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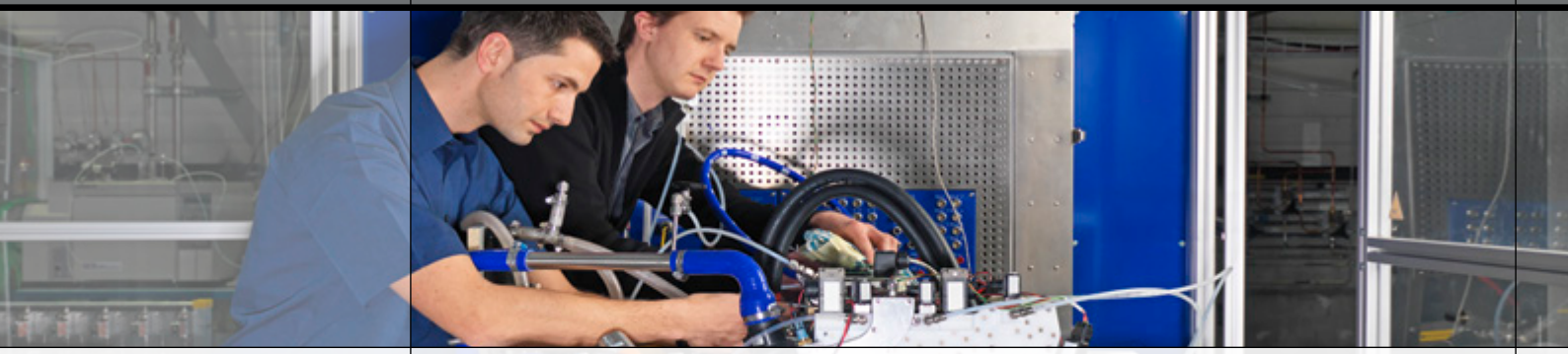
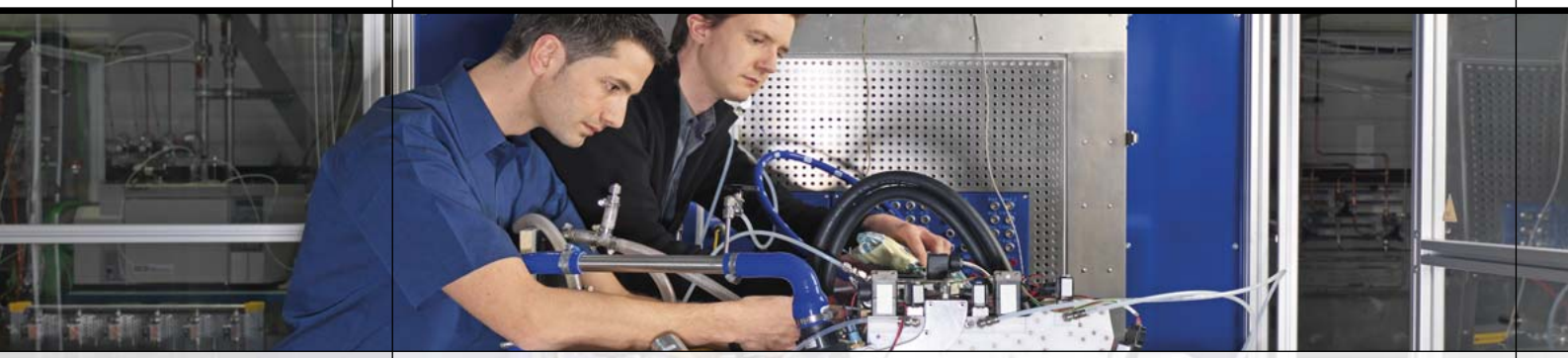


PSI Scientific Report 2010

Cover photo:
PSI researchers Marcel Hofer and Jérôme Bernard working an a fuel-cell system developed in collaboration with Belenos Clean Power AG.
(Photo: Scanderbeg Sauer Photography)



PSI Scientific Report 2010

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SINQ

Photo: Scanderbeg Sauer Photography

World-class research benefits our industry

Dear Reader,

What do automobile components, batteries, chain saws, chocolate, computer processors, concrete, fuel cells, luxury watches, medicines, satellites, semiconductors, soap and yoghurt all have in common? The answer is that they, among many other objects, have all been examined at the Paul Scherrer Institute by industrial companies. Looking inside a combustion engine or a biomolecule is possible through the use of the large-scale scientific facilities of PSI: the Swiss Light Source (SLS), the Spallation Neutron Source (SINQ), and the Swiss Muon Source (SμS), or the hot-cells for radioactive materials. These facilities are all available for industrial partners to use, for investigations that are not possible anywhere else in Switzerland, or – in some cases – even anywhere in the world.

Besides this direct use of PSI facilities by industry, other indirect benefits also exist for industry from PSI's own internal developments. Indeed, PSI scientists often require technologies for their own experiments that are not available on the market and this therefore necessitates specific in-house development to achieve a solution. It regularly happens that PSI products which derive from such developments can be used in various other types of industrial applications. Two particularly notable examples of such technology transfers originated from fundamental research at PSI.

The first is an oscilloscope, the size of a thumbnail, which had been developed for precision experiments at PSI and can perform the same functions as a conventional device the size of a shoebox. PSI is currently looking for the best way to market this product. In the second example, PSI researchers developed an innovative detector for the CMS experiment at the new Large Hadron Collider (LHC) at CERN, to reveal the presence and paths of elementary particles. Further adaptation of this device for X-ray detection resulted in the creation of the spin-off company DECTRIS. This company is now selling its products all over the world and, for this achievement, received the Swiss Economic Award in June 2010. Currently, scientists at PSI and DECTRIS are investigating the potential of this technology for applications in the field of medical imaging.

Beside these two examples, numerous other technologies developed at PSI are now used by industry; for example, power supplies for highly dynamic magnets, high-precision step-motor control systems, various components for proton-therapy treatments, catalysts for exhaust gas after-treatment, fuel cells as power supplies, or optical components for neutron sources, as produced by SwissNeutronics, another PSI spin-off company.

The next large facility to be built at PSI will be the SwissFEL X-ray free-electron laser. In building this facility, it is one of our highest priorities to involve future users at the earliest possible stage of its conception, as we want to provide a facility which is precisely tailored to the needs of Swiss research groups in both universities and industry. At the same time, we are being confronted by considerable technological challenges, which we want to solve together with industrial partners. In this way, know-how from PSI will – again – be transferred to industry, enabling the companies involved to acquire knowledge and innovation capabilities.

To conclude, although it is clear that most research performed at PSI is of a fundamental character, considerable direct and indirect benefits also result for our industry and, consequently, our society, not to mention the benefits which accrue from the significant training and educational component of PSI's mission.

Professor Dr. Joël Mesot
Director, Paul Scherrer Institute


WLHA.T05.0.03

8 SwissFEL – Project overview and new developments

An important milestone in the realization of the new SwissFEL facility was reached on 24 August 2010, when the core of the new Swiss Free-Electron Laser facility (SwissFEL) was set into operation at the Paul Scherrer Institute. The newly inaugurated injector pre-project is motivated by the challenging electron beam requirements necessary for the SwissFEL accelerator facility. Its main goal is to extensively study the generation, transport and time compression of high-brightness beams and to support the component development necessary for the SwissFEL Project.

The new SwissFEL facility will open the door to discoveries, in many areas of current research, that cannot be achieved using existing methods. The unique properties of the SwissFEL will enable experiments to be carried out at a very high resolution in both time and space. For example, it will be possible to observe the progress of extremely fast chemical and physical processes, including details down to the scale of a molecule. This will not only result in a significant increase in knowledge, it will also provide the basis for a vast range of technical and scientific developments.

The SwissFEL Project is progressing very well and, in May 2010, the new SwissFEL web site went online: www.swissfel.ch.

In July 2010, the SwissFEL Injector Conceptual Design Report – Accelerator Test Facility for SwissFEL (PSI Bericht Nr. 10-05) – was completed. Furthermore, the SwissFEL Conceptual Design Report (CDR – PSI Bericht Nr. 10-04) was published, describing the technical concepts and parameters used for the SwissFEL baseline design. Both documents are available via the SwissFEL Website: http://www.swissfel.ch.

The next highlight took place at the 32nd International Free-Electron Laser Conference in Malmö, Sweden, where the prestigious 2010 FEL Prize was awarded to Sven Reiche, of the SwissFEL Beam Dynamics team. Sven was presented with this award for his “outstanding contributions to the advancement of the field of Free-Electron Laser science and technology”.

◀ **Inauguration of the SwissFEL injector: Joël Mesot, PSI director, and Didier Burkhalter, Federal Councillor, at the injector tunnel.**

Preparations for SwissFEL science

Bruce Patterson, Rafael Abela, Bill Pedrini, Mirjam van Daalen, Matthias Kläui, Hans Sigg, Jacinto Sa, Christoph Hauri, Izabela Czekaj, Anastasija Ichsanow, Jeroen van Bokhoven, Christian David, Vitaly Guzenko, *SwissFEL Project, PSI*

Novel experimental methods for use in condensed matter science at the SwissFEL X-ray laser are being developed. These include the ultrafast initiation of surface catalytic reactions using terahertz pulses and cross-correlation analysis of scattering data from randomly-oriented particles. The ability at the SwissFEL to rapidly initiate a catalytic process will allow the characterization of short-lived intermediate states and will aid in the development of more efficient catalysts. With cross-correlation scattering, it will be possible to track in detail the time-dependent conformations of biomolecules, and hence to follow their biological function.

Beginning in the year 2017, the SwissFEL X-ray laser will provide users with coherent, ultra-bright X-ray pulses, with a duration of approximately 20 femtoseconds. Two important fields of application for this facility are the characterization of short-lived intermediate states during catalytic chemistry and the structural determination of biomolecules in solution. These are currently the subjects of investigation by the SwissFEL Photonics Group at PSI.

Terahertz initiation of catalytic chemistry

It is foreseen that the SwissFEL facility will include an independent, synchronized source of terahertz (THz) pump pulses, which will permit THz-pump / X-ray probe experiments in condensed matter, without the complications of hot electron production by a visible laser. Possible phenomena which can be triggered with such a source include magnetic switching in ferromagnets, manipulation of electric polarization in ferroelectrics, excitation of impurities in semiconductors, Cooper-pair breaking in superconductors, and heterogeneous catalytic reactions on surfaces.

Regarding the last of the above, it has been proposed that catalytic reactions may be collectively initiated by the interaction of the THz electric-field with polar molecules adsorbed on a surface [1]. A promising reaction for demonstrating such a collective initiation is the absorptive-dissociation of CO (or NO) on a transition-metal surface (see Figure 1). Upon excitation of the *hindered translation* rocking mode of the molecule, and for sufficiently large rocking angles, O binds to the surface and CO dissociates. This surface-induced bond-breaking occurs more readily as one proceeds from Pd to Rh to Ru, along row 5 of the periodic table, and as one goes from a (111) to a (100) crystal surface. It is also believed that the energy barrier involved, ΔE_{diss}, is a function of direction along the surface. Our proposal is to adjust the sample temperature to just below the point where the thermally-induced reaction occurs and to use directed half-cycle THz pulses to interact with the CO dipole moment, effectively lowering ΔE_{diss} and hence momentarily increasing the reaction probability.

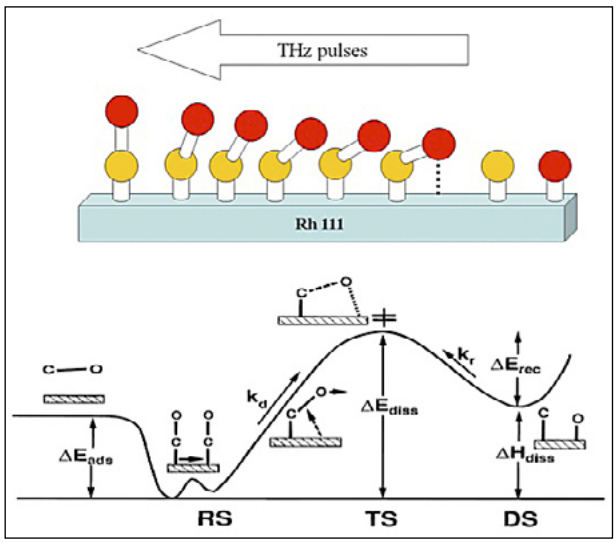

Figure 1: **(Top) A schematic representation of THz-induced absorptive-dissociation of CO (yellow = C, red = O) on a Rh surface. (Bottom) A schematic energy-level diagram for the process (RS, TS and DS refer to the reactant, dissociated and transition states, respectively [2]).**

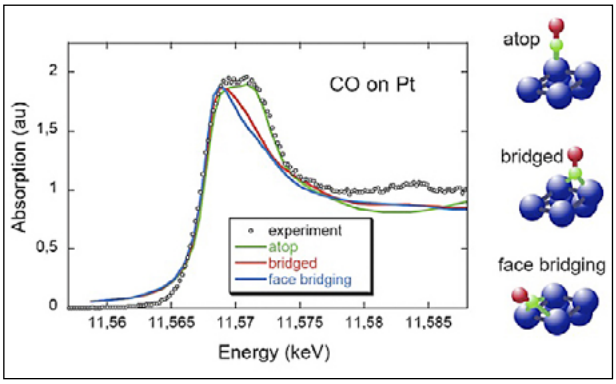

Figure 2: **In a single-shot, time-resolved experiment at the SwissFEL, a *near-edge* X-ray absorption spectrum can be collected which reflects the instantaneous atomic and electronic structure of adsorbed molecules on a surface [4].**

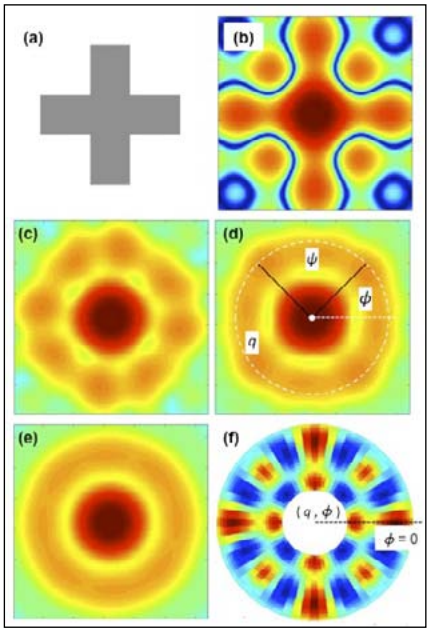

Figure 3: **(a) Schematic structure of a single 2D particle used in the simulations; (b) Diffraction pattern exposure of a single particle; (c) and (d) Inequivalent exposures of 10 randomly oriented particles; (e) Averaged diffraction intensity of 50 exposures; (f)** $C_2(q,q,\psi)$ **calculated from 50 simulated diffraction patterns, each one originating from 10 randomly oriented particles.**

Experiments to test this idea are planned in a small vacuum chamber at the laser-based THz source at the PSI 250 MeV test injector, with which THz electric fields of up to 3 MV/cm have been demonstrated [3]. Detection of the reaction will be performed either time-integrated, by detecting free CO_2, produced from the dissociated oxygen atoms, or time-resolved, by performing pump-probe IR spectroscopy.

With the advent of the SwissFEL, ultrafast THz-pump/X-ray probe experiments of such catalytic reactions are envisaged, where the probe is a single-shot measurement of the near-edge X-ray absorption spectrum. Such a spectrum provides detailed information on short-lived (picosecond) intermediate states, regarding both atomic and electronic structure [4] (see Figure 2).

The structure of dissolved biomolecules

In 1977, Kam proposed the "cross-correlation" method to derive the structure of a molecule from a large number of X-ray scattering images from molecules in solution [5]. With the advent of the XFEL, the necessary high photon flux will become available, thus renewing interest in the practical realization of the procedure [6–8]. The SwissFEL photonics group is presently performing simulations and conducting synchrotron-based experiments to test the relevant concepts.

The results of a simulated experiment in two dimensions are shown in Figure 3. Coherent X-ray scattering from a single 2D "particle" of the form shown in Figure 3a yields the scattering pattern shown in Figure 3b. Using iterative methods of phase retrieval, it is possible to recover the particle structure from the scattering pattern. In a Kam experiment, scattering is observed from an ensemble of identical, but randomly-oriented, particles. Figures 3c and d show the simulated scattered intensity $S_a(q,\phi)$ from 10 particles – the two images correspond to differently distributed particle positions and orientations. Here, $q = \frac{4\pi \sin\theta}{\lambda}$ is the scattering wave-vector (where 2θ is the scattering angle, and λ the wavelength), and ϕ is the azimuthal angle. Because the number of scattering particles is finite, preferred orientations are evident in the scattering, reflecting the 4-fold symmetry of the individual particles.

The scattering pattern from a very large number of particles, or the averaged scattering over a large number of images from a finite number of particles (see, for example, Figure 3e), converges to a radially-symmetric Debye-Scherrer ring pattern, from which only a very limited amount of structural information can be extracted.

Significantly more information is made available by performing a cross-correlation analysis of the individual images, *e.g.*, Figures 3c and d, and then averaging the correlation over a large number of images. To compute the correlation function,

one first calculates, for each image labelled by the letter *'a'*, the deviation of the observed scattering from the average:

$$\delta S_a(q,\phi) = S_a(q,\phi) - \bar{S}(q)$$
$$\bar{S}(q) = \left\langle \frac{1}{2\pi} \int d\phi \; S_a(q,\phi) \right\rangle_a$$

Following Kam, the two-point cross-correlation function is then computed and averaged over all the images:

$$C(q_1,q_2,\psi) = \left\langle \frac{1}{2\pi} \int d\phi \; \delta S_a(q_1,\phi)\, \delta S_a(q_1,\phi+\psi) \right\rangle_a$$

As can be seen in Figure 3f, the equal-q correlation function, $C(q,q,\psi)$, shows fine details which are characteristic of the structure of the individual particle.

Two important points should be stressed: a) whereas averaging independent *scattering images* yields featureless Debye-Scherrer rings, repeated measurements of the *correlation function* can be accumulated to provide fine details with increasing statistical significance; b) as the particle size is reduced, eventually to molecular dimensions, its rotational velocity in the solvent will increase, and hence the duration of the X-ray exposures must decrease. The 20 fs pulses from the SwissFEL will generally suffice to freeze the molecular motion.

Using a combination of numerical simulation and synchrotron X-ray and visible light scattering on natural and artificial test objects, we are attempting to answer the following questions:

1) What determines the optimum number of scatterers in an exposure?
2) How unique is the structural information contained in the correlation function?
3) What are effective methods for extracting this structural information?
4) How can the two-dimensional case of Figure 3 be extended to the case of 3D-particles?
5) How do counting statistics and background scattering limit the achievable spatial resolution?
6) How detrimental are the effects of inter-particle interference for the cross-correlation analysis?

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Completion of operation at the SwissFEL Low Emittance Gun (LEG) test facility

Romain Ganter, Hans-Heinrich Braun, Christopher Gough, Christoph Hauri, Eugenie Kirk, Sladjana Ivkovic, Frederic Le Pimpec, Martin Paraliev, Marco Pedrozzi, Alexandre Trisorio, Soichiro Tsujino, *SwissFEL Project, PSI*

An electron gun providing an electron beam with a low emittance is a key component for the realization of a compact free-electron laser. One possible scheme has been developed at PSI: the LEG-Project (Low Emittance Gun), which is different from most existing accelerator electron guns in that it combines pulsed DC acceleration with RF acceleration. This feature has permitted an extensive range of geometries and materials to be tested. Finally, beam brightness similar to a state-of-the-art RF photo-gun was achieved.

Operation of LEG at full energy started in January 2009 for 2 years of operation. Initial activities were dedicated to electron beam dynamic studies, which gave successful comparison between simulation and measurement [1, 2]. The pulsed DC acceleration in a diode configuration permits extensive and rapid changes of materials and geometries for electron emission. In a relatively short time, photoemission from flat surfaces and electrical emission from micron-scale Field Emitting Arrays (FEAs) have all been tested. The next goal using this test stand was to increase the electron beam brightness at low and high charge (see Figure 1).

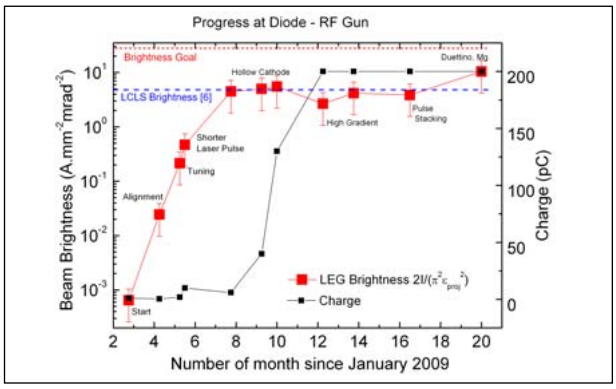

Figure 1: **Progress of the LEG beam brightness towards the SwissFEL goal.**

Laser transverse non-uniformities are known to limit beam brightness. The highest beam brightness at 200 pC has been obtained by using a multi-pass amplified laser instead of a regenerative amplifier, with a pulse duration of 4.3 ps rms and less than 10 µJ at 266 nm on cathode. Such low laser energy has good transverse uniformity but requires a high quantum efficiency cathode to reach the desired 200 pC. With an Mg photocathode prepared in our lab, we have obtained a quantum efficiency of 10^{-4} and a projected emittance of 0.55 ± 0.1 mm. mrad at 200 pC (see Figure 2), and a beam brightness of 10 A.mm^{-2}.mrad^{-2} at a 5 Hz repetition rate. Simulations have shown that an increase of the diode voltage to 1 MV should bring us to the goal of 28 A.mm^{-2}.mrad^{-2}. However, pulsed voltages of 1 MV at 100 Hz repetition rate would require further development and investment. Efforts will now be concentrated on standard RF photo-guns, which recently demonstrated similar results at LCLS for 100 Hz repetition rate (250 pC; 5 A.mm^{-2}.mrad^{-2}) [3].

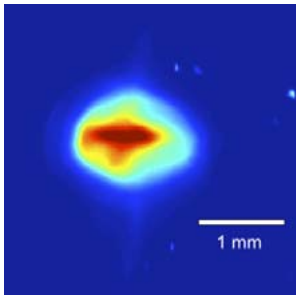

Figure 2: **Electron beam at 5.7 MeV energy, 180 pC charge; 0.55 mm.mrad emittance (10 % charge cut) with laser pulse length of 4.3 ps.**

In addition, by combining the field emitter array (FEA) cathodes being developed at PSI [4–6] with the LEG gun, we have generated sub-nanosecond field-emission electron bunches from single-gate FEAs. Bunches as short as 460 ps FWHM, using an electrical gate drive, were extracted and accelerated. This is the first FEA emitting under a diode gradient of up to 30 MV/m and subsequently accelerated to 5 MeV by a RF cavity. Further FEA research aims to obtain beam brightness enhancement by using femtosecond near-infrared laser-induced field emission [4] in double-gate structures [6].

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The SwissFEL accelerator

Hans-Heinrich Braun, *on behalf of the SwissFEL team members from PSI Departments*

Following the definition of the SwissFEL baseline design in 2009, preparations for the project progressed towards the goal of starting construction in 2012. An important milestone was taken in August 2010 with publication of the SwissFEL Conceptual Design Report, containing a coherent description and full set of parameters for all systems of the facility. Besides the start of operation of the SwissFEL injector, described in the following article, key technical developments for the main linac systems and FEL undulator lines progressed very well. In close consultation with representatives from the local communities, the building situation and design were modified to environmentally optimise SwissFEL in the Würenlingen forest.

For a very complex and technically demanding project such as PSI's future SwissFEL X-ray free-electron laser, many different groups have to work in parallel on a large variety of problems. The final goal is to obtain a facility which is as close to perfection as possible, despite a restrictive schedule and limited resources. This can only be achieved if everyone involved in the project has complete information on the technical requirements of the components they are working on, and also information on how these components interface with the rest of the facility. Therefore, having a consistent description of the facility available to everyone working on the project is of paramount importance.

The conceptual design report (CDR) is the cornerstone of this description. Over 9 months, more than fifty authors from several PSI Departments worked very hard to collect the information for, and write, this CDR. During this process, a number of technical inconsistencies and missing parts were discovered and solutions then worked out. The report was written jointly by the authors, edited and proof-read by the editorial board, and the layout and printing performed by PSI's publication services. Everything was completed just in time to have the CDR ready for distribution at the inauguration ceremony of the SwissFEL injector on 24 August. The report is also available in electronic form at the SwissFEL webpage: www.swissfel.ch.

A focus of SwissFEL technical developments is the linear accelerator for acceleration of the electrons from the injector to the FEL beamline with an energy gain equivalent to a voltage of 6 billion volts. This acceleration is achieved by exposing the electrons to the field of an electromagnetic wave travelling parallel to the electron path. The RF frequency used in the main linac is 5.7 GHz, called the C-band in RF engineer jargon. To produce this wave, 26 extremely powerful RF transmitters have to be placed along the technical gallery of the SwissFEL building. All these transmitters use an RF input from a common master oscillator, distributed through an optical fibre to all power transmitters. Because of SwissFEL's extremely tight timing tolerances (typically a few femto-seconds), the technical specification on phase noise for the master oscillator and the optical fibre distribution is at the very limits of modern technology. The RF amplification in the RF transmitters is performed by klystron amplifier tubes, providing 50 MW of power each during a 3 µs RF pulse at a 100 Hz repetition rate. A contract for the timely development of such a klystron was placed with industry in 2010, for delivery of the first prototype during 2011. The klystron itself has to be driven by a high-voltage pulse of about 300 kV, provided by high-voltage modulators. Specifications on modulator voltage stability are very tight and, together with the problems of rapidly switched high power, it requires very careful electrical engineering to avoid unwanted crosstalk across the electrical network feeding all SwissFEL installations. The RF power from the transmitters is transported through a network of waveguides, operating under vacuum, to the accelerating cavities. In these cavities, the RF wave is converted in a mode pattern with electric field in the beam direction and phase velocity of the wave equal to the electron velocity. Each RF transmitter feeds four such cavities. The active length of each cavity is 2 m and the effective accelerating RF field seen by the electron beam has a magnitude of up to 30 MV/m. To achieve the required mode pattern and the nominal accelerating field, these copper cavities have to be machined to a mechanical precision of the order of 1 µm and a surface roughness of about 20 nm. PSI's workshop has recently procured a highly specialized

ultra-precision lathe to enable the machining of prototypes to such specifications, and this is the first installation of its type in Switzerland. A study has been launched with industry to prepare for the series production of these cavities.

The main linear accelerator is built in a modular fashion, with each module consisting of one RF transmitter, the waveguide network and four accelerating cavities. The four cavities are mounted in groups of two on two support girders. A design study for these girders was performed, with the goal of obtaining a precise, low-vibration support with good alignment functionality and reasonable cost. A 3D sketch of the resulting girder design is shown in Figure 1.

All key components of the linac module were specified during 2009, and all components for a prototype module will either be constructed in-house or procured externally. This module will be assembled and power tested with nominal parameters in the OBLA building at PSI.

Another important technical development is that of the undulator magnets for the SwissFEL lasing beamlines. These undulators consist of a string of small permanent-dipole magnets with alternating polarity. The field generated by the magnets forces the electron beam to follow a wiggling trajectory. If the magnetic field pattern follows very precisely the specifications given by the theory of free-electron lasers, the wiggling path of the electron beam leads to the coherent emission of X-ray radiation and rapid amplification of radiation intensity along the undulators, which is characteristic of free-electron lasers. For SwissFEL's hard X-ray FEL beamline named ARAMIS, 12 undulator devices are required, each of which is about 4 m long and has a weight of more than 20 tons. More than 2000 small permanent magnets have to be mounted with tight mechanical precision in each device. The field pattern has to be measured and corrected to the nominal value by tiny adjustments of the magnet positions. The wavelength of the X-ray radiation can be varied by changing the distance between the magnet arrays and the electron beam in a controlled manner. One of the key technical challenges here is to control the magnet position over a distance of 4 m with µm precision, in the presence of mechanical forces equivalent to many tons of weight. A collaborative development between PSI and specialised industry was launched during 2010 for the support structures and drive mechanics of the undulators. Tests with a prototype will start in 2011.

Planning for the SwissFEL buildings made major progress in 2010. A working group with the name "AG Wald" was set up together with representatives from the local communities, the cantonal administration and PSI, to adjust the design and implementation of SwissFEL in the Würenlingen forest to meet environmental requirements. One of the results from this working group was a modification of the position of SwissFEL, but more importantly, the concept for the above-ground technical buildings was completely changed. The original concept of a free-standing light building structure was abandoned and replaced by a concrete structure with the top and one side covered by the natural terrain. After completion of the building, this terrain will be replanted with bushes and small trees and, in addition, two wildlife crossings will be made across the technical building. The layout of this new construction scheme is shown in Figure 2.

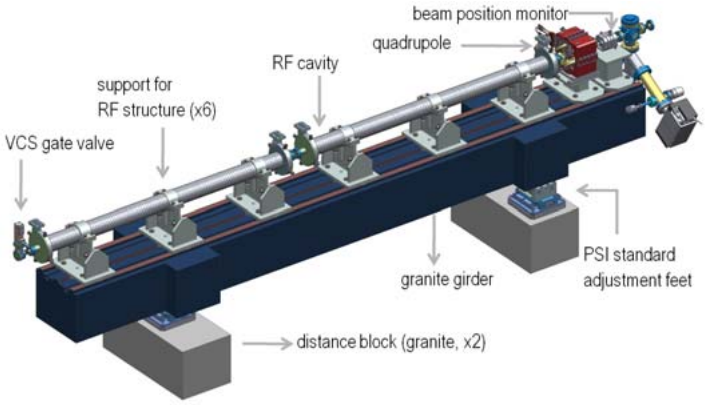

Figure 1: **Linac support girder with two C-band cavities.**

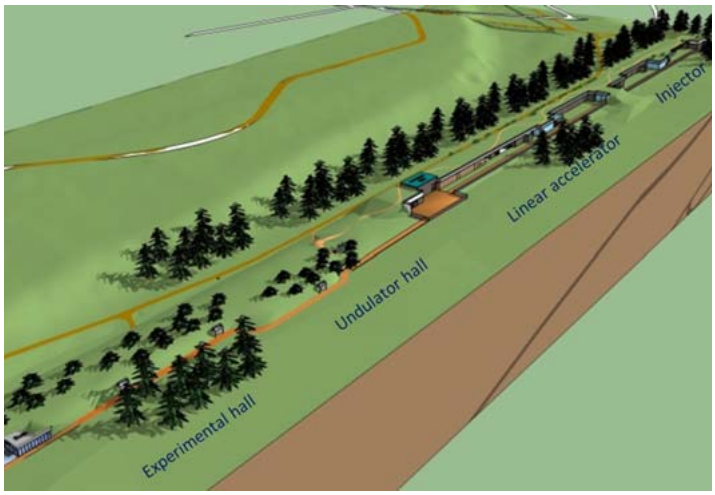

Figure 2: **New above-ground building concept.**

First operation of the SwissFEL injector test facility

Thomas Schietinger, Thomas Schilcher, *Large Research Facilities Department, PSI;*
Marco Pedrozzi, *SwissFEL Project, PSI;*
(on behalf of the many individuals within the PSI Large Research Facilities and Logistics Departments, as well as the SwissFEL Project, involved in the design, construction and commissioning of the injector test facility)

The SwissFEL injector test facility was officially inaugurated in August 2010, and the event marked the beginning of extensive studies on the generation, transport and compression of high-brightness beams. The facility's 250 MeV linear accelerator also serves as a platform for advancing the development and validation of the accelerator components needed for the realization of the SwissFEL facility.

The injector test facility [1, 2] represents the first stage of the SwissFEL accelerator complex. The high beam quality necessary to drive the FEL is primarily determined by this section of the machine, and no post-correction can be applied to recover from initial beam imperfections. This motivates the early characterization of the injector in preparation for SwissFEL, using a configuration close to that of the final assembly. The commissioning of the SwissFEL injector test facility is proceeding in several phases, the first of which started in early 2010. The initial run period between March and June was dedicated to the characterization of the electron source [3], with the assembly of the remaining accelerator section proceeding in parallel behind a shielding wall. The first electron beam, with an energy of 7 MeV, was observed on 12 March. In July, the linear accelerator was connected to the electron source to prepare for the next commissioning phase, with acceleration up to 160 MeV. The first propagation of electrons through the full length of the injector down to the beam dump was celebrated with an official inauguration ceremony on 24 August, in the presence of Didier Burkhalter, a member of the Swiss Federal Council, and representatives of the Swiss academic and political communities. Since October, the injector has been running on a regular basis at energies around 130 MeV. The priorities during this run period are the commissioning of critical components, the consolidation of measurement procedures, and initial studies on beam optics.

The electron source of the injector test facility is a photo-RF gun, i.e. electrons are extracted by laser illumination (utilizing the photo-electric effect) from a metal cathode which is integrated into the back plane of an RF cavity. The laser used to drive the electron gun throughout 2010 is based on a compact, turn-key Nd:YLF amplifier providing, after frequency multiplication, a 262 nm-wavelength Gaussian pulse (6 ps FWHM) with up to 70 µJ energy at the cathode. Transverse pulse shaping is performed by expanding the Gaussian-like intensity profile transversely and selecting the central part (about 50 %) with an aperture mask. In the future, a more powerful and more sophisticated Ti:Sapphire amplifier will be used as a gun laser. The commissioning and optimization of this system are proceeding in parallel.

After emission from the cathode surface, electrons are immediately accelerated by the RF gun field. For operation in 2010, a CERN-built gun was used which had been originally developed for high-current operation at the CLIC test facility. It is planned to replace this gun in 2012 with a new, PSI-developed RF gun optimized for FEL operation. The 2.6-cell 3 GHz (S-band) standing-wave cavity runs at a nominal gradient of 100 MV/m, with 21 MW of peak power and a repetition rate of 10 Hz. The measured pulse-to-pulse jitter of the RF field, which is delivered by a high-power klystron, is below 0.02° (rms) in phase and less than 0.019 % (rms) in amplitude. The keys to reaching such low RF jitters are having an ultra-stable RF signal source (3 GHz) tightly synchronized to a distributed reference system (214 MHz), a high-performance high-voltage modulator which delivers the power to the RF klystron, and a low-jitter low-level RF system controlling the drive signal to the klystron. A new approach was adopted for the high-voltage modulators, which are based on solid-state technology as opposed to conventional pulse-forming network techniques. The pulse-to-pulse stability of the high-voltage pulse generated was measured to be better than 0.004 % (rms). Although the klystron delivers low-jitter RF power to the RF gun, small variations in the temperature of the RF gun copper body, which is stabilized to ±0.15°C, give rise to drifts of the gun phase of

the order of ±2°. These drifts are compensated for by an active digital RF feedback system, which is able to stabilize the RF gun phase to 0.03° (rms).

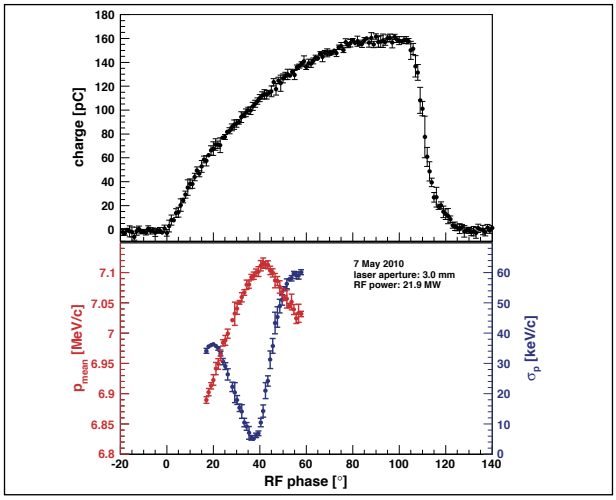

Figure 2: **RF gun phase scan showing bunch charge, momentum and momentum spread as functions of the relative phase between gun RF and laser pulse.**

Obviously, a crucial parameter determining beam energy and quality is the gun launching phase, i.e. the phase of the RF field at which the laser pulse impinges on the cathode. In Figure 1, we show a scan of this phase, where the beam charge (measured by a wall current monitor), momentum and momentum spread are monitored. The latter two quantities are measured through dispersion created by a dipole magnet (30° bending) in a spectrometer arm. The results indicate a minimal momentum spread at a launch phase of about 38°. At this phase, our regular gun operating phase, electrons are emitted from the copper cathode with a quantum efficiency of 4×10^{-5}, as determined from the linear rise in bunch charge when increasing the laser pulse energy. Typically, the gun is operated at bunch charges varying between 10 and 200 pC. A solenoid located immediately after the gun provides axisymmetric focusing of the beam while optimizing the beam emittance, i.e. the product of beam size and divergence corrected for correlation. The emittance of the beam at the beginning of the ensuing accelerating section ("booster") is of crucial importance for the quality of the beam further downstream and was carefully measured during the first commissioning phase. In Figure 2, we show the measurements of transverse beam sizes and emittance together with a comparison to a 3D particle simulation (using the PSI-developed code OPAL [4]). The beam size is measured with screens which can be inserted at various locations all along the beamline. These screens consist of YAG:Ce or LuAG:Ce scintillating crystals of 20 µm and 200 µm thickness. The emittance at low energy is determined by intercepting the beam with horizontal and vertical slit masks, while recording the resulting beamlet pattern on a subsequent screen to derive the local divergence.

The main accelerating section of the injector consists of two 3 GHz travelling-wave structures, each 4.15 m long and operating at nominal gradients of about 20 MV/m, which result in an electron energy in excess of 160 MeV, again measured with a dipole magnet. In the final configuration, the accelerating section will comprise four structures, delivering a beam energy of about 250 MeV, followed by a magnetic chicane to achieve dispersive bunch compression.

At these higher energies, beam profiles are also obtained through the observation of optical transition radiation emitted when the electrons traverse thin metal foils. This results in a higher-resolution image of the beam than with the thicker crystal screens. The emittance at full energy is derived from the beam sizes measured at various locations in a periodic lattice of focusing and defocusing quadrupole magnets ("FODO" lattice). This method requires, however, an excellent understanding of the beam optics, which is the focus of current activities. Beam optics measurements also require a well-centred beam. The transverse beam position (orbit) along the entire beamline is measured by a series of 500 MHz resonant strip-line beam-position monitors, which provide a position resolution of 7 µm (rms) between 5 and 500 pC. The same devices also determine charge, with a resolution of 1.5 % down to 2 pC bunch charge.

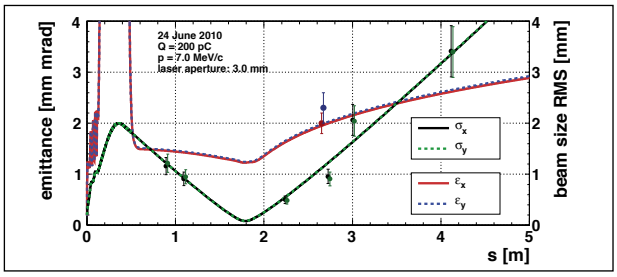

Figure 2: **Measurements of emittance and beam size in the gun section (data points with error bars) in comparison to simulation results (solid and dashed lines).**

Injector operation will proceed throughout most of 2011, interrupted by a few shutdown periods dedicated to the installation of the remaining accelerating structures to reach the nominal beam energy and the integration of the bunch compression chicane. The beam development programme will focus on the characterization and optimization of the beam parameters relevant for the realization of SwissFEL.

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PSI

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A small selection from the large number of research results obtained at PSI during 2010 is presented in the following pages. The articles cover a large variety of topics, including the development or improvement of experimental technology as well as scientific results, in the strict sense of the term, ranging from fundamental research to science which is close to the point of practical, everyday application. One article therefore shows how the muons available at PSI contribute to our knowledge of the basic forces of nature, while another describes how muons and neutrons help in the understanding of the properties of high-temperature superconductors. Synchrotron light at the SLS was used to produce an image of the arrangement of magnetic monopoles created in a system of nano-magnets, to investigate the changes that nuclear fuel undergoes during operation in a power plant, and to determine molecular structures relevant to the process of sight. Among the technical developments that will benefit SLS users is a crystallization facility installed adjacent to one of the protein crystallography beamlines. In neutron science, an upgrade at one of the instruments will allow imaging to be performed of phase-contrast objects and magnetic domains. A computer simulation enables more precise planning of the PSI proton accelerator's performance and thus benefits all scientists working at facilities powered by this accelerator.

In the field of electrochemistry, successful projects with industry in the fields of battery and fuel-cell research are reported, while in solar technology a method for producing a precursor of liquid fuel from water, CO_2 and sunlight has been developed. In atmospheric science, the impact of the Eyjafjallajökull volcanic eruption on air quality was among the topics investigated.

In proton therapy, the new OPTIS2 treatment facility for eye tumours has been put into operation and preparations for the beginning of operation at Gantry 2, where mobile tumours in the body will be treated, have made important progress.

◀ **PSI researcher Jörg Standfuss and PhD student Ankita Singahl at one of PSI's laboratories for research in molecular biology.**

Swiss Light – Source of inspiration

Johannes Friso van der Veen, *Synchrotron Radiation and Nanotechnology Department (SYN), PSI, and Department of Physics, ETH Zurich*

The Swiss Light Source has seen another year of many highlights. Stable light has inspired users from all over the world to performing research of the highest calibre. The scientists in our Department (SYN) provide not only user support, but also carry through an increasing number of their own research projects, often in collaboration with external groups. These projects occasionally go well beyond using SLS; quite a few staff members are preparing themselves for the X-ray Free-Electron Laser (SwissFEL), which is our next-generation source of inspiration.

The SLS combines high brilliance with long-term beam stability. These properties allow challenging studies to be made of a wide variety of condensed matter properties, such as the interaction of electron spins with magnetic domain walls, Fermi surfaces of topological insulators and high-temperature superconductors, magnetic 'monopoles' in an assembly of nano-scale magnets and magnetic excitations in correlated electron systems. Substantial progress has also been made in the further development of X-ray imaging techniques such as ptychography, differential phase contrast and fast tomography. The SLS holds a few world records: X-ray Fresnel-zone plate lenses providing sub-10 nm resolution, a resonant inelastic-scattering spectrometer (ADRESS) with a resolving power of more than 10,000, and pixel array detectors (EIGER) with frame rates up to 24 kHz. The SLS also houses the world's first platform for protein crystallisation that is directly coupled to a macrocrystallography beamline (PX-III) for in-situ diffraction screening. The platform has recently provided a structural basis for the nine-fold symmetry of centrioles, an organelle which is essential for generating cilia, flagella and centrosomes [1]. The latter project has resulted from close collaboration between our SYN Department and the Biology and Chemistry Department (BIO) at PSI, and this collaboration will be intensified.

Another example of interdepartmental collaboration is that, for one year, the SYN Department has operated the Laboratory for Catalysis and Sustainable Chemistry jointly with the General Energy Department (ENE). This new laboratory, which is led by Jeroen van Bokhoven, operates the microXAS, VUV, superXAS and PHOENIX beamlines for absorption and XES spectroscopy, and in addition operates on-site chemical labs for catalyst synthesis, kinetic analysis and non-synchrotron characterisation. The joint appointment of Prof. van Bokhoven at the Chemistry Department at the ETH Zurich provides a strong academic link and ensures a regular influx of students. Below, we give a research example in catalytic chemistry from this laboratory, which highlights some of the unique capabilities of the superXAS beamline.

A major technical development at the SuperXAS beamline has been the in-house design, construction and commissioning of a multi-crystal X-ray emission spectrometer (Figure 1) that allows the electronic structure of catalysts (and thus their reactivity) to be determined under reaction conditions (at several atmospheres pressure and up to 800°C). This enables the electronic structure of catalysts to be determined under functioning conditions, which had been previously impossible. The scientific highlight was the in-situ determination of the dynamic changes of Pd nanoparticles supported on ZnO during methanol steam reforming (MSR) [2]. MSR, yielding H_2 and CO_2, is among the most promising processes for on-board hydrogen production for fuel cells. The Pd and Zn structures were determined using our unique time-resolved (quick) EXAFS (Extended X-ray Absorption Fine Structure) set-up. We identified the formation of the active PdZn alloy phase in real time, which starts at the nanoparticle surface and proceeds "inwards" to the particle centre. PdZn alloying was found to be reversible. In contact with oxygen, PdZn segregates into palladium metal and ZnO. This catalyst was selective to CO/H_2 formation. The structural changes correlated with the catalytic performance were determined by simultaneous mass-spectrometric gas-phase analysis. This showed that in-situ determination of the structure-performance relationship is indispensable in the development of better catalysts and catalytic systems.

As stated above, it is the strategy of the SYN Department to bring together different disciplines around the photon source. This includes nanotechnology. The Laboratory for Micro- and Nanotechnology, which belongs to the SYN Department, produces unique diffractive X-optics elements, fabricates nanostructured materials of technological relevance, investigates molecular adsorbates on surfaces, and produces field-emitter array cathodes as a potential upgrade option for SwissFEL. The research highlights on the following pages underline the interdisciplinary character of photon science at the SLS.

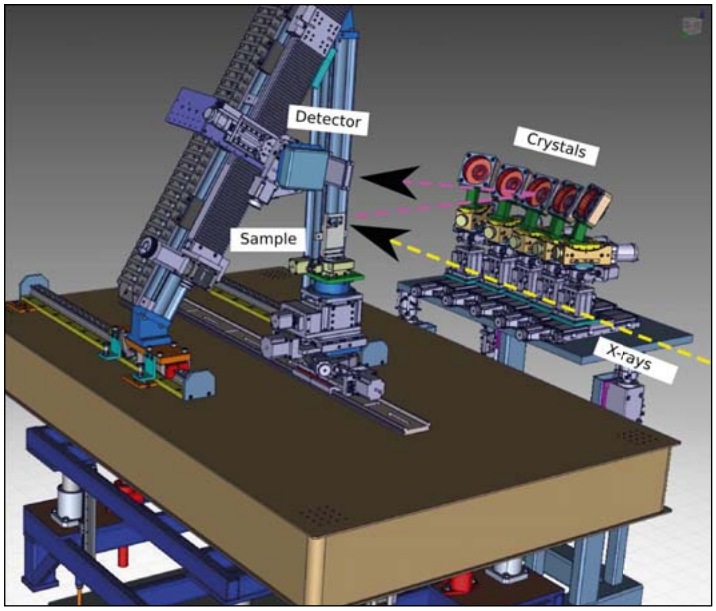

Figure 1: **Compact X-ray emission spectrometer at the superXAS beamline of the SLS.**

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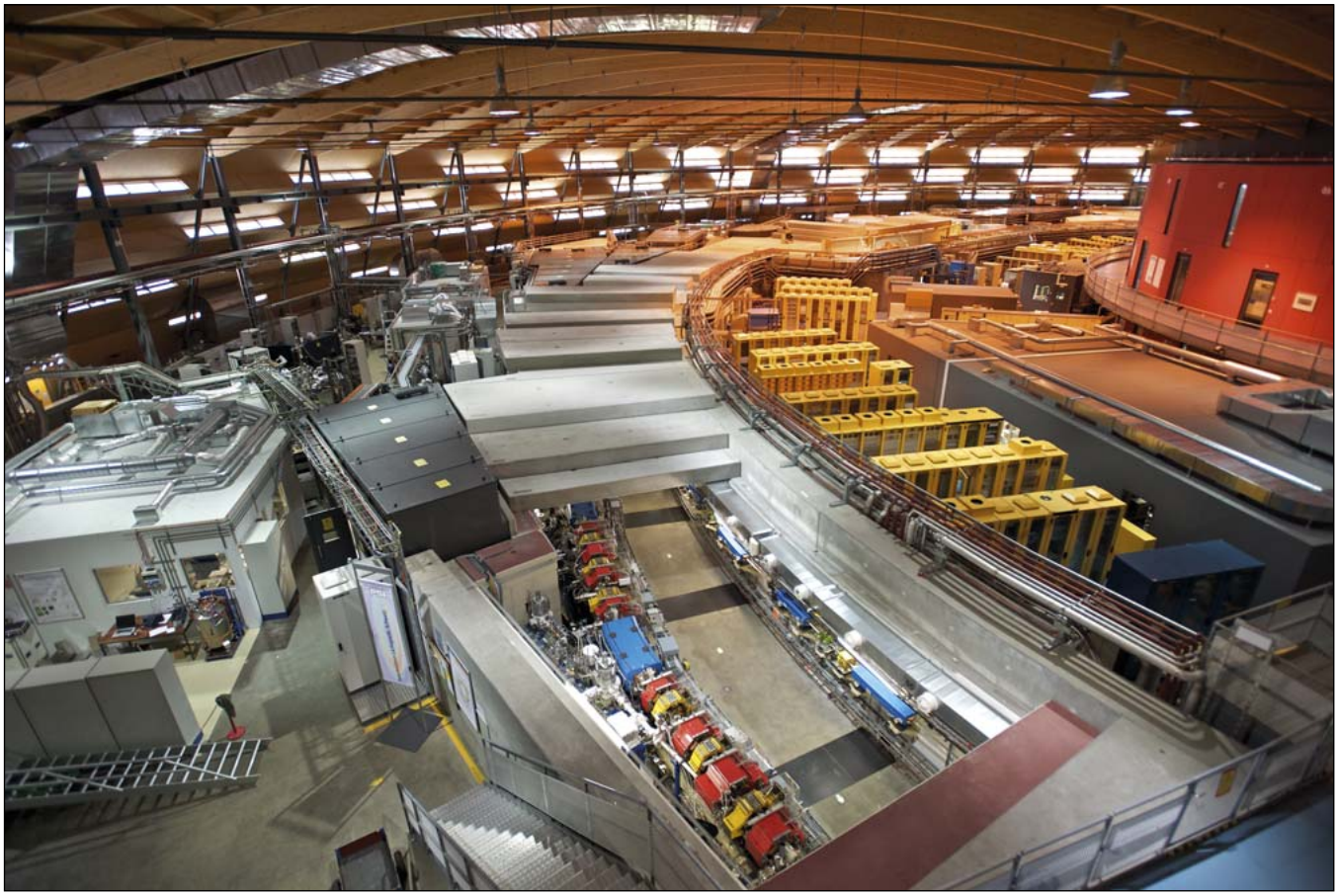

Figure 2: **The SLS storage ring from a bird's eye perspective.**

Discovering size-dependent spin structures in iron nanoparticles using soft X-ray microscopy

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Joachim Bansmann, *Institute of Surface Chemistry and Catalysis, University of Ulm, Germany;*
Andris Voitkans, *Institute of Physics, University of Rostock, Germany;*
Laura Jane Heyderman, *Laboratory for Micro- and Nanotechnology, Synchrotron Radiation Department, PSI*

Increasing experimental capabilities based on resonant soft X-ray absorption reveal many novel phenomena in nano-sized magnets. By combining X-ray magnetic circular dichroism with photoemission electron microscopy, we have discovered a size-dependent transition from exchange to magnetic anisotropy energy-dominated coupling of iron nanoparticles to a ferromagnetic support. These findings are not only important for fundamental research, but also relevant for potential applications of nanoparticles, e.g. in future high-density storage devices.

Recent research on magnetic clusters and nanoparticles has revealed many novel phenomena that are promising for future applications ranging from data storage to medicine. However, in order to benefit from these interesting properties, the nanoparticles have to be supported by a suitable medium for each particular application. The resulting contact often leads to size-dependent interactions which modify the nanoparticle properties significantly. For instance, the spins of a magnetic nanoparticle in contact with a ferromagnetic support will be subject to a strong, but short-range, exchange interaction of about 100 meV per interface atom. This energy is much larger than other relevant terms, such as the magnetic anisotropy energy (MAE) with a few μeV per atom or the thermal energy at room temperature (25 meV). Thus, the exchange interaction is expected to lead to stable and parallel coupling to the ferromagnetic support for small particles.

We have used X-ray photoemission electron microscopy (PEEM) to study the magnetic coupling of single iron particles to a ferromagnetic cobalt support [1]. For the experiments, we deposited iron nanoparticles, with sizes ranging from 5 to 25 nm, from a cluster source [2] onto a cobalt film on a silicon substrate. Making use of the magnetic contrast given by the X-ray magnetic circular dichroism (XMCD) effect and the element-specific resonance energies for X-ray absorption, we can investigate the magnetization and absorption spectra [3] of the iron nanoparticles and the cobalt support separately. With the photon energy tuned to the iron L_3 edge, we observe magnetic contrast in the nanoparticles ranging from black to white, as shown in Figure 1(a). The specific contrast depends on the projection of the magnetization, **M**, of each particle onto the propagation vector of the radiation, σ, according to $\sigma \cdot \mathbf{M}$ (see also Figure 2). In order to study the relative coupling of the nanoparticles to the substrate, the contrast associated with each nanoparticle in Figure 1(a) needs to be correlated to the domain pattern of the cobalt film [Figure 1(b)], recorded by tuning the photon energy to the cobalt L_3 edge.

The relative coupling of the particles with respect to the film magnetization is shown by the superposition of Figures 1(a) and (b), as shown in Figure 1(c). As expected, many of the black (or white) particles are situated on a black (or white) domain, indicating parallel coupling. However, some of the particles show surprising exceptions to this scheme, cf. the particles highlighted by circles in Figure 1(c), and thus reveal more complex coupling behaviour.

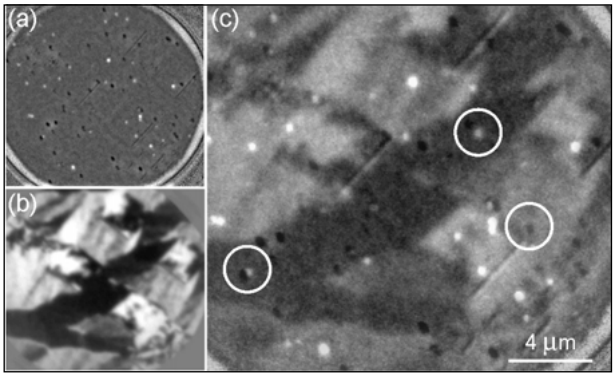

Figure 1: **(a) X-ray PEEM image obtained with circularly polarized radiation at the iron L_3 edge (708 eV). (b) Corresponding domain pattern of the cobalt support recorded at the cobalt L_3 edge (778 eV). (c) Superposition of the images in (a) and (b).**

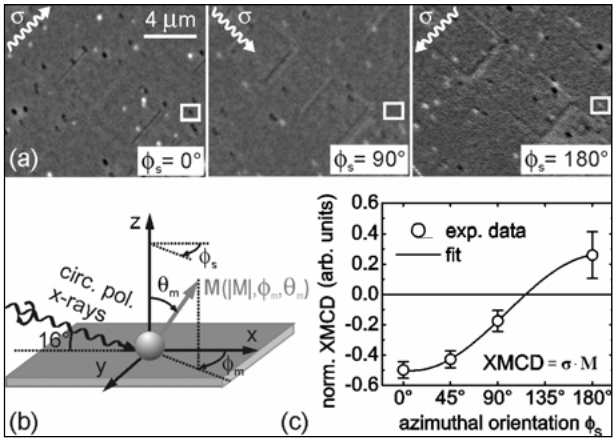

Figure 2: **(a) Magnetic contrast images recorded at different azimuthal sample orientations ϕ_s. (b) Experimental geometry. (c) Angle-dependent contrast of an individual particle marked by the square in (a) and the corresponding fit to the data.**

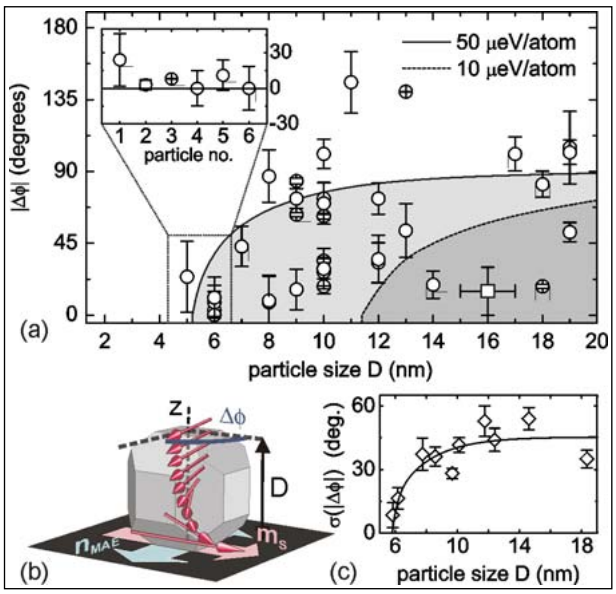

Figure 3: **(a) Circles: Size-dependent canting angle between the film and nanoparticle magnetization. Lines: Calculated canting angles. (b) Spin spiral as found in particles above the critical size. (c) Distribution width of canting angles.**

Element-specific 3D vector magnetometry with single-particle sensitivity enabled by X-ray PEEM

To study the coupling in detail, the sample has been rotated under the X-ray beam, and magnetic contrast images were recorded at a number of orientations, as shown in Figure 2(a). The varying projections of σ on **M** lead to unique changes in the contrast. Quantitative analysis, including the full experimental geometry [shown in Figure 2(b)], reveals the orientation of **M** of each individual particle, cf. Figure 2(c). A similar analysis yields the magnetization direction of the supporting cobalt film and so allows us to determine the canting angle between the magnetization of the nanoparticles and the magnetic domains in the film.

The data in Figure 3(a) show that a parallel orientation is only found for particles with sizes below 6 nm. Above this size, we find an increasingly wider distribution of canting angles, cf. Figure 3(c). This behaviour indicates competition between the strong exchange interaction at the interface and the particle MAE. Since the MAE scales with the particle size, the exchange interaction dominates only for small particles and leads to parallel coupling. In larger particles, the magnetization turns towards the easy axis given by the MAE. The wide distribution of canting angles in the larger particles reflects the random orientation on deposition [4].

To prove this hypothesis, we have numerically calculated the energetically favoured spin structure. Similar to our data, the calculations show a critical size, given by the MAE, below which a parallel coupling to the support is found, cf. the lines in Figure 3(a). Above this size, a spin spiral can be formed with a finite twisting angle, as shown in Figure 3(b). The latter leads to the canted magnetization angle which we see in X-ray PEEM. In conclusion, both experiment and calculations reveal competition between exchange and anisotropy energy, leading to size-dependent spin structures in nanoparticles when they are in contact with a ferromagnetic support. Uncovering such magnetic behaviour at the nanoscale is not only of fundamental interest but is also important for the performance of next-generation nanoscale magnetic devices.

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Four-dimensional measurements of the interface kinetics of solid-liquid mixtures during coarsening

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Determining the dynamics of elevated temperature processes, such as coarsening, in morphologically complex systems is a significant step towards understanding how materials evolve under such conditions, as well as essential for creating models that accurately represent these complex processes. Using four-dimensional (in-situ) experiments conducted at the TOMCAT beamline, we have explored a class of topological singularities which play a key role in the evolution of the microstructure during coarsening. These singularities pinch off by bulk diffusion and are found to be self-similar [1]. This universal solution has been determined theoretically and confirmed through experimental observation, and is applicable to the break-up of rods in any physical system where interface motion is driven by bulk diffusional interactions.

Dendrites are a general morphology observed for metal systems during solidification. Their growth and evolution lead to the formation of a mushy zone, a two-phase region where the solid phase has a dendritic, or tree-like, structure, and the liquid phase forms the surrounding matrix. Holding this mixture for any length of time at a temperature that yields a mushy zone results in coarsening, or growth, of the dendrites. The morphology and length scale of the microstructure can change significantly, depending on the time spent in this region, which then affects the properties of the material. Thus, it is imperative to understand the dynamics of the coarsening process.

Until recently, samples have been coarsened ex-situ, meaning that the structure is not analyzed in real-time at the coarsening temperature. Instead, the analysis takes place after quenching, and multiple samples are used, giving snap shots of the microstructure at discrete times during coarsening [2–6]. This is sufficient for understanding some aspects of the coarsening process, but it is not adequate for extracting the detailed kinetics of the process. Techniques such as synchrotron-based X-ray tomographic microscopy enable this process to be studied in real time at the coarsening temperature. Preliminary observations of the mechanisms of coarsening using in-situ X-ray tomographic microscopy have been reported [7–9], which show the promise of this technique.

In this study, we examined the underlying kinetics of topological singularities, a specific mechanism prevalent in the evolution of microstructures in many applications. Topological singularities occur when the wavelength of an axial perturbation of a rod-like morphology (embedded in a matrix) is greater than its circumference, causing it to break up into spherical particles (so-called Rayleigh instability). These morphological instabilities are driven by the necessity to reduce interfacial energy and can degrade the mechanical properties of the material. Thus, observing their formation and understanding their evolution are important for many applications. We achieved this using in-situ coarsening experiments conducted at the TOMCAT beamline of the SLS. Samples of a binary aluminium-copper mixture (Al-15wt%Cu, 74% solid volume fraction) were coarsened at 836K while tomographic data of the sample was collected. We examined the evolution of liquid, high-diffusivity rods embedded in a solid, zero-diffusivity matrix. Figure 1 shows the (experimental) evolution of a topological singularity from initial formation to pinch-off.

As is typical for the coarsening process, the interfaces evolved by bulk diffusion of solute through the liquid. We found that the shape of the interface near the singularity becomes self-similar both before and after pinching [10]. This universality

was first established through theoretical calculations of the pinching process, and a single value was observed for the stable cone angle as the singularity was approached [1]. This suggests that the cone shape is independent of the materials system and any initial conditions of the rod. Thus, its evolution is governed by a simple temporal power law ($t^{1/3}$), which determines the kinetics before and after pinch-off. This discovery allows the dynamics of the break-up process in many materials systems to be predicted, even very early in the pinching process.

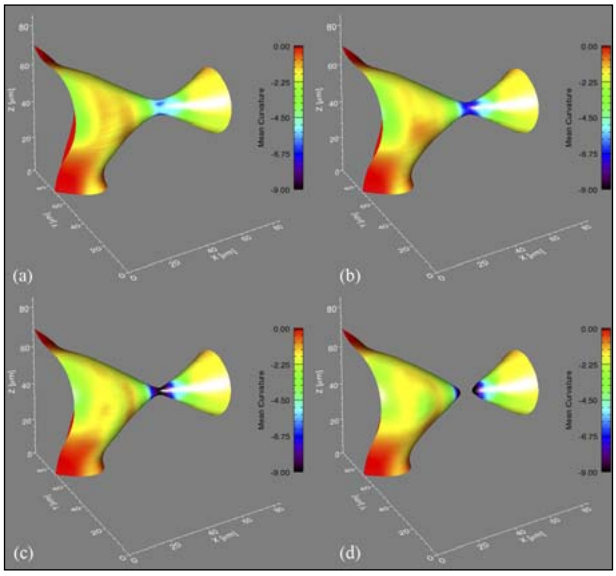

Figure 1: **A three-dimensional example of a liquid rod breaking up in an Al-15wt%Cu alloy. The interface is coloured by dimensionless mean curvature, with cooler colours (blue and black) indicating higher curvature. To reduce interfacial energy, the interface pinches off at the smallest diameter (the black-coloured interface), and the resulting cone-like shapes retract back into yellow-coloured regions of the interface.**

These results were then compared with 19 experimental pinching events found in the high solid-volume fraction sample [1]. We compared the kinetics predicted by the theoretical analysis to the time evolution of the diameters of the rod(s) up to the occurrence of the pinch-off. Linear slopes were found to be in excellent agreement with the theoretically-predicted slope. Additionally, three-dimensional representations of the experimental microstructures were aligned to the theoretically-predicted shape to determine how close the experimentally-measured shape came to the theoretical shape. The agreement between theory and experiment improved as the time to pinch-off decreased, which was expected because the singularity is dictated by local diffusional interactions as the pinch-off is approached. Further studies [10] showed that this universality also holds for systems where the high-diffusivity phase is outside the rod (instead of inside, as reported here). Because this solution is universal, it can be applied to a number of systems, from eutectic mixtures used in high-temperature applications to bicontinuous two-phase polymer blends in solar cell applications.

In summary, in-situ X-ray tomographic microscopy at the TOMCAT beamline of the SLS is providing new insights into the study of the dynamics of coarsening, such as the discovery of self-similar kinetics near topological singularities. With such techniques, we are moving closer to fully understanding the dynamics of these complex structures and to creating models that accurately predict their evolution.

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The SLS crystallisation platform at beamline X06DA

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As part of the automation concept of the macromolecular crystallography beamline X06DA at the Swiss Light Source (SLS), a crystallisation facility has been integrated directly adjacent to the experimental mini-hutch. This unique configuration allows the handling of nano-volume crystallisation drops and enables *in-situ* X-ray diffraction screening (*is*Xds, i.e. X-ray diffraction experiments directly in the crystallisation container). This provides structural biologists with rapid feedback on the diffraction capabilities of their crystalline material and allows the crystal-to-structure pipeline to be speeded up.

X-ray crystallography is the most widely used technique for macromolecular structure determination. However, it requires the production of suitable crystals, an iterative and time-consuming process which remains unpredictable. Hence, the rationale of the Crystallisation Facility [1] at the Swiss Light Source at PSI is to streamline the steps between the initial crystallisation hits and the following X-ray diffraction images, taking advantage of full integration into the synchrotron beamline X06DA [2]. This unique and fully-automated set-up allows initial crystals to be tested for their X-ray diffraction characteristics *in situ, i.e.* directly in the crystallisation container, without post-crystallisation treatment, which could harm the crystal and hamper diffraction.

Structural biologists can easily distinguish desired macromolecular crystals from unwanted salt crystals and obtain rapid feedback on the diffraction quality and important parameters such as limit of resolution, anisotropy, cell parameters, and mosaicity.

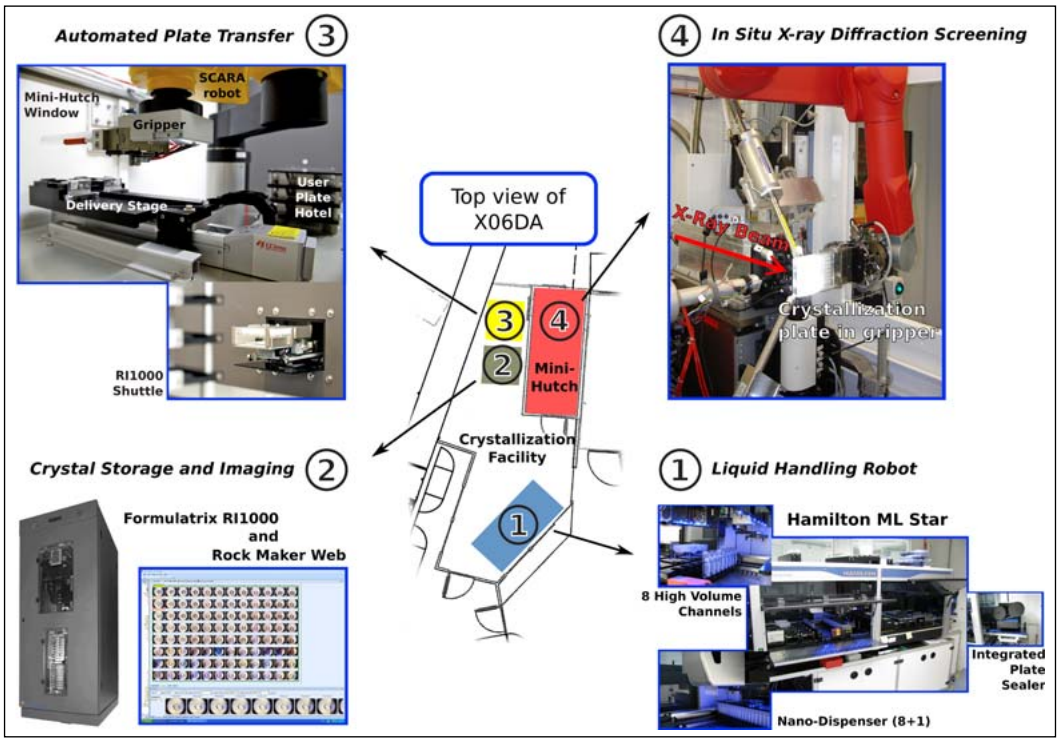

Figure 1: **Layout of the SLS crystallisation platform enabling *is*Xds at beamline X06DA. Liquid handling is accomplished on a single Hamilton ML Star robotic platform (1). Crystallisation plates are stored and imaged in an RI 1000 (2), with its customized shuttle allowing plate transfer (3) to the mini-hutch (4).**

In situ X-ray diffraction screening (*is*Xds) thus helps to better prioritise subsequent crystal optimisation trials. It also dramatically speeds up the time between crystallisation and structure determination, as has been experienced in the structural study deciphering the nine-fold symmetry of centrioles, a long-standing open question in biology [3]. The Crystallisation Facility at SLS is therefore of particular interest for both academic and industrial users involved in structural biology activities.

The crystallisation platform at the SLS

A central part of the SLS crystallisation facility is the liquid-handling robot that covers the whole workflow of macromolecular crystallisation (Figure 1(1)). Experiments are set up in SBS standard vapour diffusion containers with crystallisation drop sizes down to 100 nL. In order to support membrane protein crystallisation, future upgrades include a Mosquito nanolitre pipetting robot (TTP Labtech) designed for crystallisation in the lipidic cubic phase (LCP). The products of the crystallisation experiments are then stored and imaged in a Formulatrix Rockimager 1000 at 20°C, which is directly adjacent to the experimental hutch of beamline X06DA (Figure 1(2)). The crystallisation drops are observed using the web-based software RockmakerWeb, and *in-situ* X-ray diffraction imaging of crystallisation hits can then be requested. The macromolecular crystallography beamline X06DA is equipped with a sample-changing robot (Irelec CATS), which is fitted with a gripper designed to hold and position all SBS standard crystallisation containers (including microfluidic devices, such as the Fluidigm diffraction-capable TOPAZ® chip and CrystalHarp™ counter-diffusion plates) in the X-ray beam (Figure 1(4)). The products of the crystallisation experiments that were set up and stored at the SLS facility can then be transferred from the imaging system into the experimental hutch of beamline X06DA in a completely automated manner (Figure 1(3)).

In situ X-ray diffraction screening

In situ X-ray diffraction screening is used to quickly discriminate salt crystals from macromolecular crystals (Figures 2 A, B, C and D), to assess diffraction quality, to identify the best crystallisation conditions, or to search for new space groups (Figures 2 C and D). It is also used to identify small and low-diffracting crystals, including crystalline precipitate or nano-sized crystals (Figures 2 E, F, G and H), thanks to the high photon flux (5×10^{11} phs/sec) and focused X-ray beam (80×45 microns) at X06DA.
In a few cases where the crystals cannot be harvested, *in situ* X-ray diffraction is the only way to obtain a complete crystallographic dataset.

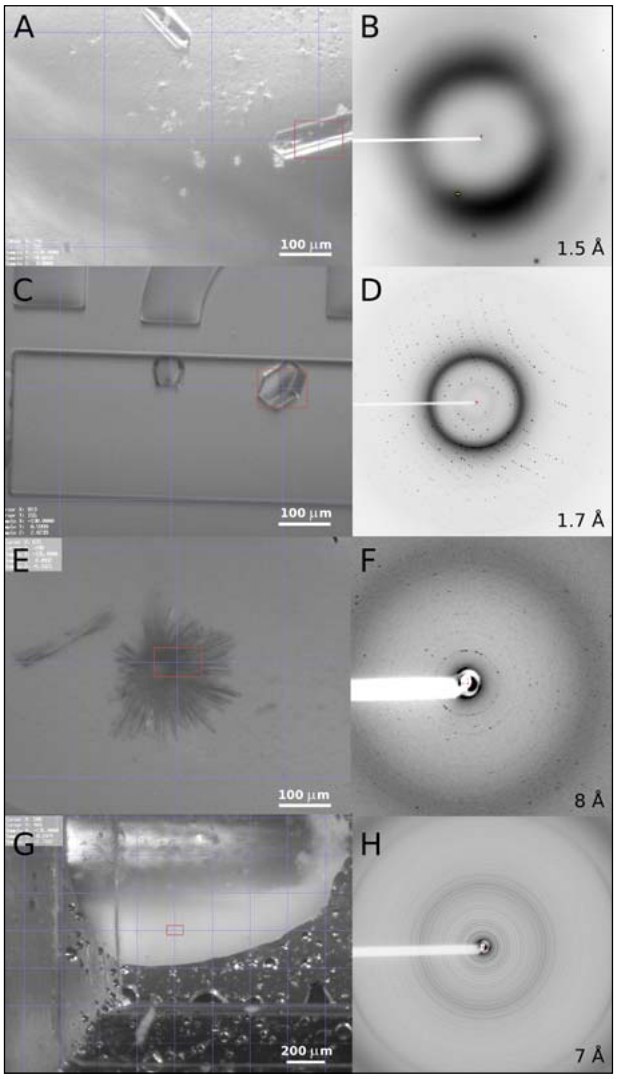

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Figure 2: ***is*Xds experiments conducted at beamline X06DA at the SLS. *is*Xds unambiguously aids in identifying salt crystals (A, B). Well-diffracting crystals, such as lysozyme, yield high-resolution diffraction images, using microfluidic chips to reduce background scattering (C, D). *is*Xds also enables diffraction information to be obtained from small crystals (E, F). Even nanocrystals in high concentrations produce clearly visible powder diffraction patterns (G, H).**

Using X-rays and neutrons at the micrometre scale to elucidate a metal artefact from the Bronze Age

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In recent years, micro-analytical facilities based on neutron beams as well as synchrotron X-ray radiation advanced to becoming indispensable instruments for investigating artwork and archaeological artefacts. By a combined approach, using neutron and X-ray micro-beam facilities, we investigated a uniquely decorated flanged axe dating from the Early Bronze Age (2200–1600 BC). This axe, found in Central Europe, is, in view of its very early dating and striking parallels to Greek objects, one of the most important artefacts concerning evaluating 'global' trading routes and knowledge transfer during the Early Bronze Age in Central Europe.

Modern beams on old objects

Historical artefacts and art objects conceal numerous secrets, not only concerning the genesis and history of the particular object itself, but also regarding the related social context or the ancient cultures which produced them. A broad range of analytical techniques can potentially be employed to obtain information concerning their physical structure and morphology, or chemical composition. Such information reveals fine details of the historic context, such as provenance, dating, manufacturing techniques and usage; or – seen in a broader context – the life style, social organization or technical capabilities of individual ancient societies, as well as the corresponding transfer of knowledge and economic interactions between these societies. In addition to revealing historical secrets, analytical investigations of artefacts and art objects are nowadays becoming more and more important in the context of conservation and restoration, falsifications or fakes, as well as the degradation and disintegration of historic and art objects.

In principle, a broad variety of analytical techniques are commonly available, but most of these chemical or physical methods are destructive in one way or another. However, at the present time, applying destructive analytical methods to art and historic objects is becoming considerably constricted, in order to preserve the integrity and (pecuniary) value of the objects. Recently, micro-analytical facilities based on neutrons, as well as on synchrotron X-ray beams, have advanced to becoming indispensable instruments in the context of the non-destructive investigation of artworks and archaeological artefacts. Both types of beam are used for multi-dimensional structural micro-analysis (physical imaging) as well as for

Figure 1: **The Bronze Age axe of Thun-Renzenbühl: top) Photograph showing the visibility of the polychrome decorations, limited due to surface corrosion; bottom) Neutron tomography reconstructions of the historical axe object, including segmentation of the two gold inlay layers and void spaces.**

chemical and crystallographic micro-imaging [e.g. 1, 2]. Advantageously, based on their characteristic and generally non-destructive interaction with matter, neutrons and X-rays provide complementary analytical contrast mechanisms.

Using a combined approach with neutron and X-ray microbeams, we investigated the unique flanged axe of Thun-Renzenbühl, dating from the Early Bronze Age. This famous object is of exceptional historical value, not only due to its age and quality of conservation, but in particular because of its characteristic polychrome decoration. Each side of the bronze body of the axe is decorated with a central stripe of pure copper and adorned with an additional 198 rhombi of gold (Figure 1, top). The axe is probably among the oldest objects found in Central Europe to exhibit this type of decoration. The famous Sky Disc of Nebra [3] is one of only a few comparable objects.

At present, it remains unclear whether the knowledge required to construct it reached Central Europe through technology transfer from the Mediterranean, Balkan Peninsula or Caucasus regions. Knowing the technical peculiarities of this form of decoration, as well as the metal alloy composition of the axe of Thun-Renzenbühl, will allow 'global' trading routes to be traced, as well as the ways in which knowledge was transferred during the Early Bronze Age in Central Europe.

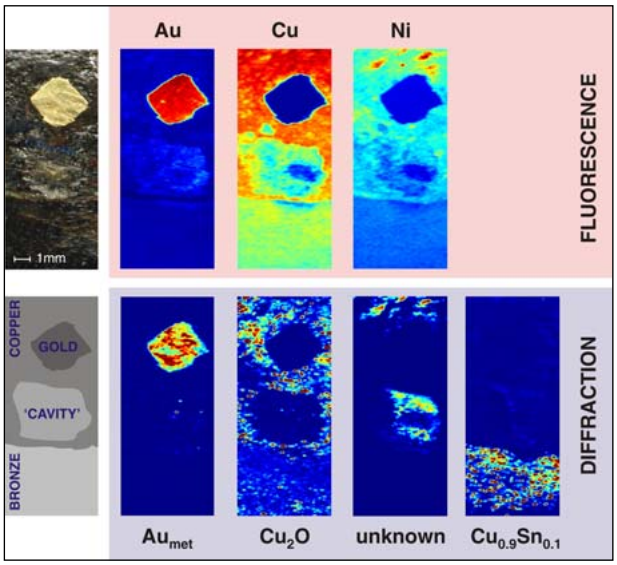

Figure 2: **Chemical and diffraction images: red panel) chemical images recorded by means of microXRF; blue panel) spatial distribution of selected crystalline compounds determined by microXRD; left) visible-light microscope-image photograph and schematic representation of the sampled area.**

Neutrons look through the object – X-rays elucidate its chemical nature

Neutron tomography provides a full, three-dimensional representation of the internal structure of an object. Void spaces, as well as gold inlays, can easily be separated and distinguished (Figure 1, bottom). The nature of internal void spaces and their deformation allows a detailed reconstruction to be made of the bronze body casting technique and its final reshaping by forging. It can further be demonstrated that the stability of the inlay composite has been achieved solely by plastic deformation through hammering. No mechanical fixation has been detected.

In order to trace the provenance of the processed raw materials, chemical analysis of the alloy composition has been performed using spatially-resolved X-ray fluorescence analysis (Figure 2, top). Most importantly, the origin of the gold ore material could be traced to the Carpathian Mountains (Transylvania). Additionally, micro X-ray diffraction imaging (Figure 2, bottom) has been employed to elucidate the existence of potential historical patination treatments, as well as to gain new information on corrosion processes occurring since burial. Compared with the axe body, an increased thickness and a vast crystallographic complexity are found for the corrosion layer of the copper decorations. This observation represents a first indication of artificial patination employed during ancient damascening decoration. This discovery is subject to ongoing investigation [4].

The present study of the axe of Thun-Renzenbühl has revealed technical and structural peculiarities distinctly different from those of Mediterranean objects which have been considered so far to be the relevant archetypes. Additionally, chemical micro-analysis has shown the usage of pure copper metal, again in contrast to the more 'exotic' copper-gold alloys employed in Mediterranean damascening decoration. In contradiction to the widely accepted concept of the strong influence of Mediterranean cultures, the present findings point towards considerable influence on Bronze Age Central Europe by cultures located in the Balkan Peninsula and the Caucasus region.

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Investigating newly discovered iron-based superconductors with muons and neutrons

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The layered iron-based superconductors discovered in 2008 constitute the first large class of high-temperature superconductors since the discovery of the high-T_c cuprates in 1986. From the very beginning of research on these systems, muon spin rotation (μSR) and neutron scattering studies performed at PSI have contributed important information on the fundamental properties of their magnetic and superconducting ground states. In 2010, a substantial part of the research on these new compounds was focused on materials possessing iron and selenium in the electronically active crystal layers.

Introduction

Magnetism and superconductivity are key elements in the electronic phase diagram of all unconventional superconductors, such as the high-T_c cuprates, heavy-fermion, organic and Fe-based superconductors. Muon spin rotation (μSR) is a powerful tool for studying the exact nature of the transition from the antiferromagnetic to the superconducting phase in high-T_c superconductors as a function of a control parameter such as doping or pressure. In this context, it is of special advantage that μSR, as a local probe, is sensitive to both the superconducting and magnetic volume fractions and to the respective order parameters, that fundamental microscopic parameters such as the magnetic penetration depth can be determined absolutely, and that μSR is extremely sensitive to small-moment and short-range magnetic order.

The magnetic and superconducting properties are examined by implanting the muon, which acts as a local magnetic probe, directly into the magnetic material or into a magnetic field distribution which is created by the magnetic vortex lattice formed when a type-II superconductor is subject to an external magnetic field (see Figure 1).

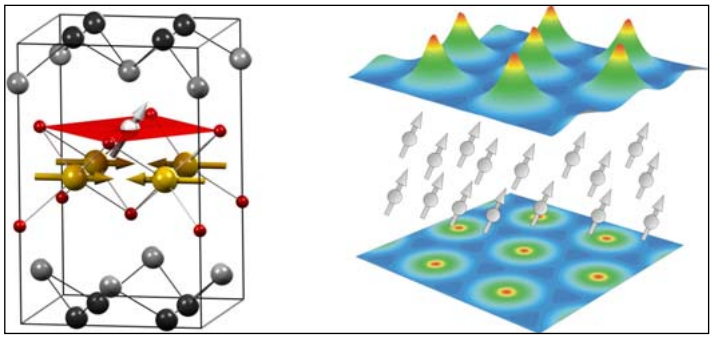

Figure 1: **Measuring magnetic and superconducting properties by implanting muons (grey arrows) into a magnetic structure (left) or a vortex lattice (right).**

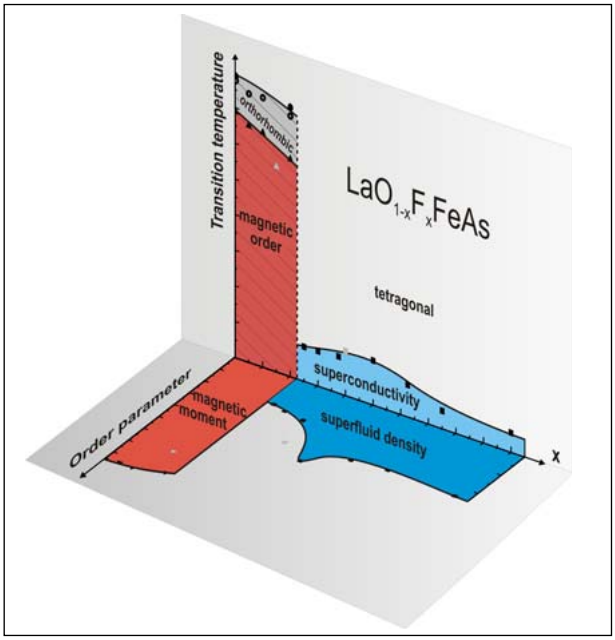

Figure 2: **Electronic phase diagram as determined by muon spin rotation techniques.**

From the very beginning of research on Fe-based materials in 2008, μSR has contributed important information. It is widely recognized as one of the key techniques for investigating fundamental magnetic and superconducting properties, as well as testing for microscopic competition or coexistence of the magnetic and superconducting ground states. Numerous studies have been performed by various groups on the μSR instruments operated by the Laboratory for Muon Spin

Spectroscopy (LMU), many of which have received extensive international attention. As one of many examples in 2010, a detailed study of the structural and electronic phase diagram of $LaO_{1-x}F_xFeAs$, the first family of iron pnictide superconductors, was honoured with the *'Top Paper of the Year Award'* by the International Society for μSR Spectroscopy. In the awarded paper [1], the small-moment itinerant spin-density wave (SDW) state and the temperature and doping dependences of the magnetic and superconducting order parameters were identified. In contrast to the cuprates, for example, a discontinuous first-order-like change of the Néel temperature, the superconducting transition temperature and the respective order parameters were found (see Figure 2). While the first Fe-based superconductors to be discovered contained the pnictogen atom arsenic, more recently, high-T_c superconductors possessing FeSe (chalcogenide) as electronically active layers in the crystal structure have been discovered. This report will concentrate on research performed in 2010 on these materials, as an example of a detailed complementary study exploiting the full range of experimental techniques offered by the NUM Department; namely, the synthesis of high-quality samples [2] by the Laboratory for Development and Methods (LDM), the determination of static and dynamic magnetic properties using elastic and inelastic neutron scattering instruments from the Laboratory for Neutron Scattering (LNS), and the determination of fundamental microscopic magnetic and superconducting parameters as functions of temperature, pressure and magnetic field by the Laboratory for Muon Spin Spectroscopy (LMU).

Pressure phase-diagram of $FeSe_{1-x}$

Similar to the situation found in the well-studied cuprates, superconductivity in Fe-based materials is found in close proximity to a static magnetic state which has to be destroyed by either doping or external or internal (chemical) pressure before superconductivity can develop its full strength. This may suggest that magnetic fluctuations are important for the mechanism of the formation of Cooper pairs. $FeSe_{1-x}$ seemed to be the one exception to this general rule, since magnetic order could not be observed in previous studies, even under the application of pressures up to 30 GPa [3]. However, a thorough investigation of the electronic phase diagram of $FeSe_{1-x}$ under pressures up to 1.4 GPa, by means of AC magnetization and muon-spin rotation, revealed a completely different picture [4]. At a pressure of 0.8 GPa, the non-magnetic and superconducting $FeSe_{1-x}$ enters a region where static magnetic order is realized above T_c, and bulk superconductivity coexists and competes on short length scales with the magnetic order below T_c (see Figure 3).

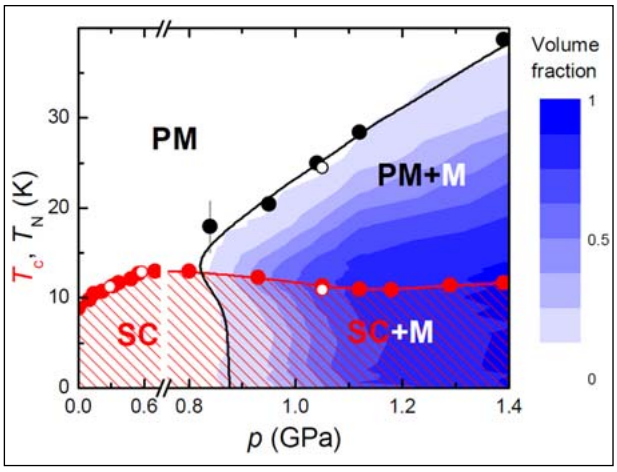

Figure 3: **Pressure dependence of the superconducting transition temperature T_c and the magnetic ordering temperature T_N for $FeSe_{1-x}$, determined by μSR.**

Static magnetic order is established below $T_N > T_c$ and bulk superconductivity sets in below T_c. The competition of the two ground states in this pressure range is evident from the following two observations: Firstly, T_c is weakened as a function of pressure as soon as magnetic order appears, leading to the local maximum at p=0.8 GPa in $T_c(p)$. Secondly, the magnetic order parameter, as well as the magnetic volume fraction, decreases as a function of temperature below T_c, showing that the magnetism, which develops at higher temperatures, becomes partially (or even fully) suppressed by the onset of superconductivity. The superconducting volume fraction is close to 100 % for all pressures. For even higher pressures (p > 1.5 GPa), an enhancement of both the magnetic and the superconducting transition temperatures, as well as of the corresponding order parameters, is observed. The data do not provide any indication of macroscopic phase separation into superconducting and magnetic clusters (larger than a few nm in size). In fact, the data rather point to the coexistence of both order parameters on an atomic scale, and both seem to be stabilized by the pressure. In addition, the magnetic penetration depth as a function of pressure has been determined using μSR [5]. The magnetic penetration depth is a relevant length for characterizing the superconducting state. Its dependence on the temperature, doping, orientation, or magnetic field contains information about the superconducting order parameter (superfluid density or density of Cooper pairs) and gap symmetry, and is of central importance for any theory of unconventional superconductivity. From these measurements it is apparent that superconductivity takes place in several electronic bands in $FeSe_{1-x}$, as was observed earlier for the Fe-pnictides. Moreover, the analysis of the superfluid density within a two-gap scheme reveals that the pressure effect on both T_c and superfluid density is entirely determined

by the band(s) where a large superconducting gap develops. This result suggests that, for the $FeSe_{1-x}$, the intraband interaction is most probably the leading pairing interaction determining the superconducting properties.

These exceptional properties, described above, make $FeSe_{1-x}$ one of the most interesting superconducting systems being investigated extensively at present.

Static and dynamic magnetic and superconducting properties of $Fe_ySe_xTe_{1-x}$

Recently, the growth of very large single crystals of $Fe_ySe_xTe_{1-x}$ has been reported. These compounds constitute a new addition to the still-expanding family of iron-based superconductors which exhibit superconducting transition temperatures up to 15 K at ambient pressure. The availability of centimetre-sized crystals allows these compounds to be studied not only with the muon spin rotation technique but also for their static and dynamic magnetic properties to be investigated by using neutron scattering. This new system was studied in detail by using the facilities of the NUM department in 2009 and 2010. Structural, static and dynamic magnetic and superconducting properties were determined as a function of iron (y), selenium (x) and tellurium ($1–x$) content, by a combination of magnetic susceptibility measurements, muon spin rotation and relaxation, as well as elastic and inelastic neutron scattering. For an iron content $y \simeq 1.0$, three regimes of behaviour have been found [6]: i) commensurate magnetic order for $x \leq 0.1$; ii) bulk superconductivity for $x \sim 0.5$; and iii) a range $x \approx 0.25 – 0.45$ in which superconductivity coexists with incommensurate magnetic order. These results are qualitatively again consistent with a two-band, mean-field model in which itinerant magnetism and extended s-wave superconductivity are competing order parameters. For the composition of $FeSe_{0.5}Te_{0.5}$, a detailed study has been performed [7] to determine the anisotropy of superconducting properties, i.e. the different superconducting response if an external magnetic field is applied parallel to the crystallographic c-axis or perpendicular to it. It turns out that, in these compounds, the anisotropy of the magnetic penetration depth and of the so-called coherence length, both of which are fundamental parameters of the superconducting state, possess opposite temperature dependence. This is especially remarkable considering that, in a simple BCS picture, these anisotropies should be equal and temperature independent. This observation again could be interpreted in a multiple-gap scenario for the superconductivity.

