Evaluation of the Basic Technology Programme

Via an EPSRC Theme Day

Ramada Jarvis Hotel, Manchester

19 May 2010

Findings and Recommendations of the Review Panel

Introduction

On 19 May 2010, the Engineering and Physical Sciences Research Council (EPSRC) carried out an evaluation of the portfolio of research in the area of Basic Technology. The investment in the portfolio currently stands at £165Million. A Theme Day was chosen as the mechanism to carry this evaluation out. At the event, 47 Basic Technology research project grants were presented as posters to a panel of experts, assembled by EPSRC, for their assessment against an international benchmark.

The Basic Technology programme was originally proposed in 1999 as a cross-Council programme to give technology research the same status as scientific research, and to develop a programme that would fund new technology for scientific research. Existing funding mechanisms in all research councils at that time were felt to be constrained by research council boundaries, and to favour novel science over novel technology developments. Science is essentially convergent-it brings many methods together to answer a single question- while technology is more divergent- a new technology can be applied in many fields. The Basic Technology programme was therefore designed to support risky new technologies of wide application, which were felt not to be supported adequately by existing mechanisms. The same assessment criteria and methods of selection were used throughout the life of the programme. There were deliberately no boundaries on what could be supported, though in later stages there was some sign-posting in the calls of areas which appeared not to be represented well in the overall portfolio.

This report gives details of the Theme Day and the findings of the panel. The Basic Technology Programme is described on page 5. The background to the review is given on page 7 alongside a brief analysis of the EPSRC Basic Technology portfolio. The Theme Day assessment process is described on page 8 and summaries of two parallel sessions facilitated by EPSRC during the Theme Day are given on page 10. The report then gives the comments made by the panel about the portfolio and its component areas; these can be found on pages 10 to 17. Finally, page 18 presents the key findings of the panel and the panel's recommendations to EPSRC.

Theme Day Objectives

The objectives for the Theme Day were:

- To benchmark the EPSRC Basic Technology portfolio internationally, as a whole and as a collection of Sub-Themes, in terms of: Research quality and contribution towards the vision for Basic Technology; Academic impact and crossing discipline boundaries; Contribution towards the provision of trained people and future research leaders; Impact on the user community and exploitation of Technology research.
- To showcase the research that the Basic Technology Programme has delivered; and to provide a forum for networking and community building.
- To further inform EPSRC future strategy in the area of Technology- led cross-disciplinary research by consulting the community.

Review Panel

The panel assembled for the Theme Day to review the EPSRC Basic Technology portfolio was:

- Professor Robert Gurney, University of Reading – Environmental Systems Science Centre (Chair)
- Professor Julian Jones, Heriot Watt University
- Dr Ian McConvey, AstraZeneca
- Dr Justin Molloy, MRC – National Institute for Medical Research
- Professor Elaine Martin, Newcastle University
- Professor Andrew Wee, National University of Singapore
- Professor Tim Wess, Cardiff University
- Dr David Auty, H_2O Venture Partners
- Dr Andrew Kearsley, Oxford Lasers Ltd

Panel members talking to presenters as part of the assessment process at the Basic Technology Theme Day

Definition of Terms

In this section, EPSRC Theme Days, the EPSRC Basic Technology portfolio and a number of component Sub-Themes are defined.

EPSRC Theme Days

EPSRC Theme Days are a mechanism for evaluating a portfolio of research projects or grants (a "Theme"). They are a constituent part of EPSRC's overall evaluation framework and feed directly into the business and strategic planning process. They are considered, for example, by the EPSRC Technical Opportunities Panel (TOP), the User Panel (UP) and the Strategic Advisory Teams (SATs) of relevant Programmes. Theme Day reports are made public following the event via publication on EPSRC's website.

During the Theme Day, an independent panel of experts provide opinion on a representative sample of grants from across the portfolio and draw conclusions about the portfolio as a whole, or major segments of it. Notably, a Theme Day is not concerned with constructing league tables of grants or researchers, nor to isolate individual failures.

EPSRC Basic Technology Programme

Basic Technology Vision

The Basic Technology Programme was originally set up as a UK Research Councils cross-council programme in 2000, spanning the entire remit of the Research Councils.

The Programme sought to raise the esteem of those who conduct basic technology research to a level of parity to those who engage in basic science, recognising that research into basic technology is of equal value to research in fundamental science. The programme sought to strengthen the UK science and technology base by harnessing scientific discoveries that will be used to address challenges and enable new discoveries.

The Programme transcended research council boundaries and potentially encompassed all research disciplines. Consequently the scope was not constrained. Interdisciplinary connectivity was promoted through consortia of research teams.

There was also an expectation that the Programme would underpin the UK inustrial base of the future, but industrial involvement was not a selection criterion at the proposal stage.

The portfolio is now managed by the Cross-Disciplinary Interfaces programme on behalf of EPSRC http://www.epsrc.ac.uk/plans/funding/Pages/default.aspx .

The aims of the programme are captured in the original Basic Technology Vision Statement below:

Basic Technology Vision Statement

The Research Councils Basic Technology Research Programme has contributed to the development of a generic technology base that can be adapted to a diverse range of scientific research problems and challenges spanning the interests of all scientific disciplines and all of the research councils.

Basic Technology Grants funded

Since 2000, 52 Basic Technology grants have been awarded to project consortia, from 7 calls for proposals, at a value of £146Million.

Just over 450 tenured researchers are engaged in the project consortia.

Most of them are in the departments of physics and astronomy (22%), computing, electronics and electrical engineering (29%), chemistry (17%), medical and biological sciences (18%), materials science (7%), environmental sciences (2%), and other departments e.g. mathematics and central facilities of the Research Councils (5%). The project grants are supporting 302 postdoctoral workers and 169 project students.

A small number of proof-of concept feasibility studies and consortia forming networks have also been supported, with aim of facilitating high quality submissions in all areas at the full proposal stage.

Translation grants funded

All Basic Technology projects to complete a mid-term review successfully have the opportunity to apply for Translation grant funding. Translation grants provide underpinning, flexible funding to enable the technology developed in the original Basic technology grants to be taken forward to the next stage: this might include exploratory research to use and adapt the Basic Technology to facilitate new science; the exploitation and further development of the technology in collaboration with users; or other novel ideas for embedding the Basic Technology within the broad user base.

