Mid-Range Facility Annual Report and Assessment Criteria

Context:

EPSRC defines a mid-range facility as a research facility which provides resources that are of limited availability to UK researchers for one of several reasons including:

- The relative cost of the kit
- Dedicated kit in every University is not needed
- Particular expertise is needed to operate the kit or interpret the results or
- Progress is enhanced by sharing information or software.

EPSRC support a range of mid-range facilities across the portfolio, usually on a 5 year contract. Since 2014, EPSRC offers research communities a yearly opportunity to submit a Statement of Need for a new mid-range facility. These Statements of Need are peer-reviewed and then ranked by an expert panel with in-depth knowledge of EPSRC's strategic drivers and EPSRC's funding routes for facilities and equipment.

During the 5 year contract period, EPSRC wishes to support the facilities in their endeavour to provide an optimal service to their users. For this reason, the Capital Equipment Strategic Advisory Team (Capital Equipment SAT) will assess the performance of all existing mid-range facilities on a yearly basis. A common template is provided to the facilities in order to facilitate this assessment. In addition, the EPSRC contact will provide a short summary of their own impression of the facility's performance.

The assessment is fed back to the facilities to enable them, together with their steering committee and EPSRC contact, to ensure the best possible service is provided to the user community and to position themselves for the next tender exercise. The prioritisation panel for new/to-renew Mid-range Facilities will have sight of an overall summary of the annual report assessments in order to give a context of the current ecosystem.

Only Mid-range Facilities that are not currently undergoing a renewal exercise are requested to submit a report.

Timeline 2014:

- Deadline for Annual Reports**: 17th Novemberr 2014**
- Assessment by the Capital Equipment SAT**: Late November 2014**
- Summary provided to the Prioritisation Panel for new / to be renewed Mid-range Facilities: **January 2015**

Annual Report for EPSRC Mid-Range Facilities

Facility: XMAS Beamline at the ESRF

Address: XMaS (BM28) ESRF - The European Synchrotron, CS 40220, 38043 Grenoble Cedex 9 France

Directors: Prof. Chris Lucas (University of Liverpool) and Dr. Tom Hase (University of Warwick)

Facility Manager:_____

Description of the Facility (max. 1/2 page): Please give a brief description of the facility and its main objectives for a non-specialist audience.

The XMaS mid-range facility is an x-ray beamline embedded in the heart of the European Photon and Neutron (EPN) Science Campus in Grenoble, France and is managed by the Universities of Liverpool and Warwick. The beamline is part of the European Synchrotron Radiation Facility (ESRF) which forms part of the EPN along with the other European institutes including the European molecular biology lab (EMBL) and the Institute Laué-Langevin (ILL) neutron source. The original beamline was conceived primarily as a tool to study magnetic materials, hence the acronym **X**-ray **Ma**gnetic **S**cattering (XMaS). The beamline has been supporting users since 1997 but has a far broader remit than magnetic scattering and supports active research groups in over 20 UK universities (representing approximately 100 independent researchers) and covers research in materials science, physics, chemistry, soft condensed matter and biomaterials. The facility is an enabling tool serving the materials science community (including academic researchers, national research laboratories and industry). It plays a major role in interdisciplinary projects and thereby contributes directly to societal challenges such as energy storage and recovery, the digital economy and advances in healthcare technologies as well as underpinning the UK research infrastructure.

The objectives of the facility are to provide access to the UK materials science community to a state-of-the-art x-ray facility (machine and experimental equipment). It also provides training for junior scientists as well as postgraduate and undergraduate students in advanced scientific methodologies embedded in a vibrant international environment.

Key Performance Indicators KPI (max. 2 pages): Please provide evidence of the facility's performance with regard to the KPIs identified in the contract over the last 12 months. For any targets that were not met, please provide an explanation and describe the steps taken to mitigate negative impact on users and measures taken to improve performance.

The following are KPI describe the activities on the facility covering the period 1st October 2013 through to 30th September 2014.

The number of Individual Researchers and University Research Groups.
There have been 148 individual researcher visits from a total of 46 UK research and 15 International research groups in the reporting period. In the current funding period there have been a total of 281 individual researcher vists, 72 UK research group visits and 43 International research group visits.

