Institution: The University of Huddersfield

Unit of Assessment: 9: Physics

a. Context

Since 2008 we have developed a physics group with extensive international research experience in fundamental physics and an aptitude and enthusiasm for bringing that expertise to bear on a wide range of societally and technologically important issues in energy, health technology, new materials and cultural heritage. In pursuing these themes, the group has ensured that the needs of relevant stakeholders are fully understood and appreciated. Correspondingly mutually beneficial relationships have been established with a number and variety of potential end-users with a view to generating impact. This approach, facilitated by the international profile of many of our staff, has placed Huddersfield Physics at the centre of several major UK, European and wider international collaborations (eg *CONFORM, DAEdALUS, European Spallation Source, US Air Force*) which in turn have led to interactions with diverse stakeholder communities and target audiences beyond academia in the commercial, political and public sectors. These include policymakers (eg *The All Party Parliamentary Group on Thorium, DECC, Illinois State legislature*), business/industry (eg *BorgWarner, Siemens, PAC*), the media (*national and international press, TV and radio)* and the general public at both national and international levels (*TEDx, café scientifique, Science Museum, Mary Rose Trust, and broadcast quality videos*).

b. Approach to impact

(i) Identifying and supporting impact: Over the last five years we have built a team of physicists specifically to carry out research which addresses the Global Grand Challenges in Healthcare, Energy and Manufacturing the Future. We have recognised that advanced accelerator science and materials development have related key roles to play in these Grand Challenges, and that by focussing expertise in and across these areas we are positioned to create maximum impact. All of the resources provided for establishing physics at Huddersfield (i.e. for staff recruitment and infrastructure) have therefore been directed to accelerator applications and materials science.

We are extremely active in national and international collaborations and consortia, playing key roles in major multimillion pound projects (eg *ESS, CONFORM*) which have significant scientific, industrial, political and public agendas. The nature of these projects has necessitated interactions well beyond academia, and this in turn has secured the impact of our research. Correspondingly, and despite the limited time we have had to witness and evaluate the full societal and economic impact of our work, we are already able to give examples of our impact in the two case studies we present, as well as in several other areas of our work.

Through management of our projects we have been able to establish a successful template for engagement to guide our interactions with stakeholders and beneficiaries in all projects. The key is to engage industry and policymakers with our projects at inception, throughout and beyond the project, and to embody public engagement deeply within the project. Whilst the former enables us to assess relevance and impact, the latter ensures the widest exposure which can, in turn, lead to further collaborations and exploitation, both nationally and internationally

(ii) Example 1: The EU ESS Preparatory Phase Project (funded from 2008) was instrumental in developing the scientific, political and socioeconomic case for the siting, design and funding of the ESS facility. It necessitated multilateral international political discussions and liaison with European industries to present opportunities for both exploiting and supplying to ESS. Huddersfield was responsible for the interactions with stakeholders, and the project culminated with a major conference in Copenhagen in 2010 which attracted over 400 industrialists and politicians from across Europe.

(iii) Example 2: The CONFORM accelerator project, led by Barlow, Cywinski and Edgecock, engaged industrial collaborators (*E2V* and *Tesla Engineering*) as stakeholders and oncologists (*Gray Institute*) as beneficiaries from the start, with the project being presented to industry, politicians and journalists at a conference held in Church House, opposite Parliament, in 2010.

The CONFORM project additionally spawned ThorEA, the Thorium Energy Association, a learned, not for profit, society with individual membership drawn from academia and industry, which holds

regular scientific and technical meetings with international and sometimes political attendance. Barlow, Cywinski and Seviour have in turn chaired ThorEA.

(iv) Engaging with Industry Our roles in the ESS and CONFORM projects have led to significant collaborations with industrialists such as *BorgWarner* (through KTP, and more recently, major RGF funding), with *Siemens* (through CASE studentships, consultancies and equipment loan), and with *ESS* itself, for which we are contracted to perform induced radiation simulations for the accelerator. These relationships continue to be nurtured and developed, for example with the conferment of a visiting professorship on Beasley of *Siemens*, and the appointment of Malins from *BorgWarner* to the RGF funded project.

Correspondingly we are now in discussions with: *3M* on exploitation of neutron tomography; the *National Physical Laboratory* on accelerator technology, radioisotope production, and dosimetry; *PAC* and *PAC(UK)* on the development of a table-top accelerator for radioisotope production; *Kromek* on dosimetry; the *NHS* on issues associated with radioisotope delivery; with auction houses and museums (eg *Christies, Michael D Long*) on the authentication of items of cultural heritage. These developments have been facilitated by either the location of these companies in the University's Buckley 3M Innovation Centre or by the advanced instrumentation at our disposal within the University and at international central facilities such as *ISIS, ESRF, ILL, PSI, CERN* and elsewhere. The transfer of the Medium Energy Ion Scattering (MEIS) facility to Huddersfield resulting from our partnership with *STFC* will enable us to develop further interactions as we will operate MEIS as a national user facility, unique in the UK, which we will be made available for industrial, as well as academic, surface science research. Similarly the MIAMI facility will pay a key role in underpinning industrial engagement, particularly in the nuclear industry.

