

# The Postgraduate Institute for Measurement Science



PostGraduate Institute  
for measurement science

Five Year Review:  
January 2015—December 2019

---

Researchers within the PGI have been investigating how to accurately measure and analyse greenhouse gas emissions on both a national and a global scale

---



## Executive summary

*p. 4*



## Setting the scene

*p. 7*



## What we have delivered

*p. 12*



## Reflections on 5 years

*p. 31*



## The next 5 years

*p. 35*

# Executive Summary

The inauguration of the Postgraduate Institute for Measurement Science (PGI) took place in October 2015, following the establishment of the Strategic Partnership between the National Physical Laboratory (NPL), the University of Strathclyde, the University of Surrey and the Department for Business Innovation and Skills (BIS) (now the Department of Business, Energy and Industrial Strategy (BEIS)). The PGI marked the creation of a unique environment and approach that has led to growth in funding, training and engagement of postgraduate researchers (PGRs) associated with NPL.



By growing the pipeline of doctoral researchers to the current cohort size of 206, the PGI is having a considerable impact on National Measurement System (NMS) research and its application in a range of sectors across industry and academia. Of the 140 graduates who have completed their research since 2015, the largest proportion have moved into industrial roles (43%), indicating their industry readiness, with a number making a rapid move into leadership positions within 3 years of graduation. Our alumni are also established in academic and other research roles (29%) at prestigious organisations worldwide, with a further 19% becoming full-time researchers at NPL.

A focused approach to industrial engagement has resulted in 41 studentships with 31 industrial partners during the five years. This growth is indicative of the way in which the PGI positions itself between industry and academia. This greater involvement of industrial partners, along with the development of a programme of metrology and professional training that is aligned to business requirements and tailored to student researcher needs, has provided the fundamental elements to create a pipeline of highly skilled and industry-ready postdoctoral researchers.

By building a community for our PGRs, the PGI has created a distinct research environment for PhD students associated with NPL. This has enabled our researchers to showcase their talents to a wide range of interested stakeholders, develop effective networks and has enriched their appreciation of and ability to articulate the relevance and need for measurement science research to address global challenges.

These strong foundations, coupled with our clear strategy and plan for future activities, strong governance and support, and measurement expertise, will continue to drive our progress.

The Strategic Partnership has worked effectively to ensure that initial development and growth has been achieved. This has been fuelled by appreciable joint investment into PhD studentships from NPL, academia, industry and other partners. The approaches developed over the past five years are now well established. With the continued aim of developing a significant increase in industry and third party engagement to further grow the PGI, we will deliver greater numbers of PGRs in order to extend the impact of measurement science research.

**43%**  
of PGI Alumni  
have moved into  
industry roles

**Cohort growth**  
**82%**  
in 5 years



---

PGI research has played an important role in the recent redefinition of the International System of Units (SI units).

---



## Setting the Scene

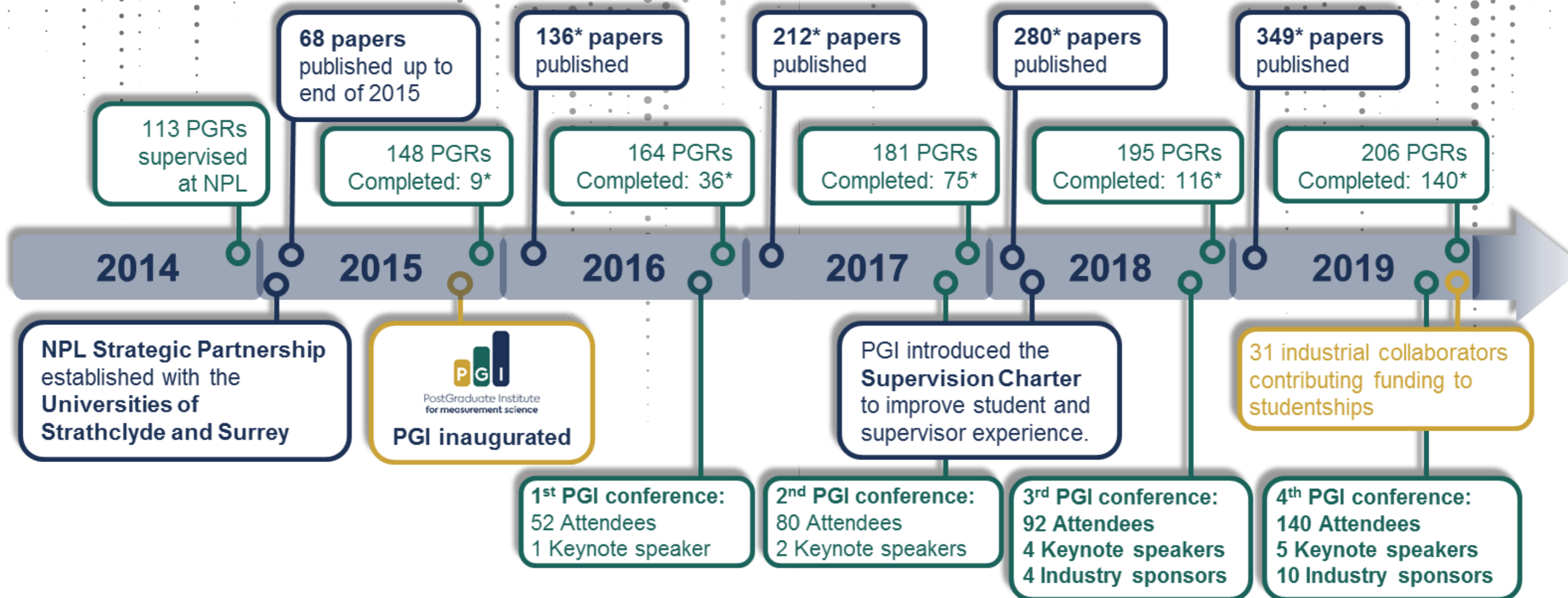
This report presents a detailed overview of the key activities and achievements of the Postgraduate Institute for Measurement Science (PGI) and sets out what has changed since its inception (Figure 1).

