Institution: University of Surrey

Unit of Assessment: UOA 9 Physics

a. Overview The Department of Physics at Surrey provides a vibrant research environment. Since 2008, we have formed a new Astrophysics Group, created six new academic posts, funded five academic staff with industrial input, won 13 fellowships, and co-founded a strong regional network (SEPnet). Our Category A-*eligible* staff (*CAS*) are organised into six research groups:
(1) Astrophysics Group (**APG**), led by Gieles, was formed in 2013 with four *CAS* to broaden the scope of the Department's research. They use specialised software and hardware to run state-of-the-art simulations of star clusters, galaxies, black holes, and the Universe as whole. Comparing their simulations with the latest observational data, they place new constraints on star and galaxy formation models and on the nature of dark matter.
(2) Nuclear Physics Group (**NPG**), led by Catford (experiment) and Tostevin (theory), is the largest UK group of its kind. NPG combines theoretical and experimental research at the forefront of basic nuclear physics. The theorists (six *CAS* and one emeritus (*em*.)) have expertise in many-body methods for nuclear structure and reaction dynamics, with an emphasis on support of experiments. The experimentalists (five *CAS* and one *em*.) employ gamma-ray and charged particle spectroscopy at overseas radioactive ion beam facilities to test the limits of nuclear stability and to study nuclear processes in stars.
(3) Photonics Group (**PG**) (five *CAS* and one *em.*) and the **(4) Theory and Computation Group** (**TCG**) (3 *CAS*) are both based in the interdisciplinary Advanced Technology Institute (ATI). Led by Sweeney, PG has a long history of experimental research on photonic materials and devices: from basic physics through to commercial application. Topics include quantum superposition of electron orbits in P-doped silicon for quantum computing and efficient devices, *e.g*. photovoltaics and lasers for energy, communications and sensing applications. TCG, led by Kearney (former Dean of the Faculty, now PVC), has a theoretical focus on topics including non-crystallographic photonic bandgap materials, quantum optics, and quantum computing with superconducting devices.
(5) Radiation and Medical Physics Group (**RMG**) is led by Bradley. The research of four *CAS* and three *em*. explores the properties and interactions of radiation in a range of medical and industrial applications. They develop detector materials and technologies, measure environmental radioactivity, and study biophysical properties of tissues.
(6) Soft Matter Group (**SMG**), led by Keddie, carries out a combination of experimental (four *CAS*) and computational (three *CAS*) research to answer questions about the structure, properties and dynamics of soft systems. Topics are nucleation, elastomers, nanomaterials (especially containing carbon), polymer colloids, and water dynamics in porous media.

b. Research strategy

Strategic Developments since 2008: Surrey Physics research is flourishing as a result of our strategic investment and staff development over the period. Our numbers have grown from 29 academic staff in 2008 to 33 in 2013. Our Research Strategy Committee (chaired by Walker) successfully implemented a four-pronged strategy: (**1**) to broaden our research portfolio by establishing the Astrophysics Group; (**2**) to build regional alliances through the South East Physics Network (SEPnet); (**3**) to form strategic partnerships with research organisations; and (**4**) to attract talented researchers on fellowships and nurture collaborations via sabbatical visits. (See Sect. c.)

(**1**) We identified the potential for a new research group to build synergistic links with the renowned Surrey Space Centre and with our nuclear astrophysicists in NPG. We also envisaged that a new Physics with Astronomy degree would make a positive impact on undergraduate intake, feeding through to our PhD student recruitment. To this end, we created APG with University investment. An Advisory Board with three external members, and with input from SEPnet colleagues, guided the strategic recruitment of two professors: Gieles (Royal Society (RS) University Research Fellow, *ex* Cambridge) and Read (*ex* ETH Zürich) in computational galaxy dynamics, an area chosen to complement existing SEPnet and UK astrophysics research. Gieles and Read oversaw the recruitment of two lecturers, Agertz (*ex* Chicago) and Gualandris (*ex* Leicester), and two PDR fellows. Gieles' €1.5M ERC Starting Grant enabled two PDRAs to be hired, and a new lecturer appointment is planned for 2014.

(**2**) The creation of SEPnet with a HEFCE grant of £12.5M plus Departmental investment have enabled our specific detailed plans articulated in RAE2008 to be realised in full:

- A SEPnet lecturer in radiation detector materials, Lohstroh (submitted to UoA 13), was appointed in 2008 to support research in RMG and to build links with particle physicists in

SEPnet. She leads SEPnet's Radiation Detection and Instrumentation theme, which supports a regional MSc degree with strong industrial input that opens new research funding streams.

- A SEPnet lecturer in soft matter theory, Adams (*ex* Cambridge), was appointed in 2009 to strengthen links across the region in the Condensed Matter theme of SEPNet. He is an expert in modelling polymer fluids and elastomers.
- A SEPnet lecturer in functional materials synthesis, Jarowski (*ex* ETH Zürich, submitted to UoA 13) was appointed in 2009 to enhance photonics research within the ATI and the wider region.
- A nuclear theory lecturer, Barbieri (*ex* RIKEN, Japan), was appointed in 2010 to reinforce Surrey's unique theory/experiment balance following Oi's return to Japan (Senshu).
- A medical physics reader, Bradley (*ex* Exeter), was appointed to contribute to the University's health agenda and to strengthen tissue analysis and dosimetry.