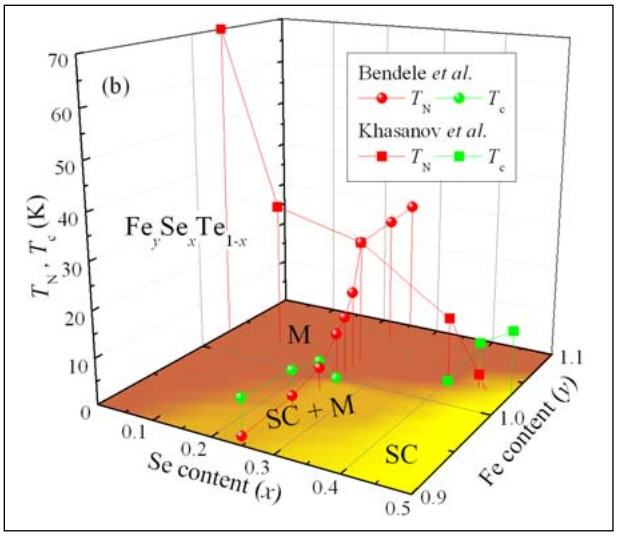

Figure 4: **Electronic phase diagram of $Fe_ySe_xTe_{1-x}$.**

Recently, it has been shown by means of muon spin rotation and elastic neutron diffraction that the superconducting and the magnetic properties of $Fe_ySe_{1-x}Te_x$ can be tuned, not only by varying the Se/Te ratio, but also by changing the Fe content [8]. Samples with $y<1$ exhibit coexistent bulk superconductivity and incommensurate magnetism. The magnetic order remains incommensurate for $y \geq 1$, but, with increasing Fe content, superconductivity is suppressed and the magnetic correlation length increases. The results are summarized in the 3-dimensional phase diagram shown in Figure 4.

A common feature in many high-T_c superconductors is the emergence of a sharply peaked mode below T_c, localised in momentum and energy space. The precise origin of this mode is still the subject of debate, but the existence of superconductivity-induced spin resonance has been shown to relate to the superconducting state and gap symmetry. In iron-based superconductors, the existence of a spin resonance at the antiferromagnetic ordering wave vector $\mathbf{Q}_0 = (0.5, 0.5, 0)$ is consistent with a pairing state with either $s^{\pm}$ or p-wave symmetry. In our work [9, 10], we have used inelastic neutron scattering at both PSI and ILL to probe the magnetic spin dynamics of optimally doped samples of $FeSe_{0.5}Te_{0.5}$ and magnetic, but non-superconducting, $Fe_{1.1}Se_{0.25}Te_{0.75}$. With this method, we have demonstrated that the resonance is intimately connected to the superconducting state and, using polarised neutrons, ascertained the symmetry of the gap function. Figure 5(a) shows a map of the inelastic neutron scattering intensity measured for a non-superconducting sample of nominal composition $Fe_{1.1}Se_{0.25}Te_{0.75}$ at 2 K. The excitation spectrum is characterised by steep incommensurate branches. The incommensurate excitations are still present at 40 K and do not appear to change for energies in the 2–7 meV range measured at these temperatures. The magnetic spectra of the magnetically ordered compound ($x = 0.25$) and the bulk superconductor ($x = 0.5$) both contain low-energy magnetic fluctuations in the vicinity of the antiferromagnetic wave vector $\mathbf{Q}_0$.

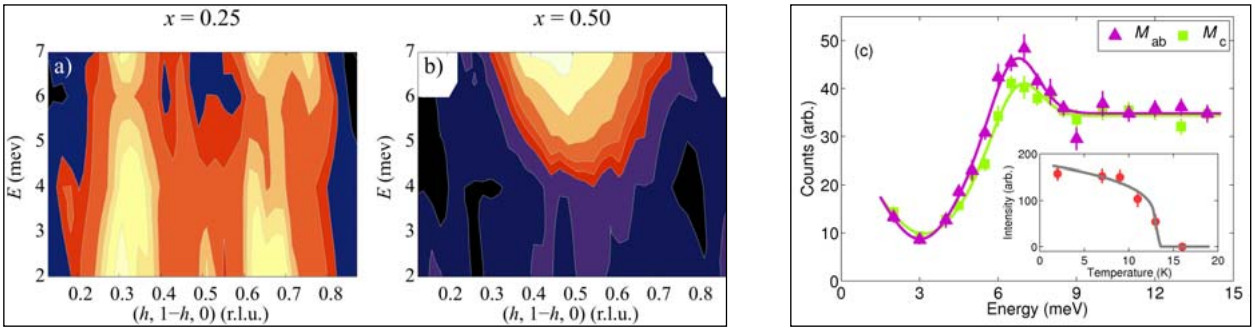

Figure 5: **Magnetic excitation spectrum of non-superconducting $Fe_{1.1}Se_{0.25}Te_{0.75}$ (panel a) and superconducting $FeSe_{0.5}Te_{0.5}$ (panels b and c).**

However, the spin dynamics obtained for $FeSe_{0.5}Te_{0.5}$ are in stark contrast to those for the non-superconducting $Fe_{1.1}Se_{0.25}Te_{0.75}$ sample. At low temperature, the magnetic spectrum of $FeSe_{0.5}Te_{0.5}$, as shown in Figure 5(b), is characterised by weak scattering up to ~6 meV. Above ~8 meV, steeply-rising incommensurate magnetic excitations are observed [11]. A commensurate excitation mode is found at ~6.5 meV, which disappears above T_c. This behaviour is consistent with the superconductivity-induced spin resonance reported in cuprate, heavy-fermion and iron-based superconductors. Depending on their symmetry, certain superconducting gap functions can result in anisotropic magnetic fluctuations at a resonance energy which can be studied using polarised neutrons. This constrains possible theoretical models.

Figure 5(c) contains measurements using neutron polarimetry at $\mathbf{Q}_0$. The signal in channels corresponding to in-plane (M_{ab}) and out-of-plane (M_c) fluctuations appears to be very similar, with a peak at the resonance energy $\Omega_0 \approx 6.5$ meV. A small discrepancy in intensities is, however, found at the energy Ω_0. These results indicate that the low-energy spin fluctuations in $FeSe_{0.5}Te_{0.5}$ are predominantly isotropic, which is consistent with a superconducting wave function having a dominant singlet superconducting ground state with $s^{\pm}$ symmetry. The small anisotropy cannot readily be explained by the usual anisotropic terms in the spin Hamiltonian, since the magnetic scattering is isotropic above and below the resonance peak. It is possible, therefore, that the superconducting pairing function contains a minority component with a different symmetry. For example, a spin-triplet with sign-reversed *p*-wave gap is predicted to give a resonance in M_{ab}, but not in M_c. The small anisotropy observed in $FeSe_{0.5}Te_{0.5}$ is very similar to that of the well-studied cuprate high-T_c superconductor system $YBa_2Cu_3O_{6+\delta}$. Both superconductors exhibit a quasi-isotropic, superconductivity-induced resonance peak which does not soften as would be expected for BCS superconductors upon increasing temperature towards T_c. Instead, the resonance peak vanishes when the temperature approaches T_c, which shows that it is correlated with the superconducting phase transition (see the insert in Figure 5(c)). Our results indicate that there may be a general origin for the superconductivity exhibited by cuprate and Fe-based superconductors.

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Neutron grating interferometry at ICON – implementation and applications

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The neutron-imaging beamline ICON has been upgraded with an instrument option for neutron grating interferometry. This new instrument makes it possible to use neutron imaging to analyze samples which exhibit phase-contrast phenomena. The method is particularly well-suited for studying materials with magnetic domains, since the domain walls can be visualized using the induced scatter. The new system has been tested successfully and will be made available as an option within the User Programme.

Introduction

Neutron grating interferometry (nGI) uses the wave properties of a neutron beam to extract information about a sample that is complementary to that obtained by standard transmission imaging. Simultaneously, it also provides differential phase-contrast images and dark-field images.

The instrument

The instrument consists of a set of three diffraction gratings, an energy selector, and a camera-based detector. Figure 1 illustrates the components of the setup, which can be installed at the ICON neutron imaging beamline as a new research tool. The principle of the instrument had already been demonstrated in 2006 [1]. During 2010, a new instrument design for nGI was finalized and the new design is now integrated in the beamline infrastructure.

The new instrument was designed to provide the nGI method as one of the permanent experiment options for users at the ICON beamline (Figure 2). An important part of this development was the installation of the energy-selector turbine as an instrument option in 2009. With this setup, the selector can be put into operation within a few minutes. The new nGI instrument consists of two components, which can be installed with high precision to be operational within a few hours.

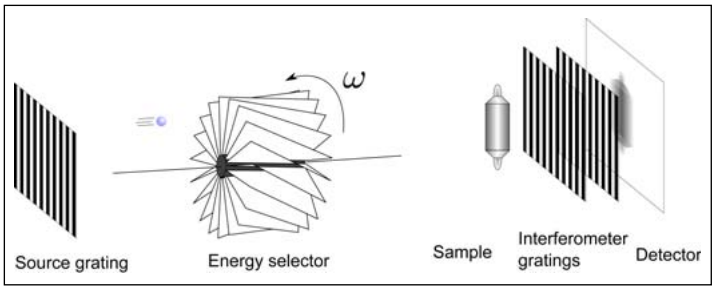

Figure 1: **Schematic drawing of the interferometer setup.**

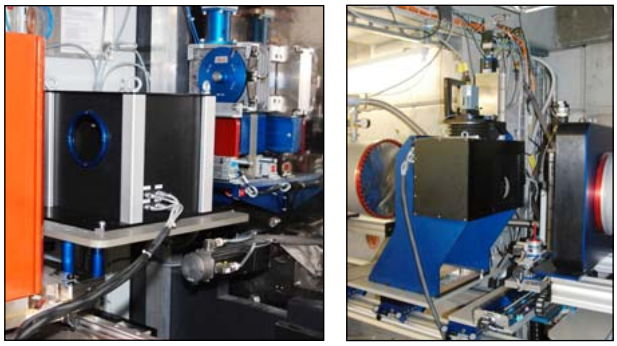

Figure 2: **Pictures of the instrument boxes installed at ICON: source grating box (left) and interferometer grating box (right).**

Measurements to characterize the instrument behaviour have been made and the new instrument is ready to receive proposals for experiments [2].

Tomography, which in general is one of the main activities at ICON, is also possible with the nGI instrument. Figure 3 shows an example of a computed neutron tomography (NCT) image of a cubic pyrite crystal (FeS_2).

The inclusions in the sample are visible in both transmission and dark-field images. By comparing the images, it can be seen that the two image types are sensitive to different regions in the inclusion. The dark field is also sensitive to edges, which are clearly seen in Figure 3c as bars on the corners of the sample.

Applications

The strength of the new instrument lies in its ability to detect small-scale defects, such as the inclusions in the pyrite sample. The differential phase images may make it possible to discriminate between materials with similar attenuation coefficients but with different indices of refraction, or when an interface between two materials exists, as shown in Figure 4. A very good field for research will be the study of magnetic domains in various materials [3]. Figure 5 shows an example of the effect of magnetic domain walls on the different image types.

The core of a 2 Euro coin is ferromagnetic. In regions where magnetic domain walls exist, contrast in the dark field image appears. By magnetizing the sample, this contrast decreases, and this can be observed in the differential phase-contrast and dark-field images shown in Figure 5. The transmission image, on the other hand, is unaffected by the presence of the magnets.

Summary

Neutron grating interferometry is being added as a new imaging method at the ICON beamline. This new instrument opens up the way for new and interesting experiments in the future. Future work will involve experiments to gather further knowledge from the new information which will be provided by the instrument.

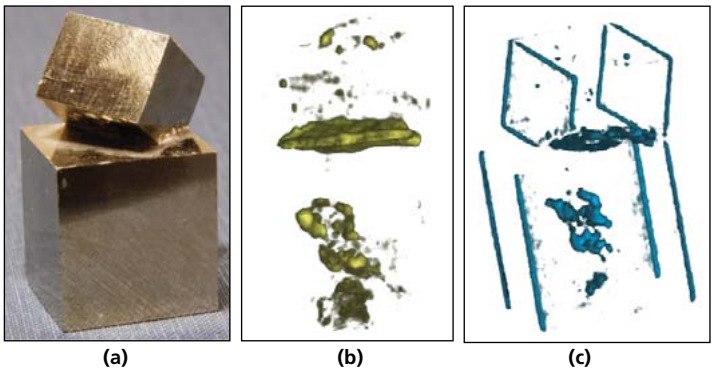

Figure 3: **Picture of the pyrite sample (a); volume-rendered transmission NCT of the sample (b); and dark-field NCT (c).**

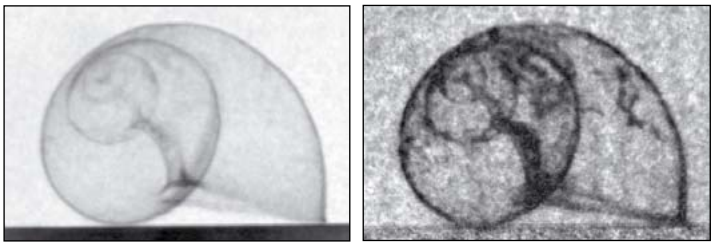

Figure 4: **Transmission (left) and dark-field (right) images of a snail shell with a surface imperfection.**

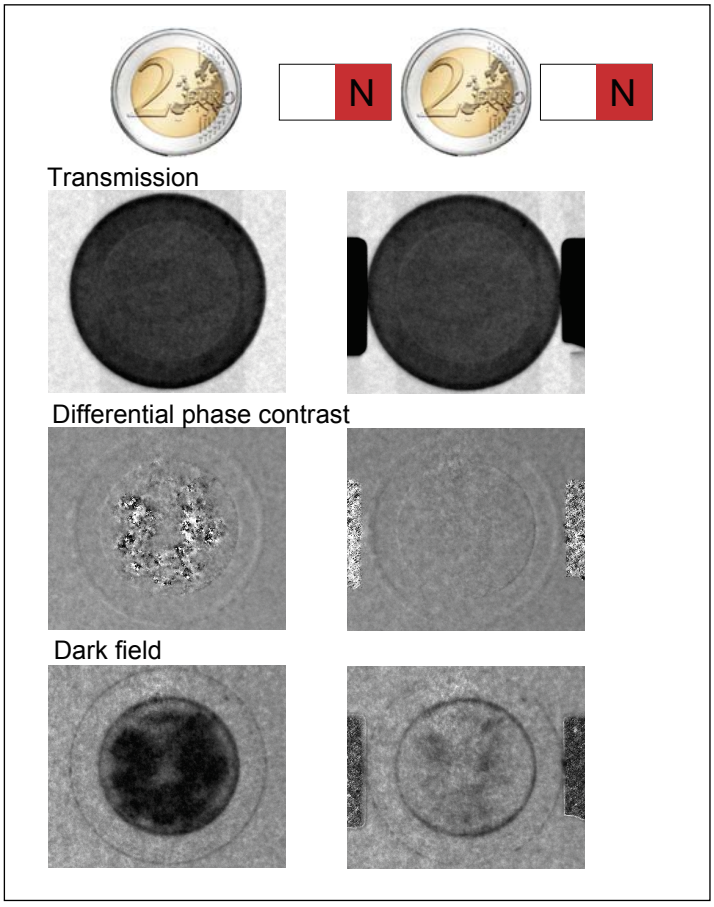

Figure 5: **Demonstration of different nGI images produced when magnets are used on a 2 Euro coin.**

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Spallation source development activities at PSI

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SINQ, the Spallation Neutron Source of PSI, can look back over 14 years of continuous, successful operation. This period has been characterized by a steady increase in the reliability of the delivery of neutrons to many users, from PSI and all over the world. The experience accumulated by operating such a facility at the 1 MW power level is of interest to other existing and future spallation sources. In addition to PSI's ties with partners in the US and Japan through well-established collaborations, new ties are being created with China and, in particular, with the European Spallation Source project, with its site in Lund, Sweden.

The new PSI source of ultra-cold neutrons is not the only focus of activity at PSI with respect to work on future spallation facilities. Until spring 2009, PSI acted as the coordinator of a European Union project called the European Spallation Source Preparatory Phase Study – "ESS-PP". Different issues related to the target, as well as compiling a cost estimate, were on the task list. The ESS is a joint European undertaking to maintain the leadership of Europe in the field of neutron-based research, beyond the time when the current flagship installation, the reactor at ILL in Grenoble, goes out of service. During the course of the ESS-PP study, the site for ESS was selected to be at Lund, in southern Sweden, just across the Oresund from Copenhagen. One of the arguments for this site was the very high number of students (more than 100,000) in the close vicinity of Lund.

ESS-PP was concluded successfully and the project at Lund benefitted from the wealth of documentation compiled during the EU-funded study. A large increase in expertise has become apparent, compared to the time when the first ESS project came to a halt in 2003.

Not only have new facilities been built since then (i.e. SNS at Oak Ridge, USA, and JSNS at JPARC, Japan), but established facilities, such as the SINQ spallation source at PSI, have also performed new feats, yielding a much enlarged base of knowledge for ESS. The liquid-metal target of the MEGAPIE project at SINQ demonstrated, for the first time, reliable operation of a target using lead-bismuth eutectic (LBE) in the MW power range. The neutron flux at SINQ was increased with the LBE target by a factor of 1.8, compared to that of the previous, solid-state, target used.

Stimulated by this fact, a new generation, equipped with new tools, set out to optimize the solid-state target and it proved possible to reach almost the same neutron yield as with MEGAPIE. The current version of solid-state target in SINQ falls short by only 15 % compared with the liquid-metal one, and this in a geometry which was originally devised for a liquid-metal target.

The experience gained during this exercise comes in addition to the long-standing STIP programme in spallation-related materials research at PSI (SINQ Target Irradiation Program). Together with the experience of actually having operated an LBE target, PSI is posed to contribute substantially to target questions. This selection process is currently going on, with PSI assisting by making all relevant experience it has obtained available within the context of the very difficult trade-offs involved.

In a first stage, PSI has investigated the option of a rod-bundle target for ESS, as used in SINQ. However, as ESS aims for power levels of 5MW+, a direct mapping of geometries applied at SINQ is not possible. Therefore, first investigations of questions concerning the thermo-mechanical and thermal-hydraulics behaviour of such a target system has been started. From the neutronic performance point of view, a first optimization of an ESS target with a rod-bundle geometry has been performed. The basis chosen for this optimization was the cold neutron flux at a distance of 10 metres from the surface of a parahydrogen moderator at a temperature of 20 K. Time structures, energy-dependent neutron fluxes and pulse shapes for different wavelength bands of outgoing neutrons have all been evaluated. Besides fluxes from the moderators of neutron sources, the signal-to-noise ratio at detector positions of scattering instruments have to be investigated in great detail. Background created by neutrons in the vicinity of detector positions, high-energy gammas created in instrument

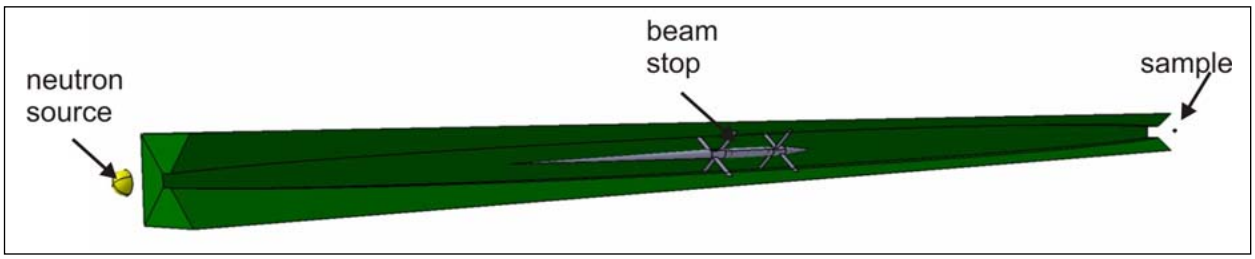

Figure 1: **Double-elliptic neutron guide with integrated beam stop.**

bunkers, and neutrons reaching detectors which are not scattered by the sample material, will add up to a noise level that should be kept as low as possible. Therefore, strategies to evaluate and minimize these background signals have to be developed and employed for the design of ESS and any upgrade of SINQ.

A first approach to minimizing the background is to couple moderator/cold source design with new kinds of neutron guide systems. In this respect, elliptical guides are most interesting. During recent years, it has been demonstrated that truly elliptically tapered guides can be fabricated. First devices/prototypes of parabolic and elliptic focusing guides using super-mirror coatings up to $m = 5$ are in use at ISIS, FRM II, SNS, ILL and PSI. It has been verified that it is possible to achieve flux gains of the order of 30 to 40 on spot sizes of the order of a few mm^2.

One disadvantage of a "standard" elliptic guide is the fact that it cannot be bent without loss in performance, with the consequence that the moderator is directly viewed by the instrument or the sample. In the case of short elliptic guides (< 30 m), the direct view may result in a significant increase in the perturbing background produced by fast neutrons (>10 keV).

An internal beam-stop in a straight elliptic guide can provide a strong reduction in this fast-neutron background (see Figure 1). At present, we are investigating the influence of different shielding materials and the position/geometry (inside the guide) of integrated beam stops on the fast neutron background at the exit of elliptic neutron guides. Figure 2 shows simulated spectra for an elliptical guide setup, with and without a beam stop. In this special configuration, at a cold-source surface, we are interested in a neutron reduction (background) below 1.5 Å (corresponding to energies >35 meV).

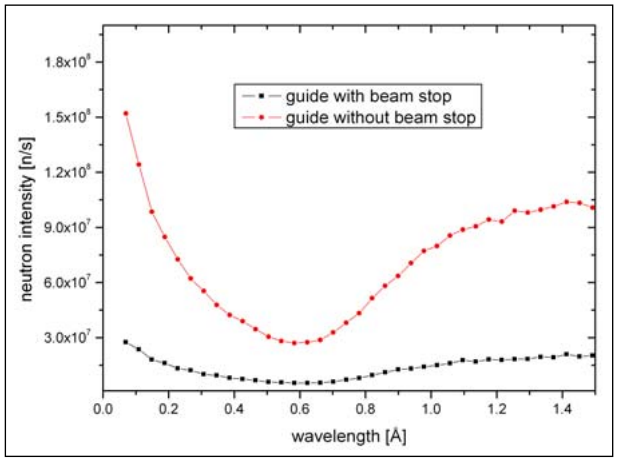

Figure 2: **Comparison of simulated background with and without beam stop for an elliptical guide setup.**

Finally, it is planned to build large-scale prototypes (a few metres long), which will be tested on the new beamline **BOA** (**B**eamline for Neutron **O**ptics and other **A**pproaches) at SINQ. At present, the 12-metre-long beamline is being assembled and it is planned that operation will start in summer 2011.

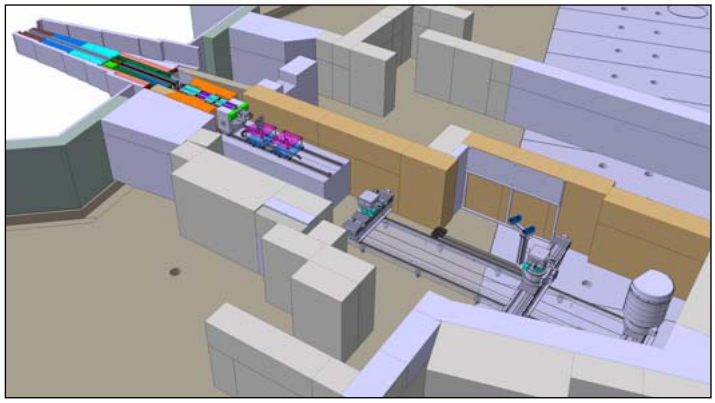

Figure 3: **Schematic of the new BOA beamline at SINQ.**

The simulated and experimental results will provide an important input to the design of future ESS/SINQ instruments at the ends of elliptic guides.

Fundamental muon physics: A high-precision approach for understanding the basic forces of nature

Stefan Ritt, *Laboratory for Particle Physics (LTP), PSI*

PSI operates the world's most intense continuous muon beams, which provide unique opportunities for investigating fundamental questions of particle physics at the high-precision frontier. The MEG experiment, searching for the lepton flavour violating decay $\mu \rightarrow e\gamma$, recorded in 2010 twice as many statistics as in 2009. The measurement of the Lamb shift in muonic hydrogen led to the determination of the proton radius 10 times more precisely than previously obtained, but disagreeing by 5 standard deviations from the previously accepted value, challenging other experiments and theory. The measurement of muon lifetime has resulted in a sub-ppm determination of the Fermi coupling constant, and measurement of muon capture on protons allows a precise determination of the weak pseudo-scalar coupling constant. Improvements to the intensity and quality of the muon beams are still foreseen, opening the door for future high-precision experiments.

Tests of fundamental theories and searches for "New Physics" beyond the Standard Model (SM) can be performed at the high-energy frontier, where new particles can be created directly using TeV-scale accelerators. An alternative approach is the high-precision frontier, where particle decay modes or atomic levels measured with very high precision can give indications for new physics. The following sections give an overview of such experiments from the Laboratory of Particle Physics (LTP), with the emphasis here on experiments using muons and pions.

Muon-capture experiments

The MuCap experiment measured the weak pseudo-scalar form factor g_P via muon capture on hydrogen gas. While the theoretical value for g_P follows basic concepts of chiral symmetry breaking, and is relatively well described, experimental confirmation prior to the MuCap experiment was inconclusive, due to systematic issues and lack of precision. The MuCap experiment was performed in a 10 bar, ultra-pure H_2 volume, which serves both as a stopping target for the muons and as the active medium for a time projection chamber (TPC). To avoid the necessity of the difficult measurement of neutral particles after the nuclear capture reaction $\mu^- + p \rightarrow \nu + n$, the so-called 'lifetime method' is employed. Here, the difference is precisely determined between the μ^+ decay rate – now given with unprecedented 1 ppm accuracy from the MuLan experiment (see below) – and the μ^- disappearance rate, measured via the recording of the time difference between muon stop in the TPC and the appearance time of the muon decay electrons. Since the μ^+ do not undergo muon capture, the difference in disappearance rate is directly related to the capture rate. A subset of the data, with $N=1.6\times10^9$ events, has already led to a result of $g_P=7.3\pm1.1$ [1], which cleared up a long-standing discrepancy. The full dataset, with ten times as much data, is currently being analyzed, and the result is expected in 2011.

New efforts are currently underway to measure the muon capture rate on the deuteron Λ_d in the MuSun experiment. The most precise experimental values of Λ_d differ somewhat and also show a discrepancy with new calculations. Λ_d has important implications on the solar fusion process $p+p \rightarrow d+e^+ + \nu_e$, on neutrino detection experiments and on neutrino cross-sections and parameters. Muon capture is the only precise way of extracting one of the as-yet unknown low-energy constants used to consistently describe all these weak processes in modern Effective Field theories. The planned improvement of the experimental uncertainty by a factor of five will shed more light on this problem in the next few years.

The Muon lifetime

Data collection for two independent experiments was recently completed at PSI, using very different techniques to measure the lifetime of the muon. This lifetime is the best way to determine the Fermi coupling constant G_F, describing the strength of the weak force as one of the four fundamental forces of Nature.

The FAST experiment uses an extended active fibre target to stop a ~1 MHz π^+ beam, and then registers the pion decays and consecutive muon decays by their decay topology inside the 1536 fibres of the target. Since the data rate, even after a second-level trigger scheme, is too high to be stored, all data are analyzed online and stored in a set of ~3000 lifetime histograms. Only a small subset of the raw data is recorded for monitoring and systematic error studies. During two beam periods in 2008 and 2009, 4.2×10^{11} muon decays were recorded. The periodic background structure from incoming beam particles was removed by re-binning the data in bins with the same time structure as the pion beam (19.8 ns). The data analysis will soon be finished, with a statistical sensitivity of ~3 ppm on the muon lifetime, equivalent to a ~1.5 ppm uncertainty in the determination of the Fermi coupling constant G_F.

The MuLan experiment used a passive target to stop muons during a 5 µs accumulation period, then operated an electrostatic deflector to turn off the muon beam and measure the decays of the accumulated muons. The decay positrons were registered by a ~4π scintillation detector, read out by high-speed waveform digitizers to effectively correct for pile-up. During two beam periods in 2006 and 2007, more than 2×10^{12} muon decays were recorded. A "blind analysis" was adopted by using a blinded clock frequency, which was only revealed after both data sets had been fully analyzed. The combined result gives the most precise measurement of $\tau_{\mu+}$ = 2.1969803 ± 0.000002.2 µs (1.0 ppm), which is the best lifetime ever measured and an improvement over the current value by more than a factor of 15, as can be seen in Figure 1. This leads to a determination of the Fermi coupling constant of G_F = $1.1663788(7)\times10^{-5}$ GeV^{-2} (0.6 ppm),

Muonic hydrogen Lamb Shift

The muonic Lamb Shift experiment measured the energy difference between two atomic levels in muonic hydrogen, which is an atom composed of a muon and a proton. Since the muon is heavier than the electron, its orbit around the proton is much smaller, so that it "feels" the proton much more, making the atomic levels much more sensitive to the proton radius compared with those of ordinary hydrogen atoms. From measurement of the 2S-2P splitting in muonic hydrogen by means of laser spectroscopy, a new proton radius r_p=0.84184(67) fm has been determined [3], which is ten times more precise than the previously known value. Moreover, the result disagrees by ~4 % from the previous value, with a significance of four to five standard deviations from the results obtained via hydrogen spectroscopy and from electron-proton scattering data. The measured variance has triggered a very lively discussion, with more than 20 publications in the last 6 months in various fields, such as proton structure, new physics, scattering analysis, fundamental constants, bound-state QED and effective field theories. The origin of the observed discrepancy is still unknown and intriguing. It is therefore planned to shed some more light on this puzzle by measuring several transitions in muonic helium ions in the near future.

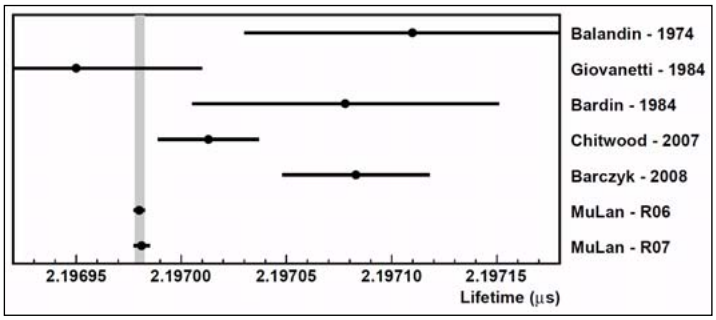

Figure 1: **History of the muon lifetime measurements over the last few decades, taken from [2]. The two lower points come from the MuLan experiment.**

The PEN experiment

In addition to muons, the decay of pions produced at the PSI accelerator offers another possibility to measure basic quantities and forces. The PEN experiment addresses the decay $\pi^+\to e^+\nu$. The branching ratio of this decay versus the "normal" decay, $\pi^+\to\mu^+\nu$, is the most precise test of lepton universality, which is the flavour independence of lepton-gauge boson coupling and one of the cornerstones of the SM. A deviation from the predicted value could indirectly indicate new physics, such as extra Higgs bosons or lepto-quarks in an energy range of many TeV, beyond the current capabilities of high-energy accelerators to produce these particles directly. The current value of the branching ratio is BR($\pi^+\to e^+\gamma$) = $1.230(4)\times10^{-4}$, while the theoretical prediction is more precise by an order of magnitude. The PEN experiment acquired 2.76×10^7 events during 2007–2010, using an active pion stopping target surrounded by a ~4 π pure CsI calorimeter and proportional wire chambers, allowing the decay $\pi^+\to e^+\nu$ to be detected, together with the decay chain $\pi^+\to\mu^+\nu$and $\mu^+\to e^+\nu\bar{\nu}$ for normalization. The acquired data are sufficient to improve the experimental accuracy from the current value of 3.3×10^{-3} to 5×10^{-4}. The final result is expected after the final analysis in 2011.

The MEG experiment

The MEG experiment searches for the decay $\mu^+\to e^+\gamma$, which would violate lepton flavour and is therefore forbidden in the

SM, but predicted to exist in most theories beyond the SM. The experiment aims to improve the current experimental limit of the branching ratio BR($\mu^+\to e^+\gamma$) < 1.2×10^{-11} by about two orders of magnitude. A description of the set-up of the experiment can be found in [4].

In 2008, a data sample of almost 10^{14} stopped muons was recorded during 78 days of data collection, leading to an upper limit of the branching ratio of BR($\mu^+\to e^+\gamma$) < 2.8×10^{-11} [5]. This beam time was affected by instabilities in the high voltage of the drift chamber (DC) system of the MEG detector, leading to a lower efficiency than expected. This problem was solved for the 2009 data collection, in which 22 million events were recorded during 43 days. Due to the higher efficiency of the DC system, positron momentum resolution was improved by about a factor of two, and the muon decay point determination on the target was improved by about 40%. Refined trigger algorithms increased the overall trigger efficiency from 66% to 84%. Several methods were used to calibrate and monitor the 900 litre liquid xenon calorimeter at various intervals. These included radioactive sources, 17.6 MeV photons produced through the ^{7}Li(p,γ)^{8}Be reaction via a dedicated 1 MeV proton accelerator, and high-energy photons coming from π^0-decays produced in the charge exchange reaction p(π^-,π^0)n using a negative pion beam stopped in a liquid hydrogen target. The 17.6 MeV photon peak, for example, was measured twice a week and found to be stable within <1%.

The analysis of the 2009 data was similar to that of the 2008 data. Each event is characterized by 5 kinematic variables: positron energy (E_e), photon energy (E_γ), relative timing ($t_{e\gamma}$) and relative angles between the positron and the photon ($\theta_{e\gamma}$, $\phi_{e\gamma}$). A "blind analysis" was adopted where events with $t_{e\gamma}$ close to zero and E_γ close to 52 MeV were removed from the data to avoid any biasing of the analysis. The remaining data were used to determine probability density functions (PDF) for the 5 kinematic variables for $\mu^+\to e^+\gamma$ signal events (SIG), $\mu^+\to e^+\,\nu\nu\gamma$ radiative muon decay (RMD) background events and accidental background events (ACC). After all calibrations and PDFs had been made, the data were un-blinded on 6 July 2010. Figure 2 shows the distribution of events around the signal region. Although there is a clustering of five events visible in the energy plane, it is not seen in the other plane.

The distributions of the 5 kinematic variables were then fitted using a maximum likelihood method, independently by three different groups, to check for possible systematic effects. The fitted results agree well with each other and give N_{RMD}=35±24/22 for the whole analysis window, and N_{sig}=3.0 for the best fit. The hypothesis of N_{sig}=0 is still within the 90% confidence limit band, and the upper limit of the band is N_{sig}<14.5. Figure 3 shows one of the signal-like events.

Normalization of the branching ratio to the number of stopped muons is performed by measuring the Michel decays $\mu^+\to e^+\nu\nu\gamma$ with a pre-scaled trigger together with the $\mu^+\to e^+\gamma$ trigger and correcting for the different detector acceptances for both event types. For the 2009 data, this normalization factor was $1.0\times10^{12}\pm8$%, leading to a preliminary sensitivity of 6.1×10^{-12}, which is an improvement of a factor of two with respect to the current value. The preliminary upper limit for the branching ratio is BR($\mu^+\to e^+\gamma$) < 1.5×10^{-11} (90% C.L.).

Data collection continued in 2010, after several further improvements during the winter shut-down. The waveform digitizer electronics were modified to optimize the inter-board timing synchronization, leading to an improvement of the electronics timing resolution by a factor of 2–3. New beamline tuning and a special target were tested for future use, allowing

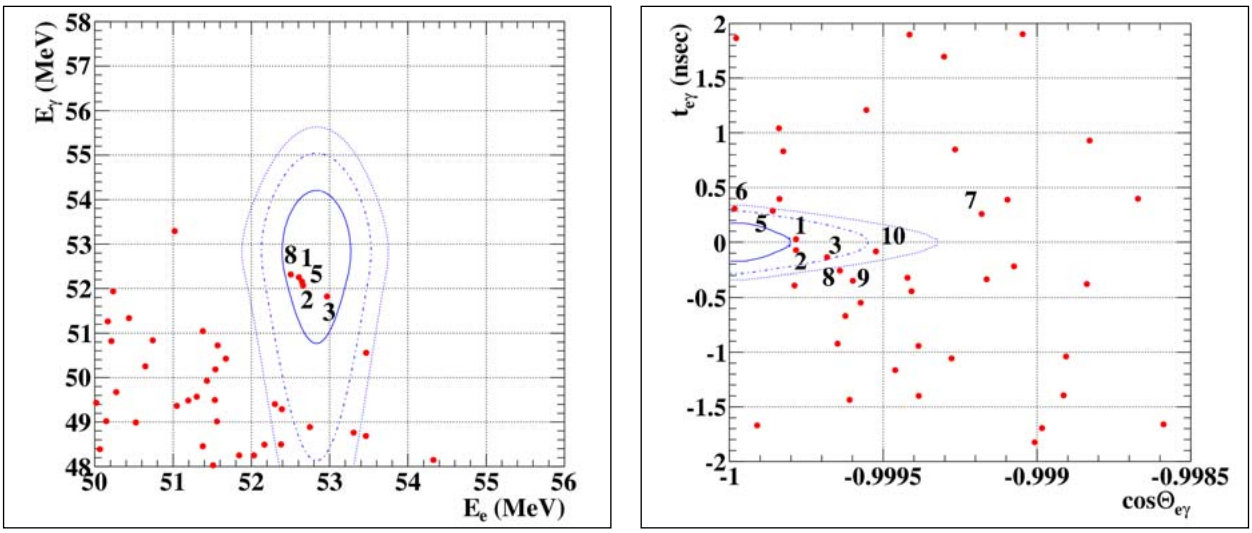

Figure 2: **Distribution of events around the signal region, for the energies E_γ and E_e (top) and the relative timing $t_{e\gamma}$ and angle $\theta_{e\gamma}$ (bottom). For each distribution, a cut is applied on the other two variables to contain 90 % of possible signal events. The contours show the two-dimensional PDFs for signal events for 1, 1.64 and 2 sigma. The (arbitrary) labels can be used to identify corresponding points for individual events on both plots.**

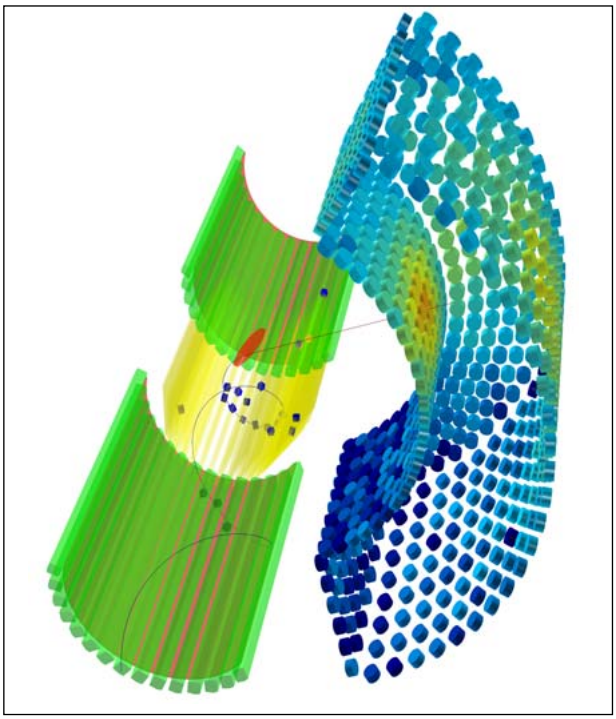

Figure 3: **One of the signal-like events, as seen by the MEG detector. The disc at the centre is the muon stopping target. The photon is detected on the right-hand side by the liquid xenon calorimeter, where each small cylinder corresponds to one photomultiplier, with the shade representing the light intensity seen by that photomultiplier. On the lower left-hand side, the positron track can be seen, first traversing the drift chamber system and then hitting three consecutive timing counters.**

monochromatic positrons to be scattered into the drift chamber system in order to study the spectrometer resolution. In the 2010 run, it was intended to take about three times the data collected during 2009, but the collection was unfortunately prematurely ended on 5 November 2010 by an incident with the super-conducting beam transport solenoid. A leak in the insulation vacuum led to quenching of the magnet, which in turn destroyed an electrical vacuum feed-through connector. The magnet had to be warmed up and repaired, which made it impossible to resume data collection before the end of the year. The electrical feed-through has since been re-engineered to ensure that such an incident cannot happen again. Nevertheless, about twice the 2009 data were collected in 2010. Data analysis is ongoing and the blinding box is expected to be opened in the middle of 2011, hopefully leading to new interesting results. A final sensitivity of a few times 10^{-13} is expected to be reached in the next three years.

Technical developments

High-precision experiments are also technically very challenging. They require excellent particle detectors, fast electronics for the read-out of the detectors, and control systems to keep the experimental conditions stable over extended periods of time. While some of these components are commercially available, others have to be developed especially for the experiments. If this cutting-edge technology is designed in a more common way, it can be interesting for other applications beyond the specific experiment. In the past few years, several of these developments have been made available to other internal and external groups, as well as to industry, through PSI's technology transfer program. One example is the silicon pixel detector for the CMS experiment at CERN, which led to the development of new X-ray detectors, now being successfully produced by the spin-off company Dectris. The MSCB control system developed for the slow control of the MEG experiment is now also used at the SLS and the SwissFEL for temperature measurements and VME crate control, as well as at TRIUMF in Canada. Another example is the DRS chip, a very fast waveform-digitizing chip originally designed for the MEG experiment, which is now used worldwide by other experiments and companies, including a research programme to deploy this chip in time-of-flight positron tomography (TOF-PET), a medical application in which the chip can improve the quality of the image data considerably compared to conventional electronics.

Future activities

While the current muon beams have sufficient intensity and quality for the experiments mentioned above, future activities, such as a new search for the $\mu \rightarrow eee$ decay, will require higher beam rates. Studies are currently underway on how to improve the rates at the PSI secondary beam lines by modifications of the current production targets, or by going new ways in utilizing other sources of muons, such as the SINQ target. This is a long-term commitment which will be followed over the next years. On the other hand, there are plans for a slow muon beam using a novel technique for phase space compression of stopped muons [6]. Such a muon beam, with an energy of about 10 eV, can be used for surface μSR studies, for muonium production or – after post-acceleration – as an ultra-monochromatic muon beam.

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Travelling monopoles tread a Dirac string path

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Emergent magnetic monopoles have been directly observed in a two-dimensional array of nanoscale magnets arranged in a honeycomb geometry. Using photoemission electron microscopy at the Swiss Light Source, it was possible to see how monopole-antimonopole pairs are created in a magnetic field and then separate along a one-dimensional path, leaving a line of overturned dipoles behind, which constitute the so-called Dirac string. Our results may one day lead to new types of devices, making use of magnetic monopoles to perform logic operations or store information.

The existence of magnetic monopoles was first contemplated by the British physicist Dirac, who tried to reconcile their existence within the framework of quantum mechanics. In order to keep in line with Maxwell's equations, he proposed that monopoles of opposite charge (so called monopole-antimonopole pairs) are connected by an arbitrarily narrow tube transporting the magnetic flux — the so-called Dirac string. During the past two years, Dirac's ideas started to materialize in an unexpected environment, namely the rare-earth pyrochlore crystals referred to as 'spin ice'. Such systems, being magnetic insulators, inherit their name from the close analogy between proton-ordering in water ice and their allowed spin configurations [1]. Several groups have been able to detect signatures of emergent monopoles and their associated physical realization of the Dirac string in these three-dimensional pyrochlore systems, employing neutron scattering at temperatures below one Kelvin [2]. Here, the monopoles are quasi-particles that emerge out of the collective behaviour of the spins in the pyrochlore crystals.

We took a different approach [3], investigating the so-called artificial kagome spin ice comprising a two-dimensional arrangement of nanoscale magnets on a surface (see schematic in Figure 1a) created at the Laboratory for Micro- and Nanotechnology, PSI. This is a system that mimics the magnetic behaviour of the bulk spin-ice systems, with the spins replaced by the magnetic moments of the islands (arrows in Figure 1a). The emergent monopoles and Dirac strings could then be directly and unambiguously observed at room temperature using the photoemission electron microscope at the SIM beamline (SLS), which allowed the magnetic state of each island to be visualized as a grey-level contrast (Figures 1a and 2a).

In order to identify the position of the monopoles, we followed the argument proposed theoretically by Castelnovo, Moessner and Sondhi [4]. Essentially, a dipole can be considerd to be represented by the moment in each nanomagnet, stretched into a dumbbell carrying opposite magnetic charges at its ends. In such a picture, a finite string of overturned dipoles corresponds to monopole-type charge defects that sit at its

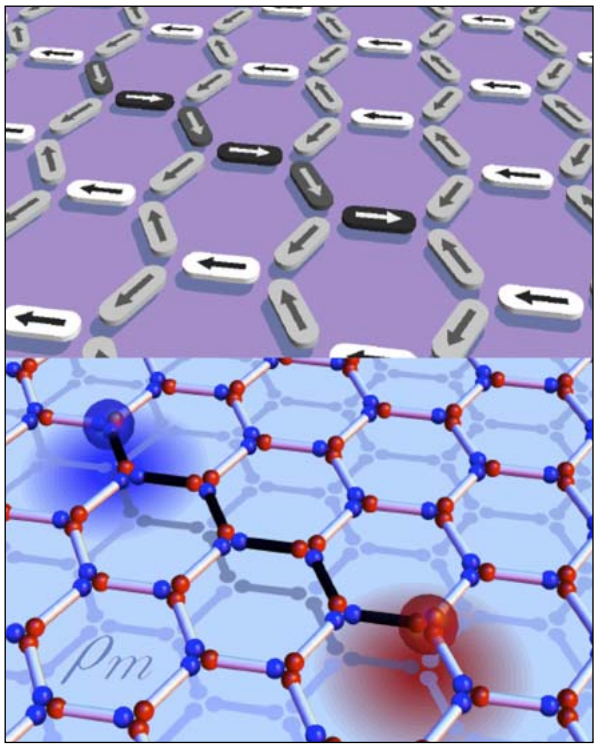

Figure 1: **Monopoles emerge in an artificial kagome spin ice [3]. (a) Schematic view of the nanolithographic array of permalloy islands, with the orientation of the magnetization indicated by arrows. (b) Corresponding charge distribution with magnetic moments replaced by dumbbells, revealing a monopole-antimonopole pair connected by a Dirac string.**

ends (Figure 1b). The monopoles can move inside the material under a magnetic field and only interact via a Coulomb interaction. The line of overturned dipoles or Dirac string has no tension and therefore does not affect the Coulomb-type interaction between them.

For the experiment, we first prepared the system by applying a large magnetic field so that the magnetic moments of all islands point to the left. We could then observe how the nanomagnets reacted to the application of a reversed field. The reversal of a particular island results in the nucleation of a monopole-antimonopole pair. Subsequently, only nearest-neighbour magnets along a one-dimensional line reverse, and this avalanche-like process only comes to rest when it reaches a resistant, 'magnetically hard' island. After this process stops, the monopole and antimonopole have separated by a large distance, leaving a path of overturned dipoles in their wake, which constitute the physical version of the Dirac string. A snapshot of the magnetic configuration of the system during magnetization reversal, with the corresponding charge map, is given in Figure 2, where several monopole-antimonopole pairs and their associated Dirac strings can be seen. As the sample fills with Dirac strings, a stripe phase forms, which is stable for a while, before all moments finally point to the right as the magnetic field is increased.

In order to obtain such a detailed understanding, we relied on the insight obtained by numerical simulations performed at University College Dublin, based on a model that reflects the geometry of the nanomagnetic array and the long-range dipolar interaction. The striking agreement between the experimental results and the theoretical model, in terms of the monopole density, hysteresis and one-dimensional behaviour, confirmed that we have discovered a particularly elegant realization of Dirac's original ideas with a well-designed experimental system.

The one-dimensional nature of the Dirac string avalanches occurring in a two-dimensional system is a unique signature of the frustration in the system. Control of the motion of the monopoles travelling along the Dirac string paths will allow us to devise not only interesting experiments but could also lead to novel spintronic devices.

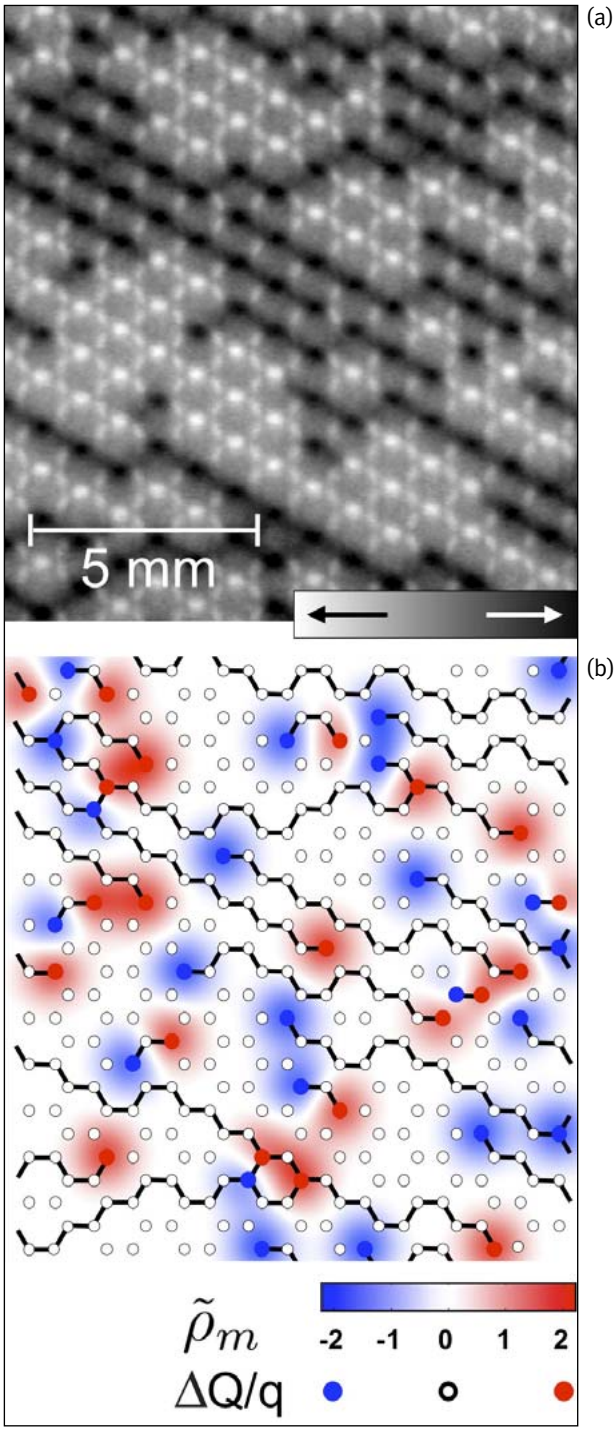

Figure 2: **Visualising emergent monopoles and their associated Dirac strings [3]. (a) XMCD image of artificial kagome spin ice during magnetization reversal. (b) Charge map and smeared charge density. The history of the movement of the monopoles (antimonopoles) is delineated by a line of flipped dipoles.**

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Nano field-emitter arrays as high-brightness electron beam sources

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PSI has been undertaking the development of a field-emitter array cathode with high-current and high-brightness characteristics, in particular as a potential upgrade option for the SwissFEL X-ray free-electron laser. The goal is to realize a cathode with a brightness higher than that of the state-of-the-art photocathode by more than a factor of 4. Here, we present nanosecond pulsed field-emission in the combined diode-RF cavity accelerator of the SwissFEL test facility. The generation of 5 pC electron bunches by ultrafast near-infrared laser-induced field emission, and collimation of the field-emission beam by a factor of ten, have also been demonstrated by using the PSI field-emitter array cathode.

Extremely high electron-beam brightness of field-emission beams, well-known for example in high-resolution electron microscope applications, has inspired many researchers in the past to extend the scope to high-current applications, such as the cathodes for accelerators, including free-electron lasers. Scaling up the current using multiple tips, while suppressing degradation of the beam brightness, is a challenge because of the difficulty of preparing uniform-size tip arrays and because of the large beam divergence of the individual field-emission beams. To overcome these obstacles, nanofabricated metallic field-emitter array cathodes with built-in collimation lens structures have been proposed [1] and studied theoretically [2]. The predicted performance of these so-called field-emitter array (FEA) cathodes with double-gate electrodes has the potential to improve X-ray free-electron laser performance, including that of the SwissFEL [3]. It would also provide the technology required for producing the compact microwave/terahertz vacuum electronic power amplifiers for ultra-broadband telecommunication and satellite communication networks in the coming decades which lack alternative cathode options.

Unlike the celebrated Spindt FEA, first demonstrated by C.A. Spindt [4], the PSI all-metallic FEA fabrication method is based on a unique moulding method [5] that can produce a uniform emitter-tip array over a large area with a radius of tip-apex curvature of a few nanometres (see the scanning electron micrograph in Figure 1). Using up to 1.2×10^5-tip single-gate FEAs fabricated at PSI, we have demonstrated nanosecond field emission in the combined diode-RF cavity electron gun of the SwissFEL test facility (Figure 1). By exploiting the low series resistance of the PSI FEA, electrical switching of the FEA electron beam down to 1.1 ns duration was realized, together

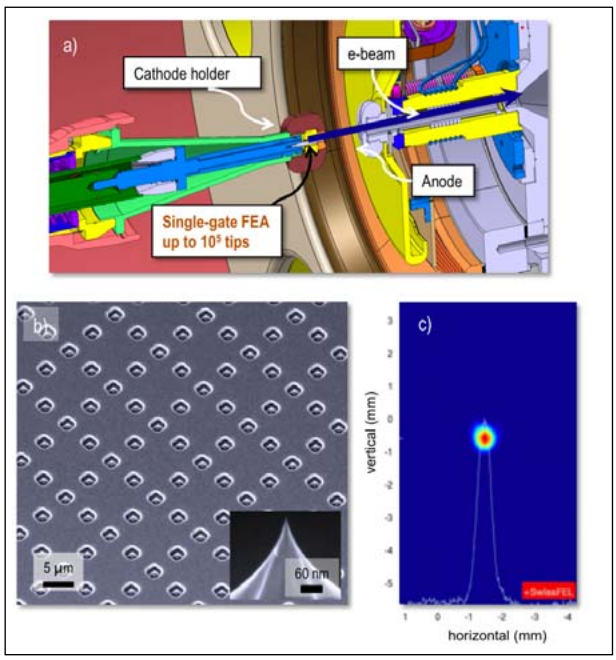

Figure 1: **(a) Schematic of FEA integration into the SwissFEL diode gun accelerator. (b) Scanning electron microscope image of a part of a 5 µm-pitch single-gate FEA with 10^5 emitter tips. The inset shows a single tip near the apex. (c) Scintillator screen image of a focussed field emission beam from the FEA shown in (b), accelerated to 200 keV in a 30 MV/m acceleration gradient.**

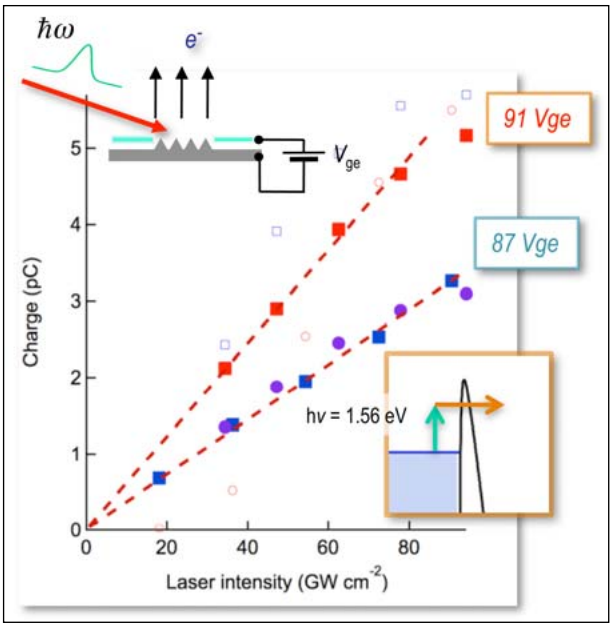

Figure 2: **Laser intensity dependence of the electron bunch charge generated from a 1.2×10^5-tip single-gate FEA under positive gate-emitter bias V_{ge}, irradiated by 50 fs Ti:Sapphire laser pulses [8].**

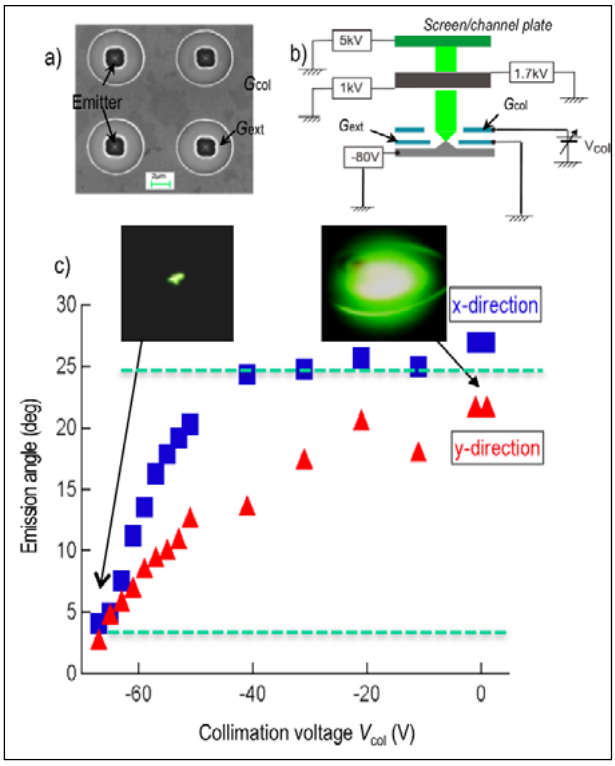

Figure 3: **(a) Scanning electron microscope image of double-gate FEA with 4 emitter tips (view from above). (b) Schematic diagram of field-emission microscopy experiment. (c) The relationship between the emission angle and the negative collimation gate bias V_{col}. Two electron beam images at V_{col}, equal to 0 V (right) and –67 V (left), are also shown [10].**

with novel pulse drivers and low-inductance FEA holder compatible with the diode gun accelerator. Stable FEA operation in an acceleration gradient up to 30 MV/m was observed [6]. By further reducing the emission pulse duration, acceleration of the FEA beam up to 5 MV was demonstrated.

In a separate experiment at SLS, field emission at higher current, with shorter pulse operation, has been demonstrated by laser-induced field emission [7]. When a metallic surface is excited by near-infrared laser pulses, the photon energy is normally not sufficient to overcome the potential barrier at the surface. However, at the surface of the electrically biased FEA tips, electrons excited by the near-infrared photons can be extracted by tunnelling. Using this principle, by irradiating our 1.2×10^5-tip single-gate FEAs by 50 fs near-infrared laser pulses with 1.6 eV photon energy, we were able to generate electron bunches up to 5 pC (Figure 2 [8]), which is within a factor of 2 of the low-charge operation target of SwissFEL.

To increase the beam brightness, it is crucial to have double-gate structures (Figure 3 [9, 10]). As a technology demonstrator, we fabricated a prototype double-gate FEA with four emitter tips, with large collimation gate apertures processed by a focused-ion-beam, and characterized the beam by field-emission microscope. We found that an electron beam with an emission angle of ~25° is emitted by applying a fixed negative bias to the emitter with respect to the extraction gate G_{ext}. However, application of negative bias to the collimation gate G_{col} reduces the emission angle by a factor of ~7, as shown in Figure 3 [10]. Enhancement of the current density by more than a factor of 10 was achieved for the first time [10].

In the next stage of our research, we expect further increases in current and beam brightness by exploring advanced fabrication and nano-optic engineering methods.

We gratefully acknowledge the support of the LMN clean-room technical team for the FEA fabrication, of the SLS control group and the vacuum group, of the ENE PSI Department and EPF Lausanne, for material characterization and FIB, and the technical support of the FIRST laboratory at ETH Zurich. This work has been performed in collaboration with the SwissFEL team and is, in part, supported by the Swiss National Science Foundation.

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Crystal structure of Meta-rhodopsin-II: A fully activated G protein-coupled receptor

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G protein-coupled receptors (GPCRs) are the largest group of transmembrane signal transducers in the human genome and are of special interest for human health. We present here crystal structures of the visual photoreceptor rhodopsin in complex with the C-terminus of the G protein α subunit. Constitutively active mutants allow us to trap this GPCR in its active conformation Meta-rhodopsin-II that retains the agonist all-trans retinal after photoactivation. Comparison with the structure of ground-state rhodopsin suggests how retinal isomerisation can induce the conformational changes that allow the G protein to bind. For the first time, we thus show how an agonist ligand can activate its GPCR.

G protein-coupled receptors as targets for pharmaceutical intervention

G protein-coupled receptors (GPCRs) comprise the largest family of membrane proteins in the human genome and mediate cellular responses to an extensive array of hormones, neurotransmitters and sensory stimuli. Over 30 % of all commercially available drugs target the GPCR mediated signalling gateway for medical intervention [1]. A better chemical and structural understanding of this signalling process facilitates the designing of new medical drugs and the improvement of established ones.

GPCR signal transduction and the molecular basis of our visual sense

All GPCRs have a common seven-transmembrane helix (TM) architecture and transmit the activation signal via guanyl nucleotide-binding proteins (G proteins).
The GPCR rhodopsin is of fundamental interest as a principal light receptor in our visual system (Figure 1). It detects light using the covalently bound vitamin A derivative retinal. Light absorption isomerizes retinal from the deactivating, inverse agonist 11-*cis* form to the fully activating agonist all-*trans* form. This initial step leads to structural changes in the receptor that result in the formation of the Meta-rhodopsin-II conformation that triggers nucleotide exchange in the visual G protein transducin and to the closing of cAMP gated ion channels.

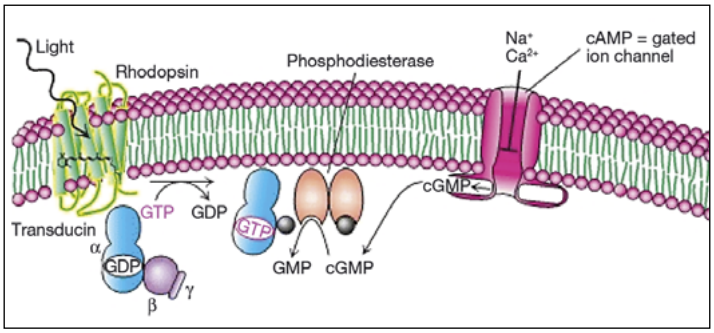

Figure 1: **GPCR-mediated signal transduction in the visual system (from Biochemistry, Lubert Stryer).**

A structural view of rhodopsin activation

To gain insight into the structural changes that occur during rhodopsin activation, we study the structures of stabilized [2], constitutively active mutants [3–4] that increase basal activity of the receptor. Co-crystallization of mutants with all-*trans* retinal and the C-terminus of the catalytic G protein subunit (GαCT) allowed us to determine X-ray structures with characteristics of the fully active Meta-rhodopsin-II conformation [5–6] (Figure 2).
Comparisons with ground-state rhodopsin [7] show how light-induced isomerisation of retinal can lead to the structural changes that allow the G protein to bind. A key feature of this conformational change is a reorganization of water-mediated hydrogen-bond networks between the retinal-binding pocket and three of the most conserved GPCR sequence motifs [4].

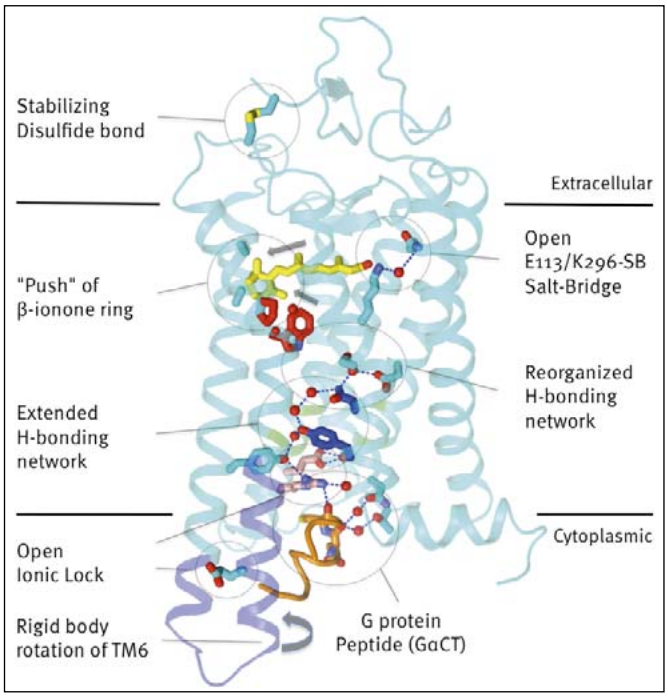

Figure 2: **The crystal structures of light-activated constitutively active rhodopsin mutants E113Q [5] and M257Y [6] show the active conformation of a GPCR with bound agonist ligand and the C-terminus of the catalytic G protein α subunit.**

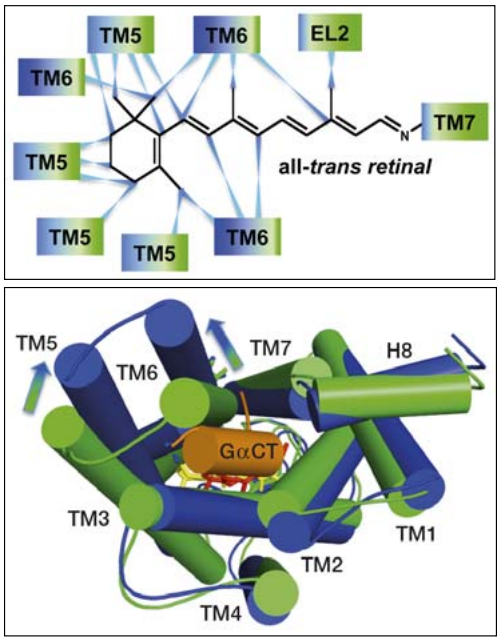

Figure 3: **The active Meta-rhodopsin-II state (blue) shows rearrangements of the seven-transmembrane helix (TM) bundle with respect to the ground state (green) [7]. Conformational changes of TM5, TM6 and TM7 open the binding site of the G protein peptide (GαCT) and are in direct contact with the full agonist all-trans retinal.**

Conclusions

Our structures show how an agonist ligand can activate its GPCR on a molecular level. Comparisons of several structures have allowed us to study how the exact binding mode can lead to the pharmacological responses of partial, full or inverse agonism. Together with structures of the ground state and several intermediates, our structures further complete our structural understanding of the rhodopsin activation pathway. For the first time, we can study activation of a GPCR on a nearly complete structural framework.

Constitutive active mutants have been described for many GPCRs and are often linked to a pathogenic phenotype. In rhodopsin they can lead to severe impairments of vision, such as Congenital Stationary Night Blindness (CSNB) and Retinitis Pigmentosa (RP). Our structures provide examples on which to study the molecular impact of constitutively active mutations, one of them in a highly conserved sequence motif that is found throughout the GPCR class of proteins. Computational homology modelling will allow us to understand to what extent mechanisms of activation are conserved among the GPCR class of signal transducers that comprise more than 1% of the human genome.

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Determinants of coiled-coil formation

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The wide range of applications of coiled coils and the important functions these structures play in most biological processes, including, for example, DNA transcription, vesicle transport and muscle contraction, highlight the need for a detailed understanding of the process of coiled-coil formation. During the last decade, we have identified key factors of coiled-coil formation. Our findings should have major implications for the rational design of coiled coils and consequently their applications.

Coiled coils are the most abundant subunit oligomerization domains found in proteins. They consist of two to five α-helices that form a helical bundle (Figure 1A). As a result of their simplicity, coiled coils are exploited nowadays as multipurpose tools in a steadily increasing number of applications, ranging from basic research to medicine. For example, designed two- and three-stranded coiled coils have been successfully used as lead molecules to target colorectal cancers and to inhibit HIV infection. For these and many other applications, knowledge of the determinants of coiled-coil formation appears essential for rationally engineering specific structures with the desired properties.

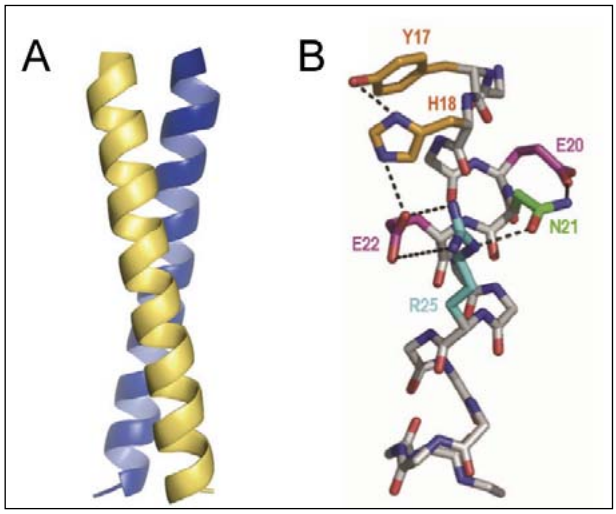

Figure 1: **(A) X-ray crystal structure of a two-stranded coiled coil; (B) NMR structure of a trigger peptide showing the stabilizing network of salt bridges.**

Trigger sequences

In 1998, we discovered so-called "trigger sequences" – short, distinct amino acid sequences that are now well-established as playing an important role in controlling coiled-coil formation [1, 2]. A characteristic feature of trigger sequences is that they fold into stable monomeric helices before the coiled-coil structure forms. In 2007 [3], we solved the NMR structure of a peptide spanning a canonical trigger sequence and showed that its structure is stabilized by a network of hydrogen bonds and electrostatic interactions (Figure 1B). Notably, the helical conformation of the trigger sequence provides an effective local structural scaffold for the interaction of key residues of coiled-coil chains. Accordingly, these preformed and folding competent local helices form a nucleation site for the initiation of coiled-coil structure formation.

The trimerization motif

In 2005 [4], we discovered the RhxxhE motif, which directs trimer formation of short three-stranded coiled coils. It is functionally conserved in many diverse protein families (Figure 2, left panel). As illustrated in Figure 2, right panel, positions 1 and 6 of the motif form a bifurcated interhelical salt bridge network between arginine (R) and glutamate (E), which are strictly conserved. Positions 2 and 5 are occupied by hydrophobic residues (h) that are compatible with the core packing geometry of three-stranded coiled coils. The struc-

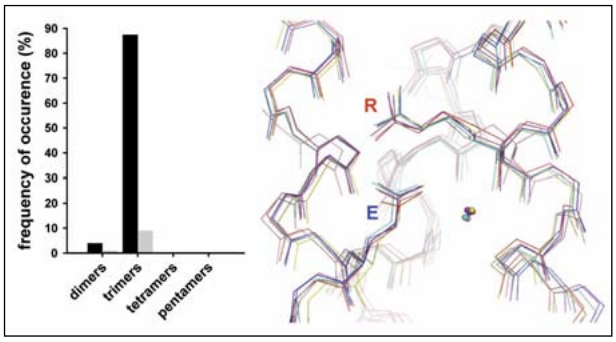

Figure 2: **The trimerization motif RhxxhE is characteristic of three-stranded coiled coils. Left panel: Frequency of occurrence of the trimerization motif in short parallel (black bars) and anti-parallel (grey bars) coiled coils. Right panel: Superposition of trimerization motifs found in six diverse three-stranded coiled coils.**

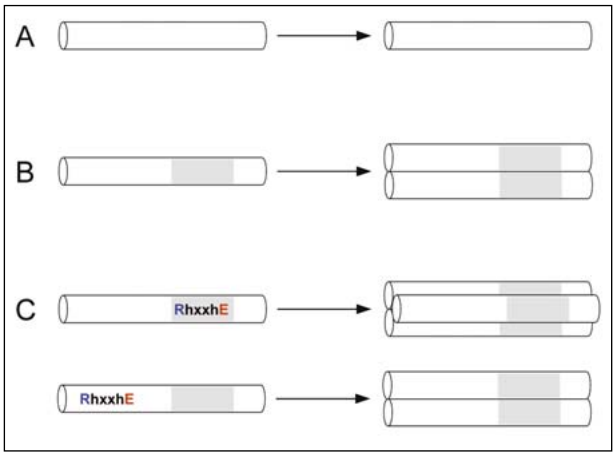

Figure 3: **Role of trigger sequence and trimerization motif for coiled-coil formation. (A) and (B): A coiled-coil amino acid sequence (bar) forms a coiled-coil structure only when a trigger sequence (represented by the grey region) is present. (C): The RhxxhE motif leads to a trimeric coiled coil only when inserted into the trigger sequence.**

tural characteristics of their side chains favour tight packing with the aliphatic moieties of the neighbouring arginine and glutamate residues of the motif that participate in the formation of the hydrophobic core. Thus the trimerization driving potential of the motif can be explained by optimal interactions between amino acid side chains.

Link between trigger sequence and trimerization motif

In 2010 [5], we addressed the important and unresolved question of why the presence of particular oligomerization-state determinants within a coiled coil frequently does not correlate with the expected coiled-coil structure. We found a surprising, general link between coiled-coil oligomerization-state specificity and trigger sequences. By using a model coiled-coil protein, we have shown that well-established trimer-specific oligomerization-state determinants, such as the trimerization motif RhxxhE, switch the protein's structure from a dimer to a trimer only when inserted into the trigger sequence (Figure 3). We have successfully confirmed our general concept in several coiled-coil proteins.

Conclusions

Despite numerous statistics- and pattern-based attempts, a reliable prediction of the specific oligomerization state of many native coiled coils remains difficult. This highlights the need for improving existing algorithms by the incorporation of experimentally verified rules, such as the ones we have discovered, which should significantly improve the prediction and rational design of coiled-coil proteins and their applications [6].

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Bacterial transglutaminase (BTG): the better way for site-specific modification of therapeutic antibodies

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The therapeutic efficacy of antibodies can be substantially enhanced by conjugation of cytotoxic compounds, such as chemotherapeutics and particle-emitting radionuclides. Conventional chemical strategies for protein modification are difficult to control and give rise to heterogeneous populations of immunoconjugates with variable stoichiometries. Such heterogeneity is often associated with non-favourable pharmacokinetics and tissue distribution. We therefore tested the characteristics of bacterial transglutaminase (BTG) for the preparation of immunoconjugates that are functionalized with different metal chelators for radiolabelling. We found that this method yields completely homogeneous immunoconjugates with a defined substrate/mAb stoichiometry and excellent in-vivo behaviour, with high tumour uptake and improved target-to-non-target ratios.

Enzymes of the family of transglutaminases (TG, EC2.3.2.13) catalyze the formation of stable isopeptidic bonds between the side chains of glutamine (Q) and lysine, with the loss of ammonia (Figure 1). Most TGs are promiscuous with respect to the lysine substrate; however, the criteria for a glutamine residue to be recognized by the enzyme are much more stringent: it should be both located in a flexible region of the protein and flanked by specific amino acids. Given this inherent selectivity, we hypothesized that TG could be an option for site-specific and stoichiometric functionalisation of antibodies. This would have a big advantage over traditional chemical protein modification strategies. The heterogeneous products of such chemical conjugation procedures lead to a mixture of antibody species with various numbers of ligands attached at different sites, each of which has its own in-vivo characteristics.

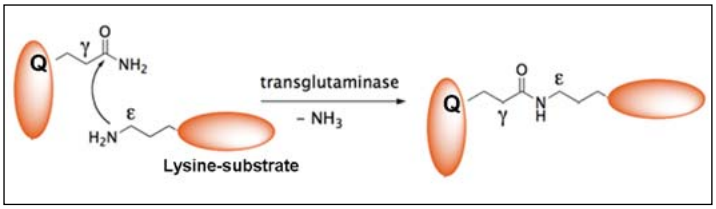

Figure 1: **Transglutaminase-mediated modification of glutamine (Q) with a lysine substrate.**

We found that an aglycosylated variant of the anti-tumour antibody chCE7 (chCE7agl), where asparagine (N) at position 297 has been replaced by glutamine (Q) to abolish *N*-glycosylation, is modified by BTG. This mutation was originally engineered to reduce the serum half-life of the radiolabelled immunoconjugate [1]. Liquid chromatography/mass-spectrometry (LC/MS) analysis revealed no modification of the light chain (LC) but exactly two modifications of the heavy chain (HC) of chCE7agl with all tested substrates. Thus, completely homogeneous immunoconjugates, with a defined substrates/mAb stoichiometry of 4:1, were formed (Figure 2a). MALDI-TOF (matrix-assisted laser desorption/ionization time-of-flight) MS analysis unambiguously proved that Q295 and Q297 in chCE7agl were the sites of BTG-mediated conjugation. Deglycosylated antibodies led to homogeneous immunoconjugates, with a substrate/antibody stoichiometry of exactly two (data not shown). Chemically functionalised chCE7agl showed varying numbers of molecules attached to both HC and LC (Figure 2 b).

To evaluate the effect of complete homogeneity versus heterogeneity of immonuconjugates on the in-vivo behaviour, we compared different functionalized chCE7agl in xenografted nude mice. Antibodies with exactly 4 (BTG modified) or with an average number of 4 (chemically modified) deferoxamine ligands (DF) per mAb were labelled with Gallium-67. Tumour uptake and distribution of ^{67}Ga-chCE7agl in normal tissues in nude mice with SKOV3ip human ovarian carcinoma metastases were measured.

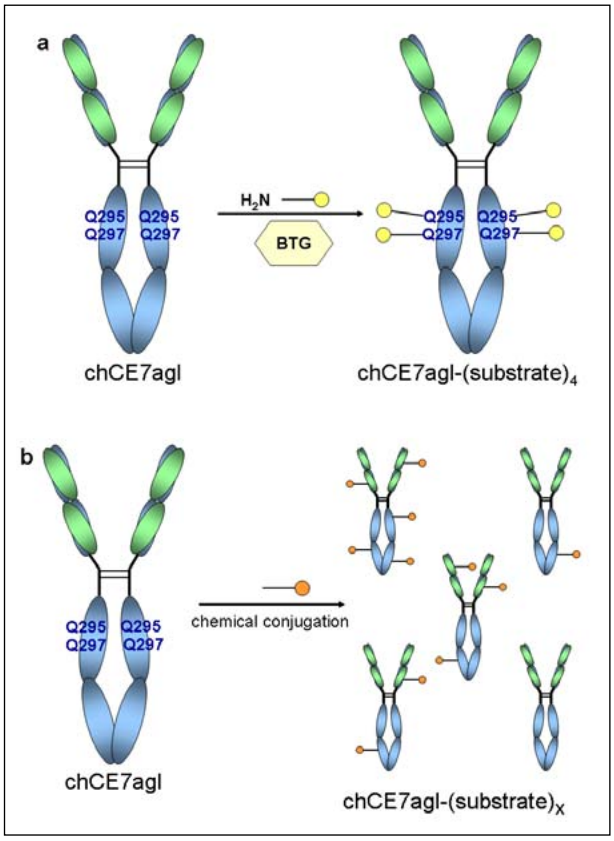

Figure 2: **(a) In the aglycosylated variant of chCE7 (chCE7agl, N297Q), Q295 and Q297 are modified by BTG; (b) Chemical functionalisation of antibodies leads to heterogeneous products with variable stoichiometries.**

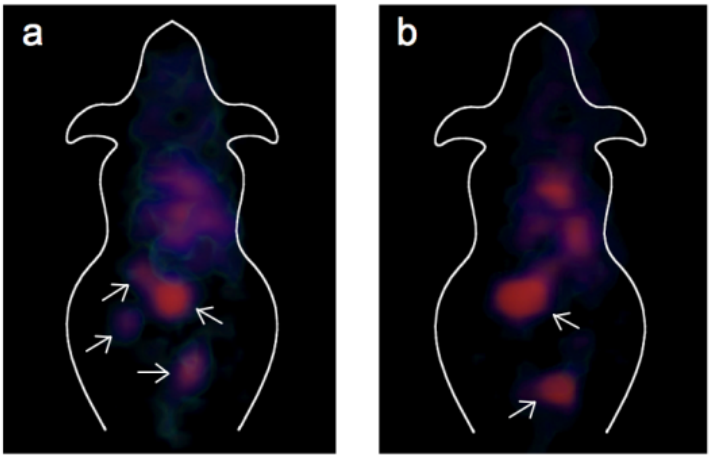

Figure 3: **SPECT images of tumour-bearing nude mice, 48 h after injection of enzymatically (a) and chemically (b) conjugated ^{67}Ga-(DF)-chCE7agl. Tumours indicated by arrows.**

Maximal tumour uptake was 43.6% ID/g for the homogeneous and 21.0% ID/g for the heterogeneous immunoconjugates at 48 h post injection (Table 1). Non-specific uptake in all of the off-target organs was low [2]. Blood levels dropped to 7.7% ID/g for ^{67}Ga-chCE7agl-BTG and 2.5% ID/g for the ^{67}Ga-chCE7agl-chem at 72 h.

	^{67}Ga-chCE7agl-BTG	^{67}Ga-chCE7agl-chem
Tissue	48 h p.i.	48 h p.i.
Blood	12.83 ± 4.04	5.63 ± 1.17
Kidney	7.96 ± 1.51	3.3.17 ± 0.29
Liver	7.28 ± 1.00	10.17 ± 3.03
Tumour	43.55 ± 16.51	21.03 ± 5.24

Table 1: **Biodistribution of enzymatically and chemically conjugated ^{67}Ga-deferoxamine-chCE7agl.**

Besides biodistribution studies, we performed SPECT (single-photon emission computed tomography) imaging (Figure 3) with ^{67}Ga-(DF)4-chCE7agl-BTG (a) and its chemically conjugated counterpart ^{67}Ga-(DF)-chCE7agl-chem (b), bearing an average of two chelators/mAb. Both immunoconjugates clearly visualized small metastases in the abdominal region of the animals (indicated by arrows). Images showed low background, thus corresponding to the high tumour/blood ratios obtained in the biodistribution experiments.

Conclusion

Bacterial transglutaminase enables the site-specific modification of the glutamine side chains of tumour-targeting antibodies. The method yields completely homogeneous immunoconjugates, with a defined stoichiometry. Comparative in-vivo studies in xenografted mice showed improved pharmacological profiles for enzymatically conjugated antibodies compared with chemically modified analogues.

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Production of terbium radioisotopes for diagnostic and therapeutic applications in nuclear medicine

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Terbium has several radioisotopes with decay properties suitable for diagnostic or therapeutic purposes. We are evaluating methods for the production of ^{149}Tb and ^{161}Tb for targeted radionuclide therapy, as well as ^{152}Tb and ^{155}Tb for PET and SPECT imaging, respectively. Radiochemical procedures based on cation exchange chromatography have been developed for the effective isolation of these radionuclides from irradiated targets. Therapeutic amounts of reactor-produced ^{161}Tb could be obtained with the high specific activity necessary for receptor-targeting radiopharmaceuticals. A similar strategy will be applied for the production of ^{152}Tb and ^{155}Tb at a cyclotron, as well as for ^{149}Tb at the on-line isotope separator facility ISOLDE at CERN.

Terbium radioisotopes for medical applications

Radioisotopes of lanthanides and yttrium are of particular interest for various applications in nuclear medicine. Thus ^{177}Lu- and ^{90}Y-labelled peptides and antibodies are being successfully used in nuclear oncology for targeted radionuclide therapy, since they allow selective deposition of a high cytotoxic dose of ionizing radiation to malignant tissue. ^{153}Sm phosphonates and ^{166}Ho- or ^{90}Y-radiolabelled microspheres are applied for bone pain palliation in skeletal metastases and selective internal radiotherapy of liver metastases, respectively.

Terbium represents a unique opportunity for further development of lanthanide-based radiopharmaceuticals, since it is characterized by the existence of several isotopes with properties suitable for diagnostic or therapeutic applications (Figure 1):

- ^{149}Tb, with a half-life of 4.1 h and 17 % emission intensity of alpha particles (E_α = 3.97 MeV), has been proposed as a very promising candidate for targeted alpha therapy [1],
- ^{152}Tb, with a half-life of 17.5 h and 17 % positron intensity, enables Positron Emission Tomography (PET) imaging [2],
- ^{155}Tb, with a half-life of 5.3 d and gamma-ray emission of 87 keV (32 %) and 105 keV (25 %), can be considered for scintigraphy by means of Single-Photon Emission Computed Tomography (SPECT),
- ^{161}Tb, with a half-life of 6.90 d, is a low-energy beta emitter, similar to the clinically-used radiolanthanide [^{177}Lu] lutetium. However, due to a significant additional fraction of low-energy electrons [4], ^{161}Tb provides a better energy transfer in small tumour volumes than ^{177}Lu [3]. Therefore, it is expected that ^{161}Tb-labeled radiopharmaceuticals have a higher anti-tumour efficiency compared with currently applied radionuclides.

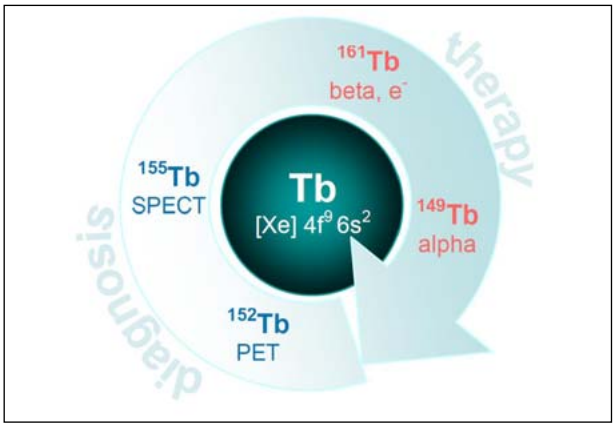

Figure 1: **Tb is characterized by the existence of several isotopes with properties suitable for various applications in nuclear medicine.**

Production of terbium radioisotopes

The production of terbium radioisotopes requires irradiation and radiochemical processing of massive gadolinium targets. ^{152}Tb and ^{155}Tb can be produced by irradiation of enriched ^{155}Gd with protons. Proton irradiation at the Injector I cyclotron at PSI was used to determine nuclear data required for assessing the production of these isotopes. Neutron-rich ^{161}Tb is formed by the irradiation of highly-enriched ^{160}Gd with neutrons (Figure 2) and was produced by long-term irradiation at the high-flux nuclear reactor at ILL (Grenoble, France). ^{149}Tb can be produced via spallation reactions at high proton energies, followed by an on-line isotope separation process, such as at ISOLDE at CERN.

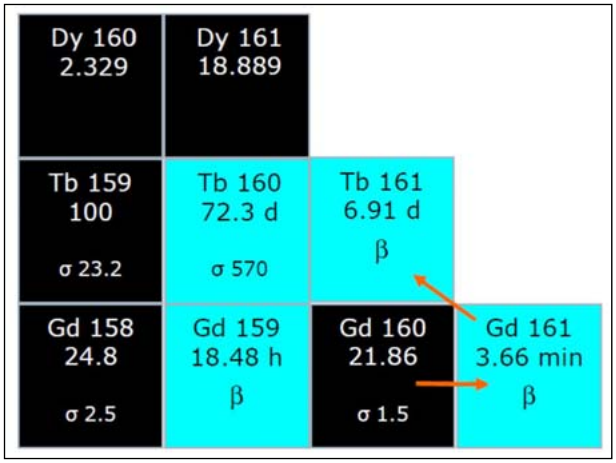

Figure 2: **Nuclide chart: ^{161}Tb is produced by neutron irradiation of ^{160}Gd and is accumulated from β^--decay of the short-lived intermediate isotope ^{161}Gd.**

After irradiation, the terbium radionuclides produced must be purified from bulky target amounts of Gd or, in the case of ^{149}Tb, from concurrently collected nuclides with the same mass of 149 Da. Because of the chemical similarity of neighbouring lanthanides, this separation is challenging. For this purpose, an efficient one-step separation method was developed at PSI, based on cation-exchange chromatography, and a semi-automated procedure established. Up to 150 mg of Gd target can be processed in a day, with a separation yield of 80–90 %. Tb radioisotopes of the highest chemical and radiochemical purity can be obtained in small quantities and in a chemical form useful for radiolabelling reactions. Thus, ^{161}Tb activities up to 7 GBq could be realized, which is suitable for clinical applications, and the radionuclide was successfully applied for the radiolabelling of novel compounds currently undergoing pre-clinical evaluation.

Conclusions

A radiochemical strategy has been developed for the isolation of terbium radioisotopes at PSI, and the production of therapeutic amounts of ^{161}Tb established. It could be demonstrated that this novel therapeutic radionuclide can be made available with high quality (specific activity) and in adequate amounts. The method is also applicable for the production of the radionuclides ^{152}Tb, ^{155}Tb and ^{149}Tb, expected to be useful for the development of novel radiopharmaceutical agents.

Acknowledgements

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Non-homogeneous distribution of radionuclides in proton-irradiated liquid-metal targets

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Liquid heavy metals are possible candidates as target materials for spallation neutron sources. For safe operation, as well as for target handling and disposal, knowledge of the induced radionuclide inventory and its distribution is mandatory. Although the liquid metal flows continuously during operation, homogeneous radionuclide distribution cannot be expected, as several extended investigations on the target materials mercury and lead-bismuth eutectic have shown. This has consequences on the experimental determination of the radionuclide inventory of the MEGAPIE target and the design of future facilities.

A high-power spallation neutron source requires, besides a high-energy, high-intensity proton beam, a heavy metal target for neutron production. Due to the high energy deposition, effective heat removal is essential. One possibility for meeting these requirements is pumping a liquid-metal target material through a circuit and heat exchanger. World-wide, two large-scale facilities are now operating with a liquid mercury (Hg) target: SNS in the US [1] and J-PARC in Japan [2]. Alternative materials are lead-based eutectics, such as lead-bismuth (LBE) or lead-gold (LGE), or pure lead, currently being studied as target material candidates for the future European Spallation Source (ESS) [3]. LBE was tested very successfully at PSI, in 2006, in a feasibility experiment named MEGAPIE [4].

For the safe operation of such a facility, as well as for the handling and disposal of the target, knowledge of the radionuclide inventory is mandatory. Especially for the disposal of the MEGAPIE target, this knowledge is now an open and very urgent issue at PSI. Due to the constant flowing of the liquid metal, homogeneous distribution of the induced radioactivity was expected, opening up the possibility of taking a few samples from the target material for radiochemical analysis and comparing the results with theoretical predictions. Unfortunately it turned out, after lengthy investigations, that homogeneous distribution of most of the radionuclides in liquid metals can definitely not be assumed.

The results of our studies on Hg and LBE will be summarized here and an outlook given on the consequences for the determination of the radionuclide inventory of the MEGAPIE target and for the design of future neutron spallation sources.