In January 2015, NPL, the Universities of Strathclyde and Surrey, and the Department for Business Innovation and Skills (BIS, now BEIS) entered into a Strategic Partnership to contribute towards the delivery of the UK Government's ambitions for NPL.

This included the creation of a postgraduate institute. The Postgraduate Institute for Measurement Science is a pioneering initiative which aims to equip the UK with an exceptionally skilled workforce ready to tackle real life industrial challenges. Prior to the initiation of the PGI, BIS had identified that a pipeline of high-level talent was required to support the development of research-intensive businesses in the UK to enable them to thrive. Key to the success of this proposed endeavour would be a joint investment model whereby student funding would be leveraged to grow investment from Higher Education Institutions (HEIs), industry and other third-party organisations. In parallel, the PGI would develop people with industry-relevant skills, to accelerate the translation of science and technology from discovery to tangible economic and social impact. This would deliver overall enhancement of the National Measurement System (NMS).

The PGI was launched at an inaugural event in October 2015 with three key objectives:

- **Enhance the science capability aligned with the UK NMS and create demonstrable impact**
- **Develop a pipeline of industry-ready researchers**
- **Enhance the cohort experience of postgraduate researchers working in collaboration with NPL**



**Figure 1:** PGI timeline highlighting prominent activities and changes in the key metrics from 2014 to 2019.

(\*Cumulative total at end of calendar year)



Since then, the PGI has worked with the Universities of Strathclyde and Surrey on our mission to bring together a consistent and integrated approach to the delivery of postgraduate studentships in measurement science. This has led to an increase in the number of studentships, greater involvement of industrial partners, and the development of a programme of metrology and professional training tailored to PGR needs and aligned to business requirements.

Through training, research partnerships, and events, the visibility of the PGI has increased. We have illustrated that, as an entity focusing on the benefits of doctoral research in measurement science, we can have an impact on society. In carrying out our mission we have demonstrated widely the value of collaborative postgraduate training in creating a cadre of future leaders for industry, academia and beyond.



Image by Free-Photos on Pixbay

PGI researchers are using satellite imaging for measurement applications in agriculture, climate studies and disaster relief.





# What we have delivered

The creation of the PGI has driven an appreciable growth in collaborative PhD studentships between NPL and our partners. It has enabled targeted and cohesive management of the large cohort of existing and new NPL-aligned PGRs. This strategic and coordinated approach has created impact through more effective alignment of our partnerships and studentships to NPL's research direction and in support of the NMS. We have driven the creation of more industry links by working closely with NPL Business Development teams and scientists, as well as our Strategic Partners and other HEIs, and identified opportunities for funded research. The establishment of a structured approach to the EPSRC<sup>1</sup> annual iCASE<sup>1</sup> allocation and the CDT<sup>1</sup> calls facilitated effective and efficient management of around 30% of the planned annual intake of PGRs, and aligns with broader plans and endeavours to sustain and grow the PGI over the period 2020-2024. This managed approach also extends to smaller engagements relating to NERC<sup>2</sup> and STFC<sup>2</sup> doctoral training centres and programmes.



The number of PGRs is a key metric for the PGI and this has seen significant growth to the current level of 206 students, an increase of 82% since the time before the PGI came into being. Detailed and consistent records began to be collected by the PGI from October 2015 and the annual figures are presented in Figure 2.

