



The impact of the ESRF and its Upgrade Programme

Enhancing scientific excellence

Engaging a new generation of scientists

Training highly skilled staff

Providing direct economic returns

Disseminating knowhow to national centres

ESRF: a new chapter in X-ray science

ESRF socio-economic returns

The primary return of the ESRF to society is scientific and technological knowledge, which is shared by the whole scientific community and in particular by researchers from partner countries. All inventive research carried out at the ESRF propagates to society and impacts the scientific cultures and the economies of its member states and beyond. Moreover, industry strongly benefits from and supports fundamental research using the ESRF.

Since its creation in 1988 the ESRF has returned contracts to commerce and industry totalling more than €2bn. This feeds directly and indirectly into the economies of partner countries, for example through training and capability-building in education and industry.

The research programmes carried out at the ESRF rely on an impressive number of young researchers, PhD students and post-doctoral fellows. In addition to training highly skilled staff, the ESRF has a strong track record in disseminating synchrotron methods and techniques to other facilities.

This report documents the impact of the ESRF on science and society, emphasising:

- The ESRF's excellence in science,
- The impact of the ESRF on innovation and business,
- The success of the ESRF in training highly skilled staff and fostering European collaborations,
- The economic return of the ESRF to Europe,
- The role of the ESRF in society,
- The timely value of the ESRF Upgrade programme.

The significance of these benefits provides strong support for investing in a new chapter in the ESRF's life: building an ultimate X-ray source in Europe.

ESRF upgrade in short

Initiated through the funding by the FP7 Capacities Programme, the ESRF Upgrade Programme (ESRF UP) has been on the Roadmap of the European Strategy Forum on Research Infrastructures (ESFRI) since its inception. ESRF UP is a two-stage process. ESRF UP Phase I (2009-2015 at a cost of €168m) is under implementation and will provide a new generation of beamlines and experimental stations. ESRF UP Phase II (2015-2020 at a cost of €150m) is under consideration.

ESRF UP Phase II is centred on an enhanced X-ray source that reduces the horizontal spread or "emittance" of the ESRF's beams to unprecedented low values. It involves:

- The construction and the commissioning of a new accelerator lattice in the storage ring,
- The construction of four state-of-the-art beamlines to exploit the brilliance and coherence of the new X-ray source,
- The development of unique instrumentation and support facilities to exploit the new X-ray source.

The Phase II of ESRF UP will:

- Make the ESRF synchrotron light source more than 30 times brighter than ever before,
- Increase the coherence of the X-ray beams to levels approaching those of lasers,
- Boost instrumentation capacities,
- Enable new technologies in magnet, radiofrequency and vacuum systems,
- Reduce the energy consumption of the storage ring by 30%,
- Optimise returns on previous investments by a 90% re-use of existing infrastructure.

In a nutshell, ESRF UP will open a new chapter in X-ray science by enabling spatial information in the studies of materials and living matter down to the level of few tens of individual atoms.

More information on the ESRF Upgrade Programme can be found on the following ESRF web pages:

<http://www.esrf.eu/about/upgrade/documentation>

<http://www.esrf.eu/about/upgrade/ESRFUP>

Back cover: Artist's impression of the new magnetic lattice developed by ESRF scientists for the ESRF UP Phase II, superimposed on the existing ESRF tunnel.

The right step for Europe



The ambitious ESRF Upgrade Programme will attract a broader community of users and will generate greater benefits to science and society.

At the ESRF, intense beams of synchrotron X-rays shed light on the behaviour of materials and living matter. We have pioneered tools to explore Nature from novel materials to snake fossils, to study rapid changes in biological processes and to determine the structure of increasingly complex proteins.

The areas of research that benefit most from the ESRF facilities have been identified as:

- Life Sciences and Soft Matter,
- Chemistry and Physics of Materials,
- Environmental Sciences and Cultural Heritage.

The science driven developments at ESRF help researchers address global societal challenges and allow companies to develop innovative products, materials and new drugs. In short, the ESRF has become a strategic tool for research and development.

After 20 years of successes that currently lead to the publication of five scientific papers in peer-reviewed journals every day, the ESRF is undergoing an ambitious upgrade programme, ESRF UP, which will:

- Make the ESRF home to the world's first ultimate hard X-ray synchrotron facility,
- Maintain its global leadership in X-ray science, vis-a-vis similar competing plans in the US and Japan,
- Unlock new research avenues thanks to nanometre-sized X-ray beams,
- Generate state-of-the-art instrumentation and data taking capacities,
- Offer exciting opportunities for a new generation of synchrotron scientists.

On time and within budget, the first stage of ESRF UP, approved by the ESRF's partner states in 2008 and designed around new and improved beamlines and instrumentation, is already more than half way through. ESRF UP Phase II, which is to take place in 2015-2020, aims to optimise the ESRF's X-ray source to produce the brightest, the most coherent and the smallest X-ray beams ever achieved by a synchrotron.

The availability of the new light source at the ESRF will attract a broad and ever increasing community of users from academia and industry.

Its success will strengthen the ESRF's position as the world's leading synchrotron facility, producing even greater returns to partner states. In line with the European Strategic Programme for Horizon 2020, the realisation of this new light source at the ESRF will benefit from the facility's unique pre-existing infrastructure.

Having access to such a powerful source of science and innovation gives Europe a strategic advantage. Pushing the ESRF towards the ultimate X-ray source today is the right step to strengthen Europe's global position.

Francesco Sette
Director General ESRF

ESRF: a facility for scientific excellence

Unparalleled publication record

The ESRF is the global leader in synchrotron science and technology, making its facilities highly attractive to scientists, students and engineers. To continuously enable new science, its staff and users have developed numerous synchrotron methods in areas including: detectors, X-ray optics, sample environment, alignment and active beam position monitoring, data handling, robotics and insertion devices.

