

**From:** STFC Physical Sciences and Engineering Advisory Panel  
**To:** STFC Science Board  
**Date:** 1<sup>st</sup> February 2015

### Consultation Exercise with Central Facility User Community

#### Overview

Following a request from Science Board in February 2014 for a Central Facility user consultation, the Physical Sciences and Engineering Advisory Panel (PS&E AP) undertook a user survey. Given that a number of Research Council United Kingdom (RCUK) connected surveys were active throughout 2014, notably the RCUK “requirements” exercise, a light-touch approach was adopted. Only a relatively small number of responses were received. However, useful feedback was obtained from the exercise. The main comments are summarised below along with recommendations following discussion within the AP:

- Users are generally satisfied with the quality of facility provision. However there are concerns about maintaining the world-class level of that provision, and projecting it into the future, given current budgetary constraints. Users are also concerned about the level of over-subscription being experienced for key capabilities.

Aspects particularly highlighted in the survey included:

- The number of ISIS beam-days delivered to users should be maximised;
- The uniqueness of UK muon-based research (*that may not be offered at European Spallation Source, ESS*) should be recognised and built upon.
- Significant participation in European Synchrotron Radiation Facility (ESRF) should be maintained to take full advantage of the unique capabilities of the 6 GeV machine following Phase I and II upgrades;
- New opportunities exist through combining state-of-the-art ultrafast laser spectroscopy with microscopy to access spectroscopy and imaging with high temporal and spatial resolution;
- A clear funded strategy for development of UK laser facilities should be created;
- A roadmap for UK Free Electron Laser (FEL) research development is required (*this is now underway*);
- The efficient use of central large-scale facilities requires adequate staff support and ancillary sample environment/preparation capabilities;
- Coherency between RCUK project funding and access to facilities should be improved;
- RCUK-wide strategies should be considered to train PhD students as well as PDRA-level scientists and engineers to provide a knowledge/expertise base for the future.

The last point was of identified as being of particular concern by both the consultation respondents and the AP as it exposes a potential vulnerability of the UK experience base for large facility research.

### Details of the survey

Respondents with connections to the disciplines of the Physical Sciences and Engineering were initially asked to identify their principal activity according to the categories of:

- Lasers
- Photons (*i.e.*, mainly synchrotron radiation)
- Neutrons and muons.

Candidates were then asked to provide responses to the following five prompts. The numbering reflects the sequence used in the survey.

2. How do you view the present capability of the central facility(ies) that you are most involved with?
3. Does the facility(ies) provide state-of-the-art capability? If not, how is each deficient in this regard?
4. What developments in central facility capability would you like to see initiated over a 5-10 year time horizon?
5. Define your area of scientific endeavour and propose areas of activity that you believe will be important in terms of scientific advancement up to (i) 2020 and (ii) beyond.
6. Do you believe that STFC is fulfilling its role of providing central facilities to a satisfactory degree? If not, what should it be doing differently?

The responses received under each of the three designated subject sub-divisions were:

- Neutrons & Muons      29 received; 7 of which were blank, so 22 full responses received.
- Photons                      7 received but 1 was blank, so 6 full responses received.
- Lasers                        12 received but 2 were blank, so 10 full responses received.

5 totally blank questionnaires with no designated subject areas were received. The Chair also received a number of email contacts providing various degrees of feedback. The sentiments of those inputs are contained within the sub-division summaries.

The AP notes that some responses were from consortia representing several researchers and institutions. Summaries for each of the three subject groupings made by the AP appear in Appendices 1-3.

**Consultation summary and feedback meeting**

The PS&EAP met on January 16, 2015 to discuss the user community feedback and provide the comments and recommendations in the Overview. The AP notes the following general points and makes suggestions to Science Board:

- There is a risk of over-consultation within the community resulting in low response rates. The panel wishes to discuss the most effective methods for gaining community input in any future consultation exercises.
- The expanded PS&E AP now has sufficient breadth and the capability to better serve Science Board as an Expert Panel in facility usage.

Dr David Lennon – University of Glasgow, Chair  
Prof Sarah Hainsworth – University of Leicester  
Prof Konstantin Kamenev – University of Edinburgh  
Prof Peter Lee – University of Manchester  
Prof Jon Marangos – Imperial College London  
Prof Paul McMillan – University College London  
Prof Zulfikar Najmudin – Imperial College London  
Prof Andrew Orr-Ewing – University of Bristol  
Prof Paolo Radaelli – University of Oxford  
Prof Andrew Randwich – AWE  
Dr Howard Stone – University of Cambridge

## Appendix-1. Lasers Sources

### General observations

Only 10 responses were received – most were from current or recent Central Laser Facility (CLF) users (including users of the Laser Loan Pool).

