A LIGHT FOR SCIENCE

ESRF news

Number 68 December 2014

INDUSTRY

Turning research into business

Single bunch imaging

20 years of user operation

A light for science

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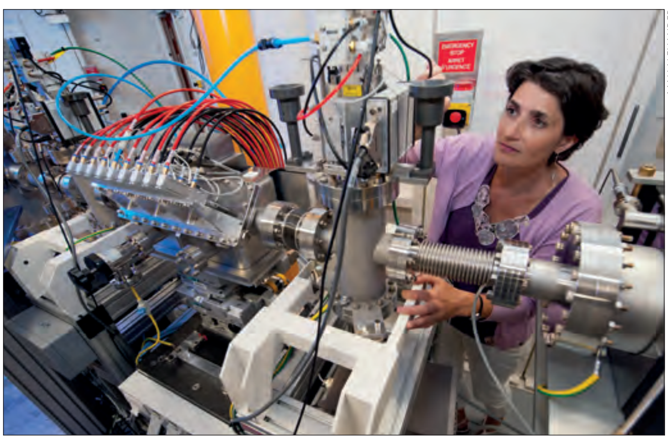

MAX ALEXANDER

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On the cover: Focus on industry use at the ESRF (pp16–27).

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ESRFnews

Driving innovation at research infrastructures

ISSN 1011-9310

Research infrastructures such as the ESRF are essential providers of advanced services and leading-edge technologies, yet their remarkable innovation potential has not always been sufficiently exploited in the past. Activities funded under Horizon 2020 – the EU's new €80 bn research programme – address this problem directly via: reinforced partnerships with industry; transfer of knowledge and other dissemination activities; use of research infrastructures by industrial researchers; and by involving industrial associations in consortia or in advisory bodies.

There is also a clear innovation potential for industry in filling procurement needs during the construction of a new research infrastructure. However, enterprises including SMEs often do not realise that they have the opportunity to benefit from this potential. Industry may also be faced with entry barriers to this sector, and industry typically constitutes a very small fraction of research infrastructure users – again because they may not be aware of the availability or relevance of research infrastructures to their own R&D activities. According to the ERID-Watch market study, 56% of research-infrastructure instrumentation suppliers say that such supply contracts have improved their sales in other market segments. There is hence a clear need to stimulate innovation and make these opportunities known both within the research infrastructures themselves and their supplier industries.

"The EC's aim is to boost industry collaboration in line with Horizon 2020"

As early adopters of advanced technologies, light sources can trigger innovation in companies that supply high-tech components such as stronger magnets or lasers. The innovation capacity of research infrastructures can therefore be strengthened by stimulating R&D partnerships with industry. Key to this is the exploitation of pre-commercial procurement (PCP) and/or public procurement of innovation (PPI) schemes.

Technology adopters

The Synchrotron Radiation Source in Daresbury, UK, for instance, has enabled £300 m in UK industry contracts such as drug research and high-tech engineering as a direct result of working with industry. More recently, studies of the economic utility generated by technology transfer and procurement contracts at CERN show that every euro paid to industrial firms generates three euros of additional business, mainly in sectors outside particle physics such as solar energy, electrical industry, computing and telecommunications. Some 38% of suppliers developed new products as a direct result of the supplier project and demonstrated that true R&D partnership is more beneficial for innovation than conventional procurement.

In order to turn the innovation potential of research infrastructures into concrete action, the European Commission will help bring together European facilities, associated research communities, industry, innovation management and entrepreneurship specialists and policymakers. The aim is to boost collaboration in line with the objectives of the Horizon 2020 strategy, facilitating a move from an "open science" to an "open innovation" paradigm while creating societal and competitive value for Europe.

Synchrotrons have been invited to forge a new collaborative model that benefits their supply industry, for example by acting as facilitators and first users of advanced prototypes such as detectors or data analytics. Facilities will also be encouraged to maintain excellent collaboration with their industrial user base.

Ana Arana Antelo
Head of Unit Research Infrastructures, DG Research & Innovation, European Commission

UM2015 will promote exchange between users and local staff.

Changes to Users' Meeting for 2015

The 25th ESRF Users' Meeting will take place at the ESRF on 9–11 February 2015. The Users Organisation Committee and the ESRF management have implemented a change in the format compared to previous meetings, with the aims of promoting exchange between users and local staff, giving higher visibility to users and their science, and improving the interaction between users, beamline staff and facility directors.

User-dedicated micro-symposia will run in parallel on 9 and 11 February covering four major scientific themes: novel routes to the study of strongly correlated electron systems; new possibilities for chemical studies; hierarchical imaging of biological, biomimetic and bio-compatible materials; and structural biology at ESRF Phase II. The sessions will include invited talks from users chosen from a selection of submitted abstracts, practical sessions such as tutorials and beamline visits, and a presentation of the offline laboratories available to users.

The plenary session will include three keynote lectures from users, a report from the facility directors and a talk from the winner of the ESRF Young Scientist Award. Poster clip sessions will give young users the opportunity to promote their work and encourage discussions during the joint poster session and cocktail on 10 February, which will be followed by the Users' Meeting dinner. An additional social evening with wine and cheese will be held on the evening of 9 February.

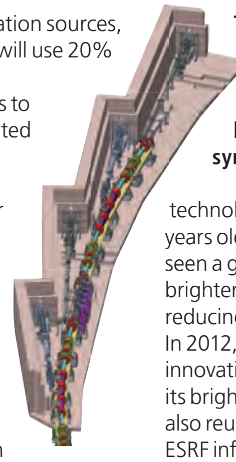
Registration is open until 23 January and more information can be found at: www.esrf.fr/home/events/conferences/um2015.html.

Green light for Phase II upgrade

The ESRF Council has expressed unanimous support for the implementation of the second phase of the ESRF Upgrade Programme and has approved the related technical design report, also known as the "orange book". During the next six years the ESRF will bring into operation a new synchrotron X-ray source housed in the existing buildings, with the objective of delivering a fully renewed facility for the benefit of users by 2022.

The improvement of the source will enable completely new X-ray microscopy, imaging and nano-crystallography applications. New research horizons will open up, bridging the gap between optical and electron microscopy and offering enormous potential for condensed matter science, innovative materials research and life sciences. The overall performance of the ESRF will be greatly enhanced by up to a factor of one million in some applications as compared to present third generation sources, yet the new design will use 20% less energy.

The current plan is to maintain uninterrupted user operation with the existing X-ray source until October 2018, and for the new storage ring to open to users in June 2020 after a 20-month long shutdown. By 2022, four new beamlines will be delivered along with improvements to detectors and big-data infrastructures across the whole ESRF.



The ESRF's hybrid multi-bend achromat lattice design for a new storage ring is already being adopted by other synchrotron facilities.

Since the ESRF was inaugurated in 1994, the brightness of the source has been increased to values beyond even the most optimistic expectations, and significant improvements were made during Phase I of the Upgrade Programme. However, third-generation synchrotron technology is now more than 20 years old and the past decade has seen a global effort to build yet brighter storage rings by further reducing the horizontal emittance. In 2012, the ESRF announced an innovative lattice that would boost its brightness by a factor 50 while also reusing 90% of the existing ESRF infrastructure.

"Today, the ESRF is the key to the success of a user community of more than 10,000 scientists from Europe and further afield," said ESRF director-general Francesco Sette. "A significant part of their studies is at the crossroads of research, innovation and industry, and the new X-ray source and beamlines will make it possible to continue this endeavour for at least another 20 years."

Users' corner

At the last proposal submission deadline on 1 September 2014, 875 new proposals were received and reviewed during the Beam Time Allocation Panel meetings on 23 and 24 October. The next deadline for submission of standard proposals is 1 March 2015. Proposers must use the most recent experiment methods template available on the user guide web pages and also ensure that experiment reports are submitted for all previous proposals. The next deadline for submission of Long Term Proposals is 15 January 2015, and proposers with LTPs ongoing must submit progress or final reports by 31 January 2015.

The 25th ESRF Users' Meeting will take place on 9–11 February 2015 (see article on left).

News from the beamlines

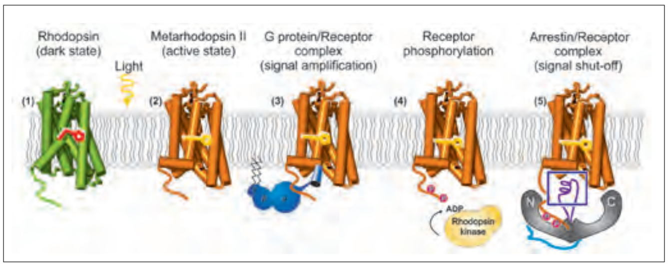
- **ID15** will be closed on 17 December 2014 for refurbishment until early 2016. The new beamline will be located on a canted section and have two branches: ID15A will be dedicated to materials chemistry and engineering, while ID15B will be dedicated to the high-pressure science programme currently hosted at ID09A-HP.
- The Rossendorf Beamline **BM20** (ROBL-CRG) will discontinue operation of its MRH end-station for materials science as of mid-2015. ROBL will continue its operation of the radiochemistry RCH end-station and therefore, as of the March 2015 proposal deadline, the beamline will be able to provide twice as many shifts for XAFS spectroscopy experiments. The focus of ROBL will remain on experiments involving actinides but will also include XAFS experiments for geosciences, chemistry, catalysis and similar fields. In the future, microspectroscopy and high-resolution spectroscopy will also be implemented.
- The high-resolution powder diffraction (HRPD) beamline resumed service in May 2014 at **ID22** following its move from ID31 in December 2013. The beamline is currently operating in its standard high-resolution scanning mode, with more than double the previous X-ray intensity. A large 2D medical-imaging detector will be installed in early 2015, allowing complementary measurements on faster timescales using photons with an energy up to 80 keV for PDF measurements or for prior checking of the texture and granularity of samples.
- The upgrade structural biology beamline MASSIF-1 (**ID30A-1**) is now operational offering a unique, fully automated service for sample evaluation and data collection. Users are able to book time flexibly and samples then enter a queuing system. The service is reliant on the new ESRF-developed sample changer RoboDiff, a highly intense beam (3×10^{12} photons per second in a spot size of $50 \times 100\,\mu m^2$) and complex workflows that fully evaluate samples, centre the best volumes and collect data sets optimised for maximum resolution with minimised radiation damage. So far 1270 samples have been processed, ranging from initial hits from crystallisation experiments to large-scale data collection for drug discovery programmes.

Taste and smell share structure

A collaboration between researchers from the Institute for Medical Physics and Biophysics (IMPB) at the Charité in Berlin and the ESRF has uncovered new details about how our senses of taste and smell function. Using the ESRF's ID29, ID23 and ID14 beamlines, the team discovered that what seem like structurally and functionally different proteins important in sight and smell, in fact share a common component.

In mammalian vision a protein called rhodopsin – the structure of which was solved using synchrotron X-rays more than a decade ago – is responsible for the initial detection of light. It belongs to the family of G-protein coupled receptors (GPCRs), which are found in the membranes around every living cell, and it changes shape in response to photons to create new signal pathways. Vision is regulated by the switching on and off of these pathways, which results in an image being produced in the brain. The signal is switched off when the protein arrestin binds to a previously activated rhodopsin protein, but the new study shows that several different variants of arrestins share a common sequence motif that

NPG



Rhodopsin signal transduction proceeds via discreet steps: (1) dark state of rhodopsin, (2) after a light signal is received the activated metarhodopsin-II state is formed, (3) G-protein binds to the activated receptor, (4) the receptor is phosphorylated, (5) arrestin binds to the phosphorylated receptor and the signal is shut off.

binds to rhodopsin. This suggests very similar interactions between GPCRs and the interaction partners involved in different senses.

Patrick Scheerer of the Charité in Berlin and his team determined the structure of rhodopsin interacting with an arrestin-like molecule obtained from very small protein crystals – a task that would not have been possible without the use of bright X-rays. The results were confirmed by David von Stetten of the ESRF using spectroscopic methods, allowing him to observe structural changes of the protein under natural conditions.

Michal Szczepek from IMPB said: "The results of this work clearly show that the G protein and arrestin both contain a structurally very similar part with a homologous protein sequence, which binds and recognises the receptor in a similar way".

The study furthers our understanding of the mechanisms by which GPCRs interact with their partner proteins in the signal transduction chain. GPCRs are known to play a vital role in physiological processes and in the development of diseases in the body, with around one third of modern drugs directly acting on them (*Nature Communications*; DOI: 10.1038/ncomms5801).

Guillaume Fleury from the University of Louvain at ID09.

Graduates top 800

This year the number of undergraduate and postgraduate diplomas obtained by students having carried out part or the totality of their placement at the ESRF passed the 800 mark. The ESRF opens its doors to over 150 young people every year, although not everyone pursues a diploma. The chance to obtain work experience in a multicultural and multidisciplinary environment attracts a surge of applicants to the ESRF between June and September.

