Imperial College London

Collaborating with the best

The value of the European Research Council to UK science

Professor Alice Gast
President, Imperial College London

The long and rich history of scientific cooperation between the UK and our European neighbours has been beneficial to all partners and to scientific progress as a whole.

While this cooperation dates back hundreds of years, there is no doubt that the EU's framework programmes for research and innovation have, since their creation in 1984, greatly deepened our scientific collaboration and revolutionised how science is done at an international level.

The EU is the UK's largest and fastest growing collaborator in research; over half of the UK's international publications are with European partners. The current Horizon framework programme represents the only international research scheme of scale anywhere in the world and is unrivalled in the access it provides to extensive networks of collaboration. It has delivered tangible benefits for the general public by leading to new technologies and products, in everything from cancer treatments to improved solar technology and developing self-driving vehicles.

The European Research Council (ERC) was created in 2007 to fund the best scientists for cutting-edge research at the frontiers of knowledge in the top of their field. Grants are awarded to the individual researcher, regardless of where they are from, and holding a grant allows a researcher to move to the best place for their work anywhere in Europe. Over the last thirteen years, ERC grants have become established as the most prestigious grants in Europe, and among some of the most respected in the world.

From the start, the UK has been disproportionately successful at winning ERC grants. At Imperial, funding from the ERC has played a significant role in supporting pioneering research in STEM, medicine and business. Around 60% of our total income from Horizon 2020 comes from ERC and Marie-Skłodowska Curie Actions, which provide grants for world-class researchers to work abroad. These sources have brought a wealth of talent to Imperial, contributing to critical mass in key science fields. This booklet sets out some of the exciting and crucial research at Imperial that ERC funding has supported across a range of disciplines, leading to breakthroughs which have had – or will have – profound benefits for patients, service users, and science as a whole.

Due to the prestige of its grants, ERC funding greatly enhances the international profile of UK researchers. As well as leveraging further funding from other international sources, these case studies show how ERC grants unlock access to networks of research collaboration at a global level and create new links with academics in world-class institutions in the EU and beyond.

Nearly half of all publications which Imperial has co-authored with organisations outside of the EU between 2014 and 2019 also have at least one co-author from an organisation within the EU. The future of science, and our success in solving global challenges, will depend on such international cooperation. The COVID-19 crisis has particularly demonstrated the value of collaboration, as well as the importance of world-leading frontier research to our future health and prosperity.

As the UK looks to negotiate a new partnership with our European neighbours and navigate the next phase of the pandemic, it is crucial that we consider the importance of maintaining and strengthening links which have benefitted UK science so much over the last few decades. To ensure our success as a science superpower in the future, the UK must continue to be at heart of the ERC.

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President, Imperial College London

Case Studies

"I am exceptionally grateful for the long-term support that the ERC has provided me with since the early days of starting my independent group. Its support has been essential in helping us to build an internationally recognised vibrant research activity."

– Professor Molly Stevens

Professor Molly Stevens

Faculty of Engineering, Department of Materials

Nanozymes Proof of Concept

ERC Grants: Starting Grant (2007); Proof of Concept (2011); Consolidator Grant (2013); Proof of Concept (2017); Proof of Concept (2019)

ERC Funding: €1,643,021; €147,918; €1,999,460; €148,646; €150,000

Professor Molly Stevens has been supported throughout her career by the ERC and now leads a research group made up of academics from over 25 countries. Together they use transformative bioengineering approaches that will overcome severe limitations in current materials in two main areas: Biosensing and Regenerative Medicine.

The emerging field of point-of-care diagnostics is working on cheaper, faster and easier to-use tests. Innovations in the design and development of nanomaterials-based biosensors could be used to detect diseases such as cancer, malaria, heart failure and tuberculosis.

Professor Stevens and engineers at MIT recently developed a simple and sensitive urine test, which produces a colour change in urine to signal growing tumours in mice. Her team now working to increase the specificity and sensitivity of the sensors by testing them in more animal models. In the future the test could help diagnose cancer patients in developing areas where there is limited medical infrastructure and reduce the need for expensive equipment and trips to the clinic.

