Institution: University of Strathclyde

Unit of Assessment: 9 Physics

a. Context

The successful transfer of research knowledge from academia to industry and other societal beneficiaries is a fundamental objective of the University's strategic plan and is reflected in its founding ethos as 'a place of useful learning'. In 2012, Strathclyde was awarded the Times Higher Education UK University of the Year award and in their citation the judges praised it for its close links with business and industry and its commitment to making an impact on the global economy. The Department's approach to generating impact from its research reflects the University's strategy and its success has been a major factor in attracting the UK's first Fraunhofer Centre to the University and in the development of the £89M Strathclyde Technology Innovation Centre (TIC).

The **main types of impact** arising from the Department's research are:

- **Economic impact and job creation:** Evidenced by a growth in turnover and personnel employed by spin-off companies since 2008, now totalling ~£116M and ~200 staff, respectively.
- **Policy and societal impact:** Tools resulting from our research have been used to screen ~12 million passengers at Glasgow Airport and are installed in BP's global commercial marine fleet.
- **Public interest and engagement in science:** Examples include science outreach activities and engagement with the Glasgow Science Centre and Glasgow City of Science.

The **main non-academic beneficiaries** of our research are, therefore:

- **Industry (national and international):** Products arising from our research are manufactured and sold by local (e.g. Cascade Technologies) and global (e.g. Coherent) companies, and industry benefits from our provision of research expertise and measurement services.
- **Public:** Indirectly through science policy changes and the widespread adoption of security and environmental instrumentation, and directly through promoting engagement in science.

b. Approach to impact

The Department's various approaches to its interaction with users and beneficiaries and to achieving impacts from its research, during the assessment period, are described below.

Building relationships with industry and end-users: Engaging with beneficiaries of our research is a core pillar of research practice across the University and this is reflected in the Department's approach to creating impact. Our approach includes developing high-value strategic alliances with leading industrial companies, including where possible, growing our relationships with industry through the provision of consultancy and industry-relevant Continuing Professional Development (CPD) training courses (e.g. in high power radio-frequency methods) - we have appointed a CPD Champion to lead on this strategic initiative. We also provide measurement facilities to industry and other non-academic users. Recent external users of our scanning electron microscope facilities, for example, include mLED Ltd., the National Physical Laboratory-NPL, Renishaw Diagnostics, Cascade Technologies and Augerson Art Conservation Services Ltd.

During the REF period the Department has earned ~£4M in income from consultancy, CPD course provision, licensing and industry commissioned research, and was ranked 2nd in the 2010-11 HESA statistics for Physics for income from UK industry, commerce & public corporations. Our approach of fostering and building relationships with industry has directly led to new opportunities for commercialising IPR. For example, new types of microwave and millimetre wave sources, based on IPR generated by Strathclyde Physics, are being manufactured and sold by companies such as e2V and TMD Technologies Ltd. The sale of the first prototype source in 2012 generated many millions of pounds, as discussed in the *Microwave and Millimetre Wave Sources* Case Study, and the potential market going forward is substantial (~£200M across the Defence (radar) and Healthcare (imaging) sectors, based on the numbers and costs of existing systems). In return, since 2008, these industries have invested more than £1M in developing the underpinning research in the Department, which ensures a continuing route for generating impact.

We have adopted a staged approach to SME engagement, which starts with pump-priming funding, growth of the relationship to include placement of project students and internships, and escalation into longer term partnerships, e.g. via KT Partnerships. The success of this approach is evidenced by the achievements of the Atoms, Beams and Plasmas (ABP) group in growing their awarded industry-income via staged-engagement from £160k/year in 2008 to £740k/year in 2012.

The Department also encourages and supports staff in building collaborations directly with end users of its research, where applicable. For example, researchers working on nanomedicine diagnostic technology have established and developed collaborations with clinicians at Kings College London School of Medicine and Guy's Hospital. The resulting KE on the development and testing of the new devices in clinical environments directly informs research in the Department.

Making use of institutional facilities, expertise and resources: Our approach to creating research impact includes use of relevant University facilities, expertise and resources, and involves engaging in emerging opportunities driven by the University. A key institutional impact-generating initiative, of which the Department is playing a central role, is the Strathclyde TIC project. This major project, involving a substantial investment (£89M) by the University, aims to take our partnerships with industry to a new level and is already driving a step change in KE activities across the University. The Department is playing a key role, with three of our academics (Jaroszynski, Martin and Birch) leaders or deputy leaders of TIC research themes. We have hosted TIC workshops bringing together our academics and non-academic research beneficiaries and plan to continue this route to developing engagement with end users of our research.

Another example in which the Department makes use of institutional expertise and resources is staff training and development in Impact and KE-related skills facilitated by the Strathclyde Programme in Research and Leadership (SPIRAL) scheme.

Supporting and enabling staff to achieve impact: Central to the Department's approach to achieving research impact is the provision of support to help our staff identify and pursue opportunities for KE and KT. The Department has appointed a KE Champion to communicate opportunities for participation in relevant schemes and end-user engagement activities to staff. It also hosts the Scottish Universities Physics Alliance (SUPA) KT directorate (3 FTE staff), whose mission is to increase commercial engagement between SUPA and industry. This helps to identify KT and impact-generating activities that are appropriate for our various research programmes, to share best practice in pursuing such activities and to raise staff awareness of the various KE/KT support schemes available. The provision of subject-specific KT support to our staff helps in the identification of potential industrial end users. It encourages impact-related activities and enables potential commercialisation opportunities to be identified by professional KT staff.