(**3**) As part of our research strategy to ensure vitality and sustainability, we have forged formal partnerships with two research organisations:
(i) *National Physical Laboratory* (NPL): An institution-level Memorandum of Understanding (MoU) between NPL and Surrey is underpinning (1) a part-time (0.4 FTE) secondment for Allam (PG) in ferromagnetic materials; (2) NPL/Surrey's first chair in Radionuclide Metrology for Regan (NPG); and (3) a jointly-appointed new lectureship for Lotay, a nuclear astrophysicist (*ex* Edinburgh).
(ii) *AWE Aldermaston*: an institutional MoU with AWE underpinned (1) Walker's AWE Penney Fellowship (2006-12) in nuclear structure, followed by (2) Sellin's Penney Fellowship (2013-16) in the National Nuclear Security division, which supports a PDRA in RMG and a package of PhD and MSc studentships.

These developments, coupled with our staffing strategy and key research collaborations (Sect. c, d), have aligned our Department with the University strategy to be in the top 10 UK universities.

Future strategy: Developed by our Faculty's and Department's Research Committees, our future strategy has three key elements:
(1) We will pro-actively engage with policy-makers and funding bodies (EPSRC, STFC, EC Horizon 2020) to influence and shape funding calls and priority areas.
(2) We will consolidate a balanced portfolio of both applied and fundamental research, exploiting strengths within, and linkages between, research groups. For instance, collaborations will grow between TCG, PG and SMG in the design of photonic materials using polymer and carbon nanomaterials and also at the APG/NPG interface in the calibration of stellar evolution codes.
(3) We will align our research with funding body priorities on topics where there is a critical mass of research excellence. Specifically, PG, TCG and SMG will align with EPSRC priorities in Energy, Functional Materials, and Quantum Technologies and with the Photonics Roadmap. NPG and APG will align with STFC's Advisory Panels' strategies. RMG will exploit STFC Innovation Partnerships and align with NIHR, Cancer Research UK, and AWE/MoD security themes.

A key platform for ensuring sustainability is our membership in Phase Two of SEPnet. For the five-year period starting in 2013, HEFCE has awarded £2.75M (with additional £9M funding committed from the partners) to create a regional Physics Graduate Network (GradNet) to support outreach and employer liaison activities across the region, and to deepen research collaboration through jointly-sponsored PhD projects. We take a lead role in GradNet with McDonald (SMG, submitted to UoA 13) appointed as the 0.5 FTE SEPnet-funded Director. Staff from Surrey's Researcher Development Programme will spread their best practice across the nine partner universities. SEPnet has also established two new posts: a Diversity Leader (0.3 FTE) and an Impact Leader (0.2 FTE) who will both contribute to sustainability of physics in the region.

APG plans to attract a new stream of STFC funding through a consolidated grant bid in 2014. The first quota studentships are expected in 2015. APG research aims are well-aligned with key STFC roadmap questions: How did the Milky Way form and evolve? How did star clusters and galaxies form? And how do supermassive black holes form? To address these questions, they have two strategies bolstered by support from Gieles' ERC Starting Grant: (i) to build in-house bespoke supercomputers with specialised software; and (ii) to use these to run massively multi-scale simulations that follow the co-evolution of star clusters on a star-by-star basis (Gieles and Gualandris) and the host galaxy (Agertz) within its full cosmological context (Read), for the first time. Comparing these state-of-the-art simulations with observational data from new ground-based and satellite missions, *e.g*. ESA Gaia and ALMA, they will place new constraints on star and galaxy formation models, and on the nature of dark matter. APG plan to attract fellowship holders with

expertise in data mining and observational data reduction to complement existing skills. A Canadian FRQNT Fellow (Henault-Brunet), working on dynamics of young massive clusters, has already joined them.

NPG will consolidate a strong position at FAIR (the new international accelerator facility where the UK became an associate member in 2013), take leading roles in new developments of the ISOL method for radioactive-beam science at CERN-ISOLDE, and continue to exploit opportunities at RIKEN. Many-body theoretical efforts will be expanded and further integrated with reactions work. NPG will strengthen links between their STFC research support and their AWE and NPL activities. Lotay's recent appointment will strengthen NPL collaborations and NPG's nuclear astrophysics research plus provide links to APG.

PG and **TCG** have worked closely together to strengthen activities in fundamental aspects of coherent control of photons, quantum information, spintronics, non-linear optics and electronic and photonic band-structure. They are ideally placed to exploit the new EPSRC theme of "Quantum Physics For New Quantum Technologies" working with their new materials and technologies, like non-crystallographic photonic materials, circuit QED with squeezed states, and topological superconductors/insulators, while developing new atomic-scale devices in industry-compatible silicon. They have expanded work in photovoltaics and high efficiency lasers, and going forward will place greater emphasis on photonics for energy and space applications (*e.g.* with EADS-Astrium as a strategic partner) and on the convergence of photonics and electronics.