Mercury

High-energy-proton irradiated Hg samples containing the complete product spectrum typical for a spallation target were obtained from the ISOLDE facility at CERN. After pouring the Hg out of one of the steel capsules, it was found that most of the radionuclides remained adsorbed on the walls of the vessel in an insoluble chemical state, to an extent of at least 60 %. A further experiment, in which some of the removed bulk

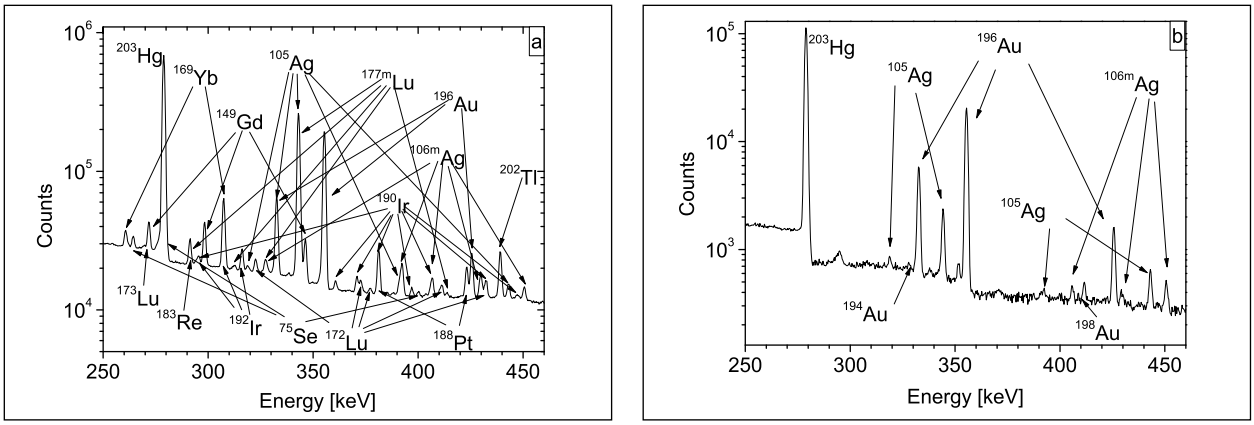

Figure 1: **γ-spectra of Hg removed from the capsule (a) and taken from the bulk (b) (for details, see text).**

volume of Hg was separated with a syringe, showed that nearly all elements that were carried by the liquid metal are not dissolved, but rather adhere to the surface of the Hg sample, with the exception of silver and gold. Figures 1a and 1b show excerpts of the γ-spectra of the Hg poured from the irradiation capsule (a), and a fraction of the same Hg removed from the bulk using a syringe (b) (for details, see [5]). These results are in very good agreement with observations from SNS, where the dose rate of a tube filled with irradiated Hg was measured. After pouring out the Hg, the tube showed a higher dose rate than before. This effect is caused by wall adsorption of radionuclides and the shielding of the opposite wall due to the high γ-ray absorption of the heavy metal mercury.

Lead-Bismuth Eutectic

Model experiments have been performed to study the behaviour of ^{210}Po in solidified LBE. We have found out that polonium – homogeneously distributed in a solid LBE pellet after melting and solidification at the beginning of the experiment – quickly migrates to the surface, leading to an increase in surface activity that can be detected by α-spectrometry (Figure 2) [6].

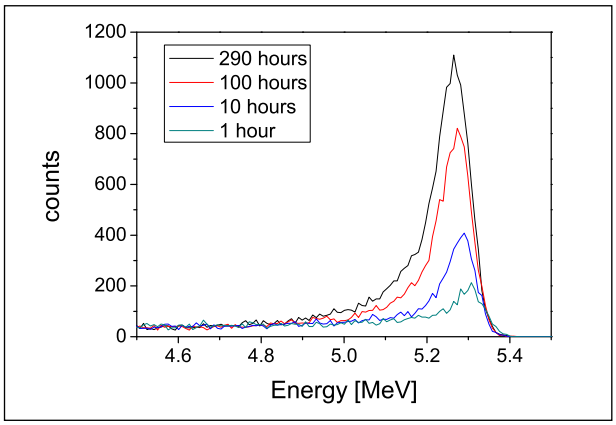

Figure 2: **α-spectra of the LBE grain after 1, 10, 100 and 290 h. Measurement time: 1 h each.**

In preparation for the MEGAPIE experiment, a target containing liquid LBE was irradiated with high-energy protons (1–1.4 GeV) at ISOLDE at CERN, in 2005. After a cooling period of several years, this target was transferred to PSI and now serves as a realistic model for radiochemical MEGAPIE target investigations. For details of the target design, irradiation conditions and sample preparation, see [7]. Examination of samples taken from the bulk phase, the LBE-vacuum interface and a thin layer below this surface showed high enrichment of ^{172}Hf/Lu on the surface (Table 1). Moreover, it was observed that melting of samples does not – as in the case of Po – cause homogenisation, but leads to further surface enrichment of ^{172}Hf/Lu. Model calculations (the last row in Table 1) satisfactorily predict the production of ^{207}Bi, which is rather homogeneously distributed. The predicted ^{172}Hf/Lu production is still in reasonable agreement with the activity found in the bulk; however, the surface enrichment by a factor of 6–7 indicates the importance of the chemical separation processes occurring in the liquid target. The extent of these surface enrichment effects may vary with operating conditions and may also lead to a depletion of radioactivity in the bulk for LBE targets.

Sample position	172Hf/Lu	207Bi
	Asp [kBq/g]	Asp [kBq/g]
LBE-vacuum interface	215	27
100 µm below LBE-vacuum interface	10	15
Bulk LBE	42	31
Calculated, bulk LBE (FLUKA)	33	33

Table 1: **Comparison of calculated bulk specific activity [8] and measured specific activities of ^{172}Hf/Lu and ^{207}Bi, in samples taken from different positions in the target.**

Consequences

In principle, predictions of the total radionuclide inventory of spallation targets, based on model calculations, can differ widely from reality, due to the complexity of the nuclear reactions involved. Moreover, our results show that homogeneous distribution of radioactivity cannot be expected. Theoretical predictions of the distribution are not possible, because of the complexity of the processes and mechanisms involved, which are presently not sufficiently understood. Therefore, experimental determination is the only way to obtain reliable information on the radionuclide inventory and its distribution across the target system. In this respect, extended and careful sampling of the MEGAPIE target within the PIE programme, at about 50 representative positions, including the interfaces to the cover gas and vessel walls, will provide a unique opportunity to analyse the radionuclide distribution in a large-scale liquid-metal target. This knowledge will be extremely valuable for the design of future neutron spallation facilities, for the evaluation of dose rates, shielding, operational safety and environmental impact, as well as for intermediate and final disposal.

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Precise simulations of high-intensity cyclotrons

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Particle losses are one of the main limiting factors in high-intensity particle accelerators. At the PSI facility, with a world-record intensity of 1.3 MW beam power [1], we require beam losses as low as one part in 10^4 to efficiently operate the Ring Cyclotron. To exploit the potential for increasing the beam intensity, and to support the challenging tuning procedures of the cyclotrons, a good theoretical understanding of the mechanisms causing particle loss is required. Results of high-performance computer simulations of the beam dynamics of the PSI cyclotrons have been obtained, together with sensitive measurements in the operating accelerator.

Experiments performed at PSI's high-intensity proton accelerator cover a wide range of applications. They utilize secondary particles, muons and neutrons, which are produced by the interaction of the beam with different targets. The quality and precision of the experiments critically depend on the particle flux, and thus there is an ongoing quest to achieve the highest possible proton beam intensity. During the acceleration phase, a small fraction of the protons may deviate from the ideal beam orbit and generate sparsely populated beam tails. Those particles hit aperture limitations and are lost immediately, or again populate new beam tails by scattering. As a result, accelerator components are activated. Since components must be easily maintained, losses from the proton beam have to be kept below a maximum of ~100 W per location. In practice, the highest losses occur by scattering at the extraction element in the Ring Cyclotron, whereas at other locations, such as beam transport lines, losses may be lower by five orders of magnitude (Figure 1).

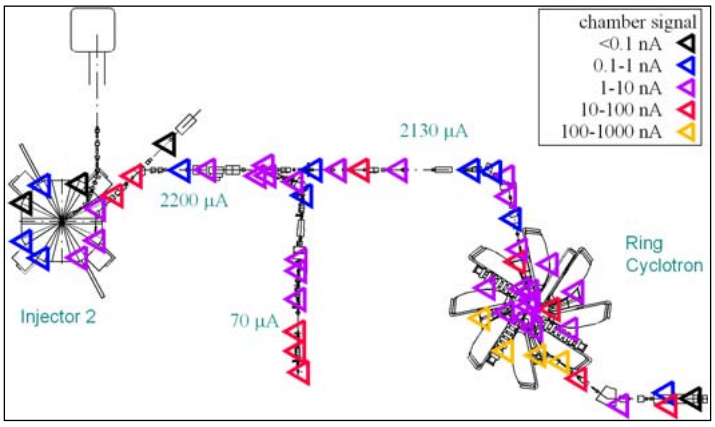

Figure 1: **Ionisation chamber readings as a measure of beam loss at cyclotrons and beamlines.**

For the numerical simulation of particle transport in our cyclotrons and beamlines, collisions between beam particles can be ignored, because typical bunch densities are low. The relativistic equations of motion of the charged particles depend on electromagnetic fields which are, in general, time and position dependent.

The most important non-linear force is a consequence of space charge fields generated by the beam itself. To model these space charge fields, we use a quasi-static approximation, in which the relative motion of the particles is assumed to be non-relativistic in the corresponding rest frame. As a consequence, in this frame, the self-induced magnetic field is practically absent, and hence the electric field can be computed by solving a Poisson problem [2], instead of the full set of Maxwell's equations. We discretise this problem using the particle-in-cell method together with structured and semi-unstructured grids. Direct and iterative methods are used to solve the resulting system of equations for the self-fields [3]. Our main goal is the study of losses over a large range of magnitude, as shown in Figure 1; hence, the tails of the particle distribution must be modelled with sufficient accuracy. Consequently, the simulation has to follow a large number of particles, close to the number of particles in the real beam, for thousands of time steps. This huge n-body problem can only be solved using state-of-the-art numerical methods in combination with high-performance parallel computing [4]. The PSI computational tool OPAL (Object Oriented Parallel Accelerator Library), developed in an international collaboration, enables such large-scale simulations to be made, utilizing thousands of compute cores.

Beam diagnostics is an indispensable tool for delivering proper initial conditions and validating simulation results. At several locations along the beamlines and in the cyclotrons,

beam diagnostic instruments provide information on beam losses and beam current. Furthermore, 1D (horizontal and vertical) and 2D (horizontal–longitudinal and, in the future, also vertical–longitudinal) projections of the density distribution of the beam particles can be measured. A detailed understanding of beam losses requires a description of beam fractions of the order of 10^{-5} of the full beam current, which already cause significant activation of accelerator components. A corresponding dynamic range for the beam diagnostics is required. The loss monitors (ionization chambers, collimators and 4-segment apertures) are already sensitive enough to detect the loss of beam fractions of 10^{-6}, and are the main tools for routine empirical beam tuning. The dynamic range of the 1D projections delivered by the wire monitors is presently, in most cases, limited to 10^3 by the speed of the readout electronics, while some of the slower radial probes reach 10^4 or more. The dynamic range of the 2D projections from the bunch-shape measurements is presently of the order of 10^2 to 10^4, depending strongly on the radiation background at the measurement location [5].

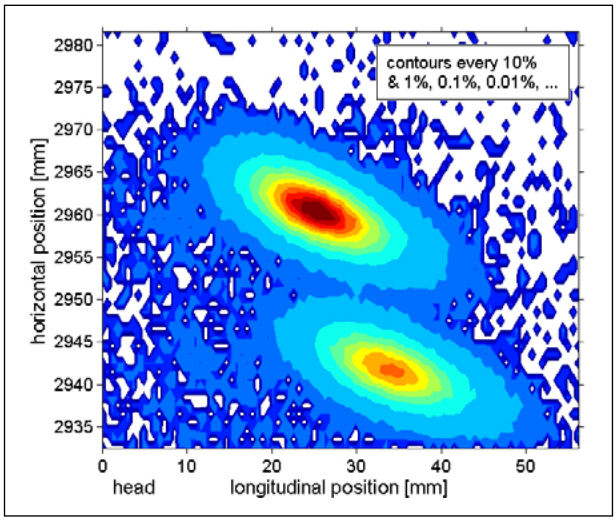

Figure 2: **Measured projections of bunches at the last two turns of Injector 2.**

In the simulations, adjustable parameters, such as the injection conditions or amplitude and phase of the harmonic cavity, are optimized similarly to the way the operators tune the cyclotron during standard operation. In the extraction region, turn separation is maximized and the beam size is minimized. For the simulation of the present production beam, a parameterized analytic 6D initial beam distribution was adjusted to approximately match measured 1D and 2D projections (Figure 2). In simulations from the exit of Injector 2 to the exit of the Ring Cyclotron, very good agreement of simulated and measured intensity profiles for the last 9 turns (180–188) of the Ring Cyclotron has been reached, over four orders of magnitude (Figure 3).

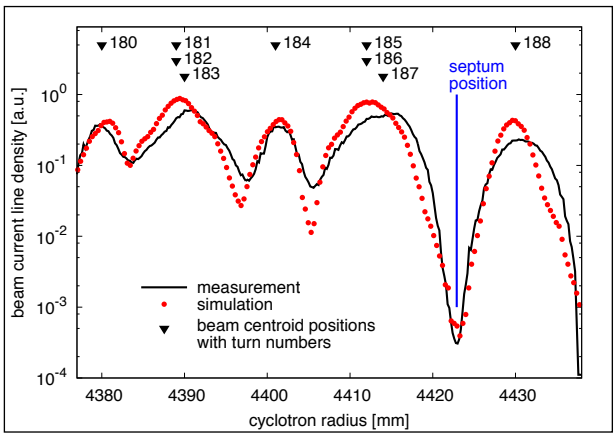

Figure 3: **Radial line density in the Ring Cyclotron.**

For the first time, it has been possible to reproduce experimental observations with this high degree of accuracy and dynamic range. The remarkable success of the numerical methods described opens up new possibilities for further development of the proton accelerator. Future research is oriented towards more-detailed refinement of the initial particle distribution and the introduction of a particle–matter interaction model to include the significant effect of scattered particles. In particular, the model will give us the capability to predict losses and beam distributions for other configurations of the accelerator, including a refined collimation scheme at low energy. Start-to-end simulations, including Injector II, will enable us to consciously configure the machine in order to achieve better matching of beam core and halo, thereby maximizing the clearance of the apertures. This allows higher beam currents with tolerable losses, simplified tuning procedures and more stable operation.

The extremely wide dynamic range achieved in the simulation is crucial for precise beam-dynamics simulations for future projects, for example for accelerator-driven systems requiring proton beams of 10 MW, or more.

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Proton Therapy – expanding horizons

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PSI will remain the only Swiss institution to offer proton therapy as patient treatment modality for several years to come. With increasing evidence of the advantages of proton therapy, the challenges of combining the seemingly conflicting missions at PSI of clinical patient treatment, technological innovation and research ranging from proton acceleration to treatment delivery will increase. However, each team involved continues to work in its own area, while respecting the commitments of the others. The following summary highlights some of the ongoing activities and overall progress made during 2010.

Patient treatment and clinical research

Gantry 1

Gantry 1 and the entire "chain of events" from proton acceleration to treatment delivery continue their unabated success of reliable performance. Our system remains the "best of the industry" in terms of beam availability for treating patients. Overall, 118 patients were treated on Gantry 1 in 2010, more than 1/3 of whom were children, including many infants.

As a new clinical initiative, we have routinely introduced "cranio-spinal axis" irradiation in young children with medulloblastoma. This is considered one of the most promising applications of proton therapy for the growing child, which requires treatment of the entire cranio-spinal axis. Proton therapy is the only radiation modality that avoids the deleterious long-term effects on all the thoracic and abdominal organs that can result from conventional photon treatment. This treatment is time consuming and challenging for the team, but well worth it.

OPTIS eye programme

The eye programme had many reasons to celebrate this year, since it completed its transition from the OPTIS programme (based on Injector 1) to the new OPTIS2 eye room, connected to the COMET cyclotron. The last OPTIS patient – the 5458th – was treated on 12 November 2010 and this ended the more than 25-year era of OPTIS. OPTIS2 is now fully integrated with COMET cyclotron operation. Thanks to the tremendous effort of the entire crew involved in this project, this transition has been essentially seamless and without significant difficulties. In analogy to Gantry 1, OPTIS2 patients are now treated on a continuous basis of approx. 5 to 8 patients per week, compared with the one treatment-week per month schedule on OPTIS. The beam is switched for treatment between Gantry 1 and OPTIS2 routinely every day. By the end of 2010, 47 patients had already been treated on OPTIS2, and Injector 1 has now been shut down.

Clinical research

Continued up-dating of our clinical results reveals increasing long-term evidence of the safety and feasibility of spot-scanning-based proton therapy, pioneered at PSI, and the Institute continues to contribute to worldwide knowledge of appropriate indications of proton therapy. We now consider the present cancer indications as established and have applied to the Swiss Federal Office of Public Health, FOPH, for permanent approval of proton therapy. One of the great challenges over the coming years will be the evaluation of spot-scanning-based proton therapy for common types of cancer, notably for breast cancer, prostate cancer and lung cancer. A clinical trial study for women with loco-regionally advanced breast cancer was recently completed and is ready for patient accrual. A second clinical study on prostate cancer will be completed shortly. The major technological emphasis of the new-generation spot-scanning system will be its application for moving targets (see below). Appropriate protocols for liver and lung cancer are under consideration.

Towards the treatment of moving targets with scanned proton beams

Status report

With an optimized proton scanning Gantry under construction, the treatment of mobile tumours is an ongoing project at the Center for Proton Therapy. An important pre-requisite for organ

motion management is the development of the appropriate tools in the treatment planning system. During the past year, our 4D dose calculation was advanced to take into account non-rigid deformations of the target geometry, as well as density changes. We use a deforming dose grid approach in the 4D dose calculation, which is a fast alternative to the common approach of warping time-resolved dose distributions to a reference phase and does not rely on 4D CT data sets. The required information about the motion can also be taken from 4D MRI data. With long acquisition times of about 1 hour, many breathing cycles can be imaged without any assumption about periodicity. For MRI data acquisition, motion, including baseline shifts, can be studied in patients as well as in volunteers. Over the last year, six 4D MRI datasets have been acquired. Images of the upper thorax, including the lung, were acquired in volunteers, which extents our current liver database to a new region of interest (ROI).

Motion information, either from 4D CT data or from 4D MRI data is extracted by deformable registration. Different deformable registration algorithms lead to different motion maps, which can result in significantly different motion effects in the 4D dose calculation. Over the last year, extensive studies on the accuracy of different deformable registration algorithms in 4D CT datasets for liver have been performed. For some methods, large uncertainties have been found due to the lack of contrast in the liver. The best results for this ROI were found for a demons model in combination with an affine transformation. An evaluation of the performance of deformable registration in treatment areas in the lung is under way and is expected to yield more accurate results, due to enhanced contrast in this ROI. Another subject of research in this context is the sliding organ boundary, resulting in discontinuous displacement maps. The implementation of an approach to overcome this problem during the calculation of our displacement maps is currently under way.

Advanced 4D dose calculations show that, in the incidence of motion, it is not sufficient to use simple target contours defined on one reference 3D CT image. A geometrical target volume definition over all motion phases, with an additional adaptation accounting for proton range variations during the course of treatment, is necessary. In the last year, we have developed a tool to automatically create appropriate target volumes for scanned proton therapy. Work on the further optimization of these target volume definitions, taking into account coverage probabilities, is in progress.

The effect of motion on a dose distribution varies with the motion and plan characteristics. In a first systematic treatment planning study, we have developed a strategy to construct robust treatment plans for mobile target sides, treated with actively scanned/re-scanned proton beams. The investigation of motion effects on intensity-modulated proton treatment (IMPT) plans showed an increasing risk of introducing target dose inhomogeneities with tightening constraints. Ongoing projects are the implementation of motion-managing approaches, such as advanced iso-layered re-scanning and gating. Further advanced 4D treatment planning studies to investigate the large-parameter space are under way.

Alongside progress being made in the completion of the new proton scanning Gantry, the experimental investigation of the treatment of moving target sites is also moving forward. From the 'beam's-eye-view' imaging system (BEV) which is currently installed, we hope to acquire real-time information about the position of a mobile target. To estimate the usability and accuracy of this information, a program to generate digitally reconstructed radiographs (DRRs) from 4D CT data has been developed. These DRRs constitute a first approximation of the expected BEV images. Studies on the extraction of target position from these images are under way.

To verify dosimetric effects shown in the 4D treatment planning studies, an experimental setup to simulate patient motion is needed. An extensive evaluation of commercially available 4D phantoms has been made. It has been decided to purchase the Modus Quasar Platform, which enables freely configurable 1D motion, including a 2D hysteresis effect. In a first step, the influence of 1D motion of up to 1cm amplitude on a re-scanned treatment field will be measured.

Progress made in this project is reflected in two journal papers submitted in 2010, as well as in five presentations given at national and international conferences.

Progress in the development of Gantry 2

Project status

In 2010, most of the time available for the Gantry 2 development was used for completion of the installations in the gantry area. The major steps taken have been the finishing of the inner architecture of the treatment room (Figure 1) and the realization of a dedicated control room near the entrance to the area. For patient positioning, a sliding CT was installed within reach of the gantry table (see Figure 1). This system will allow the patient to be positioned before treatment and the position to be checked afterwards in the room using the gantry treatment table. A "Beam's-Eye-View X-ray" system has been installed on the gantry as well. This system should make it possible to take X-ray pictures in the beam direction, in synchronisation with the proton beam delivery, provided that neutrons arising from protons stopping in the patient do not damage the X-ray panel underneath the table too quickly. The choice of this equipment underlines the main goal of the Gantry 2 project, which is to learn how to treat moving tumours with pencil-beam scanning.

We are now finally in the position where we can rotate the gantry and move the patient table with the motors, although only under local control. Completion of the equipment will allow clinical commissioning to begin soon. Most of the work to be carried out in 2011 will be on providing and testing the safety systems, providing the redundant components of the beam delivery system, implementing the procedures required for positioning the patient, characterizing the pencil beam and the precision of the dose, developing the various quality assurance tools, and learning how to operate the new system. Despite the fact that available beam time has been very limited due to ongoing installation work, it has been possible to continue development work with the proton beam. This report gives an example of some preliminary results for one of the planned advanced beam delivery techniques requiring the use of continuous line scanning with dynamic modulation of the beam intensity. This particular experiment was performed as part of a physics PhD project, submitted in 2010 at the ETH Zurich by S. Zenklusen.

Feasibility of shaped uniform scanning on Gantry 2

This method mimics passive scattering, without the need to use scattering foils. The intention was to show that a scanning gantry can, in principle, simulate passive scattering reasonably well without any change in the basic equipment, even if it is not clear whether there will be a real need for doing so in the future. Our main goal remains the treatment of moving targets with conformal pencil beam scanning not requiring the use of patient-specific hardware. The details of the experiments carried out are given below.

The two sweeper magnets of Gantry 2 were driven at high velocity over a meander path to create homogeneous proton fluence. The uniformly scanned iso-energy dose layers were stacked, resulting in a flat SOBP (layer stacking). The different energy layers were interleaved through energy changes and the volume was painted as often as possible (volumetric repainting). The dose distribution was shaped distally to the target in the same way as with scattering, namely by the use of a collimator and a range compensator. The flexible scanning

Figure 1: **Gantry 2 treatment area nearing completion, with beam nozzle, patient table and sliding CT.**

system of Gantry 2 allows painting of the energy layers according to the collimator shape, with the effect of reducing treatment time and neutron dose. In addition, the shape of the proximal energy layers can be shrunk for better target conformity, similar to that obtained by the conformal pencil beam (see Figure 2).

The energy layers for uniform scanning must be delivered with homogeneous proton fluence (in contrast to conformal scanning, where the layers are highly inhomogeneous and therefore possibly more difficult to deliver). The beam current was controlled by the dynamic vertical deflector plate situated within the cyclotron. A control loop guaranteed that the beam current at the primary dose monitor remained at the desired value. A sphere of 8 cm diameter (¼litre), centred in a 15 cm depth of water, was chosen as target. Two different fields where used, both giving 1 Gy to the target. The box field was chosen to reproduce the dose distribution obtained in conventional scattering, whereas the shrunken field uses the advantage of the active scanning system by adjusting the shape of the proximal layers. Both fields were delivered with continuous line scanning and volumetric repainting.

To measure the dose distribution with a scintillating foil at different depths, various amounts of Plexiglas, in the form of plates, were inserted into the beam. The light emitted by the protons impinging on a scintillating foil was imaged with a CCD camera looking at the screen through a 45° mirror. Images of the dose distribution were taken at 1 cm Plexiglas steps outside the SOBP and at 0.5 cm steps within the target. From the CCD images recorded at different depths of the target (indicated in Figure 2), a strip of 5 pixels of the central region was taken and combined to construct an image along the beam direction (Figure 3).

The resultant images for the box and the shrunken field are shown in Figure 4. Homogeneous target coverage was obtained in both cases. The relative dose difference with respect to the planned target volume is up to 25 % for field shrinking. The shrinking of the scanned field also leads to a reduction of treatment time, from 50 s down to 29 s. This could be important when considering larger irradiation volumes. The energy layers were repainted up to 48 times. This makes us confident that this approach is also very robust in dealing with organ motion.

This example illustrates the inherent flexibility of the new scanning equipment of Gantry 2, which aims to deliver a dose with the highest precision, very quickly and with volumetric repainting. Considering these requirements, initial experience with Gantry 2 has so far been very encouraging.

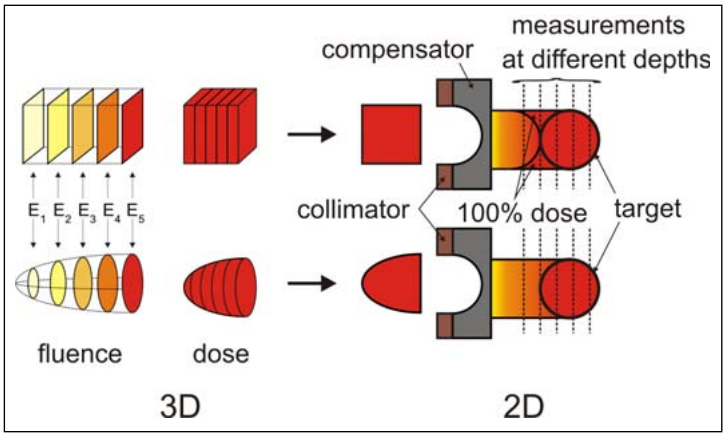

Figure 2: **Layer stacking for a spherical target; the illustration shows how shape shrinking of the more superficial layers can provide better conformity of target coverage.**

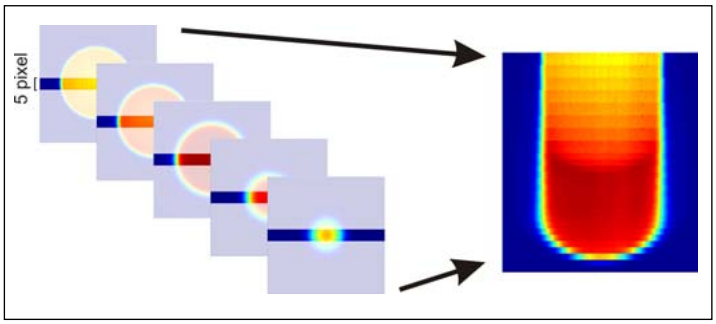

Figure 3: **Dose images (left) measured at increasing depths were combined to obtain a dose image as a function of depth (right).**

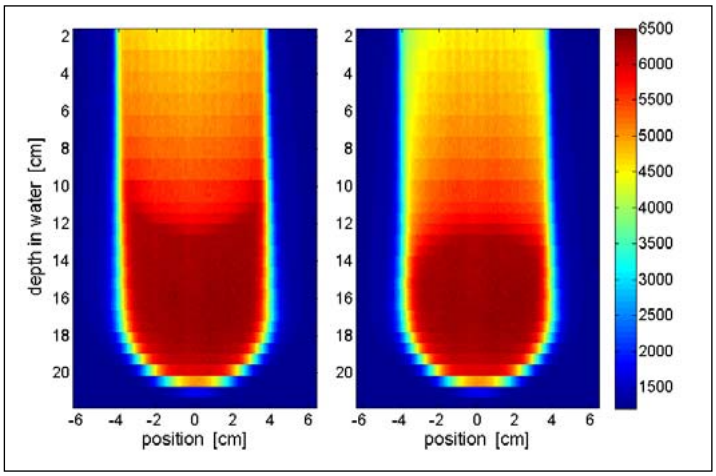

Figure 4: **Constructed images along the beam direction for the two fields, without (left) and with (right) proximal dose conformation.**

Strategy and highlights of General Energy Research

Alexander Wokaun, *General Energy Research Department (ENE), PSI*

Promoting pathways towards a resource-efficient energy system that is compatible with climate-protection goals, the General Energy Department focuses on the technical use of renewable energies, and on the efficient provision of energy services for our society. Production of the energy carrier methane from biomass is complemented by efficient and clean combustion technologies, and the assessment of the atmospheric fate of aerosols. Concentrated solar energy is used to produce hydrogen that serves as fuel in electromobility, which includes advanced batteries for energy storage. Collaboration with the large research facilities of PSI and within the Swiss Competence Center Energy and Mobility are of essential importance when addressing these grand challenges.

Surveying the research performed in the General Energy Department in 2010, several characteristic features can be noticed.

Firstly, all of the laboratories are planning or preparing for large-scale experiments that will address big challenges in the development of our energy system, as appropriate to the mission of PSI. Some of these projects will lead to demonstration plants and pilot units.

Secondly, the development and characterization of functional materials for energy plays an increasingly important role, and PSI's large research facilities are intensively used to support this aim.

Thirdly, researchers strongly engage in collaborations, both internally within PSI and externally in a plethora of European Union projects. As a member of the Executive Committee of the European Energy Research Alliance (EERA), the Department engages in several of the joint programmes launched within EERA.

Fourthly, there is a strong commitment to science and technology transfer, with the aim of achieving impact by fostering industrial innovation.

Thematically, our research supports two of the major elements of the Swiss federal energy strategy, i.e. the technical harvesting of renewable energies and the efficient conversion of energy carriers for the smart provision of energy services. In particular, this comprises the use of bioenergy coupled with clean and efficient combustion devices on the one hand, and the use of solar energy for fuelling alternative powertrains based on electrochemical energy conversion on the other hand.

Bioenergy and Catalysis

Under the new leadership of Oliver Kröcher, this Laboratory has sharpened its strategy for the use of the important biomass resource. The production of methane by hydrothermal gasification of wet biomass has led to the foundation of the spin-off company Hydromethan, which aims at industrial-scale demonstration. Targeting third-generation biofuels, efforts focus on the use of algae as a feedstock which does not compete with other uses.

Catalytic processes and analytical tools have been advanced as key competences. In-situ characterization by X-ray spectroscopy is carried out at the SuperXAS beamline of SLS, and this team is part of the Laboratory.

Energy and Environment (operated jointly by the ENE and SYN Departments)

Jeroen van Bokhoven, as head of this new Laboratory, finalized the set-up of chemical laboratories for his catalysis research. Important mechanistic insights on catalytic mechanisms have been achieved on paragon systems, such as Pd / ZnO, and supported Pt and Pd catalysts for oxidation reactions. The Laboratory is also responsible for the operation of the VUV beamline, run by a research team within the Combustion Research Laboratory.

Combustion Research

Three major thrusts are pursued in this Laboratory. Focusing on the combustion of gaseous fuels in turbines, the characteristics of hydrogen-rich turbulent flames and of catalytic partial oxidation processes are being investigated. Laser diagnostics has contributed important insights (cf. p. 66). Intense preparatory work is ongoing for the realization of a pilot and demonstration unit for syngas production from biomass, to be processed by hot gas cleaning and fluidized bed methanation. Regarding internal combustion engines, the Large Engine Research Facility has been invaluable for implementing processes that will increase the efficiency, and reduce the NO_x emissions, of large marine diesel engines.

Atmospheric Chemistry

Investigations of secondary aerosol particles, both in field campaigns and at PSI's smog chamber facility, are at the centre of this Laboratory's interests. The characterization of the important organic fraction which changes with residence time in the atmosphere was complemented by the relevant insight that the nucleation rate of new particles not only depends on the concentration of sulphuric acid but also on that of oxidized organic molecules (Figure 1). Nucleation induced by ions from cosmic rays was investigated within the CLOUD collaboration at CERN. Addressing climate change, compound specific analysis of stable isotope ratios (CSIA) became available as a powerful new tool for investigating the fate of organic matter, both in plant material and aerosol particles.

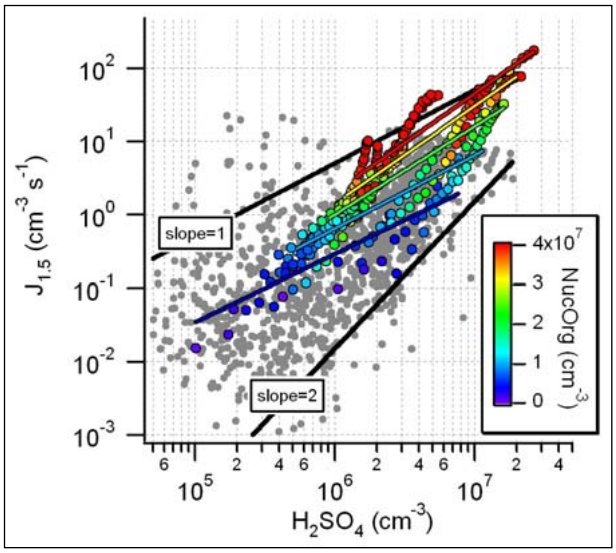

Figure 1: **Nucleation rate of 1.5 nm aerosol particles as a function of sulphuric acid concentration, for various concentrations of co-nucleating organic species. (For details, refer to: A. Metzger et al., PNAS 107, 6646 (2010)).**

Solar Technology

The Solar Technology Laboratory is advancing two major scale-up projects for fuel production, in which solar reactor technologies for the thermal gasification of carbonaceous wastes and the zinc thermochemical cycle will be demonstrated at the 100 –250 kW scale in 2011. Exploratory research targets the co-reduction of CO_2 and H_2O by solar processes, with syngas production aiming at CO_2-neutral liquid fuels.

Electrochemistry

Fundamental and application-oriented research in this Laboratory is bearing fruit in two important technology transfer projects, as described on p. 68: The storage section became a founding member of an international, industrially-funded battery research network, and an advanced 25 kW fuel cell system has been completed within the Belenos partnership. In 2011, the Laboratory will welcome Thomas Schmidt, who will take responsibility as the successor of Günther Scherer from 2012.

Energy Systems Analysis (operated jointly by the ENE and NES Departments)

Scenarios for the future energy systems of Switzerland are of high current interest, in particular concerning the role of large power plants and the emergence of electromobility. Environmental and economic modelling within the Energy Systems Analysis Laboratory has contributed important insights in this regard.

Outlook

Plans for 2011 include exploratory studies targeting the production of liquid fuels and chemical feedstocks from biomass, and the solar themochemical reduction and recycling of CO_2 powered by solar energy. Fundamental studies of electrocatalysis will be reinforced. These basic studies are complemented by scale-up projects in solar chemistry, feasibility studies for pilot and demonstration units in biomass utilization, and new facilities, including a mobile smog chamber to be used in field experiments.
Efforts will be devoted towards securing a financial basis for continuing and expanding collaborations within the Competence Center Energy and Mobility (cf. p. 70). Last but not least, PSI and its energy departments intend to provide major technological input into the Swiss Cleantech initiative, as well as to the Hightech initiative of Canton Aargau.

A Niobia-Ceria based multi-purpose catalyst for diesel exhaust gas after-treatment

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In order to meet increasingly tight automotive emission limits, complex and large catalytic exhaust gas after-treatment systems are required. In this context, a new multi-purpose niobia-ceria based catalyst has been developed at PSI that simultaneously shows high NO_x reduction efficiency and promotes good soot oxidation. This will allow significant simplification and decrease in the volume of future after-treatment systems.

Introduction

Over the past few decades, increasingly severe regulations have been introduced to reduce and control the emissions of industry, power plants and transport. Regarding automotive emissions, specific limits have been set for four major pollutants: carbon monoxide (CO), unburnt hydrocarbons (HC), particulate matter (PM) and nitrogen oxides (NO_x). Significant reduction of pollutant emissions has been obtained by engine modifications and the improvement of fuel quality, but for meeting the latest emission limits, the introduction of exhaust gas after-treatment technologies has been necessary. For future diesel vehicles, a typical after-treatment system will consist of: (i) a diesel oxidation catalyst (DOC) for CO and HC removal, (ii) an NO_x reduction system and (iii) a diesel particulate filter (DPF).

Among NO_x removal technologies, selective catalytic reduction (SCR) of NO_x with NH_3 has been successfully applied for stationary applications, and recently also for heavy-duty diesel vehicles [1]. For light-duty vehicles, its use is restricted by the complexity and large dimensions of the SCR system, which must incorporate a tank for an aqueous urea solution (NH_3 precursor), a urea hydrolysis catalyst and possibly an NH_3 slip catalyst. Other critical factors are the limited hydrothermal stability and potentially toxic emissions of currently available SCR catalysts [2, 3].

A new, multi-purpose niobia-ceria (NbCe) based catalyst has been recently developed in the Bioenergy and Catalysis Laboratory at PSI that shows high NO_x reduction efficiency, remarkable urea hydrolysis activity and good promotion of soot oxidation [4]. The combination of these properties allows the exhaust gas after-treatment system to be significantly simplified and decreased in volume, as NO_x reduction and particle filtration can be combined in a single device (Figure 1).

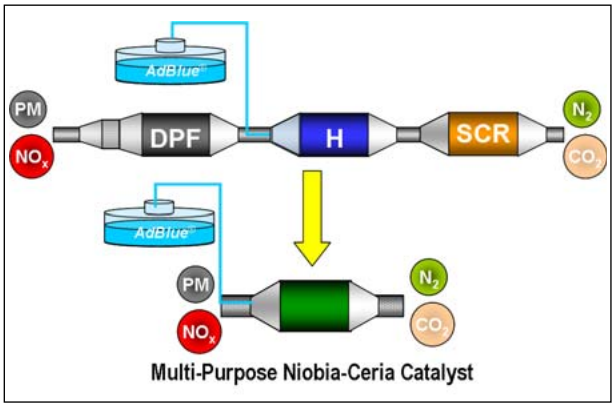

Figure 1: **From three exhaust gas after-treatment components to one by means of a NbCe catalyst.**

Experimental

The SCR activity of catalyst-coated cordierite monoliths has been determined in a quartz plug-flow reactor with a feed of 10 % O_2, 5 % H_2O, 0 – 1000 ppm NO, and 0 – 1500 ppm NH_3 in N_2. The concentrations of NO, NO_2, N_2O and unreacted NH_3 were measured with an FTIR spectrometer. As reference systems, a conventional V_2O_5/WO_3-TiO_2 and a commercial Fe-ZSM-5 catalyst were used, referred to as VWTi and Fe-ZSM-5, respectively.

The hydrolysis of urea and tests of urea-SCR activity were carried out in a plug-flow glass reactor, designed in-house and equipped with a two-component nozzle for the dosage of the liquid urea solution.

Soot oxidation tests were performed in a Thermogravimetric Analyzer (Mettler-Toledo), redesigned in-house and coupled with an FTIR spectrometer. Printex U (Evonik) was used as model soot in a 1:20 weight ratio with NbCe.

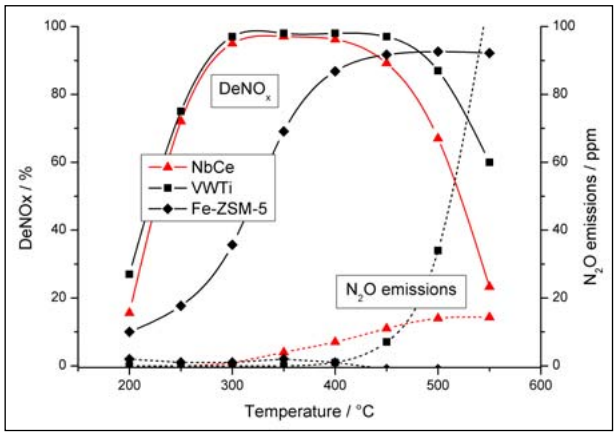

Figure 2: **NO_x removal (DeNOx) and N_2O emissions for NbCe, VWTi and Fe-ZSM-5.**

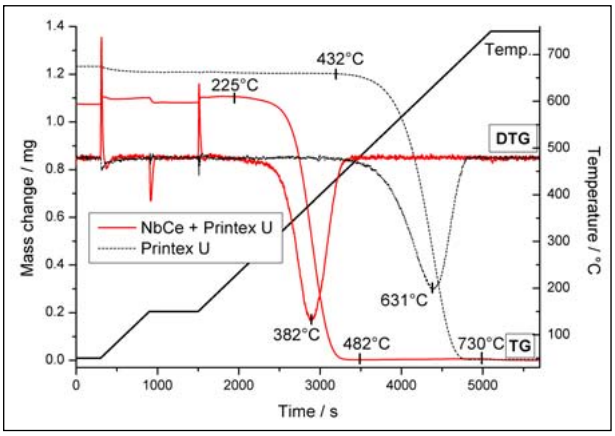

Figure 3: **TG and DTG curves recorded during Printex U oxidation with (full line) or without (dotted line) NbCe.**

Results

SCR of NO with NH_3

Figure 2 shows NO_x conversion and N_2O emissions measured at $\alpha = NH_{3,in}/NO_{in} = 1$ for the NbCe catalyst, and compared to the references VWTi and Fe-ZSM-5. Remarkably high performance, similar to that of VWTi, was obtained for the new NbCe catalyst at 250 – 450°C.

Moreover, the N_2O concentration remained below 20 ppm, even at 550°C, whereas it exceeded 100 ppm for VWTi. The SCR activity determined for the Fe-ZSM-5 commercial catalyst below 400°C was much inferior to that found for NbCe.

Urea hydrolysis

The first step of urea conversion to NH_3 is mainly thermally driven and leads to the formation of equimolar amounts of NH_3 and HNCO. For the second step, a catalyst is required to hydrolyze the HNCO to NH_3 and CO_2. Even if a slightly larger $DeNO_x$ catalyst is needed to fulfil the two tasks of urea hydrolysis *and* SCR, this may be preferred in comparison to the use of a separate urea hydrolysis catalyst.

Over the NbCe catalyst, the hydrolysis of urea reached completion above 180°C. With decreasing temperatures, the urea slip only increased to 23% at 150°. This catalytic activity is slightly superior to that recorded for a conventional TiO_2 urea hydrolysis catalyst. Moreover, the urea-SCR tests indicated that the SCR and hydrolysis functions may be accomplished by the NbCe catalyst without any additional increase of the catalyst volume.

Soot oxidation

To avoid high thermal stress in a DPF during the burning of accumulated soot particles, the regeneration temperature may be lowered, either by adding a catalyst precursor to the fuel or by catalyst-coating of the particulate filter. CeO_2-based materials are known to be highly active in the soot oxidation reaction and this property was also presumed for the NbCe catalyst. Figure 3 shows the TG and DTG curves (after blank run subtraction), recorded during calcination of the pure and mixed Printex U and NbCe samples. The obtained data revealed the outstanding activity of the NbCe catalyst for soot oxidation. A decrease of about 250°C was observed for the combustion reaction onset temperature in the presence of the NbCe catalyst.

Outlook

The niobia-ceria catalyst exhibits remarkably high activity for NO reduction with NH_3 and may simultaneously provide excellent urea hydrolysis and good soot oxidation. Since this is only the first generation of a forthcoming multi-purpose catalyst series, the possibility of further increasing its performance and stability by precise screening of the catalyst composition can also be considered if NbCe is regarded as a potential alternative to conventional VWTi or Fe-ZSM-5 catalysts.

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High-flux solar-driven thermochemical dissociation of CO_2 and H_2O using ceria redox reactions

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This research project is aimed at developing the solar process technology for thermochemically producing liquid hydrocarbon fuels from water, CO_2, and solar energy. In the work presented here, the oxygen uptake and release capacity of cerium oxide at elevated temperatures have been combined to thermochemically dissociate CO_2 and H_2O via a solar two-step redox cycle. Stable and rapid generation of fuel (CO and H_2) has been demonstrated with a 2 kW solar reactor subjected to a solar flux concentration of 1,500 suns. Solar-to-fuel energy conversion efficiencies of 0.7 to 0.8 % have been achieved and shown to be largely limited by the system scale and design.

Long-term storage and long-range transport of the vast, yet intermittent and unevenly distributed, solar energy resource is essential for a transition away from fossil energy. Liquid fuels, derived from CO_2 and H_2O, offer exceptional energy density and convenience for transportation, but their production using solar energy input has remained a grand challenge. Solar-driven approaches to thermochemical CO_2 and H_2O dissociation inherently operate at high temperatures and utilize the entire solar spectrum; as such, they provide an attractive path to solar fuel production at high rates and efficiencies in the absence of precious-metal catalysts. Cerium oxide (ceria) has emerged as a highly attractive redox active material choice for two-step thermochemical cycling, because it displays rapid fuel production kinetics and high selectivity, where such features result, in part, from the absence of distinct oxidized and reduced phases. The two-step H_2O/CO_2-splitting cycle over a nonstoichiometric oxide is described by:

high-temperature reduction step:

$$\tfrac{1}{\delta}MO_2 \rightarrow \tfrac{1}{\delta}MO_{2-\delta} + \tfrac{1}{2}O_2(g) \quad (1)$$

low-temperature fuel (H_2) production step:

$$H_2O(g) + \tfrac{1}{\delta}MO_{2-\delta} \rightarrow \tfrac{1}{\delta}MO_2 + H_2(g) \quad (2a)$$

low-temperature fuel (CO) production step:

$$CO_2(g) + \tfrac{1}{\delta}MO_{2-\delta} \rightarrow \tfrac{1}{\delta}MO_2 + CO(g) \quad (2b)$$

where M in the present case is Ce or a combination of Ce and a dopant element.

The solar reactor for performing this cycle is schematically shown in Figure 1. It consists of a cavity-receiver with a small windowed aperture for the access of concentrated solar radiation. A porous, monolithic ceria cylinder is placed inside the cavity and subjected to multiple heating-cooling cycles with the appropriate gases to induce O_2 evolution and fuel production. Reacting gases (H_2O and CO_2) flow radially across the porous ceria, while product gases (H_2 and CO) leave the cavity through an axial outlet port. Experimentation was carried out at PSI's High-Flux Solar Simulator, with a 2 kW solar reactor prototype subjected to solar concentration ratios of

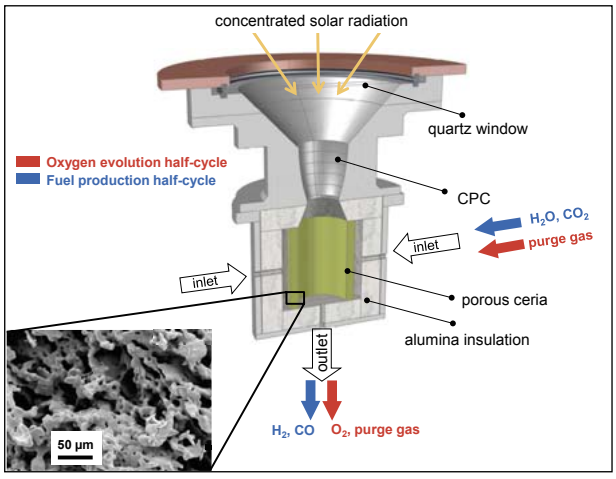


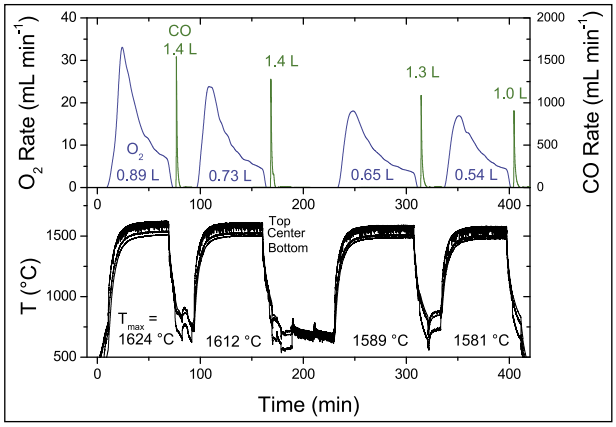
Figure 1: **Schematic of the solar reactor for the two-step, solar-driven thermochemical production of fuels. Inset shows the scanning electron micrograph of the porous ceria tube after 23 cycles. The red arrow indicates ceria reduction (Eq. 1); the blue arrow indicates oxidation (Eq. 2a/2b).**

1,500 suns (1 sun = 1 kWm^{-2}), typical of a commercial solar dish or solar tower system.

Figure 2 shows a representative solar run for splitting CO_2 (Figure 2a) and H_2O (Figure 2b). To drive oxygen-evolution (Eq. 1), the solar reactor was purged with Ar (p_{O2} =10^{-5} atm) and heated to 1,580–1,640°C, yielding a peak rate of 34 ml/

min (STP). Upon cooling to ~900°C, CO_2 or H_2O was injected into the solar reactor, resulting in the immediate production of CO (Figure 2a) or H_2 (Figure 2b) at peak rates of 1.5×10^3 and 0.76×10^3 ml/min (STP), respectively. A total of 23 cycles were performed.

(a)



(b)

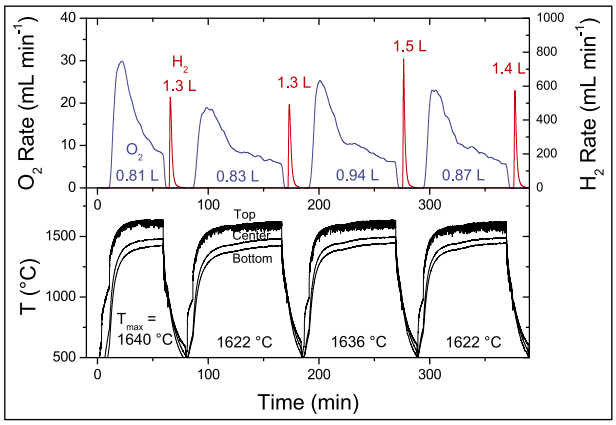


Figure 2: **Thermochemical cycling of ceria (325 g) using the solar reactor with (a) CO_2 and (b) H_2O as oxidant. The oxygen and fuel evolution rate, total volume of gas evolved, and maximum temperatures attained in the reactor are shown.**

The solar-to-fuel energy conversion efficiency is defined as the high heating value of the fuel produced divided by the sum of the incident solar power input through the reactor aperture and the power required to recycle the inert purge gas. Based on the experimental data, the peak instantaneous efficiencies for CO_2 and H_2O dissociations reached 0.8 % and 0.7 %, respectively. No heat recuperation strategy was employed. These experimentally-measured efficiencies reflect the cycle irreversibilities due to intrinsic material properties as well as solar reactor design and operation. An energy-balance analysis reveals that 50 % of the energy loss resulted from heat conduction through the reactor wall and 41% resulted from re-radiation through the aperture. The former energy penalty can be dramatically reduced by improving the thermal insulation and by scaling up to increase the volume-to-area ratio. The latter can be minimized by augmenting the solar flux such that the aperture size can be reduced. A thermodynamic analysis indicates that efficiency values in the range of 16–19 % are attainable. Thus, with reactor optimization and system integration, significant increases in both efficiency and fuel production rates are anticipated. Beyond efficiency, material stability is an essential criterion for a viable thermochemical process. Using the differential reactor system that enables rapid access to multiple cycles, stable fuel production was shown over 500 thermochemical cycles without interruption.

In summary, the feasibility of a solar-driven thermochemical cycle for dissociating H_2O and CO_2 utilizing non-stoichiometric ceria has been demonstrated in terms of materials, reaction rates, cyclability, reactor technology, and energy conversion efficiency. Essential to this demonstration is a simple and scalable reactor design using porous ceria directly exposed to concentrated solar radiation that enables high-temperature heat transfer to the reaction sites, as required for performing both steps of the cycle. Both the efficiency and the cycling rates in the reactor were limited largely by thermal losses, resulting from conductive and radiative heat transfer. The results provide compelling evidence for the viability of thermochemical approaches to solar fuel generation, while clarifying the efforts required to transform the concept into a central technology in a sustainable energy future.

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PSI's Solar Facilities accredited as an EU User Lab

The solar concentrating research facilities at PSI belong to the EU network *SFERA – Solar Facilities for the European Research Area* – which provides access and funding to researchers from industry and academia. In 2010, users of our High-Flux Solar Simulator included Siemens, Germany, for testing high-temperature components for concentrating solar power, and IMDEA-Energy, Spain, for experimentally evaluating storage materials for solar thermal energy.

http://sfera.sollab.eu/.

Characterization of combustion processes by laser spectroscopic measuring techniques

Alexey Denisov, Walter Hubschmid, Peter Radi, *Combustion Research Laboratory, PSI*

Laser spectroscopic investigations in the Combustion Research Laboratory at PSI follow two paths: To develop spectroscopic measurement techniques for combustion, and to determine data on chemical species and reactions with relevance to combustion processes. In this overview article, 2D temperature measurements by means of laser-induced fluorescence of seeded NO are described. The second section presents measurements of the sound absorption in H_2 in the MHz domain by laser-induced gratings that yield data on the rotational-translational relaxation. Finally, the first observation of the energetically lowest-lying high-spin state of C_2 by two-colour four-wave mixing is reported. The investigation explains a long-standing mystery in the spectroscopy of this important species.

2D temperature measurements with NO LIF

Temperature is one of the key parameters in combustion and much effort is spent on developing a reliable technique of non-intrusive thermometry. One of the approaches is to study the population of molecular rotational levels using laser-induced fluorescence (LIF). Nitric oxide is an attractive target for such measurements, because of its stability over a wide range of temperatures. Using an intensified CCD camera, we recorded spatially-resolved spectra of NO and fitted them with LIFSIM [1] to obtain temperature. Measurements were performed in a channel-flow reactor and results compared with state-of-the-art 2D simulations.

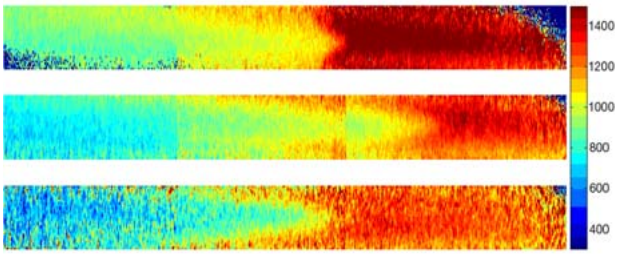

Figure 1: **Temperature distribution inside a channel-flow reactor for a methane/air flame at 3/5/10 bar (top/middle/bottom). Vertical scale is 10 times the horizontal; temperature scale: 300 K < *T* < 1500 K.**

Even though the precision deteriorates as the pressure is increased, the implemented method of thermometry using seeded NO LIF has proven to be accurate and precise within at least 50 K (which is comparable to established 1D methods such as CARS). The method is generally applicable over a wide range of flame conditions, although care should be taken in cases when the doped NO can have a (significant) effect on the kinetics of fuel oxidation.

Translational-rotational energy transfer observed via electrostrictive laser-induced gratings

We showed in our investigations that the technique of electrostrictive laser-induced gratings (LIG) is well suited to investigating dispersion and absorption of sound in gaseous media. As LIG is a time-resolved technique, experimental data contain more information on these processes than the standard techniques. This is especially useful for frequency domains where translational and internal degrees of freedom are not in thermal equilibrium with each other. Under such conditions, periodic heat transfer between translational and intra-molecular energy occurs, which changes the velocity and absorption of sound. Conversely, from determining macroscopic parameters such as sound velocity, sound absorption and related quantities, data on the energy transfer between the different degrees of freedom can be inferred.

Experiments were performed in H_2 at pressures between 0.5 and 5 bar. The sound frequency was about 14 MHz. In this domain, translational and rotational degrees of freedom are not in equilibrium with respect to each other. Especially at the lower pressures, we observed that odd-numbered peaks in the temporal evolution of the LIG intensity are strongly enhanced compared with the even-numbered peaks [2].

To model the observed behaviour, the linearised fluid dynamics equations were completed with equations for the rotational state relaxation, separate from the average relaxation of the states for ortho-H_2 and para-H_2. Figure 2 shows the experimental results of the time-resolved LIG intensity, when using H_2 at a pressure of 1 bar, in comparison with the modelled curve.

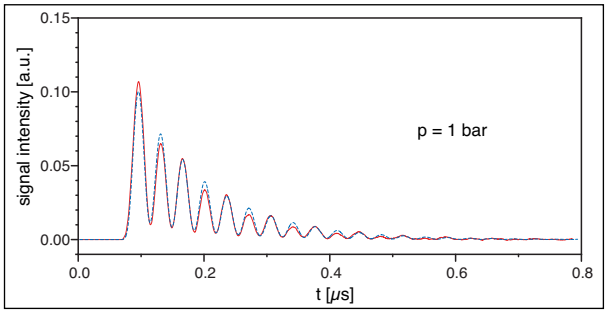

Figure 2: **Temporal evolution of LIG intensity of H_2. Solid red line: experimental data; dashed blue line: simulation.**

It was observed that the model proposed does not reflect the whole phenomenology that is observed. There is approximate agreement between model and data for the observed dispersion and for the absorption of sound in dependence on the pressure. However, the enhancement of the odd-numbered peaks in the temporal evolution of the LIG intensity predicted by the model is much lower than that for the even-numbered peaks, when compared with the measured data.

Shedding light on a dark state; the energetically lowest high-spin state of C_2

The Swan band emission between 400 and 700 nm is a prominent feature in all carbon-containing flames. The intense d $^3\Pi_g$-a $^3\Pi_u$ electronic transition is widely used to detect the molecule in combustion and astronomy studies to characterize and test chemical mechanisms. The quantitative interpretation of the spectra requires precise molecular constants for the computation of the complex molecular spectra of C_2.
We performed a de-perturbation study of the d $^3\Pi_g$, v=6 state by double-resonant four-wave mixing [3]. The high sensitivity and dynamic range of the method allows observation of "extra lines". These weak spectral features originate from adjacent, optically-dark states that gain transition strength through the perturbation process. The study unveiled the presence of the energetically lowest high-spin state ($^5\Pi_g$) in the vicinity of the $^3\Pi_g$, v=6 state and unravels major issues of the so-called high-pressure bands of C_2. The anomalous non-thermal emission initially observed in 1910 [4] and later in numerous experimental environments are rationalized by taking into account "gateway" states, i.e. rotational levels of the $^3\Pi_g$, v=6 state that exhibit significant quintet character through which all population flows from one electronic state to the other [5].

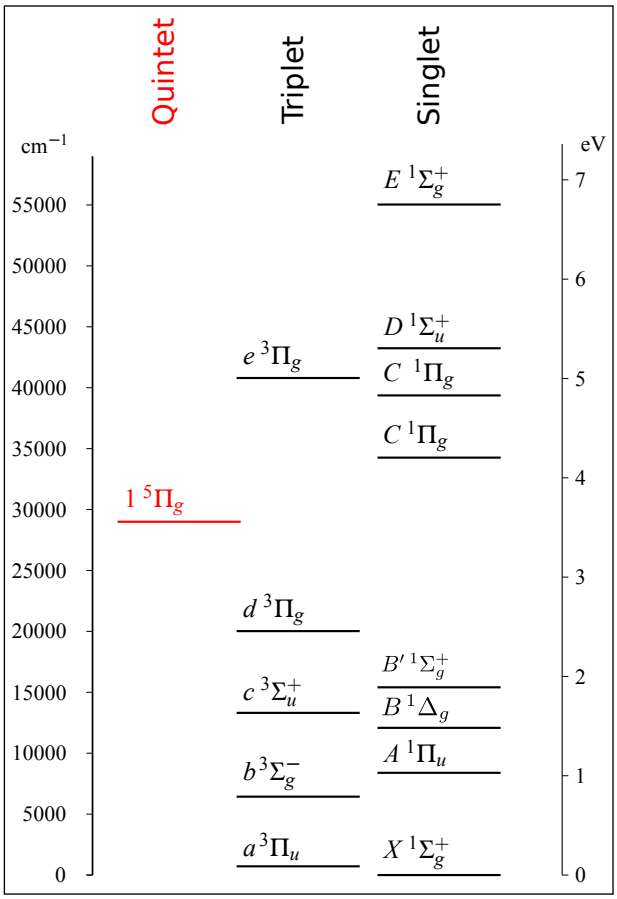

Figure 3: **Low-lying electronic states of C_2. The singlet, triplet and quintet manifolds are indicated relative to the X $^1\Sigma_g^+$, v"=0 state. The $^5\Pi_g$ state is a dark state, not accessible by direct optical methods and characterized for the first time in this work.**

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Today's technology transfer projects based upon past fundamental insights

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Philipp Dietrich, *CCEM, PSI*

Based upon broad knowledge in the field of electrochemical energy research, acquired through research activities over many years, PSI's Electrochemistry Laboratory was able, in the year 2010, to announce first results of its collaboration with Belenos Clean Power Holding in developing an H_2/O_2 fuel cell system for future automotive application. Furthermore, the Laboratory became a founding member of the BASF international research network on future battery systems for electromobility, which will considerably strengthen its effort in the research and development of electrochemical energy storage devices.

For many years, the Electrochemistry Laboratory [1] of PSI has been performing research and development in various fields related to electrochemical energy storage and conversion devices. In particular, these activities concern Li-ion batteries, supercapacitors, and polymer electrolyte fuel cells (PEFCs). Applications towards sustainable mobility were, and are, in our focus.

From the very beginning, our approach has expressed itself at various levels, and obtaining a fundamental understanding of the materials science of electrodes and electrolytes provides the basis for assembling these materials into cells of technical interest. Ex-situ and in-situ diagnostics methods, in part carried out at PSI's large facilities SLS and SINQ, continuously accompany the optimization of cells with respect to various performance aspects, e.g. power density, energy density, longevity, and cost. As a consequence, PSI's Electrochemistry Laboratory has acquired an impressive record in the scientific literature and is highly recognized in the scientific and technical community.

This comprehensive approach has triggered national and international industry to collaborate with us in many projects in the past. Recently, two major projects in the area of polymer electrolyte fuel cells and Li-ion batteries were announced to the public and will be at the focus of the Laboratory's work during the next few years.

Figure 1: **H_2/O_2 polymer electrolyte fuel cell system developed in collaboration with Belenos Clean Power AG, Biel, Switzerland.**

H_2/O_2 polymer electrolyte fuel cell systems

Based on know-how acquired in two previous automotive projects, a novel H_2/O_2 fuel cell system was designed, built, and successfully demonstrated, up to now in laboratory bench experiments, in collaboration with Belenos Clean Power AG, Biel, Switzerland. This fuel cell system is targeted for use in a hybrid configuration, together with an electrochemical storage device, as an automotive powertrain unit.

An H_2/O_2 PEFC system offers several advantages in comparison to a "conventional" H_2/air system, such as higher specific power, higher efficiency, higher power dynamics, easier water management, lower stress influence exerted by the environment (altitude, humidity, air pollution), and lower balance of plant consumption (no air compressor) [2].

Assessing the importance of this development, on 6 January 2011 the Swiss Federal Office of Energy, Bern, awarded the Watt d'Or 2011 prize in the "Energy-efficient mobility" category to PSI and Belenos Clean Power AG for this joint effort [3].

Advanced battery concepts

During the course of the year, the Laboratory became part of the BASF international research network on future battery systems for electromobility, as announced by BASF to the public on 11 August 2010 [4].

Figure 2: **Partners of the BASF international research network "Electrochemistry and Batteries" on the occasion of the kick-off meeting at BASF AG, Ludwigshafen, on 11 August 2010.** (Photo: BASF)

The founding academic partners of this research network were Prof H. Gasteiger, TU Munich, Prof. J. Janek, Univ. Giessen, Prof. D. Aurbach, Bar-Ilan Univ., Israel, and Prof. P. Novák of our Laboratory. According to BASF, leading scientists in electrochemistry, and in battery research in particular, have been brought together in a joint development to focus on common goals. Further partners will join in the future.

Novel materials and functional components for future battery types are at the focus of this joint research, for example Lithium-Sulphur and Lithium-Air batteries. Long-term exploration of these advanced systems is expected to yield batteries with higher energy densities compared with today's battery technologies for electromobility.

Conclusion

During the course of 2010, impressive progress in the important technology transfer project with Belenos Clean Power AG was demonstrated. The fuel cell system that has been developed will serve as the main component in a future hybrid powertrain.

In addition, several collaborations with industry continued in the area of in-situ diagnostics of electrochemical cells, in particular utilizing the neutron imaging beam lines at PSI's large facility SINQ.

Being an academic founding member of the BASF international research network to explore future battery concepts for automotive applications confirms the high-quality of the research carried out in the Laboratory in the area of electrochemical energy storage systems, in particular in batteries.

The implementation of these and other technology transfer projects is based on long-term fundamental research in several areas of electrochemical energy storage and conversion, carried out in the past with major support from public funding agencies, in particular during their start-up phases. These have allowed to the Laboratory to build up its current reputation over the past few years and, as a consequence, become a competent partner for industry.

Today and tomorrow, parallel to these technology transfer projects, strong efforts are continuing in fundamental research on the electrochemical energy conversion and storage devices mentioned above, to pave the way for future collaboration with industry and, in a joint effort, bring these advanced technologies to the marketplace [5].

In particular, new materials such as ionic liquids and graphene are being investigated as potential future electrolytes and electrode materials, respectively. Ionic liquids, which represent a special class of electrolytes, open the way for new electrochemical reactions, in fields such as electro-catalysis, synthesis, metal deposition, and energy storage. Graphene, with its unique properties [6], may serve as an active or supporting electrode material in all electrochemical storage and conversion devices, improving energy as well as power density.

These new research fields currently pursued in the Electrochemistry Laboratory will guarantee a sound basis for future technology transfer projects.

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Competence Center Energy and Mobility, CCEM – Results of the first completed CCEM projects

Philipp Dietrich, Alexander Wokaun, *Competence Center Energy and Mobility CCEM, Switzerland*

In 2010, the Competence Center Energy and Mobility, CCEM, completed the first group of research projects that profited from the newly installed infrastructure that had been co-financed by CCEM. Several research groups then took advantage of the synergies and networks that had been developed, and submitted proposals for continuing research on questions addressed in the first phase. An impressive presentation at the SwissBau trade fair showed the results of investigations within the 'House 2000' project, with an energy-autonomous, 2-person housing module. At the Energietagung conference on global climate protection, held at PSI, a lively debate was initiated on the potential of technologies for reducing greenhouse gas emissions.

In the current national discussion on Cleantech as a cross-disciplinary task in many economic fields, a collaborative approach is very important. In energy research, interdisciplinary collaboration has been established as being essential and has also been recognized as the "best practice" approach. Cleantech can profit from this experience in other fields where interdisciplinary effort is needed. CCEM therefore views this approach as a key prerequisite for all of its projects.

CCEM strives to foster research in the fields of energy generation, conversion, transmission and usage, and is well positioned to share its experience and results within the larger context of the Cleantech initiative. Among other measures taken in 2010, CCEM particularly focused its efforts on:

- maintaining a transparent and proven process for facilitating interdisciplinary projects, emphasizing high standards of scientific quality,
- concentrating research efforts on dedicated questions and large challenges in the field of energy,
- providing access to cutting-edge infrastructure for energy research within the ETH domain and beyond, and continuously upgrading such infrastructure for the benefit of its projects.

CCEM published a call for research proposals in October 2010. Several new proposals were submitted, with the evaluation process still ongoing.

Infrastructure in routine operation

The major infrastructure set in place within several first-wave investment projects is used within, and also beyond, the specific projects supported by CCEM. In particular, this includes the following facilities and pieces of equipment:

- *FIB plus nano-indenter:* The Focused Ion Beam (FIB) and nano-indenter have been installed at PSI in a controlled area, which also allows irradiated samples to be prepared and examined. At Empa, a nano-indentation device for a scanning electron microscope (SEM), as well as a Dual-Beam FIB prototype, have been installed and are in routine operation for various research groups.
- *LERF:* The Large Engine Research Facility (LERF) is a test bench installed at PSI for combustion research, with a 6-cylinder internal combustion engine of 1.08 MW nominal power.
- *Transient test bench:* At Empa, a highly dynamic test bench for up to 4000 Nm torque has been installed and equipped with standard exhaust gas analytics.
- *Fast exhaust-gas sampling system:* At ETH Zurich, a very fast gas-sampling system for in-cylinder and near-cylinder measurements has been made available, which can be synchronized with the combustion process.
- *FTIR:* A mobile device was commissioned for analysing combustion exhaust gases by Fourier Transform Infra-Red spectroscopy (FTIR) and is used at both PSI and Empa, at several test benches. Operation with this instrument is characterized by very low calibration gas consumption and therefore low operational costs.

In the coming years, CCEM will also invest in specific dedicated equipment required for addressing topical research questions.

Results of collaborative projects

So far, twelve investment and research projects have been completed within the CCEM framework, and PSI has participated in the HY.Change, CEMTEC, CELADE, NEADS and LERF projects in the field of mobility, and in the PHiTEM, GT-CO_2 mitigation, WoodGas-SOFC (Integrated Biomass – Solid Oxide Fuel Cell Cogeneration) and Second-Generation Biogas projects in the field of electricity production. Exemplifying the results obtained, one of the projects involving a PSI research group is outlined below. Groups are active in the areas of mobility, electricity and renewable fuels, and detailed reports on these projects can be found in [1].

In the *WoodGas-SOFC* project, several questions on the energy conversion chain from biomass to electricity were investigated. Firstly, the producer gas composition was measured and analysed at wood-fired combined heat and power plants. Secondly, the effects of trace gas poisoning on the nickel anode catalyst of the SOFC were analysed. Thirdly, the system layout for a wood-to-electricity plant was optimized, including the necessary hot-gas cleaning. Finally, a small-scale (1 kW) demonstration plant was operated for 1200 hours.

At the wood-fired power station at Kleindöttingen, Switzerland, trace compounds were measured online at the gasifier using an ICP-OES (Inductively Coupled Plasma – Optical Emission Spectroscopy) measuring system, adapted for this purpose at PSI. All relevant elements (except for V) can be detected and traced continuously for hours. Examples of trace measurements for 14 elements (S, Cl and 12 metals) are given in Figure 1. This Figure shows, in particular, the signal stability over several hours of sampling (cf. the error bars) and the differences between regular scrap wood and additive-charged wood (richer in metals).

At PSI, a complete laboratory pilot unit was set up, consisting of a wood-pellet gasifier, cleaning and monitoring equipment, further fuel treatment components (tar cracker, fuel methanator), and gas outlets for fuel-cell test beds (Siemens-Westinghouse 1 kW stack, consisting of five tubular cells). This pilot unit was successfully operated on wood gas for 1200 hours.

The current focus of effort is the methanator unit, a fuel processor that re-enriches the cleaned fuel in methane after the gasifier, such that the upgraded feed reduces the cooling requirements of the stack. Figure 2 shows the possible gain (3–5 % of stack output power) if gasified wood is re-methanated before the fuel cell.

Interaction with society

During 17–21 January 2010, two projects supported by CCEM were presented at the SwissBau building exposition in Basel. One of the major eye-catchers was SELF, a modular living space for two persons which is self-sufficient in energy.

On 11 June, PSI and CCEM presented results of various projects at the Energietagung conference at PSI, where solutions for global climate protection were put forward, and addressed the perspectives for energy production with low greenhouse-gas emissions [2].

References

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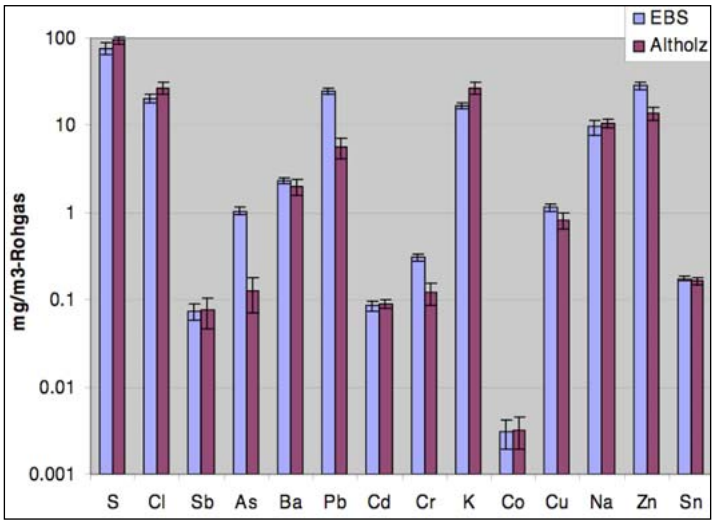

Figure 1: **On-line measurement of trace elements with a liquid quench sampling system and ICP-OES at a wood-fired power station at Kleindöttingen, with regular scrap wood ("Altholz") and also metal-loaded wood (EBS). Values are given in mg/Nm³ raw gas.**

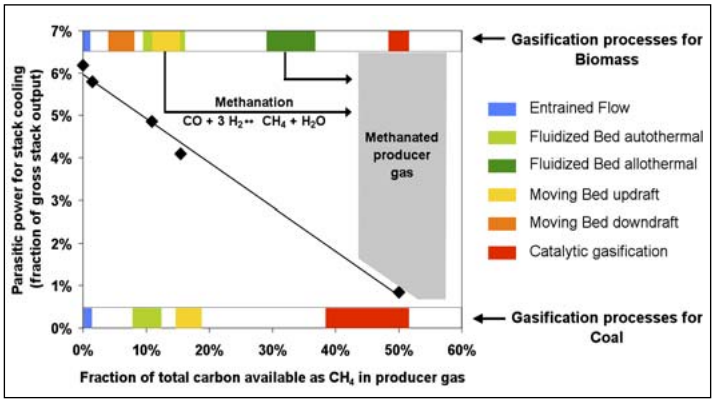

Figure 2: **High methane content in producer gas from (coal and) biomass provides a benefit in fuel cell systems with integrated gasification.**

Scientific findings on nuclear safety for stakeholder decisions

Jean-Marc Cavedon, *Nuclear Energy and Safety Department (NES), PSI*

Although the economical and ecological ratings of nuclear electricity production are objectively good and similar to the ones of renewable energies, its social acceptance is ultimately dependent on stakeholder opinion on the safety of plant operation and on the safe disposal of the radioactive waste. This year's selection of scientific highlights from the Nuclear Energy and Safety Department seeks to illustrate how we provide some answers readily applicable to these central issues. From the behaviour of the whole plant and its crew to radionuclide release and sorption, or by studying the effect of small or large losses of coolant, we establish scientific facts in order to facilitate understanding and decision-making at the stakeholder level.

There is a growing consciousness of the factual synergy between electricity from nuclear power plants and energy from renewable sources, to be seen together as a portfolio of technologies that may ease, and even eliminate, our dependency on fossil fuels, with their known detriments to our society and our environment.

This synergy in improving the ecological and economical dimensions of a sustainable energy supply does, however, not extend to the third dimension of sustainability – the social one. Renewable sources, at least at their present stages of development, are socially rather well accepted. The history of the perception of nuclear electricity production in our developed societies is often one of concern about the safety of operation of present nuclear plants and about the proper handling of the nuclear waste.

Scientific studies in recent years have been mainly used to support technical decisions. This has contributed to the fact that Switzerland now has a set of three technically-accepted reactor sites for replacement of, or the building of new, nuclear power plants. The country also has a set of six technically accepted sites for deep underground repositories. The decision process has now moved to the stakeholder level.

Through this year's selection of scientific achievements, we seek to illustrate how we use scientific and technical state-of-the-art tools to answer precise questions belonging to the two central societal issues: *Are nuclear power plants safe? Has the waste problem been solved?*

At the time of print, the severe nuclear accident at Fukushima Daiichi has not yet come to an end and no stable conclusions can be drawn from it. However, it underlines strikingly the relevance of safety studies launched well before this accident, especially for unlikely events affecting nuclear power plants.

Simulating and mitigating unlikely events

A rare event in the operation of a nuclear reactor is, for instance, the rupture of a steam generator tube. Such a rupture would connect the primary cooling circuit of a pressurized water reactor to the normally contamination-free secondary circuit. Should such an event result in a sizeable opening of some centimetres in size, and should it occur together with some other unlikely failure, it would open a pathway for radionuclides in aerosol form to the environment, by-passing the containment vessel. Although this event chain is highly unlikely, it was deemed necessary by a group of international nuclear regulators, nuclear constructors, operators and research centres to study the release of aerosols at high speed from a tube breach and to establish the efficiency of mitigation measures. The experiment was coordinated and executed by PSI. The title of the article by T. Lind et al. gives both the problem and part of the solution: flooding the leaking pipe under water reduces the aerosol transport by a factor of 100 or more.

When very low-probability event chains like the previous one are studied, other unlikely events have to be brought into the safety analyses, such as delays in action or even errors made by highly trained crew teams in emergency-handling situations. This is what V. Dang et al. describe in their analysis of crew-plant dynamic interaction: under a postulated emergency situation, a computer simulation of the plant behaviour is connected to a simulation of the crew that determines what actions the crew may perform and when these are carried out. This international exercise has brought new insights into the assumptions about the constraints on a successful crew response and provided a tool to study some of the key uncertainties that remain on this challenging topic.

The previous examples deal with topics where improvements can be brought to existing plants. We have also explored the near future, i.e. the upcoming (third) generation of nuclear plants worldwide, which incorporate by design many safety features and improvements coming from operational experience on existing plants, plus some important novel features. Y. Yun et al. have been collaborating with the Finnish regulator STUK to conduct independent safety assessments on the EPR nuclear plant under construction at Olkiluoto, Finland. Their results assess that the hottest fuel cladding spot in this plant will not reach the temperature necessary for cladding rupture, even in the event of a loss of coolant through a large break.

Safety in normal operation and in waste management

The life of a nuclear fuel pellet, even under normal operational conditions, is quite a challenge: high temperatures and temperatures gradients under high irradiation fluxes, as well as the appearance within the pellet of new chemical elements (the fission products), some in gaseous form and exerting mechanical stress. C. Degueldre et al. have succeeded in determining how irradiation affects a fuel pellet at the atomic level. The irradiation time achieved was such that the pellet reached burn-up values beyond the average level encountered in Swiss nuclear plants. The nature of the chemical links of plutonium with its atomic environment at various places within the pellet was examined with one of the finest analytical tools available: the µXAS beamline at PSI's SLS facility. First results already indicate that, under irradiation, plutonium has not undergone major changes in its chemical links (speciation). This not only qualifies the good behaviour of the pellet in the reactor, but, equally important, indicates that the chemical valences that would make Pu more soluble in water, i.e. more mobile in repository conditions, do not appear. Should the pellet be disposed of in an unchanged state in a repository site, and should water ever come to leach the pellet, plutonium would still hardly be dissolved and entrained by water.

What would happen to radionuclides if they were to be dissolved in pore water and transported by diffusion from an underground repository? M. Bradbury et al. have found that radionuclides with a variety of valences (II to IV) are sorbed strongly by two clay barriers being considered in the repository concept of the Swiss National Cooperative for the Disposal of Radioactive Waste (Nagra) – the natural clay (Opalinus Clay) in which the galleries will be bored and the engineered one (bentonite MX-80) used for filling the galleries once the waste containers are positioned. The predictive capacity of the sorption model that was developed over the past few years, supported by an extensive thermodynamic database, is quite remarkable. It reinforces the confidence in our present ability to quantitatively predict radionuclide uptake in complex geochemical systems.

Conclusions

Whether it is about the failure of a steam generator tube or the behaviour of a reactor crew in an emergency, or about keeping fuel cladding at a safe temperature in a new reactor concept, our research teams have found that operational safety is assured in both present and future reactors, provided that the proper safety margins are built in and mitigation measures are implemented.

Evaluation of the solubility of plutonium in water and of the sorption capacity of a number of radionuclides by clay has also increased our global confidence in the safety of repository systems.

In short, we are able to report here on scientific findings that support the statement that light water reactors and clay repositories can be safe.

Of course, however carefully chosen to be representative of important safety issues, our studies are not an exhaustive demonstration of the safety of all systems under all conditions. Safety studies with short-term application, ever more detailed and calling for ever more basic understanding, will remain a core activity of the NES Department for many years to come.

Safety analysis of the EPR™ reactor within the STARS project

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The EPR™ is a Generation-III Light-Water Reactor design which is among the candidates being considered for possible new reactors. In 2007/2008, the Finnish regulatory body began a collaboration with PSI to conduct independent safety assessments of the EPR™ currently under construction in Finland. At the current stage, detailed plant/system and fuel models have been developed and, on that basis, preliminary large-break loss-of-coolant accident analyses completed with the TRACE and FALCON codes. These indicate that the performance of the EPR™ safety design for this type of event is rather satisfactory.

The EPR™ (Evolutionary Pressurized Water Reactor) belongs to the third generation of Light-Water Reactor (LWR) designs. These designs are foreseen to constitute the new fleet of commercial reactors in countries where the nuclear energy option will, for the 21st century, remain, or become, one of the national energy options. The principal feature common to all third-generation LWR designs is that primary focus has been given to enhanced safety performance, i.e. significant reduction of the probability for severe accidents (core melt), either through increased redundancy and diversification of the active safety systems (GIII "evolutionary" designs) or through the introduction of passive safety systems relying mainly on known laws of physics (GIII+ "revolutionary" designs). Regarding the European landscape, GIII EPR™-type reactors are currently being constructed in both France and Finland, and the EPR™ is also being considered as a candidate by the national utilities responsible for new-build projects in Switzerland.

EPR™ modelling at PSI

At the PSI Laboratory for Reactor Physics and Systems Behaviour (LRS), the mission of the STARS project (http://stars.web.psi.ch) is to develop advanced multi-physics, multi-scale, "from Turbine-to-Pellet" (plant/core/fuel), computational methodologies for deterministic safety analysis of Swiss reactors. Although the major focus is on existing Swiss reactors, a collaboration was launched in 2007/2008 with the Finnish nuclear safety inspectorate (STUK) to obtain independent safety evaluations of the EPR™ under construction at the Olkiluoto site in Finland. For STARS, this was considered to be particularly valuable in order to start developing GIII/III+ expertise. The first phase of this collaboration has recently been completed and simulation models have been developed using, as basis, detailed EPR™ drawings/data (see Figure 1). Among these, a comprehensive plant system model (e.g. vessel, steam generators, steam lines, pumps, control and safety systems) has been developed with the TRACE best-estimate code, aimed at studying the evolution of flow, pressure, temperature and energy distributions throughout the plant during a postulated accident [1–3].

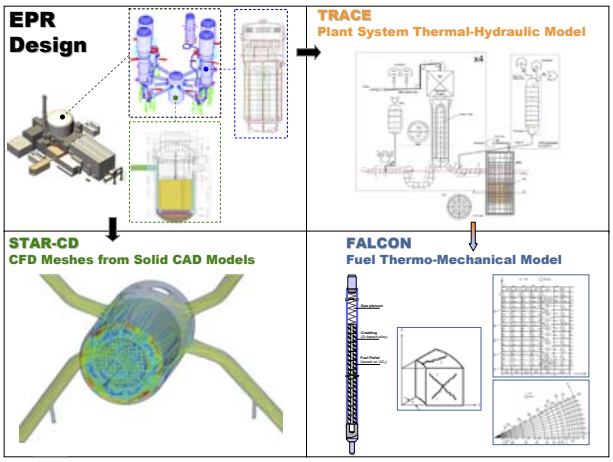

Figure 1: **EPR™ Modelling in STARS.**

To complement TRACE for analyses requiring a more detailed modelling of the flow/pressure/temperature evolution, a comprehensive solid CAD model has been developed and used to generate a detailed mesh for the STAR-CD(CCM+) Computational Fluid Dynamic (CFD) code [4]. Also, very recently, a prototypical EPR™ fuel-rod model was also developed

with the FALCON Finite-Element-Method code, in order to study the thermo-mechanical behaviour of the pellet/gap/cladding system.

Large-Break LOCA simulations

One of the Design Basis Accidents that has so far been studied is the Large-Break Loss-of-Coolant Accident (LBLOCA). For this transient, preliminary TRACE simulations have been carried out, assuming a large break in one cold leg of the primary circuit. The objective was to verify if core coolability can be maintained during and after intervention of the emergency core cooling systems when reflooding the reactor, assuming, in this context, availability of all accumulators and 2 (out of 4) safety injection systems. Core coolability is assessed by calculating the peak fuel cladding surface temperature (PCT) for all fuel rods in the core and verifying that it remains below the safety criteria of 1477 K. This limit, in combination with a criterion on the maximum allowable cladding oxidation, was established with the objective of preventing embrittlement of the cladding (the first barrier for radioactivity release to the environment) and to ensure thereby that the fuel rod structure would not lose its integrity in the case of thermal shock during and/or after the reflooding phase. As can be seen in Figure 2, which shows the time evolution of the cladding temperature at different axial core elevations, a PCT of just above 1000 K is estimated about 59.2 seconds after the break.

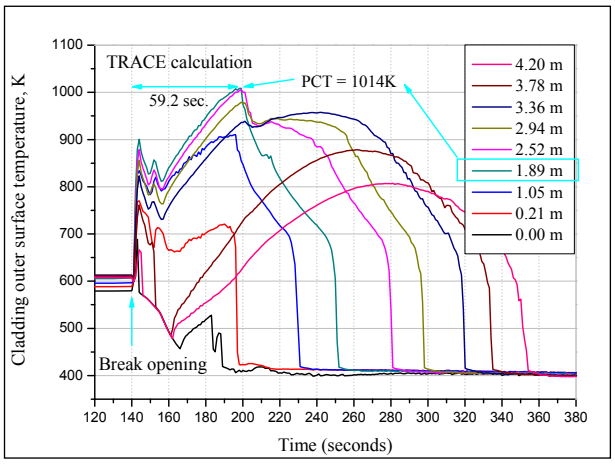

Figure 2: **Results of TRACE EPR™ LBLOCA analysis.**

Fuel behaviour analyses were subsequently conducted on this basis [5]. To ensure proper fuel rod conditions (gap conductance, amount of fission gas and internal rod pressure) at the start of the transient, steady-state base irradiation calculations were first performed using FALCON coupled to the PSI models for fission gas release and gaseous swelling. Then, FALCON transient analyses were performed, using, as additional boundary conditions, the cladding surface temperature and the coolant pressure calculated by TRACE. The FALCON results indicate that the PCT also remains well below the cladding rupture temperature ($T_{Rupture}$), calculated by the code as a function of cladding differential pressures (engineering hoop stress), using an empirical correlation validated from experiments. This is illustrated in Figure 3 for the axial elevation where the smallest difference [$T_{Rupture}$–PCT] was obtained. As can be seen, the FALCON results indicate that a comfortable margin of about 80 K remains before cladding rupture. This is mainly due to the low PCT value predicted by TRACE during the transient, which is believed to be a direct consequence of the design enhancements that were made when developing the EPR™ reactor.

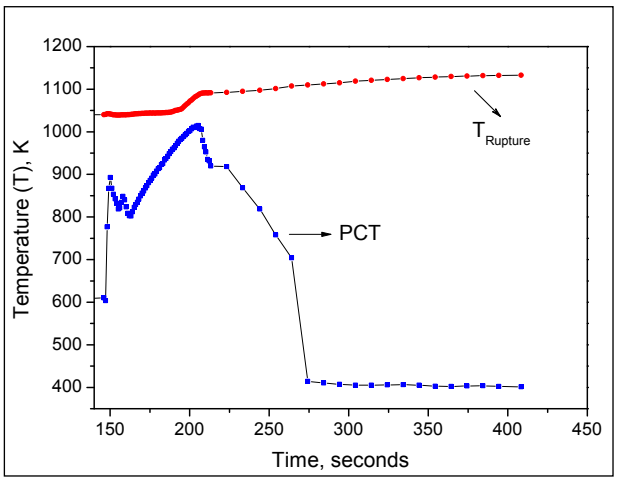

Figure 3: **Results of FALCON EPR™ LBLOCA analysis.**

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Better retention of radioactive aerosols during a steam generator tube rupture by covering the leak with water

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A steam generator tube rupture in a pressurized water reactor may cause the release of radioactive aerosol particles into the environment. This has a very low probability of occurrence, but its specific significance lies in its potential to bypass the containment vessel, because the leak connects the radioactive primary circuit with the normally inactive secondary circuit, thus providing a direct pathway for radioactivity to the environment. If the leak is covered by water, a large proportion of the aerosols are retained and the potential release of radioactivity to the environment is significantly reduced. Flooding of the secondary side of the steam generator is therefore a powerful accident management measure, allowing reactor operators to mitigate the consequences of such an accident. However, no reliable models exist to calculate this retention and therefore aerosol retention in the flooded steam generator secondary side has been determined experimentally in the ARTIST facility.

In the case of steam generator tube rupture (SGTR) in a pressurized reactor, radioactive aerosols released from the reactor core can pass to the secondary circuit, thereby creating a direct pathway to the environment. The steam generator offers ample surface where fission products may be deposited, and such deposition should significantly reduce the emission. However, due to the complicated physical processes occurring, such as particle impaction, thermophoresis and turbulent deposition, it is not possible to predict the retention potential by calculation. Therefore, PSI initiated and has coordinated the international research program ARTIST, in which experiments have been carried out to investigate aerosol retention in a steam generator during an SGTR [1].

The steam generator may be flooded with water, at least partially, in certain severe accident scenarios, or as a result of accident management measures when aerosols are released from the core. The presence of water complicates the aerosol behaviour, and it was unknown to what extent the presence of water would alter radioactive release and, consequently, if operators should be recommended to flood the secondary side in such an accident [2]. Due to the complex interaction of particles and gas flow with the water, and the complex geometrical structures, no reliable models existed for calculating this retention. New experiments were needed and the ARTIST II program was thus launched.

The ARTIST facility

The ARTIST facility is a scaled-down model of the FRAMATOME 33/19-type steam generator in operation at the Swiss power plant Beznau, which is a 1136 MWth pressurized water reactor. The facility comprises a tube bundle, one separator unit (1:1 in scale) and one dryer cell (1:1 in scale). The bundle section is composed of a scaled-down, 0.57 m-diameter tube bundle comprising 270 straight tubes with outer tube diameter of 19.05 mm and a height of 3.8 m (Figure 1).

Aerosol retention in the flooded bundle

Since 2000, several experimental campaigns have been carried out in ARTIST to determine aerosol retention in the steam generator under different accident conditions, and the effects of variation of different parameters on particle retention have been studied: particle type (spherical, agglomerate – Figure 2), particle size, gas mass flow rate and water level [3].

Experiments have shown that the existence of water in the steam generator secondary side significantly increased aerosol retention. Under certain conditions, less than 0.1 % of the aerosol that entered the flooded steam generator secondary side was transported out of the bundle. Figure 3 shows a comparison of the aerosol transport efficiency through the steam generator bundle under dry secondary-side conditions and with two levels of water above the break, under otherwise similar conditions.

