Institution: Aston University

Unit of Assessment: 13: Electrical and Electronic Engineering**,** Metallurgy and Materials

a. Overview

The Unit includes research groups in the fields of photonics (formed 1991), adaptive communications networks (**ACNRG** formed 2001), nanoscience (**NRG** formed 2008) and power engineering and power electronics (**PEPERG** formed 2011). The groups are managed in Electrical, Electronic and Power Engineering (EEPE) subject group, with the exception of Photonics, which formed the Aston Institute of Photonic Technologies (**AIPT**) in 2012, led by Prof. Sergei **Turitsyn.**

b. Research strategy

Progress since 2008. In 2008, the strategy of the Unit (then part of the General Engineering submission of the School of Engineering and Applied Science - EAS) was for research to be relevant and span basic science through to applications and exploitation; already focusing on impact. Major strategic decisions (elaborated later) have led to: the formation of AIPT, the recruitment of academic staff to strengthen AIPT, ACNRG and PEPERG, and to establish nanoscience research, the physical relocation of Power Engineering to join the Electronic Engineering activities in 2011, further investment in facilities and equipment in the Unit, the development of a research career pathway for research-only staff, and the enhancement of industrially relevant technology development via ERDF funding. This has been accompanied by a substantial increase in research income aided by the appointment of a Research Development Manager focussing on European funding. Specific plans stated in the 2008 RAE submission were:

i. **Use SRIF money to upgrade infrastructure and support diversification into nanoscale and health applications of photonics.**
Since 2008, a total of £3.2M has been invested in the photonics laboratories enabling growth in the telecommunications research activity, the development of fibre laser research and the equipping of three femtosecond laser systems covering a wide range of pulse parameters. Nanoscience work was initiated in 2008 with the appointment of two new lecturers (Ye, Rozhin) whose work is strongly linked to photonics research and power electronics.

ii. **Implement major programmes in short (fs) laser pulse inscription and micromachining**
Work in this area now ranges from fundamental research on short laser pulse interaction with matter, to industrially relevant microfabrication. The first commercial products of this activity (3 dimensional calibration targets of Optical Coherence Tomography machines) are now for sale.

iii. **Widen the applications of its fibre sensor technology**
Polymer fibre sensor technology, has now been matured to the point where there is commercial interest, evidenced by participation in an FP7-STREP (SAFUEL) and the recent award of a Marie Curie Initial Training Network (ITN), which Aston coordinates, involving company partners. Biochemical and medical sensing activities have increased: DNA hybridisation has been detected directly with a long period grating sensor, plasmonic fibre devices have been combined with aptamers to provide specific sensitivity to ultra-low concentrations of e.g. thrombin and a spin-off company, DIASENS, has been formed to exploit optical technology for cardiac and respiratory monitoring.

iv. **Study nanomodification of surfaces, with a range of applications**
Addressed with the creation of the Nanoscience Research Group, with nanoscale devices being developed for gas sensing, laser mode-locking, water purification and power electronics.

v. **Provide surface analytical services to industry via a newly formed spin-off company.**
*Midlands Surface Analysis is successful and is now privately owned by the founder (**J.Sullivan**)*

Staff profile The headcount of staff at REF submission date and the changes since 2008, are as follows: Profs. 8, +3; Readers 3, 0; Senior Lecturers 6, +5; Lecturers 10, +4; RAs/Fellows 26, +10.

Context for strategy and vision

The strategy for the Unit is set considering the University's overall strategy and integrated by the School Research Strategy Committee, constituted by representatives of the institutes and groups (that includes students), as well as Industry Advisers. The Unit contains both a major international institute (AIPT) and several smaller research groups, that require slightly different approaches.

Vision. The Aston 2020 strategy states the aim: "We will build on our reputation for world leading translational research and scholarship focussed around key areas of strength and channelled through our cross disciplinary research centres." Aligned with this, our local vision is to provide:

- A vibrant research community evidencing international influence through extensive international collaboration.