Uptime of the beamline in the previous 12 months
The percentage of uptime the beamline experienced in the period identified above was 97.96%, well above the 80% contractual target. This uptime figure is an improvement on the average uptime for the XMaS facility, which, since 1998 has been 95.1%. The result from this reporting cycle is also an improvement on the more recent 96.7% average achieved since the current mid-range facility funding began in 2012. The downtime experienced by the facility is a combination of facility instrumentation failures, user sample problems and downtime generated by external causes such as failures in the synchrotron storage ring over which we have no control. The external factors contribute approximately 50% of the total downtime with the remaining 50% a combination of facility instrument failures and/or user sample failures.

Number of user complaints: XMaS has received zero complaints in the last 12 months. 0 complaints have been received in the current funding period.

The Number of research outputs: There have been 16 publications in the reporting period, in addition to the conference and seminar presentations given by our staff and users. We have recently passed 300 published papers arising from facility usage, for more details see http://www2.warwick.ac.uk/fac/cross_fac/xmas/publications/.

Comparison with past performance: The KPIs reported above are inline with previous reporting periods (figure 1)

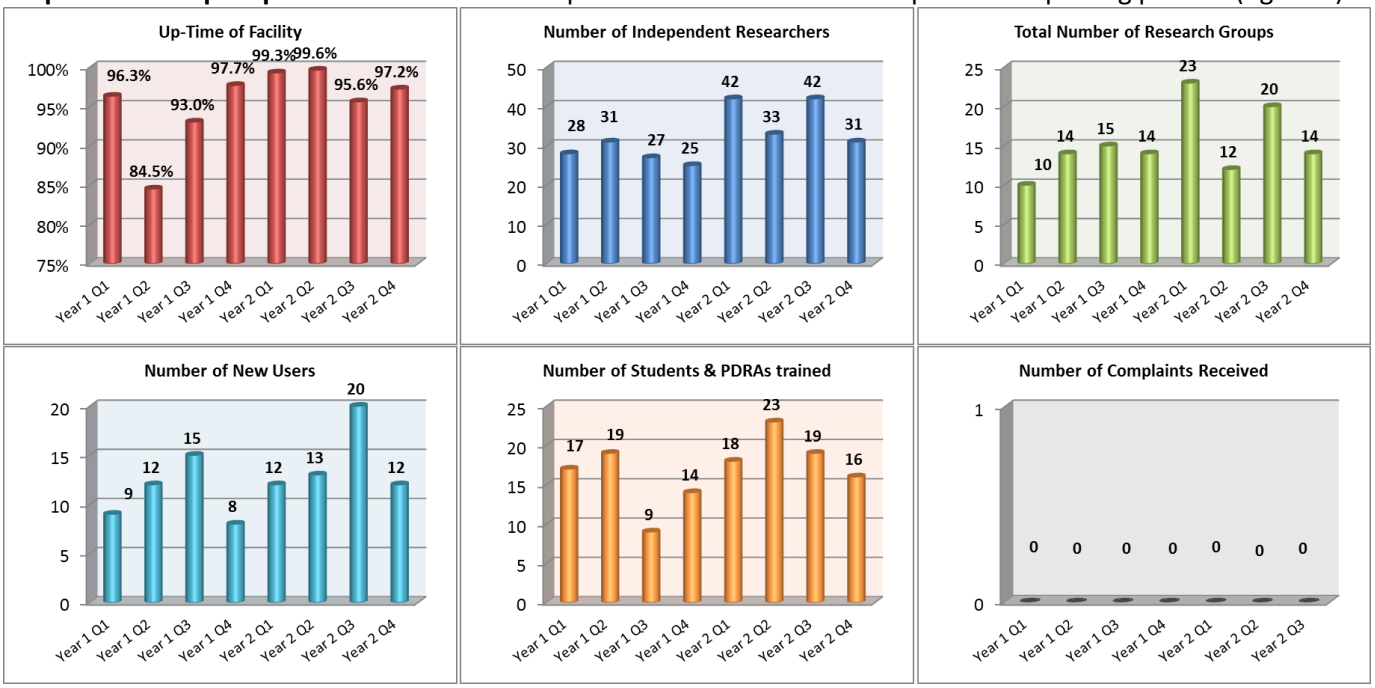


Figure 1: KPIs as a function of facility time

All targets set by the mid-range facility contract have been exceeded. For development strategies please see 'Actions taken to Promote New User Communities, non academic and business collaborations' section below.

Users (max. 1 page): Please provide data on the number of users of the facility over the last 12 months. Indicate the number of new users, academic vs. non-academic users, third party collaborations, and students using the facility. You may wish to provide data on user satisfaction and evidence of actions taken to promote the facility among new user communities, including non-academic users and business collaborations.