Physics student Miquel Alfaras Espinas at the University of Grenada in Spain, for instance, undertook a three-month traineeship during which he developed a computer simulation to predict what happens when the beamline optics are not properly aligned or sufficiently polished, leading to savings in beamtime and money.

ESRF studies space dust

In conjunction with NASA researchers and other facilities, the ESRF has contributed to a major study involving the first interstellar material brought to Earth. Dust particles captured during NASA's Stardust mission were studied using ultra-bright X-rays at several beamlines, revealing that the particles diverge from the model of interstellar dust built up by observational and theoretical work.

NASA's Stardust mission launched in February 1999. Its goal was to fly through the cloud of dust that surrounds the nucleus of a comet and to collect dust particles from interstellar space using silica-based aerogel blocks mounted in aluminium foil cells. More than 30,000 volunteers joined the search for interstellar dust impacts in a citizen science project known as Stardust@home. When the mission returned its first cometary and interstellar material

NASA/JPL-CALTECH

The Stardust mission contains a dust collector filled with aerogel.

back to Earth in 2006, the grains were found to be partly crystalline with a small carbon content – deviating from models and astronomical observations.

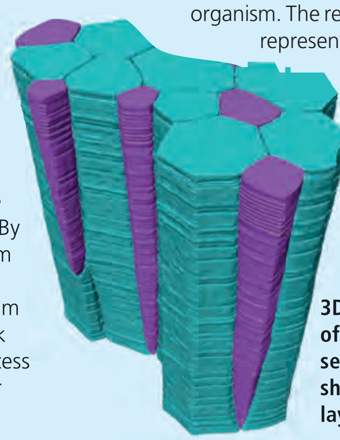
Of the thousands of particles collected and recorded, more than 50 were from spacecraft debris and interplanetary particles, but only seven dust particle impacts have been identified as having an interstellar origin. Impact tracks from the mission were studied at the ESRF's ID13 and ID22-NI nano-focussing beamlines using synchrotron X-ray fluorescence and diffraction techniques, and light sources in the US also contributed (*Science* **345** 786).

Secrets of biomineralisation revealed

Scientists have used the ESRF to follow the growth process of a giant Mediterranean fan mussel by creating a 3D reconstruction of part of its shell (*Nature Materials*; DOI:10.1038/nmat4110).

Igor Zlotnikov from the Max Planck Institute of Colloids and Interfaces and co-workers focused on the prismatic layer of the shell just beneath surface level, which consists of elongated calcite prisms that are bound together to form a honeycomb-like microstructure. By taking slices from different depths within it, the team was able to track the growth process to gain a greater understanding of the forces at play during biomineralisation. "Its like the entire growth process is frozen in the structure", explains Zlotnikov.

The study confirms classical theories about crystal growth in complex systems. Although verification of so-called grain-growth theories have been verified in non-biological materials, this is the first time it has been proven within a living organism. The results therefore represent a fundamental step towards understanding how biological organisms form.



3D reconstruction of a representative segment of the shell's prismatic layer.

Nano-imaging at ID16 accepts first users

The ESRF's new nano-imaging and nano-analysis suite at ID16, also known as NINA, welcomed its first nano-imaging users in October. The upgrade beamline provides high-brilliance beams focused down to nanometre sizes at two end stations located in a satellite building.

The brand new nano-imaging end station ID16A-NI, which is located 185 m from the source, allows quantitative 3D characterization of the morphology and the elemental composition of specimens in their native state by combining coherent imaging techniques and X-ray fluorescence microscopy. The nano-analysis end-station ID16B-NA – which is based on the previous ID22NI end station – offers a multianalysis nano-probe for spectroscopic studies (μ-XRF, μ-XAFS and μ-XRD) capable of *in situ* experiments at selective sub-micrometre scales.


C ROMAO

The first users at the ID16-NI beamline, from the Universidade Nova de Lisboa, obtained impressive results in sub-cellular biological imaging.

The performance of the beamline so far has surpassed expectations. At ID16A an initial beam size of 70 nm was reduced to 20 nm within a few weeks of commissioning, and this is expected to reach as low as 15 nm in the coming months. The long beamline, which requires minimal optics while leaving ample distance between the focusing elements and the sample is remarkably stable against thermal and mechanical drift.

The nano-imaging end-station is unique and combines several original concepts in terms of X-ray optics and nano-positioning devices. Although similar focus sizes have been demonstrated at other facilities, ID16A-NI allows routine operation with an X-ray intensity that is typically one thousand times greater. The instrument currently operates at a single energy of 17 keV, but from spring 2015 a high-energy (34 keV) option will allow studies on energy materials and 3D system integration. The next big challenge is to incorporate a cryogenic environment to allow life scientists to study samples in their native state without radiation damage. Cryo-microscopy studies will become accessible to users in the second half of 2015.

The eventual goal for ID16 after Phase II of the Upgrade Programme, which will provide a factor 20 more photon intensity and transverse coherence, is to reach a beam size of 10 nm. This will allow the investigation of matter and its dynamical properties from the atomic length scale all the way up to the size of real devices.

Tramline reaches new site entrance

After many years of construction a new tramline connecting ESRF to downtown Grenoble opened in September, with services running late into the evening. The ESRF is served by the Presqu'île stop at the terminus of line B, which is a short walk from the new site entrance. The ESRF has also changed its address to 71 Avenue des Martyrs.

The site entrance was financed by the local and regionally funded Contrat Plan Etat Region (CPER) project, which also funded the Science Building and upgrades to the Common Building. Its completion marks the end of civil construction works linked to Phase I of the ESRF Upgrade Programme, offering more flexible access to the EPN campus.

Ultra-SAXS opens at ID02

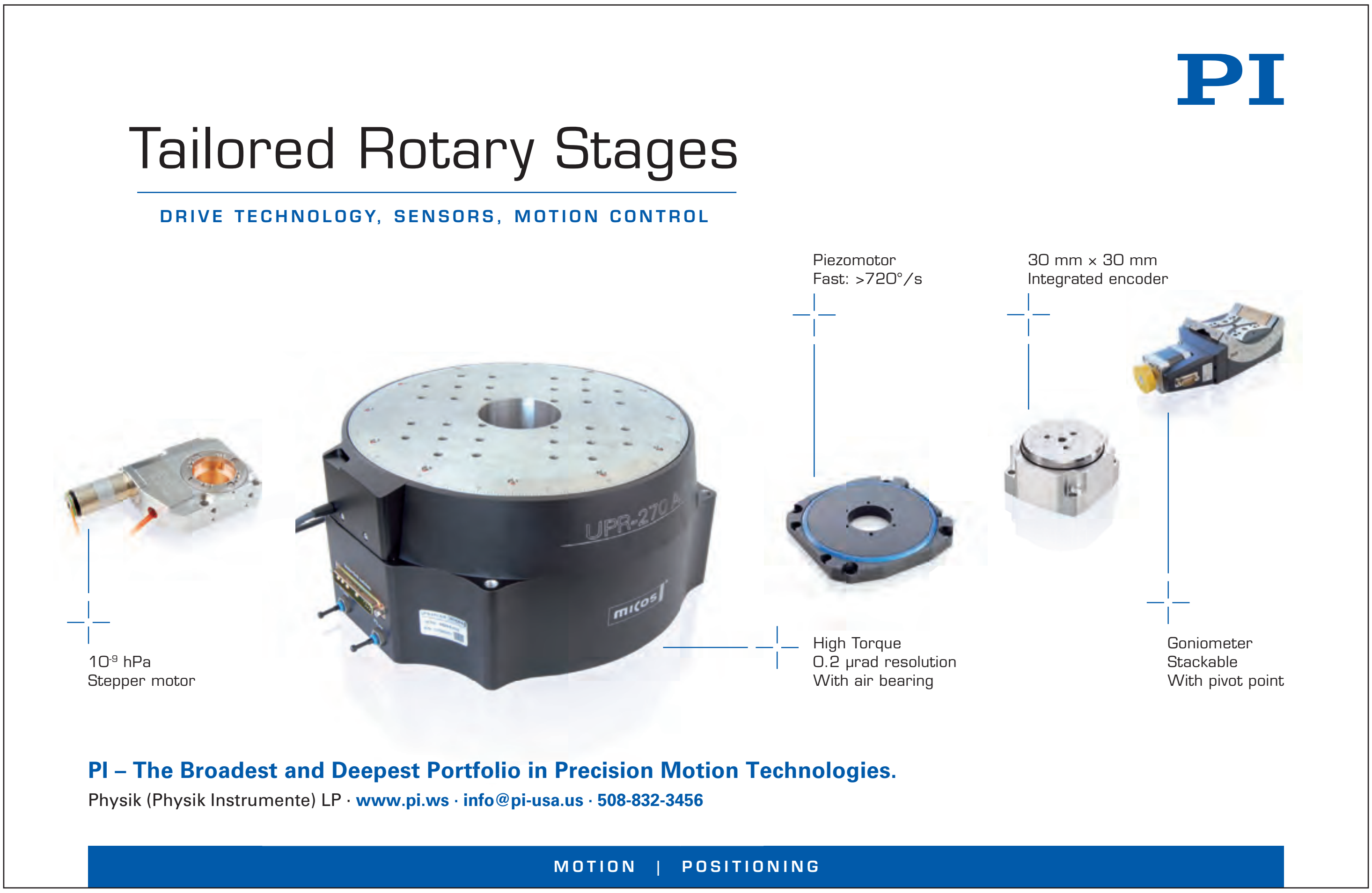
Following nearly two decades of successful operation, ID02 was designated as one of the upgrade beamlines during Phase I of the Upgrade Programme. The aim was to develop an instrument suitable for exploring highly complex dynamical systems over a broad range of size and timescales – not only hierarchically self-assembled soft matter and biomaterials, but also living cells and active systems composed of microorganisms. Former ID02 was closed in July 2013 and the new beamline reopened for users exactly after one year in July 2014.

Inside view of the 34 m-long detector tube at ID02.

The upgrade comprises a novel focusing scheme chosen to preserve the brilliance of the source and a new 34 m-long 2 m-diameter detector vacuum tube that houses multiple detectors optimised for small-, wide- and ultra-small angle scattering techniques (see image). Improvements of the source properties and detector performance, together with the accumulated experience in beamline operation, have been critical to this new design and the new beamline offers ultra-low angle capability while retaining all the features of the original ID02.

Traditionally, ultra-small-angle scattering experiments that probe large structures up to several microns across are performed using a Bonse-Hart instrument based on double or multiple crystal monochromator/analyser scheme. However, this scanning method is less suitable for the highly dynamical systems and radiation-sensitive samples that are the target of ID02. The new beamline provides the same lower angular range and resolution of a Bonse-Hart instrument but with a full 2D scattering pattern and a time resolution in the millisecond range.

Overall, the upgrade has led to a significant enhancement of the accessible scattering vector range (from 10^{-4} to 6 Å^{-1} using 1 Å X-rays) and a time resolution as short as a millisecond. Further optimisation is expected to push the scattering vector down to 6×10^{-5} Å^{-1} and to boost the time-resolution for stroboscopic experiments to the order of 100 microseconds.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Celebrating 20 years of user operation

The ESRF officially opened to users on 30 September 1994. **Christian Riekel**, who was one the first scientists to join the ESRF staff, reflects on the birth and evolution of the world's first third-generation X-ray source.

When I arrived in Grenoble in 1986 to join the local project team, little did I know how far and how fast the ESRF would evolve during the following decades. The facility did not yet even exist officially, and "European Synchrotron Radiation Facility" was merely a temporary name. At an early Council meeting, however, it was decided to stick with the name and not to adopt the proposal of the former ILL director Brian Fender to call it the "Maxwell Institute". Fender had been a strong advocate of the synchrotron at Grenoble, but the Italian delegate did not like his proposed name for it on grounds of its homonymy with a brand of instant coffee! So it was that the ESRF was born, more than a decade after it was first discussed, with 12 countries supporting the project. In 1987, the facility's scientific foundations were published in what became known as the "red book", and construction began the following year.

Back then in 1986 the project team comprised only a few people: Rupprecht Haensel, who was the first ESRF director-general; three co-directors; the heads of administration and technical services and their secretaries; and one or two technical staff. Pascal Elleaume, who would go on to become director of the accelerator and source division, was a thesis student of the then ESRF project director Jean-Louis LaClare. This was a time before mobile phones, laptops and flat-screen displays, of course. The World Wide Web would not be created for a further three years, and we all used a Macintosh computer because at the time it was the only personal computer that could be linked up to a local area network.

Big jump

It was also a time before undulator technology had been used at storage rings and some scientists even doubted that undulators would provide a sufficiently stable source. The jump in the source brilliance in going from a second- to third-generation synchrotron radiation source was tremendous, and can only be compared with the jump between today's synchrotrons and the upcoming fleet of X-ray free-electron lasers (XFELs). Indeed, some of the more bold ideas that were set out in the red book – such as performing crystallography on samples just a few unit cells in size – are only now being taken up at XFELs. Twenty-five years ago, however, we were much less sure about future applications than are present XFEL users, who have already experienced the transition to third-generation sources. The ESRF distinguished itself right from the start by the installation of an in-house R&D programme involving PhD students and post-docs. This turned out to be instrumental in exploring the potential of the new source and the programme continues to this day.

