Working Group on a Distributed Facility Model for Advanced Electron Microscopy in the Physical Sciences

Electron Microscopy and Analysis Group

History

- 2009
  - EPSRC launches mid-range facility review
  - EM community supports a statement of need for aberration-corrected STEM
  - EMAG AGM discusses idea of a distributed facility
  - EMAG organises 1-day meeting at IOP to discuss possible model
    - General support to explore possible model(s)
    - Agrees to establish a working group to generate specific proposals

More History

- 2011 SuperSTEM becomes a mid-range facility
  - Starts to develop as a hub for access to 9 institutions
- 2012 SuperSTEM takes initiative to activate working group
- 2013 EPSRC agrees to part support activities of working group.
- 10 member working group formed from nominations from SuperSTEM, EMAG and RMS (3 each)
  - Pete Nellist*, Quentin Ramasse, Jeremy Skepper (SuperSTEM)
  - Rik Brydson*, Ed Boyes, Paul Brown (RMS)
  - Ian MacLaren, Sarah Haigh, Richard Baker (EMAG)
  - Angus Kirkland (STFC/Diamond)

Working group activities

- Meeting1 - 11 June 2013
  - Identified tasks and established surveys
- Meeting 2 – 12 September 2013
  - Reviewed survey outcomes
  - Identified 4 areas on which to report
    - Current ecosystem
    - Coordination of facilities and widening access
    - Training
    - Technology watch
  - Convergence with BioImagingUK activities (attendence by Lucy Collinson, Raffaella Raffaella Carzaniga, Paul Verkade)
- Meeting 3 – 24 January 2014
  - Consider initial proposals in 4 areas and refine in preparation to present to community
- Town Hall meeting – 9 April 2014
  - Slides available at http://www.rms.org.uk/events/Forthcoming_Events/advanced-electron-microscopy-working-group

Community survey

- 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)

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

EPSRC Funding of Atomic Level Microscopy

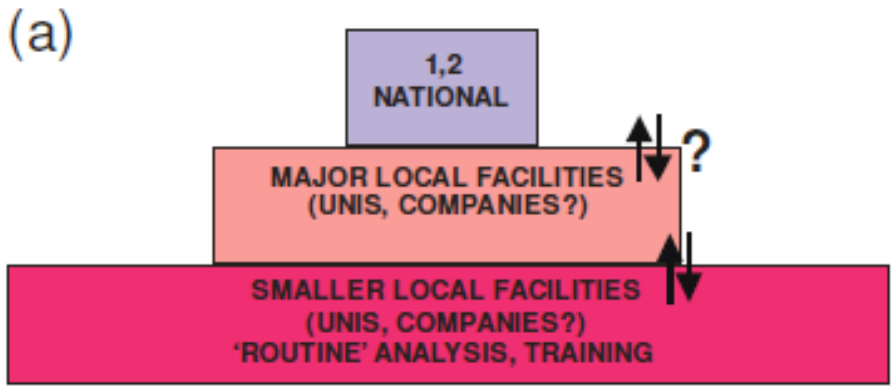
- Around £20M capital since 2006
- £0.8M through core Chemistry call
- £7.5M (of ~£85M) through Great 8 Technologies Call
- £4.7M (of ~£40M) through Strategic Equipment Scheme
- **£13.6M (of a total of ~£47M) requested for "part B" of Core Chemistry call. Includes:**
  - FEI Titan Krios
  - FEG-TEM + HR-TEM imaging, STEM, tomography and EDX
  - SEM/Raman
  - FE SEM x 2
  - FEG-TEM column, SSD and STEM systems
  - EF-TEM

Motivation for a distributed approach

- To support the sustainability of advanced EM capabilities and maximise their output
  - Lab leader survey noted that usage of instruments limited by availability of support staff (55%) and availability of existing instruments (55%)
    - Longer term funding routes for staff (research support and technical) and maintenance costs.
  - User survey suggests that there is unfulfilled demand in more advanced capabilities (AC-(S)TEM, EELS, FIB, cryo-SEM and cryo-TEM, in-situ), and that users are sticking to their own institution.
  - Lack of available expertise cited for restricting access to advanced capabilities
    - Need to enable access to advanced capabilities across institutions

Widening access

- The 2009 community meeting identified a layer cake model:



Challenges for a distributed facility

- Who decides what capability goes to which institution.
- Who gets access?
  - How is the science reviewed?
  - Facilities want to focus on doing good science and control access to their facilities.
- How does the facility become sustainable?
  - Payment of access charges raises the issue of VAT.
  - Free at point of access undercuts those aiming to cost recover through charging (lab leader survey).
- How can key staff be retained?
  - Career structures for staff.
- How can the capability be upgraded?
- Do not want to re-invent previous access schemes

The Electron Microscopy Training Partnership

To ensure that the UK's advanced electron microscopy (EM) equipment and expertise is effectively exploited, now and into the future, for the benefit of UK research and business, a national partnership is proposed to support both Continued Professional Development (CPD) and PhD training.

The model is of a virtual, distributed EM Training Partnership (EMTP) with partial funding from RCUK.

The focus of the proposed structure is materials systems. However, partial overlap or complete merging of this training structure with that described by BioimagingUK may be beneficial.

Elements of the EMTP Structure

As students will be distributed nationwide, teaching will require:

1. A comprehensive course in a VLE on a free subscription model for EMTP members, to contain:

- Core lecture courses (slides/video) on the main aspects of EM, including supporting theory, with online submission and assessment of student work. Material contributed by EMTP partners.
- A reference section including student literature reviews, technical notes, instrument details, sample preparation techniques, analysis methods, 'tricks of the trade' etc. Multimedia and student submissions encouraged.
- Links to useful EM tools such as relevant software, and external sites to augment training.
- A programme of webinars.
- Online Forum to facilitate enquiry-based learning group assignments and for exchange of ideas, results, Q&A sessions, etc.

Elements of the EMTP Structure

As students will be distributed nationwide, teaching will require:

2. Residential courses, workshops and conferences. Two, week-long residential courses during the first year (modelled on highly successful RMS and SuperSTEM courses) and an annual student conference event with workshops on emerging topics, specific techniques, specialisms. Long-standing EMAG and RMS events will be incorporated into the programme.

3. Regional Training Centres (RTCs). About ten RTCs will provide hands-on EM training, concentrating on the fundamentals, within reasonable travelling distance for the students.

4. National Training Centres will provide high-level, specialist short courses, offered nationally.

5. Miniproject. At another centre will be part of initial training. 4 weeks.

6. Research Project. 6 month pre-PhD research project at home institution.

6. Research Visits. Competitive funding will be available to support ~10 week PhD and CPD visits at other EMTP members.

The "Techwatch" Remit.

- To provide a technical structure for the field, both scientifically and organisationally

- To introduce mechanisms for Techwatch initiation, continuation and review **ensuring that all community members have the opportunity to contribute on a continuing basis** (first at MMC)

- To propose first generation target areas of interest with a mechanism for adding to them and continuing a review of initiatives at every stage

- To identify necessary enabling support actions including staffing development and other continuity needs

An Initial Priority List for Specific Instruments

- 2nd and 3rd generation in-situ microscopy Tier 1 or 2 [£5M with fast camera]
- Pulsed Sources Tier 1 [£10M+]
- Surface Microscopy Tier 1 or 2 [£2-4M]
- Chromatically Corrected Instruments Tier 1 [£10M+]§
- Low Voltage (and UHV?) TEM and SEM Tier 1 or 2. [SEM £1-2M, TEM £5M+]
- Specimen Preparation [distributed, £0.5-3M]

§ = *complementary to SuperSTEM 3 already funded*

More General Instrument Developments and Capabilities

- Anaerobic specimen preparation and transfer systems Tier 2*
- Development of standards with X-ray beam lines Tier 1
- Wet cells for living systems and organic / inorganic materials combinations Tier 2
- Vortex beams and spin polarised microscopy Tier 1 or 2
- Magnetic analyses Tier 2
- Fast electron detectors Tier 1* #
- Improved vacuum systems (UHV) Tier 1 or 2* #
- Quantitative diffraction based analysis Tier 2
- Application specific stage and control developments Tier 1 or 2 # and community wide

** = expected to be widely deployed once developed in the UK or by others*

 # = connected with in-situ EM

Where next?

- Final report
  - Short, medium and longer term recommendations
- EPSRC response to the report
- Seek networking funding in physical sciences
- Join forces with related communities