ERC funding has been essential in ensuring Professor Stevens' research is at the cutting-edge of her field, supporting her in building international networks with other world-leading academics, including through her election as a foreign member of the US National Academy of Engineering.

"The ERC grant's prestige has helped me to attract funding and build exciting new collaborations in the area of renewable energy conversion and storage with industrial partners in the EU and non-EU partners."

– Dr Qilei Song

Dr Qilei Song

Faculty of Engineering, Department of Chemical Engineering

Design and nano-engineering of microporous membranes for energy storage

ERC Grant: Starting Grant (2019)

ERC Funding: €1,499,871

Dr Qilei Song is researching next-generation cost-effective redox flow batteries – large energy storage devices which could power cities – in collaboration with institutions in the UK, EU and China.

A typical flow battery consists of two tanks of electrolytes which are pumped past a membrane held between two electrodes. The membrane separator allows ions to transport between the tanks while preventing the cross-mixing of the electrolyte solutions.

Dr Song will design and manufacture next-generation low-cost ion-selective membranes, based on nanoporous polymers with well-defined porosity and ion-conductive functionality. Highly conductive and selective membranes will improve the efficiency and lifetime of flow batteries for energy storage.

This research aims to accelerate developments in renewable energy, mitigate climate change and solve the mismatch between intermittent supply of renewable energy and the variable power grid.

"My research has built a network of partners within and outside the EU. Currently, my collaborators include academics located at Imperial, the Universities of Bristol and Lancaster and the Institute for Fiscal Studies in the UK, Harvard and MIT in the USA, and Monash University and University of Queensland in Australia."

– Professor Carol Propper

Professor Carol Propper

Imperial College Business School, Department of Economics and Public Policy

Empirical evidence on the impact of the labour market on the production of healthcare and health

ERC Grant: Advanced Grant (2017)

ERC Funding: €1,487,748

Professor Carol Propper's project aims to increase our understanding of the behaviour of public service providers. The focus is on providers – medical professionals – in the healthcare sector. To do this, she is investigating themes such as what determines the quality of public services, how shocks to the economy affect the delivery of public services, why there is such variation in the quality and efficiency of public service providers and the role that networks play in the spread of medical innovations.

Understanding how labour markets in healthcare operate is crucial to securing value for money in public investment and ensure high-quality public services as well as advancing our scientific understanding of these labour markets. She will be studying this in the context of several different healthcare systems.

This research builds on many years of Professor Propper's research on this and related topics, seeking to understand how we can improve the operation of public services and services delivered by the state. Her research on this theme includes a study of the use of team based pay to improve public service delivery, the benefits and costs of using targets for government agencies and their employees, the impact of wage regulation on death rates in hospitals and the effect of financial incentives on referral patterns of doctors.

"I have received ERC funding for my research for the last ten years. This support has been the most beneficial source of funding for my career, having allowed me to explore breakthrough ideas in high-risk research projects."

– Professor Dario Farina

Professor Dario Farina

Faculty of Engineering, Department of Bioengineering

From neurons to robots: non-invasive, general-purpose interfacing with human spinal motor neurons

ERC Grants: Proof of Concept (2016); Synergy (2018)

ERC Funding: €150,000; €9,984,021

Professor Dario Farina is a world leader in man-machine interfacing and prosthetic technology and has recently received an ERC Synergy Grant to lead a project, in collaboration with the Medical University of Vienna and Italian Institute of Technology, to develop bionic limbs which give the user a sense of touch. Synergy Grants are some of the most highly-coveted grants available, enabling small groups of Europe's best researchers to collaborate from across disciplines in cutting-edge science.

This project builds on Professor Farina's earlier work in prosthetic technology which was supported by previous ERC grants. In his last project at Imperial which was funded through an ERC Proof of Concept grant, his research group developed an arm that patients could move at will, by using a sensor to pick up movement from muscles in a stump and convert them into commands for the arm.

