global impact, are central to what we do at Queen's University Belfast.

This publication provides an overview of the world-leading research that takes place at Queen's and the impact it is having around the world. It highlights not only the scale and profile of our research at present but also our commitment to be recognised globally for the social, economic and cultural benefit we deliver through our research.

During the period 2016-21, we are re-shaping the research landscape at Queen's through our ambitious vision for research, innovation and impact.

As the results of REF 2014 demonstrate, Queen's has both breadth and depth of research quality. Building on our disciplinary excellence, we have established interdisciplinary Global Research Institutes and Pioneer Research Programmes which bring researchers together to tackle some of the greatest global challenges of our age. Our commitment to innovation is reflected in an environment which encourages and accelerates translation from ideas to validated, implemented solutions.

The work illustrated in the following pages is testament to the outstanding calibre of researchers at Queen's, our strong and growing network of partnerships with industry and other research organisations, and the vitality and relevance of research across the University.

A handwritten signature in blue ink, reading "James C. McElroy". The signature is stylized and fluid.

Professor James C. McElroy
Pro-Vice-Chancellor
(Research, Enterprise
and Postgraduate Affairs)

Research Success

Top 1%
of universities
world-wide
(QS world rankings 2015-16)

£34.5m in IP
revenues for
2014-15, ranking
1st in the UK
(HEBCI Survey 2016)

8th in the UK
for Research
Intensity
(Times Higher Intensity
Rankings based on REF 2014)

**9th in the
world** for
international
research
collaboration
(Leiden Rankings 2015)

1st in the UK
for Knowledge
Transfer Partnerships
with business
(Innovate UK 2016)

49% growth
in research
grant awards
(2010-11 – 2014-15)

Over 75% of
research assessed
as **"world-leading"**
or **"internationally
excellent"**
(REF 2014)

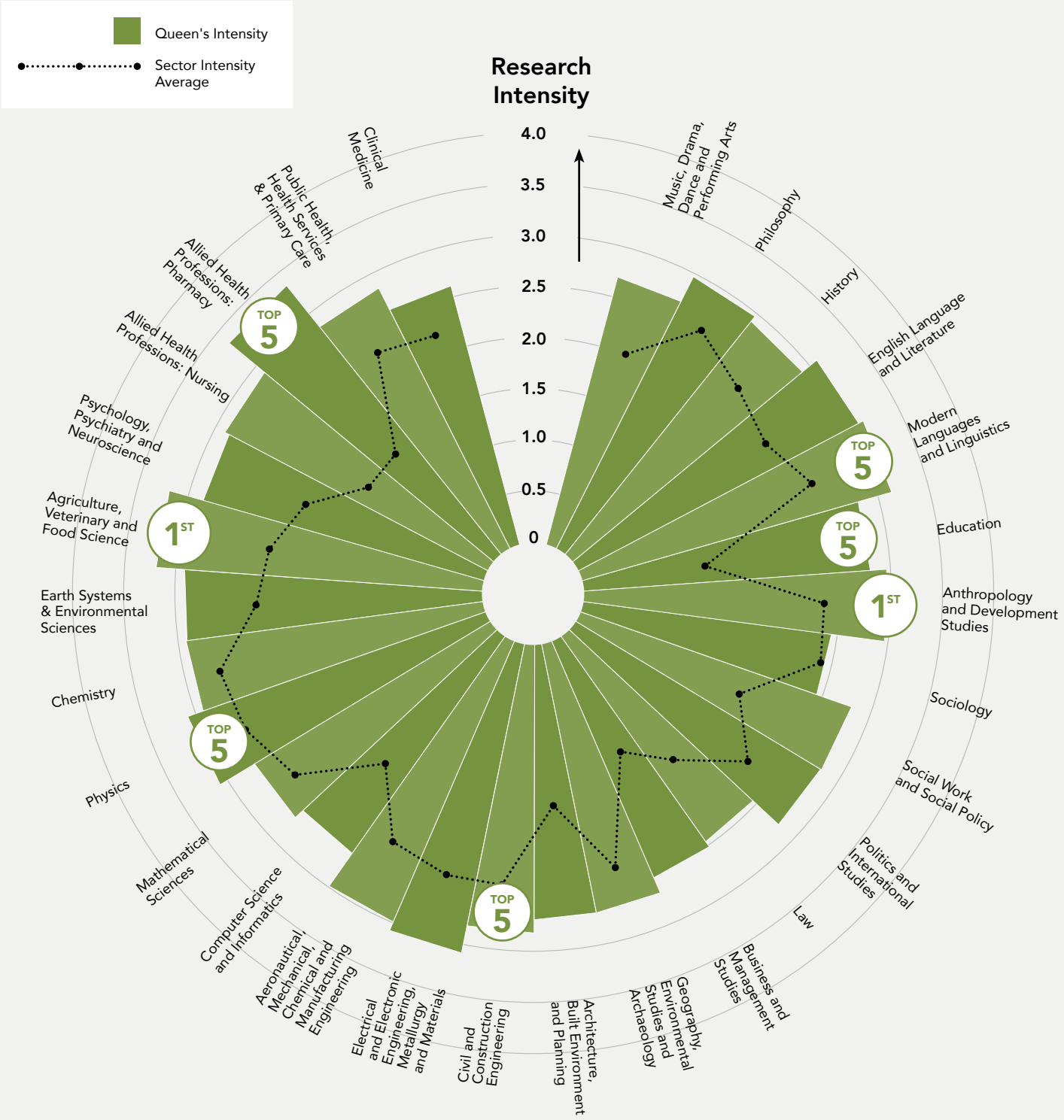
Awarded our
**6th Queen's
Anniversary
Prize** in 2015
(The Royal Anniversary Trust)

1,700 people
employed
in 47 active
spin-out
companies

REF 2014: 8th in the UK for Research Intensity

Research Intensity describes the breadth and depth of research excellence at an institution. It takes into account both the overall quality of research (as measured by the Research Excellence Framework 2014) and what proportion of the institution's researchers are contributing at that level of quality.