> **"There were heated debates preceding the installation of the first beamlines."**

The choice of the first beamlines was made in close contact with users from existing synchrotron radiation facilities based on the project descriptions provided in the red book. When the ESRF officially opened its doors to users in September 1994 it offered 15 operational beamlines and by the time it was completed in 1998 the number of beamlines had doubled. The number of annual users of the ESRF has steadily grown: during 1994 there were 271 user visits, while in 2014 there were already 2667 in the first six months.

The major change over the past 20 years has been the strong rise of life-science applications, reflecting a broader societal trend. In the beginning protein crystallographers shared a beamline with the small-angle X-ray scattering community – something that Ada Yonath, who would go on to share the 2009 Nobel Prize in Chemistry for studies of the structure and function of the ribosome undertaken partly at the ESRF, complained about at the first users' meeting. This quickly changed after the arrival of Carl Braenden, who initiated the installation of a suite of protein crystallography beamlines and was also very active in attracting world-class projects. It was also he who raised my own research interest in spider silk, which has superior properties in terms of toughness and elasticity than Kevlar. For the first time, the intense ESRF microbeams allowed us to probe the structure of single silk fibres. Indeed, at around that time I and my colleague Per Engström even studied a single hair from Napoleon for traces of arsenic contamination. The study made it into the local news, as have numerous other cultural heritage X-ray studies at the ESRF in the years since.

Exceptional quality

A major worry for the team responsible for building the beamlines was the stability of the source. There were heated internal debates preceding the installation of the first beamlines because the experimental-hall floor was not as stable as expected. Gerhard Gruebel, Ake Kvick and I installed the first three test beamlines (ID10, ID11 and ID13) to start using the machine. There were a lot of exploratory experiments in the test phase preceding official user operation in 1994 and instrumentation had to be rapidly adapted. Getting the first exciting scientific results before the third-generation sources in the US (APS) and Japan (SPring-8) became operational was a strong driving force.

The exceptional quality of the ESRF became quickly evident. At ID13, for instance, we demonstrated intense nanometer-sized beams generated by Bragg-Fresnel optics that far surpassed what was envisaged in the red book. This success relied on a young Russian scientist called Anatoly Snigirev –who would go on developing compound refractive lens X-ray optics that can now be found in multiple beamlines around the world. Led by Kvick, the ID11 beamline started to explore short wavelength studies for materials science, such as high pressure and high resolution powder diffraction, whilst Gruebel's team at ID10 explored experiments ranging from surface scattering to protein crystallography.

Instrumental R&D and beamline installation were of course not as well co-ordinated as they are nowadays. Indeed, we found ourselves installing the first beamlines without having a cooled monochromator in place, although we did have a strong R&D program on alternative schemes of coping

2.21
proposal oversubscription factor

33,776
proposals submitted

92,668
user visits

246,280
shifts delivered for experiments

10,600
biological structures solved

24,840
publications in peer reviewed journals

3
Nobel Prizes for Chemistry linked to ESRF

with the heat load. As the date for first user operation approached, we also developed in a crash-program a liquid nitrogen cooled monochromator. Nowadays a common liquid nitrogen loop feeds all the beamlines, but in 1994 the beamline staff at ID13 found itself changing the Dewar every half an hour in order to maintain the monochromator temperature. We often encountered delays in installing components, and sometimes pioneering solutions had to be found.

The range of experiments on offer today at the ESRF and the broad spectrum of users from different disciplines were impossible to imagine when the ESRF was established. Continual improvements to the source and beamlines have inspired developments at numerous other third-generation facilities that have started up since 1994, and the Upgrade Program will ensure that this continues. The number of supporting countries has also increased dramatically.

My wish for the future of ESRF is that it maintains the spirit of innovation and gives young scientists sufficient freedom to explore their own ideas, as I had the privilege of experiencing at the birth of the ESRF. Scientific advances depend not only on advanced instrumentation but also on the possibility of fostering collaborations across borders defined by beamline teams, groups and disciplines. Establishing strong links between the ESRF and XFEL facilities will be of mutual interest for these highly complementary sources.

Christian Riekel is emeritus scientist at the ESRF and former scientist-in-charge of the microfocus beamline ID13.

The ESRF under construction in the early 1990s; celebrations for its inauguration in 1994; Pascal Elleaume describing the machine to the then French minister for research François Fillon (bottom right).

Russia joins the ESRF

Following several years of discussions, the Russian Federation has become a full member state of the ESRF.

C ARGOUD/ESRF

Russian and ESRF delegates celebrate the signing of the accession protocol at the ESRF in June.

On 17 December 2013, Russian Prime Minister Dmitry Medvedev signed a governmental act authorising the accession of the Russian Federation as a new contracting party of the ESRF intergovernmental convention. On 23 June this year, on the occasion of the 61st meeting of the ESRF Council, the Accession Protocol was signed in Grenoble, making Russia the 13th Member State of the ESRF with a participation of 6%. This corresponds to approximately €5.3 m and makes Russia the facility's fifth largest contributor.

"This is wonderful news that underlines the long-standing scientific and technical collaboration existing among scientists and engineers from Russia and from the other 20 ESRF partner countries," said Francesco Sette, ESRF director-general. "Exactly 25 years after the signature of the ESRF convention, the reach of the ESRF expands on a global scale thanks to an ambitious Upgrade Programme. Russia's membership has profound implications in ensuring a successful continuation of the ESRF leadership in synchrotron science for many years to come, and I wish to thank the engagement and support of all those who made this accession possible, in particular: Mikhail Kovalchuk, who is director of the National Research Centre Kurchatov Institute (NRC-KI); the ESRF Council delegates; and Jean Moulin, who was chair of Council during the key negotiation period 2011–2013."

Present ESRF Council chair Bertrand Girard said the accession of Russia is an important step for the ESRF: "The ESRF is facing a new challenge with its Upgrade Programme Phase II and the scientific and technical contribution of the Russian scientific community will play an important role in its successful delivery, bringing the ESRF to even higher levels of excellence."

Stronger co-operation

Russian scientists have been involved with the ESRF since its beginnings and have contributed to the development and operation of several beamlines and innovative instruments. Historically, most Russian users have gained access to the beamlines by linking up with international groups. The ESRF first signed a Memorandum of Understanding with the NRC-KI in Moscow mid-2008 and subsequent negotiations paved the way towards a stronger partnership. Then, at a meeting held in Moscow at the Russian Ministry of Science on 22 June 2011, officials from the ESRF and the NRC-KI laid down an agreement for the participation of Russian scientists in experiments at the ESRF with the aim of Russia becoming a full member state. Within weeks of the 2011 meeting, the ESRF sent a 10-strong delegation of ESRF scientists, half of whom were from Russia, to the NRC-KI and invited Russian researchers who stand to benefit from synchrotrons. The level of interest surprised everybody, recalls Vladimir Dmitriev, who is director of the ESRF's Swiss-Norwegian beamline. "People had just 10 days notice of the meeting, yet over 100 turned up – some having taken a four-day train journey from the other side of the country," Dmitriev told *ESRFnews*.

Since the 2011 agreement it has been possible for Russian users to access the ESRF peer review programme under the same conditions applied to Member States. Russian nationals presently contribute some 3% to the ESRF's scientific output – a figure that is now set to grow rapidly.

Membership of the ESRF will also bring expertise in synchrotron science and engineering that will help Russia develop domestic facilities, explains ESRF research director Harald Reichert. "If you look at new third-generation sources such as PETRA III, Soleil, Diamond and Alba, you will see that many of their scientists are former ESRF staff, and many of the adopted technical solutions were initially developed at the ESRF, which tells you that there is an additional benefit from being a member of the ESRF."

Veniamin Kaganov, Deputy Minister of Education and Research of the Russian Federation, described the ESRF as a perfect example of successful international collaboration and acknowledged the support of the ESRF partner countries in Russia's accession. "Russia will do its best to help the ESRF to go further with its ambitious and challenging Upgrade Programme and to maintain its world leadership in the use of synchrotron radiation," he said.

Matthew Chalmers

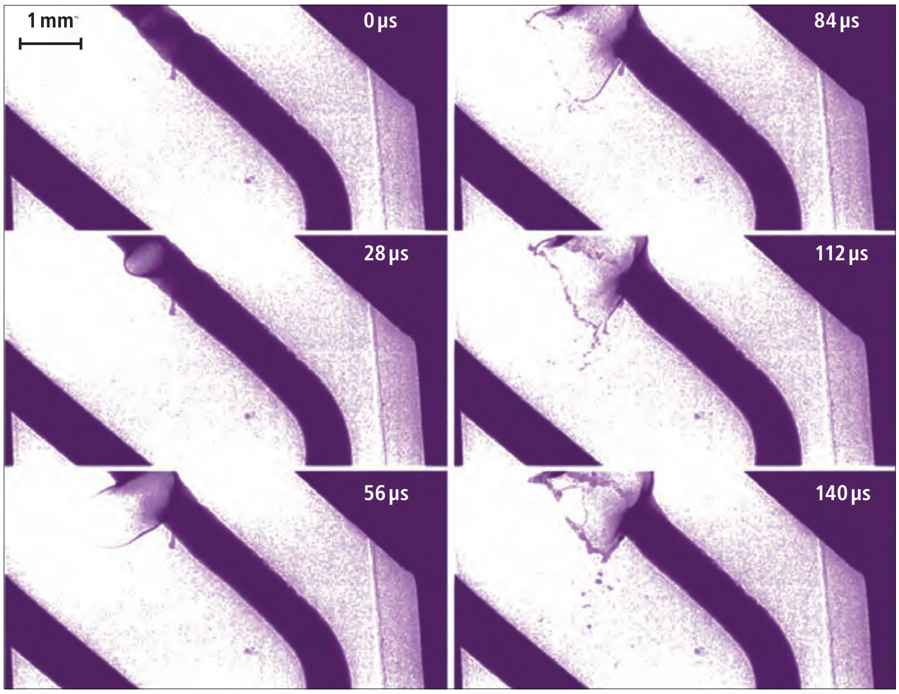
Russia targets big science

Russia has two operational synchrotron radiation sources: a 124 m-circumference 2.5 GeV storage ring at the Kurchatov Institute (SIBERIA-2) and a 75 m-circumference 2.2 GeV machine (VEPP-3) at the Siberian Synchrotron Radiation Centre in Novosibirsk. Plans for a fourth-generation synchrotron have been mooted for more than a decade. The Russian government has announced plans to invest around 130 bn Rubles (€2.7 bn) on six new "Mega-Science" projects with the objective of strengthening the country's position as a leader in research infrastructures to meet modern fundamental and applied science demands.

Among these projects stands the new advanced photon source to be built by the Kurchatov Institute. Russia is also partner in a German–Russian nano-diffraction beamline at DESY's PETRA III source, has observer status at the SESAME source in Jordan, and is a major shareholder of the European-XFEL in Hamburg. The country has held observer status at CERN since 1991 and is also a member of ITER (the fusion reactor under construction in France) and of FAIR, the facility for antiproton and ion research under construction in Darmstadt, Germany.

Single bunches offer picosecond studies

Ultrafast processes can be studied directly thanks to single-bunch X-ray imaging, diffraction and absorption techniques under development at the ESRF.



Single-bunch imaging at ID15A shows pore formation in an electric wire leading to the rupture of a fuse. A metal pore lamella, which is expanding at a rate of 17 ms^{-1}, is clearly visible.

In 1878 the British photographer Eadweard Muybridge used a series of cameras to settle a long-running debate about whether a galloping horse's feet leave the ground all at once. It was the first practical demonstration of high-speed photography and since then researchers have developed numerous ways to capture ever-faster motion. A top of the range digital camera might have a shutter speed of a few 100 ns, while advanced lasers can produce pulses lasting less than 100 attoseconds, which is sufficient to probe the motion of electrons in atoms.

Ultrafast X-ray pulses, however, can deeply penetrate matter to provide information about buried structures, their chemical compositions and the positions of atoms. The potential of hard X-ray techniques to tackle scientific challenges in fluid dynamics, crack propagation or shockwaves can be substantially increased by reducing the duration of the photon pulses.

Until now, the temporal resolving power of X-ray techniques at synchrotrons was generally limited to the shortest exposure time accessible via the detector, which is typically in the region of a few microseconds. By exploiting only the light from a single-bunch of electrons in the storage ring, however, this value drops to a few hundred picoseconds and gives synchrotron users access to a new time domain.

Proof of concept

Single-bunch imaging requires a high photon flux and detectors that are fast enough to discriminate light from different bunches. The technique was first demonstrated in 2008 at the Advanced Photon Source in the US, but transposing it to the ESRF beamlines allows us to exploit complementary features such as the increased beam dimensions as well as hard X-ray energies and superb coherence (*Journal of Synchrotron Radiation* **21** 815).