His current research project aims to build on this breakthrough to create a system which allows a person to both 'feel' and control a robotic limb by connecting muscle and skin tissues to electrodes.

This project represents the first initiative to combine the separate disciplines of neuro-interfacing, neurosurgery and robotics. This cutting-edge approach is helping to bridge the gap between academic research and clinical impact, to create new devices which will greatly benefit the quality of life of people who have lost a limb.

"The ERC starting grant has truly kick started my group's research. By providing unique funding for the setup of my own microscopy suite, it allowed us to truly push the boundaries of what we could observe and therefore to tackle the most challenging questions. This funding allowed me to implement my vision of using intravital microscopy to investigate the fundamental principles regulating haematopoietic stem cell biology."

– Professor Cristina Lo Celso

Professor Cristina Lo Celso

Faculty of Natural Sciences, Department of Life Sciences

In vivo imaging of haematopoietic stem cells in their natural niches to uncover cellular and molecular dynamics regulating self-renewal

ERC Grant: Starting Grant (2013)

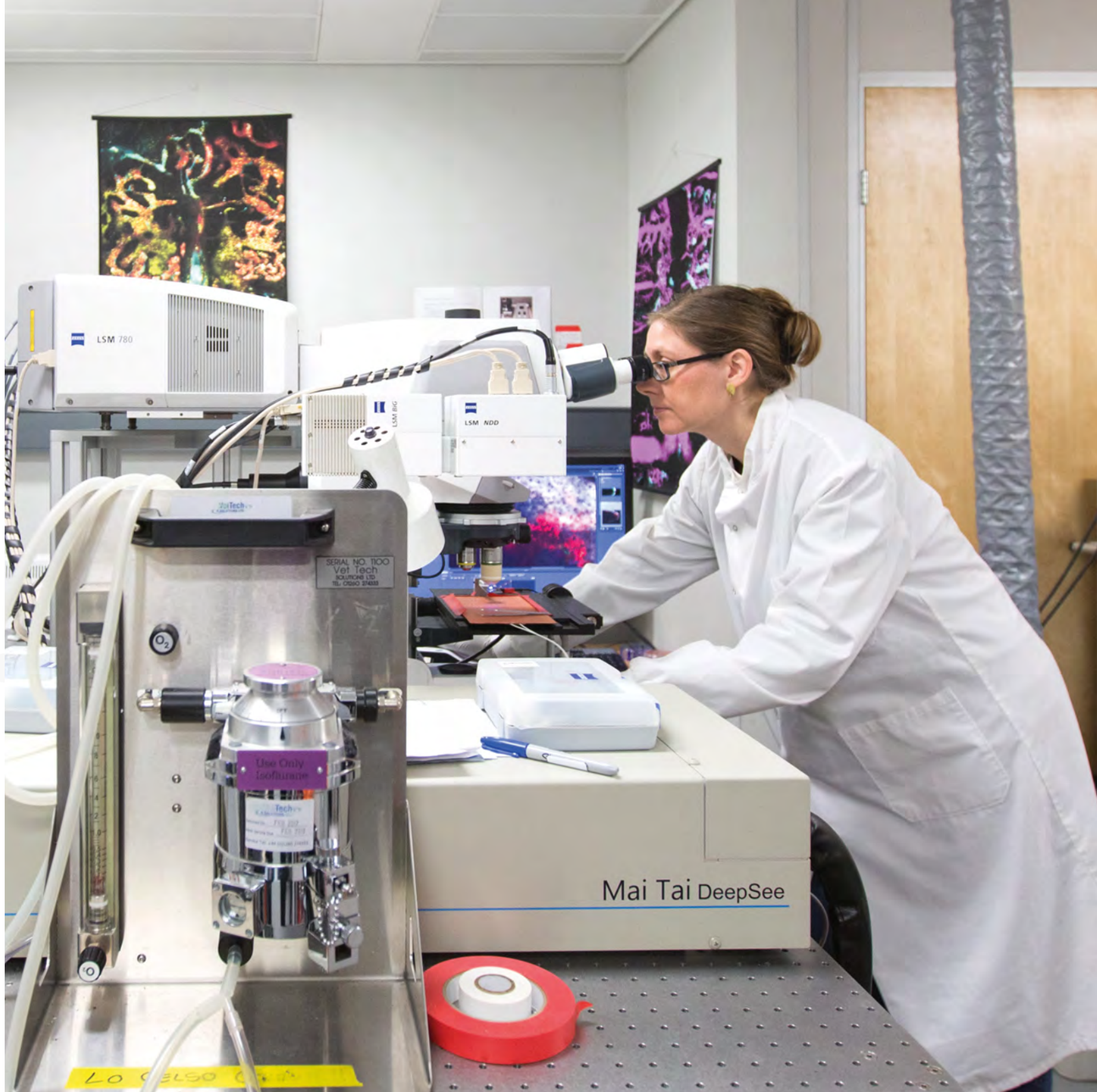
ERC Funding: €1,699,724

Professor Cristina Lo Celso's research is focused on understanding stem cells in bone marrow – which are important to maintain and regenerate the immune system and blood cells – and to use this to improve treatment of leukaemia and infection. In 2013, she received an ERC Starting Grant to support this research.

Since receiving the grant, Professor Lo Celso has made several ground-breaking discoveries, from uncovering changes in the behaviour of blood stem cells during infection, to making significant progress in understanding where stem cells reside in the bone marrow. She has also made unexpected discoveries about how leukaemia cells move throughout bone marrow and destroy vital stem cells, and how severe infections do the same.

She was awarded a Royal Microscopical Society Medal for Life Sciences for her "outstanding scientific achievements applying microscopy in the field of cell biology" in 2018, citing her "paradigm-shifting contributions" to her field. Amongst other honours, she was the first woman to receive the prestigious Foulkes medal in 2017.