Our user statistics are derived from the data generated by the ESRF access protocols and by independent user feedback provided at the end of each experimental session. As part of the contract with the ESRF, proprietary work cannot be undertaken through our collaborative agreement. Whilst we work with non-academic users as part of our third party activities, users of the facility are primarily composed of academic and student users.

Summary of Key Data coving the last 12 months

Number of user visits: **148;** Number of new users: **57;** Number of student visits: **58;** Number of PDRA visits: **18** Number of complaints received: **0,** Number of peer reviewed Publications in reporting period: **16**.

Third Party Activities

XMaS is part of the EMRP funded *Nanostrain* Project. This collaboration, led by the National Physical Laboratory (NPL), brings together EU metrology labs along with industrial partners including IBM (New York) to explore new strain mediated transistor devices to replace current CMOS technology and overcome the current energy crisis in Si based devices. This activity is highlighted in several trade magazines and online resources.

User feedback

End of run surveys of our users provide additional information about performance. These metrics, which are summarised in figure 2 for the reporting period, are scored out of 5 with 5 being the highest score.

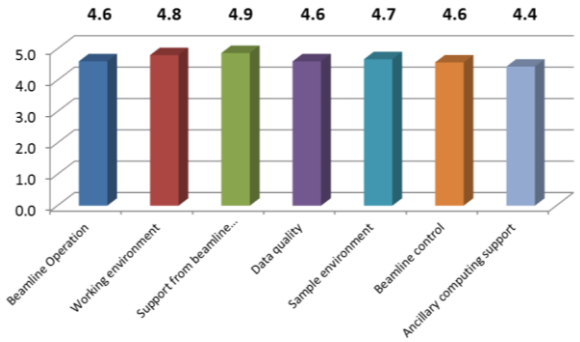


Figure 2: User feedback on facility operations covering the reporting period

Publications

In additional to the usual output we have taken action to advertise the facility to a wider audience through an article in the latest IoP "Focus on Nanotechnology" supplement of Physics World.

Actions taken to promote new Users: http://www.xmas.ac.uk

A series of meetings and seminars have been organised and supported by XMaS over the past year including:
13th May - **XAS Meeting**: *A one day workshop to explore the scientific and technical challenges for spectroscopic studies around the Cl, S and P K edges. The latest developments at XMaS, DLS and the ESRF were highlighted. http://www2.warwick.ac.uk/fac/cross_fac/xmas/past_meetings/xasmeeting/*
5th June - **User Meeting**: *Opportunity to see how XMaS operates as a mid-range facility and interact with the on-site team. Summary of new technical developments were presented and discussion on how the beamline can help users and their science were conducted.*
5th July - Sponsored event - **Latest Developments in frustrated Magnetism: spin liquids, spin glass, spin ice states**. *Sponsored meeting held at UoW to highlight how XMaS could support a topical new user community.*
3rd September - Sponsored event - **Cultural Heritage Meeting held at Marie Rose Museum**, Portsmouth: *A meeting exploring how XMaS can help cultural heritage and conservation efforts with museums and learned societies.*
4th, 5th, 11th and 12th November **- Expert Focus Groups**: *A series of meetings exploring the scientific areas which can developed on the beamline as a result of the ESRF upgrades bringing new capabilities and capacity to the facility*
7th-10th November – **University Seminars** at **Cambridge and Liverpool***: Seminars highlighting the capabilities for in-situ electric field measurements that are now available both the SR beamline and using the offline facilities.*

Mail Shot: In January 2014 with the help of our EPSRC contact, Simon Crook, we identified a list of early career researchers (ECRs) working in the area of materials research and funded by EPSRC either through the First Grant Scheme or the Fellowship Scheme. A letter from the XMaS directors and a flier advertising the facility was sent to this list of people in order to generate potential interest amongst EPSRC-funded ECRs. As a result of this interaction several attended the user meeting and subsequently applied for beamtime as CIs with more experienced users.

Scientific excellence (max. 2 pages): Please provide examples on how the facility supports scientific excellence in the UK. This should be a short narrative, including important scientific breakthroughs, case studies and related articles in scientific journals and publications for a broader audience. You may include links where appropriate.

