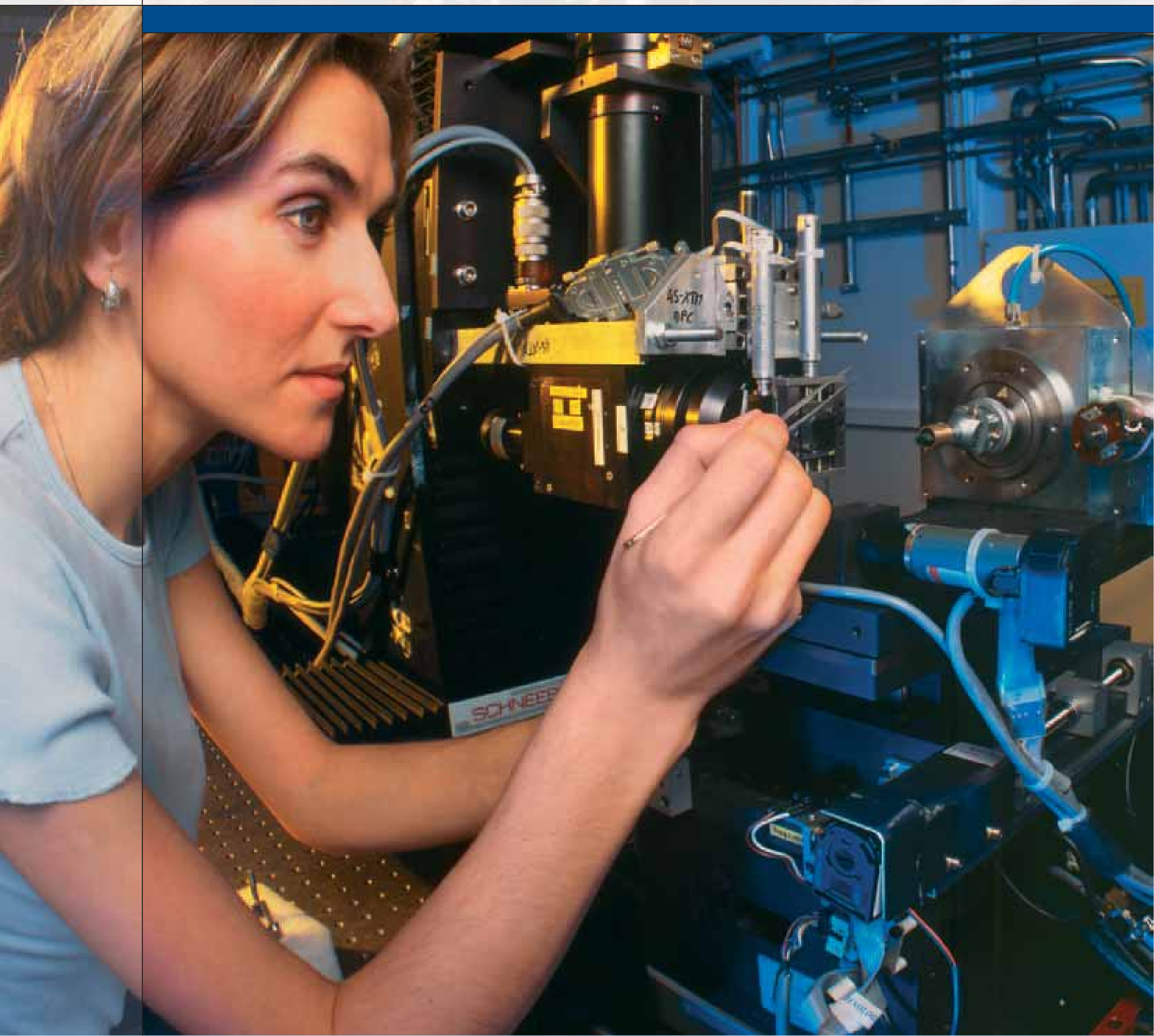
PAUL SCHERRER INSTITUT

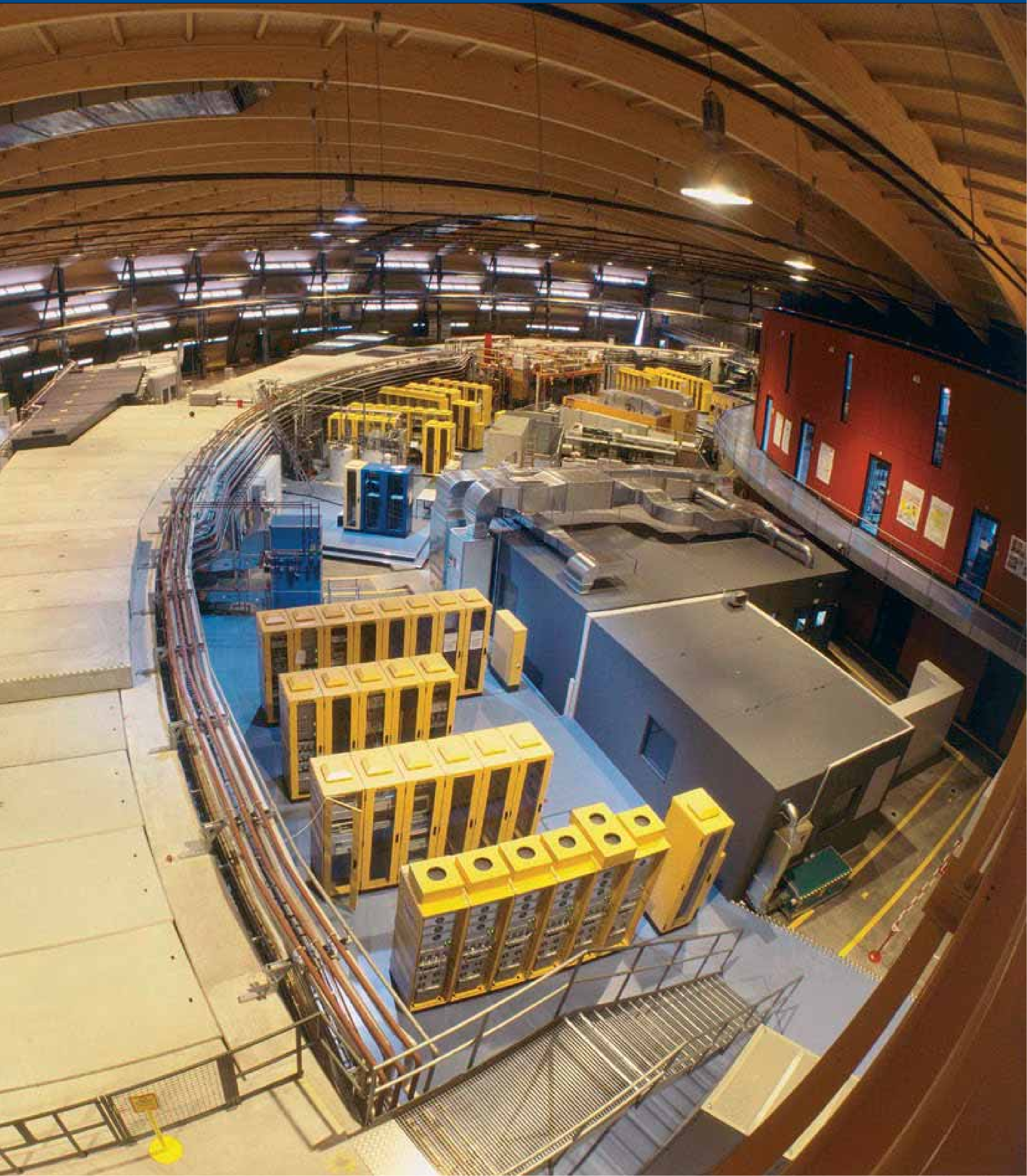
PSI

Light for Research

The Swiss Light Source at the Paul Scherrer Institute



The SLS generates sharply focussed, high-intensity light for scientific experiments.



Contents

Cover picture: Precisely-positioned sample: preparations for an experiment on the SLS micro-tomography beamline

The striking construction has an external diameter of 138 m and a covered area of 14 000 m^2.

The SLS – a well-rounded place

Giant microscope and colour micro-spotlight

The Swiss Light Source at the Paul Scherrer Institute (PSI) in Villigen generates tightly focussed, extremely intense light beams. It acts as both a giant microscope and a multi-coloured micro-spotlight. It allows researchers to delve into previously unexplored reaches of the microcosmos: for example, it can be used to decode the structure of proteins, or to investigate the characteristics of superconductors – and all this is at sizes down to one millionth of a millimetre.

The Swiss Light Source, abbreviated to SLS, came into operation in 2001. Since then, this PSI facility has been available for use by researchers from academic and industrial sectors. Scientists of all disciplines come here to carry out their experiments. "We work with biologists, chemists, physicists, engineers, environmental scientists and geoscientists," reports Stefan Müller, Science Coordinator at the SLS. In 2007, researchers carried out a total of 849 experiments. The scientists originate mainly from Switzerland, Germany, Italy and France – and they enjoy their visits, as shown by the way in which the SLS occupancy rate has grown continuously since it began operation with just four beamlines (experimental stations). A single beamline delivers light to one or more experiments, branching off tangentially from the main ring of the SLS (schematic drawing on Page 11). By now, the SLS operates 16 beamlines which are so sought-after that demand exceeds measurement time several times over.