- Select international research partnerships, providing complementary research in key and emerging areas – Russia (International Aston-Novosibirsk University Photonics Centre was formed in 2013 with the infrastructure fully funded by the Russian side), China, Vietnam.
- A critical mass of researchers providing a mix of theory, experiment and modelling expertise. In the case of AIPT we target > 100 researchers.
- An inclusive environment with a diverse cultural and gender makeup.
- A spectrum of activities ranging from blue-sky to industrially-focussed development.
- Structures to help the career progression of researchers at all levels.

The **key research challenges** we intend to address within the various research groups follow:
AIPT, led by **Turitsyn**, will tackle the "capacity" crunch facing society when data use expands to fill the available installed fibre in around 2020. We are also seeking to develop novel devices and systems based on state-of-the-art photonic technology to address industrial and medical sensing problems that conventional technology cannot tackle. **ACNRG**, led by **Blow**, will address the network management and exploitation of networks with variable transmission, hardware and topology. **NRG**, led by **Ye**, will develop functional nanomaterials for applications in personalized medical diagnostics and treatments, energy efficient smart living environment and manufacturing. **PEPERG**, led by **Cross**, will develop new converter circuits and systems to cope with the increasing electrical load on the grid as well as enabling the use of clean, renewable energy sources such as wind-farms and photovoltaics.
External influence The external environment has a significant effect on the directions of the research. Some of these influences are very positive. The University's vision to start photonics research in 1991 was timely, with photonics now recognised by the EU as a Key Enabling Technology and featuring heavily in both FP7 and Horizon 2020, as well as being an important component of EPSRC and TSB plans. The national shortage of electrical and electronic engineers, particularly in the power sector, has helped foster strong relationships between our power engineers and industry, and enhances employment prospects for PhD researchers. Other external actors are challenging. The Unit now accesses more diverse sources of funding from UK, EU, companies and further afield. The approach adopted has been to focus on strengths and build these to a scale that stands alongside groups from larger and more prominent groups elsewhere.
Specific plans The University has focussed effort on nurturing sustainable research institutes of a critical mass, capable of supporting large research projects, able to attract and retain key staff and providing a vibrant environment for research student education. The focus on institutes does not mean that smaller research groups are not valued; indeed they undertake important industrially relevant research in specific areas or in some cases they will act as the nucleus for the growth of an institute in a new field. All research groups will be structured with an appropriate mix of experience and earlier career staff, theoretical and practical specialisms, that all help to ensure a dynamic and comprehensive capability.
In the Unit, the plans being taken to achieve the vision described above are as follows:

- To ensure a regular intake of postgraduate students, we will continue to pursue two options: seeking industrial support for research students and targeting European funding. The latter in particular is proving successful; in 2013 we achieved our first successes in bids for Marie Curie Initial Training Networks, securing two such projects as coordinator. Building on this success we intend under Horizon 2020 to bid for single partner ITNs (which will incorporate significant industrial support). We have improved our Marie Curie success, with training and advice, not just on proposal construction, but on the optimum make-up of project consortia.
- We will continue to focus on projects with high potential of industrial impact to further enhance our reputation with industry, e.g. UNLOC (EPSRC – addressing the capacity crunch in fibre optic telecommunication systems), FALCON (Western Power Distribution – improvements to 11kV network), ITNs (TRIPOD – polymer fibre sensors, ICONE– telecomms), MODE-GAP (FP7 – reduced energy consumption in communication systems).
- We will enhance our international profile, strengthening our capability by collaborating with the best partners. This includes exchanges (e.g. IRSES), extensive conference participation and organisation, COST actions (currently TD1001 where **Sugden** acts as secretary) and collaboration with technology SMEs and key large companies, e.g. Airbus, France Telecom.
- We will increase the number of Principal Investigators, including not just academics but also AIPT fellows (described in section c) and senior postdocs on long term employment contracts.

