UK ELECTRON MICROSCOPY COMMUNITY MEETING
4 NOVEMBER 2009

Organised by Electron Microscopy and Analysis Group of the Institute of Physics

NOTES FROM MEETING AND OUTCOMES

The following notes summarise the presentations in their chronological order. After each presentation there was substantial discussion. The main points raised are collected and summarised here.

Morning session

1. Review of current EM Facilities in UK and also Future Needs - Pete Nellist (PDN)

PDN attempted to define advanced facilities by focussing on recent developments in electron microscopy for materials science, in particular the development of the spherical aberration corrector. It is now believed that there are 8 aberration-corrected instruments in the UK. There will inevitably be a wide variety of opinions over what should be considered for future advanced facilities. The following highlights some of the possibilities.

The use of aberration-correctors for STEM instruments raises the need for advanced EELS and EDX spectroscopy instrumentation, monochromators, and further developments in high-brightness guns. The use of aberration correctors for HRTEM and EFTEM highlights the need for monochromators, chromatic aberration correction and faster, more efficient detectors.

There are developments in controlling the specimen environment in-situ, such as providing gases, liquids, temperature control, providing sufficient space for the high tilts necessary for tomography, field-free imaging. A particular future possibility is the transfer of samples between different characterisation facilities while maintaining a desired environment or temperature.

There has been some recent developments in dynamical TEM, in which ultra-fast laser pulses are used to provide very short electron beam pulses used for investigating dynamical processes. Currently there is no UK activity in this area, and it is challenging because of the range of expertise required.

A difficulty with providing user facilities separated from an academic research environment is that it restricts possibilities for technique development work, a field in which the UK has been historically strong.

Other types of facility highlight were those for specimen preparation, control of accelerating voltage and dose, LEEM, SEM, FIB, He ion.

2. Historical and Background Context of this Meeting – Andrew Bleloch (ALB)

ALB described how the idea for this meeting had grown out of a recent consultation by the SuperSTEM group in order to establish an Expression of Need for the EPSRC review of mid-scale facilities. Informal meetings held at Imperial College in April, and at the EMAG AGM Sheffield had resulted in the idea of a UK community meeting to explore ways in which the acquisition of advanced microscopy facilities could be organised in a coordinated way rather than the current approach of individual institutions competing for resources.

ALB went on to outline some of the necessary steps to achieve such an outcome, including defining a road-map of desired facilities, defining the grounds on which institutions should seek to cooperate, and on which competitive approaches are still desirable.

Comments from the floor included:

- That it is crucial to include the physical and life-science communities. Indeed this could be a vehicle for cooperative working between EMAG and the RMS.
- There was some discussion over what support might be available for small facilities. It was discussed that NHS microscopy units were vulnerable because of the lack of young personnel being trained to take over from existing staff.
- The need for integration of training into the facilities was highlighted.
- It was pointed out that such facilities may create opportunities for cross-disciplinary research.
- The difficulty of technological development in user facilities was again highlighted.

3. Pros and Cons of Possible Models for a Distributed Facility

Three volunteers agreed to present potential models for a distributed facility. It was highlighted that these individual did not necessarily subscribe to these models. In each case the bullet points from their presentations are presented followed by a summary of the following discussion.

(a) Keep the status quo (Dave McComb - DMcC)

DMcC presented the following pros and cons for not changing the current situation:

Pros

- Many well-established and internationally leading/competitive research groups developed using existing funding models
- Excellent infrastructure
  - Many aberration corrected instruments
  - Accessible to non-expert groups
  - Funded access schemes available
- Considerable knowledge base in research officers/instrument scientists
- Well-funded research groups
  - Research council, charities, RDA/TSB
- Reasonable national distribution
- Good coverage fields/techniques/disciplines
- Large scale collaborative proposals when appropriate (SuperSTEM)
- Survival of the fittest!

Cons

- Funding challenges
  - Aging equipment profiles
  - State-of-the-art equipment (££££££)
  - Routine equipment hard to fund (FEC & CIF)
  - Need many grants to cover service contracts
  - Access schemes are inadequate
    - Poorly funded
    - Some only accessible to the “in-crowd”
- Research officers/instrument scientists on “soft money”
  - Continuity of knowledge
  - Career development prospects limited
- Difficult and time consuming to set up major infrastructure projects (SuperSTEM)

The following discussion highlighted the following:

- There was concern expressed about the possible regional distribution of facilities, and the role that might be played by regional development agencies.
- It was suggested that the potential for investigating EU funds be investigated, which led on to a discussion of problems with the ESTEEM and EPSRC access schemes.
- The difficulty of instrument development research was highlighted in light of the changing funding landscape, and there was a suggestion that one centre might be dedicated to development work.

(b) A distributed facility over a number of centres with different potential funding models (Rik Brydson - RMDB)

Why the need?