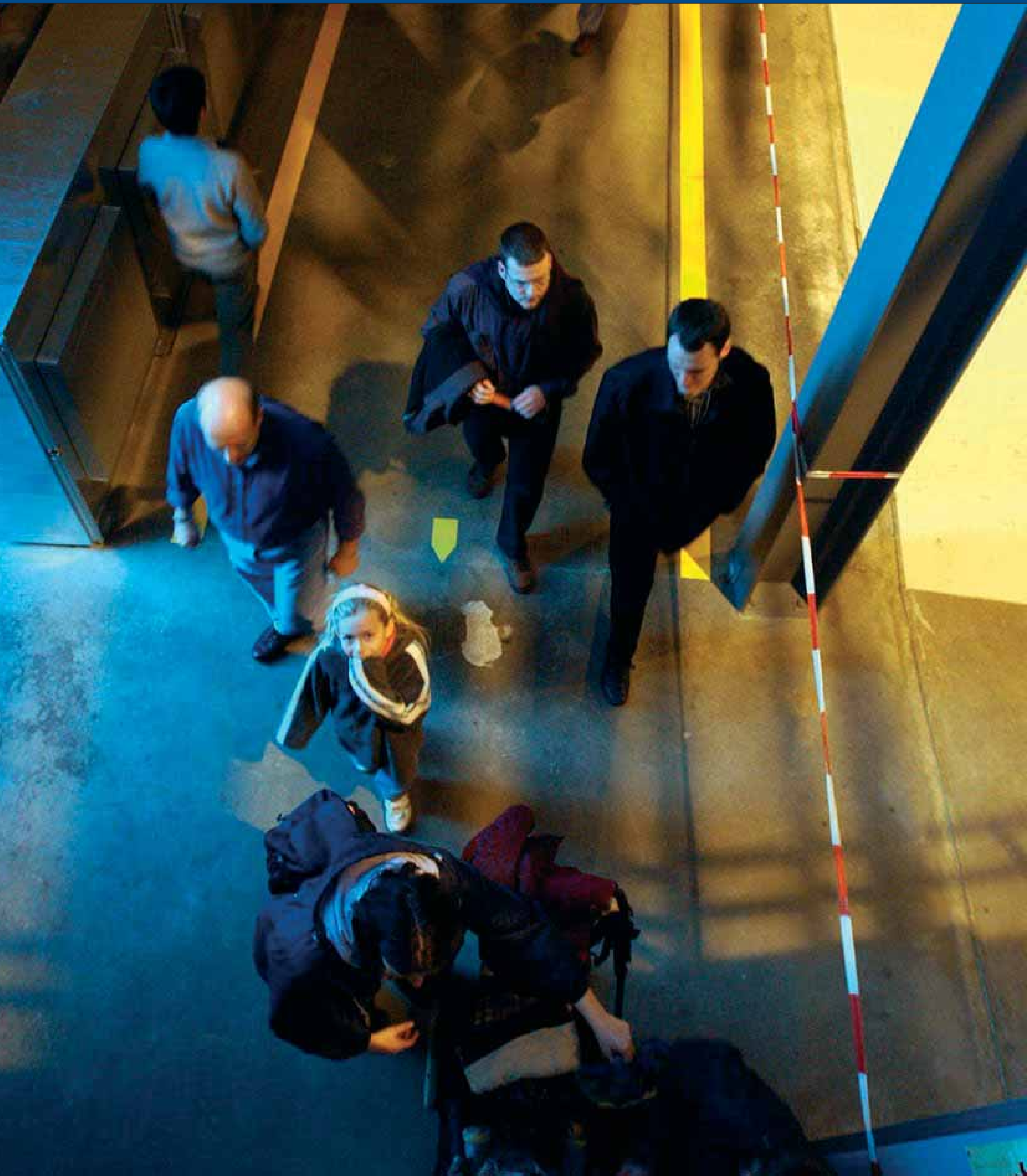
Serious congestion – further expansion

The SLS is currently one of the most advanced synchrotron light sources in the world. Its applications range from materials science through protein decoding to combustion research. The beam provided here is highly brilliant and extremely stable, which is a basic requirement for these demanding experiments. Such superlative quality is founded on new technologies that were developed by PSI, and have been adopted worldwide in the meantime. However, the good name of the facility also

Synchrotron light is a form of electromagnetic radiation – with wavelengths ranging from infrared to hard X-ray. It is generated in a facility where magnets are used to maintain electrons travelling at the speed of light on an circular trajectory, from which they emit synchrotron light. Details on Page 7.

Open days at the SLS attract thousands of visitors.

Open days at the SLS.



The SLS offers attractive opportunities for experiments and draws researchers from all over the world.

«We must develop our facilities continuously in order to stay at the top.»

Friso van der Veen,
Head of Research Department,
SLS

results in great measure from the services provided by the SLS specialists at PSI. “All those who come here to carry out their experiments find that we have an excellent infrastructure, and that they can rely on professional assistance from our staff,” explains Stefan Müller.

High publication rate

The construction of the SLS has paid off scientifically in the production of research results and publications. “In 2007, a total of more than 200 publications appeared in well-known specialist journals,” said Friso van der Veen, Head of Research Department, SLS. This is one sign that the facility is on the right track. “Now it's a case of staying on top. Our competitors will not let things rest as they are, so we must develop our facility on a continuous basis – and we will do that,” according to Friso van der Veen. Approximately 20 beamlines should be in operation by 2011.

Construction costs kept within budget

In 1997, the Swiss government approved a sum of 159 million CHF (excluding salaries) for the construction of the SLS. PSI has adhered strictly to this budget. At present, the beamlines cost about 2 million CHF per annum to maintain, with electrical power costing 3 million CHF and salaries 8 million CHF. The total operating costs are therefore 13 million Swiss Francs. On average two new beamlines are built every year at a cost of 4 million CHF per beamline.

SLS	Photon energy (eV)	BIOLOGY / MEDICINE	CHEMISTRY	PHYSICS	TECHNOLOGY
	0,1 Infrared	Biochemistry	Catalytic processes		New methods of spectroscopy (intensity, adjustability, resolution)
	1 Visible light	Biophysics	Photochemistry		
	10 Ultraviolet	Ultraviolet / X-ray microscopy	Electron spectroscopy for chemical analysis	Atomic and molecular physics, band structure of solids, surfaces and interfaces.	
	100 Vacuum ultraviolet		Investigation of radiation damage		High-power optics
	1000 Soft X-rays	Structural determination of complex biomolecules	Structure determination of polymers	X-ray optics for microscopy and lithography, cristallography, X-ray scattering and fluorescence	X-ray microscopy, lithography
	10000 Hard X-rays	X-ray angiography and tomography	Trace analysis		Materials research
	100000 γ rays			Compton scattering	

Areas of application for synchrotron radiation.

600 magnets at work: some move the electrons onto their orbiting path, while others drive them onto extremely narrow slalom routes, causing the electrons to emit synchrotron light.

Electrons whizzing through a tunnel

What exactly is synchrotron light?

There are currently about 70 synchrotron light sources in operation worldwide. However, the SLS was the first to generate synchrotron light of this quality at a reasonably-priced, compact facility. Other synchrotrons are now being built according to a similar principle to that used for the SLS at PSI.

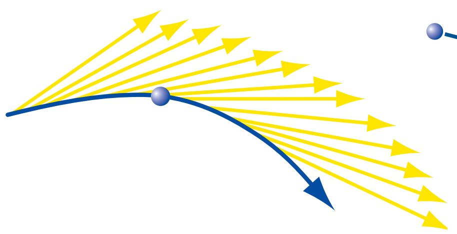
Electrons are accelerated until they approach the speed of light. They then orbit around for many hours inside a metal tube emptied of air, which the specialists call a storage ring. This storage ring is located inside a tunnel.

Light from deflected electrons

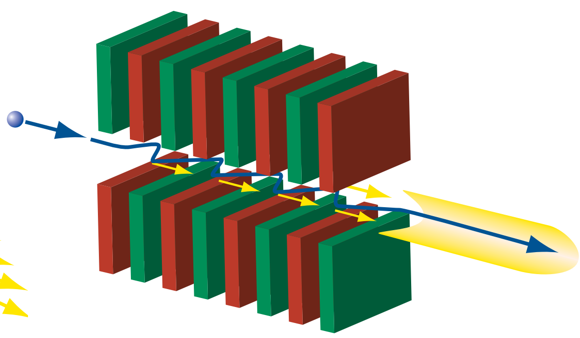
Bending magnets are used to keep the electrons moving on their orbital trajectories, from which they emit light. This light is then transmitted by mirrors to the various experiments. The light energy ranges from infrared to hard X-ray and can be freely selected to suit each particular experiment. Each beamline has unique characteristics, and each is therefore suitable for different experiments. For example, ultra-violet light and soft X-rays are used to investigate magnetic materials and superconductors, while hard X-rays are used to decode proteins and to make tomographic images. Brilliance is crucial to the quality of a synchrotron facility. This characteristic describes both the intensity and the concentration of the beam. For example, a candle has a low level of brilliance because the light dissipates in all directions. An electric torch performs better in this type of comparison because the beam is more concentrated.