Support from ERC has benefited Professor Lo Celso in building strong international links, including with researchers at the University of Porto and University of Coimbra in Portugal, and Maynooth University in Ireland, with her ERC-funded research leveraging further funding from the Royal Society to collaborate with the latter partner.



“Put simply, an ERC award is by some margin the best single investigator grant any young academic could hope for, with funding magnitude, project duration, and research freedom which are second to none! International prestige is a key outcome of ERC funding and I would unequivocally say that the connections I secured through this research have been instrumental in my progress to be an international leader in my field.”

– Professor Ferdinando Rodriguez y Baena

Professor Ferdinando Rodriguez y Baena

Faculty of Engineering, Department of Mechanical Engineering

STING – A soft tissue intervention and neurosurgical probe

ERC Grant: Starting Grant (2010)

ERC Funding: €1,499,353

Professor Ferdinando Rodriguez y Baena is Professor of Medical Robotics in the Department for Mechanical Engineering. He has developed a prototype robotic needle which is flexible enough to curve – enabling it to get to hard-to-reach places deep in tissue, for example for drug delivery in neurosurgery.

Professor Rodriguez y Baena was first awarded an ERC Starting Grant for this research in 2010. Building on this research, he won further Horizon 2020 funding for a project with seven partners, including manufacturers, across Europe to develop this basic research into patient-specific neurosurgical applications. In 2019, the team successfully performed their first preclinical flexible needle insertion in Italy.

This work delivers significant impact for the scientific community, with the promise of better outcomes for patients through making minimally invasive procedures safer and more effective.

As a result of his ERC-funded research, Professor Rodriguez y Baena now represents the UK in two current European Commission networks, Terrinet and DIH-HERO, which have been important schemes in building research links across Europe.

"We are very excited to receive this grant as it will give us the time and resources needed to explore critical research questions related to advanced materials for solar energy production, questions that have really sparked our curiosity in recent years. My team is at an early stage of our research, but it is clear that the 'ERC stamp' has already made our work more visible to researchers beyond our exact field of research."