Domains of scientific excellence range from the chemistry and physics of innovative materials to archaeology and cultural heritage, and include structural biology and medical applications.

The ESRF's scientific leadership is demonstrated by the breath and the volume of its publication record during the last 10 years:

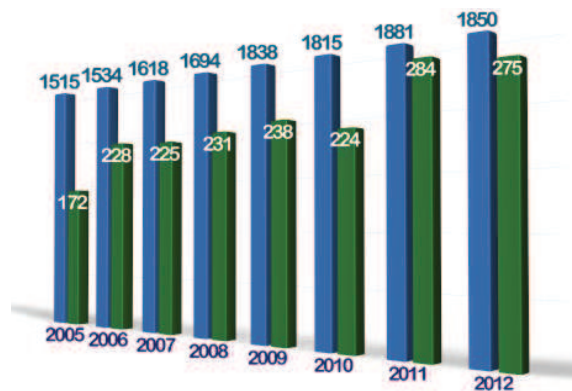
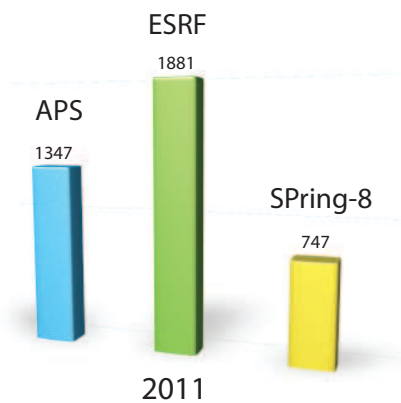
- 16,380 papers in more than 1,130 peer-reviewed scientific journals,
- 2,220 articles in highly ranked journals with impact factors equal to or greater than journals like Nature Communications, EMBO Reports and Physical Review Letters.

In 2012 alone work carried out at the ESRF was associated with more than 50 articles published in Nature and its sister journals, rivalling the output of the world's best universities and research centres. The scientific output of the ESRF is far superior to any existing synchrotron worldwide, including the competing X-ray centres in the US (APS) and Japan (SPring-8).

Thanks to progress in instrumentation and data analysis, the number of publications is increasing every year. The full ESRF Upgrade Programme will boost the ESRF's productivity even further.

Work carried out at the ESRF has been recognised by numerous distinctions during the past decade:

- Four Nobel Prize Winners in Chemistry,
- Two Gottfried Wilhelm Leibniz Prizes,
- Five medals awarded by the French CNRS and one by the UK Royal Society,
- Distinctions from learned societies in Germany, France, UK, Australia and Sweden plus international organisations.



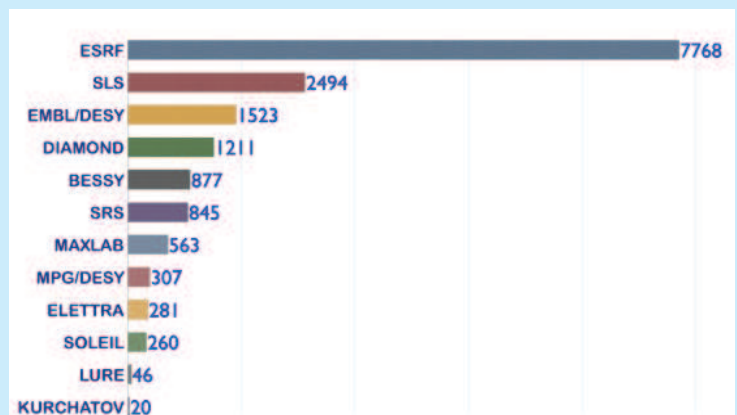
Left: Publication record at ESRF, APS (US) and SPring-8 (Japan) in 2011.

Right: Total (blue) and high-impact (green) publications in peer reviewed journals.

Bottom: Protein Data Bank deposits from Europe.

Structural biology: an ESRF success story

Determining the structure of proteins and other macromolecules is of fundamental importance for understanding biochemical processes and for designing new drugs. Thanks to outstanding instrumentation and automation, research carried out at the ESRF has contributed 48% of the total number of protein structures in the global Protein Data Bank (PDB) made by European depositors during the past 10 years and 16% of the PDB deposits overall. The total European contribution to the PDB deposits amounts to 33%, compared to 52% for the Americas and 15% for Asia/Oceania.



An efficient facility for all

Serving the user community

The ESRF Upgrade Programme offers unique instrumentation and unrivalled potential for innovative experiments, boosting the ESRF's productivity even further.

The experiments at ESRF beamlines cover an ever increasing number of scientific disciplines, many of which are closely connected with industry. Scientists from all over the world access beam time on the basis of scientific excellence. All communities are fairly represented in the distribution of beam time at the ESRF.

Based on the ESRF operation costs and the number of peer-reviewed articles, the average cost per publication at the ESRF is approximately 50k€. This makes the ESRF a very efficient facility compared with other international or national research infrastructures.

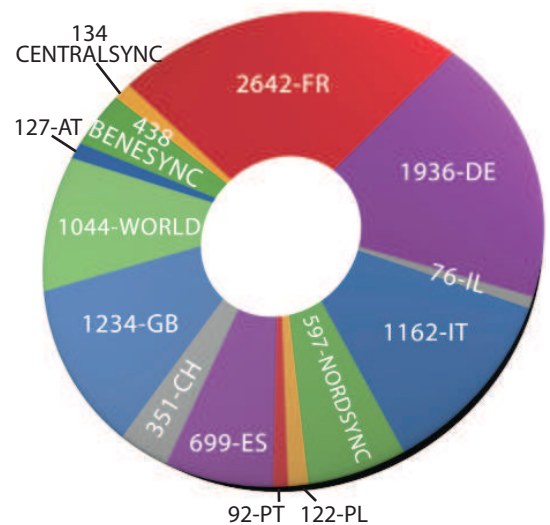
During the last 10 years, the ESRF has delivered more than 46,000 instrument-days. Over 9,500 research projects have received beamtime access based on scientific merit.