Good resolution thanks to high brilliance

The extremely high brilliance of the SLS makes it possible to investigate very small samples. The major hurdle for researchers wanting to investigate for example the structure of proteins is not actually the measurements at the SLS, but production of the required protein crystals – this is a tricky affair, and often tedious, because such crystals grow so



Bending magnets accelerate the electrons (blue) along an orbital trajectory within the storage ring. The electrons emit a continuous spectrum of synchrotron light (yellow) as they travel.

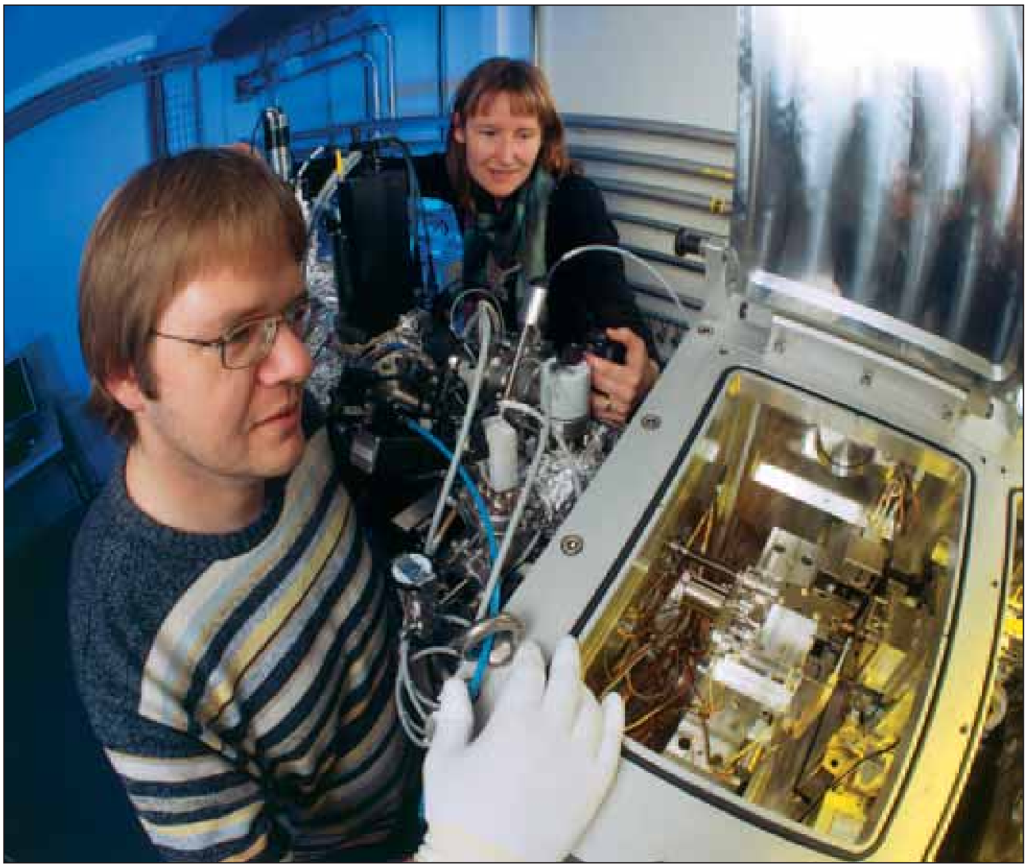


Undulators and wigglers are magnets (red and green) located within the storage ring. They force the electrons (blue) onto narrow slalom routes. The emitted waves superimpose upon each other to produce sharply focussed, high-intensity synchrotron light (yellow).

slowly. Excellent results can, however, be achieved at the SLS even when crystals are extremely small.

Sophisticated feedback system

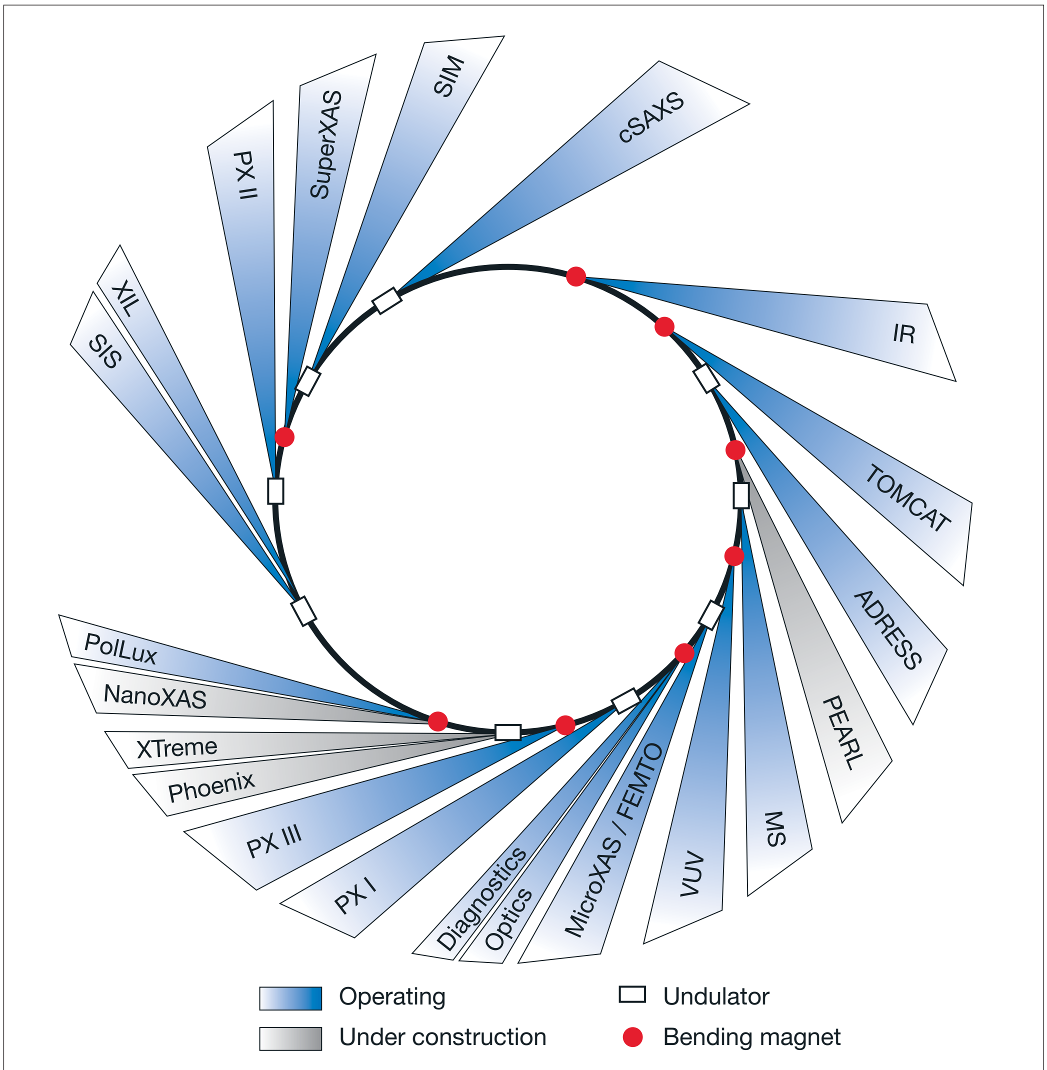
By now, the SLS team is extremely pleased that a great deal of time and money was invested in the basic concept of the facility from the very beginning. One example of this is the ingenious feedback system that uses magnets to keep electrons moving along their orbital path. If the beam in the tunnel deviates from its ideal trajectory, the relevant magnets can be controlled individually to push the beam back to its normal circulating route – a feature that distinguishes the SLS from other facilities. As a result, the beam is kept steady. This and many other technical refinements have made the SLS beam one of the most brilliant and stable in the world.



The PolLux beamline, a joint project between the German university of Erlangen-Nürnberg and PSI, was inaugurated on 23 November 2006. The German Federal Ministry for Education and Research was a co-financer of PolLux. This measurement station provides new opportunities for a wide range of research work – from the environmental sciences to biology to solid state physics.