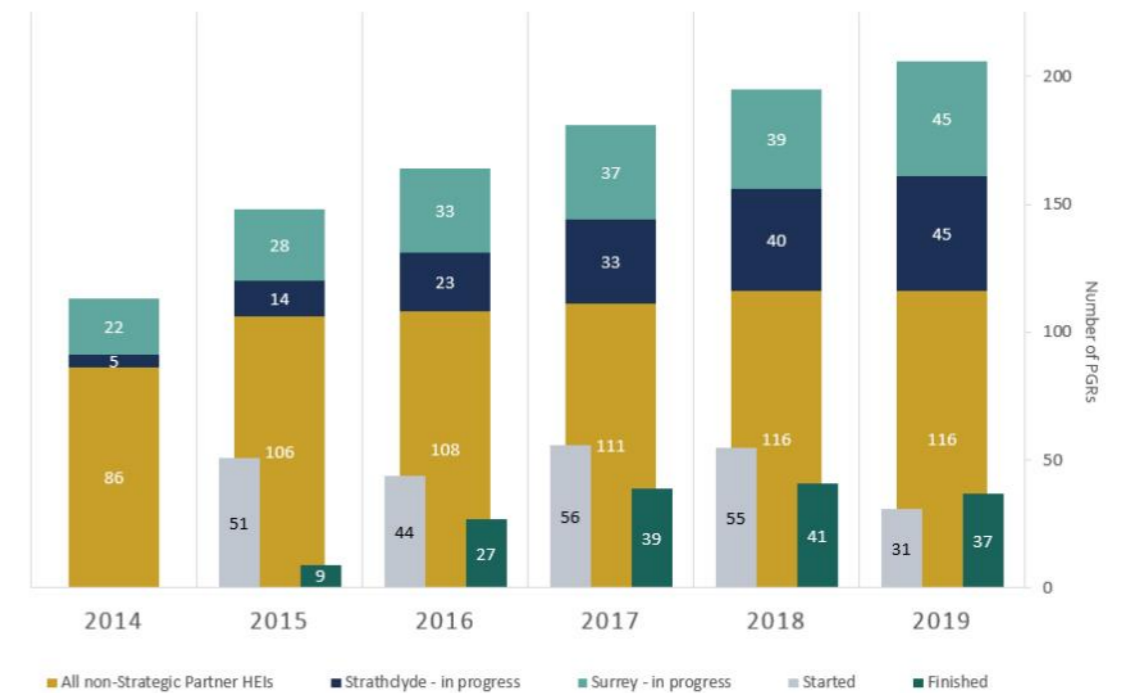


Figure 2: Changes in PGR numbers before and throughout the first five years of the PGI

Researchers in the PGI have contributed towards the development and optimisation of 5G communication technologies



The PGI has worked with 34 UK Universities, with most students enrolling with our strategic partners, the University of Surrey and the University of Strathclyde. The other main clusters of PGRs are with University College London, Imperial College London, Royal Holloway University of London, the University of Cambridge, the University of Birmingham and the University of Manchester.



Figure 3: PGI university collaborators, numbers indicate the total PGRs past and present.

The Strategic Partnership has been instrumental in ensuring that the planned development and growth of the PGI has been achieved, and this is demonstrated by the level of investment in studentships from all three parties; 44% of the current cohort is made up of Strathclyde and Surrey students.

Other funding comes from a variety of sources, including universities, Research Funding Councils (EPSRC, NERC, STFC predominantly) and industry or other third-parties. In a small number of cases individual students, mostly from outside the UK and European Union, fund their own fees and/or stipends.



The collaborative model of investment in PhD studentships, along with a flexible implementation of co-supervision, provides significant advantages to all the stakeholders – providing increased access to a wide variety of knowledge and capability for the partners, a diverse range of experience for the PGRs, and reduced cost of studentships through shared funding. This collaborative investment model also facilitates the leveraging of studentship funding to grow investment from industry and other third-party funders. There has been a total of £26M investment in studentships associated with the PGI since January 2015 (Figure 4).

In addition to this there has been a significant amount of investment of resources, in the form of PGR supervision and in-kind support from hosting around 50% of students full-time at NPL in Teddington. This has been provided in addition to basic requirements of industrial CASE awards, and long- and short-term visits associated with PhD projects funded in other ways.

The PGI is positioned at the interface of academic and industry collaboration. Aligned with this, a growing number of studentships are created through direct interactions with industrial partners. Since 2015, the number of partners with this kind of direct association with the PGI has steadily increased as a result of a targeted engagement strategy with industry, consolidation and management of the EPSRC iCASE awards and support of Centres for Doctoral Training. Consequently, the PGI has trained 41 students with 31 industrial partners.

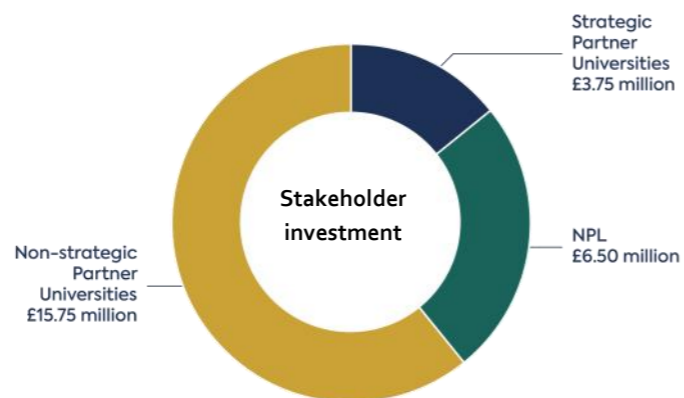


Figure 4: Investment in the PGI over five years



### GSK Case Study

In 2019 new projects were successfully negotiated with the University of Edinburgh and GSK. Three studentships are sponsored by the GSK Clinical Imaging Group and are based at the Centre for Information Research at Edinburgh; the group will form a mini cohort. A further iCASE studentship is also part of the PGI totalling four current PGRs.

The previous page highlights key examples of a coordinated and targeted industrial partnerships approach. Through different funding models (e.g. iCASE awards, CDTs and direct industrial sponsorship) we have developed strong PGI-industry relationships to create additional studentships and funding. NPL's iCASE allocation has been strongly supported by the Strategic Partners and has resulted in developing extensive connections with industry whereby the allocations to Strathclyde and Surrey (seven and eight, respectively, since 2017) have drawn support from the following industry partners:

- **Strathclyde:** Advanced Forming Research Centre, CMAC Industrial Partners, Cambridge Quantum Computing, Kelvin Nanotechnology and Keysight.
- **Surrey:** Compound Semiconductor Centre, DETECTOR, TrisKem, All About the Product, Alliance Medical Limited and TexRad

## iCASE

- Awarded 10 iCASEs per year since 2015.
- 16 projects with additional industry partner support since 2017.
- Leveraging additional industry funding and studentships.
- Matched studentships created with Strategic Partners.