The ESRF is the only synchrotron that has pooled its technology resources with some 150 staff members developing innovative devices and synchrotron techniques for both the beamlines and the accelerator complex.

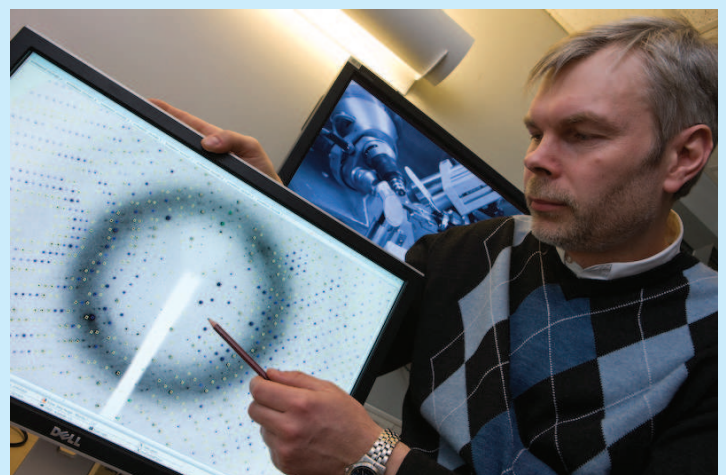
The ESRF users benefit from a fertile environment made of world-class research institutes: the ILL and the EMBL-Grenoble. These three international institutes have clustered with world-renowned national French institutes (CNRS, CEA, GEM, G-INP and Université J. Fourier) to create the GIANT Alliance with the aim to increase the international visibility and attractiveness of the Grenoble site. In return, the ESRF greatly contributes to the excellence of the site: experimental methods added to the existing palette, new research streams, access of many foreign visitors and users. Furthermore, common initiatives, seminars and workshops held at the ESRF induce significant knowledge spill over to the local environment. This results in self-reinforced feedback loops fuelling the international visibility and attractiveness of the Grenoble site.

Distribution of individual successful proposers at ESRF by country over the last 10 years.

BENESYNC: BE, NL;
CENTRALSUNC: CZ, HU, SK;
NORDSYNC: DK, FI, NO, SE.



The ESRF has dramatically increased the throughput of structural biology experiments thanks to advanced automation systems. Several software packages produced at the ESRF are now becoming standards in the community and being adopted at other facilities. The ESRF's proximity to and collaboration with the European Molecular Biology Laboratory (EMBL) has enabled some of the world's most sophisticated macromolecular crystallography beamlines. The techniques driving the ESRF's productivity are continuously improved to maintain the ESRF's global leadership in the field.



ESRF: driving innovation

Proprietary and industry backed research

The ESRF has established a significant industry-access programme that has involved more than 100 unique clients from industry, many of them using the ESRF on a regular basis, and that generates some €2m per year. The programme has had a direct impact on European wealth-generation, a prominent example being the high level of structural biology research carried out at European national light sources for the pharmacology sector thanks to the pioneering efforts of the ESRF. Notably, the increasing request for dedicated beamtime has led major players in the pharma industry to fund the construction and the operation of beamlines at leading national synchrotron centres.

The ESRF is taking a leading role in the local initiative IRT-NanoElec, which is funding a €6.5m Pathfinder Programme to allow the ESRF and its nearby sister institutions to work more closely with the micro- and nano-electronics industry.

An ultimate X-ray light source at the ESRF will create new opportunities to develop materials and understand processes relevant to today's societal challenges:

- Health and wellbeing (e.g. faster drug discovery and clinical imaging of drug delivery in single cells),
- Novel materials (e.g. watching next generation semiconductors at work and optimising high performance plastics, alloys and composites),
- Sustainability (e.g. understanding catalysis on single nano-particles),
- Secure, clean and efficient energy (e.g. new battery materials and more efficient solar cells),
- Safe and more efficient materials (e.g. understanding failure, crack formation and stress propagation at the nano-scopic level in key structural components of mass transport means).

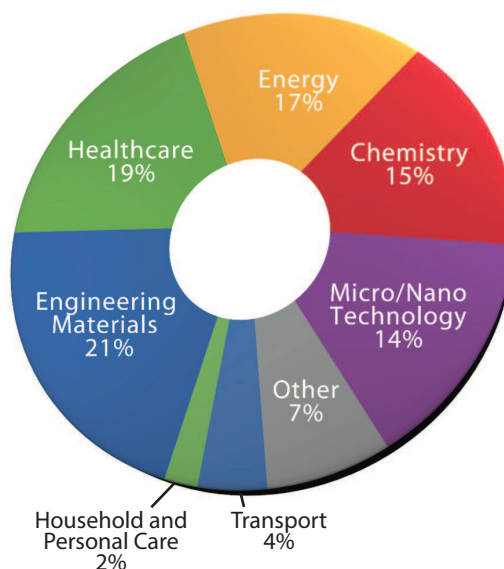
Relevance of ESRF for industry

The ESRF also drives innovation through industry-sponsored academic research under its public-access programme.

In a recent survey sampling ESRF users, 40% of respondents stated that their research has applications in industrial R&D. Almost half of ESRF users have direct links with R&D centres while one third benefit from industrial funding.