- We will continue to diversify our sources of funding, to help ensure a steady income stream.
- We will stimulate innovation in new products in industry and exploit Aston intellectual property by taking advantage of the full range of funding mechanisms. We have utilised TSB projects, KTPs, FP7, spin-outs and direct industrial funding, as well as Aston University investment in small scale technology development projects. Initial indications are that our priorities anticipate those in Horizon 2020, which should provide significant future support.
- Plans are in place to optimise the use of laboratory space in the short term, and we plan to move to enlarged consolidated laboratories in the medium term – see section c) for more details.
- We will continue to promote equality – see section d).
- We will increase local administrative support for research. The Institute model of financial sustainability has allowed us to appoint a research administrator and we have extended this activity in autumn 2013 through the appointment of a professional project manager. In addition, at the time of writing we are in the process of appointing a dedicated AIPT technician, freeing time for the existing School technicians to help the other research groups in the Unit.
- We will grow the smaller research groups to appropriate levels. For example two appointments in the last 3 years (Tang and He) have strengthened the ACNRG; PEPERG is in the process of recruiting a senior lecturer and has another position in the current budget, thanks to a burgeoning research portfolio. In the forthcoming REF period we plan to strengthen the NRG which has also already developed a strong international research profile.
- We will strengthen the overlap of our smaller research groups with institutes, to provide them with critical mass. In the Unit this is already well advanced. The NRG shares members and collaborates closely with AIPT on the use of carbon nanotubes in sensors and fibre laser systems and fs lasers are being used to process thin diamond films. ACNRG also shares members with AIPT and uses common simulation tools and methods. PEPERG is a new group and links are being developed with the new Institute for Big Systems Analytics, treating the grid as a complex system. The NRG will benefit from access to expensive fabrication facilities and this is being negotiated via the M5 consortium described in section d.
- Much of the Unit's research is collaborative (evidenced by authors on papers) and interdisciplinary; in 2009 the university funded the creation of a biophotonics laboratory (£350k), bringing together researchers from AIPT and the School of Life and Health Sciences and leading to the demonstration of real-time monitoring of DNA hybridisation using a fibre sensor.

c. People, including:

i. Staffing strategy and staff development

Staffing strategy relationship to the unit's research strategy and physical infrastructure

Academic staff appointments are made with the aim of strengthening the research groups, according to the strategy outlined. The level of experience and responsibilities for each post are also set to balance existing members of the group, to ensure that there is an appropriate mix of experienced and earlier career staff. RAs are usually appointed to fulfil the needs of specific projects, though their long term potential is always considered during the interview process. Within the REF period the following appointments have been made:

- A strategic move (presented in our 2008 RAE submission) was the establishment of a nanoscience group linking in to our photonics research activity. Two appointments at lecturer level were made in 2009 in this area (**Ye** now Reader and **Rozhin** now senior lecturer).
- ACNRG has been strengthened by appointments of lecturers in 2010 and 2012 (**Tang** and **He**).
- PEPERG is similarly being strengthened with a senior lecturer vacancy being advertised in 2013 and a second lecturer post in the budget for a 2014 appointment.
- Following its creation in 2012, AIPT has been strengthened by four professorial research appointments (**Ellis, Doran, Payne** and **Sumetsky**), whose research leadership and expertise has already had significant impact on our grant income. Two former research fellows have progressed to academic contracts following personal fellowships (**Turitsyna** and **Boscolo**). AIPT is also pioneering for the University a research-only career pathway in parallel to the usual research and teaching progression from lecturer to professor. The first two **AIPT Fellows** (equivalent to lecturer) have been appointed **(Zhou** and **Shu)** and it is expected that they will progress through positions equivalent to senior lecturer and reader to become research professors.

Career development support at all stages in research careers

Research fellows and PDRAs Induction and career development follows that for all University staff. All research PDRAs and fellows (including Marie Curie Fellows) complete a "Training Needs Analysis" with their manager. They are advised of career options, enabling them to make timely plans. Generic training is provided at University level eg in personal management, leadership, IP, ethics, proposal writing, sustainability etc. Research Fellows, particularly those seeking academic careers, will also be encouraged to participate in the gestation and preparation of research proposals, with recognition through being named as a research co-investigator. The more advanced AIPT Fellows, are allowed to bid for research funding as PI.

