

Our future workforce – creating impact through measurement

Postgraduate Institute for Measurement Science: Our 5 Year Vision



PostGraduate Institute
for measurement science

Get in touch:

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Foreword by Sam Gyimah MP, Minister of State for Universities, Science, Research and Innovation

Measurements matter. They affect every area of our lives, from climate change to diagnosing illnesses. We are a nation of innovators and the UK is a world leader in this vitally important field and our economy, quality of life and often our very lives depend on reliable measurements. It is inspiring to see what the Postgraduate Institute for Measurement Science has achieved so far and its plan for the future. I truly believe that creating the future generation of industry-ready measurement experts is crucial if the UK is to lead the way in advancing and influencing world-wide measurement and industry strategies.

About the Postgraduate Institute

The Postgraduate Institute for Measurement Science (PGI), was developed through a strategic partnership between the National Physical Laboratory (NPL), the UK's National Measurement Institute and a BEIS partner organisation, the University of Strathclyde and the University of Surrey, two leading academic institutions. The vision for the PGI is to become the number one institute for postgraduate research and training in measurement science in the UK.

This document presents our vision and ambition for the next five years, to lead on the development of measurement experts that can benefit industry and wider society.

Our extensive student community's research spans across many scientific disciplines and industrial sectors; from manufacturing and life sciences to data and the environment. The discoveries they are making contribute significantly to strengthening the UK's position

at the forefront of innovation in measurement science.

We want to expand our community, so contact us to find out more about how the PGI could help you.

Richard Burguete, Director, Postgraduate Institute for Measurement Science.
pgi@npl.co.uk

We collaborate with others to create greater impact

By adopting a collaborative approach, we are enhancing knowledge and skills in measurement science and its application, ensuring innovation and advancement in many fields of science and engineering, science research, technology and industry.

Industry – The PGI sits at the heart of the UK's National Physical Laboratory, a world leading organisation in measurement science, and through its strategic partners at the Universities of Strathclyde and Surrey has direct access to a wealth of knowledge and close links to industry. What we offer is a new model of engagement to develop the next generation of highly trained and adaptable scientists and engineers, who can pave the way to revolutionise UK industry. Good measurement science reduces business risks

throughout the product life-cycle and improves confidence and efficiency. Together we can help to transform your business and make it more productive and effective for **end-users**.

Higher Education Institutions – The PGI offers a nurturing environment with an excellent programme for development and student experience. The PGI is a community of over 200 students and around 250 supervisors across the UK, including academics from leading UK universities. Our community is diverse and offers excellent interdisciplinary experience. Our programme is extremely flexible and the welfare of the students and the needs of the supervisors sits at the heart of everything we do.

Students – Our training and access to expertise will provide a competitive advantage; by demonstrating how specific technology and products work, and can be developed, a unique set of skills can be provided in order to enable students to appreciably enhance their abilities, leading to distinct career advancement opportunities.

International – The PGI works with leading global academic and measurement institutes to understand and develop solutions for global challenges affecting the environment, manufacturing, security and health. By working with us you will have access to world experts and facilities, helping you to find solutions to your measurement challenges.



Department for
Business, Energy
& Industrial Strategy

NPL 

 **UNIVERSITY OF
SURREY**


**University of
Strathclyde
Glasgow**

Our Vision

is to contribute to economic growth and societal well-being by creating industry-ready measurement experts.

Measurement Science – making a difference across Industry

Why is measurement science important?

I have learnt through my career, many years working at Rolls-Royce Holdings plc, and through my joint research with NPL and Imperial College London, how vital accurate and assured measurement is to British industry, especially in high-tech, and tightly controlled industries, like aircraft engines. Today's aircraft engine is pushing materials and design to the limits. The physical dimensions of components must be controlled to ever-tighter tolerance, while measurement of thrust, fuel consumption, noise

and emissions remain paramount. The industry could not survive without world-class metrology.

New manufacturing techniques, like 3D printing (also known as Additive Manufacturing) open up the entire design space, but bring their own challenges. These techniques start with particles of metal powder, precisely placed and fused to form the final component, but what shape and size? What is their Chemistry? Do parts have voids and porosity leading to weakness and failure? Every new advance in manufacturing technology depends on the measurement community.