There have been 5 rounds of Translation grant funding; with 21 grants being funded at a value of £19.4Million.

Basic Technology Sub-Themes

The 52 Basic Technology grants were classified into 5 sub-themes by the panel for ease of analysis for the purposes of the panel evaluation.

Instrumentation engineering and development

The development/engineering of specific instruments; or the development of methodologies to be used in generic instrumentation development.
The emphasis can be on either i) the hardware issues eg reliability, robustness, miniaturisation; or ii) the development of instrumentation to measure important variables which are currently difficult or impossible to determine with existing methodology.

Analytical science and surfaces, probes and interfaces

Development of novel techniques, or novel applications of existing techniques, for the analysis of chemical or biological systems. Includes techniques such as spectrometry, spectroscopy, X-ray diffraction, chromatography, calorimetry.
Also included is the miniaturisation of analytical techniques and high throughput approaches to analytical approaches.
Surface science includes the study of surface mediated chemical reactions, surface adsorbed species and sensors

ICT/Computing/Mathematics

Novel mathematics and statistics.
New and emerging computer paradigms; long term, speculative, emerging areas of computing; quantum computing.
Theory and fundamental underpinning of image and vision computing.
Computer-based image interpretation; machine vision and robotics.

Optical physics and laser systems

Development of novel laser systems; laser technology and devices; and laser-matter interactions
Optical phenomena.
Applied optics – novel imaging techniques, e.g. holography.
Electronic and photonic materials and devices

Semi-conductor based devices, including solid state lasers, LEDs. Optoelectronic integrated circuits. Quantum dots, wires and wells. Optical communications.

Background to the Review

The Theme Day was conducted to review Basic Technology portfolio as a collective whole. The Theme Day was designed to review the health and balance of the Basic Technology portfolio, and to identify any gaps and areas of potential opportunity for EPSRC support in future.

EPSRC Basic Technology Portfolio

The portfolio of grants, including Translation grants, for each sub-theme is shown in table 1 below. The Portfolio has a combined value of £165Million.

Sub-theme	No of grants	Value of grants (£Million)
Instrumentation engineering and development	18	42.4
Analytical science & surfaces, probes and interfaces	10	28
ICT/Computing/Mathematics	8	17.6
Optical physics and laser systems	16	38.9
Electronic and photonic materials and devices	21	38.2
Totals	73	165

Table 1

Basic Technology Theme Day

The EPSRC Basic Technology Theme Day was held at the Ramada Hotel in Manchester on 19 May 2010. It was attended by 91 invited academics, a panel of experts chosen by EPSRC, a number of EPSRC staff, including Lesley Thompson, Director of the Research Base Directorate, and representatives of TSB,STFC, BBSRC, DBIS and from industry

EPSRC Grants Presented

In total, 45 grants were presented by the academic delegates at the Theme Day; these are listed in the Appendix. The numbers of grants presented within each Sub-Theme are given in Table 2.

All 52 grant holders were invited; with grants from all 7 Basic Technology calls for proposals; ranging from those starting in the year 2000 (grants now finished), to those starting in 2008 and not yet finished.

Theme	Number of grants eligible	Number of grants presented
Instrumentation engineering and development	12	9
Analytical science, and surfaces, probes & interfaces	9	8
ICT/Computing/ Mathematics	5	5
Optical physics and laser systems	12	11
Electronic and photonic materials and devices	14	13
TOTAL	52	46

Table 2. Grants presented at the Theme Day by Sub-Theme

Poster Presentations and Assessment Process

The grants listed in the Appendix were presented in poster form to the panel by the Principal Investigator, Co-Investigator or a nominated senior researcher.

A pair of “speakers” from the panel was assigned to each poster, including at least one expert in the research area presented. The assignment of the panel members to each poster is given in the Appendix. The presenter had 15 minutes in which to present the work of their grant to the panel and to answer any questions the panel members had. The pair were asked to agree scores for each grant, from 1-5 with 5 corresponding to “internationally leading”, across four main criteria and overall. The assessment criteria used by the Panel is outlined in the section on page 9. Presenters had been advised of the assessment criteria in advance of the Theme Day.

The scores received were based on the panel’s perception of each project compared to an international benchmark based on the information and data supplied by the presenter; this included publication, citation and other metrics as described in Table IV.

Since some projects assessed had already come to an end and others were ongoing, the panel were asked to take this into account in their assessment.

Therefore, presenters were invited to highlight the key findings and outputs of their projects so far, as well as future objectives where relevant.

At an initial pre-meeting the panel agreed metrics, the process for interviewing the presenters and the sub-theme classification of grants. A common approach to interviewing the presenters was agreed; in addition, the panel chairman joined each of the pairs of the panel "speakers" for some of the interviews by each pair to enable a degree of moderation between interviews and assessments.

Assessment criteria used by the panel

Research quality

Quality of the research proposed and undertaken.
International standing of the research group; awareness of competitor groups.
Context of the research; distinctiveness from other projects awarded to the group.
Contribution to the vision for Basic Technology

Academic Impact and crossing discipline boundaries

Impact

As indicated by refereed journal and conference publications and presentations; book chapters; citations and invited keynote speeches
Publications that have arisen relevant to this Basic Technology Grant.

Crossing discipline boundaries

Crossing traditional disciplinary boundaries and embedding multidisciplinary research within the community;
Sustainability of the collaborations that have been made and subsequent funding secured as a result (e.g. BT Translation Grants).

Contribution towards the provision of trained people and future research leaders

Equipping a cohort of scientists and engineers with new knowledge and expertise;
Ability to attract, nurture and retain people both UK and from overseas;
Subsequent employment destinations of researchers
Creation of potential leaders in the field of cross-disciplinary technology; career progression of PI.
Contribution to the flow of trained people between industry and the research base, and vice-versa

Exploitation of Technology Research – user community and economic impact. (User impact and outputs)

Examples of economic impact and potential economic impact; e.g. IP, patents, licence income, spin-out companies, industrial partners, case studies.
IP arrangements between members of the consortium.
Pathway to exploitation within the UK.
Potential benefits to society, what has been achieved. Possible application areas.
Dissemination of research outputs to the wider user base e.g. consultancy, training courses, networking events, open days.

Overall

An overall assessment of the project; management effectiveness.

