SUPA Research Fore-Sighting Discussion Paper

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Overview

This document has been prepared as a discussion paper by a meeting of SUPA theme leaders and their nominated representatives on 9th May 2016. The attendees can be found at the end of this document, Annex 1.

Motivation

This Group is one of three recently set up by SUPA, the other two being an Education and Outreach Focus Group and an Industry Focus Group. The purpose of this Group was to give a perspective from SUPA researchers on how SUPA can help develop Scottish physics research.

The SUPA theme leaders (or nominated representatives) gave their perspectives on the research currently on going and how SUPA could help in the future. The delegates were asked to engage with the following questions:-

- What are the rising areas of physics research globally?
- How can we best use the SUPA network to achieve effective cross-institutional collaboration?
- What gaps should/ could be filled in Scotland's physics research portfolio?
- What future joint centres / facilities / CDTs are we well placed to bid for collectively?
- How can we work across boundaries, i.e. interdisciplinary, pools, research institutes, industry?
- How can SUPA help with the impact agenda?
- What funding channels could lead to large awards?

For these discussions delegates were initially divided into groups according to theme. In the second session the delegates were group according to cross theme topics of PALS[1], Energy[2], Big Data and Theory, Detectors and sensors, Industry and Manufacturing. These cross theme groups were designed to highlight where SUPA could increase impact with cross disciplinary working.

Common Threads

The discussions within and across themes identified several ways in which SUPA could support researchers which were common across themes/impact areas. These included:

- Virtual Campus
  - This involves several linked ideas:
    - We should try to move towards a more seamless integration of systems (e.g. information about experimental facilities) between departments: more of a 'virtual

[1] SUPA Impact Theme
[2] SUPA Impact Theme

campus' feel. SUPA could assist by re-vamping the web site and organising relevant negotiations between individual physics departments.
    - It should be easy to find and contact colleagues working in the same theme in other Universities
    - SUPA should help to maintain networks in assist in applying for large cross sector calls
- A Cross Scotland Theory Institute
    - This would require external funding, the Kavli Foundation was suggested as a potential source.
- Industrial Engagement
    - We should maintain an "outward facing" list of facilities available to industry. (Linked to the virtual campus thread)
    - There is a role for SUPA in helping to bridge the TLR 3-5 gap.
    - The industrial placements were highlighted as good practice and widely supported.
    - Spin outs and commercialisation were seen to be weaknesses for several themes.
- The need for a cross community approach to specific problems.
    - Discussions within and across themes identified several areas of mutual interest e.g. Big data, medical imaging, detector technology. SUPA is well placed to organise cross theme meetings to develop this type of inter theme collaboration.
- The use of SUPA as a network to access large funding awards by connecting several institutions and industrial partners.
- SUPA should create a standard letter of support for use in grant applications for EU and other large grants.
- A reduction in bureaucracy associated with the 8 universities under SUPA
    - In particular the number of forms required to become a SUPA student.
- SUPA should provide help/funding for the best international students. The SUPA Prize studentships scheme has been extremely valuable and should continue if at all possible.

Theme Specific Discussions

Astronomy and Space Science

- Can SUPA help to leverage better deals when considering joining big international projects/collaborations?
- Are there synergies within SUPA that we're missing? For example,telescope follow-ups of gravitational wave events
- Can SUPA courses/workshops be used to highlight new technologies,such as GPU programming.
    - Shared seminars?
    - Shared undergraduate teaching?
- Astronomy/SpaceScience theme seems to be involved in most of the rising areas
    - Maybe should be more aware of maintaining critical mass.
      Are there,for example,Earth Observing opportunities within the Instrumentation area?

- Big Data and High-Performance computing seem to be relevant to all the areas within the theme.

- Do we all understand what Big Data really means and are we in a position to optimise what we do in this context.
- Do we need to think about how we provide High-Performance Computing to the community–both theorists and observers.
- Visualisation facilities?