Our approach to encouraging and supporting staff to achieve research impact includes setting and reviewing individual targets for growth in KE activity. This process is managed through staff annual performance reviews conducted as part of the University's Accountability and Development Review (ADR) process. Due recognition and reward (via promotions or pay awards) is made for growth in KE activity leading to impact.

Making use of partnership-building schemes: Our staff are actively encouraged and supported to maximise the non-academic impact of their research via participation in industrial and end-user knowledge exchange (KE) and partnership-building initiatives. Examples include:

- The EPSRC-funded Impact Acceleration Account and Knowledge Transfer (KT) Account have been used to enhance our links with industry and the industrial impact of our research, with ~£250k awarded since 2008 to a wide range of projects across our three research divisions;
- £1.2M funding in 2013 from the Technology Strategy Board and industrial partners (Shell, Gravitec, Guardian Global, and Fugro) for the first phase of the £2M Amadeus project – a joint Strathclyde-industry venture on monitoring carbon capture and storage;
- The SFC-funded INSPIRE programme has, since 2011, funded an initiative at the Physics-Life Sciences interface of our research to develop instrumentation for applications in medicine;
- The STFC Innovations Partnership Schemes (previously PIPPS) is being used to develop commercial exploitation from our STFC-funded research programmes. For example, £400k was awarded in 2009 for '*Transfer of enabling high power Ka-band design capability to Industry*'.
- SUPA Start feasibility funding has been used to initiate new industry engagement projects.

Developing impact on policy and public engagement: Our staff are supported in their involvement in the provision of policy advice to inform decision makers, e.g. in the research councils and in Government, and in general as advocates for the physical sciences. For example, Jaroszynski is a member of the STFC Accelerator Strategy Board and McKenna represents the U.K. high power laser community on the Institute of Physics (IoP) Large Facilities Forum, which has provided evidence to the House of Lords Science and Technology Select Committee on UK Scientific Infrastructure. Through our programme of science engagement activities ranging from

workshops for school pupils, to courses and summer schools for teachers, to building science exhibits, to science street busking and tours, we actively promote public engagement with our research. We work in partnership with a wide range of organisations including the IoP; British Science Association; Glasgow Science Centre and Glasgow City of Science. A recent exhibit built for the Glasgow Science Centre, 'LED Rainbow', has engaged 90,000 visitors since the summer of 2012. Staff members (e.g. Trager-Cowan) have also worked with the Scottish Qualifications Authority in defining the curricula for revised Physics Higher and Advanced Higher qualifications.

c. Strategy and plans

The Department has a bold vision for excellence in both its research and impact generation, and has an innovative strategy to achieve, enable and support the latter, which includes:

- **Fostering new KE opportunities and mechanisms for user engagement:** building on our areas of research excellence and seeking new opportunities for impact in areas of national importance, such as energy and next-generation healthcare technologies. Strathclyde TIC is revolutionising the way researchers in the University and industry collaborate and innovate together, and is central to this part of the Department's future impact strategy. Not only are we fully incorporating the TIC philosophy across our research divisions, but significant numbers of our researchers (e.g. the ABP and Semiconductor groups) will relocate to the new TIC building in 2015 to directly facilitate new KE opportunities. Our strategy includes the development of new avenues for economic impact from our research through direct engagement with the Fraunhofer Centre recently established at the University – the first of its kind in the UK.
- **Targeted infrastructure investment:** Examples include: the £12M flagship *Scottish Centre for Applications of Plasma Accelerators* (SCAPA), which will be established as a platform for developing applications of a transformative new laser-driven accelerator technology, enabling long term exploitation; new laboratories for the £2M *Amadeus* TSB-industry-funded R&D project; expansion of the ABP group's industry-facing research within new laboratories in the TIC building, and a future upgrade to the ARCHIE-WeSt supercomputer, which is a key element of the University's sustainable high performance computing resource provision for the Department's research and industry engagement. These areas have been targeted for growth due to their future impact potential.
- **Investment in our staff resource targeted at generating impact:** This includes the appointment of new academic staff in targeted research areas with high potential impact. Recent examples include a Reader in the ABP group and two Chairs associated with the SCAPA project. Generally in the recruitment of new academic and research staff, appropriate recognition is given for experience in industry and for applied research with the potential to lead to significant impact. Our strategy includes investment in our existing staff, through training to spot and pursue new impact opportunities (facilitated via the SPIRAL initiative and SUPA-KT support), funding staff exchanges with industry, and appropriate recognition and reward for impact generation activities via our ADR appraisal scheme.
- **Continuing to develop and strengthen our collaborations:** both within the SUPA research pool and across pools (e.g. with WestCHEM, SINAPSE) we will continue grow activities focused on interdisciplinary application-based aspects of our research.

d. Relationship to case studies

The case studies arose because dedicated KE support has been embedded within our research culture for many years. The *Microwave and Millimetre Wave Sources* case is an exemplar for how engagement and impact can escalate from small beginnings to substantial industry-funded programmes, and has informed our approach to nurturing relationships with research end-users. The *Cascade Technologies* and *Innovative Laser Companies* cases demonstrate the potential for successful spin-off companies to emerge from our research, and has informed our strategy of actively identifying new opportunities for commercialisation using SUPA KT resources. The *Fluorescence Spectrometers* case illustrates how close collaboration between academia and industry, nurtured and sustained over a significant period of time, can lead to repeat innovations in product functionality and resulting market place successes, thus informing the Department's approach to sustaining research commercialisation opportunities.