THE BEAMLINES

ADRESS	Resonant spectroscopy (CH/I)
cSAXS	Small-angle X-ray scattering
IR	Infrared spectroscopy
MicroXAS / FEMTO	X-ray absorption spectroscopy / Ultrafast processes in solids
MS	Materials research
NanoXAS	X-ray absorption spectroscopy
Optics / Diagnostics	Test stations used by the SLS
PEARL	Photoelectron diffraction and scanning tunnelling microscopy
Phoenix	X-ray absorption spectroscopy for environmental and materials research
PolLux	X-ray microspectroscopy (CH/D)
PX (I, II, III)	Protein crystallography
SIM	Microscopy of magnetic surfaces
SIS	Spectroscopy of new materials
SuperXAS	Environmental and materials research
TOMCAT	X-ray microtomography
VUV	Vacuum ultraviolet radiation
XIL	X-ray interference lithography
XTreme	X-ray absorption spectroscopy under extreme conditions



Schematic diagram of the SLS: the beamlines (experimental stations) are arranged in a circular pattern within the facility. Undulators and bending magnets accelerate electrons. These emit the extremely focussed high-intensity synchrotron light that is necessary for challenging experiments.

Microcrystals in the focussed X-ray light: researchers fit a sample in the tensile testing machine at the SLS.

Tools for first-class research

A selection of leading results at the SLS

Following a chronological selection of scientific highlights which became possible experimenting at the SLS.

The start of a new era

In March 2004, the SLS helped to gain new insight into the structure of a new and biologically-significant protein. Photo-oxidoreductase is an influential molecule in nature – photosynthesis cannot work without it. The molecule uses the sun's energy to set the photosynthesis process in motion, with the help of electron transfer. The team working around Kristina Ferreira at Imperial College was able to describe the molecule to an unprecedented level of precision. “This work marks the beginning of a new era. We will understand how this molecule works much better from now on,” wrote a commentator in the prestigious scientific journal Science.

K. Ferreira et al., Science 303 (2004) 1831.

A cholesterol protein

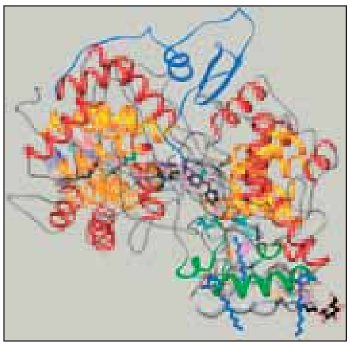
In November 2004, a research group from Hoffmann-La Roche was able to clarify the structure of a protein called OSC (oxidosqualene cyclase). OSC plays a vital part in the production of cholesterol. This discovery provides the potential for the development of a new type of cholesterol-reducing drug, as a possible complement to the statins that are currently often prescribed. Excessive levels of cholesterol can lead to arteriosclerosis and heart attack.

Ralf Thoma et al., Nature 432 (2004) 118.

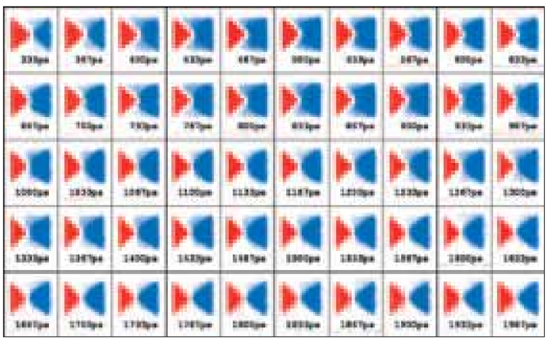
Magnetised atoms

Even though magnetism has been known to humankind for over 3000 years, we still do not have a theory that explains why some materials are magnetic and others not. A new experiment carried out by Christoph Quitmann's team at the SLS has made it possible to see the orientation of magnetic fields in particles with diameters of a few thousandths of a millimetre. The results gained by this method provide information about the forces acting between the magnetic moments in atoms. They are of great interest in basic research, but are also associated with significant technical applications, such as the way in which extremely small magnetic particles in computer hard discs store information.

J. Raabe et al., Physical Review Letters 94 (2005) 217204.



New cholesterol-reducing drugs: the 3-D structure of human OSC protein that was determined at PSI could be the key to development (Photo: Roche)

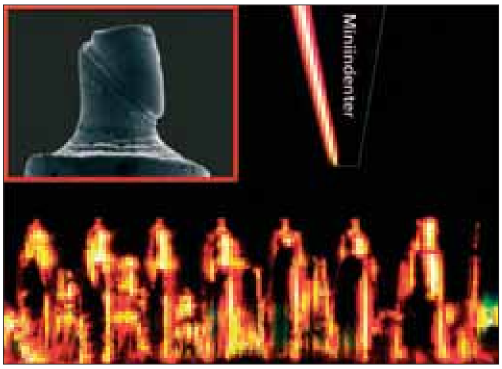


Crazy film: magnetic domains at intervals of 33 billionths of a second after excitation by a magnetic field pulse.

Why microcrystals are stronger

Despite intense research activity stretching out over almost a century, many questions relating to the deformation of metals remain unanswered and continue to form the basis for spectacular experiments to this very day. For example, and for reasons we do not understand, tiny metal crystals measuring a few *μm* are several times stronger than their macroscopic brothers. Theoretical considerations have come up with completely new kinds of mechanisms to explain this phenomenon, but they have still not been proven by experiment. Helena Van Swygenhoven's team therefore designed and carried out an experiment at PSI, using X-rays to produce an internal image of these microcrystals during deformation by a miniindenter (see photo). For the very first time, this pioneering work opens new experimental doors towards the explanation of why smaller is stronger in this particular case.

R. Maaß et al., Physical Review Letters 99 (2007) 145505.



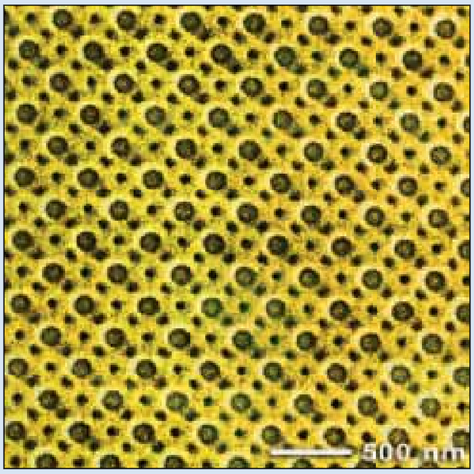
The photo shows a series of microcrystals ready for deformation by the miniindenter (top right). One of these microcrystals is shown in an enlarged view top left, after deformation.

The nano-sculptor

In the time it takes to read this sentence, a fingernail will grow by about one nanometre. This is equivalent to one billionth of a metre and is the dimension within which Harun Solak and his team at PSI carry out their experiments. With the help of a special X-ray beam, Solak managed to create structures in photo-sensitive lacquers, separated from each other by only 16 nanometres. This means that the PSI researchers hold the world record in this discipline, a record previously held by the distinguished Massachusetts Institute of Technology (MIT) in America. This success was made possible by the X-ray interference lithography beamline, known as XIL, which takes light from the SLS.

Solak's process allows large surfaces to be quickly "scored" by regular patterns, such as dots or stripes. The characteristics of such patterns make them suitable for use in component self-assembly, where synthetically-manufactured samples are used as substrates to control natural processes, such as the orientation of polymer chains. One particularly interesting idea is to use such substrates to stimulate the fabrication of protein crystals upon them. This could massively accelerate the decoding of proteins for pharmaceuticals manufacturing.

H.H. Solak et al., Journal of Vacuum Science and Technology 25 (2007) 2123.



Nano-sculptor at work

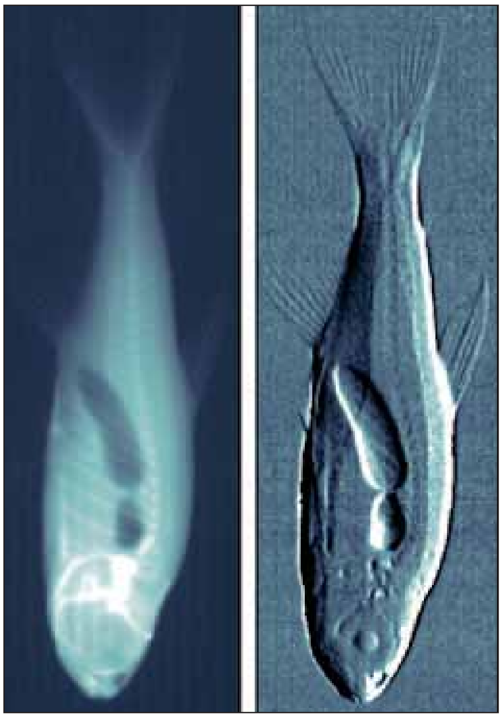
Rather than hammers and chisels, these PSI researchers work with a self-developed construction: a special beam of light in the extreme ultraviolet range generates structures in photo-sensitive lacquers, separated from each other by only a few billionths of a metre (see photo). In the future, it will be possible to use these kinds of nanostructures wherever components are becoming smaller and smaller – such as computer technology, biosensors and optics.