The world-leading position and world-class facilities hosted in the CLF in ultrafast spectroscopy (e.g. ULTRA, and developing capability in attosecond science in Artemis) and high-energy lasers (Vulcan, Astra Gemini) were noted, with the caveat that further investment is needed to upgrade ageing instruments to maintain an internationally competitive edge. [*Note: a new laser system was recently installed as part of ULTRA and new microscopes added to Octopus – but these capital equipment items were secured through competitively awarded grants from UK research councils*].

We expected to see more comments about over-subscribed facilities and the need to expand numbers of target areas and beamlines to allow access for more users. Experience on the Facilities Access Panel for the Lasers for Science Facility (LSF) [Molecular Structural Dynamics / ULTRA and Functional Biosystems Imaging / OCTOPUS] shows that demand far out-strips allocation of time on these facilities. However, the only comment in this regard concerned the Astra Gemini system. [*Note: shortage of access is a common complaint at user meetings for the high power laser systems and could be addressed by having more end-stations/target areas*].

Some of the LSF ULTRA and OCTOPUS facilities are at the border between facilities-scale equipment and instrumentation that can be maintained and operated in individual research laboratories. The role of these facilities is therefore somewhat different from the large-scale facilities like synchrotrons: many experiments are proof of principle, form the groundwork for subsequent proposals, or benefit from the local expertise at the Rutherford Appleton Laboratory (RAL) in ultrafast or imaging science. Several universities have now set up (or are establishing) their own imaging / microscopy and ultrafast science centres. The LSF still provides an essential entry-level service for newcomers to these fields and opportunities for young researchers to build up a track record, as well serving larger consortia and longer-term projects. One survey response commented that the ULTRA-type equipment would be better placed in University laboratories, but misses the benefits of a central facility – including complementary measurements to those made at Diamond or ISIS. Moreover, funding of such capital equipment in Universities is the responsibility of other research councils (principally EPSRC and BBSRC) and the Universities themselves.

Three responses regretted the demise of the Laser Loan Pool (LLP). However, this was an EPSRC-led decision. The value of the LLP in supporting new researchers and in providing an entry to laser-based measurements across disciplines was highlighted. This interdisciplinarity now extends beyond the PS&E community to biosciences and medicine.

### Specific Comments

Regrettable demise of the Laser Loan Pool – see above.

Few respondents seemed aware of the content of PS&EAP reports / documents.

Space for the CLF is at a premium and constraints may hinder future developments. However, location of elements of the CLF in the Research Complex at Harwell has proved successful in promoting interdisciplinary research and supporting the facilities with excellent analytical instrumentation.

The provision of local resources (preparation areas, technical support, nuts-and-bolts items) is essential to maximise the benefits of allocated access time.

The PS&EAP report may not have sufficiently stressed the importance of CLF research for future medical applications (*e.g.* compact X-ray sources, proton beam therapy) and associated spin-outs.

RAL must remember that its primary purpose is as a research establishment, with promotion and hosting of spin-out companies a secondary (but worthy) objective.

#### **Future Scientific Advances**

Vulcan upgrades are essential to maintain a leading UK position in high-energy lasers and laser-matter interactions but lack of recent upgrades has left its world-leading status under threat. To this end, there was strong support for the proposed Vulcan 20:20 upgrade.

UK expertise in this and related fields may also decline because of limited access to Vulcan and Astra-Gemini. Advanced diagnostic suites must accompany upgrades to maximise the benefit.

Spectroscopy with very high temporal and spatial resolution (*i.e.* combining ultrafast laser spectroscopy methods with microscopy) is an important objective for the LSF. Achieving this ambition may need developments in detector technology to deliver the types of sensitivity required, for example, for single-cell analysis.

## Appendix-2. Photons (e.g. synchrotron facilities)

### General observations

Only 6 responses were received, including one from a consortium– and some also contained comments relevant to ISIS/neutron science and/or lasers such as Astra Gemini. The need to develop a UK strategy for a X-ray free electron laser (XFEL) was highlighted by several respondents. Several respondents noted the need to have better connection between Research Councils (RC) [including STFC] funded research and facility access, as well as support for students/PDRAs to carry out beamline research.

### Additional capabilities: FEL, XFEL, VUV source and fs laser

One respondent noted the lack of VUV capability. If there is a substantial user community they could/should make a case. Perhaps the PS&EAP could introduce the possibility to Diamond ?

One respondent suggested development of a diode-pumped fs laser capability at RAL. Once more a mechanism could be suggested to evaluate the size and strength of a user community.

As noted above several respondents mentioned XFEL and FEL in general. Those topics are addressed in a separate report.