The XMaS facility provides access to synchrotron radiation (SR) to tackle many current and topical materials sciences challenges faced by the UK. As materials and their intrinsic properties underpin most of the recent technological advances, a fundamental understanding of their structure is essential if the UK is to remain at the forefront of scientific excellence. A small subset of the interdisciplinary problems tackled over the last year include:

The Energy problem: This can only be solved through materials development and understanding. Work carried out on the XMaS beamline includes studies of the next generation of photovoltaics (*Soft Matter 9, 10501-10511 (2013)*). including exploration of materials growth and synthesis. This research is supported by new sample environments developed on the beamline and the recently purchased fast detectors. In partnership with a new user community (based mostly in Chemistry and including partners in the Catalysis hub at Harwell) we have developed *in-situ* EXAFS studies utilizing the low x-ray energies available on XMaS to study catalysts and ionic liquids (*Catal. Today 229, 95-103 (2014)*).

Corrosion remains an important concern for both environmental safe-guards and archaeological preservation. It is a major cause of failure in materials and a better understanding of corrosion mechanisms due to environmental influences will have direct and lasting socio-economic benefit to the UK (Heritage Science 2014, 2:14 (2014). Experiments performed in the last year included studies of heritage artefacts as well as sweet corrosion of carbon-steel pipelines, and other components, in which the dissolution of CO_2 in aqueous brines carried along with oil is a major concern and expense for the oil industry.

New functional materials: New technologies ranging from mobile-phones to computer displays are now being developed and studies of these important heterostructure materials were carried out along with continuing developments in the tools required to measure them under routine operating conditions (temperature, humidity applied fields etc.). The low power density of the beam ensures that these sensitive soft-matter materials are undamaged by the incoming x-ray beam and is a clear advantage of the XMaS facility.

Fundamental studies of **magnetic materials** remain a key research area of the beamline (*Nat. Phys. 10, 202 (2014) and Appl. Phys. Lett. 104, 242410 (2014)*) with a range of experiments performed last year exploiting the high magnetic fields and energy ranges which are unique to the facility. New areas of research studying **multiferroics** exploited the electric field capabilities developed on the beamline (*Nat. Comm. 3, 1334 (2013)*), and, along with, new experimental metrologies developed in partnership with the National Physical Laboratory and the Nanostrain project new opportunities in measuring strain in technologically relevant systems are being explored (*physics world "Focus on Nanotechnlogy supplement (2014) and http://www2.warwick.ac.uk/fac/cross_fac/xmas/nanostrainproject/ with references therein*).

In the area of **healthcare** XMaS has been used in biophysics experiments (*Radiat. Phys. Chem. 95, 191-201 (2013)*) and more specifically the structure and crystallisation of dental materials (*Arch. Oral Biol. 58 (11) 1726-1734 (2013)* and *J. Dent. 40, 1074-1080 (2012)*) as well as bone samples from across history. Based on this research, current clinical treatments are being re-evaluated. A new research area in understanding the healthcare benefits of corroding Cu *in vivo* (*Contraception 90, 454-459 (2014)*) has recently begun.

From the above examples it is clear that the XMaS facility is interdisciplinary with outputs impacting a wide range of scientific disciplines. This is supported by the publication list as well as the number of conferences, training courses and seminars. The research performed by our users is frequently singled out in the ESRF's Highlight/Spotlight publications (http://www.esrf.eu/UsersAndScience/Publications/Highlights). The work described above, as well as highlights from the 2014 publication list are currently being edited for the 2014 newsletter (http://www2.warwick.ac.uk/fac/cross_fac/xmas/news/newsletters/) which will be available from February 2015. The facility produces an annual newsletter which is disseminated widely (600 copies) throughout the UK and internationally. Here we include a summary of a subset of the content of the 2013 newsletter which is now published:

- The malleability of Uranium (Springell *et al. Phys. Rev. B 89, 245101 (2014)*): *The paper reports on the crystallography of the ambient pressure alpha phase of Uranium. It follows the lattice parameters as a function of temperature and strain exploring the role of the latter on the charge density wave state at low temperatures.*
- Quantitative determination of quadruple transitions at the L-edges of Rare Earths: *A report on a new experimental methodology for the quantitative measurements of the quadrupole resonances in the rare earths*

which exploits the flexibility of the XMaS diffractometer and the high magnetic fields that can be applied coupled with polarisation analysis.