Phase contrast for better X-ray images in medicine

The classic method of imaging by X-rays is an extremely important aid to medical diagnosis in hospitals. The contrast in the image is created by the difference in absorption between various materials within the human body. Materials that absorb well, such as bone, can be seen clearly in conventional X-ray images, whereas the soft structures of the fleshy tissues provide hardly any contrast.

A new type of phase-contrast imaging process developed by Franz Pfeiffer and Christian David at the SLS promises significant improvements in the quality of the image. This process exploits the scattering of the beam caused by tiny differences in density within the tissues in addition to X-ray absorption, and could be used to provide improved images and a lower radiation dose during medical imaging in the future.

F. Pfeiffer et al., Nature Physics 2 (2006) 258 and
F. Pfeiffer et al., Nature Materials 7 (2008) 134.

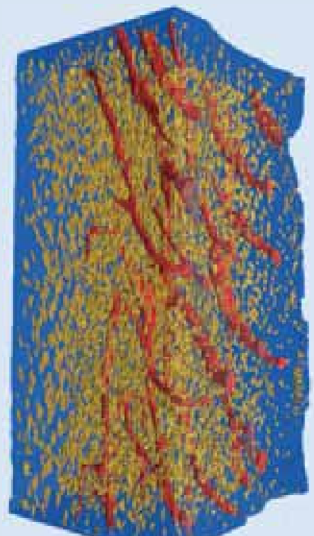


Conventional X-ray image (left); innovative phase contrast X-ray image (right).

The all-round beam

Great progress has also been achieved in X-ray microtomography. This method can be used to see inside a sample without destroying it. Marco Stampanoni and his team use the TOMCAT beamline to deliver particularly sharp X-ray images, and have notched up a number of highlights in the past few years: detailed images of the traces of Alzheimer's in the architecture of blood vessels in mice; of bones affected by osteoporosis (loss of bone density); of fossilised embryos, aluminium alloys and ceramics. The more intense the beam, the better and faster the microtomography: three-dimensional images with a resolution in the thousandths of a millimetre (micrometre) range can currently be produced within a few minutes.

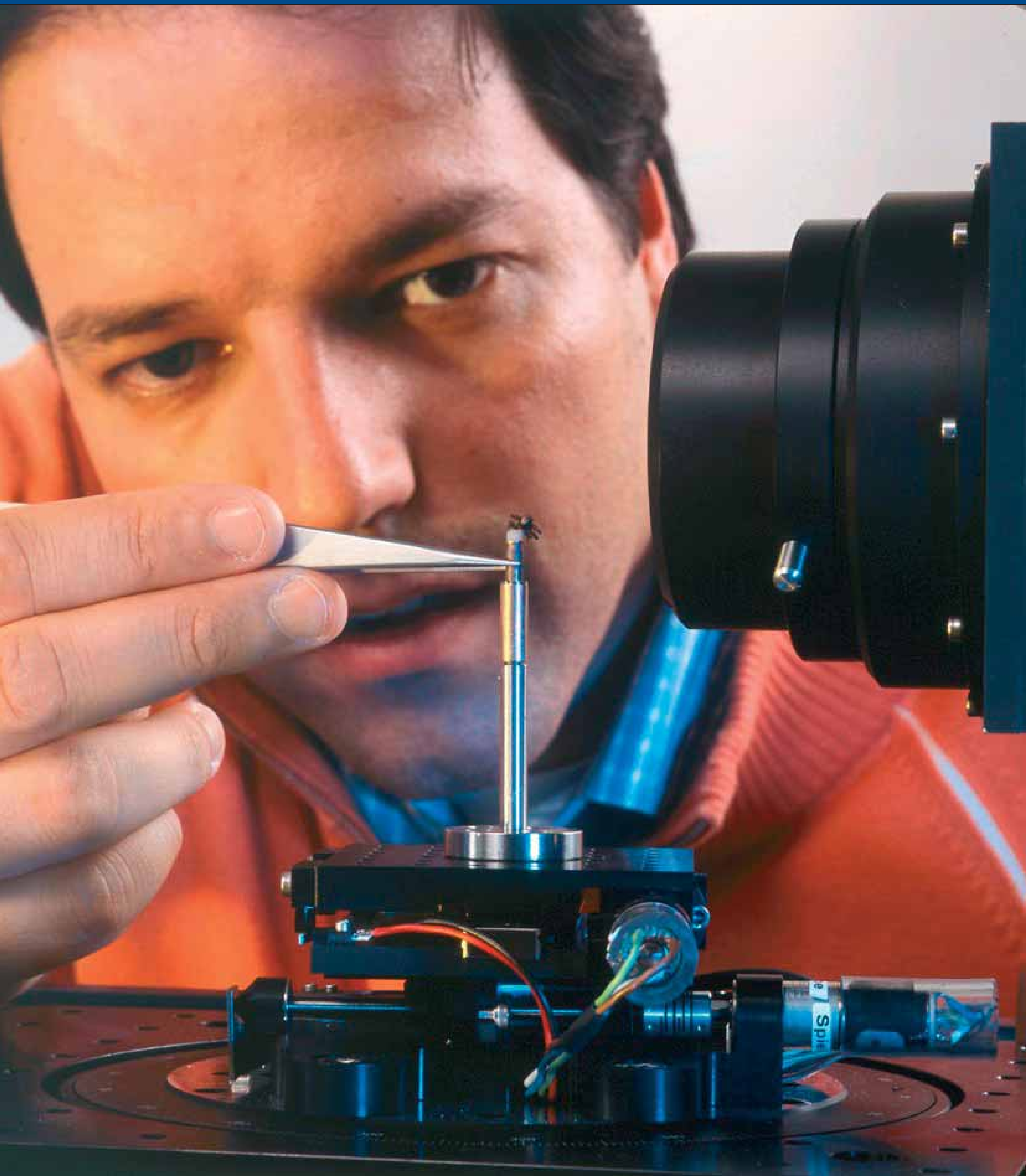
S. Heinzer et al., Neuroimage 39 (2008) 1549;
P. Schneider et al., Journal of Bone and Mineral Research 22 (2007) 1557–1570.



The battle against osteoporosis

The tomograph shows a bone sample of about a sixtieth of a cubic millimetre in size. Important information about the number and orientation of the bone cells (yellow) and the blood vessels (red) is obtained via the mechanics of the bone and way in which blood flows through it. These findings can provide explanations about the way in which new drugs work against osteoporosis. (Photo: PSI/IBT Uni/ETH-Zurich)

A wide variety of structures are investigated by X-ray microtomography at the SLS.



Quality and proximity are important

The voices of users from universities and industry

The Swiss Light Source, SLS, is a national research facility that is available for use by scientists from both Switzerland and abroad. A large number of international and multidisciplinary teams carry out experiments at the beamlines. We have picked out a number of top researchers to talk about their work, and their experience of the SLS at PSI.

«Still flexible, in spite of greater automation»

Mr. Ban, why did you carry out your experiments at the SLS in particular?

Nenad Ban is Professor of Molecular Structural Biology at the ETH in Zurich.

My research group is investigating various parts of cells with the help of X-ray crystallography – one of the most effective ways of clarifying biological structures. For our experiments, it is extremely important that we can call upon high-intensity, sharply focussed X-rays, which can only be provided by a synchrotron light source. We are fortunate that the SLS is nearby. It would be impossible to carry out our experiments without this national facility. As far as we are concerned, the quality of the beam and our proximity to the SLS are crucial factors.

Are you happy with what is available?

The facilities provided by the SLS are very good. However, we absolutely must keep up with the latest developments if the beamlines are to continue to be amongst the best in the world. This is especially important when you take into account the construction of alternative sources within Europe.

How could further improvements be made to the SLS?

The beamlines used to investigate the structure of proteins should be extended so that they can offer a higher level of automation. However, this must not be at the cost of the flexibility that is necessary for particularly challenging experiments. The most complicated and significant experiments in structural biology often have to be carried out with extremely small crystals, and it is important to us that, even if experiments have special requirements, it should still be possible to carry them out.

«Thanks to the SLS, we can improve existing medication and develop new drugs»

How important is the SLS for Switzerland as a research location?

In my opinion, the SLS is enormously important for research in the areas of physics, chemistry and biology, and especially in biochemistry and biophysics. The SLS is important to structural biologists because we can use it to gain a better understanding of the vital processes happening within cells. Thanks to the SLS, we can improve existing medication and develop new drugs.

The protein crystallography facility at the SLS is an extremely popular investigation tool, used to determine the structures of complex biological molecules.

«Since the arrival of the SLS, we've carried out all our measurements here"

Armin Ruf is a chemistry graduate and director of the X-ray crystallography group at Roche Pharma Research in Basel.

Why has your research group decided to use the SLS, Mr. Ruf?
The synchrotron radiation is of excellent quality. Also, the beamlines are reliable, and very good support is provided. Last of all: the location is extremely handy – just 45 minutes from Basel.

