

National Research Facility Annual Report: XMaS

Overview of facility

Name: XMaS

Director(s): Profs. Thomas Hase and Chris Lucas

Co-director(s): Prof. Malcolm Cooper and Dr. Yvonne Gruender

Location(s): European Synchrotron Radiation Facility, Grenoble, France

Grant reference:

Reporting Period: 2025

Purpose and vision of the XMaS NRF

XMaS is the UK Collaborating Research Group beamline at the European Synchrotron Radiation Facility in Grenoble, providing UK researchers with advanced X-ray capabilities that both reinforce and diversify national synchrotron provision. As the UK's long-standing presence at the ESRF, XMaS delivers a high-brilliance 2.1–47 keV X-ray beam, with low- and high-energy regimes that offer specialist measurement conditions not readily accessible elsewhere. Its versatile suite of techniques—including diffraction, SAXS/WAXS, reflectometry, and X-ray absorption spectroscopy—can be applied sequentially to the same sample and environment, enabling genuinely integrated multimodal and operando studies. This flexibility supports research across physics, chemistry, engineering, biosciences, energy materials, cultural heritage, and industry-driven innovation.

The facility's vision is to support the UK research community in addressing frontier scientific challenges by providing stable, high-quality capability, continuously developing instrumentation, and fostering an environment that encourages creativity, collaboration, and technical excellence. XMaS serves a broad and diverse user base, with projects frequently involving multinational teams and industrial partners, generating long-term collaborations and high-impact outcomes. Its commitment to user engagement, training, and safe, inclusive operations strengthens the resilience and agility of the UK materials research ecosystem.

XMaS occupies a distinctive strategic position, complementing Diamond Light Source through close collaboration, shared developments, and the new BAG access route with B18. Looking ahead to the Diamond upgrade dark period, XMaS is preparing to ensure continuity of access by enhancing capability, strengthening coordination, and maintaining key X-ray methods for UK researchers. Through contributions to standards bodies, advisory groups, and infrastructure planning, XMaS helps shape the future of UK and international materials research, ensuring the community remains globally connected and equipped for the scientific challenges of the coming decades.

Section 2: Quality and breadth of research that the facility has enabled

Scientific excellence and impact of the beamline are derived from the diverse and fascinating work of our users and the broad range of science that the users investigate.

Important scientific breakthroughs that have been supported by the facility: A major advance has been the demonstration that freestanding membranes of SrTiO₃ can sustain >1% reversible tensile strain, driving the material through a classical-to-quantum crossover in its ferroelectric transition. High-precision data were essential for detecting the changes in orbital anisotropy and strain-induced structural distortions, revealing the onset of a quantum-enhanced ferroelectric regime and its critical strain–temperature thresholds. These results highlight XMaS’s ability to provide an experimental window into how strain reshapes the energy landscape governing ferroelectricity in quantum materials¹. In the field of soft condensed matter, the interplay between donor–acceptor ratios and processing additives in PM6:Y6 organic solar cells was explored. Using the upgraded SAXS/WAXS capabilities, combined with improved sample handling and streamlined data-reduction workflows, it was shown that the highest efficiencies occur when the active layer forms a single, well-mixed phase in which Y6 diffusion is restricted within the PM6 matrix - an insight that underpins the optimisation of next-generation organic photovoltaic materials².

New methodologies that have been developed: During 2025, the facility optimised its metrologies to enhance operational efficiency. New multi-sample stages were introduced, including a multi-capillary holder, a transmission rack accommodating up to twenty powder specimens, and a grazing-incidence stage capable of hosting six samples. These upgrades, together with streamlined alignment routines, now support faster and more reliable operations. Efficiencies in data handling were also achieved through automated Jupyter-based workflows that convert raw (GI)SAXS/WAXS data into analysis-ready datasets. In parallel, and in collaboration with Electrosiences Ltd., we delivered an enhanced 3D visualisation and data-processing tool, including representations in reciprocal-lattice units; together, these developments exploit the computational resources of the ESRF.

The breadth of research areas that are supported, highlighting any new research areas: The scientific area of each experiment is identified by users through the end-of-run survey, with bibliometric classifications reported separately in Appendix C. As illustrated in Figure 1, the distribution of research areas in this reporting period is broadly consistent with the facility’s long-term profile, showing sustained engagement across condensed matter, energy materials and catalysis, soft-matter systems, healthcare technologies, and general materials science reflecting the diverse and multidisciplinary user community served by the facility.

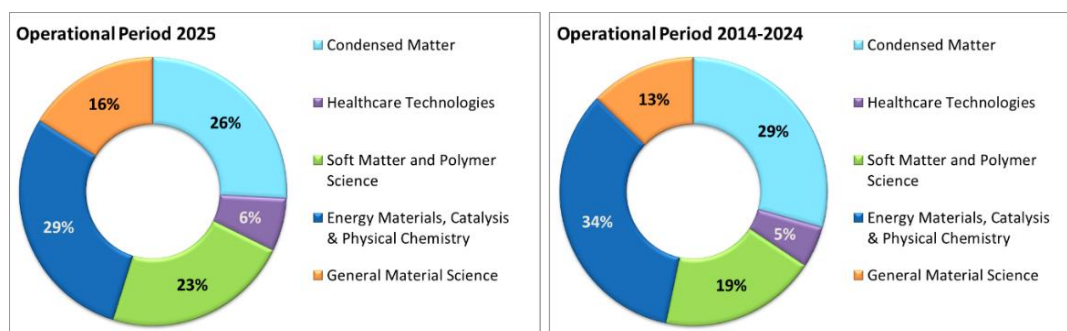


Figure 1: Research areas as reported by the users in their end of run surveys. Data from this reporting period (left) compared with the previous 10 years (2014-2024, right).

¹ J Li, *et al* *Nat. Commun.* 16, 4445, (2025).

² E Gutiérrez-Fernández *et al*, *J. Mater. Chem. C*, 13, 22722 (2025)

Publications

All XMaS publications since 1995, including DOI links, are catalogued and continuously updated on our [website](#). Users can report new outputs through a dedicated portal, and we routinely scan external repositories to ensure comprehensive coverage. In 2025, the facility produced 21 peer-reviewed papers which was similar to the number in 2024 (22) and fully consistent with long-term publication trends shown in Figure 2.

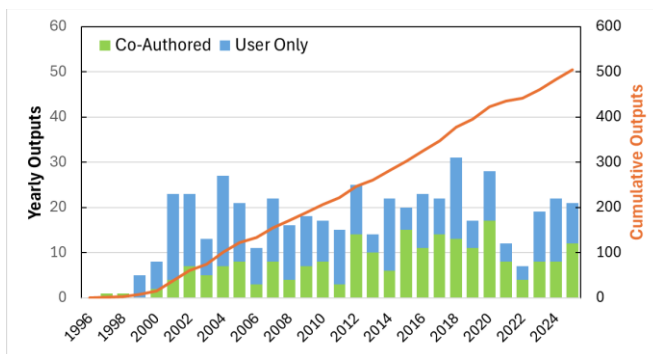


Figure 2: Cumulative output of the XMaS facility and the number of publications per year.

Scientific return remains strong, with an average of 0.8 publications per experiment. Research quality continues to be high. Over the reporting period, 33% of outputs appeared in the top 10% of journals by SNIP, and 29% in the top 5%. The 2025 portfolio again spans a broad range of scientific areas and remains highly relevant, with 55% of publications situated in the top 10% of topic prominence. Collaboration remains a defining feature of XMaS science: half of all 2025 publications involved international partners, and 5% included academic–industry collaboration. The 2025 outputs were authored by 152 unique authors from 77 independent institutions, underscoring the facility’s broad reach and impact. A detailed bibliometric analysis is provided in Appendix C. A more detailed summary of three papers, selected to highlight the scientific spectrum of outputs is presented below:

Platinum Speciation in Natural Pyrite Deposits [*Am. Mineral*]: Understanding the behaviour of platinum-group elements in natural mineral systems is essential for securing critical-metal supply chains. This study used high-energy X-ray absorption spectroscopy to determine the oxidation state and coordination of Pt in natural pyrite with a level of precision not achievable at most facilities. Access to the Pt L_3 -edge at high flux, combined with the beamline’s optimised detector configuration, was critical for resolving subtle electronic differences that underpin ore-forming processes. The NRF’s capability to deliver stable, high-energy spectroscopy made the publication possible and directly supported UK priorities in critical-minerals research. (*Research + Service Publication*)

Operando Anomalous Diffraction and XAS for Functional Materials [*J. of Appl. Cryst.*]: This paper introduces a method that interleaves anomalous X-ray powder diffraction with transmission X-ray absorption spectroscopy using a scanning 2D detector on the XMaS beamline. The beamline’s flexible geometry, beam conditioning, and rapid energy switching enable simultaneous structural and electronic measurements that are difficult to achieve elsewhere. The NRF contributed directly to the technique’s development and provided the operando environment required to demonstrate its performance. This capability strengthens UK research in catalysis, battery materials, and reaction engineering. (*Technical Development + Service Publication*)

Depth-Resolved Magnetisation in Graded Ferrimagnetic Films [*Commun. Mater.*]: Using resonant magnetic scattering at XMaS, researchers mapped depth-dependent magnetisation profiles in compositionally graded ferrimagnetic thin films, revealing how anisotropy and exchange interactions evolve through the material. The ability to tune incident energy precisely at the relevant absorption edges, combined with the availability of specialised magnetic environments, was essential for extracting element-specific magnetic information. The NRF’s contribution was critical in enabling measurements that directly inform the design of next-generation spintronic and quantum-enabled devices. The publication exemplifies strong international collaboration supported by XMaS expertise. (*Research + Collaboration Publication*)

XMaS CASE STUDIES:

Ba speciation in Biominerals

Adrian A Finch, Nicola Allison, and Anouk Borst – for more information contact Prof. Adrian Finch, School of Earth and Environmental Sciences, University of St. Andrews, UK. aaf1@st-andrews.ac.uk

Trace element geochemistry of the skeletons of marine organisms such as foraminifera, corals (Figure CS1) and bivalves capture key aspects of the seawater environment in which these organisms grew. By analysing fossil skeletons, we can reconstruct a powerful archive of past marine conditions, provided we understand how the trace metals are incorporated into the mineral phase. However, biominerals are complex nanocomposites of organic matrices and crystalline material, both of which have significant binding capacity resulting in trace elements following distinct partitioning pathways. For example, strontium, substitutes directly into the crystalline lattice and using inorganic partitioning models can be used as a proxy for sea surface temperature. Magnesium, by contrast, is predominantly bound to organic components, rendering Mg based paleoclimate reconstructions inherently flawed.

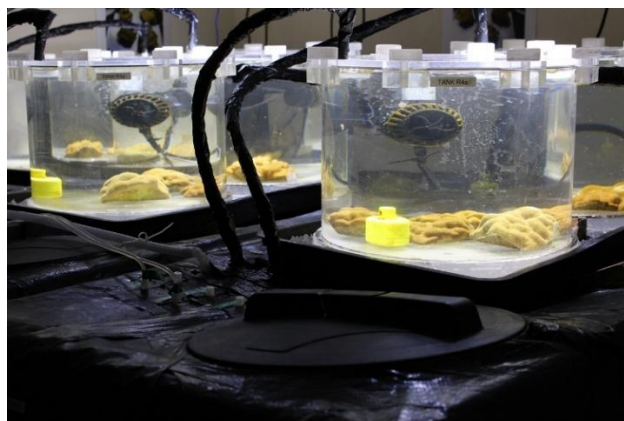


Figure CS1: Corals encode the environments in which they live in the geochemistry of their skeletons – conversely, those of fossils can be used to reconstruct marine conditions into the prehistorical past.

Barium is another environmentally sensitive trace element in biominerals, widely used to infer variations in terrestrial run off to the oceans. Yet because Ba is present only at ppm concentrations, its structural environment within biogenic carbonates has remained difficult to resolve. Our initial attempt to characterise Ba using XAFS (Finch et al., 2010) was ultimately inconclusive, as only the Ba L₃ edge was experimentally accessible. With the recent extension of the energy range on XMaS, however, Ba K edge XAFS has now become feasible. Coupled with the capability of the new Ge detector to operate efficiently at such high energies, this development opens a new metrological pathway for probing Ba incorporation in biominerals for the first time.

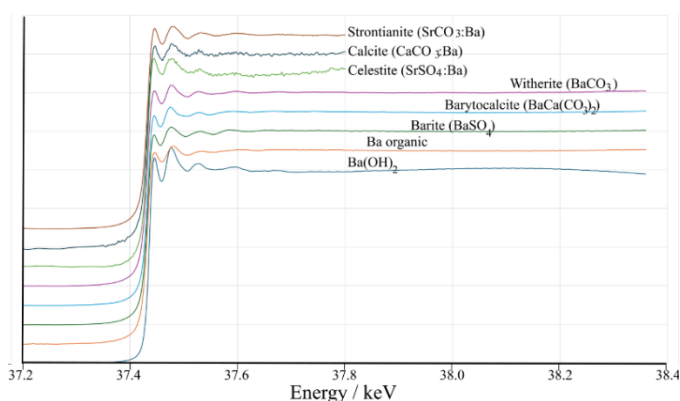


Figure CS2: Ba K-edge XAS of a variety of Ba-containing solids, including some in those in which Ba is a minor element.

Using XMaS, we collected Ba K-edge EXAFS spectra for a set of mineral and organic standards—an experimental capability our team has anticipated for more than 15 years (Figure CS2). The resulting datasets, from both standards and inorganic unknowns, are of excellent quality, with usable k-ranges extending to 11 Å⁻¹. Refinements resolve up to three coordination shells around the central Ba atom, providing tightly constrained local structural information. These measurements now allow us to quantify the lattice relaxation and dilation associated with Ba substitution in

carbonate minerals, offering unprecedented insight into the mechanisms of Ba incorporation. Coral samples proved more challenging, unfortunately. At natural concentrations of ~5 ppm, the Ba signal fell just below the detection limit, preventing reliable EXAFS extraction. Even so, the study marks a major step forward in understanding Ba behaviour in carbonate lattices and we now have a far more sophisticated understanding of Ba substitution in carbonate minerals and can predict the effect of Ba substitution. Working with the facility, we are currently assessing whether new diffraction-based detectors can isolate Ba K-edge signals in ultra dilute systems. If successful, this approach would enable the first structural characterisation of Ba in biominerals at natural abundances and open a new window onto paleoenvironmental reconstructions.

Unlocking Quantum behaviour with extreme strain of Nanometre thick oxide membranes

Philip Ryan and Jiarui Li – for more information contact Philip Ryan, Advanced Photon Source, Argonne National Laboratory, USA. pryan@anl.gov

In the mid-20th century, SrTiO₃ was explored as a potential alternative to diamond and valued for its optical brilliance. But its promise faded quickly: SrTiO₃ is extraordinarily brittle, and even slight strain causes it to crack. From a materials perspective, SrTiO₃ is also a quantum paraelectric poised on the edge of exotic electronic behaviour, but its inherent fragility prevented researchers from probing how strain might be used to unlock its hidden quantum phases. That barrier has now been overcome. By fabricating ultrathin, freestanding SrTiO₃ membranes, the material becomes remarkably flexible. These nanomembranes withstand more than 1% tensile strain, a tenfold improvement over bulk crystals, turning mechanical deformation into a precise and reversible tuning parameter for functional exploitation.

Using membranes, we repeatedly drove the material into and out of its ferroelectric state. Understanding how the lattice and electronic structure responded under strain required the combined capabilities of several synchrotron beamlines and a Razorbill strain cell. High-resolution X-ray diffraction and titanium K-edge spectroscopy at XMaS (Figure CS3) provided the sensitivity needed to track lattice coherence, strain-induced distortions, and changes in the Ti–O electronic environment. Collaboration between XMaS and APS beamlines allowed us to connect macroscopic structural response with atomic-scale electronic signatures in a way no single instrument could achieve alone. These measurements resolved a long-standing debate: the ferroelectric transition in strained SrTiO₃ is displacive, involving a coordinated shift of atoms rather than the alignment of pre-existing polar nanodomains. They also revealed a striking classical-to-quantum crossover which was tracked using X-ray linear dichroism. A crossover from a classical transition at high temperatures to a quantum paraelectric regime at low temperatures is seen in the evolution of the critical exponent, which moves from ~0.5 near 100 K to ~1.5 below 40 K. At high temperatures, the transition behaves classically, driven by thermal fluctuations. Below 100 K, however, thermal motion fades and persistent quantum fluctuations dominate, suppressing any spontaneous ferroelectric order. Mechanical strain provides the critical additional energy needed to overcome these fluctuations and stabilise low-temperature ferroelectricity. Crucially, stretching the membranes allows the ferroelectric state to be switched on mechanically as pulling the lattice apart displaces oxygen and titanium ions relative to one another, generating a spontaneous electric polarization.

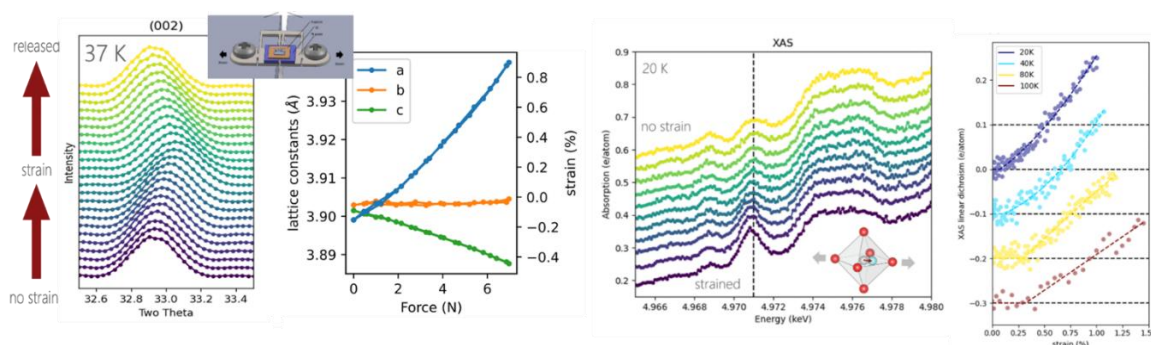


Figure CS3: By combining strain and X-ray techniques on XMaS, the ferroelectric phase transition in SrTiO₃ membranes was explored with the temperature-strain phase diagram followed using diffraction (left) and spectroscopy (right).

The ability to toggle the ferroelectric state mechanically, rather than through chemical doping or fixed epitaxial growth, offers a transformative roadmap for microelectronics where non-volatile data storage and high-efficiency switches are controlled by the subtle, reversible stretching of a membrane. The work marks an important step toward technologies in which flexible oxide nanomembranes act as mechanically tuneable quantum materials. Early results from other perovskite membranes indicate that this strategy could extend across a wide family of complex oxides. Integrated onto stretchable or biocompatible platforms, these materials could enable applications ranging from wearable quantum sensors to implantable microelectronics and lattice-based memory devices. More broadly, the findings suggest that many seemingly ordinary materials may hide remarkable functional properties, only waiting for the right experimental tools, and, in this case, the right amount of tension to reveal them.

New modes of self-assembly in side-chain liquid crystalline polymers

Y.M. Tang, Y.N. Xue, Y.X. Li, S.G. Yang, R.Y. Jia, R.B. Zhang, L. Cseh, F. Liu, X.B. Zeng, G. Ungar – for more information, contact X.B. Zeng, School of Chemical, Materials and Biological Engineering, University of Sheffield, UK. x.zeng@sheffield.ac.uk

Helical, and particularly double-helical, structures have fascinated scientists and the public since the discovery of the DNA double helix. A helix provides a topological compromise between a polymer's tendency to stay relatively straight for efficient packing and its need to twist to avoid steric clashes between side groups. In liquid crystals, however, columns self-assembled from achiral molecules rarely show long-range chiral order. Thermodynamically a one-dimensional column cannot have long-range order meaning that helices will not form unless the columns act cooperatively and this is difficult to do without crystallizing.

We have recently explored a series of side-chain liquid-crystalline polymers, in which mesogenic side groups are attached to a polysiloxane backbone (Figure CS4a), and observed the emergence of three-dimensionally ordered columnar phases in which each column adopts a double-helical structure³. The aromatic cores of the side groups form two strands that wind around one another. A columnar phase with high *Fddd* symmetry is obtained, comprising eight double-helical columns - four left-handed and four right-handed (Figure CS4b). The twisting of each helix is markedly non-uniform, consisting of alternating, nearly straight "splay" segments and sharply twisted "recovery" regions (Figure CS4b). This non-uniform torsional behaviour drives a transition to a phase of much lower triclinic symmetry, representing the first such example in liquid-crystalline systems (Figure CS4c). In compounds Si3-n, the double-helical segments connect through three-way junctions to form a complex bicontinuous four-network Gyroid (4NG) cubic structure⁴. Two networks wind around each other left-handed (blue and light blue), while the other two are right-handed (red and gold), and the equal populations of opposite handedness render the overall 4NG phase achiral (Figure CS4d). Grazing-incidence small-angle X-ray scattering (GI-SAXS) on XMaS, using oriented thin films, enabled the unequivocal indexing of the diffraction patterns associated with these highly complex 3D structures (Figure CS4e). These structural insights highlight behaviour that is strikingly different from expectations for polymeric liquid crystals which have to date been largely viewed as mirroring the phase behaviour of their low-molecular-weight counterparts, but these reports show that polymers offer new modes of self-assembly of their own. It calls for re-evaluation of some established models of self-organization in soft matter.