The main appeal of the ESRF to its industrial partners is its Business Development Office, which bridges the commercial and synchrotron worlds. Combined with the expert support of beamline scientists, the ESRF is closing the gap between scientific excellence and knowledge transfer with industry.

~ 40% of users state that the research they carry out at ESRF has applications in industry.



Industry sectors represented at the ESRF.

Sharing technology

Creating business

Creating an ultimate light source at the ESRF will enhance the leading technological role of the ESRF worldwide.

The ESRF has 25 years of experience in developing new synchrotron techniques, high-performance instrumentation and control systems. The technologies generated by the ESRF for its own needs are shared widely with other synchrotrons, and are increasingly exploited by other research facilities and by industry:

- The ESRF generates income through access to beam time for proprietary research, licenses and grants.
- Revenues from licences and direct sales of ESRF technology generated €1.4m over the last five years.
- Licensed ESRF technology allows European industry to sell high value technology to the global research infrastructure market.

Industry case studies

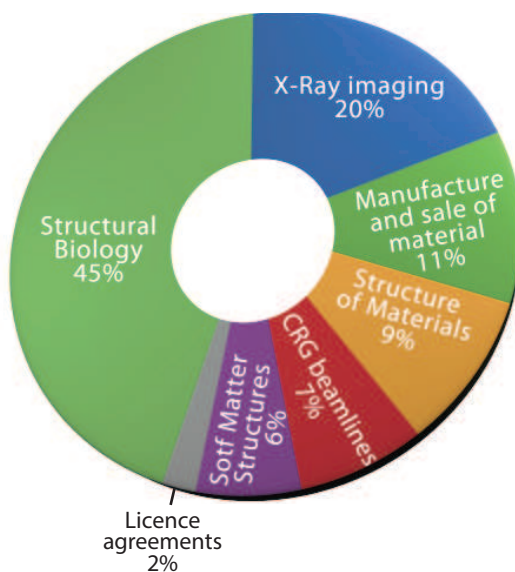
Open source control system: TANGO

Mirroring CERN's development of the World Wide Web, the ESRF has developed a product called TANGO that will impact the private sector. TANGO is an open-source control system that is already being used at almost all synchrotrons in Europe and is now propagating to industry, with great potential for test facilities and manufacturing. Market studies indicate that business generated by control systems in Europe annually is in the range of €400m for scientific facilities and in the €bn range for industry, helping European companies to be more competitive. Worldwide, the process automation market exceeds €10bn per year and estimated revenues for control systems are in the €bn range.

Magnet technology

The upgrade of the ESRF storage ring requires a new generation of magnets to be developed and built in conjunction with industry. The pioneering work on insertion devices has already given the ESRF strong experience with permanent magnets for accelerators and a successful record in working with European magnet manufacturers. The construction of the new storage ring will boost technology transfer and further benefit the European magnet and other related industries.

Commercial income by sector in 2011. Structural biology and X-ray imaging dominate beamtime sales.



The ESRF Upgrade Programme will boost the ESRF's capacities in nano-technology and nano-imaging, enabling new approaches to materials engineering and allowing industry to control the performance of new products at a much finer scale. The intense nano-sized X-ray beams will also allow researchers to move from static characterisations to time-resolved observations under real in operando conditions of single nano-particles.

ESRF: Education and training

Increasing the skills base

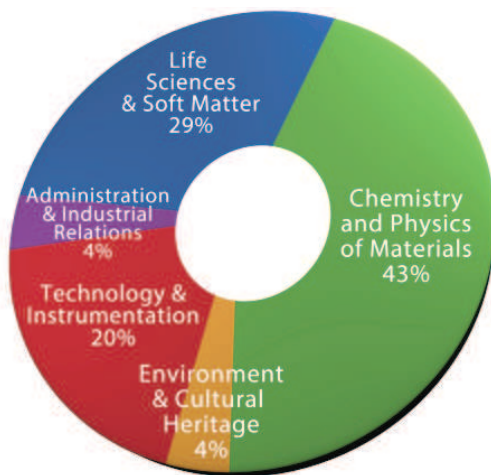
Young scientists and engineers, PhD students and post-doctoral fellows represent more than 15% of the overall ESRF staff. They are trained in world-class methods in experimental science. During the last five years, the ESRF has welcomed more than 170 post-docs and PhD students for total budget of €31.5m and supported more than 260 trainees with a total budget of €2.2m.

Numerous highly skilled personnel who have honed their skills at the ESRF are now applying their talents at other institutions in Europe and the world. This highlights the role of the ESRF in the global synchrotron science landscape.

The ESRF is paving the way for the next generation of synchrotrons and is taking the lead in synchrotron instrumentation. The realisation of ESRF UP Phase II will make the facility even more appealing to students, which is an essential prerequisite today to attract the young generation into careers in science and engineering.

The ESRF Upgrade Programme will enhance the experience and qualification of trained engineers, scientists and administrative staff even further.

The ESRF is working today to attract and inspire a new generation of scientists and engineers.



Left: Trainees, students and post-doctoral fellows researchers at the ESRF by field of activity. The indicated areas give an overview of the activities at the ESRF.

Right: Distribution of staff trained at the ESRF who have joined other research centres.

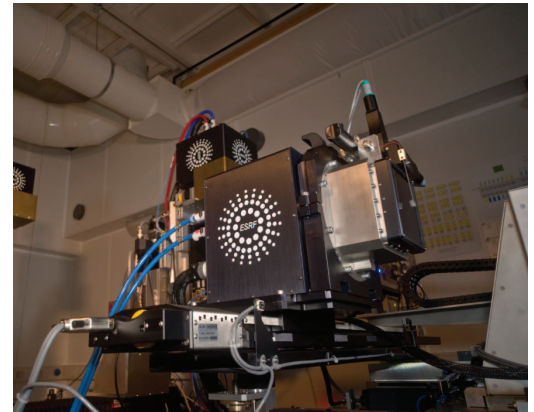


Promoting European collaborations

Transferring knowledge

Tough competition when submitting proposals to the ESRF prompts scientists to join forces: 28% of the proposals accepted at the ESRF involve researchers from three or more countries. The new and unique capabilities enabled by the upgraded X-ray source will bolster collaborations at the European level much more than today.