Measurement plays a vital role in responding to new challenges, supporting UK innovation and helping to drive the Industrial Strategy by increasing productivity. I believe that the Postgraduate Institute for Measurement Science is perfectly positioned, with its links to some of the world's most renowned Postgraduate Researchers, to lead the development of novel metrology and create a new metrology leadership community.

Professor Ric Parker CBE, FEng
Distinguished Visitor NPL

Our Ambitions

Confidence

Institutions, people and industry trust our postgraduates and alumni to deliver expertise, knowledge and accuracy.

Advancement

We are perceived as being the leaders in measurement science research, training and innovation.

Connections

The diverse research and studentships we engage with link us to universities, industry and communities.

We generate
confidence by:

- 1 Enabling research to address issues that impact industry, commerce and our quality of life
- 2 Producing experts in reliable and traceable data analysis, driving effective decision making and productivity growth
- 3 Promoting accuracy and helping to underpin competition and trust between suppliers and customers

Building trust in clinical and health outcomes

Measurement science is crucial to establishing a framework in which the creation of robust biological research data can impact on clinical and healthcare outcomes, by ensuring cost-effective disease diagnostics and improved quality of life.

Rapidly developing life science technologies are making biology a data-rich science, but ensuring that this information is translated into useful products that can be used with confidence, presents a considerable challenge for the community. One of the most significant problems is the detection of minor changes in a range of increasingly low level components, such as individual proteins or circulating tumour

DNA with inherently variable and complex biological systems.

Alternative ways of thinking will enable us to define what should be measured in these systems and what level of uncertainty is reasonable. Ongoing changes to bio-manufacturing methods and exploitation of digital capabilities requires evolving measurement support to ensure that the generation of robust biological data becomes integral to the field.

By establishing frameworks by which it is possible to draw together and train complementary communities of users, and by working in partnership with leading organisations, the national measurement laboratories will be able to provide confidence

in research and enable its rapid translation from innovation to product development.

Dr Julian Braybrook, Government Chemist and Director of Measurement Science & Partnerships, LGC

Advancing the use of new materials

University of Strathclyde case study

Light emitting diodes (LEDs) directly convert electricity into photons which means they currently generate more than twenty times more light per unit of electricity consumed than incandescent bulbs.

Light emission is the property of a certain class of materials and, like any other property, it can be optimised. Since more than a quarter of the world's electricity is used for lighting, even a few percent improvement in LEDs efficiency can greatly affect the economy.

The bottleneck of many technological advances lies in the limitations of available materials. The solution is simple, make better materials that are stronger, more flexible or with

superior optoelectronic properties. But how? This is where we conduct multi-disciplinary research across many institutions. We look closely at existing materials using scanning electron microscopes (SEMs) since they offer excellent resolution. We can image features at the same scale as the interactions producing luminescence occur. This would be impossible to achieve without measurement science.