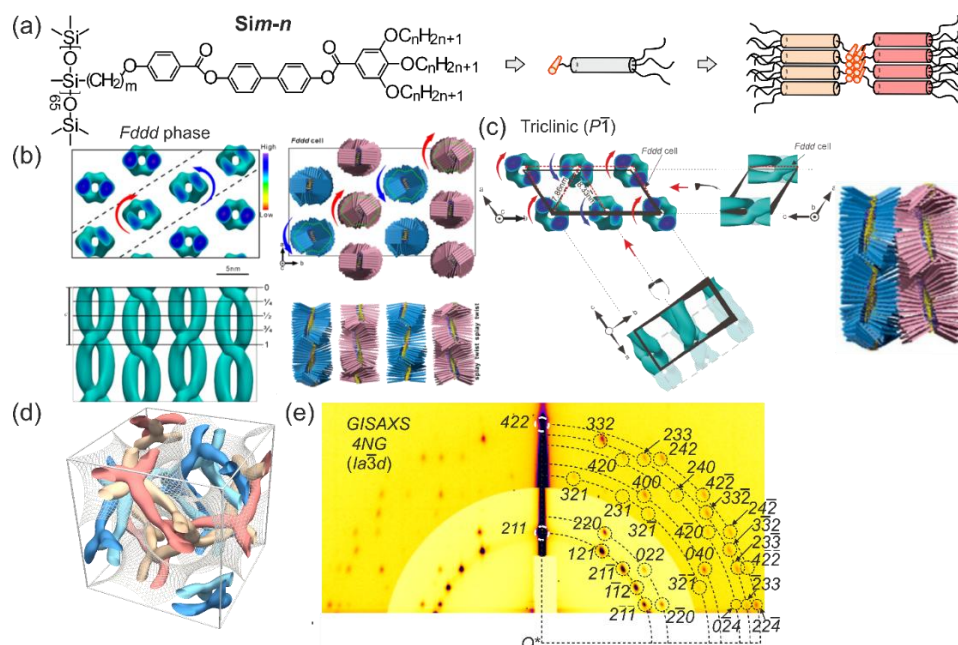


Figure CS4: (a) Chemical structure of the side-chain LC polymer. (b) Reconstructed electron density maps and the schematic molecular model of the *Fddd* phase viewed in different directions. (c) Reconstructed electron density maps viewed in different directions, and the schematic molecular model of the triclinic phase. (d) The 4NG phase with networks of double helical segments. (e) GISAXS pattern of the 4NG phase.

³ Y. N. Xue *et al.*, *Angew. Chem. Int. Ed.* 64, e202505548 (2025) and Y. N. Xue *et al.*, *J. Am. Chem. Soc.* 147, 19711 (2025).

⁴ Y. M. Tang *et al.*, *Angew. Chem. Int. Ed.* 65, e22314 (2026).

Section 3: Usage, user focus, and non-scientific impacts

Statistics on usage and the range of users

User statistics for XMaS are derived primarily from the ESRF access system, which collects user information as required under French law. These data are captured at the level of an individual user rather than a Principal Investigator or group. This approach is consistent with synchrotron facilities worldwide, which typically report users as individuals who physically access the facility and do not routinely distinguish between unique and returning users or by employment status. As XMaS user data feed directly into ESRF reporting, our statistics follow these established sector-wide conventions and remain comparable with international benchmarks.

XMaS allocates very little beam time to internal users; the overwhelming majority is awarded through an external peer-review process. No “in-house” time is reserved for facility personnel. External users are therefore defined as those who have been allocated beam time through independent peer review and subsequently attended an experiment on the beamline. Unique users include doctoral students and PDRAs. Table 1 summarises user statistics for the past five years, noting that access in 2021 remained significantly constrained by the COVID-19 pandemic. Overall, the data indicate a stable user base, with sustained engagement from both new and returning users.

Year	Number of Experiments Delivered	Unique users			Repeat users	Total users inc. repeat
		% internal	% external	Total excl. repeat		
2021	25	1	99	60	21	81
2022	33	0	100	100	26	126
2023	34	4	96	103	22	125
2024	31	3	97	97	24	121
2025	34	0	100	105	20	125

Table 1: Total users of the facility for the past five years.

A further breakdown of user visits, based on identified unique users from 2020–2025, is provided in Appendix D for additional context. More detailed information, this time based on total user visits rather than unique users, is presented in Table 2. These data reflect individuals who have physically used the facility. Through end-of-run surveys we capture the number of doctoral students, PDRAs, and industry users. We have only recently begun to collect data on the broader category of Early Career Researchers, having previously struggled to establish a definition that is meaningful and consistently interpretable for international users. As the ECR data are incomplete for 2025 we have intentionally not included them here but will do so from the next reporting period.

Year	Students	PDRAs	Academics	Industry	Total	% international
2021	35	19	27	0	81	16
2022	40	28	58	0	126	15
2023	46	29	50	1	125	25
2024	44	18	60	1	122	32
2025	37	19	70	0	126	24

Table 2: Users breakdown based on total user visits to the facility for the past five years.

In Table 2, the category “Academics” includes users based at central facilities and research institutes as the formal employment status of many international researchers is unknown. In this reporting period this category will also include ECRs who are not PDRAs or students. We also track new users as a KPI; in this reporting period, new users represented 37% of the total, consistent with historical trends. Following feedback on the 2023 annual report, we have analysed the composition of new users in more detail: in 2025, 49% were doctoral students, 21% PDRAs, and 11% academics. Historical data are provided in Appendix E. All the user data for this reporting period are consistent with previous years. Total user numbers remain broadly stable, with doctoral students accounting for approximately 30% of users and PDRAs around 15%. Having close to half of all users drawn from these groups demonstrates the facility’s strong contribution and suitability to training the next generation of researchers and aligns with UKRI priorities on skills and capability development. The steady proportion of international users reflects the continued global competitiveness of the beamline.

Industrial engagement remains more challenging to quantify. We do attempt to track experiments involving industrial collaborators, but this relies on self-reporting through end-of-run surveys. In 2025, 11% of experiments reported an industrial link, a decrease from 15% in the previous reporting period but consistent with bibliometric data. End-of-run surveys also provide insight into the breadth of the user community, with users identifying the research area of each experiment, summarised in Section 1, Figure 1. A complementary perspective on disciplinary breadth is obtained from the publication outputs themselves. Using the ASJC (All Science Journal Classification) subject-area taxonomy, XMaS publications can be mapped to recognised disciplinary categories. Individual publications may appear in more than one category, reflecting the interdisciplinary nature of the research and the journal in which the work is published. Figure 3 presents the ASJC characterisation for publications in this reporting period, noting that a publication can appear in two or more ASJC characterisations. Taken together, these indicators show that XMaS continues to support a diverse and evolving research portfolio aligned with EPSRC research areas.

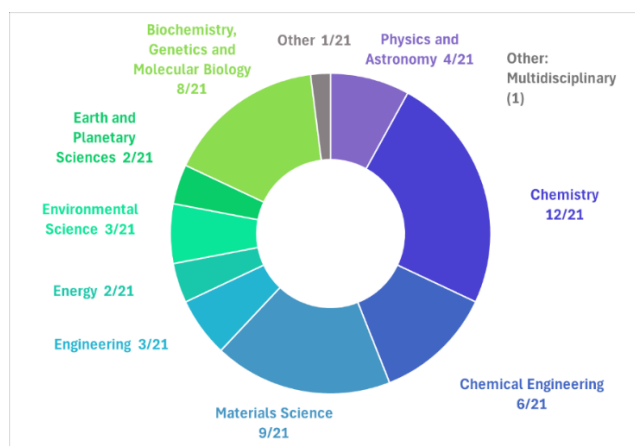


Figure 3: Research breadth as identified by publications using the Scopus research themes.

Service demand

Access to the facility continues to be governed by the Collaborating Research Group contract with the ESRF, under which 30% of full-flux beam time is allocated through the ESRF's public peer-review system via a worldwide call which can include UK users. The remaining beam time is reserved for the UK community and allocated through our independent [Peer Review Panel](#) (PRP), assessed solely on scientific merit. Beam time is scheduled in six-month allocations, using all ESRF electron-bunch modes to maximise user access and ensure efficient utilisation of the beamline. Calls for proposals are issued in April and October, with successful projects scheduled approximately six months later.

During the reporting period, 45 proposals were submitted to XMaS and 46 through the ESRF route, consistent with 2024 activity (XMaS: 44; ESRF: 40). While proposal numbers provide a useful indicator, they do not fully capture demand pressure, which is better reflected through the subscription rate (defined as the ratio of requested to delivered shifts) and this is shown in Figure 4.

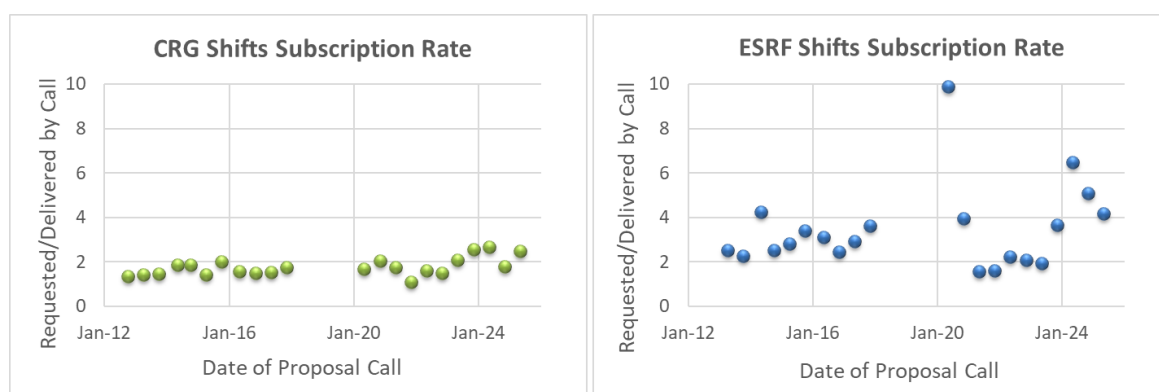


Figure 4: Subscription rates for UK (left) and international applications through the ESRF (right).

Figure 4 shows the subscription rate for both UK (CRG) and international (ESRF) access routes. CRG proposals typically exhibit around 2× oversubscription, indicating sustained demand from the UK community. ESRF submissions show greater variability but consistently reflect strong competition for international beam time. These patterns highlight the strategic importance of maintaining dedicated UK access via XMaS, ensuring that scientifically strong proposals—regularly noted by the PRP as beam-time-worthy—can be supported despite capacity constraints. At current subscription levels, we can accommodate only ~40% of the beam time requested through XMaS and ~20% of that requested through the ESRF. The PRP continues to report that most applications demonstrate strong scientific merit and would warrant beam time if capacity allowed.

The Block Allocation Group (BAG) access route, coordinated by the University of Kent in partnership with Diamond Light Source, used 2 weeks of beam time and supported users from 7 institutes, and collecting 104 datasets. In addition to synchrotron beamline access, XMaS provides use of its offline facilities, managed *ad hoc* by beamline staff, which frequently support or complement scheduled experiments to enhance overall user productivity.

Uptime

During the reporting period, the facility achieved 93.1% uptime, with 6.9% downtime—5.4% due to facility-related failures and 1.5% to external factors. This performance is broadly consistent with the previous period (94.4% uptime), with the slight reduction linked to an intermittent monochromator-encoder fault and a critical sample-environment leak in the first half of the year. Both issues were resolved promptly, contributing to an improved 95.7% uptime in the second half of the year. Additional demand and uptime statistics are provided in Appendix D.

Training, outreach, skills, and non-scientific impacts

Table 3 highlights activities that promoted the facility beyond its core user base in 2025:

Event	Description	Participants
Women in Physics Evening	Career event highlighting the experiences and achievements of women working in physics at Warwick, with contributions from XMaS staff	40
XMaS Scientist Experience 2025	Annual sixth-form outreach programme providing hands-on experimental experience, mentoring, and skills development.	16 (134 applicants)
CUWiP Conference	Career guidance sessions and engagement with undergraduate students from the UK and Ireland, alongside wider conference support.	100
IOP Materials and Characterisation Group	Online careers session focused on pathways in materials science and characterisation.	35
UK Small Angle Scattering Users Meeting	Poster presentation: "X-ray characterisation of energy materials at XMaS."	50

Table 3: Events organised by XMaS or attended by XMaS staff.

Public engagement activities run by XMaS:



Figure 5: XMaS Scientist winners at the beamline.

(Figure 5). It was an inspirational and rewarding experience for the students, and their knowledge and eagerness to learn was both impressive and encouraging. A great many questions were asked and answered by female scientists at the ESRF who are more than happy to take part, understanding the importance of encouraging the future generations of women. Feedback was overwhelmingly positive, with comments highlighting how it motivates, builds confidence and is an opportunity for the students to meet other like-minded individuals who share a passion for science. Many described the experience as influential in shaping their academic interests and future aspirations. The programme was recognised through a University of [Warwick Wonders and Wows](#) nomination and award, highlighting its contribution to community engagement. We also hosted an undergraduate student from Liverpool for a four-week internship during the summer where they prepared samples and participated in experiments on the beamline.

To complement the XMaS Scientist Experience, XMaS hosted its second online [Women in Physics Evening](#), and participated in the [IoP Materials Characteriation](#) group's online meeting which both featured female scientists at different career stages. The session offered an open forum for students to explore scientific career pathways, focusing on lived experiences rather than technical detail. Similar, in person, sessions were also run at the [CUWiP Conference](#). Together, these activities supported meaningful discussions about careers in science and helped encourage young women to pursue STEM pathways.

Hi, Sophie! We got home a while ago, and I just wanted to thank you for all the effort that you and Ally and Saffron put into arranging the XMaS trip for us, it really was the thing which I've been looking forward to for the last few months, and I somehow had even more fun than I expected! I'm really, really grateful that you all put so much time and effort into arranging this for us, getting to see a synchrotron was something I thought I'd never get to do, and now I'm more confident than ever that I'll be pursuing physics! The entire trip idea was so perfect and I'm so, so happy to have gotten the chance to find similarly passionate people, this is going to be something that DEFINITELY stays with me for the rest of my life - I promise I'm not exaggerating!

Thank you again!

Thank you for the amazing experience. absolutely loved it. She can not stop talking 21:47

Thank you Ally, Sophie and the Xmas team for the fantastic trip to Grenoble. You have made such a difference by providing this opportunity. The experience was incredibly positive, motivating and confidence building for attracting the next generation of scientists! had a fantastic time and when I asked would you recommend this trip.. she said 'are you kidding... - and was buzzing. Thank you!! 21:59

home now. I can't thank you all enough. Love to everyone 23:55

XMaS User Meeting: XMaS hosted its annual user meeting at the University of Warwick, bringing together more than 60 registered users from across the community (Figure 6). Research presentations and user “pop-up” talks showcased the breadth of science undertaken at the facility and created a forum for discussion and potential collaborations. A key element of the meeting was providing space for users to identify areas where they feel XMaS can continue to improve, and this inputs directly into decisions regarding facility development.



Figure 6: Attendees at the UoW User Meeting.

Collaborations: XMaS maintains strong and active links with a range of national and international facilities. A long-standing partnership continues with Sectors 4 and 6 at the Advanced Photon Source (APS) in the United States, whose beamline scientists regularly undertake experiments at XMaS and contribute as Co-Investigators on joint grant applications. Our relationship with Diamond Light Source is also well established and continues to deepen; XMaS participates in the Energy Materials and Catalysis BAG, providing coordinated access and shared scientific direction. XMaS is recognised as a key route for user-community mitigation during the forthcoming Diamond dark period.

Societal & economic impacts: XMaS users actively disseminate their research and facility-enabled achievements through professional social media platforms such as LinkedIn, reaching a broad and diverse community well beyond traditional academic channels. These posts are frequently reshared—often by users of other facilities and beamlines—amplifying visibility and fostering cross-facility engagement. Several users also produce vlogs and other digital content that communicate their findings in accessible formats, further broadening the societal reach of the science undertaken at XMaS.



Website: The facility website (www.xmas.ac.uk) is hosted at the University of Warwick and operates under its own dedicated URL within the .ac.uk domain. Over the past year, and excluding internal data, the site received 99,816 hits from distinct IP addresses, with traffic remaining steady at an average of 273 accesses per day. The website is actively maintained and regularly updated, with increasing depth of content including case studies. We continue to expand links to both in-house and externally developed resources to support data visualisation, data reduction, and data analysis.

User satisfaction

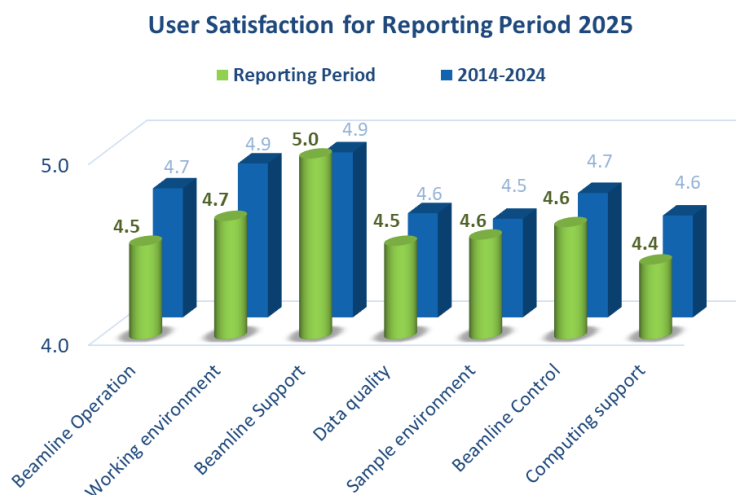


Figure 7: User survey results for the reporting period (foreground) with historical averages in the background.

User satisfaction continues to be assessed through end-of-run surveys completed by the Principal Investigator on behalf of each experimental team. Surveys score operational factors on a 1–5 scale and include free-text fields for qualitative feedback. Any low scores or flagged comments trigger direct follow-up by beamline staff to ensure concerns are addressed and improvements implemented. The 2025 survey return rate was 95%, providing a robust evidence base. Overall satisfaction remains high and broadly consistent with historical averages, and no formal complaints were received. Notably, beamline support scored 5.0, exceeding the historical average of 4.9 and reflecting continued excellence in user engagement. The ESRF quinquennial review panel also highlighted “stellar levels of user satisfaction” in its external assessment. Users provided a mix of positive reflections and constructive suggestions, summarised in anonymised form below.

Positive feedback

“Beamline scientist support was outstanding and central to our experimental success.”

“Staff were generous with their time and patient with less experienced users.”

“The atmosphere at XMaS is uniquely collaborative and supportive.”

“The Ge detector worked beautifully — a pleasure to finally complete this experiment.”

“Very good user experience — a high-quality facility with extremely competent and helpful staff.”

Areas for improvement

“Beam drift affected data quality — better monitoring tools would help.”

“Stage stability was inconsistent; batch routines for merging 2D data would be useful.”

“Compatibility with SAXS analysis tools like SASView would improve real-time assessment.”

These comments align with the slightly lower scores in beamline operation (4.5) and computing support (4.4) relative to historical averages. In response, we have implemented new routines for data reduction and are developing Jupyter notebooks to support user-led data processing. The ongoing transition to the ESRF’s BLISS control system—offering improved beam monitoring, standardised data formats, and greater operational flexibility—will further strengthen operational performance once fully embedded. Recent capital investment also continues to enhance operational resilience. User satisfaction is monitored continuously through surveys, direct communication, and a formal complaints process. All complaints are logged, acknowledged within service-level timeframes, and reviewed to ensure appropriate action. Although no complaints were received in 2025, the framework remains active and responsive. Overall, user satisfaction remains strong, with clear evidence of good practice in technical support, scientific engagement, and responsiveness to feedback. Survey results and user comments continue to inform facility planning and drive ongoing operational improvements.