- EM equipment is labour and expertise intensive
- Recently significant developments have been realised - e.g. FIB sample prep, tomographic techniques (TEM and SEM), aberration correction
- EM is a/the key tool in (Bio)Nanoscience and Technology
- UK is still a major player in EM internationally
- Capital costs are rising for a basic machine (particularly TEM) - although cheap compared to synchrotron science
- RCUK needs to maximise research benefits to research-led institutions

Possible model:

- ***Model aims to maximise international competitiveness in EM whilst providing best facilities for UK researchers in general.***
- Creation of up to (say) 10 centres (reviewed every 4/5 years by external panel) based on existing groups with track record
- Each centre offers (say) 2 specialisms (e.g. based around either an EM technique, materials expertise, sample prep. or property measurement etc.)
- SuperSTEM (EPSRC) and Imaging Solutions Centre (STFC) could be part of the model.
- Funding for dedicated staff to host external visitors for a significant proportion of the time (say 33%) (inc. travel/ accommodation and consumable costs)
- Applications reviewed by internal panel with external reps.
- Equipment funding - bids screened by an external panel and then submitted to EPSRC (bid for proportion of some nominally ring fenced funding)

Pros:

- Avoids aberration corrected chaos !
- Provides highest quality service to UK researchers
- Embeds facilities in a true research and training environment (Universities)
- Basic EM infrastructure remains in place throughout many institutions (funded by fEC), specialist facilities topped up by rolling grant facility income but these are available to all.
- Retains expertise and offers training opportunities
- Promotes collaborative research on a formal basis
- Fits neatly into current EPSRC for Access to Materials/ Nanoscience equipment facilities (*currently EM is offered by facilities at Oxford, Imperial, Leeds, Nottingham, St Andrews, Manchester Metropolitan, QMW, UCL (FIB), Bath (EBL)*).
  Also some fit to SuperSTEM facility (access here has been over complex in the past).
- Could include EPSRC, NERC, STFC (and even perhaps BBSRC) in the scheme

Cons:

- Could be viewed as a private club (in or out)
- May stifle innovation if having to provide an external service
- Would need community to self regulate through serious external review (could bring in formal international review panel).
- Would need Universities to sign up to this and to commit significant fEC funds and staff as part of the deal.
- May decrease individual University consultancy income if successful (possible industrial arm to the model ?)
- Singles out EM as a special case (albeit being a successful and coherent community to date).

- Involves significant Research Council funding – larger than a medium scale facility (probably more of the order of 20-30 million every recurrent 5 year period)
- Would need Research Councils to agree joint commitment
- Relatively novel and untested model (Australia ?)

The following discussion highlighted:

- As an example of a distributed scheme, it was suggested to examine the Australian model carefully.
- Aberration correctors will become standard on instruments, so the need for facilities to provide them is not clear.
- It is important to have a fully formed process to handle user applications and support their experiments. Experienced local administration and scientific support is crucial.
- A suggestion was made that leasing may reduce the problem of finding large capital sums.
- A potential danger of the approach was the potential to inhibit the possibility of universities being able to obtain funds for equipment.
- The difficulty of administering resource and fee transfer was highlighted, and that the distributed approach tended to negate the community and compactness of research groups.

(c) A Single (or possibly Dual ?) National Centre for UK EM (Angus Kirkland - AIK)

Some Possible Starting Assumptions

1. That the UK wishes to continue to invest in high performance Electron Microscopes for both Physical and Biological Sciences.
2. That the capital costs of the next generation of instruments exceeds that available to individual Universities and there will be limited numbers of these instruments.
3. That infrastructure and maintenance costs will approximately scale with instrument costs and that few Universities have suitable sites.
4. That there is a limited pool of skilled research scientists and technical staff to support these instruments.
5. That individual Universities (or groups) are unable to fully populate instrument time with their own projects.
6. That there exists a synergy with other large scale facilities which should be exploited.
7. That running costs will exceed realistic grant based recovery for individual Universities.

Advantages of a National Centre(s)

- Optimised environment suitable for housing the next generation instruments.
- Provision of full time staff to maintain / operate the instruments (career opportunities).
- Initial capital budget is competitive compared to other large scale facilities.
- Provision of highly specialised facilities that cannot be justified within a single University.
- Access by all groups on merit / need – no local ownership.
- Proximity to other large scale facilities - synergies.
- Maximisation of instrument use through access by a larger research community.
- International profile and National cohesion / collaboration.
- Ongoing costs passed to local groups on the basis of time used.

Disadvantages of a National Centre(s)

- Carefully planned management and infrastructure required to maintain neutrality.
- Access and Location; Hosting of visiting scientists.
- Configuration of the instrument pool requires careful thought.
- Allocation of time and costs - ? Peer reviewed ticket system.
- Incorporation of "instrument / technique development" in a user facility.
- Need to maintain links to traditional academic activities within Universities.
- Risk of creating a high visibility "white elephant"
- Confidentiality and Data protection.