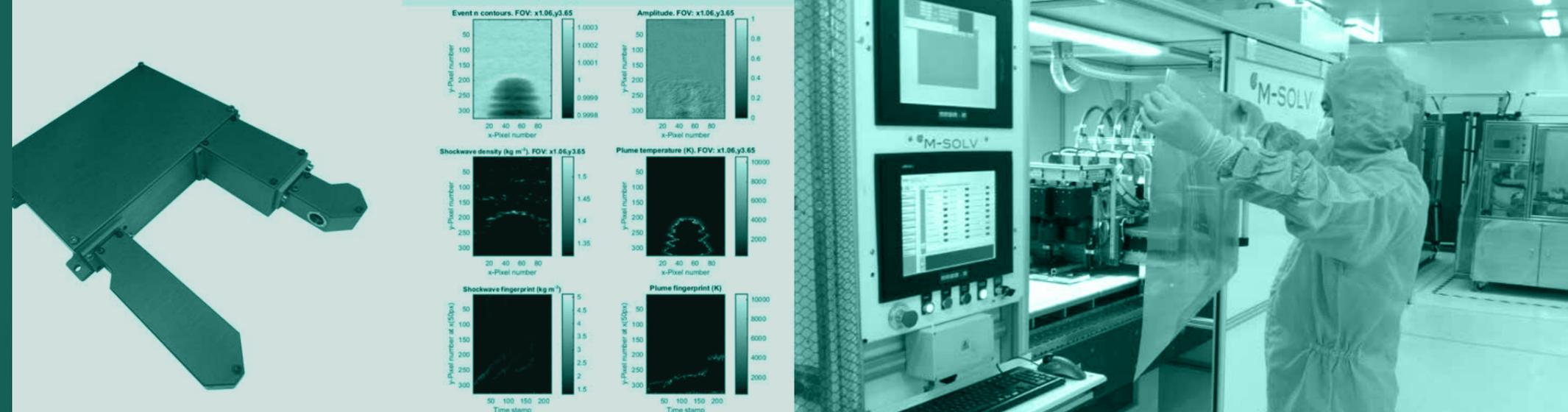
We need to understand very precisely how and what we actually image in an electron microscope. How certain features are revealed in the SEM is something I tried to understand as part of my PhD. I focused on implementing a model that can predict how certain material defects appear in the SEM. Parts of this work received the Corbett prize, awarded every four years to a young scientists for their outstanding

contribution to science at the International Conference of Defects in Semiconductors.

Elena Pascal, PGI student, University of Strathclyde

We facilitate advancement by:

- 1 Responding rapidly to new challenges
- 2 Supporting innovation throughout the UK and beyond
- 3 Developing world-leading measurement experts



A future made easier through responding to challenges

Imagine a future where your smartphone is inkjet printed in the convenience of your home, rather than being assembled in a mega factory somewhere around the world.

A future where early stage cancer diagnosis can be performed by a device purchased at your local convenience store at a cost similar to a pregnancy test; rather than following a series of invasive procedures when it is too late. Science fiction? Maybe not.

Additive Manufacturing is currently reinventing the way we fabricate goods – from structural components for aerospace applications to advanced medical electronics. It provides the means for reshaping the landscape of

global manufacturing, by making products in a much smarter, less wasteful and more cost effective way.

Leading this new era requires significant scientific and technical innovations at every step of the product ladder. From re-engineering our raw materials, to reinventing the fabrication methods and tools that we are using; the challenges are immense but so are the benefits for the one who will address them. Making the impossible-possible has always been at the heart of the UK manufacturing sector. Its ability to lead this new era will be determined by its capability to efficiently advance ahead of its competition.

Measurement Science can be at the forefront, ready to provide answers to questions we never thought that existed before. From

identifying the electrical properties of materials at the nanoscale, to increasing the yield of our production lines; measurement science expertise drives innovation and productivity.

Grigorios Rigas, Senior Research Engineer, M-SOLV Ltd, PGI Graduate

Unique fingerprinting helps promote accuracy

University of Cambridge case study

Process fingerprinting is generating a great deal of interest from industry as well as academia. There are hopes to apply the system in industrial process diagnostics and to quality assurance problems.

The PGI has engaged with researchers at the Centre for Industrial Photonics. These researchers have completed their work on developing a robust ultra-high speed holographic camera. This will provide industrial and scientific users with a way to observe highly transient phenomena and demonstrate how this is helping answer many fundamental research questions and stimulating future innovations.

The Falcon GHz HoloCam (Fourier Metrology), the world's first industrial ultrafast holographic camera, is able to detect extremely small changes in the environment at unprecedented acquisition rates, making it suitable for many fundamental research and industrial applications. In its current state, it is capable of acquiring holographic images at up to 1bn frames per second.

The system is currently undergoing field trials at a variety of industrial sites, aiming to make such a complex system readily useable by industrial and academic researchers without the need for extensive training. Another important factor is the ability to qualify the dynamics of the process: many production processes rely on post-process analysis to determine if the part or feature built has the desired characteristics.

As such, any failures are typically picked up after the process has completed. It is therefore desirable to define the process in terms of the process dynamics it undergoes, as this provides a unique fingerprint.