Queen's was ranked 8th in the UK for Research Intensity following REF 2014, and performed **above the sector average** in all of its disciplinary areas.



Research Horizons

Our researchers are working at the cutting edge, applying their insight to ambitious programmes with the potential to yield world-changing solutions.



Leading the way in developing new treatments for respiratory infections

Respiratory infections, frequently caused by drug-resistant bacteria, are the main cause of disease and death in people with cystic fibrosis and bronchiectasis. Inhaled antibiotics are helping patients live longer and enjoy a better quality of life, but infections are increasingly resistant to the drugs

available, putting lives at risk. The €50m **inhaled antibiotics in bronchiectasis and cystic fibrosis (iABC)** project, led by Queen's and involving 25 academic and industrial partners, is advancing the development of inhaled antibiotics for patients with these conditions.



Driving industrial innovation in energy sustainability

The challenges presented by the demand for sustainable energy technologies are complex and require widespread collaboration. A unique £10m industry-led research centre, hosted at Queen's, focussing on the development of innovative sustainable energy solutions will tackle these challenges. Matching industry partners with the research base in Northern Ireland, the **Centre for Advanced Sustainable Energy (CASE)** will address three key themes and present an evidence base to influence government policy and position Northern Ireland at the forefront of the global sustainable energy market.



Pioneering at the interface between the social sciences and electronic engineering

Digital technology plays an increasingly prominent role in our society, and online connectivity has significant implications for our security, presenting opportunities for enhancing surveillance, border security, and tackling cybercrime. However, with this comes considerable ethical, legal, regulatory and technical challenges. The **Leverhulme Interdisciplinary Network on Cybersecurity and Society**

(LINCS) brings together the Senator George J. Mitchell Institute for Global Peace, Security and Justice and the Centre for Secure Information Technologies (CSIT) to develop a distinctive cohort of doctoral students working across the boundaries of their disciplines and opening up new avenues of enquiry into the big questions and challenges presented by an increasingly digital world.



Helping to answer difficult questions about our troubled past

States, armed groups, churches and large corporations have in recent decades apologised for past wrongs, albeit with mixed results. For victims, apologies can be an important element of dealing with the past. However, in practice the precise interplay between apology and accountability, reconciliation, truth and legitimacy is little understood.

An ESRC-funded project at Queen's - **Apologies, Abuses and Dealing with the Past** - is examining the interplay between these three areas, using the island of Ireland as a case-study. The research is seeking to develop a bridge-head between law and other fields including politics, philosophy, anthropology, history, sociology and psychology.



Accelerating the delivery of precision medicine

Treatments for disease require the collection of a large amount of tissue samples and the use of effective techniques to analyse samples. A **national digital molecular pathology research programme** at Queen's, generously funded through the highly competitive Cancer Research UK Accelerator Award, is conducting research to

improve cancer diagnosis through tissue imaging, biomarker discovery, and clinical trials. The programme, being undertaken in partnership with the Belfast Health and Social Care Trust, will enable researchers to identify specific types of tumour, and then identify which therapies are more likely to be effective for each individual patient.



Using the study of multilingualism to address some of society's biggest challenges

A major interdisciplinary project in Modern Languages is bringing together linguists, literary specialists, educationalists and neuroscientists to respond to contemporary societal challenges around identity, diversity, social cohesion, conflict resolution and health. Queen's involvement in a new £4m research project on Multilingualism, funded through the AHRC's **Open World Research Initiative** is seeking to raise the profile and visibility of Modern Languages, to highlight the crucial role that they can play in today's increasingly multicultural societies, and to impact positively on motivations for language learning in the UK.

Research Strategy 2016-21

Mission: *To be distinguished by our academic strengths and recognised globally for the social, economic and cultural benefit we deliver through our research.*

To achieve this, we will work to create an inspiring research environment that nurtures talent and rewards outstanding leadership and excellence.

Creativity, Community, Integrity

We value **creativity** and foster an environment that facilitates and rewards innovation.

We contribute to the creation of an inclusive and enriching intellectual **community** which develops talent and enables collaboration across disciplinary boundaries.

We undertake research in accordance with the highest levels of **integrity**.

Priorities and Cross-cutting Themes

We are giving particular focus to development in three key areas affecting our research landscape during 2016-21. In support of these priorities, we are also expanding and strengthening three cross-cutting programmes of work.

Research Strategy Cross-Cutting Themes:



Internationalisation

To **consolidate our progress in expanding international partnerships, funding and recruitment** and to increase our international research standing. We will deepen our existing strategic partnerships with international companies and academic institutions to achieve global impact and foster the next wave of key partners.



Impact

To **expand the demonstrable contribution that our research brings to society** by increasing the involvement of stakeholders in the co-design and co-production of our research, helping to ensure that the **potential for impact is embedded in research projects** at the earliest stages.



Environment

To provide an **environment which enables researchers** to access the facilities necessary to achieve world-class research **outcomes**, to exchange **ideas** and develop connections, and to uphold the highest **standards** of research integrity.

Research Strategy Priorities

PRIORITY 1 | CULTURE OF RESEARCH AMBITION



Culture of Research Ambition

To create **new opportunities and flexibility for inspiring research leaders**, both established and emerging, supporting researchers to set and achieve the most ambitious research goals. We will support the next generation of world-class researchers to develop the skills to excel not just as individuals but as **leaders and motivators of others**. We will also do more to celebrate our research successes and strengths, and will foster a more **integrated research culture**, from postgraduate to professoriate, through new networking and mentoring initiatives.

PRIORITY 2 | CONNECTING TO TACKLE GLOBAL CHALLENGES



Connecting to Tackle Global Challenges

To **reshape how we organise research**, better supporting researchers to work with one another and with partners outside academia to yield solutions to some of the world's most difficult problems. We will form **Global Research Institutes** in areas where we have a critical mass of world-class research and leadership to take on major societal challenges. And we will support the emergence of novel, challenge-led research collaborations by seed-funding three-year **Pioneer Research Programmes**.