Academic staff Vacancies are advertised widely as well as notified within personal networks, to maximise the potential of recruiting top quality candidates. Applicants are interviewed by a small panel, against specified criteria for the role, so ensuring quality of opportunity and also a balance of skills and interests, experience and early career researchers, to be maintained in the groups. All new academic staff are initially on a 5 year contract with the expectation that these will normally be renewed without end date. Induction is provided for new staff, with online and more personal support from the School. A peer mentoring scheme independent of mangers, is also available.

Specific support for Early Career Researchers (ECRs) is set out in a University policy devised originally in the School. This includes mentoring by an experienced researcher, introductions to appropriate research and user community networks, and specific advice on developing and writing grant proposals, initially as co-investigators if appropriate. All ECRs develop a 5-year research plan, that is reviewed after the first 6 months with the Research Development Manager (RDM). All newly appointed academics have £10k start-up fund and a school-sponsored PhD student to support their research programme. ECRs have a lower teaching commitment in their first two years of appointment. A mutually supportive ECR community is being developed in the Unit.

Academic and research staff attend regular information sessions organised by the EAS Research Development Manager on funding opportunities. Currently these are mainly focussed around Horizon 2020 developments, but sessions have dealt with other funding sources. External speakers have included visitors from UK Research Office, Leverhulme Trust, EU etc.

Career development All staff use the University Performance Development and Reward Scheme, which includes discussion about future research plans, training and opportunities to build experience. All staff are encouraged and supported to achieve promotion, with criteria reflecting, achievements in research alongside generating impact and teaching. To enable staff to continue to develop research careers, major management roles are assigned deputies and normally restricted to a single 3 year term-of office. As evidence of the effectiveness of our career development activities, we note that one former research fellow has been promoted to head of the subject group in 2013 (**Zhang**), while two others have reached reader level (**Williams, Harper**). One former research student is now a senior lecturer and programme director (**Sugden**). Since 2008, 6 academics have been promoted (**Webb, Harper, Ye, Rozhin, Peng, Boscolo, Mezentsev)** while 4 research fellows have been transferred to on-going contracts (**Boscolo** and **Turitsyna** as academics and **Shu** and **Zhou** as AIPT fellows).

The implementation of the Concordat to Support the Career Development of Researchers

Career development is guided by the Researcher Development Framework. As a result of its actions in implementing the Concordat, Aston was among the first tranche of UK institutions to receive the EC Human Resources Excellence in Research Award in 2010. These actions included: (i) documentation in the Reference Guide for Managers of recruitment and support methods for researchers; (ii) specific webpages and a range of activities dedicated to researcher development; (iii) submission to the Athena Swan silver award in support of gender equality. Aston already achieved the Athena Swan bronze award in 2010. Aston's HR Excellence in Research award was renewed in 2012, and has an associated action plan for continuing improvement in researcher development.

Evidence of how the submitting unit supports equality and diversity

This Unit is committed, along with the whole of Aston, to improving the seniority profile by gender and ethnicity especially in science, engineering and technology areas. The University has a well-established equality and diversity policy and code of practice that is adopted by all research students and staff. The Equality Action Plan is reported on and published annually. Within the Unit, meetings and events are organised considering the needs of part-time workers; returners after longer absence are updated appropriately. We have created a Women's Chapter within AIPT: two initiatives arising from that in summer 2013 were a School's outreach event on high speed communication

that both encouraged female applicants and was predominantly taught by female role models, and a lunch for female research students organised as part of the September 2013 AIPT student conference, described later. Personal examples include: The head of EEPE from 2013 (**Zhang**) is of Chinese origin. She came to Aston as a research assistant. The current undergraduate programme director (**Sugden**) is a female former photonics research student. **Turitsyna** (female Russian) returned to academia assisted by a Royal Society, Dorothy Hodgkin fellowship following a career break to raise a family. **Boscolo** (Italian) has recently been promoted to Senior Lecturer, having being on maternity leave in 2008. She is currently working flexibly in accordance with the University Flexible Working Hours Scheme. The Director of AIPT (**Turitsyn**) is Russian and the first AIPT fellows (**Zhou** and **Shu**) are both Chinese. **Sugden** has been selected for the **New Leadership Foundation "Developing Women Leaders for HE"** programme.