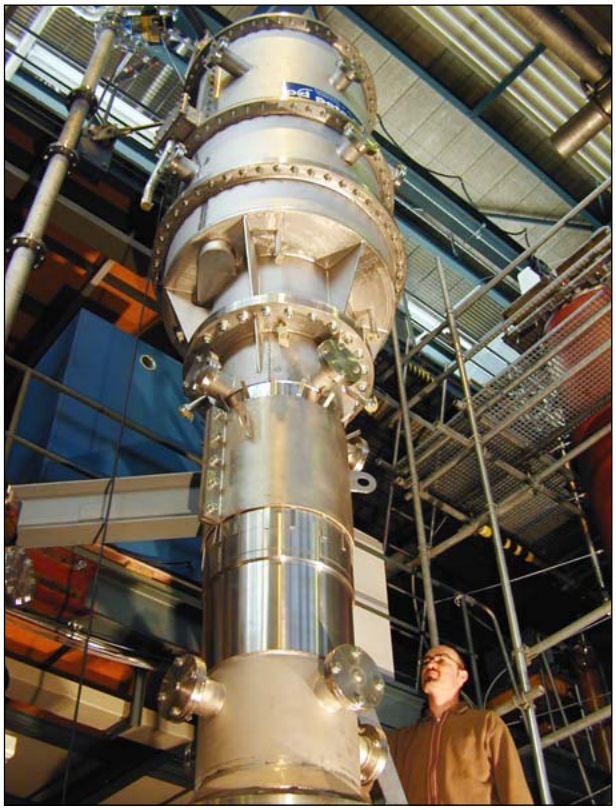

Figure 1: **The ARTIST facility: steam generator mock-up.**

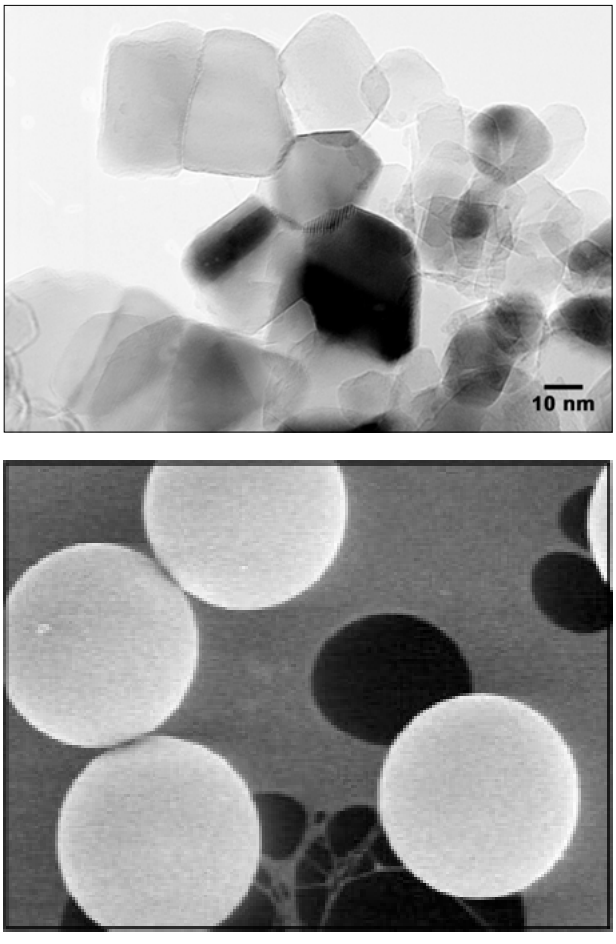

Figure 2: **Electron micrographs of test aerosols: agglomerates (top) and spherical particles (bottom).**

The following major findings were made:

- Increasing particle inertia, i.e. particle size and velocity, increases retention. Inertial mechanisms determine particle retention in the bundle close to the tube break, where major retention takes place.
- Even with a very low water level of 0.3 m above the break, only about 1 % of the aerosols are transported out of the bundle, i.e. released, compared with the amount leaving the bundle with no water coverage. Under certain conditions (high gas flow rate, large aerosol particles), aerosol transport efficiency through the flooded bundle is just 0.04 %, underlining the importance of the interactions of gas jet and bundle close to the tube break.
- Droplets are entrained from the water surface at high gas flow rates. They carry aerosol particles with them and, once the droplets evaporate, these particles are released into the gas flow. However, compared with particle retention in the water due to inertial effects close to the tube break, the effect of droplet entrainment on particle transport is small.
- Increasing the submergence depth of the break increases particle retention in the water, and the effect is much stronger in the flooded bundle than in bare pools, presumably due to jet–bundle interactions, which create very complex two-phase flows. This indicates that models developed for bare pools are not suitable for calculating aerosol retention in a flooded bundle, even in regions far from a tube break.

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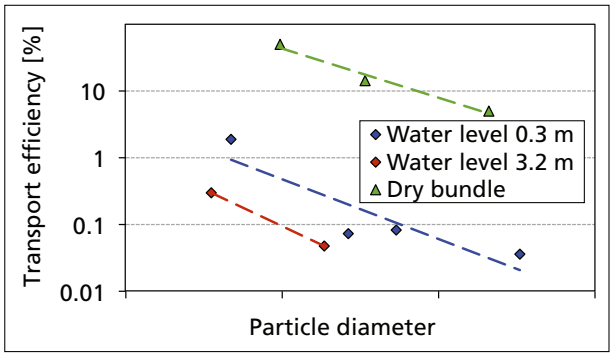

Figure 3: **Aerosol transport efficiency in a dry steam generator bundle compared with that of the bundle flooded with water.**

Predictive sorption modelling of Ni(II), Co(II), Eu(IIII) and Th(IV) on MX-80 bentonite and Opalinus Clay

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The uptake of radionuclides from the aqueous phase onto immobile solid surfaces (mineral phases in the backfill materials and the host rock) is one of the main pillars of safety in the performance assessment of deep geological repositories in Switzerland. An "in house" quasi-mechanistic sorption model, with associated non-adjustable parameters, has been used to make blind predictions of sorption isotherms of radionuclides measured on bentonite and Opalinus Clay under chemically realistic conditions. The procedures are described for Ni(II), Co(II), Eu(III) and Th(IV) and the calculated curves correspond well, or very well, with the measured data.

The disposal of radioactive waste in deep geological repositories aims at isolating the radionuclides from the biosphere for many hundreds of thousands of years. Radionuclide transport will most probably occur via the aqueous phase in the backfill and sealing materials and the host rock. The partitioning of the dissolved species between the aqueous phase and immobile solid surfaces (sorption) is a primary consideration, and it is currently common practice to treat sorption in terms of a solid/liquid distribution ratio, R_d, where $R_d = C_{sorb}/C_{eq}$, in which C_{sorb} is the quantity of metal sorbed per unit mass of sorbent (mol/kg) at an equilibrium aqueous sorbate concentration of C_{eq} (mol/L).

Sorption is a complex process, and it is therefore rather unsatisfactory that the whole of the complexity of the radionuclide/porewater/rock interacting system for each radionuclide is contained in a single lumped R_d-term. Such a purely empirical approach has clear and significant disadvantages in that it has no predictive capabilities. Consequently, there is a pressing need to better understand sorption and the factors which influence it. This has led to the development of sorption models based on a mechanistic approach to understand and quantify the processes controlling the uptake (sorption) of aqueous species.

Sorption model for clay minerals

The surfaces of clay mineral platelets carry a permanent negative charge arising from isomorphous substitution of lattice cations by cations of a lower valence. Charge neutrality is maintained by electrostatically bound cations which can undergo stoichiometric exchange with the cations in solution, called cation exchange.

A second category of reactive sites associated with clay minerals is perceived as being surface hydroxyl groups (≡SOH) situated along the edges of the clay platelets, "edge" or "broken bond" sites, which can protonate and deprotonate as a function of pH and form surface complexes with aqueous metal species.

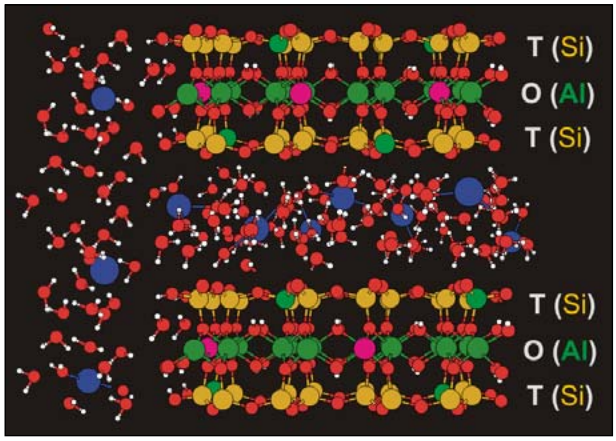

Figure 1: **Structure of the clay mineral montmorillonite.**

In radioactive waste management, the 2:1 clay minerals montmorillonite (Figure 1) and illite are important major components of bentonite and argillaceous rocks, respectively, and for this reason were chosen to be studied. A **2**-**s**ite, **p**rotolysis, **n**on-**e**lectrostatic, **s**urface **c**omplexation and **c**ation **e**xchange mass action sorption model (**2 SPNE SC/CE**) has been developed to describe the uptake of radionuclides on the different site types [1].

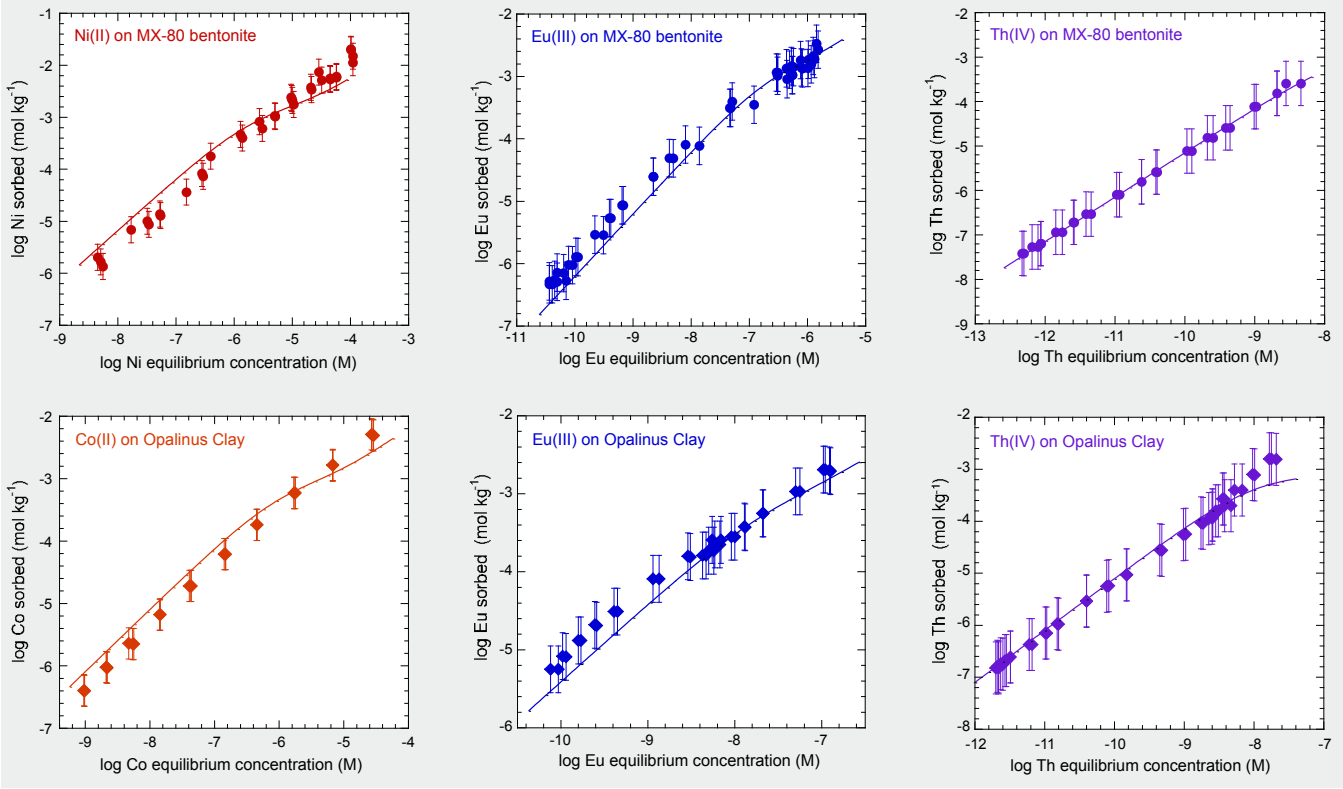

Figure 2: **Sorption isotherms on MX-80 bentonite and Opalinus Clay: Experimental results and modelling.**

The "bottom-up" approach

The "bottom-up" approach is based on the premise that radionuclide uptake in complex mineral/groundwater systems can be quantitatively predicted from a knowledge and understanding of the mechanistic sorption processes on single minerals, and the models developed to describe them. The average 2:1 clay mineral contents of bentonite and Opalinus Clay are 75 wt. % (montmorillonite) and 40 wt. % (illite and illite/smectite mixed layers), respectively, and these are assumed to be the minerals which are predominantly responsible for sorption. The sorption values were calculated as a function of concentration using the MINSORB code, incorporating the 2SPNE SC/CE model, and the Nagra/PSI 01/01 thermodynamic database [2], assuming that only the free metal and hydrolysed species are sorbing. These values were then scaled by 0.75 and 0.40 – the respective 2:1 clay mineral fractions in bentonite and Opalinus Clay.

The predicted sorption isotherms were compared with experimentally measured data on MX-80 bentonite and on Opalinus Clay.

The results of the blind modelling of the Ni(II), Co(II), Eu(III) and Th(IV) isotherms measured on MX-80 bentonite and Opalinus Clay are shown in Figure 2. The metals were chosen to provide a broad range of chemical behaviour and valence states; bivalent transition metals; trivalent lanthanides/actinides; tetravalent actinides. In most cases, the measurements cover over 4 orders of magnitude of the metal aqueous equilibrium concentration. The agreement between experimental results (solid circles and diamonds) and the blind predictive modelling is good to very good; in many cases, the calculated values lie within the experimental error bars given.

Conclusion

On the basis of the modelling results presented here, the "bottom-up" approach, used in conjunction with some simplifying assumptions and the procedures described, may be regarded as a very promising method for quantitatively calculating radionuclide uptake in complex geochemical systems. This has been illustrated for two important barriers in the current concepts for deep geological disposal: bentonite (MX-80) and argillaceous host rocks (Opalinus Clay).

References

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Dynamic crew-plant simulation

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The aim of the safety analysis of nuclear power plants is to determine whether plant systems and planned personnel responses will adequately maintain safety during a spectrum of postulated emergencies, ranging from Loss of Coolant Accidents to earthquakes. Combining a plant model with a crew model in a joint simulation allows a systematic analysis to be made of how the plant behaviour, automatic systems, and crew response interact in an accident. Such a model predicts a variety of performance contexts for operator action and allows the evaluation of the effectiveness of different responses.

In the safety analysis of nuclear power plants, many accident scenarios are examined, considering the ways in which equipment and operator action may fail to perform as required. Probabilistic Safety Analysis additionally addresses the probabilities of different failure scenarios. Results include the likelihood of undesired outcomes as well as insights into potential weaknesses and possible safety improvement measures. Plant behaviour during an accident, and the outcomes of the scenarios, are evaluated with plant simulation models. The evolution and outcome of accident scenarios result from the dynamic interactions of the plant behaviour and the equipment and crew responses. To analyze a broad range of accident scenarios in the light of these interactions requires a joint simulation, combining a plant simulation model with a crew model that determines what actions the crew may take and when.

Simulating crew response

A first approach to simulating crew response is to define a series of tasks to be performed and the time required for each task. This basic approach only requires estimations of the distributions of the time for each task. Since the required operator actions will depend on the accident scenario and how the scenario evolves, this type of model is inadequate because of its main emphasis on time response. The time to perform tasks may vary in different situations; for instance, more time may be needed to assess whether a system is functioning correctly. Concerning the series of tasks, additional tasks may be required or some tasks may not be needed. To determine the actions that crews are likely to perform in each situation, a modified approach is needed. The required response of the personnel to postulated emergencies is planned in advance and in detail, and is subject to thorough analysis and review. These plans are represented by the plant's emergency operating procedures. The application of these procedures is practised by the operators in simulator training. As a result, the crews are able to assess and respond to most scenarios without the need to resort to reasoning from a fundamental analysis of each situation.
Consequently, the crew model in this research [1] dynamically generates the crew's actions by interpreting the procedures in combination with a small set of rules for selecting response strategies or specific actions. This rule-based behaviour can represent rules learned in training or from experience. This circumvents the challenge of developing a detailed model of the operators' knowledge and of their cognitive processes for situation assessment and response planning. The simulation model is completed by a physical and thermal-hydraulic model of the plant – the RELAP5 transient and accident analysis code.

Operator response in a Loss of Coolant Accident

The application of crew-plant simulation to the analysis of a Loss of Coolant Accident (LOCA) scenario in a Pressurized Water Reactor is presented for illustration. In a small LOCA (SLOCA), a small leak in the Reactor Coolant System (RCS), the primary loops that remove heat from the core to produce steam in the steam generators of the secondary loop, is postulated. The primary pressure remains relatively high at first; the high-pressure emergency core-cooling systems actuate

automatically to inject water into the primary loop, to replace lost coolant and provide coolant to the core. Next, the crew reduces the RCS temperature and pressure in order to reach low-pressure conditions and a stable safe state. In this process of cool-down and depressurization, the crew must ensure feedwater supply to the steam generators, monitor the rate of cool-down, and control the water level in the RCS. As shown in Figure 1, the crew eventually needs to shut off the high-pressure injection pumps, which is done progressively. The time needed to reach a low-pressure condition is one of the important parameters for the safety analysis.

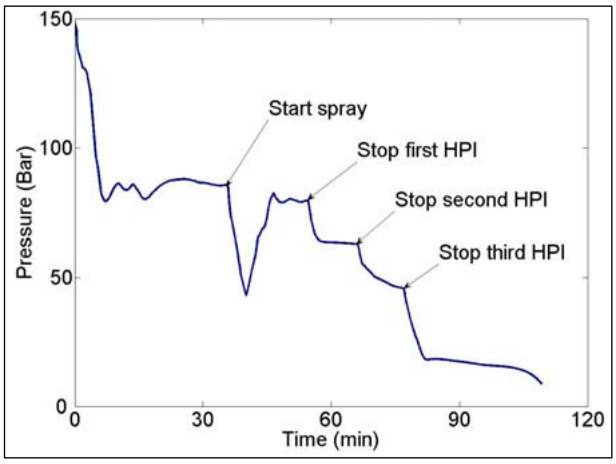

Figure 1: **Pressure response during an SLOCA, with operator actions.**

The RCS pressure and subcooling margin are shown for a set of simulations of the response in Figures 2 and 3. The operators influence the time to reach 20 bar, the conditions for low-pressure injection (Figure 2), through the speed with which they execute the procedure, as well as through the strategies they follow to cool down the core, control the pressure level, and shut off the high-pressure injection pumps. For instance, frequent and shorter actuations of the pressurizer spray (used to increase the level in this situation) were modelled, as well as longer, more extended, operation. These results show that the conditions under which low-pressure conditions tended to be reached the earliest (shown in red) were associated with the risk of having saturation (boiling) conditions in the RCS. The insight obtained is that this behaviour is actually subject to delay, if the high-pressure injection pumps need be restarted.

Outlook

Crew-plant simulation models have evolved into a useful tool for Human Reliability Analysis – the assessment of the human contribution to plant safety. They provide a deeper understanding of the human performance context and its dynamics: the available indications, the procedures and training that support decision-making and performance, and the feedback from the plant and its systems. While nuclear power-plant training simulators offer the best possibility for observing the response of crews in emergency scenarios in a highly realistic environment, simulation analysis can yield further insights from such data by considering the many possible other variants of the scenarios and crew responses.

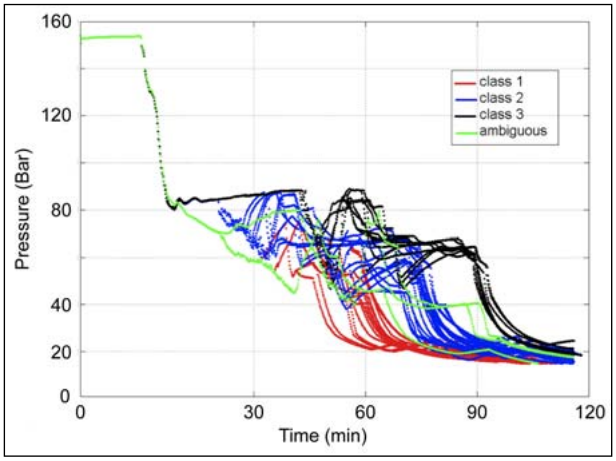

Figure 2: **Primary pressure evolutions.**

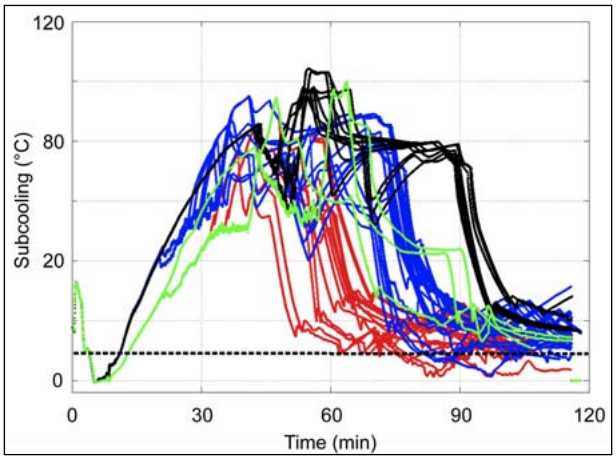

Figure 3: **Margin to saturation conditions.**

Acknowledgements

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Plutonium characterisation in mixed-oxide nuclear fuel by synchrotron radiation

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Plutonium-uranium mixed-oxide (MOX) fuels are currently used in nuclear reactors. Due to the fission reactions and heat inside the fuel, chemical and structural changes of the fuel occur, influencing the fuel performance and safety behaviour. The chemical and structural changes of MOX fuel have been studied on an atomistic level using synchrotron radiation at the PSI Swiss Light Source (SLS): the plutonium environment in the MOX has been analysed by micro-X-ray fluorescence and micro-X-ray absorption fine-structure spectroscopy. Synchrotron radiation spectroscopy techniques will also be applied to other new types of commercial nuclear fuels currently used in Swiss power plants.

Plutonium-uranium mixed oxide (MOX) fuels are used in commercial nuclear power plants. In Switzerland, MOX has been used in the Beznau reactor (KKB) and recently in the Goesgen reactor (KKG). MOX can help to make fuel utilization more efficient. With an increasing number of fission reactions, the chemistry in nuclear fuels changes due to the production of fission products and minor actinides. During high burn-up (energy output) of the fuel, the actinides (U, Np, Pu, Am and Cm) in the fuel matrix may undergo redox changes. This may make them more labile, in the hypothetical case of water contact in a geological repository. This is the reason why an atomic-level understanding of the actinide-based redox species, especially in plutonium-containing MOX fuel, is crucial. At the NES Department, emphasis is given to the safety of fuel and its spent form after use in reactor. In this LNM study, irradiated fuel has been investigated by X-ray fluorescence (XRF) and absorption fine-structure (XAFS) spectroscopy using the microXAS beam line at the Swiss Light Source (SLS). The study has been carried out to assess the redox stages of Pu (and thus its potential water solubility) in MOX on fuels before [1], and after irradiation [2]. In [3], the relevant charge distribution, local structure and speciation had already been investigated by XAFS, and the valence states of actinides examined by a combination of theoretical chemistry and XAFS experiments. Those studies completed the XAFS background needed for the interpretation of the Pu atomic environment in MOX.

Experiments

In the 1980s, MOX sphere-pac fuel was produced by PSI's own process in the Hotlab. The fabricated fuel was homogeneous MOX obtained by internal gelation and microsphere formation [2]. MOX sphere-pac fuel segments were prepared and transferred to the Swiss pressurised water reactor Beznau-1 for irradiation. The sphere-pac fuel was used through 6 reactor cycles, reaching a burn-up of 60 MW d kg^{-1} of fissile metal, corresponding to 6 % fission per initial 'heavy' metal atom (FIMA). Compared with conventional fuel in Swiss power plants, this burn-up is relatively high.

The synchrotron-based XRF and XAFS investigations were performed at the microXAS beam line of the SLS. The use of radioactive material at the beamline is subject to stringent activity limits, with the consequence that only very tiny test volumes can be examined.

The sample preparation was a challenge, and specimens were made by means of a replicate technique, applying a piece of adhesive Kapton tape and thus obtaining a kind of 'fingerprint' of the fuel surface. It was possible to collect fuel particles from different places over the fuel cross-section – from the fuel centre as well as from the periphery, the so-called rim (which has a higher burn-up than the centre). The X-ray data from the samples were collected at room temperature by monitoring the fluorescence emission, using an Si solid-state fluorescence detector. The following XAFS focused on the L_{III}-edge absorption line and energy calibration was carried out for U and Pu using a Zr film, measured in transmission.

Results and outlook

Samples were analyzed in fluorescence mode by XRF (Figure 1), prior to XAFS spectroscopy on specific spots.

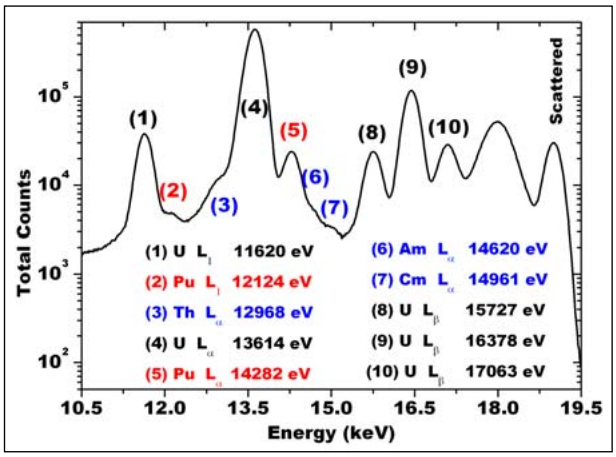

Figure 1: **Fluorescence spectrum of the irradiated MOX sample; positions (3), (6) and (7) are indicated for Th, Am and Cm, respectively, with signals which were too low to be detected.**

The environment of U and Pu can be influenced by the presence of fission products; however, for the given burn-up, the concentration of individual fission products does not reach 1 at.%, which should not a priori significantly affect the U or Pu XAFS data. For the plutonium L_{III}-edge, the E_0 was stable at 18062 ± 2 eV for all relevant cases, i.e. the non-irradiated, as well as the irradiated, samples in the rim and centre zones (Figure 2).

Comparison of the white-line factor for Pu in the irradiated and non-irradiated MOX samples reveals that the Pu remaining in the irradiated sample consisted of more than 95 % Pu(IV), but no (i.e. less than 5 %) Pu(V) or Pu(VI) could be detected, while the fuel could undergo slight oxidation in the rim zone.

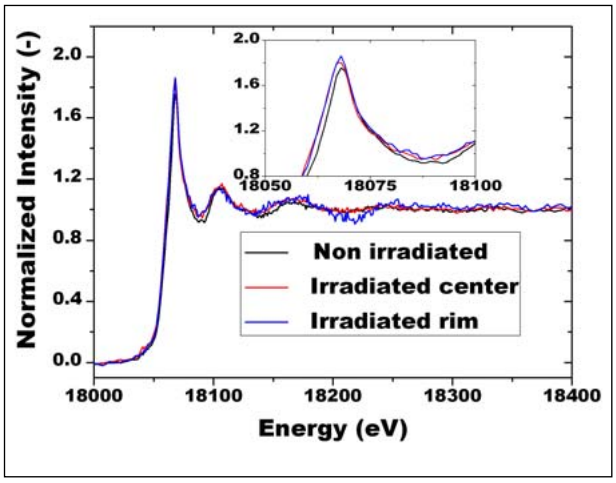

Figure 2: **Plutonium L_{III} XAFS spectra for the non-irradiated and irradiated MOX in the centre and at the rim.**

This slight oxidation may be buffered by the UO_2 matrix. The spectrum may be calculated by FEFF 8.4 for a cluster involving 295 atoms (82 U, 5 Pu, 208 O), as displayed in Figure 3. The smaller Pu(V)-O distance makes the Pu white line somewhat smaller, and shifted with an eV slip towards higher energy (below the energy resolution level).

The results for Pu confirm that, with the given detection limit, irradiation-induced detrimental speciation changes, e.g. affecting Pu water solubility, are not expected.

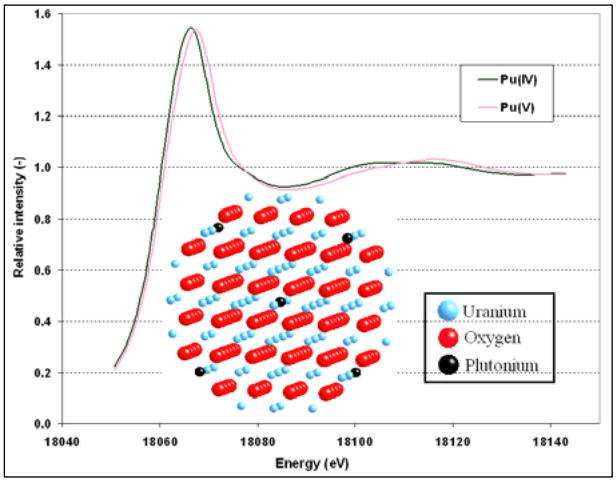

Figure 3: **Plutonium L_{III} XAFS spectra calculated for the MOX solid solution.**

The methods and results described above have evoked interest from industry. Consequently, a joint project with Swissnuclear and other partners has been launched on fuel with specific additives. The additives to be analysed should lead to better – especially gaseous – fission product retention in the fuel matrix.

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The impact of the Eyjafjallajökull volcano eruption on air quality

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Bruno Neininger, Boris Schneider, *MetAir AG;*
Ralf Kaegi, *Eawag*

The volcanic aerosol plume resulting from the Eyjafjallajökull eruption in Iceland was clearly detected in and above Switzerland on several days in April and May 2010. During these episodes, a unique set of measurements was performed at the High Altitude Research Station Jungfraujoch (3580 masl), allowing an extensive chemical and physical characterization of the volcanic aerosol to be made. The knowledge gained will significantly contribute to the retrospective assessment of the volcanic ash burden of the Swiss and European airspace.

Figure 1: **Sphinx Observatory (3580 masl) at the High Altitude Research Station Jungfraujoch (Photos: Nicolas Bukowiecki).**

Introduction

The eruption of the volcano Eyjafjallajökull in Iceland in April and May 2010 strongly impaired flight traffic over large regions of Europe. In central Europe, it caused an almost complete closure of the airspace during several days in mid-April 2010. Since the lead time for action to be taken in the predicted areas of concern after the initial eruption was very short, data from existing and operational monitoring networks were extremely valuable, considering the urgency of the situation.

The High Altitude Research Station Jungfraujoch

In Switzerland, the volcanic ash plume was clearly detected at the High Altitude Research Station Jungfraujoch (3580 masl, 46° 32'N, 7° 59'E). The site (Figure 1) is located on an exposed anticline in the Swiss Alps and is operated by the International Foundation High Altitude Research Stations Jungfraujoch and Gornergrat [1], and represents a Global Atmosphere Watch (GAW) station of the World Meteorological Organization. Within this framework, atmospheric aerosols and gases have been measured here for more than 15 years by PSI and Empa. Due to its altitude and remote location, there is no direct influence from significant anthropogenic pollution sources.

Figure 2 shows the clear presence of volcanic aerosol at the Jungfraujoch on several days in April and May 2010, indicated by a strong simultaneous increase in aerosol mass concen-

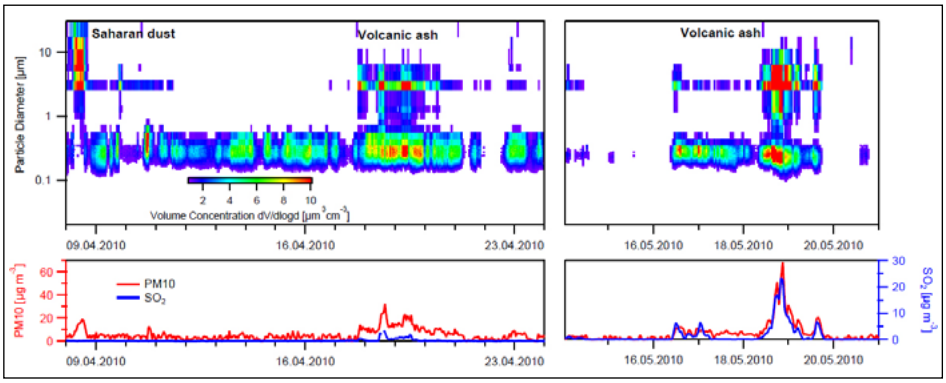

Figure 2: **Volcanic aerosol detected at the Jungfraujoch by a strong simultaneous increase in aerosol mass concentration (PM10), sulphur dioxide (SO_2, lower panel) and ash particles with a diameter of 3 µm in the aerosol volume size distribution (upper panel).**

tration (PM10), sulphur dioxide (SO_2) and coarse-mode ash particles. Due to previous mixing and dilution of the volcanic aerosol within the planetary boundary layer, the Jungfraujoch did not capture the maximum plume concentration of the ash [2].

Size distribution and chemical composition

The aerosol volume size distributions, measured during the time periods with maximal influence of the volcanic aerosol plume, exhibited a clear bimodality, as seen in Figure 3. They are characterized by an *accumulation* mode in the diameter range 0.1 – 0.8 µm and a *coarse* mode with a maximum around 3 µm.

The chemical composition of the volcano-related accumulation mode particles was dominated by ammonium and sulphate. During transport, volcanic sulphur dioxide was transformed to sulphuric acid and then neutralized to ammonium sulphate, dependent on the extent of its contact with the planetary boundary layer.

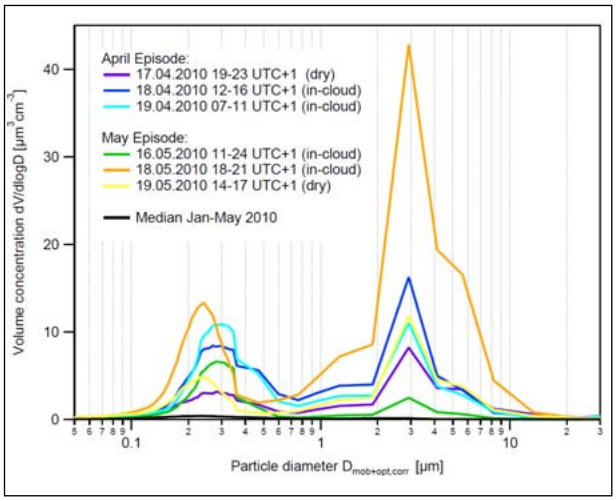

Figure 3: **Volcanic aerosol volume size distributions observed at the Jungfraujoch.**

The coarse-mode ash particles sampled at the Jungfraujoch were found to have a similar composition to those found in rock samples collected near the volcano, and showed both crystalline and glass-like structures (Figure 4).

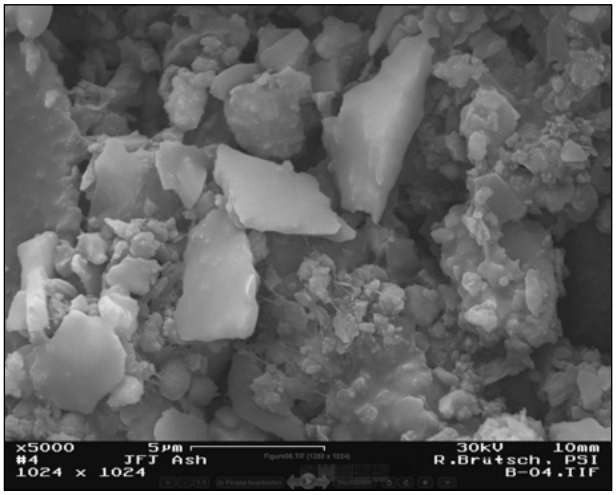

Figure 4: **Scanning electron microscope image of volcanic ash particles obtained from Jungfraujoch snow samples.**

The comprehensive physical and chemical characterization of the volcanic aerosol collected at the Jungfraujoch also allows the relationship between the aerosol mass concentration and the aerosol extinction coefficient to be established. This information is required for converting available **Lidar** (**Li**ght **d**etection **a**nd **r**anging) data into vertical profiles of mass concentrations, assuming similar size distributions. Most Lidars in Europe were operational during the Eyjafjallajökull eruption and were able to track the altitude and extent of the volcanic ash layer.

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Detecting recent climatic changes in the Russian Altai

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To understand ongoing and future climatic changes it is important to analyze the climatic variability of the past. In the absence of instrumental meteorological data, so-called proxy-indices are used to reconstruct the climate. These proxies are indirect climatic measures extracted from archives such as tree-rings, ice cores and lake sediment cores, based on chemical and physical properties of the archives. Here, for the first time, a comparison of several climate proxies has been made for the assessment of past temperature and precipitation variability in the continental Russian Altai, which is a region of high climatic sensitivity.

Valuable information about recent and past climatic and environmental changes is recorded in different natural archives, such as tree-rings, ice cores, corals and lake sediments. Each archive has its advantages and disadvantages. Climate reconstructions based on just one archive may be subject to systematic errors. More reliable climate reconstructions might therefore be achieved by combining different proxies, because deviations between the proxies could highlight uncertainties, while common trends would indicate a high degree of reliability. Despite these obvious benefits of a multi-proxy approach, few attempts have been made to explore it.

The application of stable isotope analysis in combination with classical dendrochronology based on tree-ring width measurements is steadily increasing, because stable isotope ratios, particularly $^{13}C/^{12}C$ and $^{18}O/^{16}O$ in wood or cellulose, provide complementary information about the climate. The $^{13}C/^{12}C$ isotopic ratio in tree-rings, expressed as $\delta^{13}C$ in ‰ relative to an international standard, reflects water availability and temperature, both impacting carbon and water relations of the plants. Trees respond to limited water resources during warm and dry conditions with a reduction of the stomatal conductance, to prevent desiccation, which changes the isotope fractionation during CO_2 uptake.

The oxygen isotope ratio (or $\delta^{18}O$) in tree-rings, as well as in ice cores, reflects the influence of the isotope ratio in precipitation, which is the source of water for both archives and is known to be influenced by temperature.

A previous study on the oxygen isotope variability for the Altai mountains, from an ice core of the Belukha glacier, showed strongly increasing temperatures since 1850 [1]. Additional information about climate changes in this region is available from sediment cores of the nearby Teletskoe lake, where chemical properties of the sediment were used to characterize temperature and precipitation changes [2]. Together with stable isotope tree-ring chronologies, they provide an ideal setting for the application of a multi-proxy approach to reveal similarities in the climate response [3].

Figure 1: **Photo of the tree-ring sampling site at 2300 ma.s.l. in the Russian Altai (Photo by V.S. Myglan).**

Tree-ring material was sampled from living larch trees *(Larix sibirica)* and measured for tree-ring width (TRW) for the period 1779–2007. Each ring was split with a scalpel, then cellulose was extracted and the isotope ratios $\delta^{13}C$ and $\delta^{18}O$ were determined on a mass spectrometer. Records of the three parameters were compared with the ice core and lake sediment data.

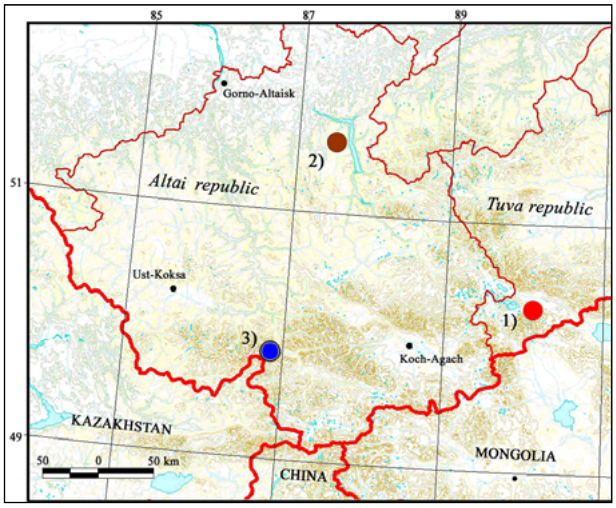

Figure 2: **Map of the study region with (1) tree-ring site, (2) Teletskoe lake, and (3) Belukha glacier.**

Results

A pronounced increasing trend since the 1880s was found for the tree-ring width and tree-ring $\delta^{13}C$ chronologies, as well as the ice core reconstructions ($\delta^{18}O$ in ice and melt layers), indicating an air temperature increase. This strong increase is also clearly reflected in the lake sediment and could be explained by the rising anthropogenic CO_2 emissions in the industrial period.

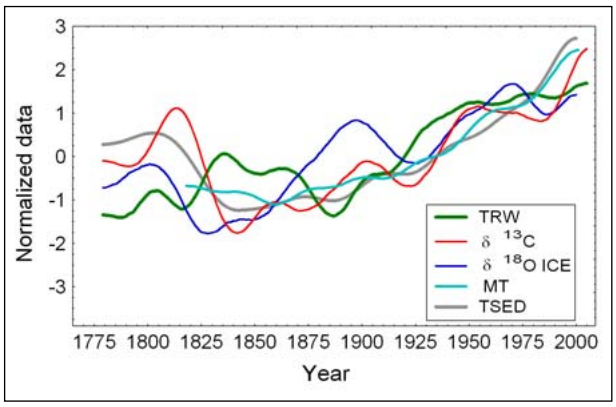

Figure 3: **Different temperature proxies from the Altai region: Tree-ring width (TRW), carbon isotope ratio of tree-rings ($\delta^{13}C$), oxygen isotope ratio in the Belukha ice core ($\delta^{18}O$ ICE), melt percent from Belukha ice core (MT), and Teletskoe lake sediment (TSED) parameters. Data are smoothed with a 41-year low-pass filter to emphasize the long-term trends.**

Furthermore, similar to the temperature reconstruction from $\delta^{18}O$ in the ice core, the $\delta^{13}C$ in tree cellulose showed two pronounced minima around 1840 and 1920, possibly explained by temperature minima during periods of decreased solar activity. Somewhat surprisingly, the oxygen isotope ratio in the tree-rings showed an opposite (decreasing) trend, thus not in line with the temperature evolution and the isotope signal in the ice core. This could be explained by the influence of melting permafrost at higher temperatures changing the $\delta^{18}O$ of water sources for the trees. Trees growing at this altitude in the Altai are growing on soil, where only the top layers are melting during summer, whereas lower parts of the soil are permanently frozen. We observed, however, that the declining trend in $\delta^{18}O$ agrees well with the precipitation reconstruction from the lake sediment, indicating that, for such site conditions, $\delta^{18}O$ of tree-rings could be used for reconstruction of precipitation.

Conclusions

Long-term climate records are necessary to observe the development of the climate and track the impact of environmental changes on high-altitude forest ecosystems and glaciers. It is evident that the combination of several independent proxies improves the reliability and quality of temperature and precipitation reconstructions back into the past and will enhance our understanding of climate variations and facilitate more realistic predictions of possible vegetation shifts in Boreal forests.

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Heuristic design for the technical characterization of passenger vehicles

Erik Wilhelm, Warren Schenler, *Laboratory for Energy Systems Analysis, PSI*

Light-duty vehicles account for roughly 10 % of the total CO_2 emitted in the developed world, and many advanced technologies are currently being developed to reduce the environmental impact of personal transportation. This work reports on methods and tools developed to help policy makers, manufacturers, and consumers make the best possible decisions about how to legislate, what to build, and what to buy.

A revolutionary (albeit gradual) process of electrification and fuel diversification is underway in personal transportation, with manufacturers choosing from a variety of technology options to satisfy consumer demand and regulatory requirements. A comprehensive overview of the impact that technologies could have is required for regulators to implement effective policies, for manufacturers to develop appropriate products, and to help consumers understand their choices. Special emphasis has been placed on fully electric and fuel cell vehicles, which are amongst the most radical and least market-ready technologies under development, and yet are of particular interest to industrial and government stakeholders.

Methodology overview

To achieve the level of detail required to evaluate technology options while examining as broad a range of technologies as possible, three methods were developed and applied. Heuristic vehicle design techniques draw on historical design rules to appropriately combine and size technology options into self-consistent vehicle designs. Simulations based on first principles are then used to evaluate design performance and feasibility. In order to objectively compare hybrid vehicles with two or more energy sources, it is critical to ensure that optimal hybrid control strategy is used for the simulation.
Deterministic dynamic programming methods were developed which optimize the power split between electric and chemical energy at each moment in the predefined driving cycle (velocity profile). Once a set of virtual vehicles has been fully characterized, multi-criteria trade-off and decision analysis is performed to evaluate the influence of stakeholder preferences and input assumptions on the robustness and suitability of the various advanced technology options.

Survey and Multi-Criteria Analysis (MCA) results

Three surveys were performed to estimate stakeholder preferences for various criteria. Figure 1 shows the survey results together with observed Swiss sales preferences for eight important technology indicators.

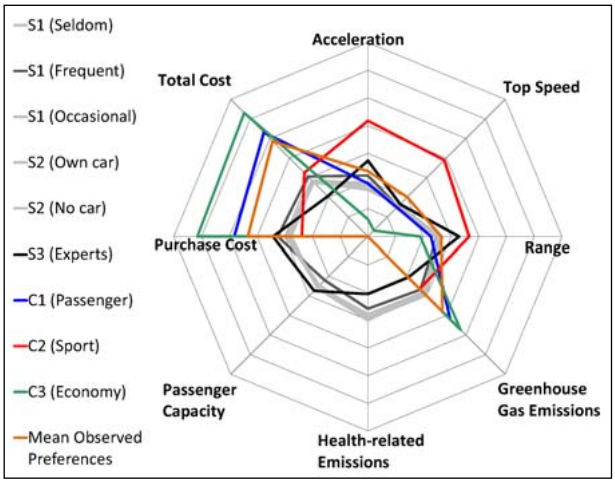

Figure 1: **Stated (S) and observed (C) preferences.**

The disparity seen in Figure 1 between stated and observed preferences shows that survey respondents generally underweight the financial, and overweight the environmental, criteria relative to real car buyers. This observation led to an investigation of how buyers' preferences could be derived from purchase data. The observed preferences calculated for the top 30 vehicles sold in Switzerland in 2010 are shown in Table 1.
The MCA algorithm was tested using real preferences, to find and compare the top-ranked 'virtual vehicle' to what consumers actually purchased, as shown in Table 1. Whenever the order of the 'green-yellow-red' triplets matches by column between the three datasets, the MCA algorithm accurately reflects the real-world trend. The algorithm performs very well

	Hybrid	Fuel (G-gasoline, D-diesel)	Displace-ment (L)	Electric Power (kW)	Battery charge (Ah)	Accel-eration 0-100 kph (s)	Top speed (km/h)	Range (km)	CO_2 (g/km)	NO_x (g/km)	Capacity (m3)	Purchase Cost (€)	Total Cost (ct/km)
Average criteria values for observed Swiss vehicle sales data clusters													
Passenger (C1)	-	G	1.4	-	-	11.9	177	789	133	n/a	n/a	16750	35
Sport (C2)	-	G/D	1.8	-	-	9.5	202	906	167	n/a	n/a	25600	46
Economy (C3)	-	G	1.2	-	-	13.5	160	778	124	n/a	n/a	9770	29
All	-	G/D	1.4	-	-	11.2	184	820	138	n/a	n/a	19102	38
Simulation models and MCDA top vehicle designs: only ICE gasoline vehicles													
Passenger (C1)	-	G	1.9	-	-	6.7	253	642	151	0.3	2.4	15965	24
Sport (C2)	-	G	2.9	-	-	6.2	269	719	288	0.2	1.7	26882	32
Economy (C3)	-	G	1.9	-	-	10.0	217	917	110	0.2	2.4	15309	21
Simulation models and MCDA top vehicle designs: All vehicles													
Passenger (C1)	Mild	Bio-Diesel	2.7	3	4.5	6.7	255	716	138	0.2	2.5	16959	24
Sport (C2)	Parallel	G	1.5	60	60	7.6	268	1197	175	0.2	1.7	37007	38
Economy (C3)	Mild	Bio-Diesel	1.7	3	4.5	10.0	219	1008	102	0.2	2.5	16303	22

Table 1: **Real and simulated vehicle characteristics coloured in triples by values to show agreement between model results and real consumer preferences (Red=low, yellow=mid, green=high, bordered=disagreement).**

for most criteria, consistently matching vehicle performance ranking with observed stakeholder preference ranking, except for the range criterion (bold border), that is difficult to match due to fuel tank size uncertainty.

The influence of varying input assumptions on vehicle design choice was investigated for Switzerland under six scenarios representing current and future technology and fuel costs (with economies of scale applied to electric and fuel cell vehicle technologies to generate reasonable manufacturing cost estimates). In Figure 2, the observed preference clusters C1 to C3 are taken as stakeholder preferences, and the first and second ranked vehicles from the MCA are presented for changing fuel cost and fuel chain emissions intensity (data from the US GREET database [3]). Bio-diesel and hydrogen fuel cell vehicles dominate the top spots for these preference weightings, due in part to their low emissions and acceptable range performance (where all-electric vehicles suffer a penalty).

In summary, a deviation between surveyed consumer preference and vehicle purchase behaviour was observed. The MCA algorithm was shown to accurately select vehicles that correspond to observed car sales based on preferences representing observed clusters of customers. Bio-diesel and hydrogen-fuelled non-hybrid, parallel, and fuel-cell hybrids are robust over a broad range of Swiss technology assumptions, for stakeholder profiles representative of current vehicle consumers.

It is important to emphasise that there are no technologies that satisfy all user criteria. In addition, there are many uncertainties concerning future fuel and technology costs and performance. In order to reconcile uncertainties with multiple stakeholder preferences in an interactive and meaningful way, a web-tool based on 'heuristic vehicle design' work has been created. This tool allows users to explore how their preferences and predictions of future technology characteristics influence which vehicle is top ranked for them. The web-tool can be accessed at multicriteria-analysis.com/. This work

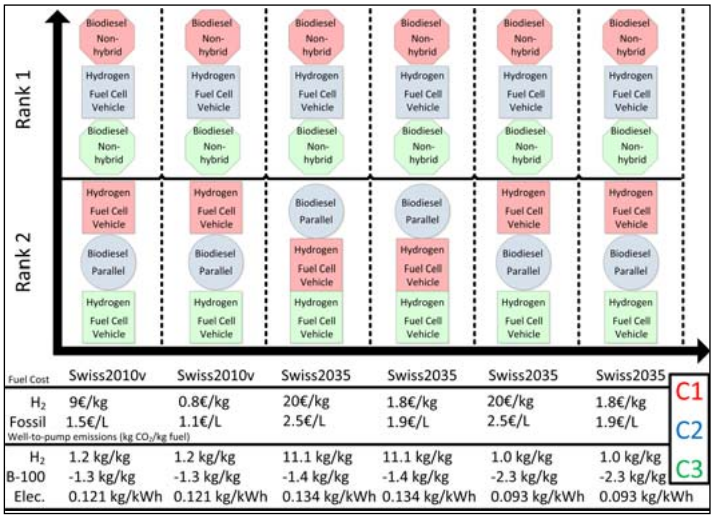

Figure 2: **Multi-criteria decision analysis on observed preferences over various present and future scenarios.**

represents the final stages of the CCEM HyCHANGE project, which will be expanded upon in the CCEM THELMA project (thelma-emobility.net), with the goal of assessing the electrification of personal vehicles and their interaction with the Swiss grid.

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SensiCam

User facilities 91

92 PSI accelerators

96 Swiss Light Source (SLS)

98 Spallation Neutron Source (SINQ)

100 Ultra-Cold Neutron Source (UCN)

102 Swiss Muon Source (SμS)

The Paul Scherrer Institute develops, builds and operates Switzerland's complex, large-scale research facilities, serving users from the national and international scientific communities. The topics under investigation include condensed matter research, materials and life sciences, as well as energy and environmental research. The facilities are the SINQ spallation neutron source, the SμS muon source and the SLS synchrotron light source. These provide beams of neutrons, muons and photons, respectively, making PSI one of only two research centres in the world with these three types of complementary research probes at one site.

Another traditional research field at PSI is elementary particle physics, and the studies performed here are complementary to the work carried out at high-energy facilities, such as the LHC at CERN. Concentrating on high beam intensity experiments with large numbers of particles enables very rare decay events to be detected or particle properties to be determined with great accuracy. In 2010, the Ultra Cold Neutron (UCN) source joined the suite of facilities at PSI intended for particle physics experiments. The UCN will contribute to our knowledge of the fundamental forces of nature by helping determine the properties of the neutron.

All of these facilities are powered by one of the two major accelerators at PSI: the neutron and muon sources by the proton cyclotron, and the synchrotron light source by an electron storage ring. An additional, smaller, proton accelerator is used for the proton therapy facilities. A large number of scientists and technicians work at the accelerators, for the benefit of the users, to ensure smooth operation and continuous improvement in performance.

The next large accelerator-based project, SwissFEL, will provide ultrashort, highly intense X-ray pulses for the investigation of fast processes and the determination of molecular structures. In 2010, the injector, representing the first stage of the SwissFEL accelerator, was inaugurated. This injector will be used to test and optimize accelerator components before they are incorporated into the final facility.

◀ **PhD student Elena Mengotti at the microscopy beamline at the Swiss Light Source SLS.**

Operation of the PSI Accelerator Facilities in 2010

Andreas Lüdeke, Anton C. Mezger, Marco Schippers, Mike Seidel, *Department of Large Research Facilities, PSI*

The Department of Large Research Facilities has responsibility for the operation and development of the accelerator facilities at PSI. These are: the High-Intensity Proton Facility, the Swiss Light Source and the Proscan medical accelerator. The Injector I cyclotron was shut down in 2010 after 37 years of very successful service for proton therapy, nuclear physics and material research applications. The new injector test facility for SwissFEL, PSI's free-electron laser project, is being commissioned. This article covers operational aspects of these facilities as well as new developments achieved in them.

High-Intensity Proton Accelerator (HIPA)

At the beginning of user operation, starting on 30 April 2010, excessive RF radiation from the third-harmonic cavity (150 MHz) in the Ring cyclotron caused several problems, including the ignition of a plasma in the vacuum chamber and unusually high dark current of the electrostatic extraction element. The cavity voltage had to be reduced, which in turn limited the maximum beam intensity that could be accelerated. The problem was solved, for the time being, by the removal of a beam stop (BR1) that presumably reflected RF waves in an unfavourable way. In the shutdown at the beginning of 2011, an additional system will be installed to allow the mechanical asymmetry of this cavity to be regulated, in order to minimize the out-coupling of RF power. The first production period, until 24 May 2010, showed not only an availability below 80 %, but also production current below 50 % of the nominal beam current of 2.2 mA (Figure 1). During the year, a new schedule for accelerator operation was introduced, with production periods of 3.5 weeks followed by 3.5 days for service and beam development. One of the reasons for implementing this schedule was the installation of a new ECR ion source in 2010 that requires less-frequent service actions than the former filament-heated source.

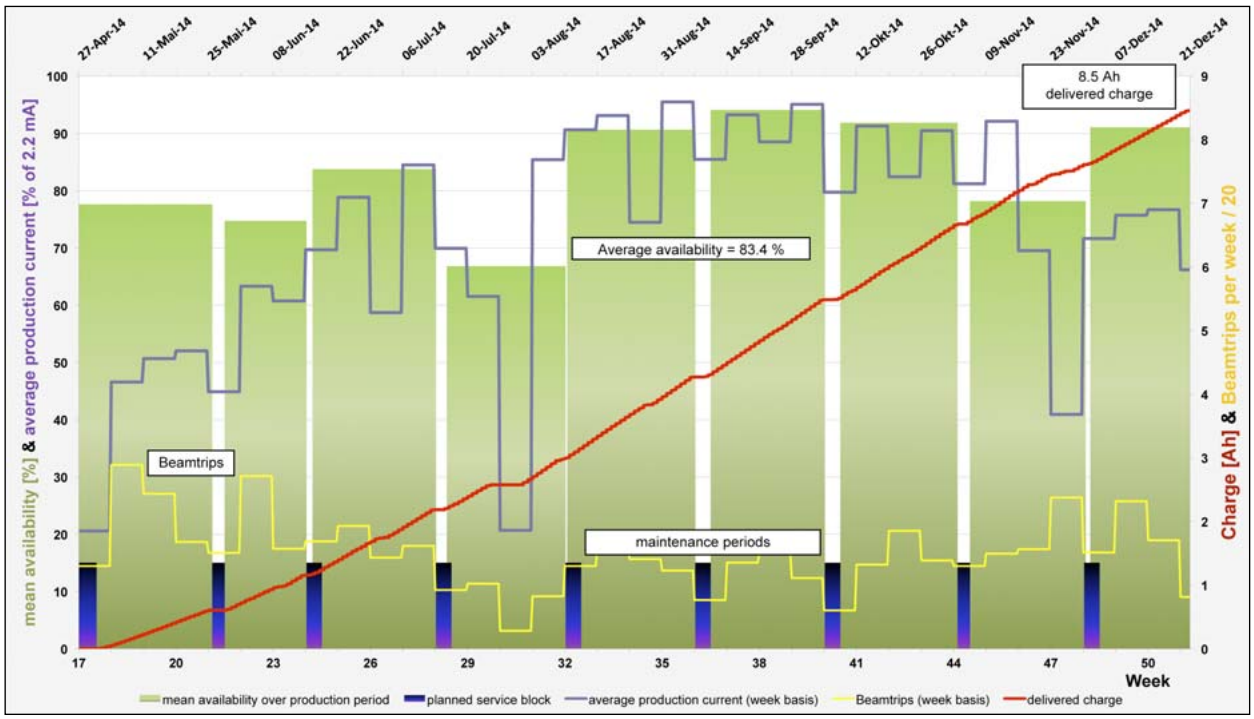

Figure 1: **Operation of the Proton Facility: availability, average current, delivered charge and beam trips.**

Beam-time statistics for HIPA	2010
Total beam time	
To meson production targets	5080 h
To SINQ	≈5000 h
Beam current integral	
To meson production targets	8.5 Ah
To SINQ	6.2 Ah
Outages	
Unscheduled outages > 5 min	536 h
Total outages (current < 1 mA)	843 h
Availability	**83.4 %**

Table 1: **Operational statistics for the proton facility.**

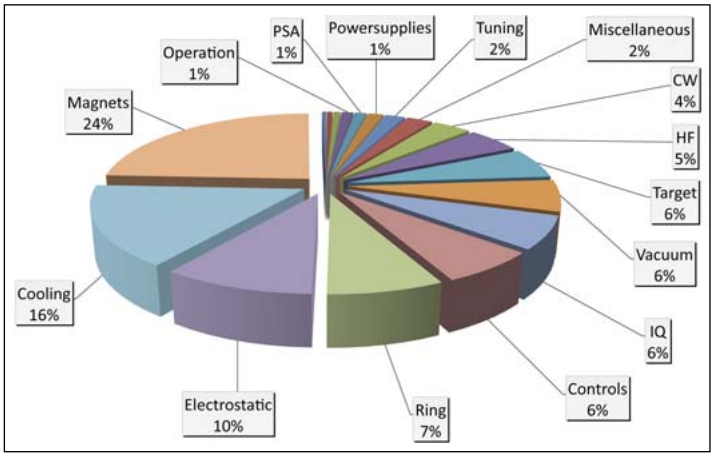

Figure 2: **Downtime characterization for HIPA outages longer then 5 minutes (ca. 340 hours).**

The new schedule also provides more flexibility for compensating for long outages, by giving up some of the service time if no urgent action is required. Examples of this are long outages in Week 30, due to a water leak of the in-vacuum magnet (AWC), and the failure of the electrostatic injection element (EIC) in Week 46. Both outages could be partly compensated for during the service blocks of Weeks 32 and 48.

Besides the failures mentioned above, the production period also suffered another major problem, starting in Week 47. This was the deformation of several trim plates in the Ring cyclotron, which most likely occurred because of overheating due to long-term deposition of RF power in connection with failure of the cooling circuit of the trim plates. The plates had bent inwards and formed a reduced gap of ≈ 20 mm height for the beam. In this situation, with a modified geometry of the vacuum vessel, discharges due to the RF (cavity 3) occurred. The accelerating voltage of cavity 3 had to be reduced, resulting in an increase in the number of beam turns. The maximum possible beam current was then limited to 1.8 mA, without affecting availability. Figure 1 shows the facility availability in blocks of four weeks, together with the weekly averaged production current, the charge accumulated on the 4 cm meson production target and the number of beam trips throughout 2010. The overall availability of the facility amounted to 83.4 %, which was considerable lower than that of recent years. As mentioned, some of the lost production time was regained by giving up beam development shifts, thus raising the availability to 88.1 %. The integrated charge was 8.5 Ah on Target E and 5.9 Ah on the SINQ spallation-target (Table 1). During the last week of operation, the new Ultra-Cold Neutron Source (UCN) was tested under production conditions. A programme of short and long pulses (up to 8 seconds) was performed on the UCN target, with currents up to 1800 µA. Cold neutrons were successfully detected, and 2011 will see this facility in user operation, with a beam pulse of 8 seconds every 800 seconds.

The various relative contributions to the downtimes in 2010 are shown in Figure 2. These downtimes were dominated by the categories: magnets, cooling, electrostatic devices and Ring. The last two items include the problems mentioned above. Outages in the category ‘magnets’ were caused by a water leak in the AWC magnet, while other failures of cooling systems are allotted to the cooling category. Together, these items represent a significant 40 % of the downtime longer then 5 minutes, and preventive measures should be taken to avoid problems arising from aging elements in the future.

PROSCAN

The 250 MeV cyclotron and beam lines of the proton therapy facility at PSI have reliably provided proton beams for patient treatment at Gantry-1 and, since 2010, for treatment at the OPTIS2 facility. Beam time has also been used for commissioning of Gantry-2, irradiations at PIF and accelerator R&D. The increase of activities since the beginning of patient treatment in 2007 caused a steady increase in operation time, reaching 5169 h in 2009 and 5933 h in 2010, reflecting the better utilization of the whole PROSCAN facility. Total availability in 2010 was 98 % (Figure 3) and the Center for Proton Therapy used 3450 h. The longest interruptions were caused by communication problems with a PLC, a molten fuse in the RF amplifier and a replacement of the vacuum window in the RF transmission line. During a scheduled 3-day repair, a stem of the RF cavity with a molten contact spring was replaced. The cause of this problem, which also occurred in 2008, is expected to be an unfavourable redistribution of currents during transients of the RF power, e.g. during a spark. Numerical simulation studies are needed to better understand this effect and to develop an effective solution.

Treatment at OPTIS2 has had a smooth and successful start. After the first treatment in January and further extension of

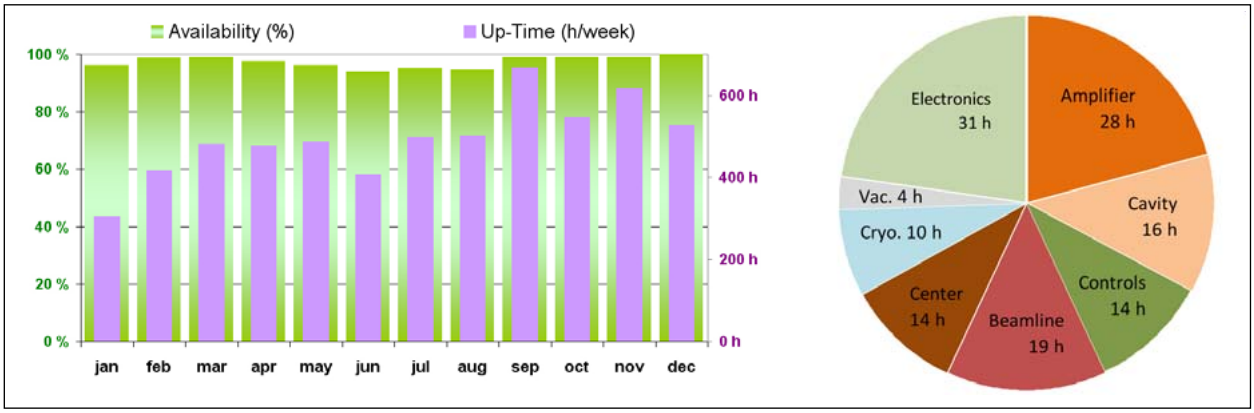

Figure 3: **Operating hours per month, availability of PROSCAN (left) and unscheduled downtime by causes.**

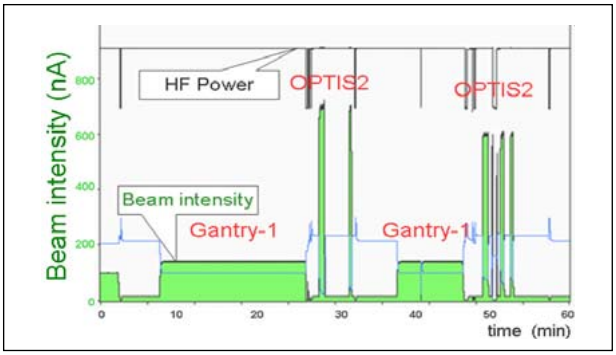

Figure 4: **Beam switching between the treatment rooms involves a change in extracted beam intensity and is done within 20 sec.**

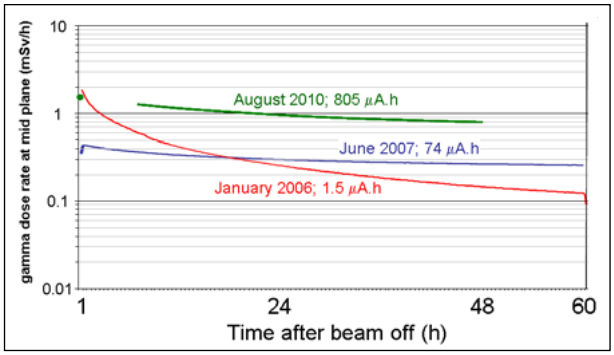

Figure 5: **Measured dose rate in the mid-plane of the opened cyclotron. The 2006 measurement was performed immediately after delivering 500 nA for 1.5 hours, and thus shows a steep initial decay.**

treatment possibilities with OPTIS2, the routine programme started in September. Switching the beam between the areas of Gantry-1 and OPTIS2 is carried out within 20 seconds, including adjustment of the beam intensity (Figure 4).

Accelerator development has focused on improvements to beam stability and reproducibility, and a study of the radioactivity created in the cyclotron. After 15 months of undisturbed operation, the newly developed tungsten puller tip is showing a remarkably long life-time, compared with 3 months for the old design.

Radioactivity in the cyclotron is caused by beam losses at extraction (20 %) and at the phase slits at 10 MeV (30–80 %). Activity and gamma spectra of selected inserts of iron and copper from the cyclotron have been measured and compared with MCNPX simulations. The very good relative agreement shown between simulation and measurement allows a prediction of the isotopic composition to be made, as well as an estimate of the dose rate that service staff will be exposed to in the future. Extrapolation of the induced activity furthermore predicts that 10 years of cool-down time, after 25 years of operation, is sufficient to reduce the activity below the legal limits for the major part of the material. The simulations also show that protons hardly activate the iron directly. In fact, activation is mainly caused by neutrons. In the mid-plane of the cyclotron (after it had been opened for service reasons), a steadily increasing amount of radiation from isotopes with a long half-life is observed (Figure 5). This suggests that cool-down times beyond 1–2 hours before service are not beneficial in reducing the dose to service staff.

Swiss Light Source (SLS)

In 2010, the SLS became the first third-generation, medium-energy light source not to use wigglers. The last wiggler was used by the materials science beamline to create hard X-rays, up to 30 keV. To generate radiation of this energy with an undulator, a very short period length is required, together with a very small gap. A cryo-cooled permanent magnet undulator of just 14 mm period length will now be used, operated with a minimum gap of 3.5 mm. This will increase the brightness of the photon beam for materials science experiments. A new type of vertical scraper has been installed, which now represents the tightest vertical aperture limitation in the storage ring. This measure will protect the in-vacuum insertion devices from radiation damage in the case of vertical beam

distortions. Average beam availability at the SLS reached about 96 % in 2010, and the mean time between failures remained at the very good level of nearly three days.

The year 2010 started with a major incident for the SLS. The liquid-helium cryostat of the third-harmonic cavity turned out to be contaminated after maintenance of the system in January. The start of user operation was therefore delayed by 100 hours, and this single event caused 50 % more downtime than all the incidents of 2009 put together. The source of the contamination is not certain, but in future, a longer cleaning procedure, by vacuum pumping, will be used for the cryostat system after each maintenance period, in order to prevent outages of this type.

In total, the six events of longer than five hours caused 70 % of the downtime. Figure 6 shows that the number and total duration of events shorter than five hours were about the same as in 2009.

We converted a block of eight development shifts into user operation reserve, since the first 100-hour outage alone would have already exceeded the foreseen user reserve time for the first half of the year. The total amount of user reserve time was finally sufficient to compensate for all beam outages in 2010. The operational data are summarized in Table 2, and Figure 7 shows beam outage events in 2010 assigned to the different failure categories.

In the first quarter of 2011, the materials science beamline will be re-commissioned with a cryo-cooled permanent-magnet undulator. The only planned new beamline will be the Photoemission and Atomic Resolution Laboratory (PEARL), which is currently under construction and is planned to start operation in 2012.

The SLS has started a collaboration effort within the European Test Infrastructure and Accelerator Research Area (TIARA) framework on ultra-low emittances. The very low coupling in the storage ring makes the SLS very suitable as a test-bed for damping rings of future linear colliders, and for the next generation of light sources.

Beam-time statistics for SLS	2010		2009	
Total beam time	6720 h	76.7%	6720 h	76.5%
• User operation	5191 h	59.3%	5007 h	57.1%
– incl. reserve time	227 h	2.5%	144 h	1.6%
• Beamline commissioning	680 h	7.8%	896 h	10.2%
• Setup + development	845 h	9.7%	800 h	9.1%
Shutdown	2048 h	23.3%	2064 h	23.6%
User operation downtimes	76		68	
• Downtime duration	214 h	4.1%	66 h	1.3%
• Injector faults (non top-up)	9 h	0.2%	14 h	0.3%
Total beam integral	2460 Ah		2448 Ah	
Availability	95.9%		98.7%	
Availability, compensated	100.3%		101.6%	
MTBF	67.4 h		72.6 h	
MTTR mean time to recover	2.8 h		1.0 h	

Table 2: **SLS Operation Statistics.**

Development of the SwissFEL Injector

A 250 MeV injector linac has been built at PSI [1] to enable the creation of high-density electron pulses suitable as the first acceleration stage for the SwissFEL project. The injector facility was inaugurated in August 2010 and its operation started from an independent control room in the WLHA building of the facility. Operation moved to the main control room in October and the operator team is now actively participating in the commissioning of this new facility. This will help to train the operators on the new facility early on and allow the accelerator physicists to focus their efforts on the design of the SwissFEL facility.

Reference

[1] M. Pedrozzi, Th. Schietinger, Th. Schilcher, *First Operation of the SwissFEL Injector Test Facility,* p. 14, this Report.

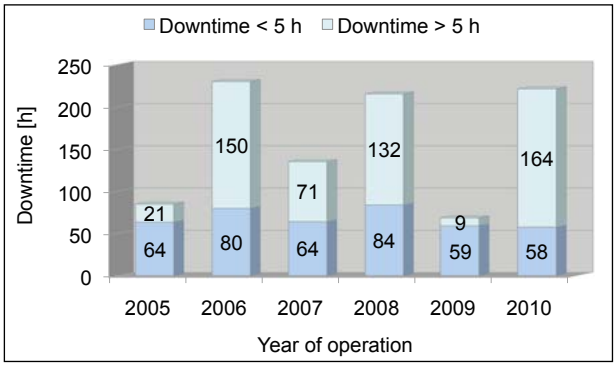

Figure 6: **Downtime totals for long and short events.**

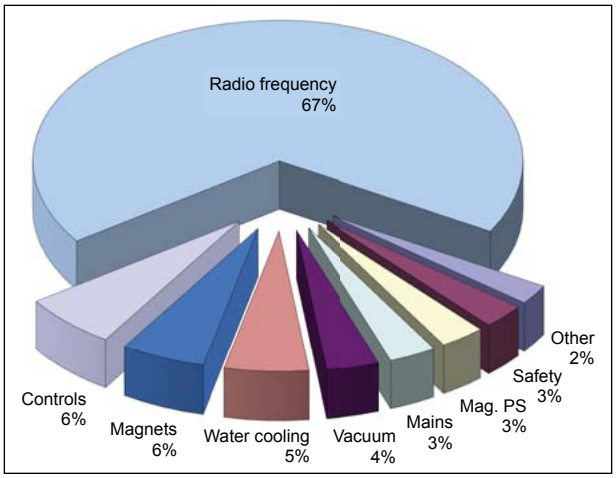

Figure 7: **Beam outages per failure category in 2010.**

The Swiss Light Source in 2010 – Covering the whole spectrum of applications

Stefan Müller, Jeroen van Bokhoven, Clemens Schulze-Briese, Christoph Quitmann, J. Friso van der Veen,
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The SLS continues to be a jewel among the synchrotron radiation sources. The reliability of the machine was higher than 95 % in 2010 and the number of user visits increased slightly compared with 2009. The geographic distribution of SLS users has stayed relatively constant over the years and showed a 55 % to 45 % ratio of international to Swiss users in 2010. With the inauguration of the new, independent XIL-II beamline, more beam time for X-ray interference lithography is now available, ready to serve industrial and academic research. Three new beamlines, NanoXAS, Phoenix and X-Treme, saw their first light and started to host pilot users in the second half of 2010. The high quality of the instrumentation and the broad spectrum of applications offered by the SLS have built a scientific environment which attracts excellent researchers from all over the world, which is proven by the high number of peer-reviewed publications produced. Public outreach activities by SLS included successful international conferences and workshops, as well as the PSI summer school.

High number of user visits – level of saturation achieved

The past year again showed an increase in the number of user visits, which rose to 3221. However, the statistics of the last eight years show that the SLS is close to achieving a level of saturation for hosting users. Sixty percent of these visits are by international users staying more than one day at the facility. On average, each individual user visits the facility twice a year. In general, the three protein crystallography beamlines are visited more often than the others. Protein crystallographers, therefore, are highly interested in reducing the number of time-consuming journeys by benefiting from the excellent SLS mail-in service and future remote-access services.

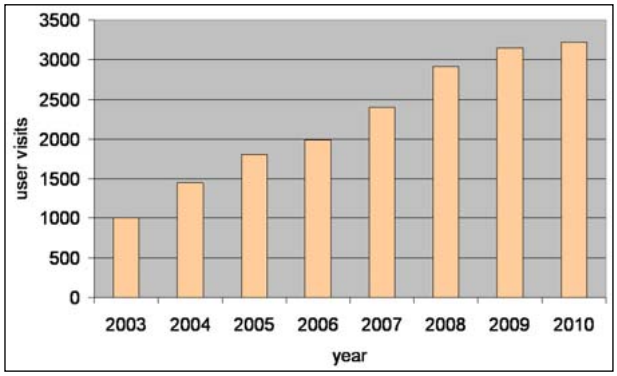

Figure 1: **Number of user visits in the years 2003–2010.**

Open access and industrial use

Access to the SLS is supported through the European integrated infrastructure project ELISA, for users from EU member or associated states. In 2010, approx. 250 projects were supported through ELISA.
In 2010, 85 % of the industrial experiments performed at SLS were carried out at the PX beamlines by companies such as Roche, Novartis and Böhringer. However, with the new X-ray interference lithography beamline XIL-II, the upgraded powder diffraction beamline and the TOMCAT beamline, a further development of proprietary user operation is envisaged.

Committees – advising for the future and evaluating scientific merit

The SLS Photon Science Advisory Committee (Photon-SAC) met in spring and autumn 2010. The committee is headed by Gerhard Materlik (Diamond Light Source) and advises PSI on the strategy to be followed for the SLS, SwissFEL and their collaborations.
The two Proposal Review Committees (PRC) evaluated a total of 661 proposals. The thorough evaluations performed by the experts in these two committees ensure fair treatment of users. However, due to an oversubscription of the beamlines by, on average, a factor of two, many promising and challenging proposals could unfortunately not be granted beam time. The

non-PX and PX committees are chaired by Philip Aebi (University of Fribourg, Switzerland) and Nenad Ban (ETH Zurich), respectively.

Pilot phase of new beamlines and inauguration of the new XIL-II beamline

Three new beamlines, NanoXAS, Phoenix and X-Treme, saw their first light and started to host pilot users in the second half of 2010. They will all be fully operational in the second half of 2011. The NanoXAS beamline aims to combine the benefits of scanning force microscopy with those of X-ray spectroscopy. For this purpose, the NanoXAS-team constructed an instrument combining a scanning, transmission X-ray microscope with a beam-deflection, atomic-force microscope in a coaxial geometry. This allows X-ray absorption spectroscopy and high-resolution topography to be combined in-situ. If the conventional scanning probe tip is replaced by a coaxially-shielded tip, the instrument will allow the detection of photoelectrons produced at photon energies around a core-level absorption edge, with a spatial resolution approaching that of an atomic-force microscope. Phoenix and X-Treme are both beamlines for X-ray absorption spectroscopy, with Phoenix focusing on environmental and materials research and X-Treme on research of magnetic phenomena in high magnetic fields and at low temperature. NanoXAS has been built in collaboration with EMPA and the University of Erlangen-Nürnberg, X-Treme in collaboration with EPFL.

Owing to the great success of the X-ray Interference Lithography beamline (XIL-I), which has been operating as a branch of the SIS beamline, it has been decided to make a significant upgrade of this beamline. XIL-II is now an independently-operated beamline having its own undulator and on-site clean-room facility. Its availability and performance are thereby increased. It provides periodic lithographic structures for academic users and can be used as a test bed for state-of-the-art lithography by industry.

Construction of the last SLS beamline, PEARL, has started and it is expected to become operational in 2011. The MS beamline is undergoing a comprehensive upgrade. The wiggler was replaced by a short-period (14 mm) in-vacuum, cryogenically-cooled, permanent-magnet undulator, (CPMU, U14), while the front end and optics will be completely redesigned to optimally exploit the characteristics of the U14 source. In addition to providing fundamental improvements to both powder and SXRD experiments, the upgrade will provide new opportunities for challenging experiments.

Great educational opportunities

It is an important part of our mission to train the next generation of scientists and to increase awareness about the unique opportunities that large-scale facilities offer for studying important scientific questions. It is an important asset of the SLS that about 50 % of its users are either PhD students (30 %) or PostDocs (20 %), and that they show a huge interest in our training activities. At our last summer school – the 9th PSI Summer School on Condensed Matter Research – from 7–13 August 2010, the topic was "Magnetic Phenomena". The lectures in Zuoz had 114 participants and 27 of these took part in the subsequent hands-on training at PSI, using all three different probes (muons, neutrons and photons).

Awards and science highlights

The SLS spin-off company DECTRIS Ltd, founded in 2006, won the prestigious 2010 Swiss Economic Award for start-up companies. DECTRIS is the first company in the world to sell novel hybrid-pixel X-ray detector systems which operate in single-photon counting mode. This new technology features a very high dynamic range, a short readout time and an excellent signal-noise ratio. Secondly, on 26 November 2010, Christian David, a scientist at the Laboratory for Micro and Nanotechnology in the SYN department, received the Röntgen Prize for research in radiation science. David pioneered a method for enhancing the quality of X-ray images and received the award jointly with Franz Pfeiffer, from the Technische Universität München, who worked closely together with him. In 2010, a remarkably high number of user publications were generated (445 in total), of which 42 were published in the leading journals Science, Nature, Cell and Phys. Rev. Letters. This illustrates the excellence of our user community and our in-house staff.

We thank all of our users for their loyalty, for the excellent science they brought to the SLS in 2010 and, last but not least, for their friendly cooperation.

The Swiss Spallation Neutron Source in 2010

Stefan Janssen, Jürg Schefer, Werner Wagner, Kurt N. Clausen, *Department of Research with Neutrons and Muons (NUM), PSI*

The year 2010 was, in general, a very successful one for SINQ. The neutron source again operated with high stability, but, as a consequence of problems with the proton accelerator, the total delivered charge was slightly lower than in 2009 (5930 mAh compared with 6218 mAh). The number of new proposals submitted for beam time at SINQ reached a record high of 355. Towards the end of the year, important tests of the monochromator shielding for the new instrument EIGER were successfully completed. New facilities on the SELENE/AMOR instruments were installed and the first trial of the new test instrument BOA took place.

Stable and successful SINQ operation

During 2010, SINQ operated with the same target as was used in 2009, now in its 7th generation. Again, performance of the target and the whole neutron source infrastructure was extremely good. The target received a total charge of 5930 mAh and had an availability of an outstanding 99.8% relative to the delivered proton beam. Nevertheless, overall availability was slightly lower than in 2009, because of the reduced performance of the proton accelerator.

Again, 2010 was a very successful year for SINQ user operation. Between May and December, 483 experiments were performed by 465 different users. The 13 SINQ instruments in operation for users provided a total of almost 2000 instrument days.

From the very beginning of its operation, SINQ has been the home base for the Swiss neutron scattering community. This was again clearly confirmed in 2010, with 59% of beam time being used by Swiss groups, who came mainly from PSI, ETH Zurich, EPF Lausanne, the University of Fribourg and Empa.

Nevertheless, SINQ is also open to users from the international user community and is well accepted by them. In 2010, scientists from 29 different countries made use of the SINQ instruments for neutron scattering and imaging. The largest foreign user community again came from Germany (8%), followed closely by groups from the United Kingdom (7%), Denmark (4%) and France (3%). But many groups from overseas also visited the Swiss neutron source, with scientists from the US, Japan, India and Russia using a total of 9% of the available beam time.

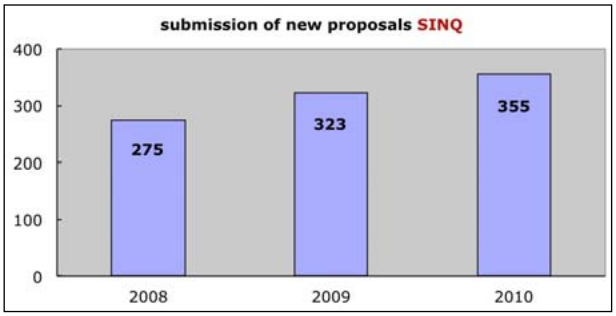

Figure 1: **Number of SINQ proposals submitted in the period 2008–2010.**

In 2010, the user community submitted more proposals than ever before with the user office counting a total of 355 new SINQ proposals submitted at the two deadlines, in May and November (see Figure 1). Ninety-six proposals were submitted for the facilities for small-angle scattering and reflectometry, 111 for the diffraction instruments, 79 for spectroscopy and finally another 69 for the two imaging beamlines at SINQ.

Instrumentation and highlights

The central project of the Laboratory for Neutron Scattering (LNS) in 2010 was the installation and testing of the monochromator shielding for the new triple-axis spectrometer EIGER (Figure 2), in collaboration with the Laboratory for Development and Methods (LDM). The new instrument will expand the energy/momentum range accessible to the triple-axis instruments at SINQ at the upper end (1–60 meV, 1–6 $Å^{-1}$). It will be equipped with a large, double-focusing PG monochromator (19.6 cm by 41.6 cm), with the possibility of installing

further automatically exchangeable monochromators later on, but firstly to be operated with the former Drüchal secondary instrument. The shielding test showed that the transmitted radiation is well within expectation. The shielding shows excellent performance, which will be sufficient even if the SINQ flux doubles in the future.

SELENE/AMOR passed its first test with an exchangeable elliptical guide, allowing measurements on small samples, in the time-of-flight mode, to be improved by approximately one order of magnitude, as illustrated in Figure 3.

The former FUNSPIN was replaced in 2010 by BOA, a new test stand for large optical neutron components using polarized neutrons.

Besides the advances made in instrumentation, LNS produced many publications – either in spite of, or because of, the limited number of neutron-days available – showing many highlights, such as the low-temperature magnetic phase diagram of the multiferroic system $FeTe_2O_5Br$ [1], phase transitions in conjugated polyelectrolyte [2], magnetic ordering in solid oxygen up to room temperature [3], or magnetic flux lines in type-II superconductors and the mathematical reasoning with the hairy-ball theorem [4].

LNS also increased its services to the Swiss universities by offering, or extending, its training courses for advanced students: VPP for ETH Zurich; training weeks for the University of Basel; and training weekends for the Zuoz students.

Conferences and schools

Many SINQ source and instrument scientists were involved in the organization and the scientific programme of two events organized by PSI during 2010: In March, 196 participants gathered at Grindelwald for the 19th ICANS meeting of the International Collaboration on Advanced Neutron Sources, where topics such as accelerators for high-power or high-efficiency neutron sources, target station design, neutron scattering instrumentation and neutron optics were discussed.

In August, PSI organized its traditional Summer School on Condensed Matter Research in Zuoz/Engadin. As usual, the material taught was aimed at training young scientists at PhD or Postdoc level in the methods offered at the PSI user facilities, such as, for example, neutron scattering. The school was attended in 2010 by 114 participants from 16 different countries, and was complemented by practical training sessions at the PSI facilities of SINQ, SμS and SLS.

For the very first time, the Summer School on Condensed Matter Physics in 2011 will not be organized in Zuoz, but in Zug. The format itself will remain as before, however, and we look forward to a successful start to the new era.

References

[1] M. Pregelj et al., Phys. Rev. B **82** 144438 (2010).
[2] M. Knaapila et al., Langmuir **26** 15634 (2010).
[3] S. Klotz et al., Phys. Rev. Lett. **104** 115501 (2010).
[4] M. Laver, E. Forgan, Nature Communications **1** 45 (2010).

Figure 2: **The EIGER area with the new monochromator shielding.**

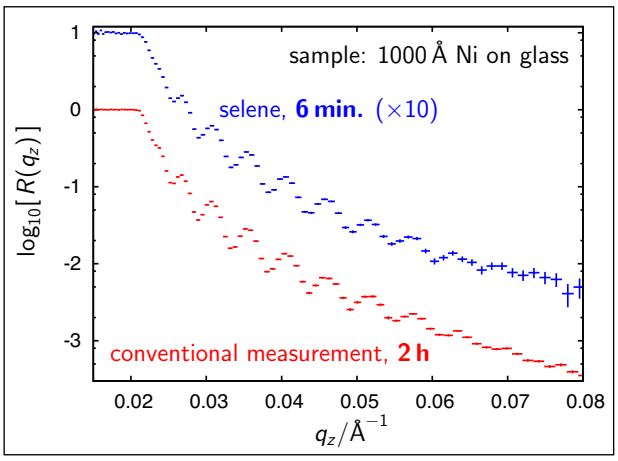

Figure 3: **Performance gain using the new elliptical guide on SELENE/AMOR, demonstrated on an Ni layer.**

Commissioning and first operation of the new, ultra-cold neutron source at PSI

Bertrand Blau, *on behalf of the PSI UCN project team, Spallation Neutron Source Division (ASQ) and Laboratory for Particle Physics (LTP), Department of Research with Neutrons and Muons (NUM), PSI*

In 2010, the ultra-cold neutron (UCN) team finished assembling PSI's new spallation neutron source dedicated solely to the production of UCN. The project team was able to demonstrate that all major subsystems of the new facility functioned extremely well. In December, UCN were produced for the first time and under full load. Performance was found to be as expected, under the present operational conditions. After the shutdown in spring 2011, the source will provide UCN to fundamental physics experiments in two experimental areas. Meanwhile, an experiment to detect the neutron electric dipole moment has already been set up in 'Area South'.

Construction of the PSI source for ultra-cold neutrons (UCN) was completed in 2010. The new UCN source is the second spallation target station driven by the PSI ring cyclotron and is designed to take macro-pulses of up to 8 s at the full proton beam intensity (590 MeV, >2 mA). Spallation neutrons are firstly thermalized in heavy water and then cooled down and converted to UCN in solid deuterium, at 5 K. The UCN can leave the solid deuterium upwards via the vertical guide into the ~2 m^3 UCN storage volume coated with diamond-like carbon (DLC). From here, the UCN can be delivered to the experimental areas via NiMo-coated neutron guides at three available beam ports. Storing and guiding ultra-cold neutrons ($v \leq 7$ m/s) is possible because of total reflection from material surfaces with sufficiently high neutron optical potential (e.g. DLC, Beryllium or Nickel).

In 2010, the UCN storage volume, thermal shield and UCN guides were inserted into the UCN vacuum tank. The technically most challenging component, the moderator vessel containing the frozen D_2, was also completed and thoroughly tested. The thin-walled aluminium vessel is cooled by supercritical Helium at 4.6 K, circulating in a multi-channel labyrinth through the side wall and bottom plate. In November, the whole 5m-long unit consisting of the moderator itself, its cryogenic piping, the UCN shutter valve and a large cryopump was successfully installed (Figure 1) inside the UCN tank.

The complete cryogenic system, including a special cold box and the stand-alone helium refrigerator, were commissioned during the first half of December, culminating in cooling 27 m^3 of deuterium gas in 60 hours down to a temperature of 5 K, yielding about 27 litres of solid D_2.

The license to start full commissioning arrived on 16 December and, between 16 and 22 December, the source was operated with the aim and duty of demonstrating the principle functioning of all major subsystems. Different modes of operation were tested, starting with 5 ms short pulses ramping from 100 µA

Figure 1: **Insertion of the Deuterium moderator unit into the UCN vacuum tank. The moderator vessel, designed to contain up to 30 litres of solid Deuterium at 5 K, is located at the lower end of the unit.**

to 1.8 mA (the operational limit of the accelerator at the time of testing). This was followed by a continuous 10 µA beam for mapping of the radiation field and dose rates around the biological shielding, especially in the experimental areas. Finally, longer pulses were delivered, starting from 500 µA for 2 s up to 1.8 mA for 8 s.

Testing of the whole accelerator chain and beam diagnostics was very successful and the desired pulses were reliably delivered. Long, intense pulses of the 1 MW beam always had 5 ms pilot pulses running a few seconds ahead and guaranteeing perfect adjustment of the proton beamline. The heavy-water system, including cooling of the spallation target and target window, had been tested before, at the end of 2009, and again performed reliably, as expected.

The cryogenic system of the source behaved extremely well in its first-ever cool-down, with the moderator vessel being cooled to below 5 K without any problem. Moderator cooling was very satisfactory, even when filled with deuterium and under full beam load. At all times, the ultra-cold neutron performance of the source was monitored by in-situ detectors and detectors at the end of all beamlines.