- Epitaxial ferromagnetic MnSb for spintronic applications *(Invited article* in *Spin 1440025 (2014)*): *A comprehensive analysis of the polymorph structures in MnSb in which both the in-plane and out-of-plane structures are compared to determine the location of the different polymorphs within the thin film.*
- A view of highly orientated In_2O_3 nanorods from reciprocal space (*Nanoscale 5, 7445-7451 (2013)*): *A report on the measurement of the orientation of rods which have applications in sensors and field effect transistors from the shape of the scattering in reciprocal space.*
- Quiescent bilayers at the mica-water interface (*Soft Matter 9, 7028 - 7041 (2013)*): *A study of the morphology and layering of soft-condensed matter systems and surfactants. The x-ray data is compared with theory and other structural studies and show the importance of x-ray data in understanding self-assembly.*

As well as the highlighted topics, work at the facility has produced the following publications since 2012:

- Bell G, *et. al.* Spin 1440025 (2014) DOI:10.1142/S2010324714400256
- Beutier G, *et al.* J. Phys.: Conf. Ser. 519, 012006 (2014), DOI:10.1088/1742-6596/519/1/012006
- Björck M, *et. al* J. Surf. Interfac. Mater. 2, 24-32 (2014). DOI:10.1166/jsim.2014.1032
- Brazier JB, *et al.* Catal. Today 229, 95-103 (2014). DOI:10.1016/j.cattod.2013.10.079
- Burn DM, *et al.*, J. Phys.: Condens. Matter 26, 236002 (2014) DOI:10.1088/0953-8984/26/23/236002
- **Dmitrienko VE, *et. al.* Nat. Phys. 10, 202 (2014) DOI:10.1038/NPHYS2859 and Supplement**
- Dmitrienko VE, *et al.* J. Phys.: Conf. Ser. 519, 012003 (2014), DOI:10.1088/1742-6596/519/1/012003
- Dressel C, et al. Angew. Chem. Int. Ed.,53 (2014), DOI:10.1002/anie.201406907
- Grayburn RA, *et al.* Heritage Science 2014, 2:14 (2014) DOI:10.1186/2050-7445-2-14
- Guilbert AAY, *et al. C*hem. Mater. 26, 1226-1233 (2014), DOI:10.1021/cm403410w
- Hase TPA, *et al.* Physical Review B 90, 104403 (2014) ,DOI:10.1103/PhysRevB.90.104403
- NHM Kaus, *et al.* J. Mater. Chem. C 2, 5447-5452 (2014) DOI:10.1039/C4TC00907J
- **King JA, *et al.* Appl. Phys. Lett. 104, 242410 (2014) DOI:10.1063/1.4883860**
- Liu F, *et al.* J. Am. Chem. Soc. 136, 6846-6849 (2014) DOI:10.1021/ja502410e
- Normile PS, J. Appl. Cryst. 47, 1769 (2014) DOI:10.1107/S1600576714020056
- Simmons L, *et al.* J. Appl. Phys. 116, 123514 (2014) DOI:10.1063/1.4896367
- Springell R, *et al.* Phys. Rev. B 89, 245101 (2014) DOI:10.1103/PhysRevB.89.245101
- **Wildemeersch D, *et al.* Contraception 90, 454-459 (2014) DOI:10.1016/j.contraception.2014.05.009**
- Abes M, *et al.* J. Appl. Phys. 113, 124303 (2013). DOI:10.1063/1.4797490
- Bikondoa O, *et al.* Sci. Reports 3, 1850 (2013). DOI:10.1038/srep01850
- Bradley DA, *et al.* Radiat. Phys. Chem. 95, 191-201 (2013) DOI:10.1016/j.radphyschem.2012.11.001
- Brown SD, *et al.* Phys. Rev. B 87 165111 (2013). DOI:10.1103/PhysRevB.87.165111
- Dane TG, *et al.* Soft Matter 9, 10501-10511 (2013). DOI:10.1039/C3SM51407B
- Geprägs S, *et al.* Phys. Rev. B 88, 054412 (2013). DOI:10.1103/PhysRevB.88.054412
- **Kim J-W, *et al.* Phys. Rev. Lett. 110, 027201 (2013). DOI:10.1103/PhysRevLett.110.027201**
- Normile PS, *et al.* Phys. Rev. B 88, 054413 (2013). DOI:10.1103/PhysRevB.88.054413
- Oropeza F, *et al.* Cryst. Growth & Des. 13, 1438-1444 (2013). DOI:10.1021/cg301455q
- Regoutz A, *et al.* Nanoscale 5, 7445-7451 (2013). DOI:10.1039/c3nr00728f
- **Ryan PJ, *et al.* Nat. Comm. 3, 1334 (2013). DOI:10.1038/ncomms2329**
- Ryding S, *et al.* Powder Diffr. 28, S2, S220 (2013). DOI:10.1017/S0885715613001024
- Simmons LM, *et al*. Arch. Oral Biol. *58 (11) 1726-1734 (2013).* DOI:10.1016/j.archoralbio.2013.08.012
- Speranza F, *et al.* Soft Matter 9, 7028 - 7041 (2013). DOI:10.1039/C3SM50336D