Evidence of procedures to stimulate exchanges between academia and industry

As described in the Impact Template in more detail, the Unit has an industry focussed culture and encourages interaction with industry on many levels. Evidence for this includes spin off-company formation, e.g. Astasense (Sugden, Webb, Zhang, Bennion) and the hosting of Royal Society Industrial Research Fellows (Foote, Forysiak) from collaborating companies.

Information on international staff appointments (incoming and outgoing), international recruitment and visiting scholars

Within the REF period, we have continued our tradition of appointing the best international staff possible enabling the development of wider collaborations – eg: from China (Z. Zhang, Li, He, Tang, Ye), Russia (Turitsyna, Sergeyev), Ukraine (Rozhin), Italy (Boscolo). In addition, our ability to attract leading researchers is evidenced by the international make-up of our research fellows (Dr. Churkin, Dr. Dubov, Dr. El-Taher, Dr. Habruseva, Dr. Preciado, Dr. Saez-Rodriguez, Dr Sygletos, Dr. Prilepskiy, Dr. Mou, Dr. W. Zhang, Dr. Farjady, Dr. Giacoumids, Dr. Fowler). The Unit hosts three international visiting professors: Prof. I. Gabitov (Arizona University), Prof. K. Kalli (Cyprus University of Technology) and Prof. A. Okhrimchuk (Prokhorov General Physics Institute, Academy of Science, Moscow).

Since 2008 the Unit has hosted 5 EU Marie Curie IEFs (S. Sergeyev, M. Preciado, T. Habruseva, D. Saez-Rodriguez, D. S. Sygletos) and 3 IIFs (Jianlin. Li, Jianfeng Li, Z. Zhang).

In the last 5 years, the Unit has hosted over 170 visitors. In that time we have published joint papers with more than 60 collaborating institutions and companies worldwide.

(ii) Research students

Recruitment

The Unit aims to recruit the very best research students internationally. Key to this is good publicity and we make use of a variety of mechanisms, including the EURAXESS web site, COST networks and our wide array of collaborators in leading UK and overseas institutions. After initial checks of formal qualifications, all students are interviewed by their prospective supervisors and a second member of academic staff. All PhD supervisors are (re)trained at 3-yearly intervals. Students are assessed to ensure they have the academic potential and personal qualities needed to succeed in research. Student stipends come from the School, industry, CASE awards, the students themselves and increasingly the European Commission, e.g. via Marie Curie Initial Training Networks, and international partnerships, e.g. VN-UK University in Vietnam.

Training and support mechanisms

All research students at Aston automatically become members of the University's "Graduate School". Established in 2010, this now provides a supportive environment for research students across the University with a view to widening and enriching their experience during their research studies. It also brings together the responsibility for maintaining the Quality Assurance of research studies and the development of training in core research and transferable skills thus enabling all research students studying at Aston to realise their full potential, whichever career path they choose. The Graduate School has produced a comprehensive "handbook" for all research students that covers both formal University requirements as well as practical help for students new to Aston and the City. All new students have the option of a peer mentor to help in their first few months.

After enrolment, students attend induction sessions in the Graduate School and EAS, where they are introduced to key University staff, and academic and support staff responsible for the PhD programme. Initially, an outline project proposal is drawn up between supervisor and student at the application stage or soon after. At least one associate supervisor is also appointed. Students complete a "training needs analysis", aligned with the Researcher Development Framework. They

also draw up a "Learning agreement" with their supervisor which expands on the outline PhD topic proposal and defines mutual responsibilities and ownership of research outputs. PhD students meet with supervisors frequently (weekly/fortnightly) for discussion and feedback.
Research students can access a variety of transferrable skills and personal development courses through the University's "ResearcherPlus" facility. These courses enable them to conduct research more effectively and succeed in their degree programme, also build up ability and skills that will prepare them for future employment. The courses include Personal Effectiveness and Research Governance aspects of the Concordat: Personal Skills and Effectiveness, Professional and Career Development Skills, Working with Others, Communication Skills, Business Skills, Academic Writing Skills, IT Skills. Towards the end of their PhD, students are supported in finding employment either in academia or elsewhere to match their individual interests, eg with CV preparation and interview skills appropriate to PhD level people. Language courses are also an option. Research students are required to complete at least 90 skills/training hours by the time of submission.