PRIORITY 3 | VIBRANT POSTGRADUATE AND POSTDOCTORAL COMMUNITY



Vibrant Postgraduate and Postdoctoral Community

To create a vibrant and ambitious postgraduate and postdoctoral community across the University, involving **significant increases in postgraduate taught, postgraduate research and postdoctoral numbers** in the years ahead. Underpinned by our newly developed Graduate School and the Queen's University Fellowship Scheme, we aim to **attract, retain and develop the very best** of postgraduate and postdoctoral research talent.

INTERNATIONALISATION

IMPACT

ENVIRONMENT

People

Our research success depends on the talent, creativity and commitment of our people. Queen's is committed to the promotion of equality of opportunity and to creating and sustaining an environment that values and celebrates the diversity of its staff and student body.



Recipient of the European Commission's **Human Resources Excellence in Research Award**

Returned over **95% of academic staff** in REF 2014 - fifth highest in the UK

Staff drawn from **70+ nationalities** across the globe

Committed to the Equality Challenge Unit's **Athena SWAN Charter**, which aims to encourage and recognise commitment to advancing the careers of women in science, technology, engineering, maths and medicine (STEMM)

12 department SWAN awards including two gold, eight silver and two bronze awards

One of only 9 holders of a **silver institutional SWAN award**

Member of the 30% Club which aims to increase representation of women on boards



Professor Joanne Hughes

Joanne is Director of the Centre for Shared Education. Her research concerns the role of education in divided societies. In 2016, she was appointed the first 'UNESCO Chair on Globalising a Shared Education Model for Improving Relations in Divided Societies', highlighting Queen's as an international leader in how shared education can promote reconciliation in divided societies.



Dr Denise Fitzgerald

Denise is a Senior Lecturer in Immunology in the Centre for Experimental Medicine and is the recipient of a prestigious Wellcome Trust Investigator Award. Her research focuses on how the immune system helps repair the brain and reverse the damage caused by Multiple Sclerosis and other neurological conditions.



Professor Stephen Smartt

Stephen is Director of the Astrophysics Research Centre and holds an ERC Advanced Grant for work on superluminous supernovae and their progenitor stars. His team have leading roles in two large international projects to study supernovae and the transient Universe: the Pan-STARRS and PESSTO projects.



Professor Dimitrios Nikolopoulos

Dimitrios is Professor and Chair in High Performance and Distributed Computing and a recipient of the Royal Society Wolfson Research Merit Award. His research explores scalable computing systems for data driven applications and new computing paradigms at the limits of performance, power and reliability.



Professor Sinéad Morrissey

Sinéad is Professor of Creative Writing at the Seamus Heaney Centre for Poetry, and was the first Belfast Poet Laureate. She is the author of five acclaimed collections of poetry. Her collection *Parallax* won the 2013 TS Eliot prize and was shortlisted for the 2015 National Book Circle Critics' Award. She was awarded the 2016 E M Forster Prize.



Professor Ryan Donnelly

Ryan holds the Chair in Pharmaceutical Technology. His innovative research on advanced microneedle drug delivery systems focuses on improving therapeutic outcomes for patients. Ryan was the BBSRC Innovator of the Year for 2013. He also won the GSK Emerging Scientist Award in 2012 and in 2016 was the recipient of the Controlled Release Society Young Investigator Award.

Queen’s University Fellowship Scheme

The Queen’s Fellowship Scheme was launched in 2015 to recruit outstanding postdoctoral researchers from all over the world and accelerate their careers at Queen’s. The new Queen’s Research Fellows are a global cohort, having relocated to Belfast from as far afield as Luxembourg, Canada, Australia and the USA.

Fellows have been appointed to each of the three faculties of the University. These prestigious positions will allow Fellows to concentrate on their research while developing rounded leadership skills through tailored career development training.

The first cohort have joined the University for a period of four years, after which, satisfying relevant criteria, the Fellows will be offered an academic position. As well as generous terms of employment and a competitive salary, Fellows will have access to funds to assist with start-up activities for their research of up to £40,000.

Some representatives of this first cohort are profiled below.



Dr Julie M. Norman

Julie is a Research Fellow at the Senator George J. Mitchell Institute for Global Peace, Security, and Justice. With an interdisciplinary background, her research focuses on unarmed resistance in protracted conflict, particularly in Israel-Palestine.



Dr Christoph Engl

Christoph is a Research Fellow in the Institute for Global Food Security. His research aims to find solutions to major societal challenges, such as maintenance of global food security, applying state-of-the-art molecular microbiology approaches.