«We are very satisfied with the SLS»

What projects does Roche carry out at the SLS?
We mainly use the protein crystallography beamlines to determine the three-dimensional crystal structure of potential chemical agents. This is usually in association with the enzymes or receptors, i.e. the place where the agents actually take effect. This information about their structure can help us to develop new chemical compounds with improved characteristics. In addition, we also occasionally take X-ray powder diffractograms of powder agents. These are useful in the determination of changes to the crystals of these powders. Our third application is the determination of the crystal structure of individual agents.

«TOMCAT produces pin-sharp structural images»

Else Marie Friis is a Department Manager at the Natural History Museum in Stockholm. Here, she is mounting a fossil plant sample at the TOMCAT beamline.

Ms. Friis, the evolutionary development of flowering plants is regarded as a major botanical mystery. Why have you decided to carry out measurements here at the TOMCAT beamline?
Our fossil plants, which only measure a few *mm* and are mostly carbonised, are extremely tricky to prepare for normal microscopy. However, here at TOMCAT, we can look into the insides of the samples without destroying them. TOMCAT produces pin-sharp images of the structures within a few minutes.

What do you expect to achieve from these investigations?
The morphological investigations of these 70 to 120 million-year-old plant remains, which belong to extinct species, allow completely new insights to be gained into the relationships between the various groups of plants. The investigations at the TOMCAT beamline provide important evidence that we are treading the right path in our approach to research.

What is your personal experience of your intensive measuring time at TOMCAT?
I feel extremely comfortable here. The TOMCAT team provides me with the best possible expert support. The measurement procedure is subject to continuous improvement, and we are able to interpret the available measurement results within a very short time. In addition, I also enjoy being able to commit myself fully to my research activities while I am here at the SLS, away from the administrative burdens of a departmental manager.

The beginnings of construction in 1998: the SLS is taking shape.

Milestones

Planning, construction and development of the facility

July 1992
Production of the initial concept report: “A concept for a Swiss Light Source (SLS).”

November 1996
The Swiss Federal Council votes in favour of the SLS. The project is then submitted to Parliament for final approval.

March/June 1997
The National Council and the Council of States approve a total of 159 million CHF for the construction of the SLS. Both of the Councils vote in favour of the proposal, without further debate.

June 1998
Construction of the SLS starts in the western area of the Paul Scherrer Institute in Villigen.

August 2001
The facility is complete. Initial experiments begin.

19 October 2001
The official inauguration day for the SLS, attended by more than 200 guests from the worlds of research, politics and industry.
Four beamlines go into operation during the following few months:

- PX I, which is suitable for investigating proteins;
- SIM, which generates soft X-rays for microscopy of magnetic surfaces;
- MS, which supplies hard X-rays for material sciences;
- SIS, which enables the study of the electronic and atomic structures of surfaces.

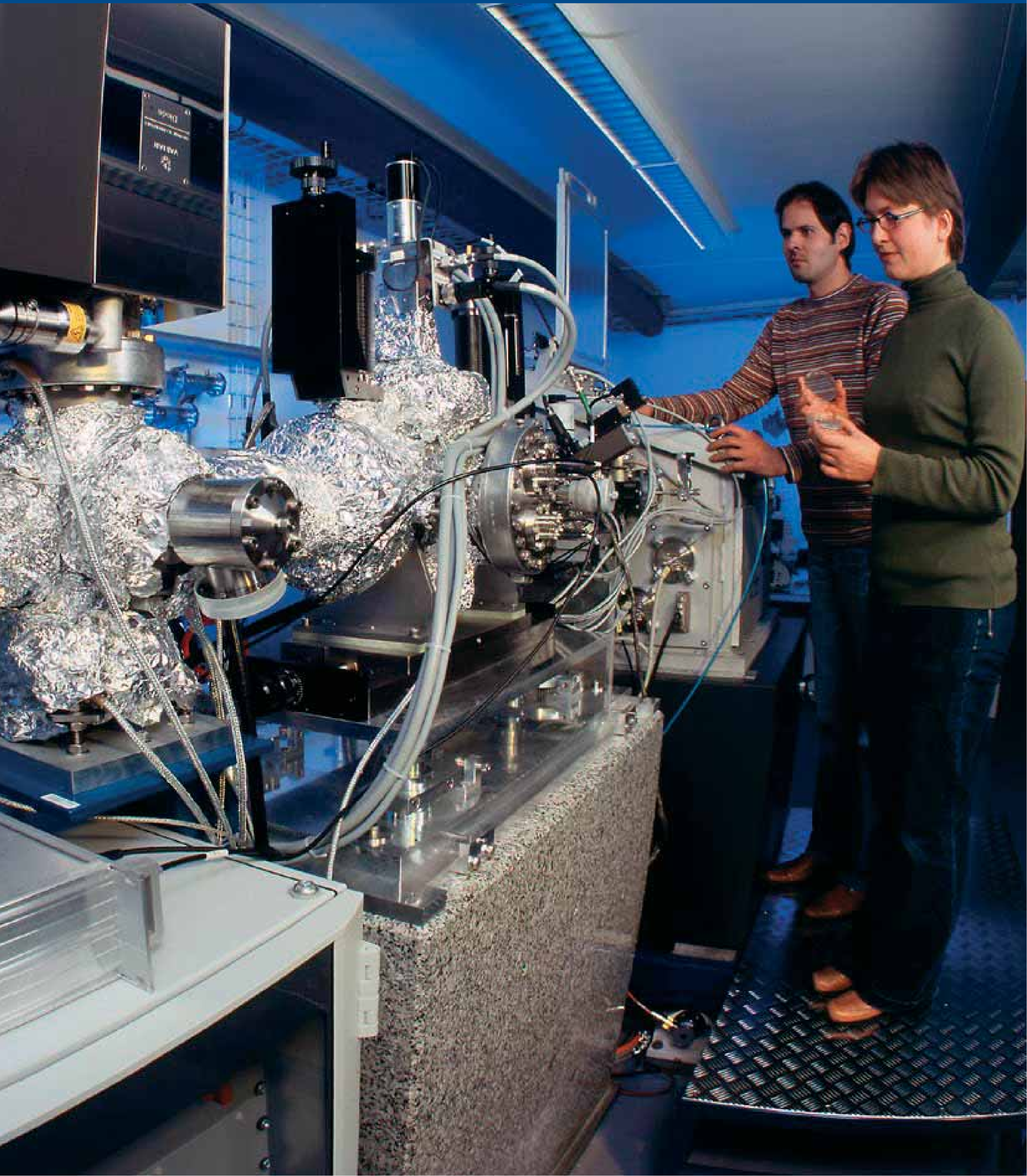
November 2002
The German Max Planck Society (MPS) join Roche and Novartis in deciding to construct an additional beamline for protein crystallography. PX II is intended to be an optimised version of the PX I beamline. MPS pay 50% of the costs, while the two pharmaceutical concerns from Basel each contribute 25%.

January 2003
First light at the new XIL beamline. The beamline is optimised for users over the next few months, then opened for operation. XIL stands for X-ray Interference Lithography.

June 2004
A further beamline is inaugurated. The specialists from PSI have constructed the LUCIA beamline in collaboration with experts from France's National Research Centre, the CNRS, and the SOLEIL synchrotron facility. This beamline allows innovative experiments to be carried out in the environmental and materials sciences, in archaeology and in many other disciplines. LUCIA stays at PSI until mid-2008 and will then be transferred to France.

The LUCIA inauguration ceremony: SOLEIL General Director Denis Raoux cuts the ribbon at the entrance to the experimental station, closely watched by Friso van der Veen, Head of Research Department, SLS.

Razor-thin X-ray: for experiments at the PolLux beamline the light from the SLS (in the steel pipe from the left) is focussed at 30 millionths of a millimetre.



January 2005
The Novartis/Roche/Max Planck Society's protein crystallography beamline is ready for service. This facility will make it possible to clarify the structure of proteins for drugs to fight a very wide range of illnesses. In January 2005, there are a total of six beamlines in operation, two almost ready to go into service, and a further four at the design stage.

December 2005
On average, the beamlines are overbooked by a factor of three. At the PXI protein crystallography line, demand for measurement time is five times greater than the time available (24-hour operation).

June 2006
PSI researches innovative imaging processes at its large research facilities. ETH Lausanne is also extremely interested in this field, and invests in a new SLS beamline for X-ray microtomography at PSI called TOMCAT which is inaugurated to great fanfare. TOMCAT will enable biomedical investigations that should ultimately lead to new discoveries about hitherto unexplained illnesses, thanks to resolution at the nanometre scale.

October 2006
A station for experiments involving time-resolved structural determination is ready for action, making use of hard X-ray pulses only 100 femtoseconds (10^{-13} s) long. This facility can be used to study extremely fast processes at atomic resolution, opening up new research areas in solid-state physics, chemistry and biology.

November 2006
Inauguration of the new PolLux beamline, a joint project between the University of Erlangen-Nürnberg in Germany and PSI. PolLux offers new opportunities for a broad range of research – from the environmental sciences through biology to solid-state physics.

2007
Five more lines (ADRESS, cSAXS, SuperXAS, VUV and PXIII) are constructed and taken into operation, partially as a result of international collaboration, and with support from industry.