Other factors:

Major Research Facilities

1. Compile, maintain and publicise an inventory of facilities nationwide or at least regionally along with mechanisms for access and high utilisation levels.

2. Create mechanisms/incentives to consolidate major materials preparation and characterisation facilities in central laboratory space to serve the broad university materials community.

From EPSRC Materials International Review, 2008.

Other thoughts:

A National centre would require a paradigm shift in our local operational models, but one that is successfully used within other communities and at SuperSTEM.

2. A National centre would NOT mean the end of University EM equipment which remains essential for initial experiments and to "feed" the National centre.

3. The National centre model (infrastructure, site, equipment, funding access…) works equally well for a small number of differentiated National centres.

The following discussion highlighted:

- The problem of university neutrality when it was likely that the local university would strongly support or influence the facility.
- The question of how many centres might be required, and whether it could be distinguished from a distributed facility.
- It was noted that often a fast access was required if a specific sample had the possibility of answering an important question. It was noted that the bureaucracy needed to be right to make this happen.

5. Presentation of Plans for the Imaging Solutions Centre at Harwell (Mike Johnson, STFC)

The presentation contained the following information:

ISC will bring together :
- Imaging Scientists (links to Research Complex, UK Universities)
- STFC's large scale facilities – ISIS, Diamond, CLF
- New lab-scale imaging techniques
- Visualisation & data interpretation software
- Imaging R&D - technique development
- Leading Detector Technology (link to Detector Centre)
- Computational Modelling (link to Hartree Centre)

What will the ISC look like ?
A. New building at RAL – possibly with specialist environment
B. New Imaging Equipment
C. Core STFC support staff (15 – 20)
D. Resident Scientific teams (30 – 50)

The ISC Consultation Process
- Four ISC Consultation panels created January 2009
- Chaired by:

Prof. Maggie Dallman (Imperial)	Life Sciences
Prof. Philip Withers (Manchester)	Materials
Prof. Lefkos Middleton (Imperial)	Medicine
Prof. Dave Stuart (Oxford)	Electron microscopy

Potential Instrumentation for the ISC
- Imaging Software and computer hardware
- Electron Microscopy for Life Scientists
- Electron Microscopy for Physical Scientists
- Super Resolution Optical Microscopy for life Scientists
- Lab-based X-ray tomography

- High Specification scan-probe microscopy

The ISC Creation Process

- ISC Consultation meeting July 2008
- ISC PM Board (Senior STFC staff , first meeting October 2008)
- ISC Advisory Panel (External Advisors)
- ISC Consultation Panels
- ISC Consultation Web pages
- ISC London Meeting (March 2009)
- ISC-Industry interaction (August – December 2009)
- ISC Business Plan (Nov. 09 – Feb. 2010)

Summary of ISC

- Entirely New entity on the RAL/Harwell campus
- Needed by Industry and Academe
- World-class facilities & solutions
- Links to Diamond + ISIS + CLF expertise
- Societal impact: energy, environment, life sciences & medicine
- Excellent Campus synergies

Similar information can be found at the website http://www.scitech.ac.uk/ResFac/Gateway/ISC.aspx.

6. Discussion of the EPSRC review of Mid Range facilities (Natalie Stear – EPSRC)

The EPSRC has recently conducted a review of Mid Range facilities in order to place the funding for such facilities on a similar footing. The first stage of this process was an invitation for the submission of Statements of Need to identify the facilities that should be included. With regard to electron microscopy, the following were noted:

- Statements of Need (SoNs) were received for aberration-corrected STEM, and other EM facilities.
- Aberration-corrected STEM has been identified to be taken forward in Phase 2 (see http://www.epsrc.ac.uk/ResearchFunding/FacilitiesAndServices/outcome.htm for complete list) under the heading of "Materials Characterisation Facility" which may include other materials characterisation methods that were proposed by SoNs that were felt by the original panel to be complimentary to the aberration-corrected STEM.
- An advisory group will be formed to decide the form of the tender for the "Materials Characterisation Facility".
- The outcome from this group will likely be presented for discussion by the community at a town hall meeting, probably in the spring or summer 2010. This is yet to be agreed by the advisory group.

The discussion following this presentation noted:

- That some coordination between the EPSRC and STFC efforts in electron microscopy is desirable. A possible vehicle for this is via RCUK.