- How can we fund the really good International students who seem keen to study in Scotland?
- Many possible interdisciplinary opportunities
  - Detector development,
  - HPC,
  - Data analysis techniques(computer science, statistics),
  - Medical imaging,
  - Earth observing.
- Also the space industry:
  - Cube Stats,
  - Space Weather in association with the MET Office
  - Clyde Space and the space port
- Maybe it is time to rethink the idea of shared UG teaching (possibly linked to the new VC rooms)
- Capitalise on gravitational waves in the same way that Higgs was capitalised on, as a route to potential funding.

CMMP

How can we best use the SUPA network to achieve effective cross-institutional collaboration?

- We still have the situation where good PhD applicants are being asked to fill out the same information two or three times. Can SUPA do something to help establish a better-coordinated system for admitting PhD physics students in Scotland? An additional benefit of this approach might be better-coordinated and more impactful advertising of PhD places.
- We should try to move towards a more seamless integration of systems (e.g. information about experimental facilities) between departments: more of a 'virtual campus' feel. SUPA could assist by re-vamping the web site and organising relevant negotiations between individual physics departments.
- SUPA could usefully identify groups of SUPA researchers to bid for big calls – especially if they were spread across several universities, so that individual universities' Research Offices might not spot the opportunity.

What are the rising areas of physics research globally?

- Quantum matter (entanglement, not just discreteness).
- Non-equilibrium / pump-probe physics (this goes beyond CMMP too).
- Active materials (local energy generation / systems with internal engines).
- Multi-scale physics and multi-scale modelling.
- Big data / data analysis.
- New materials (e.g. optically active ones).
- Predictive materials design (beyond density functional theory).

What gaps should / could be filled in Scotland's physics research portfolio?

- We didn't exactly make a bullet-point list here; instead, we would recommend that 'gaps' should be interpreted with regard to upcoming research funding calls on the five- to ten-year timescale, e.g. quantum flagship, Horizon 2020.
- That said, we did note that superconducting qubits (transmons etc.) and experimental fluid dynamics are popular areas where Scotland does not seem to have much presence.

What future joint centres / facilities / CDTs are we well placed to bid for collectively?

- There seem to be good opportunities to bid for something in the materials area. We know that more than one SUPA member university is planning to open / build a Materials Institute – perhaps SUPA could co-ordinate discussions about whether these could be part of something bigger.

Which other organisations does this theme work with?

- Fraunhofer.
- Max Planck Institute.
- UK national facilities: ISIS, Diamond, Central Laser Facility.
- Their international equivalents.
- CPI.

What are the interdisciplinary opportunities for this theme?

Natural interdisciplinary links include:

- chemistry;
- materials science;
- engineering;
- formulation network ('formulation' being what industry calls soft condensed matter).

We also identified some links between CMMP and all the other SUPA themes, with a particular note that nuclear physics, particle physics, and condensed matter physics have a common interest in finite-density fermionic matter.

Nuclear and Plasma Particle

Inter Theme Collaboration

- Possible cross fertilisation from SCAPA to future particle physics accelerators and vice versa:
  - The main research theme of wakefield laser-based acceleration at SCAPA has complementarity with other forms of wakefield acceleration, e.g.. the AWAKE experiment at CERN.
  - There are also common areas with the technology for linear colliders, such as that developed at CERN for the CLIC linear collider. The focus has been on producing low-emittance beams and developments for a X-ray Free Electron laser (XFEL), which also has common technology with the International Linear Collider (ILC).
  - A concrete action arose from this discussion on the desirability to organise a workshop at Strathclyde University to discuss applications of accelerator

technologies in different fields such as nuclear and particle physics, medical physics and material science.

- Detectors
  - SUPA has expertise in strip and pixel solid-state detectors, electronics for pixel readouts (ie. the Medipix and Timepix chips) and photon detectors (hybrid photon detectors, Silicon PMTs also known as MPPCs, multianode PMTs and large area photomultiplier tubes). These are areas of commonality that could be explored. For example, Timepix is already being used for dosimetry and beam positioning in SCAPA and for applications in hospitals (Gartnaval Hospital).
- Physics

The main physics areas defined revolved around technology and detector expertise that allows "buy-in" into big projects.