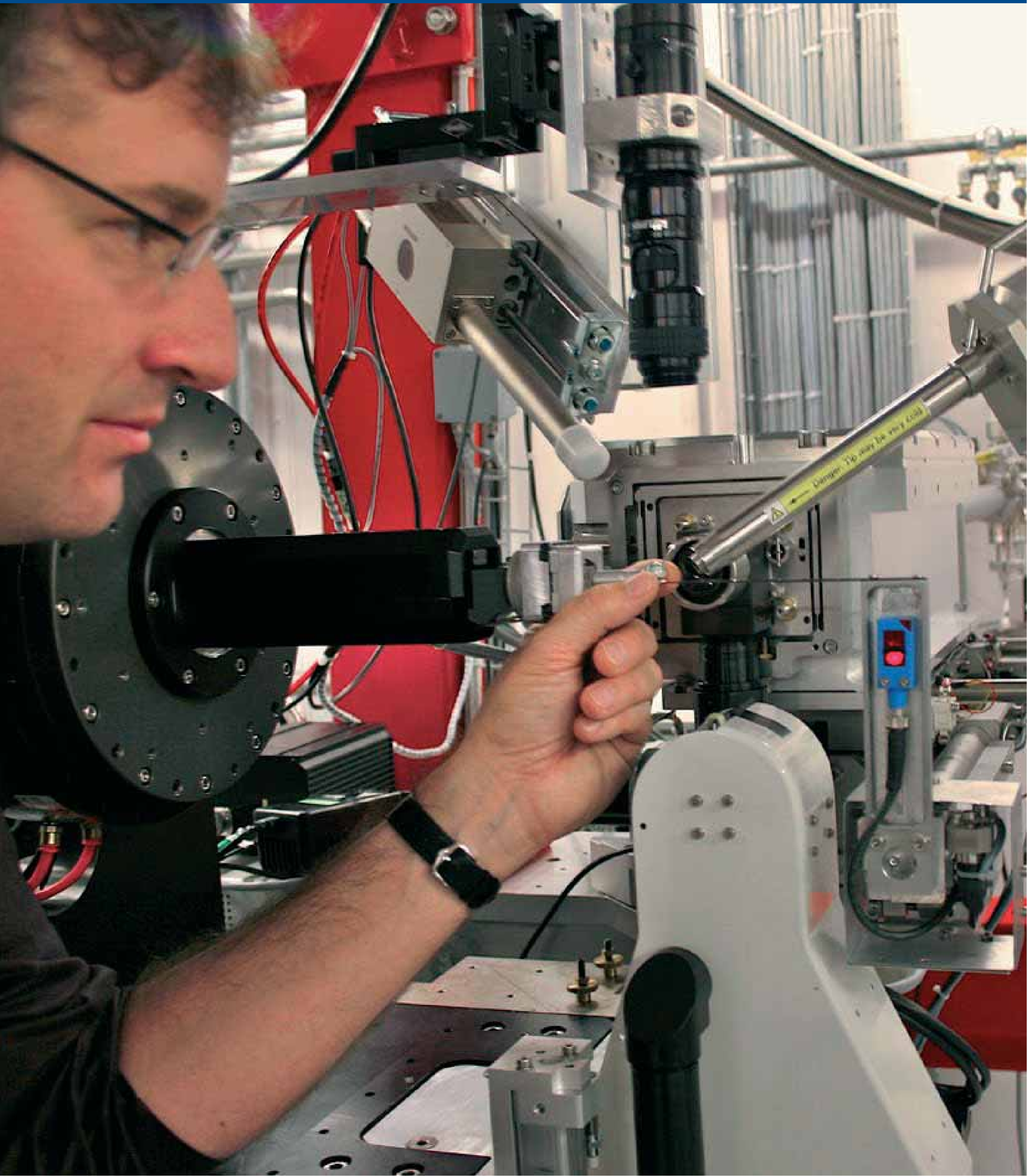
2008
The infrared beam line, providing deep insight into the dynamics of molecules, starts user operation. This expansion of the facility means that the SLS now covers practically the whole spectrum of potential applications for synchrotron radiation.

«Building an accelerator is like building a cathedral»

Leonid Rivkin,
Head of Department,
Large Research Facilities, PSI

Nicolas Hayek in discussion with Marco Stampanoni about the fuel cell research being undertaken at the Swiss Light Source.
The TOMCAT beamline is a cooperation between PSI and EPF Lausanne. This experimental station can be used to view the inside of any material, or to make the smallest of components visible.

The PXII beamline at the Swiss Light source SLS.



From laboratory to market

Technology transfer at the SLS

PSI aims to make new research discoveries available for the benefit of both society and industry. As a result, Swiss companies will become more competitive, enabling them to launch innovations onto the market. This creates new jobs and secure those that exist already.

The journey between clever idea and marketable product is often lengthy. Technology transfer (the conversion of knowledge generated by science into products developed by industrial companies) is intended to encourage and accelerate this process, and is also useful for the SLS's research results and technologies.

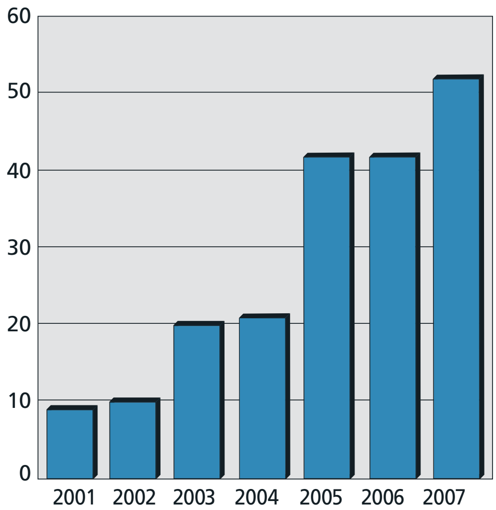
A bridge between science and industry

«Scientists are usually aware of opportunities for collaboration and marketing," explains Robert Rudolph, Head of Technology Transfer at PSI. "We can advise on the best way to prepare and implement transfer projects – including patent applications, assessments of the market potential of an invention, and with contract or licence negotiations." The technology transfer experts also possess the resources to support spin-offs during their start-up phase; they carry out a bridging function, providing services to both PSI researchers and interested industrial representatives.

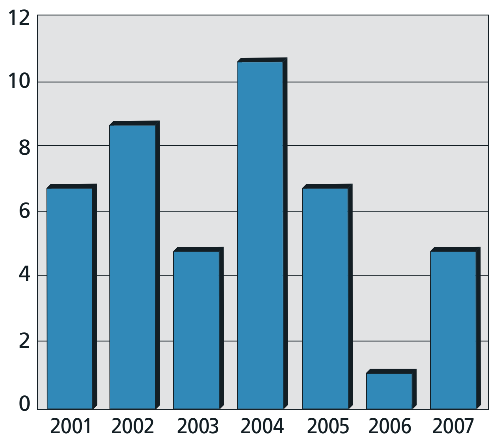
Successes with X-ray detectors

Some material for technology transfer was already produced by the construction of the SLS itself; for example, the electrical power sources developed for the SLS are able to control the flow of current extremely precisely and accurately. Special new stepper motors were also developed to control the instruments, samples and devices. Both products were subjected to further refinement so that they became ready to put on the market. New types of X-ray detectors were also developed successfully, and a spin-off company was set up accordingly.

PSI patent applications



Total number of licences awarded by PSI



Patent: Officially assigned right to sole use and commercial exploitation of an invention.

Licence: Contractually guaranteed right to make use of a patent.

Spin-off company: Newly-established company that converts a technology developed at the Institution into a marketable product.

Nanostructures using X-ray interference lithography: the very small samples produced at the SLS XIL beamline, e.g. on silicon wafers, can be used to develop products such as powerful computer components.

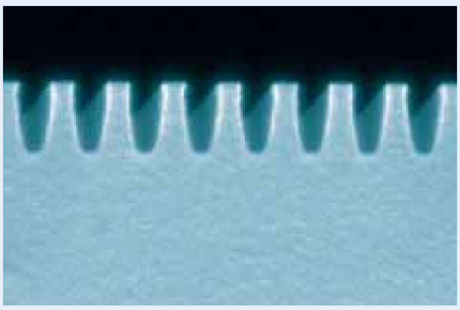
10 percent of measurement time used by partners from industry

The use of the SLS instruments by domestic and foreign industrial partners, as illustrated by Roche or Novartis in the area of protein crystallography, is another form of technology transfer. A company called 'SLS Techno Trans AG' was set up especially to provide this type of service. Its task is to market the SLS to potential industrial partners, to negotiate contracts and to co-ordinate joint projects with those partners that already exist. This kind of use by industrial partners currently takes up about ten percent of the beam time at the SLS – a good proportion by international comparison.