Panel Discussion

Following the Theme Day, panel members shared and discussed their comments about the Sub-Themes and the portfolio overall. The analysis of the scores was also presented to the panel for discussion.

Parallel Facilitated Sessions

While the poster presentations were taking place, the presenters not involved were asked to take part in each of two parallel facilitated sessions.

Identifying Technology led opportunities

In this session, Theme Day delegates were asked to identify technology–led challenges and opportunities for the UK, and to explore the future technology–led challenges, where the UK might take an international lead.

The technology-led challenges identified by the participants, where the UK might take an international lead were:

- Renewable Energy
- Biomolecular Technologies
- Communications Information and Data Handling
- Nuclear Power (fission and Fusion)
- Novel Quantum, Molecular (and Electromagnetic) Materials
- Imaging and Sensing
- Intelligent Integrated Multi-Sensor Systems

These themes were considered by the panel when drawing together their key findings and recommendations .

Delegates participating in the facilitated sessions

Results of the Assessment and Panel Comments

Scores given to individual grants by the panel, against the stated criteria , are given in figure 1 averaged for each Sub-Theme. In Table 3, a breakdown of the number of projects scoring 4 or more is given. Table 4 shows the ranges of scores allocated to individual projects, against the individual criteria, for each of the Sub-Themes and overall.

After the Theme Day, the panel were asked to share their comments about the individual Sub-Themes and the Basic Technology portfolio as a whole based in the presentations they had seen. The comments made by the panel about the individual sub-themes are given in pages 10-18.

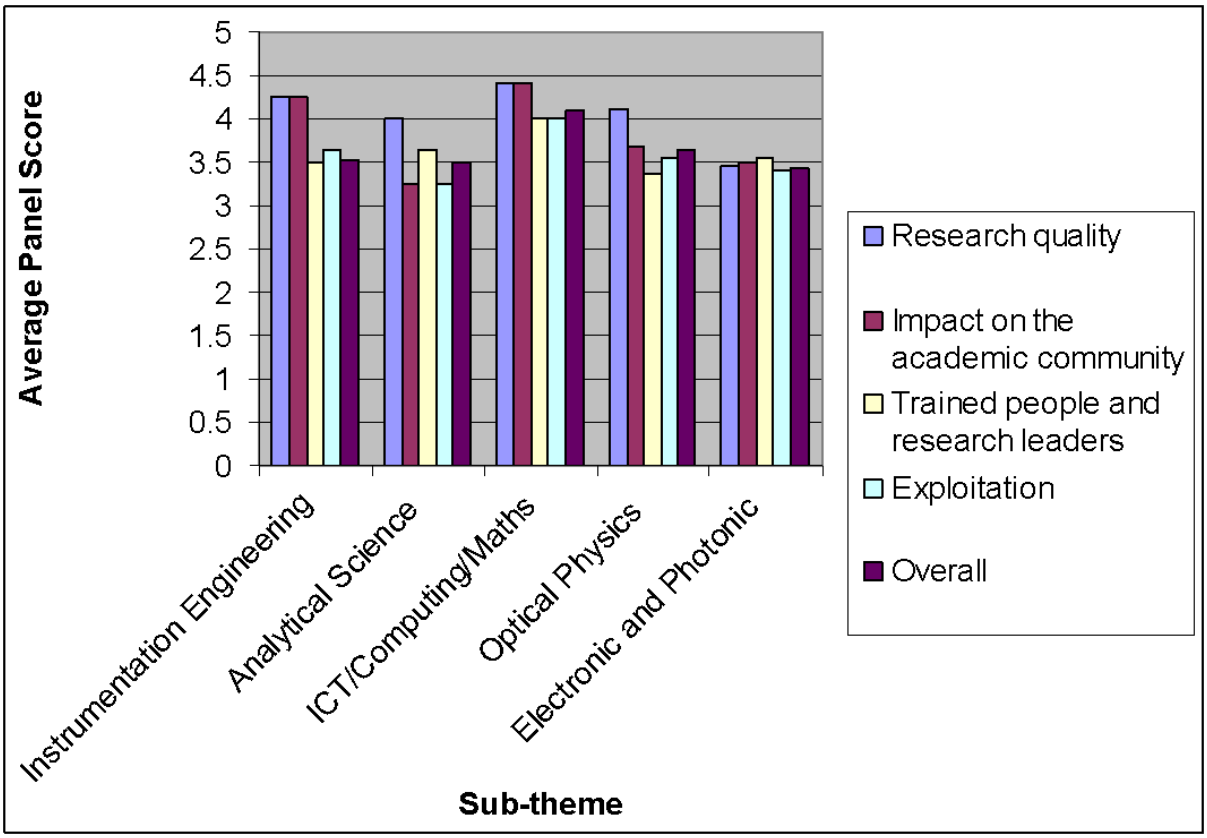

Fig 1. Panel score averaged for all grants in each Sub-Theme, by the individual criteria and overall

Sub-Theme	Research Quality	Impact on the Academic community	Trained People and Research Leaders	Exploitation	Overall
Analytical Science	4	3.25	3.63	3.25	3.5
ICT/ Computing/ Maths	4.4	4.4	4	4	4.1
Optical Physics	4.11	3.69	3.36	3.55	3.63
Electronic and Photonic	3.46	3.49	3.54	3.42	3.43

Fig 1. Panel score averaged for all grants in each Sub-Theme, by the individual criteria and overall

Sub-Theme	Total number of projects	Projects scoring 5 overall	% of total	Projects scoring 4 or more overall	% of total
Instrumentation engineering and development	9	2	22%	5	55%
Analytical science, and surfaces, probes & interfaces	8	1	13%	4	50%
ICT/Computing/ Mathematics	5	2	40%	3	60%
Optical physics and laser systems	11	3	27%	5	45%
Electronic and photonic materials and devices	13	1	8%	5	38%
TOTAL	46	9	20%	22	48%

Table 3. Numbers of grants scored 4 or more overall by the panel

Sub-Theme	Number of grants presented	Range of panel scores				
		RQ	AI	T&L	E	Overall
Instrumentation engineering and development	9	1-5	1-5	1-5	1-5	1-5
Analytical science, and surfaces, probes & interfaces	8	3-5	2-4	2-5	2-5	2-5
ICT/Computing/ Mathematics	5	3-5	4-5	3-5	2-5	3-5
Optical physics and laser systems	11	3-5	2-5	2-4	2-5	2-5
Electronic and photonic materials and devices	13	1-5	1-5	1-5	1-5	1-5
All Sub-Themes	46	1-5	1-5	1-5	1-5	1-5

Table 4. Range of scores allocated by the panel by each Sub-Theme and overall.