Impact (max. 1 page): Please provide evidence of the broader impact that the facility has on the research landscape in the UK. This can relate to training skilled people, work, collaborations and facility activities which have led/will potentially lead to benefits outside the core user community, including societal and economic impact as well as promoting Engineering and Physical Sciences to the wider public.

The XMaS project provides opportunities that underpin the UK material science community through novel research infrastructure. It delivers economic and commercial impacts, stimulates public discourse on science, transfers knowledge to a broad range of society, facilitates new experimental techniques, and provides training to UK and international stake holders. To date we hold 9 commercial licences with various companies. It contributes directly to the challenge themes of Energy, digital economy, healthcare technologies and environmental change. It provides diverse and wide-ranging training opportunities for students, PDRAs and senior researchers. In the last year we have trained 32 new users and 35 student/PDRA visits have occurred. Thus the facility is training the next generation of material scientists with specialist expertise in advanced synchrotron radiation techniques. The diverse range of people trained on XMaS, - undergraduate and postgraduate students, post-doctoral researchers, and international visitors - have then transferred their knowledge and experience to their current roles which span industry, work at other central facilities and education (secondary schools).

The facility also provides the UK science base with direct access to the EPN campus placing EPSRC funded science at the forefront of European research. EPSRC has recognized the strategic importance of support facilities located in close proximity to central facilities in order to maximize the scientific return from beamtime allocations as encapsulated in the support being given to the new research complex at Harwell (RCaH). This support has two aims; (1) to foster a closer interaction between visiting researchers, beam line scientists and the facilities themselves and (2) to provide additional support for research conducted during a beamtime allocation. These aims can also be derived due to the location of XMaS at the ESRF which is part of the EPN campus. XMaS is thus ideally positioned to take advantage of on-site developments, such as the Partnership for Soft Condensed Matter. Access to EPN facilities is guaranteed through our ESRF contribution and comes with no additional cost overheads and represents an excellent value added contribution to the facility. Technological and scientific advances developed on the EPN campus can be rapidly transferred and implemented on XMaS for the wider benefit of the UK science base. Examples already implemented include the development of our ultra-low temperature cryostat (developed with the ILL), and the use of APD detectors, electronic counting chains (MUSST Cards) and new high speed, high count-rate 2D detectors developed at the ESRF which the beamline has access to prior to full commercial distributions. As the EPN institutes attract world-leading scientists both as employees and visiting researchers, the opportunity for scientific interaction fosters strong international collaboration and greatly enhances the research and training quality for the UK community. The dissemination and visibility of XMaS science is also included in ESRF outreach activities and thereby receives European wide impact and esteem. This wider European visibility is also enhanced by the 30% international access to the facility guaranteed through our contract with the ESRF. In the most recent allocation period 14 proposals were submitted through this route, most of which were from EU laboratories and researchers. Additionally about 3,000 members of the public visit the ESRF annually. Our on-site staff conduct tours as part of the wider public engagement of the EPN campus and thereby highlight the importance and relevance of the XMaS facility and EPSRC science more generally.

Featured Articles: Examples of impact and outreach beyond the core users is typified by a selection of our publications listed below:

- Materials Today- *Creative approaches in biomimetic materials research* Maisoon Al-Jawad http://www.sciencedirect.com/science/article/pii/S1369702114002685
- ESRF Newsletter- *XMaS takes the strain off Moore's Law* *http://www2.warwick.ac.uk/fac/cross_fac/xmas/news/1407_24_esrf_newsletter_article.pdf*
- Physics World (5th June 2014 Issue) - *Mechanical promise for Moore's Law* Markys Cain

In addition, XMaS sends a Newsletter each year in January to all users who use the facility, as well as all UK physics departments and most chemistry departments as well as dissemination to many international facilities and users.