– Dr Camille Petit

Dr Camille Petit

Faculty of Engineering, Department of Chemical Engineering

Design and engineering of porous nitride-based materials as a platform for CO2 photoreduction

ERC Grant: Starting Grant (2019)

ERC Funding: €1,498,934

Dr Camille Petit from the Department of Chemical Engineering is aiming to diversify our energy portfolio by converting CO2 into a valuable fuel by using sunlight. Her team are using ERC funding to develop a radically new class of photocatalysts – materials which absorb light and trigger a chemical reaction.

This project focuses specifically on unveiling the photochemistry of a poorly understood photocatalyst, porous boron nitride, and learn how to control its properties. This process aims to take carbon dioxide, the most abundant greenhouse gas, and react it with sunlight to produce chemical fuel. Such new fuels will be essential to tackling climate change and meeting the UK's target of reducing greenhouse gas emissions to net zero by 2050.

"The ERC provides a unique opportunity to focus on challenging questions and collaborate with outstanding scientists worldwide."

– Dr Claudia de Rham

Professor Claudia de Rham

Faculty of Natural Sciences, Department of Physics

Massive gravity and cosmology

ERC Grants: Consolidator Grant (2016)

ERC Funding: €1,975,829

Professor Claudia de Rham's research focuses on exploring the interface between particle physics, gravity and cosmology. In 2016, she was awarded an ERC Consolidator Grant for a project which aims to revolutionise our understanding of the fundamental building blocks of the universe. The ambition of her research programme is to challenge current understandings of gravity and 'dark energy', and to pave the way towards a potential resolution of one the most tantalising problems of physics today: The Old Cosmological Constant Problem.

The Old Cosmological Constant Problem emerges from the significant discrepancy – by 120 orders of magnitude – between predictions about how fast the universe's acceleration should be increasing based on current theories and what is actually observed in reality. This conundrum has driven the development of dark energy as an explanation for acceleration, but many of these theories suffer from similar discrepancies.

Professor de Rham proposes a distinct way to address this dilemma and to explain the acceleration of the universe through massive gravitons, which are theoretical particles carrying gravitational force. If successful, her research could answer a problem which has puzzled scientists for decades and would lead to a fundamental rethinking of the universe which will have implications for the whole of physics.

"In addition to all the exciting scientific opportunities it affords, the ERC Consolidator Grant has provided me with greater recognition amongst scientists who are outside my field of research. The ERC grant has helped me boost my international profile as a researcher and I have now been invited to join onto consortia for proposals directly related to the topic of my ERC project, opening up further funding opportunities from both the EU and the National Research Council of Canada"

– Dr Ifan Stephens

Dr Ifan Stephens

Faculty of Engineering, Department of Materials

Electrochemical scission of dinitrogen under ambient conditions

ERC Grant: Consolidator Grant (2019)

ERC Funding: €2,744,880

Dr Ifan Stephens is studying the synthesis of ammonia, the world's most commonly produced chemical, used primarily for fertilisers. Ammonia is currently produced in large quantities at centralised facilities, at extremely high temperatures and pressures.

Current processes for synthesising ammonia are estimated to be responsible for 1% of global CO_2 emissions, approximately half the emissions of the global aviation industry. Dr Stephens' team is working to better understand the fundamental science behind ammonia synthesis to enable alternative, greener ways of producing the chemical.

Being able to produce it with electrochemical methods, at ambient temperatures and pressures, would mean it could be synthesised with renewable energy and locally, on site. This would greatly impact agriculture in developing countries, which currently lack the infrastructure to transport fertilisers to the point of consumption. If you could make the process efficient enough, you could even use ammonia as an emission-free fuel.

“I have been exceptionally fortunate to have received a number of ERC grants in the past. They have all made exceptional impact in my career and facilitate the blue skies research that can transform patients’ lives.”