With the Falcon GHz, the dynamics of the process are recorded and used as a standard for the process dynamic for all subsequent operations; using HoloCam a snapshot is taken at chosen times and compared against the standard. In this way operating failures can be picked up as the part is being manufactured, helping the development of trust between supplier and customer.

Dr Krste Pangovski, Senior Research Associate, Institute of Manufacturing, University of Cambridge

We build
connections by:

- 1 Bringing together a community of users
- 2 Fostering new collaborations between academia, research institutes and industry
- 3 Building better links between government, industry and citizens



Creating a network of successful collaboration

A PhD is no longer three years in a lab finished with a thick bound thesis and a day of celebration in a gown. PhDs are a training programme to equip new researchers to tackle the science questions of tomorrow. The training environment is therefore the difference between a good PhD and a great one.

I've worked with NPL scientists on Department for Environment Food & Rural Affairs funded environmental measurement projects for nearly 20 years. This partnership has brought together the complementary skills and capabilities of

NPL and King's College London. It has also shown me that UK universities can learn a lot from NPL's emphasis on measurement excellence.

The PGI has been key to unlocking NPL's potential as a training centre and providing a focus for PhD students at NPL, along with peer support course provision that complements the university training. The strength of the PGI is the linking of communities and brokering the relationships between students, academics, scientists, industry and many more.

Looking to the future, the PGI can go a lot further. By forming a network of supervisors it

would create a hub, which not only provides world-class postgraduate training, but can be at the heart of a research network that spans NPL, industry and the UK's universities.

I was pleased to have a student as part of the first cohort for the PGI and I look forward to being part of the PGI as it goes forward.

Dr Gary Fuller
Environmental Research Group
MRC PHE Centre for Environment
and Health King's College London

Future communication made possible by 5G

University of Surrey case study

Access to the internet and wireless communication is often a lifeline in today's information age.

We now see communities of people brought together, over vast distances, and crucial services such as healthcare, can now reach patients with greater ease. Yet to continue facilitating these advances, our wireless infrastructure must not only expand, but improve. 5G communication is a global effort to achieve the next stage of interconnectivity, with targets such as 1000 times the capacity of current network technology, millisecond latency, and low energy consumption.

To be successful, designers must push the performance boundaries of physical devices that form these systems. This is where metrology plays an important role.

5G wireless infrastructure will use devices which operate at higher frequencies and efficiencies than before, requiring new metrology practices to be disseminated to designers and manufacturers. The European Metrology Programme for Innovation and Research (EMPIR) project "MET5G", co-ordinated by NPL and involving a consortium of seven partners from academia, research and industry, covers the development of traceable metrology in support of the development and standardisation of 5G.

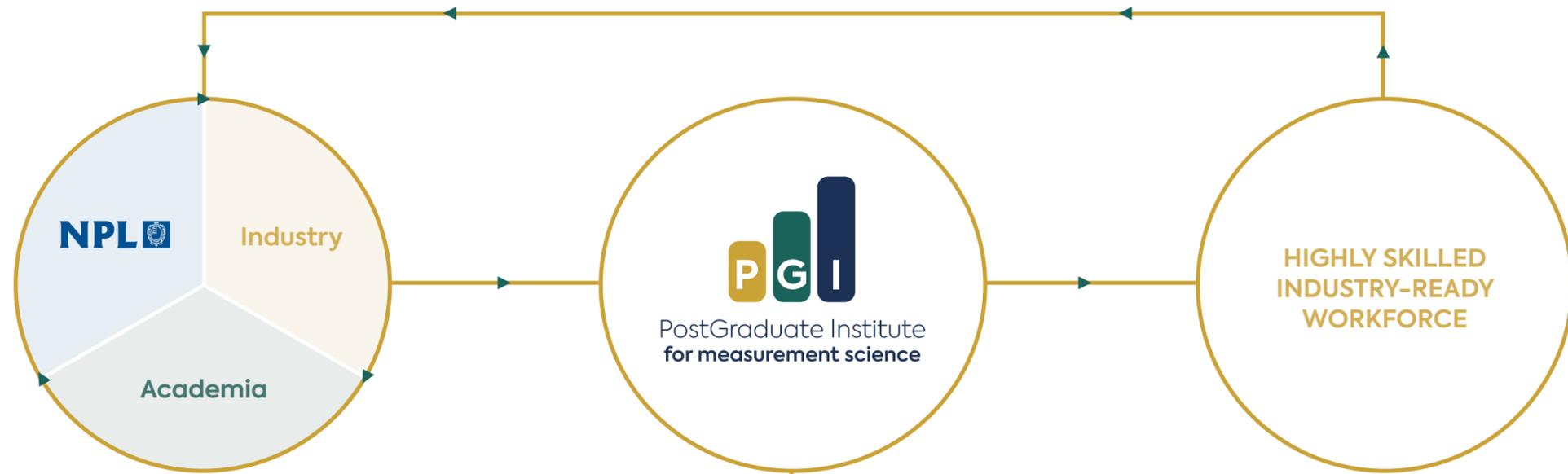
My PhD project, providing uncertainty evaluation for behavioural models of nonlinear devices, is aligned with this work, and I have been given the chance to contribute directly to MET5G.