Upcoming events: In a new initiative, XMaS has applied to STFC as well as securing additional UoW fund to support a trip for 12 female AS Level Physics students to visit XMaS, tour the ESRF and ILL as well as meeting female members of staff to promote careers in science for women. The visit will take place on April 6th-9th 2015 and be promoted through local media, university communications, XMaS newsletter, ESRF Newsletter and Social media.

Improvement (max. 1 page): Please indicate steps that have been taken to improve the access, user experience and ensure the long term sustainability of the facility.

The XMaS facility is reliant on the ESRF infrastructure, the reliability and performance of which has been a key element in the success of both the ESRF and XMaS. The long-term sustainability of the facility is thus inextricably linked to the quality of the synchrotron x-ray source. Thus, for the future improvements of the facility it is important to note that the ESRF is currently going through a series of upgrade programmes designed to ensure that it remains at the forefront of SR technology. The first upgrade phase (2009-2015) has delivered significant improvements to the x-ray source as well as facilitating new developments in both SR instrumentation and computing support. All of these improvements directly enhance and sustain the XMaS facility and can already be accessed directly through the ESRF Detector pool. The upgrades have also delivered an improved beam position diagnostic systems and new RF power sources providing higher beam stabilities with improved uptime. These have enhanced our user experience by significantly reducing a major loss mechanism for the facility (ESRF downtime is now ~1% compared with 3% prior to the upgrades). A further switch over to the top-up mode operations is planned which will result in a higher flux delivered to the facility for user experiments. The second upgrade phase (due to start in 2018) is a complete replacement of the magnetic lattice leading to a significant upgrade in the XMaS source as the current bending magnet will be replaced by a multipole wiggler. This change represents a significant opportunity as the current capabilities can be extended to increase the throughput and number of users that can be supported. An overriding objective of all upgrades is to continue the track record of excellent x-ray beam stability.

With our already newly designed cryogenically cooled monochromator and a new mirror that is already funded, the XMaS facility is well positioned to take advantage of the ESRF source upgrades. The result will be a brand new facility with a significant increase in the brilliance of the x-ray beam and, more significantly, an increased energy range of operation with possibilities of extending into the high energy x-ray regime (50-80 keV). To disseminate information about the upgrades of source and its implications for the facility, XMaS has held 4 'Expert Focus Groups' meetings in the research areas; Hard Condensed Matter, Soft Condensed Matter, Chemistry and EXAFs and Surface & electrochemistry in November 2014. These meetings have been used to collaborate with existing and potential new users to determine how XMaS can best support their needs. The majority of attendees (which were by invitation only) were not users of the XMaS beamline but leading experts in their respective research fields. The focus of the meetings was to identify new capabilities and capacities that will result from the upgrade as well as identify technological developments that will be required to realize this new science. The results of these meetings will be presented at the next Management Meeting (18th November 2014) and we have already begun the preliminary design studies needed to maximise the impact and create a transformative and unique facility in the future.

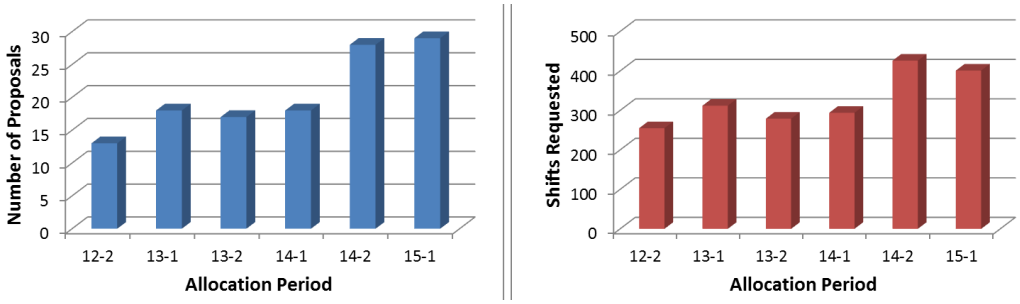


Figure 3: User access requested for the facility in terms of proposals (left) and shifts (right).