– Professor Joshua Edel

Professor Joshua Edel

Faculty of Natural Sciences, Department of Chemistry

High throughput multiplexed trace-analyte screening for diagnostics applications

ERC Grants: Starting Grant (2011); Proof of Concept (2015); Consolidator Grant (2016); Proof of Concept (2019)

ERC Funding: €1,497,620; €149,990 ; €1 997 680; €150,000

Joshua Edel, Professor of Biosensing and Analytical Sciences at the Department of Chemistry is developing novel ways to diagnose diseases earlier by detecting biomarkers in blood and urine. He has won four ERC grants for his pioneering work between 2011 and 2019.

These grants have enabled him to perform initial studies on developing strategies to detect biomarkers at ultra-low concentrations in biological fluids such as blood and urine. Their presence, or changes in their concentration, can be indicators of disease. Often rare, these biomarkers can be difficult to detect in the early stages of disease.

His latest ERC Proof of Concept grant will provide the resources required to develop a novel and inexpensive point-of-care diagnostic tool with real potential to improve patient care, survival rates and quality of life.

“This project demands a synergetic approach among us and our European counterparts. The European funding is crucial to its success as it enables us to pool together expertise, tools, methods, and collaborator networks to achieve the goals of the research”

– Professor Darryl Holm/Professor Dan Crisan

Professor Darryl Holm/ Professor Dan Crisan

Faculty of Natural Sciences, Department of Mathematics

Stochastic transport in upper ocean dynamics

ERC Grant: Synergy Grant (2019)

ERC Funding: €9,998,875

Professor Darryl Holm and Professor Dan Crisan, from the Department of Mathematics, have received an ERC Synergy Grant to partner with two French national laboratories, Inria and Ifremer, to model and analyse high-resolution satellite images and computer simulations to better understand the dynamics of the upper ocean.

It is essential for humanity to understand the response of upper ocean dynamics to climate warming. This is a huge challenge that transcends the boundaries of mathematics, physics, chemistry, biology, meteorology and climatology.

The results of the project will provide ways to measure the effects of local patterns of sea level rise, heat uptake, carbon storage and change of oxygen content and pH in the ocean. The results of the project could also improve scientific understanding for tracking oil spills and marine debris and plastic accumulation in the sea.

“Having long term major funding such as that provided by ERC Advanced Grants is vital for retaining teams of highly skilled researchers to permit fundamental research questions to be answered”

– Professor Sebastian Johnston

Professor Sebastian Johnston

Faculty of Medicine, National Heart and Lung Institute

Mechanisms of adverse effects of beta-agonists in asthma

ERC Grants: Advanced Grant (2008); Advanced Grant (2017)

ERC Funding: €2,497,761; €2,499,999

Asthma is the most common chronic respiratory disease and in many countries its prevalence continues to rise. Professor Sebastian Johnston from Imperial’s National Heart and Lung Institute is at the forefront of research into the disease and has been awarded two ERC Advanced Grants to help with this work.

In 2008, Professor Johnston was awarded an Advanced Grant for a study related to rhinovirus (the common cold virus) infection, the major cause of asthma attacks and therefore a major cause of asthma mortality, morbidity and healthcare costs. The project explored the potential for new approaches for the treatment and prevention of virus-induced asthma exacerbations, a disease area where there is a major unmet current clinical need, using both human and mouse models.

This Advanced Grant has so far led to publication of more than 50 manuscripts reporting significant advances in our understanding about the interactions between asthma and rhinovirus and have led to human clinical studies into several possible new treatments for patients.

He is now leading a team funded by his second Advanced Grant to benefit asthma patients by examining the adverse effects of beta2 agonists, which are medications universally used to treat asthma. The mechanisms of these adverse effects are currently not understood, and it would lead to significant improvements in asthma morbidity and mortality if a way to prevent the inflammatory effects of beta2 agonists was developed. His team are using state-of-the-art methods to study the mechanisms of airway inflammation induced by these treatments and to identify ways to prevent these adverse effects, with the potential to substantially improve outcomes for asthma patients.