SLS Spin-off

EULITHA – extremely small, high-quality structures

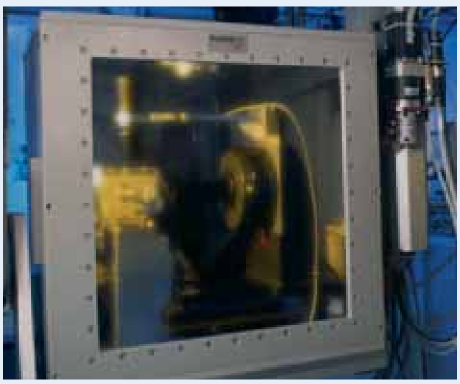
The EULITHA spin-off company develops and produces regular, extremely small, dense nanostructures with a resolution of up to 15 nanometres, using X-ray interference lithography. This production technology can, for example, be used for the mass production of computer hard discs with a storage capacity 100 times greater than the current status of technology, or for metallic nanostructures used in colour displays.



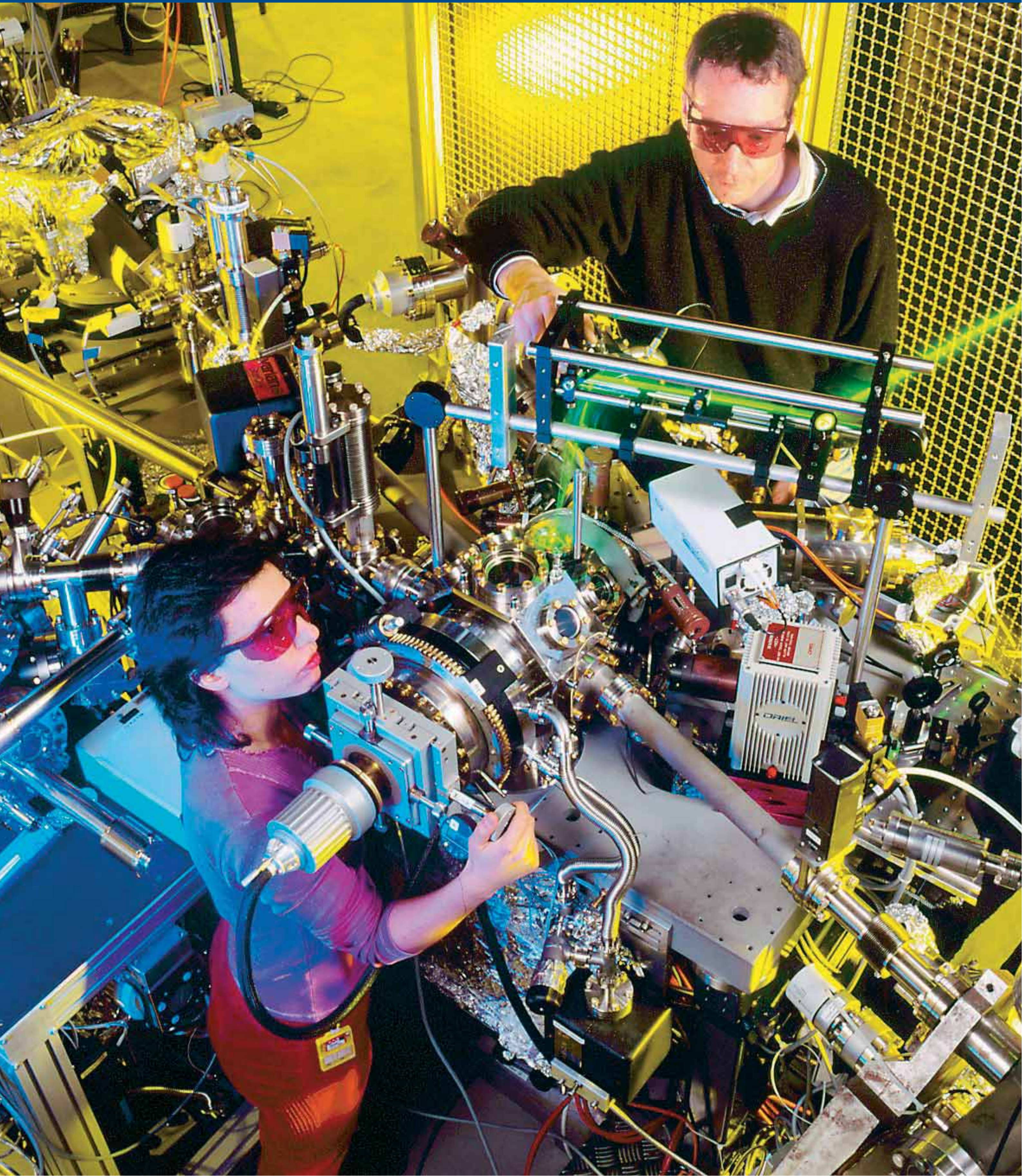
SLS Spin-off

DECTRIS – the next generation of X-ray detectors

One of the core competences of the DECTRIS spin-off company is the ongoing development of digital X-ray detectors, and their production, calibration, sales and support. These detectors have been very successfully used at the SLS under the name PILATUS (Pixel Apparatus for the SLS) for material sciences, small-angle scattering and protein crystallography.



Ultra-short sequences of magnetic switching operations: a research team at PSI using synchrotron light to investigate how magnetic particles react to excitation by laser pulses (green).



Staying on top

Future prospects for synchrotron light sources

An increasing amount of research work is now based upon tasks undertaken at synchrotron light sources. However, it is not just that the quantity of such facilities is greater – their quality is also rising. Technological progress is providing ever deeper and more perceptive insights into matter.

Synchrotron radiation now provides the basis for a branch of science that is rapidly growing and blossoming. In 2002, there were 44 ring accelerators; by 2007, this had already risen to 70, including those being planned. This upturn is also affecting the SLS, where those responsible can look back upon seven successful years. "We are now very successfully established on the international stage, and will continue to build upon our position in the years to come," says Friso van der Veen, SLS Research Department Head.

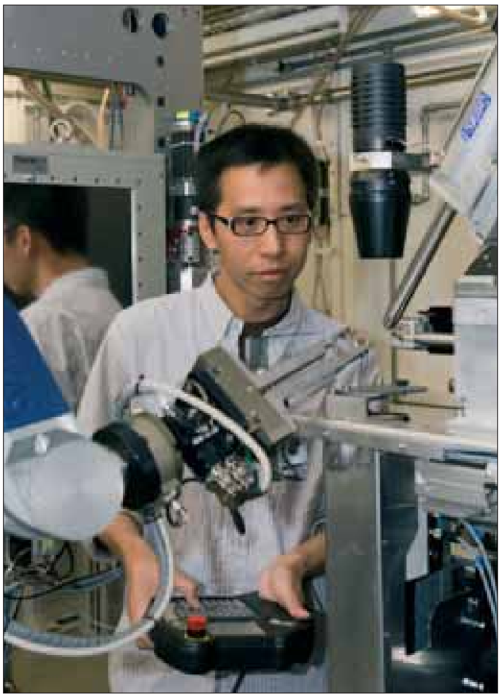
A major triumph: protein decoding

The aim is to have about 20 beamlines in operation by 2011. This is a realistic target: 16 beamlines are already operating right now. In the area of protein crystallography, i.e. in the clarification of protein structures, the managers believe that demand will continue to be just as strong for the next few years. In addition, there will be an increase in the potential for materials research, 3-D imaging and energy and environmental research.

Competition from new facilities

Despite the boom in protein crystallography and 3-D imaging, it will not be easy to achieve the SLS's ambitious goals, given the increase in competition from other countries. New foreign facilities have already been brought into service during the past few years, or are now at the design stage. For this reason, the SLS is subject to constant improvement to ensure that it stays at the top. Refinements also include automation: using robots to carry out measurements even faster.

"In the meantime, we have already reached the stage whereby samples can be sent to us. We investigate them on behalf of customers and send the information back to them," says Friso van der Veen. "As a customer, you can follow the experiment by computer, and influence the investigation as appropriate. This is particularly attractive for smaller companies, who might not be able to afford to send valuable staff to the SLS for an extended period."



Automating the measurements: robots carry out operations (such as the transfer of samples from cryogenic vessels to the measurement station) quickly and precisely at the protein crystallography beamline.

PSI in brief

The Paul Scherrer Institute (PSI) is a multi-disciplinary research centre for natural sciences and technology. PSI collaborates with national and international universities, other research institutions and industry in the areas of solid-state research and materials sciences, particle physics, life sciences, energy research and environmental research.

PSI concentrates on basic and applied research, particularly in those fields which are the leading edge of scientific knowlegde, but also contribute to the training of the next generation and pave the way to sustainable development of society and economy. The Institute is actively involved in the transfer of new discoveries into industry, and offers, as an international centre of competence, its services to external organisations.

PSI employs 1300 members of staff, making it the largest of the national research institutions – and the only one of its kind within Switzerland. It develops, builds and operates complex large-scale research facilities that impose particularly high requirements in terms of knowledge, experience and professionalism. PSI is one of the world's leading user laboratories for the national and international scientific community.

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PSI, with the SLS in the western area.

Photo: Luftwaffe Schweiz

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