For each Sub-Theme, ranges of scores are given for each of the criteria (RQ = Research Quality; AI= Academic Impact and Crossing Discipline Boundaries; T&L = Trained people and future leaders; E = Exploitation of Technology Research) and overall

Basic Technology Theme Overall

As shown in Table 4, scores allocated by the panel ranged widely, the panel deliberately using the entire scale (1-5), judged against the very highest international standards. Scores also varied significantly between the Sub-Themes. Figure 1 and table 4 show a significant variation in scores for the individual Sub-Themes, with the ICT/Computing/Mathematics Sub-Theme scoring the highest overall average, and the Electronic and Photonic Materials and Devices Sub-Theme scoring the lowest overall average. Overall, 48% of all grants scored 4 or more overall (Table 3). 9 projects out of the 45 presented were ranked overall as “internationally leading” (scoring 5); this corresponded to 20% of the total.

The panel made the following comments about the portfolio overall:

- There were some extremely high quality projects, some world leading.
- The panel were excited by much of the research presented, and impressed by the level of enthusiasm shown by participants; both for the results of the research, and for the Programme and its approach.
- The Basic Technology Programme has enabled multi-disciplinary work that would not have been possible without the programme, between and across institutions. The most exciting projects were those that most closely followed the vision for Basic Technology, developing a generic technology base. High risk projects were also enabled by the programme.
- There were a lot of very good grants, and surprisingly few outright failures, for what was designed as a programme supporting high risk research.
- There were good examples of academic leadership, development of staff, and cutting edge basic technology and exploitation.

ICT/Computing/ Mathematics

This was the smallest Sub-Theme represented at the Theme Day (5 grants)

Of these, 3 grants (60%) scored 4 or more overall; 2 grants scored 5. None of the grants scored lower than a 2 against any of the individual criteria.

The panel made the following comments about the ICT/Computing/Mathematics Sub-Theme:

This was the strongest sub-theme in the portfolio, with the highest scores for research quality, academic impact, training of people and exploitation. The panel noted that this theme offers the most opportunities for immediate impact; the grant holders form part of a strong community in the UK. The subject matter lends itself to many applications, and generic technologies have been developed.

The panel highlighted the following two projects:

M Petrou, Imperial College London. "Reverse Engineering the Human Visual System." GR/R87642/01; Translation Grant EP/E045472/01.
Collaboration with Surrey and Oxford.
The panel commented that the project demonstrated the true ethos of Basic Technology; with fundamental science progressing to technology development on to a spin-out company.
There was also genuine interaction between all team members and a willingness to acknowledge everyone's contribution.
The spin-out company, Cortexica Vision Systems, was established in 2009 with the help of Imperial Innovations. 5 patents have been filed. There is industrial engagement with several companies. Products arising from Cortexica have included BrandTrak™ and WINEFindr™
Over 60 papers and book chapters have been published

S Price, University College London. "Control and prediction of the Organic Solid State." GR/S24114/01; Translation Grant EP/F03573X/1
Collaboration between UCL, Strathclyde, Cardiff, CCLRC, Glasgow.
Publication record excellent; many papers published with industrial partners; industrial alliance set up to fund collaborative projects; group have an international reputation and represent a true collaboration who will continue to work together

Optical physics and laser systems

Overall, grants within this sub-theme scored between 2 and 5. Out of the 11 grants presented, 5 (45%) scored 4 or more. Of these, 3 scored the maximum overall of 5 (27%), corresponding to "Internationally leading"

In terms of research quality, grants scored between 3 and 5. The panel commented on the high research quality shown by some of the grants; with the involvement of some of the best optics groups in the UK contributing towards the Basic Technology Programme.

Training of people and future research leaders scored lower, with scores of between 2 and 4. Some projects did not seem to be so concerned about career development.

Some PI's commented that the equipment available to support the research in this area is quite old; some early equipment bought for awarded Basic Technology grants is now out of date, and there are no mechanisms to renew the equipment. Some PI's also commented that they had to go outside the UK to get access to central laser facilities, which was constraining them.

The panel highlighted the following two projects:

J Tisch, Imperial College, London "Attosecond Technology – Light sources, Metrology and Applications", GR/S22400/01; Translation Grant EP/F034601/01.
The panel commented that the PI was amongst world leaders in the area of attosecond technology development. The project aims to develop a toolkit. There were over 50 publications arising form the project, including some in Science, Nature Physics and PRL. There were 2 BBC research stories and over 50 invited talks were given.
Good career progression for the 12 PhD students trained on the project, who have gone on to industrial or postdoctoral positions. This project has helped the career progression of the PI towards Professorship.
There have been various follow-on grants and creation of a "user facility" at RAL, as a general utility tool. Although largely a physics project, it is having an impact on the world ultra-fast laser community

K Dholakia, St Andrews. "Sonoptics: exploiting ultrasound and laser sciences for generic non-invasive therapies" EP/D04877X/01;Translation Grant EP/H045368/01
This project is in collaboration with Dundee.
The panel commented that this was a competitive area of science, and the team had developed their own niche. There were a broad range of applications possible in basic biomedical research or in clinical applications. This was a true cross-disciplinary project between physics, biology and clinical medicine. Many people had been trained via this project and moved onto good positions.
The team have good commercial links; e.g Nikon, Elliott Scientific and understand taking value from IP.

Analytical science; and surfaces, probes and interfaces

Overall, scores in this sub theme varied between 2 and 5, with scores for research quality varying between 3 and 5. 4 of the 8 grants presented scored 4 or more. 1 of these was considered to be internationally leading, scoring 5 overall.

The panel commented that surface science is a very challenging area, with a lot of experimental work, and also long term projects. Impact and exploitation are naturally lower in this sub-theme because of that. The panel felt that it was a developing area and has a longer term path to exploitation.