RMG will target STFC/EPSRC funding related to detector development, medical imaging, nuclear energy, and security projects. Collaboration with the Royal Surrey County Hospital (RSCH) will build on current strong collaborations with NIHR and Cancer UK, through a joint appointment at RSCH. Applied nuclear work in environmental radiation, nuclear metrology and nuclear energy will be developed from the new joint appointments with NPL (Regan and Lotay) and through collaboration with IAEA Vienna. AWE's William Penney Fellowship (for Sellin) will support a new Centre for Nuclear Security Detection at Surrey for the next six years. RMG's existing links to industrial partners will be strengthened, *e.g.* Culham, RAL, Tracerco, and Centronic.

SMG foresees expansion of research at the interface with cell biology, led by Sear, and on liquid crystal elastomers, led by Adams, and materials for energy storage, led by the new EPSRC Fellow, Jurewicz. Work will continue on topics of existing strength*, e.g.* water dynamics in porous media and nanomaterials. Continued investment from multi-national companies (*e.g*. BASF, MSOLV, Avery Dennison) and the EC is expected to support colloids and nanomaterials research. Funding from the NANOCEM Consortium (via Horizon 2020) will support NMR studies of water dynamics in porous media. Research on quantum effects in biology will be a growth area led by Al-Khalili.

c. People, including:

i. Staffing strategy and staff development. We take pride in providing a welcoming and collegial environment for all. Administrative and teaching workloads are shared equitably and transparently. Three key planks of our staffing strategy are (**1**) to strengthen and grow targeted research topics through appointments; (**2**) to win externally-funded fellowships; and (**3**) to use sabbatical leave to foster (inter)national collaborations.

(**1**) Since 2008 we have made 15 academic appointments: three SEPnet; four APG; three other newly-created posts; and five replacing departing staff. **NPG** has invigorated theory activities with a lecturer appointment (Barbieri) and STFC Fellow (Rios) and experimental activity with a lecturer, Lotay (40% funded by NPL) to support Regan's Chair in Radionuclide Metrology (60% funded by NPL). In the next five years, there will be appointments in both areas as part of succession planning. In line with the **APG** strategy of simulations across multiple scales, they hired two new lecturers: Agertz, a specialist in numerical galaxy formation, and Gualandris, a specialist in numerical models of orbital motion around black holes. **PG** has appointed a synthetic chemist (Jarowski) to develop new optical materials and a spintronic device expert (Clowes, *ex* EPSRC AF) to complement existing spin physics activity. With the departure of Hess to a Leverhulme Chair at Imperial, the strategy was to use new appointments to re-focus photonics theory towards quantum technology (Ginossar, *ex* Yale) and nanophotonics (Florescu, *ex* Princeton).

(**2**) The quality of fellowship applications has been raised through the University's mandatory internal peer review process and mock interviews. This strategy has successfully led to a total of *thirteen* fellowships for newly-appointed (the first six listed below) *and* existing staff:

- Jurewicz (SMG), a Surrey PhD graduate, won an EPRSC PD Fellowship (2013-16) on carbon

materials for applications in energy storage, which is a clear success of the fellowship strategy.

- Rios Huguet (NPG) won a five-year STFC Advanced Fellowship (2011) in theoretical nuclear physics, with our support in the proposal, after joining the Department as a Marie Curie fellow.
- Lotay (NPG) joined as a lecturer with an STFC Rutherford Fellowship (2012-17) in experimental nuclear astrophysics, which provides a link to APG interests.
- Ginnosar (TCG) joined the Department as a lecturer with an EPSRC fellowship on quantum electrodynamics (2012-15), which shapes the re-focussing of TCG research.
- Gieles (APG) joined as a professor with an RS University Research Fellowship lasting to 2014.
- Clowes (PG) held an EPRSC Advanced Fellowship (2007-12) on non-magnetic semiconductor spintronics and was appointed a lecturer at its conclusion, to lead PG spintronics research.
- Sweeney (PG) won an EPSRC Leadership Fellowship (2010-15) in efficient photonic devices for near- and mid-infrared applications**.**
- Al-Khalili's (NPG) *two* successive EPSRC Senior Media Fellowships (2006-11) were used to develop radio and television programmes to communicate science to the public in collaboration with the BBC and Channel 4.
- Murdin (PG) won a RS Wolfson Merit Award (2012-16) for silicon quantum optics and quantum information processing.
- Walker (NPG) and Sellin (RMG) held/hold prestigious AWE William Penney Fellowships (as described in Sect. a).