For the first proof-of-concept experiments, we operated the ESRF in a dedicated single bunch mode in the summer of 2013. With a current of 10 mA, the measured duration of the corresponding X-ray flash was 140 ps. The revolution frequency of the bunch is 355 kHz, which corresponds to a separation of 2.81 µs – long enough to allow separation of the flashes by the ESRF's commercial CMOS-based cameras.

> **"Until now the temporal resolution was limited by detector speeds."**

In this special mode of operation we were able to capture a fuse breaking under high current using the ID15A beamline (see figure). In a parallel experiment, ID19's superb coherence properties were used to track crack propagation in a piece of glass that was being shattered through the impact of an accelerated bolt. Considering the high speeds of such events the acquired images are of excellent quality in terms of sharpness and contrast.

In parallel with the demonstration of ultrafast imaging, a team at the ESRF's ID24 beamline, which specialises in high-pressure experiments, applied single-bunch techniques to absorption studies. For the first time at a synchrotron, dynamically compressed iron, reaching pressures and temperatures corresponding to those in the Earth's core, was investigated. A compact focused laser beam was used to produce a shock in the sample with sufficient duration to be probed with a single X-ray pulse. Usually much larger and very high-energy lasers are required to produce such extreme states, making the experiments costly and less accessible. Successful tests were also performed at the ESRF's ID09B beamline, where a single-bunch diffraction pattern was measured on dynamically compressed bismuth.

Big step

Using synchrotron storage rings as a pulsed rather than continuous X-ray source opens up new scientific possibilities for users. Although a storage ring will never reach the performance of an XFEL (the European XFEL under construction in Hamburg, for instance, will produce pulse durations of a few femtoseconds), single-bunch techniques close the gap between the two types of facility. The availability of synchrotron beamlines is much higher than at an XFEL, the price per experiment lower, and the arrival time of an individual pulse is known much more precisely.

With the ESRF Upgrade Programme entering Phase II we can expect an increase of about two orders of magnitude in source brilliance, which translates directly into a corresponding increase of beam coherence. This will take ultrafast imaging from a niche application towards a routine tool in materials science and also open other exciting opportunities such single-bunch diffraction and spectroscopy. The expected performance of new near-diffraction limited light sources thus constitutes a big step towards new applications of single-bunch imaging, diffraction and spectroscopy for materials science.

Alexander Rack is a scientist at ID19; Raffaella Torchio and Olivier Mathon are scientists at ID24.

X-rays show first photos in new light

A team at the ESRF's DUBBLE beamline has revealed chemical processes that take place in daguerreotype photos, helping conservators preserve and enhance these unique artefacts.

In 1839, Louis Jacques Mandé Daguerre introduced the world to commercial analogue photography. The daguerreotype process offered the first alternative to a painting or drawing and was seen as a great novelty, with small photos often given as gifts inside cases or jewellery. The daguerreotype process began with a polished silver-coated copper plate that had been sensitised with chemicals such as chlorides of iodine and bromine. Once exposed, the plate would be returned to a darkroom and the image developed using mercury fumes and then fixed by bathing the plate in thiosulphate. The method became widely available during the 1840s and 1850s, but by the 1860s it had been superseded by new technology.

Like many photographs, the quality of the images has faded over time. But unlike more recent forms of photography, which offer the potential for replicas via negatives or digital copies, in the case of daguerreotypes only one of each image was made. This makes conservation efforts even more vital because many valuable and irreplaceable artistic portraits and historical documents, for instance relating to the American Civil War, were made using this 170-year old technique.

Earlier this year, a team from the University of Antwerp and Ghent University in Belgium took daguerreotype photographs to the ESRF's Dutch–Belgian beamline "DUBBLE" at BM26A where they used X-ray absorption fine-structure spectroscopy to gain a greater understanding of the corrosion occurring to the photographs. The team looked at the influence of natural factors such as pollutants and humidity damage but also studied the effect of different cleaning methods specifically to address the concerns of conservators.

EVA GRIETEN

A daguerreotype photo before (right) and after (left) plasma treatment. Studies at the ESRF show that such cleaning processes are not harmful to the material's microstructure.

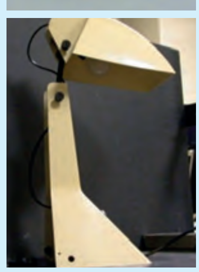
Safe cleaning

Museum conservators are constantly looking for improved cleaning methods that are able to remove corrosion products without altering the original microstructure. Until now, however, no satisfactory cleaning method exists for the treatment of coloured daguerreotypes. Traditionally, exposure to cyanide and thiourea is used but this can damage the microstructure or instigate future corrosion. One of the most promising cleaning methods under consideration is an afterglow generated by a plasma at atmospheric pressure, a technique that was discovered several years ago and further improved in the EU-project PANNA.

Olivier Schalm from the University of Antwerp and co-workers observed the daguerreotype after it had been cleaned with plasma treatment and saw that only the copper oxides that had developed on the surface, i.e. the corrosion, appeared to be reduced whereas the gold-coated nanoparticles responsible for the image formation were unchanged. Visually, the readability of the image had clearly been improved (see image). "This information will be of vital importance for conservation efforts and might allow future generations to still have access to the visual record from the early days of photography," says Schalm. "It shows that this form of cleaning isn't damaging the sample itself, but just eliminating some of the degradation that has occurred, which is exactly what conservators are looking for."
Lucy Stone

Preserving famous plastics for future generations

Iconic 1960s Italian design items, including the first "Grillo" phone to be made out of plastic and the famous E63 table lamp (pictured), have been studied at the ESRF's ID21 beamline to help conservators understand the processes that cause certain polymers within them to degrade.



Polymers have a short life span but it can be hard to pinpoint what is causing their degradation. Using infrared microscopy, a team from Politecnico di Milano and the Institute of Photonics and Nanotechnologies in Milan produced molecular maps of acrylonitrile-butadiene-styrene, an important constituent polymer that is also found in domestic appliances, luggage and musical instruments.

Samples that had been artificially aged to mimic 1000 hours of light exposure were prepared in thin transversal cross-sections in order to see how deeply beneath the surface the damage from light exposure occurs.

The team found that the plastic became almost fully degraded to a depth of 80 µm, whereas deeper within the plastic the polymers were unaffected. "Surface damage can be the starting point for severe damage as well and can affect the properties of the whole bulk causing irreversible changes to chemical properties," explains team leader Daniela Saviello. "Such evaluation is possible only by carrying out analysis with high-resolution techniques." As well as helping to preserve museum pieces it is hoped that the knowledge will help inform the development of future plastics (*Analytica Chimica Acta* **843** 59).
Lucy Stone

Case studies: ESRF adds va

Hundreds of companies in sectors ranging from the chemical industr
tools and tailored industry services to overcome the

BASF
improves coatings

Global chemical company BASF develops a range of innovative solutions for automotive and industrial coatings, refinishes and decorative paints. A key ingredient of its paints and coatings is titanium oxide (TiO_2), which is responsible for the whiteness of the coating. Improved utilisation of TiO_2 benefits consumers by requiring less coating to achieve the same opacity or "hiding" power. Such improvements also reduce the costs to the producer and can reduce the amount of energy consumed in coating production.

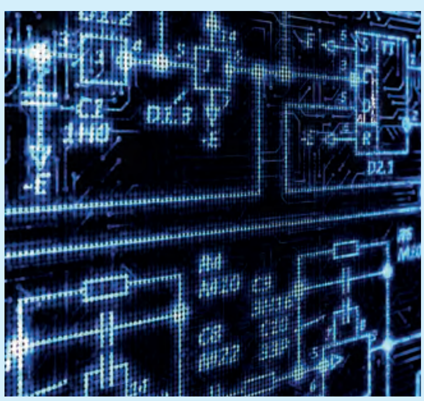
The major drivers influencing the distribution of TiO_2 in coatings can be identified by studying fundamental colloidal interactions in model and complex coating formulations. This requires a combination of characterisation techniques covering dynamic and structural properties of formulations and coatings. SAXS experiments at the ESRF's ID02 beamline have enabled systematic studies of such interactions within pigment-free systems, dispersed TiO_2 slurries and full-scale formulations as well as the dry coatings.

"We like co-operating with the ESRF due to its variety of partially unique experimental techniques, its mail-in option, professional customer-oriented beam scientists, regular beam-time availability, flexible conditions and well organised industry services group," says Volodymyr Boyko, a research scientist at BASF Material Physics who co-ordinates ESRF co-operation. "The synchrotron provides us with unique information about properties of our products and helps us to improve and/or develop our own characterisation techniques, which strengthens our R&D and improves long-term competitiveness."

STMicro
goes beyond Moore's law

Chip manufacturers need to find innovative new ways to design circuits if they are to continue the relentless technology trend described by Moore's law. IRT Nanoelec is one of seven major programmes established in France to leverage high-tech industry through public- and private-sector research, specifically concerning communications and information technology. Established in 2012 and involving the ESRF and the ILL, its aim is to develop 3D assembly for increasingly complex chips and silicon nanophotonics for faster communication within and between chips, in addition to defining preparation and characterisation processes for materials such as amorphous silicon and III-V semiconductors.

"For 3D integration of chips the ESRF provides a unique tool to characterise large-area silicon wafers," says laboratory manager Nadine Bicaïs of STMicroelectronics, which is one of several industry partners of IRT Nanoelec. "Thanks to the high brilliance provided by the ESRF, X-ray-based techniques allow us to observe large embedded features while maintaining state-of-the-art resolution."



BP
seeks better catalysts

BP scientists have entered into a two-year academic collaboration with the ESRF and University College London to explore the potential of techniques that offer real-time insight into the evolution and stability of catalysts under realistic reactor conditions, such as those found in oil refineries. A full-time postdoc has been in place since May this year and will help to establish relevant beamline techniques.

Industrial catalysis typically uses millimetre-sized catalyst bodies in fixed-bed reactors, the efficiency of which depends on the nature and distribution of metals and metal oxides across the catalyst body. However, little is known about the process by which an active phase forms from an impregnation precursor or how it behaves under reaction conditions.

Dynamic X-ray diffraction computed tomography developed at the ESRF's ID15 beamline provides 2D and 3D spatial information about the chemical species present, and the high energy and photon flux allow multiple X-ray data sets to be obtained simultaneously even when the sample is contained within a metallic vessel.

"Detector and micro-beam developments at ID15 in the past few years have meant that we can image large volumes with high resolution in a very short time, and extend a single-particle study to a number of sub-micron particles," says principal investigator Andy Beale of Harwell Research Complex and University College London, UK. "The ESRF is so well equipped that we can turn up with some loose ideas for a new experiment, yet be confident that we will return home with new data."

alue to industrial research

y to advanced medical therapies use the ESRF's unique X-ray analysis technological hurdles to new product development.

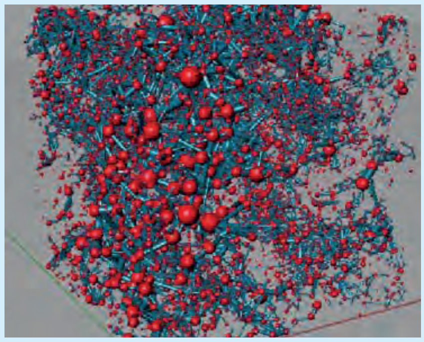
Varian
targets lung cancer

The treatment of cancer remains a major challenge. Even after surgery, chemotherapy and/or radiotherapy, the long-term prognosis for many patients is very poor for certain cancers. Shifting the radiation source from X-rays to protons and heavy ions is a promising new avenue for radiosurgery. Another potential approach presently under study is microbeam radiation therapy (MRT), which delivers very high doses of synchrotron-generated sub-millimetre X-ray beams to tissues in a fraction of a second.

MRT research carried out at Brookhaven National Laboratory in the US, SPring-8 in Japan and the ESRF over the past 20 years has shown that such beams are very well tolerated by normal tissue, with damage being highly confined and easily repaired. However, MRT beams are much less well tolerated by tumour tissue and vessels, which are more fragile.

Researchers from Varian Medical Systems in Palo Alto, California, US, are using the ESRF to investigate the potential of MRT for the treatment of lung cancers. In particular, the firm is investigating whether or not MRT generates pulmonary fibrosis, which is often a toxic side-effect of conventional radiotherapy that impacts quality of life and can even lead to death. Varian's project utilises the ESRF's ID17 beamline and nearby Biomedical Facility to perform MRT preclinical trials with rats.

"We chose ESRF because it has been the premier site for MRT studies," says Michael Wright, who is a senior scientist at Varian. "In addition to the excellent beam characteristics and beam delivery facilities, ESRF has a superb animal-care facility. We have been delighted with the expertise, enthusiasm and good will of the ESRF scientists."



iRock
improves oil recovery

iRock Technologies, which is headquartered in Beijing, China, provides innovative digital core analysis software and services to the global oil and gas community, helping to improve recovery in conventional and unconventional reservoirs. iRock's digital core analysis predicts petro-physical parameters and fluid flow properties for reservoir rocks, based on proprietary RockDNA pore-network modeling technology and direct computation on grid-based 3D rock images at multiple size levels, ranging from centimetre to nanometre scale.