Generic training for Engineering research students is also delivered through a 3 day School-wide Research Skills and Professional Development module. Many PhD students are trained and contribute to laboratory teaching, to enhance their career prospects and improve communication skills. In addition, PhD students build discipline specific knowledge within their group and also via modules from research MSc degrees (MSc Mathematics of Complex Systems, MAsters on Photonic NETworks engineering (MAPNET) etc). MAPNET is a prestigious Masters programme collaboration with the Scuola Superiore Sant'Anna (Pisa, Italy) and the Technische Universität Berlin (Germany), awarded by the European Union's Erasmus Mundus Programme. From 2014 all PhD students will be able to take advantage of some of the high quality, industrially focussed training provided by our two Marie Curie ITNs. PhD students are encouraged to support and participate in local events, such as those organised by professional institutions eg Institution of Engineering and Technology (IET), especially "outreach" to schools and the community.
A Research Student Society was established in 2008 to promote both formal and informal events that bring all research students together on a regular basis, for example for an annual poster day; this has been so successful that the Graduate School has developed similar societies in the other three schools. The student experience within the Unit is enhanced by contact with our numerous visitors. Regular research group seminars help to foster a group-wide collaborative approach to research and give students the opportunity to present their own ideas in a supportive and helpful environment. Its critical mass has enabled the AIPT students in 2013 to organise a conference targeting photonics students throughout the UK. All students are given advice and experience in presenting conference papers and writing journal papers; conference attendance is supported up to £1500 by the School. Evidence for the quality of the support comes from externally awarded prizes e.g. a photonics student won the Midlands and UK heats of the IET competition (May 2011).
With the formation of the AIPT, alongside other Groups, the Unit is increasingly integrating PhD recruitment and training into a "cohort approach", exploiting mechanisms such as Marie Curie Initial Training Networks, of which the Unit currently coordinates 2, and establishment of joint PhD programmes with overseas partners including Novosibirsk State Univeristy (Russia), University of DaNang (Vietnam), Scuola Superiore Sant'Anna (Pisa, Italy), Osaka University (Japan) and the Technische Universität Berlin (Germany). Where possible, the Unit aims to offer PhD students with experience of working for a period in an overseas laboratory.

Progress Monitoring

Formal progress monitoring of PhD students follows the University regulations and policies. Recorded meetings are held 3 monthly, together with yearly reporting by both students and supervisors. EAS requires all research students to pass the Research Skills module in their first year. The first year is assessed by a viva voce examination and a Qualifying Report (approximately 6-10k words), which students are required to pass to before formally being registered for a PhD. The Graduate School has introduced a new progression monitoring policy requiring all second year students to prepare either an article for submission to a peer-reviewed journal or to give a conference paper to members of their academic subject group. Critical feedback on the paper or presentation is provided by the supervisory team. All reviews provide students with the opportunity to provide feedback and highlight any difficulties and, in the few cases where problems arise, these are investigated by the Associate Dean for Research and the Director of Research Degrees. If required, independent counselling services are also provided by the Aston Student Hub and the Mature students' support group.

d. Income, infrastructure and facilities

Evidence of the successful generation of research income

EPEE has a current portfolio of grant funding, illustrative of our strategy to diversify sources of income. Funding comes from the Research Council, EU, charities and the TSB and supports fundamental research, applied research with industry and knowledge transfer activities.