(**3**) Career development of established academics is supported through Surrey's Sabbatical Leave Scheme. This is an essential feature of the University's commitment to strengthening staff expertise. Research in Physics has been enhanced through sabbatical leave and (inter)national appointments to other universities/industries:

- McDonald (SMG) spent one year at Ecole Polytechnique Federale de Lausanne (EPFL) where he collaborated in an internationally-leading research group in porous media.
- Tostevin (NPG) spent a sabbatical in 2012 at the National Superconducting Cyclotron Laboratory, Michigan State Univ., USA, where he is an Adjunct Prof. He held a three-month, competitive Visiting Fellowship at the Tokyo Institute of Technology in 2010.
- Sweeney (PG) spent extended periods at Arizona State Univ. (USA) where he built up a funded international network on Bi-containing semiconductors and at Univ. of Marburg (DE), where he worked on photonic III-V materials integration with Si electronics, leading to a large FP7 project.
- Walker (NPG) spent a year at CERN (2011/12) and held a CERN Associate Award.
- Allam (PG) has been seconded (0.4 FTE) to work at the NPL, where he has developed new activities on ferromagnetic materials.
- Jarowski (PG) spent six months on leave in the Lab. for Molecular Design at EPFL.
- Bradley (RMG) spent two periods of leave at the Univ. of Malaya (autumn 2012 and 2013) to use specialist facilities for the production of doped fibres to support a major collaboration on thermoluminescence radiation dosimeters. He is a Visiting Prof. at King Saud University.
- Adams (SMG) spent one month at the Newton Institute, Cambridge (as a Fitzwilliam College Fellow) in conjunction with his invitation to the Mathematics of Liquid Crystal programme.

84 visiting scholars have enriched our research. Visiting professors include Markys Cain (NPL Fellow), J..Jeff Carroll (Army Research Lab, USA), Andrew Carter (Chief Scientist, Oclaro), Peter Thompson (AWE Dist. Scientist), Michael Wiescher (Notre Dame, USA), Furong Xu (Peking, China), and Ken Young (Royal Surrey County Hospital).

We recognise excellence in research through staff promotions. Since 2008, there have been six promotions to Professor (Keddie, Regan, Bradley, Sellin, Sweeney, Podolyak), two to Reader, and three to Senior Lecturer.

Equality and Diversity: We actively engaged in the University's successful submission for an Athena SWAN Bronze Award in 2013 and we are an IOP Juno Project Supporter. A Department Working Group prepared an application for Juno Practitioner, which was submitted in November 2013. In our appointments of lecturers and professors, we advertise widely and encourage applications from under-represented groups, particularly women. We appointed during the period three female lecturers, increasing our staff diversity. Support for part-time staff, and those whose career has been interrupted, is addressed in the University flexible working policy. We offer staff returning from maternity or paternity leave flexible working times. Looking ahead, SEPnet's Diversity Leader will drive a collaborative strategy to increase diversity across the network by

sharing best practice and to support our Athena SWAN Silver Award application.
Staff Development: We pair up new lecturers and ECRs with a Senior Colleague to offer advice on the development of a research career. Lecturers are on probation for their first three years. They attend training in teaching methods during this period. Our support for probationers has contributed to a 100% success rate for EPSRC First Grant applications by four ECRs. Teaching loads are gradually ramped up over the probation period. Our new lecturers are provided with PhD studentships by their research groups.

Every staff member has a formal appraisal with a line manager annually in the Staff Development Review process. Targets are set for publications in top quartile journals, submission of research proposals, income generation, PhD student progression, and engagement with the University's on-line repository (E-prints) to make their research results widely available to end-users. A peer review process is in place to boost success rates in grant applications.

Strategy for researcher development is led by the Deputy VC (Research and Innovation) with input from academic faculties and the units responsible for career development and transferable skills training. Surrey's Researcher Development Programme (RDP) is delivered by a central specialist team (five staff) coordinating transferable skills training for PGR students from all faculties working with input from the Careers Service, Staff Development, Research and Enterprise Services, and the Dept. for Higher Education. A training programme and support are provided for ECRs in post-doctoral research (PDR) posts integrated with staff development provision for academic staff. The PDR programme consists of 16 workshops, covering research project management, publication, funding and impact. It has grown over the years, with 181 attendees in 2011-12. A Research Staff Lunchtime Series provides busy research staff with an opportunity for discussions with experienced researchers. In 2011, Surrey developed an action plan and undertook gap analysis to support the implementation of The Concordat to Support the Career Development of Researchers. The University continues to invest in making excellent progress on initiatives to improve the areas indicated in the gap analysis. The RDP staff serve on the Vitae SE Hub Steering Committee, initiated a Hub Trainer's Forum, and – at the national level - contributed to the Vitae Intrapeneurship project. The RDP is fully compliant with the Vitae RD Framework and incorporates the precepts of The Concordat.

ii. Research students. Since 2008, we have awarded an average of 20 PhDs per year (105 in total) funded by Research Councils (PPARC, STFC, EPSRC), EC, industry (*ca*. 10%), and overseas governments or universities (*ca.* 25%). Our *current* population of 87 PhD students (Oct. 2013) is maintained by increased support from industrial (co)sponsors (23%) and overseas bodies (27%) and is 26 more than in the RAE2008 census. Regional collaborations have been facilitated through ten SEPnet PhD research projects, jointly supervised with partner universities. Additionally, PG, SMG and RMG staff supervise 9 EngD students in Surrey's EPSRC Industrial Doctorate Centre (IDC) in Micro- and NanoMaterials and Technology. NPG supervises two students in the IDC in Nuclear Engineering, led by Manchester.