- The ESRF is the hub for synchrotron science in Europe, contributing to the mobility of researchers.
- The proximity of the EMBL and the Institut Laue-Langevin (ILL) has led to highly productive joint programmes to the benefit of their respective user communities.
- Partnerships in Structural Biology and Soft Condensed Matter exploit synergies between the ESRF and sister institutes on the EPN-Campus site, creating added value for users.
- The ESRF plays a leading role in combining European efforts towards new technologies, participating in 11 Framework Programme contracts.
- The ESRF coordinates and actively participates in more than 50 high-technology collaborations with institutions in partner and member countries, each typically involving five to seven partners from academia and industry.



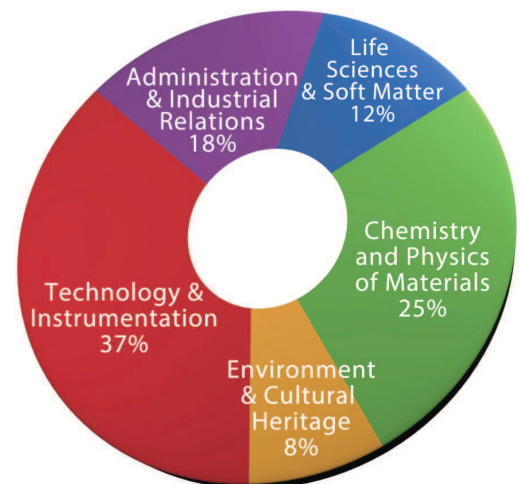
ESRF leads detector development

Developing advanced X-ray detectors is a top priority for synchrotrons and free-electron lasers. In 2009 the ESRF initiated a consortium involving all European light sources to secure state-of-the-art detectors and associated technologies. The consortium has the financial and technical momentum to maximise the returns of detector R&D and to help steer developments in industry.

Top: Photon detectors developed in-house.

Bottom: Distribution of the ESRF collaboration contracts active in 2013 according to areas of activity.

The ESRF is a visible element of the European Research Area (ERA) strategy to bolster Europe's effectiveness and competitiveness.



European projects

CRISP is a partnership of 11 research infrastructures identified by the ESRF roadmap. Co-funded by the European Commission and coordinated by the ESRF, CRISP aims to enhance the efficiency and effectiveness of physics-based large-scale facilities through developments in instrumentation and technology.





ESRF: returns on investment

Purchases

In addition to providing fair scientific return to its partner countries, the ESRF has developed special procurement and staff recruitment policies to ensure fair economic returns to all partners.

During the past five years, the ESRF has spent €228m on supplies and services. While the host region and country benefit most from this spending (at the level of ~80 %), as is typical for large research facilities, contracts for sophisticated and innovative equipment and supplies tend to be placed outside the host country.

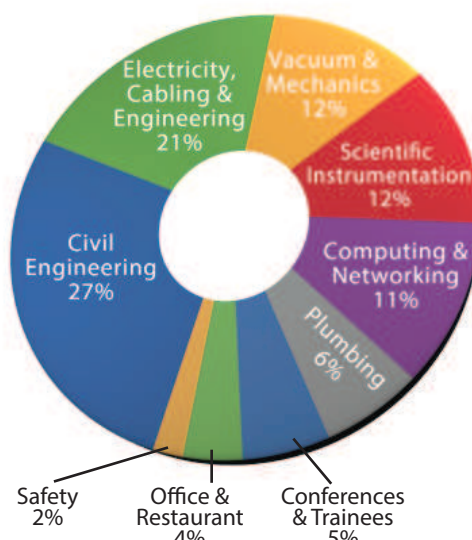
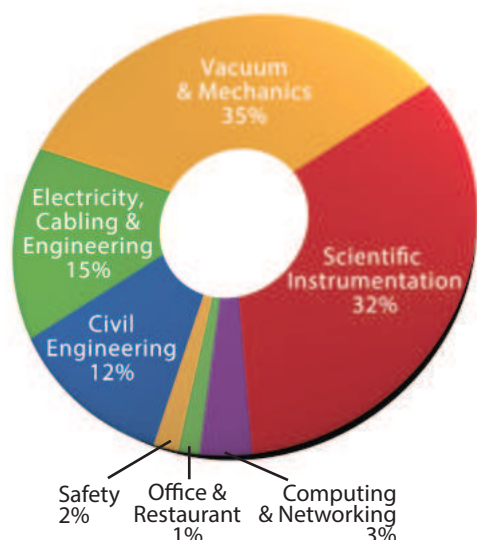
Staff salaries

Over the last 10 years, averaged yearly salary costs amount to €51m. On a yearly basis, contributions to pensions and social security are around €25m and income taxes paid by employees are of the order of €2m. That leaves net salaries of €24m per year that are spent mainly locally to the direct benefit of the Grenoble region.

The ESRF economic return to the host region is very favourable, a fact acknowledged by the French local governments (Contrat Plan Etat-Région and the Plan Campus) with the allocation of €18m to ESRF and ILL over the period 2007-2013.

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ESRF UP Phase II will have widespread impact due to its high-technology nature.