## CDTs

- Co-ordinated response to EPSRC CDT call in 2018.
- 40 letters of support provided.
- 16 CDTs funded with an overall commitment from NPL to support.
- 31 students will be supported over 5 cohorts.

In the case of the seven Strathclyde iCASE studentships, an equal number of 'matched' studentships were allocated by Strathclyde to run in parallel. These PhDs are supervised by the same NPL scientist as the associated iCASE studentship, with the funding sourced from a combination of HEI funds and industry partner contributions.

The coordination of the CDT engagement programme is a medium-term activity that will be followed up consistently to ensure that our mutually agreed studentship commitments are honoured, and deliver the maximum benefit to the collaborating parties. One significant benefit from the CDT engagement is the development and delivery of standard and bespoke metrology-related training that will provide revenue to NPL over the next five years, along with the opportunity to develop greater understanding of the relevance of measurement science to a broader audience beyond that of the PGI's co-supervised students.





## Equality, diversity and inclusion

Data has been collected on gender and nationality following a survey of the PGI cohort (Figure 5). These show that the female-to-male ratio of the survey respondents is higher than the sector average of 31%:69%<sup>3</sup> for physical sciences, computing, maths and engineering in 2018/19. The proportion of EU and international students (39%) is testament to the global nature of science and engineering research within the PGI.

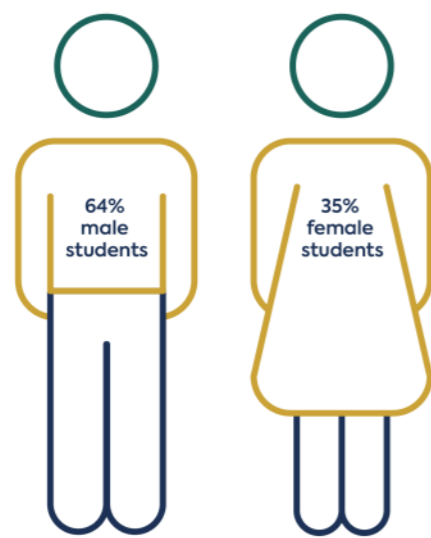
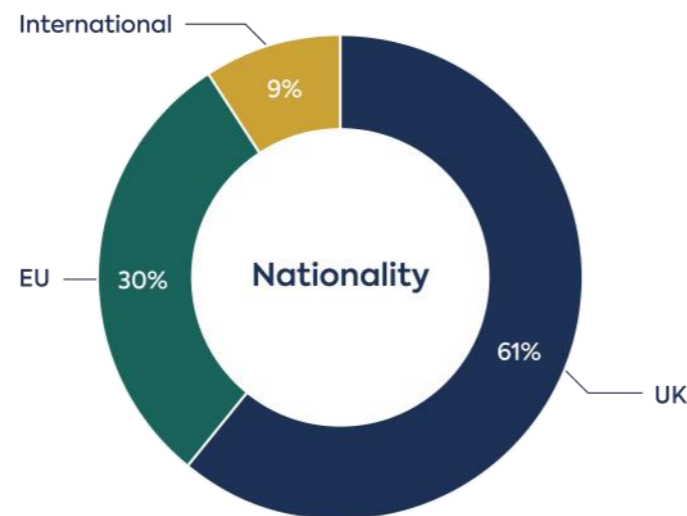


Figure 5: Gender and nationality within the PGI



<sup>3</sup> Higher Education Statistics Agency online data, [www.hesa.ac.uk](http://www.hesa.ac.uk).

## Student awards and prizes

Our current students and alumni have achieved several significant prizes and awards during their studies. External recognition has come from respected institutions such as the Institute of Physics, the Royal Commission for the Exhibition of 1851 and the Institution of Engineering and Technology. Some of these awards carry a significant cash prize element that enables the PGRs to further develop their research interests and collaborative networks.

Alumni **Flaviu Cipcigan** and **Sakthy Selvakum** named in the Forbes Top 30 Under 30 in Europe for Science and Healthcare, and Engineering and Manufacturing Awards, respectively.

Forbes 30 under 30

Current PGRs **Michael Woodley** and **Leonardo Del Bino** recognised at NPL by winning the longest-running and most prestigious NPL prize, The Rayleigh Award for best published paper.

NPL Rayleigh Award

**Robert Shearman** – Institute of Physics (IoP) Early Career Award for 'outstanding contributions to the field of nuclear physics'. The nomination was for Robert's PhD thesis research on nuclear metrology.

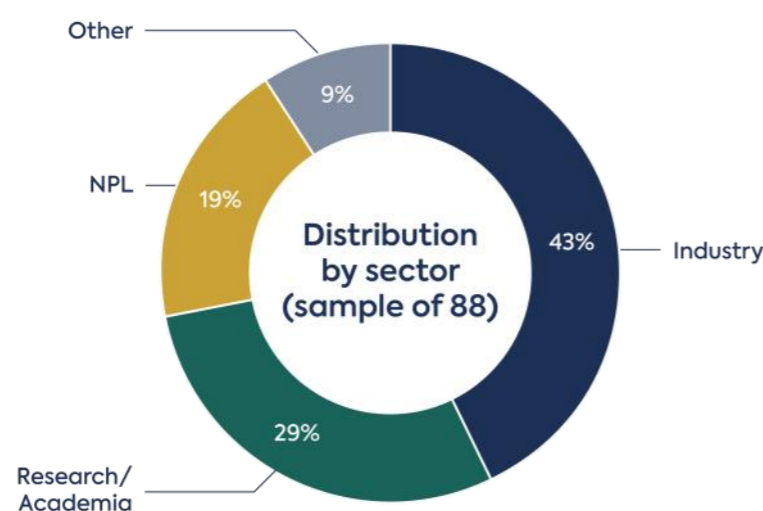
IoP and IET prestigious awards

**Greg Rigas** – Institution of Engineering and Technology (IET) Postgraduate Scholarship for an outstanding researcher at a university with an international reputation for research. The work was in the field of printed nanoelectronics and this is the highest award from the IET, with a value of £10,000.