Oversight of postgraduate researcher (PGR) recruitment, training, progress monitoring, and quality rests with the Research Degrees Committee, chaired by the Deputy VC (Research and Innovation), which reports to the University Senate. The Faculty has a Graduate School Director (reporting to the Dean) responsible for PGR admissions, progress, examinations, review and progression, and records. Our Director of Postgraduate Studies oversees student progression. Each PhD student submits a six-month report to summarise achievements and training activities with a self-assessment of their progress; supervisors make an independent assessment. An unsatisfactory outcome at an annual review will result in the initiation of unsatisfactory academic progress procedures.
Supervision and Progression: All students have a primary supervisor plus a second one, often outside of Physics in interdisciplinary projects. Supervisors undertake training offered by the RDP. At least one of the supervisors must have previously supervised a PhD student through to successful completion. PGRs are accepted on probation and after one year must submit a formal Confirmation Report to summarise achievements and to outline thesis plans. Two internal examiners interview the student and make a recommendation for training, support and progression. Problem areas are identified, and an action plan is developed to ensure timely completion. PGR progress and training are overseen by the Faculty Graduate School committee, which meets monthly and is attended by our Director of Postgraduate Studies.

Training: The RDP is the primary source of research and transferable skills training. Four trainers (with PhDs) offer *ca.* 200 workshops per year with content compliant with the Vitae Researcher Development Framework (RDF). Two RDP workshops are compulsory for all PhD students: "Welcome to YOUR PhD" and "The Confirmation Process." At the "Welcome" workshop there is an on-line analysis of training needs, delivered by Surrey Action Planner, which allows skills assessment against the areas of the RDF to produce a customised list of recommended training courses. 89% of PGRs reported the Planner to be helpful; 87.5% said that the workshop had a positive impact. In year three, students are prepared by an RDP course on 'The Viva Examination' and by a suite of training on advanced project planning and writing ('Finishing Up and Moving On'). Thesis Writing Retreats are offered to overcome hurdles. 'Success Beyond Surrey' prepares PGRs for careers. Off-campus support uses online resources, Skills Portal links, and social media.

Training takes a variety of other forms, depending on the particular research topic. Several students take training offered by the IDCs. Also, training is offered through a Marie Curie Training Network (TRANSCEND). Students are encouraged to attend summer/ winter schools, such as those organised by IOP Groups and international bodies. We offer PGR lectures on specialist topics, including Advanced Quantum Physics and Nuclear Experimental Techniques. PhD students are encouraged to attend MSc lectures, as are appropriate to their research topic, on Radiation/Medical Physics, Advanced Materials, and Nanotechnology. The National Instruments Academy, which we founded and host, provides training and workshops on instrumentation. PGRs present research to their peers at Surrey's annual PGR Conference. Similarly, SEPnet organised videoconferences, a two-day "Grand Challenges in Physics" meeting where PGRs presented posters and lectures, and the "Condensed Matter in the City" meetings. PGRs broaden their exposure by attending regular seminars with external speakers, offered by the ATI, RMG, NPG and SMG, plus IOP South Central Branch lectures. The Physics Research Forum, which meets quarterly, gives PhD students an opportunity to share experiences and information.

Recruitment: We recruit excellent candidates, *e.g.* winners of the IOP Nuclear Physics Group (x2) and Polymer Physics Group student prizes, and a SET Physics Student of the Year finalist. We advertise SEPnet studentships jointly. Our MSc programmes provide useful preparation toward PhD research. Summer studentships, funded by the Leverhulme Trust, EPSRC and SEPnet, inspire undergraduates to pursue a PhD. We provide information on projects at an annual PhD Fair. We recruited PhD students to interdisciplinary research projects from subjects such as chemistry and biology. All procedures connected with the admission of PGRs are subject to the University's Equality and Diversity Policy, the Race Equality Policy and Code of Practice, and the University Student Disability Policy. PhD applicants are interviewed by two trained interviewers.

d. Income, infrastructure and facilities

The £13.9M direct and £9.0M facilities funding in our portfolio is drawn from diverse sources: STFC, EC, ERC, EPSRC, and RS along with charities, TSB, and industry. This spread contributes to our sustainability, with industrial and EC/ERC funding expected to grow. Our direct income in 2012/13 (£123k/FTE) is significantly higher than the £87k/FTE reported in RAE2008.

Income highlights: Our NPG researchers are leading a nine-institution STFC grant with a total value of £8M (04/2010-03/2015), aimed to build equipment for FAIR, the leading European nuclear physics facility. This is the largest nuclear physics grant ever awarded by STFC. Additionally, NPG is supported by an STFC "consolidated" Grant of £2.2M (2011-15). PG leads an EPSRC Programme grant (COMPASSS, £5.7M total) on silicon-based quantum computing, in collaboration with UCL. APG has already won substantial funding (£1.3M total). Gieles' RS URF and his €1.5M ERC Starting Grant (awarded in 2013) provide a platform for the work of the entire AP group. Surrey-led usage (within the REF period) of major international facilities (not RC-supported), awarded after competitive review, totals £9.0M, as listed below.