Section 4: Effective management

Cost recovery

UK access to synchrotron radiation is delivered through the ESRF and Diamond Light Source under the long-established “free at point of use for the best science” model. The STFC commissioned Elsy Review of National Large Facilities at Harwell (2017) independently stress-tested this model and concluded that it is robust, internationally aligned, and essential for maintaining the highest-quality science. The review found no evidence that charging for academic access or expanding proprietary use would improve cost recovery without undermining scientific excellence. XMaS operates under the same model, and there is therefore limited scope for direct cost recovery, making operational efficiency and scientific leverage the primary determinants of value for money. The upgraded facility has been designed with efficiency and throughput as core drivers, ensuring that all ESRF machine modes available to the beamline are used for user access to maximise scientific return. Industrial access to the ESRF is managed directly by the ESRF and cannot be routed through XMaS. In 2025, the cost per shift delivered on XMaS was £2,824, substantially below the most recently published costs for public beamtime at major synchrotrons: ~€5,500 at the ESRF and ~£5,000 at Diamond Light Source. This demonstrates the facility’s strong value-for-money performance.

The 2023 UKRI/STFC Impact Evaluation of the ESRF further emphasised the strategic importance of maintaining efficient UK access to the facility, noting the high scientific return and unique capabilities that cannot be replicated nationally. As a UK-operated beamline embedded within the ESRF, XMaS delivers high-quality scientific output while giving UK researchers a direct pathway to interact with the facility and its staff, enhancing their research and providing clear visibility of the wider ESRF capabilities that underpin UKRI’s investment. XMaS offers distinctive opportunities to build international collaborations and its position within the ESRF ecosystem provides additional, unquantifiable benefit at no extra cost by strengthening the UK community’s presence and influence within a major European research centre.

Additional income has been secured through targeted European funding, which supports staff effort and instrument development rather than core operations. Programmes such as Horizon 2020 and EMPIR have enabled strategic enhancements—including the integration of a Raman system and the support of a dedicated PhD student—while also strengthening the facility’s research portfolio. These developments have already translated into external success, most recently through the EPSRC “Working with Centres: Advanced Materials” call, which awarded project UKR1648: *Advanced materials for next-generation spintronics: The deterministic control of altermagnets* (£312k).

Year	Running Costs	Grant Income	Other Academic	Students	Industry	% Recovered
2021	£1,141,944	£0	£0	£0	£0	0%
2022	£1,141,944	OpMetBat: £103,417	£0	£0	£0	5%
2023	£1,141,944	£0	£0	£0	£0	0%
2024	£1,411,511	£0	£0	£0	£0	0%
2025	£1,411,511	HyMetBat	£0	€76,000	£0	5%

Table 4: Additional income through other funding sources.

Risks

An active, live risk register is maintained for the facility and formally reviewed every two months. It consolidates risks into four categories:

1. **Operational Risks**, including those specific to UK users accessing an international facility.
2. **Financial Risks**.
3. **Data Risks**.
4. **Project Risks**.

The risk register is reviewed at every Project Management Committee (PMC) meeting, with additional updates made routinely as part of day-to-day operational management. The register also guides the identification of operational vulnerabilities and was used to highlight where targeted investment would deliver the greatest benefit. Ongoing PMC scrutiny has been central to refining the register, ensuring it remains responsive to emerging challenges and aligned with the facility's operational priorities. Continuous monitoring of the evolving risk landscape has supported the agreement of project deadlines, informed resource allocation, and highlighted areas requiring timely intervention. The PMC uses the register to stress-test current operations, prioritise project delivery, and ensure that short-, medium-, and long-term risks are mitigated within a sustainable staff-workload model. The latest version of the register is provided in Appendix E.

Summary of Risk Register: Overall, the risk profile remained broadly stable during 2025, reflecting a steady operational environment. No major changes were required, although several risks were refined and one significant new financial risk was added late in the year. A summary of the main categories is provided below.

Operational Risks: The most significant operational risks remain those outside the direct control of the facility (e.g., ESRF/EPN campus shutdown) or those that are inherently difficult to mitigate, such as major infrastructure failure or unexpected staff loss. These risks remained largely unchanged during the period. Mitigation efforts focused on managing obsolescence and ensuring sufficient staff resource to maintain continuity of service. A review of operational risk assessments was completed, and documentation is being updated to ensure compliance with both French and UK requirements.

Financial Risks: The facility continues to be exposed to currency fluctuations due to major commitments denominated in euros. Throughout 2025, inflationary pressures and the £:€ exchange rate remained broadly stable and within budgeted expectations. A modest upward shift in financial risk is associated with the current geopolitical environment, including the potential introduction of tariffs on imports from the USA, which could affect supply-chain costs. A more substantial new risk emerged late in the year following announcements regarding changes to the renewal of funding for physical sciences supported by the NRF. The resulting uncertainty has increased financial and operational exposure, particularly in relation to medium-term planning and staff retention, where clarity on future funding is essential for maintaining stability.

Data Risks: Secure access to and retention of user data remains a priority. XMaS follows the ESRF data policy and additional user training has been implemented to address the risks associated with single sign-on from public computers. ESRF-wide upgrades—including mandatory dual sign-on and restrictions on cross-beamline data access—have reduced some elements of data risk, although this remains a sector-wide challenge. Daily data and system backups continue. The transition to the BLISS control system has begun to address obsolescence and limitations in the previous control environment. A residual risk remains around user behaviour when accessing data from shared terminals.

Project Risks: The facility continues to manage a diverse portfolio of projects, ranging from new sample environments to beam-definition improvements and obsolescence mitigation. Overall project-related risks remained stable, but increasing pressure on staff resource must be managed carefully to ensure timely delivery of new projects associated with recent EPSRC Capital Calls. Following a detailed review of project-related risks, a strengthened project management protocol has been implemented, including tighter controls on design and specification, formal post-project reviews, and the introduction of stop-review points. A persistent risk remains around over-reliance on a small number of technical designers in the Grenoble area, which could constrain delivery if workloads increase further.

KPIs and SLAs

The current descriptors for the XMaS KPIs, along with the agreed thresholds, are presented in Table 5:

Description of KPI	Red	Amber	Green
A) The number of university research groups that have made use of the XMaS beamline in 12 months. [All beamtime]	<30	30-50	>50
B) The number of new users that have made use of the beamline expressed as a percentage of the Total Number of Users within 6 months.	<25%	25%-35%	>35%
C) The uptime of the beamline within 6 months as a percentage of the Total Available Time within that period.	<90%	90%-95%	>95%
D) The number of user complaints received within 12 months.	>2	1	0
E) The number of research outputs expressed as a Total Number for a calendar year.	<10	10-15	>15
F) The total number of publicity and/or outreach activities that the facility performs in 12 months.	<2	2	>2

Table 5: The revised XMaS KPIs and their associated RAG levels.

The KPI metrics for the reporting period (2025) are presented in Table 6 and colour coded to the thresholds defined in Table 5.

KPI	2025
A) The number of university research groups that have made use of the XMaS beamline.	77
B) The number of new users that have made use of the beamline expressed as a percentage of the Total Number of Users within 6 months.	37%
C) The uptime of the beamline within 6 months as a percentage of the Total Available Time.	93%
D) The number of user complaints received within 12 months.	0
E) The number of research outputs expressed as a Total Number for a calendar year.	21
F) The total number of publicity and/or outreach activities that the facility performs.	4

Table 6: Performance report against KPIs for the reporting period 2025.

Only the uptime KPI falls within the amber range for this reporting period. Overall uptime was 93%, with performance affected by a combination of ESRF storage-ring failures (2.5%, consistent with previous years) and a higher-than-usual incidence of beamline-specific downtime in the first half of 2025. Two experiments were particularly impacted: one experienced elevated background noise due to a cracked flight tube venting helium (72 hours), and another was affected by a shift in the electron orbit that altered the beam polarisation after the beamline had been aligned (90 hours). It remains unclear in the latter case whether the electron position in the main ring had moved, or there was an error in the alignment. In response, more rigorous checks and alignment protocols were developed and are now implemented as standard.

In the second half of the year, intermittent crashes of the monochromator secondary encoder and/or motor caused X-ray energy scans to fail, particularly during continuous fast acquisition modes. A service visit by McLennan enabled immediate remedial repairs, and a replacement motor and encoder assembly have been ordered to mitigate future failures. Some remaining communication issues are being addressed through migration to the latest ESRF standard control system, BLISS.

To support KPI A, we also assessed the average number of research groups per experiment, which was 2.1, compared with the recent historical average of 1.6, indicating broader collaborative use of the beamline. Graphical representations of the KPIs, mapped to historical statistics, are provided in Appendix E.

Service Level Agreements (SLAs)

- Requests for beamtime will have decisions made within 20 working days of the PRP meeting subject to knowledge of the ESRF review process. In 'exceptional' cases users will be informed if these benchmark times are going to be exceeded and an explanation provided.
- Facility users will be fully supported by a dedicated facility staff member during experimental time.
- The facility will respond to all user enquiries clearly and quickly in line within 5 working days for emails and 2 working days for telephone enquiries.
- The facility will respond to user complaints within 10 working days.
- The facility will treat all proposals equally, fairly and in confidence.
- The facility will treat all users equally and fairly.
- The facility will uphold high standards of integrity in all operations and in contact with users.

For the 2025 reporting period, all service levels were met comfortably.

Improvements and future plans

BAG Access: During 2025, several independent beamtime sessions were used for the newly established BAG (Block Allocation Group) access mode. The BAG focuses on high throughput of samples within energy materials and catalysis, and is co-hosted with B18 at Diamond, allowing samples to be allocated to the most scientifically appropriate beamline. This approach is supported using an identical sample holder at both beamlines, which removes barriers to sample transfer and ensures a smooth and seamless user experience. During this reporting period, applications were received from seven universities (Figure 8). Notably, 50% of applicants were ECRs, and two users accessed the facility via the BAG route for the first time. A total of 104 XAS datasets were collected, spanning ~20 X-ray absorption edges. These measurements utilised the full energy range of the beamline, from Pd L_3 -edge at 3.173 keV through to Ce K-edge at 40.4 keV. Data collection exploited our high-speed acquisition protocols, significantly improving throughput for dilute samples. In parallel, new metrologies were developed to address challenges associated with sample inhomogeneity relative to beam size, improving data robustness and enabling reliable analysis of complex or heterogeneous materials. We are also advancing automated data-reduction and analysis pathways, designed to process spectra in near-real time. These on-the-fly workflows, to be delivered through 2026, reduce user overhead, accelerate the pace of scientific output and impact, and will strengthen integration with the BAG's research themes. Expanding the BAG will be tensioned against user demand through conventional routes and monitored by the PMC.



Figure 8: Geographical representation of BAG users during 2025.

Software: The new ESRF control system, BLISS, has now been deployed on the beamline. Over a three-week period, we conducted intensive testing with highly experienced and supportive users, allowing us to perform meaningful stress testing of the system. A gap analysis has highlighted several areas requiring further development, but the core functionality has been successfully demonstrated. We have established a prioritised implementation list and developed a work plan for 2026. A significant upcoming upgrade will be the deployment of the PSIC (4S + 2D) geometry for Surface XRD and truncation rod measurements. This will require additional collaboration with the HKL.py developer at SOLEIL. Integration of device servers for the full range of XMaS instrumentation is ongoing and currently represents one of the main limiting factors in completing the rollout. Full implementation of BLISS across the beamline is expected during 2026. In parallel, we have also begun consolidating our internal and public GitLab repositories. This includes the integration of example notebooks, ready-to-use data-reduction workflows, and a curated set of code snippets.

Technical Upgrades: Within the reporting period, XMaS has continued both the consolidation and commissioning of previous capital investments whilst continuing to strengthen our resilience and safety through the latest capital call. Intermittent faults in the monochromator hardware required the diversion of staff time and technical resources; nevertheless, a series of targeted upgrades were successfully delivered to enhance operational efficiency. These include improvements to sample-holder systems and a test/demonstrator for a potential new capability through the integration of a Razorbill strain cell from the APS. The success of this experiment (case study), coupled with increasing user demand has prompted us to purchase our own strain cell for integration into our suite of sample environments during 2026. Further detail on completed upgrades, along with planned developments for the coming year, is provided in Appendix B.

Additional information: The XMaS Newsletter

XMaS activities are widely disseminated in our annual newsletter which is written for a scientifically interested reader and distributed electronically to our mailing list as well as through printed hard copies at facilities and outreach events. The newsletter highlights the range and breadth of science undertaken as well as showcasing the facility's capabilities.

- **Beamline Updates:** Released *PyXscat* for rapid visualization and reduction of 2D scattering patterns via ESRF GitHub, streamlining data workflows for users. Commissioned new GI-WAXS sample environments for energy materials, enabling advanced thin-film studies under realistic conditions. Implemented fast monochromator scanning to improve throughput. Progressed FAIR data compliance with automated DOI assignment and h5 architecture development. Launched an Energy Materials BAG in collaboration with Kent and Diamond
- **Magnetic Profiles in GdCoFe Thin Films** *Appl. Phys. Lett.* **123**, 122403, (2023): Understanding depth-dependent magnetization in rare-earth alloys is vital for spintronic devices. XRMR revealed non-uniform Gd distribution and magnetic gradients across the film thickness, influencing anisotropy and switching behaviour. XMaS provided polarization control and in-field capability, enabling element-specific magnetic profiling that conventional laboratory tools cannot achieve.
- **Vacuum-Deposited Organic Solar Cells** *APL Mater.* **11**, 061128, (2023): Non-fullerene acceptors promise higher efficiency in organic photovoltaics, but their packing in vacuum-deposited films remained unclear. GI-WAXS at XMaS resolved molecular orientation and crystallinity of BTIC-H, linking structure to charge transport. These insights guide design strategies for scalable, high-performance OSCs.
- **Organic Thin Films for Optoelectronics** *Langmuir* **39**, 12099–12109, (2023): Film morphology dictates optoelectronic performance and stability. Using GI-WAXS and specular diffraction, XMaS revealed how processing routes affect crystallinity and texture in diketopyrrolopyrrole derivatives. This structural knowledge informs fabrication methods for next-generation organic devices.
- **Nanotribology Under Nano-Confinement** *J. Colloid Interface Sci.* **653**, 1432, (2024): Friction at the nanoscale impacts coatings and lubrication technologies. X-ray reflectometry at XMaS linked polymer layering under confinement to tribological performance, providing a molecular-level basis for designing advanced lubricants with tailored properties.
- **Columnar Liquid Quasicrystal** *Nat. Chem.* **15**, 625–632, (2023): The discovery of a 2D columnar liquid quasicrystal expands the landscape of soft matter phases. Synchrotron diffraction at XMaS confirmed quasiperiodic order in self-assembled T-shaped molecules, offering new insights into molecular packing and symmetry-breaking phenomena.
- **High-Level Waste Vitrification** *J. Non-Cryst. Solids* **608**, 122240, (2023): Safe immobilization of nuclear waste depends on controlling redox chemistry during vitrification. XANES/EXAFS at XMaS tracked oxidation states in complex feeds, guiding process adjustments to minimize foaming and improve glass stability.
- **Pd Interstitial Phases During Catalysis** *ChemCatChem* **15**, e202300870, (2023): Catalytic activity often hinges on transient phases. In situ XANES at XMaS monitored PdCx and PdNx formation and stability under reaction conditions, clarifying mechanisms that influence selectivity and durability in Pd-based catalysts.
- **Colloidal Atomic Layer Deposition** *JACS* **146**, 10708–10715, (2024): Precise control of nanocrystal interfaces enables advanced optoelectronic and catalytic applications. XMaS provided synchrotron characterization to verify shell growth and structural evolution during colloidal ALD, validating a scalable route for tailored nanomaterials.
- **Solution-Processed BaTiO₃ Thin Films** *Adv. Funct. Mater.* **34**, 2403024, (2024): Integrating ferroelectrics into photonic platforms requires phase-pure, highly textured films. GI-WAXS at XMaS confirmed tetragonal phase and strong orientation in BaTiO₃, underpinning exceptional electro-optic performance for modulators exceeding 40 GHz bandwidth.

The 2025 Newsletter is currently being finalised with an anticipated release date of March 2026.

Appendices and Supporting Information

Appendix A: Purpose and vision of XMaS

A photograph of the current XMaS experimental hutch is shown in Figure A1. No significant changes in the beam delivery system were implemented during 2025. The beam enters from the right and passes through monitors and shaping optics before interacting with the sample mounted on the diffractometer which is to the left of the picture.



Figure A1: Panoramic photograph showing the experimental hutch of the XMaS facility. The beam enters from the right and proceeds via a series of in-line beam conditioning optics to the diffractometer (left).

The main source characteristics at the facility are summarised in Table A1:

Characteristic	Specification
Source	ESRF 0.86 T Short Bend dipole magnet
Bending Magnet Fan acceptance	2 mrad (H) × 0.2 mrad (V)
Double-crystal monochromator	Si (111) flat crystal pair, cryogenically cooled
Energy Resolution	1.5×10^{-4} at 10 keV
<i>Energy ranges</i>	
Focused monochromatic	2.1 – 47 keV
Unfocused monochromatic	2.1 – 47 keV
Focusing mirrors	Pair of interchangeable 1.4 m-long Pt- or Cr-coated Si mirrors with controllable toroidal shape
Source Focusing	1:1
Harmonic Rejection Mirrors	0.3 m flat Si mirrors with three stripes: Pt, Cr, and Si
<i>Usable flux at the sample:</i>	
Focused monochromatic	10^{13} photons per second per (0.1% bandwidth) at 10 keV
Unfocused monochromatic	$\sim 10^{12}$ per second
<i>Typical beam sizes (FWHM) at the sample position:</i>	
Focused monochromatic	80 μm (H) × 80 μm (V)
Unfocused monochromatic	10 mm (H) × 2 mm (V) (maximum)
KB focused	$\sim 5 \mu\text{m}$ (H) × 7 μm (V) (smallest)

Table A1: The main source characteristics of the XMaS facility.

The vision of the facility is articulated through a set of high-level objectives, reviewed annually by the external Project Management Committee. These objectives guide our operations and strategic development and are currently defined as:

- **Advance internationally leading science** through X-ray metrologies spanning diverse temporal and spatial scales.
- **Develop and deploy cutting-edge instrumentation** to maintain the UK's leadership in materials science.
- **Attract world-class researchers** to the facility and the UK.
- **Engage proactively with the UK materials community**, fostering collaboration and knowledge exchange.
- **Train the next generation of scientists**, with a focus on early career researchers and students in advanced X-ray methodologies.
- **Operate the facility with excellence** - safely, efficiently, sustainably, and resiliently - within a framework that prioritises equality, diversity, and inclusion (EDI).

Appendix B: Quality and breadth of research enabled

Details of new methodologies that have been developed over the past year

Strain Cell

XMaS has a long-standing track record of enabling measurements under applied strain. Building on this expertise, and in collaboration with colleagues at the APS (see case study), we designed and delivered a bespoke configuration in which a [RazorBill FC1X0 strain cell](#) was mounted onto one of our cryostats (Figure B1). A capacitance meter from the ESRF pool supported the initial measurements. The new sample environment allows offline, and X-ray based measurements as a function of temperature and applied strain. This demonstrator experiment generated considerable interest within our user community, with researchers from Warwick, UCL and Durham enquiring about wider access to the capability. In response, we have now procured our own RazorBill cell and capacitance meter and are integrating both into the XMaS control system. The EPSRC grant *UKR1648: Advanced materials for next generation spintronics: The deterministic control of altermagnets* provides a dedicated PDRA who will support knowledge development and help democratise this capability for a growing user base. Knowledge transfer is already benefiting from APS input and will be extended to Diamond Light Source over the coming years. Additional funded offline access will allow users to train, test samples and refine protocols ahead of beamtime. Whilst the demonstrator experiment was successful, the wiring arrangement (Figure B1) is sub-optimal, restricting base temperature and complicating sample access. We have investigated options for a dedicated cryostat to support the strain programme; however, the approximate £35k cost is currently beyond available budget.

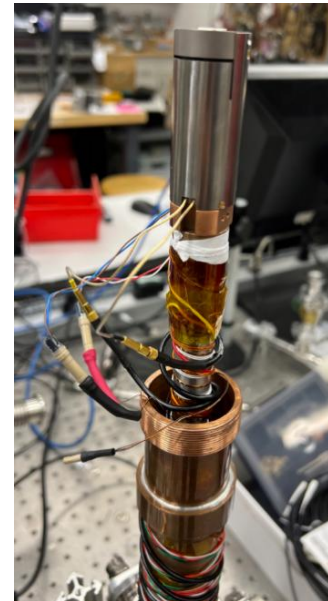


Figure B1: A RazorBill FC1X0 strain cell mounted on the end of an XMaS cryostat.

Beam Conditioning

A new, upgraded assembly has been designed and installed at the end of the incident beam path (Figure B2). The significantly reinforced structure allows beam-conditioning components to be mounted and exchanged rapidly, improving operational flexibility. High-precision slides provide accurate and reproducible positioning of these elements, an essential requirement given the small beam size at this location.