The panel highlighted the following project:

S Flitsch, Manchester; GR/S79268/01 and Translation Grant EP/G037604/01
"Glycochips – strategies for high-throughput analysis of the glycome".
This is a collaboration between Manchester, Dundee, Imperial, John Innes Centre, UEA and Liverpool.
The panel commented that this was an excellent fit to the Basic Technology ethos; a truly collaborative project that had resulted in setting up an EU centre in glycoarrays, and a Marie Curie training network
There have been no patents or licences, but there are excellent interactions and collaborations with associated academic groups (including in the US) and also with industry
Many publications have arisen from the grant including a Nature paper.

Instrumentation engineering and development

Overall, grants within this sub-theme scored between 1 and 5. Of the 8 grants presented, 5 (62%) scored 4 or more, 2 (25%) scored 5.

Overall, the panel recognised that there were considerable strengths in this area, although the portfolio is very diverse group. There was a very large spread on overall and exploitation scores, being either internationally leading, or poor - needing more help and mentoring. Most grants in this sub-the were subsequently awarded a Translation Grant. The panel felt that this was a very important area that had benefited from the Basic Technology programme funding

Most grants in this sub-theme were subsequently awarded a Translation Grant. The panel felt that this was a very important area that had benefited from the Basic Technology programme funding.

The panel highlighted the following projects:

M Smith, Warwick; EP/D045967/1 D2NP - New frontiers in electron enhanced high field solid state NMR for interdisciplinary science and technology
This is collaboration between Warwick, Oxford and St Andrews.
The panel commented that this project was well connected to the science and industrial communities, collaborating with the key industry players in this area. There is potential rich exploitation of the new NMR technology that is being developed, particularly from market leader Bruker. The project is enabling excellent training of NMR researchers.

C Abell, Cambridge; EP/D048664/1 Microfluidic microdroplet reactors Translation grant EP/H046593/1 Microdroplet technology – the next stage
This is a world leading collaboration between Cambridge and Imperial. The original Basic Technology grant has enabled this cross-disciplinary platform technology to be developed, with a diverse range of potential applications. There have been many publications arising from the grant in good journals.

14 postdoctoral researchers have been trained, most have moved to good positions elsewhere.
Several patents have been filed, and a spinout company set up.
Six proof of principle studies for the technology are being set up under the Translation Grant award, and include: algal biofuels; analysis of secreted proteins; calcium flux assays; passive, disposable devices for DNA amplification; single cell sequencing; and separation of complex mixtures of proteins.

R Prance, Sussex; GR/R87550/1 BASIC TECHNOLOGY: The development of electric potential sensors as generic tools for basic technology
This is a collaboration within the School of Engineering and Design at the University of Sussex.
A very valuable piece of generic technology has been developed from an apparently simple idea. There are currently 13 instruments out on test for varied applications: Surface body electrophysiology; Neuro-electrophysiology; Machine interfacing (HCI and assisted living); Materials imaging; Stress in rocks; Nuclear resonance and acquisition of signals.
The technology may be unique in terms of spatial applications.
27 publications have arisen from the grant. There is 1 patent arising from the grant with 5 pending.
The panel considered this grant to be an excelllent example of delivering the ethos of the Basic Technology programme.

Electronic and photonic materials and devices

Overall, grants within this sub-theme scored between 1 and 5. Of the 13 grants presented, 5 (38%) scored 4 or more; 1 (8%) scored 5.

This sub-theme was perceived to be a more mature technology area than others in the portfolio. Some of the projects have benefited more from the scale of funding rather than being a fit to the vision for Basic Technology. Some of the projects were successful, but low risk, although when they were first funded, at the time the projects would have been perceived as high risk.

The panel highlighted the following project:

H Coles, Cambridge; EP/D04894X/01 COSMOS: Coherent Optical Sources using Micromolecular Ordered Structures.
Translation Grant EP/H046658/01 COSMOS Technology Translation Proposal
This is collaboration between engineers and scientists at Cambridge that was unlikely to have taken place had it not been for the Basic Technology grant. A very established team with a strong track record and impressive achievements in polymer laser architecture.
There have been outstanding publications in Nature and Science, and several patents have been filed. The PIs have a strong track record in technology exploitation.
Commercial opportunities are already being exploited in the area of high efficiency polymer LEDs.
Substantial numbers of students and postdoctoral researchers have been trained, with many remaining in academia.

Key Findings and Recommendations of the Panel

Overall Portfolio

In overall terms, the panel found the Basic Technology research portfolio to be very healthy, highlighting academic leadership, career development and technology exploitation in a number of projects (see main report for examples). Panel members were excited by much of the research they evaluated, and impressed by the leadership shown by many of the Principal Investigators. Very few projects did not have aspects which could have been highlighted in this report.

The strengths of the Basic Technology Programme were in generating capability and not being topically prescriptive. The most exciting projects were those that were most closely aligned to the vision for Basic Technology, contributing to the development of a generic technology base.

Many of the strongest projects were those that were involved in the integration of several technologies. The divergent nature of the Basic Technology Programme was a core value that was also demonstrated amongst the best projects.

Capability

The panel identified high quality programmes of research in each of the sub-themes (ICT/Computing/Mathematics; Optical physics and lasers; Analytical science and surfaces, probes and interfaces; Instrumentation engineering and development; Electronic and photonic materials and devices)

When compared with other sub-themes, ICT/Computing/Mathematics was evaluated highly in terms of research quality, academic impact and training, with many generic technologies developed. When compared to other sub-themes, scores for analytical science were generally lower, because of longer timescales to exploitation.

Some areas were identified by the panel where there were potential applications of the generic technologies developed in this programme but where applications had not yet appeared to be developed despite some obvious potential applications, e.g. green technologies, better battery technology, environmental sciences, space, food security, energy, predictive science modelling, transport, civil engineering, materials/human interface. This needs to be considered in future spin-out from the existing portfolio.

Developing Leaders

The consortia were successful in bringing together teams of leading researchers, with complementary skills across a range of disciplines. The strengths of this approach were in encouraging and facilitating the opportunity to conduct challenge-led, multi-disciplinary research.

In a number of cases, individuals were able to build experience of academic leadership at relatively earlier stages in their careers. The panel would like to see a new generation of PIs coming forward to address emerging technology challenges.

While the panel was impressed with the leadership shown in a number of projects, they advised that greater attention be paid to developing leaders in any similar future programmes. It was recognised that this is a key goal of EPSRC's new Strategic Plan. It was felt not appropriate to expect leadership of such large projects to happen by chance. The panel also observed that projects were more successful if the PI was a strong project manager, or if a specific project manager had been appointed. There are issues of career structure for such project managers that universities need to consider.