Facility	Location	Days	Total (£k)
CLIO	Paris, FR	17	58
DESY	Hamburg, DE	3	24
ESRF	Grenoble, FR	7	56
FELIX	Nijmegen, NL	102.5	731
GANIL	Caen, FR	22	364
GSI	Darmstadt, DE	28	6,364
HFML	Nijmegen, NL	8.75	498

ISOLDE	Geneva, CH	7	304	
Legnaro INFN	Legnaro, IT	15	108	
PSI	Villigen, CH	11	92	
TRIUMF	Vancouver, CA	21	318	
CINECA Supercomputer	Bologna, IT	--	76	**TOTAL: £9.0M**
CSCS National Supercomp. Centre	Lugano, CH	--	50	

Our *secured* research income for 2013/14 totals £2.78M, and proposals with a total value of £11.1M are currently under consideration by funding bodies.

Consultancies and professional services: Regan served as an expert witness on nuclear science in (1) legal proceedings taken by the Royal British Legion in litigation over UK nuclear weapons testing in the1950s-60s and (2) on effects and measurement of Po-210. He conducted consultancy on radioactivity characterisation for the International Rectifier Corp. Keddie has offered consultancy on polymer colloids to Syngenta, SIKA, Sonardyne, ET Technologies, Akzo Nobel, and others. Sweeney has offered consultancy to QinetiQ.

Infrastructure and Facilities: Each of our research groups has well-maintained facilities, supported by technical staff, benefitting from inward investment during the period. Equipment sharing within SEPnet is facilitated by a coordinated Equipment Inventory.

NPG has two laboratories where radiation detection systems are assembled and tested, for use at overseas accelerator facilities. There is support from a "core" grant-funded research officer and a shared technician. In the REF period, with input from NPG and RMG, an Environmental Radioactivity Assessment lab (*ca*. 120 m^2) was established and used by four successful PhD projects in collaboration with Qatar, Libya, Thailand and Malaysia.

PG activities in the ATI centre on six laboratories dedicated to project-related experimental systems, including a dedicated ultra-fast laser lab, a unique high pressure capability plus facilities for characterisation at low temperature and high magnetic field, where there was recent investment of £159k on a new optical access magnet. The COMPASSS project maintains a dedicated user station at FELIX (NL) and is investing £590k for a new dilution refrigerator. PG also shares electrical and optical characterisation labs, a microscopy suite (SEM, AFM, environmental SEM), focussed ion beam (FIB) facility, as well as a 218 m^2 class 100 clean-room facility in the ATI, and it recently invested £120k in a mask-aligner. PG is supported by three technicians, a clean-room manager, and a facilities manager. In 2009, a 30 m^2 laboratory was re-fitted to support the new chemical synthesis work with extra technical support being allocated.

RMG is supported by a suite of medical physics, X-ray imaging and detector development labs, which were refurbished by £1M in SRIF funding in 2006. Micro-focus and high-flux X-ray tubes are used for imaging studies, including clinical and industrial machines up to 160 kV. The Detector Materials lab contains semiconductor opto-electronic characterisation equipment: optical DLTS, photoluminescence mapping, and IR imaging. A dedicated semiconductor fabrication lab is used for II-VI (e.g. CdTe) device fabrication, supported by a shared full-time technician. A SEPnet-funded electronics technician offered extra support.

SMG labs, renovated in 2005 with £2.5M SRIF funding and supported by two technicians, house equipment for soft matter analysis: microstructural (AFM, Raman), mechanical (DMA, adhesion), optical (ellipsometry, spectroscopy), electrical and thermal (DSC, TGA). £120k was invested for a new AFM controller and lasers for a confocal Raman/AFM kit (purchased for £450k in 2007).

Across **NPG**, **TCG, APG** and **SMG**, High Performance Computing (HPC) is done on *ca*. 400 cores of a shared server, in combination with access to national (*e.g.*, STFC's DiRAC and SEPnet SCIAMA cluster) and international HPC facilities. At the recommendation of an HPC Strategy Committee (chaired by Sear), the Faculty will invest £100k in HPC and provide a dedicated IT support post to create a Faculty HPC Centre to support Physics, especially recent appointees. APG has invested in Graphics Processing Units using an RS Equipment Grant and will invest £100k in HPC in 2014 using a second RS grant combined with Department Start-Up funding.

In 2012, we specifically targeted *ca.* £200k from the EPSRC Small Equipment scheme at ECRs working in SMG, RMG and PG labs. In RMG, a system for combined materials analysis and photocurrent measurements plus systems for hyper-spectral imaging and μCT were set up with new motion control systems. In SMG, a probe-station, diffuse reflection spectrometer, and a temperature-controlled tensile stage were added. PG invested in a suite of lasers, spectrometers and a cryostat to support ECR projects on spintronics, PVs, communications and lighting.

e. Collaboration or contribution to the discipline or research base

Major Research Collaborations: Within the REF period we have grown and led strategic international collaborations, enriching our research and leading to new funding opportunities.

NPG lead seven major collaborations. Walker (a CERN Associate 2011-12) was elected Spokesperson for the ILIMA project (100 scientists from 29 institutes (*inst.*) in 16 countries), which is planning the use of storage rings at FAIR (DE). Regan was founding spokesperson for RISING at GSI (DE) with 130 scientists from 37 *inst*. in 20 countries, and Podolyak is spokesperson for HISPEC(DESPEC) at FAIR with 229(240) scientists from 81(82*) inst.* in 25(24) countries. Regan is Vice-Chair of the EURICA collaboration council at RIBF, Japan with 150 members from 51 *inst.* Catford is a leader in three international collaborations: (1) TIARA (collaborators in UK, FR and ES); (2) SHARC/TIGRESS (UK, FR, CA and USA); and (3) GASPARD.