## PGI graduating student destinations

The PGI has seen 140 students graduate since 2015. The destinations of these students are not only noteworthy but are also diverse, ranging from postdoctoral researcher positions, to trainee patent attorney and CEO at a Quantum Technology start-up.

Information gathered from 88 graduates has shown the various post-doctorate destinations that PGI Alumni have entered into (Figure 6). Academia is defined by being based at a Higher Education Institution and we have 25 graduates in institutions across the world. Over 40% of our graduates now work in industry and hold a variety of different types of roles, with many having achieved significant promotions in their company. A considerable number of students have been successful in securing roles at NPL after completing their PhD, where they continue to be great advocates for the PGI. The remaining 9% of students are applying their skills to other sectors including scientific charities and government departments.



**Figure 6:** Student destinations for PGI graduates (sample size: information available for 88 out of 140 Alumni)

**Dr Grigorio Rigas** worked at the University of Surrey and NPL during his EngD. After graduating he joined M-Solv, an SME based in Oxford, and in just over 2 years became the Head of Advanced Research Manufacturing. Greg has said that:

*"Measurement Science is at the forefront of our work and helps provide answers to questions we never thought existed before. From identifying the electrical properties of materials at the nanoscale, to increasing the yield of our production lines."*

**Dr Karolina Kokurewicz's** joint PhD between the University of Strathclyde and NPL investigated a new radiotherapy treatment modality that uses a single very high energy electron (VHEE) beam focused by a magnetic lens to create a high dose region in a small volume.

Dr Kokurewicz is continuing her work on VHEE therapy in collaboration with NPL, CERN and the Institute of Nuclear Physics Polish Academy of Science while working as a research assistant at the University of Strathclyde.

**Dr Flaviu Cipcigan's** PhD, a joint project between the University of Edinburgh and NPL, was recognised by the Institute of Physics as making a "leading contribution in advancing theoretical condensed matter physics".

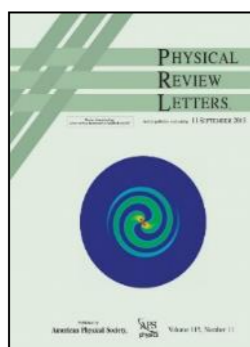
Dr Cipcigan is now a researcher at IBM Research UK and one of Forbes' 30 under 30 innovators and game changers. He works at the interface between data, physics and biology. His research applies molecular dynamics to discover and optimise new medicine and to combat global health challenges such as antibiotic resistance.



## Publications

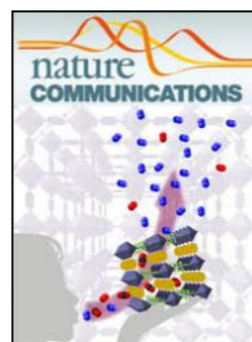
As a measure of academic achievement and the contribution that PGI students make to the body of scientific knowledge, co-authoring publications in scientific journals and conference proceedings constitutes the widely recognised and accepted approach. The number of publications that NPL postgraduate students contribute to has been consistently high over the past five years making up around 15% of all NPL publications and amounting to 349 articles in total.

Figure 7 shows examples of recent publications in high or very high-ranking journals, 2-4 and above 4 respectively, according to the SCImago Journal Rank indicator. The PGI doctoral students that have contributed to the paper are indicated in bold.



Physical Review Letters (2019) '*Interplay of Polarization and Time-Reversal Symmetry Breaking in Synchronously Pumped Ring Resonators*'; Copie, F; **Woodley, M T M**; **Del Bino, L**; Silver, J M; Zhang, S; Del'Haye, P

Nature Communications (2019) '*Continuous-variable tomography of solitary electrons*'; Fletcher, J D; **Johnson, N**; Locane, E; See, P; Griffiths, J P; Farrer, I; Ritchie, D A; Brouwer, P W; Kashcheyevs, V; Kataoka, M