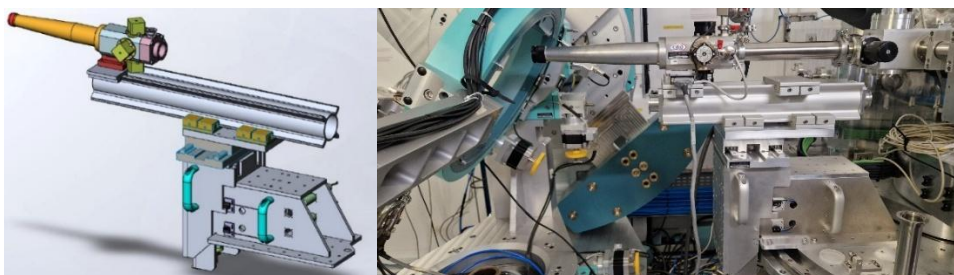


Figure B2: The updated TSX/TSZ assembly. In CAD design (left) and as manufactured and commissioned on the beamline (right).

Safety Upgrades

There remains a growing user demand for operando and *in situ* experiments, particularly those requiring gas-based sample environments which create complex, dynamic conditions and enable chemical reactions to be monitored in real time. This demand has driven the gas-delivery project, which will allow remote control and adjustment of gas mixtures (to be commissioned in 2026). To ensure full compliance with safety requirements, a critical upgrade

was implemented during this reporting period: an extraction system integrated directly into the air-handling infrastructure. The system removes any minor leaks and prevents the accumulation of hazardous gases in the experimental hutch. The new unit (Figure B3) is now permanently installed and can be positioned relative to any sample environment without compromising operational flexibility or capability.

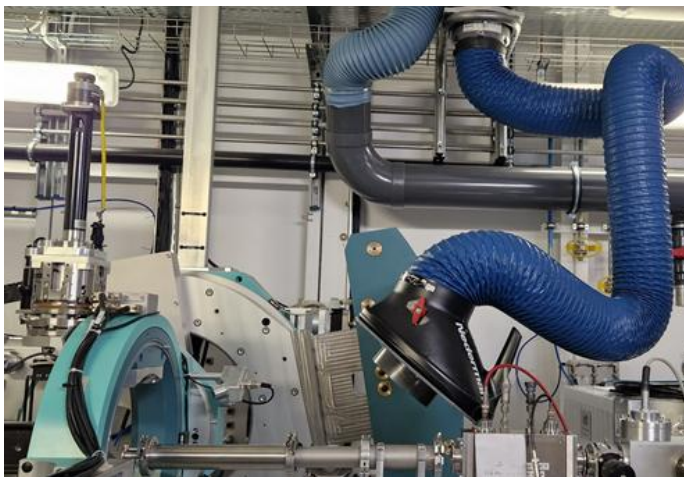


Figure B3: The new gas extraction system integrated into the air handling system positioned above the sample area.

Details of new methodologies that will be delivered in 2026

Along with delivering several new methodologies and capabilities to the facility in the reporting period, several other projects are ongoing with expected delivery through 2026.

1 T Electromagnet

XMaS was originally conceived as a magnetic-scattering beamline and was equipped with a comprehensive suite of magnets that could be mounted directly onto the diffractometer. Among these was a 1 T electromagnet with a wide bore that allowed cryostats to be accommodated with ease. Its flexible mounting arrangement made it suitable for a broad range of experiments using different techniques where the field could be applied perpendicular or parallel to the beam. Unfortunately, corrosion in the water-cooling system led to a catastrophic failure of the unit. Growing user demand has renewed the need for such a capability, which cannot be met through using the existing 4 T superconducting magnet. The original design requirements remain valid: a flexible mounting directly onto the diffractometer and a 1 T field generated by approximately 100 A through the coils. We have engaged Technicoil (USA), who are currently producing a model (Figure B4) to test the mechanical integration before final construction proceeds. Delivery of the new magnet is anticipated at the end of 2026.

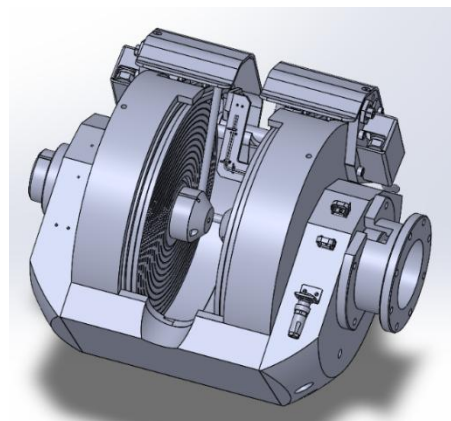


Figure B4: The proposed 1 T electromagnet with upgraded coils and enhanced cooling.

KB Mirrors

The KB mirrors, manufactured by IDT, were installed and commissioned in 2024. Further characterisation work in 2025 examined energy dependence and optimised the bending conditions for each deflecting mirror on both the Rh and Pt stripes. Reproducibility tests confirmed that beam sizes of approximately $6 \mu\text{m} \times 6 \mu\text{m}$ (H \times V) with a flux of around 10^9 photons per second can be achieved reliably using the KB mirrors on the unfocussed beam. The depth of focus of several millimetres at the sample position is possible and the best focal spot obtained to date is $4.42 \mu\text{m} \times 3.8 \mu\text{m}$ (H \times V) at 10 keV and 6 mrad (Figure B5). As seen in the figure, streaks of scatter remain visible extending away from the central spot. These will be mitigated through the installation of additional slits acting as filters. These have been procured from JJ slits through the recent EPSRC capital call and are ready for installation on the beamline. We have intentionally staggered the final delivery of the KB system to ensure that full and stable control can be achieved within the BLISS control environment. This phased approach balances available staff resource but will primarily simplify user training, support a smooth transition to routine operation, and minimise disruption during final commissioning and user tests.

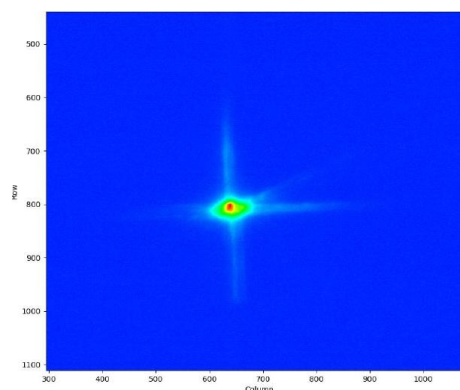


Figure B5: The micro-focused beam originating from the KB mirrors under optimal conditions.

Tender X-ray Furnace

As part of the EPSRC-funded grant awarded to Simon Kondrat at Loughborough University, “*Understanding and Optimising Alkali Species in Heterogeneous Catalysis for Sustainable Fuels Production using Operando X-ray Spectroscopy*,” a consortium comprising the Universities of Leeds and Cape Town, together with industrial partners Johnson Matthey and Drochaid Research Services Ltd., are partnered with XMaS and the B18 and B07 beamlines at Diamond to deliver a new shared capability. The project will integrate a 600 °C vacuum furnace with a controlled gaseous atmosphere onto these beamlines. The system has been designed to transfer seamlessly between facilities and to be fully integrated into each site’s control infrastructure. XMaS is leading the design activity and has identified a promising solution developed at the University of Warwick. Once completed, the furnace will be available to all users at the participating facilities and will mark the first coordinated effort to ensure compatible sample environments are deployed across multiple UK facilities with the explicit aim to ensure continuity during the Diamond dark period for the broad UK community. Commissioning is expected in 2026.

Gas Systems

Two projects are underway to support the delivery of gases to the experimental hutch. The first concerns gas supply to sample environments on the diffractometer, and the second focuses on supplying the ion chambers used to measure and normalise the beam flux.

The sample-delivery system is well advance. External gas storage and handling infrastructure is already in place, and the hutch patch panel has been designed. The key components, including the mass spectrometer, are either on order or already on site. Installation and testing are expected to be completed by spring 2026.

One of the advantages of a bending-magnet source is the ability to change energy rapidly. Because ion-chamber efficiency depends on the gas mixture with different energies requiring different gas compositions, and these adjustments must be made remotely. Our initial plan to adopt the Diamond system proved unworkable, as the supplier declined to quote and the design is incompatible with ESRF controls. We are therefore actively working with the ESRF vacuum group on a solution based on Bronkhorst pressure controllers using serial control via existing Device Servers. A new GUI will be developed, and the preliminary design (Figure B6) has already been reviewed by the ESRF Safety Group.

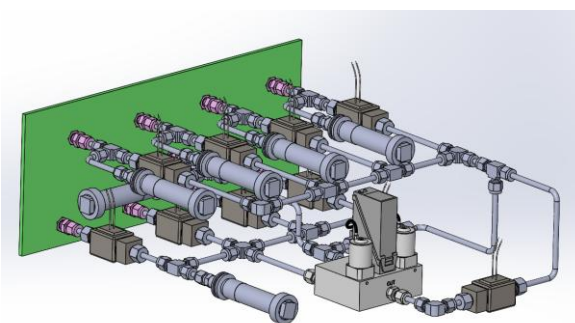


Figure B6: The preliminary design of the ion chamber gas handling system using regulators and Bronkhorst pressure controllers.

Beam Positioning Monitors

Unlike most modern beamlines, XMaS currently operates without any in-line beam-position monitors, limiting real-time tracking of beam stability and increasing the risk of avoidable downtime. No single BPM solution is ideal: in-line devices inevitably introduce energy-dependent aberrations, while intercepting systems must be inserted manually and temporarily block the beam, though they provide an essential absolute reference point.

To address this, we have developed a dual-approach strategy. First, a Basler camera coupled to a scintillator screen will provide rapid, on-demand verification of beam position by moving the screen into the beam path when required. Second, capital-call funding has enabled the purchase of a quadrant diamond BPM and associated electronics from Sydor. Integrating this device requires a redesign of the end-station chamber, which currently houses the fast shutter; this work is scheduled for completion by summer 2026. Both systems will then be incorporated into the BLISS control environment, providing a robust, flexible, and fully integrated beam-position monitoring capability.

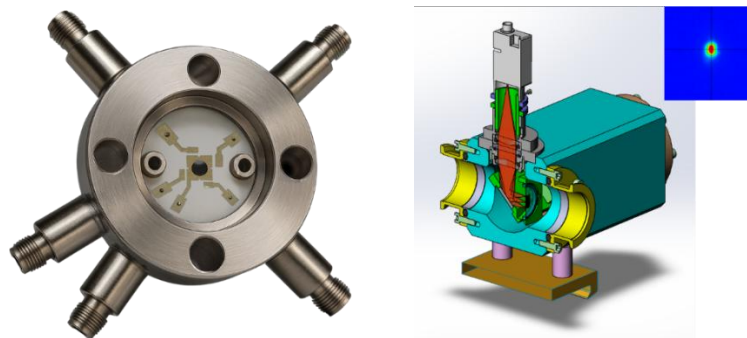


Figure B7: New XMaS beam position monitors. The Sydor system (left) and the Basler camera system (right).

Software Developments

BLISS

In 2025, XMaS began its transition to BLISS, the ESRF's de facto control system for all beamlines. Several user experiments have already been successfully conducted under BLISS across a range of techniques, including diffraction, SAXS, WAXS, and reflectivity. Key XMaS-specific controls currently implemented within SPEC including macros for phase-plate studies (such as the magloop and phase-plate flipper) as well as scanning within the PSIC geometry will be migrated to BLISS during 2026. In addition, and working closely with ESRF developers, new device servers will be deployed for the energy dispersive detectors and potentiostats. This programme will ensure that XMaS is fully aligned with ESRF control-system standards by the end of 2026.

Open Data and FAIR compliance

The data recorded under BLISS are fully compliant with the ESRF Open Data Policy and the FAIR principles. As XMaS transitions fully to BLISS, all beamline data will adopt this FAIR-aligned structure, including persistent identifiers, rich metadata capture, and standardised formats. To strengthen these data pathways, XMaS will align its data lifecycle, from acquisition to long-term reuse, with national frameworks such as the UKRI Physical Sciences Data Infrastructure (PSDI) and wider UK and European research ecosystems. We will also develop targeted training resources linked to PSDI and major European FAIR-data initiatives, enabling users to navigate the full data pathway and maximise the scientific value of FAIR-compliant XMaS data.

Appendix C: Bibliometric Analysis of XMaS Publications

Here is presented a deep-dive bibliometric analysis of the XMaS facility using data from Elsevier’s Scopus database⁵. The analysis draws on high-level, aggregated indicators from SciVal and excludes any raw, individual-level, or reconstructable data. As the focus is on the sciences, Scopus coverage is generally strong; nevertheless, citation-based indicators reflect disciplinary citation practices and visibility rather than intrinsic quality, and recent outputs may be affected by citation time-lags. All metrics are provided solely for analytical context. Metrics are calculated only for publications that we are aware of and that are indexed in Scopus.

All bibliometric data should be interpreted critically and with an understanding of its limitations. Basic descriptive indicators—such as counts of authors, institutions, and journals—are generally robust, whereas normalised metrics such as FWCI and FWVI, which are available only for publications indexed in Scopus, rely on modelling assumptions about disciplinary citation behaviour and therefore require more cautious interpretation. Similarly, the ASJC subject-area scheme is specific to Scopus, and other platforms (such as Web of Science) use different taxonomies and normalisation methods, meaning that contextual signals can vary depending on the system used. SciVal is employed here because it is the most widely used analytics platform in the UK research sector, including for REF-related analysis, providing a consistent and well-understood basis for comparison.

We conclude this Appendix with data specific to the current reporting period (2025) but begin with broader contextual overviews drawn from either the full operational period since 1996 or the most recent decade (2015–2024), depending on the metric.

XMaS Publication Overview

Journal Level Analysis:

The publication rate is roughly constant at ~20 outputs a year. Of these, some 54% are co-authored with facility staff. Exploring where outputs are published allows one to explore the impact and research areas of XMaS work. Journal level metrics include the source normalised impact factor, SNIP⁶. Analysis of outputs from the past ten years shows that 30% of XMaS outputs are in the top 10% of journals worldwide, with 65% in the first quartile and 98 within the first and second quartiles (Figure C1).

⁵ Data source: SciVal (Elsevier), based on data accessed [Jan 2026].

⁶ SNIP (Source Normalized Impact per Paper) is a Scopus journal-level metric that measures a journal’s citation impact while correcting for differences in citation practices across scientific fields. It does this by weighting citations according to the “citation potential” of the journal’s subject area, allowing journals in low-citation fields to be compared fairly with those in high-citation fields. SNIP therefore reflects a journal’s impact relative to its field, rather than relying on raw citation counts. *This is a derived metric and is based on several underlying assumptions.*

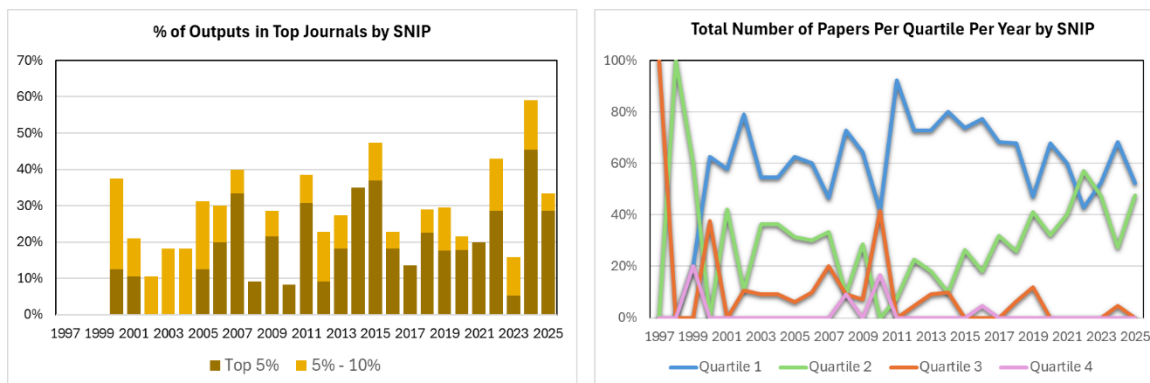


Figure C1: SNIP analysis of the XMaS publications by year showing the percentage outputs in the top 5% and 10% of journals worldwide (left). A broader breakdown by quartiles is shown (right).

Each publication can be linked to multiple all science journal classification, ASJC⁷. As a result, the subject-area totals reflect “counted appearances” rather than unique outputs, and disciplines with substantial overlap such as Materials Science, Chemistry, Physics and Astronomy, and Chemical Engineering naturally accumulate higher cross-counts. In the analysis of the 201 outputs from 2015–2024 the research outputs are dominated by Materials Science, Physics and Astronomy, and Chemistry, with smaller but still meaningful contributions from Engineering, Biochemistry and related life-science fields, and a long tail of occasional outputs across areas such as Environmental Science, Earth and Planetary Sciences, and multidisciplinary journals. The pie-chart in Figure C2 therefore illustrates the relative disciplinary footprint of the portfolio rather than a mutually exclusive classification of publications.

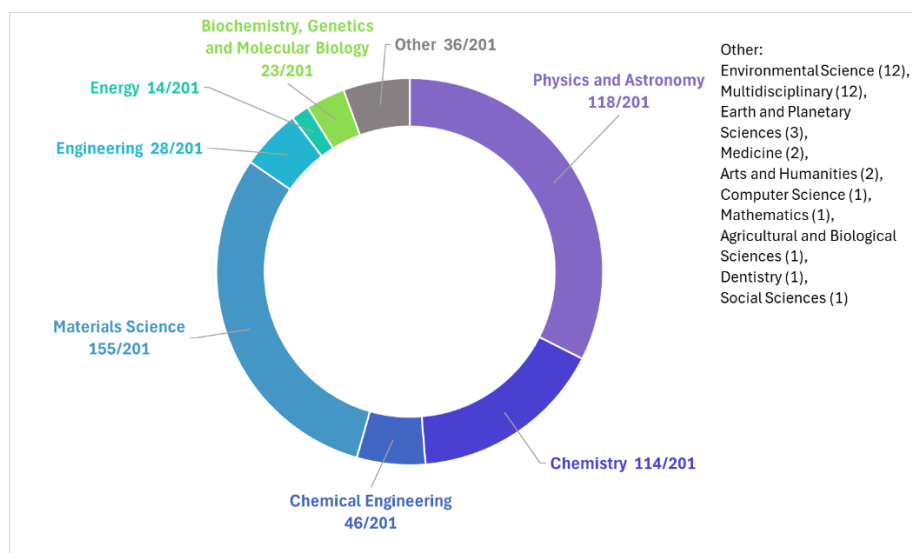


Figure C2: ASJC analysis of the research area in which outputs are published over the past decade.

⁷ ASJC (All Science Journal Classification) is the subject-area system used in Scopus and SciVal to categorise journals into a consistent, hierarchical set of scientific fields. ASJC Analysis is based on the content of the journals not the publication. It provides a snapshot of where the work is being published, but not the actual content of the articles themselves. Here we use SciVal's allocation of ASJC to "topic" themes to classify the journals in which the output appears.

Publication Overview – Individual Output Level Analysis:

Bibliometric analysis can also derive metrics based on individual publications. We begin by considering the robust metrics from each publication. For the outputs from the last decade we extract for each author, the institute and country of that organisation. The occurrence of each is shown in Figure C3 which highlights the impact and breadth of XMaS publications.

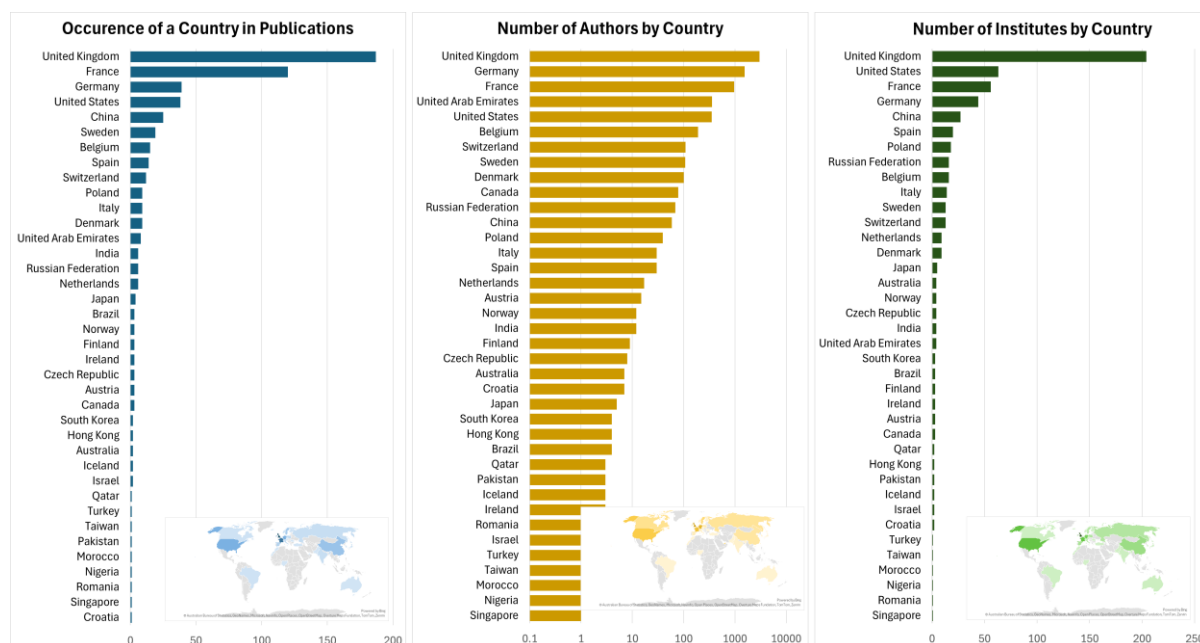


Figure C3: Country based analysis of outputs from the past decade.