In PG, Murdin is spokesperson for condensed matter users of the FELIX facility (NL) and leads the COMPASSS project collaboration with UCL and Radboud Univ. (NL). EPSRC Leadership Fellow Sweeney collaborated in a Materials World Network with Arizona State, Michigan (USA), Simon Fraser and UVic (CA) plus an EU FP7 project (BIANCHO) with partners in IE, DE, LT & UK to develop efficient new photonic materials and devices. In APG, Agertz leads the isolated galaxies working group and Read leads the SPHS simulations in the AGORA collaboration with 94 members across 47 institutions. Read is PI of the Gaia Challenge (ESF funded) with 60 members, and Gieles leads its "collisional systems" working group. APG contributes to the Gaia-ESO, SAMI Survey, and ESA Euclid Satellite collaborations. In SMG, Keddie was a workpackage leader in the €6M EC FP6 project (NAPOLEON) with 19 partners (8 industrial) developing nano-structured coatings and adhesives. SMG contributes to Nanocem: an independent, multi-disciplinary, industry-funded, consortium for basic research in cement science with 33 partners (11 industrial). Research has a far international reach; beyond the major collaborations already named, there are 37 *funded* collaborations with 69 institutions, of which 49 are overseas. In the period, papers were published with >320 institutions in >40 countries (NPG 31; APG 20; RMG 22; PG 15; SMG 15), including co-authors at Yale, MIT, Princeton, Harvard, Stanford, ETH, and Peking.

Interdisciplinary research: At the interface with biology, Sear (SMG) studies the dynamics of the protein whose absence causes the disease Duchene Muscular Dystrophy with King's College London Developmental Cell Biology, parallel to gene therapy trials. Dalton and Sear collaborated with Imperial biology to develop novel substrates for protein crystallisation. Sear collaborates with Cambridge chemists in computer simulations to increase the understanding of the nucleation of protein crystals, with relevance to rational drug design. Al-Khalili (NPG) leads a new strand of research on quantum biology. RMG has projects at the interface with medicine in collaboration with the Royal Surrey County Hospital, *e.g*. studies of the osteoarthritic condition, using synchrotron-based SAXS and XRF to examine cartilage and subchondral bone, and analysis of biomechanical changes of pericardium and synovial fluid as a result of radiotherapy doses. Studies of changes in the structure of breast tissue when malignant offer the possibility of in-surgery pathology. Projects on X-ray diffraction imaging are underway with the National Coordinating Centre for Physics in Mammography, Barts, and The London NHS Trust. Several SMG projects are conducted in collaboration with chemists (Warwick, Sheffield, University of the Basque Country, ES) who synthesise new classes of polymer nanoparticles for designing functional nanomaterials.

Industrial Research Collaborations: The University has formed a strategic partnership with NPL to foster collaborations and to facilitate tech transfer to achieve the maximum impact. The University's £6M EPSRC KTA grant, managed with NPL, funded Physics projects with companies including Harkness (3D cinema screens), Surrey Sports Park (sensing of Cl compounds), MSOLV (carbon nanomaterials for touch-screens), a consortium of four companies (M&S, AkzoNobel, Cytec, and Heraeus) to develop a new process (patent pending) to create textured polymer coatings, and NPL (solid-state lighting). A KTP project with Plastipack developed energy-saving swimming pool covers, boosting their sales. BASF, MSOLV and Avery Dennison have directly funded SM projects. Strong collaborations with AWE (two Penney Fellowships) led to a tighter focus on applications of nuclear isomers (Walker) and radiation detection systems for security applications (Sellin). EADS-Astrium (FR, DE) collaborates with PG on satellites to harvest solar energy from space.

Exemplars of Academic Leadership

International advisory board membership: Murdin is on the Scientific Advisory Committee (Comm.) of the Helmholtz Zentrum Rossendorf, Dresden (1000 staff, budget €118M) since 2006. NPG lead seven major collaborations already described. Additionally, Regan was on the EURISOL Users