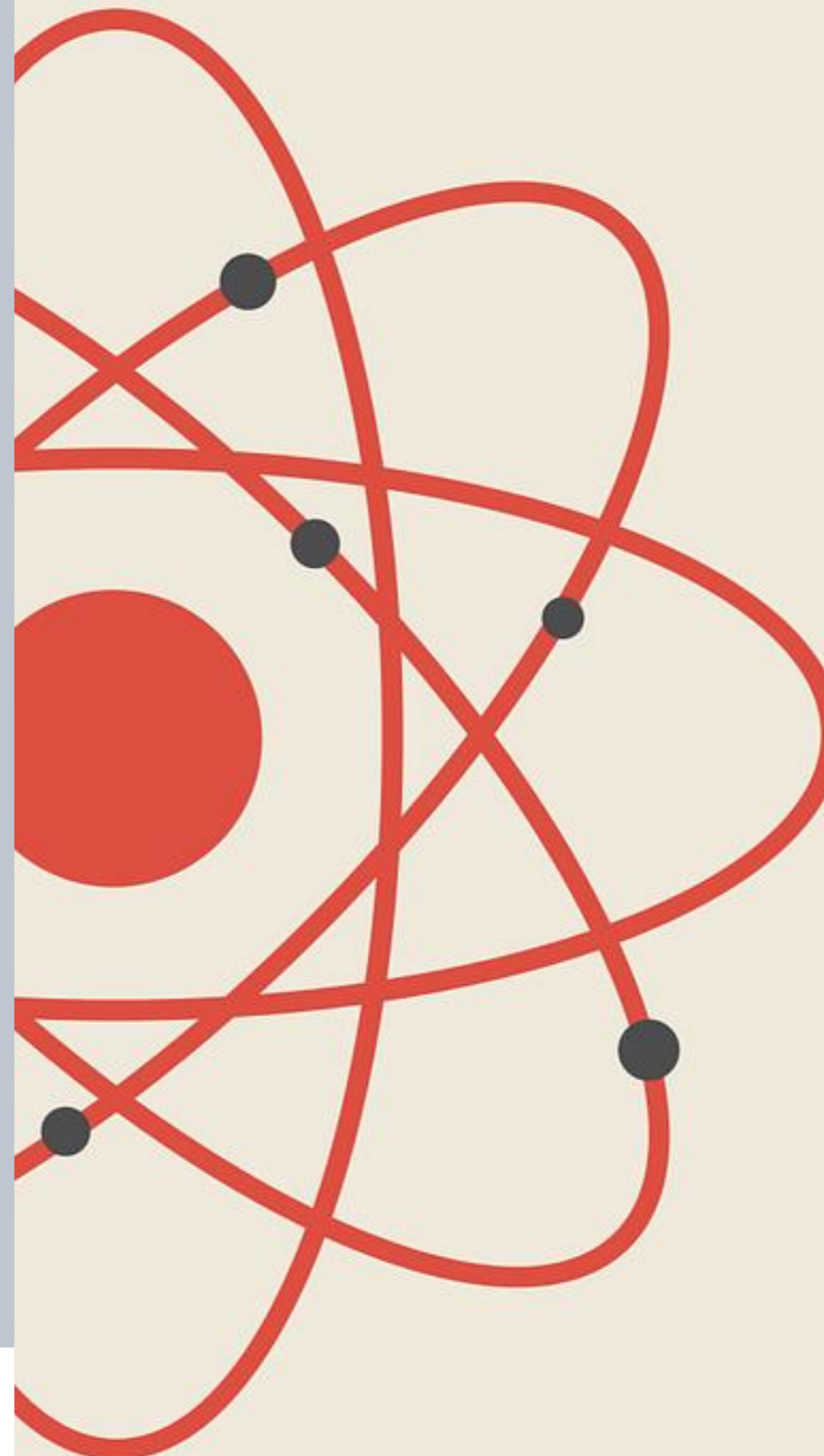
ACS Nano (2019) '*Engineering Chirally Blind Protein Pseudocapsids into Antibacterial Persisters*'; Kepiro, I E; **Marzuoli, I**; **Hammond, K**; Ba, X; Lewis, H; Shaw, M; Gunnoo, S B; De Santis, E; Łapińska, U; Pagliara, S; Holmes, M A; Lorenz, C D; Hoogenboom, B W; Fraternali, F; Ryadnov, M G

Figure 7: Recent PGI publications in high- or very high-ranking journals

---

Researchers within the PGI are developing novel quantum technologies for computing and sensor applications

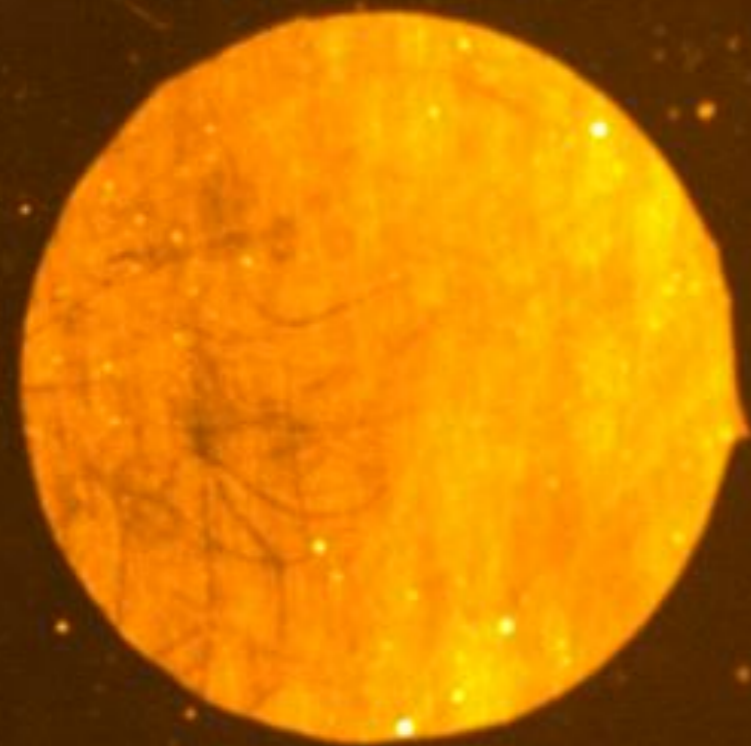
---



---

PGI research is stretching the boundaries of measurement instrumentation and technologies

---



## Training and supervision

Training is at the heart of the PGI. The postgraduate courses provided aim to develop world-class researchers to achieve a mastery of scientific methodologies and professional skills. Through developing knowledge and skills in measurement science and its application, PGRs will bring innovation and scientific advancement to their field of research and industrial sector.