The acquisition of 3D rock images, which is the input to all petro-physical simulations, requires a series of high-end imaging equipment such as micro- and nano-CT scanners and electron microscopes in order to cover the required scales. Each instrumental setup provides a highly specific range of image resolution/voxel sizes.

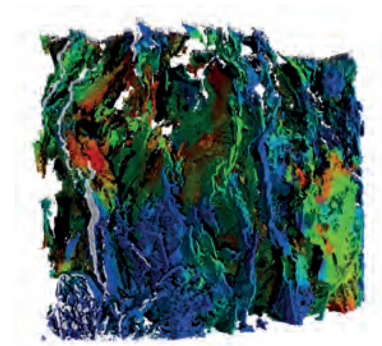
"The ESRF's ID19 beamline has the capability to acquire relatively large volumes of rocks at high resolutions, plugging the gap of commercial desktop X-ray CT scanners," says iRock technology vice-president Sven Roth. "Voxel sizes ranging from 170–300 nm currently can only be provided by synchrotron facilities such as the ESRF."

Novitom
bridges the gap

Novitom is a service provider that specialises in advanced synchrotron X-ray imaging, acting as an interface between industry and large research facilities such as the ESRF. The Grenoble-based company was created in 2011 and currently employs six people, many of who are former ESRF users. It offers clients access to non-destructive characterisation tools that reveal the 3D microstructure of materials and products with exceptional quality and resolution.

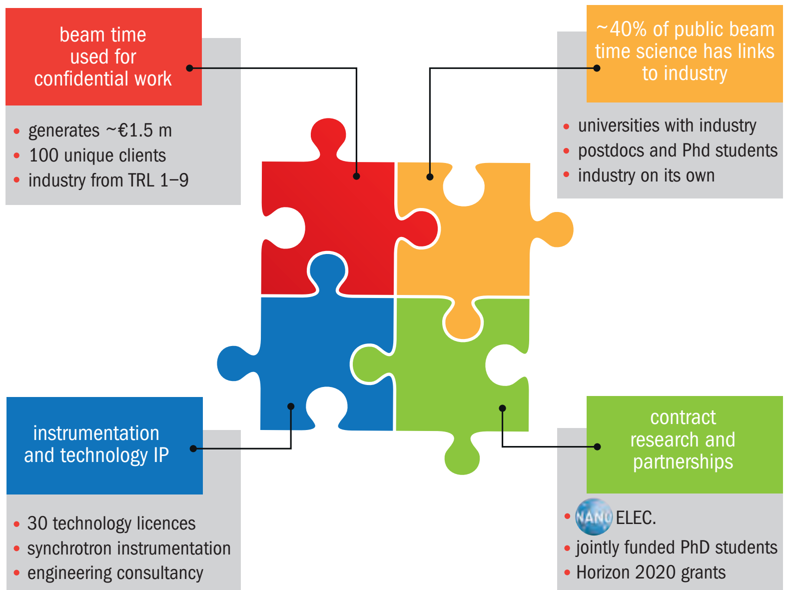
Novitom pre-books beamtime at synchrotrons (principally the ESRF so far) and offers clients a full data collection service: its teams plan and then carry out the experiment, treat the data and write a report for the client. "It's very flexible," says Novitom cofounder and CEO Barbara Fayard, who is also a former CNRS researcher. "Many synchrotrons have an industry liaison office but often they are dedicated to expert clients who know what they want to do. Ours is a different situation," she explains. "Most of our clients don't know much about synchrotron radiation but they have problems in materials characterisation, for instance, and they can't get a solution with standard laboratory techniques."

The firm's 70-plus clients span numerous sectors ranging from aerospace to pharmaceuticals, with a large number of clients working in cosmetics and composite materials. Novitom is also in discussions with other light sources, and has started to extend its services to spectroscopic and diffraction techniques. "Most of our clients come back. For them the good thing is that they get the most from these huge instruments that are really excellent for analysis, but none of the complications in using them," says Fayard.



Open for business

Creativity is at the heart of working with industry at the ESRF, be it via paid-for access, the peer review user programme, collaborations with students and postdocs or licensing and consultancy deals.



The ESRF Convention, which was signed in 1988, states that synchrotron radiation "will in future be of great significance in many different fields and for industrial applications". Embracing industry's need for routine materials characterisation and more complex R&D has therefore always been a strong motivation for member countries to invest in the ESRF. There is an expectation on taxpayer-funded facilities to deliver both curiosity-driven science and results that are directly relevant for industry, and dedicated industry offices now exist at many facilities.

The ESRF was the first facility to offer companies access to a third-generation synchrotron, and industry scientists were amongst the first ever users in late 1994. Those pioneering clients came to beamline "BL4", now ID02, for protein crystallography studies. This launched the growth of structural biology services for industry and set the scene for synchrotron use by European pharmaceutical and biotech companies (see article on p21).

Since then, the ESRF has attracted users from a range of firms that are interested in characterising materials and systems at the micro- and nano-scales. Our modern way of life depends upon smart materials such as advanced turbine blades, clothing fibres, washing detergents and catalysts. Synchrotron X-rays offer unparalleled ability to link microscale behaviour with macroscopic properties, and increasingly allow *in operando* studies of complex real systems (see case studies on pp16–17).

Strong growth

Commercial use of the ESRF generates around €1.5 m annually. Protein crystallography remains a central paid-for activity and is now almost a mature market in Europe. We have also witnessed strong growth in X-ray imaging, particularly tomography. The ESRF's large X-ray spectral range and coherence properties enables users to look inside materials ranging from rocks, steels and alloys to batteries, foods and biological implants. Following the path towards greater automation trail-blazed by structural biology, applications such as tomography, small-angle X-ray scattering and powder diffraction are now developing into routine tools.

"We need to move from an expert only to a problem solving facility."

Additional income comes from the exploitation of our instrumentation and engineering expertise via technology transfer and direct sales (see article on p23). Since the first ESRF technology licence, the market for beamline instrumentation has exploded and many supply companies have grown alongside the birth of national third-generation facilities – examples include JJ X-ray in Denmark and CINEL in Italy. Worldwide, the ESRF is probably the most knowledgeable light source in terms of synchrotron engineering expertise and instrumentation.

It is true that barriers exist to industry making the best use of central facilities (see CALIPSO article on p25), but new business models are emerging to address this.

One is the existence of companies that bridge the gap between large research facilities and the commercial world, such as Grenoble-based firm Novitom, which provides expertise in synchrotron tomography. Meanwhile projects such as NanoElec, which is being funded by the Grenoble region and the French government, are putting centre-stage the interactions between high-tech electronics firms and local neutron and synchrotron facilities (see article on p27). At a broader EU scale the recent round of Horizon 2020 calls included support to allow European research infrastructures to better interact with industry.

The next 20 years

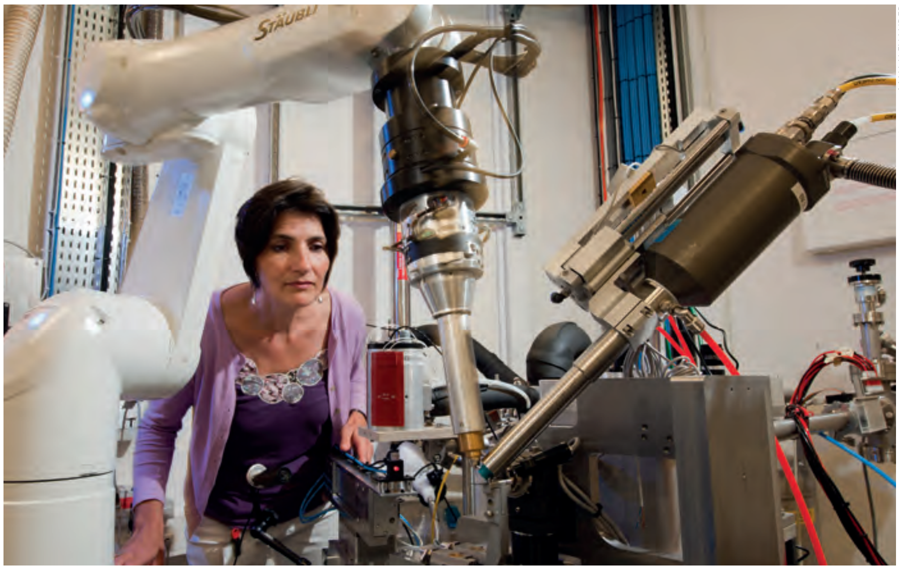
Phase II of the ESRF Upgrade Programme will open the door to wholly new capabilities to study industrial materials and processes at unprecedented spatial and temporal resolution. Harnessing these for commercial enterprise will require a shift in how the ESRF functions. As is starting to be recognised across the ESRF, we need to move away from being an "expert only" facility towards a "problem-solving" facility that is able to provide easy, rapid access to beamlines and which offers advanced online data analysis to help users interpret results and take the right decisions quickly.

The ESRF's Business Development Office has a vital role to play in this transition. Over the coming years, a growing band of ESRF technicians, engineers and scientists with the mission to conduct applied research for private enterprise could be dedicated to deliver materials characterisation at the very highest levels. Being on site and drawing together know-how with X-rays, neutrons and complementary techniques together with external experts, this force for innovation would, in the style of Germany's Fraunhoffer institutes, allow the promise of the ESRF's Convention for industry to be finally and fully realised.

Ed Mitchell is head of the ESRF's Business Development Office.

Pharma paves the way

High demands made by industry have helped drive increased automation of the ESRF's MX resources.



MAX ALEXANDER

Stephanie Monaco and the robotic sample changer at the new MASSIF-1 end station.

Biological macromolecules are made up of one or more proteins and/or nucleic acids and are responsible for energy storage, signalling, cell division, muscle contraction and numerous other essential life functions. Synchrotron beamlines that are optimised for macromolecular crystallography (MX) experiments allow scientists to investigate the fundamental structures of such molecules and how chemicals interact with them, helping industry to design more efficient medicines.

Pharmaceutical and biotech companies have worked with the ESRF's MX beamline scientists since the very start of user operations in 1994 and were quick to appreciate the power of synchrotron beamlines compared with laboratory X-ray sources. The high brilliance of the ESRF beams and the ability to focus them into very small spot sizes meant that researchers could collect much higher quality data in a much shorter time, even from challenging crystals.

Today, the ESRF operates four MX beamlines with six end stations and involves some 30 scientists and technicians. Around 20 firms are regular users. Companies that have benefitted from the ESRF include BioXtal and Novartis Vaccines, which determined the structure of a meningitis-B cell-surface protein in complex with a neutralising antibody, and Astex Pharmaceuticals who studied the structural basis of bacteria to find inhibitors for use as potential antibacterial drugs.

In 2001, a pilot study with French healthcare firm Sanofi was established in order to build the first mail-in crystallography platform at a synchrotron in Europe, which opened to other clients one year later. A close interaction with our industrial users has been an important driving force for the development of a number of critical beamline tools, including our first laboratory information management system. Originally called PXWEB, the system was transformed four years later into ISPYB to allow the transfer of sample information from the users in return for real-time information about the data collected.

The throughput of the beamlines increased dramatically in 2007 with the arrival of automatic sample changers co-developed with EMBL Grenoble. This also opened the way for remote access, which meant industry researchers could control the entire experiment from their office. Today, about 90% of industrial activity carried out at the ESRF's MX beamlines is via remote access. We have also developed optimised workflows and beamline control graphical user interfaces (proDC and then MxCuBE) to help clients carry out experiments as quickly and efficiently as possible. With the arrival of fast-readout pixel detectors in 2011 it was no longer possible to analyse data manually in real time on account of the extremely high throughput. We therefore introduced automatic data processing to allow users to keep up with the volume of data produced.

The upgrade project MASSIF (massively automated sample selection integrated facility) allows complete hands-free data collection. Samples are automatically aligned in a 50 μm^2 beam, characterised and measured following a diffraction plan calculated by the workflow software. This tool is the final incarnation of the automation process and is particularly well adapted to fragment-based screening projects. The first end station offering this service, MASSIF-1, is being trialled in conjunction with clients and will receive its first industrial users in January 2015. Running automatically, the beamline will offer highly cost-effective access to the ESRF's MX capabilities.

Fruitful collaboration

Several fruitful collaborations on specific research projects with industrial partners are also in place. Pierre Fabre Pharmaceuticals and the high throughput crystallisation platform at EMBL Grenoble, for instance, have targeted a humanised antibody fragment in order to validate its interaction with an antigen. Industry scientists are also becoming increasingly interested in bioSAXS, which can be used to study the structures of proteins that are difficult to crystallise or that require a structure validation in solution.