Exec. Comm. (2010-), the IUPAP C12 Commission (2012-), and the NuSTAR Collab. Board (2009-13). Catford was on the EXOGAM Steering Comm. (2006-11), IPN-Orsay Conseil Scientifique (2008-10), and the GANIL (2002-09), GSI (2008-12), and CERN-ISOLDE-nTOF (2013-) Programme Comm.. Walker is a member of the AGATA Steering (2003-) and the JYFL (2013-) Prog. Comm.. Catford sits on the Management Comm. of PARIS (7 inst. from UK, PL and FR).
Leadership roles in industry and commerce: Sweeney is Director and Chief Technology Officer for a UK start-up company, Zinir. He is on the EADS-Astrium Photonics Steering Group and the Photonics21 European Photonics Strategy Group. Bradley is a Trustee of the Tun Abdul Razak Research Centre (TARRC), run by the Malaysian Rubber Board in the UK.
Research Councils: Podolyak is a non-core member of the STFC's Science Board (2011-13), its principal scientific advisory body. Current STFC panel members are Podolyak (PPRP), Barbieri (NPAP) and Stevenson (NPGP). Regan, Catford, and Walker have served on STFC comm/panels. Bradley is on ESRF X-ray Magnetic Scattering (XMaS) Management Comm. Sweeney sits on the EPSRC III-V National Facility Steering Comm., contributed to the UK Semiconductor Roadmap for Optoelectronics (2010), and is an international expert for the U.S. Dept. of Energy and the NSF. Al-Khalili was on the REF Impact Pilot Panel for Physics. Kearney chaired one of the largest-ever EPSRC Programme Grant panels (2013), and seven others sat on EPSRC panels.
Learned societies: Keddie chairs the IOP Polymer Physics Group (from 2011). Sear chaired the RSC Stat. Mech. and Thermod. Group comm. (2008-11). Al-Khalili was a trustee and member of the council of the British Science Assoc. (2006–12), Vice President (2009-12) and President of the Phys. and Astron. Sect. (2010-11). He was a member of the British Council's Sci. & Eng. Advisory Group (2007–11) and sits on the IOP Review Committee on Health of Academic Nuclear Physics Research in UK (2011–12), the RS Vision for Science and Maths. Educ. 5-19 Committee (2011–), the RS Equality and Diversity Panel (2009–), and IOP External Engagement Committee (2010-).
Conference programme chairs: Since 2008, Surrey physicists have chaired/organised 25. conferences. Held at *Surrey*: 3rd Si Quantum Information Processing workshop (Murdin); 25th IOP Polymer Physics Group (Keddie); 11th Biennial Magnetic Resonance in Porous Media (McDonald); Gaia Challenge (Gieles and Read); International nuclear physics workshops x2 (Walker); 2nd International Workshop on Bi-Containing Semiconductors (Sweeney); Neutron Stars (Rios-Huguet); Quantum Biology (Al-Khalili) - the last three with partial funding from Surrey's Institute of Advanced Studies. Held *elsewhere*: IRMMA-8, Kansas, USA (Bradley); Thermodynamics 2009, Imperial, and 2011, Athens; CECAM Workshops on Crystallisation, Lausanne, x2 (Sear); ECT, Trento (Walker). Barbieri organised four meetings on nuclear theory at ECT, Trento x2, ESNT, Saclay x2. Tostevin organised/chaired seven: TNET 2008; QFS-RB '08; Confrontation and Convergence in Nuclear Theory; Decoherence in Quantum Dynamical Systems; DTP2010, all at ECT, Trento; FUSTIPEN, Caen; and Interfaces Between Structure and Reactions, INT, Seattle.
Invited keynote/plenary lectures: Staff delivered >85 within the REF period. Highlights include Walker's plenary talk on high-spin isomers at 10th Int. Conf. on Nucleus-Nucleus Collisions, Beijing (2009); Murdin's lectures opening the Gordon Research Conference on Defects in Semiconductors (2012) and at Narrow Gap Semiconductors, Blacksburg, USA (2011); Podolyak's plenary to 800 delegates at the European Nuclear Physics Conf., Bochum, DE (2009) and at the Int. Symposium on Radiation Physics, Rio de Janeiro (2012) - only invited *nuclear* physicist; Tostevin's plenary at the Rutherford Centennial Conf. on Nuclear Physics (2011); Adams' Polymer Physics Prize lecture at APS, Baltimore (2013); and Al-Khalili's 2012 Brunel Lecture at the UK Festival of Ideas.
Editorships: Bradley is an Hon. Editor of the *Brit.J. of Radiology* (2012-) and a Consulting editor for *Appl. Rad. & Isot*. and *Rad. Phys. & Chem.*. Podolyak is an Assoc. Ed. for *Rad. Phys. & Chem.* (2011-) and Al-Khalili for *Adv. Sci. Lett* (2008-). Board memberships: *Phys. Rev. C* (Regan, 2013-, Tostevin, 2010-12); *ACS Appl. Mater. & Interf.* (Keddie, 2011-), *PMC Physics A* (Al-Khalili, 2010-)
Awards and prizes: Read was awarded the 2013 MERAC Prize for Best Early Career Researcher in New Technologies in Astrophysics (€150k) by the Eur. Astron. Soc. to recognise his high-impact research in computational astrophysics and cosmology. Al-Khalili won the IOP Kelvin Medal and Prize (2011), was awarded an OBE for services to Physics (2008), delivered the 2008 RS Michael Faraday Lecture, was BAFTA nominated for *Chemistry: A Volatile History* (2010), and won the Assoc. of Brit. Sci. Writers award for best documentary for *The Secret Life of Chaos* (2011). Other prizes: 2011 Young Scientist Award from IOP's Liquid & Complex Fluids Group (Adams), 2012 RS Wolfson Merit Award (Murdin); 2011 GSI Exotic Nuclei Community award (Podolyak); 2009 *Appl. Radiation & Isotopes* Medal (Bradley, first ever UK recipient.) *NB*: Fellowships are listed in Sect. c.