The current EU funding includes: **9 FP7 Marie Curie IIF/IEF projects** (€3.2M) in the field of mid-infrared fibre lasers, communications, mode-locked fibre lasers, photonic materials, nano-science and sensing applications. **Four FP7 IRSES projects** (€1.1M) link EEPE research to world leading international centres in the areas of photonic materials, laser systems and wireless communication networks. The **FP7 Industry Academia Partnerships and Pathways project** GRIFFON (€1.5M) coordinated by AIPT is an example of international academia-industry collaboration in green technology networks. **Two FP7 Initial Training Network** (ITN) projects (€5m total, €1.2M to Aston), both coordinated by EEPE, help recruitment of the best international PhD students. **Two FP7 ICT projects**: (€871k) are aligned with the AIPT activities in integrative photonic technologies and access-network applications. The **ERC Advanced Investigator Project** ULTRALASER (€1.7M) was awarded to AIPT Director Prof. S. K. Turitsyn for ground breaking concepts in lasers and communications. Recently awarded **EPSRC grants** include: the £4.5M UNLOC Programme Grant with UCL (£2.1M to Aston); Wideband Optical Communication Systems Using Phase-Sensitive/Insensitive Fibre Optical Parametric Amplifiers (£652k); Grating and waveguide plasmonic sensors (£511k): HIPNET (£200k): Nanoscience first grant (£100k). The **European Regional Development Fund (ERDF)** project (£1.4M) aiming at business assists and collaboration with West Midlands SMEs (**25** in the new Phase 2 project (£300k) and **60 SMEs** assisted in Phase 1) demonstrates how translational research assists local SMEs. There is also direct funding from industry (e.g. Xyratex £100k, BlackBerry £43k). A number of other industrial and international projects include grants/contracts from: The Royal Society, US Air Force, Arden Photonics, Astasense, Oclaro, Rostelecom (Russia), EPSRC KT Challenge, Knowledge Transfer Partnership projects, EPSRC CASE studentships, EPSRC Dorothy Hodgkin Award, NATO, the Royal Academy of Engineering, British Council and others.

PEPERG is a new research group but in just less than three years its income has grown to total £1.3M, accomplished by direct collaboration with industrial partners such as Alstom Grid, Western Power Distribution and with funding from EPSRC, TSB and the Low Carbon Network Fund.

Over the last 5 years, funding to this UNIT has grown from £0.29M in 2008 to £2.4M for the first half of 2013 and now comes from a spread of sources, in line with our strategy.

Operational infrastructure supporting research

Since 2008, the Unit has benefitted from investment by the university of £3.2M in new equipment and the creation of laboratory space. All the Unit's activity is housed within the North Wing of the Main Building at Aston. Grant successes and the increase in research staff in the Unit in the period 2011-13 have led to the need for more laboratory space; in the medium term (2015), the Groups will all move to refurbished laboratories and offices in Aston's Main Building. This move will provide an additional 885m^2 of space following investment in infrastructure, offices and labs of £1.5M. This move will enable modernisation of facilities and a closer integration of staff, research students and laboratory space to facilitate collaborative work. In the meantime, space is being managed carefully considering project needs and priorities. The Groups are already well equipped at Aston; examples of dedicated equipment and facilities in the Unit's research groups are as follows:

<u>The Aston Institute of Photonic Technologies (AIPT)</u>

AIPT is accommodated in 29 laboratories including class 10,000 clean room facilities for photonic processing and nanofabrication. Major facilities include 4 UV and 3 fs laser systems for inscription and machining, test sets for communications up to 40 GB/s, biophotonics laboratory and environmental test facilities, all supported by a wide range of photonic and electronic test and measurement equipment.

<u>Adaptive Communications Networks Research Group (ACNRG)</u>

ACNRG has extensive simulation facilities for modelling the behaviour of networks and concurrent systems. CAD facilities are used to prototype both conventional and HDL based designs, which are then implemented using state-of-the-art FPGAs including SoC (System on Chip) devices and miniature wireless sensor nodes, or DSP devices. Graphics processing boards are used for parallel computation. There is a dedicated research laboratory.

<u>Nanoscience Research Group (NRG)</u>

The facilities include: Chemical Vapour Deposition, Electrospin, Hall Effect Measurement, Surface Contact Angle Measurement, Photolithography, Sputtering, UV-Near IR absorption/transmission Spectroscopy, Photoluminescence Excitation-Emission Spectroscopy, Micro Raman Spectroscopy, Laser Ablation Systems, Ultrasonic Processors, Ultracentrifuge.