"I can say from my experience that being an ERC grantee gives kudos to my research and greatly facilitates collaboration with other academics across disciplines, both nationally and around the world."

– Professor Guillermo Rein

Professor Guillermo Rein

Faculty of Engineering,
Department of Mechanical Engineering

Reducing the burden of smouldering megafires: an Earth-scale challenge

ERC Grants: Consolidator Grant (2015)

ERC Funding: €1,958,900

Professor Guillermo Rein of the Faculty of Engineering leads the HAZE project and specialises in research focusing on various aspects of urban fires and wildfires.

Smouldering megafires destroy essential peatland ecosystems and are responsible for 15% of annual global greenhouse gas emissions. Peat fires also lead to surges of respiratory illness in local populations, disrupt shipping and aviation routes for long periods and accelerate climate change. Despite their importance, there is limited understanding of how smouldering fires ignite, spread or extinguish, which impedes the development of any successful mitigation strategy.

Professor Rein is creating technology that will reduce the burden of smouldering fires, through better understanding of peat fires, computer models to simulate spreading of fires, and prevention and quick detection systems.

Given the growing threat of extreme weather and the global climate crisis, Professor Rein's research has never been more important, providing an opportunity to tackle a significant source of greenhouse gas emissions around the world.

"Continued ERC funding has provided both the long-term financial support and scientific freedom to take scientific risks, leading to entirely new findings. Our latest paper is the result of over seven years of work!"

– Professor Irene Miguel-Aliaga

Professor Irene Miguel-Aliaga

Faculty of Medicine,
Institute of Clinical Sciences

Sex differences in intestinal plasticity

ERC Grants: Starting Grant (2012); Advanced Grant (2017)

ERC Funding: €1,499,740; €2,485,217

Professor Irene Miguel-Aliaga is Professor of Genetics and Physiology and Programme Leader and Chair of the Genes and Metabolism Section at the MRC London Institute of Medical Sciences.

She has won ERC Starting and Advanced Grants to explore how our brains and guts communicate. Using fruit flies and mice, her research is pioneering understanding of the mechanisms by which organs sense and respond to change: the molecules, cellular events and physiological adaptations involved. Her current ERC Advanced Grant explores how the intestine differs between males and females, and how these intestinal sex differences differentially impact our response to disease and injury.

Sex differences have been historically neglected in this field, despite increasing realisation that males and females differ in their physiology, disease susceptibility and response to treatment. Her team's work should shed light on the mechanisms underlying these sex differences and therefore lead to new precision medicine treatments and improved patient outcomes.

"This grant is an important milestone in my career and great recognition that the research me and my colleagues are producing at the Business School and at the finance department is world-class."

– Dr Cláudia Custódio

Dr Cláudia Custódio

Imperial College Business School

Information frictions, financing and growth: the impact of firm certification

ERC Grant: Starting Grant (2019)

ERC Funding: €1,357,099

Dr Cláudia Custódio is measuring the economic effects of different government policies to improve the access of small and medium enterprises (SMEs) to credit.

SMEs face more difficulties in accessing capital than larger firms due to information asymmetries, with smaller businesses tending to be more opaque and so decentivising banks to lend to them. Dr Custódio is therefore looking at the benefits of giving SMEs access to credit which is less expensive through government guarantees, and policies to address information asymmetries by providing certifications to SMEs which are visible to everyone (similar to credit ratings for larger firms).

By analysing Portuguese firms, Dr Custódio's research will provide better understanding of the channels through which financing and informational frictions operate to impact firm performance and economic growth. She has been collaborating with the Bank of Portugal and Lisbon School of Economics & Management (ISEG) in this important project.

This approach has allowed her to study in a comprehensive way what the real economic effects of relaxing financial constraints are, and to understand how facilitating the access of SMEs to financing can promote economic growth. This topic is of particular relevance in the current circumstances, with the types of policies targeting SMEs which Dr Custódio is studying being similar to those which have been employed by governments during the COVID-19 crisis.