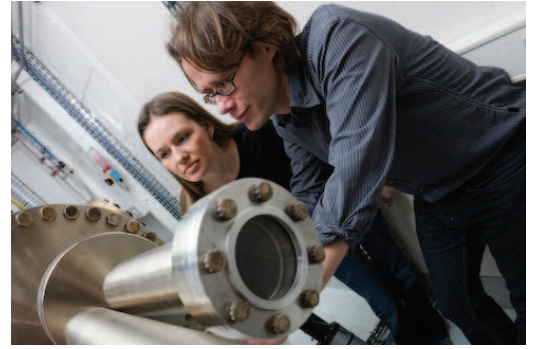


Left: Distribution of contracts and supplies from member and associate countries excluding France by sectors during 2000-2012.

Right: Distribution of contracts and supplies from France by sectors during 2000-2012.

Recruitment

Where possible, the ESRF applies the fair-return principle to staff recruitment. The host country provides the majority of the ESRF's staff, but scientist and engineer positions are much more evenly distributed among the partner countries. This fair distribution is even more apparent for students and post-doctoral researchers.



ESRF - a centre of expertise

The ESRF has knock-on effects in numerous sectors. Services and contracts placed in member and associate countries help secure follow-on industrial contracts, including the design and the manufacture of high-technology equipment. The engineering challenges of the second phase of ESRF UP will boost industrial capacity in areas such as detectors, nano-manipulation, control systems, magnets, vacuum technology, precision mechanics and high power radio-frequency technology for accelerators.

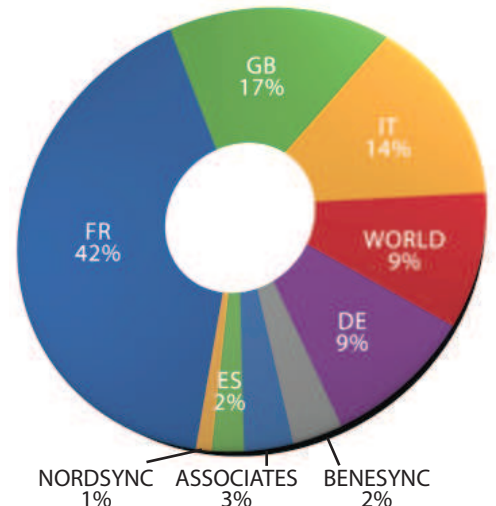
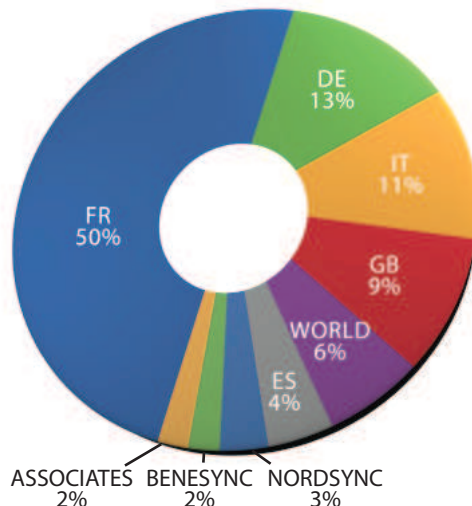


The returns to member and partner countries go further: experience with ESRF contracts increases the knowhow of national industry and provides access to other international contracts, ultimately making companies more efficient in serving national scientific communities and more competitive in the global market. Plans similar to the ESRF UP Phase II project are already under consideration in the US, Japan and China.

The engineering requirements of ESRF UP Phase II will mobilise companies in Europe to meet design and manufacturing challenges, generating returns that will enable industry to grow and to compete on the global market.

Left: National distribution of scientists, engineers and high-level positions at the ESRF during the last 5 years.

Right: National distribution of trainees at the ESRF during the last 5 years.



ESRF: a responsible role in society

Connecting with communities

The ESRF interacts with society at European, national and local levels, focussing on specific groups to maximise its impact:

Students and future scientists

For more than 20 years now, the HERCULES schools train several dozen students every year in synchrotron science. A new ESRF summer school, starting in 2014, will complement the training for undergraduate students.

Pupils and teachers

The ESRF welcomes several thousand high school and university students every year for in-depth group visits. Together with partners in EIROforum, the ESRF publishes the quarterly magazine "Science in School" to help teachers bring topical science into the classroom.

The public

Every citizen can visit the ESRF thanks to an agreement with the Grenoble Tourist Office, which organises monthly group visits. The ESRF also has regular open days and frequently participates in local events such as science festivals and exhibitions.

International media

Results obtained by ESRF users, for example in palaeontology, infectious diseases and novel materials, frequently lead to coverage in major print and online media. Media relations are coordinated with the press offices of user institutes and funding bodies.

Interested outsiders

The ESRF public website contains a wealth of scientific and technical information on synchrotron science carried out during the past 15 years. More than half a million individuals consulted ESRF public web pages during 2012.

A greener synchrotron

Scientific facilities require significant amounts of energy to operate at peak performance, but the ESRF is striving to become more energy efficient. Thanks to its design, the new synchrotron in the ESRF UP Phase II project will reduce the electricity consumption of the storage ring by almost one third, saving 9GWh per year, while boosting the brightness of its X-ray beams by a factor of 30 or more.

Furthermore, the new buildings constructed for the ESRF UP Phase I employ environmentally friendly and innovative materials, with bioclimatic design and green roofing reducing energy consumption. Globally, the ESRF is taking the necessary steps to become as energy efficient as possible, for instance actively encouraging and contributing to the use of either public transport, bicycles or car-pooling.



The new synchrotron will reduce the electricity consumption of the ESRF storage ring by almost one third.