Producing new metrology practices is very important, but even more so is communicating those practices to users. Throughout my PhD, the PGI has given me several opportunities to present my work to audiences at both NPL and my university. This has given me the confidence to take my results to a scientific conference and engage with users.

**Laurence Stunt, PGI student,
University of Surrey**

Our mission is:

To become the leading centre for postgraduate training and skills development in measurement science for the UK and beyond, developing prominent industry-ready professionals.



We will deliver our mission in three linked phases:

Years 1-2

Strengthening the foundations:
This phase will showcase the PGI and the value it is creating now and for the future.

Years 3-4

Developing capacity:
Building the PGI as the centre for measurement science with a capability of meeting future challenges.

Years 4-5

Shaping the future:
The PGI community of postgraduates and the research they produce is influencing the development of strategies and helping generate positive impact.

We are working with our partners to ensure success. Here are some of the Higher Education Institutions we work with:

“ Measure twice, cut once.”

proverb

Strathclyde	Surrey	Bath		
Birmingham	Bristol	Brunel	Cambridge	Cardiff
Cranfield	Edinburgh	Glasgow	Herriot Watt	Huddersfield
Imperial College London	Kings College London	PGI PostGraduate Institute for measurement science	Kingston	Lancaster
Leeds	Liverpool		London Metropolitan	Loughborough
Manchester	Nottingham	Royal Holloway, University of London	Oxford	Queen Mary University London
Queens Belfast	Reading	University College London	Sheffield	Southampton
St. Andrews	St Mary's		Warwick	York

How to get involved

The ambition to grow the PGI is driven by the need to equip the UK with an exceptionally skilled workforce ready to tackle real life industrial challenges. Find out about our exciting opportunities and ways in which you play a part in the PGI.

Industry

Drive productivity and increase resource through studentships and projects aligned to your industrial and measurement challenges

Contact us to discuss current and future studentship opportunities

NPL's University Liaison Managers operate in your region

Higher Education Institution

Enhance your Institution's knowledge exchange, research and impact activities through external partnerships with NPL and Industry

Meet with our team to discuss your specific measurement challenges

We can visit you to present the PGI engagement models

Students

Gain the knowledge, skills and training aligned to industry needs, that will equip you for a career tackling real world challenges

Visit our website for current vacancies

Speak to NPL's University Liaison Managers about future opportunities

The PGI not only provides unparalleled knowledge and expertise in measurement science, we also offer support and facilitate connections so that our research helps to tackle real world problems.

We do it through:

Research

PhD projects span all science and engineering disciplines and address specific measurement challenges which are relevant to industry.

Training

Each PGI student has access to specialist metrology training through on-line courses, access to equipment and 1:1 tuition from co-supervisors.

Cohort experience

The PGI cohort experience extends the students' network with industry and provides support and activities beyond the host HEI.

The PGI is associated with over

35

HE institutions

Join the PGI and become part of a community focused on the application of measurement science to boost the delivery of the UK's Industrial Strategy.

Contact the PGI by emailing: pgi@npl.co.uk