Delivering Impact

There were some excellent examples of exploitation, with the panel noting that the number of spin-out companies appeared to be significantly higher with grants funded from the Basic Technology Programme then through other avenues of research funding.

EPSRC could be more involved in assisting with exploitation, as some universities clearly did not have the resources to help the project teams. There was an opportunity for organisations such as the TSB, KTNs and University Technology Transfer offices to be involved in assisting with exploitation, but there were surprisingly few successful examples of such help in the work reviewed. There were some examples of funding being leveraged from the RDAs.

Translation grants were recognised for their role in taking the Basic Technology projects to the next level, for take up of the technology or exploitation by the wider academic community or by industry. EPSRC should work closely with other funding bodies to enable take-up of technology.

There was recognition that the speed of technology development varied across the different sub-themes and that in some areas take-up may not occur for many years.

Management

The panel recommended that EPSRC consider allocating more resources to monitoring large projects; they endorsed having a specific Research Council contact to liaise with the project team and help to keep projects on track.

The mid-term reviews of the projects should be more formalised, with a mechanism to re-focus objectives, cutting funding where implementation of recommendations is not successful. The use of project Mentors was endorsed. The concept could further benefit by strengthening the emphasis of mentor support for the PI. There should be more formality with the role, with a requirement on the mentor to follow a monitoring methodology to pick up when things are going wrong.

Methodology

The panel commented favourably on the Theme Day as a useful methodology for evaluating the Basic Technology portfolio. The assessment process enabled them to form a view of the portfolio as a whole, and to comment with authority on the component Sub-Themes.

Looking Ahead

The panel endorsed the current vision for Basic Technology, with an emphasis on a generic technology base rather than specific targeted application areas. In any future investment activity, the assessment criteria and peer review will be key. Management and monitoring of projects will play an important role in helping to shape capability, develop leaders and deliver impact. The panel were excited by much of the research it saw, and recognised the seminal nature of it, and of the programme.

Acknowledgements

The Panel would like to thank the investigators who presented for their enthusiasm for their work and their patience in explaining it; and all the EPSRC staff that arranged the evaluation and made it run so smoothly.

Appendix 1: EPSRC grants presented at the Theme Day

Poster No	Participant		Grant Number	Grant value	Project	Sub-Theme	Presentee if not PI	Speaker 1	Speaker 2	Speaker 3 Robert Gurney
1	Prof David Lurie	Aberdeen U	EP/E036775/01	£2,417,758	Fast Field-Cycling Magnetic Resonance Imaging	Instrumentation Engineering and Development		Justin Molloy	David Auty	
2	Prof Mervyn Miles	Bristol U	EP/C523687/01	£2,285,128	A Dynamic Holographic Assembler.	Optical Physics and Laser Systems		Andrew Kearsley	Elaine Martin	
2	Prof Mervyn Miles	Bristol U	EP/G037310/01	£1,033,679	Translating the Dynamic Holographic Assembler	Optical Physics and Laser Systems		Andrew Kearsley	Elaine Martin	
5	Prof Harry Coles	Cambridge U	EP/D04894X/01	£2,395,497	COSMOS : Coherent Optical Sources using Micromolecular Ordered Structures	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
5	Prof Harry Coles	Cambridge U	EP/H046658/01	£864,032	COSMOS Technology Translation Proposal	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
14	Pof Giles Davies	Leeds U	EP/C006755/01	£2,688,501	Hybrid Bio-functionalized Surfaces	Analytical Science & Surfaces, Probes and Interface		Ian McConvey	Tim Wess	Robert Gurney
4	Prof James Fawcett	Cambridge U	EP/C52330X/01	£1,803,110	Neuroelectronic interfaces for repair of damage to the nervous system	Instrumentation Engineering and Development	Stephanie Lacour	Justin Molloy	David Auty	
4	Prof James Fawcett	Cambridge U	EP/H00727X/01	£1,055,228	Micro-channel electrode neural interfaces: restoring bladder control	Instrumentation Engineering and Development	Stephanie Lacour	Justin Molloy	David Auty	
8	Mr D Arvind	Edinburgh U	EP/C523881/01	£3,721,431	A Research Consortium in Speckled Computing	ICT/Computing/ Mathematics		Andrew Kearsley	Elaine Martin	Robert Gurney

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10	Dr Andrew Pitt	Glasgow U	EP/E032745/01	£4,852,537	The Molecular Nose - A nose for cellular science	Analytical Science & Surfaces, Probes and Interface		Ian McConvey	Tim Wess	
15	Prof Aminesh Jha	Leeds U	EP/D048672/01	£3,537,856	Nano- and Micro-scale Integration of Glass-on-Semiconductor for Photonic Components Engineering	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
6	Prof Rudolf Allemann	Cardiff U	EP/F040954/01	£1,423,467	Intracellular Biophotonic Nanoswitches	Electronic and Photonic Materials and Devices	Emeline Furon	Justin Molloy	David Auty	
12	Dr John Tisch	Imperial College	GR/S22400/01	£3,605,397	Attosecond Technology - Light Sources, Metrology and Applications	Optical Physics and Laser Systems		Andrew Wee	Julian Jones	Robert Gurney
12	Dr John Tisch	Imperial College	EP/F034601/01	£996,355	Next Generation Attosecond Technology	Optical Physics and Laser Systems		Andrew Wee	Julian Jones	Robert Gurney
13	Prof Maria Petrou	Imperial College	GR/R87642/01	£2,739,687	Next Generation Artifical Vision Systems : Reverse Engineering Human Visual Processes	ICT/Computing/ Mathematics		Andrew Kearsley	Elaine Martin	
13	Prof Maria Petrou	Imperial College	EP/E045472/01	£923,846	Reverse Engineering the Human System Next generation artificial vision systems.	ICT/Computing/ Mathematics		Andrew Kearsley	Elaine Martin	
24	Prof Andrew Briggs	Oxford U	GR/S23421/01	£1,941,691	Cryogenic Instrumentation for Quantum Electronics	Electronic and Photonic Materials and Devices	Thierry Ferrus	Ian McConvey	Tim Wess	

