“The Current EM EcoSystem”

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Details of Surveys

- Information summarised from two surveys:
  - laboratory leaders (40 responses – targeted by PDN & RB)
  - general EM users (140 responses - through RMS & EMAG)
- Questions initially formulated by working group meeting on 11 June 2013 and then revised by email.
- Surveys sent out during July 2013 (Lab Leaders) and August 2013 (EM User Survey)

Limitations of the surveys

- Limited participation over the summer
  - *hence snapshot of the community*
- Lab. Leaders survey targeted at Physical and Bio EM labs in majority of UK institutions
  - *tried to catch all but undoubtedly some have been missed….*
- EM User Survey targeted mainly at RMS and EMAG/IoP members
  - *other users probably missed, e.g. RSC/IoM*
- Maybe a TEM bias over more routine SEM use ?
- Are the surveys too focused on microscopists rather than users of microscopy ?
- Does not really represent **Scanning Probe Microscopists …..**
- Unclear if the surveys have captured the needs of industry

Initial Analysis of the Surveys

See attached summaries in your booklet

Lab. Leaders Survey - key points

- Equipment base (~ 180 instruments)
  - SEM & TEM (~ 75 machines each)
  - FIBs (~ 20)
  - small number of aberration corrected TEMs (Table shown later).
- Around half of the machines offered analytical capabilities
- Age of equipment is ~ 10 years old on average
  - conventional (*i.e.* non-FEG) TEMs are kept operational somewhat longer, whilst FIBs and AC-TEMs are generally more youthful in age profile.
- Age profile correlates with previous infrastructure spending initiatives JREI, SRIF, CIF etc…
- Funding for the equipment-base came from a wide range of sources
  - Universities, Research Councils, HEFCE, Wellcome Trust, Regional Development Funds & Industry.
- Majority of laboratories (~ 75%) offer specimen preparation as a service to external users.

Initial Analysis of the Surveys

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Lab. Leaders Survey - key points

- Staff numbers per instrument:
  - ~ 1/3 fte permanent technical; ~ 1/3 fte permanent academic; & ~ 1/6 fte fixed term PDRA.
- There are ~ 2000 internal users & 700 external users for these 180 instruments
- Student / PGR use ranges from 10 - 90%, peaking at around 80%.
- Just under 80% of labs charge for instrument access and for student use
  - this cost is paid for by either Research Group leaders or to a slightly lesser extent subsidised by Department/ School.
  - **overall levels of cost recovery for EM facilities varies considerably: 20 - 100%.**
- Significant available capacity on these instruments
  - arises because of insufficient staff support; instrument downtime; or lack of trained users capable of independent working.
- Wide range of specialised capabilities missing from the UK portfolio
  - including serial block face SEM (3view), Dynamic TEM, SARVE-TEM, Advanced FIB (including cryoFIB) and analytical CryoTEM.

Initial Analysis of the Surveys

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EM Users Survey - key points

- Responses primarily from South East, Midlands, North East, North West & Scotland
- Majority of respondents have an educational affiliation
  - ~ 10% in each area associated with Industry & Governmental Organisations
- ~ 60% of respondents were permanent academics or experimental officers
  - the rest split ~ equally between students, postdocs, technicians and managers.
- Half of the respondents supervised a research team which used EM
  - size of the team varied: typically ~ 2 people, with some large teams up to ~ 10
- Use of EM was bimodal
  - some of these teams used EM partially, others used it a great deal

Initial Analysis of the Surveys

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EM Users Survey - key points

- ~ 50% of users interested partially or exclusively in biological/medical samples
  - remainder looking exclusively at materials science samples (*i.e.* physical sciences)
- Majority of usage conducted in own department or organisation
  - a small proportion (< 10%) travelled within the UK or outside for EM access
- The main techniques used were SEM and conventional TEM
  - predominantly for imaging but also for chemical analysis
  - & demand for more "high-throughput" analytical TEM, cryoTEM, cryoSEM, AC-TEM & FIB, plus occasional use of more specialised *in situ* SEM/TEM techniques (*e.g.* heating, environmental, tomography etc.) & EBSD
- The majority of respondents did not appear to feel limited in terms of access
  - where this was an issue, technical expertise and access costs appeared to be the main problem, particularly for high end techniques

Overall Analysis of both Surveys

1. Current equipment and staffing situation arrived at in a rather ad-hoc way
   - via a variety of relatively uncoordinated funding streams
   - UK is well provided for in many areas, but there are clear capability gaps
   - the age profile of equipment varies considerably - much will need renewing in the next ~ 5-10 years

2. The overall levels of (running) cost recovery for EM facilities vary considerably
   - significant capacity available, arising from insufficient staff support or a lack of trained users capable of independent working

3. In terms of the current requirements and needs of the user community:
   - demand for more “high-throughput” analytical TEM, cryoTEM, cryoSEM, AC-TEM and FIB/SEM, EBSD & *in situ* SEM/TEM techniques (*e.g.* heating, env., 3D)
   - where it was an issue, the availability of technical expertise & access costs were the main problems restricting access

Overall Analysis of both Surveys

4. A wide range of specialised capabilities were suggested as being missing from the UK portfolio:

   - serial block face SEM (3view), dynamic TEM (D-TEM), sub-Å resolution variable energy TEM (SÅRVE-TEM), electron holography, electron tomography, low voltage SEM and TEM, He ion microscopy, LEEM, advanced FIB/SEM (including cryoFIB/SEM) and analytical cryoTEM, & specialised holders for *in situ* microscopies, along with sample preparation capabilities

   - some (but not all) of these do appear to be accessible already within UK

   - perhaps the responses reflected problems with access costs, capacity, expertise / coordination ?