XMaS has a long history of engaging with the existing user community and developing sample environments to expand our remit. This has continued over the past year with new metrology techniques for the *in-situ* study of materials using (N)EXAFS as well as the purchase of new fast 2D detectors and further instrumental developments such as a redesigned (GI)-SAXS/XRR system and efficiency gains in operations. These developments have seen a significant increase in the number of users interested in the facility and we have seen an almost 50% increase in the number of proposals submitted with a 30% increase in the requested number of shifts over the past year (figure 3). By making more use of shorter access allocations and through other efficiency gains we have increased the number of users we can support and thereby kept the over-subscription rate to a manageable 2:1. In parallel to the development of the SR beamline we have also made significant developments to our suite of offline facilities for UK scientists who may not need access to SR to further their research. The principal developments are (1) An offline x-ray diffraction capability based on a high power x-ray micro-source and utilizing an existing 4-circle Huber diffractometer providing x-ray diffraction capabilities that mimic the SR beamline and (2) offline access to our capital equipment including the high magnetic and electric field measurements systems.

Strategic Fit (max. 1 page): Please provide evidence on how the facility fits the strategic priorities of EPSRC and state any actions taken / will be taken to align the facility with these strategic priorities.

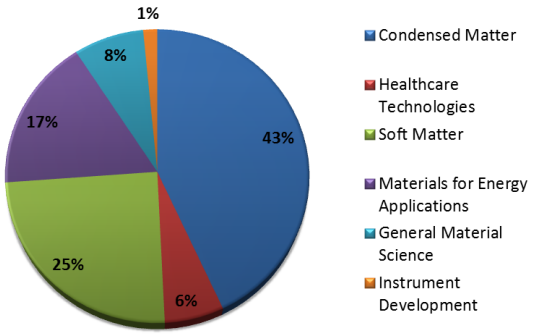
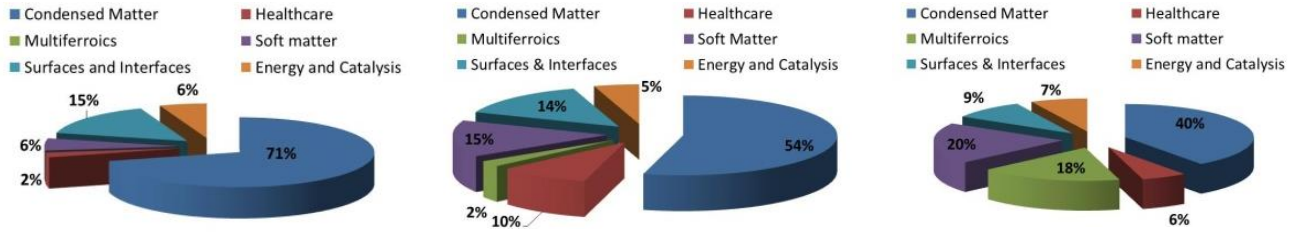


Figure 4: XMaS Experiments by research category as report by our users

The XMaS beamline provides a set of unique materials research capabilities to the UK science base. The combination of a world class photon source, continual innovation in photon techniques, high quality technical and scientific support and a strong international user community has maintained the beamline at the leading edge of materials characterisation. XMaS continues to support a diverse scientific programme cutting across the challenge themes and complements and strengthens UK based facilities. As materials discovery continues apace it is evident that the XMaS beamline has an important strategic role in providing fundamental and technologically relevant atomic information to the physical and life sciences.

The science supported on the XMaS beamline covers a much broader range of challenges than are normally found on a beamline at a SR source. Due to the multidisciplinary user community which is stretched across Physics, Chemistry and Materials disciplines within the UK science base, there is a strong mapping to many of the science and technology areas that underpin EPSRC's remit. The user profile has also continually changed and expanded with the developing capabilities of the beamline as can be seen in figure 4 which shows the research areas that are currently being studied. We are in a unique position whereby the best practices of one community have been shared, adapted and implemented by others to the benefit of all. This knowledge transfer has also extended beyond the beamline itself and finds implementation at Diamond Light Source and other central facilities worldwide.

Although original conceived as a facility to probe magnetic materials and hard condensed matter, the flexibility of the original design coupled with technological developments has enabled an ever broadening range of scientific challenges to be addressed at the beamline (figure 5). Now proposals submitted to the beamline incorporate hard condensed matter, technological materials, soft matter (photovoltaic and polymeric materials), energy and electrochemistry of catalysts and healthcare technologies:



Phase I, 1997-2002 *Phase II, 2002-2007* *Phase III, 2007 – 2012*

Figure 5: Scientific areas by proposal submission for the three phases of XMaS operation.

Much of the scientific programme at the facility is contained within the Physical Sciences remit of EPSRC, but the facility is also an important component of the UK research infrastructure that underpins the wider materials science research communities.