Figure 2 shows the UCN rate measured during and after a 1.8 mA proton pulse of 2 s duration. After the pulse, the UCN were trapped in the storage volume for 5 s and a shutter opened towards an experimental area where the UCN were detected by a special neutron counter. The decreasing UCN count rate displays nicely the draining of the storage volume into the guide and detection system over a period of more than 300 s. Both the UCN storage volume and the guides behaved as expected. Due to the approaching scheduled accelerator shutdown, the deuterium crystal had to be frozen under sub-optimal conditions (no para-to-ortho conversion, fast freeze out). Previous investigations had demonstrated that a slowly cooled ortho-Deuterium crystal displays a much larger UCN production than a quick-frozen one. In this respect, the observed UCN production rate was within expectation and considerably increased in the warm-up phase towards liquefaction, demonstrating the potential for improvement. The experiments can now expect the predicted UCN intensity once good ortho-deuterium crystals can be created, after the accelerator shutdown in spring 2011.

As a last highlight, the neutron electric dipole moment (nEDM) experiment was able to successfully detect its first UCN, both from a direct beam and after storage. The nEDM experiment originally motivated the UCN source project and it will remain the flagship experiment for the next few years. A permanent nEDM would violate time reversal symmetry which, in fundamental physics, is intimately connected to an asymmetry between matter and anti-matter, which should have been produced in equal amounts in the big-bang. The very fact that we ourselves are made of matter, and that the anti-matter seems to have vanished from our universe, calls for such an asymmetry. Earlier searches could not yet find a finite nEDM, but this time may be special as the sensitivity for its detection will be much increased, initially by a factor of 5 and ultimately by more than 50 times. The discovery of a permanent electric dipole moment would be a major breakthrough for our understanding of the universe and of fundamental particle physics.

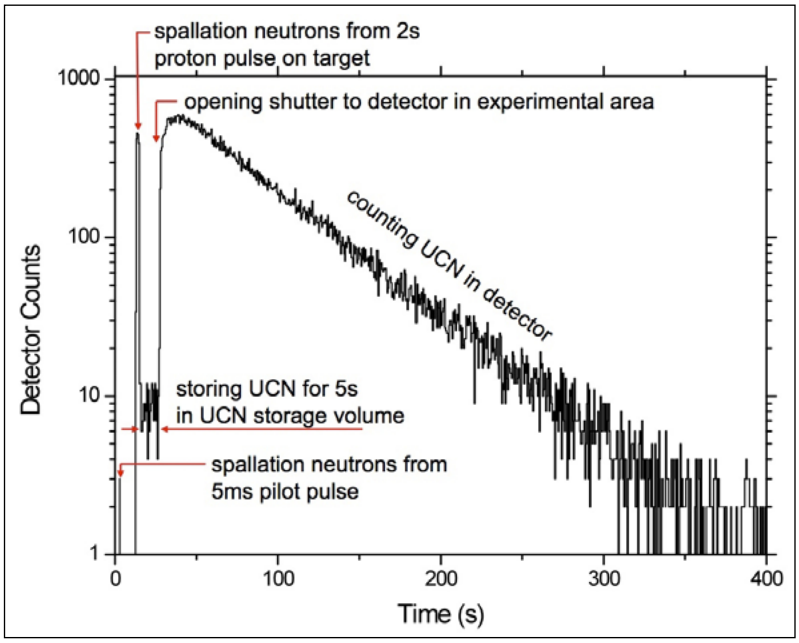

Figure 2: **Count rate versus time after the beam pulse in one of the UCN counters. A peak due to spallation neutrons during the beam pulse (1.8 mA, 2 s) can be seen, which is followed by a 5 s storage time. Then the shutter towards the experimental area and detector is opened and the UCN are counted. The count rate decreases due to draining of the storage volume.**

The Swiss Muon Source (SμS) in 2010

Elvezio Morenzoni, *Laboratory for Muon Spin Spectroscopy (LMU), PSI;*
Stefan Janssen, *Department of Research with Neutrons and Muons (NUM), PSI*

The demand for Swiss muons is greater than it ever has been. In 2010, a total of 201 new requests for muon beam time were submitted, which is 13% more than the previous record, in 2009. Substantial progress has also been made towards a new high-field, low-temperature instrument.

User Laboratory SμS

The Swiss Muon Source, SμS, is one of the large-scale PSI user facilities and can look back on a very successful year in 2010. During the operational period between April and December, the six SμS instruments delivered more than 700 experimental days, during which almost 190 experiments could be completed successfully. These numbers, together with the more than 400 visits registered by the user office, represent a 10 –15 % increase over the past year. The unbroken increase of these indicators, which we have been experiencing during the past few years, clearly indicates the strong need for the SμS facility, now and also in the future. However, this puts an increasing burden on the LMU staff who, besides carrying out their own research programmes and development work, are bearing the burden of user support and instrument operation.

Research and development

The scientific relevance of the use of muons in condensed matter research is well reflected in the papers which appeared in the course of 2010. These include publications in journals with high impact factor, such as Nature Materials (2), Journal of the American Chemical Society (1), Angewandte Chemie (1), Physical Review Letters (10) and the 30 papers in Physical Review B. Worldwide, SμS has established itself as the most active μSR centre for the investigation of the new Fe-based superconductors. On the other hand, the unique depth-dependent magnetic information obtained by the low-energy muons has resulted in several scientific highlights.
Parallel to these activities, considerable progress has been made towards the realization of the new high-field μSR instrument, as well as of the crucial upgrade of the low-energy μSR facility to provide it with a dedicated spin rotator and the possibility of performing longitudinal field measurements. Both projects rely on the use of novel positron spectrometers, based on solid-state APD detectors, which have been developed and brought to maturity in our Laboratory. The new spectrometer has already been commissioned in the low-energy muon beam line. The excellent time resolution in high magnetic fields, essential for the high-field μSR instrument, is well documented by the spectrum shown in Figure 1. This shows the precession signals of the free muon and of the muon bound to an electron (Muonium), a hydrogen isotope formed in quartz when muons thermalize in it. The observation of these transitions means that the overall time resolution of the detector is 80 picoseconds, a value about a factor of 10 better than that is achieved in conventional spectrometers.

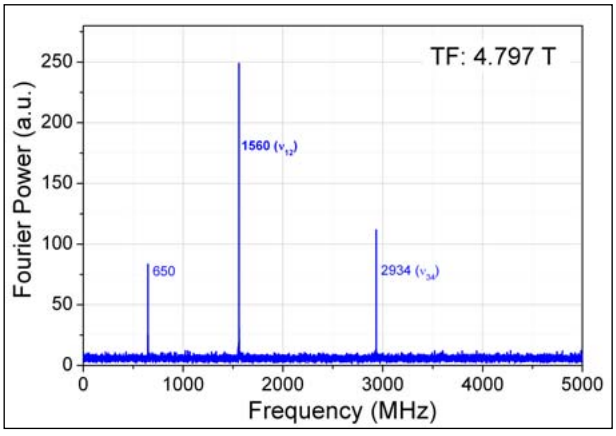

Figure 1: **Frequency spectrum of a μSR spectrum in a quartz crystal in a field of 4.797 T at ambient temperature, obtained with APD-based, fast-timing detector modules. The free-muon precession and two-muonium precession frequencies are observed. From the signal amplitudes, a time resolution of 80 ps is inferred. Such a high frequency μSR signal in a high magnetic field has never before been measured.**


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The design and construction of the large research facilities at the Paul Scherrer Institute constantly require new and innovative solutions at the cutting-edge of current technologies. Both scientists and engineers at the Institute are successfully pushing the limits in various technological fields, from power electronics to precision machining to nanotechnology. Alongside achievements in the various research fields being investigated at PSI, these accomplishments offer outstanding opportunities for commercialization by industrial partners.

The Technology Transfer office at PSI is ready to assist representatives from industry in their search for opportunities and sources of innovation at PSI, or to prepare the way for solutions to their own technological challenges.

The following pages present some promising technologies still to be discovered by our industrial partners.

◀ **PhD student Pallavi Verma investigating materials for novel batteries.**

◀◀ **PSI researcher Benjamin Watts mounting a sample at the PolLux beamline at the Swiss Light Source SLS.**

Technology Transfer: At the gateway between research and industry

Robert Rudolph, *Technology Transfer Office, PSI;* Stéphane Pierret, Helena Van Swygenhoven, Anders Kaestner, *Spallation Neutron Source, PSI;* Anna Paradowska, *ISIS, UK;* Thomas Etter, *Alstom, Switzerland;* Helmut Schift, Arne Schleunitz, Jens Gobrecht, *Laboratory for Micro- and Nanotechnology, PSI;* Xavier Deupi, Gebhard F.X. Schertler, *Laboratory of Biomolecular Research, PSI*

The mission of the Technology Transfer office is to facilitate the transfer of inventions and technologies generated by PSI's broad research activities from the laboratory to industrial applications. Such transfer activity aims to increase the competitiveness of PSI's industrial partners in their markets by offering innovations for new products and processes, or opportunities for further developments and improvements. If this economic impact consequently creates new employment and new products that advance everyday lives, the society supporting our Institute benefits from the exploitation of our scientific work.

Technology-transfer projects rely on the quality of the relationships between the persons involved in different aspects with both partners. A major factor shaping these relationships is the layout of the contractual framework and collaboration concept adopted for each transfer project. The greatest task within these boundary conditions is the alignment of the needs and expectations of the industrial and scientific partners.

The most effective way of transferring competencies in technologies and know-how is to "transfer" people, who not only take along additional, intangible knowledge to the company but also the enthusiasm to transform their research into industry-standard applications. PSI has experienced the successful "person transfer" of both PhD graduates and senior scientists.

A very useful way of supporting industrial research and development is to make available the instruments and methods used at our large research facilities. As a user lab, PSI develops and operates instruments and equipment for a wide range of applications, from material and structure analysis to imaging. The services offered by PSI include the evaluation of the appropriate measurement configuration, support with data acquisition and expertise in data analysis. The following section showcases the work performed at the Swiss Neutron Spallation Source in the context of a funded project with the industrial company Alstom on the subject of residual stress in turbine blades.

From the economic point of view, the most significant model of technology transfer is to have projects involving intellectual property rights (IPR) generated at PSI. If it is the granting of rights to use PSI-owned IPR or the transfer of patents, the industrial partner expects a direct economic advantage from applying such protected IPR in their products and is ready to compensate PSI for this advantage.

Research collaborations offer companies the opportunity to tap PSI's know-how and technologies early in the innovation process. Depending on the technological situation and requirement, a collaboration framework will be set up that equally matches the interests of the industrial partner and PSI. An agreement which includes the project plan, provisions on intellectual property and confidentiality is the basis for such collaboration. The Laboratory of Biomolecular Research at PSI is a leading lab in the research of G protein-coupled receptors. These receptors play an essential role in our organisms and therefore are of interest in the research of various diseases. The lab has entered into collaborations with various industrial partners to advance the knowledge of these receptors.

If you are interested in one of the technology transfer models described above, or if you are looking for advice or consultation on a specific topic, the Technology Transfer office is ready to connect you with the matching competencies at PSI.

Neutrons for high-temperature materials

Due to their high-temperature creep resistance and strength, single-crystal (SX) nickel-based superalloys are used in land-based gas turbines for power generation. However, residual stresses can be created while the blades are cooled from

temperatures above 1200 °C to room temperature during the manufacturing process. Relaxation of these residual stresses during subsequent heat treatment can lead to a degradation of the microstructure, decreasing the mechanical properties of the material.

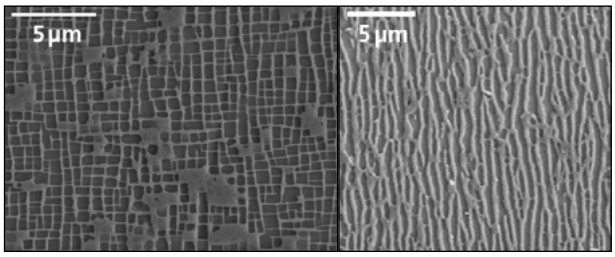

Figure 1: **SEM micrographs showing, on the left, the initial microstructure of an SX Ni-based superalloy, where the cuboidal γ′ precipitates are embedded in the γ matrix, and, on the right, degraded microstructure observed at the end of the manufacturing process of the turbine blade.**

To investigate the origin of the observed microstructure degradation in a turbine blade, neutron imaging and neutron diffraction methods have been combined. A turbine blade has a complex hollow structure, because of the presence of interconnected cooling channels. Neutron tomography is performed in order to obtain a 3D reconstructed image of the blade, as illustrated in Figure 2. This allows visualisation of the internal structure of the blade and enables correct selection of the areas within the blade where residual stresses have to be measured by neutron diffraction. This research is performed at three beamlines – the imaging beamline NEUTRA and the diffractometer POLDI (see Figure 3) at the neutron spallation source SINQ at PSI, and the diffractometer ENGIN-X at the neutron spallation source ISIS (UK).

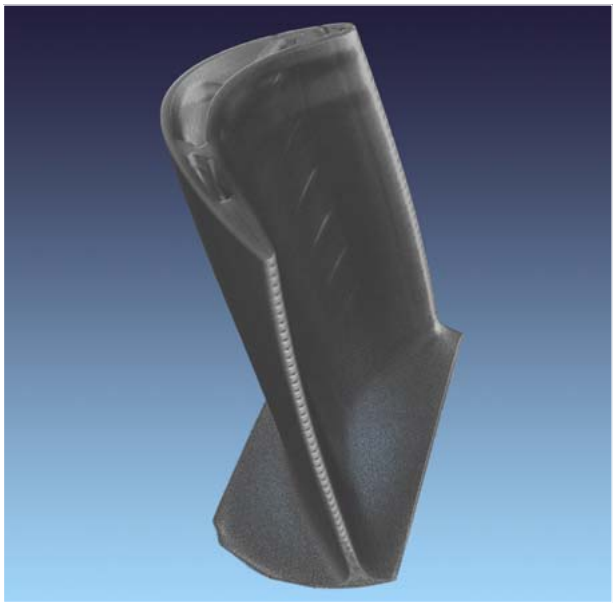

Figure 2: **3D reconstructed image of the turbine blade provided by Alstom, obtained by neutron tomography (NEUTRA, SINQ).**

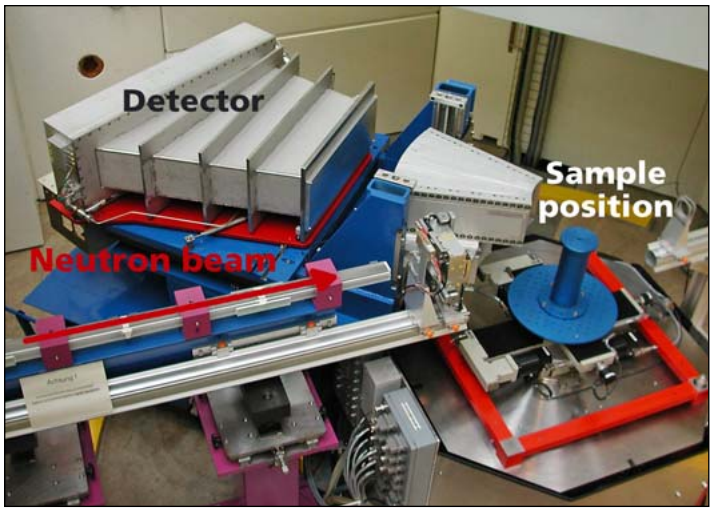

Figure 3: **Layout of the neutron strain scanner POLDI (SINQ).**

This research project is financed by the Competence Center for Materials Science and Technology (CCMX), a centre initiated by the ETH Board in 2006. The centre synergises the strengths of four ETH Domain institutions (EPFL, ETHZ, Empa and PSI) and the Swiss Center for Electronics and Microtechnology (CSEM), and involves the active participation of partners from industry, industrial associations and Swiss universities. Hence, by reinforcing the link between academia and industry, it aims to serve the interests of Switzerland in the field of materials science in terms of research, education and technology transfer. It is in this perspective that the research on turbine blades involving PSI and Alstom was begun in 2008, within the Metallurgy Education and Research Unit (MERU) of CCMX.

GPCR Competence Center – Department of Biology and Chemistry (BIO)

G protein-coupled receptors (GPCRs) comprise the largest family of proteins in the human genome. These proteins sit on the surface of virtually every cell of our body, responding to a wide variety of endogenous substances by activating intracellular G proteins. Moreover, GPCRs are also involved in the senses of sight, smell and taste. Thus, GPCRs are essential for life, and their malfunction commonly leads to disease. As an example, many neurotransmitters bind to this class of receptors, thereby controlling and modulating, for instance, emotional states or learning and memory processes. In these cases, malfunction of these receptors is related to several psychiatric illnesses, such as depression, bipolar disorder and schizophrenia. As a result, GPCRs are one of the most important targets for the development of new pharmaceuticals.

The Laboratory of Biomolecular Research (BMR) is one of the leading groups in the world in the study of the structure of GPCRs. This multidisciplinary laboratory combines experts in very diverse areas, such as structural biology and bioinformatics, biochemistry, biophysics, and molecular and cell biology. By combining their expertise, researchers at BMR plan to study GPCRs in a global perspective, to unravel the molecular basis of GPCR activation, biased signalling and intracellular trafficking (see Figure 4). Specifically, BMR scientists are focusing their studies on rhodopsin, a visual pigment responsible for the detection of light in the retina, beta adrenergic receptors, which mediate the response to adrenaline in the heart, and serotonin receptors, which respond to the neurotransmitter serotonin.

The knowledge generated at BMR can help to design new and more selective drugs targeted to this important class of proteins. Consequently, researchers at this laboratory actively collaborate with several pharmaceutical companies, such as Roche (CH), Actelion (CH) and Heptares (UK).

The third dimension of nano-machining: Selective melting for fabrication of 3D profiles in large-area optics

Guiding light by novel concepts through metallic or dielectric nanostructures opens up many new applications. Examples are in-windshield driver information systems in automobiles or windows which project daylight against the ceilings of rooms, thus reducing the need for artificial lighting. All these applications require the controlled structuring of materials or surfaces, down to sub-wavelength dimensions, over large areas. In contrast to other areas of controlled nano-patterning, such as microelectronic chip fabrication, where mainly the x- and y-directions in the material require precise machining in the nanometre regime, in nano-optics, the z-direction also needs careful design and reproducible fabrication processes. Since 2008, a European-funded Framework 7 large-scale project called "NAPANIL" has been running, involving 17 partners from industry, academia, and private institutes; for

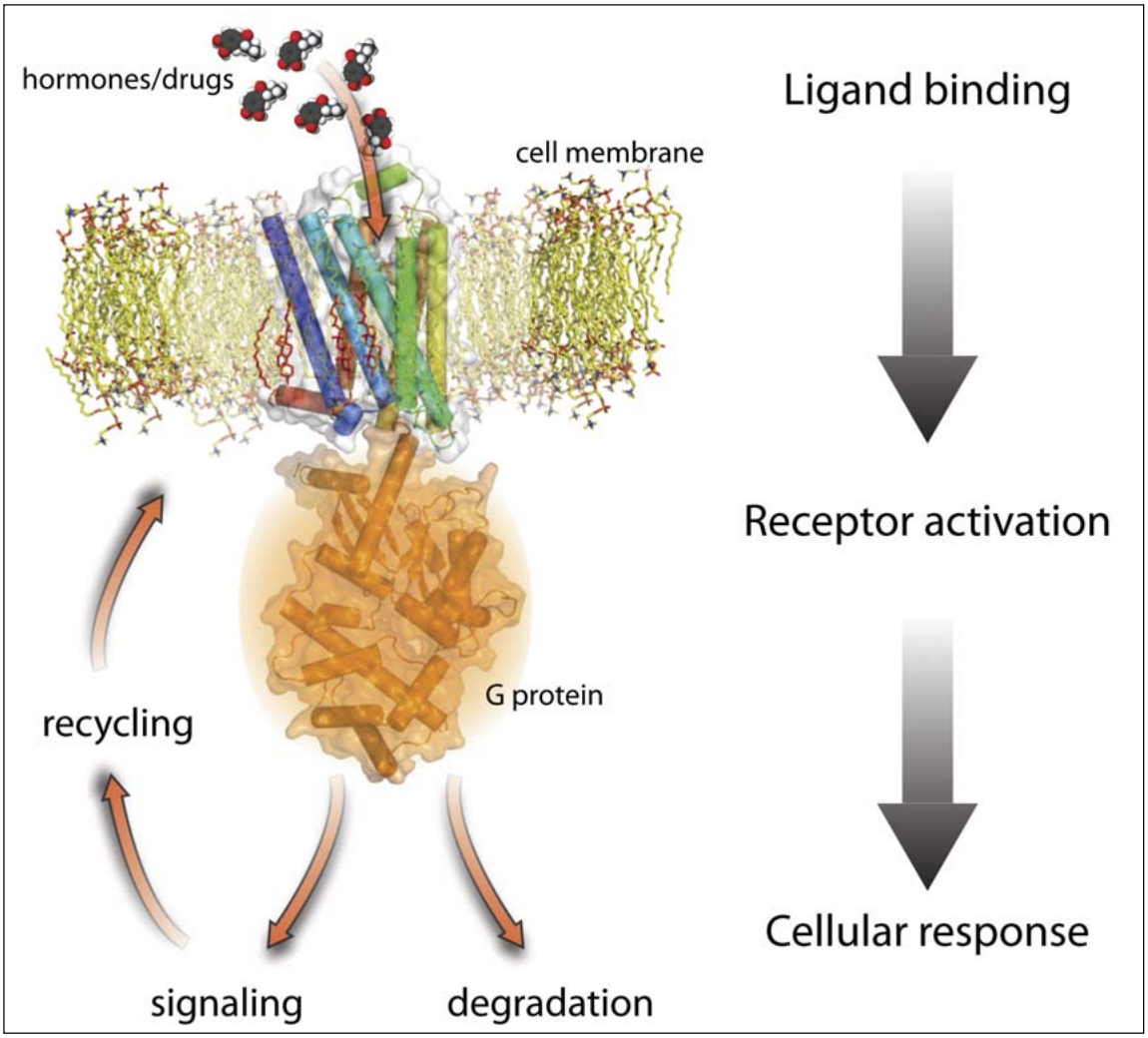

Figure 4: **Extracellular ligands, as hormones or drugs, bind the receptors sitting in the cell membrane. This leads to receptor activation and release of the G protein, which, in turn, is able to activate different types of cellular responses, such as signalling, degradation of the receptor, or its recycling to the cell surface.**

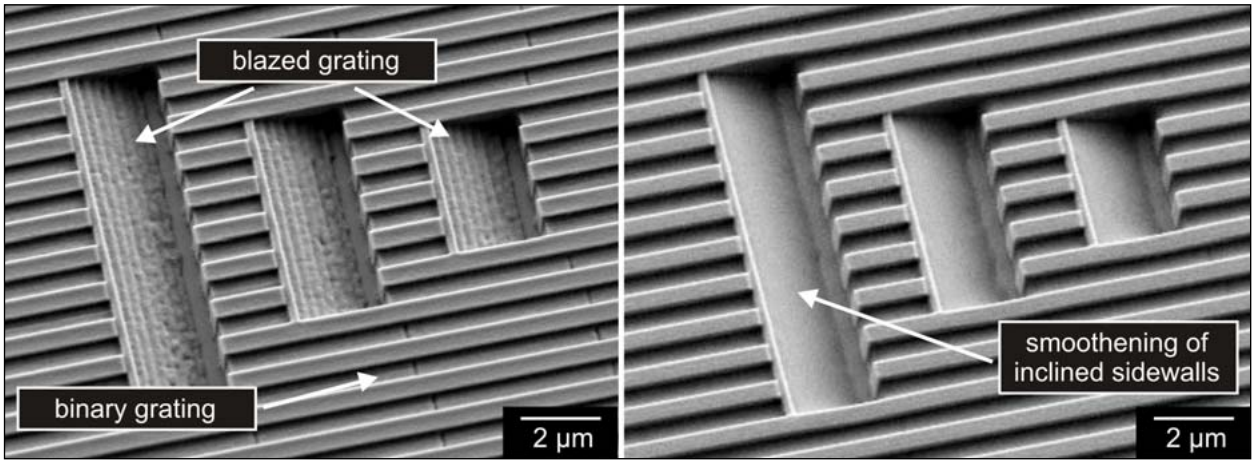

Figure 5: **Generation of an optical 3-D structure as needed for improved LED backlighting. A multi-level prism is integrated into a binary grating by electron-beam exposure and development (left). Due to local melting of the prism, the roughness is smoothed out while the outline of the complex 3-D shape is preserved (right).**

details, see: http://www.napanil.org. The role of PSI-LMN in this project is the design and development of fabrication processes which allow the shaping of dielectric materials in three dimensions at high throughput rates.

Up to now, available lithographic techniques have been mostly two-dimensional (2D), i.e. thin films can be patterned in a shadow-type way, resulting in straight sidewalls perpendicular to the z-axis for any laterally defined structure. One of the few exceptions, developed many years ago, is micro-lens arrays formed by the thermal reflow of polymeric-resist cylinders which had been defined by photolithography. In these cases, the spherical shape of the lens forms by itself, due to the surface tension of the molten polymer. In such arrays, the lens diameters range typically from a few microns to tens of microns, and they are used for focusing in micro-optical systems. For the nano-optical manipulation of light, the dimensions need to be smaller than this by one to two orders of magnitude. In the optical devices and arrays which were developed and are now being fabricated at PSI, the known reflow technique was combined with multi-level, high-energy electron beam patterning.

For the realization of the required structures with defined slope-angles, a polymer was selected for electron beam lithography which is also used for thermal processing in nano-imprint processes. By using a dose-modulated exposure with a high-energy electron beam in a commercial pattern generator (Vistec EBPG 5000+), a 3D multi-level pattern was defined, which is – due to its inherent roughness right after development – not yet suitable for optical applications. If a reflow process at a defined temperature is applied, this roughness is smoothed out, while preserving the outlines of the 3D shape.

We take advantage of the fact that the exposed polymer not only has a different solubility in the developer but also a different melting behaviour (T_g), depending on the irradiation dose. This allows a "local reflow" of well-defined areas of the polymer surface, in this case of the stepped structures into a continuous, smooth slope, while other, neighbouring, structures in the surface stay unaltered (Figure 5). Prism structures with slopes having a height of 1 µm and up to 45° inclination have been generated using different combinations of doses and reflow temperatures. The technology allows a variety of slope angles and orientations on the same substrate to be reproducibly fabricated, e.g. rear reflectors with 45° inclination. These can be combined with arrays of lenses having both convex and concave shapes. By careful tuning of step sizes, doses, reflow temperatures and time, almost any imaginable shape for manipulating light, with optical structures down to sub-wavelength dimensions, can be realized in transparent polymeric materials. In this way, an example of a functional optical 3D structure was designed and fabricated, consisting of prisms integrated into regular line gratings, e.g. as needed for improved LED backlighting for displays used in mobile phones, iPads or computer screens.

We have further developed the process by generating stamps (replication tools) on the basis of the 3D patterns. Replication by nano-imprinting, injection moulding or roll-to-roll processing is a mandatory requirement for the successful implementation of these structures in the applications envisioned, since they all require large areas processed at low cost. Currently, the process can be reproducibly controlled to a maximum resist height of 2 µm, and higher structures seem possible.

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After more than 100 pages giving examples of the first-class science being performed at PSI, the following pages present a brief overview of some statistical and organizational aspects of the Institute's activities. The initial figures show how much financial support the Swiss tax payer has invested in the research carried out at PSI and also how many people work there – as researchers or technicians, or performing administrative tasks. Subsequent numbers reflect the great interest shown in the Institute – by young people coming to work there as graduate or post-graduate students, or as apprentices, as well as the many scientists who have come to perform experiments at the large-scale facilities run by the Institute.

The Paul Scherrer Institute and its individual Departments are supported by experienced scientists acting as advisors, who thus contribute to the Institute's development. Listings of the Research Commission and Committees, and the scientists sitting on them, are given in the final section.

◀ **Inauguration of the vacuum laboratory – the new feature of iLab, PSI's school lab.**

PSI in 2010 – a statistical overview

Finances

The total expenditure of PSI in 2010 amounted to CHF 329.2 million, with the Swiss government providing 73.4 % of this amount, i.e. CHF 241.7 million. Investments totalled CHF 56.7 million (17.2 % of total expenditure). Third-party funding amounted to CHF 73.1 million, with 39.4 % coming from private industry, 31.6 % from Swiss federal research programmes and 7.2% from EU programmes.

PSI Financial Statement (in CHF million)		
	2010	
Expenditure		
Operations *	272.5	82.8 %
Investments *	56.7	17.2 %
Total	**329.2**	**100.0 %**
Expenditure according to source of income		
Federal government funding	241.7	73.4 %
Third-party	87.5	26.6 %
Third-party revenue		
Private industry	28.8	39.4 %
Federal research funding	23.1	31.6 %
EU programmes	5.3	7.2 %
Other	15.9	21.8 %
Total	**73.1**	**100.0 %**
* Including personnel expenses of CHF 208.9 million (corresponding to 63.4% of total expenditure), of which CHF 16.4 million has been transferred to investment appraisal.		

Table 1: **PSI finances in 2010.**

Employment

At the end of 2010, employment at PSI corresponded to almost 1400 full-time equivalent staff positions. Out of these, 481 were occupied by scientists, not including the PhD students employed by the Institute. A further 726 positions were occupied by technicians and engineers – a relatively large number, reflecting the importance of technical staff for the successful operation of a large laboratory with its variety of scientific facilities. Members of the administrative staff held 91 positions. Of the total staff, 23.4 % were women and 44 % were non-Swiss citizens.

Education

Besides research, education at various levels is a central task for the Paul Scherrer Institute. Research opportunities are provided for students preparing their Masters or PhD theses,

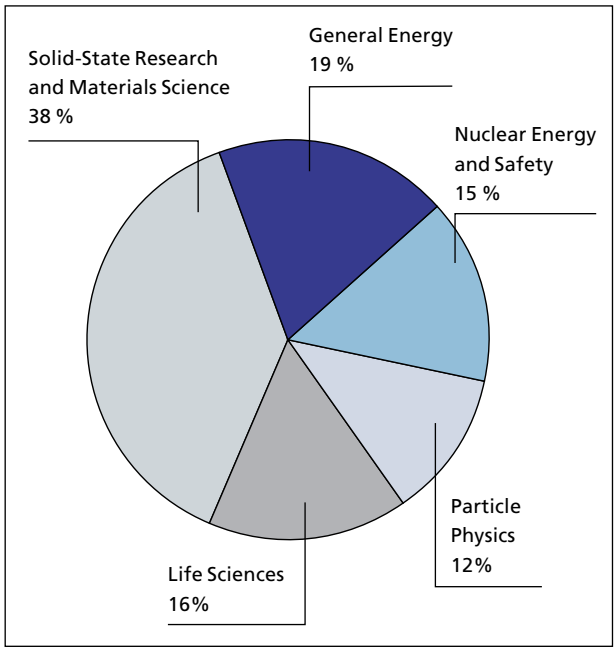

Figure 1: **Total budget distribution for 2010 across PSI departments.** Research facilities allocated to the various departments.

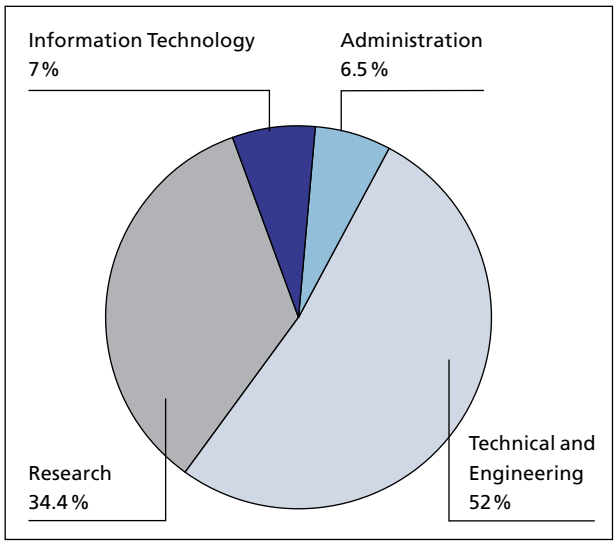

Figure 2: **The staffing structure** of the Paul Scherrer Institute reflects the importance of technical staff for running the institute's complex experimental facilities

with more than 300 PhD students working at PSI, including 197 actually employed by the Institute. The remainder are financed by other institutions or universities, but perform a substantial part of their experimental work at PSI's facilities or laboratories. The opportunity to work at PSI as trainees for a shorter period of time, to gather work experience in scientific research as well as in administrative or organizational tasks, was taken by 104 other young people – secondary-school graduates and university students. A further 80 young people were actively involved in vocational training, in 13 different professions. In addition, PSI offered courses in radiation protection and reactor technology for internal staff as well as for external groups.

The school lab (iLAB) provided pupils from secondary schools with the opportunity to perform various physics experiments and thus obtain a first-hand impression of scientific research. In 2010, the second part of the iLAB was opened, in which young visitors can investigate the effects of a vacuum. The iLAB was visited during the year by 180 classes from different schools – a large increase compared with the 105 classes which came to PSI in 2009.

PSI scientists are also active as educators outside the Institute, with more than 80 of them giving courses at universities and universities of applied sciences.

User Lab 2010						
	SLS	**SINQ**	**SμS**	**Particle Physics**	**PSI total**	**(2009)**
No. of beam-lines/ instruments	15	13	6	4	**38**	(39)
No. of experiments	1085	483	187	4	**1759**	(1734)
No. of user visits	3221	945	392	550	**5108**	(4526)
No. of individual users	1496	465	171	221	**2221**	(2168)

Table 2: **PSI user service in numbers.**

User Service

In 2010, PSI maintained its position as an attractive user lab for scientists from all over the world. More than 2200 users visited the Institute and performed more than 1700 experiments at the 38 beamlines available at the large-scale facilities. The growing interest in performing experiments at PSI is reflected in the increasing number of user visits over the years (each time a user comes to PSI, the visit is counted, so that single users may be counted several times). The total number of visits for the SLS, SINQ and SμS was well below 3000 in the years 2005 and 2006, and reached more than 4000 in 2010 (cf. Figure 2). When the users of the particle physics facilities are included, this value rises to 5108 (cf. Table 2). The overall number of peer-reviewed publications based on research performed at PSI's large-scale facilities SLS, SINQ and SμS was 613 in 2010.

The user service at PSI's large-scale facilities also makes an important contribution to the education of future generations of scientists, reflected in the large number of young scientists among the users.

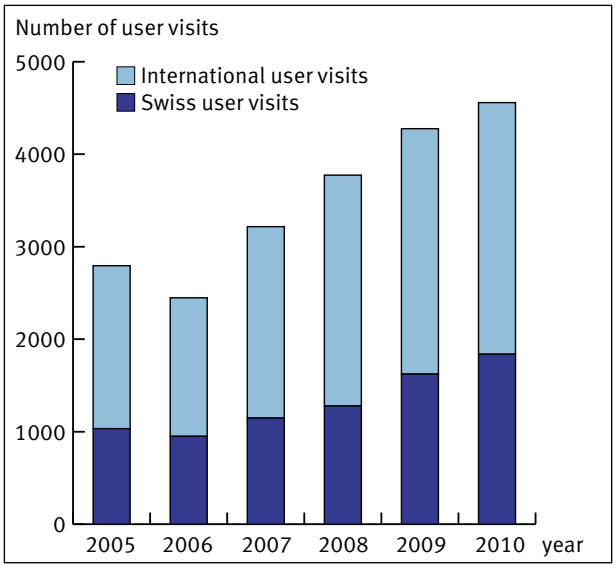

Figure 3: **The increasing number of user visits** at SLS, SINQ and SμS reflects the growing interest of scientists in performing experiments at PSI.

Research Commission

The Research Commission of the Paul Scherrer Institute advises the Directorate on decisions related to the scientific research carried out at the Institute. It evaluates proposed new projects and applications for financial support from external agencies, assesses ongoing projects and helps define appropriate new research topics for the Institute. The Commission consists of 13 staff from the various departments of PSI. Once or twice a year, meetings of the Strategic Research Commission are held, which, in addition to the members of the Internal Research Commission, also includes 11 scientists of high scientific standing from Switzerland and abroad. This Commission's main task is to advise the Directorate on the development of long-term research programmes and to evaluate the quality of past and planned research activities.

Commission and committees

Research Commission

External Members

Prof. Dr. Ø. Fischer, President	Department of Condensed Matter, University of Geneva, CH
Prof. Dr. G. Aeppli	London Centre for Nanotechnology, University College, London, UK
Prof. Dr. F. Carré	CEA, Saclay, Gif-sur-Yvette, FR
Prof. Dr. H.H. Coenen	Institute for Nuclear Chemistry, Forschungszentrum Jülich, DE
Prof. Dr. R.W. Falcone	ALS, Lawrence Berkeley National Laboratory, Berkeley, USA
Prof. Dr. R. Klanner	Institute for Experimental Physics, University of Hamburg, DE
Prof. Dr. S. Larsen	Dept. of Chemistry, University of Copenhagen, DK
Prof. Dr. T. Mason	Oak Ridge National Laboratory, USA
Prof. Dr. J. Rossbach	Institute for Experimental Physics, University of Hamburg, DE
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Prof. Dr. E. Umbach	Karlsruhe Institute of Technology (KIT), DE

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Dr. B. Delley	Research with Neutrons and Muons (NUM)
Dr. R. Eichler	Biology and Chemistry (BIO)
Dr. L. Heyderman	Synchrotron Radiation and Nanotechnology (SYN)
Dr. S. Johnson	Synchrotron Radiation and Nanotechnology (SYN)
Dr. I. Mantzaras	General Energy (ENE)
Dr. W. Pfingsten	Nuclear Energy and Safety (NES)
Dr. T. Schietinger	Large Research Facilities (GFA)
Dr. M. Steinmetz	Biology and Chemistry (BIO)
Prof. Dr. H. Van Swygenhoven	Research with Neutrons and Muons (NUM)
Dr. F. Vogel	General Energy (ENE)
Dr. P. Hasler, Secretary	Biology and Chemistry (BIO)

Permanant Guest

Prof. Dr. N. Spencer	Department of Materials, ETH Zurich, CH

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Synchrotron Radiation SYN

Scientific Advisory Committee (SAC)

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Diamond Light Source, Didcot, UK

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Swiss Federal Office of Energy, Berne, CH

Organizational Structure (as of Dec. 2010)

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Prof. Dr. Roland Horisberger

Large-Scale Project SwissFEL
Dr. Hans-Heinrich Braun/Dr. Rafael Abela

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	Waste Management	Dr. Michael Bradbury
	Nuclear Materials	Hans-Peter Seifert a.i.
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	Buildings and Services	Lilian Jakob
	Infrastructure and Electrical Engineering	Max Huser
	Mechanical Engineering Sciences	Dr. Urs Ellenberger
	Information Technology	Dr. Stephan Egli
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	Communications	Dagmar Baroke

Energy and Environment
Prof. Dr. Jeroen van Bokhoven

Energy Systems Analysis
Dr. Stefan Hirschberg

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On CD and online

The publication lists for all PSI Departments can be found on the CD version of this report, which can be ordered at www.psi.ch (Information Material) or by phone +41 (0)56 310 21 11.

The lists include the following:

- Peer-reviewed publications
- Invited talks
- Dissertations
- Conference Proceedings
- Lectures

Links to other research, not featured here, can be found on our website: www.psi.ch (Scientists & Users).

Publications 2010

Center for Proton Therapy

Peer reviewed papers

Albertini F., Hug, E.B., Lomax, A.J., *The influence of the optimization starting conditions on the robustness of intensity-modulated proton therapy plans.* Phys. Med. Biol. 55 (2010) 2863-2878

Albertini F., Gaignat S., Bosshardt M., Lomax A.J. *'Planning and Optimizing Treatment Plans for Actively Scanned Proton Therapy' in "Biomedical Mathematics: Promising Directions in Imaging, Therapy Planning and Inverse Problems".* Ed Y Censor, M Jiang, G. Wang (Madison, Medical Physics Publishing) 2010: 1-18.

Ares, C., Khan, S., Macartain, A.M., Heuberger, J., Goitein, G., Gruber, G., Lutters, G., Hug, E.B., Bodis, S., Lomax, A.J. *Postoperative Proton Radiotherapy for Localized and Locoregional Breast Cancer: Potential for Clinically Relevant Improvements?* Int J Radiat Oncol Biol Phys. 76 (2010) 685-697

Grassberger, C., Trofimov, A., Lomax, A.J., Paganetti, H., *Variations in linear energy transfer within clinical proton therapy fields and the potential for biological treatment planning.* Int. J. Radiat. Oncol. Biol. Phys [Epub ahead of print]

Knopf, A-C., Bert, C., Heath, E., Nill, S., Kraus, K., Richter, D., Hug, E.B., Pedroni, E., Safai, S., Albertini, F., Zenklusen, S., Boye, D., Soehn, M., Soukup, M., Sobotta, B., Lomax A.J. *Special Report: Workshop on 4D-treatment planning in actively scanned particle therapy – requirements and preliminary recommendations.* Med Phys. 37 (2010) 4608-14.

Krayenbuehl J., Hartmann M., Lomax A.J., Kloeck S., Hug E.B., Ciernik I.F. *Proton Therapy for Malignant Pleural Mesothelioma After Extrapleural Pleuropneumonectomy.* Int J Radiat Oncol Biol Phys. 78 (2010) 628-634

Mumot, M., Algranati, C., Hartmann, M., Schippers, J.M., Hug, E.B., Lomax A.J., *Proton range verification using a range probe: Definition of concept and initial analysis*. Phys. Med. Biol. 55 (2010) 4771-4782

Widesott, L., Pirelli, A., Fiorino, C., Lomax, A.J., Amichetti, M., Cozzarini, C., Soukup, M., Di Muzio, N., Calandrino, R., Schwarz, M., *Helical Tomotherapy (HT) vs. intensity-modulated proton therapy (IMPT) for whole pelvis irradiation in high risk prostate cancer patients.* Int. J., Radiat. Oncol. Biol. Phys [Epub ahead of print]

Van de Water, T.A., Lomax, A.J., Bijl, H.B., de Jong, M.E., Schilstra, C., Hug, E.B., Langendijk, J.A. *Potential benefits of scanned intensty-modulated proton therapy (IMPT) versus advanced photon therapy with regard to sparing of the salivary glands in oropharyngeal cancer.* Int J Radiat Oncol Biol Phys. 2010 Aug 21. [Epub ahead of print]

Veronese, I., Cantone, M.C., Chiodini, N., Coray, A., Fasoli, M., Lomax, A.J., Mones, E., Moretti, F., Vedda, A., *Feasibility study for the use of cerium-doped silica fibres in proton therapy.* Radiation Measurement 45 (2010) 635-639

Zenklusen S.M. et al. *A study on repainting strategies for treating moderately moving targets with proton pencil beam scanning at the new Gantry 2 at PSI.* Phys. Med. Biol. 55 (2010) 5103-5121

Collaboration with external institutions

Collaboration with METAS

Gagnebin S., Twerenbold D. Pedroni E., Meer D., Zenklusen S., Bula C. *Experimental determination of the absorbed dose to water in a scanned proton beam using a water calorimeter and an ionization chamber Nuclear Instruments and Methods.* Physics Research B 268 (2010) 524–528

Collaboration with University of Bern

Braccini S., Ereditato A., Kreslo A., Moser U., Pistillo C., Studer S., Scampoli P., Corayd A., Pedroni E. *First results on proton radiography with nuclear emulsion detectors.* 2010 JINST 5 P09001

Proceedings and conference abstracts

Albertini F., Negreanu C., Hug E.B., Lomax A.J., *Is it necessary to define safety margins for Intensity Modulated Proton Therapy plans?* ICCR XVI, Amsterdam, May 2010

Albertini F., Hug E., Lomax A.J. *Intensity Modulated Proton Plans: Is there a need to define safety margins?* SASROXIII, Bern, April 2010.

Bodis S., Ares C., Khan S., Heuberger J., MacArtain A.M., Lutters G., Lomax A.J., Hug E. *Technical challenges in locally advanced breast cancer*, ESTRO 29, Barcelona, September 12-16, 2010

Bolsi A., Albertini F., Amelio D., Lomax A.J., Schneider R. *Influence of metal artefacts on proton dose distributions.* SASROXIII, Bern, April 2010

Boye D., Knopf A., Lomax A.J., *4D dose calculation on a deforming dose grid for scanned proton beams and ITV margin adaption due to proton range variations,* SGSMP annual conference, Bern, November 11-12, 2010

Knopf A., Hug E., Lomax A.J. *Re-scanned proton radiotherapy for various plan scenarios – The influence of motion amplitude, motion phase and target geometry*, ESTRO 29, Barcelona, September 12-16, 2010

Knopf A-C., Hug. E., Lomax A.J. *Scanned proton radiotherapy for mobile targets - which plan characteristics require rescanning, which maybe not?* ICCR XVI, Amsterdam, May 2010

Knopf A-C., Hug E., Lomax A.J. *Scanned proton radiotherpay for mobile targets: The influence of field number and direction.* SASROXIII, Bern, April 2010.

Lederer L., Hartmann M., Lomax A.J. *A comparison between individual and standard head supports*. SASROXIII, Bern, April 2010

Schneider R., Weber D. C., Ares C., Goitein G., Geismar J., Bolsi A., Hug E. B. *Spot scanning based proton therapy for complex benign, atypical and anaplastic meningiomas: 5-year results from the Paul Scherrer Institute.* PTCOG 49, Chiba, Japan, May 2010.

Schneider R., Vitolo V., Albertini F., Koch T., Ares C., Lomax A., Goitein G., Hug E.B.
High-dose, spot scanning based Proton Therapy for paraspinal / retroperitoneal neoplasms and small bowel tolerance: Dose distribution analysis in a patient cohort. ASTRO conference, Chicago, November 1-4, 2010.

Timmermann B., Staab A., Ares C., Goitein G., Lomax A.J., Pedroni E., Weiss M., Niggli F., Hug E. *Proton radiation therapy for CNS tumors of Childhood experiences from the Paul Scherrer Institute,* ESTRO 29, Barcelona, September 12-16, 2010

Widesott L., Albertini F., Bolsi A., Amelio D., Schneider R., Hug E., Lomax A.J. *Are intensity modulated proton therapy (IMPT) plans robust enough to irradiate prostate patients with lymph node involvement?,* ESTRO 29, Barcelona, September 12-16, 2010

Zhang Y., Boye D., Knopf A., Tanner C., Lomax A.J., *Respiratory liver motion extraction for proton therapy from 4DCT by deformable registration,* SGSMP annual conference, Bern, November 11-12, 2010

Invited presentations

Hug, E.B.
Protonentherapie. Invited lecture. 20. Ärzte-Fortbildungskurs in Klinischer Onkologie, DESO, St. Gallen, Switzerland, February 18, 2010

Hug, E.B.
Proton therapy – an update. Invited lecture. 6th Engadin Prostate Cancer Winter Symposium, Zuoz, Switzerland, March 3-7, 2010

Hug, E.B.
Spot scanning based proton radiotherapy: clinical application at the Paul Scherrer Institute. Invited lecture. 24th International Congress and Eshibition on CAR, Geneva, June 25, 2010

Hug, E.B.
Particle Therapy and Medical Evidence – the need for clinical trials. Invited lecture. 21st International Conference on the Application of Accelerators in Research & Industry (CAARI), Fort Worth, USA, August, 8 – 13, 2010

Hug, E.B., Ares C.
Protonen und Brustkrebs – Vorstellung einer Pilotstudie am PSI. Invited lecture. Aerztliche Weiterbildung, Universitätsspital Zürich, November 15, 2010

Hug, E.B.
Proton treatment for Skull Base Tumors. Skull Base Malignancy and Proton Therapy Meeting, London, November 30, 2010.

Lomax, A.J.
Basic physics and treatment planning for (scanned) proton therapy. Invited seminar, Umea University Hospital, February 4, 2010

Lomax, A.J.
State of the art proton therapy. Invited lecture for the MSc course in Radiation Biology, University of Oxford. February18, 2010

Lomax, A.J.
Physics and treatment techniques. Invited lecture, St James Hospital, Leeds, February 22, 2010

Lomax, A.J.
Proton therapy 3: Current challenges. Invited lecture, XXII. DGMP Winterschule Pichl, March 3-4, 2010

Lomax, A.J.
Proton therapy 2: Treatment planning. Invited lecture, XXII. DGMP Winterschule Pichl, March 3-4, 2010

Lomax, A.J.
Proton therapy 1: Basic physics and delivery. Invited lecture, XXII. DGMP Winterschule Pichl, March 3-4, 2010

Lomax, A.J.
Do's and Don'ts of proton therapy: A practical guide to proton therapy. Invited lecture, Centro oncologica, Trento 28 – 29 May, 2010

Lomax, A.J.
Proton therapy in the UK. Invited lecture, Particle Acclerators and Beams Group of the Insitute of Physics Annual meeting (PAB2010), Manchester, July 9, 2010

Lomax, A.J.
My dream proton machine is…. 28th ESTRO conference, Barcelona, September 13-16, 2010

Lomax, A.J.
Kernphysik in der Medizin. Volkshochschule lecture, Brugg, November 10, 2010

Lomax, A.J.
Developments in proton beam therapy at PSI. EORTC Radiation Oncology Group Meeting, Lausanne, November 19, 2010

LIST OF PUBLICATIONS

COMPETENCE CENTER ENERGIY & MOBILITY

PUBLICATIONS

Conference Proceedings / Other Papers

P. Dietrich
Alternative Automotive Technologies & Fuels in Carbon restricted Economies
EVS25, The 25th World Battery, Hyprid and Fuel Cell Electric Vehicle Symposium and Exhibition, Shenzhen, China, Nov. 5-9, 2010.

TALKS

Invited Talks

P. Dietrich
How are we affected by the Cleantech-Debate? Energy-economic analysis of possible changes in the transportation sector and the MEM-industry induced by climate policies
Bühler AG, Uzwil, August 30, 2010.

P. Dietrich
Ökobilanz der Elektromobilität: EKZ e-Twingo
Labor für Energiesystem-Analysen, EKZ Dietikon, December 16, 2010.

P. Dietrich
Stärken und Schwächen des Elektroantriebes im Vergleich zum Verbrennungsmotor- und Hybridantrieb
Jahrestagung e-mobile 2010, Sion, August 25, 2010.

P. Dietrich
Effizienzpotenziale und ihr Einfluss auf das Schweizer Energiesystem – Erkenntnisse aus dem Energie Trialog Schweiz
- WWF Aargau, March 25, 2010.
- PSI-Impuls, Villigen, April 15, 2010.

P. Dietrich
Energy research and Cleantech at Paul Scherrer Institut PSI
- Visit Alberta Delegation, PSI Villigen, June 10, 2010.
- DIREC 2010, New Dehli, India, October 27, 2010.

P. Dietrich
Das moderne Gebäude - mehr als eine Behausung
ScienceCity Talk, ETH Zürich, April 25, 2010.

P. Dietrich
The Potential of H_2-O_2 Fuel Cells in the Transportation Sector
WHEC2010, Essen, Germany, April 29, 2010.

P. Dietrich
Alternative Automotive Technologies & Fuels in Carbon restricted Economies
EVS 25, Sustainable Mobility Revolution, Shenzhen, China, November 5-9, 2010.

P. Dietrich
Innovative Technologien in der Energiewirtschaft
Euroforum, Zürich, November 10, 2010.

LIST OF PUBLICATIONS 2010

Synchrotron Radiation and Nanotechnology SYN

UNIVERSITY LEVEL AND OTHER TEACHING

M. Bednarzik, J. Gobrecht, V. Guzenko, C. Padeste, H. Schift, Y. Ekinci, A. Weber
Micro- and Nanofabrication
Blockkurs (Praktikum) for University of Basel, 1 week, Villigen PSI, 13-17.09.2010 (Masterstudiengang)

A. Cervellino
Debye Function Analysis Technique: Principles and Methods
2nd PSI-SGK/SSCr-AIC Powder Diffraction International School, Paul Scherrer Institut, Villigen, Switzerland, 24.05-30.05.2010

A. Cervellino
Diffraction Techniques for the Characterization of Nanoscale and Amorphous Materials
International Sol-Gel Society (ISGS) Summer School 2010 “Advanced Characterisation Techniques for Sol-Gel Materials”, Chambon-sur-Lac, France, 18-21.07.2010

J. Gobrecht, H. Schift
Nanotechnologie für Ingenieure
Fachhochschule Nordwestschweiz (FHNW), Windisch, HS 2010/11 (Bachelorstudiengang)

F. Gozzo
Synchrotron Radiation X-Ray Powder Diffraction for the Study of Materials at the Nanoscale
2nd PSI-SSCr-AIC Powder Diffraction International School, Paul Scherrer Institut, Villigen, Switzerland, 24-30.04.2010

H. Schift
Topographical Structuring
Fachhochschule Vorarlberg (FHV), Dornbirn, Austria, HS 2009/10 (Master-Weiterbildungs-Studiengang in "Mikro- und Nanotechnik (MNT), 15.01.2010

H. Schift
LIGA technology
Neutechnikum Buchs (NTB), HS 2009/10 (Masterstudiengang Nano- and Microtechnology (NMT), 18.02.2010

H. Schift
Grundlagen zu strukturierten Oberflächen
Zürcher Fachhochschule für Angewandte Wissenschaften (ZHAW), Material- und Verfahrenstechnik, Winterthur, FS 2010 und HS 2010 (Bachelorstudiengang), 19.04.2010 and 24.11.2010

H. Schift
Nanoimprint Lithography
IMT PhD tutorials, EPFL, Lausanne, 07.10.2010

H. Schift
Structured Surfaces
International Packaging Institute (IPI), Schaffhausen, HS2010/11 (Masterstudiengang), 08.12.2010

L.J. Heyderman
Magnetic Imaging Techniques
Seminar in Lecture Series, Magnetism and Spin Dependent Transport (Prof. Kläui), Uni Konstanz, 04.02.2010

J. F. Löffler, F. Dalla Torre, Y. Ekinci, M. Niederberger
Micro and nanostructured metallic systems
ETHZ-Lecture: 327-4103-00L

A. Pauluhn
Protein Crystallography,
Zurich Center for Imaging Science and Technology CIMST Summer School on Bio-medical Imaging, ETHZ Zurich, Switzerland, 17.09.2010

L. Quaroni
Practical Synchrotron MidIR Spectromicroscopy
4th Saskatoon Synchrotron Summer School; Canadian Light Source, Saskatoon, CA; 13-18.06.2010

M. Stampanoni, P. Schneider
Micro and Nano-Tomography of Biological Tissues
ETHZ-Lecture: 227-0965-00L

M. Stampanoni, P. Bösiger, K. Prüssmann, J. Vörös, M. Rudin
Research Topics in Biomedical Engineering
ETHZ-Lecture: 227-0970-00L

M. Stampanoni, V.Sandoghdar, G. Csucs, R. Wepf
Elements of Microscopy
ETHZ-Lecture: 227-0390-00G

M. Stampanoni et al.
CIMST Interdisciplinary Summer School on Bio-Medical Imaging
ETHZ-Lecture: 551-1316-00L

T. Thüring, Exercise Assistant
Micro and Nano-Tomography of Biological Tissues
ETHZ-Lecture: 227-0965-00L

J.A. van Bokhoven
Catalysis
529-0502-00 G ETH Zurich (4 KP)

J.A. van Bokhoven
Characterization of Catalysts and Surfaces
529-0611-00 G ETH Zurich (7 KP)

J.F. van der Veen
Physik
Bachelor-Studiengang D-INFK, 402-0038-00, ETH Zürich, FS 2010

J.F. van der Veen
Materials research using synchrotron radiation
Masters-Studiengang D-PHYS & D-MATL, 402-0313-00, ETH Zürich, HS 2010

J. F. van der Veen, C. Quitmann, S. Müller et al
9th PSI Summer School on Condensed Matter Research - Magnetic Phenomena
Lyceum Alpinum, Zuoz, Switzerland, 07-13.08.2010

C. Wäckerlin, D. Chylarecka, N. Ballav, T.A. Jung
24346-01 Mastervorlesung Oberflächenphysik mit Übungen 4KP
Departement Physik der Universität Basel, Frühjahrsemester 2010

C. Wäckerlin, C. Iacovita, T. Hählen, T.A. Jung
19576-01 Seminar Oberflächenphysik 4KP
Departement Physik der Universität Basel, Herbstsemester 2010

P.R. Willmott
Anwendungen der Synchrotronstrahlung für Studierende der Biologie, Chemie und Physik - eine Einführung
Physikalisch-Chemisches Institut, Universität Zürich, Herbstsemester 2010

D. Zumbuehl, T.A. Jung
10512-01 Hauptvorlesung mit Übung: Einführung in die Physik Ifür Studierende der Biologie, Geowissenschaften und Pharmazeutische Wissenschaften) 6 KP
Departement Physik der Universität Basel, Herbstsemester 2010

PUBLICATIONS WITH SYN AUTHOR(S) AND DESCRIBING AN SLS EXPERIMENT

Abela R, Grolimund D, Pretsch E
Analytical applications of synchrotron radiation
TRAC-TRENDS IN ANALYTICAL CHEMISTRY 29, 452 (2010)

Aagesen LK, Johnson AE, Fife JL, Voorhees PW, Miksis MJ, Poulsen SO, Lauridsen EM, Marone F, Stampanoni M
Universality and self-similarity in pinch-off of rods by bulk diffusion
NATURE PHYSICS 6, 796 (2010)

Agostini G, Lamberti C, Palin L, Milanesio M, Danilina N, Xu B, Janousch M, van Bokhoven JA
In Situ XAS and XRPD Parametric Rietveld Refinement To Understand Dealumination of Y Zeolite Catalyst
JOURNAL OF THE AMERICAN CHEMICAL SOCIETY 132, 667 (2010)

Arenholz E, van der Laan G, Fraile-Rodriguez A, Yu P, He Q, Ramesh R
Probing ferroelectricity in PbZr0.2Ti0.8O3 with polarized soft x rays
PHYSICAL REVIEW B 82, 140103 (2010)

Auzelyte V, Sigg H, Schmitt B, Solak HH
Direct formation of ZnO nanostructures by chemical solution deposition and EUV exposure
NANOTECHNOLOGY 21, 215302 (2010)

Bansmann J, Kleibert A, Getzlaff M, Rodriguez AF, Nolting F, Boeglin C, Meiwes-Broer KH
Magnetism of 3d transition metal nanoparticles on surfaces probed with synchrotron radiation - from ensembles towards individual objects
PHYSICA STATUS SOLIDI B-BASIC SOLID STATE PHYSICS 247, 1152 (2010)

Bech M, Bunk O, Donath T, Feidenhans'l R, David C, Pfeiffer F
Quantitative x-ray dark-field computed tomography
PHYSICS IN MEDICINE AND BIOLOGY 55, 5529 (2010)

Bergamaschi A, Cervellino A, Dinapoli R, Gozzo F, Henrich B, Johnson I, Kraft P, Mozzanica A, Schmitt B, Shi XT
The MYTHEN detector for X-ray powder diffraction experiments at the Swiss Light Source
JOURNAL OF SYNCHROTRON RADIATION 17, 653 (2010)

Bergomi M, Cugnoni J, Wiskott HWA, Schneider P, Stampanoni M, Botsis J, Belser UC
Three-dimensional morphometry of strained bovine periodontal ligament using synchrotron radiation-based tomography
JOURNAL OF ANATOMY 217, 126 (2010)

Blaise A, Baravian C, Andre S, Dillet J, Michot LJ, Mokso R
Investigation of the Mesostructure of a Mechanically Deformed HDPE by Synchrotron Microtomography
MACROMOLECULES 43, 8143 (2010)

Boon JJ, Oberthaler E, Ferreira ESB, Marone F, Stampanoni M
Xray tomographic microscopic studies of a resin embedded paint sample from a mechanical failing area in floor tiles of The Art of Painting by Johannes Vermeer (1632-1675)
MICROSCOPY AND MICROANALYSIS 16, 1872 (2010)

Borkar S, Ooka L, Bodi A, Gerber T, Sztaray B
Dissociative Photoionization of Sulfur Chlorides and Oxochlorides: Thermochemistry and Bond Energies Based on Accurate Appearance Energies
JOURNAL OF PHYSICAL CHEMISTRY A 114, 9115 (2010)

Bradley DA, Kaabar W, Gundogdu O, Farquharson MJ, Janousch M, Bailey M, Jeynes C
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  D. Henzen, M.Sc Thesis D-PHYS and Princess Margaret Hospital, Toronto, Canada, 2010

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J.A. van Bokhoven

- *Synthesis and characterization of metal-zeolite catalysts for the conversion of methane to chemicals*
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INVITED TALKS

M. Altana
Simulation und Realität bei der Nanoimprint-Lithographie
Seminar talk at INKA/IKT colloquium, FHNW, Windisch, 24.11.2010

J. Althaus
Cell forces on functionalised and microstructured polymer substrates
Seminar talk at Department of Cell Biology, University of Rostock, Germany, 15.04.2010

P. Beaud
Structural response to ultrafast melting of charge and orbital order in a manganite
Gordon Research Conference on Ultrafast Phenomena In Cooperative Systems, Galveston TX, 28.02-05.03.2010

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Ultrafast Phase Transitions Viewed by Femtosecond XRD
NSLS-II Beamline Development Proposals Workshop, Chemical, biological and condensed matter studies with ultrafast X-ray & THz pulses, Brookhaven National Laboratory, Upton NY, 27-28.05.2010

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Colloquium, University of Kaiserslautern, Germany, 15.11.2010

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Chemical Dynamics Group Seminar, Argonne National Laboratory, Argonne IL, USA, 29.01.2010

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O. Bunk
Multimodal imaging: STXM, SXDM, scanning SAXS and interferometric phase contrast imaging on tissue samples
Technical University Munich, Institute E17 seminar, Munich, Germany, 08.04.2010

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Physikalisches Seminar, Universität Basel, Switzerland, 08.03.2010

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Seminar Talk, Cornell University. Ithaca, United States, 16.04.2010

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Imaging2010 Conference, Stockholm, Sweden, 09.06.2010

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Physikalisches Seminar, Universität Giessen, Germany, 29.11.2010

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11th International Conference on Surface X-ray and Neutron Scattering (SXNS11), Evanston, USA, 13-17.07.2010

H. Dil
Spin- and angle-resolved photoemission on low dimensional Rashba systems
IAP-Seminar, Technical University Vienna, Austria, 04.05.2010

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Spin resolved ARPES on low-dimensional systems with strong spin-orbit interaction
Solid state physics seminar, Massachusetts Institute of Technology, Boston, USA, 17.05.2010

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Spin- and angle-resolved photoemission: a direct probe for spintronics and topological insulators
Molecular physics seminar, Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany, 28.05.2010

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AG Fert, Thales CNRS, Paris, France, 10.06.2010

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J. Dreiser
THz-EPR on cyanide-bridged single-molecule magnets
BESSY low-alpha workshop, Berlin, Germany, 08.12.2010

Y. Ekinci
Novel plasmonic nanostructures for ultrasensitive biosensors
MediNano-3, 3rd Mediterranean Conference on Nanophotonics, Belgrade, Serbia, 18-19.10.2010

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EUV-IL facility at PSI
Seminar talk, Samsung Electronics, Korea, 21.10.2010

Y. Ekinci
Extreme Ultraviolet Interference Lithography
Seminar talk, University of Birmingham, UK, 28.04.2010

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Controlling the coupling in plasmonic structures for metamaterials and biosensing
Physikalisches Seminar, Universität Tübingen, Germany, 25.01.2010

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Aluminum nanostructures for metamaterials and biosensing
SPIE Photonics Europe, Brussels, Belgium, 12–16.04.2010

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4D Measurements of the Morphological Evolution and Interface Kinetics of Solid-Liquid Mixtures During Coarsening
160th ISIJ Meeting 2010, Sapporo, Japan, 25-27.10.2010

A. Fraile Rodríguez
Soft x-ray microscopy: A powerful tool to image nanostructures down to fundamental length and time scales
Master in New Materials, Universidad del País Vasco (UPV/EHU), Leioa, Spain, 21.05.2010

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55th Annual Conference on Magnetism and Magnetic Materials, Atlanta, Gerorgia, USA, 14-18.11.2010

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Workshop on Synchrotron Tools for Studies of Combustion /Energy Conversion, Lund University, Lund, Sweden, 07-08.12.2010

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Kunststoff Mikro- und Nanostrukturen für die Life Sciences
SWSS Plastics, Luzern, Switzerland, 19.01.2011

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Future Energy Concepts – Nanoscience Research and Technology
GENNESYS, International Congress on Nanotechnology and Research Infrastructures, Barcelona, Spain, 26-28.05.2010

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KATZ, Schweizerisches Kunststoff-Symposium 2010, Aarau, Switzerland, 09.06.2010

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ASPM2010 Austraian-Slovenian Polymer Meeting, Leoben, Austria, 08-10.09.2010

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Abformwerkzeuge für Mikro- undNanotstrukturen in thermoplastischen Polymeren
Swiss Laser-Net, FHNW Brugg-Windisch, Switzerland, 30.09.2010

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Shanghai Synchrotron Radiation Facility, Shanghai, China, 21.10.2010

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Suzhou Institute of Nano-Tech and Nano-Bionics, Suzhou, China, 22.10.2010

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Nanomedicine 2010, Beijing, China, 23-25.10.2010

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Synchrotron Radiation Powder Diffraction for the Structural Analysis of Organic Compounds
Workshop on Applications of Spectrophotometric and Diffraction Techniques to the Study of Pharmaceutical and Biological Samples, University of Calabria, Cosenza, Italy, 18-19.01.2010

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SLIC Workshop 2010, Saclay Laser-Matter Interaction Center, Saclay, France, 18.11.2010

L.J. Heyderman
The diversity of magnetic nanostructures: from the physics of frustration to data storage applications
Seminar in Collaborative Framework Collaborative Research Center: Magnetic Heterostructures: Spinstructures and Spintransport (SFB 491), University of Bochum, Germany 20.05.2010

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Investigation of Artificial Kagome Spin Ice with Photoemission Electron Microscopy
2nd Bragg-Stoner Symposium: "Understanding frustrated interactions using nanotechnology" University of Leeds, UK, 13-14.07.2010

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Keynote Lecture, Current research in Magnetism - CRIM 2010, Institute of Physics Magnetism Group Meeting, University of Manchester, UK, 23.07.2010

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Seminar, Sheffield University, Sheffield, UK, 13.12.2010

G. Ingold
Non-equilibrium dynamics studied by femtosecond laser-pump/x-ray-probe diffraction
XFEL International Workshop, Ryn, Poland, 14-17.02.2010

M. Janousch
A return of experience of a double mobility: the case of the LUCIA beamline between SLS/PSI and SOLEIL, part II
2nd ERF Seminar, PSI Villigen, Switzerland, 19.10.2010

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Coherent and incoherent femtosecond structural dynamics in solids studied by x-ray diffraction
Banff Meeting on Structural Dynamics, Banff, Canada, 25-28.02.2010

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Watching femtosecond structural dynamics in solids with x-rays
International Conference on Ultrafast Structural Dynamics, Lausanne, Switzerland, 07-10.06.2010

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XIV Liquid and Amorphous Metals Conference, Rome, Italy, 11-16.07.2010

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Magnetic dynamics in CuO
LCLS Users Meeting, SLAC National Accelerator Laboratory, Menlo Park, CA, USA, 17-21.10.2010

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Ultrafast dynamics and Symmetry in Solids
Seminar, ETH Zurich, Switzerland, 10.12.2010

T.A. Jung
Switching with Individual Molecules
Inaugural Lecture as a Member of the Faculty for Natural Sciences, Paul Scherrer Institut, Villigen, Switzerland, 09.03.2010

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Schalten mit einzelnen Molekuelen
Public lecture given at the Kongress Center Aarau for the occasion of the 550th anniversary of the University of Basel, Aarau, Switzerland, 28.08.2010

Ph. Lerch
Infrared micro-spectroscopy using synchrotron light
Pohang Accelerator Laboratory, Pohang, South Korea, 06.07.2010

K. Mader
Automated, high-throughput, multi-scale assessment of bone morphology and bone competence
NCCBI Meeting, National Competence Center for Biomedical Imaging, Lausanne, Switzerland, 29-30.11.2010

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Structures on all length scales – New methods using small-angle X-ray scattering
Max Planck Institut für medizinische Forschung, Heidelberg, Germany, 19.01.2010

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From Scattering to Imaging: The cSAXS Beamline at the SLS
X-Ray Scattering for Biological Applications at NSLS-II, Brookhaven National Laboratory, Upton NY, USA, 01.06.2010

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X-Ray Scattering for Biological Applications at NSLS-II, Brookhaven National Laboratory, Upton NY, USA, 02.06.2010

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X-Ray Microscopy Conference 2010, Chicago IL, USA, 17.08.2010

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X-Ray Diffraction Microscopy – turning the rather esoteric into a usable technique
SLS-Seminar on Coherent X-Ray Imaging, Villigen PSI, Switzerland, 05.10.2010

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*Data collection strategies for single photon counting pixel detector*s
Gordon Conference on Diffraction Methods in Structural Biology, Bates College, Lewiston, ME, USA, 18-23.07.2010

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Seminar talk at INKA/IKT colloquium, FHNW, Windisch, Switzerland, 10.03.2010

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Lecture Series Nano I, University of Basel, Switzerland, 15.12.2010

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Kicking a ferromagnet – magnetization dynamics probed with X-ray microscopy
Seminar Physics Department University of Uppsala, Sweden, 02.12.2010

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MaNEP Workshop on Resonant X-ray Techniques, Paul Scherrer Institut, Villigen, Switzerland, 02.11.2010

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Lecture Series Surface Science, University of Basel, Switzerland, 06.04.2010

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Lecture Series Surface Science, University of Basel, Switzerland, 30.03.2010

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Latest news at the Macromolecular Crystallography beamlines at the Swiss Light Source
Protein Structure Determination in Industry, Oxford, UK, 14-17.11.2010

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Large area nanostructures for application in biology and bio-analytics
First cross-border conference on nanosciences and nanomaterials for health, Pont-à-Mousson & Nancy, France, 21-25.06.2010

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Colloquium at the Technical University of Ilmenau, Germany, 09.06.2010

L. Patthey
Angle-resolved photoemission spectroscopy on laser deposition in situ grown films
Department of Physics, University of Warwick, Coventry, United Kingdom, 18.02.2010

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University of Colorado, Boulder, Colorado, USA, 20.05.2010

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University of British Columbia, Vancouver, Canada, 03.06.2010

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23rd Annual User Meeting, MAX-lab, Lund, Sweden, 08-10.11.2010

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Presentation at the BIOZENTRUM, Basel, Switzerland, 16.11.2010

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NanoXAS: Making the invisible visible
Annual Meeting of the Competence Center for Materials Science and Technology (CCMX), Bern, Switzerland, 28.04.2010

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Berliner Physikalisches Kolloquium im Magnus-Haus, Berlin, Germany, 03.06.2010

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Dynamics of mesoscopic magnetic objects
10th International Workshop on X-Ray Spectroscopy of Magnetic Solids (XRMS10) Diamond Light Source, Didcot, UK, 10-11.06.2010

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6th International Workshop on Nano-scale Spectroscopy and Nanotechnology (NSS6) Kobe, Japan, 25-29.10.2010

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1st International Workshop on SPEM, Trieste, Italy, 13-14.12.2010

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6th International Workshop on X-ray damage to biological crystalline samples at Stanford Synchrotron Radiation Light Source, Stanford, California, USA, 11-13.03.2010

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24th Rhine-Knee Regiomeeting, Belambra club Les Cigognes, Albé, France, 29.09-01.10.2010

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Nanopatterning of 3D Surfaces based on Nanoimprint Lithography
Seminar talk at Korea Institute of Machinery & Materials (KIMM), Daejeon, Korea, 21.01.2010

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Future Challenges in Electron Microscopy, IGBMC, Illkirch, France, 20-21.05.2010

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Workshop on Terahertz spectroscopy and its high-field applications, Forschungszentrum Dresden-Rossendorf (FZD), Dresden, Germany, 14-15.06.2010

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Development of X-ray Tomography VIII, SPIE 2010, San Diego, USA, 04.08.2010

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EMRS 2010 Spring conference, Strasbourg, France, 10.06.2010

P.R. Willmott
Buckling, mixing and transferring: LaAlO3 on SrTiO3
Workshop on surface and interface structures, Diamond Users‘ Meeting 2010, Diamond Light Source, England, 08.09.2010

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Structural studies of surfaces and interfaces of complex systems
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K.J. Zhou
New frontiers of Resonant Soft x-ray Inelastic Scattering at the SLS
Shanghai Synchrotron Radiation Facility, China, 04.01.2010

J. Ziegler
Nanostrukturen für biologische Anwendungen
Seminar talk at INKA/IKT colloquium, FHNW, Windisch, Switzerland, 19.05.2010

ORAL PRESENTATIONS

E.M.C. Alayon, M. Nachtegaal, J.A. van Bokhoven
Copper-zeolites for the conversion of methane to chemicals
SLS symposium on X-ray spectroscopies of energy materials, PSI, Villigen, Switzerland, 02.03.2010

C.N. Borca
Investigating the structure of Fe-Cr alloys using synchrotron based X-ray microanalysis
Spring 2010 European Materials Research Society, Strasbourg, France 09.06.2010

C.N. Borca
Combined imaging, diffraction and spectroscopy approach: Application to a fuel cladding of the Gösgen nuclear power plant
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C.N. Borca
Investigating the structure of Fe-Cr alloys for model validation using synchrotron based X-ray microanalysis techniques
Materials Modelling in Nuclear Energy Environments: State of the Art and Beyond, CECAM-ETHZ, Zurich, Switzerland, 27.05.2010

S. Boz, M. Schär, N. Manh, M. Stöhr, F. Diederich, T. A. Jung
Transfer of chirality from individual helicene derivatives into 2D supramolecular structures on Cu(111)
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R.V. Chopdekar, V.K. Malik, A. Fraile-Rodriguez, A. Scholl. Y. Suzuki, F. Nolting, C. Bernhard, L. J. Heyderman
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Chirality control in ferromagnetic nanoislands arranged in hexagonal ring structures
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D. Chylarecka, K. Müller, C. Wäckerlin, N. Ballav, T.A. Jung
Research opportunities at Nanojunction Lab at Laboratory for Micro-and Nanotechnology, Paul Scherrer Institut
Swiss-Polish Science and Technology Days, Warsaw, Poland, 14-15.01.2010

D. Chylarecka, C. Wäckerlin, T.K. Kim, K. Müller, F. Nolting, A. Kleibert, N. Ballav, T.A. Jung
Self-Assembly and Superexchange Coupling of Magnetic Molecules on Metallic and Oxygen-Reconstructed Ferromagnetic Thin Films
26th SAOG meeting, Fribourg, Switzerland, 22.01.2010

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N. Danilina, F. Krumeich, S. Castelanelli, J. A. van Bokhoven
Aluminum zoning in ZSM-5 crystals: Its origin and characterization
33rd British Zeolite Conference, Southampton, UK, 24-26.03.2010

N. Danilina, F. Krumeich, S. Castelanelli, J. A. van Bokhoven
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C. David, J. Vila-Comamala, S. Gorelick, V.A. Guzenko
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C. David
X-ray grating interferometry for phase-contrast imaging and optics metrology applications
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H. Dil, F. Meier, B. Slomski, J. Osterwalder
Spin and angle resolved photoemission on low dimensional Rashba systems: a direct probe to spintronics
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Y. Ekinci
Novel plasmonic nanostructures for biosensing and metamaterials
6th Workshop on Numerical Methods for Optical Nano Structures, Zurich, Switzerland, 05-06.07.2010

J.L. Fife
Development of a Furnace for in-situ X-ray tomographic microscopy
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J.L. Fife
Materials science and X-ray tomographic microscopy: revealing structures and dynamics of complex systems
CCMX Summer School: Advanced Characterization Techniques of Materials, EFPL, Lausanne, Switzerland, 27.08.2010

R. Giannini, Y. Ekinci, J. F. Löffler
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S. Gorelick, J. Vila-Comamala, V.A. Guzenko, R. Barrett, B.D. Patterson, C. David
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F. Gozzo, A. Cervellino, M.Leoni, P.Scardi, A. Bergamaschi, B. Schmitt
Instrumental Profile and Aberrations of Powder Diffraction Patterns with a Mythen Detector
12th European Powder Diffraction Conference (EPDIC-12), Darmstadt, Germany, 27-30.08.2010

P. Helfenstein, K. Jefimovs, E. Kirk, T. Vogel, C. Escher, H.-W. Fink, S. Tsujino
Electron beam properties of molybdenum field emitter arrays with stacked gates
Nr. 210, Annual Meeting of the Swiss Physical Society, Basel, Switzerland, 21-22.06.2010

P. Helfenstein
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L. J. Heyderman, E. Mengotti, A. Bisig, A. Fraile-Rodríguez, L. Le Guyader, F.Nolting, H.B. Braun
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C. Iacovita, C. Wäckerlin, D. Chylarecka, A. Kleibert, K. Müller, F. Nolting, N. Ballav, T.A. Jung
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C. Iacovita, S. Vijayaraghavan, P. Fesser, M. Stohr, F. Diederich, T.A. Jung
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S. K. Jha, Z. Ahmed, Y. Ekinci, J. F. Löffler
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A.N. Kaufmann, H. Schift, E. Meyer, T.A. Jung
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A. Kleibert, A. Voitkans, K.-H. Meiwes-Broer
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L. Le Guyader, A. Kleibert, L. Joly, R. Pisarev, A. Kirilyuk, F. Nolting, Th. Rasing, A. Kimel
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K. Mader, P. Schneider, J.-Ph. Thiran, R. Müller, M. Stampanoni
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K. Mader, P. Schneider, D. Ruffoni, G. H. van Lenthe, J.-Ph. Thiran, R. Müller, M. Stampanoni
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F. Marone, M. Stampanoni
Multimodal and hierarchical bioimaging at TOMCAT
Visit SSRF delegation, Villigen, Switzerland, 30.03.2010

F. Marone, B. Münch, M. Stampanoni
Fast reconstruction algorithm dealing with tomography artifacts
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M. Matena, J. Björk, M. S. Dyer, M. Persson, L. Lobo-Checa, L. Gade, M. Enache, M. Stöhr, K. Müller, T.A. Jung
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Interference of spin states in photoemission from Sb/Ag(111)
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A. Menzel
Multimodal scanning X-ray microscopy of biological tissues
Biology and Synchrotron Radiation, Melbourne, Australia, 17.02.2010

A. Menzel
Ptychographic Imaging of Low-Contrast Specimen
Advanced Phase Measurement Methods in Optics and Imaging, Ascona, Switzerland, 18.05.2010

P. Modregger, B. R. Pinzer, T. Thuering, Z. Wang, M. Stampanoni
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CIBM boardmeeting, Lausanne Switzerland, 10.12.2010

R. Mokso, U. Kaydok, F. Marone, G. Mikuljan, A. Isenegger, M. Stampanoni
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C. Monney, V. Bisogni, K. J. Zhou, R. Kraus, V. Strocov, J. Geck, T. Schmitt
Resonant Inelastic X-ray Scattering on a prototype edge-sharing chain compound
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A. Mustonen, P. Beaud, E. Kirk, T. Vogel, F. Feurer, B. Oswald, S. Tsujino
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S. Neuhaus, C. Padeste, N.D. Spencer
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M. Paraliev, C. Gough, S. Tsujino, E. Kirk, S. Ivkovic, F. Le Pimpec
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B. Päivänranta, T. Nuutinen, A. Koistinen, P. Vahimaa
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B.R. Pinzer, M. Cacquevel
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L. Quaroni, T. Zlateva, K. Goff, K.E. Wilson
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M. Radović
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M. Radović
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V. Scagnoli, U. Staub, R. de Souza, Y. Bodenthin, M. Garganourakis, A. T. Boothroyd, D. Prabhakaran, S.W. Lovesey
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H. Schift
Summary: Materials / Stamps
NNT2010, Int. Conference on Nanoimprint and Nanoprint Technology, Øresund, Copenhagen, Denmark, 13-15.10.2010

A. Schleunitz, H.Schift
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A. Schleunitz, H. Schift
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C. Schulze-Briese
Proteinstrukturanalyse in der Grundlagenforschung und in der Entwicklung neuer Wirkstoffe
Lions Club Brugg, Untersiggenthal, Schweiz, 09.03.10

C. Schulze-Briese
Beam me up X06DA, Inauguration of the beamline X06DA and its crystallisation facility
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B. Slomski, F. Meier, J. Osterwalder, H. Dil
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Concept of spectrometer for soft-X-ray RIXS with parallel detection in incoming and outgoing photon energies
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S. Tsujino, M. Paraliev, C. Gough, A. Mustonen, P. Beaud, E. Kirk, T. Vogel
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J.F. van der Veen
Introduction to the SLS
Visit Dr. Stefan Wurm, SEMATECH, Albany, NY, USA, PSI, Villigen, Switzerland, 22.01.2010

J. F. van der Veen
Introduction to the SLS
Visit Prof. Andreas Cavalleri, MPSD/CFEL Hamburg, PSI, Villigen, Switzerland, 18.03.2010

J.F. van der Veen
Introduction to the SLS
Visit Delegation from Shanghai Synchrotron Radiation Facility, Shanghai, China, PSI, Villigen, Switzerland, 29.03.2010

J.F. van der Veen
Introduction to the SLS
Visit Ady Paterson, CEO ANSTO, Australia, PSI, Villigen, Switzerland, 22.06.2010

J.F. van der Veen
Introduction to the SLS
Visit Marcus French, Science and Technology Facilities Council (STFC), PSI, Villigen, Switzerland, 03.08.2010

J.F. van der Veen
Introduction to the SLS
Visit Mr. Fishman and Mr. Widmer, Novartis, PSI, Villigen, Switzerland, 19.08.2010

J.F. van der Veen
Introduction to the SLS
Visit Ib Chorkendorff, Director of CINF Danish National Research Foundation's, PSI, Villigen, Switzerland, 02.09.2010

J.F. van der Veen
Welcome address
Inauguration of the beam line X06DA and crystallization facility, PSI, Villigen, Switzerland, 21.09.2010

J.F. van der Veen
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Inauguration of the beam line XIL-II, PSI, Villigen, Switzerland, 05.11.2010

J.F. van der Veen
Introduction to the SLS
Visit members of the ETH board, PSI, Villigen, Switzerland, 09.11.2010

J.F. van der Veen
Introduction to the SLS
Visit Joost W. M. Frenken, University of Leiden, PSI, Villigen, Switzerland, 11.11.2010

J.F. van der Veen
Introduction to the SLS
Visit Crispino Bergamaschi (Direktionspräsident FHNW ab 01.01.2011), PSI, Villigen, Switzerland, 08.12.2010

J.F. van der Veen
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B.R. Pinzer, M. Cacquevel, S. McDonald, P. Modregger, P. Aebischer, M. Stampanoni
Differential phase contrast tomography of amyloid plaques in an Alzheimer's disease mouse model
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M. Pistone, L. Caricchi, P. Ulmer, F. Marone, L. Burlini
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L. Quaroni, J. Schneider, D. Armstrong, J. Wambach, P. Lerch
The Infrared Beamline at the Swiss Light Source: a Tool for Chemical Microanalysis
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M. Radović, E. Razzoli, J. Stahn, Y.Sassa, M. Månsson, M. Falub, M. Shi, L. Patthey, J. Mesot
When Superconductivity meets Magnetism: Angle Resolved Photoemission Spectroscopy and Polarized Neutron Reflectometry studies on $YBa_2Cu_3O_{7-x}/La_{0.7}Sr_{0.3}MnO_3$ Heterostructures
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M. Radović, E. Razzoli, J. Stahn, Y.Sassa, M. Månsson, M. Falub, M. Shi, J. Mesot, L. Patthey
When Superconductivity meets Magnetism: Angle Resolved Photoemission Spectroscopy and Polarized Neutron Reflectometry studies on $YBa_2Cu_3O_{7-x}/La_{0.7}Sr_{0.3}MnO_3$ Heterostructures
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J.C.E. Rasch, M. Boehm, C. Ritter, H. Mutka, J. Schefer, L. Keller, G.M. Abramova, A. Cervellino, J.F. Löffler
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26th European Crystallographic Meeting (ECM-26), Darmstadt, Germany, 29.08-02.09.2010

Ch. Rajendran
The crystal structure of the GlnZ-DraG complex provides insight into membrane sequestration of the nitrogenase regulatory enzyme DraG
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E. Razzoli, M. Shi, J. Mesot
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M. Rücklin, P.C.J. Donoghue, E. Rayfield, M. Purnell, Z. Johanson, K. Trinajstic, F. Marone and M. Stampanoni
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The evolution and development of teeth and jaws before gnathostomes
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Ch. Rytka, U. Bruggisser, M. Kristiansen, H. Solak, J. Gobrecht
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A. Schleunitz, C. Spreu, T. Haatainen, A. Klukowska, H. Schift
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54th International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN 2010), Anchorage, USA, 01-04.06.2010

A. Schleunitz, C. Spreu, J.J. Lee, H. Schift
Nucleation Induced Sphere Formation by Thermal Reflow of Nanoimprinted Lines
36th International Conference on Micro- and Nano- Engineering (MNE 2010), Genoa, Italy, 19-22.09.2010

A. Schleunitz, C. Spreu, T. Maekelae, T. Haatainen, A. Klukowska, H. Schift
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A. Schleunitz, C. Spreu, J.J. Lee, H. Schift
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9th International Conference on Nanoimprint and Nanoprint Technology (NNT 2010), Oresund & Copenhagen, Denmark, 13-15.10.2010

I. Schmid, J. Raabe, S. Wenzel, R. Fink, H. Hug, C. Quitmann
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10th International Conference on X-Ray Microscopy (XRM2010), Chicago, USA, 15-20.08.2010

J. Singh, J. A. van Bokhoven
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T. Siegfried
Periodic nanostructures for deterministic SERS enhancements
PhD Summer School on Nano-Photonics, DFG-Centrum für Funktionelle Nanostrukturen, Bad Herrenalb, Germany, 26-29.08.2010

T. Siegfried
Plasmonic nanogap arrays for deterministic SERS enhancements
Photonics Day EPFL, Lausanne, Switzerland, 01.11.2010

B. Slomski, F. Meier, J. Osterwalder, H. Dil
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P. Urwyler, O. Häfeli, H. Schift, J. Gobrecht, B. Müller
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R.M. van der Veen, C.J. Milne, F.A. Lima, V.-T. Pham, A. El Nahhas, C.N. Borca, D. Grolimund, J.A. Weinstein, J. Best, J.J. Rehr, C. Bressler, M. Chergui
Retrieving photochemically active structures by time-resolved EXAFS and XANES spectroscopy
1st International Conference on Ultrafast Structural Dynamics (ICUSD'10), EPFL, Lausanne, Switzerland, 07-10.06.2010

S. Vijayaraghavan, C. Iacovita, M. Matena, K. Müller, J.-H. Dil, S. Schintke, J. Lobo-Checa, L.Gade, M. Stöhr, S. Tsujino, T.A. Jung
Electronic properties of interfaced single molecules and monolayers
NCCR annual meeting, Basel, Switzerland, 27-28.04.2010

J. Vila-Comamala, S. Gorelick, V.A. Guzenko, E. Färm, C. M. Kewish, A. Diaz,J. Raabe, M. Ritala, A. Menzel, O. Bunk, C. David
World-Record Resolution in Scanning Transmission X-ray Microscopy
10th international conference on x-ray microscopy, Chicago, United States, 16-20.08.2010

E. Vorobeva, R. A. De Souza, S.L. Johnson, P. Beaud, U. Staub, C.J. Milne, G.Ingold, A.N. Titov, H. Schaefer, J. Demsar
Laser induced CDW phase melting in 1T-$TiSe_2$
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E. Vorobeva, S. L. Johnson, P. Beaud, U. Staub, R. De Souza, C. Milne, G. Ingold, J. Demsar, H. Schäfer, A. Titov
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T. Weitkamp, I. Zanette, S. Lang, G. Schulz, H. Deyhle, B. Müller, M. Bech, A. Tapfer, F. Pfeiffer, E. Reznikova, J. Kenntner, J. Mohr, S. Rutishauser, T. Donath, C. David
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I. Zanette, C. David, T. Donath, S. Rutishauser, F. Pfeiffer, M. Bech, A. Tapfer, B. Müller, G. Schulz, S. Lang, H. Deyhle, J. Kenntner, E. Reznikova, J. Mohr, P. Tafforeau, T. Weitkamp
X-ray Imaging with a Grating Interferometer at ESRF-ID19
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K.J. Zhou, M. Rodovic, J. Schlappa, V. Strocov, R. Frison, J. Mesot, L. Patthey and T. Schmitt
Localized vs. delocalized character of charge carriers in $LaAlO_3$/ $SrTiO_3$ superlattices
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K.J. Zhou, M. Rodovic, J. Schlappa, V. Strocov, R. Frison, J. Mesot, L. Patthey, T. Schmitt
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7th International Conference on Inelastic x-ray scattering, Grenoble, France, 11-14.10. 2010

J. Ziegler, C. Padeste, V. Guzenko, M. Simon, L. Kummer, A. Plückthun, A. Engel
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WORKSHOPS AND CONFERENCES

A. Cervellino
Diffraction at the Nanoscale: Nanocrystals, Defective & Amorphous Materials
2nd PSI-SSCr-AIC Powder Diffraction International School, Paul Scherrer Institut, Villigen, Switzerland, jointly organized with Antonio Cervellino (SYN), Denis Sheptyakov (NUM), Radovan Cerny (Uni-Geneva), Norberto Masciocchi, Antonietta Guagliardi and Simona Galli (University of Insubria, Italy), 24.05-30.05.2010

M. R. Fuchs
X10SA - The beamline and its upgrades
MPG PX2/X10SA Workshop, Paul Scherrer Institut, Villigen, Switzerland, 04.03.2010

M. R. Fuchs
X-ray Fluorescence analysis
MPG PX2/X10SA Workshop, Paul Scherrer Institut, Villigen, Switzerland, 04.03.2010

F. Gozzo
Diffraction at the Nanoscale: Nanocrystals, Defective & Amorphous Materials
2nd PSI-SSCr-AIC Powder Diffraction International School, Paul Scherrer Institut, Villigen, Switzerland, jointly organized with Antonio Cervellino (SYN), Denis Sheptyakov (NUM), Radovan Cerny (Uni-Geneva), Norberto Masciocchi, Antonietta Guagliardi and Simona Galli (University of Insubria, Italy), 24-30.04.2010

F. Gozzo, V. J. Esteve Cano
Non single-crystal techniques (powder diffraction, electron diffraction, single particle imaging)
2nd Meeting of the Italian and Spanish Crystallographic Associations, Oviedo, Spain, 30.6-3.7.2010

I. Margiolaki, F. Gozzo
Biomaterials, Supramolecular Chemistry, Pharmaceuticals
12th European Powder Diffraction Conference (EPDIC-12), Darmstadt, Germany, 27-30.08.2010