5. Increasing drive in the physical sciences to image and analyse soft materials

   - significant overlaps with the BioimagingUK EM Roadmap

   - particularly in terms of analytical EM; cryo-FEGSEM, cryo-preparation and FIB/SEM, along with correlative Light and Electron Microscopy and Electron Tomography

High End TEM/STEM

SuperSTEM Consortium or ext partner

Table 1. Electron microscopes in the UK capable of sub-Å resolution (information collected from webpages of research institutions and/or publications).

Type of microscope	Energy of electron beam	Point resolution	Location	
FEI Titan3	80, 200 or 300 keV	Scanning mode 0.8 Å (HT=?) Imaging mode (?)	University of Cambridge	☑
JEOL 3100Z R005	300 keV	Scanning mode 0.63 Å Imaging mode (?)	University of Sheffield	☑
JEM ARM200F	120 or 200 keV	Scanning mode 0.8 Å (at 200keV) Imaging mode 1.1 Å (at 200keV)	University of Warwick	☑
JEOL 2200CO	80 or 200 keV	Imaging mode 0.8 Å (at 200keV) Scanning mode (?)	University of Oxford	✔
JEOL 2100FCs	80 or 200 keV	Scanning mode 0.8 Å (at 200keV) 1.2 Å (at 80keV) Imaging mode (?)	University of Liverpool	✔
JEOL ARM200F	60, 120 or 200 keV	Scanning mode <1 Å (HT=?) Imaging mode (?)	University of Glasgow	✔
Nion SuperSTEM	40-100 keV	Scanning mode <1 Å (HT=?) Imaging mode (?)	SuperSTEM, Daresbury	✔
Nion UltraSTEM 100	40-100 keV	Scanning mode <1 Å (HT=?) Imaging mode (?)	SuperSTEM, Daresbury	✔
JEOL 2100F	200 keV	Scanning mode <1 Å (at 200keV) Imaging mode (?)	University of Birmingham	
JEOL 2200 FS – modified for ETEM	200 keV	Scanning mode =1 Å (at 200keV) Imaging mode =1 Å (at 200keV)	University of York	☑
FEI Titan ChemiSTEM	80 or 200 keV	Scanning mode 0.8 Å (at 200keV); 1.2 (at 80keV)	University of Manchester	✔

The FEI Titan at Imperial College is configured for high spectral resolution EELS investigations, rather than high spatial imaging work.

New machines at Oxford, Cambridge plus St Andrews and SuperSTEM III

The AC Ecosystem Today (see Techwatch)

- SuperSTEM – inc meV EELS (v3)
- Double aberration corrected (TEM + STEM) – 6 [Man, Oxf1, York, War, Gla, She]
- 0.05nm – 1 [She]
- Probe corrected (STEM) – 5 (+2 at SuperSTEM)[Oxf2, Bir, Liv, IC, Cam]
- UHV – SuperSTEM *nearly there*
- Gas – 1 (ETEM + ESTEM) [York]
- Magnetics – 1 [Gla]
- Vortex – 1 (special apertures only, so movable)
- Wet Cell – 1 (movable wherever holder fits)
- Low voltage STEM (30kV) – 1 (SuperSTEM 3)

Comments - for discussion

- SuperSTEM - funded to 2016
- Harwell Imaging Centre (Oxford/Diamond) Development
- Materials and Nanoequipment facilities: EM facilities: *e.g.*

  St Andrews (TEM and SEM)

  Nottingham (TEM, SEM, FIB, EPMA, EBL)

  Imperial (Monochromated TEM)

  Leeds (TEM, SEM, EPMA, FIB, EBL, Nanoprobe)*,

  Cardiff (FIB),

  Manchester Metropolitan (SEM),

  Oxford (HRTEM)

  QML (3D ESEM)

  Bath (EBL)

  UCL (FIB)

* *still currently funded until 2016*

Comments - for discussion

- Demand for equipment access in terms of overall user-numbers, but obstacles include:

  - Need dedicated staff / expertise for user support and training;

  - funds for small instrument upgrades to maximise throughput;

  - VAT issues in regard to the provision of research services.

- No Lab leaders network – even in just Physical Sciences
- Link to EM Bioimaging network

  - increasing need for cross-over facilities and expertise

  - very few combined Bio/Physical facilities

- TEM bias ?
  - must not neglect high end SEM

Comments from the floor please