(v) Engaging with Policymakers and the Public: Our projects have attracted considerable public and media interest. We are therefore extremely active in public engagement, delivering tens of public lectures each year, being interviewed by radio and television (*Material World, Costing the Earth, regional news programmes and The Politics Show, BBC World's Horizons Business*), being the subject of an exhibition at the *Science Museum*, and appearing widely in the world's press (*Science editorials, Eureka, Sunday Mail colour supplement, House and Garden, the Guardian, Telegraph, Australian*, etc). The resulting public profile has in turn brought our work to the attention of policy makers, and we therefore engage regularly with, for example, *DECC*, the *APPG on Thorium*, and Baroness Worthington, as well as with NGOs such as the *Weinberg Foundation*. Additionally we have successfully extended the political and public reach of both the ESS and CONFORM projects by producing copyright-free broadcast-quality movies of the ESS (starring Sir Patrick Stewart) and CONFORM (starring Lord Robert Winston).

(vi) Positioning for Wider Impact: Finally, in a wider context, our expertise is sought to guide investment and development of facilities and programmes at major international facilities through advisory roles and committee chairs at *ISIS (UK), ILL (France), JINR (Russia), J-PARC (Japan), TRIUMF (Canada) and Sandia National Laboratory (US).* Our work is impacting the development of DOE projects in the US (including *Fermilab* and *BNL*, where our accelerator driven subcritical reactor and muon production research is informing next generation projects such as Project X). That our work has been endorsed by the *IAEA*, *Jacobs E&C Ltd* and *Siemens AG*, and our association ThorEA has been accepted as a full member of the *Sustainable Nuclear Energy Technology Platform (SNETP*) is further witness to our influence and impact.

c. Strategy and plans

An impact culture is sustained by the University through strategic recruitment; training and development opportunities in knowledge transfer and public engagement; recognition and reward of enterprising activity; and activities to encourage collaboration with the end users of research. Such a culture has led to Huddersfield being named *THE Entrepreneurial University of the Year* in 2012. This University culture has, in turn, helped to shape the Physics UoA impact strategy.

Our goal for the next five years is to build on our initial successes by further developing our strategy for impact in tandem with our overall research strategy. To this end, we have identified a number of key objectives, as detailed below.

1. Continue to develop and embed impact: We will maintain impact planning as a cornerstone of our annual review processes, particularly in staff performance, development reviews, and

recruitment, with a view to establishing stronger links between impact and career progression. Impact will be discussed and evaluated during the department's open days, postgraduate resource conferences and away-day events, the latter of which are attended by all staff, including those in support roles.

2. Continued investment in impact-enhancing infrastructure: The benefits of identifying and investing in areas of specialism with significant potential for impact have been clearly demonstrated by several of our strategic decisions during the census period. This has enabled us to establish ourselves at the forefront of the study of applied accelerator science in a very short space of time. We, and our stakeholders, are now set to benefit. We intend to give careful consideration to similar opportunities for investing in impact over the longer term.

3. Increase the involvement of the Science Advisory Committee: We are expanding the terms of reference of our external Science Advisory Committee (SAC) to include oversight of our impact strategy. The SAC was originally established to review the quality of our research in applied accelerator science but will now be asked to advise on and review impact as a more substantive component of its role. We are therefore recruiting additional industrial and social policy advisers to SAC which will hold annual assessments of research impact and provide oral and written feedback to the School and University Research Committees.

4. Ensure continued strategic alignment with stakeholder priorities: On-going dialogues with a range of external audiences is key to furthering our impact strategy. Building and extending our relationships with business and industry, policymakers, lay audiences and other stakeholders informs and guides our strategic decisions. Our research focus can thus evolve and adapt to best match the needs of stakeholders and society.

5. Develop relationships with new and existing partners: We intend to map our technology platforms to those of the companies resident in the University's recently established 3M Buckley Innovation Centre (3M-BIC). Liaison with 3M-BIC companies, and with local and national industry, will provide opportunities to engage with BIS-supported programmes, including TSB funding and KTPs. Correspondingly we anticipate that our expertise will act as a magnet for SMEs to join the 3M-BIC, as it already has for *PAC(UK)* and *Kromek*.

6. Continue to participate in outreach activities*:* Our public engagement events and activities have been extremely well received. This outreach programme will be maintained and expanded. In addition to maintaining our excellent relationships with mainstream media, we will also increase our use of social media with our blog and Twitter (the latter is already followed by *DECC* and *politicians* including the current shadow minister for energy and climate change).

d. Relationship to case studies

Our approaches to impact have been developed and refined alongside our major research programmes focussing upon the European Spallation Source and CONFORM projects. Correspondingly the examples of impact described in our two case studies (a) *Accelerator Applications* and (b) *An Alternative Nuclear Future* is a direct consequence of our impact strategy.

In (a) we illustrate how our strategy for impact has shaped our research into the application of novel compact accelerator design, and the interaction of particle beams with targets. Examples of impact politically (eg the progress of the international ESS project), commercially (eg radioisotope production, boron neutron capture therapy, proton therapy) and with the public through media coverage are discussed.

In (b) we show how our strategy has brought the discussion of the potential deployment of thorium fuel, and the development of ADSR technology to the forefront and how this work has impacted upon government policy and public opinion in the UK and abroad. We also show how the research has captured the imagination of the media and the public.