Twenty years ago, the ESRF set the scene for synchrotron use by the pharma and biotech industries. Working with industry has helped the ESRF's MX beamlines mature rapidly and we continue to nurture this interaction. Rightly, pharmaceutical use of MX is held up as an example of successful industry research at large infrastructures. Given the necessary resources, other research sectors could also undergo such evolution to make their techniques more efficient and accessible to industrial researchers.

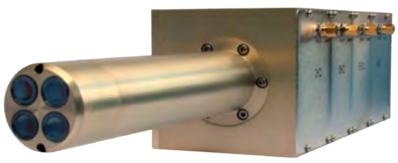
Stéphanie Monaco is an industry liaison officer for the ESRF's structural biology beamlines.

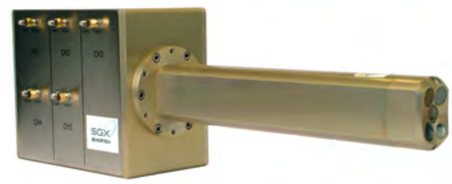
20 years of industrial macromolecular crystallography at the ESRF

1994	First MX clients at the ESRF from the US pharma industry
2001	Mail-in service begins at the request of pharma industry
2006	Automatic sample changers allow remote access and boost throughput
2011	First services offered in partnership established with EMBL Grenoble
2012	BioSAXS mail-in service broadens access to proteins in solution
2013	Remote access becomes *de rigueur*, adopted by 90% of clients
2014	MASSIF heralds beginning of fully automatic, high throughput MX

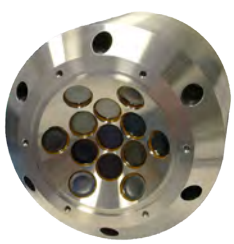
SGX SENSORTECH

Multi-element SDD detectors for beam-line applications





SGX Sensortech has a distinguished heritage in the manufacture of **Silicon Drift (SDD) and Si(Li) detectors.** Previously known as e2v scientific and Gresham Scientific, SGX specialises in producing detectors from standard designs through customised assemblies to complex multi-element detectors.



Multi-element designs feature:

- •1 to 19+ channels
- •Sensors with active areas of 10, 30, 65, 100 & 165mm^2
- •Resolution from 126eV
- •P/B >15k
- •Focussed or planar sensor arrangements
- •High count rate with CUBE® technology to >2.5Mcps
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Applications include:

- •X-Ray Fluorescence (XRF)
- •X-ray absorption spectroscopy (XAS)
- •Particle Induced X-Ray Emission (PIXE)

Android QR Code

Free App to download

X-ray Transition Energies Database App

The app includes elemental properties, x-ray transition energies and reverse energy lookup.

UPDATED Oct'14

iPhone QR code

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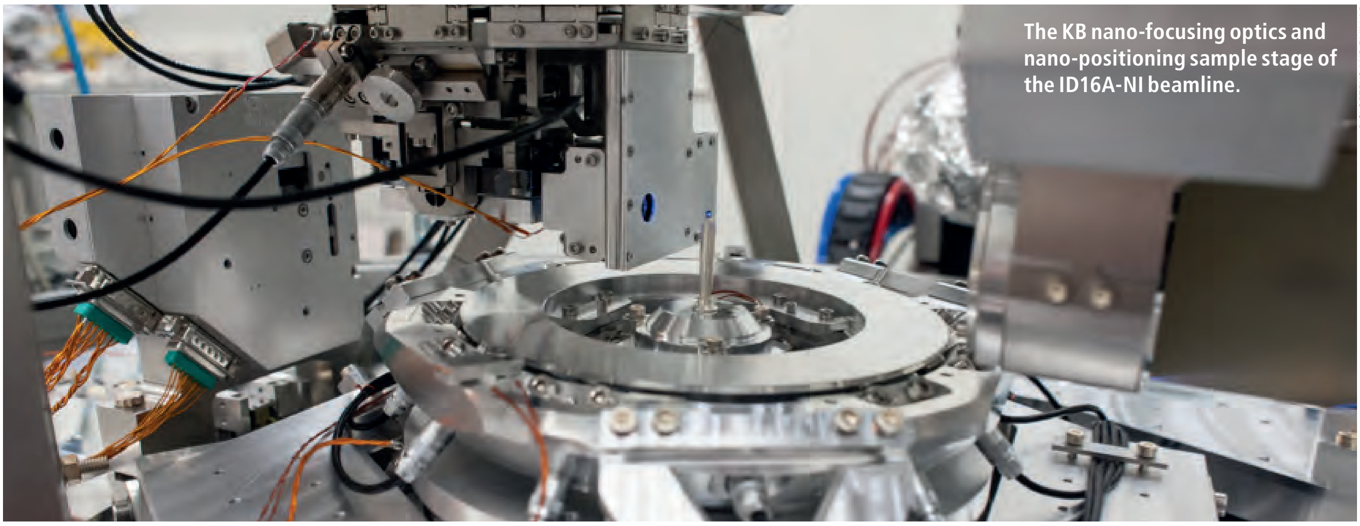
www.sgxsensortech.com

Tel: +44 (0) 1628 533 060
Email: sales.ma@sgxsensortech.com



The KB nano-focusing optics and nano-positioning sample stage of the ID16A-NI beamline.

P CLOETENS AND F VILLAR

Instrumentation gives ESRF the edge

Exploiting the ESRF's expertise in instrumentation generates income and visibility.

The ESRF is prominent among the world's light sources for its development of advanced instrumentation. Although all technical and scientific divisions at the ESRF produce and use innovative instrumentation, the Instrumentation Services and Development Division (ISDD) is fully dedicated to this mission. It brings together more than 130 people with expertise in advanced modelling, data analysis, X-ray optics, detectors, electronics, mechanical engineering and instrument control.

Technology is made available through approximately 30 licence agreements with companies, including Danfysik, Bruker Advanced Supercon, CINEL, IRELEC and JJ X-Ray. Some ESRF technologies are also sold directly in small volumes, including high-performance scintillator screens, pixel detectors (especially the MAXIPIX system), high-temperature furnaces, cryostats and advanced crystal optics.

The challenge for the ESRF is to efficiently share these technologies with member states and beyond. Traditionally, the ESRF has approached this by simply providing drawings, but increasingly this transfer is proceeding via commercial companies that generate jobs and longer-term economic value. Synchrotron instrumentation is a niche market and it would be rare for it to spill over into broader or consumer products, but this could change with Phase II of the Upgrade Programme demanding high-precision positioning and new detector technologies.

Head of the Business Development Office Ed Mitchell says that synchrotrons need to move away from traditional models and build a stronger outward-looking vision for instrumentation. "Europe offers a carrot towards this with R&D outsourcing via pre-competitive procurement calls," explains Mitchell. "This is an opportunity for the synchrotron community to look towards industry to supply common technology."

Motor control

In addition to well-defined X-ray instruments, the ESRF has expertise in specialised control modules and systems. Developed in 2007, IcePAP allows the control of the several thousand motorised position actuators that are in use across the ESRF's source and beamlines – the upgrade beamline ID20 alone has 390 motors. There are very good high-performance motor controllers on the market but none that is well suited to be managed on such a large scale in a scientific facility, explains IcePAP developer Pablo Fajardo, who is head of the detector and electronics group. "We are making tremendous savings in manpower and beamtime because of the reliability of the IcePAP controllers and the high level of standardisation, he says."

IcePAP is being taken up by ALBA, MAX-IV and other facilities have also shown interest in the system. The ESRF outsources the manufacture of the controllers and has developed a stringent in-house testing procedure, but is not currently in a position to provide after-sales support. "It's satisfying to see that something we build is desired elsewhere," explains Fajardo. "But building instrumentation for others is not always an easy decision to take because we have to find the extra time and resources."

As synchrotrons strive towards a diffraction-limited X-ray source, new instrumentation is vital to allow users to exploit the smaller, more intense and more coherent beams. The ESRF is well placed to meet that demand, says ISDD head Jean Susini. "We expect to see greater demand for *in situ* and *in operando* studies, in combination with shorter timescales and the ability to probe deeper into the structure of matter at higher resolution, and this will oblige instrumentation to be one step ahead."

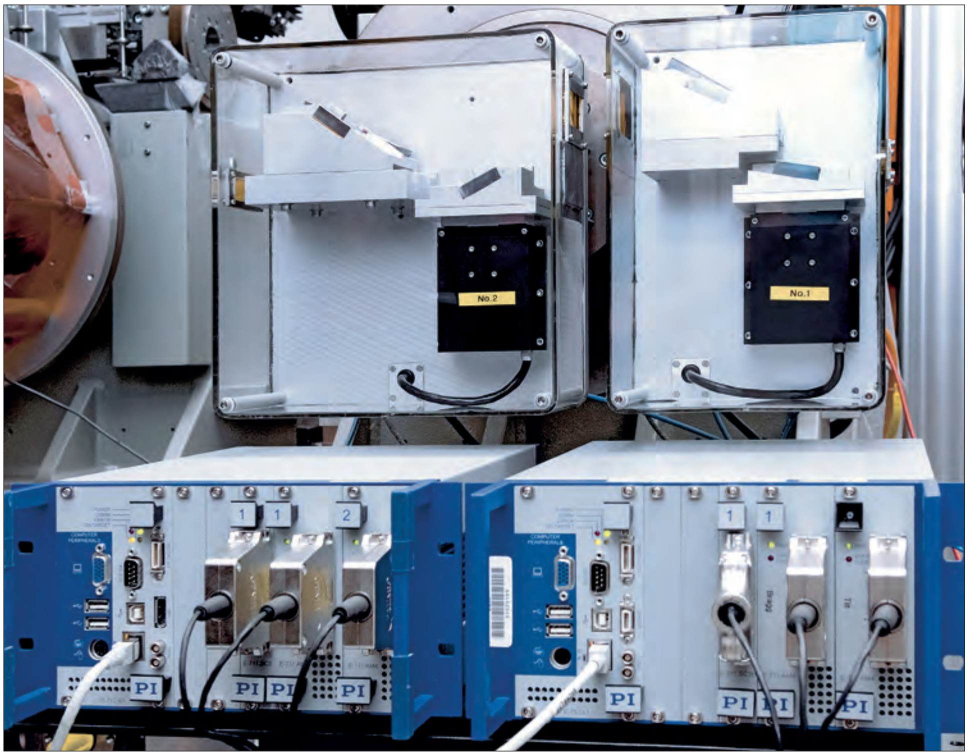
Matthew Chalmers

XMaS delivers profits

The UK-operated XMaS beamline has developed a strong instrumentation programme and is responsible for eight technologies manufactured under licence. One of the most popular is a xyz motorised sample mount licensed to Huber Diffraction that allows users to locate and align a sample's diffraction "sweet spots" and tracks them as the sample is cooled down (pictured). Another XMaS bestseller, also licensed to Huber Diffraction, is a novel in-vacuum slit assembly for collimation purposes that has minimal physical dimensions and is activated remotely. Other XMaS products include polarisation

analysers, novel diffraction oscillators and in-vacuum X-ray attenuators. "Commercialisation offers enhanced performance and reliability to users not only of our facility but at others worldwide," says XMaS scientist Simon Brown. "Often in-house developments are carried out by students or postdocs who then take their expertise elsewhere. Commercialisation is not only financially attractive to the holders of the intellectual property rights, but also provides a mechanism for sustained instrument support and development."

Double-Crystal Monochromator for an X-Ray Spectrometer



Piezo-based tilting mirrors provide superior resolution and repeatability

Research into ever smaller particles and structures uses large-scale equipment such as synchrotron beam sources or free-electron lasers. An essential part of such facilities are complex positioning systems that assure high-precision and long-term stability for aligning samples and analytical systems.

PI has now combined its competences for experiments on accelerator beamlines in its Beamline Instrumentation Division. The division's aim is to develop application-oriented solutions that go far beyond simply providing individual components. For this purpose, experts from the PI Beamline Instrumentation Division work closely together with universities and research centers. Here the experts from PI work on development projects and provide engineering services and system integration to complete instrumentation, including integration of third-party components such as cameras, detectors or additional positioning units.

High-Precision Bragg and Tilt Angle Adjustment

At the Nuclear Resonance beamline (ID18) at the ESRF, France, a double spectrometer for inelastic X-ray scattering has been installed since 2012. Phonon excitation states in solid are investigated with the help of two monochromators that filter and select the desired wavelengths with an energy resolution of 0.5 meV and 2 meV.

Each of the monochromators consists of four independent crystals arranged in pairs. The first pair of crystals collimates the beam, while the second pair selects the beam of the required energy. The width of the respective rocking curves is a few microradian only. To operate in the curve's maximum, i.e. with maximum intensity, the relative angle of the crystals in both pairs has to be adjusted with a resolution of 0.5 microradian or better.

Precise Re-Adjustment of the Double Crystals

In the course of an experiment, users may need a fast characterization of their samples with a moderate resolution of 2 meV and a high flux, to select samples for precise measurements with an ultra-high energy resolution of 0.5 meV. This requires a fast exchange of the two monochromators with precise re-adjustments of the Bragg and tilt angles for all four crystals.