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31	Prof John Rodenburg	Sheffield U	EP/E034055/01	£4,309,803	Ultimate Microsocopy: Wavelength-Limited Resolution Without High Quality Lenses	Optical Physics and Laser Systems		Justin Molloy	David Auty	
7	Prof Paul Smith	Cardiff U	GR/S23483/01	£2,271,606	Optical Biochips	Electronic and Photonic Materials and Devices	Lestyn Pope	Justin Molloy	David Auty	
16	Prof Edmund Linfield	Leeds U	GR/R87086/01	£1,432,020	Basic Technology: The Development of Terahertz Technology for Physical, Biological, and Medical Imaging and Spectroscopy	Electronic and Photonic Materials and Devices		Ian McConvey	Tim Wess	Robert Gurney
16	Prof Edmund Linfield	Leeds U	EP/E048811/01	£871,777	The development of terahertz technology for physical, biological, and medical imaging and spectroscopy	Electronic and Photonic Materials and Devices		Ian McConvey	Tim Wess	Robert Gurney
18	Robert Cernik	Manchester U	EP/D048737/01	£3,013,067	New Materials for High Energy Colour X-ray Imaging	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
18	Robert Cernik	Manchester U	EP/H046577/01	£1,241,447	HEXITEC: Translation grant. The application of colour X-ray imaging	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
19	Prof Sabine Flitsch	Manchester U	GR/S79268/01	£3,570,609	Glycochips-Strategies for High-Throughput Aalysis of the Glycome	Analytical Science & Surfaces, Probes and Interface		Andrew Kearsley	Elaine Martin	
19	Prof Sabine Flitsch	Manchester U	EP/G037604/01	£846,367	Exploitation of Glycoarrays - Translation to End-use	Analytical Science & Surfaces, Probes and Interface		Andrew Kearsley	Elaine Martin	

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9	Dr Andrew Shaw	Exeter U	EP/C52389X/01	£2,950,714	2D Attogram Surface Plasmon Imaging	Analytical Science & Surfaces, Probes and Interface		Justin Molloy	David Auty	
17	Prof Roger Barlow	Manchester U	EP/E032869/01	£7,472,362	The Non Scaling Fixed Alternating Gradient Accelerator - A matter of scale	Instrumentation Engineering and Development		Ian McConvey	Tim Wess	
22	Dr David Walker	OpTIC Technium	GR/S85344/1	£3,743,308	Ultra Precision Surfaces: A new paradigm	Optical Physics and Laser Systems		Andrew Kearsley	Elaine Martin	
22	Dr David Walker	OpTIC Technium	EP/F031416/1	£670,808	Ultra Precision Surfaces - Translation Grant	Optical Physics and Laser Systems		Andrew Kearsley	Elaine Martin	
27	Prof Nigel Allinson	Sheffield U	GR/S 85733/01	£4,411,979	M-I3 - Multidimensional Integrated Intelligent Imaging	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	Robert Gurney
27	Prof Nigel Allinson	Sheffield U	EP/G037671/01	£1,193,749	MI-3 Plus	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	Robert Gurney
20	Prof Laurence Eaves	Nottingham U	GR/S83005/01	£1,345,205	Magnetic Levitation Technology for Mineral Separation, Nanomaterials, and Biosystems for Space Exploration	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
20	Prof Laurence Eaves	Nottingham U	EP/G037647/01	£558,061	Emerging magnetoscience technology	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
21	Prof Peter Beton	Nottingham U	EP/D048761/01	£3,462,495	Templates for Biofunctional Surfaces, Quantum Information Processing and	Analytical Science & Surfaces, Probes and Interface		Ian McConvey	Tim Wess	

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					Nanoelectronics					
26	Prof John Stark	Queen Mary U of London	GR/R87703/01	£3,118,615	Nano Emitter Electrospray Technology for the Manipulation of Nanoparticles and Molecules	Analytical Science & Surfaces, Probes and Interface		Justin Molloy	David Auty	
28	Dr Beverley Inkson	Sheffield U	GR/S85689/01	£2,397,034	Nanorobotics - Technologies for Simultaneous Multidimensional Imaging & Manipulation of Nanoobjects	Instrumentation Engineering and Development		Andrew Kearsley	Elaine Martin	
28	Dr Beverley Inkson	Sheffield U	EP/G036748/01	£727,627	Nanorobotics : Transfer to applications, new science and industry	Instrumentation Engineering and Development		Andrew Kearsley	Elaine Martin	
3	Prof Chris Abell	Cambridge U	EP/D048664/01	£4,847,472	Microfluidic Microdroplet Reactors	Instrumentation Engineering and Development		Justin Molloy	David Auty	
3	Prof Chris Abell	Cambridge U	EP/H046593/01	£1,067,242	Microdroplet technology - the next stage	Instrumentation Engineering and Development		Justin Molloy	David Auty	
23	Prof Malcolm Green	Oxford U	GR/S83968/01	£1,006,925	Molography in Carbon Nanotubes	Instrumentation Engineering and Development		Ian McConvey	Tim Wess	
36	Prof Martin Dawson	Strathclyde U	GR/S85764/01	£2,657,253	A Thousand Micro-emitters Per Square Millimetre: New Light On Organic Materials & Structures	Electronic and Photonic Materials and Devices	Tim Holt	Andrew Wee	Julian Jones	Robert Gurney

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37	Prof Dino Jaroszynski	Strathclyde U	GR/R88090/01	£4,270,634	Basic Technology: Developing Laser-Plasma Accelerators and Coherent Radiation Sources as Tools for Time-Resolved Studies	Optical Physics and Laser Systems		Andrew Kearsley	Elaine Martin	
11	Prof Jonathan Cooper	Glasgow U	EP/F040857/01	£1,251,552	Listening to the Micro-World	Optical Physics and Laser Systems		Ian McConvey	Tim Wess	
30	Prof Tony O'Hagan	Sheffield U	EP/D048893/01	£2,162,270	Managing Uncertainty in Complex Models: a Step Change in Understanding How Models perform	ICT/Computing/ Mathematics	Dan Cornford	Andrew Kearsley	Elaine Martin	Robert Gurney
30	Prof Tony O'Hagan	Sheffield U	EP/H007377/01	£942,099	MUCM2	ICT/Computing/ Mathematics	Dan Cornford	Andrew Kearsley	Elaine Martin	Robert Gurney
35	Dr David Smith	South U	EP/C006763/01	£3,486,923	A Technology for the Rational Design and Organisation of Functional 3D Templated Nanomaterials	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
35	Dr David Smith	South U	EP/H007369/01	£911,572	Topological Engineering Translation Grant	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
29	Prof Graham Leggett	Sheffield U	EP/C523857/01	£3,143,258	The Snomipede: Building Materials Molecule-by-Molecule	Analytical Science & Surfaces, Probes and Interface		Ian McConvey	Tim Wess	
33	Prof Hywel Morgan	South U	GR/S23513/01	£2,608,218	4 Billion Bases a Day - Practical Individual Genome Sequencing	Analytical Science & Surfaces, Probes and Interface		Justin Molloy	David Auty	Robert Gurney