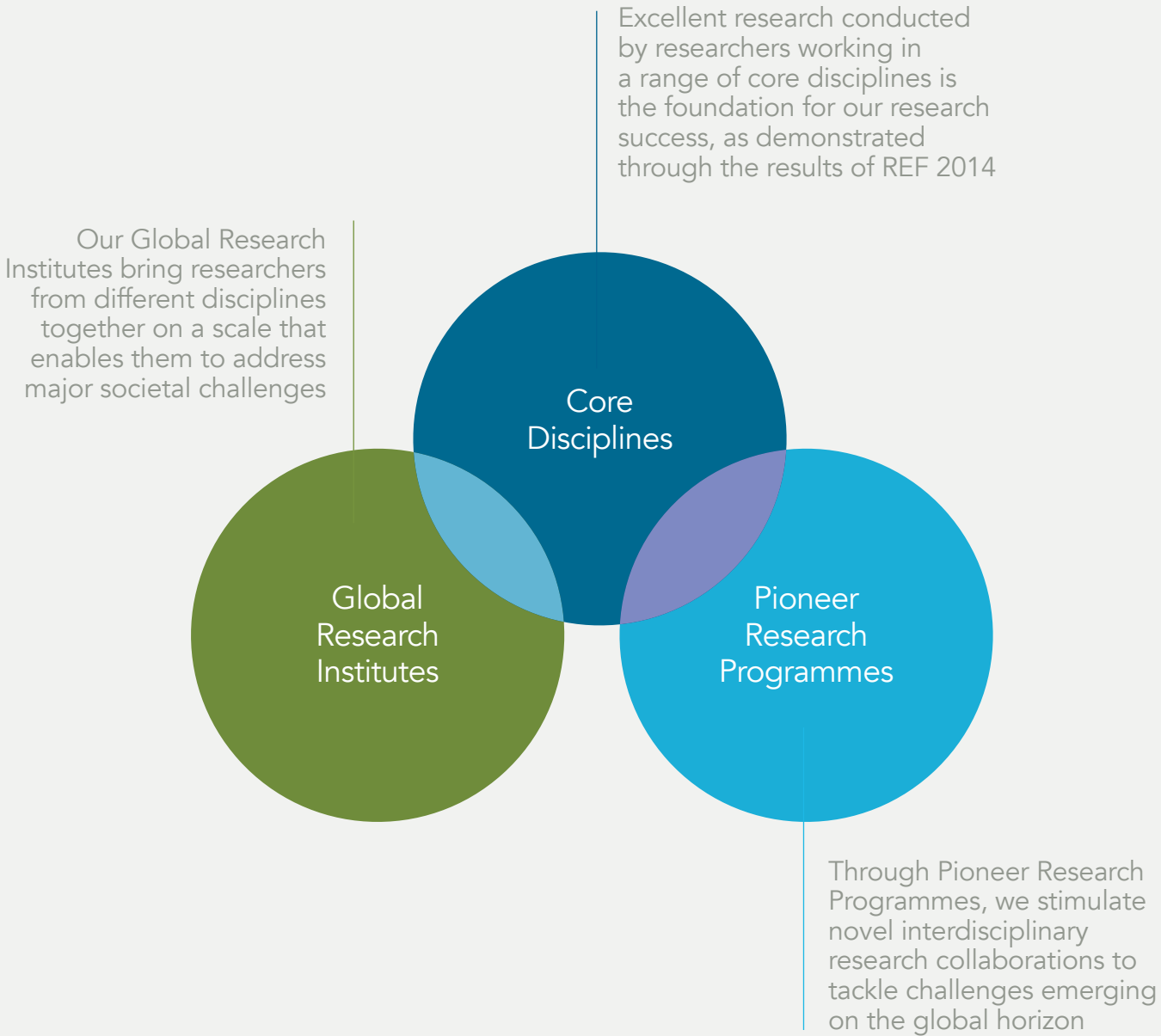
Dr Gosia Swadzba-Kwasny

Gosia is a Research Fellow in the School of Chemistry and Chemical Engineering. Her research in Green Chemistry spans fundamental studies on functional liquids, through their applications, to process optimisation and scale-up.

Research Organisation

Research at Queen's takes place in Core Disciplines, Pioneer Research Programmes and Global Research Institutes.

Each of these involves collaboration between researchers from all stages of the research career path, from postgraduate to professoriate, and links with partners at other institutions and outside the academic world.



Interdisciplinary Research Priorities

Our interdisciplinary priorities are shaped by our three Global Challenge Themes. Together they raise pressing and difficult research questions which are motivating our first cohorts of Global Research Institutes and Pioneer Research Programmes.

How can we...

...tackle cancer, respiratory conditions and eye disease that affect populations worldwide, ensuring advances can help fight a range of conditions?



...better manage risks – financial, environmental, social – to protect the most vulnerable in society?



...work with children and families in targeted, co-ordinated ways to prevent social problems that emerge later in life?



...bring together environmental and energy analysis with emerging technologies to meet the challenges of long-term energy security?



...help societies emerging from conflict resolve lingering differences, and reconcile the challenges of justice, peace and security?



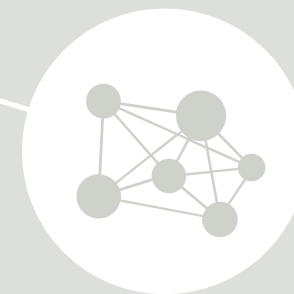
...ensure everyone has access to safe, nutritious food when the global population is growing faster than ever?



...use advanced technologies such as smart materials in drug delivery to enhance patient outcomes?



...harness advances in the fundamental understanding of radiation to improve treatments for patients with cancer?



...create smart, autonomous manufacturing systems that will make the factories of the future more productive, resilient and energy-efficient?



...deal with the challenges of collecting, storing, securing and analysing the torrent of digital data we are all generating?



Global Research Institutes

Our Global Research Institutes are flagships for interdisciplinary research in areas of major societal challenge. This initial cohort brings together a critical mass of excellent researchers from a wide range of disciplines in world-class facilities to tackle some of the greatest global issues of our age.



The Senator George J. Mitchell Institute for Global Peace, Security and Justice

Questions about peace, security and justice dominate the discourse of governments, international agencies and civil society today. How can societies emerging from violence resolve lingering grievances? How can they establish peace on a daily basis? How can the competing demands of justice, peace and security be resolved? As a society emerging from conflict, Northern Ireland continues to experience these issues close at hand and can offer insights of significant comparative value.

The Institute responds to the unprecedented global challenge of building a peaceful, secure and inclusive world, bringing together the unparalleled expertise at Queen's on these issues. It is distinctive internationally in linking

peace-making with social transformation, giving attention to the need for governance reform of state institutions alongside cultural and social processes for healing in society.

The Institute brings together Queen's researchers from fields as diverse as Politics, Mental Health, Planning and Computer Engineering, with a cross-national focus, including traditional and modern societies, and historical and contemporary cases. Through research, education and civic engagement, the Institute aims to make a difference to the lives of ordinary people who are struggling with the aftermath of conflict by empowering them to realise fairness, justice and tolerance.