  - Development of XFEL accelerators for material science, due to strong accelerator and plasma input from Strathclyde.
  - The main priority in Particle Physics is in the exploitation of the Large Hadron Collider (LHC) and developing the technology for the ATLAS and LHCb upgrade detectors.
  - SUPA groups to join the Long-baseline Neutrino Oscillation effort to discover CP violation in neutrinos (Edinburgh has joined HyperK, but there is also DUNE in the USA).
  - Linear Collider Physics and Detector studies, applied to both ILC and CLIC.
  - In Nuclear Physics, experiments on hadronic physics at Jefferson Lab (JLAB) in Virginia and ISOLDE at CERN were highlighted. There seemed to be little overlap with the programme at FAIR in Germany.
- Gaps in Scotland's Portfolio
  - long-baseline neutrino physics
  - sustained effort in linear collider physics
  - R&D towards XFEL
  - Nuclear Physics Theory (there isn't any in Scotland)

Photonics

Role for SUPA

- The theme often feels granular and needs better internal connections. SUPA could:
  - Circulate information
  - Organise internal meetings and talks across SUPA potentially making use of the new VC capabilities.
  - Maintain a cross SUPA list of facilities
  - Provide information and resources for local industries to interact with Physicists
  - Circulate funding calls
  - Help maintain networks to facilitate responses to funding calls
  - Feedback and sharing from photonics 21.
- Potential CDTS
  - Quantum Technologies

- Nano Structured and Advanced Materials

- Collaborations:
  - Biomedical optics and biophotonics: We have world leading biomedical research institutes in Scotland, such as the IGMM, QMRI & Beatson. There is a real opportunity for a Scotland-based UK Centre for Medical Photonics.
  - Photonic-enabled remote sensing and space science: We have the UKATC in Edinburgh, the new Higgs innovation centre at Blackfordhill, the Quantum-enhanced imaging hub. We have companies such as Selex, Thales and Clyde space –all interested in photonic-enabled sensing and imaging.
  - Industrial photonics: The FraunhoferUK is based in Scotland, we should be leveraging this more, with aim of taking research technologies to industry. How do we do this?
- Need better ways to link students to career opportunities in Scottish photonics companies.
- A large proportion of photonics research is in Electronic Engineering departments, SUPA should try to build links with these researchers without diluting the core physics messages

- There is a lot that SUPA can do to facilitate networking and create a number of opportunities for us to pool our resources and expertise.
- Realistically, to accomplish this we need coordination and proactivity at theme leader level. Clearly this is a big ask for (e.g.) the theme leader and it's not obviously sustainable in the mid-long term, without some form of support to the role.

Energy

- SUPA help to work across boundaries
  - Requires investment over a long term to build meaningful relationships
  - Needs dedicated staff time to grow the collaboration and a focus point or driver, e.g. an interdisciplinary studentship (funded 50:50 and joint supervisors etc)
  - Knowledge of available expertise and equipment e.g. a database
  - Possible creation of virtual institutes around specific energy topics
  - Workshops are needed to scope out potential areas for collaboration

- Impact agenda
  - Role of SUPA v institutional KE services discussed (related issues include ownership of IPR and Impact case studies for the REF etc)
  - SUPA support must work alongside the institutional support in order to be meaningful
  - Funding of workshops on specific impact topics
  - A key role for the SUPA KE personnel is to put people in contact with each other (i.e. a business development role). Academics don't have time to do this themselves and institutional business development support is typically generic (not specific to physics). The SUPA BDM should be drawing up databases and actively promoting linkages and networking across physics and industry
  - The SUPA industry placement scheme should continue

- Funding channels for large grants

- Use of SUPA Grad School to help leverage CDT awards
- Addressing the grant challenges in energy will mean working with institutions beyond Scotland and the UK – typically large EU projects
- Industry buy-in is key to leveraging / unlocking large grant funding. One of the main issues for the Energy theme is that industry will typically prefer to work with engineering disciplines, whose energy research is typically higher up the TRL

PALS

- Working with Others
  - Would like to work with a whole community of clinicians not just individuals
  - Would like joint SUPA/SUSLA seminars
  - Would like to revive the PaLS networking/speed dating
  - Work with the Farr Institute for data management
  - There is a significant skills base in SUPA linked to mathematical modelling of biological processes which could be exploited.