Positioning the Crystals Places Exceptionally High Demands

To adjust the Bragg and tilt angle, the crystals had to be moved and positioned with high precision. Additionally, excellent long-term stability and very good repeatability were required, while the stages themselves needed to fit into a very limited space.

PI's proprietary piezo-based PiezoWalk® drives with their sophisticated controller provided a perfect-fit solution. Their excellent resolution of 0.1 µrad only in both Bragg and tilt angle, and a repeatability of <0.1 µrad over a 12 µrad range even exceeded the demands. In combinations with capacitive position feedback sensors directly measuring the position of the moving platform they allow for a long-term position stability well under 0.1 microradian, while the stage's footprint of 95 mm × 78 mm × 32 mm stays very compact.

In a future step, the PI stages' angular stroke of ±2 mrad will be used to carry out a synchronized motion to vary the energy selection of the X-ray beam.

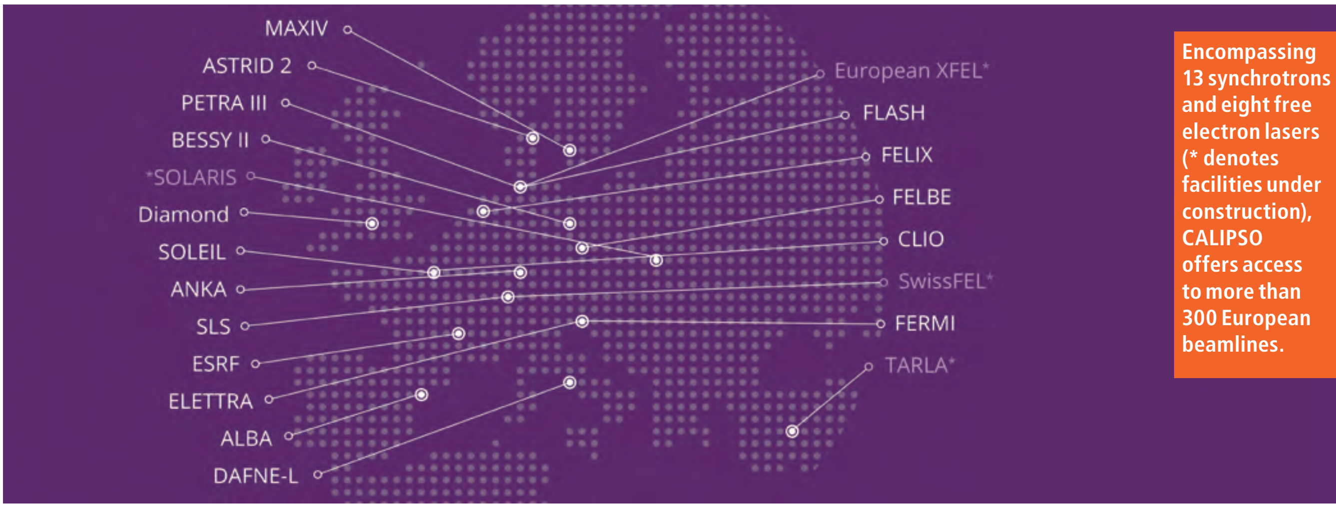
PI in Brief

Over the last four decades, the PI Group with their headquarters in Karlsruhe, Germany, has developed into the leading manufacturer of positioning systems with accuracies in the range of only a few nanometers. With four company sites in Germany and 10 sales and service offices abroad, the privately managed company operates globally.

More than 700 highly qualified employees all over the world enable the PI Group to fulfill almost any requirement from the area of innovative precision positioning technology. All key technologies are developed in-house. This allows the company to control every step of the process, from design right down to shipment: precision mechanics and electronics as well as position sensors.

The PI miCos GmbH in Eschbach, Germany, joined the PI Group in 2011. The company is specialized in applications in the areas of ultrahigh vacuum, air bearings technology, linear motors, parallel-kinematic positioning systems with six degrees of freedom and engineering services for system integration.

Physik Instrumente (PI) GmbH & Co. KG
Auf der Roemerstrasse 1
76228 Karlsruhe
Germany
www.pi.ws



Encompassing 13 synchrotrons and eight free electron lasers (* denotes facilities under construction), CALIPSO offers access to more than 300 European beamlines.

CALIPSO helps industry see the light

By boosting industry use of European light sources, the CALIPSO project can help to realise the goal of a common European Research Area.

"What kind of experiments do you run here?" This is a question that comes up frequently when researchers first encounter a synchrotron or a free electron laser (FEL) – and such a question has hundreds of answers. Virtually any scientific and technological discipline can benefit from data obtained at advanced X-ray sources. The advantages of materials characterisation can be applied to nanoelectronics but also to the food industry, for example, while 3D tomography can be used for advanced medical imaging as well as for preserving cultural heritage artifacts. Pump-probe experiments at FELs, meanwhile, can help us understand both how stars evolve and how to build more efficient solar panels.

Initiated in 2012, CALIPSO integrates Europe's synchrotrons and FELs into a single network that helps to broaden access to the facilities. Boasting the highest geographical density of state-of-the-art research infrastructures, CALIPSO has enabled 14 facilities to offer transnational access based on scientific merit and its interactive web portal www.wayforlight.eu offers a standardised proposal format and datasheets for all European beamlines. This complements activities within the European Synchrotron User Organisation (ESUO). CALIPSO also supports the HERCULES school, which offers training in neutron and X-ray methods for condensed-matter studies, and supports a joint research activity called HIZPAD2 led by the ESRF, which is aimed at developing improved high-Z pixel array detectors.

Enhancing industry access

The ELSII project within CALIPSO has identified several areas where industry access to light sources should be improved:

TIMING
- Access protocols, such as rapid access and administrative procedures, that match industry needs
- Rapid turnaround with robust methods and online/on-the-fly data analysis

STANDARDS
- Availability of sample preparation laboratories
- Quality control and use of standards where applicable

SERVICE
- Harmonisation of data formats
- Industry awareness of and education in light-source techniques
- A clear facility commitment towards industry and dedicated staff for industrial applications

Unrealised potential

There is strong unrealised potential for better industry interaction with European light sources but synchrotrons are often prisoners of their academic traditions. Slow access and unreactive procedures that are not appropriate for industrial R&D cycles, for instance, can present barriers to industry clients. CALIPSO contains a small but dedicated networking activity called the European Light Sources for Industry and Innovation (ELSII) that is being led by the ESRF. Building upon previous studies such as ERID-Watch and EIRIISS, the goal of ELSII is to increase the visibility to industry of opportunities at light sources and to remove any bottlenecks to industry involvement (see panel above).

A joint industrial advisory board (IAB) with neutron and muon sources, which are already integrated via the NMI3 project (www.nmi3.eu), was established that comprises 13 decision-makers from European companies. At its initial meeting in Frankfurt, Germany, in December 2013, members identified a number of bottlenecks, which included: differences in sample holders from facility to facility; a need for data analysis; shutdowns that are co-ordinated across facilities; and heavy administrative burdens. The second ELSII meeting, involving industrial liaison office representatives at synchrotrons and neutron sources together with the joint CALIPSO-NMI3 advisory board, took place on 19–21 November in Athens, Greece, as *ESRFnews* went to press.

Maintaining the model

CALIPSO will end in May 2015. Due to the current lack of suitable calls in the European Commission's Horizon 2020 programme, European facilities are supporting the ESUO in lobbying for a new proposal within the 2016–2017 Research Infrastructures work programme (www.esuo.org/?node=ESUOhome&file=esuo-manifesto-2014.pdf). It is envisaged that ESUO would co-ordinate transnational access and offer training as well as provide guidelines for technical services. Although ELSII is also due to come to an end, industry activities will continue thanks to mutual co-operation among facilities and hopefully also under future Horizon 2020 projects, where the joint IAB feedback is being taken on board in new proposals.

The continuation of co-ordination activities such as CALIPSO is vital to help Europe get the most out of its investment in large light source facilities and to help realise the EC's goal of a common European Research Area.

Cecilia Blasetti is deputy project manager of CALIPSO and co-ordinator of www.wayforlight.eu. She is based at Elettra-Sincrotrone Trieste in Italy.

Pixirad-1 System

The **Pixirad-1 System** is the first commercial product of Pixirad Imaging Counters s.r.l.

The core of the X-ray imaging system is a new detector, based on chromatic photon counting, that has been realized coupling a pixelated large area ASIC, known as **Pixie-II**, to a matching pixelated sensor by flip-chip bonding technique. The Pixirad-1 System is able to deliver extremely clear and highly detailed images for medical, biological, industrial and scientific applications.

Pixirad-1 Detector Module options

ASIC[1]:

– **Pixie-II read-out ASIC, 60 µm hexagonal arrangement**

Sensors:

– **650 µm thick CdTe crystal Schottky type**

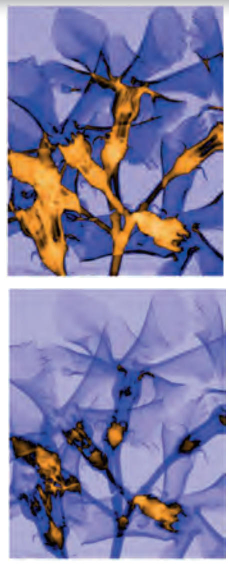
– **750 µm thick CdTe crystal Ohmic type**

– **500 µm thick GaAs crystal**

[1] The Pixirad-1 Detector Module Unit is ready to use the new Pixie-III ASIC

Due to its architecture the Pixie-II ASIC is able to count incident X-ray photons according to their energy in order to produce two 'color' images from a single exposure.

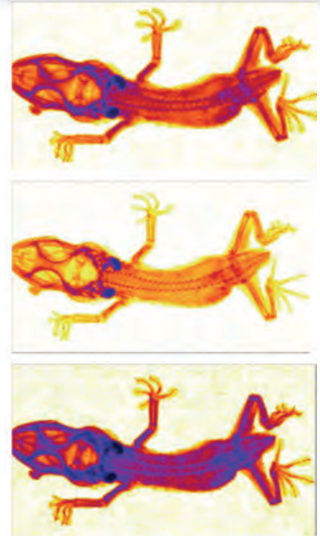
Low Energy Sensitivity



Images of a very low contrast object, taken with
a) 200 electrons global threshold corresponding to 1 keV (LOW counter, all photons)
b) at 6 keV threshold (1200 electrons). This image was taken in a single shot together with the previous one at 1 keV threshold

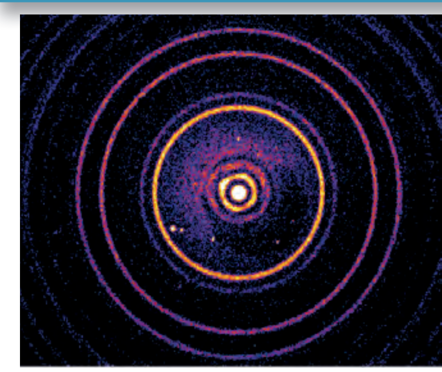
Chromatic Photon Counting

Three 'colors' from a single exposure



Images of a small dry animal obtained simultaneously by :
a) counting the X-ray photons with a low energy threshold (LOW COUNTER, all photons);
b) counting the X-ray photons with an higher threshold (HIGH COUNTER, high energy photons);
c) subtracting the previous pictures one from another (low energy photons)

X-ray Diffraction at 40 keV



Attenuated Beam and diffraction rings from a Ce02 powder (obtained at the Cornell Synchrotron on a 40 keV beam line)

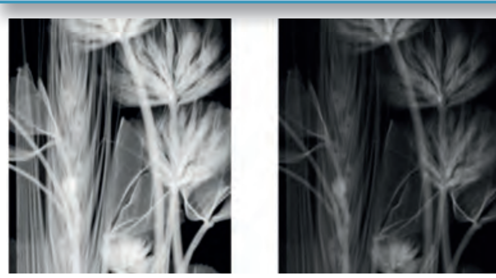
Pixirad-2 System

The new commercial product of Pixirad Imaging Counters s.r.l.

The **Pixirad-2** Detector Module Unit has 2 detector blocks (based on the **Pixie-II** ASIC) in a 2x1 pattern, with a global active area of 62 x 25 mm2.

The Pixirad-2 System is able to deliver extremely clear and highly detailed images for medical, biological, industrial and scientific applications.

Ohmic CdTe: Low Energy Sensitivity



Images of a very low contrast object, taken:
a) at 1 keV threshold (200 electrons, LOW counter, all photons);
b) at 6 keV threshold (1200 electrons) in a single shot

Pixirad-2 Detector Module options

ASIC[1]:

– **Pixie-II read-out ASIC, 60 µm hexagonal arrangement**

Sensors:

– **650 µm thick CdTe crystal Schottky type**

– **750 µm thick CdTe crystal Ohmic type**

– **500 µm thick GaAs crystal**

[1] The Pixirad-2 Detector Module Unit is ready to use the new Pixie-III ASIC

Clearing the path to innovation

Institutes in the Grenoble region are in a prime position to turn scientific research into ecosystem-based innovation.