The Institute for Global Food Security

The World Food Summit of 1996 defined food security as "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". At a time when the world's population is growing at a faster rate than any time in history, food security is a global challenge that pervades human health, sustainable economic development, environment, and trade.

The Institute for Global Food Security at Queen's was formed with the aim to play a major role in developing solutions to the complex problem of delivering safe, nutritious, sustainable, authentic food supplies to the world's population, and has become internationally recognised for its excellence in research and teaching.

The vision for the future is to develop an Institute that is unique in its ability to take a holistic approach to food security challenges.

The Global Research Institute will aim to encompass cutting-edge research activities right across the spectrum of food security research, going beyond the 'farm to fork' strategy to span the environment-farm-food-health-economics interactome to form a unique brand that redefines global food security research.



The Institute for Health Sciences

Cancer, respiratory conditions, eye disease and diabetic vascular complications cause ill health and early death in ill populations worldwide. Healthcare systems across the globe are struggling to cope. Queen's is bringing together its recognised expertise in these four areas through the Institute for Health Sciences, which will synergise basic science, translational technologies, clinical and population sciences research across the University.

The Institute will have three operational centres: the Centre for Cancer Research and Cell Biology, the Centre for Experimental Medicine and the Centre for Public Health. Together, these centres will exploit our state of the art technologies and purpose-built research facilities to promote

enhanced interdisciplinary collaboration and drive competitive programmatic research in partnership with the health and social care sector and local, national and global pharmaceutical and biotech industries.

The priority disease areas share many common biological processes and pathogenic mechanisms, and there are many examples of drugs developed for a defined disease that led to advances in other areas. Through focusing on common areas such as immunology, innate immune responses and aspects of infection, the Institute will enable a number of innovative programmes in international priority areas.



The Institute of Electronics, Communications and Information Technology

Our world has become increasingly digitised, affecting how we communicate, manage our finances, access healthcare and even interact with household devices. With more of our information held digitally and connected across multiple devices as well as in the cloud, significant new challenges are emerging: how can we process, transmit and secure the large volumes of information created by citizens, enterprise and government? And how can we accelerate the global adoption of resulting technical innovations to deliver economic impact?

The Institute seeks to transform Belfast into a world-leading centre of enterprise and innovation. Host to the award winning UK national Innovation and Knowledge Centre for cyber security, The

Centre for Secure Information Technologies (CSIT), the Institute also houses The Centre for Wireless Innovation which is redefining wireless communication and sensing systems, and The Centre for Data Science, and Scalable Computing, which is addressing the challenges relevant to the big data phenomenon.

At this unique research and innovation campus, recently recognised through a prestigious Queen's Anniversary Prize and the award of a rare Regius Professorship, almost 200 people, including academics, students, engineers and business development staff, work closely with world-leading companies and entrepreneurs, taking a business focused and entrepreneurial approach to research.

Pioneer Research Programmes

Our Pioneer Research Programmes enable researchers to form novel interdisciplinary collaborations to address emerging societal challenges. Seed funding is provided to support these collaborations to make rapid progress over an initial three-year timescale. Programmes may involve tens of researchers, or a small number of experts each with a distinctive disciplinary perspective, depending on the challenge in focus.



Understanding what works in tackling social problems through early intervention

Many of the social problems observed in adults – such as unemployment, criminal activity, antisocial behaviour and poor physical and mental health – are inter-related and have their origins in early life. Acknowledging this, there is an increasing international movement toward early

intervention and prevention in public policy. This programme seeks to look at evidence of what works – for families, for schools, for communities, and at the level of government policy – and to use robust evidence to find innovative solutions to pressing social concerns.



Securing sustainable, affordable energy supplies

The Sustainable Energy Research Centre will address research questions associated with energy security, affordability and sustainability. It builds on Queen's excellent track record in renewable energy conversion and storage, energy transportation, and sustainable chemical manufacturing. This multidisciplinary centre will combine blue skies and applied approaches and provide a critical mass of expertise to understand and tackle problems from supply to production in order to assess the best technology design.



Designing smart manufacturing systems for tomorrow's world

With rapid developments in the Internet of Things and its coming together with manufacturing Cyber Physical Systems, there is increasing awareness of the potential for embedding this technology in factories of the future through cooperative multi-robot and autonomous systems. The challenge

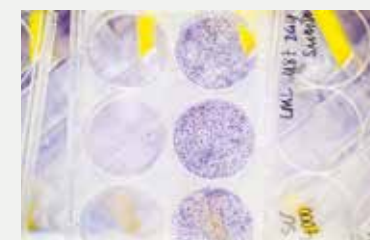
being addressed by this programme is how to design fully integrated autonomous smart manufacturing systems that can deliver a step change in capability, efficiency, flexibility, sustainability and quality, ultimately delivering more competitive and environmentally sustainable manufacturing.



Better understanding the links between risk and social inequality

Governments, companies, international organisations and public service providers spend huge budgets on the analysis and assessment of known risks, and seek to develop new risk management technologies and techniques in an effort to manage those risks. A cross-disciplinary group of researchers at Queen's is investigating the relationship between risk and

social inequality, taking as its starting point that risks of many kinds – financial, environmental, health-related – pose the greatest threat levels to low income and socially disadvantaged groups. This programme seeks to generate findings that will inform real-world risk management, developing new risk management methods and solutions.



Optimising treatment of cancer patients using radiation

Radiation is one of our most effective tools in the fight against cancer and also one of the most fundamental aspects of the universe we live in. The Centre for Advanced and Interdisciplinary Radiation Research (CAIRR) at Queen's brings together researchers who collectively have the tools and capabilities to deepen our understanding of fundamental

radiation-matter interactions and apply that understanding all the way through several layers of increasing complexity from the atom to the patient. Both experimentally and computationally the researchers are using this understanding of the chemical and biological changes possible to devise new approaches to treat cancer.