- Training
  - Ideally would like to bid for CDTs. The aim should be that students leave the PhD equally equipped with biology and physics knowledge
- Commercialisationn
  - Historically not good at this. Uncertain as to SUPAs role vs the individual HEIs

Cross Disciplinary Discussion

Big Data and Theory

- Should we be considering a Scottish theory institute?
  - How would this fit with the Higgs Centre for Theoretical Physics and the Higgs Centre for Innovation.
  - Is there also a gravitational waves angle – could we capitalize on this to leverage funding.
- Inter-disciplinary possibilities
  - Alan Turing Institute – computer science + physics + Intel
  - Data analysis methods, statistics
  - Algorithms for Big Data
  - Data Science MSc (in SUPA?)
- Knowledge exchange:
  - Best practice across the different institutions
  - Workshops?
- Funding:
  - Main funding bodies STFC, ERC
  - Can we consider approaching other organisations, such as Kavli?
  - What about direct approaches to Scottish Government, European Commission?
  - Companies – Intel already involved with Alan Turing Institute.
- Public outreach
  - Citizen science?
  - Distributed computing?

- SUPA should connect diverse interests

- SUPA should link up university research officers

Detectors and sensors

- Similarities between medical imaging (PET) and Gravitational Waves in terms of detector design
- Suggests that a wider community approach could be beneficial in problem solving
- The quantum technology hub is a good mechanism to encourage collaboration
- SUPA should encourage discussion between themes
  - It is important to meet, talk and understand opportunities
- SUPA placements are good and encourage industrial engagement
- Bridging the TRL3-5 gaps is difficult placements can help

Industry and Manufacturing

- SUPA should develop strategic relationships with industry
- Perhaps SUPA should have associate members
- Could charge or have in-kind contribution (e.g. Training)
- Ask for in kind opportunities or a recruitment success fee
- SUPA could help with expectation management between industry and academia (this cuts both ways)
- How to encourage industry as a career option
  - EngDs are a good mechanism
- Universities often separate industrial engagement with research and recruitment SUPA should reconnect this
- SUPA should act as a conduit for calls which require industry e.g. H2020, Innovate UK.
  - If possible pre-empt calls.

Annex 1: Attendees

	SURNAME	FIRST	Affiliation
1	Bashkanov	Mikhail	Edinburgh
2	Bookey	Henry	Fraunhofer CAP
3	Cunningham	Colin	ATC
4	del Debbio	Luigi	Edinburgh
5	di Falco	Andrea	St Andrews
6	Faccio	Daniele	Heriot-Watt
7	Gerardot	Brian	Heriot-Watt
8	Hamilton	David	Glasgow
9	Hammond	Giles	Glasgow
10	Hidding	Bernhard	Strathclyde
11	Hild	Stefan	Glasgow
12	Hooley	Chris	St Andrews
13	King	Phil	St Andrews
14	Kontar	Eduard	Glasgow
15	Lawrence	Andy	Edinburgh
16	Leach	Jonathan	Heriot-Watt
17	Mathieson	Keith	Strathclyde
18	McGloin	David	Dundee
19	Needham	Matt	Edinburgh
20	Nicholls	John	M2 Lasers
21	Reid	Stuart	UWS
22	Robson	Aidan	Glasgow
23	Ross	Iain	Technology Specialist
24	Stamps	Bob	Glasgow
25	Taylor	Jonathan	Glasgow
26	Thijssen	Job	Edinburgh
27	Weijmans	Anne-Marie	St Andrews
28	Woan	Graham	Glasgow
29	Wyper	David	SINAPSE
30	McKenna	Paul	Strathclyde
31	Soler	Paul	Glasgow
32	Rice	William Ken	Edinburgh
33	Miller	Alan	SUPA
34	Killow	Christian	SUPA
35	Pawsey	Anne	SUPA
36	Wasley	Matt	SUPA