### Additional capabilities: ancillary equipment at beamlines

The GW4 consortium (Universities of Bath, Bristol, Cardiff and Exeter) response highlighted the need for funding to provide supporting equipment (e.g. lasers, environmental cells, and specimen preparation, etc.) at Diamond. PS&EAP should note that this is already available or under development at certain beamlines (e.g. I15 Extreme Conditions), and DLS are currently developing a strategy for this. Perhaps user groups could be encouraged to develop specific cases? Would funding be available via EPSRC or STFC? In this context the consortium highlighted the need to develop techniques for operando studies of functional materials and devices.

The consortium also noted the need to better develop soft matter science at ISIS & Diamond, again including specimen prep and environmental cells. PS&EAP could note that the ESRF/Institut Laue-Langevin (ILL) Partnership for Soft Matter Science could provide a model.

### ESRF ring upgrade

One respondent asked about the impact of the planned rebuild of the ESRF ring planned for 2018-2020. Another noted the negative impact of reduced UK participation in ESRF for obtaining beamtime. The PS&EAP should make a note of this to UK central facilities management. Are we maintaining/protecting our investment in this large and important EU capability? The GW4 made the same comment on the EU XFEL.

### Other issues

Several respondents noted the lack of, and critical need for, coherency between EPSRC project funding and access to beamtime. *(The PS&EAP could note that although the previous "tickets" system had many faults, it did provide a mechanism for ensuring that funded projects had sufficient beamtime to carry out the specified research).* One respondent pointed out that NERC successfully coordinate funding / facility access.

A related comment suggested STFC should provide additional PhD support *via* a joint Centre for Doctoral Training (CDT) or other research/training consortium project.

### Appendix-3. Neutrons and Muons

*Q2: How do you view the present capability of the central facility(ies) that you are most involved with?*

Both **capacity and capabilities** of the current neutron sources is felt to be very good. There is a desire for better exploitation of current facilities, for example, more beam days at ISIS (several strongly worded responses) and related comments on excellent science not being done because of the shortage of beamtime; desire for more attention to muons (second most common comment); full exploitations of reactor beam ports with up-to-date instrumentation etc. Improvements in data reduction and analysis suits are noted but the development is still slow.

*Q3: Does the facility(ies) provide state-of-the-art capability? If not, how is deficient in this regard?*

When ask specific questions about **deficiencies in provisions**, a range of techniques that need improved access or better instruments are identified, particularly in the area of dynamics – longer timescales, spin-echo (though Larmor is now operational), INS on poly-crystalline materials, absorption of incoherent scattering materials, neutron imaging and tomography, polarized beam guide for OSIRIS. Need for the implementation of the next set of TS2 instruments is highlighted. Sample environment can be improved (low-T and high-P are mentioned specifically). Pre-identified PS&EAP deficiencies are seen as reasonable but some prioritization is urged.

*Q4: What developments in central facility capability would you like to see initiated over a 5-10 year time horizon?*

When asked about **provisions on the 5-10 year horizon**, respondents focus on evolutionary improvements of facilities (esp. in the area of sample environment) and better exploitation of the data (in particular in bio-applications), through a renewed software initiative. Handling of hydrogen-rich materials has been highlighted as an issue.

*Q5: Propose areas of activity that you believe will be important in terms of scientific advancement up to (i) 2020 and (ii) beyond.*

When asked about **important scientific developments requiring neutrons/muons**, respondents mention off-specular neutron reflectometry (mentioned more than once), small-angle neutron scattering (SANS) and diffraction from bio-membranes, dynamic chemistry and time-resolved drug delivery imaging. Progress with techniques to study organic, lithium- and hydrogen-rich, amorphous, nanocomposite as well as magneto-caloric materials. Interesting points are made about extending the techniques to neutron imagine of macroscopic properties and processes (structure analysis at interface, *in-situ* flow, structure, dispersion, alignment and dynamics).

*Q6: Do you believe that STFC is fulfilling its role of providing central facilities to a satisfactory degree? If not, what should it be doing differently?*

Respondents generally agree that RCUK should collectively take responsibility for funding the science underpinned by facilities (though there are opposing voices). Issues such as funding of PhD students, full economic costing (FEC) for research done at facilities, “policy-by-announcement approach”, etc. come up frequently.

**General comments on the survey:**

- The most significant issue emerging from the survey is **the criticism for the lack of attention to muons.**
- Little is addressed in terms of comparative analysis of ISIS to other international central facilities (*i.e.* ILL, Spallation Neutron Source (SNS), Japan Proton Accelerator Research Complex (JPARC), ESS), which is important for long-term planning and development.
- STFC should do more to focus on core activities, *i.e.* maximizing the number of beam-days, maintaining and developing large-scale facilities, and to better explain its remit to the research community.