Scopus assigns each institution to a broad organisational sector—academic, corporate, medical, or government. For this analysis, central facilities and research institutes are included within the government category. By linking authors to their institutional sectors, we can characterise the sectorial composition of the research ecosystem and examine how different sectors contribute to, and collaborate within, the publication record, Figure C4.

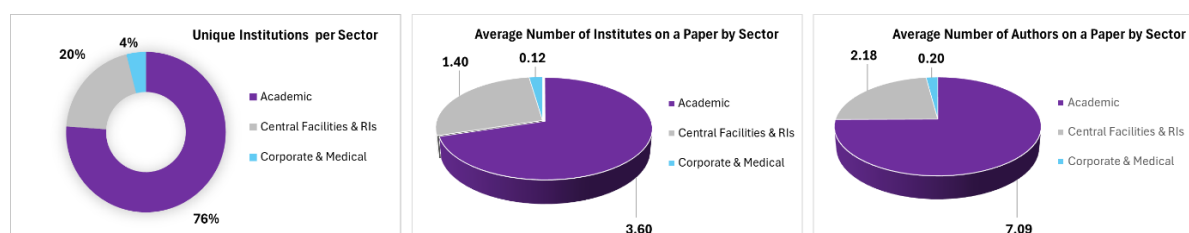


Figure C4: Sector analysis of the publications over the past decade. The sector associated with each unique institute (left), the average number of institutes per output (centre) and the average number of authors by sector per output.

Central facilities appear prominently in this mapping, largely because beamline scientists and research-infrastructure staff are correctly credited as co-authors. Their visibility is a positive indicator of healthy facility practice: it reflects the essential technical expertise required to deliver high-quality experiments and demonstrates that national infrastructure is actively enabling and supporting a broad user community. This pattern highlights the strategic value of central facilities as collaboration hubs and as critical enablers of UK research capability. Although corporate and medical organisations represent a smaller proportion of the overall

institutional landscape, their presence is significant. Industry-linked authorship signals that facility-enabled research is reaching beyond academia and contributing to innovation and industry. Even modest levels of corporate engagement can represent high-value interactions and strengthens the UK’s translational research pipeline. Taken together, this sectoral mapping provides a structural view of how different parts of the system engage with the research output—showing not only who participates, but how their participation reflects the role and impact of national research infrastructure across both academic and industrial domains.

The sectorial analysis allows us to examine the types of collaborations that underpin research carried out on XMaS. Figure C5 compares the proportion of outputs authored solely by academic partners with those involving both academic and industrial institutes. Collaborations that include an industrial partner account for around 10% of the total output, indicating a modest but meaningful level of engagement with industry. A similar comparison between academic authors and those from central facilities or research institutes shows that approximately 70% of outputs involve these partners—unsurprising given that many publications include contributions from beamline staff. Finally, considering the international reach of the facility, around 35% of outputs arise from collaborations within the UK, while 65% involve international partners. These international collaborations are roughly evenly split between those that include beamline staff and those that do not, reflecting both the facility’s global user base and its integration into international research networks.

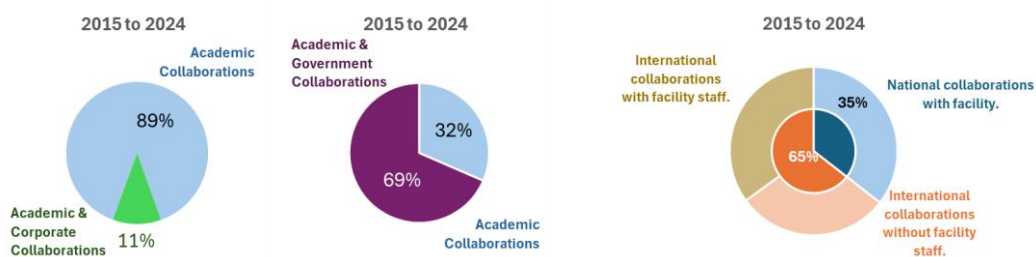


Figure C5: Collaboration analysis of the outputs from the past decade. Outputs with academic collaborations are compared with corporate and government institutes (left) as well as internationally (right).

It is also possible to categorise unique authors in a similar way as was done for unique users and explore how individual authors are represented within the publication data set. Figure C6 shows the ~1000 unique users from publications over the past decade and how many publications are associated with each.

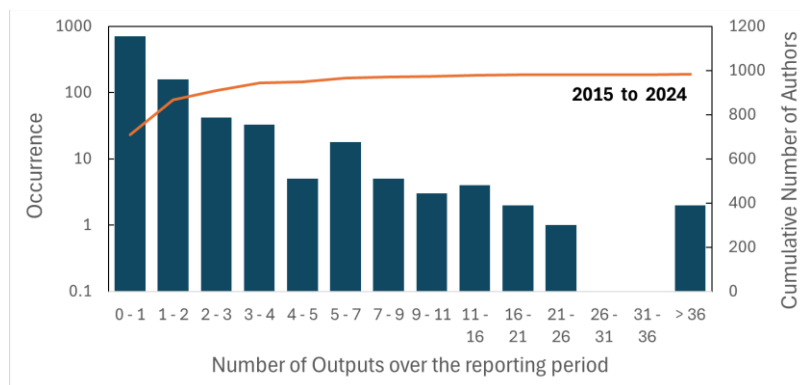


Figure C6: Unique authors and their publication frequency over the past decade.

A further breakdown of the unique-author dataset shows the split between UK-based and international contributors. We have also examined authors' output rates, categorising them as single-output authors, returning authors (½ output per year), expert authors (1 output per year), and super-enabling authors (more than one output per year). The data, shown in Figure C7, map closely onto the unique-user profile presented in Figure C2. A substantial majority of authors—around 70%—publish only once, a pattern largely associated with our large number of PhD and ERC users and reflects the broad reach of the research undertaken at the facility. The remaining authors, particularly those who return year-on-year, provide the sustained and enabling impact that underpins long-term scientific programmes. As expected, the proportion of returning and expert authors is higher among UK-based contributors, indicating a more stable domestic user community with deeper ongoing engagement.

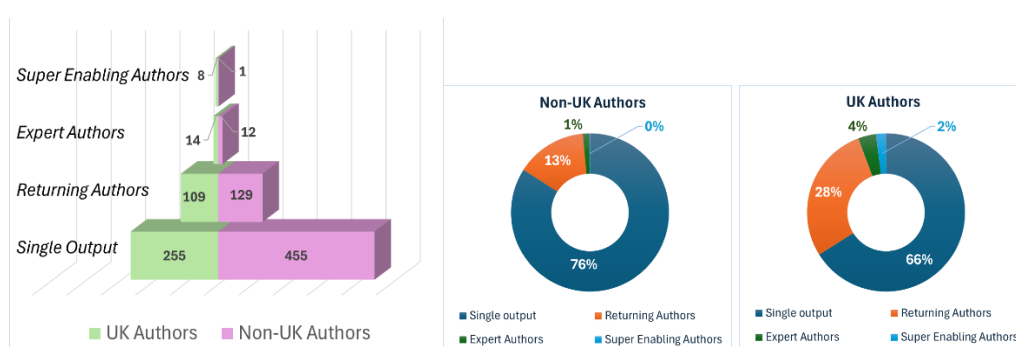


Figure C7: Breakdown of unique authors by number of publications. Absolute numbers (left) and percentages (right) separated by UK and non-UK authors.

SciVal also identifies instances where XMaS-acknowledged publications are cited within patents or policy documents, offering a view of how facility-enabled research occasionally informs technological development and wider societal decision-making. The time-series shows that these impacts arise intermittently rather than uniformly across years, with small but distinct peaks in both patent citations and policy mentions at several points in the facility's operational history. Such events typically correspond to specific research outputs gaining relevance for industrial innovation or contributing to governmental or organisational guidance. Although the absolute numbers are modest—consistent with expectations for a facility focused on fundamental science—the presence of both patent and policy citations demonstrates that XMaS research does, at times, translate beyond academia into applied and strategic domains.

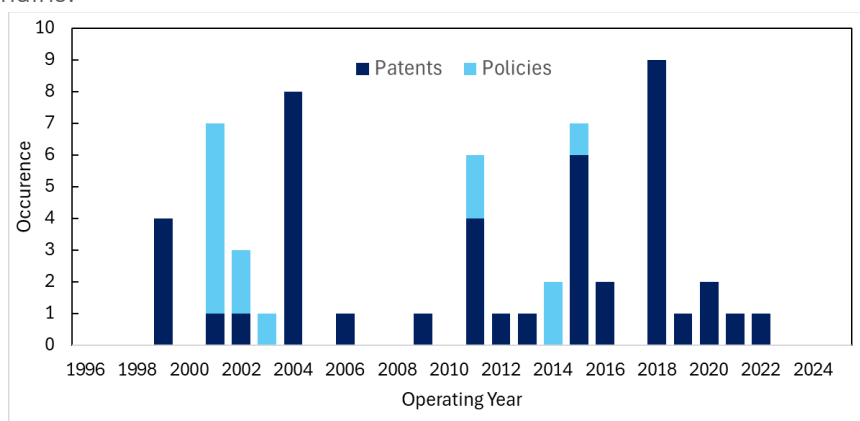


Figure C8: Occurrence of XMaS outputs in Patents and Policy documents.

The relative impact of outputs within the publication dataset can be explored using normalised citation and view metrics (FWCI and FWVI). Field-weighted view data are available only for outputs published from 2004 onwards. As an initial indicator, we calculate the proportion of outputs that fall within the top 1% or top 10% globally, based on field-weighted comparisons that benchmark each paper’s citations or views against the expected performance of similar publications (same field, type, and year) – Figure C9. The year-to-year variability reflects both the modest annual publication volumes and the fact that high-impact papers tend to arise from specific projects rather than uniformly across the portfolio.

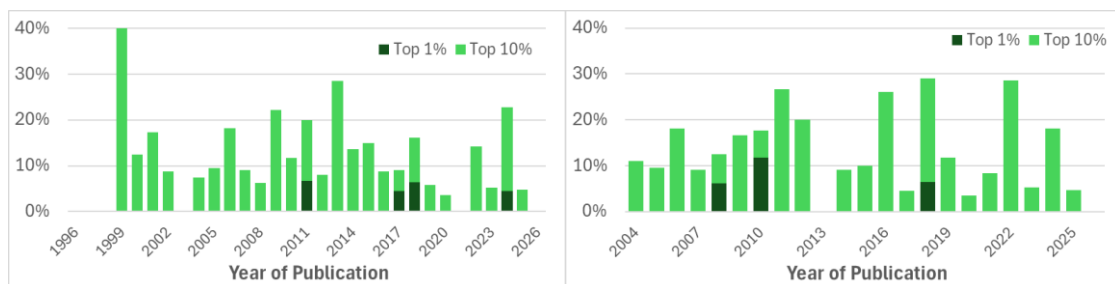


Figure C9: Proportion of outputs that fall within the top 1% or top 10% globally, based on field-weighted citations (left) or views (right).

Figure C10 provides a more granular breakdown of citation- and view-based impact across the full publication set. The year-by-year FWCI and FWVI plots show variability, which is typical for facilities with modest annual output, but both metrics consistently sit above the global baseline on average (FWCI ≈ 1.26 ; FWVI ≈ 1.25). The distribution plots reveal that most papers cluster around the world-average impact range (0.5–1.5), with progressively fewer outputs in the higher-impact bands. A meaningful tail of papers exceeds values of 2.5 and above, demonstrating that while high-impact outputs are not the norm, they arise regularly and contribute to the facility’s cumulative influence. The apparent dip in the most recent years should be interpreted cautiously, as newer publications have had limited time to accrue citations or views and therefore tend to under-represent their eventual impact. Together, these panels illustrate a balanced portfolio: a broad base of solid, field-typical publications punctuated by a steady stream of higher-impact outputs.

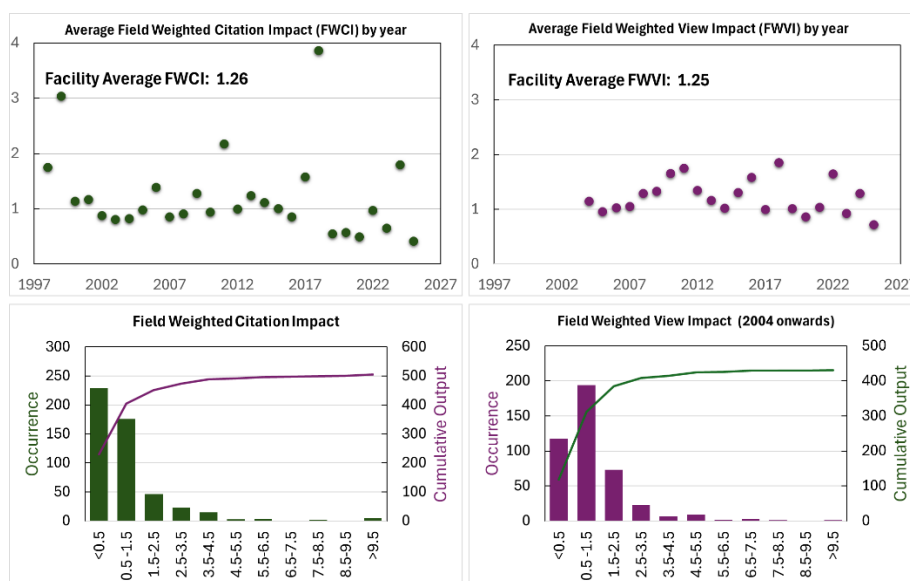


Figure C10: Field weighted citations (left) or views (right) by year (top) and overall distribution (bottom).

Within the SciVal data universe, each publication is automatically assigned, at varying levels of confidence, to a Topic and a broader Topic Cluster, which are derived from citation relationships and journal subject classifications. In the Topic Wheel visualisation, Figure C11, each bubble represents one of these Topics or Clusters, with its size indicating the volume of outputs associated with the topic within the reporting period. The position of each bubble is determined by the ASJC subject areas of the journals in which the underlying publications appear; this placement reflects the Topic as a whole. Topics located closer to a particular side of the wheel are more strongly influenced by the ASJCs in that region, while those nearer the centre tend to be more multidisciplinary.

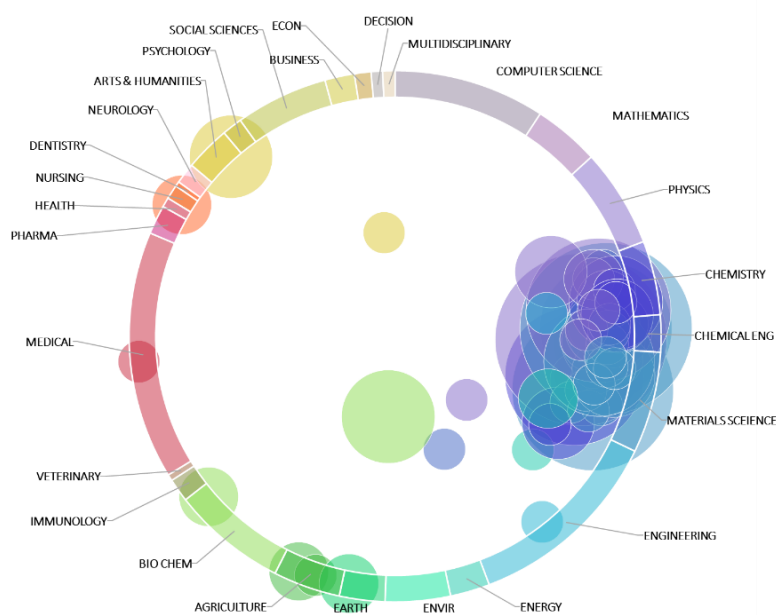


Figure C11: Topic Cluster analysis of the outputs from the last decade. The outer ring details the 27 major thematic areas within Scopus, with the arc size proportional to their weight in the global publication universe. XMaS data from the past decade is plotted as “bubbles” whose size is proportional to the number of outputs and whose location is defined by the ASJC value of the Topic Cluster.

The Topic Wheel shown in Figure C11 offers a visual snapshot of the disciplinary spread of the facility’s research activity over the previous decade. The bubbles cluster predominantly across the physical sciences reflects the facility’s core scientific remit. At the same time, the presence of bubbles extending into neighbouring areas such as environmental science, energy research, and selected life-science domains highlights the breadth of applications enabled by the beamline. The varying bubble sizes signal where activity has been most concentrated, whilst their distribution across the wheel illustrates how the facility’s outputs intersect with both established disciplinary areas and more interdisciplinary spaces. Overall, the pattern conveys a research portfolio that is anchored in the physical sciences but with clear pathways into adjacent and emerging fields.

The topic-prominence⁸ percentile provides a useful, though not definitive, indication of the momentum associated with each research area. It should not be interpreted as a direct measure of research quality, but rather as a signal of how widely a topic is being engaged with across the broader scientific landscape. With that context in mind, the distribution shown in Figure C12 suggests that work carried out on the beamline is, for the most part, aligned with topical and emerging fields. This pattern reflects both the scientific relevance of the facility and its responsiveness to contemporary research challenges. At the same time, the presence of outputs in lower-prominence percentiles shows that beamtime continues to support fundamental, exploratory, and niche investigations. Maintaining this balance is important: it demonstrates that the beamline contributes to high-impact, fast-moving areas while still enabling the foundational studies that often underpin future breakthroughs.

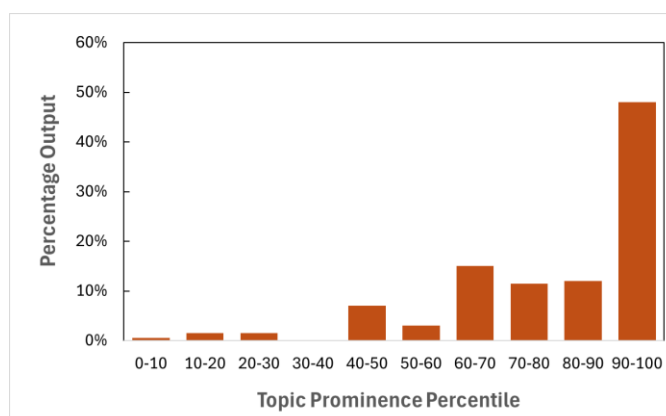


Figure C12: Histogram of the occurrence of XMaS publications over the past decade by topic prominence percentile.

For topic clusters with more than seven XMaS outputs, some limited statistical comparison becomes possible, although the small sample sizes mean that any conclusions should be treated cautiously. For each qualifying topic, we calculate the average FWCI and compare it with the corresponding global cluster average, as shown in Figure C13. Overall, the XMaS outputs are broadly consistent with global citation behaviour across their respective fields. The main deviation from this pattern appears in the area of perovskite and dye-sensitised solar cell innovations, where XMaS-associated work exhibits a noticeably higher citation impact than the cluster norm.

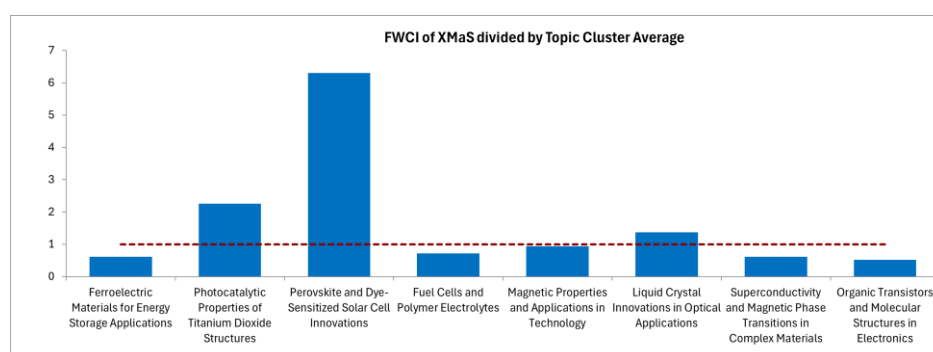


Figure C13: Average FWCI for the Topic clusters with at least 7 outputs within the past decade.