Using advanced technologies to improve healthcare outcomes

Without a holistic, "molecule to patient" approach to the development of new healthcare products, medicines can be wasted, patients can suffer avoidable adverse effects, or even go untreated. Researchers at Queen's with disciplinary backgrounds in Pharmacy, Chemistry and Engineering are working together to join up the stages involved in creating and delivering new treatments: identification of therapeutic targets, drug discovery, materials science, pharmaceutical formulation and manufacture. This approach aims to have a major impact in the care of all patients, but especially the very young and old: the populations in which medicines can present the greatest risk, but can have maximum benefit.

Impact

Impact is the demonstrable contribution that our research brings to society. This contribution may be to communities, cultures, the economy or the environment. It may enhance public policy or services, or lead to improved health or quality of life. It may take place in any geographical context.

Challenge

In 2013 the UK faced a food adulteration scandal, whereby products advertised as containing beef were revealed to contain undeclared horsemeat in proportions of up to 100%. The scandal resulted in major public concerns in the UK and Ireland.

Elliott Review into the horsemeat scandal

Professor Chris Elliott became the key expert in the British Government's response to the horsemeat scandal when he was chosen to head the most thorough independent review of food safety ever conducted in the UK. **The Elliot Review** addressed weaknesses in food supply networks and recommended measures to address them, including a Food Crime Unit. Queen's Institute for Global Food Security continues to develop and implement new methods of detecting multiple chemical contaminants in food and feed, one of the most pressing global problems for the food industry.

Challenge

Outdoor air pollution is contributing to around 40,000 deaths a year in the UK (9,500 in London alone) – mostly from vehicle exhausts. Air pollution costs the UK £15bn per year, mainly from the cost of treating respiratory diseases and heart attacks caused by pollution.

Driving forward London's transport future

Technology at Queen's is reducing this pollution. A collaboration between local business Wrightbus (Wrights Group) and a Queen's research team led by Professor Roy Douglas has resulted in the design of the new eco-friendly hybrid diesel-electric bus which won the **New Bus for London contract – 'The Boris Bus' – worth £230m**. The full fleet has twice the fuel economy of a standard diesel and will reduce harmful emissions by 57% and an astounding 230,000 tonnes of CO2 every year.

Challenge

Prescribing in nursing homes for older people has long been problematic. The overuse of psychoactive medications that are not clinically-indicated have been used to sedate and subdue older people. Such drugs lead to complications, such as strokes, if taken long-term.

Nursing home care: from observation to intervention

Research led by Professor Carmel Hughes in collaboration with colleagues in the USA found that 20% of elderly people in care homes were given antipsychotic drugs compared to 1% who were living in the community. The research resulted in the development and implementation of **the Fleetwood Model**, a pharmacy intervention service in which pharmacists work directly with nursing home staff, which has led to a reduction in the inappropriate prescribing of psychoactive medications.

Challenge

Children and adults with physical disabilities and learning difficulties lack access to technologies and equipment which allow them to compose and perform their own music independently.

Performance without barriers: new musical interfaces for disabled musicians

An exciting collaboration between Queen's Sonic Arts Research Centre and Drake Music - the **"Big Ears project"** - has opened up new possibilities for musicians with disabilities. Composition and performance skills are enhanced by using adapted computer interfacing technology, so that physical and cognitive abilities are matched to an appropriate gestural interface, allowing people with disabilities the opportunity to express their creativity in an independent and controllable environment.

Challenge

For centuries the justice system has struggled with the certainty with which courts convict or acquit those accused of serious crime in the absence of eyewitness testimony or other evidence.

Investigating crime: geoforensics at work

A geoforensics team, led by Dr Alistair Ruffell, advises law enforcement organisations worldwide on **improving evidence collection from the landscape at crime scenes**, helping to gather, analyse and test evidence during investigations. The team looks at the geophysics of graves, detection and excavation of toxic waste dumps and the spatial analysis of criminal activity using GIS technology. This unique approach has been used in 70 serious crime and 21 environmental crime cases.

Challenge

In 2012 2,644 children were looked after in NI. This equates to 44 per 10,000 children compared with 37 per 10,000 in England. Looked-after children do less well than their peers on a range of educational, health and social outcomes.

Improving outcomes for looked-after children

Professor John Pinkerton's research in social work and social policy has changed the way in which policy makers and practitioners think about the care system. The research has helped to improve the **stability and quality of the placements** provided to looked-after children and the support given to them when they leave care.

The UK's leading institution for research commercialisation

Queen's is a powerhouse of invention. We are the highest-performing university in the UK for revenue generated from intellectual property, and have created around 1,700 jobs through our spin-out companies.

47
spin-out companies
still active

1,700
jobs created

£190m
current turnover

£75m
total external
investment

1st in the UK
for IP revenues, achieving
£34.5m in 2014-15

External
commercialisation
funds of
c. £10m
per annum

Kainos

Kainos Software Ltd, a portfolio company of the University's commercialisation entity QUBIS Ltd, **listed on the Main Market of the London Stock Exchange in July 2015** with a market capitalisation of **£225m**.

Kainos, founded in April 1986, is a **high-growth UK-based provider of IT services, consulting and software solutions**. Headquartered in Belfast, the company provides approximately 730 jobs across its seven offices. The majority of these posts are highly skilled IT professionals and provide **a direct benefit to the local economy**.

Kainos is also a **global player** and has offices in the US, Poland, Republic of Ireland and the UK. Its customers include blue chip corporates such as Diageo and Netflix; and UK Government departments and agencies. It is the UK market leader in providing ERDM solutions to the NHS.

Queen's retains a strong partnership with Kainos at a number of levels, and continues to supply high-tech graduates to the company and to work on collaborative research and development projects.