Since 2015 the PGI has developed and delivered a programme of training and professional development courses. The programme enhances students' knowledge and understanding of measurement science and experimental practice, and enables them to develop their broader professional skills, including communication and presentation skills. The PGI training provision has evolved in response to student feedback and the requirements of industry stakeholders. During 2018 and 2019 the PGI trained over 150 students via 26 courses, with an additional 90 students completing on-line metrology training.

Integral to the PGI's core training is co-supervision by NPL scientists who work closely with students and university supervisors, and is formally set out in the PGI Supervision Charter. Developed through a partnership with the Universities of Surrey and Reading and the National Nuclear Laboratory, the Charter was launched in 2018. Aligned to the Quality Assurance Agency standards for postgraduate supervision, training to support the Charter is also provided to new supervisors and students on a regular basis in a streamlined and accessible way.

*'The training session for giving effective presentations was fantastic. The positive effect of this training course was clearly visible at the PGI conference.'*

*NPL student 2019, Effective Presentations Training  
Source: PGI Stakeholder Survey*

*100% of delegates rated the 'Instrumentation and Sensors' course as Excellent or Good (2018 and 2019).*

*Source: Course feedback forms*



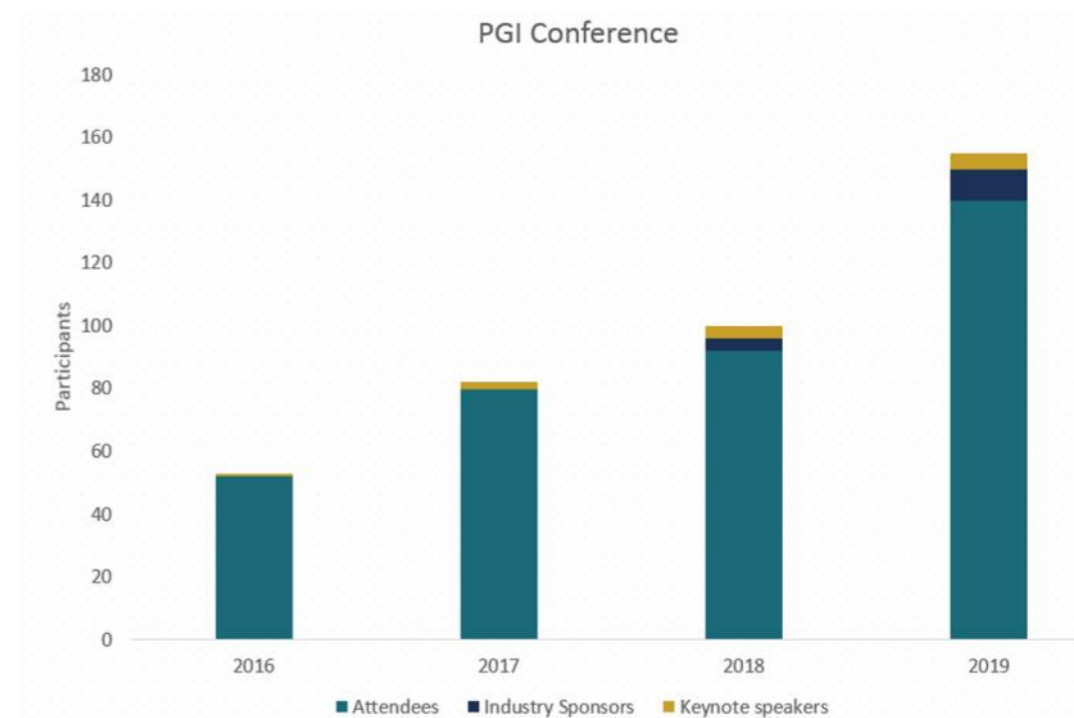
## Cohort experience & events

The cohort experience starts with an induction day; these sessions have been held in Strathclyde and Teddington to welcome new students to the PGI. The induction day introduces the students to measurement science and NPL, the Supervision Charter and PGI training provision for communication skills development.

The flagship PGI Annual Conference is now in its 5th year and brings the national PGI cohort together. It provides students with networking opportunities and time to consider their career options. An ideal training platform, the event is also managed and delivered by a committee of students who gain skills in planning, event management and budgeting, as well as honing their negotiating skills. The event has gone from strength to strength with valuable input from Industry who provide careers sessions, exhibition stands and sponsorship. For those participating, the event offers opportunities to promote their research and develop their communications skills through poster and oral presentations.



The scale of participation and industry involvement in the 2019 event (Figure 8) demonstrates the significant positive evolution of the PGI Annual Conference. Over the two days of the 2019 conference there were 140 participants, 12 student talks, 26 posters, 5 keynote speakers and 10 industry sponsors. Other student events include the summer picnics, winter socials and regular pizza nights and cake afternoons. These events are held in both Strathclyde and Teddington, meaning there is opportunity for students to travel to a convenient location. The organisation and delivery of PGI events are supported by a committee of Student Ambassadors who are engaged in developing the student voice and activities across the PGI and wider NPL community.