Decades ago, in his groundbreaking theory of innovation, the Austrian economist Joseph Schumpeter defined technological economic development in simple terms: an investment in technology that generates new businesses and territorial wealth. Iconic illustrations of this model include Silicon Valley, where leading firms emerged from research in computer science, and the smart card that has entered mass markets spanning health, banking, telecommunication, transport and retail.

Empirical studies show that the transformation of scientific knowledge and technologies into economic value relies on two key "actors". The first is the techno-entrepreneur who creates value by applying new knowledge and technologies to industrial problems and launches new solutions that are first adopted by technology-enthusiast customers. Since such customers amount to less than 15% of the total potential market, however, broader diffusion is required to ensure a sustainable return on investment in science and technology. This requires a second actor: an industrial firm that complements the entrepreneur's capabilities, for example via strong customer relationships and operational excellence that can help beat imitators. Ideally, the objective is to impose a "standard" new technology on mainstream markets, although technology is still important at this stage for both process innovation and product improvement.

Routes into industry

So how does this model apply to large research facilities such as the ESRF? In the traditional Schumpeterian view, attention has centered on the integration of new technologies into unique tangible solutions – the success of which depends on how the different actors, i.e. industry and research facilities, are connected. In particular, research organisations should not underestimate their role in producing economic value because their own sustainability depends on reinvestment capabilities.

Most research organisations have several routes into industry. In the Grenoble region these include a world-class pool of techno-entrepreneurs via "Gate 1" (a regional incubator for the early development of start-ups based on the output of public research labs) and close relationships with industry via intermediates such as the micro- and nanotechnology research hub Minatec.

"The ESRF should not underestimate its role in producing economic value."

Facilities such as the ESRF and ILL may also provide complementary services such as testing, marketing and intellectual property, or take part in initiatives such as the Junior Scientist and Industry annual meeting (JSIam) event, at which PhD students present both their lab's results and themselves to industry researchers.

Today, however, such initiatives are not always sufficient by themselves to turn research into economic value. Global competition means that firms become more selective in who they partner with, for example, while research organisations pay more attention to a firm's ability to diffuse their technologies. Talents, both scientific and entrepreneurial, also become selective and mobile so that geographical location becomes key. Today's mass markets are characterised by high novelty and high risk, with public actors including governments becoming much more active in defining their socio-economic ambitions and in targeting specific technological and industrial areas for funding.

Turbulence and disruption

These new conditions introduce turbulence and disruptions to the innovation environment, forcing us to upgrade Schumpeter's model – perhaps towards his idea of "recombination of full economies". When totally new value chains are substituted into existing economic settings, as was the case with the transition from horses to cars and then electric mobility, the challenge is not to succeed once in transforming technology into innovation but to create, capture and share value from a continuous flow of transformational initiatives. The rationale behind Google's driverless car experiment and other green-mobility challenges, for instance, is to create competing ecosystems of innovation and value networks to address complex global challenges more effectively. Without local government pressures to reduce pollution, the decision of authorities to take risks about road use and individuals willing to try such cars, it would not have been possible to trial such a system in real-life in order to learn whether it can be further deployed.

Research organisations have an important role to play in creating their own ecosystems of innovation by bringing scientific excellence to the table, initiating an entrepreneurial mindset, exploring new ways to address critical challenges and in educating and engaging all relevant actors. In the Grenoble region, the GIANT project (www.giant-grenoble.org) helps establish such alliances and offers an ideal place for ecosystem-based initiatives such as IRT Nanoelec, which is a public–private consortium that aligns research, education and innovation. In this framework, the ESRF is taking the lead with research projects linked to industrial firms, thus optimising its potential social and economic impact.

Sylvie Blanco is a senior professor at Grenoble Ecole de Management and academic director of training programmes at Nanoelec Institute of Research and Technology.

In search of perspective

Keijo Hämäläinen, vice rector of the University of Helsinki and chair of the ESRF's Science Advisory Committee, views science in terms of its broader impact on society.

Keijo Hämäläinen used to keep a note of the number of times he had visited the ESRF. When he reached 103, though, he decided to stop counting – and that was five years ago. The Finnish physicist has been an ESRF user since the start of operations in 1994 and in 2001 he became chair of the user organisation. Hämäläinen joined the ESRF's Science Advisory Committee (SAC) in 2006, became its vice chair in 2009 and then chair in 2012. Hämäläinen will hand over to his successor at the end of this year.

In addition to further visits to Grenoble, it's a job that demands a certain level of diplomacy, he explains. The role of the SAC is to advise the ESRF Council on scientific issues and also to advise the ESRF management based on input from the community. Hämäläinen sees it as the ideal way to represent the voice of the users, while also putting the science in perspective. "I'm the middle man," he says. "Although each member represents one country, few people are looking at things from a national perspective but rather deciding what is best for the science overall. It has been surprisingly easy to reach consensus."

From the micro to the macro

A desire to understand the "bigger picture" has driven Hämäläinen's career from the outset – including his research, which began with a topography study of a silicon wafer at HASYLAB in 1986. He says he is one of the first generations of scientists to have grown up on synchrotron radiation rather than X-ray tube sources. "I study the electronic and molecular structure of materials in order to understand their bulk properties," he explains. His research was more technique than topic driven, using inelastic X-ray scattering to link the microscopic with the macroscopic in samples, including the study of teeth grown from stem cells.

VEIKKO SOMERPURO

Keijo Hämäläinen in brief

Born: 1963, Viitasaari, Finland.

Education: MSc (1987) and PhD (1990), University of Helsinki.

Career: Postdoc, Brookhaven National Laboratory (1990–92); research fellow, Academy of Finland (1993–2002); professor (2002–present), dean of the faculty of science (2010–2014), vice rector (2014–present), University of Helsinki.

Family: Married, two children.

Interests: Sport, orienteering, family.

"You have to explain why the ESRF should be funded."

"Now I am trying to do the same thing as an academic leader in the university," he says.

As vice rector of the University of Helsinki, Hämäläinen is now exposed to the big questions in other fields such as archeology, biology, even the humanities. "I see things in terms of impact rather than the specifics of a field," he says. "It's similar to what I like about SAC meetings. It forces you to ask what impact does this research have on society? How can I highlight the best science? You have to explain why countries should fund things like the ESRF."

So does he prefer dealing with electrons or with people? "Definitely electrons! When you look at scientific leadership you are working with very intellectual people who know what they want, so it's about steering them towards the big picture. You can't force a scientist to do something."

Hämäläinen is also a member of the SACs of DESY and MAX-IV – the advanced storage ring under construction at Lund in Sweden. "In Finland we have involvement with ESRF and MAX-IV so we have to explain to funding agencies why we sit in both, for example, and we do argue if there are two identical beamlines under consideration, for instance," he explains. "But that is the advisory role of the SACs, and it works extremely well. I've always sought out organisation roles because I like to interact with people and find consensus – I'm probably a masochist!"

NordSync impact

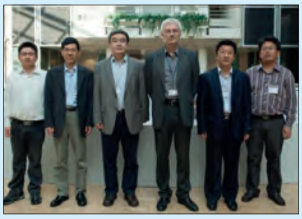
The number of Scandinavian ESRF users will increase once MAX-IV switches on in 2016, he predicts, since there will be collaborations and a higher volume of users. "As we have seen with archaeology and imaging, as soon as you demonstrate something new everyone jumps on it, and a few years from now there will be communities that don't exist now." Scandinavian countries contribute around 4–5% of the ESRF budget via the NordSync consortium. Hämäläinen says they overuse it by up to a factor two, and that negotiations to increase the NordSync contribution are currently underway.

Sweden's decision to invest in MAX-IV is also driven by the potential for industrial involvement, he explains. Southern Sweden has a very strong pharmaceutical industry, as does the Danish region, and the Nordic countries also have a broad research programme in materials science that benefits the automobile, aero and metals industries. But is there too much expectation on research infrastructures to deliver short-term returns?

"The ESRF should focus on the best possible research and characterisation tools, and then the breakthroughs and applications will come. Research should never be routine, and mediocre applied research should not be in the focus of ESRF," says Hämäläinen. "In meeting the demands from society a lot can be improved by simply mediating the scientific results and possibilities more intensively, which the ESRF does very well."

Matthew Chalmers

SSRF visits the ESRF



In October the ESRF welcomed a delegation from the Shanghai Synchrotron Radiation Facility (SSRF) for a two-day visit during which representatives discussed the potential for future collaboration with the ESRF. The SSRF, which is run by China's Shanghai Institute of Applied Physics (SINAP), opened to users in 2009 and became the first intermediate-energy third-generation light source in Mainland China. So far the machine has been operating with seven beamlines but another six experimental stations are soon to open for user experiments. A further seven beamlines are under construction or in the advanced design phase, and sixteen more are planned.

Delegates were exposed to the latest installations at the ESRF including the MASSIF-1 beamline, where a new generation of sample robotics has recently allowed the first fully automated data collections. "As the most productive light source worldwide, the ESRF is a pioneer in synchrotron facilities and photon science," said SINAP Director General Zhentang Zhao. "The ESRF is one of the best reference models in the world for SSRF, its experience and success have benefited the SSRF design, construction and user operation." Based on the existing collaborative framework MoU between ESRF and SSRF, continued Zhao, the goal of the visit was to explore specific collaborative objects with mutual interests and other long term plans for the new era of X-ray science that is opening up.

ESRF research director Harald Reichert said the ESRF management was very pleased to host the visit and is excited to see how the SSRF's developments pan out during the coming years. "With both synchrotrons currently planning phase II of their developments it makes sense to discuss technologies that are potentially of common interest," said Reichert. The ESRF will travel to the SSRF next spring in a return visit.

Communications group change

Head of the communications group, Claus Habfast, left the ESRF at the end of August after his election as Vice-Chair of the Grenoble Metropolitan Council where he is responsible for universities, research and sport. He joined the ESRF in October 2007 having previously worked in various roles at the European Space Agency. The focus of his work at the ESRF was to strengthen communication with users, media coverage for science results and outreach to local citizens, notably at schools and universities. Kirstin Colvin is acting head of the communications group.

High-pressure prize

Innokenty Kantor, a physicist who works in high-pressure experiments at the ID24 beamline, was presented with the European High Pressure Research Group (EHPRG) award during the group's 52th international meeting held in Lyon on 7–12 September. Kantor, who is 34, is currently on a five-year scientist contract at the ESRF that will end next spring. His research has focused on the melting of iron under extreme conditions such as those found in the Earth's core and he has contributed greatly to the ESRF's *in situ* laser heating facility. "I am very flattered with this award," said Kantor. "I'm very glad that the European high-pressure community recognizes our achievements at the ESRF in creating new instruments for experimental science."

Lasker foundation award

French physician Alim-Louis Benabid of Université Joseph Fourier, who was a member of the ESRF Science Advisory Committee from 2006–2008 and then an observer (2009–2011), has been named co-winner of the 2014 Lasker~DeBakey Clinical Medical Research Award by the Albert and Mary Lasker Foundation in New York.

Young chemist wins ESRF trip

Hungarian student Szabolcs Rozsnyik,18, was awarded the ESRF Prize at the 2014 European Union Contest for Young Scientists held in Warsaw in September. Rozsnyik 's project researched the photochemical properties of composite multi-walled carbon nanotubes, and in particular investigated whether it is possible to impregnate carbon nanotubes with different metal-oxides such that the metal-oxides take their positive effects on nanotube based composites simultaneously. His prize is a one-week long stay at the ESRF. Other winners of the contest's 30 special donated prizes included Aleš Zupančič from Slovenia, who won a trip to the ILL, and Jakub Šalko from Slovakia who won the European XFEL prize.

The contest was set up by the European Commission in 1989 to encourage co-operation between young scientists and to give them an opportunity to be guided by some of Europe's most prominent researchers (http://eucys2014.pl/category/projects/).

ESRF lights up the Royal Albert Hall

Photos from the ESRF and the ILL are featured at an exhibition by New Zealand photographer Max Alexander at London's Royal Albert Hall. Titled *Illuminating Atoms* and timed to celebrate the International Year of Crystallography, the exhibition opened on 4 November and will run until 7 December. Alexander spent two days at the ESRF earlier this year taking exterior shots and photos inside the beamlines (www.royalalberthall.com/tickets/exhibitions/illuminating-atoms/default.aspx).

Visitors' open day

Hundreds of people visited the ESRF and ILL on during the weekend of 18–19 October as part of Fête de la Science, with events based around theme of the 2014 International Year of Crystallography. Members of the public took tours to see how X-rays and neutrons are created at the facilities and were shown the latest beamlines under development at the ESRF.

Mathilde Pascal, who is 23 and studies at the Institute for Political Sciences, said: "Despite living in Grenoble I have never been inside the ESRF and so this was a good opportunity. The facility was much more complex than anything I could have expected but the explanations of what goes on here were easier to understand than I thought they'd be."