F. Nolting
International workshop on Laser-induced magnetization dynamics in nanostructures
Stoos, Switzerland 06-07.10.2010

A. Pauluhn
The SLS MX beamline infrastructure
MPG PX2 Workshop, Paul Scherrer Institut, Villigen, Switzerland, 04.03.2010

U. Staub
MaNEP Workshop on Resonant X-ray Techniques,
Paul Scherrer Institut, Villigen, Switzerland, 02.11.2010

U. Staub
Swiss Physical Society meeting
University of Basel, Switzerland, 21-22.06.2010

PUBLIC RELATIONS

H. Dil
- Spintronics without magnetism?, J.H. Dil, SPG Mitteilungen 30.08.2010

J. Gobrecht
- Nanotechnologie zwischen Science Fiction wird Realität, Vortragsreihe, PSI, Villigen, Switzerland, 05.05.2010
- Das Institut für nanotechnische Kunststoff-Anwendungen, Transfer Transparent, Hochschule für Technik der FHNW, Windisch, Switzerland, 09.05.2010
- Aktuelle Nanotech-Forschung am PSI, i-net NanoMeeting am PSI Villigen, Switzerland, 31.08.2010
- Science Fiction wird Realität – dank Nanotechnologie?, TecDay@KSWo, SATW und TecNight@KSWo, Kantonsschule Wohlen, Switzerland, 02.12.2010
- Editorial in „PSI Facilities Newsletter IV-2010

J. Gobrecht, F. Gassmann
- Nanotechnologie an Grossforschungsanlagen, Poster at the "Science Days 2010", Europapark Rust, Rust Germany, 15-17.10.2010

M. Guizar-Sicairos, D. Zhu, J. R. Fienup
- Differentially encoded holography for x-ray coherent imaging
  'Optics in 2010' December special issue, Opt. and Phot. News 21, 52, 2010

L. Patthey
- Research at Paul Scherrer Institute's Large Scale Facilities, Oral Presentation for the Event on: The Brightest Lights of Science, Swissnex San Francisco, San Francisco, California, USA

C. Wäckerlin et al, the article: "Controlling Spins in Adsorbed Molecules by a Chemical Switch" was mentioned in the following press releases:

- Neue Karriere für lebenswichtiges Biomolekül möglich: http://www.academics.de, 24.08.2010
- Neue Karriere für lebenswichtiges Biomolekül möglich: http://www.analytik.de, 27.08.2010
- Paul Scherrer Institute: A possible new career for a vital biomolecule: http://www.biovalley.com, 26.08.2010

- Neue Karriere für lebenswichtiges Biomolekül möglich: http://www.chemie.de, 27.08.2010
- Neue Karriere für lebenswichtiges Biomolekül möglich: http://www.ch-forschung.ch, 24.08.2010
- Wichtiges Protein macht Karriere in der Technik: http://derstandard.at, 24.08.2010
- Molekularer Magnet arbeitet als Schalter: http://www.dradio.de, 25.08.2010
- Neue Karriere für lebenswichtiges Biomolekül möglich: http://idw-online.de, 24.08.2010
- Porphyrin: Änderung der magnetischen Eigenschaften: http://www.internetchemie.info, 25.08.2010
- Forscher arbeiten an Datenspeicher aus Blut: http://www.krone.at, 25.08.2010
- A possible new career for a vital biomolecule: http://www.myscience.ch, 24.08.2010
- Porphyrin-Komplex mit schaltbaren, magnetischen Eigenschaften: http://www.organische-chemie.ch, 25.08.2010
- Zukunftsweisende Ideen eines lebenswichtigen Biomolekül: http://www.pressemitteilungen-online.de, 25.08.2010
- Neue Karriere für lebenswichtiges Biomolekül möglich: http://www.pressrelations.de, 24.08.2010
- A possible new career for a vital biomolecule: http://www.psi.ch, 24.08.2010
- Neue Karriere für lebenswichtiges Biomolekül möglich: http://schattenblick.org, 24.08.2010
- Blutfarbstoff-Molekül als Magnetschalter: http://www.scinexx.de, 25.08.2010
- Ein- und Ausschalter aus Blut: http://www.suedkurier.de, 31.08.2010
- Neue Karriere für lebenswichtiges Biomolekül möglich: http://uni-online.de, 24.08.2010
- Porpyrin: Änderung der magnetischen Eigenschaften: http://www.webnews.de, 25.08.2010

DISSERTATIONS

M. Chergui

- *Ultrafast X-ray and Optical Spectroscopy of Binuclear Molecular Complexes*
  R.M. van der Veen, EPFL, Lausanne, Switzerland, (2010)

H. Dil, J. Osterwalder

- *Rashba-Type Spin-Orbit Coupling in the Surface Alloys on Ag(111) Probed by Spin- and Angle-Resolved Photoemission Spectroscopy*
  F. Meier, University of Zürich, Switzerland, (2010)

L.J. Heyderman, F. Nolting

- *The artificial kagome spin-ice system: from building blocks to emergent monopoles*
  E. Mengotti, ETH Zürich, Switzerland, (2010)

G. Ingold

- *Structure and dynamics of crystalline nano-systems*
  S. Mariager, University of Copenhagen, Denmark, (2010)

T.A. Jung

- *Controlling intermolecular interactions at surfaces through chemical ligands: supramolecular aggregation, covalent coupling and chirality at reduced dimensions*
  S. Boz, Faculty of Natural Sciences, University of Basel, Switzerland, (2010)

B.D. Patterson, H. Keller, P.R. Willmott

- *Structural Studies of h-BN and Graphene Single-Layers on Transition-Metal Surfaces*
  D. Martoccia, University of Zürich, Switzerland, (2010)

J.A. van Bokhoven

- *Synthesis, Characterization, and Catalytic Function of Zeolites and Zeotypes*
  D. Nadiya, ETH Zurich, Switzerland, (2010)

- *Determination of the active sites in supported platinum catalysts by means of X-ray absorption and emission spectroscopy*
  S. Jagdeep, ETH Zurich, Switzerland, (2010)

J.F. van der Veen

- *Extreme ultraviolet holography for fabrication of high resolution Fresnel zone plates*
  S. S. Sarkar, ETH-Zürich, Switzerland, (2010)
- *Structure of molecular liquids under nanometre confinement*
  E. Perret, ETH-Zürich, Switzerland, (2010)

AWARDS

N. Dainlina:
George-Kokotailo Poster-Award, the best oral presentation prize
33rd British Zeolite Conference

C. David, F. Pfeiffer
Röntgenpreis der Universität Giessen
Giessen, Germany, 26.11.2010

S. Gorelick
Best poster award
Bioplasmonic Conference, Monte Verita, Ascona, Switzerland, 18-23.04.2010

S. Gorelick
Best poster award
36th International Conference on Micro and Nanoengineering, Genova, Italy, 19-22.09.2010

MEMBERSHIPS IN EXTERNAL COMMITTEES

A. Cervellino

- Member of the Swiss Society for Crystallography SGK/SSCr - http://www.sgk-sscr.ch/
- Member of the International Sol-Gel Society - http:// www.isgs.org

C. David

- Member of the International Program Committee of the MNE: Micro- and Nano-Engineering Conference Series
- Member of the International Consortium for Coherent X-ray Diffractive Imaging (ICCDXI)
- Member of the Scientific Advisory Board of the Courant Research Centre "Nano-Spectroscopy and X-ray Imaging", University of Göttingen, Germany
- Member of the Editorial Board of the Journal of X-ray Optics and Instrumentation
- Member of the Program Committee of the ICXOM: International Conference on X-ray Optics and Microanalysis Conference Series

U. Flechsig

- Member of the International Programme Committee, EuroFEL Workshop on Photon Beamlines & Diagnostics, Hamburg, Germany, 28-30.06.2010

J. Gobrecht

- Head of the Institute of Polymer Nanotechnology, University of Applied Sciences Nordwestschweiz, Brugg/Windisch, Switzerland
- Vice Director Technology of the Swiss Nanoscience Institute at the University of Basel
- Member of the board of the Swiss Micro- and Nanotechnology Network
- Member of the Scientific Advisory Board, HeiQ Materials AG, Bad Zurzach, Switzerland
- Member of the board of directors, Eulitha AG, 5232 Villigen PSI

- Epert reviewer for the “Förderpreis für Jungunternehmen” of the “W. A. de Vigier Foundation”, Solothurn, Switzerland
-- Member of the management team of i-net Basel Nano, and leader of innovation circle “Nanofabrication” within i-net Basel Nano
- Member of the proposal review committee, Karlsruhe Nano- and Micro-Facility in the Karlsruhe Institute of Technology
- Member of the nomination committee for a W3 chair in experimental physics, University of Konstanz, Germany, 2010
- Member of the nomination committee for an ext. ord. professorship in microtechnology at the Ecole Polytechnique Federale de Lausanne (EPFL), 2010
- External thesis examiner for PhD thesis of Janne Laukkanen, *“Fabrication of metallic micro- and nanostructures for optical solutions”,* Univ. of Eastern Finland, Joensuu, 2010
- External thesis examiner for PhD thesis of Sascha Pierre Heussler, *“Design, micro manufacturing and characterisation of a new, fast parallel-processing Fourier transform interferometer with single, non periodic pulse capability”,* National University of Singapore, Singapore 2010

F. Gozzo

- Member of the *Commission of Instrumentation and Computing*
- Italian Crystallography Association http://www.cristallografia.org/detail.asp?IDN=206&IDSezione=30

L.Heyderman

- Member of the Advisory Committee of the IEEE Magnetics Society
- Member of the Editorial Board of Journal of Magnetism and Magnetic Materials
- Member of the International Advisory Committee of the International Colloquium on Magnetic Thin Films and Surfaces (ICMFS)
- Member of the International Advisory Committee, International Conference on Magnetism 2012
- Member of International Program Committee, MNE2010

T.A.Jung

- Priority Program of the ‘Deutsche Forschungs Gemeinschaft’ SPP 1243 "Quantum transport at the molecular scale": Review Panel Member
- Scientific Committee for New and Emerging Health Risks (SCENIHR) of the Health and Consumers Directorate General of the European Commission
- Scientific Advisory Board for the European Physical Journal
- Editorial Advisory Board of the Europhysics News
- Steering Committee, Annales Henry Poincare

A. Menzel

- Beamline Development Proposal Team “High-Brilliance X-ray Scattering for Life Sciences (LiX)” for the National Synchrotron Light Source II (NSLS II), headed by Lin Yang, Photon Sciences Directorate – Brookhaven National Laboratory, Upton NY, USA

S. Müller

- Member of the EU Research Infrastructure Programme Committee

F. Nolting

- Member of the Proposal Review Committee of Soleil, France

  NSRRC Microscopy committee, Taiwan, 2010

  PhD Thesis committee, J. Hellsvik, University of Uppsala, Sweden, 03.12.2010

L. Patthey

- Member of the International Program Committee, CORPES11, Berkley, USA
- Member of UWG for beamline I05-ARPES at Diamond Light Source, UK

L. Quaroni

- External Beamteam Member. MidIR Spectromicroscopy Beamline, Canadian Light Source. Since 2009
- External Beamtime Proposal Reviewer, Canadian Light Source. Since 2009

C. Quitmann

- Member of the Scientific Advisory Committee of Diamond Light Source Ltd., Didcot, UK - www.diamond.ac.uk
- Member of the Scientific Advisory Committee of ALBA Synchrotron Light Facility, Barcelona, Spain - www.cells.es
- Member of the Council of the Swiss Norwegian Beamlines at ESRF, Grenoble, France - www.esrf.eu
- Member of the International Program Committee of the 10th International Conference on X-Ray Microscopy (XRM2010), Chicago, USA - http://xrm2010.aps.anl.gov
- Member of the International Advisory Committee of the X-ray Spectroscopy of Magnetic Solids (XRMS) meeting, Didcot, UK - www.xrms10.org/xrms2010
- Member NSRRC Microscopy committee, Taiwan, 2010
- Member of the Proposal Review Committee of the Canadian Light Source, Saskatoon, Canada

C. Schulze-Briese

- Berufungskommission Professur für Strukturbiologie der Universität Basel, Basel, Switzerland, 20.-21.01.2010
- EMBL@PETRA3 Scientific Advisory Board, Hamburg, Germany

H. Sigg

International Conference on Intersubband in Quantum Wells (ITQW), External Advisory Committee Member

M. Stampanoni

- Member of the W. Meyer-Ilse Award Committee, XRM2010, Chicago
- ESRF Program Review Committee - Medical Panel, Grenoble, France
- ACNI: Advisory Committee for Neutron Imaging, Villigen, Switzerland
- Australian Synchrotron Review Panel, Melbourne, Australia
- CIMST – Steering Committee, Zürich, Switzerland
- Swiss Euro Bioimaging – Steering Committee, Zürich, Switzerland

S. Tsujino

- Secretary of the International Steering Committee, International Vacuum Nanoelectronics Conference

U. Staub

- Executive committee member of the Swiss Physical Society (representative for condensed matter physics)
- Member of the Proposal Review Panel of FLASH
- Member of the Scientific Committee of NCCR MaNEP

J.A. van Bokhoven

- ESRF SNBL, Council
- Member of the Diamond Proposal Review Committee

- Phys. Chem. Chem. Phys. Advisory Board
- Chem. Eng. J. Special Issue bEditorial Board
- Phys. Chem. Chem. Phys. Special Issue Editorial Board

J.F. van der Veen

- Science Advisory Committee of Elettra, Trieste.
- Chairman of Science Advisory Committee of the Advanced Light Source, Berkeley, USA
- Science Advisory Committee of Synchrotron SOLEIL, Gif-sur-Yvette, France
- Science Advisory Committee of Advanced Photon Source, Argonne National Laboratory, USA
- Science Advisory Committee of ANKA, Karlsruhe Institute of Technology, Karlsruhe, Germany
- Science Advisory Committee for Brookhaven National Laboratory's Light Sources Directorate, USA
- Science Advisory Committee of Synchrotron NSRRC, Hsinchu, Taiwan
- Programme Committee of PSI Summer School on Condensed Matter Research, Zuoz, Switzerland
- Scientific Advisory Committee of HERCULES, Grenoble
- International Advisory Committee of the International Conference Series on Synchrotron Radiation Instrumentation
- Advisory Committee of the International Conference Series on Surface X-Ray and Neutron Scattering
- Steering Committee CCMX, Competence Centre for Materials Science and Technology, ETH, Switzerland
- Steering Committee NCCBI, National Competence Center in Biomedical Imagine, ETH, Switzerland.
- Science Advisory Committee for the Van der Waals-Zeeman Instituut, University of Amsterdam, The Netherlands
- Chairman of committee reviewing physics research at the universities of the Netherlands

P.R. Willmott

- Member of the Diamond Light Source Proposal Review Committee

PATENTS

B. Schmitt, A. Bergamaschi, A. Mozzanica
X-ray detector with integrating readout chip for single photon resolution
European patent application 2009P09800EP

Research with Neutrons and Muons

Staff NUM, Condensed Matter Theory

LIST OF PUBLICATIONS (PEER REVIEWED)

Atanasov M, Delley B, Reinen D
A DFT Study of the Energetical and Structural Landscape of the Tetrahedral to Square-Planar Conversion of Tetrahalide Complexes of Copper(II)
ZEITSCHRIFT FUR ANORGANISCHE UND ALLGEMEINE CHEMIE **636**, 1740 (2010)

Brandl C, Tiwari S, Derlet PM, Van Swygenhoven H
Athermal critical stresses for dislocation propagation in nanocrystalline aluminium
PHILOSOPHICAL MAGAZINE **90**, 977 (2010)

Chuasiripattana K, Warschkow O, Delley B, Stampfl C
Reaction intermediates of methanol synthesis and the water-gas-shift reaction on the ZnO(0001) surface
SURFACE SCIENCE **604**, 1742 (2010)

Cui XY, Carter DJ, Fuchs M, Delley B, Wei SH, Freeman AJ, Stampfl C
Continuously tunable band gap in GaN/AlN (0001) superlattices via built-in electric field
PHYSICAL REVIEW B **81**, 155301 (2010)

Cui XY, Delley B, Freeman AJ, Stampfl C
Tunnel magnetoresistance in trilayer junctions from first principles: Cr delta-layer doped GaN/AlN/GaN (0001)
JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS **322**, 395 (2010)

Delley B
Time dependent density functional theory with DMol(3)
JOURNAL OF PHYSICS-CONDENSED MATTER **22**, 384208 (2010)

Derlet PM, Maass R, Loeffler JF
The bribrational properties of model bulk metallic glasses
MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS **1224**, GG-05-1 (2010)

Deupi X, Kobilka BK
Energy Landscapes as a Tool to Integrate GPCR Structure, Dynamics, and Function
PHYSIOLOGY **25**, 293 (2010)

Deupi X, Olivella M, Sanz A, Dolker N, Campillo M, Pardo L
Influence of the g- conformation of Ser and Thr on the structure of transmembrane helices
JOURNAL OF STRUCTURAL BIOLOGY **169**, 116 (2010)

Duan X, Warschkow O, Soon A, Delley B, Stampfl C
Density functional study of oxygen on Cu(100) and Cu(110) surfaces
PHYSICAL REVIEW B **81**, 075430 (2010)

Dudarev SL, Gilbert MR, Arakawa K, Mori H, Yao Z, Jenkins ML, Derlet PM
Langevin model for real-time Brownian dynamics of interacting nanodefects in irradiated metals
PHYSICAL REVIEW B **81**, 224107 (2010)

Gaff JF, Franzen S, Delley B
Ab Initio Calculation of Resonance Raman Cross Sections Based on Excited State Geometry Optimization
JOURNAL OF PHYSICAL CHEMISTRY A **114**, 11681 (2010)

Hou CY, Chamon C, Mudry C
Deconfined fractional electric charges in graphene at high magnetic fields
PHYSICAL REVIEW B **81**, 075427 (2010)

Lyle MJ, Warschkow O, Delley B, Stampfl C
Coverage and charge-state dependent adsorption of carbon monoxide on the zinc oxide (0001) surface
PHYSICAL REVIEW B **82**, 165401 (2010)

Nuebler J, Umansky V, Morf R, Heiblum M, von Klitzing K, Smet J
Density dependence of the nu=5/2 energy gap: Experiment and theory
PHYSICAL REVIEW B **81**, 035316 (2010)

Ryu S, Mudry C, Ludwig AWW, Furusaki A
High-gradient operators in perturbed Wess-Zumino-Witten field theories in two dimensions
NUCLEAR PHYSICS B **839**, 341 (2010)

Ryu S, Mudry C, Obuse H, Furusaki A
The Z(2) network model for the quantum spin Hall effect: two-dimensional Dirac fermions, topological quantum numbers and corner multifractality
NEW JOURNAL OF PHYSICS **12**, 065005 (2010)

Santos L, Neupert T, Chamon C, Mudry C
Superconductivity on the surface of topological insulators and in two-dimensional noncentrosymmetric materials
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Santos L, Ryu SS, Chamon C, Mudry C
Topological qubits in graphenelike systems
PHYSICAL REVIEW B **82**, 165101 (2010)

Schaniel D, Mockus N, Woike T, Klein A, Sheptyakov D, Todorova T, Delley B
Reversible photoswitching between nitrito-N and nitrito-O isomers in trans-[Ru(py)(4)(NO2)(2)]
PHYSICAL CHEMISTRY CHEMICAL PHYSICS **12**, 6171 (2010)

Storni M, Morf RH, Das Sarma S
Fractional Quantum Hall State at nu=5/2 and the Moore-Read Pfaffian
PHYSICAL REVIEW LETTERS **104**, 076803 (2010)

Todorova T, Delley B
Molecular Crystals: A Test System for Weak Bonding
JOURNAL OF PHYSICAL CHEMISTRY C **114**, 20523 (2010)

Todorova T, Peitz D, Kraecher O, Wokaun A, Delley B
Guanidinium Formate Decomposition on the (101) TiO2-Anatase Surface: Combined Minimum Energy Reaction Pathway Calculations and Temperature-Programmed Decomposition Experiments
JOURNAL OF CHEMICAL PHYSICS **114**, 10.1021 (2010)

Ye SX, Zaitseva E, Caltabiano G, Schertler GFX, Sakmar TP, Deupi X, Vogel R
Tracking G-protein-coupled receptor activation using genetically encoded infrared probes
NATURE **464**, 1386 (2010)

INVITED TALKS

X. Deupi
Integration of GPCR Structure, Dynamics and Function
Keystone Symposia on Molecular and Cellular Biology: G Protein-Coupled Receptors April 7 - 12, 2010. Breckenridge, Colorado.

X. Deupi
A conserved activation mechanism for Class A GPCRs
14th International Conference on Retinal Proteins August 2-6, 2010. Santa Cruz, California

P. Derlet:
Sound in Amorphous Materials,
Departmental Seminar talk, Dpt. de Fisica i Enginyeria Nuclear, Universitat Politnica de Catalunya, Barcelona, Catalonia-Spain, December 12th, 2010

P. Derlet:
Atomistic simulations of model bulk metallic glasses,
Keynote lecture, International Symposium on Metastable, Armorphous and Nanostructured Materials, Zurich, Switzerland, July 4th-9th 2010

P. Derlet:
Fission And Fusion Technologies, Demented Rabbits, or the complexity and stability of materials under extreme irradiation environments,
CIMTEC, 5th Forum on New Materials, Florence, Italy, Symposium FF: Materials Challenges For Future Nuclear, June 13th-18th 2010

P. Derlet:
The low-frequency vibrational properties of model bulk metallic glasses within the harmonic approximation,
Topical Talk, DPG Spring Meeting 2010 of the Condensed Matter Section, Regensburg, Germany, March 21st-26th 2010,

C. Mudry:
Deconfined fractional electric charges in graphene at high magnetic fields,
The Japan-Swiss bilateral conference ``New Trends in Theory of Correlated Materials (NTTCM", Chiba, Japan, Sep. 8-10, 2010.

C. Mudry:
High-gradient operators and Anderson localization,
Advanced workshop on ``Anderson localization, nonlinearity and turbulence: a cross-fertilization", ICTP, Trieste, Italy, 23 August - 3 September 2010.

C. Mudry:
Topological qubits in graphene-like systems,
UIUC, October 2010.

C. Mudry:
Deconfined fractional electric charges in graphene at high magnetic fields,
Université de Toulouse, May 2010.

C. Mudry:
Topological qubits in graphene-like systems,
RIKEN, April 2010.

C. Mudry:
Masses, topological phase transitions and fractionalized particles in graphene,
APS March Meeting, Portland, March 2010.

C. Mudry:
Deconfined fractional electric charges in graphene at high magnetic fields,
APS March Meeting, Portland, March 2010.

C. Mudry:
Superconductivity on the surface of topological insulators and in two-dimensional noncentrosymmetric materials,
APS March Meeting, Portland, March 2010.

C. Mudry:
Topological qubits in graphene-like systems,
APS March Meeting, Portland, March 2010.

T. Neupert:
Zero-energy states in two-dimensional superconductors: Creating a chain of Majorana fermions,
Harvard University, Cambridge, Massachusetts, USA, Oct 22 2010

T. Neupert:
Zero-energy states in two-dimensional superconductors: Creating a chain of Majorana fermions,
Boston University, Boston, Massachusetts, USA, Oct 13 2010

R. Morf:
Numerical Study of Localized Quasiholes at nu=5/2 and the Majorana Fermion at Nordita, Stockholm, workshop on Quantum Matter: Opportunities and Challenges September 16th 2010

R. Morf:
Non-Abelian statistics of quasiparticles in fractional quantum Hall systems,
Tribute to Uriel Frisch: The Turbulence School of Nice, Observatoire de Nice December 11th 2010

MEMBERSHIP IN EXTERNAL COMMITTEES

Dr. K. Clausen
- Member of the Board of NMI3 (since 2004)
- International Advisory Committee for The RIKEN-RAL Muon Facility
- Member of the NIAC (J-PARC)
- Chairman ESS Technical Advisory Committee
- Member ob ILL Scientific Advisory Committee

CONFERENCE ORGANIZATION

Clausen K., Bercher R.
Sommerschool on Condensed Matter Research - Magnetic Phenomena, Zuoz, August 7 – 13, 2010

Research with Neutrons and Muons

Spallation Neutron Source Division (ASQ)

LIST OF PUBLICATIONS (PEER REVIEWED)

Badorreck A, Gerke HH, Vontobel P
Noninvasive Observations of Flow Patterns in Locally Heterogeneous Mine Soils using Neutron Radiation
VADOSE ZONE JOURNAL **9**, 362 (2010)

Boillat P, Frei G, Lehmann EH, Scherer GG, Wokaun A
Neutron Imaging Resolution Improvements Optimized for Fuel Cell Applications
ELECTROCHEMICAL AND SOLID STATE LETTERS **13**, B25 (2010)

Brandl C, Tiwari S, Derlet PM, Van Swygenhoven H
Athermal critical stresses for dislocation propagation in nanocrystalline aluminium
PHILOSOPHICAL MAGAZINE **90**, 977 (2010)

Carminati A, Moradi AB, Vetterlein D, Vontobel P, Lehmann E, Weller U, Vogel HJ, Oswald SE
Dynamics of soil water content in the rhizosphere
PLANT AND SOIL **332**, 163 (2010)

Donath T, Pfeiffer F, Bunk O, Grunzweig C, Hempel E, Popescu S, Vock P, David C
Toward Clinical X-ray Phase-Contrast CT Demonstration of Enhanced Soft-Tissue Contrast in Human Specimen
INVESTIGATIVE RADIOLOGY **45**, 445 (2010)

Esser HG, Carminati A, Vontobel P, Lehmann EH, Oswald SE
Neutron radiography and tomography of water distribution in the root zone
JOURNAL OF PLANT NUTRITION AND SOIL SCIENCE **173**, 757 (2010)

Frick CP, Clark BG, Schneider AS, Maass R, Van Petegem S, Van Swygenhoven H
On the plasticity of small-scale nickel-titanium shape memory alloys
SCRIPTA MATERIALIA **62**, 492 (2010)

Gao N, Samaras M, Van Swygenhoven H
A new Fe-He pair potential
JOURNAL OF NUCLEAR MATERIALS **400**, 240 (2010)

Grunzweig C, David C, Bunk O, Kohlbrecher J, Lehmann E, Lai YW, Schafer R, Roth S, Lejcek P, Kopecek J, Pfeiffer F
Visualizing the propagation of volume magnetization in bulk ferromagnetic materials by neutron grating interferometry (invited)
JOURNAL OF APPLIED PHYSICS **107**, 09D308 (2010)

Hase M, Doenni A, Pomjakushin V, Keller L, Gozzo F, Cervellino A, Kohno M
Magnetic structure of Cu2CdB2O6 having magnetization plateau and antiferromagnetic long-range order
JOURNAL OF PHYSICS: CONFERENCE SERIES **200**, 022015 (2010)

Josic L, Steuwer A, Lehmann E
Energy selective neutron radiography in material research
APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING **99**, 515 (2010)

Kaestner A, Vontobel P
Pushing the limits of neutron tomography
GEOCHIMICA ET COSMOCHIMICA ACTA **74**, A488 (2010)

Keunecke D, Mannes D, Niemz P, Lehmann E, Evans R
SILVISCAN VS. NEUTRON IMAGIN TO GENERATTE RADIAL SOFTWOOD DENSITY PROFILES
WOOD RESEARCH **55**, 49 (2010)

Lehmann EH, Deschler-Erb E, Ford A
NEUTRON TOMOGRAPHY AS A VALUABLE TOOL FOR THE NON-DESTRUCTIVE ANALYSIS OF HISTORICAL BRONZE SCULPTURES
ARCHAEOMETRY **52**, 272 (2010)

Lehmann EH, Hartmann S, Speidel MO
INVESTIGATION OF THE CONTENT OF ANCIENT TIBETAN METALLIC BUDDHA STATUES BY MEANS OF NEUTRON IMAGING METHODS
ARCHAEOMETRY **52**, 416 (2010)

Lehmann EH, Wagner W
Neutron imaging at PSI: a promising tool in materials science and technology
APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING **99**, 627 (2010)

Manke I, Kardjilov N, Schaefer R, Hilger A, Strobl M, Dawson M, Gruenzweig C, Behr G, Hentschel M, David C, Kupsch A, Lange A, Banhart J
Three-dimensional imaging of magnetic domains
NATURE COMMUNICATIONS **1**, 125 (2010)

Mannes D, Marone F, Lehmann E, Stampanoni M, Niemz P
Application areas of synchrotron radiation tomographic microscopy for wood research
WOOD SCIENCE AND TECHNOLOGY **44**, 67 (2010)

Moradi AB, Carminati A, Vontobel P, Lehmann E, Weller U, Vogel HJ, Oswald SE
Micro-scale distribution of water around plant roots
NEW PHYTOLOGIST **Submitted**, Submitted (2010)

Moradi AB, Swoboda S, Robinson B, Prohaska T, Kaestner A, Oswald SE, Wenzel WW, Schulin R
Mapping of nickel in root cross-sections of the hyperaccumulator plant Berkheya coddii using laser ablation ICP-MS
ENVIRONMENTAL AND EXPERIMENTAL BOTANY **69**, 24 (2010)

Niemz P, Mannes D, Koch W, Herbers Y
Investigation regarding the behaviour of wood impregnated with nano-particles and exposed to the open weather.
BAUPHYSIK **32**, 226 (2010)

Niemz P, Mannes D, Koch W, Herbers Y
Studies on water absorption coefficient of variation of wood and wood with liquid
BAUPHYSIK **32**, 149 (2010)

Saito S, Kikuchi K, Hamaguchi D, Usami K, Ishikawa A, Nishino Y, Endo S, Kawai M, Dai Y
Proton irradiation effects on tensile and bend-fatigue properties of welded F82H specimens
JOURNAL OF NUCLEAR MATERIALS **398**, 49 (2010)

Schneider IA, von Dahlen S, Bayer MH, Boillat P, Hildebrandt M, Lehmann EH, Oberholzer P, Scherer GG, Wokaun A
Local Transients of Flooding and Current in Channel and Land Areas of a Polymer Electrolyte Fuel Cell
JOURNAL OF PHYSICAL CHEMISTRY C **114**, 11998 (2010)

Seyfang BC, Boillat P, Simmen F, Hartmann S, Frei G, Lippert T, Scherer GG, Wokaun A
Identification of liquid water constraints in micro polymer electrolyte fuel cells without gas diffusion layers
ELECTROCHIMICA ACTA **55**, 2932 (2010)

Sonderegger W, Hering S, Mannes D, Vontobel P, Lehmann E, Niemz P
Quantitative determination of bound water diffusion in multilayer boards by means of neutron imaging
EUROPEAN JOURNAL OF WOOD AND WOOD PRODUCTS **68**, 341 (2010)

Symietz C, Lehmann E, Gildenhaar R, Kruger J, Berger G
Femtosecond laser induced fixation of calcium alkali phosphate ceramics on titanium alloy bone implant material
ACTA BIOMATERIALIA **6**, 3318 (2010)

Thomsen K
Pressure Measurement Based on Thermocouples
IEEE TRANSACTIONS ON NUCLEAR SCIENCE **57**, 3694 (2010)

Thomsen K, Butzek M, Gallmeier F, Wolters J
A Case for a SINQ-type Cannelloni Target at the ESS Power Level
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT **625**, 5 (2010)

Thomsen K, Conder K, Dai Y, Frison R, Kiselev D, Medarde M, Moormann R, Platacis E, Pomjakushina E, Toeroek S, Zanini L, Zimmermann P
Lead Gold Eutectic, first steps towards the qualification of a novel target material for ESS
PROCEEDINGS OF ICANS XIX, 19th MEETING ON COLLABORATION OF ADVANCED NEUTRON SOURCES **.**, . (2010)

Tong Z, Dai Y
The microstructure and tensile properties of ferritic/martensitic steels T91, Eurofer-97 and F82H irradiated up to 20 dpa in STIP-III
JOURNAL OF NUCLEAR MATERIALS **398**, 43 (2010)

Turski M, Clitheroe S, Evans AD, Rodopoulos C, Hughes DJ, Withers PJ
Engineering the residual stress state and microstructure of stainless steel with mechanical surface treatments
APPLIED PHYSICS A-MATERIALS SCIENCE & PROCESSING **99**, 549 (2010)

Van Swygenhoven H, Van Petegem S
The Use of Laue Microdiffraction to Study Small-scale Plasticity
JOM **62**, 36 (2010)

Zhang P, Wittmann FH, Zhao T, Lehmann EH
Neutron imaging of water penetration into cracked steel reinforced concrete
PHYSICA B-CONDENSED MATTER **405**, 1866 (2010)

Zhang P, Wittmann FH, Zhao TJ, Lehmann E, Jin ZQ
Visualization and quantification of water movement in porous cement-based materials by real time thermal neutron radiography: Theoretical analysis and experimental study
SCIENCE CHINA-TECHNOLOGICAL SCIENCES **53**, 1198 (2010)

Zhang P, Wittmann FH, Zhao TJ, Lehmann EH, Tian L, Vontobel P
Observation and quantification of water penetration into Strain Hardening Cement-based Composites (SHCC) with multiple cracks by means of neutron radiography
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT **620**, 414 (2010)

Zimmermann J, Van Petegem S, Bei H, Grolimund D, George EP, Van Swygenhoven H
Effects of focused ion beam milling and pre-straining on the microstructure of directionally solidified molybdenum pillars: A Laue diffraction analysis
SCRIPTA MATERIALIA **62**, 746 (2010)

LIST OF PUBLICATIONS

De Ridder,M., Van den Bulcke, J., Vansteenkiste, D., Van Loo D., Dierick, M., Masschaele, B., De Witte, Y., Mannes, D., Lehmann, E., Beeckman, H., Van Hoorebeke, L., Van Acker, J.
High-resolution proxies for wood density variations in Terminalia superba.
Annals of Botany DOI:10.1093/aob/mcq224, available online at www.aob.oxfordjournals.org

Gramlich A., Moradi A.B., Robinson B.H., Kaestner A., Schulin R.
Dimethylglyoxime (DMG) staining for semi-quantitative mapping of Ni in plant tissue
Environmental and Experimental Botany, In Press, Accepted Manuscript

C. Grünzweig, A. Kaestner, E. Lehmann, M. Reichler, A. Kölmel, T. Gegg, K.-M. Uhl
Visualization of a Fired Two-Stroke Chain Saw Engine Running at Idle Speed by Dynamic Neutron Radiography.
SAE Technical Paper 2010-32-0013, doi:10.4271/2010-32-0013 (2010).

Manke I, Kardjilov N, Schäfer R, Hilger A, Strobl M, Dawson M, Grünzweig C,Behr G, Hentschel M, David C,Kupsch A, Lange A& Banhart J
Three-dimensional imaging of magnetic domains
NATURE COMMUNICATIONS, Volume 1, 125, Nov 23, (2010)

INVITED TALKS

C. Gruenzweig
Visualization of magnetic domains and magnetization processes in bulk materials by neutron dark-field imaging.
Conference talk, Magnetic Measurements 2010, Prague (2010).

Christian Gruenzweig
Visualization of magnetic domains and magnetization processes in bulk materials by neutron dark-field imaging.
Seminar talk, National Institut of Standards and Technology NIST, Gaithersburg (2010).

Christian Gruenzweig
Visualization of magnetic domains and magnetization processes in bulk materials by neutron dark-field imaging.
Conference talk, 11th Joint MMM-Intermag Conference, Washington DC (2010).

A.P. Kaestner, P. Vontobel, E. Lehmann,
Neutron Imaging Methods in Geoscience
GeoX 2010, New Orleans, March, 2010. invited talk

E. H. Lehmann, C. Grünzweig, I. Johnson, L. Josic, Neutron Imaging – detector options in progress, IWORID-12, Cambridge, June, 2010
E. H. Lehmann, P. Boillat, P. Oberholzer, Neutron Imaging Methods fort he Investigation of Energy Related Materials. MRS-2010, May, 2010

S. Van Petegem
ISMANAM 2010, 17th International Symposium on Metastable, Amorphous and Nanostructured Materials, Zurich, Switzerland (July 4-9, 2010)
Invited talk: 'In-situ X-Ray Diffraction Study of Nanocrystalline Metals'

S. Van Petegem
TMS annual meeting 2010 (February 2010)
Invited talk: 'Size Effects in Plasticity Investigated by In Situ Laue Diffraction'

Helena Van Swygenhoven
Invited talk in the Joint SSSTC-CAS Workshop on Renewable Energy/Cleantech and Materials Science, Shengyan and Bejing, September 9-14, 2010 as a member of the Swiss delegation to China within the Sino- Swiss Science and Technology Cooperation.

H. Van Swygenhoven
Plenary lecture in "Materials Science and Engineering", Darmstadt August 24-28, 2010, Germany.

H. Van Swygenhoven
Invited talk "Mechanical properties of materials" in EMPA Akademie in the framework of the CCMX Technical Apero between industry and ETH-research community. October 20, 2010.

Helena Van Swygenhoven
Invited talk in the 7th Pacific Rim International Conference on Advanced Materials and Processing, 1-5 August, 2010, Cairns, Australia.

H. Van Swygenhoven
Invited lecture in the VIP Workshop 'Advanced Characterization and Modelling in Metals Research' on 9-10 August, 2010, Melbourne, Australia.

H. Van Swygenhoven
Invited lecture in CAMTEC series, Symposium on fine-scale mechanical characterization and behaviour, Cambridge, 29-30 March, 2010, England.

H. Van Swygenhoven
Invited lecture in the international conference on Computational Physics, CCP2010 in Trondheim, Norway, June 23-26, 2010.

H. Van Swygenhoven
Plenary lecture in the European Powder Diffraction Meeting, Darmstadt Aug 27-30, 2010 , Germany.

H. Van Swygenhoven
Invited talk 7th International symposium on metastable, amorphous and nanostructured materials, Zurich, June 4-9, 2010.

W. Wagner
Design concepts of High Power Spallation Targets – with emphasis on SINQ target development and operation
ASIPP – Institute of Plasma Physics, Chinese Academy of Science, Hefei, China, 24.1.2010 (invited)

W. Wagner
Design concepts of High Power Spallation Targets – with emphasis on SINQ target development and operation
ISPP – Institute of Solid State Physics, Chinese Academy of Science, Hefei, China, 26.1.2010 (invited)

W. Wagner
Status of the PSI Spallation Neutron Source and Development Projects
ICANS XIX, International Collaboration on Advanced Neutron Sources, Grindelwald (CH) 9.3.2010

W. Wagner
PSI experience with high power target design and operation
OECD Internatl. Workshop on 'Technology and Components of Accelerator Driven Systems TCADS, Karlsruhe (D), March 15-17, 2010

W. Wagner
MEGAPIE target: R&D, operation and PIE
International Workshop on China ADS Project, Institute of Modern Physics, Chinese Academy of Science, Lanzhou, China, October 14 - 15, 2010

W. Wagner, M. Wohlmuther
The MEGAPIE target on the way to PIE
IWSMT-10, International Workshop on Spallation Target Technology, Beijing, China, October 18 - 22, 2010

W. Wagner
PSI experience with cold neutron sources
Consultancy Meeting on "Directionally Focused Moderators for Enhanced Neutron Beam Intensities to Support Materials Research and Applications"
IAEA- Vienna, December 7-9, 2010

CONFERENCE, WORKSHOP AND SEMINAR CONTRIBUTIONS

B. Blau and W. Wagner
Status of the Ultracold Neutron Source at PSI
Proceedings of ICANS XIX, International Collaboration of Advanced Neutron Sources, March 8 – 12, 2010, Grindelwald, Switzerland, PSI Proceedings 10-01, ISSN-Nr. 1019-6447 (2010)

G. Burca, J. James, M. Fitzpatrick, W. Kockelmann, J.F. Kelleher , SY. Zhang, J. Hovind, R. van Langh,
Tomography driven diffraction experiments,
NEUWAVE-3, Sapporo, Hokkaido, Japan, June 6-9, 2010

L. Butler, L. Josic, E. Lehmann,
Neutron Refraction Edge Effects: Examples, Explanation, Modeling, and Possible Applications,
NEUWAVE-3, Sapporo, Hokkaido, Japan, June 6-9, 2010

Y. Dai and W. Wagner
The Status of Studies on Structural Materials under High Energy Proton and Neutron Mixed Spectrum
Proceedings of International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators, 4-8 May 2009, IAEA, Vienna (2010) AP/INT-01
STI/PUB/1433, ISBN 978-92-0-150410-4, ISSN 1991-2374 (2010)

M. Grosse, M. van den Berg, E. Lehmann, B. Schillinger,
In-situ neutron radiography investigations of the hydrogen diffusion and absorption in zirconium alloys,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

M. Grosse, M. Steinbueck, A. Kaestner,
Wavelength dependent neutron transmission and radiography investigations of the high temperature behaviour of materials applied in nuclear fuel and control rod claddings,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

L. Josic, E.H. Lehmann, A. Kaestner,
Energy selective neutron imaging,
9th World Conference on Neutron Radiography, 3 - 8 October 2010, Kwa-Maritane, South Africa

L. Josic, Eberhard H. Lehmann, Anders Kaestner,
Energy selective neutron imaging,
ICANS XIX, 19th meeting on Collaboration of Advanced Neutron Sources, March 8 – 12, 2010 Grindelwald, Switzerland

L. Josic, Eberhard H. Lehmann, Anders Kaestner,
Energy selective neutron radiography and tomography¨,
NEUWAVE-3, Sapporo, Hokkaido, Japan, June 6-9, 2010

A.P. Kaestner,
MuhRec – A CT-reconstructor for neutron imaging,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

A. Kaestner, C. Grünzweig, S. Hartmann,
Neutron grating interferometry instrumentation,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

J. Kickhofel, R. Zboray, M. Damsohn, A. Kaestner, E.H. Lehmann, H.-M. Prasser,
Cold Neutron Tomography of Annular Coolant Flow in a Double Subchannel Model of a Boiling Water Reactor,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

E. H. Lehmann, D. Mannes, W. Sonderegger, S. Hering, P. Niemz,
Nondestructive determination of moisture transfer in wood by means of neutron imaging,
11th Int. IUFRO Wood Drying Conference, Skelleftea, Jan. 2010

E. H. Lehmann, A. Kaestner, L. Josic, S. Hartmann, D. Mannes,
Imaging with cold neutrons,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

E. H. Lehmann, P. Vontobel, G. Frei, G. Kühne, A. Kaestner,
How to organize a neutron imaging user lab?,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

E.H. Lehmann, L. Josic, J. Hovind, U. Filges, A. Bollhalder, P. Vontobel,
BOA – a beam line for very cold and polarized neutrons - options for its use in imaging,
NEUWAVE-3, Sapporo, Hokkaido, Japan, June 6-9, 2010.

D. Mannes, S. Le Conte, E. Lehmann (2010)
Neutron vs. X-ray computed tomography: comparative study on the example of a violin.
4th International Conference of COST Action IE0601: Interaction between Wood Science and Conservation of Cultural Heritage. Izmir, Turkey, 20-22 October 2010

D. Mannes, E. Lehmann, W. Sonderegger, S. Hering, P. Niemz (2010)
Determination of moisture transport processes by means of neutron imaging.
COST Action IE0601: Workshop of wood structure/function relationships. Hamburg, Germany, 5-8 October 2010

D. Mannes (2010)
Neutron imaging – basic principles.
COST Action IE0601: Workshop of wood structure/function relationships. Hamburg, Germany, 5-8 October 2010

R. Moormann, M. Medarde, E. Platacis and K. Thomsen,
Proceedings of the International Workshop of Technology and Components of Accelerator Driven Systems, Karlsruhe, Germany, 15-17 March 2010.

M. Tamaki, L. Josic , A. Hilger, N. Kardjilov, Lehmann EH ,Sh. Honda, S. Srisatit, Y. Tsuji,
Concept, development, experiment and analysis of coherent neutron CT Imaging,
NEUWAVE-3, Sapporo, Hokkaido, Japan, June 6-9, 2010

K. Thomsen, K. Conder, Y. Dai, D. Kiselev, M. Medarde, R. Moormann, E. Platacis, E. Pomjakushina, S. Török, L. Zanini, P. Zimmermann
Lead Gold Eutectic, First Steps towards the Qualification of a Novel Target Material for ESS,
Icans XIX, March 2010.

A.S. Tremsin, J.B. McPhate, J.V. Vallerga, O.H.W. Siegmund, W.B. Feller, E. Lehmann, L. Josic, W. Kockelmann, A. Paradowska, S.Y. Zhang, J. Kelleher, A. Steuwer, M.J. Mühlbauer, B. Schillinger, H.Z. Bilheux, D. Penumadu, L. Butler, N. Kardjilov, M. Dawson, M. Strobl, I. Manke,
High resolution neutron imaging and transmission diffraction with noiseless readout,
NEUWAVE-3, Sapporo, Hokkaido, Japan, June 6-9, 2010

P. Trtik, B. Muench, W.J. Weiss, G. Herth, A. Kaestner, E. Lehmann, P. Lura.
Neutron tomography investigation of water release from superabsorbent polymers in cement paste.
Proc. Int. RILEM Conf. on Material Science (MatSci), Aachen, Germany, Volume III, PRO 77, 175-185. September 6-10, 2010

P. Trtik, B. Münch, W.J. Weiss, A.Kaestner, I. Jerjen, E. Lehmann, P. Lura,
Neutron tomography of water release from lightweight aggregates in cement pastes,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

P. Trtik, B. Münch, W.J. Weiss, A.Kaestner, I. Jerjen, E. Lehmann, P. Lura,
Patch microstructure of cement pastes – an insight by the combination of neutron and X-ray tomographies,
Proc. World Conference on Neutron Radiography – 9, Kwa Maritane, South Africa, Oct., 2010

W. Wagner, on behalf of the MEGAPIE collaboration
The MEGAPIE Operation Synthesis
Proceedings HeLiMeRT 2009, 5th International Workshop on Materials for Heavy Liquid Metal cooled Reactors and Related Technologies, SCK-CEN, Belgium, SCK-CEN-ER-0113, December 2009

W. Wagner
The MEGAPIE Operation Synthesis
Proceedings of International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators, 4-8 May 2009, IAEA, Vienna (2010) ADS/ET-09
STI/PUB/1433, ISBN 978-92-0-150410-4, ISSN 1991-2374 (2010)

W. Wagner, B. Blau, H. Heyck, E. Lehmann, K. Thomsen, M. Wohlmuther
Status and Development of the Swiss Spallation Neutron Sources SINQ&UCN
Proceedings of ICANS XIX, International Collaboration of Advanced Neutron Sources, March 8 – 12, 2010, Grindelwald, Switzerland, PSI Proceedings 10-01, ISSN-Nr. 1019-6447 (2010)

M. Wohlmuther, D. Gavillet, K. Geissmann, D. Kuster, R. Meier, J. Neuhausen, D. Schumann, A. Strinning, P. Suter, S. Teichmann, R. Thermer, K. Thomsen, W. Wagner, J. Zuellig, C. Zumbach, and C. Hoesli
MEGAPIE on the Way to PIE
Proceedings of International Topical Meeting on Nuclear Research Applications and Utilization of Accelerators, 4-8 May 2009, IAEA, Vienna (2010) ADS/ET-10
STI/PUB/1433, ISBN 978-92-0-150410-4, ISSN 1991-2374 (2010)

LECTURES AND COURSES

Hajo Heyck
Kerntechnik
Vorlesung an der Fachhochschule Nordwestschweiz (FHNW) Brugg-Windisch, (University of Applied Sciences, Northwest Switzerland)

A.P. Kaestner
Applications of neutron imaging
Pre-conference School for Imaging with Radiation, Johannesburg, South Africa,

E. Lehmann
Neutron & X-ray Imaging for Cultural Heritage
Uni Basel, Ringvorlesung “Einführung in die Archäometrie”

E.H. Lehmann
Facilities for Neutron Imaging
WCNR9 Pre-conference School for Imaging with Radiation, Johannesburg, South Africa,.

S. Van Petegem
Powder 2010, Diffraction at the Nanoscale: Nanocrystals, Defective & Amorphous Materials, Paul Scherrer Institut, Villigen, Switzerland (May 24-30, 2010)
Lecture: ‘Introduction to Nanoscale-Ordered Materials in Material Sciences and Engineering’

S. Van Petegem
CCMX Summer School on Materials Characterisation, Lausanne, Switzerland (August 25-27, 2010)
Lecture: ‘Introduction to x-ray and neutron diffraction in materials science’

H. Van Swygenhoven
Lecture in the European Erasmus Mundus masters program MAMASELF “Masters in material science exploiting large facilities”, May 3-6, 2010, Rigi-Kulm, Switzerland.

H. Van Swygenhoven
Doctoral course MX13 in the program of Materials Science and Engineering of the EPFL: “Atomistic and Phase Field Modeling: Two Complementary Techniques to Experiments for Nanostructured Metallic Materials and Phase Transformations”, Prof. M. Rappaz, Prof. H. Van Swygenhoven

H. Van Swygenhoven
Lecture in winter school MECANO “Mecanique des nano-objets”, Autrans, March 14-19, 2010

H. Van Swygenhoven
Lecture in bilateral workshop on the materials program between EPFL-IMX and Tokyo Institute of Technology, Jan. 17-23 2010.

BOOKS (CHAPTERS)

A. Adriaens, M. Dowsett, E. H. Lehmann, Y. Farhi, J. Gunneweg, L. Bouchenoire
The coin beneath the crust: a pilot study of coins from the Mediterranean coast of Israel,
Koninklijke Brill NV, Leiden, 2010

MEMBERSHIP IN EXTERNAL COMMITTEES

E. Lehmann
- President of the International Society for Neutron Radiology 2010-2014
- Referee Committee des FRM-II, TU München, D
- Member of the Beam Instrumentation Advisory Group of ANSTO, Australia
- Swiss Representative in COST-IE 0601, Member of the Steering Committee

D. Mannes
- Swiss Representative in COST-FP0904, Member of the Management Committee

A.P. Kaestner
- Board member of the International Society for Neutron Radiology 2010-2014

H. Heyck
- Basic Energy Sciences Review of the Lujan Neutron Scattering Center Los Alamos Neutron Science Center
- DOE Basic Energy Sciences Triennial Review of Spallation Neutron Source SNS and High Flux Isotope Reactor HFIR

W. Wagner
- ESS Target-Technical Advisory committee (t-TAC), ESS, Lund, Sweden
- International Neutron Technology Advisory Committee of the CSNS China Spallation Neutron Source Project

H. Van Swygenhoven
- Member of the Advisory Board for the Doctoral Training Centre (DTC) on Theory and Simulation of Materials (TSM) at Imperial College (see www.cmth.ph.ic.ac.uk/dtc/)
- Member of the International Advisory Committee of the International Risø Symposium on Materials Science
- Elected by the EC-commission as a member of the External Advisory Group (EAG) of the NMP program
- Member of the board of Interdisciplinary Center for Advanced Materials Modelling (ICAMS), Ruhr-University Bochum, Germany,
- Vice chair of the International Committee of Strength of Materials (ICSMA).
- Elected member of the PSI research commission (FOKO).
- Member of the international review panel of the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) in the high profile program “Excellence Initiative”, Dec 14-16, 2010.
- Member of the international review panel for the Helmholtz Association to evaluate the proposed Helmholtz institute in Ulm (electrochemical foundations of energy storage) as a satellite of KIT (Karlsruhe institute of technology); November 11-12, 2010.

DISSERTATIONS

Andreas Elsener
An Atomistic Simulation Method for Oxygen Impurities in Aluminium Based on Variable Charge Molecular Dynamics.
EPFL Thesis, No 4702 (2010)

Samuele Chiesa
Optimization of embedded atom method interatomic potentials to simulate defect structures and magnetism in α-Fe
EPFL Thesis No 4775 (2010)

EXCHANGE STUDENTS

Mr. P. Ghosh, Masters student Indian Institute of Science, Department of Materials Engineering, IISc Bangalore, Prof. A. Chokshi, August 2010-January 2011 (experiments).

Miss. E. Wiltshire, Summer internship Department of Materials Science & Metallurgy, Cambridge, European Vacation Placement Scheme, July-August 2010 (experiments).

Dr. V. Lemiale, January 10-22, 2010 to start up a collaboration in modelling in plasticity with Prof. Y. Estrin, Monash University, Department of Materials Engineering (simulations).

Miss. Lin Li, PhD student Ohio State University, Faculty Material Science and Engineering, Prof. P. Anderson; June 22-July 4th 2009 and April 26-May 22 2010, (simulations).

Mr. P. Schloth, Masters student from Technical University Darmstadt, Prof. M. Heilmeier (March-July 2010) to perform research with xrays/neutron on ODS steels (experiments).

CONFERENCE ORGANIZATION

H. Van Swygenhoven
- Symposium “Modelling in material science” at the Swiss Physical Society, Basel June 21-22, 2010

W. Wagner
- International Collaboration on Advanced Neutron Sources ICANS XIX, Grindelwald, March 8-12

Research with Neutrons and Muons

Laboratory for Developments and Methods (LDM)

LIST OF PUBLICATIONS (PEER REVIEWED)

Atchison F, Daum M, Henneck R, Heule S, Horisberger M, Kasprzak M, Kirch K, Knecht A, Kuzniak M, Lauss B, Mtchedlishvili A, Meier M, Petzoldt G, Plonka-Spehr C, Schelldorfer R, Straumann U, Zsigmond G
Diffuse reflection of ultracold neutrons from low-roughness surfaces
EUROPEAN PHYSICAL JOURNAL A **44**, 23 (2010)

Babkevich P, Bendele M, Boothroyd AT, Conder K, Gvasaliya SN, Khasanov R, Pomjakushina E, Roessli B
Magnetic excitations of Fe1+ySexTe1-x in magnetic and superconductive phases
JOURNAL OF PHYSICS-CONDENSED MATTER **22**, 142202 (2010)

Baledent V, Fauque B, Sidis Y, Christensen NB, Pailhes S, Conder K, Pomjakushina E, Mesot J, Bourges P
Two-Dimensional Orbital-Like Magnetic Order in the High-Temperature La2-xSrxCuO4 Superconductor
PHYSICAL REVIEW LETTERS **105**, 027004 (2010)

Bendele M, Amato A, Conder K, Elender M, Keller H, Klauss HH, Luetkens H, Pomjakushina E, Raselli A, Khasanov R
Pressure Induced Static Magnetic Order in Superconducting FeSe1-x
PHYSICAL REVIEW LETTERS **104**, 087003 (2010)

Bendele M, Babkevich P, Katrych S, Gvasaliya SN, Pomjakushina E, Conder K, Roessli B, Boothroyd AT, Khasanov R, Keller H
Tuning the superconducting and magnetic properties of FeySe0.25Te0.75 by varying iron content
PHYSICAL REVIEW B **82**, 212504 (2010)

Bendele M, Weyeneth S, Puzniak R, Maisuradze A, Pomjakushina E, Conder K, Pomjakushin V, Luetkens H, Katrych S, Wisniewski A, Khasanov R, Keller H
Anisotropic superconducting properties of single-crystalline FeSe0.5Te0.5
PHYSICAL REVIEW B **81**, 224520 (2010)

Braun A, Mun BS, Sun Y, Liu Z, Groening O, Maeder R, Erat S, Zhang X, Mao SS, Pomjakushina E, Conder K, Graule T
Correlation of conductivity and angle integrated valence band photoemission characteristics in single crystal iron perovskites for 300K <T<800K : Comparison of surface and bulk sensitive methods
JOURNAL OF ELECTRON SPECTROSCOPY AND RELATED PHENOMENA **181**, 56-62 (2010)

Casola F, Shiroka T, Wang S, Conder K, Pomjakushina E, Mesot J, Ott HR
Direct Observation of Impurity-Induced Magnetism in a Spin-1/2 Antiferromagnetic Heisenberg Two-Leg Spin Ladder
PHYSICAL REVIEW LETTERS **105**, 067203 (2010)

Comment A, Jannin S, Hyacinthe JN, Mieville P, Sarkar R, Ahuja P, Vasos PR, Montet X, Lazeyras F, Vallee JP, Hautle P, Konter JA, van den Brandt B, Ansermet J-Ph Gruetter R, Bodenhausen G
Hyperpolarizing Gases via Dynamic Nuclear Polarization and Sublimation
PHYSICAL REVIEW LETTERS **105**, 018104 (2010)

Garcia-Fernandez M, Staub U, Bodenthin Y, Pomjakushin V, Mirone A, Fernandez-Rodriguez J, Scagnoli V, M Mulders A, M Lawrence S, Pomjakushina E
Doping and temperature dependence of Mn 3d states in A-site ordered manganites
PHYSICAL REVIEW B **82**, 235108 (2010)

Grimmer H
Opechowski-Guccione-like symbols labelling magnetic space groups independent of tabulated (0,0,0)+sets
ACTA CRYSTALLOGRAPHICA SECTION A **66**, 284 (2010)

Kenzelmann M, Gerber S, Egetenmeyer N, Gavilano JL, Straessle TH, Bianchi AD, Ressouche E, Movshovich R, Bauer ED, Sarrao JL, Thompson JD
Evidence for a Magnetically Driven Superconducting Q Phase of CeCoIn5
PHYSICAL REVIEW LETTERS **104**, 127001 (2010)

Khasanov R, Bendele M, Amato A, Conder K, Keller H, Klauss HH, Luetkens H, Pomjakushina E
Evolution of Two-Gap Behavior of the Superconductor FeSe1-x
PHYSICAL REVIEW LETTERS **104**, 087004 (2010)

Khasanov R, Bendele M, Conder K, Keller H, Pomjakushina E, Pomjakushin V
Iron isotope effect on the superconducting transition temperature and the crystal structure of FeSe1-x
NEW JOURNAL OF PHYSICS **12**, 073024 (2010)

Kortyka A, Puzniak R, Wisniewski A, Zehetmayer M, Weber HW, Tang CY, Yao X, Conder K
Evidence for a temperature dependent anisotropy of the superconducting state parameters in underdoped SmBa2Cu3Ox
PHYSICAL REVIEW B **82**, 054510 (2010)

Moormann R, Medarde M, Platacis Thomsen K
Lead Gold Eutectic (LGE) as target material for ESS
PROCEEDINGS OF THE INTERNATIONAL WORKSHOP ON TECHNOLOGY AND COMPONENTS OF ACCELERATOR DRIVEN SYSTEMS **.**, . (2010)

Podlesnyak A, Furrer A, Straessle T, Pomjakushina E, Conder K, Khomskii DI
Evidence for Magnetic Polarons in Hole-Doped Cobalt Perovskites
MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS **1256**, N04-02 (2010)

Pomjakushin VYU, Sheptyakov DV, Pomjakushina EV, Conder K, Balagurov AM
Evidence for the strong effect of quenched correlated disorder on phase separation and magnetism in (La1-yPry)0.7Ca0.3MnO3
JOURNAL OF PHYSICS-CONDENSED MATTER **22**, 115601 (2010)

Saxer S, Pieles U, Elsener M, Horisberger M, Tosatti S, Textor M, Gademann K, Zuercher S
Design of a high-troughput device for screening surface modification protocols
PROGRESS IN ORGANIC COATINGS **67**, 20 (2010)

Schneider CW, Esposito M, Marozau I, Conder K, Doebeli M, Hu Y, Mallepell M, Wokaun A, Lippert T
The origin of oxygen in oxide thin films: Role of the substrate
APPLIED PHYSICS LETTERS **97**, 192107 (2010)

Simmen F, Hintennach A, Horisberger M, Lippert T, Novak P, Schneider CW, Wokaun A
Aspects of the Surface Layer Formation on Li1+xMn2O7-d during Electrochemical Cycling
JOURNAL OF THE ELECTROCHEMICAL SOCIETY **157**, A1026 (2010)

Simmen F, Lippert T, Novak P, Horisberger M, Doebeli M, Mallepell M, Wokaun A
Influence of metal layer coated glassy carbon substrates of the properties of PLD deposited Li1+xMn2O4-d films
JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS **12**, 523-527 (2010)

Stahn J, Panzner T, Filges U, Marcelot C, Boeni P
Study on a focusing, low-background neutron delivery system
NUCLEAR INSTRUMENTS AND METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT , (2010)

Thomsen K, Conder K, Dai Y, Frison R, Kiselev D, Medarde M, Moormann R, Platacis E, Pomjakushina E, Toeroek S, Zanini L, Zimmermann P
Lead Gold Eutectic, first steps towards the qualification of a novel target material for ESS
PROCEEDINGS OF ICANS XIX, 19th MEETING ON COLLABORATION OF ADVANCED NEUTRON SOURCES ., . (2010)

Tsyrulin N, Xiao F, Schneidewind A, Link P, Ronnow H, Gavilano J, Landee CP, Turnbull MM Kenzelmann M
Two-dimensional square-lattice S=1/2 antiferromagnet Cu(pz)2(ClO4)2
PHYSICAL REVIEW B **81**, 134409 (2010)

Wang S, Pomjakushina E, Shiroka T, Deng G, Nikseresht N, Rueegg CH, Ronnow HM, Conder K
Crystal growth and characterization of the dilutable frustrated spin-ladder compound Bi(Cu1-xZnx)2PO6
JOURNAL OF CRYSTAL GROWTH **313**, 51-55 (2010)

White JS, Das P, Eskildsen MR, DeBeer-Schmitt L, Forgan EM, Bianchi AD, Kenzelmann M, Zolliker M, Gerber S, Gavilano JL, Mesot J, Movshovich R, Bauer ED, Sarrao JL, Petrovic C
Observations of Pauli paramagnetic effects on the flux line lattice in CeCoIn5
NEW JOURNAL OF PHYSICS **12**, 023026 (2010)

Zapf VS, Kenzelmann M, Wolff-Fabris F, Balakirev F and Chen Y
Magnetically induced electric polarization in an organometallic magnet
PHYSICAL REVIEW B **82**, 060402(R) (2010)

Zimmer O, Schmidt-Wellenburg P, Fertl M, Wirth HF, Assmann M, Klenke J, van den Brandt B
Ultracold neutrons extracted from a superfluid-helium converter coated with fluorinated grease
EUROPEAN PHYSICAL JOURNAL C **67**, 589-599 (2010)

INVITED TALKS

M. Bartkowiak
Adding pieces to the pnictide Puzzle - experiments at high magnetic fields
Institut Seminar, Laboratoire National des Champs Magnétiques Intenses
Toulouse, France, May 19, 2010

K. Conder
Crystal growth of oxides by optical floating zone technique
National Conference on Recent Advances in Magnetic Materials & Applications (MAGMA 2010)
Madurai, India, January, 20-21, 2010

K. Conder
Crystal growth of oxides by traveling solvent floating zone technique
1st BIMR Summer School on Crystal Growth
Mc Master University,
Hamilton, Canada, June 23-25, 2010

H. Grimmer
Quaternions and their applications to crystallography
MaThCryst Satellite Conference to ECM26
Darmstadt, Germany, August, 27-29, 2010

P. Hautle
DNP - from polarized targets to metabolic imaging
Seminar Jefferson Lab
Newport, News, USA, November 5, 2010

P. Hautle
AFP - a fast and easy nuclear polarization reversal?
Santa Fe Drell-Yan physics Workshop
Santa Fe, USA, October 31 - November 1, 2010

M. Kenzelmann
Coupled magnetic and superconducting order in $CeCoIn_5$
Physical Phenomena at High Magnetic Fields (PPHMF-VII)
Tallahassee, Florida, December 3-8, 2010

M. Kenzelmann
Multiple-order phases in materials close to a quantum critical point
Joint IOP-PSI Workshop
Bad Zurzach, Switzerland, October 13-15, 2010

M. Kenzelmann
Magnetically-induced ferroelectricity in perovskites
European MRS 2010 Fall Meeting,
Warsaw, Poland, September 13-17, 2010

M. Kenzelmann
Multiferroic materials
23rd General Conference of the European Physical Society, Condensed Matter Division
Warsaw, Poland, August 30–September 3, 2010

M. Kenzelmann
Coupled magnetic and superconducting order in $CeCoIn_5$
New physics of new materials
ETH Zürich,
Zürich, Switzerland, August 22-25, 2010

M. Kenzelmann
Coupled magnetic and superconducting order in $CeCoIn_5$
International Conference on Strongly Correlated Electron Systems (SCES 2010)
Santa Fe, U.S.A, June 27-July 3, 2010

M. Kenzelmann
Field-induced ferroelectric polarization in magneto-electrics
CIMTEC 2010,
Montecatini Terme, Italy, June 6-11, 2010

M. Kenzelmann
Coupled magnetic and superconducting order in $CeCoIn_5$
International Conference on Core Research and Engineering Science of Advanced Materials & Third Int. Conference on Nanospintronics Design and Realization, 3rd-ICNDR
Osaka, Japan, May 30-June 4, 2010

M. Kenzelmann
Field-induced ferroelectric polarization in magneto-electrics
International Conference on Superconductivity and Magnetism, ICSM-2010
Antalya, Turkey, April 20-25, 2010

M. Kenzelmann
Magnetically-induced ferroelectricity in $Ni_3V_2O_8$
Advances in the Fundamental Physics of Ferroelectrics and Related Materials
Aspen, January 31-February 4, 2010

M. Kenzelmann
Multiferroics – Experiments
Lecture, 9th PSI Summer School on Condensed Matter Research,
Zuoz, Switzerland, August 7-13, 2010

M. Kenzelmann
Coupled magnetic and superconducting order in $CeCoIn_5$
Seminar, FRM2-Technische Universität Munich,
Munich, Germany, May 3, 2010

M. Medarde
The metal-insulator transition in $RNiO_3$ perovskites: solving the Jahn-Teller instability close to the itinerant limit
Département de Physique de la Matière Condesée, Université de Genève
Geneve, Switzerland, December 2, 2010

E. Pomjakushina
Fe1+y SexTe1-x superconductors: phase diagram, crystal growth, structural and magnetic properties
Seminar
Univerisity of Zürich,
Zürich, Switzerland, November 10, 2010

CONFERENCE, WORKSHOP AND SEMINAR CONTRIBUTIONS

M. Bartkowiak, O. Ignatchik, S. Seyfarth, M. Cote, A.D. Bianchi, J. Wosnitza
Exploring the fermi surface of phosphorous-based pnictides
LEES2010,
Les Diablerets, Switzerland, July, 5-10, 2010 poster

K. Conder, G. Deng, E. Pomjakushina
Crystal growth of cuprate spin ladder compounds by optical floating zone technique
IX International Conference of Polish Society for Crystal Growth - ICPSCG-9
Gdansk-Sobieszewo, Poland, May, 23-27, 2010, talk, contributed

J. Destraves, Th. Gahl, M. Kenzelmann, M. Schild
A new generation of control and data acquisition electronics for neutron scattering instrumentation at SINQ
Deutsche Tagung für Forschung mit Synchrotronstrahlung, Neutronen und Ionenstrahlen an Grossgeräten - SNI 2010
Freie Universität Berlin,
Berlin, Germany, February, 24-26, 2010 poster

J. Destraves, Th. Gahl, M. Kenzelmann, M. Schild
Towards a 2nd generation instruments electronics @ SINQ - A new generation of control and data acquisition electronics for neutron scattering instrumentation
International Collaboration on Advanced Neutron Sources (ICANS-XIX)
Grindelwald, Switzerland, March 8-12, 2010 poster

R. Frison, K. Conder, S. Heiroth , M. Esposito, Th. Lippert
Oxygen mobility in the double layered cobalt-perovskite family
6th nternational Conference on Diffusion in Solids and Liquids
Paris, France, July 5-7, 2010 talk, contributed

R. Frison, K. Conder
Oxygen non-stoichiometry and diffusion in the double layered cobalt-perovakite PrBaCo2O5.5+x
7th International Conference on Inorganic Materials
Biarritz, France, September 12-14, 2010 poster

H. Grimmer
Opechowski-Guccione-like symbols of magnetic space groups
European Crystallographic Meeting ECM26
Darmstadt, Germany, August 29 - September 2, 2010 poster

H. Grimmer
Opechowski-Guccione-like symbols of magnetic space groups
SGK / SSCr annual meeting 2010
Geneva, Switzerland, September 17, 2010 poster

M. Haag, T. Eichhorn, B. van den Brandt, A. Comment, P. Hautle
Electron paramagnetic resonance on the triplet state of pentacene doped naphthalene crystals,
EPR summer school University of Konstanz,
Konstanz, Germany, September 6-11, 2010 poster

M. Haag, T. Eichhorn
DNP using the photoexcited triplet state of pentacene
Meeting Dynamic Nuclear Polarization for NMR spectroscopy
EPFL
Lausanne, Switzerland, September 14-15, 2010 talk, contributed

M. Haag, T. Eichhorn, B. van den Brandt, A. Comment, P. Hautle
Electron paramagnetic resonance on the triplet state of pentacene doped naphthalene crystals
EPR summer school University of Konstanz,
Konstanz, Germany September 6-11, 2010 Poster

M. Haag, T. Eichhorn
DNP using the photoexcited triplet state of pentacene
Meeting Dynamic Nuclear Polarization for NMR spectroscopy
EPFL
Lausanne, Switzerland, September 14-15, 2010 talk

M. Koennecke
The NeXus approach HDF5 as hyperspectral data format
Grenoble, France, January, 10-13, 2010 talk, contributed

M. Koennecke
The State of NeXus
NOBUGS 2010,
Oakridge, USA, October 13, 2010 talk, contributed

M. Koennecke
Experiences with SICS
NOBUGS 2010,
Oakridge, USA, October 13, 2010 poster

M. Koennecke
NeXus application definitions standard data formats for experiments with photons, neutrons, ions
Hamburg, Germany, October, 27-29, 2010 talk, contributed

M. Koennecke
NeXus standard data formats for experiments with photons, neutrons, ions
Hamburg, Germany, October, 27 -29, 2010 talk, contributed

M. Medarde, E. Pomjakushina, R. Frison, K. Conder, K. Thomsen, R. Moormann
Structural characterization of lead gold eutectic: an x-ray thermodiffractometry study
10th Internationl Workshop on Spallation Materials Technology
Beijing, China, October 18-22, 2010 talk, contributed

M. Medarde, E. Pomjakushina, R. Frison, K. Conder, K. Thomsen, R. Moormann
Thermal expansion and chemical stability of lead gold eutectic, a novel target material for ESS
19th meeting on Collaboration of Advanced Neutron Sources (ICANS XIX)
Grindelwald, Switzerland, March 8-12, 2010 poster

M. Medarde
on behalf of the FP7 ESS-Preparatory Phase Project participants:
Paul Scherrer Institut (CH. Coordinator), ESS-Bilbao (ES), University of Lund (SE), ESS-Hungary (HU), University of Huddersfield (UK), STFC (UK), Forschunzentrum Jülich (D), CNR-INFM (I), CNISM (I), CEA (F) and University of Latvia (LV)"
ESS-preparatory phase: an EC-funded FP7 project to pave the way to the realization of the European Neutron Spallation Source
19th meeting on Collaboration of Advanced Neutron Sources (ICANS XIX)
Grindelwald, Switzerland, March 8-12, 2010 poster

M. Medarde
Several European SpallationSource-PreparatoryPhase Project meetings
Barcelona (x1), Copenhagen (x5) and Kloten (x2)
Spain, Dennmark and Switzerland, January-March 2010
Organization and/or coordination

E. Pomjakushina, K. Conder, V. Pomjakushin, M. Bendele, R. Khasanov
Fe1+y SexTe1-x superconductors: phase diagram, crystal growth, structural and magnetic properties
MaNEP Workshop Neuchatel,
Neuchatel, Switzerland, January 28, 2010 talk

E. Pomjakushina, K. Conder, V. Pomjakushin, M. Bendele, R. Khasanov
Fe1+y SexTe1-x superconductors: phase diagram, crystal growth, structural and magnetic properties
IX International Conference of Polish Society for Crystal Growth - ICPSCG-9
Gdansk-Sobieszewo Poland, May, 23-27, 2010 talk

E. Pomjakushina, K. Conder, V. Pomjakushin, M. Bendele, R. Khasanov
Fe1+y SexTe1-x superconductors: phase diagram, crystal growth, structural and magnetic properties
7th International Conference on Inorganic Materials
Biarritz, France, September 12-14, 2010 talk

S. Wang, E. Pomjakushina, Ch. Ruegg, H.M. Rønnow, K. Conder
Crystal growth and characterization of dilutable frustrated spin-ladder compound: BiCu2PO6
The 16th International Conference on Crystal Growth(ICCG-16) and Related Summer School
Beijing / Dalian, China, August.1-13, 2010 20mins talk, contributed

S. Wang, H. M. Ronnow, E. Pomjakushina, M. Kenzelmann, K. Conder
Single crystal growth of Bi(Cu1-x Znx)2PO6 spin-ladder system by a traveling solvent floating zone method
2010 Swiss Physical Society - MaNEP meeting;
Basel, Switzerland, June 21-22, 2010 poster

S. Wang, E. Pomjakushina, G.C. Deng, H.M. Ronnow, K. Conder
Crystal growth and substitution effects in the spin-gap BiCu2PO6 system
4th EPFL EDAX Doctoral day Meeting
Lausanne, Switzerland, October 15, 2010 talk and poster

M. Zolliker, M. Bartkowiak
Progress on sample environment at SINQ
6th International Workshop on Sample Environment at Neutron Scattering Facilities
Hersching, Germany, September 29- October 1, 2010 poster

M. Zolliker, M. Bartkowiak
Progress on sample environment at SINQ
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LECTURES AND COURSES

K. Conder
Keramik II
(Semesterprogramm 327-0603-00) Fakultät Werkstoffe ETH Zürich,
Zürich, Switzerland, March 17- April 28, 2010 Lecture (18) Vorb. (18)

M. Könnecke
NeXus for Synchotrons
Paul Scherrer Institut
Villigen, Switzerland, May 10, 2010

MEMBERSHIP IN EXTERNAL COMMITTEES

H. Grimmer
- Consultant to the Commission on Mathematical and Theoretical Crystallography (International Union of Crystallography (since 2008)
- Member of the General Editorial Board Journal “Symmetry” (since 2009)

M. Kenzelmann
- Conference Advisory Committee, Physical Phenomena at High Magnetic Fields (PPHMF-VII) in Tallahassee, Florida December 3-8, 2010.
- Conference Advisory Committee, International Advisory Board of CIMTEC 2010, Montecatini Terme, Italy June 6-11, 2010.
- Conference Programme Committees, European Conference of Neutron Scattering, Prague (July 2011).
- Programm Committee, 9th PSI Summer School on Condensed Matter Research, Zuoz, Switzerland August 7-13, 2010.
- Berufungskommission, Deparment of Materials Science, ETH Zürich, 2010.
- Elected Member at large, Executive Committee of the NIST Center for Neutron Research User Group, since February 2008.
- Elected Board Member, Swiss Neutron Scattering Society, since September 2009.

- Judge of posters, Int. Conference on Core Research and Engineering Science of Advanced Materials & Third Int. Conference on Nanospintronics Design and Realization, 3rd-ICNDR, Osaka, Japan, May 30-June 4 2010.
- Ph.D. Examination Committee, Curtin Technical University, Perth, Australia.
- Ph.D. Examination Committee, Technical University of Denmark, Copenhagen, Denmark.
- External Proposal Reviewer, NIST, since 2005.
- External Project Reviewer, Agence National de la Recherche, France, since 2008.
- Onsite Review Committee, Brookhaven National Laboratory, 2011.
- PSI representative, ILL associates neutron working group, 2010-2011

M. Könnecke
- NeXus International Advisory Committee (since 2001), (1xyear)
- NOBUGS International Advisory Committee (since 2004) (5xyear)

M. Medarde
- External evaluator for Scientific Projects
  Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), Generalitat de Catalunya (since March 2005) Spain, 6x per year

MEMBERSHIP IN INTERNAL COMMITTEES

M.Medarde, E. Pomjakushina
Zukunftstag
Organization of the station "Physik"
PSI, Villigen, Switzerland,
November 12, 2010

DISSERTATION

J. Gironnet
supervisors P. de Marcillac, P.Hautle, B. van den Brandt,
Spectrométrie de neutrons rapides par bolomètres à cible lithium pour la réduction du fond des expériences de détection directe de matière noire.
Thesis, Université Paris Sud II, U.F.R. Scientifique d'Orsay, September 30, 2010

Research with Neutrons and Muons

Laboratory of Muon Spectroscopy (LMU)

LIST OF PUBLICATIONS (PEER REVIEWED)

Akiyama R, Ikedo Y, Mansson M, Goko T, Sugiyama J, Andreica D, Amato A, Matan K, Sato TJ
Short-range spin correlations in beta "-LiFeO2 from bulk magnetization, neutron diffraction, and mu SR experiments
PHYSICAL REVIEW B **81**, 024404 (2010)

Andreica D, de Reotier PD, Yaouanc A, Amato A, Lapertot G
Absence of magnetic phase separation in MnSi under pressure
PHYSICAL REVIEW B **81**, 060412 (2010)

Azzouz M, Hewitt KC, Saadaoui H
Dichotomy and pseudogap signature in the Raman response of high-T-c cuprates
PHYSICAL REVIEW B **81**, 174502 (2010)

Babkevich P, Bendele M, Boothroyd AT, Conder K, Gvasaliya SN, Khasanov R, Pomjakushina E, Roessli B
Magnetic excitations of Fe1+ySexTe1-x in magnetic and superconductive phases
JOURNAL OF PHYSICS-CONDENSED MATTER **22**, 142202 (2010)

Bendele M, Amato A, Conder K, Elender M, Keller H, Klauss HH, Luetkens H, Pomjakushina E, Raselli A, Khasanov R
Pressure Induced Static Magnetic Order in Superconducting FeSe1-x
PHYSICAL REVIEW LETTERS **104**, 087003 (2010)

Bendele M, Weyeneth S, Puzniak R, Maisuradze A, Pomjakushina E, Conder K, Pomjakushin V, Luetkens H, Katrych S, Wisniewski A, Khasanov R, Keller H
Anisotropic superconducting properties of single-crystalline FeSe0.5Te0.5
PHYSICAL REVIEW B **81**, 224520 (2010)

Calder S, Ke X, Bert F, Amato A, Baines C, Carboni C, Cava RJ, Daoud-Aladine A, Deen P, Fennell T, Hillier AD, Karunadasa H, Taylor JW, Mendels P, Schiffer P, Bramwell ST
Magnetic properties of Ba2HoSbO6 with a frustrated lattice geometry
PHYSICAL REVIEW B **81**, 064425 (2010)

Dawin UC, Dilger H, Roduner E, Scheuermann R, Stoykov A, Giesselmann F
Chiral Induction in Lyotropic Liquid Crystals: Insights into the Role of Dopant Location and Dopant Dynamics
ANGEWANDTE CHEMIE-INTERNATIONAL EDITION **49**, 2427 (2010)

Deac I, Tetean R, Balasz I, Andreica D, Vladescu A, Dudric R, R Tunyagi A, Burzo E
Magnetic transitions in the perovskites Pr1-xSrxCoO3
JOURNAL OF PHYSICS: CONFERENCE SERIES **200**, 052003 (2010)

Di Castro D, Kanigel A, Maisuradze A, Keren A, Postorino P, Rosenmann D, Welp U, Karapetrov G, Claus H, Hinks DG, Amato A, Campuzano JC
Muon spin rotation study of the magnetic penetration depth in the intercalated graphite superconductor CaC6
PHYSICAL REVIEW B **82**, 014530 (2010)

Dubman M, Shiroka T, Luetkens H, Rothermel M, Litterst FJ, Morenzoni E, Suter A, Spemann D, Esquinazi P, Setzer A, Butz T
Low-energy mu SR and SQUID evidence of magnetism in highly oriented pyrolytic graphite
JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS **322**, 1228 (2010)

Dunsiger SR, Carlo JP, Goko T, Nieuwenhuys G, Prokscha T, Suter A, Morenzoni E, Chiba D, Nishitani Y, Tanikawa T, Matsukura F, Ohno H, Ohe J, Maekawa S, Uemura YJ
Spatially homogeneous ferromagnetism of (Ga, Mn)As
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Fritzsche H, van der Knaap JM, Hesselberth MBS, Nieuwenhuys GJ
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PHYSICAL REVIEW B **81**, 132402 (2010)

Gibson MCR, Rule KC, Wolter AUB, Hoffmann JU, Prokhnenko O, Tennant DA, Gerischer S, Kraken M, Litterst FJ, Sullow S, Schreuer J, Luetkens H, Bruhl A, Wolf B, Lang M
Magnetoelastic and structural properties of azurite Cu-3(CO3)(2)(OH)(2) from neutron scattering and muon spin rotation
PHYSICAL REVIEW B **81**, 140406 (2010)

Gibson MCR, Rule KC, Wolter AUB, Hoffmann JU, Prokhnenko O, Tennant DA, Gerischer S, Kraken M, Litterst FJ, Sullow S, Schreuer J, Luetkens H, Bruhl A, Wolf B, Lang M
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PHYSICAL REVIEW B **81**, 149902 (2010)

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PHYSICAL REVIEW B **81**, 094434 (2010)

Hord R, Luetkens H, Pascua G, Buckow A, Hofmann K, Krockenberger Y, Kurian J, Maeter H, Klauss HH, Pomjakushin V, Suter A, Albert B, Alff L
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Ikedo Y, Sugiyama J, Mukai K, Mansson M, Goko T, Andreica D, Amato A
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Ito TU, Higemoto W, Ohishi K, Satoh K, Aoki Y, Toda S, Kikuchi D, Sato H, Baines C
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Khasanov R, Bendele M, Amato A, Conder K, Keller H, Klauss HH, Luetkens H, Pomjakushina E
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NEW JOURNAL OF PHYSICS **12**, 073024 (2010)

Khasanov R, Kondo T, Bendele M, Hamaya Y, Kaminski A, Lee SL, Ray SJ, Takeuchi T
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PHYSICAL REVIEW B **82**, 020511 (2010)

Khasanov R, Shengelaya A, Savic IM, Baines C, Keller H
Comment on "Muon-spin-rotation study of the superconducting properties of Mo3Sb7"
PHYSICAL REVIEW B **82**, 016501 (2010)

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PHYSICAL REVIEW B **81**, 180502 (2010)

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Anomalies in the Fermi Surface and Band Dispersion of Quasi-One-Dimensional CuO Chains in the High-Temperature Superconductor YBa2Cu4O8
PHYSICAL REVIEW LETTERS **105**, 267003 (2010)

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Relaxation of muon spins in molecular nanomagnets
PHYSICAL REVIEW B **81**, 140409 (2010)

Maisuradze A, Schnelle W, Khasanov R, Gumeniuk R, Nicklas M, Rosner H, Leithe-Jasper A, Grin Y, Amato A, Thalmeier P
Evidence for time-reversal symmetry breaking in superconducting PrPt4Ge12
PHYSICAL REVIEW B **82**, 024524 (2010)

Mamedov T, Herlach D, Gritsaj K, Ketsko V, Nipan G, Stoykov A, Khasanov R, Zimmermann U
Search for Magnetic Ordered Phase in ZnCoO Compound using muSR Metod
PHYSICS OF PARTICLES AND NUCLEI **7, n.6**, 410 (2010)

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Structural and Magnetic Nature for Fully Delithiated LixNiO2: Comparative Study between Chemically and Electrochemically Prepared Samples
JOURNAL OF PHYSICAL CHEMISTRY C **114**, 8626 (2010)

Mukai K, Sugiyama J, Ikedo Y, Nozaki H, Kamazawa K, Andreica D, Amato A, Mansson M, Brewer JH, Ansaldo EJ, Chow KH
Microscopic Magnetic Study on the Nominal Composition Li[Li1/3Mn5/3]O-4 by Muon-Spin Rotation/Relaxation Measurements
JOURNAL OF PHYSICAL CHEMISTRY C **114**, 11320 (2010)

Nakano T, Suehiro R, Hanazawa A, Watanabe K, Watanabe I, Amato A, Pratt FL, Nozue Y
mu SR Study on Antiferromagnetism of Alkali-Metal Clusters Incorporated in Zeolite Sodalite
JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN **79**, 073707 (2010)

Rodriguez J, Aczel AA, Carlo JP, Dunsiger SR, Macdougall GJ, Russo PL, Savici AT, Uemura YJ, Wiebe CR, Luke GM
Study of the Ground State Properties of LiHoxY1-xF4 Using Muon Spin Relaxation
PHYSICAL REVIEW LETTERS **105**, 107203 (2010)

Saadaoui H, MacFarlane WA, Salman Z, Morris GD, Song Q, Chow KH, Hossain MD, Levy CDP, Mansour AI, Parolin TJ, Pearson MR, Smadella M, Wang D, Kiefl RF
Vortex lattice disorder in YBa2Cu3O7-delta probed using beta-NMR (vol 80, 224503, 2009)
PHYSICAL REVIEW B **81**, 019901 (2010)

Sakarya S, Gubbens PCM, Yaouanc A, de Reotier PD, Andreica D, Amato A, Zimmermann U, van Dijk NH, Bruck E, Huang Y, Gortenmulder T
Positive muon spin rotation and relaxation measurements on the ferromagnetic superconductor UGe2 at ambient and high pressure
PHYSICAL REVIEW B **81**, 024429 (2010)

Salman Z, Giblin SR, Lan Y, Powell AK, Scheuermann R, Tingle R, Sessoli R
Probing the magnetic ground state of the molecular dysprosium triangle with muon spin relaxation
PHYSICAL REVIEW B **82**, 174427 (2010)

Sanna S, De Renzi R, Shiroka T, Lamura G, Prando G, Carretta P, Putti M, Martinelli A, Cimberle MR, Tropeano M, Palenzona A
Nanoscopic coexistence of magnetic and superconducting states within the FeAs layers of CeFeAsO1-xFx
PHYSICAL REVIEW B **82**, 060508 (2010)

Schulz L, Nuccio L, Willis M, Desai P, Shakya P, Kreouzis T, Malik VK, Bernhard C, Pratt FL, Morley NA, Suter A, Nieuwenhuys GJ, Prokscha T, Morenzoni E, Gillin WP, Drew AJ
Engineering spin propagation across a hybrid organic/inorganic interface using a polar layer
NATURE MATERIALS LETTERS **doi:10.1038/nmat2912**, (2010)

Sedlak K, Shiroka T, Stoykov A, Scheuermann R
Geant4 Simulation of the New ALC mu SR Spectrometer
IEEE TRANSACTIONS ON NUCLEAR SCIENCE **57**, 2187 (2010)

Shermadini Z, Kanter J, Baines C, Bendele M, Bukowski Z, Khasanov R, Klauss HH, Luetkens H, Maeter H, Pascua G, Batlogg B, Amato A
Microscopic study of the superconducting state of the iron pnictide RbFe2As2 via muon spin rotation
PHYSICAL REVIEW B **82**, 144527 (2010)

Storchak VG, Eshchenko DG, Morenzoni E, Ingle N, Heiss W, Schwarzl T, Springholz G, Kallaher RL, von Molnar S
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PHYSICAL REVIEW B **81**, 199902 (2010)

Storchak VG, Eshchenko DG, Morenzoni E, Prokscha T, Suter A, Ingle N, Heiss W, Schwarzl T, Springholz G, Kallaher RL, von Molnar S
Magnetic polarons in Eu-based films of magnetic semiconductors
PHYSICAL REVIEW B **81**, 153201 (2010)

Teyssier J, Giannini E, Guritanu V, Viennois R, van der Marel D, Amato A, Gvasaliya S
Spin-glass ground state in Mn1−xCoxSi
PHYSICAL REVIEW B **82**, 064417 (2010)

Weyeneth S, Bendele M, Puzniak R, Muranyi F, Bussmann-Holder A, Zhigadlo ND, Katrych S, Bukowski Z, Karpinski J, Shengelaya A, Khasanov R, Keller H
Field-dependent superfluid density in the optimally doped SmFeAsO1-xFy superconductor
EPL **91**, 47005 (2010)

Zaberchik M, Chashka K, Patlgan L, Maniv A, Baines C, King P, Kanigel A
Possible evidence of a two-gap structure for the CuxTiSe2 superconductor
PHYSICAL REVIEW B **81**, 220505 (2010)

CONFERENCE, WORKSHOP AND SEMINAR CONTRIBUTIONS

A. Amato et al.,
Absence of magnetic phase separation in MnSi under pressure
Annual Meeting of the Swiss Physical Society, Basel, Switzerland, June 21-22, 2010

H. Luetkens et al.,
Magnetic and superconducting properties of electron doped La2−xCexCuO4 epitaxial thin films
Annual Meeting of the Swiss Physical Society, Basel, Switzerland, June 21-22, 2010

A. Maisuradze et al.,
Superfluid Density and Energy Gap-Function of Superconducting PrPt4Ge12
Annual Meeting of the Swiss Physical Society, Basel, Switzerland, June 21-22, 2010

E. Morenzoni et al.
Interaction between the magnetic and superconducting order parameters in a La1.94Sr0.06CuO4 wire
Annual Meeting of the Swiss Physical Society, Basel, Switzerland, June 21-22, 2010

G. Pascua et al.,
Structural and magnetic properties of the parent compound T'-La2CuO4 of electron-doped cuprates
Annual Meeting of the Swiss Physical Society, Basel, Switzerland, June 21-22, 2010

H. Saadaoui
Search for time-reversal symmetry breaking order at the (110) interface of YBa2Cu3O7-delta using beta NMR
Swiss Physical Society-MaNEP meeting, Basel 21-22 June, 2010

Z. Salman
Measuring the magnetic properties of monolayers of single molecule magnets
Oral presentation at the 3rd Joint International Conference on Hyperfine Interactions and International Symposium on Nuclear Quadrupole Interactions (HFI/NQI 2010), CERN, Geneva, Switzerland 2010

Z. Salman
Probing the magnetic ground state of the molecular Dysprosium triangle
Poster presentation at the 4th International Conference on Molecular Materials (MOLMAT 2010), Montpellier, France 2010

Z. Shermadini et al.,
Microscopic Study of the Superconducting State of the Iron Pnictide RbFe2As2
Annual Meeting of the Swiss Physical Society, Basel, Switzerland, June 21-22, 2010

INVITED TALKS

M. Bendele
Anisotropic superconducting properties of single-crystalline FeSe0.5Te0.5
Annual Meeting of the Swiss Physical Society, Basel, Switzerland, June 21-22, 2010

R. Khasanov
Magnetism and superconductivity of FeSe1-x
PSI - IOP Joint Workshop on Studies of Novel Materials using Large Facilities,
Bad Zurzach, Switzerland, October 13-15, 2010

H. Luetkens
Magnetic and superconducting properties of Iron-Pnictides - a muon spin relaxation study
Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany, July 23, 2010

H. Luetkens
Magnetic and superconducting properties of electron doped La2-xCexCuO4 epitaxial thin films
1st TU Darmstadt – PSI Workshop, TU Darmstadt, Germany, March 12, 2010

H. Luetkens
A Short Introduction to Muon Spin Rotation
1st TU Darmstadt – PSI Workshop, TU Darmstadt, Germany, March 11, 2010

E. Morenzoni
The High Field μSR Project at PSI
ISIS Muon High Field and User Meeting, Abingdon, UK, September 6-7, 2010

E. Morenzoni
Local studies of superconducting and magnetic properties of thin films and heterostructures with spin polarized probes
Condensed Matter Seminar, University of Zürich, December 15, 2010

T. Prokscha
The Production and Application of Low Energy Muons,
International Nuclear Physics Conference INPC 2010, Vancouver, Canada, July 2010

J. Rodriguez, R. Scheuermann, K. Sedlak, A. Stoykov, A. Amato
The fast-timing detector system for the 10 Tesla μSR instrument
NIM3 meeting, Barcelona, Spain, May 10 to 12, 2010

J. Rodriguez
He-Cryostat for the High-Field Magnet
High-Field Meeting, PSI, Switzerland, December 3, 2010

H. Saadaoui
Beta-NMR probe of vortex lattice disorder and surface magnetism in high-Tc superconductors YBCO
LMU seminar, PSI, March 18, 2010

Z. Salman
Magnetic state preparation for μSR measurements using magnetic fields
ISIS Muon High Field and User Meeting, Abingdon - UK, September 2010

Z. Salman
Introduction to low energy muons
9th PSI Summer School on Condensed Matter Research: Magnetic Phenomena, Zuoz, Switzerland, August 2010.