⁸ Topic Prominence is a metric that combines 3 metrics to indicate the momentum of the Topic and is not a quality indicator. Due to the nature of certain research fields, there are Topics which will never become "Prominent", however this is not mutually exclusive with the Topic not being important.

Bibliometric Analysis of 2025 Publications

We now focus on the bibliometric analysis of the 2025 publication portfolio. Field-weighted analyses are excluded at this stage, as the 2025 outputs have had limited time to accumulate citations or views and therefore tend to under-represent their eventual impact. At the time of writing, SciVal is also affected by a corruption of some author-level data, meaning that a subset of metrics cannot be reliably included in this analysis.

Across 2025, 21 research outputs were recorded. The number of contributing institutions and unique authors remained broadly consistent with previous reporting periods. One third (33%) of the publications appeared in journals ranked within the top 10% by SNIP, maintaining the stable quality profile observed in earlier years. Where possible, outputs were also assigned a UN Sustainable Development Goal. Of these, 32% aligned with SDG 7 (Affordable and Clean Energy) and 5% with SDG 15 (Life on Land).

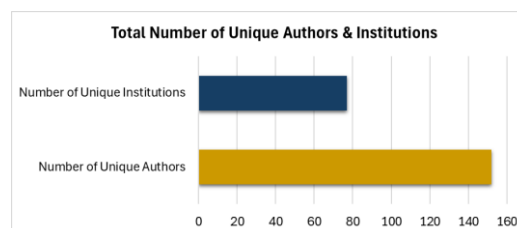


Figure C14: Number of unique institutions and authors from outputs in 2025.

Publications across 2025 demonstrate clear international reach and impact, with contributions from authors affiliated with a wide range of countries and institutions (Figure C15). However, due to the recent SciVal data loss, detailed author-level information cannot be included at this time.

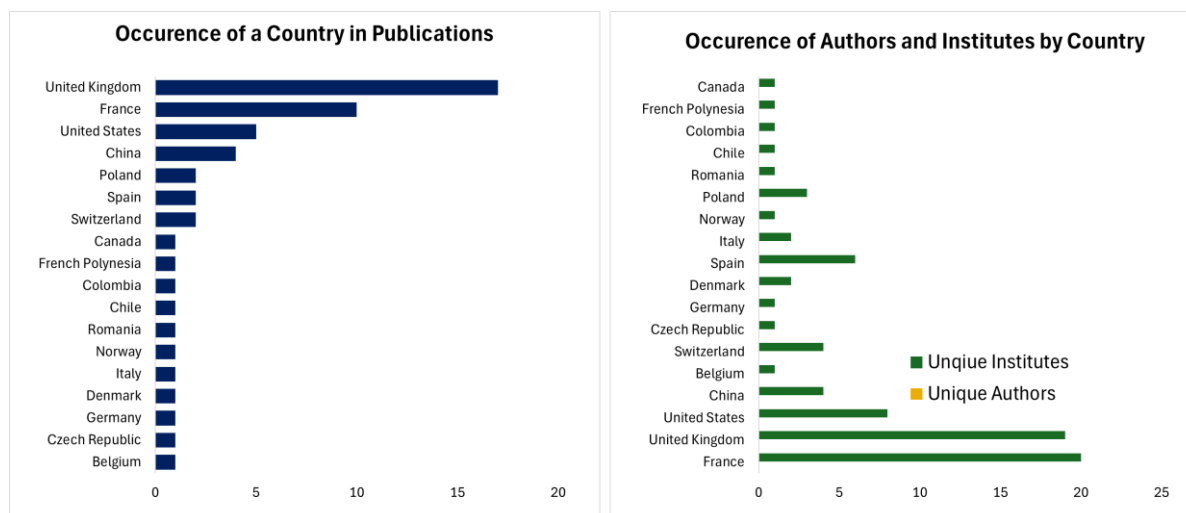


Figure C15: Country based analysis of outputs from the 2025 publication portfolio.

An institutional-sector view of the data (Figure C16) aligns closely with trends observed over the previous ten years. Academic institutions remain the primary source of authorship, while contributions from corporate and medical sectors continue at comparatively low levels. The sustained presence of central-facility authors, including ESRF staff and colleagues from associated research institutes, highlights the ongoing collaborative ecosystem that links the facilities with the wider academic community.

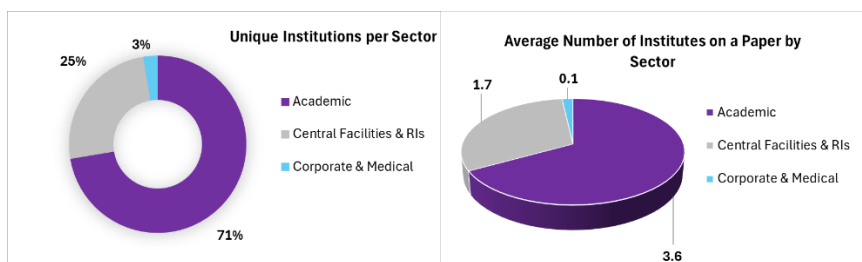


Figure C16: Sector analysis of the 2025 publications. The sector associated with each unique institute (left) and the average number of institutes per output (right).

Collaboration patterns in 2025 also align closely with established long-term trends, including stable levels of engagement with corporate partners (10%) and continued collaboration between academic authors and central-facility or research-institute colleagues (Figure C17). The only notable divergence from previous years is a drop in international collaborations, paired with a rise in national partnerships. With the overall output volume remaining modest, this fluctuation is best understood as routine annual variability rather than a meaningful change in collaborative practice.

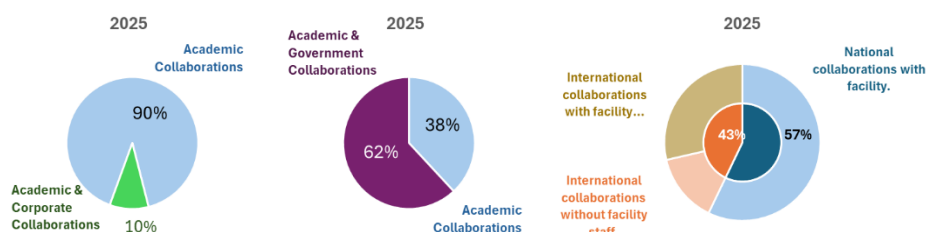


Figure C17: Collaboration analysis of the outputs from the past decade. Outputs with academic collaborations are compared with corporate and government institutes (left) as well as internationally (right).

While the 2025 portfolio size is relatively small, the ASJC distribution still provides a reliable indication of the facility's broad scientific reach (Figure C18). The spread across multiple ASJC categories highlights the inherently interdisciplinary nature of the research, with many outputs positioned at the interface of chemistry, materials science, biochemistry and engineering. An important caveat is that these categories reflect the disciplinary scope of the journals in which the work is published, rather than a direct classification of the underlying research itself. Even so, the diversity observed is consistent with the versatility of the beamline's capabilities and the wide range of scientific challenges it supports.

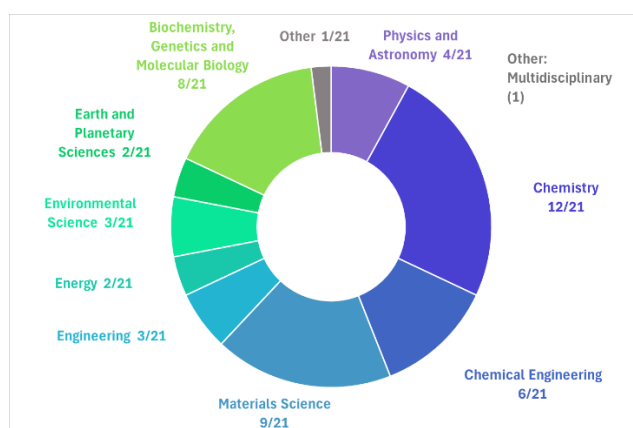


Figure C18: ASJC analysis of the research area in which outputs are published during 2025.

The breadth visible in the ASJC classifications seen in Figure C18 is echoed when examining how the 2025 outputs map onto topic clusters. The topic wheel, Figure C19, shows that the papers occupy a wide set of interconnected research areas, reflecting the diverse scientific communities publishing work from the beamline. When considered alongside the topic-prominence profile, a further pattern emerges: a substantial proportion of the outputs fall within highly prominent research topics, indicating that even within this modest portfolio, research activity is in areas of strong momentum and visibility. Together, these perspectives provide a complementary view of the wider research landscape in which users are publishing.

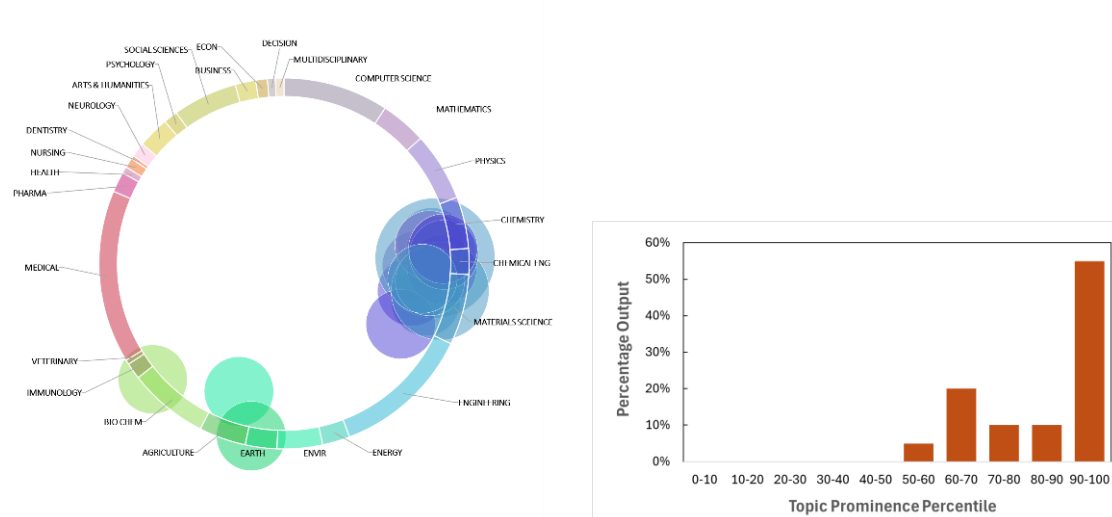


Figure C19: Topic cluster and prominence for the 2025 data portfolio.

The bibliometric profile of XMaS, reinforced by the 2025 analysis reflects a stable and high-performing facility whose outputs continue to demonstrate scientific depth, disciplinary breadth, and strong international engagement. Publications arising from the beamline tackle a broad range of scientific challenges from quantum materials and functional oxides to soft matter, energy-related systems, and advanced characterisation of complex materials—illustrating the facility’s role in enabling both fundamental discovery and application-driven research. The overall quality of outputs remains consistently high, with many papers appearing in influential journals and within globally prominent research themes. Collaboration continues to be a defining characteristic of XMaS-enabled science, with widespread participation from international partners and a steady engagement across the academic and industrial research landscape. Mapping publications to recognised disciplinary taxonomies highlights the facility’s interdisciplinary footprint and its alignment with UK research priorities. The 2025 publication portfolio underscores XMaS’s continued contribution to high-impact research and its importance within the wider UK and international materials science community.

Appendix D: Usage and user statistics

User statistics are collated by the ESRF User Office, to which we have had access since 2001. Data for 2025 remain consistent with previous reporting periods and continue to be effectively limited by beamline capacity. Cumulative plots of scheduled hours, user visits, and the number of experiments are shown in Figure D1.

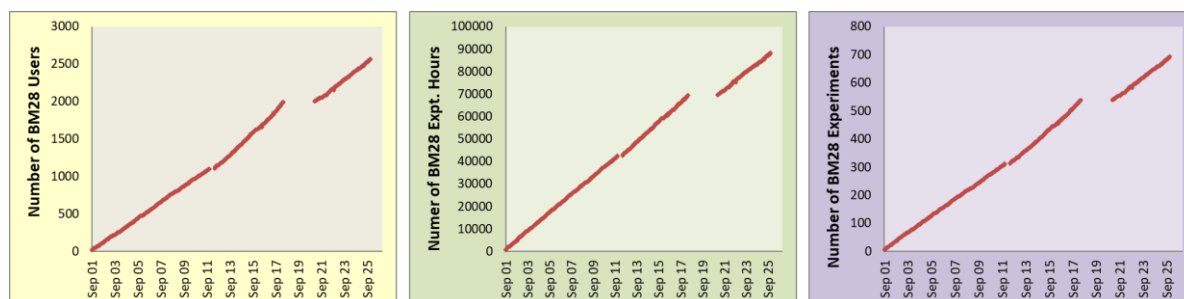


Figure D1: Historical performance metrics for XMaS including the number of scheduled hours (left), the number of user visits to the facility (centre) and the number of individual experiments performed on the beamline (right).

The dataset is stable across the full reporting period from 2021 onwards, coinciding with the post-upgrade and post-COVID restart of operations. The modest rise in user visits and experiment numbers during 2015–2018 reflects a period in which a greater proportion of short experiments was scheduled. Following the EBS upgrade and the COVID shutdown, experiment lengths have returned to the standard 18-shift allocation. This shift, driven by increased demand for *in situ* and *operando* studies, has resulted in cumulative performance trends that closely resemble earlier operating periods when 18-shift allocations were the norm.

A further breakdown of user access is obtained by examining how individual researchers engage with XMaS over time. Across 2021–2025, a total of 337 unique users were identified. For each user, we tracked both the number of visits made per year and the number of shifts allocated. These data are shown in Figure D2, where users are ordered such that the most frequent visitors appear at the lowest indices, with colour bars indicating operational years. Given the large number of students and PDRAs who undertake experiments at XMaS, it is expected that most users participate in only a single experiment during their early-career training. Over the five-year period, 68% of users visited once, 15% returned for beamtime at least twice, 7% visited three or more times, and 9% visited four or more times. The higher-frequency users are typically PIs or senior researchers whose groups make regular use of the facility and who drive longer-term research programmes. Crucially, this cohort of regular users plays a central role in sustaining the facility’s scientific development. Their repeated engagement provides continuity of expertise, supports the introduction and testing of new capabilities, and enables effective knowledge transfer between user groups and the XMaS team. These users act as anchors for the scientific programme, helping to shape beamline evolution while also mentoring early-career researchers who join their projects.

Taken together, these patterns are consistent with demographic and bibliometric trends observed at other synchrotron facilities and demonstrate that XMaS supports a large, diverse, and continually renewing user community. No single group dominates access, and the distribution reflects substantial training opportunities for new researchers alongside the stable, long-term engagement needed to sustain facility development.

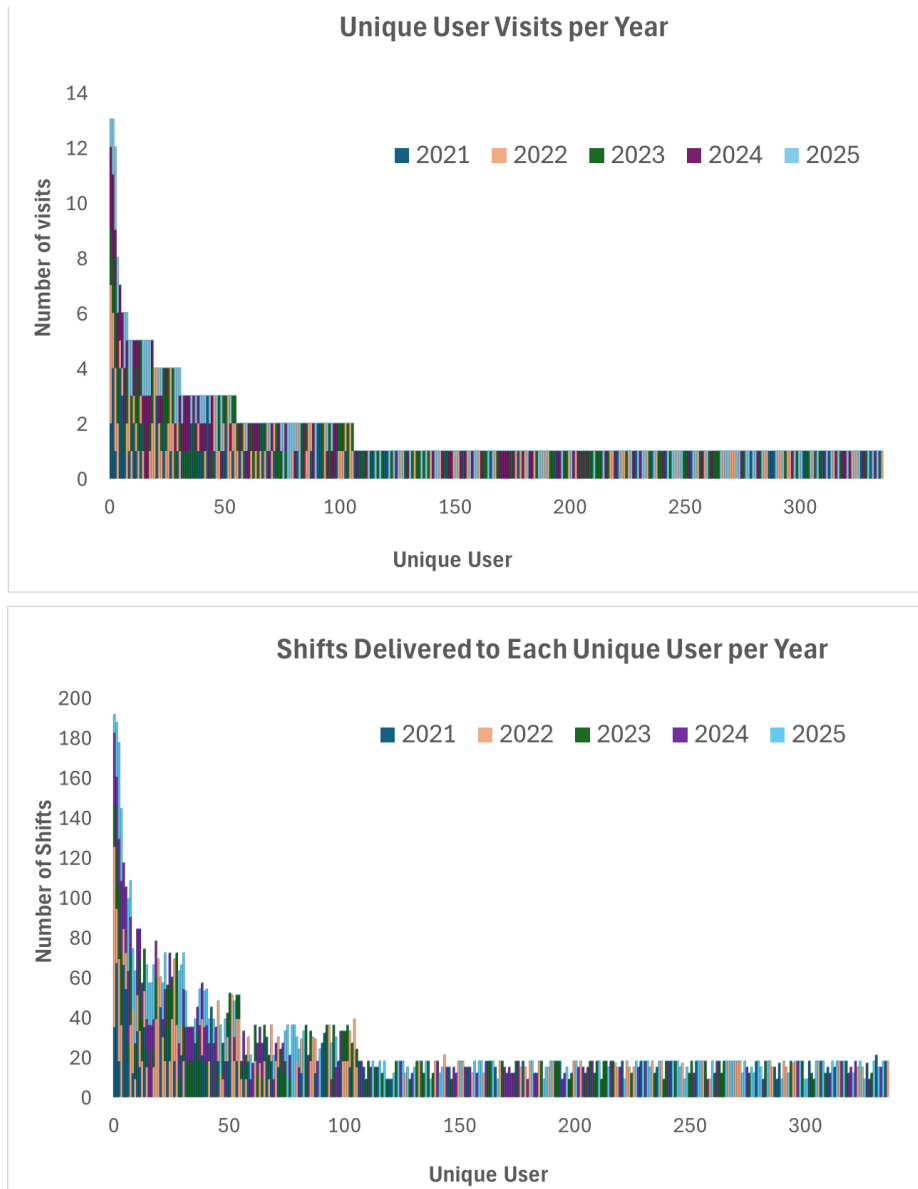


Figure D2: Unique user visits per year (top) and shifts per unique user(bottom) for the period 2021-2025.

A more granular view of 2025 alone, comprising 105 unique users and presented in Figure D3, shows the same trends: the overwhelming majority were single-visit users, a smaller proportion returned for multiple visits, and only a very small number were expert repeat users. This consistency reinforces the fact that XMaS attracts a broad user base while sustaining a stable cohort of experienced researchers who underpin long-term scientific productivity.

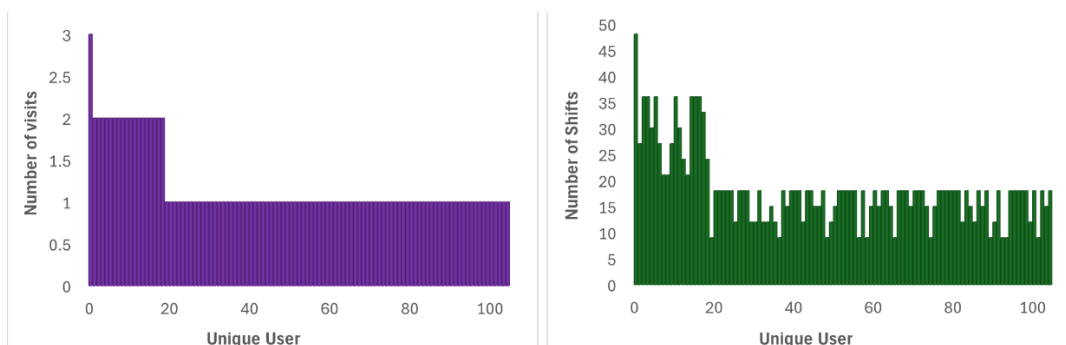


Figure D3: Unique user visits per year (left) and shifts per unique user(right) for the period 2025.

Service demand: Subscription

Unlike most synchrotron beamlines worldwide, XMaS allocates *all* available beamtime through open user calls. This ensures maximum impact and value for money. Exceptions are made only for essential commissioning or technical interventions. No “in-house” time is reserved for facility staff; they are expected to apply through the same competitive calls as the wider community. This approach maximises the number of shifts delivered to users and reduces the proportion of proposals that must be rejected.

Although scheduling constraints or equipment availability can occasionally delay experiments, we report here in Figure D4 the number of accepted shifts as a percentage of those requested, alongside the number of proposals submitted to each call. The data are separated by application route and provide additional context to the service demand discussed in Section 3.