7. Summary of meeting (Andrew Bleloch – ALB)

ALB summarised the meeting with the following bullet points:

Background

- UK has a strong history in EM
- EM is key enabling technology for nano age.
  - Not investing in EM is not an option

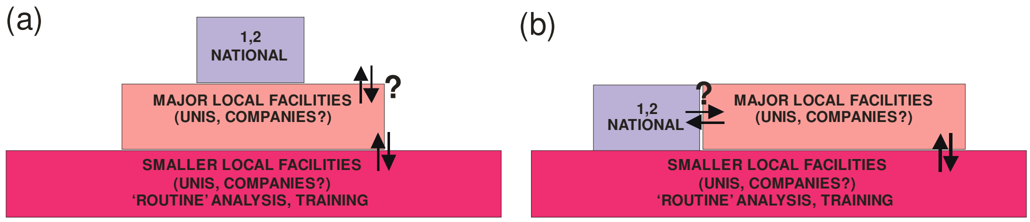
- International competitiveness

Summary of morning session

- Context for this meeting
- Discussion of models
  - Responsive mode funding of competing university facilities
  - Distributed network of advanced facilities
    - Ring-fenced funding
  - National centre(s)
- Others?

Presentation of a 'Layer Cake' model (Richard Baker – RTB, EMAG Chair)

After the formal presentations and considerable interesting discussion, RTB suggested a further model to the meeting which would combine several aspects of those models already presented. The motivation for this was to try to persuade the EM users and the funding bodies to consider the whole electron microscopy community, and its various activities, as a whole. This holistic approach may have the benefits of increasing the efficiency and effectiveness with which finite resources – financial, human and technical - were employed overall.



During the day, funding proposals for two large electron microscopy centres, the pre-existing SuperSTEM facility and the proposed ISC at Harwell, were discussed. The benefits of such national facilities for the provision of very high-end expertise and equipment were highlighted. It was also hoped that these facilities would be heavily involved in the development of improved and new EM techniques (e.g. 4-D EM). These facilities form the top layer in part (a) of the Figure. The next layer represents major local facilities, and may correspond for example to university- and company-based EM centres with aberration-corrected TEM instruments. Again, these centres have the capability to offer very high-end analysis facilities and expertise. Much of this is, and will be, directed at research led by scientists of the individual research centre in question. A major consideration here is the rising cost of state-of-the-art instrumentation and of the operation and maintenance of these instruments. It had been stated that these are rising out of reach of many university departments, or even of universities themselves. There is motivation therefore to pool, and reduce, costs and resources and improve efficiencies by (1) allowing freer and more frequent access to outside scientists of these major local facilities and (2) planning instrument purchases and developing centre capabilities so that they become complementary rather than competing. The ease and equity of access arrangements to these national and major local facilities were also considered to be of great importance to avoid a 'them' and 'us' culture within the EM community.
It is possible that major local facilities – and access to them - will develop under this model to the extent that they become roughly equivalent to the 'national' facilities. A situation illustrated in part (b) of the figure.
The lower and largest layer of the structure represents less expensive, 'lower-end' microscopy facilities which are available in a large number of university and commercial locations. Under the current funding regime, facilities which are simply very useful but which do not in themselves show great innovation or adventure are very difficult to obtain, especially in the price range of even modest EM facilities. However, they are an essential part of the overall EM structure (and of science, medicine and engineering in the UK). This is where thousands of hours of mainly 'routine' but necessary research is performed. It would be a false economy to underfund this layer of the structure in order to fund the upper layers, since this kind of routine work would then be forced onto the more expensive high-end facilities, representing a disproportionate consumption of resources.(The phrase 'routine' here is unfair since a great deal of highly innovative work is performed on instruments which do not represent the current state-of-the-art.) Equally, the number of trained EM scientists was cited as a serious and growing problem and particular emphasis was given to medical research. This layer of our structure provides the large majority of the training for the EM community as a whole. This training is necessary for the activities within this layer itself but also acts as the entry level to those layers above.

In order for these separate layers to form a real whole together, there must be very significant exchange and communication between them. First of all, changes (positive and negative) in the availability of resources at any one centre may cause it to rise or fall between layers. Much more importantly is the exchange of information and mutual access to facilities. The exchange of information between centres in the same layer but also between layers is vital for the planning of an overall structure that is truly complementary and efficient. This efficiency will not be attained unless there is equitable, timely, organised and uncomplicated access by workers at any centre (or none) to facilities they need for their work. For such communication, planning and effective access, the whole cake needs to be considered together. Therefore, we must engage the whole EM community and the relevant funding bodies, at a high level, in a careful and deliberate action to safeguard and build upon the excellent resources we have in the UK for EM by considering them as a whole.

8. Next steps

It was generally agreed that it will be necessary to engage with funding agencies to explore ways in which a coordinated UK strategy for UK could be supported. It was agreed that a working party should be constituted, working closely with the Royal Microscopical Society with suitable representatives from the life sciences and physical sciences electron microscopy communities, to develop a specific model proposal that could then be put to a future community meeting. The EMAG committee have asked Prof Rik Brydson to convene this working party.