Spin-out company
Andor Technology
purchased for
£176m by
Oxford Instruments
in 2013

Innovative
micro-incubator
facility launched
in 2014 and
currently at
full capacity

Over
**30 invention
disclosures**
each year

Four consecutive
awards from the
prestigious MRC
Confidence in
Concept initiative
worth £1.2m

Partnerships

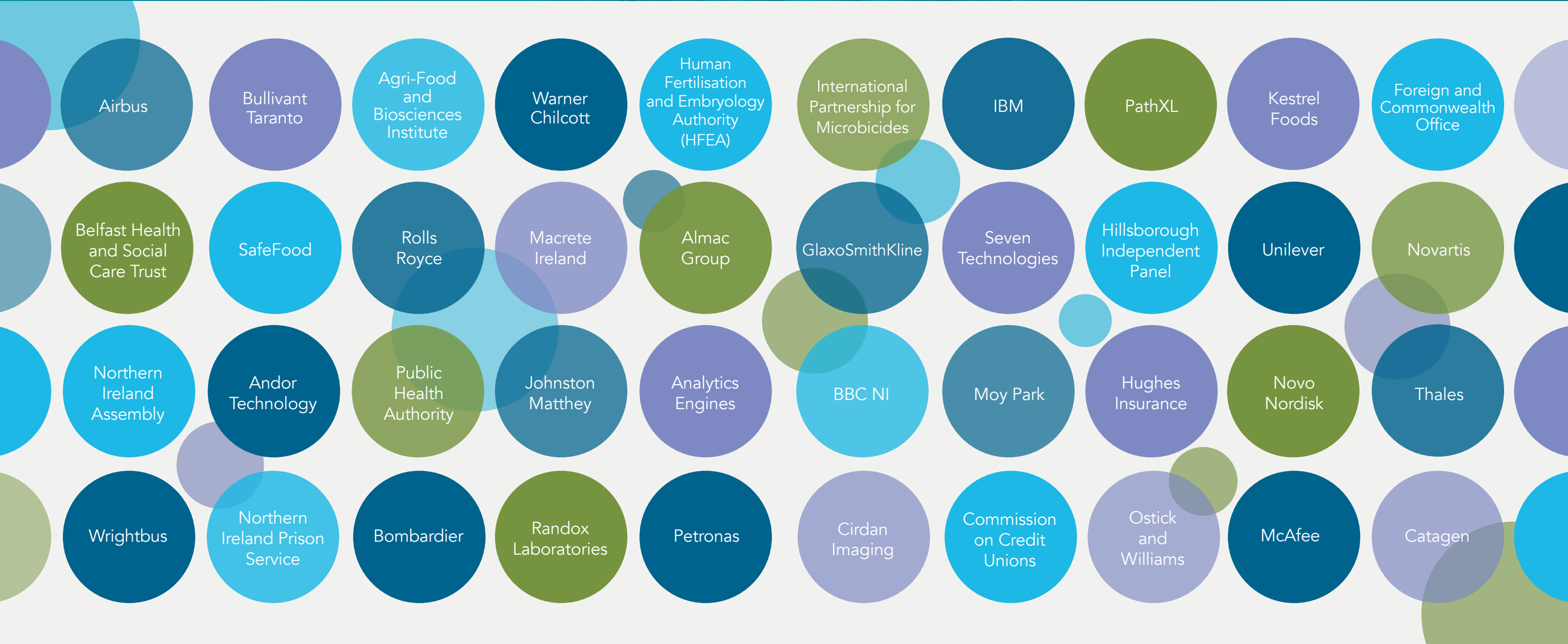
Queen's researchers partner with organisations large and small, local and international, and across the public, private and third sectors. Working together to share knowledge, insight and facilities enables us to produce world-class research that brings greater commercial, economic, societal and cultural benefits.

£100m
in collaborative
research income
(HEBCIS, 2010-2015)

£75m
in contract
research income
(HEBCIS, 2010-2015)

3,670
consultancy projects
supporting the
development of
regional SMEs
(HEBCIS, 2010-2015)

350
successful Knowledge
Transfer Partnerships (KTP)
leading to careers for
400 graduates



Global Connections



Queen's University
Belfast

50 projects
co-ordinated
under Framework
Programme 7

**32 new
Horizon
2020 grants**
awarded to date

**24th most
international
university in
the world**
(Times Higher Education 2016)

**52.7% papers
co-authored**
with institutions in
other countries

Europe

Providing the next generation of secure cryptographic solutions for ICT through the €3.8m SAFEcrypto (Secure Architectures of Future Emerging Cryptography) collaboration. The project is the brain child of Professor Maire O'Neill (Centre for Secure Information Technologies) and involves multiple partners across Europe.

Developing technologies to accelerate the remediation of contaminated sites through the REMEDIATE consortium, a €3.7m Innovative Training Network co-ordinated by Queen's. The Network will recruit Early Stage Researchers from across Europe.

12 cross-border collaborations worth £7m under the Investigators Programme jointly funded by the Northern Ireland Executive and Science Foundation Ireland.

Americas

Forging new academic partnerships in Sao Paulo through our new joint mobility and planning collaboration with FAPESP (Sao Paulo Research Foundation).

Understanding how the built environment can promote healthy urban living in Brazil through a major 3-year inter-disciplinary project led by Professor Geraint Ellis and supported by the ESRC/Newton Fund.

Tackling diabetes related blindness, as part of a €2.25m US-Ireland R&D partnership, with collaborators at the University of Utah and Dublin City University.

Co-ordinating UK input into the world's largest solar telescope. Queen's Astrophysics Research Centre is leading the UK consortium developing cameras for the Daniel K. Inouye Solar Telescope being constructed by the US National Solar Observatory in Hawaii.

Leading participatory projects involving communities in Belfast and favelas in Maré, Rio de Janeiro, resulting in sound art exhibitions at venues such as the MAC Belfast, Espaço Ecco in Brasília and Parque Lage and Museu da Maré in Rio.

Asia

Investigating sustainable intensification of agriculture in China, led by Professor Andy Meharg, and supported by the Newton Fund initiative.