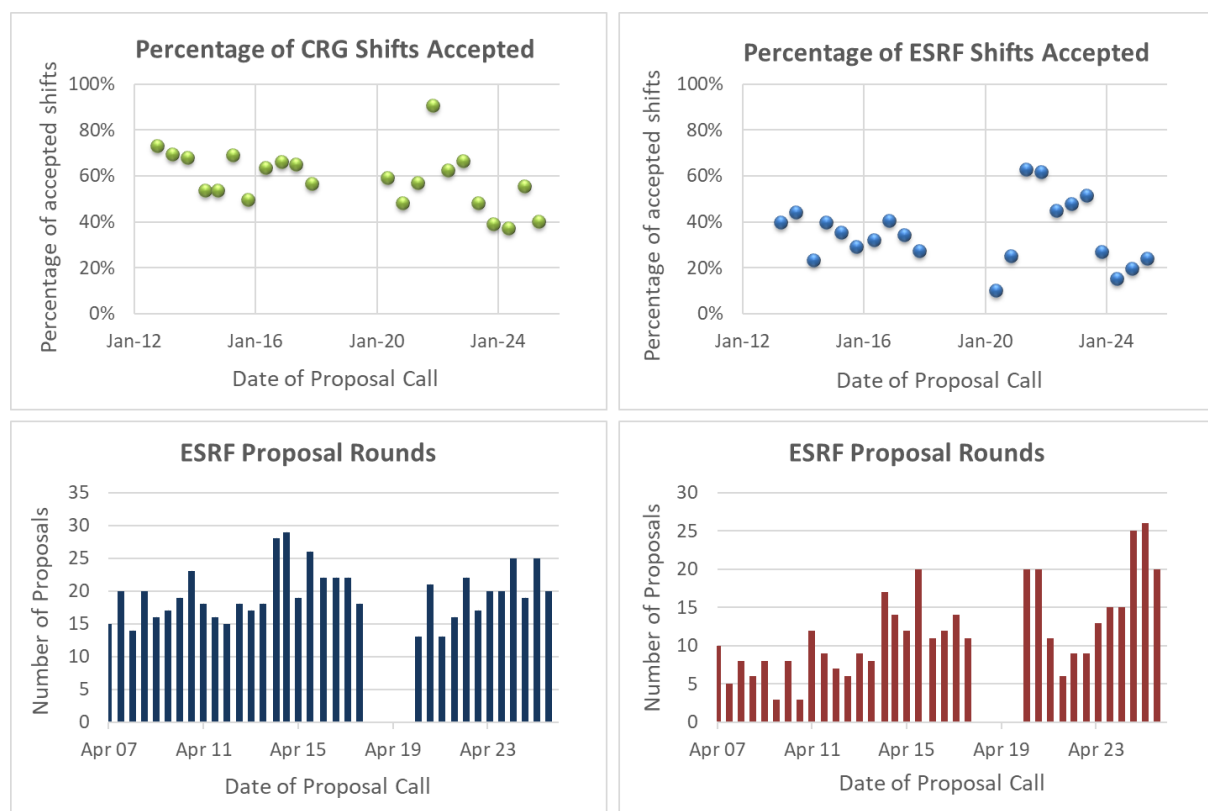


Figure D4: Percentage of proposals accepted (top) and the total number of proposals (bottom), Data are presented separately for UK CRG access (left) and ESRF public calls (right).

Experience on XMaS and across comparable synchrotron beamlines shows that subscription rates between 1.5 and 2 are generally optimal. At this level, high-quality science is supported while maintaining a reasonable likelihood of securing beamtime and enabling effective long-term research planning. Subscription levels of 3–4 or higher are typically unsustainable, as the probability of obtaining beamtime becomes very low, whereas rates below 1 indicate under-utilisation of the facility. XMaS currently operates at a healthy subscription rate of just over 2, maximising scientific impact and ensuring sustained engagement from its user community.

Facility Uptime

The ESRF, and therefore XMaS, is operational 24 hours a day during storage-ring operations, and as noted in the main report, the vast majority of this time is dedicated to user experiments. Downtime is a key determinant of user satisfaction, with high uptime and minimal beamline-derived losses contributing directly to the consistently strong feedback reported in Section 3. Figure D5 presents the operational efficiency of the facility over time. Downtime arises either from beamline-specific issues or from factors outside the control of the XMaS team. External causes include ESRF storage-ring interruptions as well as user-related issues such as samples not being ready or last-minute cancellations due to external constraints.

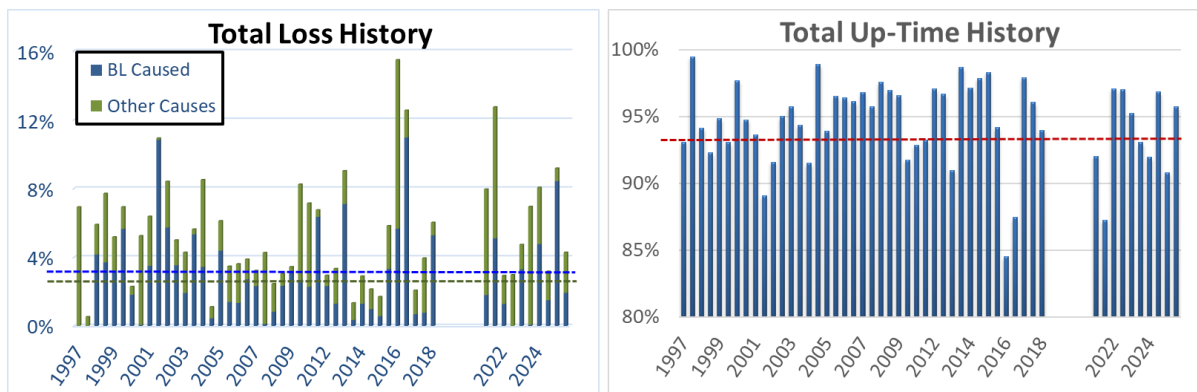


Figure D5: Downtime or loss as a function of time separated by cause (left) and the corresponding total uptime (right). Data are presented on a 6-month reporting period.

The dashed lines in Figure D5 represent averages across the full dataset. Notably, the pre-shutdown and post-shutdown averages are now closely aligned. This convergence indicates that operational performance with the upgraded storage ring and beamline has stabilised at levels comparable to the pre-shutdown period, providing a robust benchmark for ongoing operations.

Appendix E: Effective management

KPIs and SLAs

KPI metrics, based on all beam time for all users is mapped and compared with historical data and are shown in the figures below.

KPI A: The number of university research groups that have made use of the XMaS beamline:

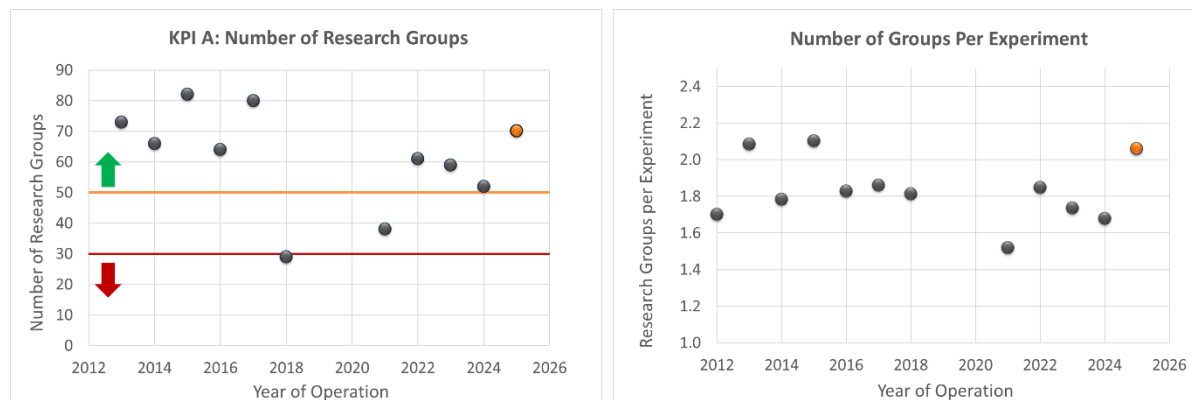


Figure E1: KPI A as a function of time (left). The orange and red lines represent the RAG thresholds. The number of groups attending each experiment is shown in the right panel.

The 2025 value for KPI A remains well within the green threshold, (Figure E1) demonstrating sustained reach across a broad user community engaging with the facility. In addition to KPI A, we also track the number of groups per experiment. For the reporting period, this has been slightly higher than in recent years, with typically more than two independent research groups attending each experiment. This alternative metric provides a useful normalisation of KPI A and helps account for year-to-year variations in the number of experiments that can be scheduled, which depend on the ESRF's operational cycle and any periods in which beamtime is reduced due to commissioning or other necessary interventions. Taken together, these data show the facility as supporting and nurturing collaborative studies from both the UK and internationally, reflecting the growing need for interdisciplinary and multi-institutional approaches to complex scientific challenges and the facility's effectiveness in enabling such collaboration.

KPI B: The number of new users that have made use of the beamline expressed as a percentage of the Total Number of Users within 6 months.

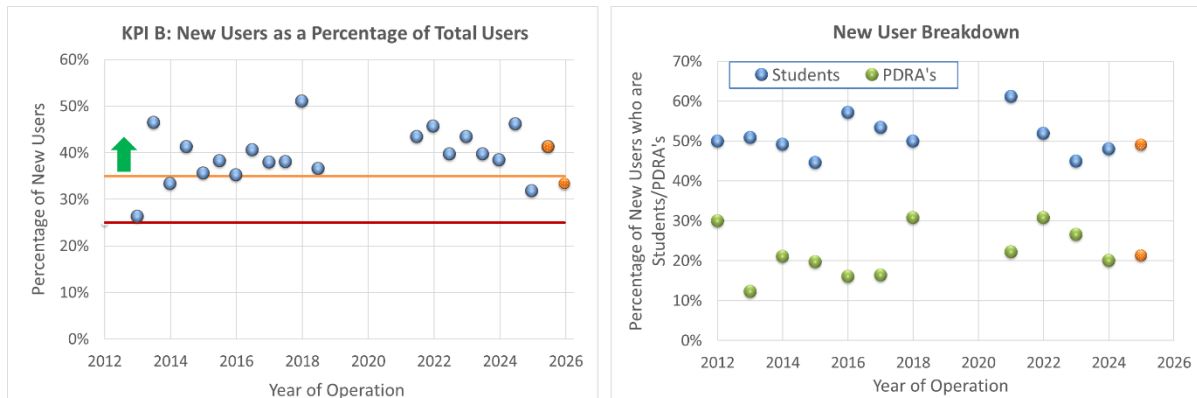


Figure E2: KPI B as a function of time (left). The orange and red lines represent the RAG thresholds.

KPI B measures the total number of new users attending the facility each year, and the 2025 value remains strong, showing that the facility continues to draw new users into its programme and maintains a healthy level of renewal within the user community (Figure E2). In addition to KPI B, we also disaggregate this metric to identify those who are PDRAs or students. While not a formal KPI, these cohorts are especially important for evaluating the facility’s role in training and its impact on the next generation of scientists. We note that commissioning activities with established user groups during the second quarter of 2025 reduced the overall opportunity for new users to access the facility. Even so, the breakdown of new users continues to show strong engagement from both students and PDRAs, underscoring the facility’s contribution to early-career development and its ongoing role in supporting hands-on, collaborative research training.

KPI C: The uptime of the beamline within 6 months as a percentage of the Total Available Time.

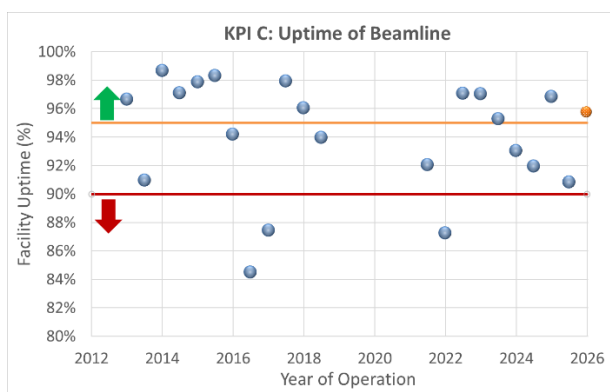


Figure E3: KPI C as a function of time. The orange and red lines represent the RAG thresholds.

Figure E3 shows the uptime of the beamline. The 2025 data point, shown in orange, falls within the green performance band, signifying that uptime remains above the minimum threshold and aligns with the facility’s historical performance. This consistency reinforces operational reliability and suggests sustained infrastructure effectiveness across reporting periods.

KPI D: The number of user complaints received within 12 months.

There have been zero complaints made against the facility over its entire operation.

KPI E: The number of research outputs expressed as a Total Number for a calendar year.

KPI F: The total number of publicity and/or outreach activities that the facility performs.

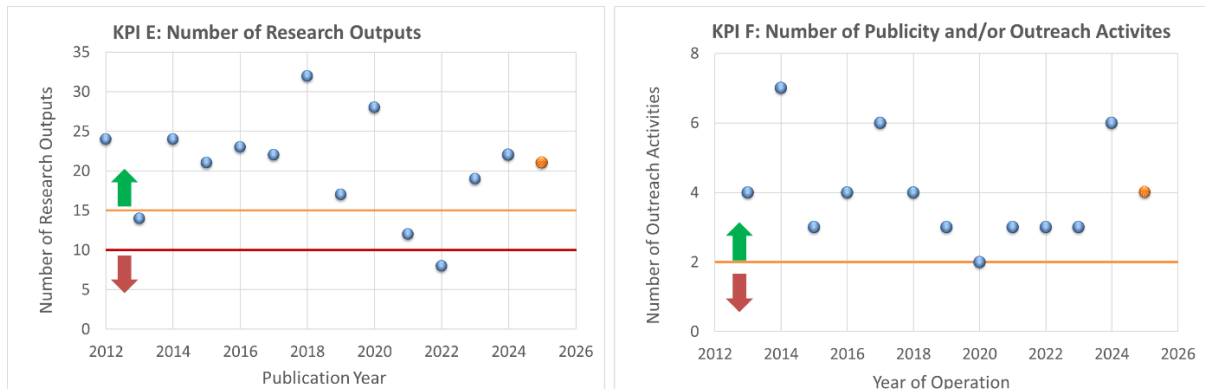



Figure E4: KPIs E and F as a function of time. The orange and red lines represent the RAG thresholds for each KPI.

Performance in 2025 aligns well with the established trajectory across both KPIs and is consistent with the patterns illustrated in Figure E4. Research outputs remain comfortably above the green RAG threshold, reinforcing the sustained post-2014 growth trend. Outreach activity similarly meets the strategic engagement target, maintaining the steady level of external visibility seen in recent years. Taken together, the 2025 data sit cleanly within the long-term upward trend shown in Figure D4, underscoring a stable and mature performance profile.

Risk Register

The latest version of the Risk Register is appended in the following pages.

XMaS Operational / Technical Risk Register										Jan-26		
RISK IDENTIFICATION						CURRENT IMPACT ASSESSMENT				POST RISK TREATMENT		
Unique Risk No	Risk Change	Previous Risk Score	Risk description	Mitigation in place	Risk Owner	Impact Type Cost / Time / Performance / Reputation	Probability 1=Low 5=V. High	Impact 1=Low 5=V. High	Current Risk Score	Mitigations to be carried out	Target Completion Date	Date of Last Change
OPS_A	↔	25	Long-term Failure of ESRF Machine: No x-ray source for a considerable period and possible shutting down of the project.	Outside XMaS control. ESRF preventative maintenance.	Management	P	1	25	25	Ensure clear communication pathways exist between Universities, ESRF and UKRI.	Ongoing	June 21
OPS_B	↔	25	EPN Campus shutdown: Radiation (ILL), terrorism, pandemic or other unforeseen impact. Depending on length of shutdown could result in shutting down of the project.	Outside XMaS control. Mitigation would depend on the length of the shutdown.	Management	P	1	25	25	Ensure clear communication pathways exist between users, universities, ESRF and UKRI.	Ongoing	June 21
OPS_J	↓	22	Failure of Main Components - Diffo/Mono/Mirror: Risk to ongoing operations if critical components fail and cannot be repaired quickly. These include mirror, monochromator, diffractometer and shutter.	Expected operational lifetime for all components >20 years. Diffo and mirrors new and preventative maintenance completed on monochromator. Safety shutter redesigned in 2017 and we have spare parts.	Team / Management	C / T / P / R	1	20	20	All major components installed have had preventative maintenance or have recently been replaced. All operational. Continuing and regular preventative checks carried out. New components added to monochromator in 2025. New cryo cooling system, that meets current ESRF standards being processed for tender.	Ongoing	Jan 26
OPS_C	↔	20	Restricted access to EPN Campus: External factors such as a National incident, terrorism, pandemic or other unforeseen event preventing Staff and/or users accessing the facility and limiting the ability for the facility to operate.	Outside XMaS control. Mitigation would depend on ESRF access protocols and length of restrictions.	Team / Management	P / T	1	20	20	Ensure clear communication pathways exist between users, universities, ESRF and UKRI. Move to remote access operations with concomitant increase in Staff workload. Note: Covid variant JN.1 is more contagious with increasing risks of impact.	Ongoing	Jan 24
OPS_D	↔	4	UK University shutdown: Closure of UK tertiary institutes due to terrorism, pandemic, extreme weather events or other unforeseen factors which impact the ability of users to provide samples and for PIs to respond to project needs.	Outside XMaS control. Follow relevant government advice.	Team / Management	P / T	1	4	4	Mitigation will depend on length of shutdown. Remote working and approvals would be in place to provide oversight with the team in France managing the operations. Early delivery of samples if travel is impacted would allow remote operations to continue. Clear liaison with stakeholders and extra oversight by PMC.	Ongoing	Feb 25
OPS_E	↔	20	Failure of essential ESRF infrastructural resources: Failure of infrastructure such as the IT infrastructure, electricity supply or similar would impact all operations and prevent delivery of service.	Outside XMaS control. ESRF preventative maintenance.	Team / Management	P / T	1	20	20	Ensure clear communication pathways exist between Universities, ESRF and UKRI. New strogare ring should be more resilient.	Ongoing	Jan 26
OPS_F	↔	15	Incapacitation of Staff: sudden loss of Staff with concomitant loss of knowledge and expertise of the beamline and its components leading to inability to operate beamline safely.	Confluence page (Wiki) developed that covers essential operations.	Team / Management	P / T	1	15	15	Ensure any local copies of data (and logbooks) are secure and updated regularly. Wiki page being compiled - needs work on navigating to find relevant information. More and more information is provided within Confluence.	Ongoing	Nov 25
OPS_G	↔	8	Restricted University Operations (management): Closure or restricted access to one of Liverpool or Warwick University due to external factors such as a national incident, terrorism, pandemic or other unforeseen event which would limit the ability of the PIs to respond to project needs.	Outside XMaS control. Follow relevant government advice.	Team / Management	P / T	2	4	8	Mitigation would depend on length of impact. Redundancy built in with two PI institutions who can cover each other with added online working. Extra oversight by PMC and clear communication with stake holders.	Ongoing	May 25
OPS_H	↔	6	IT security breach: Hack of data stored on University or ESRF systems which potentially releases personal information. Increasing risk as seen at other facilities.	All personal data to be stored on password protected files and behind University firewalls. Staff training on GDPR mandatory. SSO advisories posted on public computers. ESRF implemented double authentication for login.	Team / Management	P / T	2	3	6	Regular review of processes and data handling. Report of any possible GDPR failure to Information Commissioner's Office via the Universities. Require Staff training which has been renewed recently. The ESRF has implemented a Cyber Security Plan.	Ongoing	Nov 25
OPS_I	↓	8	IT data breach: Hack of experimental data stored on ESRF systems, possibly impacting proprietary data sets.	All experimental data is backup up on ESRF maintained servers behind firewalls. Limited amount of proprietary data collected. Dual identification login put in place end of 2023.	Team / Management	P / T	2	3	6	Ensure any local copies of data (and logbooks) are secure and recorded with user knowledge and approval. Improving ESRF activities in relation to authentication and firewalls. New security protocols where beamline data is in secure silos has reduced risk	Ongoing	Jan-26
OPS_J	↔	8	Access for users with reduced mobilities: Accessing the beamline control station and experimental hutch for users with reduced mobility.	ESRF safety office review of operations, but will need an individual assessment on what can be done safely.	Team / Management	P / T	2	4	8	Update risk assessments and standard operating procedures. Liaise with ESRF safety office for guidance and update web page accordingly.	Ongoing	Jan 24
OPS_K	↔	3	Remote Access: Increasing use of remote access. Possible impacts of unintended collisions and damage to critical components.	Guacamole software allows remote operations of the control computer, but there is necessarily an increase in the possibility of collisions and damage.	Team / Management	P / T	1	3	3	Remote access needs are reducing. Ensure planning for remote access operations is continued should future needs require it. Beamline Staff can access system remotely to support users.	Ongoing	Feb 23
OPS_L	↔	6	Industrial Action: Risk to operations due to industrial action at EPN campus or externally. Users may not be able to get to the ESRF and experiments would need to be cancelled if there was no beam. Concomitant impact on user research activities. More likely around French elections	Direct communication between Staff, ESRF and users. Clear and easy to find information to be put on website.	Team / Management	P / T	2	3	6	Mitigation would depend on length of impact and whether the ESRF was providing beam. Switch to remote access if appropriate.	Ongoing	Nov-24