Z. Salman
Low energy muons and physics at interfaces
ISIS Training Course in Pulsed Muon Techniques, ISIS Facility, Rutherford Appleton Laboratory - UK, May 2010

Z. Salman
β-NMR investigation of the magnetism at the interface between insulating $SrTiO_3$ and $LaAlO_3$
ISAC Science Forum, TRIUMF, Vancouver - Canada, April 2010

R. Scheuermann
The High Magnetic Field μSR Facility at SμS: Challenges- Solutions- Realisation
Erweiterte Bereichsleitersitzung GFA, PSI, Switzerland, June 6, 2010

K. Sedlak, J. Rodriguez, R. Scheuermann, A. Stoykov, A. Amato
Geant4 Simulation of the High Field μSR Instrument
NIM3 meeting, Barcelona, Spain, May 10 to 12, 2010

A. Stoykov
High-Field Project: Detectors
High-Field Meeting, PSI, Switzerland, February 26, 2010

A. Stoykov
The high-time resolution detector for the 10 Tesla μSR instrument
LMU Seminar, PSI, Switzerland, January 22, 2010

A. Stoykov
Application of Geiger-mode Avalanche PhotoDiodes in Muon Spin Spectroscopy
LTP Seminar, PSI, Switzerland, February 11, 2010

A. Stoykov
A lens-coupled scintillation counter in cryogenic environment
LMU Seminar, PSI, Switzerland, November 22, 2010

LECTURES AND COURSES

H. Luetkens
Introduction to Muon Spin Rotation and Relaxation
PSI Summer School, Zuoz, Switzerland, August 9, 2010

E. Morenzoni
Physik mit Myonen: von der Atomphysik zur Festkörperphysik, Vorlesungen und Übungen
Universität Zürich and ETH Zürich, FS-2010

E. Morenzoni
Praktikum: Myon Spin Rotationsspektroskopie
ETH Zürich, FS-2010

E. Morenzoni, A. Amato, H. Luetkens, T. Prokscha, A. Suter
Praktikum: Myon Spin Rotationsspektroskopie
Universität Basel, FS-2010

E. Morenzoni
*muSR spectroscopy vs. neutron scattering, Special Lecture **in** "Neutron Scattering in Condensed Matter Physics II course" (A. Zheludev)*
ETH Zürich, FS-2010

MEMBERSHIP IN EXTERNAL COMMITTEES

A. Amato
- Member of the "Program Advisory Committee for Material and Life Science", RIKEN, Japan

- International Advisory Committee for the 12th International Conference on Muon Spin Rotation, -Relaxation and Resonance
- Member of the “Facilities Subcommittee” of the International Society for μSR Spectroscopy (ISMS)

H. Luetkens
- Executive committee member of the International Society for μSR Spectroscopy (ISMS)
- International Advisory Committee for the 12th International Conference on Muon Spin Rotation, Relaxation and Resonance

E. Morenzoni
- International Advisory Committee for the 12th International Conference on Muon Spin Rotation, Relaxation and Resonance
- Chairman Muon Scientific Committee J-PARC Center and KEK

Z. Salman
- CERN's ISOLDE and Neutron Time-of-flight Committee (INTC)
- International advisory committee of the Euro-Mediterranean Meeting on Functionalized Materials (EMM-FM 2011)

A. Suter
- ISIS Facility Access Panel

Research with Neutrons and Muons

Laboratory for Neutron Scattering (LNS)

LIST OF PUBLICATIONS (PEER REVIEWED)

Abakumov AM, Hadermann J, Batuk M, D'hondt H, Tyablikov OA Rozova MG, Pokholok KV, Filimonov DS, Sheptyakov DV, Tsirlin AA, Niermann D, Hemberger J, Van Tendeloo G, Antipov EV
Slicing the Perovskite Structure with Crystallographic Shear Planes: The AnBnO3n-2 Homologous Series
INORGANIC CHEMISTRY **49**, 9508-9516 (2010)

Akiyama R, Ikedo Y, Mansson M, Goko T, Sugiyama J, Andreica D, Amato A, Matan K, Sato TJ
Short-range spin correlations in beta "-LiFeO2 from bulk magnetization, neutron diffraction, and mu SR experiments
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Babkevich P, Bendele M, Boothroyd AT, Conder K, Gvasaliya SN, Khasanov R, Pomjakushina E, Roessli B
Magnetic excitations of Fe1+ySexTe1-x in magnetic and superconductive phases
JOURNAL OF PHYSICS-CONDENSED MATTER **22**, 142202 (2010)

Babkevich P, Prabhakaran D, Frost CD, Boothroyd AT
Magnetic spectrum of the two-dimensional antiferromagnet La2Co04 studied by inelastic neutron scattering
PHYSICAL REVIEW B **82**, 184425 (2010)

Baledent V, Fauque B, Sidis Y, Christensen NB, Pailhes S, Conder K, Pomjakushina E, Mesot J, Bourges P
Two-Dimensional Orbital-Like Magnetic Order in the High-Temperature La2-xSrxCuO4 Superconductor
PHYSICAL REVIEW LETTERS **105**, 027004 (2010)

Balog S, Gasser U, Mortensen K, Gubler L, Scherer GG, Ben Youcef H
Correlation between Morphology, Water Uptake, and Proton Conductivity in Radiation-Grafted Proton-Exchange Membranes
MACROMOLECULAR CHEMISTRY AND PHYSICS **211**, 635 (2010)

Baran S, Kaczorowski D, Penc B, Sheptyakov D, Szytula A
Crystal structure and magnetic properties of TbFe0.4Ge2 compound
JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS **322**, 2195-2198 (2010)

Baran S, Kaczorowski D, Sheptyakov D, Sikora W, Szytula A
Antiferromagnetic square-modulated structure in HoRhSn
SOLID STATE COMMUNICATIONS **150**, 1291 (2010)

Beck P, Liebi M, Kohlbrecher J, Ishikawa T, Rueegger H, Fischer P, Walde P, Windhab E
Novel Type of Bicellar Disks from a Mixture of DMPC and DMPE-DTPA with Complexed Lanthanides
LANGMUIR **26**, 5382 (2010)

Beck P, Liebi M, Kohlbrecher J, Ishikawa T, Ruegger H, Zepik H, Fischer P, Walde P, Windhab E
Magnetic Field Alignable Domains in Phospholipid Vesicle Membranes Containing Lanthanides
JOURNAL OF PHYSICAL CHEMISTRY B **114**, 174 (2010)

Bendele M, Babkevich P, Katrych S, Gvasaliya SN, Pomjakushina E, Conder K, Roessli B, Boothroyd AT, Khasanov R, Keller H
Tuning the superconducting and magnetic properties of FeySe0.25Te0.75 by varying iron content
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Bendele M, Weyeneth S, Puzniak R, Maisuradze A, Pomjakushina E, Conder K, Pomjakushin V, Luetkens H, Katrych S, Wisniewski A, Khasanov R, Keller H
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A. Furrer
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M. Laver
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M. Laver
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J. Schefer
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J. Stahn
Introduction to polarised neutron and resonant x-ray reflectometry
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J. Stahn
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Influence of water aggregation on the structure of aqueous aprotic solvents by lattice modeling
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A. Poole
Magnetic structure of multiferroic $BaMnF_4$
JCNS Bernried, Germany
Bernried, Germany, October 3-7, 2010

M. Pregelj, O. Zaharko, Z. Kutnjak, Z. Jaglicic, M. Jagodic, P. Jeglic, A. Zorko, H. Berger, D. Arcon
Magnetoelectricity in a novel multiferroic $FeTe_2O_5Br$ system
International Conference on Superconductivity and Magnetism
Antalya, Turkey, April 25-30, 2010

M. Pregelj, T. Apih, A. Gradisek, A. Zorko, P. Jeglic, H. Berger, D. Arcon
NQR study of a novel multiferroic $FeTe_2O_5Br$ system magnetic resonance in highly frustrated magnetic systems
Kranjska Gora, Slovenia, February 1-4, 2010

M. Pregelj, O. Zaharko, A. Zorko, Z. Kutnjak, M. Jagodic, Z. Jaglicic, P. Jeglic, H. Berger, D. Arcon
Phase diagram of a novel multiferroic $FeTe_2O_5Br$ system
International Symposium on Advanced Magnetic Materials and Applications
Sendai, Japan, July 12-16, 2010

K. Prsa
Neutron scattering investigations of weakly coupled and weakly connected antiferromagnets
Paul Scherrer Institut, Villigen, Switzerland
Villigen, Switzerland, March 29, 2010

M. Radovic, Y. Sassa , J. Stahn, E. Razzoli, M. Månsson, M. Falub, M. Shi, L. Patthey, J. Mesot
Relationship between high-temperature superconductivity and magnetic order in $YBa_2Cu_3O_7$-x/$LaF_{0.7}Sr_{0.3}MnO_3$ bilayers angle resolved photoemission spectroscopy and polarized neutron reflectometry studies
Joint Annual Meeting of the Swiss Physical Society (SPS) - MaNEP
University of Basel,
Basel, Switzerland, June 21-22, 2010

M. Radovic, Y. Sassa , J. Stahn, E. Razzoli, M. Månsson, M. Falub, M. Shi, L. Patthey, J. Mesot
Relationship between high-temperature superconductivity and magnetic order in $YBa_2Cu_3O_7$-x/$La_{0.7}Sr_{0.3}MnO_3$ bilayers angle resolved photoemission spectroscopy and polarized neutron reflectometry studies
International Conference on Low Energy Electron Dynamics in Solids 2010 (LEES)
Les Diablerets, Switzerland, July 5-10, 2010

J.C.E. Rasch, M. Boehm, C. Ritter, H. Mutka, L. Keller, J. Schefer, J.F. Loeffler
Magnetoelastic coupling in the triangular lattice antiferromagnet $CuCrS_2$ investigated by neutron and X-ray diffraction, neutron polarimetry and inelastic neutron scattering
26th European Crystallographic Meeting (ECA)
Darmstadt, Germany, August 29-September 2, 2010

J.C.E. Rasch, M. Boehm, J. Schefer, H. Mutka, C. Ritter, J.F. Loeffler
Spin dynamics in $CuCrS_2$, effect of magnetic order and lattice distortion
17th International Symposium on Metastable, Amorphous and Nanostructured Materials (ISMANAM 2010)
Zürich, Switzerland, July 4-9, 2010

Y. Sassa, M. Radovic, M. Månsson, X. Cui, S. Pailhes, E. Razzoli, S. Guerrero, M. Shi, P. Willmott, F. Miletto, L. Patthey, J. Mesot
Revealing the Ortho II band folding in $YBa_2Cu_3O_7$-x films
Joint Annual Meeting of the Swiss Physical Society (SPS) - MaNEP
University of Basel,
Basel, Switzerland, June 21-22, 2010

Y. Sassa, M. Radovic, M. Månsson, X. Cui, St. Pailhès, E. Razzoli, S. Guerrero, M. Shi, Ph. Willmott, F. M. Granozio, J. Mesot, L. Patthey
Revealing the Ortho II band folding in $YBa_2Cu_3O_7$-d films
International Conference on Low Energy Electron Dynamics in Solids 2010 (LEES)
Les Diablerets, Switzerland, July 5-10, 2010

J. Schefer, T. Drokina, L. Keller
Magnetic structure and phase transitions in quasi-one-dimensional clinopyroxene $NaFeGe_2O_6$
7th International Conference on Inorganic Materials 7th International Conference on Inorganic Materials
Biarritz, France, September 12-14, 2010

V. Sikolenko, A. Sazonov
Doping effects in complex cobalt oxides with perovskite structure
PNPI Winter school on condensed matter physics
St.Petersburg, Russia, March, 15-20, 2010

V. Sikolenko, A. Sazonov, V. Efimov, I.Troyanchuk, M.Tovar
Isothermal structural transition in Bi_{1-x} $LaxFeO_3$
HZB users meeting
Berlin, Germany, December 9-10, 2010

M. Smirnov, N. Mazhenov, N. Aliouane, P. Saint-Gregoire
Novel features of the a–ß phase transition in quartz-type $FePO_4$ as evidenced by X-ray diffraction and lattice dynamics
E-MRS Spring Meeting
Strassbourg, France, June 6-11, 2010

V. Städele
Ordering behaviour in mixtures of magnetic and nonmagnetic particles in magnetic fields
Swiss Soft Day, Uni Fribourg
Fribourg, Switzerland, October 20, 2010

V. Städele, U. Gasser
Ordering behaviour in mixtures of magnetic and nonmagnetic particles in magnetic fields
SFB TR6 Summer School on Soft Matter "Physics of colloidal suspensions and granular media"
Cargese, Corsica, France, September 27-October 9, 2010

J. Stahn
Study on a focusing, low-background neutron delivery system
International Workshop on Neutron Optics (NOP)
Alpes d'Huez, France, March 17-19, 2010

J. Sugiyama, Y. Ikedo, M. Isobe, Y. Ueda, O. Ofer, E.J. Ansaldo, J.H. Brewer, K.H. Chow, M. Månsson
μSR study on the quasi-one-dimensional vanadium oxide, $K_2V_8O_{16}$
65th Annual Meeting of the Physical Society of Japan
Okayama, Japan, March 20-23, 2010

J. Sugiyama, Y. Ikedo, K. Mukai, H. Nozaki, M. Månsson, O. Ofer, M. Harada, K. Kamazawa, Y. Miyake, J.H. Brewer, E.J. Ansaldo, Kim H. Chow, I. Watanabe, T. Ohzuku
How muons contribute to the industrial world - μSR on Li battery materials
PSI Condensed matter seminar
Villigen, Switzerland, August 24, 2010

J. Sugiyama, K. Kamazawa, M. Harada, H. Ohta, C. Michioka, K. Yoshimura, M. Månsson, D. Andreica, A. Amato
Successive magnetic transitions in RECoAsO studied by μSR
International and Interdisciplinary Workshop on Novel Phenomena in Integrated Complex Sciences from Non-living to Living Systems
IIW-2010
Kyoto, Japan, October 11-14, 2010

J. Sugiyama, K. Kamazawa, Y. Doi, Y. Hinatsu, O. Ofer, J.H. Brewer, E.J. Ansaldo, K.H. Chow, M. Månsson
μSR study of quasi-one-dimensional compounds, $EuYb_2O_4$ and $EuLu_2O_4$
2010 Autumn Meeting of the Physical Society of Japan
Osaka, Japan, September 23-26, 2010

J. Sugiyama, K. Mukai, H. Nozaki, K. Ariyoshi, T. Ohzuku, M. Månsson, J.S. Lord
μSR study of Li^+ diffusion in Li-Ti-O and Li-Mn-O system
2010 Autumn Meeting of the Physical Society of Japan
Osaka, Japan, September 23-26, 2010

J. Sugiyama, Y. Ikedo, H. Ohta, C. Michioka, K. Yoshimura, J.H. Brewer, E.J. Ansaldo, S.L. Stubbs, K.H. Chow, M. Månsson, J. S. Lord
μSR study of water-absorbed $NaxCoO_2$
2010 Autumn Meeting of the Physical Society of Japan
Osaka, Japan, September 23-26, 2010

J. Sugiyama, K. Kamazawa, M. Harada, H. Ohta, C. Michioka, K. Yoshimura, M. Månsson, D. Andreica, A. Amato
Microscopic magnetic nature of RECoAsO probed by μSR
2010 Autumn Meeting of the Physical Society of Japan
Osaka, Japan, September 23-26, 2010

R. Sura, M. Ceretti, O. Hernandez, C. Prestipino, W. Paulus, J. Schefer, L. Keller, G. Vaughan
Single crystal growth and twinning in non-stoichiometric $Sr(Fe,Co)O_{3-x}$
9th PSI Summer School on Condensed Matter Research 2010 – Magentic Phenomena
Zuoz, Switzerland, August 8-13, 2010

R. Sura, W. Paulus, M. Ceretti, O. Hernandez, C. Prestipino, J. Schefer, L. Keller
Evolution of the crystal and twin domain structure of $SrFeO_{2.5}$ and $SrFeO_{2.875}$ single crystals during oxygen uptake with temperature
7th International Conference on Inorganic Materials
Biarritz, France, September 12-14, 2010

R. Sura, M. Ceretti, O. Hernandez, C. Prestipino, W. Paulus, J. Schefer, L. Keller, G. Vaughan
Evolution of the twin domain structure of $SrFeO_{2.5}$ single crystals with temperature observed by fast data Acquisition on ID11 ESRF
Swiss Society for Crystallography
Geneva, Switzerland, September 17, 2010

R. Vavrin, J. Kohlbrecher, A. Wilk, M.L. Lettinga, K. Tomczyk, J. Buitenhuis, G. Meier
Structure and phase diagram of an adhesive colloidal dispersion under high pressure
Swiss Soft days
ETH Zürich
Zürich, Switzerland, February 10, 2010

J.S. White, P. Das, M.R. Eskildsen, L. DeBeer-Schmitt, E.M. Forgan, A.D. Bianchi, M. Kenzelmann, M. Zolliker, S. Gerber, J.L. Gavilano, J. Mesot, R. Movshovich, E.D. Bauer, J.L. Sarrao, C. Petrovic
Observations of Pauli paramagnetic effects on the flux line lattice in $CeCoIn_5$
Joint Annual Meeting of the Swiss Physical Society (SPS) - MaNEP
University of Basel,
Basel, Switzerland, June 21-22, 2010

J.S. White, P. Das, M.R. Eskildsen, L. DeBeer-Schmitt, E.M. Forgan, A.D. Bianchi, M. Kenzelmann, M. Zolliker, S. Gerber, J.L. Gavilano, J. Mesot, R. Movshovich, E.D. Bauer, J.L. Sarrao, C. Petrovic
Observations of Pauli paramagnetic effects on the flux line lattice in $CeCoIn_5$
Low Energy Electrodynamics in Solids Conference
Les Diablerets, Switzerland, July 5-10, 2010

J.S. White, M. Kenzelmann, N. Tsyrulin, Ch. Niedermayer, C. Broholm, Ya. Shapiro, L.A. Demianets
High field and low temperature neutron diffraction studies of the triangular lattice multiferroic $RbFe(MoO_4)_2$
Low Energy Electrodynamics in Solids Conference
Les Diablerets, Switzerland, July 5-10, 2010

A. Wiedenmann, R. Gähler, Ch. Dewhurst, U. Keiderling, S. Prévost, J. Kohlbrecher
Stroboscopic polarized SANS for studying magnetization dynamics in nanomaterials
PNCMI
Delft, Netherlands, July 5-8, 2010

O.Zaharko
PANTHER project update TriCS
Paul Scherrer Institut
Villigen, Switzerland, July 16, 2010

LECTURES AND COURSES

M. Bestel
Praktikum zu den Grundzügen der Erdwissenschaften I, Prof. Naegler
Institute of Geological Sciences University of Bern Switzerland
September, 29 - December 23, 2010, practical training

N. Egetenmeyer
Preparation of the ETH student practical training on SANSII
Paul Scherrer Institut
Villigen, Switzerland September until December 2010 practical training

J.P. Embs
PSI Condensend Matter School Practical training at PSI-SINQ
Paul Scherrer Institut
Villigen Switzerland, August 14-16, 2010 practical training

S. Gerber
Neutron Scattering in Condensed Matter Physics, Dept. Physics ETH Zurich,
Zürich, Switzerland
Spring term 2010, training

Th. Geue
Introduction to Small Angle Neutron Scattering Dept. Physics ETH Zürich, Switzerland
Neutron Scattering in Condensed Matter Physics,
March 31, 2010 lectures

S. Gvasaliya
PSI Condensend Matter School Practical training at PSI-SINQ PSI Villigen Switzerland
August 14-16, 2010, practical training

J. Kohlbrecher
Neutron Scattering Lund University PSI Switzerland
December 8-14, 2010 lectures, training

J. Kohlbrecher
Small Angle Scattering ETHZ Zuerich Switzerland
May, 19, 2010, lecture, training

M. Laver
PSI Condensend Matter School Practical training at PSI-SINQ PSI Villigen Switzerland
August 14-16, 2010, practical training

Ch. Niedermayer
Kern und Elementarteilchenphysik Universitaet Konstanz, Konstanz, Germany
October 2010 - February 2011 lectures, training

V. Pomjakushin
Advanced magnetic structures: classification and determination by neutron diffraction
ETH Zurich, Switzerland, ETHZ lecture course ""Neutron Scattering in Condensed Matter
Physics, lecture

J. Schefer
PSI Condensend Matter School Practical training at PSI-SINQ
Paul Scherrer Institut,
Villigen, Switzerland, August 14-16, 2010, practical training

D. Sheptyakov
PSI Condensend Matter School Practical training at PSI-SINQ
Paul Scherrer Institut,
Villigen, Switzerland, August 14-16, 2010, practical training

J.Stahn
PSI Condensend Matter School Practical training at PSI-SINQ
Paul Scherrer Institut,
Villigen, Switzerland, August 14-16, 2010, practical training

W. Wallace
Anorganische Chemie I Course (laboratory component) University of Bern
Bern, Switzerland
November 4- December 18, 2010, practical training

O. Zaharko
Neutrons as a complementary probe for nanoscale order International Summer School
Diffraction at the Nanoscale
Paul Scherrer Institute Switzerland
Villigen, Switzerland, May 22-27, 2010 lectures, training

O. Zaharko
Magnetic diffraction PSI Summer School on Condensed Matter Research
Zuoz Switzerland, August 7-13, 2010 lectures

MEMBERSHIP IN INTERNATIONAL COMMITTEES

A. Furrer
- Advisor 3rd World Academy of Sciences (Since 2003, periodically)
- Editorial Advisory Board: The Open Superconductors Journal (Since 2008, periodically)

U. Gasser
- Secretary of the Swiss Society for Neutron Scattering, SGN, Switzerland (Since 2009)

J.L. Gavilano
- Academia Peruana de Ciencias nucleares, Peru (March 2010)

Th. Geue
- Scientific Advisory Committee Budapest Neutron Center BNC, Budapest, Hungary (Since 2008)
- User Selection Panel Budapest Neutron Center BNC, Budapest, Hungary (Since 2008)
- User Selection Group NIST NIST, Gaithersburg, USA (Since 2010)

J. Kohlbrecher
- Scientific Advisory Committee ILL, Chair of College 1 ILL, Grenoble, France (Since 2008)

V. Pomjakushin
- ILL, College 5b - Magnetic structures ILL Grenoble, France (Since 2009)
- Commission on Magnetic Structures of the International Union of Crystallography. IUCr (Since 2010)

B. Roessli
- Program Advisory Committee, Flipper2010 ILL, Grenoble, France (Since 2009)
- International Advisory Committee, PNCMI2010 Delft, Netherlands (Since 2009)
- Board Member, Tables Rondes LLB, Saclay, France (Since 2010)

J. Schefer
- Scientific Advisory Committee FRM-II, structure Forschungsquelle Heinz Meier-Leibnitz, Munich, Germany (since 2008)
- Editor Newsletter of the Swiss Society for Crystallography SGK/SSCr, Swiss Society for Crystallography, Switzerland (Since 2006)
- Member of the Organizing Committee Summer School on Condensed Matter Research, Zugerberg, Switzerland (Since 2008)
- Board Member Swiss Society for Crystallography, Switzerland (Since 2006)
- MaMaSELFevaluation board, MaMaSELF Erasmus Mundus, Rennes, France (Since 2009)

J. Stahn
- Scientific Advisory Committee – expert group ESS, Sweden (Since 2010)
- Program Committee NOP 2010, Alpes d`Huez 2010, France (Since 2009)

DISSERTATIONS

Krunoslav Prsa
Neutron scattering investigations of weakly coupled and weakly connected antiferromagnets
March 2010 (Dissertation EPFL Lausanne N°4594), LNS N°233

Julia Charlotte Else Rasch
The triangular lattice antiferromagnet $CuCrS_2$: magnetic order, lattice distortion and spin Dynamics
March 2010 (Dissertation ETH Zürich N°18973), LNS N°234

Nikolay Tsyrulin
Neutron Scattering Studies of Low-Dimensional Quantum Spin Systems
January 2010 (Dissertation ETH Zürich N°18845), LNS N°235

Mohamed Zayed
Novel States in Magnetic Materials under Extreme Conditions: A High Pressure Neutron Scattering Study of the Shastry-Sutherland compound $SrCu_2(BO_3)_2$
January 2010 (Dissertation ETH Zürich N°19103), LNS N°236

Patrick Thomas Huber
X-ray Scattering on Ordered Colloidal Assemblies
January 2010 (Dissertation ETH Zürich N°18828), LNS N°237

Gelu Rotaru
Statics and dynamics of polar nanoregions in Pb based relaxors
26th of March, 2010 (Dissertation ETH Zürich, No 18968). LNS N°.238

CONGRESSES ORGANIZED

J. Schefer
3rd Status Meeting MaMaSELF: Master in Materials Science Exploiting Large Scale Facilities, May 3-6, 2010, Rigi Kulm Switzerland

R. Cerny, A. Cervellino, S. Galli, F. Gozzo. A.Guagliardi, N. Masciocchi, D. Sheptyakov, PSI-AIC-SCCr/SGK Summer School on Diffraction at the Nanoscale: Nanocrystals, Defective and Amorphous Materials, May 24-30, PSI Villigen, Switzerland

Research with Neutrons and Muons

Laboratory for Particle Physics (LTP)

LIST OF PUBLICACTIONS (PEER REVIEWED)

Aaron F, Alexa C, Andreev V, Antunovic B, Backovic S, Baghdasaryan A, Barrelet E, Bartel W, Begzsuren K, Belousov A, Bizot JC, Boudry V, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Bruncko D, Bunyatyan A, Buschhorn G, Bystritskaya L, Campbell AJ, Avila KB, Cerny K, Cerny V, Chekelian V, Cholewa A, Contreras JG, Coughlan JA, Cozzika G, Cvach J, Dainton JB, Daum K, Deak M, Delcourt B, Delvax J, De Wolf EA, Diaconu C, Dodonov V, Dossanov A, Dubak A, Eckerlin G, Efremenko V, Egli S, Eliseev A, Elsen E, Falkiewicz A, Favart L, Fedotov A, Felst R, Feltesse J, et al.
Inelastic production of J/psi mesons in photoproduction and deep inelastic scattering at HERA
EUROPEAN PHYSICAL JOURNAL C **68**, 401 (2010)

Aaron FD, Abramowicz H, Abt I, Adamczyk L, Adamus M, Al-daya Martin M, Alexa C, Andreev V, Antonelli S, Antonioli P, Antonov A, Antunovic B, Arneodo M, Aushev V, Bachynska O, Backovic S, Baghdasaryan A, Bamberger A, Barakbaev AN, Barbagli G, Bari G, Barreiro F, Barrelet E, Bartel W, Bartsch D, Basile M, Begzsuren K, Behnke O, Behr J, Behrens U, Bellagamba L, Belousov A, Bertolin A, Bhadra S, Bindi M, Bizot JC, Blohm C, Bold T, Boos EG, Borodin M, Borras K, Boscherini D, Bot D, Boudry V, Boutle SK, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Brock I, et al.
Combined measurement and QCD analysis of the inclusive e(+/-)p scattering cross sections at HERA
JOURNAL OF HIGH ENERGY PHYSICS , 109 (2010)

Aaron FD, Abramowicz H, Abt I, Adamczyk L, Adamus M, Martin MA, Alexa C, Andreev V, Antonelli S, Antonioli P, Antonov A, Antunovic B, Arneodo M, Aushev V, Bachynska O, Backovic S, Baghdasaryan A, Bamberger A, Barakbaev AN, Barbagli G, Bari G, Barreiro F, Barrelet E, Bartel W, Bartsch D, Basile M, Begzsuren K, Behnke O, Behr J, Behrens U, Bellagamba L, Belousov A, Bertolin A, Bhadra S, Bindi M, Bizot JC, Blohm C, Bold T, Boos EG, Borodin M, Borras K, Boscherini D, Bot D, Boudry V, Boutle SK, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Brock I, et al.
Events with an isolated lepton and missing transverse momentum and measurement of W production at HERA
JOURNAL OF HIGH ENERGY PHYSICS , 035 (2010)

Aaron FD, Alexa C, Alimujiang K, Andreev V, Antunovic B, Asmone A, Backovic S, Baghdasaryan A, Barrelet E, Bartel W, Begzsuren K, Belousov A, Bizot JC, Boudry V, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Bruncko D, Bunyatyan A, Buschhorn G, Bystritskaya L, Campbell AJ, Avila KBC, Cassol-Brunner F, Cerny K, Cerny V, Chekelian V, Cholewa A, Contreras JG, Coughlan JA, Cozzika G, Cvach J, Dainton JB, Daum K, Deak M, de Boer Y, Delcourt B, Del Degan M, Delvax J, De Roeck A, De Wolf EA, Diaconu C, Dodonov V, Dossanov A, Dubak A, Eckerlin G, Efremenko V, Egli S, Eliseev A, et al.
Jet production in ep collisions at high Q(2) and determination of alpha(s)
EUROPEAN PHYSICAL JOURNAL C **65**, 363 (2010)

Aaron FD, Alexa C, Alimujiang K, Andreev V, Antunovic B, Backovic S, Baghdasaryan A, Barrelet E, Bartel W, Begzsuren K, Belousov A, Bizot JC, Boudry V, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Bruncko D, Bunyatyan A, Buschhorn G, Bystritskaya L, Campbell AJ, Avila KBC, Cerny K, Cerny V, Chekelian V, Cholewa A, Contreras JG, Coughlan JA, Cozzika G, Cvach J, Dainton JB, Daum K, Deak M, Delcourt B, Delvax J, De Wolf EA, Diaconu C, Dodonov V, Dossanov A, Dubak A, Eckerlin G, Efremenko V, Egli S, Eliseev A, Elsen E, Falkiewicz A, Favart L, Fedotov A, Felst R, et al.
Measurement of the D(+/-) meson production cross section and F-2(c(c)over-bar) at high Q(2) in ep scattering at HERA*
PHYSICS LETTERS B **686**, 91 (2010)

Aaron FD, Alexa C, Andreev V, Antunovic B, Backovic S, Baghdasaryan A, Barrelet E, Bartel W, Begzsuren K, Belousov A, Bizot J, Boudry V, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Bruncko D, Bunyatyan A, Buschhorn G, Bystritskaya L, Campbell A, Avila KBC, Cerny K, Cerny V, Chekelian V, Cholewa A, Contreras JG, Coughlan JA, Cozzika G, Cvach J, Dainton JB, Daum K, Deak M, Delcourt B, Delvax J, De Wolf EA, Diaconu C, Dodonov V, Dossanov A, Dubak A, Eckerlin G, Efremenko V, Egli S, Eliseev A, Elsen E, Falkiewicz A, Favart L, Fedotov A, Felst R, Feltesse J, et al.
Measurement of leading neutron production in deep-inelastic scattering at HERA
EUROPEAN PHYSICAL JOURNAL C **68**, 381 (2010)

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Jet production in ep collisions at low Q(2) and determination of alpha(s)
EUROPEAN PHYSICAL JOURNAL C **67**, 1 (2010)

Aaron FD, Martin MA, Alexa C, Alimujiang K, Andreev V, Antunovic B, Asmone A, Backovic S, Baghdasaryan A, Barrelet E, Bartel W, Begzsuren K, Belousov A, Bizot JC, Boudry V, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Bruncko D, Bunyatyan A, Buschhorn G, Bystritskaya L, Campbell AJ, Avila KBC, Cassol-Brunner F, Cerny K, Cerny V, Chekelian V, Cholewa A, Contreras JG, Coughlan JA, Cozzika G, Cvach J, Dainton JB, Daum K, Deak M, de Boer Y, Delcourt B, Del Degan M, Delvax J, De Wolf EA, Diaconu C, Dodonov V, Dossanov A, Dubak A, Eckerlin G, Efremenko V, Egli S, Eliseev A, et al.
Measurement of the charm and beauty structure functions using the H1 vertex detector at HERA
EUROPEAN PHYSICAL JOURNAL C **65**, 89 (2010)

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Diffractive electroproduction of rho and phi mesons at HERA
JOURNAL OF HIGH ENERGY PHYSICS , 032 (2010)

Aaron FD, Martin MA, Alexa C, Andreev V, Antunovic B, Backovic S, Baghdasaryan A, Barrelet E, Bartel W, Begzsuren K, Belousov A, Bizot JC, Boudry V, Bozovic-Jelisavcic I, Bracinik J, Brandt G, Brinkmann M, Brisson V, Bruncko D, Bunyatyan A, Buschhorn G, Bystritskaya L, Campbell AJ, Avila KBC, Cerny K, Cerny V, Chekelian V, Cholewa A, Contreras JG, Coughlan JA, Cozzika G, Cvach J, Dainton JB, Daum K, Deak M, de Boer Y, Delcourt B, Del Degan M, Delvax J, De Wolf EA, Diaconu C, Dodonov V, Dossanov A, Dubak A, Eckerlin G, Efremenko V, Egli S, Eliseev A, Elsen E, Falkiewicz A, Favart L, et al.
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Schmidt-Wellenburg P.
The nEDM experiment PSI (Talk)
International Workshop Time&Matter, Budva. Montenegro, October 4 - 8, 2010

Spira M.
Higgs Physics at e^+e^- and Photon Colliders
Proceedings Photon09, DESY Hamburg, Germany, January 2010

Theidel G. and Schmid E.
Modular High Bandwidth Data Acquisition System with Gigabit and 10 Gigabit Ethernet Uplinks
17th Real-Time Conference
IEEE-MPSS Technical Committee on Computer Applications in Nuclear and Plasma Sciences

Zenner J.
A new measurement of the neutron electric dipole moment (Talk)
Fruehjahrstagung 2010 der DPG, Universitaet Bonn, March 15 - 19, 2010

Zenner J.
Non-metallic electrodes for the neutron electric dipole moment experiment (Talk)
Jahrstagung 2010 der SPG, Universitaet Basel, 21 . – 22. Juni, 2010

Zsigmond G.
Neutron optics simulations for the UCN source and nEDM projects at PSI (Talk)
International Collaboration on Advanced Neutron Sources - ICANS XIX, Grindelwald, Switzerland
March 8 – 12, 2010
PSI-Proceedings 10-01 ISSN-Nr. 1019-6447, July 2010

INVITED TALKS

Actis S.
NLO electroweak corrections to Higgs production in gluon-gluon fusion
LPT seminar, Orsay, France, February 25, 2010

Baldini A.
Rare lepton and K-meson decays
ICHEP 2010, 35th International Conference on High Energy Physics, Paris, France, July 22 - 28, 2010

Baracchini E.
First results from the MEG experiment
Les Rencontres de Morionde EW 2010, La Thuile- Vallee d'Aoste, Italy, March 6 - 13, 2010

Cavoto G.
Recent MEG results
NOW 2010, Neutrino Oscillation Workshop, Conca Specchiulla Otranto, Lecce, Italy, September 4 - 11, 2010

Cei F.
Lepton flavour violation experiments in LHC era
PASCOS 2010, 16th International Symposium on Particles, Strings and Cosmology, Valencia, Spain, July 19 - 23, 2010

Daum M.
Status of the PSI Ultracold Neutron Source and nEDM Search
Wokshop at ECT*: Precision Tests of the Standard Model: From Atomic Parity Violation to Parity-Violating Lepton Scattering, Trento, Italy, November 2010

Daum M.
R&D experiments for the PSI UCN source
UCN2010 International Workshop on UCN and Fundamental Neutron Physics RCNP, Osaka, Japan, April 2010

Denner A.
Branching Ratios -- SM
Freiburg, Germany, April 12 – 13, 2010
Inauguration Workshop of the LHC Higgs Cross Section Working Group

Denner A.
NLO QCD corrections to t anti-t b anti-b production at the LHC
Wörlitz, Germany, April 25 – 30, 2010
Loops and Legs in Quantum Field Theory

Denner A.
Die Welt der kleinsten Teilchen: Expedition ins Innerste der Materie
Münnerstadt, June 16, 2010
Schönbornkolleg Münnerstadt

Denner A.
Multileg NLO
Trento, Italy, September 26 - October 01, 2010
Workshop: QCD at the LHC

Dinapoli R.
A new family of pixel detectors for high frame rate X-ray applications
Pixel 2010, Grindelwald, Switzerland, September 6 – 10, 2010

Dinapoli R.
EIGER: a new generation of pixel detectors for high frame rate X-ray applications
IEEE-NSS, Knoxville (Tennessee), USA

Fertl M.
The New Neutron Electric Dipole Moment Experiment at PSI
Particle Physics Seminar
Brookhaven National Laboratory, Upton, NY, USA, October 28, 2010

Golden B.
Results from the 2009 Data of the MEG Experiment in search for Mu -> e gamma
TAU 2010, 11th International Workshop on Tau Lepton Physics, Manchester, UK, September 13 – 17, 2010

Grassi M.
Status and prospects for lepton flavour violation searches
DISCRETE2010, Symposium on Prospects in the Physics of Discrete Symmetries, Rome, Italy, December 6 – 11, 2010

Henneck R.
Searching the electric dipole moment of the neutron with ultracold neutrons (I)
University of Washington, Seattle, USA, July 12, 2010

Iwamoto T.
Performance of the MEG detector to search for mu+ -> e+ gamma decays at PSI
ICHEP 2010, 35th International Conference on High Energy Physics, Paris, France, July 22 - 28, 2010

Kallweit St.
NLO QCD corrections to VV+jet production
DPG Frühjahrstagung der Deutschen Physikalischen Gesellschaft, Bonn, Germany, March 15, 2010

Kiselev O.
Search for the lepton flavor violation - status and the first results of MEG experiment
XLIV PNPI Winter School, Roschino, Russia, March 9 - 14, 2010

Kirch K.
The search for permanent electric dipole moments
CERN colloquium, Geneva, Switzerland, June 17, 2010

Kirch K.
Experiments with neutrons, pions and muons
CPT10, Bloomington, USA, June 28 – July 2, 2010

Kirch K.
Search for an EDM of the neutron at PSI
LeptonMoments 2010, Cape Cod, USA, July 19 - 22., 2010

Kirch K.
Overview of EDM searches
Meson2010, Krakau, Poland, October 10 -15, 2010

Kirch K.
Teilchenphysik mit langsamen Myonen
KET2010, Perspektivworkshop der Deutschen Teilchenphysik, Dortmund, Germany, October 25 - 26, 2010

Kirch K.
New sensitivity with neutrons at PSI
ECT* Workshop on Searches for CP- and T-violation in atoms and nuclei, Trento, Italy, November 15 - 19, 2010

Langenegger U.
Recharting the Standard Model with the CMS Experiment
invited colloquium at the Ecole Polytechnique, Palaiseau, France, October 11, 2010

Lauss B.
Efficient guides for ultra-cold neutrons at PSI's UCN source (Talk)
International Collaboration on Advanced Neutron Sources - ICANS XIX, Grindelwald, Switzerland, March 8 – 12, 2010
PSI-Proceedings 10-01 ISSN-Nr. 1019-6447, July 2010

Lauss B.
Searching the electric dipole moment of the neutron with ultracold neutrons (II)
University of Washington, Seattle,USA, July 12, 2010

Li Q.
Higgs production with a 4th generation
MadGraph 2010 : BSM and more", Bruxelles , Belgium, October 7, 2010

Mihara S.
MEG liquid xenon detector
GLA2010, 1st International Workshop towards the Giant Liquid Argon Charge Imaging Experiment, KEK Tsukuba, Japan, March 28 - 31, 2010

Mihara S.
MEG experiment at the Paul Scherrer Institute
4th international symposium on Symmetries in Subatomic Physics, Taipai, Taiwan, June 2 - 5, 2009
Proceedings: Nucl. Phys. A 844 (2010) 150c-154c

Mihara S.
New results from the MEG experiment
SUSY10, 18th International Conference on Supersymmetry and Unification of Fundermental Interactions, Bonn, Germany, August 23 - 28, 2010

Natori H.
Lepton flavour violation search with mu-> e gamma decay: the MEG experiment
BEACH 2010 IXth International Conference on Hyperons, Charm and Beauty Hadrons, Perugia, Italy, June 21 - 26, 2010

Nishiguchi H.
MEG experiment – new results and prospects
NuFact10, 12th International Workshop on Neutrino Factories, Superbeams and Beta Beams, Mumbai, India, October 20 - 25, 2010

Papa A.
New results on the mu to e gamma decay from the MEG experiment
NAPP 2010 2010, 3rd International Conference on Nuclear and Particle Physics with CEBAF at Jefferson Lab, Dubrovnik, Croatia, October 3-8, 2010

Piredda G.
First results from the MEG experiment
Les Rencontres de Physique de La Vallee d'Aoste, La Thuile- Vallee d'Aoste, Italy, February 28 – March 6, 2010

Piredda G.
Muon physics overview
NuFact10, 12th International Workshop on Neutrino Factories, Superbeams and Beta Beams, Mumbai, India, October 20 - 25, 2010

Ritt St.
DRS Chip Developments
Picosecond Workshkop, Clermont-Ferrand, France, January 27 - 29, 2010

Ritt St.
Development and usage of high speed waveform sampling ASICs
Instituto Superior Tecnico, Lison, Portugal, May 19, 2010

Sawada R.
Analysis of the MEG experiment to search for mu+ -> e+ gamma decays
ICHEP 2010, 35th International Conference on High Energy Physics, Paris, France, July 22 - 28, 2010

Signorelli G.
Search for lepton flavour violation the μ -> e gamma decay: first results from the MEG experiment
BEYOND2010, 5th International Conference on Beyond the Standard Models of Particle Physics, Cosmology and Astrophysics, Cape Town, South Africa, February 1 - 6, 2010

Spira M.
Supersymmetric Higgs Yukawa Couplings to Bottom Quarks at NNLO'
International Workshop on Linear Colliders 2010, CERN, Switzerland, Oktober 2010

Spira M.
Codes: New Developments
Higgs Days, Santander, Spain, Oktober 2010

Spira M.
Supersymmetric Higgs Yukawa Couplings to Bottom Quarks at NNLO'
Conference SUSY10, Bonn, Germany, August 2010

Spira M.
Theory BSM'
Workshop ``Higgs Hunting'', Orsay, France, July 2010

Spira M.
Progress Report on ttH Cross Section'
Workshop of LHC Higgs Cross Section Working Group, CERN, Switzerland, July 2010

Spira M.
4-Flavour bbH Calculations
Workshop of LHC Higgs Cross Section Working Group, CERN, Switzerland, July 2010

Spira M.
Neutral Higgs Production - Status and Tools: Michael's view'
Kickoff Meeting of the ggh and QQh Working Group, Wuppertal, Germany, March 2010

Uchiyama Y.
Search for lepton flavour violating muon decay: latest results from MEG
HQL 2010, IXth International Conference on Heavy Quarks & Leptons, Frascati, Italy, October 11 - 15 2010

Voena C.
Lepton flavour violation in the mu-> e gamma decay: results from the MEG experiment
FPCP 2010 8th Conference on Flavor Physics and CP Violation 2010, Torino, Italy, May 25 - 29, 2010

LECTURES AND COURSES

M. Daum
Kursvorlesung "Particle Physics"
Université de Fribourg, Herbstsemester 2010

R. Horisberger
Elektronik für Physiker
ETH Zürich, HS2010

K. Kirch
Einführung in die Kern- und Teilchenphysik
Frühjahrssemester 2010, ETH Zürich

K. Kirch
Precision experiments with neutrons
3 lectures at the FANTOM school November 8 – 12, 2010, Emmen, Nederland

U. Langenegger
Experimentelle Methoden und Algorithmen der Teilchenphysik
University of Zurich and ETH

M. Spira
Phänomenologie der Physik jenseits des Standardmodells -
FS 2010 *(*ab 7.Semester, mit Filip Moortgat)
Vorlesung: Mittwoch 12:45 - 14:30 Uhr HIT F 12
Übungen: Mittwoch 14:45 - 15:30 Uhr HIT F 12

AWARDS

L. Caminada
2010 CMS Thesis Award for Dissertation “Study of the Inclusive Beauty Production at CMS and Construction and Commissioning of the CMS Pixel Barrel Detector”

H. Friederich
IEEE Real Time Conference Best Student Paper Award for “A Scalable DAQ System Based on the DRS4 Waveform Digitizing Chip”

S. Streuli
CMS Achievement Award 2010 for the contribution to the construction of the CMS pixel detector

CONFERENCE ORGANIZATION

Spira M., Denner A.
PSI Zuoz Summerschool “Gearing up for LHC Physics”
Lyceum Alpinum Zuoz, Switzerland, August 1 -7, 2010

Horisberger R., Kotlinski D., Starodumov A.
5th International Workshop on Semiconductor Pixel Detectors for Particles and Imaging (PIXEL 2010)
Grindelwald, Switzerland, September 6 – 10, 2010

Kirch K., Lauss B., Ritt St.
Physics of fundametnal Symmetries & Interactions (PSI 2010)
Villigen PSI, Switzerland, October 11 – 14, 2010

Ritt St.
17th Real-Time Conference (RT10)
Lisboa, Portugal, May 24 – 28, 2010

MEMBERSHIPS IN COMMITTEES

R. Horisberger
- President of the PSI internal FOKO
- Member of “Photon Science Committee” HASYLAB, DESY, Hamburg
- Member Berufungskommissionen ETHZ, D-Phys, für 2 Professuren

K. Kirch
- US Department of Energy, EDM Review panel
- Working group "Fundamental Interactions" for NuPECC long range plan
- Swiss Institute of Particle Physics, CHIPP, executive board
- Swiss Physical Society, SPS, board

U. Langenegger
- Member of International Advisory Committee for the conference "Flavor Physics and CP Violation"
- Member of Thesis committee for Marc Olivier Bettler (EPF Lausanne), "Construction of the Inner Tracker and Sensitivity to the Bs -> mu+ mu- Decay at LHCb"

S. Ritt
- Technical Chair IEEE NPSS Computer Applications in Nuclear and Plasma Sciences Society
- Member of Thesis committee for Luca Galli (INFN Pisa), "A Real-Time Glance at the Lepton Flavor Violating Decay mu -> e gamma in the MEG Experiment"
- Member of the Executive Committee for the 17th Real-Time Conference, Lisbon, Portugal, May 24 - 28, 2010

T. Rohe
- Delegierter CHIPP Outreach Group

R. Rosenfelder
- Program Advisory Committee, PSI Ring-Zyklotron

M. Spira
- Convenor of the working group “Electroweak Gauge Theories and Alternative Theories” of the ECFA Study of Physics and Detectors for a Linear Collider
- Convenor of the working group “ttH Higgs Associated Production Process” and the working group “MSSM Neutral Higgs of the LHC Higgs Cross Section Working Group”

DISSERTATIONS

L. Caminada
Study of the Inclusive Beauty Production at CMS and Construction and Commissioning of the CMS Pixel Barrel Detector
Diss. ETH No 19091, CERN-THESIS-2010-149
Advisors: Prof. Dr. F. Pauss (ETHZ), Prof. Dr. R. Eichler (ETHZ), Prof. Dr. R. Horisberger (PSI)

L. Galli
A real time glance at the Lepton Flavor Violating decay mu -> e gamma in the MEG experiment
Doctoral Thesis: Graduate Course in Physics University of Pisa, Italy, December 2010
Advisor: Dr. M. Grassi (INFN Pisa)

F. Xiao
Measurement of the Radiative Muon decay Branching Fraction in the MEG Experiment
Doctoral Thesis: University of California Irvine, USA, September 2010
Advisor: Prof. B. Molzon (UCI)

DIPLOMA

L. Bäni
Measurement of the B--> mu Do X production cross section at the CMS experiment at sqrt(s)=7TeV
Diplomarbeit, ETH Zürich, August 2010

M. Rossini
First observation of D0 production and the study of the tracking efficiency with b --> D mu nu decays in the CMS experiment*
Master thesis, ETH Zürich, April 2010.

DEPARTMENT OF BIOLOGY AND CHEMISTRY

BIOMOLECULAR RESEARCH
CENTER FOR RADIOPHARMACEUTICAL SCIENCES
RADIOCHEMISTRY AND ENVIRONMENTAL CHEMISTRY

BIOMOLECULAR RESEARCH

LIST OF PUBLICATIONS

A. Akhmanova, M.O. Steinmetz
Microtubule plus-end tracking proteins
J. Cell Sci. 123, 3415 – 3419 (2010).

F. Bourquin, H. Riezman, G. Capitani, M.G. Grütter
Structure and function of sphingosine-1-phosphate lyase, a key enzyme of sphingolipid metabolism
Structure 18, 10541 – 1065 (2010).

B. Ciani, S. Bjelic, S. Honnappa, H. Jawhari, R. Jaussi, A. Payapilly, T. Jowitt, M.O. Steinmetz, R.A. Kammerer
Molecular basis of coiled-coil oligomerization state specificity
Proc. Natl. Acad. Sci. USA 107, 19850 – 19855 (2010).

C.O. De Groot, I. Jelesarov, F.F. Damberger, S. Bjelic, M.A.Schaerer, N.S. Bhavesh, I. Grigoriev, R.M. Buey, K. Wuthrich, G. Capitani, A. Akhmanova, M.O. Steinmetz
Molecular insights into mammalian end binding protein heterodimerization
J. Biol. Chem. 285, 5802 – 5814 (2010).

S.B. Daly, J.E. Urquhart, E. Hilton, E.A. McKenzie, R.A. Kammerer, M. Lewis, B. Kerr, H. Stuart, D. Donnai, D.A. Long, B. Burgu, O. Aydogdu, M. Derbent, S. Garcia-Minaur, W. Reardon, B. Gener, S. Shalev, R. Smith, A.S. Woolf, G.C. Black, W.G. Newman
Mutations in HPSE2 cause urofacial syndrome
Am. J. Hum. Genet. 86, 963 – 969 (2010).

D. Dell'Era Dosch, K. Ballmer-Hofer
Transmembrane domain-mediated orientation of receptor monomers in active VEGFR-2 dimers
FASEB J. 24, 32 – 38 (2010).

J. Dolenc, J.H. Missimer, M.O. Steinmetz, W.F. van Gunsteren
Methods of NMR structure refinement: molecular dynamics simulations improve the agreement with measured NMR data of a C terminal peptide of GCN4-p1
J. Biomol. NMR 47, 221 – 235 (2010).

J.M. Duarte, R. Sathyapriya, H. Stehr, I. Filippis, M. Lappe
Optimal contact definition for reconstruction of contact maps
BMC Bioinformatics 11, 283 (2010).

A.C.M. Figueira, I. Polikarpov, D. Veprintsev, G.M. Santos
Dissecting the relation between a nuclear receptor and GATA: Binding affinity studies of thyroid hormone receptor and GATA2 on TSHβ promoter
PLoS One 5(9): e12628. doi:10.1371/journal.pone.0012628 (2010).

J.S. Hub, F.K. Winkler, M. Merrick, B.L.de Groot
Potentials of mean force and permeabilities for carbon dioxide, ammonia and water flux across a rhesus protein channel and lipid membranes
J. Am. Chem. Soc. 132, 13251 – 13263 (2010).

G. Kägi, J. H. Missimer, E. Abela, R. J. Seitz, B. J.Weder
Neural networks engaged in tactile object manipulation: Patterns of expression among healthy individuals
Behavioral and Brain Functions 6, 71 – 87 (2010).

A. Kriz, K. Schmid, N. Baumgartner, U. Ziegler, I. Berger, K. Ballmer-Hofer, P. Berger
A plasmid-based multigene expression system for mammalian cells
Nat. Commun.1, 120 – 125 (2010).

A. Kriz, K. Schmid, N. Baumgartner, U. Ziegler, I. Berger, K. Ballmer-Hofer, P. Berger
A plasmid-based multigene expression system for mammalian cells.
Nat Commu,. Nov; 1(8):120 (2010).

S. Lachkar, M. Lebois, M.O. Steinmetz, A. Guichet, N. Lal, P.A. Curmi, A. Sobel, S. Ozon
Drosophila stathmins bind tubulin heterodimers with high and variable stoichiometries
J. Biol. Chem. 285, 11667 – 11680 (2010).

V.-M. Leppänen, A.E. Prota, M. Jeltsch, A. Anisimov, N. Kalkkinen, T. Strandin, H. Lankinen, A. Goldman, K. Ballmer-Hofer, K. Alitalo
Structural determinants of growth factor binding and specificity by VEGF receptor 2
Proc. Natl. Acad. Sci. USA 107, 2425 – 2430 (2010).

M. Lone, T. Kungl, A. Koper, W. Bottenberg, R. A. Kammerer, M. Klein, S. T. Sweeney, R.P. Auburn, C.J. O'Kane, A. Prokop
The nuclear protein Waharan is required for endosomal-lysosomal trafficking in Drosophila
J. Cell Sci. 123, 2369-2374 (2010).

P.R. Macdonald, A. Lustig, M.O. Steinmetz, R.A. Kammerer
Laminin chain assembly is regulated by specific coiled-coil interactions
J. Struct. Biol. 170, 398 – 405 (2010).

J.H. Missimer, R. J. Seitz, R. Kleiser
Data-driven Analyses of an fMRI Study of a Subject Experiencing Phosphenes
Journal of Magnetic Resonance Imaging 31, 821 – 828 (2010)

J.H. Missimer, J. Dolenc, M.O. Steinmetz, W.F. van Gunsteren
Exploring the Trigger Sequence of the GCN4 Coiled-coil: Biased Molecular Dynamics Resolves Apparent Inconsistencies in NMR Measurements
Protein Sci. 19, 2462 – 2474 (2010).

S. Montenegro Gouveia, K. Leslie, L.C. Kapitein, R.M. Buey, I. Grigoriev, M. Wagenbach, I. Smal, E. Meijering, C.C. Hoogenraad,. L. Wordeman, M.O. Steinmetz, A. Akhmanova
In vitro reconstitution of the functional interplay between MCAK and EB3 at microtubule plus-ends
Curr. Biol. 20, 1717 – 1722 (2010).

N. Olieric, M. Kuchen, S. Wagen, S. M. Sauter, S. Crone, S. Edmonson, D. Frey, C. Ostermeier, M.O. Steinmetz, R. Jaussi
Automated seamless DNA co-transformation cloning with direct expression vectors applying positive or negative insert selection.
BMC Biotechnol. 10, 56 (2010).

M.A. Schärer, M.G. Grütter, G. Capitani
CRK: an evolutionary approach for distinguishing biologically relevant interfaces from crystal contacts
Proteins 78, 2707 – 713 (2010).

F. Schmidt, N. Treiber, G. Zocher, S. Bjelic, M.O. Steinmetz, H. Kalbacher, T. Stehle, G. Dodt
Insights into peroxisome function from the structure of PEX3 in complex with a soluble fragment of PEX19.
J. Biol. Chem. 285, 25410 – 25417 (2010).

H. Stehr, J.M. Duarte, M. Lappe, J. Bhak, D.M. Bolser
PDBWiki: added value through community annotation of the Protein Data Bank
Database (Oxford) 2010:baq009 (2010).

D. Truan, L.F. Huergo, L.S. Chubatsu, M. Merrick, X.D. Li, F.K.Winkler
A new P(II) protein structure identifies the 2-oxoglutarate binding site
J Mol Biol. 400, 531 – 539 (2010).

UNIVERSITY LEVEL AND OTHER TEACHING

G. Capitani
Introduction to Bioinformatics: Concepts and Applications
ETH Zürich, HS 2010

R. Jaussi
Molecular Molecular Cell Biology
University of Zürich, HS 2010

R. Jaussi
Gentechnik für Medizinstudierende
University of Zürich, FS 2010

X.D. Li
Membrane Protein Biology
University of Basel, 2010

T. Ishikawa
Macromolecular Structure and Biophysics
ETH Zurich, HS 2010

T. Ishikawa
Correlative Structural Biology with a Main Focus on Electron Microscopy
ETH Zurich, FS 2010

CONTRIBUTIONS TO CONFERENCES, WORKSHOPS AND SEMINARS

T. Ishikawa
Molecular mechamism of flagellar/ciliary bending motion revealed by electron cryo-tomography
ESF-EMBO Symposium on Emergent Properties of the Cytoskeleton: Molecules to Cells, Sant Feliu, Spain, October 3 – 8, 2010

T. Ishikawa
Molecular mechamism of flagellar/ciliary bending motion revealed by electron cryo-tomography
ESF-EMBO Symposium on Emergent Properties of the Cytoskeleton: Molecules to Cells, Sant Feliu, Spain, October 7, 2010

T. Ishikawa
Direct visualization of molecular cooperativity: How is flagellar bending coordinated?
Japan-ETH Symposium organized by Prof. Wendelin Jan Stark (D-CHEM, ETH Zurich), Zurich, Switzerland, August 12, 2010

T. Ishikawa
3D structural analysis of flagella/cilia by electron cryo-tomography
Department seminar organized by Prof. Yoko Toyoshima (Graduate School of Arts and Sciences, University of Tokyo), Tokyo, Japan, October 12, 2010

T. Ishikawa
Coordinated arrangement and motion of flagellar dyneins revealed by electron cryo-tomography
Department seminar organized by Prof. Jonathon Howard (Max Planck Institute of Molecular Cell Biology and Genetics), Dresden, Germany, November 15, 2010

G. Schertler
Micro- and nanodiffraction of membrane proteins
ESRF USERS' Meeting 2010, Grenoble, France, 10.2.2010

G. Schertler
The future of structural biology of membrane proteins
4D Biology Workshop on integration of proteomics, interactomics and structural biology via systems biology approaches, DG Research, Brussels, Belgium, 16.-17.3.2010

G. Schertler
Structure of a constitutively active rhodopsin: implications for ligand binding and activation of GPCRs
Keystone Symposium, G Protein-Coupled Receptors, Beaver Run, Colorado, USA, 7.-12.4.2010

G. Schertler
Structural insights into G protein-coupled receptor activation
BCA Spring Meeting, University of Warwick, England, 13.-15.4.2010

G. Schertler
Long time-scale molecular dynamics simulations of G-protein-coupled receptors
ASPET Experimental Biology 2010, Anaheim, California, USA, 24.-28.4.2010

G. Schertler
Structure of a constitutively active rhodopsin mutant: Insights into receptor activation
Gordon Research Conference, Photosensory Receptors & Signal Transduction, Pisa, Italy, 18.-20.4.2010

G. Schertler
Structure of G protein-coupled receptors (GPCRs): implications for ligand binding and activation
Seminars on Drug Discovery and Development, ETH Zürich, Switzerland, 5.5.2010

G. Schertler
Structure of life defining membrane receptors: G protein-coupled receptors
Max-Planck-Institut, Heidelberg, Germany, 18.05.2010

G. Schertler
The future of micro- and nanodiffraction of membrane protein samples
ISDSB, 3rd international Symposium on Diffraction Structural Biology, SOLEIL, Paris, France, 25.-28.5.2010

G. Schertler
New G protein-coupled receptor crystal structures: insights and limitations
World Pharma 2010, 16th World Congress on Basic and Clinical Pharmacology, Copenhagen, Denmark, 17.-23.7.2010

G. Schertler
Structure of active and inactive G protein-coupled receptors: implications for signaling and pharmacology
35th FEBS Congress, Molecules of Life, Göteborg, Sweden, 23.6.-1.7.2010

G. Schertler
Exploring the ligand binding site of the beta 1 adrenergic receptor: Structures of agonists and antagonists bound to the receptor
14th International Conference on Retinal Proteins, UCSC Porter College, Santa Cruz, California, USA, 2.-6.8.2010

G. Schertler
Expression, purification and crystallization of membrane proteins
EMBO practical course, Protein Expression, Purification and Crystallisation, EMBL Hamburg,Germany, 23.-31.8.2010

G. Schertler
New G protein-coupled receptor crystal structures: Insights and limitations
21st International Symposium on Medicinal Chemistry, Brussels, Belgium, 5.-9.9.2010

G. Schertler
Structure of g protein-coupled receptors (GPCRs):Implications for ligand binding and activation
5th Summer School Medicinal Chemistry, Universität Regensburg, Germany, 13.-15.9.2010

G. Schertler
Crystallisation and structure determination of stabilised G protein-coupled receptors
ICCBM13,13th International Conference on the Crystallization of Biological Macromolecules, Trinity College, Dublin, Ireland, 12.-16.09.210

G. Schertler
New G protein-coupled receptor crystal structures: Implications for signaling and pharmacology
IRIC, University Montreal, Canada, 4.10.2010

G. Schertler
Implications for signaling and pharmacology of active GPCR structures
The Rockefeller University, New York, USA, 5.10.2010

G. Schertler
New G protein-coupled receptor crystal structures: structures of constituitively active rhodopsin
Yale University, USA, 6.-8.10.2010

G. Schertler
Structures of constitutively active GPCR mutants: How an agonist activates the GPCR
GPCR Workshop, Structure Based Drug Discovery, Honolulu, Hawaii, 7.-10.12.2010

J. Standfuss
Crystal structure of Meta-rhodopsin-II: A fully activated GPCR
Keystone Symposia, Transmembrane Signaling by GPCRs and Channels, Taos, USA, 24.01.2011

J. Standfuss
Structures of constitutively active rhodopsin: How an agonist can activate its GPCR
Gordon Research Conference, Ligand recognition and Molecular Gating Lucca, Italy, 20.05.2010

J. Standfuss
Structures of constitutively active rhodopsin: How an agonist can activate its GPCR
14th International Conference on Retinal Proteins, Santa Cruz, USA, 04.08.10

J. Standfuss
Structures of constitutively active rhodopsin: How an agonist can activate its GPCR
German Pharmaceutical Society Marburg, University Marburg, Germany, 25.10.2010

J. Standfuss
Structures of constitutively active rhodopsin: How an agonist can activate its GPCR
Lecture at Hoffmann-La Roche, Basel, Germany, 07.12.2010

L. Tiefenauer
Integration and recording of a reconstituted voltage-gated sodium channel in planar lipid bilayers
10th World Congress Biosensors 2010, Session Nanobiosensors, nanomaterials & nanoanalytical systems, Glasgow U.K., May 26-29, 2010

D. Veprintsev
Stability of full-length p53 family members
3rd Annual Proteins Congress, Berlin, Germany, 27.-28. October 2010

THESIS

F. Grünewald
Structure function alalysis of neuropilin interactions with vascular endothelial growth factors
ETH Zurich, Diss-ETH Nr. 19185, 22.7.2010

D. Truan
Structural studies of ligand binding modes of the signal transduction pII protein GlnZ from Azospirillum brasilense, Phospholipase C from Pseudomonas aeruginosa and peptide nucleic acids
ETH Zurich, Diss-ETH Nr. 19372, 11.11.2010

CENTER FOR RADIOPHARMACEUTICAL SCIENCES

LIST OF PUBLICATIONS

S. Jeger, K. Zimmermann, A. Blanc, J. Grünberg, M. Honer, P. Hunziker, H. Struthers, R. Schibli
Site-specific and stoichiometric modification od antibodies by bacterial transglutaminase
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V. Mumprecht, M. Honer,B. Vigl, ST. Proulx, E. Trachsel, M. Kaspar, NE. Banziger-Tobler, R. Schibli, D. Neri, M. Detmar
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D. Peckl-Schmid, S. Wolkersdorfer, S. Königsberger, G. Achatz-Straussberger, S. Feichtner, E. Schwaiger, N. Zaborsky, M. Huemer, I.K. Gratz, R. Schibli, M. Lamers, R. Crameri, K. Moser, E.O. Luger, G. Achatz
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Mol Pharm 7 (2): 597 – 604 (2010)

C. Zahnd, M. Kawe, MT. Stumpp, Ch. De Pasquale, R. Tamaskovic, G. Nagy-Davidescu, B. Dreier, R. Schibli, H.K. Binz, R: Waibel, A. Plückthun
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J.R. Mitchell, M. Verweij, K. Brand, M. van de Ven, S. van den Engel, T. Chu, F. Forrer, C. Müller, M. de Jong, W. van IJcken, J.N. IJzermans, J.H.Hoeijmakers, R.W. de Bruin
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Current Radiopharmaceuticals, 3(3), 224-242 (2010).

M. Honer, T. Ebenham, P.R. Allegrin, S.M. Ametamey, M. Becquet, C. Cannet, H. Lane, T.M. O`Reilly, P.A. Schubiger, M. Sticker-Jantscheff,, M. Stumm, P.M.J. McSheehy
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C.A. Baumann, L. Mu, S.N. Wehrli, S.D. Krämer, M. Honer, P.A. Schubiger, S.M. Ametamey
„Synthesis and pharmacological characterisation of thiazole derivatives as potential mGluR5 PET ligands "
Bioorganic & Medicinal Chemistry 18, 6044-6054 (2010)

UNIVERSITY LEVEL AND OTHER TEACHING

R. Schibli
Metal Based Drug and Drug Development
ETH Zurich

R. Schibli
Practicum Medicinal Chemistry
ETH Zurich

R. Schibli, S.M. Ametamey, P.A. Schubiger, C. Müller
Einführung in die pharmazeutischen Wissenschaften I
ETH Zurich

R. Schibli, S.M. Ametamey, P.A. Schubiger, C. Müller, M. Brühlmeier
Einführung in die pharmazeutischen Wissenschaften II
ETH Zurich

P.A. Schubiger, S.M. Ametamey, R. Schibli
Radiopharmazeutische Chemie
ETH Zurich

R. Schibli, S.M. Ametamey, E. Fischer, C. Müller, P. Bläuenstein, R: Waibel, J. Grünberg
In vitro and in vivo characterization of radiopharmaceuticals: Antibodies
Postgraduate course, Module II: Radiopharmaceutical chemistry

R. Schibli, C. Müller
Preparation and Quality Control of ^{99m}Tc-Radiopharmaceuticals
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Swiss Society for Radiopharmacy and Radiopharmaceutical Chemistry (SGRRC)
ETH Zurich, Switzerland

K. Zhernosekov
Nuclear- and Radiochemistry lecture (master course)
Universität Bern

R. Schibli, S.M. Ametamey, A. Hohn
PET and SPECT: Physical principles and basic strategies of radiotracer development for pre-clinical use
CIMST Summer School, ETH Zurich, Switzerland.

CONTRIBUTIONS TO CONFERENCES, WORKSHOPS AND SEMINARS

R. Schibli
Radiopharmaceuticals for the Imaging of Folate Receptors
Bad Hofgastein 21. Januar 2010

R. Schibli
Zevalin "Swiss Made" Vorstellung des Zevalin-Zentrallabors
Januar Symposium Radiopharmazie & Nuklearmedizin am Kantonsspital Aargau, 22. Januar 2010

R. Schibli
Targeted tumor Imaging with Radiolabeled Peptide Nanoparticles (NanoPER-SPECT)
Nanotechday Nordwestschweiz, Universität Basel, 11. Mai 2010

R. Schibli
Pre-clinical and clinical investigation of a new Tc-99m labeled vitamin B12 derivative for detection of neoplastic tissues: A story of Mice and Man
SNM Annual Meeting, Salt Lace City, June 5 – 9, 2010

R. Schibli
Organometallic Chemistry of Technetium and Rhenium: An Inspiration for Chemists and Radiopharmacists
Int. Symposium on Technetium and other Radiometals in Chemistry and Medicine, TERACHEM 2010. Bressanone. 8. September 2010

R. Schibli
Targeting of Tumors with Radiolabeled Vitamins
Kinderspital Zürich

R. Schibli
In vivo profiling of self-assembling peptides nanoparticles for potential diagnosis and therapy
Nanobiotechnology, Russian Academy of Sciences , Moscow, November 1st, 2010

R. Schibli
Radiopharmazeutische Forschung am PSI
Besuch der Geschäfts- und Bereichsleitung des Kantonsspitals Aarau am PSI, 9. November 2010

R. Schibli
Assesment of HIF transcriptional activity in a mouse tumor model using GPI anchored avidin.
5th ESMI Meeting, Warschau, Polen, 26 – 29.Mai 2010

E. Fischer
Tailoring antibodies for radionuclide delivery
7th Antibody Platform Meeting, Zurich, Switzerland, 19th January 2010

E. Fischer
Development of Vitamin B12 Derivatives for selective tumor targeting
18th Arbeitstagung der Arbeitsgemeinschaft Radiochemie/Radiopharmazie, Germany, Bad Boll, September 2010

C. Müller
"Folic Acid Conjugates for Folate Receptor Targeted Radioimaging and Potential Radionuclide Therapy"
20th Meeting of the International Research Group in Immuno-Scintigraphy and Therapy (IRIST), Invited: "Groningen, The Netherlands, 10th April 2010

C. Müller
"Folic Acid Conjugates for Folate Receptor Targeted Radioimaging and Potential Radinuclide Therapy"
Johannes Gutenberg University, Institute for Nuclear Chemistry, Mainz, Germany, 26th April 2010

C. Müller
Application of a Novel ^{67}Ga-DOTA-Folate Conjugate in Combination with Various Drugs to Improve the Tumor-to-Kidney Ratio of Radioactivity
Annual Congress of the European Association of Nuclear Medicine (EANM 10), Vienna, Austria, October 2010

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Application of a Novel ^{67}Ga-DOTA-Folate Conjugate in Combination with Various Drugs to Improve the Tumor-to-Kidney Ratio of Radioactivity
11th Annual Congress of the Swiss Society of Nuclear Medicine (SGNM), Lugano, Switzerland, June 2010

K. Zhernosekov
The low-energy β- and electron emitter ^{161}Tb as alternative for ^{177}Lu for targeted radionuclides therapy
Physics for health in Europe workshop CERN, February 2010

K. Zhernosekov
Development of a novel metal-fee ^{68}Ge/^{68}Ga radionuclide generator system
EANM, Wien, Austria, October 2010.

K. Zhernosekov
Positron emitting radiolanthanides for PET: ^{140}Nd in vivo generator and ^{152}Tb.
Workshop WIRP on innovative PET radionuclides, Nantes, France, July 2010.

R.Waibel
"Pre-clinical and clinical investigation of a new radiolabeled vitamin-B12 derivative for detection of neoplastic tissue"
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R.Waibel
"Clinical pilot study with a novel radiolabelled vitamin B12 derivative for detection of neoplastic tissue"
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S. Geistlich
"Zentrale Zevalinmarkierung"
Hybridtechnologie in der Nuklearmedizin, SVMTRA Weiterbildung der Fachgruppe Nuklearmedizin, Zürich, Switzerland, 23rd October 2010

V. D'Alessandro
"*Pro-protein convertases for targeted therapy of pediatric soft tissue sarcomas."*
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Organometallic Chemistry of Technetium and Rhenium: An Inspiration for Chemists and Radiopharmacists
Proceedings: Technetium and other Radiometals in Chemistry and Medicine 2010

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The low-energy β- and electron emitter ^{161}Tb as alternative for ^{177}Lu for targeted radionuclides therapy
ISRS, International Symposium on Technetium and other Radiometals in Chemistry and Medicine, Bressanone, Italy, September 2010
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Q. J. Nucl. Med. 54, Suppl. 1, 14-15 (2010)

E. García Garayoa, S. Daepp, L. Brans, V. Maes, A. Blanc, O. Gasser, D. Tourwé, R. Schibli.
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S.V. Selivanova, M. Honer, S.D. Kraemer, F. Combe, K. Isensee, H. Stark, A.P. Schubiger, S. Ametamey
"Potential PET Tracer for H_3 Receptor Imaging - in vitro and in vivo Evaluation of a High Affinity Antagonist"
European Journal of Nuclear Medicine and Molecular Imaging, vol.37, Supplement 2, p.S287, 2010

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Cindy Anna Baumann
Development of novel fluorine-18 labeled PET tracers for imaging of the metabotropic glutamate receptor subtype 5 (mGluR5)
Diss., Eidgenössische Technische Hochschule ETH Zürich, Nr. 18915, 2010

Marianne Isabelle Kehl
Refinement and standardization of small animal PET scanning experimentation and data analysisI
Diss., Eidgenössische Technische Hochschule ETH Zürich, Nr. 19373, 2010

RADIOCHEMISTRY AND ENVIRONMENTAL CHEMISTRY

LIST OF PUBLICATIONS

HEAVY ELEMENTS

L.-L. Andersson, D. Rudolph, P. Golubev, R.-D. Herzberg, R. Hoischen, E. Merchán, D. Ackermann, Ch.E. Düllmann, K. Eberhardt, J. Even, J. Gerl, F.P. Heßberger, E. Jäger, J. Khuyagbaatar, I. Kojouharov, J.V. Kratz, J. Krier, N.Kurz, W.Prokopowicz, M. Schädel, H. Schaffner, B. Schausten, E. Schimpf, A. Semchenkov, A. Türler, H.-J.Wollersheim, A. Yakushev, P. Thörle-Pospiech, W. Hartmann, A. Hübner, B. Lommel, B. Kindler, J. Steiner
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R. Graeger, D. Ackermann, M. Chelnokov, V. Chepigin, C. E. Düllmann, J. Dvorak, J. Even, A. Gorshkov, F. P. Heßberger, D. Hild, A. Hübner, E. Jäger, J. Khuyagbaatar, B. Kindler, J. V. Kratz, J. Krier, A. Kuznetsov, B. Lommel, K. Nishio, H. Nitsche, J. P. Omtvedt, O. Petrushkin, D. Rudolph, J. Runke, F. Samadani, M. Schädel, B. Schausten, A. Türler, A. Yakushev, Q. Zhi
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CHIMIA **64:** 293-298 (2010).

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C. E. Kolb, R. A. Cox, J. P. D. Abbatt, M. Ammann, E. J. Davis, D. J. Donaldson, B. C. Garrett, C. George, P. T. Griffiths, D. R. Hanson, M. Kulmala, G. McFiggans, U. Pöschl, I. Riipinen, M. J. Rossi, Y. Rudich, P. E. Wagner, P. M. Winkler, D. R. Worsnop, C. D. O' Dowd
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A. Křepelová, T. Huthwelker, H. Bluhm, M. Ammann
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A. Křepelová, J. Newberg, T. Huthwelker, H. Bluhm, M. Ammann
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A. Rouvière, M. Ammann
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RADWASTE ANALYTICS

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T. Nikula, U. Köster, B. Ponsard, K. Zhernosekov, P. Juntunen, L. Nikula
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ENVIRONMENTAL RADIONUCLIDES UNIVERSITÄT BERN

D. Ceburnis, A. Garbaras, S. Szidat, A.S.H. Prevot, C. Facchini, C.D. O'Dowd
North Atlantic marine boundary layer organic aerosol: sources and fluxes
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D. Ceburnis, A. Garbaras, S. Szidat, S. Fahrni, N. Perron, L. Wacker, M. Rinaldi, A.S.H. Prevot, G. Jennings, V. Remeikis, C. Facchini, C.D. O'Dowd
Unambiguous origin of aerosol organic matter by ^{13}C and ^{14}C analysis
International Aerosol Conference 2010, Helsinki, Finland, 29 August - 3 September, 2010.

S. Fahrni, L.Wacker, M. Ruff, S. Szidat, H.-A. Synal
Improved measurements of gaseous ^{14}C samples at MICADAS
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S. Fahrni
Improved measurements of gaseous ^{14}C samples at MICADAS
Seminar of the Laboratory of Radiochemistry and Environmental Chemistry, Paul Scherrer Institute and University of Berne,
Switzerland, 30 April, 2010.

S. Fahrni, S. Szidat, H.W. Gäggeler, M. Ruff, L. Wacker
Source apportionment by compound-specific ^{14}C measurements of aerosol components
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H.W. Gäggeler
Scientific and private reminiscences from a post-deadline sabbatical leave to New Zealand,
Seminar of the Laboratory of Radiochemistry and Environmental Chemistry, Paul Scherrer Institute and University of Berne,
Switzerland, 17 December, 2010.

A. Hodzic, J.L. Jimenez, A.S.H. Prévôt, N. Marley, S. Madronich, S. Szidat
Can 3D models predict the observed fractions of modern and fossil carbon in and near Mexico City?
EGU, General Assembly 2010, Vienna, Austria, 02-07 May, 2010.

A. Hodzic, J.L. Jimenez, A.S.H. Prevot, S. Szidat, J.D. Fast, S Madronich
Can 3D models explain the observed fraction of non-fossil carbon in Mexico City?
International Aerosol Conference 2010, Helsinki, Finland, 29 August - 3 September, 2010.

J. Liebl, S. Fahrni, R. Golser, W. Kutschera, K. Mair, A. Priller, P. Steier, I. Vonderhaid, L. Wacker, E.M. Wild
^{14}C AMS measurement and sample preparation methods of µg-sized carbon samples
DPG Frühjahrstagung, Hannover, Germany, 8-12 March, 2010.

M.C. Minguillón, N. Perron, X. Querol, S. Szidat, S. Fahrni, L. Wacker, C. Reche, M. Cusack, U. Baltensperger, A.S.H. Prévôt
Origin of fine carbonaceous particulate matter in the Western Mediterranean Basin: fossil versus modern sources
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M.C. Minguillón, N. Perron, X. Querol, S. Szidat, S. Fahrni, L. Wacker, C. Reche, M. Cusack, U. Baltensperger,

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N. Perron, P. Lienemann, R. Gehrig, S. Szidat, S. Fahrni, M. Ruff, L. Wacker, A.S.H. Prévôt, U. Baltensperger
^{14}C-supported evidence of non-exhaust traffic resuspension in an Alpine valley
International Aerosol Conference 2010, Helsinki, Finland, 29 August - 3 September, 2010.

A.S.H. Prévôt, N. Perron, S. Szidat, V.A. Lanz, J. Sandradewi, M.R. Alfarra, A. Caseiro, U. Baltensperger
Comparison of several wood smoke markers and source apportionment methods for wood burning particulate mass
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A.S.H. Prévôt, N. Perron, J. Sandradewi, M.R. Alfarra, S. Szidat, M.N. Wehrli, M. Ruff, S. Weimer, V.A. Lanz, E. Weingartner, A. Caseiro, A. Kasper-Giebl, H. Puxbaum, L. Wacker, U. Baltensperger
News on source apportionment methods for wood-burning particulate matter
International Aerosol Conference 2010, Helsinki, Finland, 29 August - 3 September, 2010.

S. Szidat, S. Fahrni, M. Ruff, N. Perron, L. Wacker, H.-A. Synal
Online ^{14}C analysis of ultra-small samples with accelerator mass spectrometry
16th Radiochemical Conference, Marianske Lazne, Czech Republic, 19-23 April, 2010.

S. Szidat
Compound-specific radiocarbon analysis: techniques and applications
Seminar Laboratory for Waste Management, Paul Scherrer Institut, Switzerland, 01 June, 2010.

S. Szidat
Sources of atmospheric carbonaceous aerosols
SCS Young Faculty Meeting 2010, University of Bern, Switzerland, 25 June, 2010.

S. Szidat
^{14}C and other environmental radionuclides - Research focus of the Szidat group
OCCR Work Package 1&2 Workshop, Gwatt, Switzerland, 17-18 August, 2010.

S. Szidat, N. Perron, Y. Zhang, S. Fahrni, M. Ruff, L. Wacker, M.C. Minguillon, A.S.H. Prevot, U. Baltensperger
Towards fast and reliable separation of OC and EC for ^{14}C-based source apportionment
International Aerosol Conference 2010, Helsinki, Finland, 29 August - 3 September, 2010.

S. Szidat
Offline- und Onlinemethoden zur ^{14}C-Messung von Kleinstproben
23. Seminar Aktivierungsanalyse und Gammaspektroskopie, Dresden, Germany, 6-8 September, 2010.

S. Szidat
Bestimmung von Feinstaubquellen mit Radiokohlenstoff
FZD-Kolloquium, Forschungszentrum Dresden-Rossendorf, Dresden, Germany, 8 September, 2010.

S. Szidat, S. Fahrni, M. Ruff, N. Perron, A.S.H. Prévôt, L. Wacker
Improved ^{14}C analysis of carbonaceous particulate matter
11th Int. Symp. on Environmental Radiochemical Analysis, Chester, U.K., 15-17 September, 2010.

S. Szidat
Analytics of ^{14}C, ^{210}Pb and other radionuclides
OCCR Work Package 3 Workshop, Bern, Switzerland, 29 October, 2010.

Y.L. Zhang, D. Liu, G. Zhang, C.D. Shen, P. Ding
A preparation system for OC/EC measurement of radiocarbon in China
The Society of Environmental Toxicology and Chemistry (SETAC), Asia/Pacific Annual Meeting, Guangzhou, China, 4-5 June, 2010.

Y.L. Zhang
Source appointment of aerosols by radiocarbon analysis
1st Year Graduate Student Symposium, University of Bern, Switzerland, 13 September, 2010.

Y.L. Zhang
Source appointment of aerosols by radiocarbon analysis
Seminar of the Laboratory of Radiochemistry and Environmental Chemistry, Paul Scherrer Institute and University of Berne,
Switzerland, 19 November, 2010.

LECTURES AND COURSES

Prof. Dr. A. Türler

Universität Bern, FS2010:
Bachelor
- Instrumentalanalytik II (with others) (3 ECTS)
- Allgemeine Chemie (Einführung Radioaktivität) (with others) (4 ECTS)

Universität Bern, HS2010:
Bachelor
- Physikalische Chemie IV (with Prof. T. Wandlowski) (3,75 ECTS)
- Praktikum Phys. Chemie II (with others) (4 ECTS)
- Biochemische Methoden I (with others) (3 ECTS)

Master
- Nuclear and Radiochemistry (3 ECTS)
- Lab course: Nuclear and Radiochemistry at the PSI (with others) (4 ECTS)
- Seminar Radio- und Umweltchemie in collaboration with Paul Scherrer Institut (organized by D. Schumann)

Prof. Dr. M. Schwikowski

Universität Bern, FS2010:
Bachelor
- Instrumentalanalytik II (with others) (3 ECTS)

Universität Bern, HS2010:
Master
- Environmental Chemistry (with S. Szidat) (3 ECTS)

Dr. M. Ammann

ETH Zürich, FS 2010:
- Atmospheric Interface Chemistry (3 ECTS)

Dr. T. Bartels-Rausch

HS2010:
- Lab course: Nuclear and Radiochemistry at the PSI (with Prof. A. Türler and S. Szidat) (4 ECTS)

Dr. R. Eichler

Universität Bern, HS2010:
- Praktikum Phys. Chemie II (with Prof. A. Türler) (4 ECTS)
- Lab course Nuclear and Radiochemistry (with Prof. A. Türler and S. Szidat) (4 ECTS)

Dr. D. Schumann

- Seminar Radio- und Umweltchemie in collaboration with Paul Scherrer Institut

PD Dr. S. Szidat

Universität Bern, FS2010:
- Ergänzungen zur analytischen Chemie für Pharmazeuten (Vorlesung und praktische Übungen) (2 ECTS)

Universität Bern, HS2010:
- Chemie für Studierende der Veterinärmedizin (with C. Leumann) (4.5 ECTS)
- Environmental Chemistry (with M. Schwikowski) (3 ECTS)
- Praktikum Physikalische Chemie II (with others) (4 ECTS)
- Lab Course Nuclear and Radiochemistry (with A. Türler and R. Eichler) (4 ECTS)

Dr. K. Zhernosekov

Universität Bern, HS2010:
- Nuclear and Radiochemistry (with Prof. A. Türler) (3 ECTS)

DOCTORAL THESIS

Nolwenn Perron
Radiocarbon-supported source apportionment of carbonaceous aerosols
Prof. Dr. U. Baltensperger / PSI
Prof. Dr. H.W. Gäggeler / PSI & Uni Bern
May 2010

Alexey Serov
On the chemical investigation of superheavy elements (Z>110)
Dr. R. Eichler / PSI
Prof. Dr. H.W. Gäggeler / PSI & Uni Bern
October 2010

Manuel Schläppi
Accumulation rates and chemical composition of precipitation derived from Pío XI ice core, Southern Patagonia Icefield
Prof. Dr. M. Schwikowski / PSI & Uni Bern
December 2010

MASTER THESIS

Bernadette Hammer
Production and distribution of long-lived radionuclides in a lead-bismuth target from ISOLDE
Dr. D. Schumann / PSI
Prof. Dr. A. Türler / PSI & Uni Bern
December 2010

AWARDS

Nadzeya Homazava
Award for the Doctoral Thesis
Development of a novel micro-flow capillary technique online hyphenated to the inductively coupled plasma mass spectrometry for the spatial- and time-resolved investigation of local corrosion
Faculty price of the Faculty of Sciences, University of Bern, February 2010.