Tackling climate change through Intelligent Grid Interfaced Vehicle Eco-charging (iGIVE), partnering with Harbin Institute of Technology and State Grid Electric Power Research Institute in China

Providing safer energy through mercury-free natural gas as part of the long-standing partnership between Queen's ionic liquids laboratory, QUILL, and Malaysian petro-chemical giant Petronas.

Working with world leading IT corporation Infosys through our Centre for Secure Information Technologies (CSIT) to develop solutions and intellectual property for combatting cyber-security threats.

Africa

Reducing global crop loss in the developing world through trials in Kenya of technology being developed by Dr Jonathan Dalzell with \$1m of support from the Bill and Melinda Gates Foundation.

Improving child growth outcomes. Further support from the Bill and Melinda Gates Foundation is supporting Queen's researchers in the School of Biological Sciences to identify the mechanism by which aflatoxin exposure causes child stunting in the first two years after birth.

Preventing HIV AIDS through trials with thousands of women in Africa of a novel drug delivery device initially developed by Queen's Pharmacy Professors David Woolfson and Karl Malcolm.

Postgraduate Research

The Graduate School

The newly opened state of the art Graduate School, is home to Queen's postgraduate community. It is a central pillar of the University's Vision to create a vibrant and ambitious postgraduate and postdoctoral culture across the University, with significant increases in postgraduate taught, postgraduate research and postdoctoral numbers ahead.

This extensively refurbished space has new meeting rooms, study areas and social spaces, creating a vibrant hub for intellectual exchange and collaboration. Integrating the needs of Masters students and PhD researchers, The Graduate School caters for the differing needs of lab-based, international, full-time and part-time students, as well as students with disabilities.

Queen's Doctoral Training Centres

The £11.2m **Northern Bridge project**, funded by the Arts and Humanities Research Council (AHRC), is part of a national network of Doctoral Training Partnerships which brings together the cutting-edge expertise and exceptional resources of Queen's, Newcastle University, Durham University and their partners for the training and development of outstanding Arts and Humanities postgraduate researchers.

The new £8.1m **Centre for Doctoral Training in Photonic Integration for Advanced Data Storage** at Queen's, in collaboration with the University of Glasgow and funded by the Engineering and Physical Sciences Research Council (EPSRC), will address a skills shortage in the photonics industry and develop new products and systems to address the expanding data storage needs of today's fast-moving digital world.

Queen's is one of 12 partner universities involved in the **AHRC Centre for Doctoral Training in the Celtic Languages**. Also involving collaboration with BBC Northern Ireland, the National Library of Wales and Bòrd na Gàidhlig, the Centre will provide funding for 26 PhD awards across the partnership between 2014 and 2019. The Centre supports doctoral research and training in Celtic languages, literatures and cultures.

The new £1m **Leverhulme Interdisciplinary Network on Cybersecurity and Society (LINCS)**, a collaboration between the **Centre for Secure Information Technologies** and the **Senator George J. Mitchell Institute for Global Peace, Security and Justice**, will provide 30 doctoral students with three-year scholarships over the next seven years, working at the interface between the social sciences and electronic engineering.

Enablers

Achieving the ambition of our Research Strategy and continuing to deliver outcomes that address global challenges requires a strong portfolio of research funding and ongoing investment in our researchers and the services and facilities that support them. Since 2010 we have increased our research awards by 49%, including an 86% increase in EU awards. We also have in place a major programme of investment in research support and infrastructure.

Infrastructure

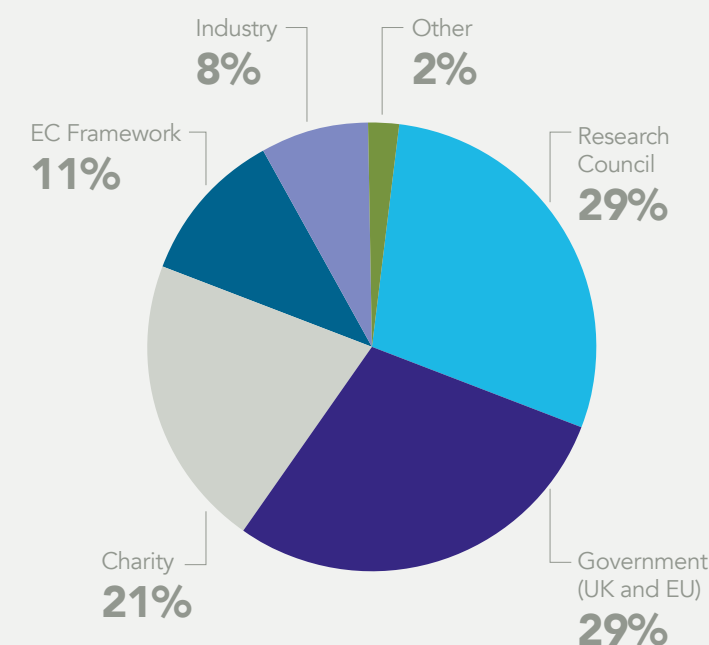
Over the past decade we have invested almost £350m in infrastructure initiatives to deliver a world class environment for our staff and students. This has included:

- The Centre for Experimental Medicine – funded by a £32m UK Research Partnership Investment Fund award
- The Institute of Electronics, Communications and Information Technology, based in the heart of the Northern Ireland Science Park
- The award-winning McClay Library and state of the art Graduate School

But we're only half-way there. Over the next decade we will invest at least a further £350m to meet our strategic priorities. This will include:

- New homes for the School of Law and School of Biological Sciences
- Cutting-edge facilities for Computer Science

Research Funding Portfolio (2010-2015)



Professional support

Researchers at Queen's have access to a wide-range of support services across Faculties and professional support units.

In recent years the University has made a **series of significant investments** in its professional support for researchers, which included the launch of a newly formed Research and Enterprise Directorate in 2012.

The University will **commit to further significant investment in research support during the period 2016-2021**, including specialist support in priority theme areas and dedicated staff to support research impact, application development and partnership building.



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