OPS_1	↔	15	Staff: Risk to operations if Staff leave, are injured or demotivated.	Clear and open dialogue with management. Resources available at both Universities. Potential of increased Staff loads due to extra work.	Team / Management	C / T / P / R	3	5	15	Be open and sensitive to potential issues. Have regular meetings. More onsite users helps with workloads. Impact depends on number of Staff involved - evidence shows one absence can be covered, but serious impact to operational resilience if more than one Staff member is absent. Need some cross expertise across the team. New grant award provides job security for 5 years.	Ongoing	May 24
OPS_3	↔	6	Project Management: Risk to managing the project with two directors at two institutions who are physically distanced from the team in France. Risk of decisions not being taken and a lack of on the ground management.	Regular meetings with the team (in person if possible) as well as directors meetings to discuss and highlight potential issues. Historically it has worked well.	Team / Management	C / T / P / R	2	3	6	Be open and sensitive to potential issues. Have regular meetings. Regular face to face meetings not happening (or online) so making it difficult to define priorities.	Ongoing	May 25
OPS_6	↑	5	Disruption of Main Components - Difo/Mono/Mirror: Risk to operations if critical components fail. These include mirror, monochromator, diffractometer and shutter.	Expected operational lifetime for all components >20 years. Spare safety shutter.	Team / Management	C / T / P / R	2	5	10	Regular preventative checks to be carried out. Update SOPs with any experience gained. Monochromator issues identified through 2025 - replacement parts installed/on order	Ongoing	Jan 26
OPS_8	↔	4	Lack of novel new experiments proposed through PRP. Risk of failing to deliver internationally competitive science, especially after restart with concomitant risk of lack of renewal in future funding calls.	Advertise capabilities through website, newsletter, user meetings and wider outreach activities. No evidence of any change in the last few rounds.	Team / Management	P / R	2	2	4	Ensure user communities which have recently been more active are encouraged to apply. We are seeing a return to normal proposal numbers and request for new sample environments and capabilities.	Ongoing	Nov 23
OPS_9	↔	4	Reduction in number of proposals or days. Risk that the subscription rate would fail to below sustainable levels. Risk of lack of renewal in future funding calls. An increasing risk in the future after a Diamond upgrade.	Advertise capabilities through website, newsletter, user meetings and wider outreach activities.	Team / Management	P / R	2	2	4	Ensure user communities which have recently been more active are encouraged to apply. We are seeing a return to normal proposal numbers and request for new sample environments and capabilities.	Ongoing	Nov 23
OPS_10	↔	4	Narrowing of User Community: Risk that the science base narrows with a reducing user community.	Advertise capabilities through website, newsletter, user meetings and wider outreach activities. XMaS integral to Diamond mitigation strategies which will bring new users to the facility.	Team / Management	P / R	2	2	4	No evidence of any change but need to be mindful of reaching out to new communities such as Royce and Diamond. Need to be active in attracting new users post COVID and during DLS shutdown. Large number of people attending the next user meeting.	Ongoing	Nov 23
OPS_11	↓	12	Industrial Community: Risk that industrial users do not make use of the facility for proprietary work. Risk to reputation at EPSRC/BEIS if industry is conspicuously absent from portfolio.	Work with industry partners to create marketing material catering for industrial users using relevant case studies. Invest 2 days per operational cycle for developing case studies and/or rapid access work.	Team / Management	P / R	3	3	9	Case studies and material need to be generated. Bibliometric data analysis shows ~10% of outputs have a direct industrial author. This can be improved, but impact within the industrial sector is as expected.	Ongoing	Jan 26
OPS_12	↓	20	Health & Safety: Risk of missing H&S compliance data. Risk assessments/Standard Operating procedures needed for both UK HSE and French equivalent. Risk of invalid insurance and liability cover if not fully compliant.	Operations fully approved by ESRF Safety group. Work with ESRF Safety office and CRG office to clarify audit documentation.	Team	C / P	4	4	16	Review of current paperwork shows we are missing data and audit reports. Need to compile a H&S repository. Over a year outstanding. H&S is fully compliant within France. Additional RAs and COSHH needed to comply with UK.	Feb-21	Jan 26
OPS_15	↔	9	User engagement: risk of disenfranchisement with user community if communication is not robust.	Advertise capabilities through website, newsletter, user meetings and wider outreach activities.	Team	P / R	3	3	9	Increasing appetite for face to face meetings to be planned through the new grant. New long-term secondments for PIs and students funded in new grant. XMaS support meetings needed to target communities.	Ongoing	Nov 23
OPS_16	↔	4	Beam stability: Risk of insufficient stability affecting long duration experiments and beam position movements after or during energy changes/scans.	Beam commissioning show beam instabilities as a function of time, but origin is unknown. Beam position monitor checks beam position at all times.	Team	P / T / C	1	4	4	Worked with ESRF to look at frequency analysis of main components but much better. Still potential for new feedback options if stability / position remains an issue. Still slight problems (40 Hz) on the mirror vessel. Would require a redesign of the Harmonic mirrors to run with piezo actuators and new high speed amplifiers for the BPM. Limited budget for exploratory studies if needed.	Ongoing	Nov 21
OPS_17	↔	4	Detectors: Risk of having inappropriate and obsolete detectors for science applications which would limit impact and reach.	All new detectors used during operations. Recognise that a new multielement detector and associated electronics needed for spectroscopy studies, especially at high energies.	Team	P / R	2	2	4	All new detectors available for operations. Keep under review operational needs	Ongoing	May 25
OPS_18	↔	6	Sample environments: A risk to the user programme from damaged or inappropriate sample environments.	Consumable budget available for project work with users to develop bespoke systems for wider use.	Team	R	2	3	6	New funds can be sought through capital calls from EPSRC during the next operational cycle.	Ongoing	May 25
OPS_23	↔	12	Ongoing Upgrades and development projects: Risks to operational effectiveness and relevance for the community if there are delays or descoping.	Engagement with team members about delivery and prioritisation of projects.	Team	T/R	3	4	12	Maintain an active and evolving opportunity register with delivery milestones as a separate register to monitor delays and impacts on users. Current status of projects defines the risk profile here.	Ongoing	Nov 25
OPS_19	↔	12	Inadequate resources for data reduction and visualisation. Risk of poor computing support for user community and a loss of impact for science performed if users cannot leave with partially processed data sets. Likely to increase risk with move to hdf5 file formats	New computing and software resources being deployed and monitored continuously. Community needs being reviewed on a continuous basis.	Team / Management	T/P/R	3	4	12	Active area for the PDRA appointments. Possible meeting based around data management in this area in Jan. 2026. Actively being worked on within the BLISS deployment.	Ongoing	Nov 25
OPS_20	↑	8	Failure of IT control and data systems: Risk of operational disruptions and loss of data and beamtime if IT infrastructure fails as we are not on BLISS and current control software is increasingly unsupported.	Complete backups of control systems made every 24 hours. Recovery within 24 hours with support of ESRF computing services.	Team / Management	P / R	3	4	12	Work with ESRF computing services to deliver BLISS by 2026. Already started with offline facility. BLISS delivery is taking longer than expected with the concomitant increase in risk associated with not operating using the ESRF standard.	Ongoing	Jan 26


OPS_21	↔	5	Operational Resilience: Failure of small scale but essential infrastructure could severely impact operational efficiency and damage user confidence.	Preventative maintenance where possible, and spares of critical components. Use of Capital Call to "fill" gaps.	Team / Management	P / R	1	5	5	Increasing instabilities of ESRF ring. Data and network less resilient.	Ongoing	May-24
OPS_24	↔	5	Failure of long-lead time items: Failure of critical components such as belows that have a long lead time could result in significant down time affecting the user programme.	Identify redundancy and availability at the ESRF and/or ensure we have spares.	Team	P/R	1	5	5		Ongoing	Nov 23
OPS_26	↔	4	Network ports: not enough ports and compromised speed.	Ensure the operation with the ESRF latest standards. Running out of network ports, especially inside EH. New port installed and increased capacity now available.	Team (DW) / Management	T/ R	2	2	4		ongoing	May 25
OPS_27	↔	9	Projects: Risk of using obsolete equipment or not investing the latest state of the art will limit both capacity and capability. Increasing risk of not being able to run multi-modal studies. Reputational risk of failing to meet user expectations. Divergence from user needs.	End of run surveys and interactions with users identify needs. A prioritised project portfolio is maintained by the team and reviewed at weekly meetings.	Team / Management	P / R	3	3	9	Project list is reviewed 6 monthly by oversight committee who provide additional long-term vision. Increasing risk in allocating sufficient and dedicated resources.	Ongoing	Nov-25
OPS_28	↑	12	Projects - Delivery: Delays in delivering projects and beamline developments from concept to delivery including leasing with relevant ESRF departments. Risk of trying to deliver too many projects and spreading resources too thinly. Risk in phasing projects to match user/beamline needs and requirements. Risk of risk assessments becoming outdated.	The project portfolio includes resource needs and identifies project owner. Update risk assessments as final completion step on all projects. Have a clear pathway for project delivery and ensure projects are completed before stating new ones.	Team / Management	P / R	4	4	16	Work with clear communication within the team and succinctly identify potential issues early. Engage openly as a team. Use off-the shelf components where possible. Acknowledge the risk of managing long term with short term issues and user requests. Limit the number of active projects using new projects protocols. Complete delivery of outstanding projects as fast as resources allow.	Ongoing	Jan-26
OPS_29	↑	12	Project Staffing: Risk of overworking staff and managing workloads.	The project portfolio includes resource needs and identifies project owner. Ensure tasks are allocated to available resource being mindful of over work needs at the facility.	Team / Management	P / R	4	4	16	Work with clear communication within the team and succinctly identify potential issues early. Engage openly as a team. Use project initiation and close down procedures. Ensure enough stop/go checks are in place. New protocols for 2026	Ongoing	Jan-26
OPS_30	NEW	9	Projects: Reliance on a small number of technical designers and companies	Projects needs design and technical expertise and this requires onsite meetings. There are limited number of companies that we can use, and this can cause financial risks to develop.	Team / Management	P / R	3	3	9	Work with clear communication within the team and diversify risk where possible. Monitor use of companies, their value for money in quotes and quality of service.	Ongoing	Jan-26

XMaS Financial Risk Register



Jan-26

RISK IDENTIFICATION				CURRENT IMPACT ASSESSMENT					POST RISK TREATMENT			
Unique Risk No	Risk Change	Previous Risk Score	Risk description	Mitigation in place	Risk Owner	Impact Type Cost / Time / Performance / Reputation	Probability 1=Low 5=V. High	Impact 1=Low 5=V. High	Current Risk Score	Mitigations to be carried out	Target Completion Date	Date of Last Change
FR_A	↔	20	Withdraw or suspension of funding: Would result in closure of the facility and end of contract leading to closure of beamlines and loss of Staff.	XMaS to make the best business case possible and via user representation.	Management	C/P	1	20	20	Maintain an ongoing dialogue with EPSRC. Continue working with EPSRC to highlight the implications of funding levels; to demonstrate impact to UK PLC and value for money. Respond to all questions on a timely basis and seek flexibility of movement between Capital and Resource budgets. Strive for improving KPI and SLA metrics.	Ongoing	Jan-24
FR1	↑	15	Lack of renewal funding at next review would lead to closure of beamlines and loss of Staff. Risk to project reputation and Staff retention if not resolved early.	XMaS to make the best business case possible to stakeholders through annual reports, but recent announcements by EPSRC about a strategic re-alignment of the NRFs and a possible summer funding application has increased short term risk	Management	C/P	4	5	20	Maintain an ongoing dialogue with EPSRC. Continue working with EPSRC to highlight the implications of funding levels; to demonstrate impact to UK PLC and value for money. Respond to all questions on a timely basis and seek flexibility of movement between Capital and Resource budgets. Uncertainty in funding progress due to mid-term review being delayed as new EPSRC team review funding processes.	Ongoing	Jan 26
FR2	↓	8	Exchange rate fluctuations between the Euro and Pound. Many costs are fixed in Euros, with the funding in pounds sterling. Uncertainty around exchange rates may make purchases more expensive.	Manage and review budgets regularly. Reprioritise budgets as and when needed but at a risk of performance and reputation. Exchange rate has been very stable.	Management	C/P/R	2	3	6	Capital equipment and consumables to be quoted and agreed in sterling wherever possible. Make use of additional capital awards to rebalance priorities and ensure competitiveness. Exchange rate has stabilised over the past year. Time within the grant funding period to manage impacts. Pound stabilising on global markets.	Ongoing	Jan 26
FR4	↔	8	Exchange rate fluctuations between the Euro and Pound impacting Staff salaries moving to such an extent that salaries (which are paid in sterling) become uncompetitive and Staff moral is impacted.	Manage and review regularly and benchmark against ESRF posts.	Management	C/P/R	2	4	8	Maintain open dialogue with Staff members and liaise with University HR departments as needed.	Ongoing	May 25
FR5	↔	12	Rising costs of equipment: Cost increases over and above estimates when grant submitted. Increasing risk from tariffs and trade disputes	Manage and review regularly. Some equipment 50% more expensive than estimated in 2018	Management	C/P/R	3	4	12	Prioritise and manage budgets. Plan capital uplifts sympathetically.	Ongoing	Nov 25
FR6	↔	6	Extended delivery and lead times: Stress in the delivery chain.	Plan project delivery with extra margins and contingency. Extend project deadlines.	Management	C/P/R	2	3	6	Clear communication with suppliers and stakeholders in planning. French registered VAT (EROI) number granted to UoW facilitating imports.	Ongoing	Nov-24
FR7	↔	9	Inflationary pressures: UK inflation exceeding the 2% forecast in funding models. Increasing risk of inflation drive by trade disputes	Increased costs over and above expected levels due to rising fuel costs and global situations.	Management	C/P/R	3	3	9	Planning needed to ensure spend profile remains on track. Reprioritise spend and ensure budget lines are sufficient.	Ongoing	May 25
FR8	↔	9	Cost of Living: Risk to staff motivation if cost of living costs are not mapped by salary uplifts	Increased costs over and above those expected within grant costings.	Management	C/P/R	3	3	9	Forward planning and salary reviews at next grant application stage. Re-bench mark to ESRF salaries.	Ongoing	Nov-24

XMaS Data Risk Register										Jan-26		
RISK IDENTIFICATION						CURRENT IMPACT ASSESSMENT				POST RISK TREATMENT		
Unique Risk No	Risk Change	Previous Risk Score	Risk description	Mitigation in place	Risk Owner	Impact Type Cost / Time / Performance / Reputation	Probability 1=Low 5=V. High	Impact 1=Low 5=V. High	Current Risk Score	Mitigations to be carried out	Target Completion Date	Date of Last Change
Data_01	↔	20	Data Security: Risk of viruses and malware compromising data security and operations.	Windows and servers should be operating with the latest software and updates. A separate network for users and controls minimises risk to core systems.	Team / Management	P / R	4	5	20	Regular checks on system functionality. Training of users by local contact on appropriate and safe computer usage.	Ongoing	May 22
Data_02	↑	12	FAIR Data: XMaS data should align to the FAIR (findability, accessibility, interoperability, and reusability) policy. A funding requirement.	The ESRF is moving to make all data collected at the ESRF facility to be FAIR compliant.	Team / Management	R	4	4	16	Automatic DOI, meta-data and electronic laboratory notebooks are being developed and deployed by the ESRF. XMaS will follow the ESRF data policy in all areas. Will become automatic within BLISS. XMaS is partly compliant. Increasing risk with delays in deploying BLISS	May 2024	Jan 26
Data_03	↔	8	Loss of experimental data: Loss of user data collected.	Data from all XMaS facilities are stored on ESRF servers which are backed up continuously. After 6 months the data is backed up to tape storage. Data is available locally and through the ESRF data portals. Data backups progressing smoothly	Team / Management	T/ P / R	2	4	8	Users are encouraged to take a copy of the data with them on completion of the experimental session. This can be downloaded, or copied locally onto an external hard disk (provided by XMaS). Increasingly large data sets being generated which are harder to manage. Use of GLOBUS to be encouraged.	Ongoing	May 25
Data_04	↓	10	Loss of access to data: Inability to read or access data on the beamline or at home institute.	All data are stored on ESRF servers. There is a risk of network failure, but this is low and managed through the ESRF but proving difficult to access and download when users try.	Team / Management	T/ P / R	2	4	8	ESRF policy requires experimental data to be compiled into a DOI repository linked with the experimental run number. These data can be accessed post-experiment for up to 2 months by logging into the ESRF user portal. Local contact will ensure this is done at the end of each session.	Ongoing	Jan 26
Data_05	↔	8	Loss of Metadata / Lab-books: Lab-books provide the contemporaneous record of the experimental session and allow users to correlate scan numbers with samples and initial results. They are currently hand-written, but electronic notebooks becoming a reality.	All metadata and electronic lab-notebooks are stored on ESRF servers. These data are collapsed into the DOI repository and stored with the experimental data. A detailed log file of all commands entered into the control system is automatically generated and saved.	Team / Management	T/ P / R	2	4	8	Hard-copy laboratory notebooks are stored at the beamline/XMaS facilities. Users are encouraged to take a copy of the hand-written lab-book at the end of the experimental session, convert to a PDF and save with data. Users can request Staff to copy the lab-book, but this is not guaranteed and remains the users' responsibility. Need to define a method to upload and incorporate with ESRF data backup. Working with PSDI to look at archiving digital copies - work in progress	Ongoing	Jan 26
Data_06	↔	6	Intellectual Property: Data may be commercially or academically sensitive. Possibility of sensitive data being exploited by others.	A separate laboratory note-book should be used to record the contemporaneous record. Data is embargoed for all experiments for 3 years, although an extension can be requested as outlined in the ESRF policy. Access to data is through ESRF login-in linked to PI of experimental run. Non-proprietary data remains embargoed for all time and is owned by the client.	Team / Management	T/ P / R	2	3	6	The ESRF has isolated the individual networks and implemented a protocol where you have to log on via your own login.	Ongoing	Nov 25
Data_07	↔	8	Single sign on (SSO): Many applications use single sign on protocols. If a user fails to log-off correctly, the beamline systems (with opd28 login) will remember the sign on and allow unauthorised access to data.	Provide training for users and place clear warnings on all computers. Clearly state computers are public and users about the need to completely log-off from single sign on applications (often google mail, University systems etc).	Team / Management	T/ P / R	2	4	8	Generic issue on all public computers. Users should be aware - notices in the beamline area. User behaviour not changing with issues continuing to be identified. More clear notices placed on all beamline computers.	Ongoing	May 25
Data_08	↔	5	Loss of data for Control: Control of XMaS facilities requires operational data. Loss of these data would deleteriously impact any re-start up.	Spec sessions and controls backed up continually to remote servers. Reconfiguration possible using local back-ups. Using ESRF standards allows hardware to be replaced from central stores.	Team / Management	T/ P / R	1	5	5	Servers updated regularly to latest operational standards including software updates.	Ongoing	May 25
Data_09	↔	8	Controls and data collection expertise: Skilled IT consultants are required to ensure smooth operations.	XMaS contributes to, and has access to, the ESRF computing teams and support. New dedicated support from computing support available.	Team / Management	T/ P / R	2	4	8	Transition from SPEC to BLISS after ESRF beamlines have transitioned. Always use the ESRF control standards in terms of hardware and software. Ensure compatibility with systems before purchases.	Ongoing	May 25
Data_10	↔	4	Data analysis computers (Windows): Obsolete computers limit data analysis whilst on beamtime.	Ensure suitably specified systems are available for users.	Team / Management	T/ P / R	2	2	4	Computer bought and installed under Win11.	Ongoing	May 25

Data_11	↔	12	Access to high performance and high throughput computing: On the fly data visualisation and reduction are critical in experimental planning and successful outcomes.	Not possible on desk-top PCs. Work with ESRF, STFC etc. to signpost to suitable resources. No clear access for users at present.	Team / Management	T/ P /R	3	4	12	Not an immediate issue, but on-the-fly analysis becoming an increasing need. Increasing need for post-processing of collected data into suitable reduction pathways. New python based codes being deployed to the beamline which directly exploit ESRF servers. Increasing use of ESRF resources in data analysis.	Ongoing	Jan 26
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