LIST OF PUBLICATIONS 2010

NES – Nuclear Energy and Safety

Publications in Scientific and Technical Journals

ABOLHASSANI-DADRAS S., BART G., JAKOB A.
"Examination of the chemical composition of irradiated zirconium-based fuel claddings at the metal/oxide interface by TEM", J. Nucl. Mater. (ISSN 0022-3115), **399**, 1-12 (2010)

ALBIOL T.[1], VAN DORSSELAERE J.[1], CHAUMONT B.[2], HASTE T., JOURNEAU C.[3], MEYER L.[4], SEHGAL B.[5], SCHWINGES B.[6], BERAHA D.[6], ANNUNZIATO A.[7], ZEYEN R.[7]
"SARNET: severe accident research network of excellence", Progr. Nucl. Energ. (ISSN 0149-1970), **52**, 2-10 (2010)
[1] IRSN, Cadarache, FR
[2] CEA, Cadarache, FR
[3] CEA, Grenoble, FR
[4] FZK, Karlsruhe, DE
[5] KTH, Stockholm, SE
[6] GRS, Garching, DE
[7] EC-JRC/ISIS, Ispra, IT

ANDREANI M., PALADINO D.
"Simulation of Gas Mixing and Transport in a Multi-Compartment Geometry using the GOTHIC Containment Code and relatively Coarse Meshes", Nucl. Eng. Des. (ISSN 0029-5493), **240**, 1506-1527 (2010)

ANDREANI M., PALADINO D., GEORGE T.[1]
"Simulation of basic gas mixing tests with condensation in the PANDA facility using the GOTHIC code", Nucl. Eng. Des. (ISSN 0029-5493), **240**, 1528-1547 (2010)
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"Development of a Wide-Range Pre-CHF Convective Boiling Correlation", J. Nucl. Sci. Technol. (ISSN 0022-3131), **47**, 357-366 (2010)

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[2] NAGRA, Wettingen, CH

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[2] ISC RAS, St. Petersburg, RU
[3] CEA, Grenoble, FR
[4] JRC/ITU, Karlsruhe, DE
[5] IRSN, Cadarache, FR
[6] CIEMAT, Madrid, ES
[7] GRS, Garching, DE
[8] VTT Energy, Espoo, FI
[9] SPbAEP, St. Petersburg, RU

CAMMELLI S., DEGUELDRE C., CERVELLINO A., ABOLHASSANI-DADRAS S., KURI G., LÜTZENKIRCHEN-HECHT D.[1], FRAHM R.[1]
"Cluster formation, evolution and size distribution in FeCu alloy: analysis and simulation by XAFS, XRD and TEM", Nucl. Instrum. Methods Phys. Res., Sect. A (ISSN 0168-9002), **268**, 632-637 (2010)
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[2] JNC, Tokai, JP

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[2] Gruner AG, Basel, CH
[3] CSIC-IJA, Barcelona, ES
[4] ANDRA, Bure, FR
[5] IRSN, Fontenay-aux-Roses, FR
[6] University of La Coruna, ES

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[1] Chinese Academy of Sciences, CN

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[1] University of Frankfurt, DE
[2] Curtin University, Peth, AU

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KIVEL N.
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ANKLIN H.
"Grundlagen der Kernphysik", "Kernspaltung und Kernbrennstoffe", Swissnuclear-PSI Fortbildungskurs Kerntechnik. Modul A: Reaktorphysik, Paul Scherrer Institute, Villigen PSI, Switzerland, 11 Jan. 2010

BADILLO A.
"Phase Field: I", "Phase Field: II", "Phase Field: III", Lectures given at the University of Sevilla, Spain, Feb. 22-26, 2010

BAEYENS B.
"Modelling of sorption processes and sorption databases", International Training Course (ITC) on Transport and Retention of Radionuclides in Argillaceous and Fractured Media, Paul Scherrer Institute, Villigen PSI, Switzerland, 30 Nov. – 7 Dec. 2010

CAVEDON J.-M.
"Einführung zum Kurs", Swissnuclear-PSI Fortbildungskurs Kerntechnik 2010, Paul Scherrer Institute, Villigen PSI, Switzerland, 11 Jan. 2010

CAVEDON J.-M.
Course: From nuclear structure to nuclear energy (402-0627-00L), ETHZ, Zurich, Switzerland, Autumn Semester, 2010

CHAWLA R.
“Diffusionstheorie, Kritikalität, Leistungsverteilung”, “Reaktorkinetik Reaktivitätsänderungen”, “Einführung in das Reaktorpraktikum”, Swissnuclear-PSI Fortbildungskurs Kerntechnik 2010, Modul A: Reaktorphysik, Paul Scherrer Institute, Villigen PSI, Switzerland, 12 Jan. 2010

CHURAKOV S.
“Molecular simulations of Zn^{2+} sorption on edges of montmorillonite”, Université Pierre et Marie Curie (UPMC), Paris, France, 29 Oct. 2010

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“Up-scaling molecular diffusion coefficients in clay-rich materials”, University of Zurich, Switzerland, 9 Dec. 2010

DEGUELDRE C.
“Comportement des radionuclides dans l’environnement”, Lecture Course, Centre des sciences naturelles de l'environnement, University of Geneva, Switzerland, Autumn Semester, 2010

DEGUELDRE C.
“Nuclear materials characterisation by advanced techniques”, Seminar, RWTH, Aachen University, Germany, 17 Dec. 2010

GIMMI T.
“Fluids in the Crust”, Masters Course in Environmental and Resource Geochemistry, University of Berne, Switzerland, Autumn Semester, 2010

GIMMI T.
“Upscaling from lab to field; Part I: Field experiments and upscaling from lab to field; Part II: natural tracer profiles”, International Training Course (ITC) on Transport and Retention of Radionuclides in Argillaceous and Fractured Media, Paul Scherrer Institute, Villigen, Switzerland, 30 Nov. - 7 Dec. 2010

GIUST F.
“Neutron transport theory and Light Water Reactor (LWR) lattice calculations”; “LWR core modeling”; “Reactor shielding”, Lectures given in the Master Course: Special Topics in Reactor Physics, ETHZ, Zurich, Switzerland, Spring Semester, 2010

GLAUS M.
“Diffusion of radionuclides in clays: experimental aspects”, International Training Course (ITC) on Transport and Retention of Radionuclides in Argillaceous and Fractured Media”, Paul Scherrer Institute, Villigen PSI, Switzerland, 30 Nov. – 7 Dec. 2010

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Lectures given in the Course: Nuclear Energy Systems, ETHZ, Zurich, Switzerland, Spring Semester, 2010

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“Kernbrennstoffe“, Strategic Exercise given in the Course: Analytische Chemie V, ETHZ, Zurich, Switzerland, 26 Oct. 2010

HUMMEL W.
Lectures given in the Course: Nuclear Energy Systems, ETHZ, Zurich, Switzerland, Spring Semester, 2010

HUMMEL W.
“Landfilling, nuclear repositories and contaminated sites”, Lectures given for the degree of Master in Biogeochemistry and Pollutant Dynamics, and for Master of Environmental Engineering, ETHZ, Zurich, Switzerland, Spring Semester, 2010

KOLBE E.
“Radioisotopes and Radiation Applications”, Lectures given in the Nuclear Energy Masters Program, EPFL, Lausanne, Switzerland, Autumn Semester, 2010

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KOLBE E.
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KOSAKOWSKI G.
"Statistics in Earth Sciences", Lecture Course: Master of Applied Environmental Geoscience, University of Tubingen, Germany, Autumn Semester, 2010

KOSAKOWSKI G.
"Introduction to the reactive transport modeling with OGS-GEMS", Special Lecture for Bachelor and Master Students, Gibbs Energy Minimalization Sector (GEMS) Teaching, University of Gunma, Japan, 21-22 Oct. 2010

KRACK M.
"Basics of Electronic Structure Calculations", Lecture given at the 1st F-BRIDGE School on Ceramic Nuclear Fuel and Cladding Materials, KIT, Karlsruhe, Germany, 28 Sept. – 2 Oct. 2010

KULIK D.
"From atomistic calculations to thermodynamic modelling", DMG-DGK-Helmholtz-Virtual-Institute Workshop, Gibbs Energy Minimalization Sector (GEMS) teaching, University of Frankfurt, Germany, 1-6 March, 2010

KULIK D.
"EMU-School 2010, Ion-partitioning in ambient temperature aqueous systems", Lecture given in Gibbs Energy Minimalization Sector (GEMS) teaching, EMU School, Oviedo, Spain, 27-30 June, 2010

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"Geochemical Speciation & Bioavailability of Trace Elements: Progress, Challenges and Future Trends", GeoSpec2010 Conference, Gibbs Energy Minimalization Sector (GEMS) teaching, University of Lancaster, UK, 7-8 Sept. 2010

MANERA A.
Lectures given in the Course: Multiphase Flow (151-1906-00L), ETHZ, Zurich, Switzerland, Spring Semester, 2010

MANERA A.
Lectures given in the Course: Nuclear Reactor's Laboratory Course (151-0162-00L), ETHZ, Zurich, Switzerland, Spring Semester, 2010

MANERA A.
"Störfälle in Kernkraftwerken – Ursachen und Auswirkungen", "Sicherheit moderner Kernkraftwerke", Lectures given in the Course: SGK-Grundlagenseminar – Einführung in die Kernenergie und ihr Umfeld, SGK, Kurszentrum Bundesamt für Sport, Magglingen, Switzerland, 5-7 Oct. 2010

MIKITYUK K.
"Multi-physics, coupled calculations for reactor dynamics", "Generation IV fast reactor systems", Lectures given in the Course: Special Topics in Reactor Physics (151-0166-00L), ETHZ, Zurich, Switzerland, Spring Semester, 2010

NICENO B.
"Essentials of Multiphase Flows", "Continuum Phase Modeling", "Wall Modeling", "Introduction to Multiphase Flow Modeling", "Two-Fluid Model", "Interface Tracking Techniques", "Mechanistic Modeling of Boiling", Lectures given in Master Course: Computational Multiphase Thermal Fluid Dynamics, ETHZ, Zurich, Switzerland, Spring Semester, 2010

PELLONI S.
"Fast reactor neutronics and perturbation theory", Lecture given in the Course: Special Topics in Reactor Physics (151-0166-00L), ETHZ, Zurich, Switzerland, Spring Semester, 2010

PFINGSTEN W.
Lectures given in the Course: Modelling of Processes in Soils and Aquifers (701-1334-00L), ETHZ, Zurich, Switzerland, Spring Semester, 2010

PFINGSTEN W.
"Transport processes and coupling of transport and chemistry", International Training Course (ITC) on Transport and Retention of Radionuclides in Argillaceous and Fractured Media, Paul Scherrer Institute, Villigen, Switzerland, 30 Nov. – 7 Dec. 2010

PRASSER H.-M.
"Allg. Merkmale der thermodynamischen Zyklen von Kernanlagen", "Elemente der Thermohydraulik", Swissnuclear-PSI Fortbildungskurs Kerntechnik. Modul B: Thermodynamik, Thermohydraulik & Sicherheit", Paul Scherrer Institute, Villigen PSI, Switzerland, 13 Jan. 2010

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PRASSER H.-M.
“Charakter und Arten von Störfällen der Sicherheitsebene 3”, Swissnuclear-PSI Fortbildungskurs Kerntechnik. Modul G: Sicherheit und Risiko, Paul Scherrer Institute, Villigen PSI, Switzerland, 8 March 2010

SEIFERT H.-P.
“Werkstoffalterung”, Swissnuclear-PSI Fortbildungskurs Kerntechnik. Modul E: Nukleare Werkstoffe und Wasserchemie, Paul Scherrer Institute, Villigen PSI, Switzerland, 1 March 2010

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SMITH, B.L.
“Introduction to Computational Fluid Dynamics”, “Governing Equations, Turbulence Modelling and Numerical Procedures”, “Identification of Nuclear Reactor Safety Issues where Single-Phase CFD can bring Real Benefits”, “Error Control, Verification, Validation and Best Practice Guidelines”, “Assessment Databases for Single-Phase CFD Applications with Emphasis on Nuclear Reactor Safety Issues”, Lectures given at IAEA Regional Workshop on Application of Computational Fluid Dynamics Codes to Nuclear Safety, University of Zagreb, Croatia, 22-25 March, 2010.

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[1] KKB, Beznau, CH

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“Advanced Topics in Nuclear Reactor Materials”, Lecture given in the Nuclear Energy Master Program, ETHZ, Zurich, Switzerland, Autumn Semester, 2010

Habilitation, Doctoral, Master and Bachelor Theses

ADAMS R.
“Coupled Neutronic/Thermal-Hydraulic Simulation of Selected Phénix End-of-Life Tests”, EPFL/ETHZ MS Thesis, Sept. 2010

EPINEY A.
“Improvement of the Decay Heat Removal Characteristics of the Generation IV Gas-Cooled Fast Reactor”, Doctoral Thesis No. 4792, EPFL, Lausanne, July 2010

FELICIANI C.
“Development of an isotope dilution technique for the quantitative analysis of fission gases in nuclear fuels“, Master Thesis “nuclear engineering”, EPFL/ETHZ MS Thesis, April 2010

PITTARELLO R.
“Monte Carlo Analysis of the H.B. Robinson II Reactor Pressure Vessel Dosimetry Benchmark”, EPFL/ETHZ MS Thesis, April 2010

PONT RIBAS A.
"Simulation of CABRI loss-of-flow experiments with the TRACE/FRED codes", EPFL/ETHZ MS Thesis, March 2010

RAMESH M.
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ROZOV K.
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SCHREIER T.
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BRADBURY M.H., BAEYENS B.
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"Implementation of Severe Accident Management Measures (ISAMM 2009)", PSI-Bericht Nr. 10-07

HERMANN A.
"Autoclave Corrosion of Zircaloy-4 Cladding Samples in LiOH Solutions", PSI-Bericht Nr. 10-02

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"Core Exit Temperature (CET) Effectiveness in Accident Management of Nuclear Power Reactors", OECD Nuclear Energy Agency Report, CSNI/R(2010)9, 2010
[1] AEKI, HU
[2] AREVA-NP SAS, Paris, FR
[3] SSM, SE
[4] AREVA, Erlangen, DE
[5] AEKI, HU
[6] University of Pisa, IT
[7] CSN, ES
[8] OECD-NEA, FR

General Communications and Public Relations

CAVEDON J.-M.
"Evolution de la technologie nucléaire générations III et IV", Séminaire romand de lancement de la campagne nucléaire, economiesuisse, Lausanne, Switzerland, 1 Sept. 2010

HARDEGGER P.
"Die Sicht der Forschung: Konfrontation mit der Wirklichkeit", Energie Nachrichten, Schweizerischer Energierat, Sonderausgabe zum 21st World Energy Congr. (ISSN 1660-6833), Montreal, Canada, 11-16 Sept. 2010

HARDEGGER P.
"Berichterstattung über den Weltenergiekongress WEC 2010 Montreal aus der Sicht der Forschung: Traum und Wirklichkeit", Generalversammlung Energierat, Zurich, Switzerland, 25 Oct. 2010

HARDEGGER P.
"Berichterstattung vom Weltenergiekongress, WEC 2010 Montreal aus der Sicht der Forschung: Traum und Wirklichkeit", Podiumsdiskussion, Energy Science Center, ETHZ, Zurich, Switzerland, 11 Nov. 2010

HARDEGGER P.
"CME/WEC 2010 Montréal: Vue de la Recherche, Rêve et Réalité", Seminar Series, Energy Center, EPFL, Lausanne, Switzerland, 16 Nov. 2010

PFINGSTEN W.
"Neue analytische Forschungsmethoden am PSI für die sichere Tiefenlagerung radioaktiver Abfälle", SGK Apéro, Schweizerische Gesellschaft der Kernfachleute, Baden, Switzerland, 7 Sept. 2010

Awards

ABOLHASSANI S.
"Corrosion", Swissnuclear Project of the Year 2010, Olten, Switzerland, 2 June 2010

CHENU A.
Best paper: Eur. Nuclear Conf. 2010 (4th ENEN PhD Event 2010), Barcelona, Spain, 3-6 June 2010

FROIDEVAL A.
Poster award (2nd prize): "Towards new opportunities in nuclear materials science and technology at the proposed SwissFEL X-ray laser", Eur. Materials Research Society (E-MRS), Spring Meeting, 7-11 June 2010, Strasbourg, France, 2010

ORLOV A.
Poster Competiton Award: Nuclear Plant Chemistry Conf. (NPC 2010), Quebec City, Canada, Oct. 3-7, 2010

Membership of External Committees

BERNER, U.
- Member of the International Scientific Committee of the Migration Conference on Chemistry and Migration Behaviour of Actinides and Fission Products in the Geosphere

CAVEDON J.-M.
- Member of the KNS (Swiss Federal Nuclear Safety Commission)
- Member of the Advisory Board of the French Institut de Radioprotection et de Sûreté Nucléaire IRSN
- Member of the Advisory Board of OECD/NEA/CSNI (Committee on the Safety of Nucxlear Installations)
- Swiss representative to the Policy Group of the Generation IV International Forum
- Member of the Board of the Swiss Nuclear Forum

CHAWLA R.
- Vice Chairman of the OECD/NEA Nuclear Science Committee (NSC)
- Invited Expert on the Scientific Committee of the French CEA's Direction de l'Energie Nucléaire (DEN)
- Member of the Editorial Board of Annals of Nuclear Energy
- Member of the Training and Academic Affairs Committee of the Eur. Nuclear Education Network (ENEN)

DEGUELDRE C.
- Member of the scientific review committee of the ESRF, Grenoble, Section: Applied Materials and Engineering
- Chairmen of the Eur. Materials Research Society (E-MRS)

HOFFELNER W.
- Invited expert of the ASME Section III Div. 5 Code development for gas and liquid metal cooled reactor
- Organizer of the ANS Nuclear Fuels and Structural Materials Symposium
- Leitung DGM Fachausschuss für Untersuchungen mit Strahllinien

MANERA A.
- Member of the Editorial Board: Science and Technology of Nuclear Installations
- Vice-President of the Schweizerische Gesellschaft der Kernfachleute (SGK)

RITTER S.
- Vice-Chairman of the Executive Committee of the Eur. Cooperative Group on Corrosion Monitoring of Nuclear Materials (ECG-COMON)

SEIFERT H.-P.
- Member of the Executive Committee of the International Cooperative Group on Environmentally Assisted Cracking of Water Reactor Materials (ICG-EAC)

SMITH B.L.
- Chairman of Governing Board, THINS, EU 7th FWP
- Chairman of the OECD/NEA Working Group on the Analysis and Management of Accidents (WGAMA) CFD Special Group

STREIT M.

- Vice President of the European Nuclear Society
- Programm Committee Member of the European Nuclear Society
- Member of the Board of the Swiss Nuclear Society
- Member of the Board of Directors of the International Youth Nuclear Congress

VAN LOON L.R.

- Member of the International Scientific Committee of the Migration Conference on Chemistry and Migration Behaviour of Actinides and Fission Products in the Geosphere
- Member of the Editorial Board: Transport in Porous Media

WIELAND E.

- Member of the Editorial Board: The Open Waste Management Journal

ZIMMERMANN M.A.

- Swiss representative to the Committee for the Safety of Nuclear Installations (OECD/CSNI)
- Chairman of the CSNI Expert Group Safety Margin Assessment and Application (SM2A)
- Member of the “Comité de Visite de l’Institut de Radioprotection et Sûreté Nucleaire (IRSN)”
- Swiss representative to the GIF International Expert Group

LIST OF PUBLICATIONS 2010

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[1] PIK, Potsdam, DE
[2] University of Cambridge, UK
[3] Enerdata, Grenoble-Gieres, FR
[4] University of Grenoble, FR
[5] Netherlands Environmental Assessment Agency (PBL), NL

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[2] Queensland University of Technology, Brisbane, AU

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[2] Queensland Dept of Primary Industries, Toowoomba, AU

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[1] UK Energy Research Centre, London, UK
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[1] INL, Idaho Falls, US
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[1] SNL, Albuquerque, US
[2] University of Maryland, College Park, US

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[1] SNL, Albuquerque, US
[2] US NRC, Rockville, US
[3] OECD Halden Reactor Project, Halden, NO
[4] US NRC, Bethesda, US
[5] Scientech, EPRI, US

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"Quantification of Uncertainty in Fault Tree Analysis with Correlated Basic Events", Eur. Safety and Reliability Conf. (ESREL 2010), 5-9 Sept. 2010, Rhodes, Greece, pp. 1619-1629, 2010 (ISBN 978-0-415-60427-7)

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MOSLEH A.[1], FORESTER J.[2], BORING R.[3], HENDRICKSON S.[2], WHALEY A.[3], SHEN S.H.[4], KELLY D.[3], CHANG Y.H., DANG V.N., OXSTRAND J.[3], LOIS E.[4]
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[1] University of Maryland, College Park, US
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PODOFILLINI L., REER B.
"Assessment of the CESA-Q HRA method against simulator data", Eur. Safety and Reliability Conf. (ESREL 2010), 5-9 Sept. 2010, Rhodes, Greece, pp. 2419-2428, 2010 (ISBN 978-0-415-60427-7)

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"Life-Cycle Assessment of Battery Electric and Internal Combustion Engine Drivetrains for a Small Passenger Car", 18th Int. Symp. on Transport and Air Pollution, 18-19 May 2010, Dübendorf, Germany, pp. 125-130, 2010

WILHELM E., SCHENLER W.
"Reducing the Weight of Electric, Hybrid, and Fuel-Cell Vehicles using Heuristic Design", 2010 Int. Advanced Mobility Forum Geneva, 9-10 Mar. 2010, Geneva, Switzerland, USB, 2010

WILHELM E., SCHENLER W.
"A Multi-Criteria Decision Analysis on Personal Transportation Technology using Heuristic Design", 23rd Int. Conf. on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems, 14-17 June 2010, Lausanne, Switzerland, CD-ROM, 2010

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BALTENSPERGER U., LOHMANN U.[1], PETER T.[1], BEY I.[2], HECK T., HÜGLIN C.[3], BURTSCHER H.[4]
"IMBALANCE: Impact of Biomass Burning Aerosol on Air Quality and Climate", Latsis Symp. 2010, ETHZ, Zurich, Switzerland, 15-17 Nov. 2010
[1] ETHZ, Zurich, CH
[2] EPFL, Lausanne, CH
[3] EMPA, Dübendorf, CH
[4] FHNW, Windisch, CH

BAUER C., BURGHERR P., HECK T., HIRSCHBERG S., SCHENLER W., SIMONS A.
"Sustainability analysis of future power generation technologies: integrating environmental, economic and social aspects", Science and Technology for Environmental Protection (SETAC), Eur. 20th Annual Meeting, Seville, Spain, 23-27 May 2010

BURGHERR P.
"Severe accident risks in the energy sector: comparative assessment in the context of energy security", Seminar: Institute for the Protection and Security of the Citizen (IPSC), EC-Joint Research Centre (JRC), Ispra, Italy, 1 July 2010

BURGHERR P., ECKLE P., HIRSCHBERG S.
"Security risks of critical infrastructures in the oil and gas sectors", Int. Disaster & Risk Conf. (IDRC), Davos, Switzerland, 30 May – 3 June 2010

BURGHERR P., ECKLE P., HIRSCHBERG S., CAZZOLI E.[1]
"Severe Accidents and Terrorist Threats within the Context of Energy Security", SECURE Stakeholder Meeting, Milan, Italy, 18-19 July 2010
[1] Cazzoli Consulting, Nussbaumen, CH

ECKLE P.
"Risk Analysis of Severe Accidents in the Fossil Energy Chains", Seminar: Institute for the Protection and Security of the Citizen (IPSC), EC-Joint Research Centre (JRC), Ispra, Italy, 1 July 2010

ECKLE P., BURGHERR P.
"Severe Accidents in the Energy Sector Triggered by Natural Events", 1st Annual Conf. of the Int. Soc. for Integrated Disaster Risk Management (IDRiM), Vienna, Austria, 1-4 Sept. 2010

ECKLE P., BURGHERR P., HIRSCHBERG S.
"Comparative Analysis of Severe Accident Risk in the Fossil Energy Chains", Int. Disaster & Risk Conf. (IDRC), Davos, Switzerland, 30 May – 3 June 2010

HECK T., MEYER N.
"External costs related to impacts of biomass combustion systems", Latsis Symp. 2010, ETHZ, Zurich, Switzerland, 15-17 Nov. 2010

HIRSCHBERG S.
"Electricity Supply Options in Comparative Perspective", Int. Energy Seminar, Lisbon, Portugal, 11 May 2010

HIRSCHBERG S.
"Sustainability Assessment of Energy Systems", Swiss Phys. Soc. Annual Meeting, Basel, Switzerland, 21-22 June 2010

HIRSCHBERG S.
"Interdisciplinary assessments of present and future electricity supply technologies", Nuclear Energy: Technology and Investments, Konferencja Miedzynarodowa, Warsaw, Poland, 23-24 Sept. 2010

HIRSCHBERG S.
"How sustainable is nuclear power for the UK?", Panel discussion, 2nd Stakeholder Workshop of the 'Sustainability Assessment of Nuclear Power: An Integrated Approach (SPRING)' Project, Univ. of Manchester, UK, 28 Oct. 2010

HIRSCHBERG S.
"Internal and external costs of nuclear and other electricity supply technologies", Swiss Association for Energy Economics Annual Meeting, ETHZ, Zurich, Switzerland, 10 Nov. 2010

HIRSCHBERG S., BURGHERR P.
"Energy-Related Severe Accident Risks: a Comparative Perspective", KIT Seminar, Karlsruhe, Germany, 4 May 2010

HIRSCHBERG S., ECKLE P., BURGHERR P.
"How to Assess Different Policy Options for Energy Security", SECURE Final Conf., Brussels, Belgium, 25 Nov. 2010

JAYARATNE E.[1], RISTOVSKI Z.[1], MEYER N., MORAWSKA L.[1]
"Particle number emissions from diesel and CNG buses during acceleration", Int. Aerosol Conf., Helsinki, Finland, 29 Aug. – 3 Sept. 2010
[1] Queensland University of Technology, Brisbane, AU

KANNAN R.
"Experience from the development of a new Swiss TIMES Electricity Model", Joint Meeting of the Energy Research Institute of India and Energy Technology Systems Analysis Program (TERI-ETSAP) Workshop, New Delhi, India, 21-22 Jan. 2010

KANNAN R., TURTON H.
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"Analyzing energy technology options for Switzerland in the face of global uncertainties", 9th Int. National Centres of Competence in Research (NCCR) Climate Summer School, Grindelwald, Switzerland, 29 Aug. – 3 Sept. 2010

MARCUCCI A., TURTON H.
"Mitigation and sustainable energy strategies under global uncertainty", National Centres of Competence in Research (NCCR) Climate Workshop, Berne, Switzerland, 11 Nov. 2010

MEYER N.
"Air Quality Control – from the Large-Scale to the Nanoscale", Public Colloquium, ETHZ, Zurich, Switzerland, 12 Feb. 2010

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"Size-dependent particulate and gas-phase emissions from biomass combustion in Switzerland", 14th ETH Combustion Nanoparticle Conf., ETHZ, Zurich, Switzerland, 26-29 June 2010

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"Thermal decomposition and hygroscopicity of ammonium sulfate-citric acid aerosol mixtures", Int. Aerosol Conf., Helsinki, Finland, 29 Aug. – 3 Sept. 2010
[1] Queensland University of Technology, Brisbane, AU

PODOFILLINI L.
"An identification and grouping approach to analyze the output of a dynamic safety assessment", Int. Conf. on Sensitivity Analysis of Model Output (SAMO 2010), Milan, Italy, 19-22 July 2010

PODOFILLINI L.
"Is Probabilistic/Quantitative Safety Assessment Generic? Insights from Cross-Domain Applications", Int. Conf. RAMSSYS 2010 (RAMS/LCC, Quality Engineering in spurgeführten Verkehsystemen), ETHZ, Zurich, Switzerland, 4-5 Oct. 2010

SCHENLER W.
"Economic & Ecological Potential for Geothermal Electricity in Switzerland: a Comparison with other Renewables", World Wildlife Fund (WWF): Geothermie Tagung, Berne, Switzerland, 23 Aug. 2010

SIMONS A., BAUER C.
"LIONs and ZEBRAs: an LCA of their use in electric vehicles", Tag der Technik: Nachhaltige Mobilität – Quo Vadis Automobil?, EMPA, Dübendorf, Switzerland, 27 Oct. 2010

WILHELM E.
"Reducing the Weight of Light-Duty Vehicles Today and in 2035 using Advanced Materials", EMPA PhD Symp., EMPA, Dübendorf, Switzerland, 6 Oct. 2010

WILHELM E.
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YAN J.
"What is Required to make CCS Commercial?", Energy Technology Network (IEA), Carbon Capture and Storage (CCS) Summer School, Svalbald, Norway, 22-27 Aug. 2010

YAN J.
"How can Transfer of Technology be Improved within the Clean Development Mechanism", National Centres of Competence in Research (NCCR), Summer School, Grindelwald, Switzerland, 2 Sept. 2010

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University Level Teaching

BURGHERR P.
"Severe accident risks in the energy sector: a comparative analysis and new developments", Lecture given in the Course: Climate and Energy, University of Geneva, Switzerland, 6 Dec. 2010

DANG V.N.
"Human Reliability Analysis (HRA)", Swissnuclear-PSI Fortbildungskurs Kerntechnik. Modul G: Sicherheit und Risiko, Paul Scherrer Institute, Villigen PSI, Switzerland, 10 March 2010

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"Comprehensive Assessment of Energy Systems: Introduction"; "Environmental Assessment: Burdens, Impacts and External Costs"; "Comparative Risk Assessment"; "Integrated Sustainability Assessment"; "Energy Supply for Switzerland: Today and in the Future", Swissnuclear-PSI Fortbildungskurs Kerntechnik. Modul I: Wirtschaftlichkeit & Globale Energiesituation, Paul Scherrer Institute, Villigen PSI, Switzerland, 22 March 2010

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Habilitation, Doctoral, Master and Bachelor Theses

BOULET C.
"Life Cycle Assessment Case Studies of Nuclear Waste Disposal and Carbon Capture & Storage", EPFL/ETHZ MS Thesis, March 2010

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"Discrete Dynamic Event Tree Modeling and Analysis of Nuclear Power Plant Crews for Safety Assessment", Doctoral Thesis No. 19321, ETHZ, Zurich, Dec. 2010.

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[1] EMPA, St. Gallen, CH
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[3] Doka Life Cycle Assesments, Zurich, CH
[4] ESU-services, Uster, CH
[5] ETHZ, Zurich, CH
[6] EPFL, Lausanne, CH
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"Nukleare Energie: Nachhaltigkeit, Sicherheit und Abfallentsorgung", PSI-Informationsveranstaltung, Villigen PSI, Switzerland, 3 March 2010

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DIETRICH P., BAUER C.
"Wer rechnet, hat recht?", Automotive Agenda (ISSN 1867-495X), **3**(6), 83-84 (2010)

HIRSCHBERG S.
"Die Elektrizitätsversorgung der Schweiz, heute und in der Zukunft", Public lecture, FDP Sektion Aarberg, Aarberg, Switzerland, 11 March 2010

HIRSCHBERG S., BAUER C., SCHENLER W., BURGHERR P.
"Sustainable Electricity: Wishful thinking or near-term reality?", Mirror On Energy (ISSN 1661-5115), No. 20 / June 2010

WILHELM, E.
"Die Autos der Zukunft", TecNight@KSWo, Kantonschule Wohlen, Switzerland, 2 Dec. 2010

Membership of External Committees

DANG V.N.

- Director of International Association for Probabilistic Safety Assessment and Management (IAPSAM)
- Board Member of Human Reliability Analysis Society

HIRSCHBERG S.

- Member of the Advisory Board “Technology, Innovation and Society” Programme of Helmholtz Association
- Individual Member of Swiss Academy of Technical Science
- Member of the Editorial Board of the International Journal of Risk Assessment and Management
- Member of ecoinvent Board of Directors

PODOFILLINI L.

- Chairman of Technical Committee on Human Factors and Human Reliability, European Safety and Reliability Association (ESRA)
- Board Member of Human Reliability Analysis Society

LIST OF PUBLICATIONS

ENE – General Energy

PROJECT COLLABORATIONS WITH EXTERNAL PARTNERS

ALLIANCE FOR GLOBAL SUSTAINABILITY

Projektleiter: A. Wokaun, S. Ulli-Beer
Transition to Hydrogen Based Transportation – Challenges and Opportunities
(Project Part: Dynamics of transportation technology development and diffusion)
with MIT (Alliance for Global Sustainability)

AXPO NATURSTROM FONDS

Projektleiter: S.M.A. Biollaz
Graskraftwerk

Projektleiter: S.M.A. Biollaz
Holzgas-Brennstoffzelle

Projektleiter: F. Vogel
Regenerierung von Katalysatoren für die hydrothermale Vergasung

BFE

Projektleiter: S.M.A. Biollaz, T. Schildhauer
Entwicklung der ingenieurwissenschaftlichen Grundlagen der schwefel-resistenten Methanierung

Projektleiter: F.N. Büchi
Cal.PEF-CH: Modelbased Investigation of PE Fuel Cell Performance with Focus on Porous Layer Properties
with ZHAW, Winterthur

Projektleiter: F.N. Büchi
Röntgen Mikro-Tomographie an Polymerelektrolyt-Brennstoffzellen

Projektleiter: F.N. Büchi
Gas-Analysis in Polymer Electrolyte Fuel Cells

Projektleiter: T. Gerber
Investigation of Reactions and Species Dominating Low Temperature Combustion

Projektleiter: L. Gubler
Lebensdauer Limitierungen von Brennstoffzellen- Membranen: Mechanismen, Methoden und Innovationen

Projektleiter: L. Gubler, I.A. Schneider
go.PEF-CH: Enhancing PEFC Durability and Reliability Under Application-Relevant Conditions
Partner: Berner Fachhochschule Technik und Informatik (BFH-TI, Biel BE), CEKA Elektrowerkzeuge AG & Co. KG (Wattwil SG), MES-DEA SA. (Stabio TI)

Projektleiter: R. Kaufmann-Hayoz, S. Ulli-Beer
E-Scooter, Marktentwicklung, Analyse der Akteure, E-Scooter Technologie, Ladestationen, LCA, Verbrauchsmessungen, Auswertung von Alltagserfahrungen, Fördermassnahmen
Forschungsprojekt New Ride with Uni Bern, Interface, Empa & U. Schwegler

Projektleiter: Ch. Ludwig
MOPSID Monitoring of Process Gases with a Surface Ionization Detector

Projektleiter: J. Mantzaras
Modeling of Energy Conversion Processes at the Microscale with Application to PEFCs

Projektleiter: A. Meier
IEA-SolarPACES (International Energy Agency – Solar Power and Chemical Energy Systems)
IEA Implementing Agreement

Projektleiter: A. Meier
Solar Production of Zinc and Hydrogen – Reactor Optimisation for Scale-up
R&D Project

Projektleiter: A. Meier
Towards Industrial Solar Production of Zinc and Hydrogen – 100 kW Pilot Reactor for ZnO Dissociation
P&D Project

Projektleiter: A.S.H. Prévôt
Erweiterte Partikelanalytik für Holzfeuerungsabgase

Projektleiter: T.J. Schildhauer
Design und Optimierung der Hochtemperatur-Entschwefelung für den Prozess „Methan aus Holz“

Projektleiter: F. Vogel
Optimierung der Hydrolyse und Salzabtrennung bei der hydrothermalen Vergasung von Biomasse

Projektleiter: F. Vogel
Stofflich-energetische Verwertung von KOMPOGAS-Presswasser durch hydrothermale Vergasung

BAFU

Projektleiter: S. Aksoyoglu Sloan, J. Keller, A.S.H. Prévôt
Aerosol-Modelling – Schadstoffbilanzen

Projektleiter: S. Aksoyoglu Sloan, J. Keller, A.S.H. Prévôt
Source Apportionment Modelling for Aerosols in Switzerland: Contribution from abroad

Projektleiter: S. Aksoyoglu Sloan, A.S.H. Prévôt
Modellierung der Luftqualität mit CAMX für drei Episoden

Projektleiter: A.S.H. Prévôt, U. Baltensperger
Evaluierung des Wochenendeffektes von Grobstaub an schweizerischen Stationen

Projektleiter: A.S.H. Prévôt, U. Baltensperger
Mobile Messungen in Härkingen

Projektleiter: A.S.H. Prévôt, U. Baltensperger
Messungen der flüchtigen Anteile in Zürich von PM1 und Quellenzuordnung der organischen Masse während eines gesamten Jahres

Projektleiter: A.S.H. Prévôt, U. Baltensperger
Aerosol Chemical Speciation Monitor

Projektleiter: A.S.H. Prévôt, U. Baltensperger
^{14}C im Feinstaub der Schweiz

BAYERISCHE FORSCHUNGSSTIFTUNG (BFS)

Projektleiter: M. Elsener
Thermal Stability of Vanadium Oxide Species on V2O5/WO3-TiO2 SCR catalysts
MTU Friedrichshafen GmbH, Germany
Porzellanfabrik Frauenthal GmbH, Wien, Austria

Projektleiter: O. Kröcher, Ch. Gerhart[1]
NO_x -Reduzierung i. motor. Abgas mit Guanidinsalzen
Prof. Dr. Th. Sattelmayer, Lehrstuhl für Thermodynamik, TU München, Germany
Prof. Dr. G. Wachtmeister, Lehrstuhl für Verbrennungskraftmaschinen, TU München, Germany
AlzChem Trostberg GmbH, Germany
NIGU Chemie GmbH, Germany
[1] AlzChem Trostberg GmbH, Germany

Projektleiter: O. Kröcher, E. Rohart[1]
Development of SCR Catalysts Based on Mixed Rare Earth Metal Oxides
[1] Rhodia, Aubervilllier Cedex, France

Projektleiter: O. Kröcher
Investigation of the Decomposition of Urea in the SCR Process
TOTAL, Paris, France

CCEM

Teilprojektleiter: S.M.A. Biollaz
WOODGAS-SOFC-Verfahrenstechnik
EPFL, Empa

Projektleiter: S.M.A. Biollaz
Attrition Resistant Reactive Bed Materials (*ARRMAT)*
Empa

Projektleiter: F.N. Büchi
*hy.muve: Development of **Hy**drogen Powered **Mu**nicipal **Ve**hicle*
with Empa Dübendorf and Industrial Partners

Projektleiter: P. Dimopoulos[1], M. Ammann, U. Baltensperger, K. Boulouchos[2], H. Burtscher[3], N. Heeb[1], O. Kröcher, M. Mohr[1]
NEADS (Next Generation Exhaust Aftertreatment for Diesel Propulsion Systems)
[1] Empa Dübendorf
[2] ETH Zürich
[3] FHNW Windisch

Projektleiter: P. Dimopoulos[1], M. Ammann, K. Boulouchos[2], O. Kröcher, A.S.H. Prévôt, S. Aksoyoglu Sloan
NADiP (NOx Abatement in Diesels: Process Analysis Optimisation and Impact
[1] Empa Dübendorf
[2] ETH Zürich

Projektleiter: Ch. Ludwig
SunCHem

Projektleiter: S. Stucki
2nd Generation Biogas
Partner: PSI, Empa, ETHZ, EPFL, EAWAG, WSL

Projektleiter: S. Ulli-Beer, F.N. Büchi
Technische und wirtschaftliche Datenanalyse eines wasserstoffbetriebenen Brennstoffzellen-Fahrzeuges im Alltagstest
with Hy-Muve, BFE

Projektleiter: J. Wochele
WOODGAS SOFC (Integrated Biomass - Solid Oxide Fuell Cell Cogeneration):
WP2: (Gas Analysis)

Projektleiter: M. Zimmermann[1], S. Ulli-Beer
Advanced Energy-Efficient Renovation of Buildings
(Project Part: Diffusion Dynamics of Energy Efficient Renovations)
with IEA, SNF, BFE, Stadt Zürich, Novatlantis
[1] Empa Dübendorf

CCEM/SWISSELECTRIC

Projektleiter: S.M.A. Biollaz
Attrition Resistant Reactive Bed Materials (*ARRMAT)*
Empa

Projektleiter: P. Jansohn
Clean and Efficient Large Diesel Engines (CELaDE)

Projektleiter: P. Jansohn
Carbon Management in Power Generation (CarMa), SP2 „Pre-combustion capture“

Projektleiter: I. Mantzaras, P. Jansohn
Carbon Management in Power Generation (CarMa), „Key combustion technologies”

Projektleiter: I. Mantzaras, P. Jansohn
Technologies for Gas Turbine Power Generation with CO_2 Mitigation

Projektleiter: J. Wochele, Ch. Ludwig
TREPGAS: Trace Elements in Product Gases

CCES

Projektleiter: U. Lohmann[1], Th. Peter[1], U. Baltensperger, Th. Heck, Ch. Hüglin[2], H. Burtscher[3], I. Bey[4]
IMBALANCE (IMpact of Biomass Burning Aerosol on Air Quality aNd ClimatE)
[1] ETH Zürich
[2] Empa Dübendorf
[3] FHN Windisch
[4] EPF Lausanne

COST

Projektleiter: T. Gerber
Detailed Chemical Kinetic Models for Cleaner Combustion, CM0901

ENERGIE TRIALOG SCHWEIZ

Projektleiter: A. Wokaun, Ph. Dietrich, S. Hirschberg
Studies on Energy Efficiency, Renewable Electricity, Scenarios, Multi-Criteria Decision Analysis

ESA

Projektleiter: U. Baltensperger, E. Weingartner
ESA Climate Change Initiative aerosol-cci

ETH-RAT

Projektleiter: A. Wokaun, S. Ulli-Beer
Erlebnisraum Nachhaltige Mobilität Basel
- Erdgas- / Biogasfahrzeuge
- Wasserstoff-Fahrzeuge
novatlantis – Nachhaltigkeit im ETH Bereich

EU

Projektleiter: U. Baltensperger, J. Dommen
EUROCHAMP-2 (Integration of European Simulation Chambers for Investigating Atmospheric Processes)

Projektleiter: U. Baltensperger, E. Weingartner, M. Gysel
EUSAAR (European Supersites for Atmospheric Aerosol Research

Projektleiter: U. Baltensperger, A.S.H. Prévôt, E. Weingartner
EUCAARI (European Integrated Project on Aerosol Cloud Climate and Air Quality Interactions)

Projektleiter: U. Baltensperger, E. Weingartner
CLOUD-ITN (Cosmics Leaving OUtdoor Droplets, Initial Training Network)

Projektleiter: U. Baltensperger, A.S.H. Prévôt, E. Weingartner
MEGAPOLI (Emissions, Urban, Regional and Global Atmospheric POLlution and Climate Effects, and Integrated Tools for Assessment and Mitigation

Projektleiter: F.N. Büchi
*JTI FCH: Auto-Stack: **Auto**motive Fuel Cell **Stack** Cluster Initiative for Europe*
with Auto-Stack consortium

Projektleiter: P. Delaporte[1], Work Package Leader: T. Lippert
Laser Printing of Organic/Inorganic Material for the Fabrication of Electronic Devices (eLIFT)
[1] Université de la Méditerranée, Marseille, France

Projektleiter: P. Jansohn
HERCULES-B (High Efficiency Engine R&D on Combustion with Ultra Low Emissions for Ships)

Projektleiter: P. Jansohn
H_2-IGCC (Low Emission Gas Turbine Technology for Hydrogen-Rich Syngas)

Projektleiter: P. Jansohn, J. Mantzaras
H_2-IGCC (Hydrogen Integrated Gasification Combined Cycle Plants)

Projektleiter: Ch. Ludwig
PROSUITE

Projektleiter: A. Meier
SOLHYCARB (Hydrogen from Solar Thermal Energy: High Temperature Solar Chemical Reactor for Co-production of Hydrogen and Carbon Black from Natural Gas Cracking)

Projektleiter: P. Novák
MAHEATT (Materials for High Energy Accumulators in Traction and Tods)

Projektleiter: A.S.H. Prévôt
CIRCE (Climate Change and Impact Research: The Mediterranean Environment)

Projektleiter: A.S.H. Prévôt, E. Weingartner
EUROSTARS (Fast and Loading Compensated Aethalometer-an Instrument for Real Time Measurement of Light Absorbing Carbonaceous Aerosol)

Projektleiter: M. Saurer
MILLENNIUM (European Climate of the Last Millennium)

Projektleiter: O. Sidorova
EU-ISOTREC (Climatic and Environmental Changes in the Eurasian Subarctic Inferred from Tree-Ring and Stable Isotope Chronologies for the Past and Recent Periods)

Projektleiter: E. Weingartner, U. Baltensperger
GeoMon (Global Earth Observation and Monitoring of the atmosphere)

Projektleiter: Ch. Wieckert
SFERA (Solar Facilities for the European Research Area)

FORSCHUNGSVEREINIGUNG VERBRENNUNGSKRAFTMASCHINEN (FVV)

Projektleiter: O. Kröcher
Differenzierte Mikroanalytik von Particulate Matter (PM)

ENSI

Projektleiter: F. Gassmann
ADPIC- Aktualisierung

INDUSTRY

Projektleiter: Ch. Ludwig, S. Stucki
KVA plus
Stiftung Autorecycling Schweiz, SARS

Projektleiter: W. Märkle
Graphite für Lithiumionen-Batterien
TIMCAL SA, Bodio

Projektleiter: W. Märkle
Kohlenstoffe
Heraeus Quarzglas GmbH & Co. KG, Kleinostheim, Germany

Projektleiter: P. Novák
HE-Lion
BASF SE, Ludwigshafen, Germany

Projektleiter: P. Novák
Forschungsnetzwerk „Elektrochemie und Batterien“
BASF SE, Ludwigshafen, Germany

Projektleiter: I.A. Schneider
Diagnostics of Polymer Electrolyte Fuel Cells
Automotive industry

Projektleiter: F. Vogel
Hydrothermal Gasification of Micro Algae to Methane – Process Evaluation
confidential

KARLSRUHE INSTITUTE OF TECHNOLOGY

Projektleiter: F. Vogel
EtaMax – Mehr Biogas aus lignozellulosearmen Abfall- und Mikroalgenreststoffen durch kombinierte Bio-/Hydrothermalvergasung

KTI

Projektleiter: P. Dietrich
Development of a 25 hW Hydrogen/Oxygen Fuel Cell System

Projektleiter: J. Mantzaras
Combustion Technology for Gas Turbine Combustion Technology Power Generation with CO_2 Mitigation

Projektleiter: Ch. Wieckert
SOLSYN (Solar High Quality Syngas from Low Grade Fuels or from Wastes as Fuel for Cement Kilns)

METEO SCHWEIZ

Projektleiter: U. Baltensperger, E. Weingartner, N. Bukowiecki
GAW-CH (Aerosol Monitoring Programm auf dem Jungfraujoch)

Projektleiter: E. Weingartner, U. Baltensperger
GAW-Plus (*Continuous Measurement of Number Size Distributions and Cloud Condensation Nuclei at Jungfraujoch Research Station*

NATIONALFONDS

Projektleiter: U. Baltensperger, J. Dommen
Investigation of Secondary Organic Aerosol Formation in the PSI Smog Chamber

Projektleiter: U. Baltensperger, E. Weingartner
FORCE, Investigation of Secondary Organic Aerosol Formation in the PSI Smog Chamber and at CERN

Projektleiter: A. Foelske-Schmitz
Degradation Mechanisms of Electro-Catalysts Used in Polymer Electrolyte Fuel Cells

Projektleiter: M. Geiser Kamber[1], M. Kalberer[2], J. Ricka[1], J. Dommen
From Aerosol to Health Effects: Mobile System for Controlled, Standardized Studies of Health-Effects by Inhaled (Nano)Particles and Gases
[1] University of Bern
[2] University of Cambridge, UK

Projektleiter: L. Gubler
Antioxidant Strategies for the Stabilization of Fuel Cell Membranes Against Oxidative Stress

Projektleiter: M. Gysel
Soot Nanoparticles in the Past and Present Atmosphere

Projektleiter: P. Jansohn, A. Denisov
Investigation of Collisional Processes Relevant for Laser-Induced Fluorescence of Nitric Oxide and Oxygen in High Pressure Combustion

Projektleiter: Ch. Körner[1], R.T.W. Siegwolf
Swiss Canopy Crane Project: CO_2–enrichment
[1] University of Basel

Projektleiter: R. Kötz
Graphite Oxides and Graphene for Electrochemical Energy Storage

Projektleiter: O. Kröcher
Investigation of the Selective Catalytic Reduction of NO_x on Diesel Soot

Projektleiter: T. Lippert, L. Gauckler[1]
Single Crystalline Films of Ion Conductors
[1] ETH Zürich

Projektleiter: Ch. Ludwig
Seasonality of Municipal Waste Generation and Composition and Corresponding Fluctuations of Various Environmental Indicators for Waste Management and Treatment Facilities

Projektleiter: J. Mantzaras, I. Czekaj
Computational Modeling of Pd/PdOx Transformation in Redox Catalytic Cycles

Projektleiter: J. Mantzaras
Direct Numerical Simulation of Turbulent Catalytic Combustion

Projektleiter: M. Nachtegaal
Facility for In Situ Analysis of Functional Materials
Partner: PSI, ETH

Projektleiter (MaNEP-III): C. Niedermayer (PSI-LNS), C.W. Schneider (as subcontractor)
Novel Phenomena at Interfaces and in Superlattices: Conducting Interfaces

Projektleiter: P. Novák
Synthetic Solid Electrolyte Interphase on Carbon Electrodes for Lithium-Ion Batteries

Projektleiter: P. Novák
New Oxyphosphates as High Specific Charge Electrode Materials for Lithium-Ion Batteries

Projektleiter: P. Novák, R. Kötz, T. Lippert, R. Nesper[1]
Advanced Materials for Efficient Portable Energy Supplies
[1] ETH Zürich

Projektleiter: F. Nüesch[1], M. Nagel[1], T. Lippert, A. Wokaun
Fabrication of Patterned Organic Multilayer Devices Using Dynamic Release Layer Assisted Laser Induced Forward Transfer
[1] Empa Dübendorf

Projektleiter: M. Rossi
Elementary Chemistry at the Gas-Condensed Phase Interface: Implications for Atmospheric Science

Projektleiter (CCMX): J. Rupp[1], L. Gauckler[1], T. Lippert, K. Conder, T. Graule[2], S. Pratsinis[1]
NANCER (*Nanocrystalline Ceramic Thin Film Coating Without Sintering*)
[1] ETH Zürich
[2] Empa Dübendorf

Projektleiter: M. Saurer, R.T.W. Siegwolf
Climatic Changes,Tree-Ring Growth and C- and O-Isotope Variations Along Longitudinal Transects in Siberia and in the Urals

Projektleiter: R.T.W. Siegwolf, J. Dommen, U. Baltensperger
Compound Specific Isotope Analyses in Ecological and Aerosol Research (R'Equip)

Projektleiter: J. Wambach
Catalysis Under Extreme Conditions: In Situ Studies of the Reforming of Organic Key Compounds in Supercritical Water

Projektleiter: A. Wokaun, T. Lippert
Thin Metal Oxide Films by PLD: "Tracing" the Oxygen and Understanding its Role

NATO

Projektleiter: M. Dinescu[1], E. Verona[2], T. Lippert
Polymers Based Piezoelectric Sensor Array for Chemical Warfare Agents Detection
[1] National Institute for Lasers, Plasma and Radiation Physics, Bucharest, Romania
[2] CNR-IDAC Rome, Italy

NOVATLANTIS

Projektleiter: A. Wokaun, S.F. Lienin, S. Ulli-Beer, C. Bach[1]
Erlebnisraum Mobilität: Aufbau einer sozio-technologischen Feldversuchsumgebung
Nachhaltigkeit im ETH Bereich
[1] Empa Dübendorf

OSTLUFT

Projektleiter: A.S.H. Prévôt
Mobile Aerosolmassenpektrometer-Messungen im Rheintal und in Zürich

SBF

Projektleiter: J. Keller
COST 728 (Linking Meteorological and Photo-Chemical Dispersion Models: Development and Tests of an Interface with Improved Turbulence Schemes)

Projektleiter: R.T.W. Siegwolf
COST 639 (Carbon Cycling in Alpine Soils in a Warmer World)
Swiss Agency for Development and Cooperation (SDC)

Projektleiter: Ch. Ludwig
Within the EPFL SDC 2009-2012 Scientific Cooperation Fund. Relevance of Arsenic Complexed with Organic Matter in Chinese Ground Water

UGZ

Projektleiter: E. Weingartner, J. Brunner[1]
Entwicklung eines SMPS-Systems für den kontinuierlichen Einsatz
[1] Amt für Umwelt- und Gesundheitsschutz, Zürich

VELUX STIFTUNG

Projektleiter: Ch. Ludwig
Hydrothermal Methane from Microalgae (the SunCHem Process)

TEACHING ACTIVITIES (LECTURES)

UNIVERSITY LEVEL TEACHING

Prof. Dr. U. Baltensperger, Prof. Dr. H. Burtscher, Dr. C. Marcolli
Aerosole II
ETH Zürich, FS 2010

Prof. Dr. U. Baltensperger, Prof. Dr. H. Burtscher, Dr. C. Marcolli
Aerosole I
ETH Zürich, HS 2010

Prof. Dr. K. Boulouchos[1], Dr. O. Kröcher
IC-Engines and Propulsion Systems II
ETH Zürich, FS 2010
[1] ETH Zürich

Dr.-Ing. P. Jansohn
Gasturbinen: Prozesse und Verbrennungssysteme
(Vorlesung für höhere Semester/Master in den Studiengängen Maschineningenieurwissenschaften und Energy Science & Technology)
ETH Zürich, FS 2010

PD Dr. T. Lippert
Mikro- und Nanostrukturen: Laseranwendungen in Industrie und Forschung
ETH Zürich, HS 2010

PD Dr. T. Lippert
Inorganic Thin Films: Processing, Properties and Applications
Contributions (4 lectures on the topic: *Vacuum thin film deposition techniques* and *Thin film industrial applications*) to the lecture: by L. Gauckler, J. Rupp, A. Bieberle
ETH Zürich, FS 2010

Prof. Dr. Ch. Ludwig
Advanced Solid Waste Treatment
Master 7th and 9th semester
EPF Lausanne, FS / HS 2010

Prof. Dr. Ch. Ludwig
Analyse des polluants dans l'environnement, together with Dr. Felippe de Alencastro
Bachelor 5th semester
EPF Lausanne, FS / HS 2010

PD Dr. J. Mantzaras, Dr. C. Frouzakis[1]
Theoretical and Numerical Combustion
ETH Zürich, FS 2010
[1] ETH Zürich

Dr. M. Nachtegaal
Cook and look: Synchrotron techniques (Vorlesung im Master Studiengang Umweltnaturwissenschaften und Ausbildung während des Doktorats)
ETH Zürich, FS 2010

Prof. Dr. P. Novák
Elektrochemie
ETH Zürich, HS 2010

Prof. Dr. P. Novák
Elektrochemie und Batterien – Von der Grundlagen zur Anwendung
„HE-Lion Battery School“ der Justus-Liebig-Universität Giessen, FS 2010

Dr. A.S.H. Prévôt, Prof. J. Staehelin
Tropospheric Chemistry
ETH Zürich, FS 2010

Dr. R.T.W. Siegwolf, Dr. M. Lehmann
Stabile Isotope in den Umwelt- und Geowissenschaften
University of Basel, WS 09/10, 2010

Prof. Dr. A. Steinfeld, Prof. Dr. R. Abhari
Energy Systems and Power Engineering
ETH Zürich, FS 2010

Prof. Dr. A. Steinfeld
Thermodynamics III
ETH Zürich, HS 2010

Prof. Dr. A. Steinfeld
Radiation Heat Transfer
ETH Zürich, HS 2010

Dr. F. Vogel (gemeinsam mit Prof. Dr. Ph. Rudolf von Rohr)
Einführung in die Verfahrenstechnik / Vorlesung 5. Semester Maschinenbau und Verfahrenstechnik
ETH Zürich, HS 2010

Prof. Dr. A. Wokaun, Dr. P.G. Loutzenhiser
Renewable Energy Technologies I
ETH Zürich, HS 2010

Prof. A. Wokaun, Dr. G. G. Scherer, Dr. F. Noembrini
Renewable Energy Technologies II
ETH Zürich, FS 2010

CONTRIBUTIONS TO COURSES AT UNIVERSITIES, FHL, AND OTHER INSTITUTES

Dr. S.M.A. Biollaz
Renewable Energy Technologies I (Biomass: Options for technical use)
ETH Zürich, December 7, 2010

Dr. S.M.A. Biollaz
Renewable Energy Technologies I (Biomass: Fuel production)
ETH Zürich, December 14, 2010

Dr. M. Nachtegaal
9th PSI summer school on condensed matter research (practical training at PSI facilities)
PSI Villigen, August 14-16, 2010

Dr. A.S.H. Prévôt, C. Astorga, M. Hallquist
Summer School on Organic Aerosols
Ispra, Italy, June 21-25, 2010

Dr. R.T.W. Siegwolf
Tree Physiology and Stable Isotopes
Summerschool, University of Goetheburg, Sweden, August 23-29, 2010

Dr. R.T.W. Siegwolf, Dr. M. Saurer
Stabile Isotope in der Ökologie
University of Zürich, Lecture and Practicum, January 25-29, 2010

Prof. Dr. A. Steinfeld
Concentrated Solar Power and Fuels
Universidad Tecnologica de Buenos Aires, Argentina, September 2010

Dr. F. Vogel
Bioenergie, Lehrgang Techniker HF
sfb Bildungszentrum für Technologie und Management, Dietikon, FS 2010

Prof. A. Wokaun
Energy Situation
EMBA and Executive Diploma Program "Utility Technology": Module 3
iimt, University of Fribourg, September 29, 2010

PUBLICATIONS

BOOKS AND REVIEWED BOOK CHAPTERS

S. Canulescu[1], C.N. Borca, M. Döbeli[2], P. Schaaf[3], T. Lippert, A. Wokaun
Processing and properties of thin manganites films
Magnetic properties of solids, ISBN: 978-1-60741-550-3, Ed. K. B. Tamayo, Nova Science Publishers, Hauppage, USA, 179-202 (2010).
[1] Empa Thun
[2] ETH Zürich/PSI
[3] TU Ilmenau, Germany

H.A. Gasteiger[1], H. Uchida[1], V. Ramani[1], A. Weber[1], T.J. Schmidt[1], T.F. Fuller[1], P. Strasser[1], P. Shirvanian[1], M. Inaba[1], M. Edmundson[1], F.N. Büchi, D. Jones[1], C. Lamy[1], R. Mantz[1], S.R. Narayan[1], R. Darling[1], T.A. Zawodzinski[1]
Polymer electrolyte fuel cells 10
ISBN: 978-1-56677-820-6, ECS Transactions, **33**, 218th ECS Meeting, Las Vegas, USA, October 10–15 (2010).
[1] external co-organizer of the 218th ECS Meeting

H. Herrmann[1], T. Kuhlbusch[1], T. Gnauk[1], S. Weinbruch[1], U. Baltensperger, U. Pöschl[1]
Chemische Charakterisierung von Feinstäuben
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P. Zieger, E. Weingartner, J. Henzing[1], M. Moerman[1], G. de Leeuw[1], J. Mikkilä[1], M. Ehn[1], T. Petäjä[1], K. Clemer[1], M. van Roozendael[1], S. Yilmaz[1], U. Friss[1], H. Irie[1], T. Wagner[1], R. Shaiganfar[1] S. Beirle[1], A. Apituley[1], K. Wilson[1], U. Baltensperger
Comparison of ambient aerosol extinction coefficients obtained from in-situ, MAX-DOAS and LIDAR measurements at a continental site (Cabauw)
American Geoscience Union Fall Meeting, San Francisco, USA, December 13-17, 2010.
[1] external member of the CINDI consortium

Y. Yamada (Sasaki), T. Nakamura[1], R. Kötz, K. Yano[1]
Fabrication and application of hollow mesoporous silica microcapsules.
TransPore 2010, Villigen PSI, August 19-20, 2010.
[1] Toyota Central R&D Labs., Inc., Nagakute, Japan

CONFERENCES, WORKSHOPS & EXHIBITIONS

U. Baltensperger
ACP Symposium 2010
Interlaken, June 7-10, 2010.
Organizer

P. Dietrich
CLEANTECH, Bern, November 4, 2010.
Mitorganisator

M. Furger
DACH 2010 - Deutsch-Österreichisch-Schweizerische Meteorologentagung
Bonn, Germany, September 20-24, 2010.
Co-organizer

M. Furger
EMS/ECAC 2010 - 10th Annual Meeting of the European Meteorological Society and 8th European Conference of Applied Climatology
Zürich, September 13-17, 2010.
Co-organizer

P. Jansohn
Forschungsprogramm "Kraftwerk 2020" (Jahrestagung)
Bundesamt für Energie (BFE), Bern, June 9, 2010.
Organisator/Programmleiter

R. Kötz
ESSCAP'10, 4th European Symposium on Super Capacitors & Applications
Bordeaux, France, October 21-22, 2010.
Member of the International Scientific Committee

R. Kötz
2010 International Conference on Advanced Capacitors
Kyoto, Japan, May 31 - June 2, 2010.
Session Chair
Member of the International Advisory Committee

T. Lippert
international conference on Synthesis and Photonics of Nanoscale Materials VII (SPnSM-VII) part of
Photonics West LASE 2010, San Francisco, USA, January, 2010.
Member of the programm committee

T. Lippert
High power laser ablation VIII, Santa Fe, USA, April, 2010.
Member of the programm committee

T. Lippert
CLEO/IQEC'10, Laser Processing of Materials: Fundamentals and Applications, San Jose, USA, May, 2010.
Sub-committee member

T. Lippert
E-MRS Spring Meeting, Strasbourg, France, May, 2010.
Co-Chair

T. Lippert
International Symposium on Laser Precision Microfabrication (LPM 2010), Stuttgart, Germany, June, 2010.
Member of the program committee

T. Lippert
E-MRS 2010 conference, symposium on Laser Processing and Diagnostics for Micro and Nano Applications, Strasbourg, June, 2010.
Member of the international advisory committee

T. Lippert
7th International Conference on Photo-Excited Processes and Applications (ICPEPA), Copenhagen, Denmark, August, 2010.
Member of the international advisory committee

T. Lippert
1 th International Conference on Ceramic Processing Science (ICCPS), Zürich, August 2010.
Member of the international advisory committee

A. Meier
CIMTEC 2010 - 5th Forum on New Materials, Montecatini Terme, Italy, June 13-18, 2010.
Member Advisory Board

A. Meier
16th SolarPACES Conference, Perpignan, France, September 21-24, 2010.
Member Scientific Committee

P. Novák
International Meeting on Lithium Batteries IMLB-15
Montreal, Canada, June 27 - July 2, 2010.
Member of the Scientific Committee

P. Novák
CIMTEC 2010 - 12th International Conference on Modern Materials and Technologies
Montecatini Terme, Italy, June 6-18, 2010.
Member of the Advisory Board Symposium “Electrochemical Energy Storage Systems: the Next Evolution”

G.G. Scherer, R. Kötz, P, Novák
Electrochemistry in Switzerland
26th One-Day-Symposium, PSI Villigen, May 5, 2010.

A. Wokaun
Energietagung 'Lösungsansätze zum Schutz des globalen Klimas', PSI Villigen, June 11, 2010.
Member of the Organizing Committee

A. Wokaun
Erneuerbare Energien verstärkt durch innovative Technologien
EnergyCom, Gottlieb Duttweiler Institut, Rüschlikon, November 25, 2010.
Tagungsleiter

MEMBERSHIPS IN EXTERNAL COMMITTEES

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National Research Council
Member

Urs Baltensperger
Umweltforschung der Forschungszentrum Jülich GmbH
Wissenschaftlicher Beirat, Vorsitzender
Wissenschaftlich-Technisches Ausschuss Mitglied

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Programme Advisory Board of APPRAISE (Aerosol Properties, Processes And InfluenceS on the Earth 's climate)
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SNC-IUGG - Swiss National Committee of the International Union of Geodesy and Geophysics
National Correspondent of the International Association of Meteorology and Atmospheric Sciences (IAMAS)
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International Energy Agency (IEA),
Implementing Agreement on Energy Conservation and Emission Reduction in Combustion
Collaborative Task Leader "Gas Turbine Combustion"

P. Jansohn
International Energy Agency (IEA), GHG R&D Programme
Representative (Alternate) for Switzerland

P. Jansohn
ProcessNet Fachgemeinschaft „Sustainable Production, Energy and Resources",
Fachausschuss „Hochtemperaturtechnik"
berufenes Mitglied

P. Jansohn
European Turbine Network (ETN)
Member

P. Jansohn
European Technology Platform – Zero Emission Fossil Fuel Power Plants (ETP-ZEP)
Taskforce Technology and Government Group
Member/ Representative (Alternate) for Switzerland

R. Kötz
ISE Publication Committee
Chair

T. Lippert
E-MRS
Board of Delegates
Member of the Executive Committee

T. Lippert
Journal of Laser Micro/Nanoengineering (JLMN)
Co-Editor

T. Lippert
Laser Chemistry
Associate Editor

T. Lippert
Materials
Member of the Editorial Board

T. Lippert
special issue Novel Thermoelectric Materials and Applications in Materials, 2010
Guest editor (together with A. Weidenkaff)

J. Mantzaras
Combustion and Flame Journal
Member of the Editorial Board

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International Energy Agency SolarPACES
Operating Agent

A. Meier
SOLLAB – Alliance of European Laboratories on Solar Thermal Concentrating Systems
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sc nat Commission, Atmospheric Chemistry and Physics
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Member Advisory Board

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European Federation of Chemical Engineering
Member - Process Engineering for Alternative Energy Resources Committee

A. Steinfeld
ASME Kreith Energy Award
Member Selection Committee

S. Ulli-Beer
Sustainability (online open access journal)
Member of the Editorial Board

S. Ulli-Beer
System Dynamics Review
Associated editor

E. Weingartner
Fachgruppe zum Thema: Partikelzählung/ Partikelgrössenanalyse
Ziel: Erarbeiten von Empfehlung zum Einsatz von Partikelzählern und Partikelgrössenanalysatoren bei Aerosolen
Member

E. Weingartner
Atmospheric Chemistry and Physics
Editorial Board

E. Weingartner
Energiekommission der Gemeinde Ennetbaden
Erarbeiten eines neuen Energieleitbildes und entsprechender Fördermassnahmen
Member

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Schweiz. Akademie der Technischen Wissenschaften (SATW)
Einzelmitglied

A. Wokaun
Helmholtz-Gemeinschaft deutscher Forschungszentren
Mitglied der Senatskommission

A. Wokaun
European Climate Forum
Member of Council

A. Wokaun
novatlantis –Nachhaltigkeit im ETH-Bereich
Mitglied des Leitungsausschusses

A. Wokaun
Studiengruppe Energieperspektiven
Präsident

A. Wokaun
CORE
Mitglied

A. Wokaun
Advisory Group on Energy (AGE), European Union
Mitglied

A. Wokaun
Competence Center Energy and Mobility (CCEM)
Chairman of Steering Committee

A. Wokaun
Eureopean Energy Research Alliance (EERA)
Member of Executive Committee

PATENT APPLICATIONS

M. Casapu, M. Elsener, O. Kröcher
Catalyst for a De NO_x -application and a process for selective catalytic reduction of nitrogen oxides
Patent Application No. EP 2010P04370, 2010.

M. Gassner, F. Vogel, F. Maréchal
A process and a plant for hydrothermal SNG production from waste biomass
Patent Application No. EP 10165557.9, June 10, 2010.

AWARDS

B. Flury[1], J. Frommer[2], U. Eggenberger[1], U. Mäder[1], M. Nachtegaal, R. Kretzschmar[2]
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Best environmental technology paper, First Runner-up in ES&T's, 2010.
[1] University of Bern
[2] ETH Zürich

A. Hintennach
Anwendungen der in situ Ramanmikroskopie für Lithiumionen-Batterien
Swisselectric Research Award 2010.

V. Lanz
Sources and evolution of airborne organic compounds
ACP, The Atmospheric Chemistry and Physics Award 2010.

L. Klüpfel, M. Nachtegaal, H. Schulenburg, T. Engl
XAS studies of leached PTCo catalysts for PEMFCs
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H. Schneider
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SCS Metrohm Prize for the best oral presentation in the section Physical Chemistry of the SCS Fall Meeting 2010.

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Progress MEA 2010, 2nd Poster Award, La Grande Motte, France, September 20-22, 2010.
[1] EPF, Lausanne

A. Steinfeld
Elected to the Swiss Academy of Engineering Sciences.

LIST OF PUBLICATIONS 2010

Large Research Facilities and SwissFEL Project

UNIVERSITY LEVEL AND OTHER TEACHING

R. Abela
SwissFEL Project: Fundamentals, Scientific Opportunities
Graduiertenschule Universität Zurich, Ligerz, Schweiz
13 August 2010

A. Adelmann, P. Arbenz
Parallel Numerical Methods
ETH Zurich, Switzerland
Spring Semester 2010

A. Adelmann
Statistics and Probability
University of Applied Science, Zurich, Switzerland
Spring Semester 2010

H.H. Braun
RF beam diagnostics
Course at CERN Accelerator School “RF for Accelerators”, Ebeltoft, Denmark
14-15 June 2010

H.H. Braun
Der Röntgenlaser SwissFEL
Ringvorlesung „50 Jahre Laser“ Volkshochschule Zurich, Switzerland
19 November 2010

M. Dittmar, U. Langenegger, K. Müller, O. Steinkamp, U.D. Straumann, A. Streun
Experimental Methods of Particle Physics
Zurich University (UZH) and Zurich Technical University (ETHZ)
Autumn Semester 2010

B. Oswald
The 3D Finite Element Time Domain Method in Electrodynamics Guest Lecture at Department of Information Technology and Electrical Engineering
ETH Zurich, Switzerland
Spring Semester 2010

J.A. Patorski
Thermographische Temperaturmessung
Paul Scherrer Institut, Villigen, Switzerland
November 2010

B.D. Patterson
EPFL Biophysics School
Crans Montana, Switzerland
15 February 2010

B.D. Patterson, Th. Greber
Physik der Kondensierten Materie
University of Zurich, Switzerland
Autumn Semester 2010

B.D. Patterson
The SwissFEL X-ray Laser Project at PSI
Lecture in the course „Medical Imaging and Therapeutic Applications of Particle Physics“ (B. Müller and T. Lomax)
ETH Zurich, Switzerland
19 November 2010

L. Rivkin
Introduction to Particle Accelerator Physics
EPFL Lausanne, Switzerland
Fall semester 2010

L. Rivkin
Synchrotron Light, Electron Dynamics with Radiation and Synchrotron Light Sources
CERN Accelerator School, Introduction to Accelerator Physics, Varna, Bulgaria
20-30 September 2010

L. Rivkin
Synchrotron radiation and Light Sources
African School of Physics ASP2010, Stellenbosch, South Africa
1-21 August 2010

J.M. Schippers
Accelerators for proton therapy
PSI Winterschool, Bad Zurzach, Switzerland
20 January 2010

J.M. Schippers, E. Pedroni
Cyclotrons for particle therapy
Teaching course at PTCOG 49, Chiba, Japan
17-22 May 2010

J.M. Schippers
Particle Generation, Accelerator Technology ESTRO Teaching Course on Radiotherapy with Protons and Ions
ETH Zurich, Switzerland
26 September 2010

J.M. Schippers
New technologies in particle therapy for hospital based centers ESTRO Teaching Course on Radiotherapy with Protons and Ions
ETH Zurich, Switzerland
29 September 2010

J.M. Schippers
Radiobiology in radiotherapy
Medical Physics Course
ETH Zurich, Switzerland
10 December 2010

M. Schneider
Elektronik
Technikerschule HF, Zurich, Switzerland
Spring Semester 2010

E. Zimoch
Accelerator Controls
Joint Universities Accelerator School (JUAS), Archamps, France
1 March 2010

PEER REVIEWED PAPERS

R. Abela, B.D. Patterson
Time-Resolved Scattering from Chemical Systems at the Proposed SwissFEL X-Ray Laser
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A. Adelmann, P. Arbenz, Y. Ineichen
A Fast Parallel Poisson Solver on Irregular Domains Applied to Beam Dynamic Simulations
Journal of Computational Physics, **229** (12), 4554, doi:10.1016/j.jcp.2010.02.022 (2010)

A. Adelmann, K. Kirch, C.J.G Onderwater, T. Schietinger
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S. Dementjevs, S. Ivanov, M. Wohlmuther
On a concept of EMP for the liquid metal target for routine operation in SINQ
MAGNETOHYDRODYNAMICS, **46**, No. 1, 59 (2010)

N Fomin, J. Arrington, D.B. Day, D. Gaskell, A. Daniel, J. Seely, R. Asaturyan, F. Benmokhtar, W. Boeglin, B. Boillat, P. Bosted, A. Bruell, M.H.S. Bukhari, M.E. Christy, E. Chudakov, B. Clasie, S.H. Connell, M.M. Dalton, D. Dutta, R. Ent, L. El Fassi, H. Fenker, B.W. Filippone, K. Garrow, C. Hill, R.J. Holt, T. Horn, M.K. Jones, J. Jourdan, N. Kalantarians, C.E. Keppel, D. Kiselev, M. Kotulla, R. Lindgren, A.F. Lung, S. Malace, P. Markowitz, P. McKee, D.G. Meekins, T. Miyoshi, H. Mkrtchyan, T. Navasardyan, G. Niculescu, Y. Okayasu, A.K. Opper, C. Perdrisat, D.H. Potterveld, V. Punjabi, X. Qian, P.E. Reimer, J. Roche, V.M. Rodriguez, O. Rondon, E. Schulte, E. Segbefia, K. Slifer, G.R. Smith, P. Solvignon, V. Tadevosyan, S. Tajima, L. Tang, G. Testa, R. Trojer, V. Tvaskis, W.F. Vulcan, C. Wasko, F.R. Wesselmann, S.A. Wood, J. Wright, X. Zheng
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Phys. Rev. ST Accel. Beams, **13**, 093502 (2010)

G. Ghobadi, L.E. Hogeweg, H. Faber, W.G.J. Tukker, J.M. Schippers, S. Brandenburg, J.A. Langendijk, R.P. Coppes, P. van Luijk
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S. Hiebel, T. Grossmann, D. Kiselev, J. Schmiedeskamp, Y. Gusev, W. Heil, S. Karpuk, J. Krimmer, E.W. Otten, Z. Salhi
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D. Kiselev, S. Teichmann
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F. Le Pimpec, C. Gough, M.L. Paraliev, R. Ganter, C. Hauri, S. Ivkovic
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F. Loehl, V. Arsov, M. Felber, K. Hacker, W. Jalmuzna, B. Lorbeer, F. Ludwig, K.-H. Matthiesen, H. Schlarb, B. Schmidt, P. Schmueser, S. Schulz, J. Szewinski, A. Winter, J. Zemella
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C. Milne, V.T. Pham, W. Gawelda, A.E. Nahhas, R.M. van der Veen, S.L. Johnson, P. Beaud, G. Ingold, C. Borca, D. Grolimund, R. Abela, M. Chergui, C. Bressler
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J.A. Patorski
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J.A. Patorski, P.H. Hirt, N. Jaussi
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Electro Technology R&D Center, LS Industrial Systems, Cheongju, Korea, 11 October 2010

A. Luedeke
Controls tools for operation management at the Swiss Light Source
EPICS Collaboration Meeting, Aix-en-Provence, France, 2 June 2010

A. Luedeke
Status of the Swiss Light Source
XVIIIth ESLS Workshop, Sincrotrone Trieste, Italy, 25 November 2010

N. Milas
Switchyard design for SwissFEL
CANDLE-DESY-PSI collaboration workshop, Yerevan, Armenia, 2 July 2010

B. Oswald, P. Leidenberger
Short Course on The Finite Element Time Domain Method in Electrodynamics - With an Emphasis on Nano-Optics
6th Workshop on Numerical Methods for Optical Nano Structures, Swiss Federal Institute of Technology, Zurich, Switzerland, 5-7 July 2010

B. Oswald, P. Leidenberger
Array Concepts for Optical Antennas - Revisiting Traditional Antenna Architectures
6th Workshop on Numerical Methods for Optical Nano Structures, Swiss Federal Institute of Technology, Zurich, Switzerland, 5-7 July 2010

T. Pal
Snapshots: Configuration Management for Software and Firmware at PSI
Workshop on Virtualization Technologies; at ICALEPCS 09, Kobe, Japan, 10 October 2009

B.D. Patterson
The SwissFEL X-ray Laser Project at PSI
EMPA Akademie, Dübendorf, Switzerland, 2 March 2010

B.D. Patterson
The SwissFEL X-ray Laser Project at PSI
SLAC-LCLS Seminar, Stanford, USA, 2 June 2010

B.D. Patterson
Proposed Science at the SwissFEL X-ray Laser
NSLS Seminar, Brookhaven, USA, 23 June 2010

B.D. Patterson
Proposed Science at the SwissFEL X-ray Laser
ALS/CXRO Seminar, Berkeley, USA, 14 July 2010

B.D. Patterson
Thoughts on Time-Resolved Stimulated X-ray Raman Scattering
APS Complexity and Hard X-ray Workshop, Chicago, USA, 12 October 2010

B.D. Patterson
SwissFEL - Ein Röntgen-Laser für atomare Movies
SATW TechNight, Kantonsschule Wohlen, Switzerland, 2 December 2010

B.D. Patterson
SwissFEL - Ein Röntgen-Laser für atomare Movies
SATW TechDay, Kantonsschule Zürcher Oberland, Switzerland, 8 December 2010

J.-Y. Raguin
Long Range Wakefields for C-Band:Preliminary Results with Uncoupled Model
CANDLE-DESY-PSI Collaboration Workshop, CANDLE, Yerevan, Armenia, 30 June 2010

J.M. Schippers
Fysische aspecten van protonentherapie
Integraal Kankercentrum Noord Oost, Zwolle, the Netherlands, 2 Feburary 2010

J.M. Schippers
The use of a SC cyclotron for protontherapy at PSI
SINAP, Shanghai, China, 26 Feburary 2010

J.M. Schippers
Protonentherapie: Fysica en nieuwe technologie voor de gezondheidszorg
Symposium “Nieuwe Ontwikkelingen in de Gezondheidszorg”, Nederlands Kanker Instituut / Anthony van Leeuwenhoek Ziekenhuis, Amsterdam, the Netherlands, 12 March 2010

J.M. Schippers
Neue “preiswerte” Beschleuniger für Hadronentherapie
Symposium Hadronentherapie und Hyperthermie, 16. Jahrestagung DEGRO, Magdeburg, Germany, 4 June 2010

J.M. Schippers
Fast scanning techniques for Cancer therapy with hadrons-a domain of cyclotrons
19th Int. Conference on cyclotrons and their applications, Lanzhou, China,
6-10 September 2010

J.M. Schippers
Physics of proton therapy and proton accelerators
Symposium Protonen in Oost-Nederland, Universitair Medisch Centrum Nijmegen, the Netherlands, 17 September 2010

J.M. Schippers
Protontherapy at PSI: Physics and Technology for Healthcare
Los Alamos Nat. Laboratory, Los Alamos (NM), USA, 6 October 2010

J.M. Schippers
Experience with the SC-cyclotron for fast scanning techniques at PSI
Mass. General Hospital, Francis Burr Proton Therapy Center, Boston (MA), USA,
17 November 2010

V. Schlott
Highlights from DIPAC 2009
BIW10, Santa Fe, New Mexico, USA, 06 May 2010

V. Schlott
Femto-Second Diagnostics
ANKA, Karlsruher Institut für Technologie, Karlsruhe, Germany, 17 May 2010

V. Schlott
Photon Diagnostics for SwissFEL
IRUVX-PP Expert Groups Meeting, PSI, Villigen, Switzerland, 25 November 2010

M. Seidel
Recent Progress with the High Intensity Proton Accelerator at PSI
ICANS10, Grindelwald, Switzerland, 9 March 2010

M. Seidel
Experience with the Production of a 1.3MW Proton Beam in a Cyclotron Based Facility
TCADS10, Karlsruhe, Germany, 16 March 2010

M. Seidel
Production of a 1.3 Megawatt Proton Beam at PSI
IPAC'10, Kyoto, Japan, 25 May 2010

M. Seidel
The PSI High Intensity Proton Accelerator – Operational Experience and Development Plans
RIKEN Seminar, Tokyo, Japan, 31 May 2010

M. Seidel
Production and application of the 1.3 MW proton beam at PSI
GSI Colloquium, Darmstadt, Germany, 15 June 2010

M. Seidel
Towards the 2MW Cyclotron and Latest Developments at PSI
CYCLOTRONS'10, Lanzhou, China, 7 September 2010

L. Stingelin
High Power RF-Systems and Resonators for Sector Cyclotrons
IMP, Lanzhou, China, 9 September 2010

L. Stingelin
RF-Developments at PSI
14 ESLS-RF Meeting, ELETTRA, Trieste, Italy, 27 September 2010

A. Streun
Lattices for Light Sources, Non-linearities in Light Source Lattices
ANKA, Karlsruher Institut für Technologie, Karlsruhe, Germany, 30 August 2010

A. Streun
Storage Ring based Light Sources
CANDLE-DESY-PSI collaboration workshop, Yerevan, Armenia, 30 June 2010

WORKSHOPS (organized by GFA or SwissFEL)

H.H. Braun, W. Decking (DESY), V. Tsakanov (CANDLE)
Organizers
CANDLE-DESY-PSI Workshop
CANDLE, Yerevan, Armenia, 30 June-2 July 2010

T. Garvey, S. Wuest
Organizers
RFTech 2nd Workshop
PSI, Villigen, Switzerland, 2-3 December 2010

B. Keil, D. Nölle
Organizers
European XFEL BPM & Beam Stability Collaboration Workshop
DESY, Hamburg, Germany, 24-25 June 2010

M. Seidel, A. Adelmann, M. Bugmann, J. Chrin, S. Foiera, J. Grillenberger
46th ICFA Advanced Beam Dynamics Workshop on High-Intensity and High-Brightness Hadron Beams
Swiss Holiday Park, Morschach, Switzerland, 26 September – 1 October 2010

BACHELOR / MASTER THESES

M. George
A Preliminary Study for a Sub-Micron Electron Bunch Length Diagnostics
Master Thesis, EPFL Lausanne, Switzerland, 3 February 2010
Thesis Advisors: Prof. Dr. L. Rivkin (EPFL, PSI)
Dr. P. Emma (LCLS/SLAC, USA)
Thesis Expert: Dr. V. Schlott (PSI)

Vadims Geza
Investigation of turbulent flow characteristics in liquid metal target
Master Thesis, MSc University of Latvia, Riga, Latvia, 31 May 2010
Thesis Advisors: Prof. Dr. A. Jakovic (University of Latvia, Riga, Latvia)
R.Ž. Milenkovic (PSI)
S. Dementjevs (PSI)

Uldis Locans
Eksperimentāls un skaitlisks iegremdētas plūsmas raksturojums protonu stara mērķa izstrādes vajadzībām
Master Thesis, MSc Ventspils University, Ventspils, Latvia, 12 June 2010
Thesis Advisors: Prof. Dr. N. Jekabsons (Ventspils University, Ventspils, Latvia)
R.Ž. Milenkovic (PSI)
S. Dementjevs (PSI)

R. Mutzner
Multi-bunch effect of resistive wall in the Beam Delivery Service of the Compact Linear Collider
Master Thesis, EPFL Lausanne, Switzerland, 1 February 2010
Thesis Advisors: Prof. Dr. L. Rivkin (EPFL, PSI)
Dr. G. Rumolo (CERN)
Dr. R. Tomás Garcia (CERN)
Dr. T. Pieloni (EPFL, PSI)

P.-L. Pernet
Echo-7 commissioning studies, a study of echo-enabled harmonic generation
Master Thesis, EPFL Lausanne, Switzerland, 21 July 2010
Thesis Advisors: Prof. Dr. L. Rivkin (EPFL, PSI)
Prof. Dr. T. Raubenheimer (SLAC, Stanford, USA)
Thesis Expert: Dr. S. Reiche (PSI)

S. Rabaioli
A fast neutron irradiation station for the SINQ target
Bachelor thesis, Università degli studi dell'Insubria, Como, Italy, 15 December 2010
Thesis Advisors: M. Prest (Università degli studi dell'Insubria, Como, Italy)
L. Zanini (PSI)

DISSERTATIONS

V. Previtali
Performance Evaluation of a Crystal-Enhanced Collimation System for the LHC
Thesis No. 4794 / EPFL Lausanne, Switzerland 2010
Thesis advisors: Prof. Dr. L. Rivkin (EPFL, PSI)
Dr. R. Assmann (CERN)

L. Lari
Beam-Machine Interaction Studies for the Phase II LHC Collimation System
Thesis No 4910 / EPFL Lausanne, Switzerland 2010
Thesis advisors: Prof. Dr. L. Rivkin (EPFL, PSI)
Dr. V. Vlachoudis (CERN)

Memberships in external Committees

R. Abela
- European XFEL, Science Advisory Committee
- Canadian Light Source, Science Advisory Committee
- ESRF, Science Advisory Committee, chairman
- EuroFEL, Member of Director's Board

A. Adelmann
- Speedup Society (treasury)
- CSCS "Rosa (Horizon) Project" Steering Committee
- Program Committee ICFA High Brightness Beam Dynamics Workshop
- International Super Computing Conference (ISC), Program Committee

M. Boege
- PLS-II Design Review Committee, POSTECH, Pohang, Korea

H.H. Braun
- DESY, Machine Advisory Committee
- European XFEL, Machine Advisory Committee
- PAL IAC, Korea
- ANKA (KIT), Machine Advisory Committee

R. Dölling
- Spiral2 Beam Stop Technical Review, Committee Member

T. Garvey
- European Committee for Future Accelerators (plenary)
- Scientic and Technical Committee for the Accelerator, Cryogenic and Magnet Department of CEA-Saclay
- CLIC/CTF3 Collaboration Board
- EuCARD Governing Board

J.A. Patorski
- member of the Thermosense Steering Committee; USA , SPIE Defense, Security + Sensing

L. Rivkin
- MAXIV Machine Advisory Committee (Chairman)
- CERN Accelerator School, Advisory Committee
- CERN, CLIC CTF3 Collaboration Board
- DESY, Machine Advisory Committee (Chairman)
- Joint Universities Accelerator School, Program Committee
- ESGARD
- TIARA Governing Board

W. Roser
- Swiss Society for Radiation Biology and Medical Physics (SGSMP), board member
- Comité Electrotechnique Suisse (CES), Member of Technical Committee 62
- Int. Electrotechnical Commission (IEC), Member of Working Group 1 of TC 62C

J.M. Schippers
- TRIUMF Accelerator Advisory Committee, Vancouver BC, Canada
- Board Member of the Groningen proton therapy Center, Univ. Medical Center, Groningen, The Netherlands
- Chairman of subcommittee “particle dosimetry” of the Netherlands Commission on Radiation Dosimetry
- Advisory committee on the new cyclotron and its commissioning and acceptance of the Legnaro National Laboratory of the INFN (Istituto Nationale di Fysica Nucleare), Legnaro, Italy
- Advisory committee on the new 400 MeV/n carbon cyclotron and its commissioning and acceptance, at the ARCHADE project, Caen, France
- Review Committee on a design of a small SC cyclotron for 250 MeV protons, MIT, Cambridge (MA), USA

V. Schlott
- ALBA Spanish Light Source, Machine Advisory Committee, Bellaterra, Spain
- ANKA Machine Advisory Committee, KIT, Karlsruhe, Germany
- DIPAC Scientific Program Committee
- In Kind Review Committee for the European XFEL (Chairman)

L. Schulz
- SESAME, Jordan, Technical Advisory Committee

M. Seidel
- Int. Conferences on Cyclotrons and their Applications: Int. Organizing Committee + Program Committee
- Accelerator Technology Advisory Committee for the Chinese Neutron Spallation Source (CSNS)
- Series ICFA Workshops on High Brightness, High Intensity Hadron Beams, Scientific Advisory Committee
- European Cyclotron Progress Meetings, Scientific Advisory Committee
- OECD/NEA Int. Workshop on Technology and Components of Accelerator Driven Systems (TCADS), Scientific Advisory Committee
- KoRIA project Seoul/Korea, Technical Advisory Committee
- Swiss Vacuum Society, Member of Managing Board

Logistics 2010

LIST OF PUBLICATIONS

Eikenberg, J. and Wilhelm, C.
Methodenübersicht zur Radionuklidanalytik beim Anlagenrückbau
Strahlenschutzpraxis 1/2010, 29-39, ISSN 0947-434 X, 2010.

Fabbrizio, A., Schmidt, M., Günther, D. and Eikenberg, J.
Ra-partitioning between phlogopite and silica melt and ^{226}Ra/Ba-^{230}Th/Ba isochrons
Lithos 114, 121 – 131, 2010.

Fiechtner, A., Mayer, S., Boschung, M.
Practical consequences for the use of a personal dosemeter for fast neutrons at high-energy accelerators based on PADC detectors exposed up to one year
Radiation Measurements Vol. 45(10), 1557-1559, 2010.

Gertisser, R., Self, S., Gaspar, J.L., Kelley, S.P., Pimentel, A., Eikenberg, J., Barry, T. and Vespa, M.
Imbrignite strategy and chronology on Terceira Island, Azores
In: Gropelli and Viereck-Goette (eds.) Stratigraphy and Geology of Volcanic Areas, Geological Society of America Special Paper, 133-154, 2010.

Goetti, R., Leschka, S., Boschung, M., Mayer, S., Wyss, C., Stolzmann, P., Frauenfelder, T.
Radiation doses from phantom measurements at high-pitch dual-source computed tomography coronary angiography
Publication submitted to European Journal of Radiology, 2010.

Hoedlmoser, H., Butterweck, G., Schuler, Ch., Mayer, S.
Simulation of the influence of a water environment on the calibration of a high dose rate probe
Submitted to Radiat. Prot. Dosim., 2010.

Hohmann, E., Safai, S., Bula, Ch., Lüscher, R., Harm, C., Mayer, S., Morath, O., Pedroni, E., Zenklusen, S.
Investigation of the neutron stray field produced by irradiating a water phantom with 200 MeV protons
Nevada Section Topical Meeting 2010, accepted for publication in Nuclear Technology, 2010.

Mayer, S., Boschung, M., Fiechtner, A., Hohmann, E., Fehrenbacher, G., Radon, T., Pleskac, R. and Wengenroth, M.
Response studies of fission track detectors within moderators in CAVE A at GSI
Radiation Measurements, Vol. 45(10), pages 1560-1563, 2010.

Mayer, S., Boschung, M., Meier, K., Laedermann, J.-P. and Bochud, F.
Characterisation of the PSI whole body counter by radiographic imaging
Radiat. Prot. Dosim., ncq322 first published online Nov 2, doi:10.1093/rpd/ncq322, 2010.

Schuler, Ch., Butterweck, G., Hödlmoser, H.
Kalibrierung von Oberflächen-Kontaminationsmonitoren
Strahlenschutzpraxis 2/2010, 54 – 59, 2010.

Zhang, G., Becker, F., Urban, M., Xuan, Y., Fürstner, M., Mayer, S.
Simulating the angular response of makrofol as a detector for neutron induced recoils
Submitted to Radiation Measurements, 2010.

CONFERENCE, WORKSHOP AND SEMINAR CONTRIBUTIONS

Kalt H., Böhler P., Schwarb A. , Sonderegger S. , Keller A., Maag S. , Gerber Th. , Ellenberger U. (2010)
Three Grating Monochromator for the VUV Beamline at the Swiss Light Source SLS
Proceedings of the MEDSI international Conference - Oxford (Great Britain) - July 2010

Emmenegger, M., Jäckle, H., Künzi, R., Richner, S.
A new generation of digital power supply controllers
IPAC 2010, Kyoto

Ke, X., Jenni, F., University of Applied Sciences Northwestern Switzerland, Windisch
Künzi, R., Paul Scherrer Institut
Investigations on a high performance control structure for accelerator magnet power supplies
PCIM 2010, Nürnberg

Beer, H. and Eikenberg, J.
LSC Methods for radionuclide immission measurements in Northern Switzerland
Int. Conf. Liquid Scintillation Spectrometry, Paris, Sept 6-10, 2010.

Butterweck, G. and Bucher, B.
Brief description of the setup of the Swiss measurement technique, with a special focus on the developments after 2002
Workshop Aero-Gammaspectrometry, Berlin, 27. – 28. Oct. 2010.

Calmet, D., Ameon, R., Beck, T., Bombard, A., Bourquin, M.N., Brun, S., De Jong, P., Forte, M., Fournier, M., Herranz, M., Hollensteiner, M., Jerome, S., Klett, A., Kwakman, P., Llaurado, M., Loyen, J., Michel, R., Nardoux, P., Richards, T., Schuler, Ch., Tokonami, S. and Woods, M.
International standardization work on the measurement of radon in the atmosphere and water
6th International Conference on Protection Against Radon at Home and at Work, Prague, Czech Republic, Sept 13-17, 2010.

Eikenberg, J.
Determination of H-3 and C-14 in the frame of decommissioning projects at the Paul Scherrer Institute, Switzerland
Int. Conf. Liquid Scintillation Spectrometry, Paris, Sept 6-10, 2010.

Eikenberg, J., Jaeggi, M. and Ruethi, M.
Radionuklid-Emissionsmessungen der Fortluft am Paul Scherrer Institut
In: Natürliche und künstliche Radionuklide in der Umwelt. (A. Neu, A. Bayer, T. Steinkopff, Eds.) Publikationsreihe Fortschr. Strahlensch., FS-2010-153-T, 26-32, 2010.

Fiechtner-Scharrer, A., Mayer, S., Boschung, M. and Whitelaw, A.
Influence of variation of etching conditions on the sensitivity of CR-39 detectors with a new evaluation method
Presented at European Conference on Individual Monitoring of Ionizing Radiation (IM2010), Athens, Greece, March 8-12, 2010.

Jäggi, M., Beer, H., Rüthi, M. und Eikenberg, J.
Fast method to separate Am and Pu from soil matrix
11th International Symposium on Environmental Radiochemical Analysis, Sept 15–17, 2010.

Jäggi, M., Ehrlicher, U. und Eikenberg, J.
Bestimmung des Nuklidvektors bei Rückbauprojekten am PSI (Paul Scherrer Institut)
42. Jahrestagung des Fachverbandes für Strahlenschutz: Natürliche und künstliche Radionuklide in unserer Umwelt, 26. – 30. Sept. 2010.

Mayer, S.
Dosimetry at PSI
Presentation of IMS at the European Conference on Individual Monitoring of Ionizing Radiation (IM2010), Athens, Greece, March 8-12, 2010.

Mayer, S.
Stand der Personendosimetrie in der Schweiz
CPR/KSR-Strahlenschutzseminar, Bern, 12. Feb. 2010.

Mayer, S., Boschung, M., Fiechtner-Scharrer, A.
Reproducibility assessment for a new neutron dose evaluation system
In: Proc. 3rd European IRPA Congress, IRPA-2010europe, Helsinki, Finland, June 14-18, 2010.

Mayer, S., Hoedlmoser, H., Boschung, M.
Neutronen- und Gammamessungen an einem BE-Behälter
Seminar im Kernkraftwerk Gösgen, Däniken, 29. Okt. 2010.

Mayer, S.
Measurements on and around a spent fuel cask at the nuclear power plant Gösgen
PSI-IRA-Kolloquium, Lausanne, 29. Nov. 2010.

Mayer, S.
Präsentation der Sektion Messwesen
Arbeitskreis Dosimetrie des Fachverbandes für Strahlenschutz, PSI, 12. – 13. Apr. 2010.

Schuler, Ch., Butterweck, G., Wernli, C.
Calibration of instruments for thyroid screening
PSI-IRA-Kolloquium, Lausanne, 29. Nov. 2010.


Cytostatika
Cytostatic drugs
Pro]3-130

◀ **Pharmacist Susanne Geistlich preparing the inactive components of a radiopharmaceutic at PSI's Center for Radiopharmaceutical Sciences.**
(Photo: Scanderbeg Sauer Photography)

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