Power Electronics and Power Engineering Research Group (PEPERG)

Three high-speed LeCroy Oscilloscopes with current and high-voltage differential probes. Several high current bench supplies, arbitrary waveform generators and electronic loads. A new 5 Hz-50 MHz combined network analyser and impedance analyser has just been purchased by the Group. There are rapid prototyping facilities - both DSPace and OPAL-RT systems - and surface-mount equipment for prototype development. The group has various simulation packages.

Increasingly, as a member of the M5 consortium, the University aims to share major equipment and facilities for greater research effectiveness (http://www.m5universities.ac.uk/facilities/).

Evidence of investments (both current and planned) in infrastructure and facilities

The formation and growth of AIPT has been supported by significant investment by the University with refurbishment of laboratories and offices (£400k), creation of new laboratories for biophotonics, fibre lasers and communications (£800k), purchase of fs laser systems (£1.3M), and creation of additional research office space.

The formation of the NRG was seeded with the investment by the University of £500k in equipment and £70k in laboratory refurbishment. Anticipated future investment has been summarised above.

e. Collaboration or contribution to the discipline or research base – non-exhaustive list

Collaborative arrangements

Virtually all our research is collaborative, involving both industry and academia, with much of it international in scope. As an indication, we have had more than 170 research visitors working at Aston for more than a few days in the REF period and published papers with more than 60 other institutions. Further evidence appears at the start of section d) above. Directorships of research focussed Technology Companies in the REF period – Astasense (Sugden, Webb, Zhang), Astelics (Sugden, Harper, Shu), Pilot Photonics (Ellis).

Membership of research councils or university research advisory panels

Member of Abilitazione Scientifica Nazionale (Italy – Turitsyn) University Research Advisory Panel (Turitsyn, Novosibirsk).

Leading positions in professional subject associations etc.

Member of IET Professional Development Board (Sugden); Secretary and Chair of IoP Signal Processing, Electronics and Communications Group (Blow); Editorships: Optics Express & Journal of Optical Communications and Networking (Ellis), Optical Engineering (Webb), Photonic Sensors (Zhang & Webb), International Journal of Smart and Nanomaterials (Zhang), Board of Journal of Modern Optics (Blow), Wireless Communication and Mobile Computing (He), International Journal of Communication Systems (He), KSII Transactions on Internet and Information Systems (He); PhD examination in Hong Kong (Webb x2), Belgium (Webb), Denmark (Webb); Senior Membership – FInstP (Blow, Turitsyn), SMIEEE (Peng, He, Turitsyn), FOSA (Turitsyn).

Organisation of conferences and scholarly encounters

Examples: OFC TPC (Zhang, Ellis), ECOC TPC (Ellis), CLEO Europe TPC (Sugden, Ellis, Turitsyn), Int. Conference on Optical Fiber Sensors TPC (Webb), OSA Topical Meetings (Zhang, Blow, Turitsyn), General Chair of Int. Conference on Advanced Infocomm Technology (He)

Refereeing academic publications or research proposals

All research active staff undertake journal and conference paper refereeing duties. Most review proposals, some from overseas funding bodies (Turitsyn, Blow, Ellis, Webb, Saez).

Scholarly awards or fellowships

Dorothy Hodgkin Fellowships (Turitsyna); EPSRC Advanced Fellowship (Derevyanko); Leverhulme Trust Early Career Fellowship (Boscolo); Royal Society Wolfson Merit Fellowships (Turitsyn, Ellis); Royal Society Industrial Research Fellows (Foote from BAE Systems and Forysiak from Oclaro); IEEE Photonics Society Distinguished Lecturer (Ellis)

Most recent invited keynotes, lectures and/or performances.

Ellis, “Current Capacity Limits and Activities within the EU Project MODE-GAP to Overcome them”, Keynote in Proc. IEEE Summer topical meeting on Spatial Multiplexing, (2012). Keynote at Zaytoonah University International Engineering Conference on Design and Innovation in Infrastructure 2012,(Strickland), fully funded Keynote in Osaka (Blow – EDIS 2013).