A key actor in the European Research Area

Progress in science and technology is crucial for European companies to innovate and remain competitive, to create more and better jobs, and to keep improving the daily lives of Europeans in a sustainable manner. This is why the European Union decided that investment in research should be increased to 3% of European wealth.

The ESRF is a prime example of successful European collaboration: a hub for scientific excellence that has significant impacts on European economies and societies, which is in line with the objectives of the European Research Area. Investing in the ESRF has been an excellent decision of European governments:

- Synchrotron radiation helps industry improve processes and develop new products.
- The science and techniques stemming from the ESRF address major societal challenges facing Europe in the coming decades.
- The ESRF has become an exciting and attractive workplace for engineers, students and scientists.
- The ESRF has a track record in disseminating results and in training highly skilled individuals.

The ESRF contributes efficiently to the ERA mobility programme of European scientists, engineers, administrators and technical staff.

Initiated as project in the ESFRI Roadmap, the realisation of ESRF UP Phase II, leading to an X-ray source with unprecedented performances, is a strategic step to strengthen Europe's lead in science and technology.

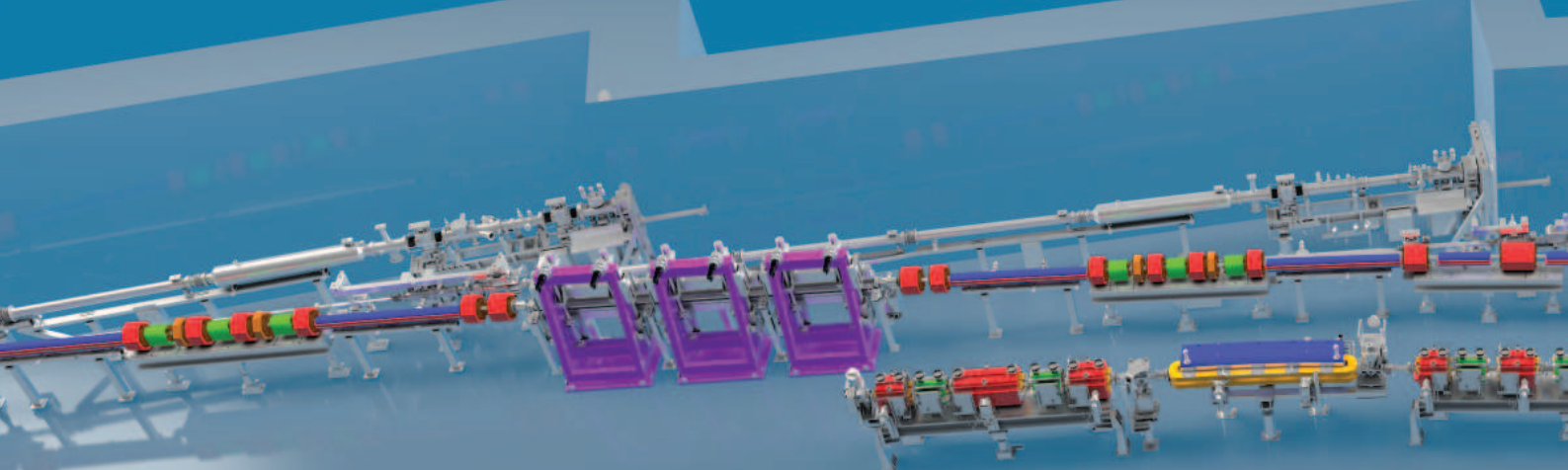
Given the impact the ESRF has had on partner countries so far, it is expected that the phase II of ESRF UP will:

- Enhance Europe's scientific output,
- Maintain and strengthen Europe's leadership in synchrotron science,
- Boost capacities in European industry,
- Provide direct economic returns to member and associate countries,
- Support and stimulate European industry in the global high-technology marketplace,
- Maximise returns on investment.

The ESRF is a prime example of successful European collaboration.

Synchrotron facilities in Europe with an active user programme (members of CALIPSO).





ESRF UP Phase II: why now?

Today, Europe has the opportunity to launch the world's first ultimate synchrotron source, delivering X-ray beams with unprecedented brilliance, coherence and spatial dimensions. Taking this vital step in synchrotron science requires investments beyond the reach of national facilities and builds on the highly specialised and diversified skills of ESRF's international staff. Only the ESRF has the capacity to do so, efficiently and rapidly. As in the past, other synchrotrons across Europe will benefit from the ESRF's pioneering role.

All users will profit from the gains in brilliance and coherence provided by the new X-ray source. Potential applications include:

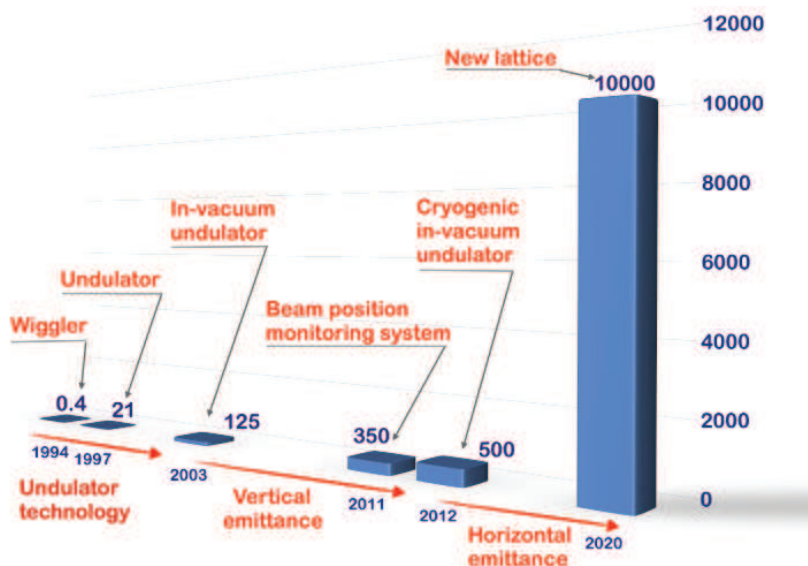
- Transmission nano-scscopy with X-rays providing spatial resolution down to a few tens of atoms,
- Serial scattering from nano-crystals or even non-crystalline materials, to understand the functional relations between particle properties and particle conformations,
- Extremely fast three-dimensional X-ray imaging of materials processing and reactions in operando conditions.