**Figure 8:** Number of PGI conference attendees, sponsors and keynote speakers for the past 4 years

Researchers within the PGI are addressing the increasing need for fast communications and computing power by improving conversion between optical and electrical signals

## Reflections on 5 years

Taking into consideration the outcomes from the first five years of operation, it is worth reflecting on what have been the main achievements of the PGI, highlight where there has been a notable change in the way PGRs develop during their PhD, and consider how industry and academic stakeholders have benefited from the PGI.

The primary outcome from the five years of operation of the PGI is the appreciable increase in student numbers, alongside the coordinated management approach which has evolved to drive an increase in industry involvement. In terms of raw impact, the growth of 82% in studentship numbers shows how the PGI is contributing directly to the research objectives of the UK NMS as evidenced by the significant growth in number of scientific publications over the last 5 years. In addition, the increase in PGR numbers is making an important contribution to the national target of growth to 2.4% of GDP investment in R&D by 2027.

Furthermore, the distribution of PGR destinations shows that 43% of our PGRs move into industry roles. That some of them are already in a leadership positions, is indicative of the success that arises from conducting a PhD with the support and involvement of NPL, the HEI partners, and industrial collaborators. A clear signal that this approach is having a positive effect is that there has been significant growth of industry and third-party funded projects to 41 studentships in 2020 catalysed by the PGI. The mechanisms for developing these engagements are now well embedded, having matured significantly since 2015, and the associated processes are now operating effectively, in order to drive the targeted upward trajectory of the PGI.



The PGI conference has been a strong catalyst for developing students' capabilities, showcasing their skills to a broad audience and, through the increased engagement with industry, a key opportunity to develop their networks and the PGI's industry and third-party interactions. The growth in positive feedback on PGR oral and poster presentations has resulted from specific training activities directed at communication and related skills that are provided in the run up to the event. These professional skills, and the development of contacts and networks, benefit our PGRs and facilitate routes into employment.

Our coordinated approach provides a comprehensive view of research projects across NPL and our academic partners, which can be evaluated for alignment to strategic objectives, enabling more targeted industry engagements. The PGI creates new opportunities for collaboration that aids the NPL science community and facilitates academic research collaborations. The strategic partners, and some other HEIs, have reciprocated by bringing in their industry collaborators to support funded projects, using university funds to leverage involvement from business. The level of financial contributions from all stakeholders shows how this co-investment in PhDs has resulted in growth over the past five years, with potential for longer term sustainability of the PhD talent pipeline.



Some aspects of PGI progress are not so easily expressed simply with such data and statistics. Student excellence, for example, can be highlighted as a significant achievement of the PGI and is indicated by several factors. Having demonstrated their readiness, our PGRs have transferred to a career in science and engineering, with industry being the principal pathway as indicated by the 43% of alumni employed therein. Many of the industrial, research, and academic institutions at which PGI graduates now work are prominent multinational corporations or high-tech industries, as well as research and academic establishments of very high esteem. Journal publications and external awards are also a key measure of academic and research achievement, as are the prominent examples of independent recognition by the science and engineering community. The highlights identified above present only brief exemplars from a significant array of awards and prizes and a broad spectrum of internationally leading outputs amassed by PGI students over the past five years.

The PGI's growth, and wider engagement, should also be seen in the context of postgraduate research more widely, where there has been little change in industry engagement in the past 20 years<sup>4</sup>. As part of this challenging landscape, the PGI has cultivated some new approaches which have resulted in an array of green shoots that we can now develop with our stakeholders to more fully drive the progress and expansion of the PGI's collaborative and industry-focused PhD programmes.

<sup>4</sup> David Willetts 'The road to 2.4 per cent, Transforming Britain's R&D performance', The Policy Institute, Kings College, December 2019

---

Researchers within the PGI have contributed to knowledge in radiation science for environmental, medical and nuclear decommissioning purposes

---



## The next 5 years

This report has provided a comprehensive overview of what the PGI has achieved and the changes to postgraduate research and training delivered in the past five years. The PGI has created a unique and diverse environment for PGRs to focus on measurement science-related research and enables this developing cadre of research talent to understand how they are making an impact on national and global challenges by performing research in collaboration with a National Laboratory.

Our vision for the next five years is informed by the successes and initiatives outlined above, as well as feedback that we have received from our stakeholders. Our focus will be on:

- **Developing a sustainable cohort size with increased industry and 3rd-party funding and engagement**
- **Securing additional investment from public and private sources**
- **Extending our international reach and partnerships**
- **Enhancing the PGI's relationship with our Alumni**
- **Expanding the training offer to attract researchers and stakeholders alike**

These objectives will enable the PGI to continue towards achieving the vision set out at the start of the Strategic Partnership. The collaborative funding model will be instrumental in driving the increase in industrial and international backing, and will deliver appreciable escalation of measurement science-related research and training. By developing further our engagement with stakeholders through more formal and informal networks, the PGI will be better connected to the needs of its stakeholders to provide the critical elements that will support the doctoral talent pipeline. All of this will serve to drive the growth of R&D investment in line with government targets and for the PGI to become the premier UK and International centre for doctoral research, training and skills development in measurement science.





PostGraduate Institute  
**for measurement science**

## Contact us

✉ [pgi@npl.co.uk](mailto:pgi@npl.co.uk)

🐦 [@PGImetrology](https://twitter.com/PGImetrology)

📷 [@pgimetrology](https://www.instagram.com/pgimetrology)

🌐 [www.npl.co.uk/pgi](http://www.npl.co.uk/pgi)

DOI: <https://doi.org/10.47120/npl.pgi.8814>