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38	Dr Graham Smith	St Andrews U	GR/S85719/01	£2,531,535	Bringing the NMR paradigm to ESR	Instrumentation Engineering and Development		Andrew Wee	Julian Jones	
38	Dr Graham Smith	St Andrews U	EP/F039034/01	£994,435	Translation Grant for The HIPER project - "Bringing the NMR Paradigm to ESR"	Instrumentation Engineering and Development		Andrew Wee	Julian Jones	
41	Prof Sally Price	U College London	GR/S24114/01	£2,438,768	Control and Prediction of the Organic Solid State	ICT/Computing/Mathematics		Andrew Kearsley	Elaine Martin	
41	Prof Sally Price	U College London	EP/F03573X/1	£946,361	Control and Prediction of the Organic Solid State: Translating the Technology	ICT/Computing/Mathematics		Andrew Kearsley	Elaine Martin	
25	Prof Marco Borghesi	Queens U Belfast	EP/E035728/01	£4,707,228	Laser Energised Radiation Source Technology - Ultra emissions	Optical Physics and Laser Systems	Dave Neely	Andrew Wee	Julian Jones	Robert Gurney
34	Prof Nikolay Zheludev	South U	EP/F040644/01	£2,253,909	NANOSCOPE: Looking Inside a Living Cell with Nanoscale Resolution	Optical Physics and Laser Systems	Edward Rogers	Justin Molloy	David Auty	
40	Prof Robert Prance	Sussex U	GR/R87550/01	£1,033,868	The Development of Electric Potential Sensors as Generic Tools for Basic Technology	Instrumentation Engineering and Development		Ian McConvey	Tim Wess	Robert Gurney
40	Prof Robert Prance	Sussex U	EP/E042864/01	£757,804	The electric potential sensor - a basic technology for measurement science	Instrumentation Engineering and Development		Ian McConvey	Tim Wess	Robert Gurney

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42	Prof Marshall Stoneham	U College London	GR/S23506/01	£3,672,132	Putting the Quantum into Information Technology	ICT/Computing/Mathematics	Andrew Fisher	Andrew Kearsley	Elaine Martin	
44	Dr David Leadley	Warwick U	EP/F040784/ 01	£1,069,459	On-Chip milliKelvin Electronic Refrigerator for Astronomical and Quantum Device Applications	Electronic and Photonic Materials and Devices		Andrew Wee	Julian Jones	
32	Prof Jeremy Frey	South U	GR/R87307/01	£2,493,400	New Technology for Nanoscale X-ray Sources: Towards Single Isolated Molecule Scattering	Optical Physics and Laser Systems		Ian McConvey	Tim Wess	
43	Dr Peter Doel	U College London	EP/D04880X/01	£3,072,089	Smart X-ray optics	Optical Physics and Laser Systems		Andrew Kearsley	Elaine Martin	
39	Prof Kishan Dholakia	St Andrews U	EP/D04877X/01	£2,065,098	Sonoptics: Exploiting Ultrasound and Laser Sciences for Generic Non-Invasive Therapies	Optical Physics and Laser Systems	Paul Campbell	Justin Molloy	David Auty	Robert Gurney
39	Prof Kishan Dholakia	St Andrews U	EP/H045368/01	£964,448	Making Light Deliver: translation of methods of photoporation	Optical Physics and Laser Systems	Paul Campbell	Justin Molloy	David Auty	Robert Gurney
45	Dr Tim Jones	Warwick U	EP/F041160/01	£684,120	Molecular Spintronics	Electronic and Photonic Materials and Devices		Andrew Kearsley	Elaine Martin	
46	Prof Mark Smith	Warwick U	EP/D045967/01	£4,161,693	D2NP - New Frontiers in Electron Enhanced High Field Solid State NMR for Interdisciplinary Sience and Technology.	Instrumentation Engineering and Development	Mark Newton	Andrew Wee	Julian Jones	

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47	Prof John Rees	NERC British Geological Survey	EP/C523776/01	£3,476,858	Biologically Inspired Acoustic Systems (BIAS).	Instrumentation Engineering and Development	Dave Gunn	Ian McConvey	Tim Wess	
*	Prof Borivoj Vojnovic	Gray Cancer Institute	GR/R87901/01	£1,172,791	Deep, Time-Resolved Imaging in Aberrant Biological Media by Adaptive and Predictive Wave Front Correction	Optical Physics and Laser Systems				
*	Colin Lambert	Lancaster U	GR/S 84057/01	£593,236	Controlled Electron Transport Through Single Molecules	Analytical Science & Surfaces, Probes and Interface				
*	Prof Peter Morris	Nottingham U	GR/S23582/01	£1,996,088	Hyperpolarised Technologies for Medical and Materials Sciences	Instrumentation Engineering and Development				
*	Prof Ed Hinds	Sussex U	GR/R87024/01	£1,104,492	Atom Chips - Integrated Circuits for Nanoscale Manipulation of Cold Atoms	Electronic and Photonic Materials and Devices				
	Prof Ed Hinds	Sussex U	EP/E043631/01	£1,070,040	Atom Chips - Integrated Circuits for Nanoscale Manipulation of Cold Atoms	Electronic and Photonic Materials and Devices				
	Prof Malcolm Levitt	South U	EP/C00664X/01	£2,882,477	Cryogenic magic-angle-spinning NMR	Instrumentation Engineering and Development				

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	Prof Malcolm Levitt	South U	EP/G035695/01	£776,394	Realising the potential of cryogenic magic-angle spinning nuclear magnetic resonance	Instrumentation Engineering and Development				

* Projects not represented at the Theme Day