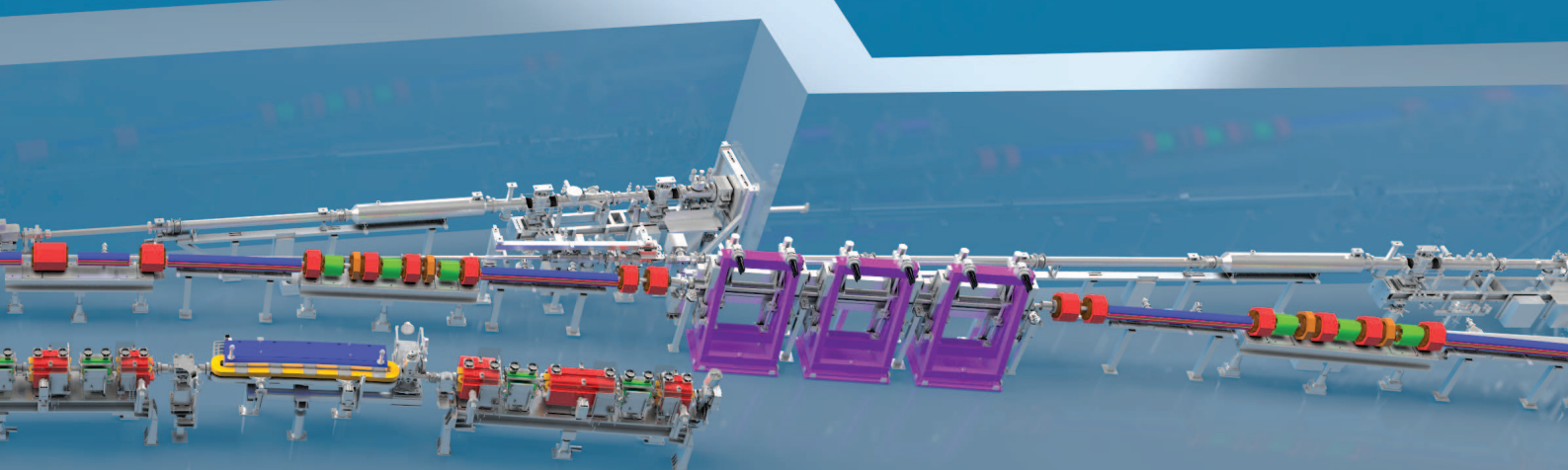
The second phase of ESRF UP is the logical and necessary choice for the next-generation synchrotron in Europe:

- It fulfils the ESRF's mission to develop and implement new methods and forefront technology to the benefit of science and other synchrotrons in Europe.
- Its timely implementation will allow the ESRF to lead synchrotron science at the world level, thanks to a qualitatively superior source.
- It optimises returns on investment compared to a new facility since it will use ~90% of the existing infrastructure and instrumentation.
- It will benefit from the ESRF staff expertise for a swift realisation.
- Environmentally concerned, the ESRF UP Phase II will be significantly more "green" and more energy efficient than the present storage ring.

Evolution of the X-ray brilliance on ESRF beamlines measured in units of 10^{18} photons/(sec. $mm^2.mrad^2$). Texts in red indicate the elements that led to major gains in brilliance. The qualitative leap in 2020 is the result of ESRF UP Phase II.

Now is the time to launch the ESRF UP Phase II. Building upon the successful completion of the first phase in 2015, ESRF UP Phase II will see scientists using X-rays of unprecedented quality as soon as 2020, powering new discoveries by existing and new user communities.





The ESRF in a nutshell

Top: Artist's impression of the new ESRF synchrotron. One of the existing 32 sectors to be replaced is shown in the foreground.

Bottom: ESRF Members and Associate Countries as of May 2013.

The ESRF is a research facility and the global leader in its field. It is supported and shared by 20 countries. It circulates electrons in a 844m-circumference storage ring so that they emit beams of intense X-rays, which are used by researchers from academia and industry to study the inner structure of materials.

Founded in 1988, the ESRF began operations in 1994 and has since exceeded all initial objectives. Today, the success of the ESRF is demonstrated by the 6,000 users from all over the world who visit the ESRF every year to carry out experiments at the frontiers of knowledge. More than 21,700 scientific articles based on work carried out at the ESRF have been published during the last 20 years, many in the world's foremost peer-reviewed journals.

The ESRF hosts 42 specialised X-ray beamlines equipped with state-of-the-art instrumentation which are unique in their performance in Europe and worldwide. As an internationally funded facility organised as a French non-profit company, the ESRF supports users on the basis of scientific excellence, in particular those from its partner countries, and carries out the necessary research and development work in synchrotron techniques.

The ESRF's impact is felt in all partner countries such as helping to improve the performance of industry and making possible the discovery of new materials and products that enhance European competitiveness. Having access to the most efficient synchrotron worldwide has become a strategic advantage for Europe.



The ESRF impacts society at many levels:

- **Taking science into new territories,**
- **Generating research programmes for young scientists,**
- **Driving innovation and creating business,**
- **Training highly skilled individuals for the European labour market,**
- **Disseminating results and achievements.**



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